THE CABLE THAT WIRED THE WORLD

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Telecoms milestone

Today we take global communications for granted. Whether telephoning someone in America, sending emails to Australia or simply browsing the web, we accept that our global telecommunications networks will make it all happen. Nevertheless, life hasn't always been this convenient and this year we are celebrating the 150th anniversary of a significant event that proved to be the catalyst for a telecommunications revolution that laid the foundations of the global connectivity that we all enjoy today – the first fully-operational telecommunications cable to be laid under the Atlantic.

In 1866 the first fully-operational telecommunications cable was laid under the Atlantic Ocean between the UK and Newfoundland, thereby linking the so-called old and new worlds. Now over 95% of our global telephone and Internet traffic is carried on fibre optic cables laid under the world's oceans. However, as is so often the case, the successes enjoyed in 1866 were the culmination of several years of engineering endeavour and the need to overcome major failures and financial crises.

By the 1850s most industrial nations had begun to develop their own national telecommunications networks based upon the electrical telegraph. The growth in these networks was in no short measure due to the expansion of the railways, which had taken over from the military as the main driving force behind the development of telecommunications. However, linking the telegraph network of one country with that of another was an altogether different scale of problem, especially when those countries were separated by an ocean. The motivation to attempt this came from international trade, especially that of industries such as cotton weaving, which saw 6,000 bales of cotton being landed at the port of Liverpool each day from the cotton fields of America to supply the hundreds of mills in Manchester and the surrounding Lancashire towns.

Figure 1: Cyrus Field (1819-1892), Pioneer of the Trans-Atlantic Telegraph
Portrait from the book The Atlantic Telegraph (1865), published in London, so perhaps a British photograph.

Improving the communications along this important supply chain was clearly an attractive proposition to the cotton merchants and growers. However, it was an American, Cyrus Field (see Figure 1), who on 6 November 1856 established the Atlantic Telegraph Company and sought to raise £350,000 to manufacture and lay a telegraph cable between Britain and North America. To appreciate the scale of what was being proposed, 1,600 nautical miles of cable would be required to cross the Atlantic at its shortest width between the west coast of Ireland and the east coast of Newfoundland, Canada. The longest successful undersea cable that had been constructed up until that time was a mere 300 miles in length under the Black Sea, linking the Crimea to Varna on the Bulgarian coast.

Nevertheless, the Victorian can-do attitude prevailed and on 31 July 1857, HMS Agamemnon and USS Niagara set sail from Valentia in Ireland and headed west towards Trinity Bay in Newfoundland. Each ship had to carry half of the cable as no single ship existed anywhere in the world that was capable of transporting the full length. Disaster soon struck when it became apparent that the on-board paying-out equipment wasn't able to adequately control the rate at which the cable was leaving the ship. More and more pressure was used to try and retard the cable but to no effect. The cable ultimately snapped and with that the mission had to be abandoned until the following year. With a new design of paying-out equipment and the availability of the same two ships, two further attempts were made in 1858 with success being achieved on 5 August 1858. Sadly, despite its early promise and the transmission of 400 messages between Ireland and Newfoundland over the next few weeks, the last complete message was received on

Images: all atlantic-cable.com website unless specifically stated

1 September 1858 and the cable completely failed a few days later. It had been a costly and embarrassing failure, but in many ways the business case and technical feasibility had all been proven. The big question was whether anyone had the courage to try again.

The Committee of Enquiry and a new beginning

Such was the magnitude and impact of the failure of the 1858 Trans-Atlantic telegraph cable that the British Government was prompted to convene a Committee of Enquiry; commonplace today but pioneering back then. Bringing together over a period of eight months many notable experts in their field, such as Professor Charles Wheatstone, who had produced the first practical electrical telegraph, Captain Douglas Galton of the Royal Engineers and William Fairbairn, President of the British Association for the Advancement of Science, the committee presented its findings to the British Government in April 1861. They stated that the failure had, "been due to causes which might have been guarded against had adequate preliminary investigation been made into the question." Fortunately, they also concluded that, "a well-insulated cable, properly protected, of suitable specific gravity, made with care, and tested underwater throughout its progress... possesses every prospect of not only being successfully laid in the first instance, but may reasonably be relied upon to continue for many years in an efficient state for the transmission of signals." This therefore gave the green light to another attempt, but the American Civil War (1861-65) had just broken out, which put on hold any interest or enthusiasm for building a new Trans-Atlantic telegraph cable.

