

LF NETWORKING

LFN DDF and Plugfest Report

Results and lessons from the LF Networking
Developer Design Forum (DDF) and Plugfest,
June 11-14, 2019, in Stockholm, Sweden.

Please direct any questions to lfn-info@linuxfoundation.org.

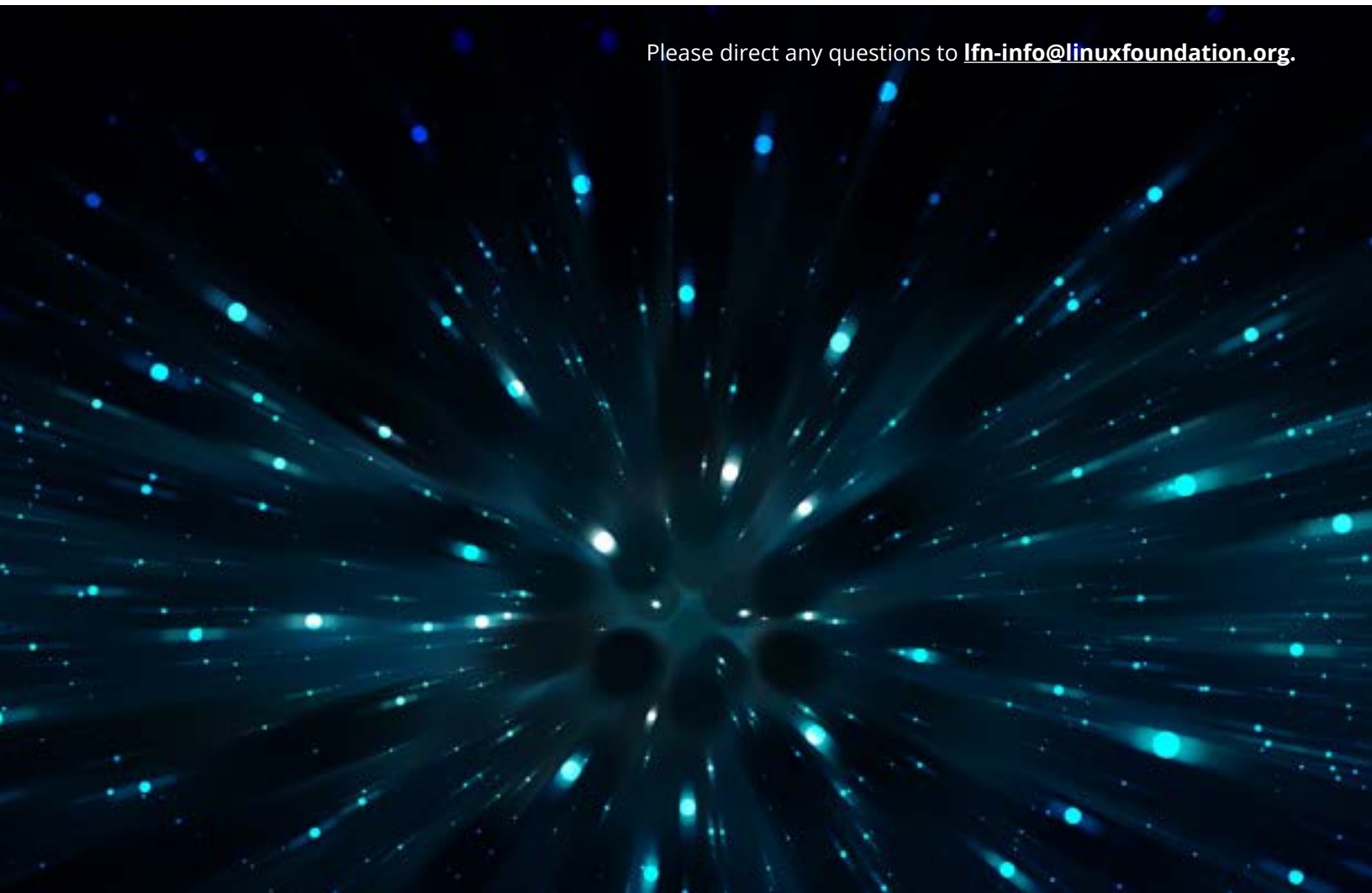


Table of Contents

Executive Summary.....	3
OPNFV Verification Program (OVP)	4
FD.io	4
ONAP.....	5
OpenDaylight.....	14
OPNFV.....	15
Ericsson Activities.....	16
Participants.....	17
Conclusion	20
References	20

