THE MOBILE PHONE TIMELINE

1942

• Radio with the first printed circuit board

1947

• DH Ring at Bell Labs describes principles of cellular frequency reuse.

1948

• Shockley invents the transistor

1959

• CEPT created to promote telecommunications standardisation within Europe

1965

• Circuit blocks and integrated circuits

1969

* Bell introduces first commercial system using cellular principles (handover and frequency reuse) on trains between Washington and New York. Mobile handover triggered by track hardware. Land stations are controlled by a central computer. Note that cellular with deterministic handover was working in 1969, but it took 10 years to solve the general handover problem illustrating the key importance of microprocessor development.

1971

• Intel introduces first commercial microprocessor, the 4004.

1976

• Apple 1A Personal computer
• Cray Super Computer

1977

• First commercial AXE switch shipped by Ericsson.
• First direct conversion receiver architecture developed at Standard Telecommunication Laboratories in Harlow used in the world's first single chip radio pager.

1978

• Bahrain Telephone Company opens first commercial cellular telephone system, using Panasonic equipment.

1979

• WARC'79 takes decision to set aside spectrum in 900MHz range for land mobile communications.
* Commercial mobile cellular opens in Japan.

1981

• NMT cellular service introduced in Scandinavia. Supports international roaming.
• Development of patented TDD system at STL Harlow later used in Phonepoint Rabbit CT2 cordless telephones.
• Early work on software defined radio.

1982

• CEPT R21 managers reserve frequencies in the 900MHz band for a pan European mobile service
• Groupe Speciale Mobile (GSM) has its first meeting in Stockholm.

1983

• Early business plans predicated on high priced mobile or transportable handsets, low penetration (less than 2%) and low network cost to achieve profitability.

1984

• The Joint Radio Telephone Interfaces Group (JRTIG) is established between BT, Sectel and Racal, to define the TACS mobile standard. By September, JRTIG had agreed the key principles of interconnect and air interface that opened UK telecommunications to and set mobile operators as equal partners to incumbent telcos.
• Network architecture and signalling influenced by need for ISDN compatibility and use of SS7 signalling.
• Vodafone decide to use Ericsson AXE switch, rather than AT&T's 5ESS to ensure compliance with CCITT standards.

1985

• October Franco-German political declaration to cooperate on joint R&D programme for digital cellular radio to be brought into operation in the early 1990s.

1986

• Racal Millicom (later Racal Telecom and then Vodafone) launches the UK's first cellular radio service on 1 January, based on the analogue TACS standard, adapted from US AMPS but with 25kHz, rather than 30kHz, channel spacing). Cellnet follows eight days later. Original system used 1000 channels (25MHz paired band) later extended to 1320 channels (ETACS 33MHz paired band).
• A typical analogue FM TACS/ETACS mobile phone has a few kilobytes of memory, 10MIPS of processor bandwidth and 10,000 lines of code.
• Use of optimised FR4 pcbs in order for phones to work at 900MHz. Every phone took 8 hours to do rf tests.
• Agreement in Oslo to standardize SMS service.

1987

• Developing awareness that VLSI scaling could offer the opportunity to design low cost small energy efficient handsets serviced from denser lower power networks.
• UK's 100,000th TACS customer connected in October.
• Racal buys out 20% minority stake in Vodafone for £130m.
• Germany, France, Italy and UK meet in Bonn and agree basic parameters of GSM, serices, narrow band TDMA with DTX and SFH, GSM full rate codec and network architecture principles.
• EU RACE UMTS Research project launched.
• UK proposal for drawing up of GSM MoU is accepted and GSM MOU group formed.
• UK government awards digital GSM licenses to Racal and Cellnet.
• 13 countries sign MOU in Copenhagen, commiting the mobile operators to complete the standard, procure networks and open GSM services by 1991.
• UK's 250,000th TACS customer connected in December.
• Use of optimised FR4 pcbs in order for cellphone users by 1989, more than three times more than the estimates of rival bidders. By 1999 Racal (Vodafone) and BT (Cellnet) together had 1.1million customers.

1988

* MOU operators from 13 countries issue simultaneous invitations to tender for network build out. This fires up entire industrial ecosystem from chips to mobiles to base stations to mobile telephone exchanges to invest in the industrialisation of GSM.

