

Basic application development training for MindSphere (3 days)

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MindSphere Cloud Development

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Cloud Essentials

Learning Goals

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How can we build „cloud native applications“ & What has changed over the last 5 years?

- Cloud Computing (NIST)
- 12 Factor APPs
- Javascript / node.js

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Cloud Essentials

What is Cloud Computing?

NIST*-Definition

<http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf>

Essential Characteristics:

- On-demand self-service
- Broad network access
- Resource pooling
- Rapid elasticity
- Measured service

FLEXIBILITY
SCALABILITY
TRANSPARENCY

Compared to
traditional software business solutions



Technically, but also
business-wise

*National Institute of Standards & Technologies

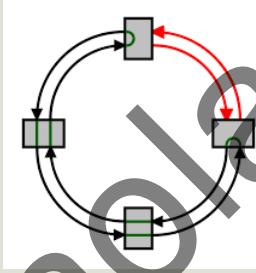
Cloud Essentials

Cloud Computing – Essential characteristics (NIST)

| On-Demand Self-Service | Broad Network Access | Resource Pooling | Rapid Elasticity | Measured Service |
|--|---|---|---|--|
| Automatic provision of computing capabilities without human interaction with each service provider e.g. server time, storage, virtual machines and services <i>„Use what you need, when you need it“</i> | Capabilities available over the network, accessible via standard mechanisms Use across mobile devices, laptops and workstations <i>„One solution for each size of need“</i> | Multi-tenant model, dynamically assignment of physical and virtual resources e.g. storage, processing, memory and network bandwidth <i>„Tailor resources to what is required“</i> | Virtually unlimited resources, elastic provisioning and releasing Manual or automatic provisioning inwards and outwards <i>„React to changing demands with one click“</i> | Controlled and optimized resources by service metering e.g. storage, processing, bandwidth and active user accounts <i>„Pay per use, control your costs“</i> |

Cloud Essentials

Cloud Computing – Additional Important Topics

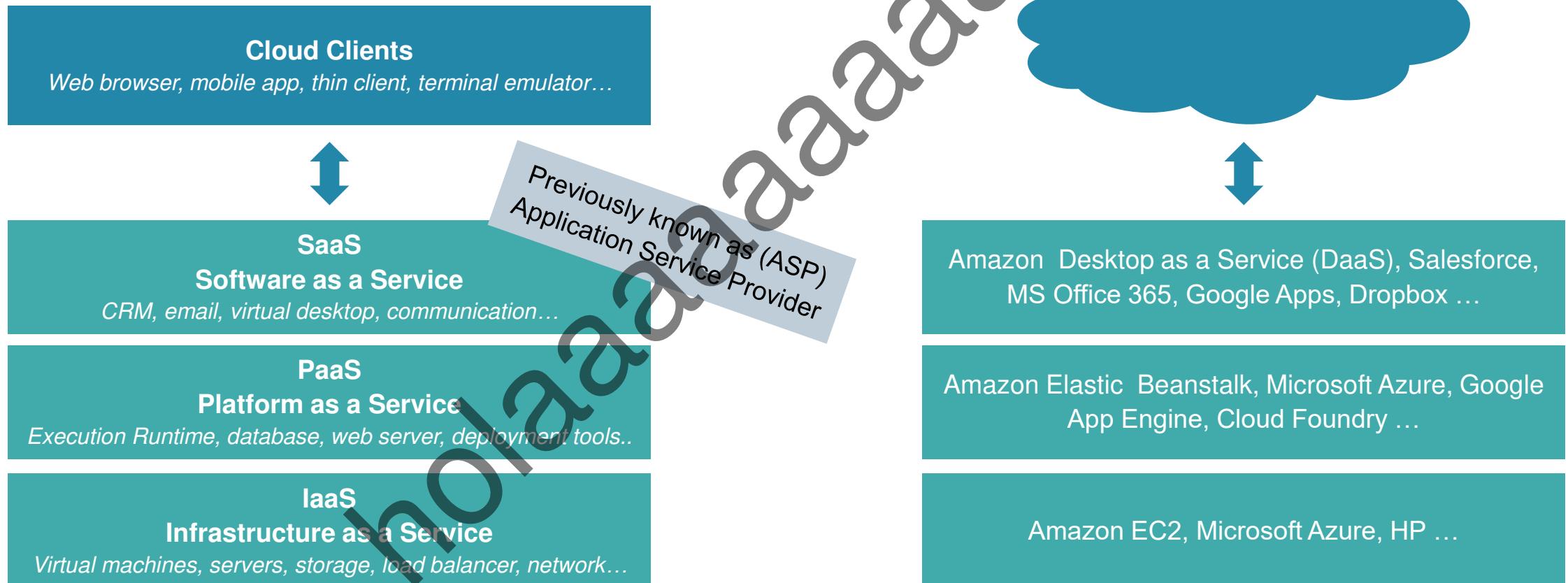
| Redundancy and Robustness | Self-Healing | Auto-Scaling |
|--|---|--|
| Avoidance of Single Point of Failure (SPOFs) | Monitoring (availability) + Automated provisioning = Self-healing | Monitoring (through-put) + Automated provisioning = Auto-scaling |
| Scalable architecture (load balancing) | | |
| Robustness through clustering (Failover) |  | |



<http://www.publicdomainpictures.net/view-image.php?image=66632>

Cloud Essentials

Cloud Computing - Service Models



Cloud Essentials

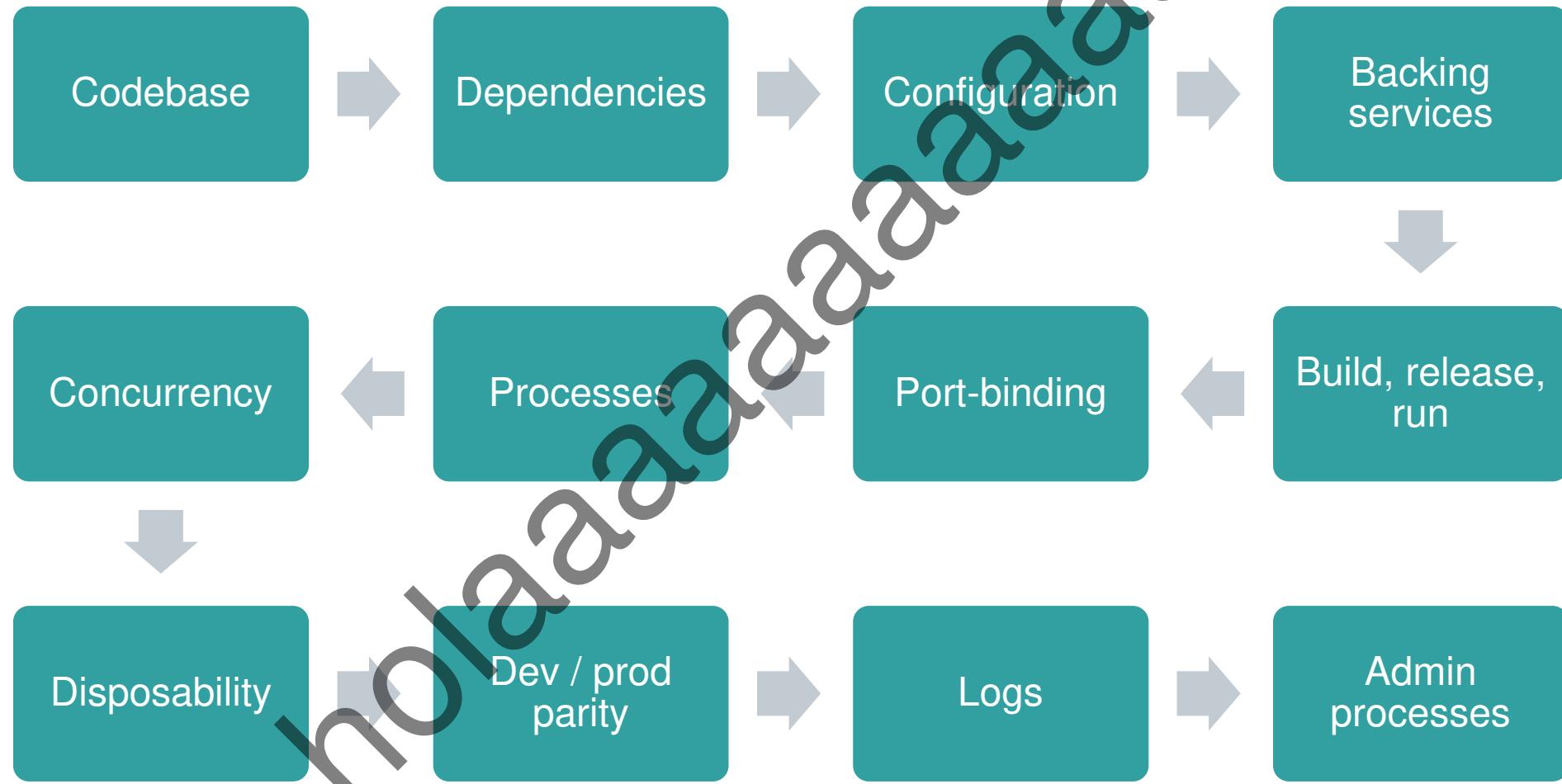
Cloud Computing – Deployment Models (NIST)

| Public Cloud | Private Cloud | Hybrid Cloud | Community Cloud |
|---|---|--|--|
| <ul style="list-style-type: none">- Multi-tenant- Open usage- Publicly accessible | <ul style="list-style-type: none">- Single tenant- Exclusive usage- Single organization- Multiple consumers- On and off-premise | <p>Private + public cloud-mix:</p> <ul style="list-style-type: none">- Cloud bursting- Untested workloads- High availability- Disaster recovery | <p>Private cloud for groups:</p> <ul style="list-style-type: none">- Computing collaboration- Multiple organizations- Community- Common concerns- Shared interests |
| AWS, Cloud Foundry, Heroku | Oil & Gas, Governmental Services | <p>“Buy the base, rent the spike”</p> <p>“fail fast, fail cheap”</p> | Shared costs |

