Claude Chappe and the First Telecommunication Network (Without Electricity)

Stefano Selleri

Department of Information Engineering
University of Florence
Via di S. Marta,3, I-50139, Florence, Italy
E-mail: stefano.selleri@unifi.it

Abstract

This paper briefly reviews the essential stages of the telecommunication networks that have developed, mainly at the European level, before the discovery of electricity and the invention of the electric telegraph. In particular, it focuses on the most widespread of these, the only one that really deserves the name of "telecommunication network," the one implemented by Claude Chappe in France between the late 1700s and early 1800s.

1. Introduction

Nowadays, we are all able to instantly communicate with almost every other human being on the planet, thanks to the pervasive fixed and mobile telecommunication networks. This possibility, which now seems completely natural, was born with the creation of telegraphy by Carl Friedrich Gauss, Wilhelm Eduard Weber, William Fothergill Cooke, Charles Wheatstone, David Alter, and the ultimate commercial success of Samuel Morse's telegraph system (1837) [1]. Electric-based telecommunications rapidly flourished with the subsequent inventions of the telephone by Antonio Meucci in 1854 [2, 3], followed by Alexander Graham Bell's patents in 1876 and 1877 [4, 5], and, of the radio by Heinrich Rudolf Hertz in 1888 and Guglielmo Marconi in 1895 [6, 7].

Even if all these methods of communications are inextricably linked to electricity and electromagnetism, this does not mean that telecommunications were born with them. The need to communicate with people far away has characterized all civilizations and throughout history. Each sufficiently evolved centralized state tried to set up its own communication network. However, these networks were, with rare exceptions, postal networks, with the exchange of written messages at the top speed technologically available: pigeons and horses.

True telecommunications are instead something where *information*, rather than a physical, material object, is delivered. The earliest systems of true telecommunications were very rough. In the Persian Empire, the horse-change post stations also had a signaling beacon associated with them. This allowed the much faster sending of elementary messages (yes/no or on/off: a bit, in modern terms) by lighting the beacons in the chain. This beacon-based system remained for a long time the only form of telecommunication. Its usage was also testified to by bas-reliefs on Trajan's Column in Rome (113 A.D.), which shows the use of towers with fires on mobile poles. Polybius also described some more-complex systems based on multiple torches and synchronized clepsydrae [water clocks], but there is no evidence they were ever used in practice [8]. Much later, in the Renaissance, letter-based coding was introduced, conveyed via light flashes [9] or on a few reconfigurable symbols [10]. Regardless, these systems were somewhat awkward and never got through.

Figure 1. Claude Chappe [December 25, 1763, Brûlon, France – January 23, 1805, Paris, France] (from [11])

2. The Chappe System

The man who actually linked his name to the first modern telecommunication network is Claude Chappe (Figure 1). Chappe, born on December 25, 1763, was the grandson of a Baron. He was supposed to become a clergyman, but at the outcome of the French revolution (1789-1799), he switched to the career of inventor.

Toward the end of 1790, he devised a system based on synchronized clocks (Figure 2), similar to one of the many theoretically enunciated by Polybius. Transmitting and receiving clocks had a hand and numbers on their quadrants, and the hands were to be kept synchronized. When the hand at the transmitting side was on the number to be transmitted, a sound signal was issued. The same number was of course indicated by the synchronized clock on the receiving station, and the sound signal allowed people on the receiving side to take note of it. Figure 3 shows the description, written by Claude Chappe's brother, Ignace [11].

During an official demonstration on March 2, 1791, Chappe used a painted wooden sign, white on one side and black on the other, in place of sound signals (Figure 2 shows this panel). This allowed a distance of over 10 miles between the two stations.

Claude Chappe called this first device "tachygraphe" (ancient Greek: fast writer), and decided to propose it to the French Government for nation-wide employment. Chappe also very early changed the name of his invention from tachygraphe to télégraphe (ancient Greek: remote writer).

The system was not substantially different from one described by Polybius. It had his weak point in the need to have a series of perfectly synchronized clocks. Chappe himself was not too pleased with the pendulum system. After some other experimental communications, he designed a

Figure 2. An engraving, based on suppositions and probably unauthentic, dating back to the XIX century, of the first telegraph devised by Claude Chappe (from [11]).

ses frères. La première correspondance télégraphique qu'ils eurent ensemble fut établie avec deux pendules à secondes, parfaitement en harmonie entre elles; le cadran étoit divisé en dix parties, dont chacune désignoit un chiffre de la numération ordinaire. Lorsque l'aiguille des secondes de l'un des cadrans passoit sur le chiffre qu'on vouloit indiquer, on faisoit entendre un son qui annonçoit au

8 *

124 HISTOIRE

poste correspondant que le chiffre sur lequel se trouvoit l'aiguille, au moment où le son étoit entendu, étoit significatif, et en appliquant successivement les chiffres aux mots d'un vocabulaire, on pouvoit rendre toutes les idées.

Figure 3. The text describing the first telegraph by Claude Chappe, written by his brother Ignace (from [12, pp. 123-124]). English translation: "The first telegraph communication which they (*the Chappe brothers*) performed together was established by two pendulum clocks, kept in perfect sync. The dials of the watches were divided into ten areas, each bearing a cardinal number. When the seconds hand went to the number you wish to transmit a sound was produced, that announced the recipient that the number that was indicated by the hand of his watch, at the instant in which the sound was heard, was significant. Compiling an appropriate dictionary associating numbers and words so as to convey every thought."

new transmitter that had a rectangular wooden structure with five sliding panels that could be shown individually or obscured by pulleys. The five panels gave birth to a binary code with 32 possible combinations, more than three times the symbols used in the previous system.

Nevertheless, the panels were not satisfactory for Chappe, who realized that elongated objects would be more visible from a distance with respect to the panels. The solution at which he arrived at the end was that of a vertical axis, at the top of which a mobile bar was hinged. To both ends of this bar were hinged two shorter bars, they also being mobile. Reciprocal rotations were controlled by a series of pulleys and cranks (Figure 4). The description of the development, also from a political point of view, we still find in the book by Ignace Chappe (Figure 5).

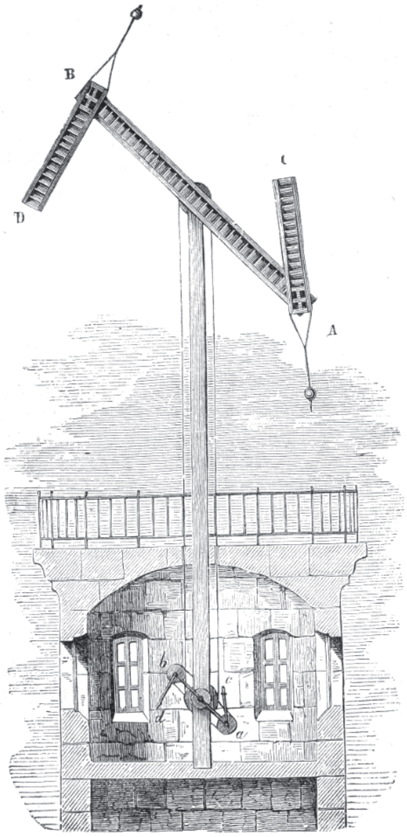


Figure 4. An engraving based on the actual design of the device devised by Claude Chappe for his telecommunication network (from [11]).

