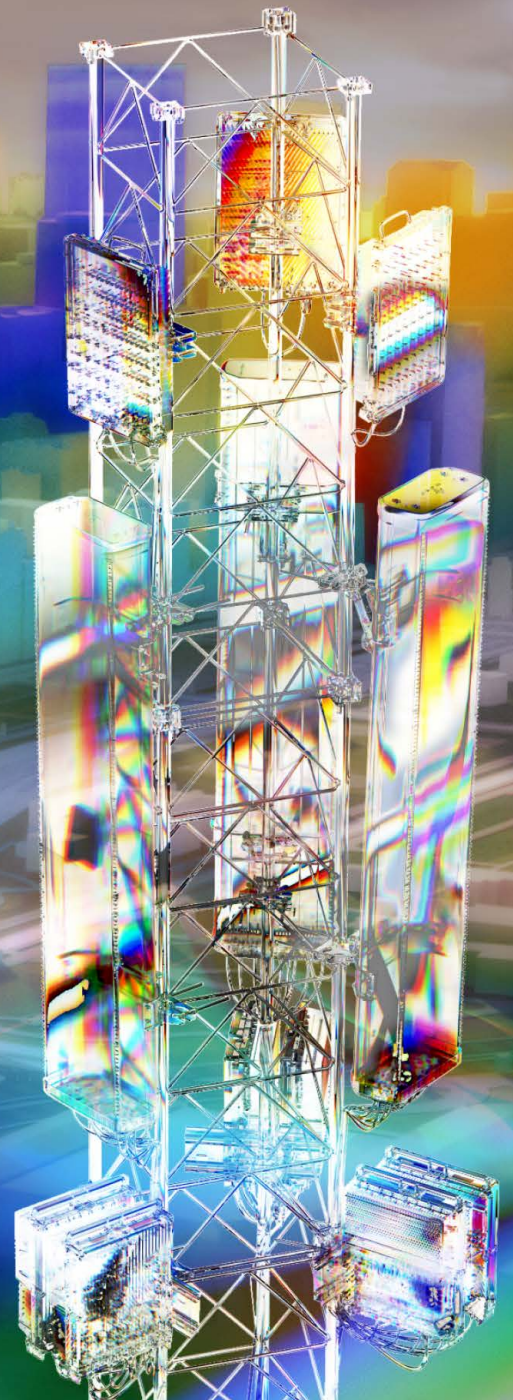




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Enabling high-performing programmable networks with Ericsson 5G Advanced

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5G Advanced is the new set of network capabilities that will help communications service providers (CSPs) achieve their goal of high-performing programmable networks, with more openness. This will ensure consistent and superior user experience at any time and place, and influence network behavior to achieve a desired outcome.

Ericsson offers 5G Advanced radio access network (RAN) software solutions that will support customer business objectives in areas like performance, sustainability, automation and new services.

It will incentivize service providers to accelerate deployment and uptake of 5G standalone (also known as 5G SA or SA) and empower service providers to deliver differentiated connectivity that will further monetize 5G.

Executive summary

- CSPs have built strong networks in the first phase of 5G, which improved user experience, supported new use cases and helped grow Fixed Wireless Access (FWA) business.
- CSPs have made substantial investments in building 5G networks in terms of spectrum, mid-band expansion, nationwide coverage, traffic steering and optimization and introduction of new radio (NR) standalone.
- Ericsson's view is that while the industry has yet to realize the full business potential of this investment – 5G is still on track to fulfill its promise. Balancing this, many CSPs have yet to progress to a standalone architecture and make the network fully ready for 5G Advanced and take the technology to the next level.
- Moving towards enabling differentiated connectivity in the industry is crucial to offering new services developed directly by ecosystems around CSPs.
- With Ericsson 5G Advanced, our customers will get the RAN software, to support them to transform their 5G networks into high-performing programmable networks that can meet specific business goals such as increasing revenue, reducing operational costs, leading in performance, and setting apart user experience.
- Benefitting from increasingly open architectures, AI coupled with automation and intent-driven networks, Ericsson 5G Advanced can help translate business objectives into RAN performance and sustainability. Service-aware RAN software also offers different user experience levels that can be measured and compared with service level agreements (SLAs).
- As mobile networks become an even more integral part of nations' critical infrastructure, it is important to enable CSPs to proactively defend against targeted and sophisticated cyberattacks on the RAN.
- Ericsson 5G Advanced software includes 10 software subscriptions: Outdoor Positioning, RAN Differentiated Connectivity, Mission Critical Services, RedCap (reduced capability), Critical IoT, Energy Efficiency and Management, Premium Network Performance, Device Battery Performance, Real-time AI-powered Automation and Premium RAN Security.



