Geographic information system (GIS)

Utility operators will need GIS to make the best decisions about key issues such as collecting data, managing smart meter and sensor installation, analyzing customer behavior, and incorporating renewable energy.

When viewed in the context of geography, data is quickly understood and easily shared. Furthermore, GIS technology can be integrated into any enterprise information system framework.

Data Management:

Utilities already rely on GIS to manage assets and outages and map the location of overhead and underground circuits.

GIS links utility asset data with customer information to streamline the rollout of smart grid work orders.

With GIS, utilities can capture the mashup of information related to the smart grid, from customer behavior and the placement of smart meters to the location of electric vehicle chargers and renewable resources.

Managing data within GIS ensures the degree of accuracy required for smart grid functionality.

Planning and Analysis:

To see whether a smart grid deployment is effective, utilities use GIS to analyze marketing campaigns and study customer behavior patterns along with demand response.

With a rich set of easy-to-use spatial analysis tools, GIS helps determine the optimal location for smart grid components such as smart meters, sensors, and cell relays.

GIS can also help identify vulnerabilities, weigh asset investments, and gauge customer response to a smart grid implementation.

Workforce Automation:

A smart grid relies on accurate data. Mobile GIS is the surest way to move data quickly to and from the field and the office.

The productivity of a smart grid implementation can be increased by using GIS to schedule and dispatch utility crews.

A GIS allows utilities to monitor the location and status of field work. From the field, crews have access to a set of application templates for recording and reporting the progress of smart grid hardware installation.

Situational Awareness:

Utilities bring it all together with GIS to view and track smart grid deployment and operation.

Through GIS-based graphic outputs and Web-based reporting, they are able to quickly monitor and demonstrate how the organization is progressing on smart grid activities.

GIS provides a Web-based dashboard that shows the status of any project, alerts staff to variances in the schedule, monitors investments, and locates new work orders.

The global positioning system

The GPS was initiated with the launch of the first Block I satellites in 1978 by US Department of Defense.

By 1994 the complete constellation of 24 modern satellites was put in place. (In 2007 there are 30 active satellites in orbit, the extra satellites providing for greater accuracy in estimation of spatial coordinates of the receivers Block I and II satellites have been retired.

These are arranged in six orbital planes displaced from each other by 60° and having an inclination of about 55° with respect to the equatorial plane as shown in Fig.

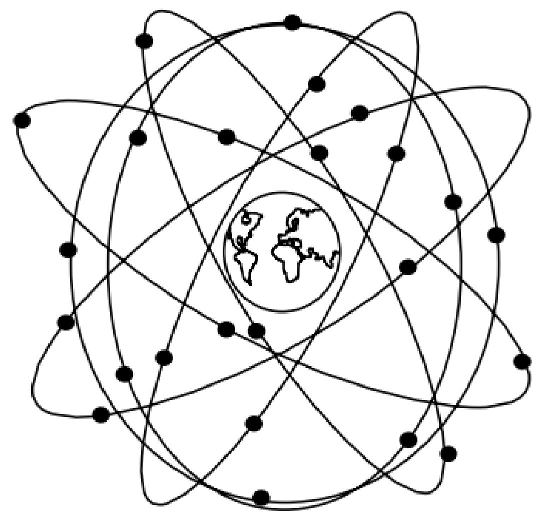


Fig. Representation of the GPS satellite disposition. There are four satellites in each of the six orbits, which orbit around the earth with a period of half a day

The most common use of the GPS system is in determining the coordinates of the receiver, although for the PMUs the signal which is most important is the one pulse per-second.
This pulse as received by any receiver on earth is coincident with all other received pulses to within 1 microsecond. In practice much better accuracies of synchronization – of the order of a few hundred nanoseconds – have been realized.

The GPS satellites keep accurate clocks which provide the one pulse per-second signal. The time they keep is known as the GPS time which does not take into account the earth's rotation. Corrections to the GPS time are made in the GPS receivers to account for this difference (leap-second correction) so that the receivers provide UTC clock time.

Communication options for PMUs

Communication facilities are essential for applications requiring phasor data at remote locations. Two aspects of data transfer are significant in any communication task.

Channel capacity is the measure of the data rate (in kilobits per second or megabits per second) that can be sustained on the available data link.

The second aspect is the latency, defined as the time lag between the time at which the data is created and when it is available for the desired application.

The data volume created by the PMUs is quite modest, so that channel capacity is rarely a limiting factor in most applications. On the other hand, some applications may require relatively small latency – in particular, applications for real-time control of power systems.

At the other extreme are post-mortem analysis applications, which require PMU data to help analyze the power system performance during major disturbances. These applications are not affected by large delays in transferring the data.

