Global mobile Suppliers Association

Evolution to LTE report

October 26, 2016

4G MARKET and TECHNOLOGY UPDATE

INTRODUCTION

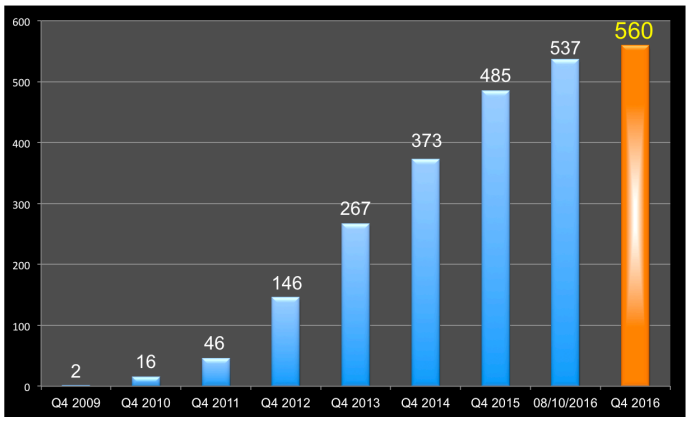
LTE is a global success with 1.453 billion subscriptions by Q2 2016. LTE connects almost 1 in 5 mobile users worldwide (19.5%). New subscriptions signed up during Q2 2016 at an average of 53 million per month. LTE is the fastest developing mobile system technology ever.

LTE is specified by 3GPP as a single global standard for paired and unpaired spectrum users. The vast majority of the standard is the same for FDD & TDD.

GSA's **Evolution to LTE** report provides an independent in-depth status view and analysis of the global 4G/LTE, LTE-Advanced and LTE-Advanced Pro market, supported by facts, and confirms the trends. Information is researched and verified by GSA. This report is updated quarterly and referenced widely by industry and across the whole ecosystem.

In this report:

LTE networks growth globally 2009-2016



Related charts and maps are available together with short topic "Snapshot" reports from www.gsacom.com

LTE Market Status

GSA's Evolution to LTE report – OCTOBER 2016

771 operators investing in LTE in 195 countries

- 744 operator commitments in 190 countries
- 27 pre-commitment trials in 5 more countries

537 commercially launched LTE or LTE-Advanced networks in 170 countries

incl. 80 LTE TDD (TD-LTE) launched in 47 countries

166 launched networks are LTE-Advanced or LTE-Advanced Pro in 76 countries

GSA forecasts 560+ commercially launched LTE networks by end 2016

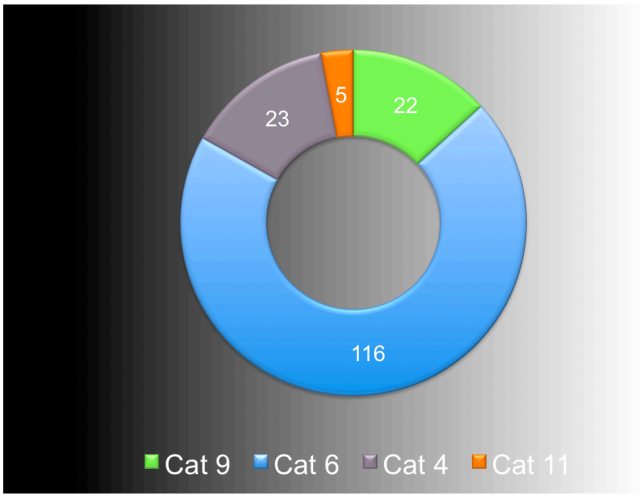
6,504 LTE user devices announced

(GSA – October 10, 2016)

1.453 billion LTE subscriptions globally: Q2 2016

© GSA www.gsacom.com

LTE-Advanced / LTE-Advanced Pro networks



12 operators commercially launched LTE-Advanced Pro networks

158 operators in 72 countries are investing in VoLTE deployments, studies or trials

***93** operators launched VoLTE-HD voice in 52 countries*

254 operators (47.3%) in 111 countries use 1800 MHz in commercial LTE networks

The drive towards LTE, LTE-Advanced and LTE-Advanced Pro for operators is more capacity, performance management and improved efficiencies to lower delivery cost. LTE is a big step in the user experience, enhancing demanding apps such as interactive TV, video blogging, advanced gaming, and professional services. Deployment of LTE-Advanced carrier aggregation technology is the major industry trend, and interest in LTE-Advanced Pro is high.

LTE is a full IP network and harmonizes with other radio access technologies and is the natural evolution choice for GSM/HSPA, CDMA and WiMAX™ operators, enabling a single unifying global standard supporting with TDD & FDD modes.

Spectrum for LTE deployments

Pressure for spectrum is high and operators should deploy the most efficient technologies using paired spectrum where available. LTE can be deployed in existing 2G or 3G bands and/or new bands e.g. 2.6 GHz or digital dividend spectrum (700/800 MHz) for more geographical coverage and improved in-building performance. 2.6 GHz is the capacity band in most regions. There is high interest in refarming 2G spectrum for LTE. 1800 MHz (band 3) is the mainstream choice for LTE in most regions.

700 MHz (bands 12, 13, 14 and 17) and 800 MHz (band 20) are firmly established, according to region, as the main LTE bands arising as the "digital dividend" from the migration of TV broadcasters from analogue to digital transmission. Adoption of the APT700 MHz band plan by over countries across the APAC and Latin America regions and in Europe represents a major opportunity for near-global spectrum harmonization for LTE deployments, paving the way for ensuring the greatest economies of scale for devices and capacity for mobile broadband services, and for roaming. The FDD plan configuration (band 28) has attracted most support. Several mobile networks use APT700 band 28 in commercially launched networks; see later in this report. GSA is not aware of any country or regulator anywhere in the world firmly adopting or recommending allocation of spectrum in the TDD (band 44) arrangement.

In some regions 450 MHz spectrum is attracting interest for rural coverage, and for M2M service applications. LTE450 is commercially launched in a several markets.

LTE radio network products incorporate several features to simplify building and management of next-generation networks. Plug-and-play, self-configuration and self-optimization simplify and reduce network rollout and management cost. LTE is being deployed alongside simplified, IP-based core and transport networks that are easier to build, maintain and introduce services on. The 3GPP core network has also undergone System Architecture Evolution, optimized for packet mode and the IP-Multimedia Subsystem (IMS) to support all access technologies, including fixed access. This allows:

- Improvements in latency, capacity, throughput
- Simplification of the core network, and optimization for IP traffic, services, and growth
- Simplified support and handover to non-3GPP access technologies

The resulting evolved packet system comprizes the core network, evolved packet core (EPC) and radio network. The whole system is often called LTE.

Category 4 (Cat 4) is an evolutionary step, enabling 150 Mbps peak downlink data speed when allocating 20 MHz of LTE transmission bandwidth.

Deployment of **LTE-Advanced** technology is the major industry trend in all regions. Carrier aggregation was the first feature to be commercialised and facilitates higher data throughput rates, more efficient use of spectrum assets for network operators, and an enhanced user experience of mobile broadband. Numerous **LTE-Advanced Pro** trials and deployments have been announced and completed in 2016, ushering in the Gigabit era for enhanced mobile broadband service. **A new report about the status of LTE-Advanced Pro developments will be published by GSA shortly and regularly updated**. **LTE-Advanced Pro** also includes support for the Internet of Things (IoT), including the NB-IoT Low Power Wide Area standard. See GSA's ***The Evolution to Narrow Band Internet of Things*** report for the latest status.

The introduction of HD voice services for LTE users enabled by VoLTE is also developing quickly globally.

Commercialization of LTE Broadcast, enabled by eMBMS technology, continues to progress well.

LTE TDD (TD-LTE) systems

LTE is an open standard developed by 3GPP. The advanced technological performance of LTE came with in-built flexibility to operate in either paired (FDD, or Frequency Division Duplexing, mode) or unpaired (TDD, or Time Division Duplexing mode) spectrum and various channel bandwidths – all with a single technology. Companies from around the globe contributed to the LTE standard and its evolution. The emphasis was always to leverage synergies between the two duplex modes to the largest extent possible. This allows operators to best utilize their current network assets, spectrum allocations and various bandwidth needs, while securing support, choice and economies of scale from the global vendor ecosystem, and limit potential market fragmentation. The result is major commonality of the LTE specifications for the FDD and TDD modes – in fact the vast majority of the LTE standard is identical for both modes, and the huge global success of LTE.

Most current LTE deployments use paired spectrum (FDD). The LTE TDD mode is complementary and the perfect choice for providing high-speed mobile broadband access in unpaired spectrum. Several operators have deployed both the FDD and TDD modes in their networks. LTE TDD also provides a future-proof evolutionary path for TD-SCDMA, another 3GPP standard, as widely deployed in China. LTE TDD is an integral part of the 3GPP standard, implementing a maximum of commonalities with LTE FDD and offering comparable performance characteristics and similar high spectral efficiency.

Within globally assigned IMT bands for mobile services, significant resources are suitable for LTE TDD. LTE TDD has been selected by most WiMAX™ operators as their path to business growth. LTE TDD operator commitments, system maturity and the devices ecosystem are covered in this report.

FOR GSA's LIST OF OPERATORS WORLDWIDE WHO COMMERCIALLY LAUNCHED LTE AND ALL OTHER DEPLOYMENTS AND TRIALS

SEE PAGES 111 – 117

LTE networks, developments global round-up

Americas

USA

On September 21, 2010 regional carrier **MetroPCS** became the 1st US operator to launch LTE, and offered the world's first commercially available LTE handset (Samsung SCH-R900/Craft™). Service launched in Las Vegas, then Dallas/Forth Worth, Detroit, Boston, Sacramento and New York. The Craft was also the first multi-mode CDMA-LTE handset. MetroPCS later merged with T Mobile USA.

Verizon Wireless commercially launched LTE using 2x10 MHz of 700 MHz (band 13) on December 5, 2010. LTE is available to 98% of the population. Verizon also launched LTE in 2x 10 MHz of AWS spectrum and on May 19, 2014 announced its "XLTE" service: compatible user devices select either 700 MHz or AWS spectrum where available.

Verizon Wireless deployed VoLTE and key LTE-Advanced features in 2014. The company has refarmed and brought into commercial use 1900 MHz band 2 spectrum for LTE. LTE-Advanced is available in 461 cities nationwide (August 29th, 2016) utilising 2 carrier (225 Mbps) or 3 carrier (300 Mbps) carrier aggregation leveraging spectrum from band 2, band 4 or band 13, or using all three bands for 300 Mbps.

Verizon Wireless' Advanced Calling 1.0 service with HD voice over LTE (VoLTE and video calling support commercially launched on September 15, 2014. In July 2014 Verizon announced plans to partner with Qualcomm and Ericsson on a supplemental LTE downlink trial in 3.5 GHz spectrum.

Through its "LTE in Rural America" program Verizon is working with partners to collaboratively build and operate an LTE network that covers over 2.6 million people in rural communities over 82,000 square miles by sharing its 700 MHz Upper C block spectrum. The "LTE in Rural America" participants include:

- Appalachian Wireless – Kentucky
- Bluegrass Cellular - Kentucky

- Cellcom – Wisconsin and Michigan
- Chariton Valley – Missouri
- Chat Mobility - Iowa
- Carolina West Wireless - North Carolina
- Convergence Technologies – Indiana
- Copper Valley Telecom - Alaska
- Cross Telephone - Oklahoma
- Custer Telephone Cooperative – Idaho
- KPU - Alaska
- Matanuska Telephone Association – Alaska
- Mid-Rivers Communications - Montana
- MTPCS – Montana, Louisiana, Texas
- NorthwestCell – Missouri
- Pioneer Cellular – Oklahoma
- Sagebrush Cellular (Nemont) – Dakota, Montana
- S and R Communications - Indiana
- Strata Networks – Utah
- Thumb Cellular - Michigan

Verizon Wireless trialled LTE Broadcast (known as LTE Multicast) and showcased the technology at SuperBowl 2014 and Indy 500. At CES 2015 a connected vehicle equipped with Verizon's LTE Multicast technology showed the vehicle hub communicated with an embedded automotive telematics module to receive over the air firmware updates via LTE Multicast. Verizon's Go90 TV application (launched in October 2015) supports LTE Broadcast/Multicasr and several eMBMS-capable devices are promoted on the company's website.

Pioneer Cellular commercially launched LTE service on April 30, 2012.

Cellcom launched commercial LTE service on April 30, 2012 in Green Bay, Sturgeon Bay, Appleton, Oshkosh, Wausau, Oconto and Marinette Counties.

Chariton Valley commercially launched LTE service for CPEs and personal hotspots in September 2012.

Bluegrass Cellular commercially launched LTE on November 5, 2012 covering 348,000 population. On May 3, 2016 it was announced that Bluegrass is deploying XLTE technology (LTE-Advanced carrier aggregation of band 13 and AWS spectrum).

Sprocket Wireless (Cross Telephone) commercially launched its first phase of 4G LTE service including portions of the Muskogee and Pittsburg counties in Eastern Oklahoma on November 9th, 2012.

Strata Networks commercially launched service on November 19, 2012.

Thumb Cellular commercially launched 700 MHz LTE service on January 13, 2013.

KPU Telecommunications (Alaska) i.e. Ketchikan Public Utilities leases a 22 MHz spectrum block from Verizon Wireless and commercially launched its LTE network for data users on May 5th, 2014. **KPU** launched VoLTE in 2015.

Chat Mobility commercially launched LTE service on May 23, 2013.

Appalachian Wireless commercially launched its LTE service on June 10, 2013.

Matanuska Telephone Association (MTA) commercially launched LTE service in mid-2013.

Custer Telephone Cooperative commercially launched 4G LTE service on July 26, 2013.

Copper Valley Telecom commercially launched service on September 30, 2013 in Valdez, Prince William Sound, and Cordova.

S and R Communications commercially launched in Indiana on November 17, 2013.

Mid-Rivers Communications commercially launched LTE service on December 9, 2013 in 12 communities across the eastern half of Montana.

NorthwestCell commercially launched LTE on May 13, 2013.

Carolina West Wireless commercially launched 4G/LTE on November 3, 2014.

AT&T Mobility commercially launched LTE on September 18, 2011 in 700 MHz (band 17) in Atlanta, Chicago, Dallas, Houston and San Antonio. AT&T plans to close its GSM network by 2017 latest and re-farm the band to support its 3G and 4G networks. 1900 MHz band 2 was introduced in some regions since by end 2013. In January 2013 AT&T

announced plans to pay Verizon Wireless US$ 1.9 billion for 700 MHz B band spectrum covering 42 million people in 18 states, plus AWS spectrum in markets including Phoenix, Los Angeles, Fresno, and Portland. This spectrum is earmarked for LTE. AT&T launched LTE-Advanced in Chicago in March 2014, using carrier aggregation of 700 MHz and AWS spectrum (110 Mbps peak downlink speed assumed).

VoLTE was commercially launched on May 23, 2014 in Illinois, Indiana, Minnesota and Wisconsin and has since been extended. At end December 2015 AT&T stated said VoLTE service covered more than 295 million people.

AT&T trialled LTE Multicast (LTE Broadcast) technology including at the Ohio State Buckeyes v. Oregon Ducks College Football National Championship in Arlington, Texas, January 12, 2015.

In December 2013 **AT&T** announced LTE roaming with **Rogers Communications** (Canada) and **EE** (UK). Many more partners are now offered.

In April 2014 AT&T announced plans to use its 2.3 GHz WCS C and D block spectrum for the air to ground component of LTE-based in-flight connectivity services for airlines and passengers within the United States, subject to FCC approval.
FCC filing http://apps.fcc.gov/ecfs/comment/view?id=6018260948

AT&T started to deploy LTE in its 2.3 GHz WCS (Wireless Communications Service) spectrum in 2015 to support extra capacity requirements in main population centres and urban areas. WCS is in the 2305-2320 and 2345-2360 MHz range. AT&T is a major holder of WCS spectrum. 3GPP standardized band 30 to accommodate this range.

The AT&T LTE network uses bands 2, 4, 5, 17 and 30. AT&T is currently deploying 3C CA

T-Mobile USA commercially launched LTE on March 26, 2013 in AWS spectrum. With the MetroPCS merger completed the new single company trades as **T Mobile US**, and *MetroPCS* continues in the market as a brand operated by T Mobile US. VoLTE was commercially launched with HD voice on May 22, 2014 initially in Seattle and across its whole network within 2 months. T-Mobile has launched Enhanced Voice Service (EVS) for VoLTE users.

T Mobile allocates different amounts of spectrum for LTE service in different markets. Spectrum totaling 20 MHz paired was deployed in parts of North Dallas in late 2013. T-Mobile re-farmed most of the 1900 MHz PCS spectrum used in its EDGE network for LTE by mid 2015. The company also brought into service in Q4 2014 700 MHz A block spectrum (band 13) acquired from Verizon Wireless and others (Actel and I-700 A Block LLC). Band 12 spectrum was brought into commercial use in 2015 using carrier aggregation with the AWS band. By early September 2016 the company had widely deployed 3C CA, 4x4 MIMO, 256QAM (downlink) and 64QAM (uplink) LTE-Advanced technologies to deliver theoretical peak downlink speeds up to 400 Mbps. The 3C CA solution combines spectrum in bands B2, B4 and B12.

MiSpot, a subsidiary of **Agri-Valley Communication**, commercially launched 700 MHz LTE service on March 14, 2013 in 37 counties in northern and central Michigan.

Adams NetWorks (western Illinois) commercially launched fixed broadband LTE service in band 17 C block spectrum in May 2013.

Big River Broadband (SE Missouri) commercially launched LTE in AWS spectrum on August 7, 2012.

Bay Area Regional Interoperable Communications System (BayRICS) vision was established by the 10 Bay Area Counties and 3 core cities, San Francisco, Oakland, and San Jose in 2006 through the creation of a strategic plan with the goal of providing voice and data interoperability throughout the Bay Area region. BayRICS is a state of the art communications system-of-systems. Bay Area Wireless Enhanced Broadband (BayWEB) is the broadband component of BayRICS which has acquired 700 MHz in which an LTE-based public safety system is intended to be deployed. In April 2011, the first public-safety LTE pilot network in the San Francisco Bay Area was tested. These tests were commissioned by the East Bay Communications System Authority, which oversaw the pilot LTE network deployment.

BendBroadband was the first carrier in Central Oregon to offer commercial LTE service but later sold its 700 MHz Block B and AWS spectrum to AT&T and exited the wireless market. BendBroadband discontinued its LTE service as of July 25, 2014.

C Spire Wireless holds 700 MHz band 12 spectrum for most of Mississippi, Tennessee and Alabama and commercially launched LTE service on September 10, 2012 in McComb, Brookhaven, Meridian and Greenville. Due to limited device support for band 12, C Spire initially used band 25 (1850 – 1915 / 1930 - 1995 MHz) for LTE. 700 MHz and 850 MHz was deployed in the network from 2016. VoLTE is planned.

CenturyLink plans to deploy LTE in 700 MHz, after spending USD 149 million in the 700 MHz auction on 69 A and B block concessions.

Colorado Valley Communications (Texas), a member of the NetAmerica Alliance, commercially launched LTE service in 700 MHz band 12 in December 2013 in Ellinger, Fayetteville, Flatonia, La Grange, Schulenburg and Weimar.

Country Wireless is deploying a 100 Mbps LTE TDE network in Wisconsin using 3.65 – 3.7 GHz spectrum, and will use LTE-Advanced 4x4 MIMO technology.

Enhanced Telecommunications Corporation (ETC) commercially launched 4G LTE using 700 MHz in August 2013, initially serving Decatur and Ripley counties. Coverage now includes Jefferson, Jennings, Ohio, Scott and Switzerland counties.

Leap Wireless' **Cricket** subsidiary commercially launched LTE on December 21, 2011 in Tucson in AWS spectrum. On July 12, 2013 AT&T Mobility announced plans to acquire Leap Wireless. FCC approval was secured in March 2014. On March 13, 2014 AT&T announced that the company had closed its acquisition of Leap Wireless and is in the process of integrating Cricket into AT&T's operations. The new Cricket is an independently operated, wholly owned subsidiary of AT&T.

Great Northwest Woods Wireless is deploying an LTE network in 2016 to offer services on a wholesale basis to other carriers.

Syringa Wireless (Eastern Idaho) commercially launched LTE service in October 2013.

CDMA operator **Alaska Communications (ACS)** commercially launched LTE on October 12, 2012 in Anchorage, Fairbanks and Juneau in AWS spectrum.

Alaska Communications and **General Communication, Inc. (GCI)** announced on July 23, 2013 that the companies had completed the transaction to form **The Alaska Wireless Network, LLC ("AWN").** AWN provides the latest wireless services, including LTE, to its owners Alaska Communications and GCI, intended to independently sell these services to their respective retail customers and continue to operate as competitors in Alaska. In December 2014 **Alaska Communications** announced it would sell its wireless subscriber base and interest in AWN to **GCI**.

CDMA operator **Nex-Tech Wireless** commercially launched LTE on November 27, 2013 using 700 MHz B Block spectrum (band 12) acquired in May 2012.

Sprint commercially launched LTE FDD service on July 15, 2012 in 10 MHz of existing 1900 MHz spectrum (band 25) in 15 cities: Atlanta, Athens, Calhoun, Carrollton, Newnan and Rome, Ga.; Dallas, Fort Worth, Granbury-Hood County, Houston, Huntsville, San Antonio and Waco, Texas; and St. Joseph and Kansas City, Mo.. Following its buyout of **Clearwire**, **Sprint** additionally commercially launched LTE TDD service in band 41 on July 19, 2013. Sprint stopped selling WiMAX™ service after 2012 and deployed LTE-Advanced technology in 800 MHz (ESMR/iDEN spectrum) from 2013 using 3GPP Release 10 in a 10x10 configuration. iDEN service closed in 2013. The Sprint LTE Plus service using LTE-Advanced carrier aggregation i.e. 40 MHz of TDD band 41 spectrum was launched on March 17, 2014 and delivered peak theoretical speeds of more than 160 Mbps. In October 2016 Sprint reported having over 250 LTE Plus markets in commercial use.

On March 15, 2016 **Sprint** announced more than 300 Mbps downlink speed had been achieved in its 3-channel carrier aggregation tests. Commercial 3C CA using 60 MHz of band 41 spectrum (3 x 20 Mhz carriers) was launched in August 2016, initially in Kansas City extending today to Chicago, San Francisco, Minneapolis, Dallas, Denver, Cleveland, and Columbus. The company said that these deployments will provide peak download speeds of over 200 Mbps on capable devices when available.

It was reported in 2014 that **Sprint,** together with its infrastructure vendor, had demonstrated 2.6 Gbps

throughput over a single sector by aggregating 120 MHz of TDD spectrum. VoLTE is in deployment.

Sprint negotiated rural LTE roaming partners including:

All West Wireless (Wyoming and Utah)
Bluegrass Cellular (Kentucky)
Blue Wireless (New York and Pennsylvania)
Breakaway Wireless (Utah)
Carolina West Wireless
C Spire Wireless
CTC Telecom (Idaho)
Custer Telephone Wireless (Idaho)
Flat Wireless d.b.a Clear Talk
Illinois Valley Cellular
Inland Cellular
James Valley Telecommunications
Nex-Tech Wireless (Kansas, Colorado)
NNTC (Colorado)
nTelos
Pine Belt Wireless (Alabama)
Pioneer Cellular (Oklahoma and Kansas)
Phoenix Wireless
Public Service Wireless (Alabama and Georgia)
SI Wireless / Mobile Nation
Silver Star Wireless (Wyoming and Idaho)
Snake River PCS (Oregon)
South Central Communications (Utah)
SouthernLINC Wireless
Strata Networks (Utah, Wyoming and Colorado)
Syringa Wireless (Idaho)
VTel Wireless

Shenandoah Telecommunications (**Shentel**), wholesale partner affiliate of Sprint, has access to Sprint 800 and 1900 MHz spectrum in return for building a compatible LTE network. **Shentel** launched commercial LTE service on November 23, 2012 in Maryland, Pennsylvania, Virginia and West Virginia. In May 2013 Shentel confirmed its LTE coverage had reached 75% of its network footprint.

As part of a $32.1 million stimulus grant, **Commnet Wireless, LLC** (subsidiary of Atlantic Tele-Network Inc.) will develop and operate an LTE network in the Navajo Nation. The grant, plus partial matching funds, will provide broadband infrastructure access to the Navajo Nation across Arizona, New Mexico and Utah, enabling fixed and mobile service for over 30,000 households (c.135,000 people) and 1,000 businesses in 15 of the largest communities in the Navajo Nation, including Window Rock, Shiprock, Kayenta, Chinle, and Tuba City. The project will also provide high-capacity connectivity on the combined middle-mile backbone to 49 more tribal communities. Atlantic Tele-Network was the subject of a takeover by AT&T Mobility which completed in September 2013.

Satellite TV provider **DISH Network** applied to the FCC in August 2011 for approval to deploy LTE-Advanced in S-band Mobile Satellite Services (MSS) spectrum bought from TerreStar, adding to spectrum acquired from the purchase of satellite company DBSD North America, for a total of 40 MHz (2000-2020 MHz and 2180-2200 MHz). This spectrum is now known as AWS-4. FCC granted formal approval to DISH on December 11, 2012 subject to specific power level restrictions to avoid interference to the adjacent AWS-H spectrum. AWS-H spectrum comprises 1915–1920 MHz (uplink) and 1995–2000 MHz (downlink), and is adjacent to the PCS-G spectrum occupied by Sprint. DISH acquired all 176 H block licences auctioned (Auction 96) by FCC in February 2014 after more than a month of bidding.

DISH trialled fixed wireless broadband LTE TDD service in Corpus Christi using 2.5 GHz BRS and EBS spectrum (2496-2690 MHz i.e. band 41). DISH provides service as an MVNO on Sprint's network.

SI Wireless/Mobile Nation commercially launched LTE in September 2014.

Silver Star Communications commercially launched LTE using band 12 spectrum on November 24, 2014.

Illinois Valley Cellular is preparing to launch LTE service, understood to be in band 12, for the 250,000+ population in its service area, via a partnership with a network host provider.

iWireless, a partnership between T-Mobile USA and Iowa Network Services (INS) serving Iowa, eastern Nebraska and western Illinois, commercially launched LTE with almost 300 sites in AWS band 4 spectrum on 15th December 2015. An additional 100 sites are planned to be built in 2016. Nationwide roaming has been achieved by a partnership with T-Mobile.

Greenfield operator **Lightsquared** planned to deploy the first US wholesale-only LTE network, and

selected its infrastructure supplier for deployment using 46 MHz in the range 1.4 to 1.6 GHz (mostly in L-Band). However the company first had to work through major regulatory obstacles because the FCC ruled that its proposed operating frequency interferes with GPS and aircraft flight safety systems. Lightsquared filed for bankruptcy in May 2012 in order to try to continue operations, keeping control over its Chapter 11 status as the company tried to emerge from bankruptcy, which it did in December 2015 and at that time settled a remaining lawsuit clearing the way for deployment of its network.

Rural CDMA operator **Mosaic Telecom** (NW Wisconsin) holds 700 MHz and AWS spectrum and commercially launched LTE service in July 2011.

NetAmerica Alliance LLC aims to help bring LTE mobile broadband services to 700 MHz and AWS spectrum holders for consumers and businesses in smaller markets and rural areas, under the service brand Bonfire™. NetAmerica joins forces with rural independent license holders deploying new converged 4G mobile/fixed networks and provide them with business and network services including combined buying power, nationwide branding, 24x7 network monitoring, core networking elements, apps development and other key services. www.netAmericaAlliance.com

Network operators **Etex Telephone Cooperative, Panhandle Telephone Cooperative, Peoples Telephone Cooperative**, and **S&T Telephone Cooperative/Communications** committed to LTE network deployments and joined NetAmerica Alliance. On October 26, 2011, NetAmerica Alliance announced a live LTE pilot network for members to use to develop, test and refine operating methodologies prior to turn-up of service.

Flat Wireless, LLC, d.b.a **Clear Talk**, providing wireless telecommunication services in West Texas, also joined the Alliance. In 2013 the company bought 10 lower 700 MHz B-block licenses from Verizon Wireless. Flat Wireless doing business as Clear Talk commercially launched at end November 2013 using AWS-1 i.e. band 4 spectrum. 1900 MHz spectrum is used in one market.

Peoples Telephone Cooperative commercially launched LTE in rural Texas on February 14, 2012 replacing its WiMAX™ system with LTE in 700 MHz.

Panhandle (PTCI) has spectrum in 6 counties covering 45,000 people in 20,000 households over 7,500 square miles and commercially launched LTE in March 2012 in rural Oklahoma with a network of 45 towers covering 5,000 square miles and 30,000 population.

Buggs Island Telephone Cooperative (BIT Communications) joined NetAmerica Alliance on January 6, 2014 and is deploying an LTE network using 700 MHz C band. On September 9, 2014 NetAmerica Alliance, LLC announced that **BIT Communications** commercially launched LTE broadband service with 9 live sites using the NetAmerica Alliance service brand, Bonfire™.

Immix Wireless, which serves Pennsylvania, is building an LTE network in 700 MHz spectrum.

Union Wireless, serving Wyoming and adjacent areas of northwest Colorado and northeast Utah, is deploying an LTE network.

O2 Secure Wireless, an Internet communications company, has embarked on phase one of its LTE network strategy. The company plans to provide coverage to over 500,000 customers in under-served or unserved markets in Florida, Kentucky, Mississippi, Alabama, North Carolina, and South Carolina.

Public Service Wireless is deploying a 700 MHz LTE network in central and southwest Georgia.

SRT Communications (North Dakota) is committed to introducing LTE service. NewCore Wireless will host SRT's LTE network.

Nortex Communications commercially launched LTE using 700 MHz band 17 in September 2012 in a 2-county area of Texas.

South Georgia Regional Information Technology Authority is deploying a 700MHz LTE system.

WiMAX™ operator **SpeedConnect** commercially launched LTE TDD in the Quad Cities using band 41 spectrum on May 19, 2015.

Infrastructure Networks, a Houston-based provider of broadband wireless networks to critical infrastructure industries, commercially launched LTE service in the Permian Basin area of West Texas on July 25, 2012 using 700 MHz.

Former CDMA operator **Rock Wireless** commercially launched LTE using 700 MHz band 12 spectrum on October 23, 2014 serving the Standing Rock Sioux Reservation in remote parts of the Dakotas region.

Texas Energy Network (TEN) committed to deploy an LTE network targeting the oil and gas industries beginning with the Eagle Ford Shale region.

Evolve Broadband (Texas) commercially launched LTE in 700 MHz band 17 in February 2013. VoLTE is launched.

CDMA operator **United Wireless** commercially launched BWA LTE service using 700 MHz band 12 on April 9, 2013. Support for LTE mobile phones was introduced on May 12, 2014.

Redzone Wireless launched an LTE-Advanced TDD network in Portland, Waterville and Great Diamond Island on June 3, 2015 leasing band 41 spectrum from Univ. of Maine (GSA's assumption 100 Mbps).

Rise Broadband is planning to deploy broadband fixed LTE in rural and suburban areas of Idaho, Illinois, Iowa, Nebraska, Oklahoma and Texas. The LTE equipment that Rise uses currently operates in the 3.65 GHz "lightly licensed" band and in the 2.5 GHz licensed band. Rise has 16 licences in the 2.5 GHz band and continues to acquire more 2.5 GHz spectrum. Their LTE equipment will be able to operate in the 3.55 GHz to 3.65 GHz band (sometimes known as citizens broadband radio service - CBRS) that the FCC has moved to free up for broadband wireless use on a shared basis with the Department of Defense.

US Cellular in partnership with King Street Wireless commercially launched 700 MHz LTE on March 22, 2012 in selected cities in Iowa, Maine, North Carolina, Oklahoma, Texas and Wisconsin. VoLTE is being trialled in 3 markets since Q4 2015.

VTel Wireless commercially launched LTE in rural Vermont on July 1, 2014. 700 MHz (band 17) and AWS (band 4) are used. Spectrum owned within BRS band 41 (2496 MHz - 2690 MHz) will be used later. VTel Wireless said it is the first 4G/LTE-only network in the USA. Vtel is also deploying VoLTE. By mid-2015, VTel planned to cover 95% of Vermont households with 180 sites.

West Central Wireless, subsidiary of Central Texas Telephone Cooperative, commercially launched LTE 700 MHz (band 17) in 2015 (E) for fixed wireless services.

US CDMA regional operator **Penasco Valley Telecommunications (PVT)** commercially launched LTE under the Fuego Wireless brand using 700 MHz band 12 spectrum on May 17, 2013.

CDMA operator **nTelos Wireless**, which serves Kentucky, Maryland, North Carolina, Ohio, Virginia, and West Virginia commercially launched LTE service in selected areas using band 2 spectrum in late December 2013. nTelos Wireless also owns spectrum in band 41. Sprint and nTelos have a network sharing agreement until 2022.

Shentel acquired nTelos in a deal closed on May 9, 2016.

On September 10, 2013 IDEN™ operator **SouthernLINC** announced plans to build a mission critical regional LTE data services network for Southern Company electric utilities. Construction started in 2015. The network should be fully operational by 2018.

On January 25, 2011 the **FCC** mandated LTE for first responders (public safety communications). Mandating of a single technology by the FCC was unprecedented. The Order and FNPRM requires all 700 MHz public safety mobile broadband networks to use a common air interface, specifically LTE, to support roaming and interoperable communications.

The **City of Charlotte Council** awarded a contract in October 2011 for an LTE Public Safety Network in the dedicated Public Safety 700 MHz band.

On April 26, 2012 two key members of the House Energy and Commerce Committee's Subcommittee on Communications and Technology - Congressman

Cliff Stearns and Congresswoman Doris Matsui, introduced a bill (H.R 4817) calling for re-purposing and pairing of the 1755-1850 MHz band with the internationally harmonized 2155 – 2180 MHz band (FCC's AWS-3). H.R. 4817 would require pairing and auction within three years of February 22, 2012. The President would be required to clear 1755-1780 MHz within 5 years unless it could be shown that relocation of a particular government assignment is not possible "without jeopardizing essential military capability." The auction, known as Auction 97, started November 13, 2014 with a USD 10.5 billion reserve. 1,614 licenses were offered on a geographic area basis to 70 prequalified bidders. Bidding went much higher than expected. The AWS-3 auction closed on January 29, 2015. The total of spectrum bids reaching USD 44,899,451,600.

PUBLIC SAFETY – Band 14 (788-798/758-768 MHz)

- **Las Vegas Metropolitan Police Department** (LVMPD) trialling LTE in band 14.
- **Miami-Dade police** trialling LTE in band 14

The Iowa Statewide Interoperable Communications System Board (**ISICSB**) issued a request for proposals (RFP) for industry-funded, LTE public safety broadband network proof-of-concept demonstrations (LTE PSBND), to educate public safety and officials at federal, state, county, local, and tribal levels about LTE statewide public safety wireless communications systems. Proposals were requested by June 19, with Iowa State planning to award a contract running July 1, 2012-June 30, 2013.

The FCC adopted revised rules to enable Wireless Communications Service (WCS) licensees' to use up to 30 MHz of underutilized 2.3 GHz spectrum for wireless broadband services. 20 MHz may be used for mobile broadband, leaving 10 MHz for fixed broadband, which in future may be used as a downlink path for mobile broadband users.

The FCC started the 600 MHz broadcast TV spectrum incentive auctions on May 31, 2016. There were 62 qualified bidders. The first part was cleared in July 2016. TV broadcasters agreed to free 126 MHz of their spectrum for 86.4 billion USD. Allowing for auction and related costs, sale of the frequencies must generate 88.4 billion USD. In Stage 2 of the auction the FCC reduced the bandwidth amount to 114 MHz which was repackaged to 90 MHz of clean spectrum for auctioning. At the time of writing Stage 2 of the auction had completed with bids totalling only around 21.5 billion USD. Stage 3 and further phases will follow.

Canada

Rogers Wireless commercially launched LTE service in AWS spectrum on July 7, 2011 in Ottawa. In April 2013 the company said it would be first to launch service on its 2.6 GHz LTE spectrum. 2.6 GHz is little used in Canada, and is facilitated by Rogers and Bell in their partnership company **Inukshuk Wireless** which built a network using pre-WiMAX© technology but was later shelved. Rogers statement: "The Rogers LTE 2600 MHz bandwidth is in all markets where we offer LTE AWS 2100." In May 2013 Rogers launched its dual-band AWS/2.6 GHz LTE network as "LTE Max". 700 MHz was brought into commercial use in Calgary, Toronto and Vancouver in April 2014 following the auction (see below). LTE-Advanced was commercially launched in 12 markets on October 24, 2014 using carrier aggregation. On January 26, 2015 Rogers announced launch of 225 Mbps LTE-Advanced in Guelph, Toronto, Vancouver and Victoria, with further rollouts planned. Carrier aggregation is used to combine 10 MHz of 2.1 GHz (band 4 AWS) and 20 MHz of 2.6 GHz (band 7) spectrum. VoLTE HD voice service was commercially launched across Canada on March 31, 2015.

Bell Mobility commercially launched LTE in Toronto, Mississauga, Hamilton, Kitchener-Waterloo and Guelph on September 14, 2011. 150 Mbps downlink (peak) was enabled in some locations with 2.6 GHz band 7 spectrum from 2012. Users outside LTE coverage use DC-HSPA+ or HSPA+. Following acquisition of 700 MHz Lower C block spectrum, Bell also uses 700 MHz since April 2014. Bell additionally commercially launched LTE TDD fixed wireless Internet service in some areas on October 1, 2014 using 3.5 GHz (band 42) spectrum. LTE service extends to remote Northwest Territories communities via satellite links.

In February 2015, **Bell Mobility** launched LTE-Advanced supporting theoretical 220 Mbps LTE-downlink speed using a combination of Band 7, Band 4 and Band 2. In August 2015 **Bell Mobility** announced the commercial launch of tri-band LTE-

Advanced service (believed to be using bands 4, 7 and 17) with a theoretical peak downlink speed of 335 Mbps in selected communities. VoLTE was soft-launched in February 2016 in parts of the network.

EastLink simultaneously commercially launched HSPA+ and LTE services using 2.1 GHz spectrum (AWS) on February 15, 2013. Eastlink launched VoLTE on June 1, 2016 in Timmins.

Telus commercially launched LTE on February 10, 2012 using AWS spectrum. The company website (January 2016) indicates peak downlink speed up to 225 Mbps with LTE-Advanced. In April 2014 Telus commercially launched LTE TDD service in Quebec (3.5 GHz band 42), British Columbia and Alberta (2.3 GHz band 40). Telus acquired CDMA operator **Public Mobile** and plans to use its 1900 MHz G-block spectrum. Public Mobile was subsequently relaunched by Telus as an MVNO. Telus launched VoLTE for some users in April 2016. On October 4, 2016 Telus announced the first site had been upgraded to LTE-Advanced Pro technology, with more sites coming in the next few weeks.

MTS Allstream commercially launched LTE on September 25, 2012 in Manitoba. Coverage is also provided in Winnipeg and Brandon. On June 13, 2013 **MTS** and **Rogers Wireless** announced an LTE network sharing agreement in Manitoba.

SaskTel commercially launched LTE on January 31, 2013 in band 4 in Regina, Saskatoon, Clavet, Dundurn, Langham, Lumsden, Martensville, Osler, Pense, Vanscoy, Warman and White City. In 2013 coverage expanded to Dalmeny, Balgonie, Estevan, Moose Jaw, North Battleford, Prince Albert, Swift Current, Weyburn and Yorkton; future phases being dependent on success in the 700 MHz auction (see below). Sasktel won one block of 700 MHz spectrum at the auction in the C1 band.

VoLTE is being deployed. Sasktel ran an LTE TDD trial to help determine the feasibility of wireless broadband and voice services in predominantly rural locations. On September 23, 2013 SaskTel announced commercial launch of its High Speed Fusion Internet Service in band 41. EV-DO service has closed and 850 MHz is being refarmed for LTE.

ABC Communications commercially launched LTE TDD in British Columbia using 3.5 GHz on April 23, 2014 according to information provided to GSA by the operator, who advised that coverage is commercially available in a specific geographic region around the community of Quesnel at its first rollout stage.

WiMAX™ operator **CCI Wireless** offers broadband high speed internet to rural Alberta and commercially launched an LTE TDD network in December 2014 using 3.5 GHz band 42.

Tbaytel commercially launched band 7 LTE in the Thunder Bay area on March 23rd, 2015.

Rural ISP **Core Broadband** is deploying LTE for fixed wireless broadband in Muskoka, Ontario.

Wind Mobile was deploying an LTE network using AWS spectrum initially in Vancouver for commercial launch in 2016. Its parent company was bought by **Shaw Communications** effective on 1 March 2016.

In May 2013 Videotron announced an agreement with **Rogers Wireless** to jointly deploy an LTE network in Quebec and Ottawa. **Videotron** commercially launched 150 Mbps LTE using AWS spectrum in Quebec on September 10, 2014. Videotron may sell unused AWS spectrum in the Greater Toronto area to Rogers, subject to regulatory approval.

Rural WiMAX™ operator **Xplornet Communications** announced on December 8, 2011 completion of LTE TDD tests in 2.6 GHz and 3.5 GHz bands. The trials demonstrated a seamless LTE TDD option over existing WiMAX infrastructure, offering a smooth migration path from WiMAX™ to LTE TDD. The 3.5 GHz trial used the same band that Xplornet uses for WiMAX™. Xplornet is deploying an LTE fixed-wireless network and will activate two state of the art next generation satellites in 2016 with the aim of making 25 Mbps broadband service available at affordable prices to 100% of Canadian homes and businesses outside of the big urban cities. Commercial LTE TDD service was launched on December 3, 2014 initially in New Brunswick. Regulatory approval has been given for transfer of 81 2.3 GHz licences from NextWave to Xplornet.

Toronto-area ISP **Iristel** is deploying an LTE network.

Quebec regional operator **ICE Wireless** is deploying an LTE network.

Industry Canada started an auction of 700 MHz, aligning with US band plan, on January 14, 2014. 97 licences were auctioned raising almost USD 5 billion. Spectrum came into use from mid-April 2014.
Results: http://news.gc.ca/web/article-en.do?nid=816869

Three auctions were held in 2015. The first was for licences for Advanced Wireless Services in the bands 1755-1780 MHz and 2155-2180 MHz (AWS-3); this is adjacent to the existing AWS band. The list of 10 qualified bidders was announced on February 13, 2015. Sealed bids were required by March 3, 2015. Rogers didn't participate in the bidding. Results were announced March 6, 2015 raising C$2.11 billion.

- WIND acquired spectrum in British Columbia, Alberta and Ontario
- Eastlink acquired spectrum in Newfoundland and Labrador, Nova Scotia, New Brunswick, Prince Edward Island and Northern Ontario
- Videotron acquired spectrum in Quebec and Eastern Ontario
- TELUS acquired spectrum in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and Quebec
- Bell acquired spectrum in Newfoundland and Labrador, Nova Scotia, Prince Edward Island, New Brunswick, Northern Quebec, Ontario, Nunavut, Northwest Territories and Yukon

An auction of BRS spectrum (2500–2690 MHz, 3GPP band 7) and ended May 5, 2015, with over 300 blocks raising C$ 755 million. The winning companies were:

- Bell Mobility Inc.
- Bragg Communications Inc.
- Corridor Communications Inc.
- MTS Inc.
- Rogers Communications Partnership
- TBayTel
- TELUS Communications Company
- Vidéotron s.e.n.c.
- Xplornet Communications Inc.

http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11030.html

The third auction, of unallocated spectrum from the recent 700 MHz and AWS auctions, concluded in September 2015. AWS blocks were sold. Leftover 700 MHz spectrum was unsold.

Antigua and Barbuda

Digicel commercially launched fixed LTE service in 700 MHz (band 17) on November 6, 2012.

FLOW (formerly LIME) commercially launched LTE using AWS spectrum (band 4) on November 20, 2014.

Argentina

Personal commercially launched LTE in AWS band on December 19, 2014 in Buenos Aires, Córdoba and Rosario. 84 sites were operational at launch. All major cities were due to be covered by mid-2016. VoLTE and ViLTE are in deployment.

Movistar commercially launched LTE service on December 22, 2014 using AWS spectrum in parts of Buenos Aires. By May 2016 coverage reached 68% of population. A carrier aggregation trial combining spectrum in AWS and APT700 bands achieved 134 Mbps downlink speed in a laboratory environment. A subsequent trial using commercially available terminals achieved 288 Mbps.

VoLTE is in test mode in preparation for service launch in 2016.

Claro commercially launched LTE in June 2015 using 1720-1730 MHz and 2120-2130 MHz, within band 4. At launch LTE was available in Buenos Aires, Mendoza, Cordoba and Rosario. By end of 2015 coverage was planned to reach Mar del Plata, Salta, Santiago del Estero, Bariloche, Neuquen, San Luis, San Juan, Formosa, Resistance, Comodoro Rivadavia, La Rioja, Tucumán, Santa Fe, Posadas, Paraná, Jujuy, Corrientes and Bahia Blanca.

DirecTV commercially launched LTE TDD in 2013 in band 43.

Regulator SECOM announced on September 5, 2012 it would allocate to state-owned operator **Arsat** all the 850 MHz and 1900 MHz spectrum returned by Movistar when parent Telefonica bought some of the assets of former operator Movicom from Bell South.

The government announced an auction of 120 MHz of AWS and 90 MHz of APT700 spectrum for 4G/LTE deployments on October 31, 2014. Claro Argentina, Telecom Personal, Movistar, and Arlink (Grupo Uno) obtained documentation. The results were announced on November 3, 2014 with bids totaling 2.23 billion USD for 3G and 4G spectrum.

- **Claro** gained 10 MHz paired AWS
- **Movistar** gained 10 MHz paired AWS
- **Personal** gained 15 MHz paired AWS

Movistar and **Airlink** were each awarded 2 x 10 MHz of APT700 spectrum.

Aruba

Setar NV commercially launched LTE1800 on November 6, 2013.

Bahamas

On August 13, 2012 the Utilities Regulation and Competition Authority (URCA) awarded a 700 MHz license (24 MHz) to **BTC** who commercially launched LTE on February 13, 2014.

Cable TV operator **Cable Bahamas Limited (CBL)** received the 2nd mobile license through an auction in October 2015.

Belize

SpeedNet Communications (Smart Telecom) commercially launched LTE on December 15, 2015 in Belize City.

BTL (Digicell) is deploying an LTE network targeting service launch in 2016.

Bermuda

CellOne commercially launched LTE in Hamilton on May 20, 2016 using band 5 spectrum.

Fixed telecoms operator **North Rock Communications** requested an LTE license. Later the company merged with another ISP, **Logic**. Logic and CellOne merged as one company in 2016.

Digicel is deploying an LTE network for 2016 launch.

Bolivia

Entel Movil commercially launched a USB modem-based post-paid LTE service on December 16, 2012 in La Paz, Cochabamba and Santa Cruz in 700 MHz.

Tigo acquired 2 x 12 MHz of 700 MHz for LTE and also acquired spectrum in 1900 MHz and AWS bands in 2013. **Tigo** commercially launched LTE in 700 MHz on July 17, 2014 in 7 capital cities. By June 2015 coverage had been extended to 26 cities including at least 1 city in each of the country's 11 Departments.

NuevaTel PCS (Viva) commercially launched LTE service using AWS band 4 on July 24, 2015.

Bonaire

UTS (Chippie) commercially launched LTE1800 on June 17, 2015.

Telbo (Kla) **(**Telefonia Bonairiano NV**)** commercially launched LTE1800 on June 19, 2015.

Brazil

The auction of 2.6 GHz LTE spectrum by regulator Anatel was concluded on June 12, 2012 with the winners being (2 x 20 MHz MHz), **Claro** (2 x 20 MHz), **TIM** (2 x 10 MHz) and **Oi** (2 x 10 MHz). As no separate bids for 450 MHz spectrum were made, regulator Anatel bundled the unsold channels with the new 2.6 GHz concessions. The auction included spectrum suitable for TDD deployments, acquired by **Sky Brasil Servicos** and **Sunrise Telecomunicacoes**, the latter for Sao Paulo state.

Sky Brasil Servicos commercially launched 2.6 GHz LTE TDD (band 38) in Brasilia on December 13, 2011. 85 municipalities were covered by May 2015.

Sunrise changed its name to **On Telecomunicacoes** and commercially launched 2.6 GHz LTE TDD service in band 38 in Itatiba, Louveira, Valinhos and Vinhedo in March 2013 and has since been extended to cover several cities in Sao Paulo state.

Claro commercially launched LTE FDD service on December 13, 2012 in Recife, Campos do Jordao, Buzios and Parat, using 2.6 GHz spectrum. Service was opened in Curitiba on January 29, 2013 and

Porto Alegre on March 7, 2013. 1800 MHz was introduced into the LTE network later. Claro successfully tested 300 Mbps LTE-Advanced technology by adding APT700 band 28 spectrum.

Claro commercially introduced 700 MHz in Rio Verde on June 15, 2016, simulatenously launching 3C CA in the city (Bands 3, 7 and 28)

Claro and **NET** – part of America Móvil group – were the first operators in Brazil to showcase the potential of LTE Broadcast. The trial took place at the biggest tennis tournament of South America, the Rio Open, February 15 – 21, 2016 in Rio de Janeiro.

Oi commercially launched LTE on April 25, 2013 in Rio de Janeiro. **Oi** and **Portugal Telecom** are merging. Oi plans to deploy an LTE450 network in rural areas (see section *LTE: 450 MHz band* below).

TIM commercially launched LTE on April 30, 2013 in Confederations Cup venues. **TIM** and **Oi** shared LTE network infrastructure in cities hosting the Confederations Cup matches.

TIM is deploying LTE1800 in Rio de Janeiro state which was soft launched in Búzios on January 17, 2015 and commercially introduced in March 2014. By end 2015 **TIM** provided LTE coverage in 411 cities i.e. 59% of the urban population or 100 million people. TIM plans to cover 1,000 cities by end 2016.

It was announced in early 2015 that **TIM** trialled VoLTE in a laboratory environment. VoLTE and ViLTE were commercially launched on August 2, 2016 in Rio de Janeiro ahead of the start of the Olympic Games.

TIM commercially introduced 700 MHz in Rio Verde on June 15, 2016, simulatenously launching 3C CA in the city (Bands 3, 7 and 28).

TIM Brasil is studying NB-IoT technology.

Vivo commercially launched LTE on April 30, 2013 in Sao Paulo and the 6 Confederations Cup venues.

In October 2016 **Vivo** announced results of a 3C CA LTE-Advanced Pro trial in Sao Paulo achieving 530 Mbps downlink speed. The configuration used 35 MHz of spectrum in bands 3, 7, and 28 plus 4x4 MIMO and 256QAM on the downlink.

Algar Telecom (**CTBC**) conducted LTE trials in 850 MHz and 1800 MHz and is deploying a commercial network using 700 MHz (APT700) spectrum.

Nextel commercially launched LTE1800 on June 16, 2014 in 19 regions of Rio de Janeiro and plans to extend service to Sao Paulo in 2016. Anatel has approved the change in use for Nextel's 800 MHz licence to allow LTE to be deployed in this spectrum.

Anatel auctioned 15 lots of spectrum on December 6, 2011 for USD 132.7 million. 39 lots were not auctioned, including 29 for WiMAX™. **TIM, Oi** and **Sercomtel** bought spectrum in the 1800 MHz band but issues have arisen over usage rights.

Claro bought spectrum in the 800 MHz band.

Anatel adopted the APT700 FDD band plan in February 2013 and agreed terms of the auction to take place on September 30, 2014. Oi and Nextel decided not to participate in the tender. **TIM, Claro** and **Vivo** secured nationwide APT700 spectrum blocks. **Algar Telecom** won spectrum for its service area in the states of Goiás, Minas Gerais, Mato Grosso do Sul and São Paulo

APT700 spectrum will most likely be available for use for LTE for 60% of the population by end 2017, nationwide by November 2018.

Nine applicants were confirmed by Anatel for the auction of additional 1800 MHz, 1900 MHz and 2.6 GHz spectrum in December 2015. Bids totaled about USD 186 million. **Nextel** won additional 1800 MHz spectrum that they will use for LTE in San Pablo. **Vivo** acquired 2.6 GHz spectrum covering areas including Rio de Janeiro, Florianopolis, Porte Alegre and Palmas. **Claro** and **TIM** also acquired 2.6 GHz spectrum. Sercomtel bought some 1800 MHz spectrum. 3.5 GHz spectrum may be auctioned later.

Sao Paulo military police force is testing LTE in 700 MHz with 5 base stations. **Brazil Army** is testing LTE in 700 MHz for public security solutions. With two sites in Brasilia covering Esplanada dos Ministérios, and Communications Center and the Army Electronic Warfare (CCOMGEX).

LTE in 450 MHz (3GPP band 31)

In June 2012 ANATEL auctioned licences for the 450 MHz (and 2.6 GHz bands) for 4G systems. The 450 MHz band was split over 4 geographical areas, each one assigned to a main carrier already operating in the Brazilian market. The winning bidders accepted technology performance and coverage obligations. The Ministry of Communications approved projects worth USD197 million to bring LTE to 14 States using 450 MHz.

Case study - Brazil: LTE 450 MHz technology for broadband services in rural and remote areas
https://itunews.itu.int/en/4618-LTE-450MHz-technology-for-broadband-services-in-rural-and-remote-areas-BR-Case-study-of-Brazil.note.aspx

Oi is deploying LTE450 in Goiás and the Federal District. **Claro** is approved to deploy LTE450 in the states of Amazonas, Amapá, Maranhão, Roraima, Pará, Acre, Rondonia and Tocantins, and Bahia.

Cayman Islands

Digicel commercially launched LTE using 1800 MHz (LTE1800) on November 28, 2013. The company also has 700 MHz band 13 spectrum.

FLOW (formerly LIME) commercially launched LTE using 700 MHz (band 17) on November 29, 2013. Rollout to all islands was completed in May 2014.

Chile

Regulator Subtel announced in July 2012 **Movistar**, **Entel** and **Claro** each won 2 x 20 MHz in the 2.6 GHz auction. **Nextel** (**WOM**) and MVNO **VTR** didn't bid.

Claro commercially launched 144 Mbps LTE on June 27, 2013 using 2.6 GHz. 216 Mbps (peak) LTE-Advnaced (branded 4G LTE +) was commercially launched on 18th October 2016 in the Santiago metropolitan area, aggregating band 28 and band 7 spectrum. The second stage of coverage will be in Valparaiso and Biobio region.

Claro, **Entel** and **Movistar** each won APT700 band spectrum auctioned in February 2014. **Entel PCS** announced completion of LTE trials using APT700 on 10 sites in December 2014 and deployed APT700 sites as frequency permits were granted.

Entel PCS commercially launched LTE on March 28, 2014 using 2.6 GHz on 803 sites. APT700 spectrum was introduced on May 17, 2016 and simultaneously launched LTE-Advanced 300 Mbps service**.**

Movistar commercially launched LTE in 2.6 GHz on November 14, 2013 in regional capital cities. APT700 spectrum was brought into use on May 17, 2016 and from July combined with band 7 using LTE-Advanced carrier aggregation technology for 300 Mbps theoretical peak downlink speed.

WOM (Novator) commercially launched LTE in Viña del Mar (close to Santiago) using AWS band 4 spectrum on 9th November 2015. By January 2016 coverage reached Arica, Iquique, Calama, Antofagasta, Copiapó, La Serena, Coquimbo, Ovalle, Valparaiso, Santiago, Rancagua, San Fernando, Curicó, Talca, Linares, Concepción, Temuco, Osorno, Puerto Montt, Valdivia, Punta Arenas and Coyhaique.

Colombia

UNE-EPM launched commercial LTE service on June 14, 2012 in 2.6 GHz in Bogotá and Medellín. Coverage extended to 40 cities by end 2013 by which time around 200,000 subscriptions were activated.

The Ministry of ICT (MinTIC) auctioned new spectrum in June 2013, offering:

- 3 blocks of 30 MHz each in the AWS band; one block reserved for new players
- 3 blocks of 30 MHz and 1 block of 40 MHz in 2.6 GHz spectrum; 1 block for new players
- 5 MHz of 3G/1.9 GHz

- Movistar won 30 MHz in AWS band
- ETB and Tigo consortium won 30 MHz in AWS band
- Avantel (new entrant) won 30 MHz in AWS band
- DirecTV won one 30 MHz and one 40 MHz block of 2.6 GHz spectrum
- Claro won 30 MHz in 2.6 GHz band

The 1900 MHz spectrum auction was declared void.

Movistar commercially launched LTE on December 2, 2013 in AWS spectrum. 73% population coverage was reached by early December 2014. VoLTE was commercially launched on September 1, 2016.

Tigo commercially launched LTE on December 2, 2013 in AWS spectrum. **Tigo** and **UNE-EPM** have

merged; completion of the deal was announced on August 14, 2014.

ETB agreed to sell a stake in **Colombia Movil** including 15 MHz of 2.6 GHz spectrum to **Tigo**. **ETB** commercially launched LTE using AWS spectrum on October 7, 2014 in 41 towns and cities.

Claro commercially launched LTE on February 13, 2014 using band 7 in Bogota.

DirecTV commercially launched band 38 LTE TDD on July 25, 2014 in Barrancabermeja, Chía, Monteria and Palmira. By October 2015 LTE covered 18 cities.

New-entrant **Avantel** commercially launched LTE using AWS on August 19, 2014 in 20 municipalities for business users, targeting 1 million customers in the first year and coverage to 57 cities/towns by mid-2015. VoLTE is in deployment.

Regulator **ANE** adopted the APT700 band plan on May 30, 2012. A draft resolution proposed allocating 100 MHz of 2.3 GHz for mobile broadband services.

In 2015 MinTIC published conditions for a proposed spectrum auction in 700 MHz, 900 MHz, 1,900 MHz and 2.5 GHz. Comments were due by June 12, 2015.

Costa Rica

ICE launched a data-only commercial LTE service for dongles and tablets in 110 districts using band 7 on November 25, 2013 under the Kölbi Ultra brand. LTE smartphones support was offered from March 2014.

Claro commercially launched LTE1800 on April 1, 2014.

Movistar commercially launched LTE1800 on July 4, 2014.

Pan Latin American WiMAX™ operator **IBW International**, with operations in Costa Rica, El Salvador, Guatemala, and Nicaragua is planning to migrate to 2.3 GHz LTE TDD.

Regulator Sutel recommended adoption of the APT700 FDD band plan in 2012. Sutel is considering allocating new 1800 MHz (40 MHz) and 1900/2100 MHz (30 MHz) spectrum.

Curaçao

UTS (Chippie) commercially launched LTE using 1800 MHz band 3 on June 17, 2015.

Regulator **BTNP** adopted the APT700 band plan.

Dominica

FLOW (formerly LIME) commercially launched 700 MHz LTE for corporate clients on October 16, 2014.

(**Digicel Dominica** launched a 4G branded service in February 2015; the technology used is HSPA+)

Dominican Republic

Orange Dominicana commercially launched LTE1800 in Santo Domingo on July 9, 2012.

CDMA operator **Tricom** commercially launched LTE using 1900 MHz (band 2) spectrum on March 18, 2013 covering the National District, metropolitan zone of Santiago and other principal cities.

Claro commercially launched LTE using AWS on July 17, 2014.

WiMAX™ operator **Wind Telecom** commercially launched LTE TDD in band 38 on February 19, 2015.

Regulator Indotel adopted the APT700 FDD band plan in 2013.

