

# VOLUME 1, SECTION 3.15: DARK FIBER SERVICES



### **3.15 DARK FIBER SERVICES (DFS) [C.2.5.3, M.6.1(B)]**

This section of our proposal addresses the (3)Enterprise Dark Fiber Service (DFS) offering. Our service meets the requirements for DFS as contained in RFP Section C.2.5.3.

A description of our DFS offering is provided below, followed by responses to the requirements in RFP Section L.34.1.4.6 as they apply to this service.

Level 3 supports DFS through end-to-end solutions. Level 3 can deliver connectivity to the dark fiber resource directly if Level 3 has fiber connectivity into the Government facility – the facility is on-net – or if the Government desires to receive connectivity in one of our collocation facilities, or another on-net building. If the agency building is off-net, then the alternatives of new construction and third-party dark fiber will be explored to find the optimum solution.

Level 3 has constructed extensive metropolitan fiber optic networks in 27 cities throughout North America and 9 cities throughout Europe. In addition to the “lighted” services Level 3 has developed, we have also deployed dark fiber services as a standard product. Product support for dark fiber requires a unique set of facilities, equipment and technical support, which Level 3 has invested in and developed. Unlike traditional lighted optical services, dark fiber customers desire long-term contractual relationships. Level 3 also has experience with these customized contractual relationships and has provided customers with an Indefeasible Right of Use (IRU) for the lease of optical fiber on these networks. Our facilities were designed to support use by dark fiber customers with additional collocation space, more than adequate power, environmental controls and security

features. In addition, Level 3 has a standard product offering for remote field services, to provide “remote hands” requirements, specifically to support dark fiber services. All of these services are available to agencies requiring Level 3 dark fiber services.

Level 3 has developed and continues to invest in its online, geographical information system (GIS) and fiber management system (FMS). These systems enable Level 3 to provide unique services in support of our dark fiber product. Our systems provide a common database between sales, the customer, network design and planning, the outside plant management organization, the Network Operations Center (NOC), and our in-house Cable Protection Bureau. These systems enable faster delivery and implementation, flexibility in customer network designs, communication of scheduled and unscheduled maintenance events, and protection of the physical layer of the network.

Level 3 mitigates risks the Government might encounter because of our extensive experience developing, implementing and supporting this core product area. Level 3 is the premier provider of DFS in CONUS for the following reasons:

- **Experience:** Level 3 has delivered more than 800,000 fiber route miles of dark fiber.
- **Design:** From Day 1 the network was planned and built to support DFS.
- **Product Support:** From Day 1, Level 3 has sold dark fiber as a standard product and has all the systems and personnel in place.
- **Network:** Fully route diverse with multiple conduits available for expansion.

- **Bury Depth and Right of Way (ROW):** Level 3 Network fiber is buried at least 42", to the top of the conduit bank wherever possible and mostly along railroad right-of-way (ROW). This reduces fiber cuts, which increases reliability.
- **Conduit Enhancements:** Level 3 has implemented enhanced protection mechanisms – such as concrete encasements at utility crossovers – to reduce fiber cut risk.
- **Hut Spacing:** The nominal design rule for the Level 3 intercity network is 100 km hut spacing, thus reducing the number of facilities and amplifiers. This reduces equipment costs and increases reliability since there are fewer active elements to fail on the fiber path.
- **Facilities:** Level 3 facilities are designed and built to accommodate growth for DFS customers' equipment with plenty of space and power.
- **Fiber:** Level 3 currently uses one of the best Non-Zero Dispersion-Shifted Single-Mode (NZ-DFS) fibers (SMF) deployed in the world, Corning Large Effective Area Fiber (LEAF) for intercity and Corning SMF-28 for metro networks.
- **Expansion:** Level 3 is constantly expanding its network with new construction for customer-specific DFS requests and the addition of new buildings to the network.

### 3.15.1 Technical Description of DFS

In this section we address the requirements for DFS as defined in RFP Section C.2.5.3.1. Additional background on the Level 3 offering is provided below, followed by a discussion of our capabilities in the following areas:

- Standards

- Connectivity
- Technical capabilities
- Features
- Interfaces

Level 3 welcomes the opportunity to work with Government agencies to identify and qualify their dark fiber services requirements, then to assist in whatever capacity the customer desires to design and implement solution that completely satisfies the agencies needs. Level 3 can work with Government agencies and assist in acquiring, equipment, engineering, or technical resources during the design and engineering phases of DFS ordering.

The basic Level 3 DFS product is the raw, unlit fiber on both the intercity and metropolitan networks. Dark fiber is controlled by and connected to the Level 3 Network only in that it is part of the conduit and cable system along our routes. For dark fiber, however, Level 3's control and responsibility ends at the physical layer of the fiber. An agency acquiring Level 3 DFS will be able to control and will be responsible for every aspect beyond that layer, including optical electronics, network planning, network operations, or any other aspect of managed services to make the fiber functional.

