Integrating Dynamic Networks and e-Infrastructures

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• GEANT Project
• Goals
• Motivation
• Integration
  • OSS/BSS
  • Multi domain
  • Standards / APIs
• Orchestration
• Network & Tech
• Proof of Concept
• Summary
Introduction

• GÉANT project (GN4-2 JRA1-T3)
  • JRA1 - Network Infrastructure Evolution
  • Task 3 - Tasked with **Infrastructure** and **Cloud Service Provider** interoperation

• JRA4 - Cloud Procurement
  • Single Digital Market across the European NREN community
  • Centralized procurement
  • Cloud Catalogue
  • Requested Integration
    • Standards based simplified APIs
    • Operational & Business Processes
    • Single Interface/ 1-Stop-Shop
Goals

- **Standardized delivery of services**
- Following the consumer cloud paradigm
  - Not just about network connectivity (this is already solved)
  - On-demand and throwaway services (setup/teardown)
  - Focus on **interoperability** at the **service provider layer**
    - Managing a single order across multiple organisations
    - Fulfilment, Control, Performance, Assurance, Usage/Analytics
    - One-stop-shop (marketplace) for users
- **Orchestration**
- **Automation**
- **Global digital marketplace**
Why is this important to us?
GEANT Numbers

- 50 Million users
- 10,000 institutions
- 40+ Partners
  - *Multi-domain*
  - NREN
    - Regional Networks
    - NOCs
- “Single digital market”
- NREN to NREN services
Scaling issue
DELIVERING...AS A SERVICE

**How/when is my traffic steered to my pool of VMs?**
**When does charging start?**
**Who do I turn to in case of performance incidents?**
**What is the guaranteed uptime of my service?**
**How can I dynamically update my services?**
Integration/Interoperation

How do we do this
System Architecture - OSS/BSS

- **Business Support Systems (BSS)**
  - Systems used to manage the business or customer.

- **Operational Support Systems (OSS)**
  - Systems used to manage the network.

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<table>
<thead>
<tr>
<th>BSS Layer</th>
<th>OSS Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self service order</td>
<td>Provisioning</td>
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<tr>
<td>CRM</td>
<td>Monitoring</td>
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<tr>
<td>Service Catalogue</td>
<td>Network Management</td>
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<tr>
<td>Billing System</td>
<td>Management Systems</td>
</tr>
<tr>
<td>Service Management</td>
<td>Service Bus</td>
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</tbody>
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- Modular, compartmentalized systems.
- Internal interaction via message bus.
- Middleware - brains
Orchestrator

- Has a **workflow engine** exposing a service bus for external communications
  - **Deconstructs** an end-to-end order and enables the B2B transactions between domains.
  - **Controls** these interactions and implements e2e service delivery and management logic

- Orchestrators can be deployed:
  - in a **centralized** mode (e.g. a single orchestrator overarching campus, NREN, GEANT, SP network) or
  - in a **distributed** mode: each SP deploys a workflow engine that supports east-west interactions with peering SPs
Multi domain environment
A multi-Service Provider environment
Orchestrated business and operations

- Service catalogue management
  - SPs should maintain and dynamically expose their up-to-date portfolio in an open market place

- Composable services
  - Users should be able to browse multiple SP catalogs and cherry pick services to compose their working environment
  - SPs could provide bundled service offerings to users (e.g. cloud machines accessible via L2 private lines and/or VPN instances)

- Order management
  - The order should be seamlessly handled by underlying providers.
  - The user should be presented with live status updates on the status of his order from a one-stop-shop.

- Service assurance
- Event and incident management
- SLA management

- Orchestration for:
  - Provisioning
  - Troubleshooting
  - Decommissioning

- Accounting usage levels (later billing)
- User analysis and retention

A campus user submits a service order to obtain L2 access to a remote data center/CSP facility.

Operational level – transparent to user
An eInfrastructure interoperation scenario

- Standardized APIs expose selected internal business/operational functions of each party
- East-West interfaces for business delivery and service operations
- CSPs/3rd party providers
  - Understand APIs and external signaling concept well
How does it work?

