



Maat as a Source of Truth for orchestrated network services

Deployment in PIONIER

Tomasz Szewczyk (PSNC), Roman Łapacz (PSNC)
GN5-1 WP6

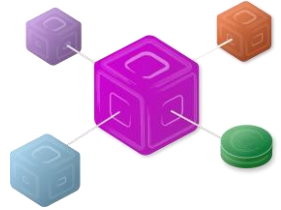
31st STF, April 2024





Source of Truth

Source of Truth (SoT)



- Represents the desired state of the network - declarative approach
- Only a state in SoT is the proper one (and should be reflected on an infrastructure)
- A key component of the Infrastructure as Code (IaC) that supports the managing and provisioning of infrastructure using code instead of manual processes

Maat



Maat is a microservice for open digital platforms to manage the information about physical and logical resources and/or services

Open standard-based API

- Full CRUD support offers automation and orchestration implementation out of the box
- AuthN with OAuthN 2.0
- TMF638 Service management REST API
- TMF639 Resource management REST API

Extensible data model

- JSON-based data model for resources and services
- Request validation based on data model schema file
- Data model extensions do not require changes in the application code or in the database
- Support for multiple data models defined in schema files provided by the user

Event notifications

- External applications can register and listen to selected inventory events
- Events can be archived (EventListener)
- TMF standard API

Technology stack

- NoSQL database (MongoDB)
- Spring Boot 3 library
- Docker
- Keycloak

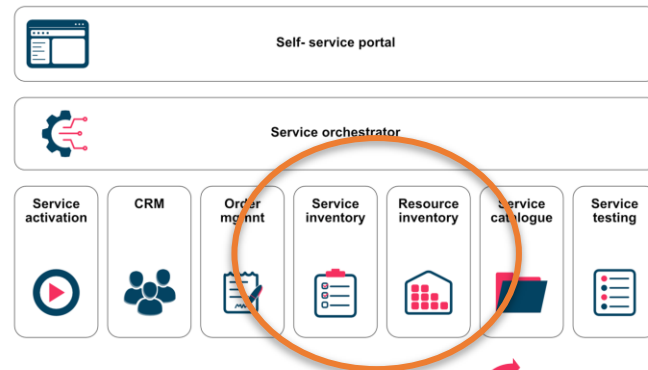
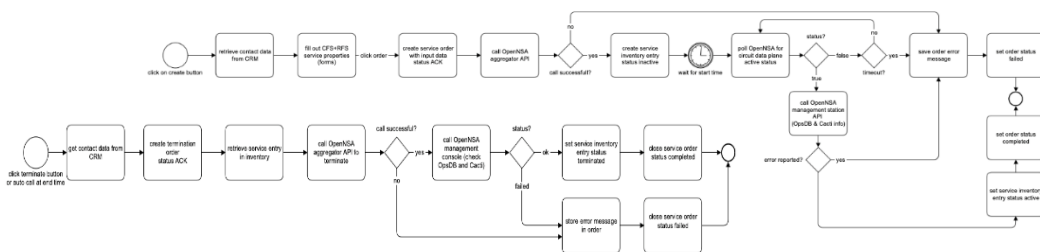


