

NETWORK TECHNOLOGIES - 3G

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3G - Universal Mobile Telecommunication system (UMTS)

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- ▣ Why 3G?
- ▣ UMTS (Universal Mobile Telecommunication system)
- ▣ Use of 3G at the moment

The Third Generation (3G)

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- Current and older technologies
 - ▣ GSM
 - ▣ GPRS
 - ▣ EDGE
- 3G is the currently widely available
 - ▣ High speed data access over a cellular environment
 - ▣ The user can get access anywhere any time!

The Need for 3G

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- 2G and 2.5G systems are incompatible around the world
 - Although GSM is dominant there are still lots of other technologies
 - ▣ Worldwide devices need to have multiple technologies e.g. tri-band phones, dual-mode phones
- 3G - a single standard be accepted around the world
 - ▣ One device should be able to work anywhere !
 - ▣ “Access to Information from Anyplace, Anytime”

The Need for 3G

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- 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
 - ▣ Europe
 - ▣ Japan 2001 (this was achieved)
 - ▣ Worldwide usage

The Need for 3G

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- Different standards with operators in different countries and the rest of the world
 - In the US market forces dictate the adopted technologies in Europe this is done by the EU with the agreement of the member states
- In the future market forces may move towards a single standard
 - ▣ VHS and Betamax video tapes currently seen in DVD standards
- Difficulties
 - ▣ World wide identical available spectrum
 - ▣ Agreement on the encoding/decoding technique used
 - ▣ Local influence groups
 - Manufacturers who have invested in one technology

The 3G Standard

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- Written by the International Telecommunication Union (ITU) and 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)

The 3G Standard

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- 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 - Europe
 - ▣ CDMA2000 - America
 - ▣ TD-SCDMA – China

Further 3G Standards

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- Two specification groups create the standards within the ITU specifications
 - ▣ 3GPP
 - Developed the standards for the UMTS system which is built upon GSM
 - ▣ 3GPP2
 - Developed the standards building upon the US CDMA networks, specifically the CDMA-2000 standard
- The Chinese group is referred to as
 - ▣ Chinese Academy of Telecommunications Technology (CATT)

3G UMTS Areas of Standardisation

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- Builds upon the successful European GSM network
 - ▣ Incorporates the developments made for the GPRS and EDGE networks
- Areas of standardisation
 - ▣ Radio
 - ▣ Core Network
 - ▣ Terminals
 - ▣ Services

3G UMTS – The Core Network

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□ The core network

▣ Asynchronous Transfer Method (ATM) – The core network Technology

- ATM allows circuit switched transfer of data using packets.
- High speed data transfer – currently maximum 10 Gbps
- Guarantee of QoS 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.

3G UMTS – IPv6

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□ IPv6

- ▣ Arguments are being pushed for the core network to allow IPv6
- ▣ [RFC3314](#), September 2002
 - This allows 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 Features

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- Full packet driven architecture
 - ▣ For voice and for data transmissions.
 - ▣ Packet based networks allow 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 Features

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- Offers voice and data services the same as EDGE
 - ▣ Services offered will be classed into one of the following
 - ▣ From these classes certain defined Quality of Service (QoS) specifications are guaranteed like packet delay time

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

3G UMTS Data Rates

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□ Intended Data Rates

▣ Actual data rates will be effected by

- Interference (other devices, background, buildings)
- Over use of the frequency
- Weather!
- Amount of other traffic
- Base station / cell actually attached to
- Speed you are moving at !

