Study Committee D2

Information System and Telecommunications

Paper 10983_2022

ELECTRIC POWER INDUSTRY OF SERBIA IP MPLS NETWORK UPGRADE: PROVIDING OPERATIONAL AND CORPORATE SERVICES

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Motivation

- The main reason for the upgrade of IP MPLS network was originated by the process of centralization in organization structure of EPS which caused development of central applications and services which are mutually utilized at the level of the whole company.
- The centralization of traffic flows had a great impact on demand for larger capacities of links in the network.
- Requirements made by utility systems regarding high reliability and secure communications for operational traffic which needed to be realized by the same communications platform using IP MPLS network.
- Support for Power Grid Automation / Smart Grid

Method/Approach

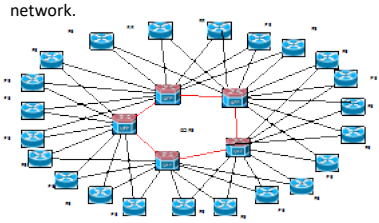
- The approach of EPS telecommunication system development is based on the construction of a new backbone and aggregation part of the high capacity IP MPLS network, improvement of the access plane of the IP MPLS network and building of a new transmission network based on the implementation of DWDM / OTN technology -**Technology**
- In order to provide all the required services for operation of Electric Power Industry, IP MPLS network utilizes new links of capacities 10 Gbps and 1 Gbps within transport telecommunications network based on DWDM OTN technology with possibility of upgrade up to 100 Gbit/s - **Capacity**
- Availability improvement of network services is achieved through implementation of redundancy at hardware level of IP MPLS network which is coupled to redundancy of links and redundancy at the level of transmission network in order to eliminate the single point of failure in the system - **Redundancy**

Objects of investigation

- Improvement of IP MPLS network in order to meet current and future requirements for data transmission within the utility and business management system of EPS.
- Provisioning of all the services with guaranteed quality through IP MPLS network which represents universal platform to fulfill service requirements made by both technical and corporate systems enabling improvement related to capacity, reliability and scalability.

Network setup & results

- New backbone and aggregation planes of IP MPLS network were formed during the upgrade of the network.



- The backbone routers (P) forward packets based on the MPLS label, do not transmit VPN routes and do not participate in VPN MPLS routing.
- The network provides MPLS L3 VPN and L2 VPN services at the level of aggregation routers (PE). PE routers isolate user traffic within virtual routing and forwarding tables (VRF).
- PE routers establish neighbourhood only with Route Reflectors (RR) which forward the information obtained from one PE router to all other PE routers in the network.

Discussion

- In the core and aggregation part of the IP MPLS network, a scalable and flexible solution is applied in terms of equipment capacity and number of connections it provides, in order to meet current needs and provide the possibility of introducing new nodes and connecting new user networks in the future without changing device platforms.
- Network traffic is organized within different classes of services. Different routing policies are applied depending on the traffic class.
- The following services were implemented within the IP MPLS network: IP telephony with video conferencing, Business data transfer, SCADA for the needs of Technical Information Systems, SCADA for the needs of Dispatch Centers of Electricity Distribution Company, Video surveillance, Technical Monitoring Systems…
- The implementation of the multiservice IP MPLS network enables services that are provided centrally at the level of the entire company, and at the same time services that are used at the regional level of individual branches.
- Existing branch-level services are migrated from the SDH network to the IP MPLS network and traffic is primarily forwarded through the IP MPLS network, while SDH connections are retained for redundancy purposes.

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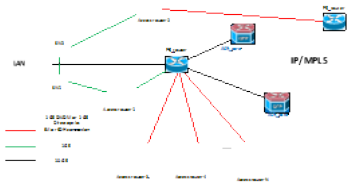
Model of organization of Backbone and Aggregation network after upgrade

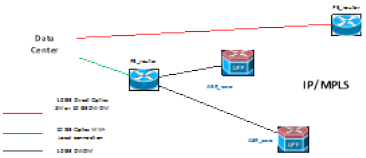
- The backbone of the IP MPLS network is formed in a ring topology where the connections between routers, with a capacity of 10 Gbit / s, are realized with protection at the path level using DWDM OTN network.
- Aggregation routers connect to backbone routers using 10 Gbit / s or 1 Gbit / s connections, depending on the position in the network. To ensure redundancy, aggregation routers are connected to two backbone routers with protection at the IP MPLS network level.
- The MPLS network uses the LDP protocol to exchange labels between routers.
- The OSPF protocol has been set up between backbone routers, as well as between backbone routers and aggregation routers and aggregation routers and access routers within which physical links and loopback addresses of routers are advertised.
- PE routers provide exchange:
- ipv4 VPN routes between PE router and user L3 equipment using BGP protocol or static routing depending on the possibilities and situation on the user side at certain locations in the network.
- VPNv4 route with other PE routers in the network via MP BGP (Multiprotocol BGP) protocol
- backbone route with P routers and other aggregation PE routers in the network using the OSPF protocol.

