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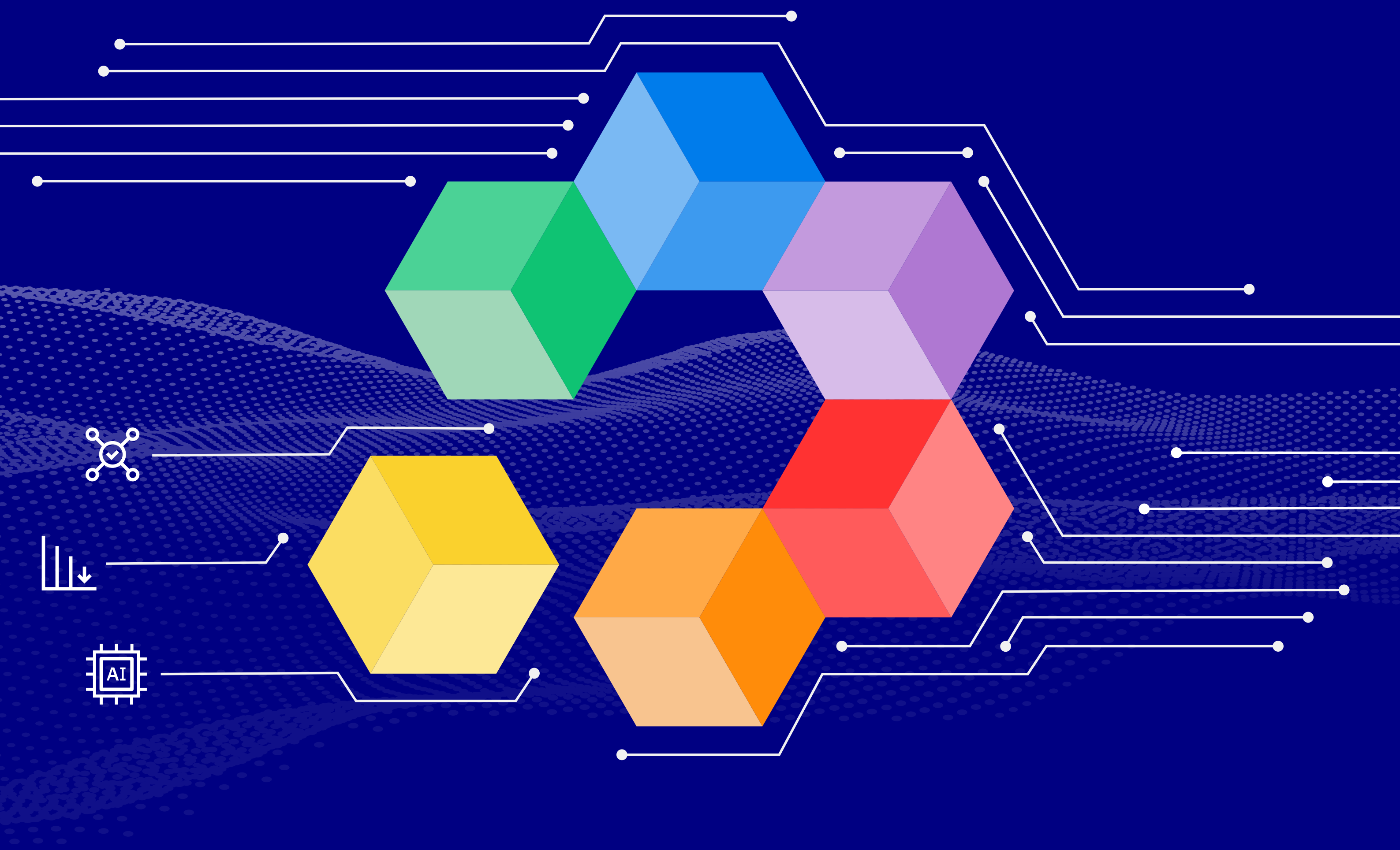
Intelligent optimization

How intelligent RAN automation will re-energize the SON market



Intelligent Automation Guide Series
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Introduction

Self-organizing networks (SON) began when LTE roll-outs started circa 2010. Ericsson's hybrid approach to SON allows SON use cases to be applied where most beneficial, which results in reduced opex and enhanced customer experience. However, the adoption of centralized SON (CSON) solutions was not as high as expected.

