Overall **MPLS Course** Objectives

- The drivers for MPLS
- MPLS control and data plane operation
- MPLS terminology and uses in an Alcatel-Lucent environment
- LDP and RSVP protocol operation and configuration
- Options available for TE in an MPLS network, including configuration and operation
- How to traffic engineer in a hierarchical network using LDP-over-RSVP
- [Week11-12] The available options for achieving resiliency with MPLS networks
- [Week11-12] The implementation of fast re-route in an Alcatel-Lucent environment

Mod 1, Sec 1: MPLS drivers – the role of MPLS in:

- Improving forwarding performance
- Traffic Engineering applications
- Building High Available Networks
- Consolidation of Services over a common infrastructure
- Delivering Layer 2 and Layer 3 Services
- Triple Play Solutions
- Building a BGP Free Core

Mod 1, Sec 2: Intro to MPLS – a brief definition of MPLS and provide RFC references.

- Offer a brief definition of MPLS and provide RFC references.
- Introduce the concept of a label.
- Introduce the data plane operation of MPLS (Push, POP, Swap)
- Define the basic terminology used in MPLS (P/PE/CE, LER, LSR, FEC)
- Present the requirements for label signaling protocols in MPLS and relate the LIB/LFIB relationship to the RIB/FIB of IP routing protocols.

Mod 2, Sec 1: MPLS data plane operation

- Explain the MPLS Label Stack Operation
- Explain the MPLS Label structure in detail (label values, EXP, S, TTL fields)
- Explain pipe vs. uniform mode operation with respect to TTL, EXP; the impact to a label stack
- Explain frame vs. cell mode label implementation

Mod 2, Sec 2: MPLS control plane operation

- Explain the requirement for IGP and label distribution protocols.
- Discuss the various label distribution and control and retention modes.
- Introduce the various label space implementation modes.
- Introduce the various MPLS signaling protocols.
- Explain the use of MPLS reserved labels (0-15).
- Explain the Nokia Service Router support for the various presented modes and features.

Mod 3, Sec 1: LDP operation

- Explain the LDP peer discovery and session establishment processes.
- Describe the prerequisites and parameters to establish LDP sessions.
- Investigate the label distribution process for Link LDP and explain how the label databases are populated.

Mod 3, Sec 2: Additional LDP features
- ECMP for LDP
- LDP Export and Import Policy Implementation
- Label Withdraw and Release Actions
- LDP aggregate-prefix-match feature
- Targeted LDP
- LDP Authentication

Mod 4, Sec 1: RSVP control plane operation
- Introduce the Resource Reservation Protocol (RSVP).
- Introduce RSVP with Traffic Engineering (TE) extensions.
- Explain LSP signaling using RSVP.
- Explain RSVP session establishment process for an LSP.
- Introduce RSVP message types to establish or clear LSPs, and to signal error conditions.
- LSP-Ping and LSP-Trace for RSVP-TE based LSPs.

Mod 4, Sec 2: RSVP session refresh optimization
- RSVP-TE Hello Protocol
- Refresh-Time Randomization (RFC 2205 – Section 3.7)
- RSVP Refresh Overhead Reduction
  - Reliable message delivery using MESSAGE-ID and MESSAGE-ACK
  - Summary Refresh messages

Mod 5, Sec 1: MPLS Traffic Engineering Fundamentals
- Review the drivers for Traffic Engineering (TE)
- Discuss the additional information required in TE (administrative constraints).
- Understand how these attributes are signaled via IGP (OSPF and IS-IS TE extensions)
- Discuss the operation of CSPF (Constraint-Based Shortest Path First) algorithm.
- Discuss the use of ERO (Explicit Route Object) for signaling TE-based LSP paths.