Cloud Essentials

Cloud Computing – 12 factors in 5 minutes

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Cloud Essentials

Cloud Computing – 12 factors in 5 minutes

| Config (Configuration) | Backing services | Disposability |
|---|---|---|
| <ul style="list-style-type: none">- Vary between deploys- Resource (service binding)- Credentials- Per-deploy values | <ul style="list-style-type: none">- No distinction between local and third party services- Services as a resource- Access via URL | <ul style="list-style-type: none">- Start / stop at a moment notice- Minimized start time- Shut down gracefully- Stateless service |
| <ul style="list-style-type: none">- Manifest file- Environment variables- Config files | <ul style="list-style-type: none">- Easy swap of backing services- Transparency of the provider and location | <ul style="list-style-type: none">- Robustness against sudden death- “Lift and Shift” |

Server Side Scripting

Model-View-Controller Model (View = webpage)

Examples

- SSI (Server Side Include) / CGI
- PHP (Original)
- JSP / JavaServer Pages
- JSF / JavaServer Faces
- ASP / Active Server Pages

Multi page application (MPA)

SPA / Single Page Application

= a web application or web site that fits on a single web page with the goal of providing a user experience similar to that of a desktop application

Examples

| angular | ember.js | backbone | knockout |
|--|----------|---|----------|
| Advantages | | Disadvantages | |
| <ul style="list-style-type: none">• Fast• JS/CSS only load once• Minimal data transfer• Usability | | <ul style="list-style-type: none">• Slowly first pageload• SEO (not relevant for us) | |

Progressive webapps

= Combination of webapps and native apps

- Fast
- Reliable
- Indexability
- Push notifications
- Can use device specific functions, e.g. camera, gps

Cross-Platform Development

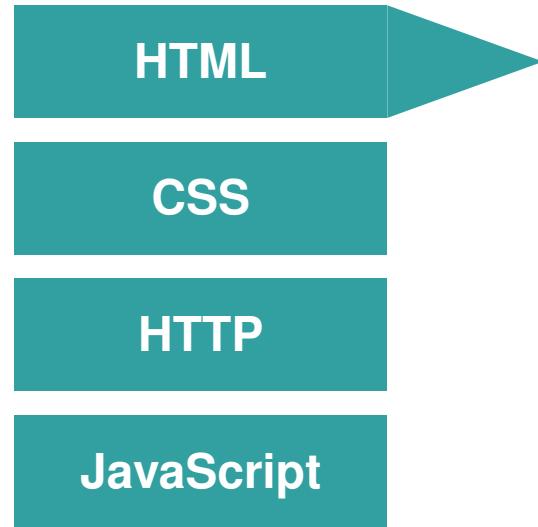
| | |
|---------------|---|
| ionic | http://ionicframework.com |
| NativeScript | http://docs.nativescript.org |
| Xamarin | https://www.xamarin.com |
| Sencha Ext JS | https://www.sencha.com |
| ... | |

Still the same basics



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Still the same basics

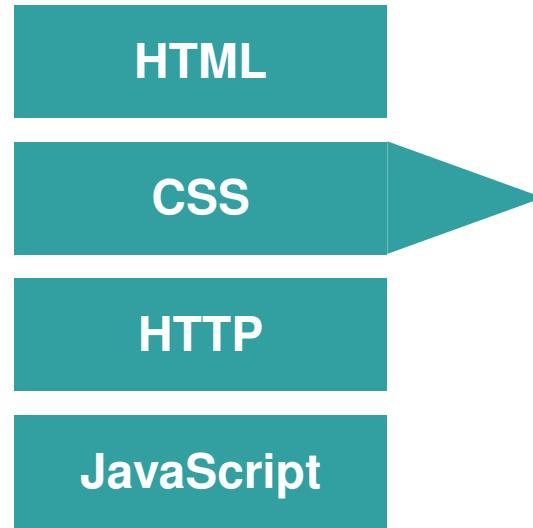


Current version: HTML 5.2 (27. March 2018)

Latest features

- Canvas
- Drag&Drop
- Video
- Audio
- Markup
- Web Storage
- Geolocation

Still the same basics



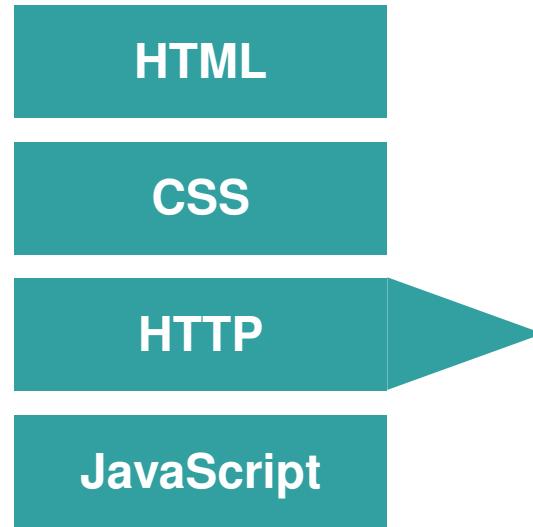
Current version: Level 2 Revision 1 (CSS 2.1)

CSS3 modules recommendations

- 2012-06-19: Media Queries
- 2011-09-29: Namespaces
- 2011-09-29: Selectors Level 3
- 2011-06-07: Color

| Latest features | CSS Frameworks |
|-----------------|--|
| • Media Queries | <ul style="list-style-type: none">• Bootstrap• Foundation• YUI CSS grids |

Still the same basics



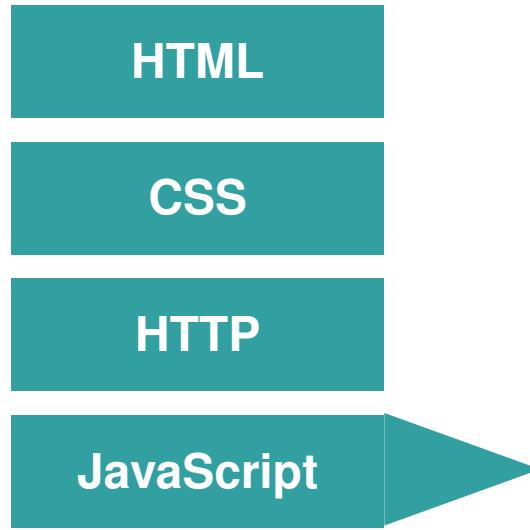
Current version: HTTP/2 (May 2015)

HTTP functions as a request–response protocol in the client–server computing model

Latest features

- stateless
- Encrypted connections
- HTTP-Statuscodes
- HTTP-Authentication
- HTTP-Compression
- Encrypted connections (HTTPS)

Still the same basics



JavaScript is a high-level, dynamic, weakly typed, object-based, multi-paradigm, and interpreted client-side programming language

Current version: **ECMAScript 2018** / June 2018

Differentiation

- **ECMAScript** - standardized by Ecma International in ECMA-262 and ISO/IEC 16262
- **JavaScript** - generic term for different versions and implementations
- **TypeScript** - strict syntactical superset of JavaScript, and adds optional static typing - developed by Microsoft

Node.js

an open-source, cross-platform JavaScript run-time environment for executing
JavaScript code server-side

Current version: 11.4.x & 10.14.x (LTS) (Dez 2018)

| Main features | Package Management |
|---|--|
| <ul style="list-style-type: none">• event-driven architecture• asynchronous I/O• single threaded• non-blocking I/O calls | <ul style="list-style-type: none">• node package manager - npm• dependency management• package registry (online database of public packages) |

Angular (angular.io) is a framework for building client applications in HTML and JavaScript

Current Version: 7.1.x

- Maintained by Google
- Started 2009
- Angular 2 - completely rewritten in 2015 / Angular 1 still available as AngularJS

Latest features

- Modules
- Components
- Templates
- Data binding
- Directives
- Services
- Dependency injection

Official name: **Representational state transfer**

REST-compliant web services allow requesting systems to access and manipulate textual representations of web resources using a uniform and predefined set of stateless operations

Core ideas

- Performance
- Scalability
- Simplicity of a uniform Interface
- Visibility of communication between components by service agents
- Statelessness

Important: REST is an architectural style, not a protocol

*REST was defined by Roy Fielding in his 2000 PhD dissertation
Roy Fielding is the co-founder of the Apache HTTP Server project*

Web Development Basics

REST



HTTP-based RESTful APIs are defined with the following aspects:

- base URL, such as `http://api.example.com/resources/`
- an internet media type that defines state transition data elements, for example JSON
- standard HTTP methods (e.g., OPTIONS, GET, PUT, POST, and DELETE)

| Verb | Usage |
|--------|---|
| GET | Used to retrieve a resource. |
| POST | Primarily used to create a new resource. It is also used to retrieve resources if the input for the retrieval request is so large that it has to be sent in the request body instead of the header. |
| PUT | Used to fully replace an existing resource. |
| PATCH | Used to partially update an existing resource. |
| DELETE | Used to delete an existing resource. |

HTTP status codes

| Code | Status | Code | Status | Code | Status |
|------|------------|------|--------------------|------|-----------------------|
| 200 | OK | 400 | Bad Request | 500 | Internal Server Error |
| 201 | Created | 401 | Unauthorized | 501 | Not Implemented |
| 204 | No Content | 403 | Forbidden | | |
| | | 404 | Not Found | | |
| | | 405 | Method Not Allowed | | |
| | | 406 | Not Acceptable | | |

Web Development Basics

JSON

```
{  
    "firstName": "John",  
    "lastName": "Smith",  
    "isAlive": true,  
    "age": 27,  
    "address": {  
        "streetAddress": "21 2nd Street",  
        "city": "New York",  
        "state": "NY",  
        "postalCode": "10021-3100"  
    },  
    "phoneNumbers": [  
        {  
            "type": "home",  
            "number": "212 555-1234"  
        },  
        {  
            "type": "office",  
            "number": "646 555-4567"  
        },  
        {  
            "type": "mobile",  
            "number": "123 456-7890"  
        }  
    ],  
    "children": [],  
    "spouse": null  
}
```



JSON: JavaScript Object Notation

JSON is a **language-independent** data format.

