BSS Parameters

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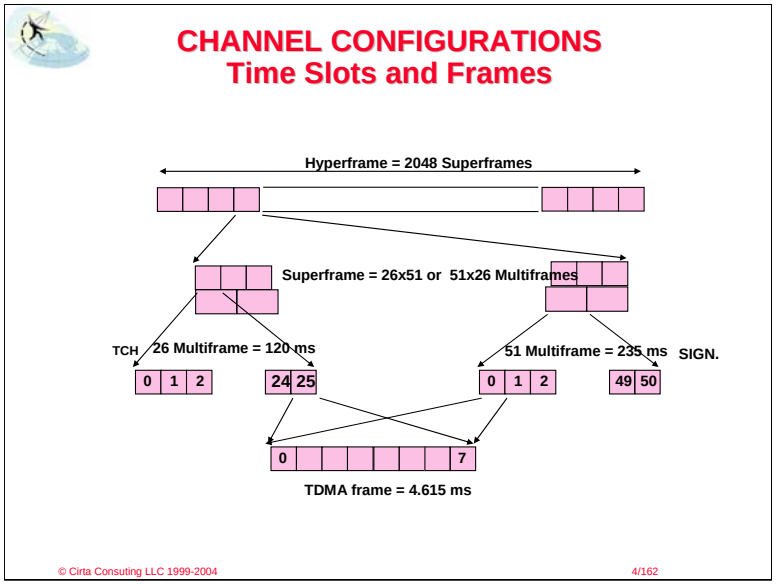
INTRODUCTION
Contents of BSS PARAMETERS

- Channel Configuration
- Idle Mode Operation
- Protocols
- Radio resources
- Measurements
- Power Control
- HO process
- Half Rate

We will revise the list at the end

CHANNEL CONFIGURATIONS
Contents



GSM Structure is based on a mix of FDMA and TDMA. Frequency Division Multiple access consists of 124 frequencies spaced 200 kHz.

Band 890 - 915 for the Uplink 935 - 960 for the Downlink

On top of that each carrier has eight channels consisting of eight timeslots numbered from 0 to 7.

Each Timeslot lats 0,577 msec. (15/26 msec.). The structure of the 8 timeslot form the TDMA frame which lasts 4,615 msec.

Timeslots can host traffic channels or signalling channels.

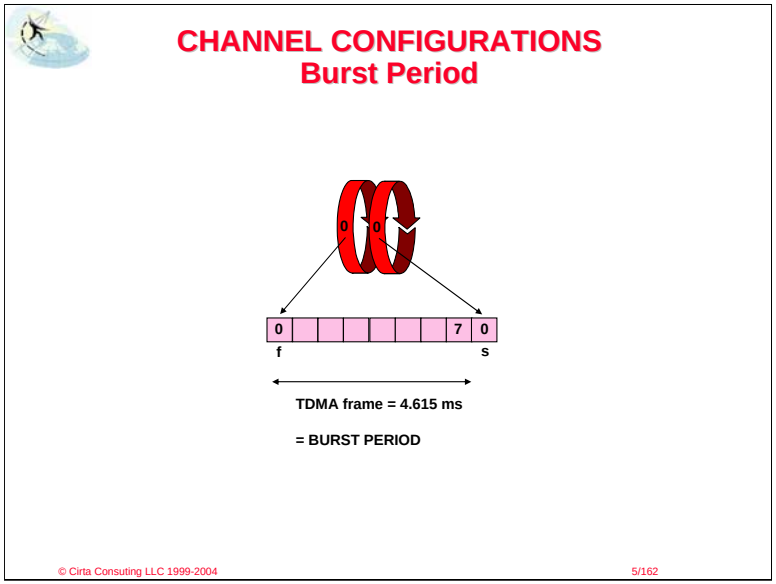
In case of traffic, the 26th TDMA is used for signalling and therefore the TDMA frames are organized into a 26 frames Multiframe (120 msec.)

In case of signalling the structure repeats itself every 51 TDMA frames and therefore the TDMA frames are organized into a 51 frames Multiframes.

Two types of Multiframes exist then, depending on the channel being a traffic or a signalling channel.

A common structure (Superframe) can only be made of 51 Multiframes of the first type (51 26-frames-Multiframes) or of 26 Multiframes of the second type (26 51-frames-Multiframes).

A Hyperframe is then made 2048 Superframes, equal to 2.715.648 TDMA frames. This means that Frame Number varies from 0 to 2.715.647 and that the Hyperframe lasts about 3 hours 28 minutes 53 secs.



Two concepts :

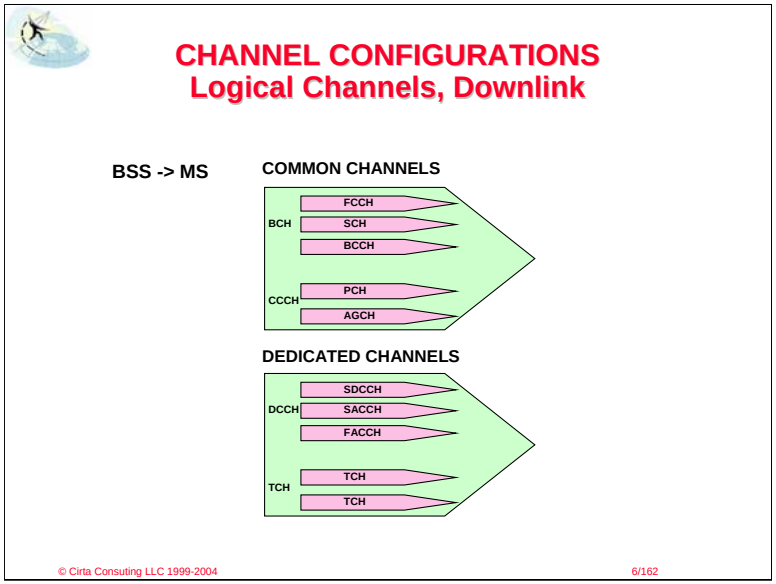
First the graphical description of a physical channel : timeslot 0 of the first TDMA frame and timeslot 0 of the second TDMA frame are placed one after the other to indicate that they are two consecutive elements of the same Physical Channel.

Second thing is that the timeslot lasts 0,577 (=15/26 milliseconds) which corresponds to 156,25 bits. The content of the timeslot is called BURST. There are five different types of bursts, and of these, 4 are 148 bit long and one is 88 bit long.

A temptative definition of a Physical Channel is as follows:

A physical channel is defined by a TSL number, a sequence of consecutive Frame Numbers and a function associating to each FN a frequency.

Logical Channels make use of the Physical Channels available between the MS and the BTS



In the Downlink direction :

Broadcast Channels : available all the time in the DL direction. Used in Idle Mode.

FCCH : Frequency Correction Channel is used by the MS to correct its frequency. It correspond to unmodulated carrier.

SCH : Synchronization Channel carries information upon the identification of the Base Station (BSIC) with 3 bits of NCC and 3 bits of BCC. Plus the information allowing the MS to identify the Frame Number.

BCH : Broadcast Control Channel contains general information as

Organization of the Common Control Channels (0c / 0 / 0,2 / 0,2,4 / 0,2,4,6)

Number of Blocks for Access Grant (0 .. 2 combined / 0 … 7 non combined)

Number of Multiframes Between Paging (2 … 9)

Common Control Channels different in UL and DL.

PCH : Paging Channel used for paging the MS

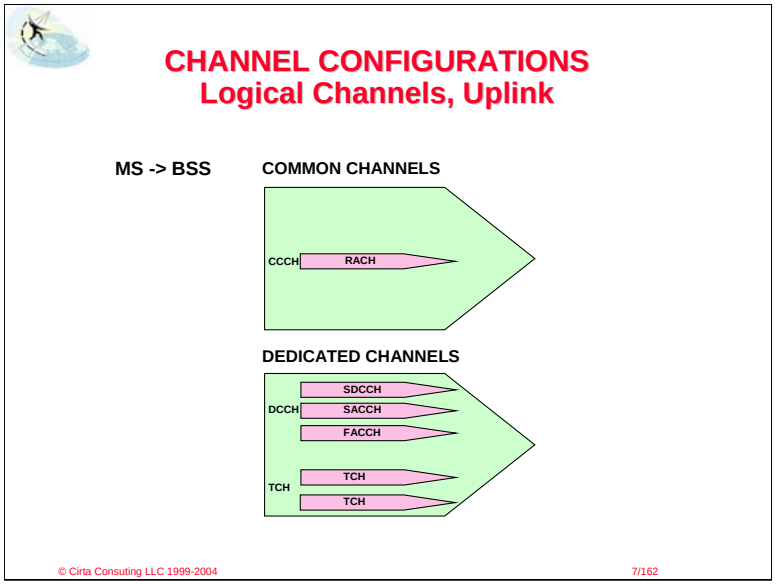
AGCH : Access Grant Channel used to allocate either an SDCCH or TCH to the MS

Dedicated Control Channels UL and DL

SDCCH : Stand-alone Dedicated Control Channel, used during call setup or location update or for short messages.

SACCH : Slow Associated Control Channel is used for system information (DL). Is associated to either TCH or SDCCH and is "slow" due to the fact that it occurs regularly (every 26th frame on the TCH)

FACCH : Fast Associated Control Channel is used for Handovers mainly and in Phase 2 for other purposes (emergency call setup, normal call setup…).



In the Uplink direction :

Common Control Channels different in UL and DL.

RACH : Random Access Channel is used by the MS to ask for service. The Access Burst is used. Short burst. This is located in the same TSL as used by PCH and AGCH in the DL.

Dedicated Control Channels UL and DL

SDCCH : Stand-alone Dedicated Control Channel, same as in DL, used during call setup or location update or for short messages.

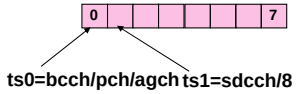
SACCH : Slow Associated Control Channel is used for sending measurements (UL). Is associated to either TCH or SDCCH and is "slow" due to the fact that it occurs regularly (every 26th frame on the TCH)

FACCH : Fast Associated Control Channel is used for Handovers mainly and in Phase 2 for other purposes (emergency call setup, normal call setup…).

CHANNEL CONFIGURATIONS
Configuration of Signalling Channels

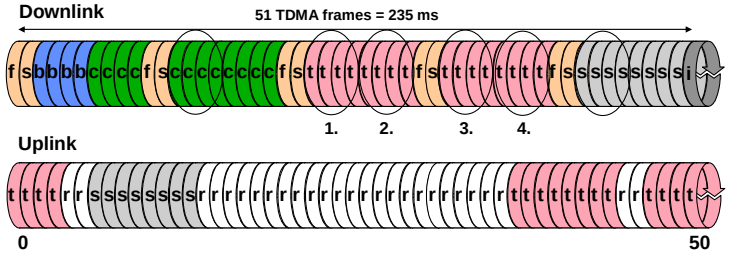
Combined Configuration

Separated Configuration



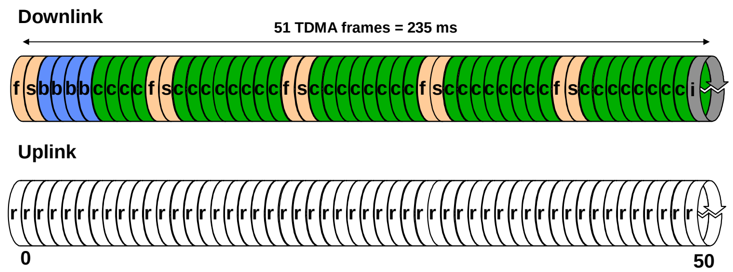
Depending on the capacity requirements , we can define the signalling channels in two different ways.They have trade offs!

CHANNEL CONFIGURATIONS
Combined CCCH/SDCCH/4 Multiframe



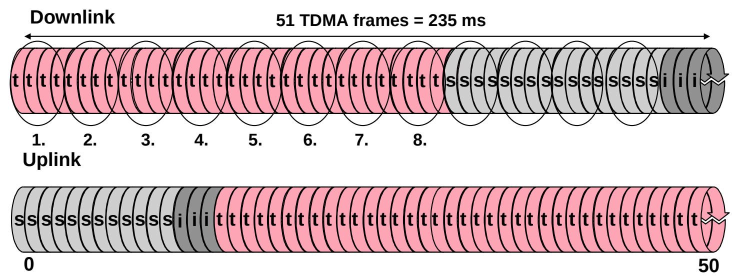
CHANNELS	f = FCCH	b = BCCH	r = RACH	i=idle
	s = SCH/SACCH	c = CCCH	t = SDCCH/4	

CHANNEL CONFIGURATIONS
BCCH/CCCH Multiframe

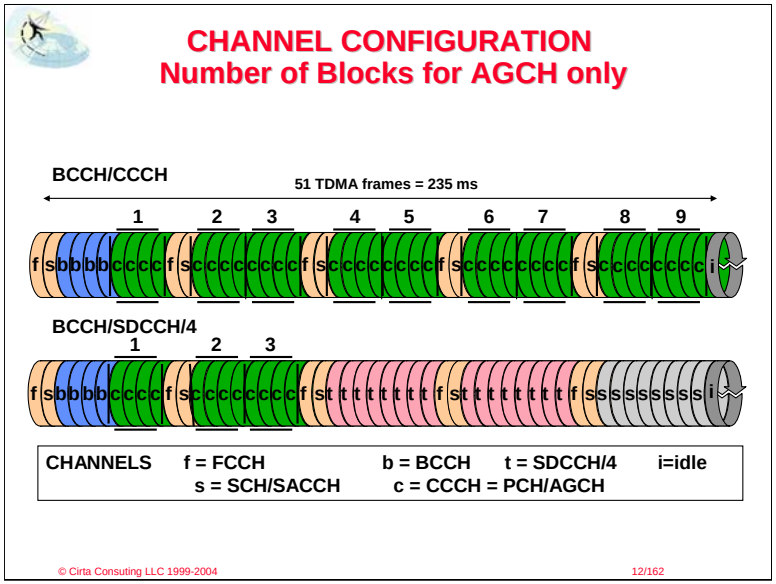


CHANNELS	f = FCCH	b = BCCH	r = RACH	i=idle
	s = SCH	c = CCCH = PCH/AGCH		

CHANNEL CONFIGURATIONS
SDCCH/8 Multiframe



CHANNELS	t = SDCCH/8	s = SACCH/8	i=idle

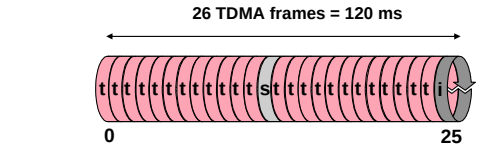


Paging and the immediate assignment processes use the same resources on the signalling channels, CCCHs. There can be different strategies in defining their priorities to escjh other.

PCH has in normal case priority to AGCH.

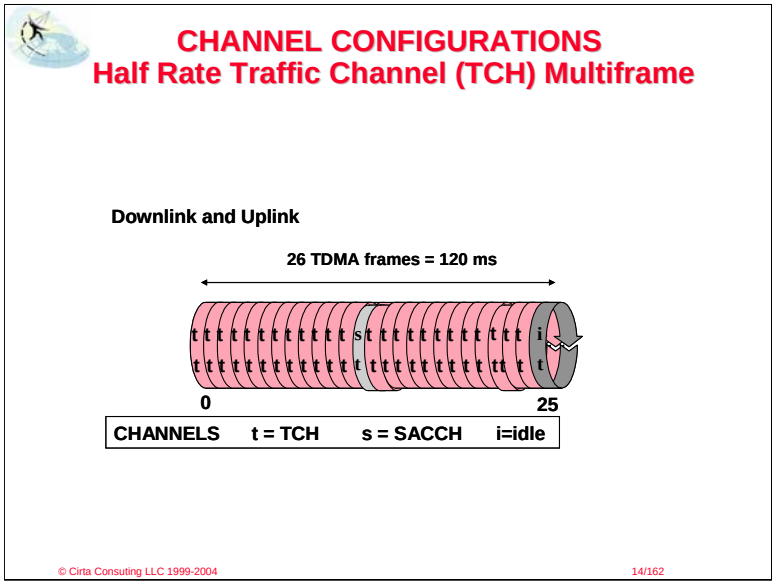
CHANNEL CONFIGURATIONS
Full Rate Traffic Channel (TCH) Multiframe

Downlink and Uplink



CHANNELS	t = TCH	s = SACCH	i=idle

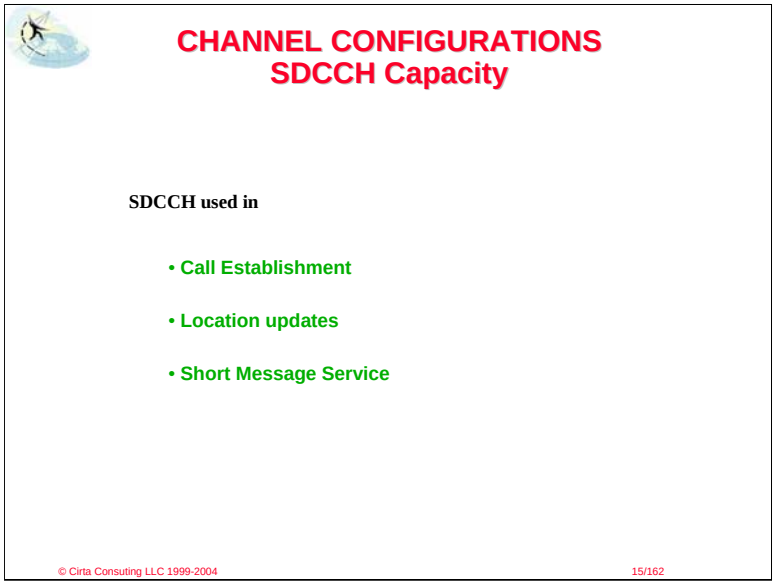
Now the Traffic channels.



New

With the half rate coding it is possible to maximise the spectrum efficiency. When compared with the use of full rate traffic channels, half rate coding almost doubles the amount of radio resources.

Full rate speech and data is coded and transferred by using 16 kbit/s channels in the BSS. With the half rate coding 8 kbit/s transmission can be used on the BSC-BTS interface. This is possible also on the BSC transcoder interface when the BSS (BTS, BSC, Transcoder) and mobile stations support the half rate. The low rate data services can be employed with the half rate traffic channels.

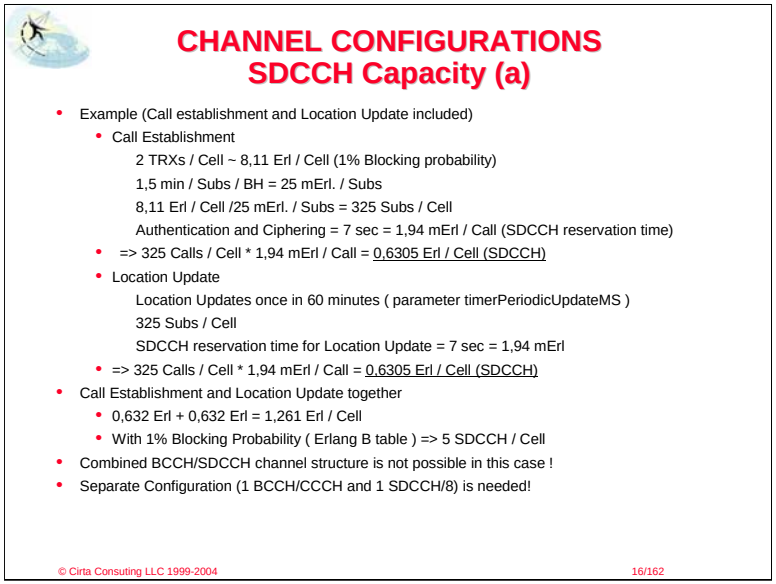


Just one comment

the Handover can take place when the radio connection is on an SDCCH either to a TCH of another cell (Directed Retry) or to an SDCCH of another cell.

This doesn't mean that the SDCCH is used for the HO.

It can also be noted that the Call set-up can take place on the TCH (FACCH Call set-up).



MODIFIED

Ask if everybody knows how to calculate the traffic.

This slide and the next one are put together.

The traffic on the TCHs depends on the time that each subscribers spends on the phone. The traffic on the SDCCH depends on the number of calls that each subscribers makes or receives.

25 mErl / subscribers can be 1.5 minutes per call - 1 call per hour OR 1 minute per call, 1.5 calls per hour. Same thing for TCHs different thing for SDCCH.

The other thing is that the time for call setup is generally shorter than 7 seconds. It is more likely tyo be 4 - 5 seconds. However when Queueing and Directed Retry are in use the time spent on the SDCCH may increase significantly.

One more issue is that when we calculate the capacity for a 2 TRX/Cell configuration, with 1% Blocking Probability, we assume that we have 15 TCH timeslots.

The basic message is that with 2 TRXs per Cell, when we have 1 hour Periodic Location Update, the configuration of Combined BCCH / SDCCH leads to a significant risk of CONGESTION on the SDCCH.

CHANNEL CONFIGURATIONS
Erlang B Table

Chs	1%	2%	3%	5%	Chs	1%	2%	3%	5%
1	0.01	0.02	0.03	0.05	**21**	12.80	14.00	14.90	16.20
2	0.15	0.22	0.28	0.38	**22**	13.70	14.90	15.80	17.10
3	0.46	0.60	0.72	0.90	**23**	14.50	15.80	16.70	18.10
4	0.87	1.09	1.26	1.52	**24**	15.30	16.60	17.60	19.00
5	1.36	1.66	1.88	2.22	**25**	16.10	17.50	18.50	20.00
6	1.91	2.28	2.54	2.96	**26**	17.00	18.40	19.40	20.90
7	2.50	2.94	3.25	3.75	**27**	17.80	19.30	20.30	21.90
8	3.13	3.63	3.99	4.54	**28**	18.60	20.20	21.20	22.90
9	3.78	4.34	4.75	5.37	**29**	19.50	21.00	22.10	23.80
10	4.46	5.08	5.53	6.22	**30**	20.30	21.90	23.10	24.80
11	5.16	5.84	6.33	7.08	**31**	21.20	22.80	24.00	25.80
12	5.88	6.61	7.14	7.95	**32**	22.00	23.70	24.90	26.70
13	6.61	7.40	7.97	8.83	**33**	22.90	24.60	25.80	27.70
14	7.35	8.20	8.80	9.73	**34**	23.80	25.50	26.80	28.70
15	8.11	9.01	9.65	10.60	**35**	24.60	26.40	27.70	29.70
16	8.88	9.83	10.50	11.50	**36**	25.50	27.30	28.60	30.70
17	9.65	10.70	11.40	12.50	**37**	26.40	28.30	29.60	31.60
18	10.40	11.50	12.20	13.40	**38**	27.30	29.20	30.50	32.60
19	11.20	12.30	13.10	14.30	**39**	28.10	30.10	31.50	33.60
20	12.00	13.20	14.00	15.20	**40**	29.00	31.00	32.40	34.60

CHANNEL CONFIGURATIONS
SDCCH Capacity (b)

- Example (Call establishment and Location Update included)
  - Call Establishment
    - 2 TRXs / Cell ~ 8,11 Erl / Cell (1% Blocking probability)
    - 1,5 min / Subs / BH = 25 mErl. / Subs
    - 8,11 Erl / Cell /25 mErl. / Subs = 325 Subs / Cell
    - Authentication and Ciphering = 7 sec = 1,94 mErl / Call (SDCCH reservation time)
  - => 325 Calls / Cell * 1,94 mErl / Call = 0,6305 Erl / Cell (SDCCH)
  - Location Update
    - Location Updates once in 120 minutes (parameter timerPeriodicUpdateMS)
    - 325 Subs / Cell
    - SDCCH reservation time for Location Update = 7 sec = 1,94 mErl
  - => 325 Calls / Cell * 1,94 mErl / Call * 1/2 = 0,31525 Erl / Cell (SDCCH)
- Call Establishment and Location Update together
  - 0,6305 Erl/Cell + 0,31525 Erl/Cell = 0,94575 Erl/Cell (SDCCH)
  - With 1% Blocking Probability (Erlang B table) => ~ 4 SDCCH / Cell
- Combined BCCH/SDCCH channel structure is possible in this case !

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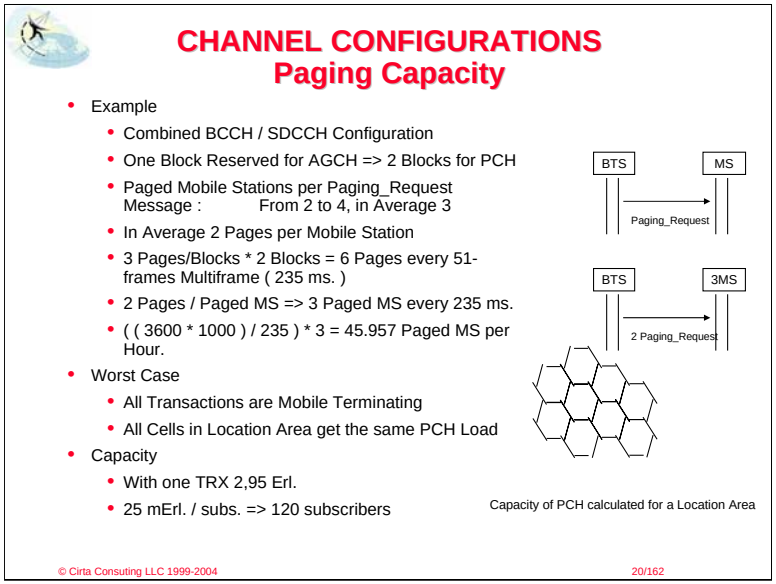
CHANNEL CONFIGURATIONS
SDCCH Capacity (c)

- Example (Call establishment and Location Update included)
  - Call Establishment
    - 2 TRXs / Cell ~ 8,11 Erl / Cell (1% Blocking probability)
    - 1,5 min / Subs / BH = 25 mErl. / Subs
    - 8,11 Erl / Cell /25 mErl. / Subs = 325 Subs / Cell
    - Authentication and Ciphering = 7 sec = 1,94 mErl / Call (SDCCH reservation time)
  - => 325 Calls / Cell * 1,94 mErl / Call = 0,6305 Erl / Cell (SDCCH)
  - Location Update
    - Location Updates once in 120 minutes (parameter timerPeriodicUpdateMS)
    - 325 Subs / Cell
    - SDCCH reservation time for Location Update = 7 sec = 1,94 mErl
  - => 325 Calls / Cell * 1,94 mErl / Call * 1/2 = 0,31525 Erl / Cell (SDCCH)
  - SMS
    - SMS traffic estimation 1.0 mErl / subscriber
  - => 325 Calls / Cell * 1 mErl / Call = 0,325 Erl / Cell (SDCCH)
- Call Establishment, Location Update and SMS together
  - 0,6305 Erl/Cell + 0,31525 Erl/Cell + 0,325 Erl/Call = 1,27075Erl/Cell (SDCCH)
  - With 1% Blocking Probability (Erlang B table) => ~ 5 SDCCH / Cell
- Separated channel structure is possible in this case



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In a Paging Request Message, there is space for

2 paged MS (with IMSI)

3 paged MS (one with IMSI and two with TMSI)

4 paged MS (all with TMSI)

Paging to one MS can be repeated and we can assume that for each MS there is need in average for 2 Paging_Request messages. MSC related parameter are : Repaging_Interval (time between consecutive paging messages T3113) and Number_Of_Repaging_Attempts (additional paging attempts).

Note that to avoid waste of PCH capacity, the time defined in the MSC between consecutive attempts should be higher than the time defined by the numberOfMultiframesBetwenPaging (*235msec).

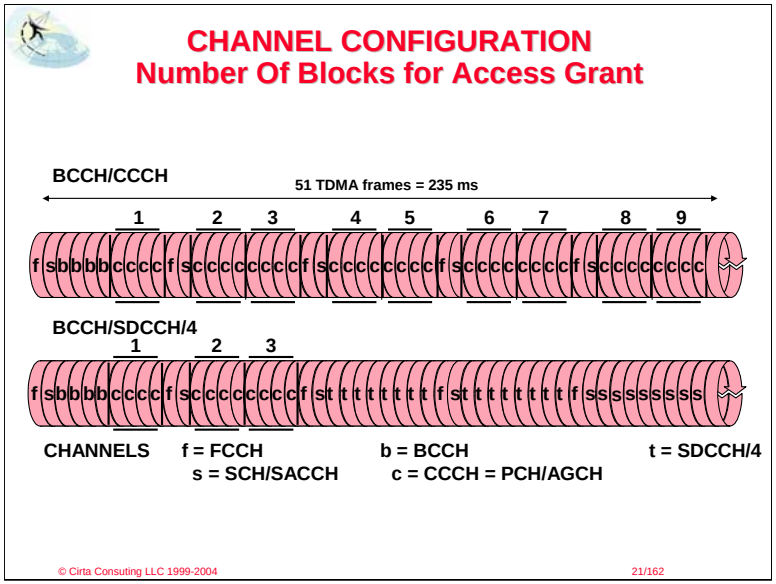
If there are no SDCCH available the Network sends a "wait indication" to the MS. Therefore the time defined in the MSC between consecutive attempts should be higher than the wait indication time defined in the BSC.

