Chapter 3

3G Operational Issues

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Introduction

The Mobile communication networks has evolved from basic GSM to GPRS , EDGE and now to UMTS. Generation wise basic GSM is referred as 2^{nd} Generation (2G) systems, GPRS is referred as 2.5 G systems , EDGE is referred as 2.75 G systems whereas UMTS networks is referred as 3G networks.

The main idea behind 3G is to prepare a universal infrastructure able to carry existing and also future services. The infrastructure should be so designed that technology changes and evolution can be adapted to the network without causing uncertainties to the existing services using the existing network structure

The further advancements in UMTS networks leads to HSDPA networks and then to HSUPA networks.

Split architecture in Mobile Network.

The split architecture environment is also called horizontally layerd architecture where connectivity domain , control domain and application domain are independent to each other and are at different layers namely connectivity layer, control layer and application layer. This layered arhitecture is developed to make the system grow as per the future demands and with the least changes in the network nodes architecture.

So following the layered architecture approach the functionalities of MSC has been distributed by split arhitecture into two different node namely MSC-Server (MSC-S) and Media Gateway (MGW). All connectivity functionalities goes to MGW and all control functionalities goes to MSC-S. The MSC-Server is the controller of Media gateway.

The Main MSC-S Functions

- Service control
- Mobility management
- Charging control and CDR generation
- Can control more than one MGW

The Main MGW Functions

- Speech & media processing
- Setup/release of user data bearers
- Interfacing between different transport standards
- Boundary between different networks
- Can be controlled by several MSC Servers

Benefits of layered architecture

Physical separation between connectivity and control will contribute to lower CAPEX and OPEX by:

- Enabling packet transport of circuit switched traffic. The same network can be used for voice as well as GPRS and any other datacom traffic (e.g. O&M) within the operators network. By sharing the same transport, trunking effects will be achieved.
- The physical separation of connectivity and control for circuit switched traffic makes it possible to grow independently in each layer. This means, for example, that increased traffic in one area may require a new media gateway but no investments in MSC Servers. In the same way may an increase in the subscriber base require a new MSC Server, but no new media gateways.
- The physical separation of connectivity and control also gives the opportunity to place the nodes more efficiently in the network. A few MSC Servers can initially serve the whole network. By building "MSC-server farms", the nodes can be served by fewer people, than if the MSC's were distributed.
- The Media Gateways can be placed close to the radio access network. This gives opportunity to optimize the transmission, as the MSC Server will find the terminating side of the call and the Packet Backbone Network (PBN) will find the closest route.
- By separating connectivity and control, a change of transmission technology is invisible from an MSC point of view. This means that such a change can be made when the technology is mature enough and the price/performance is advantageous, without affecting the overall network design. The Media Gateway

can translate between TDM/ATM and IP, and the transmission network could consist of more than one of these technologies at the same time.

Common Network for GSM and WCDMA

CAPEX savings can be obtained by re-use of the GSM Core nodes also for WCDMA. It is mainly software that needs to be added in order to also have a WCDMA enabled Core Network. Also the intersystem signalling will be reduced meaning that interface boards and transmission can be saved.

Less intersystem & Handover signalling also means savings in capacity demand.

On the OPEX side, savings can be achieved mainly within the O & M area, fewer sites/nodes to handle (daily operation& maintenace tasks, less nodes to upgrade etc.). Also by continuing with the same system also for WCDMA there will be less need for training of the personell.

It will be easier to achieve a seamless network experience since the node features for GSM also will be part of the WCDMA features. The same service layer and IP Multimedia systems can be used for GSM and WCDMA.