3G UMTS Cell Types

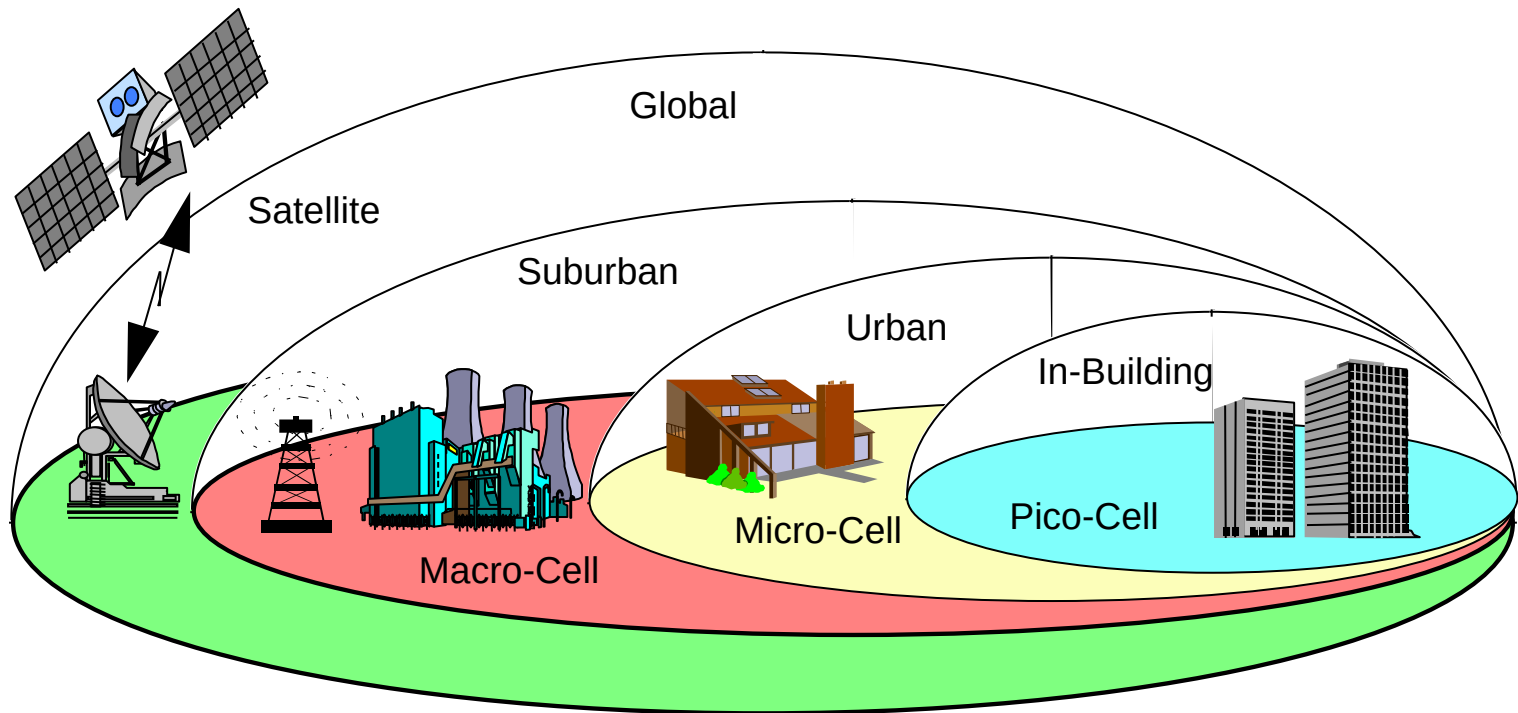
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- Types of Cells and Base station to use them
 - ▣ Macro Cell
 - These cover a large area and will give slow access
 - 144 Kbps – max speed of 500 Km/h
 - ▣ Micro Cell
 - These should cover a medium area
 - 384 Kbps - max speed 120 Km/h
 - ▣ Pico Cell
 - 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 Cell Types