The exciting journey of 5G

5G has been a commercial success in the five years since its launch, with the quickest adoption of any new radio access technology ever. It has greatly enhanced the individual user experience by adding more spectrum, boosting uplink and downlink speeds, and improving the quality of network services.

In recent years we have also introduced elements of Open RAN architecture into 5G networks, to achieve another major transformation by shifting from vertically integrated networks to open horizontal networks.

However, when we started out with 5G, the intent wasn't just to improve established user experience for mobile broadband.

It was also about making sure that we can capture the impact of connectivity in more areas of society and thereby unlocking additional values from what connectivity provides to different enterprises as well as providing new services for consumers.

5G Advanced will further enable an open network architecture and will fully focus on harvesting the great 5G networks that we have built in the last five years globally. Ericsson's view is that the industry has not seen anything near the full business potential of this 5G investment – so we are moving the entire industry to the next level on the way to high-performing programmable networks.



The path towards high-performing programmable networks

To make the most of 5G, we need a network that can perform well and be adaptable – one where we can ensure consistent and superior user experience at any time and place, and influence network behavior to achieve a desired outcome – a high-performing programmable network, where Ericsson 5G Advanced plays an important role.

The traditional way of network deployment has been done with a slow feedback loop, observing traffic updates and performance and tuning and optimizing each site through a service-led approach, addressing constraints within the build-outs or improvements in existing capacity.

Because we start by defining the outcome that we would like to see expressed as a business goal, the logic for high-performing programmable networks is different. If we want to provide a minimum and consistent level of uplink and downlink performance for each user in this segment of the network, the objective of the software is to make sure this is carried out, and resources on every node are divided in such a way as to achieve this outcome, reporting back on the results.

This has the potential to really improve the generation of revenue by the introduction of concepts such as differentiated connectivity, where you can segment network performance and avoid the volatility typically seen when operating on a best-effort basis.

Differentiated connectivity will bring the capability to shift from a best-effort network, to one that enables SLA-based connectivity with different performance needs. It will be more about ensuring consistent quality and user experience, targeted to specific needs, rather than promoting peak rate speed.

From a technology perspective, the key RAN capabilities 5G Advanced will bring are intent-driven networks, AI-powered RAN and service-aware RAN. New network capabilities are in the offing, and increased levels of automation will make it possible to offer business models based on performance.

- **Intent-driven networks** will let CSPs interpret customer objectives - known as intents – and perform RAN actions to meet those objectives. It will simplify the complex processes and let CSPs communicate with the system more easily – CSPs will say “what they want”, not “how”.
- **AI-powered RAN**, where both AI and automation will play a crucial role in realizing intent-driven networks, enabling RAN to understand the intents, process vast amounts of data and make intelligent decisions in real time. Real-time processing is essential for 5G Advanced, as we will bring AI-nativeness directly into our RAN Compute and solve the problems with real-time information for maximum network performance and energy efficiency.
- **Service-aware RAN** will enable rapid scaling of new use cases and customer needs, by being able to adapt to the connectivity requirements of different services and ensuring that RAN can adjust in real time to fulfil service requirements and provide observability to support proof of delivery for each service.