The model of connecting an existing user location to an IP MPLS network



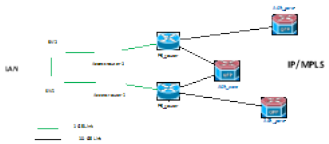
- The concept is that complete user traffic flows through the multiservice IP MPLS network, both for the needs of central services as well as for internal communication between the branches of the company

The model of connecting the Data Center and Central locations



- The primary connection of the Data Center is made to a local PE router at the level of 10 Gbit /s.
- Redundancy is realized at the level of optical connection of Data Center being established to a remote PE router with direct optical connections at the level of 10 Gbit / s using 10 GE ZR interfaces.
- The BGP protocol has been set up on the connections between the PE router and the central L3 switch of the Data Center.
- In case of failure of the primary link, ie failure of the PE router or DWDM node in Data Centre, the traffic is automatically redirected to remote router PE, which achieves a complete redundancy in connecting the Data Center or Central Location

General model of access node connection



- Access plane nodes consist of redundant access routers and switches that connect to two different aggregation routers in the network using two different optical paths.
- An eBGP routing protocol has been set up between PE routers and access routers within individual VRFs.
- HSRP (Hot Standby Routing Protocol) is used, which allows a set of interfaces of several routers to work together and to present themselves as one virtual router for LAN.
- The first router is active, while the second router, which is in the "standby" status, takes on the role of active router in case of failure of the first router.
- Also, on the active router, the mechanism of monitoring (IP SLA probe) of the link to the PE router (uplink) is applied.

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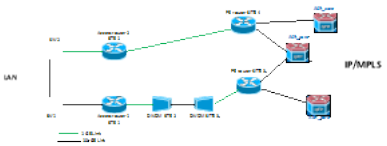
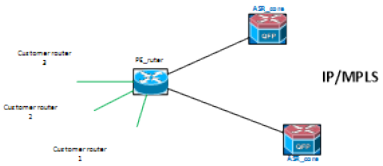
Connecting the access node by direct optical connection and DWDM link



Model of connecting user equipment at remote locations to a PE router



Implementation of SCADA Service in IP MPLS Network for Technical Information System and CDS System..

- SCADA service for the needs of the Technical Information System and Central Dispatch Systema is implemented to enable communication of remote gateway devices with SCADA servers at a central location through a dedicated VRF SCADA at all power plants connected to the optical network.
- Hardware redundancy at the gateway level is combined at the level of hardware redundancy within the IP MPLS network and redundancy at the level of the telecommunications transmission network and optical paths in order to achieve greater system reliability and availability
- For security reasons, the principle of connecting gateway devices in production facilities required the establishment of a direct physical connection between the gateways and access switches within the IP MPLS node.
- The hub and spoke model was applied, which enables communication between remote gateways, servers and workstations in a central location.

Concept of establishing connections for the needs of SCADA system

- Defining a special VRF for the SCADA service ensures the logical isolation of the SCADA system in relation to the corporate and other networks that connect through the IP MPLS network.
- In order to ensure greater availability and security of central system communication, direct physical connections have been established between 2 PE routers, one in the central and the other in the remote location, and redundant Firewalls within the CDS system.
- The BGP protocol is used for routing traffic between PE routers and Firewalls.
- For communication between the CDS SCADA environment and the CPS system, as well as individual participants from the corporate network, special L3 connections are made between the PE routers and the Firewall, using the same physical links.
- This means that communication with the CDS environment will take place through Firewalls using separate L3 connections for SCADA and Data traffic, depending on needs.

Conclusion

- Presented various solutions applied in practice in terms of connecting customer sites to IP MPLS network, confirm the principle that all services should be provided at the level of multiservice IP MPLS network, while all available resources of the transmission network are combined and used to provide services with the highest possible quality in terms of capacity and availability .
- The process od migrating services from the SDH network to the IP MPLS network enables an improvement in the quality of service in terms of capacity, availability and traffic routing.
- The concept of connecting Technical Information Systems to IP MPLS network through Firewalls and logical separation of SCADA traffic within a specific VRF provides flexible approach for meeting current and future demands related to operational data transmission.