ONAP
OPEN NETWORK AUTOMATION PLATFORM

Harmonizing Open Source and Open Standards:

The Progress of ONAP

Lingli Deng (CMCC),
Hui Deng (Huawei) and
Stephen Terrill (Ericsson)

As part of the broader evolution of open networking, the Linux Foundation networking projects have been working closely with a range of networking standards groups to align complementary efforts. This work has been described in “Harmonization 2.0: How Open Source and Standards Bodies Are Driving Collaboration Across IT” and “Harmonizing Open Source and Standards in the Telecom World” in 2017.

Following the direction, in 2018, “Harmonizing Open Source and Open Standards: A Case Study of ONAP” provides a closer look at the ONAP (Open Network Automation Platform) project within the Linux Foundation in order to provide concrete details about what standards might be related for ONAP project and what ONAP is doing on harmonizing open source and Open Standards.

This paper elaborates in more detail about the progress and status along the way from both the open source community and the standard organizations perspectives. We leverage various community use-cases/blueprints as the vehicle and focus on three areas of ONAP-related industry standards and best practices: architecture, model-driven approaches, and APIs. By sharing our experiences to date, we hope to stimulate broader industry contributions towards shared objectives.

1. ONAP USE CASES

ONAP is expected to be a general model driven platform to support various service blueprints, across traditional access, transport and core network domains, which involve different traditional telecom industry standards design organizations (or SDOs in short). Hence, the following 4 blueprints are chosen to illustrate the collaboration efforts in specific domains and their current status.

1.1 ACCESS NETWORK SERVICE BLUEPRINT: VCPE

CPE use case demonstrates ONAP capability to deploy residential broadband services including High Speed Internet access, IPTV and VoIP services, in which ONAP is used to design, instantiate, configure and manage the vCPE service as a cloud service that may be collocated with other subscriber services such as vSTB, cloud DVR and VoD-streaming vCDN.

1.2 CORE NETWORK SERVICE BLUEPRINT: VOLTE

VoLTE use case demonstrates ONAP capability to deploy mobile networks, which includes two key underlying core network services: Evolved Packet Core (EPC) and IP Multimedia Subsystem (IMS). A Mobile Service Provider can leverage ONAP to design, deploy, scale and terminate the service on demand. In addition, ONAP can also monitor the service status from both the VIM and VNFs metrics, from which the root-cause analysis and self-healing action will be automatically triggered for faults.

1.3 TRANSPORT NETWORK BLUEPRINT: CCVPN

CCVPN use case emerged on the demands of providing high-value customers a flexible, intelligent and instant VPN service, where a cross operator, cross domain and cross layer VPN service could be created and updated by a self-serving portal via ONAP. Besides the basic STON/SD-WAN VPN service between sites, CCVPN also extends to value added functions to customize the traffic handling or service automation.

1.4 END-TO-END SERVICE BLUEPRINT: 5G

5G use case team, which started with physical network function (PNF) support, is now studying on how to leverage ONAP to support network slicing. RAN slicing, with initial support for two slice types: mobile broadband and ultra-low latency with high reliability, is a work-in-progress for the coming release. The team is also studying the impact of end-to-end slicing.

2. ONAP ARCHITECTURE

2.1 ARCHITECTURE INTRODUCTION

ONAP provides a functional architecture, including a definition of the architectural comonents and their related interfaces, as well component realizations, with their implementation architecture in the form of opensource software, for managing the services and resources (VNFs, PNFs, Container based VNFs, etc.) throughout their entire lifecycle.

While ONAP provides a full architectural approach together with well defined components, it provies the option for service providers and vendors to either adopt the entire platform or only subset which are required and best suit for their specific business or adoption requirements.

From a very high level, ONAP architecture is consisting of a design time environment and runtime environment, where the former supports the ability to on-board resources, compose services and design closed loops to be exported to the runtime environment to instantiate, and lifecycle manage the services and resources.

