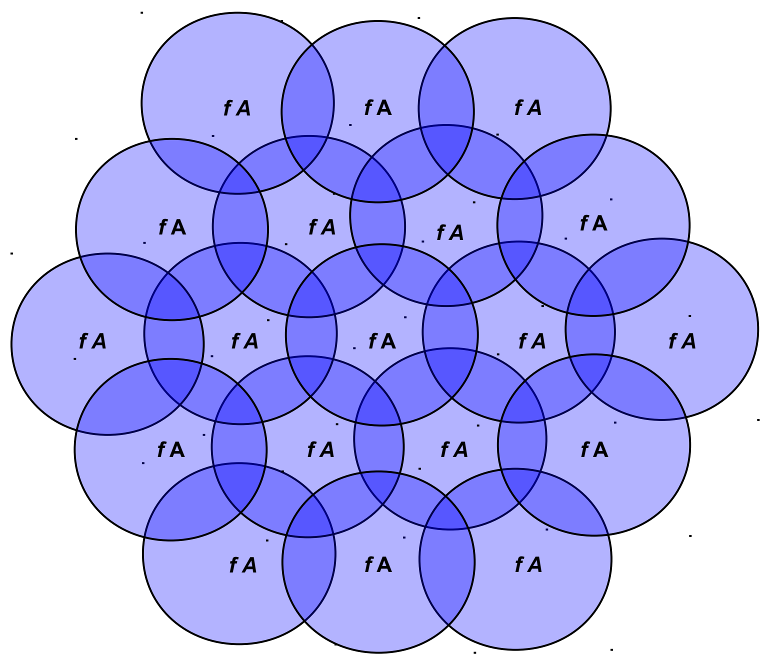
CMP4204
Wireless Technologies

Lecture 08

Cellular Mobile
2G, GSM and CDMA



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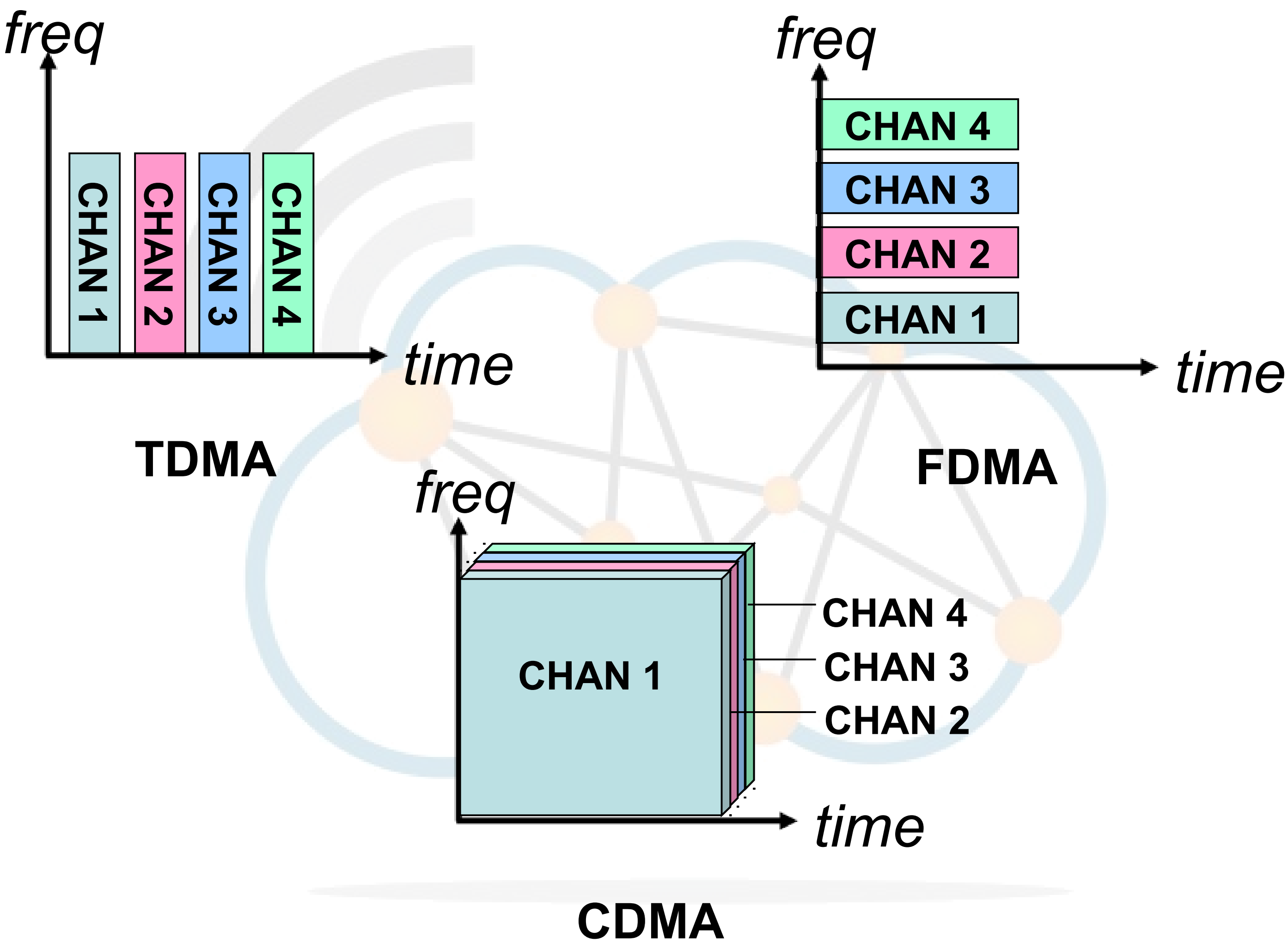
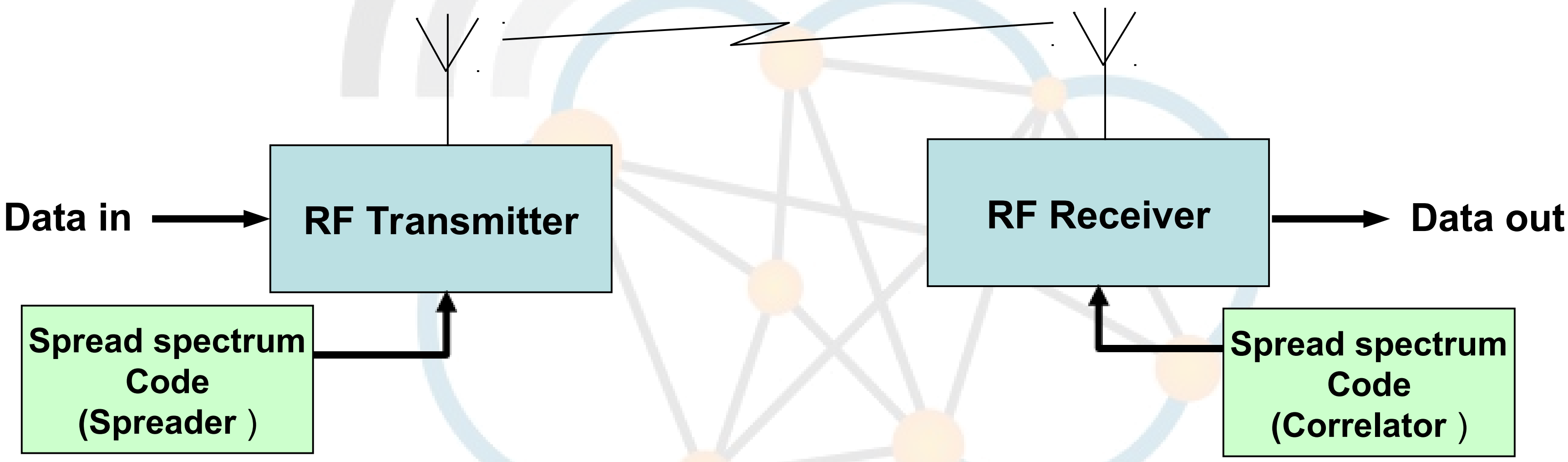
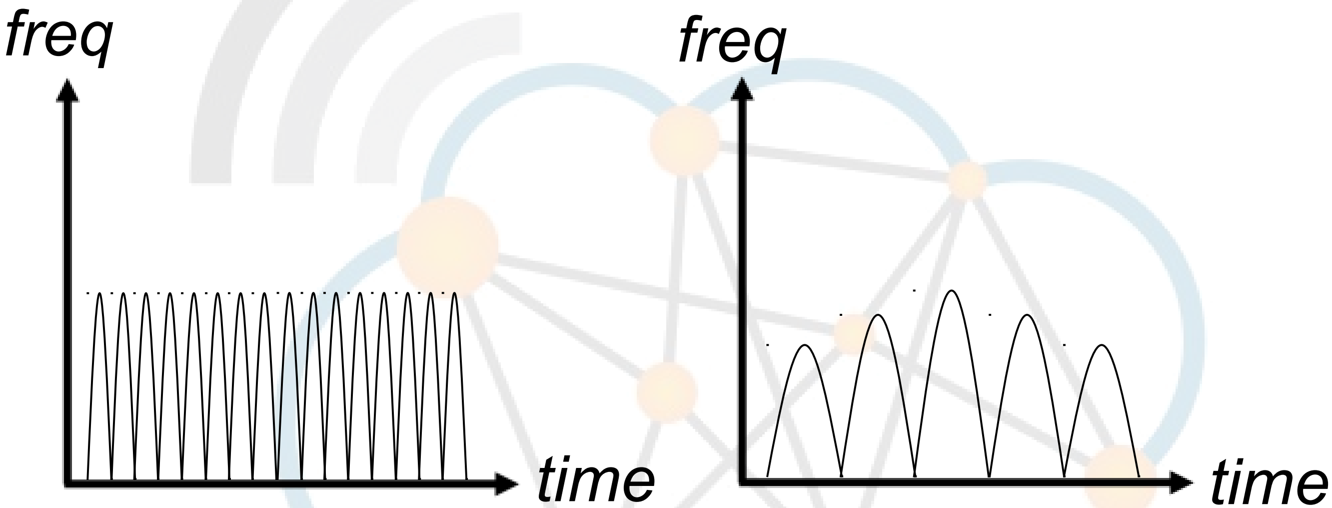
Multiple Access methods