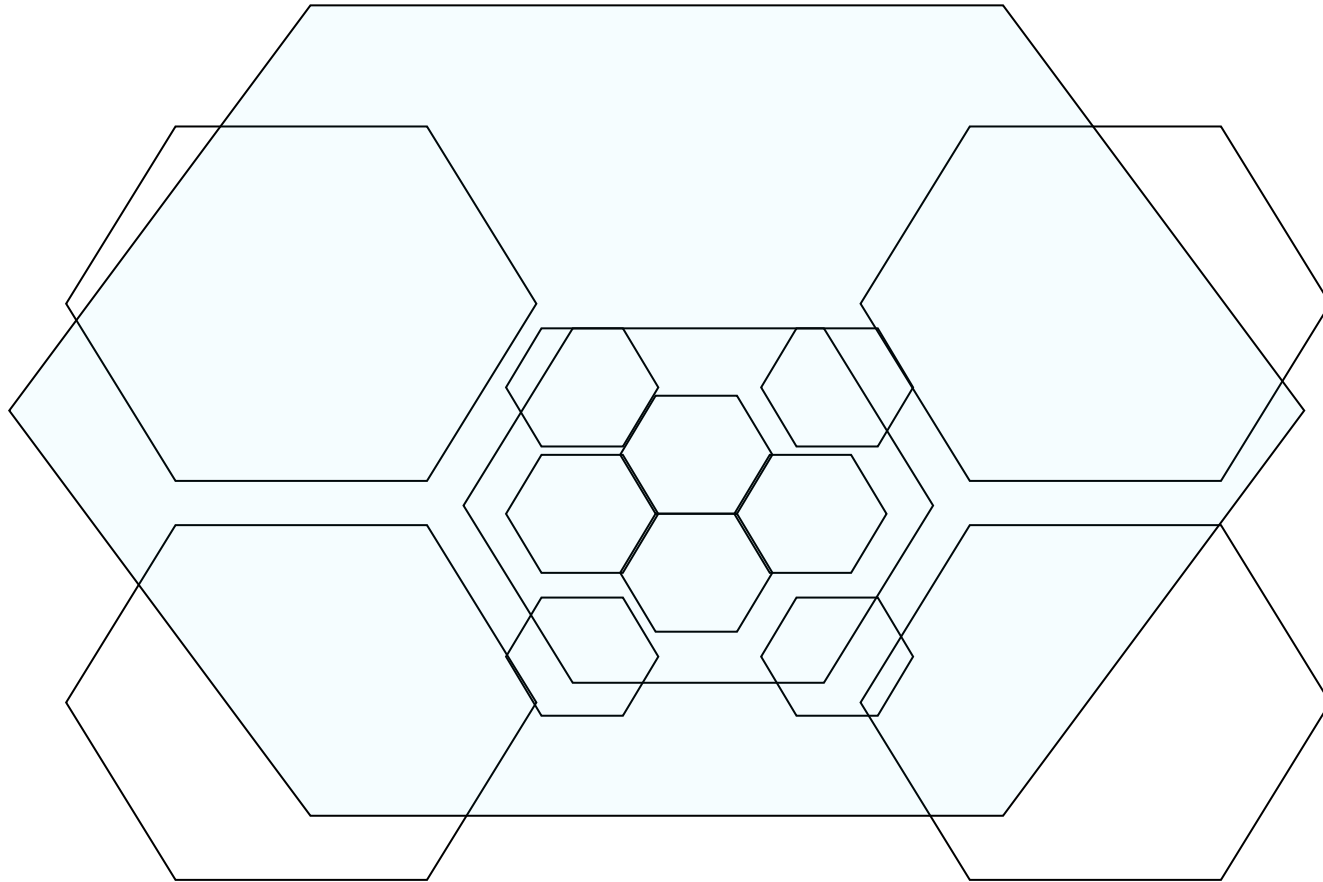
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- Types of Cells and Base station to use them
 - ▣ Cells will operate in a hierarchy overlaying each other



3G UMTS – Hierarchy of Cells

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3G UMTS Data Rate Calculation

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- These data rates are in Mega Bits per Second and Kilo Bits per second
 - ▣ Data Rate of 1 Kbps = 1000 bps
 - ▣ Not the 1024 which is used for data storage
- Example
 - ▣ 2 Mega Bits per Second (Mbps) = 244 Kilo Bytes per second (roughly)

3G UMTS Transmitters and Base Stations

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(<http://www.scotland.gov.uk/library/pan/pan62-05.asp>, 2009)

3G Base Station Locations - Stafford

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Name of Operator	Orange
Operator Site Ref.	STA0047
Station Type	Macrocell
Height of Antenna	17.8 Metres
Frequency Range	1800 MHz
Transmitter Power	29.2 dBW
Maximum licensed power	32 dBW
Type of Transmission	GSM

Name of Operator	Orange
Operator Site Ref.	STA0047
Station Type	Macrocell
Height of Antenna	17.8 Metres
Frequency Range	2100 MHz

