Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Services and Network Management

2. Date despre disciplină

2.1 Course name (ro) (en)				Sisteme integrate de management Integrated Management Systems			
2.2 Course Lecturer				Prof. Dr. ing. Eugen Borcoci			
2.3 Instructor for practical activities				Prof.dr.ing. Marius Vochin			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DS	2.9 Course code	UPB.04.M3.O.11-31		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	4	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	28
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					40
Tutoring					0
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	44.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Course on programming, telecommunications and computer technologies and computer networks in the undergraduate program that includes the TCP/IP networks.

4.2 Results of learning	Basic knowledges on programmimg, computer architectures and operating systems, telecommunication technologies, architectures of computer networks, protocols and technologies.

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Lecture room equipped with video projector, screen, blackboard/whiteboard.
5.2 Seminary/ Laboratory/Project	Laboratory equipped with computers with Windows (or Linux) operating system andvideo projector. Software for networks and servces and specialised modules formanagement and control

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The course will provide students knowledge on main concepts, models, architectures, methods and systems for orchestration, management and control of communication networks and services. The graduated students will sufficiently skilled to work in exploitation activities , maintenance, development of OMC systems for various network and services types.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	Describe, analyze and explain the architecture and the operation of OMCsystems for networks and services based on standard technologies and protocols. Develop efficient and scalable solutions for management and control adapted to different use cases using OMC standard technologies.
Transversal (General) Competences	Methodical analysis of the problems encountered in the activity, identifying theelements for which there are established solutions, and thus ensuring thefulfillment of professional tasks. - Ability to adapt to new technologies and to document oneself (in English andRomanian), for professional and personal development, through continuoustraining. - Ability to reason using scientific concepts and domain specific terminology, toindependently explore and analyze information, as well as to find and presentconclusions and/or solutions. - Ability to analyze and summarize the acquired knowledge by systematicanalysis. - Ability to cooperate with other specialiss and work in a team; efficientcommunication and coordination with the other team members. - Observe academic ethics principles, such as citing correctly the bibliographicalsources used during documentation

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* - Knowledge on concepts, architectures, methods, protocols and implmentation of the orchestrationmanagement and control subsystems in circuit and packet networks, including the modern 4G, 5Gwireless technologies - Knowledge on modern technologies applied in OMC (policy based management, autonomic andcognitive management, AI/ML , SDN and NFV technologies applied in OMC)
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* - Identifies and formulates the basic functional requirements of users and providers for network andservces - Analyzes, describes and explains the purpose and operation of the OMC main components of anetwork - Identifies, implements and tests OMC solutions for integrated networks .
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Selects and understands relevant bibliographic sources. - Observes the principles of academic ethics, such as correctly citing the bibliographic sources. - Demonstrates responsiveness to new learning contexts. - Collaborates with colleagues and instructors during the teaching activities. - Demonstrates autonomy in organizing the learning situation or in solving problems. - Realizes the value of his contribution in the field of engineering to the identification of viable andsustainable solutions to solve problems in social and economic life (social responsibility). - Analyzes and capitalizes on business/entrepreneurial opportunities in the specialization field. - Demonstrates management skills real-life situations.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

The teaching process will use both expository (lecture) and conversational-interactive teaching methods,based on discovery learning models facilitated by direct and indirect exploration (experiment,demonstration, modeling), but also using action-based methods, such as exercise, hands-on activities andproblem-solving. The teaching activity uses lectures presentations illustrated with images and diagrams(architectures, messages, algorithms, interactions), so that the information is easier to understand and toassimilate. The presentations are supplemented with examples built interactively on the board. Theintroductory presentations of the courses and laboratory work highlight the connection with the notionspresented earlier.

In the lab, the students build and configure examples of networks and systems with focus on OMCsubsystems (small-scale models of real life networks and systems). Then, they carry out experiments that

10. Contents

COURSE		
Chapter	**Content**	**No. hours**

1	Chap. 1 Introduction in management and control (M&C) for networks and services Basic functions of M&C Layered M&C architecture; role of the Management Plane and Control Plane. Management functions for network services and high level services Orchestration, Management and Control-(OMC) - concepts and obiectives New Trends in OMC (PBM, ANM, AI, SDN, NFV, etc.)	4
2	Chap.2 Telecommunication Network M&C Function, Physical, Information and Logical Layered Architecture in TMN Abstract languages basics for M&C information representation (ASN1)Implementation examples	4
3	Chap.3 Current Internet Management and Control SNMP framework (SNMP1, 2, 3). Remote Monitoring 1, 2. Management Information Base organization and access Comparison TMN versus Internet SNMP framework CMIP over TCP/IP Main TCP/IP control protocols- revision (routing, resource reservation, mobility,higher layer protocols)	6
4	Chap.4 Policy-based, autonomic and cognitive management Policy-based management (PBM)-concepts, arhitecture IBM arhitecture, IRTF/IETF model Generic autonomic management arhitecture(GANA). Artificial intelligence and machine learning in OMC- introduction	6
5	Chap.5 Advanced techniques in OMC Virtualization concepts and methods Software defined Networking- SDN in OMC Network Function Virtualization (NFV) in OMC	4
6	Chap 6 Management in 5G General 5G architecture Slicing concepts and architectures Resources and services management in 5G sliced networks SDN and NFV used in 5G OMC	4
7	Annexes	0
	Total:	28

Bibliography:

