INTRODUCING
ETSI OPEN SOURCE MANO (OSM)

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ETSI OSM Chair
Space travel requires a leap of faith... ...but a lot of good engineering!
Which spaceship would you choose?

Enterprise (NCC-1701)
- Designed in the 60’s...
- Faster than x8 light speed
- Much bigger than a football pitch, comfortable for 10s crew members
- Public was interested for decades
- You can wear comfortable clothes
- Never flew for real

Apollo XI
- Designed in the 60’s...
- Much slower than light speed (0.0037%)
- Maybe bigger than an open kitchen, terribly uncomfortable for 3 people
- Public was interested just a few days
- Need to wear awkward outfits
- Can bring you to the Moon and return safely!
Reality is not always pretty at first glance; it is pretty mostly because it works!

- Best if you like wearing pajamas and be on TV
- Best if you want to go to the Moon for real!
Open Source MANO

Understanding the journey
NFV promises to go from traditional network management...

**Day 0**
- PNF installation
- Initial configuration to make PNF reachable (user, pwd, network, etc.)

**Day 1**
- License activation
- Injection of configuration
- Neighbor configuration
- Network configuration

**Day 2**
- Service provisioning
- Business provisioning
... to native NFV management, with highly efficient automation and operation

Day 0 (static)
- VNF deployment
- NS deployment (complex topology)

Day 1 (parametrized)
- OSS
- EMS
- Network Service
- VNF
- VNF
- VNF

Day 2
- BSS
- OSS
- EMS
- Network Service
- VNF
- VNF
- VNF

NETWORK SERVICE INSTANTIATION

LICENSE ACTIVATION

NEIGHBOR CONFIGURATION

SERVICE PROVISIONING

BUSINESS PROVISIONING
Leveraging replaceable components that can be safely & automatically assembled...
... OK, SO WHAT’S OUT THERE THEN?
Operating a real Virtualised Network looks more like this, with multiple sites and technologies...

(*) Topologies and combinations of technologies are provided as examples
... that require the configuration & coordination of an even larger set of elements...

VNF setup

NFVI + VIM domain

Switch + SDN domain

VNFs

- VNF A
- VNF B
- VNF C

IFs

- Paravirt
- SR-IOV
- Passthrough

Config

- Ansible
- YANG
- Expect

VIMs

- OpenStack
- vCloud Director
- AWS
- KVM
- ESXi
- XEN

Hyperv.

- Haswell
- Broadwell
- Skylake

Servers

- Niantic
- Fortville
- Other NIC

NICs

- ODL
- ONOS
- Flood Light

Switcheing

- Switch A
- Switch B

NFV SITE

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... and unless we are ready to respect the layering, management gets really complicated
... and unless we are ready to respect the layering, management gets really complicated
... and unless we are ready to respect the layering, management gets really complicated
Modelling is not helping either…

- INADEQUATE VNF MODELLING
- HARD ONBOARDING
- UNEVEN VNF CATALOGUE
- Basic NSD
- Ad hoc integration often needed
- BASIC AND HAND-MADE NETWORK SERVICE
NFVI, VIM, and App evolution are highly independent from specs...
... while many technologies & IFs evolve independently from SDOs

... impacting also some of the interfaces...
And changes in both of them usually require changes in the IM for effective use...

How can we keep up evolving the IM at the pace of cloud evolution?
SO, WHAT ARE YOU DOING ABOUT IT?
A.K.A. “how you are planning to take me the moon?”
Why Open Source for IM progression?
Many technologies & IFs evolve independently from NFV specs

Open Source SW is really well suited for non-ambiguous testing & evolution...

... and is a good conduit to provide a consistent approach to interoperability
Strategy for a smart maturation

**Focus on what we have in common**

Key is **interoperability**, not full architecture

**Multiple VIMs & SDNs are here to stay** (public clouds too!)

**Leverage on ETSI NFV work**

**Ready for Greenfield and Brownfield**

**Performance matters for the business case**

**Open source as tool to facilitate convergence**

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SO, WHAT DOES OSM PROVIDE IN PRACTICE?
OSM provides a production-quality MANO stack...