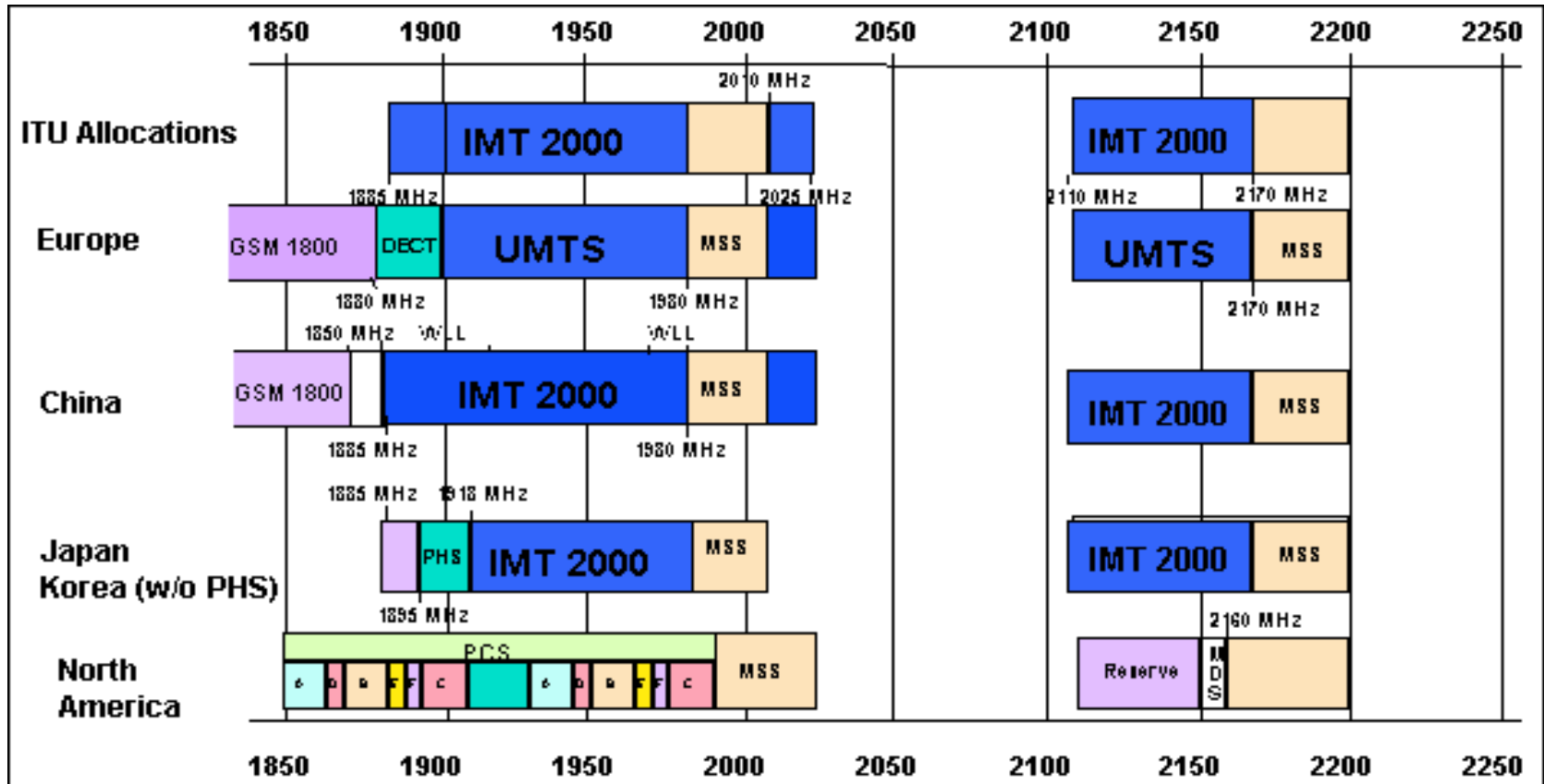


Single Operator GSM technology	Single Operator UMTS technology	Single Operator TETRA technology	Base stations with more than one operator or more than one technology
5	6	1	9

A database of all cellular base stations is provided by OFCOM in the UK
<http://www.sitefinder.ofcom.org.uk/>

3G UMTS Radio Interface – Allocated Frequencies

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3G – UK Spectrum Cost

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- License A is the largest size of the spectrum
 - ▣ A new company in the UK won the License type 'A'
 - ▣ Auction closed on the 27th April 2000
 - ▣ Original estimates were for a total selling value of £1.5 billion (http://www.3gnewsroom.com/html/whitepapers/nao_3g_report.zip)
 - ▣ The license is allocated until the 31st December 2021
 - ▣ The operators must have 80% UK coverage by the 31st December 2007 otherwise they will be fined

<u>License</u>	<u>Company</u>	<u>Paid (Pounds)</u>
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

