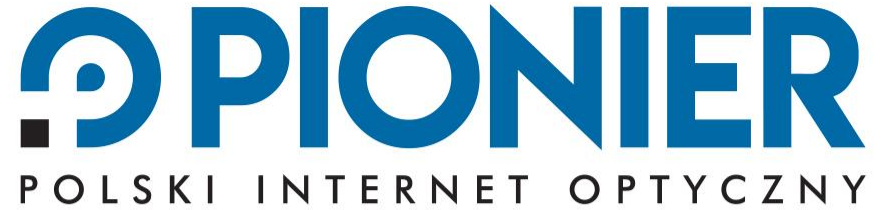


INFRASTRUKTURA DLA e-NAUKI

<http://www.pionier.net.pl/>



# Maat – PIONIER Source of Truth

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23rd SIG-NOC



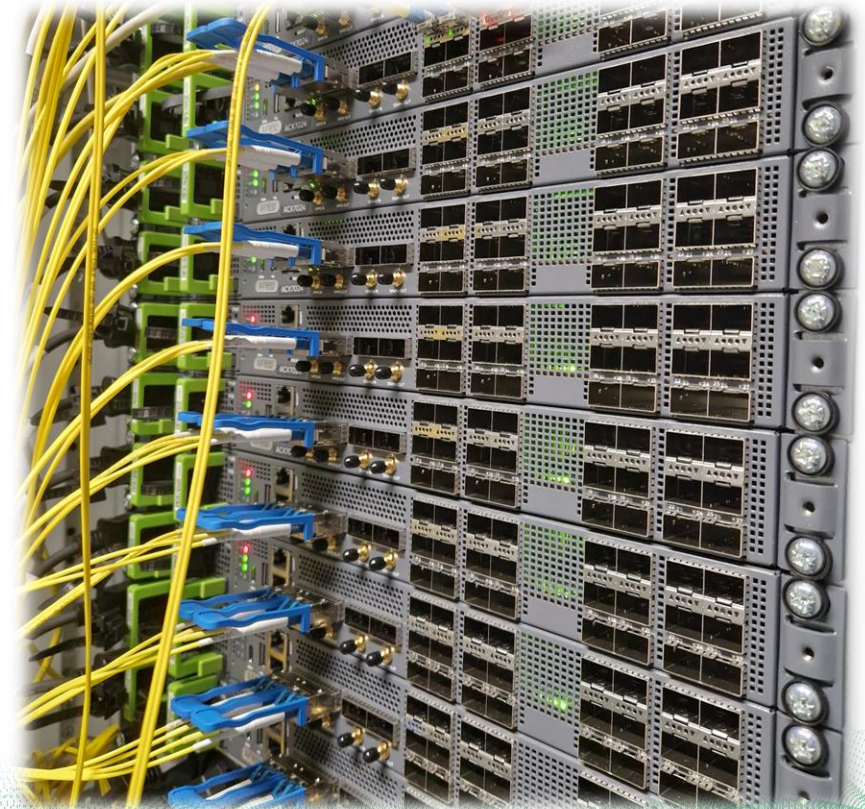
## Environment

- 21 MANs including 5 HPC centers
- Optical DWDM transmission based on own fibers
- MPLS based packet network
- Transmission interfaces
  - 10Gbps
  - 100Gbps
  - 400Gbps
  - 800Gbps



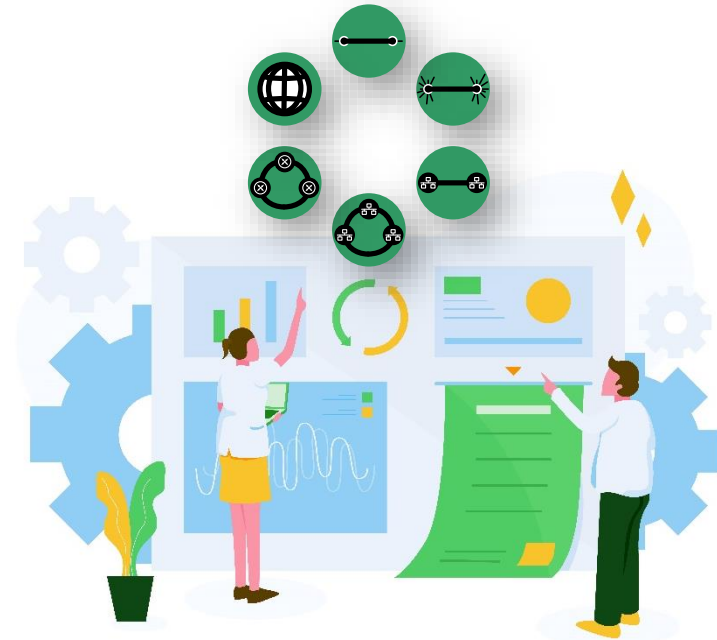
## Need for automation

- Many **different** software and hardware platforms, even if they come from the same vendor
  - **JunOS**
    - MX304
      - Juniper **Trio6**
  - **Junos EVO**
    - PTX10001-36MR
      - Juniper **Express4**
    - ACX 7100 series
      - Broadcom **Jericho2**
    - ACX 7024
      - Broadcom **Qumran-2U**
- Avoid mistakes for repetitive instances
- Use valid(ated) configuration for given platform