1989

- GSM standardisation transferred to ETSI Phones on the Move, published by UK DTI, puts in place measures to accelerate mass market technology adoption of mobile radio and adds rocket booster to GSM.
- UK Government awards PCN licences to Unitel, Mercury PCN and Microtel for deployment in the 1800MHz band. Spectrum is found at 38GHz to make backhauling dense cell networks economic.
- DTI mandates GSM technology to be used for early scale economies for mobiles.
- Oftel imposes favourable regulatory conditions to improve investment case for new entrants rolling out dense cell networks at 1800MHz. All measures needed to get the cellular business model to flip from relatively low cost wide area cell networks, high handset prices and low customer penetration to much higher cost dense cell networks, low handset prices and mass market adoption.

1990

- Phase 1 GSM900 specification are frozen, DCS adaptation started
- UK's 1millionth TACS customer connected in May.
- ITU-R issues first recommendation defining Future Public Land Mobile Telecommunications System (FPLMTS).

1991

- Telecom Geneva first GSM network 11000 calls made
- Australian regulator becomes first non European body in MoU
- Racal Telecom renamed Vodafone Group and demerged from Racal Electronics.
- Unitel and Mercury PCN agree to pool their resources to build a shared network in a new jointly owned organisation called Parallel Network Architectures. This has a parallel with the shared H3G/T-Mobile network build

1992

- GSM rebranded as Global System for Mobile Communications
- First international roaming agreement between Vodafone UK and Telecom Finland
- Telstra signs the MOU, interim type approval agreed.
- European SMS acceptance tests.
- Vodafone launches GSM commercially in June, its LowCall service in October; Cellnet follows with one month later.
- Unitel and Mercury PCN merge to form One2One.
- First SMS sent in December.

1993

- WARC 92 identifies 230MHz of spectrum for FPLMTS now renamed IMT2000 with additional spectrum for satellite services.
- 1million GSM customers on 32 networks.
- First SMS phones available.
- One2One launches the world's first DCS/PCN1800 service, with coverage limited to inside the M25.
- Vodafone connects its millionth customer.
- Telstra joins GSM MOU.

1994

- 4million GSM customers on 69 networks
- US FCC auctions 1900 MHz
- Comparative trials of GSM and CDMA held in China.
- UK's 2millionth customer connected in January.
- Cellnet connects millionth customer in March.
- Hutchison launches the Orange 1800 service.
- UK reaches the 3million milestone in October.

1995

- 1millionth GSM customer in the UK connected, 12 million GSM customers globally on 117 networks
- GSM phase 2 specifications agreed, start of SMS.
- UK DTI establishes UMTS Technical Advisory Committee
- Vodafone becomes the first network to introduce TACS authentication measures, to combat cloning fraud on the analogue network.
- A typical mobile phone has a few megabytes of memory, 100MIPS of processor bandwidth and 100,000 lines of code.

1996

- GPRS evolution based on SS7 signalling protocols.
- All networks become SMS capable and international SMS roaming becomes available.
- SMS starts to be used by young people
- PCS1900 standard (GSM adapted for American frequency bands) approved by ANSI in March.
- First PCS 1900 network in USA by American Personal Communications (Washington DC).
- 30million GSM customers worldwide on 167 networks
- Triband phone development initiated.
- UMTS forum is inaugurated
- WCDMA wide band test bed voice, video and data multiplexed on a 5MHz radio channel.
- Orange lists on the London Stock Exchange.
- UK reaches 10% penetration in May.
- Vodafone launches UK first prepaid service in September.
- GSM overtakes TACS in December.
- Mobile VCE established – geared to harness UK University research to industry's needs.

1997

- Orange and One2One both connect their millionth customer in December.
- PCS1900 networks in the US support 400,000 users.
- GSM MOU represents 239 members from 109 countries.

1998

- IMT 2000 ITU R recommendation on 3G WCDMA based on need for ATM compatibility to support multimedia multiplexing.
- GSM connections reach 100m in April.
- UK's 10millionth customer connected in August.
- Q4 sees 2.5m new connections – the first seven digit quarter.
- ETSI selects Wideband CDMA as the technology to be used for UMTS in the paired spectrum and TD CDMA for unpaired spectrum.
- 3GPP formed to pursue harmonisation work.
- Bluetooth Special Interest Group founded.
- The launch of the Nokia 6110 – the first ARM Powered mobile phone. Significant because it was a pocket sized digital 'phone with long battery life. It also introduced games on mobile phones.
- Symbian established by Ericsson, Nokia, Motorola and Psion.
- World's first dual band GSM phone – the Motorola 8800 – launched.