It was derived from JavaScript, but as of 2017 many programming languages include code to generate and parse JSON-format data

Cloud Essentials

Summary

How can we build „cloud native applications“?

Follow NIST, comply to the 12 factors and build upon Cloud Foundry

What has changed over the last 5 years?

Node.js ecosystem has produced a lot of cool (=useful) tools



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MindSphere Architecture & API

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Architecture & API

Learning Goals

**How is MindSphere designed
&
how shall we develop
applications for
MindSphere?**

- MindSphere Architecture
- MindSphere APIs
- MindAccess Developer

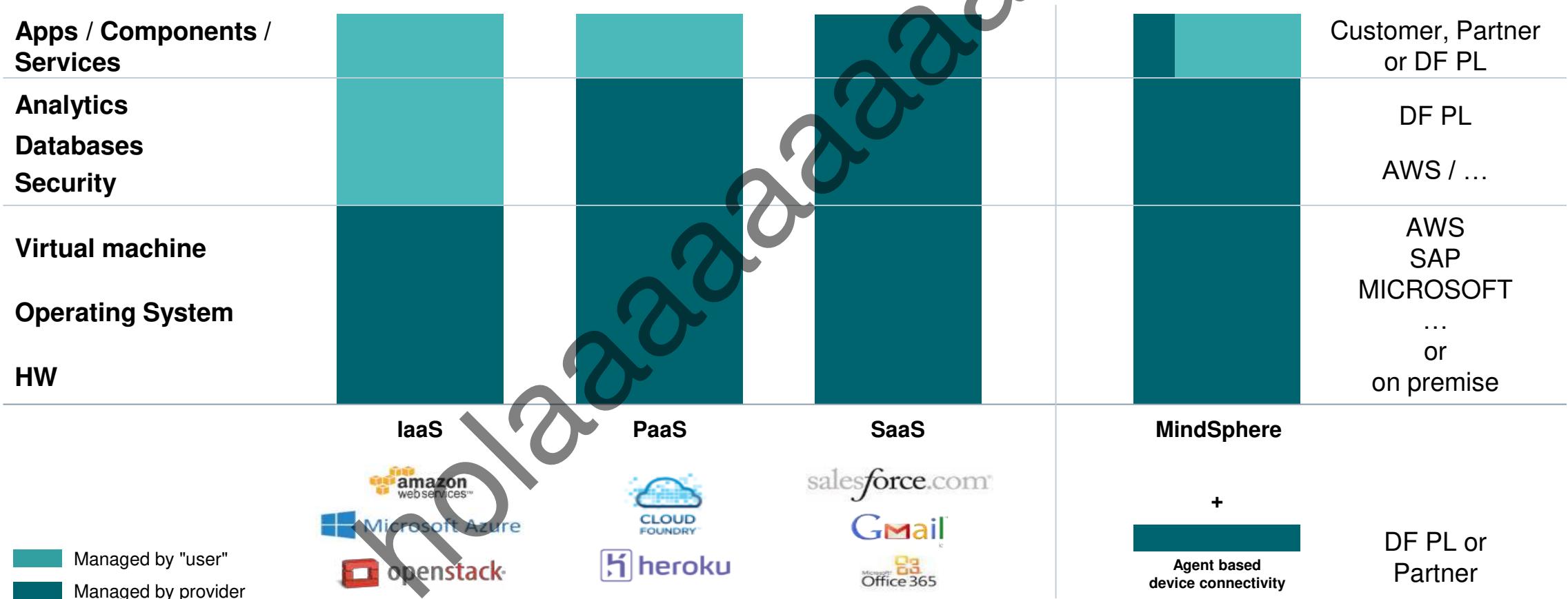


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MindSphere is an end to end IoT operating system that enables a partner ecosystem

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Generic overview of different cloud models



MindSphere Portfolio Overview

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MindApps

Powerful industry applications and digital services for asset transparency and analytical insights



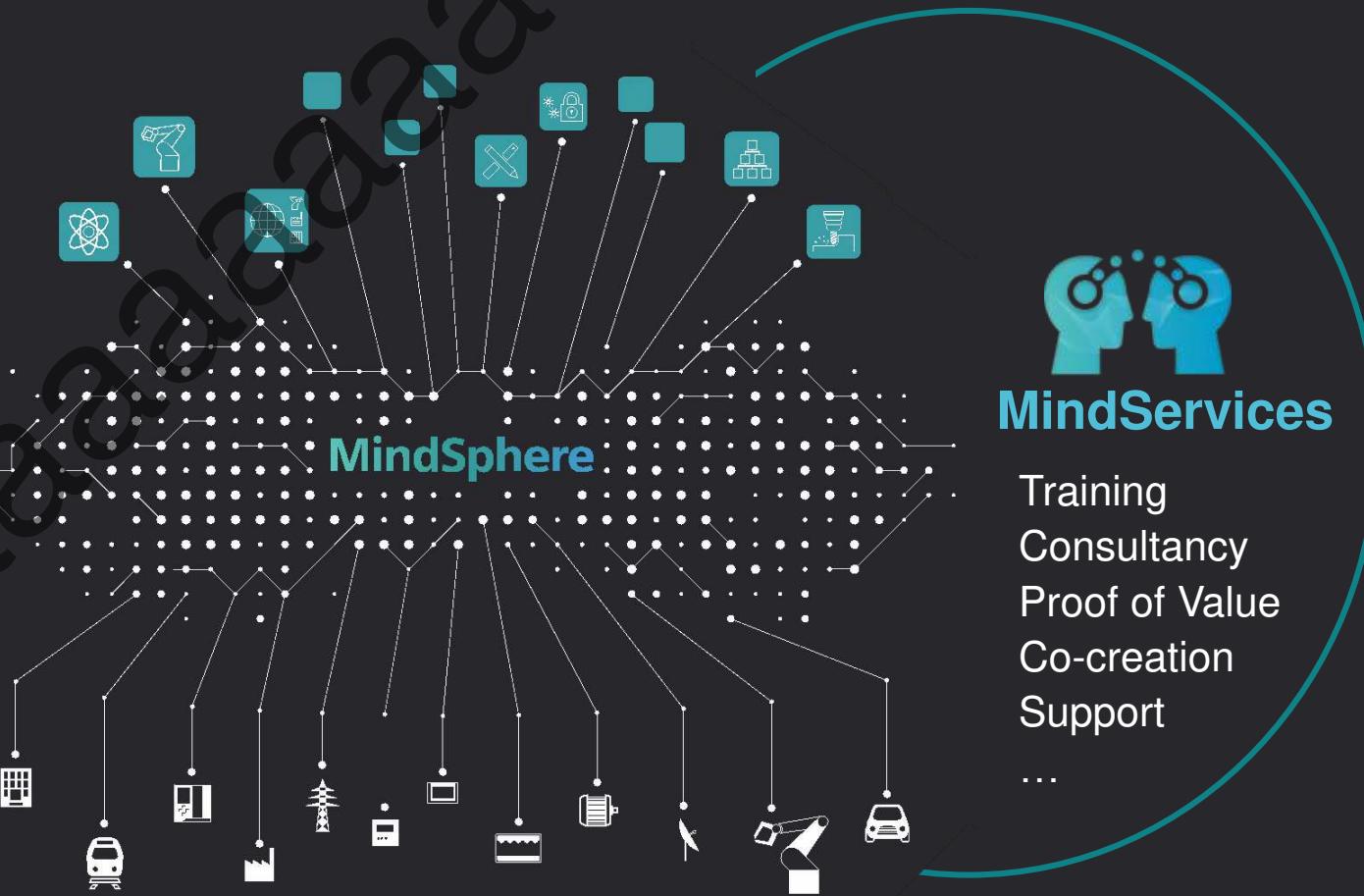
MindSphere & MindAccess

Open Platform as a Service (PaaS) for scalable, global IoT connectivity and application development



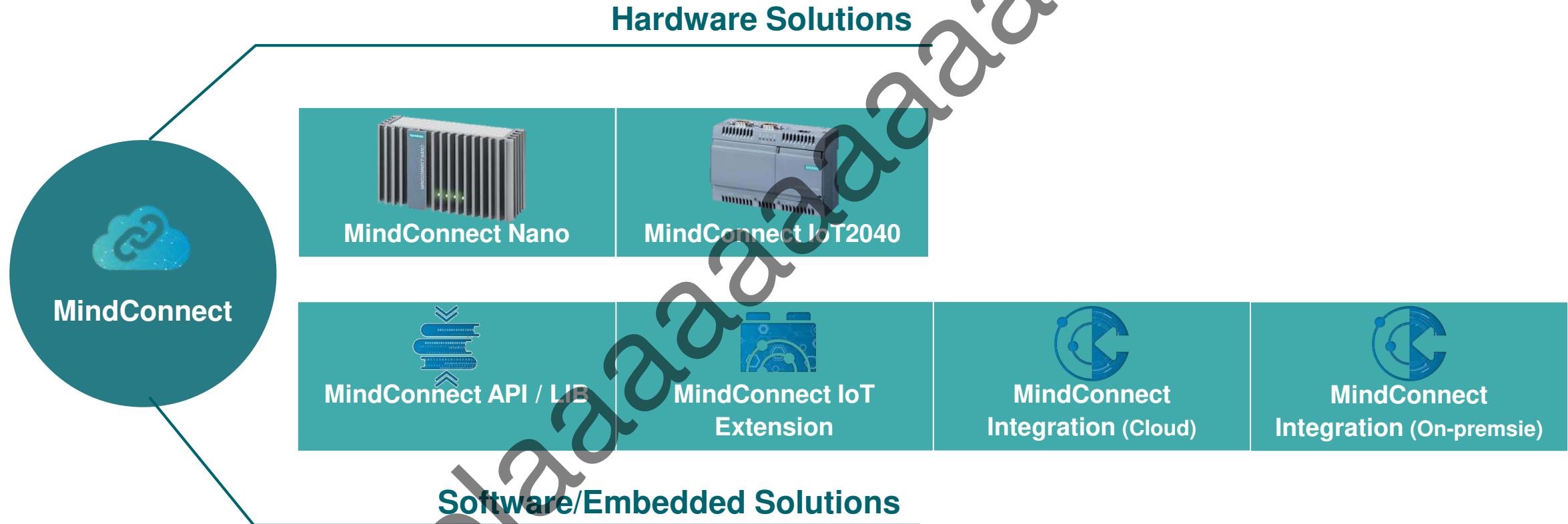
MindConnect

Secure plug and play connection of Siemens and third-party products and equipment



Connecting Assets to MindSphere: MindConnect

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Connectivity @ MindSphere

MindConnect IoT Extension¹



Description

MindConnect IoT Extension is a connectivity layer that expands the number of protocols that can communicate directly with MindSphere. Various field protocols are supported along with an increased range of hardware connectivity agents that create direct connection to assets in the production environment. Use the complete environment to create and manage agents and devices . MindConnect IoT Extension is included in MindAccess IoT Value Plan and Developer Plan with upgrades available for increases in data ingestion based on solution requirements.



