

## NETWORKED MUSIC & SOUNDART TIMELINE – AN OVERVIEW OF PRACTICES RELATED TO SOUND TRANSMISSION AND DISTANCE

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*(temporary introduction before english corrections)*

This timeline aims to provide an overview of the principal events and projects in the realm of networked music and networked sonic performances since the beginning of the XX<sup>o</sup> century. The overview covers various domains and types of events : technologies and softwares, forward thinking literature, musicology, sound anthropology and history of communication, contemporary music to soundart. Most of the entries, such as events, works and technologies, have a short description. The historical timeline is complemented with an alphabetical list of scientific papers and publications. In order to ensure that this timeline and list are continuously updated, the document is available as a contributive file and resource for researchers and artists.

This timeline stems from previous research. It began seven years ago concerning itself with the ‘organology of netmusic’ and theoretical frameworks of in-progress projects on the Internet. The current iteration has been launched at the occasion of the 2008 Locus Sonus research report **and now takes part in the research of the lab by opening a documentary and critic corpus for projects and for the community of searchers, students and artists.** It has been fed too by parallel studies developed in recent years within Locus Sonus concerning remote sound recording and playing, open mikes of the Locustream project, and ‘geotagged’ sound projects.

If networked music is historically locatable, **we must** probe its definition in front of the modifications it implies with regard to interpretation, organology, **listening practices**, and composition compared with the investigations led with technologies. Secondly we must clarify and distinguish the characteristics of networked systems in the frameworks of instrumental and electronic/electroacoustic music interpretation and music composition. This investigation could open new studies and analysis around these topics and offer to explore recent and today nodes of research and artistic practices. We certainly are at the beginning of an era for music **with the development of live music collaborations over the Internet**, and at the same time we must continue to question historical concepts and to elucidate new problems **that progressively occur within the artists’ and audiences’ practices**, implied in the relations between music and technologies, as well as sociological changes.

**The general idea is to study the built and in-progress environments and fields of inter-connected and correlated sonic spaces and temporalities, like living “eco-milieus” which enhance group creativity. Historically constituted by various and intersected sources, the fields of networked sound exhibits a continuous art fabric directly connected to social environments via the exploration of technics and technologies, and the site-specific and time-specific experiences of perception and action at a distance. The specificity of networks permits realtime interactions and connections between locations, and modifies the perceptions and practices of spaces and times. The concepts of ‘distance’ and ‘remote/local’ - as well as ‘permanence’, ‘audiences’, ‘acousmatic’, ‘co-op systems’, etc. - are paramount in this specificity that explores the soniferous and musical state of networks.**

Since 2000, some relevant papers and texts have been released related to the Networked Music topic<sup>1</sup>, and at the same time various approaches of a definition of Networked Music were developed :

- networked performance occurs whenever a performer’s instrument receives input from a source other than the

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<sup>1</sup> 2002 Golo Föllmer “Making Music on the Net, social and aesthetic structures in participative music”; 2002 Nathan Schuett “The Effects of Latency on Ensemble Performance”; 2003 Jörg Stelkens “Network Synthesizer”; 2003 Gil Weinberg “Interconnected Musical Networks: Bringing Expression and Thoughtfulness to Collaborative Music”; 2006 Álvaro Barbosa “Displaced Soundscapes”; 2007 Alain Renaud & Pedro Rebelo “Networked Music Performance - State of the Art”.

performer himself or herself, or the performer's instrument behavior is modified by an outside influence. (Stephan Moore & Timothy A. Place)<sup>2</sup>

- music practice situations where traditional aural and visual connections between participants are augmented, mediated or replaced by electronically-controlled connections. (Jason Freeman)<sup>3</sup>

- the expression "networked" commonly implies a multi-site distribution of **permanent** points of transmission and of reception and realtime simultaneous interactions between sites : remote sonic captations and remote acoustics, interconnections between physical and virtual places, and a distributed *collective of players*. (Locus Sonus)<sup>4</sup>

- in the same vein, distributed ensembles : a distributed ensemble consists of a group of musicians that is distributed between two or more locations. Whereas standard ensemble performance relies on a common acoustic space between performer and audience, distributed ensemble performances need to take into account the superimposition of acoustic spaces : remote acoustics, remote soundscapes, networked laptop improvisation (Alain Renaud & Pedro Rebelo)<sup>5</sup>

This could involved a **palette** of other aspects :

- Public, shared and distributed audiences, and practices of listening<sup>6</sup>.

