

**SCHEDULE 3  
DESIGN AND CONSTRUCTION SPECIFICATIONS**

**1. OVERVIEW**

**1.1 Definitions**

In this Schedule 3, in addition to the terms defined in Schedule 1 [Definitions and Interpretation]:

“**COLO Sites**” means those co-location Sites identified in Appendix 7A [Site Locations];

“**CPE**” means customer premise equipment managed by Project Co, unless otherwise stated;

“**Device Multicast Support**” means Equipment that can support seamless routing of multicast streams through the device;

“**DWDM**” means dense wave division multiplexing;

“**Equipment**” has the meaning set out in Schedule 1;

“**Huts**” means those Sites identified as Huts in Appendix 7A [Site Locations];

“**HQoS**” means hierarchal quality of service;

“**IOT**” means interoperability testing;

“**IP Multicast**” is a method of sending packets to selected group of receivers to minimize packet replication;

“**MOP**” means the method of procedure that outlines the detailed steps to be taken as part of the testing of a Site or Ring, which is determined using the information from the Site Survey and any applicable lab testing;

“**MPLS**” means multi-protocol label switching;

“**Multicast Service**” is an end to end service design to offer multicast as a service through the NG-KIH System;

“**Node**” means the Equipment installed at the Node Sites;

“**OTDR**” means optical time domain reflectometer;

“**OTN**” means optical transport network;

“**Product Service Catalog**” means those available services ranging from Layer 1 (optical transport) to Layer 3 (transparent routing) depending on the CPE deployed, as set out in Appendix 3A [Product Service Catalog] for Node Sites, Service Level 1 Sites and Service Level 3 Sites that connect to the NG-KIH System, which indicate services available for each of the following categories: optical transport services, Ethernet point to point services, Ethernet point to multipoint services, Ethernet multipoint to multipoint services, routed virtual private network services and internet access services;

“**QoS**” means quality of service;

“**ROADM**” means reconfigurable optical add drop multiplexers;

“**Site Surveys**” has the meaning set out in Section 2.1.1 of this Schedule 3; and

“**Site Survey Report**” has the meaning set out in Section 2.1.2.4 of this Schedule 3.

## 1.2 List of Appendices

Appendix	Title
3A	Product Service Catalog
3B	Migration Roles and Responsibilities
3C	Designated Equipment
3D	Designated Equipment Protocol
3E	Design Map

## 1.3 Network Build Counts

The NG-KIH System shall be based on the following:

### 1.3.1 31 Nodes

1.3.1.1 Nodes contain two categories: 17 Huts and 14 COLO Sites.

1.3.1.2 1 Flashwave 9500 system comprised of 2 chassis and 1 MX960 at 9 sites.

1.3.1.3 1 Flashwave 9500 system and 1 MX480 at 22 sites.

### 1.3.2 291 Service Level 1 Sites

1.3.2.1 2 6EX4300s

1.3.2.2 289 EX4300

### 1.3.3 775 Service Level 3 Sites

1.3.3.1 775 EX2200-C

### 1.3.4 Fiber Types

1.3.4.1 The Backbone will be constructed of 288 count fiber or a fiber count to be mutually agreed upon by the parties, taking into account any Third Party Infrastructure Agreements as may be applicable.

- 1.3.4.2 Laterals will be non-armored cable consisting of 144, 96, 72, 48 or 24 count fiber.

## 2. SCOPE OF WORK

### 2.1 Site Survey and Engineering

#### 2.1.1 Overview

The site surveys (the “**Site Surveys**”) will determine the physical status of the Site Locations, including a determination of suitability for the installation of the Equipment. Project Co will perform Site Surveys and engineering at each of the Site Locations.

#### 2.1.2 Scope

- 2.1.2.1 In connection with the Design and Construction Plan and Site Access Plan, Project Co shall schedule the Site Surveys as soon as possible and reasonably in advance.
- 2.1.2.2 A detailed Site Survey Report (the “**Site Survey Report**”) with pictures will be generated by Project Co. The Site Survey Report is a physical evaluation, and does not include evaluation of the optical design of the network elements or the operational status of existing alarms that may be in existing equipment.
- 2.1.2.3 Using the information provided in the Site Survey Report, Project Co will generate a detailed engineering design package.
- 2.1.2.4 The Site Surveys will determine the physical status of the site including a determination of suitability for the installation of the Equipment. A detailed Site Survey Report will be generated by the Project Co and will include:
  - 2.1.2.4.1 The site layout document(s);
  - 2.1.2.4.2 Determination of recommended network element, relay rack and cabinet placements;
  - 2.1.2.4.3 An itemized work task summary including installation details;
  - 2.1.2.4.4 Creation of detailed site/building layout drawings;
  - 2.1.2.4.5 Pictures taken (where allowed) of the front of the buildings, identifying the entrance and the general location of the existing equipment in the building. Where pictures are not allowed to be taken, the Authority shall provide the required pictures at no cost to Project Co;
  - 2.1.2.4.6 Inspection of the area where Equipment is to be installed, including an assessment of any existing ancillary equipment (i.e. existing relay racks, conduits, ducts, overhead or under floor structures etc.). Evaluate how well the Equipment would be protected and its environment including ventilation, dust, cleanliness, and temperature;

- 2.1.2.4.7 Inspection of the power systems and power connections. This includes inspection of fuse panels and available capacity;
  - 2.1.2.4.8 Evaluation of cabinet/rack grounding and grounding connections to include visual inspection and review of available grounding documentation for the Sites;
  - 2.1.2.4.9 If spares are to be located on a Site Location, determine their location, assess their protection and storage. Evaluation of card handling techniques, the presence of grounding straps, etc.;
  - 2.1.2.4.10 Evaluation of any other physical condition that may impact the NG-KIH System and implementation of services described within the Design and Construction Specifications;
  - 2.1.2.4.11 Identification of trouble areas, recommendations for corrective action and the long-term supportability and operational stability potential of the Equipment;
  - 2.1.2.4.12 Engineering and Construction requirements as required;
  - 2.1.2.4.13 Building access/entry for fiber entry;
  - 2.1.2.4.14 Location and details of termination/demark room; and
  - 2.1.2.4.15 Perform required engineering work applicable to the type of Site Location.
- 2.1.2.5 If the Site Survey identifies out of scope work activities and/or materials that would be required in advance of Project Co performing Construction, Project Co shall request the applicable Change in accordance with Schedule 6 [Changes, Minor Works and Innovation Proposals] or arrange for the Authority to perform the activities. Out of scope work may include but not limited to clearing the fiber path, rack or cabinet installation space, power systems and distribution as well as fiber distribution panels and alarm panels.
  - 2.1.2.6 Project Co will supply to the Authority the engineering requirements for paths, power and access to Sites.
  - 2.1.2.7 Install specification.

### **2.1.3 Authority Responsibilities**

- 2.1.3.1 The Authority will provide:
  - 2.1.3.1.1 all power, building maintenance, janitorial and HVAC, at Sites. during both the Construction Period and the Operating Period;
  - 2.1.3.1.2 "3/4" flame retardant plywood at each Site Location;

2.1.3.1.3 any out of scope work activities or any out of scope materials that would be required in advance of Project Co performing the Construction as identified on the Site Survey;

2.1.3.1.4 where possible, an electrical circuit to any standby generator located at an Authority owned Site Location;

2.1.3.1.5 one or two, as applicable, 120V/15A NEMA 5-15R receptacle outlets;

2.1.3.1.6 ambient temperature of equipment mounting location to be 0° to +45°C, allowing for internal cabinet temperatures in accordance with Equipment specifications;

2.1.3.1.7 external Ethernet or fiber cable interfaces to Juniper EX2200-C or EX4300 shelves;

2.1.3.1.8 surge protection devices that are not included with the cabinet design to protect copper cables exiting the building;

2.1.3.1.9 installed racks at COLO Sites; and

2.1.3.1.10 Fiber jumpers between Equipment and any existing equipment.

## **2.2 Outside Plant Design and Engineering**

The NG-KIH System consists of a middle mile network consisting of fiber segments and sites as referred to in Section 1.3 of this Schedule 3. The Construction will consist of both aerial and underground construction methods using existing Utility Company rights of way and public easements, as well as easements provided by the Authority and those obtained by Project Co.

### **2.2.1 Scope**

2.2.1.1 Project Co will provide the outside plant network design, engineering functions and specifications to include the following:

2.2.1.1.1 Outside Plant Design

2.2.1.1.2 Civil

2.2.1.1.3 Environmental

2.2.1.1.4 Structural

2.2.1.1.5 Auto CAD/GIS

2.2.1.1.6 Document Control

2.2.1.1.7 Construction Manual

2.2.1.1.8 Quality Control and Quality Assurance

2.2.1.2 Project Co will perform the following tasks related to outside plant network design and engineering:

2.2.1.2.1 Base mapping, to include, but not limited to the following:

1. Right-of-way information
2. Utility maps (poles, aerial, etc.)
3. Roadways (centerline, etc.)
4. Railroads
5. Streams
6. Bridges
7. County boundaries
8. Utility boundaries
9. Local Exchange Carrier boundaries

2.2.1.3 Preliminary Design to include but not limited to the following:

2.2.1.3.1 Overlay actual Site Locations onto base maps

2.2.1.3.2 Determine potential conflicts

2.2.1.3.3 Layout Backbone route to the Nodes

2.2.1.3.4 Layout lateral routes to the Sites

2.2.1.3.5 Determine aerial and underground routes

2.2.1.3.6 Provide site assessment results to the engineering team to incorporate into the network design contemplated in Section 2.3 of this Schedule 3.

2.2.1.3.7 Contact Utility Companies and right-of-way owners (Kentucky Transportation Cabinet and local jurisdictions) regarding fiber placement and adjust in the design as necessary

2.2.1.3.8 Identify environmental requirements and contact relevant entities and state, federal and local government agencies

2.2.1.4 Perform engineering/construction ride out to review design for:

2.2.1.4.1 Make ready engineering issues and concerns

1. Pole issues

2. Power attachments
3. Communication attachments
4. Height of each conductor attachment and proposed attachment height on the poles
5. Tree trimming required
6. Take photos and gather existing pole and span information for pole analysis

2.2.1.4.2 Produce final design of the NG-KIH System based on input from ride out and pole analysis (including pole loading analysis reports) performed by Project Co or the utility, depending on the requirements of the utility.

2.2.1.4.3 Generate final drawing packages as required for the Construction of the NG-KIH System:

1. Permitting
2. Construction
3. Profile drawings for road bores and duct placement
4. Regulatory compliance

## **2.3 Network Design and Engineering**

### **2.3.1 Overview**

Network design and engineering includes the full range of network engineering design, architecture standards, integration, including, but not limited to, concept development, planning, requirements definition and analysis, systems design, integration, and deployment. Network design and engineering will be based on Customary Industry Standards and specifications including applicable code and environmental and safety standards.

Project Co will perform end-to-end network design that incorporates the following high-level objectives:

- 2.3.1.1 Diverse connectivity and dual homing to Node Sites, based on the design.
- 2.3.1.2 IP routing at core and regional Nodes
- 2.3.1.3 Minimum 40 channel up to 8-degree reconfigurable optical add-drop multiplexer (ROADM) technology
- 2.3.1.4 Core device level redundancy
- 2.3.1.5 Support for prioritized traffic

2.3.1.6 Less than 50ms failover time in Core network

## **2.3.2 Scope**

2.3.2.1 Network Planning: Project Co shall design the middle mile network using industry standards and best practices.

2.3.2.1.1 Develop standards and plan for the NG-KIH System

2.3.2.1.2 Document design objective

2.3.2.1.3 Analyze and recommend specific network elements that meet the approved design and plan criteria

2.3.2.2 Network Architecture: Project Co shall provide the analysis, standards, and decision support for the overall middle mile network architecture.

2.3.2.2.1 Create middle mile architecture based upon standards developed during design

2.3.2.2.2 Document overall architecture of the middle mile network

2.3.2.3 Network Engineering: Project Co shall engineer the middle mile network infrastructure for data communications; provide final engineering designs, system requirements and network data.

2.3.2.3.1 Define networking requirements

2.3.2.3.2 Develop network design, engineering and integration procedures that meet requirements and objectives

2.3.2.3.3 Recommend networking capacity thresholds

2.3.2.3.4 Develop and document network system specifications and topologies (e.g., router configurations, routing policies, routing diagrams/IP addressing tables, hardware/software listings, VLAN assignment, VPN assignment, multicast groups)

2.3.2.3.5 Document infrastructure configuration files and IP addressing schemes

2.3.2.4 Upon request of the Authority and pursuant to Schedule 6 [Changes, Minor Works and Innovation Proposals], Project Co will deliver any of the services set out in the Product Service Catalog

## **2.3.3 Design Requirements**

2.3.3.1 DWDM Equipment. The optical transport domain consists of common ROADMs elements at main sites in the NG-KIH System. Each ROADM Node is capable of scaling up to 8 optical degrees each of which supports 88 wavelengths at 100Gbps; however, the current design includes varying

number of ROADM degrees as the requirements dictate. To facilitate the requirement for the 100G Ethernet transport cloud, Project Co deploys an OTN based centralized switch fabric that will provide 100Gbps network connectivity across every network optical connection of the Backbone network. The OTN switch fabric will support 100Gbps Ethernet cloud to share the bandwidth among the Backbone Sites. The design requirements of Project Co are:

2.3.3.1.1 Fiber termination on panels at the applicable Sites.

2.3.3.1.2 One 100 Gbps channel from Lexington to Cincinnati, and one 100 Gbps channel from Lexington to Louisville for peering connections to Internet 2.

2.3.3.1.3 One dedicated 100 Gbps Channel to interconnect Core MX960 Routers

2.3.3.1.4 One dedicated 100 Gbps Channel to create the Ethernet Cloud to connect Edge Routers to Core Routers

2.3.3.1.5 Different types of optical amps have been used fitting the required distances in the core.

2.3.3.1.6 DWDM equipment is DC based. AC power is supported with an add-on rectifier solution.

2.3.3.1.7 FW9500 configuration has been tailored for each Site regarding its requirements in terms of distance, site connectivity (degree), and optics. Any variation from this configuration will be subject to a Change.

### 2.3.3.2 Core Router

The design requirements of Project Co are:

2.3.3.2.1 Core routers at 9 Site Locations identified by the Authority in Appendix 7A [Site Locations].

2.3.3.2.2 Core routers have 100Gbps connectivity to other core routers.

2.3.3.2.3 Core routers will aggregate and interface with edge routers with a minimum single 10Gbps link to each connected edge router. In the future, it may be upgraded to multiple bundled interfaces.

2.3.3.2.4 Core routers will interface directly to optical transport platforms for the transportation of data traffic at 100Gbps.

2.3.3.2.5 Core router will function as mainly IP/MPLS units assuming function of Provider Edge (PE) and Provider (P) routers based on IETF industry standardized drafts.

2.3.3.2.6 Core routers will support MPLS based L2VPN, VPLS, L3VPN, BGP, IGP protocols and other industry standardized protocols.

2.3.3.2.7 Core routers support IPv6.

2.3.3.2.8 Core routers will interface directly to optical transport platforms for the transportation of data traffic.

2.3.3.2.9 Core routers will also assume function of route-reflector at least at 2 locations to provide route-reflection hence eliminating need to separate routers.

2.3.3.2.10 Core facing links will provide QoS at port level with hardware queues.

2.3.3.2.11 Client facing links can provide HQoS and per vlan QoS at ingress.

2.3.3.2.12 General model of QoS will leverage ingress policing and egress shaping.

2.3.3.2.13 Core routers can directly connect to CPE in the COLO Sites.

2.3.3.2.14 Core router 100Gbps links will be on redundant modules.

2.3.3.2.15 Client facing (CPE facing) links will be on the redundant modules when providing redundant uplink from the same CPE (such as LAG/LACP).

2.3.3.2.16 Design includes use of virtual route reflectors.

2.3.3.2.17 Design includes use of standardized features to interface with 3<sup>rd</sup> party units.

2.3.3.2.18 Service design includes use of IPv4 addresses.

2.3.3.2.19 Service design includes the use of BGP peering to Customer equipment if applicable.

2.3.3.2.20 Multicast is supported with PIM SSM, DM, SM and DVMRP. Juniper EX CPE will run IGMP to support customer multicast and at Core PIM, SSM, DM, SM and DVMRP (whichever is applicable) to enable multicast service.

### 2.3.3.3 Authority Responsibility

The Authority is required to setup appropriate configuration to enable Device Multicast Support, such as the appropriate Multicast Routing Protocol.

### 2.3.3.4 Edge Router

The design requirements are:

2.3.3.4.1 22 of the 31 Node Sites will contain MX480s.

2.3.3.4.2 Edge router has chassis level redundancy such as power, routing-engine/switch-fabric, and Uplink redundant modules.

2.3.3.4.3 Edge routers are designed with uplink connectivity to support an oversubscription ratio of 1:1.2 under normal operation, based on the bandwidth assigned in Appendix 7A [Site Locations] and subject to the outside plant and inside plant final design.