Executive Summary

The LFN DDF + Plugfest was held at the Kista Convention Center (Kistamässan) in Stockholm, Sweden, from June 11-14 and was built on the success of four prior ONAP DDF and six OPNFV Plugfest events.

The event focused on bringing end users, academic institutions, vendors, and individuals together to plan upcoming LFN project releases and to perform hands-on testing and integration activities on current software releases. The event was attended by 202 individuals from 35 organizations that included 13 end users and 3 research and nonprofit organizations.

Given the historical background, most of the sessions were around ONAP, OPNFV, and the OPNFV Verification Program (OVP). However, moving forward we expect this event to encompass LFN-wide design and interop testing activities and all LF Networking project communities are welcome to participate. Additionally, this forum will become an important place for cross-community collaboration and OVP testing with ready access to TSC chairs, project technical leads, and key committers.

Specifically, the OVP presentations covered the current state of compliance and validation testing and future plans on both NFVi and VNF interop. ONAP tracks focused on planning for two upcoming releases — El Alto and Frankfurt. The talks covered topics ranging from real-world ONAP experience and use case blueprints, project demos and planning, architecture, standards and 3rd party open source project collaboration, and S3P (stability, scalability, security, and performance) enhancements. OPNFV topics covered project planning for the upcoming Iruya release, as well as data plane acceleration (Rocket project), testing with Functest and Yardstick, Lab as a Service (LaaS), and Cross-Community Continuous Integration (XCI). Finally, there were a couple of presentations on FD.io and OpenDaylight as well. A more detailed description of these activities is provided below.

OPNFV Verification Program (OVP)

OVP is an open source, community-led compliance and verification program to demonstrate the readiness and availability of commercial NFV products and services using OPNFV and ONAP components. The presence of experts across multiple projects provided an opportunity to make progress on the OVP roadmap.

This set of talks was kicked off with an overview of the current OVP program which was especially useful for the ONAP community. The subsequent discussions focused on fortifying the current VNF compliance tests for Heat and TOSCA VNF descriptors (VNFDs), planning the next set of VNF validation tests that will perform VNFs lifecycle testing on a running ONAP instance, and starting to think about testing VNFs on Common NFVi Telco Taskforce (CNTT) reference implementations in lieu of the current OPNFV OpenStack scenarios.

In addition, there was an OVP session around NFVi. This session discussed a number of new Functest, Yardstick, and Rally tests that could be added to the next version of the compliance and validation test suite. There was also a demo of Dovetail running on an XCI installed OPNFV scenario and a discussion of a reviewers guide, the need to update the current tutorial, and a possible need for a commercial VNF for NFVi validation.

FD.io

There was a session on the FD.io Sweetcomb project. Sweetcomb is an open source FD.io project that provides a unified management interface to configure and collect telemetry for appliances, VNFs, and CNFs. There are 12 industry founders, including Intel, Cisco, Pantheon Technologies, Huawei, Tencent, Alibaba, China Mobile, and others. It has published two official releases so far. Sweetcomb can be leveraged for edge/cloud networking use cases such as SD-WAN, 5G, IoT, and others. This session introduced the project and covered topics around 1) NMI interface and OpenConfig Yang models for the cloud, 2) NETCONF and RESTCONF interfaces and IETF Yang models for telcos, 3) support for different dataplane technologies such as VPP, DPDK, Linux kernel, and OVS, 4) integration with SDN controllers and orchestration software such as ONAP, Kubernetes (k8s), OpenDaylight and ONOS, and 5) support for high availability and real-time streaming telemetry in containers.