Maat



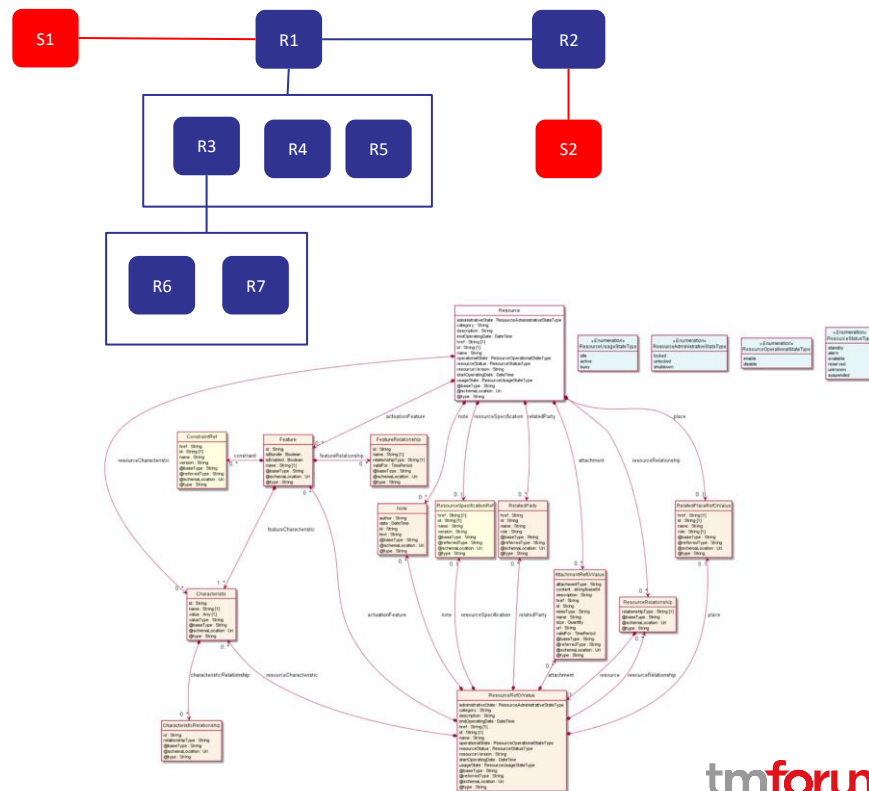
Maat as a Source of Truth in a distributed modern digital platform enabling automation and orchestration

- lesson learned from the work on the GÉANT Connection Service
- feedback from the users



Maat – Resource data model

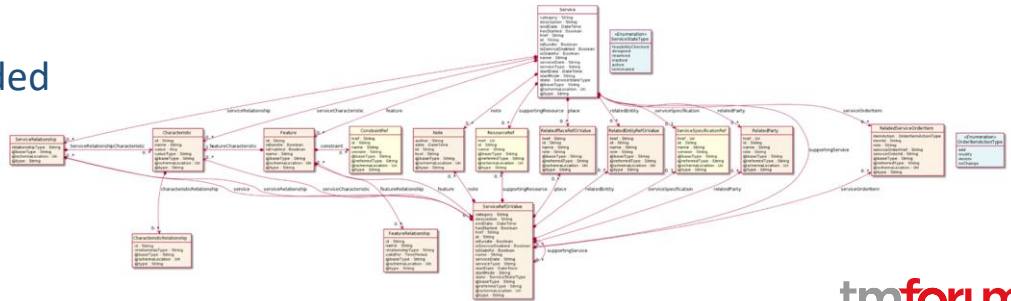
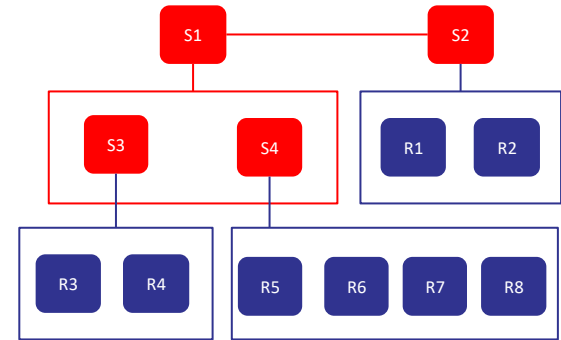
- Resource as a basic object
- Resource can be composed of other resources
- Resource has attributes and characteristics
- Relationships between Resources
 - chains of references
- Definition of a Resource can be easily extended



https://github.com/tmforum-apis/Open_Api_And_Data_Model/tree/master/schemas/Resource

Maat – Service data model

- Service as a basic object
- Service can be composed of other services
- Service has attributes and characteristics
- Relationships between Services
 - chains of references
- Service may have links to Resources
- Definition of a Service can be extended



Maat – Open APIs

Open API dashboard for January 2024

All time totals: **802,153** Open API downloads by **45,730** developers from **2,750** organizations | [81 Organizations have certified 981 Open APIs](#)

tmforum



DOWNLOADS THIS MONTH

API downloads	19,321
Unique organizations	450
Unique individuals	2,659

TOP DOWNLOADERS*

Parent Account	Rank	Downloads
Vodafone Group	1	1,136
AT&T Inc.	2	830
Bell Canada	3	754
Tech Mahindra Limited	4	619
Orange	5	584
Jio Platforms Limited	6	579
Deutsche Telekom AG	7	481
Tata Consultancy Services	8	445
Amdocs Management Limited	9	433
Accenture	10	357
TM Technology Services Sdn Bhd	11	353
Entel PCS Telecomunicaciones S.A. ...	12	314
Verizon Communications	13	265
Celfocus	14	256
BT Group plc	15	252
Ericsson Inc.	16	241
PIA Bilgişim Hizmetleri A.Ş.	17	226
IBM Corporation	18	203
TELEFONICA	19	182
Axiata Group Berhad	20	177

