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Intelligent innovation

How open interfaces are driving innovation

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Introduction

Intelligent innovation accelerates rApp ecosystem development and rewards innovators for their contributions. Intelligent RAN automation with service management and orchestration (SMO) provides a significant industry opportunity to drive this rapid, profitable innovation.

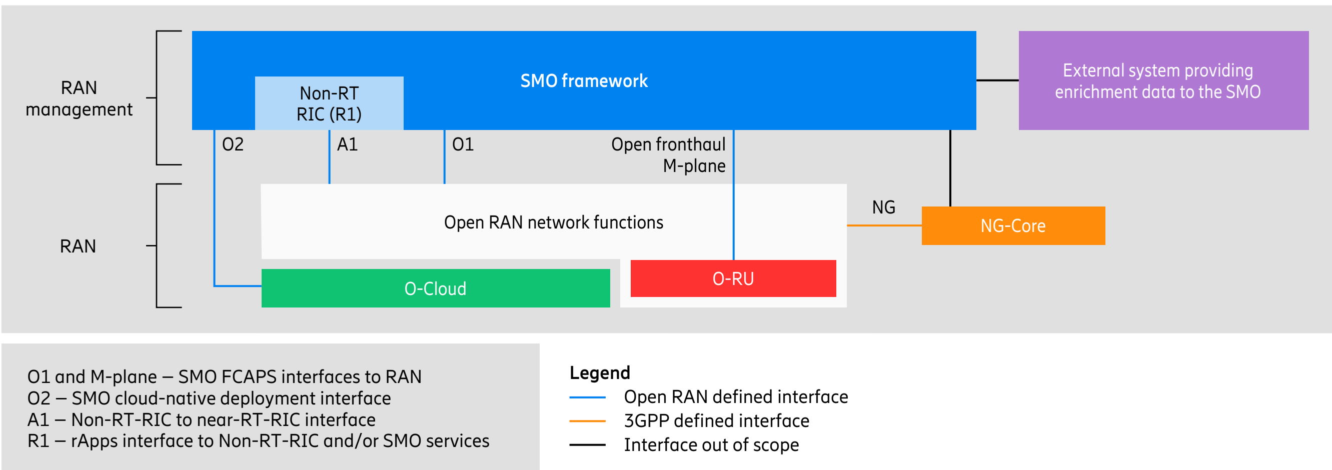
5G and 5G evolution enables open innovation, supporting the digitalization of society and powering the digital transformation of industries including small and medium-sized enterprises as well as enhancing consumer experience. This platform for growth is being used by innovative companies worldwide.

Instead of a traditional vertical network setup, networks are evolving to become more dynamically adaptable. Network functions and applications run on top of cloud-based platforms to optimize performance, cost, and business agility. This transformation is enabled through the horizontalization of the network architecture, where distributed cloud resources and open interfaces such as Application Programming Interfaces (APIs) offer the programmability and flexibility needed.

In future, interfaces supporting horizontalization will become increasingly important multi-vendor interfaces. They will need to be specified using best practice, including the use of traditional standardization processes (used in forums such as 3GPP and O-RAN Alliance), open source initiatives and open APIs. However, it will be important to balance these standardization activities against innovation opportunities. Standardized interfaces should always create good business value that outweighs any potential deployment delays due to new innovations and performance improvements.

A prime example of the horizontalization of network interfaces is the creation of a network automation framework based on O-RAN Alliance specifications. The framework consists of an open SMO framework and automation applications (or rApps) using the platform. This open framework will allow application developers to leverage global ecosystems such as artificial intelligence/machine learning (AI/ML) and enterprise use cases.

Figure 1: The network automation framework based on O-RAN Alliance specifications



Source: O-RAN Alliance architecture

Balancing standardization and open innovation

A **standardized interface** is an agreement between a multitude of stakeholders such as 3GPP Uu interface.

A **published interface** or API such as Google Maps is owned by a single company or entity with the right to change or alter that interface at will.