Benefits

- Expands MindSphere connectivity to all machines across the production floor
- Supports various field protocols and software agents
- Supports a wide range of hardware connectivity devices
- Provides a complete environment for agent development and device management



Scope²

Software Agents: MQTT Agent, Java Agent, C++ Agent

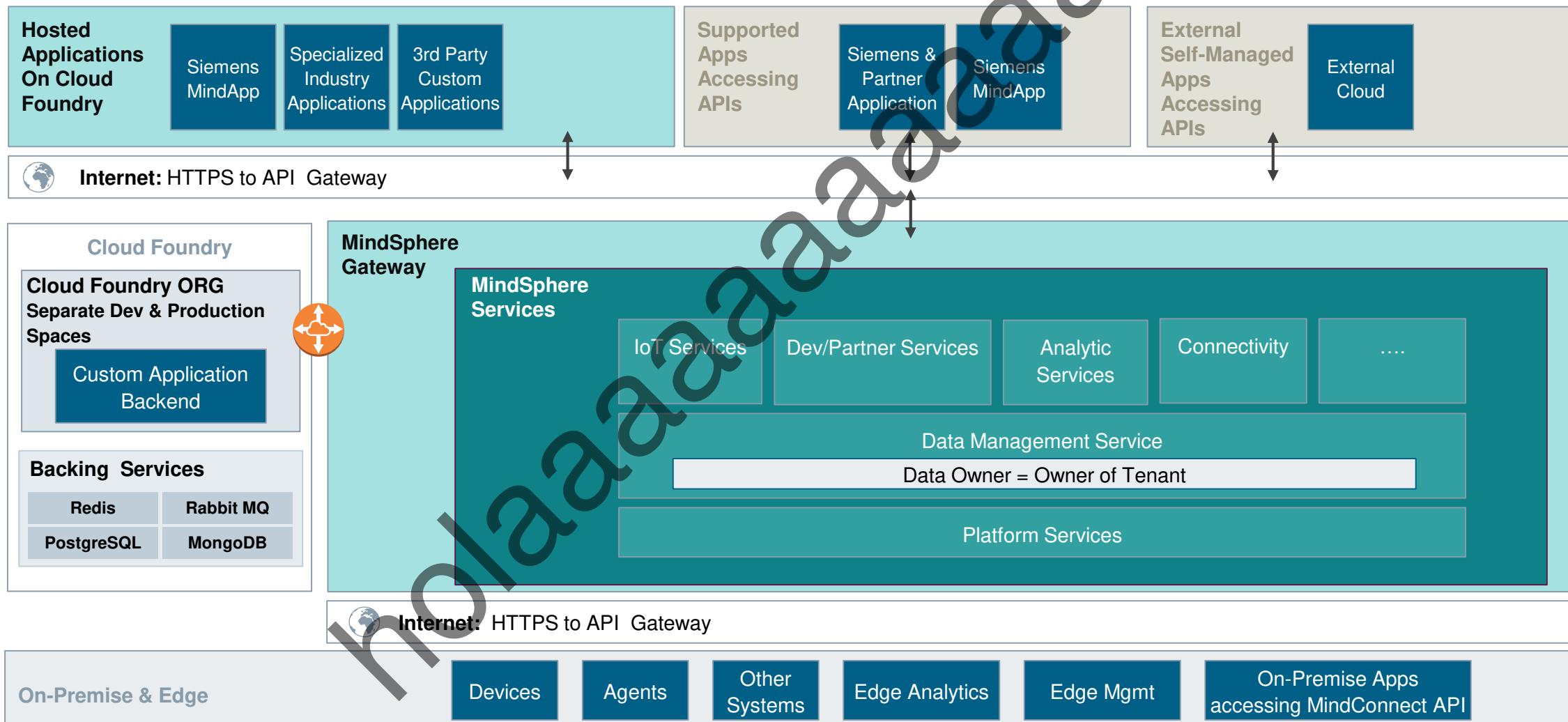
Agent Development and SDKs: REST API, Web SDK, Web SDK for AngularJS

Supported field protocols: HTTP/HTTPS, TCP, VNC, MQTT / MQTT+TLS, REST, SmartRest 1.0 / 2.0, OPC-UA, Modbus/RTU, Modbus/TCP, CAN bus, MMC, SPI, I2C, McASP, device specific protocols

Compatible Devices: Adeunis LoRAWAN, BeagleBone Black, Cinterion Java Modules, CloudGate, Dell Edge Gateway, INSYS Smart Devices – INSYS OS, INSYS Smart Devices – icom OS, Janz Tec emPC A/RPI, Libelium-Mesehlium, Mbed u-blox C027, Meitrack, Netcomm, OPCUA Java Gateway, OWA3x, QuecLink, RaspberryPi, Red Lion RAM, SMARTBox, Robustel, SIGFOX, SMARTBox IO, SMARTBox Mini, TC3G, Telic, TinkerForge, Tixi

MindSphere 3.0 Technical Architecture

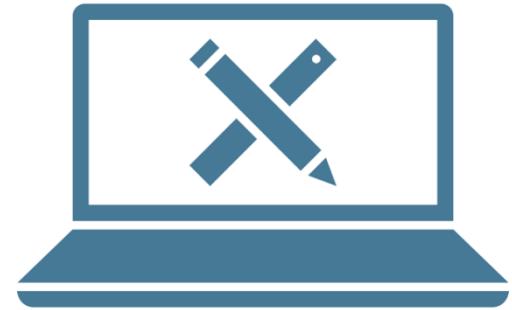
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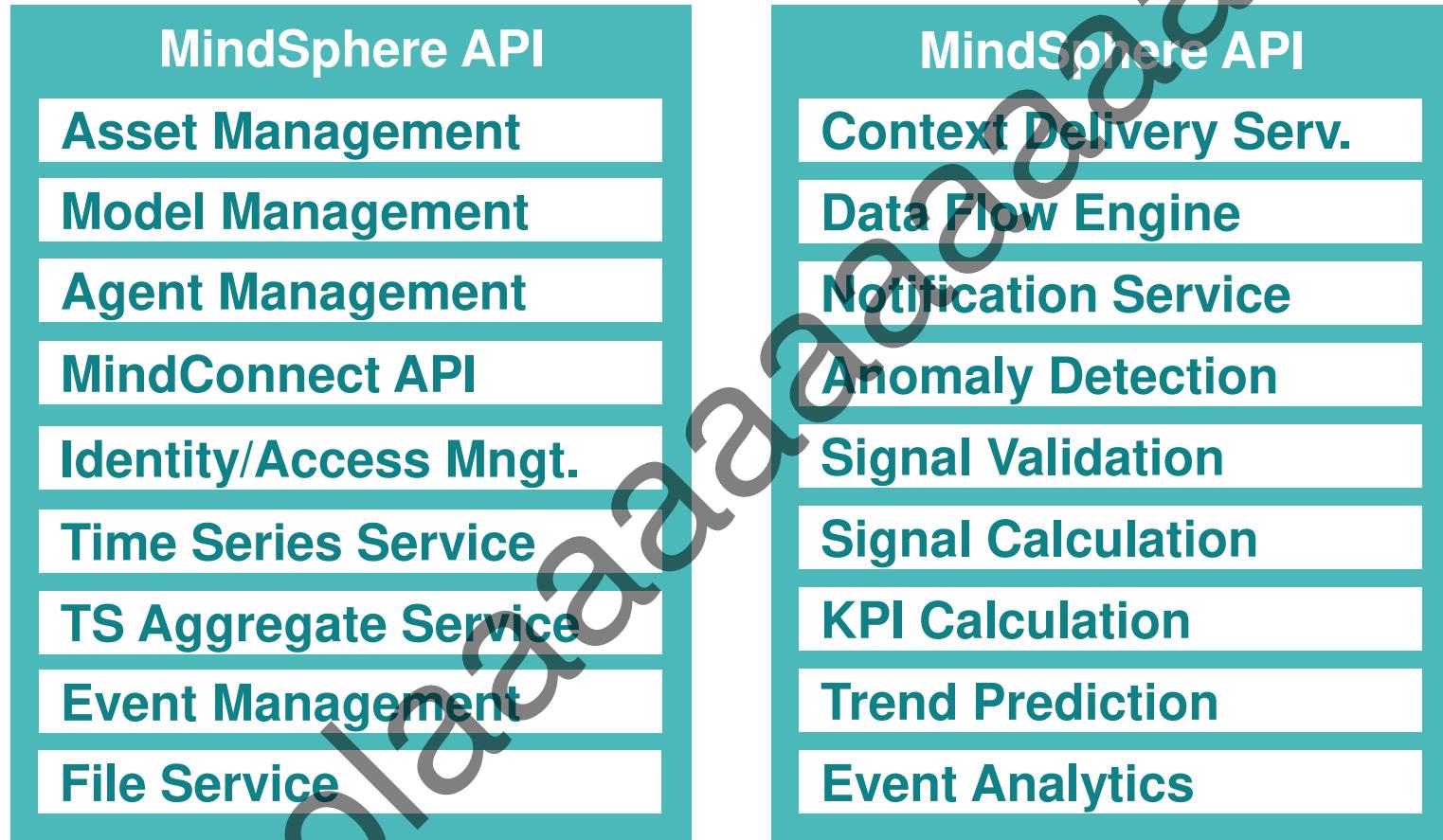


