



MAXedge Services

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Deepphought2

- Built in 2014
- 488 nodes, 9840 cores, E5-2680v2 (2.8GHz)
- 128GB of RAM each (6.4GB/core)
- 40 GPU nodes (2 Nvidia K40 GPUs each)
- 5 Large memory nodes (1TB RAM each)
- FDR (56Gbps) Infiniband
- 1PB Lustre

MARCC/Bluecrab

- Built in 2014, some more recent additions
- UMD owns 15% share
- 846 nodes, 21792 cores (most Haswell 2.5GHz), additional Broadwell, Ivy Bridge and Skylake (2.5GHz-3GHz)
- 128 GB of RAM each
- 50 GPU nodes with 2 Nvidia K80s each
- Handful of GPU nodes with Nvidia P100s
- 50 Large memory nodes (1TB RAM each)
- FDR (56 Gbps) Infiniband
- 2PB Lustre, 20PB ZFS/NFS

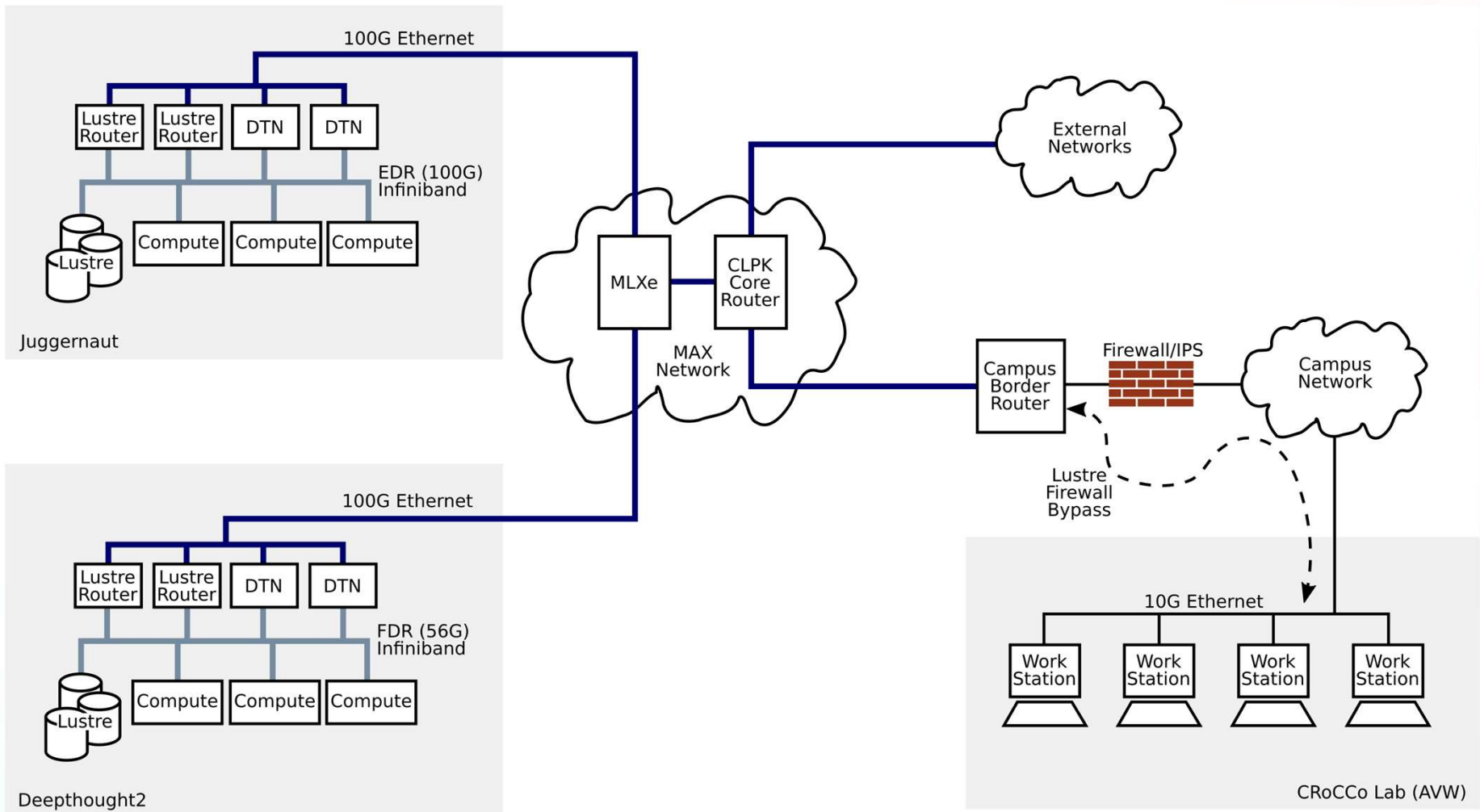
Juggernaut

- Built in November, 2018
- 15 nodes, 600 cores (Skylake 2.4GHz)
- 384GB of RAM each (9.6 GB/core)
- 1 GPU node (with 2 Nvidia P100s)
- EDR (100Gbps) Infiniband
- 1.5 PB Lustre

Deepthought3

- Currently in the planning stages
- Somewhere in the 2 Petaflop range
- Will have a small number (<10) of large memory nodes (1.5TB RAM)
- Will have around 40 GPUs, probably Nvidia V100
- Lustre storage (~2PB)
- Additional archival storage
- HDR/EDR (200Gbps/100Gbps) Infiniband

UMD/MAX HPC Networking



Outline

- What is MAXedge?
 - How do we use MAXedge?
 - What services does MAXedge offer?
- How does MAXedge work? – A deep dive

What is MAXedge?

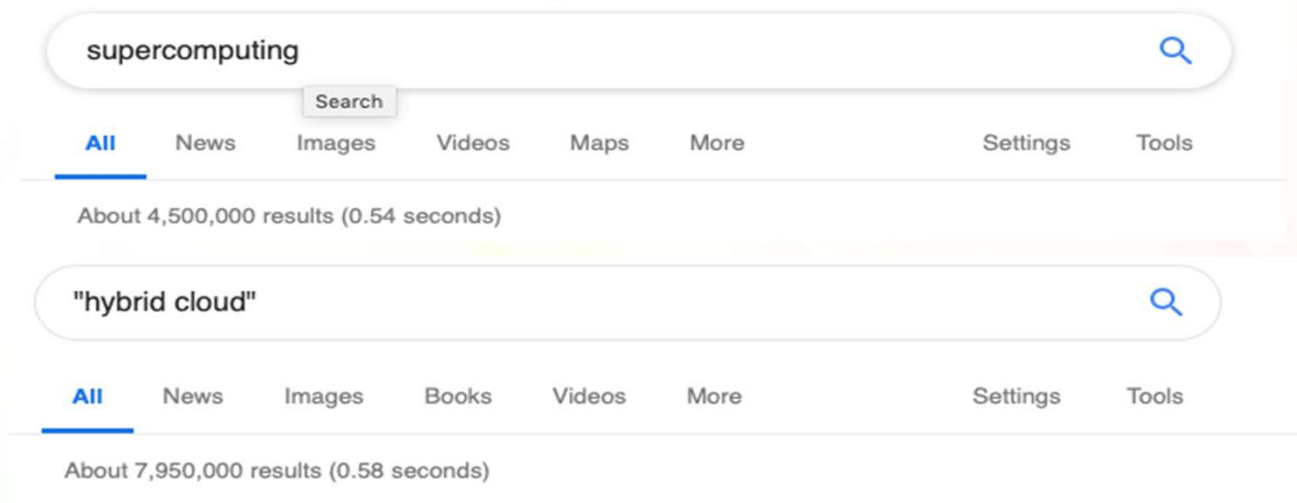
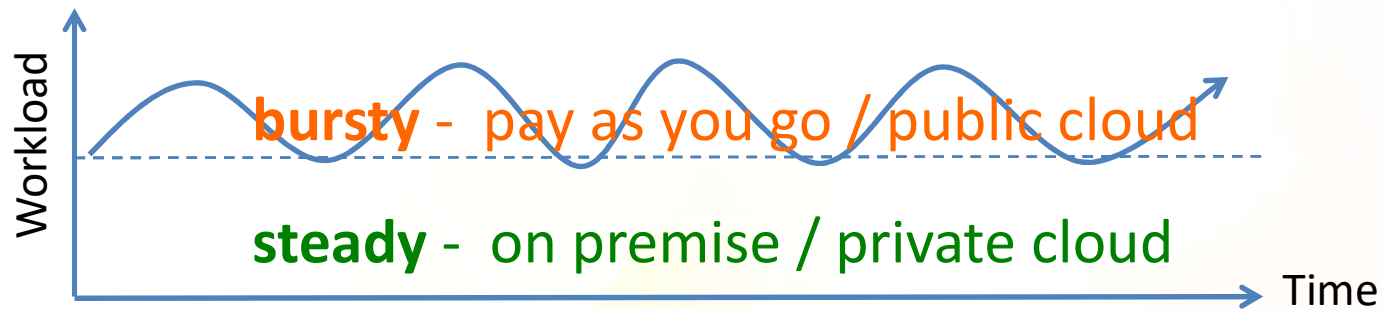
MAXedge is an intelligent, advanced and innovative edge computing facility operated by MAX.

It is built upon modern **SDN** and **cloud computing** technologies, and provides secure and high-performance services in a **multi-tenancy, on-demand** and **as-a-service** fashion.

Software Defined Networking @MAX

- DRAGON Research Network (production)
- GENI Network and GENI Rack (production)
- Software-Defined ScienceDMZ (protoduction)
- Software-Defined WIX Exchange (prototype)
- OpenFlow and SDN Testbeds (research)
- SENSE Testbed (research)

Cloud Economics



A Need for “Edge”

- Edge Computing: A distributed computing paradigm focused on processing data at local compute servers and devices, instead of transmitting them to data centers.
- Edge Cloud: A distributed cloud facility (or scaled-down data center) at network edge.
- ScienceDMZ: A widely adopted “edge” networking solution for big science data movement for the research community.
- For both economic and performance reasons, our community needs a cloud-like ScienceDMZ facility that adopts edge computing paradigm and is customized for scientific research workflows.

A Chronicle of Ideas

- MAX was among the first to use **AWS Direct Connect** service at its eastern region.
- In 2013, we started experimenting provisioning multi-tenancy services over a 10G AWS Direct Connect pipe, **dynamically**.
- An extension of the DRAGON control plane, plus BGP and VRF tricks – a **Cloud Connect** precursor.

SDN, Cloud and Edge

- The NSF **SDNX** project (2012-2014) promoted the idea of **bringing applications to network edge**.
- The NSF **HPCDNA** project (2013-2015) conceived the idea of **network-embedded compute and storage** and started integrating SDMZ, HPC and AWS over SDN, to break into the “walled garden”.

Infrastructure Datafication

- The DOE **RAINS** project (2014-2017) developed the Multi-Resource Markup Language (MRML) and laid the foundation for **model driven full-stack automation and orchestration**.
- The NSF **RECAST** project (2015-2017) leveraged RAINS technologies and developed the **Software Defined ScienceDMZ (SD-SDMZ)** architecture.
- **SD-SDMZ** = cloud-like, regionalized / shared, as-a-service model.

Big Orchestration

- The DOE **SENSE** project (2016-2019) adopted RAINS modeling and computation tools, and developed the SENSE software stack for **distributed and scalable end-to-end orchestration**.
- **MAXedge** is on the converging paths of SD-SDMZ architecture and SENSE orchestration software.
- In 2018, MAX rolled out the **Advanced Hybrid Cloud (AHC)** and **Edge Cloud Connect (ECC)** pilot services.

The MAXedge

- An SD-SDMZ built on SENSE software stack.
- A model-driven end-to-end service orchestrator.
- Arbitrary combination of SDN, Cloud, HPC and Edge compute and storage resources based on abstract user intents.
- Secure, high-performance, dedicated and API-driven services for end-to-end workflows.