In mobile communications, open multi-vendor interfaces are used to create the industry ecosystem. These interfaces may be standardized in technical bodies and verified via extensive interoperability testing. From a technology perspective, a company can focus on developing subsystems enclosed by open multi-vendor interfaces that are guaranteed to interwork with other externally built subsystems. Innovation can be done freely and independently within a domain as long as the open multi-vendor interfaces are left intact. From a business perspective, a company can form its business around standardized domains, interacting with its customers, suppliers, and partners in a many-to-many ecosystem over the open interfaces.

Traditionally, multi-vendor interfaces in mobile systems have been created by formal standardization, where industry partners jointly develop technical specifications for later implementation. This method has proven to be extremely successful, as demonstrated by the success of 3GPP in developing mobile systems for 3G, 4G and 5G over three decades. While this route is still attractive for hardware-implemented interfaces, software-based interfaces are more commonly specified using a reference implementation. Future mobile systems are expected to use all methods of specification when creating multi-vendor interfaces: standardization, open-source projects, and API publication.

Perhaps the best example of a successful standardized open multi-vendor interface is the Uu interface between the 3GPP user equipment (such as a mobile phone) and the 3GPP base station. After successful interoperability testing, any terminal manufacturer building their device according to 3GPP specifications can expect their terminal to work over the radio interface (Uu interface) with any 3GPP-compliant base station.
APIs are typically defined at the application level to enable connections between different applications. They are widely used in the mobile ecosystem. Some of the world's most used APIs, such as Facebook and APIs provided by Google Maps, are present in almost all mobile phones.

Creating open multi-vendor interfaces leads to both benefits and drawbacks
A good multi-vendor interface supports a many-to-many business relationship, stimulates competition, and prevents vendor lock-in. It also allows for the re-use of investments/technology across industries by horizontalization.

However, a multi-vendor interface can be slow and difficult, requiring industry-wide innovation initiatives. Once deployed, it can be difficult to update or change – and if poorly designed, it can be costly and difficult to fix. Open multi-vendor interfaces also have a high industry cost for specification, development, and testing – too many can lead to incompatible products on the market and high system integration costs.

Due to the compromise needed between varying algorithmic solutions developed by different vendors, there is also a risk of sub-optimal performance over the interface. For example, a radio resource management algorithm from vendor A that is optimized using a specific set of inputs (if the interface peer was also from vendor A), will need to work with a different set of inputs (from vendor B, for example).

Examples of good open multi-vendor interfaces
A quality multi-vendor interface supports a many-to-many business relationship.
- Example 1: Many-to-many relationships between content providers (such as Facebook, Amazon, Google) and mobile service providers.
- Example 2: The 3GPP open multi-vendor interface S4 enables many-to-many roaming business relations between mobile service providers.

Open multi-vendor interfaces stimulate competition and prevent vendor lock-in.
- Example: The 3GPP open multi-vendor interface S1 enables a service provider to swap an existing packet core vendor without changing the radio network.

A good multi-vendor interface may lead to horizontalization and re-use of investments/technology across industries.
- Example: Open multi-vendor transport-infrastructure interfaces mean transport technology for wide-area networks can be reused by the mobile industry.

Open interfaces in the future networks

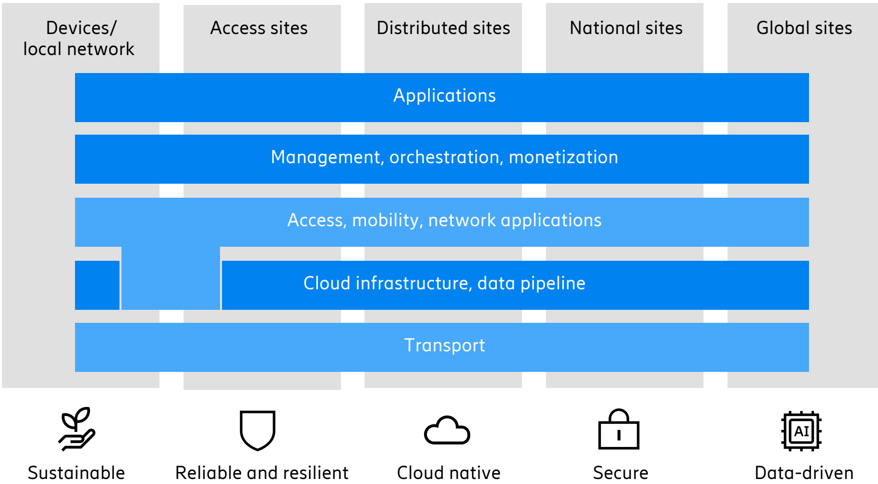
Future networks will provide a platform for open innovation, and an open platform will be used by innovative companies worldwide to launch the best applications needed to digitally transform society, industries, and consumer experiences.