Ecuador

The Telecommunication and Information Society Ministry (MINTEL) announced the National Broadband Plan is to be strengthened to assist development of high speed Internet access to underserved areas. The main objective is to provide Internet services in underserved areas and technologically isolated amongst the main goals, to achieve by 2017 at least 75% of Ecuador's population with access to broadband. Measures include a resolution to implement LTE in all regions. Considering the benefits of the new mobile technologies, the Telecommunication and Information Society Ministry (MINTEL) and the National Secretary of Telecommunications (SENATEL) organized various events to demonstrate new mobile

technologies like LTE, in order to increase the technological and social development. To help fulfill these goals and objectives, regulator CONATEL approved the re-allocation of frequency bands for the introduction of IMT systems as follows:

- 700 MHz band: 90 MHz
- AWS band: 120 MHz
- 2.5/2.6 GHz band: 190 MHz

CONATEL confirmed its adoption of the APT 700 MHz FDD band plan in October 2012.

State-owned operator **CNT** received 30 MHz of APT700 (band 28) and 40 MHz AWS spectrum for a LTE network. **CNT** commercially launched LTE in the main cities of Quito and Guayaquil in December 2013 in AWS, ahead of a wider launch for data customers in March 2014. Packages for smartphones were launched in August 2014. VoLTE deployment began in April 2014. CNT's CDMA network closed in 2014.

AWS spectrum for LTE deployments has been acquired by **Movistar** and **Claro** in addition to some 1900 MHz 3G spectrum.

Movistar commercially launched LTE in Quito on May 22, 2015 using band 2, later covering Guayaquil, Ambato and Azoques. AWS will also be used later.

Claro commercially launched LTE in Quito and Guayaquil on July 28, 2015 using AWS. Coverage extended to 18 cities in the mainland by June 2016.

Utility company **Etapa** is seeking LTE spectrum.

El Salvador

Pan Latin American WiMAX™ operator **IBW International**, operating in Costa Rica, El Salvador, Guatemala, and Nicaragua, is planning to migrate its operations to 2.3 GHz LTE TDD technology.

Regulator SIGET plans to auction AWS and 1900 MHz spectrum.

French Guiana

Orange Caraibe has received a licence to deploy a 4G/LTE network (800MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz).

Outremer has received a licence to deploy a 4G/LTE network (800MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz).

Digicel has received a licence to deploy a 4G/LTE network (800MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz).

Free Mobile has received a licence to deploy a 4G/LTE network (900MHz, 1800MHz, 2100MHz and 2600MHz).

Guadeloupe

Arcep awarded a test licence to **Dauphin Telecom** to trial 800 MHz LTE at Sainte-Anne.

Digicel Antilles-Francaise Guyane has received a licence to deploy a 4G/LTE network (1800MHz, 2100MHz and 2600MHz).

Free Mobile has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Orange Caraibe has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Outremer has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Guatemala

Movistar commercially launched LTE in Guatemala City on October 29, 2014 in 1900 MHz band 2.

Tigo commercially launched LTE on May 4, 2015 in band 5 in Guatemala, Mixco, Villa Nueva, Amatitlán, San José Pinula, Santa Catarina Pinula, Fraijanes and San Miguel Petapa.

Pan Latin American WiMAX™ operator **IBW International**, operating in Costa Rica, El Salvador, Guatemala, and Nicaragua is planning to migrate its operations to 2.3 GHz LTE TDD technology.

An auction of AWS and APT700 spectrum is planned.

Haiti

Natcom is the only operator authorised to trial LTE technology, covering six metropolitan areas of the capital Port-au-Prince, and will launch a trial network. The other mobile operators are **Digicel** and **Haitel.**

Progress is reported to be being made for an auction of spectrum/licences for 4G/LTE services.

Honduras

Regulator CONATEL awarded AWS spectrum to **Claro**, **Hondutel** and **Tigo**. LTE coverage must reach 15% of territory by 2016, equivalent to major cities.

Tigo commercially launched LTE using AWS on December 10, 2014 in the main cities of Tegucigalpa, San Pedro Sula, and La Ceiba.

Claro commercially launched LTE using AWS on March 25, 2015.

Hondutel plans to launch LTE in in the metropolitan area Valle de Sula.

CONATEL adopted the APT700 FDD band plan.

Jamaica

Digicel commercially launched LTE with 700 MHz band 17 spectrum on June 9, 2016 in Kingston, St Andrew and parts of St James.

FLOW (formerly LIME) acquired AWS spectrum and is deploying LTE initially in major high traffic parts of Kingston metropolitan area and the North Coast.

Caricel, a new market entrant, is deploying an LTE network.

Martinique

Digicel Antilles-Francaise Guyane has received a licence to deploy a 4G/LTE network (1800MHz, 2100MHz and 2600MHz).

Free Mobile has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Orange Caraibe has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Outremer has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Mexico

On September 21, 2012 regulator **COFETEL** confirmed adoption of the APT700 FDD band plan.

Telefonica Movistar commercially launched band 4 LTE on October 15, 2012 in Ciudad de México, later in Guadalajara and Monterrey for post-paid users. Service for pre-paid users started in January 2015.

Telefónica and **Iusacell** have a network sharing arrangement.

Nextel de Mexico commercially launched LTE on October 13, 2014 in Guadalajara, Mexico City, and Monterrey in AWS band 4. The company was bought by **AT&T** and rebranded to **AT&T Mexico**. **AT&T** also acquired **Iusacell**. The **AT&T** LTE network covers 70 million people in 144 cities (October 14, 2016).

Telcel commercially launched LTE in band 4 for post-paid customers on November 6, 2012 in Mexico City, Guadalajara, Monterrey, Queretaro, Puebla, Ciudad Juarez, Tijuana, Hermosillo and Merida. Service for pre-paid users was launched in February 2015. By June 2015 LTE covered 65.5% of the population.

2x 40 MHz of AWS band 4 spectrum has been auctioned in 8 national blocks for LTE deployments. The auction started on February 15, 2016 and spectrum was won by the 2 bidders, **AT&T** and **Radiomóvil Dipsa (America Movil-Telcel)**. The spectrum was allocated to the winners in May 2016.

Regulator IFT plans to allocate 700 MHz (APT700) and 2.6 GHz (2500 – 2690 MHz) spectrum. A single open-access APT700 LTE network is proposed. The network will be known as “Red Compartida”. Industry interest is high. 37 companies indicated interest in participating in ths program. A field trial has been conducted in Acapulco using APT700 band spectrum during which 120 Mbps downlink speed was reached. Red Compartida will be allocated 2x 45 MHz of

APT700 spectrum and bids are likely to be invited in early 2017. The auction for 2.6 GHz spectrum is expected to follow a similar timeline.

A public consultation has been launched about the possibility to use 440-450 MHz band for LTE.

Nicaragua

Claro commercially launched LTE using AWS band 4 spectrum on October 1, 2015, initially in the cities of Esteli, Leon, Managua and Matagalpa.

Movistar commercially launched LTE in band 2 on 11th November 2015 in Managaua. Coverage extended to San Juan del Sur in March 2016, and Chinandega, Granada, Leon and Masaya mid-2016.

Pan Latin American WiMAX™ operator **IBW International**, operating in Costa Rica, El Salvador, Guatemala, and Nicaragua is planning to migrate its operations to 2.3 GHz LTE TDD technology.

Panama

C and W Panama has 700 MHz (APT700), 850 MHz, and 1900 MHz spectrum. C and W commercially launched LTE in band 28 on March 11, 2015 in parts of Panama City and the city of San José de David.

Movistar commercially launched LTE in band 28 on March 27, 2015 for data users in the capital Panama City and the international airport. Coverage extensions to new provinces are planned.

Claro commercially launched LTE on August 6, 2015 using 700 MHz (APT700) and 1900 MHz spectrum.

Panama confirmed its adoption of the APT700 FDD band plan in October 2012.

Paraguay

Personal commercially launched LTE in refarmed 1900 MHz band 2 on February 8, 2013 in Asuncion and surrounding areas, for data users only. LTE service extended to smartphones on 16th December 2015. LTE coverage is in over 50 locations (July '16).

Vox (Copaco) commercially launched LTE service using AWS on February 18, 2013 for data users. Initially Vox launched with 109 sites of which 89 served Asuncion and metro area, 14 were in Ciudad del Este, 5 in Encarnación, and 1 in Pilar. By April 2016 a total of 109 municipalities were covered.

Regulator CONATEL auctioned AWS spectrum in December 2015 that was awarded to Claro and Tigo, the only registered applicants.

Tigo commercially launched LTE on April 7, 2016 in 24 cities using AWS spectrum. Tigo won 2 x 5 MHz AWS spectrum blocks in the December 2015 auction. A further 7 cities will be covered by end 2016.

Claro commercially launched LTE on April 13, 2016 in 14 cities using AWS spectrum.

CONATEL plans next to auction APT700 and 2.6 GHz spectrum and will start a consultation in September 2016.

Peru

Ministerio de Transporte y Comunicaciones del Perú auctioned 2 blocks of AWS spectrum for LTE, won by **Telefonica Moviles** and **Americatel Peru** (**Entel).** Coverage conditions include a requirement to cover 234 district capitals within 6 years, and to ensure coverage in a number of cities by mid-2016.

Telefonica Movistar commercially launched LTE in parts of Lima on January 2, 2014 in AWS spectrum.

Telefonica is also deploying LTE for fixed wireless internet access in the Peruvian Amazon region, initially targeting public sector entities including schools and healthcare centres. 4G+ LTE-Advanced downlink speed of 250 Mbps combining 700 MHz and AWS spectrum was announced on July 25, 2016 and activated for commercial use initially in the district of Coishco (Ancash) and in some areas of Puente Piedra, San Juan de Lurigancho and the town of Aguaytía (Ucayali). Movistar is deploying VoLTE for launch in Lima in Q3 2016.

Claro commercially launched LTE in existing 1900 MHz spectrum on May 21, 2014. Claro announced on September 6, 2016 that APT700 spectrum had been brought into commercial use. Claro also deployed fixed wireless LTE TDD service on July 1, 2015 in band 42 for connectivity to rural and remote areas.

WiMAX™ operator **Olo** had plans to migrate to LTE TDD, deploying 1,000 base stations over 5 years using its existing 2.5 GHz spectrum. However on May 10, 2016 it was announced that **Olo** and **TVS Wireless** (which also has 2.5 GHz spectrum) would be bought by **Claro Peru** (subject to conditions).

Entel (subsidiary of **Americatel)** commercially launched LTE TDD on October 13, 2014 in Lima using band 40 spectrum, targeting medium and small companies using outdoor CPEs. An LTE-Advanced demonstration with 2-carrier aggregation of band 4 and band 28 spectrum in Lima on July 26, 2016 achieved 260 Mbps.

DirectTV bought WiMAX™ operator Digital Way and is deploying LTE TDD using its 2.3 GHz spectrum.

3 blocks of paired 15 MHz spectrum according to the APT700 band plan were to be auctioned in May 2016 (according to the latest timetable) for LTE deployments:

Block A: 703 MHz-718 MHz, 758 MHz-773 MHz;
Block B: 718 MHz-733 MHz, 773 MHz-788 MHz,
Block C: 733 MHz-748 MHz, 788 MHz-803 MHz
According to reports, incumbents Movistar, Claro and Entel each won one block. There are coverage obligations.

Bitel (Viettel) had been seeking APT700 spectrum to support deployment of their LTE network using 1900 MHz spectrum, but was not successful in the auction. Bitel said that LTE service will be launched end 2016.

Puerto Rico

AT&T Puerto Rico commercially launched LTE in 700 MHz on November 20, 2011 in San Juan then Guayama, San German and Yauco in 2012. LTE-Advanced was commercially launched in 2014 (GSA assumption 110 Mbps peak downlink speed) adding in AWS. AT&T also owns 2.6 GHz spectrum. VoLTE was commercially launched on October 8, 2015.

Claro commercially launched 700 MHz LTE on November 24, 2011.

CDMA operator **Open Mobile** launched 700 MHz commercial LTE service on April 19, 2012.

Sprint announced commercial launch on December 18, 2012 using 1900 MHz spectrum.

T Mobile USA commercially launched LTE in AWS spectrum on July 11, 2013. 4x4 MIMO LTE-Advanced technology was launched in September 2016 to double theoretical peak speeds.

Aeronet Wireless Broadband is leasing band 41 spectrum and deploying LTE TDD for backbone and customer access.

Saint Maarten (Saint-Martin)

Regulator Bureau of Telecommunication and Post of Saint Maarten launched a consultation on the use of LTE and which bands to allocate. Comments were due by November 1, 2013. In 2013 French regulator ARCEP granted 800 MHz LTE test spectrum covering the islands of Saint Martin, Guadeloupe and Saint Barthelemy to **Dauphin Telecom**.

UTS commercially launched an LTE1800 network on November 12, 2015. APT700 band 28 spectrum will be used in 2016.

Dauphin Telecom has received a licence to deploy a 4G/LTE network (900MHz, 1800MHz, 2100MHz and 2600MHz).

Digicel has received a licence to deploy a 4G/LTE network (800MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz).

Free Mobile has received a licence to deploy a 4G/LTE network (800MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz).

Orange Caraibe has received a licence to deploy a 4G/LTE network (800MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz).

Saint Helena, Ascension and Tristan da Cunha

Saint Helena, Ascension and Tristan da Cunha is a British Overseas Territory.

Sure South Atlantic commercially launched an LTE1800 network on St Helena and Ascension Island in September 2015 for data users.

Suriname

Telesur commercially launched LTE1800 for fixed wireless broadband service on June 5, 2015 with 2x 20 MHz band 3. 2x 15 MHz APT700 band 28 was brought into commercial LTE use on January 29, 2016. Telesur is targeting 90% coverage by end of 2016, at which time mobile service will be introduced.

Trinidad and Tobago

TSTT announced launch on April 16, 2014 of its Blink Wireless Broadband Pilot Project using LTE technology in rural communities. **TSTT** commercially launched LTE TDD (TD-LTE) in Tobago on December 18, 2014 with two 20 MHz carriers of band 41. All former WiMAX™ sites have been migrated to LTE TDD. Fixed/nomadic wireless broadband service is offered for use with CPEs, USB dongles and personal hotspots/MiFi devices.

Regulator TATT issued an RFP initiating a competitive authorization process including:

a) Provision Of A Public Domestic Mobile Telecommunications Network And Public Telecommunications Services By A Potential 3rd Mobile Operator;
b) Award Of 800 MHz and 1900 MHz spectrum To Eligible Mobile Operator(s); and
c) Award Of 700 MHz spectrum To Mobile Operators

6 applicants included **Digicel T&T** and **CWC**.

Turks & Caicos Islands

In February 2013 **Digicel** (700 MHz Lower B and C) and **Islandcom** (700 MHz Upper C) received licences to deploy LTE networks. **LIME** did not win a licence. On February 26, 2015 **LIME** announced it had reached an agreement to acquire the assets of **Islandcom** and plans to offer customers 4G/LTE service. Closure was achieved and Islandcom ceased to trade on July 31, 2015.

Digicel commercially launched its LTE700 network (700 MHz Lower B & C spectrum) on March 25th, 2015 with 94% population coverage.

FLOW (formerly LIME) commercially launched LTE700 on July 31st, 2015 across Provo, Grand Turk and South Caicos.

Uruguay

Antel commercially launched LTE on December 13, 2011 using AWS in Montevideo and Punta del Este.

In March 2013 regulator URSEC announced an award made to the 3 incumbent mobile operators following a tender process for 900 MHz, 1900 MHz and AWS spectrum:

- **Movistar** won 4 blocks of 1900 MHz spectrum
- **Claro** won 2 blocks of 1900 MHz and 2 blocks of AWS spectrum
- No bids were made for 900 MHz

Antel did not take part in the auction and had to pay for reserved spectrum of 1 block in 900 MHz and 4 blocks of AWS.

Claro commercially launched LTE in Montevideo in AWS spectrum on February 13, 2014.

Movistar commercialy launched LTE in 1900 MHz band 2 on September 5, 2014 in Montevideo.

Wireless broadband company **Dedicado** is planning to invest US$ 5 million in deployment of “4Motion” network using WiMAX™ and LTE TDD in 3.5 GHz.

Regulator Ursec plans to auction 700 MHz band 28 spectrum by end 2016.

British Virgin Islands

On June 11, 2015 regulator Telecommunications Regulatory Commission (TRC) announced a consultation on a proposed spectrum award in the 450 MHz, 700 MHz, 1800 MHz, 1900 MHz, 2100 MHz, and 2500 MHz bands by comparative tender, which stated “Of particular importance is the 700 MHz band which is the main band for 4G services based on LTE in the United States (and its territories in the Caribbean) and which has now been assigned in a number of Caribbean states e.g. Anguilla, Antigua and Barbuda, Jamaica, Trinidad and Tobago, and Turks and Caicos”. Bid applications were required by July 26, 2016. TRC announced that CCT, Digicel and Flow were awarded in 700 MHz 9vand 28), 1900 MHz (band 2) and AWS (band 4).

CCT has deployed an LTE network for which service launch is pending allocation from the auction.

Digicel has deployed an LTE network for which service launch is pending allocation from the auction.

FLOW (formerly LIME) has deployed an LTE network targeting service launch in November 2016. Early tests demonstrated 40 Mbps downlink data speed.

US Virgin Islands

Sprint commercially launched LTE in band 25 on April 17, 2013.

AT&T Mobility commercially launched LTE in band 17 on St Croix and St Thomas on July 2, 2013. VoLTE was commercially launched on October 8, 2015.

Choice Wireless is deploying an LTE network.

Venezuela

Regulator Conatel issued an invitation for the allocation of 35 MHz paired spectrum bands:

1930-1940 MHz paired with 1850-1860 MHz (band 2)
1945-1955 MHz paired with 1865-1875 MHz (band 2)
1810-1825 MHz paired with 1715-1730 MHz (band 3)

Digitel was awarded 30 MHz of 1800 MHz and 1900 MHz spectrum.

Movilnet and **Movistar** each received 20 MHz of extra spectrum in those bands.

Digitel commercially launched LTE1800 on July 31, 2013 for post-paid consumers and business users. Full commercial launch was on September 9, 2013. Digitel is testing VoLTE.

Movistar switched off its CDMA system in April 2014 and commercially launched LTE using AWS on February 19, 2015 with initial coverage in the metropolitan area of Caracas and Puerto la Cruz.

WiMAX™ operator **Movilmax** has a nationwide licence with 48 MHz of 2.6 GHz spectrum and announced the company is migrating to LTE.

On December 2, 2013 Conatel launched an auction for 80 MHz paired comprising 4 blocks of 2.6 GHz and 2 blocks of AWS spectrum that may be used for LTE. Bids were due by December 30, 2013 but the auction stalled; procedures restarted in August 2014.

Three LTE-suitable licences were awarded in December 2014 to **Movilnet**, **Movistar** and **DirecTV** (via its Galaxy Entertainment subsidiary).

Movilnet is deploying LTE in AWS spectrum, targeting service launch in December 2016.

DirecTV is deploying LTE though launch is delayed.

Cofetel adopted the APT700 FDD band plan in April 2013. A further spectrum auction is planned in 2016.

Asia Pacific and Oceania

Afghanistan

Etisalat Afghanistan completed an LTE trial.

The APT700 band plan has been adopted for frequency allocations in the 700 MHz band.

Australia

Telstra commercially launched LTE1800 service on September 27, 2011 in capital city CBDs (central business districts) and more than 30 regional and metropolitan centers. The NextG network upgrade uses Telstra's existing 1800 MHz spectrum refarmed to deliver LTE to areas where traffic demand is most concentrated and is integrated with Telstra's existing HSPA+ service in the 850 MHz band. Telstra offers dual mode LTE/HSPA+ mobile broadband devices for seamless operation across 1800 MHz and 850 MHz.

In February 2013 Telstra announced plans to deploy LTE in re-farmed 900 MHz spectrum – some sites are running now. In July 2014 Telstra announced plans to close its 2G/GSM network by end 2016. In July 2013 Telstra demonstrated carrier aggregation using 900 MHz and 1800 MHz spectrum. Telstra successfully demonstrated speeds up to 300 Mbps with LTE-Advanced carrier aggregation using 40 MHz of 1800 MHz and 2600 MHz spectrum on its live commercial network. In May 2014 Telstra demonstrated 450

Mbps speed using LTE-Advanced carrier aggregation technology in its commercial network by combining three 20 MHz carriers (20 MHz 1800 MHz plus two 20 MHz 2.6 GHz carriers). 2100 MHz spectrum has been refarmed for LTE in some locations. Telstra also won new APT700 and 2.6 GHz spectrum in the auction.

Telstra commercially launched APT700 (band 28) service on July 25, 2014 in Perth, Freemantle, Griffith, Esperance, Mount Isa and Mildura. Each site is equipped with:
* 2 x 20 MHz of APT700 (enabling theoretical peak speeds on Cat 4 devices of 150 Mbps) and
* 2 x 20 MHz of LTE1800 (enabling theoretical peak speeds on Cat 6 devices of 300 Mbps)

Telstra's 300 Mbps LTE-Advanced service, marketed as "4GX", uses 700 MHz and 1800 MHz spectrum and is commercially available in parts of Adelaide, Brisbane, Darwin, Hobart, Melbourne, Perth, Sydney, and selected regional areas. Telstra now has 4G/LTE coverage to over 90% of the population, and 4GX/APT700 services over 1,000 Australian towns and suburbs. In February 2015 Telstra confirmed over 1 Million APT700 enabled devices operational on their 4GX network.

APT700 spectrum was obtained with early release to enable services to be started in Sydney and Adelaide central business districts in mid-September 2014. On September 11, 2014 Telstra announced population coverage for LTE would expand to 90% by end January 2015. APT700 coverage was extended to selected areas of Sydney, Adelaide, Darwin, Bundaberg, Yamba and Sarina in September 2014. All top end devices now support APT700 band 28.

Telstra, together with its network and devices partners, demonstrated 450 Mbps downlink speed (Category 9) using carrier aggregation to combine three 20 MHz carriers in Bands 3 (LTE1800), 7 (2.6 GHz) and 28 (APT700). First sites were activated in April 2015; compatible devices were launched in August 2015.

On February 26, 2015 Ericsson with Qualcomm and observed by Telstra, announced that 600 Mbps (Category 11) had been demonstrated in their labs. The first Cat 11 device (Telstra WiFi 4GX Advanced III Mobile Broadband Hotspot) came onto the Telstra market in September 2015 offering commercial service in selected 4GX coverage areas. On 9th November 2015 Telstra - working with Ericsson, confirmed the successful demonstration of over 950 Mbps downlink speed by aggregating 100 MHz of spectrum across the 700 MHz, 1800 MHz, 2100 MHz and 2600 MHz (2 x 20 MHz) bands and delivered to a Cobham Aeroflex TM500 mobile device. On September 9, 2016 Ericsson, Qualcomm and Telstra announced download speeds of 979 Mbps and upload speeds of 129 Mbps were achieved during live testing on Telstra's LTE network. The trial used LTE-Advanced pro technology including 4×4 MIMO and higher order modulation schemes 256QAM on the downlink and 64QAM on the uplink.

In October 2013 Telstra announced completion of the world's first LTE Broadcast session on a commercial LTE network. LTE Broadcast technology was deployed across the LTE network by May 2015 in preparation for commercial trials and planned customer launch.

Telstra commercially launched VoLTE on September 16, 2015 to postpaid users with compatible terminals. ViLTE (Video over LTE) is targeted for launch in 2H 2016.

Optus conducted an LTE1800 trial in Newcastle and Hunter Valley in New South Wales. Commercial LTE service launch for small business, enterprise and government customers in Sydney and Perth was confirmed on July 31, 2012 using LTE1800, before a wider launch on September 4, 2012. VoLTE rollout to major cities began on May 9, 2016.

Optus acquired **Vivid Wireless** obtaining access to 98 MHz of 2.3 GHz spectrum and commercially launched LTE TDD service in the Canberra area on June 6, 2013. Dual mode (FDD and TDD) devices were offered by the company at launch. The company has since added LTE TDD coverage for Melbourne, Brisbane, Sydney and Adelaide. On December 19, 2013 Optus announced in tests they had paired two 20 MHz channels of 2.3 GHz spectrum in Melbourne. Optus claimed the test is "the first time in the world that 4G carrier aggregation has been introduced into a live LTE TDD network, not a lab". Optus 4G Plus LTE-Advanced (theoretical peak downlink of 220 Mbps TDD) is live in parts of Adelaide, Brisbane, Canberra, Melbourne & Sydney. Customers with

compatible terminals can connect in either FDD 1800 MHz or TDD 2300 MHz modes.

Optus acquired APT700 and 2.6 GHz spectrum in the 2013 auction, see below, and was granted Australia's first outdoor metro trial licences for 4G in 2.6 GHz spectrum. Optus has undergone testing for compatibility of the new spectrum with the latest devices and with television broadcasters. The trials using APT700 and 2.6 GHz were extended to Darwin and Perth. **Optus** commercially launched LTE service using APT700 spectrum in Perth and Darwin on July 23, 2014. APT700 coverage for Canberra was activated on December 8, 2014, supplementing previous TDD only coverage before that date. APT700 spectrum is available for commercial use nationally from January 1, 2015. 2.6 GHz spectrum could be used in most areas from October 1, 2014.

Optus commercially launched 2-carrier aggregation (2 x CA, Category 6) and 3-carrer aggregation (3 x CA, Category 9), claiming a world first for the latter for 1x FDD + 2x TDD carrier aggregation according to a company announcement on August 14, 2015. Optus activated 3x CA in the Newcastle NSW suburbs of Lambton, Mayfield and Mayfield West ahead of the first compatible category 9 devices being released commercially in Australia. Customers with the latest category 9 smartphones, such as the Samsung Galaxy S6 edge+ and Samsung Galaxy Note 5 can experience significantly maximized mobile download speeds compared to a single 4G channel. Mobile data download speeds of 317 Mbps were achieved using a category 9 device at Mayfield West in Newcastle. Optus deployed 3x CA technology in the Melbourne CBD in early September and will roll out to the Sydney CBD early 2016, followed by the Brisbane and Adelaide CBDs from mid-2016.

3C Carrier Aggregation on Optus 4G Plus uses a unique combination of 20 + 20 MHz of 2300 MHz and 15 MHz paired of 1800 MHz spectrum.

2x CA is available on the Optus 4G Plus network in selected areas of Sydney, Melbourne, Brisbane, Adelaide, Canberra, Hobart and Darwin as well as 20 major regional centres.

2x CA on Optus 4G Plus uses several combinations of bands including 2300 MHz and 2300 MHz in selected capital cities, 700 MHz and 1800 MHz in selected capital cities and major metropolitan areas and 700 MHz and 2600 MHz in major regional town centres.

In March 2015 Optus announced LTE download speeds of 480 Mbps to a single user device, accomplished by aggregating 4 separate carriers, each 20 MHz wide, to a single user device.

Separately, Optus tested carrier aggregation in conjunction with 4x4 MIMO, achieving a peak download speed of 415 Mbps in 40 MHz of spectrum.

In February 2016 Optus confirmed a live trial of LTE-Advanced Pro technology achieved downlink speeds of 1.41 Gbps at a trial of LTE-Advanced Pro in Newcastle, by aggregating aggregated 100 MHz (5 20MHz carriers) of Optus spectrum, 4×4 (MIMO) and 256QAM technologies.

On August 5, 2015 Optus announced its planned closure of its GSM network from April 1, 2017 allowing the spectrum to be refarmed for LTE.

Vodafone confirmed results of its first LTE1800 trial in Q4 2010 in Newcastle, NSW using 10 MHz of 1800 MHz. A second trial in Sydney followed. In September 2011 the company announced that an agreement with the Australasian Railway Association, which holds licences for 1800 MHz spectrum, to create contiguous blocks of spectrum in NSW, Victoria and South Australia, had been approved by the Australian Communications and Media Authority (ACMA).

Vodafone commercially launched LTE1800 service for existing customers already having their own compatible LTE device on June 12, 2013 in selected metro areas of Sydney, Perth, Melbourne, Adelaide, Brisbane; and Newcastle and Wollongong. The LTE service was opened to new customers on July 10, 2013. In January 2014 the company announced 1 million LTE devices were connected. Cat 4 (150 Mbps) devices were offered in January 2014 (dongle and portable hotspot). In August 2014 the company announced plans to update its core network. LTE using refarmed 850 MHz spectrum was launched in Adelaide in October 2014. **Vodafone** commercially launched 225 Mbps LTE-Advanced using carrier aggregation to combine 5 MHz of refarmed 850 MHz (band 5) with 20 MHz LTE1800 (band 3), was launched on November 17, 2014. This configuration

is used on many sites, and another 5 MHz of band 5 was introduced in 2015. Some sites use 20 MHz + 10 MHz of 1800 MHz band 3. 96% coverage of metro population was achieved by mid-2015 by refarming 850 MHz previously used for 3G. LTE-Advanced coverage was launched in Brisbane, the Gold Coast, and Sydney by December 4, 2014. In May 2016 Vodafone offered to buy 2 x 10 MHz blocks of unallocated APT700 spectrum, which the government rejected preferring instead to auction these channels. On February 6, 2015 Vodafone announced completion of a VoLTE trial ahead of service launch in December 2015 for post-paid users. On May 17, 2016 Vodafone announced its successful completion of a trial of pre-standard NB-IoT. Vodafone trialled NB-IoT across Melbourne in April 2016.

Vodafone plans to launch its first NB-IoT networks (LTE-Advanced Pro technology) in Australia, Ireland, the Netherlands and Turkey.

In September 2016 Vodafone announced its planned closure of its GSM network on September 30, 2017 allowing the spectrum to be refarmed for LTE.

NBN Co was established to design, build and operate the national broadband network and launched LTE TDD commercial wholesale services on April 2, 2012. There are 15 service providers accredited to provide services over the network and NBN Co is installing services for them across four locations in Australia, expanding to a national footprint covering 4% of the population by the end of 2015. This locks in with the same product set being offered over fibre and satellite to make the total picture of 100% population coverage. Retail price packages are available from *SkyMesh, iiNet, and Activ8Me. In March 2015 NBN announced completion of an LTE TDD trial at 2 sites using a 20 MHz 3.5 GHz carrier.

EnergyAustralia's Ausgrid trialled an LTE platform at 15 sites in 2011, with intent to migrate to a full LTE network. EnergyAustralia was chosen by the Government to lead the Smart Grid, Smart City demonstration project to test Australia's first fully integrated, commercial-scale smart grid.

WiMAX™ operator **BigAir** plans to deploy LTE.

An auction by ACMA of APT700 and 2.6 GHz began April 23, 2013. Results were confirmed May 7, 2013. Nearly AUS$2 billion was raised. VHA did not bid.

APT700 band winners:
Optus 2 x 10 MHz; Telstra 2 x 20 MHz

2.6 GHz band winners:
Optus 2 x 20 MHz; Telstra 2 x 40 MHz
TPG Internet 2 x 10 MHz

TPG Internet is a nationwide fixed telecoms service provider with international assets (submarine cable) and plans to deploy LTE.

ACMA is consulting on proposals for prioritizing more spectrum for mobile broadband including changing the 3.4 – 3.6 GHz band status to "primary" from "secondary", suitable for LTE. ACMA is also evaluating using the 400 MHz band for interoperable government wireless communications. An auction of 30 MHz of unsold 700 MHz spectrum is being considered for Q1 2017.

Bangladesh

Robi Axita and **Airtel** are merging. **Robia Axiata** is trialling LTE and achieved downlink speed of over 71 Mbps in Gulshan at their corporate offices.

State-owned **Teletalk** plans to deploy an LTE network.

Regulator BTRC announced its decision in December 2013 to allow 5 companies to receive LTE TDD licences:

- Banglalion
- Qubee
- Bangladesh Internet Exchange Limited (BIEL)
- Mango
- BTCL

WiMAX™ operators (**Banglalion, BIEL, Qubee**) are allowed to deploy LTE TDD in their 2.6 GHz spectrum subject to application and payment of additional fees.

3.5 GHz WiMAX™ operator **BIEL** (ollo) acquired a 2.6 GHz BWA license and commercially launched LTE TDD on 17th September 2015 in Jessore.

BTCL plans a fixed wireless LTE TDD service by June 2017 and applied for 35 MHz in 2.6 GHz band.

Wateen and **Qubee** announced in December 2013 plans to merge their respective WiMAX™ operations, subject to regulatory approval.

Bangladesh adopted the APT700 FDD band plan. BTRC had proposed to auction APT700 spectrum in 2015, however the timetable was delayed. Guidelines are being prepared to auction 450 MHz after APT700 is allocated.

Operators are seeking approval to refarm 1800 MHz for LTE systems. BTRC planned to auction unused 1800 MHz and 2.1 GHz spectrum in Q2 2015 but this was delayed.

Bhutan

Bhutan Telecom commercially launched LTE1800 service on October 24, 2013 in the capital, Thimpu.

An announcement by the South Asian Telecom Regulatory Council (SATRC) in May 2013 confirmed Bhutan's adoption of the APT 700 FDD band plan.

TashiCell commercially launched LTE using 20 MHz APT700 band 28 spectrum on April 2, 2016 in Thimphu, Paro and Phuntsholing.

Brunei

DST commercially launched LTE1800 on November 15, 2013.

Progresif Cellular plans to deploy an LTE network.

Regulator AITI adopted the APT700 FDD band plan in June 2013.

Cambodia

Smart Axiata commercially launched LTE1800 on January 22, 2014 in several indoor locations in parts of Phnom Penh. By June 2015 coverage had been extended to all 25 provinces of the country.

Sotelco (**Beeline Cambodia**) had planned to deploy an LTE network. Sotelco was sold to **Viettel** (**Metfone**) in March 2015. **Metfone** commercially launched LTE in June 2015, and now covers up to 90% of urban areas.

New market entrant **South East Asia Telecommunication Holdings (SEATEL)** commercially launched its LTE network with VoLTE on July 26, 2015 in band 5. At launch the service was available in 17 provinces, including the capital Phnom Penh, Kandal, Sihanoukville and Siem Reap, and will cover the remaining provinces by year-end. SEATEL acquired CDMA operator **Excell**.

WiMAX™ operator **Kingtel** (formerly **EMAXX)** commercially launched an LTE TDD network on September 1, 2015, initially in Phnom Penh, using band 41, and is expanding nationwide.

Cellcard commercially launched LTE1800 in November 2015.

Chuan Wei Ltd is deploying a commercial LTE network with VoLTE.

The APT700 band plan has been adopted for frequency allocations in the 700 MHz band.

China

China Mobile built its TD-SCDMA network so that sites and other elements are reusable for LTE TDD. China Mobile ran a pilot of LTE TDD technology until September 2011 using 850 base stations in 6 cities in Phase 1. This followed a large-scale showcase trial network during the 2010 World Expo in Shanghai. The second phase of trials involved 15 cities and 7 suppliers. In June 2013, 5,000 users begin testing the newly deployed LTE TDD network in Shanghai where 1,000 base stations - 700 outdoors and 300 indoors – were deployed covering the Inner Ring region, later extending to the whole city. China Mobile has 1.9 GHz, 2.0 GHz, 2.3 GHz and 2.6 GHz bands (the F, A, E and D bands). Trials used D and F bands.

210 MHz of LTE TDD spectrum is allocated in China:

- 130 MHz for 326 cities in 1880-1900 MHz (band 39), 2320-2370 MHz (band 40), and 2575-2635 MHz (band 41) to **China Mobile**
- 40 MHz for 55 cities comprising 2300-2320 MHz and 2555-2575 MHz to **China Unicom**
- 40 MHz for 42 cities comprising 2370-2390 MHz and 2635-2655 MHz to **China Telecom**

LTE TDD operating licences were issued by MIIT to **China Mobile**, **China Telecom** and **China Unicom** on December 4, 2013.

China Mobile commercially launched LTE TDD on December 18, 2013 in Beijing, Guangzhou and Chongqing in bands 39, 40, and 41.

China Mobile conducted carrier aggregation trials in 2014 achieving 220 Mbps on the downlink. Uplink carrier aggregation has been trialled over Jiangsu Mobile's network. 220 Mbps service began in Q4 2014 utilising 2 x 20 MHz TDD band 41 spectrum. Not national coverage .3 carrier CA LTE TDD using band 41 spectrum is being trialled to achieve up to 330 Mbps i.e. Category 9. The test cluster in Guangzhou is largely comprised of 2-carrier CA sites and a few sites support 3-carrier. On July 16, 2105 it was announced that Shanghai Mobile, a subsidiary of China Mobile, had deployed what its supplier claimed to be the world's first intra-band (3.5 GHz and 2.6 GHz TDD bands) TD-LTE-Advanced small cell carrier aggregation in its commercial network to achieve 220 Mbps peak downlink data transmission rates.

China Telecom commercially launched LTE TDD service in bands 40 and 41 on February 14, 2014, initially offering service in almost 100 cities.

China Unicom commercially launched LTE TDD service in bands 40 and 41 on March 18, 2014 in 25 cities. LTE-Advanced is in deployment, to deliver 300 Mbps initially and 330 Mbps in 2016 with tri-band carrier aggregation. VoLTE service was launched in Henan province in March 2016.

China Telecom and **China Unicom** both received FDD trial licences from MIIT in June 2014.

China Unicom initially deployed FDD-TDD technology in 16 cities: Shanghai, Guangzhou, Shenzhen, Chongqing, Zhengzhou, Wuhan, Chengdu, Xi'an, Changsha, Jinan, Hangzhou, Shenyang, Harbin, Fuzhou, Nanjing and Shijiazhuang. China Telecom initially trialled FDD in 16 cities: Shanghai, Xi'an, Chengdu, Hangzhou, Wuhan, Nanjing, Jinan, Hefei, Shijiazhuang, Haikou, Zhengzhou, Chongqing, Shenzhen, Nanchang, Nanning and Lanzhou. Both China Unicom and China Telecom were subsequently authorized in August 2014 to extend trials using FDD from the original 16 cities to 40 cities. Subsequently China Unicom and China Telecom gained approval to extend trials to 56 cities. China Unicom deployed 90,000 FDD and 10,000 LTE TDD base stations by end 2014 for continuous 4G coverage in most urban areas. 150 Mbps downlink data rate has been achieved on its network. 300 Mbps LTE-Advanced service was launched on December 8, 2015.

In June 2016 MIIT authorised China Unicom to conduct FDD trials using 900 MHz band 8 spectrum in 14 provinces including Anhui, Jiangsu, Shanghai, and Zhejiang.

A 3C CA trial was completed by China Unicom in May 2016, achieving 375 Mbps.

Chian Unicom is planning large-scale NB-IoT trials in more than 5 cities in 2016 using band 3 and band 8 spectrum and plans deployment in 2016 and nationwide service coverage by end 2018.

China Telecom claimed the world's first FDD-TDD carrier aggregation demonstration including a user device chipset. A peak download speed of 260 Mbps was achieved using 20 MHz of 1.8 GHz FDD band 3 and 20 MHz of 2.6 GHz TDD band 41 spectrum.

On February 27, 2015, MIIT awarded LTE FDD commercial licences to China Telecom and China Unicom, as follows:

- **China Telecom** received an additional 2x20 MHz band 3 licence, and permission to refarm 2x15 MHz of its band 1 spectrum for LTE FDD
- **China Unicom** received an additional 2x10 MHz band 3 licence for LTE FDD

After receipt of an LTE FDD licence **China Unicom** confirmed plans to invest over USD 16 billion. **China Telecom** is deploying LTE FDD across 12 Provinces in 40 cities including Shanghai, Jiangsu, Shandong, Zhejiang, Hunan, Hubei, Guangxi, Fujian, Jiangxi, Shaanxi, Inner Mongolia and Liaoning. **China Telecom** is deploying LTE-Advanced carrier aggregation combining FDD and TDD. **China Telecom** launched its "Tianyi 4G+" 300 Mbps LTE-Advanced service on August 1, 2015 using 1800 MHz and 2.1 GHz spectrum. China Telecom began trialling VoLTE in 2015 after which deployment will start for

2017 widescale service launch. In June 2016 MIIT approved plans for China Telecom to offer LTE service using 850 MHz spectrum.

China Telecom plans to deploy LTE-Advanced Pro NB-IoT using band 5 spectrum by end 1H 2017.

China Mobile has applied for an FDD licence in support of its LTE TDD network and to showcase convergence, according to reports.

On November 13, 2013 **China Mobile**, working with SK Telecom, completed the first FDD – TDD VoLTE interoperability tests. **China Mobile** has deployed VoLTE supporting eSRVCC on its LTE TDD network in Guanghzou. China Mobile commercially launched VoLTE HD voice service in Zhejiang, the first province in China to enter into the VoLTE era. VoLTE deployment is now completed covering over 300 cities and 5 million active users. In April 2014 results of FDD/TDD LTE-Advanced CA trials were announced. Air interface tests achieved 250 Mbps.

Qatar Ooredoo and **China Mobile** trialled FDD-TDD 10-carrier CA.

MIIT confirmed there were 584.5 million (45.09% of the mobile user base) 4G users by end May 2016.

The government is also considering 1.4 GHz and 3.5 GHz spectrum for TD-LTE allocation, as well as exploring the application of 50 GHz and beyond to meet future demand of mobile broadband. Band 42 (3.5 GHz) is an important future band for China.

On July 6, 2016 **China Mobile** and Huawei jointly announced a demonstration of a claimed first end-to-end LTE TDD system operating over the 3.3 GHz to 3.4 GHz band, in Shanghai. After the 3.3 GHz to 3.4 GHz band was identified at WRC '15 in 45 countries in Africa, Latin America, and Asia Pacific, continuous spectrum was achieved in these countries.

China Mobile is demonstrating and trialling NB-IoT na dopened a Cellular IoT Open Lab.

Press release
http://www.huawei.com/en/news/2016/7/shouge-33-34GHz-TD-LTE-duandaoduan-xitong
MIIT announced that the number of LTE subscriptions reached 200.774 million with 22.8 million being added in May 2015.

In **Hong Kong SAR**, 2 x 15 MHz blocks of 2.6 GHz spectrum were obtained via auction each by China Mobile HK (**Peoples Phone**), Genius Brand (**Hutchison Telecom/HKT** JV) and **CSL Limited**.

Telstra sold **CSL Limited** to **Hong Kong Telecom (HKT)** owner of **PCCW Mobile** for US$2.4 billion. HKT. **HKT** is the company entity for telecom services and **CSL** is the new mobile services identity.

Genius Brand has deployed a city-wide LTE network on which **Hutchison** and **CSL** operate their respective commercial LTE services.

On November 25, 2010 **CSL** commercially launched its combined LTE2600/1800/DC-HSPA+ network for corporate services, extended to all customers on May 16, 2011. Although the first LTE1800 site was on air at the initial launch, LTE1800 is widely available in several in-building locations and in general commercial use (shown in this report to be from November 2011 as advised to us by CSL). On July 3, 2013 CSL announced it had brought into service more 1800 MHz spectrum across most of the network, expanding in-service 1800 MHz LTE bandwidth to 2×15 MHz. CSL also uses 20 MHz of paired 2.6 GHz spectrum for LTE. LTE-Advanced carrier aggregation using 20 MHz of LTE1800 (B3) and 20 MHz of LTE2600 (B7) was commercially launched on December 22, 2014. VoLTE was soft-launched on December 5, 2013 and commercially launched on May 15th, 2014. In June 2013 the network was upgraded to Cat 4 operation (theoretical peak downlink 150 Mbps). CSL commercially launched VoLTE on May 15, 2014 including eSRVCC delivering seamless handover of voice calls from 4G to 3G. On April 23, 2015 CSL's owner HKT announced demonstration of 3-carrier LTE-Advanced technology, achieving 435 Mbps. This technology is now being deployed for commercialisation in 2016.

Hutchison 3 HK is deploying an LTE FDD and TDD network and in the first phase launched commercial LTE FDD service using 2.6 GHz spectrum on May 2, 2012. LTE1800 was brought into commercial service in October 2012. The 3 HK LTE network can support CAT 6 mobile devices in LTE band 3 and band 7 at a maximum data speed of over 200 Mbps. 3 HK commercially launched VoLTE on May 15, 2014. 3 HK has demonstrated an FDD and TDD LTE-Advanced configuration using carrier aggregation and

plans to launch a 2 component carrier (2CC) FDD TDD LTE-Advanced network. The company acquired 2.3 GHz band 40 in an auction in 2012 (see below) and plans to launch commercial service using this TDD spectrum in October 2016. Refarmed 900 MHz spectrum was commercially introduced for LTE in June 2016. 3CCA is in development for commercial service launch in 2H 2016. 3 HK is also committed to deploying a 5CC LTE-Advanced network.

On 3rd November 2015 using 1800 MHz and 2600 MHz bands for FDD with 2300 MHz of TDD frequency band (60 MHz total) with carrier aggregation, 3 HK demonstrated download speeds of up to 1 Gbps.

SmarTone announced commercial LTE1800 launch on August 28, 2012 with service available to selected customers by invitation, then generally available to customers on September 11. The company confirmed that LTE coverage would be available at the first MTR underground station (at Admiralty) on October 15, 2012. Rollout has been extended across all MTR stations and adjoining tunnels. LTE-Advanced technology was commercially launched in July 2014 for up to 150 Mbps. Dual band combines two from bands 3 (2x10 MHz), 7 (2x10 MHz) and 8 (2x 5 MHz). Tri-band is being deployed using all these bands. VoLTE was commercially launched in August 2014.

On February 6, 2012 regulator OFCA announced the auction results after 6 bidding rounds for 90 MHz of 2.3 GHz spectrum for BWA services, divided into 3 x 30 MHz blocks. 30 MHz blocks were won each by Hutchison Telephone Company Limited, China Mobile Hong Kong Company Limited, and new entrant **21 ViaNet Group Limited.**

China Mobile HK commercially launched LTE FDD in 2.6 GHz on April 25, 2012 and 2.3 GHz LTE TDD in December 2012. The world's first bi-directional handover between LTE FDD and TDD on a live network was announced by Ericsson and China Mobile HK on June 20, 2012. LTE1800 was deployed in 2013. VoLTE was commercially launched on September 8, 2015.

China Mobile HK trialled 3C CA LTE-Advanced technology, combining 15 MHz Band 7, 20 MHz B40 and 10 MHz Band 40. A maximum downlink data speed of 272 Mbps was achieved. China Mobile HK is deploying an LTE-Advanced Pro network.

OFCA auctioned spectrum in the 2.6 GHz range, offering five blocks of 2 x 5 MHz in the 2515 – 2540 MHz and 2635 – 2660 MHz range. The auction involved 5 bidders: China Mobile Hong Kong, China Unicom (Hong Kong), CSL Limited, Genius Brand, and SmarTone, beginning on March 18, 2013 and ending on March 19, 2013 after 18 rounds of bidding. China Unicom failed to gain any spectrum.

Fiji

Fiji adopted a modified version of the APT700 band plan, allowing the option of using 800 MHz equipments for LTE.

700 MHz, 800 MHz and 1800 MHz LTE spectrum was auctioned In July 2013. All the operators fulfilled their quotae of 30 MHz each. Results:

- **Vodafone**: 30 MHz paired 1800 MHz
- **Digicel**: 15 MHz paired APT700 and 15 MHz paired 1800 MHz
- **TFL**: blocks in APT700 and 1800 MHz

No bids for 800 MHz spectrum were received.

Vodafone Fiji commercially launched 100 Mbps LTE1800 on December 5, 2013 with coverage available in most parts of Suva, Lami and parts of Nasinu. On August 19, 2016 Vodafone announced launch of 225 Mbps LTE-Advanced (branded 4G+) by introducing band 20 spectrum, covering 65% population and targeting 85% by end of 2016.

In June 2016 **TFL** completed a pilot launch of LTE TDD technology for its Connect 4G+ wireless broadband division. **TFL** commercially launched its Connect 4G+ 4G service using LTE deployed in band 20 spectrum on September 15, 2016.

Digicel commercially launched LTE1800 on August 14, 2014 covering Nadi, Suva and Lautoka. On August 14, 2016 the company announced coverage had been extended to Nasinu, Ba and Labasa.

Frency Polynesia

WiMAX™ ISP **Viti** commercially launched LTE (**Ora** brand) on February 16, 2015 in bands 7 & 20. VoLTE is being studied. A pilot may be launched in 2017.

Guam

IT&E commercially launched LTE on June 28, 2012 using 700 MHz band 12, initially for business users, and extended to all users in early July 2012 as "4G LTE Wireless Data Network for the Home".

DoCoMo Pacific announced launch of LTE commercial services in 700 MHz on October 4, 2012.

iConnect commercially launched LTE service using 700 MHz spectrum on March 20, 2013.

GTA commercially launched LTE service using AWS spectrum on October 11, 2013. Sites are located in the villages of Agana, Agana Heights, Asan, Agat, Barrigada, Chalan Pago, Dededo, Mangilao, Sinajana, Tamuning, Tumon and Yigo. Expansion to 95% of population is targeted by September 2015. GTA is in the process of being acquired by PT Telekomunikasi Indonesia (Telkom).

India

The 2.3 GHz BWA auction began with 11 companies bidding for 2 blocks in each of the 22 circles. The government had earlier allocated one 20 MHz unpaired spectrum block each to **MTNL** and **BSNL**.

Tikona Digital Networks won spectrum in 5 circles and is committed to deploy LTE TDD. Commercial launch is expected in 1H 2016.

Qualcomm and **Bharti Airtel** won 4 circles each. Qualcomm gained spectrum in the key circles of Delhi, Mumbai, Haryana and Kerala, announced Global Holding Corporation and Tulip Telecom as initial shareholders for its LTE venture for network deployment, and started trials. In May 2012 it was announced that **Bharti Airtel** would buy 49% of the Qualcomm license (Qualcomm Asia Pacific – QAP), comprising the 26% owned by Global Holding Corporation and Tulip Telecom, plus a further 23% of the company (according to reports, as a first step to taking full ownership in 2014). Bharti Airtel subsequently raised its share to 51%. **Bharti Airtel** has BWA licences in four other circles - Kolkata, Karnataka, Punjab and Maharashtra.

On April 10, 2012 **Bharti Airtel** commercially launched LTE TDD data-only service in Kolkata; support for mobiles was introduced in June 2014. Service opened in Bangalore on May 7, 2012 and Pune on October 18, 2012 including CSFB, then Chandigarh, Mohali and Panchkula in March 2013. In March 2015 Airtel announced it had 20,000 4G base stations which would double in the coming year. An integrated FDD and TDD LTE network entered customer trials in the Delhi NCR (National Capital Region) on June 18, 2015. A nationwide expansion was announced on August 6, 2015 with an additional 296 cities receving LTE. On February 21, 2016 Airtel announced commercial launch of 2C CA 135 Mbps LTE-Advanced service in Kerala aggregating spectrum in bands 3 and 40. On August 31, 2016 Airtel announced commercial launch of 2C CA 135 Mbps LTE-Advanced service in Mumbai aggregating the same bands. Airtel is trialling VoLTE.

Aircel won BWA spectrum in 8 circles and commercially launched LTE TDD on July 16, 2014 for enterprise users in 4 circles: Andhra Pradesh, Assam, Bihar and Orissa. **Airtel** agreed to buy Aircel spectrum in 8 circles in a spectrum trading deal.

Infotel Broadband was the only pan-India winner, and was later bought by Reliance Industries Ltd (RIL).

Reliance Jio Infocomm began to migrate CDMA customers to its 4G LTE network beginning in May 2016. The network uses band 3, band 5 and band 40 spectrum. On September 5th, 2016 Reliance Jio launched nationwide LTE and VoLTE service launch in 18,000 cities and 200,000 villages across all India's 22 circles. By March 2017 the network is planned to conver 90% of India's population. Data usage and voice calling are free until December 31, 2016.

BSNL acquired 2.6 GHz BWA spectrum licences in band 41 in 22 circles for $1.6 billion and is deploying LTE TDD network targeting launch in 1H 2016.

MTNL bought 2.6 GHz and is studying introducing LTE TDD in addition to current WiMAX deployments.

Videocon is deploying a commercial LTE1800 network for launch in 2016 & plans to deploy VoLTE.

SSTL bidding under the name of **MTS** secured 800 MHz (ex-CDMA) spectrum and technology neutral licences in 8 circles by auction in November 2012.

The company intends to migrate LTE but considers its current spectrum assets insufficient.

On 2nd November 2015 **Reliance** announced it has agreed to acquire **SSTL/MTS.**

Regulator TRAI is consulting on 700 MHz spectrum and IMT-Advanced/LTE-Advanced systems.

In March 2013 TRAI recommended adoption of the APT700 FDD band plan.

In January 2014 the Indian government agreed a refund to BSNL and MTNL in exchange for return of the unused 2.6 GHz spectrum.

DoT started an auction of technology-neutral 900 MHz & 1800 MHz spectrum on February 3, 2014. Bharti Airtel, Vodafone and Idea were the biggest spenders. Reliance Jio Infocomm bought contiguous spectrum 1800 MHz spectrum in 14 circles but did not buy any 900 MHz spectrum. Other winners were **Telenor** (via Telewings), **Aircel** and **RCOM**.

Vodafone India commercially launched LTE1800 on 8th December 2015 in Kochi, Kerala. Bengaluru, Kolkata, Mumbai, New Delhi were also covered in the first phase.

Idea Cellular commercially launched LTE1800 on 23rd December 2015 across 75 towns in 4 Telecom service areas: Andhra Pradesh and Telangana, Karnataka, Kerala and Tamil Nadu. Rollout of LTE in 10 more service areas was achieved by March 2016.

Telenor (formerly Uninor) commercially launched LTE1800 in Varansi city in UP East circle on March 13, 2016. The company plans to roll out LTE to its 6 active circles by end of March 2017.

Bharti Airtel is deploying LTE1800 alongside 2.3 GHz LTE TDD deployments to establish a pan-India 4G/LTE footprint. **Reliance Jio Infocomm** is deploying LTE1800 alongside its existing 2.3 GHz LTE TDD deployments to establish a pan-India 4G/LTE footprint through an integrated ecosystem.

An auction of 800 MHz, 900 MHz, 1800 MHz and 2.1 GHz spectrum ended March 25th, 2015 after 19 days and 115 rounds of bidding, raising 17.6 billion USD.

An auction of spectrum across the 700, 800, 1800, 2100, 2300, and 2600 MHz bands was concluded in early October 2016, raising almost 10 billion USD. The greatest interest was for spectrum in band 1, band 3 and band 40. A large amount of spectrum was not sold including the entire 700 MHz band on offer.

Some operators expressed interest in L-Band allocations for mobile service.

Indonesia

Indosat Ooredoo trialled 2.6 GHz LTE in 2010 and in October 2011 announced completion of an LTE1800 trial using 10 MHz in Surabaya and Denpasar in Bali. **Indosat Ooredoo** launched a pre-commercial trial service capable of theoretical peak 185 Mbps downlink/41 Mbps uplink in November 2014 in 1800 MHz. LTE in 5 MHz of 900 MHz spectrum was commercially launched in Jakarta on December 22, 2014. Commercial service using 2 x 10 MHz 1800 MHz (LTE1800) was launched on July 5, 2015 in Balikpapan, East Kalimantan. On December 10, 2015 150 Mbps LTE-Advanced was launched to customers in the Java, Sumatra and Kalimantan regions, using carrier aggregation of band 3 and band 8 spectrum.

The CDMA network operated by Indosat (StarOne) was turned off end June 2015.

Telkomsel and **XL Axiata** each launched an LTE network trial in Nusa Dusa, Bali in advance of the APEC summit in October 2013.

Telkomsel commercially launched LTE using 5 MHz paired refarmed 900 MHz spectrum on December 8, 2014 with over 200 base stations in Jakarta and Bali. Commercial service using 1800 MHz (LTE1800) was launched on July 5, 2015 in Makassar, South Sulawesi. Manado, Jakarta, Bali, Bandung, Medan, Surabaya and Lombok have since been covered. By April 2016 100 cities were covered at which time the company had 5 million LTE customers.

Telkomsel tested NFV-based VoLTE in 2015.

The CDMA network operated by Telkomsel (Flexi) closed down in 2015.

The parent company of **Axiata** acquired **Axis,** which owned 15 MHz of 1800 MHz, on March 20, 2014. **XL**

Axiata commercially launched LTE in refarmed 900 MHz spectrum on December 22, 2014 in Jakarta, Medan, and Yogyakarta. LTE1800 was commercially launched in Mataram, Lombok on July 6, 2015. 1800 MHz is the main band for expansion. The LTE1800 network also supports VoLTE service.

XL Axiata and **Indosat Ooredoo** are establishing a joint venture co. for future network deployments.

XL Axiata has deployed 4x4 MIMO in parts of the network enabling 210 Mbps when using 2x 15 MHz spectrum, XL Axiata plans to launch LTE Advanced Pro technology in the network in 2017. The company has already trialled Licence Assisted Access (LAA), which is an LTE-Advanced Pro technology.

3 Indonesia commercially launched its LTE1800 network in Banjarmasin, Senin on July 6, 2015 using only 5MHz of its band 3 allocation. Further locations covered by March 2016 include Sumatra, Kalimantan, Sulawesi, Java and Bali.

CDMA operator **Smartfren** has 30 MHz of 2.3 GHz TDD spectrum, 10 MHz band 5, 1800 MHz band 3 spectrum and 13.75 MHz of band 2 spectrum. Smartfren commercially launched Cat 6 LTE-Advanced using 850 MHz (band 5) and TDD 2300 (band 40) spectrum in Jakarta and nationwide in August 2015. Spectrum utilization is 20 MHz band 5 + 10 MHz TDD band 40 support now, and later will support 3 carrier aggregation 20 MHz + 10 MHz TDD band 40 + 10 MHz FDD spectrum. Smartfren launched VoLTE on February 19, 2016. ViLTE was launched in July 2016.

CDMA operator **Bakrie Telecom** is merging with **Smartfren** and take a 6% share in Smartfren and lease part of Smartfren's network.

Government agency SDPPI is consulting on use of 2300 – 2360 MHz spectrum (part of Band 40) for BWA, which may lead to licence awards. Some operators called for new 700 MHz spectrum for LTE following analog to digital TV migration. SDPPI adopted the APT700 FDD band plan in June 2013.

PT Indosat Mega Media (IM2), subsidiary of PT Indosat Tbk (ISAT), selected LTE TDD for 2.3 GHz spectrum won in a BWA license auction in 2009.

WiMAX™ operator **PT Internux** commercially launched LTE TDD on November 14, 2013 using the BOLT brand in Jakarta, Bogor, Depok, Tangerang, and Bekasi, using 15 MHz of 2.3 GHz (band 40). In April 2015 the company announced upgrade to 2C CA LTE-Advanced (band 40) 200 Mbps service in the Greater Jakarta area.

WiMAX™ operator **First Media** is migrating to LTE TDD having 15 MHz of 2.3 GHz (band 40). A Strategic Alliance with PT Internux has been agreed.

2.3 GHz WiMAX™ operator **Berca Hardayaperkasa** is deploying LTE TDD, targeting 75 Mbps service amd 2H 2016 launch in Bali, Makassar and Pekanbaru.

Japan

NTT DoCoMo launched Japan's first commercial LTE system on December 24, 2010 in 2.1 GHz spectrum under the "Xi™" brand, in Tokyo, Nagoya and Osaka. DoCoMo aimed to cover 98% of population with LTE by March 2015. NTT DoCoMo has also launched LTE in 1.5 GHz (band 21) and plans to begin installing APT700 FDD compatible base stations in readiness as this band is allowed for commercial LTE use in 2015. **NTT DoCoMo** also deployed LTE in 1800 MHz band 3 from September 2013.

150 Mbps downlink was first introduced in Kawasaki on July 30, 2013 and extended Tokyo, Nagoya and Osaka that year. An outdoor Advanced C-RAN trial leveraging carrier advanced technology was completed in early 2015 and achieved 240 Mbps using 35 MHz of paired spectrum. NTT DoCoMo launched its Premium 4G 225 Mbps LTE-Advanced service on March 27, 2015 using carrier aggregation to combine spectrum in bands 3 and 19, and bands 1 and 21. The peak downlink speed increased to 300 Mbps by March 2016 and was launched in 22 prefectures. The maximum uplink speed is 50 Mbps. A new top speed of 375 Mbps is to be deployed by March 2017, rising to 500 Mbps during 2017, and 1 Gbps by 2020.

