

Annual Administrative Report

1. General Information

1.1. Program and Project information	
Name of the Program:	IDEAS - Engineering and Technological Sciences
Name of the Project:	Hybrid Integrated Satellite and Terrestrial Access Network
The Project acronym:	hi-STAR
Total Project budget:	32,297,049.58
Project realization period (from dd/mm/yyyy to dd/mm/yyyy):	Start date:01/01/2022 - End date:31/12/2022
Reporting period:	Y1

1.2. Project participants information	
1.2.1. Principal Investigator (PI) and Lead Science and Research Organization (SRO)	
Name and last name of the PI:	Predrag Ivaniš
Academic and research title of the PI:	Full professor
SRO name:	School of Electrical Engineering, University of Belgrade (SEE)
SRO authorized person (legal representative) name and last name:	dr. Dejan Gvozdić

1.2.2. Project Partners - Science and Research Organizations (SRO)*	
SRO name:	Faculty of Electronic Engineering, University of Niš (FEE-UNI)
SRO authorized person (legal representative) name and last name:	Prof. dr Dragan Mančić, dean
SRO name:	Innovation Center, School of Electrical Engineering, University of Belgrade (ICEF)
SRO authorized person (legal representative) name and last name:	Ilija Radovanović, vice director

*Copy this table as needed to provide information about all Partner SROs.

1.2.3. Members of the project team		
Name, last name*	Academic and research title**	Science and Research Organization (SRO) Acronym
PI: Predrag Ivaniš	Full professor	SEE
P1: Goran Đorđević	Full professor	FEE-UNI
P2: Lazar Saranovac	Full professor	SEE

P3: Zoran Čiča	Full professor	SEE
P4: Dejan Drajić	Senior research associate	ICEF
P5: Srđan Brkić	Assistant professor	SEE
P6: Dragomir El Mezeni	Assistant professor	SEE
P7: Vesna Blagojević	Associate professor	SEE
P8: Vladimir Petrović	Assistant professor	SEE
P9: Haris Turkmanović	Teaching assistant	SEE
P10: Đorđe Sarač	Junior teaching assistant	SEE

*Insert only names of the project participants who were engaged during this reporting period.

**In case of any changes in the status of academic and research titles of team members, submit the appropriate decision on acquiring academic and research title of the team member(s) in question, justifying the change of the status.

2. Annual Project Summary

2.1. Project and Progress Summary – Please refer to the project objectives, methodology, achieved results during the first year of project implementation and expected impact.

Please present the project's most significant results in a way that is comprehensible to the general public. The Project summary can be used by the Science Fund of the Republic of Serbia for promoting and demonstrating the value and impact of the Project.

English (up to 250 words)

During the first project year, we were focused on algorithms that could increase the reliability of low-latency links. We performed a reliability analysis of satellite links subjected to deep fades, and we have developed an accurate simulator of the terrestrial-satellite channel. We proposed a novel framework that can be applied to increase the reliability of earth or satellite links, based on the genetic optimization algorithm that is incorporated into the recently proposed Gradient Descent Bit-Flipping Decoding with Momentum (GDBF-w/M). The resulting low-complexity decoder outperforms all state-of-the-art probabilistic bit-flipping decoders, and additionally, it can be trained to perform beyond BP decoding. We have developed the architecture of the hybrid modem physical layer. GNU radio and Open Air Interface are chosen for DVB-S2x and 5G modems. Different architectures are analyzed for the DVB-S2x physical layer in GNU radio in order to optimally use the processing platform. Hardware accelerators are developed for the most demanding blocks in the physical layer. The BCH decoder is completed while the LDPC decoder is still under development. During the first year of the project, after a detailed examination of several state-of-the-art network simulators, we started to create our own hybrid radio access MATLAB simulator, with the ability to estimate improvements of the hybrid access in terms of reliability and achievable information rates. We tested several state-of-the-art MADM (multi-attribute decision-making) algorithms and quantified the gain achieved by using hybrid access. The first-year research goal was also the design analysis of the 5G network core and gateway for hybrid access. Research of open source 5G network core solutions was conducted and two platforms were found as potential candidates – Open Air Interface and Free5GC. Also, possible approaches for gateway design were investigated, and from the selected architectures, we will select the one that matches the best to the solutions found in WP2 and WP3 that cover hybrid user terminal design and overall system architecture. The project website is created with all project details and achievements and is continuously updated. Dissemination materials, i.e. project presentation, poster, and fact sheet are created for promoting the main ideas of the project. Professional and social networks profiles are created and managed (LinkedIn, Facebook). Defined KPIs are regularly monitored. Project results are published in journals (3 papers) and conferences (7 papers).