Spread Spectrum



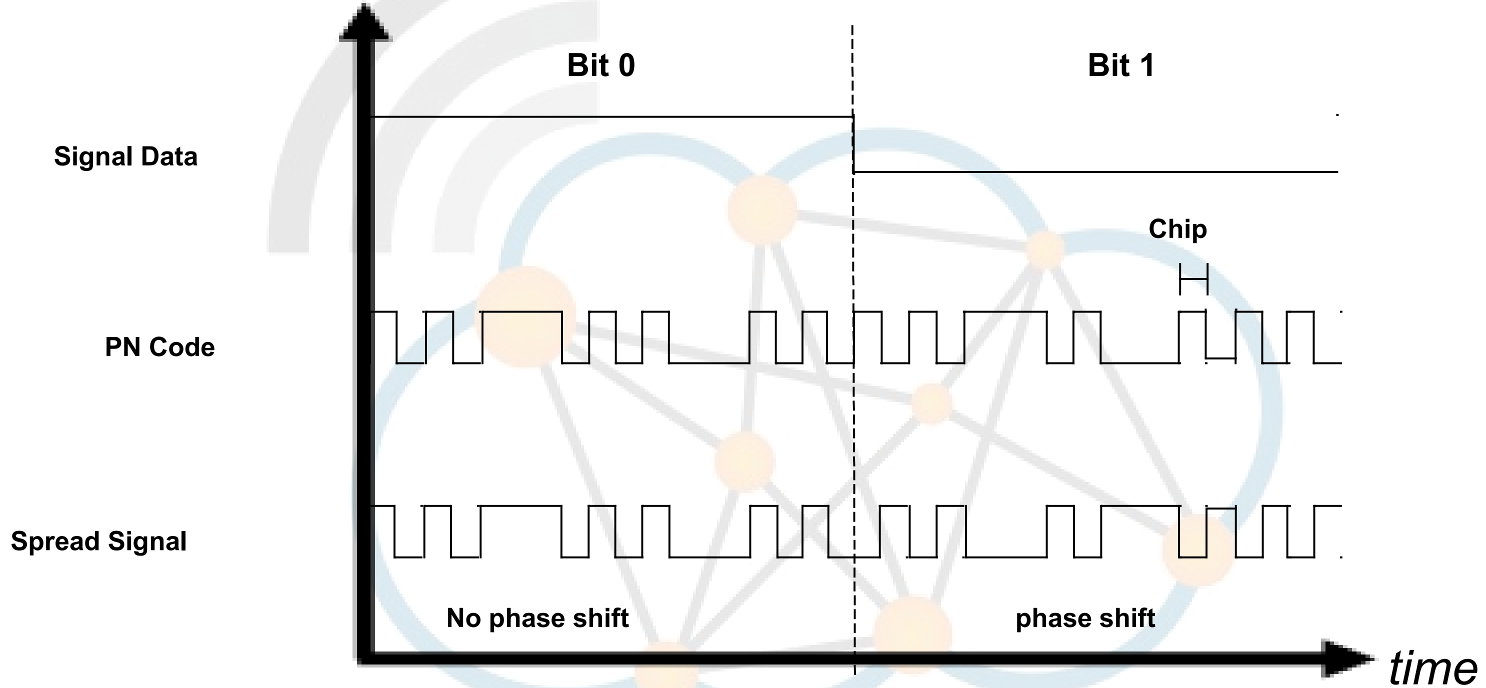
Spread Spectrum



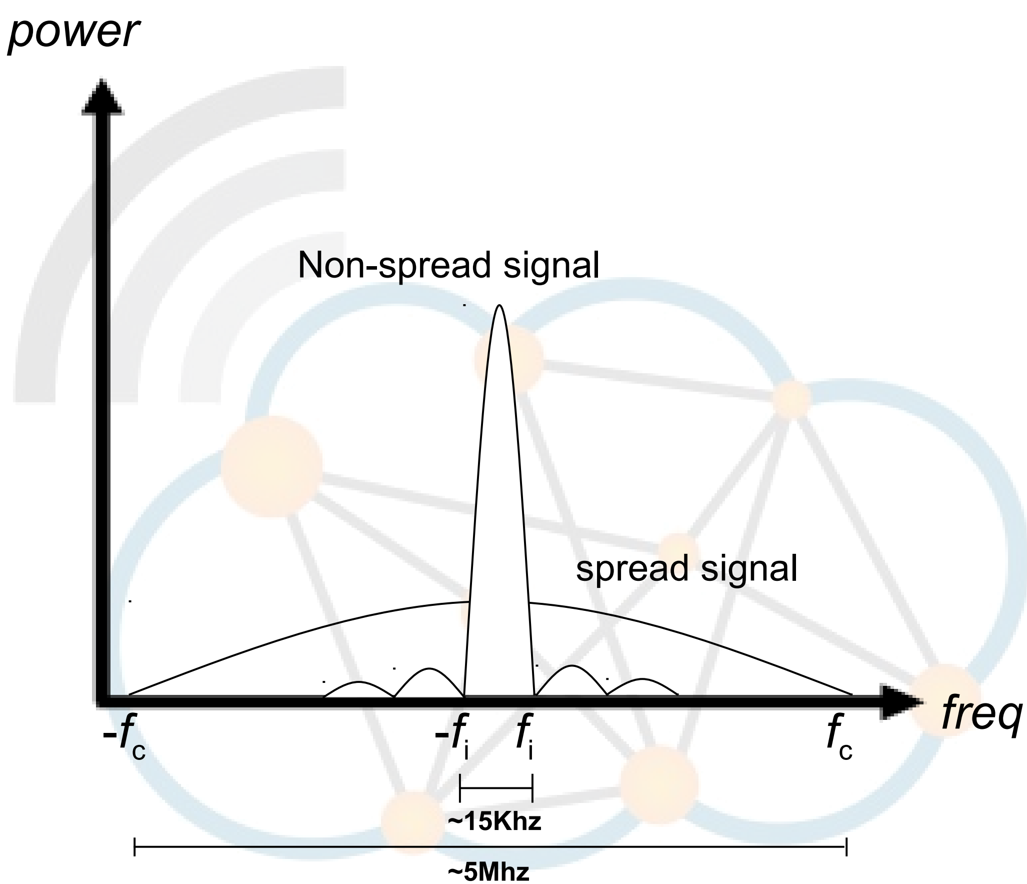
Frequency Hopping

Direct Sequence (DS)

CDMA Spreading



CDMA Spreading



Bandwidth of Digital signal = 2 * Bit rate

$$f_c + f_i \approx f_c \text{ as } f_c >> f_i$$

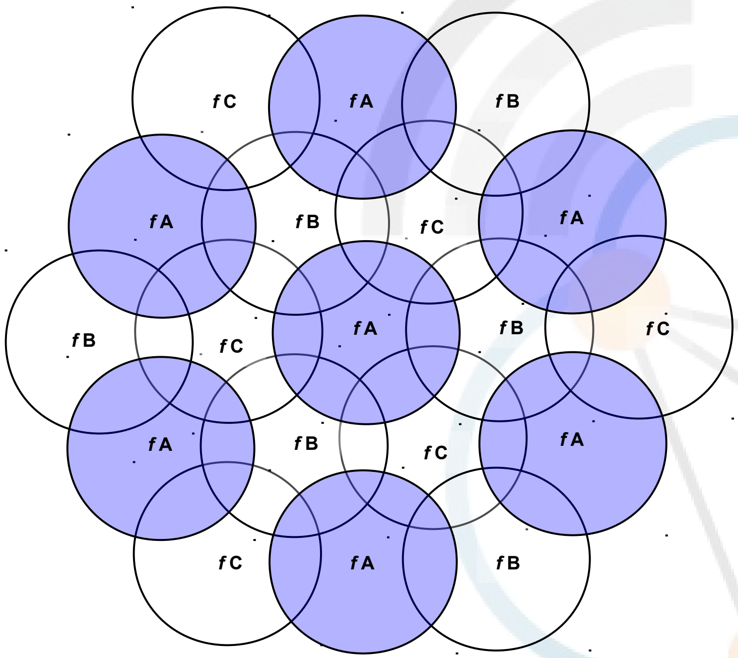
CDMA Gain

- Processing Gain (G_p) is the theoretical system gain that results from the spreading effect.
- This gain is also known as the Spreading Factor and is given by:
  - $G_p = f_c / f_i$
- Spreading Factor is the ratio of the chips (i.e. 3.8 Mchips/s) to the baseband information rate.
  - So for QPSK for example:
    - G_p = 3.8 Mchips/s / 15 K Symbols/s = 3800000 / 15000 = 253
    - 10log253 = 24dB gain

Multipath and Rake Receivers

- CDMA units use Rake receivers. These are essentially a set of several correlators.