DoCoMo reported 36.29 million LTE subscribers at end 2015, representing 28.3% annual growth.

VoLTE was commercially launched end June 2014. In February 2015 DoCoMo announced successful

testing of VoLTE roaming with KT, South Korea. DoCoMo launched EVS VoLTE service on May 19th. The first mobile phones to support EVS include Sony Xperia X Performance, Samsung Galaxy S7 edge and Sharp AQUOS Zeta.

NTT DoCoMo announced on August 21, 2014 a successful demonstration of *Licensed Assisted Access* technology using LTE in unlicensed spectrum in the 5 GHz band. Company press release https://www.nttdocomo.co.jp/english/info/media_center/pr/2014/0821_00.html

NTT DoCoMo announced LTE roaming service from March 31, 2014 for its customers travelling to the US, Canada, France, Hong Kong, Puerto Rico and the US Virgin Islands. Roaming to Malaysia was activated in April 2014.

KDDI launched commercial LTE service on September 21, 2012. The LTE service was launched in 2.1 GHz spectrum (band 1) to align with the LTE band support offered by the iPhone 5, which KDDI also introduced on the same day. 800 MHz (band 18) spectrum is also now used for commercial LTE service and APT700 (band 28) was introduced later. 225 Mbps LTE-Advanced carrier aggregation, combining bands 1 and 18 spectrum, was launched in May 2014. 300 Mbps LTE-Advanced carrier aggregation, combining bands 1, 18 and 28 spectrum, was launched in 2015. KDDI claims the biggest number of international LTE roaming partners among the local carriers, through partnerships with SK Telecom, CSL, M1, Bouygues Telecom, Swisscom, Orange Spain, AT&T, Rogers, VIVO, and Claro. KDDI commercially launched VoLTE in early December 2014.

WiMAX™ operator and KDDI subsidiary **UQ Communications Inc.** which has 50 MHz of 2.5 GHz (band 41) spectrum, commercially launched LTE TDD service (branded WiMAX 2+) using band 41 in Tokyo on October 31, 2013. Nationwide service was announced on November 1, 2014. LTE-Advanced carrier aggregation and 4x4 MIMO are being deployed across the network and 4x4 MIMO compatible devices were introduced in March 2015.

Ymobile Corporation (formerly eAccess) launched commercial LTE service using 1.7 GHz on March 15, 2012 (i.e. band 9, which is within LTE1800 band 3. A band 9 device will not work on all band 3 networks). Coverage is scheduled to cover 99% of population of Tokyo, Osaka and Nagoya by end June 2012. Ymobile Corp announced in September 2013 the results of its first trials of LTE-Advanced Carrier Aggregation technology and has applied to the regulator for additional 1700 MHz FDD and 80 MHz of 3.5 GHz TDD spectrum for further CA trialling.

Softbank Mobile commercially launched XGP/LTE TDD services on February 24, 2012 via its affiliated company **Wireless City Planning** following a pre-commercial pilot service starting on November 1, 2011. The network is deployed in 20 MHz of 2.5 GHz spectrum (band 41) bought from Willcom (PHS operator) and had over 2.6 million subscriptions by December 2013, with 50,000 eNodeBs deployed.

A 3.5 GHz LTE-Advanced trial was held in the Ginza area of Tokyo (4 x 20 MHz carriers 2480 – 3560 MHz) in 2014.

In September 2015 a trial of 3-band LTE-Advanced carrier aggregation using 10 MHz band 8, 10 MHz band 3, and 15 MHz on band 1 achieved 262.5 Mbps.

Softbank Mobile also owns licences to operate mobile systems in 2.1 GHz FDD (band 1), 1.5 GHz (band 11) and 900 MHz (band 8), and commercially launched LTE FDD service in band 1 on September 21, 2012 when introducing iPhone 5.

Softbank Mobile commercially launched HD voice enabled by VoLTE and SRVCC on December 12, 2014 with launch of a compatible handset, the Aquos Crystal X. At the same time, HD voice was launched on Softbank's 3G network.

Softbank Corp. acquired domestic rival **Ymobile** through a stock swap deal valued at $2.3 billion, providing Softbank with more subscribers and additional radio spectrum (band 9).

In August 2013 **Softbank** demonstrated 5-carrier Carrier Aggregation for LTE TDD using 3.5 GHz spectrum and achieved 770 Mbps downlink in Tokyo. Carrier Aggregation (CA), Coordinated Multi-Point (CoMP) and Cloud BB (Baseband) LTE-Advanced technologies and VoLTE were employed in the trial.

SoftBank announced on September 14, 2016 that the company would carry out a field test for LTE-

Broadcast. Selected baseball games from September 17-19, 2016 were transmitted by LTE Broadcast.

NTT DoCoMo, **KDDI** and **eAccess** (now called ***Ymobile Corporation***) were granted APT700 FDD spectrum in June 2012 for LTE for use from 2015.

The Ministry of Internal Affairs and Communications (MIC) launched a consultation on expansion of regional BWA systems by assigning a band in the 2.6 GHz range to the AXGP standard, which is LTE TDD compliant. Comments were required by 26 July 2013.

MIC confirmed 3.5 GHz TDD licenses on December 19, 2014 would be granted to KDDI, NTT DoCoMo and SoftBank each being allocated 40 MHz. Widescale commercial launches are expected during 2016. The 3 operators shall start the 3.5 GHz LTE base station operation from March 31, 2016 and commercial service in 2016. All committed to over 50-55% coverage population by 2018, for a total 5-year investment commitment of 428.4 Billion Yen (US$3.6 Billion) on base stations by 2019. MIC said its goal is to achieve 1 Gbps of superfast wireless broadband with 3.5 GHz, meaning the 3.5 GHz band in Japan is applicable to LTE-Advanced for operators to carrier aggregate with other band(s) to achieve this goal. In the MIC announcement, UL/DL 1:3 is the choice accepted by all 3 operators; this is the current global mainstream configuration for commercial LTE TDD.

Softbank pans to launch an LTE-Advanced Pro NB-IoT and Cat-M network.

Kiribati

Telecom Services Kiribati Ltd (TSKL) commercially launched LTE for CPE business users in August 2013 using 700 MHz band 12 spectrum. Wider service launch followed on October 29, 2013.

Laos

Unitel (Star Telecom Company) commercially launched LTE on June 23, 2015 in Vientiane, Champassak, Savannakhet and Lu ang Prabang provinces.

Lao Telecom commercially launched 2.6 GHz LTE network on April 9, 2015 (date and frequency band are subject to confirmation).

On May 15, 2012 the Ministry of Post and Telecommunication awarded an LTE licence to **Beeline Lao**. Now in testing phase in Vientiane where coverage will open, uses 1800 MHz spectrum.

The APT700 band plan has been adopted for frequency allocations in the 700 MHz band.

Macau

6 companies applied for 4G licences (LTE FDD and/or TDD). Winners announced in March 2015:

- Companhia de Telecomunicacoes de Macau (CTM)
- China Telecom Macau
- SmarTone Macau
- Hutchison Telecom Macau (3Macau)

Winners accepted coverage obligations of 50% of population by end 2015, 100% in 2016.

Companhia de Telecomunicacoes de Macau (CTM) commercially launched LTE1800 on October 20, 2015 claiming peak downlink speed of 112 Mbps. In 2016 CTM plans to trial 2CA LTE-Advanced carrier aggregation using band 1 and band 3. CTM plans to deliver 450 Mbps peak theoretical downlink speed using 3CA adding TDD band 40 spectrum. VoLTE and ViLTE (Video over LTE) was commercially launched for all customers on June 23, 2016.

SmarTone Macau commercially launched LTE1800 on 11th November 2015.

China Telecom Macau commercially launched LTE1800 on 25th November 2015.

3Macau commercially launched LTE1800 on 15th December 2015 claiming a peak theoretical downlink speed of 112 Mbps. 95% outdoor coverage was claimed by March 2016. VoLTE is in deployment for launch in 2016.

Malaysia

Regulator MCMC named 9 recipients of 20 MHz (2x 10 MHz) of 2.6 GHz spectrum: **DiGi, Celcom Axiata, Maxis, U Mobile,** WiMAX operators **Asiaspace, P1, REDtone International, YTL Communications** (Yes brand) and **Puncak Semangat Sdn Bhd (Altel)** which received 40 MHz (2x 20 MHz). A number of

parties are interested in obtaining access to 700 MHz, and additional 900 MHz and 1800 MHz spectrum (see below.

Maxis commercially launched LTE on January 1, 2013 in 2.6 GHz. 1800 MHz (LTE1800) was added mid-April 2013. In October 2011 **Maxis** and **U Mobile** signed a RAN sharing agreement covering LTE.

Maxis commercially launched 225 Mbps in the Klang Valley in November 2015.

Celcom Axiata commercially launched its LTE service using 2.6 GHz spectrum in the Klang Valley on April 22, 2013. Celcom planned to have 620 live sites by end 2013, and nearly double that figure by Q1 2014. The current LTE network expansion deployment program includes using 2.6 GHz and refarmed 1800 MHz (LTE1800) spectrum.

In July 2013 Celcom Axiata and Altel announced an agreement to jointly develop, establish, build, operate and manage shared infrastructure. Each will pool 2 x 10 MHz of 2.6 GHz bandwidth for LTE deployment. In addition, Altel will consider Celcom's request for the remaining 2 x 10 MHz spectrum owned by Altel. The agreement allows for Altel to appoint Celcom as the exclusive infrastructure and wholesale provider to enable Altel to operate as an MVNO and for other services that are under consideration.

In December 2013 Celcom and DiGi announced they had entered entered into agreement with **Telekom Malaysia** for provision of backhaul services for LTE.

DiGi commercially launched LTE in high traffic spots in the Klang Valley on July 5, 2013 using 2.6 GHz, and has also introduced band 3 into service. 2-carrier 150 Mbps LTE-Advanced service was launched at end 2015 on 30% of the network. The start of VoLTE testing was announced in October 2015 targeting service launch in 2016.

U Mobile commercially launched LTE service using 2.6 GHz on December 17, 2013 in strategic areas within the Klang Valley, namely Bandar Sunway, Subang Jaya, Puchong and Berjaya Times Square as well as Taman Molek in Johor Bahr. Currently the network has approaching 2,000 LTE sites. On August 13, 2016 **U Mobile** announced commercial launch of LTE-Advanced initially in Kota Belud, Sabah. Bands 3 and B7 are combined using LTE-Advanced carrier aggregation, the maximum peak downlink speed is 100 Mbps.

WiMAX™ operator **Packet One Networks P1** (Malaysia) is upgrading its 2.3 GHz network with an LTE TDD overlay. **Telekom Malaysia** confirmed in March 2014 its purchase of 57% of P1. The network is currenty in trial phase.

Telekom Malaysia commercially launched LTE service branded TMgo in 850 MHz band 5 on August 8, 2014 in Alor Setar, Kedah. TM plans to convert 1,200 CDMA sites to LTE. 2.6 GHz band 7 spectrum will be deployed in dense population areas.

WiMAX™ operator **Asiaspace** is deploying LTE TDD in 2.3 GHz.

WiMAX™ operator **YTL** commercially launched LTE TDD (TD-LTE) on June 30, 2016 using band 38 and band 40 spectrum. VoLTE was commercially launched at the same time.

Maxis and **REDtone** agreed infrastructure and spectrum sharing in July 2012. In addition to newly-acquired 2.6 GHz spectrum, **REDtone** has 2.3 GHz band 40 spectrum which it uses for WiMAX™ service.

MCMC announced in February 2016 its plan to reallocated spectrum in the 900 MHz and 1800 MHz bands and has now proposed allocations and related pricing to the operators that were included in the spectrum reallocation process. The operators have until November 1st, 2016 to accept the new 900 MHz and 1800 MHz allocations.

MCMC adopted the APT700 FDD band plan in June 2013 and in December 2013 said that its auction would be delayed until 2018, as broadcasters need to vacate the band before it can be allocated for mobile.

Maldives

Ooredoo commercially launched LTE using 700 MHz in Male for data users on April 28, 2013. Smartphone service was enabled in December 2013. Maafushi received service August 2014. Ooredoo announced on October 23, 2014 successful testing of LTE-Advanced technology.

Dhiraagu commercially launched LTE1800 in Male' City, Hulhumale', Villimale & Ibrahim Nasir

International Airport on October 28, 2014. LTE covered 58% of the population at July 2016. Dhiraagu commercially launched 300 Mbps LTE-Advanced combining band 7 and band 3 spectrum on September 10, 2015.

Marshall Islands

The country's sole operator **NTA** is deploying an LTE network using band 28 APT700 spectrum.

Mongolia

3.5 GHz WiMAX™ operator **Ulusnet** plans to migrate to LTE TDD in the same band. The company also has 50 MHz in 3.5 GHz and 20 MHz in 2.5 GHz.

Communications Regulatory Commission of Mongolia (CRC) allocated band 3 & band 28 specrum for LTE. See http://www.crc.gov.mn/en/k/2lE

Mobicom is deploying an LTE network in bands 3,28.

Unitel is deploying an LTE network in bands 3,28.

Skytel is deploying an LTE network in band 3.

Myanmar

Myanmar Posts and Telecommunications (MPT) had standardised 1800 MHz (20 MHz) for LTE. MPT launched a trial service in 2013 for the SEA Games. LTE using band 1 spectrum was soft-launched in Nay Pyi Taw and Yangon in October 2016.

Ooredoo commercially launched LTE on May 21, 2016 in parts of Yangon, Nay Pyi Taw and Mandalay using band 1 and band 8 spectrum.

Telenor commercially launched LTE on July 7, 2016 in the capital city Nay Pyi Taw using 5 MHz of band 1 2.1 GHz spectrum. VoLTE is planned in future.

Viettel plans to enter the 3G and 4G market.

Regulator MCIT plans to auction 2.6 GHz spectrum in 2016 and 1800 MHz in Q1 2017. **Telenor** and **MPT** are amongst many companies to have expressed interest in participating in the 2.6 GHz auction.

Ooredoo confirmed interest to bid in the 1800 MHz auction.

The APT700 band plan is adopted for allocations in the 700 MHz band.

Nepal

WiMAX™ operator **Nepal Telecom** trialled LTE TDD and FDD modes and plans to launch an LTE-Advanced network, seeking approval from the Nepal Telecom Authority (NTA) to use its existing 1800 MHz spectrum for LTE and targeting commercial launch on December 15, 2016.

Smart Telecom is seeking approval from NTA to deploy an LTE network.

The APT700 band plan is adopted for allocations in the 700 MHz band.

New Caledonia

OPT commercially launched LTE service on February 16, 2015. Spectrum in band 20, band 3 and band 7 is utilized according to the sites. Coverage to over 85% of the population is targeted by end 2016.

New Zealand

Vodafone New Zealand launched LTE commercial service on February 28, 2013 in Auckland using 1800 MHz (LTE1800). Service reached Christchurch on May 29, 2013 and 6 more cities including Wellington by July 2013. The LTE network is available to 3.56 million people (over 85% of population - September 2015, increasing from 74% in February 2015). Public demonstrations of LTE-Advanced carrier aggregation were made in May 2013. Vodafone is deploying APT700 spectrum for rural coverage which the company first brought into service on July 18, 2014. On 20th October 2015 Vodafone announced deployment of LTE-Advanced technology at 72 sites. The company has spectrum assets in band 3, 7, and 28 and uses all three bands for LTE deployed in tri-band (300 Mbps) and dual-band carrier aggregation configurations.

In February 2015 Vodafone announced completion of a successful trial of VoLTE in Auckland.

Spark commercially launched Cat 4 LTE service in Auckland, Wellington and Christchurch on November 12, 2013 using 1800 MHz (LTE1800). LTE-Advanced carrier aggregation (CA) was deployed on 6 sites in May 2014, combining 20 MHz band 3 with 20 MHz band 7. Cat 6 devices were not offered immediately.

APT700 band 28 was brought into service for rural coverage on August 28, 2014 initially on 12 sites in the Waikato region. Spark is trialling VoLTE but has not committed to launching a VoLTE-based service.

2degrees commercially launched LTE1800 Cat 4 in Auckland on June 30, 2014. Coverage extended to Christchurch, Hamilton and Wellington by end 2014. APT700 was brought into service 26 January 2015.

The government adopted the APT700 FDD band plan and attempted to auction spectrum in 9 paired 5 MHz blocks. Bidding started on October 29, 2013. Spectrum was usable from January 1, 2014.

- **Vodafone** obtained three lots (2 x 15 MHz)
- **Spark** obtained three lots (2 x 15 MHz)
- **2degrees** obtained two lots (2 x 10 MHz)

The remaining 2 x 5 MHz block was auctioned and won by **Spark** with a bid of NZ$ 83 million.

Kordia was considering upgrading its 2.3 GHz rural mobile network to LTE TDD, though sold 35 MHz of its spectrum to Woosh in 2013.

Woosh owns rights to spectrum including 35 MHz of 2.3 GHz band 40 spectrum but failed to win new business under the government's Rural Broadband Initiative. Spectrum must be utilized for service by June 2016. **Spark** has expressed interest to buy unused 2.3 GHz spectrum for LTE deployment.

Northern Mariana Islands (NMI)

IT&E commercially launched LTE (and HSPA+) on July 14, 2014 using 700 MHz band 12.

Pakistan

The Pakistan Telecommunication Authority MoIT auctioned 30 MHz of 3G 850 MHz and 20 MHz of 4G 1800 MHz spectrum in April 2014.

China Mobile Pakistan (CMPak), which operates under the brand name **Zong**, was the only winner of 4G spectrum and commercially launched LTE1800 in 7 cities on September 27, 2014. By the end of 2016 the network is expected to comprise 6,000 sites. In a company press release on August 10, 2016 **Zong** confirmed its LTE service covered over 100 cities.

10 MHz of 850 MHz spectrum and 10 MHz of 1800 MHz spectrum was unsold.

Mobilink (formerly Warid Telecom) commercially launched LTE1800 on December 26, 2014 using refarmed spectrum. **Mobilink** and **Warid Telecom** merged with effect from July 1, 2016.

Telenor commercially launched 150 Mbps LTE850 in six cities on August 8th, 2016.

The APT700 band plan has been adopted for frequency allocations in the 700 MHz band.

MoIT is preparing to auction a single licence with 2 x 10 MHz of 850 MHz spectrum.

Papua New Guinea

Digicel PNG was allocated APT700 FDD spectrum (2 x 22.5 MHz) in April 2012 and commercially launched 4G/LTE on March 26, 2014 for postpaid customers. A CPE and MiFi were offered at launch.

Telikom PNG and **bmobile** are deploying a joint 3G/4G network. Telikom expects to deploy LTE by end 2016.

The Philippines

Following a period of limited commercial LTE service beginning in Boracay in April 2011 then extended to additional locations including Cebu and Davao, **Smart Communications** commercially launched wider LTE service on August 25, 2012 in Metro Manila using 2.1 GHz (band 1). Commercial LTE service was also launched using 1800 MHz (LTE1800 – band 3) on September 5, 2012. To further extend coverage, 850 MHz spectrum (band 5) was brought into use on September 14, 2012. Smart conducted trials of LTE-Advanced technology in Metro Manila, Davao City and Boracay. LTE-Advanced is activated in some locations. Smart is also conducting LTE TDD trials. In November 2013 Smart announced completion of LTE Multicast (eMBMS) trials for delivery of multimedia content. 3C CA 250 Mbps LTE-Advanced was introduced in April 2016 in Boracay.

Smart activated 3 APT700 band 28 sites on June 6, 2016 and plans to deploy 360 700 MHz cell sites by end 2016. 222 Mbps LTE-Advanced is available at

700 MHz sites, e.g. Tanay where band 3 and band 28 spectrum are combined using LTE-Advanced CA.

On 20 October 2016 **Smart** announced results from its 5C CA LTE-Advanced Pro lab technology trial, achieving 1.4 Gbps downlink data speed.

Smart's owner **PLDT** commercially launched LTE TDD BWA service "*HOME Bro Ultera"* on April 29, 2014 alongside its WiMAX™ service. PLDT launched with 200 LTE TDD band 42 sites and planned to deploy 5,000 sites for 50% geographical coverage.

Globe Telecom launched commercial LTE1800 service (Tattoo brand) on September 28, 2012 in Makati City. Globe demonstrated up to 230 Mbps LTE-Advanced CA in 2014 using 2x 20 MHz spectrum which is now in deployment, and announced plans to launch LTE Broadcast in selected areas. Globe is migrating from WiMAX™ network to LTE TDD and FDD in Visayas and Mindanao. Globe activated its first APT700 site in Quezon City on June 6, 2016, demonstrating 100 Mbps. 250 sites were equipped with APT700 by September 2016 and 500 sites in total are planned by end 2016. 2.6 GHz was introduced for service on 130 sites in June 2016. Globe is currently deploying an LTE-Advanced Pro network.

Bayan Telecommunications indicated interest to deploy LTE in existing 1800 MHz spectrum and has since been acquired and integrated into Globe's operations. The Bayan brand may be retired.

Belltel Philippines is deploying an LTE network using band 28 spectrum for launch in 2017.

Regulator NTC plans to conduct an auction of spectrum for 3G and 4G services and confirmed interest exists for for awarding a third operator licence for the country.

Samoa

Digicel launched an LTE network on May 31, 2016 with coverage across Apia, Salelologa and Tuasivi.

Singapore

M1 launched commercial 75 Mbps LTE services in the financial district on June 21, 2011 using 2.6 GHz, later adding LTE1800. Nationwide coverage using dual band was announced on September 15, 2012. M1 network speed was raised to 150 Mbps peak in early 2014. 300 Mbps LTE-Advanced was commercially launched on December 2, 2014 and available in more than 95% of indoor areas and most outdoor areas. VoLTE was commercially launched on April 8, 2015. In January 2016 M1 confirmed it had achieved over 1 Gbs downlink and 130 Mbps uplink speeds in a laboratory trial by combining 4x4 MIMO, 3CCA downlink, 2CCA uplink, 256QAM and using a Cat 14 prototype device.

M1 is deploying a nationwide LTE-Advanced Pro NB-IoT network by 1H 2017.

StarHub tested LTE in 2.6 GHz and 1800 MHz. An LTE1800 network in refarmed 1800 MHz was commercially launched September 19, 2012 in the Central Business District, Changi Airport and Singapore Expo. 2.6 GHz band 7 spectrum was brought into use in 2013. StarHub launched VoLTE-enabled HD Voice+ service on June 28, 2014 for its SmartSurf HD subscribers. Parts of the network were upgraded to 150 Mbps in mid 2014. 300 Mbps Cat 6 LTE-Advanced was launched in December 2014 with carrier aggregation combining B3 and B7 spectrum. On May 27, 2015 StarHub announced that 600 Mbps downlink data speed was achieved trialing tri-band LTE-Advanced carrier aggregation technology and 4x4 MIMO. 2C CA carrier aggregation with 64QAM on the uplink is being deployed for commercial service by end 2016. A trial combining uplink spectrum in band 3 and band 7 achieved 150 Mbps. StarHub is also trialling TDD in bands 38 and 40.

SingTel launched commercial LTE1800 service on December 22, 2011 with 2.6 GHz spectrum. SingTel also trialled LTE overseas with carriers in which it holds stakes i.e. SingTel Optus (Australia), Telkomsel (Indonesia), Globe Telecom (Philippines). SingTel announced in May 2013 the company had achieved nationwide coverage and upgraded its network to Cat 4 (peak downlink speed of 150 Mbps). On May 28, 2014 SingTel unveiled its 300 Mbps Cat 6 LTE-Advanced network, which combines 20 MHz band 3 and 20 MHz band 7 spectrum and in February 2015 announced that the 300 Mbps service will be available nationwide from March 2015. A Cat 6 MiFI hotspot device manufactured by Huawei was offered in SingTel retail outlets from July 24, 2014. 260 Mbps

was achieved using carrier aggregation combining 20 MHz of FDD & 20 MHz of TDD spectrum. 900 MHz was brought into use on July 28, 2015 as part of a 337 Mbps tri-band LTE-Advanced system. SingTel is deploying 3-band 450 Mbps LTE-Advanced. VoLTE was commercially launched on May 31, 2014 using the brand name "4G ClearVoice". Singtel is trialling TDD in bands 38 and 40.

On July 26, 2016 **Singtel** announced successful trial of LTE License Assisted Access (LAA) on Singtel's live 4G/LTE network. Using 20 MHz of band 3 spectrum as the anchor carrier augmented with 20 MHz of unlicensed 5 GHz spectrum up to 275 Mbps throughput was measured. *With the successful trial of LAA, this service will be progressively deployed in Singapore over the next two years, beginning in the first half of 2017, enabling Singtel to extend its current in-building coverage capacity and provide a better 4G experience to its mobile customers. New handset models supporting LAA are expected to be available by early 2017. In the future, customers with LAA-capable handsets will be able to enjoy peak download throughput up to 450 Mbps* (Company press release).

SingTel trialled eMBMS LTE Broadcast in 2014. A further LTE Broadcast trial was held at the South East Asian (SEA) Games, Singapore 5-16 June 2015.

In June 2013 regulator IDA auctioned additional 1800 MHz and 2.6 GHz spectrum to all three incumbent mobile operators: SingTel Mobile, StarHub and M1, which will be used for LTE. IDA adopted the APT700 FDD band plan in June 2013.

Operators' rights to use 900 MHz band 8 expire in April 2017. IDA plans to auction this spectrum and also 700 MHz (APT700). Incentives are proposed to encourage a new 4th player. A consultation paper was published on July 7, 2015. Final rules have been confirmed for an auction of spectrum in 700 MHz, 900 MHz, 2.3 GHz and 2.6 GHz that could take place in October 2016.

Fibre broadband provider **MyRepublic** is bidding to become the country's fourth mobile operator and is trialling LTE technology. **AirYotta and TPG Telecom** are the other two other hopeful bidders.

M1, Singtel and StarHub announced they will close 2G/GSM services in Singapore from April, 2017 with spectrum to be refarmed for 3G/HSPA and 4G/LTE.

South Korea

LG Uplus commercially launched LTE on July 1, 2011 using 10 MHz of 850 MHz (band 5), achieving nationwide coverage by April 2012. Multi-carrier services were commercialized in July 2012 and released in 84 cities by July 18, 2013, with 10 MHz paired 2.1 GHz spectrum (band 1). LTE-Advanced Carrier Aggregation technology was commercialized on July 18, 2013, supporting up to 150 Mbps peak download by combining two paired 10 MHz frequencies (850 MHz and 2.1 GHz bands) creating an effective bandwidth of 20 MHz paired. Results of a 3-carrier aggregation trial (850, 2100, 2600 MHz) with 300 Mbps downlink were announced in June 2014. Single-mode LTE service was commercially launched on July 20, 2013 and claimed to be a world first for commercialization of single-mode LTE delivering data and HD voice (VoLTE) without WCDMA support.

LG Uplus gained 40 MHz of 2.6 GHz in August 8, 2013. In all, **LG Uplus** has secured a total of 80 MHz paired LTE spectrum made from 20 MHz of 800 MHz, 20 MHz of 2.1 GHz, and 40 MHz of 2.6 GHz. Since December 30, 2013 LG Uplus claims to be the top operator servicing the broadest LTE bandwidth in the world at 80 MHz and offers LTE, LTE-Advanced and 20 MHz wideband LTE services using this full bandwidth. **LG Uplus** launched Carrier Aggregation in wideband LTE mid-2014, supporting up to 225 Mbps peak download by combining two different 20 MHz bandwidth frequencies (800 MHz and 2.6 GHz).

LG Uplus claimed to be the first South Korean operator to deploy a tri-band multicarrier LTE system which automatically handles both voice and data traffic, by using 850 MHz, 2.1 GHz and 2.6 GHz spectrum. This service was initially available in Seoul and selected Greater Seoul areas, and rolled out to nationwide coverage by July 2014. Tri-band LTE-Advanced carrier aggregation service using 2x10 MHz 800 MHz + 2x10 MHz 2.1 GHz + 2x20 MHz 2.6 GHz was commercially launched on January 11, 2015 with the Cat 6 compatible LG G Flex 2 phone.

LG Uplus successfully conducted a field test of uplink CA service providing theoretical uplink speed of 100

Mbps and claimed as the world's first such test. Using wideband LTE service in 2.6 GHz spectrum, paired with 800 MHz band nationwide LTE service, **LG Uplus** demonstrated the field test in June 2014. As stated in the previous paragraph, LG Uplus commercially launched 3-band carrier aggregation. In the area where **LG Uplus** provides 2x20 MHz wideband service in 2.6 GHz spectrum, the company has presented uplink speed of 50 Mbps, which the company claimed as the fastest uplink speed in the country. Combining the 300 Mbps downlink speed with the uplink speed of 50 Mbps in South Korea **LG Uplus** claimed to be the sole telecommunication company offering the fastest downlink and uplink speed simultaneously where wideband LTE is deployed.

In the current **LG Uplus** LTE network, downlink 64 QAM and 2x2 MIMO are used. On 23rd November 2015 LG Uplus announced it had conducted a demonstration of potential 1.2 Gbps capability by deploying LTE-Advanced Pro 256QAM (boosts speeds by over 30%) and 4 x 4 MIMO (doubles speed) achieving up to 780 Mbps. More spectrum will be sought by the company in a new spectrum auction this year to enable 4 band CA to be deployed to achieve 1 Gbps capability. Commercial 2 CC CA uplink peak 108 Mbps was introduced in April 2016.

LG Uplus is deploying a nationwide LTE-Advanced Pro NB-IoT network by 2017.

LTE-Advanced Pro: KT and LG U+ with Huawei formed a NB-IoT alliance.

SK Telecom commercially launched LTE service in Seoul on July 1, 2011 in 10 MHz in Band 5 (850 MHz). The company reached nationwide (84 cities) coverage by April 1, 2012. In December 2011 SK Telecom started deploying dual-mode femtocells with LTE and Wi-Fi that, according to the Small Cell Forum, were the first LTE femtocells on a commercial network. In May 2012 SK Telecom announced multi-carrier trials (LTE-Advanced) to allow combining of Band 5 and Band 3 spectrum. A multi-carrier LTE service was launched on July 1, 2012, extending across all of Seoul by end 2012 and to 23 other major cities by early 2013. SK Telecom said that this was the world's first commercialization of Multi Carrier.

SK Telecom launched commercial VoLTE HD Voice (W-AMR) service in August 2012. SK Telecom informed GSA that the company had 10.14 million VoLTE users as of June 9, 2014

SK Telecom announced start of international LTE roaming service with **Globe Telecom** (Philippines) on 1 April 2013, adding to existing roaming agreements with CSL Ltd (Hong Kong) from June 1, 2012 and SingTel from March 1, 2013. SK Telecom announced plans to launch quad-band LTE devices (850 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz) during Q2 2013.

LTE-Advanced (Release 10) Carrier Aggregation was commercially launched by **SK Telecom** on June 26, 2013, claiming that Carrier Aggregation had been commercialized for the first time in the world, supporting up to 150 Mbps peak downlink by combining two 10 MHz carriers (1.8 GHz and 800 MHz bands) to create an effective bandwidth of 20 MHz. SK Telecom began offering LTE-Advanced in Seoul and central areas of Gyeongg-do and Chungcheong-do, and expanded LTE-Advanced to 84 cities nationwide. The LTE-Advanced service was launched with the world's first LTE-Advanced phone, Samsung Galaxy S4 LTE-A and 7 different LTE-Advanced smartphones were introduced in 2H 2013.

SK Telecom won 20 MHz of 1800 MHz (LTE1800) in the August 2013 auction and began offering 150 Mbps LTE service using this wider bandwidth in 1800 MHz on September 30, 2013 with plans to expand nationwide by July 2014. 225 Mbps (20 MHz 1800 MHz + 10 MHz 800 MHz spectrum combined using carrier aggregation) peak downlink service was commercially launched on June 19, 2014 together with a new Samsung Galaxy S5 for 225 Mbps.
http://www.sktelecom.com/en/press/detail.do?idx=1075

SK Telecom began building LTE base stations using 2.1 GHz spectrum in Q2 2014. The world's first tri-band LTE-Advanced service was commercially launched by SK Telecom on December 29, 2014 combining 20 MHz in 1800 MHz band, 10 MHz in 800 MHz band, and 10 MHz in the 2.1 GHz band for theoretical peak downlink of 300 Mbps. Tri-band LTE-Advanced is offered in areas where coverage of all 3 component carriers intersect.

SK has also trialled FDD-TDD carrier aggregation. In April 2014 **SK Telecom** claimed the world's first

commercialization of Uplink CoMP (Uplink Cooperative Multi-Point), and plans to apply the feature across its network.

On June 11, 2014 at Mobile Asia Expo 2014 in Shanghai, **SK Telecom** with its infrastructure partner used LTE-Advanced carrier aggregation to combine 200 MHz bandwidth (9 TDD carriers + 1 FDD carrier) achieved a peak downlink throughput of 3.8 Gbps, which was claimed at the time as a world record.

SK Telecom with its system partner has demonstrated 4x4 MIMO technology, which has the potential to double maximum downlink speeds, achieving 600 Mbps downlink speed using carrier aggregation of two 20 MHz bandwidths.

SK Telecom announced on January 28, 2015 that together with its infrastructure partner the company had commercialized a core LTE-Advanced technology called 'Enhanced Inter-Cell Interference Coordination (eICIC)' which it claimed was for the first time in the world. eICIC technology controls signal interference between macro and micro base stations to enhance the quality of the LTE-Advanced network. With the deployment of eICIC, SK Telecom expects to provide its customers with enhanced experience by reducing inter-cell interference by 15% in traffic congested areas where macro and micro cells are concentrated. SK Telecom has applied eICIC to its LTE-Advanced network located in Gwangju Metropolitan City and planned to apply the technology to the rest of its nationwide LTE-Advanced network by the first half of 2016. Company press release http://www.sktelecom.com/en/press/detail.do?idx=1100

SK Telecom with Nokia Networks announced on December 9, 2015 that 428 Mbps downlink speed was achieved in a trial of three-carrier TD-LTE-Advanced in band 41 spectrum with 256QAM.

Current status of SK Telecom LTE-A network:

- Since June 1, 2016, SK Telecom has been providing LTE-Advanced Pro, which supports peak data rates of 500Mbps, by applying 256QAM technology to its tri-band LTE-Advanced CA network. Also, with the additional 30 MHz bandwidth acquired at the spectrum auction held in May 2016, SK Telecom now has the largest amount of spectrum resources in Korea, thus securing the basis for LTE Advanced 5 Band Carrier Aggregation.

- SK Telecom commercialized the LTE-Advanced Pro service by applying 256QAM to its 375 Mbps tri-band LTE-Advanced CA (20MHz bandwidth in the 800MHz band, 10MHz bandwidth in the 1.8GHz band, and 10 MHz bandwidth in the 2.1GHz band) network

- LTE-Advanced Pro is currently being provided in main areas of the southeastern region of Korea (i.e. Yeongnam area) including Pusan, Ulsan and Daegu, and will be expanded to the southwestern region (Honam area) including Gwangju in July 2016, and to the Seoul Metropolitan area and mid-western region (Chungcheong area) in August 2016.

- SK Telecom secured a pair of spectrum blocks (10MHz + 20MHz) in the 2.6 GHz band at the spectrum auction held on May 2, 2016

- SK Telecom plans to roll-out its LTE network using the 30MHz bandwidth of 2.6GHz band, covering Seoul and six metropolitan cities by the end of 2016, main areas of 85 cities nationwide by the end of 2017, and all areas of the 85 cities by the end of 2018 (the nationwide network will cover over 90% of the population).

- With successful acquisition of new spectrum in the 2.6 GHz band, SK Telecom secured a basis for LTE-Advanced 5 band CA, which, once realized, will support peak data rates of 525Mbps. Building on this, SK Telecom will also apply LTE-Advanced Pro technologies such as 256QAM and 4X4 MIMO to provide customers with peak data rates over 1Gbps.

- SK Telecom with Qualcomm recently announced completion of a trial of Enhanced License Assisted Access (eLAA) and License Assisted Access (LAA) technology using both licensed and unlicensed spectrum. The trial in Bundang combined 2.6 GHz licensed apectrum and 5 GHz unlicensed spectrum.

KT commercially launched LTE services in Seoul on January 3, 2012 in re-farmed 1800 MHz (Band 3) (LTE1800). KT announced on April 23, 2012 LTE coverage in 84 cities.

VoLTE service was commercially launched October 8, 2012 nationwide on the whole KT LTE network. In February 2015 DoCoMo announced successful testing of VoLTE roaming with KT.

KT has delivered a 20 MHz wideband 1800 MHz LTE service since mid-September 2013 by adding the additional 1800 MHz frequency bought by auction in August 2013 (see below). Therefore the peak downlink throughput is 150 Mbps at 1800 MHz (LTE1800) supporting Cat 4 devices and KT believes this was the first 20 MHz wideband LTE service in the Korean market. By bringing into service an additional 5 MHz, a total of 15 MHz was allocated for the uplink.

In the area where KT provides 20 MHz wideband LTE services, KT also provides 10 MHz multicarrier service by bringing into use 10 MHz of 900 MHz band 8 spectrum. In addition KT is using Carrier Aggregation to combine 10 MHz B3 and 10 MHz B8 in the other area where 20 MHz wideband is not used. KT plans to support 20 MHz B3 combined with 10 MHz B8, subject to availability of UE terminals. **KT** has confirmed its successful demonstration of FDD-TDD carrier aggregation.

KT announced on June 16, 2015 its plan to commercialise its GiGA-LTE network which combines 3-band carrier aggregation LTE with WiFi to offer a theoretical maximum downlink speed of 1.17 Gbps. KT operates over 200,000 LTE base stations and 140,000 WiFi hotpsots nationwide. GiGA-LTE service was immediately offered to Samsung Galaxy S6 and S6 Edge users. The service is non-standard since a device implementation is required (firmware update). GiGA-LTE is to be extended to other smartphone models, all of which need firmware upgrades.

KT announced commercial launch of the world's first eMBMS-enabled LTE Broadcast service on January 27, 2014. The service is branded ***Olleh LTE Play*** and targets consumers using Samsung Galaxy Note 3 devices who have downloaded the Olleh eMBMS application to stream 2 major channels. By January 2015 MBMS service covered hot spots areas including the No. 1 subway line in Seoul and most baseball stadiums in South Korea. eMBMS is supported by Galaxy Note 3, Note 4 and S5 devices.

Regulator **KCC** conducted an auction in August 2011 of spectrum in 800, 1800 MHz and 2.1 GHz bands. SK Telecom and KT were barred from bidding for 2.1 GHz spectrum. **SK Telecom** won 20 MHz of 1800 MHz spectrum. **KT** won 10 MHz of 800 MHz spectrum. **LG Uplus** won 20 MHz in 2.1 GHz for LTE deployments.

After around 50 rounds of bidding in August 2013, KT won 15 MHz of new 1800 MHz spectrum next to its current holding used in its LTE network. This allocation will enable introduction of Cat 4 (150 Mbps). SK Telecom also acquired more 1800 MHz channels. **LG Uplus** won 2.6 GHz spectrum on August 8, 2013, thereby securing 800 MHz, 2.1 GHz & 2.6 GHz LTE spectrum totaling 40 MHz paired.

KT announced commercial launch of 3-band 300 Mbps LTE-Advanced service in the major areas of 85 cities with availability of commercial Cat 6 compatible Samsung Galaxy Note 4 phones on January 23, 2015. The LG G Plex2 Cat 6 phone was offered from January 30, 2015. The 300 MBps service had been available from December 28, 2014 for users with non-commercial terminals to experience the tri-band carrier aggregation performance. The service combines 10 MHz B1 + 20 MHz B3 + 10 MHz B8.

KT demonstrated NB-IoT in September 2016.

LTE-Advanced Pro: KT and LG U+ with Huawei formed a NB-IoT alliance.

SK Telecom, KT and LG Uplus announced the world's first national commercial interconnected VoLTE service in June 2015.

Korea Mobile Internet (KMI), a consortium of local MVNOs, has repeatedly applied for permission to deploy an LTE TDD network. If approved, KMI plans to launch services in all 85 major cities by October 2015. KMI would operate a wholesale model to MVNOs to retail services to their customers.

South Korea has allocated 2 x 20 MHz bandwidth in accordance with the APT700 FDD band plan. Spectrum may be auctioned in 2016.

MSIP attempted to auction spectrum in 700 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands in April 2016. Spectrum was won by the three incumbents. The 700 MHz block was unsold. Summary of results:

- SKT won 60 MHz paired 2.6 GHz
- LG U+ won 20 MHz paired 2.1 GHz
- KT won 20 MHz paired 1800 MHz

http://www.mobileworldlive.com/asia/asia-news/korea-auction-attracts-limited-interest-700mhz-goes-unsold/

Sri Lanka

Dialog Axiata commercially launched LTE TDD in 2.3 GHz (band 40) via its DBN subsidiary on December 30, 2012 in Colombo. Dialog later acquired 10 MHz of 1800 MHz by auction and commercially launched LTE1800 on April 2, 2013 in Colombo. The LTE TDD system continues to be developed for fixed wireless services. In May 2013 the company announced it had gained an extra block of 2.3 GHz following the acquisition of a pay TV operator. On July 14, 2015 Dialog Axiata announced the commencement of its LTE-Advanced Pilot Network that will provide data speeds exceeding 100 Mbps for Home Broadband users in the City of Colombo. In June 2016 **Dialog** demonstrated 1 Gbps with LTE-Advanced Pro using 4 carriers of band 40 (3 x 20 MHz carriers + 1 x 15 MHz carrier), 256QAM on the downlink, and 4 x 4 MIMO. VoLTE was soft-launched on June 23, 2016. VoLTE commercial service launch network-wide was announced on September 1, 2016.

Mobitel (subsidiary of Sri Lanka Telecom) launched commercial LTE1800 service on January 6, 2013.

On June 17th, 2016 **Mobitel** announced the company had successfully trialled LTE-Advanced Pro in its test laboratories. Mobitel is trialling VoLTE.

Etisalat is deploying a commercial LTE network.

WiMAX™ and CDMA operator **Lanka Bell** commercially launched LTE TDD in band 40 on February 4th, 2014 in Colombo and Greater Colombo.

SLT commercially launched fixed wireless access LTE TDD in band 38 (2.6 GHz) on January 19, 2014.

Analog to digital TV transmission is expected to be completed by 2020, after which 700 MHz spectrum could be allocated for LTE.

Taiwan

Chunghwa Telecom trialled LTE in 2.6 GHz and 700 MHz, completed FDD and TDD tests on the high-speed rail system using 2.6 GHz, and commercially launched the country's first LTE network on May 29, 2014 using 900 MHz and 1800 MHz spectrum. LTE-Advanced with carrier aggregation of 15 MHz band 3 + 10 MHz band 8 spectrum was activated on December 29, 2014, for theoretical peak downlink speed of 180 Mbps for users with compatible devices. Chunghwa introduced recently won 2.6 GHz (see below) and launched 3-band 340 Mbps LTE Advanced service in March 2016.

FarEastone commercially launched LTE using APT700 FDD band 28 on June 3, 2014 and added 1800 MHz band 3 in August 2014 using LTE-Advanced carrier aggregation. 2.6 GHz band 7 was combined from March 31, 2016 to achieve 300 Mbps service capability. VoLTE HD voice service was commercially launched on June 10, 2015.

Taiwan Mobile commercially launched its LTE network using 700 MHz APT700 FDD band 28 spectrum (15 MHz) on June 4, 2014 and introduced 5 MHz of 1800 MHz band 3 spectrum (LTE1800) and LTE-Advanced carrier aggregation on September 1, 2014. Initial coverage was in six metropolitan areas covering about 80% of the corresponding population, and 1.1 million LTE subscritpions were signed by end 2014. At launch the network comprised over 1,500 base stations, rising to over 4,000 by end 2014. Taiwan Mobile launched VoLTE on January 26, 2016.

FarEasTone and **China Mobile** co-operated on an LTE TDD trial in Taipei. The **National Chiao Tung University** conducted an LTE TDD trial in 2010. BWA operators **Global Mobile, Tatung, FET and VMAX** have technology-neutral licences.

2.6 GHz WiMAX™ operator **Global Mobile** has received approval to switch to LTE TDD and has begun testing.

PHS and WiMAX™ operator **Fitel** trialled LTE TDD for a year from July 1, 2011 in Taoyuan, and is

expected to request the NCC to allow migration from WiMAX to LTE if their trial proves successful.

NCC began an auction on September 3, 2013 for APT700, 900 and 1800 MHz bands totaling 135 MHz x 2, ending the following month. Results:

- **Chunghwa Telecom** won spectrum in the 900 MHz and 1800 MHz bands
- **FarEasTone** won APT700 and 1800 MHz
- **Taiwan Mobile** won APT700 and 1800 MHz
- **Hon Hai** won APT700 and 900 MHz
- **Taiwan Star Mobile** won 900 MHz
- **Asia Pacific Telecom** won APT700

http://www.ncc.gov.tw/english/content_field_detail.aspx?site_content_sn=215&is_history=0&pages=0&sn_f=69

CDMA operator **Asia Pacific Telecom** commercially launched LTE on December 24, 2014 with a range of band 28 compatible phones. VoLTE was commercially launched in May 2016.

Hon Hai (Foxconn) is backing **Ambit Microsystems** which is deploying the LTE network. Ambit is pursuing a merger with APT. Taiwan Mobile is purchasing 14.9% stake in Ambit and has been approved to purchase an additional 5 MHz block of APT700 spectrum from Ambit.

Ambit Microsystems commercially launched LTE on May 15, 2015 using APT700 and 900 MHz spectrum together with VoLTE HD voice service.

Taiwan Star Mobile commercially launched LTE using 900 MHz on August 25, 2014 claiming 85% coverage at launch. The company brought newly gained 2.6 GHz spectrum (see auction below) in April 2016 and launched 2C CA 225 Mbps LTE-Advanced. The company acquired 3G/HSPA operator **VIBO** in June 2014. VoLTE was launched in July 2015.

In November 2015 NCC auctioned 190 MHz of 2.6 GHz spectrum, covering FDD (140 MHz) and TDD (50 MHz) bands (all to be released in 2016). The auction ended on December 7, 2015 with the following winners:

Chunghwa Telecom
Asia Pacific Telecom
Taiwan Star
FarEasTone

Taiwan Mobile withdrew during the auction.

2.1 GHz spectrum will be auctioned in 2017. 1900 MHz, 2.3 GHz and 3.5 GHz spectrum may also be auctioned after 2015. Spectrum in the band 5.7 – 6.4 GHz has been identified for operators wishing to deploy LTE small cells, for which no charge will be made to applicants, according to reports.

Thailand

Regulator NBTC approved trialling of LTE in 2.3 GHz and 1800 MHz. **TOT** partnered with its concession holder **AIS** to trial 2.3 GHz LTE TDD in 20 MHz of its total 64 MHz allocation with 20 sites in central Bangkok in January 2012. TOT plans to deploy LTE service using 2.3 GHz, which must be achieved by end 2017 otherwise approval will be revoked.

Softbank has a partnership with **TOT**, which focused on joint development of a 2.3 GHz LTE TDD network using TOT's allocation of 64 MHz bandwidth. The first test phase ran until May 2012.

AIS subsidiary **Digital Phone Co** joined with **CAT Telecom** to test LTE1800 from mid-January 2012 in Maha Sarakham. The trial had 8 sites and ran until March 2012. TOT planned new trials involving up to 400 sites using 30 MHz of 2.3 GHz spectrum.

AIS launched LTE pre-commercial service in December 2015 with free usage leading to the planned official commercial launch of 2CA 190 Mbps LTE-Advanced on January 26, 2016 combining 2 x 15 MHz band 1 and 2 x 15 MHz band 3 spectrum.

AIS commercially launched its LTE-Advanced Pro network on March 24, 2016 using 4x4 MIMO, carrier aggregation of band 3, band 1, unlicensed spectrum enabled by LTE-U technology, use of 256QAM on the downlink and 64QAM on the uplink to realize theoretical peak downlink speed of 550 Mbps. The initial service launch area was Bangkok and surroundings. Their website states user devices will be available in 2016. **AIS** commercially launched VoLTE on March 24, 2016 across all 77 provinces

True Move commercially launched LTE service on May 8, 2013 using 2.1 GHz. LTE1800 was brought into service as a complementary band in mid-December 2015 (see below regarding 1800 MHz

auction results). Currently up to 335 Mbps is offered across parts of the network using 3C CA 10 MHz B1 + 15 MHz B3 + 5 MHz B8 with 4x4 MIMO. VoLTE was launched on May 1, 2016.

DTAC, rebranded as **TriNet**, commercially launched LTE in 2.1 GHz on May 10, 2014 using 5 MHz bandwidth in inner Bangkok with major business and residential districts covered. 1800 MHz was refarmed for LTE and commercially used from October 2015. DTAC plans nationwide LTE in 2016. VoLTE was commercially launched on October 15, 2015.

On August 14, 2015 **DTAC TriNet** and **AIS** announced a tower-sharing partnership.

NBTC auctioned LTE-suitable 900 MHz and 1800 MHz licences. Until then, **True Corp** and **AIS** could continue using 1800 MHz for GSM services, while **AIS** is allowed to continue using its 900 MHz spectrum. CAT Telecom is allowed to use a separate 2 x 20 MHz block of 1800 MHz until September 2018.

30 MHz of paired 1800 MHz spectrum was auctioned on 12-13 November 2015 and won by **AIS** and **True Move** who paid USD 2.2 billion.

Two 900 MHz licences were auctioned in December 2015, won by **True Move** and fixed operator Jasmine (**Jas Mobile**), the latter proposing to enter the mobile market with LTE. Jas Mobile failed to meet the licence payment deadline and forfeited the licence. Unused 900 MHz was won by AIS.

The APT700 band plan has been adopted for frequency allocations in the 700 MHz band.

Tokelau

Local telecommunications operator **Teletok** is deploying an LTE network with VoLTE in 2016 using APT700 band 28 spectrum

Tonga

The APT700 FDD band plan was adopted in 2012.

Vanuatu

WanTok (formerly Can'l) commercially launched 2.3 GHz (band 40) LTE TDD in Port Vila on April 1, 2014. Regulator TRR adopted APT700 band 28.

Digicel Vanuatu commercially launched LTE in APT700 band 28 on January 19, 2016 in Port Vila.

Vietnam

Regulator MIC authorized trials by **VNPT, Viettel, FPT Telecom, CMC, VTC, EVN Telecom** and **Gtel**. **RusViet Telecom** also trialled LTE in 2010 in Hanoi. **Viettel** said in May 2011 it was testing LTE in Hanoi and HCM City, offering dongles to 240 friendly users.

700 MHz spectrum will be allocated after digital TV switchover, scheduled to begin in 2015 in big cities. The APT700 band plan has been adopted for frequency allocations in the 700 MHz band.

WiMAX™ operator **Indochina Telecom** is studying migration to LTE TDD.

Viettel is deloying an LTE network and in December 2015 announced a trial LTE-Advanced service in parts of the Ba Ria-Vung Tau province, demonstrating up to 230 Mbps.

Vinaphone (VNPT) confirmed trialling of LTE-Advanced started on January 18, 2016 in Phu Quoc and Hochiminh City and reached 588.61 Mbps.

MobiFone launched a trial of 4G/LTE services including a digital TV service "MobiTV" (using eMBMS / LTE Broadcast) in Hanoi, Danang and Ho Chi Minh cities in July 2016.

FPT applied for a new trial license to ensure compatibility with exising networks.

In October 2016 MIC awarded 4G 1800 MHz licences to **GTel, MobiFone**, **Viettel**, and **Vinaphone** (**VNPT**).

Europe

May 8, 2015: EC adopts L band 1452-1492 MHz

Member States *should make the spectrum available within six months*. The Decision allows the 1452-1492 MHz band to be used for advanced mobile services such as audiovisual streaming or high speed downloading and introduces the technical conditions

for wireless broadband use as downlink-only supplemental downlinks (SDL) for aggregation with other LTE carriers.
European Commission press release, May 8, 2015: http://ec.europa.eu/digital-agenda/en/news/commission-decision-opens-new-frequency-band-advanced-mobile-services

Abkhazia

A-Mobile commercially launched LTE using band 20 spectrum on June 4, 2014 in Sukhumi and Gagra.

Aquafon, a subsidiary of **Megafon,** commercially launched LTE on August 6, 2014 in Sukhumi and other cities. In July 2013 Aquafon confirmed receipt of a licence to deploy LTE with 800 MHz.

Åland Islands

Ålcom (Ålands Telekommunikation Ab) and **TeliaSonera** each has licences to deploy LTE networks using 800 MHz, 1800 MHz or 2.6 GHz and in 2016 acquired 450 MHz spectrum. **Ukkoverkot** and **Ålcom** signed a cooperation agreement under which Ukkoverkot will operate the 450 MHz network as part of its Ukko Mobile LTE network that covers the whole of Finland.

TeliaSonera commercially launched LTE in June 2012. 1800 MHz and 2.6 GHz is used in Mariehamn. 800 MHz is used outside Mariehamn.

Ålcom commercially launched LTE1800 on March 3, 2015 covering 42% of the population. 800 MHz band 20 is also commercially used since April 13, 2015. **Ålcom** acquired 450 MHz spectrum in 2016. Ukkoverkot and Ålcom have signed a cooperation agreement, according to which Ukkoverkot will operate the 450 MHz network as part of its Ukko Mobile LTE network that covers the whole of Finland.

Albania

Eagle Mobile (owned by ALBtelecom) commercially launched 150 Mbps LTE1800 on September 1, 2015. 300 Mbps LTE-Advanced is in deployment to bring into use recently acquired B7 spectrum.

Telekom Albania (formerly **AMC)** commercially launched 150 Mbps LTE on July 22, 2015 in 2.6 GHz band 7 spectrum. 225 Mbps LTE-Advanced commercially launched on September 1, 2015 in 7 main cities of Albania (Tirana, Durres, Elbasan, Shkodra, Fier, Vlora, Korça), with carrier aggregation of spectrum in the 1800 MHz and 2.6 GHz bands. Albtelecom later purchased an additional 2 x 20 MHz of 2.6 GHz band 7 spectrum.

Vodafone Albania commercially launched LTE in July 2015 using 2.6 GHz spectrum. LTE-Advanced "4G+" service was launched on September 1, 2015.

Plus Communication is trialling LTE technology and bought 2 x 15 MHz bandwidth of technology-neutral band 1 spectrum for network deployment.

In August 2014 regulator Electronic and Postal Communications Authority AKEP approved refarming of GSM bands (900 MHz, 1800 MHz) for LTE. 2 x 6 MHz of technology neutral 1800 MHz spectrum was sold in March 2015 to Telekom Albania, Vodafone Albania and Eagle. Each also has 2.6 GHz spectrum. 2.1 GHz spectrum is also technology neutral.

Andorra

Andorra Telecom commercially launched LTE using 800 MHz band 20 spectrum on October 21, 2014, initially covering 50% of the territory.

Armenia

VivaCell-MTS commercially launched LTE in Yerevan on December 28, 2011 in 2.6 GHz spectrum. Coverage was later extended to Armavir, Dilijan, Echmiadzin, Gyumri, Tsakhnadzor and Vanadzor.

Orange Armenia organized a demonstration of LTE in 2010 but did not commit to network deployment. On August 7, 2015 the Orange Group announced the sale of Orange Armenia to local ISP **UCOM,** which has completed.

UCOM commercially launched 250 Mbps LTE-Advanced in Yerevan on September 24, 2016.

ArmenTel (Beeline/Vimpelcom) commercially launched an LTE450 network for fixed wireless service on May 25, 2016 – initially in Vayots Dzor and extended nationwide by July 2016. The service is branded Hi-Fly.

Austria

Regulator RTR completed a 2.6 GHz auction on September 20, 2010, raising €39.5m from **A1 Telekom, Hutchison 3, T-Mobile** and **Orange**. 14 paired and 9 unpaired blocks were sold.

A1 Telekom commercially launched LTE in Vienna and St. Pölten on November 5, 2010. The company announced in June 2013 it had successfully demonstrated the LTE-Advanced carrier aggregation feature and launched 300 Mbps service using 800 MHz and 2.6 GHz spectrum in Graz on November 25, 2014. A1 Telekom launched an LTE data roaming service with Swisscom in December 2013. The company announced on January 29, 2014 that 800 MHz spectrum (band 20) was in service on over 200 sites. VoLTE commercially launched on 30.11.15.

T-Mobile Austria commercially launched LTE service using 2.6 GHz spectrum on July 28, 2011. 150 Mbps (Category 4) service was launched in March 2014. The company tested carrier aggregation using 2.6 GHz and 1800 MHz spectrum, achieving almost 300 Mbps peak downlink, and is testing VoLTE.

On 20 October 2016 **T-Mobile Austria** announced results from its LTE-Advanced Pro trial achieving over 2 Gbps downlink data speed. The test configuration included 5C CA, 4x4 MIMO and 256QAM on downlink. 20MHz bandwidth of spectrum in 800MHz, 900MHz, 1800MHz, 2.1GHz and 2.6GHz was used.

3 Austria (Drei) commercially launched LTE FDD service in Vienna using 2.6 GHz on November 18, 2011. LTE TDD deployment in (band 38) is under study. LTE1800 was commercially introduced in Q3 2014 after approval to refarm GSM spectrum bands for LTE (see below). The company gained additional 900 MHz spectrum in early 2016 that will be used for coverage enhancement. 300 Mbps LTE-Advanced combining 1800 MHz and 2.6 GHz spectrum was commercially launched in 2015.

Orange Austria tested LTE and won 2 x 10 MHz of 2.6 GHz in the 2010 auction. Orange was taken over by Hutchison Group (January 3, 2013).

RTR auctioned 28 blocks of 800 MHz, 900 MHz and 1800 MHz, announcing the results in October 2013:

- A1 won 800 MHz, 900 MHz and 1800 MHz
- T-Mobile won 800 MHz, 900 MHz, 1800 MHz
- H3G Austria won 900 MHz and 1800 MHz

On July 28, 2014 RTR approved proposals by the incumbent mobile operators to refarm existing GSM spectrum for 3G and 4G/LTE. On August 12, 2015 RTR confirmed approval for 3G 2100 MHz spectrum to be refarmed for 4G/LTE with immediate effect. 700 MHz, the second digital dividend, will be auctioned for bringing into mobile use from year 2020.

Azerbaijan

Azercell commercially launched LTE1800 on June 19, 2012.

Azerfon (Nar Mobile) commercially launched LTE1800 in Baku in April 2015, initially for corporate customers. By end 2015 Azerfon had over 15,000 subscriptions on its network of 591 base stations. The network now supports 225 Mbps downlink.

Bakcell commercially launched 150 Mbps LTE1800 on May 5, 2015 using the 4th Sür@ brand name. Coverage was initially in several areas of Baku, the network planned over 1,000 sites by Q1 2016. On 15th October 2015 Bakcell announced deployment of 225 Mbps LTE-Advanced using 40 MHz paired band 3 in Baku city, the Absheron peninsula to follow later.

WiMAX™ operator **Sazz** (Azqtel) has 60 MHz of 3.5 GHz spectrum (bands 42, 43) and plans to deploy LTE TDD-Advanced for 2017 launch. **Sazz** demoed 900 Mbps downlink at the Bakutel 2015 exhibition.

WiMAX™ operator **Delta Telecom** is migrating to LTE TDD and launch in 2016, initially as a data service covering Baku and Absheron peninsula.

Nakhtel, CDMA operator in the autonomous region of Nakhchivan with band 5, plans to LTE launch in 2016.