These key RAN capabilities allow us to achieve very specific business outcomes, such as providing a minimum and consistent level of uplink and downlink performance for each user in a specific segment of the network. The software works to make this a reality, allocating resources on each node to achieve the desired outcome and providing observability to understand if the goal has been achieved or not.

Network performance will continue to improve in 5G Advanced through innovations and advanced software features will enable extra coverage and capacity combined

with the ability to allocate resources with precision in real time and to use live network data to drive decisions. This will in turn offer best-in-class user experience, reduced churn, and additionally enable more services on the same network due to the increased network capacity.

What is unique about 5G Advanced that enables it to achieve a desired outcome in a much better way?

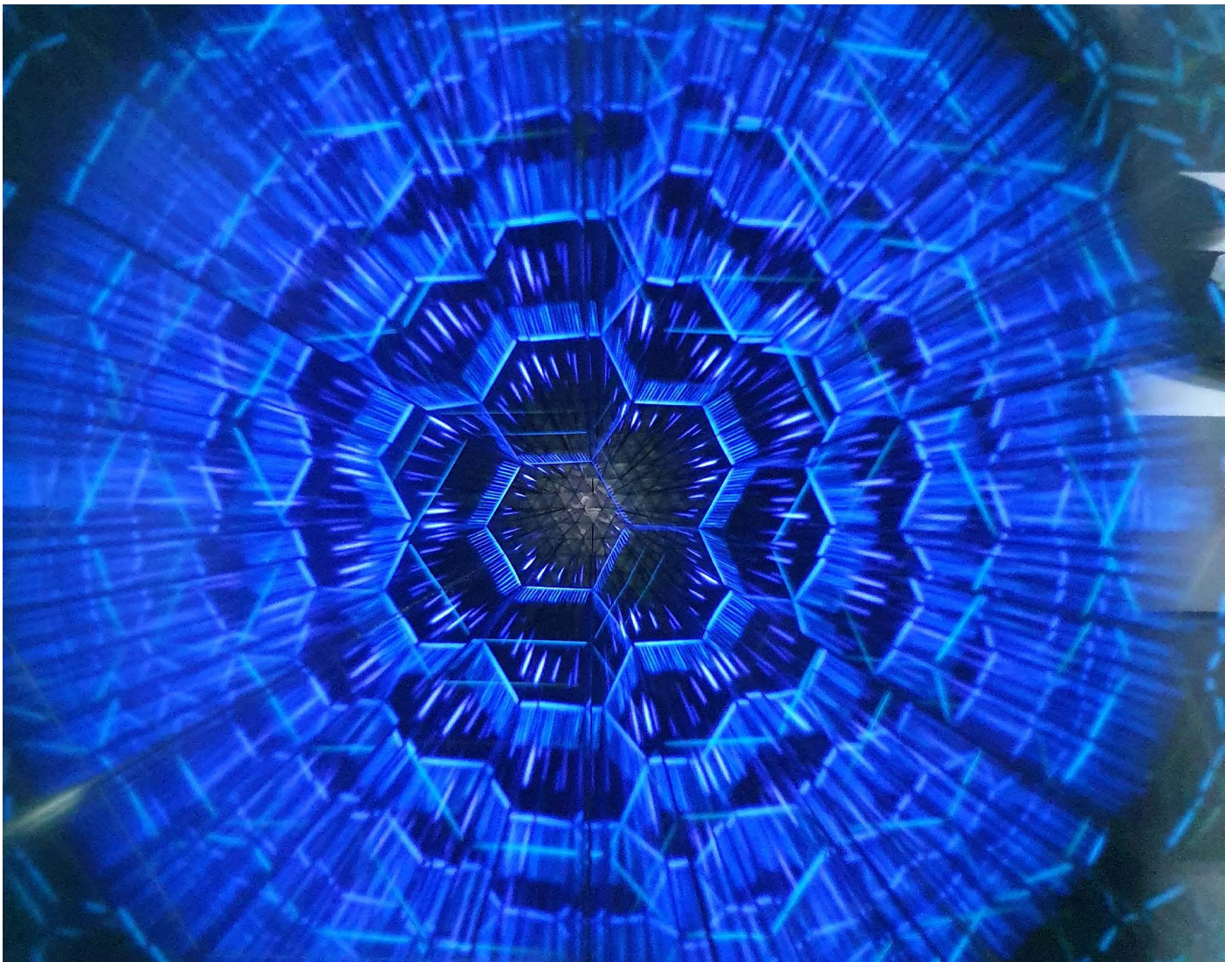
As the next wave of evolution leveraging software-defined enhancements and AI to optimize performance and deliver new services, 5G Advanced plays a vital role in realizing high-performing programmable networks.