It is then easy to calculate the number of Paged MS per Hour.

Note

The capacity of the Paging Channel is not depending from the Paging Groups as defined based on the numberOfMultiframesBetweenPaging. However the calculation of the capacity is based on the MS being uniformly distributed among the Paging Groups.

Additionally it should be noted that a MS is paged over a whole Location Area and that therefore the same Paging_Request Messges go through all of the BTSs in the LA. The size of the LA should then be referred to the smallest CCCH configuration in the area.



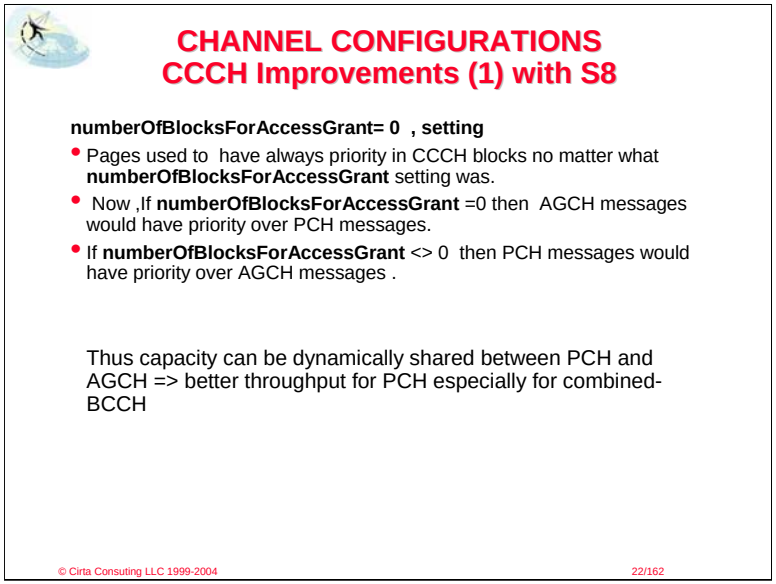
PCH has in normal case priority to AGCH

Parameters we are interested in are :

BS_AG_BLKS_RES = numberOfBlocksForAccessGrant indicates the number of the CCCH blocks - available in a 51frames Multiframes - dedicated to Access Grant Channel

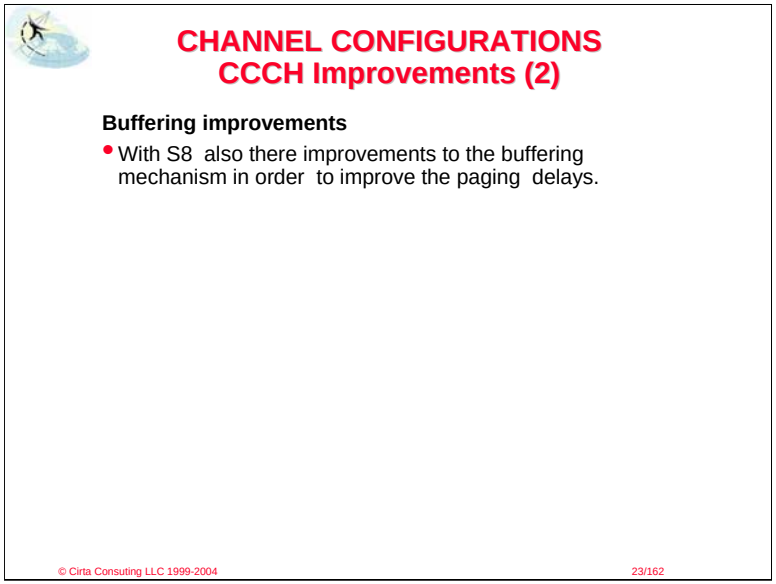
BS_PA_MFRMS = number of 51 frames Multiframes between two consecutive Paging Requests for the same Mobile Station.

Additionally, the BS_CCCH_SDCCH_COMB (not a BSS parameter) indicates if the SDCCH is combined with the other signalling channels on TSL 0. Therefore it gives the number of the CCCH blocks available in a 51frames Multiframes for CCCH.

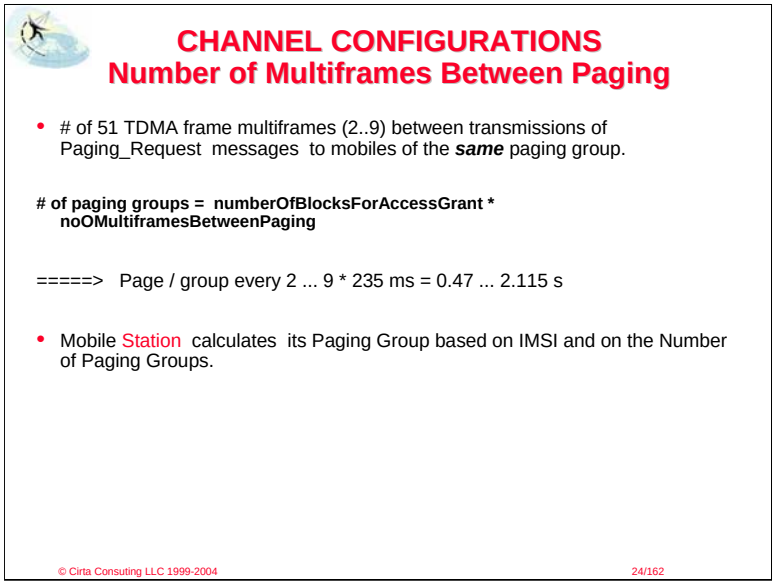


INTRODUCTION

The CCCH scheduling algorithm will be improved to allow priority for access grant messages over paging messages when BS_AG_BLKS_RES equals zero. For non-zero values the situation will remain the same as now, i.e. paging messages have priority over access grant messages on PCH. This greatly improves the PCH throughput especially for combined-BCCH-CCCH channel structure.



The buffering mechanism for CCCH-messages will be modified. For PCH the target is to offer a buffering mechanism in which the paging buffer capacity per paging group is dependent on the CCCH-configuration and the used identity type (IMSI/TMSI) in such a way that configuration independed maximum paging delay for a paging message can be offered. In current scheme each paging group buffer has a fixed depth (8 Abis page messages) regardless of the paging group repetition rate (BS_PA_MFRMS). In the worst case, (when buffers are full and BS_PA_MFRMS = 9 and IMSI used), a page arriving to BTS may have to wait for transmission 4 paging multiframes (approx 8.4 seconds). The page is clearly outdated by the time it gets transmitted to air. Since page repetition is done at the MSC, after some point in time it is better to discard excessive pages rather than store them for very long time. In this new mechanism a page is not deleted because of insufficient buffering space but because it cannot be transmitted to air within the defined maximum paging delay.



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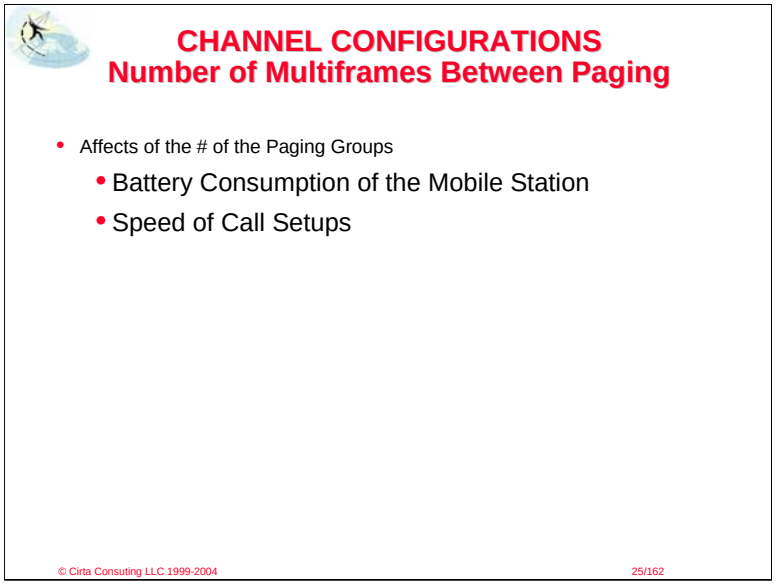
The message sent by the Network to the MS is Paging_Request

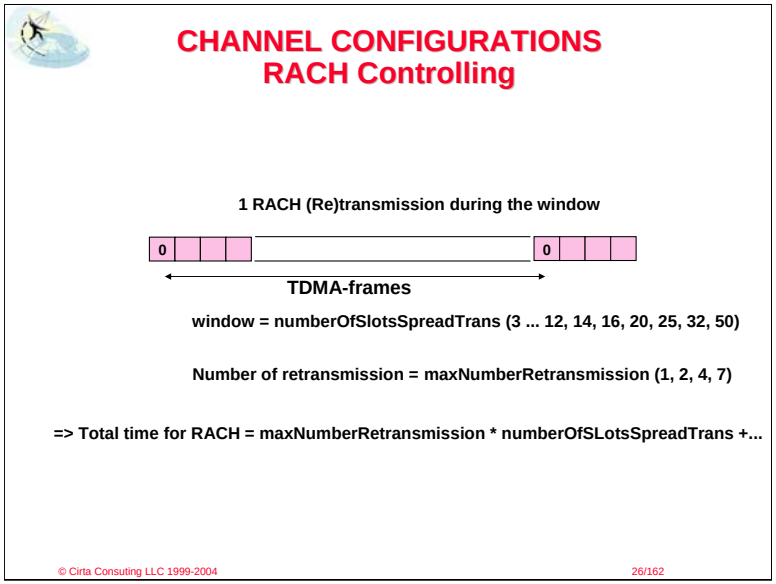
If we assume that the paging of a MS requires in average 2 Paging_Request Messages, then it may take up to 4,2 seconds for a call setup.

On the other hand the more often the MS listens to the Paging, the quicker is the battery consumption.



Q: When there are no pages to send for the MSs, what is sent on the Paging channels?

A: Dummy pages .



the retransmission of the RACH is controlled by a timer (in MS) T3120 which is calculated on the basis of the parameter numberOfSlotsSpreadTrans.

However this parameter doesn't represent the INTERVAL inside which all the retransmissions are sent, but rather the interval between two consecutive CHANNELREQUEST messages.

This is described in GSM 04.08 and the naming convention is :

MAX-RETRANS = maxNumberOfRetransmission

TX-INTEGER = numberOfSlotsSpreadTrans

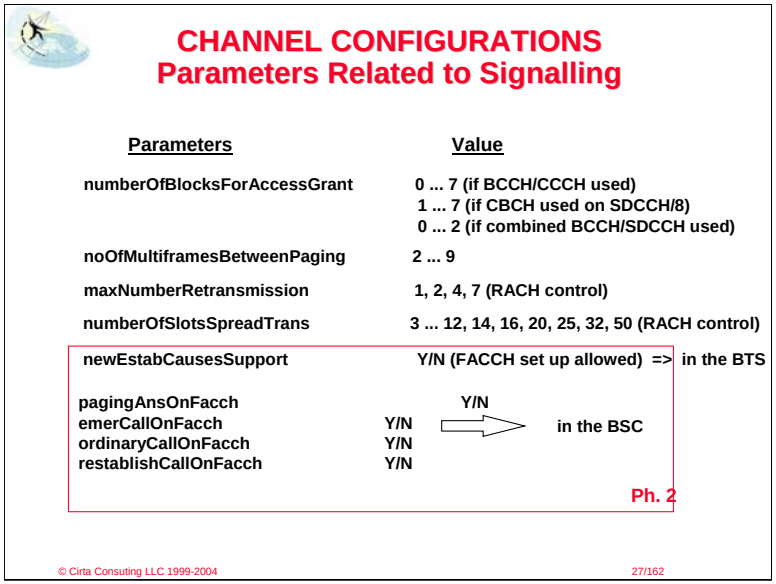
Please look at the additional slides (file S_R_98_1.ppt) called RACH PARAMETER

As a summary:

Q: How many times the MS sends channel request for a call?

A: The maximum number of RACH sent by the MS is equal to

1 + maxNumberOfRetransmission



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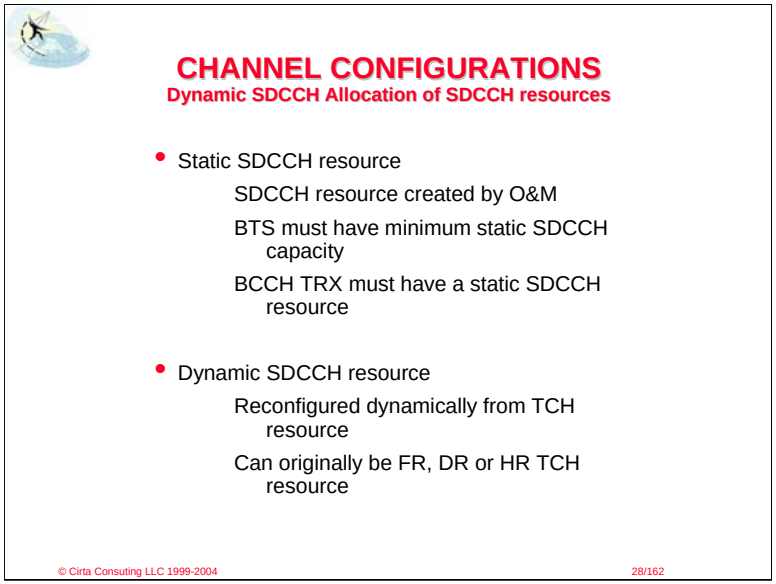
The parameter facchCallSetup (0 … 4) doesn't appear anymore in S6

numberOfBlocksForAccessGrant = 1 … 7 if CBCH is used. The problem is that

If SDCCH is in TSL 0 of another TRX, then CBCH overlaps with the 1st CCCH and the risk is that it overlaps with PCH.

If SDCCH is in TSL 1 then still the risk is that the MS has to follow two consecutive TSL in the same TDMA frame, one with PCH and the other with Cell Broadcast

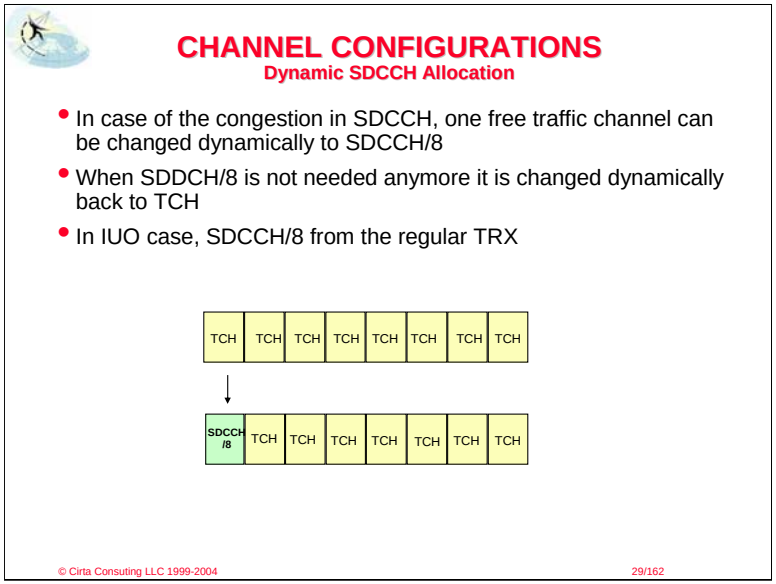
If the MS has to listen to an Access Grant there is no problem of overlapping because it is leaving the idle mode.



DESCRIPTION OF THE FEATURE

There are two type of SDCCH resources in BTS, static and dynamic SDCCH resources. Static SDCCH is created by O&M to be a standing SDCCH resource. Dynamic resource is reconfigured from a (FR, DR or HR) TCH resource to SDCCH resource on the Abis Telecom interface.

The BTS must always be created minimum static SDCCH configuration, the BCCH TRX must have an SDCCH. This ensures that BTS has SDCCH capacity while dynamic resources can not be configured for resource reasons or the Dynamic SDCCH option is turned off.



INTRODUCTION

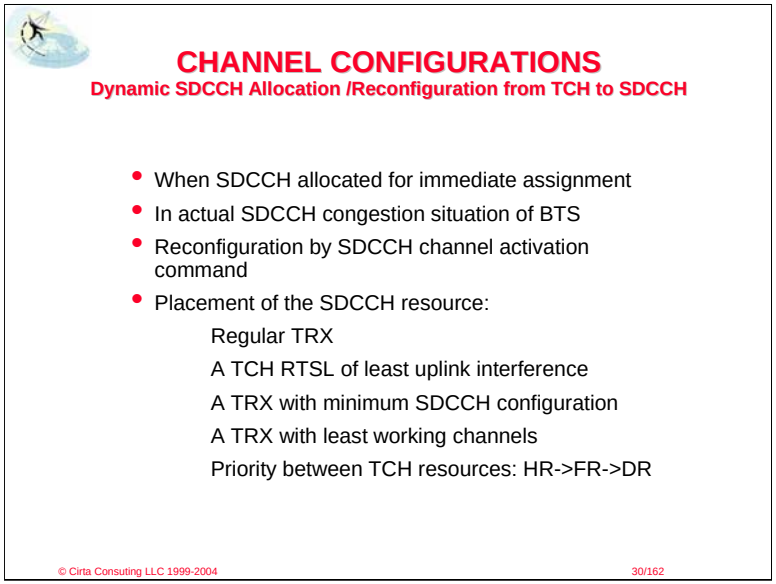
Feature Dynamic SDCCH makes possible to configure the SDCCH resources according to the actual SDCCH traffic situation of cell. When the BTS needs a temporarily larger SDCCH capacity than normally, then idle TCH resources are configured for SDCCH use by BSC. When the SDCCH congestion situation is over the extra SDCCH resources are configured back to TCH resources.

A particular benefit is derived from this feature in traffic cases where the signalling is the only transmission mode during the connection to the network. Short Message service (SMS) traffic as well as location updatings are counted among them. In some special places - airports, ports - the location updatings can produce sudden short time SDCCH traffic peaks which can now be handled without any need to configure extra permanent SDCCH capacity for safety's sake only.

The operator is required to configure to the BTS the minimum static SDCCH capacity sufficient to handle the normal SDCCH traffic.

Extra SDCCH resource is allocated only when the actual SDCCH congestion situation has been fallen into after the last free SDCCH is allocated. Consequently, when the dynamic SDCCH radio resource is totally free again it is immediately configured back for TCH use. Thus the maximum number of TCHs are always in traffic use depending on the actual need of the SDCCH resources at each moment.

This feature is optional



Dynamic SDCCH resource can be configured when SDCCH is allocated for immediate assignment.

Placement of the new dynamic SDCCH is depending on the following factors:

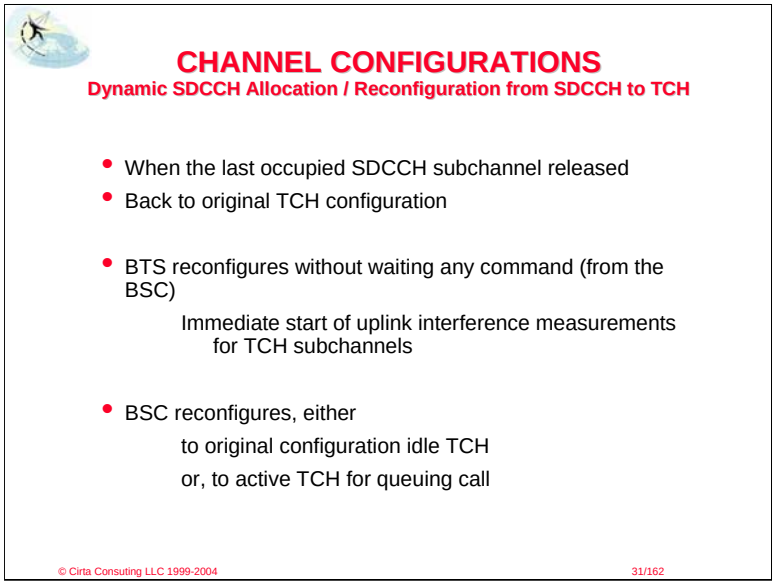
SDCCH resource is configured only to regular TRX. A RTSL of least uplink interference should be selected.

The SDCCH is configured to a TRX which does not yet have any SDCCH resources or has least of them.

Priority is given to the TRX which has least working channels.

When in a particular TRX amd a different type of TCH resource must be selected, then the preference order is the following:first HR then FR, DR TCH resource.

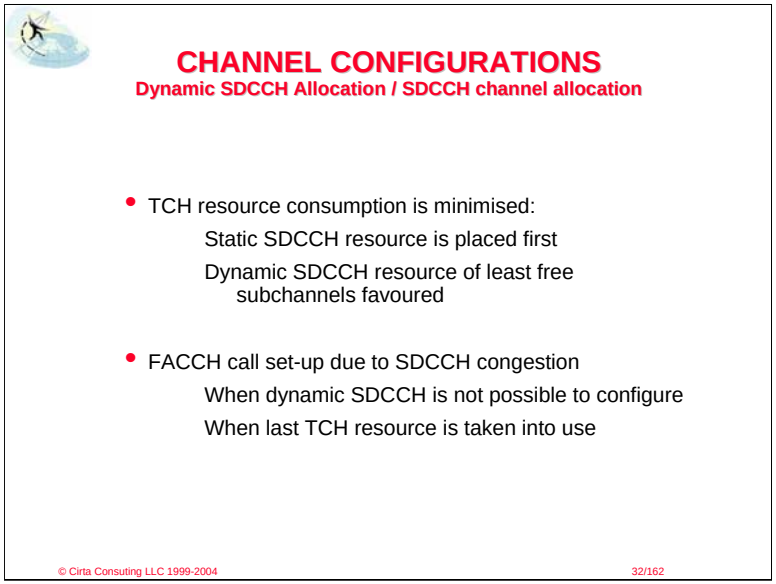
These requirements must be compromised according to the actual TCH occupation situation in the TRXs.



When the need for extra SDCCH resource has vanished the RTSL is configured immediatelly back to the TCH resource of the original configuration.

At the moment all SDCCH subchannels are free the BTS performs the the reconfiguration without waiting for any special command from BSC. The RTSL is then ready for TCH use, e.g., the idle channel uplink interference measurements are immediately started for the TCH subchannels.

Also, in the BSC, the idle dynamic SDCCH resource is at the same time returned back to the original TCH configuration. While there is any call queuing for TCH, BSC allocates traffic channel from the resource for it.



Principles in radio channel allocation from the SDCCH resources of the BTS are:

SDCCH is always allocated from static SDCCH resource if there is any free channel left.

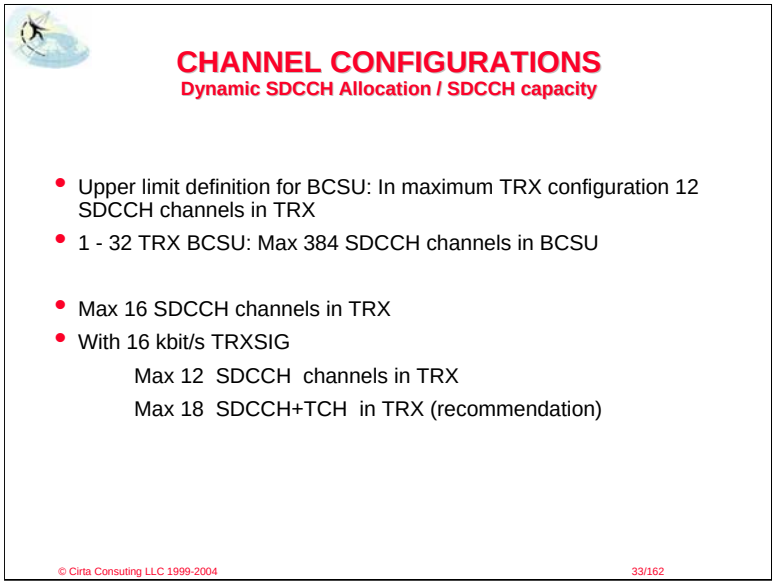
When SDCCH is allocated from the dynamic SDCCH resources then the one shall be used which has least idle channels left.

These rules are for minimising the consumption of the TCH resources.

When the feature FACCH call set-up is activated, in situations of SDCCH congestion of the BTS, the MS can be assigned a TCH from the CCCH at the time of Immediated Assignment. This feature can be applied also with the Dynamic SDCCH in some special cases:

The FACCH call set-up is used in true SDCCH congestion when not it is not possible to to configure any dynamic SDCCH resource in the BTS.

When the last TCH resource of the BTS is going to be taken in use and the connection requires a TCH then it is reasonable to use the FACCH call set-up.



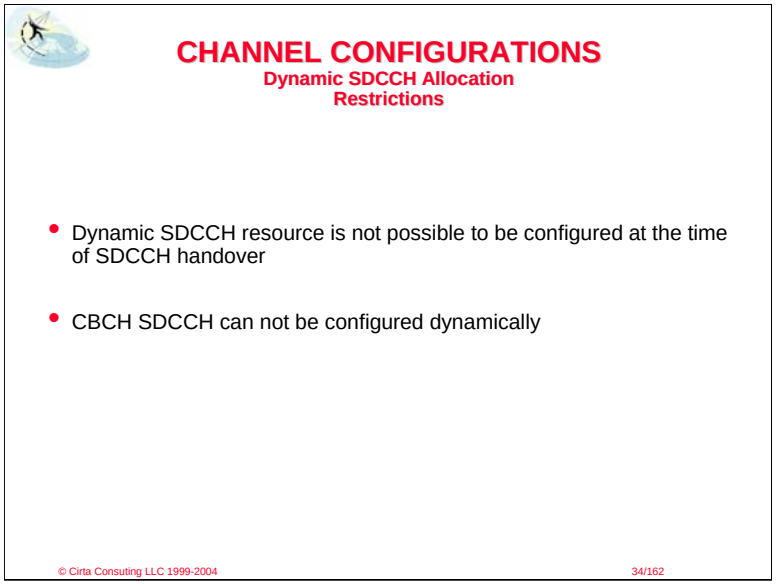
Upper limit for the number of SDCCHs which are possible to configure in BSC are determined by the number TRXs connected to the BSC Signalling Unit (BCSU). With maximum TRX configurations the average SDCCH capacity is determined to be 12 SDCCH channels per TRX. The amount is actually the same as the max number of SDCCHs which can configured per TRX by O&M. For 1-32 TRX BCSU the max number of the SDCCH channels is 384.

Dynamic SDCCH resources can be shared between all TRXs of the BTS. The absolute limit is that the maximum SDCCH number in a TRX must not exceed 16 channels; while this limit value is reached then at least one of the two SDCCH/8 resources must be dynamic one.

The capacity restrictions of the 16 kbit/s Telecom signalling link produces additional constraints. The uplink capacity is not sufficient in the worst traffic load cases. Main reason for the capacity loss is the increased uplink load in measurement result reporting. The maximum number of dynamic and static SDCCH channels together is limited to 12 subchannels (i.e. SDCCH/4 and SDCCH/8).

This restriction is sufficient when the configuration of TRX consists of 18 radio channels maximum, i.e., 12 SDCCH and 6 TCH. This channel configuration can be exceeded with half rate traffic channels. Where the 16 kbit/s TRXSIG is used and the Dynamic SDCCH option used there the half rate configuration of TRX is recommended to be done so that the requirement of max 18 channels is fulfilled.

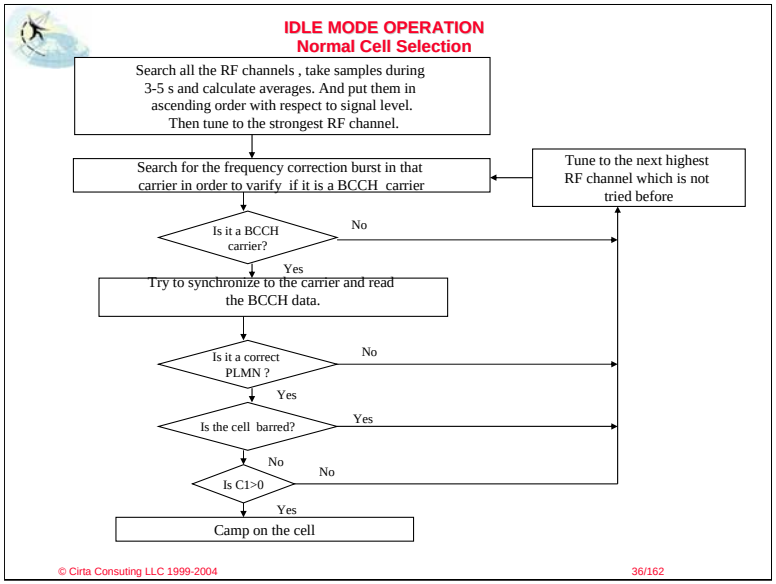
The bitrate of the TRXSIG is checked in the creation of dynamic SDCCH resource.