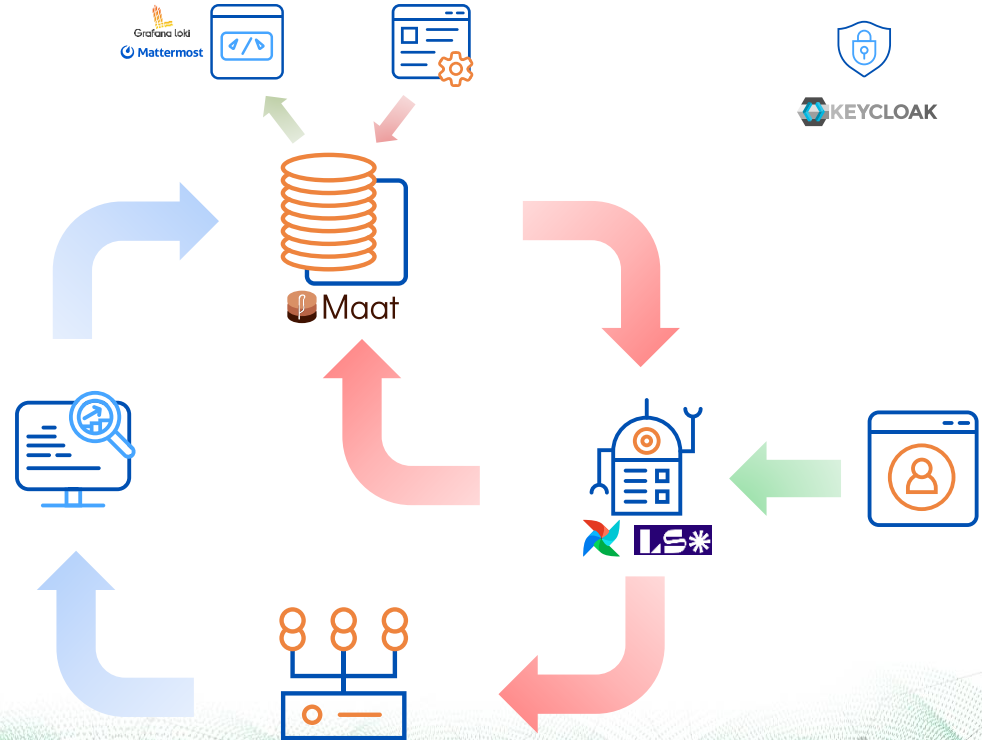


## Need for orchestration

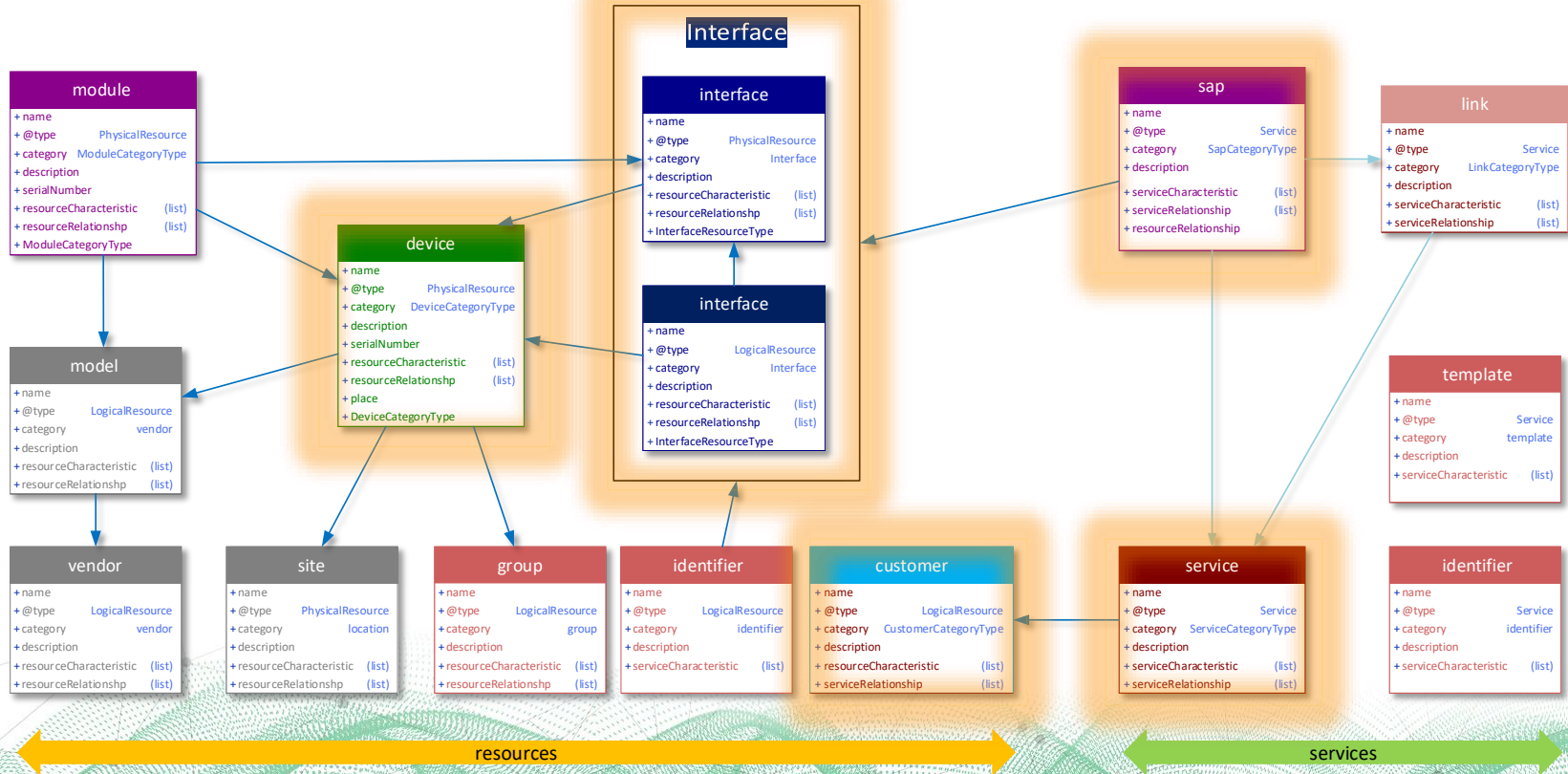
- Wide set of services
  - Internet access
  - MPLS based
    - Virtual networks (VRFs)
      - Unicast
      - Multicast
    - Point to point circuits
      - BGP based
      - LDP based
    - EVPN
- Demanding users with different needs
- Atomic development and deployment
- Generic solution and tools for future development



- Resources and services modeling in Maat
  - Describe resources and services
  - Avoid data duplication
- Workflows
  - Collect user input
  - Interact with Maat via REST API
    - Read existing data
    - Create new object
    - Modify existing objects
  - Control implementation on devices
- Changelog