5G Advanced supports differentiated connectivity and new use cases and will allow service providers to segment network performance and offer predictable outcomes for different industry verticals and consumer segments. It will also enable new services such as positioning, mission critical services, and RedCap (reduced capability) devices.

5G Advanced introduces openness and disaggregation in the network architecture, supporting open interfaces and disaggregated hardware and software and enabling more innovation and flexibility in the network. It will also integrate with service management and orchestration platforms to provide end-to-end automation and policy control.

5G Advanced embeds AI in the network for real-time optimization, using AI to automate network operations and optimize resource allocation based on business intents and user demands. It will also provide observability and feedback loops to measure and improve the network outcomes.

Ericsson 5G Advanced will provide service providers with new and innovative software capabilities, which will help CSPs achieve their goal of high-performing programmable networks, tailored to meet specific business objectives – whether they are revenue growth, operational expenditure reduction, performance leadership or user experience differentiation, while supporting open architectures.



From business intent to execution thanks to AI-powered RAN



Ericsson 5G Advanced makes it easy and scalable to convert business objectives to RAN parameters, ultimately realized as intents, while ensuring service-level parameter outcomes can be observed and reported against service-level agreements (SLAs).

Put simply, it is about translating intents into desired behavior, reducing complexity via automation and providing service differentiation.

In this new framework, it is necessary to adapt the 5G RAN to make it more flexible to meet the business needs. For that, AI-powered RAN plays a crucial role in realizing intent-driven

networks. It enables RAN to understand the intents, process vast amounts of data and make intelligent decisions in real time. Real-time processing is essential for 5G Advanced, as we will bring AI-nativeness directly into our RAN Compute and solve the problems with real-time information for maximum network performance and energy efficiency.

This requires the combination of service-aware RAN and new distributed real-time automation to realize intents through AI, with observability towards SLAs, and also centralized automation via rApps through the Ericsson Intelligent Automation Platform in a non-real time closed loop.