- Each correlator in a Rake receiver is called a Rake-receiver finger. The base station combines the outputs of its RAKE-receiver fingers.
- Typically mobile receivers have 3 Rake-receiver fingers and base station receivers had 4 or 5 depending on the equipment manufacturer.
- There are two primary methods used to combine the Rake-receiver finger outputs:
  - equal-gain combining.
  - maximal-ratio combining.
    - Uses the data to estimate weights which maximize the SNR.

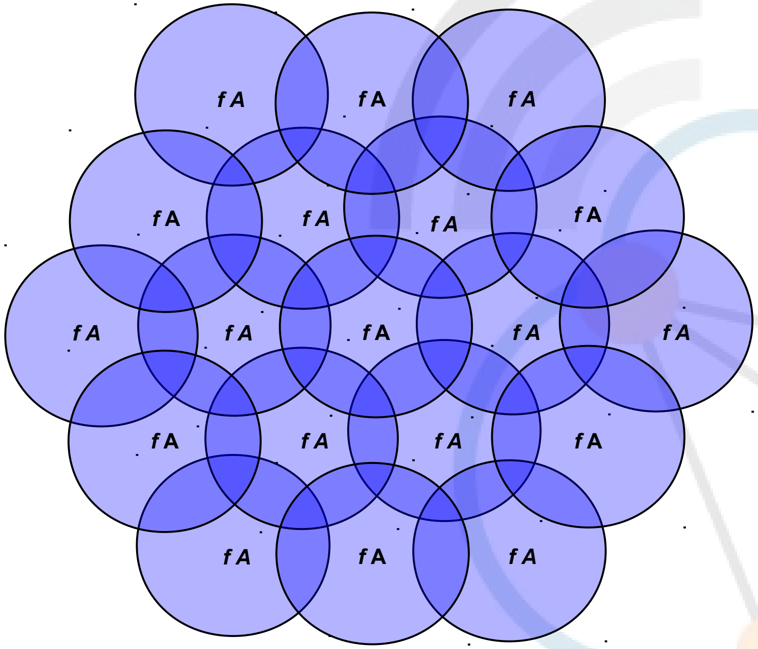
Hard Handover in FDMA & TDMA systems



FDMA

- In FDMA fA cells are separated from each other by other cells with frequency B or C necessitating a hard handover mechanism.
- TDMA employs a similar mechanism using time as the separator.
- Hard handover means that the mobile station must break the connection in the cell it is leaving before making a connection in the new cell it is entering.
- Hard handover can be seamless or non-seamless.