Outline

- What is MAXedge?
- How do we use MAXedge?
 - What services does MAXedge offer?
- How does MAXedge work? – A deep dive

Orchestrator Portal

System Health:

Visualization

Catalog

Details

Drivers

Admin

Account

Logout

Service Instances

Create New

CSV

Search:

Alias	Type	Reference UUID	State
MAX-StackVCluster-3xVM (PROD)	Virtual Cloud Network	cdb74535-4559-4ada-8c3c-1ffb61cfc862	CREATE - READY
VCN-FreeIPA-Devel (PROD)	Virtual Cloud Network	3c768525-20b7-4471-97c3-85bf887f356d	CREATE - READY
VCN-ReleaseTest-Docker-VM	Virtual Cloud Network	df277f17-d957-480b-90a4-7a1239ee85e0	CREATE - READY
IPA-ALM-Plugin-Test (180.161)	Virtual Cloud Network	2318799f-bee4-41c0-8c33-fc1eba5c6d83	CREATE - READY
MAX-MD2-Dev-IPA162	Virtual Cloud Network	faf06ddb-0f76-4ead-bc45-dc88b372dec0	CREATE - READY
SENSE-BDE-Recover-VM.148	Virtual Cloud Network	dc0e6d65-f978-4262-bc2f-d280a5c7316a	CREATE - READY

Showing 1 to 6 of 18 entries

Previous

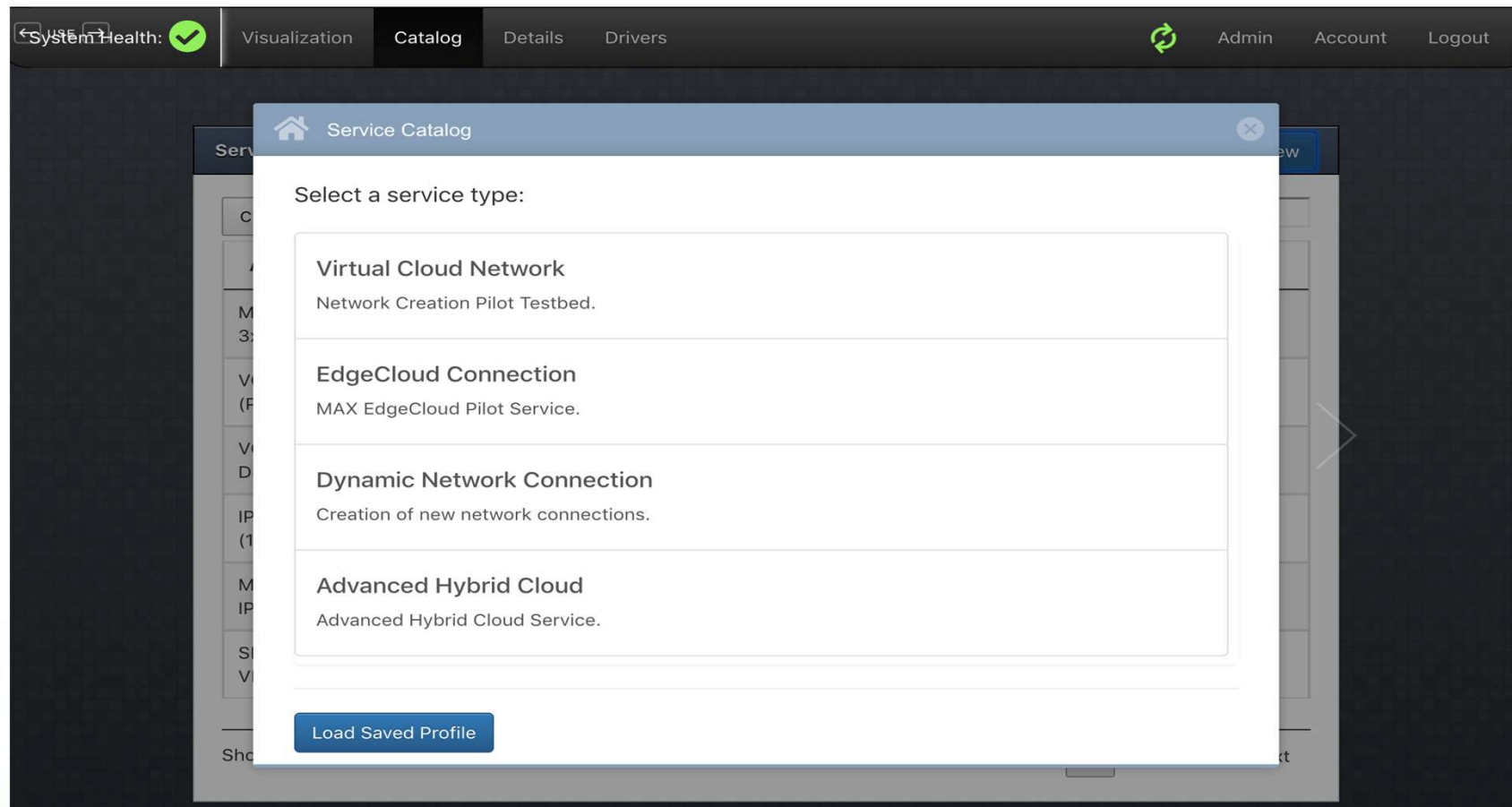
1

2

3

Next

Service Catalog



Service Intent and Lifecycle Management

The image displays three screenshots of a network management interface, likely for Service Intent and Lifecycle Management.

Top Screenshot: Connections Configuration

This screenshot shows the 'Connections' configuration page. A sidebar on the left indicates the 'Dynamic Network Connection' type, with 'BDE-IntentX' selected. The main area is titled 'Multi-Path P2P VLAN' and shows configuration for 'Connection #1'. The 'Name' field is set to 'connection 1'. Under 'Terminal #1', the 'URI' is 'urn:ogf:network:es.net:2013::chic-cr5-3_2_1:+' and the 'VLAN Tag' is 'any'. Under 'Terminal #2', the 'URI' is 'urn:ogf:network:maxgigapop.net:2013-180-148.research.maxgigapop.net' and the 'VLAN Tag' is 'any'. There are 'Add Connection' and 'Assign IP' buttons.

Bottom Left Screenshot: Instance Details

This screenshot shows the 'Instance Details' page. The 'System Health' is green. The 'Details' tab is active. The instance details are as follows:

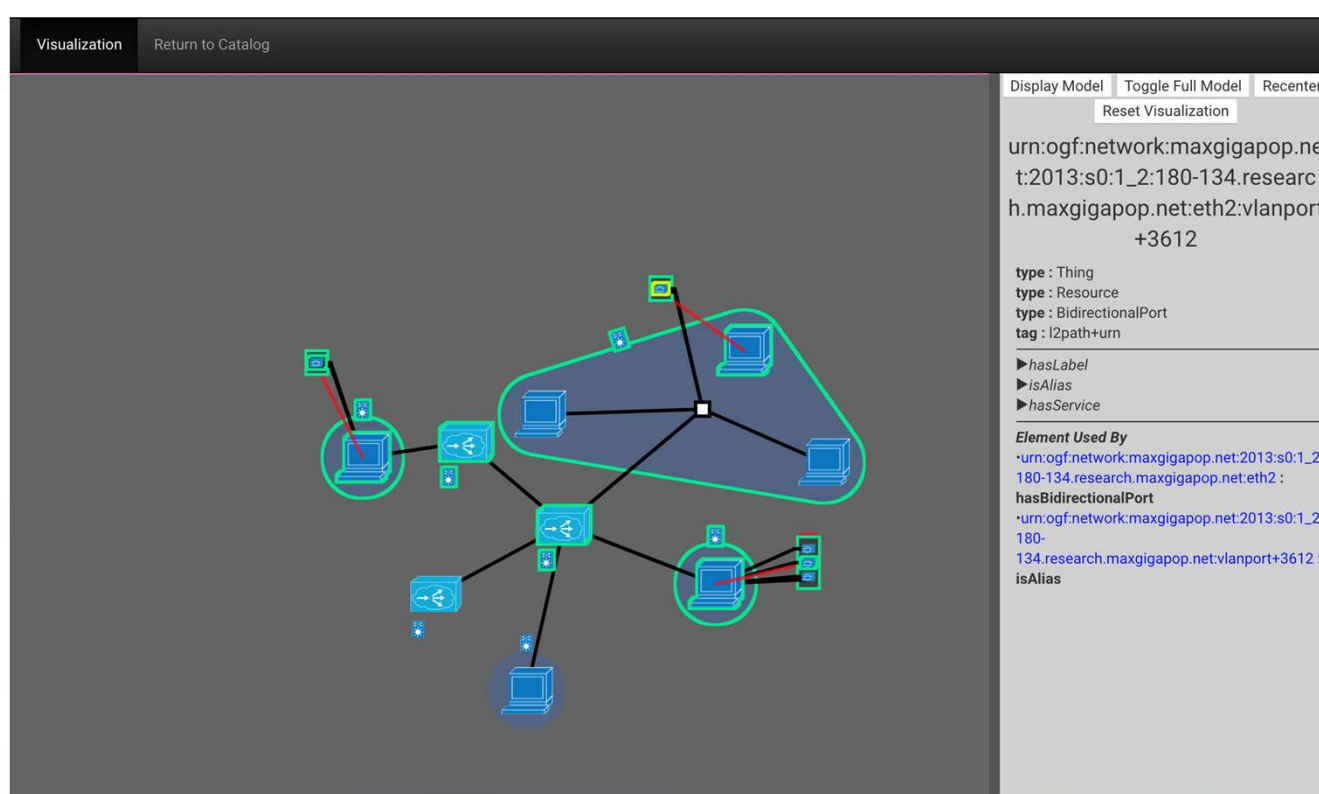
Instance Details	
Instance Alias	MAX-StackVCluster-3xVM (PROD)
Reference UUID	cdb74535-4559-4ada-8c3e-1f1b61cfc862
Owner	xyang
Creation Time	2017-12-11 09:18:21.0
Instance State	CREATE
Operation Status	READY

Below the table, it states 'Service has been successfully verified.' At the bottom, there are 'Cancel', 'Delete', and 'Delegate' buttons.

Bottom Right Screenshot: Verification Status

This screenshot shows the 'Verification' page. The 'System Health' is green. The 'Verification' tab is active. It displays two sections: 'Unverified Addition' and 'Verified Addition'. The 'Verified Addition' section shows a diagram of a network topology with a central node and two peripheral nodes. Below the diagram are buttons for 'View Text Model', 'Recenter', and 'Display Manifest'. The 'Unverified Reduction' section is currently empty.

Infrastructure and Service Visualization



API Driven Interaction for App Workflows

The screenshot displays the SwaggerHub interface for the SENSE-O Northbound Intent API. The interface is divided into three main sections: a left sidebar with a search bar and a list of API categories (COMPUTATION, CONNECTION, DISCOVERY, MONITORING), a central editor showing the OpenAPI specification in JSON, and a right sidebar showing the visual representation of the API.

Left Sidebar: Contains a search bar and a list of API categories. The 'COMPUTATION' category is expanded, showing a list of endpoints: POST /service, POST /service/{siUUID}, DELETE /service/{siUUID}, GET /service/{siUUID}/status, POST /service, POST /service/{siUUID}, DELETE /service/{siUUID}, GET /service/{siUUID}/status, PUT /service/{siUUID}/reserve, POST /service/{siUUID}/reserve, PUT /service/{siUUID}/commit, PUT /service/{siUUID}/release, PUT /service/{siUUID}/terminate, GET /discovery, GET /discovery/edgepoints, GET /discovery/edgepoints/{domainID}, GET /discovery/edgepoints/{domainID}/peer, and GET /discovery/services.