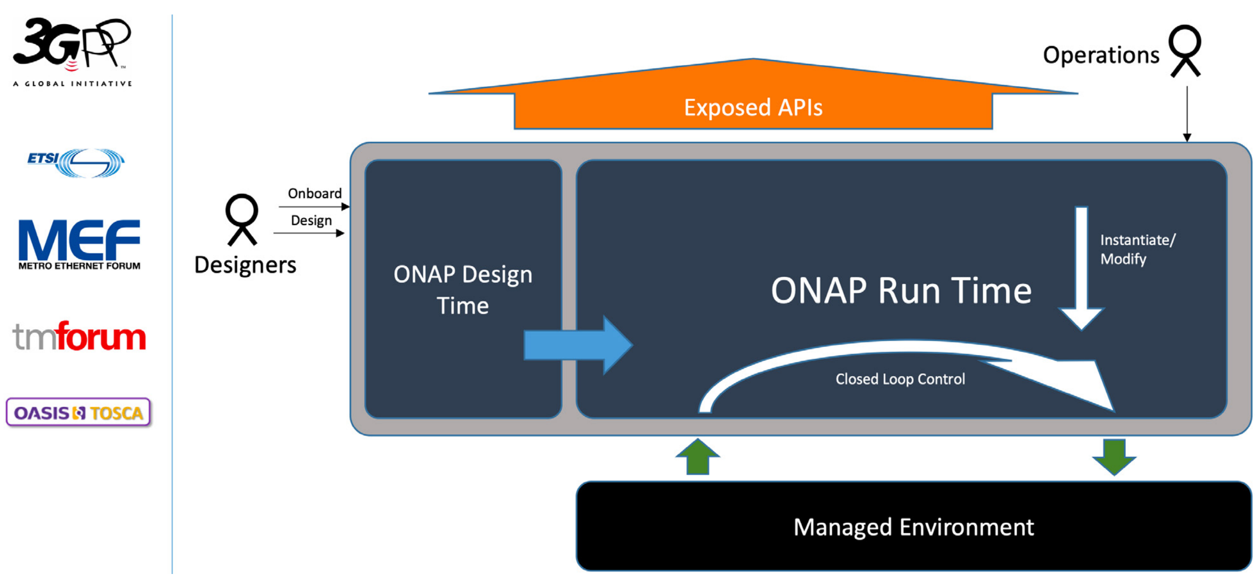

Figure 1 High Level ONAP architecture

Figure 2 provides a more detailed view of the ONAP Casablanca release architecture with modules that are either influencing or using industry standards highlighted in orange.

