

Quarterly Administrative Report

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
Project realization period (from dd/mm/yyyy to dd/mm/yyyy):	Start date:01/01/2022 - End date:31/03/2022
Reporting period (insert Q1, Q2, Q3, Q4, ..., Q8):	Q1

2. Project participants information	
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:	Prof. dr Dejan Gvozdić

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.

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	Associate professor	SEE
P4: Dejan Drajić	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	Teaching assistant	SEE
P9: Haris Turkmanović	Teaching assistant	SEE
P10: Đorđe Sarač	Junior teaching assistant	SEE

*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.

2.4. Project team performance
Are the project team members performing their roles and tasks in line with the approved Project Proposal (as presented in the Project Description A, Gantt Chart, Budget and other project documentation)? Is the cooperation between team members adequate? If NO, elaborate.
Project team members are performing roles and tasks fully in line with the approved Project Proposal. The planned milestone is achieved, and three deliverables are reached. The cooperation between team members is adequate. We have established the hi-STAR collaborative environment - an e-mail distribution list is defined, the public website is launched, 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 quartal.
During the reporting period, were there any unforeseen circumstances requiring a change in any of the team members, including the PI? (This includes a change of job or contract of a team member, or a change in the research or academic title, longer-term absence like parental leave, inability to work or any other relevant change.) If YES, elaborate.
P8 - Vladimir Petrović changed the research title. He was promoted to Assistant Professor (his previous title was Research Assistant) on the 14 th of March, 2022. The corresponding documentation is sent by e-mail.

3. Progress on implementation and results achieved										
3.1. Milestones - Short description of milestones achieved during the reporting period, with reference to the Project Description and Gantt Chart.										
<table border="1"> <thead> <tr> <th></th> <th>Milestones title – insert milestone name*</th> <th>Delivery month (Mx) from Gantt Chart</th> <th>Milestone reached</th> <th>If not reached, enter estimated month (Mx)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>M7.1 Website set-up and available online</td> <td>M01</td> <td>Yes</td> <td></td> </tr> </tbody> </table>		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	
	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							

*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. 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.
N/A. The milestone is timely reached. The website is available at the address https://hi-star.etf.bg.ac.rs/index.html .

3.3. 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	

*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).

3.4. 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. All deliverables are timely reached. Deliverables 7.1 and 1.1. are classified as Public, and they are available for download from the address https://hi-star.etf.bg.ac.rs/deliverables.html . Deliverable 1.2 is classified as Confidential, as it describes the project team's working procedures, and it is not of interest to the public.

3.5. Project results (recommended up to 250 words) – brief summary of the Project progress (briefly describe performed project tasks, activities and results relevant for the current reporting period).
The project progresses as scheduled. In Q1, WP1, WP2, WP3, WP4, and WP7 have been active. <ol style="list-style-type: none"> WP1 – Subactivity 1.1: We created an internal web-based platform for collaboration, e-mail list, and MS Teams channel. Also, the project management handbook is written. WP2 – Subactivity 2.1: The system architecture of existing hybrid integrated Satellite and terrestrial access networks has been reviewed from the literature, and the analytical models of the corresponding communication channels are analyzed. WP2 – Subactivity 2.2: We conducted a reliability analysis of Earth-space links subjected to deep fades, modeled as burst erasure channels. Also, we considered increasing spectral efficiency of terrestrial 5G networks by Faster than Nyquist signaling. Finally, we proposed a novel low-complexity algorithm that can be used for decoding low-density parity-check (LDPC) codes, used in 5G and satellite systems. WP3 - Subactivity 3.1: The main focus of this subactivity was on SDR solutions for DVB-S2x standard. We have managed to find several suitable software solutions for the physical layer implementation of DVB-S2x. The found software solutions were analyzed with particular reference to future development (the simplicity of implementing the solution on an embedded platform), code reusability, and performance. WP3 - Subactivity 3.2: Even though we still have not completed the exact code profiling of the

transmitter/receiver embedded SW implementation, it is even now clear that some tasks are extremely time-consuming and should be offloaded to FPGA logic. In modern communication standards such as 5G and DVB-S2x, the most complex operations are related to channel coding. The main channel codes used in both standards are LDPC codes. However, the two standards have different code structures, so the encoder and decoder must be different.

