ONAP 5G

Blueprint Overview

ONAP Promises to Automate
5G Deployments

OVERVIEW:

- 5G poised to transform the global economy
- ABI Research predicts 5G economic output to be $10T by 2035
- 5G is characterized by faster broadband, machine-to-machine/IoT communication, and reliable low latency

CURRENT PROBLEM:

- To satisfy expected demand, current LTE Radio technology would require 10x number of RF heads
- Order of magnitude greater network service lifecycle management and RF/ network optimization complexity
- Edge automation required to support hybrid radio and new applications

SOLUTION:

- ONAP 5G blueprint will developed over multiple releases
- Key initiatives include PNF support, network slicing, network optimization and lifecycle management
- Implementation compliant with standards such as 3GPP, IETF, and TM Forum

Overview

The move from 4G to 5G is well underway. The true promise of 5G is not just the 50x more speed, 10x lower latency, and 1000x more capacity[1], but that it will dynamically support multiple different services concurrently.

This combination of capabilities will transform the global economy by unlocking new use cases such as immersive media, autonomous vehicles, smart factories/cities/buildings, connected health, farming, next generation education, and others. In fact, use cases such as agriculture, healthcare, and education are likely to accelerate in the COVID-19 era. Unlike previous generations, 50% of the data generated in 5G will be through IoT devices. With these new 5G applications, ABI Research predicts that the total 5G economic output by 2035 will be $10T.

Average Internet Use 1.5 GB/day	Autonomous Vehicles 4 GB/day	Connected Planes 5 GB/day	Smart Factory 1PB/day	Cloud Video Providers 750PB/day

Figure 1: Mobile Network Data by 2020 For Sample Applications[2]

[1] Cisco VNI Forecast and Methodology, 2016-2021

[2] "Network of Tomorrow — 5G and Edge" presentation at Open Networking Summit Europe 2018

Some key technologies in 5G are:

- **eMMB (enhanced mobile broadband):** Promises to provide broadband capability to users with a peak data rate of 20 Mbps enabling services such as immersive video.

- **uRLLC (ultra-reliable low-latency communications for a remote device):** Guarantees sub millisecond response times enabling services such as industry 4.0, remote surgery, AR/VR, and rescue and smart car applications.
- **MMTC (massive machine-type communications):** Supports 1 million devices per square km (2,589,000 devices per miles2) enabling applications such as autonomous vehicles, machine-to-machine (M2M) applications, and IoT.

These new use cases and technologies bring with them a level of dynamic network behavior unlike previous generations of wireless technologies.

Problem

The level of dynamic behavior stems from different applications requiring different levels of latency, reliability, availability, mobility, bandwidth, and cost. For example:

Autonomous vehicle	Low latency, high mobility
IoT	Low cost, low bandwidth
Factories	High reliability, low mobility
Video	High bandwidth, variable latency

Table 1: Different 5G Applications Have Different Needs

The core technology that supports these diverse requirements is called network slicing, that per 5G.co.uk is the ability to “provide dedicated virtual networks with functionality specific to the service or customer over a common network infrastructure”. Furthermore, the environment becomes even more dynamic with the need to deliver edge computing applications to subscribers on-demand.

To support 5G networks, network automation becomes a key consideration, and the following new requirements emerge for the management and orchestration (MANO) layer:

1. **Network Slicing:** End-to-end network slicing requires a communication service management function (CSMF) that relates to the customer service and generates allocation requests for a slice instance and the network slice management function (NSMF) that deals with the end-to-end slice. The NSMF communicates with multiple network slice subnet management functions, each for a specific domain such as RAN, core, or transport. Whether these layers reside within the MANO software or not is an architectural decision.
2. **Radio Access Network (RAN) support:** 5G requires some parts of the radio network to be implemented in the form of Physical Network Functions (PNFs). This means that a 5G network service will need to support both PNFs and virtual/cloud-native network functions (VNFs or CNFs[3]). In addition, the MANO layer needs to support functionalities such as Non-RealTime RAN Intelligent Controller (RIC) as specified by the O-RAN Alliance.
3. **Cloud Native Architecture Support:** Traditional network services and their constituent VNFs have been deployed in big datacenters. With 5G, both the 5G core and virtualized RAN will be highly distributed, and these components are increasingly moving towards a cloud native architecture that requires Kubernetes as an NFVI.
4. **Real-time analytics:** 5G networks need to optimize themselves in real-time in response to subscriber requests and network behavior. This means that real-time analytics will be required to influence lifecycle management actions such as scaling, fault management, performance optimization, and others.

Solution

The Open Network Automation Platform (ONAP) project automates 5G using software defined networking (SDN) and network functions virtualization (NFV) technologies.

ONAP is an open source project that provides a common platform for telecommunications, cable and cloud operators and their solution providers to rapidly design, implement and manage differentiated services. ONAP provides orchestration, automation, and end-to-end lifecycle management of network services. It includes all the Management and Orchestration (MANO) layer functionality specified by the ETSI NFV architecture; additionally, it provides a network service design framework and FCAPS (fault, configuration, accounting, performance, security) functionality. In addition to VNFs, ONAP can handle PNFs and CNFs, to help support a hybrid radio or the move to the cloud native respectively.

[3] PNF/VNF/CNF are jointly referred to as xNF in this paper for convenience

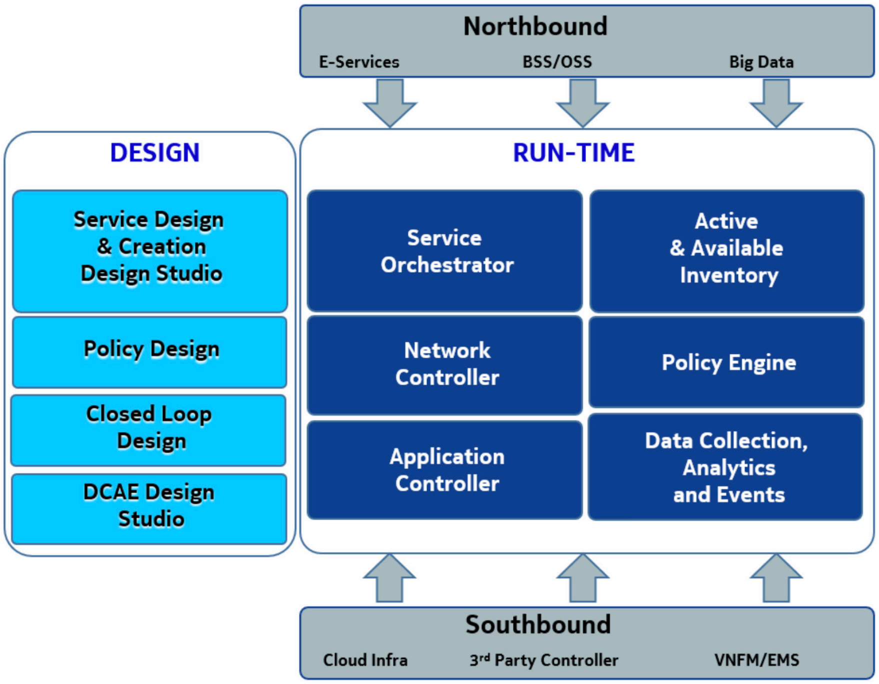

Figure 2: ONAP Functionality

The major 5G related ONAP initiatives include:

- End to end network service orchestration
- Lifecycle management
- Network slicing (modeling development and PoC)
- PNF auto-discovery (Plug and Play) & integration
- 5G network optimization

End to End Network Service Orchestration

The modeling work in ONAP (roughly 100+ parameters modeled) allows a designer to create an end-to-end 5G network service. These models are aligned with ETSI and 3GPP. An end-to-end service consists of the RAN elements consisting of the remote radio unit (RU), distributed unit (DU) (5G base unit), and centralized unit (CU) and core elements consisting of the 5G core xNFs modeled in TOSCA. The service can then be orchestrated including day 0 configuration by the runtime components of ONAP.