API: Application Programming Interface

- A set of subroutines, protocols and tools to build application software
= Building blocks that make the application development fast and easy
- MindSphere 3.0:
 - 18 API optimized for industrial IoT application development
 - Long term stability for min. 2 years to fulfill industrial needs (long product lifecycles)
 - API versioning and backward compatibility
 - Continuous demand-based functionality extension

Develop your own applications
running on MindSphere





REST based API

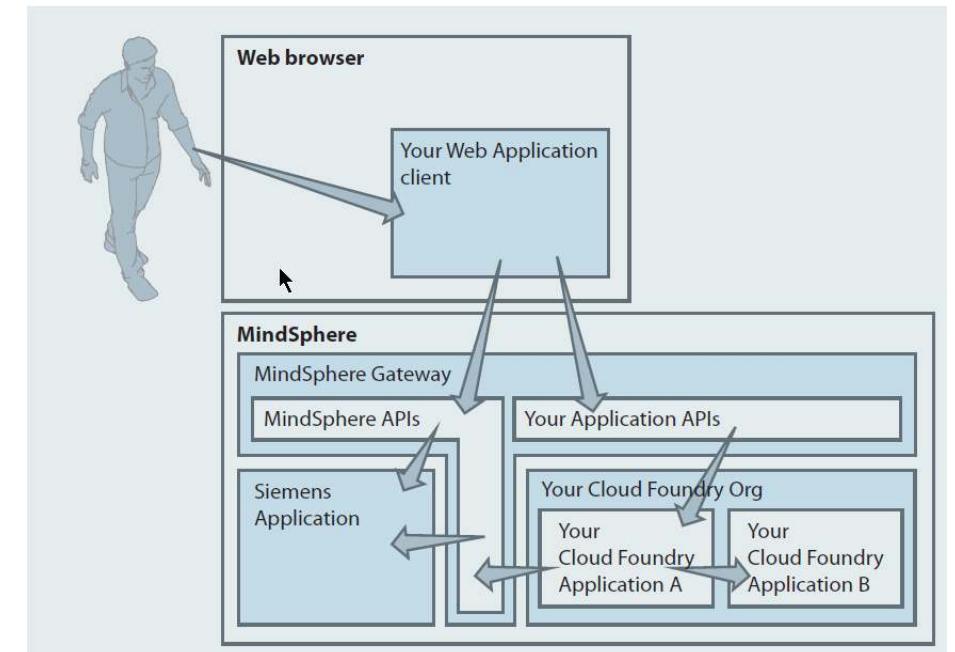
Usage over MindSphere Gateway:

`https://gateway.eul.mindsphere.io/api/...`

Or directly from a browser via a registered app:

`https://<app-url>.eul.mindsphere.io/api/...`

Content-Type: JSON



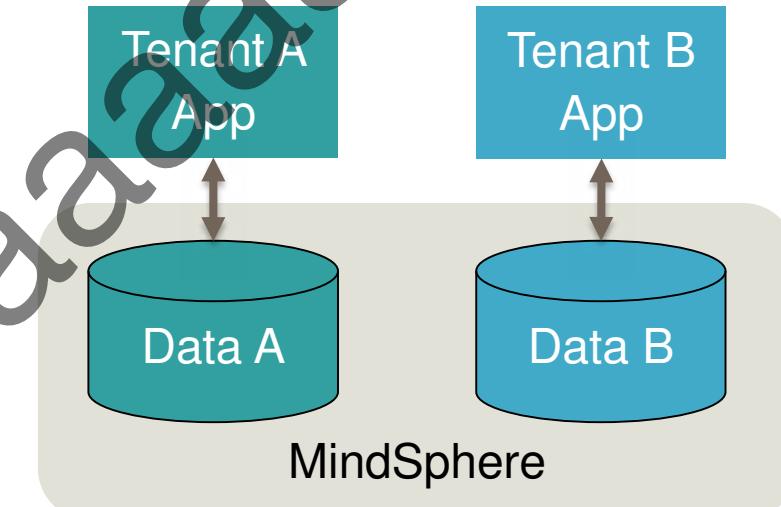
Hypertext Application Language (HAL)

- Standard convention of defining hypermedia within JSON or XML code
- MindSphere API Users should not create URIs themselves
→ they should use the links below to navigate from resource to resource instead

```
"_links": {  
    "self": {  
        "href": "https://gateway.eu1.mindsphere.io/api/assetmanagement/v3/assets/db70d09526b34f20bdf3945517d67047"  
    },  
    "aspects": {  
        "href": "https://gateway.eu1.mindsphere.io/api/assetmanagement/v3/assets/db70d09526b34f20bdf3945517d67047/aspects"  
    },  
    "variables": {  
        "href": "https://gateway.eu1.mindsphere.io/api/assetmanagement/v3/assets/db70d09526b34f20bdf3945517d67047/variables"  
    },  
    "location": {  
        "href": "https://gateway.eu1.mindsphere.io/api/assetmanagement/v3/assets/db70d09526b34f20bdf3945517d67047/location"  
    },  
    "parent": {  
        "href": "https://gateway.eu1.mindsphere.io/api/assetmanagement/v3/assets/d724fb736bed492abce635e77d38b88d"  
    },  
    "children": {  
        "href": "https://gateway.eu1.mindsphere.io/api/assetmanagement/v3/assets?filter=%7B%22parentId%22%22db70d09526b34f20bdf3945517d67047%22%7D"  
    }  
}
```

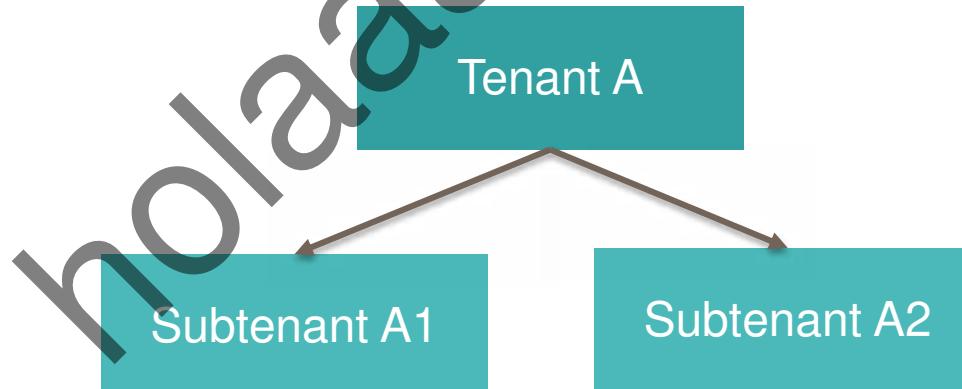
Multitenant System

- Strict data separation between tenants
- Data access only for the assigned owner of the tenant (=data owner)



Hierarchical tenant system ("OEM Usecase")

- Tenant
- Subtenant



| Asset | Aspect | Datapoint / Timeseries |
|--|--|--|
| <ul style="list-style-type: none"> “Asset” is a logical representation of a machine or any device that can provide data to the system Hierarchical relations possible Data sources, e.g. MindConnect Elements, are mapped to Assets | <ul style="list-style-type: none"> “Aspect” contains summarized data points from data sources for a specific evaluations Group of datapoints Aspect can define multiple variables with pre-defined units / data-types | <ul style="list-style-type: none"> Contains historical data from assets as defined by aspects Timestamp format: ISO 8601 |



* simplified

MindSphere Time Format ISO 8601



Typical usage

YYYY-MM-DDTHH:MM:SS . SSSZ

2015-12-21T08:03:34 . 123Z

Complete syntax

https://en.wikipedia.org/wiki/ISO_8601

<https://xkcd.com/1179/>

PUBLIC SERVICE ANNOUNCEMENT:

OUR DIFFERENT WAYS OF WRITING DATES AS NUMBERS CAN LEAD TO ONLINE CONFUSION. THAT'S WHY IN 1988 ISO SET A GLOBAL STANDARD NUMERIC DATE FORMAT.

THIS IS **THE** CORRECT WAY TO WRITE NUMERIC DATES:

2013-02-27

THE FOLLOWING FORMATS ARE THEREFORE DISCOURAGED:

02/27/2013 02/27/13 27/02/2013 27/02/13

20130227 2013.02.27 27.02.13 27-02-13

27.2.13 2013. II. 27. 2⁷/2-13 2013.158904109

MMXIII-II-XXVII MMXIII ^{LVII}_{CCCLXV} 1330300800

((3+3)×(111+1)-1)×3/3-1/3³ 2013 Mississ

10/11011/1101 02/27/20/13 01237 22747



MindSphere Offering Structure



Customers need to order at least one of the base plans...