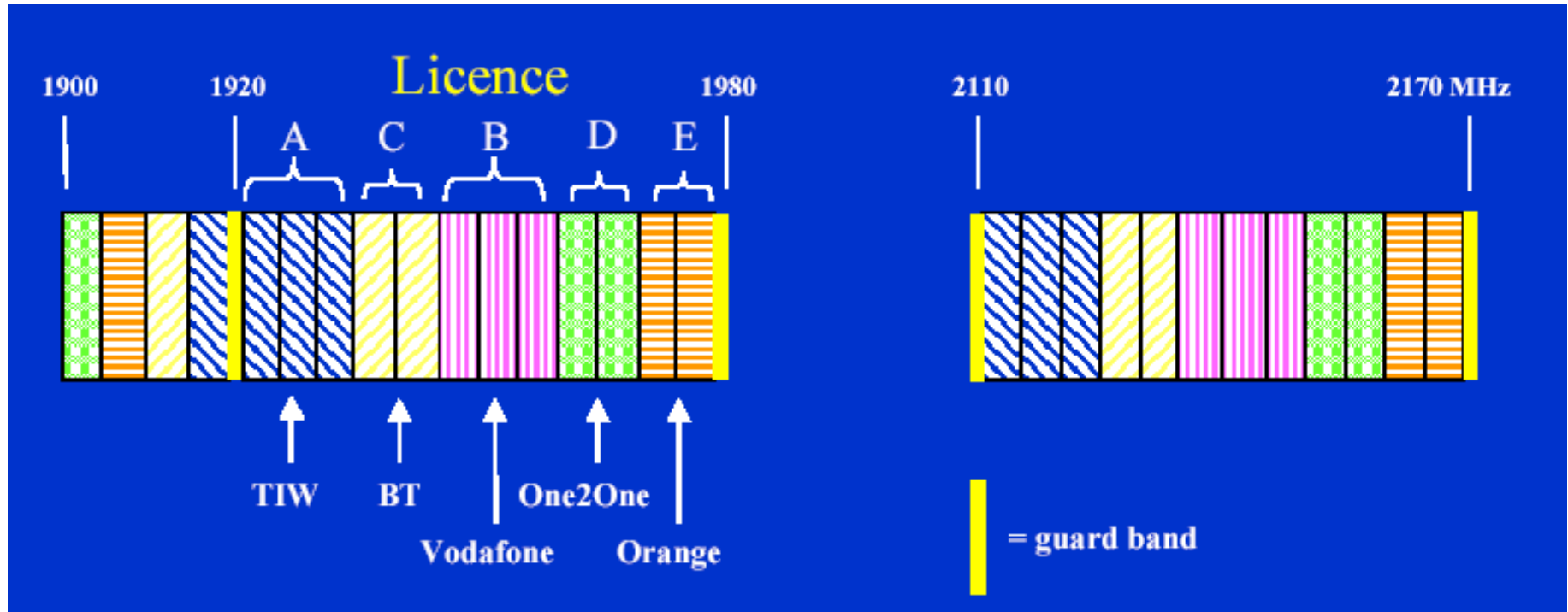
3G – UK Spectrum Cost

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- The UK phone companies in June, 2003 said that they would claim the VAT back on the license purchases! About £3.3 Billion pounds
 - ▣ European Court case started in 2004
 - ▣ This claim though was dismissed though in June 2007 (http://www.theregister.co.uk/2007/06/26/no_vat_on_3g/)

3G UMTS – UK 3G Winners

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3G UMTS – Radio Interface

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- 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 and CDMA

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- Same 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 and W-CDMA

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- WCDMA operates the same but takes place over a wider area of frequency
 - ▣ UMTS uses 5MHz for the signal
 - ▣ CDMA (narrowband) uses 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 – WCDMA Frequency Reuse Factor

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- Distance which needs to be left between cells
- As the same frequency is reused and the chipping code which is used is change 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