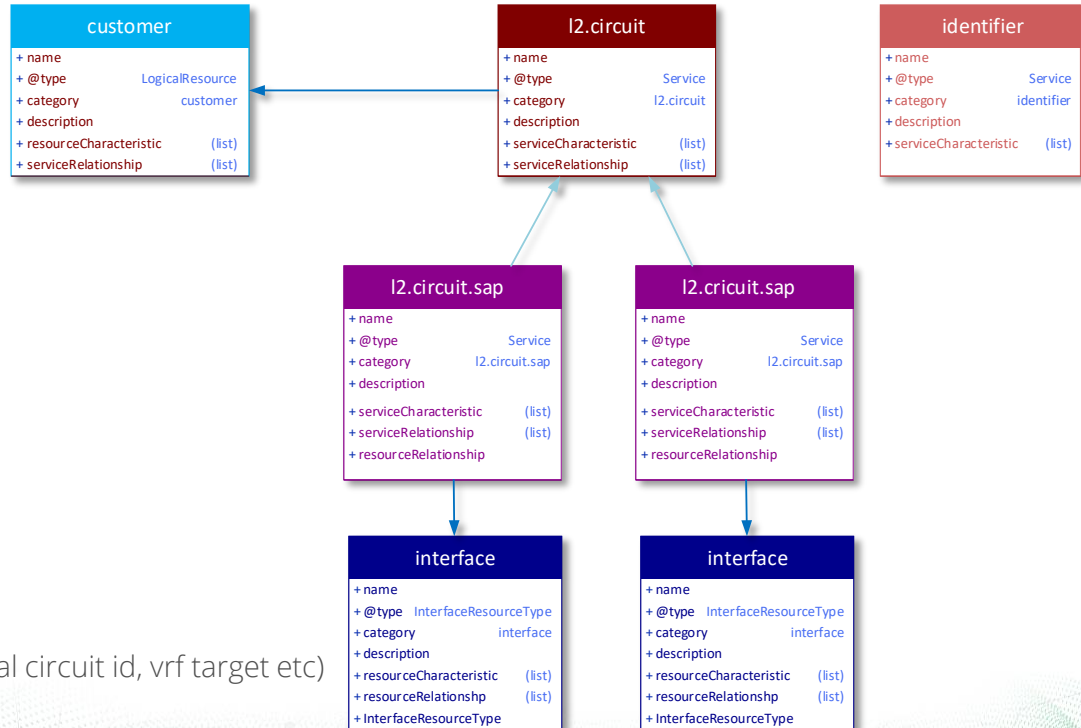


## TMF based resources and services models



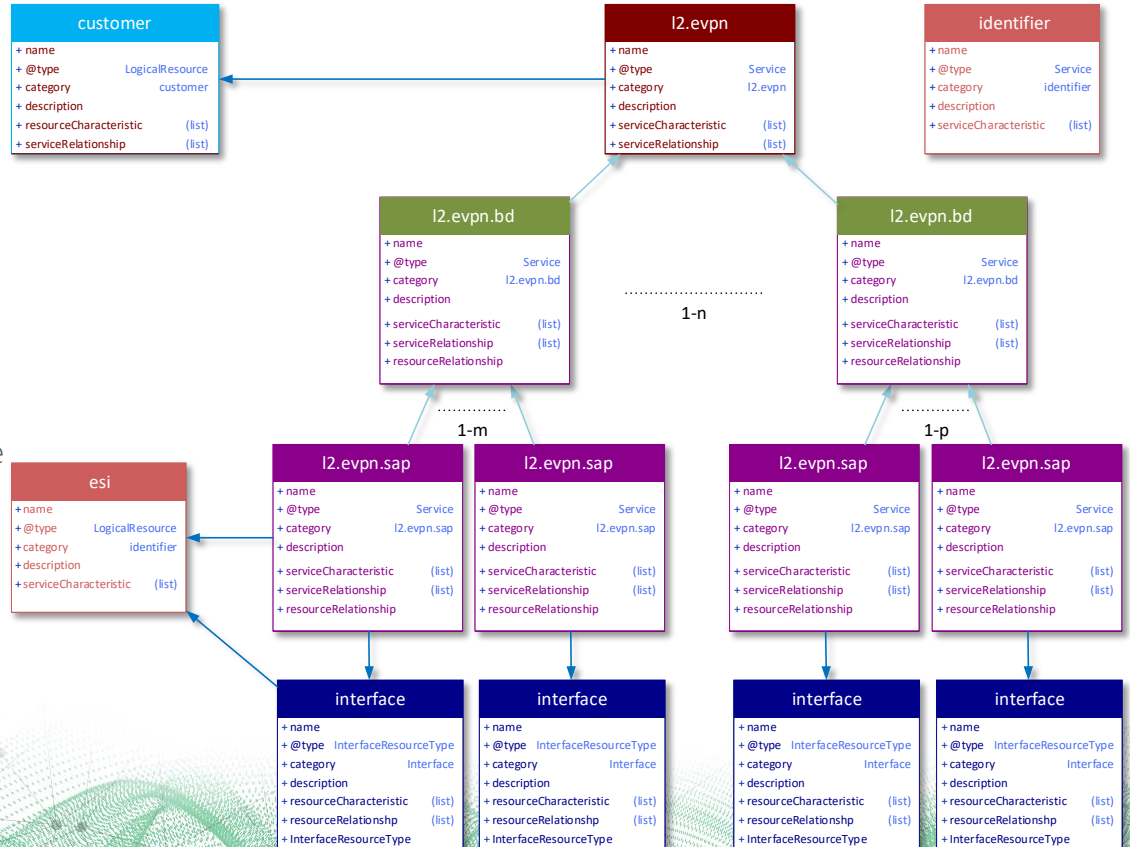
## Ethernet point to point circuits (E-LINE)

- @type – Service
- category
  - I2.circuit
  - I2.circuit.sap
- serviceCharacteristic
  - Parameters specific to service instance
- references
  - serviceRelationship
  - resourceRelationship
- identifier
  - Register for available identifiers (eg. virtual circuit id, vrf target etc)