6. WP4 – Subactivity 4.1: Time simulator for shadowed-Rice fading model used at satellite links is created. The simulator will be used in analyzing the reliability of data-link layer transmission over satellite Ka band. Also, the simulator for two waves with a diffuse power fading model used in terrestrial (5G) communications has been reviewed in the literature.
7. WP4 – Subactivity 4.2: Handover procedures based on the collected attributes has been reviewed in the literature.
8. WP7 – Subactivity 7.1: The project website is created, and will be continuously updated throughout the project lifetime. Dissemination and communication plan are defined. Professional and social network profiles are created and will be managed actively throughout the project (LinkedIn, Facebook, Twitter). The project is presented at the meeting of COST action.

3.6. Project deviations (recommended up to 250 words) – In case of any deviation/discrepancy from the Project Description A, briefly describe reasons for its occurrence and appropriate further steps. In case of no deviations/discrepancies, enter N/A.

Project activities are executed fully according to the Project proposal (Annex 1 of the Contract on the Project financing).

However, there is a significant deviation in the payment schedule due to delays which are described in the following paragraph. The deviations refer 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 (RF-SoC boards, Spectral Analyzer, RF connectivity components, computer equipment, and IoT equipment), the procedure of the modification of the public procurement plan has been executed at the leading SRO. The procedure took time due to several decision-making instances at the ETF (leading SRO). Since there are no vendors of specified pieces of equipment in Serbia, an importing of the equipment is necessary. All necessary steps have been taken, so the purchasing of the equipment is expected during Q2 of the project.

Personnel costs for all researchers M3 will be paid in the first half of April, according to a general payment schedule.

3.7. Project risks

3.7.1.a. Foreseen risks - the risks identified in Table 3.3 in the Project Description A – for the current reporting period.

Risk No.	Risk title	Description of risk	Work Packages/Tasks concerned	Risk-mitigation measures (as in Project Description A)
1	Procurement	The procured equipment (RF-SoC development board) delivery delay	Primarily WP3, but also partially WP4	Use similar equipment available at School of Electrical Engineering; lease equipment from third-party company

3.7.1.b. Status of risk mitigation measures				
Risk No.	Risk Title	Did the risk occur?	Did you apply risk mitigation measures?	If the risk still applies, describe the next steps for risk mitigation.
1		Yes	No	In this phase of the project, the application of risk mitigation measures is still not necessary. Due to need for public procurement of the planned equipment (RF-SoC boards, Spectral Analyzer, RF connectivity components, computer equipment and some parts of the IoT equipment), the procedure of the modification of the public procurement plan have been executed at the leading SRO. In the meantime, we will use similar equipment available at School of Electrical Engineering.

3.7.2.a. Unforeseen Risks - describe all the additional risks that were NOT initially identified in Table 3.3 in the Project Description A.				
Risk No.	Risk title	Description of risk	Work Packages/Tasks concerned	Proposed risk-mitigation measures
1	N/A			

3.7.1.b. Status of risk mitigation measures (for unforeseen risks)				
Risk No.	Risk Title	Did the risk occur?	Did you apply risk mitigation measures?	If the risk still applies, describe the next steps for risk mitigation.

3.8. Publishable summary* – description (up to 250 words) of the activities and significant results achieved by the project in the reporting period in both English and Serbian.
<p>English (up to 250 words)</p> <p>The aim of the hi-STAR project is to propose and analyze the potential of intelligent hybrid integrated satellite-terrestrial network architecture, solving currently open problems related to traffic distribution between terrestrial and satellite parts of the network. The main goal is to develop a novel Intelligent Traffic Control Unit that distributes traffic between 5G and satellite radio networks (based on current link quality and network demands). In this scenario, there are a few challenges that we did not face in our previous research, related to the novel propagation conditions (both in 5G and satellite links), as well as the efficient implementation of 5G and DVB-S2x modems in one device.</p> <p>During the first quarter of the project, we have identified the appropriate channel models for various propagation scenarios. Typical fading channel models are applied to describe short-term fading episodes in microwave terrestrial links, and a more complex two-way model with diffuse power will be used to model the terrestrial millimeter-wave links. Shadowed Ricean and gamma-shadowed Ricean fading models are identified as appropriate for the satellite links, and we developed the corresponding simulator capable to model its first-order statistics. Also, we have proposed a method for reliability analysis of satellite links subjected to deep fades, invariant of the used statistical fading model.</p>