#### **3.15.1.1 STANDARDS [C.2.5.3.1.2]**

Level 3's DFS complies with the required standards (as applicable) delineated in RFP Section C.2.5.3.1.2. Level 3 is committed to implementing future standards as technologies are developed and as standards are defined and become commercially available. Level 3 purchases standards-compliant fiber and standards-compliant test equipment, and follows the industry best practices and procedures for using them.

When building its intercity network, Level 3 conducted extensive research and optical modeling, eliciting the support of several dense wavelength division multiplexer (DWDM) equipment suppliers including [REDACTED] before selecting Corning LEAF over other types of G.655 as well as G.652 compliant fibers. LEAF is a G.655 compliant NZ-DSF fiber optimized for the support of DWDM systems over long distances. Final selection was based on overall network economics and service flexibility. A key differentiator of LEAF versus other G.655 fibers is the larger effective area. This supports larger power inputs and translates directly into more channels supported or longer spans between amplification points. Figure 3.15-1 compares the performance of Level 3 intercity fiber with some of the other well-known types.

Providing best-in-class dark fiber services requires close adherence to

|                   | Rating     | Excellent  | Good       | Fair       | Poor       | Very Poor  |
|-------------------|------------|------------|------------|------------|------------|------------|
| industry standard |            |            |            |            |            |            |
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make the necessary adjustments quickly, efficiently and with the highest quality. Level 3 has buried between 10 and 12 conduits throughout the physical layer of the long-haul network, with no fewer than 8 conduits throughout Level 3's metro infrastructure. Level 3 is therefore uniquely positioned to be able to deploy new fiber throughout the wide and local areas, where new fiber might be required in order to comply with the standards listed, or comply with any alternative standards proposed by the Government after the contract has been awarded.

#### **3.15.1.2 CONNECTIVITY [C.2.5.3.1.3]**

Dark fiber connectivity is usually complicated by a shortage of local access fiber. A Level 3 core competency is network construction; as such, we provide end-to-end lifecycle process management of DFS to ensure the highest level of service and support prior to and after delivery of DFS. We also constantly work with other dark fiber providers to effect low costs solutions. With a dark fiber solution from Level 3, the Government will benefit from:

- **Planning and Design Services:** Level 3 provides extensive Network Design Support, which includes route diversity planning, capacity and traffic planning, management of interconnections to the Level 3 Network and to other carriers' networks, collocation space, and equipment planning. Level 3 also provides Outside Plant (OSP) Planning, which includes lateral construction, planning for alternative providers, and an extensive and collaborative review process.
- **Construction and Project Management Services:** Level 3 handles all aspects of construction, including site surveys, network design, contractor implementation management implementation, dedicated



project management for dark fiber builds, full outside/inside plant management, fiber diversity management, and fail-over testing..

Dark fiber is always terminated at the customer-designated Fiber Optics Distribution Panel (FDP), with optical connectors as specified by the customer.

Level 3 can deliver DFS as a wide-area network (WAN), local-area network (LAN), to an Internet service provider (ISP), inter-exchange carrier (IXC), point of presence (POP), competitive local exchange carrier (CLEC) or another agency network. Redundant or diverse paths will be provided, if desired. Maps demonstrating the redundancy, diversity and avoidance design incorporated in the DFS design will be provided on request. Level 3 specifically chose Corning SMF-28 and Corning LEAF fiber optic cable to form the basis of our metro and long-haul networks because of their flexibility, standards compatibility and broad vendor support. Level 3 is confident that the Government will experience superior DFS based on these products.

Redundant paths can be provided for backbone transport path or access circuit paths. While it makes sense to have redundancy for the entire route, in some cases, the last mile may be costly, and therefore a hybrid solution is sometimes a reasonable compromise. The Level 3 backbone is fully redundant, and thus transport diversity is available between any two nodes. For access circuits, redundancy and diversity are options that may require additional construction. Level 3 has extensive experience designing, engineering and managing fiber construction that will assure a successful project implementation.

### 3.15.1.3 TECHNICAL CAPABILITIES [C.2.5.3.1.4]

Our DFS offering complies with the mandatory requirements listed in RFP Section C.2.5.3.1.4. The discussion below focuses on the more broad requirements. Additional detail is provided in Section 9 of this volume.

#### 3.15.1.3.1 Facility Documentation

To design a network with the highest level of reliability, Level 3 will offer a dedicated team of network architects to jointly design a unique solution. This team is the same organization responsible for designing the Level 3 Network, as well as some of the world's largest customer networks. Many of these designs and network deployments involved construction to new sites and fulfillment of all physical diversity requirements.

Although Level 3 has dark fiber network resources in Europe as well as North America, Level 3 is not proposing non-domestic DFS services under the Network procurement.

##### 3.15.1.3.1.1 Intercity Connectivity

**Intercity routes:** At present, Level 3 has more than 36,000 intercity route miles, with over 5,700 on-net buildings in North America, and carrier-neutral data centers with over 350 carrier interconnections. Figure 3.15-2 provides a high-level overview of the intercity connectivity the Level 3 network offers. Details of specific routes are provided in Appendix A.

**Availability of regeneration and hut space:** The Level 3 Network was designed and built to support dark fiber as a mainstream product line. The Level 3 intercity network has an average of 93-km running-line (regeneration and amplification) hut spacing in North America, with collocation space available in all huts. As illustrated in Figure 3.15-2, all facilities along the Level 3 Network can support either amplification (Inline Amplifier – ILA) or

regeneration (Retime, Reshape and Regenerate – 3R) equipment. Typical intercity huts are built on five-acre plots providing adequate room for growth. The Government can place equipment in the Level 3 collocation space and power that equipment to light the dark fiber network procured from Level 3 and leverage the existing power and environmental facilities Level 3 installed for that purpose. Level 3 engineering, implementation and technical assistance is available to assist the Government in planning and managing their DFS-based networks.

[FIGURE 3.15-24-7 REDACTED IN ITS ENTIRETY.]

### 3.15.1.3.1.2 Intra-city Connectivity

**Available metropolitan networks:** Street level maps of Level 3’s metro networks are provided in Appendix A of this volume. All metro networks are multi-conduit. Fiber interconnects can be in on-net buildings, at mid-span meet points in the street, or at new locations after construction. Collocation facilities are also available at all Level 3 facilities in metro areas. As shown in Table 3.15-1, at present, Level 3 has 27 metropolitan networks in the United States, within which we offer metro DFS. Additional markets will become available to Networx customers as Level 3 continues to expand our metropolitan area network coverage.

| 115 Metropolitan Networks |                   |               |                   |
|---------------------------|-------------------|---------------|-------------------|
| Atlanta, GA               | Baltimore, MD     | Boston, MA    | Chicago, IL       |
| Cincinnati, OH            | Dallas, TX        | Denver, CO    | Detroit, MI       |
| Houston, TX               | Los Angeles, CA   | Miami, FL     | New York, NY      |
| Newark, NJ                | Orange County, CA | Orlando, FL   | Philadelphia, PA  |
| Phoenix, AZ               | Portland, OR      | San Diego, CA | San Francisco, CA |
| San Jose, CA              | Seattle, WA       | St. Louis, MO | Stamford, CT      |
| Tampa, FL                 | Washington, DC    | Weehawken, NJ |                   |

Table 3.15-1: At present, Level 3 offers metro DFS in 27 metropolitan networks in North America

**Connection options:** Level 3 offers multiple ways for agencies to connect to Level 3’s DFS:

- Customer-provided fiber cross-connects
- Cabinet-to-cabinet cross-connects
- Over 5,700 on-net buildings in North America
- Laterals (either Level 3 or Government provided)

- Mid span meet points where access to the Level 3 Network is provided at a splice point along the route, as opposed to in a building
- Riser fiber in on-net buildings

**Ability to upgrade to a multi-conduit system:** The Level 3 Network was designed from inception to be future-proof. Our intercity and metro networks were installed as multi-conduit systems from the beginning. The Level 3 intercity networks have between 10 and 12 conduits already buried, with up to 18 conduits buried in metro markets, making deployment of new fiber operationally easier than needing to upgrade to a multi-conduit system.

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**List of collocation facilities:** The collocation facilities listed in Table 3.15-2 are on-net facilities specifically designed to provide collocation services. In addition to the collocation facilities listed in the table, Level 3 will provide the Government with collocation space in other POPs along the Level 3 long-haul fiber network (also as part of our on-net facilities), where requirements and facility capabilities coincide. Level 3 will update the list of collocation facilities as necessary.

Level 3's collocation facilities also provide:

- **Carrier-neutral facilities** with connectivity to an average of 8-10 telecommunications providers just a cross-connect away, with very aggressive installation lead times for cross-connect services
- **State-of-the-art space**, designed to uniform environmental and security standards throughout the Level 3 Network
  - **Security:** Multilayer security control procedures, biometric palm readers, and 24x7 closed-circuit video and alarm monitoring
  - **Power:** Uninterruptible redundant AC and DC power solutions that are flexible and upgradeable

- **Cooling:** HVAC redundant design with air distribution under raised flooring for complete temperature control
- **Fire Suppression:** Smoke detection system above and below raised floor; double-interlock, pre-action, dry-pipe fire suppression
- **Overhead Cable Management and Ladder Racking:** Easy access to all cabling while deterring obstructions from under the raised flooring
- **Rapid response**—Level 3 owns and operates its own unified metro and intercity network infrastructure, which means diagnosis and resolution of problems is easier and quicker
- **Hands-on technical support** options through our Tech remote hands service, available around the clock in every facility

#### 3.15.1.3.2 Configuration Options

**Point-to-point:** Point-to-point dark fiber configurations are quite common, and Level 3 can provide this service between any two points on our network. We will design a solution that incorporates the Government's existing access links as well as a solution that might require new dark fiber laterals or access links to be constructed (at additional cost).