## EVPN

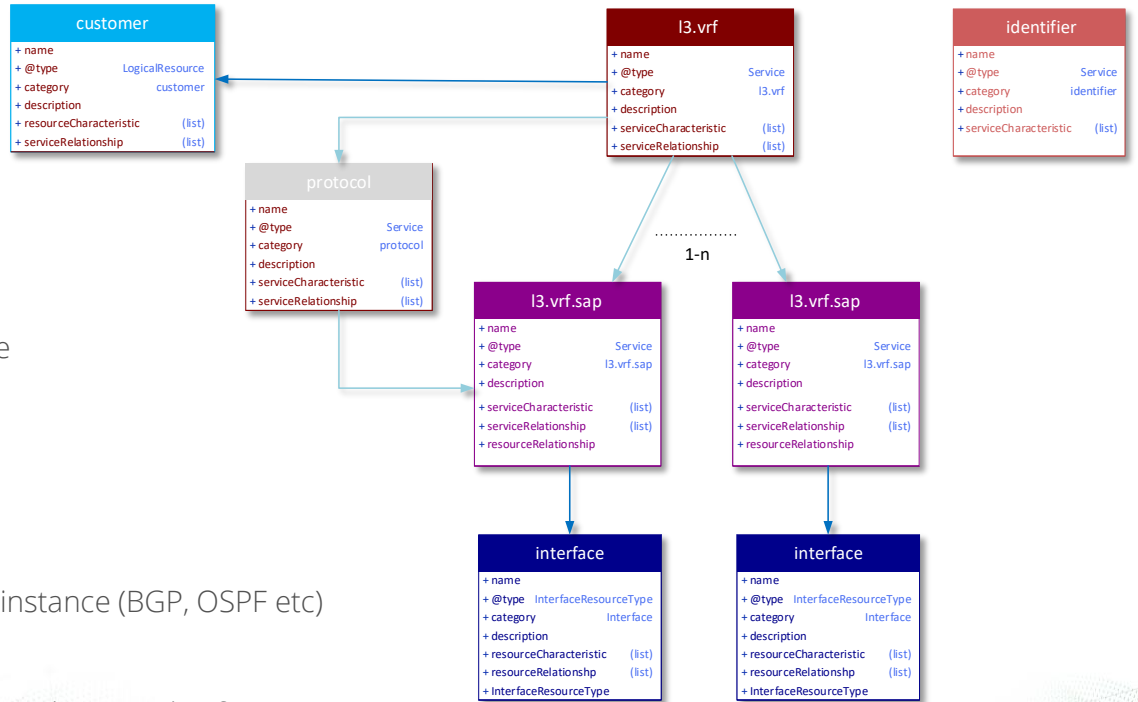
- @type – Service
- category
  - I2.evpn
  - I2.evpn.bd
  - I2.evpn.sap
- serviceCharacteristic
  - Parameters specific to service instance
- references
  - serviceRelationship
  - resourceRelationship
- esi
  - Ethernet segment identifiers





## VRF

- @type – Service
- Category
  - I3.vrf
  - I3.vrf.sap
- serviceCharacteristic
  - Parameters specific to service instance
- References
  - serviceRelationship
  - resourceRelationship
- protocol
  - signaling protocol enabled for service instance (BGP, OSPF etc)
- identifier
  - Register for available identifiers (eg. Virtual circuit id, vrf target etc)



## Maat GUI

- **Administrative (technical) purposes only**
- Quick browsing of database objects
- Manual editing of selected objects
- Fix missing entries or references for manually defined objects or properties on infrastructure

Maat Resources **Services** tomeks ▾

Maat service url:  
https://maat.pionier.net.pl/serviceInventoryManagement/v4.0.0/service

**Create new Service**

- > identifier
  - I2.circuit
  - I2.circuit.sap
- > network.core
  - > network.core.link
  - > network.core.sap
- > I2.evpn
  - > I2.evpn.bd
  - > I2.evpn.sap
- > I2.circuit.local
- > I3.vrf
  - > I3.vrf.sap

Table JSON

**CREATE NEW IDENTIFIER** 🔍 ⚙️ ☰ ☰

Actions	Name	Description	Type	Category	LastUpdateDate	ServiceDate
	service_ids	Service identifier for CP	Service	identifier	2025-09-26T06:02:08Z	2025-02-07T18:07:24Z

Rows per page 10 ▾ 1-1 of 1 < >

Maat

## Maat GUI

- Resources and Services tabs
- Category pane
  - Text search
  - Filtering
  - Property display selector
- JSON object overview

The screenshot shows the Maat GUI interface. At the top, there are tabs for 'Resources' and 'Services', with '@type' written above them. The 'Resources' tab is active. Below the tabs, there is a 'Maat service url:' field containing 'https://maat.pionier.net.pl/resourceInventoryManagement/v4.0.0/resource'. A 'Create new Resource' button is visible. To the left, a category pane lists various categories: vendor, model, customer, site, device.router, interface (highlighted), group, and identifier. A red bracket labeled 'category' spans this list. The main area displays a table of interfaces. The table has columns for Actions, Name, Description, Type, Category, UsageState, and StartOperatingDate. The data rows show various interface instances with their respective states and descriptions.

Actions	Name	Description	Type	Category	UsageState	StartOperatingDate
	et-0/0/0	Not used	PhysicalResource	interface	idle	2025-02-07T18:07:39Z
	et-0/0/4	== Bialystok d4 1/8/c1 ==	PhysicalResource	interface	busy	2025-02-07T18:07:39Z
	et-0/0/5	Not used	PhysicalResource	interface	idle	2025-02-07T18:07:39Z
	et-0/0/6	Not used	PhysicalResource	interface	idle	2025-02-07T18:07:39Z
	et-0/0/7	Not used	PhysicalResource	interface	idle	2025-02-07T18:07:39Z
	et-0/0/8	-- Mikolajki d4 1/9/c1 --	PhysicalResource	interface	active	2025-02-07T18:07:39Z
	et-0/0/9	Not used	PhysicalResource	interface	idle	2025-02-07T18:07:40Z
	et-0/0/10	-- OLMAN (man) --	PhysicalResource	interface	active	2025-02-07T18:07:40Z
	et-0/0/11	Not used	PhysicalResource	interface	idle	2025-02-07T18:07:40Z
	et-0/0/12	Not used	PhysicalResource	interface	idle	2025-02-07T18:07:40Z

At the bottom of the table, it says 'Rows per page 10 1-10 of 1324'.

