UMTS

Dr. Bheemarjuna Reddy Tamma
IIT Hyderabad

Adapted from Justin Champion Slides

3G UMTS

- Contents
  - Why 3G
  - UMTS
  - Use of UMTS at the moment

3G UMTS

- The Dream (intention)
  - 2G and 2.5G systems are incompatible around the world.
    - Worldwide devices need to have multiple technologies inside of them, i.e. tri-band phones, dual-mode phones
  - To develop a single standard that would be accepted around the world
    - One device should be able to work anywhere !

"Access to Information from Anyplace, Anytime"

3G UMTS

- The Dream (continued)
  - Worldwide positioning available
    - Able to pinpoint a device and direct services to it.
    - Mostly to be used for “Push” services
  - Increased data rate
    - Maximum 2048Kbps
  - Operational
    - in Europe by 2002
    - Japan 2001 (this was achieved)
    - Worldwide usage by 2005 (not happened!)

3G UMTS

- The reality
  - Different standards with some operators in America and the rest of the world
  - In the future market forces may move towards a single standard
    - i.e. LTE
  - Difficulties
    - World wide identical available spectrum
    - Agreement on the encoding/decoding technique used
    - Local influence groups
      - Manufacturers who have invested in one technology

3G UMTS

- Standard
  - The 3G standard was written by the International Telecommunication Union (ITU)
    - The standard was referred to as IMT-2000
      - The key to the standards was the available data over the air interface
        - 2Mbps in fixed or in-building environments
        - 384 kbps in pedestrian or urban environments
        - 144 kbps in wide area mobile environments
        - Variable data rates in large geographic area systems (satellite)

3G UMTS

- Other parts of the standard
  - Frequency Spectrum
  - Technical Specification
  - Radio and Network components
  - Tariffs and Billing
  - Technical Assistance
- 3 Main technical implementations were agreed
  - UMTS (W-CDMA)- Europe
  - CDMA2000 - America
  - TD-SCDMA –China

3G UMTS

- Universal Mobile Telecommunication system (UMTS)
  - UMTS
    - Builds upon the successful European GSM network
      - Incorporates the developments made for the GPRS and EDGE networks
    - Five areas of standardisation
      - Radio
      - Core Network
      - Terminals
      - Services

3G UMTS

- The core network
  - Asynchronous Transfer Method (ATM)
    - Has been defined as the core networking technology
      - ATM allows circuit switched transfer of data using packets.
      - High speed data transfer – currently maximum 10 Gbps
      - Guarantee of quality of service for the duration of packet transfer
      - Small packets used called cells for the transfer of data to minimise the impact on the routers, network and switches.
  - IPv6
    - Arguments are being pushed for the core network to allow IPv6
    - RFC3314, September 2002
      - This would allow packets to be transferred directly from the internet to the device with no translation
      - IPv6 does contain QOS headers, which can be used with the correctly configured hardware
      - All 3G devices could have a single IP address that would not need to change

3G UMTS

- UMTS
  - Full packet driven architecture
    - For voice and for data transmissions.
    - Packet based networks allow for an increased amount of traffic on a medium.
    - The only time part of that medium is blocked is when a device is transmitting or receiving.
      - Consider how often in your phone calls you actually say nothing
        - Natural pause between words
        - Taking a breath
        - Waiting for a response
        - Thinking of something to say

3G UMTS

- UMTS
  - Offers voice and data services the same way as EDGE
    - Services offered will be classified into one of the following:

Conversational	Streaming	Interactive	Background
Real-Time		Best-effort, guarantee of quality delivery	
Voice	Streaming Video	Web Pages	MMS, SMS, emails

    - From these classes certain defined Quality of Service (QOS) specifications are guaranteed like packet delay time

