

Leased Circuit Requirements Summary for Protective Relaying

Past Practice

Electric utilities have a long history of using telephone company (telco) non-switched, private line, leased circuits for transmission line teleprotection. On the bulk electric system (BES), leased circuits are typically used alongside the electric utility's own private network (power line carrier, microwave radio, or fiber optic). In fact, on non-BES power lines, telco leased circuits are often the only means of teleprotection. These leased circuits may be broadly categorized into two types—analogue (audio tone) or digital time division multiplexing (TDM).

These legacy telco circuits have predominantly used twisted-pair copper cabling to provide this service to substations. The use of conductive telephone cable at electric supply locations presents concerns in the areas of safety and reliability due to the possibility of induced voltages and ground potential rise (GPR), the latter being prevalent during fault conditions on a high voltage transmission line.

The industry has developed high voltage protection (HVP) apparatus and techniques to mitigate these issues, which are well documented in IEEE standard 487-2015, "IEEE Standard for the Electrical Protection of Communications Facilities Serving Electric Supply Locations—General Considerations." The standard defines an area—referred to as the zone of influence (ZOI)—that due to GPR may have a hazardous potential voltage (typically 300 V peak) above a remote ground point.

IEEE-Std-487-2015 further defines various service types and service performance objective (SPO) classifications. These categorizations are used to define the circuits' purpose and required reliability. Tables 1 and 2 below are extracted from that IEEE standard and provide definitions of the service types and SPO classifications. The large, regional telcos have created service order forms that contain fields for the electric utilities to specify the combination of service type and SPO. The telco would then design and install the leased circuit with the appropriate HVP equipment to meet the requirements. However, some utilities have leased circuits that pre-date the practices detailed in IEEE-Std-487-2015. In such cases, the telcos consider the installation as "grandfathered," which usually means that as long as no change is made to the circuit, it is allowed to remain in place without HVP that is compliant to the current standard.

Table 1 Service Type

Type	Definition
Type 1	Services requiring either dc transmission or ac and dc transmission used for 1. Basic exchange telephone service or private line, or both; voice telephone service (e.g., telephone, tie lines, trunks, radio control, dc alarms, telegraph); and digital data service (DDS) (ac and dc transmission). 2. Telemetry, supervisory control, etc.
Type 2	Private line services requiring ac or dc transmission, or both, used for pilot wire protective relaying, or dc tripping.
Type 3	Private line services requiring only ac transmission used for telemetry, supervisory control, data, etc.
Type 4	Private line services requiring only ac transmission used for audio tone protective relaying.
Type 5	Digital services with equipment subject to latency, or synchronization, time delay issues. May include services such as DS-1 digital transmission, time-division multiplex (TDM), packet-based, T-1, ISDN PRI, xDSL private line transport services, DDS (ac transmission only), and Ethernet.

Table 2 SPO Classification

SPO Class	Definition
Class A	Non-interruptible service performance (shall function before, during, and after the power fault condition)
Class B	Self-restoring interruptible service performance (shall function before and after the power fault condition)
Class C	Interruptible service performance (can tolerate a station visit to restore service)

Current Situation

Utilities report that issues arise when a non-standards compliant substation leased circuit installation is modified, for example, by increasing the quantity of circuits, changing the parameters of an existing circuit such as data rate, or shifting from analog to digital. For this type of case, the telco requires installation of modern HVP or a fiber optic cable entrance to replace the copper cable. In either event, there is a cost to the utility of tens of thousands of dollars.

An even more pressing issue has surfaced from the wireline communications industry, which is in the midst of a technology transition involving retirement of the copper wire cables and replacement with fiber optics. Furthermore, the telcos have largely completed the transition of their network equipment and protocols (at both the core and access levels) from TDM and have implemented a converged (voice/video/data) packet-switched network. These modern telco networks are best suited for high-speed data (aka “broadband”) communications, as opposed to delivering low-speed data for critical teleprotection in a consistent, reliable manner.

As a result, electric utilities are finding that they are no longer able to obtain new analog or digital TDM private line services. In many cases, telcos have obtained permission from public utility commissions to discontinue these types of service offerings. Electric utilities are receiving “sunset” notifications

from telcos that these services are no longer tarified, and often a date is included for when the services will be disconnected. Where legacy services continue to be available, it is on an individual case basis (ICB), which is usually at an increased and often escalating cost.

Gaps

The packet-switched service offerings from a telco are generally available in either a Layer 3 multiprotocol label switching (MPLS) version or Layer 2 (Carrier Ethernet). In addition, for either of these service types, interfaces are available that are able to emulate the legacy private line offerings. While these packet-switched services are available to enterprise customers, they are not yet available with HVP for use in substations.

Recommendations

AT&T and CenturyLink were both contacted regarding the availability of MPLS and/or Carrier Ethernet service with HVP for use at substations. It was learned from CenturyLink that a teleprotection Type 5 (packet-switched), SPO Class A (non-interruptible) offering is planned to be available in the fourth quarter of 2017. This will require installing fiber from the telephone company central office to the substation, and the utility will need to provide mounting space for telco equipment (Tellabs UMC100) in the substation control house along with dc power.

CenturyLink is still working out details with their MPLS and Carrier Ethernet product groups. It seems apparent that with this Tellabs product, CenturyLink would be able to continue offering the legacy analog and digital TDM private line services for teleprotection.

The following questions should be included in an electric utility's discussion with their telco account representative:

- What is the sunset date for legacy analog and digital (TDM) private line leased circuits?
- Are MPLS and/or Carrier Ethernet available for ordering with HVP (Service Type 5) and with Class A (non-interruptible) reliability classification?
- If Class A is available with MPLS and/or Carrier Ethernet, please clarify if this applies beyond the HVP and if the committed information rate (CIR) is guaranteed under all telco network loading conditions.
- Are legacy analog and/or digital TDM circuit emulation available on the MPLS and/or Carrier Ethernet service offering?
- What are the fees, charges, terms and conditions that accompany MPLS and/or Carrier Ethernet with HVP?
- Are there locations within the electric system territory for which the telco uses a local exchange carrier to reach the utility substations? If so, are there any exceptions to the previous answers?

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