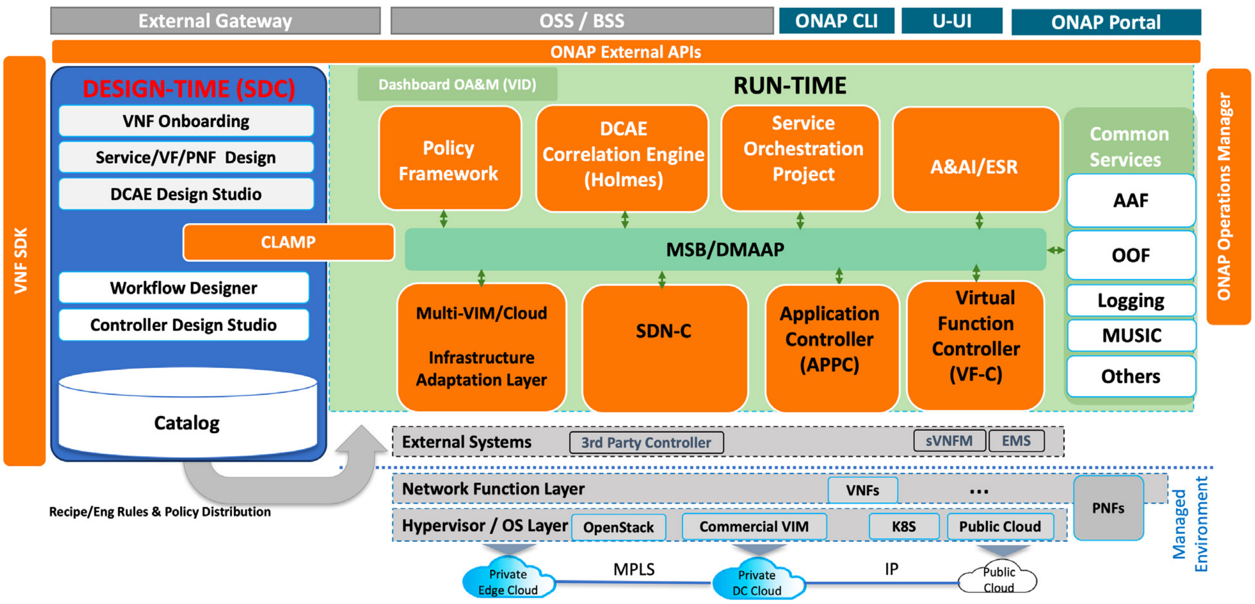

Figure 2 ONAP Standards Impacting Modules

2.2 RELATED SDOS AND USECASE COLLABORATION

Table 1 shows the relationship between various ONAP Platform modules and related SDOs in a more detailed manner by grouping those modules highlighted in Figure 2 into Design Time and Runtime modules and listing respectively related SDOs.

ONAP Platform Modules	Key Functions	Related SDOs
	Design Time	
SDC, VNF-SDK, VVP	Closed-loop Control Design	TM Forum, ETSI NFV
	Onboard VNF/PNF	TM Forum, ETSI NFV
	Services and Operations Design	TM Forum, MEF, OASIS TOSCA
	Test, certify, and distribute models for Runtime Execution	ETSI NFV Plugtests, OPNFV
Closed-loop Control Design	CLAMP Design Artifacts	ETSI ZSM, TM Forum, 3GPP-SA5
	Policy Design Artifacts	ETSI ZSM, TM Forum, 3GPP-SA5
	Run Time	
External Framework APIs	Expose ONAP capabilities to OSS/BSS and partner ecosystems	(see more details in API section)
OOM	ONAP Operations Manager	OASIS TOSCA, CNCF
Orchestrator	Service coordination, instantiation, and lifecycle management	ETSI NFV, TM Forum
Generic NF controller*	Resource Lifecycle Management	ETSI NFV (VNF)
	Resource Configuration	3GPP SA5 EMS
SDN-C controller	Common SDN management abstraction	IETF ACTN, IETF YANG
Close Loop Control Runtime	DCAE	3GPP SA5, ETSI ZSM
	CLAMP	ETSI ZSM
	Policy	ETSI ZSM

*Note. Generic NF controller is a directional functional module to be implemented by ONAP controllers.

Table 1 ONAP Architecture and Related SDOs

ONAP is agnostic to services and resources that it manages. This has two aspects – one being that a service provider can use ONAP to manage services and resources of differing scopes, where the way to manage those services and resources is by the models and applications that are ingested into or used by ONAP; and the other being that the components comprising ONAP are striving to be model driven implying that a service provider can select components requires to complement their particular network, which is also well reflected by the community use cases. For example,

- The vCPE blueprint phase 1 leverages SO for both service and VNF orchestration (with design capabilities), while phase 2 leverages VF-C for both network service and VNF orchestration (without requiring ONAP design capabilities).
- Both VoLTE and CCVPN blueprints leverage SO for end-to-end service orchestration, VF-C for network service orchestration and third-party VNFM for VNF orchestration. But in its simplest form, the transport network service along, with no VNF provisioning, does not involve VF-C.

3. ONAP Modelling

3.1 A MODEL-DRIVEN APPROACH

Model-driven is a widely adopted principle of IT system design, and often a business requirement in large enterprises or complex ecosystem operations, where the business logic of the software application is specified through the model at a higher level of abstraction, decoupled from the implementation code. Running behaviours can be changed through interpreting/ executing the models, which enables the agility to support multiple business and service scenarios.

In other words, with the model-driven approach, there is no need for any code modification to ONAP when deploying a new service if its deployment requirements can be described with the ONAP information model using ONAP data modelling templates.