Communications service providers wanted to remain in control of the network parameter changes and were already using many different mature solutions to address parameter changes in network operations. With the introduction of 5G and the varying deployment architectures (purpose-built RAN and Cloud RAN/Open RAN), the complexity of network management continued increasing, with RAN automation becoming essential.

The intelligent ecosystem is enabled by the service management and orchestration (SMO) architecture, combined with the introduction of non-real-time radio intelligent controller (non-RT RIC) and artificial intelligence/ machine learning (AI/ML) capabilities. Pairing all of this together with the software development kit (SDK) availability, a world of new possibilities is opened to evolve and improve the CSON solutions into automation applications on top of the SMO platform. These are called rApps.

This guide will focus on centralized automation, including a background to SON and market development. We will explore the main service provider challenges in a multi-vendor and multi-technology environment, outlining how centralized automation will overcome these challenges by leveraging the SMO platform capabilities with the introduction of the non-RT RIC. Finally, we'll discuss the transformation of the Ericsson offering into an open environment for innovation and centralized RAN automation.

CSON background

SONs were defined by the Next Generation Mobile Networks Alliance (NGMN Alliance) in 2008 and standardized by the 3GPP in Release 8 to self-configure, self-optimize, and self-heal the LTE RAN network.

The initial SON drivers were:
- automation of repetitive processes
- improvement of runtime operations
- improvement of user experience and network performance
- reduction of opex, capex and complexity in RAN network management

In recent years we have seen an increased interest in sustainability as an additional SON driver.

SON functionality can be located at different levels in the network. This means there could be distributed SON (DSON) functionality embedded at the eNodeB level, or CSON functionality located at the network management level and managing an entire network of eNodeBs. A hybrid SON approach is also possible, with functionality at both levels and the CSON function acting as the coordinator and orchestrator.

An important consideration for the development of a SON function in the network is the need to evaluate the decision loop timescale. This timescale is determined by the need to average enough data in time to make good decisions and validate them, and the time it takes to execute the change.

A key zero-touch[1] principle is to maintain different decision loops to ensure stable conditions for both manual and automatic decision making. To further emphasize the stability and reduce work efforts, it is important to maintain consistent configurations across the network. These decision loops should represent all major activities needed for network management. Overall, zero-touch network management results in an effort reduction in each control loop thanks to automation and AI, which brings the effort of future network management close to zero.

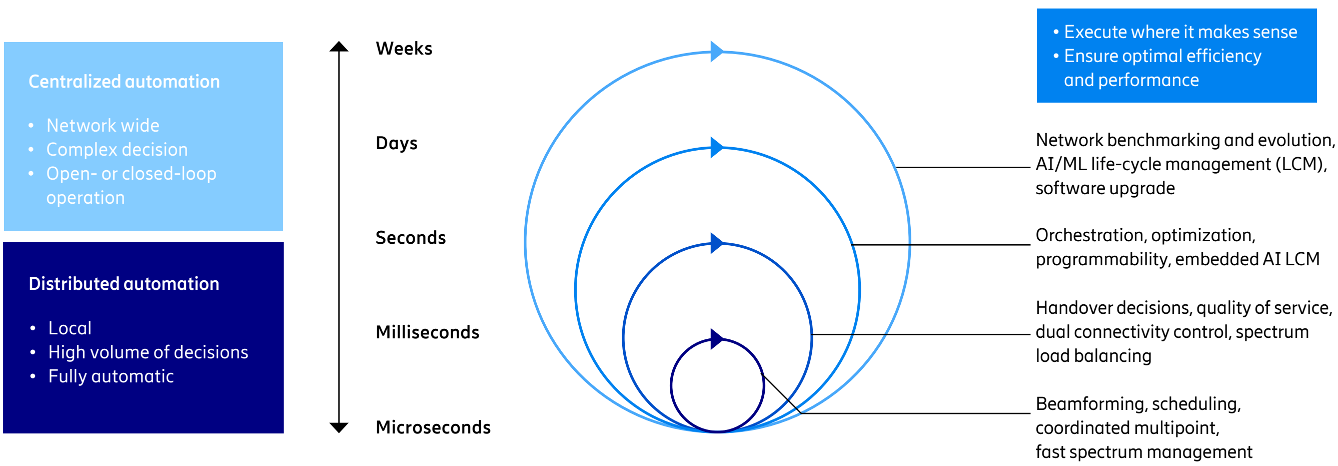
The fastest decision loops are performed in the network nodes themselves where SON functionality is an integral part of the node – called smart nodes – and these are mainly focused on self-configuration and traffic control. Mobility robustness (MRO) is an example of DSON functionality.

CSON functions typically take care of actions which require non-real-time decision loops of minutes, hours, days or even weeks. The CSON functionality is primarily meant for self-optimization, self-configuration and self-healing in a network-wide manner, providing automation and control ideally supporting a multi-technology and multi-vendor environment. Coverage and capacity optimization (CCO) is an example of CSON functionality.

As reported by LightCounting[2] as LTE started to grow, many service providers started to add a CSON located at the operational support systems (OSS) layer to manage entire networks of eNodeBs and act as a centralized coordinator of DSON and CSON functionality. This was the catalyst for creating today's CSON ecosystem.

It started with dozens of vendors including RAN vendors, SON specialists, OSS/BSS players and test and measurement companies, which has shrunk to around 10 active players today. The complexity and proprietary nature of the early CSON market meant that not every service provider deployed a CSON solution and as a result, software and services sales never grew to a significant level. The reasons for limited CSON adoption by some service providers include: the creation of in-house solutions; the outsourcing to service companies or finding the platform complexity; the lack of multi-vendor capability; and the proprietary nature of many SON applications off-putting operationally.

Figure 1: Automating where it makes the most sense



[1] Operations of the future: Reaching for zero-touch operations – Ericsson
[2] LightCounting Network Automation-SON-RIC Report – October 2020

Key challenges for service providers in a multi-vendor and multi-technology environment

Software applications with embedded intelligence and domain expertise are key to addressing the need for network operations automation. The rollout of 5G networks has increased operational complexity, despite 2G and 3G networks being dismantled. Automation is the answer, which also improves opex and sustainability.

Today, the automation platform and applications are often tightly paired, with the platform vendor also being the application vendor. Nodes from different RAN vendors are typically optimized by different platforms and applications. This adds complexity, increasing opex and causing data processing and storing inefficiencies.

Contrastingly, a service provider using a single platform and application vendor creates lock-in and increased dependency, reducing flexibility and vendor diversity. Swapping optimization application vendors involves the costly replacement of both the platform and application.

Openness

Openness is vital for centralized automation-type solutions. Service providers want to use their own algorithms for optimization or configuration purposes, and so SDK availability is key.

Open RAN technologies with common, standardized interfaces offer the potential to simplify centralized automation solution deployment on multi-vendor networks. It also enables single CSON solution deployment across any compliant vendor network using the A1, O1 and O2 interfaces. The proposed open R1 interface between the SMO non-RT-RIC enables rApp deployment across multiple SMO vendor platforms if required.

Service providers have a track record of developing their own solutions to optimize network performance and customer experience. rApp SDKs will allow service providers to use their own technology to optimize networks, and sell their rApps to non-competing service providers.

OSSii

The successful Operations Support Systems interoperability initiative (OSSii) began in May 2013 to promote OSS interoperability between different OSS vendors' equipment.

It simplifies interoperability between OSS systems, reducing costs and enabling shorter 5G time-to-market. OSSii also simplifies integration capabilities towards multi-vendor service provider's OSS systems, maximizing the use of autonomous technologies.

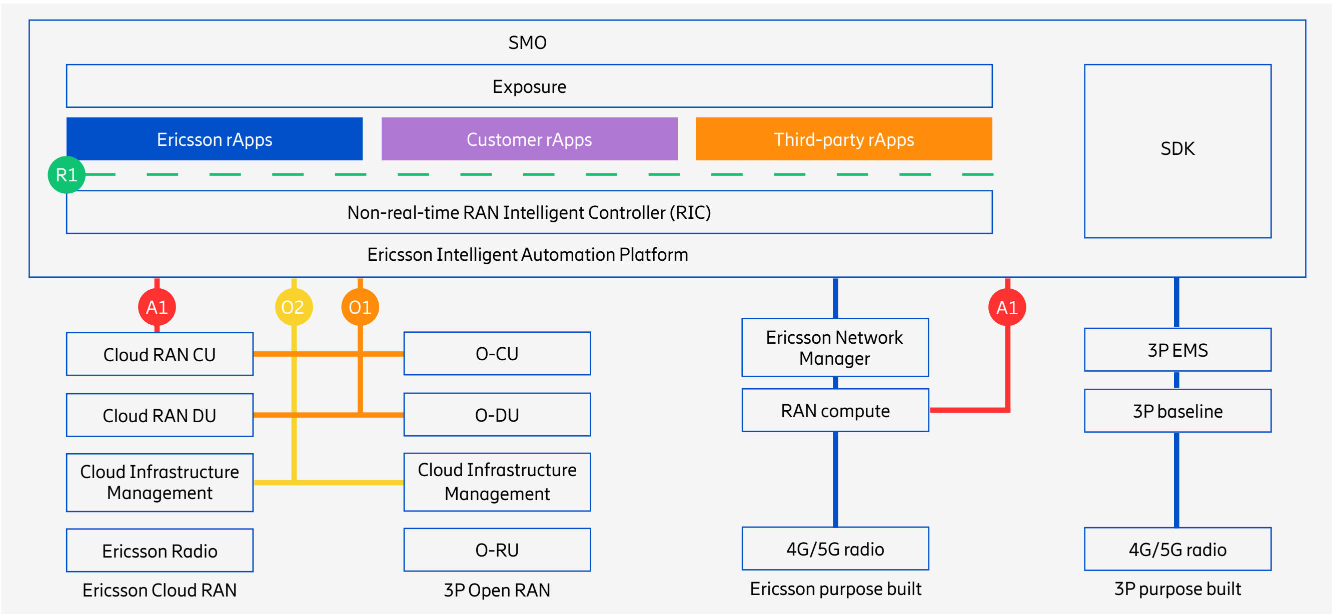
The Intelligent Automation Platform is Ericsson's new SMO entity. It includes a non-RT-RIC for running radio network applications (rApps) as part of Intelligent RAN Automation.

Currently, FCAPS (fault, configuration, accounting, performance and security) northbound interface is exposed over Ericsson Network Manager (ENM) through the OSSii channel to ensure SON ecosystem solution providers can receive the information required to develop the solution.

Benefits of OSSii to the SON ecosystem include:

- establishing the communication channel between Ericsson and independent software vendors (ISVs)
- Ericsson directly supporting ISVs in terms of the specifications and advanced change notifications
- supporting multi-vendor solutions

Figure 2: Key components of the Ericsson Intelligent Automation Platform SMO architecture for multi-technology, multi-vendor RAN



Centralized automation will leverage the SMO non-RT RIC

With the increased complexity balanced against new business opportunities, we see that automation in general – and the network-wide centralized automation in particular – is growing in both importance and the way it is used. Linking this with the raised demands for open and multi-vendor applications and use cases, we see that the current SON specification is not enough.

There are new automation use cases which don't follow any SON 3GPP standardization. The way we set and manage the policies in a network loaded with many automation algorithms plays a vital role in describing the overall automation level in a network. Add the increased need for AI and ML in these algorithms to flexibly handle a huge amount of data and predict future changes, and this is what we at Ericsson call "Intelligent RAN Automation".

Ericsson supports the original SON definitions, but we see the need to extend SON to address new areas of industry importance.

