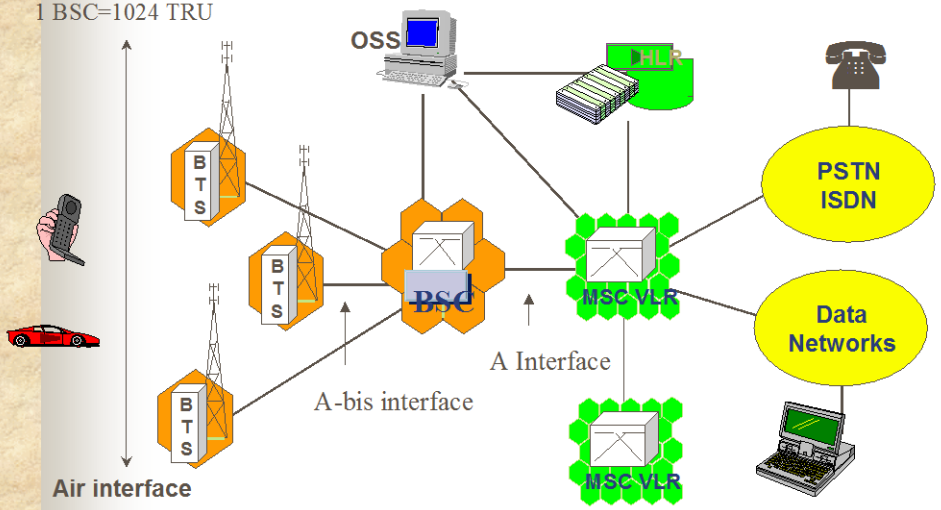
Various Interfaces and their Mapping

SKGOCHHAYAT
RTTC, BHUBANESWAR

Network Architecture

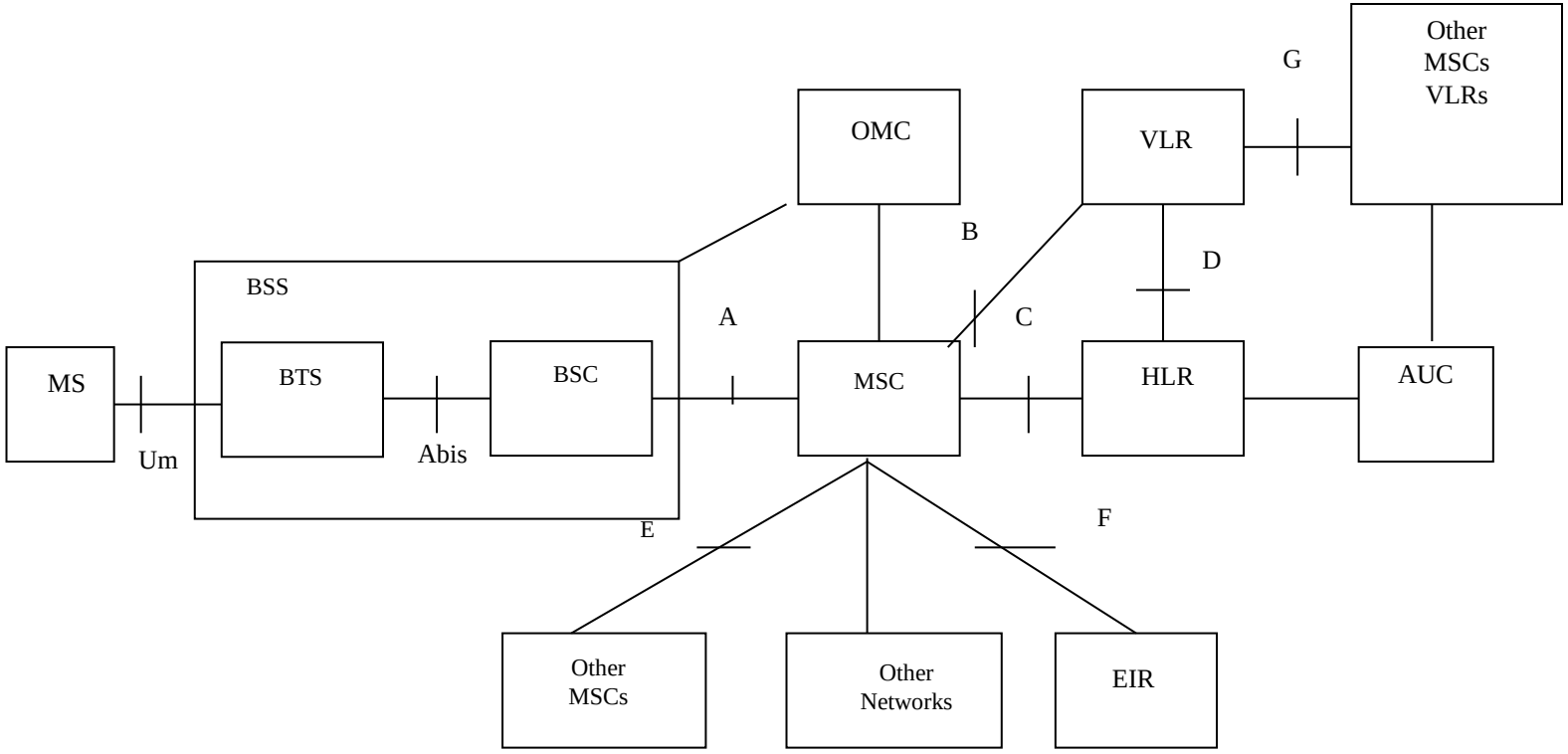
1 MSC=16 BSC

1 BSC=1024 TRU

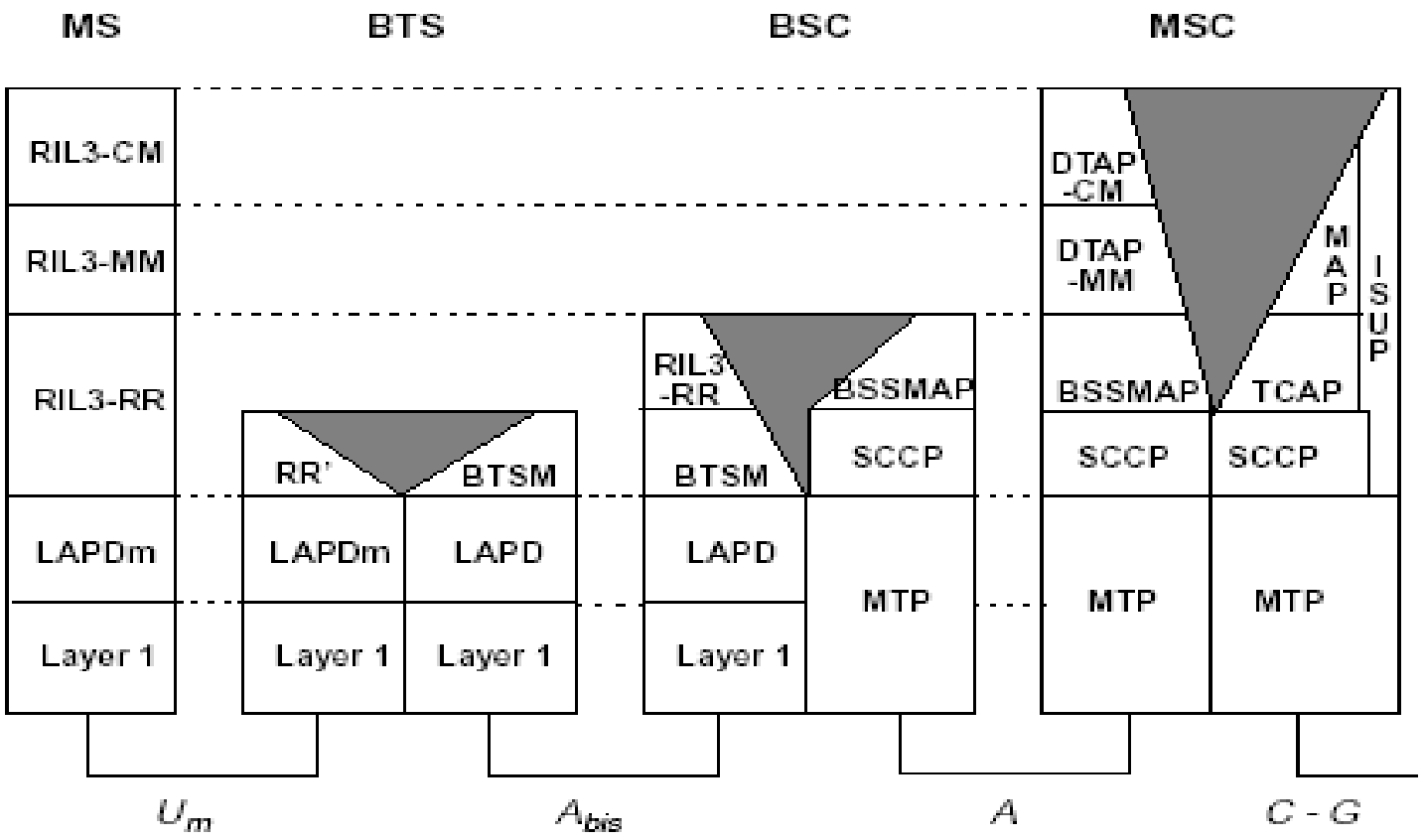


BSC:BASE STATION CONTROLLER, BTS: BASE TRANSRECEIVER STATION, OSS: OPERATION AND SUPPORT SUBSYSTEM.ss

Different interfaces in GSM network



GSM Signaling Architecture



MS-BTS interface (Um interface)

- Layer 1: Radio subsystem layer (Physical layer)
- Layer 2: LAPDm (modified version of ISDN LAPD protocol)-protected transfer of signalling messages
- Layer 3: Three protocols
  - **RIL3-RR (Radio Interface Layer 3 - Radio Resource management)**
    - **Direct MS-BSC communication**
    - **paging, ciphering, handover, radio channel access**
  - **RIL3-MM (Mobility Management)**
    - **Direct MS-MSC communication**
    - **Roaming & Authentication procedures**
  - **RIL3-CM (Connection Management)**
    - **Direct MS-MSC communication**
    - **Call establishment and release**

BTS-BSC interface (Abis)