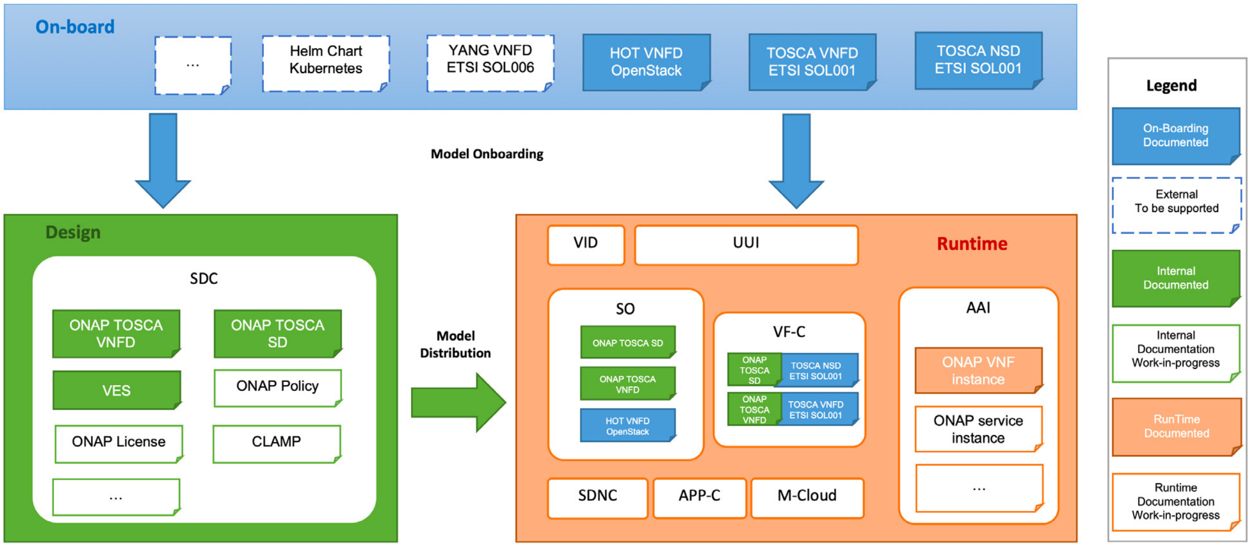

Figure 3 ONAP Modelling Scope/Distribution

As shown in Figure 3 above, to harmonize the efforts and better leverage the prosperous achievement of the industry, ONAP modelling scope is broken down into on-boarding model, internal model and runtime model. On-boarding model is the model provided by external entities, with regard to deployment and management of various resources or services. Internal model is the model used for service design in SDC (based on ECOMP AID), including its own representation of the resources and services, as well as license, policy, close loop and other enriched information. And the Runtime model (or ONAP runtime A&AI model) is what describes the status of managed resources and services in runtime.

In ONAP Casablanca release, the following models are documented: VNFD and NSD on-boarding model based on ETSI NFV SOL001; VNFD on-boarding model based on OpenStack HOT; VNFD, SD and VES internal model and VNF instance runtime model. More models are planned to be supported and documented, such as policy and license internal model, YANG configuration models, etc.

3.2 RELATED SDOS AND USECASE COLLABORATION

ONAP has set up a modelling subcommittee to work on modelling across modules in the community. Following are the external SDOs which may be related to in that work.

Scope	Model Types	Related SDOs and Open Source Projects
On-boarding model	Network Function descriptions	ETSI NFV, OASIS TOSCA, OpenStack HEAT, Kubernetes
	VNF Application Configuration	3GPP SA5
	Service descriptions	TM Forum, ETSI NFV, OASIS TOSCA
	Network Slicing	3GPP SA5
	SDN Device Configuration and Management	IETF YANG
Internal model	Network Function/Service descriptions and management	TM Forum, ETSI NFV, OASIS TOSCA, 3GPP SA5
	LCM workflow	ETSI NFV MANO, OASIS TOSCA, BPEL
	SDN Device Configuration and Management	IETF
	Data Collection, Analysis Rules, Automatic OPs Policy, etc.	OASIS TOSCA, IETF, OpenStack
	Homing Policy	TM Forum, ETSI NFV MANO, OASIS TOSCA
	License	TM Forum, ETSI NFV MANO
Runtime model	Network Function/Service instance	ETSI NFV, 3GPP SA5, TM Forum, IETF
	SDN Device Configuration and Management	IETF