## Maat GUI

- Object attributes overview and editing
- Define new attributes
  - Schema validation applied by Maat API
- Dynamic links to referenced objects

The screenshot displays the Maat GUI interface for creating a new resource. The main form includes the following sections:

- resourceCharacteristic:** A table with one row:
 

Actions	Name	Value
[icon]	speed	1000
- resourceRelationship:** A table with two rows:
 

Actions	RelationshipType	Resource id	Resource href	Resource name
[icon]	href device router	12d7f48-c4de-688e-5b6c-e5802e3e9460	https://maat.pionier.net.pl/443/resourceInventoryManagement/v4.0.0/resource/12d7f48-c4de-688e-5b6c-e5802e3e9460	gryzacz
[icon]	href interface	6f58020a-efbe-4c53-8ade-37cb02a13f54	https://maat.pionier.net.pl/443/resourceInventoryManagement/v4.0.0/resource/6f58020a-efbe-4c53-8ade-37cb02a13f54	uaf
- serviceRelationship:** A table with no records to display.

At the bottom, there are fields for `startOperatingDate` (2025-02-07T18:29:55Z), `lastUpdateDate` (2025-09-30T14:33:51Z), `href`, and `id` (a5e3710-688b-4432-9403-03958f65c7b). A dropdown menu is set to 'string' with an 'Add attribute' button.

## Maat GUI

- Automatic creation of new references between objects
  - “backward reference” (**bref:.**) defined in Maat GUI
  - Automatic reference (**ref:.**) from target object created by Maat API

The screenshot displays the Maat GUI interface. The main content area shows the 'Services' section for a service named 'GEANT\_AP1'. A dialog box titled 'Create new Relationship to Service' is open, allowing the user to define a relationship. The dialog includes a 'Target category' dropdown set to 'I2.circuit' and a 'Target entry' dropdown set to 'GEANT\_AP1 - (GEANT AP1) - ID:9a82e06a-66d1-4f...'. Below the dialog, the 'serviceCharacteristic' table is visible, containing one row with 'vlan\_id' set to '10'. At the bottom, the 'serviceRelationship' table is shown, containing one row with 'bref I2.circuit' as the relationship type, the service ID '9a82e06a-66d1-4f92-97ef-b522ac7b6e36', the service href, and the service name 'GEANT\_AP1'.

## Maat GUI

- JSON format overview and editing

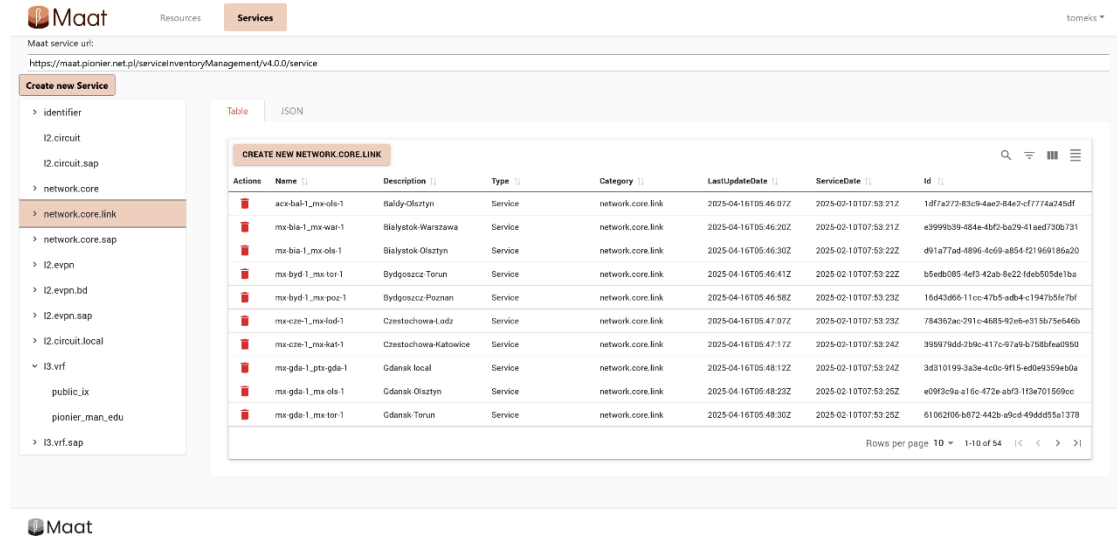
The screenshot displays the Maat GUI interface for editing a resource. The top navigation bar includes the Maat logo, a 'Resources' tab, and a 'Services' tab. The main content area shows a 'Maat service url' and a 'Create new Resource' button. A sidebar on the left lists categories: vendor, model, customer, site, device.router, interface, group, and identifier. The main area is split into 'Table' and 'JSON' views, with the 'JSON' view selected. A small dialog box titled 'Key Name' is open over the JSON editor. The JSON content is as follows:

```
{
  "category": "interface",
  "description": "... GEANT CBPIO (a6) ...",
  "name": "et-0/9/4",
  "resourceCharacteristic": [
    {
      "name": "speed",
      "value": "100G"
    }
  ]
}

@schemaLocation: "https://bitbucket.software.geant.org/projects/OSS855/repos/maat-schema/raw/7f639-ResourceInventory-v4-pionier.json"
@type: "PhysicalResource"
usageState: "busy"
resourceRelationship: [
  {
    "relationshipType": "bref:device.router"
    resource: [
      {
        "id": "12a9744d-c4de-448e-b6e2-e5b82ee3e945"
        href: "https://maat.pionier.net.pl:443/resourceInventoryManagement/v4.0.0/resource/12a9744d-c4de-448e-b6e2-e5b82ee3e945"
        name: "ptx-poz-1"
      }
    ]
  },
  {
    "relationshipType": "bref:interFace"
    resource: [
      {
        "id": "8d5882fa-ef9e-4c53-8ade-37c8d3a13f54"
        href: "https://maat.pionier.net.pl:443/resourceInventoryManagement/v4.0.0/resource/8d5882fa-ef9e-4c53-8ade-37c8d3a13f54"
        name: "a66"
      }
    ]
  }
]
serviceRelationship: [ ]
startOperatingDate: "2025-02-07T18:09:55Z"
lastupdateDate: "2025-09-30T14:33:51Z"
href: "https://maat.pionier.net.pl:443/resourceInventoryManagement/v4.0.0/resource/a05e3710-6d8b-4432-9403-63958fb65c7b"
id: "a05e3710-6d8b-4432-9403-63958fb65c7b"
}
```