As the Civil War neared its end, the Atlantic Telegraph Company had only raised £300,000 against a projected cost of over £800,000 for a new cable. Glass, Elliot and Co, manufacturers of half of the 1857/8 cables, were approached to build a new cable, but they felt that it was financially too risky for them to take on. It was at this point that John Pender, a Scot who had made his fortune as a cotton merchant in Manchester, came forward and suggested a merger with Gutta Percha, a company that had manufactured the core of the 1857/8 cables. This in turn was only agreed on the understanding that John Pender would himself underwrite by personal guarantee the sum of £250,000 to ensure the merger could go ahead. This he duly did and on 7 April 1864 a new company called the Telegraph Construction and Maintenance Company Ltd (Telcon) came into being with John Pender as its Chairman. The intention now was that Telcon would manufacture and lay a new Trans-Atlantic cable under contract to the Atlantic Telegraph Company.

Figure 2: SS Great Eastern (Cable ship).
Painting by Henry Clifford, mechanical engineer and designer of the paying-out machinery

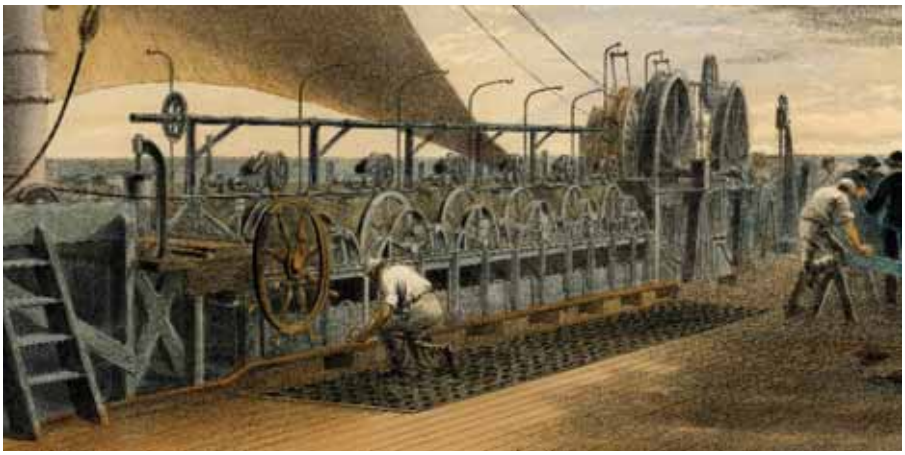


Figure 3: Part of the cable paying-out equipment on board the Great Eastern.
Painted by the artist Robert Dudley who sailed aboard Great Eastern for both the 1865 and 1866 missions

There was one further issue to be addressed and that was what ship to use? Fortunately, thanks to Isambard Kingdom Brunel, a ship did exist that would prove to be perfect for the task and that was the gigantic SS Great Eastern (see Figures 2 and 3). Although dogged with problems, the Great Eastern was the largest ship ever built during the 19th century and sailed on her maiden voyage to America on 17 June 1860, nine months after Brunel's death. The ship was a commercial failure as a passenger liner, and was subsequently bought by Daniel Gooch, Chairman of the Great Western Railway, in 1864 for which he formed the Great Eastern Steamship Company with fellow Directors

