Co-funded by the Erasmus+ Programme of the European Union

Project:	Boosting the telecommunications engineer profile to meet modern society and industry needs [BENEFIT]
Project ID:	585716-EPP-1-2017-1-AT-EPPKA2-CBHE-JP
Work Package 3:	Modernization of teaching methodologies and infrastructures
Title:	D3.2 Creation of 6 joint University-Industry Labs
Lead Organization:	UNS
Participating Organizations:	UNI-KLU, UL, FERIT, UBL, UNSA, UNTZ, UB, UNI, ENT, BICOM, BIT, CISCO, NiCAT, RT-RK
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Deliverable data	Work Package and Outcome ref.nr	WP3 D3.2
	Title	Creation of 6 joint University-Industry Labs
	Type	☐ Teaching material ☐ Event ☐ Learning material ☒ Report ☐ Training material ☒ Service / Product
	Description	The report describes the acquired equipment and the established facilities at the 6 HEI partners. In collaboration with local ICT industries they created joint labs in order to foster traineeship and entrepreneurial education of future graduates. Specifically the labs are focused on the following fields: - University of Banja Luka: "Signal Processing in Telecommunications Lab" in collaboration with Bicom and AlfaNum; - University of Sarajevo: "Telecommunications Lab" in collaboration with BIT Centar; - University of Tuzla: "VoIP Services Lab" in collaboration with Bicom and BIT Centar; - University of Belgrade: "Networks and IoT Lab" in collaboration with CISCO; - University of Nis: "Machine-to-Machine Communication Lab" in collaboration with NiCAT; - University of Novi Sad: "Wireless Communications and Information Processing Lab" in collaboration with RT-RK and Saga.
	Date	14.04.2020
	Language	English and Croatian (Bosnian/Serbian)
Target groups	☒ Teaching staff ☒ Students ☐ Trainees ☐ Administrative staff ☒ Technical staff ☐ Librarians ☒ Industry partners, WB Higher education authorities	
Dissemination level	☐ Department / Faculty ☐ Local ☐ National ☐ Institution ☐ Regional ☒ International	
Lead Organization	UNS	
Participating Organizations	UNI-KLU, UL, FERIT, UBL, UNSA, UNTZ, UB, UNI, ENT, BICOM, BIT, CISCO, NiCAT, RT-RK	
Task	T3.2: Creation of joint university/industry labs and modernization of the lab infrastructure (UNI-KLU).	

Revision History				
Version	Date	Author(s)	Organization(s)	Brief description of change
01	03.04.2020	V. Delić	UNS	Initial draft incl. Section 1 and 2
02	07.04.2020	D. Vukobratović, M. Narandžić, Ž. Bojović, S. Sečujski, A. Mujčić, N. Suljanović, Z. Babić, D. Bošković, M.Mehić, M.Hamza, M. Koprivica, J. Ćertić, G. Marković, N. Maleš-Ilić, A. Tonello	UNS, UNS, UNS, AlfaNum, UNTZ, UNTZ, UBL, UNSA, UNSA, UNSA, UB, UB, UB, UNI, UNI-KLU	Contributions to Section 3
03	14.04.2020	A. Tonello, M. Zajc, D. Žagar, N. Suljanović, M. Sečujski	UNI-KLU, UL, FERIT, UNTZ, UNS	External review revisions
release 1	01.09.2020			

Table of Contents

1. Introduction

The deliverable D3.2 “Creation of 6 joint University-Industry Labs” reports the results of the activities carried out in:

T3.2: Creation of joint **university/industry labs** and modernization of the lab infrastructure (**Task leader: UNI-KLU**).

Every WB HEI is involved in a joint university-industry lab development:

1. University of Banja Luka: “Signal Processing in Telecommunications Lab” in collaboration with Bicom and AlfaNum;
2. University of Sarajevo: “Telecommunications Lab” in collaboration with BIT Centar;
3. University of Tuzla: “VoIP Services Lab” in collaboration with Bicom and BIT Centar;
4. University of Belgrade: “Networks and IoT Lab” in collaboration with CISCO;
5. University of Nis: “Machine-to-Machine Communication Lab” in collaboration with NiCAT;
6. University of Novi Sad: “Wireless Communications and Information Processing Lab“ in collaboration with RT-RK and Saga.

The report describes the acquired equipment and the established facilities at the 6 HEI partners. In collaboration with local ICT industries they created joint modern labs in order to foster traineeship and entrepreneurial education of future graduates.

2. Objectives of the Deliverable

The main objective of the deliverable is to describe the upgrade of the lab infrastructure through the development of novel thematic joint university-industry labs that will increase HEI-Industry cooperation through the implementation of new trainings and internships. Their joint activities with students have been implemented through specifc agreements related to operation of the the joint labs. The partners collaborate in the development of teaching methodologies that involve participation of industrial partners, including project tasks for students, implementation/development challenges, hackathons and team competitions. Acquired equipment are adopted in novel teaching/learning methods. The creation of joint labs and advanced lab solutions will translate into more job opportunities.