- Three layers:
  - Layer 1: Physical layer
  - Layer 2: LAPD
  - Layer 3: BTS Management Protocol
    - Start of ciphering process
    - Paging to localize an MS of connection set-up.
- Used for
  - signalling exchange between BSC and BTS
  - Synchronization information from BSC to BTS
  - Voice-data traffic

BSC-MSC Interface (A)

- Message Transfer Part (MTP)
  - Routing and protected transport of signalling messages
  - Message transport in SS7 network
- Signalling Connection Control Part (SCCP)
  - Connection-less SCCP: Paging from MSC to BSC
  - Connection oriented SCCP
- BSS Application Part (BSSAP)
  - BSS Management Application Part (BSSMAP)
    - Admn. and control of Radio resources,
    - Maintenance & hand-over control
  - Direct Transfer Application Part (DTAP)
    - Direct interface between MSC and MS
    - DTAP-MM & DTAP-CM

B, C, D, E, F Interfaces

- MSC-VLR Interface (B)
  - Internal interface as VLR resides in MSC
- MSC-HLR Interface (C)
  - MAP protocol to retrieve routing information from HLR and to store routing information in HLR
  - TCAP protocol to manage dialog between two network entities
- VLR-HLR Interface (D)
  - MAP protocol to support the transfer, cancel or modify the subscriber information
- MSC-MSC Interface (E)
  - ISUP
  - MAP protocol for inter-MSC handover and SMS
- MSC-EIR Interface (F)
  - MAP protocol to retrieve IMEI from EIR

G, H, M Interfaces

- VLR-VLR Interface (G)
  - MAP protocol to support transfer of subscriber information between VLRs
- HLR-AUC Interface (H)
  - Internal interface
  - MAP protocol to HLR to access AUC database.
- BSC-TRAU Interface (M)
  - Internal interface
  - Encodes bit rate of A-interface (64 kbps) to the A-bis interface (16 kbps)

Multiplexing Technique

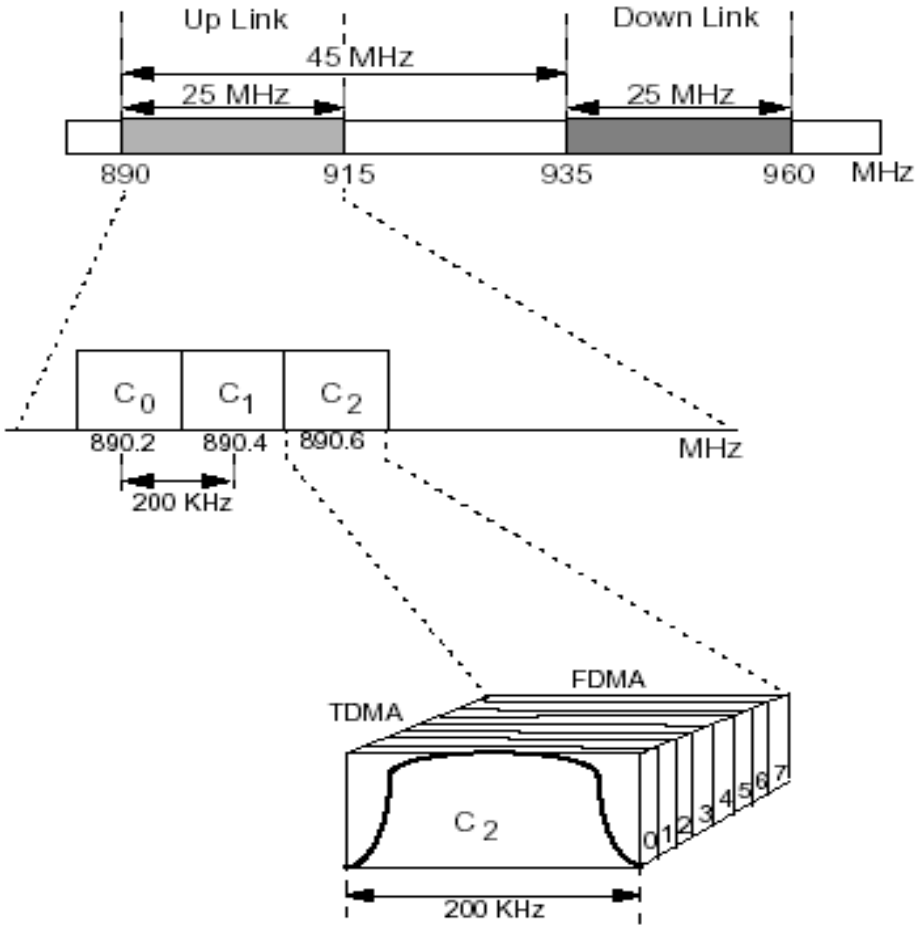
Sharing of scarce transport medium resource by use of a fixed partitioning between several users. GSM standard has two simultaneous multiplexing techniques.

- Time Division Multiple Access (TDMA)
  - Resource is shared by time
  - Each channel is divided into timeslots, each conversation uses one timeslot.
  - Many conversations are multiplexed into a single channel.
  - GSM standard divides each channel (carrier frequency) into bursts [0.577 ms]. 8 such bursts are a frame.

Multiplexing Technique…..

- Frequency Division Multiple Access (FDMA)
  - Resource is shared by frequency
  - Available frequency band (25MHz freq.) is divided into 124 sub-bands (separate physical radio communication channel).
  - Each channel is identified by central frequency i.e. carrier frequency
  - Each base station gets few of those carrier frequencies.