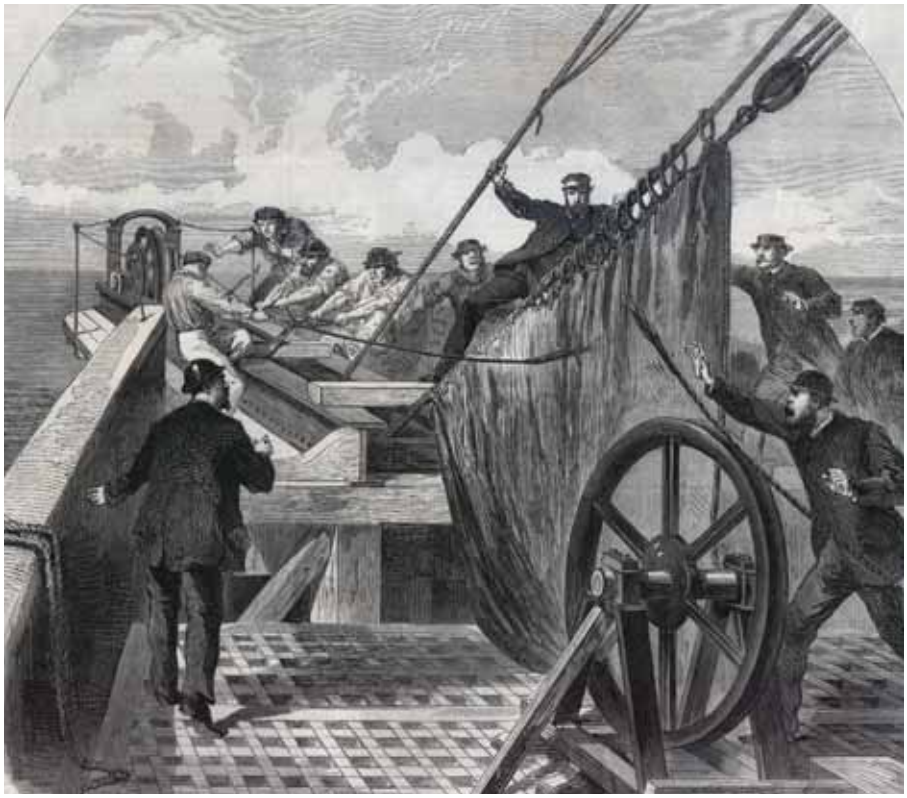


Figure 4: The 1865 cable breaks and is lost overboard.

John Pender and Thomas Brassey. The Great Eastern was subsequently chartered by Telcon following its conversion into a cable ship. To facilitate this conversion, one of the ship's five funnels was removed, along with a boiler and most of the passenger cabins, to create three huge cable tanks that could, collectively, hold the entire length of the Trans-Atlantic cable.

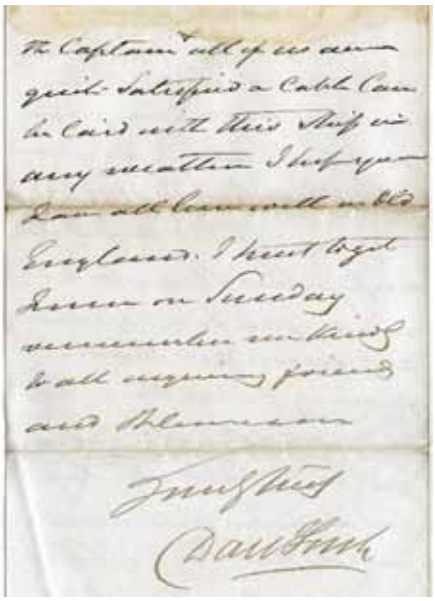
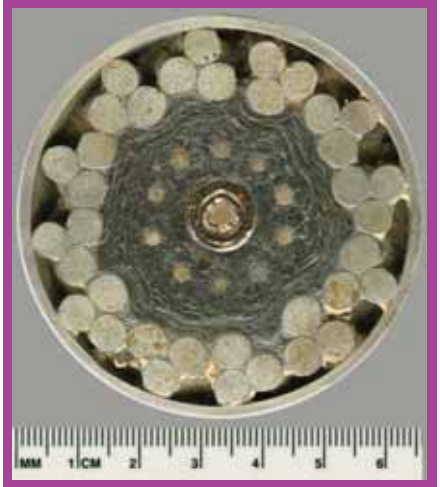


Figure 5: Part of a letter written by Daniel Gooch on board the Great Eastern after the loss of the 1865 cable, in which he states that "the Captain & all of us are quite satisfied a cable can be laid with this ship in any weather." This point would be proved correct within a year.

Everything was now in place for a new attempt to lay a Trans-Atlantic Telegraph cable. At noon on 1 July 1865 Great Eastern, under Captain James Anderson, was fully loaded, weighed anchor and set out for Ireland with Daniel Gooch, Cyrus Field and several Directors of the Atlantic Telegraph Company and engineers from Telcon on board. She left Valentia Bay on 23 July, paying out the Trans-Atlantic cable as she sailed west towards Newfoundland, reaching a speed of 6.5 knots when the first cable fault was detected. Cable laying stopped whilst the cable was recovered and repaired. It was found that a piece of the armouring wire had pierced the cable's insulation. Further similar faults were detected but, again, each was repaired, until on Wednesday, 2 August at just 600 miles from Newfoundland the cable snapped, slipped overboard and sank to the bottom of the ocean, 2,000 fathoms down (see Figure 4).

Despite valiant efforts to recover the cable over the next two weeks, it proved impossible and so there was little choice but to mark the position of the failure with a buoy and sail the Great Eastern back to

The 1865/66 Trans-Atlantic Telegraph Cable



The 1865 cable was manufactured by the Telegraph Construction & Maintenance Company (Telcon) at Greenwich, London. The conductor was a strand of seven copper wires, No.18 BWG; the central wire was covered with Chatterton's compound to fill any voids in the conductor, and this was coated with four layers of gutta percha insulation to form the core of the cable. The core was then covered with tanned jute, and finally the assembly was armoured with ten homogeneous iron wires of No.13 BWG. The shore end had an additional armouring of twelve triple-stranded wires.