- Networks as an instrument and a musical resource<sup>7</sup>.

- Interconnections of spaces<sup>8</sup>.

- Internal technical conditions and constraints of networks : realtime, synchronicity, latency, delays, bandwidths, sound quality, ...

- Social creativity, interactions, collaborations and facilitators involved in collective systems of attention<sup>9</sup>.

- Live collaborations over the Internet and telepresence.

The first part of this study gathers references in literature, philosophy, history of telecommunications and early visions by composers in Music and artists. This offers a comparison, by going back and forth between the experiments and realizations in technology and the utopias described in literature or imagined in musical composition and in arts. This includes some references to science fiction literature.

In order to give important marks in the historical, societal and technological contexts, the second part concerns a chronological list of works, festivals, public events in music and soundart, and some main references in theoretical studies (aesthetics, philosophy, art criticism) and in other artistic practices such as digital arts. Each entry is classified with the work's title, the name(s) of the author(s), elements relating to the context of realization, urls of related websites, and a description of the work. This covers various domains beyond the scope of the primary ones, networked music and sound art on networks, to encompass areas of intersect between networks (net communities, social networking), communication (broad- and narrow-casting), sound (field recording, audio and sonic geotag systems and processes), performance and technologies.

This part will probe and reference art movements throughout the XX<sup>o</sup> century, pointing out practical and theoretical aspects involved in notions like Conceptual Art (location, duration), Minimal Art and AntiForm (extra-visual and new perceptions), LandArt and site-specific art, Performance Art and Process Art, Contextual Art and Relational Aesthetics,

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<sup>2</sup> "KromoZone : a platform for networked multimedia Performance", Stephan Moore & Timothy A. Place, Proceedings of the International Conference "Music without Walls? Music Without Instruments?", De Montfort University, Leicester, 2001

<sup>3</sup> "In one sense, almost all music is networked music: whenever musicians play together, their eyes and ears are connected by a complex, real-time network of aural and visual signals that have a tremendous impact on what they play and how they play it. And musicians are usually part of a second network as well, which connects them back to the composer who created the score and the listeners who hear the performance (or a recording of it). That formulation, of course, is too broad to be particularly useful. So here is a more restricted version: networked music is music in which we consciously manipulate, transform, or mediate the connections between performing musicians and/or between the composer, performers, and listeners." (Jason Freeman)

<sup>4</sup> "Networked Sonic Spaces", Jérôme Joy, Peter Sinclair, Locus Sonus, ICMC'08, Belfast, 2008.

<sup>5</sup> "Network Performance: Strategies and Applications", Alain Renaud, Pedro Rebelo, SARC, NIME'06

<sup>6</sup> "Media without an audience" by Eric Kluitenberg, "Singing without Being Together - juxtaposed music for an invisible public" by Dana Rappoport.

<sup>7</sup> "The Internet, a musical instrument in perpetual flux" by Netochka Nezvanova, the concept of net-organology we try to develop on our side, "The Environment as a Musical Resource" by Bill Fontana, "The World as an Instrument" by Francisco Lopez.

<sup>8</sup> "The use of remote acoustics and the idea of exchanging acoustic spaces suggests the network acting as an extension of a closed acoustic space. The combination of several geographically displaced acoustic spaces is only possible in a networked situation." "Network Performance : Strategies and Applications" by Alain Renaud and Pedro Rebelo.