3. Acquired Equipment and Established Facilities at the Six Joint Labs

The first activities were related to the identification of lab infrastructure to be restructured in each WB university according to the initial steps for joint university-industry labs that were undertaken through survey of industrial partners. After that, the equipment for 6 joint labs was specified and public procurements have been initiated separately at the University of Novi Sad for 3 Serbian universities and at the University of Tuzla for 3 universities in Bosnia and Herzegovina. The complexity of the public procurement process determined some delas bay, more notably in B&H and less in Serbia. However, the issues have bene solved and the process finalized.

The purchase and installation of the laboratory equipment have been mostly finished in the last 12 months. Equipment at three Serbian universities has been installed and its usage started in the new labs. Public procurement was finalized somewhat later for the three Bosnian universities. Delivery of

equipment was also partially delayed in Bosnia because of the pandemic situation. However, as of June 2020 all processes have been finalized.

In the meantime, establishment of formal links and joint lab operation agreements between university and company were initiated. An initial version and template for the joint lab operation agreement has been preaprd by a lawyer from AlfaNum and forwarded to partners. UNTZ has signed agreements with both Bicom and BIT Centar, UNSA with BIT Center, UB with CISCO Serbia, UNI with NiCAT. The agreement UBL-AlfaNum is near final negotiation (as of may 2020) with the goal of completing this during summer 2020. UNS has prepared agreements with RT-RK and Saga, but they are waiting of moving the joint lab to the Science and Technology Park at the University of Novi Sad in September 2020.

Concept of Academia-industry agreements

In the following, a list of the main aspects covered by the cooperation agreements is given.

- **Aim and Subject of Cooperation**
  - The aim is to establish scientific and technical cooperation between partners
  - The subject is establishment and exploitation of a joint university-industry lab
    - place for fostering research and work on joint university-industry projects
    - training students and upgrading the capacity of teaching staff
- **Form of Cooperation and Framework**
  - Joint action with the aim of establishing and exploitation the Laboratory at the University
  - Intellectual property created as a result of joint activities at lab, will be joint of partners, considering:
    - provisions of the BENEFIT
    - legal rules of the University/Faculty
  - Conclude this Agreement for an unlimited period of time
  - Appoint the contact persons on behalf of both partners
- **Duties and responsibilities in agreements**
  - <u>University partner:</u>
    - Coordinate the founding of the Lab
      - Project proposal, Grant Agreement
      - Provide location and equipment
    - Appoint one staff member to supervise and administer the Lab
    - Take into account Industry partner evaluation of practical skills and competences for students
      - obtained through joint projects as well as other joint activities
  - <u>Industry partner:</u>
    - Actively participate in the design, deployment and exploitation of the Lab:
      - Identification of research topics for the preparation of bachelor, master and doctoral theses
      - Consultative activity in the process of preparation of theses and curricular activities such as lab exercises
      - Research activities that may lead to future student traineeships with Industry partner
    - Not provide any remuneration for or charge any costs on the University in return for the completion of the tasks of this Agreement

In the following, the labs infrastructure and aims are summerized.

“Signal Processing in Telecommunications Lab” - University of Banja Luka in collaboration with Bicom and AlfaNum

Public procurement is finishing. New equipment are already used for development of new lab sessions. Operational agreement with Bicom and AlfaNum is under negotiation and should be signed during the summer 2020. Activities should be implemented in collaboration with these industrial partners.

The list of equipment in the Signal Processing in Telecommunications Lab acquired at the UBL as a part of the project BENEFIT until April, 2020:

1. DSP development kit software: Node locked license for CrossCore Embedded Studio
2. PC equipment upgrade
3. Desktop computer with monitor and Windows OS

CrossCore Embedded Studio (item 1) is an integrated development environment for the Blackfin, SHARC and ARM processor families from Analog Devices. It was chosen as it offers compatibility with a variety of development hardware, including multi-core processing boards, and extender cards supporting audio and video capture, processing, and display. We are using CrossCore Embedded Studio primary for lab exercises within the subject Systems for digital signal processing. Moreover, it is available for student projects in subjects at all levels of study at Faculty of Electrical Engineering (University of Banja Luka) related to communications and signal processing, as well as for allowing experimental work to be documented in scientific papers. Installation of Node locked license was performed by teaching staff, and appropriate teaching material was written to ensure easier work of students.

