



SYLLABUS

1. Study Program

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|-----|------------------------------|------------------------------------------------------------|
| 1.1 | Higher Education Institute | Technical University of Cluj-Napoca |
| 1.2 | Faculty | Electronics, Telecommunications and Information Technology |
| 1.3 | Department | Communications |
| 1.4 | Study domain | Electronics and Telecommunications Engineering |
| 1.5 | Study level | Master |
| 1.6 | Study program/ Qualification | Telecommunications/ Master |
| 1.7 | Type of education | IF (Full-time learning) |
| 1.8 | Discipline code | TC-E11.10 |

2. Discipline

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|-----|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------|---|-----|------------|------|-----|--------------------|------|
| 2.1 | Discipline name | Quality of Services in Next Generation Networks | | | | | | | | | |
| 2.2 | Subject area | Electronics and Telecommunications Engineering | | | | | | | | | |
| 2.3 | Responsible | Assistant Professor Andrei Bogdan RUS, Ph.D. Bogdan.Rus@com.utcluj.ro Eng. Gabriel Lazar, Gabriel.Lazar@com.utcluj.ro | | | | | | | | | |
| 2.4 | Titular | Assistant Professor Andrei Bogdan RUS, Ph.D. Bogdan.Rus@com.utcluj.ro | | | | | | | | | |
| 2.5 | Year of study | 1 | 2.6 | Semester | 2 | 2.7 | Evaluation | Exam | 2.8 | Type of discipline | O/DA |

3. Total estimated time

| Year/ Sem | Discipline name | No. of weeks | Course | | | | Applications | | | | Indiv. study | TOTAL | ECTS |
|--------------|----------------------------|-----------------|--------------|---|---|---|--------------|---|----|--|-----------------|-------|------|
| | | | [hours/week] | | | | [hours/week] | | | | | | |
| | | | C | S | L | P | S | L | P | | | | |
| I/2 | Quality of Services in NGN | 14 | 2 | | 1 | | 28 | | 14 | | 58 | 100 | 4 |

| | | | | | | | | |
|-----------------------------------------------------------------------------|---------------------------------|-----|-----|--------|----|-----|--------------|-------|
| 3.1 | Number of hours per week | 4 | 3.2 | course | 2 | 3.3 | applications | 1 |
| 3.4 | Total hours per curriculum | 56 | 3.5 | course | 28 | 3.6 | applications | 14 |
| Individual study | | | | | | | | Hours |
| Study based on manuals, course materials, references and notes | | | | | | | | 18 |
| Supplementary documentation in libraries, electronic platforms and on field | | | | | | | | 12 |
| Preparation of seminars/laboratories, homeworks, essays, portfolios | | | | | | | | 10 |
| Tutorial work | | | | | | | | 12 |
| Assessments | | | | | | | | 2 |
| Other activities | | | | | | | | 4 |
| 3.7 | Total hours of individual study | 58 | | | | | | |
| 3.8 | Total hours per semester | 100 | | | | | | |
| 3.9 | ECTS | 4 | | | | | | |

4. Prerequisites (if necessary)

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|-----|-------------|--------------------------------------------------|
| 4.1 | Curriculum | Computer networks, Switching and routing systems |
| 4.2 | Competences | NO |

1. Requisites (if necessary)

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|-----|--------------|-------------------------------------|
| 5.1 | Course | Video-projector, screen, whiteboard |
| 5.2 | Applications | PCs with Internet access |

6 Specific competences acquired

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|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Professional competences | Theoretical knowledge (What do the student should know) | <p>The students will know:</p> <ul style="list-style-type: none"> - The most important packet switching WAN technologies available today - The most important routing protocols - The QoS parameters associated with the IP traffic - Basic knowledge regarding Linux operating system |
| | Acquired skills (What the student is able to do) | <p>The students will be able to:</p> <ul style="list-style-type: none"> - Evaluated the performance of existing QoS mechanisms - Identify the needed devices when implementing QoS techniques into an IP network - Understand the major traffic modeling algorithms - Understand the queue management features - Know the configuration commands needed to configure QoS mechanisms on Cisco and Linux devices |
| | Acquired abilities (what equipment/ instruments/ software the student is able to handle) | <p>The students will be able to use:</p> <ul style="list-style-type: none"> - The command line of Cisco 2011, 1750 routers and Linux PCs with Fedora Core distribution - Packet analyzers like Wireshark and Analyzer - IPROUTE2 tools embedded into Fedora Core Linux distribution - The most important parameters available in any QoS enabled system |
| Transversal competences | <p>CT3 Adapting to new technologies, professional and personal development through continuing education using electronic documentation and printed sources, in Romanian and in at least one international language (English). Competencies for analysis and synthesis and optimization systems thinking. Flexibility in thinking and ability to work with interdisciplinary concepts and tools.</p> | |