On June 27, 2015 the Ministry of Communications and High Technologies (MCHT) approved mobile operators using new bands to expand LTE networks. Operators could use band 20 for LTE from end 2015.

Belarus

MTS (with **Beltelcom**) and **BeST (Life)** completed LTE trials by May 1, 2011.

Wholesale operator **beCloud** has a license with 1800 MHz (LTE1800) and 2.6 GHz spectrum and, with MTS, tested LTE-Advanced in Minsk, achieving 250 Mbps. The LTE1800 network was commercially launched on December 17, 2015. LTE-Advanced combining band 3 and band 7 was deployed in Q1 2016. An expansion phase is to complete by 2017. All 3 mobile operators in Belarus are required to the beCloud network for their 4G/LTE services, the network being initially used by MTS.

MVNO **Unet** offers 4G/LTE service since July 2016 using the beCloud network.

MTS commercially launched LTE1800 on 17th December 2015.

BeST (Life) has 2 x 15 MHz in 2.6 GHz for network deployment and commercially launched 112 Mbps (peak) LTE in Minsk on August 9, 2016 with an initial one-month free service.

800 MHz band 20 may become available. Additional 900 MHz and 1800 MHz may also be allocated.

CDMA operator **Dialog** plans to deploy LTE in 450 MHz subject to regulatory approval.

Belgium

Belgacom (Proximus) commercially launched LTE1800 service on November 5, 2012. 300 Mbps LTE-Advanced was introduced initially in Ghent, Antwerp, Leuven and Bredene at end 2014. On May 11, 2016 Proximus announced plans to launch VoLTE. In May 2016 Proximus announced that their LTE-Advanced Pro demonstration using 4CCA bands 1, 3, 7, and 20 had achieved 1.1 Gbps downlink.

Base commercially launched LTE1800 on October 1, 2013. By May 2014 coverage was available to 50% of population, including in Brussels and 800 MHz spectrum was also brought into use that year. Base confirmed data speed of over 250 MBps in trials of LTE-Advanced carrier aggregation.

Telenet trialled LTE in 2010 and in June 2011 acquired 900, 1800, and 2100 MHz spectrum. Telenet agreed to buy **Base** from its owner, **KPN**, subject to regulatory approval. The merged company would be able to offer fixed and mobile services. **Telenet** acquired BASE in 2015.

Mobistar has 800 MHz, 1800 MHz (LTE1800) and 2.6 GHz that can be used for LTE. On November 25, 2013 Mobistar opened access to its network in 30 cities and towns to existing mobile data customers to try out LTE technology having an LTE-compatible device and on a compatible tariff plan. Mobistar later confirmed its commercial offer allowing 4G access at no extra cost from March 31, 2014; at that time population coverage was 50%. Mobistar uses 800 MHz (band 20) and 1800 MHz (band 3/LTE1800). Mobistar undertook LTE-Advanced carrier aggregation testing by combining 20 MHz of 1800 MHz and 10 MHz of 800 MHz reaching 213 Mbps downlink and 41 Mbps uplink speeds. Full-scale commercial trials of LTE-Advanced were launched in Brussels, Mechelen and Mons on May 15, 2015 enabling theoretical peak download speeds of up to 213 Mbps and peak uploads up to 43 Mbps. The 4G+ service covers over 85% of the population in Brussels, 91% in Mons, and 99% in Malines.

b•lite Telecom BVBA commercially launched an LTE TDD fixed wireless access network in 3.5 GHz (band 42) spectrum in the city of Aalst on April 22, 2014.

Regulator BIPT auctioned 4G licences for 77 million Euros, comprising 45 MHz of 2.6 GHz TDD spectrum and 3 x 20 MHz paired blocks in 2.6 GHz for FDD systems. The auction ended November 28, 2011. New licences run for 15 years from July 1, 2012. LTE FDD spectrum was acquired by the three mobile incumbents and TDD spectrum was won by new entrant **BUCD** (backed by Asian investors). The technology choice is understood to be TD-LTE.

BIPT auctioned 3 x 10 MHz paired blocks of 800 MHz band 20 spectrum starting and finishing on November 12, 2013. The 3 incumbent mobile networks each bid 120 million Euros (the reserve price) for a 10 MHz paired block. There was no new market entrant.

Operators **b.lite** and **Mac Telecom** have transferred their icences to **Broadband Belgium**, a local start-up planning to deploy a nationwide LTE TDD network, and targeting to have a pre-commercial network operational in Brussels by end 2016. This follows a decision by BIPT in December 2015. The operators have transferred spectrum assets in the 3.5 GHz and

10.5 GHz bands. The company will provide service in each of Belgium's' regions (Brussels, Flanders and Wallonia). The higher spectrum will not be used, but the geographic coverage and capacity should increase in the 3.5 GHz band, BIPT said.

Bosnia and Herzegovina

Telekom Srpske (m:tel) tested 4G LTE technology in Banja Luka.

BH Telecom is preparing for testing of LTE.

Bulgaria

Mtel commercially launched 130 Mbps LTE1800 on April 25, 2016 with 75% pop coverage. VoLTE is planned. 260 Mbps will be implemented in future in 25% of the network by using 4 x 4 MIMO.

VIVACOM commercially launched LTE1800 in Sofia, Pernik and Vratsa on May 9, 2016.

The Communications Regulation Commission (CRC) stated December 15, 2011 that 3 technology-neutral licences for vacant 1800 MHz spectrum had been granted to **Max Telecom** (2x 8 MHz), **4G Com EAD** (2 x 8 MHz) and **Bulsatcom** (2 x 5 MHz).

WiMAX™ operator **Max** commercially launched LTE1800 on May 20, 2014 in Sofia, Ruse, Stara Zagora, Sliven, and Bansko. The service was initially positioned for tablet users. On July 1, 2015 Max announced its LTE network covered 31 cities and towns, equivalent to 50% of the urban population. VoLTE has been demonstrated and is in deployment.

Bulsatcom is deploying a LTE network.

Telenor Bulgaria (formerly GloBul) commercially launched LTE1800 on 1st December 2015 with outdoor coverage to 56.73% of population. By April 2016 coverage reached 75%. Telenor acquired additional 1800 MHz spectrum from CRC to expand coverage and raise the theoretical peak downlink speed from 75 MBps to 100 Mbps.

Additional 1800 MHz spectrum was also assigned to **Mtel** and **Vivacom** meaning all three operators now have 2 x 15 MHz band 3 spectrum. Start-up **4G Com EAD** had its licence withdrawn.

CRC is planning to auction 2.6 GHz spectrum blocks:

- Three 2 × 20 MHz paired blocks (FDD)
- One 2 x 10 MHz paired block (FDD)
- Five 10 MHz unpaired blocks (TDD)

Interested parties had to bid by October 29, 2015.

Croatia

T-Hrvatski Telekom commercially launched LTE in 10 MHz of 1800 MHz spectrum (LTE1800) on March 23, 2012 in Zagreb with free mobile data access on its LTE network until October 1, 2012. Commercial LTE service using 800 MHz spectrum was introduced in December 2012 in Drenovaca, Josipdola, Koprivnice, Otocca, Ozlja and Petrinje. On May 14, 2014 the company announced completion of LTE-Advanced carrier aggregation testing, which combined 10 MHz paired 1800 MHz and 10 MHz paired 800 MHz sprectrum to achieve 136 Mbps.

VIPNet demonstrated LTE in 800 MHz in March 2011 and launched a trial for 20 consumers on September 1 2011 in Novi Zagreb using 800 and 1800 MHz spectrum. VIPNet commercially launched LTE1800 service on March 23, 2012. Vipnet plans to introduce 300 Mbps LTE-Advanced service by end 2016 and has demonstrated this speed in technology trials.

Tele2 Croatia commercially launched a nationwide 150 Mbps LTE1800 network on February 1, 2016 covering 90% of the population at launch.

Velatel (**Novi-net**) has 42 MHz spectrum in 3.5 GHz and had planned to deploy an LTE TDD network. But according to a statement on its website the company decided not to invest further in the Croatia market.

In October 2012 regulator HAKOM announced results of the 800 MHz band 20 auction. Three blocks were offered. **VIPNet** and **T-Hrvatski Telekom** were the only bidders, Tele2 did not submit a bid. The total raised from the auction was about €40 million. VIPNet acquired 2 x 10 MHz. The winners are required to achieve geographical coverage of 50% in five years. The remaining two blocks of 2 x 5 MHz were later auctioned in a sealed bid process; 2 bids were opened on October 28, 2013. HAKOM awarded the spectrum to bidders VIPNet and T-Hrvatski Telekom.

HAKOM launched a consultation into use of 900 and 1800 MHz for mobile broadband including LTE. **Tele2** and **T-Hrvatski Telekom** requested and received additional 1800 MHz technology-neutral spectrum in December 2014. **T-Hrvatski Telekom** subsequently increased the theoretical peak downlink speed from 75 Mbps to 150 Mbps using this 1800 MHz spectrum.

2.1 GHz spectrum is now technology neutral.

Cyprus

The Department of Electronic Communications published tender documents for an auction of 2.6 GHz spectrum by August 31, 2013. On offer were:

- Three 20 MHz paired blocks (FDD)
- One 40 MHz unpaired block (TDD)

No bids were made and the auction was cancelled.

Formerly an MVNO-only operator, **PrimeTel** secured the third mobile network operator license with technology neutral 900, 1800 and 2100 MHz spectrum. **PrimeTel** commercially launched LTE1800 on March 10, 2015 with 50% population coverage. (3G/HSPA service was launched February 23, 2015).

MTN commercially launched LTE1800 on March 10, 2015 in Famagusta, Larnaca, Limassol, Nicosia and Paphos.

CYTA commercially launched LTE1800 in November 2015 in the urban centres of Nicosia and Limassol.

A public consultation regarding the proposed sale of spectrum in 800 MHz (band 20), 1470 MHz (L-Band), 2.6 GHz (band 7) and 3.4-3.8 GHz (bands 42 and 43) required comments by October 2, 2015. Results of the auction of 800 MHz and 2.6 GHz spectrum were announced in June 2016 with **MTN**, **CYTA** and **Cablenet** each securing 2 x 10 MHz paired blocks in band 20, one 2 x 20 MHz block in band 7, and 15 MHz band 38 TDD spectrum.

Czech Republic

O2 Czech Republic commercially launched LTE1800 in Jesenice (west district of Prague) on June 19, 2012. Service is being extended to more areas of the city in May 2013 and Brno was covered in October 2013. On July 15, 2014 the company announced availability of higher LTE speeds (peak 110 Mbps uplink, 55 Mbps downlink) as a result of increasing the bandwidth allocated for its LTE service. LTE-Advanced service combining 10 MHz of 800 MHz and 20 MHz of 1800 MHz spectrum (achieving 185 Mbps) has been introduced in the town of Černovice and extended to Prague. 3C CA is planned.

On February 26, 2015 **O2** announced successful testing of VoLTE and start of deployment phase. At the time of writing of this report (July 2016) VoLTE was in pilot testing phase. By this time LTE service covered 90% of the population. A fixed wireless service, Air Internet, enabled on its LTE network was launched in June 2015.

T-Mobile commercially launched 150 Mbps LTE1800 on October 1, 2013 in Prague and Mlada Boleslav and using 800 MHz in rural areas. In May 2014 T-Mobile launched 800 MHz LTE in Plzeň-jih Pilsen Region and start of a two-month trial phase. By end 2015 T-Mobile's LTE network reached 82% population coverage. T-Mobile launched LTE-Advanced service combining 10 MHz of 800 MHz and 20 MHz of 1800 MHz to achieve peak downlink speed of 225 Mbps in Mlada Boleslav and later extend to half of Prague's population. A 4x4 MIMO test using 800 MHz spectrum was completed and announced in March 2015. 375 Mbps LTE-Advanced is commercially available in two locations as confirmed on December 16, 2015 by combining 20 MHz band 1 with 20 MHz band 3 and 10 MHz band 20 in selected locations. 2.6 GHz band 7 spectrum was commercially introduced in Prague in February 2016.

VoLTE was commercially launched on May 4, 2015 initially for customers using the Samsung Galaxy S5. In May 2016 T-Mobile announced it had launched internal pilot operation of ViLTE (Video over LTE), which enables making high-quality video calls in the LTE network. T-Mobile proposes to offer this service, which is now being tested on Samsung Galaxy S6 edge devices, to customers "in the coming months."

T-Mobile and **O2 Czech Republic** extended network sharing to include 4G/LTE and LTE-Advanced.

On June 4, 2013 **Vodafone** announced launch of a 20-site LTE1800 trial Karlovy Vary in Carlsbad. On December 10, 2013 **Vodafone** announced commercial launch of LTE using 900 MHz in areas

around Litoměřice, the northern part of the Plzeň region and some areas in the Liberec region. 92% population coverage was achieved by end 2014. LTE1800 is in service in Karlovy Vary. On March 4, 2014 Vodafone announced launch of dual carrier (for Category 4 devices) i.e. theoretical 150 Mbps peak downlink speed, using part of the spectrum obtained in the November 2013 auction (see below). LTE tests with 800 MHz band 20 began in June 2014. LTE-Advanced carrier aggregation was launched in 2014 combining 15 MHz B3 and 15 MHz B20 spectrum in Karlovy Vary enabling 225 Mbps peak speed. Vodafone also launched LTE service using 2.1 GHz (band 1) spectrum in Kladno, Olomouc and Slaný in December 2014. 1800 MHz and 800 MHz is deployed in Prague. In October 2015 tri-band 300 Mbps service was commercially launched in the city of Karlovy Vary combining spectrum in band 3 (20 MHz), band 20 (10 MHz) and band 1 (10 MHz).

300 Mbps downlink is also possible using band 3 spectrum with LTE-Advanced technology and 4x4 MIMO as deployed in an area of Prague.

To achieve a theoretical speed of up to 375 Mbps per second when downloading and 50 Mbps when sending data, Vodafone uses a combination of three bands - 800 MHz, 1,800 MHz and 2,600 MHz and is preparing for its commercial introduction.

By September 2015, Vodafone covered 92% of the population and 83% of the country with LTE.

Vodafone launched VoLTE on July 18, 2016 for users with compatible Android smartphones.

In September 2011, regulator CTU issued terms and conditions for a planned auction of 800, 1800 and 2600 MHz. CTU said that the 1800 MHz spectrum was reserved for a possible new entrant. The auction started on November 12, 2012 with 4 bidders (three incumbents plus **PPF Mobile Services**) but was cancelled on March 8, 2013 due to "excessively high prices" which was felt could lead to high prices for consumers. The auction was replayed according to new rules, starting on November 11, 2013. 800 MHz spectrum was reserved for new entrants however no new player came forward and the replayed auction resulted in spectrum being allocated to incumbents.

The remaining 7 blocks of 1800 MHz and 2.6 GHz, which can also be used for LTE, was auctioned in June 2016 and acquired by the three incumbent operators, O2, T-Mobile and Vodafone.

CDMA operator **U:fon** plans to deploy an LTE network using refarmed 450 MHz spectrum.

Denmark

Regulator DEA (Energistyrelsen) concluded an auction of 2500-2690 MHz and 2010-2020 MHz spectrum on May 10, 2010, awarding spectrum to **Hi3G Denmark ApS**; **TDC A/S**; **Telia Nättjänster Norden AB**; and **Telenor A/S**. On October 12, 2010 Telestyrelsen announced that **Hi3G Denmark** had been granted 900 and 1800 MHz spectrum, which could be used to deploy 2G, 3G or LTE technologies nationally.

Telia launched the country's first commercial LTE system on December 9, 2010 in Copenhagen, Aarhus, Odense and Aalborg in 2.6 GHz (20 MHz). On October 10, 2011 LTE commercial service was introduced using 10 MHz of 1800 MHz (LTE1800) as a complement to 2.6 GHz. Tri-band 800/1800/2600 MHz LTE dongles and routers are available. In August 2015 Telia announced start of deployment of 300 Mbps LTE-Advanced carrier aggregation technology using band 3 and band 7 spectrum.

Telenor commercially launched LTE1800 and 2.6 GHz on March 20, 2013, covering 192 towns and cities, representing 75% of the population. 90% population coverage is targeted by end 2015. Dual carrier (band 3 + band 7) LTE-Advanced carrier aggregation deployment began in 2015 and by December 8, 2015 300 Mbps was commercially available in Copenhagen, Aalborg, Odense, Aarhus and Roskilde. Testing of 450 Mbps tri-band carrier aggregation is ongoing. VoLTE was commercially launched on November 30, 2015.

Telenor and **Telia** attempted to merge 4G/LTE, 3G and 2G networks into a JV called TT-Netværket P/S. 4G sharing uses LTE1800 and LTE800, but cancelled this concept due to regulatory requirements.

TDC commercially launched 2.6 GHz LTE on October 10, 2011 in Copenhagen, Aarhus, Odense, Aalborg, Esbjerg, Randers, Kolding, Horsens, Vejle, Roskilde.

800 MHz was brought into service in early 2013. TDC announced on July 3, 2015 that the company is deploying 300 Mbps LTE-Advanced across its network and is in commercial service using B7 and B20 spectrum.

225 Mbps LTE-Advanced carier aggregation is also in commercial service using, according to the area, band 3 + band 20, or band 3 + band 7.

A 3 Component Carrier Aggregation trial combining band 20, band 3 and band 7 was subsequently commercially launched enabling a peak throughput of 412 Mbps. 1 Gbps peak was demonstrated in June 2016 using LTE-Advanced Pro technology including 256QAM and 4x4 MIMO. Commercial launch is planned in 2017. On November 27, 2014 **TDC** announced testing of VoLTE. Volte was commercially launched leveraging nationwide coverage in 2015.

3 Denmark is deploying an LTE FDD network combined with 25 MHz of TDD spectrum, and launched its commercial LTE FDD service using 1800 (LTE1800) and 2600 MHz spectrum on September 28, 2012, at the same time introducing the iPhone 5. 150 Mbps LTE-Advanced was commercially launched in Q4 2014 with carrier aggregation combining 1800 MHz and 2.6 GHz spectrum. 3 carrier CA (FDD + TDD) has been laboratory trialled (10 MHz band 3 + 10 MHz band 7 + 20 MHz band 38). 3 Denmark is deploying VoLTE targeting launch in 2016. VoWiFi is commercially available.

TDC and **TT-Netværket P/S** were awarded 800 MHz spectrum in the auction which closed on June 26, 2012. TDC won 2 x 20 MHz and TT-Netværket won 2 x 10 MHz. 739.3 million Danish Kr (approx USD 124.3 million) was paid for 5 blocks of spectrum on offer (four 2 x 5 MHz blocks, one 2 x 10 MHz block).

Net1 is deploying a nationwide LTE450 network.

Bidding started on September 20, 2016 for additional 1800 MHz spectrum. DEA awarded a total of 2x 65 MHz to the winning 3 incumbents

Estonia

Regulator TJA (Tehnilise Järelevalve Amet) awarded LTE licences in 2.6 GHz spectrum to incumbent mobile operators **EMT** (now **Telia**), **Elisa** and **Tele2** plus fixed-line operator **Elion Enterprises**. TJA announced on December 16, 2011 that **Telia, Elisa** and **Tele2** are permitted to deploy mobile broadband technologies e.g. LTE in 1800 MHz band. A consultation was simultaneously launched on procedures for allocating digital dividend spectrum.

Telia launched the first commercial LTE service in Estonia on December 17, 2010 in 2.6 GHz in Tallinn, Tartu, Kohila, and at the IT College of Tallinn University of Technology. On December 19, 2011 EMT announced start of LTE network deployment in 1800 MHz. Commercial service is now delivered using 2.6 GHz, 1800 MHz (LTE1800) and from June 2013, 800 MHz helped the company to achieve 95% population coverage six months ahead of schedule, and has since reached 99% population coverage. Telia launched Cat 6 300 Mbps peak downlink LTE Advanced service in August 2014 using a combination of 20 MHz band 3 (1800) and 20 MHz band 7 (2600) spectrum in Kiisa and near the Tallin TV tower where mobile traffic is heaviest. On June 21, 2016 Telia announced results of tests with partner Ericsson using LTE-Advanced Pro technology on its live network, achieving 1 Gbps using 3C CA 1 block Band 3 and 2 blocks Band 7, 4x4 MIMO and 256QAM modulation on the downlink.

Telia commercially launched VoLTE July 12, 2016.

Tele2 Estonia commercially launched LTE in Tallinn using 1800 MHz (LTE1800) and 2.6 GHz on November 27, 2012. 8.3 MHz new 1800 MHz spectrum was acquired end 2011. On March 11, 2014 Tele2 announced it had doubled its 2.1 GHz holding, which could be used immediately for 3G and later in its LTE network. The first 800 MHz (band 20) site was launched May 9, 2014. 300 Mbps LTE-Advanced service was launched in December 2014. Tele2 deployed 375 Mbps capability launching in Keila in December 2015. On July 14, 2015 Tele2 announced it is also using 2.1 GHz on its LTE network. 90% Tele2 may also deploy LTE in 450 MHz, 900 MHz, and 2.3 GHz spectrum.

Elisa commercially launched LTE on February 14, 2013 using 1800 MHz (LTE1800), plus 2.6 GHz in urban areas. Commercial service was extended using 800 MHz acquired in August 2013. By end 2013 LTE covered 95% of territory and 97% of the population and the company is progressing towards its 99%

population coverage target. Elisa has trialled 300 Mbps LTE-Advanced in Tallinn using carrier aggregation combining 20 MHz of 800 MHz and 20 MHz of 2.6 GHz spectrum.

Tele2 beat cable operator **Starman** for the remaining block of 800 MHz. Tele2 plans 95% geographical coverage by mid-2014.

A public consultation was held about planned auctions of spectrum in the bands 694-790 MHz (700 MHz) and 2500 - 2690 MHz (2500 MHz). Comments were required by September 5, 2016.

Finland

20-year 2.6 GHz licences were auctioned by regulator FICORA on 23 November 2009:

- **Elisa** obtained 50 MHz, and launched a pre-commercial trial in Helsinki on June 2, 2010
- **TeliaSonera** acquired five blocks of 2 x 5 MHz and launched an LTE network on June 2, 2010 for pre-commercial use in the city of Turku
- **DNA** obtained 40 MHz

Finland was the first country in Europe to allow 1800 MHz spectrum to be used for LTE deployments.

TeliaSonera launched the first commercial LTE service in Finland on November 30, 2010 in Turku and Helsinki in 2.6 GHz spectrum. LTE1800 was commercially launched as a complementary band on August 31, 2011. Results of a 3-band carrier aggregation LTE-Advanced trial using 20 MHz band 3, 20 MHz band 7 and 10 MHz band 20 were stated on September 2, 2015 achieving 375 Mbps.

TeliaSonera commercially launched 300 MBps LTE-Advanced carrier aggregation service in parts of Helsinki combining 2 x 40 MHz from bands 3 and 7.

Elisa commercially launched a 2.6 GHz LTE network for corporate users on December 8, 2010, and announced its first client. The company launched LTE2600/LTE1800 service combined with DC-HSPA+ for consumers on November 17, 2011. LTE service reached 230 locations by October 2013. 800 MHz was brought into use in January 2014.

Elisa commercially launched 300 Mbps LTE-Advanced using carrier aggregation to combine 2 x 20 MHz of Band 3 and 2 x 20 MHz of Band 7 spectrum in 12 localities on March 31, 2015.

On January 25, 2016 Elisa announced a pilot base station had been deployed in Vierumäki with 3C CA technology capable of reaching 450 Mbps downlink.

On August 23, 2016 Elisa announced the result of a trial of LTE-Advanced Pro technology on their live network, which reached a maximum of 1.9 Gbps downlink data speed. The configuration used 100MHz bandwidth downlink and uplink across 5 bands i.e. 800/900/1800/2100/2600 MHz with 4x4 MIMO and 256QAM used in all bands. (Note 900MHz is used for 2G and 3G and not 4G currently).

DNA commercially launched LTE on December 13, 2011. DNA uses 1800 MHz (LTE1800) with 2.6 GHz for populated areas where extra capacity is required. 800 MHz was launched in January 2014 in Lohja.

DNA reported that in 2015 data traffic on their 4G/LTE network tripled and 85% of new phones sold are LTE-capable. The LTE network covers 99% of the population in mainland Finland by end 2016. 2G and 3G network data volumes are no longer growing.

On August 20, 2014 **DNA** (49%) and **TeliaSonera** (51%) announced agreement to set up a new JV company *Suomen Yhteisverkko Oy* to build a joint 2G/3G/4G network to cover 15% of the population in 50% of Finland's geographical area in the north and east. Band 20 for LTE is pooled in areas covered by the JV. The new network configuration would be 300 Mbps LTE-Advanced from launch.

DNA commercially launched 300 Mbps LTE-Advanced carrier aggregation in May 2015 using 2x 20 MHz band 3 and 2x 20 MHz band 7. The company also advised GSA about other carrier aggregation combinations (225-375 Mbps) available in RAN are:

10 MHz band 20 + 20 MHz band 3
10 MHz band 20 + 20 MHz band 3 + 20 MHz band 7
20 MHz band 3 + 10 MHz band 1 + 20 MHz band 7

An auction of 800 MHz spectrum (band 20) in six 5 MHz paired blocks (791 – 812 MHz paired with 832 – 862 MHz) started on January 24, 2013 for licences

with 20 years duration. Winners DNA, Elisa and TeliaSonera were announced October 30, 2013. 800 MHz spectrum was usable from January 1, 2014.

On May 12, 2016 DNA announced introduction of 3C CA 600 Mbps service using 20 MHz band 1 + 20 MHz band 3 + 20 MHz band 7 + 256QAM on the downlink.

DNA launched VoLTE service and VoWiFi on March 14, 2016.

Ukko Mobile commercially launched the world's first LTE450 (band 31) network on November 17, 2014, providing data access only with 99.9% population coverage. 241 sites are deployed, cell radius typically 20-50 km. Ukko Mobile is also deploying LTE-Advanced LTE TDD as a capacity layer and in hotspots using 2.6 GHz (band 38) to be commercialized according to customer demand.

In January 2015 **Ukko** announced completion of a TDD LTE-Advanced lab demonstration that showed a peak throughput of over 507 Mbps using 2 x 20 MHz bandwidth 2.6 GHz carriers (Ukko has 50 MHz of band 38 bandwidth). UKKO commercially launched LTE TDD with limited coverage on August 14, 2015.

Fixed broadband operator **Anvia** trialled LTE in Lapua using 700 MHz spectrum.

700 MHz spectrum will be allocated for mobile services and align with the lower duplexer arrangement of the APT700 band (band 28).

France

FT/Orange launched a pilot LTE network in Marseille in June 2012. Coverage in Lyon, Lille and Nantes was added later. Marketing to corporate customers began on November 22, 2012. Consumer services began in February 2013. Service was introduced in Paris in February 2013. The network uses 2.6 GHz and 800 MHz. LTE-Advanced technology combining 800 MHz and 2.6 GHz was commercially introduced in Strasbourg and Toulouse in July 2014. Results of trials aggregating 3.5 GHz and 2.6 GHz spectrum in FDD configuration were announced in December 2014, achieving 300 Mbps downlink speed. Speaking at the LTE World Summit 2015, Orange committed to deploy 3-carrier aggregation to enable 450 Mbps peak downlink speed by end 2017. VoLTE service was introduced on January 25, 2016.

SFR launched commercial LTE service on November 28, 2012 in Lyon and in Montpellier on December 18, 2012 and uses 800 MHz and 2.6 GHz spectrum. The La Defense business region of Paris went live in January 2013, Marseille in March 2013. SFR commercially launched 187.5 Mbps LTE-Advanced carrier aggregation in Toulon combining 800 MHz and 2.6 GHz spectrum on October 21, 2014, followed by launches in Lyon and Toulouse, then Marseille. SFR plans to launch VoLTE. On May 25, 2016 (the first day use of band 3 was allowed) SFR launched 3C CA initially in Brest, capable of 337.5 Mbps, and will be extended to 20+ large cities by end 2016.

Bouygues Telecom trialled LTE1800 in 10 MHz using 2 x 2 MIMO at sites in Orléans and ran a pilot network in Lyon from June 2012.

Regulator ARCEP auctioned 2.6 GHz spectrum and confirmed the successful bidders and allocations:

- Bouygues: 2535-2550 MHz/2655-2670 MHz
- Free Mobile: 2550-2570 MHz/2670-2690 MHz
- FT/Orange: 2515-2535 MHz/2635-2655 MHz
- SFR: 2500-2515 MHz/2620-2635 MHz

On January 17, 2012 ARCEP announced 800 MHz spectrum had been won by Orange, SFR and Bouygues Telecom, each receiving 2 x 10 MHz.

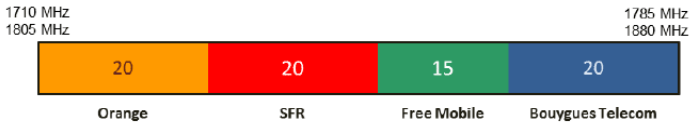
Bouygues Telecom commercially launched LTE using 2.6 GHz on May 6, 2013 in Lyon, Strasbourg, Issy-les-Moulineaux, Vanves, Malakoff, and Toulouse. The company requested permission from ARCEP to use its 1800 MHz for LTE. Approval was given for use from October 1, 2013 subject to spectrum disposal conditions. On October 1, 2013 the company extended coverage to 63% of the population with commercial LTE launch in refarmed 1800 MHz spectrum (LTE1800). Coverage increased to 71% by March 2015. Bouygues Telecom trialled LTE-Advanced technology in October 2013 using carrier aggregation with 800 MHz, 1800 MHz and 2.6 GHz spectrum combinations. The company commercially launched 220 Mbps LTE-Advanced in Bordeaux, Lyon, Grenoble, Vanves, Issy-les-Moulineaux, Malakoff and Rosny-sous-Bois with devices for sale from July 1, 2014, smartphones from

September 2014. Different combinations of spectrum are used according to location. At the same time Bouygues Telecom increased the 1800 MHz allocation from 10 MHz to 15 MHz in a number of cities. 300 Mbps tri-band LTE-Advanced service was commercially launched in Lyon on November 12, 2015 combining spectrum in bands 3, 7, and 20. Using 3C CA with 256QAM, over 400 Mbps was demonstrated according to a company statement on November 30, 2015. A trial of LTE-Advanced Pro technology in May 2016 enabled by 60 MHz bandwidth across 4C CA, plus 4x4 MIMO, 256QAM achieved over 1 Gbps. 2C CA was also trialled.

Bouygues Telecom commercially launched VoLTE on November 25, 2015.

SFR and **Orange** were permitted to use some or all of their 1800 MHz for LTE from May 25, 2016.

Free Mobile commercially launched LTE claiming 150 Mbps theoretical peak downlink speed, using 2.6 GHz on December 1, 2013. In November 2014 Free Mobile received 2 x 5 MHz of additional technology neutral 1800 MHz spectrum which will allows testing of LTE-Advanced carrier aggregation by combining spectrum in band 3 and band 7 in Seine-Maritime. In January 2015 ARCEP confirmed 2x5 MHz of 1800 MHz band 3 had been allocated to Free Mobile for commercial use from January 1, 2015 in all of metropolitan France except Marseille, Nice and Paris. 2 x 10 MHz 1800 MHz spectrum was allocated in September 2015 for use from May 25, 2016



Source: ARCEP

WiMAX™ operator **Bollore Telecom** plans to introduce LTE TDD system within its current allocation of 30 MHz of band 42 (3.5 GHz) spectrum.

ARCEP started a consulation in December 2014 on its proposed allocation of 700 MHz spectrum for mobile communications, to align with the lower duplexer arrangement of the APT700 band. Auction terms were confirmed and a call issued for bidding interest solicited bidding interest from the four incumbent operators. The auction and subsequent specrum allocations were planned for November and December 2015 respectively raising €2.8 billion.

Iliad: won two 5 MHz paired blocks of 700 MHz
Orange: won two 5 MHz paired blocks of 700 MHz
Bouygues: won one 5 MHz paired block of 700 MHz
SFR: won one 5 MHz paired block of 700 MHz

All four of the country's mobile network operators (Orange, Bouygues, Numericable-SFR and Free Mobile) secured 700MHz spectrum in the auction held by the Regulatory Authority for Electronic Communications and Posts (Autorite de Regulation des Communications Electroniques et des Postes, Arcep) in late October 2015. The regulator revealed that the price of the six 5 MHz blocks on offer reached EUR466 million (USD528.8 million) apiece, with Orange France and Free Mobile securing two blocks each in the aforementioned band; Bouygues Telecom and Numericable-SFR secured one each.

Migration to HD MPEG-4 digital TV transmission was completed by April 5, 2016, paving the way for release to begin of 700 MHz spectrum for mobile services. Bouygues Telecom has reportedly installed a few 700 MHz antennas in Paris, and Free Mobile has deployed 3 base stations in Tarbes.

ARCEP offered interested players to conduct technology tests using 2.6 GHz TDD and 3.5 GHz (WLL) spectrum, ahead of auctions in 2018. BWA operator **Infosat** received approval to test fixed LTE using 2.6 GHz for six months in Canteleu. **Bouygues Telecom** received approval to trial LTE TDD using 15 MHz of 3.5 GHz band 42 spectrum in a Paris suburb between May 1st - September 15th, 2016.

Georgia

Regulator GNCC allowed 2G and 3G licences and spectrum bands to become technology neutral.

Magticom commercially launched LTE1800 on February 1, 2015 in Tbilisi and all the main cities. Having acquired 800 MHz spectrum in an auction on May 31, 2016, Magticom commercially launched 185 Mbps LTE-Advanced on June 3, 2016 combining band 3 and band 20 spectrum.

Beeline (Mobitel) commercially launched LTE on February 1, 2015 in 30 cities and towns using recently acquired 800 MHz band 20 spectrum.

Geocell (Telenor) commercially launched LTE1800 in certain areas of Tbilisi on March 15, 2015.

Germany

A multiband spectrum auction was completed in May 2010, covering 360 MHz in 4 bands: 800 MHz (digital dividend), 1800 MHz, 2.1 GHz, 2.6 GHz. All 4 incumbents acquired 2.6 GHz to be used for LTE. **Telefonica O2, Vodafone** and **Deutsche Telekom** (but not **E Plus**) additionally acquired 800 MHz spectrum for LTE. The 800 MHz spectrum raised €3.576 billion, i.e. over 81.5% of the auction's total value. **E Plus** is able to use 900 MHz spectrum (in which HSPA+ will be deployed) also for LTE if it does not cause interference with other mobile networks.

E Plus completed LTE trials in 2.1 GHz, 1800 MHz, 2.6 GHz and LTE TDD 2.6 GHz. Since July 2011 the E Plus HQ building has LTE1800 trial coverage and having received re-farming approval in January 2013 the company commercial launched its LTE1800 network on March 6, 2014 for customers in Berlin, Leipzig and Nürnberg.

Vodafone launched the first rural LTE mobile broadband service across Germany on December 1, 2010 and plans to upgrade all base stations to LTE. In August 2013 Vodafone announced it had increased the theoretical peak downlink speed to 150 Mbps using 2.6 GHz spectrum. 225 Mbps service was launched in several cities in early 2015 by combining band 7 and band 20 spectrum. Category 8 was demonstrated at the IFA show in Berlin In September 2014, achieving 350 Mbps downlink and 50 Mbps uplink, and ping time of 7 ms. By early October 2014 Vodafone had established 23 international roaming partners. Vodafone commercially launched VoLTE on March 16, 2015 during CeBIT, and is now nationwide. On August 31, 2016 Vodafone announced launch of Enhanced Voice Service (EVS) VoLTE technology for enhanced voice quality, and initially covering 89% of the population.

On May 26, 2015 Vodafone announced its LTE network reached 77% of the population with over 5 million customers having access up to 100 Mbps, and 225 Mbps in selected locations by combining 800 MHz and 2.6 GHz spectrum. VoLTE is deployed nationwide. 3C CA LTE-Advanced service enabling 375 Mbps was activated near Hanover in July 2016 and extended to another 21 cities on September 16th, 2016. A further 8 cities have been named for coverage by end 2016.

Deutsche Telekom (DT) commercially launched its "Call & Surf Comfort via Funk" LTE service in 800 MHz on April 5, 2011. In February 2011 the company announced plans to launch LTE using 1800 MHz (LTE1800) and 2.6 GHz. The "Speedstick LTE" dongle was offered from Q3 2011 supporting LTE in 800, 1800 and 2600 MHz bands plus DC-HSPA+, HSPA and WCDMA in 2100 MHz, and EDGE/GPRS. The company commercially launched LTE in Cologne on July 1, 2011 in 1800 MHz (LTE1800). Peak downlink throughput was increased to 150 Mbps in September 2013 and is now in over 150 cities.

DT commercially launched 300 Mbps LTE-Advanced service on November 17, 2014 in urban areas, including Berlin, Bonn, Chemnitz, Cologne, Dortmund, Dresden, Dusseldorf, Duisburg, Leipzig, Magdeburg, Mannheim, Potsdam, Rostock and Stuttgart, using carrier aggregation to combine 2 x 20 MHz 1800 MHz and 2 x 20 MHz 2.6 GHz spectrum. 375 Mbps was achieved in a 3C CA trial in October 2015, by aggregating spectrum in bands 3, 7 20. In October 2015 **DT** announced successful testing of Inter-sector MIMO (IS-MIMO) LTE-Advanced technology in Lingen, achieving 150 Mbps at cell edge. DT demonstrated 1.2 Gbps using LTE-Advanced Pro in Berlin in September 2016 using 5C CA and 4x4 MIMO technology. **DT** commercially launched VoLTE January 11, 2016. DT has activated NB-IoT onits live network in preparations for demonstrations in Berlin in October 2016.

Telefonica O2 commercially launched LTE on July 1, 2011 in rural areas using band 20, marketed as "O2 LTE für Zuhause (at home). On July 3, 2012 O2 commercially launched mobile LTE service in urban areas, Nuremberg and Dresden, followed by other major cities including Berlin and Munich on March 31, 2013. In November 2013 O2 announced deployment of 1800 MHz and 2.6 GHz LTE-Advanced carrier aggregation in some base stations enabling theoretical downlink speed up to 225 Mbps using Cat 6 devices. VoLTE was launched in April 2015.

Telefonica O2 bought **E Plus** creating Germany's biggest network. The deal completed October 2014.

WiMAX™ operator **Deutsche Breitband Dienste (DBD)** has a licence with 42 to 70 MHz of 3.5 GHz spectrum nationwide and plans to deploy LTE TDD.

Regulator BNetz auctioned 270 MHz of 700, 900 and 1800 MHz spectrum, which started on May 27, 2015 and raised €5,081,236,000 (approx. US$5.75 billion). The 700 MHz spectrum aligns with the lower duplexer arrangement of the APT700 band. The 700MHz band is used by broadcasters and will be available for mobile from 2017, and nationwide in mid 2018. There is a 98% population coverage condition attached to this spectrum. BNetz announced that after 16 days and 181 rounds the spectrum auction for mobile broadband ended today in Mainz. Telefónica Deutschland GmbH & Co. OHG, Telekom Deutschland GmbH and Vodafone GmbH, were successful in bidding for spectrum in line with their business models. All three operators acquired spectrum in the 700, 900 and 1800 MHz. Telekom and Vodafone each additionally obtained 20 MHz of 1.5 GHz TDD spectrum. This spectrum can be combined with existing LTE spectrum assets using carrier aggregation to increase downlink capacity, or could be used in small cell solutions, or for LTE Broadcast by deploying eMBMS. Results:

http://www.bundesnetzagentur.de/EN/Areas/Telecommunications/Companies/FrequencyManagement/ElectronicCommunicationsServices/MobileBroadbandProject2016/project2016_node.html

Gibraltar

Gibtelecom commercially launched 225 Mbps LTE-Advanced using band 7 and band 20 on February 16, 2016.

Greece

Cosmote commercially launched LTE1800 on November 16, 2012 in Athens and Thessaloniki. Coverage targeted 70% by end 2014. Cosmote also has spectrum allocations in band 20 (2x 10 MHz), band 7 (2x 30 MHz) and TDD band 38 (20 MHz, studying for indoor applications) and all will be used for LTE. In November 2014 Cosmote announced progress on LTE-Advanced technology testing, combining newly-acquired 800 MHz and 2.6 GHz spectrum targeting 300 Mbps launch in selected areas in 2015. Band 7 spectrum was brought into use in January 2015. The 800 MHz band could be used from March 1, 2015. On this date 300 Mbps LTE-Advanced capabilities in the network was commercially launched. Tri-band 375 Mbps LTE-Advanced was commercially launched in parts of Athens and Thessaloniki on October 8th, 2015, combining spectrum in bands 3, 7 and 20.

At the InfoCom World Conference (24th November 2015) in a claimed world first, Deutsche Telekom and **Cosmote** together with Nokia, presented an innovative technology that combines 1.8 GHz (FDD) and 3.5 GHz (TDD) spectrum achieving an increase of mobile broadband networks capacity. This combination enhances capacity, speed and quality for demanding services like video streaming and significantly improves customer experience.
LTE-Advanced FDD-TDD 3 x Carrier Aggregation (3CA – 1.8 GHz (20 MHz, LTE FDD) & 3.5 GHz (20+20 MHz, LTE TDD). Max DL speed 370 Mbps.

Visitors to the conference on the **Cosmote** booth also had the opportunity to experience speeds up to 500 Mbps via the **Cosmote** 4G+ network in collaboration with Ericsson and Qualcomm Technologies Inc.
LTE-Advanced 3 x Carrier Aggregation (3CA – FDD: 20 MHz band 3 + 20 MHz band 7 + 10 MHz band 20) & 256 Quadrature Amplitude Modulation (256 QAM)

Vodafone commercially launched a limited LTE1800 service (users with dongles or personal hotspots) on December 17, 2012 in Athens. Full commercial launch was in June 2013. VoLTE has been trialled. On February 26, 2015 Vodafone commercially launched 300 Mbps LTE-Advanced in parts of Athens with user devices and using carrier aggregation of 2.6 GHz and 1800 MHz spectrum. Tri-band 375 Mbps LTE-Advanced was trialled in 2015, combining band 3, band 7 and band 20 spectrum.

WIND Hellas commercially launched its LTE1800 network on March 3, 2015 in Athens (75% coverage) with a free usage promotion until end April 2015.

Regulator EETT completed a 900 and 1800 MHz technology-neutral auction on November 14, 2011 to incumbents Cosmote, Vodafone and Wind raising 380.5 million Euros. EETT is consulting on potential granting of technology neutral licences in 3.4-3.8 GHz spectrum. On May 30, 2014 EETT launched a

consultation on 800 MHz and 2.6 GHz spectrum. Comments were required by June 30, 2014. Results were announced in October 2014; incumbents Cosmote, Vodafone and Wind each won 800 MHz and 2.6 GHz blocks for their LTE deployments.
http://www.eett.gr/opencms/opencms/EETT_EN/Electronic_Communications/Telecoms/Licensing/RoU800_2600results10.html

Greenland

Tele-Post Greenland commercially launched LTE in Nuuk on December 1, 2013 in band 20 for mobile broadband users. Coverage extended to Sisimiut on March 28, 2014 and Qaqortoq in June 2014, at which time the LTE network reached 50% of the population. Smartphone access was enabled in September 2014.

Guernsey

CICRA (the Channel Islands Competition and Regulatory Authorities) consulted in July 2013 on allocating spectrum, specifically 800 MHz (band 20) and 2.6 GHz (band 7), for LTE services in the Channel Islands (Guernsey and Jersey). CICRA later confirmed LTE-suitable spectrum awards to **JT**, **Sure** and **Airtel** for Guernsey and Jersey. A consultation followed concerning 900 MHz spectrum.

JT commercially launched what the company called an LTE-Advanced network in June 2015. The network uses bands 3, 7 and 20.

Sure commercially launched Channel Islands-wide LTE1800 on May 31, 2015. 800 MHz band is being deployed.

Airtel-Vodafone commercially launched LTE in July 2015.

Hungary

Magyar Telekom (MT) commercially launched LTE technology-based services using 1800 MHz on January 1, 2012 initially covering 10 districts of Budapest (over 40% of Budapest's population). By end 2014, population coverage reached 80%. 800 MHz band 20 and 2.6 GHz (band 7) spectrum were brought into use on October 16, 2014.

Magyar Telekom announced in April 2014 completion of LTE-Advanced carrier aggregation tests using 1800 MHz and 2.6 GHz. A small number of sites in downtown Budapest have deployed carrier aggregation of 20 MHz band 3 and 20 MHz band 7 but compatible devices were not then offered. In 2015 Telekom expanded 4G/LTE nationwide residential coverage to 97%, with theoretical peak downlink speed up to 150 Mbps. On December 3, 2015 300 Mbps LTE-Advanced was launched in Nyíregyháza and is now offered in 13 cities. By July 2016 LTE covered 98% of the population.

Telenor commercially launched LTE branded Hipernet 84 on July 5, 2012 using LTE1800. Telenor offers 84 Mbps maximum nominal download speed in 60 towns covering 700,000 population (July 2012), which was expanded to 76 towns by February 2013. The network was upgraded in October 2013 to support 150 Mbps peak downlink using additional 1800 MHz spectrum (total 20 MHz paired). 300 Mbps LTE-Advanced combining spectrum in band 3 and band 20 was launched in 2016 in the inner-city districts of Budapest and at several sites in Gyor. VoLTE is being trialled.

Vodafone commercially launched 75 Mbps LTE service on November 12, 2014 in bands 7 and 20.

MVM Net is deploying a nationwide LTE network using 450 MHz. 95% geographical coverage is targeted by March 2016 to achieve network readiness. Usage is geared towards governmental needs rather than the retail market. The network is currently in trial mode.

On May 22, 2014 regulator NMHH launched auction procedures for a proposed sale of 800 MHz, 900 MHz, 1800 MHz & 2.6 GHz spectrum. 4 applications were made by the June 16, 2014 deadline. Four companies submitted bid applications: **Magyar Telekom, Telenor, Vodafone** and **DiGi Telecommunications.** The auction ended on September 29, 2014 raising 130.6 billion HUF. In addition to the existing 3 mobile incumbents, **Digi** will start to develop a new, fourth network. Results:

Magyar Telekom won 800, 900, 1800 MHz & 2.6 GHz
Vodafone won 800, 900 MHz & 2.6 GHz
Telenor won 800, 900 MHz & 2.6 GHz
DiGi won 1800 MHz

Details:
http://english.nmhh.hu/cikk/164409/NMHH_Hungary_adds_new_frequencies_to_the_digital_economy

In April 2016 NMHH presented rules for the upcoming auction of 3.4 GHa nd 3.8 GHz spectrum, requiring applications by May 2nd.

Iceland

Nova commercially launched LTE1800 on April 4, 2013 in Reykjavik and is testing 800 MHz. Nova won an auction for 1800 MHz and 800 MHz spectrum for LTE in March 2013, alongside **Fjarskipti** (**Vodafone**) and **Simmin.**

Fjarskipti commercially launched LTE using 800 MHz on July 4th, 2013. The company advised GSA that 1800 MHz (LTE1800) will also be used later.

Regulator PTA approved a network sharing agreement by **Nova** and **Fjarskipti**.

Siminn commercially launched LTE1800 on January 15, 2014 using 2 x 20 MHz 1800 MHz offering 100/50 Mbps data speed, increased to 150 Mbps in April 2015 when LTE covered 84% of the population.

365 Media won 800 MHz spectrum and commercially launched 4G/LTE in 2016 with a revised obligation to cover 97% of the population by end 2016.

PTA launched a consultation in 2013 about future use of 2.6 GHz. Vodafone requested an extension to its MMDS in the band from June 2014 until 2020, however only a 2 year extension was approved. PTA reassigned 900 MHz spectrum to existing users Siminn and Vodafone: this band will become technology neutral from February 2017. An auction of LTE-suitable 700 MHz, 2.1 GHz and 2.6 GHz spectrum is planned by end 2016. Comments to the proposals are required by November 1, 2016.

Ireland

Regulator ComReg launched the auction process on May 25, 2012 to cover the 800, 900 and 1800 MHz bands for the period 2013-2030. In total 140 MHz of paired spectrum was offered. The results were announced on November 15, 2012. Meteor, Telefónica O2 and Vodafone were each awarded blocks in the 800 MHz band. Hutchison 3 Ireland, Meteor, Telefónica and Vodafone were each awarded spectrum in both the 900 MHz and 1800 MHz bands.

Meteor commercially launched LTE service using 800 MHz and 1800 MHz spectrum on September 26, 2013 in Dublin, Carlow and Athlone, covering 1.2 million customers, almost 30% of the population.

Vodafone commercially launched data-only LTE service in 800 MHz (band 20) on October 14, 2013 in 6 cities and 23 towns. Smartphones were supported from December 10, 2013. On April 25, 2016 the company announced completion of its national LTE network covering over 90% of the population. 150 Mbps LTE-Advanced was launched in Waterford on December 1, 2014 followed by Cork, Dublin and Limerick by end of 2014. On July 13, 2015 Vodafone announced a higher speed, 225 Mbps service initially in Dublin, Cork, Galway, Limerick and Waterford using band 3 and band 20 spectrum. On July 5, 2016 Vodafone with Ericsson announced they had demonstrated 136 Mbps uplink data speed. Uplink carrier aggregation was implemented using LTE FDD 40 MHz (two 20 MHz carriers) together with 64QAM in the network in Dublin. The demonstration also featured the Qualcomm® Snapdragon™ 820 processor with X12 LTE.

Vodafone is planning to launch its first NB-IoT networks (LTE-Advanced Pro technology) in Australia, Ireland, the Netherlands and Turkey.

3 Ireland commercially launched LTE1800 on January 27, 2014 at no additional charge to current data plans until July 31, 2014 with over 60% coverage initially in Galway, Limerick and Waterford. **O2 Ireland** had planned commercial launch of LTE in 2014, and in September 2013 commenced trials in the cities of Dublin, Cork and Galway. Its parent **Telefonica** announced the sale of O2 Ireland to Hutchison 3. The deal was legally completed in July 2014. 3 Ireland now uses LTE1800 and 800 MHz band 20 on its merged network. 3 Ireland commercially introduced 225 Mbps LTE-Advanced (branded 4G Plus) and announced plans to deploy to 56% of the country by end April 2016.

3 Ireland and **Eircom** have a network sharing agreement meeting one of the merger conditions.

Imagine Group has about 220 MHz of 3.5 GHz spectrum (bands 42, 43) in all strategic parts of the country and is operating a WiMAX 802.16e network nationally. **Imagine** is deploying LTE TDD.

ComReg is considering the future of the 2.6 GHz band including a review of the operation of existing licences within this spectrum which are used for the provision of Pay TV services and MMDS. All MMDS licences expire on April 18, 2014. ComReg proposes that the current MMDS licences should be renewed for 2 years i.e. to April 18, 2016 and that a competitive process be implemented to award new licences on a service and technology neutral basis – which could be used e.g. for MMDS or LTE services. In September 2013 ComReg launched a consultation about allocating unsold 1800 MHz spectrum. In January 2014 ComReg announced that no bids had been received and the spectrum remains unsold.

Italy

Italy's spectrum auction closed with the four incumbents **TIM, Vodafone Italy, Wind** and **3 Italia** submitting bids totalling over € 3.9 billion. Spectrum was awarded in 800, 1800 and 2600 MHz bands for use from end 2011 (1800 MHz), end 2012 (2.6 GHz), and January 2013 (800 MHz).

3 Italia launched a small-scale trial in Acuto on November 6, 2012. Commercial service was launched in Nizhny Novgorod and Rome on February 1, 2013 using 1800 MHz (LTE1800). 3 Italia plans to introduce LTE-Advanced carrier aggregation of 1800 MHz and 2.6 GHz spectrum. 3 Italia acquired TDD spectrum (band 38) for future deployment.

Wind has spectrum for LTE in 800 MHz and 2.6 GHz and commercially launched Category 4 with 800 MHz on January 12, 2014. According to Wind's Q1 2014 results, LTE is available in Rome, Milan, Bologna, Turin, Padova and main airports, and was available in the 17 largest cities by end 2014.

Vodafone announced it had secured 60 MHz of new spectrum, comprising 2 x 10 MHz in 800 MHz, 2 x 5 MHz in 1800 MHz, and 2 x 15 MHz in 2.6 GHz. Vodafone commercially launched LTE1800 service on November 6, 2012 in Milan and Rome. 225 Mbps LTE-Advanced service was launched on December 2, 2014 in 80 cities (90 cities announced on December 23, 2014), rising to 250 cities during April 2015 then 500 cities by August 2015. The service combines two of the bands 800 MHz, 1800 MHz and 2.6 GHz according to location. VoLTE was commercially launched on July 16, 2015 under the Call+ brand. Using all available bands Vodafone demonstrated 1.2 Gbps download speed.

TIM launched its LTE program in 2009 followed by trials. A public users trial was launched in Turin February 16-22, 2012. TIM has spectrum for LTE in 800, 1800 and 2600 MHz bands. Commercial service was launched on November 7, 2012 using LTE1800 in Rome, Milan, Turin and Naples. TIM stated that LTE coverage was available in 651 municipalities by end 2013. A public trial of LTE-Advanced carrier aggregation was conducted in July 2014, combining band 3 and band 7 spectrum, followed by commercial launch of 225 Mbps LTE-Advanced (4G Plus) service in 60 cities from the beginning announced on November 5, 2014 (171 cities coverage was announced on March 5, 2015) by combining 2 frequencies from 800 MHz, 1800 MHz and 2.6 GHz used in the network for LTE. By mid-February 2015 LTE covered 80% of the population. TIM commercially launched 300 Mbps LTE-Advanced service initially in Milan on 26th November 2015 combining spectrum in bands 3, 7, and 20. This 300 Mbps service is now offered on the LTE network in eight cities - Rome, Milan, Genoa, Turin, Naples, Prato, Verona and Palermo. VoLTE was commercially launched on December 21, 2015 throughout the whole LTE network.

On 21 October 2016 TIM announced reults of its LTE-Advanced Pro trial achieving 500 MBps downlink speed in its labs in Turin and in field tests using the live network. 500 Mbps service may launch end 2016 when compatible devices may be available.

On 29 April 2015 **TIM** demonstrated live eMBMS (LTE Broadcast) technology in San Siro, the stadium of Milano, during a Serie A soccer match against Genoa. Separately, a concert was broadcast using LTE Broadcast technology at Expo 2015, Milan's World's Fair in October 2015, where trial users were able to experience the live event with superior quality, and choose on phablets from several channels of content. Another demonstration, in collaboration with RAI, was made during the closing event.

WiMAX™ operator **AFT-Linkem** commercially launched LTE TDD for residential wireless broadband access in band 42 on December 3, 2014. The company plans to deploy LTE-Advanced in Rome.

WiMAX™ operator **GO Internet** commercially launched 3.5 GHz LTE TDD in Marche and Emilia-Romagna on September 1, 2015.

ISP **Tiscali** merged with **Aria** (a WiMAX™ operator), in 2015 and is deploying a 3.5 GHz LTE TDD network. The system provider has been announced.

Telecoms regulator AGCOM approved L-Band (1452–1492 MHz) spectrum for wireless broadband supplemental downlink use. An auction in September 2015 raised €462 million (USD518 million) from the sale of L-Band spectrum to TIM and Vodafone. 3.6 - 3.8 GHz spectrum will be auctioned in 2016.

Jersey

On July 23, 2014 regulator CICRA confirmed LTE-suitable spectrum had been awarded to applicants **Airtel JT**, and **Sure**.

JT commercially launched LTE-Advanced on February 13, 2015. 800 MHz and 1800 MHz are used across the island and additionally 2.6 GHz in towns. Theoretical peak downlink speeds are 150 Mbps with a Cat 4 device and 300 Mbps with a Cat 6 device.

Sure commercially launched Channel Islands wide LTE1800 on May 31, 2015. 800 MHz band is being deployed.

Airtel-Vodafone commercially launched LTE in July 2015.

Kazakhstan

Altel (CDMA operator) (JSC Kazakhtelecom and JSC ALTEL) commercially launched LTE1800 branded ALTEL4G in Astana and Almaty on December 25, 2012. By mid-May 2015 LTE coverage reached 56% of population. VoLTE is in deployment. The CDMA operation closed on July 1, 2015. On 4th November 2015 **Tele2** and **Kazakhtelecom (Altel)** announced both companies had agreed to combine their mobile assets into a new joint venture, which completed on March 1, 2016.

Kar-Tel (Beeline Kazakhstan) commercially launched LTE on July 5, 2016 in Almaty using band 1 and in Uralsk and Aksai using band 3 spectrum.

Kcell commercially launched 100 Mbps LTE service on August 31, 2016 in Almaty, Atyrau, Aktau, and Shymkent using band 3 and band 20 spectrum. On the same date Kcell announced a network sharing agreement with **Beeline Kazakhstan**, enabling 50% coverage to be reached by end 2017.

In January 2016 **Kcell** and **Beeline** each acquired additional 800 MHz and 1800 MHz spectrum.

TeliaSonera acquired the WiMAX™ operations of Alem Communications including a network in 6 major cities and 2.6 GHz (band 38) spectrum, which is compatible for other technologies e.g. LTE TDD.

A technology neutral policy for spectrum was adopted by the regulator in December 2015.

Kosovo

IPKO commercially launched LTE1800 service t on December 11, 2014 in central parts of Prishtina and the international airport.

Vala commercially launched LTE1800 on April 28, 2015.

Regulator ARKEP is preparing to allocate additional technology neutral 1800 MHz spectrum to IPKO and Vala following requests each made in 2015. ARKEP is also preparing to allocate spectrum in the 2.1 GHz and 3.4 – 3.8 GHz range.

Kyrgyzstan

Saima Telecom launched commercial 2.6 GHz FDD LTE services in Bishkek on December 9, 2011.

The National Communications Agency allocated spectrum for LTE and WiMAX™ to 12 companies: **AsiaInfo, Global Telecom Asia, ToTel, Aknet, Kurulush Invest, T-Com, Fraton Plus, Aytel, Foris Telecom, WTT, Saima Telecom** and **Intranet KG**.

Nur Telecom branded as **O!** commercially launched LTE in Bishkek on May 8, 2014 using 2.6 GHz (band 7) supporting theoretical peak downlink of 150 Mbps.

Nur Telecom (O!), Sky Mobile (Beeline) and **Megacom** won 800 MHz band 20 spectrum in an auction held in September 2015.

Megacom commercially launched LTE on March 10, 2016 using spectrum in band 1, band 3, and band 20.

Sky Mobile (Beeline) commercially launched LTE in all regions on May 18, 2016 using band 20 spectrum.

The national transition from analogue to digital TV transmission is scheduled to be completed by July 31, 2016.

Latvia

LMT commercially launched LTE1800 on May 31, 2011; population coverage reached 72% by November 2014. 150 Mbps LTE-Advanced was commercially launched on November 5, 2014, combining spectrum in bands 3 and 7.

Tele2 commercially launched LTE in December 2013 using 1800 MHz (LTE1800). Tele2 also purchased 800 MHz spectrum for use from July 1, 2015 and also uses 2.6 GHz. Tele2 achieved 90% population coverage with LTE assisted by 800 MHz spectrum, which was brought into use on July 1, 2015.

On 12th December 2015 Tele2 announced commercial availability of tri-band 375 Mbps LTE-Advanced (branded LTE++ service) in several areas of Riga. Further coverage is planned.

Bite commercially launched LTE and LTE-Advanced on May 5, 2015 (branded 4G and 4G+ respectively) in Riga and nearby vicinities (Marupe, Pinki, Babītes, Tīraines Bukultu, Carnikavas, Adazi, Kadaga, erection, Upesciema, Mucenieku, Ulbrokas, Sauriesi, Salaspils, Olaine, Jaunolaine, Ikšķile, Skulte, Baloži, Ķekavas) as well as Jurmala, Ogre, Sigulda and Saldus locations together covering 42% of the population, planning 70% by end 2015 and 90% by Q1 2016. Two carrier aggregation combines bands 3 and 7 for 300 Mbps peak downlink. 800 MHz is used in rural areas and as supplementary for carrier aggregation in cities. Single band 1800 MHz sites are mainly in cities. 2.6 GHz is the capacity layer.

