

Looking Back on 40 Years of Ethernet



In May this year Ethernet celebrated its 40th birthday. Telecom Review looks back at the technology's humble beginnings.

In the late 70s, Bob Metcalfe was asked to create a local area network for Xerox's Palo Alto Research Center (PARC). Little did he know that his creation would revolutionize communications across the world.

At the time, Metcalfe, David Boggs and other members of the PARC team were looking somewhat closer to home, having been tasked with enabling PARC's Xerox Altos personal workstations to connect with a graphical user interface and the world's first laser printer, EARS, which printed 500 dots per inch and a page per second.

"We were going to put personal computers in a building, the

Xerox Alto. The notion of having a computer on the desk was at that time controversial, as was having a building full of PCs. That may have been the first time it ever occurred to us, and our great fortune was to be given this problem that had not previously existed," says Metcalfe. The network was required to connect hundreds of computers at the same time and had to be fast enough to drive the printer running at 20Mbps. One of the largest problems was the sheer amount of cables required. Back then, the cable used was very heavy and could easily break, according to Metcalfe.

Metcalfe drew inspiration from the work of Norman Abramson, the inventor of ALOHAnet, a technology used to provide

data connections between the Hawaiian Islands, and he went on a month field trip in Oahu at the University of Hawaii to study it.

Having looked at the wireless ALOHAnet and having decided the modems were too large to have one for every desk and that the speed of 9,500 bits per second was not fast enough, Metcalfe and his colleagues eventually opted for a system that used one wire of coaxial cable. In choosing the name of the technology, Metcalfe opted for the 19th century phrase 'Ether'. Luminiferous ether was the name given to the medium through which light travelled. "We chose thick coaxial cable because it could be tapped passively, but we anticipated other media would be used, so we didn't call it coax-net. We called it Ethernet because the ether could be coax, twisted

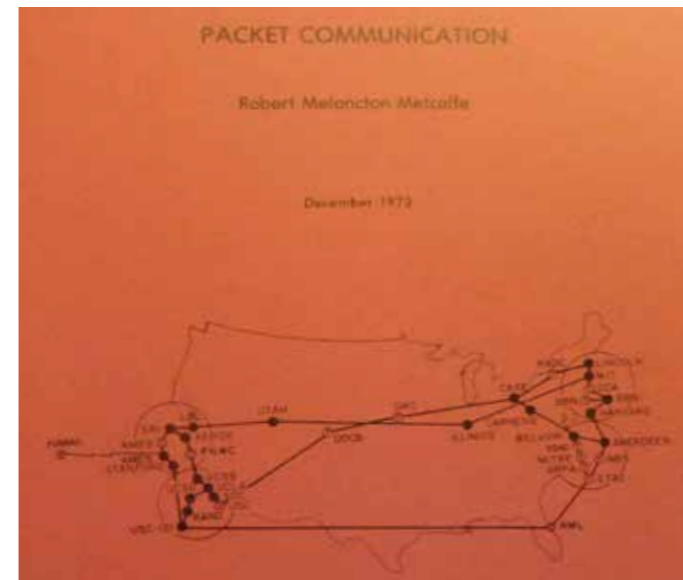
pair, radio, optical fibers, power line, whatever you wanted," says Metcalfe

It was decided that the network would be completely passive, with stations arranged to take turns using one wire. Metcalfe and his colleagues realized that Ethernet would exist through a series of protocols with seven layers, which became key to simplifying its design.

The moment widely recognized with being the birth of Ethernet came on May 22, 1973, when Metcalfe wrote a memo to the PARC management explaining how Ethernet would work. Following this, coaxial cable was laid in PARC and the first computers were attached to the network on November 11. The technology proved to be an immediate success internally. Ethernet remained an in house system until 1976 when Metcalfe and Boggs published their paper titled "Ethernet: Distributed Packet Switch for Local Computer Networks". Xerox patented the technology but opened it up to others.