MindAccess IoT Value Plan

Use MindSphere applications based on ingested data – without development know-how

- Data ingest & storage
- Productive tenant
- Asset management
- User management
- Fleet Manager
- MindConnect IoT Extension
- Access to MindSphere Store

MindAccess DevOps Plan

MindAccess Developer Plan
Develop applications on a test system

- Cloud Foundry developer space
- Developer test tenant
- Basic APIs including analytics
- Test asset and user management
- Developer data storage
- Developer cockpit

MindAccess Operator Plan

Operate applications on a productive system and offer them via MindSphere Store

- Cloud Foundry productive space
- Basic APIs including analytics
- Operator cockpit / access to MindSphere Store

MindAccess IoT Value Plan

Resources Overview

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| IoT Value Plan | S small customers/ OEMs | M worldwide installed base | L big international plants |
|--|----------------------------|-------------------------------|-------------------------------|
| No. of users / Subtenants ⁴⁾ | 50 / 10 | 150 / 40 | 500 / 80 |
| Agents onboarded (MindConnect Elements or Lib) | 10 | 25 | 100 |
| Assets included (types/ instances) | 5 / 50 | 10 / 250 | 50 / 1,000 |
| Data ingest rate ³⁾ (time series) | 2 KB/s | 10 KB/s | 100 KB/s |
| Data storage time series (cold storage) | 60 GB | 300 GB | 3 TB |
| Data ingest via IoT extensions ²⁾ , monthly | 5 GB | 5 GB | 5 GB |
| File storage | 50 GB | 100 GB | 500 GB |
| User Management | ✓ | ✓ | ✓ |
| Asset Management | ✓ | ✓ | ✓ |
| Productive Tenant | ✓ | ✓ | ✓ |
| Access to MindSphere Store | ✓ | ✓ | ✓ |
| Fleet Manager Basic incl. rules and events ¹⁾ | ✓ | ✓ | ✓ |

1) Limited use of rules & events. one active concurrent rule included in all plan sizes; upgrade available 2) Part of overall data ingest

3) Based on no. of assets, no. of variables per asset, size per variable, read cycle interval and sending frequency; exemplary use case for M size: 200 assets with 10 variables each sending frequency 10s, 20 assets with 100 variables each sending frequency 10s, etc. (assumptions: 50 Bytes per variable including overhead – float from MindConnect Nano/ IoT2040 or S7-FB, read cycle equals sending frequency) 4) Release upcoming for MindSphere on Azure

Restricted © Siemens

MindAccess Developer Plan

Resources Overview

| Developer Plan (Cloud Foundry) | S | M | L |
|--|---|--------------|---------------|
| Test & development resources (RAM) | 2 GB | 10 GB | 20 GB |
| Cloud Foundry development space | ✓ | ✓ | ✓ |
| Highly available system (several availability zones) | ✓ | ✓ | ✓ |
| Development tenant | ✓ | ✓ | ✓ |
| Developer cockpit | ✓ | ✓ | ✓ |
| Fleet Manager Basic incl. rules and events ³⁾ | ✓ | ✓ | ✓ |
| MindSphere APIs ¹⁾ | ✓ | ✓ | ✓ |
| Unlimited no. of routes | ✓ | ✓ | ✓ |
| Included backing service instances (plan XS) | 2 | 4 | 6 |
| Number of developers/ test users | 10 | 50 | 100 |
| Connected assets types/ instances/ agents ²⁾ | 5 / 20 / 1 | 25 / 100 / 5 | 50 / 200 / 10 |
| Outbound traffic, monthly ⁴ | 60 GB | 300 GB | 600 GB |
| New app transfers to operations system, monthly | 1 | 5 | 10 |
| Developer resources | Documentation, Getting Started, Community | | |
| Supported Build Packs | Go, Java, Node.js, .Net core, PHP, Python, Ruby, Static File (s. Product Sheet for always up-to-date information) | | |

1 Comprehensive set of MindSphere APIs e.g. analytics, notification service, context delivery service; number of calls limited, higher packages include more calls; upgrades available

2 Inbound traffic and respective storage for testing included (according to data sheet)

3 Limited use of rules & events; one active concurrent rule included in all plan sizes; upgrade available

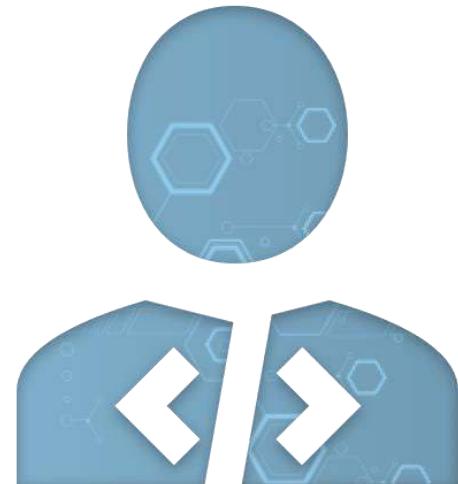
4 Release upcoming for MindSphere on Azure

MindAccess Developer Plan (S, M, L)

Administrative Tools

To **develop, test and manage** own applications in the **dedicated development environment**

| Administrative Tools | Usage Transparency | User Management | Asset Manager |
|----------------------|---|--|--|
| | <p>information regarding resources consumption, e.g.</p> <ul style="list-style-type: none">• number of API calls• numbers of users• inbound and outbound traffic | <p>to manage user rights, permissions and subtenants:</p> <ul style="list-style-type: none">• overview of all users of a specific tenant• Manage users (adding and removing users)• Assign groups and roles• Manage access to applications for users group | <ul style="list-style-type: none">• Onboard and offboard connectivity agents• Configure assets, asset types, aspects and aspect types |



MindAccess Developer Plan (S, M, L)

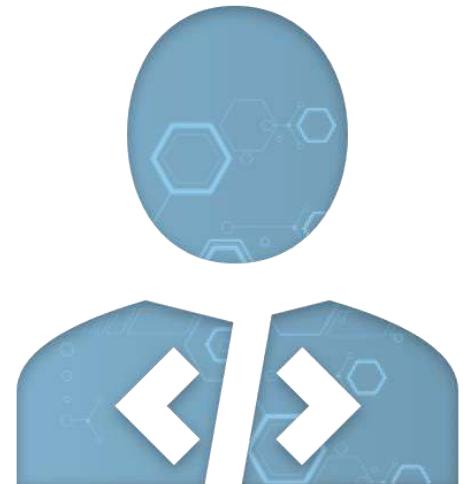
Administrative Tools



To **develop, test and manage** own applications in the **dedicated development environment**

Administrative Tools

| Developer Cockpit |
|---|
| <ul style="list-style-type: none">• Create applications• overview of developed apps• Configure applications, e.g. app icon or display name• Secure applications on an endpoint level• Bring applications to the developer Launchpad• Manage application specific roles• Transfer new or updated applications from developer to productive environment by assigning applications to a MindAccess Operator account• Manage versions of applications |



MindAccess Operator Plan

Resources Overview

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| Operator Plan (Cloud Foundry) | S | M | L |
|--|---|--------------|---------------|
| Productive system resources (RAM) | 2 GB | 10 GB | 20 GB |
| Cloud Foundry productive space | ✓ | ✓ | ✓ |
| Highly available system (several availability zones) | ✓ | ✓ | ✓ |
| Productive tenant for monitoring & support | ✓ | ✓ | ✓ |
| Operator cockpit w/ access to MindSphere Store | ✓ | ✓ | ✓ |
| Fleet Manager Basic incl. rules and events ³⁾ | ✓ | ✓ | ✓ |
| MindSphere APIs ¹⁾ | ✓ | ✓ | ✓ |
| Unlimited no. of routes | ✓ | ✓ | ✓ |
| Number of operator users | 5 | 10 | 25 |
| Connected assets types/ instances/ agents ²⁾ | 5 / 20 / 1 | 25 / 100 / 5 | 50 / 200 / 10 |
| Outbound traffic, monthly ⁴⁾ | 60 GB | 300 GB | 600 GB |
| New uploads to MindSphere Store, monthly | 1 | 5 | 10 |
| Operator Resources | Documentation, Getting Started, Seller Guide | | |
| Supported Build Packs | Go, Java, Node.js, .Net core, PHP, Python, Ruby, Static File (s. Product Sheet for always up-to-date information) | | |

1 Comprehensive set of MindSphere APIs e.g. analytics, notification service, context delivery service; number of calls limited, higher packages include more calls; upgrades available

2 Inbound traffic and respective storage for testing included (according to data sheet)

3 Limited use of rules & events. one active concurrent rule included in all plan sizes, upgrade available

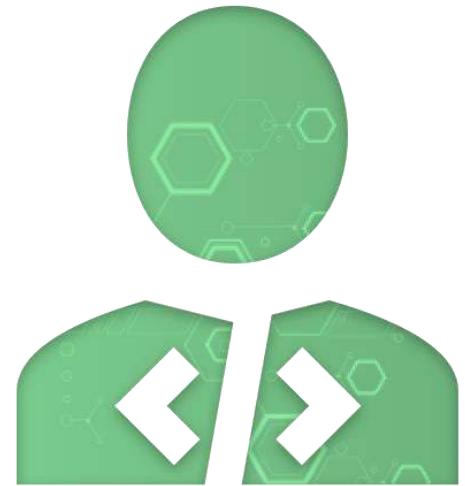
4 Release upcoming for MindSphere on Azure

MindAccess Operator Plan (S, M, L)

Administrative Tools

To **operate** and **manage** applications in the **productive environment** and to publish **applications** in the MindSphere Store

| Administrative Tools | Usage Transparency | User Management | Asset Manager |
|----------------------|---|--|--|
| | <p>information regarding resources consumption, e.g.</p> <ul style="list-style-type: none">• number of API calls• numbers of users• inbound and outbound traffic | <p>to manage user rights, permissions and subtenants:</p> <ul style="list-style-type: none">• overview of all users of a specific tenant• Manage users (adding and removing users)• Assign groups and roles• Manage access to applications for users group | <ul style="list-style-type: none">• Onboard and offboard connectivity agents• Configure assets, asset types, aspects and aspect types |



MindAccess Operator Plan (S, M, L)

Administrative Tools

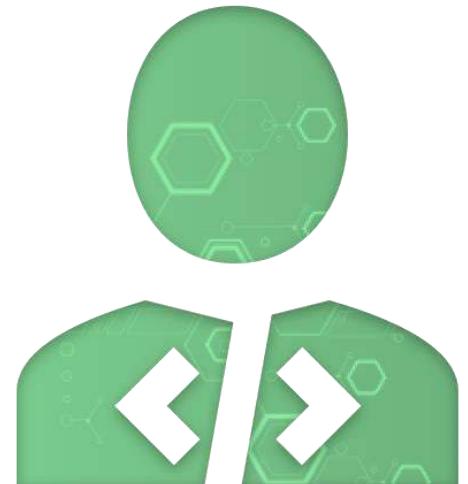
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Ingenuity for life

To **operate** and **manage** applications in the **productive environment** and to publish **applications** in the MindSphere Store

Operator Cockpit

- **Overview** of all own **applications** running on their MindAccess Operator account
- Check **health status** of all their applications
- Receive and display **notifications** concerning theirs applications
- Get **information** on **usage** and **traffic**
- Get information on **new subscriptions** from the MindSphere Store
- **Pull** applications from a MindAccess Developer account to their MindAccess Operator Account by deploying them to the productive environment and operating them
- **Publish** own applications to the **MindSphere Store** and make them visible to only certain customers or to the public (subscribers of a MindAccess IoT Value Plan)
- **Provide** applications to **new customers** that bought their app in the MindSphere Store

