University of Salford MANCHESTER

CW Wireless Heritage SIG

"1994 to 2014: Mass consumer cellular and the mobile broadband revolution" - Broadband radio, digital radio, smart phone and smart networks.

Andy Sutton
Visiting Professor
Department of Computing, Science and Engineering

University of Salford MANCHESTER

Agenda

- GSM900 and DCS1800 (2G)
- From voice and text to data and multi-media on the move
- TETRA
- UMTS and that auction! (3G)
- 3G evolution, high speed packet access
- Not just cellular, digital broadcasting, Bluetooth, NFC, GNSS, WiFi…
- LTE (4G)
- Mobile broadband use cases
- LTE-Advanced, true 4G mobile broadband

University of Salford MANCHESTER

GSM timeline in the UK

- 1980: Conservative Government pursued two parallel policy objectives – privatisation and liberalisation, both would play a role in shaping the UK telecommunications landscape
- 1989: The UK Department of Trade & Industry (DTI) produced a document 'Phones on the Move' that first proposed PCN (Personal Communications Networks (later known as DCS 1800 and subsequently GSM 1800) networks to operate in the 1800MHz frequency band
- July 1992: Vodafone launched the Country's first GSM900 network
- September 1993: Mercury one2one launched the Country's first DCS1800 network (later became GSM1800) – The first 1800MHz network in the World
- December 1993: Cellnet launched their GSM900 network
- April 1994: Orange launched their DCS1800 network (later became GSM1800)

University of Salford MANCHESTER

GSM timeline in the UK

- April 1994: Orange launched their DCS1800 network (later became GSM1800)

University of Salford MANCHESTER

cellnet

4 UK GSM operators

Mercury one2one

orange™

hutchison telecom

Vodafone opened its pan-European GSM network in December 1991, providing coverage in the London area. Ultimately GSM subscribers will be able to make and receive calls throughout Europe.

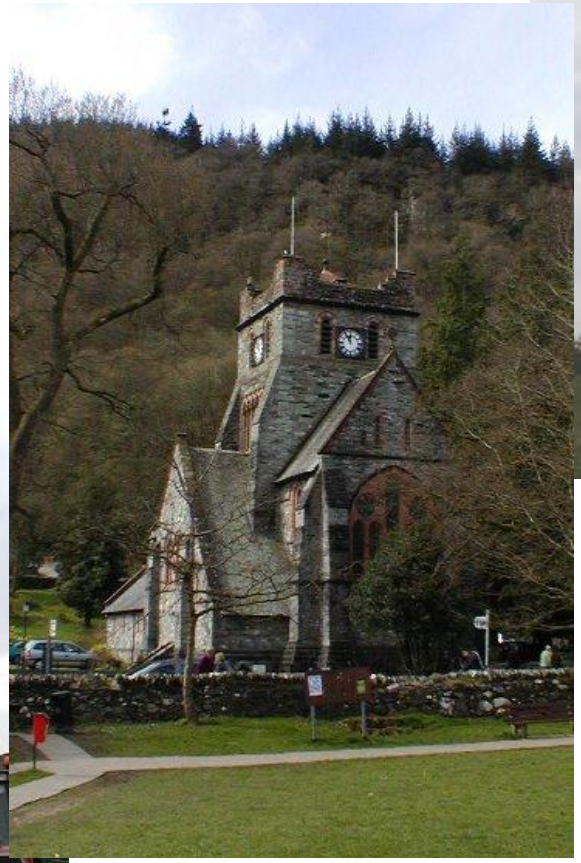
Vodafone Group information source:
http://www.vodafone.com/content/dam/vodafone/investors/annual_reports/annual_report_accounts_1992.pdf

University of Salford MANCHESTER

GSM installations

University of Salford MANCHESTER

GSM installations



University of Salford MANCHESTER

Macro-cell sites

- Non of these are original equipment's from the 1992/93/94 launch networks, these are upgraded base stations, later generations of equipment…

University of Salford MANCHESTER

Micro-cell sites

One GSM transceiver = typically 7 voice channels + control channel

Two GSM transceivers = typically 14 voice channels + control channels

University of Salford MANCHESTER

Core network

University of Salford MANCHESTER

DCS1800 (later GSM1800)