Serbian (up to 250 words)

Tokom prve godine rada na projektu, posebno smo razmatrali algoritme koji treba da obezbede veliku pouzdanost linkova koji zahtevaju mala kašnjenja. Izvršili smo analizu satelitskih linkova na kojima je prisutan duboki fading, a razvili smo i simulator koji se precizno modeluje satelitski kanal sa osenčenim Rajsovim fadingom. Predložili smo novi metod za adaptaciju baziran na genetskom algoritmu, koji se može direktno primeniti na nedavno predloženi bit-flipping dekodir sa gradijentnim spustom sa momentumom (Gradient Descent Bit-Flipping Decoding with Momentum, GDBF w/M). Ovo rešenje obezbeđuje malu kompleksnost odgovarajućeg dekodera, uz izuzetno dobre performanse. Razvijena je arhitektura fizičkog sloja hibridnog modema. GNU radio i Open Air Interface su odabrani za realizaciju DVB-S2x i 5G modema. Analizirane su različite arhitekture DVB-S2x fizičkog sloja u GNU radiju kako bi se optimalno iskoristili dostupni procesorski resursi. Razvijeni su hardverski akceleratori za najzahtevnije blokove fizičkog sloja. BCH dekodir je kompletiran dok se LDPC dekodir još razvija. U toku prve godine projekta, nakon detaljne analize postojećih mrežnih simulatora, započeto je dizajniranje novog MATLAB simulatora koji omogućava kvantifikovanje povećanja pouzdanosti prenosa kao i povećanja protoka prema krajnjim korisnicima, koje se postiže upotrebom hibridnog radio pristupa. Simulator je testiran na nekoliko algoritama odlučivanja iz skupa MADM (eng. multi-attribute decision making). Cilj prve godine istraživanja je bila i analiza mogućnosti dizajna 5G mrežnog jezgra i gejtheja za hibridni pristup. Istražena su postojeća rešenja otvorenog koda za 5G mrežno jezgro i dve platforme su nađene kao potencijalni kandidati - OpenAirInterface i Free5GC. Takođe, istraženi su mogući pristupi za dizajn gejtheja, i od elektovanih arhitektura će biti izabrana ona koja najbolje odgovara rešenjima ostvarenim u WP2 i WP3 koji se bave dizajnom hibridnog korisničkog terminala i sistemske arhitekture. Napravljen je sajt projekta i kontinuirano se ažurira. Materijali za diseminaciju, tj. prezentacija projekta, poster, "factsheet" su kreirani za promovisanje glavnih ideja projekta. Kreirani su profili profesionalnih i društvenih mreža (LinkedIn, Facebook) i regularno se održavaju. Definisani ključni indikatori se redovno prate. Rezultati projekta su objavljeni u časopisima (3 rada) i na konferencijama (7 radova).

3. Project Implementation - Annual Overview

3.2. Progress of the annual project activities for reporting period				
3.2.1. Milestones - Short description of milestones achieved during the reporting period, with reference to the Project Description and Gantt Chart.				
	Milestones title – insert milestone name*	Delivery month (Mx) from Gantt Chart	Milestone reached	If not reached, enter estimated month (Mx)
1	M7.1 Website set-up and available online	M01	Yes	M01
2	M3.1 Unified 5G/Sat framework verification	M08	Yes	M12

*Based on milestones planned in Table 3.2d in the Project Description A (Approved Project Proposal - Project Description, in accordance with the Decision of the Managing Board) and Gantt Chart (Annex 3 of the Contract on the Project financing).

