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DAMAGE TO COMMUNICATIONS UTILITY INFRASTRUCTURE

by
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OVERVIEW

America, and the world, are becoming ever more dependent on communications.

Almost all communications is digital and electronic. Even audio and video is translated to a digital form before being transmitted more than a few miles.

The message format was digital but the drums as heard in the old Tarzan movies just don't provide the bandwidth needed for modern digital communications. Some of the more modern methods by which these digital signals are transmitted include satellite, coaxial copper cable, optical fiber (fiber optic) cable, both twisted and straight paired copper cable, laser, and radio (including microwave radio.)

For the purposes of this article we will concern ourselves with the more easily accessible and damaged cables.

A FEW DEFINITIONS

AWG - American Wire Gauge. A standard for the diameter of wire.

Last Mile - The connection between a telecommunications provider and telecommunications consumer. Typically copper pair for the telephone industry and coaxial cable for the cable television industry.

TDR and OTDR - Time Domain Reflectometer or Optical Time Domain Reflectometer. An instrument for measuring the physical performance of a communications by injecting an electrical or optical signal into a communications circuit and measuring the reflections.

TYPES OF INFRASTRUCTURE THAT ARE PHYSICALLY AVAILABLE FOR DAMAGE.

Infrastructure based on radio or microwave radio is not easily available to physical damage. Microwave towers and satellite base stations are generally well protected. The satellite's themselves are obviously out of easy reach.

Lasers are useful for campus situations and since they have no conducting medium other than space between the buildings, are generally immune to physical damage.

Copper cables (coaxial cable, twisted and straight pair cable) are the traditional technology that is found overhead on utility poles and buried in the ground. Copper is an excellent conductor of electricity. It has a number of other physical characteristics that, together with cost, made it the traditional backbone (no pun intended) of the telecommunications industry. As optical fiber becomes more widely used, the traditional copper pair is seldom used for new work and is generally relegated to last mile connections.

> Overhead (pole mounted) copper wires and cables are found everywhere. Just look out of the nearest window. Today's pole mounted copper cables and wires are typically telecommunications cables containing one or more pairs of solid wire in the 22 AWG to 26 AWG range. The cable television industry also still uses pole mounted coaxial cables for distribution.

> Underground (direct burial and conduit) cables are similar to the pole mounted wires and cables. They require a different type of outer jacket for insulation and protection and are installed below the earth's surface by trenching or boring. Installation depths are normally below 12" and can be as much as 96"

> Underwater cables are also damaged in Florida. Typically, communications cables are not laid on the bottom of rivers, harbors, and passes, but they can be. They can also be found attached to bridges and poles set in water.

Optical Fiber has become the new technology backbone of choice. It has the capability of carrying hundreds, if not thousands, of times as much data as a copper conductor, and is physically about the same size. Because of this capacity, damage to optical fiber cables generally involve much larger losses of service than damage to similar sized copper cables.

Overhead (pole mounted) optical fiber cables are generally comprised of multiple strands of a highly specialized glass encased in a jacket. The fibers are generally organized in pairs with one fiber carrying data in each direction of a communications circuit. Fiber optic cables have physical advantages and disadvantages over copper cables. Copper is less easily damaged mechanically and can be easier to repair. Copper is less susceptible to damage from expansion and contraction. Copper can be damaged by lightning and electrical surges where optical fiber is electrically non-conductive and unaffected by electrical disturbances.

> Underground (direct burial and in conduit) optical fiber cables are comprised of the same materials and manufactured in much the same fashion as overhead cables. The cables can be directly buried or pulled through conduit which is previously buried. In either case, the underground optical fiber cable is installed with

several layers of protection against stretching or other mechanical damage during installation.

AMPLIFIERS AND OTHER EQUIPMENT

Almost any communication circuit will have electronic equipment including line conditioners, splices, taps, distribution amplifiers, and similar equipment, installed along with both the overhead and underground cable. Such equipment can be in-line overhead or underground, pole mounted, pad mounted on grade, and pedestal mounted.

TYPES OF DAMAGE

Mechanical (stretching and breaking)

One of the serious advantages copper conductors have over fiber optic conductors is the fragility of optical fiber. Where a stretched copper conductor will work almost as well as it did before the damage, a optical fiber cable stretched the same amount can be useless.

Vehicle impact is a common cause of mechanical damage to overhead cables. The motor vehicle strikes a utility pole causing the pole to shift its position or fall and mechanical damage results.

Backhoe and construction equipment are the favorite killers of underground cable. In spite of the industry agreements and state laws regarding location of underground utilities before digging, cables are cut and pulled up everyday.

