Service Interfacing at the Access Point 14

14.1 Legacy Interfacing

Unlike the office network where device interfaces have been standardized to wired IP/Ethernet since a long time (with wireless increasingly taking over today), the power system communication network interfaces have till recently remained largely diversified. The most common, but far from being exhaustive, are as follows:

- EIA RS232C/ITU-T V.24–V.28—is probably the most widely used serial communication interface in the power system allowing communications of SCADA RTUs, Instrumentation HMI, recorders, data loggers, alarm transmitters, etc. This is a non-balanced interface consisting of 1-wire Tx and Rx signals + Control signals + Ground + clocks for synchronous mode. It can transmit synchronous or asynchronous data at speeds up to 20–30 kbps.
- EIA RS422/RS423 (ITU-T V11/V10) allows higher speeds and longer distances than RS232. Transmit and receive signals are balanced (2-wires) for RS422/V11. It is mainly used for applications requiring higher speed than 20 kbps (e.g., teleprotection signaling).
- ITU-T G.703—is the telecom carrier interface for transporting a full primary multiplex at 2048 kbps, currently referred to as 2 Mbps or E1 (as well as its US equivalent T1). In the power system, it corresponds to an output of the primary interface multiplexer, to an input of the SDH transmission system, or to the communication interface of certain devices requiring high speeds or bypassing of the primary multiplexer. G703 also defines co- and contra-directional 64 kbps interfaces used by some protection signaling and current differential protection relays now being replaced by E1, by IEEE C37.94 or by Ethernet.
- Analog 4-wire Voice Frequency interface(4-wire E&M)—This interface is used not only for connecting legacy analog voice systems now largely replaced, but also as a transparent signal transmission channel for older generation substation devices such as voice frequency modems or protection signaling.

C. Samitier (ed.), *Utility Communication Networks and Services*,
CIGRE Green Books, DOI 10.1007/978-3-319-40283-3_14

- Subscriber-side and Exchange-side analog voice interfaces—these 2-wire interfaces called FXS and FXE provide signaling, loop-disconnect, ringing current, and all other functions necessary for connecting an analog telephone set to a remote telephone exchange.
- IEEE C37.94—is an optical interface allowing the transmission of Nx64 kbps between protection relay and the communication system in the substation local area ($\sim$2 km) over optical fibers and hence avoiding electromagnetic influences and potential rise on copper wire connections.

These legacy interfaces in the electrical power substation are bound to disappear in time but with a lifetime that can be very long. The replacement and re-commissioning of protection relay devices and SCADA RTUs require significant effort and is typically extended in time according to a gradual migration plan. It is therefore important to keep legacy device interface aggregation (i.e., substation access multiplexers) as long as these legacy interfaces persist. Interface conversion can be costly when used in extensive manner, is a source of faults and human errors, and degrades performance.

14.2 Ethernet Access

Replacing legacy data interfaces in the substation by Ethernet ports presents the following benefits:

- Single interface replacing many different functional, electrical, and mechanical interfaces for data and voice circuits are used in the electrical power environment (RS-232, RS-422/V.11, RS-423/V.10, RS-485, X.21, G.703, etc.). This interface standardization results in reduced engineering and coordination effort, reduced documentation requirements, reduced spare parts, and no interface converters.
- Low cost of connection point—RJ45 is the most economical connection point well below any other data interface (connector, patch cord, port hardware, network hardware).
- Bit rate flexibility—All interfaces are at the same bit rate. The throughput at the interface and across the network is soft controlled and can be modified without changing any physical boards or channel reprogramming across the network.
- Fiber isolation—Spans of cable that require galvanic isolation or electromagnetic immunity can be implemented in optical fibers often without any external electro-optical converters.
- No Protocol conversion and transcoding—Knowing that at the central node, generally it is required to connect into a platform on an Ethernet LAN, direct Ethernet interfacing at the substation end avoids protocol conversions.
- Easy implementation of back up control center routing—No junction splitters required for broadcasting data to two different destinations.

- Stable and standard protocol—Ethernet is the most dominant standard in the networking industry. Its widespread use guarantees its availability for a very long time.
- Transmission span—Ethernet allows much longer separation between the application equipment and the network equipment than any of the legacy data interfaces that it replaces.
- Strong industry support—Ethernet technology is available from a large number of suppliers with continuous development (switching, speed, fiber, wireless …) both at the supplier end and at the standardization end.
- Extensive topological flexibility—Through the use of Ethernet switches it is possible to adapt to any topology and environment constraint.

Various standard Ethernet interfaces have been defined and used extensively for different applications. Industrial-grade versions exist abundantly on the market. The most common operate at a line bit rate of 100 Mbps (Fast Ethernet) over copper wire and over optical fibers. 1 Gbps interfaces Gigabit Ethernet (GbE) are mostly used in the network interconnecting communication nodes or inside the substation LAN but not common in the connection of an application network to the transport network (user-to-network interface).

Higher bit rate Ethernet interfaces are continually being developed and introduced in different application domains. 10 G is widely available and occasionally used in utility core networks, 40 and 100 G for the moment only in mainstream telecommunications.