3.2.2. If a milestone is not reached, please explain – based on milestones planned in Table 3.2d in the Project Description A (Approved Project Proposal - Project Description, in accordance with the Decision of the Managing Board) and Gantt Chart (Annex 3 of the Contract on the Project financing). If a milestone is reached, enter N/A.
Both milestones are reached. Milestone M7.1 is reached in a timely, in M01, according to Table 3.2. Milestone M3.1 is reached with a delay of four months, in M12, due to the delay of the equipment.

3.2.3. Deliverables - Short description of deliverables achieved during the reporting period, with reference to the Project Description A and Gantt Chart.					
	Tasks/activities*	Deliverable name**	Delivery month (Mx) from Gantt Chart	Achieved Deliverable	If not achieved, enter estimated delivery month (Mx)
1	WP7 – Dissemination and communication activities	D7.1 - Project website and dissemination and communication plan	M01	Yes	
2	WP1 – Project management	D1.1. Internal web-based platform for collaboration	M02	Yes	
3	WP1 – Project management	D1.2. Project management handbook	M02	Yes	
4	WP1 – Project management	D1.3. Quarterly progress reports Q1	M03	Yes	
5	WP1 - Project management	D1.3. Quarterly progress reports Q2	M06	Yes	
6	WP3 - Satellite and terrestrial modems implementation	D3.1 Unified SDR framework for DVB-S2X and 5G modems	M08	Yes	
7	WP1 - Project management	D1.3. Quarterly progress reports Q3	M09	Yes	
8	WP2 - System architecture and attributes selection	D2.1. Hybrid 5G/Sat network architecture	M12	Yes	
9	WP1 - Project management	D1.3. Quarterly progress reports Q4	M12	Yes	

*Based on tasks presented in Table 3.2c in the Project Description A (Approved Project Proposal - Project Description, in accordance with the Decision of the Managing Board) and Gantt Chart (Annex 3 of the Contract on the Project financing).

**Based on deliverables presented in Table 3.2c in the Project Description A (Approved Project Proposal - Project Description, in accordance with the Decision of the Managing Board) and Gantt Chart (Annex 3 of the Contract on the Project financing).

3.2.4. If a deliverable is not reached, please explain – based on deliverables presented in Table 3.2c in the Project Description A (Approved Project Proposal - Project Description, in accordance with the Decision of the Managing Board) and Gantt Chart (Annex 3 of the Contract on the Project financing). If a deliverable is reached, enter N/A.
N/A

3.4. Scientific publications

3.4.1. Insert the full reference with the link of the publication.

Authors	Full Reference title with link of the publication	Type*	Journal ranking (M-category)	Publication status**	Open Access (yes/no)	DOI or ISBN (for books)
1 Predrag Ivaniš, Srđan Brkić, Bane Vasić	P. Ivaniš, S. Brkić, and B. Vasić, "Suspicion Distillation Gradient Descent Bit-Flipping Algorithm," Entropy, vol. 24, no. 4: 558, April 2022 (web: https://www.mdpi.com/1099-4300/24/4/558#cite , impact factor: 2.524).	article in journal	M22	Published	Yes	DOI: 10.3390/e24040558
2 Srđan Brkić, Predrag Ivaniš, Bane Vasić	S. Brkić, P. Ivaniš, and B. Vasić, "Adaptive Gradient Descent Bit-Flipping Diversity Decoding," IEEE Communication Letters, vol. 26, no. 10, pp: 2257-2261, October 2022 (web: https://ieeexplore.ieee.org/abstract/document/9844740 , impact factor: 3.553)	article in journal	M22	Published	No	DOI: 10.1109/LCOMM.2022.3195026
3 Zvezdan Marjanović, Dejan Milić, Goran Đorđević	Z. Marjanović, D. N. Milić, and G. T. Đorđević, "Estimation of Truncation Error in Statistical Description of Communication Signals over mm-Wave Channels," Axioms, vol. 11, no. 10: 569, October 2022 (web: https://www.mdpi.com/2075-1680/11/10/569 , impact factor: 1.824).	article in journal	M22	Published	Yes	DOI: 10.3390/axioms11100569
4 Srđan Brkić, Zoran Čiča, Andreja Radošević, Đorđe Sarač, Predrag Ivaniš	S. Brkić, Z. Čiča, A. Radošević, Đ. Sarač, P. Ivaniš, "Reliability of Earth - Space Links under Deep Fades with Interleaved Reed - Solomon Codes," in Proc 9th IcETRAN 2022, TEI 1.5, Novi Pazar, Serbia, 6-9 June 2022, https://www.etrans.rs/2022/en/proceedings/ / (chosen as the best paper in the section Telecommunications).	publication in conference	M33	Published	No	ISBN 978-86-7466-930-3
5 Jovan Milojković, Srđan Brkić, Jelena Čertić	J. Milojković, S. Brkić, J. Čertić, "On Pulse Shaping for Generalized Faster than Nyquist Signaling with and without Equalization," in Proc 9th IcETRAN 2022, TEI 1.1, Novi Pazar, Serbia, 6-9 June 2022, https://www.etrans.rs/2022/en/proceedings/ .	publication in conference	M33	Published	No	ISBN 978-86-7466-930-3
6 Goran Djordjević,	G. T. Djordjevic, J. Makal, B. Vasic, and B. Vasic, "Effect of Phase Noise on Error Probability of MPSK Receiver over	publication in conference	M33	Published	No	ISBN 978-86-7466-930-3