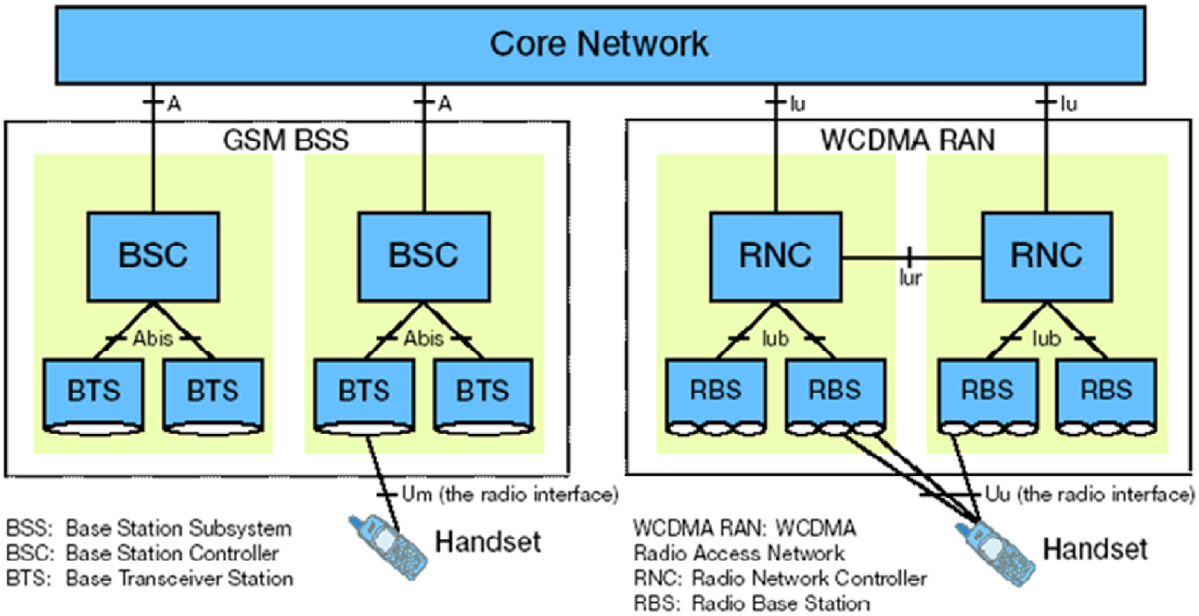
GSM / WCDMA Architecture

The GSM Base Station Subsystem (BSS) and the WCDMA RAN are both connected to the GSM core NW to provide a radio connection to a handset.

BTS---→RBS, BSC-----→ RNC

The A – interface of GSM was the basis of the development of the Iu interfaces of WCDMA. Main difference is the new services handled by WCDMA.

Iur is a remarkable difference with GSM. It brings completely new abilities for the system to efficiently utilize its radio resource management and mobility management



Cell breathing

Cell breathing is the constant change of the range of the geographical area covered by a cellular telephone transmitter based on the amount of traffic currently using that transmitter.