* Organizations with 5+ unique users in the month



Useful links

[Open API table](#) | [Pre-production API table](#) |
183 Open API manifesto signatories (current TM Forum members)



CERTIFICATIONS

OPEN API CERTIFICATION LEADERBOARD



TOP APIs CERTIFIED



LATEST OPEN API CERTIFICATIONS



WHAT'S NEW

LATEST API UPDATES APPROVED

Gen5 TMF640 Service Activation
 TMF632 Party Management

THIS MONTH'S MOST POPULAR APIs

API Full Name	Rank	Downloads
TMF622 Product Ordering	1	1,362
TMF666 Account Management	2	1,115
TMF620 Product Catalog Manage...	3	988
TMF629 Customer Management	4	806
TMF632 Party Management	5	766
TMF637 Product Inventory Mana...	6	661
TMF639 Resource Inventory Man...	7	627
TMF641 Service Ordering Manag...	8	607
TMF621 Trouble Ticket	9	557
TMF638 Service Inventory Manag...	10	475
TMF678 Customer Bill Managem...	11	407
TMF673 Geographic Address Ma...	12	375
TMF669 Party Role Management	13	369
TMF679 Product Offering Qualific...	14	365
TMF651 Agreement Management	15	359

NEW API RESEARCH & CASE STUDIES

[How Telstra is advancing its network-as-a-service with new service management Open APIs](#)

[CSPs see CAMARA collaboration as a model for standards](#)

[A week in telecoms: Deutsche Telekom sets up new network API unit](#)

Maat GUI

- Layout design and software development consulted with the user (PIONIER)
- Useful for visualisation, data analysis or troubleshooting but the REST APIs of Maat play a key role for orchestration
- Inspired by NetBox

The screenshot displays the Maat GUI interface, which is designed to resemble NetBox. It is divided into two main sections: Resources and Services.

Resources Section:

- Left Sidebar:** A tree view showing a hierarchy: vendor > model > device.router. Under 'device.router', several items are listed: ptk-pio-2, ptk-pio-1, ptk-war-1, ptk-wrp-1, ptk-gdb-1, ptk-ks-1, interface, and unit.
- Main Table:** A table with columns: Name, Description, Type, Category, SerialNumber, StartOperatingDate, LastUpdateDate, and ID. It contains 8 rows of data, all of which are Python API generated physical resources of type 'device.router'.

Services Section:

- Left Sidebar:** A tree view showing a hierarchy: ID.circuit > user00 > ID.circuit.sap. Under 'ID.circuit.sap', two items are listed: SAP1.user00 and SAP2.user00.
- Main Area:** A JSON view of a service object. The JSON structure includes:
 - category: "ID.circuit.sap"
 - description: "SAP00 VID 20"
 - name: "SAP1.user00"
 - serviceCharacteristic: An array of objects with name and value.
 - schemaLocation: A URL pointing to a schema file.
 - type: "Service"
 - serviceRelationship: An array of objects with relationshipType, service, and href.
 - resourceRelationship: An array of objects with relationshipType, resource, and href.
 - lastUpdateDate: "2024-04-08T11:49:53Z"
 - href: A URL pointing to the service object.
 - contentType: "application/json"

Maat – pilot deployments



- Maat has been added to the NMaaS catalogue
- Test instance for GP4L
- Test instance for the Polish PIONIER network
 - PSNC develops a platform for orchestrated network service provisioning
 - Maat as the SoT
 - Production deployment in 2024
- Bitbucket repo

<https://bitbucket.software.geant.org/scm/ossbss/maat.git>

<https://bitbucket.software.geant.org/scm/ossbss/maat-eventlistener.git>

Maat website

<https://geant-netdev.gitlab-pages.pcss.pl/MaatDocs/>

Maat

DOCUMENTATION

Extensible, reusable and automation ready solution for defining and managing your network resources and services.

Get Started

Contact Us

We make it.
You own it.

Go to GitHub Repo

What is Maat?