We have decided to utilize the Open RAN SMO architecture, including the non-RT RIC, to be the vehicle for carrying these centralized automation functions forward both for networks utilizing the new O-RAN Alliance's interfaces to automate Cloud RAN and Open RAN, as well as for existing, multi-vendor purpose-built RAN.

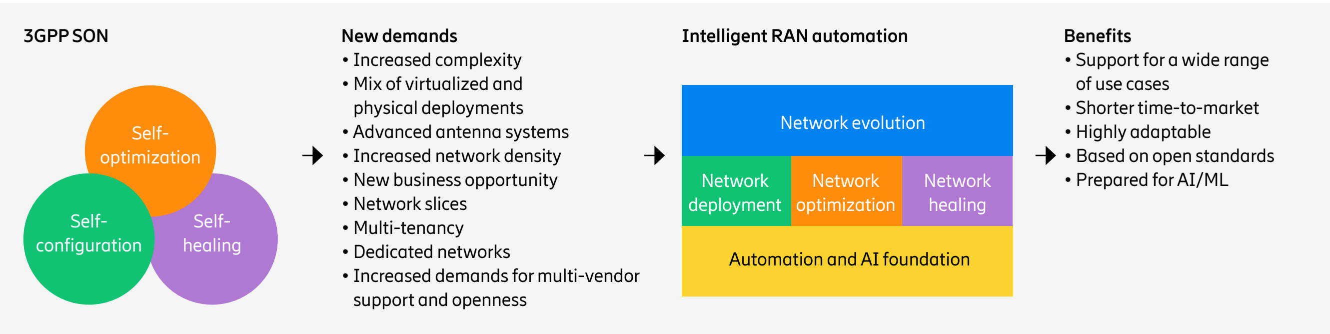
The SMO provides a standardized platform for automation applications, or rApps. The ability to evolve proprietary SON applications and platforms to open (eventually standards-based) SON rApps on a common non-RT RIC platform will kick-start widespread SON adoption globally.

At the top level, one common automation platform is required, with open and standardized interfaces, such as the Ericsson Intelligent Automation Platform.[3] This platform must interwork with different element manager systems and optimization applications from different providers. It will have the ability to deliver their functions to both the full network, or individual parts of it. The common platform must be cloud native and scalable, to eliminate the border effects of either geographical or vendor equipment, and will help service providers reduce maintenance costs and avoid lock-ins to specific providers.

The closed or proprietary approach to CSON didn't drive the creation of application ecosystems, and this made it difficult for service providers.

Achieving coordination of multiple optimization functions sat on different platforms requires significant effort and cost. Additionally, development and integration work must be customized to the specific platforms and functions present in the service provider's network. In this scenario, the coordination effort increases exponentially when new functions are added to the automation set. However, when an open platform hosts the optimization rApps, the coordination of rApp actions can sit centrally on the platform, making it much easier to maintain the ever-increasing set of automations.

Figure 3: Ericsson Intelligent RAN Automation goes beyond 3GPP SON



[3] Intelligent Automation Platform – Ericsson

Coordination of centralized automation functions

One of the key benefits of a common SMO platform is the ability to manage and orchestrate the priorities and hierarchies of potentially conflicting rApps:

- **Location/time-based prioritization –** coordinating CSON functions based on time or area. For example, one rApp takes priority when there is an outage for the affected area and for the duration of the outage.
- **Conflict management –** identifying potential conflicts between rApps. For example, two rApps proposing contradictory changes to the same network node in the same period is avoided.
- **Precedence management –** setting precedence of rApp changes. For example, a priority list is defined for the rApps and time windows in which those priorities apply.
- **Scheduled/pre-scheduled change management –** scheduling changes in sequence to maximize performance gains and avoiding performance degradation.
- **Resource management –** eliminating cyclic changes to the same node coming from different rApps.