2.3.3.4.4 Edge router has a minimum of dual 10Gbps uplink connectivity between edge routers and nearest core routers, with upgradeable option to additional 10Gbps links.

2.3.3.4.5 Edge router has fully redundant 10Gbps uplinks to nearest core router.

2.3.3.4.6 Edge routers will interface directly to optical transport platforms for the transportation of data traffic at 10Gbps.

2.3.3.4.7 Edge router will function as mainly IP/MPLS units assuming function of Provider Edge (PE) and Provider (P) routers based on IETF industry standardized drafts.

2.3.3.4.8 Edge router will support MPLS based L2VPN, VPLS, L3VPN, BGP, IGP protocols and other industry standardized protocols.

2.3.3.4.9 Edge routers support IPv6.

2.3.3.4.10 Edge router will interface directly with optical transport platforms for the transportation of data traffic.

2.3.3.4.11 Core facing links on edge router will provide QoS at port level with hardware queues.

2.3.3.4.12 Client facing links on edge router will provide HQoS and per VLAN QoS at ingress.

2.3.3.4.13 General Model of QoS will leverage ingress policing and egress shaping.

2.3.3.4.14 Edge router can directly connect to Customer Managed CPE connections.

2.3.3.4.15 Core router 10Gbps up-links will be on redundant modules.

2.3.3.4.16 Client facing (CPE facing) links will be on the redundant modules when providing redundant uplink from the same CPE (such as LAG/LACP).

2.3.3.4.17 Design includes use of standardized features to interface with 3<sup>rd</sup> party units.

2.3.3.4.18 Service design includes use of IPv4 addresses.

2.3.3.4.19 Service design includes the use of BGP peering to Customer equipment.

2.3.3.4.20 Multicast is supported with PIM SSM, DM, SM and DVMRP. Juniper EX CPE will run IGMP to support customer multicast and at Core PIM, SSM, DM, SM and DVMRP (whichever is applicable) to enable multicast service.

#### 2.3.3.5 Authority Responsibilities

The Authority is required to setup appropriate configuration to enable Device Multicast Support, such as the appropriate Multicast Routing Protocol.

#### 2.3.3.6 Project Co. Customer Premise Equipment

The design requirements of Project Co are:

##### 2.3.3.6.1 Redundant Configuration

1. Configuration based on EX4300.
2. 1G/10G redundant CPE will have power level redundancy and will offer 24 copper ports and 4x10Gbps ports.
3. CPE will be installed in cabinets.
4. Single CPE per cabinet per Site Location.
5. Based on the service levels, redundant uplinks can be offered either single-homed or dual-homed at both uplinks.
6. Uplink connectivity is assumed not to exceed 2x10G.
7. Client's connectivity is assumed not to exceed 2x10G.
8. QoS is provided at port level with 8 queues.
9. Ingress policing and egress shaping is assumed.
10. Limited layer 3 capability is provided with Advanced/Enhanced feature license set.
11. Every Service Level 1 Site and Service Level 3 Site is limited to a maximum fiber distance of 70 km for 1Gbps links and 80 km for 10Gbps links to the nearest connection point.

##### 2.3.3.6.2 Non-Redundant Configuration

1. Configuration is based on EX2200-C.
2. 1Gbps non-redundant CPE will offer 12 copper ports 10/100/1000BaseT and 2x1Gbps dual purpose SFP ports.
3. CPE will be installed in cabinet.

4. Single CPE per cabinet per Site Location.
5. Based on the service levels, uplinks will be single-homed.
6. QoS is provided at port level with 8 queues.
7. Ingress policing and egress shaping is assumed.
8. A limited layer 3 capability is provided with no support of BGP.

#### 2.3.3.7 Network Security

2.3.3.7.1 Network Infrastructure will be secured through built-in firewall filters and protecting the control plane on infrastructure devices. Configurations will be used to limit ICMP visibility, use prefix lists, access-list and management access.

2.3.3.7.2 No separate security appliance or device is included in the network design.

2.3.3.7.3 Remote management access will be secured through dedicated MPLS circuits.

2.3.3.7.4 Distributed Denial of Service (DDOS) will be mitigated, to the extent possible, via use of Remote Triggered Black Hole (RTBH) filtering per RFC 5635.

#### 2.3.4 Documentation

- 2.3.4.1 High-Level Design Document. The document shall provide a high-level architectural overview of the NG-KIH System and significant design decisions to satisfy business and services requirements. The document will summarize the overall design, product platforms, network services and various technical components of the NG-KIH System.
- 2.3.4.2 Detailed Design Document. The document shall provide details of network features, protocols, configurations, and data to support service delivery across the NG-KIH System. The document will cover network services and various technical details of features that are provisioned for each network element across the NG-KIH System.
- 2.3.4.3 Bill of Materials. Full listing of the hardware and software components for each network element, by core network and Site, and quantities included in the design.
- 2.3.4.4 Product Service Catalog. The Product Service Catalog outlines available services for Service Level 1 Sites and Service Level 3 Sites connected to the NG-KIH System. Available services range from Layer 1 (optical transport) to Layer 3 (transparent routing) and depend on the CPE deployed.

## 2.3.5 Scope Exclusions

### 2.3.5.1 Core DWDM

2.3.5.1.1 In-shelf module level OTDR type functionality is not included in the design.

2.3.5.1.2 Colorless directionless contentionless technology is not included in the DWDM/ROADM design.

### 2.3.5.2 Core Routing

2.3.5.2.1 Hardware does not support HQoS on core facing 100G links.

2.3.5.2.2 Design excludes SFLOW/JFLOW/NETFLOW accounting and monitoring.

### 2.3.5.3 Edge Routing

2.3.5.3.1 Hardware does not support HQoS on core facing 100G links.

2.3.5.3.2 Design excludes SFLOW/JFLOW/NETFLOW accounting and monitoring.

### 2.3.5.4 Project Co. Managed Customer Premise Equipment

#### 2.3.5.4.1 Redundant Configuration

1. Switch-Fabric/Routing engine level redundancy is not included.
2. Chassis redundancy is not included.
3. Per VLAN, QoS or HQoS is not included.
4. Limited Layer3 capability is provided with no MPLS or MPLS based VPNs or BGP support.

#### 2.3.5.4.2 Non-Redundant Configuration

1. Switch-Fabric/Routing engine/power level redundancy is not included.
2. Chassis redundancy is not included.
3. Per VLAN, QoS or HQoS is not included.
4. Limited Layer3 capability is provided with no MPLS or MPLS based VPNs or BGP support.

#### 2.3.5.4.3 Network Security

1. Security services to end users are not provided with the Equipment.

## **2.4 Interoperability Lab Services**

### **2.4.1 Overview**

Project Co shall build the lab for continuous testing and verification up to the Expiry Date and conduct the end-to-end interoperability testing of the NG-KIH System. The lab will be maintained by the Service Provider at the completion of the Construction Period.

#### 2.4.1.1 Lab Objectives

##### 2.4.1.1.1 Support interoperability testing.

1. Current and future new software release validation testing and verification.
2. Feature testing for current and future requirements.
3. Smooth, seamless, least interrupted feature and software rollouts.
4. Test and preempt against software bugs, apply bug fixes and check against network vulnerabilities.

#### 2.4.1.2 Interoperability Testing (“IOT”) Objectives

2.4.1.2.1 Perform interoperability testing between all network elements, including CPE, core router, core edge routers and Optical/DWDM transport network elements.

2.4.1.2.2 Perform interoperability testing between external connection, peering points and core router, core edge routers and Optical/DWDM transport.

### **2.4.2 Scope**

#### 2.4.2.1 Test Methodology

2.4.2.1.1 Project Co shall develop a requirements document for testing to identify necessary functional areas to be validated.

2.4.2.1.2 Project Co shall develop the test plan for execution.

2.4.2.1.3 Project Co shall maintain version control of test documents and reported results.

2.4.2.1.4 Any services requested by the Authority that are not contained within the Product Service Catalog or architecture changes/additions must be made by way of a Change.

2.4.2.1.5 Testing is contingent upon available support from peering networks or vendors for equipment not required to be provided pursuant to this Schedule

3. This may include, but not limited to, external transport node, router, and switches.

### **2.4.3 Test Reporting**

Upon completion of the testing, Project Co shall document the test results in a report which will contain the following:

- 2.4.3.1 Test Requirements
- 2.4.3.2 Test Architecture
- 2.4.3.3 Test Use Cases
- 2.4.3.4 Test Methodology
- 2.4.3.5 Relevant Test Configuration
- 2.4.3.6 Test Results
- 2.4.3.7 Test Conclusion

### **2.4.4 Scope Exclusions**

- 2.4.4.1 Testing will be limited to items directly pertaining to the NG-KIH System infrastructure performance, but excluding any Third Party Infrastructure Provider's fiber and COLO equipment and cabling.
- 2.4.4.2 Testing of issues external to the NG-KIH System, including but not limited to customer applications, features, equipment, configurations.

