USEEN4 - Network Operations, Virtualization and Automation

Mis à jour le 16-03-2026

Code : USEEN4

Unité spécifique de type cours

6 crédits

Responsabilité nationale :
EPN05 - Informatique / Stefano SECCI

Contact national :

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Présentation

Prérequis

M1 courses or equivalent courses at another institution.

Objectifs pédagogiques

The goal of this course is to present new technologies designed for advanced operations of IP networks in the last twenty years. The course starts with the evolution of IP switching and routing architectures, with a particular focus in traffic engineering and quality-of-service architectures. Then, the evolution of the Ethernet architecture and layer-2 protocols in general is presented, showing the extensions applied to let layer-2 protocols scale going from local area to metropolitan and data-center network segments. The course shows how IP and Ethernet evolutions recently converged in novel softwarized network environments, making use of data-plane programmability, network virtualization, cloud-native systems and automation frameworks.

Programme

Contenu

Topics :

- High availability: infrastructure planning, redundant systems, computing standards for availability and reliability.
  - *Technologies* : CEI 61078, MTTF, MTBF.
- Internet routing: advanced Internet routing and network mapping protocols.
  - *Technologies : BGP, LISP.*
- *Label switching, MPLS* : history and principles of label switching, label distribution protocols, label stacking, and multi-layer generalizations.
  - *Technologies* : ATM, MPLS, LDP, MP-BGP, MPLS-VPN, GMPLS, T-MPLS.
- *Traffic engineering*: traffic engineering in link-state routing protocols, IP/MPLS traffic engineering and inter-domain extensions, centralized control plane.
  - *Technologies* : OSPF/ISIS-TE, MPLS-TE, PCE, SDN.
- *Ethernet carrier-grade* : Ethernet evolution from shared Ethernet to switched Ethernet and Ethernet routing, Ethernet carrier grade extensions for metropolitan area and data-center networks.
  - *Technologies* : IEEE 802.1 family, STP, RSTP, VLAN; PB, PBB, MSTP, LAG; PBB-TE, OpenFlow, TRILL, L2LSP, PWE3; VPLS.
- *Network Virtualization*: virtual bridging, data-center architecture, reliability and node-path redundancy, virtualization of network functions, network operating systems, cloud network overlay protocols, cloud quality of experience.
  - *Technologies* : NFV, VMM, VXLAN, NVGRE, STT, OpenStack, Kubernetes.
- *Orchestration and Automation* : NFV orchestration, 5G slicing, virtual machine mobility, differences between automation and orchestration, automation from script-based management to autonomous networks and zero-touch management. Review of recent advances in standardization bodies and open source communities.
  - *Technologies* : ZSM, ETI, ONAP.
- *Network Optimization*: revisiting studied routing and traffic engineering problems (IP-TE, MPLS-TE, MSTP-TE, SDN, NFV) with mathematical programming, formulation and understanding of mixed integer linear programs.

Modalités de validation

- Contrôle continu
- Projet(s)
- Examen final

Description des modalités de validation

TP lab reports, mini-project report and final exam.