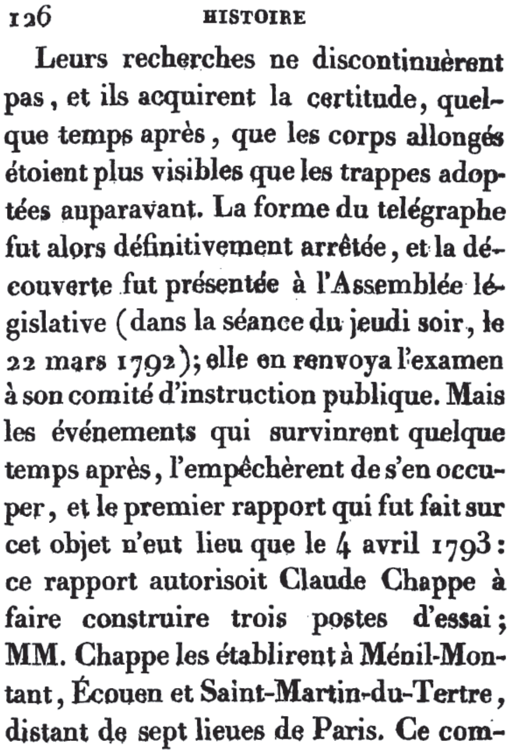
Claude Chappe established that the rotations of the three movable bars was to be made in 45° steps. This defined four positions for the main beam, and eight for each of the secondary beams (Figures 4 and 6), for a total of 256 different symbols. He called these devices "sémaphores" (ancient Greek: sign bearer).

Meanwhile, France was going through that stage of the revolution that eventually brought the downfall of the monarchy. Chappe's studies on the "sémaphores" system were well regarded by the Assembly but opposed by the people. In a riot, they destroyed the experimental installations in the park of Menil-Montant in 1792, believing them to be some odd monarchical device. Chappe thought it well to put his own equipment under the protection of the Assembly (September 11, 1972).

The Legislative Assembly was replaced on September 21, 1792, by the National Convention. Ignace Chappe, a member of the Assembly, was not confirmed to the Convention. This led to a stoppage of the telegraph development until April 1, 1793, when the Convention decided to fund the experiments. On July 12, 1793, the demonstration of the telegraph "sémaphores" in the presence of members of the Commission appointed by the Convention finally took place.

3. The Network

After the demonstration, things began to accelerate. On July 26, 1973, the Convention approved the establishment of the "Telegraphs of the French State." On August 4, 1793, the Convention passed a loan of 58,400 francs for the construction of the first line: fifteen stations, from Paris to Lille. On September 24, 1793, Chappe had *carte blanche* to use any tower or existing house, cutting down all interfering trees, to hire staff, and to roll out a regulation for the "French Telegraph." Chappe was also appointed "Telegraph Engineer," and was given a monthly salary of 600 francs for his services. In this context, Chappe


126 HISTOIRE

Leurs recherches ne discontinuèrent pas, et ils acquirent la certitude, quelque temps après, que les corps allongés étoient plus visibles que les trappes adoptées auparavant. La forme du telégraphe fut alors définitivement arrêtée, et la découverte fut présentée à l'Assemblée législative (dans la séance du jeudi soir, le 22 mars 1792); elle en renvoya l'examen à son comité d'instruction publique. Mais les événements qui survinrent quelque temps après, l'empêchèrent de s'en occuper, et le premier rapport qui fut fait sur cet objet n'eut lieu que le 4 avril 1793: ce rapport autorisoit Claude Chappe à faire construire trois postes d'essai; MM. Chappe les établirent à Ménil-Montant, Écouen et Saint-Martin-du-Tertre, distant de sept lieues de Paris. Ce com-

Figure 5. The text describing the development of the telegraph and its political issues, written by Ignace Chappe (from [12, pp. 126]). English translation: "Their research (*of the Chappe brothers*) has not stopped, and reached the consciousness, some time later, that the elongated bodies are more visible than the plates previously used. The telegraph form was then finalized, and the invention was presented to the Legislative Assembly (in the Thursday night session, March 22, 1792). The Assembly referred the matter to its Committee of Education. Subsequent events prevented the Committee from dealing with it and the first report was not written down before April 4, 1793. In this report Claude Chappe was authorized to build three test stations; the Chappes positioned them at Menil-Montant, at Écouen and at Saint-Martin-du-Tertre, seven leagues from Paris."