FDMA and TDMA



Um Interface

- **Interface between Mobile Station (MS) and Base Station (BS)**
- **Two types of channels**
  - Physical Channel
    - TDMA (Time Division Multiple Access) frame
  - Logical Channel: These are transmitted on time slots of the physical channels.
    - Payload transport
    - Signalling
    - Synchronization
    - Channel assignment etc.

Logical channels

It transports either user data during a call or signalling information for MS or base station.

Two groups of logical channels:

- Traffic Channels, for call data
- Signalling (control) channels, to communicate service data between network equipment nodes.

Traffic channel (TCH)

- **Transmission of user payload data (speech, data, fax)**
- **Do not carry any control information**
- **Communication over TCH can be**
  - Circuit-switched (Telephony)
  - Packet-switched
- **May be fully used (full-rate TCH, TCH/F)**
  - **Gross bit rate of 22.8 kbit/sec**
  - **Provides a net bit rate at 13 kbit/sec for coded speech.**
  - **data streams at 14.4, 12, 9.6, 6, 4.8, 3.6 or 2.4 kbit/sec.**
  - **Also known as Bm channel (Mobile B channel)**

Traffic channel (TCH)…

- **May be split into two half-rate traffic channels (half-rate TCH, TCH/H)**
  - **can be allocated to different subscribers**
  - **Two users share a voice channel**
  - **Less transmission bandwidth than full-rate TCH channels hence doubling the network capacity.**
  - **Gross bit rate of 11.4 kbit/sec**
  - **Provides a net bit rate for coded speech of 6.5 kbit/sec.**
  - **Half-rate data services with 6, 4.8, 3.6 and 2.4 kbit/sec.**
  - **Also known as Lm channel (lower-rate mobile channel)**
- **Enhanced full rate traffic channel (TCH/EFR)**
  - **Improved voice quality**
  - **Provides net bit rate of 12.2 kbit/sec.**

Signalling (Control) channel

- During a call, signalling channel is associated with a traffic channel and supports the radio link between the mobile terminal and the BS.
- When no active connection, signalling information like Location Update is permanently transmitted over the air interface to the BS.
- Offers a continuous signalling service to MSs.
- Also known as Dm channel (mobile D channel)

Signalling channel…

Three types

1. **Broadcast Channel (BCH)**

2. **Common Control Channel (CCCH)**

3. **Dedicated/ Associated Control Channel (D/ACCH)**

Signalling channel…

1. Broadcast Channel (BCH)

- Uni-directional signalling channel (BSS to MS) i.e. Downlink channels
- Used by Base Station Sub-system (BSS) to broad cast the same information to all MSs in a cell.

2. Common Control Channel (CCCH)

- Uni-directional signalling channel (either Up-link or Down-link) to deal with access management
- Assignment of dedicated channels (SDCCH)
- Paging to localise a Mobile station.

3. Dedicated/ Associated Control Channel (D/ACCH)

- Bi-directional signalling channel (Up-link and Down-link) to deal with access management

Broadcast Channel (BCH)

Four types

1. **Broadcast Control Channel (BCCH)**
2. **Frequency Correction Channel (FCCH)**
3. **Synchronisation Channel (SCH)**
4. **Cell Broadcast Channel (CBCH)**

Broadcast Control Channel (BCCH)

- **Broadcast on the first frequency assigned to the cell (BCCH carrier)**
- **Radio channel configuration of currently used cell and of neighboring cells**
- **Contains parameters used by MS to access the network, e.g. CGI, LAI, RAI, BA, BSIC, ciphered mode etc.**
- **Synchronization information (Frequency as well as TDMA frame number)**

Broadcast Channel (BCH)

2. Frequency Correction Channel (FCCH)

- Information about correction of transmission frequency
- Sends a constant frequency shift of the radio frequency carrier (i.e. Pure carrier wave).
- Always broadcast with BCCH

3. Synchronisation Channel (SCH)

- Broadcasts information to identify a BTS (BSIC) (i.e. Base Station transceiver Identity Code)
- Broadcasts data for the frame Synchronisation of an MS. (TDMA frame number)
- Always broadcast with BCCH

4. Cell Broadcast Channel (CBCH)

- Sends SMS messages in a cell

Common Control Channel (CCCH)

Four types

1. **Random Access Channel (RACH)**
2. **Access Grant Channel (AGCH)**
3. **Paging Channel (PCH)**
4. **Notification Channel (NCH)**

Common Control Channel (CCCH)

1. Random Access Channel (RACH)

- From MS to BSS i.e. uplink portion of CCCH
- Request for a dedicated channel (SDCCH) by an MS for exclusive use of the MS for one signalling transaction.

2. Access Grant Channel (AGCH)

- From BSS to MS i.e. downlink portion of CCCH
- Used to assign an SDCCH or a TCH to a MS.

Common Control Channel (CCCH)

3. Paging Channel (PCH)

- From BSS to MS i.e. downlink portion of CCCH.
- When an incoming call arrives, BS sends out a request on the PCH to find the mobile stations requested by the call to activate the call establishment process.

4. Notification Channel (NCH)

- From BSS to MS i.e. downlink portion of CCCH.
- Used to inform all MSs about incoming group and broadcast calls.

Dedicated/Associated Control Channel (D/ACCH)

Three types

1. **Stand-alone Dedicated Control Channel (SDCCH)**

2. **Slow Associated Control Channel (SACCH)**

3. **Fast Associated Control Channel (FACCH)**

Stand-alone Dedicated Control Channel (SDCCH)

- Not tied to the existence of TCH.
- Used for signalling between an MS and BS when there is no active connection.
- Requested from MS via RACH and assigned via AGCH.
- After the completion of signalling transaction, SDCCH is released and can be re-assigned to another MS.
- Examples: Updating of location information, subscriber authentication, ciphering initiation or parts of the connection set-up until the connection is switched through, assignment of TCH.
- Net bit rate is 0.8 kbps.

Slow Associated Control Channel (SACCH)

- Always assigned and used with TCH/FACCH or SDCCH.
- Carries information for maintenance of the connection e.g.
  - command for synchronisation, transmitter power control, timing advance data on the down-link and
  - Radio link measurements reports on the up-link.

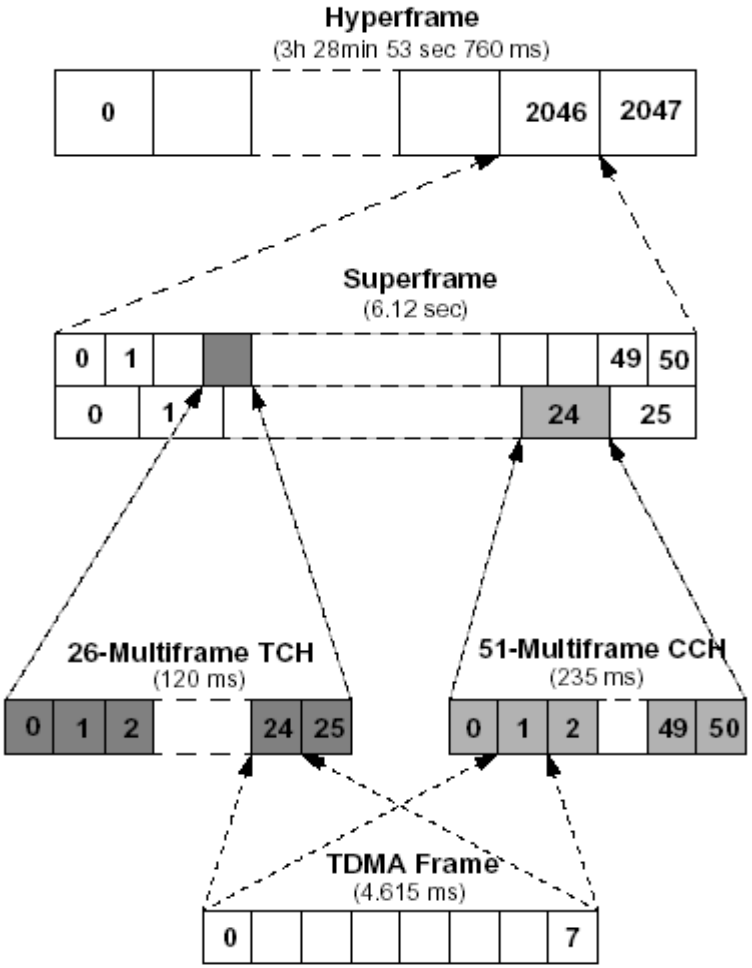
Fast Associated Control Channel (FACCH)

- Always assigned with TCH.
- Using dynamic pre-emptive multiplexing on a TCH, additional bandwidth can be made available for signalling for shorter duration. i.e. during handover or call release.
- FAACH data is transmitted over the allocated TCH.
- Marked by a stealing flag.
- Its short time usage is at the expanse of the user data transport.

Frame types on the Um interface

- TDMA frame
  - One Time slot (Burst Period)= 0.577 ms
  - TDMA frame= 8 BP = 8* 0.577ms = 4.62 ms.
- 26-TDMA multi-frame
  - 26 TDMA frames= 26 * 8 BP = 120 ms cycle
- 51-TDMA multi-frame
  - 51 TDMA frames= 51 * 8 BP = 235 ms cycle
- Super frame
  - 51 * 26 TDMA frames= 51 * 26 * 8 BP= 6.12 sec
- Hyper frame
  - 2048 super frames = 2048 * 6.12 sec= 3 hours 28 minutes 53 sec. and 760 ms.

