



Dr Andrew Harter CBE DL FEng

It wasn't just the development of a new approach to connecting computers that singled out Dr Andrew Harter CBE DL FEng, he also invented new ways of bringing technology to the world. He talked to Michael Kenward OBE about the origins of the smartphone and his time as High Sheriff of Cambridgeshire.

A PASSION FOR NETWORKS

He may be a leading light in the innovation hub of Cambridge, but Dr Andrew Harter CBE DL FEng's influence does not stretch far enough to get him a decent internet connection to his home. Fortunately, as an innovator in networking technology, he can overcome the challenges of living in one of the city's infamous 'not spots', where broadband speeds are stuck in the 20th century. Dr Harter is a director of RealVNC, a company he founded with his colleagues to commercialise their research into computer networking at the AT&T Cambridge Laboratory. Thanks to RealVNC software, which won the Royal Academy of Engineering's MacRobert Award in 2013, Dr Harter and many millions across the world can work from home during lockdown, accessing computers remotely and sharing screens during video conferencing.

YOUNG ENGINEER

Like many, Dr Harter was bitten by the engineering bug when messing around with things when younger. "I loved tinkering with things as a boy," he says. Dr Harter was inspired by his grandfather – a cabinet maker turned engineer, who made Spitfire propellers during the Second World War. "We spent hours making things together: in wood, metal or whatever." Dr Harter attributes this activity to his fascination with taking things apart, putting them back together and then trying to make them work again.

At school Dr Harter became interested in electronics. "Electronics wasn't in the curriculum, but I taught myself." He used his hobby to good effect, building a stage lighting system for the school. He lauds his school, a boys' grammar school in Wakefield, for nurturing creative, enquiring minds that solve problems. "Hobbies spill over into academic learning. They feed off each other."

Dr Harter's interest in electronics led him to computers. These were the early days of home computing, the era of the Sinclair

Spectrum and BBC Micro. You could buy a kit of parts and build your own computer, but he went further. "I designed and built my own computer out of components from the electronics catalogue," he explains, buying a microprocessor chip and designing a circuit to make it work. As it sprang into life, his grandad's contribution was to make a splendid wooden case for the 'Harter Mark I' with its flashing lights and switches.

When it came to turning his interest in technology into a career, Dr Harter opted to first study maths at the University of Cambridge. Why not study for a degree in a more obvious engineering subject? He believes that mathematics provides a good grounding in many areas of engineering. There is logic, precision and rigour to it, he adds, "that is really good training for an engineer, for a computer scientist."

KEEN ON COMPUTERS

The transition into computer engineering began during the degree course, when Dr Harter took holiday jobs at Acorn Computers working for Professor Andy Hopper CBE FEng FRS and Dr Hermann Hauser KBE FEng FRS. Acorn pioneered personal computing in the UK, making its own devices and the groundbreaking BBC Micro. Dr Harter's holiday jobs involved computer-aided design for some of Acorn's electronic chips and led to the research for his PhD. "Notwithstanding the fact that I enjoyed the discipline of maths," he says, "I have always enjoyed applying things." His PhD involved research into three-dimensional integrated-circuit layouts and resulted in a novel computer-aided design system. "That was all software," Harter explains, "coming up with new algorithms and new ways of laying out chips, circuit design in three dimensions." The PhD not only collected an accolade as the year's best PhD dissertation on computer science in the UK, it ended up as a book, which is still in print.

THE WORLD'S FIRST SMARTPHONE?



The AT&T broadband phone

Towards the end of the 20th century, Dr Harter and his team at AT&T Laboratories Cambridge showed off what they called a 'broadband phone'.

The desktop version was designed and built from scratch. It had an ARM processor; a full-colour touchscreen; a wired ethernet connection; cloud architecture; a set of apps from a curated app store; and an intuitive graphical user interface. Around 500 were produced and were such a hit that the team quickly turned their minds to a portable version.

Using a state-of-the-art PDA, Dr Harter led the team to reimplement the exact same software architecture on the mobile device, which had broadband connectivity through a Wi-Fi card. Nearly a decade later, Dr Harter and his colleagues were amused when Apple's first iPhone reached the market. It was similar to the AT&T device. In what may have been another pioneering development, the team's broadband phones ran on a version of Linux, later used in Google's Android devices.

Dr Harter reflects that his fully functional broadband phone family could have been manufactured at a similar cost to today's products. He adds that society wasn't quite ready. When he later reflected on the fate of the idea, he said: "There is a saying in the investment community that being too early is a good as being wrong. But the concepts we mapped out have undoubtedly lived on."

One part of the innovation behind the broadband phone also lives on in the VNC system.