Maat's focus is on providing a reusable, high quality single source of truth for network services and resources, through its core components:

- Extensible data model
 - Open REST APIs
 - Event notification listener
- By sharing different data models within the community, you can get your SSOE up and running on **faster and easier** than mapping from scratch.
- Maat is open source, documented, tested, used in production environments and **fully supported by the development team**.

Maat Features

The screenshot shows the Maat website documentation page. At the top, there is a navigation bar with 'Home', 'Concepts', 'Features', and 'User guide'. A search bar is located on the right. Below the navigation, there is a decorative graphic of a person's head profile. The main content area is titled 'Maat Features' and contains six feature cards:

- API Open, standards-based API**
 - Full CRUD support offers automation and orchestration implementation out of the box.
 - TMF638 Service management API
 - TMF639 Resource management API
- Scalable extensible architecture**
 - Single, consolidated database
 - Integrated validation and logging
 - Compose complex objects using two-way relationships
- Extensible data model**
 - Industry compatible service and resource base model
 - Endlessly customisable
 - Model your own resources using templates
- Modular structure**
 - Schema based non-SQL database
 - Separate service and resource APIs
 - Individual event management
- Dynamic GUI**
 - Easy to use, intuitive design
 - Adapts to your customised model definitions
 - Supports different data views
- Event Notification**
 - Separate notification engine
 - Listen and react to events
 - Log all activities

Below the features, there is a section titled 'Maat Components' with three cards:

- Physical Resources**: Describe infrastructure elements and details of physical location and utilization (card distribution, allocation of physical ports, ...)
- Logical Resources**: Describe virtual resources, connections and relationships between resources
- Services**: Collect detailed information about services and map them to logical and/or physical resources.

Why Maat?

If you implement our **Resource and Service Inventory** and the **Data Model Schema** via **Maat API**, you will get your entire network and services described in the way you want it with as many details as you want.

We've built every component based on the best-recommended practices, mainly following the **TM Forum Open API spec**, enabling you to implement, reuse and automate your network activities faster.

Maat will hold the desired state of your entire infrastructure and grant you the possibility to orchestrate service management in an easy and powerful way.



Maat as a Source of Truth in PIONIER



Evolution of PIONIER

Model	Devices
MX304	82
PTX10001-36MR	6
ACX7100-48L	50
ACX7100-32C	28
ACX7024	367
EX4600-40F	17
EX4650-48Y	13
EX2300-C-12T	93



Interfaces	Total
1GE	1 116
10GE	186
1/10GE	408
1/10/25GE	8 808
10/25GE	624
40GE	68
100GE	2 540
400GE	1 116