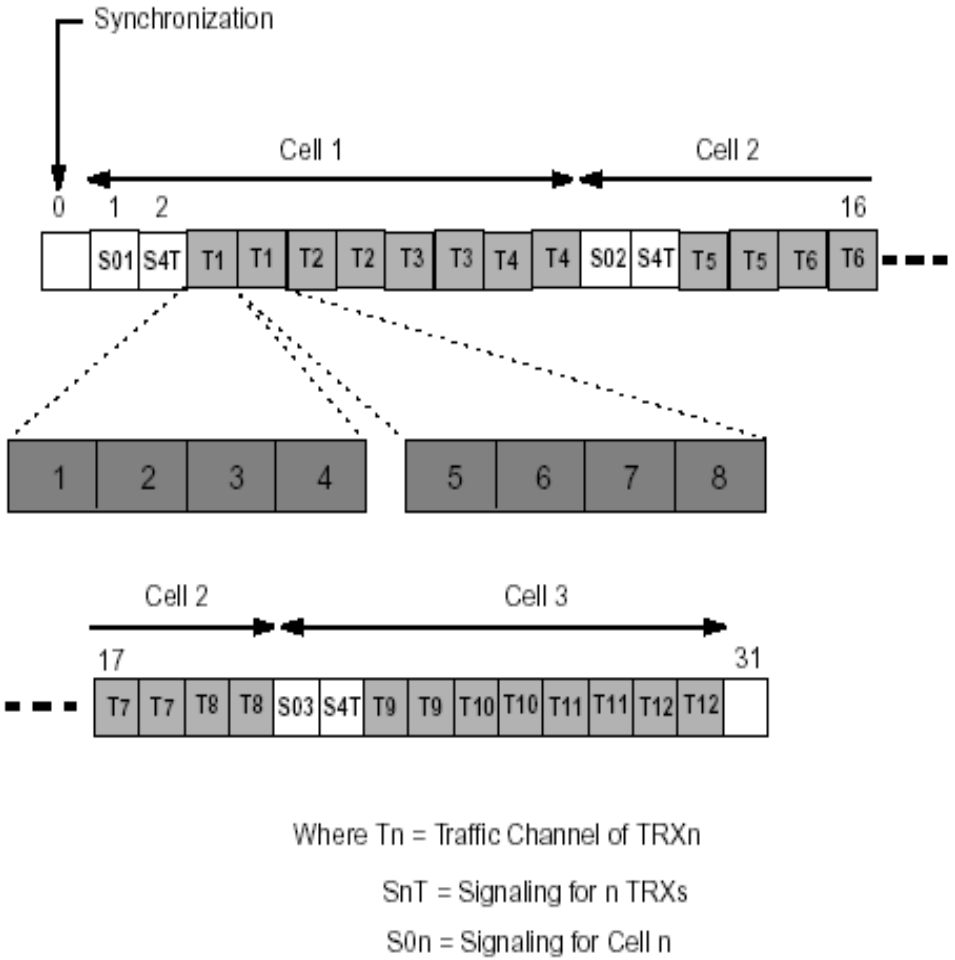
Frame types


Hyperframe
(3h 28min 53 sec 760 ms)
0
2046
2047
Superframe
(6.12 sec)
0
1
49
50
0
1
24
25
26-Multiframe TCH
(120 ms)
0
1
2
24
25
51-Multiframe CCH
(235 ms)
0
1
2
49
50
TDMA Frame
(4.615 ms)
0
7

Abis-Interface configuration

- PCM 30 (E1) On Abis
  - Timeslot 0 is used for synchronization purposes
  - Timeslots 1 to 31 are used for exchanging the Um-interface formatted 13kbit/s data for signaling.
  - The 13 kbit/s data is sub-multiplexed into the 64 kbit/s PCM 30-channels of the Abis-interface.
  - sub-timeslots (16 kbps) carries one traffic channel with a traffic data rate of 13kbit/s. The remaining 3 kbit/s are used for synchronization and in band signaling between the BTS and BSC.
  - Abis-link can carry physical channels from up to 12 TRXs

Example-1 for PCM 30



Where Tn = Traffic Channel of TRXn

SnT = Signaling for n TRXs

S0n = Signaling for Cell n

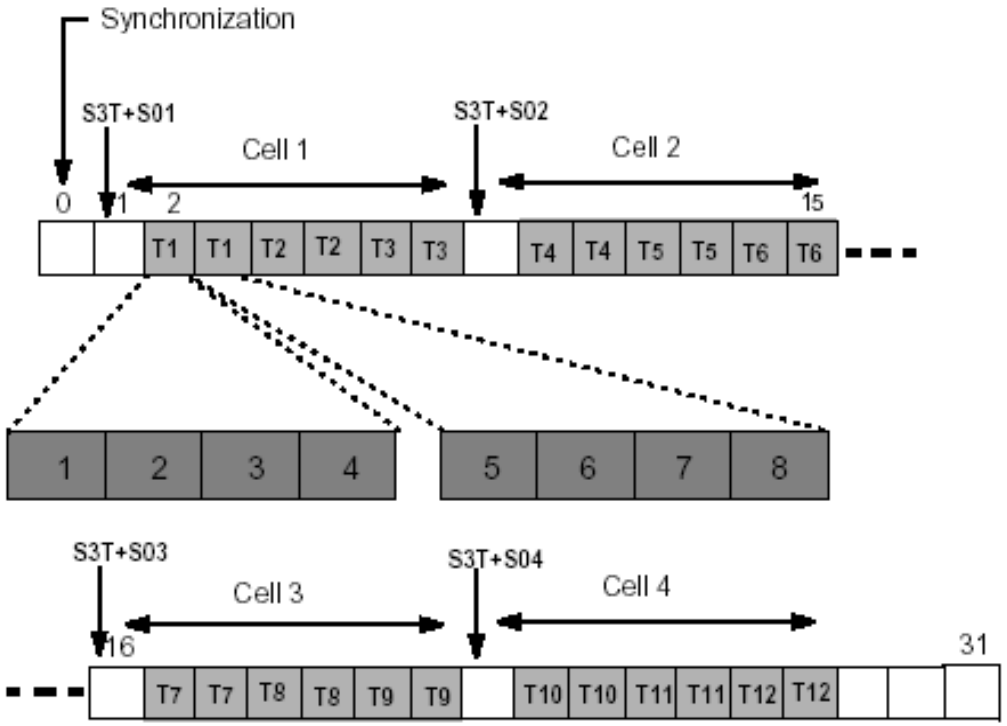
Abis-Interface configuration…..