Mod 5, Sec 2: Configuring TE in a single-area (flat) network
- Configure administrative constraints on the links (administrative group, TE-metric)
- Configure path definitions using strict and loose hops
- Specify constraints in LSP path configuration
- Use CLI show commands, demonstrate how to monitor an LSP path configuration
- Explain possible configuration errors and failure scenarios
- Explain the CSPF path-check tool with an example

Mod 5, Sec 3 (Not covered; skip this section)

Mod 5, Sec 4: TE in a multi-area network
- The LDP-over-RSVP solution

Mod 5, Sec 5: MPLS Shortcuts
- LDP-Shortcut for BGP next-hops
- RSVP-TE Shortcut for BGP next-hops
- LDP-Shortcut for IP forwarding
- RSVP-TE Shortcut for IP forwarding
- 6PE – IPv6 tunnels over MPLS

Midterm 2 includes: Services Architecture (Mod 1; Mod 2, slides1-14; Mod 3, sections 1-2)

Overall **SA Course** Objectives

- Demonstrate the significance of Nokia services
- List the different service types available and their components
- Explain the encapsulation of service data with a service label and transport label
- Explain the concept of SAP and SDP and how they are used
- Describe the operation of VPWS services
- Configure, verify and troubleshoot an epipe service
- [Forthcoming; very briefly] Recognize the interworking capabilities of the different VPWS
- Explain the operation of Virtual Private LAN Service (VPLS)
- Configure and verify a VPLS
- [Partly covered] Use the correct operations, administration and maintenance (OAM) tools to analyze, manage, and troubleshoot IP/MPLS service networks
- [Forthcoming] Describe mirror service; differentiate between local & distributed mirror service
- [Forthcoming] Explain the operation of Internet enhanced services (IES)
- [Forthcoming] Describe the operation of the basic VPRN architecture
- [Forthcoming] Configure, verify, and troubleshoot an IPv4 VPRN
- [Not covered; skip this section] Configure, verify, and troubleshoot an IPv6 VPRN

Mod 1, Sec 1: Introduction to Services

- Describe the features of a service router
- List the differences between a service router and a traditional router
- Define the concept of a “service”
- Describe the types of services offered by the Nokia 7750 SR

Mod 1, Sec 2: Transport and Service Label Signaling

- Explain how customer data is transmitted across the service provider network (MPLS versus GRE tunnels)
- Explain the encapsulation of customer payload with transport and service labels
- Explain how transport labels and service labels are signaled

Mod 1, Sec 3: Service Components

- Describe the main components required for Nokia services (SAP, service ID, VC-ID, SDP)
- Explain the concept of SAP and encapsulation identifier
- Describe the operation of a local service
- Configure and verify a local service
- Describe the operation of a distributed service
- Define a service distribution point (SDP) and list its characteristics
- Configure and verify a ~~distributed~~ local service

Mod 1, Sec 4: Distributed Service Configuration

– Review of service configuration requirements
– Review of service configuration presented in previous section
– Configuring SDPs, usage of SDPs in spoke (and mesh) mode
– Example of complete configuration, verification, and testing

Mod 2, slides 1-14 on Ethernet and SAP encapsulation
- Ethernet encapsulation types: null, dot1q, QinQ
- Terminology & definitions of inner/outer, top/bottom Q tags
  – where within the order of frame fields would these tags be
- SAP encapsulations:
  – syntax for declaring each of the three basic types
  – "service delimiting" tags (essentially: explicit numeric values coded in the SAP definitions)
  – special definitions: dot1Q (default, null), QinQ (wildcard, null, null bottom)

Mod 3, Sec 1: Intro to VPLS operation
- Define a VPLS and list its features
- Explain the similarities and differences between ePipe and VPLS
- List the advantages of a VPLS from the perspective of both the customer & service provider
- Explain VPLS flooding behavior
- Identify the difference between mesh SDP and spoke SDP
- Describe the MAC learning process in VPLS

Mod 3, Sec 2: Intro to VPLS operation
- Identify the steps to configure a VPLS
- Configure and verify a VPLS
- [Forthcoming] Complete Lab 3 — Configuring a VPLS