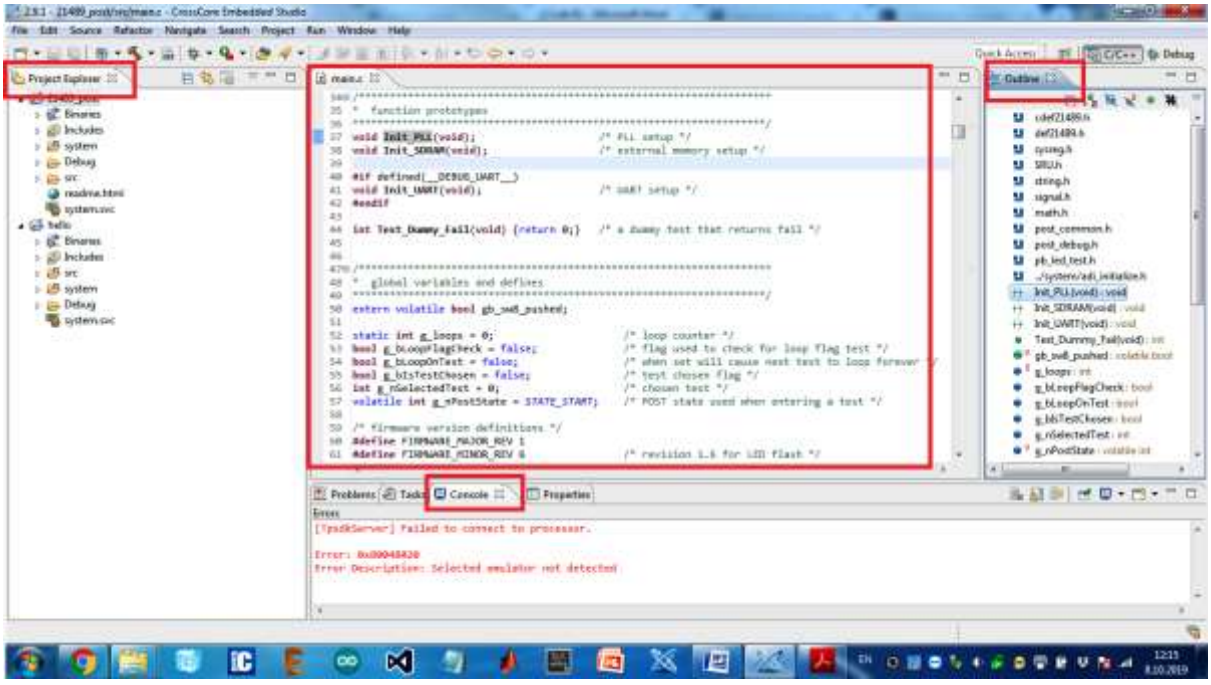
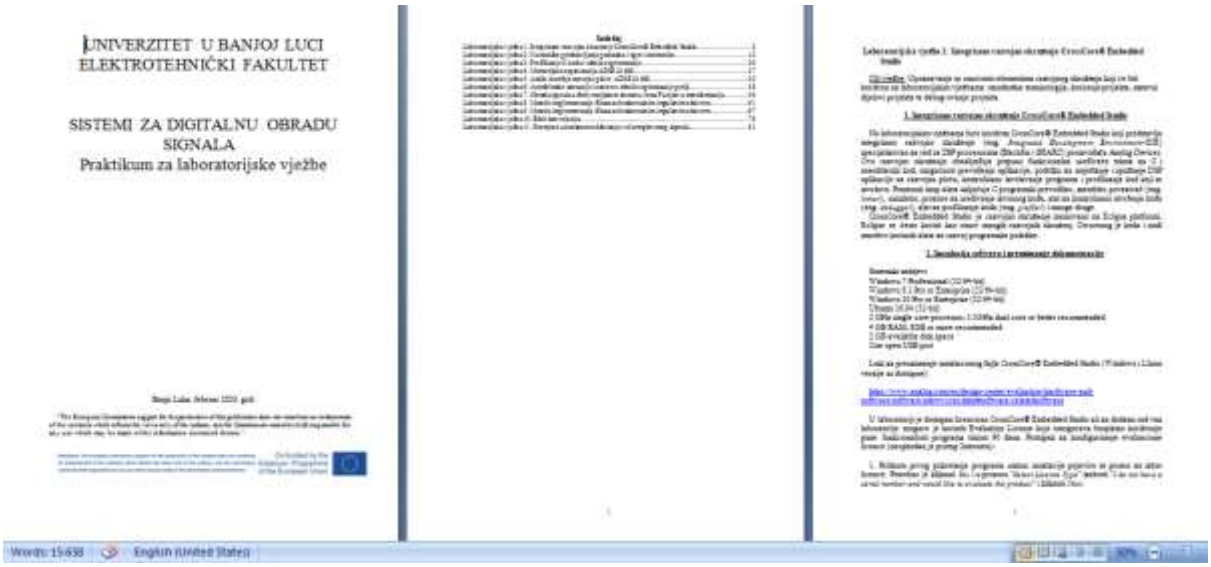


Fig. 1 *Screenshot of CrossCore Embedded Studio*


UNIVERZITET U BANJOJ LUCI
ELEKTROTEHNIČKI FAKULTET

SISTEMI ZA DIGITALNU OBRADU SIGNALA
Praktikum za laboratorijske vježbe

Fig. 2 *Screenshot of teaching material for students*

The PC equipment upgrade (item 2) consists of NVIDIA GTX 1050Ti graphic processing units (GPUs) and Seagate 4TB SATA hard disk drives. These parts have been used to upgrade existing laboratory PCs, and make it possible to deploy new and updated laboratory exercises in Digital Signal Processing, Systems for Signal Processing and Multimedia Signals and Systems. Furthermore, the available PC equipment can now be used for more complex student projects involving processing of audio, image and video signals.