## **2.5 Permitting**

### **2.5.1 Overview**

Project Co will research the requirements for and will obtain, as required, the necessary Permits (excluding Pole Attachment Agreements), and will produce the engineering drawings required based on the collection of the necessary information from the relevant Governmental Authorities for Permit submittal.

### **2.5.2 Scope**

- 2.5.2.1 Types of Permits include but are not limited to the following:
  - 2.5.2.1.1 Stream and river crossings excluding environmental impact requirements
  - 2.5.2.1.2 Wetland crossings excluding environmental impact requirements
  - 2.5.2.1.3 Road and railroad crossings

2.5.2.1.4 Interstate highway crossings

2.5.2.2 Project Co will perform the following tasks:

2.5.2.2.1 Contact jurisdictions to determine and provide jurisdictional and permitting process requirements, including but not limited to:

1. Building Permits
2. Electrical Permits
3. Certificate of occupancy Permits
4. Traffic control Permits
5. Excavation Permits

2.5.2.2.2 Contact Utilities Companies to determine and provide the necessary requirements for utility construction permitting and approvals for obtaining right-of-way Permits.

2.5.2.2.3 Contact transportation authorities (highway, railroad, etc.) to determine and provide the necessary requirements to obtain the required Permits.

2.5.2.2.4 Determine any other Permits required and provide the documentation required to obtain such Permits.

2.5.2.2.5 Project Co's name and contact information is required to be placed in the notification section of the Permits.

2.5.2.3 Authority Responsibilities

The Authority will ensure that the Commonwealth of Kentucky, Transportation Cabinet will provide a single point of contact that will work with all twelve districts to expedite permitting and develop a standardized drawing requirement. The Authority will also fulfil its obligations in respect of Pole Attachment Agreements as set out in Section 3.9 of the Project Agreement.

**2.6 Outside Plant Construction**

**2.6.1 Overview**

Project Co will provide all aspects of NG-KIH fiber construction and the Authority will provide the Access required by Project Co as set out in Appendix 2D [Initial Site Access Plan]. Project Co will track and report on the execution of make-ready construction by third parties, Project Co or its subcontractors, terminate fiber at the optical fiber distribution panel and then test the fiber. Project Co will manage subcontractors regarding construction, safety and quality.

## 2.6.2 Scope

Project Co will perform the following tasks:

- 2.6.2.1 Maintain a list of qualified subcontractors that have been approved to perform the types of work described above.
- 2.6.2.2 Track hiring of local Kentucky resources.
- 2.6.2.3 Make ready Construction, if permitted by the Utility Company or telecom carrier, which will include, but not be limited to the following:
  - 2.6.2.3.1 Pole replacement (by Project Co, its subcontractors or third parties)
  - 2.6.2.3.2 Pole transfers (by Project Co, its subcontractors or third parties)
  - 2.6.2.3.3 Cable rearrangements (by Project Co, its subcontractors or third parties), which does not include remedying existing pole attachment or pole violations which do not comply with the most current version of the National Electric Safety Code or pole owner specification whichever is more stringent.
  - 2.6.2.3.4 Vegetation clearing (by Project Co, its subcontractors or third parties)
- 2.6.2.4 Aerial construction
  - 2.6.2.4.1 Place strand and guys
  - 2.6.2.4.2 Place cable
  - 2.6.2.4.3 Cable lashing
  - 2.6.2.4.4 Fiber storage loops
  - 2.6.2.4.5 Supporting hardware attached and applied
  - 2.6.2.4.6 Traffic control
  - 2.6.2.4.7 Right of way restoration
- 2.6.2.5 Underground and buried Construction
  - 2.6.2.5.1 Utility locates
  - 2.6.2.5.2 Traffic control
  - 2.6.2.5.3 Potholing will be provided as appropriate
  - 2.6.2.5.4 Directional bore, trench, or plow as appropriate
  - 2.6.2.5.5 Install conduit, tracer wire and fiber cable

2.6.2.5.6 Adequate and appropriate restoration applied according to local requirements

2.6.2.5.7 Setting cabinets, vaults, hand holes

2.6.2.6 Splicing and testing of fiber

2.6.2.6.1 Splicing by appropriate fusion splicing methods

2.6.2.6.2 Securing splices and slack loop as required

2.6.2.6.3 Terminate fibers in the fiber distribution panel as designed with the specified connector type.

2.6.2.6.4 Optical Time-Domain Reflectometer (OTDR) testing of the fibers at 1550 and 1625 nm and Power Meter testing at and 1550 nm and 1625 nm to be performed by Project Co for each backbone segment. In addition, testing at 1310 nm is will be done on all fibers used for laterals.

2.6.2.6.5 Splice loss to be less than 0.05 dB per event; or segment span splice loss in the aggregate shall not exceed 0.25 dB per km at 1550 and 0.35 dB at 1625nm bi-directionally averaged.

2.6.2.6.6 Fiber testing reports

2.6.2.7 Construction methods to be compliant with Customary Industry Practice.

2.6.2.8 Public facing construction personnel shall be badged with project ID and contact information.

## **2.7 Fiber Segment/Node Closeout and Handoff**

### **2.7.1 Overview**

Project Co will ensure that fibers are meeting performance specifications set out in this Schedule 3 prior to Equipment turn up and testing.

### **2.7.2 Scope**

Tasks for the fiber segment/node closeout and handoff will include the following:

2.7.2.1 Handoff – Project Co will verify quality of workmanship, material standardization, permit closures and OTDR and power meter test results provided in report format.

2.7.2.2 Complete “as-built” drawings with digital photos and configuration documentation utilizing GIS format and CAD format for street level drawings.

2.7.2.3 Repair/replace/retest and document the fibers not meeting specifications set out in this Schedule 3.

## **2.8 Procurement of Equipment and License of Software**

### **2.8.1 Overview**

Project Co shall supply core and transport network Equipment. Subject to Section 3.6 of the Project Agreement, Project Co shall supply the outside plant materials based upon the requirements of these Design and Construction Specifications.

### **2.8.2 Scope**

2.8.2.1 The core and transport network Equipment will be purchased from the relevant OEM.

2.8.2.2 The outside plant materials required for the Project are commodity type materials. Suppliers currently included in Project Co commodity program will be considered, along with industry specific suppliers that specialize in the materials required. Critical materials will be purchased by Project Co and these materials include:

2.8.2.2.1 Fiber optic cable

2.8.2.2.2 Fiber identification label (tube) to be placed on fiber at each pole and underground enclosure

2.8.2.2.3 Splice closures

2.8.2.2.4 Vaults

2.8.2.2.5 Underground duct

2.8.2.2.6 Strand and associated hardware, risers and riser guards

2.8.2.2.7 Huts and associated Equipment

## **2.9 Rack and Cabinet Integration**

### **2.9.1 Overview**

Project Co's will design and manufacture an indoor wall mount cabinet assembly to support the Juniper Networks® Ethernet Switch units as follows:

2.9.1.1 Ethernet Switch Cabinet Design:

2.9.1.1.1 One cabinet design to support AC powered Juniper Model EX2200-C-12T-2G Compact Ethernet Switch.

2.9.1.1.2 One cabinet design to support AC powered Juniper Model EX4300-24T Ethernet Switch.

2.9.1.2 Cabinet Installation:

2.9.1.2.1 The completed assemblies will include the equipment and hardware integral to the completed assembly. External cabling requirements and connections will not be included in the supplied materials or configurations.

