TECH ADOPTION SCENARIOS FOR FUTURE 6G NETWORKS

WHITE PAPER

enable 6g.eu

Executive Summary

The deployment of 5G and 6G networks hinges on the creation of additional sources of revenue that contribute to the investment in infrastructure. Historically, telcos had covered the cost of deployment and then recouped the investment through customer fees.

However, as infrastructure costs raise and revenue per customer diminishes, alternative sources of revenue are required to ensure the deployment of mobile networks.

In this white paper, we explore the new business opportunities created by the development Machine Learning-based Privacy Preserving Analytics for 6G Mobile Networks (MAP-6G) and Low Consumption Reconfigurable Intelligent Surfaces (RISC-6G).

Content

Introduction

In the Enable 6G Tech Adoption Scenarios for Future 6G Networks webinar, the development of mobile networks and supporting business models for mass market expansion held a central role. In this whitepaper, we explore the challenges that stakeholders in this field are facing, and how the different business use cases can help overcome these by bringing in new sources of revenue.

The deployment of Mobile networks since the 1st generation, all the way to the 4th iteration, known as 4G or LTE, consisted of a gradual upgrading of the existing infrastructure. With the development of 5G, a new, comprehensive network architecture that provides a platform for new business models and applications, new opportunities surfaced in the telecommunications, services, and computing sectors.

Compared to previous generations, 5G brings forward significant improvements in network speed, latency, and capacity. Furthermore, new applications and business models are possible thanks to the introduction of the following features:

- Massive Multiple Input Multiple Output (MIMO) capabilities
- Signal slicing
- Network function virtualisation

The 5G network development enabled the development of numerous Cloud and IoT applications and is pivotal to their success. Currently, the U.S., Europe and China enjoy an increasing level of 5G coverage, and the contribution of 5G to the global GDP is estimated at over $1 trillion. Around 40% of the revenue is expected to be healthcare related, with use-cases such as remote medicine and live collaboration, while smart utilities, consumer and media applications, industry and finance would make up for the rest of the impact.

5G Challenges

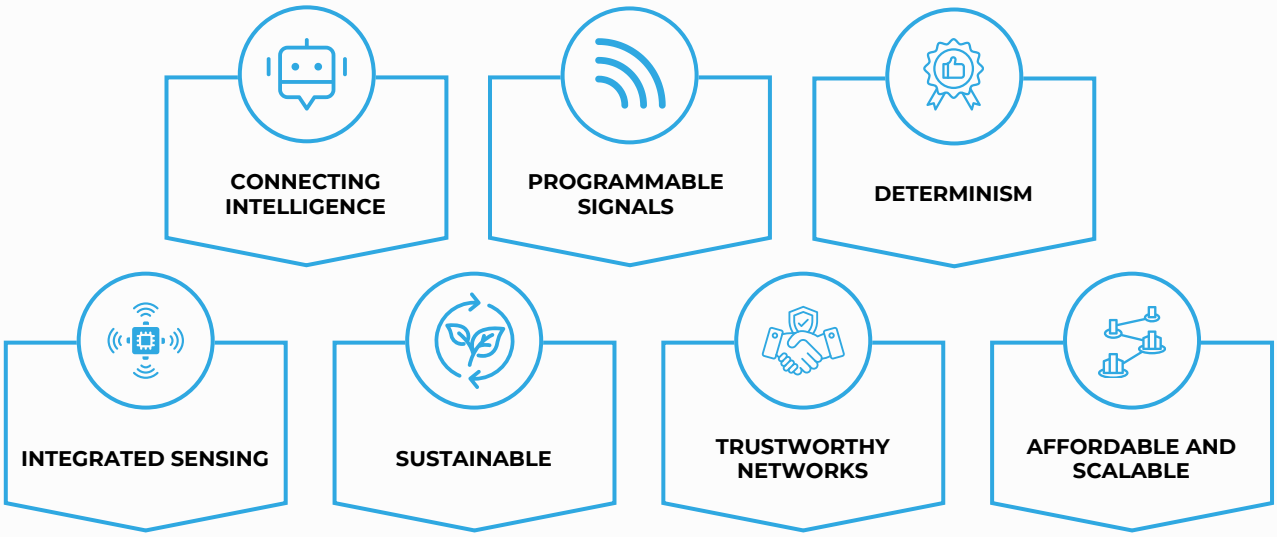
Traditionally, the deployment of mobile communications networks was performed by telcos, that would amortise the investment through consumer fees. However, due to the rising costs of hardware and technology, telcos are struggling to recoup the investments and are incurring in losses that are affecting their ability to maintain their shareholder value and overall financial health.