When the UK entered its first lockdown, staff at RealVNC knew some of their solutions were already being used to keep critical infrastructure running. After all, the business provides virtual network computing (VNC) technology that allows secure remote access to computers. NHS trusts are among the company's clients and many diagnostic imaging machines rely on the technology

In 1990, with the PhD completed, Professor Hopper recruited Dr Harter to join what was then the Olivetti Research Laboratory. The lab started life in 1985 as Olivetti's research operation when the Italian company acquired Acorn Computers. Dr Harter became one of three deputy directors and then the lab's director of research and engineering. In 1999, following another takeover, the research centre became the AT&T Cambridge Laboratory.

He describes the lab as "a very interesting model, which sadly doesn't seem to exist anymore". Impact was not measured just by academic papers, but also by technology transfer, licensing deals and spin-outs. "The lab paid for itself several times over, in the return to our parent companies." Independent and industrially funded, he adds, "we operated on the

edge of the university. We placed grants in the engineering and computer science departments to establish collaborative projects. We funded PhD students and welcomed interns. Some of us had university roles to a greater or lesser extent. There was a great synergy."

The lab's research focused on high-speed networking, wireless communications and a forward-looking view on their applications. Groups also worked on projects that would later be recognised as part of the Internet of Things, an 'active badge', for example, that would track where people and objects were and control and configure devices accordingly.

The lab's engineers designed advanced prototypes, building and assembling some of the most sophisticated systems around. "We built, what were at the time, the

world's most advanced, high-resolution, full-colour digitally networked multimedia systems." The lab even came up with what Dr Harter likes to describe as the world's first smartphone: a device that predates Apple's iPhone.

This type of work came to an end in 2002, when the 'dot com' bubble and big companies everywhere cut back on R&D. Overnight AT&T went from having seven labs, including Cambridge, to having just one in the US.

This 'extinction event', as Dr Harter describes it, was by no means the end of the road for the work carried out by the AT&T Cambridge Laboratory. "It was an awful time, making about 60 really talented engineers and computer scientists redundant," he says. "But what was fascinating was that rather than 60 people

going their separate ways, they formed some 10 or so startup companies." This migration grew out of how the lab was run: small groups of engineers intensely focused on a particular topic and its commercial application. After the lab closed, "people essentially continued their line of research in a startup". Some tapped into the local network of 'angels' and venture capital to raise funds, some set up consultancies and some grew organically. "I think they are all still around in some shape or form," says Dr Harter. "They have all done very well."

REMOTE WORKING

One of those successful spin-outs was RealVNC, the business that Dr Harter set up, with Professor Hopper and three other colleagues that had worked together on virtual network computing (VNC), the challenge of remote networking of computers. If you have ever sat in front of a computer watching someone control it from afar, you may well have come under the spell of VNC. "It is a way of remotely accessing one computer screen from another," Dr Harter explains, "so you can see and use one computer screen from anywhere else on the planet." The key to RealVNC's technology is in the underlying algorithms that reduce how much data must pass between devices. The data traffic uses patented encoding to efficiently send only those parts of a screen that are changing.

Dr Harter had already convinced the lab to make a version of VNC freely available in an early example of open-source software, and by 2002 there were many millions of users already. "The point was to create the market that we could subsequently tap into and monetise," says Dr Harter. RealVNC became the vehicle for the commercial

transition. Dr Harter led the company up an organic growth path, resisting external investment. Instead RealVNC started selling 'I love VNC' branded mouse mats, T-shirts and baseball caps to users of the free software, which made them hundreds of thousands of pounds. It helped that RealVNC was giving away decent software, which also worked on different kinds of computer. The software architecture behind the systems means that it can easily be made to work on any device with a screen, including those that do not yet exist.

Then, some users told the company that they didn't need any more T-shirts but would like to support the business by giving money, without strings. As Dr Harter recalls: "We thought 'this can't be right', but we indulged them." So RealVNC put a 'Donate' button on the front page of its website and made another few hundred thousand pounds. Dr Harter believes this is the earliest example in technology of what is now called crowdfunding, a term that wasn't even coined until much later in 2006.

The company's business model then came up with another move that has also become a part of the software business landscape. "We pioneered what is now known as the freemium model," Dr Harter says. "You provide a free version and then charge for a license key that unlocks a better experience. It could perform better, have stronger security, or work in slightly different ways with more features."

RealVNC didn't just create a commercial success, it has picked up several awards over the years, including three Queen's Awards for Enterprise and the Academy's MacRobert Award (see 'Remote access software', *Ingenia* 57). As John Robinson CBE FREng, Chair of the MacRobert Award judging panel at the time, said: "RealVNC was selected for the MacRobert Award because of the engineering excellence and tenacious

entrepreneurship required for them to have opened the door to countless new markets for new product and services. For a relatively small UK company with no external investors to have grown to work with the world's biggest technology companies is truly inspiring."