- PCM 24 (T1) On Abis
  - A framing bit (F) is added to the beginning of each frame to allow detection of frame boundaries (synchronization) and for transport of additional maintenance information.
  - Timeslots 1 to 31 are used for exchanging the Um-interface formatted 13kbit/s data for signaling.
  - The 13 kbit/s data is sub-multiplexed into the 64 kbit/s PCM 30-channels of the Abis-interface.
  - Each sub-timeslots (16 kbps) carries one traffic channel with a traffic data rate of 13kbit/s. The remaining 3 kbit/s are used for synchronization and in band signaling between the BTS and BSC.
  - Abis-link can carry physical channels from up to 10 TRXs

Signaling link concentration

- Both TRX related signaling and cell (O&M) related signaling can be combined into a single timeslot on the Abis-interface. However, all signaling channels sharing a timeslot must belong to the same cell.
- This implies that one timeslot can accommodate signaling for:
  - Up to four TRXs (all TRXs must be in the same cell) or,
  - Three TRXs + one O&M (all TRXs must be in the same cell and O&M must relate to that cell).

Example-2 for PCM 30



Where Tn = Traffic Channel of TRXn

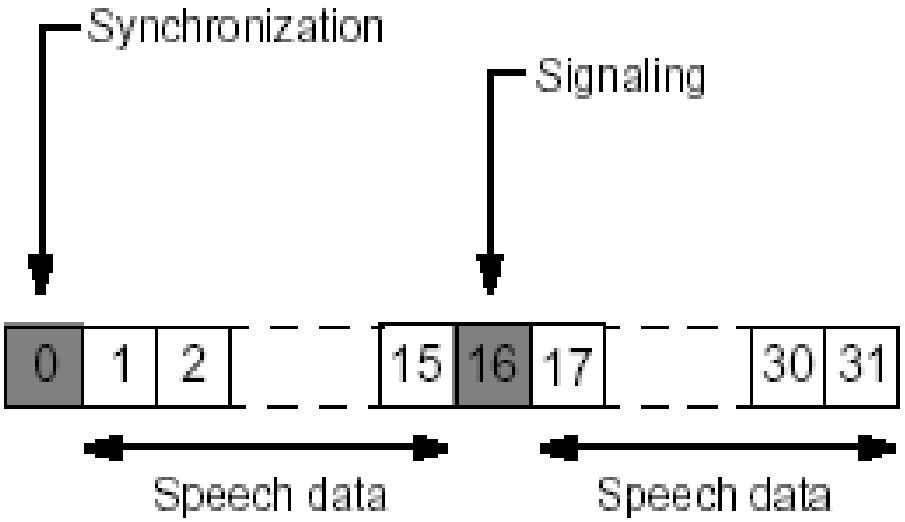
SnT = Signaling for n TRXs

S0n = Signaling for Cell n

A-Interface configuration

- PCM 30 (E1) on A link
  - Timeslot 0 is used for synchronization purposes
  - Timeslots 1 to 31 and 17 to 31 are used for exchanging the 64kbit/s speech data.
  - Timeslot 16 is used to transfer the CCS#7 signaling between the BSC and the MSC.
- PCM 24 (T1) on A link
  - framing bit for synchronization is added before time slot1
  - Time slot 1 to 15 and 17 to 24 are used for exchanging the 64 kbit/s/ speech data.