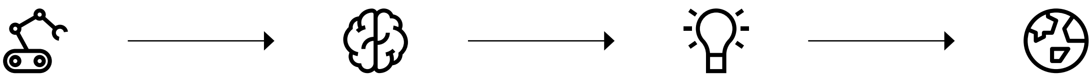
For application providers creating multi-vendor optimization applications, agreements such as the OSSii for the purpose-built RAN are beneficial, as this enables the sharing of information about the proprietary vendor interfaces in the existing RAN networks. However, not all existing vendors are part of the OSSii. Vendors would need to exchange additional information to build more complex optimization functions that require a deep understanding of the radio resource management techniques implemented by the different equipment vendors.

The adoption and standardization of O-RAN Alliance interfaces will minimize interoperability testing, as the nodes will be equipped with the specified interfaces (O1, O2, A1) that allow optimization application providers to build multi-vendor functions which make use of industry specifications.

A key benefit of a common SMO platform is the ability to orchestrate and coordinate actions towards the network.

SDKs can accelerate automation innovation, but must be built on a solid foundation of industry experience. Platform SDKs, such as the Ericsson Intelligent Automation Platform SDK, are much bigger than a set of APIs for development and integration. SDKs need to provide developers with everything required to build and take the application through the different stages in the most effective way, from development to production.[4]

Figure 4: Centralized automation with Ericsson Intelligent Automation Platform benefits



Architecture technology evolution
- Cloud-native, future-proof, microservice-based platform
- Seamless multi-vendor support for built-in purpose-built RAN based on standard interfaces

Enhanced functionality
- Coordination of CSON functions centralized policy control and orchestration to prevent RAN parameters conflicts between various rApps
- Built-in ML/AI capabilities

Flexibility and innovation
- Open APIs and enhanced SDK capabilities
- Enables ecosystems to develop CSON rApps
- Reduces time for prototyping and productization

More than increased scalability
- Consolidation in one platform for all automation functions across Ericsson
- Multi-MNS support

[4] Ericsson Intelligent Ecosystem Guide

Centralized automation evolution towards rApps in Ericsson's platform

Centralized automation applications are expected to be the early use cases for the transformation to rApps. Ericsson is in the process of consolidating various platforms on the Ericsson Intelligent Automation Platform and transforming the existing SON use cases from SON Optimization Manager into rApps. However, not all rApps will be CSON type.

We expect to see other use cases that go beyond the scope of CSON, such as the cognitive technologies use cases that will also be available in the form of rApps on top of the Ericsson Intelligent Automation Platform. Transforming the complexities of 5G network arrivals into opportunities, cognitive technologies blend large amounts of data with unique network domain expertise to deliver speed, scale, and accuracy in intent-based network operations. For more information, please refer to the recently launched Ericsson rApps.[5]

Intent-based networks enable service providers to define the behavior required of their network, such as improving network quality, for the system to then translate it intuitively into real-time network action. Through closed-loop automation that includes business intent capture, translation and activation, the network will continuously monitor and adjust to ensure alignment to the business intent – with minimal human intervention – whenever needed.

A good example of the functionality evolution throughout the automation journey is Remote Electrical Tilt (RET) optimization. This started with manual RET changes, moved into rule-based automatic RET optimization, and then evolved the functionality to apply ML techniques, such as the reinforcement learning model, to the optimization of passive and active antenna systems. The final purpose is to evolve to cognitive intent-based networks.[6]

