Lec24

Tuesday, March 10, 2020 3:15 PM

2G systems - 10min

Saturday, March 29, 2008 10:22 AM

Overall system architecture

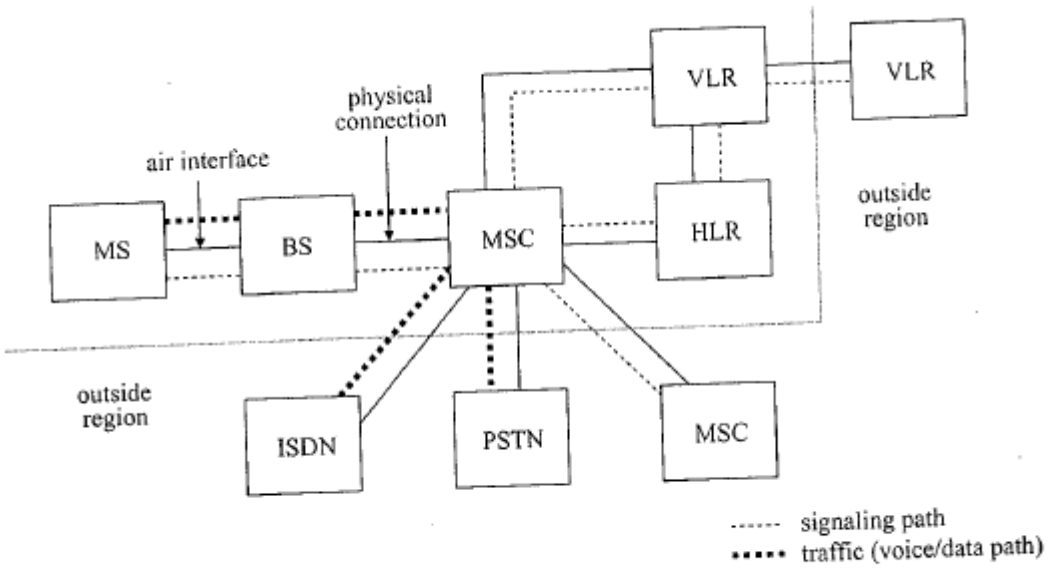


Figure 8.1 Cellular system, simplified

p200 Fig 8.1

MS – mobile station
BS – base-station
MSC – mobile switching center

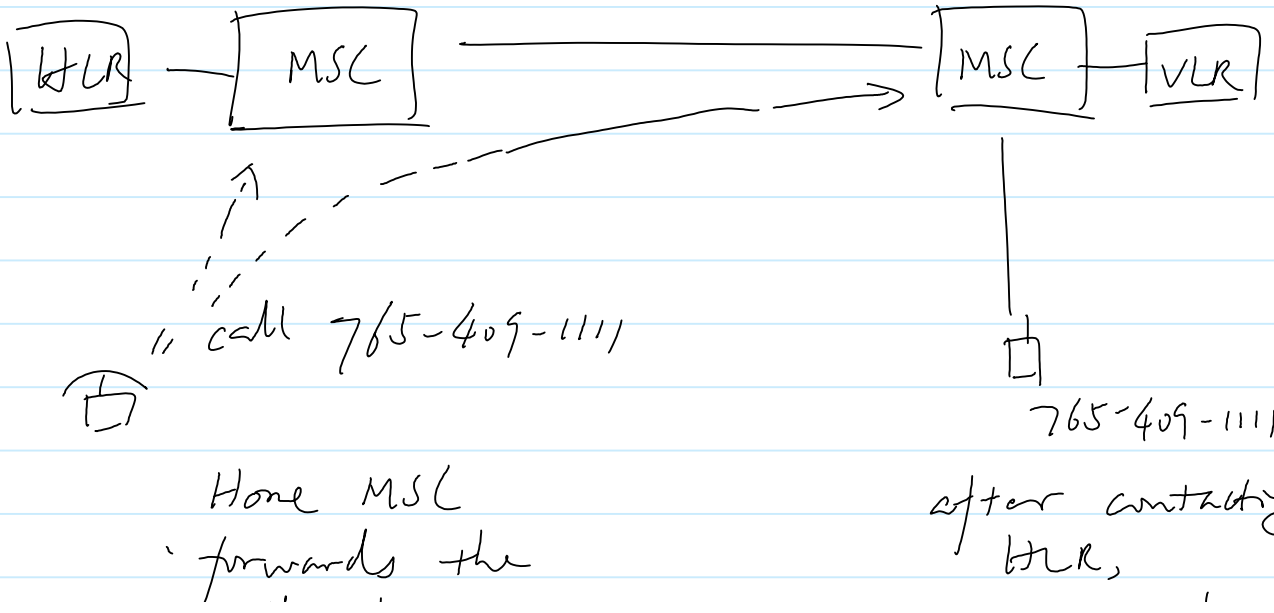
MSC works with BS
{ inter-cell handoff

mobile location, paging

HLR – home location register
- corresponds to a MSC
- reference & profile info for mobiles registered with this MSC as their "home location"

VLR – visitor location register
- "roaming" mobiles registered with the MSC