When Metcalfe left Xerox to form 3Com in 1979, he decided to exploit his idea and get DEC, Intel and Xerox to agree to commercialize it, forming a consortium known as DIX.

"Given that everybody had access to Ethernet technology, how did 3Com win in those days? It's very simple. We had a time machine. The group of us had gone into the future at Xerox PARC and we lived there for eight years and we knew what the future looked like. Then in 1979, we flew back into the present, we knew what the



future was going to be, and it was buildings full of PCs," Metcalfe notes when looking back at the success of 3Com.

It was not until 1983 that the IEEE 802 committee approved Ethernet as a standard, or at least the CSMA/CD version of it. By then, Ethernet had evolved in Ethernet II and was becoming increasingly popular. This was partly due to the fact that it had become easier to deploy. The arrival of the IBM PC two years earlier, in 1981, also contributed to Ethernet's success, with previous computer systems having been unable to use the technology to its full effectiveness.

It was during the 1980s that what Metcalfe describes as the "LAN wars" occurred between Ethernet and the IBM backed Token Ring, a protocol that resided in the data link layer and used a special three byte frame called a token. Token Ring ran at LAN speeds of 4Mbps and 16Mbps and initially appeared to have theoretical advantages over Ethernet due to its greater efficiency, with larger packet sizes and faster speed.

Metcalfe himself admits the technology did have him worried because for a decade, he was being told from across the industry that Ethernet was doomed, due to IBM having the muscle when it came to making standards.

The conflict changed Ethernet, with the technology switching from coaxial cable to the twisted pair system used by Token Ring. "We were fighting in the market with the IBM Token Ring, which used twisted pair, and the customers kind of liked that, so Ethernet decided to become twisted pair too, and that sealed the doom of the Token Ring," says Metcalfe.

The key disadvantage of Token Ring was in its lack of compatibility with non IBM equipment, while Ethernet was able to drum up support from over 20 companies with standards based products that worked together. This meant the technological gap between the two was closed quickly and in 1990, the 10BaseT IEEE standard allowed the use of hubs and switches in Ethernet, switching it from a bus architecture to

one with the flexibility of a star architecture and made management for network administrators much easier. By the early 90s, this form of Ethernet was much cheaper than Token Ring and then with the development of Ethernet switching, and 100Mbps 'Fast Ethernet' in 1995, Token Ring could not keep up.

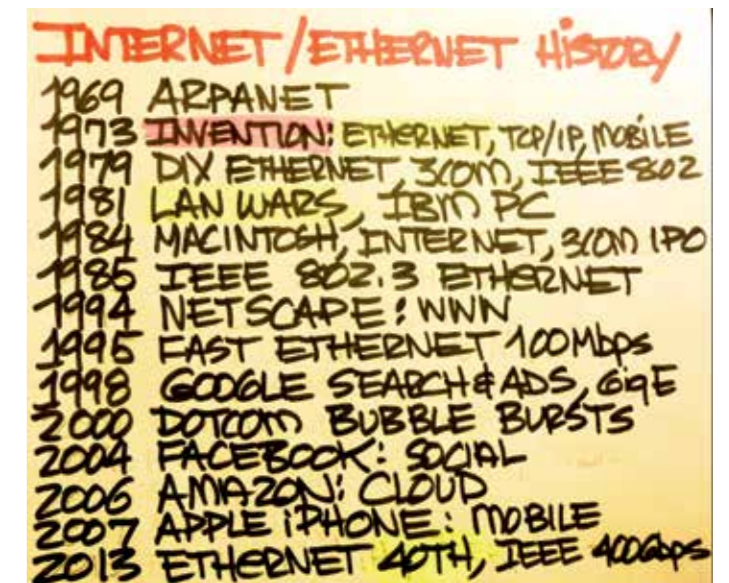
"What they underestimated was the power of an open standard, and I'm referring to the old IBM now. There's a new company called IBM which is different, but in that old IBM, in its dark little heart, it was not committed to open standards and its products were not interoperable," says Metcalfe.