Figure 5: The transformation of Ericsson's offering

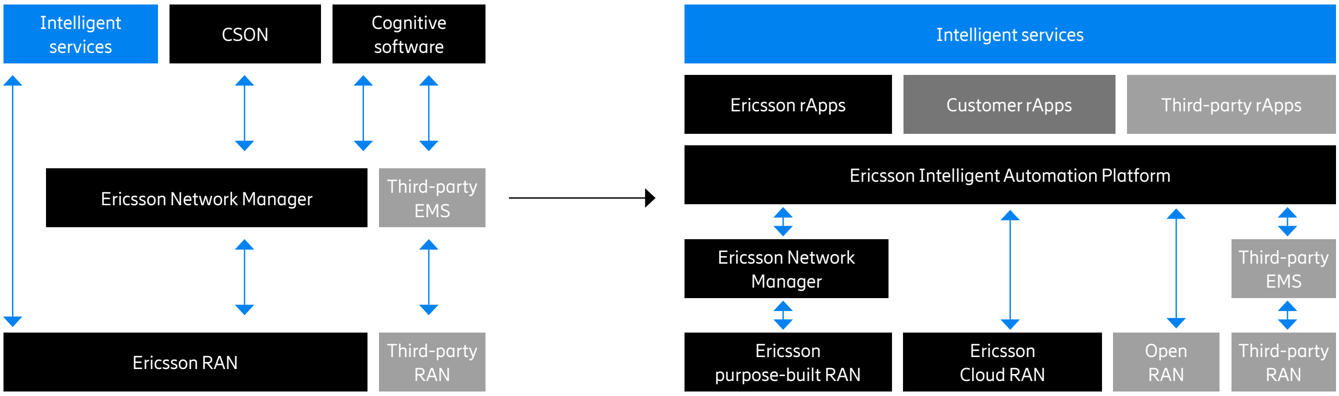
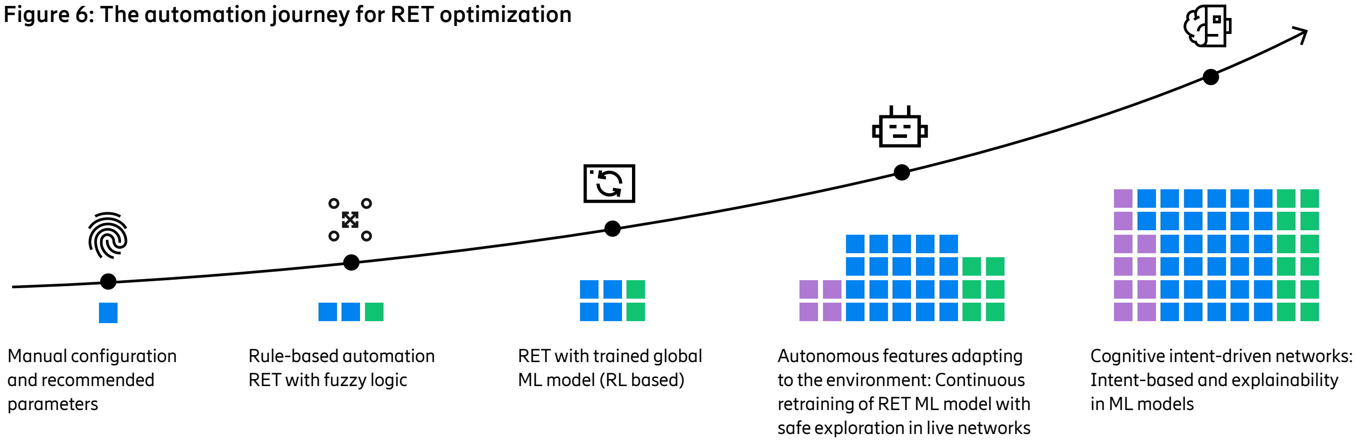


Figure 6: The automation journey for RET optimization



[5] rApps for Intelligent Automation – Ericsson
[6] Intent-based networks in telecom operations – Ericsson

Centralized SON benefits in numbers

The benefits of CSON functions are very much dependent on what one wants to achieve, as well as the network status where the function is applied. We have seen a multitude of improvements in several network optimization areas and in different networks. Some improvements can be achieved independently of each other, while others are mutually exclusive.

Individual function examples

- Automated Cell Outage Management: This use case is based on RET Optimization, so the functionality is to utilize surrounding sites and the cells they provide to offer the best possible area coverage despite outages. It is a valuable function in situations such as natural disasters, where parts of the overall network are down and when reaching others to inform them about the situation is vital. The more common use case is still in "normal" outage situations where different network outages can be automatically compensated without manual intervention, avoiding unplanned site visits.
- Frequency Layer Manager: This is where several different frequency bands need to be utilized in the optimal way to ensure a positive experience for the network end users. The algorithm will coordinate policies for the LBDAR profiles (LBDAR stands for load-based distribution at release) controlled centrally, as well as settings for idle mode mobility and load-balancing features controlled in the RAN itself. The framework also provides estimations of how contiguous each frequency layer is in each area and where capacity expansions are needed (such as when high load cannot be alleviated with further optimization).

