Cellular development

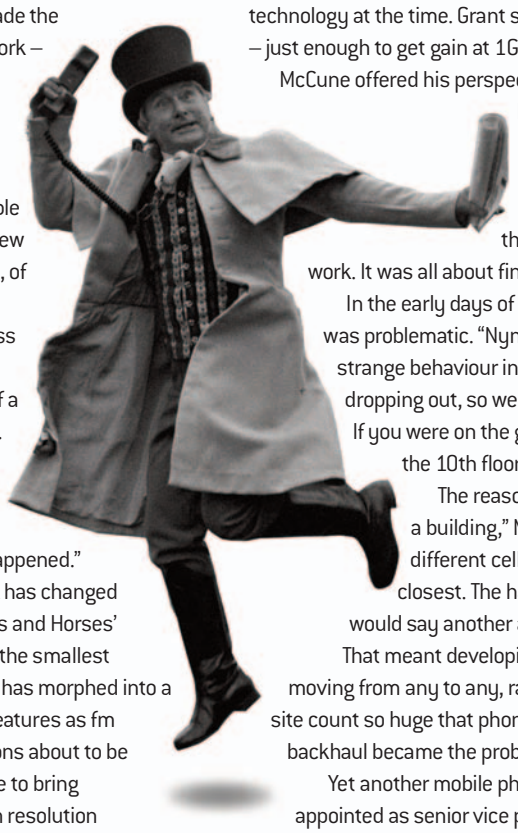
In the 25 years since Ernie Wise made the first mobile phone call in the UK, the technology has changed beyond recognition. By **Graham Pitcher**.

On New Year's Day 1985, comedian Ernie Wise made the first call on Racal Vodafone's mobile phone network – the UK's first mobile phone service provider.

The mobile phone has now developed to the point where, according to a recent survey, while a car is still seen as a luxury, a mobile phone is seen as essential.

But Wise's call wasn't the first ever call from a portable phone – that was made more than 10 years earlier, in New York. Before that, there were 'transportable' phones and, of course, car phones.

Earl McCune has been working in the mobile business for 35 years, including running Panasonic's rf team in Japan. "The first mobiles were large boxes in the back of a car, with a cable snaking to a console close to the driver. There weren't many cells, so the devices had to be powerful – maybe 20W. People had expectations of call quality and we had to meet them. There were all kinds of technical 'insurance policies' to make sure it happened."



A quarter of a century on, the mobile phone network has changed beyond recognition. The 'bricks' pastiched on 'Only Fools and Horses' have been replaced by phones which fit comfortably in the smallest pocket. A device that could only make and receive calls has morphed into a communications hub, with texting supported by such features as fm radio, Bluetooth and WiFi, with Near Field Communications about to be added. Smartphones have ridden the convergence wave to bring personal computing functionality to the user, while high resolution cameras are to be found on almost every high street shelf.

When Wise made that first call, it was over an analogue network. But planners already had the future in their sights. As the Groupe Speciale Mobile, the participants drew up the rules for a digital future; what has now evolved in the Global System for Mobile Communications – GSM.

Doug Grant, once a business development director with Analog Devices, is a mobile phone veteran. "What's amazing," he reflected, "is those who framed GSM were smart enough to realise how quickly the technology would accelerate. The technology went from 'dumb analogue' to things using dsps for voice compression and equalisation, all operating in the microwave region. At the time the GSM standard was ratified, a dsp that would only do voice compression cost $100. Yet the recognition was there that Moore's Law would prevail and, today, the entire telephony function can be supplied on a $5 chip."

Another mobile phone veteran is Mike Short, (right) vice president, research and development, for 02 Telefonica Europe. "In the 1980s, mobile phones were all about voice. Today, it's all about data. Mobile data used to be about texting; today, it's the mobile internet."

The move to digital, in Grant's view, was 'daunting'. "The initial challenge was to get a sensitive uhf radio in the same box as a dsp and to make it work. There were not a lot of wireless digital communications systems outside of the military and the challenges were daunting."

He continued: "Those used to doing GaAs radar for the military built circuits with 20 chips. Meanwhile, those coming from the linear side did 25 transistor circuits for biasing."

It's worth pointing out the 'state of the art' process technology at the time. Grant said: "The best processes had an ft of 5 to 10GHz – just enough to get gain at 1GHz. It was a real challenge."

McCune offered his perspective. "CMOS was only running at hundreds of kHz and susceptible to static. The pc was being developed around the same time, so the amount of digital stuff we had to work with was poor. It took a lot of digital chips to make things that behaved well enough to make the phone work. It was all about finding out what 'just enough' was."

In the early days of the mobile phone, handing off from cell to cell was problematic. "Nynex, an operator in New York, was experiencing strange behaviour in its network," McCune recalled. "Most calls were dropping out, so we started tests and realised that New York was 3d. If you were on the ground, hand off worked well, but if you were on the 10th floor or higher, it didn't."

The reason was hand off tables. "As callers moved around a building," McCune continued, "their phone would point at different cells and the strongest cell wasn't necessarily the closest. The hand off table would say one thing, but the phone would say another and the call dropped."

That meant developing a hand off system that would support calls moving from any to any, rather than to adjacent cells. "The result was a cell site count so huge that phones could only talk to a close one. And then backhaul became the problem," McCune noted.