In the years that followed, Ethernet was to extend its reach far beyond the LAN, first entering the WAN, where it was slowly wiping out SONET and then over the airwaves supplying WiFi access points. The work of the Metro Ethernet Forum (MEF), which was launched in 2001 to develop business services for enterprise users accessed over optical metropolitan networks, has

now transformed Ethernet into becoming a service offering for carriers "going across the telechasm between the LAN, the WAN and Ethernet," as Metcalfe puts it. The speed of Ethernet also continues to increase with the IEEE recently starting a project to standardize 400GE, while terabit is also on the horizon.

Ethernet in its role as the plumbing of the internet has disrupted many industries over time including music, books, telecoms and television, and Metcalfe now predicts the technology will go even further. In his presentation at the Ethernet Innovation Summit, he predicted that three more industries - energy health care and education - are set to be impacted via new types of video, mobile and embedded traffic.

"Even though Ethernet is 40 years old, it is not dead. And apparently it is blooming. It is blossoming. And so there's something like a \$100 billion industry for us to pay attention to, and that's what we're doing today," says Metcalfe. ■



NetEvents Celebrates the 40th Anniversary of Ethernet



the world for the better? How do you create innovation?" One point he was keen to emphasize is how the biggest consequences of developing a standard often come after it is accepted, because as Ethernet has shown, standards stay around for much longer than imagined.

"Good standards become a platform for further innovation. They evolve, they change, they expand other opportunities for devices that nobody ever imagined would even exist. And so this is a story about innovation. It's a story about evolving standards. It's about something that happened 40 years ago that sent events running off in absolutely the right direction, to create innovations that are still continuing today. That's why we're here."

Saffo was then joined on stage by Bob Metcalfe who gave his personal perspective on how Ethernet was invented and who was involved, with his keynote presentation 'From ALOHA to Ethernet.' Highlights of the presentation included a timeline of Ethernet, the cover of Metcalfe's PhD dissertation and a map of computers on the internet in 1973.

The Inventors of Ethernet

One of the first panel sessions was titled 'Meet the inventors of Ethernet' featuring Ethernet co-inventor Dave Boggs; Bill Hawe, who

important the Ethernet was to the creation of this highly distributed network," he said during his welcome speech. Technology forecaster, Paul Saffo, who followed Hoover on stage, then began proceedings by raising questions to be answered over the next two days of keynotes, panels and interviews.

"Events that happened 40 years ago are extremely relevant today, because this is about innovation. This is about whitespace. This is about changing the world. And our computers have changed - I haven't even seen one of these things connected to a phone for about a decade. But amidst all the changes, the constant is: how do you change the world? How do you change

Area Network (LAN) space. Among those invited were individuals who have shaped Ethernet technology over the past 40 years, including Bob Metcalfe, widely credited as its inventor.

Opening the summit was Steve Hoover, CEO of Palo Alto Research Center, the facility where Ethernet was conceived.

"The creation of the Ethernet and associated technologies really are the fabric of our lives today, as I look in the room and I see the set of computers we have, and how

Telecom Review attended the Ethernet Innovation Summit event that celebrated 40 years since the invention of Ethernet technology.

On May 22 and 23, press, analysts and representatives from across the world celebrated the 40th anniversary of Ethernet technology at a special event held at the heart of Silicon Valley in Mountain View, California.

Over the course of two days, a tightly packed schedule of keynote speeches, presentations and roundtables gave those in attendance unique and informative insight into the development of Ethernet, its expansion to become a global standard and its growing potential outside of the Local



helped develop Ethernet at Digital Equipment Corp; Radia Perlman, inventor of the Spanning Tree protocol; and Norm Abramson, inventor of the ALOHAnet system which was part of Metcalfe's inspiration for Ethernet. During the session, Boggs spoke of how he became involved in the Ethernet project and the role he played, while Abramson recalled Metcalfe's trip to Hawaii to study the radio ALOHAnet system. Abramson was particularly proud to point out the increasing relevance of wireless Ethernet over wired and its similarities with ALOHAnet.