Figure 7: Automated Cell Outage Management functionality

Removing manual work in the NOC and unplanned site visits:
- More than 1,200 hours of outages compensated for a month
- "A great help for a well-staffed and prepared service provider, a revolution for the unprepared"

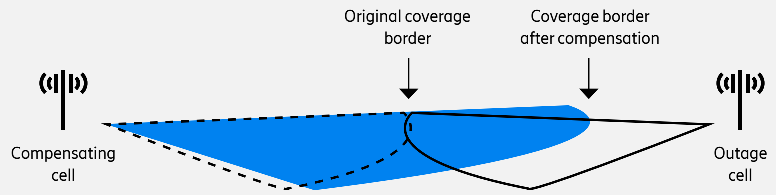
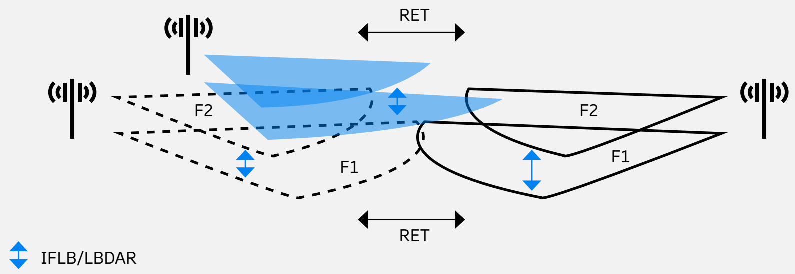


Figure 8: Frequency Layer Manager results

Based on real outcomes in a North American service provider's network:
- 10 percent reduction of unhappy users not receiving target throughput
- 12 percent improvement in sector throughput



Conclusion

This guide has outlined the clear benefits of evolving CSON solutions to rApps using an SMO non-RT RIC architecture that can support multi-vendor and multi-technology networks. Ericsson will evolve solutions such as CSON and cognitive software onto its SMO platform, the Ericsson Intelligent Automation Platform.

This evolution will enable not only the adoption of the Open RAN SMO concept, including the non-RT RIC architecture, but will also leverage the new and improved capabilities that this latest platform and ecosystem will bring. Examples include cloud native-based platforms, SDK availability, openness, and AI/ML functionality that rApps developers could utilize to improve existing use cases and develop new ones.

In this regard, traditional CSON vendors have an advantage to new players that want to enter the SMO non-RT RIC market. Omdia[7] forecast is that the traditional CSON market will be flat in 2021 and 2022, supported by 5G and NSSMF use cases, but expect it to decline from 2023 onwards, as spending will shift toward the SMO-based RIC. The expected growth is based in RIC, and rApps will lead to strong growth in the overall CSON and RIC market in 2022 and beyond.

According to Omdia, service providers are demanding a higher level of network automation for management and optimization. This is not new, and we are all aware of the complexity in managing the networks of the future with 5G introductions that put the focus on RAN automation. The need for AI/ML techniques, however, is indeed new and will be increasingly important. It will allow network management to move from reactive to predictive, solving network issues before they affect customer experience.

The CSON evolution into rApps is the starting point of the intelligent optimization revolution we will see in the coming years. This includes an ecosystem that will not only evolve current CSON solutions, but will also stimulate new rApp development (with the latest players), collaborations such as those ongoing between Ericsson and Infovista and Viavi.[8] Further, there's the utilization of new data sources that will enrich the optimization of the networks of the future.

Ericsson has ample experience in developing excellent optimization use cases across different solutions and services, and we will leverage this experience for the evolution to Intelligent RAN Automation with the new Ericsson Intelligent Automation Platform.

[7] Omdia Self-Organizing Networks and RAN Intelligent Control Analysis, 2021
[8] Intelligent Automation Platform – Ericsson

About Ericsson

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.
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