M2
NEVA – Network Evolutions with Virtualization and Automation
RSX217 – Nouvelles architectures de réseaux

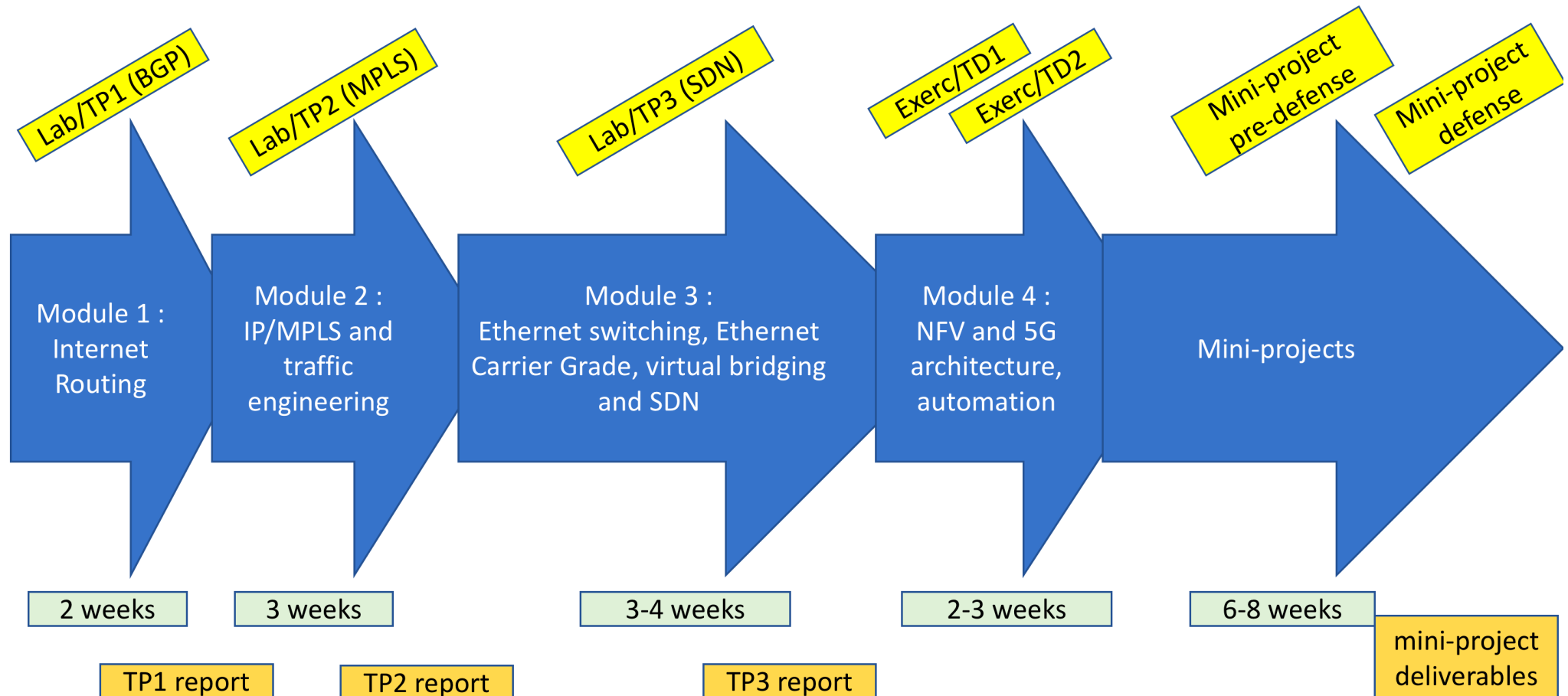# Introduction

Planning and details

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Detailed programme - NEVA

- New technologies designed for advanced operations of IP networks in the last twenty years
  - evolution of IP switching and routing architectures, with a particular focus in traffic engineering and quality-of-service architectures.
  - evolution of the Ethernet architecture and layer-2 protocols in general is presented, showing the extensions applied to let L2 protocols scale going from local area to metropolitan and data-center segments.
  - how IP and Ethernet evolutions recently converged in softwarized network environments, making use of data-plane programmability, network virtualization, cloud-native systems and automation frameworks.
- *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 generalizaitons.
    - *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 briding, 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.