7 Discipline objectives (based on the grid of specific competences acquired)

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|-----|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.1 | General objective | Develop competences in the field of New Generation Networks (NGN) |
| 7.2 | Specific objectives | <ol style="list-style-type: none"> 1. Assimilate theoretical knowledge regarding communications architecture, including QoS mechanisms; 2. Obtain configuration skills for IP networks |

8. Contents

| 8.1. Course (titles) | | Teaching methods | Observations |
|----------------------|---------------------------------------------------------------------------------------|---------------------------|----------------|
| 1 | Overview of Cross-Layer Techniques | Presentation, discussions | Videoprojector |
| 2 | QoS Measurements | | |
| 3 | Applications Using Cross-Layer QoS | | |
| 4 | QoS on Cisco Devices – Part1 | | |
| 5 | QoS on Cisco Devices – Part2 | | |
| 6 | QoS on Cisco Devices – Part3 | | |
| 7 | QoS on Cisco Devices – Part4 | | |
| 8 | Best-Effort Networks. QoS implementation necessities. QoS definitions and components. | | |

| | | | |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|---------------|
| 9 | Components of a generic router. Best-Effort routers. QoS-enabled routers. Traffic classification at Data-Link, Network and Transport Layers. | | |
| 10 | Traffic shaping. Leaky Bucket and Token Bucket algorithms. TCP congestion control. | | |
| 11 | Waiting queues management policies. FIFO – First In First Out. RED – Random Early Detection. WRED – Weighted Random Early Detection. | | |
| 12 | Packet Schedulers. Simple schedulers. FIFO. SP - Strict Priority. RR – Round-Robin. Adaptive schedulers. DRR, WRR, GPS, PFQ, WFQ, WF2Q. | | |
| 13 | QoS Architectures. Differentiated Services (DiffServ). DiffServ field in the IPv4 header. PHB. EF, AF and Default PHB. DiffServ field in the IPv6 header. | | |
| 14 | QoS Architectures. Integrated Services (IntServ). CL – Controlled Load. GS – Guaranteed Service. IntServ signaling - RSVP. | | |
| 8.2. Applications (laboratory work) | | Teaching methods | Observations |
| 1 | Generating and receiving traffic TCP, UDP and ICMP with the iperf command. | Simulations, experiments | PC, simulator |
| 2 | Configuring Linux as router – using virtual machines, text editors, network configuration (the ip command). | | |
| 3 | Linux commands for traffic control. The tc command – classification, management and queue disciplines configuration. Example: the netem queuing discipline. | | |
| 4 | Admission control and traffic shaping using the netfilter framework. Experiments with the iptables command. Admission control for TCP connections. | | |
| 5 | Rate distribution of multiple TCP connections (TCP fairness). Queue management. Examples with the FIFO discipline. | | |
| 6 | Scheduling in Linux. Configure PRIO (SP algorithm) with tc. SFQ (RR algorithm). | | |
| 7 | HTB – Hierarchical Token Bucket using tc. The RED queuing discipline. | | |
| 8 | Miniproject: Assign tasks, establish teams, source documentation | | |
| 9 | Miniproject: Configure Linux as router | | |
| 10 | Miniproject: Configure QoS mechanisms (part 1) | | |
| 11 | Miniproject: Configure QoS mechanisms (part 2) | | |
| 12 | Miniproject: Define and implement testing scenarios | | |
| 13 | Miniproject: Interpret results (packet capture and visualisation) | | |
| 14 | Retake of missed practical activities | | |
| References: | | | |
| 1. | | | |
| Other information: | | | |

9. Discipline content corroborated with the expectations of the epistemic community representatives, associations, professional and related program employers

Acquired skills will be needed in the following possible COR occupations: electronics engineer, telecommunications engineer, system and computer design engineer, or new occupations proposed to be included in COR (sales support engineer, developer of multimedia applications, network operating engineer, test engineer, project manager, traffic engineer, communications system consultant).

10. Assessment

| Type of activity | 10.1 | Evaluation criteria | 10.2 | Evaluation method | 10.3 | The weight of the final grade |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------|------|------------------------------------------------|------|-------------------------------|
| Course | | Written test (T = 1...10) | | Written test that should be solved in 2 hours. | | T = 75% |
| Applications | | Project developed during the semester in the laboratory (P = 0 ... 10) | | Project defended at the end of semester | | P = 25% |
| 10.4 Minimum performance standard | | | | | | |
| The final grade (N) is calculated as the sum T+P. The condition for obtaining the ECTS credits is that the final grade to be higher than or equal to 5 (five). | | | | | | |

Date
24.06.2018

Titular
Assistant Professor Andrei
Bogdan RUS, Ph.D.

Responsible
Assistant Professor Andrei
Bogdan RUS, Ph.D.

Date of approval
24.06.2018

Head of Department
Professor Virgil Dobrota, Ph.D.