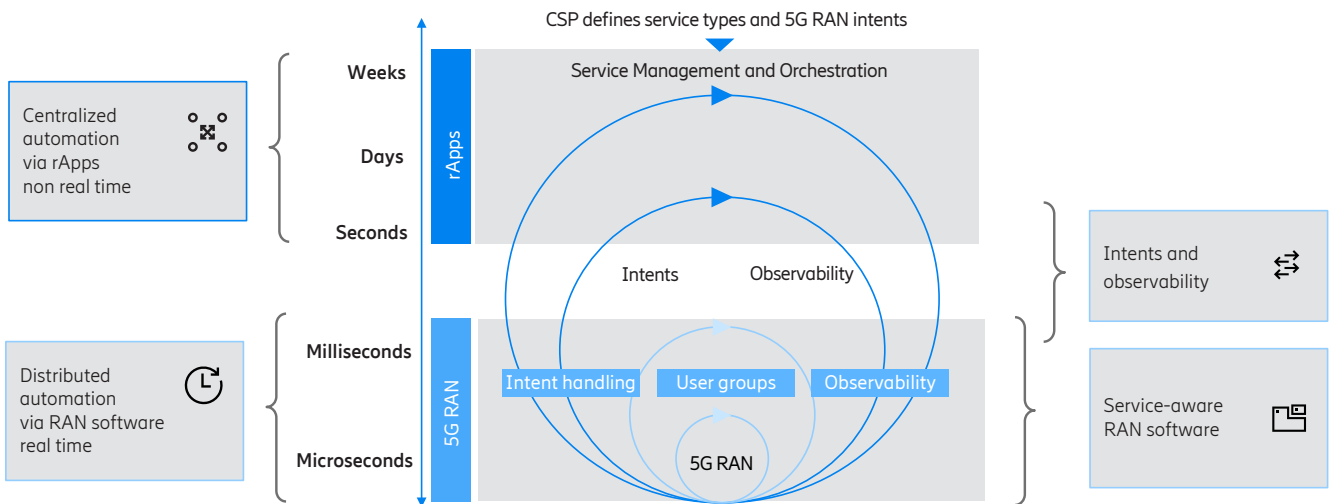


Figure 1: Adapting RAN behavior to fulfill business needs

To effectively address different use cases and customer needs, the RAN must deliver upon a range of SLAs.

Service-aware RAN has two parts:

1. Service-adaptive RAN functionality to ensure RAN adapts in real time to fulfil varying service requirements.
2. Service-specific observability to ensure CSPs can monitor the SLA performance per service and take actions.

In summary, it is about adapting the RAN behavior in real time to fulfill business needs, automating as many of the operations as possible, with the best possible performance, energy efficiency and service-level assurance.

Ericsson 5G functionality is already well-prepared to adapt the RAN behavior in real time and according to service requirements, as more than 85 percent of all RAN features are service-aware and with that, service providers have a comprehensive overview of the services being used by

the user in the network. In addition, the dynamic resource sharing is done every millisecond, and the service-aware capability is for any combination of user grouping framework such as 5G quality of service identifier (5QI), slice and subscriber group. This provides the ability to assign network resources towards a business intent for multiple services in real time.

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5G Advanced in open architectures

Ericsson 5G Advanced will also make the RAN more programmable by simplifying and scaling up the translation of business goals to RAN execution.

To understand how 5G Advanced fits into the RAN open architecture, let us begin with the horizontal industry logic, and then look at Ericsson's view on open architecture.

The industry is exploring alternatives to the traditional setup, with networks divided into geographical regions with vertically integrated stacks, towards a horizontal architecture with vendor diversity across the layers of the architecture (including radio units), and a single vendor on the software layer.

Ericsson foresees that the logic for networks will become more horizontal for greater value, with each layer having its own strengths based on the best industry capability. In summary, from the bottom up, the horizontal layers are radio, Cloud RAN/RAN compute, RAN software, and management and orchestration.

This new approach will help to build the best high-performing programmable networks, a stepwise shift to cloud-native RAN software that is multi-platform capable, and a competitive hardware portfolio complemented by partnerships.

Apart from the **cloudification** of RAN with a separation or disaggregation of hardware and software, it is also complemented with improved **intelligence and automation** in RAN, **open fronthaul and open interfaces** O1/A1 towards management and orchestration, and R1 towards third-party rApps. Ericsson 5G Advanced RAN software will incorporate these aspects of the open architecture and help to unlock openness.

The benefits to be realized include supply chain diversity, solution flexibility and new capabilities that can increase competition and further innovation. Ericsson sees automation and virtualization playing a key role in future network evolution and as a foundation for openness. Delivering this at scale means leveraging industry-wide cloud technologies through collaboration with our partners and customers.

