Deployable fiber-optic systems for harsh industrial environments

December 18, 2013

By Rick Hobbs, Optical Cable Corp.

As the use of fiber optics has increased within the industrial sector, so have the number of “deployable” systems used in applications from oil and gas exploration, drilling, and distribution to mining.

As opposed to fixed installations, deployable systems are designed to be quickly installed, retracted, and then relocated in the field and even deep underground in some of the most inhospitable environments on earth.

Given the environments in which they reside, industrial-grade fiber-optic systems are typically commercialized versions of field-tested, proven military-grade products. As such, the component parts of the system are designed to withstand everything from dust and debris to chemical exposure, temperature extremes, UV, radiation, electrical power transients, interference, fire, moisture, humidity, water, crush, tension, flexing, impact, and vibration. Unlike fixed applications, a deployable system is designed from beginning to end (plug and play) and delivered to the field as a complete solution.

The primary elements of a deployable system include hardened cable jacketing, “genderless” connectors for quick deployment without regard for male or female ends, hybrid systems that include copper along with fiber to deliver data communications and power, and reel systems that speed deployment and retraction while protecting the fiber while not in use or during transit.

Hardened cabling

For purposes of deployment, experts typically recommend tight-bound, tight-buffered distribution style cabling, which is ideal because of its small diameter and lightweight construction. The cable’s tight-bound outer jacket is pressure-extruded directly over the cable’s core. This combination of a helically stranded core and a pressure-extruded outer jacket provides an overall cable construction that offers better crush and impact protection and increased tensile strength. The design also reduces outer jacket buckling during deployment.

Escalating degrees of cable protection are available as needed to meet the specific needs of an application. For example, various jacket materials are available, including PVC or polyurethanes, which are specifically tailored to meet the mechanical and environmental needs of the application. Options within each jacket material include coefficient of friction, cold temperature flexibility, and temperature range, to name a few. Water-tolerant options also are available that take advantage of the qualities of tight-buffered cable and super-absorbent polymer aramid yarn.

Fiberglass or metal braided jackets not only provide excellent abrasion resistance, but also deliver increased rodent protection. In deployable applications, exposed cable is often an intriguing temptation

for animals, which can, and often do, chew on it. Custom rodent-resistant cables are available that include metal or dielectric armor or additives to the outer jacket.

Hybrid cables, connectors

For applications that would benefit from a combination of fiber optics and copper, hybrid connector-cables offer both within the same cabling sheath.

These hybrid cable-connector designs bundle the high performance of fiber with the copper power or control signals in one cable. This design reduces the number of cables that must be designed, purchased, and deployed into a system. Such cables also offer distinct savings in labor and cable structure costs.

Genderless connectors

“Genderless” connectors have both male and female elements, and perhaps are more appropriately described as “dual-gender.” They are designed for quick deployment, enabling the user to unreel fiber cable without regard for male or female ends. In addition, the connector system is designed to resist extreme mechanical and environmental conditions including high vibration, mechanical and thermal shock, and fluid immersion.

Another benefit of genderless connectors is that multiple identical cable assemblies can be daisy-chained (sequenced) together to extend the distance of a deployable system while maintaining polarity. Polarity can be an issue when connecting an odd number of traditional male to female gender connectors. In such cases, an additional connector is required to correct polarity. However, such connectors are known for high loss and add additional components to the system. Therefore, genderless connectors provide a distinct advantage over traditional interconnection systems.

This type of genderless connector provides maximum flexibility in the case of redeployment, particularly when the length of the cable assemblies required for the next application are not fixed, or not even known. Distances of several kilometers are possible, limited only by system link budget (dBm), thanks to genderless connectors.

Reel systems

The key characteristics of a reel system in deployable fiber-optic applications are that the system is lightweight and stackable for storage and transit. To meet these requirements, suppliers provide lightweight alternatives to traditional metal reels. Constructed of durable, yet lightweight, impact-absorbing polymers, these modular reel systems are designed specifically for the demanding needs of harsh-environment fiber-optic installations.

Reels can be used with a simple deployable axle or a flange-supported deployment and acquisition system. These types of systems include A-Frames, cable acquisition cradles, transit case systems, tripods, bumper mounts, backpacks with or without fiber-optic slip rings, and cartridge systems.

The cartridge system, which comes with casters, is an ideal choice in many deployable applications. These systems enable a single person to handle multiple spools at once, quickly deploying fiber and rewinding on the reel without assistance.

To simplify shipping and transit, cartridge systems, transit cases, and reels are designed with interlocking stacking features.

Reel systems also provide a measure of protection for unspooled cabling or when the cabling is retracted. This benefit reduces the need to refurbish components regularly, because the system is better protected during its deployment.

Wireless access/data communications

Although deployable fiber-optic systems are largely "wired," hybrid cabling (the combination of fiber optic and copper/electrical within the same cable sheath mentioned previously) also supports installation of wireless access points anywhere, even underground. This is ideal when access points are constantly changing.

Unlike traditional wireless networking options that require a 110-VAC power supply for each device, a hybrid system can supply power via the same cable that also carries voice and data. As a result, any 802.11-certified devices can communicate through the network, including personal devices such as PDAs, laptops, VoIP devices, and cell phones. This means even personnel deep within mines can communicate with each other and make calls outside the system. In addition, sensor-based data such as temperature, humidity, airflow, and gas levels can also be collected and delivered wirelessly for use by the entire network.

Increasing conversion to fiber optics

There are many industrial companies that are converting to fiber optics as the costs for components continue to drop, making fiber a better option than copper in most applications. Even die-hard copper devotees are moving to fiber – and when they do, they rarely look back.

When system engineers realize the bandwidth opportunities fiber can provide, they usually expand the capabilities of their network and identify creative new ways to enhance the services provided for their applications.

Rick Hobbs is director of business development at Optical Cable Corp. (OCC) in Roanoke, VA.