Fig. 3 *Laboratory for Signal Processing*

One desktop PC (item 3) was installed and used for advanced network simulations and analysis.
It has the following specification

- Intel Core i5-8500 3.0GHz
- MB Intel B360 based
- RAM 16 GB DDR4
- Disk SSD 240GB
- HDD 1TB SATA III
- nVidia Geforce GTX1060 TURBO 6GB
- Motherboard Midi tower ATX
- Power 600W
- Monitor 23,8" 2xHDMI

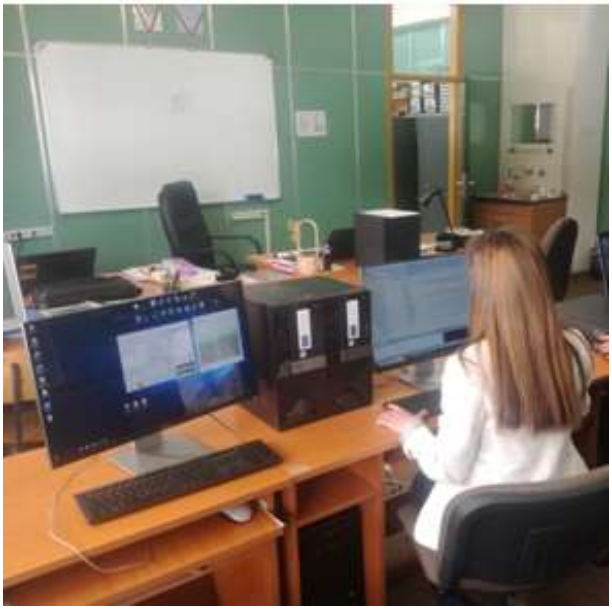


Fig. 4 *Laboratory for Signal Processing*

“Telecommunications Lab” - University of Sarajevo in collaboration with BIT Centar

Telecommunications Lab UNSA equipement:

1. Software-based LTE base station running on a computing machine for the telecommunication lab: Amari LTE 100 eNodeB + EPC Software 4G network
2. Vector Network Analyzer 100kHz - 3.2GHz with the Calibration kit
3. High-perfromance software defined radio equipment: USRP X310 and USRP N210

Procurement of the high-perfromance software define radio equipment: USRP X310 and USRP N210 made the first inventory items of the Joint Telecommunications Lab.

Procurement of the Vector Network Analyzer 100 kHz–3.2 GHz with the Calibration kit and the software-based LTE base station with the accompanied processing unit was additionaly prolonged due to pandemic situation, but the process was completed and the Joint Telecommunications Lab was established at the Department of Telecommunications ETF – UNSA. After that, the operational agreement with BIT Centar was negotiated and agreed.

The equipment was immediately used for students’ work on the final thesis projects for both BSc and MSc students, which are usually completed in September.

Topics of these projects include: Planning principles for multi-technology mobile networks; Experimental insight into the architecture and signaling procedures of a 4G mobile network; Review and analysis of software and hardware tools for developing test environments for 5G mobile networks; Implementation of advanced transmission techniques in the fourth generation mobile network and others.

The lab works for courses such as "Telecommunications Network Management", "Advanced telecommunication protocols and new generation networks" and "Antennas and Wave Propagation", are modernized in a manner to include the equipment.

Fig. 5 Software-based LTE base station running on a computing machine for the telecommunication lab: Amari LTE 100 eNodeB + EPC Software 4G network

Fig. 6 Vector Network Analyzer 100kHz - 3.2GHz with the Calibration kit

Fig. 7 High-perfromance software defined radio equipment: USRP X310 and USRP N210

“VoIP Services Lab” - University of Tuzla in collaboration with Bicom and BIT Centar

The operational agreements were negotiated and signed between UNTZ and industrial partners Bicom and BIT Center. New equipment have already been used for the development of new lab sessions and new practicums with lab sessions while video tutorials are under preparation. Further activities will be implemented in collaboration with those two industrial partners. The equipment procured during the BENEFIT project is combined with the equipment procured by UNTZ using other financial sources, to make a higher impact. As an example, procured digital oscilloscopes are combined with new five other digital oscilloscopes that UNTZ procured from internal sources. In the future, the lab will provide ten student sites fully equipped to work on lab sessions independently. Such high-quality lab is an opportunity to be offered for the local industry for the training and tutorials.
The following equipment was procured and deployed in the joint lab:

1. HP High-perfformance server [x2]
    a. Supermicro Server 2U - 4 Nodes for Xeon E5-2600v3, 8xIntel 2.10GHz Xeon E5-2620 v4 Octa-Core (8-Core), 32xKingston DDR4 ECC Memory 8GB, 8xIntel S3510 DC 480GB, 4xSATA DOM boot/OS device, 10xHDD RAID
2. Network switch with OpenFlow support [x1]
3. Rack with UTP panel [x1]
4. UPS with network card [x1]
5. Network structured cabling system [x1]
6. WiFi acces point [x1]
7. Desktop computers with monitors and Windows OS [x10]
8. Software for embedded prototyping: TINA 11.0 - Design Suite Educational version [x12]
9. Digital oscilloscope [x2]
10. Laptop [x2]
11. Development boards for embedded design including uP and FPGA, such as ARM Coretx-M Protoyping Sistem [x12]
12. Audio-video recording equipment for the preparation of online courses and teaching materials [x1]
13. 4K camera, wireless microphone, tripod for camera

The laboratory layout is given in Fig. 8, while photos of the communication equipment situated in the rack are presented in *Fig.* 9.

Fig. 8 *VoIP Service Lab – layout*

Fig. 9 *Communication equipment in the rack*

The lab equipment can be categorized into three categories: computer and network equipment, laboratory equipment and software. The VoIP Service Lab has been designed in the modular manner, to be easily upgraded in the future and to be utilised for various courses delivered at the Department of Telecommunications of University of Tuzla. The first six components represent the equipment which is used for the lab session related to the courses in the knowledge areas of communication networks and communication systems (e.g. Network security). Bicom have installed VoIP system on one server and this software is used for the lab sessions as well as for the industrial trainings. Ten all-in-one desktop computers are aimed for the students participating in the lab sessions, for all enhanced courses at the University of Tuzla. TINA software, which has been installed on these computers, are used for the delivery of lab sessions in the areas of electronic and embedded design. Digital oscilloscopes and development boards have been used for the experimental sessions in fundamental courses, such as Signals and Systems, Fundamentals of Communications, Introduction to Electronics, Analog Integrated Electronics as well as advanced courses as Microprocessor systems in Telecommunications. Video equipment has been used for the production of video materials that explain how to use laboratory equipment. In the future, it will also be used for the video recording of lectures and tutorials.

Examples of lab session set up sa provided in Fig. 10.

Fig. 10 *Examples of lab session setups*

Bicom have installed two products, SERVERware and PBXware software, on the server in the joint lab. SERVERware is Bicom Systems virtualization platform dedicated to hosting telephony and Unified

Communications in the cloud. SERVERware virtualization platform was installed in Standalone edition, which offers Fault Tolerance, High Availabillity as well as Processing and Storage Scalability. It serves many different types of clients with different PBXware editions at the same time, all through one SERVERware interface. PBXware is the Professional Open Standards Turnkey Telephony Platform which supports a wide range of PSTN and VoIP technologies. Control panel of the system is presented in Fig. 11.

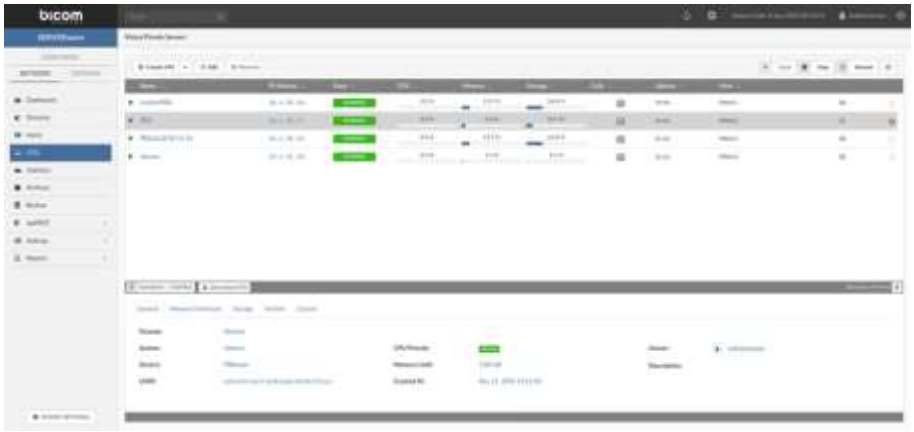


Fig. 11 *Screen shot of the control panel oft he VoIP system installed in the joint lab*

“Networks and IoT Lab” - University of Belgrade in collaboration with CISCO

“Networks and IoT Lab” is established at the University of Belgrade - School of Electrical Engineering, Telecommunications Department. Formal establishment is based on Decision of the Academic Council of the University of Belgrade - School of Electrical Engineering on the establishment of the Laboratory adopted on June 20th, 2019. “Networks and IoT Lab” is the joint lab with industry partner CISCO SRBIJA DOO BEOGRAD. Operational agreement with CISCO is already negotiated and should be signed during the summer 2020. Activities should be defined and implemented in collaboration with CISCO Serbia.
Public procurement has been already completed the list of equipment in the Networks and IoT Lab at the UB already purchased is as follows:

1. Desktop computers with monitors (8 pcs) - Desktop unit: Intel® i5-8400, 16GB DDR4 2400MHz, 1TB SATA 3 7.2krpm + SSD 240GB SATA 3, Monitor 23", 1920x1080, 16 : 9, YU Set Standard Keyboard, Optical mouse.
2. Tablet SAMSUNG Galaxy Tab A LTE (2018, 10,5") - SM-T595NZAASEE (2 pcs).
3. Projector EPSON EB-U42 (1pcs).
4. Tektronix Digital Storage Oscilloscope TBS1072B-EDU (8 pcs).
5. Tektronix Arbitrary Function Generator AFG 1062 (8 pcs).
6. SparkFun extended Inventor’s Kit (8 pcs).
7. Raspberry Pi 3 IBM IoT Learner extended kit (8 pcs).
8. Cisco Wireless Gateway for LoRaWAN IXM-LPWA-800-16-K9- (3 pcs).
9. Cisco IR829GW-LTE-GA-EK9 Industrial Integrated Services Router with IOX-SOFTWARE (1 pcs).

New equipment is used for laboratory exercises, project based learning, and diploma and master theses. In the Laboratory, we basically established 8 working environments (equiped with measurement equipment, Raspbery and Arduino extended kit, 1 PC computer, etc) as working environment for 2 students. The equipment is intensively used, especially for the newly established course „IoT networks“ (developed in the scope of project BENEFIT), for the newly developed lab excersises and project development.

Having in mind an unexpectedly large number of students using resources of the Laboratory, especially for the course „IoT networks“, we submitted request for approval of acquisition of additional „Desktop PC computers with monitors (8 pcs)“ for the Laboratory and established working environments, which is approved. Procurement of the of additional eqipment is already started. This additional computers will significantly improve efficiency since we will be able to provide 1 PC computer per student and enable them to work and different tasks simultaneously.

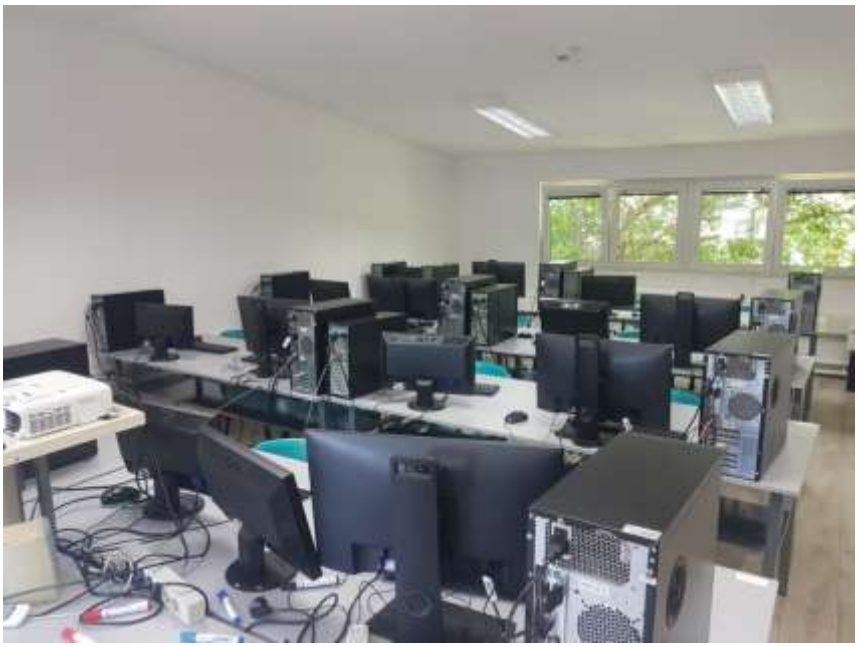


Fig. 12 *"Networks and IoT Lab" – layout*

Fig. 13 *"Networks and IoT Lab" – equipment*

“Machine-to-Machine Communication Lab” - University of Nis in collaboration with NiCAT

Different kind of new equipment are used for development of new lab sessions for different courses. New practicums with lab sessions and video tutorials are under preparation. Operational agreement with NiCAT is negotiated and will be signed soon. Activities should be defined and implemented in collaboration with industrial partners.