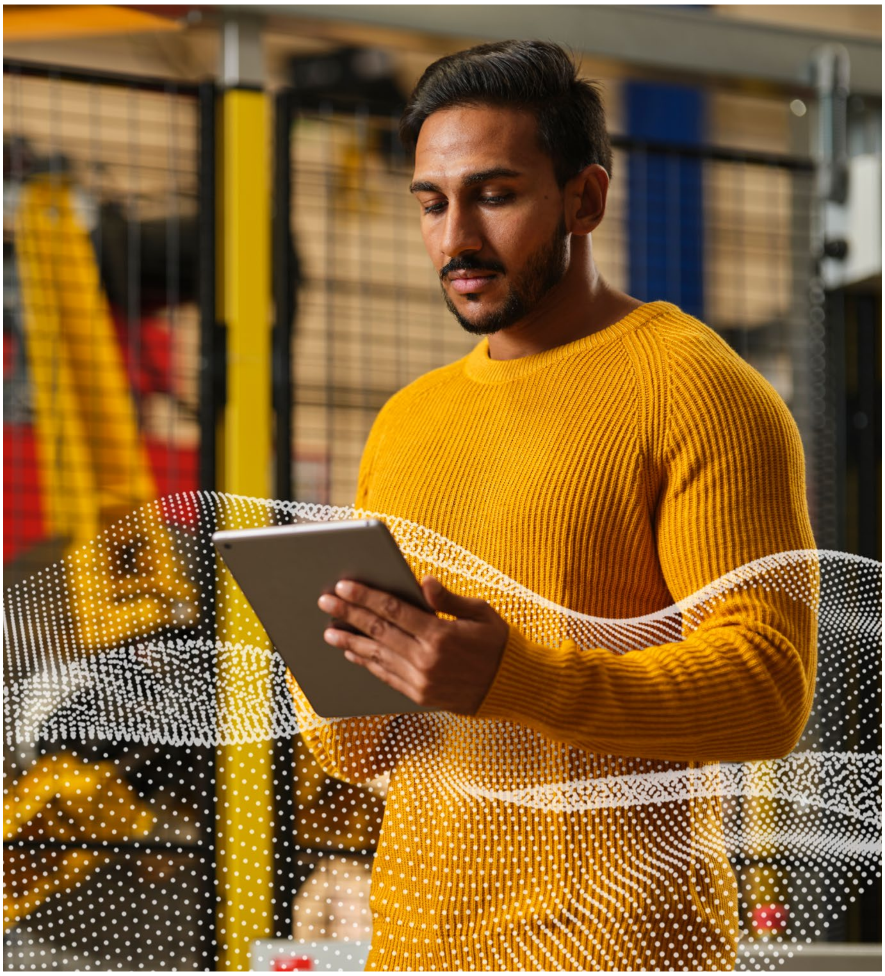
At a high level, we foresee the following horizontal functional domains in future networks:

- "Applications" containing network external applications and that utilize the network for communication, execution, and storage.
- "Management, orchestration, monetization" containing functionality to manage and control the network as well as running the business management of customers to the network. It also contains the exposure between network functionality and external applications.
- "Cloud infrastructure, data pipeline" containing functionality for secure processing and storage of both network functionality as well as application functionality. The data pipeline supports all network domains with collection, storage, distribution, and processing of data.
- "Access, mobility, network application" containing functionality securing all types of access as well as network integrated applications.
- "Transport" containing functionality for transmission and transport primarily between sites but also within sites.