1999

- Vodafone merges with Air Touch Communications to create the world's largest mobile operator, with 26m customers.
- BT buys Securicor's 40% interest in Cellnet.
- Deutsche Telekom acquires One2One
- Air Touch merges its US businesses with GTE Mobility and Bell Atlantic Wireless to form Verizon Communications.
- Mannesmann buys Orange from Hutchison Whampoa for £20bn.
- Virgin Mobile launches the UK's first MVNO service in December.
- 3GPP2 formed in the US to oversee CDMA2000 standardisation and potential harmonisation with 3GPP standards.
- Release 99 in December establishes circuit switch and packet switch standard, radio bearers, MMS and location services.
- GSM connections reach 0.25bn in December.
- First triband GSM phone – the Motorola Timeport L7089, including WAP – shown at Telecom 99.

2000

- Vodafone buys Mannesmann for €137bn.
- UK Government auctions five UMTS licences, raising £22.5bn.
- UK's 30 millionth customer connected, equivalent to more than 50% penetration.
- Vodafone sells Orange to France Telecom for £25.1bn.
- Mobiles outnumber landlines for the first time.
- WRC 2000 identifies 2500 to 2690GHz band for IMT (now known as Band VII).
- UMTS auctions of the 1.9/2.1GHz band (Band I)) in Germany, Italy, the Netherlands, Austria, Norway, Switzerland, Portugal and Sweden raise more than €100bn.
- HSDPA work item within 3GPP for WCDMA.
- Low cost energy efficient fast dense memory starts changing the form factor and functionality of cellular phones.
- Ericsson R380 Smartphone launched: the first Symbian based smartphone.

2001

- FT refloats Orange on the London Stock Exchange.
- Vodafone buys Airtel in Spain and J-Phone in Japan
- UK penetration hits 75%.
- BT sells its mobile businesses.
- Release 4 standard for TD SCDMA for China.
- GSM connections reach 0.5bn

2002

- BT Cellnet rebrands as O2 following its demerger from BT.
- UK's 50millionth connection.
- Release 5 March 2002 HSDPA.
- Global connections (all technologies) exceed 1bn and exceed fixed line subscriptions (1.3 billion) by year end.
- Orange SPV – the first Microsoft powered smartphone – launched.

2003

- Hutchison launches the '3' 3G service.

2004

- FT delists Orange.
- Virgin buys DT's 50% stake in Virgin Mobile.
- H3G connects its millionth customer.
- UK reaches 100% penetration.
- 1billion GSM global subscribers.
- Nokia becomes largest global camera vendor.

2005

- O2 overtakes Vodafone to become the UK's largest network.

Release 6 March 2005 enhanced uplink and wireless LAN interworking.

- 2billion connections worldwide.
- LTE research and standardisation started by Ericsson.

2006

- A typical mobile phone has a few gigabytes of memory, 1000 MIPS of processor bandwidth and 1million lines of code.
- RF tests on the production line now take seconds, although conformance testing now takes months – and will get worse as additional bands are added.
- Telefonica buys O2.
- 5millionth W-CDMA customer connected in May.
- Mobile outnumbers landline two to one.
- 2bn GSM connections.
- Green Radio identified as a vital requirement by Mobile VCE's Visions Group

2007

- Release 7 September 2007 HSPA evolution, including MIMO
- LTE feasibility study WRC 07 identifies additional spectrum at UHF, 2.3GHz and 3.4GHz to 4.2GHz.
- 3billion mobile connections.
- First LTE prototypes available.
- UK's 70 millionth connection.

2008

- 10 millionth W-CDMA customer connected.
- Touch screen display technologies, positioning and movement sensing start changing the form factor and functionality of cellular phones.
- First Apple iPhone launched.
- O2 connects its 20millionth customer.
- 83bn text messsages sent in the UK.
- 3billion global GSM connections.
- 0.25billion W-CDMA connections.
- Release 8 December 2008 LTE ODFMA/SC FDMA air interface specification.

Introduction of Home Node B and Home eNB Femto cell standard and self configuring network specification.

- 4billion mobile connections in December
- Industry generates approximately $1trillion annually.
- 3-4 trillion short messages generate between $80 and $100billion.
- LTE interoperability tests.
- Launch of Mobile VCE's Green Radio research programme

2009

- UK penetration reaches 125%.
- Orange and T-Mobile announce plans to merge.
- Global forecast of 4.55billion subscribers by the end of 2009, of which 4billion are GSM.
- Commercial launch of femtocells by Vodafone.
- Android handsets introduced by Verizon in the US, increasing uptake of mobile broadband.
- Nokia N900: First Maemo 5 device and a new breed of Internet tablet.
- LTE chip sets become available.

2010

- 3GPP Release 10 LTE Advanced and System Architecture Evolution and Evolved Packet Core and Evolved Packet System specification, integration with IETF IP protocol standards making and related LTE work items.

2015

- 100% global penetration?