"We really haven't said goodbye to the Ethernet, but we have said hello to ALOHA again, after a hiatus of perhaps 20 years. That hiatus, by the way, was not a technology hiatus; it was a regulatory hiatus. Until the frequencies were available for the connections that we all use today, there was no sense in going from Ethernet to WiFi or ALOHA," he said.

During the session, Bill Hawe delivered one of the standout lines of the conference: "Success has many fathers, but failure is an orphan. I think Ethernet was particularly promiscuous in that regard."

Ethernet or Ethernot

One of the most thought provoking aspects of Ethernet's 40th anniversary was the fact that the technology came close to being made obsolete by a rival system, the IBM backed Token Ring.

This made hearing from Dan Pitt, who was previously behind Token Ring, all the more interesting during the 'Ethernet or Ethernot' panel.

During the session, Pitt insisted that he would set the history straight around Token Ring, which he described as being "unfairly maligned". He explained why IBM opted to back its Token Ring as a LAN standard rather than Ethernet. "IBM had contrary opinions on everything. But the reason



wasn't to be abstruse. The reason was that our customers were the banks. And they absolutely required reliable, predictable delivery of bits and services and we could deliver that with Token Ring, whereas in those days you couldn't deliver it with CSMA CD and this cable strung around the C links," he said. "So we had a legitimate business reason for wanting Token Ring against Ethernet."

Pitt also shared his experiences during the LAN wars competing against Ethernet, stating, "No one was happy to see me walk into the room," but he expressed there was largely no personal animosity between him and the Ethernet supporters and he later went on to work with some of them.

John Shoch, from Alloy Ventures, who was also on the panel, described the discussion of the arguments back then as feeling like he'd gone back in time.

Pitt closed the panel with his thoughts on the standards

process and produced a limerick he wrote during the late 80s during the time of Token Ring, Ethernet and Token Bus.

"Any nitwit with standards acuity. Soon learns of their self-perpetuity. The work was all done. Back in March '81. But these trips are a lifetime annuity."

Carrier Ethernet

Presentations and panels also sought to chart the future of Ethernet, looking into areas including research funding, the rise and evolution of Carrier Ethernet standards and the future of networking.

Major industry analysts presented their own key facts and figures on how the Ethernet market is developing. Among them was Tam Dell'Oro, founder and President of Dell'Oro Group, who showed in her slides how the market for Carrier Ethernet switches and routers has been growing since



arriving in the early 2000s, with it set to reach nearly \$9 billion by the end of the year. During Dell'Oro's subsequent Q&A panel session, James Walker, Vice President of Managed Network Services at Tata Communications, explained how the company's Ethernet business has grown fifteen fold over the past five years and customers were increasingly demanding Ethernet services to perform certain tasks.

Meanwhile, Verizon's Executive Director of International Network Planning, Yali Lui, said that Ethernet was one of the carrier's fastest growing products for the telco because it provides higher speed and differentiated class of service. She stated that Verizon had experienced double digit growth in Ethernet services over the past few years and had seen very high adaption of native Ethernet as access to customers on a global level. Verizon announced during the conference the availability of gigabit Ethernet to 120,000

new office buildings in the US under its FiOS service.

There were two further announcements made during the conference in relation to Carrier Ethernet. First was the launch of the Metro Ethernet Forum's first new committee in eight years. The Service Operations Committee (SOC) has been created to define streamline and standardize processes for buying, selling, delivering and operating MEF-defined services. The committee aims to help service providers with more consistent contracts and to standardize ordering processes that takes into account national regulatory factors and the greater diversity of Ethernet services compared to TDM.

Following this, Walker announced the formation of the CloudEthernet Forum, an organization designed to address the specific issues of scaling and applying suitable Ethernet services to meet the stringent demands of delivering cloud services.



The Innovation Awards

On the evening of May 22, the Computer History Museum played host to the annual Innovation Awards, which honor organizations and individuals that lead the world by innovation and performance in the networking and telecommunications sector.