- Capable of consuming **openly published IM/DM**
- **Available for everyone**, to minimize uncertainties
- **Suitable for all VNFs**, capturing real production complexity
- **Operationally significant**: including Service Orchestration too!
- VIM-independent

**Aligned to NFV ISG Information Models**
- ... but capable of providing **prompt and constructive feedback** whenever needed

**Enabling An ECO-System Of IM-Compliant VNF Vendors**
- Ready to be offered to cloud and service providers
- No need of integration per- customer & MANO vendor basis
... which **minimizes entry barriers** for VNF developers

**LOCAL DEVELOPMENT & TESTING**
- Open Development Env
- Functional tests
- Low cost
- Integration from the beginning

**TEST POOL FOR DEVELOPERS**
- Real servers and switches
- Performance tests (EPA can be enforced)
- Cost-effective shared infrastructure
- Move the value to VNF services

**SERVICE PROVIDER**
- Production/pre-production environment
- Real network scenarios
- Final service configuration
- Fast deployment
- Low final integration cost

**SAME IMAGES AND VNF PACKAGE** ACROSS ALL THE CHAIN!
... with a rich IM that embeds all the operational procedures and requirements...
... presenting northbound a clear view of Day-2 operations available for the NS/Slice...

NS actions are available northbound as high level primitives during runtime
... while any NS/Slice can run across different types of VIM+NFVI, Transport, Physical Functions and OSS.
Key is INTEROPERABILITY, allowing architectural alternatives and competition.

WHAT NEEDS TO BE IN COMMON
OSM community is really LARGE AND DIVERSE, with 105+ members today.

- 12 Global Service Providers
- Leading IT/Cloud players
- VNF providers

(*) Names & brands may be claimed as the property of others
... and open to more fellow travellers, with REALLY LOW BARRIERS FOR PARTICIPATION

<table>
<thead>
<tr>
<th>ETSI MEMBERS</th>
<th>NON-ETSI MEMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sign Member Agreement &amp; CCLA</td>
<td>• Sign Participant Agreement &amp; CCLA</td>
</tr>
<tr>
<td>• Free participation</td>
<td>• Fees per F2F meeting (same as in ETSI NFV)</td>
</tr>
</tbody>
</table>

**Individual developers and end users**

• Just create an individual account

MORE INFO AT: osm.etsi.org
OK, BUT HOW CLOSE IS OSM TO TAKE ME TO THE MOON?
OSM has demonstrated to be an agile community, with regular release delivery since its foundation...

- **OSM#1** (Apr) 8 Founding members
- **OSM-MR#1** (Jun)
- **1st NFV Plugtests** (Jan)

- **OSM#2** (Oct) 30 Members
- **OSM-MR#2** (Feb)

- **OSM#3** (Apr) 46 Members
- **OSM-MR#3** (Jul)
- **2nd Hackfest** (Mar)

- **OSM#4** (Oct) 65 Members
- **OSM-MR#4** (Feb)

- **OSM#5** (Apr) 83 Members
- **1st Hackfest** (Jan)

- **OSM#6** (Oct) 98 Members
- **OSM-MR#5** (Jun)
- **2nd NFV Plugtests** (Jan)
- **3rd Hackfest** (Jun)
- **3rd NFV Plugtests** (May)
... with a large community of users and testers behind each release...
... which is also consistently reflected in industry statistics and surveys...

Source: Heavy Reading ("NFV Assurance & Analytics")
... debunking some pre-conceived ideas
Releases TWO & THREE brought a really comprehensive set of capabilities

- **Multi-VIM**
  - OpenStack
  - openvim
  - VMware
  - Amazon Web Services

- **Multi-SDN**
  - OpenDaylight
  - Floodlight
  - ONOS

- **Network Service scaling**

- **Monitoring**
  - Plugin Model, NFVI to VDU correlation, App metrics, normalization

- **Multi-site Network Services**

- **VIM emulator** (OpenStack-like)

- **SDN assist for underlay chaining with EPA**
  - Enables EPA deployments E2E for VIMs with no underlay support

- **Anti-affinity rules for VNF resiliency**

- **Explicit port ordering & Device Role Tagging**

- **Role-Based Access Control**

- **Full Day 0 & Day 1 operations**

- **One-click installer** (multiple formats)

- **Tenants/Projects in orchestration**

... and many improvements in interoperability, stability, security, etc.
... while Release FOUR extended OSM in almost all areas

MODEL-DRIVEN NORTHBOUND INTERFACE

- SOL005 aligned
- OpenAPI model

MONITORING IMPROVEMENTS

- On-demand config of alarms & metrics
- Push notifications (via bus)
- Policy support

IMPROVED MODELLING & NETWORKING

- Full support of IP profiles
- Consistency checking of addressing
- MAC address setting
- Support of alternative images

USER EXPERIENCE & OPTIMIZATION (CLOUD-NATIVE BUILD)

- Reduced footprint
- Faster startup and responsiveness
- Improved stability
- Better event and log visualization
- New Lightweight GUI
- Docker install (LW build)
- Batteries included: OSM client, emulator, event visualization, etc.

Available at: osm.etsi.org

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AREN'T WE DONE YET?

IS THE SOFTWARE FINISHED?
SOFTWARE IS NEVER FINISHED.

DID YOU FIX ALL OF THE BUGS?
THERE'S NO WAY TO KNOW.

I CAN'T MANAGE YOU IF YOU DON'T LEARN TO LIE.

OKAY, THE SOFTWARE WILL BE PERFECT IN 2.3 DAYS.
OSM is continuously **open to feedback** to make the system better

- **12K+ downloads & 17K+ installs/upgrades!**

- This huge amount of activity brings a **wealth of useful feedback** from user community (e.g. via OSM_TECH ML)
  - Early bug detection
  - Usability improvements
  - Feature priorities
  - Focus on most relevant use cases

- **All-in-one installer** and **small footprint** are essential
  - OSM community keeps pushing to make installer even easier, leaner, and more robust!
... while OSM activities create continuous feedback loops with other industry initiatives...

- Architectural Framework
- Information/Data Model (IM/DM)
- API definitions
- Test Specs

**ETSI NFV**

- **Testing**
  - Architectural Framework
  - Information/Data Model (IM/DM)
  - API definitions
  - Test Specs

**Release White Papers**

- IM improvements (100+ points raised), bugs in APIs
- Lessons learnt [EUAG White Paper](https://example.com)
... with plenty of contributions to accelerate the maturation of NFV standards and technologies...

- **Feedback to ETSI NFV ISG**
  - ~100 comments to IFA WG

- **Alignment with ETSI NFV SOL specs**
  - SOL005
  - SOL004
  - SOL002 (planned)
  - SOL006 (bi-lateral feedback)
  - SOL003 (under consideration)

- **3 OSM Hackfests (+1 in preparation for Autumn)**
  - VNF onboarding
  - General troubleshooting with OSM

- **Participation in all NFV Plugtests (“Supporting Open Source Project”)**
  - Initially, as community; lately, led by OSM members with OSM distros
  - API validation track
  - Target: improve interoperability and incorporate lessons learnt in new releases

- **6 OSM Tutorials (+1 in preparation for Autumn)**

- **Keynotes in OpenStack Summits**

- **White Papers**
  - 1 per new release
  - 1 from End User Advisory Group
... while it has become the orchestrator of choice for most of 5G Research Projects (5GPPP)
OSM was again present in the latest NFV Plugtests (3rd), in touch with reality

- 2 commercial OSM-based distros

<table>
<thead>
<tr>
<th>Organisations</th>
<th>Name</th>
<th>Location</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alices Labs</td>
<td>SONATA</td>
<td>Spain/Netherlands</td>
<td>Open Source SONATA NFVO + Generic VNFM</td>
</tr>
<tr>
<td>Atos</td>
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<td>Demokritos</td>
<td>MEC</td>
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<tr>
<td>Cisco</td>
<td>Network Services Orchestator (NSO) and Elastic Services Controller (ESC)</td>
<td>USA</td>
<td>NFVO + Generic VNFM</td>
</tr>
<tr>
<td>EnterpriseWeb</td>
<td>EnterpriseWeb</td>
<td>USA/Canada</td>
<td>Microservice-based NFVO + Generic VNFM</td>
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<tr>
<td>Ericsson</td>
<td>Cloud Manager</td>
<td>New Jersey, USA</td>
<td>MANO Orchestrator, Generic VNFM.</td>
</tr>
<tr>
<td>Huawei</td>
<td>CloudOpera Orchestrator NFV</td>
<td>Xi'an/China</td>
<td>NFVO + Generic VNFM</td>
</tr>
<tr>
<td>Luxoft</td>
<td>SDL</td>
<td>Romania</td>
<td>NFVO + Generic VNFM</td>
</tr>
<tr>
<td>NetAppia</td>
<td>Hybrid Orchestrator</td>
<td>Wayham, MA</td>
<td>NFVO + Generic VNFM</td>
</tr>
<tr>
<td>RIFT.io</td>
<td>RIFT Manager</td>
<td>USA</td>
<td>Open Source NFVO + Generic VNFM.</td>
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<td>Ubiquiti</td>
<td>OpenManage</td>
<td>Finland</td>
<td>Network and Security Automation Framework</td>
</tr>
<tr>
<td>WhiteHatLib</td>
<td>WhiteNFV</td>
<td>USA</td>
<td>OSM distribution (NFVO + Generic VNFM)</td>
</tr>
</tbody>
</table>

- No other commercial MANOs were based on open source projects

- Leveraging on community experience:
  - Wealth of VNFs with available OSM descriptors/packages
  - Interop guaranteed upfront with participant NFVI+VIM
  - Usually, some new functionalities have been conceived as result of Plugtests

OTHER ACHIEVEMENTS:
- Multi-vendor PoC
- Kick-off of collaboration with OPNV
Multi-vendor PoC @ Plugtests
4G Mobile Network Orchestration

VENDORS MAPPING TO NFV ARCHITECTURE

NETWORK SERVICE

DEPLOYMENT & OPERATION VIEW
• OSM in OPNFV XCI (Cross-project CI/CD)

- Upstream CI Pipelines
- Upstream Gerrit Artifact Repo
- XCI Verify & Periodic
- XCI Repo
- XCI Long Loops

INCREASE IN CONFIDENCE

• NSH-based SFC Testing
OSM has already organized 3 Hackfests to enable the ecosystem... and planning a new one!

1st OSM Hackfest (Sophia Antipolis, France)
- Co-located with 2nd NFV Plugtests @ ETSI premises

2nd OSM Hackfest (Madrid, Spain)
- Co-located with Zero Touch CA Congress @ Intel

3rd OSM Hackfest (Oslo, Norway)
- Co-located with OSM-MR5 @ Telenor

4th OSM Hackfest (Palo Alto, USA)
- Co-located with OSM#6 @ VMware
COMMERCIAL AVAILABILITY
(a.k.a. Ecosystem pages)
Who can take a ride to the moon?
What is the “OSM Ecosystem”? 

**OSM Ecosystem:** Companies listing together their products and offers related to OSM (like “OSM Yellow pages”)

- Searchable by potential customers looking for OSM-related products
- Only with demonstrable OSM-related products/offers
- Opt-in process, continuously open

OSM Ecosystem
(as of today)

https://osm.etsi.org/wikipub/index.php/OSM_Ecosystem

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Key directions for Release FIVE and SIX

- Full support of 5G use cases
  - Network Slicing
  - Orchestration of micro-services

- PNF and HNF(*) support

- WIM support (Dynamic inter-DC connections)

- Monitoring progression and Self-*

- User experience improvements

- Interop with new technologies and initiatives

(*) Hybrid Network Functions
If you want to explore further:

- OSM Release FOUR – **GIVE IT A TRY!**
  - Follow instructions at: [https://osm.etsi.org](https://osm.etsi.org)

- OSM EUAG White Paper

- OSM Release FOUR White Paper

- Tutorials and examples from 3rd OSM Hackfest
OSM is really committed to optimize code efficiency continuously...

<table>
<thead>
<tr>
<th>Release</th>
<th>Min. RAM (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed code (2016-Q1)</td>
<td>24</td>
</tr>
<tr>
<td>Release ZERO (2016-Q2)</td>
<td>24</td>
</tr>
<tr>
<td>Release ONE (2016-Q4)</td>
<td>16</td>
</tr>
<tr>
<td>Release TWO (2017-Q2)</td>
<td>12</td>
</tr>
<tr>
<td>Release THREE (2017-Q4)</td>
<td>8</td>
</tr>
<tr>
<td>Release FOUR (2018-Q2) target</td>
<td>2</td>
</tr>
</tbody>
</table>
... bearing in mind that perspective sometimes helps

Min. RAM (GB)

- Star Trek's ENTERPRISE (2017-Q4): 336 GB
- Seed code (2016-Q1): 24 GB
- Release ZERO (2016-Q2): 24 GB
- Release ONE (2016-Q4): 16 GB
- Release TWO (2017-Q2): 12 GB
- Release THREE (2017-Q4): 8 GB
- Release FOUR target (2018-Q2): 2 GB

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Some requirements to make Open Source MANO fit for purpose

- OPEN TO PLAYERS OF ALL SIZES
  - Need of a diverse community
  - Adding expertise & demand

- SUSTAINABLE AND RELIABLE
  - The leaner, the better

- OPEN TO NEW TECHNOLOGIES
  - Key for future-proof

- AND READY TO DELIVER!

- Focus on the core, leave the rest to INTEROP
WHAT WE WANT TO PRESERVE

• Keep the pace of delivery
  • OSM participants want to do things for real!