## Maat GUI

- Boost single source of truth development
  - Add (develop) new services and resources not yet supported by workflows
  - Include emergency fixes or changes for services and resources which are not yet supported by workflows
  - Allow “atomic” automation and orchestration approach

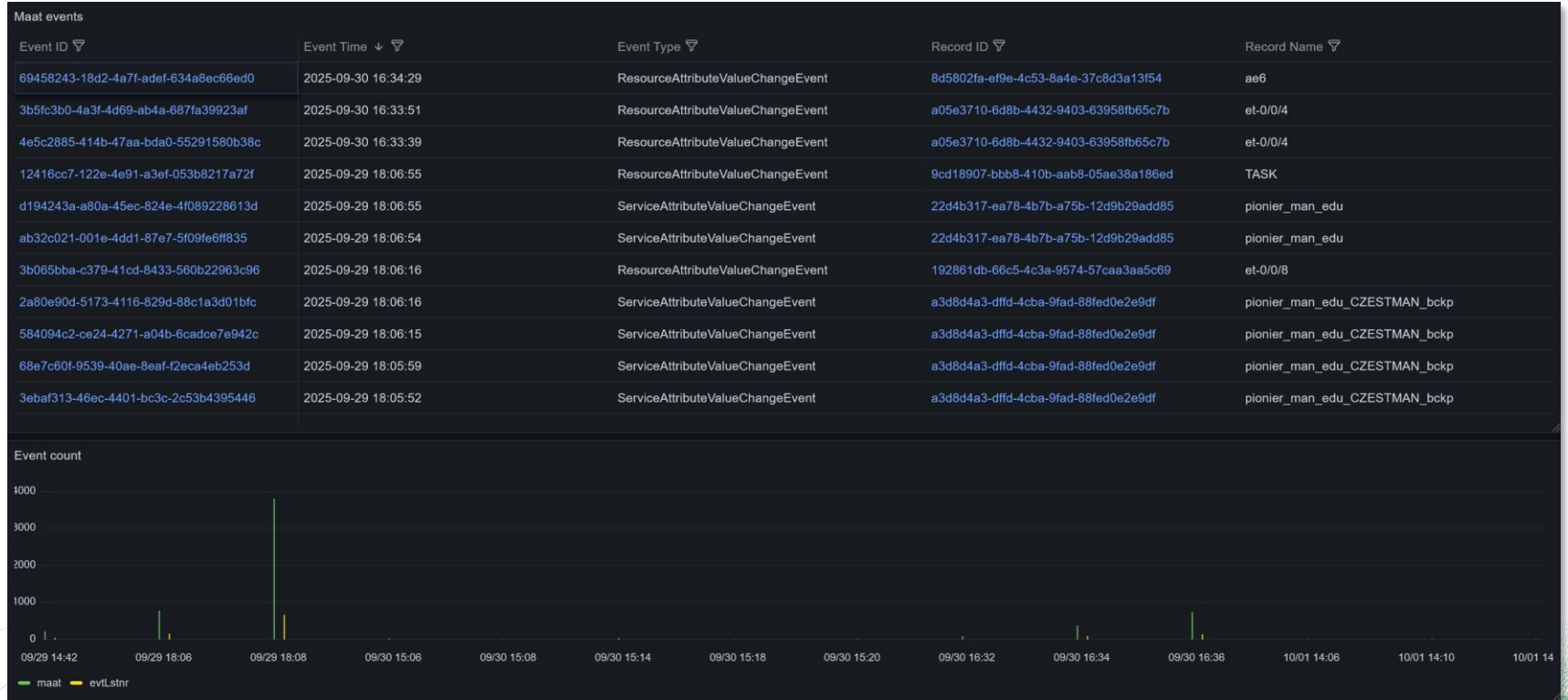


The screenshot shows the Maat GUI interface. At the top, there are tabs for 'Resources' and 'Services'. Below the tabs, there is a 'Create new Service' button and a sidebar menu with a tree view of categories like 'i2.circuit', 'i2.evpn', and 'i3.vrf'. The main content area displays a table titled 'CREATE NEW NETWORK CORE LINK' with columns for Actions, Name, Description, Type, Category, LastUpdateDate, ServiceDate, and Id. The table contains several rows of data representing different network core links.

Actions	Name	Description	Type	Category	LastUpdateDate	ServiceDate	Id
	acc-bai-1_mx-ola-1	Bialy-Olsztyn	Service	network_core.link	2025-04-16T05:46:07Z	2025-02-10T07:53:21Z	1d8fa272-83c9-4aa2-84a2-cf7774a245df
	mx-bia-1_mx-war-1	Bialystok-Warszawa	Service	network_core.link	2025-04-16T05:46:30Z	2025-02-10T07:53:21Z	e3999059-484e-4bf2-ba29-41aedf320d731
	mx-bia-1_mx-ola-1	Bialystok-Olsztyn	Service	network_core.link	2025-04-16T05:46:30Z	2025-02-10T07:53:22Z	d91a77ad-4896-4c69-a854-f21969186a20
	mx-byd-1_mx-tor-1	Bydgoszcz-Torun	Service	network_core.link	2025-04-16T05:46:41Z	2025-02-10T07:53:22Z	b5ed0b65-4ef3-42ab-8c22-f6eb505de1ba
	mx-byd-1_mx-poz-1	Bydgoszcz-Poznan	Service	network_core.link	2025-04-16T05:46:58Z	2025-02-10T07:53:23Z	16d43d66-11cc-47b5-adb4-c1947d55e7bf
	mx-cze-1_mx-led-1	Czestochowa-Lodz	Service	network_core.link	2025-04-16T05:47:07Z	2025-02-10T07:53:23Z	784362ae-291e-4685-92e6-e315b75e646b
	mx-cze-1_mx-kat-1	Czestochowa-Katowice	Service	network_core.link	2025-04-16T05:47:17Z	2025-02-10T07:53:24Z	395979d8-2b9c-417c-97a9-b708dfeaa950
	mx-gda-1_pte-gda-1	Gdansk local	Service	network_core.link	2025-04-16T05:48:12Z	2025-02-10T07:53:24Z	34310199-3a3e-4c0c-9f15-ed0e9359a80a
	mx-gda-1_mx-ola-1	Gdansk Olsztyn	Service	network_core.link	2025-04-16T05:48:23Z	2025-02-10T07:53:25Z	e09f3c9e-a16c-472e-ab93-1f3a701569cc
	mx-gda-1_mx-tor-1	Gdansk Torun	Service	network_core.link	2025-04-16T05:48:30Z	2025-02-10T07:53:25Z	61062f06-b872-442b-e9cd-494d055e1378