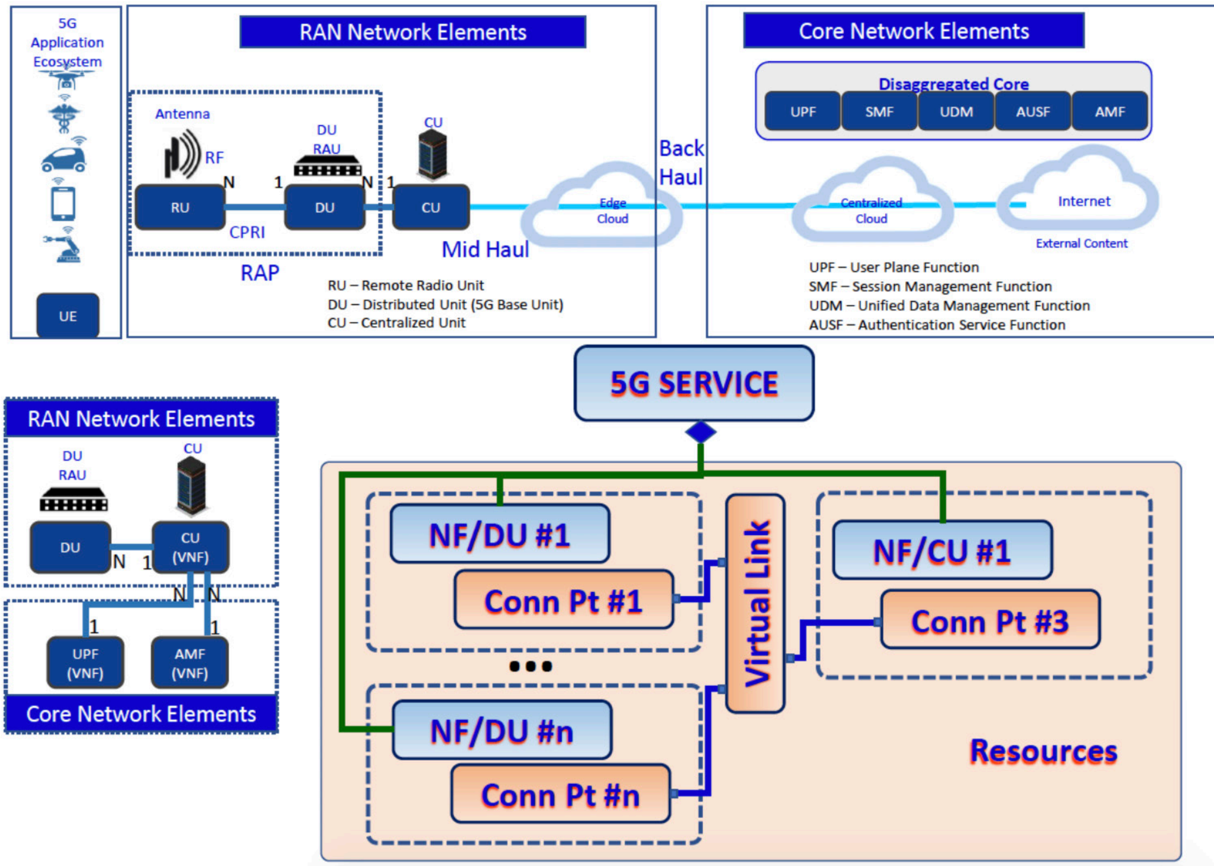

Figure 3: End-to-end 5G Service Design and Orchestration

Lifecycle Management

Once deployed, xNFs in a 5G network service need ongoing lifecycle management in terms of change management (updates, upgrades), day 1 or day 2 configuration, healthchecks, and more. ONAP provides comprehensive support for all lifecycle management tasks. For configuration, ONAP uses traditional mechanisms such as YANG/NETCONF/RESTCONF or newer ones such as REST APIs. ONAP can also perform lifecycle management by using REST APIs, Ansible playbooks, or Python scripts. ONAP already supports the O1 interface for O-RAN configuration with support for initial implementation of the A1 interface to the Near Real-Time RIC software in O-RAN for policy management available as well. Finally, there is also a Configuration & Persistency Service database in ONAP for persistency and querying purposes.

Network Slicing

ONAP includes modeling and orchestration functionality of a slice that includes 5G RAN, core, and transport network slice subnets. More specifically, ONAP includes workflows and user interfaces for communication service management function (CSMF) and network slice management function (NSMF) with an interface to an external network slice subnet management function (NSSMF). This functionality allows the