	Jaroslav Makal, Bata Vasic, Bane Vasic	TWDP Channel - Simulation Study," in Proc. 9th IcETran 2022, TEI 1.6, Novi Pazar, Serbia, 6-9 June 2022, https://www.etrans.rs/2022/en/proceedings/ .					
7	Goran Đordjević, Nenad Milošević, Jaroslav Makal, Dejan Milić	G. Djordjevic, N. Milosevic, J. Makal, and D Milic, "Outage Probability of Mixed Satellite RF / Terrestrial FSO Cooperative System", in Proc 57th International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST 2022), Ohrid, North Macedonia, 16-18 June 2022, https://ieeexplore.ieee.org/document/9828581 .	publication in conference	M33	Published	No	Electronic ISBN:978-1-6654-8500-5
8	Jelena Anastasov, Predrag Ivanis, Jaroslav Makal, Goran Đordjević, Dejan Milić	J. Anastasov, P. Ivanis, J. Makal, G. T. Djordjevic, D. Milic, "On the Secrecy Analysis of Satellite-Terrestrial Communication Link over Gamma-shadowed Ricean Fading Channels," in Proc 13th International Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP 2022), Porto, Portugal, 20-22 July 2022, pp 179-184, https://ieeexplore.ieee.org/document/9908002 .	publication in conference	M33	Published	No	Electronic ISBN:978-1-6654-1044-1
9	Goran Đordjević, Ivan Đordjević	G. T. Djordjevic, I.B. Djordjevic, "Multidimensional LDPC-coded signal transmission over TWDP fading channel," in Proc. 13th International Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP 2022), Porto, Portugal, 20-22 July 2022, pp. 219-222, https://ieeexplore.ieee.org/document/9907966 .	publication in conference	M33	Published	No	Electronic ISBN:978-1-6654-1044-1
10	Haris Turkmanović, Dragomir El Mezeni, Vladimir Petrović, Lazar Saranovac	H. Turkmanović, D. El Mezeni, V. L. Petrović, L. Saranovac, "Profiling of GNU Radio DVB-S2X transmitter using multi-core CPU and hardware accelerators", 2022 30th Telecommunications Forum (TELFOR), November 15-16, 2022, Belgrade, Serbia, pp. 1-4, https://ieeexplore.ieee.org/document/9983695 .	publication in conference	M33	Published	No	Electronic ISBN:978-1-6654-7273-9

Important note: state only publications that were referenced and accepted within the project Quarterly Administrative Reports.

* Type of scientific publication: article in journal, publication in conference/workshop, book/monograph, book chapter etc.