Table 2 ONAP Modelling Related SDOs and Open Source Projects

The ONAP use cases as described in section [1] demonstrate the model-driven approach by utilising the various ONAP models, and bring new areas as targets for future modelling, for example:

- The vCPE blueprint phase 1 demonstrates the usage of OpenStack HOT on-boarding VNFD model and ONAP TOSCA internal SD model.
- The vCPE blueprint phase 2 demonstrates the usage of ETSI NFV SOL001 VNFD/NSD on-boarding models.
- The 5G use case team references 3GPP SA5 for augmenting ONAP internal SD model for network slicing.

4. ONAP APIs

4.1 ONAP API DESIGN PRINCIPLES

To enable service providers and users of ONAP to quickly integrate ONAP with their existing systems, such as the OSS/BSS, ONAP embraces an architecture with well-defined APIs that fosters interoperability both within ONAP and across complementary projects and applications.

There are two categories of APIs in the ONAP platform, which adhere to the above design principles:

1. **ONAP External APIs:** These allow ONAP to be viewed as a "black box" by providing an abstracted view of the ONAP platform's capabilities. They can also be used for connecting to systems where ONAP uses the capabilities of other systems.
2. **ONAP Internal APIs:** These are APIs exposed by individual ONAP modules for exchanging information with other modules and jointly fulfill the functions provided by ONAP.

The ONAP External API Framework project (ExtAPI, also shown in Figure 2) provides the entry point for external API interfaces for the northbound OSS/BSS interface.

4.2 RELATED SDOS AND USECASE COLLABORATION

The following table outlines the SDOs which may be related for ONAP APIs development.

Purpose	Standards	Remarks
Northbound: OSS/BSS APIs	TM Forum 641 APIs TM Forum 633 APIs TM Forum 638 APIs MEF Legato Reference Point	641 (Service Order) fully supported. Plan to fully support TMF 633(Catalogue) and TMF 638(Service State) in Dublin release by adding Hub Notification capabilities.
East-West: Partner, Developer APIs	TM Forum 641 APIs MEF Interlude Reference Point	Peering interaction for cross ONAP cases, like CCVPN
Southbound: Resource Management APIs	ETSI NFV – SOL 003 IETF ACTN (for TE network) IETF L2VPN/L3VPN	Industry compliant interface interaction for domain specific resource/service management. Was support in VoLTE, CCVPN UseCase.
ONAP Internal APIs	ETSI NFV – SOL 003 and 005	Industry compliant interface interaction to enable incremental adoption and smooth evolution

Table 3 ONAP APIs and SDO Collaborations

Currently, most of the ONAP APIs are ONAP-specific. As we continue with our standards harmonization and alignment efforts, we expect ONAP internal APIs will become standards-compliant, and in turn, ONAP may influence the industry standards development as well.

Take the ONAP use cases, CCVPN uses the openAPI from TMF for ONAP peering interfaces. vCPE phase 2 uses the SOL005 and SOL003 from ETSI NFV for VF-C NB and SB interfaces, respectively.

5. OPEN SOURCE AND STANDARDS COMMUNITIES WORKING TOGETHER

ONAP has a standard coordinator, who periodically organize Multi-SDOs workshops during ONAP events to collect issues currently under development in the community and inviting SDO feedback.

SDO representatives are participating as individual ONAP community contributors and committers, for either documenting (e.g. modelling or architecture sub-committees) or implementing (e.g. use case or functional module development). At the same time, SDOs also actively work on developing/reviving their specifications in context of interacting/integrating ONAP, which is largely achieved through organizations that have participating members as well as through the ONAP standards and open source coordinators. Here are two examples of these on-going efforts.

- **Coordination with ETSI NFV**

  ETSI NFV ISG specifies the NFV architecture framework, interfaces and data, to deploy and manage the virtualized network functions.

  The IFA and SOL working groups have set up dedicated meetings to discuss the feedback from ONAP model about the VNFD/NSD models. Besides, ETSI NFV has a close cooperation with ONAP on topics like HPA and package artefact registries.

