

Information & Communications Technology

**Technical Standards (TS)**

**ICT-TS-202010-CoreNetwork**

**(CORE NETWORK UPGRADE)**

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1. **Introduction**

The components proposed to be supplied by the Contractor or Contractor shall be branded industry proven products. All supplies shall conform to the requirements of relevant International standards. The Contractor shall provide all the required components and services to fulfil the intent of the specification and to ensure the completeness, operation and maintainability of the system at no extra cost to the procuring entity.

* 1. **Supplies**

In summary the Contractor is expected to supply the following;

* + 1. Design, source and install the Core Network and other components listed
    2. Full and complete As-Built documentation of the design and build of the infrastructure
    3. Comprehensive labelling of all installed devices/components which shall be contained in the network documentation.
    4. Provide any necessary accessories to ensure that both wired and wireless reception is wholesomely achieved in the PPL Centre offices.
    5. Wireless Access points must be configured with two SSIDs. One for PPL Staff and the second SSID for guest access. The guest SSID platform shall not be broadcasted.
  1. **Objectives**

The objectives of the PPL Core Network project will be the following;

* + 1. Speed – To ensure speed, reliability and certainty of delivery of services at the HQ
    2. Infrastructure – replace old equipment and expand the current network both for wired and wireless
    3. Security – strengthen our security capabilities and encrypt data transmission between endpoints
    4. Mobility – support mobile and remote access solutions
    5. Reliability – exceed our customer and employee expectations
    6. Capacity – able to handle increased traffic now and into the future
    7. High Availability – robust and automatic re-routing capability

1. **Scope of Work**

The scope of this project comprises a detailed design, sourcing, installation, testing and commissioning of a structured and secure Core Network as described in this documentation. PPL shall strive to achieve this noble objective by deploying sustainable, reliable and affordable technologies in the market.

Overall role of the Contractor would be to design, source and install a secure and resilient network covering HQ with reliable and secured connectivity to Power Station (PS) and Remote Offices (RO).

* 1. The Contractor shall be responsible for ensuring the Core Network installation devices are fully compatible with PPL’s provided specifications;
  2. The Contractor shall include the required/necessary modifications and rectifications to the systems during the system implementation phase. Any of such modifications and rectifications must be done in writing to the project manager for approval before they are implemented.
  3. The Contractor shall ensure that all Wired and Wireless Access Points (WAP) are configured to access internet and other network resources from the Datacentre server and can broadcast the so signal. This shall be done to ensure that all Access Points (APs) and extenders have the required configuration.
  4. Access point shall be configured in different channels to avoid signal overlap within the same broadcast length.
  5. The Contractor shall provide all necessary additional resources and solutions to mitigate any project schedule risks.
  6. The Contractor shall provide Operation and Maintenance Manuals to document the installation that include the test reports and the manuals.
  7. The Contractor shall provide a full and complete As-Built document within two weeks after commissioning of the upgrade.
  8. The Contractor shall provide 3-month Defects Liability Period (DLP) after practical completion date. The Contractor shall provide system performance warranty for the installed system from the components system manufacturers.
  9. The Contractor shall provide Service Level Agreements (SLAs) to ensure maintenance and resolving of issue with the Network Services.
  10. The Contractor will design the PPL Core Network architecture to provide data, voice and video services at the HQ and integrate Power Stations and Remote Office with the HQ.
  11. Management, Monitoring and Operation of the entire network through centralized Network Operations Centre (NOC) at HQ.
  12. The solution proposed should be interoperable, based on open standards and should be scalable and there should be provision of integrating with the networks already existing.
  13. The solution should also support all new technology that is prevalent and should have the scope for upgrade.

1. **Framework of the CORE Network architecture**

The figure below schematically represents Core Network Failover Architect Diagram.



The PPL Core Network shall have a two-tier architecture enabling modular structuring of the network into

small, easy-to-understand elements also facilitates resiliency via improved fault isolation. The PPL Core Network should operate at a minimum of 10Gbps with 40Gbps where possible with built in readiness for 100Gbps.

The connectivity between the first tier i.e. the HQ with the second tier i.e. the Power Stations (PS) and that between the second tier Remote Office (RO) will be though optical fibre, the medium and bandwidth will be provided by PPL Operations with a minimum bandwidth of 200 Mbps. The PPL Core Network will connect with the WAN on a Software Defined Network (SDN) model.

* 1. **Conceptual Design and Specifications**

The technology selected for the PPL Core Network is IP and all services i.e. Data, Video conferencing and Voice (telephony) will be IP based.

PPL Core Network shall also provide single point Internet connectivity through multiple Internet leased line at HQ, which will be increased progressively at any time as per requirement/usage.

* 1. **Network Design Principles**

The key design considerations for building this network is as follows:

* + 1. **Protocol:** All the protocols used should be industry standard protocols. The network protocol to be used would be the industry standard Internet Protocol (IP). The design should also support IPV6 in future.
    2. **Redundancy:** The network should be designed to minimize the single point of failure. The network shall have capability for defining and enabling alternate routes to avoid disruption in service. Contractor shall provide the details of redundancy and the level of redundancy provided in the network. The network shall have redundancy of relevant elements at appropriate levels so that any one failure does not cause a total disruption of services.
    3. **Scalability:** The network design shall accommodate future scalability. Chassis based switches and access equipment shall be used to ensure future scalability at the equipment level as well. The design shall be scalable with respect to number of connected nodes, connection to Power Stations and Remote Offices; number of interfaces per site and bandwidth at all the levels. The various interfaces shall be realized on plug-in cards with hot swappable facility.
    4. **Optimization:** The Network shall have industry efficient compression engine to optimize bandwidth utilization
    5. **Performance Considerations:** The equipment selected to ensure adequate back plane capacity to route under peak load to prevent any performance issues. Performance of the network will be periodically monitored using Network Management tools and capacity will be upgraded proactively. Necessary memory slots to be provided on all routers/SDWAN to accommodate future performance scalability.
    6. **Manageability:** A centralized Network Management System (NMS) should be deployed to manage the Core Network as well as the Wide Area Network (WAN). NMS should also support SNMP, SFlow and NetFlow. The Network Management System used shall be capable of doing fault management (at the network and server level) performance management, configuration management, security management and also accounting management (if inter-departmental accounting is needed). The Network Management System should be scalable as well and would be able to provide a hierarchical, topological view of the entire network and provide trouble ticketing. The design shall have sufficient diagnostic facilities to identify & locate the faults and easy rectification of faults. The Contractor shall specify the details & level of diagnostics provided.
    7. **Standards:** The equipment/interfaces shall comply with relevant ITU-T/ IEEE/ IETF/ EIA/TIA/ ANSI/ NEBS/ TEC etc. standards as applicable. The design shall comply to interconnect and security guidelines issued by Government of PNG and NICTA from time to time.
    8. **Configurable:** The network shall route the data traffic as per the requirement from any location to any other location. The network shall allow Internet connectivity to all/selective users at all/selective centres/locations as per requirement using the same network infrastructure.
    9. **Interconnect with Existing network:** The proposed network design shall allow the connectivity of existing networks using standard protocol.
    10. **Security:** The proposed design should adhere to International security guidelines. The design shall also take care of all the security requirements mentioned.
    11. **Interoperability:** The network should have adherence to the PPL ICT’s interoperability guidelines.
  1. **Installation & Commissioning of Equipment**

The CONTRACTOR shall install, integrate and commission the network equipment connecting all equipment at the HQ as per approved deployment design within the specified time period, as specified in the Time Schedule Section of RFT.

The Contractor shall design the PPL Core Network for optimal routing and load balancing as per the needs of PPL, for efficient utilization of the bandwidth. Installation of all active and passive components and accessories should be done as per standards for successful integration and implementation of the network at the HQ for internet connectivity and configuring associated security systems like Firewall/IDS/IPS etc. as approved by PPL. Similarly, subsystems should be configured to achieve overall optimal network performance and highest security.