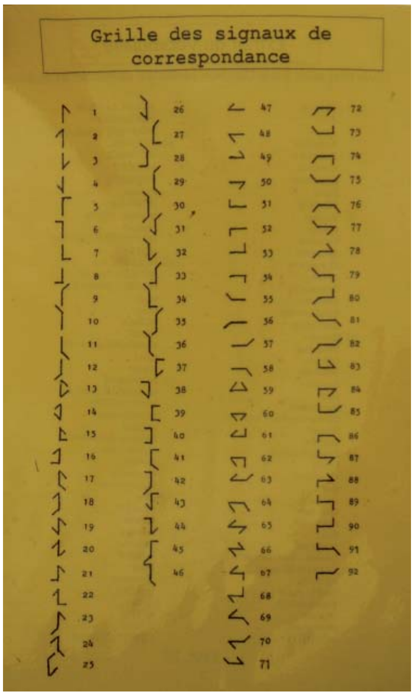


Figure 6. The final 92 beam positions of the Chappe code [Anne Goldenberg, Creative Commons License].

published the first manual containing signal coding for transmission on his telegraph lines. The manual contained 8464 different messages that could be transmitted, obtained by pairing individual symbols.

These were much less than the 256 × 256 possible pairs. However, Chappe had noticed difficulties during transmissions due to erroneous recognition of those signals corresponding to the perfect alignment, inward or outward,

Figure 7a. The French optical telecommunication network at its maximum extent, in France and Belgium [14].

Figure 7b. The French optical telecommunication network at its maximum extent in Italy [14].

of the two shortest beams. He hence had reduced the original 256 possible configurations to 98 the first time, and later to only 92 (Figure 6). Considering the signals in pairs, this led to 8464 possibilities.

On April 30, 1794, after only one year from the resolution of the Convention, the Paris-Lille line was completed, and tests were started. There were 18 stations, including two in Paris and one in Lille. On July 16, 1794, the line was officially opened. The towers were built at a distance of 10 km to 15 km from each other, and formed a line that extended along 190 km. At the beginning, the transmission occurred at the speed of a signal per minute.

Since then, growth was unstoppable (Figure 7, [12]):

1794	from Paris to Lille	190 km
1794	from Paris to Landau and Strasbourg	128 km
1798	from Lille to Dunkerque	64 km
1798	from Paris to Brest	210 km
1799	from Strasbourg to Hunigue	96 km
1803	from Lille to Brussels	96 km
1803	from Lille to Boulogne	80 km
1804	from Paris to Dijon and Lyon	370 km
1804	from Lyon to Turin	250 km
1804	from Turin to Milan	100 km
1805	from Lyon to Toulon	305 km

As one can note from the list, the development was given new impetus when Napoleon proclaimed himself emperor in 1804. He understood the enormous potential of the telegraph network.

Claude Chappe was not without his critics. Many attacked him claiming to have invented the telegraph before him, including Abraham-Louis Breguet, the renowned clockmaker who had collaborated with the construction of the Chappe “sémaphores” prototype. Other claims arrived from Agustin de Betancourt and other people who had unsuccessfully offered alternative schemes. In the last years of his life, Chappe particularly suffered from these criticisms, and fell into depression and committed suicide in 1805 [12].

4. The End of Optical Systems

For most of the nineteenth century, telecommunication networks based on optical signaling continued to expand, even after the death of Claude Chappe (1905) and the fall of Napoleon (1915). Only in France:

1809	Brussels to Antwerp	40 km
1809	Antwerp to Vlissingen	72 km
1810	Antwerp to Amsterdam	128 km
1810	Milan to Venice	241 km
1813	Metz to Mainz	225 km
1816	Lille to Calais	80 km
1821	Lyon to Toulon	305 km
1823	Paris to Bordeaux	507 km
1823	Bordeaux to Bayonne	160 km
1823	Avranches to Nantes	157 km
1825	Paris to Lille (expanded)	190 km
1828	Avignon to Perpignan	209 km
1833	Avranches to Cherbourg	108 km
1834	Bordeaux to Toulouse	205 km
1834	Toulouse to Narbonne	127 km
1834	Narbonne to Montpellier	84 km
1834	Montpellier to Avignon	80 km
1840	Boulogne to Calais	32 km
1840	Narbonne to Perpignan	54 km
1840	Calais to Boulogne	40 km
1840	Dijon to Besancon	72 km
1844	Bordeaux to Agen (replaced)	145 km
1845	Boulogne to Eu	100 km
1846	Bayonne to Behobie	30 km

The possibility of transmitting signals by means of electricity was yet in the air, starting with Gauss and Weber (1933). Morse devised in 1832, experienced in 1835, and protected with a caveat on September 28, 1837, a single-wire technique significantly cheaper than the other technique proposed. This technique came to fruition in 1844 to finally be tested over large distances and fully patented in 1849 [15].

