

# THE Locomotive

## THE *full* STORY

### **Telecommunications Equipment — Advances in Technology Continue to Transform the Industry**

By Robert Weir, P.E.

Despite the global economic downturn in the telecommunications industry, telecommunications equipment technology continues to rapidly expand. There are equipment breakdown risks associated with switching and transmission equipment that compose a telecom network. This article examines the technologies of modern telecommunications. An accompanying article (“Heat and Power Problems are the Greatest Risks To Telecom Equipment”) discusses telecommunications equipment and the factors that can lead to a breakdown.

#### **Telecommunications is Complex**

Telecommunications equipment has evolved from a simple device that conveyed voice over modest distances (telephony) to complex media that transfer voice and data worldwide. Telecom now uses analog and digital technology, and fiber-optical conductors.

The development of cellular telephones illustrates the complexity of telecommunications today. A small radio transceiver — a cell phone — is continuously tracked by a system of cell towers. When we place a call to the office, the transceiver contacts the nearest cell on one of hundreds of available frequencies. Using full duplex transmission (both parties can speak and hear simultaneously), it connects our call through the cellular switching network to the local telephone network in the vicinity of the office. The call is ultimately connected to the line and telephone that corresponds to the number that was dialed.

These events occur in about five seconds. The availability of this service is so robust that we become annoyed when we encounter perfectly understandable limitations imposed by terrain or cell-tower density.

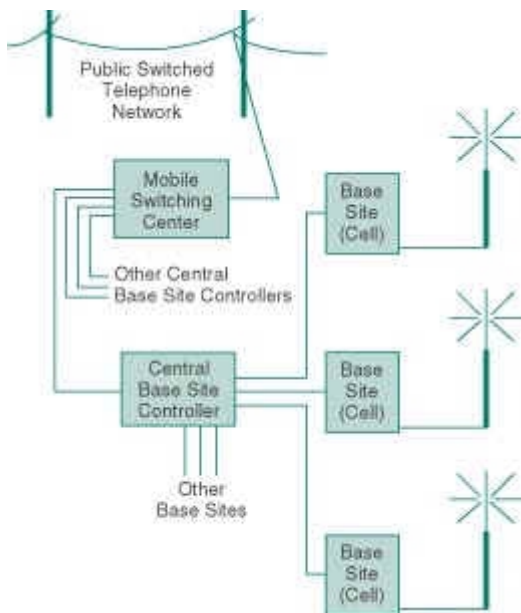


Figure 1

Figure 1 shows only the portion of the cellular telephone system that connects the cell antenna to the public switched telephone system. A more complex network makes the connection to the dialed telephone number.

## The Technologies of Telecommunications

Virtually all kinds of electronic and digital technology are used to manage telecommunications. Although the majority of telephone sets are still connected to copper wire (analog), the network handling the calls uses digital computers, a variety of multiplexers, solid-state and analog switches and satellite, radio and microwave links. Recently, telephone connection using the same broadband cable that provides television and Internet service has become a reality. This development may indicate that broadband cable may be the telephone connection of the future. On the other hand, Digital Subscriber Line (DSL) technology is giving new life to existing copper wired circuits.

The essence of a telephone network is its ability to switch connections. Originally, telephone connections were actual electrical circuits, switched at the local telephone office by human operators who used a switchboard of patch cables and plugs. That same function survives, but a computer system using solid-state electronics serves as the physical switch as well as providing the switching logic once supplied by the operator.

Another aspect of the network is the successive concentration of connections from the individual telephone sets toward the center of the network.

Figure 2, below, illustrates this principle. Individual telephone lines are connected by local telephone wiring to a central office, sometimes called an exchange. They are then connected to terminals on the central office switch, sometimes called a signal switching point, or SSP, as shown here. The central office switch can then connect the individual telephone line to one of several trunks (sets of wiring or fiber optic lines) that connect the central office switch to other switches in the network.

Eventually, a connection can be made through a succession of switches to another telephone line in another geographic location. However, all connections are redundant from the point where the individual telephone line connects to the central office switch to the corresponding point at the remote telephone line. Figure 2 shows that there are at least three separate routes available to make the connection.

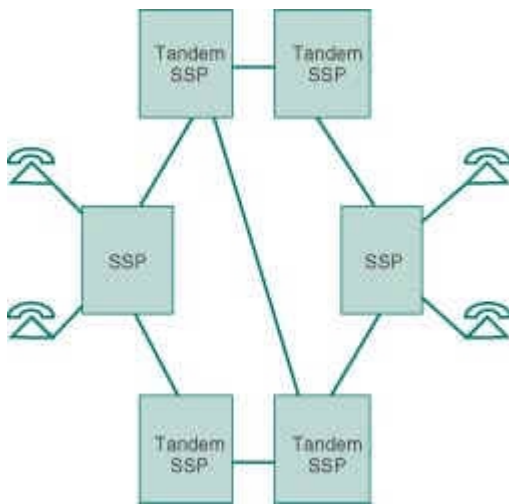


Figure 2

This simplified diagram conveys the basics of a “ring network,” in which all SSPs are arranged in a ring formed by interconnected trunks. It is this interconnecting system that makes telephone communication so resistant to interruption caused by local events and even disasters, for example the destruction of the World Trade Center on Sept. 11, 2001.

Note here that the lines connecting the SSPs in this diagram will be referred to as trunk lines, or trunks, in this discussion.

## **From Operators to Digital Switches**

Figure 2 illustrates how telephone systems work. It is not significantly changed from the days of human operators, except switching and trunk design have advanced. Connections between telephone offices can now involve microwave links, fiber-optic links and sometimes satellite links, in addition to traditional copper conductors. Switches are now built around digital computer systems that manipulate sophisticated, solid-state devices to manage trunk line traffic and routing.

Connections to the trunk lines involve additional equipment, the switch (SSP), referred to as transmission equipment. Transmission equipment concentrates the communications load to maximize the capacity of the trunks. Transmission equipment also includes devices such as digital and analog multiplexers and demultiplexers and packet switching. Packet switching divides a message or conversation into discrete “chunks,” and sends them to a destination sometimes using different physical routes. The “chunks” are reassembled at the final destination. Packet switching and multiplexing are both methods for maximizing available trunk capacity when moving voice and data traffic.

## **Equipment is Durable, but Still Can Be Damaged**

Telecommunications equipment, while very sophisticated and cutting edge, has a strong record of reliability. But modern telecommunications equipment is still vulnerable to damage that can sometimes be costly to repair and disruptive to operations. The accompanying article (“Heat and Power Problems are the Greatest Risks To Telecom Equipment”) discusses telecommunications equipment in greater detail and examines the exposures that can increase the risk of equipment breakdown.

**Robert Weir, a director with The Hartford Steam Boiler Inspection and Insurance Company, is a Professional Engineer and has an extensive background in the design and construction of power generation and industrial equipment and systems. A graduate of the U.S. Naval Academy, he holds a Master’s Degree in mechanical engineering from Worcester Polytechnic Institute and is a graduate of Suffolk University Law School. He is a member of the American Society of Mechanical Engineers (ASME), a permanent committee member of the National Fire Protection Association (NFPA 37), and is admitted to practice in Massachusetts and federal courts, including the U.S. Supreme Court. He is a registered patent attorney.**