Example for PCM 30 on A link



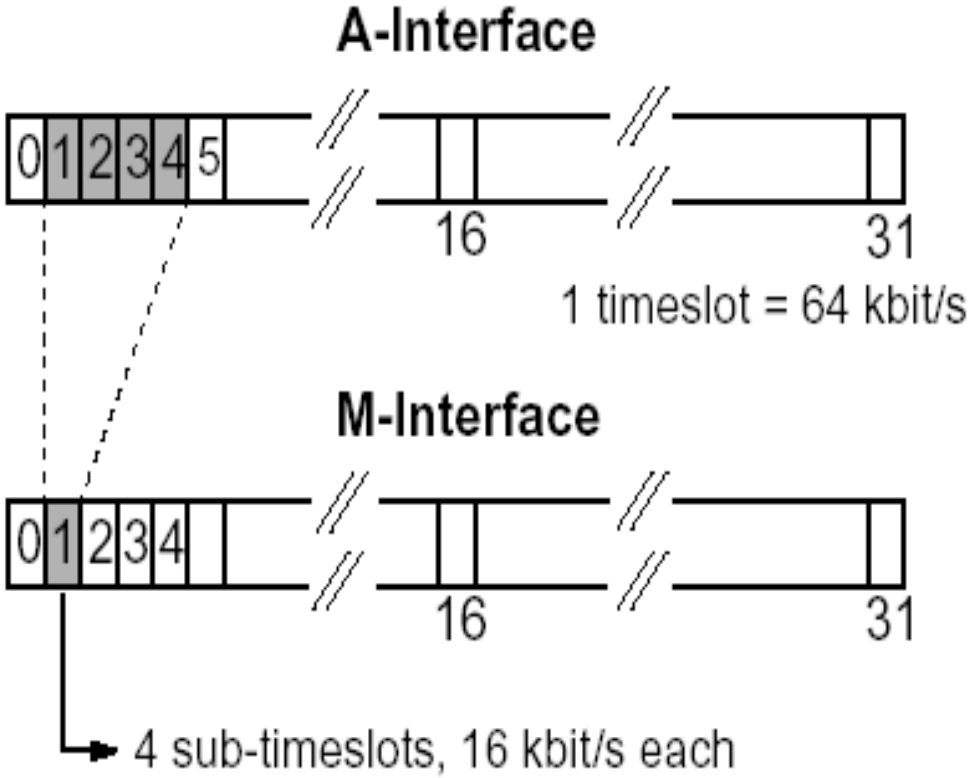
M-Interface

- Internal interface (BSC-TRAU)
- The M-interface is a multiplexed and transcoded A-interface.
- TRAU (Transcoder/Rate Adapter Unit) encodes the 64 kbit/s PCM signal to a 16 kbit/s signal,
- Transcodes four channels of an A-interface into one channel of an M-interface.

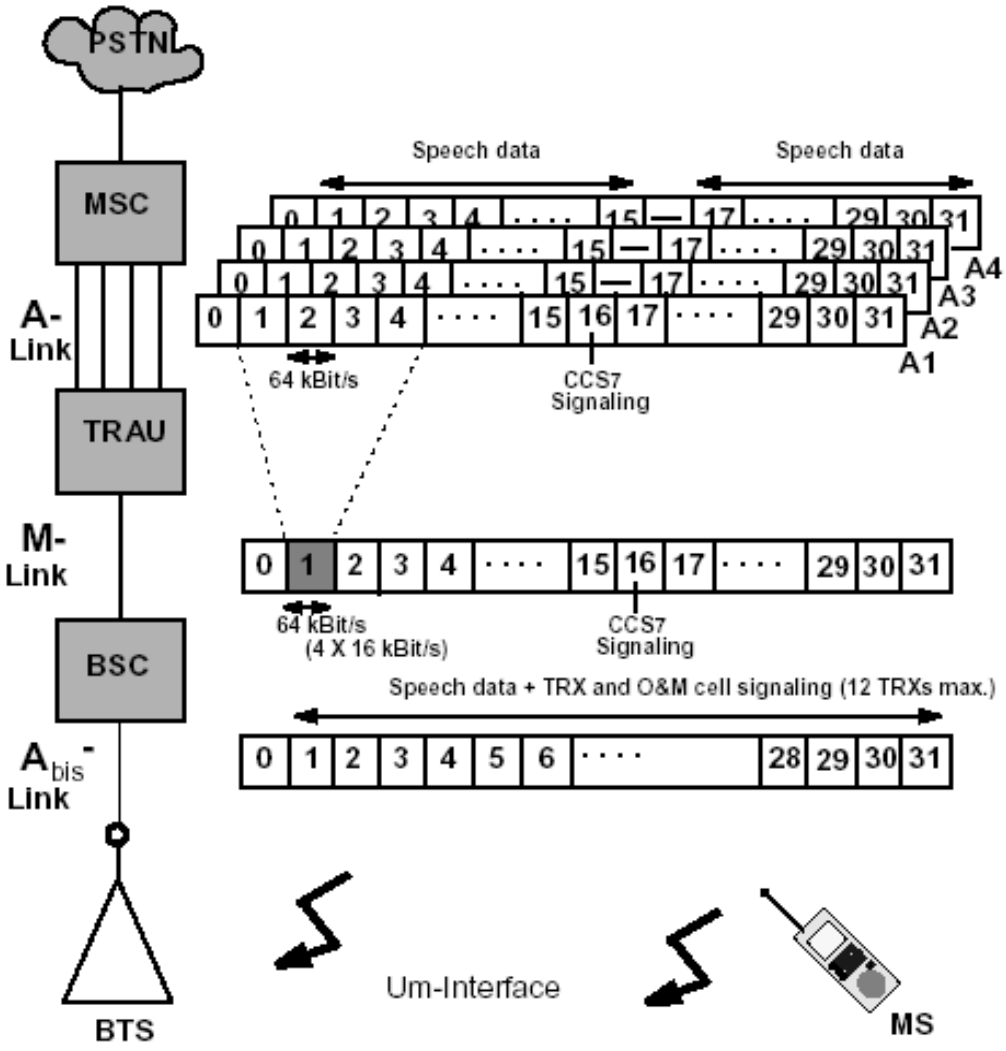
M interface configuration

- M interface on PCM 30
  - Each of the timeslots 1 to 15 and 17 to 31 on the M-interface contains four multiplexed A-interface channels.
  - Timeslot 0 is used for synchronization purposes.
  - Timeslot 16 contains the signaling information which is transparently mapped from timeslot 16 of the A-interface.
- M interface on PCM 24
  - Time slot 0 is framing bit (F) for synchronization
  - Time slot is up to 24

M interface on PCM 30



Mapping of A, M, Abis and Um Interfaces



Thanks