Efficient Resource Allocation in 5G and Beyond Networks

Newsletter 4: Final Newsletter – Project Completion

Project objectives and target

The ERA5G-Beyond project aimed to address the challenges posed by the increasing number of connected devices and the growing demand for efficient resource allocation in 5G and Beyond Networks. The project was structured into two main phases. In the first phase, researchers explored promising existing technologies, such as Multi-User Multiple-Input Multiple-Output (MU-MIMO) and Downlink and Uplink Decoupling (DUDe). They analyzed potential limitations that could hinder their performance and developed new mechanisms or algorithms to optimize the allocation of physical resources. In the second phase, the project integrated Machine Learning (ML) and Game Theory (GT) to enhance these mechanisms.

Several research initiatives in Europe and the United States had already funded projects related to 5G networks. However, the rapid expansion of users and the widespread adoption of IoT devices required even more efficient resource utilization. Technologies such as DUDe and MU-MIMO had emerged as promising solutions for resource allocation, and the ERA5G-Beyond project sought to further refine and improve their performance using ML and GT techniques. ML played a crucial role in addressing dynamic challenges in 5G networks, such as real-time resource distribution. Techniques like data mining, big data analysis, and deep learning automated network management and optimized key network parameters.

During the third year, the project primarily focused on the second phase. The research team explored and evaluated various MU-MIMO approaches to tackle resource allocation challenges in 5G and Beyond Networks. Specifically, they analyzed the benefits and limitations of MU-MIMO and proposed new mechanisms and algorithms to enhance its performance. A key aspect of this phase involved evaluating user and bandwidth allocation in MU-MIMO-based 5G networks. Additionally, the team conducted further research on resource allocation, applying ML and GT techniques to optimize performance. By leveraging these advanced methodologies, the project improved DUDe and MU-MIMO technologies, ensuring more efficient resource allocation.

The scientific impact of the ERA5G-Beyond project lay in its contributions to the foundational knowledge of 5G and Beyond Networks. By developing innovative resource allocation mechanisms, the project improved key network performance metrics, such as throughput, capacity, spectral efficiency, and energy consumption. The economic impact was expected to

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be substantial, as the adoption of these technologies drove productivity growth, created new market opportunities, and encouraged investments in network infrastructure and technological innovations. From a societal perspective, 5G and Beyond Networks had the potential to transform various aspects of daily life, particularly in smart city development. The ERA5G-Beyond project recognized the importance of efficient resource allocation in unlocking the full potential of these networks, fostering interconnected smart cities that enhanced the overall quality of life.

Final Announcement – Project Completion

The ERA5G-Beyond project has officially concluded, marking the successful completion of 42 months of research and innovation in the field of wireless communications. Funded by the Hellenic Foundation for Research and Innovation (H.F.R.I.), the project addressed one of the most critical challenges of modern mobile networks: the efficient and intelligent allocation of limited physical resources in 5G and Beyond environments.

Project Scope & Achievements

ERA5G-Beyond focused on designing, implementing, and evaluating advanced resource allocation mechanisms for 5G networks, leveraging emerging technologies including:

- Multi-User MIMO (MU-MIMO)
- Downlink and Uplink Decoupling (DUDe)
- Machine Learning (ML)
- Game Theory (GT)

The project was implemented in two major phases. The first phase focused on assessing the capabilities and limitations of MU-MIMO and DUDe, proposing improved models for user and bandwidth allocation. The second phase introduced ML and GT approaches to develop predictive and adaptive algorithms that enhanced performance, energy efficiency, and fairness in dynamic network environments.

Dissemination & Impact

The dissemination outcomes significantly exceeded the initial targets:

- 25 international conference publications
- 4 peer-reviewed journal articles
- A fully operational project website
- Organization of the ERA5G-Beyond Workshop (May 30, 2025), with broad academic participation in hybrid format
- Annual newsletters and continuous online engagement

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These activities reinforced the project's impact across academic, industrial, and policy-making communities. The project's findings contribute directly to the advancement of 5G network performance and set a strong foundation for future 6G research.

Scientific, Economic & Societal Benefits

- Scientific: Novel algorithms combining ML and GT with 5G RA mechanisms
- Economic: Improved infrastructure efficiency and lower energy consumption for network operators
- Societal: Enabling reliable, high-quality wireless communication for smart cities, remote healthcare, and digital inclusion

Acknowledgments

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Stay Connected

Although the project has concluded, the knowledge generated continues to drive research and innovation. Visit our website to access public deliverables, publications, and outcomes:

https://era5g.upatras.gr

Let's keep building the networks of tomorrow!

Web Site

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