Central Editor: Displays the OpenAPI specification in JSON. The specification includes the following details:

```
1  swagger: '2.0'
2  info:
3    version: '0.9.0'
4    title: 'SENSE-O Northbound Intent API'
5    description: 'StackV SENSE-O Northbound REST API Documentation'
6
7  # Added by API Auto Mocking Plugin
8  host: 179-132.research.maxgigapop.net
9  basePath: /StackV-web/restapi/sense
10 schemes:
11   - https
12
13 tags:
14   - name: computation
15     description: Computation and query methods
16   - name: connection
17     description: Connection Service related methods
18   - name: discovery
19     description: API endpoints, service type, capabilities and topology discovery methods
20   - name: monitoring
21     description: Service monitoring related methods
22   - name: troubleshoot
23     description: Service monitoring related methods
24   - name: notification
25     description: Handling notification for callback events
26
27 paths:
28   /service:
29     post:
30       tags:
31         - computation
32         - connection
33       summary: Create service instance
34       description: Create a service instance (negotiation optional)
```

Right Sidebar: Shows the visual representation of the API. The title is 'SENSE-O Northbound Intent API' with version '0.9.0'. The base URL is '179-132.research.maxgigapop.net/StackV-web/restapi/sense'. The API is categorized under 'StackV SENSE-O Northbound REST API Documentation'. The 'Schemes' dropdown is set to 'HTTPS'. The 'computation' category is expanded, showing a list of endpoints: POST /service (Create service instance), POST /service/{siUUID} (Create/Negotiate a service instance), DELETE /service/{siUUID} (Delete service instance), and GET /service/{siUUID}/status (Instance status). The 'connection' category is also expanded, showing a list of endpoints: POST /service (Create service instance) and POST /service/{siUUID} (Create/Negotiate a service instance).

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- **What services does MAXedge offer?**
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Hybrid Cloud for HPC + Big Data?

- Cloud services are doing great for Big Data,
 - Applications such as Hadoop at large scale
- But they still cannot deliver the performance many high-end apps need.
 - limited type of resources by public providers
 - performance capped by virtualization and inter-cloud networking
 - It just does not feel like your high performance computing, parallel storage, high speed data transfer and deterministic speeds at “home”.

Advanced Hybrid Cloud (AHC)

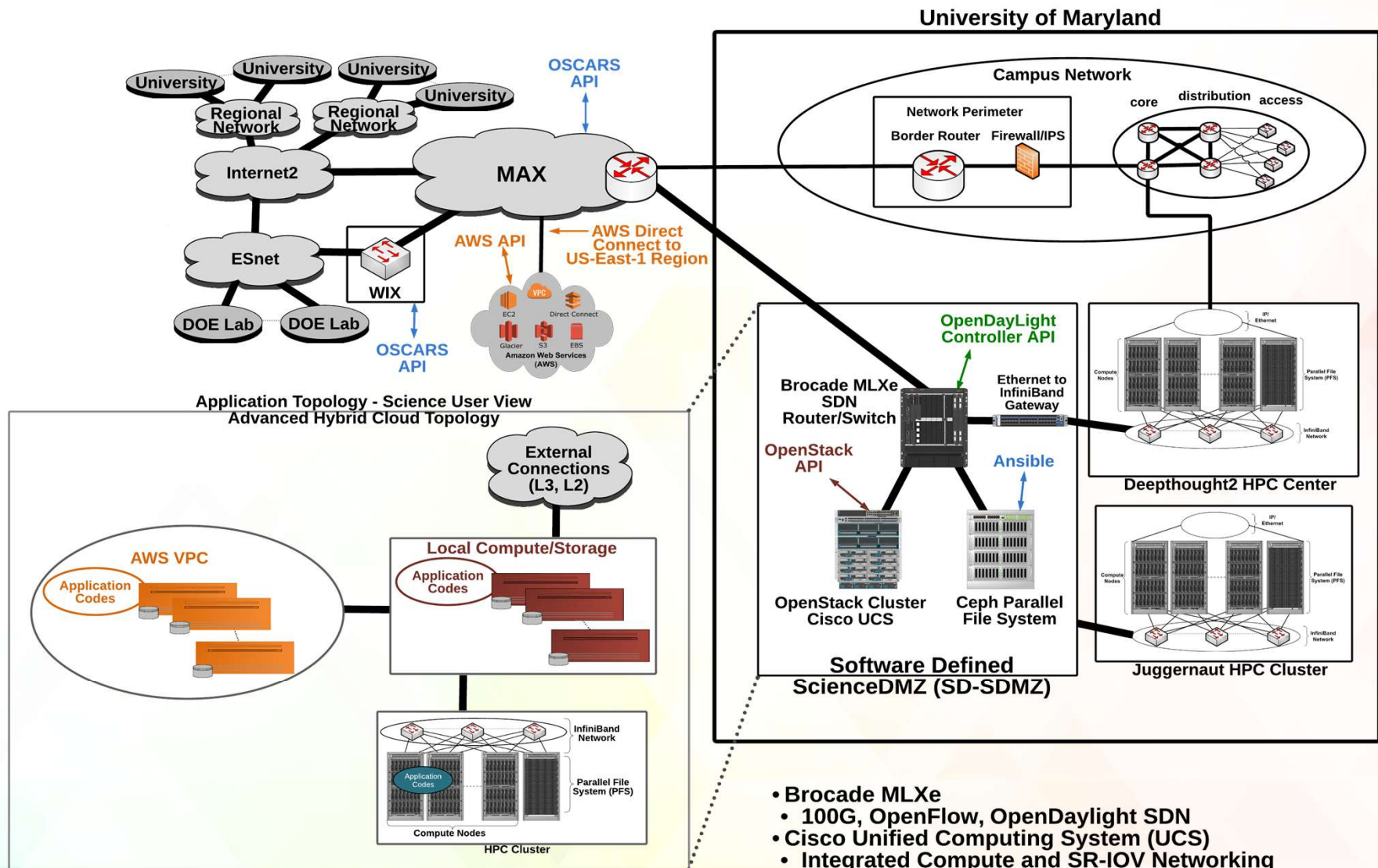
Cloud-Like Service + HPC Experience

- ✓ **Orchestrated hybrid cloud with deterministic end-to-end high performance**
- ✓ **Local OpenStack Virtual Machines (with SRIOV interfaces to network and storage)**
- ✓ **Dedicated Local Ceph Storage Resources and Connections (SRIOV interface)**
- ✓ **Integrated AWS Resources (VPC or Public over Direct Connect)**
- ✓ **Dedicated Network Connections with QoS**
- ✓ **Set up in one click “as-a-service”**

User Supplies the following information

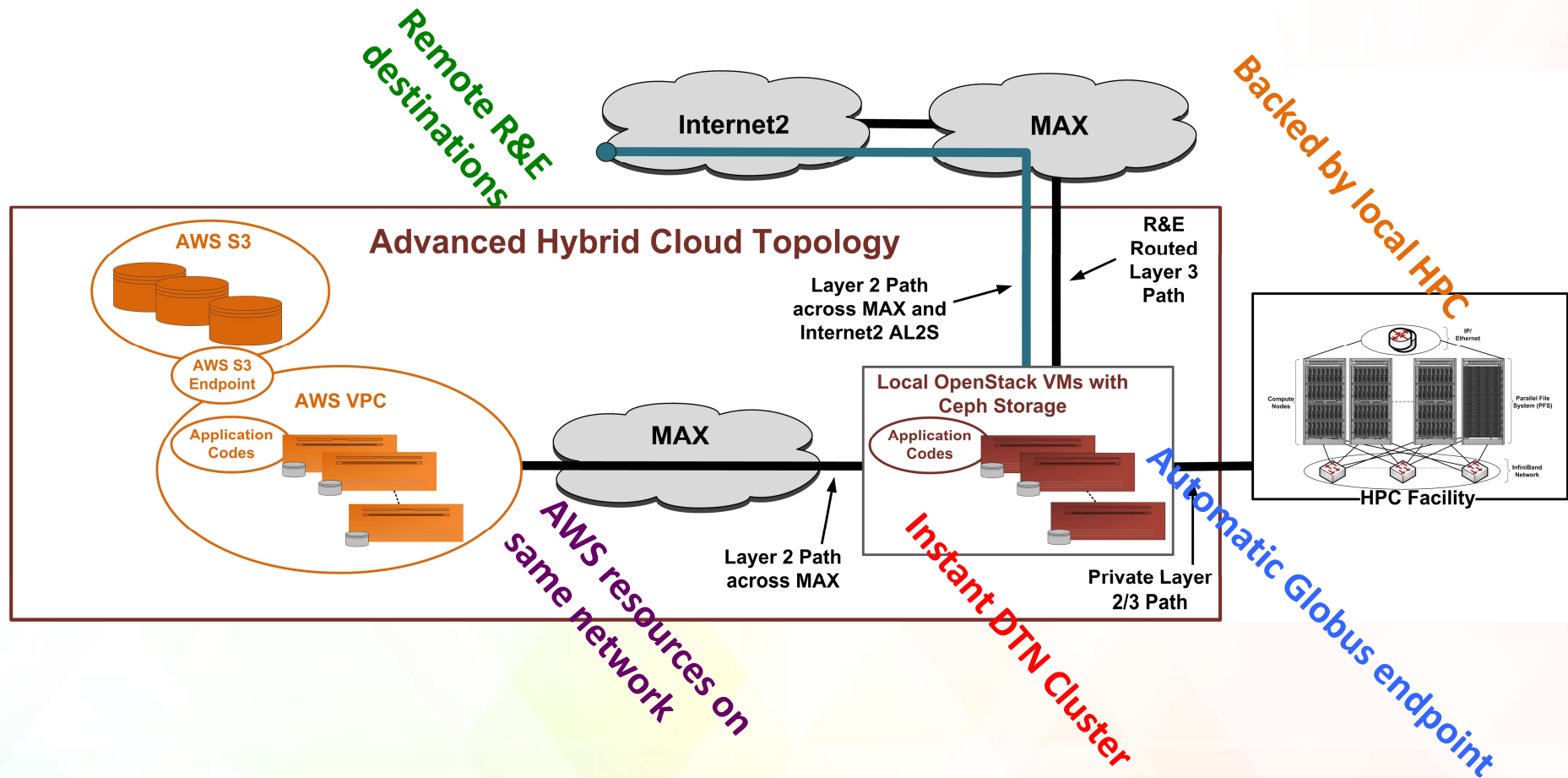
- 1) Local Cloud Resources**
 - number of VMs
 - amount of storage
- 2) Public Cloud (AWS) Resources**
 - **Direct Connect access**
 - Shared (with preemption)
 - Dedicated (bandwidth, schedule (start time, end time))
 - **AWS account number (User or MAX?)**
 - If User AWS account number that is all that is needed
 - If MAX AWS account number, specify AWS Resources, VPC, Instance Type, Storage amount, S3 Endpoint
- 3) External Connections (urn list discoverable from MAXedge portal or API)**
 - AL2S (remote endpoint)
 - Other external resources as available
- 4) Service Level Parameters**
 - Define number of simultaneous service instances allowed