To digress for a moment, some years ago a small motel receptionist had an 18" piece of 50 pair copper telephone cable on his reception desk. Being an engineer, I had to ask about its story. It seems that the owner had contracted for a local handyman to dig a trench behind one wing. The handyman showed up and started work. He appeared at the office routinely requesting ever larger and sharper tools mumbling something about tree roots. At the end, he showed up with what he proudly proclaimed was the 'toughest tree root he had ever seen, and funny looking too.'

Upheaval usually occurs when a tree falls. The root system can bring the nearby buried cables to the surface, stretching and breaking them. Upheaval can also damage equipment.

Falling objects such as tree limbs can bring down overhead cables and damage equipment.

Anchors snag and damage underwater cables.

Fire (Heat) near or under an overhead cable can melt both copper and optical fiber cables. Since utility poles are often installed on road right-of-way, auto accidents can contribute to fire damage even when there is no mechanical contact. Again, building fires can damage overhead cables and above ground equipment just from radiant heat.

Other (Lightning, flood, etc.) Lightning can damage any metallic cable including straight and twisted pair cable, coaxial cable, and metal sheathed fiber optic cable. Rising water can damage any electronic device including metallic cables and support electronics for copper or optical fiber systems. Cables often cross rivers overhead on poles, attached to highway or railroad bridges, or laid on, or in, the river bottom. Any waterborne debris can mechanically damage cables or their supporting structures.

IDENTIFICATION

Overhead communications cables often share utility poles with other services. By tradition and code, services are pole mounted with the highest working voltage cables on top and the lowest working voltage cables at the bottom. If you want to look at a typical shared utility pole, you might see a 13,000 volt electric utility distribution circuit at the top of the pole, an electric utility 240/120 volt secondary circuit mounted lower on the pole, then telephone circuits, cable TV circuits, and other communications circuit.

Underground communications cables are a little more difficult to identify. Local tradition and codes may specify the color of the conduit used when a circuit is buried in conduit. Tradition and code also require that electrical power circuits are buried deeper than communications circuits. Some direct burial cables are marked with an impression in their outer jacket describing the contents of the cable, others are not.

One easy thing to identify is a broken cable. Copper conductors are opaque and copper covered. Straight or twisted pair cables, such as a telephone company might use, have 22 to 26 AWG conductors, in pairs, with color coded insulation. Optical fiber cables have clear fibers, comparable in size to a human hair. Coaxial cable has metallic copper conductors but cables are arranged with an insulated center conductor and a metallic wrapped or braided shield around the center conductor. Typically coaxial cables have a center conductor in the 22 to 26 AWG size and the overall cable can be the size of a pencil and smaller.

REPAIR OR REPLACE

Repair of twisted pair copper cables and coaxial cables is fairly simple. A skilled technician can match the color codes of the conductors and mechanically splice the individual conductors back together, and, if necessary, add a length of cable to replace any cable that was lost. The nature of metallic copper conductors is such that it is seldom necessary to replace an entire cable run because a section of cable was lost or damaged. Installation of paired cable in particular can require a number of splices or other connections such as punch down blocks.

Repair of optical fiber cable is a little more difficult. Optical fibers are spliced by a skilled technician with a fairly expensive support facility. The optical fibers are carefully inspected, cleaned, aligned and then welded or melted together. Due to the nature of the optical fiber, each splice can represent a significant loss of signal relative to the overall performance of the circuit. In older systems, this loss may require the replacement of the cable rather than a simple splice.

1 splice is required if there is sufficient length of undamaged cable to re-attach the individual damaged conductors.

2 splices will be required if a enough cable is lost that conductors must be extended to be re-attached.

COSTS TO REPAIR

Material costs vary widely based on availability so it is difficult to give a 'rule of thumb' for pricing by the foot or by the splice. Copper wire and optical fiber cable are commodities so the price can fluctuate significantly. Technology advances have greatly reduce the cost of optical fiber splice materials in recent years while electrical splice materials have remained about the same, or risen.

Labor cost vary from location to location and a high end cost can often be determined by checking the government or union pricing in the area of the repair. If the break is a big one in a fiber optic cable, mobilization costs can become significant.

Licenses, Permits, Insurance, etc. are required in most jurisdictions for private contractors. Public utilities are likewise exempt in most jurisdictions. Check with your local building code enforcement office to determine if licenses and permits are necessary.

Overhead and Profit are similar to that of electrical contractors and contractors in general for the subject area..

ABOUT THE AUTHOR

Curtis E. Falany is a Florida Professional Engineer and Master Electrician. He has previously worked with fiber optic claims involving losses from fires, vehicular impact, windstorms, business failures, specificity disagreements and payment claims.

ELECTRONIC COLLISION DATA RETRIEVAL FOR GM CARS AND COMMERCIAL TRUCKS

by : Stephen B. Chewning
Accident Reconstruction Coordinator

As the electronic capabilities of automobiles and commercial vehicles continues to improve, so does our ability to use the available data in the field of Accident Reconstruction.

We have been trained and certified on specialized equipment to download useful data after a collision from GM vehicles manufactured after 1994 utilizing the Vetronix Crash Data Retrieval Kit.

The available data is stored in the vehicles Sensing and Diagnostic Module or SDM. The SDM constantly monitors numerous vehicle functions on a passive basis, then "wakes up" and begins to store data when the host vehicle undergoes sudden deceleration such as extremely hard braking, or when air bag deployment takes place during a crash.

This technology has existed in General Motors vehicles equipped with air bags since 1990, but little useful data was available from an accident reconstruction standpoint during the initial phase of the program (1990-1993).

Fortunately, the recorded data available improves each year. In 1994 the initial data available was the delta V or speed loss during collision and impact duration in milliseconds. In 1999 additional data was made available including engine RPM, vehicle speed, throttle position, brake switch status, and the state of the driver's seat belt switch for the 5 seconds preceding the crash.

We have been able to make great use of this data in correlation with the physical evidence at the crash scene and on the vehicles to ascertain the circumstances surrounding collisions. This data has also been used to verify or disprove claims of sudden acceleration, premature air bag deployment, engine failure, and in some states where it is admissible if the seat belt was fastened at the time of collision.

It should be noted that the stored data is kept within the vehicle's non-volatile memory, known as EEPROM. Use of this type system allows downloading of the data without destruction of the existing memory. Investigators downloading data from a vehicle therefore are not in any way spoiling the evidence stored in the vehicle from the crash, or preventing any subsequent downloads by other investigators.

The claimed accuracy of the vehicle speed data by General Motors is +/- 4%, but the data collected from the barrier crashes in the New Car Assessment Program by the National Highway Traffic Safety Administration (NHTSA) is actually +/- 0.5 miles per hour.

General Motors is currently the only automobile manufacturer allowing access to its stored electronic data. Other manufacturers have onboard data recording to various degrees but as of this writing have not made the data available to anyone outside of their company. This is likely to change in the future and we will update you as it changes.

DATA AVAILABLE FROM COMMERCIAL TRUCKS

On the commercial vehicle side, trucks from different manufacturers can be ordered with engines from Detroit Diesel, Cummins, and Caterpillar, etc. As the electronic controls of large diesel engines have advanced, the use of the Electronic Control Module or ECM has become a useful tool for forensic investigations.

Originally the storage and reading capabilities of the ECM was geared toward storing generalized data for fleet maintenance and driver monitoring such as fuel economy, idle time, average speed, component monitoring to improve service intervals, number of times a vehicle had been driven over a set speed, number of times the engine was operated above a set RPM limit, etc.

As the ECM technology has advanced, the capabilities now exist to store data any time a sudden deceleration causes a loss of a set amount of miles per hour in 1 second. The speed loss threshold to trigger the recording may be fixed from the factory, or can be set by the individual fleet owner of the vehicle.

Once triggered, the data available from the recording loops on these vehicles is longer than the GM vehicles previously discussed. The Detroit Diesel engine recording loop as an example covers 1 full minute before and 14 seconds after a sudden deceleration event. The parameters covered and stored include vehicle speed, engine RPM, brake and clutch switch status (applied or not applied), engine load, percent throttle application, if the cruse control was engaged, and if there were any diagnostic codes set at the time.

When ECM data is queried by an investigator with the proper software and hardware, the stored information is printed in both numerical and graph form for evaluation.

The stored data is extremely useful due to its quality and duration. Testing performed on a client fleet by FORCON revealed that the ECM data is accurate to within 1 mile per hour of verified RADAR speed measured at the time of brake application. This finding was also verified by a second type of decelerometer mounted in the unit at the same time.

SUMMARY

When considering how a collision took place always take advantage of FORCON'S ability to obtain electronic data from the vehicles in addition to the tried and true standard methods of Accident Reconstruction.

We have attempted in this short article to make you generally aware of this rapidly changing field, but there is much more information available that can be printed here. Should you have questions or desire additional information, please feel free to call our Accident Reconstruction Team at 1-800-877-3260

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