**Route diversity:** The entire Level 3 Network has been designed with a multi-ringed architecture to ensure complete physical diversity. We can easily support diverse dark fiber ring topologies. Not only is the Level 3 Network built with exacting standards of physical diversity at the fiber level, we also ensure that as we expand our on-net presence, that we have diverse entries into on-net buildings. Therefore, we can accommodate a route-diverse design with dual drops as standard. However, if the Government prefers to have Level 3 incorporate network elements from an alternate provider in a carrier-

diverse solution, Level 3 is positioned to support that configuration. In addition, mid-span splicing to avoid a particular building is an option.

**Star configuration (optional):** Level 3 can provide multiple point-to-point dark fiber links hubbed to one location. If required by the Government application, we can augment the current network by building new fiber segments.

### **3.15.1.3.3 Fiber Service Delivery Point (FSDP)**

Designing customized, hybrid dark fiber solutions is a core competency of Level 3. We have a dedicated team of network designers who will work with the Government collaboratively to jointly design a unique network solution. The assets and knowledge of fiber-based plant that this team brings to bear are unmatched in the industry. Level 3 will, therefore, comply with the Government's requirement for hybrid configurations.

In all cases, Level 3 will consult with the Government to determine its specific needs and discuss the viable options and associated costs and risks.

Level 3 DFS meets all applicable standards. Level 3 has high fiber count cables available to provide fibers. We can terminate the dark fibers where the Government directs. If there is new construction required, extra ducts can be installed to enable quick and inexpensive new fiber installations. Any construction will be at additional cost.

Level 3 will provide the fiber count that is specified by the agency. If the network design involves a Level 3 lateral pull or new construction, we will install a larger count cable than what is required (typically, 24 or more fibers). This enables us to quickly provide additional fibers to the Government, if required. If all fiber in an existing cable is consumed, a new cable will be pulled through one of our multiple empty conduits.

### 3.15.1.3.4 Channel Count

Level 3 is stringent in adhering to existing and evolving industry standards, to maximize performance, flexibility, and interoperability our systems with other major fiber optic network operators. For a number of years, Level 3 has been deploying Corning LEAF, Corning SMF-28, and Corning MetroCor fiber, fiber types which are all capable of more than 80 DWDM wavelength channels per fiber. The exact limit (up to 192 in one known case) is determined by the equipment vendor the Government selects to light the dark fiber. [REDACTED]

[REDACTED]

### 3.15.1.3.5 Gateways

The Level 3 collocation facilities listed in Table 3.15-2 offer all of the services listed plus a rich suite of access controls. Many other Level 3 POP locations can also support customer access with varying levels of on-site equipment support.

Uninterruptible power supply (UPS) battery backup is provided at all Level 3 gateway facilities. Additionally, Level 3 employs generator backup to all Level 3 POPs, including all running line sites.

The UPS power backup time for AC-powered equipment is 15 minutes at 100% load, while the DC power backup time is four hours at 100% load. The UPS batteries support all customer equipment and essential AC-powered Level 3 equipment.

All Level 3 facilities have diesel generators that will, at a minimum, match utility load. Generators are configured for auto-start and will typically start up within approximately seven seconds of a power failure. In the event of a power failure, automatic transfer switches (ATS) ensure smooth transition to backup power sources without interruption of UPS or DC power. Battery backup and emergency generators provide enough backup power to keep Level 3 facilities operational at maximum load. Generators are designed to run for 24 hours at maximum capacity without refueling.

Level 3 provides locked cabinets, with the Government's choice of either 19- or 23-inch mounting rails. Locked private suites are also available in varying sizes.

Level 3 will provide keys or combination locks on all Government collocation space. The Government has sole responsibility for locking and/or activating the device. If a key lock is used, Level 3 will provide two sets of keys at no charge. The Government personnel will receive their keys or combination when they pick up their badge and get their palm scanned on their first visit. Additional keys may be requested.

If a combination lock is provided, the Government can provide the combination to anyone it deems appropriate to enter its suite.

Visitors will not be allowed to access the Government collocation area unless escorted by a badged Government representative. All visitors must sign in at the front desk and show a photo ID. A Level 3 representative will supply a visitor badge that must be returned at the end of the day.

Level 3 provides 24x7 access to the collocation area of its gateway facilities. This is achieved by registering and providing access badges to the collocation customer and setting the customer up for access to the specific

gateway facility. Access to the rest of the facility (outside of the customer collocation area) is not permitted.

Level 3 facilities feature stringent physical security policies and controls to restrict unescorted access into the collocation areas. All Level 3 facilities are monitored 24x7. Universally, photo ID access cards are utilized as the first layer of security. These access devices are located at major points of entry and are used to secure critical areas within each facility. All perimeter doors are alarm-monitored. In addition, authorized customers and vendors are required to have a validated palm scan to enter the collocation area. The access control system also supports video monitoring and logging of all entryways. Please see Section 4.3 of this volume for further discussion of physical security of our facilities.

The Government may also install its own cameras in its collocation suites. Each camera must be mounted inside the collocation space and may only be used to monitor access and egress of the exterior door of the suite.

Level 3 continues to invest in its business and expand as the demand requires. Gateway expansion, both in terms of building out existing space and, when justified, acquiring new space is possible for most Level 3 Gateways and gateway markets.

All gateway locations are monitored remotely by the Level 3 NOC. Remote video monitoring of all internal and external doors as well as video surveillance for all Level 3 facilities is fed back to our security NOC.

All power, mechanical, and environmental systems (including, but not limited to, all of the HVACs, UPSs, DC power rooms, chiller plants and fire suppression systems for all Level 3 Gateway collocation facilities) are remotely monitored by our security NOC. All equipment is connected to an

alarm-monitoring system where equipment status is monitored and reported to both the site and the NOC if an abnormal condition occurs. Once reported, NOC personnel evaluate the status alarm and take action to resolve the issue.

Level 3 complies with local and national earthquake codes and standard practices in all seismically classified geographic areas. Modifications to facilities include, but are not limited to, the following:

- Seismic bracing for the raised floor
- Seismic bracing for cabinets
- Seismic bracing for electrical switchboards
- Seismic bracing for overhead distribution trays and troughs
- Seismic bracing on the piping and associated supports
- Redundant DC power plants that are also seismically braced
- Compliance with OSHA standards in all Level 3 facilities

#### **3.15.1.3.6 Amplification**

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On the Level 3 network there is wide usage of EDFAs and hybrid amplifiers on LEAF today, and some usage of Raman amplifiers.

#### **3.15.1.3.7 Fiber Deployed**

Level 3 has deployed Non-Zero Dispersion Shifted Fiber (NZ-DSF) single-mode fiber (SMF) in the intercity and metro network. In the intercity network, Corning LEAF fiber is employed throughout CONUS and Europe. There are



primarily two types of fiber deployed in Level 3's metro networks: Corning SMF-28 and Corning MetroCor.

The current standard SMF types for new installation are Corning LEAF for intercity networks and Corning SMF-28 for metro networks. Multimode fiber (MMF) is also available with some Level 3 services within Level 3 gateway facilities and additional multimode fiber can be deployed if requested by the Government. Level 3's multi-conduit network was built for upgrade flexibility and allows for the relatively quick addition of other types of fiber to the network as the Government requires.

SMF-28 is the most widely used fiber in the metro markets, but in a handful of cases, longer segments contain MetroCor. MetroCor offers superior performance to SMF-28 in high-bit rate, long-distance metro loops. Level 3 also has isolated segments of legacy Lucent True-Wave and Alcatel TeraLight SMF fiber installed.

#### **3.15.1.3.8 Required Optical Characteristics [C.2.5.3.1.4-8; C.2.5.3.4]**

**Attenuation coefficient SMF 1550nm:** For metro networks, 0.30 dB/km is the maximum attenuation, as specified by the fiber manufacturer, for standard-grade fiber. The newer metro fibers will meet the <0.25 dB/km specification. For the intercity network, based on measurements for over 400 spans, <0.235 dB/km is achievable.

**Attenuation coefficient SMF 1310nm:** For metro networks, 0.40 dB/km is the maximum attenuation, as specified by the fiber manufacturers, for standard grade fiber. The newer metro fibers will meet the <0.35 dB/km specification. For the intercity network, this measurement is not relevant since wave division multiplexer (WDM) wavelengths are used (i.e. 1530-1610nm).

**Attenuation coefficient MMF 850nm and 1300nm:** Level 3 does not currently use multimode fiber (MMF) in our metro networks. We will purchase the appropriate fiber that meets this specification, when requested by the Government at additional cost. However typically, for MMF, the maximum distances (<1km) are so short that dispersion is far more important than optical loss.

**Polarization mode dispersion inter-city network:** Level 3 uses LEAF fiber in the inter city network. Based on measurements of more than 400 fiber spans, the span polarization mode dispersion (PMD) value is typically below 0.06 ps/ $\sqrt{\text{km}}$ .

**Polarization mode dispersion intra-city network:** For the metro fiber, Level 3 exceeds the Government requirement. The fiber specification is PMD < 0.1 ps/ $\sqrt{\text{km}}$ .

**Chromatic dispersion at 1550 nm:** The Government apparently has a typo in this specification. For the intercity network, the chromatic dispersion is greater than 2 ps/nm-km, as required for WDM systems to operate correctly, and matches the dispersion characteristics of the fibers listed by the Government.

**Reflectance events:** We meet the reflectance event AQL. Typically, in the fiber, reflectance events are greater than 60dB. [REDACTED]

[REDACTED]

[REDACTED] All other splices had reflectance of greater than 70dB.

**Time to Restore (TTR):** Level 3's DFS offering will comply with the Government's performance metrics for TTR specified in Section C.2.5.3.4.1 of the Network RFP.

**Return loss and Insertion loss:** The return loss for Level 3 connectors is less than 50 dB and the insertion loss for Level 3 connectors is less than 0.5dB.

#### **3.15.1.3.9 Network Services Verification Testing [C.2.5.3.1.4-9]**

The end-to-end attenuation tests and optical time domain reflectometer (OTDR) tests will be performed for each fiber and a report will be delivered to the Government. The wavelength tests will follow those listed in RFP Section C.2.5.3.1.4, item 9, summarized below.

- Single-Mode Fiber (SMF): loss at 1310nm and 1550nm
- Multimode Fiber (MMF): loss at 850nm and 1310nm
- OTDR SMF: 1550nm
- OTDR MMF: 1310nm

OTDR testing will ensure that the installed fiber is in good condition and is acceptable for commissioning of electronics. OTDR testing will also aid in fault location, restoration, and maintenance, and DWDM system turn-up. OTDR bi-directional testing will be done for each fiber in each span. Any single reflectance event in the OTDR trace will be less than 40 decibels (dB)

The Level 3 Team will set the OTDR for proper operation in accordance with the length of the fiber span and distance between splices by setting the appropriate pulse width, range, resolution, and averaging time, as specified in the Level 3 Team OTDR Set Up Procedures. The Level 3 Team will set in the OTDR the proper Index of Refraction and Backscattering Coefficient,

matching the fiber's specifications. All connectors will be cleaned with a Chem-Wipe and alcohol or a dry connector cleaner. OTDR settings will remain constant during the testing of all fibers on a span. There will be no smoothing allowed on any traces. The Level 3 Team will assume the responsibility of obtaining an acceptable launch on all traces.

The Level 3 Team will confirm that all field splices of the tested link are identifiable and reported. The Level 3 Team will enter into the OTDR the specific location and identification data for the link including end locations and fiber trace. SMF-28 fiber will be tested at 1310 nm. The Corning LEAF fiber will be tested at 1550 nm. The OTDR test will then be conducted in the opposite direction. The OTDR trace data for each direction will be stored onto a CD.

Power meter tests ensure that the fiber installed meets compliance and that the signal transmitted through the fiber will remain strong and accurate. Power meter tests aid in the commissioning of transmission electronics. Prior to power meter testing, the Level 3 Team will calculate the loss budget. Power meter loss due to all impairments will be less than 0.25 dB/km when measured at a wavelength of 1550 nm for each fiber on each span tested.

For Corning LEAF fiber, the Level 3 Team will perform the end-to-end power meter test using a stable laser light source at 1550 nm and 1310 nm. The link-loss test on each fiber in the link will be conducted in both directions, at both wavelengths.

Testing personnel will be in constant communication using a fiber-optic talk set or other Level 3 Team-approved method of communication during the performance of the tests. Level 3 Team personnel will ensure that the link connectors and test patch cord connectors are kept clean at all times during the tests. The connector style used will be SC-UPC and will match

connectors within the OSX or FDP shelf. It is important to minimize the connecting and/or reconnecting of jumpers to avoid scratching connector faces.

Two fiber patch cords, also with SC UPC connectors, will be used by the Level 3 Team personnel throughout the tests to produce a stable reference launch power on the source patch cord and a stable reference loss on the meter patch cord. Level 3 Team personnel will document these power and loss data in the Link Loss Report.

The Level 3 Team will submit all test results to an internal QA/QC team to review and ensure that all work conducted meets or exceeds specifications. Should the fiber not meet prescribed specifications, the Level 3 Team will perform corrective action and retest segments.

The Fiber Test Result Submittal Package will be completely filled out by the Level 3 Team and submitted within 14 days of test completion. The Level 3 Team will maintain all documentation including daily logs, redlines, production figures, fiber forms, test forms, and all electronic media. This documentation will be available to the Government for review. The Level 3 Team will provide a final sign-off sheet with all documentation and test results for each specific span that is tested.

A Government representative may witness the fiber testing. Government users will notify the Level 3 Team no later than 48 hours from the date of requested testing as to whether the date and time are acceptable. At that time, the Level 3 Team will request the contact information from the Government representative so that coordination of the testing can take place.

### **3.15.1.3.10 Service Components [C.2.5.3.1.4-10]**

The Level 3 Network is composed of trunk cables in the metro areas varying in size from 144 to 832 SMF-28 fiber strands. On the intercity network, the trunk routes vary from 72 to 288 LEAF fibers. These are shared by a variety of contractors, Government agencies, universities, and others with interests in the fiber.

As standard practice, a 12-fiber cable is the minimum Level 3 uses for laterals, and typically 24-fiber cables are employed. However, the Government may request any number of fibers per cable when laterals are built on behalf of the Government. The maximum cable size now exceeds 1,000 fibers.

Upon Government request, Level 3 will provide fiber panel terminations within agency premises and consult and coordinate with the Government agency to assure the connector size and type is that desired by the Government. This is standard practice for Level 3 with its commercial customers today.

### **3.15.1.4 FEATURES [C.2.5.3.2]**

#### **3.15.1.4.1 Collocation Service**

Collocation is a standard service of Level 3 and has been planned into our facility designs. We operate 70 collocation data centers in CONUS (see table 3.15-2) totaling nearly 6.7 million square feet of space. The Level 3 facilities provide a choice of cabinets or suites, custom or pre-built configurations, and AC or DC power with access to the full suite of Level 3 services and interconnection to scores of different service providers just a cross-connect away. An additional number of sites offer carrier-grade DC power, private line, Ethernet, dark fiber, and wavelength services. As a dark fiber customer, the Government will also benefit from collocation services at each of the running

line huts along the long-haul network. These offer locked cabinets, suites, and electrical power.

#### **3.15.1.4.2 Duct**

Level 3 has constructed a multi-conduit intercity and metro network. Any new construction for the Government will include the number of ducts required by the Government agency.

#### **3.15.1.4.3 Dark Fiber Local Loop**

Level 3 can provide this capability with an existing fiber lateral, with third party dark fiber or can build a new fiber lateral as required.

#### **3.15.1.4.4 Diverse Route Single Dual Drop**

Level 3 has unparalleled network diversity at all levels of the network. Level 3's intercity and metro networks are built with complete rings, so that there is always a diverse path between two points. There are no collapsed intercity or metro rings or single points of failure in the Level 3 Network. To ensure diversity, the network offers two or three separate entrances into each Level 3 gateway, diverse laterals into over 95 % of Level 3's on-net buildings, and a multi-conduit system that allows Level 3 to have an empty duct for maintenance and repair. Single and dual drop designs will be supported on the Level 3 route-diverse network. Where required, Level 3 will construct additional laterals or purchase third-party dark fiber to enable this capability, after discussion with the agency. As illustrated in Appendix A, diverse routes are readily available.

#### **3.15.1.4.5 Diverse Route Dual Drop**

As noted in above, Level 3 has designed our fiber optic network with unprecedented route diversity, based on ring architectures. Therefore, Level

3 is positioned to deliver diverse route, dual drop Government solutions as an intrinsic feature of the network design.

#### **3.15.1.4.6 Intercity Connectivity**

Intercity dark fiber connectivity is a standard Level 3 service offering. The Level 3 collaborative network design team of architects has up-to-date, accurate inventory of not only the fiber on the Level 3 Network, but also the fiber of many other carriers' networks. Intercity and metro connectivity can be supplied by Level 3 with our own fiber or on the fiber provided by a different carrier if route and carrier diversity dictate this necessity. If fiber provided by a third party is required to cost-effectively reach the Government customer building, Level 3 will secure that fiber on behalf of the Government.

#### **3.15.1.4.7 Multiple Duct**

Level 3's intercity and metro networks were designed from inception to be future-proof as multi-conduit systems [REDACTED]

[REDACTED] The Level 3 intercity networks have between 10 and 12 conduits already buried (with up to 18 conduits buried in metro markets), making deployment of new fiber operationally easier than needing to upgrade to a multi-conduit system. Network expansion will extend the multi-duct capability of the Level 3 network.

#### **3.15.1.4.8 Off-net Laterals**

A Level 3 core competency is network construction. Level 3 built its own intercity and metro networks from inception, which included burying the conduits and blowing the fiber. Building laterals, therefore, is also a Level 3 core competency, which we perform nearly every day. Level 3 will provide off-net laterals to the Government as the Government requires:



- Between our own existing fiber and an agency's premises to the nearest splice point
- On our own newly built lateral between an agency's premises to the nearest splice point
- From the agency to third-party fiber

If it becomes necessary to procure the fiber of a third party to reach a certain Government location, Level 3 will procure the fiber on the Government's behalf.

#### **3.15.1.5 INTERFACES**

For testing purposes, Level 3 supports SC and LC connectors as standard, but any connectors can be supported if requested by the Government for the FSDP.

#### **3.15.2 Required Performance Metrics [C.2.5.3.4]**

Specific responses to the performance requirements of Level 3's dark fiber are provided in Sections 3.15.1 and 3.15.1.3.8 of this volume. Level 3's quality of service standards meet the performance metrics requirements specified in Section C.2.5.3.4.1 of the RFP. In addition, Section 3.15.8 of this proposal volume describes Level 3's testing procedures to verify acceptable performance and KPI/AQL compliance.

#### **3.15.3 Proposed Service Enhancements**

Many of Level 3's DFS parameters exceed the Government's requirements. However, Level 3 does not propose to exceed the specified service requirements. Level 3 is offering the following optional services: collocation service, dark fiber local loop and off-net laterals.

### 3.15.4 Experience Delivering DFS

The Level 3 network was planned and built to deliver DFS as a standard product, not as an after-thought. At present, we are the premier provider of DFS in CONUS. Some of our more relevant metrics include:

- Level 3 has deployed more than 1 million intercity dark fiber miles to more than 50 customers and over 150,000 metro dark fiber miles to more than 85 metro customers

[REDACTED]

[REDACTED]

- Level 3 is a premium vendor of DFS to the Federal Government
- Level 3's experienced field staff has performed thousands of fiber splices and measurements for DFS handover reports to customers

Our experience reflects our pioneering role in the development of a formal optical infrastructure delivery product. Level 3 has always sold DFS as a standard service, which provides a mechanism for Government agencies to directly benefit from our experience and will prove invaluable for timely and efficient delivery of services.