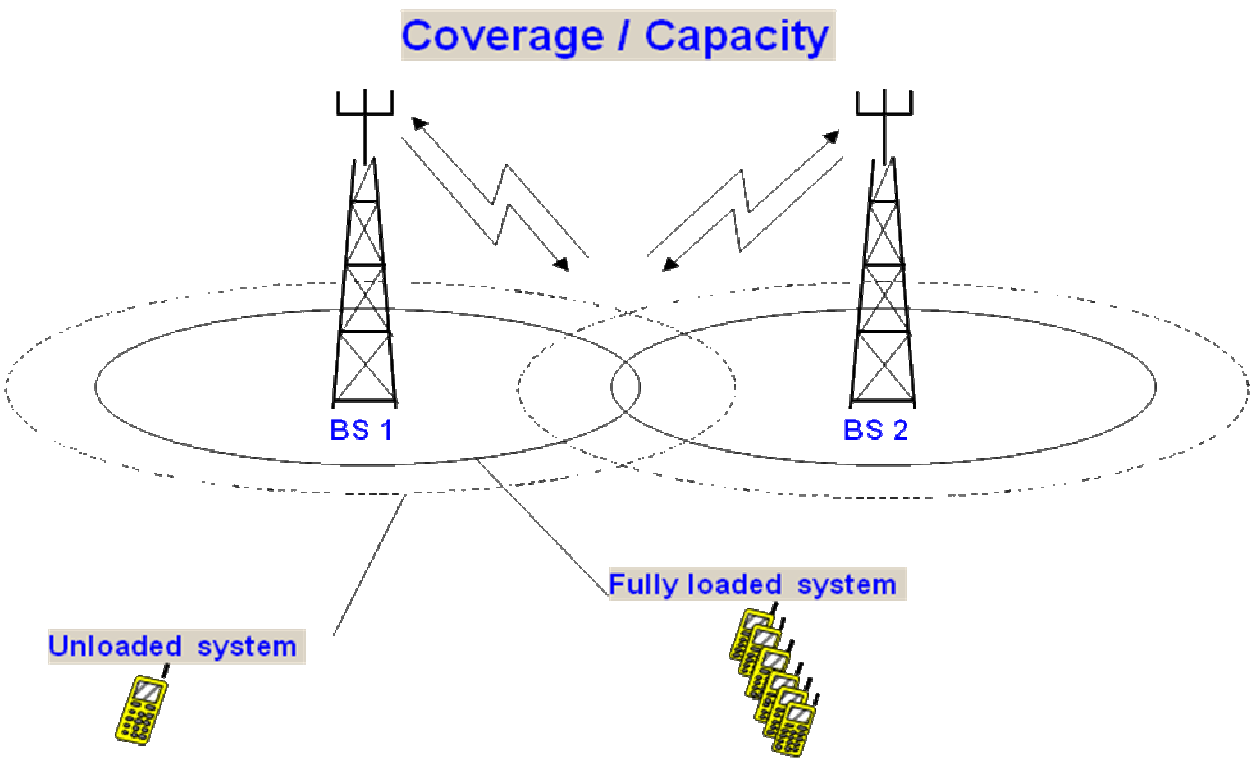
When a cell becomes heavily loaded, it shrinks. Subscriber traffic is then redirected to a neighboring cell that is more lightly loaded, which is called load balancing. Cell breathing is a common phenomenon of 2G and 3G wireless systems including code-division multiple access (CDMA). WCDMA Systems are designed to manage cell breathing.

- The WCDMA technology enables multiple transmitters to use the same frequency at the same time.
- Each transmission appears like background noise to other receivers.
- However this reduces the signal to noise ratio (SIR).
- This means that there will be interference between users in the same cell and in neighboring cells.
- The WCDMA spreading and despreading processes allow this interference to be suppressed to some degree.
- The Level of suppression is termed the system processing gain.
- The processing gain will vary according to the service.
- When the number of subscriber in the cell is low (low load), good quality can be

achieved even at the long distance.

- As the number of subscriber increases loading within the cell is increased, the Base Station noise floor appears to rise.
- The mobiles must transmit additional power to overcome the ncreased interference or have to get closer to the base station to achieve good quality.

  - **When the cell load is low coverage area is more. (Expansion)**
  - **When the cell load is high coverage area low. (Shrinking)**



Power Control

Power control is the mechanism by which Mobile equipment and base station instruct each other for increase or decrease the transmission power levels. WCDMA is a interference dependent system so there is high requirement for power control mechanism.