## **2.9.2 Scope**

Project Co will execute the following tasks:

- 2.9.2.1 Analyze the primary equipment requirements to support the network design configuration including:
  - 2.9.2.1.1 Circuit/port capacity
  - 2.9.2.1.2 Physical size
  - 2.9.2.1.3 Power requirements
  - 2.9.2.1.4 Operating temperature/thermal requirements
- 2.9.2.2 Identify ancillary equipment requirements to support the primary Equipment including:
  - 2.9.2.2.1 Fiber distribution panel requirements/port capacity
  - 2.9.2.2.2 Fiber jumper requirements
- 2.9.2.3 Identify equipment enclosure suitable to support primary Equipment and ancillary equipment including:
  - 2.9.2.3.1 Ventilation to support primary Equipment and ancillary equipment thermal requirements
  - 2.9.2.3.2 Locking features to promote cabinet security
  - 2.9.2.3.3 Mounting requirements to support weights
  - 2.9.2.3.4 Power/grounding provisions and requirements
  - 2.9.2.3.5 Alarm support capabilities as required
- 2.9.2.4 Create a complete set of manufacturing documentation to procure, build and test the cabinet configurations in the Project Co factory, including:
  - 2.9.2.4.1 Assembly, wiring, and testing documentation
  - 2.9.2.4.2 Change management and revision control per established TL9000 processes and metrics
- 2.9.2.5 Coordinate the creation of a comprehensive technical information bulletin (TIB) including:

- 2.9.2.5.1 Product identification/description
- 2.9.2.5.2 Primary Equipment/ancillary equipment specifications
- 2.9.2.5.3 Cabinet alarms
- 2.9.2.5.4 Grounding
- 2.9.2.5.5 Labeling
- 2.9.2.5.6 Wiring diagrams
- 2.9.2.5.7 Installation instructions
- 2.9.2.5.8 Support information
- 2.9.2.5.9 Ordering information
- 2.9.2.5.10 The Project Co contact information

2.9.2.6 In addition, Project Co will:

- 2.9.2.6.1 Validate rack requirements as part of Site Surveys
- 2.9.2.6.2 Review Project Co product specifications to determine rack requirements
- 2.9.2.6.3 Procure required racks
- 2.9.2.6.4 Deliver and install required racks in the location
- 2.9.2.6.5 Pull fiber to and terminate fiber at the fiber distribution panel

### **2.9.3 Rack and Cabinet Integration Design Assumptions**

Project Co will design and manufacture an indoor wall mount cabinet assembly to support the Juniper Networks® Model EX2200-C and EX4300 Ethernet Switches as follows:

- 2.9.3.1 Ethernet Switch Cabinet Design I. One indoor wall mount cabinet design to support AC powered Juniper Model EX2200-C-12T-2G unit with the following specifications:
  - 2.9.3.1.1 Fiber Distribution Panel (FDP)
    1. 12 Port, type SC
    2. Patch/Splicing capability
    3. 1RU, 19" mounting

4. Fiber jumpers included

#### 2.9.3.1.2 Equipment Cabinet

1. Front access
2. 25 x 21 x 7 in (H x W x D)
3. Louver ventilation
4. Removable front cover
5. Bellcore 216 hex lock
6. Provisions for alarm termination wire wrap block
7. Door alarm switch
8. Integral ground bar with 25 ft., #6 AWG ground cable
9. NEMA 5-15P power cord

#### 2.9.3.1.3 Authority Requirements

1. Equipment cabinet capable of being mounted on ¾" flame retardant plywood, customer provided, at each location.
2. One 120VAC/15A NEMA 5-15R receptacle outlet within 6 feet of proposed cabinet installation location.
3. Ambient temperature of equipment mounting location to be 0° to +35°C, allowing for internal cabinet temperatures in accordance with Equipment specifications.
4. Fiber jumpers between Equipment and any other equipment.
5. Interfacing copper Ethernet cables.
6. Surge protection devices are not included with the cabinet design to protect copper cables exiting a building.

#### 2.9.3.1.4 Certifications

1. Completed cabinet assembly will not be UL listed or registered.
2. Individual Equipment will bear listings, certifications as applicable.

#### 2.9.3.2 Ethernet Switch Cabinet Design II. One cabinet design to support AC powered Juniper Model EX4300-24T Ethernet Switch unit with the following specifications:

2.9.3.2.1 Juniper Model EX4300-24T

1. Operating temperature range: 0° to +45°C

2.9.3.2.2 Fiber Distribution Panel (FDP)

1. 12 Port, type SC/UPC
2. Fiber patching/splicing capability
3. 1RU, 19" mounting

2.9.3.2.3 Equipment Cabinet

1. Front access
2. 25 x 21 x 7 in (H x W x D)
3. Louver ventilation
4. Removable front cover
5. Bellcore 216 hex lock
6. Provisions for alarm termination wire wrap block
7. Door alarm switch
8. Integral ground bar with 25 ft., #6 AWG ground cable
9. Dual NEMA 5-15P power cords]

2.9.3.2.4 Certifications

1. Completed cabinet assembly will not be UL listed or registered.
2. Individual Equipment will bear listings, certifications as applicable.

2.9.3.3 Fiber terminations at wall mount cabinets:

Fiber terminations will be terminated directly to the supplied FDP/splicing fiber panel. Fiber jumpers are supplied from the FDP panel to the Equipment.

**2.9.4 Deliverables**

2.9.4.1 Indoor wall mount cabinet design and assembly to support AC powered Juniper Model EX2200-C-12T-2G unit.

2.9.4.2 Indoor wall mount cabinet design and assembly to support AC powered Juniper Model EX4300-24T unit.

2.9.4.3 Supporting Technical Information Bulletin (TIB) documentation.

## **2.9.5 Exclusions**

2.9.5.1.1 UL listing or registration of completed cabinet assemblies.

2.9.5.1.2 120V/15A NEMA 5-15R outlet(s), located within 6 feet of placement of cabinet assemblies at customer locations

## **2.10 Hut Configuration and Installation**

### **2.10.1 Overview**

2.10.1.1 Project Co will design the type of racks and the quantity of racks required for each Hut and supply the necessary Equipment.

2.10.1.2 Project Co will be responsible for the site preparation, including pouring the concrete pad, installing the Hut and rack, and terminating the fiber in the Hut/rack. Project Co will install and test the Equipment.

### **2.10.2 Scope**

Project Co will execute the following tasks:

2.10.2.1 Pour concrete pad

2.10.2.2 Install Hut

2.10.2.3 Install rack

2.10.2.4 Clean up and restoration of the site

2.10.2.5 Install primary power from meet point into the Hut sub-panel

2.10.2.6 Provide and install battery back-up and generator system

2.10.2.7 Terminate fiber

2.10.2.8 End-to-end test fiber

2.10.2.9 Hut design document

## **2.11 COLO Sites**

### **2.11.1 Scope**

Project Co will install the Equipment into the COLO Site.

### **2.11.2 Authority Responsibilities**

During the Term, the Authority is responsible for the following obligations and costs in relation to COLO Sites: rack, power, HVAC, cross connects, cabling, non-recurring charges or recurring charges, lease obligations (including securing space), interconnection fees and any other obligations or costs associated with the COLO Sites.

## **2.12 Equipment for Core and COLO Sites**

### **2.12.1 Overview**

Installation services shall be performed by Project Co in accordance with the manufacturer's recommended specifications and within the provisions of these Design and Construction Specifications.

### **2.12.2 Scope**

Project Co shall develop the details of the installation activities upon completion of Site Survey Report. General tasks for installation work shall include:

- 2.12.2.1 Create an Installation specification using information gathered during the Site Survey(s).
- 2.12.2.2 Prepare installation MOP per TL9000 requirements.
- 2.12.2.3 Install Core or transport Equipment in accordance with the manufacturer's recommended specifications within 50 feet of cable termination point into the appropriate installed racks or bays.
- 2.12.2.4 Provide clean-up which includes removal of trash and packing material on a daily basis.
- 2.12.2.5 As-built installation specification.

### **2.12.3 Authority Responsibilities**

The Authority will provide the existing service provider demark location in the building at all Node Sites and COLO Sites in order to facilitate Equipment installation and cutover.

## **2.13 Turn-Up and Test Services**

### **2.13.1 Overview**

Turn-up & test services shall be performed in accordance with the manufacturer's recommended specifications and within the provisions of the Implementation Plan. Project Co shall develop the MOP details of the turn-up and test activities at the completion of Site Surveys on a test by test and Site by Site basis. Turn-up & test activities are performed in the same trip to the Site. This includes turn-up & test for the Equipment at the Site.