design, orchestration/activation, and deactivation/termination of a slice. Subsequent releases will allow more sophisticated lifecycle management functions and incorporate certain NSSMF software components in ONAP.

PNF Integration

With 5G, CSPs need to deploy disaggregated 5G Radio Access Network (RAN) elements . Some of these network functions are virtualized, running on an edge cloud infrastructure while others are appliance-based or PNFs. ONAP supports the complete lifecycle management of PNFs. The various steps to support PNFs are:

- **Design time**
  - PNF modeling
  - PNF package compliance and validation
  - PNF pre-onboarding & validation
  - PNF onboarding
- **Run-Time**
  - PNF instance declaration
  - PNF bootstrapping
  - PNF discovery and registration
  - PNF activation
  - PNF configuration (using NETCONF)
  - PNF software upgrade

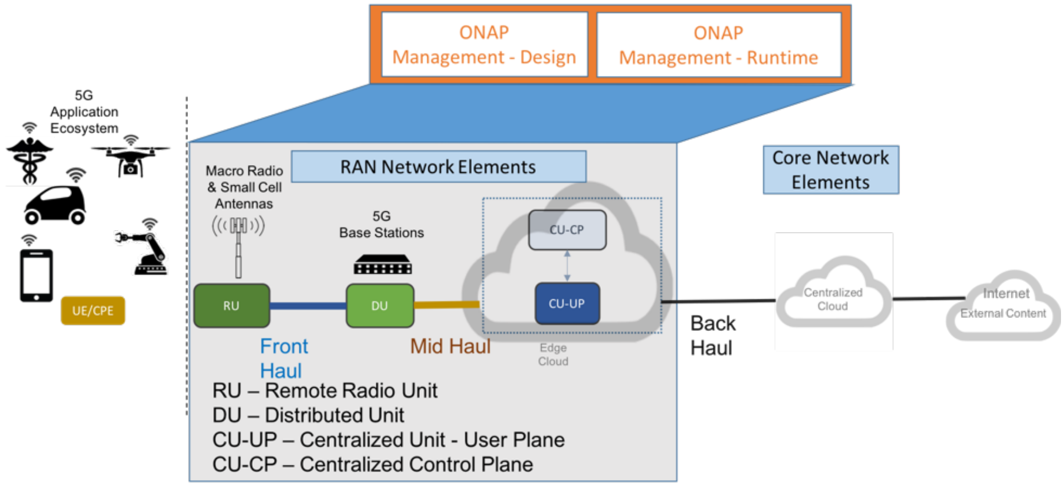

Figure 4: Disaggregated Hybrid RAN

5G Network Optimization

A CSP will need to, in real-time, optimize the performance of the 5G service. This optimization will require dynamic configuration of relevant 5G radio and backhaul network parameters. To date, optimization functions have been realized in 3G and 4G networks via vendor-proprietary hardware and software. ONAP enables the design and implementation of an open ecosystem for 5G optimization.