The list of equipment in the Machine-to-Machine Communications Lab at the UNI purchased during the project BENEFIT is as follows:

1. NI ELVIS II+ Hardware (For academic use only)
2. DJI Dron Mavic Air Fly More Combo (Arctic White)+Tablet Lenovo IdeaTab4 8 (8504X) + 8.0"HD IPS,QC 1.4GHz/2GB/16GB/FaceUnlock/4GB/Andr 7.1
3. LabVIEW Full Development System
4. FPGA ZC706 Board + AD-FMCOMMS5-EBZ RF transceiver
5. Matlab for education
6. Microphon NTi Audio M2230
7. Sound source NTi DS3
8. NTi Audio tripod NTI 600 000
9. Calibrator NTi 94/114 dBSPL
10. Vector signal generator VSG25A
11. Spectrum analyzer USB-SA44B
12. Software define radio NI USRP-2901
13. Mechanism for laser coupling with monomode fiber MBT612D/M
14. Olympus lens RMS20X
15. Aaronia low-noise amplifier UBBV 0910
16. XBee S2D ZigBee Mesh Kit
17. Blackmagic Design SmartScope Duo 4K + DeckLink Studio 4k
18. Computer Altos Extreme II, Intel Core i7-8700K/32GB/SSD 480GB/HDD 2TB/nVidia RTX 2080)
19. Laptop HP Envy 13-ah0006nm, 4TT50EA.

The listed equipment provides the students and researchers the capabilities offered by the software MatLab and LabVIEW and to apply them in Laboratory work and research projects planned within many courses accredited in UNI. The purchased Items 1, 4, 12, 16 will enable practical experiences for students into architectures and programming of up to date hardware for contemporary communication technologies and systems such as M2M in IoT and WSN. Audio equipment 6 to 9 will broaden communication opportunities between hardware platforms by using sound as a tool. Additionally, 12 can upgrades students and teacher knowledge related to modern technology in monitoring, real time video transmission processes. Moreover 17 and 18 are used in signal processing (video, data) required in communication world. The available signal generators 10, measurement instrument 11, and supporting devices 15 enable necessary equipment for various laboratory measurement setups and Laboratory exercises. Also, equipment 13 and 14 provide the laboratory work in the domain of optical communication systems.

In the application for BENEFIT project, we planned the equipment item ***NI WSN Starter*** for education in the field of Wireless sensor networks (WSN) but the manufacturer National Instruments did not offer this equipment in the time of equipment ordering procedure. The equipment set that adequately replaces the ***NI WSN Starter kit*** originally planned in the application for BENEFIT project, and that properly complements the purchased equipment includes the items 1. to 19 below, are aso aquired:

1. Zigbee Development Tools (802.15.4) OpenMote B (Super LOW consumption IoT board 2.5GHZ / SubGHz SMA Antena)
2. Development Boards & Kits - ARM Zedboard + SDSoC
3. Antennas Ant Ext 0.617-3.8GHz SMA
4. Antennas Ext ISM868/915/2.4 SMA

5. RF Modules LoStik – EU
6. RF Development Tools LoRa(R) Technology Eval Kit – 800
7. Gateways 8 Channel LoRa Gateway Kit comes with Raspberry Pi LoRa and GPS
8. Audio amplifier, Art Pro Audio SLA1
9. Audio card, Focusrite, Scarlett 6i6, 2nd Gen
10. Single Board Computers RASPBERRY PI 4 MODEL B, 4GB, BULK
11. Seeed Studio Accessories Raspberry Pi 9 Layers Acrylic Case with Fan (Support Pi 4)
12. Seeed Studio Accessories Raspberry Pi Official Power Supply 15.3W USB-C with 1.5M Cable - EU Plug 5.1V 3A Black
13. Adafruit Accessories 16GB Card with NOOBS 3.1 for Raspberry Pi Computers including 4
14. USB Cables / IEEE 1394 Cables USB 2.0 M TO F STRAT 2M CORD BLACK
15. Interface Modules 7 Port USB Hub

We consider this equipment will enable us to offer the wide and thorough practical education in the area of WSN. Those listed equipment offer student opportunity to form the diverse topologies of Wireless sensor networks supported by contemporary communication technologies and protocols (such as Zigbee, LoRa etc), as well as to track, measure and visualize the network parameters.
BENEFIT team from UNI are engaged in forming Laboratory exercises for students and guidelines with instructions for the equipment usage. The installation of all equipment will be finalized by the end of summer 2020. The Figures related to a few item of M2M Communication Lab. equipment are given below.

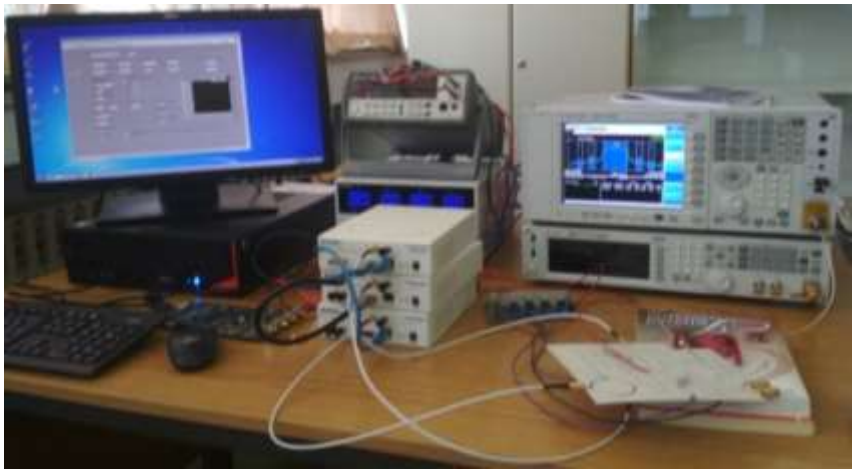


Figure 14. USRPs applied in measurement setup

Figure 15. Sound source applied in measurement in anechoic chamber

Figure 16. Some items of purchased equipment in M2M communications Lab. in UNI

“Wireless Communications and Information Processing Lab“ - University of Novi Sad in collaboration with RT-RK and Saga