Besides, the hi-STAR project team has managed to find several suitable software solutions for the physical layer implementation of DVB-S2x. The found software solutions were analyzed with particular reference to future development (the simplicity of implementing the solution on an embedded platform), code reusability, and performance. GNU Radio is selected as a software framework that would enable the simulation of the data flow through DVB-S2x transmitter, communication channel, and DVB-S2x receiver, in the general case.

Serbian (up to 250 words)

Cilj projekta hi-STAR je da se predloži arhitektura inteligentne hibridne satelitsko-zemaljske mreže, kao i da se analiziraju njeni potencijali, a posebno vezano za probleme usmeravanja saobraćaja kroz zemaljski i satelitski deo mreže. Osnovni cilj je razvoj nove inteligentne jedinice za kontrolu saobraćaja, koja treba da distribuirala saobraćaj između 5G i satelitske radio mreže (na osnovu trenutnog kvaliteta linka i zahteva mreže). U ovom scenariju, postoji nekoliko izazova sa kojim se nismo susreli u našim prethodnim istraživanjima. Oni su vezani za nove propagacione uslove (kako u 5G, tako i na satelitskim linkovima), kao i za efikasnu implementaciju 5G i DVB-S2x modema u jednom uređaju.

Tokom prvog kvartala, identifikovali smo odgovarajuće modele kanala za različite propagacione scenarije. Tipični modeli kanala sa fadingom primenjeni su da opišu brzi fading na mikrotalasnim zemaljskim linkovima, dok će složeniji statistički model koji uključuje dva talasa sa difuznom snagom biti primenjen za modeliranje zemaljskog linka na milimetarskim talasima. Rajsov model sa osenčavanjem i Rajsov model sa gama-osenčavanjem su identifikovani kao adekvatni za opis satelitskih linkova, pa je razvijen odgovarajući simulator koji je u stanju da modelira karakteristike prvog reda za ove modele kanala. Predložili smo i metod za analizu pouzdanosti satelitskih linkova na kojima deluje duboki fading, koji se može primeniti za proizvoljan statistički model fadinga.

Osim toga, tim angažovan na hi-STAR projektu analizirao je više dostupnih softverskih rešenja za implementaciju fizičkog sloja u skladu sa DVB-S2x standardom. Odgovarajuća softverska rešenja su analizirana po pitanju budućeg razvoja (jednostavnosti implementiranja rešenja na izabranoj platformi), ponovnog korišćenja koda i performansi. GNU Radio je izabran kao softverska platforma koja omogućava simulaciju toka podataka kroz DVB-S2x predajnik, komunikacioni kanal i DVB-S2x prijemnik, u opštem slučaju.

*This summary should clearly explain the key features of the Project to a non-scientific audience. The Publishable summary for the current reporting period should not consist of more than 250 words. It should focus on achievements to date and how these will generate impact. The Publishable summary can be used by the Science Fund of the Republic of Serbia for promoting and demonstrating the value and impact of the Project.

4. Dissemination*

4.1. Scientific publications – Insert the full reference with the link of the publication: article in journal, publication in conference/workshop, book/monograph, book chapter etc.

In Q1 one journal paper and four conference papers are submitted, but it is not published or presented in Q1:

[1] P. Ivanis, S. Brkić, B. Vasic, Suspicion Distillation Gradient Descent Bit-Flipping Algorithm (status: submitted to Entropy Journal in Q1, accepted in Q2, impact factor: 2.524).