MAXedge AHC-Ready Infrastructure



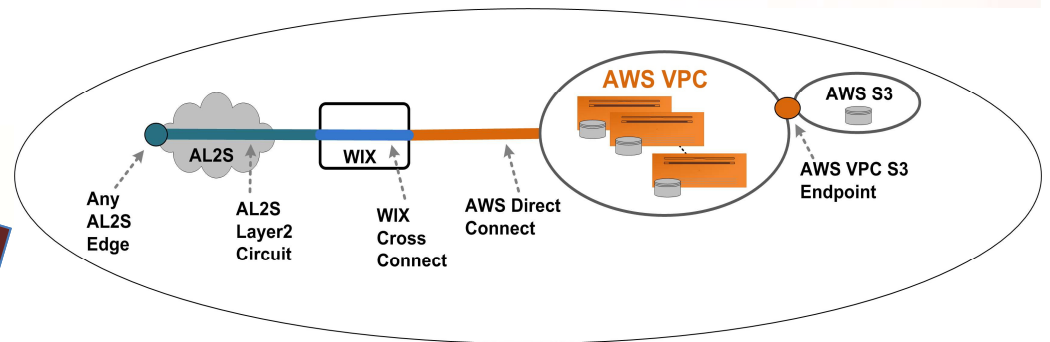
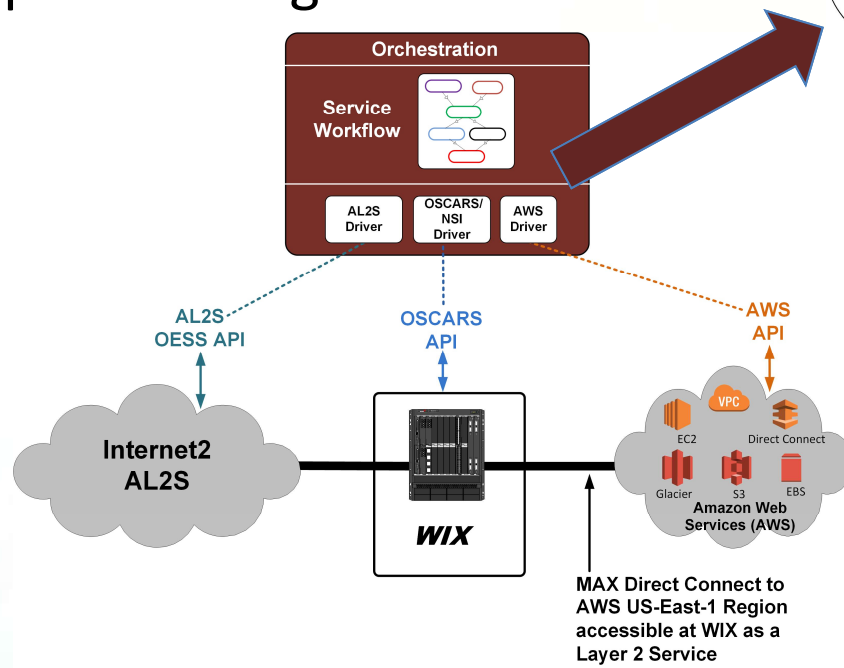
- Brocade MLXe
- 100G, OpenFlow, OpenDaylight SDN
- Cisco Unified Computing System (UCS)
- Integrated Compute and SR-IOV Networking
- Ceph High Performance Storage System

MAXedge AHC Service in One Click



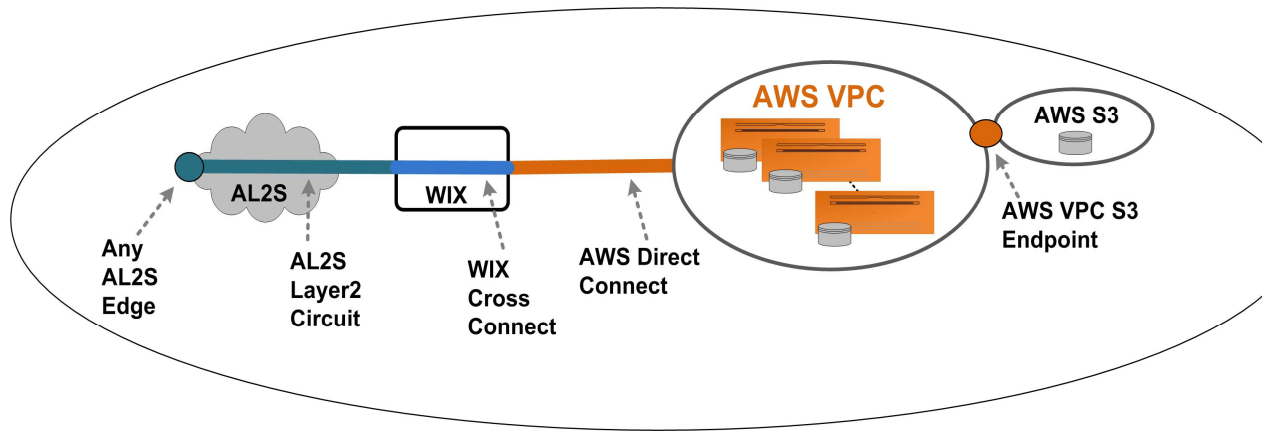
Edge Cloud Connect (ECC) Service

MAXedge orchestrates AL2S, WIX, and AWS Direct Connect provisioning



Dedicated layer-2 connection with QoS

Edge Cloud Connect (ECC) Service



- Available: AWS Direct Connect via shared or scheduled/dedicated mode
- Not available: compute, storage, BGP instance for AWS peering

User supplies the following information

1) Public Cloud (AWS) Resources

- **Direct Connect access**
 - Shared (with preemption)
 - Dedicated (bandwidth, schedule (start time, end time))

- User AWS account number

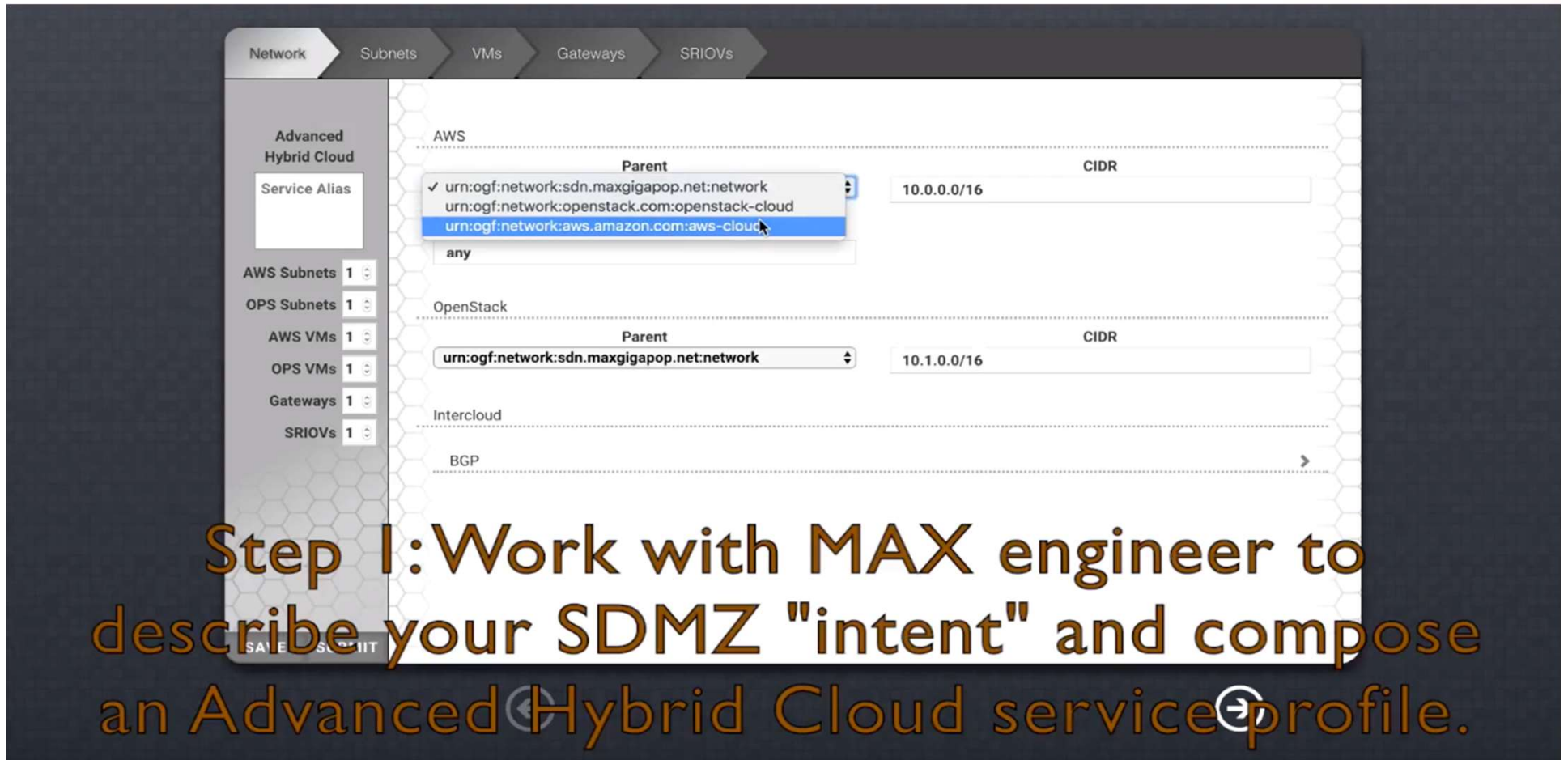
2) External Connections

- AL2S (remote endpoint)

3) Service Level Parameters

- Define number of simultaneous service instances allowed

MAXedge Service Workflow for Customers



The screenshot displays the MAXedge Service Workflow interface, specifically the 'Network' tab. The interface is divided into a left sidebar and a main configuration area. The sidebar contains a 'Service Alias' input field and a list of resource counts: AWS Subnets (1), OPS Subnets (1), AWS VMs (1), OPS VMs (1), Gateways (1), and SRIOVs (1). The main configuration area is organized into sections: AWS, OpenStack, Intercloud, and BGP. The AWS section is currently active, showing a 'Parent' dropdown menu with three options: 'urn:ogf:network:sdn.maxgigapop.net:network' (selected), 'urn:ogf:network:openstack.com:openstack-cloud', and 'urn:ogf:network:aws.amazon.com:aws-cloud'. A 'CIDR' input field next to the dropdown contains the value '10.0.0.0/16'. The OpenStack section shows a 'Parent' dropdown with the value 'urn:ogf:network:sdn.maxgigapop.net:network' and a 'CIDR' input field containing '10.1.0.0/16'. The Intercloud and BGP sections are currently empty.

Step 1: Work with MAX engineer to describe your SDMZ "intent" and compose an Advanced Hybrid Cloud service profile.