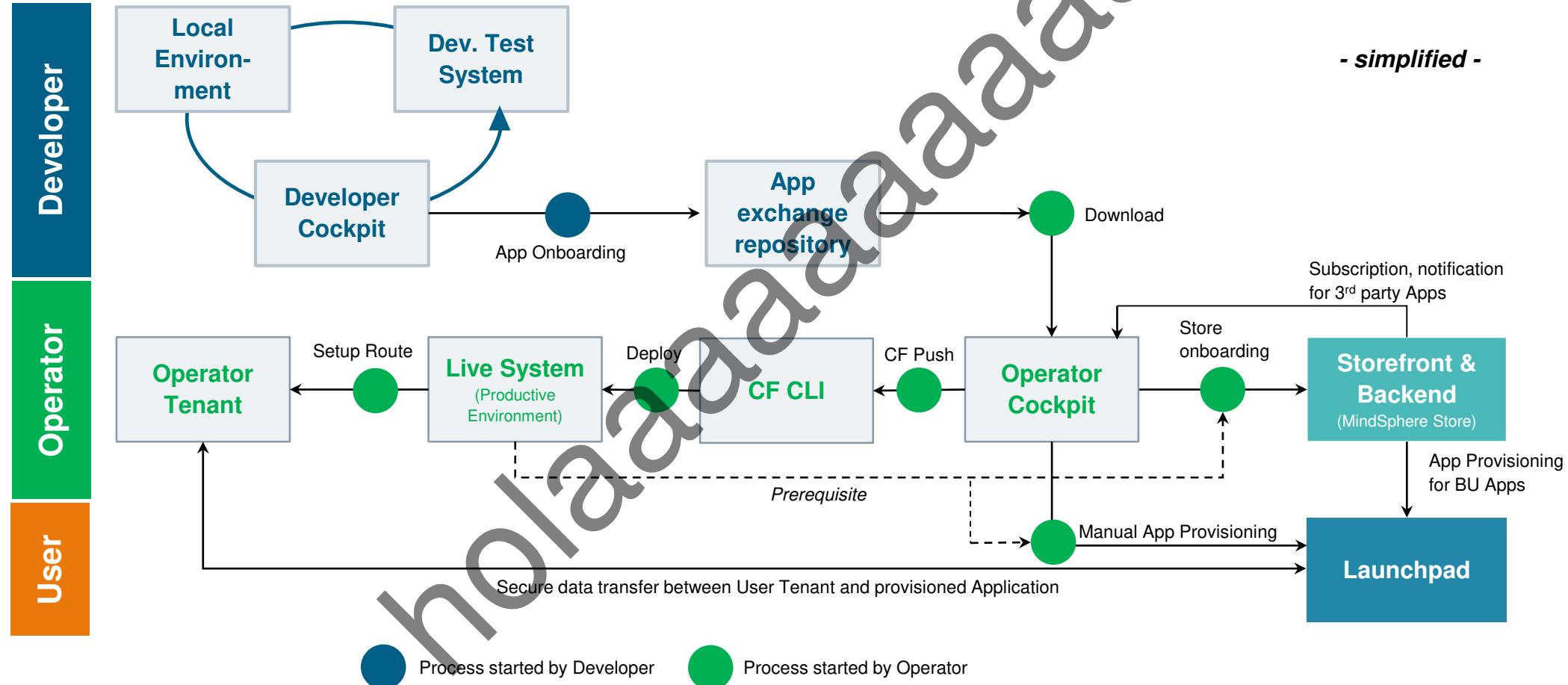
Administrative Tools



Application Lifecycle

How to get an App from the Developer to the User?

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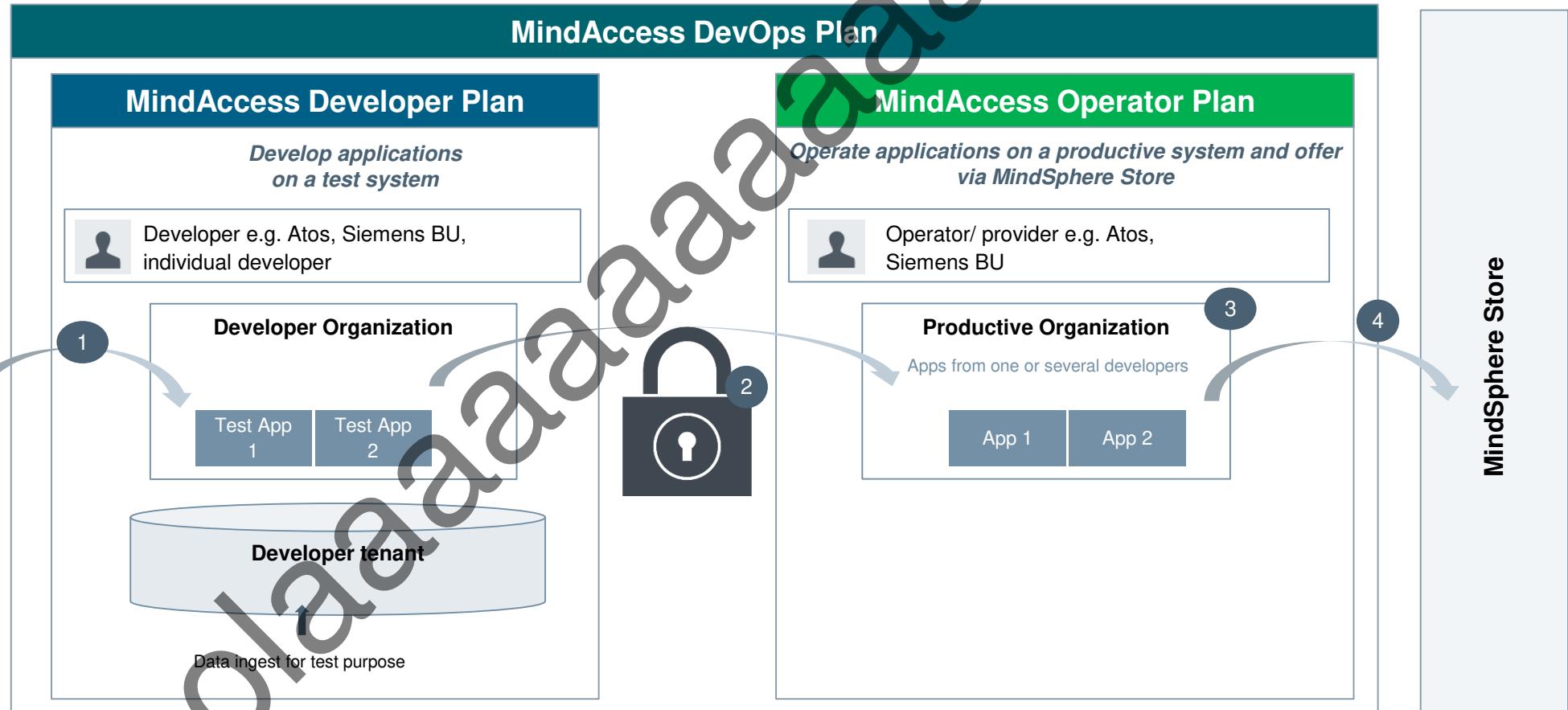


CLI = Command Line Interpreter

Restricted © Siemens

How to Use MindSphere Platform?

Develop and Operate Apps



Exemplary user journey:

1 Developer pushes App to development system

2 Developer transfers App to operations system

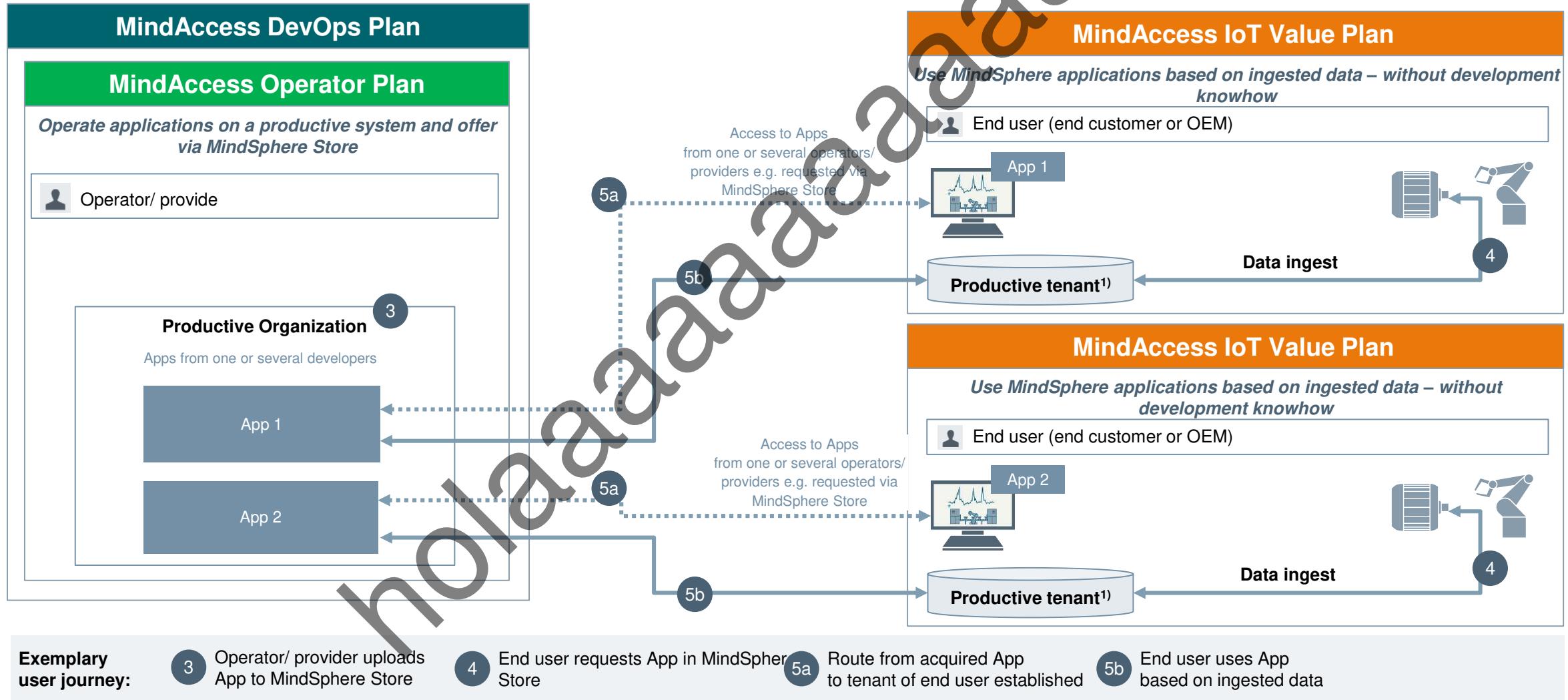
3 Operator/ provider operates App

4 Operator/ provider creates Offering in MindSphere Store

How to Use MindSphere Platform?