The list of network optimization ONAP features is:

- **High Volume Performance Management:** 5G requires real-time analytics for time sensitive Performance Management (PM) data delivered at frequent intervals (less than one minute) from a large number of edge locations. This analytics data is used to drive network and customer experience optimization. Until 4G, optimization algorithms have resided in network elements; ONAP will change that by absorbing these algorithms to unburden xNFs. This analytics capability will ultimately lead to AI/ML based algorithms that will fully automate the network.
- **Bulk Analytics:** 5G also requires batch processing of bulk PM data delivered less frequently (say every 5-15 minutes) for optimization purposes. A PM dictionary is used to standardize vendor provided bulk PM data.
- **Homing:** ONAP will find the best edge location for a given workload. Workloads include VNFs, edge analytics, and possibly edge computing (MEC[4]) applications. Homing includes considerations such as Physical Cell ID (PCI), Automate Neighbor Relations (ANR), Fault Management(FM)/PM data and RF optimization. ONAP also allows homing policies based on hardware platform awareness.
- **Scaling & Healing:** With the sheer increase in edge locations, it becomes important to automatically scale-in/out Centralized Units (CU) and other VNFs to provide a balanced network with the right amount of capacity. Self-healing goes hand-in-hand with scaling.
- **Edge Automation:** For all of the above reasons, it is critical to onboard and register edge compute locations with ease.
- **Self-Organizing Networks (SON):** SON includes self-configuration, self-optimization and self-healing; ONAP has developed a PCI (Physical Channel Identifier) collision and resolution solution as a SON microservice, with other analytic functions to come.
- **SDN Controller Enhancements:** To enable radio optimizations, a number of RAN specific enhancements are required around RAN information model, Policy interface, config/op databases.

In addition to these major initiatives, the community has also been active in harmonization of ONAP activities with standard definition organizations. ONAP is actively collaborating with the O-RAN Alliance (for O1 and A1 interface definitions), 3GPP (for data collection formats and network slicing), and ETSI (for model and package definitions).

[4] Multi-access edge computing

Implementation Details

While all ONAP projects contribute to 5G in some way, the below projects are especially noteworthy.

Project	Function
Service Design and Creation (SDC)	Design of an end-to-end 5G service Design of closed control loops Design of configuration and lifecycle management templates
Service Orchestrator (SO)	Implementation of new workflows such as CSMF, NSMF, and the adapter(s) to NSSMF
Active and Available Inventory (A&AI)	Schema support for 5G service design and slicing models
Data Collection Analytics and Events (DCAE)	Collectors and other microservices required to support the telemetry collection for 5G network optimization; this includes the O1 interface from O-RAN
External API	Support for new network slicing and other 5G related APIs
Use Case User Interface (UUI)	New dashboard screens for CSMF and NSMF
MultiCloud	Interface to K8s clouds
OOF	Support for homing and network slice/slice subnet selection
SDN-C	Radio related optimizations through the SDN-R sub-project

Summary

CSPs consider 5G to be a critical use case for ONAP. The 5G use case blueprint is a multi-release effort, that covers all aspects of 5G automation from orchestration, lifecycle management, network slicing, radio area network support, to 5G optimization. Given that the operators involved with ONAP represent more than 70% of mobile subscribers and the fact that they are directly able to influence the roadmap paves the way for ONAP to become a compelling management and orchestration platform for 5G use cases. ONAP's appeal is reinforced by its strong collaboration with standard development organizations such as 3GPP, ETSI, and the O-RAN Alliance. Moving forward, in the Guilin release will introduce O-RAN A1 adaptor extensions, intent based networking, more sophisticated management of network slicing, better ETSI SOL00x alignment, SO building block workflow management, and expanded CNF support.

References

5G Use Case Proposal

5G Use Case in ONAP's Frankfurt release

ONAP Network Slicing Technical Overview