<sup>9</sup> "Facilitating Collective Musical Creativity" by Atau Tanaka.

etc. This will insert essential concepts issued from theoretical and philosophical reflections, questioning our relation to technologies and socio-technical environments, approaching fundamental nodes such as hybridization, machinism, device/apparatus, and so on. The intention is to start the questioning of the networking culture within a controversy related to the culture of representation, existing since the beginning of the 60s. The (hyper-)mediatization, changeability and multiplication of technical prothesis are coming from a slow and progressive shift within our life and culture. Today, the remarkable delicacy of our relationship to technology wavers between euphoria and fatalism, from blind faith to neo-luddism, a continuous negative mistrust. We should continue to build communal networks (social circuits) and encourage a pliable social fabric, in a deliberate and aware manner out of this orthodoxy of proselytism and terror, passiveness and fickleness. These controversies show the vitality of this debate and the necessity to be involved in these questions. Our initiative is to take hold of these debates and perspectives, **and to help to shift questions and viewpoints** through this timeline by illustrating convergences, meetings and crossings in a wider view in art and theoretical practices, social contexts, and technological developments.

The third part contains a list of reference papers, proceedings of international conferences and books.

Entry descriptions span out of quotes belonging to original sources (websites, books, papers, conferences, comments, etc.). Credits to authors and researchers are associated each description. One can browse the Timeline in the style of a linear reading of a text file or via a search feature through keywords. The Networked Music & SoundArt Timeline will grow step by step thanks to its shared, open and dynamic structure, it will evolve from a text file (pdf file download) to conform a fruitful resource accessible to an even wider community.

The development of this Timeline has began within the Locus Sonus lab and was initiated in the framework of research collaborations and projects : Eu-phonic (with SARC Belfast, CRiSAP University of Arts of London, CultureLab University of Newcastle, IRCAM Paris, STEIM Amsterdam), School of the Art Institute of Chicago SAIC (PUF franco-american program), and with a pool of contributors - researchers and artists - in order to complete this first version of the Timeline.

Contributing additions (preview list) : Alvaro Barbosa, John Bischoff, Samuel Bordreuil, Angus Carlyle, Andrea Cera, Chris Chafe, AnnMarie Chandler, Nicolas Collins, Jean Cristofol, Paul DeMarinis, William Duckworth, Alejo Duque, Golo Föllmer, Bastien Gallet, Peter Gena, Andrew Gerszo, Manuel Gottschieg, JoAnne Green, GH Hovagymian, Christophe Kihm, Tetsuo Kogawa, Brandon Labelle, Pauline Oliveros, Pedro Rebelo, Alain Renaud, Jocelyn Robert, Atau Tanaka, Dante Tanzi, Helen Thorington, Peter Traub, Mark Trayle.

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Additional reviewers : Robert Adrian X, Maryanne Amacher, Clarisse Bardiot, Stephan Barron, Steve Bradley, Alain Depocas, Steve Dietz, Christopher Dobrian, Jean-Paul Fourmentraux, Heidi Grundman, Andrew Hemment, John Hopkins, Eduardo Kac, Derrick de Kerkhove, Roger Malina, Luc Martinez, Michel Redolfi, Marc Relieu, Allen S.Weiss.