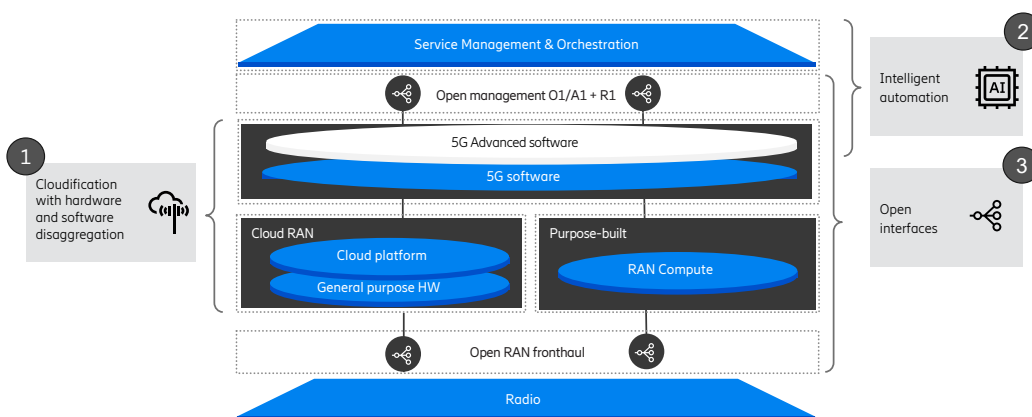


Figure 2: 5G RAN Advanced in the open architecture

Ericsson 5G Advanced RAN software will also play a crucial role in the open architecture and help to unlock openness.

Ericsson 5G Advanced RAN portfolio: Implementing a software-defined RAN

5G Advanced enables us to move from building powerful networks to adding defined software. This means a network that lets us make the most of our investment and offer new services, create differentiated connectivity for new sectors, and add more services on top of that. It will also bring AI into the networks, which will greatly impact how we do things, from making individual features more efficient to optimizing and coordinating parameters based on outcomes and intents rather than scripts. This is a change in how you build, operate, and run your network.

To allow our customers flexibility in their network evolution, Ericsson will introduce eight new software subscriptions to complement the already launched RedCap and Critical IoT. The new 5G Advanced software capabilities will be used to deliver value to our customers in the three following areas: generate revenue, drive operational efficiency and enhance user experience.

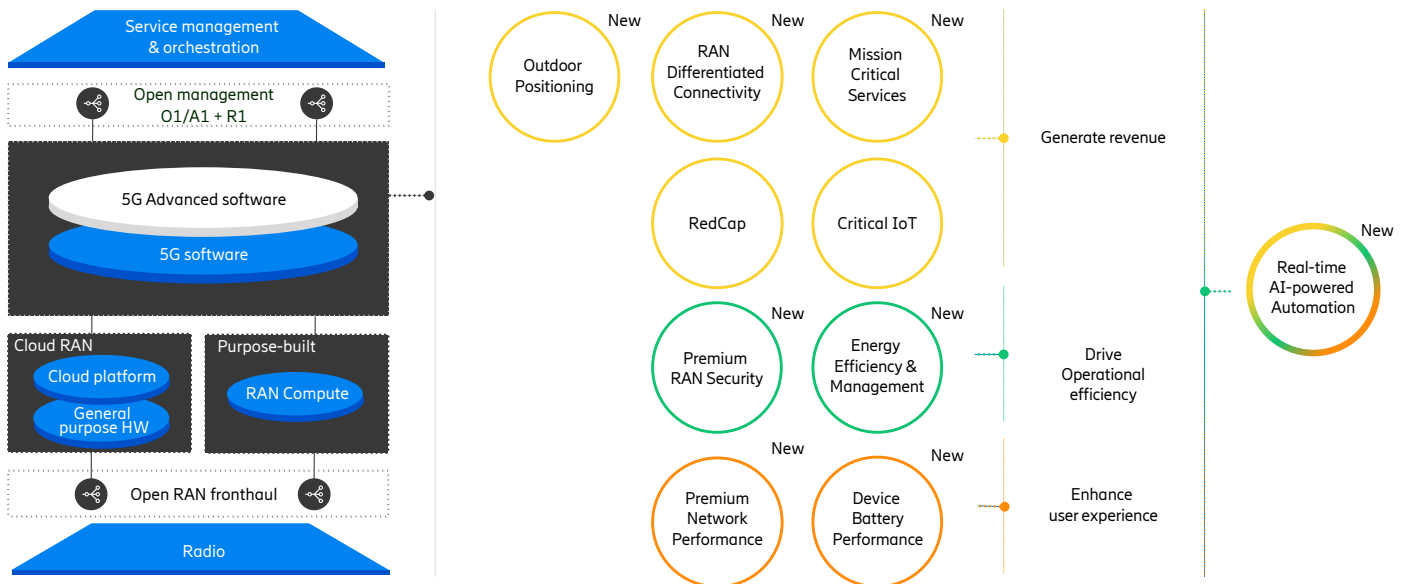


Figure 3: Ericsson 5G Advanced RAN portfolio: implementing a software-defined RAN