Fixed operator **Lattelecom** carried out tests in 850 MHz in 2011 and plans to offer LTE service.

CDMA operator **Triatel** tested LTE in 800 MHz. Triatel owns 450 MHz spectrum.

LMT, Tele2, Bite and **Baltcom** won 2.6 GHz spectrum for use from January 1, 2014. 4.7 million Euros was raised from an auction of 800 MHz (band 20) spectrum in October 2013. **Bite**, **LMT** and **Tele2** each won 2 x 10 MHz for use from July 1, 2015.

Liechtenstein

Regulator AK approved technology neutral use of 800, 900, 1800 MHz and 2.1 GHz spectrum.

Orange Liechtenstein commercially launched 100 Mbps LTE1800 on September 2, 2013 with 91% population coverage. The peak theoretical downlink speed was increased to 150 Mbps by end 2013.

FL1 (Telecom Liechtenstein) commercially launched 150 Mbps LTE in band 20 on February 1, 2015.

Swisscom Liechtenstein commercially launched 150 Mbps LTE on March 5, 2015. The network uses 900 MHz, 1800 MHz and 2.1 GHz. VoLTE was commercially launched on June 10, 2015.

Lithuania

Regulator RRT confirmed the 2.6 GHz auction result on March 20, 2012. In October 2013 RRT announced results of its auction of 800 MHz (band 20) licences of one 10 MHz paired plus 4x 5 MHz paired blocks:

Bite won 791-801 / 832-842 MHz
Omnitel: 801-806/842-847 & 806-811/847-852 MHz
Tele2: 811-816/852-857 & 816-821/857-862 MHz

Omnitel commercially launched LTE on April 28, 2011 in Vilnius, Kaunas, Klaipėda, Šiauliai and Panevėžys using 1800 MHz (LTE1800). Omnitel won 2 x 20 MHz of 2.6 GHz in the March 2012 auction. The LTE network covered 70% population (November 2014) with the use of 800 MHz spectrum, increasing to 99% by May 2016. On November 6, 2014 Omnitel announced LTE-Advanced had been tested, followed by commercial launch on December 5, 2014 of peak throughput up to 200 Mbps in Vilnius, Kaunas, Klaipeda, Siauliai and Panevezys using band 3 and band 20. 4G++ launched in December 2015 for a downlink peak up to 375 Mbps, latest extending coverage to Vilnius. In February 2016 Omnitel

announced it had deployed LTE-Advanced Pro technology and demonstrated download speeds of 750 Mbps by combining 4 spectrum bands and using 4x4 MIMO and the latest modulation schemes.

Omnitel commercially launched VoLTE on September 28, 2016.

Omnitel and fixed line operator TEO LT ar ein the process of merging, thereby consolidating Telia's Lithuanian subsidiaries.

Tele2 won 2 x 20 MHz of 2.6 GHz and commercially launched LTE in Alytus, Jonava, Marijampole, Mazeikiai, and Utena in March 2013. 1800 MHz was used from September 2013. 800 MHz is also used. Tele2 may also deploy LTE in 900 MHz, 2.1 GHz and 2.6 GHz spectrum. 99% population coverage with LTE was announced in September 2016. LTE-Advanced service opened in January 2015 with 10 MHz band 20 and 15 MHz band 3 for theoretical peak downlink speed of 210 Mbps. On August 3, 2015 Tele2 announced commercial launch of LTE-Advanced in 12 cities, representing 20% of the country's population. The initial cities with coverage were Vilnius, Kauno, Klaipėdos, Šiaulių, Panevėžio, Jonavos, Mažeikių, Alytaus, Marijampolės, Nidos, Palangos and Šventosios. Tele2 4G LTE++ tri-band carrier aggregation (bands 3, 7 and 20) was launched in November 2015 in Vilnius up to 350 Mbps theoretical peak downlink. By June 2016 the LTE-Advanced network was available in 33 towns & cities.

Bite Lithuania commercialy launched a 300 Mbps LTE-Advanced network on April 15, 2015. Two carrier aggregation is deployed with 2 main combinations: 800 + 1800 MHz (225 Mbps) and 1800 MHz + 2.6 GHz (300 Mbps). Single 800 MHz LTE sites are deployed in rural areas, 1800 MHz mainly in cities. 2.6 GHz is the capacity layer. Bite targets 95% population coverage by end 2016.

WiMAX™ operator **LRTC (Telecentras)** commercially launched LTE TDD using the MEZON brand with 20 MHz bandwidth of band 40 spectrum on 25th November 2015 covering Klaipėdoje, Tauragėje, Telšiuose, Utenoje, Alytuje and Anykščiuose. Maximum Internet speed 206 Mbps. Coverage in Kaunus and Siauliai was launched in April 2016. 400 LTE base stations were deployed by August 2016. The company is trialling LTE-Advanced Pro to reach 400 Mbps.

RRT started an auction of 900 MHz and 1800 MHz spectrum on January 7, 2016 that the three incumbents can use until October 31, 2017 (the new licences take effect on November 1, 2017). The 3 incumbents were the only participants, each winning spectrum in both bands.

Luxembourg

Regulator Institute Luxembourgeois de Régulation (ILR) introduced technology neutral licences for POST, Orange and Tango and granted extra 1800 MHz spectrum at their request.

- **Tango** commercially launched LTE1800 on October 1, 2012, 150 Mbps theoretical peak
- **Orange** commercially launched LTE1800 on October 29, 2012. 85% population coverage was achieved by mid-December 2014.
- **POST** commercially launched LTE1800 in October 2013.

Tango launched 225 MBps LTE-Advanced (branded 4G+) on December 15, 2014 using bands 3 and 20.

Macedonia

Regulator AEC auctioned 800 MHz and 1800 MHz spectrum. In August 2013 **VIP mobile, ONE** (Telekom Slovenije Group) and **T-Mobile** each won 2x 10 MHz 800 MHz and 2x 15 MHz 1800 MHz.

T-Mobile commercially launched LTE service using 800 MHz and 1800 MHz on December 2, 2013 in most of Skopje and Mavrovo for customers owning LTE devices and the appropriate type of SIM. On 9th November 2015 the company launched LTE-Advanced carrier aggregation in the downtown area of Skopje supporting theoretical peak downlink data speed up to 220 Mbps. At that time the LTE network covered 45% of territory and 70% of the population.

VIP mobile commercially launched LTE service using 800 MHz and 1800 MHz spectrum on July 2, 2014.

ONE commercially launched LTE service using 800 MHz and 1800 MHz spectrum on August 29, 2014.

AEC is consulting on allocating 2.6 GHz for mobile.

Malta

Vodafone commercially launched 150 Mbps LTE1800 on November 1, 2013 initially in Valletta, Sliema and St. Julians.

GO commercially launched its fully fibre connected LTE1800 service on 2nd December 2015.

Regulator Malta Communication Agency (MCA) plans to auction 800, 1800 MHz, and 2.6 GHz bands.

Expressions of interest were stated by incumbents **Vodafone, GO** and **Melita** for the first auction, covering 800 MHz (band 20) spectrum.

Moldova

Following receipt of a 2.6 GHz license from regulator ANRCETI, **Orange** commercially launched LTE on November 20, 2012 in Chișinău. 150 Mbps (Cat 4) was offered in 12 major cities from February 28, 2014. **Orange** acquired additional spectrum for LTE in 800 MHz and 900 MHz bands in November 2015 and in January 2016 launched 300 Mbps LTE-Advanced service in 1000 cities.

Moldcell commercially launched LTE for corporate users using 2.6 GHz on November 16, 2012. Commercial service was extended to all customers on December 24, 2012. Moldcell acquired new licences & spectrum for use from November 6, 2014 continuing use of 900 MHz and buying new technology-neutral band 3 & band 20 spectrum. Moldcell will abandon using 2.1 GHz and 2.6 GHz.

Moldtelecom (Unite) commercially launched 175 Mbps LTE1800 on October 28, 2015. Coverage is currently available in Chisinau, Balti, Edinet, Comrat Ialoveni, Cahul, Hincesti, Rezina, Soroca, Ungheni, Ceadîr Lunga and Vulcanesti.

CDMA operator **InterDnestrCom (IDC)** commercially launched LTE in 800 MHz in Trans-Dniester in Tiraspol, connecting its first customer April 21, 2012.

ANRCETI offered 4G licences to each of the 3 mobile networks in ranges 2500-2690 MHz and 3400-3800 MHz. In July 2015 ANRCETI launched a consultation on its intended allocation of 2500-2690 MHz and 3400-3800 MHz spectrum and a separate consultation about 800 & 900 MHz spectrum for LTE. ANRCETI invited applications for 16 licences to be auctioned, comprising 1 in band 20 (800 MHz), 2 in band 8 (900 MHz), 2 in band 1 (2.1 GHz), 3 in band 7 (2.6 GHz), 8 licences in bands 42 & 43 (3.4-3.8 GHz). Applications were required by November 13, 2015.

Monaco

Monaco Telecom commercially launched 2.6 GHz LTE on October 1, 2013 across 98% of the Principality. 223 Mbps LTE-Advanced adding in 800 MHz band 20 was launched as 4G+ in January 2015. In October 2015 the company said it is deploying a tri-band 450 Mbps LTE-Advanced network.

Montenegro

Telenor commercially launched 2.6 GHz LTE on November 8, 2012 in Podgorica, Bar, Niksic, Cetinje.

Crnogorski Telekom commercially launched LTE1800 on November 28, 2013 in Podgorica, Nikšić, Budva, Bar, Kotor, Tivat and Herceg Novi for 38% population coverage. By November 2014 LTE covered every city, equivalent to 62% population coverage. 150 Mbps is deployed in selected areas. 300 Mbps LTE-Advanced technology is being trialled.

Velatel (Montenegro Connect) has 40 MHz spectrum in 3.5 GHz and planned to deploy LTE TDD. According to its website, the company decided not to invest further in the Montenegro market.

Regulator EKIP auctioned 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz, and 2.6 GHz spectrum in August 2016. Spectrum lots were awarded as follows:

Crnogorski Telekom: 800,900,1800MHz, 2.1+2.6GHz
Mtel: 800MHz, 2.6GHz
Telenor: 900,1800MHz,and 2.1GHz

Netherlands

2.6 GHz FDD spectrum was auctioned in April 2010, and awarded to **KPN**, **Vodafone**, **T-Mobile**, **Ziggo 4** and **Tele2**. TDD spectrum was unsold.

Vodafone NL commercially launched LTE using 2.6 GHz in Eindhoven on May 1, 2012. Amsterdam, The Hague, Rotterdam, and Utrecht followed on August 5, 2013 using 800 MHz and LTE1800. Nationwide coverage (95% of population) was confirmed on September 30, 2014. LTE-Advanced was launched in Amsterdam on September 30, 2014, combining 20 MHz Band 3 and 10 MHz Band 20 spectrum. Vodafone is currently deploying tri-band LTE-Advanced to achieve 300 Mbps by bringing into use 2.6 GHz spectrum. Vodafone is deploying VoLTE targeting launch in 2H 2016. Working with Ericsson and claimed as a world first, Vodafone successfully demonstrated CA of licensed (20 MHz of 1800 MHz band 3) and unlicensed (20 MHz of 5 GHz U-NII-1 band) spectrum over its commercial network. A press release on 18th November, 2015 said the testing validated LTE performance in the unlicensed band and fair co-existence with other technologies like Wi-Fi within the unlicensed 5 GHz band. Vodafone is testing LTE in band 1 spectrum.

Vodafone is planning to launch its first NB-IoT networks (LTE-Advanced Pro technology) in Australia, Ireland, the Netherlands and Turkey.

Ziggo commercially launched LTE on May 3, 2012 for Internet Plus business users in Breda, Oss, and Zwolle.

Tele2 commercially launched its LTE-only network in 2.6 GHz band 7 on May 8, 2012 in Amstelveen, Amsterdam, Haarlem, Lelystad and Tilburg. 800 MHz came into use in January 2015. On December 12, 2014 Tele2 announced a “Pioneer Package” tariff for 225 Mbps LTE-Advanced service from March 2015 initially available in the Randstad; nationwide outdoor coverage is planned by March 2016. Tele2 cmmercially launched VoLTE on March 29, 2016.

KPN commercially launched LTE in 2.6 GHz on May 11, 2012 in The Hague and Utrecht for business users. Commercial service using 800 MHz was launched in Amsterdam in February 2013. Refarmed 1800 MHz (LTE1800) was brought into use in 2014. The LTE network now covers over 95% population. Over 2 million LTE subscriptions were connected by end 2014. Several international roaming partnerships have been announced. KPN trialled LTE Broadcast technology during an Ajax soccer game in Amsterdam on May 3rd, 2014. KPN commercially launched LTE-Advanced carrier aggregation combining band 3 and band 20 spectrum on July 1, 2014 in Amsterdam, Schiphol, Rotterdam, Utrecht, The Hague and Eindhoven where a large portion of KPN’s 4G customers live. A trial of tri-band carrier aggregation combining 800 MHz, 1800 MHz and 2.6 GHz spectrum achieved 297 Mbps in Delft in February 2015. On March 14, 2016 KPN announced that working with partners Ericsson and Qualcomm they had activated 3-carrier channel aggregation with 256 QAM on a live site in Delft. 10 MHz (band 20) + 20 MHz (band 3) + 10 MHz (band 7) with 256 QAM was used, achieving a download speed of 391 Mbps using a Qualcomm test device.

225 Mbps carrier aggregation (20 MHz B3 + 10 MHz B20) was introduced on the live network in April 2015. VoLTE is targeted to launch by end 2016 and is currently available for users to test nationwide.

According to reports, **KPN** plans to offer LTE services as a fixed broadband replacement for home and business users in rural locations. **KPN** is also testing LTE in band 1 spectrum in Schiedam.

T-Mobile commercially launched LTE on May 11, 2012 for business users in some cities initially in 2.6 GHz. LTE1800 was launched for the consumers on November 18, 2013 with the full Randstad covered. The company pledged nationwide LTE coverage using 1800 MHz by October 2015. T-Mobile brought 900 MHz spectrum into LTE use in mid-2015 and plans to cover nationwide with LTE900 by end Q1 2016. 225 Mbps peak is now supported using 2CA LTE1800/LTE900. Trials of 3C CA have started in Woerden by adding in B1 spectrum. There are limited deployments on band 7 and TDD band 38 which are in commercial service. T-Mobile plans to launch VoLTE in Q4 2016.

T-Mobile has a passive site sharing agreement with **Tele2** using 800 MHz and 2.6 GHz spectrum.

According to reports, **T-Mobile** plans to offer LTE services as a fixed broadband replacement for home and business users in rural locations.

Regulator AT auctioned 800, 900 and 1800 MHz spectrum on October 31, 2012. 2 x 10 MHz of 800 MHz and 2 x 5 MHz of 900 MHz was reserved for new entrants. The sale to KPN, Vodafone and T-Mobile earned 3.8 billion Euros. Ziggo-UPC withdrew.

Norway

Norway held Europe's first 2.6 GHz spectrum auction in 2007, Awards were made to **Telenor** and **TeliaSonera** (**NetCom**); total allocation 2 x 90 MHz.

TeliaSonera launched the world's first LTE networks in Oslo (NetCom) and Sweden using 2.6 GHz spectrum on December 14th, 2009. Telia also commercially used refarmed 1800 MHz (LTE1800) in its network from Q4 2011. 800 MHz was used to reach 65% pop coverage by end April 2014. Telia's 4G/LTE is available now to 95% of the population, 4G and 4G+ offers speeds of up to 80 Mbps and 300 Mbps. 4G+ was commercially launched first in Kristiansand on 26 February 2015. Telia commercially launched VoLTE on October 14, 2016.

On December 14th, 2015 **Netcom** claimed a world record by demonstrating 1 Gbps on its LTE-Advanced Pro pilot network deployment. To achieve this speed, NetCom used 4 frequency bands simultaneously: 800 MHz, 1800 MHz, 2100 MHz and 2600 MHz.

Telenor deployed LTE initially with 2.6 GHz. Commercial service 4G (80 Mbps peak) was launched on October 10, 2012 in 11 cities and towns. LTE1800 is also used in Tromsø. **Telenor** also brought 800 MHz into service, and plans for LTE to reach 99% population coverage by end 2016. **Telenor** commercially launched its 4G+ 300 Mbps LTE-Advanced service on April 10, 2015 in over 200 municipalities, combining band 3 either with band 20 or band 7 depending on location. The company has trialled LTE TDD technology using band 43 spectrum. VoLTE was commercially launched on January 20, 2016.

Tele2 Norge offered LTE to its customers in 2014 as an MVNO on the Netcom network. Tele2 was not successful in acquiring spectrum to support deployment of its own LTE network and in July 2014 announced the company's sale to TeliaSonera. The Norwegian Competition Authority Nkom (formerly NPT) approved the sale. The Tele2 brand in Norway closed down in November 2015.

Nkom held a spectrum auction starting on December 2, 2013. Results:

Telenor won 2 x 10 MHz of 800 MHz, 2 x 5 MHz of 900 MHz and 2 x 10 MHz of 1800 MHz.

TeliaSonera won 2 x 10 MHz of 800 MHz, 2 x 10 MHz of 1800 MHz and 2 x 5 MHz of 900 MHz.

Telco Data (Access Industries, owner of Ice.net) won 2 x 10 MHz of 800 MHz and 2 x 5 MHz of 900 MHz and 2 x 20 MHz of 1800 MHz. **Ice.net** commercially launched LTE nationwide in October 2015 using LTE450, replacing entirely its CDMA system. 800 MHz, 900 MHz and 1800 MHz spectrum have also been deployed as needed. VoLTE will be trialled.

Maritime telecommunications operator **Maritime Communication Partner (MCP)** is deploying an LTE network on the Norwegian Continental Shelf MCP, in addition to its existing GSM-based phone and internet access service for offshore companies. MCP obtained band 20 spectrum in August 2014.

Nkom auctioned unsold 2x15 MHz of 1800 MHz spectrum in December 2015. Telenor (won 2x 10 MHz) and NetCom (won 2x 5 MHz) emerged winners.

900 MHz spectrum licences currently allocated to Telenor and Netcom will expire in 2017. Nkom opened a consultation in June 2015 and published the final conditions in October 2015 concerning the planned sale of that 900 MHz spectrum (which would be available for use from January 1, 2018) in 2016.

Poland

The world's first LTE1800 network was deployed by Aero2 and commercially launched on September 7, 2010 by **Mobyland** and **CenterNet**. The primary customer is **Cyfrowy Polsat** – an MVNO that launched commercial services on August 30, 2011.

(GSA does not categorize MVNOs as "networks" - therefore Cyfrowy Polsat is not included in GSA's list of commercially launched LTE networks).

In November 2009 **Aero2** acquired 50 MHz in Band 38 for LTE TDD. After testing in Aleksandrów Łódzki and Łódź, Aero2 announced launch of their LTE TDD network in May 2011 and start of availability of their dual LTE network, since Aero2 had already deployed an LTE1800 network. Aero2 brought 800 MHz band 20 spectrum into service on March 24, 2015.

Polkomtel was acquired on June 30, 2011 by Spartan Capital Holdings, which is indirectly controlled by Zygmunt Solorz-Zak, chairman/founder of Cyfrowy Polsat, and who controls Aero2, owner of Mobyland. Polkomtel operates a GSM 900/1800 and 3G/2100 network. Polkomtel launched commercial LTE services as an MVNO on November 29, 2011 under its **Plus** brand, utilizing the LTE 1800 and HSPA+900 networks of Aero2 and Mobyland/Centernet in 16 major cities, representing 22% population coverage.

Polkomtel's LTE1800 network was commercially launched in September 2012. **Polkomtel** and **Cyfrowy Polsat** have trialled LTE-Advanced using 20 MHz B3 and 20 MHz B7 spectrum, reaching 225 Mbps downlink data speed. Tri-band carrier aggregation has been trialled. In September 2014 Polkomtel has completed VoLTE trials. Polkomtel trialled eMBMS-enabled LTE Broadcast at a World Volleyball Championship match in Warsaw on August 30, 2014.

Sferia owns 850 MHz spectrum (band 5) in which LTE technology was being deployed as part of their co-operation with NFI Midas for constructing their LTE network used by Polkomtel and MVNO Cyfrowy Polsat. As a result of legal arguments where it was stated Sferia could not use this band as intended, Sferia was instead allocated a 2x 5 MHz block of 800 MHz spectrum (band 20) for LTE for use from January 1, 2015 in return for handing back some of the 850 MHz spectrum. LTE 850 is now being deployed. The company plans to launch VoLTE.

6 companies including Sferia made bids for 5 lots of 1800 MHz auctioned by regulator UKE, which ended mid-February 2013. Winners: **Play** and **T-Mobile.**

Orange Polska commercially launched LTE1800 service on September 10, 2013. By September 2016 coverage was available to 96% of the population assisted by introducing band 20 spectrum following the auction success – see result below. Tri-band LTE-Advanced carrier aggregation has been trialled. Two spectrum combinations were tested and in both cases a download speed of 296 Mbps was achieved:

- 10 MHz band 20 + 10 MHz band 3 + 20 MHz band 7
- 10 MHz band 20 + 10 MHz band 7 + 20 MHz band 7

Play commercially launched 150 Mbps LTE1800 in 13 cities on November 11, 2013. Band 7 and band 20 spectrum won in the 2015 auction (see below) was commercially introduced in 1H 2016. Band 1 spectrum came into commercial use on August 11, 2016 enabling 4C CA LTE-Advanced Pro delivering downlink speeds up to 262 Mbps. The service is branded "LTE Ultra". VoLTE is in deployment.

Orange (PTK Centertel) and **P4** (Play) are deploying a shared LTE network. The JV was allowed to bid in the 2.6 GHz auction.

Orange Polska uses 800 MHz, 1800 MHz and 2.6 GHz for LTE-Advanced service. 300 Mbps is available commercially launched.

Orange Polska commercially launched VoLTE on October 13, 2016.

Orange Polska announced that Orange Labs with its partner Huawei launched an LTE-Advanced Pro test site aggregating 4C CA with 256QAM and 4x4 MIMO, to achieve 1 Gbps on the downlink. A subsequent test using 5C CA (100 MHz of bandwidth across bands 1, 3, 5, 7 and 20) with 256QAM on the downlink achieved 1.91 Gbps.

T-Mobile (formerly PTC/ERA) commercially launched LTE1800 on June 5, 2014 under the "Jump" brand with initial coverage of 45% of the population. **T-Mobile** uses 800 MHz, 1800 MHz and 2.6 GHz spectrum for LTE. T-Mobile has commercially launched 3C CA by aggregating bands 3, 7 and 20 to enable peak downlink speed of 300 Mbps. On other sites 2C CA is deployed (b3 + b20 or b3 + b7) enabling up to 220 Mbps.

T-Mobile demonstrated 4C CA LTE-Advanced Pro aggregating 4 bands each of 20 MHz to achieve 1.2 Gbps downlink data speed.

VoLTE is in deployment, launch is planned Q4 2016.

WiMAX™ operator **Milmex,** in southern Poland, is deploying a 3.5 GHz LTE TDD network and also seeks LTE-suitable 800 MHz and 2.6 GHz spectrum.

On December 30, 2013 regulator UKE announced plans to auction 800 MHz (band 20) and 2.6 GHz (band 7). Bids were required by February 13, 2014. The auction was cancelled owing to a technical problem. The auction restarted on February 10, 2015

of 5 blocks of 10 MHz in band 20 and 14 blocks of 10 MHz in band 7. Polkomtel withdrew from bidding for band 20 spectrum. Orange withdrew from bidding for one 2.6 GHz block in March 2015. The auction ended on October 15, 2015. The results were:

800 MHz: Orange won 2 blocks, NetNet, Play P4, and T-Mobile won one block each

2.6 GHz: Play P4 and Polkomtel each won 4 blocks, Orange and T-Mobile each won 3 blocks

NetNet decided later not to take up their 800 MHz spectrum which T-Mobile later bought.

The auctioned 800 MHz and 2.6 GHz spectrum was allocated in June 2016.

On August 23, 2016 **Polkomtel (Plus)** and **Cyfrowy Polsat** commercially launched 2C CA 300 Mbps LTE-Advanced. The service aggregates 20MHz of band 3 and 20MHz of band 7 spectrum.

Portugal

Regulator **ANACOM** announced the results of its auction on December 12, 2011 after 9 bidding rounds. 800 MHz, 1800 MHz and 2.6 GHz spectrum was sold to the 3 incumbents. **Vodafone** also acquired 2 x 5 MHz of new 900 MHz spectrum, but another block was not sold. Spectrum in 450 MHz and 2.1 GHz was not sold.

Meo launched commercial LTE service on March 12, 2012 in 2.6 GHz. Population coverage passed 80% in April 2012 when 800 MHz spectrum was brought into use. 1800 MHz was brought into commercial use in September 2012. 300 Mbps LTE-Advanced was commercially launched in October 2014. To achieve this, 20 MHz B7 and 20 MHz B3 is used with carrier aggregation. Some sites have 225 Mbps service, achieved using 20 MHz B7 and 10 MHz B20.

Vodafone commercially launched LTE FDD service on March 12, 2012 in 2.6 GHz and 800 MHz. LTE1800 was brought into service in October 2012. Current peak speed is theoretical 150 Mbps peak. On December 16, 2013 the company announced it had achieved 300 Mbps downlink in an LTE-Advanced trial using carrier aggregation combining 1800 MHz and 2.6 GHz spectrum, which was commercially launched on October 20, 2014. The first Cat 6 device (CPE Vodafone 4G B4000) went on sale on June 9, 2014. In November 2014 Vodafone announced improved trial speeds up to 450 Mbps. On July 27, 2015 Vodafone announced results of another trial, where 600 Mbps was achieved using three 20MHz blocks and 256QAM equipment. Vodafone is also trialling FDD-TDD convergence combining 20 MHz Band 38 (2.6 GHz) and 15 MHz Band 3 (1800 MHz).

Vodafone commercially launched VoLTE HD voice service on September 28, 2015.

NOS commercially launched LTE on March 15, 2012 using LTE1800 plus 2.6 GHz in more dense areas. 800 MHz is used in rural areas. NOS commercially launched 2C CA 300 Mbps LTE-Advanced in November 2015 using band 3 and band 7 spectrum. Commercial 2C CA 225 Mbps LTE-Advanced commercial service is available using either band 20 + band 3 or band 20 + band 7.

Broadband Portugal is a wireless start-up company based in Lisbon and plans to deploy an LTE TDD wireless broadband access network in all of Portugal except the Azores using 3400-3600 MHz and 3600-3800 MHz spectrum.

Romania

On July 2, 2012 regulator ANCOM published rules for auctioning 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz spectrum for mobile in the 2013-2029 timeframe. The auction was held on September 10, 2012.

Orange acquired new spectrum in the 800, 900, 1800 and 2.6 GHz bands in the auction. Orange commercially launched LTE1800 service on December 12, 2012 in Bucharest and holiday resorts. Having brought band 20 into use, coverage exceeds 90 cities and over 1,000 localities representing 45% of the population. Theoretical peak downlink speed was increased from April 7, 2014 to 150 Mbps. Testing of 300 Mbps Cat 6 was undertaken in April 2014 in selected locations and was commercially launched using 20 MHz band 3 combined with 20 MHz band 7 spectrum on September 22, 2014 in Bucharest, Brasov, Cluj-Napoca, Galati, Iasi and Timisoara. 3C CA 375 Mbps (adding B20) was available from March 2016 initially at 4 retail outlets. 1 Gbps enabled by LTE-Advanced Pro technology was

demonstrated on a test network in July 2016. VoLTE HD voice service launched on September 14, 2015.

Vodafone acquired additional 800, 900, 1800 and 2.6 GHz spectrum for EUR 228.52 million. On October 31, 2012 Vodafone announced pilot LTE1800 networks had been deployed. Commercial LTE1800 service was launched in 10 cities (Arad, Bacau, Brasov, Bucharest, Cluj, Constanta, Craiova, Iasi, Galati and Timisoara) on November 20, 2012. Having brought band 20 into use, the LTE network covered 19 cities representing 90% of population by June 2014. **Vodafone** announced it has raised theoretical downlink peak speed to 150 Mbps (Cat 4) under its Supernet brand, and launched 300 Mbps LTE-Advanced service (Supernet 4G+) on September 5, 2016 in all 41 county capitals. On November 5, 2014 Vodafone announced launch of its Call+ service which is enabled with VoLTE. In LTE-Advanced Pro technology trials Vodafone reached 1.35 Gbps.

Orange and **Vodafone** formed a network JV company (Ovidiu) for expansion and rural coverage.

Telekom (formerly Cosmote) acquired 1 block in 800 MHz, 2 blocks in 900 MHz, 5 blocks in 1800 MHz & 2 blocks in 2.6 GHz. Comsote commercially launched LTE1800 data service on April 29, 2013 in Bucharest, Otopeni, Ploiesti, Cluj, Iasi, Sinaia, Busteni, & Predeal. Theoretical peak downlink speed is now 150 Mbps. Band 20 was brought into into use in 2014.

RCS & RDS (**Digi**) initially planned to deploy LTE in newly acquired 900 MHz spectrum, though 3G had been the priority, and acquired **2K Telecom** in August 2015. **2K Telecom** won 2 blocks of 15 MHz of 2.6 GHz TDD spectrum (band 38) and commercially launched LTE under the **Idilis** brand in March 2015. **RCS & RDS** (**Digi**) announced commercial launch on October 20, 2016 of FDD band 1 service in Oradea and Pitesti complementing its existing TDD service.

In October 2012 ANCOM published a draft Decision proposing to allow use of 900 and 1800 MHz for 4G (including LTE). 4G systems may also be deployed using 800 MHz and 2.6 GHz from 2014. Operators may choose whether to implement new technologies in these frequencies, deployment timescale, and date of commercial service launch. The draft decision is subject to consultation before becoming effective.

In January 2014 ANCOM opened a consultation regarding one 5 MHz block of 800 MHz (band 20) and eight 5 MHz blocks of 2.6 GHz (band 7) spectrum left unsold in the September 2012 auction.

3.4-3.8 GHz spectrum became available. The deadline for applications was October 5, 2015. **Orange, Vodafone, RCS&RDS (Digi), Radiocom (SNR)** and **2K Telecom** submitted bids. All 5 were granted spectrum; demand was less than supply. 10-year concessions began January 1, 2016. Previously Radicom (SNR) had the only 3.6–3.8 GHz licence.

Russia

MTS, Vimpelcom, Tele2, MegaFon and **Rostelecom** are committed to deploying LTE. The Regulator in principle admits that technology neutrality can be applied to 900/1800MHz spectrum. However, to avoid GSM service quality deterioration if LTE is launched alongside GSM frequencies this topic was examined further in a study in 2012.

On February 2, 2012 **MTS** announced the company had been awarded the first license to provide LTE services in Moscow and the Moscow region. The license granted is for LTE TDD deployment in the 2595 – 2620 MHz range (in band 38) and is valid until December 29, 2016. **MTS** announced commercial launch of its LTE TDD service (replacing its WiMAX™ service) on September 1, 2012 initially covering most of Moscow and 40 population centers in the surrounding Moscow region. **MTS** tested VoLTE in St Petersburg and in May 2014 announced completion of its first VoLTE call using Cloud infrastructure.

Tele2 Russia requested permission to deploy LTE1800. In October 2011 Tele2 indicated it would conduct an independent trial of LTE technology in the 1800 MHz band, and applied to the State Commission for Radio Frequencies (SCRF) for permission to run tests in Pskov and Omsk, setting aside 5 MHz of spectrum in 1800 MHz for the tests. Tele2 has already provided the results of earlier research commissioned by themselves as well as from reports by leading global manufacturers of telecommunication equipment showing that GSM and LTE networks can operate simultaneously in the 1800 MHz frequency band. The efficiency of this solution was clearly demonstrated by research carried out and published in a report by the Global mobile Suppliers

Association (GSA) – this free report "Embracing the 1800MHz opportunity: Driving mobile forward with LTE in the 1800MHz band" is available on request to GSA.

Tele2 Russia announced completion of tests by end March 2012 in trial zones in Omsk and Pskov. Tests were performed according to a method developed by the State Radio Institute and with the assistance of its experts, and intended to demonstrate that LTE and GSM technologies can share the same frequencies without degrading the quality of end user service. Tele2 showed that the test results confirmed that there was no service quality degradation in the GSM network, while the data transmission rate in the LTE network reached 75 megabits per second. A detailed report on LTE technology testing in 1800 MHz was prepared and submitted by NIIR to the State Commission for Radio Frequencies.
www.en.tele2.ru/news.html?year=2012&month=3&news_id=6170

Tele2's then-owners exited from Russia with the announcement on April 4, 2013 that the business had been sold to Russian bank VTB Group following receipt of FAS approval. VTB purchased 100% of the business for subsequent resale.

On June 20, 2013 Tele2 announced launch of LTE testing in 1800 MHz in its network in Kaluga Region. The tests comply with the methodology drafted by NIIR and aim to confirm that the use of LTE and GSM technologies in the same frequency range is efficient and does not entail deterioration of quality. Tele2 and NIIR completed the tests by 24 June 2013. NIIR produced the detailed report on LTE tests in 1800 MHz for the State Commission for Radio Frequencies (GKRCh). The GKRCh confirmed on December 11, 2013 that technology neutrality is allowed, allowing LTE to be deployed in 1800 MHz (LTE1800).

In December 2013 the board of **Rostelecom** approved the plan to contribute its mobile assets into a joint venture with **Tele2 Russia**. The new company is known as LLC T2 RTK Holding operating as the **Tele2** brand. **Tele2 Russia** commercially launched LTE1800 on December 17, 2014 in Tula and settlements of the Leninsky district, Shchekin, Novomoskovsk, knots, Don, North Zadonsk, Sokolniki and Aleksinon. Rollouts in major cities progressed in 2015.

NOTE: *Because Tele2 Russia and Rostelecom created the joint venture company* ***T2 Мобайл*** *– in this report there is one entry in the list of LTE networks to replace the former 2 entries. This entry is called* ***Tele2 Russia****. The commercial launch date shown is the earliest achieved by the former two companies (i.e. 03.06.13).*

MegaFon and **Rostelecom**, general partners of the Sochi 2014 Winter Olympic Games, successfully tested LTE networks close to the key Sochi site of Roza Khutor. The Defence Ministry has reportedly given **Rostelecom** approval to deploy LTE TDD in 2.3 GHz spectrum. **MegaFon** showcased LTE at the IX International Investment Forum (Sochi) in Sept 2010. **Rostelecom** activated LTE sites in Krasnodar and in Sochi for the Winter Olympics.

Megafon acquired WiMAX™ operator **Synterra** in 2010, and commercially launched LTE TDD using 2.6 GHz (band 38) spectrum in Moscow on September 1, 2012. **Megafon** also had an agreement with Yota and since 1H 2012 had been operating as an MVNO over Yota's LTE network in Moscow and other cities.

In September 2011 SCRF issued an authorization for **Yota** (Skartel) to deploy an LTE FDD network in 2.6 GHz spectrum in 180 cities. **Yota** is shifting from WiMAX™ to LTE and launched commercial LTE FDD service in Novosibirsk, Siberia on January 15, 2012 following a friendly-launch test phase that began on December 20, 2011. **Yota** launched commercial LTE service in Moscow on May 10, 2012, Krasnodar (also on May 10), and Sochi (May 11) and plans to deploy 1,550 LTE-enabled base stations instead of current WiMAX™ equipment. Service has since been launched in several other locations. In October 2012 Yota announced that a test LTE-Advanced network had been deployed in Moscow, featuring Carrier Aggregation (Release 10 feature). Yota is also implementing VoLTE with SRVCC. *See information below about the company's acquisition by Megafon.*

In September 2011, **VimpelCom** announced an LTE network-sharing deal with **MTS**.

Military operator **OJSC Osnova Telecom** has a license for 2.3 GHz LTE TDD. On November 28, 2013 the company announced technical readiness to launch LTE but commercial launch has been delayed indefinitely due to legal/regulatory issues. The

company has trialled TDD LTE-Advanced in its laboratory achieving a downlink speed of 226.1 Mbps.

Vainakh Telecom deployed a commercial LTE TDD network in 2.3 GHz (band 40) in Chechnya. Commercial service launch in Grozny was delayed from early 2013 because of a dispute about local equipment manufacturer certification. Commercial service was officially launched on September 3, 2013.

GSM1800 regional operator **MOTIV** commercially launched LTE1800 on November 6, 2014 after 6 weeks of public user trials in 4 Russian Regions: Sverdlovskaya, Kurganskaya, Khanty-mansiskiy AO, and Yamalo-nenetskiy AO. In February 2016 the company won 2.6 GHz LTE TDD spectrum covering Kurgan, Sverdlovsk, Tyumen, Ugra and Yamal. MOTIV plans to introduce VoLTE following recently received approval.

SMARTS Group has deployed a pilot LTE trial network in Ufa comprising at least 7 base stations and re-uses SMARTS' existing 1800 MHz spectrum. The trial involved cooperation of the NIIR and the findings were presented to SCRF. SMARTS has committed to deploy a commercial LTE1800 system.

Regional operator **JSC Tattelecom** (Republic of Tatarstan) commercially launched LTE on June 27, 2014 using 1800 MHz acquired from the purchase of SMARTS-Kazan. Tattelecom was the first operator to commercially launch an LTE1800 network in Russia, and at launch operated 228 LTE base stations.

3.5 GHz WiMAX™ operator **Enforta,** providing services to business users in 172 cities, tested LTE TDD in Kemerovo. A commercial network will not be built as the company has agreed to give up these frequencies for use by others for LTE deployments.

Smoltelecom is planning to introduce LTE TDD.

On May 3, 2012 Russian regulator Roskomnadzor published the conditions for application for and subsequent awarding of LTE licences in 791-862 MHz spectrum, comprising four lots, each consisting of two 7.5 MHz blocks in the range of 791-862 MHz. Recipients of each of the lots would also be awarded two 7.5 MHz blocks in the 720-791 MHz range and two 10 MHz blocks in the 2500 – 2690 MHz range. All licences are nationwide. Eight companies submitted bids to participate in the auction, **MegaFon, Vimpelcom, MTS, Rostelecom, Summa Telecom, TTK, Tele2-Voronezh, and Tele2-Omsk.** LTE licences were granted to **MTS, Vimpelcom, Megafon,** and **Rostelecom** with the conditions that the networks must be launched by mid 2013, annual investment targets must be met (RUB 15 billion), and nationwide coverage by 2019. Each operator was granted spectrum within band 20 (720-750 MHz and 761–791 MHz) plus 2,500–2,690 MHz spectrum.

TTK owns 3.5 GHz spectrum and is deploying WiMAX™. TTK launched a LTE test network in the Voronezh region in May 2013. TTK is reported to be planning to buy **Antares Telecom**. Antares has deployed 5 LTE base stations for a trial network using 1900 – 1920 MHz (Band 39) spectrum in Moscow.

Megafon commercially launched LTE FDD service on May 14, 2013 in Moscow using its own network and 2 x 10 MHz of 2.6 GHz (band 7) spectrum. Currently **Megafon** has commercial LTE service in 53 regions of Russia. It has not been possible to bring 800 MHz into use so far due to negotiations with the military.

Megafon obtained regulatory approval for its proposed takeover of **Skartel (Yota)** and formally announced on October 1, 2013 its acquisition of Maxiten, the holding company controlling Skartel/Yota. As a result MegaFon obtained 40 MHz of 2.6 GHz spectrum and 648,000 LTE subscribers. The Yota LTE network covered 27% of the population. On April 24, 2014 MegaFon announced completion of the key processes of the integration of Skartel (Yota), 100% of the shares of which were purchased by Megafon.

On February 25, 2014 **MegaFon** announced the commercial launch of the world's first 300 Mbps LTE Advanced network, supporting Cat 6 user devices, and using a combination of its own 2.6 GHz spectrum and 2.6 GHz allocated to Skartel. The service was initially launched within the Garden Ring in Moscow. The company plans to expand coverage to include Russia's largest cities. 300 MBps LTE-Advanced service was later launched in St Petersburg. Brand, 4G+ is used to promote mobile Internet. LTE-Advanced smartphones are now offered. Megafon has tested 450 Mbps LTE-Advanced for Category 9 user devices, combining 20 MHz 2.6 GHz + 20 MHz 2.6 GHz + 20 MHz 1800 MHz (band 3).

MegaFon commercially launched LTE1800 in Izhevsk in February 2015.

Megafon began LTE network deployment using 800 MHz band 20 spectrum in St Petersburg.

Megafon launched VoLTE initially in trial phase in Moscow on September 3, 2015. Regulatory approval for VoLTE service was granted December 12, 2015. Service was commercially launched in Moscow in September 2016 for users of a certain phone type.

On June 16, 2016 in St. Petersburg Megafon demonstrated 1 Gbps downlink speed using LTE-Advanced Pro technology:

20 MHz of band 3 and 20+20 MHz of band 7 spectrum, 256QAM on the downlink, 4x4 MIMO. A commercial service of LTE-Advanced Pro to be launched later would also include 64QAM on the uplink, and VoLTE.

Studies have been made regarding 3GPP NB-IoT and, with the standard now available, tests will begin.

Press release:
http://www.londonstockexchange.com/exchange/news/market-news/market-news-detail/MFON/12856521.html

MTS commercially launched LTE FDD service in May 2013 in Moscow using its own network and 2 x 10 MHz of 2.6 GHz (band 7) spectrum. LTE1800 was introduced in Moscow in December 2014 and is being deployed in other areas. 800 MHz spectrum was brought into use in Moscow in early 2015. LTE1800 was activated in Ufa and St Petersburg in early 2015.

On September 10, 2014 **MTS** announced successful testing of LTE-Advanced carrier aggregation combining 30 MHz of bandwidth spanning the 1800 MHz and the 2600 MHz ranges to achieve 225 Mbps on its commercial network in Bashkirian (later extended to Moscow). http://www.mtsgsm.com/blog/

One June 18, 2015 **MTS** confirmed deployed 2-band (150 Mbps) or 3-band (225 Mbps) LTE-Advanced systems in 15 Regions by end 2015, and LTE1800 in 19 Regions. Most base stations will have a dual-band network: 1800 + 2600 MHz or 2600 MHz LTE800 depending on spectrum availability. In the regions of North-West, including St. Petersburg and Leningrad regions, three types of aggregation of the two bands will be used. In this region in 2015, MTS started deploying 3C CA sites 800 + 1800 + 2600 MHz.

MTS deployed an FDD-TDD carrier aggregation network in Moscow's business district, a first for the country delivering 187 Mbps using carrier aggregation of 10 MHz in band 3 and 20 MHz in band 38.

Russia's first live trial of LTE Broadcast technology was announced on 9th October 2015. Ericsson, **MTS** and Qualcomm Technologies, Inc., successfully completed their first live tests of LTE Broadcast. The trial took place at MTS' office in Nizhny Novgorod, while video content was distributed from Aachen, Germany, using Ericsson's end-to-end LTE Broadcast solution, which shows the feasibility of a fully distributed operator solution. Pre-configured LTE Broadcast-enabled mobile devices were powered by Qualcomm® Snapdragon™810 processor with an integrated X10 LTE modem.

LTE-U was trialled by **MTS** in June 2016 achieving 200 Mbps using 10 MHz in band 3 and 20 MHz of 5GHz unlicensed spectrum.

Rostelecom confirmed commercial launch of LTE FDD service in Sochi on June 3, 2013 using 2.6 GHz and 800 MHz spectrum. The company plans to build LTE networks in 8 Regions by the end of this year.

Rostelecom plans to deploy LTE using 450 MHz spectrum (currently used for CDMA) having completed trials in this band in the Kostroma region in December 2013.

Vimpelcom (Beeline) commercially launched LTE FDD in Moscow on May 27, 2013 using 2.6 GHz. Coverage was extended to the Moscow region in July 2014, again using 2.6 GHz. On August 27, 2014 the company announced launch of 110 Mbps using LTE-Advanced carrier aggregation (bands 7 and 20) within the Garden Ring. Beeline announced the sale of compatible smartphones (Samsung Galaxy Alpha) beginning on September 18, 2014. VoLTE was tested in Q1 2014 and VoLTE HD Video was also tested in October 2014. VoLTE service in Moscow and Moscow Region opened in August 2015 for users with the specified compatible phone. Regulatory approval for VoLTE service was granted December 12, 2015.

New frequency auctions for 2.6 GHz LTE TDD band 38 spectrum are foreseen during 2014, for which a new decree was signed on May 24, 2014. On July 22, 2014 SCRF extended technology neutrality principle to allow use of 900 MHz (formerly GSM-only band) and 450 MHz for LTE deployments.

Tele2 commercially launched LTE450 (band 31) under the **SkyLink** brand on May 27, 2016 in the Tver and Novgorod regions, expanding to St Petersburg in June, and Moscow on July 1, 2016. Two types of 4G router for a country house, and a mifi for travelling, are offered, operating on 450 MHz, 800MHz, 1800 MHz and 2.6 GHz. These devices automatically switch to the highest band available.

MTS and **Vimpelcom** announced in December 2014 a collaboration agreement to on joint planning, development and usage of LTE infrastructure in Russia and the CIS region. Practical deployments were launched in 31 Regions during 2015. The agreement has been expanded to enable spectrum sharing using 2.6 GHz in 20 Regions from 2016. Each companies owns 2 x 10 MHz bandwidth and this arrangement will allow both companies to double theoretical peak downlink speeds to 150 Mbps.

The Ministry of Telecom & Mass Communications (Minsvyaz) announced on June 30, 2015 that SCRF has cleared a wide range of frequencies for shared usage between mobile operators for LTE deployments. The spectrum ranges approved for LTE network sharing are 791-820MHz, 832-861MHz, 890-915MHz, 935-960MHz, 1710-1785MHz, 1805-1880MHz and 2500-2690MHz, with effect from October 1, 2015. The decision is designed to accelerate LTE market development in Russia.

Roskomnadzor auctioned technology-neutral 1800 MHz spectrum beginning on September 29, 2015. The spectrum was bought by Megafon, MTS, Tele2 and Vimpelcom.

In August 2016 **Beeline** and **Tele2 Russia** announced a network sharing agreement across 27 regions and encompassing sharing of spectrum, passive and active infrastructure.

SRFC is considering liberalising 2.1 GHz spectrum, presently used only for 3G services.

Roskomnadzor is preparing for a second auction of spectrum in the bands 2570-2595 and 2595-2620 MHz for 81 regions in Russia, to be held in 3 stages during February 2016.

Serbia Republic

In February 2015 regulator RATEL auctioned 1800 MHz band 3 spectrum suitable for LTE network deployments. The bidders were the 3 incumbent mobile operators: **Telenor, VIP Mobile** and **MTS**. RATEL announced that all were successful in obtaining 10 MHz paired of spectrum each, which is expected to be used for LTE network deployments.

Vip Mobile launched a 150 Mbps LTE network in Pančevo on March 24, 2015. By end 2015 LTE covered 24% of population. 225 Mbps 2 carrier LTE-Advanced (bands 3 and 20) was launched in January 2016 and is being further rolled out.

Telenor commercially launched LTE1800 for post-paid customers on March 25, 2015. The network initially covered areas of Belgrade, Subotica city centre, Kopaonik and Zlatibor.

MTS commercially launched LTE1800 on April 3, 2015 with coverage in Belgrade, Novi Sad, Nis, Kragujevac, Arandjelovac, Sabac, Novi Pazar, Pancevo and Kopaonik.

RATEL auctioned 800 MHz band 20 spectrum in November 2015 attracting bids from the three incumbents. All were successful, each obtaining 10 MHz paired spectrum that is expected to be used for LTE network deployments.

Slovak Republic

Regulator TU SR granted licences to **O2 Slovakia, Orange** and **T-Mobile Slovensko** for each to trial LTE FDD networks in 2.6 GHz in Banská Bystrica.

O2 Slovakia commercially launched LTE on a small scale on August 2, 2012 using LTE1800. A wider commercial launch followed in Bratislava and Kosice on December 9, 2014. O2 Slovakia reached 25% population coverage by December 2015 with the introduction of 800 MHz spectrum. O2 is trialling dual-band LTE-Advanced carrier aggregation combining spectrum in bands 3 and 20 in Bratislava and has

achieved 165 Mbps downlink data throughput. The company has trialled LTE TDD in the 3.5 GHz band and may use it to complement its FDD network.

Slovak Telekom commercially launched LTE1800 in Trnava, Nitra, Zilina, Banska Bystrica and Presov on November 15, 2013. 2.6 GHz was brought into use in April 2014 to support Cat 4 service in Bratislava. 800 MHz has also been comemrcially introduced. 225 Mbps LTE-Advanced was launched in Nitra on June 25, 2015 combining 2 x 20 MHz band 7 & 2x10 MHz band 3. Coverage reached 85.1% of the population by October 1, 2016. 300 Mbps LTE-Advanced service combining 2x40 MHz in band 7 was launched on November 24, 2015 in Petrzalka in Bratislava. On June 23, 2015 a trial using 20+20 MHz band 7 + 10 MHz band 3 spectrum achieved 375 Mbps in Bratislava.

The company is trialling LTE TDD band 41 technology.

Results from an LTE-Advanced Pro trial by **Slovak Telekom** were announced in August 2016. The trial achieved downlink speeds up to 900 Mbps using 50 MHz 3C CA with 256QAM on the downlink and applied 4x4 MIMO across 40 MHz of spectrum.

VoLTE trials began in December 2015.

TU SR conducted an auction of 800 MHz, 1800 MHz and 2.6 GHz spectrum for LTE in late 2013. **O2 Slovakia** subsequently announced that the company had won channels in the 800 MHz and 1800 MHz bands. O2, owned by investment group PPF, plans to use 800 MHz and 1800 MHz in its LTE network. Other winners were **Orange** and **Telefonica O2** plus new market entrant and domestic 3.5 GHz WiMAX™ operator **Swan Telecom**. Results:

- **Orange Slovensko:** 2 x 10 MHz 800 MHz, 2 x 4.8 MHz 1800 MHz, 2 x 20 MHz 2.6 GHz
- **Slovak Telekom**: 2 x 10 MHz 800 MHz, 2 x 40 MHz 2.6 GHz, 50 MHz 2.6 GHz TDD band 38
- **O2 Slovakia:** 2 x 10 MHz 800 MHz, 2 x 0.6 MHz 1800 MHz
- **Swan Telecom:** 2 x 15 MHz 1800 MHz

Orange Slovensko commercially launched 150 Mbps CAT 4 LTE on July 7, 2014 in the cities of Bratislava, Banska Bystrica and Kosice, using bands 7 and 20. 51.5% pop. coverage was achieved by July 2015. Orange commercially launched 225 Mbps LTE-Advanced in 7 cities on December 7, 2015 combining 20 MHz of band 7 with 10 MHz of band 20 spectrum.

Swan Telecom commercially launched an unlimited data-only 75 Mbps theoretical peak LTE1800 and TDD band 43 service brand named 4G INTERNET v1.0 in 50 cities on March 13, 2015 together with several compatible devices: Huawei E5373 LTE portable router, ZTE MF831 LTE USB modem, ZTE MF910 LTE portable router, Huawei E8278 USB modem, Huawei E5180 router, ZTE MF283 + router, and BandRich R551P router. The company relaunched with a new brand (**4ka**) in October 2015, supporting voice and data calls and over a larger footprint. **4ka** LTE network covered 64% of population by September 2016. **4ka** commercially launched VoLTE and ViLTE on October 12, 2016.

WiMAX™ operator **Slovanet** commercially launched LTE TDD using 3.5 GHz on November 10, 2015 in Nitra, Vranov, Trebišov and more than 100 municipalities in the wider area. By June 2016 coverage reached 220 municipalities.

Regulator RU sold 20MHz TDD and 2x5 MHz FDD spectrum in the 3.5 GHz range, for nationwide use, to **O2**. The licence includes coverage obligations.

Regulator RU awarded 3.5 GHz band 43 licences each of 40 MHz bandwidth to **Benestra, O2 Slovakia,** and **Swan Telecom.** Swan Telecom and O2 each additionally gained 3.4-3.6 GHz band 42 spectrum in another auction announced mid-2015.

Slovenia

Si.mobil announced commercial launch of LTE service on July 12, 2012 in Ljubljana, Brnik, and Bled using 1800 MHz (LTE1800). 800 MHz band 20 channels were brought into use in June 2014. The company provides LTE coverage to over 80% of the population (June 2015), targeting 95% by mid-2017. Si.mobil launched 300 Mbps LTE-Advanced launched in selected locations across 6 cities on November 25, 2014 using 800 MHz and 1800 MHz spectrum. VoLTE is being deployed.

Telekom Slovenije commercially launched LTE service on March 20, 2013 using refarmed 1800 MHz

spectrum (LTE1800). By end February 2015 the LTE network covered 200 cities and towns, representing over 80% of the population, the network supporting a theoretical peak downlink speed of 150 Mbps using 20 MHz paired 1800 MHz spectrum. The company announced on June 1, 2014 that 800 MHz spectrum acquired in April 2014 (see below) had been brought into service for LTE. LTE service was also launched in 5 MHz bandwidth of 900 MHz spectrum on September 22, 2014 and coverage will be expanded to 300 sites by end 2016. 300 Mbps LTE-Advanced using carrier aggregation to combine 20 MHz of 1800 MHz and 20 MHz of 2.6 GHz spectrum was launched on December 14, 2014. LTE using 2.1 GHz (band 1) was introduced in March 2015. 225 Mbps LTE-Advanced combining 10 MHz 800 MHz and 20 MHz 1800 MHz was commercially launched in March 2015. The LTE network runs alongside UMTS, which has continuously been upgraded and which has supported 42 Mbps DC-HSPA+ since 2011. VoLTE is in deployment.

Regulator AKOS authorized test spectrum for LTE in the 700 MHz band (746-756MHz / 777-787 MHz) to a company called Neuron for tests between October 9, 2012 and January 9, 2013 in Ljubljana.

AKOS auctioned off frequencies in the 800 MHz, 900 MHz, 1800 MHz, and 2.6 GHz bands for 15 years, and unassigned 2100 MHz frequencies until September 2021. All of the offered bands, with the exception of two blocks (20 MHz) in the 1800 MHz band and one block (10 MHz) in the 2100 MHz FDD band, were sold. The total proceeds of the auction were EUR 148,740,934.00. The auction started on April 3, 2014. Results were announced after 55 bidding rounds on April 29, 2014. Licences included coverage obligations.

Si.mobil acquired FDD spectrum in 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz and TDD spectrum in 2.6 GHz (band 38).

Telekom Slovenije won FDD spectrum in 800 MHz, 900 MHz, 1800 MHz, and 2.6 GHz

Tušmobil acquired FDD spectrum in 800 MHz, 900 MHz, and 1800 MHz and embarked on a network upgrade program for LTE in May 2015. **Tušmobil** was rebranded to **Telemach Mobil** by its new owner, cable TV and ISP Telemach**.** With 25% LTE coverage customers could switch to using LTE from 1st September 2015 free for a limited period. LTE coverage will increase to 75% of the population on completion of the network upgrade.

On April 20, 2015 AKOS started a consultation on allocating 700 MHz, 1400 MHz, 2.3 GHz, 3.5 GHz, and 3.7 GHz channels. Bids for 1800 MHz and 2.1 GHz spectrum, which had remained following the auction completed in spring 2014, were required by July 4, 2016. The auction was concluded on September 5, 2016. AKOS offered 3 blocks in the 1800 MHz and 2100 MHz bands. The spectrum was awarded to Telekom Slovenia and Telemach for a total price of € 6,550,000.00.

Spain

An auction began on June 29, 2011 for 58 blocks of 800, 900 MHz and 2.6 GHz frequencies, with licences valid to 2030. The auction ended on July 29, 2011 raising €1.65 bn for 800 MHz and 2.6 GHz licences. Spectrum was won by **Vodafone**, **Telefónica** and **FT-Orange**. 800 MHz channels could be used after digital TV switchover, the first location being the city of Zamora from September 2014. However the spectrum was not released until April 2015. 2.6 GHz could be used immediately. **Vodafone** plans to use both bands for LTE, and re-farm 900 MHz for additional rural HSPA or LTE-based coverage.

It was subsequently confirmed that 800 MHz could be used by all 3 operators from July 20, 2015.

Vodafone commercially launched LTE Cat 4 on May 29, 2013 in Barcelona, Bilbao, Madrid, Malaga, Palma de Mallorca, Seville and Valencia. 1800 MHz (LTE1800) and 2.6 GHz is used. On October 15, 2014 announced launch of commercial 300 Mbps LTE-Advanced service using band 3 and band 7 spectrum in Barcelona, Madrid and Valencia. LTE-Advanced service was extended to Seville, Bilbao, Malaga, Zaragoza and La Coruña in December 2014. 800 MHz band 20 spectrum was introduced from January 2015. LTE coverage in June 2016 reached to 95% of the population and more than 2,800 municipalities in all provinces. Band 1 spectrum is also used for LTE service. On February 15, 2016 Vodafone announced that 3 carrier aggregation enabled 330 Mbps and 30 large cities are able to enjoy up to 400 Mbps. With the addition of 20 MHz of

TDD spectrum Vodafone intends to offer 600 Mbps theoretical peak in enterprise environments. By May 2016, 600 Mbps service was available to users in selected areas of Madrid, using LTE-Advanced Pro technology with MIMO. NB-IoT will also be trialled and deployed.

VoLTE was commercially launched across its whole LTE-Advanced network on July 7, 2015.

On May 17, 2015 **Vodafone** trialled LTE Broadcast technology showing 5 HD video channels in HD (High Definition) format during a soccer match at Estadio Mestalla where Valencia were playing against Celta. Triallists had real time access to 5 channels of multimedia content from the match.

Vodafone demonstrated NB-IoT on its live network in Madrid in September 2016.

Orange commercially launched LTE on July 8, 2013 in Barcelona, Madrid, Malaga, Murcia, Seville and Valencia using 1800 MHz (LTE1800) and 2.6 GHz. 800 MHz was introduced in Q2 2015. The company trialled LTE-Advanced in Valencia for which 20 MHz of 2.6 GHz and 10 MHz of 1800 MHz spectrum was combined using carrier aggregation and subsequently demonstrated 300 Mbps at the Mobile World Congress 2015 in Barcelona, This service, branded 4G+, is commercially available in Madrid, Bareclona and Valencia. In September 2015 Orange upgraded its LTE network to 336 Mbps for Barcelona and Madrid customers. The company intends to soon bring into service refarmed 2.1 GHz, 900 MHz and 1,800 MHz spectrum. Tests by the company at its Barcelona labs achieved 500 Mbps using 3-band LTE-Advanced carrier aggregation with 256QAM on the downlink. An LTE-Advanced Pro in Valencia achieved 1.54 Gbps using 4C CA (bands 3, 7, 20 and TDD band 42), 256QAM and 4x4 MIMO technologies.

Yoigo commercially launched LTE service (LTE1800) on July 18, 2013.

Telefónica Movistar offered LTE service from September 13, 2013 as an MVNO on the Yoigo LTE1800 MHz network and commercially launched service on its own LTE1800 network in 28 cities from October 2013. 95% pop coverage was reached by May 2016. Movistar commercially launched 300 Mbps LTE-Advanced service on October 2, 2014 for customers in Barcelona and Madrid, and widely expanded in 2015 with the availability of the 800 MHz band 20 spectrum. Movistar is also trialling VoLTE. Movistar trialled LTE TDD technology in band 42.