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**MENU**

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<ul style="list-style-type: none"> <li>• ∞ - 90 <a href="#">go to bookmark</a></li> <li>• 90 - 1000 <a href="#">go to bookmark</a></li> <li>• 1000 - 1600 <a href="#">go to bookmark</a></li> <li>• 1600 - 1700 <a href="#">go to bookmark</a></li> <li>• 1700 - 1800 <a href="#">go to bookmark</a></li> <li>• 1800 - 1835 <a href="#">go to bookmark</a></li> <li>• 1835 - 1849 <a href="#">go to bookmark</a></li> <li>• 1849 - 1860 <a href="#">go to bookmark</a></li> <li>• 1860 - 1876 <a href="#">go to bookmark</a></li> <li>• 1876 - 1884 <a href="#">go to bookmark</a></li> <li>• 1884 - 1890 <a href="#">go to bookmark</a></li> <li>• 1890 - 1900 <a href="#">go to bookmark</a></li> <li>• 1900 - 1910 <a href="#">go to bookmark</a></li> <li>• 1910 - 1920 <a href="#">go to bookmark</a></li> <li>• 1920 - 1930 <a href="#">go to bookmark</a></li> <li>• 1930 - 1940 <a href="#">go to bookmark</a></li> <li>• 1940 - 1960 <a href="#">go to bookmark</a></li> <li>• 1960s <a href="#">go to bookmark</a></li> </ul>	<ul style="list-style-type: none"> <li>• <a href="#">1950</a> - <a href="#">1951</a> - <a href="#">1952</a> - <a href="#">1953</a> - <a href="#">1954</a> - <a href="#">1955</a> - <a href="#">1956</a> - <a href="#">1957</a> - <a href="#">1958</a> - <a href="#">1959</a> -</li> <li>• <a href="#">1960</a> - <a href="#">1961</a> - <a href="#">1962</a> - <a href="#">1963</a> - <a href="#">1964</a> - <a href="#">1965</a> - <a href="#">1966</a> - <a href="#">1967</a> - <a href="#">1968</a> - <a href="#">1969</a> -</li> <li>• <a href="#">1970</a> - <a href="#">1971</a> - <a href="#">1972</a> - <a href="#">1973</a> - <a href="#">1974</a> - <a href="#">1975</a> - <a href="#">1976</a> - <a href="#">1977</a> - <a href="#">1978</a> - <a href="#">1979</a> -</li> <li>• <a href="#">1980</a> - <a href="#">1981</a> - <a href="#">1982</a> - <a href="#">1983</a> - <a href="#">1984</a> - <a href="#">1985</a> - <a href="#">1986</a> - <a href="#">1987</a> - <a href="#">1988</a> - <a href="#">1989</a> -</li> <li>• <a href="#">1990</a> - <a href="#">1991</a> - <a href="#">1992</a> - <a href="#">1993</a> - <a href="#">1994</a> - <a href="#">1995</a> - <a href="#">1996</a> - <a href="#">1997</a> - <a href="#">1998</a> - <a href="#">1999</a> -</li> <li>• <a href="#">2000</a> - <a href="#">2001</a> - <a href="#">2002</a> - <a href="#">2003</a> - <a href="#">2004</a> - <a href="#">2005</a> - <a href="#">2006</a> - <a href="#">2007</a> - <a href="#">2008</a> -</li> </ul>	<ul style="list-style-type: none"> <li><a href="#">A</a>    <a href="#">B</a>    <a href="#">C</a></li> <li><a href="#">D</a>    <a href="#">E</a>    <a href="#">F</a></li> <li><a href="#">G</a>    <a href="#">H</a>    <a href="#">I</a></li> <li><a href="#">J</a>    <a href="#">K</a>    <a href="#">L</a></li> <li><a href="#">M</a>    <a href="#">N</a>    <a href="#">O</a></li> <li><a href="#">P</a>    <a href="#">Q</a>    <a href="#">R</a></li> <li><a href="#">S</a>    <a href="#">T</a>    <a href="#">U</a></li> <li><a href="#">V</a>    <a href="#">W</a>    <a href="#">X</a></li> <li><a href="#">Y</a>    <a href="#">Z</a></li> </ul>

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**EARLY HISTORY & EXAMPLES IN ANTICIPATION LITERATURE**

- **ca - 2400 BC** \_\_ Communication via written documents that an intermediary carries from one person or place to another almost certainly dates back almost to the invention of writing. The development of a formal postal system comes much later, however. The first documented use of an organized courier service for the diffusion of written documents is in Egypt, where Pharaohs used couriers for the diffusion of their decrees in the territory of the State (2400 BC). This practice almost certainly has roots in the much older practice of oral messaging and may have been built on a pre-existing infrastructure. The first credible claim for the development of a real postal system comes from Assyria, but the point of invention remains in question. Other sources claim much earlier dates for an Assyrian postal system, with credit given to Hammurabi (1700 BC) and Saragon II (722 BC). Mail may not have been the primary mission of this postal service, however. The role of the system as an intelligence gathering apparatus is well documented, and the service was (later) called *angariae*, a term that in time turned to indicate a tax system. The Old Testament (Esther, VIII) makes mention of this system: Ahasuerus, king of Medes, used couriers for communicating his decisions. [http://www.wikinfo.org/index.php/Postal\\_system](http://www.wikinfo.org/index.php/Postal_system)