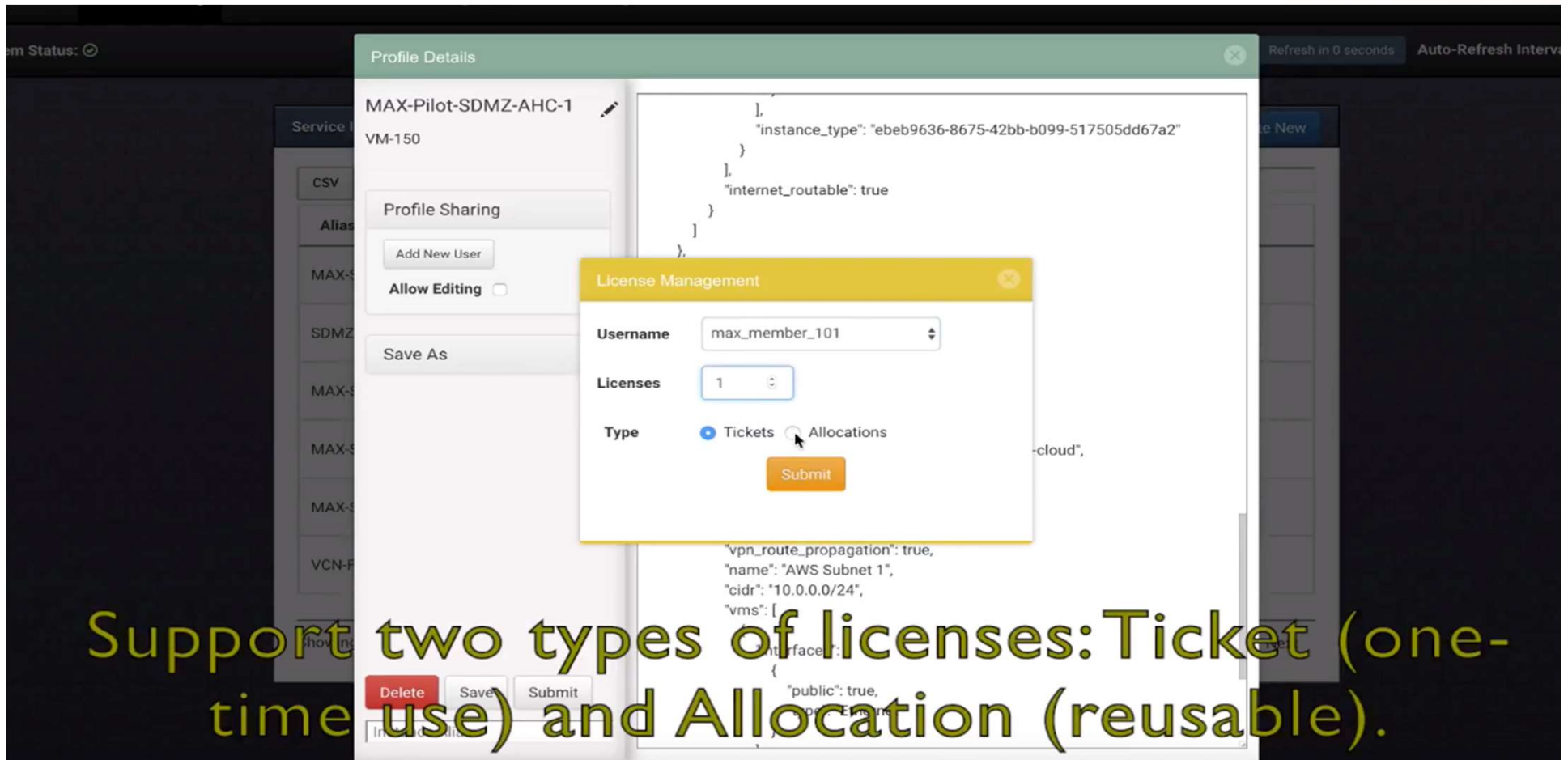
MAXedge Service Workflow for Customers

The screenshot displays the MAXedge Service Workflow interface. A 'Profile Details' window is open for the profile 'MAX-Pilot-SDMZ-AHC-1'. The window shows a 'Profile Sharing' section with an 'Add New User' button and an 'Allow Editing' checkbox. Below this is a 'Save As' button. The main content area displays a JSON configuration for a service profile. The configuration includes an 'instance_type' of 'eb9b9636-8675-42bb-b099-517505dd67a2', an 'internet_routable' flag set to true, and an 'intercloud' section with 'bgp' settings for authentication, ASN, VM host, and networks. The 'aws' section specifies the parent cloud provider, CIDR, direct connect VLAN, and subnets, including a VPN route propagation configuration. The 'vms' section is also present. The interface includes a 'Status' indicator, a 'Refresh in 0 seconds' button, and an 'Auto-Refresh Interval' setting. A large text overlay at the bottom reads: 'Step 2: MAX engineer "licenses" the service profile to you (and designated users)'.

```
{
  "instance_type": "eb9b9636-8675-42bb-b099-517505dd67a2",
  "internet_routable": true,
  "intercloud": {
    "bgp": {
      "authentication_key": "versastack",
      "amazon_asn": "7224",
      "vm_host": "OpenStack VM 1",
      "networks": "10.10.0.0/16"
    }
  },
  "aws": {
    "parent": "urn:ogf:network:aws.amazon.com:aws-cloud",
    "cidr": "10.0.0.0/16",
    "direct_connect_vlan": "any",
    "subnets": [
      {
        "vpn_route_propagation": true,
        "name": "AWS Subnet 1",
        "cidr": "10.0.0.0/24",
        "vms": [
          {
            "public": true,
            "type": "ebs"
          }
        ]
      }
    ]
  }
}
```

Step 2: MAX engineer "licenses" the service profile to you (and designated users).

MAXedge Service Workflow for Customers



The screenshot displays the MAXedge Service Workflow interface. A 'Profile Details' window is open, showing the profile 'MAX-Pilot-SDMZ-AHC-1' with a 'VM-150' instance. The 'Profile Sharing' section includes an 'Add New User' button and an 'Allow Editing' checkbox. A 'License Management' dialog box is overlaid on the profile details, featuring a 'Username' dropdown set to 'max_member_101', a 'Licenses' input field with the value '1', and a 'Type' section with radio buttons for 'Tickets' (selected) and 'Allocations'. A 'Submit' button is at the bottom of the dialog. The background shows a list of services on the left and a JSON configuration on the right.

Support two types of licenses: Ticket (one-time use) and Allocation (reusable).

MAXedge Service Workflow for Customers

Service Instances

CSV

Alias	Type	Reference User
-------	------	----------------

Service Profiles

Select a saved service profile:

MAX-Pilot-SDMZ-AHC-1 created by xyang (Read only)
VM-150

Return to Service Catalog

Profile Details

MAX-Pilot-SDMZ-AHC-1
VM-150
Created by xyang
Using 2 out of 3 roles

```
{
  "data": {
    "openstack": {
      "parent": "urn:ogf:networkopenstack.com:openstack-cloud",
      "gateways": [
        {
          "name": "Gateway 1",
          "type": "Intercloud Network"
        }
      ],
      "connects": [
        {
          "from": "External-Access"
        }
      ],
      "name": "Gateway 1.2",
      "type": "UCS Port Profile"
    },
    "connects": [
      {
        "from": "Ceph-Storage"
      }
    ],
    "name": "Gateway 1.3",
    "type": "UCS Port Profile"
  },
  "cidr": "10.1.0.0/16",
  "subnets": [
    {
      "name": "OpenStack Subnet 1"
    }
  ]
}
```

Step 3: You login to MAX service portal and review shared service profile and licenses

MAXedge Service Workflow for Customers

The screenshot displays the 'Profile Details' window for a service instance named 'MAX-Pilot-SDMZ-AHC-1'. The instance is of type 'VM-150', created by 'xyang', and is using 0 out of 1 slots. The 'Read Only' status is indicated. The 'Service Instance' section shows a 'CSV' button and an 'Alias' field. The 'JSON' section displays the following configuration:

```
{
  "data": {
    "openstack": {
      "parent": "urn:ogf:network:openstack.com:openstack-cloud",
      "gateways": [
        {
          "name": "Gateway 1",
          "type": "Intercloud Network"
        },
        {
          "connects": [
            {
              "from": "External-Access"
            }
          ],
          "name": "Gateway 1_2",
          "type": "UCS Port Profile"
        },
        {
          "connects": [
            {
              "from": "Ceph-Storage"
            }
          ],
          "name": "Gateway 1_3",
          "type": "UCS Port Profile"
        }
      ],
      "cidr": "10.1.0.0/16",
      "subnets": [
        {
          "name": "Openstack Subnet"
        }
      ]
    }
  }
}
```

At the bottom of the window, there are 'Save' and 'Submit' buttons. The background of the interface shows a 'Service Instance' list with a 'Show' button and a 'Next' button.

Step 4: You create service instances for up to the number of license allowance.

MAXedge Service Workflow for Customers

Service Catalog Service Details Account Logout

Logging Details Visualization Refresh in 10 seconds Auto-Refresh Interval 15 sec.

Logs - Current time: 15:57:14 Logging Level INFO

CSV Search:

	Timestamp	Event	Reference UUID	Level
🟢	2018-04-23 12:56:57,804	MCE_VMFilterPlacement.process.end	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,744	MCE_VMFilterPlacement.process.end	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,740	MCE_VMFilterPlacement.doPlacement.message	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,731	MCE_VMFilterPlacement.doPlacement.message	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,713	MCE_VMFilterPlacement.process.start	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,713	ActionBase.execute.message	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,679	MCE_VMFilterPlacement.process.end	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,673	MCE_VMFilterPlacement.doPlacement.message	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,613	MCE_VMFilterPlacement.process.start	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO
🟢	2018-04-23 12:56:57,613	ActionBase.execute.message	dbaf9ebd-b16f-4d7b-80ae-acbc084daae5	INFO

Showing 1 to 10 of 33 entries

Step 5: You provision, manage and monitor individual service instances by self service.

MAXedge Service Workflow for Customers

The screenshot displays the 'Manifest Portal' web application. The left sidebar contains navigation tabs: 'Service Catalog', 'Service Details' (selected), 'Logging', 'Details', and 'Visualization'. Under 'Service Details', there are sub-tabs for 'Service', 'System', and 'Verification' (selected). The 'Verification' tab shows two sections: 'Unverified Addition' and 'Unverified Reduction'. The main content area, titled 'Manifest Portal', displays details for an 'Advanced Hybrid Cloud Service' with UUID: dbaf9ebd-b16f-4d7b-80ae-acbc084dae5. The service is identified as 'AWS Virtual Private Cloud (VPC) / Public Cloud'. The configuration details are as follows:

- Virtual Network Name:** urn:ogf.network:service+dbaf9ebd-b16f-4d7b-80ae-acbc084dae5:resource+virtual_clouds:tag+vpc1
- L2 Subnets**
 - Virtual Machines**
 - VM Name:** urn:ogf.network:service+dbaf9ebd-b16f-4d7b-80ae-acbc084dae5:resource+virtual_machines:tag+AWS_VM_1
 - Instruction:** To access the VM: ssh -i keypair+driver_key ec2_user@34.229.161.184
 - Private IP(s)**
 - IP Address:** 10.0.0.84
 - Interface:** urn:ogf.network:service+dbaf9ebd-b16f-4d7b-80ae-acbc084dae5:resource+virtual_machines:tag+AWS_VM_1:eth0
 - Subnet Name:** urn:ogf.network:service+dbaf9ebd-b16f-4d7b-80ae-acbc084dae5:resource+virtual_clouds:tag+vpc1-subnet0
 - CIDR (IPv4 Range):** 10.0.0.0/24
 - CIDR (IPv4 Range):** 10.0.0.0/16
- VTN Name:** urn:ogf.network:service+dbaf9ebd-b16f-4d7b-80ae-acbc084dae5:resource+virtual_clouds:tag+vpc2
- L2 Subnets**
 - Virtual Machines**
 - Private IP(s)**
 - IP Address:** 10.10.0.1/24
 - Mac Address:** 08:00:27:00:12:34
 - Port Profile:** Cisco_UCS_Port_Profile+AWS1769
 - vNIC URI:** urn:ogf.network:openstack.com:openstack-cloud:port+eth7a0270a3-4c58-4198-a2e5-

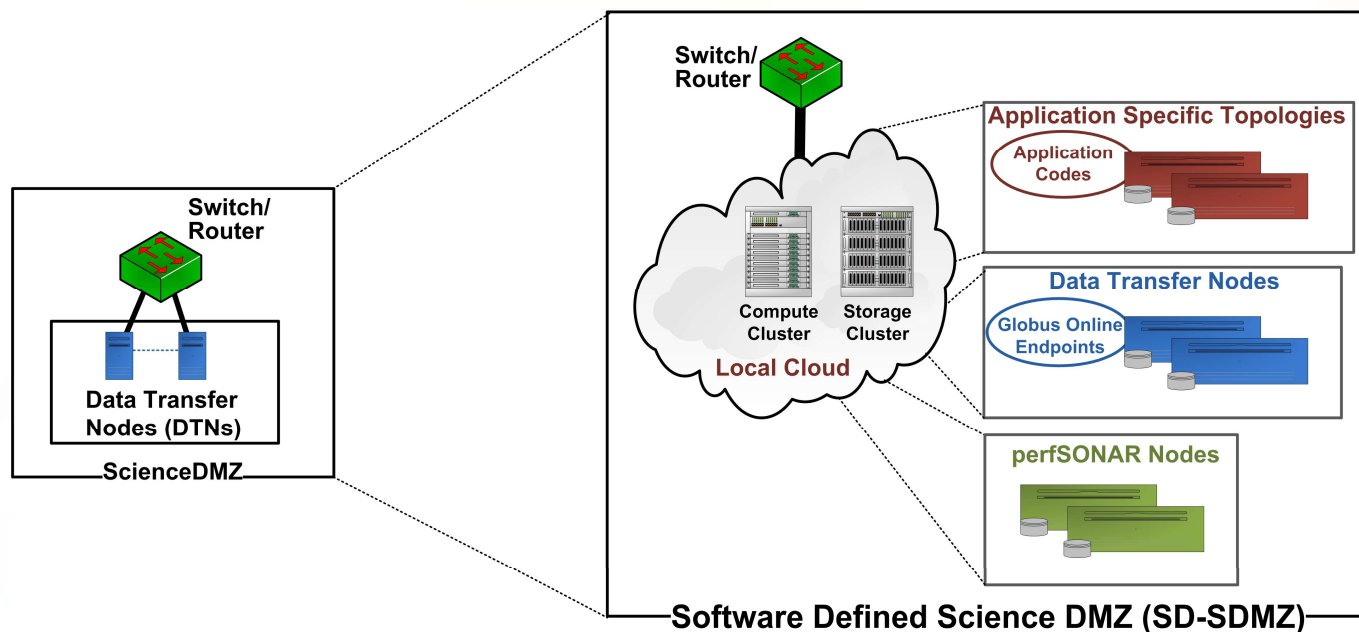
Service verification and manifest tools
provide straightforward information views.