ONAP

The ONAP community was very active at the DDF and made significant progress in planning the El Alto and Frankfurt releases. The sessions can roughly be classified into the following categories.

Real World Experience

There were numerous presentations, demos, and proposals on using ONAP in real world situations. The sessions were roughly in the areas of end user requirements, 5G, cloud native network functions (CNFs), edge computing, residential connectivity, and other use case blueprints.

Requirements from the End User Advisory Group (EUAG)

Eight end users — AT&T, Bell Canada, China Mobile, Orange, Swisscom, Telstra, Telecom Italia, and Vodafone — had provided detailed requirements for future ONAP releases. The requirements were reviewed and normalized into six categories: modularity, maturity, infrastructure abstraction, documentation, usability, and use case blueprints (such as 5G). This session demonstrates both the keen interest end users are taking in the development of ONAP as well as one of the key benefits of open source — end users can influence the direction of the technology more effectively than proprietary products.

5G

Several sessions focused on 5G related topics such as network slicing, radio area network (RAN), and physical network function (PNF) support. A dedicated session on 5G network slice management reviewed 3GPP SA5 standards related to slicing, current commercial PoCs using ONAP, and a call for a common approach by converging different options. Another session covered the open source vRAN approximation project FlexRAN, and how to onboard and deploy it using ONAP. Next, a session covered how to perform a software upgrade of a PNF through ONAP. Finally, there was discussion around provisioning network resource model (NRM) configurations for PNFs per the 3GPP SA5 standard using the ONAP Configuration Design Studio (CDS). See also the C-RAN/O-RAN topic in the OPNFV section.

Cloud Native Network Functions

The Dublin release supports k8s-based cloud/edge regions. A session on this topic discussed this feature, potential El Alto and beyond ideas, and proposals in the areas of hybrid VNF/CNF network services, multiple networks per Pod, cloud k8s services, new technologies (such as Virtlet, Multus, OVN, Flannel), the LF Edge EdgeX Foundry project orchestration using ONAP, multi-cluster support, and improved monitoring/configuration. The talk also discussed the relationship of this activity with the Edge Automation Working Group, OPNFV, Akraino, and CNCF. The session also included a demo of the vFW use case blueprint where one network function was implemented as a CNF while the other as a VNF. Another session discussed container infrastructure requirements for CNFs. Specifically, the presentation covered 5G deployment modes, containerized PaaS services on an edge platform, and operational tools. The session also covered how additional technologies such as Kuryr to run Pods and VMs in the same network, service mesh, monitoring and visualization, tracing, and Spinnaker for continuous delivery can help with CNFs.

CCVPN

The cross layer cross domain VPN use case blueprint was first introduced during the Casablanca release. China Mobile discussed their recent CCVPN progress with the dynamic insertion of a video surveillance service, control loop with AI for monitoring and anomaly recognition, and new requirements around catalog, design artifact distribution, lifecycle management (LCM) rollback, k8s integration, and service function chaining.

Edge Computing

The DDF attendees actively discussed how ONAP can manage edge clouds and workloads. One session talked about a single management platform for the edge, where edge requirements, telco edge models, and results from China Mobile's

testing of different deployment models of a lightweight OpenStack stack were covered. The Edge Automation Working Group discussed plans for the Frankfurt release, OOM enhancements, and the recent support for k8s edge/cloud regions. In addition, a session on SD-WAN and edge talked about how to orchestrate SD-WAN using an external SD-WAN controller and edge services (camera and echo plug-and-play) using ONAP. The demo also covered a closed control loop to configure the bandwidth of SD-WAN on demand based on the application video quality.

Residential Connectivity

There are two residential connectivity use case blueprints in ONAP. The first, virtual customer premise equipment or vCPE, has been updated with TOSCA VNF descriptors orchestrated by the VF-C controller enabling TOSCA VNFs. This use case blueprint showcases the use of hardware platform awareness (HPA) where VNFs are placed in a cloud that supports its specific requirements such as SR-IOV, PCI passthrough, instruction set extensions, huge pages, and others. The second residential connectivity use case blueprint, Broadband Service or BBS, was demonstrated along with its development process and roadmap.

Other Use Case Blueprints

Many existing ONAP use case blueprint roadmaps were presented. Some of these use cases were mobile service chaining, control loop, optical service orchestration, change management, HPA, and distributed analytics.

In addition, two other use cases relating to VNF application configuration and intelligent automation were discussed in-depth. The VNF application configuration discussion was around the support of SOL002 to configure VNFs and a Generic Network Function Controller (GNFC) that would include the current APP-C functionality along with both a SOL003 and SOL002 adapter to external sVNFs and VNFs respectively. In the intelligent automation session, multiple presenters shared a vision of control loops including Acumos and a data lake, details of work around 3GPP SA2 Network Analytics Data Analytics Function (NWDAF) and SA5 Management Data Analytics Function (MDAF), progress on the distributed analytics as a service use case blueprint, and a proposal to set up a working group to drive requirements for intelligent automation across other ONAP projects.

Project Planning

Consistent with the goal of the event, the bulk of the DDF was dedicated to future planning of specific projects and related initiatives. This section covers details of these sessions and related topics such as architecture planning.

A&AI: The presentation covered the basics of the A&AI project in terms of data models, visualization, and graph traversal. There was discussion on how to query the graph database and three available visualization tools.

API Gateway/Fabric: Internal communication between ONAP components can be complicated due to a large number of granular APIs. A proposal around an API gateway/fabric discussed how an API gateway can solve this problem by abstracting granular APIs through a Facade and Mediation layer.

Architecture: There were several ONAP architecture sessions. One session covered architecture priorities for the Frankfurt release (since there is no major change in El Alto) in nine categories: model driven ONAP, orchestration scenarios, allotted resources, hierarchical orchestration, edge automation, CLI for VNF, controller evolution, VNF configuration, and architecture documentation. There were also discussions on documenting the ONAP architecture better and forward looking architecture task force review priorities in the areas of service mesh, API gateway, implementation technologies, orchestration scenarios, allotted/shared resources, multi-tenancy, model driven, and HA/distributed ONAP.

CCSDK: Today ONAP has three types of controllers — APP-C/SDN-C to manage and configure VNFs, DCAE to monitor VNFs, and OOM to control the ONAP infrastructure. The long term vision of CCSDK is to be the common code base for all three types of controllers, even though today it only supports the first type.

CDS (Controller Design Studio): A session showed a demo of CDS integration with APEX for a PNF control loop. The speaker discussed potential future requirements and proposals for further architectural exploration in the area of the Policy and CLAMP projects.

Control Loop: The session on this topic reviewed relevant Frankfurt release requirements. There are three improvement areas A) to enable fully self service control loops where policies can be designed through SDC, B) to support metadata driven control loops to go from a 3-stage loop (DCAE→Policy→Actor) to N-stage that could include AI/ML and other stages with arbitrary triggers, and C) to provide explicit support for PNFs.

DCAE: The DCAE team showed demos of key Dublin features: k8s multi-site deployment, Helm chart deployment through Cloudify, support for the new Policy API, blueprint generator tool, dashboard integration, cloudify manager resiliency, and new microservices — 1 collector, 4 event processors, and 2 analytics/root-cause analysis engines. The team also held planning sessions for El Alto and Frankfurt releases. Some items being considered are flow enhancement, topology based event reconfiguration, PNDA integration, and Acumos integration. There was also a detailed presentation on CDAP, the data analytics framework embedded in DCAE. This presentation included CDAP's current state, future roadmap, and an overview of the managed version of CDAP on Google Cloud called Cloud Data Fusion.

Documentation: The team discussed short and long term improvements in different areas such as API, security, architecture, end-to-end flow description, structure, and processes around review and release.

License management: A rather vibrant presentation and ensuing discussion covered a top-down approach for xNF (xNF means VNF and PNF, and in the future, CNF) license management and ONAP. The proposal covered key license management principles and use cases.

Modeling: Given that ONAP is model driven, the discussion of data models is a rather important topic. During the DDF, several talks covered items ranging from model harmonization, modeling subcommittee updates, and a discussion around the full vision of a model driven ONAP. The model harmonization session discussed how different ONAP components have developed their data models independently to fill their respective needs often creating inconsistencies, e.g. PNF version number being represented differently by different project models. However, as the complexity of ONAP increases, there is a need not only to document these data models, but also to compare them, find commonalities, create abstractions, and define common principles. The session covered one path to accomplish this through reverse-engineering. The modeling subcommittee discussed advances in the Dublin release such as nested models, VES model accepting 3GPP characteristics, and 5G related enhancements. Future efforts for the Frankfurt release, especially around 5G, were also discussed. Finally one session reviewed the vision of a fully model driven future and how to better align ONAP with it.

MultiCloud: A MultiCloud session talked about the use of the project by SO and future release plans. The session proceeded with a demo of how MultiCloud, along with SO, can be used to instantiate a vFW network service with a mix of a VNF and a CNF along with HPA.

OOM: An OOM session covered planned enhancements for the El Alto and Frankfurt releases in the areas of database consolidation, common storage provider, automated upgrades, and improved security. Another presentation covered efforts around an offline installer, where ONAP installation would be done without an online connection. Next, a session covered using Alpine Linux for Docker images to reduce the overall footprint of ONAP. Policy containers saw a footprint reduction of around 49% by moving from Ubuntu to Alpine Linux.

Parser: Currently ONAP has multiple TOSCA parsers and catalogs creating code inefficiencies and duplication of work. This presentation proposed coalescing these multiple components over the next two ONAP releases.

Policy: The architecture and the implementation of the ONAP Policy Framework was substantially upgraded in the ONAP Dublin release. In this talk, the speakers presented the evolved ONAP Policy framework and its most important improvements and architecture. The session highlighted the power of TOSCA Policy

types. Another session covered the new components of Policy framework using an OOM deployment of ONAP. The talk concluded with a demo of creating and deploying a Policy in a PDP (Policy Deployment Point) engine using the new Policy architecture.

SO: In earlier releases, to make any updates to a SO workflow, changes were required to both the BPMN workflow and the corresponding Java/Groovy code. The onboarding of custom workflows was also manual. A new SO “building blocks” approach, first introduced in the Dublin release, breaks complex workflows into “macros” that can be stitched together to form a new workflow. The talk discussed how the design and distribution of these custom flows will be fully automated in the Frankfurt release. Another talk provided a background on using self-service configuration templates and building blocks together by using SO, CDS, and APP-C together. Finally, a talk on using SO to communicate with an external sVNFM examined how SO workflow monitoring features such as filtering, pathing, sub-flow, variable, and statistics visualization can be used to reduce troubleshooting/debug time from hours to minutes.

VF-C: There was one session dedicated to VF-C highlights in Dublin and plans around the next two releases. The session also covered requirements ranging from multiversion VNFDs, SOL005 northbound interface (NBI) alignment, onboarding of VNFs with and without SDC, enhancements in interfacing with MultiCloud and OOF, and stability. The speakers discussed proposals for El Alto in terms of adding TOSCA deployment CI tests and increased TOSCA VNFD validation support and Frankfurt around flexible workflow engines.



Standards and 3rd Party Open Source

Increasingly, ONAP is being used as the de-facto reference implementation of relevant standards and 3rd party open source projects. Specifically, the following activities and initiatives were discussed at the DDF.

ETSI NFV ISG

Over time, ONAP's support for ETSI NFV ISG standards has been increasing. In Dublin, SO now supports an external sVNFM via a SOL003 interface. A talk on this topic discussed the interface and provided a demo. The speakers also covered the roadmap for enhancing the SOL003 adapter over the next two ONAP releases. The talk concluded with the exploration of greater levels of ETSI standards harmonization, e.g. package management based on SOL005/003 and ETSI catalog database support for network services and xNFs. Additionally, ONAP was represented at the 4th NFV Plugtests™ event in Sophia Antipolis in June 2019. A session discussed the learnings from testing ONAP with 5 VNF and 2 VIM vendors.

Other Collaboration

In addition to ETSI, other collaborations were discussed as well. One session covered the cooperation in the network management area with 3GPP SA5, ETSI NFV ISG, ETSI ZSM ISG, IETF, Broadband Forum, MEF, and TM Forum to align architectures, models, use cases, and security patterns.

Next a session covered the potential for increased collaboration with CNCF. The speaker argued that given the much larger CNCF community, it makes sense to take CNCF technologies where possible instead of creating something overlapping with a much smaller group of contributors. Examples of these areas are MSB, DCAE Cloudify, AAF, and DMaaP, where CNCF technologies can provide equivalent if not better solutions. The session also discussed the formation of the Telecom Users Group (TUG) in CNCF and possibilities for alignment and collaboration. Finally, CNCF can be useful in the journey to cloud native with centralized logging, tracing, KPIs, alerts, network policies, and a container registry.

S3P Improvements and Related Topics

S3P stands for scalability, security, stability, and performance. It includes manageability, resilience, usability, and documentation as well. The discussions for this track started with El Alto backlog prioritization, since El Alto is primarily a non-functional or S3P oriented release. The key ideas were around improved documentation, security, integration, and installation via OOM, and a faster release cycle given that ONAP is roughly on a 6 month release cycle at this time. Additional presentations included the following:



Certified ONAP Professional (COP) exam: The Linux Foundation training team plans to roll out a 100% hands-on exam to certify ONAP professionals. One of the talks discussed the nature of the exam, difficulties encountered in its development, and a call for volunteers to help create the exam.

Container development experience: There is little to no commonality between ONAP container base images. There are 5 Node, 9 OpenJDK, and 13 Python base images. A talk on this topic stressed the need to drive toward commonality and reuse of images across projects. The speaker also proposed a lifecycle management flow for images from the proposal stage to getting retired, vetting images with the Security Subcommittee, and using a stable OS image to increase overall stability.

Continuous Delivery (CD): OOM gating involves ONAP deployment followed by a set of tests on patchsets submitted to the OOM repository. This talk covered lessons and proposals emerging from the experience of using OOM gating. The speaker discussed how Orange has launched more than 500 ONAP deployments for OOM gating in their OpenLab.

Contributing to ONAP: A new contributor to ONAP presented some of the initial difficulties he encountered with missing and conflicting documentation, poorly described items in JIRA with no backlog grooming and missing bug reports, local development environment problems, and inadequate communication. The goal of this presentation was to help solve new developer issues that will help increase the community size.

Documentation: Several talks around documentation covered improving the architecture, end-to-end, API, and security topics documentation. These sessions also discussed revising the documentation structure and laying out concrete milestones for the team to accomplish.

Modularization: Users often need only a subset of ONAP. Though ONAP is already modular to some degree, a talk on this topic proposed a formalized approach to modularization at the module, component, and microservice layers.

OpenLab: There are 7 Open Labs available to the community to develop, integrate, and test ONAP. A session reviewed each of the labs with a description of their focus areas and capabilities. There were discussions on lab planning for the next couple of ONAP releases as well.

Registry: There is a migration of the ONAP container registry from Nexus3 to Dockerhub. This talk discussed the main reason for this — the desire to support platform independent images. The speaker stressed the need for team cooperation to make the migration a smooth one.

Robot testing: ONAP uses the Robot framework for testing. To make the framework easier to use, a talk discussed making common tasks easier and supporting different types of tests using Robot — CSIT (continuous system integration and testing), installation validation, environment/site data provisioning, and use case regression tests.

Runtime dependency removal: Some images download additional files post-deployment. This is both time consuming and a security risk. Additionally some downloaded items depend on the context which makes it impossible to certify what is being downloaded. For this reason one of the talks discussed an offline installer and a proposal to create rules for containers to be read-only (barring exceptions) with reduced privileges.



Security: Security was a key area of S3P focus at the DDF. An overall security talk covered general security topics, penetration testing, k8s security guidelines, vulnerability management security process overview, CII badging, certificate management, and secure storage. Another presentation talked about container security and trustworthiness and how to reduce package/container vulnerability. Next, a session discussed using ONAP with network security as a platform. This talk looked into the security of a managed environment, which could be represented as a 3rd party application using ONAP. The questions explored were around how a 3rd party application uses ONAP securely and how to extend ONAP northbound APIs to provide a greater set of security services. Another talk covered security concerns around k8s installation. The speaker provided information around unmet CIS (Center for Internet Security) benchmarks and recommendations on how to correct these issues. Finally, an El Alto security statement of work presentation made a proposal around penetration testing, standardizing ONAP environment versions (Java, Python, Docker, etc.), upgrading libraries to reduce vulnerabilities, and the need for every ONAP project to obtain CII badging.

Test improvement: ONAP is now up to 244 k8s Pods. A presentation discussed how it is important to make sure that every Pod gets tested in end-to-end testing in addition to unitary, healthchecks, and manual/semi-automated tests (through pairwise and use case testing). The idea is to reduce the current gaps in testing.

Unconference: While the DDF itself could be viewed as an unconference, there was a dedicated unconference within the DDF. The unconference discussed topics such as a better developer environment, improved tutorials, scheduling releases such that they allow enough time to develop code, making JIRA items easier to understand for beginners, and expanded unit testing. The unconference was a success and the attendees agreed upon topics for future sessions.

Versioning: There was a talk that proposed a set of container versioning improvements in conjunction with CI testing.

OpenDaylight

There was a discussion on OpenDaylight scalability. This presentation discussed how the OpenDaylight community release is not ready to enter superscale data centers with 1000+ servers where reliability, horizontal scalability, and performance are fundamental requirements. The talk provided possible solutions for some of these issues. The presenter also encouraged project technical leads (PTLs) to participate in the scalability dialogue and proposed scalability solutions for their particular projects.

OPNFV

The focus of the OPNFV sessions was mostly on certain aspects of the Hunter release along with planning for the upcoming Iruya release. Specifically, OPNFV sessions covered the following topics.

C-RAN: A presentation on the OPNFV C-RAN project provided an overview of the project along with a discussion of related open source OpenAirInterface (OAI) and the Linux Foundation O-RAN project. The talk also discussed C-RAN use cases, the use of hardware acceleration (ASIC, FPGA), deployment scenarios, and a trial based on the LTE standard. Specifically, the use cases covered vBBU + cloud and MEC application + virtualized base station. The deployment scenarios covered k8s, OpenStack, and a hierarchical cloud architecture.

Rocket: A talk on Rocket discussed several topics such as common dataplane API for VNFs, acceleration architecture, architecture specification, the need for a common API, and the relationship between Rocket and OpenStack Cyborg, OVS offload, and GPRS Tunneling Protocol (GTP) offload. In a related topic, China Mobile presented its work around hardware acceleration. The talk argued that packet forwarding performance requirements (connections, latency, bandwidth) exceed processor performance over time, and so hardware acceleration is needed for functions such as: OVS offload, GTP offload, HQoS, AR/VR, IPSec, video rendering, audio/video codec, and picture processing. There are four options to accelerate the dataplane: FPGA, ASIC, SmartNIC, and NPU. Out of these four techniques, OVS offload results have been promising and GTP offload was demonstrated at MWC Shanghai. Finally, the talk discussed how GPUs help with immersive media applications such as AR/VR.



Lab-as-a-Service (LaaS): Since it is not straightforward to bring up OPNFV scenarios, the Pharos lab allocation for development and CI is static and often underutilized. A new effort as part of the LaaS initiative will automatically deploy OPNFV on Pharos PODs using a dashboard interface.