Telefonica with its partner Ericsson confirmed completion of a live, over-the-air demonstration of LTE in 5GHz unlicensed spectrum (LTE-U) over Telefonica's network. A high-performance indoor pico cell solution was used offering LTE, W-CDMA and Wi-Fi radio technologies, 10 frequency bands and up to 300Mbps LTE carrier aggregation. LTE-U enables operators to utilize unlicensed 5 GHz spectrum in combination with their licensed LTE spectrum.

On October 11, 2016 Telefonica announced successful completion of its LTE-Advanced Pro demonstration using 4x4 MIMO and 256QAM that achieved 800 Mbps downlink data speed.

ONO, JazzTel, Euskaltel, R, Telecable and **TelecomCLM** won regional 2.6 GHz licences. ONO has been acquired by Vodafone and the spectrum returned for re-auction.

Regional start-up **COTA** commercially launched LTE TDD FWA service in band 38 spectrum in Región de Murcia on March 1, 2013, branded as Murcia4G.

WiMAX™ operator **Neo-Sky** commercially launched LTE TDD service in 3.5 GHz (band 42) in June 2013. In December 2014 MVNO **Masmovil** acquired **Neo** including its 4G licence and has first refusal to the Neo-Sky WiMAX™ and LTE TDD systems.

Cable operator **R** (R Cable y Telecomunicaciones Galicia) is conducting LTE FDD and TDD trials in 2.6 GHz in 3 areas of Galicia and may launch only as an MVNO (by partnering with Vodafone).

2.6 GHz and 3.5 GHz spectrum is to be auctioned.

Sweden

TeliaSonera launched the world's first LTE networks in Stockholm and Norway (Oslo) in December 2009. An 800/1800/2600 MHz multimode modem was introduced July 2011. By end 2012 almost 700 cities in Sweden are served. Coverage was set to double by end 2013. On October 1, 2012 TeliaSonera was

the first LTE operator in Europe to offer an LTE Cat4 modem. TeliaSonera is deploying VoLTE.

Tele2 Sweden and **TeleNor Sweden** deployed an LTE network via a jointly-owned company (Net4Mobility), which includes spectrum sharing in 900 MHz and 2.6 GHz. Using this network, **Tele2 Sweden** and **TeleNor Sweden** commercially launched LTE services to their respective customers on November 15, 2010, initially in Stockholm, Gothenburg, Malmo and Karlskrona. The network now also uses 800 MHz and covers over 99% population. 1800 MHz and 2.6 GHz deliver capacity and speed. In May 2012 Tele2 Sweden and Telenor Sweden announced joint trials of LTE-Advanced and on June 13, 2016 both commercially launched 2C LTE-Advanced services in over 200 municipalities. An additional 256 x 900 MHz transmitters were confirmed as activated from July 4, 2016. On August 24, 2016 a company spokesperson confirmed that 450 Mbps 3-band carrier aggregation had been activated in 400 sites, mainly in urban areas. VoLTE was tested in the network in December 2012 and is planned to be launched by Tele2 and TeleNor.

3 Sweden has deployed an LTE FDD and TDD network. Network technical readiness was announced on December 15, 2011 and commercial LTE service was launched April 23, 2012. The LTE network uses TDD in 2.6 GHz and FDD in 2.6 GHz and 800 MHz. Customers may also use 3G/HSPA up to 42 Mbps (peak DL) in 2.1 GHz and 900 MHz bands.

3 Sweden launched 150 Mbps LTE-Advanced during November 2015 initially in Örebro, Finspång, Kumla, Norrköping and in the central areas of Stockholm, Malmö, Göteborg and Uppsala by combining 20+20 MHz band 38 with 10 MHz band 7 and 10 MHz band 20. An upgrade to 225 Mbps is scheduled for completion in 2016.

TeliaSonera acquired more nationwide frequencies in the 1800 MHz band. The new frequencies are being used in their LTE network and for strengthening the mobile telephony network. In addition to its existing 10 MHz, TeliaSonera acquired 2 x 25 MHz of 1800 MHz spectrum. **Net4Mobility** also acquired more 1800 MHz spectrum for LTE1800. It means Net4Mobility and TeliaSonera each has 2 x 35 MHz in 1800 MHz. A consultation has started to determine interest/future use of 2.3 GHz (Band 40).

CDMA operator **Net1** deployed a nationwide LTE450 network which was commercially launched and completed by October 2015. CDMA users were migrated to the new 4G LTE service.

An auction for 800 MHz opened on February 28, 2011 and ended after 5 days and 31 rounds. An auction for 2 x 35 MHz of 1800 MHz spectrum, for use from January 2013, began on October 11, 2011. The new licences were valid for 25 years from 2013.

700 MHz will be allocated for mobile services aligning with the lower duplexer arrangement of APT700. Regulator PTS plans to auction 2×30 MHz technology neutral nationwide 700 MHz spectrum on December 1, 2016 (application deadline November 1, 2016), valid from April 1, 2017.

PTS auctioned 2 × 5 MHz of technology neutral 1800 MHz (valid from June 1, 2017) on October 24, 2016. 3 was the only bidder and won the spectrum.

Switzerland

Salt (formerly Orange Switzerland) commercially launched LTE1800 on May 26, 2013. **Salt** was acquired by Xaviel Niel on 23 February 2015. Some 2.6 GHz sites were activated in November 2013. LTE covered 90% population by end 2014. Theoretical peak download speeds are up to 150 Mbps (Cat 4). Some 800 MHz sites entered service in May 2014. On December 11, 2014 Salt announced commercial launch of 300 Mbps LTE-Advanced service in Berne combining 20 MHz each of bands 3 and 7. Rollout of LTE-Advanced in other major cities including Geneva, Lausanne, Basel and Zurich is ongoing.

Swisscom commercially launched LTE on November 29, 2012 in 26 towns and cities. The network uses 800, 1800 (LTE1800), and 2600 MHz bands. Approx. 400,000 customers use the LTE service. An upgrade for 150 Mbps Cat 4 service was introduced with compatible devices offered for sale from June 2013. VoLTE was commercially launched on June 10, 2015. Swissom launched 300 Mbps LTE-Advanced on June 16, 2014 in Berne and Lausanne railway stations, with the cities of Berne and Biel following in early July 2014. 2.1 GHz spectrum (band 1) will be introduced for LTE. A few sites are enabled for 450 Mbps. Swisscom demonstrated LTE-Advanced three-carrier aggregation combining LTE in both FDD and TDD

modes on August 18, 2015 using 3 carriers in two bands in a radio access network and used commercial-grade chipsets. Swisscom plans its rollout to subscribers in metropolitan areas by Summer 2016 to coincide with 3-carrier FDD/TDD smartphone availability. For the demonstration in their live commercial network, 2 LTE TDD carriers, each with 20 MHz bandwidth in the 2.6 GHz frequency band (band 41), and one LTE FDD carrier with 15 MHz in the 2.1 GHz band (band 1) were used. With this set-up 335 Mbps downlink speed was achieved.

On September 17th, 2015 Swisscom conducted a further demonstration in their commercial LTE-Advanced network. By introducing 256QAM (quadrature amplitude modulation) in the combined three-carrier aggregation LTE FDD/TDD network, peak downlink speeds pver 426 Mbps were achieved, compared with 335 Mbps with the same set-up using current 64 QAM technology for the downlink. In June 2016 **Swisscom** announced an LTE-Advanced Pro trial achieved 1 Gbps downlink speed.

Swisscom plans to close down its GSM by 2020.

Sunrise Communications commercially launched LTE on June 19, 2013 in Zurich, Bern, Lucerne, Geneva, Lausanne, Basel-Stadt, and several other locations using 1800 MHz (LTE1800) and 2.6 GHz. 800 MHz (band 20) is in commercial use. Sunrise is targeted 97% population coverage (same as 3G/HSPA) by 2015. LTE-Advanced carrier aggregation was trialled. Comemrcial 300 Mbps (Cat 6) service was launched June 1, 2016. VoLTE is being deployed.

Tajikistan

Babilon-Mobile commercially launched LTE in Dushanbe on October 6, 2012 in 1800 MHz (LTE1800) and 2100 MHz, for data users.

Tcell commercially launched its 4G/LTE network using a 10 MHz carrier in 800 MHz (band 20) on April 15, 2014 covering Dushanbe, Khujand, Kayrakkum, Chkalov and Gafurov inside and outside buildings.

Megafon-Tajikistan launched an 800 MHz pilot network in Dushanbe and Khujand in 2015 and commercially launched 70 Mbps LTE service on June 24, 2016 in Dushanbe, Khujand and Kurgan-Tube with a range of user devices and price plans.

Turkey

Turkcell has trialled LTE. In stationary tests downlink speeds up to 170 Mbps were achieved. On April 6, 2012 Turkcell announced results of its mobile LTE trial in an area between Kartal and Maltepe (Istanbul). Turkcell demonstrated LTE-Advanced in July 2013, and achieved downlink speed of 891.6 Mbps. On April 20, 2015 Turkcell announced completion of testing of “Enriched VoLTE”.

In December 2015 Turkcell said it had achieved downlink speed of 1.2 Gbps by aggregating 5 carriers in a demonstration at its Istanbul headquarters, using 79.8 MHz made up of 29.8 MHz in band 3, 30 MHz in band 1, and 20 MHz in band 7.

Turkcell commercially launched 4.5G LTE-Advanced Pro on April 1, 2016 countrywide i.e. all 81 provinces. At launch Turkcell had deployed:
* Band 3, Band 7, Band 20, and B1 in some sites
* 2CA in all sites with (B3+B20) over 30 MHz (20+10) (for 225 Mbps networkwide)
* 3CA in dense areas with (B3+B7+B20) over 50 MHz (20+20+10) (for 375 Mbps)
* 3CA in some sites with (B1+B3+B7) over 60 MHz (20+20+20) (for 450 Mbps)
* 3CA in some sites with (B1+B3+B7)+256QAM over 60 MHz (20+20+20) (for 600 Mbps)
* 3CA in some sites with (B3+B3+B7)+256QAM+4x4 MIMO over 50 MHz (20+10+20) MHz (for 800/100 Mbps network readiness)
* 4x4 MIMO ready in the whole network
* VoLTE/ViLTE launched in the whole network

Rollout will continue to enlarge LTE-A footprint and enhance indoor coverage. Band 1 (2100) will be migrated gradually to LTE-A as LTE-A picks up traffic from 3G. TDD rollout will be considered to offload traffic from FDD (in or after 2017).

Ericsson and **Turkcell** delivered the first immersive live streaming mobile experience over LTE Broadcast in Turkey. This took place during a derby between Fenerbahce and Galatasaray Odeabank, two of Istanbul's biggest basketball teams.

Turk Telecom (formerly Avea) commercially launched 3C CA LTE-Advanced Pro including 256QAM on April 1, 2016 countrywide i.e. all 81 provinces, including VoLTE.

Vodafone Turkey commercially launched 3C CA LTE-Advanced Pro including 4x4 MIMO and 256QAM on April 1, 2016, including VoLTE.

Vodafone is planning to launch its first NB-IoT networks (LTE-Advanced Pro technology) in Australia, Ireland, the Netherlands and Turkey.

Regulator BTK auctioned 390 MHz of 800, 900, 1800, 2100 & 2600 MHz LTE spectrum on August 26 2015. €3.36 billion was paid by the incumbent operators.

Avea: 900, 1800, 2.6 GHz FDD, 2.6 GHz TDD
Turkcell: 900, 1800, 2.1 GHz, 2.6 GHz FDD, 2.6 GHz TDD
Vodafone: 900, 1800, 2.6 GHz FDD, 2.6 GHz TDD

More at http://www.btk.gov.tr/tr-TR/Kurumdan-Haberler/45-G-Ihalesi-Ankarada-Yapildi

Turkmenistan

TMCELL commercially launched 2.6 GHz LTE in Ashgabat and Turkmenbashi on September 18, 2013.

Ukraine

Vodafone Ukraine (brand name leased to MTS-Ukraine) has trialled LTE-Advanced technology combining bands 1 and 3 spectrum to achieve 173 Mbps downlink speed.

Astelit (lifecell) announced in August 2016 results of its trial of LTE-Advanced Pro technology aggregating five 20 MHz FDD blocks across bands 1, 3, 7, 8, and 20 with 4x4 MIMO and 256QAM claiming a top downlink speed of 1.5 Gbps.

ITC (CDMA Ukraine) is considering deploying LTE in 850 MHz spectrum.

Kyivstar announced in July 2014 around 300,000 LTE-capable devices on its network.

A President's decree on 23 July 2014 approved the principle of technology neutrality, allowing operators to deploy 3G or 4G technology in GSM spectrum bands subject to licence amendments.

Digital dividend spectrum will be released after digital TV transition is achieved in June 2018. Release of spectrum in both 800 MHz and 700 MHz digital dividend bands is foreseen.

Regulator NCCIR plans to auction nationwide band 40 TDD licences and regional band 38 TDD licences.

United Kingdom

UK Broadband on February 29, 2012 announced switch-on of its first LTE TDD system in London. This was the world's first LTE TDD 3.5 GHz deployment and first commercial LTE deployment in the UK, and uses allocations within Bands 42 and 43 (3.5/3.6 GHz). UK Broadband operates a wholesale model and launched commercial service on June 28, 2012. LTE service is now available for consumers and businesses in Reading, Scunthorpe, Southwark (London), and Swindon. Indoor and outdoor CPEs, portable hotspots and a femtocell are available.

O2 tested LTE in 2.6 GHz spectrum and trialled LTE800 in Carlisle in 2010. In November 2011 the company started a large-scale LTE trial in central London, lasting until summer 2012, using 20 MHz of test spectrum in the 2.6 GHz band. The trial ran across 25 LTE cell sites and covered 40 sq. km.

Manx Telecom (Isle of Man) commercially launched LTE island-wide using 1800 MHz (LTE1800) and 800 MHz band 20 spectrum on July 29, 2014

SURE Telecom (Isle of Man) commercially launched LTE1800 and 800 MHz band 20 on March 2, 2015.

EE commercially launched LTE1800 on October 30, 2012. EE announced over 14 million LTE subscriptions had signed up to end 2015. On November 5, 2013 EE switched on its LTE-Advanced network in part of London (Tech City) delivering a theoretical peak downlink speed of 300 Mbps. The network uses carrier aggregation combining 20 MHz of 1800 MHz and 20 MHz of 2.6 GHz spectrum. Users working for Tech City area companies were selected to trial the service. 300 Mbps service was commercially launched in large parts of central London on October 30, 2014. EE has also

successfully tested LTE Category 9 using 20 MHz 1800 MHz + 20 MHz 2.6 GHz and 15 MHz 2.6 GHz blocks, achieving 410 Mbps peak downlink speed. The same configuration was demonstrated by EE at London's Wembley Stadium in February 2015, achieving 400 Mbps. EE is deploying 450 Mbps 3C CA LTE-Advanced technology in over 500 sites by end 2017. In December 2013 EE announced its first LTE roaming agreement, with AT&T for the US. Additional roaming destinations of France and Spain were announced in March 2014. EE introduced VoLTE in March 2016 in parts of the network and is expanding availability.

EE is investing in LTE Broadcast trials including in partnership with the BBC. eMBMS was demonstrated during the Commonwealth Games 2014, in Glasgow. A major trial at Wembley is planned in Summer 2015.
The 800 MHz and 2.6 GHz auction of 250 MHz of LTE spectrum by Ofcom was repeatedly delayed. Bidding by 7 companies opened on January 23, 2013. On February 20, 2013 Ofcom announced the winning bidders who collectively paid £2.34 billion:

- EE (800 MHz, 2.6 GHz FDD)
- Hutchison 3G UK Limited (800 MHz)
- Niche Spectrum Ventures (BT) (2.6 GHz FDD & TDD)
- Telefónica UK Limited (800 MHz)
- Vodafone (800 MHz, 2.6 GHz FDD & TDD)

HKT (UK) and MLL Telecom did not win spectrum.

EE brought 800 MHz into commercial use in 2015. In January 2016 **BT** received regulatory approval to take over **EE**.

Vodafone and **O2** both commercially launched 4G/LTE services on August 29, 2013 using 800 MHz (band 20), initially in London, Bradford and Leeds.

By April 2016 **O2** extended LTE coverage to 87% of the outdoor population. VoLTE is in deployment targeting service launch in 2016.

Vodafone launched LTE in London and has 68% coverage (December 2015). In October 2014 Vodafone announced it had begun deploying 225 Mbps LTE-Advanced carrier aggregation combining 20 MHz of band 7 and 10 MHz of band 20 in Birmingham, London and Manchester. Vodafone is deploying VoLTE. **Vodafone** has trialled LTE TDD technology using band 41 spectrum and aquired L-Band spectrum from Qualcomm.

On July 27, 2016 Vodafone, with its partner Huawei, announced trials of its band 38 TDD spectrum with 4x4 MIMO technology in combination with 8T8R on its network in Manchester (LTE-Advanced Pro TDD+ technology).

3 UK bought 2 x 15 MHz of 1800 MHz from EE and commercially launched LTE1800. From December 2, 2013, 3 UK started upgrading customers with an LTE-compatible device, enabling access to LTE when in coverage. 3 UK announced 63% of the population (December 2015) is covered by its LTE network. 3 UK is deploying LTE in 800 MHz to boost indoor & outdoor coverage and support the VoLTE service launched on September 15, 2015. 3 UK aquired L-Band spectrum from Qualcomm.
Ofcom has authorized all mobile operators to trade the rights to the radio spectrum they hold, covering 900 MHz, 1800 MHz and 2100 MHz.

Ofcom announced on July 9, 2013 that mobile operators are allowed to refarm 2G (900, 1800 MHz) and 3G (2.1 GHz) spectrum for 4G (e.g. LTE). A 3dB increase in maximum transmit power using 900 MHz spectrum was approved. Requests from EE, 3 UK, O2 and Vodafone for a similar 3dB power increase for 3G and 4G services using 1800 MHz is under consideration.

Ofcom conducted a consultation on use of 700 MHz for mobile broadband, following the Resolution passed at WRC 2012 that could lead to ITU Region 1 i.e. Europe, Africa, Middle East adopting 700 MHz for mobile broadband from 2015. A public consultation was launched on May 28, 2014 setting out proposals to make spectrum in the 700 MHz band available for mobile broadband from 2022 or possibly up to two years earlier. It includes an assessment of costs and benefits of such a change and invites comments by August 29, 2014. Ofcom recognises that European Member States including France, Sweden and Finland have already decided to use 700 MHz for mobile services and that others are considering plans to do so. Ofcom also acknowledges the benefits of compatibility with the APT700 band plan. On November 19, 204 Ofcom announced its decision to proceed with licensing this spectrum (which aligns with the lower duplexer arrangement of APT700). On

October 17, 2016 Ofcom announced its decision to accelerate the programme by 18 months and release the 700 MHz band in Q2 2020. For more details see https://www.ofcom.org.uk/__data/assets/pdf_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-Statement.pdf

The Ministry of Defence will release 190 MHz of spectrum to Ofcom to allocate available for commercial use. It includes 40 MHz in the 2.3 GHz band and 150 MHz above 3.4 GHz for TDD deployments. Both segments will be suitable for LTE deployments. Ofcom launched a consultation on October 16, 2013 after which it was decided that this spectrum will be auctioned. Spectrum will be offered in 38 lots of 5 MHz; caps will be imposed. Consultations on details are progressing. The auction will be held after the European Commission announces its decision on the proposed O2-Three merger in the UK.

Ofcom announced a Notice of Proposal to permit LTE1800 mobile devices on board aircraft on a licence exempt basis. Comments were required by March 12, 2014. Use of mobile devices on aircraft has been permitted since 2008 but limited to GSM1800 (2G) only. This proposal extends licence exemption arrangements to cover use of 3G and 4G terminals. EU Member States were required to adopt this EU decision into national law by May 12, 2014.

CICRA (the Channel Islands Competition and Regulatory Authorities) consulted in July 2013 on the appropriate method of allocating spectrum, specifically 800 MHz (band 20) and 2.6 GHz (band 7), for enabling provision of LTE services in the Channel Islands (Guernsey and Jersey). CICRA later confirmed LTE-suitable spectrum had been awarded to **JT**, **Sure** and **Airtel** for Guernsey and Jersey.

Uzbekistan

Ucell (TeliaSonera) commercially launched LTE using 2.6 GHz band 7 in Tashkent on August 9, 2010. The current peak downlink speed is 150 Mbps.

Beeline Uzbekistan announced its LTE network in Tashkent entered into a test phase in February 2012 and commercially launched LTE using 2.6 GHz band 7 in some areas of Tashkent on September 4, 2014.

2.3 GHz WiMAX™ operator **Super iMAX (EVO)** commercially launched LTE TDD in this band on April 1, 2015 in Tashkent, Samarkand, and Bukhara.

Universal Mobile Systems **(UMS),** a JV between the government and MTS, commercially launched LTE on June 20, 2016 in Tashkent, using band 20 spectrum.

Middle East and Africa

Algeria

WiMAX™ operator **Algérie Télécom** commercially launched fixed LTE1800 service (peak 150 Mbps) for business users on May 1, 2014, and consumers on September 8, 2014.

The company's mobile arm, **Mobilis**, commercially launched 150 Mbps peak LTE1800 with VoLTE on October 2, 2016. Coverage is currently available in the wilayas of Algiers, Oran and Ouargla

Ooredoo announced on May 27, 2015 testing of LTE-Advanced achieved 301.6 Mbps downlink. Pre-commercial service started July 11, 2016. **Ooredoo** commercially launched LTE1800 on October 2, 2016.

Djezzy commercially launched LTE1800 on October 2, 2016.

Regulatoy ARPT plans to release 2.6 GHz spectrum in "1-2 years". Frequency neutrality of 900 MHz band 8 (currently used only for GSM service) is under consideration.

Angola

Movicel commercially launched LTE1800 in Cabinda on April 14, 2012. Luanda, Cacuaco since covered.

Unitel commercially launched LTE1800 on December 16, 2012 in Luanda and on December 18, 2013 demonstrated LTE-Advanced CA band 3 and band 8. 3-band CA was demonstrated on December 5, 2014 with 2x 20 MHz in each of bands 1, 3, and 7, for 450 Mbps downlink. VoLTE is being tested.

3.5 GHz WiMAX™ operator **Multitel** is deploying LTE TDD.

WiMAX™ operator **Net One** commercially launched LTE TDD using band 41 in August 2014.

Bahrain

Zain commercially launched LTE1800 on April 18, 2013 for fixed access. Support for smartphone and tablet users was added on April 30, 2014.

VIVA launched a small-scale commercial LTE1800 network on January 1, 2012. Broader commercial service was launched in January 2014. In May 2016 a 50% upgrade to 150 Mbps was announced.

Batelco commercially launched LTE1800 on February 27, 2013. Downlink speed raised to 150 Mbps on September 26, 2013. VoLTE was launched September 2015. In June 2016 Batelco announced start of deployment of LTE-Advanced. Batelco is developing NB-IoT use cases and plans to deploy NB-IoT.

WiMAX™ operator **Menatelecom** commercially launched 3.5 GHz LTE TDD on November 19, 2013. The company announced lanch of LTE-Advanced service on September 6, 2016.

Regulator TRA cancelled an auction of 900, 1800, 2100 MHz and 2.6 GHz spectrum. 900 MHz, 1800 MHz & 2.1 GHz licences were given to Batelco, Viva and Zain in September 2013.

Benin

Benin Telecoms commercially launched LTE1800 service on November 26, 2015 in five cities. Band 20 spectrum may be usable from 2016.

Botswana

Orange Botswana commercially launched LTE1800 on February 13, 2015 in Gabarone, to be extended within weeks to Francistown, Palapye & Maun.

Mascom Wireless announced on June 12, 2012 the start of an LTE pilot trial network that was completed in March 2013 and commercially launched LTE1800 on February 14, 2015.

BTC is deploying a commercial LTE network. Trial services are running using 8 sites in Gaborone. 105 4G sites are planned to be deployed by end 2016.

Burkina Faso

Airtel applied to regulator ARCEP for a licence to offer 4G. Orange plans to buy the company.

Burundi

Lumitel (Viettel Burundi) commercially launched LTE on February 24, 2016 in Bujumbura, Gitega, Ngozi, Rumonge Makamba and Muyinga provinces.

Cameroon

WiMAX™ operator **YooMee** is deploying band 41 LTE TDD.

MTN commercially launched 3G and 4G/LTE TDD Band 41 service in four cities on 17th December 2015.

Orange is deploying an LTE network.

Afrimax-Vodafone is deploying an LTE TDD network.

Viettel Cameroon (**Nextel**) plans to deploy an LTE pilot network in early 2017

Cape Verde

Regulator Agencia Nacional das Comunicacoes (ANAC) launched a consultation on September 21, 2015 into distribution of 4G LTE licences, including spectrum choices, for comment by October 30, 2015.

http://www.anac.cv/images/consultapublicaintroducaorede4g.pdf

Chad

Tigo Chad commercially launched LTE in band 7 on September 10, 2014.

Airtel Chad received a 4G licence in April 2014.

Comoros

Telma won the 2nd telecom licence on October 1st, 2015 and is deploying LTE for 2016 launch. Cooperation with **Comores Télécom** is anticipated.

Côte d'Ivoire

WiMAX™ operator **YooMee** commercially launched LTE TDD in band 40 in Abidjan on April 4, 2014.

WiMAX™ operator **VipNet** is deploying a band 42 LTE TDD network.

Orange launched a trial network on June 13, 2014 and commercially launched 100 Mbps (theoretical peak) LTE1800 on 29 January 2016.

The future of small mobile networks **Comium, Cafe Mobile** and **Lap Green** is uncertain. There is pressure for them to merge into a single operator.

Democratic Republic of Congo

Orange is deploying a band 38 LTE TDD network.

Smile is deploying a commercial LTE network and is expected to launch in 2016 including VoLTE.

Vodacom is deploying a band 42 LTE TDD network.

Djibouti

Djibouti Telecom is test at 10 sites for a possible LTE network deployment.

Equatorial Guinea

WiMAX™ operator **Guineanet** plans migration to LTE

Egypt

Vodafone, Orange and **Etisalat Misr** each trialled LTE.

Telecom Egypt, a fixed telecoms operator, obtained a 4G licence in August 2016 and is expected to begin trial operations using LTE in 2017.

Orange obtained a 4G licence in October 2016 and plans to deploy an LTE network

Vodafone obtained a 4G licence in October 2016 and plans to deploy an LTE network.

Etisalat Misr obtained a 4G licence in October 2016 and plans to deploy an LTE network.

Ethiopia

Ethio Telecom commercially launched 150 Mbps LTE1800 on March 21, 2015 in Addis Ababa for CPE and dongle users.

Gabon

Gabon Telecom commercially launched LTE on October 20, 2014. 4G+ LTE-Advanced launched on 21st November 2015 claiming 233 Mbps theoretical peak downlink speed. HD Voice was offered on 3G and LTE networks from October 27, 2015.

Airtel Gabon commercially launched LTE on December 10, 2015 in Libreville.

Gambia

WiMAX™ operator **Netpage** commercially launched fixed wireless access 2.3 GHz LTE TDD in March 2015 covering Greater Banjul and south to Brikama. MiFi, indoor and outdoor CPE devices are offered.

I-Link has an ISP licence with rights to build a wireless broadband network and plans to deploy LTE.

Gamtel is deploying 2.3 GHz LTE TDD.

Ghana

Surfline has 2 x 15 MHz of 2.6 GHz band 7 and commercially launched LTE on August 19, 2014 in Accra and Tema. An expansion phase is underway.

Blu Telecoms (was **G-Kwiknet Limited)** has 30 MHz 2.6 GHz (band 38) and commercially launched LTE TDD on October 14, 2014 in Accra and Tema.

Busy commercially launched 2.3 GHz LTE TDD on January 26, 2016 in Accra and Tema.

Goldkey Telecom has 2 x 15 MHz of 2.6 GHz spectrum. **Expresso Telecoms** has 2 x 10 MHz of 850 MHz spectrum and operates a CDMA network.

As part of the e-Government Network Infrastructure being deployed by the National Information Technology Agency **(NITA)** all 30 WiMAX™ BTSs installed were upgraded by February 2014 to LTE TDD for last mile connectivity using band 41.

MTN and **Vodafone** each has 33 MHz paired spectrum in 900/1800/2100 MHz bands. MTN Ghana also holds 2 x 10 MHz of band 20 for LTE acquired via its Scancom unit by auction in December 2015.

Vodafone commercially launched LTE on January 2, 2014 for users with compatible phones.

MTN commercially launched LTE on June 23, 2016 using band 20 spectrum in all 10 regions of Ghana.

Airtel and **Globacom** each has 2x 30 MHz spectrum across 900/1800/2100 MHz bands.

Glo Mobile under parent **Globacom** planned to invest USD 600 million to deploy a 'unique, seamless and world class LTE network'. **Tigo** has 2x28 MHz across these bands.

Guinée Bissau

Orange Bissau commercially launched LTE on 22nd December 2015 in the capital Bissau.

Iran

MTN Irancell commercially launched 3G and 4G/LTE1800 service in Mashhad on November 24, 2014. The company has trialled LTE-Advanced Pro technology achieving 1.2 Gbps downlink speed using 2 1800 MHz (band 3) carriers.

MTN Irancell is migrating from WiMAX™ based services and commercially launched LTE TDD fixed broadband wireless services using 3.5 GHz spectrum on August 3rd, 2016 expanding to cover 49 cities by September 2016.

WiMAX™ operator **Mobinnet Telecom Co. (MTC)** is migrating to LTE TDD and launched a pilot trial.

WiMAX™ operator **HiWeb** is deploying an LTE TDD (TD-LTE) fixed wireless access network nationwide.

The Communications Regulatory Authority (CRA) announced a tender in October 2015 for unpaired spectrum suitable for LTE TDD networks in the 2.3 GHz, 2.6 GHz and 3.5 GHz bands.

Iraq

Regional Telecom (Kurdistan) commercially launched band 7 LTE on June 10, 2013 under the Fastlink brand.

MaxyTel is deploying an LTE TDD network.

Newroz Telecom (Kurdistan) is deploying LTE.

WiMAX™ operator **Tishknet** (Kurdistan) is deploying a band 41 LTE TDD network.

Israel

Partner (**Orange**) commercially launched LTE1800 on July 15, 2014 in 2 x 5 MHz refarmed spectrum. **Partner** announced in November 2013 a proposed 4G network sharing agreement with **HOT Mobile** subject to regulatory approval.

Cellcom commercially launched LTE1800 on August 3, 2014 using refarmed 2 x 5 MHz spectrum.

Pelephone commercially launched LTE1800 on August 4, 2014 using refarmed 2 x 5 MHz spectrum. Regulator MoC auctioned 1800 MHz LTE spectrum. 6 bidders participated: Celcom, Golan Telecom, HOT Mobile, Partner, Pelephone, and 018 Xfone. Around 63 million USD was raised. Results in January 2015 confirmed all won spectrum, in varying amounts.

In December 2013 **Cellcom**, **Golan Telecom** and **Pelephone** announced a 15-year agreement to operate a shared LTE network, subject to approval, and to co-operate to obtain spectrum. On 5th November 2015 Cellcom announced an agreement to purchase 100% of Golan Telecom shares for NIS 1.17 billion. The deal needs government approval.

Jordan

Regulator TRC launched an auction of 800 MHz, 2100 MHz, 2.3 GHz and 2.6 GHz in 2013. Two bids, from potential new market entrants, were rejected. After a fresh call for interest in April 2014, **Zain** paid c. $270 million for 3G & 4G spectrum.

Zain commercially launched 150 Mbps LTE1800 in all 12 Administrative Regions of the country, using 2x20 MHz spectrum, on February 14, 2015.

Orange acquired 2x10 MHz of 1800 MHz for LTE and commercially launched LTE1800 on May 26, 2015.

Umniah Telecommunications completed LTE trials in 2013 and is deploying a network in band 3 (LTE1800) and TDD (band 42) for commercial launch in early 2016. Umniah will also launch a fixed 4G offer with speeds of 150 Mbps.

Kenya

Safaricom commercially launched 150 Mbps LTE-Advanced on December 4, 2014 in areas of Nairobi plus Mombasa airport. Initially LTE1800 was used and band 20 using carrier aggregation was introduced in January 2015. 800 MHz for LTE may be allocated to the company by the Communications Authority of Kenya in July 2016.

Airtel plans to launch LTE service by end 2016. 800 MHz for LTE may be allocated to the company by the Communications Authority of Kenya in July 2016. Airtel received regulatory approval in 2015 to start testing 4G LTE using its current frequency spectrum.

Orange (Telekom Kenya) plans to launch LTE service. 800 MHz for LTE may be allocated to the company by the Communications Authority of Kenya in July 2016. Orange received regulatory approval in 2015 to start testing 4G LTE using its current frequency spectrum.

Band 41 WiMAX™ operator **iWayAfrica** is migrating to an LTE TDD system.

Kuwait

Viva commercially launched LTE1800 on December 27, 2011 and is deploying LTE-Advanced carrier aggregation. VoLTE was launched on June 9, 2015.

Zain commercially launched nationwide LTE1800 on November 21, 2012 and is deploying LTE-Advanced CA. On December 27, 2015 Zain demonstrated 1 Gbps. NB-IoT network deployment is planned. VoLTE was launched on July 13, 2016.

Ooredoo commercially launched LTE1800 on July 9, 2013 and commercially launched 185 Mbps LTE-Advanced on March 26th, 2015 combining bands 3 and 20. VoLTE is being trialled.

Lebanon

Alfa commercially launched LTE1800 in Beirut on May 15, 2013 and is deploying VoLTE. On March 9th, 2016 Alfa announced contracts for deployment of LTE-Advanced Pro technology for completion by September 2016. Band 3 and band 20 will be combined using carrier aggregation. **Alfa** commercially launched LTE-Advanced on August 2nd, 2016 using carrier aggregation to combine 20 MHz of 1800 MHz and 15 MHz of 800 MHz spectrum for up to 262.5 Mbps theoretical peak downlink speed.

Touch commercially launched 150 Mbps LTE on May 22, 2013 in Beirut using 800 MHz and LTE1800 spectrum. A 225 Mbps LTE-Advanced trial combining 800 with 1800 MHz spectrum ended in April 2013. In early 2016 Touch announced plans to upgrade to LTE-Advanced Pro technology during 2016.

Lesotho

Vodacom commercially launched LTE on October 2, 2014 in Maseru using 800 MHz band 20 spectrum.

Liberia

Cellcom commercially launched 150 Mbps LTE1800 in Monrovia on April 14, 2016

Libya

Al Madar plans to deploy an LTE network.

Madagascar

WiMAX™ operator **Blueline** commercially launched LTE TDD in band 38 in April 2014.

Telma commercially launched LTE on 19 June 2015.

Orange is deploying LTE in the major cities, targeting launch by end 2016.

Airtel is deploying LTE for 85% of the population.

Malawi

Fixed line and CDMA operator **Access Communications** commercially launched band 5 LTE in Blantyre on April 8, 2015 for business clients.

Telekom Networks Malawi (TNM) commercially launched LTE with VoLTE HD voice on June 28, 2016 in Blantyre, Lilongwe, Mzuzu and Zomba.

Globe Internet is deploying LTE in Lilongwe.

Mauritius

Orange commercially launched LTE1800 on June 21, 2012.

Emtel commercially launched LTE1800 in July 2012.

MTML commercially launched LTE1800 on May 20, 2015.

Mayotte

Orange has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

SFR Mayotte has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Telco OI has has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

BJT Partners has received a licence to deploy a 4G/LTE network (1800MHz, 2100MHz and 2600MHz).

Morocco

Regulator ANRT auctioned LTE spectrum, confirming awards on March 18, 2015 to the incumbent mobile operators: Itissalat Al Maghrib (IAM, Maroc Telecom), Wana (Inwi) and Medi Telecom (Meditel) for band 3, 7 and 20 spectrum. 65% of the population must be covered within 5 years.

Meditel commercially launched LTE on June 8, 2015 in Casablanca, and in Rabat on June 15, 2015.
Inwi (Wana) commercially launched 150 Mbps LTE1800 in 21 cities, major highways, June 17, 2015.

IAM (Maroc Telecom) commercially launched 225 Mbps (Category 6) LTE-Advanced on July 13, 2015.

Namibia

On 30 March 2012 the Communications Regulatory Authority of Namibia (CRAN) converted **MTC**, **AfricaOnline** and **WTN** licences to technology and service neutrality.

MTC commercially launched LTE1800 on May 16, 2012 in Windhoek. Band 20 was introduced for rural areas. 300 Mbps LTE-Advanced service was launched on April 14, 2016. At the same time a demonstration of LTE-Advanced Pro technology currently being trialled achieved 1 Gbps and is being deployed. VoLTE is planned.

Telecom Namibia acquired **Leo** and is deploying a unified 2G/3G/4G-LTE network. The company rebranded to **TN Mobile**, commercially launching LTE1800 on November 27, 2013 in Windhoek and surrounding areas, Walvis Bay, Swakopmund, Langstrand Henties Bay, Ondangwa, Ongwediva, Oshakati, Ohangwena and Oshikango.

Nigeria

Globacom provides LTE-connectivity to a 3rd party company providing backhaul services to corporates in Lagos etc. Nationwide (9 cities) commercial service for mobile users was launched using band 28 spectrum on October 4, 2016. Coverage to a further 8 cities was announced a fortnight later.

Zoda Fones is deploying LTE TDD in band 41. CDMA operator **Starcomms** is studying deployment of LTE. A proposal is in development to merge **Starcomms**, **Multilinks** and **MTS First Wireless** to form **CAPCOM.** This new company would seek to refarm 20 MHz of 1900 MHz spectrum to allow it to become the first national LTE broadband operator.

In December 2012 **Airtel** announced the end of a LTE trial in Lagos, and is deploying an LTE network.

Etisalat commercially launched LTE1800 in Lagos on October 8th, 2016.

MTN Nigeria is deploying LTE and bought **Vlsafone** heralding closure of the last CDMA network in Nigeria and freeing up 800 MHz for LTE. A trial LTE800 (band 20) service opened on August 4, 2016.

Separately, MTN acquired spectrum in 2.6 GHz band which will be introduced into commercial service later.

MTN commercially launched its HyNet prepaid Internet service using LTE TDD technology in Lagos replacing 3.5 GHz WiMAX™ on July 22, 2015.

Commercial LTE FDD service was launched by **MTN** using band 7 spectrum in Abuja, Lagos and Port Harcourt on October 4th, 2016. MTN is trialling of LTE using 800 MHz spectrum acquired through the acquisition of Visafone.

SWIFT Networks acquired the WiMAX™ operation of ISP ***Direct on PC*** to expand wireless broadband services in Abuja, Lagos and Port Harcourt. The new entity uses the expanded capacity and 3.5 GHz and 2.3 GHz spectrum to deploy LTE TDD alongside WiMAX™. Swift commercially launched band 40 LTE TDD in Lagos in November 2013 and obtained an additional 15 MHz of 3.5 GHz TDD spectrum by buying **Chromecom**. Over 100,000 WiMAX™ subscribers were migrated to the LTE network.

WiMAX™ operator **Spectranet Limited** commercially launched 2.3 GHz LTE TDD in Lagos on August 20, 2013, Abjua in November 2013. ISP **AG-Placid** plans to deploy LTE.

WLL CDMA operator **Intercellular** is deploying an LTE network using 800 MHz spectrum. The company rebranded to **InterC** and commercially launched on August 23, 2016 in Abuja, Kaduna, and Port Harcourt.

WiMAX™ operator **Mobitel** is deploying LTE TDD in band 40. WiMAX™ operator **ADIV** is deploying LTE in band 42.

Smile Communications has 2x 10 MHz 800 MHz in band 20 and commercially launched LTE in Ibadan on June 6, 2013 then Lagos, Abuja and Port Harcourt. VoLTE was commercially launched on March 8, 2016.

Cyberspace commercially launched LTE TDD in August 2015 using band 42 spectrum.

Ntel commercially launched 230 Mbps LTE-Advanced and VoLTE service in Lagos and Abuja on April 8, 2016 using 900 MHz & 1800 MHz spectrum.

The Nigerian Communications Commission (NCC) auctioned 30 MHz of band 40 2.3 GHz in February 2014 for a nationwide wholesale broadband service won by **Bitflux** who are deploying LTE TDD initially in Abuja, Lagos and Port Harcourt. Commercial 300 Mps LTE-Advanced wholesale services were first launched using the network by VDT Communications in Lagos on June 15, 2016.

NCC tried to auction 2 x 70 MHz of 2.6 GHz in March 2016 but in May 2016 announced only one bidder had emerged. After due diligence is completed it is possible the spectrum will be awarded to that bidder.

Oman

Omantel launched commercial LTE TDD service on July 16, 2012 in band 40. Omantel commercially launched LTE1800 service on December 30, 2012. On April 27, 2015 Omantel announced commercial launch of "4.5G" LTE-Advanced with up to 200 Mbps theoretical peak downlink. Omantel also acquired additional band 7 and band 20 spectrum for LTE. On May 25, 2016 **Omantel** announced results of its LTE-Advanced trial using existing spectrum to achieve 1 Gbps downlink speed.

Ooredoo began deploying a 2.3 GHz LTE TDD network. Subsequently the regulator granted access to 1800 MHz spectrum. Ooredoo commercially launched LTE1800 in Muscat on February 17, 2013. On September 3, 2014 Ooredoo launched a Home Broadband package enabled by LTE TDD on the Batinah coast and Muscat, offering Cat 4 CPEs. On May 10, 2015 Ooredoo announced availability of its "4.5G" LTE-Advanced service with up to 200 Mbps theoretical peak downlink in hotspots around Muscat. 800 MHz spectrum acquired in 2015 is now also in commercial use.

Qatar

Vodafone commercially launched 150 Mbps LTE using 800 MHz on June 3, 2014. Its 4G+ LTE-Advanced service was launched on May 12, 2015, combining band 3 and band 20 spectrum. 70% of LTE sites were 4G+ enabled at that time. Enhancement to 225 Mbps followed. Vodafone launched the first tri-band carrier aggregation using 50 MHz bandwidth adding 2.6 GHz band 7 for a top speed of 375 Mbps on August 9, 2015.

Ooredoo commercially launched LTE on April 16, 2013 using 800 MHz and 2.6 GHz. National coverage was achieved January 2014. 225 Mbps 4G+ LTE-Advanced using bands 7 and 20 was launched December 1, 2014. 150 Mbps is available outside of 4G+ areas. 375 Mbps Category 9 tri-band LTE-Advanced was commercially launched in several high traffic areas of Doha on 23rd December 2015. The network aggregates 2 x 20 MHz carriers in bands 3 and 7 with 1x 10 MHz band 20 carrier. 325 Mbps is available to all other users from May 25, 2016 with compatible devices. On 17th October 2015 Ooredoo announced results of testing 3C CA LTE-Advanced Pro including 256QAM and achieving a peak data rate of 590 Mbps (for UE Category 11). A pre-commercial test phase of VoLTE was launched on December 1, 2015 with soft-launch of VoLTE enabled HD voice service taking place on May 18, 2016.

Ooredoo and **China Mobile** demonstrated 4.1Gbps using LTE-Advanced carrier aggregation of ten 20 MHz carriers of TDD and FDD spectrum.

Réunion

French regulator ARCEP announced on March 13, 2014 that LTE system test spectrum in the 1800 MHz and 2.6 GHz bands has been granted to **SRR**.

Orange has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

SFR Réunion has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Telco OI has received a licence to deploy a 4G/LTE network (800MHz, 1800MHz, 2100MHz and 2600MHz).

Zeop Mobile has received a licence to deploy a 4G/LTE network (1800MHz, 2100MHz and 2600MHz).

Rwanda

Olleh Rwanda Networks deployed a national wholesale LTE network using 2 x 20 MHz band 20 offering 150 Mbps theoretical peak downlink and 95% coverage of Kigali from November 11, 2014.

Airtel commercially launched retail LTE service using Olleh on November 11, 2014.

MTN commercially launched retail LTE service using Olleh on November 11, 2014 for data users. Service was opened to smartphone users in early 2016.

Tigo commercially launched retail LTE service using Olleh on January 8, 2015. The service is available in Kigali, Rubavu, Rusizi, Huye and Musanze.

Olleh Rwanda rebranded to **Korea Telecom Rwanda Networks** on June 27, 2016.

Saudi Arabia

Etisalat (Mobily) commercially launched LTE TDD on September 14, 2011 via its **Bayanat** subsidiary in band 38 (2.6 GHz). Mobily is currently deploying 4x4 MIMO which will raise theoretical peak speed up to 220 Mbps without increasing spectrum utilized from 20 MHz currently. Mobily commercially launched LTE1800 FDD in January 2013 and completed VoLTE trials in May 2013.

STC commercially launched band 40 LTE TDD on September 14, 2011. LTE1800 was introduced February 2013. On February 8, 2014 STC announced commercial launch of TDD LTE-Advanced 20+20 MHz band 40 (GSA assumption 150 Mbps) and in December 2014 completion of TDD-FDD carrier aggregation trials using band 3 and band 40. In December 2015 STC confirmed successful testing of so-called TDD+ LTE-Advanced Pro technology achieving downlink speed up to 1.59 Gbps. STC with its partner Nokia tested MulteFire technology (LTE-U, an LTE-Advanced Pro feature) in May 2016 VoLTE was commercially launched on April 11, 2016.

On October 18, 2016 it was announced that STC is deploying LTE-Advanced Pro technology across the country including TD-LTE CA techniques.

Zain commercially launched LTE1800 on September 14, 2011. Refarmed 2.1 GHz and 1800 MHz spectrum is used in the 150 Mbps LTE-Advanced network commercially launched on June 24, 2015. VoLTE was commercially launched initially for iPhone users on May 23, 2016. 187.5 Mbps 3C CA service was commercially launched in Jeddah in May 2016 using 2 x 25 MHz bandwidth across bands 1, 3 and 8.

Data service provider **ITC** is deploying an LTE TDD network using 3.5 GHz spectrum, initially in Riyadh.

Senegal

Regulator ARTP authorised testing of LTE until March 21, 2015. **Orange** (Sonatel) and **Tigo** both launched pilot trials.

A tender for 700 MHz, 800 MHz and 1800 MHz spectrum for 4G was launched seeking interest by January 18, 2016. None of the incumbents applied.

Orange subsequently secured a licence which includes 4G (band 3 and band 20).

In July 2016 **Tigo** stated the company is in talks with ARTP to secure a 4G licence.

Expresso (**Sudatel)** also has a trial permit. In July 2016 Expresso stated the company is in talks with ARTP to secure a 4G licence.

Seychelles

Airtel commercially launched an LTE800 network (band 20) on November 26, 2014.

Cable and Wireless is deploying an LTE network.

Somalia

Somcable commercially launched LTE as a last mile solution on January 5, 2016.

Somtel is deploying an LTE network.

Nordic Group is licensed and plans to deploy LTE.

WiMAX™ operator **Sahal Telecoms** (Glocall Telecoms) is migrating to LTE TDD.

New entrant **SomCom** has national 900 MHz, 1800 MHz, 2.1 GHz & 2.6 GHz licences and seeks an investment partner to deploy GSM-3G-LTE networks.

South Africa

Vodacom commercially launched LTE1800 on October 10, 2012 in Johannesburg. 270 Mbps download speed using LTE-Advanced was demonstrated on Vodacom's network in September 2014, using temporary 2 x 20 MHz paired 2.6 GHz. VoLTE was commercially launched on April 10, 2015. Vodacom has activated what it claimed to be the first commercial LTE-Advanced (LTE-A) site near Cape Town demonstrating 3-band carrier aggregation combining spectrum in bands 1, 3 and 8 achieving 170 Mbps downlink data speed. In May 2016 Vodacom deployed LTE-Advanced Pro technology LTE-U using 5.8 GHz band spectrum in an area of Sandton and also trialled the technology in Midrand using 10 MHz band 3 and two 20 MHz blocks of 5.8 GHz spectrum to achieve 217 Mbps downlink data throughput speed. In a later trial (June 2016) enabled by LTE-Advanced Pro and using 3C CA the peak downlink speed exceeded 1 Gbps.

MTN commercially launched LTE1800 in Durban, Johannesburg, and Pretoria on December 1, 2012. Bloemfontein and Cape Town were added in 2013. MTN launched LTE-Advanced on March 16, 2016 in parts of Cape Town, Pretoria and Johannesburg using refarmed 1800 MHz and 2.1 GHz, with speeds up to 120 Mbps. On May 19, 2016 MTN announced a trial of LTE-Advanced Pro LTE-U technology aggregating two 5GHz unlicensed band carriers (40 MHz) with 15 MHz band 1, achieving 1 Gbps.

Telkom Mobile (TM) has 70 MHz in band 40. LTE TDD was commercially launched on April 21, 2013. 150 Mbps band 40 LTE-Advanced was launched on November 15, 2014 in the Parkview and Parkhurst areas, later raised to 220 Mbps. Telkom Mobile plans to refarm a portion of 1800 MHz for LTE later. 3C CA LTE-Advanced enabling 260 Mbps was demonstrated on a Telkom site in August 2016. TM also operates 3.5 GHz WiMAX™.

Cell C commercially launched 2.1 GHz LTE in Gauteng and KZN province on September 23, 2015. 138 Mbps LTE-Advanced was demonstrated in November 2015. Commercial LTE-Advanced service was launched on April 25, 2016 in Cape Town, Johannesburg and Pretoria.

CDMA operator **Neotel** commercially launched LTE using 1800 MHz (LTE1800) in Gauteng on August 21, 2013. **Neotel** also owns 3.5 GHz (used for WiMAX™) and 800 MHz spectrum.

ISP **Afrihost** (owned by MTN) commercially launched LTE1800 fixed wireless broadband on April 22, 2015.

Multisource, owner of iBurst and Broadlink, plans to deploy a 2C CA commercial LTE-Advanced service in 2017. Multisource will use 1800 MHz and 2.6 GHz and has deployed a trial using TDD band 38 2.6 GHz spectrum. also has 3.5 GHz spectrum.

Transnet has requestec an allocation of 2x5 MHz 1800 MHz spectrum for LTE use in certain cities including Cape Town and Port Elizabeth.

Regulator ICASA issued invitations to apply for 700 MHz, 800 MHz and 2.6 GHz spectrum but the auction cannot proceed until the government publishes its spectrum policy.

Transnet, a large South African rail, port and pipeline company, has requested an allocation of 2x5 MHz 1800 MHz spectrum for LTE use in certain cities including Cape Town and Port Elizabeth.

Sudan

Zain commercially launched LTE1800 in Khartoum, Medani, Port Sudan, and El Obeid on April 25, 2016.

Swaziland

MTN is deploying an LTE1800 network.

Tanzania

Smile commercially launched 800 MHz (band 20) LTE on May 30, 2012 in Dar es Salaam for a limited set of users. By May 2013 coverage reached most of Dar es Salaam for all users. 2.6 GHz is also used. VoLTE service was launched on March 8, 2016.

Tigo commercially launched band 20 LTE on April 24, 2015 in parts of Dar es Salaam. All major cities are to be covered by end 2016.

Smart Telecom commercially launched LTE TDD using band 40 on August 27, 2015.

Vodacom commercially launched LTE on May 11, 2016 in Dar es Salaam. Vodacom has 800 MHz, 1800 MHz (LTE1800) and TDD band 42 spectrum.

TTCL commercially launched an LTE network using band 3 FDD and band 40 LTE TDD spectrum on December 21st, 2015 initially in Dar es Salaam and plans nationwide coverage by 2018. VoLTE is being deployed.

Telesis Tanzania, a mobile virtual network aggregator (MVNA) supporting a number of MVNOs, is deploying its own 800 MHz LTE network in Dar es Salaam and Mtwara, ahead of a national rollout.

Togo

The government has opened discussions with the two incumbent mobile network operators **Togocell** and **Moov Togo** concerning the possible award of 4G licences.

Tunisia

Ooredoo reached 225 Mbps Mbps in LTE-Advanced tests. Having acquired its licence on March 3, 2016 Ooredoo commercially launched 150 Mbps LTE using band 3 and band 20 spectrum on March 30, 2016.

Orange Tunisia commercially launched 150 Mbps LTE using band 3 and band 20 spectrum on March 30, 2016.

Tunisie Telecom commercially launched 150 Mbps LTE using band 3 and band 20 spectrum on March 30, 2016.

Regulator Mincom opened an LTE auction November 2015 for 3 licences which the three incumbents were awarded on March 30, 2016.

UAE

Etisalat commercially launched LTE on September 25, 2011 using 2.6 GHz indoors & 1800 MHz (LTE1800) outdoors in urban & suburban areas. Cat 4 dongles were sold from June 2013. 300 Mbps (Cat 6) LTE-Advanced was commercially launched in September 2014 with CA of 20 MHz band 3 and 20 MHz band 20. Coverage began in Aub Dhabi region and then covered UAE cities with 100 LTE-Advanced sites. On October 12, 2014 **Etisalat** announced that testing of 700 Mbps tri-band carrier aggregation on its network had been completed. VoLTE & SRVCC was tested successfully in the commercial network in July 2014. Implementation started in Abu Dhabi region and was completed for sites all over UAE. Etisalat is planning to introduce 450 Mbps LTE-Advanced in

2016. **Etisalat** is also deploying LTE TDD using band 42. VoLTE was launched on July 10, 2016.

Du commercially launched LTE1800 on June 12, 2012 targeting 90% pop coverage by 2014. In August 2014 Du announced VoLTE was installed and tested over its commercial LTE network and demoed VoLTE calls at GITEX 2014. VoLTE and WiFi calling will be introduced.

Du tested LTE-Advanced with carrier aggregation over its commercial network with 300 Mbps peak combining band 20 (800 MHz) and band 3 (1800 MHz) in July 2014 and commercially launched 225 Mbps LTE-Advanced on March 1, 2015 combining 20 MHz band 3 + 15 MHz band 20.

TRA plans to release 700 MHz and 800 MHz for mobile broadband by combining band 20 with the lower duplexer (2x30 MHz) of APT700.

Uganda

Smile commercially launched LTE for business users in Kampala in October 2012 in band 20. Service was extended to consumers on June 9, 2013. 2.6 GHz (band 7) is also in service. VoLTE was commercially launched on November 23, 2015.

MTN commercially launched band 41 LTE TDD network on April 25, 2013 in Greater Kampala and Entebbe. Service was extended to all major towns on July 9, 2015. By mid-2016 the network included 85 base station sites.

Africell (ex-Orange) commercially launched band 20 LTE on July 31, 2013.

Afrimax (branded **Vodafone)** commercially launched band 38 LTE TDD service on February 9, 2015 in Entebbe and Kampala.

Airtel is deploying an LTE network.

Zambia

MTN commercially launched LTE1800 on January 16, 2014 in Lusaka, Kitwe, Ndola and Livingstone.

Zamtel commercially launched LTE in Kitwe on January 21, 2014.

Airtel is deploying an LTE network.

ISP **Massnet** acquired a licence to deploy a 2.6 GHz LTE FDD network, and seeks an investment partner.

Zanzibar

Zantel commercially launched LTE on April 14, 2016.

Zimbabwe

Econet Wireless commercially launched LTE1800 on August 22, 2013 in the Victoria Falls area to provide coverage at the UNWTOGA. Coverage is now available using (estimated by GSA) 26 sites in Bulawayo, Harare, and Victoria Falls. Initially offered only to users with compatible dongles, LTE service was extended in Q4 2015 to mobile phones users.

NetOne commercially launched LTE1800 on 11th November 2014. NetOne has a national presence and plans to deploy 2,300 LTE base stations by end 2016. Deployment using APT700 band 28 spectrum started in 2015, though is not yet been brought into commercial use.

WiMAX™ operator **Aqiva Wireless** is planning to deploy an LTE network.

Telecel (owned by **Vimpelcom**) is deploying an LTE network. ZARNet has acquired a majority stake.

LTE-Advanced global status

"LTE-Advanced" covers 3GPP technology from Release 10 (Rel. 10) onwards. Key features are carrier aggregation (to leverage more spectrum, increase data rates), advanced antenna technique/MiMO enhancements (more capacity), and relays. Enhancements include optimising HetNets (even more capacity and advanced interference management). Enhancements for both WCDMA-HSPA and LTE systems include architecture improvements for eNobeBs, local IP traffic offloading, optimizations for M2M, SRVCC and eMBMS. Rel. 10 was finalised in 2010. In addition to refining some Rel. 10 features, Rel. 11 includes basic functionality for coordinated multipoint (CoMP) transmission and reception, and enhanced support for heterogeneous deployments, eICIC. These features are now being introduced. The first LTE-Advanced feature to be commercialized was carrier aggregation, from mid-2013. 40% of operators are investing in LTE-Advanced.