At the bottom right of the table, it says 'Rows per page 10' and '1-10 of 54'.

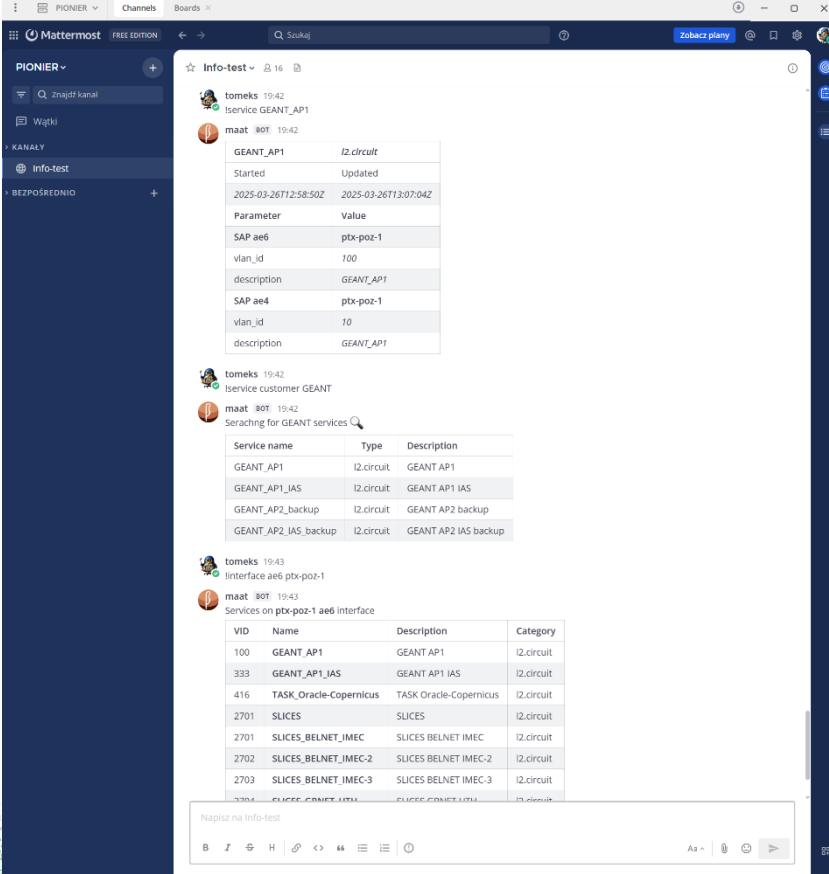
## Maat EventListener





## Mattermost integration

- Interface between Mattermost channel and Maat database
  - Quick lookup for services, resources and parameters
  - Errbot based 



The screenshot shows a Mattermost chat interface with a channel named 'Info-test'. The chat history includes the following messages:

- tomeks** 19:42: Iservice GEANT\_API
- maat** 19:42:
 

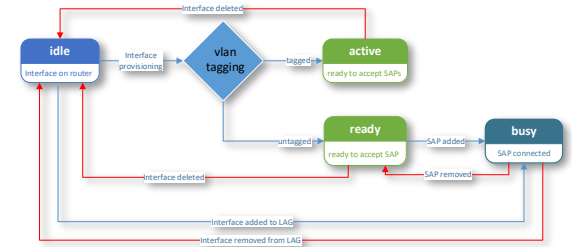
GEANT_API	I2.circuit
Started	Updated
2025-03-26T12:58:50Z	2025-03-26T13:07:04Z
Parameter	Value
SAP ae6	ptx-poz-1
vlan_id	100
description	GEANT_API
SAP ae4	ptx-poz-1
vlan_id	10
description	GEANT_API
- tomeks** 19:42: Iservice customer GEANT
- maat** 19:42: Searching for GEANT services
 

Service name	Type	Description
GEANT_API	I2.circuit	GEANT AP1
GEANT_API_IAS	I2.circuit	GEANT AP1 IAS
GEANT_API_backup	I2.circuit	GEANT AP2 backup
GEANT_API_IAS_backup	I2.circuit	GEANT AP2 IAS backup
- tomeks** 19:43: Interface ae6 ptx-poz-1
- maat** 19:43: Services on ptx-poz-1 ae6 interface
 

VID	Name	Description	Category
100	GEANT_API	GEANT AP1	I2.circuit
333	GEANT_API_IAS	GEANT AP1 IAS	I2.circuit
416	TASK_Oracle-Copernicus	TASK Oracle-Copernicus	I2.circuit
2701	SLICES	SLICES	I2.circuit
2701	SLICES_BELNET_JMEC	SLICES BELNET IMEC	I2.circuit
2702	SLICES_BELNET_JMEC-2	SLICES BELNET IMEC-2	I2.circuit
2703	SLICES_BELNET_JMEC-3	SLICES BELNET IMEC-3	I2.circuit
3704	SLICES_COPERNICUS	SLICES COPERNICUS	I2.circuit

## Apache Airflow and GEANT LSO

- Generalized workflows for use across multiple networks
  - PIONIER
  - GP4L
- GEANT LSO
  - configuration changes on devices (resources)
  - Ansible playbooks
  - Jinja templates