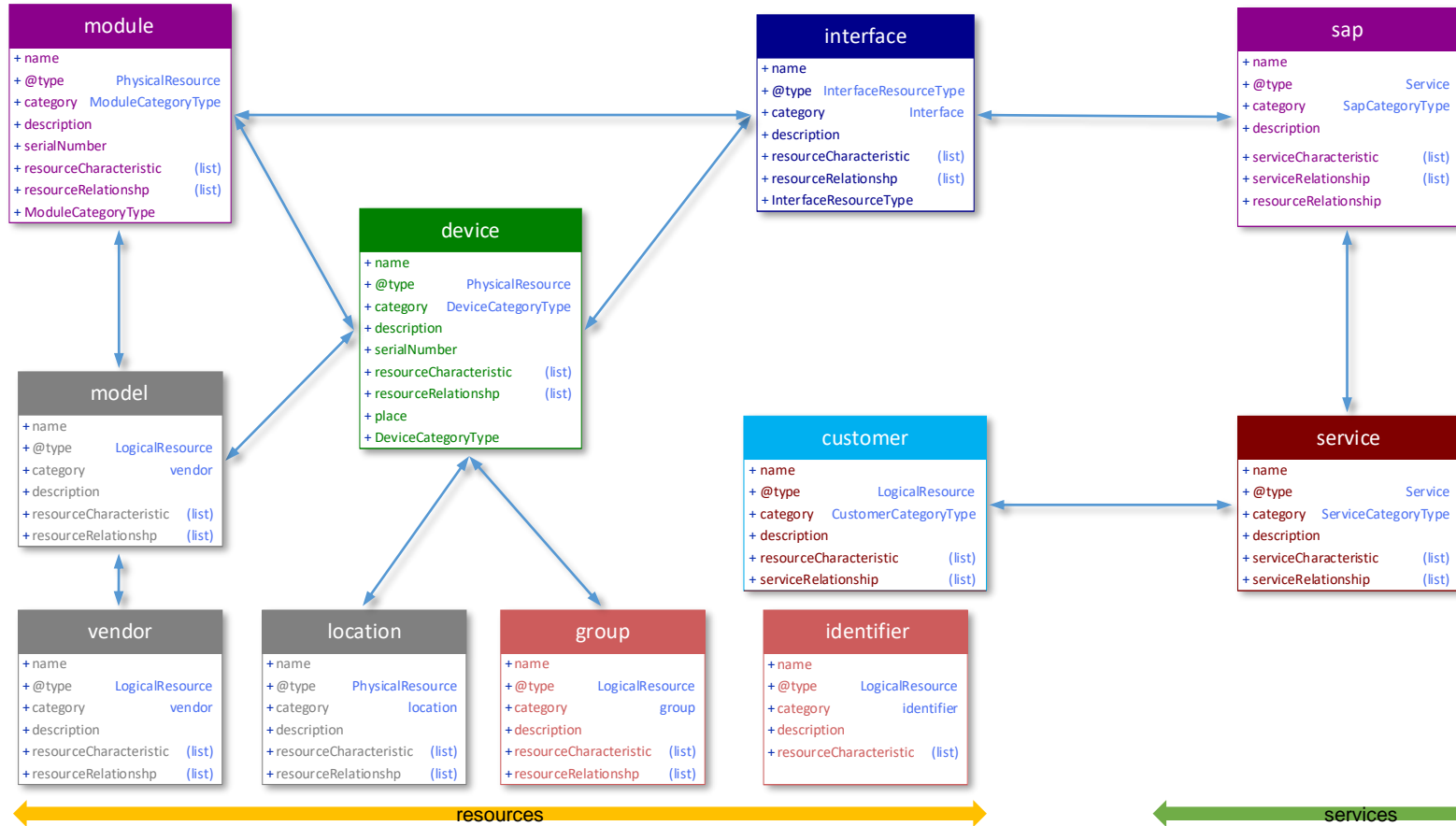
Network management platform for PIONIER

- Multiple independent tools/platforms
 - NMS
 - Traffic statistics
 - Config backups
- Independent customer management
- Network device configs is “source of truth”

Source of Truth as a key component of the platform

- New model using SoT
 - Resources management
 - Services management
 - Users management
- Must support step by step implementation on operational infrastructure
- User (network engineer) friendly 😊
- Database supporting NOC

PIONIER resources and services in Maat – data model



PIONIER resources and services in Maat - devices



Resources

Services

- > vendor
- > model
- ▼ device.router
- ptx-poz-2
- ptx-poz-1
- ptx-war-1
- ptx-wro-1
- ptx-gda-1
- ptx-kra-1
- interface
- unit

Table

JSON

Name	Description	Type	Category	SerialNumber	StartOperatingDate	LastUpdateDate	Id
ptx-poz-2	Python API generated ptx-poz-2	PhysicalResource	device.router	HGW698	2024-04-03T11:24:01Z	2024-04-03T11:24:14Z	5aa83382-85ab-4bae-9b4e-dbd06af005f0
ptx-poz-1	Python API generated ptx-poz-1	PhysicalResource	device.router	HGW971	2024-04-03T11:24:21Z	2024-04-03T11:24:33Z	97362dd7-e017-4053-ad6d-ac7ce1f84fcd
ptx-war-1	Python API generated ptx-war-1	PhysicalResource	device.router	HGW429	2024-04-03T11:24:40Z	2024-04-03T11:24:57Z	1a8e82d8-bb16-4b33-9cf2-28038ae1a55f
ptx-wro-1	Python API generated ptx-wro-1	PhysicalResource	device.router	HGW217	2024-04-03T11:25:01Z	2024-04-03T11:25:11Z	bb1fecf6-6770-46fa-a20b-11659e467f22
ptx-gda-1	Python API generated ptx-gda-1	PhysicalResource	device.router	HGW590	2024-04-03T11:25:16Z	2024-04-03T11:25:28Z	60548d56-549c-4fee-bb32-b0aae175b93a
ptx-kra-1	Python API generated ptx-kra-1	PhysicalResource	device.router	HGW968	2024-04-03T11:25:33Z	2024-04-03T11:25:44Z	6462da40-1327-4983-bcdb-3865cb0b2aa1