  As a result of these coordination, ETSI-NFV standards (e.g., IFA011, SOL001) have been updated based on ONAP feedback via organizations that are participating both ETSI-NFV and ONAP.

- **Coordination with 3GPP**

  3GPP SA5 specifies the architecture for the operations and management of 3GPP networks. It is currently studying how the ONAP functions of DCAE (data collection analytics and events) and controllers fit into the 3GPP management architecture, the result of which are captured in the 3GPP Technical Report 28.890. Further to this, 3GPP SA5 has evaluated the ONAP approach of connecting to network functions via the YANG/NETCONF standards and has also adopted this approach.

  3GPP SA2 has defined the NWDAF (Network Data Analytics Function) which is defined in TS 23.501 as a function which provides analytics services to 5GC NFs, AFs and OAM. This is an area for further cooperation as it has the potential to be realized using the DCAE component from ONAP.

6. SUMMARY

ONAP provides an automation platform for the management and orchestration of both services and resources by providing a design time and run time environments as part of the platform. In realizing the platform ONAP resides in an ecosystem with standards design organizations where cross influences occur for the benefit of the industry. However, ONAP does not necessarilly have to follow all SDO specifciations. It has to strick a trade-off between adoption flexibility with implmentation consistency. For example, ONAP internal VNF/Service model is different from standard model, most standard models are treated as onboarding model only. As for external APIs, ONAP try to support as much as possible in order to accomendate more adoption scenarios. E.g. for north bound API, it could support TMF API as well as ETSI NFV SOL005.

It is evident that as ONAP matures, with more platform capabilities introduced in each release, standards become increasingly important to ensure an extensible and interoperable ecosystem that the ONAP platform can support.

7. ACRONYMS

ONAP Specific Terms		General Industry Terms	
AID	Architecture integration document	DSL	Domain Specific Language
CLAMP	Closed Loop Automation Management Platform	EMS	Element Management System
DCAE	Data Collection, Analytics, Events	LCM	Lifecycle Management
ExtAPI	External API Framework Module	NFV	Network Function Virtualization
OOM	ONAP Operations Manager	NSD	Network Service Descriptor
SD	Service Descriptor	OSS/BSS	Operations Support Systems/Business Support Systems
SDC	Service Design and Creation Module	PNF	Physical Network Function
SO	Service Orchestator Module	SDK	Software Development Kit
TSC	Technical Steering Committee	SDN	Software Defined Network
VES	VNF Event Stream	SDOs	Standards Development Organizations
VF-C	Virtual Function Controller	VIM	Virtual Infrastructure Manager
VVP	VNF Validation Project	VNF	Virtual Infrastructure Manager
EPC	Evolved Packet Core	VNFD	VNF Descriptor
IMS	IP Multimedia Subsystem	VoD	Video on Demand
VoLTE	Voice over LTE	vSTB	Virtual Set Top Box
vCPE	Virtual Customer Premis Equipment		
vCDN	Virtual contentt delivery network		

Standards and Open Sources	
3GPP	The 3rd Generation Partnership Project http://www.3gpp.org
CNCF	Cloud Native Computing Foundation https://www.cncf.io/
ECOMP	Enhanced Control, Orchestration, Management & Policy, one of the source project of ONAP
ETSI	European Telecommunications Standards Institute http://www.etsi.org/
IETF	Internet Engineering Task Force https://www.ietf.org/
LSO	Lifecycle Services Orchestration, a specification developed by MEF
MEF	Metro Ethernet Forum http://www.mef.net/
NFVO	Network Function Virtualization Orchestrator, a key component from ETSI MANO specification
OASIS	Organization for the Advancement of Structured Information Standards https://www.oasis-open.org/
ONF	Open Networking Foundation https://www.opennetworking.org/
Open Daylight	https://www.opendaylight.org/
OpenStack	https://www.openstack.org/
OPNFV	https://www.opnfv.org/
SAS	Telecom Management working group under 3GPP
TM Forum	https://www.tmforum.org/
TOSCA	Topology and Orchestration Specification for Cloud Applications, a specification of OASIS
YANG	A data modelling language spec. developed by IETF
ZSM	Zero touch network and Service Management, an Industry Specification Group under ETSI