[2] G. T. Djordjevic, I. B. Djordjevic, Multidimensional LDPC-coded signal transmission over TWDP fading channel, (status: submitted to conference CSNDSP 2022).

[3] J. Anastasov, P. Ivanis, J. Makal, G. Djordjevic, D. Milic, On the Secrecy Analysis of Satellite-Terrestrial Communication Link over Gamma-Shadowed Ricean Fading Channels” (status: submitted to conference CSNDSP2022).

[4] S. Brkić, Z. Čiča, A. Radošević, Đ. Sarač, P. Ivaniš, Reliability of Earth-Space Links under Deep Fades with Interleaved Reed-Solomon Codes (status: submitted to conference IcETRAN 2022).

[5] J. Milojković, S. Brkić, J. Čertić, On Pulse Shaping for Generalized Faster than Nyquist Signaling with and without Equalization (status: submitted to conference IcETRAN 2022).

The papers are not published, and we do not give full details for the references, as the pagination, vol, no etc. are not available at the moment. Full details will be given in the next reports.

*Please keep in mind that only activities that are properly labelled according to promotion, publicity and visibility rules as stated in the Contract of the Project financing will be accepted as Project results. As additional documentation, please submit a copy of the main pages of all publications.

4.2. Type of dissemination and communication activities*
<p>The website of the project https://hi-star.etf.bg.ac.rs/ is designed and launched.</p> <p>The project logo and visual identity are completed.</p> <p>Social pages are created and launched:</p> <ul style="list-style-type: none"> · LinkedIn - https://www.linkedin.com/company/hi-star/ · Facebook - https://www.facebook.com/hiSTAR2022 · Twitter - https://twitter.com/hiSTAR2022 <p>The project is presented at the meeting of the COST Action CA19111 “European NEtWork on Future Generation Optical Wireless CommUnication TechnologieS (NEWFOCUS)”, 4th Management Committee Meeting (hybrid), Thessaloniki, Greece, 28-29 March 2022. The project was presented by Goran Djordjević, as a part of a presentation entitled "Outage probability of mixed satellite RF / terrestrial FSO relaying system".</p>

*List only activities directly linked to the Project like organization of a conference, workshop, press release, website, social media, training etc. Provide the website/social media link for this reporting period. As additional documentation, please submit visibility activities supporting documentation (e.g. workshop materials, pictures, promotion materials etc.).

5. Ethical approvals (if applicable)					
No.	Ethical approval*	Period covered by the ethical approval	Issuing authority	State which SRO is covered by the ethical approval	State which work package/task is covered by the ethical approval

*List all documentation (approvals, decisions etc.) required by relevant laws.

5.1. If the ethical approval has not been obtained, please elaborate.
<p>N/A. Ethical approval is not required for this project.</p>

6.1 Environment - Please indicate if your research involves use of potentially hazardous or harmful elements for the environment (such as chemicals, polluting substances etc.). In case your answer is yes, please elaborate how do you ensure environment protection in compliance with the official standards in Serbia. Please list official protocols or permissions obtained by the public authorities you follow, if any.

6.2 Health and Safety - Please indicate if your research involves activities potentially hazardous for the workers' health (e.g. field work in dangerous terrain, laboratory work etc.). In case your answer is yes, please elaborate safety measures you undertake prior to, and during those activities in compliance with the official standards in Serbia. Please list official protocols you follow, if any.

7. Additional information relevant for Project implementation (if needed)

N/A

8. Date and signature

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

Name and last name of the authorized person

- | | |
|---|--------------------|
| 1. _____ | <u>11.05.2022.</u> |
| Leading SRO (stamp) | date |
| Prof. Dejan Gvozdić, dean | |
| 2. _____ | <u>11.05.2022.</u> |
| Project PI | date |
| Predrag Ivaniš | |
| 3. _____ | <u>11.05.2022.</u> |
| SRO 1 (stamp) | date |
| Prof. dr Dragan Mančić, dean | |
| 4. _____ | <u>11.05.2022.</u> |
| SRO 2 (stamp) | date |
| Ilija Radovanović, vice director | |