The armouring wires were supplied by Webster & Horsfall of Hay Mills, Birmingham. James Horsfall quoted a price of £45 per ton, £40 in cash and the rest in shares of the Atlantic Telegraph Company, and the contract for the wire was signed on 9 May 1864. The firm was then committed to supplying 1,600 tons of .095 inch diameter crucible-cast steel wire in fourteen months, which it did successfully. This was the largest order the company had ever received, and remained so for the next hundred years.

Ireland where she arrived on 17 August 1865.

Despite this failure the mood remained positive, with all parties enthusiastic about a further attempt (see Figure 5). Telcon agreed to manufacture and lay another cable in return for shares in the Atlantic Telegraph Company. The Company then set about raising new capital of its own through a share issue but immediately hit a legal snag because it had originally been formed through a private Act of Parliament. This meant that it was barred from issuing new stock without Parliamentary approval and that was simply not possible because firstly, Parliament was in recess, and secondly, important legal deadlines had already passed. Money had to be returned to investors and the possibility of any further cable attempt now looked extremely bleak.

Figure 6: Testing the Recovered Atlantic Telegraph Cable of 1865
The Illustrated London News, 13 Oct 1866

Saving the venture

Daniel Gooch suggested an elegant solution to the impasse. He proposed that a new company should be formed under the Companies Act which would give it the freedom to raise its own capital. The Anglo American Telegraph Company was duly formed in March 1866 and capitalised to £600,000, with most of that money being raised from within the UK. Telcon was contracted to manufacture and lay the cable from Valentia Bay in Ireland to Heart's Content in Newfoundland, again using the Great Eastern.

The manufacture and procedure for the 1866 cable was the same as for the 1865 cable with the exception of the armouring wires, which this time were galvanised. Improvements were also made to the paying out and picking up machines aboard the Great Eastern. Great Eastern, once again under Captain James Anderson, left Sheerness at midday on 30 June 1866 heading for Valentia in Ireland, where 30 nautical miles of shore-end cable had already been laid by the 7 July. It had been decided to commence laying on Friday, 13 July and on that day at 3.00 pm Great Eastern set sail heading west towards Newfoundland with HMS Terrible leading the way, charged with the task of preventing any vessel from getting in the way of the expedition. After the trials and tribulations associated with the 1865 cable and those before it, the laying of this new cable went very smoothly. On two occasions the cable became tangled and the ship had to be stopped, but after fourteen days at sea, on Friday, 27 July 1866 the Great Eastern sailed into Heart's Content, Newfoundland with an intact and operational Trans-Atlantic cable behind it! The 1866 mission had been a complete success and from that day to this, there has been an operational telecommunications cable linking Europe to Canada and the USA under the Atlantic Ocean.

Following celebrations, the Great Eastern set out on the 9 August to help in the recovery of the lost 1865 cable. It was not until 31 August, after thirteen attempts, that the cable was hooked and raised to 1,000 fathoms and buoyed. Slowly but surely it was hauled aboard, cleaned, connected to transmitting apparatus on the ship, and a message sent to Valentia. A reply came back that both cables were operational (see Figure 6). A new piece of cable was then spliced onto the recovered end of the 1865 cable and Great Eastern sailed back to Newfoundland, arriving at Heart's Content on 7 September 1866. With that it was proclaimed that the world had now got two Trans-Atlantic cables for the price of one!

Encircling the Globe

Completion of the 1866 cable proved to be the trigger that unleashed a rapid expansion of the world's undersea cable infrastructure. In particular, the UK Government was keen to establish a route to India that avoided the use of existing overland telegraph cables that were controlled by countries outside of the Empire. Responding to this, John Pender formed in 1869 the British Indian Submarine Telegraph Company and then in 1870, the Falmouth, Gibraltar and Malta Telegraph Company. However, Falmouth harbour was soon found to be an unsuitable landing point for a cable because it was simply too busy with shipping, and as a result, the small Cornish village of Porthcurno was chosen, a decision that would turn it into the centre of international communications for the British Empire. A telegraph service from London to Mumbai opened on 23 June 1870 via these new submarine cables. By 21 October 1872, the service had been extended to Adelaide in Australia and John Pender's companies had been merged to form the Eastern Telegraph Company. This company was set to dominate global telegraph communications with new cables linking the UK to South

America in 1874 and South Africa in 1880 and 1889, all emanating from Porthcurno.