Overall planning

Teachers: Stefano Secci (Cnam), Bruno Chatras (Orange),
            Mario Patetta (Cnam), Francesca Fossati (SU), Chi-Dung Phung (Cnam)

Lab/TP1 (BGP)	Lab/TP2 (MPLS)	Lab/TP3 (SDN)	Exerc/TD1 Exerc/TD2	Mini-project pre-defense Mini-project defense
Module 1 : Internet Routing	Module 2 : IP/MPLS and traffic engineering	Module 3 : Ethernet switching, Ethernet Carrier Grade, virtual bridging and SDN	Module 4 : NFV and 5G architecture, automation	Mini-projects
2 weeks	3 weeks	3-4 weeks	2-3 weeks	6-8 weeks
TP1 report	TP2 report	TP3 report		mini-project deliverables

Programme 2023/2024

TP = technical laboratories; TD = written exercise sessions

1. Carrier grade networks, Internet routing   S. Secci   22/09
   1. TD1 MTTR, MTBF (except ROC-alt)   F. Fossati   22,28/9, 5,6/10
   - TP1 (3h) – BGP   M. Patetta   10,12,13,19,20/10
2. Label-switching, Traffic Engineering   S. Secci   13/10
   - TP2 (3h) – MPLS   M. Patetta   26,27/10, 9,10/11
3. Ethernet Carrier Grade, Virtual Switching   S. Secci   27/10
4. NFV, SDN   S. Secci   24/11
   - TP3 (3h) – SDN   M. Patetta   23,24,30/11, 1/12
5. ETSI NFV, automation   B. Chatras   1/12

(start of mini-projects : announcement on Nov. 25, choice by Dec. 2, assignment by Dec. 4)

6. Mini-project pre-defenses   Phung, Patetta, Secci   22/12
7. Network Optimization   F. Fossati   -
   1. TD2 network optimization (except ROC-alt)   F. Fossati   7,8,14,15/12
   2. TP4 network optimization (except ROC-alt)   F. Fossati   18,19,25,26/12
8. Mini-project working sessions
   1. Work on mini-projects (4h free in January planning per group)   21,22/12, 11,12,15, 22/1
9. Exams correction   20/1
10. Mini-project defense   Phung, Patetta, Secci   26/1
11. Exam   9/2
    (final deliverables due for mini-projects : 16/2)

Moodle and deliverables submission rules

- The moodle is organized in
  - 4 modules
  - 3 questionnaires for the first 3 modules
    - Answers to each questionnaire is required to
      - Access the corresponding TP/Lab submission form
      - Access the next module
    - TP/Lab submission forms for module 2 and 3
      - Not available if you have not submitted the previous TP/Lab report
  - Module 4
    - Not available if you have not submitted all the questionnaires and reports
  - Miniprojets
    - Presentations, final report and deliverables have to be submitted via its forms
    - Final report and final presentation
      - Cannot be submitted if you have not submitted the mid-term presentation
    - Final deliverables (files, videos)
      - Cannot be submitted if you have not submitted the final report and presentation
- **No exceptions, no favoritism : no deliverable, no mark**
  - Retards accepted only with medical justification sent to
    - CNAM: master-roc@cnam.fr, entreprise@lerebours.org
    - SU : alexandre.martin@sorbonne-universite.fr , Kim.Thai@lip6.fr, Stefano.Secci@Cnam.fr

TP/Labs - NEVA

- Groups of maximum 4 persons per report

- Moodle used for TP/Lab report submission
  - account to join the NEVA moodle in https://lecnam.net before the first TP/Lab

- A linux Virtual Machine (VM) linux is made available with all the software for the three TPs preinstalled
  - C-BGP, GNS-3, Wireshark, ONOS, ODL, OVS, Java
  - VM can be executed locally in your laptop/PC but you need at least 8GB RAM

- VM usage:
  - A remote access to the VM, one per student, run in the research platform https://roc.cnam.fr will be assigned to each student
    - VM image and remote access to be sent mid october
    - Recommendation to work on the local VM only if problems with the remote VM
  - During the TP/Lab slot in the assigned room at Jussieu : it will have the same VM running with name "TPNEVA_2022".
  - After login, launch the VM from terminal with "Vbox TPNEVA_2022".