- after communicating with the HLR, reference & profile info stored in VLR

Roaming



Home MSC forwards the

after contacting HLR,

- forwards the call the foreign MSC

HLR, register with VLR

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2G structure - handout

Monday, March 31, 2008 2:53 PM

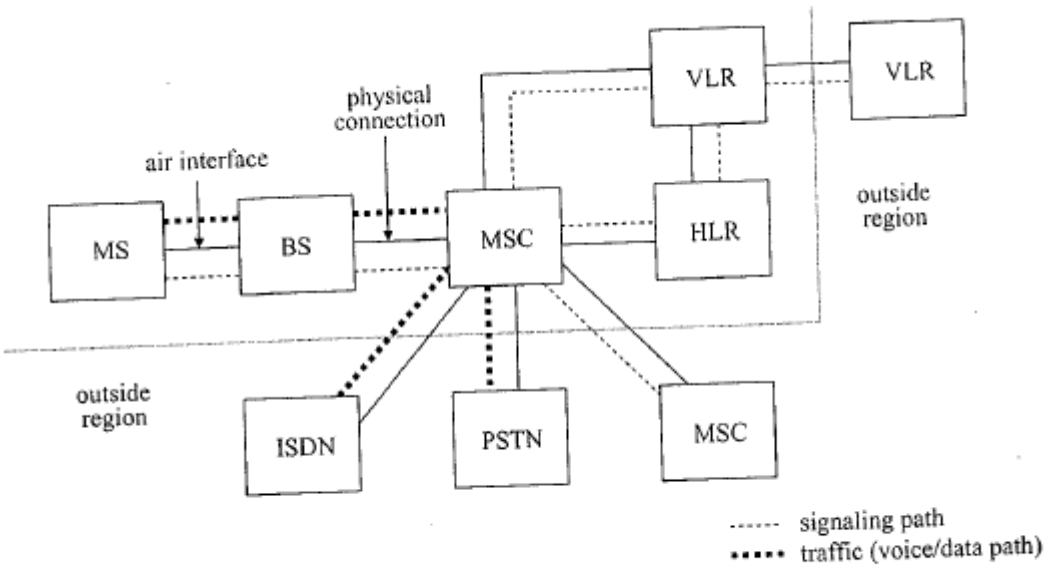


Figure 8.1 Cellular system, simplified

GSM - 20min

Saturday, March 29, 2008 10:22 AM

GSM (Global Systems for Mobile Telecommunications)

- 25 MHz in each direction

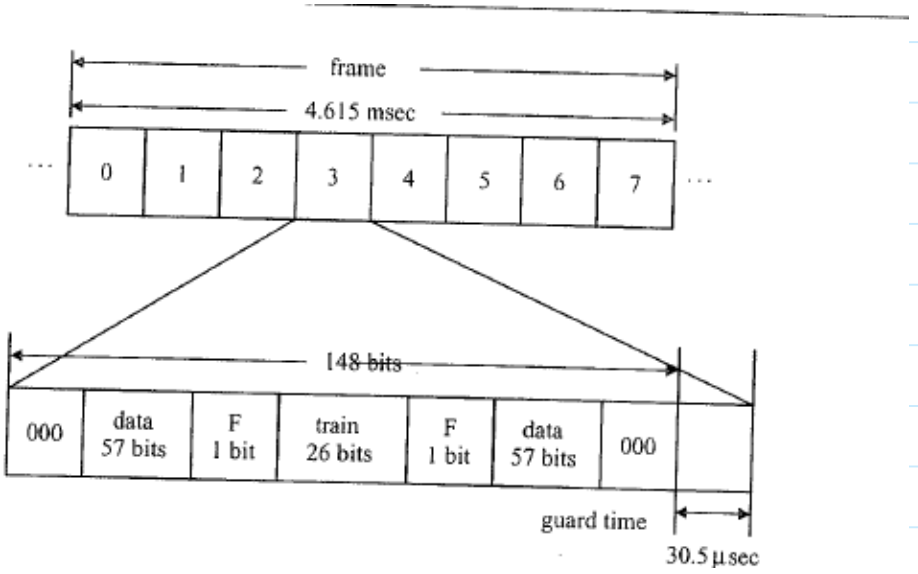
GSM 900
- 890 - 915 MHz uplink
- 935 - 960 MHz downlink

other variants : GSM 900/1800 Europe/Asia
GSM 850/1900 Americas

- divided into 200 kHz channels
  - 124 x 200 kHz for data
  - 1 x 200 kHz for guard band.

- frame structure

P20 78.2 Schwartz



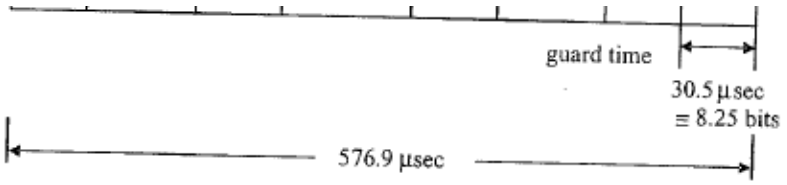


Figure 8.2 GSM frame/slot structure; traffic channel slots

- each frame has 8 time-slots
  - 4.615 msec long
- each slot has 148 bits
  - data : 57x2 bits
  - 000 : synchronization
  - F : data or control
  - train : estimating channel, equalization
  - + guard time : separation
- raw data rate
  156.25 bits / 0.577 msec = 270.833 kbps

per-user data rate
114 bits / 4.615 msec $\times \frac{12}{13}$ = 22.8 kbps

- 1 out of 13 frames is reserved for control signal

Control during a call

p202

Fig 8.3 setting up a call

p202

Fig 8.3 setting up a call

Roughly speaking, the following sequence of events occur:

- a mobile power on
- attach to a BS
  - what freq is the BS on?
  - what is the timing (beginning of the time slot)?
- mobile wants to initiate a call
  - how to request/acquire a channel?
  - how to notify the receiver that there is an incoming call?

To complete these functionalities, we will need communication channels for control information:

- some channels need to be easy to find (e.g. assist mobiles attaching to BS)
- some channels are random access (e.g. "jump-start")
- some channels are dedicated for signalling during the call.

signalling during the call!

What are the logical channels?
— Fig 8.3 & table 8.1

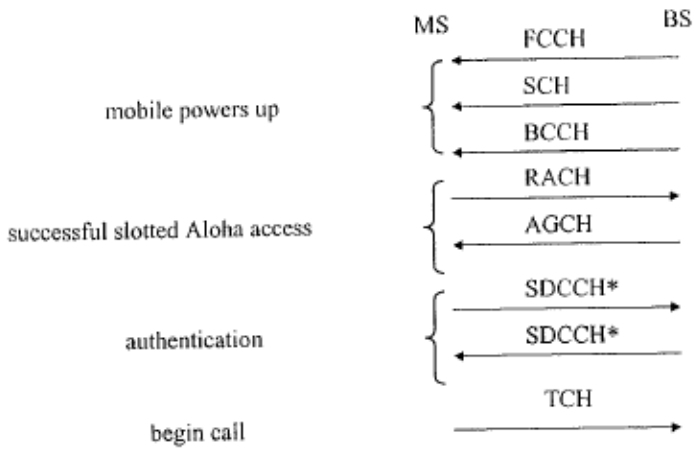


Figure 8.3 Setting up a GSM call
Note: * Can be a series of these messages.

Table 8.1 *List of GSM control channels*

Broadcast channels (all downlink, BS→MS direction)
1 Frequency correction channel, FCCH
2 Synchronization channel, SCH
3 Broadcast control channel, BCCH

Common Control channels
1 Paging channel, PCH (downlink, BS→MS)
2 Access grant channel, AGCH (downlink, BS→MS)
3 Random access channel, RACH (uplink, MS→BS)

Dedicated Control channels (bi-directional)
1 Stand-alone dedicated control channel, SDCCH
2 Slow associated control channel, SACCH
3 Fast associated control channel, FACCH

Broadcast Channels

- used when mobile power on
- BS → MS

(1) - FCCH: Frequency correction channel
  - enables MS to adjust or sync frequency characteristic to that of BS.
  - broadcast by BS

(1) - SCH: Synchronization channel
  - identifies the BS
  - provide time/frame synchronization to mobile

(1) - BCCH: Broadcast Control Channel
  - once freq & timing is acquire, MS listens to BCCH
  - provides information needed to set up a call (cell configuration, network to which it belongs, ⊗ → access & control channel info, etc.)

Common Control Channels

- used when mobile initiates a call

(1) — RACH (Random Access Channel)

- MS → BS
- use slotted Aloha

- Indicate purpose to
  - attempt new call, respond to paging
  - register location,
  - sent a short text message

(1) — AGCH (Access grant channel)

- BS → MS
- acknowledgement to RACH

- direct MS to specified stand-alone channel (SDCCH), over which the mobile transmits the signaling info required for authentication & call connection

① — PCH (Paging channel)

- BS → MS
- paging, locate a mobile.

Dedicated Control Channels (bi-directional)

- bidirectional
- SDCCH: Standalone dedicated control channel
  - mobile transmits information for authentication and call connections
  - If the call setup is successful, BS replies with SDCCH msgs directing mobile to TCH
- TCH: traffic channel
  - actual voice (digitized)
  - corresponds to assigned freq/time slot

② — SACCH: slow associated control channel

- power control, timing advance

(downlink)
- channel measurement
(uplink)

(3) - FACCH: fast associated control channel
- handoff, urgent signalling msgs.

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GSM Frame structure - handout

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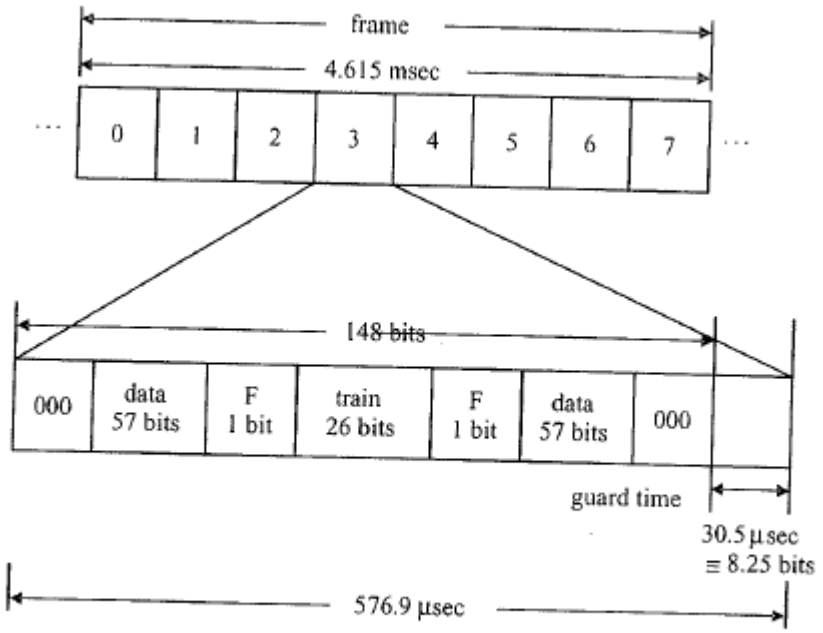

Figure 8.2 GSM frame/slot structure; traffic channel slots

Control channels - handout

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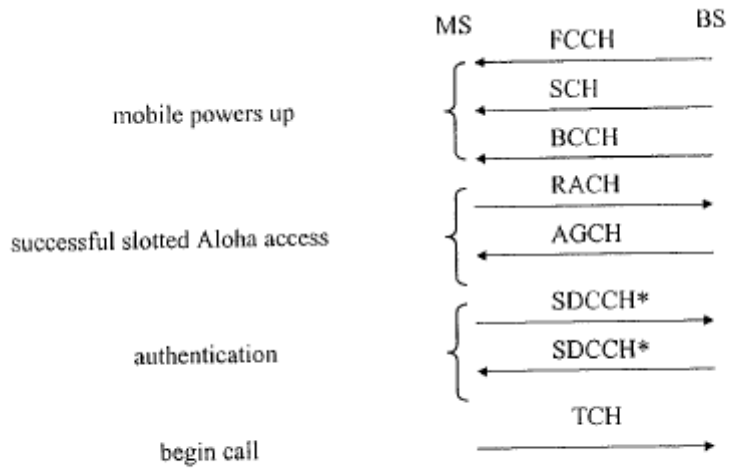