Queen Victoria celebrated her Golden Jubilee in 1887 and that same year was also the 50th anniversary of the original Cooke-Wheatstone electrical telegraph. To mark this anniversary, the Postmaster-General presided over a banquet in London attended by many of the telegraph pioneers and influential figures. Lord Derby toasted John Pender and declared that he, more than any other, was the man to whom they owed the present development of the telegraphic system of the world. When John Pender died in 1896 his Eastern Telegraph company was the largest of its type, owning one third of the total telegraph mileage of the world, handling two million messages per year, employing 1,800 people and operating a fleet of 10 cable ships. Further amalgamations would see Eastern become part of Imperial & International Communications Ltd. in 1929, which in 1934 was renamed Cable & Wireless.

Sadly, John Pender never lived to see perhaps the greatest achievement of all, the circumnavigation of the globe with submarine telegraph cables. In 1901 the Pacific Cable Board was formed jointly by the Governments of the UK, ~~USA~~, New Zealand, Canada and Australia to lay the Pacific telegraph cable. Laying of the cable was contracted to Telcon who commissioned the building of a new purpose-designed cable ship, the Colonia, for the laying of the 8,000-ton section of cable stretching from the tiny British dependency of Fanning Island to Bamfield, Vancouver Island, in British Columbia, Canada. On 31 October 1902 the cable was completed, making it possible to send a world-circling telegram whose route comprised only countries of the British Empire via landline and undersea cables; the so called "All Red Line".

Completion of the telegraph network that encircled the globe brought year-on-year increases in the volume of telegraph traffic. By 1918 the Porthcurno cable station was handling 180 million words per year and at the beginning of the Second World War, Porthcurno had become the largest and most important cable station in the world, with 14 cables connecting it to a global network spanning 150,000 miles in length.

New technical advances saw transmission rates increased through improved cable design and the use of automatic transmission equipment. The first Trans-Atlantic Telephone cable (TAT-1) opened on 25 September 1956, providing capacity for 36 voice channels, and in 1988 the first Trans-Atlantic fibre optic cable was laid (TAT-8). Today, a network of fibre optic cables criss-crosses the world's oceans offering terabits of data-carrying capacity and following very much the same routes that those Victorian cable pioneers used all those years ago.

So next time you make an international telephone call, interact with social media, or simply browse the web, spare a thought for those brave men who, 150 years ago, overcame the technical, legal and financial challenges to establish the foundations of today's global network.

FURTHER READING

The Atlantic Telegraph: Its History, from the Commencement of the Undertaking in 1854, to the Return of the "Great Eastern" in 1865. Bacon & Co., 1865.

Report of the Joint Committee Appointed by the Lords of the Committee of Privy Council for Trade and the Atlantic Telegraph Company to Inquire into the Construction of Submarine Telegraph Cables. Her Majesty's Stationery Office, 1861. Folio; 44, 520pp.; plates.

Field, Henry M. History of the Atlantic Telegraph. New York: Charles Scribner & Co., 1866 (367pp.)

History of the Atlantic Cable & Undersea Communications from the first submarine cable of 1850 to the worldwide fiber optic network. Retrieved from: http://atlantic-cable.com

ABOUT THE AUTHORS

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Nigel is Professor of Telecommunications at the University of Salford. He is an electronic engineer by profession who specialises in computer networks and their applications and has research interests that cover location and context-based services, communication protocols, the delivery of multimedia applications, network design and the use of networks for sensing. In addition, he takes a keen interest in telecommunications heritage and is active in public engagement for which he delivers lectures and appears in the media. Nigel chairs the Connected-Earth Heritage Network and is a member of the Editorial Board for the ITP Journal. Nigel is also a Chartered Engineer and Chartered IT Professional and a Fellow of the ITP, Institution and Engineering and Technology and British Computer Society.

Bill Burns

Bill is an electronics engineer who worked for the BBC in London before moving to New York in 1971. There he spent a number of years in the high-end audio industry, writing equipment reviews and magazine articles on technical subjects. His research for these led to an interest in the history of communications, and in 1994 a chance find of a section of the 1857 Atlantic cable inspired him to set up the Atlantic Cable website: http://atlantic-cable.com. The site now has over a thousand pages on all aspects of undersea communications from 1850 until the present. Bill's research into cable history has taken him to all of the surviving telegraph cable stations around the world, and to archives and museums in North America and Europe.

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