** Status can only include: submitted, under review, accepted, or published.

3.5. Open research data				
3.5.1. Insert the full reference with the link of the publication: article in journal, publication in conference/workshop, book/monograph, book chapter etc.				
Title with short description (specify the data in terms of size, structure, format, to whom the dataset is accessible, is it a primary or secondary data, what are the terms of use etc.)	Link	Is the data set openly accessible?	Is the data set reusable?	If the dataset is linked to a publication, specify the DOI of the publication

3.6. Intellectual property rights resulting from the project (if applicable to this project)				
3.6.1. Insert all necessary information regarding intellectual property rights				
Type of IP Rights (patent, trademark, technical solution, industrial design etc)	Date of the application	Official title of the application	Has the IPR protection been awarded?	If available, official publication number of a protection award

3.7. Ethics risks
Please note only those ethics risks that emerged unexpectedly/unplanned during the first year of the project, i.e. those that were not listed in the Project Description B (Approved Project Proposal - Project Description, in accordance with the Decision of the Managing Board). Enter N/A if not applicable to the project.
N/A

* Up to 250 words.

3.8. Environmental and social management
3.8.1. Please describe relevant environmental and social management. Include what was done during the first year of the project in terms of its impact on the environment. Please note if the project had previously undergone a screening meeting with the SF consultants and experts (what were the conclusions and recommendation, and what was done so far).
N/A

4. Project Management Information - Annual Overview

4.1. Project management information – please describe the overall program management, team performance, collaboration among team members and partner institutions (management of scientific, administrative, and financial tasks).

All project activities are monitored and coordinated. Project team members are performing roles and tasks fully in line with the approved Project Proposal, and the cooperation between team members is adequate. The project results achieved in WP2 and WP3 will be used in WP4 and WP5 during the next year. Therefore, we expect an even stronger collaboration between the research groups with expertise in different areas (Telecommunication, Electronics, Information theory, Machine learning) during the second and the third project year.

At the project beginning, a kick-off meeting is organized, and the procedures and the project management methods are defined. We have established the hi-STAR collaborative environment - an e-mail distribution list is defined, and we created the internal web for information exchange in-between the team members. Also, we have established measurable KPI indicators for web site and social networks. Periodic meetings are held every quarter to review the project's progress. The Microsoft Teams channel is created, and several meetings are organized during the first project year.

The project finances will be conducted based on Grant Agreement. The Science Fund deposited money to the coordinating institution, which will convey funds to the other participants institutions. A financial report was submitted to the Science Fund every quarter, and it was accepted after the corresponding procedure was applied.

Project team members are performing roles and tasks fully in line with the approved Project Proposal, and the achieved results represent a good starting point for the synergy of the project team in the next project years.

4.2. Execution of the project

4.2.1. Please provide information on the execution of the project and implementation challenges.

During the first project year, we established the hi-STAR collaborative environment - an e-mail distribution list is defined, and we created the internal web for information exchange in-between the team members. The Microsoft Teams channel is created, and several meetings are organized during the first project year. The public website is launched, and the deliverables and the administrative part of the reports are published on the project website.

In the first project year, our focus was on the creation of an adequate simulation environment that describes the propagation in satellite and 5G communication links, as well as on algorithms that could increase the reliability of low-latency links. The accurate simulator of the satellite-terrestrial link is developed and we evaluated the statistical parameters of the signal envelope over the terrestrial mm-Wave channel. We have proposed the adaptation method based on the genetic optimization algorithm that is incorporated into a state-of-the-art decoding algorithm, resulting in a low-complexity LDPC decoder with superior performance. A detailed analysis of the GNU radio SDR framework is completed, and the SW architecture for DVB-S2x physical layer implementation is defined. We have optimized DVB-S2X physical layer software implementation to achieve better usage of processing resources. HDL design of the standalone BCH decoder is completed while LDPC is still under development. The focus of this activity besides hardware implementation is on porting 5G NR chain to the Xilinx development platform. We continued work related to examining handover techniques based on the MADM and reinforced learning applicable to hybrid radio network access. Also, we focused on the LEO/GEO satellite networks and we discussed the potential of doing horizontal handover within the satellite access networks. Further analysis steps were conducted regarding the choice between OpenAirInterface 5G-core network and free5GC solutions that have been selected and initially analyzed in the research done in the previous period (OpenAirInterface will be in focus regarding the 5G network core, but the free5GC user element emulation will be used for initial tests). Also, gateway design and gateway connection to considered 5G network core solutions have been analyzed.