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Implementation - 15min

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In GSM, these control channels are "logical" channels, and are implemented in one of three ways

① set aside a prescribed # of frequency channels (from the 124 available) and "robs" time-slot 0 of each frame for control purpose

② allocate one time-slot every 13 normal sequence of traffic channel time-slots, as a "control" channel.

③ as needed, change a regular traffic channel time-slot into control channel, by setting the F bit.

These numbers are labelled next to each channel (above).

More details

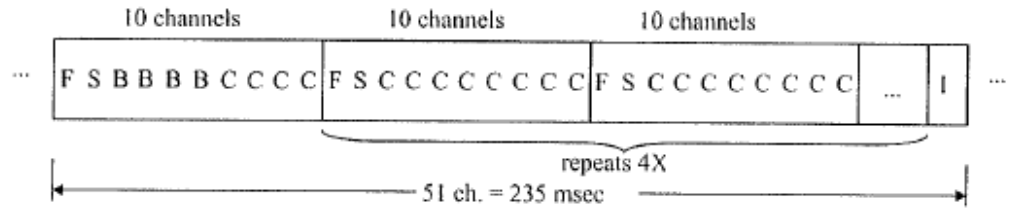
In GSM:

① is implemented by robbing time-slot 0

at prescribed frequencies. (at most 64 out of the 124 freq)

Downlink:

Fig 8.5



F = FCCH B = BCCH
S = SCH C = PCH or ACH

Figure 8.5 GSM downlink multiframe control structure (slot 0 of selected frequency channels)

- These are all time-slot 0 of each frame in the downlink (at the designated freq)
- 51-frame multi-frame structure
- organized into five 10-frame groups

Uplink:

- All for RACH

(2) is implemented by taking one out of

is normal traffic channel time slots for a given mobile

— Fig 8.4

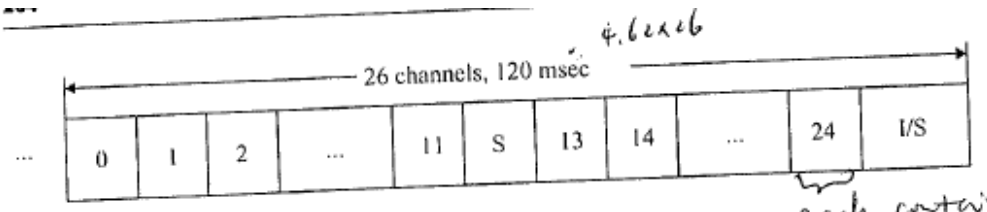


Figure 8.4 Repetitive 26-ch multiframe structure, GSM

each contain 8 slots one for each TCH

— 26-frame multiframe structure

— TCH: 0–11, 13–24 : 22.8 kbps
SACCH: 12, 25 : 950 bps if one channel
1900 bps if two channels

— "slow" SACCH

(3) is implemented by setting the F-bit in normal traffic channels

— urgent messages use FACCH

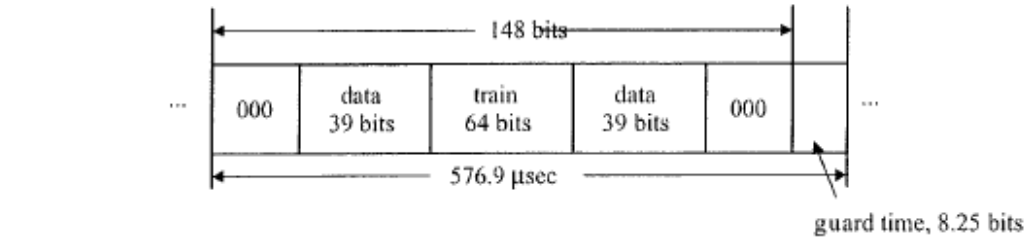
Finally, SDCCH uses non-zero time-slots of the prescribed frequency channel