166 LTE-Advanced systems launched in 76 countries

Country	Operator	LTE-A Pro
Albania	Telekom Albania	
Albania	Vodafone Albania	
Algeria	Mobilis	
Armenia	UCOM	
Australia	Optus	
Australia	Telstra	In service
Australia	Vodafone	
Austria	A1 Telekom	
Austria	3 (Drei)	
Azerbaijan	Bakcell	
Azerbaijan	Nar Mobile	
Bahrain	Menatelecom	
Bahrain	Viva	
Belarus	beCloud	
Belgium	Mobistar	
Belgium	Proximus	
Brazil	Claro	
Brazil	TIM Brasil	
Canada	Bell Mobility	
Canada	Rogers Wireless	
Canada	Telus	
Chile	Claro	
Chile	Entel PCS	
Chile	Movistar	
China	China Mobile	
China	China Telecom	
China	China Unicom	
Czech Republic	O2	
Czech Republic	T-Mobile	
Czech Republic	Vodafone	
Denmark	3	
Denmark	TDC	
Denmark	Telenor	
Estonia	Telia	
Estonia	Tele2	
Fiji	Vodafone	
Finland	DNA	In service
Finland	Elisa	
Finland	TeliaSonera	
France	Bouygues Telecom	
France	Orange	
France	SFR	
Gabon	Gabon Telecom	
Georgia	Magticom	
Germany	DT	
Germany	O2	
Germany	Vodafone	
Gibraltar	Gibtelecom	
Greece	Cosmote	
Greece	Vodafone	
Hong Kong	3 HK	
Hong Kong	CSL	
Hong Kong	SmarTone	
Hungary	Magyar Telekom	
Hungary	Telenor	
India	Airtel	
Indonesia	Indosat Ooredoo	
Indonesia	Internux (Bolt)	
Indonesia	Smartfren	
Indonesia	XL Axiata	
Ireland	3	
Ireland	Vodafone	
Italy	TIM	
Italy	Vodafone	
Japan	KDDI	
Japan	NTT DoCoMo	
Japan	UQ Communications	
Jersey	JT	
Kenya	Safaricom	
Kuwait	Ooredoo	
Latvia	Bite	
Latvia	LMT	
Latvia	Tele2	
Lebanon	Alfa	
Lithuania	Bite	
Lithuania	Omnitel	
Lithuania	Tele2	
Lithuania	Mezon/Telecentras	
Luxembourg	Tango	
Macau	CTM	
Macedonia	T Mobile	
Malaysia	Digi	
Malaysia	Maxis	
Malaysia	U Mobile	
Maldives	Dhiraagu	
Moldova	Orange	
Moldova	Unite	
Monaco	Monaco Telecom	
Morocco	IAM Maroc Telecom	
Namibia	MTC	
Netherlands	KPN	

Netherlands	T Mobile NL	
Netherlands	Tele2	
Netherlands	Vodafone	
New Zealand	Spark	
New Zealand	Vodafone	
Nigeria	Bitflux	
Nigeria	Ntel	
Norway	Telia	
Norway	Telenor	
Oman	Omantel	
Oman	Ooredoo	
Peru	Movistar	
Philippines	Smart	
Poland	Orange	
Poland	Play	In service
Poland	Polkomtel	In service
Poland	T-Mobile	
Portugal	Meo	
Portugal	NOS	
Portugal	Vodafone	
Puerto Rico	AT&T Mobility	
Puerto Rico	T Mobile	
Qatar	Ooredoo	
Qatar	Vodafone	
Romania	Orange	
Romania	Vodafone	
Russia	Megafon	
Russia	MTS	
Russia	Vimpelcom	
Saudi Arabia	STC	
Saudi Arabia	Zain	
Serbia	VIP Mobile	
Singapore	M1	
Singapore	SingTel	
Singapore	StarHub	
Slovak Republic	Orange	
Slovak Republic	Slovak Telekom	
Slovenia	Si.mobil	
Slovenia	Telekom Slovenije	
South Africa	Cell C	
South Africa	MTN	
South Africa	Telkom Mobile	
South Korea	KT	
South Korea	LG Uplus	
South Korea	SK Telecom	In service
Spain	Movistar	
Spain	Orange	
Spain	Vodafone	In service
Sweden	3	
Sweden	Telenor	
Sweden	Tele2	
Switzerland	Salt	
Switzerland	Sunrise	
Switzerland	Swisscom	
Taiwan	CHT	
Taiwan	FarEasTone	
Taiwan	Taiwan Star	
Taiwan	Taiwan Mobile	
Thailand	AIS	In service
Thailand	True	In service
Tunisia	Ooredoo	
Tunisia	Orange	
Tunisia	Tunisie Telecom	
Turkey	Turkcell	In service
Turkey	Turk Telecom	In service
Turkey	Vodafone	In service
UAE	Du	
UAE	Etisalat	
UK	EE	
UK	Vodafone	
USA	AT&T	
USA	Redzone Wireless	
USA	Sprint	
USA	T Mobile US	In service
USA	Verizon Wireless	

212 operators investing in LTE-Advanced: 88 countries

Country	Operator	LTE-Advanced status	In service
Albania	**Telekom Albania**	**Commercial CA 225 Mbps**	**B3 + B7**
Albania	**Vodafone Albania**	**Commercial CA 225 Mbps**	**Bands to be advised**
Albania	Eagle Mobile	300 Mbps LTE-A 2CCA in deployment	
Algeria	**Mobilis**	**Commercial CA 150 Mbps**	**B3**
Algeria	Ooredoo	Trialled LTE-Advanced CA Achieved 301.6 Mbps	
Angola	Unitel	Trialled CA in B3 & B8 Trialled CA 450 Mbps using 2x20 MHz B1 + 2x20 MHz B3 + 2x20 MHz B7	
Argentina	Movistar	Trialled LTE-A CA in B4 + B28 achieved 288 Mbps	
Armenia	**UCOM**	**Commercial 250 Mbps CA**	**Bands to be advised**
Australia	**Optus**	**Commercial CA TDD 220 Mbps** **Commercial CA FDD 185 Mbps** **Commercial CA FDD 225 Mbps** **Commercial CA TDD + FDD 220 Mbps** **Commercial CA 2 TDD + 1**	**2 x 20 MHz B40** **15 MHz B3 + 10 MHz B28** **20 MHz B7 + 10 MHz B28** **15 MHz B3 + 20 MHz B40** **15 MHz B3 + 20 MHz B40** **15 MHz B3 +20+20 MHz**

		FDD 330 Mbps Demonstrated 480 Mbps using 4 CA (1 FDD, 3 TDD) Category 8 test drive 20 MHz B7 + 3x20 MHz B40	**B40**
Australia	**Telstra**	**Commercial CA 300 Mbps** **Commercial CA 450 Mbps** **Commercial CA 600 Mbps with 256QAM** 979 Mbps downlink and 129 Mbps uplink capability demonstrated using LTE-Advanced Pro technology	**20 MHz B3 + 20 MHz B28** **20 MHz B3 + 20 MHz B7 + 20 MHz B28** **20 MHz B3 + 20 MHz B7 + 20 MHz B28**
Australia	**Vodafone**	**Commercial CA 225 Mbps** LTE-Advanced Pro NB-IoT in deployment	**20 MHz B3 + 5 MHz B5 on many sites** **20 MHz B3 + 10 MHz B3 some sites**
Austria	**A1 Telekom**	**Commercial CA 300 Mbps**	**20 MHz B7 + 20 MHz B20**
Austria	**3 (Drei)**	**Commercial CA 300 Mbps**	**B3 + B7**
Austria	T Mobile	Trialled CA with B3 and B7 achieving 289 Mbps Trialled 5C CA LTE-Advanced Pro technologies including 4x4 MIMO, 256QAM with spectrum in B1, B3, B7, B8 and B20	
Azerbaijan	**Bakcell**	**Commercial CA 225 Mbps**	**20 MHz B3 + 20 MHz B3**
Azerbaijan	**Nar Mobile**	**Commercial CA 225 Mbps**	
Azerbaijan	Sazz	Demonstrated 900 Mbps 3.5 GHz LTE TD-Advanced CA	
Bahrain	Batelco	LTE-Advanced in deployment NB-IoT in deployment	
Bahrain	**Menateleco m**	**Commercial LTE-A service**	**B42, B43**
Bahrain	**Viva**	**Commercial 150 Mbps**	**B3**
Belarus	**BeCloud**	**Commercial 2C CA** **225 Mbps LTE-Advanced** Wholesale network	**B3 + B7**
Belgium	Base	Deploying 300 Mbps LTE-A	
Belgium	**Mobistar**	**Commercial CA 213 Mbps**	**20 MHz B3 + 10 MHz B20**
Belgium	**Proximus**	**Commercial CA 300 Mbps** Demonstrated LTE-A Pro up to 1.1 Gbps using	**Bands to be advised**
		B1+B3+B7+B20 spectrum	
Bulgaria	Mtel	Demonstrated 260 Mbps using 4x4 MIMO. Deployment is planned in parts of the network	
Brazil	**Claro**	**Commercial 3C CA**	**B3+B7+B28**
Brazil	**TIM**	**Commercial 3C CA** Studying LTE-Advanced Pro NB-IoT technology	**B3+B7+B28**
Brazil	Vivo	3C CA LTE-Advanced Pro trial achieved 530Mbps using 35MHz spectrum across B3+B7+B28, 256QAM and 4x4 MIMO	
Canada	**Bell Mobility**	**Commercial 3C C** **335 Mbps (selected areas)** **220 Mbps elsewhere**	**B4 + B7 + B17** **From B2, B4, B7**
Canada	**Rogers**	**Commercial CA 225 Mbps**	**10MHz B4 + 20MHz B7**
Canada	**Telus**	**Commercial CA 225 Mbps** Deploying LTE-Advanced Pro sites	**Bands to be advised**
Chile	**Claro**	**Commercial CA 216 Mbps**	**B7 + B28**
Chile	**Entel PCS**	**Commercial CA 300 Mbps**	**B7 + B28**
Chile	**Movistar**	**Commercial CA 300 Mbps**	**B7 + B28**
China	**China Mobile**	**Commercial CA 220 Mbps** LTE-A CA in deployment using 40 MHz B41, 40 MHz B40, 40 MHz B41 + B39, and 30 MHz B39 LTE-A CA uplink trialled 3 carrier LTE TDD B41 in trial phase up to 330 Mbps Ooredoo Qatar with CMCC trialled FDD-TDD 10-carrier Trialled LTE-Advanced Pro NB-IoT in 2016	**2 x 20 MHz B41**
China	**China Telecom**	**Commercial 300 Mbps** "Tianyi 4G+" service 3C CA LTE-A planned Deploying LTE-Advanced Pro NB-IoT nationwide in 2017	**B1 + B3**
China	**China Unicom**	**Commercial 300 Mbps**	**Bands to be advised**

		375 Mbps 3C CA demonstrated in Chengdu Traillaing LTE-Advanced Pro NB-IoT. Network deployment started in 2016	
Croatia	T-Hrvatski Telekom	Trialled CA with 10 MHz B3 + 10 MHz B20 for 136 Mbps	
Croatia	Vipnet	Demonstrated 300 Mbps DL speed using LTE-Advanced	
Czech Republic	**02 Czech Republic**	**Commercial CA 185 Mbps 2C CA** 3C CA is planned	**20 MHz B3 + 10 MHz B20**
Czech Republic	**T-Mobile**	**Commercial 375 Mbps in selected areas** **Commercial CA 225 Mbps B3 + B20** **Elsewhere 150 Mbps B1 + B20**	**20 MHz B3 + 20 MHz B7 + 10 MHz B20**
Czech Republic	**Vodafone**	**Commercial CA 300 Mbps (in Karlovy Vary)** **Commercial CA 225 Mbps** 300 Mbps using B3 only and 4x4 MIMO deployed in Prague Deploying 375 Mbps 3-CA with introduction of B7	**20 MHz B3 + 10 MHz B20 + 10 MHz B1** **15 MHz B3 + 15 MHz B20**
Denmark	**3**	**Commercial CA 150 Mbps** 3CCA FDD+TDD CA trialled B3 + B7 + B38	**B3 + B7**
Denmark	**TDC**	**Commercial CA 412 Mbps** **Commercial CA 300 Mbps** **Commercial CA 225 Mbps** An LTE-Advanced Pro demo using 256QAM & 4x4 MIMO achieved 1 Gbps downlink	**B3+B7+B20** **B7+B20** **B3+B20 B3+B7**
Denmark	**Telenor**	**Commercial CA 300 Mbps** Trialing 3-band 450Mbps CA	**B3 + B7**
Denmark	Telia	Deploying 300 Mbps CA B3 + B7	
Estonia	Elisa	Deploying CA 300 Mbps 20 MHz B3 + 20 MHz B7	
Estonia	**Telia**	**Commercial CA 300 Mbps** Demoed 1 Gbps LTE-A Pro 3CCA 20MHz B3 + 40MHz B7, 256QAM, 4x4 MIMO	**20 MHz B3 + 20 MHz B7**
Estonia	**Tele2**	**Commercial CA 375 Mbps** In major cities 300Mbps in many other areas	**B1+B3+B20**
Fiji	**Vodafone**	**Commercial CA 225 Mbps**	**B3 + B20**
Finland	**DNA**	**Commercial CA 600 Mbps 3C CA + 256QAM**	**20 MHz B1 + 20 MHz B3 + 20 MHz B7**
Finland	**Elisa**	**Commercial CA 300 Mbps** LTE-Advanced 3C CA 450 Mbps in deployment LTE-Advanced Pro demo achieved 1.9 Gbps DL speed using 5C CA, 4x4 MIMO and 256QAM	**20 MHz B3 + 20 MHz B7**
Finland	**TeliaSonera**	**Commercial CA 300 Mbps** 3-band CA trial achieved 375 Mbps B3+B7+B20	**B3 + B7**
Finland	Ukko Mobile	TDD LTE-Advanced demo achieved 507 Mbps with 2 x 20 MHz B38	
France	**Bouygues Telecom**	**Commercial CA 300 Mbps (Lyon: 12.11.15)** **Commercial CA 225 Mbps** Trial of 3-band with 256QAM using B3+B7+B20 spectrum achieved over 400 Mbps DL LTE-Advanced Pro trial achieved over 1 Gbps using 4C CA, 4x4 MIMO, 256QAM on DL and 2C CA uplink	**B3+B7+B20** **15 MHz B3 + 15 MHz B7**
France	Free Mobile	Trialling CA 220 Mbps B3 + B7	
France	**Orange**	**Commercial CA 225 Mbps** 300 Mbps CA trial used 3.5GHz and 2.6GHz in FDD Committed to deploy 450 Mbps 3CA by end 2017	**10 MHz B20 + 20 MHz B7**
France	**SFR**	**Commercial CA 187.5Mbps** **Commercial 3C CA 337.5 Mbps**	**B7 + B20** **B3+B7+B20**
Gabon	**Gabon Telecom**	**Commercial CA 233 Mbps**	**Bands to be advised**
Georgia	**Magticom**	**Commercial CA 185 Mbps**	**B3 + B20**
Germany	**DT**	**Commercial CA 300 Mbps** 3-band CA 375 Mbps trialled B3 + B7 + B20	**20 MHz B3 + 20 MHZ B7**

		Tested IS-MIMO 1.2 Gbps LTE-Advanced Pro demonstrated using 5C CA + 4x4 MIMO Demonstrationg NB-IoT on live network	
Germany	**O2**	**Commercial CA 225 Mbps**	**B7 + B20**
Germany	**Vodafone**	**Commercial CA 375 Mbps** Deploying LTE-Advanced Pro	**B3+B7+B20**
Gibraltar	**Gibtelecom**	**Commercial 225 Mbps**	**B7 + B20**
Greece	**Cosmote**	**Commercial CA 375 Mbps** 370 Mbps demonstrated FDD-TDD 3CA 500 Mbps demonstrated 3CA FDD & 256 QAM	**B3+B7+B20**
Greece	**Vodafone**	**Commercial CA 300 Mbps** 375 Mbps trialled	**B3 + B7**
Guernsey	JT	Deploying B7 + B20	
Hong Kong	**CSL**	**Commercial CA 300 Mbps** 3-carrier 450 Mbps in deployment	**20 MHz B3 + 20 MHz B7**
Hong Kong	**SmarTone**	**Commercial CA 150 Mbps** Tri-band CA in deployment B3+B7+B8	**Two from B3, B7, B8**
Hong Kong	**3**	**Commercial 2C CA over 200 Mbps** Deploying FDD & TDD CA Demonstrated LTE-Advanced Pro technology up to 1 Gbps using FDD and TDD carriers with 256 QAM 3C CA (FDD+TDD) to commercially launch in 2016 Committed to 5C CA deployment	**10 MHz B3 + 20 MHz B7**
Hong Kong	China Mobile HK	LTE-Advanced Pro network in deployment Trialled 15 MHz B7 + 20 MHz B40 + 10 MHz B40 Deploying an LTE-Advanced Pro network	
Hungary	**Magyar Telekom**	**Commercial 300 Mbps CA**	**20 MHz B3 + 20 MHz B7**
Hungary	**Telenor**	**Commercial 300 Mbps**	**B3 + B20**
India	**Airtel**	**Commercial 2C CA 135 Mbps**	**B3 + B40**
Indonesia	**Indosat Ooredoo**	**Commercial CA 150 Mbps**	**B3 + B8**
Indonesia	**Internux (Bolt)**	**Commercial 2C CA 200 Mbps**	**B40 + B40**
Indonesia	**Smartfren**	**Commercial CA 225 Mbps** Future deployment: 20 MHz B40 + 10 MHz B40 + 10 MHz FDD	**20 MHz B5 + 10 MHz B40**
Indonesia	**XL Axiata**	**Commercial 210 Mbps** 4x4 MIMO deployed in parts of the network enabling 210 Mbps when using 15 MHz bandwidth Trialling LAA LTE-Advanced Pro service is targeted for launch 2017	**B3**
Iran	MTN Irancell	Trialled LTE-Advanced Pro using 2C CA B3 and achieving 1.2 Gbps	
Ireland	**H3G**	**Commercial 225 Mbps CA**	**B3 + B20**
Ireland	**Vodafone**	**Commercial 225 Mbps CA** Demoed 2C CA uplink + 64QAM reaching 136 Mbps LTE-Advanced Pro NB-IoT in deployment	**B3 + B20**
Israel	Cellcom	Deploying	
Italy	3 Italia	CA planned B3 + B7	
Italy	Linkem	LTE-Advanced to be deployed in 3.5 GHz spectrum: peak speed not known	B42/43
Italy	**TIM**	**Commercial CA 300 Mbps** **225 Mbps elsewhere** 500 Mbps LTE-Advanced Pro demonstrated in Turin	**B3 + B7 + B20**
Italy	**Vodafone**	**Commercial CA 225 Mbps** CA 1.2 Gbs demonstrated	**Two from B3, B7, B20**
Japan	**NTT DoCoMo**	**Commercial CA 300 Mbps** 375 Mbps CA tin deployment then 500 Mbps	**B3 + B19 and B1 +21 B28**
Japan	**KDDI**	**Commercial CA 300 Mbps**	**B1 + B18 + 28**
Japan	Softbank	5C TDD CA using B42 demoed 770 Mbps. CoMP and Cloud BB used in trial LTE-Advanced Pro Trialling CA B9 + B42 4C TDD CA using B42 trialled	

		3-band CA trial: B1 + B3 + B8 achieved 262.5 Mbps LTE-Advanced Pro: NB-IoT will be deployed	
Japan	**UQ Comms**	**Commercial 220 Mbps 4x4 MIMO** CA in deployment	**20 MHz B41**
Jersey	**JT**	**Commercial CA 300 Mbps**	**B3 + B7 + B20**
Kenya	**Safaricom**	**Commercial 2C CA 150 Mbps**	**B3 + B20**
Kuwait	Viva	Deploying	
Kuwait	**Ooredoo**	**Commercial CA 185 Mbps**	**B3 + B20**
Kuwait	Zain	Deploying LTE-Advanced Trialled LTE-Advanced Pro achieving 1 Gbps downlink Plans NB-IoT deployment	
Latvia	**Bite**	**Commercial CA 300 Mbps**	**B3 + B7**
Latvia	**LMT**	**Commercial CA 150 Mbps**	**B3 + B7**
Latvia	**Tele2**	**Commercial CA 375 Mbps**	**B3+B7+B20**
Lebanon	**Alfa**	**Commercial CA 262.5Mbps** Deploying LTE-Advanced Pro	**B3 + B20**
Lebanon	Touch	Trialled CA 250 Mbps B3 + B20 Deploying LTE-Advanced Pro	
Lithuania	**Bite**	**Commercial CA 300 Mbps** **Commercial CA 225 Mbps**	**B3 + B7** **B3 + B20**
Lithuania	**Omnitel**	**Commercial CA 375 Mbps**	**Includes B3 + B20**
Lithuania	**Tele2**	**Commercial CA 350 Mbps** **Commercial CA 210 Mbps**	**B3+B7+B20** **10 MHz B20 + 15 MHz B3**
Lithuania	**Mezon**	**Commercial CA 206 Mbps** Trialling 400 Mbps LTE-Advanced Pro	**20 MHz B40**
Luxembourg	**Tango**	**Commercial CA 225 Mbps**	**B3 + B20**
Macau	**CTM**	**Commercial 112 Mbps** 2CA B1 + B3 in 2016 Plans evolution to 450 Mbps by adding in B40	**B3**
Macedonia	**T Mobile**	**Commercial CA 220 Mbps**	**B3 + B20**
Malaysia	**DIGI**	**Commercial 150 Mbps CA**	**B3 + B7**
Malaysia	**Maxis**	**Commercial CA 225 Mbps**	**Bands to be advised**
Malaysia	**U Mobile**	**Commercial 2C CA 100 Mbps**	**B3 + B7**
Maldives	**Dhiraagu**	**Commercial CA 300 Mbps**	**B3 + B7**
Maldives	Ooredoo	Trialled	
Moldova	**Orange**	**Commercial CA 300 Mbps**	**Bands to be advised**
Moldova	**Unite**	**Commercial 175 Mbps**	**B3**
Monaco	**Monaco Telecom**	**Commercial CA 223 Mbps** Deploying tri-band 450 Mbps LTE-A CA	**B7 + B20**
Morocco	**IAM: Maroc Telecom**	**Commercial CA 225 Mbps**	**Bands to be advised**
Montenegro	Crnogorski Telekom	Trialling CA 300 Mbps	
Namibia	**MTC**	**Commercial CA 300 Mbps** Demoed 1 Gbps LTE-Advanced Pro technology	**B3 + B20**
Nepal	NT	Planned	
Netherlands	**T Mobile NL**	**Commercial CA 225 Mbps** Trials planned/ongoing: CA 225 Mbps: 20MHz B3+10MHz B1 CA 300 Mbps: 10MHz B8+20MHz B3+10 MHz B1 CA 300 Mbps: 20 MHz B3+20MHz B38 Trialling 3C CA by adding B1	**B3 + B8**
Netherlands	**Tele 2**	**Commercial CA 225 Mbps**	**B7 + B20**
Netherlands	**KPN**	**Commercial CA 225 Mbps** Trialled B3+B7+B20 and 256QAM achieved 391 Mbps	**20 MHz B3 + 10 MHz B20**
Netherlands	**Vodafone**	**Commercial CA 225 Mbps 2C CA** Deploying 3-band CA 300 Mbps Trailled CA of licensed (1800 MHz) and unlicensed (5 GHz) bands LTE-Advanced Pro NB-IoT in deployment	**10 MHz B20 + 20 MHz B3**
New Zealand	**Vodafone**	**Commercial CA 300 Mbps**	**B3 + B7 + B28**
New Zealand	**Spark**	**Commercial CA 300 Mbps**	**20 MHz B3 + 20 MHz B7**
Nigeria	**Bitflux**	**Commercial CA 300 Mbps**	**B40**
Nigeria	**Ntel**	**Commercial CA 230 Mbps**	**B3 + B8**
Norway	**Telia**	**Commercial CA 300 Mbps**	**B3 + B7 +**

		1Gbps demonstrated 4-band LTE-A CA: B1, B3, B7,B20	**B20**
Norway	**Telenor**	**Commercial CA 300 Mbps**	**B3 + B20 B3 + B7**
Oman	**Omantel**	**Commercial CA 200 Mbps** Using LTE-Advanced Pro B3+B7+B20 demoed 1 Gbps	**Bands to be advised**
Oman	**Ooredoo**	**Commercial CA 200 Mbps**	**Bands to be advised**
Peru	Entel	Demonstrated 260 Mbps 2C LTE-Advanced carrier aggregation B4 + B28	
Peru	**Movistar**	**Commercial 2C CA 250 Mbps**	**B4 + B28**
Philippines	Globe	Deploying 225 Mbps CA Deploying LTE-Advanced Pro network	
Philippines	**Smart**	**Commercial CA 250 Mbps** 5C CA LTE-Advanced Pro lab trial achieved 1.4 Gbps downlink	**B1 + B3 + B5 B28 +B3 some sites**
Poland	**Orange Polska**	**Commercial 300 Mbps 3C CA** **Commercial 225 Mbps** 2C CA B3 +B20 Announced 4C CA LTE-Advanced Pro trial by Orange Labs achieving 1 Gbps using 256QAM and 4x4 MIMO 1.91 Gbps in lab tests using 100 MHz across 5 bands: B20 B8 B3 B1 and B7	**15MHz B3 +15MHz B7 +10MHz B20**
Poland	**Play**	**Commercial 4C CA 262 Mbps LTE-Advanced Pro**	**5MHz B1 +10MHz B3 +20MHz B7 +5MHz B20**
Poland	**Polkomtel & Cyfrowy Polsat**	**Commercial 300 Mbps 2C CA**	**20MHz B3 + 20MHz B7**
Poland	**T-Mobile**	**Commercial 300 Mbps 3C CA** **Other sites offer 220 Mbps 2C CA** 20MHz B3 + 20MHz B20 or 20MHz B3 + 20MHz B7 4C CA LTE-Advanced Pro demonstrated achieving 1.2 Gbps DL data speed using 80 MHz spectrum in 4 bands	**15MHz B3 + 15MHz B7 + 10MHz B20**
Portugal	**Meo**	**Commercial CA 300 Mbps** **Commercial CA 225 Mbps**	**20 MHz B7 + 20 MHz B3 20 MHz B7 + 10 MHz B20**
Portugal	**NOS**	**Commercial 300 Mbps 2C CA** **2C CA 225 Mbps 2C CA 225 Mbps**	**B3 + B7 B3 +B20 B7 + B20**
Portugal	**Vodafone**	**Commercial CA 300 Mbps** Trialled 450 Mbps B3 + B7 Trialled 600 Mbps tri-band CA with 256Qam	**B3 + B7**
Puerto Rico	**AT&T Mobility**	**Commercial CA 110 Mbps**	**B4 + B17**
Puerto Rico	**T Mobile**	**Commercial CA 220 Mbps (E) using 4x4 MIMO**	
Qatar	**Ooredoo**	**Commercial CA 375 Mbps** (some areas of Doha) **325 Mbps elsewhere** 590 Mbps Category 11 achieved in tests, Oct 2015	**B3+B7+B20**
Qatar	**Vodafone**	**Commercial CA 375 Mbps**	**B3 + B7 + B20**
Romania	**Orange**	**Commercial CA 375 Mbps 3C CA** 300 Mbps elsewhere LTE-Advanced Pro demonstration on a test network achieved 1 Gbps	**20 MHz B3 + 20 MHz B7 + B20**
Romania	**Vodafone**	**Commercial 2C CA 300 Mbps service** LTE-Advanced trials achieved 1.35 Gbps	**B3+B20**
Russia	**MegaFon**	**Commercial CA 300 Mbps** 450 Mbps LTE-A CA trialled using 20 MHz B7 + 20 MHz B7 + 20 MHz B3 Demoed 1.06 Gbps with 3CCA LTE-Advanced Pro B7+B3+256QAM+4x4MIMO Trialling NB-IoT	**20 MHz B7 + 20 MHz B7**
Russia	**MTS**	**Commercial CA 225 Mbps** Deploying 150 Mbps and 225 Mbps in the Regions **Commercial 3CCA 187 Mbps FDD-TDD:** 10MHz B3+10MHzB7+5MHz B20 Trialled LTE-U	**B3+B7+B20**

		achieved 20 Mbps 10 MHz B3 + 20 MHz 5GHz	
Russia	Osnova	Lab tested TDD LTE-A CA achieving 226.1 Mbps	
Russia	**Vimpelcom**	**Commercial CA 110 Mbps**	**B7 + B20**
Saudi Arabia	**STC**	**Commercial TDD LTE-A 150 Mbps (GSA assumption)** FDD-TDD CA demonstrated: B3 + B40 TDD+ (LTE-Advanced Pro feature) trialled achieving 1.59 Gbps MulteFire (LTE-Advanced Pro LTE-U feature) trialled May 2016 LTE-Advanced Pro network in deployment including TD-LTE carrier aggregation techniques	**20 + 20 MHz B40**
Saudi Arabia	Mobily	Deploying 4x4 MIMO on its TDD network to achieve 220 Mbps peak DL on a 20 MHz carrier	
Saudi Arabia	**Zain**	**Commercial CA 187.5 Mbps** **3C CA**	**B1 + B3 + B8**
Serbia	**VIP Mobile**	**Commercial 2CA 225 Mbps**	**B3 + B20**
Singapore	**M1**	**Commercial CA 300 Mbps** Lab trial achieved over 1 Gbs DL and 130 Mbps UL combining 4x4 MIMO, 3CCA DL, 2CCA UL, 256QAM and a Cat 14 prototype device Deploying nationwide NB-IoT network	**20 MHz B3 + 20 MHZ B7**
Singapore	**SingTel**	**Commercial CA 337 Mbps** FDD-TDD CA trialled (260 Mbps achieved) Deploying 450 Mbps CA Trialled pre-standard LAA using B3 spectrum as anchor carrier	**20 MHz B3 + 20 MHz B7 + B8**
Singapore	**StarHub**	**Commercial CA 300 Mbps** 27.05.15 announced 600 Mbps demo using 3C CA, 4x4 MIMO LTE-Advanced Pro 11.04.16 showcased 55MHz across B1+B3+B7, 256QAM, 4x4 MIMO achieving over 1 Gbps indoors LTE-Advanced Pro Deploying 150 Mbps 2C CA 64QAM on uplink	**B3 + B7**
Slovak Rep	O2	Trialling CA using B3 + B20 165 Mbps achieved	
Slovak Rep	**Orange**	**Commercial CA 225 Mbps**	**20 MHz B7 + 10 MHz B20**
Slovak Rep	**Slovak Telekom**	**Commercial CA 300 Mbps** **Commercial CA 225 Mbps** in many other areas Trialled 375 Mbps using 20+20 MHz B7 + 10 MHz B3 Trailled LTE-Advanced Pro 3C CA, 4x4 MIMO, 256QAM achieving 900 Mbps	**2x 40MHz B7** **10 MHz B3 + 20 MHz B7**
Slovenia	**Telekom Slovenije**	**Commercial CA 300 Mbps** **Commercial CA 225 Mbps**	**20 MHz B3 + 20 MHz B7** **10 MHz B20 + 20 MHz B3**
Slovenia	**Si.mobil**	**Commercial 300 Mbps CA**	**20 MHz B3 + 20 MHz B20**
South Africa	**Cell C**	**Commercial CA** (assumed 120 Mbps)	**Bands to be advised**
South Africa	iBurst	Deploying an LTE-A network	
South Africa	**MTN**	**Commercial CA 120 Mbps** 200 Mbps demoed using LTE-Advanced Pro LTE-U to aggregate one unlicensed 5GHz carrier + band 3 1 Gbps demoed using LTE-Advanced Pro LTE-U to aggregate 2 unlicensed 5GHz carriers + band 1 with 4x4 MIMO	**15MHz B1 + 10MHz B3**
South Africa	Multisource	Deploying 2C CA LTE-Advanced using band 3 and 2.6 GHz spectrum	
South Africa	**TM**	**Commercial CA 220 Mbps** 3C CA demonstrated up to 260 Mbps	**B40**
South Africa	Vodacom	Demonstrated CA 270 Mbps using 2 x 20 MHz paired B7 Demonstrated 3C CA B1 + B3 + B8 achieving 170 Mbps Demonstrated LTE-Advanced Pro LTE-U using B3 + 5.8 GHz spectrum achieving 217 Mbps	

		Demonstrated LTE-Advanced Pro 3C CA achieving over 1 Gbps	
South Korea	**LG Uplus**	**Commercial CA 300 Mbps 3C CA** Demonstrated 3C CA + 256QAM + 4 x 4 MIMO achieving 780 Mbps DL Commercial LTE-Advanced Pro uplink 2C CA 108 Mbps Deploying nationwide NB-IoT network LTE-Advanced Pro: KT and LG U+ with Huawei formed a NB-IoT alliance	**10MHz B1 + 10MHz B5 + 20 MHz B7**
South Korea	**KT**	**Commercial CA 300 Mbps** Demonstrated NB-IoT LTE-Advanced Pro: KT and LG U+ with Huawei formed a NB-IoT alliance	**10 MHz B1 + 20 MHz B3 + 10 MHz B8**
South Korea	**SK Telecom**	**Commercial CA 500 Mbps LTE-Advanced Pro 3C CA and 256QAM** Uplink CoMP trialled June 2014 using 200 MHz in 10C CA trial (9 TDD + 1 FDD) achieved 3.8 Gbps DL 3-carrier TD-LTE-A trial in band 41 +256QAM achieved 428 Mbps Trialled eLAA abd LAA	**10 MHz B1 + 10MHz B3 + 20MHz B5 + + 256QAM**
Spain	**Movistar**	**Commercial CA 300 Mbps** LTE-U demonstrated 800 Mbps LTE-Advanced Pro demoed using 4x4 MIMO and 256QAM	**20 MHz B3 + 20 MHz B7**
Spain	**Orange**	**Commercial CA 300 Mbps** **Commercial CA 336 Mbps in Barcelona and Madrid** Lab demonstration achieved 500 Mbps using 3 band LTE-A CC and 256QAM 4C CA LTE-Advanced Pro demonstration achieved over 1.5 Gbps using 256QAM and 4x4 MIMO	**B3 + B7 + B20**
Spain	**Vodafone**	**Commercial CA 400 Mbps** **Commercial CA 600 Mbps** Deploying 600 Mbps adding in TDD spectrum NB-IoT trialled on live network	**20 MHz B3 + 20 MHz B7 + B8**
Sri Lanka	Dialog Axiata	Trialled LTE-Advanced Pro Achieved 1 Gbps with 75 MHz B40, 256QAM DL 4 x 4 MIMO	
Sri Lanka	Mobitel	Trialled LTE-Advanced Pro in test lab	
Sweden	**3**	**Commercial CA 150 Mbps** Deploying 225 Mbps	**20+20 MHz B38 + 10 MHz B7 + 10 MHz B20**
Sweden	**Tele2**	**Commercial CA 300 Mbps**	**B7 + B20**
Sweden	**Telenor**	**Commercial 450 Mbps CA 3C CA**	**B7 + B20**
Switzerland	**Salt**	**Commercial 300 Mbps**	**20 MHz B3 + 20 MHZ B7**
Switzerland	**Sunrise**	**Commercial CA 300 Mbps**	**B3 + B7 + B20**
Switzerland	**Swisscom**	**Commercial CA 300 Mbps** (a few locations can receive **450 Mbps)** Demonstrated 335 Mbps B1 + B41 LTE-Advanced Pro trials: 426 Mbps achieved in tests using 256QAM 1 Gbps reached April 2016	**20 MHz B3 + 20 MHz B7**
Taiwan	**CHT**	**Commercial 3CA 340 Mbps**	**15 MHz B3 + 10 MHz B8 + B7**
Taiwan	**FarEasTone**	**Commercial CA 300 Mbps**	**B3 + B7 + B28**
Taiwan	**Taiwan Mobile**	**Commercial CA 150 Mbps**	**5 MHz B3 + 15 MHz B28**
Taiwan	**Taiwan Star**	**Commercial CA 225 Mbps**	**B7 + B8**
Thailand	**AIS**	**Commercial CA 190 Mbps** **Commercial LTE-Advanced Pro 550 Mbps: B1+B3+LTE-U+256/64QAM + 4x4 MIMO**	**15 MHz B1 + 15 MHz B3** **B1 + B3 + 5GHz UL band**
Thailand	**True Move**	**Commercial CA 335 Mbps**	**10 MHz B1 + 15 MHz B3 +**

			5 MHz B8 4x4 MIMO
Tunisia	Oordeoo	Commercial CA 150 Mbps	B3 + B20
Tunisia	Orange	Commercial CA 150 Mbps	B3 + B20
Tunisia	Tunisie Telecom	Commercial CA 150 Mbps	B3 + B20
Turkey	Turkcell	Commercial CA 450 MHz (Cat 9) LTE-Advanced Pro Readiness to > 800 Mbps for Cat 16 DL UEs Demonstrated 891.6 Mbps Demonstrated 1.2 Gbps using 5 carriers	B1/B3/B7/ B20 in 2CA and 3CA deployments plus 4x4 MIMO & 256QAM
Turkey	Turk Telecom	Commercial 3C CA 300 Mbps LTE-Advanced Pro including 256QAM	B3/B7/B20
Turkey	Vodafone	Commercial 3C CA 300 Mbps LTE-Advanced Pro including 4x4 MIMO, 256QAM LTE-Advanced Pro NB-IoT in deployment	B3/B7/ B8/B20
UAE	Du	Commercial CA 225 Mbps 900 Mbps demonstrated using MIMO 4x4	20 MHz B3 + 15 MHz B20
UAE	Etisalat	Commercial CA 300 Mbps Trialling 700 Mbps CA 20 MHz B3 + 20 MHz B20 + 20 MHz B7 Planning 450 Mbps LTE-A launch in 2016	20 MHz B3 + 20 MHz B20
UK	EE	Commercial CA 300 Mbps Deploying CA 450 Mbps Cat 9 using 20 MHz B3 + 20+15 MHz B7 spectrum	20 MHz B3 + 20 MHz B7
UK	Vodafone	Commercial CA 225 Mbps Trialling TDD+ with 8T8R (LTE-Advanced Pro feature)	20 MHz B7 + 10 MHz B20
Ukraine	Lifecell	LTE-Advanced Pro trial achieved 1.5 Gbps downlink using 5 x 20 MHz blocks in bands 1,3,7,8,20 plus 4x4 MIMO and 256QAM	
Ukraine	Vodafone	2C CA LTE-Advanced trial using B1+B3 achieved 173 Mbps downlink speed	
USA	AT&T	Commercial CA 110 Mbps Deploying 3C CA	2x15 MHz of B4 + B17
USA	Bluegrass Cellular	Deploying (Verizon) XLTE CA of band 13 + band 4	
USA	DISH	Planned	
USA	Redzone Wireless	Commercial CA 100 Mbps	B41
USA	T Mobile	Commercial CA 400 Mbps Using 3C CA with MIMO, 256QAM, 64QAM LTE-Advanced Pro	B2 + B4 + B12
USA	Sprint	Commercial 3C CA 300 Mbps Commercial LTE-A 164 Mbps	20+20+20 MHz B41 20+20 MHz B41
USA	Verizon	Commercial launch 225 Mbps 2C CA and 300 Mbps 3C CA	20MHz B13 + 20MHz B2 + 20MHz B4
Vietnam	MobiFone	LTE-A services pilot trial	
Vietnam	Viettel	Demonstrated up to 230 Mbps using CA	
Vietnam	Vinaphone (VNPT)	Demonstrated up to almost 600 Mbps using CA	

GSA publishes a status report which list all LTE-Advanced networks and their peak downlink speeds:

LTE-Advanced Carrier Aggregation deployments: peak speeds

Distribution is restricted – see the GSA website for more information www.gsacom.com

LTE-Advanced Pro worldwide development status: look for the new GSA report coming soon.

LTE-Advanced User Devices

According to GSA's Status of the LTE Ecosystem report (October 10, 2016), 3,398 devices support UE Category 4 (up to 150 Mbps downlink), i.e. 52.2% of all LTE devices.

Deployment of LTE-Advanced systems for Category 6 (300/50 Mbps) or 7 (300/100 Mbps) user devices is a major trend. 441 devices support speeds up to UE Category 6 (419 devices) or 7 (22 devices) e.g. smallcells, routers, MiFis, smartphones, tablets.

61 Category 9 devices are launched (450/50 Mbps)
1 Category 10 device is launched (450/100 Mbps)
1 Category 11 device is launched (600/50 Mbps)
9 Category 12 devices (600/100 Mbps)
24 Category 13 devices (390/150 Mbps)

VoLTE global deployments

158 operators are investing in VoLTE in 72 countries *including 93 operators with commercially launched VoLTE-HD voice service in 52 countries*

Country	Operator	VoLTE status
Algeria	Algérie Télécom / Mobilis	Launched
Australia	Optus	Launched
Australia	Telstra	Launched
Australia	Vodafone	Launched
Austria	A1 Telekom	Launched
Bahrain	Batelco	Launched
Brazil	TIM Brasil	Launched
Cambodia	SEATEL	Launched
Canada	Bell Mobility	Launched
Canada	Eastlink	Launched
Canada	Rogers Wireless	Launched
Canada	Telus	Launched
China	China Mobile	Launched
China	China Unicom	Launched
Colombia	Movistar	Launched
Czech Republic	T Mobile	Launched
Czech Republic	Vodafone	Launched
Denmark	TDC	Launched
Denmark	Telenor	Launched
Estonia	Telia	Launched
Finland	DNA	Launched
France	Bouygues Telecom	Launched
France	Orange	Launched
Gabon	Gabon Telecom	Launched
Germany	DT	Launched
Germany	O2	Launched
Germany	Vodafone	Launched
Hong Kong	3 HK	Launched
Hong Kong	China Mobile HK	Launched
Hong Kong	CSL	Launched
Hong Kong	Smartone	Launched
India	Reliance Jio	Launched
Indonesia	Smartfren	Launched
Indonesia	XL Axiata	Launched
Italy	TIM	Launched
Italy	Vodafone	Launched
Japan	KDDI	Launched
Japan	NTT DoCoMo	Launched
Japan	Softbank	Launched
Kuwait	Viva	Launched
Kuwait	Zain	Launched
Liechtenstein	Swisscom	Launched
Lithuania	Omnitel	Launched
Macau	CTM	Launched
Malaysia	YTL (Yes)	Launched
Netherlands	Tele2	Launched
Nigeria	Ntel	Launched
Nigeria	Smile	Launched
Norway	Telenor	Launched
Norway	Telia	Launched
Poland	Orange Polska	Launched
Portugal	Vodafone	Launched
Puerto Rico	AT&T Mobility	Launched
Qatar	Ooredoo	Launched
Romania	Orange	Launched
Romania	Vodafone	Launched
Russia	Beeline (Vimpelcom)	Launched
Russia	Megafon	Launched
Saudi Arabia	STC	Launched
Saudi Arabia	Zain	Launched
Singapore	M1	Launched
Singapore	SingTel	Launched
Singapore	StarHub	Launched
Slovakia	4ka (Swan Telecom)	Launched
South Africa	Vodacom	Launched
South Korea	KT	Launched
South Korea	LG Uplus	Launched
South Korea	SK Telecom	Launched
Spain	Vodafone	Launched
Sri Lanka	Dialog	Launched
Switzerland	Swisscom	Launched
Taiwan	Ambit Microsystems	Launched
Taiwan	Asia Pacific Telecom	Launched
Taiwan	FarEasTone	Launched
Taiwan	Taiwan Mobile	Launched
Taiwan	Taiwan Star	Launched
Tanzania	Smile	Launched
Thailand	AIS	Launched
Thailand	DTAC	Launched
Thailand	True Move	Launched
Turkey	Turkcell	Launched
Turkey	Turk Telecom	Launched
Turkey	Vodafone	Launched
Uganda	Smile	Launched
UAE	Etisalat	Launched
UK	3 UK	Launched
UK	EE	Launched
USA	AT&T Mobility	Launched
USA	Evolve Broadband	Launched
USA	KPU	Launched
USA	T-Mobile US	Launched
USA	Verizon Wireless	Launched
US Virgin Isles	AT&T Mobility	Launched
Algeria	Oordeoo	In deployment
Angola	Unitel	In deployment
Argentina	Movistar	In deployment
Argentina	Personal	In deployment
Austria	T Mobile	Trialling
Belgium	Proximus	In deployment
Bulgaria	Mtel	Planned
Bulgaria	Max	In deployment
Cambodia	Chuan Wei Ltd	In deployment
Canada	Sasktel	In deployment
China	China Telecom	In deployment
Colombia	Avantel	In deployment
Czech Republic	O2 Czech	Pilot trialling
Denmark	3	In deployment
DRC	Smile	In deployment
Ecuador	CNT	In deployment
France	SFR	In deployment
French Polynesia	ORA (Viti)	Studying
Greece	Vodafone	Trialled
Hungary	Telenor	Trialling
India	Bharti Airtel	Trialling
India	Videocon	Planned
Indonesia	Telkomsel	Trialled
Kazakhstan	Altel	In deployment
Kuwait	Ooredoo	Trialled

Lebanon	Alfa	In deployment
Macau	3Macau	In deployment
Malaysia	DiGi	Trialling
Myanmar	Telenor	Planned
Namibia	MTC	Planned
Netherlands	KPN	In deployment
Netherlands	T-Mobile	In deployment
Netherlands	Vodafone	In deployment
New Zealand	Spark	Trialling
New Zealand	Vodafone	Trialled
Norway	Ice.net	Trials planned
Peru	Movistar	In deployment
Poland	Polkomtel Plus	Trialled
Poland	Play P4	In deployment
Poland	Sferia	Planned
Poland	T-Mobile	In deployment
Russia	MOTIV	Planned
Russia	MTS	In deployment
Saudi Arabia	Mobily	In deployment
Serbia	Vip Mobile	Trialled
Slovakia	Slovak Telekom	Trialling
Slovenia	Si.mobil	In deployment
Slovenia	Telekom Slovenije	In deployment
Spain	Telefonica Movistar	Trialling
Sri Lanka	Mobitel	Trialling
Sweden	Tele2	In deployment
Sweden	Telenor	In deployment
Sweden	TeliaSonera	In deployment
Switzerland	Sunrise	In deployment
Tanzania	TTCL	In deployment
Taiwan	Asia Pacific Telecom	In deployment
Tokelau	Teletok	In deployment
UAE	Du	In deployment
UK	O2	In deployment
UK	Vodafone	In deployment
USA	C Spire	Planned
USA	US Cellular	User trial
USA	Sprint	In deployment
USA	VTel	In deployment
Venezuela	Digitel	Testing

Orange announced plans to launch VoLTE in all of its European operations during 2016 and early 2017.

EVS (Enhanced Voice Service) Codec

The EVS codec was developed within 3GPP as part of Release 12 and offers HiFi call quality for speech and audio alike. EVS is the first 3GPP conversational codec offering up to 20 kHz audio bandwidth, delivering speech quality that matches other audio input such as stored music. In addition, EVS increases call reliability and network efficiency due to its high robustness against packet loss.

http://www.3gpp.org/news-events/3gpp-news/1639-evs_news

EVS deployment status

Country	Operator	EVS status
Germany	Vodafone	Launched
Japan	NTT DoCoMo	Launched
USA	T-Mobile	Launched

The first mobile phones to support EVS include:

* Sony Xperia X Performance
* Samsung Galaxy S7 edge
* Sharp AQUOS Zeta

Although the EVS codec was developed in particular for LTE, it will bring benefits to any VoIP and CS system. The EVS codec is fully interoperable with HD Voice. EVS is the industry mandatory audio codec for superwideband transmissions via VoLTE. Read more about the EVS codec at:

http://resources.alcatel-lucent.com/asset/200002

https://www.ericsson.com/res/docs/whitepapers/wp-evolved-hd-voice-for-lte.pdf

ViLTE (Video over LTE)

ViLTE is “video over LTE” and is an extension of VoLTE, which enhances voice services with a high quality video channel. In order to deploy ViLTE, Voice over LTE (VoLTE) is required.

ViLTE deployment status (source: GSA)

Country	Operator	ViLTE status
Brazil	TIM Brasil	Launched
Indonesia	Smartfren	Launched
Macau	CTM	Launched
Slovakia	4ka	Launched
Turkey	Turkcell	Launched
Argentina	Personal	In deployment
Australia	Telstra	In deployment
Czech Rep	T-Mobile	In deployment

LTE TDD (TD-LTE) global status

80 LTE TDD (TD-LTE) systems are commercially launched in 47 countries. 28 operators have deployed converged FDD & TDD networks.

Country	Operator	TDD band
Angola	Net One	Band 41
Argentina	DirecTV	Band 43
Australia	NBN Co.	Band 40
Australia	Optus FDD & TDD	Band 40
Bahrain	Menatelecom	Band 42
Bangladesh	Ollo/BIEL	Band 38
Belgium	Broadband Belgium	Band 42
Brazil	On Telecomunicacoes	Band 38
Brazil	Sky Brazil Services	Band 38
Cambodia	Kingtel	Band 41
Cameroon	MTN	Band 41
Canada	ABC Communications	Band 42
Canada	Bell Mobility FDD & TDD	Band 42
Canada	CCI Wireless	Band 42
Canada	Sasktel FDD & TDD	Band 41
Canada	Telus FDD & TDD	40, 42
Canada	Xplornet	Band 42
China	China Mobile	39/40/41
China	China Telecom FDD & TDD	Band 40, 41
China	China Unicom FDD & TDD	Band 40, 41
Colombia	DirecTV	Band 38
Côte d'Ivoire	YooMee	Band 40
Dominican R.	WIND Telecom	Band 38
Finland	Ukko Mobile FDD & TDD	Band 38
Gambia	Netpage	Band 40
Ghana	BLU	Band 38
Ghana	Busy	Band 40
Ghana	NITA	Band 41
Hong Kong	CMHK FDD & TDD	Band 40
India	Aircel	Band 40
India	Bharti Airtel FDD & TDD	Band 40
India	Reliance Jio FDD & TDD	Band 40
Indonesia	PT Internux	Band 40
Indonesia	Smartfren FDD & TDD	Band 40
Iran	MTN Irancell FDD & TDD	Band 42
Italy	GO Internet	Band 42
Italy	Linkem	Band 42
Japan	Softbank FDD & TDD	Band 41
Japan	UQ Communications	Band 41
Lithuania	Mezon/Telecentras	Band 40
Madagascar	Blueline	Band 41
Malaysia	YTL (Yes)	Band 38, 40
Netherlands	T Mobile NL FDD & TDD	Band 38
Nigeria	Bitflux	Band 40
Nigeria	Cyberspace	Band 42
Nigeria	MTN HyNet	Band 42
Nigeria	Spectranet	Band 40
Nigeria	Swift Networks	Band 40
Oman	Omantel FDD & TDD	Band 40
Oman	Ooredoo FDD & TDD	Band 40
Peru	Americatel (Entel)	Band 40
Peru	Claro FDD & TDD	Band 42
Philippines	PLDT	Band 42
Poland	Aero2 FDD & TDD	Band 38
Romania	Idilis/Digi FDD & TDD	Band 38
Russia	Megafon FDD & TDD	Band 38
Russia	MTS FDD & TDD	Band 38
Russia	Vainakh Telecom	Band 40
S. Arabia	Mobily FDD & TDD	Band 38
S. Arabia	STC FDD & TDD	Band 40
S. Africa	Telkom Mobile (8ta)	Band 40
Slovak Rep	4ka FDD & TDD	Band 43
Slovak Rep	Slovanet	Band 42
Spain	COTA Murcia4G	Band 38
Spain	Neo-Sky	Band 42
Sri Lanka	Dialog Axiata FDD & TDD	Band 40
Sri Lanka	Lanka Bell	Band 40
Sri Lanka	SLT	Band 38
Sweden	3 Sweden FDD & TDD	Band 38
Tanzania	Smart Telecom	Band 40
Tanzania	TTCL FDD & TDD	Band 40
Trini&Tobago	TSTT	Band 41
Uganda	MTN	Band 41
Uganda	Vodafone	Band 38
UK	UK Broadband	Band 42, 43
USA	Redzone Wireless	Band 41
USA	Speedconnect	Band 41
USA	Sprint FDD & TDD	Band 41
Uzbekistan	EVO	Band 40
Vanuatu	WanTok	Band 40

LTE TDD (TD-LTE) bands in commercial use

Band	No. of networks
38	18
39	1
40	32
41	16
42 and/or 43	20

LTE TDD User Devices Ecosystem

GSA maintains a database of LTE FDD and TDD user devices. Key metrics are published in the Status of the LTE Ecosystem report. The report on October 10, 2016 confirmed that GSA has verified 6,504 LTE devices announced by 502 manufacturers.

2,505 devices i.e. 38.5% of all LTE devices support the LTE TDD (TD-LTE) mode.

Detailed analysis of all of these LTE TDD devices is possible using GSA's **GAMBoD** tool.

Access restrictions apply – see www.gsacom.com/gambod

LTE1800 global deployments

LTE network deployment in 1800 MHz nand 3 spectrum is mainstream. The motivations are clear:

- Coverage area approx. 2 times compared to deploying in 2.6 GHz band
- Possibility to re-use assets including antenna cables of GSM1800 or WCDMA-HSPA2100
- Possibility to deploy multi-RAN with simultaneous LTE and GSM capabilities
- 1800 MHz band widely available throughout Europe, APAC, MEA, regions of South America – thus having the potential to be a core - and global - band for LTE deployments
- Operators often have sufficient bandwidth in 1800 MHz to secure the full benefits of LTE
- Often easier to re-farm than 900 MHz
- Has the largest user device eco-system
- Can be a transition strategy between HSPA and availability of new (e.g. 2.6 GHz, digital dividend) spectrum

254 commercially launched LTE1800 systems

254 operators have commercially launched LTE1800 (band 3) systems in 111 countries/territories either as a single band or as part of a multi-band deployment. 1800 MHz is the most widely used and prime band for LTE globally, deployed in 47.3% of LTE networks, greatly assisting international roaming for mobile broadband services. More LTE1800 deployments are in progress. 1800 MHz mobile licences have been awarded to 350+ operators in nearly 150 countries.

Country	Operator
Åland Islands	Ålcom
Åland Islands	Teliasonera
Albania	Eagle Mobile
Albania	Telekom Albania
Algeria	Algérie Télécom/Mobilis
Algeria	Djezzy
Algeria	Ooredoo
Angola	Movicel
Angola	Unitel
Aruba	Setar NV
Australia	Optus
Australia	Telstra
Australia	Vodafone
Austria	3
Azerbaijan	Azercell
Azerbaijan	Bakcell
Azerbaijan	Nar Mobile
Bahrain	Batelco
Bahrain	Viva
Bahrain	Zain
Belarus	beCloud
Belarus	MTS
Belgium	BASE
Belgium	Mobistar
Belgium	Proximus
Benin	Benin Telecoms
Bhutan	Bhutan Telecom
Bonaire	Telbo
Bonaire	UTS
Botswana	Mascom
Botswana	Orange
Brazil	Claro
Brazil	Nextel
Brazil	TIM
Brunei	DST
Bulgaria	Max
Bulgaria	Mtel
Bulgaria	Telenor
Bulgaria	Vivacom
Cambodia	Cellcard
Cambodia	Smart Axiata
Cayman Islands	Digicel
China	China Telecom
China	China Unicom
Costa Rica	Claro
Costa Rica	Movistar
Côte d'Ivoire	Orange
Croatia	T-Hrvatski
Croatia	Tele2
Croatia	VIPNet
Curaçao	UTS
Cyprus	CYTA
Cyprus	MTN
Cyprus	PrimeTel
Czech Republic	O2 Czech Republic
Czech Republic	T Mobile
Czech Republic	Vodafone
Denmark	3
Denmark	TDC
Denmark	Telenor
Denmark	Telia
Dominican Republic	Orange Dominicana
Estonia	Elisa
Estonia	Telia
Estonia	Tele2
Ethiopia	Ethio Telecom
Fiji	Digicel
Fiji	Vodafone Fiji

Finland	DNA
Finland	Elisa
Finland	TeliaSonera
France	Bouygues Telecom
Georgia	Geocell
Georgia	Magticom
Germany	DT
Germany	O2
Germany	Vodafone
Greece	Cosmote
Greece	Vodafone
Greece	Wind Hellas
Guernsey (UK)	Sure
Hong Kong	3HK
Hong Kong	China Mobile HK
Hong Kong	CSL
Hong Kong	Smartone
Hungary	Magyar Telekom (MT)
Hungary	Telenor
Iceland	Nova
Iceland	Siminn
India	Idea Cellular
India	Reliance Jio Infocomm
India	Telenor
India	Vodafone
Indonesia	3 Indonesia
Indonesia	Indosat Ooredoo
Indonesia	Telkomsel
Indonesia	XL Axiata
Iran	MTN Irancell
Ireland	3 Ireland
Ireland	Meteor
Ireland	Vodafone
Isle of Man	Manx Telecom
Isle of Man	Sure
Israel	Cellcom
Israel	Partner – Orange
Israel	Pelephone
Italy	3 Italia
Italy	TIM
Italy	Vodafone
Japan	Ymobile Corp (band 9)
Japan	NTT DoCoMo
Jersey (UK)	JT
Jersey (UK)	Sure
Jordan	Orange
Jordan	Zain
Kazakhstan	Altel
Kazakhstan	Kar-Tel / Beeline
Kazakhstan	Kcell
Kenya	Safaricom
Kosovo	IPKO
Kosovo	Vala
Kuwait	Viva
Kuwait	Ooredoo
Kuwait	Zain
Kyrgyzstan	Megacom
Latvia	Bite
Latvia	LMT
Latvia	Tele2
Lebanon	Alfa
Lebanon	Touch
Liberia	Cellcom
Liechtenstein	Orange
Liechtenstein	Swisscom
Lithuania	Bite
Lithuania	Omnitel
Lithuania	Tele2
Luxembourg	Orange
Luxembourg	POST
Luxembourg	Tango
Macau	3Macau
Macau	China Telecom Macau
Macau	CTM
Macau	Smartone Macau
Macedonia	ONE
Macedonia	T Mobile
Macedonia	Vip
Malaysia	Celcom
Malaysia	DiGi
Malaysia	Maxis
Maldives	Dhiraagu
Malta	GO
Malta	Vodafone
Mauritius	Emtel
Mauritius	MTML
Mauritius	Orange
Moldova	Unite
Montenegro	Crnogorski Telekom
Morocco	Inwi
Namibia	MTC
Namibia	TN Mobile
Netherlands	KPN
Netherlands	T Mobile
Netherlands	Vodafone
New Caledonia	OPT
New Zealand	2degrees
New Zealand	Spark
New Zealand	Vodafone
Nigeria	Etisalat
Nigeria	Ntel
Norway	Ice.net
Norway	Telenor
Norway	Telia

Oman	Ooredoo
Oman	Omantel
Pakistan	Mobilink
Pakistan	Zong
Philippines	Globe
Philippines	Smart
Poland	Mobyland/CenterNet
Poland	Orange Polska
Poland	Play
Poland	Polkomtel
Poland	T-Mobile Polska S.A
Portugal	Meo
Portugal	NOS
Portugal	Vodafone
Qatar	Vodafone
Romania	Telekom
Romania	Orange
Romania	Vodafone
Russia	Megafon
Russia	MOTIV
Russia	MTS
Russia	Tattelecom
Russia	Tele2 Russia
Saudi Arabia	Mobily
Saudi Arabia	STC
Saudi Arabia	Zain
Serbia	MTS
Serbia	Telenor
Serbia	VIP Mobile
Singapore	M1
Singapore	SingTel
Singapore	StarHub
Slovak Republic	O2 Slovakia
Slovak Republic	Slovak Telekom
Slovak Republic	4ka (Swan Telecom)
Slovenia	Telekom Slovenije
Slovenia	Telemach Mobil
Slovenia	Si.mobil
South Africa	Afrihost
South Africa	MTN
South Africa	Neotel
South Africa	Vodacom
South Korea	KT
South Korea	SK Telecom
Spain	Movistar
Spain	Orange
Spain	Vodafone
Spain	Yoigo
Sri Lanka	Dialog Axiata
Sri Lanka	Mobitel
St. Helena	Sure South Atlantic
St. Maarten	UTS
Sudan	Zain
Suriname	Telesur
Sweden	Tele2
Sweden	Telenor
Sweden	TeliaSonera
Switzerland	Salt
Switzerland	Sunrise
Switzerland	Swisscom
Taiwan	Chunghwa Telecom
Taiwan	FarEasTone
Taiwan	Taiwan Mobile
Tajikistan	Babilon-Mobile
Tanzania	TTCL
Thailand	AIS
Thailand	DTAC
Thailand	True Move
Tunisia	Ooredoo
Tunisia	Orange
Tunisia	Tunisie Telecom
Turkey	Turkcell
Turkey	Turk Telecom
Turkey	Vodafone
UAE	Du
UAE	Etisalat
UK	3 UK
UK	EE
Venezuela	Digitel
Zambia	MTN
Zimbabwe	Econet Wireless
Zimbabwe	NetOne

LTE1800 User Devices Ecosystem

GSA maintains a database of LTE FDD and TDD user devices. Key metrics are published in the Status of the LTE Ecosystem report. In the October 10, 2016 report GSA confirmed 6,504 LTE devices announced by 502 manufacturers. 1800 MHz (3GPP band 3) has the largest LTE user devices ecosystem. **59.8% of LTE devices can operate in band 3 spectrum.** 3,889 LTE1800 (band 3) user devices are announced. 2,764 LTE1800 smartphones represents 71% of LTE1800 devices, and 376 support UE Category 6 or above. 313 LTE1800 tablets equates to 8% share of the LTE1800 device ecosystem. Detailed analysis of all announced LTE devices as verified by GSA is available using GSA's GAMBoD tool.

Access restrictions apply – see www.gsacom.com/gambod

LTE1800 LinkedIN Group:
http://www.linkedin.com/groups?=&gid=3129390

APT700 band global status

Industry support for the APT700 band plan is strong. Whereas APT700 provides both FDD and TDD arrangements, it is the FDD plan that has gained global support from industry and regulators in markets addressing approaching 4 billion people. The FDD configuration is standardised by 3GPP (band 28) for a 2 x 45 MHz arrangement, with 10 MHz guardband between downlink and uplink.

APT700 FDD band plan (3GPP Band 28)

703-748 MHz for the uplink
10 MHz guard band
758-803 MHz for the downlink

Telstra, GSA and the GSMA jointly promote APT700 spectrum allocations for LTE to explain the benefits and opportunities from its use. The main infrastructure systems providers including Ericsson, Huawei and Nokia Networks support APT700. 700 MHz is excellent for wide area coverage in regional and rural environments, and for in-building coverage, and is an important digital dividend arising from the shift by TV broadcasters to digital transmissions. Adoption of the APT700 FDD band plan by many countries has created a major opportunity for near global spectrum harmonization for LTE, ensuring the greatest economies of scale for user devices, capacity for mobile broadband, and roaming.