### 3.15.5 Access Arrangements

Level 3 provides access fiber where available, constructs new fiber paths, and employs third-party fiber in solutions for its customers. All options with their risks, benefits, and costs are presented to the customer for their decision-making process. Aerial as well as buried solutions are considered so that the customer can weigh the lower-cost, higher-outage risks of aerial vs. higher-cost, more-reliable buried solutions. Collapsed laterals (i.e., only one

physical path to the building) and diverse laterals, where one path is aerial and one is buried, are considered as well.

Access is a high-cost variable, which Level 3 will work with the Government to manage, even if multiple rounds of designs and discussions are required to arrive at the optimum solution. Access fiber for a DFS solution may interconnect to the Level 3 Network inside a building or meet at a splice point along the route. Level 3 processes and procedures, including measuring the fiber splices, guarantee a high-quality connection to the Level 3 Network and predictable performance for Government applications.

### **3.15.6 Monitoring and Measuring KPIs and AQLs**

A description of testing procedures is provided in Section 3.15.1.3.9 of this volume. The specific measurements listed in RFP Section C.2.5.3.1.4 (9)(a) will be conducted and the results provided in a report to the Government.

The Level 3 Team will provide a comprehensive Test and Acceptance Plan. All testing will be performed in accordance with the procedures described in the plan.

If necessary in order to meet the Government's testing schedule, multiple testing crews will be used. Each crew will consist of two trained technicians, with all necessary test equipment. Existing backbone fiber spans will be measured first, with any access spans to be tested once construction is complete.

Level 3 will perform fiber acceptance and testing, span by span, after the fiber is placed, spliced, and terminated at FSDPs. These tests will confirm that the fiber meets Government requirements. Measurement results will be provided to the Government on a span-by-span basis.

### **3.15.7 Handling Time-Sensitive Traffic**

This is not relevant to a dark fiber service. Level 3 has no visibility into the services that exist on DFS.

### **3.15.8 Integrated Access for Different Performance Requirements**

This is not relevant to a dark fiber service. Level 3 has no visibility into the services that exist on DFS.

### **3.15.9 Infrastructure Enhancements and Emerging Services**

Level 3 is committed to providing all customers with access to the latest technology development and enhancements for both hardware and software. Significant changes to systems or fiber on The Level 3 Network are not entered into lightly. We perform rigorous testing and qualifying of both our new offerings and those of our partners. We are in close communication with the major fiber manufacturers to provide feedback to them on their developments and to monitor their newest commercial offerings. Level 3 has a multi-conduit network that can easily and quickly adopt new generations of fiber. If a newly deployed fiber proves to be of dubious quality (highly doubtful given our pre-purchase testing practice), we can always pull another cable in one of our empty ducts, thus mitigating risk. We expect that there will be at least one new generation of fiber deployed over the 10-year period of the Network Program.

Level 3 has established an elaborate test facility at our corporate headquarters in Colorado. Sections 2.3.3 and 2.3.4 of this volume discuss the Level 3 testing process prior to deploying new services and enhancements and development processes in detail. In addition, extensive field trials of any new fiber and equipment are always conducted prior to deployment.

### **3.15.10 Network Convergence**

This is not relevant to DFS.

### **3.15.11 Interoperability of IP and PSTN**

This is not relevant to DFS.

### **3.15.12 IPv4-to-IPv6 Migration**

This is not relevant to DFS.

### **3.15.13 NS/EP Requirements**

See the detailed response in Section 2.5 of this volume.

### **3.15.14 Protection of SS7 Signaling**

This is not relevant to DFS. Level 3 has no visibility into the traffic the Government places on dark fiber.

### **3.15.15 National Capital Region Service**

Section 2.5.2.2 of this volume demonstrates Level 3's compliance with the Government's requirements for service in the National Capital Region.

For DFS in particular, we note that

[REDACTED]

Thus, Level 3 offers significant inter-city dark fiber diversity for the NCR. Detailed drawings are available in Appendix A of this volume.

### **3.15.16 Meeting Section 508 Provisions**

Not applicable to DFS.

### **3.15.17 Optional Services Impact on Network Architecture**

DFS is part of the Level 3 standard commercial offerings. Providing this service to the Government under Networx will have no adverse impacts on network architecture or performance.

### **3.15.18 Optimizing Engineering**

This is not relevant to DFS. Level 3 has no visibility into the services the Government places on dark fiber and therefore cannot optimize them. Section 3.1.5.1 discusses service optimization in detail.

### **3.15.19 Service Internetworking**

This is not relevant to DFS. The services the Government places on dark fiber are transparent to Level 3 operations and management infrastructure. This topic is discussed in Section 3.1.5.4 of this proposal volume.

### **3.15.20 Traffic Model**

This is not relevant to DFS. Level 3 has no visibility into the services the Government places on dark fiber and therefore cannot comment on how the traffic model affects capacity and utilization. These are also determined by the DWDM equipment that the Government selects for its network. There will be no impact on The Level 3 Network from the sale of DFS.