Dynamic SDCCH resource can be configured only when SDCCH is allocated for Immediate Assignment, during the SDCCH handover it is not allowed (restriction concerns the BSC). However, channels of the already existing dynamic SDCCH resources can be used in handovers.

CBCH carrying SDCCH can not be configured dynamically. This as well as the combined CCCH/SDCCH has to be configured by O&M, both of them are representing static resources on the Abis Telecom interface.

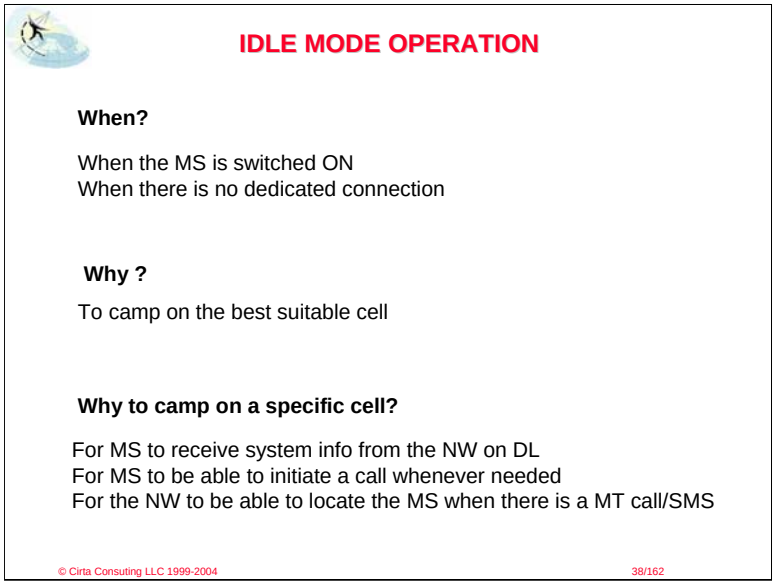
IDLE MODE OPERATION



Flow chart of cell selection

IDLE MODE OPERATION
Contents

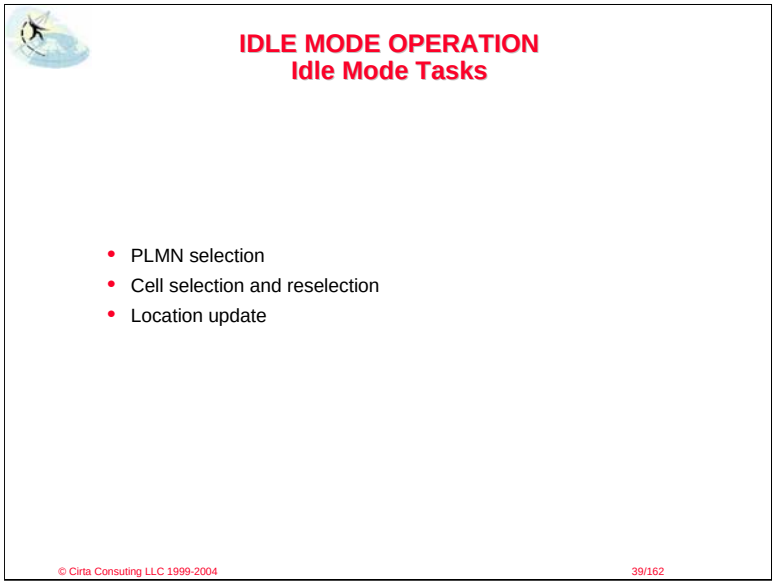
1. IDLE Mode tasks overview
2. ID's and ID Codes , Frequencies
3. PLMN selection
4. Cell selection and cell reselection
    - •C1 Algorithm
    - •C2 Algorithm
5. Location Area Management (as in Radio Resource Management)
    - •Location Updates
    - •Time Periodic Location Update
6. IMSI Attach/Detach



New

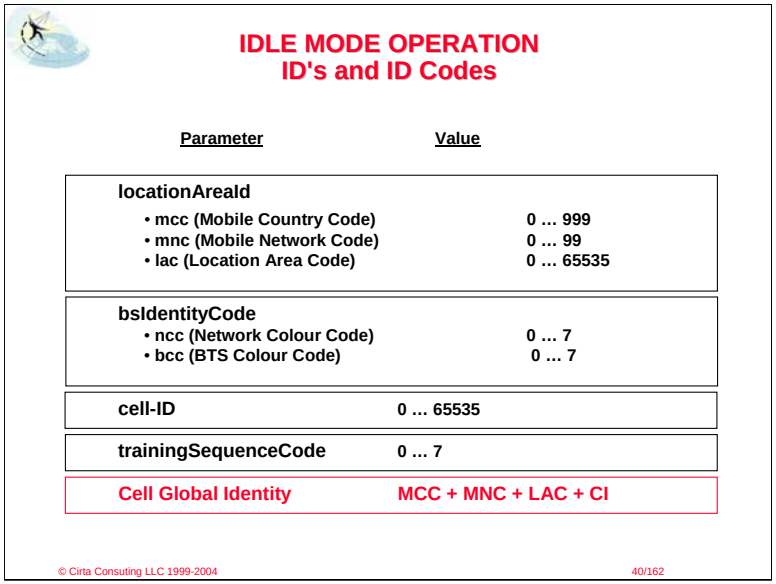
Summary:

When an MS is switched on, it attempts to make contact with a GSM public land mobile network (PLMN). The particular PLMN to be contacted may be selected either automatically or manually. The MS looks for a suitable cell of the chosen PLMN and chooses that cell to provide available services, and tunes to its control channel. This choosing is known as "camping on the cell". The MS will then register its presence in the registration area of the chosen cell if necessary, by means of a location registration (LR), GPRS attach or IMSI attach procedure. If the MS loses coverage of a cell, it reselects onto the most suitable alternative cell of the selected PLMN and camps on that cell. If the new cell is in a different registration area, an LR request is performed. If the MS loses coverage of a PLMN, either a new PLMN is selected automatically, or an indication of which PLMNs are available is given to the user, so that a manual selection can be made.



New

So the Idle mode tasks are three.



We first mention about the Ids and ID codes which are very important for the identification of network elements.

And frequencies.

SLIGHTLY MODIFIED

Network Colour Code and Base Station Colour Code form the BSIC and are transmitted on the SCH channel . They are decoded by the MS. Note that they are both coded with 3 bits, but in some cases the 6 bits are put together, thus creating some problems of decoding.

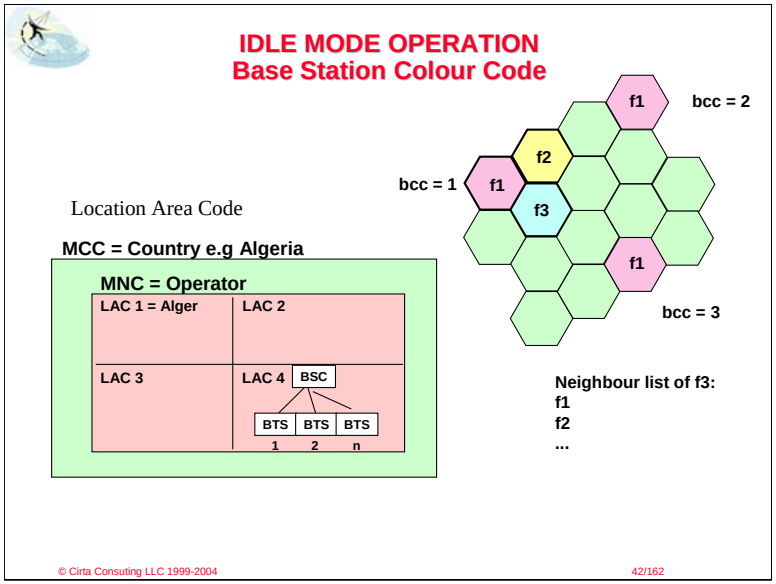
E.g. BSIC 6,3 = 110 , 011 => 110011 = 51

For Broadcast and and common control channels, the Training Sequence Code must be equal to the BCC (GSM 05.02 paragraph 5.2.2)

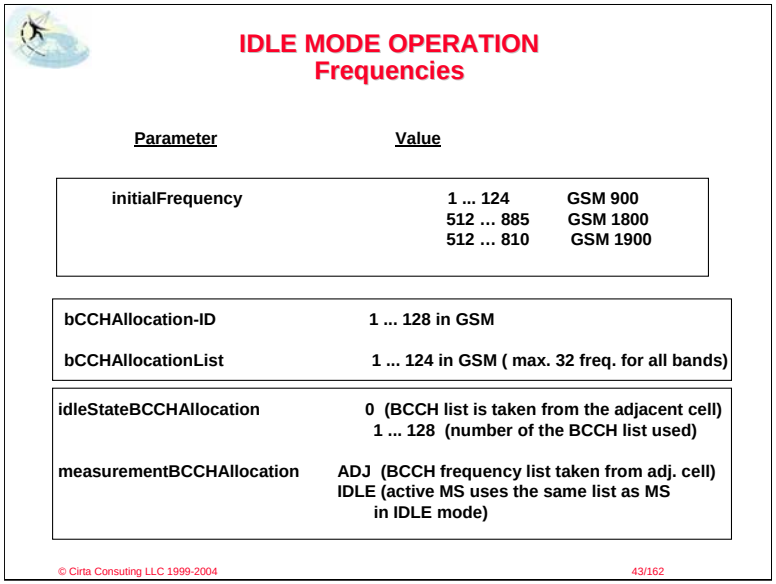
IDLE MODE OPERATION
BaseStation Identity Code (BSIC)

- BSIC is a combination of NCC and BCC
- Reported in Measurement Results to BSC
- Can be listed in Hex or Decimal

NCC (0...7)			BCC (0...7)			
4	2	U	4	2	U	
32	16	8	4	2	U	Range
0	0	0	x	x	x	0 - 7
0	0	1	x	x	x	8 - 15
0	1	0	x	x	x	16 - 23
0	1	1	x	x	x	24 - 31
1	0	0	x	x	x	32 - 39
1	0	1	x	x	x	40 - 47
1	1	0	x	x	x	48 - 55
1	1	1	x	x	x	56 - 63



TWO SLIDES TOGETHER



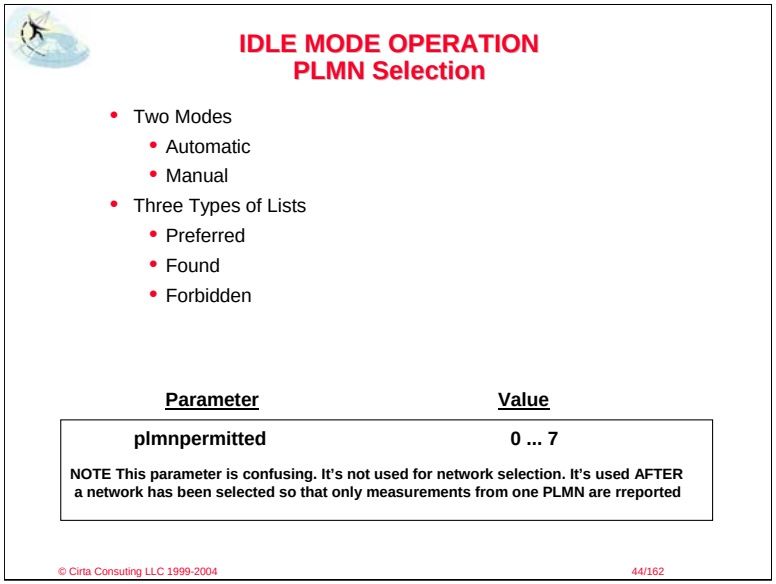
InitialFrequency is a TRX parameter that defines the ARFCN in use for that TRX. The problem is when the Cell uses RF Hopping. In that case in fact the frequency is a sort of reference to be used when hopping is disabled.

BcchAllocationId defined in the BSC, identifies one of 128 lists of frequencies that can be defined in the BSC.

BcchAllocationList defined in the BSC, contains a list of ARFCNs, with a maximum of 32 frequencies. They are interpreted by the MS as BCCH frequencies to listen to.

IdleStateBcchAllocation BTS parameter specifies which set of BCCH frequencies, the MS should listen to.

MeasurementBcchAllocation specifies if in dedicated mode the MS should use the real list of neighbour or the list of BCCH defined for the idle mode.



The MS leaves a PLMN if

a) the user decides so

b) the serving PLMN cannot give coverage anymore

The Home PLMN is always a priority PLMN to select.

FORBIDDEN PLMN's LIST

The set of PLMN where the MS can make roaming is changing all the time. Therefore the information is dynamically handled in the SIM based on the attempts to register in the PLMN.

When the MS finds a new PLMN it may try to register into it the NW rejects the attempt and the PLMN is inserted in the list.

FOUND PLMN's LIST

In manual mode the Mobile scans the GSM band and the list of the PLMNs found is presented to the user, independently from the PLMN being forbidden or not. Then the user can choose one of the PLMN and try the registration.

PREFERRED PLMN's LIST

It's a list of PLMN (at least 8) stored in order of priority in the SIM. The selection of the PLMN in automatic mode will consider the PLMNs of the FOUND LIST and sort them according to the PREFERRED LIST provided that they are not in the FORBIDDEN LIST.

The PREFERRED LIST can be created by the Operator and then modified by the subscriber.

PLMNpermitted is a parameter defined in GSM 05.08 par. 7.2 as a bitmap of 8 bits to select the NCC of the cells that can be measured and reported by the MS in dedicated mode.

IDLE MODE OPERATION
Cell Selection in Idle Mode

Two methods:
a) Normal cell selection
b) Stored list cell selection (opt)

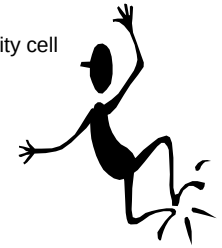
If no suitable cell found with with method b) then a) is tried.

New

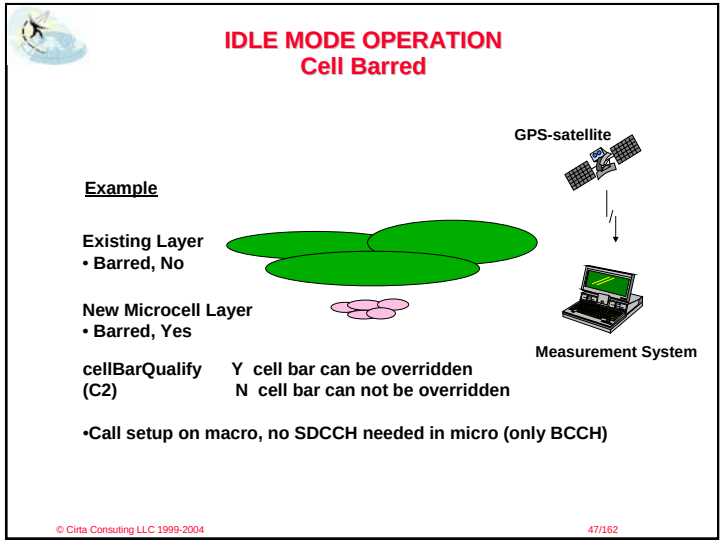
Stored list is the list of the BCCH frequencies used in the NW. Maybe achived during the previous contact with that PLMN?????

IDLE MODE OPERATION
Suitable cell to camp on

- Cell is in the selected PLMN
- Cell is not barred
- It is not in a forbidden location area for national roaming
- C1 >0
- If there is no normal priority cell then low priority cell



New



We may not want the MSs camp on some cells.Those cells are barred.So an MS comes to those cells only by HOs. The information of a cell being barred is in the system info on BCCH.

cellBarQualify = The parameter indicates whether cell barring can be overridden in C2 microcell re-select.

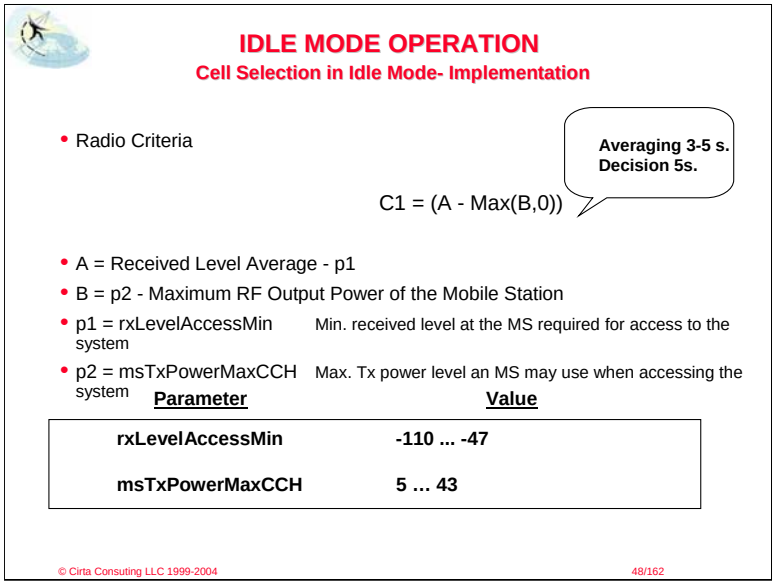
The parameter cellBarQualify contributes defining the priority of the Cell in Cell Selection in combination with the cellBarAccess.

Value Yes indicates that Cell-Barring is overridden in Cell re-selection

cellBarQualify = The parameter indicates whether cell barring can be overridden in C2 microcell re-select.

In cell selection a cell with low priority will be selected only if a suitable cell with normal priority cannot be found (GSM 03.22). Cfr. Slide "C2 Parameters" in the additional set.

cellBarQualify	cellBarred	Cell Selection Priority	Reselection state
N	N	normal	normal
N	Y	barred	barred
Y	N	low	normal
Y	Y	low	normal



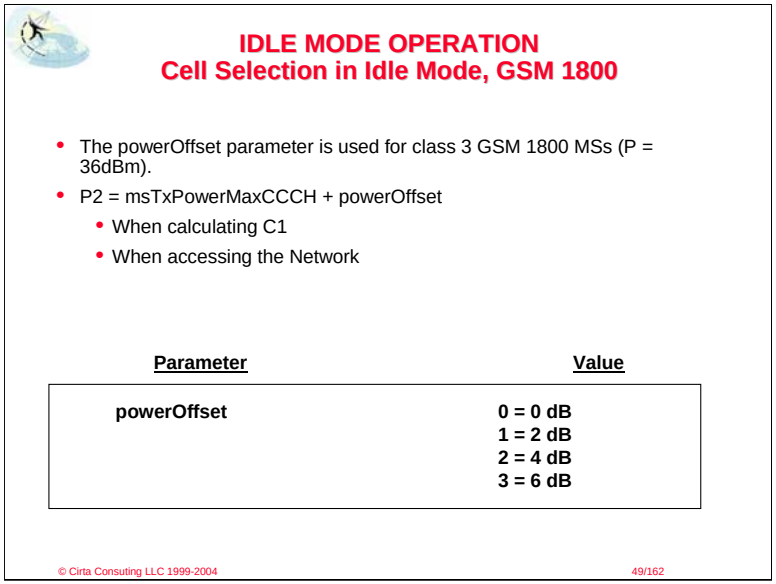
Cell Selection is based on C1, when the MS has no prior knowledge of which GSM channels are BCCH carriers.

Cell reselection was also based on C1 in Phase1, now is based on C2 (Phase2), and takes place when the Mobile is camping on a cell.

The measurements for Cell Selections are based on 5 samples spread over 3-5 seconds for each BCCH carrier and decision has to be taken within 5 seconds.

The re-selection requires the MS to measure the 6 strongest BCCH carriers in the BA list. The BA list is given in the cell that the MS is currently camping.

One interesting thing is that p1 and p2 appear with the same sign in the equation. Therefore if one is decreased (rxLevAccessMin -102 -> -104)the other has to be increased (msTxPowerMaxCCH 33 -> 35) and viceversa



NEW

GSM specs 05.08 clearly say that "the power offset will be used in conjunction with the MS_TX_POWER_MAX_CCH parameters by the class 3 DCS 1800 MS"

and

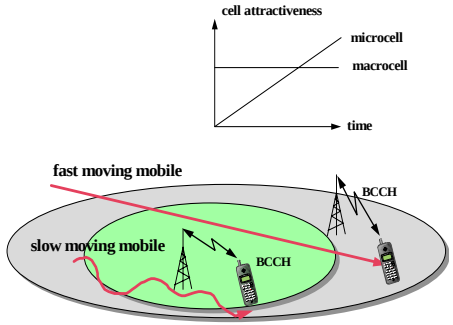
When accessing a cell on the RACH and before receiving the first power control command,… The class 3 DCS 1800 MS shall use the power level defined by MS_TX_POWER_MAX_CCH plus the value POWER_OFFSET also broadcast on the BCCH of the cell.

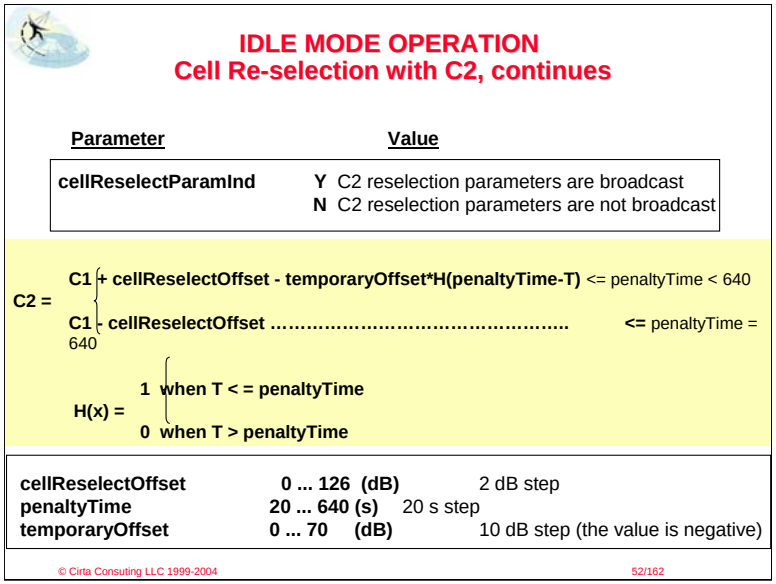
IDLE MODE OPERATION
Cell Re-selection in Idle Mode

MS will calculate the C1 and C2 for the serving cell, every 5 s
MS will calculate the C1 and C2 for the neighbour cells, every 5 s

Cell re-selection is needed if
- Path Loss criterion C1 < 0 for cell camped on ,for more than 5 seconds.
- There is DL signalling failure
- The cell camped on has become barred.
- There is a better cell in terms of C2 criterion
- A random access attempt is still unsuccessful after " **maxNumberRetransmission** " repetitions.

IDLE MODE OPERATION
Cell Re-selection with C2





The idea is that

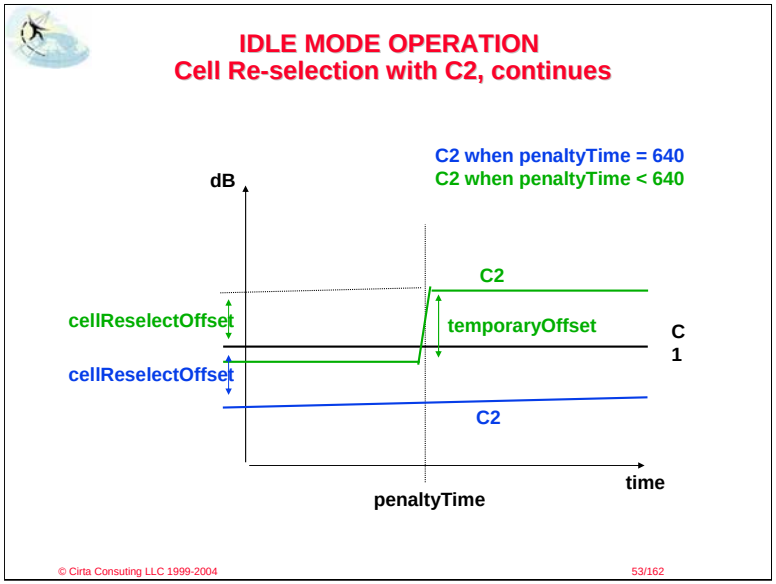
It is possible to reduce the accessibility to a cell of a quantity cellReselectOffset. In this way accessin that Cell is more difficult. This is the case of penaltyTime = 11111=640.

On the other hand it is possible to make the access to a cell more favourable when penaltyTime < 11111. This is the case of a Microcell which has to gather more traffic than the pure radio conditions would allow.

The point is however that Microcells are small and what really matters is how small they are, compared to the speed of the MS. If the MS moves fast it shouldn't camp on the Microcell. Therefore the Microcell is hidden for a while by means of a temporaryOffset which is valid for penaltyTime.

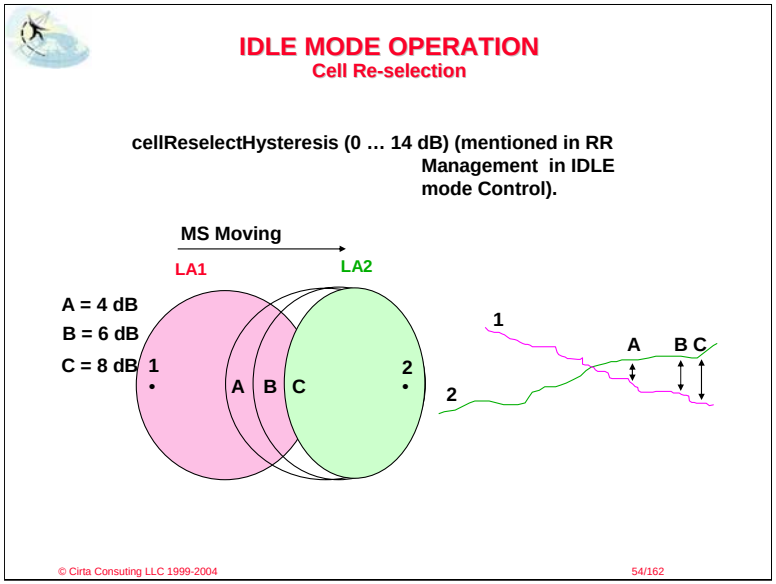
More precisely when the MS sees the cell in the six strongest neighbours it starts the timers. The timer is reset if the cell is removed from the 6 strongest neighbours.

640 = 31 * 20



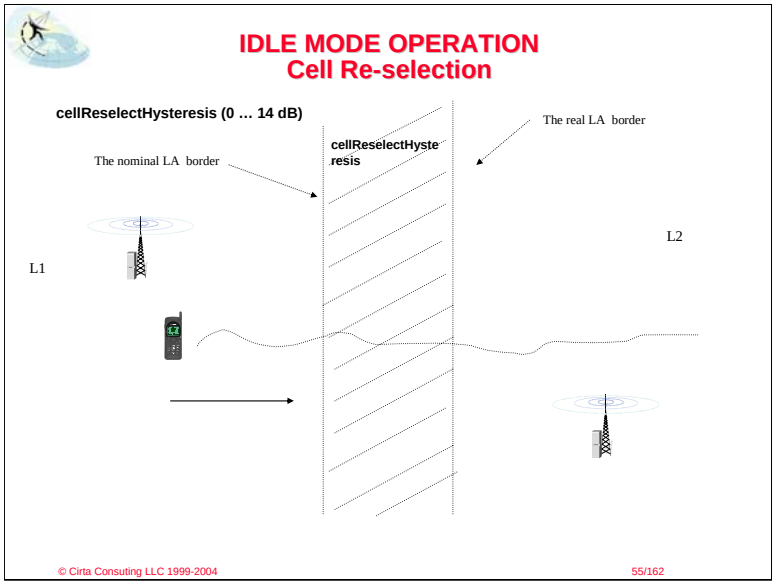
Please note that according to GSM specs,

if cellReselectParamInd = Y	C2 parameters are broadcast on the BCCH.
If cellReselectParamInd = N	or hasn't been received then CellBarQualify has to be put to 0=N, all of the C2 parameters are set to 0 and C2 = C1.