The components to be installed and configured shall include but not limited to:

* + Core Routers
  + SDWAN devices/appliances
  + Layer2/Layer 3 Switches
  + Rack/Passive Components
  + Core Firewalls
  + AAA Servers with required software
  + TACACS+ server with required software
  + RAS/NMS

In case the Contractor needs to bring any installation equipment and tools required for the installation and commissioning of the system, the same will be done by him and no extra charges would be paid by PPL towards this equipment or their transportation to the sites.

The Contractor will install and configure routers/SDWAN with internet service providers along with necessary firewall at HQ and will also install and configure to allow web servers, e-mail servers, application servers, AAA servers etc. along with relevant software and other utilities.

The Contractor will also carry out all general tests such as Power on test on delivery, pre-installation checks to ensure correct connections, completeness of system documentation etc.

The monitoring of the installation of the Network will be ensured by the Contractor and will also ensure regular submission of reports to PPL as per the approved timelines of the project.

The Contractor will also ensure integration of all existing or operational LANs of PPL Issues like IP addressing will have to addressed by the Contractor in order to ensure complete integration and to enable the applications to run smoothly. It shall be the responsibility of the Contractor to configure the systems.

* 1. **System Integration**
     1. The CONTRACTOR shall be responsible for integration of all hardware as well as software components supplied as per details given the RFT.
     2. The CONTRACTOR shall be responsible for integration of IP PBX with Voice Gateway, IP ABX (Soft-switch), IP Phones over the network.
     3. The CONTRACTOR shall configure quality (QoS) of service parameters on network switching and routing devices for end-to-end QoS for data, voice, video and other critical traffic over the network.
     4. The CONTRACTOR shall be responsible for integration of security components in the network to ensure a secured network access for users.
     5. The CONTRACTOR shall be responsible for integration of all existing/operational LANs and WAN links to provide enterprise wide access to resources and services. It shall be the responsibility of the CONTRACTOR to configure the systems to take care of all IP addressing or similar issues arising at the time of integration and should also ensure that all the existing applications run smoothly.
     6. The CONTRACTOR shall configure network management policies for managing all the network and security devices using network management systems.
  2. **Structured Cabling**

The Contractor is required to install and commission on a turnkey basis, the structured cabling at the HQ involving CAT5E/CAT6 cables, Surface Mount I/Os, 3’ CAT 5E/CAT6 patch cord, 7’ CAT 5E/CAT6 patch cords, Jack Panel, Racks, PVC conduit / casing / capping with accessories, any other required components such as labels, ferrules etc., and all associated civil works at all the HQ in accordance with the following guidelines.