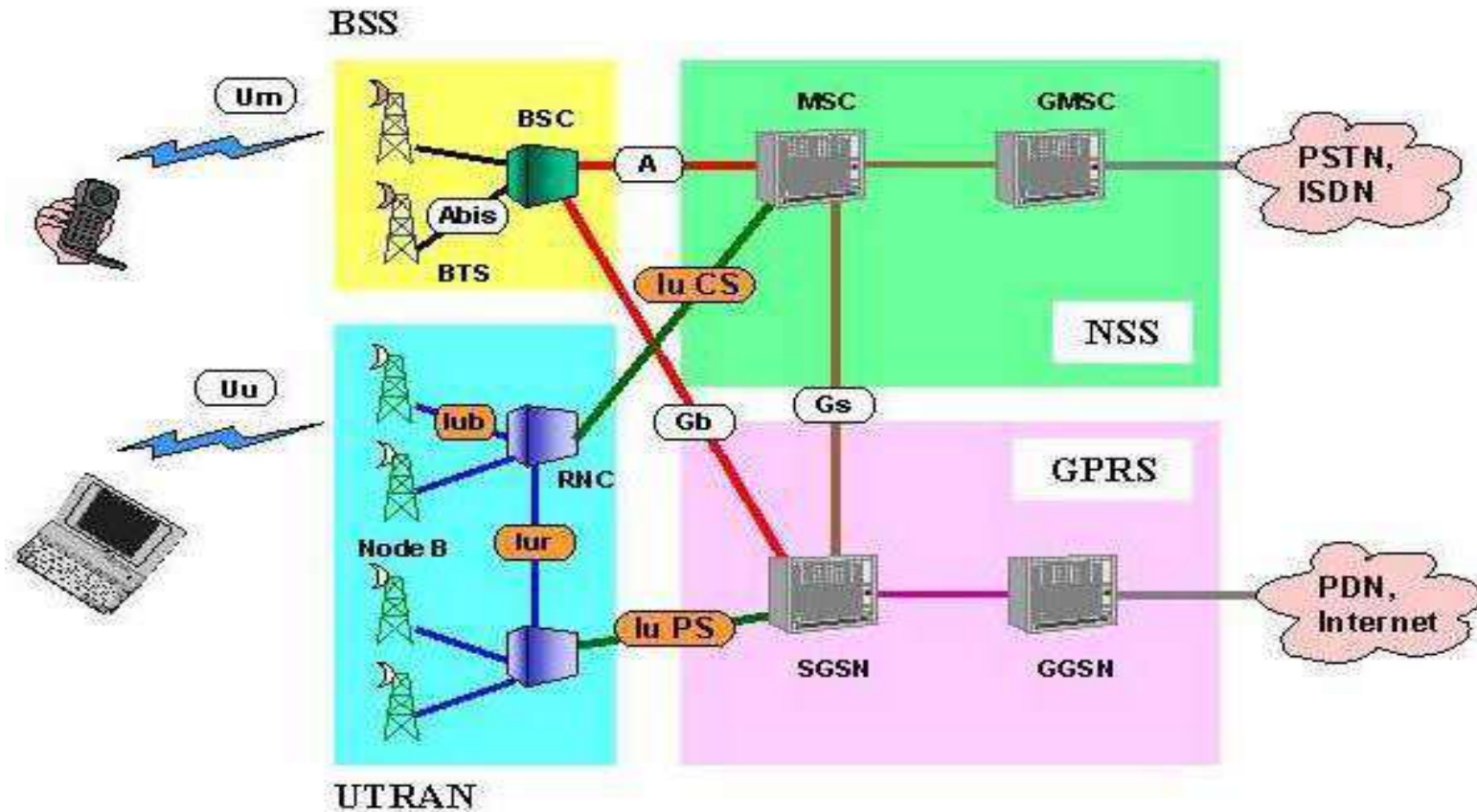
3G UMTS – Power Control

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- 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 English
 - 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 and W-CDMA Infrastructure

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3G UMTS and W-CDMA, UTRAN

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- 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

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

W-CDMA and UMTS Terrestrial Radio Access Network (UTRAN)