Three papers were published in international journals indexed in the JCR list (Entropy, IEEE Communications Letters, and Symmetry), and seven papers are presented at international conferences (IcEtran 2022, Icest 2022, CSNDSP 2022, Telfor 2022). A new laboratory, entitled Laboratory for the Intelligent Communications and Information Theory is established at the School of Electrical Engineering, University of Belgrade.

The main problems were related to a significant deviation in the payment schedule related to the timeframe of the purchasing of the Equipment. With some delay, the most important and the most expensive parts of the equipment are delivered to the SROs (two RF-SoC boards, spectral analyzer, oscilloscope, five desktop computers, some parts of IoT equipment, power splitters, cables, printing paper, and lumpsum). The rest of the equipment (a few parts of IoT equipment, with an estimated price of less than 1% of the total costs of the equipment) is currently not available in the market, and we believe that it should be delivered during the next year. The delay in the equipment delivery resulted in some delays in the activities.

4.2.2. Please describe to what extent and what kind of support you received from the Lead SRO and partnering SROs during the project implementation. If you have recommendations for improvement with this regard, please specify.

A new laboratory, entitled Laboratory for the Intelligent Communications and Information Theory is established at the Lead SRO (School of Electrical Engineering, University of Belgrade).

4.3. Team capacity development

4.3.1. Please provide information on contribution of the project for the research careers of project team members, including special qualifications and special possibilities / opportunities opened up by the project (especially PhD theses).

Two researchers changed the research title during the first project year. Vladimir Petrović was promoted to Assistant Professor on the 14th of March, 2022, and Dejan Drajić was promoted to Senior research associate on the 26th of October, 2022.

Two researchers continue their work on Ph.D. theses.

4.4. Collaboration with the SF

4.4.1. Please describe the overall cooperation and communication with the SF staff during the project realisation. If you have recommendations for improvement with this regard, please specify.

Four quarterly progress reports are submitted and accepted after the scanned copies of the signed documents are timely uploaded to the portal, and the hard copies of the reports are sent to the Science Fond. Modifications of the project budget were proposed in February 2022 and May 2022, and it was accepted after the corresponding procedure.

The research titles for Vladimir Petrović and Dejan Drajić have been updated according to the PI request. In general, we are satisfied with the collaboration (especially after the portal is launched).

*Recommended up to 250 words.

5. Applications for other grants

5.1. Have you submitted or plan to submit a project proposal to an internationally funded program using the reference to the project funded by the program IDEAS?

No, we have not applied for the other grants during the first project year.

*Recommended up to 250 words.

5.2. Have you established or have plans for collaborations with international researchers or diaspora researchers within the scope of this project or after its realization? If yes, please specify. Otherwise, enter N/A .

We established cooperation with the University of Arizona, within the scope of WP2, especially the application of machine learning techniques in the optimization of the error correction codes applied in 5G and satellite modems.

*Recommended up to 250 words.

6. Risk Management – Annual Overview

6.1. Risk management in the first year of project implementation - methodology risks, timing, milestones and deliverables, participants and scientific institutions, procurement, budgetary issues, and other risks.

Type of risk*	Category**	Describe in detail the risks and the risk management actions, applied mitigation measures, undertaken actions and their results. Were the measures successful? What was the result of these actions? If the risks still apply, state expected time frame of the risk mitigation. What are the possible implications to project implementation if the risks are not resolved?	Risk level***
WP2 fails to deliver accurate channel models in physical layer or fails to deliver solution for reliable communication in DLL layer	Work package 2, deliverables 2.1 2.2 and 2.3, milestone	The proposed actions: the WP2 leader has experience in channel modeling, and PI has an experience in the design of solutions able to support high throughput satellite communications, hence, the risk is low. However, in that case, the DLL layer will be excluded from PoS demonstrations. The measures were successful, and there is a very low possibility of this risk (activities in WP2 will continue during the second project year).	Low
Delays in implementation of complete satellite and terrestrial modems	Work package 3, deliverables 3.1. and 3.2, milestone 3.1	The proposed actions: the WP3 leader has significant experience in this type of R&D, as he was a PI of a project where a modem for satellite communications was already developed. However, if delays happen, the PoS will demonstrate only basic modem functionalities, that are mandatory for traffic management (user plane functionalities). The risk still applies, due to the delay of the equipment procurement.	Low
Dissemination requires more effort than expected, project publications are not accepted at target conferences.	Work package 7, deliverables and milestones	The proposed actions: the project will adopt an agile strategy and regularly revise the status of its communication process and rebalance the allocation of its resources accordingly and prioritize the actions that have the highest multiplying effect and longer-term impact. The partners already have a good track of publications. The measures were successful, and during the first project year, all planned publications were published. The risk still applies, as there is two more project years, and a lot of papers will be submitted in this period.	Low
Not available enough real network data for analysis and SDN controller handover prediction algorithm development	Methodology risk	The proposed actions: Use existing and available traffic and channel mathematical models. The risk still applies, as there are two more project years, and WP4 and WP5 will have intense activities during the next two years.	Medium