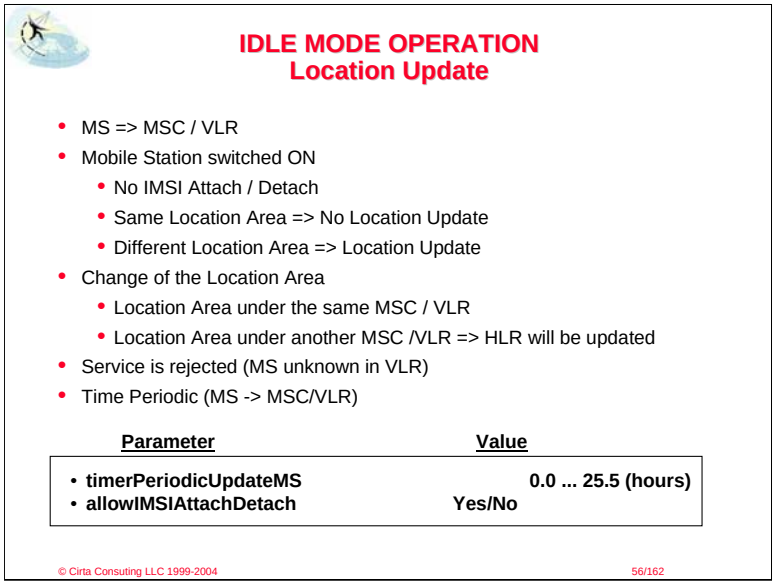


Normally the cell re-selection is harmless in terms of signalling from the point of view of the Network.

However when the process involves a change in the Location Area the MS will recognize the need for a Location Update. To avoid ping pong effects on the border of a Location Area, an hysteresis is introduced



@Please use it if you like the slide. Optional



MODIFIED

When the MS is switched on, the action taken by the location updating process is :

a) SIM present and no LU needed (because of the status of the stored LAI and "attach" flag): The MS is in the update state UPDATED;

b) SIM present and LU needed: A LU request is made;

c) No SIM present: The MS enters the update state Idle, NO IMSI.

Furthermore, an LU request indicating Normal Location Updating is also made when the response to an outgoing request shows that the MS is unknown in the VLR.

The timer for the Periodic Location Updating is broadcast by the Nw in the System Info 3 within the CCCH description. This timer is T3212.

A timer in the MS is started randomly and when it reaches T3212 a Periodic LU is required.

Periodic Location Update is a compromise between the load in terms of signalling between the MS and the VLR (!) for frequent periodic LU and the risk of the MS not being reached in case of a MTC if for some reason the information in the VLR looses its validity or is lost.

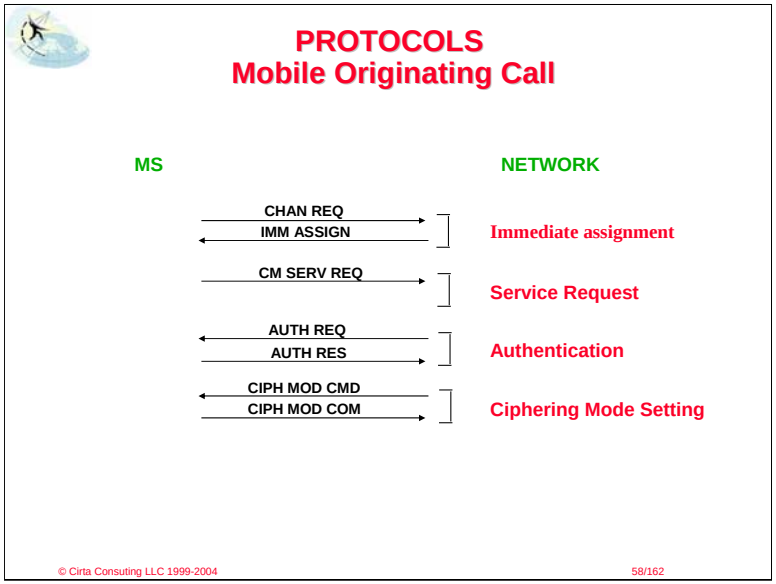
The BCCH will contain an indicator indicating whether or not IMSI attach/detach operation is mandatory :

allowIMSIAttachDetach

When IMSI attach/detach operation applies, a MS shall send the IMSI detach message to the network when the MS is powered down.

PROTOCOLS
Contents

1. Mobile Originating Call
2. Mobile Terminating Call
3. Location Update
4. Disconnect
5. Handover
   - Synchronized
   - Non-Synchronized
   - Failure



CHAN REQ	Channel Request message The MS, on the RACH tells the Nw that it wants service and it gives the reason for the request
IMM ASSIGN	Immediate Assignment on AGCH The Nw assigns a SDCCH (normally) to the MS to complete signalling

After sending the IMM ASS, the network starts timer T3101.

The MS tunes to the assigned SDCCH and starts establishing the signalling link. There are two Layer2 messages SABM (MS -> Nw) and UA (Nw -> MS). When the Nw receives the SABM it stops timer T3101 The SABM contains a Layer3 message which in our case is

CM SERV REQ Call Management Service Request The MS explains which service it wants, plus some other information for identification.

UA is the answer from the Network which contains exactly the same message.

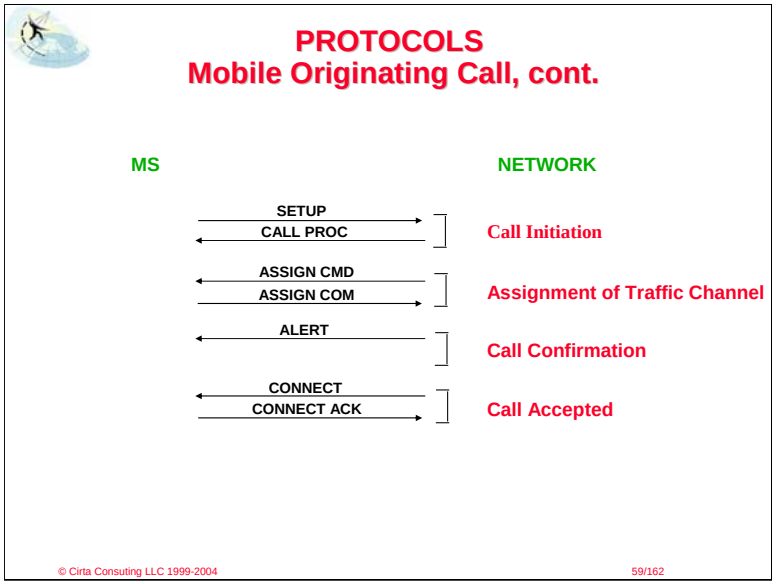
AUTH REQ	Authentication Request The Nw (VLR) sends the MS a Random number (RAND 128 bits). The MS calculates the answer SRES based on an identification key Ki and RAND using algorithm A3
AUTH RES	Authentication Response The MS sends SRES to the Nw (VLR) that compares it to the one it has calculated.

The RAND is also combined to generate (with algorithm A8) the cyphering key Kc which is then used with algorithm A5 to encode speech

CIPH MOD CMD Ciphering Mode Command is sent by Nw to MS

CIPH MOD COM Ciphering Mode Complete is the answer

SABM	Set Asynchronous Balanced Mode
UA	Unnumbered Acknowledgement



SETUP The MS sends to the Nw (MSC) the called subscriber number

CALL PROC Call Proceeding is the answer from the Nw to tell that the requested connection has been started

The MS is still on the SDCCH and is now time to move onto the TCH.

ASSIGN CMD Assignment Command Tells the MS which channel to go to. Information about the channel rate, the tx power are given, together with infor about Frequency Hopping

The MS moves to the new channel and sends a Lyer2 message (SABM). The Nw sends an acknowledgement by means of a Layer2 message (UA)

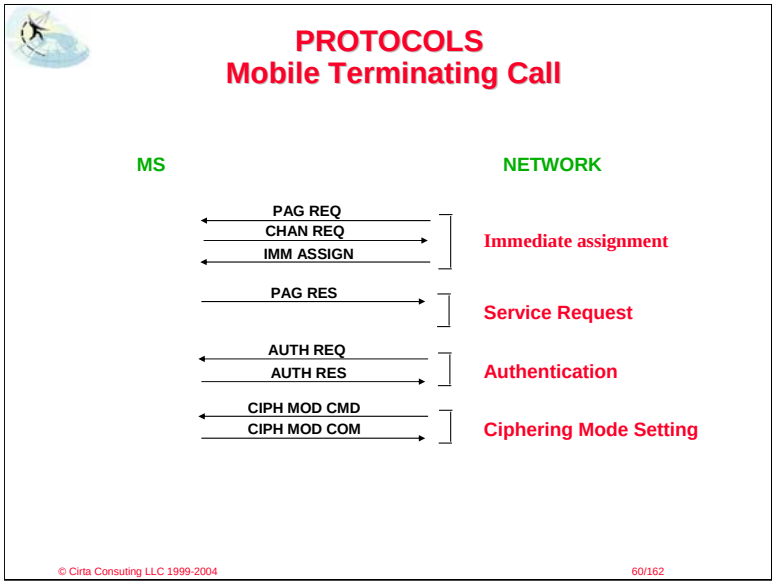
ASSIGN COM Assignment Complete The MS has successfully seized the TCH

The SDCCH is then released by the Nw.

ALERT The MS is informed that the complete called party number has been received by the destination exchange.

CONNECT The call has been accepted by the called subscriber

CONNECT ACK Connect Ackcnowledgement. The connection between the two subscribers is ready to be used.



PAG REQ Paging Request When the Nw searches for a MS it sends the paging via all the BTS in the LA where the MS is located.

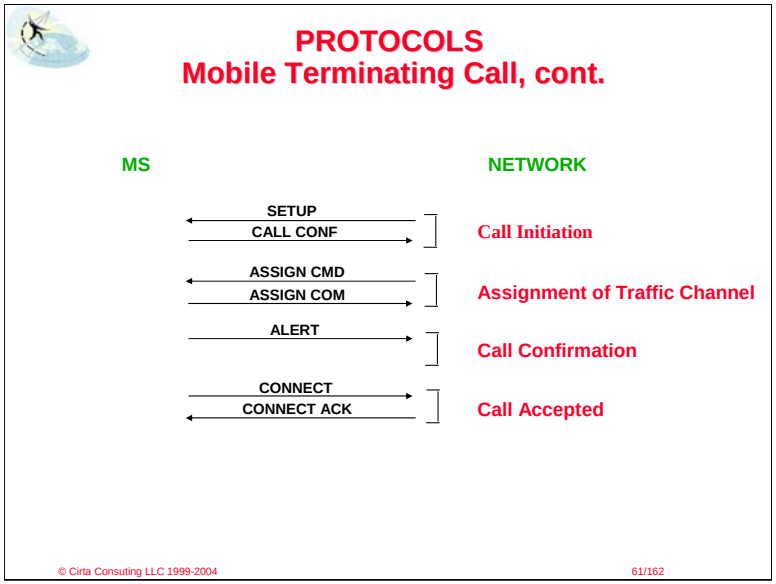
CHAN REQ The Channel Request sent by the MS to the Nw contains as Establishment Cause "Answer to Paging"

IMM ASS SDCCH is assigned by means of Immediate Assignment on the AGCH.

PAG RES The answer to the Immediate Assignment is a Layer2 message (SABM) which contains a Layer3 message. This time is a Paging Response

Authentication is the same as in the MOC

Ciphering is the same as in the MOC



SETUP The major difference with the MTC is that the SETUP message is from the Nw to the MS to inform it of the incoming call

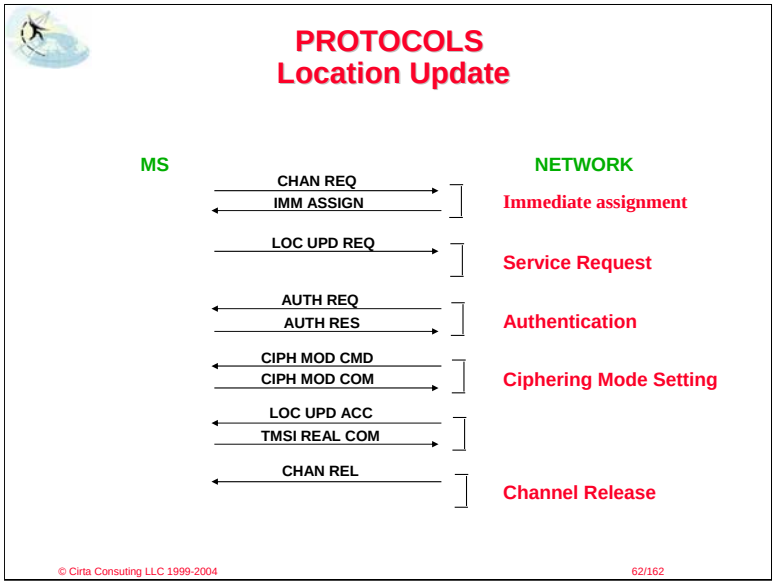
CALL CONF Call Confirm is the answer from the MS

The Assignment procedure is the same

ALERT This is also in the opposite direction than in the MOC. The MS has started ringing and tells this to the Nw that can send the Alert to the calling party.

CONNECT This is when the called party answers

CONNECT ACK The Nw confirms that the connection is ready to be used.



CHAN REQ Channel Request message The MS, on the RACH tells the Nw that it wants service and it gives the reason for the request

IMM ASSIGN Immediate Assignment on AGCH The Nw assigns a SDCCH (normally) to the MS to complete signalling

The MS gets the SDCCH and sends a SABM as answer to the Immediate Assignment with a Layer3 message.

LOC UPD REQ The MS tells the Nw that the reason for asking service is a Location Update

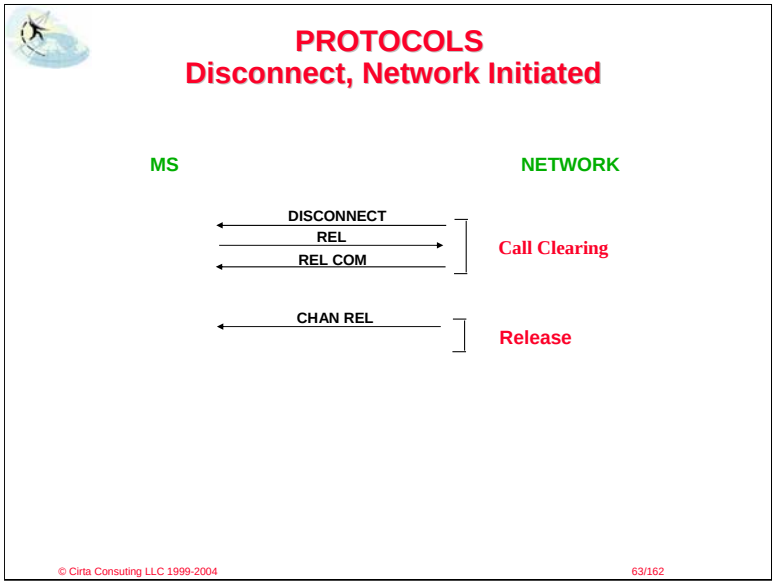
Authentication is the same as in the MOC

Ciphering is the same as in the MOC (the main difference is that ciphering is needed if TMSI has to be sent to the MS)

LOC UPD ACC Location Updating Accepted is sent as answer to the MS after updating all the necessary information in the VLR / HLR. It may include a new TMSI

TMSI REAL COM TMSI Reallocation Complete The MS acknowledges the new TMSI

CHAN REL The Nw sends a Channel Release command to the MS



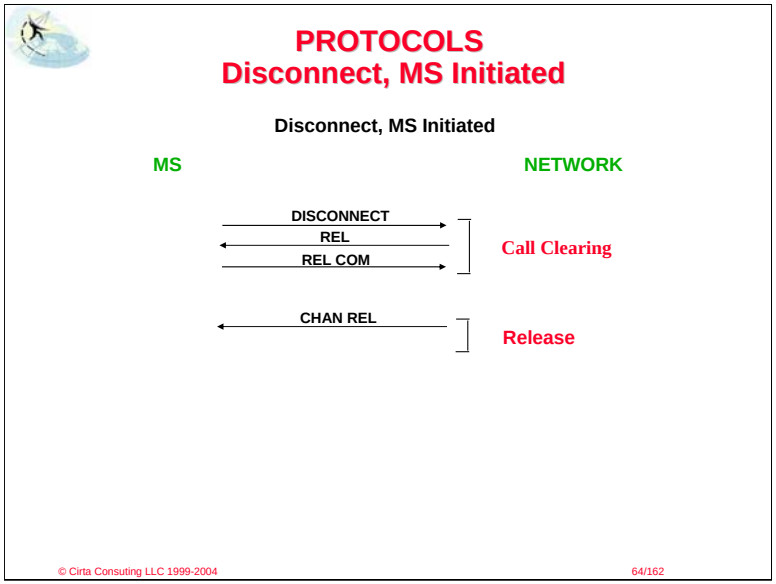
MODIFIED

Channel Release is from the Nw.

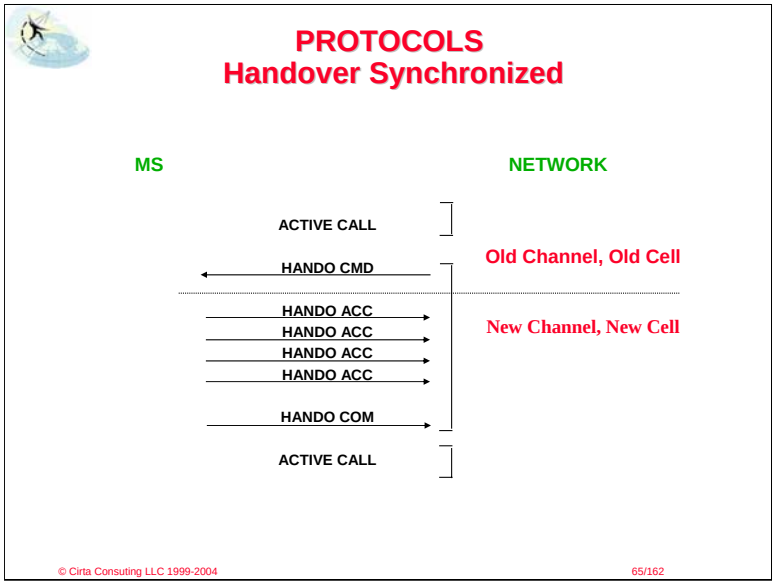
DISCONNECT	The Nw sends to the MS an invitation to clear the call
REL	The MS sends a Release to the Nw as answer to the Disconnect message

Upon receipt of a Release, the Nw releases all MM connection and returns to the null state

REL COM	Release Complete is sent to the MS that in turns releases all MM connections and returns to the null state
CHAN REL	The Channel Release is used by the Nw to tell the MS to release the Physical Channel.



DISCONNECT	The MS sends to the Nw a Disconnect in order to clear the call. This message stops charging.
REL	The Nw sends a Release to the MS as answer to the Disconnect message
REL COM	Release Complete is sent by the MS to the Nw as acknowledgement
CHAN REL	The Channel Release is used by the Nw to tell the MS to release the Physical Channel.



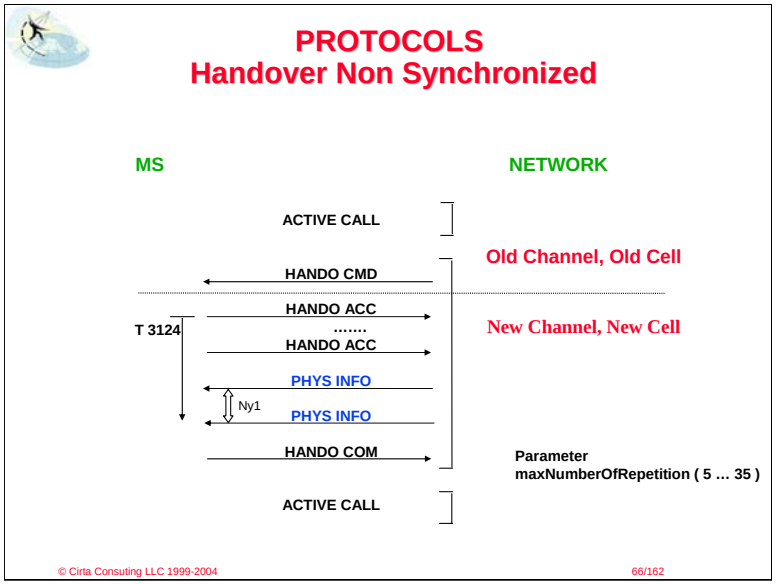
HANDO CMD Handover Command (or Assignment Command in case of an Intra Cell HO). It describes to the MS the new channel it has to seize in the HO attempt.

HANDO ACC Handover Access is sent by the MS in the new channel (FACCH) with an Access Burst (short). It is sent 4 times in consecutive TSL

After this the MS sends a SABM to set the link layer. The Nw sends back a UA and as a consequence the MS can send a

HANDO COM Handover Complete (or Assignment Complete in case of Intra cell handover). Is the message that is then used by the Nw to release the old channel.

In case of a Synchronized handover, the MS doesn't need information about Timing Advance (and Frame Number ?)



HANDO CMD	Handover Command. It describes to the MS the new channel it has to seize in the HO attempt.
HANDO ACC	Handover Access is sent by the MS in the new channel (FACCH) with an Access Burst (short). It is sent several times until the MS receives a:
PHYS INFO	Physical Information. It contains various physical layer related information, allowing a proper transmission by the MS.

When sending the first Handover Access the MS starts timer T3124 (320 msec.).

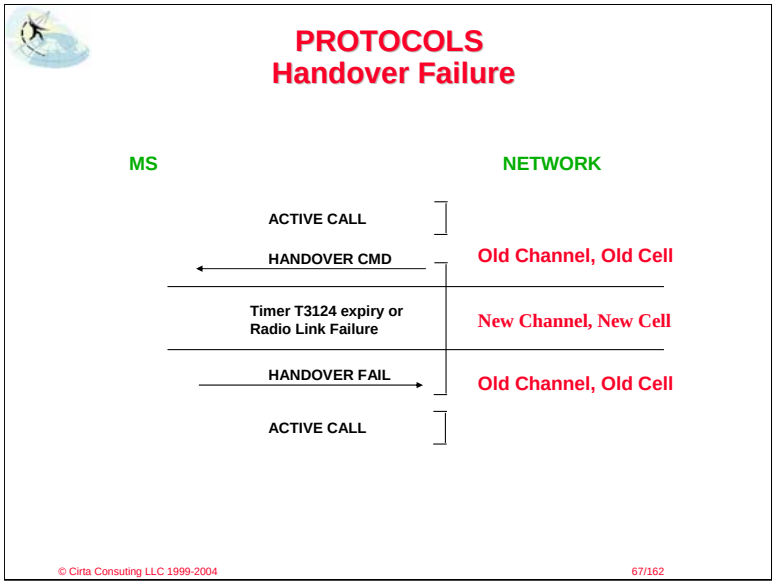
The Physical Info is sent by the Nw which starts timer T3105.

When the MS receives a Physical Info, it sends a Layer2 message (SABM) which is acknowledged by another Layer2 message (UA).

If timer T3105 expires without SABM reception, another Physical info is sent. The maximum number of times that the Physical info is sent is defined by the parameter

Ny1 = "maxNumberOfRepetition"

Therefore T3124 waits for the Physical Info, T3105 schedules the repetition of the Physiscal Info.



If something happen so that the MS is not capable of accessing the new channel, it may return to the old channel where it sends a

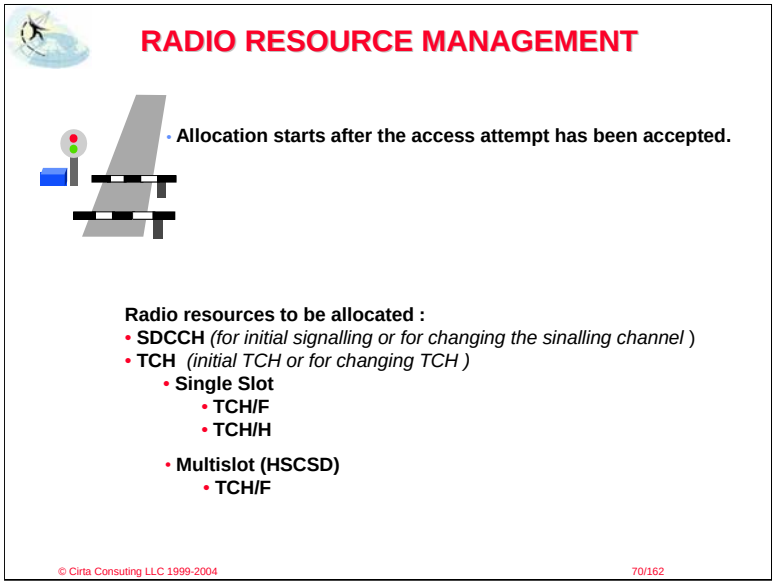
HANDOVER FAIL Handover Failure

and the call is continued in the old channel.

RADIO RESOURCE MANAGEMENT

RADIO RESOURCE MANAGEMENT Contents

1. Traffic Channel Allocation
2. Priority in TCH Allocation
3. FACCH call set up
4. Preferred BCCH TRX
5. Frequency Hopping
   - BB, RF, Freeform RF Hopping
   - Flexible MAIO Management
6. DR and IDR
7. Queuing
8. Call Drop Control
9. Dynamic SDCCH



New

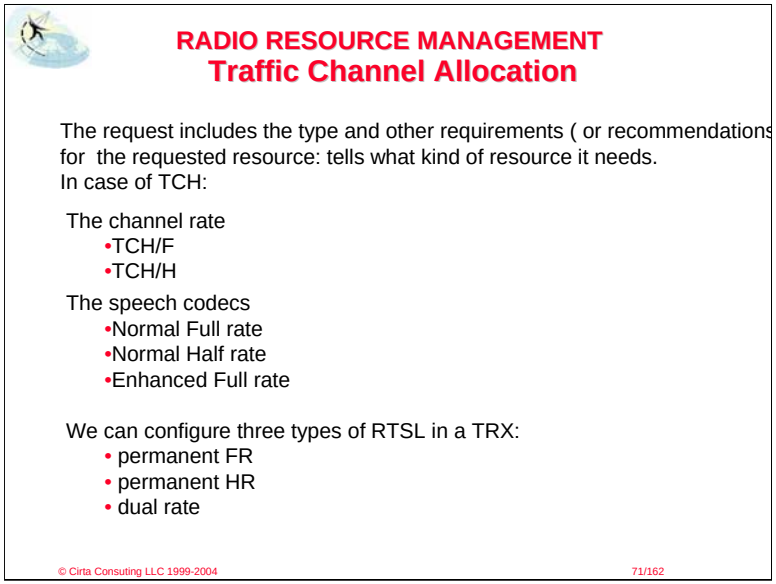
Quite complicated process.

The outline of the principals of the RR allocation in the BSC.

After the access is granted.

Basic types of the RR resources ….

Two basic algorithms for TCH ; Single slot , multi slot . Also for the regular TCH and super-reuse TCH there are differences.



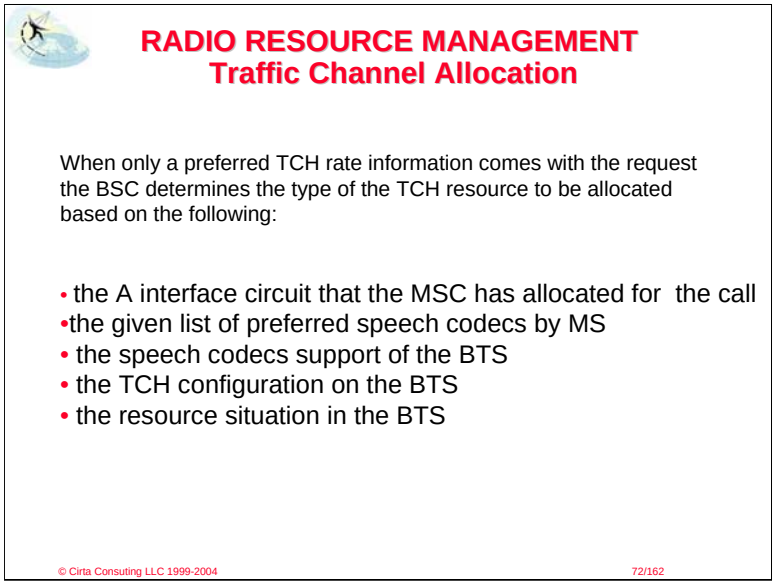
New

The following are used to determine which kind of resourse to allocate:

The resource request determines the type of the required channel, which is either an SDCCH or a TCH.

In the TCH case the request can define the rate of the channel (TCH/F or TCH/H) explicitly or it can give only a recommendation of the preferred TCH rate if both a HR channel and a FR channel can be accepted.

Along with the channel rate requirement or recommendation, for speech calls there is a list of preferred speech codecs that are allowed to be used on the requested channel. In order for a certain rate type of channel to be allocated in a cell it must have a suitable codec on the codec list of the request. In addition to this, the target BTS must support the speech codec in question.



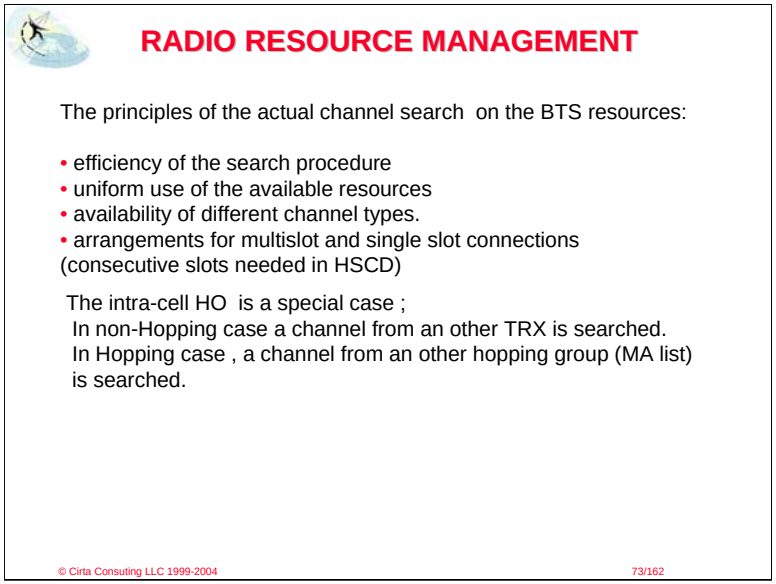
New

This slide is for summarizing what factors affect the DECESION of the BSC for RR allocation. There could have been restrictions for all factors like:

MS coould only be a Half rate MS

BSC does not support Halfrate speech codecs

There is no Dual rate or Half rate TSL free on the BTS.



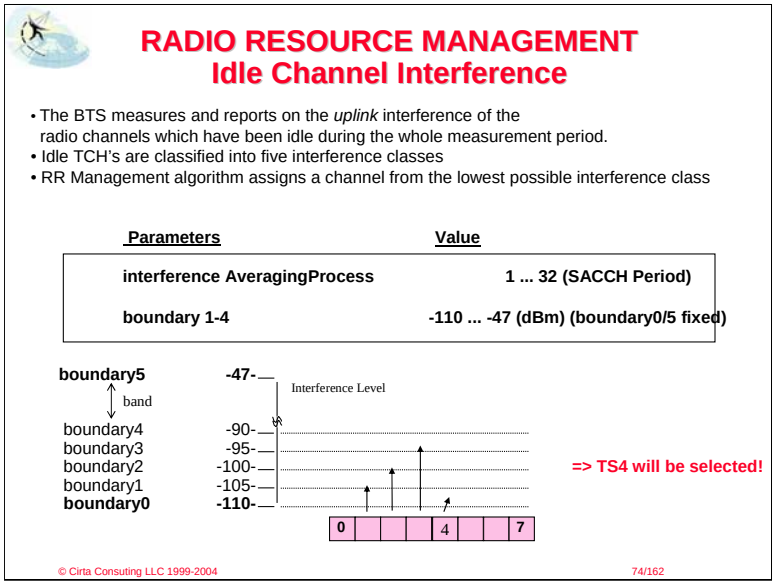
New

1. Roughly checking of the available resources on a BTS

2. It tries to use all the TRXs, RTSLs and subchannels equally frequent.

3. Optimize the resource availibility for différent type of RTSLs.Like if one Half rate subchannel of a dual rate RTSL is used, the other Half rate subchannel will be allocated first, instead of using again the half of an other Dual rate RTSL.

4. Single slot alocations will start from the edges of the TRXs leaving the centre for consecutive TSLs allocation (needed for High Speed Data).



Additionally the BSC tries to allocate a channel with a lowest possible interference.

The idle channel inteference level measurements are used for this purpose. They are normal SS measurements on the idle channels. However as there is no traffic all we measure is interference. This channel allocation criterio based on C/N is also valid for intra- BSC inter-cell HO. Additionally some BTSs can also measure idle channle C/N even immidiately after the channel release.

MODIFIED

Part of one slide related to Interference measurements and part of another slide showing the boundaries.

Note that the boundaries 0 and 5 are fixed, that is why the parameter include boundaries 1 - 4.

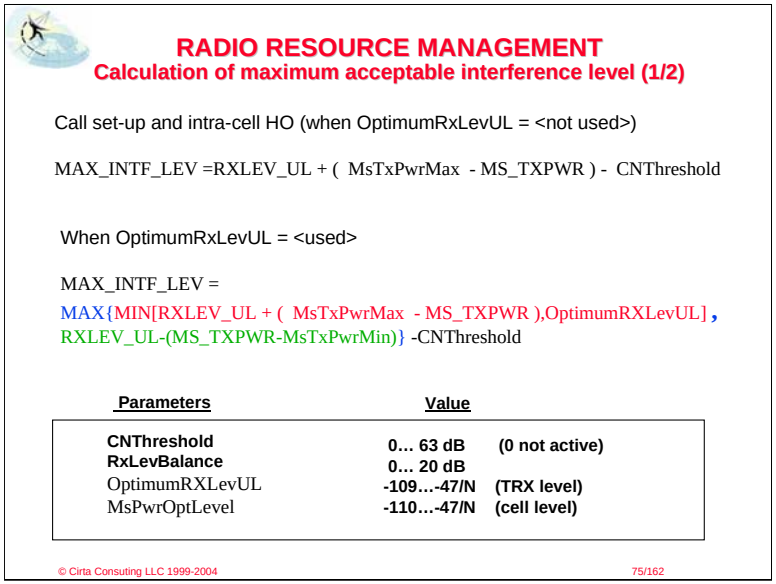
Active channel interference estimation

In S6 the BTS can measure the Uplink interference on Active Channels

• in silent timeslots when UL DTX is used

• in Full Rate channels during the 4 idle TSL in the 26-frames Multiframe

Additionally the interference UL is also considered for those TSL that haven been idle for the whole averaging period.

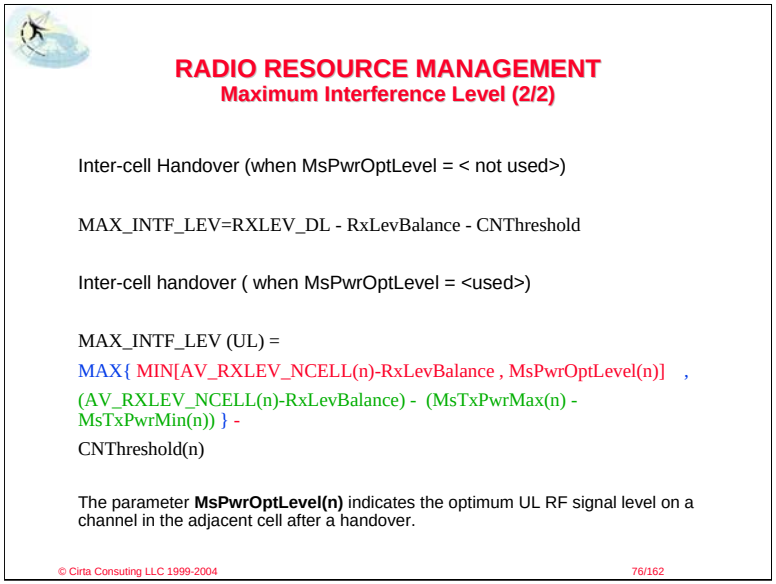


The BSC first calculates the maximum acceptable interference level MAX_INTF_LEV.

The calculation differs for call setup and Intra-cell HO from Inter-cell HO .

Also if Optimisation of the MS power level in handover and call set-up is employed the calculation will be different for the both cases.

After this calculation, the BSC tries to find appropriate channels for the traffic.

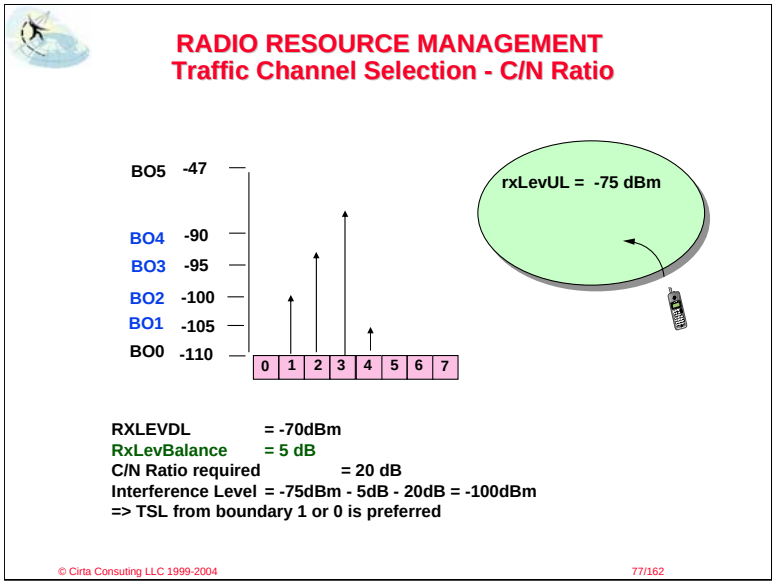


Note:

RxLev_DL-RxLevBalance gives an estimation of the UL Interference Lev of the adj cell.

CNThreshold (set on BTS level):

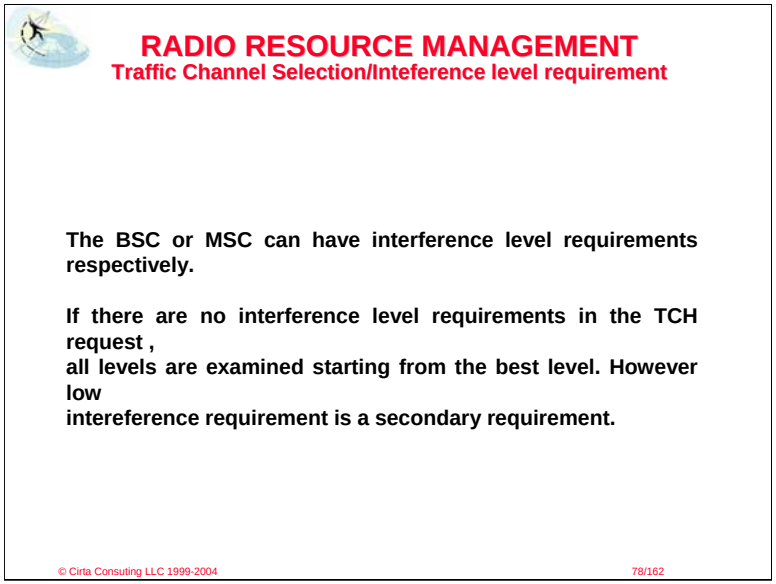
The parameter gives a recommendation about the minimum acceptable C/N ratio when selecting a time slot to be allocated for a call or handover.



The channel selection procedure is influenced by the idle channel interference levels measured by the base station. In a hopping BTS the idle channel interference measurements are done in all frequencies included in the Mobile Allocation list.

NOTE!

This example can be used for better explanation of the previous slides, but it could as well be skipped.



The TCH request can include two kinds of interference level requirements set by the MSC or the BSC respectively. If both of the interference level requirements are present, the channel is searched for according to the MSC requirement. In single slot TCH allocation a free TCH is searched for starting from the best allowed level (containing the least interference) and proceeding to the worst allowed level (containing the most interference allowed in the request).

When only the BSC has set its interference level requirement, which is merely a recommendation in regular TCH allocation, a free TCH is searched for initially among levels equal to or better than the one the BSC recommends. n single slot allocation the TCH search is performed starting from the level the BSC recommends and proceeding towards the best interference level. If no available TCH can be found on these levels, also interference levels worse than the BSC recommends are examined. In single slot allocation the search outside the recommendation is made starting from the best level and proceeding to the worst.

If no interference level demands are found in the TCH request, all interference levels may be examined. In single slot allocation the search starts from the best level. However, low interference is regarded as a secondary criterion and a TCH in a permanent rate TSL is allocated if there is one available.

Simplify it!

RADIO RESOURCE MANAGEMENT

TRX PRIORITISATION IN TCH ALLOCATION

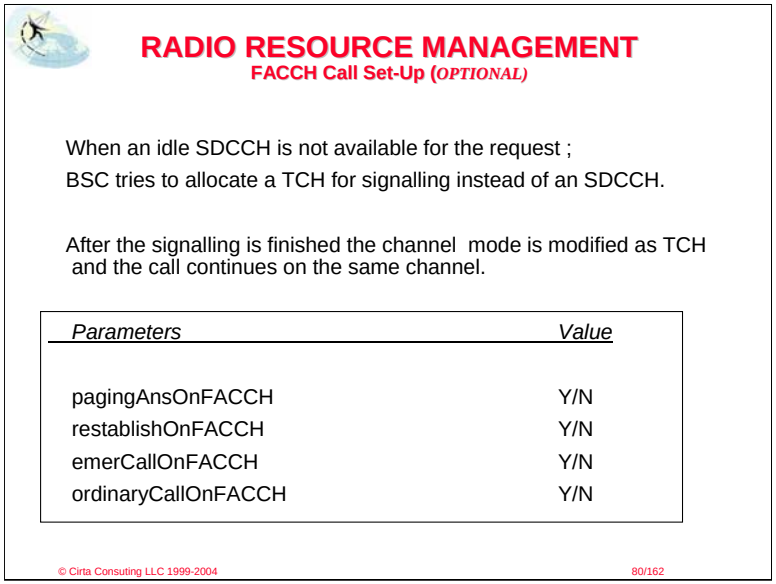
- **The advantages of using the BCCH carrier for call set up:**
  - **It would not increase interference in the network**
  - **BCCH channels are planned to be the least interfered one**
- **The advantage of using the TCH TRX for call set up:**
  - **The hopping gain**

It is possible to set priority between the TCH TRXs and BCCH TRX.

Parameters	Value
TrxPriorityInTCHAllocation	0 … 2 where 0 = no preference 1 =BCCH preferred 2 =Beyond BCCH preference

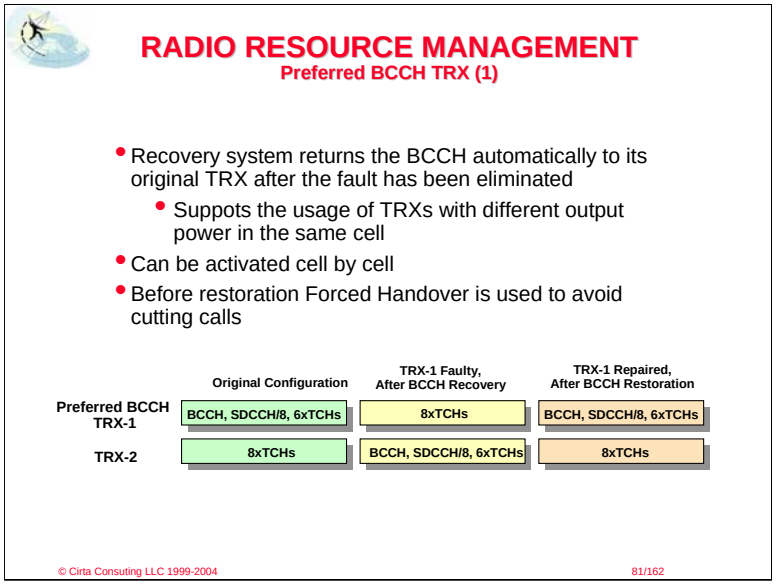
Normally the parameter value is 0, equal priority between BCCH TRX and TCH TRX. In RF FH case it is experienced that 2 is performing better.

About first bullet in Advantage in using BCCH preference: reason is due to the fact that BCCH sends at full power anyway.



This feature is not used much .

OPTIONAL (FACCH Call Set Up)You can set the FACCH call setup feature ON or OFF in PRFILE.



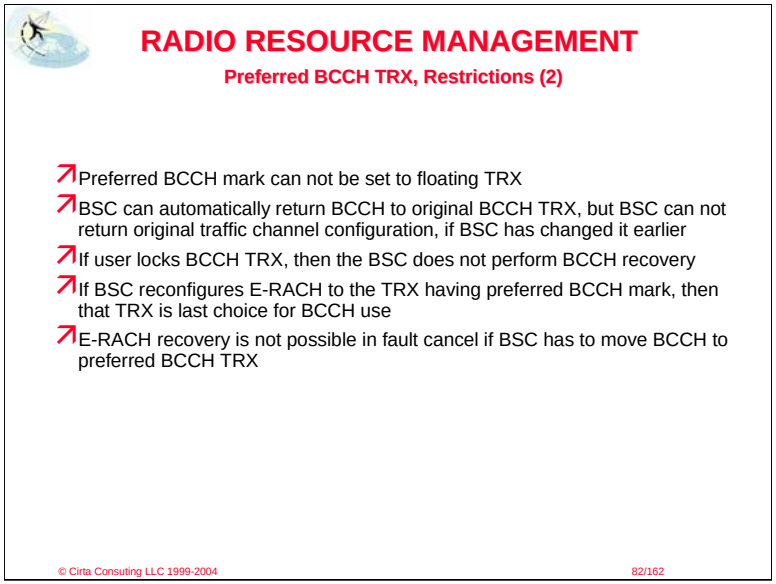
INTRODUCTION

The TRXs are not always similar within a cell as regards to the antenna power, Abis transmission or for example to the safety of the power feed. This may result in a requirement of keeping the BCCH on a certain physical TRX always when possible.

However, a fault concerning the BCCH TRX initiates the reconfiguration procedure, which moves the BCCH to another TRX. The change in the configuration remained permanent before the S7, even if the broken TRX is restored. Restoring the original TRX configuration required manual actions.

This feature enables the recovery system to return the BCCH automatically to its original TRX after the fault has been eliminated. Manual actions are not needed any more to keep the BCCH permanently on a particular TRX. The feature utilises the forced handover procedure to avoid cutting any calls.

The feature is controlled by a TRX parameter, which forces the recovery system to configure the BCCH back to a particular TRX of a cell, i.e. to the Preferred BCCH TRX. It is possible to mark more than one TRX of a cell as preferred, in which case the recovery system selects one of the marked TRXs for the BCCH.



BSC may change the traffic channel configuration in the following situations:

1. If Half rate feature is in use and Abis timeslot allocation is optimized so that BCCH RTSL don't have Abis allocation, then BCCH recovery may decrease the number of traffic channels. (then the alarm 7727 Traffic channel number decreased is set) If the BSC reconfigures BCCH to the original TRX then the BSC sets the swapped traffic channels always as full rate channels though they may have been half rate channels.

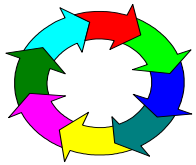
2. If Half rate feature is in use and all TRXs in cell do not support half rate then BCCH recovery may decrease number of traffic channels. (then the alarm 7727 Traffic channel number decreased is set)

E-Rach recovery is not possible in fault cancel, if BSC has to move BCCH to preferred BCCH TRX, because BSC can not handle two reconfigurations in one scenario. E-RACH stays blocked even though there is working TCH TRX.

Recommendation: this much detail is not necessary. No need to use everytime.

RADIO RESOURCE MANAGEMENT
Frequency Hopping

Frequency hopping is changing the carrier frequency during the connection.



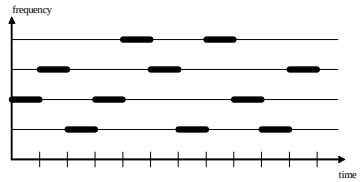
- **Originated from military transmission systems .**
- **The Frequency Hopping (FH) in GSM is slow FH which means that the frequency changes per burst bases ,it does not change during the transmission of the burst.**

New

optional info: you can show it or not.

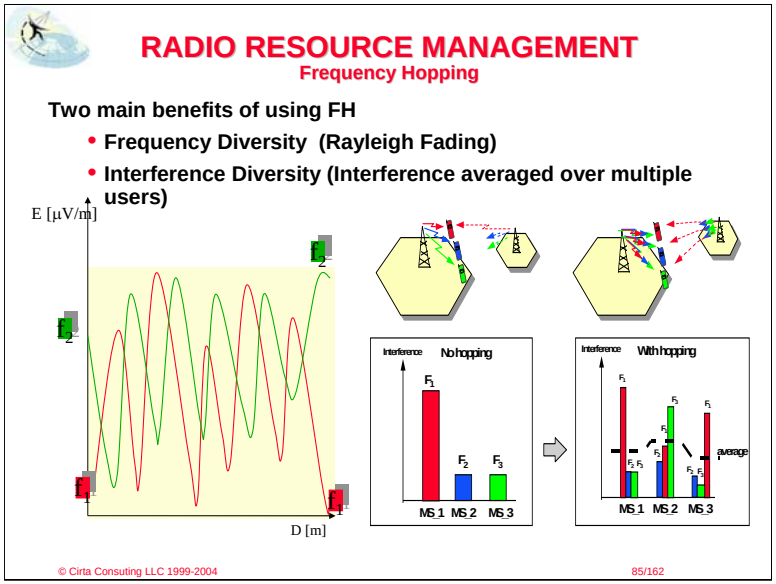
RADIO RESOURCE MANAGEMENT

Frequency Hopping



- **The frequency remains the same during the burst (0. 577 ms).**
- **All dedicated channel types can hop (TCH/SDCCH/FACCH/SACCH)**

SDDCH can hop if it's other than BCCH.



New

1 Frequency diversity: The multipath fading (Rayleigh fading)is a property of the radio propagation. And in the distribution of this fading depends on the frequency of the radio signal. And the fading of different signals become more and more independent if the difference between frequencies increase. So as the dips and peaks of signals at different frequencies are at different locations, the FH hopping can help the stationary or slow moving MSs. So without FH a slow MS could be stationary at a dip location of the frequency its call is using for many burst causing bad C/I, quality , long time. But if there is FH it has high probability to have a good call as the other frequencies would not have a dip at the same location.

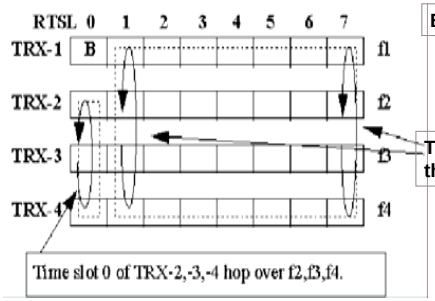
Frequency diversity would not affect fast moving mobiles.

Gain could be theorically around 5-6 dB.

2. Without the FH call on a interfered frequency would experience bad quality all the time .With the FH the interference is spreaded to all the calls on that cell, noone will have very bad or very good calls but everyone wil have good enough calls, also with the help of speech codings and interleaving.As the speech coding and interleaving are more efficient with changing interference.

RADIO RESOURCE MANAGEMENT

BB Hopping



B= BCCH TSL. It does not hop.

TSL 1….7 of all TRXs hop over the MA list (f1,f2,f3,f4)

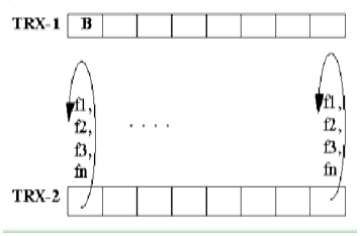
BB hopping on 4 TRXs. Also the BCCH TRX is hopping except on RTSL-0.
The call is hopping over TRX (TRX keep the same frequency as planned)

New

Optional

RADIO RESOURCE MANAGEMENT
RF Hopping

B= BCCH TSL. TRX does not hop.



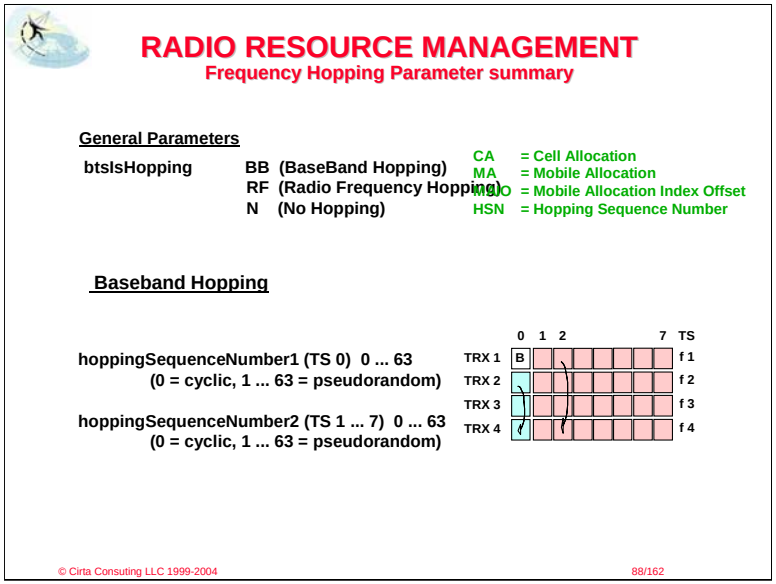
Non BCCH TRXs are hopping over the MA-list (f1,f2,f3).

RF hopping in 2-TRX cell. The BCCH TRX cannot hop because the BCCH frequency must be continuously transmitted in a cell.
TRX will physically change frequency along a specified MAL.

New

Optional

The frequencies in the MAL are ordered in the ascending order in respect to Frequency number



There are two types of Hopping Modes : Base Band Hopping and Synthesized Hopping

Base Band Hopping

Bit streams are directed to different TRXs. TRXs keep their frequency.

TSL0 of BCCH TRX never hops, but the other do as long as the BCCH TRX is always on air. Dummy Burst are used for this purpose.

There are two hopping groups one for TSL 0 non-BCCH TRXs, the other for TSL 1..7 all TRXs. Therefore two HSN are needed, and two MA are calculated.

In the first group MAIO goes from 0 to N-2, in the second goes from 0 to N-1 where N is the number of TRXs.

Synthesized Hopping

TRXs change their frequency according to the Hopping Sequence generation.

The BCCH TRX doesn't hop There is only one Hopping Group including all TSL of non-BCCH TRXs. HSN1 is taken into account. Generally HSN1=HSN2 is set.

There is only one Hopping Sequence Number.

HSN=0 is cyclic hopping. Others are different randomly generated sequences.Random sequences give more frequency Hopping gain as hopping sequencies of interefers could be less correlated in this case.

The MA can include any frequency (max 63) and has to be defined in the BSC (mobileAllocationList). It is identified by means of the mobileAllocationId and the association is created by means of the parameter usedMobileAllocation.

Different TRXs are given (automatically) different MAIOs to avoid conflict between TSL with the same TSL number

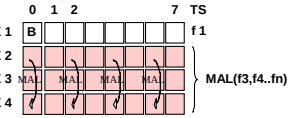
RADIO RESOURCE MANAGEMENT

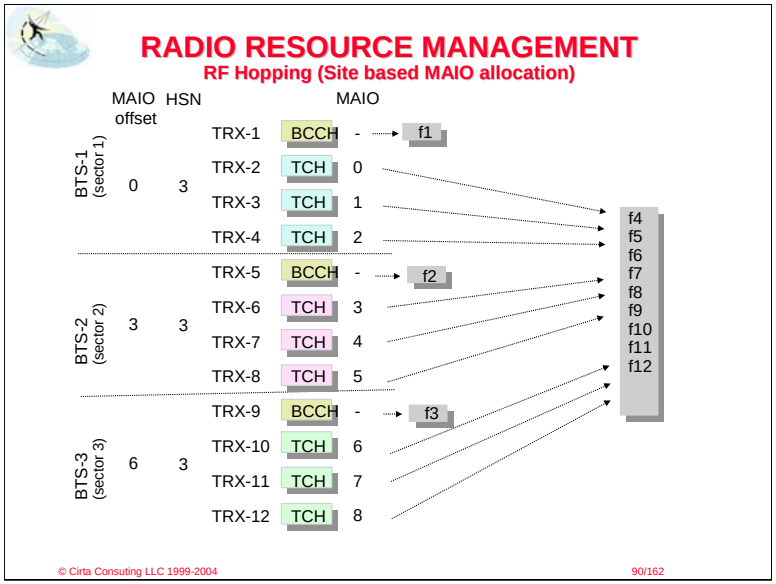
Frequency Hopping Parameter summary

RF or Synthesized Hopping

Synthesized Hopping (from 3rd generation BTS onward)

mobileAllocationList 1 ... GSM: 1..124 and 975..1023, 0
GSM 1800: 512..885
GSM 1900: 512..810
Note! Max. 63 Frequencies
mobileAllocationId 1 … 128
usedMobileAllocation 1 … 128
hoppingSequenceNumber1 0 … 63
(0 = cyclic, 1 ... 63 = pseudorandom)





MAIO Offset parameter (MO) defines the lowest value of the MAIO used in the Cell.

This allows using the same MA in all of the sectors of the Site. The advantage is that with the same band and the same re-use, the number of frequencies in the MA increases 3 times with much higher protection against both

-fading

- interference

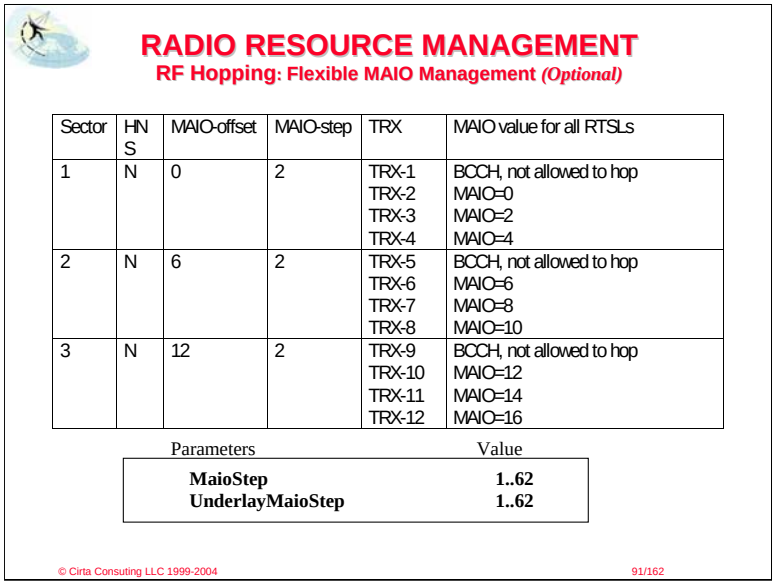
The idea is of course that the parametrization is such as to avoid collision between different physical channels. This means that the same frequency cannot be used (at the same time) by two different TRXs in the site.

The following must be fulfilled.

- Hopping Sequence number has to be the same in all of the sectors, otherwise collisions will take place regularly.
- Sectors must be frame synchronized i.e. the FN must be the same for all of them all of the time.
- N1, N2 and N3 are the numbers of TRXs in the three sectors. Then the number of Frequencies in the MA list must include at least (N1 + N2 + N3 - 3) frequencies. The frequencies in the MAL are ordered in the descending order in respect to Fruquency number
- MO is 0 in the first sector, N1 - 1 in the second and N1 + N2 - 2 in the third sector.

Two mistakes in the documentation

HSN is only one in RF FH. 128 possible MAL can be defined in BSC each with max 63 frequencies.

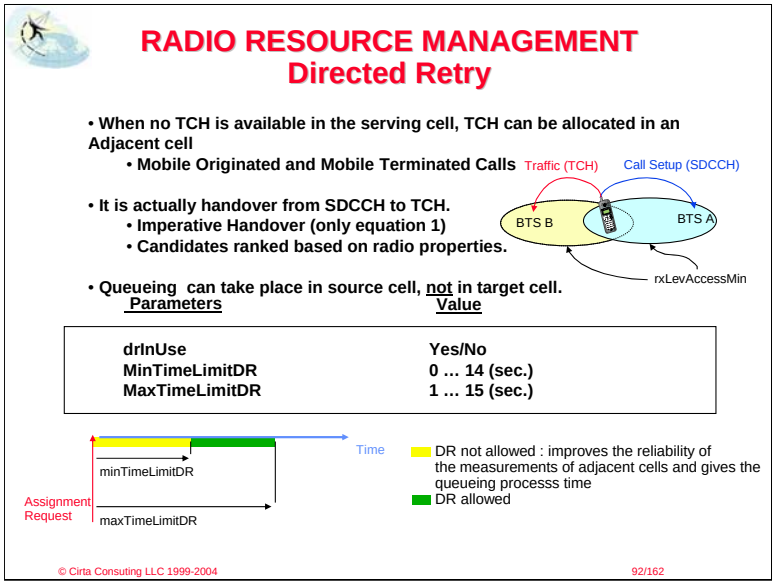


MaioStep

MS = decimal number

With this parameter you choose the MAIOs not to be allocated successively for the cell, but for instance every second or every third value. The values range from 1 to 62. However if the MAIO step is more than 1 ,the number of the frequencies in the MAL should be doubled, trippled … and so on.Otherwise there would be collisions , and the NMS will complain that MAL is short.

You can only modify this parameter when the BTS is LOCKED, underlay TRXs are LOCKED or the underlay hopping mode is not RF hopping.



Directed Retry is an Optional Feature and has to be enabled in the BSC. The command

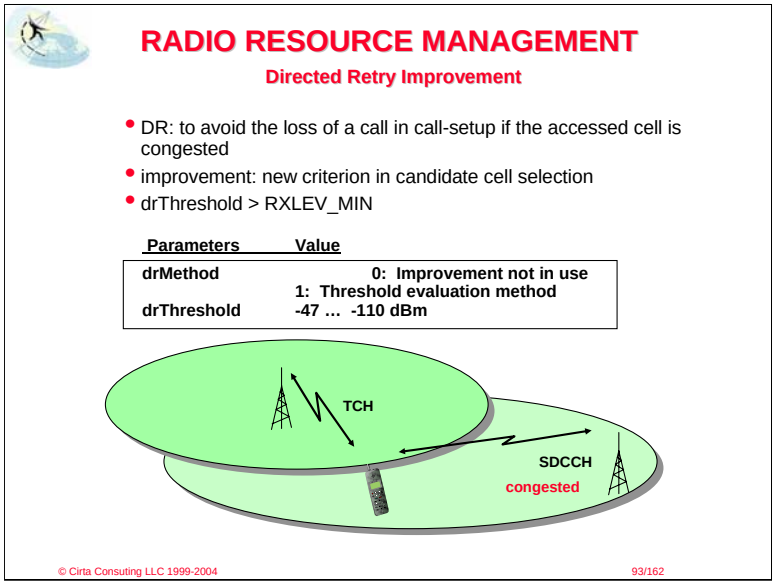
ZWOO;

lists the optional features in BSC and their status of activation.

Directed Retry is possible to adjacent Cells that belong to different BSC. In this case the BSC parameter "disable_external_directed_retry" has to be set to "NO"

Queueing can be active in the starting cell. During the period of DR not allowed/allowed, a TCH can be released in the serving cell and allocated. Therefore the DR retry attempt is terminated. When maxTimeLimitDR expires the call attempt is released even if the queueing is still ongoing for the call.

Queueing is not possible in the target cell.



INTRODUCTION

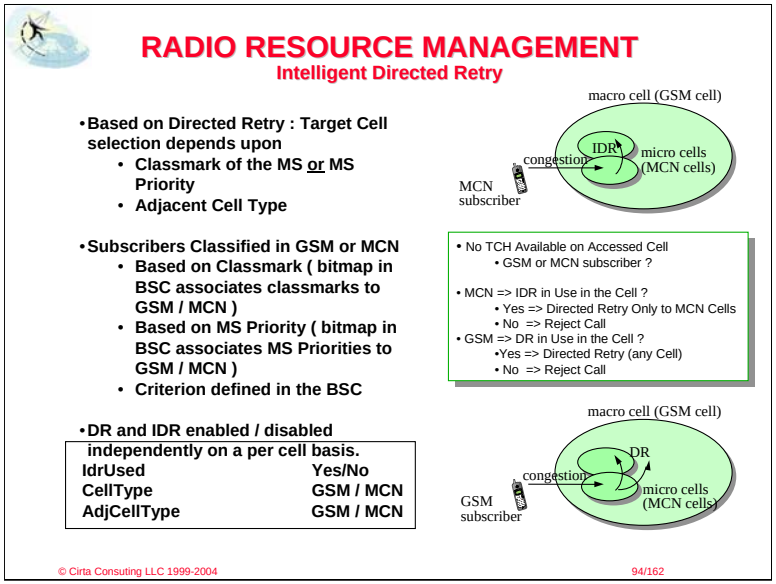
Directed Retry procedure is a facility in a cellular radio system which is triggered by the assignment procedure in the call set-up phase. It allows the mobile subscriber to make a second attempt at gaining access if the first one fails due to congestion.

Due to this feature the selection of the candidate cells in DR procedure is now able to perform in a more improved way. The determination is based on the predefined minimum threshold value of rx signal level, which is adjusted with the parameter. Due to this improvement the quality of the signal in the cell is better after Directed Retry is performed successfully.

In DR procedure, the criteria for selecting the possible candidate cells are not as strict as in the normal handover algorithm analysis. The field strength, the MS classmark, and the maximum power level in the cell are taken into account during the candidate cell list creation procedure of directed retry handover. If there are no neighbouring cells with satisfactory radio quality, the creation of a candidate list is not possible, and therefore it is not possible to continue the started Directed Retry procedure.

In this method the predefined threshold value of the signal level is used. This threshold value stands for the minimum level of the signal strength in the adjacent cell. When the signal strength level is lower than this threshold value the cell is not accepted as a candidate cell in Directed Retry procedure.

This feature is an improvement to existing optional feature Directed Retry.



The basic idea is that IDR works in the same way as DR, also using the two parameters minTimeLimitDR and maxTimeLimitDR. However IDR works for MCN subscribers only, while DR works for GSM subscribers.

GSM subscribers are privileged, because they can be served from any type of Cells GSM or MCN. Also the DR can be to any cell.

On the contrary MCN subscribers can only be served by MCN cells and also the DR can be only to MCN cells.

Cells are classified based on parameter CellType and also adjacen cells are classified based on parameter adjacentCellType.

Subscribers can be classified either based on the Classmark of the Mobile Station or based on the subscriber's priority level defined in the MSC (HLR?).

The option is defined at the BSC

Still at BSC there is a bitmap that associates the different values to either GSM or MCN. Two different bitmaps for priority and classmark.

If IdrUsed = No, then all subscribers are considered GSM from the DR point of view.

The parameter CellType actually is not involved in the IDR, but the idea is that if the Cell is not MCN, there shouldn't be any call attempt from the subscriber.

RADIO RESOURCE MANAGEMENT
Queuing of Radio Resources

Purpose

- **to avoid rejecting call set-up or handover attempt by waiting for the release of a suitable traffic channel**

Queuing Environment

- **queuing is a BTS specific procedure (controlled by the BSC)**
  - **each BTS has a queue of its own**
  - **individual queue parameters and queue management for each BTS**

RADIO RESOURCE MANAGEMENT

Queuing

- Queuing is BTS specific controlled by the BSC
- Only traffic channels are queued
- Call attempts and Handovers in the same queue
- The maximum queue length is relative to the number of traffic channels
- The maximum queuing time can be set individually for both queue types
- The queuing can be deactivated by setting queuing time or queue length to zero
- Different priorities according to queue type (Call/Ho) and/or MS priority

RADIO RESOURCE MANAGEMENT

Queue Management

Entering the queue:

- The queue is entered when there is no traffic channels available of requested kind and ***if***
  - queuing is allowed in the BTS
  - queuing enabled in the assignment request from MSC
  - queue is not full (of higher or equal priority requests)

Prioritization:

- The placement in the queue is determined by:

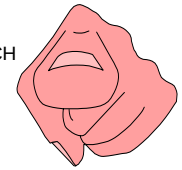
  - queue type (priority)
    call set-up
    handover attempt (non-urgent)
    urgent handover attempt
  - MS Priority level in the PIE element of Assignment Request or Handover Request
  - time of entering the queue

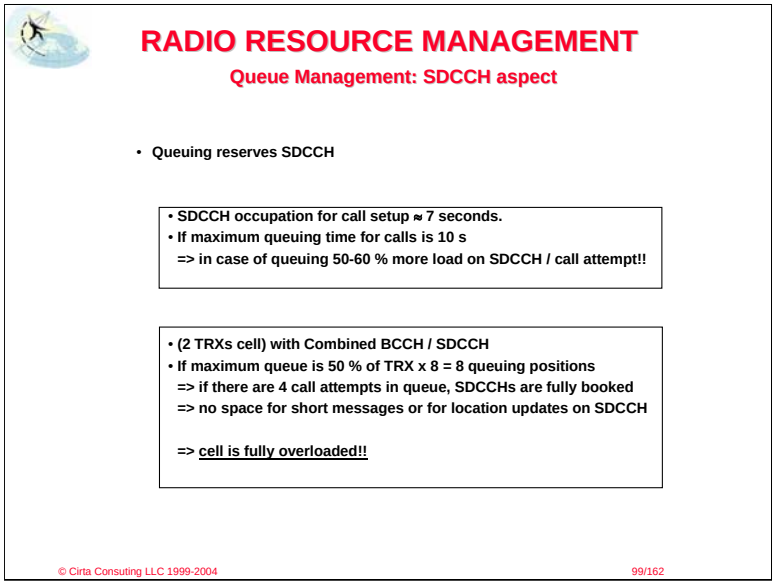
RADIO RESOURCE MANAGEMENT

Queue Management: allocation of TCH

- When a TCH is released (in either channel release or TSL/TRX deblock) the queue is checked from top to bottom in order to find a queuer whose requirements matches with the released channel

- If a suitable queuer is found the TCH is allocated to the queuer and the queue is reorganized





Of course we don't have to reach this extreme case of SDCCH congested!
Something can be done on the parameter setting in order to avoid this situation.

RADIO RESOURCE MANAGEMENT

Queue Management: Leaving the queue

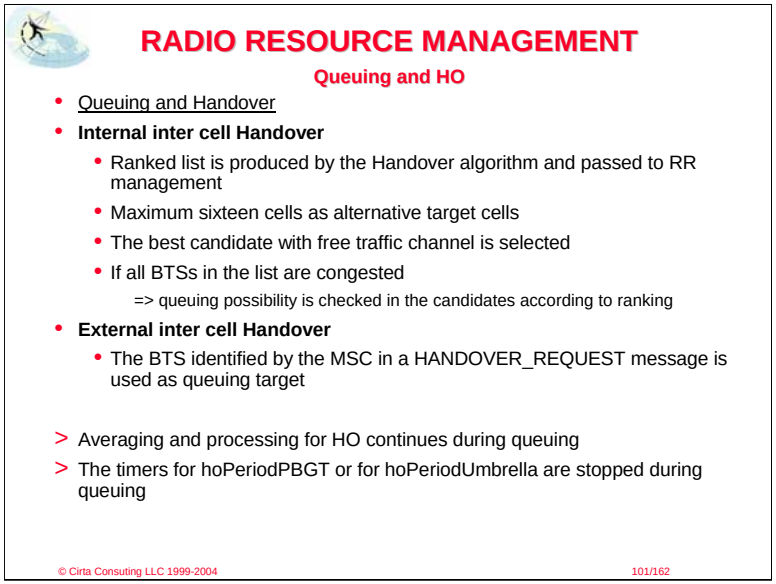
- A queuer is removed from the queue when

No suitable channel is released within queuing time limit => timer expires

Higher priority subscriber (queue type and/or MS priority) replaces a queuer when the queue is full

The queueing TRX/TSL is blocked (call release)

Queue size is reduced due to removing TRX's



MODIFIED

When queueing is consequent a ho attempt, then the target cells are ranked by the handover algorithm and the place is searched among them.

If there is no TCH available there the best target with space in the queue is selected for a queued handover attempt.

This is true in case of an internal inter-cell handover, the target BSC receives the target BTSs (one or more than one ?) in the HANDOVER_REQUEST message from the BSC. It is not clear whether this target list can include only one or more than one BTS (parameter *GenHandoverReqMessageNoOfPrefCells*). In case of more cells, how are they ranked ?

If queueing is for a Call setup, the connection is placed in the SDCCH where the handover is possible.

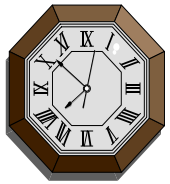
> EnableSdcchHO indicates whether the handover from a DCCH channel to a DCCH channel is enabled. However, power budget handovers and umbrella handovers are not performed from a DCCH to a DCCH.
>
> Directed Retry and queueing are independent with each other, but if during queueing the DR is possible to another cell, then the TCH is allocated there.

One issue is that the SDCCH HO is not possible after the DR procedure has been initiated (to be verified)

RADIO RESOURCE MANAGEMENT

Queuing and DR

Directed retry and queuing are parallel procedures.



When the *queueing* and *DR* process are both *active* for a call ,

- **if MaxTimeLimitDR time elapses without any DR attempt , the queing will be terminated even if the queueing timer have not elapsed as well as DR process itself**
- **if a TCH is released in the serving cell during the period when DR is not allowed/allowed, DR process is terminated.**

New

Queueing can be active in the starting cell. During the period of DR not allowed/allowed, a TCH can be released in the serving cell and allocated. Therefore the DR retry attempt is terminated. When maxTimeLimitDR expires the call attempt is released even if the queueing is still ongoing for the call.

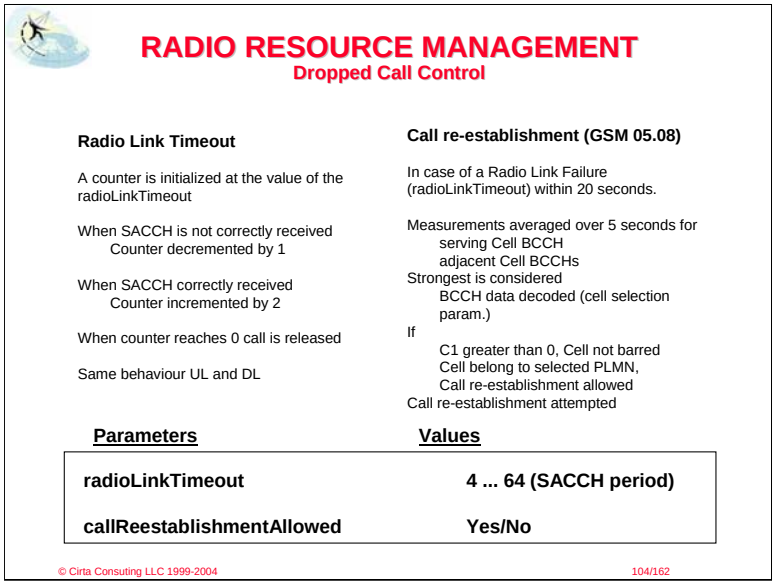
Queueing is not possible in the target cell.

RADIO RESOURCE MANAGEMENT

Queuing Parameters

Parameters	Values	
maxQueueLength	**0 ... 100**	(% of TRXs x 8)
timeLimitCall	**0 ... 15 (s)**	disabled with value 0
timeLimitHandover	**0 ... 10 (s)**	disabled with value 0
msPriorityUsedInQueuing	**Yes / No**	
queuePriorityUsed	**Yes / No**	
queuingPriorityCall	**1 ... 14**	lower value, higher priority
queuingPriorityHandover	**1 ... 14**	
queuingPriorityNonUrgentHO	**1 ...14**	

msPriorityUsedInQueuing : MS priority set in the SIM card.



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Radio Link failure indicates a bad link so that the the MS can not hear the BTS anymore i.e. MS can not decode the DL messages. The failure criterion is based on a radio link counter which in away measures the # of decoded or undecoded SACCH messages as a measure of the link quality. In case of Radio Link failure the call is re-established or released.

In case of the call re-establishmenst , there is a similar to idle mode kind of algorithm ,based on the last 5 sec. Mesurements, in order to select a cell. 6 best is tried.

Once the target cell has been identified, the MS sends a CHANNEL_REQUEST on the RACH with "establishment cause" is call re-establishment (parameter NECI set to ON)

Timer 3120 is started.

A CM_SERVICE_ACCEPT message indicates that the connection has been re-established. (T3120 is stopped)

A CM_SERVICE_REJECT can also be received (T3120 is stopped)

If timer3120 expires, the call re-establishment is aborted. Timeout is 15 seconds.

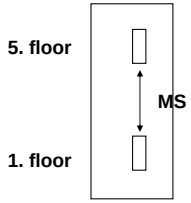
RADIO RESOURCE MANAGEMENT

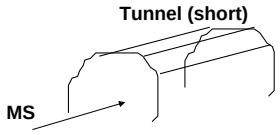
Radio Link Timeout

radioLinkTimeout (default) = 20(SACCH)

Indoor → radioLinkTimeout = 40 → **Outdoor**

Elevator





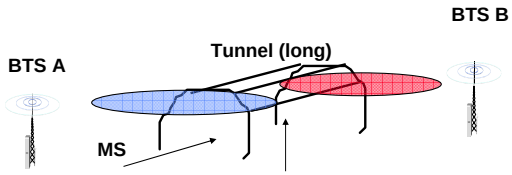
We can play with the time , like in an elevator case, longer time.

If the tunnel is short enough for example , you can manage without an indoor cell.

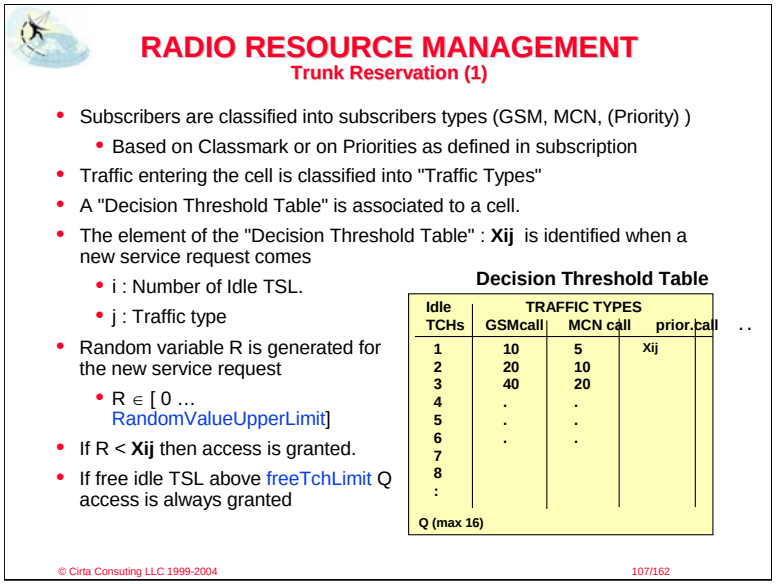
RADIO RESOURCE MANAGEMENT
Call Re-establishment

Outdoor

radioLinkTimeout (default) = 20 (SACCH)



Unsuccessfull Handover=> use Call Re-Establishment



The subscribers are classified based either on the classmark or on priorities with a parameter in BSC.

If based on classmark there will be GSM subs and MCN subs

If based on priorities there will be GSm subs. , MCN subs and priority subscribers.

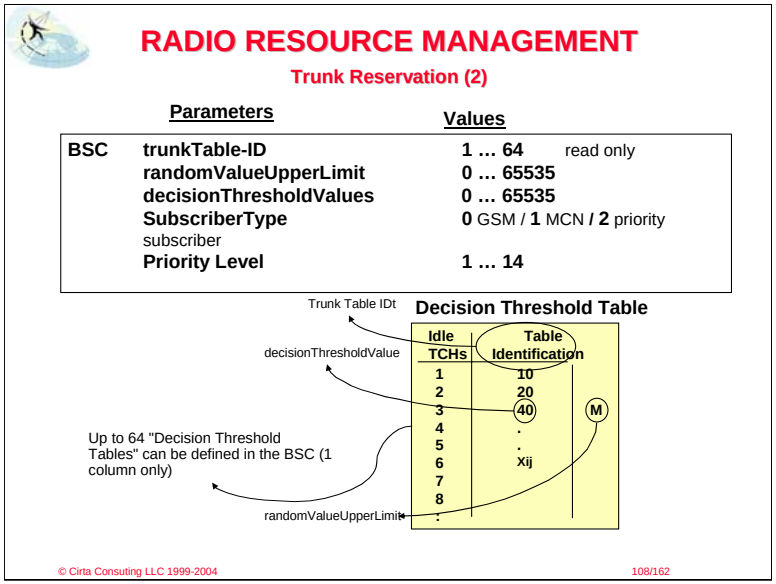
Cells are classified as GSM cells or MCN cells by means of parameter cellType. MCN subscribers can camp and get service only from MCN cells (cfr. IDR) while the other types of subscribers can get service from any cell.

MCN subscruibers can enter GSM cells via handover.

There are different TrafficTypes depending on the subscribers type and on the access being a call setup or a handover.

RandomValueUpperLimit is a parameter defined at BSC level.

freeTCHLimit is a parameter defined at the BTS level.



As explained in the document "Trunk reservation"

A decision threshold table can be determined as a pair of a limit value M and an array (Xi:i=1,2,...,Q_BSC) of the decision threshold values, where:

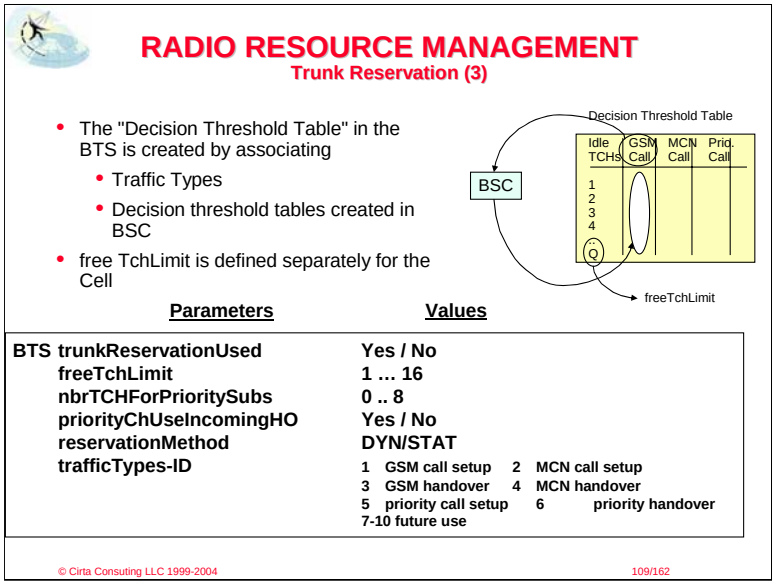
the value M defines the upper limit to the pseudo-random test values R so that always R < M

- the threshold values Xi should meet the following condition for each i = 1, 2, ..., Q_BSC: Xi+1 >= Xi.

To distinguish the threshold tables from each other, we have to identify them with a special decision threshold table identifier T_ID.

Parameters "SubscriberType" and "PriorityLevel" are used to create the association between subscribers priorities and subscribers type.

The smaller is Xij compared to the RandomValueUpperLimit, the more difficult is to allocate that resource.



The Decision Threshold Table is defined in the BTS by an association of one (or more) traffic types to a table defined in the BSC.

Trunk reservation gives the possibility to use two alternative reservation methods of traffic channels: static and dynamic. The reservation method is of significance only if the priority subscriber traffic type is employed in the BSC.

Static reservation method

In static reservation, once the priority channels have been allocated to priority subscribers, the remaining spare channels are available to other subscribers. Thus, in static reservation the number of channels reserved for priority subscribers is actually the number of simultaneous priority calls which the BTS is able to transmit.

Dynamic reservation method

In dynamic reservation the number of channels reserved for priority subscribers means the number of channels that have to be left available to the priority subscribers only, no matter how many ongoing priority calls there are in the BTS.

The parameter "PriorityChUseIncomingHo" defines the availability of priority channels to others than priority subscribers in an incoming handover; the default is that priority channels are available only for priority subscribers

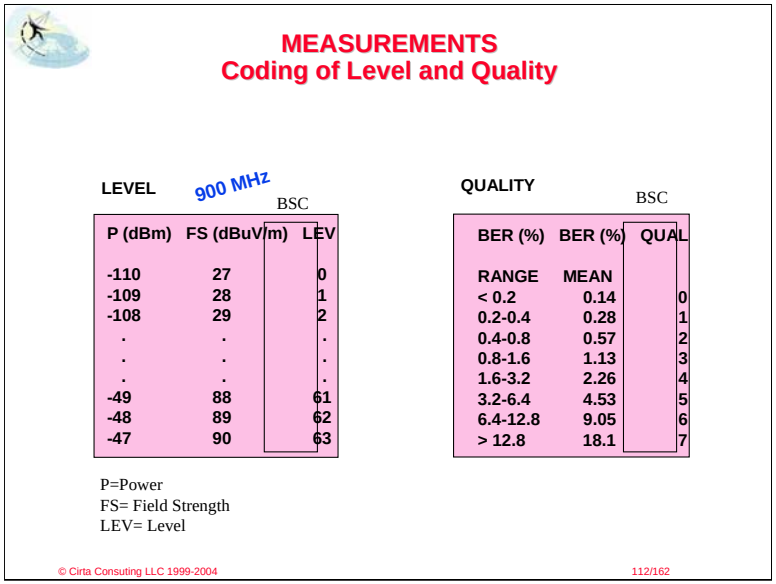
Trunk Reservation is before any considerations about interference recommendations or queueing.

In a cell, all traffic types shall appear in the Decision Threshold Table.