With all these elements coming together, Ericsson 5G RAN Advanced gives service providers full freedom of choice to address their business needs.

The Premium RAN Security subscription will enable CSPs to better and proactively defend against targeted and sophisticated cyberattacks on the RAN. This subscription package will include Ericsson’s innovative RAN security

features that go beyond standards for product security and basic security hygiene.

As a summary, the figure below illustrates a high-level description of the use cases enabled per Ericsson 5G Advanced subscription and a summary of the RAN capabilities Ericsson 5G Advanced brings to realize high-performing programmable networks.

Ericsson 5G Advanced subscriptions in a nutshell

Value driver	5G Advanced subscription	Enables	High-performing programmable networks	
			New network capabilities	5G Advanced RAN capabilities
Generate revenue	Critical IoT	Dedicated deployments for high value connectivity	Scaling of differentiated connectivity use cases	AI-powered RAN Support for small AI models to run on-node without additional hardware requirements.
		Connectivity enhancements for time-critical use cases like XR, cloud gaming		
	RedCap	New device types for mid-tier use case with rightsized cost		
	Outdoor Positioning	Localization based services with or without GPS assistance		
	Mission Critical Services	Priority-based connectivity and tailored features		
	RAN Differentiated Connectivity	New services requiring uplink and latency prioritization	Define, deliver, measure and observe performance towards a target intent in a nationwide network with 1000s of nodes.	
Drive operational efficiency	Energy Efficiency & Management	Optimization of energy consumption while securing quality of service target	Intent-driven networks shifts operational focus from how to what. Moving from manual configuration, scripts and parameter optimization to defined outcomes and relevant QoS targets per service.	Service-aware RAN RAN features that are aware of connectivity requirements and can be configured to behave differently per service. Intent-driven networks Interpret customer objectives - known as intents – and perform RAN actions to meet those objectives.
	Real-time AI-powered Automation	Distributed automation that allows real-time optimization at scale, with increased use of AI		
	Premium RAN Security	Unprecedented defense capabilities to RAN against targeted and sophisticated cyber-attacks		
Enhance user experience	Premium Network Performance	High load scenario performance gain		
		Uplink centric performance enhancements		
		Optimized performance for new devices		
	Device Battery Performance	Network side optimizations that allows the device to extend battery life		

Define your path to high-performing programmable networks

Ericsson understands that the 5G network evolution strategy for CSPs varies widely, and we want to provide a means to introduce 5G Advanced in a flexible way so they can tailor the opportunities based on their specific business priorities.

We believe that, in the long term, all components of Ericsson 5G Advanced will be beneficial in terms of achieving high-performing programmable network for service providers, and the path to maximizing the benefits of high-performing programming networks is dependent on where the focus of the service provider is, whether that be revenue generation, drive operational efficiency or enhancing the user experience.

Revenue focus - differentiated connectivity and new services



The goal here is to expand net sales, and Ericsson believes that the path of enabling differentiated connectivity and launching additional new services, like RedCap on top, is the right way.

This path is about transforming networks dimensioned for best-effort mobile broadband (MBB) to ones that can provide differentiated connectivity and new services with consistent performance levels and real-time observability.

It is vital to change the way service providers can increase the value of connectivity and offer innovative services to consumer, enterprise and to leverage the Internet of Things (IoT).