For open innovation, the most important domains are "applications", "management, orchestration, monetization" and "cloud infrastructure".

Figure 2: A high-level overview of horizontal functional domains in future networks





Management, orchestration, monetization

Management of the virtualized environment and new services becomes even more important when all services need to be managed in real-time. This dynamic and competitive environment requires network management and supporting systems to be:

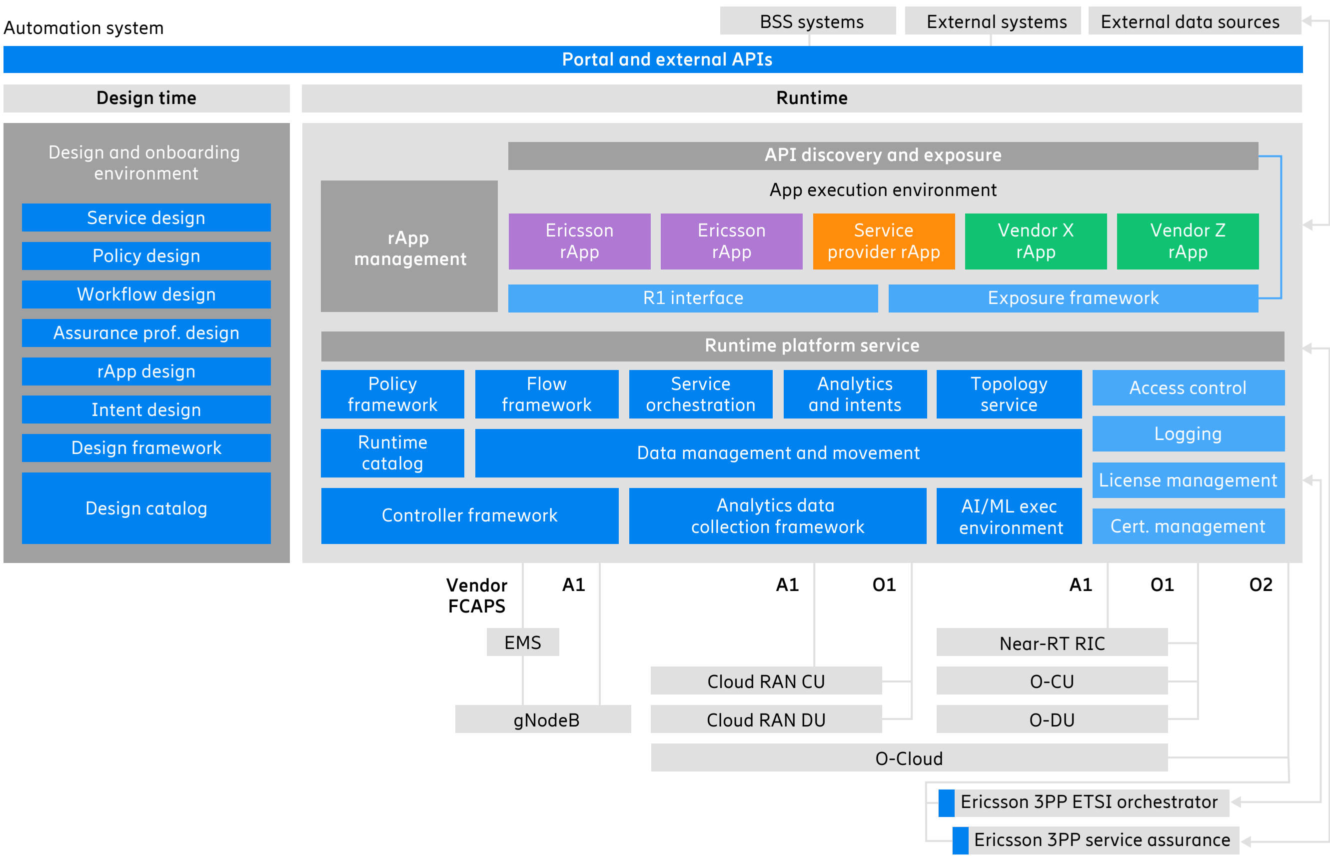
- less expensive to manage and maintain
- self-provisioned to drive down costs in an instant-access, cloud, and application-driven world
- flexible and modular to support 'network slices' and 'micro services' for new use cases driven by market needs
- deployable at speed to roll out new services with 'zero-touch' fulfillment
- scalable, with an agile IT operational model
- able to bridge the physical and virtual environment