- **ca - 1400 BC** \_\_ Oldest record of writing in China on bones. The oldest known Chinese writing was carved on "oracle bones," bones and turtle shells used for foretelling fate in the Shang Dynasty (about 1600 to 1045 BC). <http://china.org.cn/english/2003/Jun/66806.htm>

- **ca - 1200 BC** \_\_ According to Aeschylus, the conquest of the town of Troy was transmitted via torch signals. In Agamemnon, Clytemnestra describes the Progress of the Beacon Fires that carried the Tidings of the Fall of Troy: « GLEAM -- a gleam -- from Ida's height, By the Fire-god sent, it came; From watch to watch it leapt, that light, As a rider rode the flame! It shot through the startled sky, And the torch of that blazing glory Old Lemnos caught on high, On its holy promontory, And sent it on, the jocund sign, To Athos, Mount of Jove divine. Wildly the while, it rose from the isle, So that the might of the journeying Light Skimmed over the back of the gleaming brine! Farther and faster speeds it on, Till the watch that keeps Macistus steep See it burst like a blazing Sun! Doth Macistus sleep On his tower-clad steep? No! rapid and red doth the wild fire sweep; It flashes afar on the wayward stream Of the wild Euripus, the rushing beam! It rouses the light on Messapion's height, And they feed its breath with the withered heath. But it may not stay! And away -- away -- It bounds in its freshening might. » [http://www.poetry-archive.com/a/the\\_beacon\\_fires.html](http://www.poetry-archive.com/a/the_beacon_fires.html)

- **ca - 1100 BC** \_\_ Egyptians use homing pigeons to deliver military information. Homing pigeons are amazing birds whose use by humans has been documented as far back as ancient Egypt, Carthage and Rome. Caesar used them in his defeat of Gaul. Use of pigeons spread to India, China and Greece. In fact, China had a postal service that relied on homing pigeons to carry the mail. The Reuters News Service was created in the nineteenth century and relied upon the use of homing pigeons. Homing pigeons were used in the twentieth century in war, and are still used today to pass military communications, as well as rescue operations. Peter James and Nick Thorpe in "Ancient Inventions" state that pigeons were first domesticated in Sumer (southern Iraq) around 2000 B.C.: "Most likely it was the Sumerians who discovered that a pigeon or dove will unerringly return to its nest, however far and for however long it is separated from its home" (James and Thorpe). But the "first actual records of their use as carrier birds come from Egypt," although the authors here do not specify when this occurred (James and Thorpe). Another account in *The Early History of Data Networks* holds that "in the days of the Pharaohs the Egyptians announced the arrival of important visitors by releasing pigeons from incoming ships," which may have been prevalent as early as 2900 B.C. (Holzmann and Pehrson). Elsewhere, centuries later, it is said that "the outcomes of the Olympic Games in ancient Greece, around 776 B.C., were sent to Athens by pigeons" (Holzmann and Pehrson). [Holzmann, Gerard J. and Björn Pehrson. *The Early History of Data Networks*. California: IEEE Computer Society Press, 1995] [James, Peter and Nick Thorpe. *Ancient Inventions*. New York: Ballantine Books, 1994] [http://cultureandcommunication.org/deadmedia/index.php/Homing\\_Pigeons](http://cultureandcommunication.org/deadmedia/index.php/Homing_Pigeons)

- **ca 1000 BC** \_\_ Inuksuit are among the most important objects created by the Inuit who were the first people to inhabit portions of Alaska, Arctic Canada, and Greenland. The term Inuksuk (the singular of Inuksuit) means 'to act in the capacity of a human.' It is an extension of Inuk, meaning 'a human being.' These stone figures were placed on the temporal and spiritual landscapes. Among many practical functions, they were employed as hunting and navigation aids, coordination points, indicators, and message centers. The Inuit are the descendants of what anthropologists call the Thule culture, who emerged from western Alaska around 1000 AD. <http://www.arcticinuitart.com/culture/inuk.html>