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PIONIER resources and services in Maat – parameters and relations

Maat Resources Services

Human readable

JSON

```

{
  "vendor": "PTX",
  "model": "PTX-KRA-1",
  "device": "router",
  "name": "ptx-kra-1",
  "description": "Python API generated ptx-kra-1",
  "category": "device.router",
  "resourceCharacteristic": [
    {
      "name": "routerID",
      "value": "150.254.253.69"
    },
    {
      "name": "isoID",
      "value": "49.9112.1502.5425.3069.00"
    },
    {
      "name": "mgmt",
      "value": {
        "default": "10.255.248.222",
        "inet": {
          "re0": "10.255.248.218/28"
        }
      }
    },
    {
      "name": "chassis",
      "value": {
        "aggregated_devices": {
          "ethernet": {
            "device_count": "4"
          }
        }
      }
    }
  ]
}
  
```

Maat Resources Services

backward reference

reference

```

]
@schemaLocation: "https://raw.githubusercontent.com/GEANT-NETDEV/Inv3-schema/main/TMF639-ResourceInventory-v4-pionier.json"
@type: "PhysicalResource"
serialNumber: "HG968"
resourceRelationship: [
  {
    relationshipType: "bref:model"
    resource: {
      id: "1a5aae2-7ea3-43a8-8439-6bcd6c03452"
      href: "https://10.27.1.10:8082/resourceInventoryManagement/v4.0.0/resource/1a5aae2-7ea3-43a8-8439-6bcd6c03452"
      name: "PTX10001-3GMR"
    }
  },
  {
    relationshipType: "ref:interface"
    resource: {
      id: "fd3a917c-f68d-4377-99bd-329f3a551ca6"
      href: "https://10.27.1.10:8082/resourceInventoryManagement/v4.0.0/resource/fd3a917c-f68d-4377-99bd-329f3a551ca6"
      name: "et-0/0/0"
    }
  }
]
@type: "ResourceRelationship"
}
}
relationshipType: "ref:interface"
resource: {
  id: "cdd2ab83-c283-4923-8b10-c1e778914ab6"
  href: "https://10.27.1.10:8082/resourceInventoryManagement/v4.0.0/resource/cdd2ab83-c283-4923-8b10-c1e778914ab6"
  name: "et-0/0/1"
}
@type: "ResourceRelationship"
}
  
```

PIONIER resources and services in Maat - services

- I2circuit/VLL service example
 - Two SAPs referenced to the service instance
 - Each SAP has reference to physical interface on the device

Maat Resources **Services**

> I2.circuit
▼ I2.circuit.sap
SAP1.user60
SAP2.user60

Table JSON

Name	Description	Type	Category	LastUpdateDate	ServiceDate	Id
SAP1.user60	user60 VID 20	Service	I2.circuit.sap	2024-04-08T11:49:55Z	2024-04-08T11:49:55Z	cd904be2-914e-4069-9ef8-05265767afdc
SAP2.user60	user60 VID 20	Service	I2.circuit.sap	2024-04-08T11:49:55Z	2024-04-08T11:49:55Z	9cef02ec-1811-4fc0-8f0f-765308ed3d95

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Development of orchestrated service provisioning in PIONIER

- Maat keeps parameters for network devices and services
 - JSON format
 - REST API
 - Flexible
 - Resources, services and parameters
 - No need for another external tool
 - Data browser with GUI
 - Linked references
 - Customizable tables
- Airflow orchestrator
- GEANT LSO as tamer for ansible workhorse



Thank you!



Co-funded by
the European Union

netdev@lists.geant.org

The scientific work is published for the realization of the international project cofinanced by Polish Ministry of Science and Higher Education in the years 2019 - 2022 from financial resources of the programme entitled "PMW"; Agreement No. 5023/H2020/2019/2



Maat or Ma'at (Egyptian: mꜣꜥt /'murʕat/, Coptic: ⲙⲉⲓ)[1] comprised the ancient Egyptian concepts of truth, balance, order, harmony, law, morality, and justice. Ma'at was also the goddess who personified these concepts, and regulated the stars, seasons, and the actions of mortals and the deities who had brought order from chaos at the moment of creation. Her ideological opposite was Isfet (Egyptian jzft), meaning injustice, chaos, violence or to do evil.