A future reference architecture will be based on the following founding principles to support a real-time management environment of the ecosystem:

- an open architecture
- a micro service-based architecture
- data-centric applications where the application logic should have control on how, what, and when the data can be exposed
- support and expose open APIs to allow easy access to management data
- use of software development kit (SDK) (development runtime, tooling, documentation, and reference applications) where applicable
- repository of reusable, deployable, and runnable applications (that can be further integrated and/or extended)
- a platform-agnostic execution environment

Major functional components are used to realize automation. This view captures a design-time set of functions (SDK) and a run-time set of functions (all others) that will interwork to realize the automated life-cycle management of network functions and services. Service orchestration functionalities are at the foundation of the architecture to enable service- and intent-based automation. Machine learning capabilities are present to enable intent-based automation capabilities.

Figure 3: The Ericsson Intelligent Automation Platform



Case study: Openness and innovation to automate the RAN

Network automation
Automating a network includes the radio resource handling and telecom operations process specifics. The ecosystem goal is to lead the telecom industry to a single industry architecture, avoiding fragmentation.

Automation solutions must respect the standardized interfaces and include a migration path from existing networks, which requires separating industry-agnostic components. In turn, this allows more focus on value creation in industry-specific applications, leveraging outside-telecom investments in general automation components.

By standardizing network data and automation control loop interfaces, automation applications can be developed to work in open mobile networks. A successful standard must maintain stability. Where layer two (scheduling, beam selections) and layer three (handovers and mobility) are fully automated, a standard must not interfere with the existing 3GPP control loop hierarchy.

SMO architecture
At Ericsson, we have implemented key interfaces and components from the Open RAN SMO architecture in our Intelligent Automation Platform. These interfaces are defined and published by working groups, potentially becoming an open source project – or industry standards – in their own right.

We have also extended the non-real time RAN Intelligent Controller (non-RT RIC) concept beyond Open RAN and Cloud RAN automation to include existing 4G and 5G purpose-built RAN networks from any vendor. This means the Intelligent Automation Platform is both a multi-vendor and a multi-technology platform.