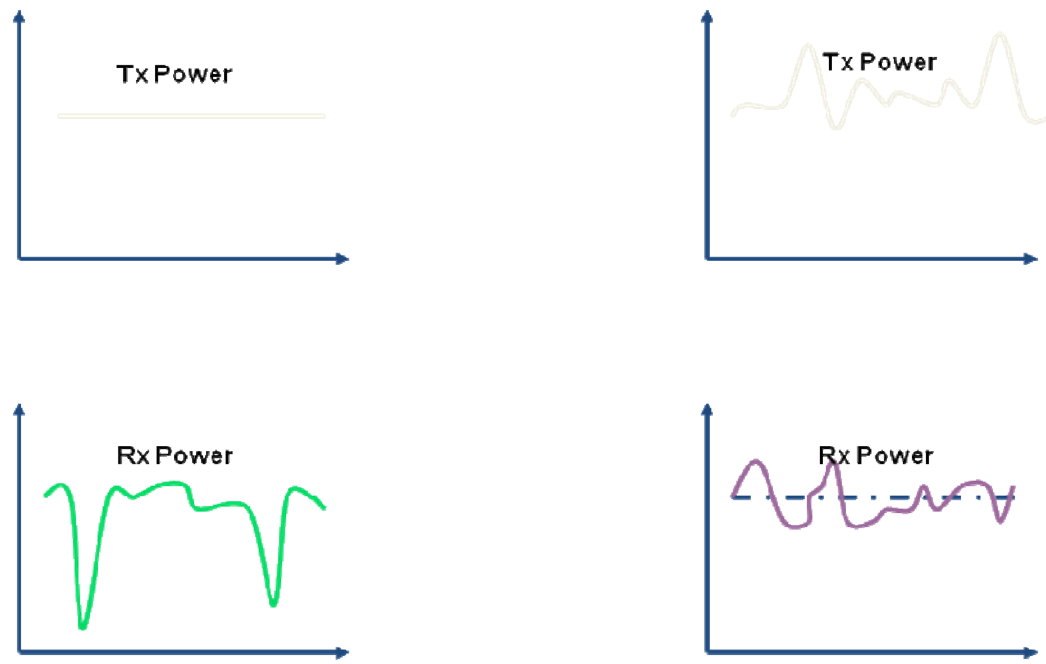
Tight and fast power control is the most important aspect in WCDMA, in particular on the uplink. Without it , a single overpowered mobile could block a whole cell.

The main reasons for implementing power control are :-

* near-far problem

* interference dependent capacity

* limited power source of the UE



Without Power Control **Wit Power Control**

There are three types of power control

- Open loop power control
- Closed inner loop power control
- Closed outer loop power control

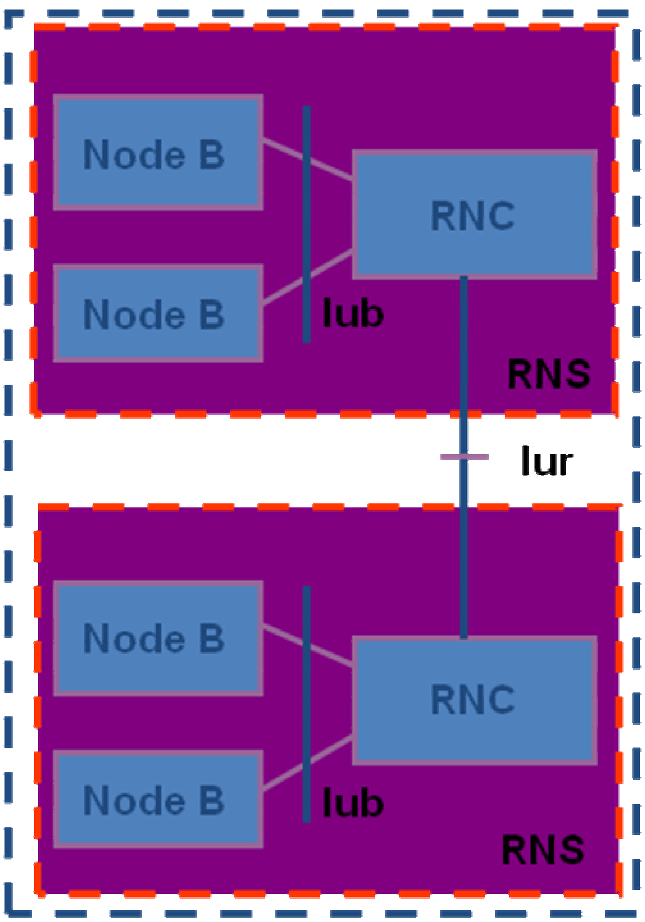
UMTS Radio Access Network

The subsystem controlling the wideband radio access has different names, depending on the type of radio technology used. The general term is Radio Access Network (RAN).