MEASUREMENTS AND MEASUREMENT PROCESSING

MEASUREMENTS
Contents

1. Coding Level and Quality
2. MS Measurements in Idle Mode
3. MS Measurements in Dedicated Mode

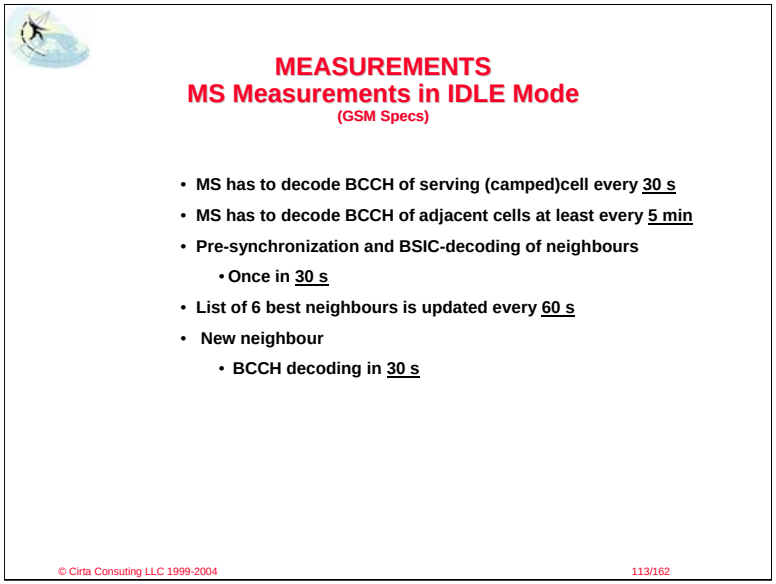


The relationship between Field Stregth (measured in dBuV/m) and Received Power (measured in dBm) is

FS (dBuV/m) = RxLev (dBm) +77,2+20Log[freq(MHz)]

Based on the formula above for GSM 1800 "P" corresponds to "FS" values different from GSM 900 case.

Add FER here……



GSM 05.08: par. 6.6.1

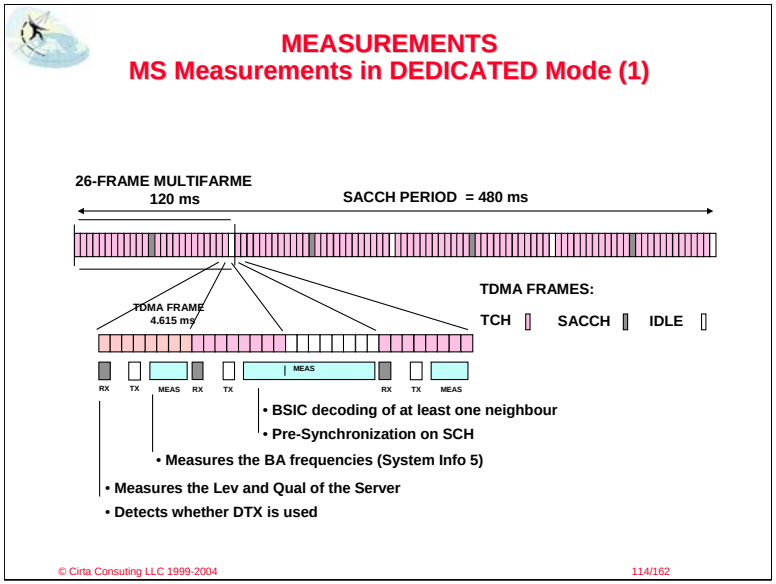
The MS shall attempt to decode the full BCCH data of the serving cell at least every 30 seconds.

The MS shall attempt to decode the BCCH data block that contains the parameters affecting cell reselection for each of the 6 strongest non-serving cell BCCH carriers at least every 5 minutes.

When theMS recognizes that a new BCCH carrier has become one of the 6 strongest, the BCCH data shall be decoded for the new carrier within 30 seconds.

The MS shall attempt to check the BSIC for each of the 6 strongest non-serving cell BCCH carriers at least every 30 seconds, to confirm that it is monitoring the same cell. If a change of BSIC is detected then the carrier shall be treated as a new carrier and the BCCH data redetermined.

The maximum time allowed for synchronization to a BCCH carrier is 0.5 s, and the maximum time allowed to read the BCCH data, when being synchronized to a BCCH carrier, is 1.9 s.

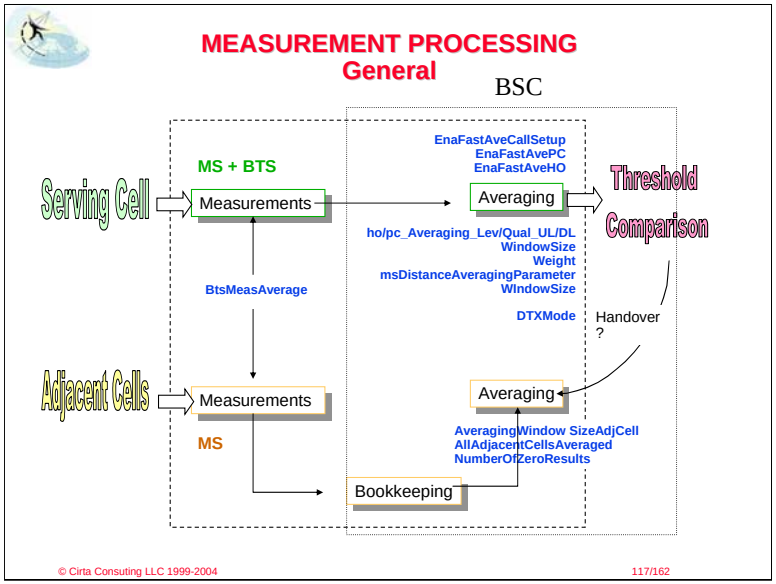


Pre-synchronization is to the neighbour.

MEASUREMENTS
MS Measurements in DEDICATED Mode (2)
(GSM specs)

- Pre-synchronization and BSIC-decoding of adjacent cells
  - Once in 10 s
- New neighbour
  - 5 s decoding BSIC + Pre-synchronization
    - If not succesfull -> Old neighbour list + New try
- Measurement results of 6 best neighbours will be sent to BSC
  - Every SACCH period 480 msec.

MEASUREMENT PROCESSING
Contents

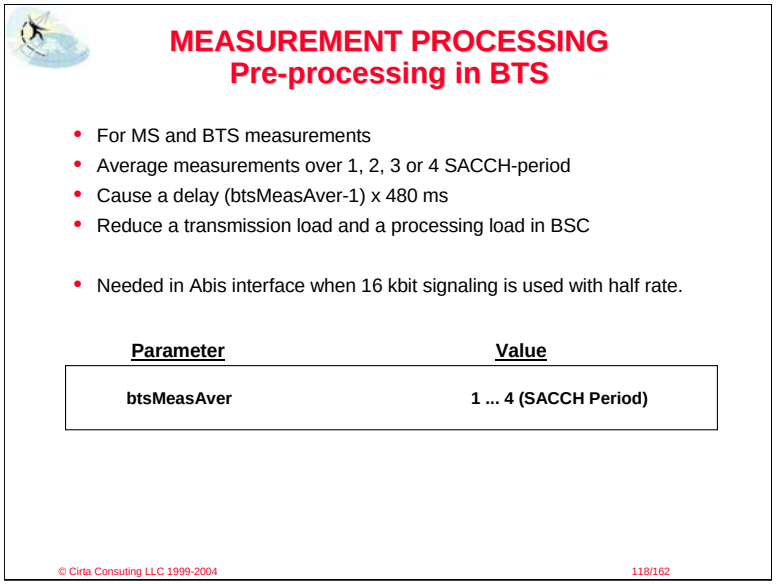


NEW

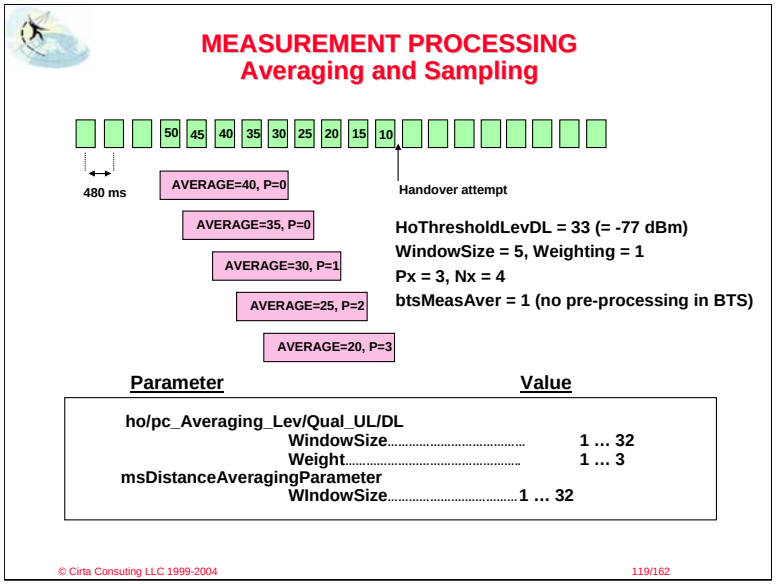
This slide is an overview of the Averaging process as carried out for the Serving Cell (UL and DL) and for the Adjacent Cells (DL only).

An important issue is that the BSC is capable of storing measurements of 32 adjacent Cells for each BTS and save the last 32 measurement samples taken by the MS for each of them for every ongoing call.

However the averaging for these is performed only when the BSC recognizes the need for a handover.



Last bullet: in HR load is doubled, so pre-processing is required.



MODIFIED

Parameters added

Parameters related to Averaging are :

- Window Size
- Weighting

and they are independently defined for

HO Downlink Level	HoAveragingLevDL
HO Uplink Level	HoAveragingLevUL
HO Downlink Quality	HoAveragingQualDL
HO Uplink Quality	HoAveragingQualUL

and

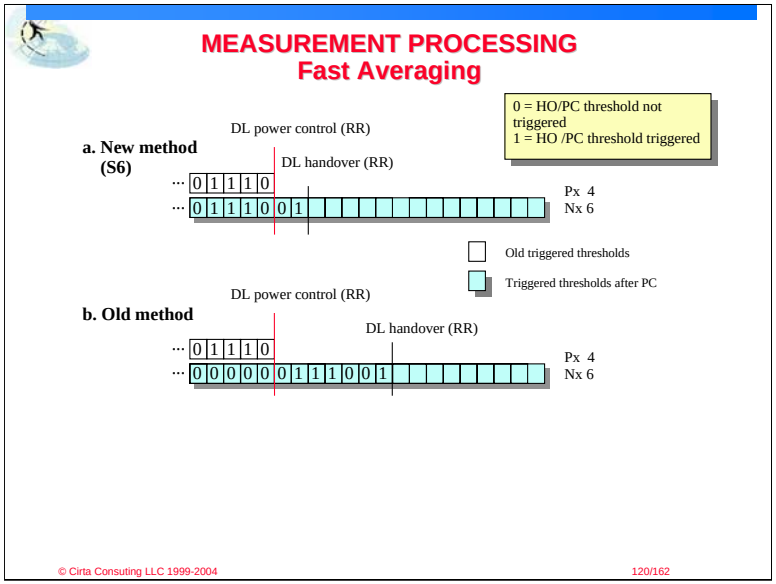
PC Downlink Level	PcAveragingLevDL
PC Uplink Level	PcAveragingLevUL
PC Downlink Quality	PcAveragingQualDL
PC Uplink Quality	PcAveragingQualUL

plus

Timing Advance	MsDistanceAveragingParam

which doesn't require any weighting because it is not affected by the DTX.

What is really important is that the AVERAGED values are COMPARED with the relevant thresholds and when the number of occurrences of the threshold being trespassed is in accordance with Px and Nx a Power Control or Handover is

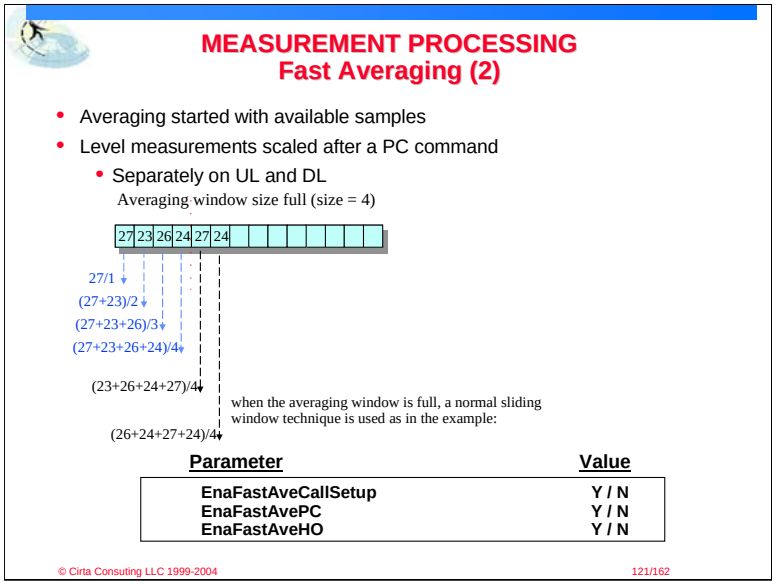


MODIFIED

The above improvement refers to two different methods of evaluating the samples.

The measurement results (uplink or downlink) preceding the MS/BTS power change are not valid after the power change. If the scaling of measurement results is disabled (selected by means of the parameter EnaFastAvePC), the averaging and threshold comparison based on those measurement results (uplink/downlink) must start from the beginning after the power change (this concerns both Handover and Power control). When the *scaling of measurement results* is enabled (S6), the BSC scales the relevant measurement results preceding the power change so that they correspond to the new transmission power level of the MS/BTS and thus the averaging and threshold comparison can continue without interruption, with the exception of the PC threshold comparison which always starts from the beginning after the power change.

With" triggered" we mean HO/POC Thresholds exceeded/met by the comparison with the averaged values.



Parameters added

The basic averaging procedure does not start until the required number of samples is available. For example, if the PcAveragingLevUL/Window size is 8, the averaging of uplink level for power control can start as soon as the BSC has received 8 measurement results.

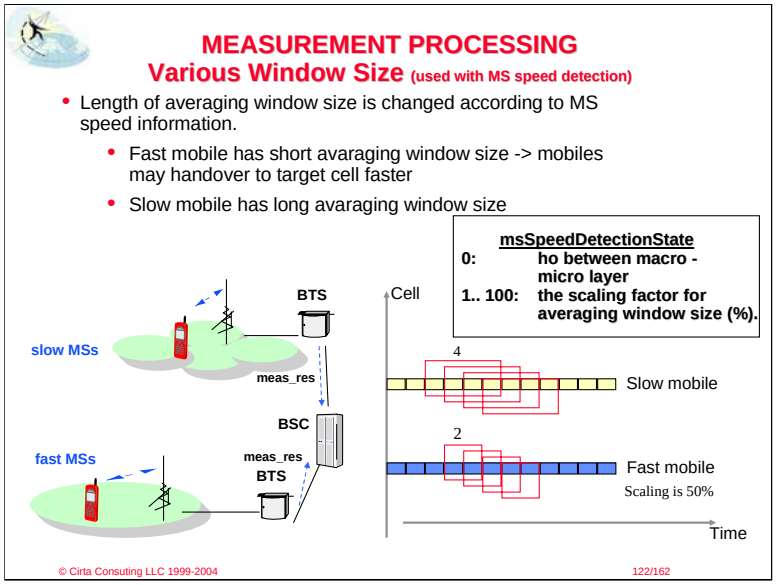
The BSC is also able to start the averaging of level and quality from the first measurement sample. In this case the BSC calculates averaged values from those measurement samples which are available until the number of measurement samples fills the averaging window size.

This property (fast averaging method) is controlled by the following parameters:

1.EnaFastAveCallSetup . The parameter indicates whether the fast averaging method is enabled at the beginning of a SDCCH seizure (either in a call or in a SDCCH handover).

2.EnaFastAveHO . The parameter indicates whether the fast averaging method is enabled at the beginning of a TCH seizure (either in a call or in a handover).

3.EnaFastAvePC . The parameter indicates whether the fast averaging of signal quality measurements and the scaling of signal level measurements are enabled just after the increase/decrease of the MS/BTS transmission power (see section General considerations).



INTRODUCTION

The MS Speed Detection is a feature in BSS6. The basic idea of the MS Speed Detection feature is to keep the fast moving MS's in macro cells and direct the slow moving MS's into micro cells. However some operators have different strategies for traffic distribution. It is suggested not to use Speed Information as a micro to macro handover indication because “Speed” itself has different interpretations in different locations. Therefore, it is reasonable to have various window size (i.e. Better Cell Trigger / Quality Trigger) according to the speed indication.

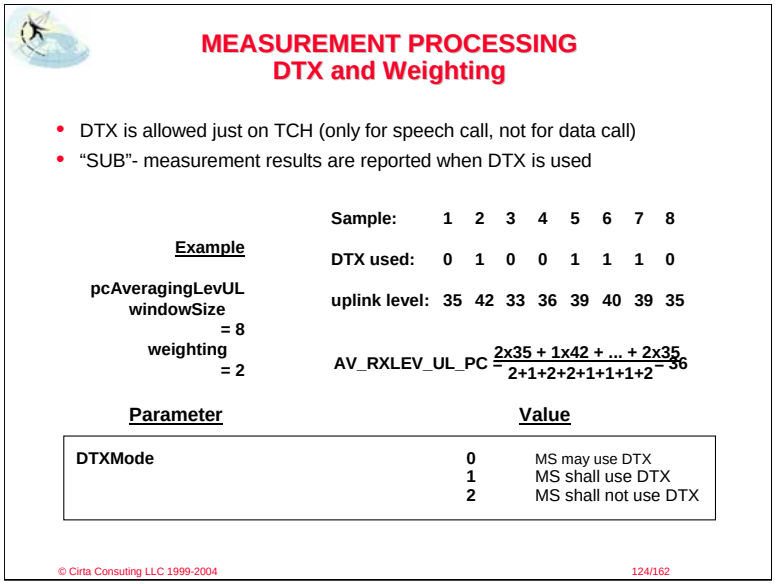
In principle, high-speed MS should use shorter average window size, and low-speed MS should use longer average window size. Therefore, all averaging-processes should have two sets of window parameters, one set for high speed MS and one set for low speed MS. By applying various window size, fast-moving MSs have shorter window size and they may handover to target cell faster. For a slow-moving MS, a longer window size is applied in order to prevent it from unnecessary oscillation.

This feature is an Addition to existing optional feature “MS Speed Detection”.

MSSpeedDetectionState
Parameter

The BSC may use the information on the speed of the mobile station to do the following by means of the parameter **MsSpeedDetectionState:**

- 0 MS speed information is used to control traffic between separate layers of the multi-layered cellular network by means of the handover procedure.
- 1 - 100 MS speed information is used to scale the values of the averaging parameters. The range is from 1% to 100%. That is, if the value is, for example, 80% it means that the averaging window is 80% of the normal window size.



In a SACCH frame, composed by 104 Frames, frames 52 to 59 shall be transmitted and used by the MS / BTS to assess the Level and Quality of the connection.Finally 12 out of 104 is sent so DTX samples are less realiable.

The information about DTX UL is broadcast on BCCH in System Info 3 (Cell Options) and indicates that

The MS MAY use Uplink Discontinuous Transmission

The MS SHALL use Uplink Discontinuous Transmission

The MS SHALL NOT use Uplink Discontinuous Transmission

Same effect of the Weighting is on the Quality processing.

MEASUREMENT PROCESSING
Book-keeping

- BSC is able to maintain up to 32 last measurement results of 32 adjacent cells
- Mobile reports to BSC 6 best results and the rest are 0 (= -110 dBm)
- Zero Results can be eliminated from averaging (up to 7)
- All adjacent cells can be averaged or just 6 best (reported by the mobile in the last measurements)

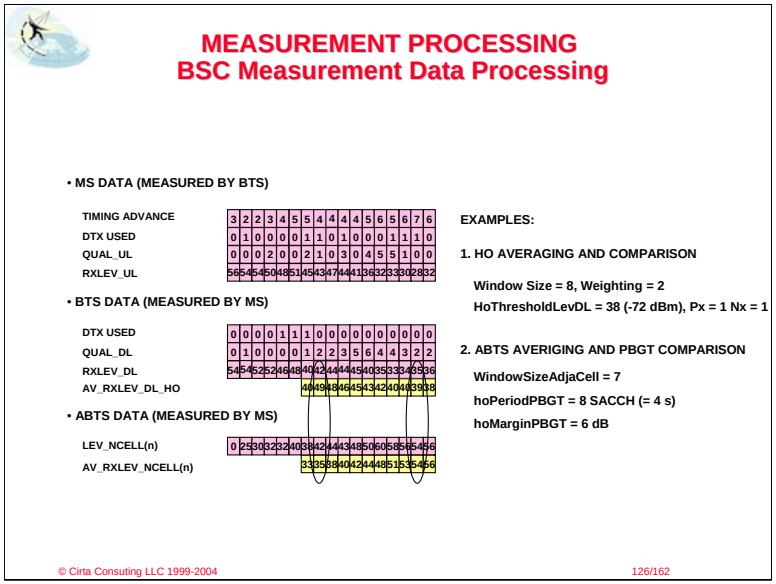
Example

allAdjacentCellsAveraged = No
numberOfZeroResults = 2
WindowSize = 8

Sample:

	1	2	3	4	5	6	7	8
1	-65	-67	-71	-69	-72	-70	-73	-71
2	-73	-75	-74	-75	-76	-77	-75	-77
3	-77	0	-80	-79	-81	-79	0	-80
4	-85	-83	-87	-88	-84	0	-86	-87
5	-90	-94	-91	-90	-95	-93	-92	-90
6	-97	-99	-98	-99	-96	-97	0	0

Parameter	Value
averagingWindowSizeAdjacentCells	**1 … 32**
numberOfZeroResutlts	**0 … 7**
allAdjacentCellsAveraged	**Y / N**



This slide is used to give an overview about the amount of data used in doing the data processing in the BCS. You don't have to go into a detailed explanation of the slide since HOs procedures will be described later.

MEASUREMENT PROCESSING

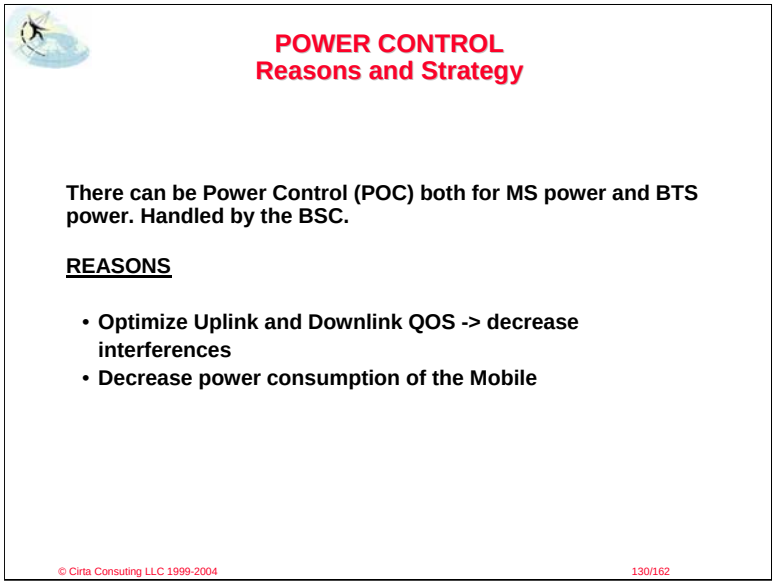
Parameters Related to Measurements and Measurement Processing

Parameter

btsMeasAver	**1 ... 4** (SACCH Period)
ho/pc_Averaging_Lev/Qual_UL/DL	
WindowSize	**1 … 32** (SACCH Period)
Weight	**1 … 3**
msDistanceAveragingParameter	
WIndowSize	**1 … 32** (SACCH Period)
EnaFastAveCallSetup	**Y / N**
EnaFastAvePC	**Y / N**
EnaFastAveHO	**Y / N**
DTXMode	**0** MS may use DTX
	1 MS shall use DTX
	2 MS shall not use DTX
averagingWindowSizeAdjacentCells	**1 … 32**
numberOfZeroResutlts	**0 … 7**
allAdjacentCellsAveraged	**Y / N**

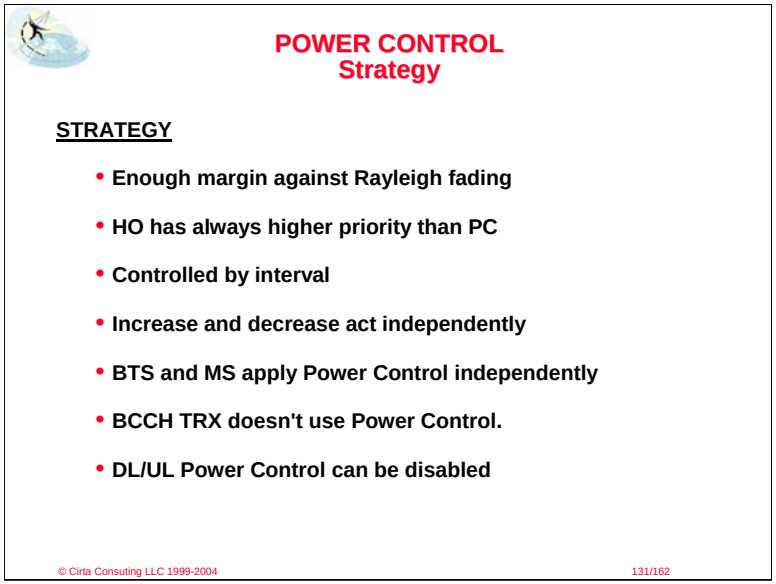
POWER CONTROL

POWER CONTROL
Contents



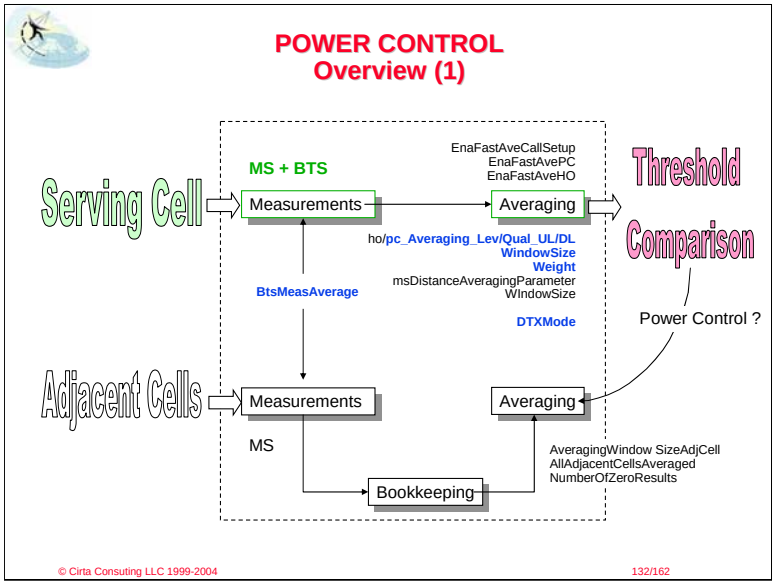
MODIFIED

Some issues added in the Strategy part.



NOTE:

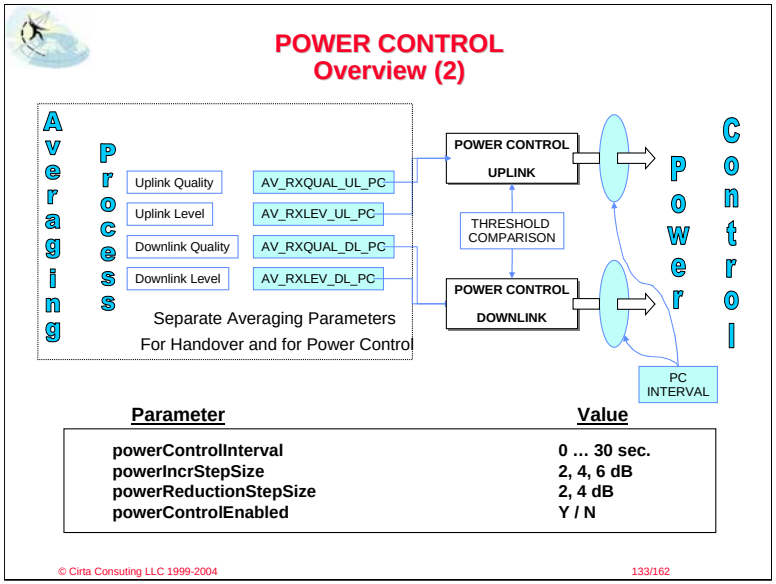
DL Power Control can be disabled by means of the switch type parameter :powerControlEnabled (=N)
UL Power control can be disabled by means of minMsTxPower=msTxPwrMax.



NEW

The purpose of this slide is to re-associate the Averaging Process to the Power Control as well as to the Handover.

It is the same as in the Handover part, with the difference of the part related to PC being highlighted.



NEW

The Power Control Process is shown with an overview.