Soft Handover in CDMA systems



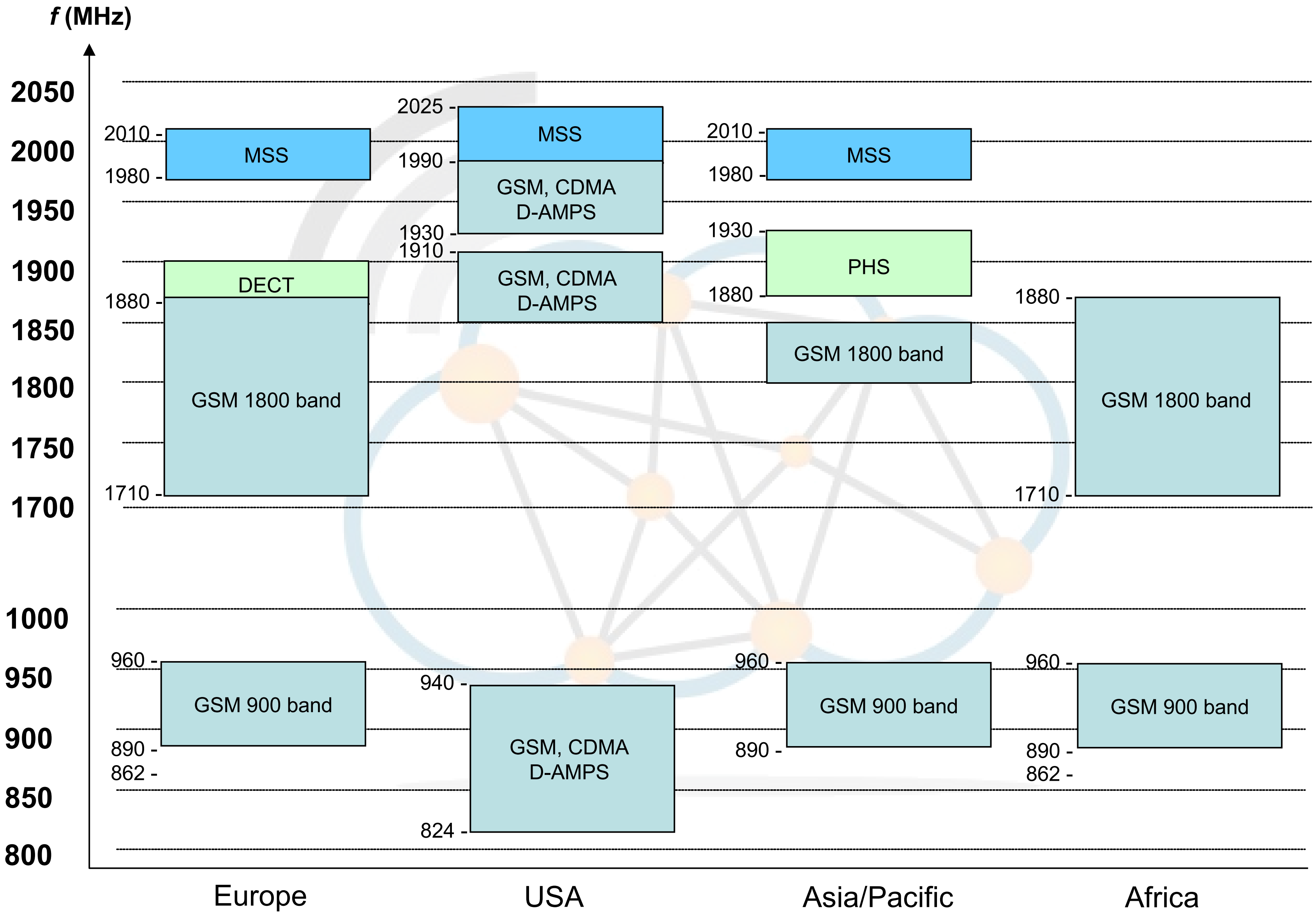
CDMA

- As all cells in CDMA use the same frequency, it is possible to make the connection to the new cell before leaving the current cell.
- This is known as a "***make-before-break***" or "***soft***" handover.
- Soft handovers require less power, which reduces interference and increases capacity.
- "***Softer***" handover is a special case where the radio links that are added and removed belong to the same cell node.
- The cell node entity is called a Node B.