Yet another mobile phone pioneer is Edgar Auslander, recently appointed as senior vice president and head of strategic planning for ST Ericsson, but who cut his mobile teeth with Texas Instruments.

"In the early days, it was important to get a phone that was transportable and worked; 30 minutes talk and standby time was good." He noted the first real deployment of GSM took place in 1991. "At the time, a typical mobile phone architecture was one or two dsps, a microcontroller, a/d conversion, power management, an rf chip and a power amplifier. Companies differentiated their phones by having better equalisation, but a portable – not transportable – phone with standards was a big deal."

In fact, the first GSM call was made on 1 July 1991 by Finnish Prime Minister Harri Holkeri.

Technology was an interesting debate. "DSPs were not only doing part of the modem function," Auslander observed, "but also the vocoder. Different companies had different approaches. VLSI Technology took an asic route, while TI was trying to do everything in dsp."

Grant gave an outline of the challenges. "With an analogue phone, you took audio from a microphone and the transfer path was simple. With a digital phone, you had to digitise the audio, with an a/d converter that wasn't there before, pass it to a dsp to reduce the number of bits, then modulate the bitstream onto a carrier using a d/a converter that wasn't there before. There was a lot of analogue and a dsp to replace what was a resistor and a varactor. It became a complicated way of doing something that was simple. But now networks are digital, users can access more features and there's more capacity per channel."

McCune expanded: "With GSM, the transmit and receive sides don't work at the same time, so the system works by

Old mobile phones courtesy of fonebank (www.fonebank.com) Photo: Charlie Milligan

Auslander: "Doing everything in hardware can be the equivalent of fitting a Ferrari with wooden wheels."

compressing digitised voice. This doesn't need a lot of air time to send information, so it can support eight users per channel. That, as well as the fact that you didn't have to design the transmit to work with the receive alongside, allowed the cost of handsets to drop dramatically."

Not only has the cost dropped, the choice has widened considerably. Auslander sees the market moving in two broad directions. "Low end, with super high integration and the rf moving to digital, and high end, with features such as mobile internet. When you're on the move, the information you need is often contextual and I envision applications which provide augmented reality. However, these phones will demand even more performance."

Grant has an opinion on this. "While one evolutionary path has led towards the single chip phone, another has seen features added consistently. But these features haven't been integrated because everyone wants something different. So, on one hand, we're moving to the single chip phone, on the other, we're seeing phones with more chips inside."

Auslander explained this is because integrating functions is difficult. "If you aren't careful, you can end up with an integrated device with a huge chip and no flexibility. On the other hand, many small chips in a phone brings more flexibility. If you try to do everything in software, your phone will consume too much power. Doing everything in hardware can be the equivalent of fitting a Ferrari with wooden wheels: it won't work as expected."

But perhaps the biggest surprise to all involved in the development of GSM is texting. John Caterer, managing director of Qualcomm Europe, noted: "There was a free channel reserved for diagnostics, which engineers used to discuss signalling and so on. Somebody came up with the idea of using this for texting, but nobody could have imagined how big and profitable the short message service would become."

Indeed. Britons now send in excess of 1billion texts per week.

The next 25 years

So where does the mobile phone world go in the future?

Caterer said: "Mobile tv and video calling haven't taken off, despite the technology being available and proven. What will be more challenging is services such as the BBC iPlayer, which needs more bandwidth."

He believes that capacity will be delivered by 4G. "The dominant choice is LTE, which will be data, rather than voice, oriented. 3G will carry on, supporting voice and text, while the 2G network will also be there, supporting M2M, low latency and non real time applications."

02's Short developed the point. "There has been significant data traffic growth and it shows no sign of stopping. The bigger challenge is how to build ecosystems that support applications anywhere and at any time, systems that support mobility and convenience."

Short and Caterer agree the mobile phone of the future will be much more than a device that supports voice, text and mobile internet access. Short: "Data rates and coverage may still not be good for everyone and it's our job to improve that and to continue to do so. We will also need to develop techniques that optimise data rates and data compression. We need to get the signal closer to the customer, but we also have to plan how to best use the radio spectrum for a range of customers."

David Barker, cto of antenna specialist Quintel Technology, said: "Antennas can't be miniaturised, so if you want more coverage, you need more sites. That's why we're beginning to see operators sharing towers. But our technology – which produces multiple beam tilts from the same array – can help by reducing the number of conventional antennas needed."

Caterer noted: "Healthcare and remote monitoring could be the surprise package. It won't be the most 'sexy', but the 'sexy' stuff is already out there. This will be much more about the essentials."

Short concluded: "Applications will be the biggest driver and we'll be doing more with mobile devices than we can imagine. We'll be talking about mobiles in education, mobiles in healthcare and mobiles in transport.

"We will need to think about the system from end to end. It will not just be about phones in shops; it will be about putting together a secure end to end system. It's going to be all about putting together two of the biggest inventions – mobile phones and the internet – with solutions in mind."

*** For a mobile phone timeline, go to www.newelectronics.co.uk**

Cellular 25 takes place at the Science Museum on 21 January. For more information, go to www.cambridgewireless.co.uk/cellular25