If especially talking about UMTS with WCDMA radio access, the name UTRAN or UTRA is used

The UTRAN is divided into Radio Network Subsystem (RNS). One RNS consist of set of radio elements and their corresponding controlling element. In UTRAN the radio element is Node B or Base Station (BS), and the controlling element is Radio Network Controller (RNC).

The RNSs are connected to each other over access network-internal interface Iur .



UMTS Base Station (Node B)

- It logically corresponds to GSM BTS.
- It is also known as Node B.
- It is located between the Uu and Iub interface.
- Main task is to establish the physical implementation of Uu interface towards UE and Iub interface towards the network.
- Convert the data flow between the Iub and Uu interface.
- Participate in radio resources management.
- It performs channel coding.
- It performs interleaving .
- It performs rate adaptation.
- It performs spreading
- It performs power control.

UMTS Base Station Control (RNC)

- It is the switching and controlling element of the UTRAN.
- It is located between the Iub and Iu interface.
- It also has the third interface called Iur for inter-RNS connection.
- It interfaces the core network.
- It terminates the Radio Resource Control (RRC).
- It logically corresponds to the GSM BSC.
- It controls the mobility and handover within the RAN.

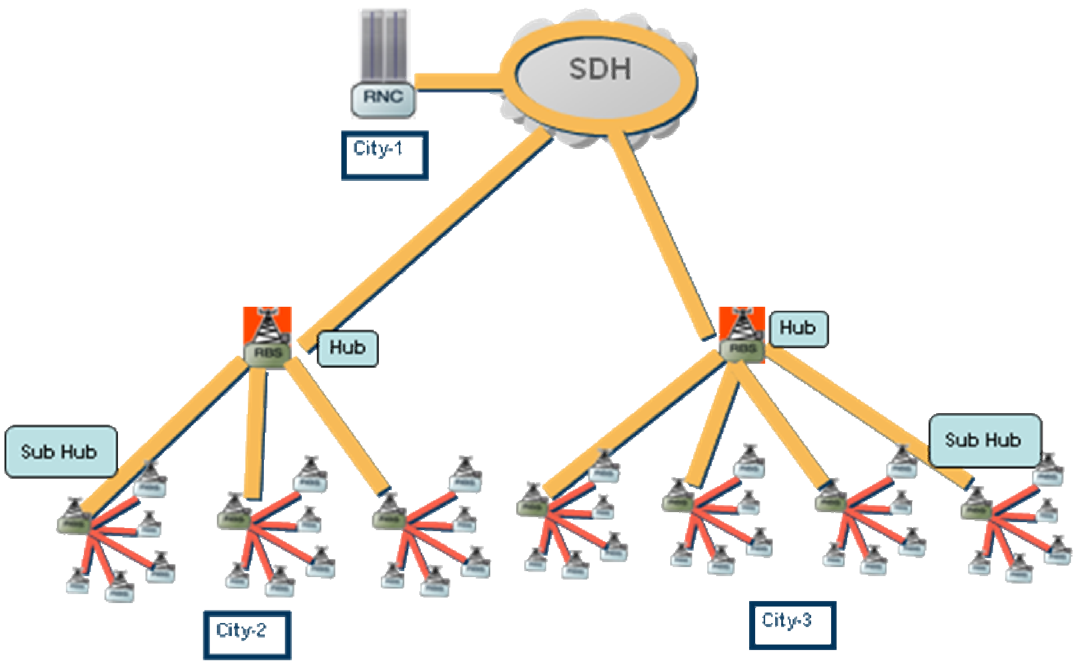
Transport Design Criteria

Design Criteria:

- Up to 6 Node-Bs grouped into one cluster of a Sub-hub.
- Up to 4 Sub-Hub clusters grouped into 1 hub.
- STM-1 from Hub/Sub-Hub to RNC through BSNL media.