Siemens m200 & Motorola m300

Nokia 2140

Motorola mr1

University of Salford MANCHESTER

Data

Option GPRS data card

Nokia 2140 with CS data card (9k6)

Nokia HSCSD data card (28k8)

University of Salford MANCHESTER

CSD - HSCSD - GPRS - EDGE

Nokia 7110

Ericsson R380

Nokia 9210

Nokia 6230i

University of Salford MANCHESTER

Smartphones…

Blackberry

- Designed and Manufactured by RIM (Research In Motion)
- First model came to market in 1999
- Integrate with enterprise email via BES (Blackberry Enterprise Server)
- Integrated security
- GSM/GPRS

Apple iPhone

- On January 9, 2007 Steve Jobs announced the iPhone at the Macworld convention
- On June 29, 2007 the first iPhone was released
- Networks competed for the iPhone - a very new business model… o2 network in UK
- GSM/GPRS

University of Salford MANCHESTER

Nokia dominated the GSM market

Nokia 1011 Nokia 2140 Nokia 3210e Nokia 6230i

University of Salford MANCHESTER

TETRA

- Trans European Trunked Radio Access
- Standardised by ETSI in 1995
- TETRA uses TDMA with four user channels on one radio carrier and 25 kHz spacing between carriers
- Both point-to-point and point-to-multipoint transfer can be used
- Digital data transmission is also included in the standard though at a low data rate
- Commercial networks failed in the UK due to the rise of cellular
- UK Emergency services network – Airwave
- Transport for London and some airports

University of Salford MANCHESTER

UMTS timeline

- 1991 – ETSI establishes SMG5 to develop standards for UMTS
- 1992 – Global radio frequencies are reserved for UMTS
- (92/93/94 – UK GSM networks launch)
- 1998 – ETSI & ARIB unite to form 3GPP
- 1999 – 3GPP published first version of UMTS standards (R99)
- 2000 – UK Spectrum auction
- 2001 – NTT DoCoMo launches the World's first WCDMA network
- 2003 – First UMTS networks launch in UK

University of Salford MANCHESTER

3G, an expensive gamble…

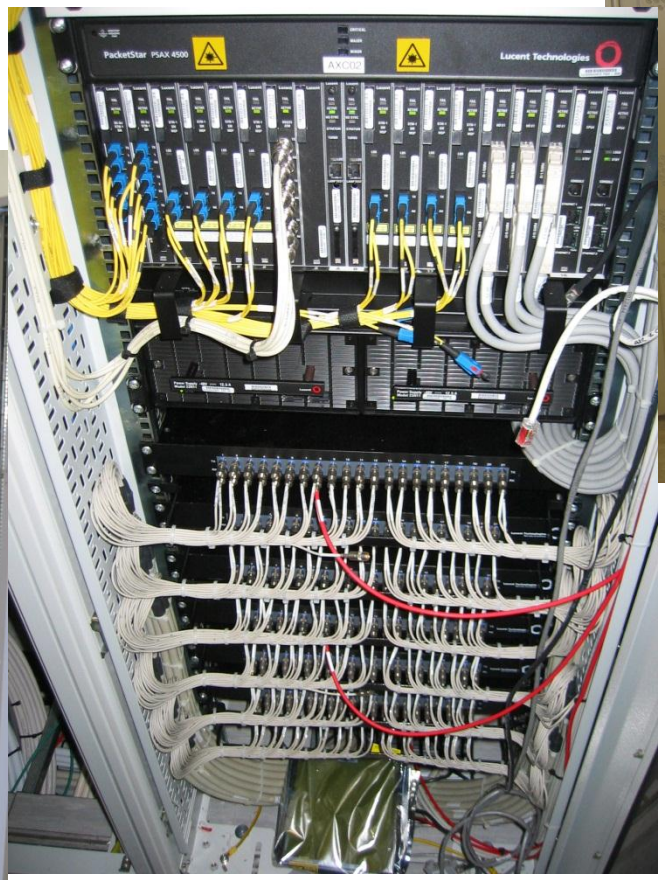
- In the year 2000 an auction was held for spectrum in the 2100MHz band, this band was to support the new 3G technology
- The outcome of the auction was 5 awards:
  - Licence A – TIW (H3G) at a cost of £4,384,700,000
  - Licence B – Vodafone at a cost of £5,964,000,000
  - Licence C – BT at a cost of £4,030,100,000
  - Licence D – One2One at a cost of £4,003,600,000
  - Licence E – Orange at a cost of £4,095,000,000
- A total of **£22,477,400,000** was raised for the UK treasury