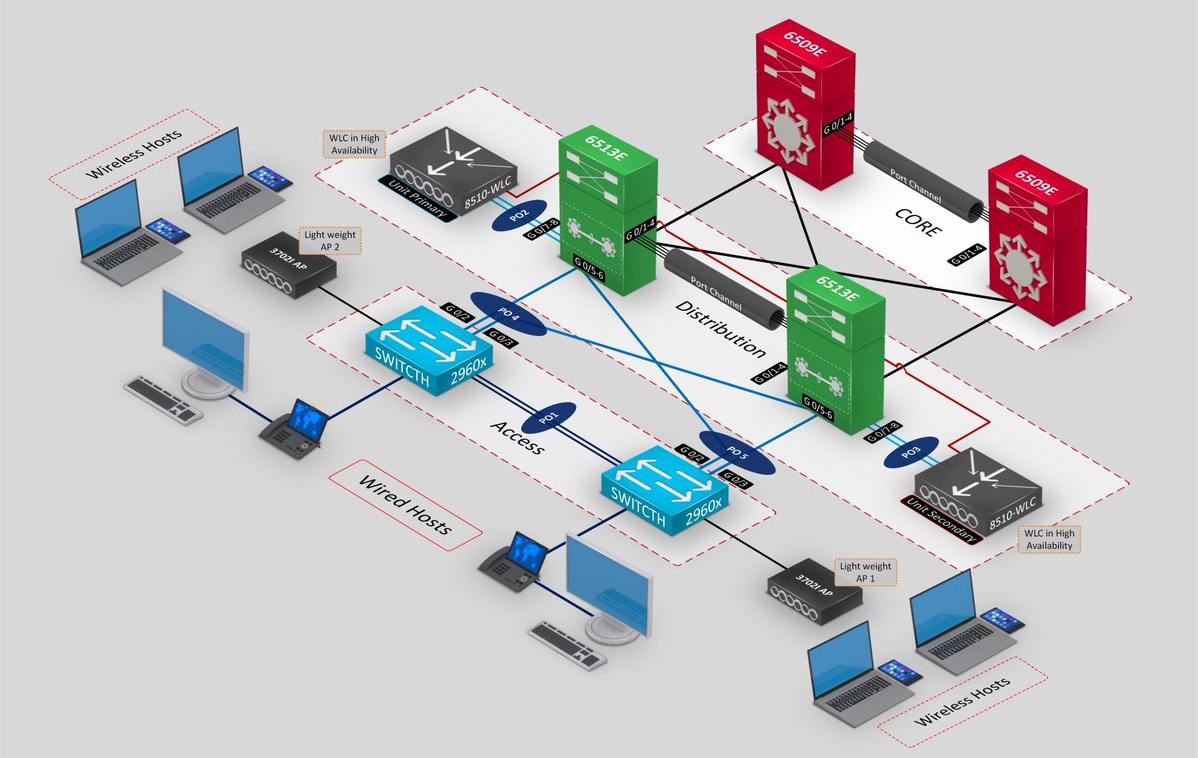
* + 1. Carrying out of the required surveys prior to installation work is the responsibility of the Successful Contractor, if deemed necessary.
    2. The cabling job should be carried out under the supervision of certified engineers.
    3. All the wiring should be fully concealed inside the conduit and no cable (except patch cords) should be visible to the naked eye.
    4. The actual ratio of trenching and casing work will depend upon the site layout. The Contractor is advised to familiarize itself with the site layout of the HQ through representative surveys/site visits and ascertain the actual ratio.
    5. The cabling shall be properly labelled and covered so as to facilitate easy identification and maintenance. The labelling and run shall be documented.
    6. All civil work like cutting, chiselling, drilling, etc. shall be finished to ensure smooth levelled surfaces matching the existing surface finish without disturbing the existing aesthetics of the office to the extent possible.
    7. Testing, in conformance to measurement procedures and test parameters for V.35, CAT 5E / CAT 6 and other communication cables installation as defined in TIA/EIA-568-B standards, of each node at each site. The certified test results are to be submitted to PPL in hard copy as well as electronic copy.
    8. Certification of each site for minimum 15 years performance warranty based on the above test results from the manufacturer of the structured cabling components.
    9. Fixing & installation of existing switches, if any, inside the supplied rack(s)
  1. **Power Cabling**

The Contractor is required to install & commission the Power Cabling from the power source to the UPS & from the UPS to the network equipment that involves design, laying, fixing, installation, & commissioning of the power cabling system including electrical box / boards, cables, UPS, MDB, MCB, and associated civil works at each of the sites on a turnkey basis in accordance with the following guidelines.