Outline

- What is MAXedge?
- How do we use MAXedge?
- What services does MAXedge offer?
- How does MAXedge work? – A deep dive

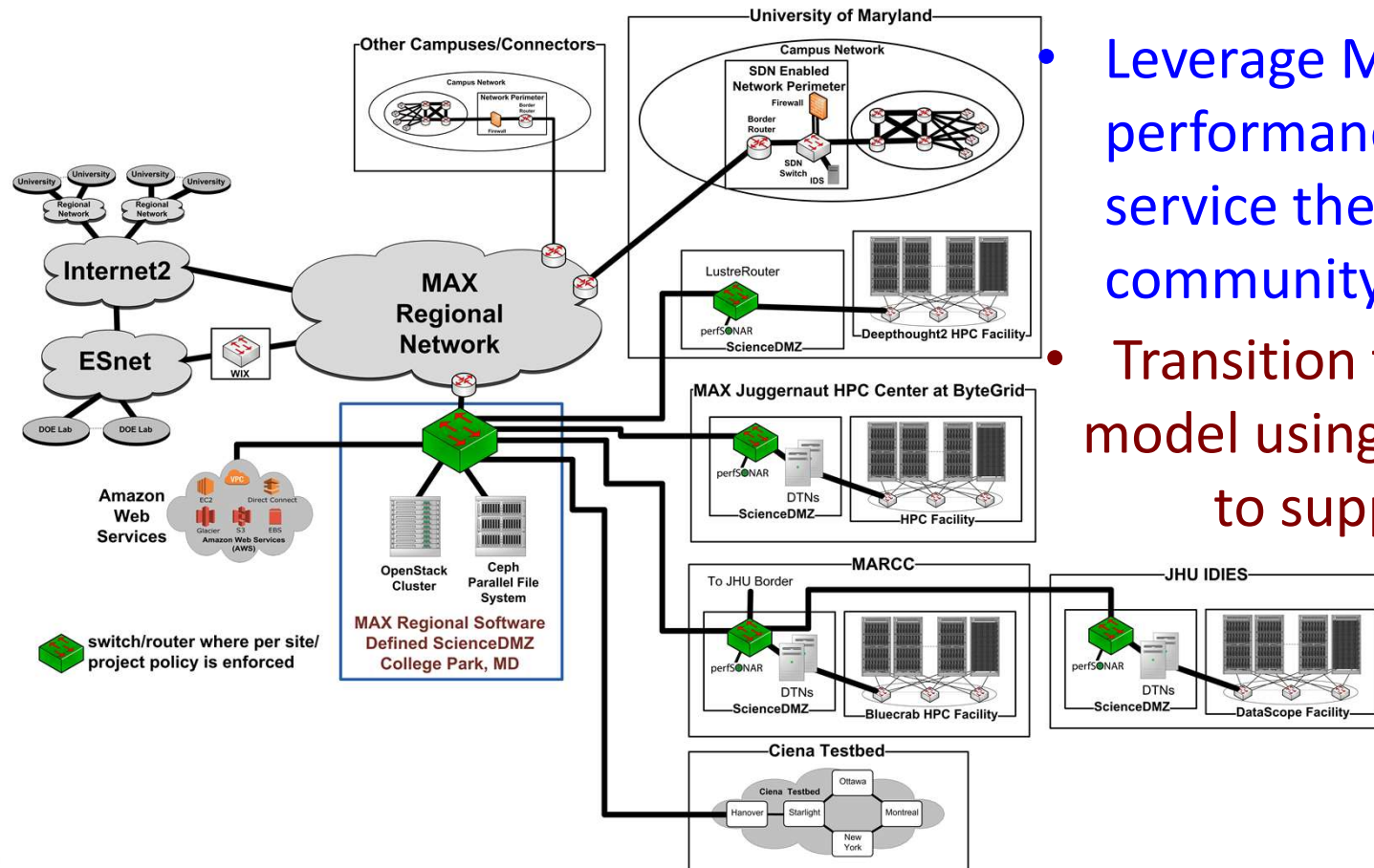
MAXedge: Virtualize and Cloudify

- ScienceDMZ transitions to local cloud compute, storage, SDN control. On-demand, scalable Hybrid Cloud services.



- Bare metal to local cloud evolution enabled by full stack automation and orchestration

MAXedge: Regionalize and as-A-Service



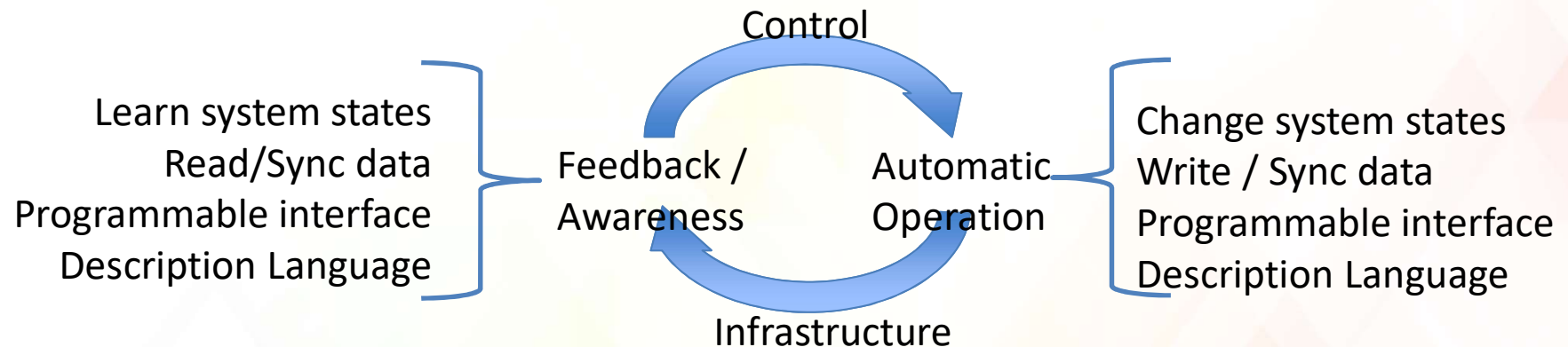
- Leverage MAX high performance networks to service the regional community
- Transition to “as A Service” model using “web services” to support “web scale” operations

Technical Approach

- Multi-Resource Orchestration
 - integrating and orchestrating the network and network services with the things that attach to the network – compute, storage, clouds, and instruments.
- Full-Stack Model Driven
 - using semantic models to describe resources in order to allow integrated reasoning, abstraction, and user intents, consistently through all layers of the system stack.
- Intelligent Computation Services
 - pluggable Model Computation Modules and “composable intelligence” to orchestrate “arbitrary” services in response to high level user requests.
- “Orchestrate the Automaters”
 - Lots of automations work together, end-to-end

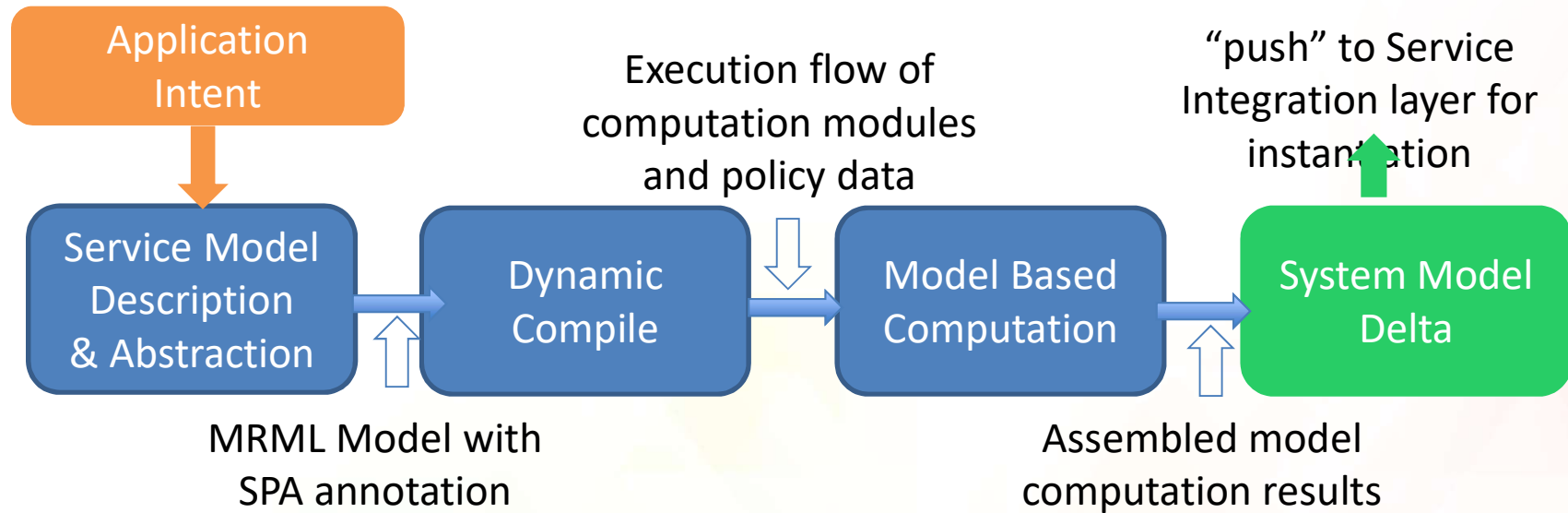
Model Based Orchestration

It is all about Automation and Orchestration in a Control-Feedback loop.