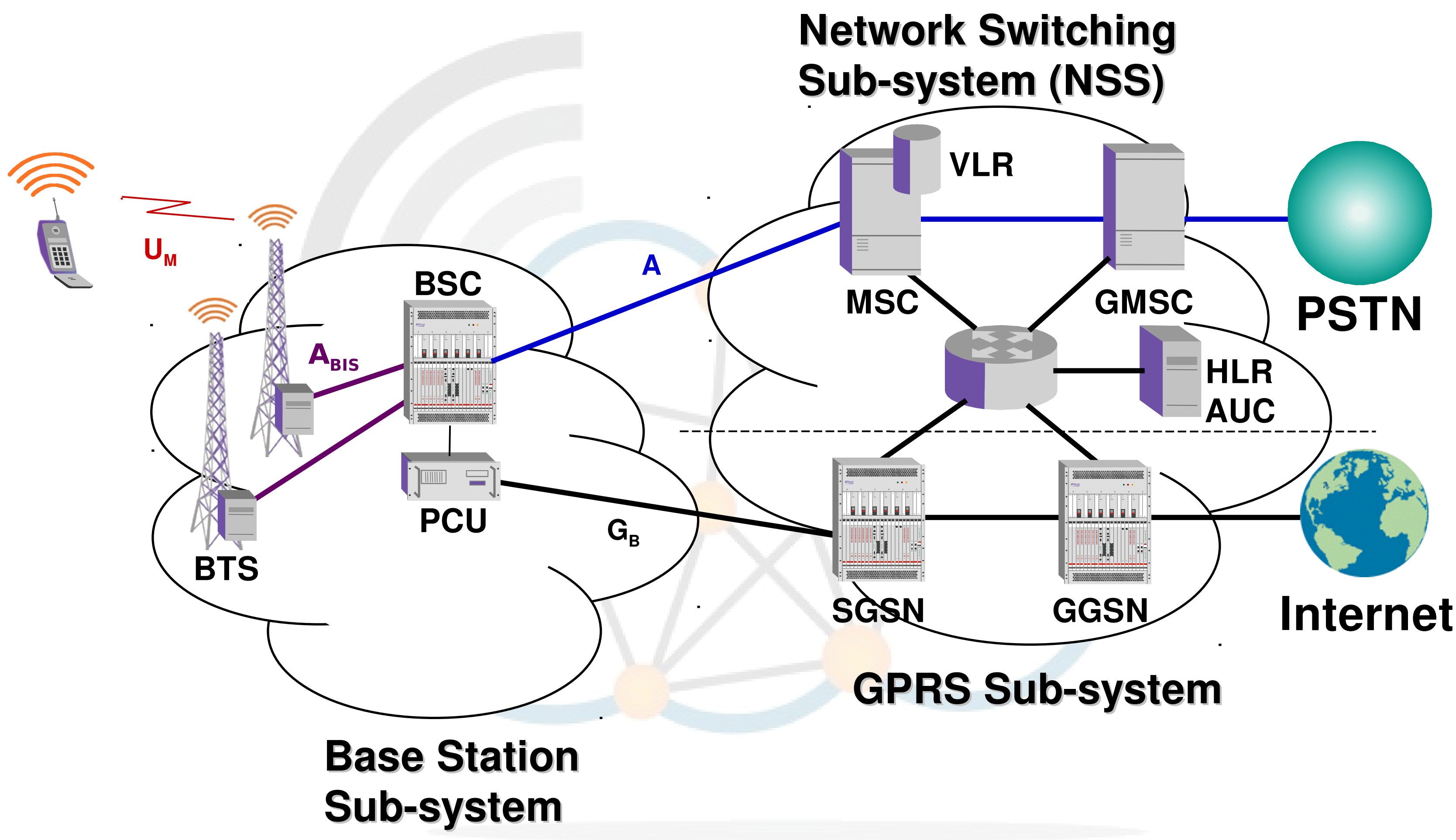
Mobile Evolution

- 1G
  - Initial analogue mobile systems
- 2G
  - GSM, D-AMPS, cdmaOne
  - SMS
  - WAP, i-mode
- 2.5G
  - GPRS
  - EDGE
  - EDGE Evolution

2G Spectrum

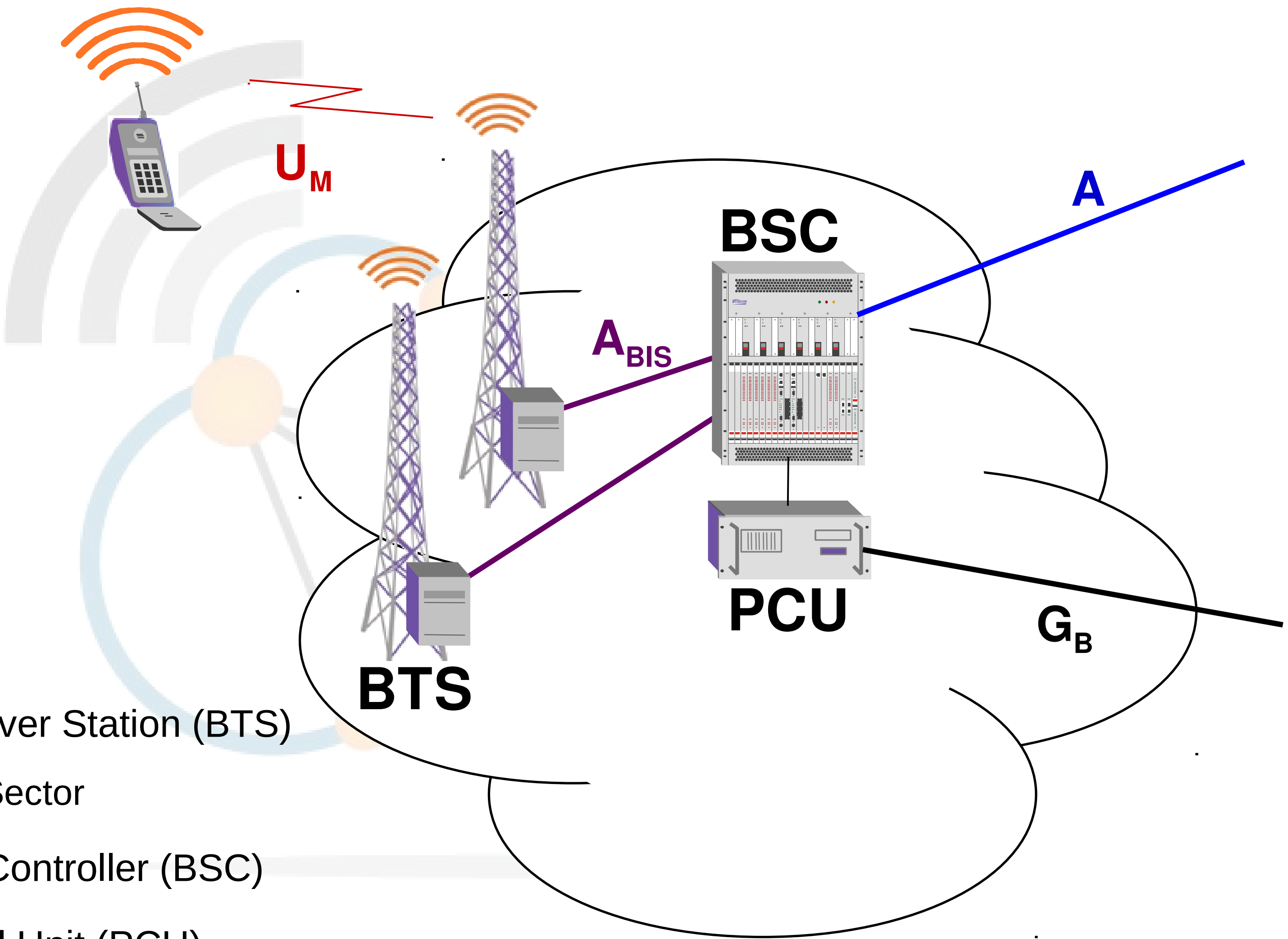

f (MHz)
2050
2000
1950
1900
1850
1800
1750
1700
1000
950
900
850
800
2010 -
1980 -
MSS
DECT
1880 -
GSM 1800 band
1710 -
960 -
GSM 900 band
890 -
862 -
2025 -
MSS
1990 -
GSM, CDMA D-AMPS
1930 -
1910 -
GSM, CDMA D-AMPS
940 -
GSM, CDMA D-AMPS
824 -
2010 -
MSS
1980 -
1930 -
PHS
1880 -
GSM 1800 band
960 -
GSM 900 band
890 -
1880 -
GSM 1800 band
1710 -
960 -
GSM 900 band
890 -
862 -
Europe
USA
Asia/Pacific
Africa