— SDCCH is assigned temporarily by ACH

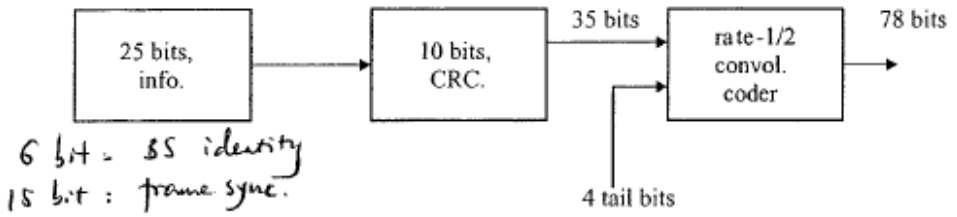
before the TCH is assigned

Some control channels have different frame-structure as the traffic channel

- FCCH: all 0's over 148 bits (within a time slot)



(a) SCH time-slot structure



6 bit - BS identity
15 bit : frame sync.

(b) Generation of 78-bit SCH data field

Figure 8.6 SCH implementation, GSM

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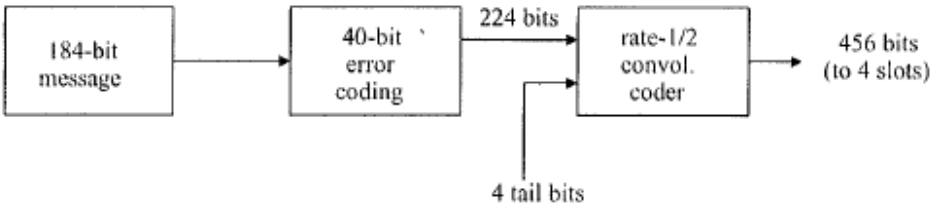

Figure 8.7 Generation of 114 bits/slot data field, BCCH, PCH, AGCH: GSM

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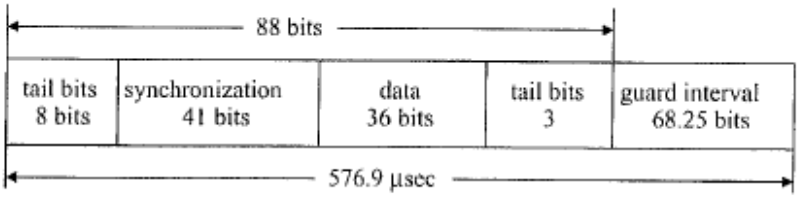
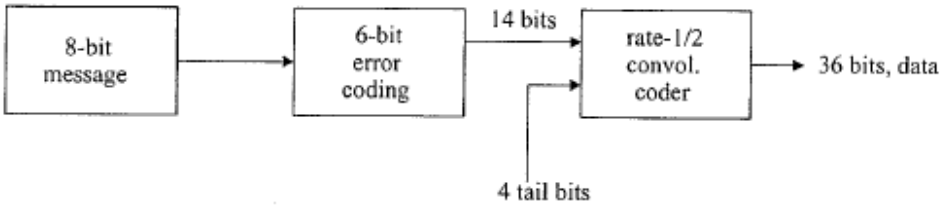


(a) Slot structure



(b) Generation of 36-bit data field

Figure 8.8 Random access channel, RACH: GSM

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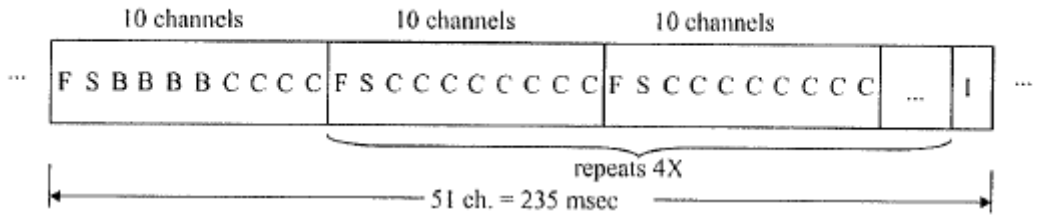
Control implementation - handout