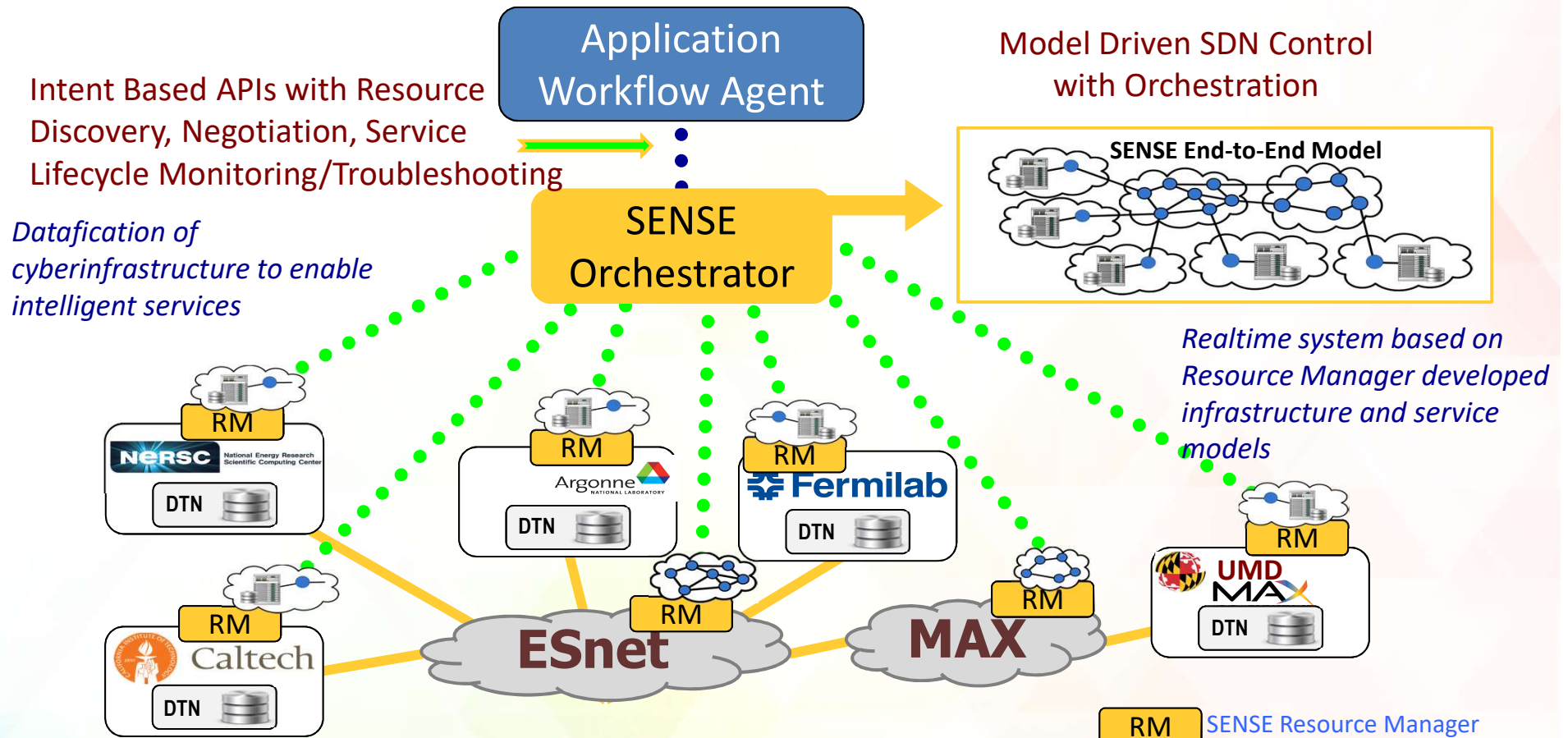


Objective is to allow the machines to automate, iterate, react, and adjust to find solutions and not bring the humans in until absolutely necessary

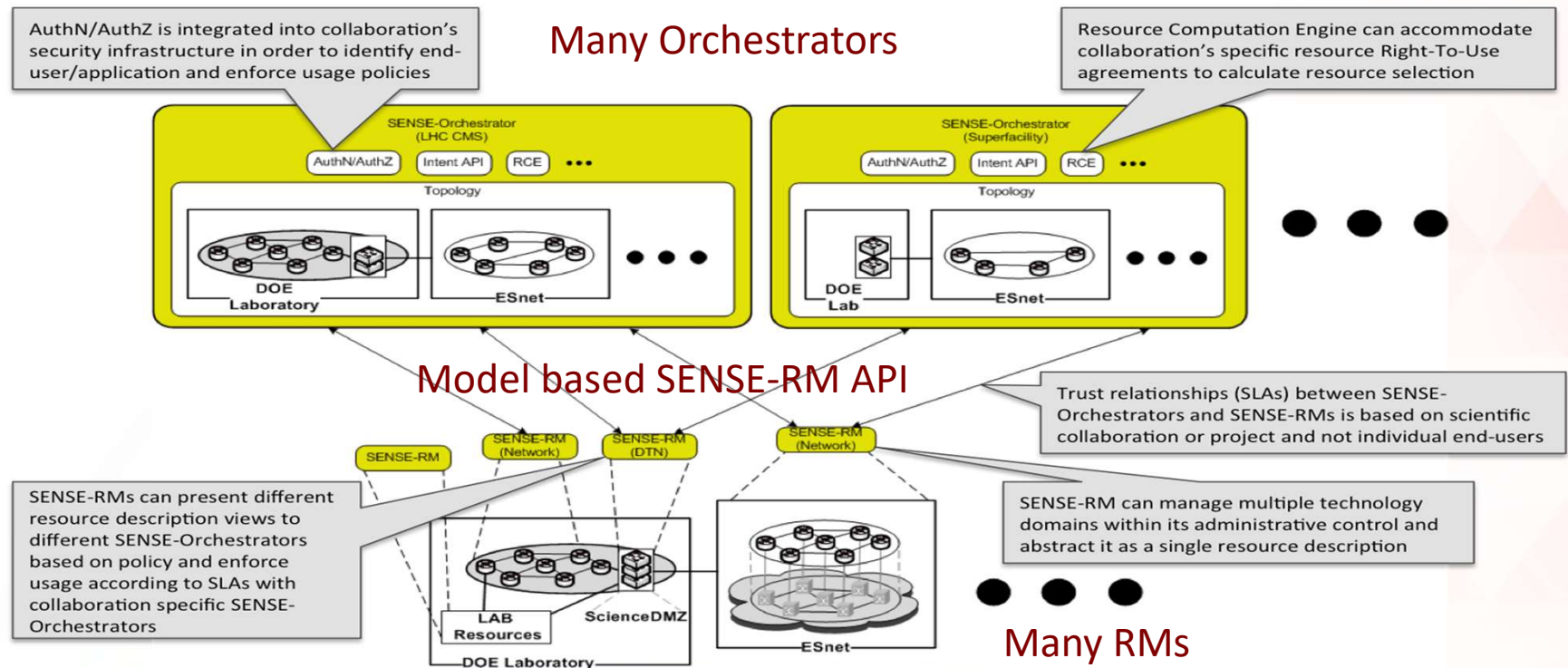
Service Orchestration Workflow



MAXedge Is Built on SENSE Architecture

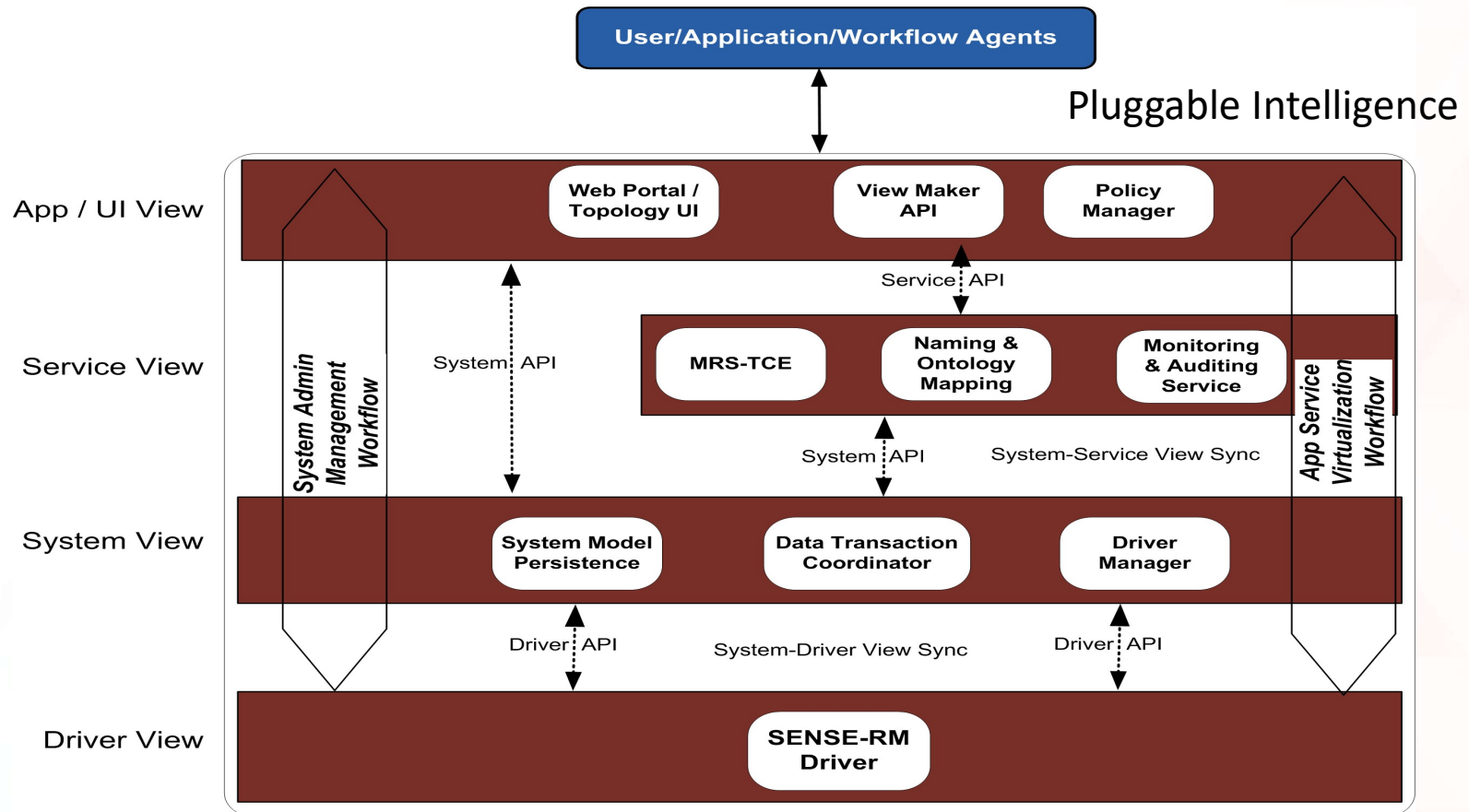


Many-to-Many Service Oriented Architecture

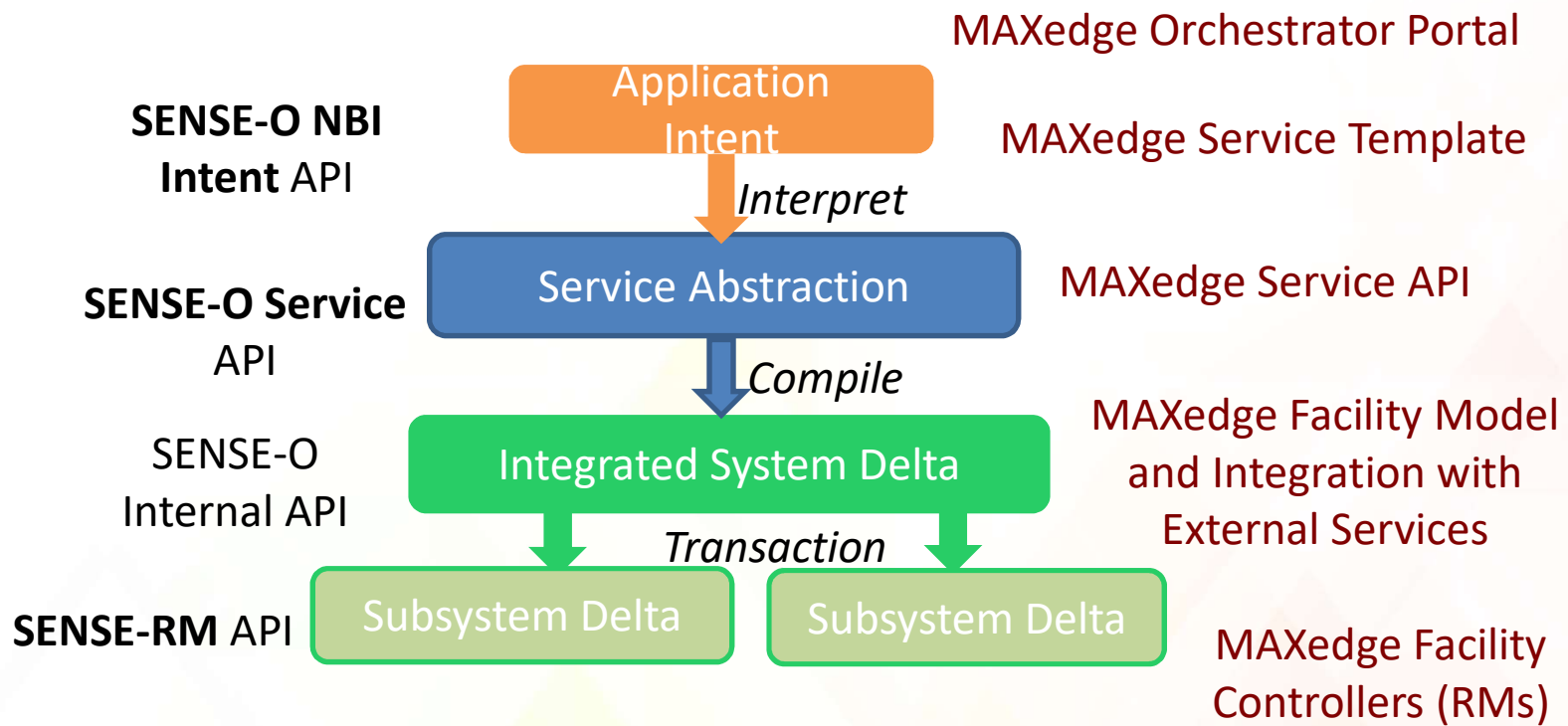


SENSE Orchestrator Software

SENSE Open Source Software Stack



MAXedge: A Local SENSE System Instantiation



Modernize an SDMZ / Facility / Site with the SENSE stack ...

