Science Fund
of the Republic of Serbia

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:01/10/2024 - End date:31/12/2024
Reporting period (insert Q1, Q2, Q3, Q4, …, Q8):	Q12

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 Lazar Saranovac

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 Vladimir Ćirić , 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	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 research assistant	SEE
P11: Ivan Vajs	Research associate	ICEF
P12: Goran Marković	Associate professor	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 perform roles and tasks fully per the approved Project Proposal. The cooperation between team members is adequate, and the obtained results represent a good starting point for the synergy of the project team in the next quarter.

In the twelfth quarter, the focus was on WP4, WP5, WP6, and WP7.

In this reporting period, we have concentrated on analyzing the handover strategies in land mobile satellite networks, developing the accurate channel emulator for 5G/satcom signals, and creating the corresponding framework implementation. Furthermore, we considered possible business models and use cases that would be of interest to telecommunication operators and companies.

Six papers were presented at the international conference TELFOR 2024, where a special section related to the project was organized. A workshop with a focused group (industrial companies) was held.

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.

No.

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.

Milestones title – insert milestone name*		**Delivery month (Mx)** from Gantt Chart	**Milestone reached**	**If not reached, enter estimated month (Mx)**

*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 (no milestones were planned in Q12).

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	WP6, Subactivity 6.1	D6.1 Channel emulator for 5G/satcom signals	M30	Yes	
2	WP6, Subactivity 5.3	D5.3 Use cases and business models	M34	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.

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 Q12, WP1, WP4, WP5, WP6, and WP7 were active.

WP1 - Subactivity 1.1: The eleventh quarterly progress report was submitted, the signed documents were uploaded, and the hard copy of the report was sent to the Science Fund. The reports were accepted, and the administrative part of the report was published on the project website. The project budget has been modified and accepted. The requirement for the extension of the project realization period was submitted and approved by the Science Fond, and the modified Grant Chart was submitted and accepted.

WP4 - Subactivity 4.3: The various handover procedures are analyzed, and we have proposed a procedure based on neural networks for implementation in the HUT.

WP5 - Subactivity 5.3: The work on the preparation of the D5.3 deliverable is finished. The additional activities were dedicated to preparations for the Workshop (held on 17th December) to present the most interesting use cases and business models to invited telecommunication operators and companies.

WP6 - Subactivity 6.1: A detailed channel emulator for the satellite-terrestrial link is developed using Shadowed-Rician fading and assuming LEO satellite-terrestrial communication in rural environments. Outage probability is calculated for different SNR thresholds assuming various propagation scenarios.

WP6 - Subactivity 6.2: Channel emulator is used to generate a series of SNR values for each time instance and is used to determine which modcod should be used for optimal transmission. Based on these values and higher layer headers, payload size and optimal transmission speed is determined to match current channel conditions.

WP6 - Subactivity 6.3: Hybrid user terminal (HUT) receives previous SNR values estimated from the channel (currently generated by channel model) and predicts next values of SNR and consequently modcod that should be used. If the prediction doesn't match values generated by the channel model, the transmission will be either slower than optimal or packets will be discarded due to lower SNR than the used modcod can support.

WP7 – Subactivity 7.1: The project website is regularly updated. Website, Google Analytics, and social networks KPIs are monitored regularly.

WP7 – Subactivity 7.2: Six conference papers are published on the 32nd Telecommunications Forum Telfor 2024.

WP7 - Subactivity 7.3: Special Session on 32nd Telecommunications forum Telfor 2024, Serbia, Belgrade, November 26-27, 2024. was held (6 papers were presented). The section was entitled "Hybrid Integrated Satellite and Terrestrial Access Networks (hi-STAR)". A workshop with a focused group (industrial companies) was held on 17th December 2024. In the workshop, the results and the outcomes of the project are presented.

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 have been executed according to the Project proposal (Annex 1 of the Contract on the Project financing).

The realization of the planned activities in WP4 and WP6 has been delayed by a few months due to changes in the project team and equipment failures. Therefore, the extension of the project duration is proposed and accepted by the Science Fund.

According to a general payment schedule, personnel costs for all researchers from SEE and ICEF in M36 will be paid in January 2025.

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)

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.**

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	The failures in the equipment	WP4	The failures appeared in the main desktop computer used in the activities in WP4 (hard disc was replaced in Q10, processor was replaced in Q12).	The hard disc was replaced in Q10, and the processor was replaced in Q12, and the computer can be used now. Due to delay in the corresponding activities, the extension of the project duration is proposed and accepted by the Science Fund.

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.
1	The failures in the equipment	Yes	Yes	The computer can be used now. Due to delay in the corresponding activities, the extension of the project duration is proposed and accepted by the Science Fund.

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.