## 2.13.2 Scope

2.13.2.1 Project Co shall supply the required test equipment to perform the turn-up & test services described within these Design and Construction Specifications. General tasks for turn-up & test activities shall include:

2.13.2.1.1 Prepare Turn-up & Test MOP per TL9000 requirements. The MOP includes the following sections and will be applied to all of the tests set out in this Section 2.12.2:

1. Introduction
2. Revision
3. Scope
4. Site Information
5. Contacts and Escalations
6. Daytime Windows
7. Maintenance Windows
8. Equipment and Materials Required
9. Tools Required
10. Service Impact Notes
11. General Information
12. Preparation
13. Procedure
14. Completion
15. Back-Out Procedure
16. Appendices

2.13.2.1.2 Site Turn-up and Test. A series of actions checks and tests to confirm the Site is operational and ready to be provisioned for traffic and includes the following actions:

1. verification that power requirements are within specifications set out in this Schedule 3, including primary and secondary power, ground and voltage levels;

2. conduct a visual inspection of Equipment installation and cabling as appropriate;
3. inventory, unbox, inspect, clean optical interfaces and slot cards if required. Includes verification of inventory on Site, unpacking the Equipment and inspecting for damage, and slotting of the units if required;
4. installation of common plug-In equipment - Includes installation of the fans, management units, and switch fabrics, and common equipment elements where applicable;
5. sequence up the power and initiate the software load;
6. confirm operation of Equipment and enter basic element provisioning;
7. perform loop back testing on the populated slots;
8. verify connectivity and communication with the NOC and confirm Equipment level alarm (against industry standards and/or thresholds set as mutually agreed, i.e. up/down, signal loss, traffic ID) reporting, if facilities exist; and
9. measure and set optical levels to connect the Site to the NG-KIH System in accordance with the specifications for the Equipment.

2.13.2.1.3 Acceptance Test. A series of actions and tests to integrate multiple Sites into the NG-KIH System and confirm the network's performance is within the acceptable range for the relevant Equipment. This is performed upon completion of the Site Turn-up and Test on a Site-by-Site basis on the Ring. Project Co engineers will use specific test & measurement tools following manufacturer turn-up and testing procedures, and will execute temporary circuit provisioning to enable end-to-end testing across the ring. Once all rings are operational, inter-ring operability and IP/MPLS failover requirements will be verified. Ethernet Services and DWDM Services will be tested as follows:

(a) Ethernet Services

1. Two Minute Bit Error Rate Test
2. One Minute Throughput Test of each packet size 64, 256, 1024, 1518 bytes, and jumbo frame (2000, 9000 and 9600)
3. Latency (RTD) Test
4. Frame Loss Test
5. Back to Back Test

(b) DWDM Services

1. Channel testing: all applicable channels will be tested across applicable Node Sites on the NG-KIH System for 15 minutes per channel.

2.13.2.2 Detailed test report showing the results of the tests performed per the steps identified in the MOPs to include the provisioning detail and light levels per standards and specifications as required by the Equipment.

## **2.14 Service Migration**

### **2.14.1 Overview**

Analyze the current Authority carrier network and develop an optimized strategy to migrate existing services, circuits and traffic from the current platform to the NG-KIH System. Service migration is conducted in three phases: discovery, analysis and migration.

### **2.14.2 Scope**

2.14.2.1 Network Discovery: Project Co shall combine and complete an electronic and physical audit of the current network state. Items to be examined include:

2.14.2.1.1 Network topology

2.14.2.1.2 Circuit utilization

2.14.2.1.3 Fiber types and connectors

2.14.2.1.4 End-to-end connectivity

2.14.2.1.5 Working with the primary site contact, Project Co shall download site specific services, device databases and network configuration parameters enabling migration of existing services to the NG-KIH System.

2.14.2.1.6 Project Co and the Authority shall work together to ensure Sites on the current platform can communicate with Sites on the NG-KIH System.

2.14.2.2 Network Analysis: Project Co shall analyze legacy network environment to determine best method for service migration

2.14.2.2.1 Project Co shall develop site specific detailed MOP

2.14.2.2.2 Project Co shall create master design sheet which will:

1. Show full port correlations old and new systems
2. Create fully scripted commands for provisioning
3. Create fully scripted commands for migration

4. Create detailed fiber distribution and rewire information
5. Create fiber jumper run list including length, quantity and connector types

2.14.2.3 Migration Execution: Project Co shall migrate traffic from legacy platform to the NG-KIH System

2.14.2.3.1 Project Co shall perform comparative testing to validate the provisioning and functioning of the NG-KIH System versus the existing network.

2.14.2.4 Provisioning: Project Co shall provision traffic from legacy platform to the newly installed Service Level 1 Site and Service Level 3 Site platform. Project Co will remotely add the new circuits, activating new groups/slots/ports, IP route, routing tables for the transitioning customers within the NG-KIH System.

2.14.2.4.1 Project Co shall execute cutover of traffic as detailed in the MOP

2.14.2.4.2 Project Co will swing CPE fibers/ cables from old to new

2.14.2.4.3 Project Co shall verify alarms to ensure traffic is stable and provide detailed cut sheets to the Authority for status

2.14.2.4.4 Project Co to verify system stability with the Authority and the NOC

**2.14.3 Authority Responsibilities**

2.14.3.1 Provide information required by Project Co as set out in Section 2.14.2.1.5 and Section 2.14.2.1.6 of this Schedule 3;

2.14.3.2 Coordination between Service Level 1 Sites and Service Level 3 Sites and Project Co migration team in accordance with the Project Schedule or any amendments thereto;

2.14.3.3 Fiber jumpers between Equipment and any other equipment, pre-existing or otherwise;

2.14.3.4 Circuit ID and Circuit type i.e. Fiber SM or MMF, frame relay, DS-1, DS-3, OC-x, and Ethernet (as required);

2.14.3.5 Circuit ID port interface type, DSX-1 panel, DSX-3 panel, Ethernet patch panel, Fiber distribution panel SM or MMF interface (as required);

2.14.3.6 Current existing Circuit line protocol i.e. for a T-1 AMI or B8ZF (as required);

2.14.3.7 Work with Project Co to enable the connection and communication between the current network and the NG-KIH system; and

- 2.14.3.8 Any other responsibility set out in Appendix 3B [Service Migration Roles and Responsibilities] identified as an “Authority Responsibility” will be completed in accordance with the critical path timing set out in the Project Schedule.

#### **2.14.4 Scope Exclusions**

Decommissioning, de-installation and removal of replaced equipment.

### **2.15 Training**

#### **2.15.1 Overview**

Project Co will provide training services, as selected by the Authority, at a mutually agreed Authority location in Kentucky regarding the use and maintenance of the Equipment incorporated into the NG-KIH System to the extent such training is included in the FNC Training Catalog, along with specific Juniper training as set out in the scope below.

#### **2.15.2 Scope**

Project Co to provide two (2) four (4) day classes for up to 6 Authority students each based on the various training courses for products in the NG-KIH System. The Authority will, in its sole discretion, select from the training courses offered by Project Co, including those in the FNC Training Catalog and/or Juniper courses offered by Juniper through FNC. The Authority will, in its sole discretion, select from the training courses offered by Project Co.

#### **2.15.3 Authority Responsibility**

- 2.15.3.1 The Authority to work cooperatively with Project Co on scheduling the classes selected by the Authority.
- 2.15.3.2 Student travel and living expenses while attending the training course.
- 2.15.3.3 The non-traffic lab equipment, servers, test equipment to be used for the training.
- 2.15.3.4 A classroom environment adequate to meet the student’s needs: network access to training lab server, an LCD projector, whiteboard and easel and one PC/laptop per every two students.

**APPENDIX 3A  
PRODUCT SERVICE CATALOG**

**1. Service Catalog Summary**

The service catalog outlines available services for Service Level 1 Sites and Service Level 3 Sites connected to the NG-KIH System. Available services range from Layer 1 (optical transport) to Layer 3 (transparent routing) and depends on the CPE deployed. Optical transport services are restricted to 100G wavelength but Ethernet and Routed services can be provisioned with speeds ranging from 100Mbps to 10Gbps.

Available Speed	λ Service	Managed Ethernet Service			Managed Routed Service	
		PtP (E-LINE)	PtMP (E-TREE)	MPtMP (E-LAN)	L3VPN	Internet
100G	✓	✓	✗	✗	✗	✓
10G	✗	✓	✓	✓	✓	✓
Sub 10G	✗	✓	✓	✓	✓	✓
1G	✗	✓	✓	✓	✓	✓
Sub 1G	✗	✓	✓	✓	✓	✓

**2. Optical Lambda Transport Services (OLTS)**

Optical Lambda Transport Service is a high-bandwidth point to point wavelength service that is delivered on DWDM fiber optic links. Lambda services can be used to connect different Service Level 1 Sites and Service Level 3 Sites and/or large university campus and government buildings or to provide dedicated communication channels for stand-alone applications such as research/government data sharing, educational Web-hosting, Video, VoIP, data backup, or VPN access. Such services provide dedicated low latency with high bandwidths and feature strict SLAs with guaranteed speeds. The service can be offered at all ROADM locations. The CW network admins will have the option to hand-off 100 GE client lambda over this service.