University of Salford MANCHESTER

A new operator…

University of Salford MANCHESTER

Building 3G networks



WCDMA (Wideband Code Division Multiple Access)

NodeB and RNC, introduction of ATM (Asynchronous Transfer Mode)

University of Salford MANCHESTER

Hello mobile broadband…

384kbps downlink DCH
64kbps uplink DCH

Nokia 6650

Nokia 7600

NEC e606

University of Salford MANCHESTER

3G phones

NEC e606 Motorola V975

LG U8110 LG U8800

Nokia 6680 Nokia N73

University of Salford MANCHESTER

Smarter devices and apps…

University of Salford MANCHESTER

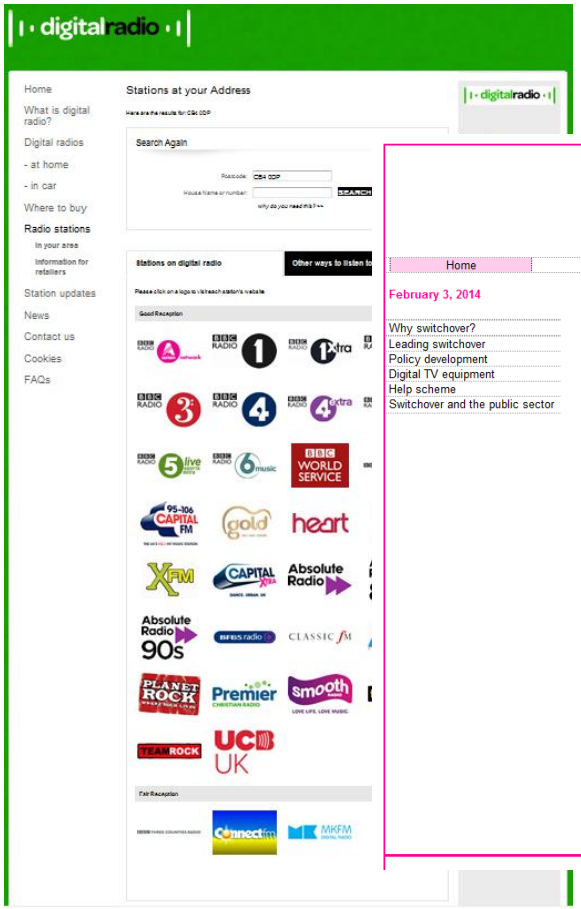
Not just cellular radio…

- Bluetooth SIG formed in 1998 with 5 member companies, this increased to 400 by the end of the year with over 20,000 member companies now!
- During 2013 Cumulative *Bluetooth*® product shipments surpass 2.5 billion*
- NFC is enabling the digital wallet
- GPS (and GNSS in general) enables mapping and location based services
- WiFi (WLAN) has evolved at great pace with new standards from the IEEE

*ABI Research

University of Salford MANCHESTER

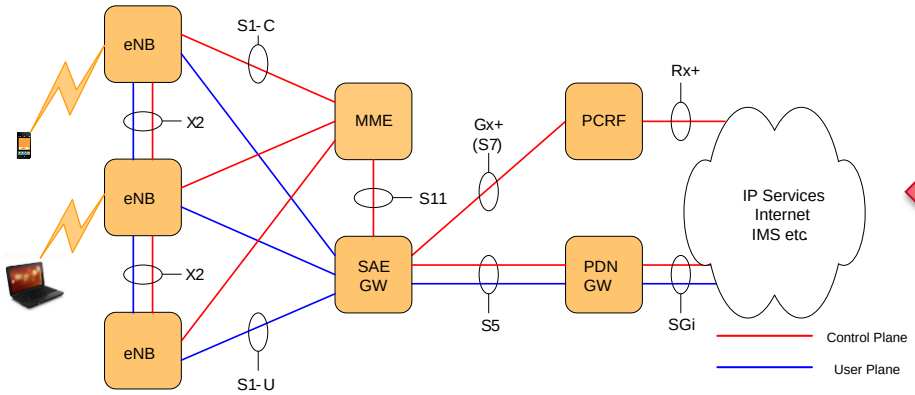
Digital terrestrial broadcasting



University of Salford MANCHESTER

4G, a game changer…

Flexible channel BW allocation, OFDMA, flexible resource scheduling, MIMO antenna systems, Het-Nets…