With its optical systems, Europe resisted the introduction of the electrical telegraph, which indeed spread quickly in United States. The country that resisted the introduction of the electric telegraph most was, understandably, France. In 1864, there were still 24 optical stations, flanked by 174 electric stations. The optical stations were used where it was difficult to lay electric cables. Only in 1881 were the last three stations for optical signaling dismantled.

5. Conclusions

The most significant telecommunication network ever realized before the advent of the electrical telegraph was the network initially set up by Claude Chappe. At its apex, it encompassed several thousand kilometers. It connected the main cities of France and northern Italy, and was mimicked by similar systems in England, Germany, and Sweden. The development of the electric telegraph in the thirties of the nineteenth century marked the end of the short service life of the optical telegraph.

6. Bibliography

1. J. J. Fahie, *A History of Electric Telegraphy to the Year 1837*, London, E. & F. N. Spon, 1884.

2. B. Catania, *Antonio Meucci – L’Inventore e il suo Tempo - Da Firenze a L’Avana, Vol. 1*, [Antonio Meucci, the

Inventor and His Time – From Florence to Havana], Roma: Seat - Divisione STET, Editoria per la Comunicazione, 1994.

3. B. Catania , *Antonio Meucci – L'Inventore e il suo Tempo - New York 1850-1871, Vol. 2* [Antonio Meucci, the Inventor and His Time – New York 1850-1871, Volume 2], Torino, Seat - Divisione STET, 1996.

4. A. G. Bell, US Patent 174465, "Improvement in Telegraphy," February 14, 1876.

5. A. G. Bell, US Patent 186787, "Improvement in Electric Telegraphy," January 30, 1877.

6. G. S. Smith, "An Analysis of Hertz's Experimentum Crucis on Electromagnetic Waves," *IEEE Antennas and Propagation Magazine*, **58**, 5, October 2016, pp. 96-108.

7. G. Pelosi, S. Selleri, and B. Valotti, "From Poldhu to the Italian Station of Coltano: Marconi and the First Years of Transcontinental Wireless," *IEEE Antennas and Propagation Magazine*, **46**, 3, June 2004, pp. 47-54.

8. Polibio, *Histories, Book X, Cap. 44,45 (ca. 220-146 A.C.)*, London, Macmillan, Trad. Ing. di Evelyn S. Shuckburgh,1889.

9. F. Kessler, *Unterschiedliche bisshero mehrern Theils Secreta oder Verborgene*, *Geheime Kunste* [Various and Up to Now Hidden, Secret Arts], Oppenheim (D), 1616.

10. R. Hooke, "Dr. Hook's Discourse to the Royal Society, May 21, 1684 Shewing a Way How to Communicate One's Mind at Great Distances," in *Philosophical Experiments and Observations of the Late Eminent Dr. Robert Hooke*, William Derham (ed.), London, W. and T. Innys, 1726, pp. 142-150.

11. L. Figuier, *L'Elettricità e le sue applicazioni* [Electricity and its Applications], Milan (I), F.lli Treves, 1884.

12. I. U. J. Chappe, *Histoire de la télégraphie [History of the Telegraph],* Paris, L'Imprimerie de Crapelet, 1824.

13. G. J. Holzmann and B. Pehrson, *The Early History of Data Networks*, Hoboken, NJ, John Wiley & Sons, 2003.

14. Multiple Authors, *La Télégraphie Chappe* [Chappe Telegraph], Fédération Nationale des Associations de Personnel des Postes et Télécommunications pour la Recherche Historique (FNARH) (ed.), Nancy, France, Éditions de l'Est, 1988.

15. S. F. B. Morse, *Improvement in Electric Telegraphs*, US Patent 6420, May 1, 1849.