Monday, March 31, 2008 2:55 PM



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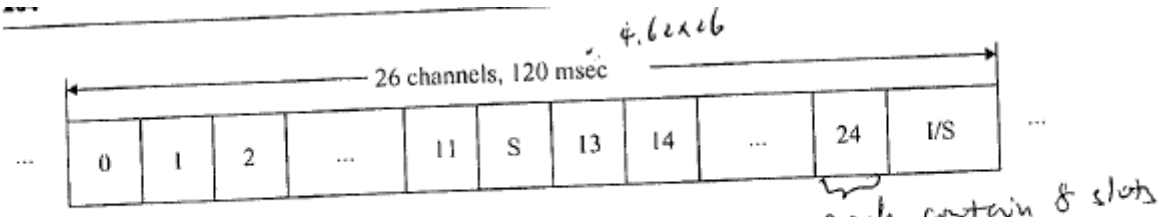

Figure 8.4 Repetitive 26-ch multiframe structure, GSM

Control frame format - handout

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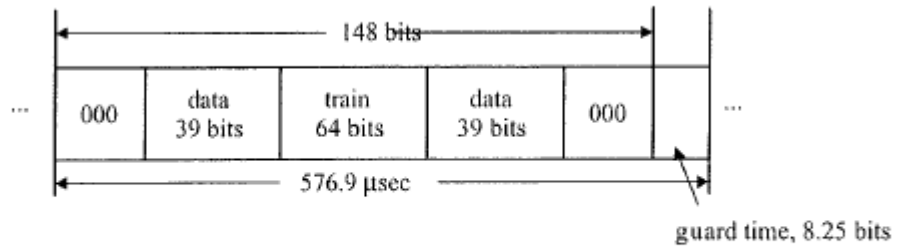
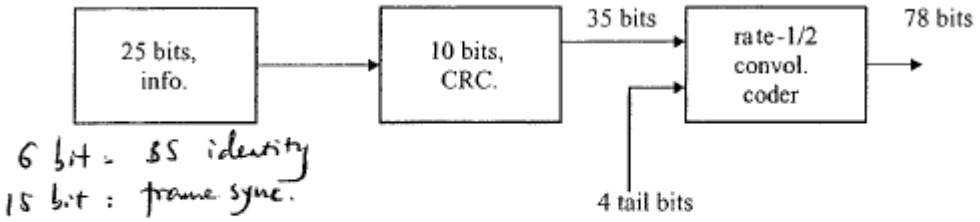


(a) SCH time-slot structure



(b) Generation of 78-bit SCH data field

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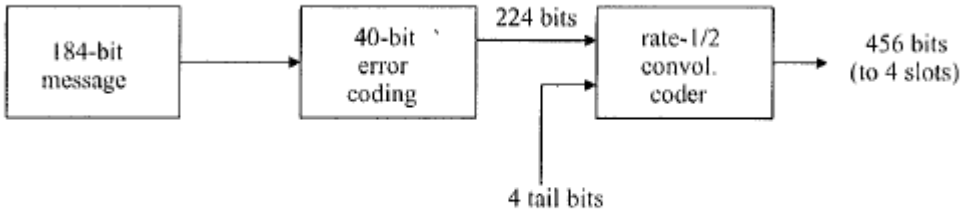

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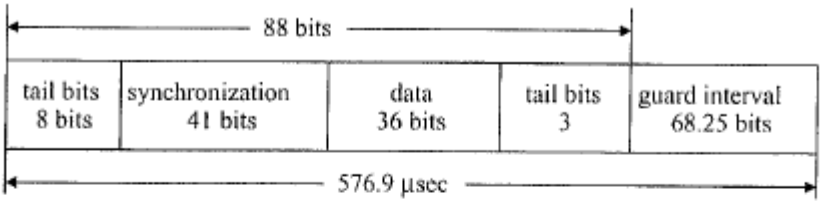
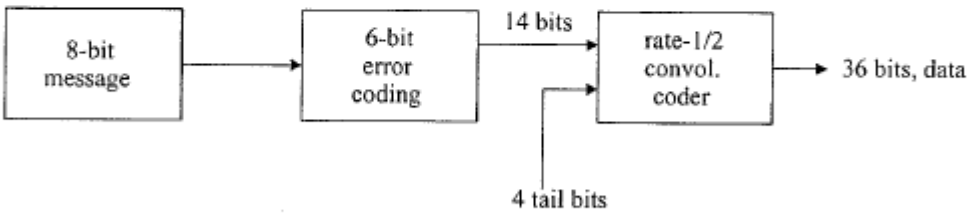


(a) Slot structure



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