Book Review: The Early History of Data Networks

Review by Rob Pike

The Early History of Data Networks
by Gerard Holzmann and Björn Pehrson
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Some of the early builders of the Internet have been seen at recent commemorations publicly applauding each other's ingenuity and perseverance in solving problems in the creation of what was then called the ARPANET. These congratulations are justified: the Internet is a technological marvel that deserves celebration. It is not, however, unprecedented. The celebrants might pause to consider that many of their ideas are centuries old.

The first international data network was built in 1801 between Denmark and Sweden. Naturally, the two networks being joined used different coding schemes, so some gatewaying procedures needed to be developed, but the rest was in place: national data networks were common in Europe by the turn of the 19th century. Stationed on hilltops every ten or so miles, signalers used telescopes to read the symbols displayed on huge articulated boards at the upstream station, then reproduced them on their own boards to be read by the downstream station. In good weather, a message could get from Toulon, on the Riviera, to Paris in about a quarter of an hour during the Napoleonic wars, which compares favorably to mail delivery time on the Internet.

Some have argued that this technology contributed to Napoleon's downfall. By permitting Paris to be consulted about the progress of battles at the periphery of the empire, the French data network made it possible for the emperor to meddle constantly in the doings of his military leaders. The English, unable to communicate from London to the ships and armies in the field, produced a more self-sufficient officer class that could adapt quicker to changing situations. Although this may be stretching the point, it would be poetic if true, because the fundamentals of this type of data networking were invented by an Englishman. They first appeared, along with many of the principles of networking protocols, including acknowledgement and retransmission, rate control, and priority, in a paper Robert Hooke read to Royal Society in 1684, almost three hundred years before the Internet. As Holzmann and Pehrson say, the need for communication "must have been felt every bit as much by the Pharaohs" as it is today, which is why the story of data communication can be traced back thousands of years. At the siege of Troy, signal fires would have been as unremarkable as radio telephone calls in a modern battle.

The Early History of Data Networks tells the story of the invention of digital networking. It ends in the mid-1800's, with the technology mature and practical and electrical telegraphy on the horizon. The electromagnetic telegraph changed little but the signaling technology anyway; the breakthroughs were all made in optical networking. Two men in particular, Claude Chappe in France and Abraham Edelcrantz in Sweden, created near the end of the 18th century what might be called, with only slight exaggeration, the first modern digital networks.

Chappe was the true visionary. Losing his job at the beginning of the French revolution in 1789, he returned to his home town southwest of Paris and teamed up with his four brothers, also recently unemployed, to perform experiments with telegraphy, a topic that had become current after a battle had been won (against Horatio Nelson!) in 1783 through the use of signalling from a hilltop on an island in the Mediterranean. The Chappes tried a variety of acoustic and optical signalling methods in their experiments, suffering along the way many hardships including destruction of their equipment and buildings by peasants resentful of the ex-aristocrats' status. They persevered through the time of terror, however, and on the second of March, 1791, demonstrated reliable transmission of a message by optical signaling across about 20km. Although the experiments (and difficulties with the peasants) continued, Claude Chappe used this success to petition the Revolutionary government to fund the development of a true network. By May, 1794, an optical telegraph line was communicating between Paris and Lille, 190km north. Through 1795, this line communicated happy news of the military successes of the French in Belgium and Holland, and the messenger, Chappe, was hailed as a "benefactor of the motherland." The construction of the subsequent network across France became Chappe's successful career, recounted in charming detail by Holzmann and Pehrson.

The core of the "History", though, is the work of Abraham Edelcrantz, a Swede who decided to apply Chappe's ideas in Sweden. In 1796, after great success, Edelcrantz wrote *A Treatise on Telegraphs*, which first appears in English

translation as Chapter Four of Holzmann and Pehrson. Even if the rest of their book were not so valuable, the *Treatise* alone justifies its publication. Edelcrantz's explanation of the history, theory, and technique of optical telegraphy is literally definitive. He didn't just mimic Chappe's work, he thought the issues through for himself and, if less of a visionary, was more of an engineer and thinker. He was also a superb writer, leaving most modern scientific authors (including Holzmann and Pehrson) in the shade. The *Treatise* presents the design and construction of the Swedish telegraph stations, and the coding system used, so clearly that it could serve as a reference manual for the operators and builders of the network. Although the translation is into a distinctly modern style of English, Edelcrantz's thinking shines through, illuminating a time when a single dedicated gentleman, with a commission from the government, could create a whole new technology.

Of course, Edelcrantz's *Treatise* is not a history of the Swedish telegraph, but Holzmann and Pehrson, as with Chappe, fill in the background with telling details. Consider the telegraph code words dictating punishment for negligent operators, such as 001-245, 'hard labor', and 001-247, 'confinement to telegraph'. Code word 001-721, 'step onto the lower telegraph arm', was introduced for the station at Hissingen, which was often operated by the superintendent's young daughters; we can only surmise what the punishment was for. The more ominous code word 001-727, 'I am in custody', suggests a telegraph station being overrun by the enemy.

Throughout the book, we are reminded that history will repeat itself, even in the continually novel field of technology. The struggles of Chappe and Edelcrantz to get funding from their governments and honor from their peers are achingly familiar to a modern researcher. The book concludes with a discussion of the nature of invention, explaining why Chappe and Edelcrantz are the true inventors of telegraphy, even though others had written about and experimented with the idea. The distinction is in thoroughness: studying the problem, identifying the pieces that need to be addressed, solving them all, building a working prototype, and putting it into service. The practitioners of the Internet could identify completely with their precursors who, as Holzmann and Pehrson say, solved the problem 'in a way that made it look easy, ... almost two centuries before we understood the problem well enough to recognize it as hard.'