50+ countries and territories have allocated, committed to, or recommend APT700 FDD (band 28) for LTE system deployments:

LAC region: Argentina, Brazil, Chile, Colombia, Costa Rica, Curaçao, Dominican Republic, Ecuador, Honduras, Mexico, Panama, Peru, Suriname, Venezuela

APAC/Oceania: Afghanistan, Australia, Bangladesh, Bhutan, Brunei, Cambodia, Fiji, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Singapore, South Korea, St. Maarten, Taiwan, Thailand, Tokelau, Tonga, Vanuatu, Vietnam

MEA UAE confirmed adoption of the APT700 lower 2 x 30 MHz duplexer. This is also the preferred frequency arrangement for 700 MHz allocations in Europe and throughout ITU Region 1.

In Africa: Zimbabwe

Europe: Notwithstanding the EU Council position (see above), the appropriate actions are committed, completed, underway or planned in Austria, Finland, France, Germany, Iceland, Slovenia, Sweden, UK

The number of commitments to compatibility with APT700 in Europe will be much higher. On May 26, 2016 the EU Council adopted a general approach on a draft decision aimed at boosting broadband services. The 700 MHz band would be made available for wireless broadband in Europe by 2020.

According to the Council position, EU countries must reassign the 700 MHz band (694-790 MHz*) to wireless broadband services under harmonised technical conditions by 30 June 2020.

If they are unable to do this they may decide, for duly justified reasons, to delay the availability of the band by up to two years.

Member states must adopt a 'national roadmap' by 30 June 2018, setting out how they will implement the decision. These roadmaps are to be made public.

APT700 band 28 is licensed to mobile operators in many countries, including: Argentina, Australia, Bhutan, Brazil, Chile, Ecuador, Fiji, France*, Germany*, Japan, Mexico, New Zealand, Nigeria, Panama, Papua New Guinea, Peru, Panama, Philippines, South Korea, Suriname, Taiwan, Tokelau and Vanuatu

*compatible with the lower duplexer arrangement of APT700 (703-733 / 758-788 MHz)

APT700 band *LINKEDIN group:*
http://www.linkedin.com/groups?gid=4759091

28 commercially launched APT700 b28 operators in 15 countries

Country	APT700 Network	Launched
Papua NG	Digicel	26.03.14
Taiwan	FarEasTone	03.06.14
Taiwan	Taiwan Mobile	04.06.14
New Zealand	Vodafone	18.07.14
Australia	Optus	23.07.14
Australia	Telstra	25.07.14
New Zealand	Spark	28.08.14
Taiwan	Asia Pacific Telecom	24.12.14
New Zealand	2degrees	26.01.15
Panama	C and W	11.03.15
Panama	Movistar	27.03.15
Taiwan	Ambit Microsystems	15.05.15
Japan	KDDI	2015 (E)
Japan	NTT DoCoMo	2015 (E)
Panama	Claro	06.08.15
Peru	Movistar	25.07.16
Vanuatu	Digicel	19.01.16
Suriname	Telesur	29.01.16
Bhutan	TashiCell	02.04.16
Chile	Entel PCS	17.05.16
Chile	Movistar	17.05.16
Philippines	Globe	06.06.16
Philippines	Smart	06.06.16
Brazil	Claro	15.06.16
Brazil	TIM Brasil	15.06.16
Peru	Claro	06.09.16
Nigeria	Glo (Globacom)	04.10.16
Chile	Claro	18.10.16

APT700 User Devices Ecosystem

GSA confirmed in the Status of the LTE Ecosystem report published on October 10, 2016 that 469 APT700 band 28 devices have been announced comprising smartphones, tablets, CPEs & MiFis etc. are announced by many suppliers across all price points.

Detailed analysis of all announced LTE devices as verified by GSA is available using GSA's GAMBoD tool. Access restrictions apply – see www.gsacom.com/gambod

Visit the APT700 community on the GSA website http://gsacom.com/communities/apt700/

LTE Broadcast

LTE Broadcast (also called LTE Multicast) enabled by eMBMS technology substantially reduces the bandwidth needed to deliver multimedia content one-to-many thus allowing operators to efficiently launch media services over LTE to meet this demand. It offers mobile-network operators a profitable business proposition through service differentiation, new revenue opportunities, and more efficient distribution of live and other digital media. LTE Broadcast enables multiple users to receive the same content simultaneously. LTE broadcast can deliver the same content to multiple users with the capability to support a virtually unlimited number of users simultaneously, thereby maintaining efficient use of spectrum and network investments. LTE Broadcast will open new business models for mobile network operators.

In November 2015 GSA published a major report: **Evaluating the LTE Broadcast Opportunity**. The report was sponsored by EE, PCCW HKT (CSL), Plus (Polkomtel), Smartfren, Telstra plus key contributions also from the BBC, Ericsson, Expway, Huawei, Institut fuer Rundfunktechnik GmbH, Nokia Networks, and Qualcomm Inc. as well as inputs from other key stakeholders. In the report GSA forecasts the market for LTE Broadcast services will reach $14bn worldwide by 2020.

GSA report "Evaluating the LTE Broadcast Opportunity" is free for registered GSA site users.

Sign in to http://www.gsacom.com and follow the link to download the report. **You will need to register if you are a first time visitor to the new GSA site.**

Several mobile network operators are planning to test eMBMS. Additionally, numerous TV broadcasters/ content owners are engaged in LTE Broadcast trials e.g. BBC (UK), IRT (Institut für Rundfunktechnik, research institute of broadcasting companies in Austria, Germany and Switzerland, Bavarian broadcast company, Bayerischer Rundfunk, and further research partners), TDF (France) and RAI (Italy). The wide range of LTE Broadcast activities worldwide are summarised in the following table.

Country	Network	Status
Australia	Telstra	Deploying
Brazil	Claro and NET	Trialled
Brazil	Vivo	No details
Canada	Bell Mobility	No details
China	China Mobile	Trialled
China	China Telecom	Largescale user trial
France	Orange	Trialled
France	TDF	Trialling convergence potential of eMBMS with DVB
Germany	Vodafone	Trialled
Germany	T-Mobile	No details
Germany	IRT	Trialling
Hong Kong	China Mobile	Demonstrated
Hong Kong	PCCW (CSL)	Internal tests
India	RJIL	Trialled
Indonesia	Smartfren	Trial planned
Italy	RAI	Trialling convergence potential of eMBMS with DVB
Italy	TIM	Trialled
Japan	Softbank	Trialled
Netherlands	KPN	Trialled
Philippines	Globe	Deploying
Philippines	Smart	Trialled
Poland	Polkomtel Plus	Trialled
Portugal	Meo	Trialling
Portugal	Vodafone	No details
Russia	Megafon	Lab tests
Russia	MTS	Trialled
Singapore	SingTel	Trialling
South Korea	SK Telecom	Development
South Korea	KT	**COMMERCIAL**
Spain	Vodafone	Trialled
Turkey	Turkcell	Demonstrated
UAE	Etisalat	Trialling
UK	EE with BBC	Trialling
UK	Three UK	Trialling
USA	AT&T	Trials, deploying
USA	Verizon	**COMMERCIAL**
Vietnam	MobiFone	MobiTV pilot trial

ALSO SEE this white paper by Nokia Networks:

"LTE for Wide Area Broadcast"

Includes trial results

Nokia is running a field trial in Munich with the "Institut für Rundfunktechnik", the research institute of the public broadcasting corporations in Austria, Germany and Switzerland and other research partners with the support of Bayerischer Rundfunk, the Bavarian public broadcast corporation. The research project is funded by Bayerische Forschungsstiftung (BFS). Review the trial results and next steps/way forward in the free white paper "LTE for Wide Area Broadcast" at http://www.gsacom.com

LTE Broadcast Alliance:

Founders: EE, KT, Telstra, Verizon Wireless

In April 2016 EE, KT, Telstra, and Verizon Wireless announced formation of a new Alliance to encourage global support for LTE Broadcast services from all device makers and to encourage new business models and see that every top-and mid-tier device launched in 2017 is LTE Broadcast capable.

In September 2016 the LTE Broadcast Alliance confirmed 5 additional operator members and several vendor supports together with GSA.

Join the discussion group on Linkedin

LTE-Broadcast
http://www.linkedin.com/groups?gid=7435919

LTE-Advanced Pro

3GPP approved a new LTE marker that is used for the appropriate specifications from Release 13 onwards.

LTE-Advanced Pro allows mobile standards users to associate various new features – from the Release's freeze in March 2016 – with a distinctive marker that evolves the LTE and LTE-Advanced technology series. The new term is intended to mark the point in time where the LTE platform has been dramatically enhanced to address new markets as well as adding functionality to improve efficiency.

The major advances achieved with the completion of Release 13 include: MTC enhancements (including the NB-IoT LPWA specification), public safety features – such as D2D and ProSe - small cell dual-connectivity and architecture, carrier aggregation enhancements, interworking with Wi-Fi, licensed assisted access (at 5 GHz), 3D/FD-MIMO, indoor positioning, single cell-point to multi-point and work on latency reduction. Many of these features were started in previous Releases, but became mature in Release 13.

As well as sign-posting the achievements to date, the introduction of this new marker confirms the need for LTE enhancements to continue along their distinctive development track, in parallel to the future proposals for the 5G era.

The 3GPP Project Coordination Group approved the use of LTE-Advanced Pro at their meeting in Vancouver the week of October 19, 2015.

Source: 3GPP press release (October 28, 2015)

NOTE: GSA is a Market Representation Partner in 3GPP and participated in the 3GPP Project Coordination Group (PCG) discussions and decisions in the Vancouver meeting

GSA monitors and promotes LTE-Advanced Pro system developments and deployments globally. Details are included in this report.

744 LTE operator commitments in 190 countries / territories

537 commercially launched in 170 countries

Country	Operator	Launch
Norway	Telia	Launched 14.12.09
Sweden	TeliaSonera	Launched 14.12.09
Uzbekistan	UCell	Launched 09.08.10
Poland	Aero2 FDD and TDD later	Launched 07.09.10
USA	T Mobile US	Launched 21.09.10
Austria	A1 Telekom	Launched 05.11.10
Sweden	TeleNor Sweden	Launched 15.11.10
Sweden	Tele2 Sweden	Launched 15.11.10
Hong Kong	CSL Limited	Launched 25.11.10
Finland	TeliaSonera	Launched 30.11.10
Germany	Vodafone	Launched 01.12.10
USA	Verizon Wireless	Launched 05.12.10
Finland	Elisa	Launched 08.12.10
Denmark	TeliaSonera	Launched 09.12.10
Estonia	Telia	Launched 17.12.10
Japan	NTT DoCoMo	Launched 24.12.10
Germany	Deutsche Telekom	Launched 05.04.11
Philippines	Smart Communications	Launched 16.04.11
Lithuania	Omnitel	Launched 28.04.11
Latvia	LMT	Launched 31.05.11
Singapore	M1	Launched 21.06.11
South Korea	SK Telecom	Launched 01.07.11
South Korea	LG Uplus	Launched 01.07.11
Germany	O2 (Telefonica)	Launched 01.07.11
Canada	Rogers Wireless	Launched 07.07.11
Austria	T Mobile	Launched 28.07.11
USA	Mosaic Telecom	Launched Jul 2011
Canada	Bell Mobility FDD, LTE TDD later	Launched 14.09.11
Saudi Arabia	Mobily LTE TDD and later FDD	Launched 14.09.11
Saudi Arabia	STC LTE TDD and later FDD	Launched 14.09.11
Saudi Arabia	Zain	Launched 14.09.11
USA	AT&T Mobility	Launched 18.09.11
UAE	Etisalat	Launched 25.09.11
Australia	Telstra	Launched 27.09.11
Denmark	TDC	Launched 10.10.11
Austria	3	Launched 18.11.11
Puerto Rico	AT&T Mobility	Launched 20.11.11
Puerto Rico	Claro	Launched 24.11.11
Kyrgyzstan	Saima Telecom	Launched 09.12.11
Brazil	Sky Brazil (LTE TDD)	Launched 13.12.11
Finland	DNA	Launched 13.12.11
Uruguay	Antel	Launched 13.12.11
USA	Leap Wireless/Cricket	Launched 21.12.11
Singapore	SingTel	Launched 22.12.11
Kuwait	Viva	Launched 27.12.11
Armenia	Vivacell-MTS	Launched 28.12.11
Bahrain	Viva	Launched 01.01.12
Hungary	Magyar Telekom	Launched 01.01.12
South Korea	KT	Launched 03.01.12
Russia	Megafon/Yota FDD and TDD	Launched 15.01.12
Canada	Telus FDD later TDD	Launched 10.02.12
USA	Peoples Telephone Co-op	Launched 14.02.12
Japan	Softbank (TDD later FDD)	Launched 24.02.12
Portugal	Meo	Launched 12.03.12
Portugal	Vodafone Portugal	Launched 12.03.12
Portugal	NOS	Launched 15.03.12
USA	US Cellular	Launched 22.03.12
Croatia	T-Hrvatski Telekom	Launched 23.03.12
Croatia	VIPNet	Launched 23.03.12
USA	Panhandle Telephone Co-op	Launched 03.2012
Australia	NBN No (LTE TDD)	Launched 02.04.12
India	Bharti Airtel LTE FDD and TDD	Launched 10.04.12

Angola	Movicel	Launched 14.04.12
Puerto Rico	Open Mobile	Launched 19.04.12
Moldova	IDC	Launched 21.04.12
Sweden	3 Sweden LTE FDD and TDD	Launched 23.04.12
Hong Kong	CM HK LTE FDD later TDD	Launched 25.04.12
USA	Cellcom	Launched 30.04.12
USA	Pioneer Cellular	Launched 30.04.12
Netherlands	Vodafone	Launched 01.05.12
Hong Kong	3 HK	Launched 02.05.12
Netherlands	Ziggo	Launched 03.05.12
Netherlands	Tele2	Launched 08.05.12
Netherlands	KPN	Launched 11.05.12
Netherlands	T-Mobile LTE FDD later TDD	Launched 11.05.12
Namibia	MTC	Launched 16.05.12
Tanzania	Smile	Launched 30.05.12
UAE	Du	Launched 12.06.12
Colombia	Une-EPM	Launched 14.06.12
Azerbaijan	Azercell	Launched 19.06.12
Czech Republic	O2 Czech Republic	Launched 19.06.12
Mauritius	Orange	Launched 21.06.12
Guam	IT&E	Launched 28.06.12
UK	UK Broadband (LTE TDD)	Launched 28.06.12
Åland Islands	TeliaSonera	Launched 06.12
Hungary	Telenor	Launched 05.07.12
Dominican R	Orange Dominicana	Launched 09.07.12
Slovenia	Si.mobil	Launched 12.07.12
USA	Sprint LTE FDD later TDD	Launched 15.07.12
Oman	Omantel LTE TDD later FDD	Launched 16.07.12
USA	Infrastructure Networks	Launched 25.07.12
Australia	Optus FDD and LTE TDD later	Launched 31.07.12
Mauritius	Emtel	Launched Jul 2012
Slovak Republic	O2 Slovakia	Launched 02.08.12
USA	Big River Broadband	Launched 07.08.12
Hong Kong	Smartone	Launched 28.08.12
Poland	Polkomtel Plus	Launched 09.12
USA	Chariton Valley Comms	Launched 09.12
USA	Nortex Communications	Launched 09.12
Russia	MTS LTE TDD later FDD	Launched 01.09.12
USA	C Spire Wireless	Launched 10.09.12
Singapore	StarHub	Launched 19.09.12
Japan	KDDI	Launched 21.09.12
Canada	MTS Allstream	Launched 25.09.12
Denmark	3 Denmark	Launched 28.09.12
Philippines	Globe	Launched 28.09.12
Luxembourg	Tango	Launched 01.10.12
Guam	DoCoMo Pacific	Launched 04.10.12
Tajikistan	Babilon Mobile	Launched 06.10.12
Norway	Telenor	Launched 10.10.12
South Africa	Vodacom	Launched 10.10.12
USA	Alaska Communications	Launched 12.10.12
Mexico	Telefonica Movistar	Launched 15.10.12
Luxembourg	Orange	Launched 29.10.12
UK	EE	Launched 30.10.12
Uganda	Smile	Launched Oct 2012
Belgium	Belgacom / Proximus	Launched 05.11.12
USA	Bluegrass Cellular	Launched 05.11.12
Antigua-Barb	Digicel	Launched 06.11.12
Italy	Vodafone	Launched 06.11.12
Mexico	Telcel	Launched 06.11.12
Italy	TIM	Launched 07.11.12
Montenegro	Telenor	Launched 08.11.12
USA	Sprocket Wireless	Launched 09.11.12
Greece	Cosmote	Launched 16.11.12
Moldova	Moldcell	Launched 16.11.12
USA	Strata Networks	Launched 19.11.12
Moldova	Orange	Launched 20.11.12
Romania	Vodafone	Launched 20.11.12
Kuwait	Zain	Launched 21.11.12
France	Orange	Launched 22.11.12
USA	Shentel	Launched 23.11.12
Estonia	Tele2	Launched 27.11.12
France	SFR	Launched 28.11.12
Switzerland	Swisscom	Launched 29.11.12
South Africa	MTN	Launched 01.12.12
Romania	Orange	Launched 12.12.12
Brazil	Claro	Launched 13.12.12
Angola	Unitel	Launched 16.12.12
Bolivia	Entel Movil	Launched 16.12.12
Greece	Vodafone	Launched 17.12.12
Puerto Rico	Sprint	Launched 18.12.12
Kazakhstan	Altel	Launched 25.12.12
Sri Lanka	Dialog LTE TDD later FDD	Launched 30.12.12
Malaysia	Maxis	Launched 01.01.13
Sri Lanka	Mobitel	Launched 06.01.13
USA	Thumb Cellular	Launched 13.01.13
Canada	Sasktel LTE FDD later TDD	Launched 31.01.13
USA	GCI	Launched 2013
USA	Evolve Broadband	Launched 02.13
Italy	3 Italia	Launched 01.02.13
Estonia	Elisa	Launched 14.02.13
Canada	Eastlink	Launched 15.02.13
Paraguay	Personal	Launched 08.02.13
Oman	Ooredoo LTE FDD later TDD	Launched 17.02.13
Paraguay	Vox	Launched 18.02.13
Bahrain	Batelco	Launched 27.02.13
New Zealand	Vodafone	Launched 28.02.13
Brazil	On Telecomunicacoes LTE TDD	Launched 03.13
Lithuania	Tele2	Launched 03.13
Spain	COTA Murcia4G (LTE TDD)	Launched 01.03.13
USA	MiSpot	Launched 14.03.13
Dominican R	Tricom	Launched 18.03.13
Denmark	Telenor	Launched 20.03.13
Guam	iConnect	Launched 20.03.13
Slovenia	Telekom Slovenije	Launched 20.03.13
Iceland	Nova	Launched 04.04.13
USA	United Wireless	Launched 09.04.13
Qatar	Ooredoo	Launched 16.04.13
US Virgin Isles	Sprint	Launched 17.04.13
Bahrain	Zain	Launched 18.04.13
South Africa	Telkom Mobile / 8ta (LTE TDD)	Launched 21.04.13
Malaysia	Celcom Axiata	Launched 22.04.13
Uganda	MTN Uganda (LTE TDD)	Launched 25.04.13
Brazil	Oi	Launched 25.04.13
Maldives	Ooredoo	Launched 28.04.13
Romania	Telekom	Launched 29.04.13
Brazil	TIM Brasil	Launched 30.04.13
Brazil	Vivo	Launched 30.04.13
USA	Adams NetWorks	Launched 05.2013
France	Bouygues Telecom	Launched 06.05.13
Thailand	True Move	Launched 08.05.13
USA	NorthwestCell	Launched 13.05.13
Lebanon	Alfa	Launched 15.05.13
USA	PVT/Fuego Wireless	Launched 17.05.13
Lebanon	Touch	Launched 22.05.13
USA	Chat Mobility	Launched 23.05.13
Switzerland	Salt (formerly Orange)	Launched 26.05.13
Russia	Vimpelcom	Launched 27.05.13
Spain	Vodafone	Launched 29.05.13
Spain	Neo-Sky LTD TDD	Launched Jun 2013
Russia	Tele2 Russia	Launched 03.06.13
Nigeria	Smile Communications	Launched 06.06.13
Iraq	Fastlink (Regional Telecom)	Launched 10.06.13
USA	Appalachian Wireless	Launched 10.06.13
Australia	Vodafone	Launched 12.06.13
Switzerland	Sunrise Communications	Launched 19.06.13
Chile	Claro	Launched 27.06.13
USA	MTA	Launched mid-2013
US Virgin Isles	AT&T Mobility	Launched 02.07.13
Iceland	Fjarskipti (Vodafone Iceland)	Launched 04.07.13
Malaysia	DiGi	Launched 05.07.13
Spain	Orange	Launched 08.07.13
Kuwait	Ooredoo	Launched 09.07.13
Puerto Rico	T Mobile	Launched 11.07.13
Spain	Yoigo	Launched 18.07.13

USA	Custer Telephone	Launched 26.07.13
Uganda	Africell	Launched 31.07.13
Venezuela	Digitel	Launched 31.07.13
USA	ETC	Launched 08.2013
Nigeria	Spectranet (LTE TDD)	Launched 20.08.13
South Africa	Neotel	Launched 21.08.13
Zimbabwe	Econet Wireless	Launched 22.08.13
UK	O2	Launched 29.08.13
UK	Vodafone	Launched 29.08.13
Kiribati	TSKL	Launched 02.09.13
Liechtenstein	Orange	Launched 02.09.13
Russia	Vainakh Telecom (LTE TDD)	Launched 02.09.13
Poland	Orange Polska (ex Centertel)	Launched 10.09.13
Turkmenistan	TMCELL	Launched 18.09.13
Ireland	Meteor	Launched 26.09.13
USA	Copper Valley Telecom	Launched 30.09.13
Belgium	BASE (Telenet)	Launched 01.10.13
Czech Republic	T Mobile	Launched 01.10.13
Monaco	Monaco Telecom	Launched 01.10.13
Luxembourg	POST	Launched 10.2013
Spain	Movistar	Launched 10.2013
USA	Syringa Wireless	Launched 10.2013
Guam	GTA	Launched 11.10.13
Ireland	Vodafone	Launched 14.10.13
Bhutan	Bhutan Telecom	Launched 24.10.13
Japan	UQ Communications (LTE TDD)	Launched 31.10.13
Nigeria	Swift Networks (LTE TDD)	Launched 11.13
USA	Flat Wireless d.b.a Clear Talk	Launched 11.13
Malta	Vodafone	Launched 01.11.13
Aruba	Setar NV	Launched 06.11.13
New Zealand	Spark	Launched 12.11.13
Poland	Play	Launched 13.11.13
Chile	Movistar	Launched 14.11.13
Indonesia	PT Internux (LTE TDD)	Launched 14.11.13
Brunei	DST	Launched 15.11.13
Slovak Republic	Slovak Telekom	Launched 15.11.13
USA	S and R Communications	Launched 17.11.13
Bahrain	Menatelecom (LTE TDD)	Launched 19.11.13
Costa Rica	Kölbi (ICE)	Launched 25.11.13
Namibia	TN Mobile	Launched 27.11.13
USA	Nex-Tech Wireless	Launched 27.11.13
Montenegro	Crnogorski Telekom	Launched 28.11.13
Cayman Islands	Digicel	Launched 28.11.13
Cayman Islands	FLOW	Launched 29.11.13
France	Free	Launched 01.12.13
Greenland	Tele-Post	Launched 01.12.13
Colombia	Movistar	Launched 02.12.13
Macedonia	T Mobile	Launched 02.12.13
UK	3 UK	Launched 02.12.13
Fiji	Vodafone Fiji	Launched 05.12.13
USA	Mid-Rivers Communications	Launched 09.12.13
Czech Republic	Vodafone	Launched 10.12.13
Malaysia	U Mobile	Launched 17.12.13
China	China Mobile (LTE TDD)	Launched 18.12.13
Ecuador	CNT EP	Launched 12.13
Latvia	Tele2	Launched 12.13
USA	Colorado Valley	Launched 12.13
USA	nTelos Wireless	Launched 12.13
Argentina	DirecTV (LTE TDD)	Launched 2013
Ghana	Vodafone	Launched 02.01.14
Peru	Telefonica Movistar	Launched 02.01.14
Italy	Wind	Launched 12.01.14
Iceland	Siminn	Launched 15.01.14
Zambia	MTN	Launched 16.01.14
Sri Lanka	SLT (LTE TDD)	Launched 19.01.14
Zambia	Zamtel	Launched 21.01.14
Cambodia	Smart Axiata	Launched 22.01.14
Ireland	3 Ireland	Launched 27.01.14
Ghana	NITA (LTE TDD)	Launched 02.14
Sri Lanka	Lanka Bell (LTE TDD)	Launched 04.02.14
Bahamas	BTC	Launched 13.02.14
Colombia	Claro	Launched 13.02.14
Uruguay	Claro	Launched 13.02.14
China	C. Telecom LTE TDD then FDD	Launched 14.02.14
China	C. Unicom LTE TDD then FDD	Launched 18.03.14
Papua N Guinea	Digicel PNG	Launched 26.03.14
Chile	Entel PCS	Launched 28.03.14
Belgium	Mobistar	Launched 31.03.14
Madagascar	Blueline (LTE TDD)	Launched 04.14
Costa Rica	Claro	Launched 01.04.14
Vanuatu	WanTok (LTE TDD)	Launched 01.04.14
Côte d'Ivoire	YooMee (LTE TDD)	Launched 04.04.14
Tajikistan	Tcell	Launched 15.04.14
Belgium	Broadband Belgium (LTE TDD)	Launched 22.04.14
Canada	ABC Communications (LTE TDD)	Launched 23.04.14
Philippines	PLDT (LTE TDD)	Launched 29.04.14
Algeria	Algérie Télécom/Mobilis	Launched 01.05.14
USA	KPU (Alaska)	Launched 05.05.14
Kyrgyzstan	O!	Launched 08.05.14
Thailand	DTAC – TriNet	Launched 10.05.14
Bulgaria	Max	Launched 20.05.14
Peru	Claro FDD later TDD	Launched 21.05.14
Taiwan	Chunghwa Telecom	Launched 29.05.14
Qatar	Vodafone	Launched 03.06.14
Taiwan	FarEasTone	Launched 03.06.14
Taiwan	Taiwan Mobile	Launched 04.06.14
Abkhazia	A-Mobile	Launched 04.06.14
Poland	T-Mobile Polska S.A	Launched 05.06.14
Brazil	Nextel	Launched 16.06.14
Russia	Tattelecom	Launched 27.06.14
New Zealand	2degrees	Launched 30.06.14
USA	VTel	Launched 01.07.14
Macedonia	Vip	Launched 02.07.14
Costa Rica	Movistar	Launched 04.07.14
Slovak Republic	Oramge Slovensko	Launched 07.07.14
NMI	IT&E	Launched 14.07.14
Israel	Partner – Orange	Launched 15.07.14
India	Aircel (LTE TDD)	Launched 16.07.14
Bolivia	Tigo	Launched 17.07.14
Dominican R	Claro	Launched 17.07.14
Colombia	DirecTV (LTE TDD)	Launched 25.07.14
Isle of Man	Manx Telecom	Launched 29.07.14
Angola	Net One (LTE TDD)	Launched 08.14
Israel	Cellcom	Launched 03.08.14
Israel	Pelephone	Launched 04.08.14
Abkhazia	Aquafon	Launched 06.08.14
Malaysia	Telekom Malaysia	Launched 08.08.14
Fiji	Digicel	Launched 14.08.14
Colombia	Avantel	Launched 19.08.14
Ghana	Surfline Communications	Launched 19.08.14
Taiwan	Taiwan Star Mobile	Launched 25.08.14
Macedonia	ONE	Launched 29.08.14
USA	SI Wireless / Mobile Nation	Launched 09.14
Uzbekistan	Beeline	Launched 04.09.14
Uruguay	Movistar	Launched 05.09.14
USA	BIT Communications	Launched 09.09.14
Canada	Videotron	Launched 10.09.14
Chad	Tigo	Launched 10.09.14
Pakistan	Zong	Launched 27.09.14
Lesotho	Vodacom	Launched 02.10.14
Colombia	ETB	Launched 07.10.14
Mexico	AT&T	Launched 13.10.14
Peru	Americatel / Entel (LTE TDD)	Launched 13.10.14
Ghana	BLU (LTE TDD)	Launched 14.10.14
Dominica	FLOW	Launched 16.10.14
Gabon	Gabon Telecom	Launched 20.10.14
Andorra	Andora Telecom	Launched 21.10.14
USA	Rock Wireless	Launched 23.10.14
Maldives	Dhiraagu	Launched 28.10.14
Guatemala	Movistar	Launched 29.10.14
USA	Carolina West Wireless	Launched 03.11.14
Russia	MOTIV	Launched 06.11.14
Rwanda	Airtel	Launched 11.11.14
Rwanda	MTN	Launched 11.11.14

Zimbabwe	NetOne	Launched 11.11.14
Hungary	Vodafone	Launched 12.11.14
Finland	Ukko Mobile FDD: TDD later	Launched 17.11.14
Antigua-Barb	FLOW	Launched 20.11.14
Iran	MTN Irancell FDD: TDD later	Launched 24.11.14
USA	Silver Star Communications	Launched 24.11.14
Seychelles	Airtel	Launched 26.11.14
Canada	Xplornet (LTE TDD)	Launched 03.12.14
Italy	Linkem (LTE TDD)	Launched 03.12.14
Kenya	Safaricom	Launched 04.12.14
Indonesia	Telkomsel	Launched 08.12.14
Honduras	Tigo	Launched 10.12.14
Kosovo	IPKO	Launched 11.12.14
Trinidad&Tobago	TSTT (LTE TDD)	Launched 18.12.14
Argentina	Personal	Launched 19.12.14
Argentina	Movistar	Launched 22.12.14
Indonesia	Indosat Ooredoo	Launched 22.12.14
Indonesia	XL Axiata	Launched 22.12.14
Taiwan	Asia Pacific Telecom	Launched 24.12.14
Pakistan	Mobilink	Launched 26.12.14
Canada	CCI Wireless (LTE TDD)	Launched 12.2014
Liechtenstein	FL1	Launched 01.02.15
Rwanda	Tigo	Launched 08.01.15
Georgia	Magticom	Launched 01.02.15
Georgia	Mobitel	Launched 01.02.15
Uganda	Vodafone (LTE TDD)	Launched 09.02.15
Botswana	Orange	Launched 13.02.15
Jersey	JT	Launched 13.02.15
Botswana	Mascom	Launched 14.02.15
Jordan	Zain	Launched 15.02.15
Fr. Polynesia	Viti (Ora)	Launched 16.02.15
New Caledonia	OPT	Launched 16.02.15
Dominican R	WIND Telecom (LTE TDD)	Launched 19.02.15
Venezuela	Movistar	Launched 19.02.15
Gambia	Netpage (LTE TDD)	Launched 03.15
Romania	Idilis/Digi LTE TDD later FDD	Launched 03.15
Isle of Man	SURE Telecom	Launched 02.03.15
Åland Islands	Ålcom	Launched 03.03.15
Greece	Wind Hellas	Launched 03.03.15
Liechtenstein	Swisscom	Launched 05.03.15
Cyprus	MTN	Launched 10.03.15
Cyprus	PrimeTel	Launched 10.03.15
Panama	C and W	Launched 11.03.15
Slovak Republic	4ka (LTE FDD and TDD)	Launched 13.03.15
Georgia	Geocell	Launched 15.03.15
Ethiopia	Ethio Tel	Launched 21.03.15
Canada	Tbaytel	Launched 23.03.15
Serbia	VIP Mobile	Launched 24.03.15
Serbia	Telenor	Launched 25.03.15
Honduras	Claro	Launched 25.03.15
Turks & Caicos	Digicel	Launched 25.03.15
Panama	Movistar	Launched 27.03.15
Uzbekistan	EVO (LTE TDD)	Launched 01.04.15
Serbia	MTS	Launched 03.04.15
Malawi	Access Communications	Launched 08.04.15
Laos	Lao Telecom	Launched 09.04.15
Lithuania	Bite	Launched 15.04.15
South Africa	Afrihost	Launched 22.04.15
Tanzania	Tigo	Launched 24.04.15
Kosovo	Vala	Launched 28.04.15
Azerbaijan	Nar Mobile	Launched 04.15
Guatemala	Tigo	Launched 04.05.15
Azerbaijan	Bakcell	Launched 05.05.15
Latvia	Bite	Launched 05.05.15
Taiwan	Ambit Microsystems	Launched 15.05.15
USA	Speedconnect (LTE TDD)	Launched 19.05.15
Mauritius	MTML	Launched 20.05.15
Ecuador	Movistar	Launched 22.05.15
Jordan	Orange	Launched 26.05.15
Guernsey	Sure	Launched 31.05.15
Jersey	Sure	Launched 31.05.15
USA	Redzone Wireless (LTE TDD)	Launched 03.06.15

Suriname	Telesur	Launched 05.06.15
Morocco	Meditel	Launched 08.06.15
Morocco	Inwi (Wana)	Launched 17.06.15
Bonaire	UTS	Launched 17.06.15
Curaçao	UTS	Launched 17.06.15
Bonaire	Telbo	Launched 19.06.15
Madagascar	Telma	Launched 19.06.15
Laos	Unitel	Launched 23.06.15
Argentina	Claro	Launched 06.15
Cambodia	Metfone	Launched 06.2015
Guernsey	JT	Launched 06.15
Indonesia	3 Indonesia	Launched 06.07.15
Indonesia	Smartfren (LTE FDD & TDD)	Launched 07.07.15
Morocco	IAM Maroc Telecom	Launched 13.07.15
Albania	Telekom Albania	Launched 22.07.15
Nigeria	MTN HyNet (LTE TDD)	Launched 22.07.15
Bolivia	Viva	Launched 24.07.15
Cambodia	SEATEL	Launched 26.07.15
Ecuador	Claro	Launched 28.07.15
Turks & Caicos	FLOW	Launched 31.07.15
Albania	Vodafone Albania	Launched 07.15
Guernsey	Airtel-Vodafone	Launched 07.15
Jersey	Airtel-Vodafone	Launched 07.15
Panama	Claro	Launched 06.08.15
Tanzania	Smart Telecom (LTE TDD)	Launched 27.08.15
Nigeria	Cyberspace (LTE TDD)	Launched 08.2015
Italy	GO Internet (LTE TDD)	Launched 01.09.15
Albania	Eagle Mobile	Launched 01.09.15
Cambodia	Kingtel (LTE TDD)	Launched 01.09.15
Slovenia	Telemach Mobil (ex-Tušmobil)	Launched 01.09.15
Bangladesh	Ollo/BIEL (LTE TDD)	Launched 17.09.15
South Africa	Cell C	Launched 23.09.15
Saint Helena	Sure South Atlantic	Launched 09.2015
Sweden	Net1	Launched 10.2015
Nicaragua	Claro	Launched 01.10.15
Macau	CTM	Launched 20.10.15
Norway	Ice.net	Launched 10.2015
Moldova	Unite	Launched 28.10.15
Cyprus	CYTA	Launched 11.2015
Chile	WOM (formerly Nextel)	Launched 09.11.15
Slovak Republic	Slovanet (LTE TDD)	Launched 10.11.15
Macau	Smartone Macau	Launched 11.11.15
Nicaragua	Movistar	Launched 11.11.15
St. Maarten	UTS	Launched 12.11.15
Lithuania	Mezon/Telecentras (LTE TDD)	Launched 25.11.15
Macau	China Telecom Macau	Launched 25.11.15
Benin	Benin Telecoms	Launched 26.11.15
Cambodia	Cellcard	Launched 11.15
Macau	3Macau	Launched 15.12.15
Bulgaria	Telenor	Launched 01.12.15
Malta	GO	Launched 02.12.15
India	Vodafone	Launched 08.12.15
Gabon	Airtel Gabon	Launched 10.12.15
Belize	Smart Telecom	Launched 15.12.15
USA	iWireless	Launched 15.12.15
Belarus	beCloud	Launched 17.12.15
Belarus	MTS	Launched 17.12.15
Cameroon	MTN (LTE TDD)	Launched 17.12.15
Tanzania	TTCL (FDD and TDD)	Launched 21.12.15
Guinée Bissau	Orange Bissau	Launched 22.12.15
India	Idea Cellular	Launched 23.12.15
USA	West Central Wireless	Launched 2015 (E)
Somalia	Somcable	Launched 05.01.16
Vanuatu	Digicel	Launched 19.01.16
Côte d'Ivoire	Orange	Launched 29.01.16
Thailand	AIS	Launched 16.01.16
Ghana	Busy (LTE TDD)	Launched 26.01.16
Croatia	Tele2	Launched 01.02.16
Gibraltar	Gibtelecom	Launched 16.02.16
Burundi	Lumitel	Launched 24.02.16
Kyrgyzstan	Megacom	Launched 10.03.16
India	Telenor	Launched 13.03.16

Tunisia	Ooredoo	Launched 30.03.16
Tunisia	Orange	Launched 30.03.16
Tunisia	Tunisie Telecom	Launched 30.03.16
Turkey	Turkcell	Launched 01.04.16
Turkey	Turk Telecom	Launched 01.04.16
Turkey	Vodafone Turkey	Launched 01.04.16
Bhutan	TashiCell	Launched 02.04.16
Paraguay	Tigo	Launched 07.04.16
Iceland	365 Media	Launched(E) 04.2016
Nigeria	Ntel	Launched 08.04.16
Paraguay	Claro	Launched 13.04.16
Liberia	Cellcom	Launched 14.04.16
Zanzibar	Zantel	Launched 14.04.16
Bulgaria	Mtel	Launched 25.04.16
Sudan	Zain	Launched 25.04.16
Bulgaria	Vivacom	Launched 09.05.16
Tanzania	Vodacom	Launched 11.05.16
Kyrgyzstan	Sky Mobile (Beeline)	Launched 18.05.16
Bermuda	CellOne	Launched 20.05.16
Myanmar	Ooredoo	Launched 21.05.16
Armenia	Beeline / ArmenTel	Launched 25.05.16
Samoa	Digicel	Launched 31.05.16
India	Reliance (LTE TDD and FDD)	Launched 05.2016
Jamaica	Digicel	Launched 09.06.16
Nigeria	Bitflux (LTE TDD)	Launched 15.06.16
Uzbekistan	UMS	Launched 20.06.16
Ghana	MTN	Launched 23.06.16
Tajikistan	MegaFon-Tajikistan	Launched 24.06.16
Malawi	TNM	Launched 28.06.16
Malaysia	YTL Communications (LTE TDD)	Launched 30.06.16
Kazakhstan	Kar-Tel (Beeline)	Launched 05.07.16
Myanmar	Telenor	Launched 07.07.16
Pakistan	Telenor	Launched 08.08.16
Belarus	BeST life:)	Launched 09.08.16
Nigeria	InterC	Launched 23.08.16
Kazakhstan	Kcell	Launched 31.08.16
Fiji	Telecom Fiji Ltd (TFL)	Launched 15.09.16
Armenia	UCOM	Launched 24.09.16
Algeria	Djezzy	Launched 02.10.16
Algeria	Ooredoo	Launched 02.10.16
Nigeria	Globacom	Launched 04.10.16
Nigeria	MTN	Launched 04.10.16
Nigeria	Etisalat	Launched 08.10.16
Azerbaijan	Delta Telecom (LTE TDD)	2016
Azerbaijan	Nakhtel	2016
Belize	DigiCell	2016
Bermuda	Digicel	2016
Brit Virgin Isles	FLOW	2016
Cameroon	Orange	2016
Comoros	Telma	2016
Côte d'Ivoire	VipNet (LTE TDD)	2016
D R Congo	Smile	2016
Gambia	Gamtel (LTE TDD)	2016
Ghana	Goldkey Telecom	2016
Honduras	Hondutel	2016
Hungary	MVM Net	2016
India	BSNL (LTE TDD)	2016
India	Tikona (LTE TDD)	2016
India	Videocon	2016
Indonesia	Berca Hardayaperkasa LTE TDD	2016
Indonesia	First Media (LTE TDD)	2016
Iraq	Newroz Telecom	2016
Iraq	Tishknet (LTE TDD)	2016
Ireland	Imagine Group (LTE TDD)	2016
Jamaica	Caricel	2016
Jamaica	FLOW	2016
Jordan	Umniah (LTE TDD and FDD)	2016
Kenya	Airtel	2016
Madagascar	Orange	2016
Malaysia	Asiaspace (LTE TDD)	2016
Malaysia	P1 Networks (LTE TDD)	2016
Malaysia	REDtone	2016

Nepal	Nepal Telecom	2016
Papua N Guinea	Telikom PNG	2016
Peru	Bitel	2016
Peru	DirecTV (LTE TDD)	2016
Poland	Milmex (LTE TDD)	2016
Puerto Rico	Aeronet (LTE TDD)	2016
Senegal	Expresso	2016
Senegal	Orange	2016
Senegal	Tigo	2016
Tanzania	Telesis	2016
USA	BayRICS	2016
USA	CenturyLink	2016
USA	Great Northwest Woods	2016
USA	Illinois Valley Cellular	2016
Venezuela	DirecTV	2016
Venezuela	Movilnet	2016
Zambia	Massnet	2016
Zimbabwe	Telecel	2016
Azerbaijan	Sazz (LTE TDD)	2017
Botswana	BTC	2017
Canada	WIND Mobile	2017
French Guiana	Orange Caraibe	2017
French Guiana	Outremer	2017
French Guiana	Digicel	2017
French Guiana	Free Mobile	2017
Guadeloupe	Digicel	2017
Guadeloupe	Free Mobile	2017
Guadeloupe	Orange Caraibe	2017
Guadeloupe	Outremer	2017
Mayotte	BJT Partners	2017
Mayotte	Orange	2017
Mayotte	SFR Mayotte	2017
Mayotte	Telco OI	2017
Philippines	Belltel	2017
Réunion	Orange	2017
Réunion	SFR Réunion	2017
Réunion	Telco OI	2017
Réunion	Zeop Mobile	2017
South Africa	Multisource	2017
St. Maarten	Dauphin Telecom	2017
St. Maarten	Digicel	2017
St. Maarten	Free Mobile	2017
St. Maarten	Orange Caraibe	2017
Thailand	TOT (LTE TDD)	2017
Tokelau	Teletok	2017
Italy	Tiscali (LTE TDD)	2018
USA	SouthernLINC	2018
Angola	Multitel (LTE TDD)	To be confirmed
Argentina	Airlink	To be confirmed
Australia	BigAir	To be confirmed
Australia	EnergyAustralia Ausgrid	To be confirmed
Australia	TPG Internet	To be confirmed
Bahamas	CBL	To be confirmed
Bangladesh	Banglalion (LTE TDD)	To be confirmed
Bangladesh	BTCL (LTE TDD)	To be confirmed
Bangladesh	Mango (LTE TDD)	To be confirmed
Bangladesh	Qubee (LTE TDD)	To be confirmed
Bangladesh	Robi Axiata-Airtel	To be confirmed
Bangladesh	Teletalk	To be confirmed
Belgium	BUCD (LTE TDD)	To be confirmed
Brazil	Algar Telecom	To be confirmed
Brit Virgin Isles	CCT	To be confirmed
Brit Virgin Isles	Digicel	To be confirmed
Brunei	Progresif Cellular	To be confirmed
Bulgaria	Bulsatcom	To be confirmed
Bulgaria	4G Com	To be confirmed
Cambodia	Chuan Wei Ltd	To be confirmed
Cameroon	Afrimax-Vodafone (LTE TDD)	To be confirmed
Cameroon	Nextel	To be confirmed
Cameroon	YooMee (LTE TDD)	To be confirmed
Canada	Core Broadband	To be confirmed
Canada	Ice Wireless	To be confirmed

Canada	Iristel	To be confrimed
Chad	Airtel	To be confirmed
China	Velatel-Aerostrong (LTE TDD)	To be confirmed
Costa Rica	IBW International (LTE TDD)	To be confirmed
Cyprus	Cablenet	To be confirmed
Czech Republic	U:fon	To be confirmed
D R Congo	Orange (LTE TDD)	To be confirmed
D R Congo	Vodacom (LTE TDD)	To be confirmed
Denmark	Net1	To be confirmed
Egypt	Etisalat Misr	To be confirmed
Egypt	Orange	To be confirmed
Egypt	Telecom Egypt	To be confirmed
Egypt	Vodafone	To be confirmed
Equat Guinea	Guineanet	To be confirmed
El Salvador	IBW International (LTE TDD)	To be confirmed
France	Bollore Telecom (LTE TDD)	To be confirmed
Gambia	I-Link	To be confirmed
Germany	DBD (LTE TDD)	To be confirmed
Ghana	Glo Mobile	To be confirmed
Guatemala	IBW International (LTE TDD)	To be confirmed
Hong Kong	21 Vianet Group (LTE TDD)	To be confirmed
Indonesia	IM2 (LTE TDD)	To be confirmed
Iran	HiWeb (LTE TDD)	To be confirmed
Iran	MTC (LTE TDD)	To be confirmed
Iraq	MaxyTel (LTE TDD)	To be confirmed
Kazakhstan	Tele2	To be confirmed
Kenya	Orange (Telecom Kenya)	To be confirmed
Kenya	iWayAfrica (LTE TDD)	To be confirmed
Laos	Beeline	To be confirmed
Libya	Al Madar	To be confirmed
Madagascar	Airtel	To be confirmed
Malawi	Globe Internet	To be confirmed
Malaysia	Altel	To be confirmed
Marshall Islands	NTA	To be confirmed
Mongolia	Mobicom	To be confirmed
Mongolia	Skytel	To be confirmed
Mongolia	Ulusnet (LTE TDD)	To be confirmed
Unitel	Unitel	To be confirmed
Myanmar	MPT	To be confirmed
Nepal	Ncell	To be confirmed
Nepal	Smart Telecom	To be confirmed
Nicaragua	IBW International (LTE TDD)	To be confirmed
Nigeria	Airtel	To be confirmed
Nigeria	ADIV (LTE TDD)	To be confirmed
Nigeria	AG-Placid	To be confirmed
Nigeria	Mobitel (LTE TDD)	To be confirmed
Nigeria	Zoda Fones (LTE TDD)	To be confirmed
Norway	MCP	To be confirmed
Peru	Olo (LTE TDD)	To be confirmed
Portugal	Broadband Portugal (LTE TDD)	To be confirmed
Russia	Antares Group	To be confirmed
Russia	Osnova Telecom (LTE TDD)	To be confirmed
Russia	SMARTS	To be confirmed
Russia	Smoltelecom (LTE TDD)	To be confirmed
Russia	TTK	To be confirmed
Saudi Arabia	ITC (LTE TDD)	To be confirmed
Seychelles	Cable and Wireless	To be confirmed
Somalia	Nordic Group	To be confirmed
Somalia	Sahal Telecoms (LTE TDD)	To be confirmed
Somalia	SomCom	To be confirmed
Somalia	Somtel	To be confirmed
Sri Lanka	Etisalat	To be confirmed
St Helena/Asc/TdC	Sure South Atlantic	To be confirmed
Swaziland	MTN	To be confirmed
Taiwan	Global Mobile (LTE TDD)	To be confirmed
Trinidad&Tobago	Digicel T&T	To be confirmed
Uganda	Airtel	To be confirmed
Uruguay	Dedicado (LTE TDD)	To be confirmed
UK	NSV (BT) (FDD and TDD)	To be confirmed
US Virgin Isles	Choice Wireless	To be confirmed
USA	All West Wireless	To be confirmed
USA	Blue Wireless	To be confirmed
USA	Breakaway Wireless	To be confirmed
USA	Etex Telephone Co-op	To be confirmed
USA	Convergence Technologies	To be confirmed
USA	Country Wireless (LTE TDD)	To be confirmed
USA	DISH	To be confirmed
USA	Inland Cellular	To be confirmed
USA	Immix Wireless	To be confirmed
USA	James Valley Telecoms	To be confirmed
USA	Lightsquared	To be confirmed
USA	MTPCS	To be confirmed
USA	NNTC	To be confirmed
USA	Phoenix Wireless	To be confirmed
USA	Pine Belt Wireless	To be confirmed
USA	Rise Broadband	To be confirmed
USA	Sagebrush Cellular (Nemont)	To be confirmed
USA	Snake River PCS	To be confirmed
USA	South Central Communications	To be confirmed
USA	SRT Communications	To be confirmed
USA	O2 Secure Wireless	To be confirmed
USA	S&T Telephone Cooperative	To be confirmed
USA	SGRITA	To be confirmed
USA	Texas Energy Network	To be confirmed
USA	Union Wireless	To be confirmed
USA	Public Service Wireless	To be confirmed
USA	City of Charlotte Council	To be confirmed
Vietnam	RusViet Telecom	To be confirmed
Vietnam	GTel	To be confirmed
Vietnam	MobiFone	To be confirmed
Vietnam	Viettel	To be confirmed
Vietnam	Vinaphone (VNPT)	To be confirmed
Venezuela	Movilmax (LTE TDD)	To be confirmed
Zambia	Airtel	To be confirmed
Zimbabwe	Aqiva Wireless	To be confirmed

GSA's definition of commercial launch

The phase in which a public telecommunications operator is carrying commercial traffic on its LTE network, or offers to provide public service. Only licensed operators with spectrum assigned for use in public LTE communications networks are considered. MVNOs are not included. The LTE operator's business model may be retail or wholesale. Devices compatible for use on the LTE network may be sold direct by the operator to the customer, or via distributors, resellers or other third parties, or already be owned by persons wishing to use the service.

PRE-COMMITMENT TRIALS, STUDIES

27 pre-commitment LTE trials, studies

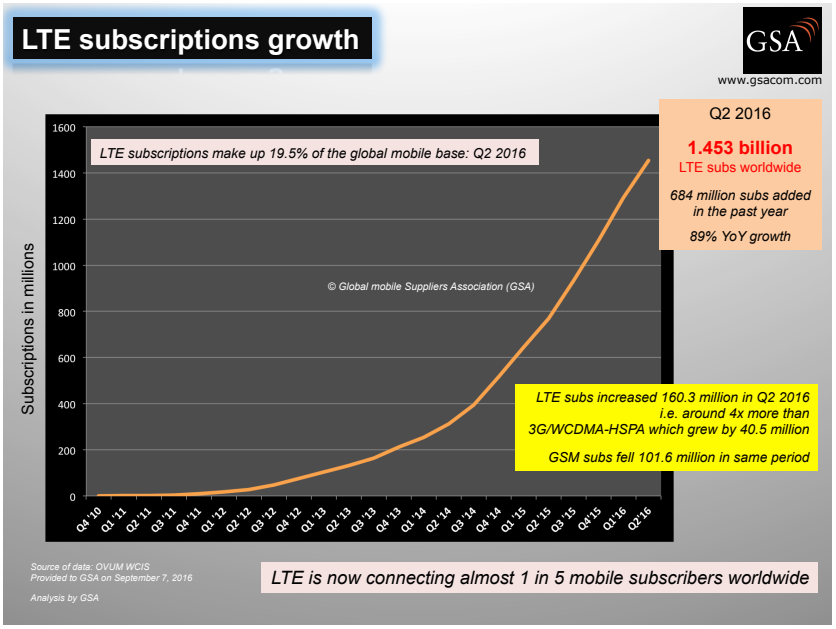
Country	*Operator*
Afghanistan	Etisalat
Albania	Plus Communication – trialling LTE
Bosnia – H	Telekom Srpske trial completed
Bosnia – H	BH Telecom is planning a trial
Djibouti	Djibouti Telecom testing LTE
Finland	Anvia – trialling in 700 MHz spectrum
France	Infosat trialling band 38 TDD
Haiti	Natcom
India	MTNL – study phase LTE TDD
Latvia	Triatel
Latvia	Lattelecom
Myanmar	Viettel is seeking the 4th license
New Zealand	Kordia – study phase

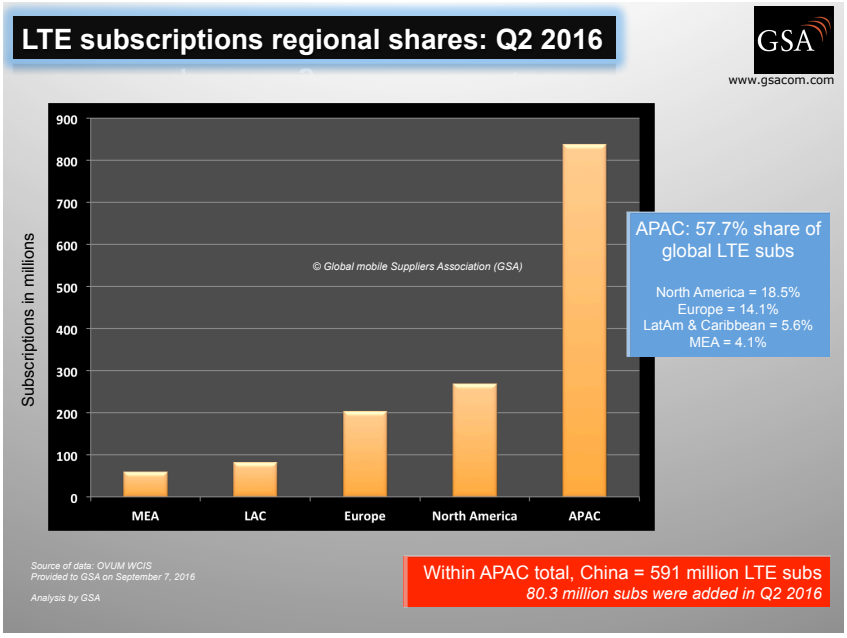
New Zealand	Woosh – study phase
Nigeria	Starcomms – study phase
Réunion	SRR trial in 1800 MHz & 2.6 GHz
Singapore	MyRepublic – potential LTE license bidder
Singapore	airYotta – potential LTE license bidder
Singapore	TPG Telecom – potential LTE license bidder
South Korea	KMI applied for LTE TDD licence
Spain	"R" conducting LTE TDD trials
Taiwan	Fitel (LTE TDD)
Ukraine	ITC
Ukraine	MTS-Ukraine
USA	ISICSB
Vietnam	FPT Telecom
Vietnam	Indochina Telecom LTE TDD

Operators listed in the above table are investing in LTE trials, studies etc. or plan to do so but have not formally committed to deploy a commercial LTE network. Over time many complete their studies and progress to formally deciding on commercial network deployment commitments

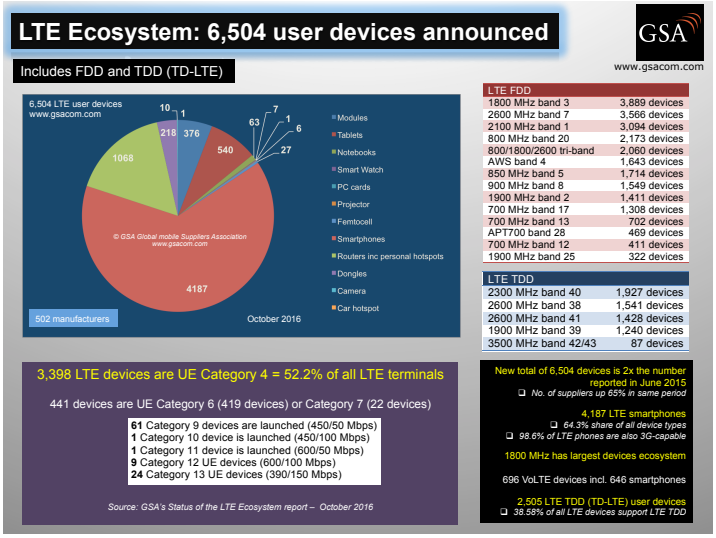
Worldwide LTE subscriptions: 1.453 billion – Q2 2016

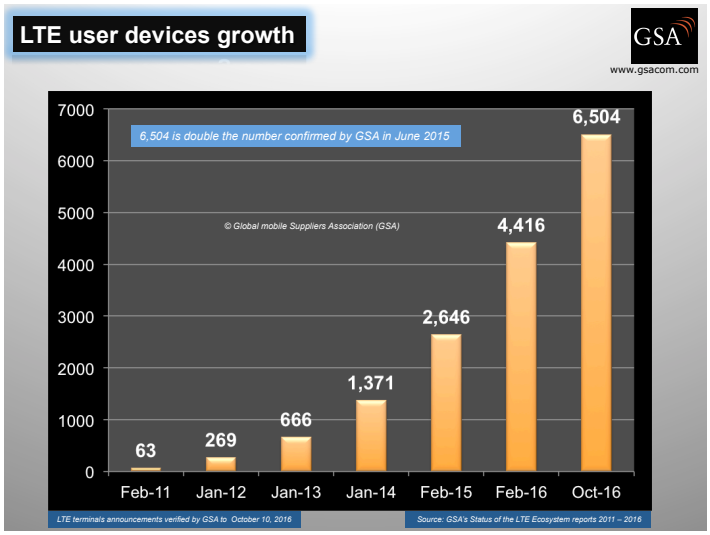
(data source for subscriptions: Ovum)





6,504 LTE User Devices launched – October 2016 (GSA report)





See GSA's Status of the LTE Ecosystem report: Free download for GSA registered site users via the link on http://www.gsacom.com

Download the above charts and more charts, maps etc. from http://www.gsacom.com

GSA confirms 6,504 LTE devices announced by 502 manufacturers

Free report:

Status of the LTE Ecosystem – October 10, 2016

Download from www.gsacom.com

Useful LinkedIN discussion groups

Global mobile Suppliers Association (GSA) http://www.linkedin.com/groups?gid=2313721

APT700 band http://www.linkedin.com/groups?gid=4759091
HD Voice (W-AMR) http://www.linkedin.com/groups?=&gid=3032759
LTE1800 http://www.linkedin.com/groups?=&gid=3129390
LTE-Broadcast http://www.linkedin.com/groups?gid=7435919
LTE Public Safety and Critical Communications http://www.linkedin.com
LTE TDD http://www.linkedin.com/groups?gid=3978061
LTE User Devices http://www.linkedin.com/groups?gid=4146472
NVP - New Ventures Program http://www.linkedin.com/groups?gid=4176808
UMTS900 http://www.linkedin.com/groups?gid=3031942
Spectrum http://www.linkedin.com/groups?gid=8362083
CIoT and M2M http://www.linkedin.com/groups?gid=8358660
LTE-U http://www.linkedin.com/groups?gid=8307556
5G http://www.linkedin.com/groups?gid=5089259

GSA (Global mobile Suppliers Association) represents GSM/EDGE/WCDMA-HSPA/HSPA+, LTE/LTE-Advanced and future 5G suppliers. GSA brings together a global industry community of telecoms professionals through its website, reports, information papers and practical activities to inform, influence, educate, explain and promote the opportunities enabled by mobile broadband systems. The GSA website www.gsacom.com has thousands of active registered users for knowledge gathering and information sharing of key facts, trends and analysis, and around 25,000 connections use our social network platforms - LinkedIn, Twitter and Facebook.

Register for updates, reports, information papers, maps, charts, RSS newsfeeds etc. at http://www.gsacom.com

GSA Secretariat
Press: press@gsacom.com
General: info@gsacom.com
Phone: +44 1279 439 667
Website: www.gsacom.com

GSA LinkedIN group www.linkedin.com/groups?gid=2313721
Twitter: www.twitter.com/gsacom
Facebook: www.facebook.com/pages/Global-mobile-Suppliers-Association-GSA/123462771012551

Your comments about this report and updates are welcome by email please to info@gsacom.com

ETSI registered "LTE" as a trademark for the benefit of the 3GPP Partners. GSA is a Market Representation Partner in 3GPP