3G UMTS

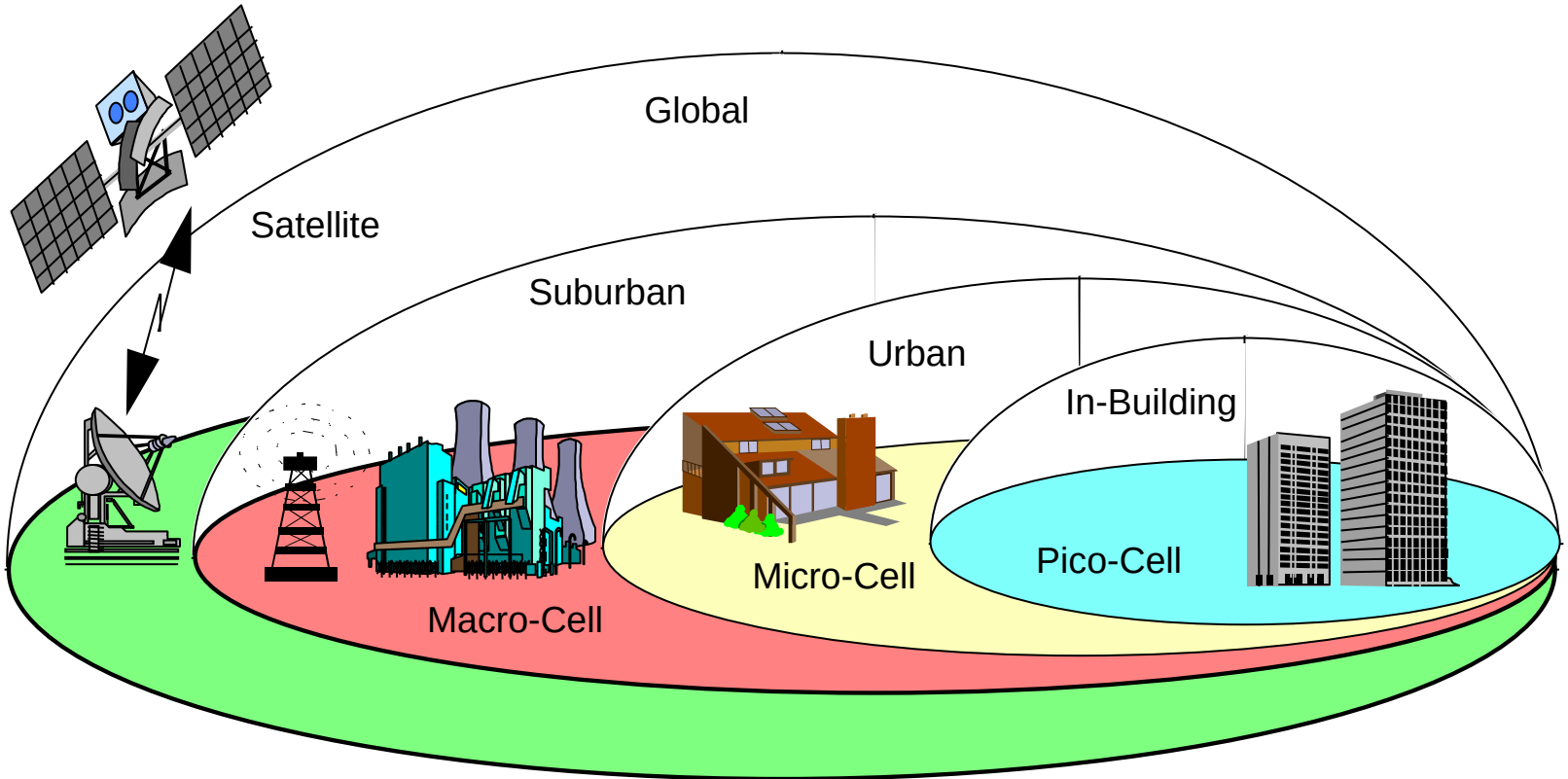
- Intended Data Rates
  - Actual data rates will be effected by
    - Interference (other devices, background, buildings)
    - Over use of the frequency
    - Amount of other traffic
    - Base station / cell actually attached to
    - Speed you are moving at !

3G UMTS

- Types of Cells and Base station to use them
  - Macro Cell
    - These cover a large area and will give slow access
    - 144 Kbps – max speed of 500 Km/h
  - Micro Cell
    - These should cover a medium area
    - 384 Kbps max speed 120 Km/h
  - Pico Cell
    - Less than 100 metres
    - 2 Mbps – max speed of 10 Km/h
- Difficult to predict
  - Actual distances and bandwidth depend on local conditions

3G UMTS

- Types of Cells and Base station to use them
  - Cells will operate in a hierarchy overlaying each other