- **ca - 976 BC** \_\_ The first recorded example of airmail parcel post in history. *Nizar Abu Mansur al-Aziz, the caliph (975-996) of North Africa, has cherries grown in Baalbek, Lebanon delivered to him in Cairo, Egypt by 600 homing pigeons each with a small silk bag containing a cherry attached to its leg (James and Thorpe 1994:526, cited in Sterling & Kadrey 1999, note 04.1). A pigeon can fly 60-100 kms/hr at over distances of up to 800 km (500 mi) or more. It can navigate both during day and night, and feed itself during the travel (PWN 1966b:771, Grolier 1993).* <http://www.ciolek.com/GLOBAL/early.html>

- **ca 900 BC** \_\_ A postal service is used for governmental purposes in China. It is clear that an organized postal infrastructure is put in place during Qin Dynasty (221 BC-207 BC) and that it is substantially expanded during the subsequent Han Dynasty. The origins of a Chinese mail system may go back to the Zhou Dynasty (1122 BC - 256 BC), when Confucius (551 BC-479 BC) says "news of deeds travels faster than the mail." It may also build on a pre-existing messaging infrastructure started by the Shang Dynasty. Whatever its point of origin, the Chinese Postal Service has clear title to the world's oldest continuously operating mail system. Today's Chinese mail system is continuous with one that was probably formalized under the Qin Dynasty.

- **ca. 624 BC** \_\_ It was known to the ancients at least 600 years before Christ, that a piece of amber when excited by rubbing would attract straws, and that a lump of lodestone had the property of drawing iron. A Greek legend tells us that the lodestone was discovered by Magnes, a shepherd who found his crook attracted by the rock. Thales of Miletus attributed the attractive properties of the amber and the lodestone to a soul within them. The name Electricity is derived from ELECTRON, the Greek for amber, and Magnetism from Magnes, the name of the shepherd, or, more likely, from the city of Magnesia, in Lydia, where the stone occurred. These properties of amber and lodestone appear to have been widely known. The Persian name for amber is KAHRUBA, attractor of straws, and that for lodestone AHANG-RUBA attractor of iron. (John Munro 1891) <http://www.worldwideschool.org/library/books/tech/engineering/HeroesoftheTelegraph/chap1.html>

