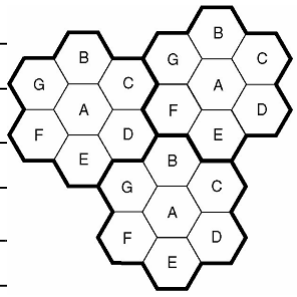
Mobile Telephones

- Introduction
  - Cells, Handoff
  - AMPs
- 2nd Generation
  - D-AMPS
  - GSM
  - CDMA
- Future
  - UMTS, CDMA2000
  - 2.5G

Cellular Structure

- Divide into cells
  - Frequencies: Reuse _____
    _____
  - Size _____
    _____
  - Capacity: To increase _____
    _____
    - Microcells _____
- MTSO / MSC _____
  - Base stations at _____
  - Normally connected to _____



Handoff

- The movement of users _____
  - Handoff process takes _____
  - Transfer call to the base station _____
    _____
  - The phone may have to _____
- Two types of handoff:
  - Soft handoff: _____
    _____
    - This provides _____
    - Requirements: _____
  - Hard handoff: _____
    _____
    - Possibility of _____

AMPS (1st generation)

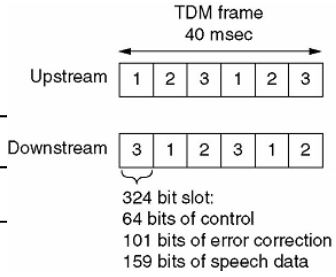
- FDM – 832 _____
  - 824-849MHz & 869-894MHz
  - 4 kinds of channel:
    - Control: _____
    - Paging: _____
    - Access: _____
    - Data: _____
- Phone ID: _____

AMPS (1st generation)

- Joining a cell:
  - Control channel _____
  - Broadcast _____
- Outgoing calls:
  - Access channel_____
  - Control channel _____
  - Collision _____
- Incoming calls:
  - Paging channel _____
- Problems:
  - Eavesdropping _____
  - Cloning _____

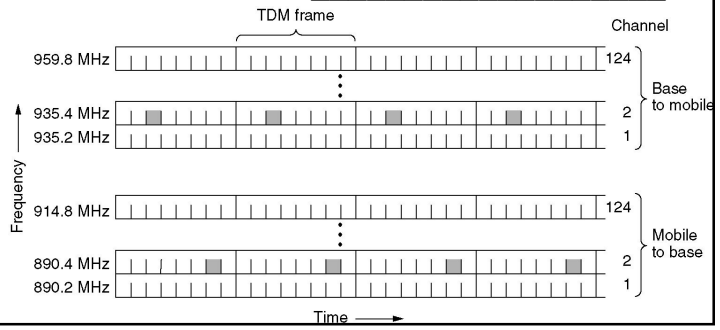
D-AMPS (2nd generation)

- Extension on AMPS. Uses the same frequencies plus 1850-1910MHz, 1930-1990MHz
- Compressed digitised voice _____
  _____
  - 3 users / 6 users _____ using TDM
- Control similar to AMPS
- Handoff when _____
  _____
  - MAHO _____

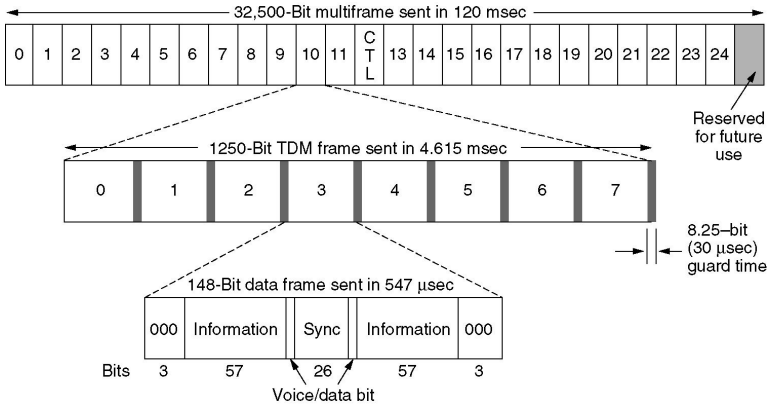


GSM (2nd generation)

- FDM:
  - 124 channels (890-915MHz, 935-960MHz)
- TDM:
  - 8 users per 200kHz
  - Different Slots used as _____



GSM framing hierarchy



- Data rates _____
- 51 slot multiframe _____

CDMA (2nd generation)

- Use entire frequency range _____
  - Need to be able to _____
- Encoding
  - Divide each bit time _____
    - Typically _____
    - Each station has a unique _____
  - Transmission
    - 1 → Transmit _____
    - 0 → Transmit _____

CDMA example

A: 0 0 0 1 1 0 1 1
B: 0 0 1 0 1 1 1 0
C: 0 1 0 1 1 1 0 0
D: 0 1 0 0 0 0 1 0

(a)

A: (–1 –1 –1 +1 +1 –1 +1 +1)
B: (–1 –1 +1 –1 +1 +1 +1 –1)
C: (–1 +1 –1 +1 +1 +1 –1 –1)
D: (–1 +1 –1 –1 –1 –1 +1 –1)

(b)

Six examples:

– – 1 –	**C**	S_1 = (–1 +1 –1 +1 +1 +1 –1 –1)
– 1 1 –	**B** + $\overline{\mathbf{C}}$	S_2 = (–2 0 0 0 +2 +2 0 –2)
1 0 – –	**A** + $\overline{\mathbf{B}}$	S_3 = (0 0 –2 +2 0 –2 0 +2)
1 0 1 –	**A** + **B** + **C**	S_4 = (–1 +1 –3 +3 +1 –1 –1 +1)
1 1 1 1	**A** + **B** + **C** + **D**	S_5 = (–4 0 –2 0 +2 0 +2 –2)
1 1 0 1	**A** + **B** + $\overline{\mathbf{C}}$ + **D**	S_6 = (–2 –2 0 –2 0 –2 +4 0)

(c)

$S_1 \bullet C$ = (1 +1 +1 +1 +1 +1 +1 +1)/8 = 1
$S_2 \bullet C$ = (2 +0 +0 +0 +2 +2 +0 +2)/8 = 1
$S_3 \bullet C$ = (0 +0 +2 +2 +0 –2 +0 –2)/8 = 0
$S_4 \bullet C$ = (1 +1 +3 +3 +1 –1 +1 –1)/8 = 1
$S_5 \bullet C$ = (4 +0 +2 +0 +2 +0 –2 +2)/8 = 1
$S_6 \bullet C$ = (2 –2 +0 –2 +0 –2 –4 +0)/8 = –1

(d)

CDMA Orthogonality

- Chip sequences need to be special…
  - Pairwise Orthogonal: $S \bullet T = \sum S_i T_i = 0$
- Limitations
  - Sychronisation: _____
  - Power Levels: _____
  - Knowledge of Sender: _____
    _____
- Available bandwidth typically _____
  _____

3rd generation

- IMT-2000: _____
  - Voice _____
  - Messaging _____
  - Multimedia _____
  - Internet _____
- Proposals – both based on _____
  - UMTS: W-CDMA _____
    - Compatible with GSM so _____
  - CDMA2000 _____

2.5G technology

- 3G Cost vs. Benefit? _____
  _____
- Alternatives
  - EDGE: _____
  - GPRS: _____
    - Operates on top of _____
    - Transmits _____
    - Higher data rates: _____