GSM



Network Switching Sub-system (NSS)
VLR
MSC
GMSC
PSTN
HLR
AUC
A
BSC
U_M
A_{BIS}
BTS
PCU
G_B
SGSN
GGSN
Internet
GPRS Sub-system
Base Station Sub-system

GSM Base Station Sub-system (BSS)

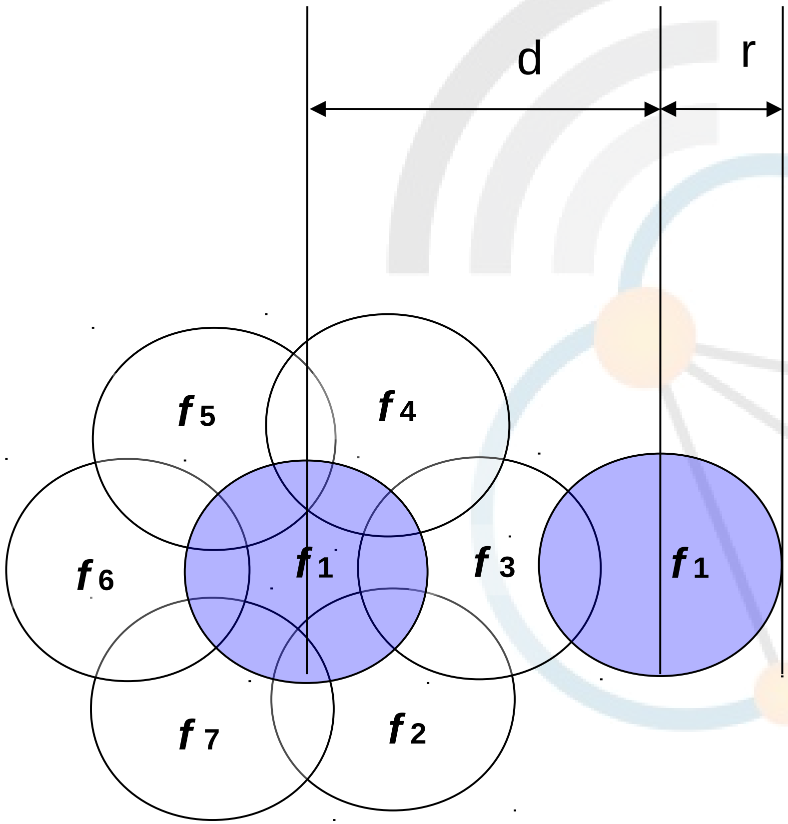


- Base Transceiver Station (BTS)
  - TXR per Sector
- Base Station Controller (BSC)
- Packet Control Unit (PCU)

European GSM Channels

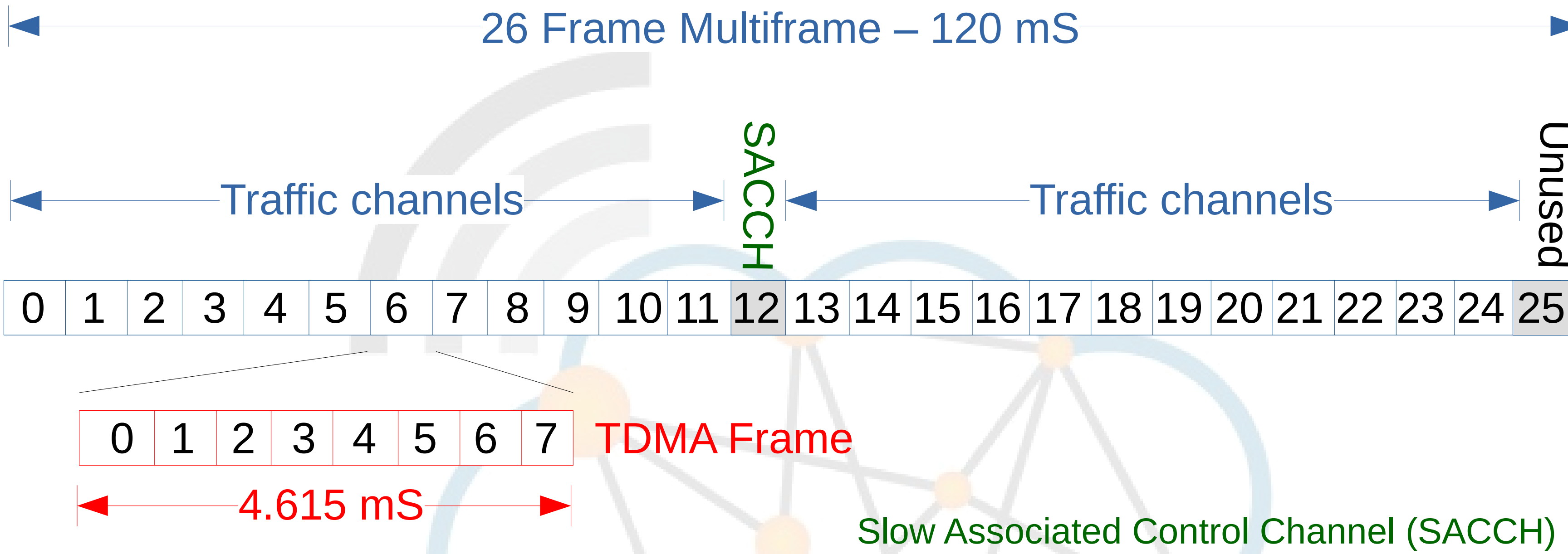
- GSM-900 system, two frequency bands:
  - 124 Channels (1 – 124)
  - 890 - 915 MHz for the uplink (direction MS to BS)
  - 935 - 960 MHz for the downlink (direction BS to MS).
- GSM-1800 system, two frequency bands:
  - 374 Channels (512 – 885)
  - 1710 - 1785 MHz for the uplink (direction MS to BS)
  - 1805 - 1880 MHz for the downlink (direction BS to MS).
- 25 MHz bands split into 124 pairs of frequency duplex channels with 120 kHz carrier spacing.
  - One or more sets are assigned to each TRX in the BTS.