- **ca 550 BC** \_\_ The best documented claim (Xenophon) attributes the invention of the postal system to Cyrus the Great (550 BC), while other writers credit his successor Darius I of Persia (521 BC). As recorded by Herodotus and Xenophon, the first regular postal system in the history was established in Iran during the reign of the first king of the Achaemenid (Hakhamaneshi) dynasty, Cyrus the Great, in 6th century BC This communication service was covering the Persian Empire from Europe, Asia Minor, and Egypt to Babylon, Aden, and Arabia to Indian Ocean. The messengers were carrying mail by day and night; the relay stations were built only so far distant from each other so that a horse could run without resting or feeding. Thousands of kilometers roads were built to facilitate the delivery of mail throughout the Persian Empire. ANGAR'IA (ἀγγαρεία, Hdt. ἀγγαρηϊόν) is a word borrowed from the Persians, signifying a system of posting, which was used among that people, and which, according to Xenophon, was established by Cyrus. Horses were provided, at certain distances, along the principal roads of the empire; so that couriers (ἀγγαροῦ), who also, of course, relieved one another at certain distances, could proceed without interruption, both night and day, and in all weathers (Herod. VIII.98; III.126; Xen. Cyrop. viii.6 §17; Suid. s.v.). It may easily be supposed that, if the government arrangements failed in any point, the service of providing horses was made compulsory of individuals; and hence the word came to mean compulsory service in forwarding royal messages; and in this sense it was adopted by the Romans under the empire, and is frequently found in the Roman laws. The Roman *angaria*, also called *angarium* *exhibitio* or *praestatio*, included the maintenance and supply, not only of horses, but of ships and messengers, in forwarding both letters and burdens; it is defined as a *personale munus*; and there was no ground of exemption from it allowed, except by the favour of the emperor (Dig. 50 tit. 4 s18 §§4, 29; tit. 5 s10, 11; Dig. 49 tit. 18 s4 § 1; Cod. Theod. 8 tit. 5; Cod. Justin. 12 tit. 51). [Philip Smith, Univ. of London]. A pony express mail service (*chaapar*) exists in Persia. Darius initiated an express mail service to allow fast communication within his vast empire. This was achieved by a series of relay riders on horseback. Herodotus, said "nothing, stops these couriers from covering their allotted stages in the quickest possible time - neither snow, rain, heat, nor darkness." On the basis of information reported by the Greek historians Herodotus and Xenophon, the first regular postal service in the world was established in ancient Iran in 6th century BC during the reign of the first king of the Achaemenids, Cyrus the Great (550 BC-529 BC). The service used the system of a messenger (in Persian: *Chapaar*) or the relay messengers (in Persian: *Chapaar-beh-Chaapar*). The messengers were riding horses and carrying mails by day and night; the relay stations were built only so far distant from each other so that a horse could run without resting or feeding. The riders would stop at regularly placed Post Houses (in Persian: *Chapaar-Khaneh*) to get a fresh horse or to pass on their packets of dispatches to another messenger for the remainder of the distance. Herodotus also praised the swift courier posts of ancient Persian Empire. [http://penelope.uchicago.edu/Thayer/E/Roman/Texts/secondary/SMIGRA\\*/Angaria.html](http://penelope.uchicago.edu/Thayer/E/Roman/Texts/secondary/SMIGRA*/Angaria.html) [http://www.iranian.ws/cgi-bin/iran\\_news/exec/view.cgi/13/7579/printer](http://www.iranian.ws/cgi-bin/iran_news/exec/view.cgi/13/7579/printer) [http://members.ozemail.com.au/~ancientpersia/intro\\_frm.html](http://members.ozemail.com.au/~ancientpersia/intro_frm.html)

- **ca 500 BC** \_\_ Greeks use smoke signals, mirrors, beacon fires, trumpets and shouting to relay messages. Aeneas Tacitus, a Greek military scientist and cryptographer, invented an optical communication system that combines water and beacon telegraphy. Torches indicated the beginnings and the ends of message transmissions while water jars were used to transmit the messages. These jars had a plugged standard-size hole drilled on the bottom side and were filled with water. As those who sent and those who received the message unplugged the jars simultaneously, the water drained out. Because the transmitted messages corresponded to water levels, the sender indicated by torch signal that the appropriate water level has been reached. It is a disadvantage that the possible messages are restricted to a given code, but as this system was mainly used for

military purposes, this was offset by the advantage that it was almost impossible for outsiders to understand these messages unless they possessed the codebook. [http://www.smith.edu/hsc/museum/ancient\\_inventions/decoder2.html](http://www.smith.edu/hsc/museum/ancient_inventions/decoder2.html)

- - **ca 350 BC** \_\_ *Water Telegraph*. The first recorded telegraph was built around 350 BC by a Greek named Aeneas. A torch gave the signal for sender and receiver to start water flowing out of out of identically sized vessels. A floating marker, with a series of possible messages, falls with the water. When the desired message lines up with rim, the sender signals again and the receiver stops the water and reads off the message. The Roman historian Polybius (ca. 200-118 BC) says this 'hydraulic telegraph' was used to send military messages from Sicily to Carthage during the First Punic War (264-241 BC). In the year 360, "Aeneas the Tactician" describes in his book, "The Art of Beset", his invention of a hydro-optical telegraph. His basic idea was to store the signals of earlier torch telegraphs so they could be read at a later time. At both telegraph stations equivalent water vessels with taps were posted. With torch signals, orders were given to open and close the taps. This way the level of the water within the vessel sank. In advance there were messages assigned to every level of the water. On the one hand you couldn't send any message you wanted, but on the other hand you could store a message. [http://science.uniserve.edu.au/school/curric/stage6/phys/communicates/History\\_section/history\\_narrative.htm](http://science.uniserve.edu.au/school/curric/stage6/phys/communicates/History_section/history_narrative.htm)

