NFV MANO: What's Wrong & How to Fix It

EXECUTIVE SUMMARY

In 2014, Axel Clauberg of Deutsche Telekom – a key network functions virtualization (NFV) "mover and shaker" – coined the term "zoo of orchestrators" to describe different vendors' interpretations of what is still a weakly defined component of the NFV reference architecture: the NFV Management and Orchestration (MANO) stack.

NFV MANO is the largest source of operator confusion and the biggest barrier to NFV adoption today. Yet it is also critical to the NFV venture: The NFV MANO architecture is responsible for orchestrating and managing the cloud infrastructure on which virtualized network functions (VNFs) execute; the VNFs themselves, as they run in a cloud execution environment; and – because we are talking about the network, where network functions don't exist in isolation from one another – the services that are composed from multiple, chained VNFs, as they execute across the cloud.

At its simplest, NFV MANO consists of a cloud management system (CMS) and a service orchestration engine that knows how to deploy services composed of VNFs and how to assure those services throughout their lifetime in a dynamic cloud environment. But life is not so simple: first, because a CMS is no better defined than the MANO stack, so different candidate CMSs have different sets of capabilities; and second, because it turns out that a CMS needs significant extension to support NFV. An NFV MANO vendor's implementation is contingent on a number of factors at this early stage in the market, including the kind of VNFs it needs to orchestrate and manage and, perhaps more critically, its CMS assumptions, starting point and partnerships.

OpenStack is the clear favorite of all possible candidates for the CMS – or to use NFV MANO terminology, the Virtualized Infrastructure Manager (VIM). OpenStack is immature today and needs significant proprietary extensions to support NFV. This means that each NFV MANO vendor is wrapping OpenStack with its own, non-standardized implementation of these extensions, often displacing them into higher levels of the MANO stack to avoid accusations of "forking" open source code.

Moves are afoot through the Open Platform for NFV (OPNFV) Project and the OpenStack subteam for NFV to fast-track the development of open source versions of NFV extensions, but at present, vendor support for OpenStack is no guarantee of interoperability between NFV MANO implementations and other components of the NFV reference architecture: VNFs and NFV infrastructure (NFVI) cloud platforms.

In its second, "implementation" phase, the European Telecommunications Standards Institute (ETSI) NFV Industry Specification Group (ISG) intends to focus on creating clearer, prescriptive definitions of the functionality that operators want to see at each level of the MANO stack. Since operators may wish to plug in different vendors at different MANO levels, they don't want to pay twice for the same functionality, or have to sort out conflicting capabilities if they want to offer advanced NFV services, such as NFVI as a service (NFVIaaS) or VNF(s) as a service (VNFaaS).

NFV MANO: What's Wrong & How to Fix It looks at the need for clarification around NFV MANO and new proposals and initiatives that could influence its implementation. It discusses the way in which OpenStack is influencing interpretations of NFV MANO and analyzes the approaches that different vendors are taking to fulfilling one or more layers of the NFV MANO stack. The report profiles 19 NFV MANO solution vendors, which we classify into three categories:

- NFV reference architecture vendors – the world's largest network equipment vendors and IT players, selling solutions for every aspect of the NFV reference architecture
- NFV MANO vendors – a small, select band of vendors that focus on the NFV MANO stack only and intend to remain neutral regarding VNFs and NFVI hardware and software
- CMS vendors – these vendors sell a VIM capability, and are forging partnerships with larger network equipment providers, in a bid to become a strategic component of their NFV reference architecture implementations

Clauberg's "zoo of orchestrators" has arisen as early implementers of NFV MANO have built extensions to IT CMS in ways that are often highly specific to different VNF use cases and/or NFVIs. In the absence of strong definitions for each of the functional layers of the NFV MANO stack, they have idiosyncratically implemented MANO functionality, especially the additions to the IT CMS needed to support NFV. Most of this additional functionality ends up in implementations of the NFV Orchestrator, as shown in the excerpt below.

Excerpt 1: Range of NFV Orchestrator Functions in Commercial Implementations

FUNCTION	DESCRIPTION	FUNCTIONAL LAYER OF MANO STACK
Infrastructure automation	Templates and scripts needed to stand up resource cloud platform(s)/NFVI(s)	Inter-domain resource management/VIM
Global view of resources	Visualization of virtual resources, including network resources and their capabilities, across multiple and/or distributed NFVIs	Inter-domain resource management
Network integration	Support for seamless orchestration of data center and WAN networking with compute and storage resources	Inter-domain resource management
Policy-driven VNF placement (scheduling)	Placement of VNFs on appropriate resources/NFVI(s) in optimal location(s) according to policies; automatic, manual and semi-manual placement may be supported	Inter-domain resource management/VIM
KPI monitoring, analysis and presentation and event handling	Monitoring of both virtual resource and VNF KPIs and event triggers/alerts for breaches of KPI thresholds	Each layer should be self-instrumenting; FCAPS should be pervasive
VNF lifecycle management	Support for VNF instantiation, configuration and subsequent scaling up/down/in/out of virtual resources; resilience and recovery actions throughout the VNF's lifetime	VNF management
OSS/IT service management integration	Support for information exchange that enables correlation and joint management of virtual and physical resources in the NFVI	Network service MANO
Auditing, reporting and license management	Audit trails of scaling requests and events, policy enforcement, resource usage, SLA breaches, license deployments, etc.	Pervasive across orchestration architecture

Source: Heavy Reading

The NFV reference architecture vendors are just as confused as the rest of the market about what should go into each layer of the NFV MANO stack, and agree that there is an urgent need for a prescriptive taxonomy. As a result, their NFV MANO implementations remain works in progress. The excerpt below summarizes vendor virtualization and MANO stack partner/product strategies.

Excerpt 2: NFV Virtualization/Virtualization Management Components by Vendor

VENDOR	VIRTUALIZATION LAYER	VIRTUAL INFRASTRUCTURE MANAGER	VNF MANAGEMENT	NFV ORCHESTRATOR
Alcatel-Lucent	Focus on Red Hat KVM	CloudBand Node including Red Hat OpenStack or CloudStack	CloudBand Carrier PaaS (CPaaS)	CloudBand Management System
Cisco	KVM, VMware	Cisco OpenStack, VMware	Evolved Services Platform	Evolved Services Platform in development
Ericsson	Ericsson Cloud Execution Environment (KVM-based), VMware	Mirantis OpenStack plus Ericsson extensions, VMware	Ericsson Cloud Manager	Ericsson Cloud Manager
HP	VMware, Red Hat KVM, Microsoft	HP Helion OpenStack Community Edition/Enterprise Edition, VMware, CloudSystem Matrix Operating Environment + tools, e.g., CloudStart	HP NFV Director	HP NFV Director
Huawei	FusionSphere FusionCompute, KVM, VMware, Microsoft, XEN	FusionSphere (with Huawei OpenStack distro)	Huawei VNF Manager	Huawei NFV Orchestrator
IBM	PowerVM	SmartCloud Orchestrator (based on IBM OpenStack implementation)	Tivoli Netcool (monitoring capabilities)	SmartCloud Orchestrator
Nokia	VMware, Red Hat KVM	Red Hat and HP Helion OpenStack	Cloud Application Manager	Planned
Oracle	OracleVM (XEN-based), VMware	Oracle OpenStack distro, Nimbula Director, Oracle Enterprise Manager, VMWare vDirector	Oracle Communications Application Orchestrator	Oracle Communications Network Service Orchestration

Source: Heavy Reading

Report Scope & Structure

NFV MANO: What's Wrong & How to Fix It is structured as follows:

Section I is an introduction to the report, including the key findings of our research.

Section II assesses the current shortcomings in the way NFV MANO has been defined and the implications for its implementation.

Section III analyzes the issues that are affecting the implementation of NFV MANO.

Section IV looks at the progress the OpenStack initiative is making in supporting NFV and what this means for the NFV MANO VIM layer.

Section V discusses vendor strategies behind their NFV MANO stacks or component products.

Section VI profiles 19 leading suppliers that are engaging with NFV MANO.

Section VII provides two network operator perspectives on NFV MANO.

Section VIII summarizes the conclusions of our research.

NFV MANO: What's Wrong & How to Fix It is published in PDF format.

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* All charts and figures in this report are original to Heavy Reading, unless otherwise noted.

NFV MANO SOLUTION VENDORS PROFILED (19)

Alcatel-Lucent (NYSE: ALU) / www.alcatel-lucent.com

Amdocs Ltd. (NYSE: DOX) / www.amdocs.com

Canonical Ltd. / www.canonical.com

Cisco Systems Inc. (Nasdaq: CSCO) / www.cisco.com

Cyan Inc. (NYSE: CYNI) / www.cyaninc.com

Ericsson AB (Nasdaq: ERICY) / www.ericsson.com

GigaSpaces Technologies Inc. / www.gigaspaces.com

Hewlett-Packard Co. (NYSE: HPQ) / www.hp.com

Huawei Technologies Co. Ltd. / www.huawei.com

IBM Corp. (NYSE: IBM) / www.ibm.com

Intel Corp. (Nasdaq: INTC) / www.intel.com

Mirantis Inc. / www.mirantis.com

NEC Corp. (TSE: 6701) / www.nec.com

Nokia Corp. (NYSE: NOK) / www.nokia.com

Oracle Corp. (Nasdaq: ORCL) / www.oracle.com

Overture Networks Inc. / www.overturenetworks.com

Red Hat Inc. (NYSE: RHT) / www.redhat.com

VMware Inc. (NYSE: VMW) / www.vmware.com

Wind River Systems Inc., a subsidiary of Intel Corp. (Nasdaq: INTC) / www.windriver.com