GSM Cellular scheme



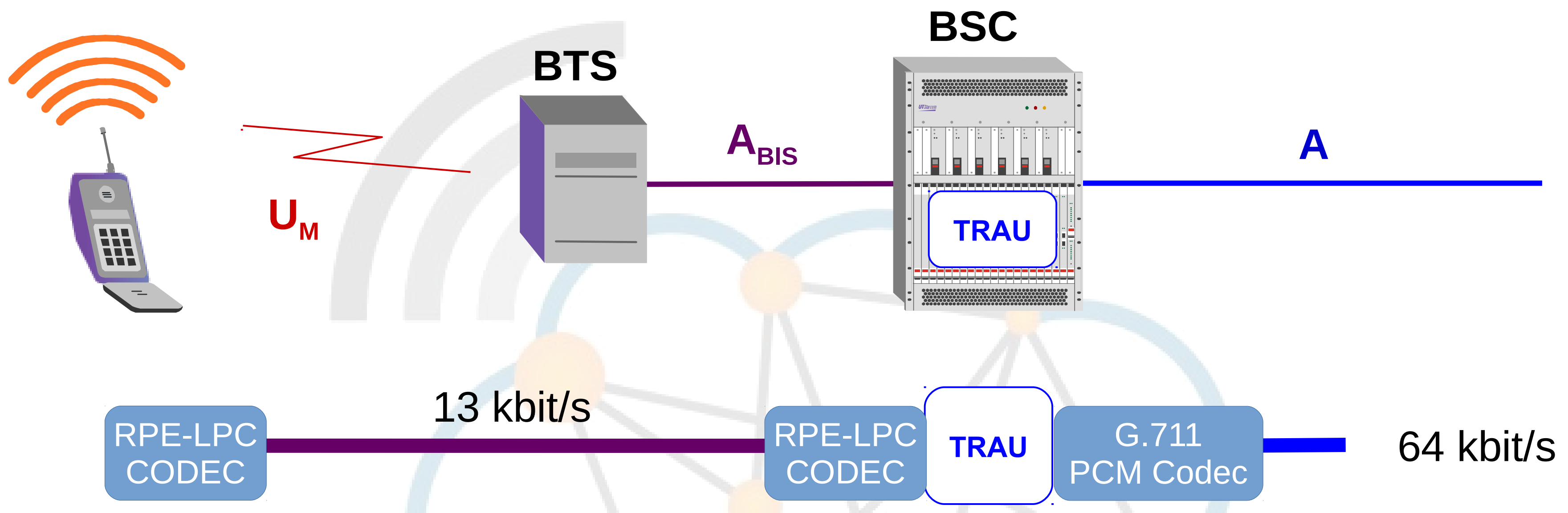
Seven sets of frequencies are sufficient to cover a typical large area, providing the repeat-distance *d* is larger than twice the maximum radius *r* covered by each transmitter.

TDMA Frame Structure



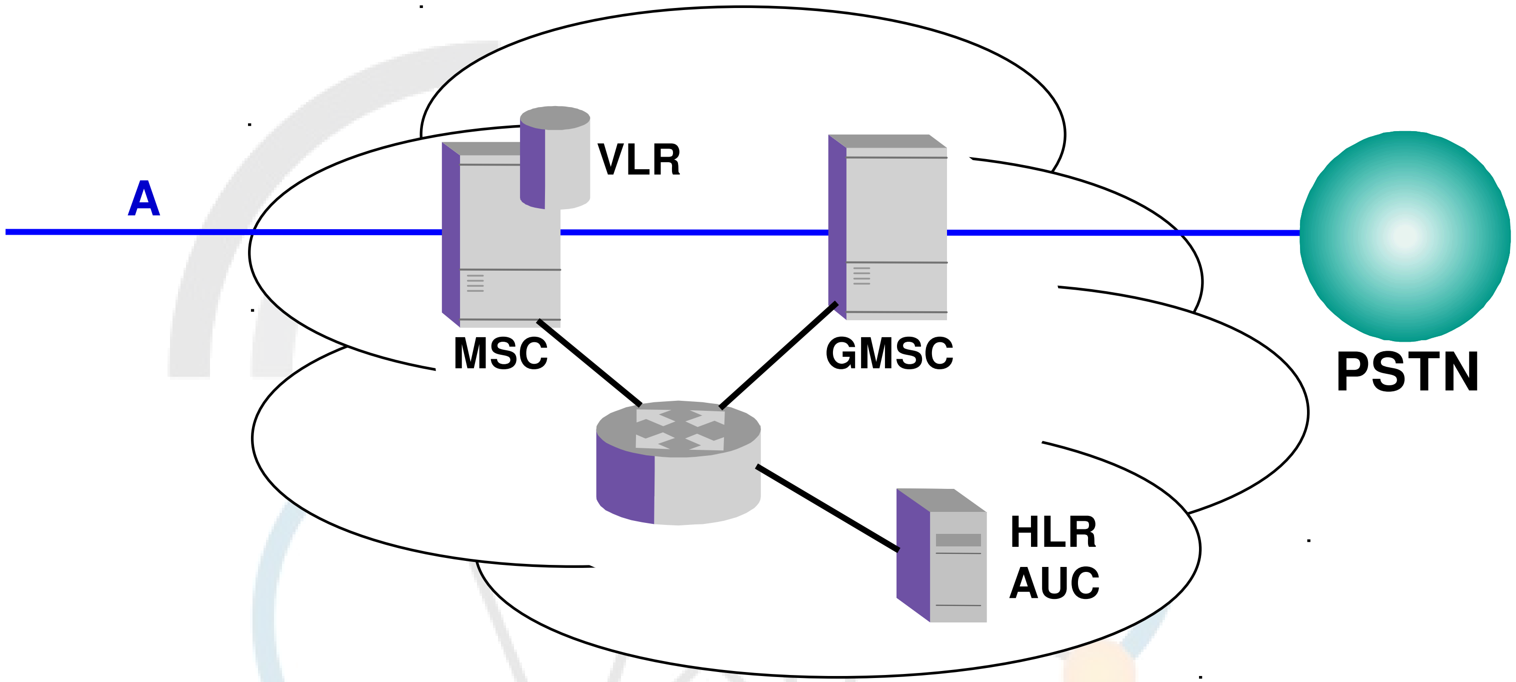
- Frame consists of a 200 kHz radio channel divided into 26 TDMA timeslots.
- Each TDMA timeslot is split into 8 bursts (a burst is assigned to a single user).
- GSM Terminal is therefore only transmitting for 1/8 4.615 mS (0.577 mS).

Transcoder and Rate Adaption Unit



- Regular Pulse Excited-Long Term Prediction (RPE-LPC)

Network Switching Sub-system (NSS)



- Mobile Switching Centre (MSC)
- Visitor Location Register (VLR)
- Gateway Mobile Switching Centre (GMSC)
- Home Location Register (HLR)
- Authentication Centre (AuC)