Functest: A presentation on Functest covered future developments around infrastructure verification and Xtesting/chained CI. New features being worked on for the Iruya and J-release include the ability to deploy your own Xtesting CI/CD toolchains and other enhancements.

XCI: After providing a background of XCI, a session on XCI continued with how the SFC project has successfully used XCI to date and the experience of Dovetail with an XCI scenario. Next, the XCI team discussed plans for the Iruya release.

Ericsson Activities

Ericsson generously hosted the overall event and kicked it off with a discussion of the relevance of open source and its impact to the telecom industry. Subsequently, during an evening reception hosted by Ericsson, the company organized four demos (the first three were also part of DDF sessions):

- PNF orchestration using ONAP
- PNF closed control loop automation using ONAP
- ONAP SO to external sVMFN communication using the SOL003 interface
- A VR 360 video demo that demonstrated the value of edge computing

Finally Ericsson also hosted a Women in Open Source reception. The event provided a good networking opportunity to discuss various ways to foster and grow the number of women in open source. It was also interesting to see how many of the women arrived at their current positions through non-traditional career paths.

Participants

The following companies participated in the event. Many thanks to all the participants.

Company	Description	URL
Aarna Networks	ONAP products and services	aarnanetworks.com
Amdocs	Software and services provider to communications and media companies	amdocs.com
Arm (OAM Technology Consulting)	CPU architecture provider	arm.com
AT&T	Telecommunications service provider	att.com
China Mobile	Telecommunications service provider	www.chinamobileltd.com
China Telecom	Telecommunications service provider	www.chinatelecomglobal.com
Deutsche Telekom	Telecommunications service provider	telekom.com
ENEA	Information technology company	enea.com
Ericsson	Network equipment vendor providing communication technology and services	ericsson.com
Google	Organizer of world's information and making it universally accessible and useful	google.com
Huawei	Networking and telecom equipment vendor	huawei.com
Intel	Semiconductor and computing vendor	intel.com
Intracom Telecom	Global telecommunication systems and solutions vendor	intracom-telecom.com
KDDI	Telecommunications service provider	kddi.com

Keysight Technologies	Helps companies accelerate innovation to connect and secure the world	keysight.com
The Linux Foundation	Non-profit organization that accelerates open technology development and commercial adoption	linuxfoundation.org
Mackasoft	Provider of software development services	facebook.com/MackaSoft
Netcracker	Services and software products for communication and cable service providers	netcracker.com
Nokia	Communications and information technology company	nokia.com
OpenStack Foundation	Open source software foundation	openstack.org/foundation
Orange	Telecommunications service provider	orange.com
Samsung	Consumer electronics and technology vendor	samsung.com
SUSE	Open source software-defined infrastructure and application delivery solutions vendor	suse.com
Swisscom	Telecommunications service provider	swisscom.ch
Tata Communications	Telecommunications service provider	tatacommunications.com
Tech Mahindra	Provider of IT services, outsourcing, and IT consulting	techmahindra.com
Telecom Italia	Telecommunications service provider	telecomitalia.com
Telia	Telecommunications service provider	telia.fi

Telstra	Telecommunications service provider	telstra.com.au
Tieto	Software and services company	tieto.com
ULAK Haberlesme	Provider of mobile and broadband communication systems	ulakhaberlesme.com.tr
Uppsala University	Research university in Sweden	uu.se
Verizon	Telecommunications service provider	verizon.com
Vodafone	Telecommunications service provider	vodafone.com
Wind River	Embedded and open source software	windriver.com

Table 1: Participating Organizations

Conclusion

The 2019 June LFN DDF and Plugfest was a significant event for the industry as LF Networking projects were able to collaborate at an unprecedented level and achieve outputs greater than the sum of the parts. The event activities moved the state of SDN/NFV forward towards greater automation and testing.

Announcements for future events will be made on wiki.lfnetworking.org/display/LN/Technical+Community+Events, and respective project mailing lists. Please join us!

References

Links to presentations and Zoom session recordings <https://wiki.lfnetworking.org/display/LN/2019+June+Event+Topic+Proposals>