The total cost of deployment of the 5G infrastructure is estimated at $33.5 bn, of which only $2,7 bn will be in the form of government subsidy. To ensure the timely and effective deployment of 5G networks, alternative business models must be created to share the investment burden across all stakeholders.

6G Opportunities

While 5G is currently in the deployment phase, the working principles of 6G are being laid out. The applications that will be using these networks are becoming increasingly complex and will require the key improvements brought by 6G over 5G.

By allowing for faster data transfer rates, increased location accuracy, superior device density capacity, energy efficiency and decreased latency, 6G will enable the development of the cloud edge continuum, and build towards higher value-added goals:



The deployment of 6G infrastructure will be supported by the additional revenue generated through novel use cases enabled by the improvements of 6G and other existing networks.

Use cases to foster tech adoption

The deployment of 6G networks hinges on new business models and applications to support the financial investment on infrastructure required.

In the Enable 6G Tech Adoption Scenarios for Future 6G Networks webinar, several use cases were presented that demonstrate potential added revenue streams for 6G.

MAP-6G (Machine Learning-based Privacy Preserving Analytics for 6G Mobile Networks)

Researchers from the IMDEA Institute and Telefónica are developing technological solutions that will integrate communication with big data analytics for applications such as localisation.
with privacy-preserving solutions by design. The design problem is the creation of a scalable, distributed privacy-preserving ML algorithms.

Privacy preserving analytics have two main building blocks:

Federated learning (FL)	Differential Privacy (DP)
Decentralised approach to training of the model machine learning models, which does not require an exchange of data from client devices to global servers. Instead, the model is trained locally on the edge devices.	A mathematical framework for ensuring the privacy of individuals in datasets by allowing data to be analysed without revealing sensitive information about any individual in the data set.

Use cases to foster tech adoption

The MAP-6G projects is investigating the following key approaches to data privacy:

- **CROSS MOBILE APPLICATION FEDERATED LEARNING**
- **CROSS SILO FEDERATED LEARNING**
- **DIFFERENTIAL PRIVACY + HIERARCHY (HFL)**
- **ADVERSARIAL ATTACKS FOR THE COMBINATION OF FEDERATED LEARNING, DIFFERENTIAL PRIVACY, AND HIERARCHICAL FEDERATED LEARNING**

Through experimental evaluation, researchers at IMDEA have managed to demonstrate the use cases of 5G new radio localisation, which enables further applications such as a framework for wireless technology classification. In essence, through the evaluation of 5G radio waves, it is possible to determine the location of a human within a room in real time without the need for a camera. It is also possible to determine the gait, height, and location of limbs and torso with a high level of accuracy.

These applications can have many potential business use cases, such as security and defence applications, as well as for privacy-conscious crowd management.

Additionally, the use of a de-centralised, multi-agent reinforcement learning (MARL) network has proven to provide an effective network handover mechanism with improved latency, reliability, and network capacity.

Use cases to foster tech adoption

Lastly, the application of Federated Learning as a Service (FLaaS), allows for privacy protection in edge computing. In a multi-element network, the sensing devices can share anonymised data to the edge devices, which in turn use the data to train AI/ML models which are sent back to the device after re-training. A business model for such application is the Home-as-a-Computer (HaaC), where Telefónica is integrating all the devices in a home to improve the user experience while ensuring their privacy is protected.

RISC-6G (Low Consumption Reconfigurable Intelligent Surfaces)

Localisation and position determination are possible with communication mm waves, with high level of accuracy and low latency, features which can be exploited in several industries such as smart factories, agriculture, digital twins, and healthcare.

RIS (Reconfigurable Intelligent Surfaces)

Many applications developed with the use of 6G networks in mind require millimetre-wavelength signals. These wavelength size signals show material penetration issues, in essence, difficulty in covering an area with physical impediments on the way such as walls, glass, appliances etc. The traditional solution to this issue would require densification of base stations to provide line-of-sight based coverage, which is cost intensive and power-hungry but does provide better performance.

However, as demonstrated in an experiment by NEC Lab, low energy, low latency is possible thanks to RIS, and can increment the spread of signal without having to install additional antennas, working as a sort of “signal mirrors” that provide added coverage with the same number of base stations and low power requirements.

Conclusion

The success of the deployment of the 6G network will depend on the additional business cases that can provide additional revenue streams to the infrastructure provider. As telcos can no longer justify the investment into infrastructure, new business models that exploit the new features of 6G networks will be developed.

Through localisation, monitorisation and new service offerings, the exploitation of 6G networks could become a viable investment and provide new and improved quality of services for existing telco customers. Additionally, thanks to the usage of RIS, the deployment costs could be reduced by employing such surfaces to provide coverage to areas that are not in the line of sight of the antennas, thus reducing the necessity for antenna deployment and further empowering 6G applications.

This initiative is funded by

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