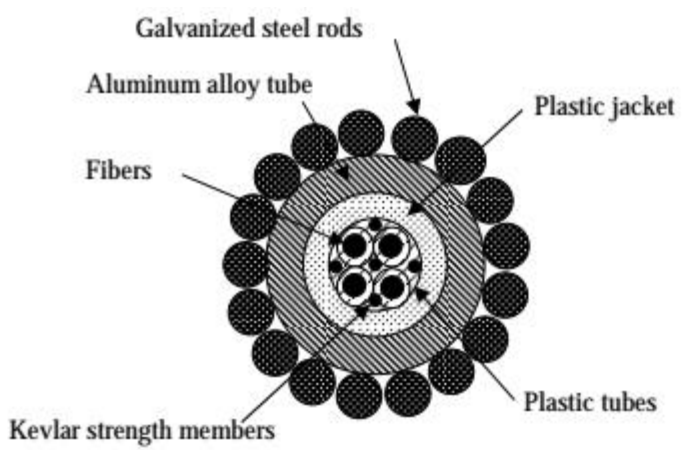
The communication options available for PMU data transfer may be classified according to the physical medium used for communication.

Leased telephone circuits were among the first communication media used for these purposes.

Switched telephone circuits can be used when data transfer latency is not of importance.

More common electric utility communication media such as “power line carrier” and microwave links have also been used, and continue to be used in many current applications.

Of course, the medium of choice now is fiber-optic links which have unsurpassed channel capacity, high data transfer rates, and immunity to electromagnetic interference. shows typical construction of a fiber-optic cable



The most popular deployment of fiber-optic cables is in the ground wires of transmission lines. The ground wires may carry multiple fibers which may be used for other communication, protection, and control applications for power system operation and management.

Other configurations of fiber-optic links may involve separate towers for the fiber cable in the electric utility right-of-way, wrapping the fiber cable around the phase conductors, or direct burying the fiber cable in the ground.

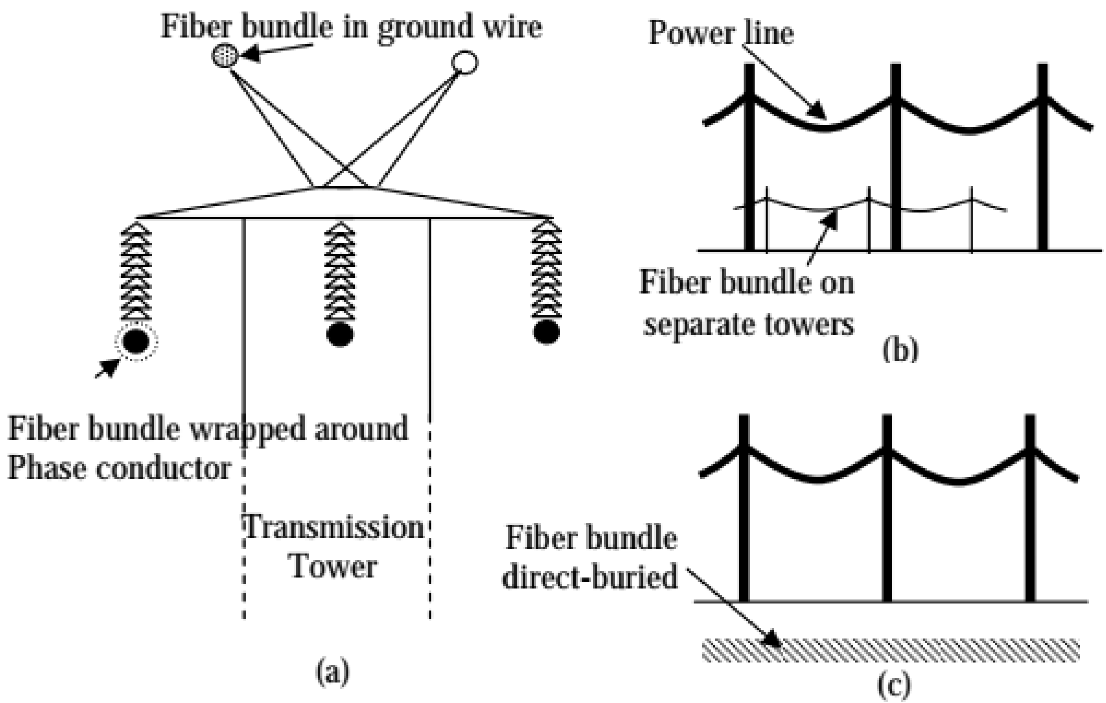


Fig. 5.5 Arrangement of fiber-optic bundle commonly employed by electric utilities. (**a**) The fiber is in the ground wire. (**b**) The fiber bundle is strung on separate towers on transmission line right-of-way. (**c**) The fiber-optic cable is direct-buried.