- **Contact in case of technical problems with the VM: chi-dung.phung@lecnam.net**

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Mini-projects - NEVA

- Based on the TP SDN

- Project list distributed on Nov. 25

- Choice to take on Dec. 2; assignments on Dec. 4.

- Can be done in groups up to 4 persons max, no exceptions

- Working time planned in December/January (free room)

- Pre-defense of each mini-project on Dec. 22 (Cnam)
  - 5' per project, 3 slides, every person must present part of the presentation
  - Environment preparation
  - Difficulties
  - Planning ahead
    !!!! Upload the slides before the pre-defense day, otherwise not evaluated

- Final defense on Jan 26
  - 5' per project, 1 slide with all important details, 1 demo video of 2', every person must present part of the presentation
  - Remaining difficulties
    !!!! Upload the slides before the defense day, otherwise not evaluated

- Final report, code files, demo video files to upload before Feb. 16

- **Contact in case of BIG problems : chi-dung.phung@lecnam.net, mario.patetta@lecnam.net**

Rules for TP and mini-projects deliverables

- Deliverables are: TP reports, and mini-project presention slides, files, demo videos, final report

- Every student should submit each deliverable by the deadline
    - If you do not submit it, the deliverable mark will be 0, even if your team mates have submitted one with your name.

- Penalties appy on the marks
    - If submitted files are corrupted deliverable marked 0/20 : check it opening withing the moodle environment after submission
    - Deliverable submitted after the deadline by only some students marked with a penalty only for the student having submitted it late, not the others
    - If report is correct from a technical standpoint but it is badly written, it will undergo a penalty

- No response to any message on this matter will be given
- **Reports submitted by email will not be evaluated**

Logistics - NEVA

- Teachers:
  - Lessons: Stefano Secci, Bruno Chatras, F. Fossati
  - TD/Exercices & TP/Lab & miniprojects : F. Fossati, M. Patetta, L. Linguaglossa
- Evaluation
  - Labs mark (40%)
    - Based on the TP/lab & mini-project reports
    - Reports & miniproject slides+files to upload in the moodle by the given deadlines
  - Final exam (60%)
    - 1 A4 paper hand-written on both pages : no other support allowed
    - Typical exam:
      - One practical exercice on network protocol understanding
      - One analytical exercise on network optimization or on network reliability modeling
  - No external book required, slides and provided exercices are enough
- Slides + annals
  - Available in the moodle

Some books (optional)

- ATM, MPLS, carrier networks
  - « Connection-oriented networks : SONET/SDH, ATM, MPLS, and optical networks » -- Harry G. Perros
  - Les Réseaux -- G. Pujolle. Edition Eyrolles, 2011.
- Carrier Ethernet
  - « Delivering Carrier Ethernet » -- A. Kasim. Edition McGraw-Hill. (chap. 1,2,4,13,14)
- Network optimization
  - « Routing, Flow, and Capacity Design in Communication and Computer Networks » -- Michal Pioro, Deep Medhi, Elsevier Science&Tech. Books. 2004.
- Availability and Reliability
  - Téléinformatique: transport et traitement de l'information dans les réseaux et systèmes téléinformatiques et télématiques - chapitre »Sécurité des systèmes téléinformatiques" -- C. Macchi, J.-F. Guilbert. Dunot, 1987/91.
- IP Networking
  - O. Bonaventure, Computer Networking: Principles, Protocols and Practice https://scm.info.ucl.ac.be/release/cnp3/Book/0.0/