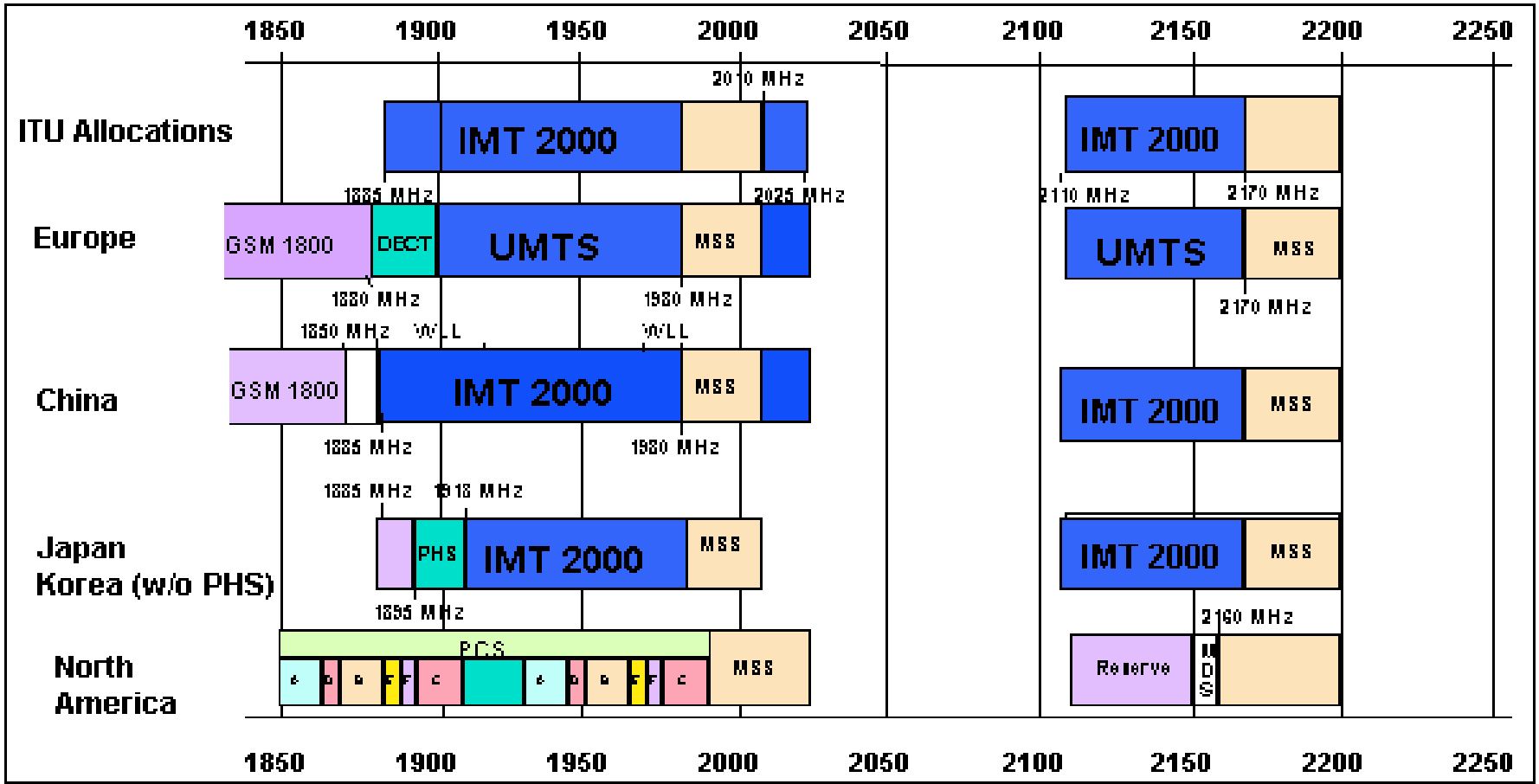


3G UMTS

- Types of Cells and Base station to use them
  - Cells will operate in a hierarchy overlaying each other
    - Pico Cells will operate in a Time division Duplex (TDD) mode
      - TDD mode will use the same frequency to send and receive with a time frame being allocated.
    - All other cells will operate in Frequency Division Duplex (FDD) Mode
      - FDD will operate in the same manner as GSM, with a different frequencies for the Uplink and Downlink

3G UMTS

- Radio Interface
  - Allocated Frequencies



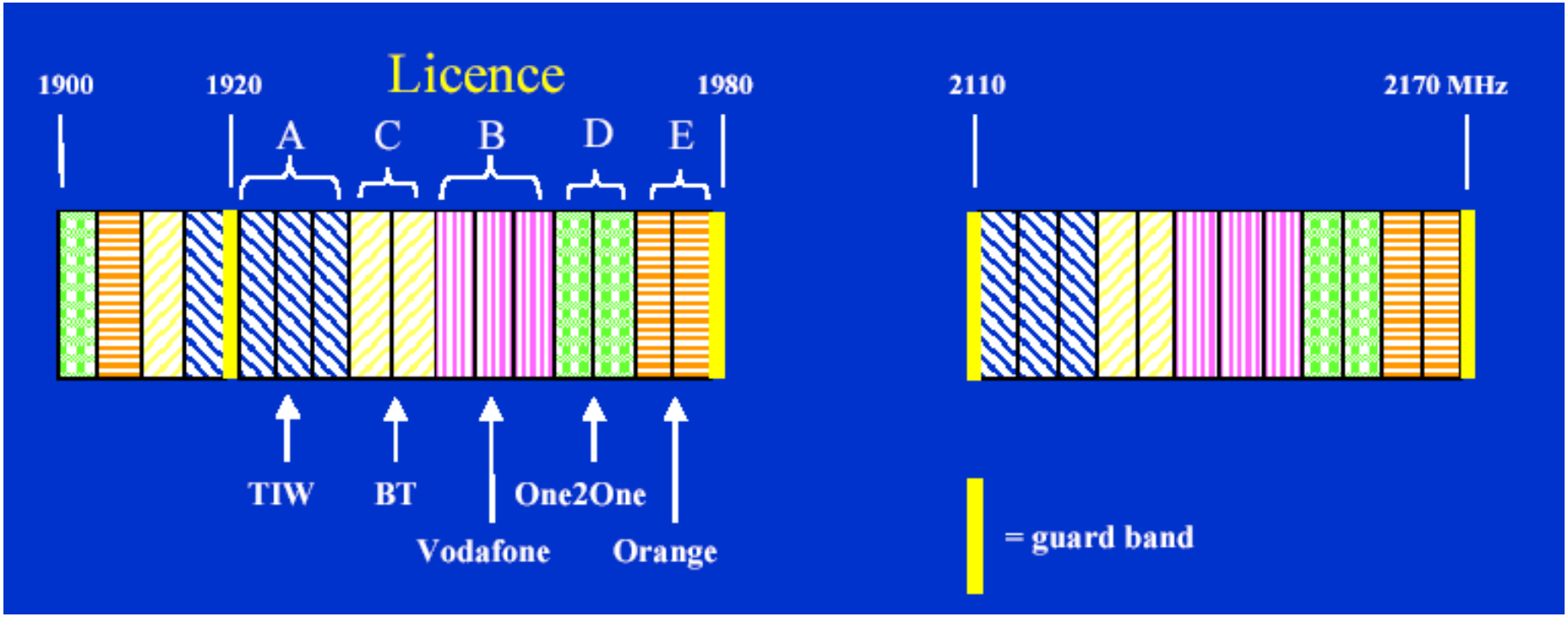
3G

- 3G spectrum auction
  - License shows the size of the spectrum with A being the largest
    - Part of the auction rules was a new company in the UK won the License type ‘A’
    - Auction closed on the 27th April 2000
  - The UK phone companies in June, 2003 said that they would claim the VAT back on the license purchases! About £4 Billion pounds
    - Court case started on the 9th of Feb 2004

License	Company	Paid (Pounds)
A	TIW (3)	4,384,700,000
B	Vodafone	5,964,000,000
C	MM02	4,030,100,000
D	One2One (T-Mobile)	4,003,600,000
E	Orange	4,095,000,000

3G UMTS

- UK 3G Winners ??