- - **ca 200 BC** \_\_ *Human messengers on foot or horseback common in Egypt and China with messenger relay stations built. Sometimes fire messages used from relay station to station instead of humans.*

- - **ca 62 BC** \_\_ *The first best-documented postal service is that of Rome and was created during the time of Augustus Caesar (62 BC-AD 14). The service was called 'cursus publicus' and had light carriages (rhedae) with fast horses. There was also a slower service which had two-wheels carts (birolae) pulled by oxen. Thus the concept of regular and speed post was very much in existence even then. The service was originally for Government correspondence but soon even citizens had access to it. About the creation of the cursus publicus Suetonius (Aug. 49.3) noted: So that he [Augustus] quickly and easily could receive reports of events in every province, he stationed first young men, and later carriages, at points along the military roads. The latter system proved itself more advantageous, because then the same courier could deliver the message to its destination and, if necessary, also personally be questioned. The text states clearly that Augustus' primary concern was the transportation of important messages. Suetonius describes two methods by which messages were transmitted. At first, young men from local communities were posted at points along the viae militares, apparently as a sort of relay system of runners, who passed messages at each station from one to the next. As Suetonius notes, this system had the disadvantage that the courier had no personal knowledge of his messages' content and, therefore, could neither answer questions nor provide supplementary information about conditions or events at the place where the message originated. The system was later changed to include vehicles that could be exchanged at the staging posts. Under the revised system, the same messenger could travel from his point of departure directly to his destination. The cursus publicus was a government transportation system based on obligations placed by the Roman state on private persons. They provided equipment, animals and wagons used by government agents during their travels. In the early empire, compensation had to be paid for this service, but that had fallen into abeyance in late antiquity. The burden of this munus then fell completely on the inhabitants, who also had to maintain the way stations and care for the animals. [Anne Kolb - Transport and Communication in the Roman state] <http://www.ancientworlds.net/aw/Places/Property/881679>*

- **ca 37** \_\_ *Heliograph (A device for transmitting messages by reflecting sunlight) - first recorded use of mirrors to send messages by Roman Emperor Tiberius. It is a wireless solar telegraph that signals using Morse code flashes of sunlight reflected by a mirror. The flashes are produced by momentarily pivoting the mirror, or by interrupting the beam with a shutter. The heliograph was a simple but highly effective instrument for instantaneous optical communication over 50 km or more. The first recorded use of the heliograph was in 405 BC, when the Ancient Greeks used polished shields to signal in battle. In about 35 AD, the Roman emperor Tiberius, by then very unpopular, ruled his vast empire from a villa on the Isle of Capri. It is thought that he sent coded orders daily by heliograph to the mainland, eight miles away. <http://www.sonso.net/Heliograph>*

## 90 - 1000

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- **ca 100** \_\_ « The Pneumatics », Hero (or Heron) of Alexandria. A collection of around 80 mechanical apparatus, that work with air, steam or hydraulic pressure. This includes a fire extinction apparatus, automata that provide water if a coin is inserted and the first steam engine (Aeolipile). The Heronball, Thermoscope, Syphon, Fontain, and Aeolipile. "The investigation of the properties of Atmospheric Air having been deemed worthy of close attention by the ancient philosophers and mechanists, the former deducing them theoretically, the latter from the action of sensible bodies, we also have thought proper to arrange in order what has been handed down by former writers, and to add thereto our own discoveries : a task from which much advantage will result to those who shall hereafter devote themselves to the study of mathematics. We are further led to write this work from the consideration that it is fitting that the treatment of this subject should correspond with the method given by us in our treatise, in four books, on water-clocks. For, by the union of air, earth, fire and water, and the concurrence of three, or four, elementary principles, various combinations are effected, some of which supply the most pressing wants of human life, while others produce amazement and alarm." (excerpt of the Preface). Heron of Alexandria, who lived in the first century AD, wrote an extended treatise on Pneumatics, in which he described his use of pneumatic