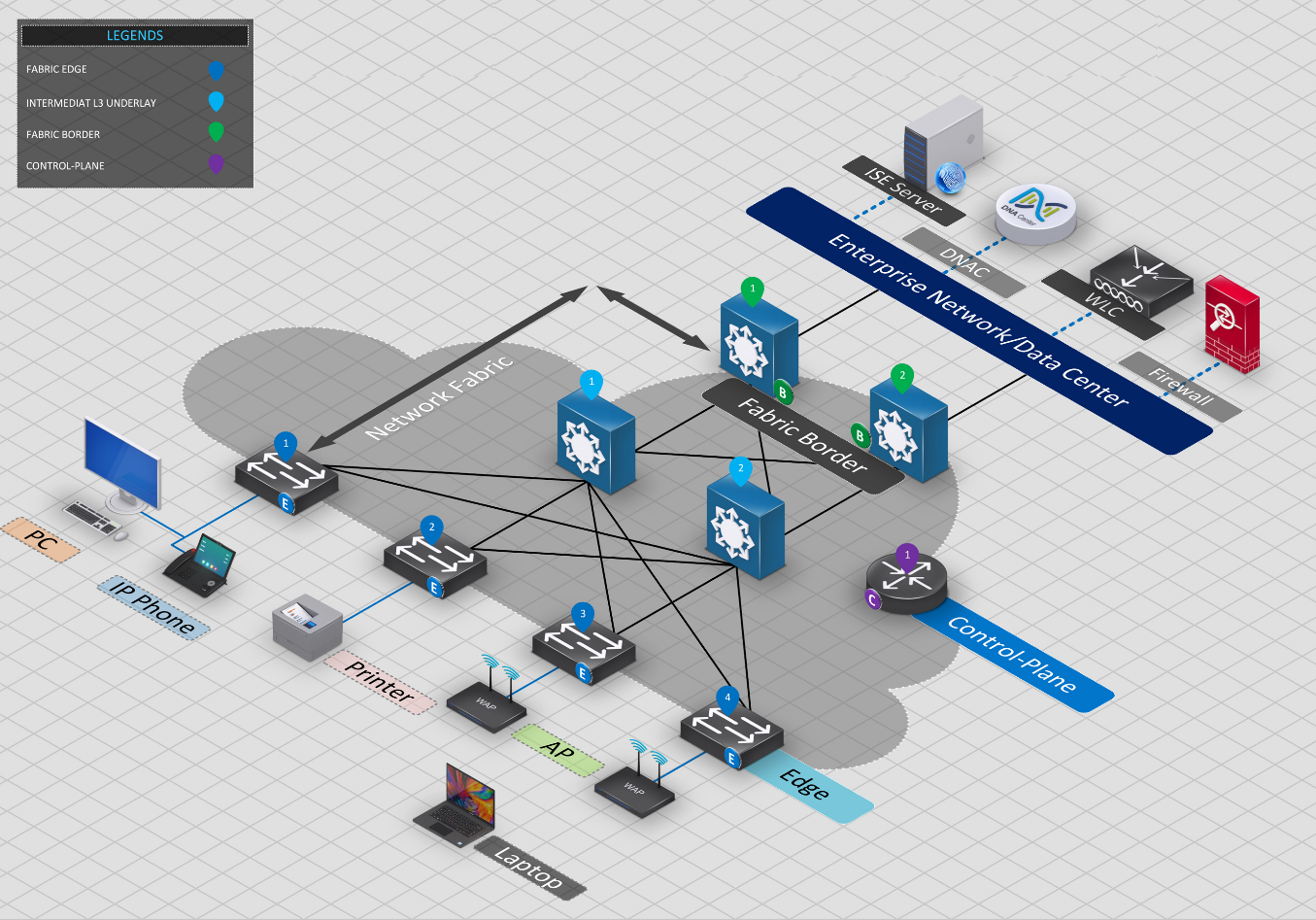
* + 1. The power-cabling job should be carried out under the supervision of licensed electrical technicians.
    2. All the wiring should be fully concealed inside the conduit / G.I. pipe / Aluminium Channel and no cable should be visible to the naked eye.
    3. The cabling shall be properly labelled and ferruled so as to facilitate easy identification and maintenance. The labelling and ferruling shall be as documented.
    4. All civil work like cutting, chiselling, drilling, etc. shall be finished to ensure smooth levelled surfaces matching the existing surface finish without disturbing the existing aesthetics of the office.
    5. All waste material shall be properly disposed from the premises in an environment friendly manner and compliant to applicable civil / municipal guidelines.
    6. The Contractor is required ensure a proper electrical earth for Power Cabling is available in the sites. The Contractor is also required to properly earth the UPS. The Contractor also shall repair the existing power earth(s), if any, and make sure that the existing earth is working properly.
    7. Each electrical point should be tested with line tester / multi-meter. Test results are to be submitted to PPL in hard copy as well as electronic copy.
  1. **Testing**
     1. The Contractor shall prepare detailed acceptance testing plan (ATP) for all the components of the PPL Core Network. ATP shall be carried out for 15 days for all the components of the PPL Core Network.
     2. If any outage occurs on the network during the ATP period, the ATP period shall be extended by as many numbers of days of outage and it will be treated as delay, but if more than three days of outage occurs during this period, Contractor would be required to resolve all the network problems and restart the ATP afresh for 15 days, which shall also be treated as delay and be liable for penalty.
     3. After installation, the cabling system shall be tested as per the Standard Testing procedure laid out by the certification agencies/OEM. The Contractor shall bring to site all the test equipment as required under the procedure to carry out link testing. Node-wise test reports shall be submitted to the purchaser.
     4. The Contractor shall be responsible for integration of all existing/operational LANs and WAN links to provide enterprise wide access to resources and services. It shall be responsibility of the Contractor to configure the systems to take care of all IP addressing or similar issues arising at the time of integration and should also ensure that all the existing applications run smoothly.
     5. The Contractor shall ensure that the cabling and crimping/termination is done in accordance with the EIA/TIA standards and supported by the Original Equipment Manufacturer (OEM) fully tested and certified for operations for a minimum period of 20 years.
     6. All the functionality, features and configuration relevant to the PPL Core Network shall be documented by the Contractor for the Network, IP Telephony equipment etc. and shall be demonstrated to the purchaser.