3G UMTS

- Radio Interface
  - UMTS uses Wideband-Code Division Multiple Access (W-CDMA)
    - Also known as “IMT-2000 Direct Spread”
    - Extremely complex algorithms
    - Uses 10x the current 2G processing power!
    - Modulation is done with Quadrature phase shift keying (QPSK)
      - This encodes 2 bits with each change
    - Supports two modes of operation
      - Frequency Division Duplex (FDD)
      - Time Division Duplex (TDD)

3G UMTS

- W-CDMA
  - Operates in the same manner as the CDMA used in the US
    - CDMA allows multiple users to communicate at the same time over the same frequency
      - Each of the devices is given a “Chipping code” this is known by the device and the base station.
      - This chipping code is then used to identify the signal and allows the BS to receive the signal
      - The chipping code is used to adjust the frequency of data transferred during the transfer
      - The essential point of CDMA is the use of power control

3G UMTS

- W-CDMA
  - Wideband CDMA operates the same but this takes place over a wider area of frequency
    - UMTS uses 5MHz for the signal
    - CDMA (narrowband), GSM/GPRS use 200 KHz
    - These communications are secure by the nature that unless the chipping code is known, the sequence of the data can not be known
    - Communications can take place as soon as the device is ready and frequency reuse factor is now one

3G UMTS

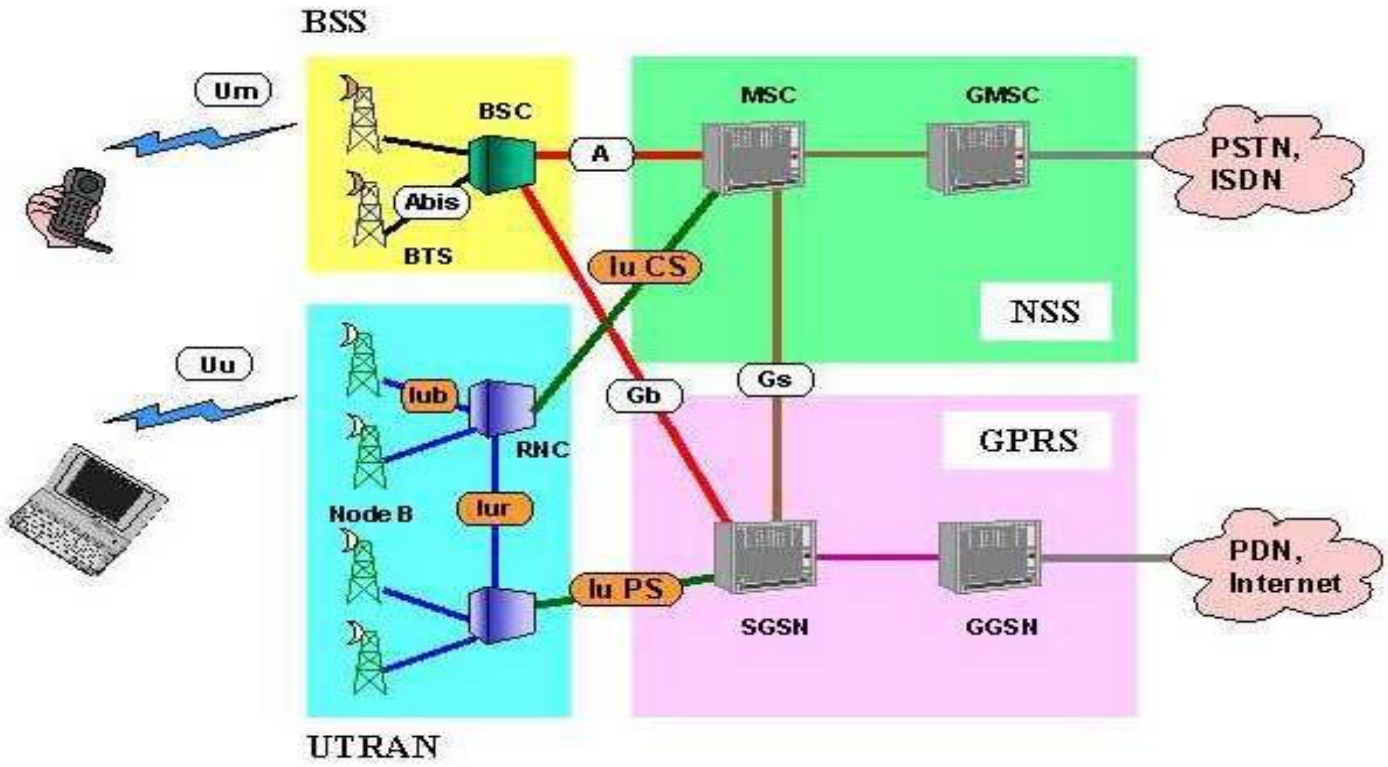
- W-CDMA
  - Frequency Reuse Factor
    - This is the distance which needs to be left between cells
    - As the same frequency is reused and the chipping code which is used is changed and unique to a BS
    - The frequency can be reused in adjoining cells
    - Temporary Base stations can be added to the infrastructure if required, as long as the chipping code was unique