English (up to 250 words)

The channel model for the satellite-terrestrial link is completed and it provides ground-truth values of channel SNR that will be used in HUT performance evaluation. Considering frame formats for each communication standard DVB-S2X and 5G NR optimal data transfer speed is determined for every channel condition. The various handover procedures are analyzed, and the one based on neural networks is chosen for HUT implementation. Additional activity was work on business models and use cases workshop presentation that would be of interest to telecommunication operators and companies. Six conference papers have been presented at the international conference Telfor 2024 that contain the results of previously conducted research.

Serbian (up to 250 words)

Kompletiran je model kanala satelitsko-zemaljske komunikacije na osnovu koga se kreiraju referentne SNR vrednosti koje će biti korišćenje za evaluaciju performansi HUT-a. Određena je optimalna brzina prenosa podataka po svakom od kanala uzimajući u obzir strukturu frejmova za svaki od komunikacionih standarda DVB-S2X i 5G NR. Analizirane su različite procedure hendovera i izabrana procedura bazirana na neuralnim mrežama, pogodna za implementaciju u HUT. Dodatne aktivnosti su uključivale pripremu izlaganja na radionici, a vezano za biznis modele i scenarije primene koji bi bili interesantni za prisutne telekomunikacione operatere i kompanije. Takođe, prezentovano je šest radova na međunarodnoj konferenciji Telfor 2024, koji sadrže rezultate prethodnih istraživanja.

*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 Q12, six papers were presented at the international conference Telfor 2024:

[1] G. T. Djordjevic, D. Milić, P. Ivaniš, I. Radojković, "A Simulation Model for Generating Time Variant Gamma-Shadowed Rician Fading Samples", 2024
32th Telecommunications Forum (TELFOR 2024), November 26-27, 2024, Belgrade, Serbia, pp. 1-4
(https://ieeexplore.ieee.org/document/10819177, DOI: 10.1109/TELFOR63250.2024.10819177), M33.

[2] J. Milojković, S. Brkić, P. Ivaniš, B. Vasić, "Optimization of the iterative decoding algorithms for irregular block codes", 2024 32th
Telecommunications Forum (TELFOR 2024), November 26-27, 2024, Belgrade, Serbia, pp. 1-4.
(https://ieeexplore.ieee.org/document/10819061, DOI: 10.1109/TELFOR63250.2024.10819061), M33.

[3] I. Vajs, P. Ivaniš, D. Drajić, Z. Čiča, "CNN and LSTM Neural Networks for spectral efficiency improvements in LEO Satellite networks", 2024 32th
Telecommunications Forum (TELFOR 2024), November 26-27, 2024, Belgrade, Serbia, pp. 626-629
(https://ieeexplore.ieee.org/document/10819092, DOI: 10.1109/TELFOR63250.2024.10819092), M33.

[4] B. Živković, Z. Čiča, "Multi-Connectivity Framework Based on Open-Source 5G Network Core", 2024 32th Telecommunications Forum (TELFOR 2024), November
26-27, 2024, Belgrade, Serbia, pp. 1-4 (https://ieeexplore.ieee.org/document/10819121, DOI: 10.1109/TELFOR63250.2024.10819121), M33.

[5] A. Stoimenov, Z. Čiča, "Performance Measurement Testbed for Hybrid Access Based on Multipath Transport Layer Protocol", 2024 32th Telecommunications
Forum (TELFOR 2024), November 26-27, 2024, Belgrade, Serbia, pp. 1-4
(https://ieeexplore.ieee.org/document/10819151, DOI: 10.1109/TELFOR63250.2024.10819151), M33.

[6] H. Turkmanović, D. El Mezeni, Z. Čiča, L. Saranovac, "Distributed Simulation Framework for Assesing Multipath Transport Protocols", 2024 32th
Telecommunications Forum (TELFOR 2024), November 26-27, 2024, Belgrade, Serbia, pp. 1-4
(https://ieeexplore.ieee.org/document/10819132, DOI: 10.1109/TELFOR63250.2024.10819132), M33.

*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*

The website of the project https://hi-star.etf.bg.ac.rs/ is updated. Website Google Analytics and social networks KPIs are followed regularly.

Six conference papers were published in a Special Session entitled "Hybrid Integrated Satellite and Terrestrial Access Networks (hi-STAR)", which was organized at the 32nd Telecommunications Forum Telfor 2024, Serbia, Belgrade, November 26-27, 2024.

The project posters and factsheets were printed and given to the industry partners. The final demo video was recorded.

A workshop with a focused group (industrial companies) was held on 17th December 2024. In the workshop, the results and the outcomes of the project were presented.

*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.

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)

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. _____ **11.03.2025.**
Leading SRO (stamp) **date**
Prof. dr Lazar Saranovac

2. _____ **11.03.2025.**
Project PI **date**
Predrag Ivaniš

3. _____ **11.03.2025.**
SRO 1 (stamp) **date**
Prof. dr Vladimir Ćirić , dean

4. _____ **11.03.2025.**
SRO 2 (stamp) **date**
Ilija Radovanović, vice director