**3. Managed Ethernet Transport Services**

- 3.1 Managed Ethernet Transport Services are delivered on the NG-KIH System for site connectivity. Managed Ethernet Transport Services carry the standardized features defined by IEEE 802.3 and will be implemented with and comply with the IEEE 802.3 standard, including QoS, high availability and resiliency, scalability, and operations, administration and maintenance.
- 3.2 Managed Ethernet Services are provided on MPLS based network using MPLS based Pseudowires and MPLS VPLS. By leveraging MPLS technology, these Managed Ethernet Transport services are protected at the MPLS layer across the Core Nodes.
- 3.3 The scalability of such services will allow the Authority to increase bandwidth, if required. If the Authority requires additional bandwidth such increase will be made by way of a Change. Managed Ethernet Transport Services exist between User-to-Network

interface (UNI) and Network-to-Network interface (NNI). UNI is defined as the demarcation point between existing or other equipment and the Equipment. Ethernet Virtual Connection (EVC) connects two or more UNIs for an Ethernet Service delivery and multiple EVCs can be multiplexed on the same UNI. There are three types of EVCs that can be delivered by this design.

### 3.3.1 Point-to-Point Ethernet Transport Services (E-TREE)

3.3.1.1 A Point-to-Point (E-Line) Ethernet Transport Service will provide Layer 2 Ethernet pipe between two end points. The service is defined between two UNIs and called Ethernet Private Lines. It is mostly used for Internet access or dedicated site to site connectivity. This service will provide an Ethernet connection that originates from one Ethernet port and ends at another which can be either port based or VLAN based.

### 3.3.2 Point-to-Multipoint Ethernet Transport Services (E-TREE)

3.3.2.1 The Point-to-Multipoint (Hub & Spoke) Ethernet Transport Service will utilize multiple point-to-point (E-Line) services which stem from a common Hub site (Root). Routing and routing policies across the Authority domain shall be undertaken by the Authority's IT staff.

### 3.3.3 Multipoint to Multipoint Ethernet Transport Services (E-LAN)

3.3.3.1 Multipoint-to-Multipoint E-LAN service will provide LAN based services connecting multiple end points in a single broadcast domain. This service is defined between more than two UNIs where any communication between parties is equally possible. This service can be used for multipoint L2 VPNs and transparent LAN service. In this service offering, the service can be used for setting up departmental or institution-based private VPNs. The service provides different Classes of Service (CoS) over scalable bandwidth.

## 4. Managed Layer 3 Virtual Private Network (L3VPN) Services

NG-KIH Managed L3VPN service extends routing capabilities between locations to create single routing domain. L3VPN service is based on MPLS Architecture. Layer 3 VPN service provides the Authority its own unique routing domain (instance). The Authority will be provided with a virtual routing instance with its own routing table. Managed L3VPN service is offered at any number of end points at various locations in the NG-KIH network footprint. All the handoffs in this service are IP based. A CPE router will be provided at Service Level 1 Sites and Service Level 3 Sites.

## 5. Internet Service

Internet Service connects end points to the Internet. The NG-KIH System provides high speed, dedicated Internet access over a fiber infrastructure. Choice of speed can range from 100Mbps to 10G and can be made available at 100G. Internet Service is delivered through Tier 1 ISPs connected to the NG-KIH network at various POPs. Internet access redundancy can be configured through dual homing of Service Level 1 Sites and Service Level 3 Sites to the Node Sites.

**APPENDIX 3B  
MIGRATION ROLES AND RESPONSIBILITIES**

<b>Discovery</b>		
<p>The Authority will provide and/or coordinate access from the current network provider(s) to the detailed legacy circuit information required to migrate Sites, maintain site to site communications and establish communications between the old Authority network and the NG-KIH System. Information required can include network topology, design, statistics, details, history, current state, known issues and health. It is expected Project Co will work with the Authority’s Operating Representative and any required technical resources to identify and gather the necessary information to ensure first time migration success.</p>		
	<b>Project Co</b>	<b>Authority</b>
Network Topology	X	X
Circuit Utilization	X	X
Physical Fiber Types and Connectors	X	X
End-to-End Connectivity (Physical/Logical/Virtual)	X	X
Configuration Databases (Confirm Logical Configurations and Software - Version/Release/Features/Protocols)	X	X
Hardware (Environment/Equipment/Power)	X	X
Software (Version/Release/Features/Protocols)	X	X
<b>Analysis</b>		
	<b>Project Co</b>	<b>Authority</b>
Develop site specific detailed Method of Procedure (MOP)	X	X
Document full port correlations for old and new systems (Master Design Sheet - MDS)	X	X
Create fully scripted commands for provisioning (MDS)	X	
Create fully scripted commands for migration (MDS)	X	
Create fiber distribution/rewire information (MDS)	X	

Create fiber jumper run list including length, quantity, connector types (MDS)	X	
Develop project timeline and resource requirements	X	
Respond and Assist to outline rationale in legacy design, engineering, and configuration decisions, when necessary		X
<b>Migration</b>		
	<b>Project Co</b>	<b>Authority</b>
Perform testing to verify provisioning / wiring.	X	
Create master cutover plan	X	
Execute cutover of traffic as detailed within MOP	X	
Engineer to physically migrate CPE fibers/T1 cables from old to new	X	
On-board device under NOC Control	X	
Verify alarms to ensure traffic is stable	X	
Verify system stability with the commonwealth and the Network Operations Center (NOC).	X	
Provision traffic from legacy platform to the newly installed CAI platform.	X	
FNC will remotely add the new circuits, activating new groups/slots/ports, IP route, routing tables for the transitioning customers within the CW KIH Network.	X	
Provide detailed cut sheets to CW for circuit migration status	X	

**APPENDIX 3C  
DESIGNATED EQUIPMENT**

See attached.

Material	Manufacturer	Model No.	Quantity	
288 Ribbon Fiber, all dielectric, gel-free, 24 Fibers per ribbon	OFS Corning	AT-3BE843X-288 288EV4-14100D53	9,532,829	\$17,349,038
144 Fiber, Loose Tube, All dielectric, gel-free, Single jacket	OFS Corning	AT-3BE12YT-144 144EU4-T4100D20	1,095,895	\$1,147,436
96 Fiber, Loose Tube, All dielectric, gel-free, Single jacket	OFS Corning	AT-3BE12YT-096 096EU4-T4100D20	936,863	\$679,752
72 Fiber, Loose Tube, All dielectric, gel-free, Single jacket	OFS Corning	AT-3BE12YT-072 072EU4-T4100D20	1,104,316	\$587,239
48 Fiber, Loose Tube, All dielectric, gel-free, Single jacket	OFS Corning	AT-3BE12YT-048 048EU4-T4100D20	4,942,042	\$1,903,093
24 Fiber, Loose Tube, All dielectric, gel-free, Single jacket	OFS Corning	AT-3BE12YT-024 024EU4-T4100D20	1,246,461	\$352,547
Splice Enclosure FOSC 450-B6 Series with (3) Ground Studs, Standard Basket, w/ 1 tray	TE Connectivity	FOSC450-B6-6-NT-0-B3V	2,545	\$535,340
Splice Enclosure FOSC 450-D6 Series with (3) Ground Studs, Standard Basket, w/ 1 tray,	TE Connectivity	FOSC450-D6-6-NT-0-D0V	732	\$227,345
Splice Tray FOSC 450-B Series Loose Tube, (2) SM-12 Modules	TE Connectivity	FOSC-ACC-B-TRAY-24-KIT	5,090	\$72,327
Splice Tray FOSC 450-D Series Ribbon, (R2)	TE Connectivity	FOSC-ACC-D-TRAYRIBN-24	8,784	\$290,590
Vault, Telecom/Utilities, Below-Grade, (30Wx48Lx36D) PolyConcrete, (vault only)	Highline Products	PHA304836	845	\$208,951
30x48 Split Cover w/ 1/4 Turn L-Bolt Lock & 2X Lifting Slot, Polymer Concrete, ANSI/SCTE 77-2010 Tier 15 Light Duty Load	Highline Products		424	\$100,678
30X48 Cover, Telecom/Utilities, Split, For Below-Grade, 3IN THK X 30IN W X 48IN L, Polymer Concrete, 4X 3/8IN-16 UNC Bolt Access Holes, 2X Lifting Slots, ANSI/SCTE 77-2010	Highline Products		423	\$96,313