Service Provider
- Ordering portal
- CRM
- Other BSS
- Service inventory/catalogue

Orchestration
- Provisioning systems
- Other OSS

Business interactions
- Service interactions
- Operational interactions

APIs (examples)

- **provisioning-controller**: Provisioning Controller
  - GET
  - POST
  - DELETE

- **service-inventory-controller**: Service Inventory Controller
  - GET
  - POST
  - DELETE

- **order-capture-controller**: Order Capture Controller
  - GET
  - POST
  - DELETE

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Adopting standards
Application Programming Interfaces

• Open Interfaces
  • Catalog Interface
  • Service Ordering & Activation
  • SLA Management
  • Performance
  • Inventory
  • Resource Order
  • Trouble Ticket
  • Security
  • Event/problem management
  • .....
Network

Topology

Technologies
• Decentralised Orchestration tool
  • How does it know which local systems to engage for e2e service delivery?
    • Interconnection points and path information becomes important

• Solved problem for on demand circuit provisioning tools (BoD, ION, OSCARS)
  • NSI Aggregator and Path Computation Engine (PCE)
Path Computation Engine

- Standalone PCE for use by Aggregator
  - STPs, SDP

- NSI domains already have it
  - Non-NSI can implement it independently

- RESTful API
  - Designed to talk to aggregator
  - Could be peer-to-peer.
    - Just another East<->West interface
Network connectivity provisioning
Technologies at GÉANT/NRENs

Orchestration

BoD cloud

Network Services Agent (NSA)

NSI-capable NSPs

Orchestration

MDVPN fabric

NSPs

Orchestration

EVPN/DCI fabric

Data center

IX

IX

IX
Proof of Concept
Proof of Concept

- Microsoft Azure ExpressRoute
  - Amsterdam (AMS & LON)
  - Provided by Netherlight (SURFnet)
- Institution -> NREN -> GEANT -> Netherlight -> MS Azure
- Network
  - ExpressRoute
  - BoD
  - MD-VPN
  - MD-VPN Proxy
- Some automation
- All orchestrated
Short-term plan: ‘two-stops’ shop

**Cloud SP portal**
Order VMs
Select network connectivity provider -> GEANT
Retrieve ‘CSP Service ID’ and ‘S-VLAN’

**Network connectivity one-stop-shop portal**
Insert institution, CSP and ‘CSP Service ID’ information
Insert S-VLAN information
Order e2e L2 VPN to VMs

Orchestration

Network service providers - NSPs

NREN

GÉANT

CSP

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Long-term plan: one-stop shop

R&E Cloud Services one-stop-shop portal
✓ Authenticate in institution via eduGAIN
✓ Select CSP ①
✓ (CSP catalogue retrieved) ② order VMs ④
✓ (Network services catalogue retrieved) ③ order L2 link ⑤
✓ Use dashboard to manage/monitor service ⑥

1. Dynamically populated GÉANT Cloud Service Provider Catalogue
2. Catalogue offerings of the selected CSP
3. Network services catalogue offerings (e.g. L3 connectivity, L2 VPN)
4. Invoke CSP API or B2B interfaces for order management & provisioning
5. Invoke NSP API or B2B interfaces for order management & provisioning
6. Invoke CSP/NSP API or B2B interfaces for monitoring and service management
Summary

• Standardized delivery of services

• Integration. Orchestration. Automation

• Architecting compartmentalized systems
  • expose via APIs
  • East-west APIs for SP to SP interaction

• Managing order end-to-end

• Global digital marketplace
Thank you

Additional slide credits to Afrodite Sevasti, GRNET

GEANT
Networks · Services · People
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A flexible model
Opt-in interoperability

Orchestrator-invoked interfaces
- No automation required
- Basic information exposed via RESTful APIs towards the orchestrator
- Notifications via emails, ticketing system etc.

B2B/operational interfaces
- Orchestration entry points (e.g. URIs)
- Advertising catalogue
- Resource topology
- Order Management & Provisioning
- Service Lifecycle Management
- Operations (Monitoring, Troubleshooting, SLAs)
- Accounting/billing

User-demand as an incentive for automation
High Level Architecture design

![High Level Architecture Diagram]

- **BSS Orchestra**: Orchestrates BSS, CRM, ITSM services.
- **SSP Adapter**, **CRM Adapter**, **ITSM Adapter**, **BSS Orchestra Adapter**.
- **OSS Orchestra**: Orchestrates OSS services.
- **OSS System X Adapter**, **OSS System Y Adapter**, **OSS System Z Adapter**.
- **Provisioning System X**, **Provisioning System Y**, **Provisioning System Z**.
- **Containerized Microservices**

**TMFized payload over HTTPS**