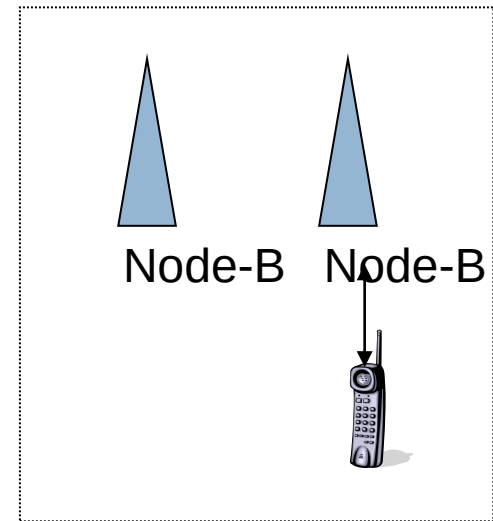
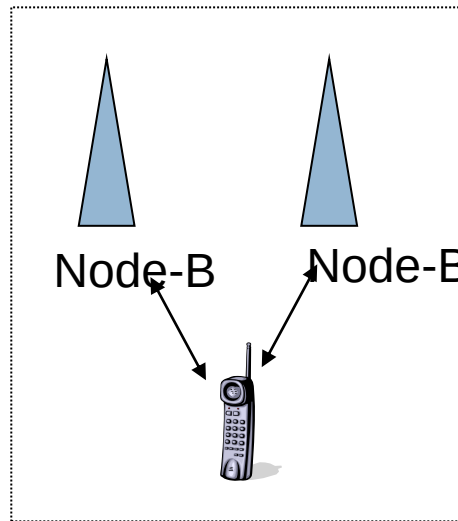
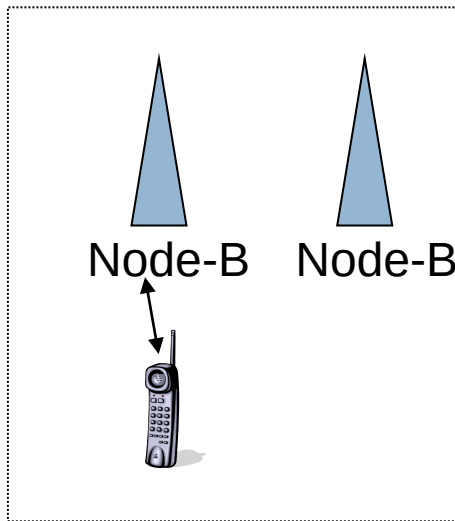
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- A device which wishes to communicate needs to request access to the network
 - ▣ To prevent too many devices communicating at once
 - ▣ Although CDMA will theoretically allow a very large number of user to communicate at once
 - What actually happens is the quality of the calls is reduced considerably
 - This is an issue for voice but is a disaster for data calls

W-CDMA Handover

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- 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 – WCDMA Patent

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- The WCDMA has some patented content
 - ▣ Any handset manufacturer needs to pay royalties to Qualcomm
 - ▣ On the 1st of October 2007 the European Community started looking into this to investigate if Qualcomm was overcharging
 - <http://www.iht.com/articles/2007/10/01/business/cell.php>
 - "If the other patent holders were to do as Qualcomm is doing, royalties could raise the cost of WCDMA handsets considerably - thus raising the prices to consumers."
 - In October 2008 Nokia paid \$2.3 Billion for the use of the technology
 - This will settle worldwide court cases which were ongoing
 - <http://www.eetimes.com/news/semi/showArticle.jhtml?articleID=211200865>

3G UMTS Testing

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- 3G UMTS was tested in the Isle of Man for Europe
 - The equipment was 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
 - A single killer app, like SMS was for GSM, is unlikely
 - It is more likely a series of applications will be popular
 - http://www.conted.ox.ac.uk/cpd/electronics/links/killer_applications_for_3g.asp

3G Availability

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□ 3G is now widely available

- Most of the operators started to get the infrastructure working in 2004
- Wide choices of devices and the cost has come down.
- 3G USB dongle for laptops or smartphones

▣ Japan

- When we consider Japan for the killer app it was email!
 - 3G bandwidth is not needed for email!



Mobile Broadband

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- Mobile broadband as an alternative to DSL
 - ▣ Increasing number of devices which can make use of this technology with USB dongles or inbuilt technology
 - ▣ On the 30th of September 2008 a number of companies have linked with the GSMA to produce a symbol to rival the Wi-Fi logo



Mobile Broadband

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- Mobile Broadband to be put onto Laptops which support 3G connectivity
 - ▣ http://www.gsmworld.com/news/press_2008/press08_61.shtml
- Government statistics on this technology
 - ▣ Some 19% of mobile phone users had used it to connect to the Internet in the last 3 months
<http://www.statistics.gov.uk/pdfdir/iahi0808.pdf>

UMTS

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□ Links

▣ Details of the 3G license auction (UK)

- www.umts-forum.org/servlet/dycon/ztumts/umts/Live/en/umts/Resources_Licensing_UK

▣ UMTS standards documents

- www.3gpp2.org/Public_html/specs/index.cfm