Tier 22 Heavy Duty Load				
Vault, Telecom/Utilities, Below-Grade, (24x36Lx24D) PolyConcrete w/Drop-In Cover	Highline Products	PHA243624	1,923	\$501,411
Conduit, 1.25" dia, Smooth Wall, SDR 13.5 w/ 1250LB Pull Tape, HDPE, No Lube, Orange		SW1.25-SDR135-9483-O	2,537,258	\$922,437
1/4" EHS Galvanized Strand, 5,000 ft reels	Bekaert		14,469,233	\$2,384,430
Backup Generator, 50kW, Diesel, 200amp, 120/240V, 1-Phase, Outdoor-Steel, 210 Gallon	Generac Kohler	SD050-3-4I 50REOZJE	21	\$305,002
Transfer Switch, 200amp, 120/240, 1-Phase, NEMA 3R	Generac Kohler	ATS 200-T	21	\$63,923
Communication Shelter, 10' W x 22' L x 9' Tall, (1) 3' W Steel Entry Door, Stone Aggretate Exterior, Painted "I" Beam Skid Frame, R11 Insulation, Vinyl Floor, 200 amp Dist Panel, fully wired w/ lighting, outlets, switches. (2) 3-ton 5kW AC units, (70') 12" cable ladder, (7) 19" Newton racks installed, Halo Ground System, Alarm contacts for door, smoke, hi/low temp, power fail, (1) Floor Penetration. KY Approved Drawings			21	\$918,148
			<b>Total</b>	<b>\$28,646,000</b>
** Note – Quantities above are estimated based on preliminary design as of July 10, 2015. These quantities are subject to change as final design is completed.				

**APPENDIX 3D  
DESIGNATED EQUIPMENT PROTOCOL**

See attached.

## **APPENDIX 3D DESIGNATED EQUIPMENT PROTOCOL**

The Authority is required to purchase the Designated Equipment pursuant to Section 3.6 of this Project Agreement and in accordance with the Project Schedule and this Appendix 3D.

### **EQUIPMENT AND MATERIALS**

The Designated Equipment is listed in Appendix 3C [Designated Equipment]. As at the Effective Date, there are no purchases of equipment or materials required by the Authority, other than the Designated Equipment. The Authority agrees that the Designated Equipment will be delivered visibly undamaged to the appointed location at the time specified. The Authority represents and warrants that it will make all necessary undisputed payments required and will comply with all other terms and conditions of any purchase order or other documentation in respect of the Designated Equipment.

### **PROCESS**

#### **Quantities and Estimated Purchase Order Initiation and Delivery Dates:**

The Authority will appoint a purchasing representative to coordinate, with the Design-Builder purchasing representative, the ordering activities of the Designated Equipment. The Authority will work with the Design-Builder purchasing representative to place the orders including allowing the Design-Builder purchasing representative the opportunity to review the purchase orders or other documentation prior to submission to the vendors. The type and quantity of the Designated Equipment and the exact delivery location address, time window and delivery date will be specified by the Design-Builder purchasing representative only.

The Design-Builder purchasing representative will advise the Authority purchasing representative 5 days in advance of the Authority Order Dates set out below. The applicable required order dates (the “**Authority Order Dates**”) for the various Designated Equipment types are:

20 weeks in advance of the required delivery date for fiber orders;

12 weeks in advance of the required delivery date for Hut orders; and

6 weeks in advance of the required delivery date for Bulk Material orders.

“**Bulk Materials**” means that portion of the Designated Equipment listed in Appendix 3C for vaults, covers, strand, splice closures, trays and conduit.

The quantities and delivery requirements for the Designated Equipment are estimated as follows:

- Approximately 25% of the quantities as reflected on Appendix 3C were ordered prior to the Effective Date for delivery from August through December 2015.
- 25% of the quantities as reflected on Appendix 3C must be ordered and added to the purchase orders each month at the rate of 5% per month commencing on the 1st day of

each month effective October 2015 to support Ring 1A & Ring 1B construction currently scheduled January 2016 through May 2016.

- 50% of the quantities as reflected on Appendix 3C must be ordered and purchased as indicated by the Design-Builder's purchasing representative, over the following two years from January 2016 through January 2018 to support Project Schedule for Rings 2-5.

All Bulk Materials will be purchased through a local Kentucky distributor selected by the Design-Builder and agreed to by the Authority, acting reasonably. The local Kentucky distributor will ship some materials directly to the construction subcontractors using an FCA destination basis which makes the distributor responsible for any shipping damage or loss. The local Kentucky distributor will also utilize two (2) Kentucky warehouses to stage and kit materials for smaller subcontractors. The Authority's and Design-Builder's purchasing representative will work with the distributor to determine the minimum/maximum inventory levels to be carried at each warehouse location. The Design-Builder will inform Authority whether the shipments will be direct shipments to the primary construction subcontractors (as defined below) or whether the shipments will be directed to the local warehouse facilities. The Design-Builder will provide regular updates to the Authority on the status of any orders and shipments and respond to inquiries from the Authority or Project Co within 1 Business Day.

The Hut enclosure will be purchased from a building manufacturer outside of Kentucky who will design, fabricate and deliver the enclosures to each Node Site Location in Kentucky. Backup generators and automatic transfer switches will be purchased by the Authority directly from the manufacturer and shipped directly to the Hut Location Sites where they are required.

#### Designated Equipment Delivery Locations:

The Authority acknowledges that the three primary construction subcontractors will establish various material staging yards around the Commonwealth of Kentucky to support local construction crews and deliveries of Designated Equipment shall be made directly to each primary construction subcontractor's staging yard and the purchase orders or other documentation will contemplate the unloading of the shipment by the transportation provider at the designated location. Huts will be delivered directly to the jobsite where each is being installed. The Authority will be responsible for paying the freight cost for all Designated Equipment deliveries on a prepaid and invoiced basis.

If the Authority anticipates a delay in the ordering or delivery of the Designated Equipment whether due to an Authority caused delay or for any other reason or the timely performance of any of the Authority's obligations in respect of the Designated Equipment, it will immediately notify Design-Builder purchasing representative.

#### Terms and Conditions of the Designated Equipment Purchase Orders:

In the event the Design-Builder purchasing representative is of the opinion that the purchase order terms and conditions do not support the Project Schedule, the Design-Builder purchasing representative will discuss the matter with the Authority's purchasing representative and resolution will be sought so as to not impact the Project Schedule or expose the Design-Builder to additional risk or costs. Additionally, when the Authority's representative is placing any purchase orders for the Designated Equipment it will contain the following terms and conditions:

- 1) The Design-Builder is authorized to act “as agent” on behalf of the Authority in regard to the purchase order or other documentation; however, the Design-Builder shall notify the Authority whenever they have acted as an agent thereof subject to the following sentence. For purposes of clarity, it is anticipated that the Design-Builder will act as the agent of the Authority for communicating with the material vendors, distributors and construction subcontractors regarding specific details of material orders such as shipping, delivery times, locations and quantities and it shall not be necessary for the Design-Builder to notify Authority each time it acts in that capacity.
- 2) The warranty term of the Designated Equipment will cover any shipping, storage and contractual warranty terms applicable to the Project (the specific warranty term to be confirmed with the Design-Builder’s representative).
- 3) The warranty applicable to the Designated Equipment is fully assignable to the Design-Builder. The specific warranty term can be confirmed with the Design-Builder’s purchase representative.
- 4) The risk of loss and title transfer of any particular shipment is clearly defined to allow the equipment and materials to come into the possession of the Design-Builder at a defined point (a designated warehouse or primary construction contractor’s materials staging yard) and to be included in the BAR insurance coverage.
- 5) Issues pertaining to the ordering and delivery of the Designated Equipment shall be handled as follows:
  - a) In the event the Authority fails to order Designated Equipment in accordance with the Authority Order Date or places an incorrect order or orders, the Design-Builder will assist the Authority in determining the source of the issue; however, it will be the Authority’s obligation to correct and reorder any Designated Equipment so as not to impact the Project Schedule or if the Authority is unable to do so it will be a breach of this Designated Equipment Protocol by the Authority. It shall be the Design-Builder’s responsibility to provide accurate and timely information, in accordance with this Designated Equipment Protocol, to the Authority as to the quantity of, or delivery dates for the Designated Equipment.
  - b) If the Designated Equipment is delivered late or damaged to either (i) the Design-Builder at the warehouse facility or (ii) directly to a construction subcontractor at its staging yard, in either (i) or (ii) through no fault of the Authority, the Design Builder agrees to assist the Authority in working with any supplier or transporter claims process on behalf of the Authority to collect documentation (paperwork and pictures) to support any Authority claim.

The parties agree that if the process and requirements set out in this Appendix 3D are not followed by the any party, the Project Schedule will be impacted. The parties acknowledge that they are relying on one another’s compliance with this Appendix 3D and each agrees to comply with all of its obligations hereunder.