Efficiency focus - optimizing energy consumption, driving automation with AI and achieving advanced security posture



CSPs are very concerned about how much energy they use and how much they affect the environment, and they want to greatly reduce their carbon emissions. Also, it is important to balance the use of advanced energy-saving tools with the intent of user experience, using existing solutions like Automated Energy Saver.

AI, automation introduction, and the ability to control intents has the potential to tremendously improve networks in terms of moving from scripted operations or manual configurations into a more automated approach happening in real-time everywhere. Embedding AI in real-time automation adds a very powerful and capable tool to work on the problems at hand for each CSP.

Another important aspect of operational efficiency in RAN is identifying and stopping attacks in their infancy, thereby achieving and maintaining an advanced security posture. Because mobile networks operate in a landscape where cyber threats are evolving and increasing daily, the question is not "if" RAN will face a significant cyber-attack, but "when". Therefore, CSPs must take actions when there is still a chance and be prepared to address attacks from anywhere - in the air interface, platform, application, and transport.

User experience
focus - consistent
and premium
performance

Previously there has been a big focus on single-benchmark performance, but in the long term what really matters for a large set of users is a lower level of volatility in the perceived performance levels throughout the network. The focus is still on increasing capacity network-wide, improving spectral efficiency and maximizing the return on investment of newly added spectrum like mid-band, to improve the user experience.

The new paradigm is to transform service providers' networks, designed to optimize cell capacity from the lowest level to a network where performance solutions are offered to each user group for each session, based on defined service provider intents.

In short, it is about to unlock additional capacity in most loaded scenarios without adding extra sites, stretch flagship device performance and offer more deployment flexibilities for most technical demanding scenarios. It is also vital to enhance users' 5G experience by targeting improved battery performance for any 5G device, including smartphones, wearables, AR/VR glasses.



Join the journey towards high-performing programmable networks together with Ericsson

Ericsson's innovative 5G Advanced software capabilities can support service providers in meeting their diverse business needs and attaining their goals. The unique Ericsson 5G Advanced solution to offer real time, AI-powered RAN driven by intents will help communications service providers (CSPs) achieve their goal of high performing programmable networks – a real breakthrough.



Authors



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Dr. Sibel Tombaz is responsible for the Profit and Loss (P&L) and life cycle of Ericsson's global 5G RAN product and is based in Stockholm, Sweden.

She leads her team in bringing innovative software solutions needed to successfully develop and deploy best performing 5G networks to meet the needs of both enterprise and consumer markets. These technologies continue to transform every sector and create positive change benefiting not only customers but society in general.

Tombaz joined Ericsson in 2014 and held positions in research and product management. She worked on 5G concept development, 5G use cases and energy performance of radio access networks. She also initiated and introduced award-winning Ericsson Spectrum Sharing solution which allows service providers to transition from 4G to 5G utilizing the same spectrum band – which has never been done until now.

Tombaz holds a Ph.D. degree in communication systems from KTH Royal Institute of Technology in Stockholm.



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Gabriel holds a Masters of Engineering and a Degree in Industrial Management & Organization from the Royal Institute of Technology, Stockholm Sweden, and also studied at Bond University, on the Gold Coast Australia. Gabriel is based in Stockholm, Sweden, where he lives with his family. Outside of work, Gabriel is a youth football coach and enjoys travelling, cooking, modern art, and spending time with friends and family.

In his previous role, Gabriel worked with Ericsson Open RAN offering, focused on the introduction of Cloud RAN to the Networks portfolio. Gabriel joined Ericsson in 2016 and has worked in commercial management, product development, and solution/technical sales support, with a common focus and passion for enabling customer success. Prior to Ericsson, Gabriel worked in both management consulting and engineering-driven companies focused on mining and metals and industrial productivity solutions.

Ericsson's high-performing, programmable networks provide connectivity for billions of people every day. For nearly 150 years, we've been pioneers in creating technology for communication. We offer mobile communication and connectivity solutions for service providers and enterprises. Together with our customers and partners, we make the digital world of tomorrow a reality.