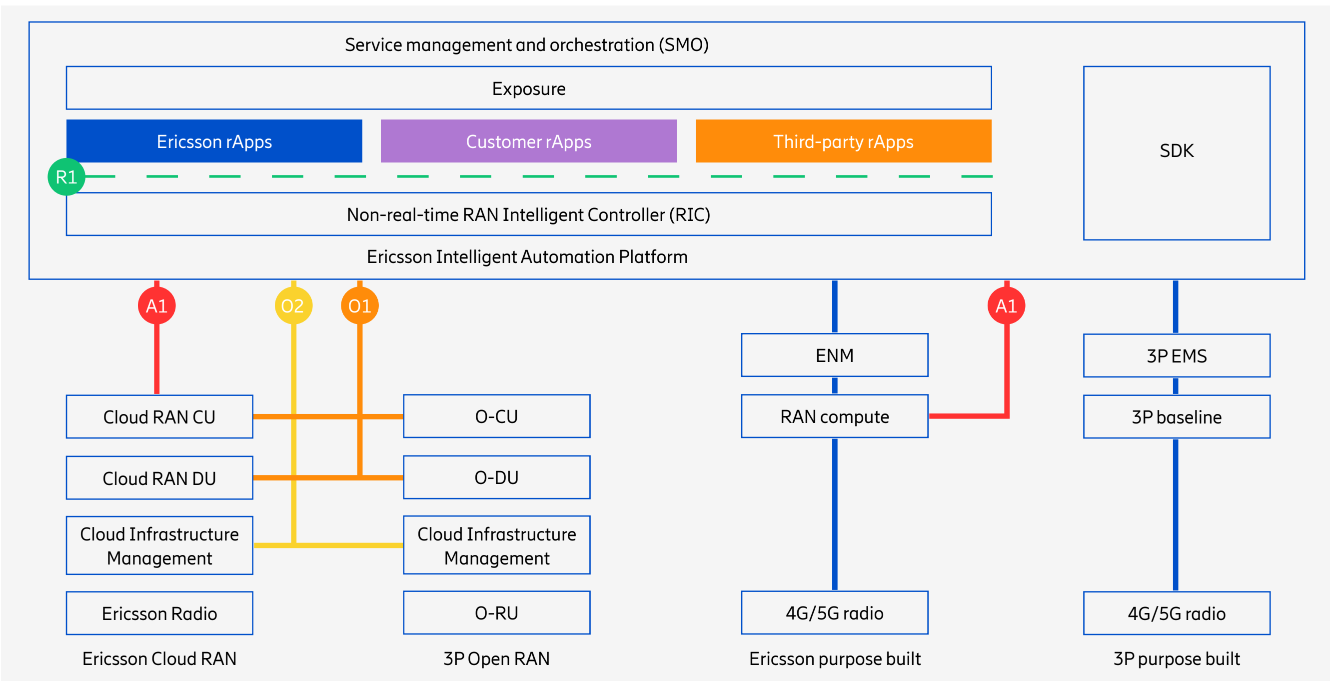
Open interfaces
The Ericsson platform supports open interfaces A1, O1, O2 and R1, which secure the RAN automation applications, or rApps, that interwork with the network regardless of RAN supplier mix. The platform provides a safe, feature-rich rApp execution environment that enables diverse RAN automation use cases.

The platform supports vendor-specific FCAPS interfaces (fault, configuration, accounting, performance, and security) to Ericsson and third-party equipment management systems (EMS) and a series of northbound interfaces. Arguably the most interesting interface driving innovation and interoperability between rApps is the R1 between the non-RT RIC, Ericsson, the service provider and third-party rApps.

The open R1 interface drives innovation
An open R1 interface enables rApp portability. Once the O-RAN Alliance completes specification, the interface should be published and standardized to reduce the need for rApp interoperability testing across different vendors' SMOs.

For an rApp developer, a standardized R1 interface increases opportunities to monetize specific rApps which are not locked to a specific vendor. Ideally, the R1 interface would allow out-of-the-box interoperability but in reality, a level of simple interoperability testing and certification is expected.

Figure 4: A high-level architecture of the automation platform



Network automation innovation framework

rApp innovation framework
One key aspect of the horizontal architecture of the O-RAN Alliance SMO is the ability to expose network capabilities to application developers through a set of well-defined APIs. The O-RAN Alliance specifies a set of those capabilities through the R1 interface. This interface exposes execution capabilities that rApps will consume on top of the SMO, and data collection and network actuation capabilities allow the rApps to interact with O-RAN Alliance-compliant nodes.

The rApp innovation framework used at Ericsson is a good example of how open innovation can occur using non-standardized technology. By publishing and making our rApp SDK widely available, we are providing a platform for open innovation that is owned by a single company with the right to change or alter it.

rApp development using open SDKs
The platform SDKs are much more than simply a set of APIs for development and integration. SDKs need to provide developers with everything required to build and effectively take the application through from development to production. Built on a solid foundation of services, the platform is cloud native (deployed on Kubernetes) and provides a defined architecture, making it easy to understand how rApps can be structured. In addition, published interfaces to integrate with logging, authentication, certificate management and data movement for example, allow developers to focus on the business logic and deliver the key value of the use case.

