Synchronous and Asynchronous Communication Systems

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INTRODUCTION

This article talks generically about telecommunication systems. A telecommunication system involves a transmitter, a transmission medium, and a receiver. The type of communication between the transmitter and the receiver can be the synchronous transmission mode or the asynchronous transmission mode. Synchronous communication is sending data with synchronization to an external clock. The most significant aspect of synchronous communication is that the transmitter and receiver clocks are dependent and synchronized. The synchronous communication is a transmission technique that is widely used in telecommunications. Asynchronous communication is sending data without synchronization to an external clock. The most significant aspect of asynchronous communication is that the transmitter and receiver clocks are independent and are not synchronized. The synchronous communication is a transmission technique, which is widely used in personal computers, providing connectivity to printers, modems, fax machines, and so forth.

Communication systems can function in the synchronous and asynchronous transmission mode. In the synchronous mode all the transmitted bits are information bits, and therefore the transmission efficiency is 100%. However, in the asynchronous mode, not all the transmitted bits are of information, since the start and stop bits must be added.

With 8 bit words, transmitted without coding, the efficiency is in the synchronous case of 8/8=1 -> 100%, whereas in the asynchronous case of 8/10=0.8 - > 80%. For this reason, the synchronous mode is more efficient in terms of transmission since all the bits are information, and there is no redundancy. Then for the same transmission bit rate, the synchronous system carries more information bits.

The synchronous and the asynchronous systems differ essentially in the local clock recovery block. The asynchronous system needs only a detector of start/stop bits to control the local oscillator, whereas the synchronous one needs a synchronizer that detects the data transitions to recover the clock.

This article has various parts. In the beginning, we deal with the fundamentals of telecommunication systems after we present the synchronous and asynchronous transmission modes, and later we concentrate our attention in the synchronous system mode. We present the blocks diagram of a general synchronous transmission system. Finally, we focus our work in the block synchronizer, which is the heart of the repeater. The signal loses energy and gets deformation when it travels between the transmitter and the receiver. Then, it is necessary to have repeaters along the transmission medium. The repeater restores the lost energy and samples the signal, recovering its original format without errors. The synchronizer or clock recovery is the principal part of the repeater and will be particularly developed in this work. For people less familiar and more curious with telecommunication systems, we introduce the Fundamentals of Telecommunications in a subsection.

FUNDAMENTALS OF TELECOMMUNICATIONS

Telecommunication is the transmission of signals over a distance for the purpose of communication. Telecommunication is a compound of the Greek prefix "tele" meaning "far off" and "communication" meaning "exchange of information." Nowadays, this process involves the sending of electromagnetic waves by electronic transmitters, but in earlier years, it involved the use of smoke signals, drums, or semaphores. Today, telecommunications use devices such as the television, radio, and telephone. There is also a vast array of networks that connect these devices, including computer networks, public telephone networks, and radio and television networks. Computers communicating across the Internet is just one of many examples of telecommunications.

The basic elements of a telecommunication system are:

- **A transmitter:** Takes information and converts it to a signal for transmission.
- **A transmission medium:** The medium or channel over which the signal is transmitted.
- **A receiver:** Receives the incoming signal and converts it into usable information.

Telecommunication over a phone line is called point-to-point communication because it is between one transmitter and one receiver; telecommunication over a transmission point and various receivers is called poin-to-multipoint because there is one sender (data source) and various receivers (mobiles or computers); telecommunication through radio broadcast is called broadcast communication because it is between one powerful transmitter and numerous receivers. In a radio system, the broadcast tower is the transmitter, the free space is the transmission medium, and the radio is the receiver. Often, telecommunication systems are two-way, and the devices act as both a transmitter and receiver, or a transceiver.

Signals can be analog or digital. In the analog system, the signal varies continuously. In the digital system, the signal varies abruptly and is a set of discrete values (0s and 1s). An analog network may consist of one or more switches that connect two or more users. Digital networks may consist of one or more routers that route data to the correct user. Modulation would permit the transmission of a base band signal, not suitable for transmission due to its low frequency. Then, this base band information can be superimposed on a higher frequency signal known as the carrier wave. Modulation can also be over digital systems as for example amplitude shift keying, frequency shift keying, and phase shift keying. Bluetooth uses phase shift keying for exchanges between devices.

BRIEF HISTORY OF TELECOMMUNICATIONS

In the early telecommunications, the first forms of telecommunications include smoke signals and drums. Drums were used by natives in Africa, New Guinea, and tropical America, whereas smoke signals were used by natives in North America and China.

In 1792, a French engineer, Claude Chappe (1763-1805), built the first visual telegraphy (or semaphore) system between Lille and Paris. In 1794, a Swedish engineer, Abraham Edelcrantz (1754-1821), built a quite different system from Stockholm to Drottningholm. As opposed to Chappe's system which involved pulleys and rotating beams, the Edelcrantz system relied only upon shutters and was therefore faster. Semaphore, as a communication system, suffered from the need of operators and expensive towers at intervals of only 10 to 30 kilometers (6 to 19 miles). As a result, the last commercial line was abandoned in 1880 (Halsey & Johnston, 1989).

Telegraph and Telephone

The first commercial electrical telegraph was constructed by Charles Wheatstone (1802-1875), a British inventor, and William Fothergill Cooke (1806-1879), a UK inventor. It used the deflection of needles to represent messages and started operating over 21 kilometers (13 miles) of the Great Western railway on April 9, 1839. On the other side of the Atlantic Ocean, Samuel Morse (1791-1872), a U.S. inventor, independently developed a version of the electrical telegraph that was unsuccessfully demonstrated on September 2, 1837. He was joined by Alfred Vail (1807-1879), another U.S. inventor, and developed a register or telegraph terminal. This was demonstrated successfully over five kilometers (three miles) on January 6, 1838 and later over 64 kilometers (40 miles) between Washington and