ITU-T Recommendation, SERIES M 3000: Telecommunications management network Principles fortelecommunications management network
ITU-T Rec. Y.2011, “General Principles and General Reference Model for Next Generation Network.”
Jianguo Ding, 2010, Advances in Network Management, CRC Press , Auerbach Publications, 2010.
http://en.wikipedia.org/wiki/Element_management_system
http://en.wikipedia.org/wiki/Simple_Network_Management_Protocol
N. Agoulmine, et. Al., Autonomic Network Management Principles: From Concepts toApplications.Academic Press, 2010.
J. Strassner, “DEN-ng: achieving business-driven network management”, in Network OperationsandManagement Symposium, 2002.NOMS , pp. 753–766, 2002.
L. Stojanovic, J. Schneider, A. Maedche, S. Libischer, R. Studer, Th.Lumpp, A. Abecker, G. Breiter andJ.Dinger, “The role of ontologies in autonomic computing systems”, IBM Syst. J. , vol. 43, n. 3, pp. 598–616,2004.
G. Tesauro, “Reinforcement Learning in Autonomic Computing: A Manifesto and CaseStudies”, IEEE Internet Comput. , vol. 11, n. 1,pp. 22–30, Jan.-Feb. 2007.
N. Samaan and A. Karmouch, “An Automated Policy Based Management Framework forDifferentiatedCommunication Systems”,
IEEE J.Select. Areas Commun. , vol. 23, n. 12, pp. 2236–2247, December 2005.
Diao Y., J. Hellerstein, S. Parekh, R. Griffith, G.E. Kaiser and D. Phung, “control theory foundationforself-managing computing systems”,
IEEEJ. Select. Areas Commun. , vol. 23, n. 12, pp. 2213 – 2222, Dec.2005.
Jianguo Ding, 2010 Advances in Network Management, CRC Press , Auerbach Publications, 2010.
http://en.wikipedia.org/wiki/Simple_Network_Management_Protocol
IRTF Autonomic Networking - Definitions and Design Goals, draft-irtf-nmrg-autonomic-network-definitions-04.txt, October 2014
N.McKeown, T.Anderson, et. Al., OpenFlow:Enabling Innovation în Campus Networks, - http://www.openflow.org/documents/openflow-wp-latest.pdf.
M.Mendonca, et. al., A Survey of Software-Defined Networking: Past, Present,and FutureofProgrammable Networks, http://hal.inria.fr/hal-00825087/
Software-Defined Networking: The New Norm for Networks ONF White Paper April 13, 2012
ONF 2014 OF-CONFIG 1.2 OpenFlow Management and Configuration Protocol
Han B., Gopalakrishnan V., Ji L., and Lee S., ‘Network Function Virtualisation: ChallengesandOpportunities for Innovations’, IEEE Communications Magazine, February 2015, pp. 90-97
ETSI GS NFV 002 v1.2.1 2014-12, NFV Architectural Framework
ONF, “OpenFlow-Enabled SDN and Network Functions Virtualisation,”https://www.opennetworking.org/images/stories/downloads/sdn-resources/solutionbriefs/sb-sdn-nvf-solution.pdf
Reid A., ‘Network Functions Virtualisation and ETSI NFV ISG’, http://www.commnet.ac.uk/documents/commnet workshop networks/CommNets EPSRC workshopReid.pdf
J. Ordonez-Lucena et al., "The Creation Phase in Network Slicing: From a Service Order to anOperativeNetwork Slice", European Conference on Networks and Communications (EuCNC),2018, https://arxiv.org/abs/1804.09642
ETSI GR NFV-EVE 012, Release 3 “NFV Evolution and Ecosystem;Report on Network SlicingSupportwith ETSI NFV Architecture Framework”, Technical Report, V3.1.1, December, 2017.
A. Galis, “Network Slicing- A holistic architectural approach, orchestration and management withapplicability inmobile and fixed networks and clouds”,
http://discovery.ucl.ac.uk/10051374/

LABORATORY		
Crt. no.	**Content**	**No. hours**
1	Network Devices monitoring system Nagios (Remote Plugin Executor and SNMP	4
2	Hosts management and monitoring through Microsoft Active Directory	4
3	Internet services monitoring tools: Advanced web statistics tool, Multi Router Traffic Grapher	4
4	Evaluation	2
	Total:	14
PROJECT		
Crt. no.	**Content**	**No. hours**
1	Software subsistems for orchestartion, managemnt and control in jntegrated networks	12
2	Evaluation	2
	Total:	14

Bibliography:

M.Vochin, R.Lupu- SIMC lab. platforms data sheets- on Moodle and Teams platforms
IETF RFCs for IPPM and MIBs
Nagios documentation
Monitoring tools documentation – for active/passive measurements

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	- Knowledge of the OMC concepts,methods, architectures and protocolsstudied in the course. - Ability to describe, analyze, and explainnetwork and services OMC operation indifferent systems l by applying the theaquired knowledge (examples of networks,services)	Written exam	30%
	Applying OMC methods to real networks - Ability to describe, analyze, and explainnetwork and services OMC operation indifferent systems l by applying the theaquired knowledge (examples of networks,services)	written exam	20%
11.5 Seminary/laboratory/project	Ability to configure, test, analyze and run OMC subsystems for netwoks and servicesthat use the methods and protocols presented in the course Analysis of project design	Laboratory exam and project evaluation	40%
11.6 Passing conditions			

The students must obtain minimum of 50/100 for the exam paper and minimum 50/100 for the laboratory and project examination.

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

The complex communication networks and services, interconnecting fixed and mobile terminals require animportant OMC support. In the real IT&C world an important effort – human and financial (CAPEX andOPEX) is spent by the operators/providers on OMC activities. These course and laboratory provide studentsa background for ability to work in exploitation, maintenance and development of IT&C systems

Date	Course lecturer	Instructor(s) for practical activities
09.09.2022	Prof. Dr. Eugen Borcoci	Prof. dr. ing. Marius Constantin Vochin

Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja

Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea