MEF 3.0: Agile, Assured, & Orchestrated Communication Services across Multi-Providers’ Networks using ONAP

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Navigation

1. Introduction to MEF 3.0
2. LSO Reference Architecture
3. Open Source & Standards Collaboration
4. LSO API Projects and PoCs focusing on ONAP
5. Conclusions
Introduction to MEF 3.0
Launched Nov 2017

- A transformational services framework
- Defining, delivering, and certifying agile, assured, and orchestrated services
- Across a global ecosystem of automated networks.
Enabling a new, revenue-generating, multi-services framework
Enabling a transformation to a new, revenue-generating, multi-services framework
MEF 3.0 - A Transformational Framework

Orchestrated Services
• Wavelengths
• Carrier Ethernet
• IP VPNs
• SD-WAN
• Security-as-a-Service
• Application Services

On-Demand Certification
• Cloud-based test platform
• Certification of services & LSO APIs
• Subscription-based

Open LSO APIs
• Orchestration across multiple service providers
• Supporting multiple network technology domains

Community
• MEF global membership
• MEF 3.0 projects on MEFnet
• MEF Developer Community
• Open source projects and SDOs
• Certified professionals
• Enterprise Advisory Council
Lifecycle Service Orchestration Reference Architecture (LSO-RA)
Goal: Develop a model to automate, orchestrate and communicate subscriber intent
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e.g., Dynamic CE Service
Goal: Develop a model to automate, orchestrate and communicate subscriber intent
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And do so across inter-organizational boundaries

e.g., Multi-Operator CE Service
Introducing MEF 55 and its purpose: What is LSO?

1. Orchestrated management and control Reference Architecture
   • of MEF 3.0 services across all internal and external network domains from one or more network operators

2. Characterizes the Domains, Functional Entities, and Interface Reference Points
   • enabling federated LSO capabilities

3. Overcomes complexity
   • by defining product, service, and resource abstractions that hide the complexity of underlying technologies and network layers from the applications and users of services

4. Agnostic to underlying network technology
   • can be implemented using legacy or SDN/NFV infrastructure

5. Dramatically decreases the time to establish and modify the characteristics a service
   • assuring overall quality and security for services
LSO APIs enable end-to-end service orchestration across networks & over technology domains
Lifecycle Service Orchestration & APIs

Based on MEF 55: LSO Framework Specification
Released as IPSs and experimental SDKs
Available in experimental or published states
Experimental API PoCs published on a 6 month sprint cycle
The LSO Reference Architecture

CUS: Customer Application Coordinator
BUS: Business Applications
SOF: Service Orchestration Functionality
ICM: Infrastructure Control and Management
ECM: Element Control and Management
LSO RA - Cantata

Customer Domain

- CANTATA (CUS:BUS)
- ALLEGRO (CUS:SOF)
- customer application coordinator

Business Applications

SP Domain

- SONATA (BUS:BUS)
- INTERLUDE (SOF:SO)
- PRESTO (SOF:ICM)
- LEGATO (BUS:SOF)
- SERVICE ORCHESTRATION FUNCTIONALITY

- ADAGIO (ICM:ECM)
- ELEMENT CONTROL AND MANAGEMENT
- Network Infrastructure

Partner Domain

- LEGATO (BUS:SOF)
- PRESTO (SOF:ICM)
- SERVICE ORCHESTRATION FUNCTIONALITY

- ADAGIO (ICM:ECM)
- ELEMENT CONTROL AND MANAGEMENT
- Network Infrastructure

LSO Cantata

- Product catalog
- Product feasibility
- Product ordering
- Acceptance testing info
- Billing and usage
- Trouble reports / status
- Product level quality

ENNI
LSO RA - Sonata

Customer Domain

- Customer application coordinator

SP Domain

- Business Applications
  - Service Orchestration Functionality
    - PRESTO (SOF:ICM)
  - Infrastructure Control and Management
    - ADAGIO (ICM:ECM)
- Network Infrastructure

Partner Domain

- Business Applications
  - Service Orchestration Functionality
    - PRESTO (SOF:ICM)
  - Infrastructure Control and Management
    - ADAGIO (ICM:ECM)
- Network Infrastructure

LSO Sonata

- Address validation
- Serviceability
- Ordering
- Quoting
- Billing assurance
- Testing
- Change management
LSO RA - Legato

Customer Domain

- CANTATA (CUS:BUS)
- ALLEGRO (CUS:SOF)

SP Domain

- Business Applications
  - LEGATO (BUS:SOF)
- Service Orchestration Functionality
  - INTERLUDE (SOF:SOF)
- Infrastructure Control and Management
  - PRESTO (SOF:ICM)
- Element Control and Management
  - ADAGIO (ICM:ECM)

Partner Domain

- Business Applications
  - LEGATO (BUS:SOF)
- Service Orchestration Functionality
  - PRESTO (SOF:ICM)
- Infrastructure Control and Management
  - ADAGIO (ICM:ECM)

LSO Legato

Service feasibility
Service configuration & activation
Usage events & metrics
Service performance & quality
Service policy

ENNI

Network Infrastructure
LSO RA - Presto

Customer Domain

- CANTATA (CUS:BUS)
- ALLEGRO (CUS:SOF)

Customer application coordinator

SP Domain

- Business Applications
- Service Orchestration Functionality
- Infrastructure Control and Management

- PRESTO (SOF:ICM)
- ADAGIO (ICM:ECM)

Real-Time Business Coordination

Partner Domain

- Business Applications
- Service Orchestration Functionality
- Infrastructure Control and Management

- PRESTO (SOF:ICM)
- ADAGIO (ICM:ECM)

LSO Presto

Connectivity & network function feasibility
Configuration, activation & management of connectivity and logical network functions
Topology and routing
Performance and Fault
Connectivity policy
LSO RA - Adagio

Customer Domain

Customer application coordinator

SP Domain

Business Applications

Service Orchestration Functionality

Element Control and Management

Infrastructure Control and Management

Network Infrastructure

Partner Domain

Business Applications

Service Orchestration Functionality

Element Control and Management

Network Infrastructure

LSO Adagio

Manage fabric or network functions on specific elements
Element level configuration
Element resource state
Element fault and performance
Element level policy
LSO RA - Allegro

Customer Domain

- customer application coordinator

SP Domain

- Business Applications
  - LEGATO (BUS:SOF)
  - SONATA (BUS:BUS)

Service Orchestration Functionality

- PRESTO (SOF:ICM)

Infrastructure Control and Management

- ADAGIO (ICM:ECM)

Element Control and Management

Network Infrastructure

Partner Domain

- Business Applications
  - LEGATO (BUS:SOF)

Service Orchestration Functionality

- PRESTO (SOF:ICM)

Infrastructure Control and Management

- ADAGIO (ICM:ECM)

Element Control and Management

Network Infrastructure

LSO Allegro

Dynamic service control
Service state info
Service performance & quality
Service related alerts
LSO RA - Interlude

**Customer Domain**
- Customer application coordinator

**SP Domain**
- Business Applications
  - LEGATO (BUS:SOF)
  - PRESTO (SOF:ICM)
- Service Orchestration Functionality
- Infrastructure Control and Management
  - ADAGIO (ICM:ECM)
  - Network Infrastructure

**Partner Domain**
- Business Applications
  - LEGATO (BUS:SOF)
- Service Orchestration Functionality
- Infrastructure Control and Management
  - ADAGIO (ICM:ECM)
  - Network Infrastructure

**LSO Interlude**
- Dynamic service control
- Service parameter configuration
- Service state info
- Service performance info
- Service problem alerts

**Diagram Notes**
- CANTATA (CUS:BUS)
- ALLEGRO (CUS:SOF)
Lifecycle Service Orchestration – Completed Work

• **Lifecycle**
  – MEF 50.1 (Service Lifecycle)
  – MEF 52 (CE Perform. Reporting Framework)
  – MEF 53 (CE Services Qualification Questionnaire)
  – MEF 54 (Ethernet Interconnect Point)
  – MEF 57 (Ethernet Ordering)

• **Orchestration**
  – MEF 55 (LSO Reference Architecture, Operational Threads, TOSCA templates)
  – MEF 59 Network Resource Model
  – MEF 60 Network Resource Provisioning

• **Services / Modeling**
  – MEF 58 Yang Modules for MEF services
Lifecycle Service Orchestration – Work in Progress

- **Lifecycle**
  - Commercial Affecting Attributes
  - MEF 57 enhancements (IPS, Access E-Line)
  - Presto SOAM and SAT

- **Orchestration**
  - MEF 55 (LSO Reference Architecture SOF, Security)
  - Access e-Line Service Control
  - MEF Network Slicing Architecture

- **Services / Modeling**
  - MEF Core Model
  - Policy Driven Orchestration
<table>
<thead>
<tr>
<th></th>
<th>MEF Work Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transport for 5G</td>
</tr>
<tr>
<td>2</td>
<td>Network Slicing</td>
</tr>
<tr>
<td>3</td>
<td>Orchestrating 5G Services</td>
</tr>
<tr>
<td>4</td>
<td>MEF Services over 5G</td>
</tr>
</tbody>
</table>
MEF 22 Phase 4 - Transport for 5G

- Functional Splits can be in 1 or 2 stages (RRH-DU-CU)
- Three types of Fronthaul Networks
- Each has its own KPIs

- RRH, CU, DU, and Core distributed based on Services KPIs
- Multiple configurations can be co-located
- Transport Network can provide support for all

- MEF Ethernet Service Types – Mobile Fronthaul 1,2,3, Mobile Backhaul, Ethernet Backhaul
- Multiple Ethernet Service Types can co-exist
Data-Driven Orchestration

Network Slice Catalogue:
- Mobile Broadband
- Nomadic Broadband
- Industry Automation
- Wire-line Internet access
- Enterprise Communication
- Massive Sensors/Actuator
- Health Care

Network Slice Resources:
- Access/Mobility
- Service Provider Core
- Service Provider IT Cloud
- Management & Control
- Access
- Applications
- Cloud Infrastructure
- Transport

Network Service Composition

Physical Resources (Access, Connectivity, Computing, Storage, ..)

Logical Networks

Service.. n
- Health
- Robotic communication
- Premium Communication
- Media
- MBB Basic
5G Network End-to-End Orchestration

- E-2-E LSO = Mobile LSO + Transport LSO
- MEF LSO -> Transport LSO
- MEF LSO extends to E-2-E LSO and/or Mobile LSO
Orchestrating 5G Services

Ensuring 5G-based services are orchestratable through SDN controllers as part of:

- Heterogeneous connectivity service
  - Multi-Operator
  - Multi-Technology
- Full service lifecycle
  - Network resource provisioning
  - Service OAM and SAT
  - Service assurance (e.g. Zero touch telemetry, closed loopback control)
  - OpenCS 5G project
- Defining use cases, epics and user stories
- Use case -> Information Model -> Data Model -> standardized open northbound APIs for 5G environments
MEF Services Over 5G – Why?

More and more traffic is now terminated on mobile devices

Customers would like the same SLA
  • at the office, home, or traveling

Fiber availability is limited

Copper plants are old and deteriorating
  • Optimized for low bandwidth
  • T1/E1 replacement

Low CAPEX (FedEx vs. Technician)
Open Source & Standards Collaboration
Open Source & Standards Collaboration - Examples

- MEF is associate member of ONAP & Linux Foundation
- LF is auditing member of MEF
- Jointly create LSO APIs – e.g., working with ONAP External API Project in defining Use Cases and Information Model for LSO Legato
- MEF17 PoC demonstrated ONAP-ONAP with LSO
- MEF 3.0 Multi-ONAP Implementation Guide Project

- LSO Sonata R1 extended 4 TM Forum Open APIs for address validation, serviceability, and ordering (in SDK)
- TR258 Mapping MEF LSO RA to TMF APIs
- Catalyst - Outstanding Open Architecture and API Design: Partnering Platform for MEF Services (MEF, PCCW Global, Vodafone, DGIT Systems, Inomial)

- LSO Presto NRP leverages ONF’s TAPI model for network resource activation and topology

- Jointly develop Ethernet Ordering Technical Specification: Business Requirements and Use Cases

- LSO Presto NRP API is supported within an ODL SDN controller plug-in contributed into the ODL UNI Manager project.
- LSO Presto NRP SDK has a reference implementation with the ODL SDN controller that demonstrates how a northbound app can provision an end-to-end network connectivity service between two endpoints in both a technology-agnostic and vendor-agnostic manner
LSO API and Experimental PoCs
LSO Sonata

- Incremental approach with regular releases
- Access E-Line is initial focus but API is designed to be product-agnostic
- Extensible data and information model
- Not dependent on requiring a Product Catalog
- TM Forum APIs with MEF extensions (ongoing collaboration)
- The buyer on-boarding process has already been performed
- 20+ companies participated in LSO Sonata projects thus far
LSO Sonata PoC Projects at a Glance

Contract
- Create Billing Account

Serviceability
- Perform Address Validation
- Retrieve Site
- Perform Product Qualification

Quote
- Get Quote for New
- Get Quote for Modification
- Get Quote for Termination

Order
- Submit New Order
- Retrieve an Order
- Submit Order to modify configuration
- Submit Disconnect Order
- Cancel an Order in flight
- Modify an Order in flight
- Submit a Future Dated Order
- Receive Order Progress Notifications
- Submit Order to perform complex Configuration Change

Inventory
- Retrieve Inventory Data

Trouble Ticket
- Create Trouble Ticket
- Update Trouble Ticket
- Close Trouble Ticket
- Cancel Trouble Ticket
- Retrieve Trouble Ticket
- Receive Trouble Ticket Status Change Notification

Bill
- Retrieve Invoice

Release 1
Release 2
Release 3+
LSO Sonata PoC R1 - Released in July 2017

Service Providers need to be able to...

**Serviceability**
1. Request Address Validation for a geographic location with Partner
2. Retrieve Sites at a given location from Partner
3. Request Serviceability (Product Offer Qualification) at a given location from Partner

**Ordering (New Order)**
1. Request a new Product order with Partner
2. Retrieve the Product order from Partner
LSO Sonata PoC R2 – Targeted January 2018

Service Providers need to be able to...

Ordering
1. Retrieve Product Inventory from Partner
2. Order for requesting Product Changes with Partner
3. Order for requesting Product Disconnections with Partner
4. Cancel the inflight Product order with Partner

Ticketing
1. Request creating Trouble Ticket with Partner
2. Request modifications or cancellation on the Trouble Ticket with Partner
3. Receive notification on the Trouble Ticket’s progress from Partner

Quote
1. Request for Quote for a Product from the Partner
Model Driven Paradigm

Models
- Resource definition
- Service composition
- Product models
- Lifecycle models (Operational Integration)
- Processes and policies
- Optimization rules
- Software images

Execution Engines
- Orchestration
- Policy execution
- Data movement
- Data storage
- Coded algorithms
- Control
- Standard data models

Behaviors
- Real-time service delivery
- Elastic scalability
- Self-optimizing
- Self-healing
LSO & ONAP
In a Nutshell

• LSO: Comprehensive framework for agile, assured, orchestrated services, over multiple technologies, across multiple domains, using multiple components (open/closed)

• ONAP: Comprehensive platform for automated services

• LSO: Constructs embrace, speed ONAP deployment

• MEF: Commitment, many fronts for collaboration
ONAP Implementation of LSO Framework
LSO Incorporating SDN, NFV, Open Source

Self-service Web Portal

LSO Allegro

LSO Cantata

LSO Legato

LSO Interlude

LSO Sonata

LSO Presto

Business Applications

Network Operator 1

Network Operator 2

End-to-End Network-as-a-Service

EMS: Element Management System  PNF: Physical Network Function  SOF: Service Orchestration Function
MEF-ONAP Collaboration

• Shared objectives
  – Orchestrate services across multiple providers & technology domains
  – Framework for RT, policy-driven SW automation of VNFs & PNFs
  – Minimize fragmentation & silos

• Model of SDO/OSS collaboration
  – ONAP open-source ref. implementation & MEF standards
  – ONAP/LF & MEF mutual membership: 250 companies
  – LSO hackathons

• Target projects
  – Initial: LSO framework & APIs
  – Longer: Federated info. models; MEF Reference Point APIs in ONAP

• Broader MEF/LF collaboration
  – ODL controllers (Presto API code already upstreamed)
  – PNDA big data analytics (for MEF Analytics project)
# LSO-ONAP Potential Project Areas

<table>
<thead>
<tr>
<th>Project Areas</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSO Framework</td>
<td>Align Framework</td>
</tr>
<tr>
<td>LSO Reference Implementation</td>
<td>ONAP as an open source reference implementation</td>
</tr>
<tr>
<td>Core Modeling</td>
<td>Federated modeling framework</td>
</tr>
<tr>
<td>Services</td>
<td>Demonstrate some NaaS services</td>
</tr>
<tr>
<td>Microservices Platform</td>
<td>Common platform to innovate on APIs</td>
</tr>
<tr>
<td>MEF Development Community</td>
<td>ONAP to show LSO integrated with other open-source projects</td>
</tr>
<tr>
<td>LSO Hackathons</td>
<td>MEF hackathons to work on ONAP for new ideas</td>
</tr>
<tr>
<td>LSO Reference APIs</td>
<td>Align on open APIs (esp. Presto, Sonata, Legato)</td>
</tr>
<tr>
<td>Analytics</td>
<td>Align on closed loop analytics</td>
</tr>
</tbody>
</table>
POC at MEF17 (Orlando) November 13-15, 2017

• ONAP instances: AT&T, Orange; concatenating with Colt
  – 2 POCs: Orange-AT&T; AT&T-Colt-AWS; with Amdocs, Ciena, Fujitsu

• Interconnection via LSO APIs (Sonata, Interlude, Legato, Cantata)
  – Product order processing
  – Service fulfillment
  – Product ordering
  – Product order confirmation
  – Service threshold detection
  – Service policy processing
  – CIR change implementation
  – CIR scaleback
Business use cases:

- **Global E-line service order:**
  - NSP delivers E2E Ethernet service across two locations in coordination with partners
  - NSP’s portal for ordering, activation & monitoring
  - SLA reporting with elastic BW changes

- **Global E-line with dedicated cloud access & cloud orchestration**
  - NSP delivers E2E Ethernet service and cloud access port in coordination with partners
  - Enterprise App orchestrates network & cloud configuration, monitoring & optimization
  - Enterprise manages own routers & cloud peering
Objectives

- **Enable a global virtual fabric:**
  - Create a frictionless experience with automation & self service
  - Build Third Network service: connectivity and cloud-hosted services across interconnected operators and cloud providers

- **Orchestrate using LSO APIs** per the MEF 55 LSO framework:
  - **Sonata** release 1 and extensions, along with **Interlude** reference points to homogenize the inter-carrier and other partner (e.g., cloud provider) interactions
  - **Legato** reference point to demonstrate efficiencies in the service delivery by harvesting the intelligence of the network and utilizing it to make smart decisions about the assets
  - **Cantata** reference point to demonstrate customer interactions via an intent API for requesting cloud service from a provider
  - As applicable, use TMF open API and rest pattern as input assumptions and start base for API design

- **Demonstrate interoperability** of LSO stacks:
  - Open source based platforms with > 75% open source such as ONAP and Blue Planet
  - Proprietary LSO systems stack such as Colt Novitas

- **Target audience:** retail, wholesale, cloud, service providers, enterprise, government institutions

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Achievements

- **MEF 55 LSO** reference points with **API services** to aid automation in service orchestration:
  - MEF **Sonata** Release 1 API
  - Alpha extension of **Sonata**
  - Alpha version of **Cantata**, e.g., request/modify EVPL (EVC)
  - Alpha version of **Interlude**, e.g., request/response for SLS objectives of MEF 33/51 Access E-Line service (OVC)
  - Alpha version of **Legato**, e.g., request/modify Access E-Line service (OVC)

- **Integration of:**
  - open source based platforms such as ONAP and Blue Planet interoperating with proprietary LSO system stack with LSO reference points
  - operator specific proprietary platform, Colt Novitas, exposing LSO reference points

- **E2E service orchestration** for connectivity and cloud hosted services (with customer request to Service Provider(s))

- **Network analytics** with use of SDN controller to collect utilization, performance, & asset information and ONAP DCAE analyze it by using data analytics software
ONAP & MEF: Better Together

- Open Source LSO and automation platform
- Developer Community
- ONAP University
- NFV framework and VNF validation

- NaaS reference implementation platform
- LSO API standardization and specifications
- NaaS service standardization
- Channel to market
- Certification and professional education

Complementary missions to accelerate market adoption
Conclusions

- MEF LSO abstractions, APIs:
  - Operator choice of technologies
    - Layer (1/2/3); openness (proprietary, open I/Fs, open source)
  - Gradual evolution of brownfield
  - Services, apps invariant over technology choices
  - Inter-carrier service concatenation

- ONAP lessons already learned
  - Sonata, Interlude enable ONAP inter-carrier service concatenation
  - ONAP in one operator domain compatible with non-ONAP domains