Interfaces:

- End node-B: E1 interface.
- Sub-Hub: E1 interface southbound and STM-1 interface northbound.
- Hub: STM-1 interface.



Security in UMTS

Legacy from 2G

- Authentication of the User
- Encryption of communication in the radio interface
- Use of temporary identities

Criticized points in GSM Securities

- Active attacks towards the network are possible
- Sensitive control data sent on air without ciphering
- Security algorithms does not create trust

Security features in UMTS

- Mutual authentication of the user and the network.
- Use of temporary identities.
- Radio access network encryption.
- Protection of signaling integrity inside UTRAN.

UMTS security starts with the Authentication & Key Agreement (AKA)

Mutual Authentication

- Identifying the user to the network
- Identifying the network to the user

Key Agreement

- Generating the cipher key
- Generating the Integrity key

After Authentication and Key Agreement (AKA)

- Integrity protection of signaling data
- Confidentiality protection of user data

When Authentication and Key Agreement (AKA) is performed?

AKA is performed when the following things happen:

- Registration of a user in a serving network
- After a service request
- Location update request
- Attach request
- Detach request
- Connection re-establishment request

Commonly found issues

The operational issues are varying circle to circle .Most common and repeated operational issues are given below.

1. Poor 3G data speed.
2. High VSWR
3. Improper neighbour definitions. (missing neighbours and unwanted neighbours)
4. BSIC/BCCH clashes in 2G networks.
5. Loose connectors or improper connector fixing.
6. Antenna degradation.
7. Water in the feeder cables.
8. Huge LAC updations.
9. Ping Pong handovers.
10. One way speech and call mute.
11. Cross talk.
12. Echo.

Common reasons:

1. Call drop: common reasons

1. Interference/quality.
2.Neighbour issues due to missing neighbour / Co BCCH & BSIC clashes in 2G network.
3. Low coverage
4. Hardware unit faulty in Node B.
5.Error in air interface.
6.Faulty Transcoding Modules in MGW(drop in multiple sites)
7.Faulty switching cards in RNC(Multiple sites) or Node B .
8. Presence of a Jammer in the coverage area.
9. MUX problems.

2. Handover failures : common reasons

1. Poor quality in the destination cell.
2. Co BCCH/ BSIC issue in 2G network.
3. Wrong BSIC/BCCH propagation to neighbours in OMC /BSC.
4. Wrong Neighbours.
5. Hardware malfunctions.
6. Cable swap.
7. Handover parameters wrongly defined in OMC.
8. Overshooting cells , multi path and stray signals.

9. More neighbours leads to less averaging of each neighbour measurement for uplink and hence less accurate. So define only the required neighbours

3. Access failures : common reasons

1.Congestion in Traffic and Signalling Channel.
2. Interference/poor quality.
3. Hardware(Node B) malfunction.
4. Error in Air interface.
5. Feeder Cable swap and the internal Node B RF cables fault.
8. Jammers.
9. Congestion in Iu interface .
10. Processor overload in core Nodes like MSC server, MGW etc.

4.Cross Talk : common reasons

1. Wrapping problems during Stream wiring. (This can also lead to echo)
2. Hardware (MGW) malfunction
3. Hardware (Node B) malfunction.

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5.Echo : common reasons.

1. Hardware (Node B) malfunction.
2. Stream Problems.
3. Problem in Echo Canceller in MGW.

6. Mute: common reasons.

1. Interference.
2. Hardware (Node B) malfunction.
3. Stream Fault.
4. Faulty Transcoding modules in MGW.
5.CIC mismatch.

7. 3G data speed: common reasons.

1. Cross-check HSDPA and HSPA related parameters in RNC & Node B
2. Check SGSN Profile
3. Check HLR Profile (user profile).
4. Check for Time Delay & Jitter using Ping Plotter tool.
5. Signal strength, Interference, Cell change Loading.
6. Availability in Node B.
7.Verify Routing, delays, congestion, QoS profiles etc
8. Transport errors.

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