MAXedge and MAX Research

- UMD/MAX R&D Team
 - Xi Yang
 - Alberto Jimenez
 - Multiple Students
- Results from several research projects including:
 - SDN for End-to-End Networked Science at the Exascale (SENSE)
 - Regional Embedded Cloud for As-a-Service Transformation (RECAST)
 - Resource Aware Intelligent Network Services(RAINS)
 - High Performance Computing with Data and Networking Acceleration (HPCDNA)
 - Software Defined Network Exchange (SDNX)
 - GENI Enabled Software Defined Exchange (SDX)





THANKS

MAX SD-Science DMZ Resources

Brocade MLXe:

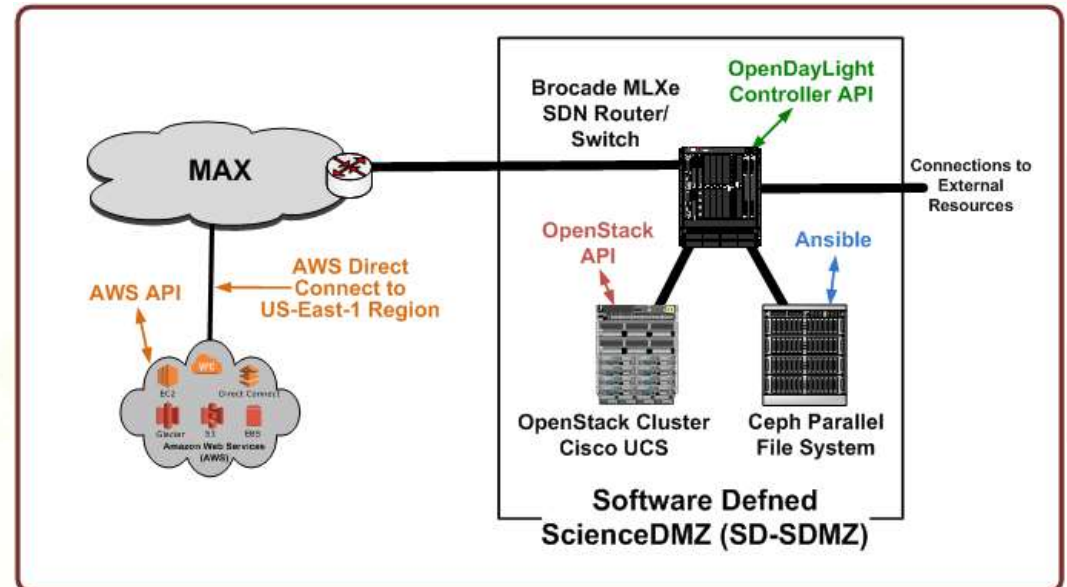
- 4x40G Ports
- OpenFlow 1.3 Capable
- 24x10G Ports
- 8x100G Ports
- 48x1G Ports

Cisco Unified Computing System (UCS):

- 12 Compute Blades, dual socket, multi-core
- 2x2 redundant Fabric Interconnects with FEX technology
- 2x3548 Nexus OpenFlow capable switch
- running OpenStack Liberty

Ceph (luminous)/Ethernet High Performance File System:

- 6 Object Storage Devices at 36 TB each (12x3TB drives)
- Approximately 200 Terabytes high performance cache storage



• Each OSD chassis

- 2U Chassis, 2 Intel Xeon E5-2609 Quad-Core, 2.4Ghz CPUs
- 8GB Memory
- LSI MegaRaid 9280-16i4 SAS, 6GB/s PCI-e RAID Card
- Dual Port 10Gbe NIC card
- 12 3 Tbyte SATA 6GB/s Hard Drives

Standards/Open Source based User Identity, Authorization, Federation

Keycloak

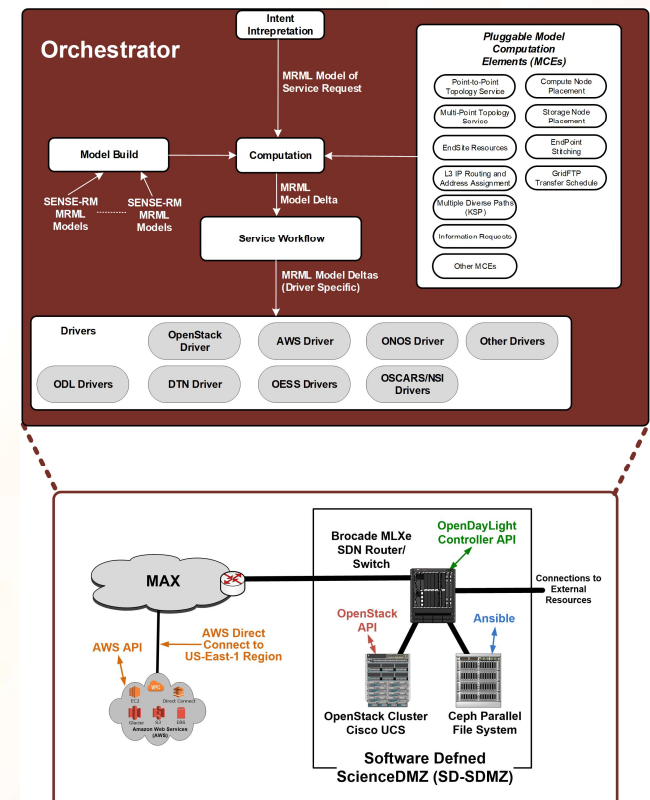
- Role based access for StackV Web Pages/Services
- Single Sign On (OAuth, OpenID)
- Federation (Shibboleth)
- opensource
- www.keycloak.org

FreeIPA

- Local Identity Provider
- HBAC (Host Based Access Control)
- Centralized kerberos management for VMs
- LDAP for MetaData
- Integration with external automation (ansible, others)
- opensource
- www.freeipa.org

KeyCloak

FreeIPA



Application

Service is not working, please check status

Failure on a network element, problem fixed

SENSE Orchestrator

RM (Resource Manager)

DTN (Delay Tolerant Network)

ESnet

MAX

Caltech

Fermilab

JPL

SLAC

Request 20 Gbps P2P service between Caltech and Fermilab

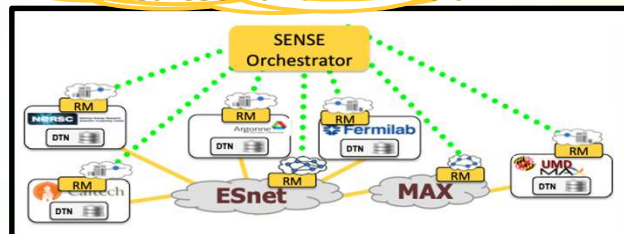
20 Gbps available for a P2P service between Caltech and Fermilab

Request 20 Gbps P2P service between Caltech and Fermilab. If 20 Gbps not available 10Gbps is ok.

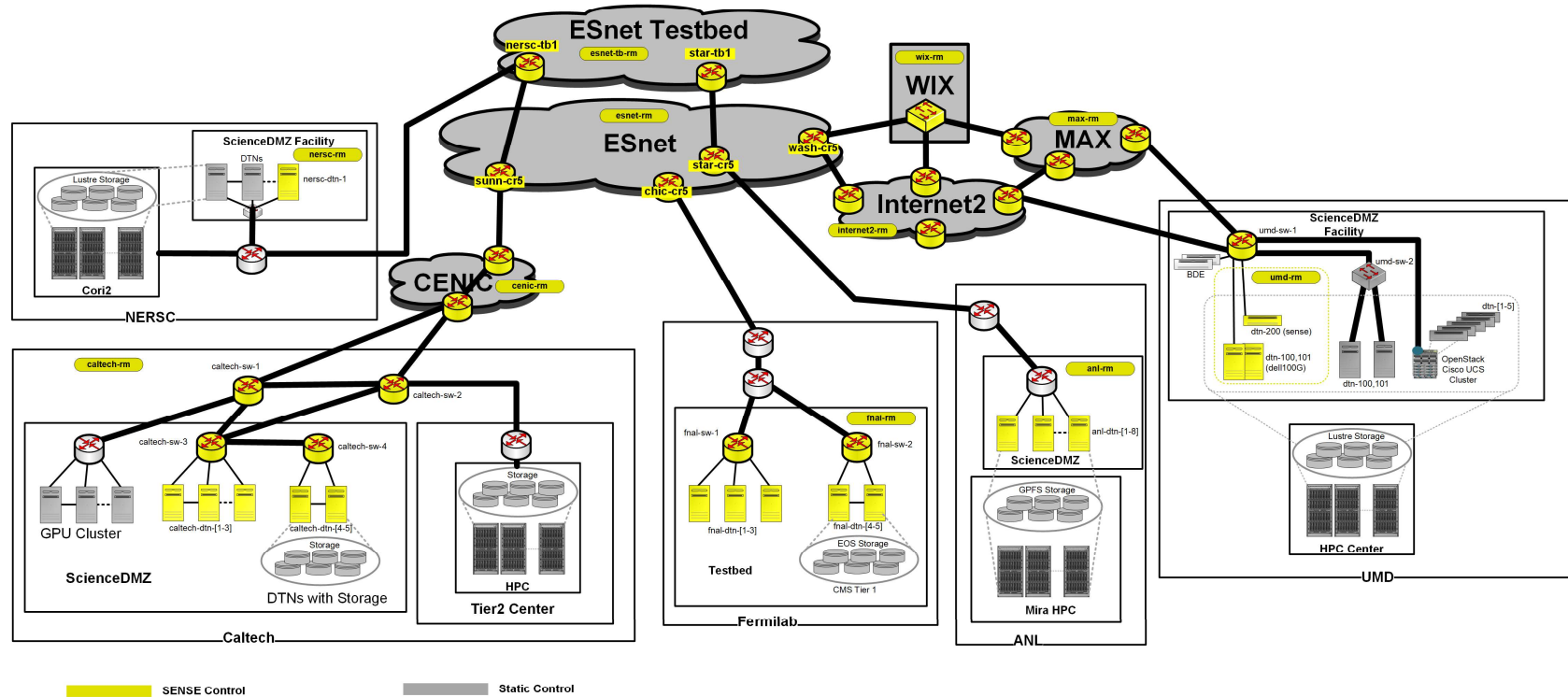
15 Gbps P2P service between Caltech and Fermilab Instantiated

Service is not working, please check status

Failure on a network element, problem fixed



SENSE Testbed Deployment



SENSE Scalability – 68 Domains Test