## Data/information acquisition

- Predefined forms for specific workflows
- Existing data retrived from Maat
  - Devices
  - Interfaces
  - Identifiers

### L2 circuit submit form

L2 circuit name  
test\_circuit

L2 circuit description  
Some demo circuit

Customers  
WASK  
ZIELMAN  
PIONIER\_IP  
**PIONIER\_DEMO**

Device dX  
ptx-poz-1

Device dY  
mx-poz-1

Interface IX  
ae6 (active) --- GEANT AP1 (peer) --

Interface IY  
ae3 (active) -- POZMAN (mar

Vlan ID (dX)  
50

Vlan ID (dY)  
46

no-control-word

ignore-encapsulation-mismatch

ignore-mtu-mismatch

pseudowire-status-tlv

Community  
community text

mtu  
mtu number

bandwidth  
bandwidth

Units  
kbps

burst  
0

Submit

### Interface creation form

Interface type  
aggregated

Device  
mx-poz-1

Interfaces  
et-0/0/13 - Not used  
et-0/0/9 - Not used  
et-0/1/0 - Not used  
et-0/1/13 - Not used

Aggregate name  
Some name

LACP

Active

Type  
core

MTU  
choose mtu number (256-16000) or leave empty

Tagged

Encapsulation

Description  
Some description

Groups  
Some groups names

ESIs

ESI  
ID in form 00:00:11:22:33:44:55:00:02:02

ESI Description  
Description e.g. LAN1

Submit



## Apache Airflow and GEANT LSO

- Airflow Mattermost integration DAG
  - LSO input
  - LSO callback

```

1  {
2    "job_id": "ac7acd31-1162-4545-9984-bc83648231f2",
3    "output": ""
4  }
5  PLAY [Main workflow runner playbook] *****
6
7  TASK [Print the usage] *****
8  skipping: [pe1]
9  skipping: [pe2]
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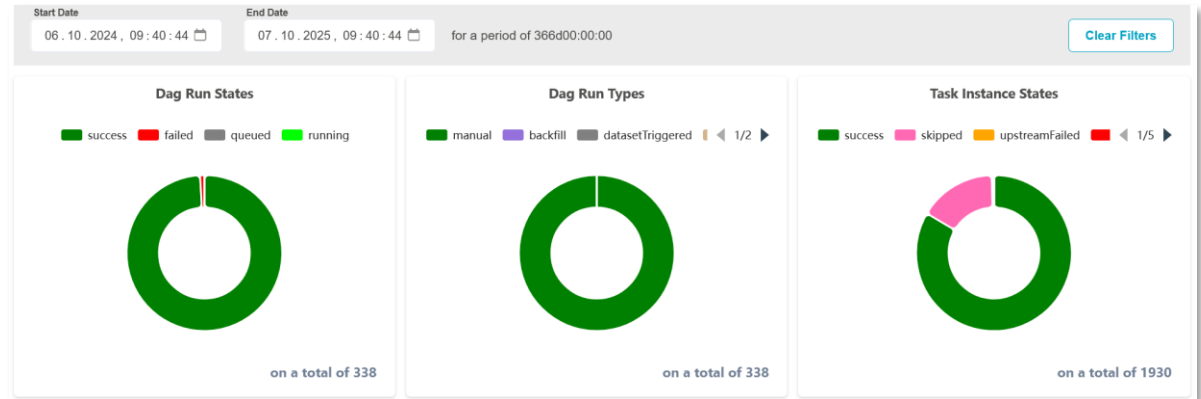
```

1  {
2    "callback": "http://10.255.224.129:8099",
3    "extra_vars": {
4      "operation": "verify",
5      "service": {
6        "category": "l2_circuit",
7        "description": "l2_ckt_test",
8        "name": "l2ckt1_test",
9        "serviceCharacteristic": {
10       "virtual_circuit_id": "150"
11     }
12   },
13 },
14 "inventory": {
15   "pionier": {
16     "hosts": {
17       "pe1": {
18         "ansible_host": "190.254.253.1",
19         "model": "v900",
20         "sap": {
21           "category": "l2_circuit.sap",
22           "id": "ad5230d-68ca-435a-984c-e06f0d49369a",
23           "interface": "ge-0/0/3",
24           "neighbor": "150.254.253.4",
25           "serviceCharacteristic": {
26             "vlan_id": "50"
27         }
28       },
29       "vendon": "Juniper"
30     },
31     "pe4": {
32       "ansible_host": "190.254.253.4",
33       "model": "v900",
34       "sap": {
35         "category": "l2_circuit.sap",
36         "id": "5d2b50d3-2866-4994-8806-fc880e78f97d",
37         "interface": "ge-0/0/3",
38         "neighbor": "190.254.253.1",
39         "serviceCharacteristic": {
40           "vlan_id": "50"
41         }
42       },
43       "vendon": "Juniper"
44     }
45   },
46   "playbook_name": "workflow_runner.yaml"
47 },
48 }
49
    
```

playbook command  
ansible role  
service parameters  
SAP referenced interface  
SAP parameters  
model name  
vendor name  
Playbook name

## Usage statistics

- Maat / SSoT objects
  - Resources – **1 400+**
    - **1 300+** interface
    - **45** device.router
    - **50+** customer
  - Services – **1 374**
    - **~370** l2.circuit
    - **2** l2.evpn
    - **2** l3.vrf
    - **50+** network.core.links
- Airflow
  - **330+** DAG runs
  - **1930** task states



## Future works

- New workflows development
  - EVPN
    - vlan-based
    - vlan-bundle
    - vlan-aware
  - Network configuration consistency verification
  - VRF
  - Ingres bandwidth control on SAPs
    - Maat UI ready
- Enabling user roles and Maat object access filtering
  - Development finished
  - Lab testing phase
- The use of LLM for advanced data search functionality and user interaction

INFRASTRUKTURA DLA e-NAUKI



# Konsorcjum PIONIER Polski Internet Optyczny Poznańskie Centrum Superkomputerowo-Sieciowe

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## PARTNERZY



The scientific work is published for the realization of the international project co-financed by Polish Ministry of Science and Higher Education from financial resources of the programme entitled "PMW"