This year the awards ceremony was combined with a gala dinner and charity auction with all the proceeds donated to the Science, Technology, Engineering and Math (STEM) education project. The event was streamed live to the world via Carrier Ethernet broadcast services from Comcast Business and Tata Communications.

Among the highlights was a special honorary award for 'The Greatest Contribution to the Networking Age', presented to Bob Metcalfe in his role as Co-Inventor of Ethernet & UT Austin Professor of Innovation.

There was also the 'Ethernet Idol' award presented to the individual considered to have successfully continued the work of the original Ethernet inventors and made the most outstanding contribution to Ethernet in the last 15 years. The award was presented to industry legend Andy Bechtolsheim, following an online vote by more than 300 delegates in attendance. "It's ironic that Andy would be voted 'Ethernet Idol' for his work in the last 15 years of Ethernet when he was my Ethernet Idol for the first 15 years," Metcalfe commented when handed the award to Bechtolsheim.

The other seven award categories for organizations were:

Carrier Ethernet Business Services – won by Verizon for the most innovative new business service to enterprise clients within the past 18 months.

Telecoms Product – won by RAD Data Communications for



"best in class" infrastructure equipment and innovative solutions to service providers' current challenges.

Enterprise Wireless Solutions –

won by Xirrus for the most innovative solution to managing the BYOD challenge. Xirrus founder Dirk Gates was presented with the award by ALOHAnet inventor Norm Abramson.

Cloud/Datacenter Solution – won by Arista Networks for the most innovative Cloud/Datacenter solution, providing major business benefits.

Security Solution – won by ClickSecurity for the most innovative contribution to countering the latest threats, including organized crime and government-sanctioned hacking and cyber attacks.

SDN Solution – won by HP for the most innovative SDN solution.

Hottest 'NEW' Networking Company – won by Gigamon

amid fierce competition. This award was not for a company that meets specific criteria, but rather one that surprises the judges with something truly fresh and original.

Metcalfe's Closing Remarks

Bob Metcalfe took to the stage to give his closing comments on the last day of the conference. He spent much of his keynote discussing what had been learnt from the past two days and sought to highlight some of the goals that had been in mind when the idea for the event was first conceived.

"Of course it was intention all along that it would be more than a celebration of the 40th. I'm not a professor of innovation, so I thought it'd be useful if we collected and gathered some lessons from Ethernet history about how to innovate."

In an interview after his speech, Metcalfe told Telecom Review of the irony that he himself had predicted the



demise of Ethernet in an article years ago when ATM technology was tipped to replace it.

"I remember writing that I thought Ethernet's last product would be introduced in 2003 and it would be replaced by ATM. I interviewed a group of people and they all said ATM was going to kill Ethernet, and being in the guise of a journalist I wrote that. The amount of investment going into ATM was huge so it was expected."

When asked if he thought that there was any technology that could replace Ethernet, Metcalfe was frank, citing the examples of how IBM and Microsoft had risen and fallen from dominance in the past. He did, however, suggest that lambda switching, a technology used in optical networking to switch individual wavelengths of light on separate paths for specific routing in conjunction with wavelength division multiplexing (WDM), could replace Ethernet.

"The idea is that we're going more and more towards flows, towards large transmissions instead of really small ones, so one could imagine a switching infrastructure involving optical fibers, and lambdas being allocated on the fly and various transmissions with a control plane handling it all," said Metcalfe. "That's the only thing I can think of that would mean the death of Ethernet."

The conference fittingly ended where it all began 40 years previously with a reception at the Palo Alto Research Center, which featured an exhibition charting the invention of Ethernet and a video of the PARC during a failed test of the first laser printer.

As well as the power of innovation and open standards, the 40th birthday celebration of Ethernet proved that the technology is showing no signs of dying off any time soon. Here's hoping Telecom Review is invited back to celebrate Ethernet's 50th anniversary in ten years time. ■