Project team member leaves the Project	Members of the project team and SROs	The proposed actions: Reorganize the assignments to cover the missing member - this can lead to delay in the completion of some subactivities. We did not apply action, as no one left the project during the first year. The risk still applies, as there are two more project years.	Low
The procured equipment (RF-SoC development board) delivery delay	Procurement	The proposed action: Use similar equipment available at the School of Electrical Engineering; lease equipment from a third-party company. We applied this action where necessary, and it was partially successful, as the specific parts of the equipment (e.g RF-SoC boards) were not available. The risk does not exist anymore, as the procurement is practically finished. Only a few parts of IoT equipment (with an estimated price of less than 1% of the total costs of the equipment) are not delivered, and it has no vital importance for the success of the project.	Medium
Some conferences can be canceled or delayed due to the epidemiological situation.	Budgetary issues	The proposed actions: The papers will be presented remotely or we will transfer some funds from conference expenses into journal expenses. There was no need to apply this action, as all conferences were organized timely. However, remote presentation remains as an option at some scientific events, and it can be useful in the future. It appears that the risk does not exist anymore.	High
Poor quality of deliverables and delay in meeting the deadlines.	Management risk	The proposed actions: Proper internal peer review procedures and criteria (D1.2) will be in place to ensure the quality of the deliverables and their preparation in a timely manner. We applied this action, although all reports and deliverables were submitted and accepted without significant delay. The measure was successful, and we will apply it until the end of the project.	Low

* Type of risk: methodology risks, timing, milestones and deliverables, participants and scientific institutions, procurement, budgetary issues, and other risks.

** Categories: foreseen risk and unforeseen risk.

***Risk level: high, medium, low.

7. Annual Financial Overview

7.1. Annual Financial Overview		
7.1.1. An integral part of this report is Annual Financial Progress Report, which form is separately attached in Excel format. Information provided in this report should be in line with the approved budget and approved realised costs.		
Total amount received for the reporting period in RSD*	Project realised cost for the reporting period in RSD**	Unspent funds at the end of the first year in RSD (deviation)***
14373010.34	12017884.98	2355125.36

*Total amount received for all SROs in total.

** Total amount of realised costs for all SROs in total.

*** Unspent funds at the end of the first year should be equal to total amount received for the reporting period reduced for project realised costs for the reporting period.

7.1.2. Briefly describe financial management of the project in the first year of implementation, total amount received during the first year vs amount spent, all deviations and challenges that were encountered related to the financial aspects of the project management. *

Deviations will be briefly described in the following text:

1. The overhead is not spent at Lead SRO (1159367,82 RSD), SRO1 (21,925.80 RSD), and SRO2 (107,334.97 RSD). A part of the overhead is spent at SRO1 only, and at Lead SRO and SRO2, the complete amount paid for overhead is still unspent.
2. The personal costs for M12 are not included in the first-year report, as it was paid at the beginning of the second project year; the gross amounts are: Lead SRO (450,969.26 RSD), SRO1 (61,687.05 RSD), and SRO2 (52,539.56 RSD);
3. It is still unspent part of the amount paid for equipment at Lead SRO (amount of 314,064.40 RSD), SRO1 (15,159.20 RSD), and SRO2 (54,552.50 RSD). A few parts of small equipment have to be delivered in the second year at Lead SRO (there are not paid yet), and equipment at SRO1 and SRO2 is paid less than expected.
4. It is not spent part of the amount paid for costs at the conferences IcETRAN 2022 and TELFOR 2022, at Lead SRO (amount of 5,190.00 RSD). Only the registration fee for the conference IcETRAN is paid from this project, and the other costs are paid from other sources (15,140 RSD is unspent, as the costs of stay are not paid by this project). At the moment when the project started, we estimated the registration for the conference TELFOR as 11800 RSD and this amount is paid when the project started. The registration fee is increased to 21750 RSD, and the corresponding change is approved in the budget modification in February 2022 (and we spent 9,950.00 RSD more for this conference when it is compared with the amount paid from the Science Fund in December 2021).
5. It is not spent a part of the amount paid for costs at the conference CSNDSP 2022, at SRO1 (amount of 88,700.10 RSD). The registration fee, travel costs, and per diems are paid from the project account. Although specified in the approved budget, the local transportation costs and cost of stay are not paid by the hi-STAR project. These costs are paid from other sources, as a COST action is organized in Porto in the same period as the CSNDSP conference (P1 is also a member of that COST action).

In the next period, we will propose an alternative way to allocate the unspent amounts to the costs that are saved in the categories of Travel and dissemination, and Equipment.

There are a few minor differences between the reported costs in quarterly reports and real costs. At the moment when QAR1 and QAR2 are reported, FEE-UNI did not provide us with bank statements related to maintaining accounts with the Treasury Administration. The corresponding cost, related to five statements no. 1, 2, 4, 5, 7, and 11, amounts to RSD 1,363.46 in total, and these costs go through Overhead. By typing mistake, the amount from statement no. 28 was entered in QFR Q3 as 17694.38 instead of 17649.38. After these changes, the total spent amount for SRO 1 is increased to the amount of 1318.46 RSD, when compared to previously reported costs. The total spent amount for SRO 2 is increased by 600 RSD when compared to the previously reported costs, and the difference is related to the costs related to the bank account, documented with bank statement no. 7. This cost also goes through Overhead for SRO 2. All these statements (related to minor differences in SRO 1 and SRO 2) are uploaded at the moment when QAR4 is reported.

There was also a significant deviation in the payment schedule related to the timeframe of the purchasing of the Equipment. All pieces of equipment were scheduled for purchase in Q1 of the hi-STAR project. However, due to the need for public procurement of the planned equipment, the procedure of the modification of the public procurement plan has been executed at the leading SRO. Public procurement for the part of the equipment (Spectral Analyzer, RF connectivity components, and some parts of the IoT equipment) was finished in Q2. However, the delivery of the equipment was performed mostly in Q3 and Q4. With some delay, the most important and the most expensive parts of the equipment are delivered to the SROs in Q4 (two RF-SoC boards, spectral analyzer, oscilloscope, five desktop computers, some parts of IoT equipment, power splitters, cables, printing paper, and lumpsum). The rest of the equipment (a few parts of IoT equipment, with an estimated price of less than 1% of the total costs of the equipment) is currently not available in the market, and we believe that it should be delivered during the next year.

*Recommended up to 250 words.

7.1.3. If your project involves procurement of capital equipment, briefly describe how you ensured availability of capital equipment to all the project team members, as well as other interested researchers in SROs from consortium and researchers in Serbia in general. Enter N/A if this is not applicable to the project.

N/A

8. Additional comments - if there are any other recommendations, insights, conclusions regarding the Project implementation that were not covered by the previous parts of this report, please note them here. Enter N/A, if not applicable.

N/A

Date and signature

We hereby confirm that all information in the Annual Report is accurate.

Name and last name of the authorized person

- | | |
|----------------------------------|--------------------|
| 1. _____ | <u>22.03.2023.</u> |
| Leading SRO (stamp) | date |
| dr. Dejan Gvozdić | |
| 2. _____ | <u>22.03.2023.</u> |
| Project PI | date |
| Predrag Ivaniš | |
| 3. _____ | <u>22.03.2023.</u> |
| SRO 1 (stamp) | date |
| Prof. dr Dragan Mančić, dean | |
| 4. _____ | <u>22.03.2023.</u> |
| SRO 2 (stamp) | date |
| Ilija Radovanović, vice director | |