     7. All the features and functionality of the Network Management System to monitor/ manage/ control the core network including LAN and WAN infrastructure as well as for managing the QoS on the LAN/WAN links in the enterprise shall be demonstrated at the NOC.
     8. Acceptance Test shall be conducted at HQ.
     9. The date on which such certificate is issued shall be deemed date of the successful commissioning of the PPL Core Network Upgrade Project. Any delay by the Contractor in the performance of its contracted obligations shall render the Contractor liable to the imposition of appropriate penalties, unless agreed otherwise by Client.
     10. Any delay by the Contractor in the Final Acceptance Testing shall render the the Contractor liable to the imposition of appropriate Penalties.
  2. **Commissioning**
     1. The Contractor shall configure the network equipment, transmission medium, IP telephony equipment, Security and servers etc for end-to-end user access to applications/services.
     2. The Contractor shall be responsible for the installation and configuration of software applications/modules for the Network Management and security management, IP telephony etc.
     3. The Contractor shall be responsible for integration of all existing/operational LANs and WAN links to provide enterprise wide access to resources and services. It shall be responsibility of the Contractor to configure the systems to take care of all IP addressing or similar issues arising at the time of integration and should also ensure that all the existing applications run smoothly.
     4. After acceptance of the Core Network by PPL, the network would be deemed to have been commissioned.
  3. **Documentation**
     1. The Contractor shall document all the installation and commissioning procedures and provide the same to PPL within 30 days of the commissioning of the PPL Core Network.
     2. The Contractor shall submit a complete cabling system layout (As installed) including cable routing, telecommunication closets and telecommunication outlet/ connector designations. The layout shall detail locations of all equipment and indicate all wiring pathways. This shall be submitted to the purchaser within 15 days of completion of cabling system.
     3. Manufacturer's technical documentation on all devices used in the system including user manuals for configuring of switches, routers, etc and their 'As installed' configuration, Network topology and Network diagram with redundant path, if any, shall be provided by the Contractor.
  4. **Training**
     1. The Contractor will extend as a part of the project implementation training to at least 2 officers nominated by PPL ICT at the HQ on the operations and management of the PPL CORE NETWORK covering the following:
* Installation procedure
* Configuring & fine tuning
* Administration and Management
* Security & Policies
* Operations & Monitoring
  + 1. The CONTRACTOR will also be required to provide information or advice for the equipment, Hardware, Software etc. procured later for NOC or any other project, whose equipment will be installed / integrated at NOC.