With some industry standards still under definition, the platform takes a leading approach in pushing forward these interfaces based on the re-use of open source components. With our extensive industry knowledge, we are driving key use cases on the platform, ensuring the APIs are industry-grade.

Developers who are experienced in cloud-native development, including microservices, can re-use the industry-standard information along with Open RAN knowledge to push the boundaries of automation.

Ericsson Intelligent Automation Platform APIs
The Ericsson Intelligent Automation Platform SDK offers developers a suite of APIs in the following areas:

- AI/ML training and execution – AI/ML model life-cycle management, execution, and a training environment.
- Analytics data collection – raw data in a file or stream-based format. Standard collection interfaces for fault management (FM), performance management (PM) and others will be provided and supported out of the box.
- Analytics insights – analytics processing capabilities to enable valuable insights into network behavior and performance.
- Base services – general features every rApp requires to provide the best usability and seamless integration in the platform, such as logging, user management, certificate management, user interface and portal capabilities.
- Data management and movement – infrastructure supporting the transit or sharing of data in the platform, as well as various persistence technologies.
- Design and onboarding environment – easy tools to design, build and package applications. When ready to launch, the onboarding process can help validate, deploy, configure, and monitor the app.
- Controller framework – using the open standard R1 interface, this enables parameter configuration on managed elements and uses an events-based API to be easily notified of changes in an application and act on it in near real-time. Abstracts complex details of the underlying system to allow developers to focus on their use case.
- Inventory and topology – near real-time source of truth for inventory and topology.
- Policy design and execution – design and execution for policy handling using multiple engines.
- Service orchestration – TOSCA-based orchestration engine to support declarative orchestration of end-to-end services through ETSI-MANO resource orchestrators.
- Workflow execution – realization of flows of activities that orchestrate system functions and capabilities in a flexible manner, supporting the design and creation of new use cases.

By publishing an rApp development SDK and making it available to the wider industry, we aim to drive open innovation.

Conclusion

Intelligent innovation is about balancing an optimal mix of standardization and proprietary development. Future networks will rely heavily on open interfaces designed to improve interoperability and reduce operational costs.

In the future, open interfaces and APIs supporting horizontalization will become multi-vendor interfaces. Open interfaces need to create business value that is not outweighed by either the cost and overheads associated with standardization, or the risks associated with control and ownership by a single entity.

Four key principles of 'good openness'

1. Backward compatibility – implement standard interfaces with a migration path to existing technology
2. Reward investment – reward innovation and value creation, as creators and contributors need to be able to monetize their work
3. Optimized standardization – avoid artificial constraints through over standardization, but leverage the benefits of well-defined and published APIs
4. Unified architectural approach – encourage a single industry architecture through collaborations and avoid regional technology splits, such as GSM and CDMA

The Ericsson approach to SMO is an example of 'good openness'. The SMO domain is being developed collaboratively with the O-RAN Alliance, 3GPP, Cloud Native Computing Foundation (CNCF/Kubernetes) and the Open Networking Automation Platform (ONAP).The O-RAN Alliance architecture specifies several key interfaces including A1, A2, O1, O2 and R1, which will aid multi-vendor interworking.

The expectation is that once specified, these interfaces will be published either as an open source project or standardized through an organization like ETSI. Standardized interfaces will enable multi-vendor RAN network interworking and stimulate the rApp development communities.

Ericsson is also taking an alternative approach to openness with its Intelligent Automation Platform SDK. The SDK will be made available to service providers and third-party developers to simplify and accelerate rApp development. The SDK will utilize the open R1 interface, but the toolkit will remain under the control of a single-corporate entity to enable faster changes and enhancements that will drive the growth of rApp ecosystems.

This is intelligent innovation: using the right mix of standardization and company-specific IPR to maximize innovation.

References and further reading

1. Press release – Ericsson joins O-RAN Alliance 04 Feb 2019
2. Blog – How open development ecosystems drive rApp innovation 10 Nov 2021
3. White paper – SMO enabling intelligent RAN operations 02 Nov 2021
4. White Paper – Open standards: Together we innovate 18 Dec 2019

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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