New equipment are already used for development of new lab sessions. They are used for project based learning, diploma/master theses. New practicums with lab sessions and video tutorials are under preparation. Operational agreements with RT-RK and Saga are under negotiation and should be signed by September 2020. Activities should be defined and implemented in collaboration with the industrial partners.

The list of equipment in the Wireless Communications and Information Processing Lab acquired at the UNS during the project BENEFIT:

1. QNAP STORAGE NAS TVS-682-i3-8G [x2]
2. WD Hard disk drive WD30PURZ [x8]
3. Server SUPERMICRO SYS-7049A-001 (Dual Socket P - Xeon 4110 8-core, 2.1GHz; RAM: 128GB ; Storage: 3* 300GB SSD; Integated GPU)
4. Server SUPERMICRO SYS-7049GP-002 (Dual Socket P - Xeon 4110 8-core, 2.1GHz; RAM: 128GB; Storage: 3* 300GB SSD; Integated GPU + NVIDIA TITAN Xp Graphics Card)
5. Comm Sys MIMO Teaching Bundle: 2x USRP-2901 (70 MHz to 6 GHz, 2-Channel USRP SDR Device), Cables, Courseware 784114-01 [x3]
6. Software Radio Educational Lab Station: 2x NI USRP-2920 Bundles with Lab Materials [x4]
7. Dual Band 2.4-2.48 GHz and 4.9-5.9 GHz Vertical Antenna, 3dBi Gain [x12]
8. Dual-band Cellular and ISM Vertical Antenna Vert 900: 824-960 MHz, 1710-1990 MHz [x4]
9. Tri-band 7-inch vertical antenna: 144 MHz, 400 MHz, and 1200 MHz [x4]
10. LabVIEW Communications System Design Software: Basic software package for prototyping wireless applications that require only a desktop processor [x1]

The equipment at the Information Processing Lab (items 1, 2 and 3) is used at all levels of academic study. We have focused on developing educational resources (real-network platforms, hands-on labs, physical testbeds, virtual arhitectures, and NAS storage), for teaching-learning and research process, [1]. These resources provide students with a methodology to adopt practical soft skills in real environments (albeit on a smaller scale). All the laboratory activities were developed by professors, assistants and students, who were challenged to design new laboratory material for a hands-on learning experience in ICT (especially in the field of advanced software technology for information processing).

Wireless equipment is based on a reconfigurable Software Defined Radio (SDR) platform. SDR concept provides wide educational and experimentation base that can be exploited in many courses related to digital wireless communication systems. We have selected SDR platform named Universal Software Radio Peripheral (USRP) developed by Ettus/National Instruments. USRP is widely spread across academia, which will allow easy cooperation with other institutions and will support student’s mobility. The chosen hardware is easily interfaced through MATLAB and GNURadio software environments. Therefore, laboratory exercise in new and updated courses will heavily rely on these hardware-software combinations. The particular products (items 5 and 6) come as teaching bundle: two USRP devices are accompanied with teaching/lab materials (courseware), which additionally helps in course development/improving. In order to cover all operational bandwidths of USRP-2901 (70 MHz - 6 GHz) and USRP-2920 (50 MHz – 2.2 GHz), different antennas are provided (items 7-9). In order to support rapid experimentation and development of customized lab exercises, LabVIEW Communications System Design Software is envisioned (item 10).

Figure 17. Wireless Communications and Information Processing (UNS)

4. Conclusions

The final goals of the task “Creation of joint university/industry labs and modernization of the lab infrastructure” have been the adoption of tools and equipment to enable innovative teaching methodologies and the inclusion of industrial partners in the development of joint labs and joint work with students. Organizational agreements were signed by industry and university partners. New industry partners may be added as part of the exploitation plan after the project termination.

New equipment was installed and applied in 6 joint industry-academia labs. The labs offer an infrastructure to develop, modernize and implement selected courses. The developed lab sessions and practicums were, and will be, posted on the E-platform. Student projects and their theses are organized in collaboration with industry partners. Joint activities with industry partners have been established and developed during the project and they will continue after the project end, including co-advising student projects and theses, summer schools and internships, as well as student competitions and hackathons.

5. References

[1] S. Šobot, N. Gavrić, Ž. Bojović, D. Vukobratović: An Overview of Open Source Environments for 5G Internet of Things Experimentation, 29th International Electrotechnical and Computer Science Conference, ERK, September 2020, Portorož, Slovenia.