3G UMTS

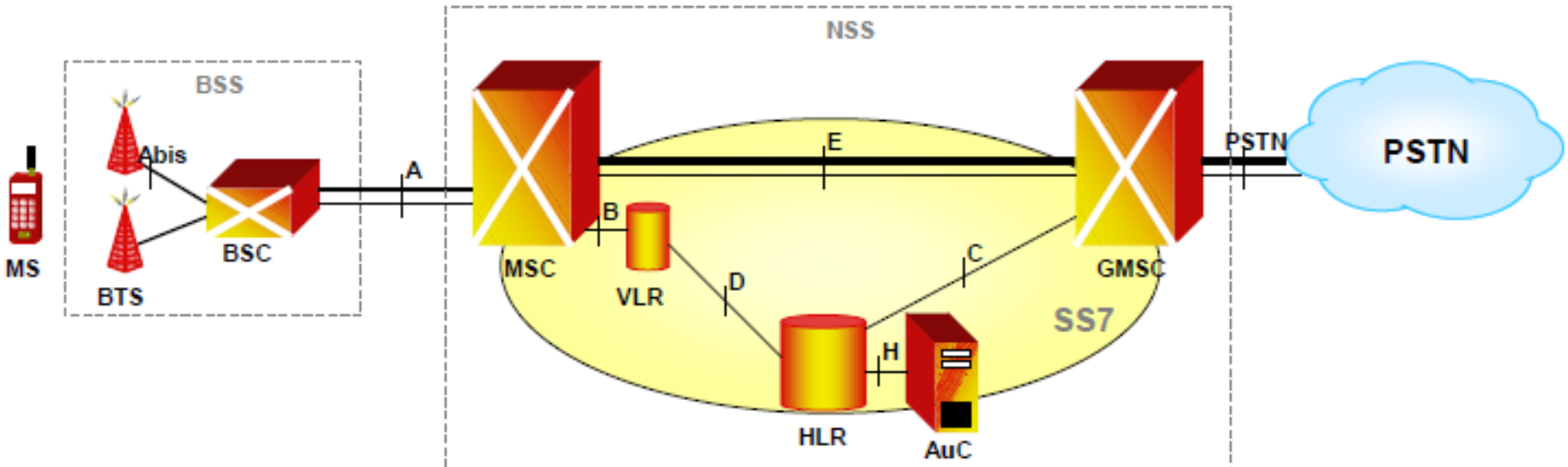
- Power Control
  - If you consider a group of people speaking, Chinese, English and Italian
    - If these all speak at the same volume you can then listen for the parts which you understand.
      - If the English person starts talking louder than the rest, the all you will hear is Italian
      - The other languages will be drowned out
    - CDMA Works on the same basis
      - One point of CDMA is the power control, so that the power sent out is just enough to allow data transfer to take place.
        - As a side effect of this technology this controlling of the power that the radio interface uses, also saves the battery on the device

3G UMTS

- W-CDMA
  - Infrastructure



GSM 2G Architecture



BSS Base Station System

BTS Base Transceiver Station

BSC Base Station Controller

MS Mobile Station

NSS Network Sub-System

MSC Mobile-service Switching Controller

VLR Visitor Location Register

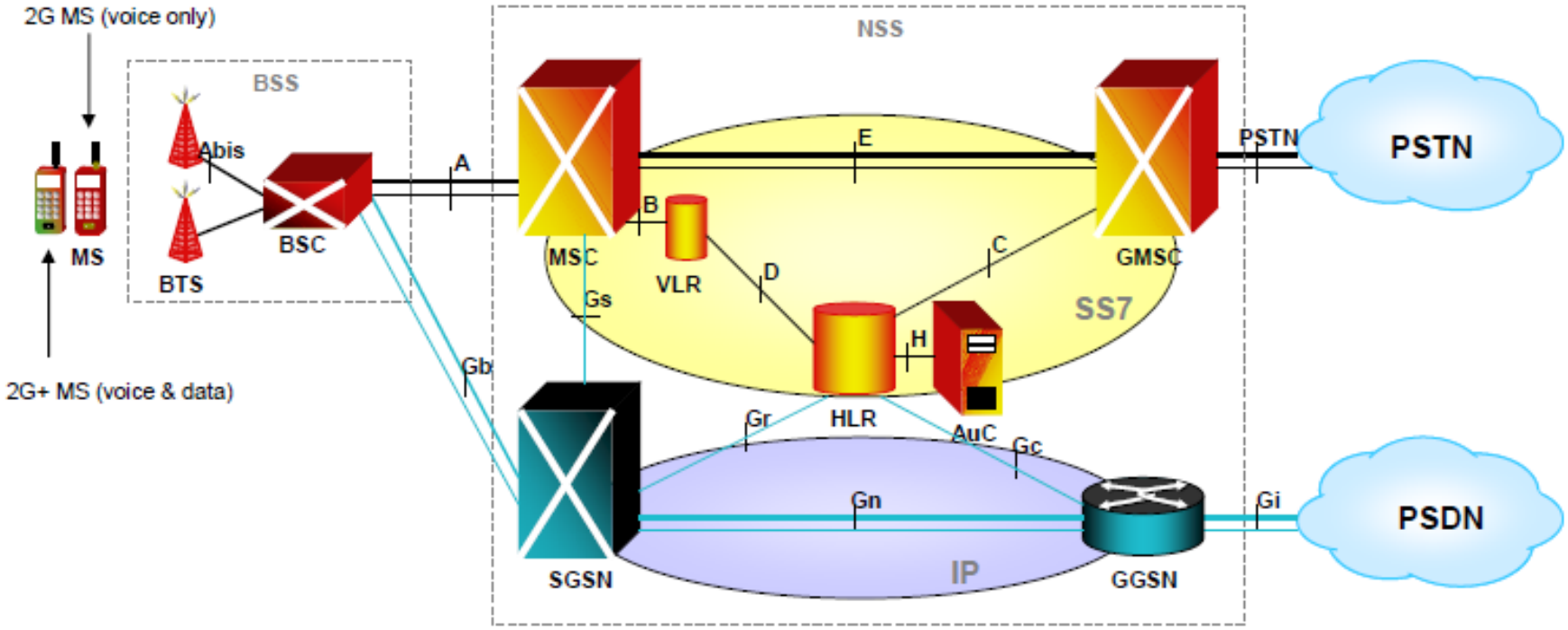
HLR Home Location Register

AuC Authentication Server

GMSC Gateway MSC

GSM Global System for Mobile communication

2.5G GPRS Architecture



BSS Base Station System
BTS Base Transceiver Station
BSC Base Station Controller

NSS Network Sub-System
MSC Mobile-service Switching Controller
VLR Visitor Location Register
HLR Home Location Register
AuC Authentication Server
GMSC Gateway MSC

SGSN Serving GPRS Support Node
GGSN Gateway GPRS Support Node

GPRS General Packet Radio Service

3GPP

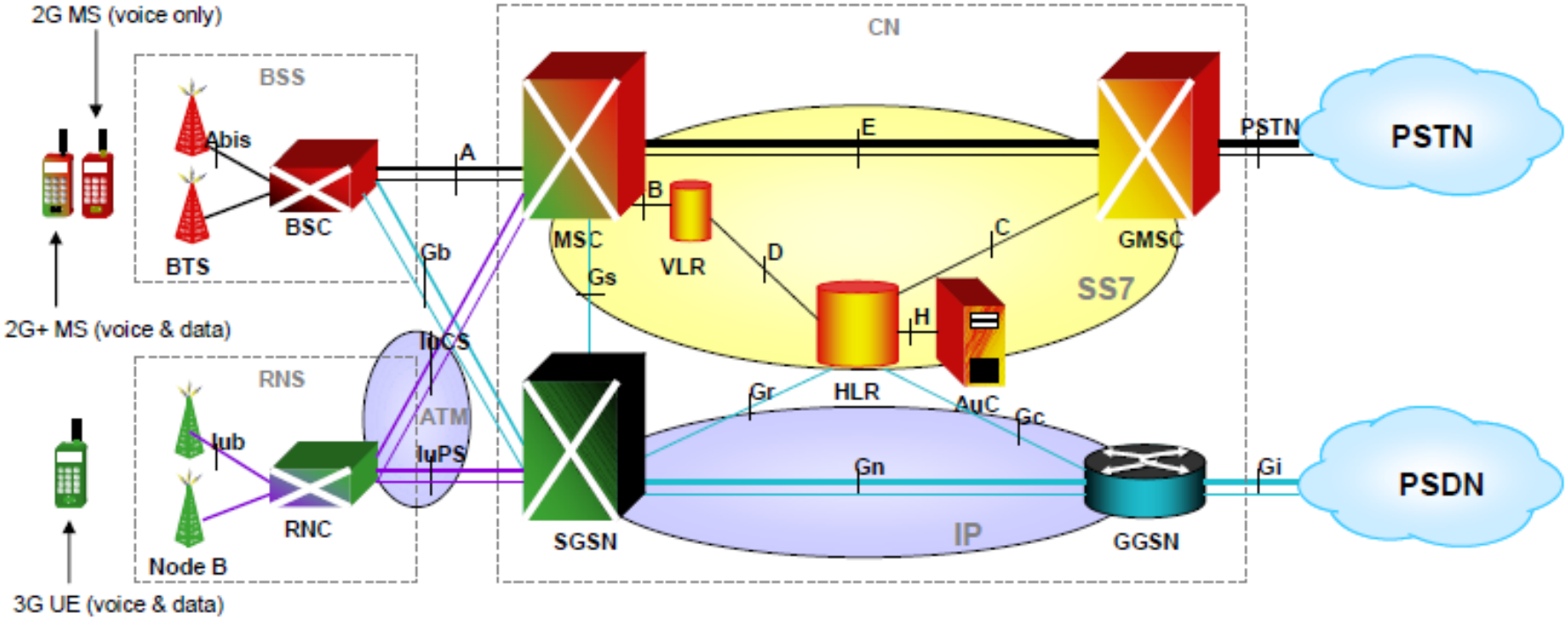
Defines migration from GSM to UMTS/ 3GSM

A GLOBAL INITIATIVE

Release	Specs complete	First deployed	Major new features defined
98	1998		Last purely 2G GSM release
99	1Q 2000	2003	W-CDMA air interface
4	2Q 2001	2004	Softswitching IP in core network
5	1Q 2002	2006	HSDPA & IP Multimedia System (IMS)
6	4Q 2004	2007	HSUPA, MBMS, GAN, PoC & WLAN integration
7	4Q 2007	future	HSPA+, Better latency & QoS for VoIP
8	? 2009 ?	future	LTE, All-IP

W-CDMA – Wideband CDMA modulation
HSxPA – High Speed (Download/Upload) Packet Access
MBMS – Multimedia Broadcast Multicast Service
GAN – Generic Access Network
PoC – Push-to-talk over Cellular
LTE – Long Term Evolution, a new air interface based on OFDN modulation

3GPP rel99 Arch (UMTS)



BSS Base Station System

BTS Base Transceiver Station

BSC Base Station Controller

RNS Radio Network System

RNC Radio Network Controller

CN Core Network

MSC Mobile-service Switching Controller

VLR Visitor Location Register

HLR Home Location Register

AuC Authentication Server

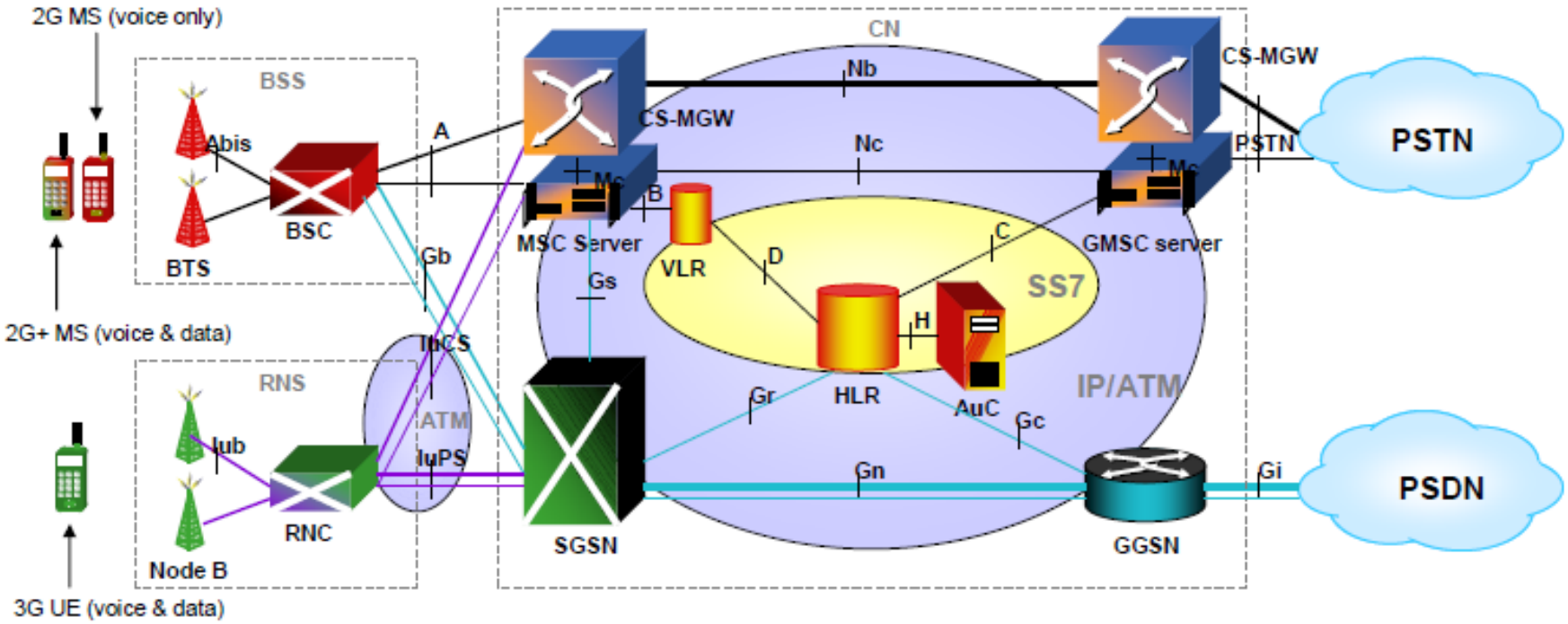
GMSC Gateway MSC

SGSN Serving GPRS Support Node

GGSN Gateway GPRS Support Node

UMTS Universal Mobile Telecommunication System

3GPP rel4 Arch (UMTS) – soft switching



BSS Base Station System

BTS Base Transceiver Station

BSC Base Station Controller

RNS Radio Network System

RNC Radio Network Controller

CN Core Network

MSC Mobile-service Switching Controller

VLR Visitor Location Register

HLR Home Location Register

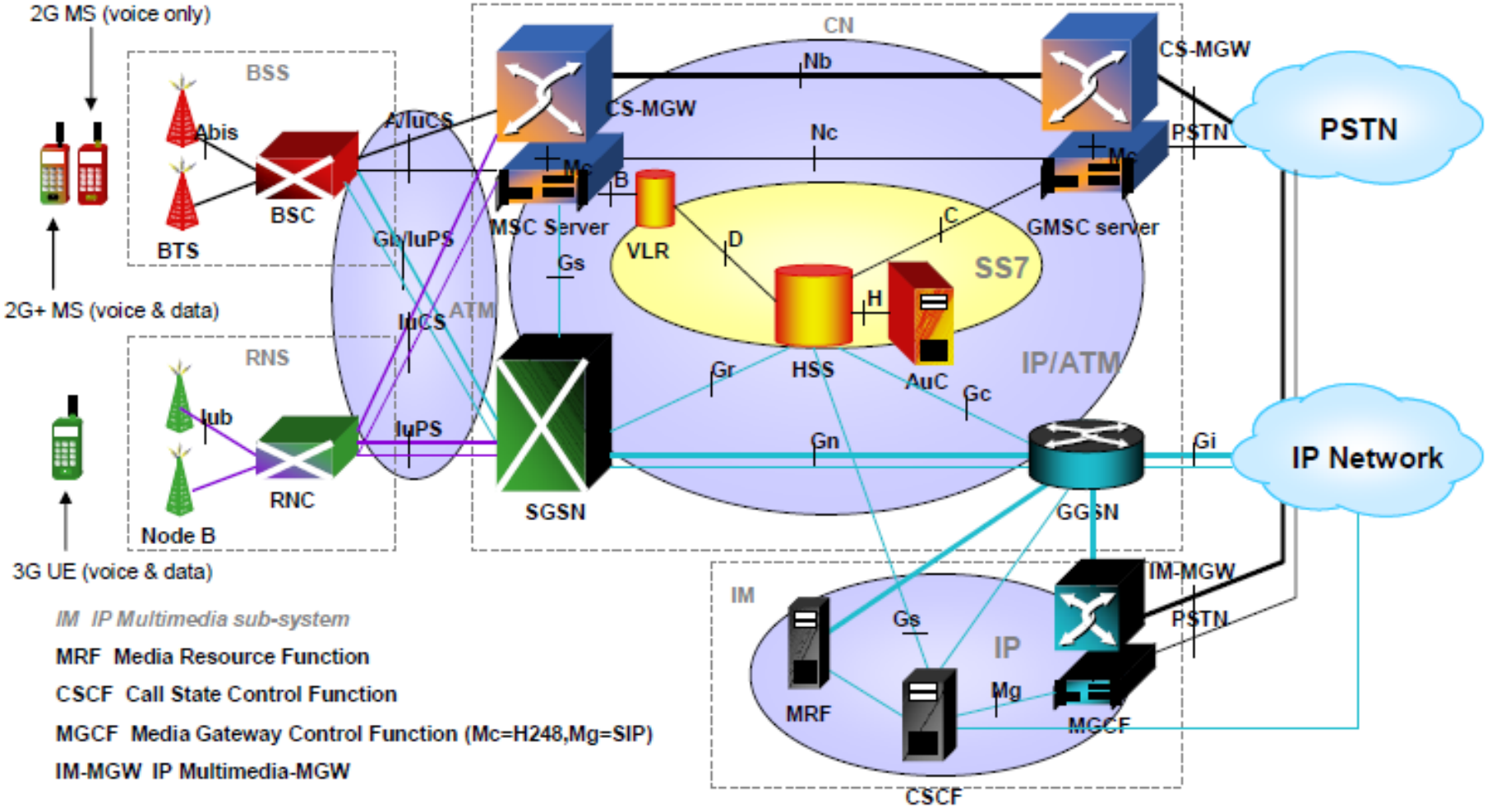
AuC Authentication Server

GMSC Gateway MSC

SGSN Serving GPRS Support Node

GGSN Gateway GPRS Support Node

3GPP rel5 Arch – IP Multimedia



3G UMTS

- W-CDMA – UTRAN
  - The core network for 3G will remain the same as GSM
    - This is a purely cost issue, in the future the infrastructure will be upgraded

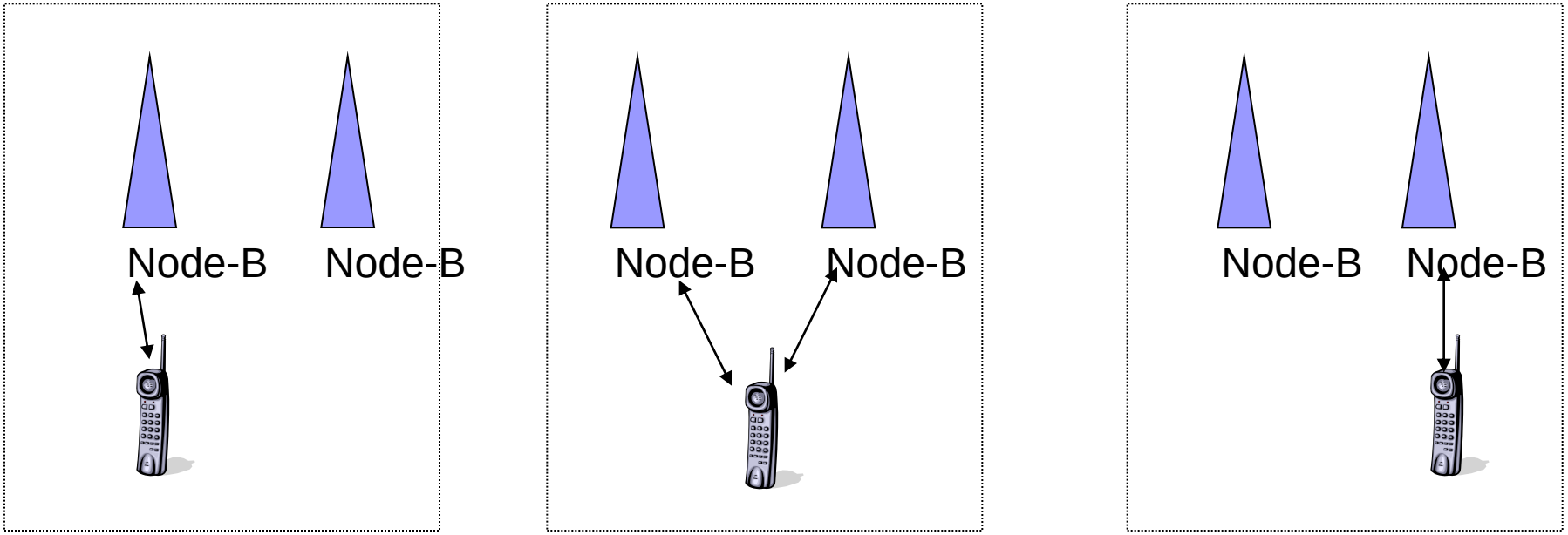
GSM	UMTS
Mobile device/station (MS)	User Equipment (UE)
Base Station (BS)	Node-B
Base Station Controller (BSC)	Radio Network Controller (RNC)

3G UMTS

- W-CDMA
  - UMTS Terrestrial Radio Access Network (UTRAN)
    - A device which wishes to communicate need's to request access to the network
      - This is to prevent too many devices communicating at once
      - Although CDMA will theoretically allow a very large number of user to communicate at once
        - What actually happens is the quality of the calls is reduced considerably
        - This is a issue for voice but is a disaster for data calls

3G UMTS

- W-CDMA
  - Handover (RNCs are connected directly)
    - UMTS will use a soft handover technique
      - GSM used a hard handover technique
      - In a handover the device is always attached to at least one BS



– 3G UMTS

- 3G UMTS is working in one part of the UK
  - Isle of man has the equipment to use 3G
    - This equipment is run and operated by O2
    - The license spectrum used on this island was given free by the government
    - The actual devices used were given to some of the islanders
      - The idea was to trial the equipment in a limited manner
      - Also they wanted to see if there was a pattern of usage for the technology i.e. the killer app
      - As it is known now they have not found the single killer app, like SMS was for GSM
  - Japan
    - When we consider Japan for the killer app it was email!
      - 3G bandwidth is not needed for email!

References

- UMTS Forum
  - www.umts-forum.org/
- UMTS standards documents
  - http://www.3gpp.org/specifications