All IP network, Ethernet interfaces, No circuit switching, IMS, VoIP, RCSe, Broadcast and multicast…

What is LTE?

- A work group established within 3GPP
- The next step in the evolution of 3GPP radio interface to deliver “Global Mobile Broadband”
- A plan first conceived in 2004 that’s
  - Based on clearly defined performance targets
  - Based on clearly defined economic targets
  - Based on improved use of the radio spectrum
  - Based on simplified system design

University of Salford MANCHESTER

21st August 2012

a a a Display options Cymraeg

Ofcom

Independent regulator and competition authority for the UK communications industries.

Home | Consumers | Licensing | Stakeholders | Media & Analysts

Search... | All of Ofcom | Search

News Releases | Analyst relations | Speeches & Presentations | Facts & figures | Images & logos

Home / News

Print | +1 | Tweet | Like

Ofcom allows Everything Everywhere to use existing spectrum for 4G

August 21, 2012

Ofcom has today approved an application by the mobile phone operator Everything Everywhere (EE) to use its existing 1800 MHz spectrum to deliver 4G services.[1]

Following a consultation, Ofcom has concluded that varying EE's 1800 MHz licences now will deliver significant benefits to consumers, and that there is no material risk that those benefits will be outweighed by a distortion of competition.[2] Delaying doing so would therefore be to the detriment of consumers.

The decision takes account of the forthcoming release of additional spectrum in the 800 MHz and 2.6 GHz bands, in an auction process set to begin later this year, which will enable other operators to launch competing 4G services from next year.[3]

In parallel with this decision, Ofcom has now issued varied licences to EE which authorise LTE services from 11 September 2012. This means that EE can launch LTE services using its 1800 MHz spectrum at any point from that date, although the precise timing of any launch is a commercial decision for Everything Everywhere.

The full decision can be found here.

ENDS

University of Salford MANCHESTER

UK's first 4G network

LTE1800

30.10.12
LIFT OFF

University of Salford MANCHESTER

Turning heads…

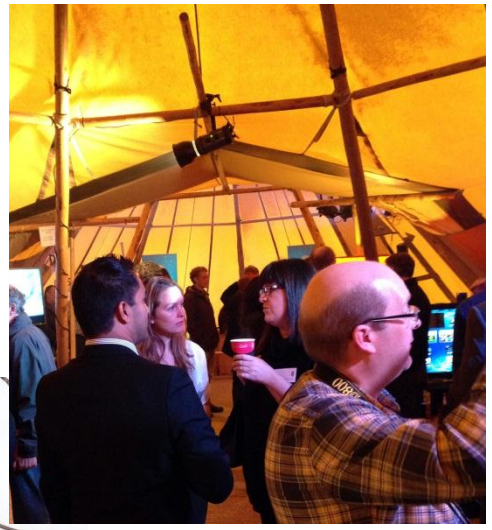
University of Salford MANCHESTER

Another auction

- The award of 800 and 2600MHz spectrum resulted in the launch of 4G networks for O2, Vodafone and Three while BT also acquired spectrum in the 2600MHz band

University of Salford MANCHESTER

Rural broadband



University of Salford MANCHESTER

LTE-Advanced

- CA consists of Component Carriers(CC).
- CC are either intra-band (contiguous & non-contiguous) or inter-band.
- Current focus on downlink

University of Salford MANCHESTER

Summary

- We’ve gone digital…
- We’ve evolved to wideband radio systems such as WCDMA and more recently LTE with OFDMA
- During this period mobile phones have evolved into handheld computers with full multi-media capabilities
- 2G, 3G & 4G will likely co-exist for many years however the future is 4G with 5G coming along as and when appropriate…

Thank You!

Any question?