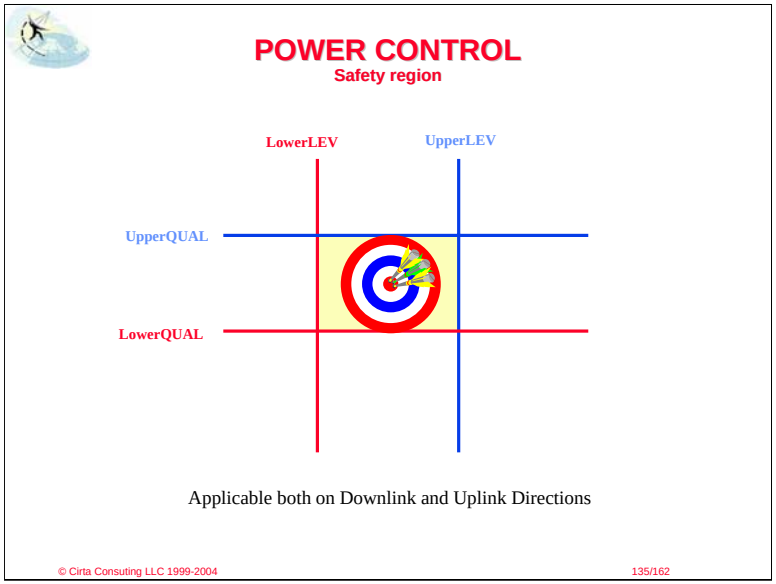
The major issues are :

- The averaging windows and weight are different for PC and for HO, even though it is still quality and level that are averaged.
- Averaged Values are then compared to the relevant thresholds, every SACCH period.
- There is an interval between two consecutive Power Control Commands. This interval is the same, but works independently for UL and DL.

powerIncrStepSize and powerReductionStepSize are used for both.

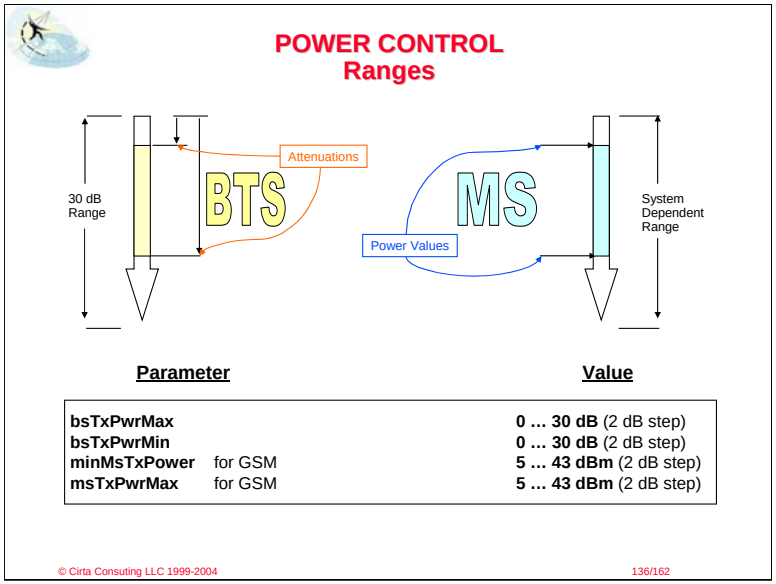
POWER CONTROL
Parameters

Parameter		Value
pcUpper/LowerThresholdsLevUL		
rxLevel		-110 ... -47 (dBm)
px		1 ... 32
nx	AV_RXLEV_UL_PC	1 ... 32
pcUpper/LowerThresholdsLevDL		
rxLevel		-110 ... -47 (dBm)
px		1 ... 32
nx	AV_RXLEV_DL_PC	1 ... 32
pcUpper/LowerThresholdsQualUL		0 ... 7
rxQual		1 ... 32
px		1 ... 32
nx	AV_RXQUAL_UL_PC	
pcUpper/LowerThresholdsQualDL		0 ... 7
rxQual		1 ... 32
px		1 ... 32
nx	AV_RXQUAL_DL_PC	



Use this slide to explain where we should stand in order not to have any POC.

You might want to add values (taken from the Defaultset.xls) in order to make the example more realistic.

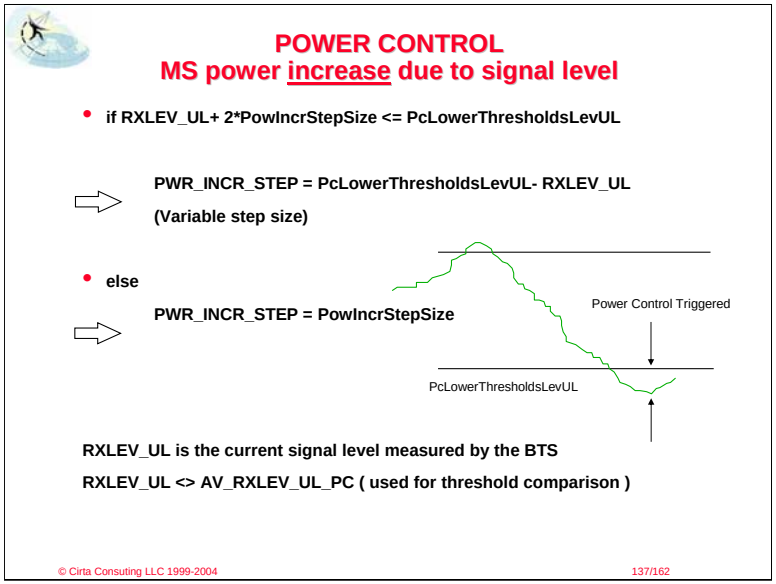


New

the idea is to show the ranges for Power Control and in particular the fact that for the BTS the range is defined by attenuation values.

NOTE : bsTxPwr is given as attenuation (dB) and for the mobile we use actual power level (dBm).

.

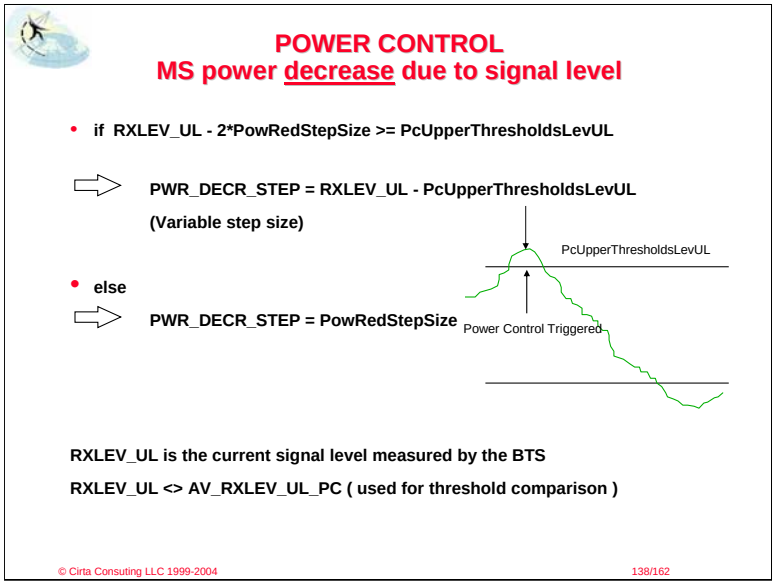


NEW

If the Power Control Increase has been triggered, it means that the AV_RXLEV_UL_PC is below the low threshold PcLowerThresholdLevUL.

Fixed step is the default, but if the signal level is very low, the transmission power of the MS is increased to the required power level at one go (in order to maintain the call) by using the variable power change step size.

Note that the trigger is based on the averaged level, the decision on the variable step is based on the current received level.

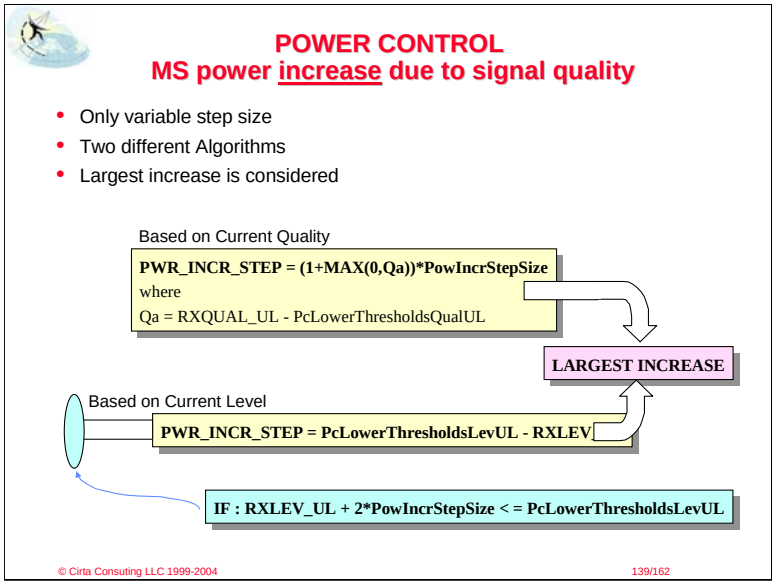


NEW

If the Power Control Decrease has been triggered, it means that the AV_RXLEV_UL_PC is above the upper threshold PcUpperThresholdLevUL.

However if the current distance between the RXLEV_UL and the threshold cannot be compensated with two consecutive Power Control Commands, the the Variable Step Power Control is used.

Note that the trigger is based on the averaged level, the decision on the variable step is based on the current received level.



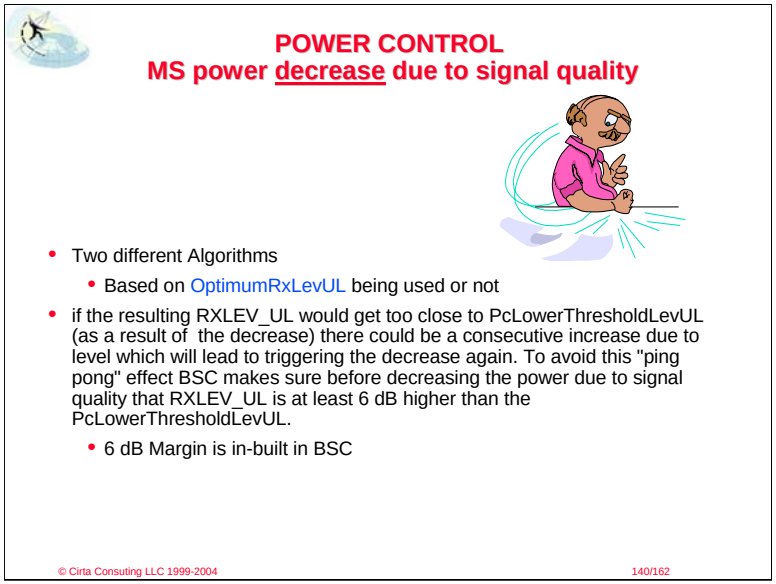
NEW

Power Control due to Quality has been triggered. This means that the AV_RXQUAL_UL_PC is below the lower quality threshold : PcLowerThresholdQUalUL

Then the variable step is used only in Power Control to increase the power of the MS. However both Current signal level and Current signal quality are considered, the former only if the current level is below the lower level threshold.

This is to avoid a simple increase equal to 2 times the increment step.

The largest increase is used.



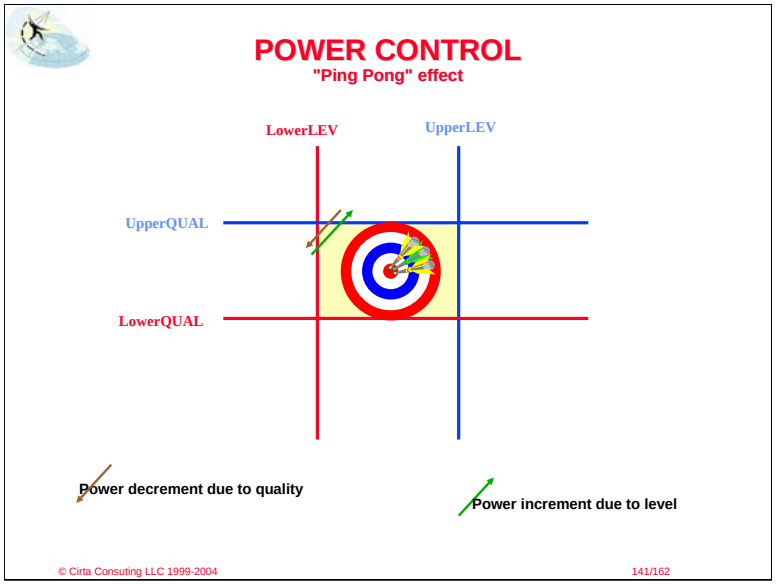
NEW

Power Control due to Quality has been triggered. This means that the AV_RXQUAL_UL_PC is above the upper quality threshold : PcUpperThresholdQualUL

There won't be decrease due to quality if there's a chance that it would trigger the threshold pcLowerThresholdLevUL/DL.

The parameter OptimumRxLevUL is used to assign the MS the optimum transmission power when accessing the Network in Call Setup and in intracell handover.

It has to be defined for each TRX.



You might want to use this slide to explain the ping pong effect (as explained in the previous slide), or you can draw it on the flip chart.

POWER CONTROL
MS power decrease due to signal quality (1)

IF : optimumRxLevUL = N

- **if RXLEV_UL - 2*PowRedStepSize >= PcUpperThresholdsLevUL**

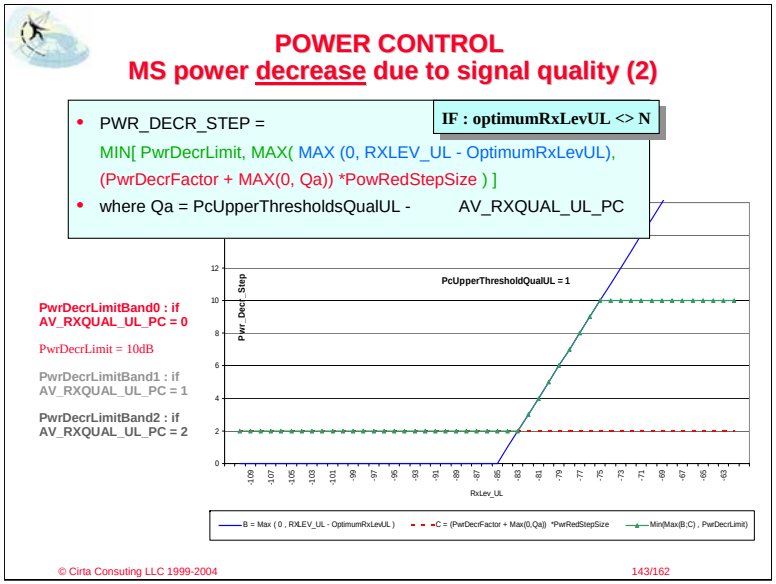
⇨ **PWR_DECR_STEP = RXLEV_UL - PcUpperThresholdsLevUL**

(Variable step size)

- **else**

⇨ **PWR_DECR_STEP = PowRedStepSize**

Same as in the MS Power decrease due to Signal Level, but Triggered by different condition (quality)



NEW

The quantity in blue color tells how much we are exceeding the Optimum Rx Lev UL and is the curve in blue.

Then there is an increment due to the quality, which is the difference between the averaged quality referred to the upper threshold added to another term and multiplied to the step.

The maximum between these two is considered, but limited by a maximum value that is PwrDecrLimit.

In order to avoid 0 values, there is a term PwrDecrFactor that guarantees at least a decrease equal to PwrRedStepSize

NOTE :

The decrease in power does not take place if there is the posibility that it would trigger the threshold PcLowerThresholdsLevUL (the safety margin is 6dB).

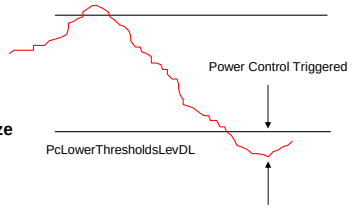
Note also that a different value for *PwrDecrLimit* applies if the averaged RxQuality is 0 or rather 1 or rather 2

POWER CONTROL
BTS power increase due to signal level

- **if RXLEV_DL + 2*PowIncrStepSize <= PcLowerThresholdsLevDL**

⇨ **PWR_INCR_STEP = PcLowerThresholdsLevDL - RXLEV_DL**

(Variable step size)



⇨
- **else**

PWR_INCR_STEP = PowIncrStepSize

RXLEV_DL is the current signal level measured by the MS

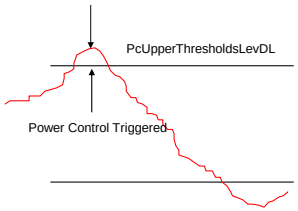
RXLEV_DL <> AV_RXLEV_DL_PC (used for threshold comparison)

POWER CONTROL
BTS power decrease due to signal level (1)
(S9 improvement)

- **VariableDLStepUse = Y/N**
  (S9 new feature)

- If **VariableDLStepUse = N**
  - PWR_DECR_STEP = PowRedStepSize

    (no variable step size)



POWER CONTROL
BTS power decrease due to signal level (2)
(S9 improvement)

- VariableDLStepUse = Y

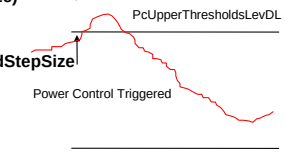
if RXLEV_DL - 2*PowRedStepSize >= PcUpperThresholdsLevDL

PWR_DECR_STEP = MIN((RXLEV_DL - PcUpperThresholdsLevDL),10)

(Variable step size)

else

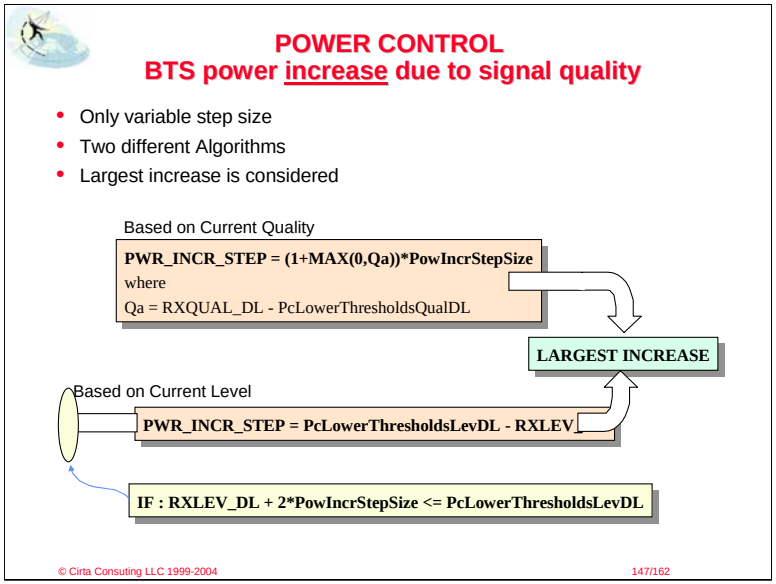
PWR_DECR_STEP = PowRedStepSize



RXLEV_DL is the current signal level measured by the MS

RXLEV_DL <> AV_RXLEV_DL_PC (used for threshold comparison)

Please note that DL Power decrease is limited to 10 dB due to problems for MSs.



NEW

Power Control due to Quality has been triggered. This means that the AV_RXQUAL_DL_PC is below the lower quality threshold : PcLowerThresholdQualDL

Then the variable step is used only in Power Control to increase the power of the BTS. However both Current signal level and Current signal quality are considered, the former only if the current level is below the lower level threshold.

This is to avoid a simple increase equal to 2 times the increment step.

The largest increase is used.

POWER CONTROL
BTS power decrease due to signal quality (S9 improvement)

- **VariableDLStepUse =Y/N** (S9 new feature)
- **OptimumRxLevDL = -109…-47 dBm/N**
- If **VariableDLStepUse = N**
  - PWR_DECR_STEP = PowRedStepSize
    (no variable step size)

PWR_DECR_STEP = PowRedStepSize
(no variable step size)
The decrease in power does not take place if there is the posibility that it would trigger the threshold PcLowerThresholdsLevDL (the safety margin is 6dB).

POWER CONTROL
BTS power decrease due to signal quality

- Two different Algorithms
  - Based on OptimumRxLevDL being used or not
- if the resulting RXLEV_DL would get too close to PcLowerThresholdLevDL (as a result of the decrease) there could be a consecutive increase due to level which will lead to triggering the decrease again. To avoid this "ping pong" effect BSC makes sure before decreasing the power due to signal quality that RXLEV_DL is at least 6 dB higher than the PcLowerThresholdLevDL.
  - 6 dB Margin is in-built in BSC

POWER CONTROL
BTS power decrease due to signal quality (2)
(S9 improvement)

- VariableDLStepUse = Y
- OptimumRxLevDL = < not defined >

- if RXLEV_DL - 2*PowRedStepSize >= PcUpperThresholdsLevDL

PWR_DECR_STEP = MIN((RXLEV_DL - PcUpperThresholdsLevDL),10)

(Variable step size)

- else

PWR_DECR_STEP = PowRedStepSize

RXLEV_DL is the current signal level measured by the MS
RXLEV_DL <> AV_RXLEV_DL_PC (used for threshold comparison)

POWER CONTROL
BTS power decrease due to signal quality (2)
(S9 improvement)

VariableDLStepUse = Y

OptimumRxLevDL = < defined> (-109…-47 dBm)

IF : optimumRxLevUL <> N

- PWR_DECR_STEP =
  MIN{ PwrDecrLimit, MAX[MAX (0, RXLEV_DL - OptimumRxLevDL),
  (PwrDecrFactor + MAX(0, Qa)) *PowRedStepSize] }
- where Qa = PcUpperThresholdsQualDL - AV_RXQUAL_DL_PC

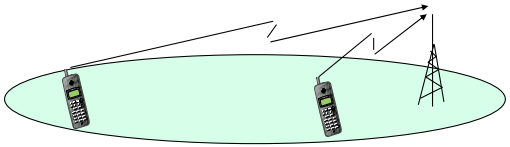
POWER CONTROL
MS Power Optimization in Call Set-up

- Normally MS accesses the TCH with the maximum Tx Power allowed in the cell

  msTxPwrMax
- When power optimization is employed

  MS_TXPWR_ OPT =
  MsTxPwrMax - MAX (0, (RXLEV_UL - OptimumRxLevUL))
- Parameter OptimumRxLevUL must be defined for each TRX in the Cell

  If different values then maximum is considered
- RXLEV_UL is measured during signalling phase



POWER CONTROL
MS Power Optimization in Handover

- Intracell Handover
  - Normally MS uses the maximum Tx Power allowed in the target cell
    msTxPwrMax
  - When power optimization is employed

    MS_TXPWR_ OPT = MsTxPwrMax -
    MAX(0, (AV_RXLEV_UL_HO + (MsTxPwrMax - MS_TXPWR) -
    OptimumRxLevUL)
- Parameter OptimumRxLevUL must be defined for each TRX in the Cell

  If different values then maximum is considered

Example: AV_RXLEV_UL_HO= -75 dBm

OptimumRxLevUL= -80 dBm
dBm+80 dBm)

MS_TXPWR_MAX= 33 dBm

MS_TXPWR = 33 dBm

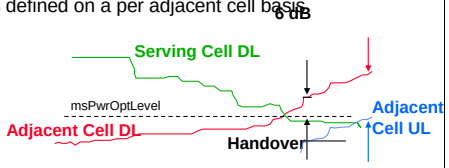
MS_TXPWR_OPT = 33 dBm -MAX(0, -75

= 33 dBm -5 dB = 28 dBm

Parameter	Value
OptimumRxLevUL	**-109 … -47 dBm / N**

POWER CONTROL
MS Power Optimization in Handover

- Intra BSC intercell Handover
  - Normally MS uses the maximum Tx Power allowed in the target cell
    msTxPwrMax
  - When power optimization is employed
    MS_TXPWR_ OPT(n) =
    MsTxPwrMax(n) - MAX (0, (AV_RXLEV_NCELL(n) - MsPwrOptLevel))
- Parameter msPwrOptLevel is defined on a per adjacent cell basis
- Affects Uplink
  - Either Uplink signal equals downlink signal
  - Or Differences in UL / DL considered when defining msOptPwrLevel



Parameter	Value
msPwrOptLevel	-110 … -47 dBm / N

MODIFIED

The basic idea is that the signal level received from the adjacent cell is used as a reference. The value is compared to the parameter msTxPwrLevel defined on a per adjacency basis. The difference

AV_RXLEV_NCELL(n) - MsPwrOptLevel

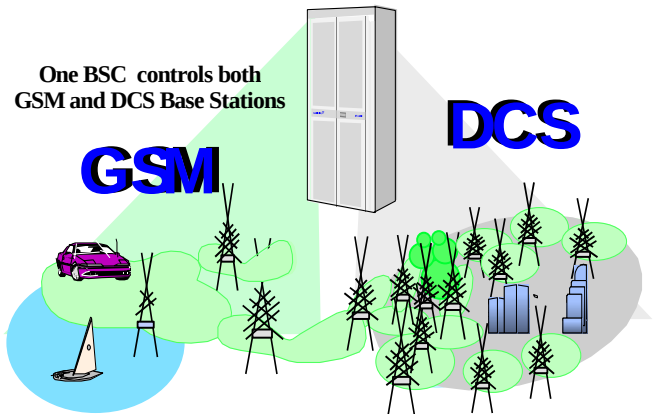
is considered power in eccess in the UPLINK connection.

Therefore if the Downlink signal is 10 stronger than the Uplink signal, then the parameter msTxPwrLevel should be put 10 dB higher than the value that is considered optimum for the UL.

Half Rate and Dual Band Support

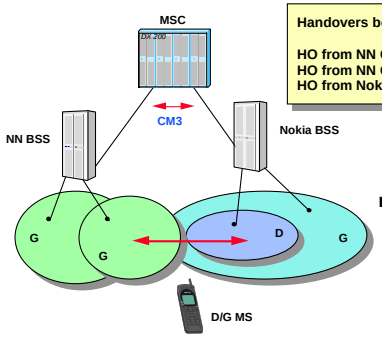
Dual Band Support

One BSC controls both
GSM and DCS Base Stations



Dual Band Support

- Can be used in multivendor environment

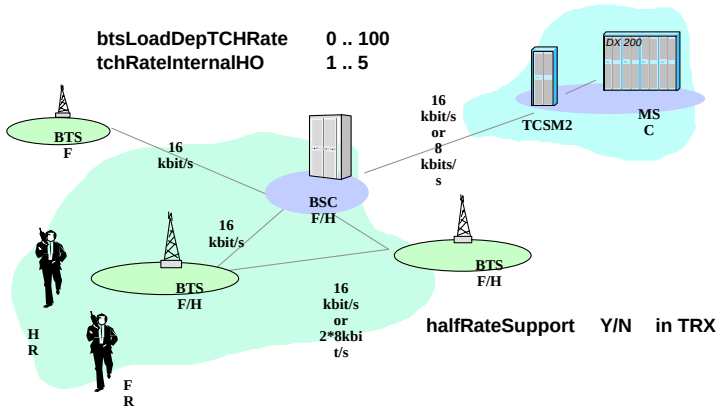


Handovers between Nokia and NN BSS cells

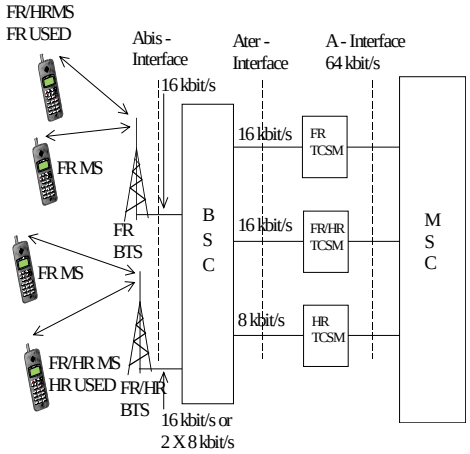
HO from NN GSM to Nokia GSM cell acting as umbrella
HO from NN GSM to Nokia DCS cell
HO from Nokia DCS or GSM to NN GSM cell

multiBandCell Y/N

Half Rate Support

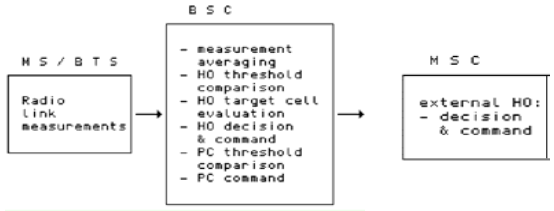


Half Rate Support



POWER CONTROL
AND
HANDOVER PROCESS

POWER CONTROL AND HANDOVER PROCESS



The PC for the BTS and MS runs independently in parrallel with the HO process.

If both the HO and PC conditions occur at the same time , HO has priority to PC.
If in this case HO can not be performed, PC is used to help for the time.

POWER CONTROL AND HANDOVER PROCESS

The initial power level used by MS in the new cell after a HO, is determined by the BSC. The default is maximum permitted level in the target cell. Optionally PC/HO processes can optimise the initial RF power level in case of intra-BSC HO.

Parameter	Value
MsPwrOptLevel	-110… -47 dBm
OptimumRxLevUL	-109… -47 dBm

MsPwrOptLevel for inter-cell HO (cell level)
OptimumRxLevUL for call set-up and intra-cell HO(TRX level)

Used not so often