NETWORKS AND ECOSYSTEMS

Dr Harter believes that the success of companies like RealVNC owes much to the fact that there is something about Cambridge that encourages the birth of new businesses. It helps that the city has the essential ingredients, including a top university, to be an innovation powerhouse. Cambridge may be a small place, but there is a lot going on, with plenty of companies in life sciences and technology. "We are all really quite close together physically and through our networks. There is a concentration that means people do know each other. Then there is money," he adds. "There are private investors, there are angel investors and there is venture capital here on tap." Throw in business incubators and hubs in some of the research and business parks and Cambridge has plenty of spaces in which to innovate and grow. There are many lawyers and accountants with extensive early-stage and mergers and acquisitions experience.

The final ingredient, says Dr Harter, is networking organisations. He should know, having chaired Cambridge Network since 2014. Cambridge Network was created 20 years ago as a partnership between the university and local business to foster the exchange of ideas and practices. You don't even have to be a Cambridge academic to tap into the local network, Dr Harter insists. "Not all of the technology and startups have come out of the university by any stretch of imagination."



In his time as High Sheriff of Cambridgeshire, Dr Harter and his family took part in many fundraising activities, including the Cambridge Half Marathon

COMMUNITY SPIRIT

Dr Harter believes strongly in the importance of business supporting the wider community. "I think it is an obligation to put something back into society," says Dr Harter, pointing to hundreds of thousands of pounds of financial support that RealVNC has provided over the years. "Time and expertise are sometimes just as valuable, and we encourage staff to participate in voluntary and charitable work."

He has taken this a step further. Between 2018 and 2019, Dr Harter was appointed the High Sheriff of Cambridgeshire, an ancient office that is over 1,000 years old. Originally the monarch's representative in the county with substantive powers such as

maintaining law and order, these days the role is essentially ceremonial.

During his year as High Sheriff, Dr Harter and his family threw themselves into fundraising for charity. "Some people describe our year as being quite hyperactive," he says with a laugh. "We decided to cross over the county in lots of weird and wonderful ways." There was a cycle ride from Peterborough in the north to Cambridge in the south. This was on two tandem cycles, with Dr Harter and his wife Lily Bacon on the front as captains and their two young sons on the back as stokers. Then there was a mad dash with an early morning start to visit every railway station in the county by train in a day. They rounded off the year with a 42-mile walk from Ely Cathedral to Peterborough Cathedral

following the Hereward Way through the Fens, fittingly during storm Gareth. His year as Sheriff raised over £100,000 to support smaller charities in the county.

Dr Harter and his wife's fundraising continues – both are Deputy Lieutenants of Cambridgeshire – again, with an imaginative approach. The latest session was sparked off by their own experience during the first lockdown. "We struggled with trying to school our boys at home," he explains, "and we are very fortunate." There are families in and around Cambridge and Cambridgeshire that are far less fortunate, he adds. "Cambridge is a very unequal city. You have prosperity in the centre and just a mile or two away you have schools where half the kids receive free school meals." Dr Harter's response was yet another challenge. When the London Marathon fell victim to the global pandemic, he looked for something to do instead. "We worked out, by chance, that the distance between all of the 31 colleges of the university, in alphabetical order, starting at Christ's and finishing at Wolfson, is almost exactly a full marathon distance." So, they completed their virtual London Marathon by criss-crossing the streets of Cambridge. "We raised £50,000, which we put into recovery projects in some of the maintained schools in Cambridgeshire."

While in the past, Dr Harter would also have been responsible for collecting the king's taxes as the High Sheriff of Cambridgeshire, in that role and as Deputy Lieutenants, he and his wife have done the reverse: encouraging those who are able to enhance the opportunities of others.

BIOGRAPHY

Michael Kenward OBE has been a freelance writer since 1990 and is a member of the *Ingenia* Editorial Board. He is Editor-at-Large of *Science|Business*.

CAREER TIMELINE AND DISTINCTIONS

Studied mathematics and computer science at the University of Cambridge **1980–1983**. PhD in computer science, **1990**. Research Engineer, Principal Research Engineer, Director of Research and Engineering, AT&T Laboratories Cambridge, **1990–2002**. Founded RealVNC, **2002**. Awarded Royal Academy of Engineering Silver Medal, **2010**. Fellow of the Royal Academy of Engineering, **2011**. Received the MacRobert Award, **2013**. Trustee of the Royal Academy of Engineering, **2013–2016**. Appointed Chair of the Cambridge Network, **2014**. Honorary Doctor of Science, Anglia Ruskin University, **2015**. Awarded the Institution of Engineering and Technology's Faraday Medal, **2016**. CBE for services to engineering, **2017**. Director, RealVNC, **2002 to present day**.