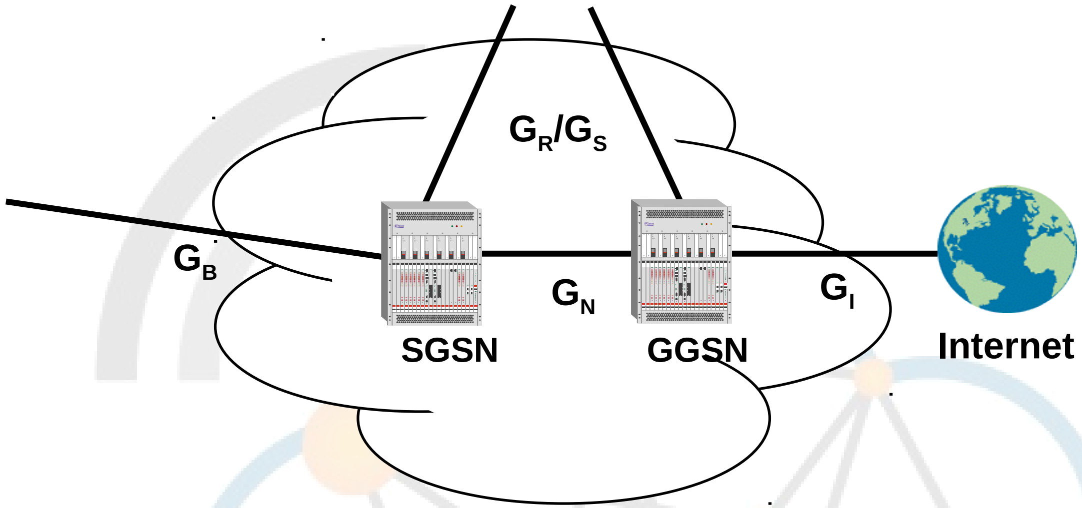
Subscriber Identity Module (SIM)

- Removable smart card for mobile cellular telephony devices.
- SIM cards store the International Mobile Subscriber Identity (IMSI) subscriber ID.

International Mobile Subscriber Identity (IMSI)

- The IMSI is derived from the following steps.
  - Mobile Network Code (MNC): 011
  - Mobile Country Code (MCC): 256
  - Mobile Subscriber Identity Number (MSIN): 705446743
- Result: 011256705446743

General Packet Radio Service (GPRS)

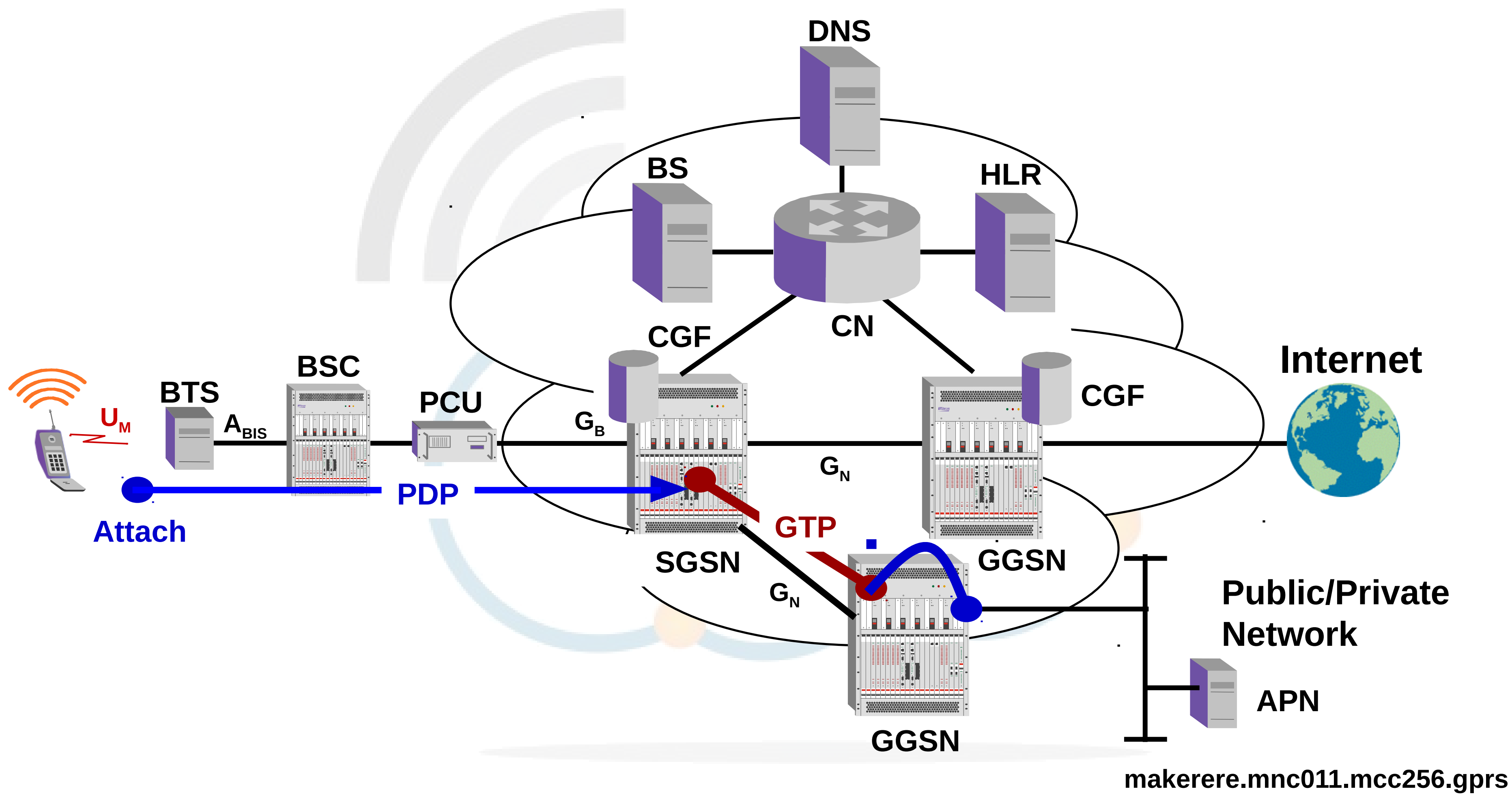


- Serving GPRS Support Node (SGSN)
  - Tracks the location of an individual MS.
  - Performs security functions and access control for packet services.
- Gateway GPRS Support Node (GGSN)
  - Gateway routing function for the GPRS network.
  - IP Router from the perspective of external packet data networks.
  - Firewall and filtering functionality, to protect the GPRS core network.
  - Billing functionality for packet data services.

Access Point Name (APN)

- Access Point Name (APN)
  - Abstract Syntax Notation One (ASN.1)
  - Provides routing info for SGSN and GGSN.
  - The APN consists of two parts:
    - APN Network ID (APN-NI) identifies the external PDN which the MS wishes service.
      - makerere
    - APN Operator ID (APN-OI) specifies the GGSN is located (Optional).
      - mnc<MNC#>.mcc<MCC#>.gprs
      - mnc011.mcc256.gprs
    - APN: makerere.mnc011.mcc256.gprs

GPRS Data Call



GSM Data uplifts

- Enhanced Data Rates for GSM Evolution (EDGE)
  - Unofficial standard 2.75G, due to its slower network speed.
  - DL speeds up to 236.8 kb/s.

- EDGE Evolution
  - EDGE Evolution improves on EDGE in a number of ways.
    - Lower Latency.
    - Bit rates are increased up to 1 Mb/s peak.
    - Improved Signal quality.

Thank You

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