1. **Technical Specifications**

Switch Platform and Hardware



Design concept for a Failover mechanism

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* 1. **Core Layer**

Use of DATA CENTER and VIRTUALISATION Switches in this layer.

The Core layer provides connectivity between distribution layers for large LAN environments.

|  |  |
| --- | --- |
| Features/Components | Specifications |
| Latency (nano sec) | 850 |
| CPU Memory | 16Gb |
| SSD | 32Gb |
| Packet Buffer | 32Mb |
| Maximum Power | 455W |
| Typical power | 310W |
| Maximum current | 2.1A@220VAC |
| Fan modules | 4 |
| Form Factor | 1RU |
| Max thermal output | 1552 BTU/h |
| Redundant power supplies | AC Power Supply, IO Panel to PSU Airflow AC Power Supply |
| Fans | Fan module, IO Panel to PSU Airflow |
| Optics | Transceiver, 100GbE, PSM4 (500m) QSFP28  Transceiver, 100GbE, CWDM4 (2Km) QSFP28 Transceiver, 100GbE, LR4 QSFP28 Transceiver, 40GbE, SR4 optic QSFP+ Transceiver, 40GbE, BIDI optic QSFP+ |
| Cables | 100GbE, 2x50GbE, 2xQSFP to 2xQSFP28, passive DAC, breakout 40GbE, QSFP+ to QSFP+, active optical 40GbE, QSFP+ to QSFP+, passive DAC 40GbE, MTP to 4xLC optical breakout 40GbE, 4x10GbE, QSFP+ to 4xSFP+, passive DAC |
| Cable Management | Z9100 Cable Breakout Kit, MTP to LC (1RU 64-port LC over MMF) Z9100 Cable Breakout Kit, MTP to LC (1RU 64-port LC over SMF) |
| 1/2.5/5/10/25/40 Gbps, Multigigabit, UPOE, 10/100/1000BASE-T 320-Gbps switching capacity |  |

* 1. **Distribution Layer**

Use of CAMPUS LAN Switches in this layer

The Distribution layer aggregates access layers and provides connectivity to services.

|  |  |
| --- | --- |
| Features/Components | Specifications |
| Latency (nano sec) | 850 |
| CPU Memory | 16Gb |
| SSD | 32Gb |
| Packet Buffer | 32Mb |
| Maximum Power | 455W |
| Typical power | 310W |
| Maximum current | 2.1A@220VAC |
| Fan modules | 4 |
| Form Factor | 1RU |
| Max thermal output | 1552 BTU/h |
| Redundant power supplies | AC Power Supply, IO Panel to PSU Airflow AC Power Supply |
| Fans | Fan module, IO Panel to PSU Airflow |
| Optics | Transceiver, 100GbE, PSM4 (500m) QSFP28  Transceiver, 100GbE, CWDM4 (2Km) QSFP28 Transceiver, 100GbE, LR4 QSFP28 Transceiver, 40GbE, SR4 optic QSFP+ Transceiver, 40GbE, BIDI optic QSFP+ |
| Cables | 100GbE, 2x50GbE, 2xQSFP to 2xQSFP28, passive DAC, breakout 40GbE, QSFP+ to QSFP+, active optical 40GbE, QSFP+ to QSFP+, passive DAC 40GbE, MTP to 4xLC optical breakout 40GbE, 4x10GbE, QSFP+ to 4xSFP+, passive DAC |
| Cable Management | Z9100 Cable Breakout Kit, MTP to LC (1RU 64-port LC over MMF) Z9100 Cable Breakout Kit, MTP to LC (1RU 64-port LC over SMF) |
| Modular and Stackwise Virtua l160-Gbps switching capacity PoE, PoE+ |  |