• Keep following OSM’s architectural principles
  • Layering, modularity, abstraction, simplicity

• OSM is opinionated, avoiding “all things to all people”

• Preserve and improve the current WoW
  • Current WoW gives a lot of freedom to evolve project’s organization as OSM Community requires

• Meritocracy and technical competence are tied with empowerment
  • All OSM MDLs are in control of their module and fully understand E2E implications
Leadership Group (LG)
Chair: F.J. Ramón Salguero (Telefónica)
Vice-Chair: Andy Reid (BT)
Vice-Chair: Pål Grønsund (Telenor)

Technical Steering Committee (TSC)
Chair: Vanessa Little (VMware)
Member: Gerardo García de Blas (Telefónica)
Member: Mark Shuttleworth (Canonical)
Member: Matt Harper (Rift.io)
Member: Jatinder Pancar (Intel)

End User Advisory Group (EUAG)
Chair: Andy Reid (BT)

Marketing TF (MARCOM)
Convenor: Mona Hrapkowicz (Intel)

User Interfaces and Apps TF (UI)
TF Lead: Francesco Lombardo (EveryUp)

Service Orchestration MDG (SO)
MDG Lead: Rajesh Velandy (RIFT.io)

Resource Orchestration MDG (RO)
MDG Lead: Alfonso Tierno Sepúlveda (Telefónica)

Information Model and Northbound If MDG (IM-NBI)
MDG Lead: Vanessa Little (VMware)

Monitoring MDG (MON)
MDG Lead: Gianpietro Lavado (WhiteStack)

DevOps MDG (DEVOPS)
MDG Lead: Mike Marchetti (Sandvine)

NS to VNF Communication MDG (N2VC)
MDG Lead: Adam Israel (Canonical)
OSM has an organization oriented to the production of upstream code...
... which favours efficient decision taking...

LEADERSHIP GROUP
- Sets the policies of the organization
- Takes administrative decisions

END USER ADVISORY GROUP
- Produces feature requests
- Produces use cases

TSC
- Sets the Information Model
- Decide features per release

MDG
- Creates/removes MDG
- Appoints/revokes MDG leads

Reports progress on features
Reports progress to the LG
Confirms TSC Chair
Supports TSC work

Commits project releases
Commits module releases
Reports progress on features
Reports progress to the LG
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ETSI NFV & ETSI OSM

**ETSI NFV**: Industry Specification Group on Network Functions Virtualisation

**ETSI OSM**: ETSI hosted Open Source project developing a Management and Orchestration (MANO) stack aligned with ETSI NFV Architectural Framework and IM
Why ETSI OSM?

Layering  Abstraction
Modularity  Simplicity

Open Source MANO

ETSI NFV

Open Source MANO
3 reasons to go to open source

1. To accelerate the availability of a reference standard

2. To build a wide and competitive market of producers and consumers

3. To answer the **BUY vs. MAKE** question

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Feedback to ETSI NFV about IM

<table>
<thead>
<tr>
<th>In/Out</th>
<th>Title</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out (to ETSI)</td>
<td>VNFD Implementation Challenges (NFVIFA(15)0001351)</td>
<td>2015</td>
<td>Findings based on implementation of ETSI-NFV ISG Phase 1 models. Partially incorporated in phase 2 models</td>
</tr>
<tr>
<td>Out (to ETSI)</td>
<td>OSM Release ONE Feedback on Phase 2 VNFD and NSD (NFVIFA(16)0001511r1)</td>
<td>Dec 13th 2016</td>
<td>Overview of clarifications, defects (sightings) and feature requests related to the VNFD and NSD</td>
</tr>
</tbody>
</table>

~100 comments to the current specs, around these areas:

- Enhanced Platform Awareness
- Lifecycle management in NSD and VNF
- VNFD connection points and L2/L3 addresses
- VNFFGD
- Deployment flavours
- Nested services
- Local Affinity Rules vs. Local Affinity Groups
OSM CI/CD pipeline...

Stage 1: Trigger per-module pipelines
Stage 2: Scan, U Test, Build, Archive
Stage 3: Archive, System Install
Stage 4: VNF, NFVI & VIM, System Tests, Smoke Tests

Artifact Storage

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OSM scope covers all that is required to deliver a **production-quality MANO stack**

### RUN-TIME SCOPE
- Automated E2E Service Orchestration
- Superset of ETSI NFV MANO
- Plugin model for integrating multiple SDN controllers
- Plugin model for integrating multiple VIMs
- Integrated Generic VNFM with support for integrating Specific VNFM
- Support for Physical Network Function integration
- Greenfield and brownfield deployments

### DESIGN-TIME SCOPE
- Network Service Definition
- Model-Driven Environment with Data Models aligned with ETSI NFV
- VNF Package Generation
- GUI

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... attached to a **Network of Remote Labs to test interop** with different VIMs and NFVIs