* 1. **Access Layer**

Use of CAMPUS LAN Switches in this layer

The layer provides endpoints and users direct access to the network

|  |
| --- |
| Feature |
| Day 0 network bring-up automation Network Plug-and-Play application, network settings, device credentials |
| Element management Discovery, inventory, topology, software image, licensing, and configuration management |
| Element management Patching |
| Network monitoring Product Security Incident Response Team (PSIRT) compliance, end-of-life/end-of-sale reporting, telemetry quotient, client 360, device 360, top talkers/ NetFlow/streaming telemetry collection and correlation |
| Static QoS configuration and monitoring EasyQoS application |
| Policy-based automation SD-Access, group-based policy for access, app prioritization, monitoring, and path selection; SD-Access with integrated wireless |
| Network assurance and analytics Insights gained from analytics and machine learning for the network, clients and applications that cover onboarding, connectivity, and performance |
| Stack power Technology |

* 1. **Firewalls / SDWAN Layer**
     1. The proposed SD-WAN solution should have the following minimum features:
* On-premise Customer Edge Device (CoE)
* Application visibility and Analytics,
* High Availability,
* Centralized Orchestration & Policy Management,
* Transport Independent Overlay Solution,
* Voice Over IP (VOIP),
* Video Conferencing
* Application Aware Routing,
* Performance based App Aware Routing & Load Sharing,
* Segmentation & Dynamic Topologies,
* Application Based QoS (Quality of Service),
* Local Internet Break out,
* Path Brownout,
* Security & Encryption,
* Managed service offering,
* Self Service Portal.
  + 1. Essentials and Advantage package features

|  |  |  |
| --- | --- | --- |
| Feature | Small | Large |
| Maximum Clients | Up to 1,024 | Up to 4,096 |
| Firewall throughput | 2 Gbps | 8 Gbps |
| Encrypted throughput (AES-CBC) | 1.2 Gbps | 6 Gbps |
| Active firewall sessions | 32K | 64K |
| WAN/LAN Interfaces | 4 | 2 (combo) |
| PoE in/out | Out; 100W | Out; 150W |
| PoE in/out | Yes (2); USB 2.0 | Yes (1); USB 2.0 |
| Form factor/footprint | 1RU | 1RU |

* 1. **Wireless Access Points / Controller**

Essentials and Advantage package features

|  |
| --- |
| Feature |
| Resiliency   * Active and standby controllers running simultaneously on two access points, * Seamless software updates enable faster resolution of critical issues and introduction of new access points with minimal downtime |
| Security   * Rogue detection, classification, and containment * 802.1X supplicant support on EWC-AP * Walled garden and DNS ACLs |
| Management   * Dashboard (web browser) and easy-to-use mobile app for deploying, provisioning, and monitoring * Standards-based interoperability tools using programmable interfaces |
| Guest   * Central web authentication, local web authentication, and BYOD * Iintegration for personalized and relevant guest experience |
| Intelligent Capture   * Intelligent Capture probes the network and provides deep analysis. This feature allows for more informed decisions on your wireless networks |
| Wi-Fi 6 (802.11ax) and RF features   * Access point can perform advanced RF spectrum analysis and delivers features such as, Wireless Intrusion Prevention System (WIPS), Fast Locate, and Dynamic Frequency Selection (DFS) detection Future) * Uplink/downlink OFDMA: Orthogonal Frequency-Division Multiple Access to reduce overhead and latency * MU‑MIMO: Multiuser Multiple-Input Multiple-Output (MU-MIMO) to split spatial streams between client devices to maximize throughput * Target Wake Time (TWT): TWT is a new power-saving mode that allows the client to stay asleep and to wake up only at prescheduled (target) times to exchange data with the access point. * Flexible Radio Assignment: Allows the access points to intelligently determine the operating mode of serving radios based on the RF environment |
|  |