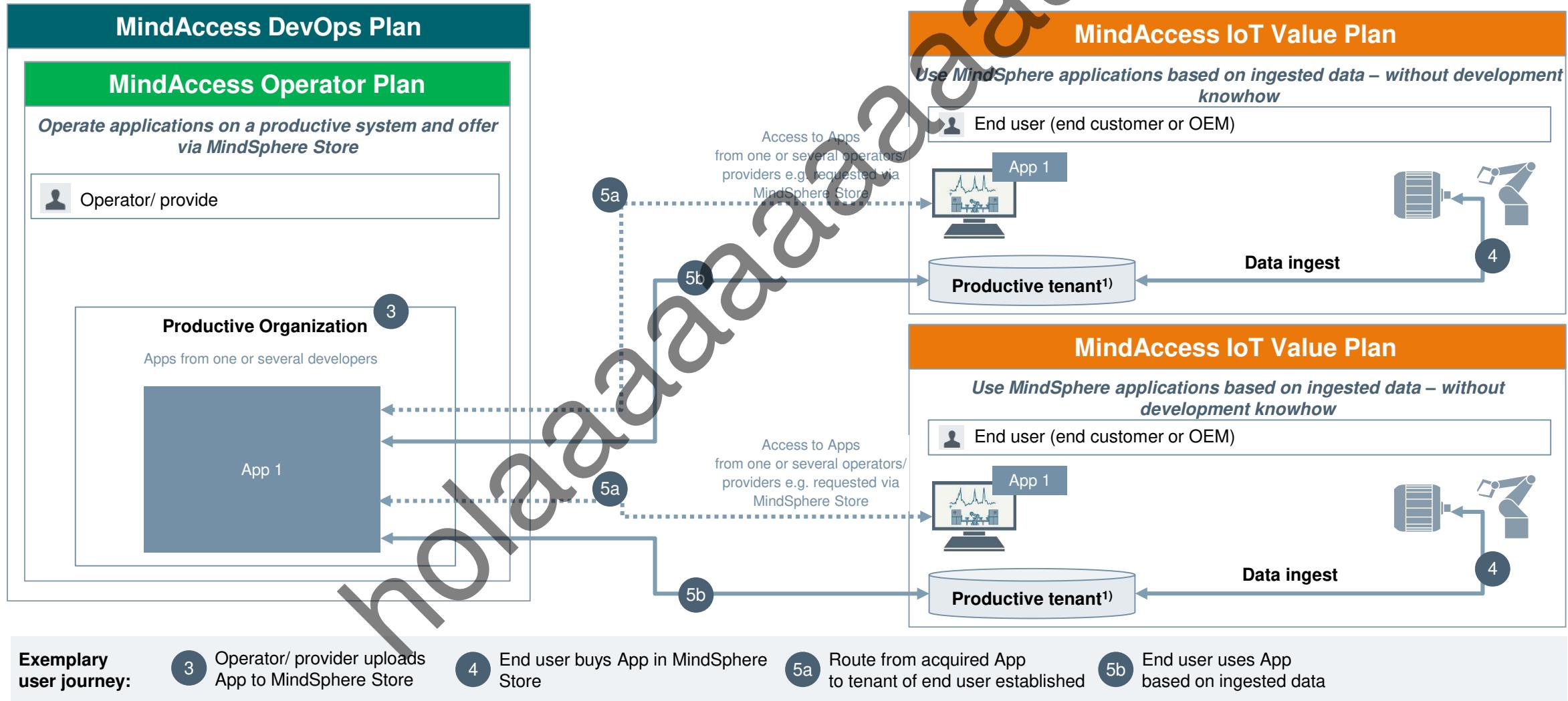
Consume App

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MindSphere 3.0

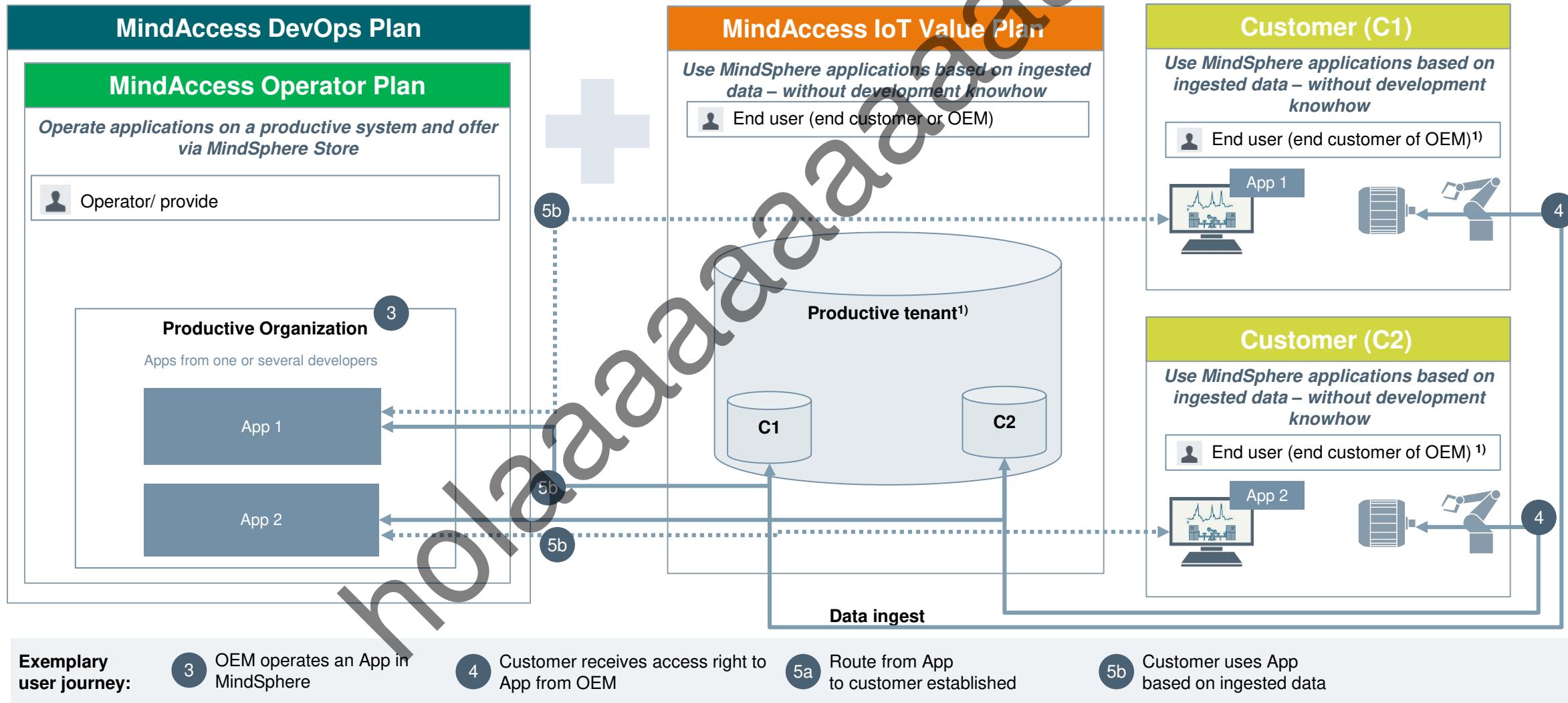
Consume Multitenancy App



How to Use MindSphere Platform?

OEM Use case

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Architecture & API Summary

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How is MindSphere designed?

As an open platform as a service (PaaS) for scalable, global IoT connectivity and application development.

How shall we develop applications for MindSphere?

By getting MindAccess Developer plan (S, M, L), we can start using 18 different APIs to make the application development easy and fast.

MindSphere Tools for Training

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MindSphere - Tools for Training

Learning Goals

Which tools do we use in the training?

- Virtual Box
- Ubuntu Linux
- Cloud Foundry CLI
- Visual Studio Code
- Postman



holaaaaaaaaaaaaaa

We use the following tools in the training:

- Ubuntu Linux
- CloudFoundry CLI
- Microsoft Visual Studio Code
- Postman
- Browser (Chrome)

Where do you get these tools?

Preperations:

- Everybody should have already installed the Virtual Box on your notebook.
- BIOS flag for virtualization (VT-X) has to be enabled.

What to do next:

- Copy the OVA file from the USB-Stick to you notebook.
- Import the OVA file to your Virtual Box (just double-click on the icon).
- Make sure you have internet access inside the linux box.
- Setup proxy (depends on location and internet connection).

Linux Login

- Username: beta
- Password: workshop

MindSphere - Tools for Training

Summary

Which tools do we use in the training?

- Tools are provided
- Install Virtual Box and the latest OVA file



holaaaaaaaaaaaaaa

MindSphere Cloud Foundry Essentials

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Cloud Foundry Essentials

Learning Goals



**What is Cloud Foundry
&
what is its advantage?**

- Cloud Foundry
- Cloud Foundry Foundation
- Build packs

holaaaaaaaaaaaaaa

- Multi cloud application platform as a service (PaaS)
- SpringSource, VMWare, EMC, Pivotal
- Development startet in 2009
- First version in 2012



Onsi Fakhouri, VP Cloud R&D, Pivotal

Cloud Foundry Foundation is a 501(c)(6) **nonprofit, open source** project.

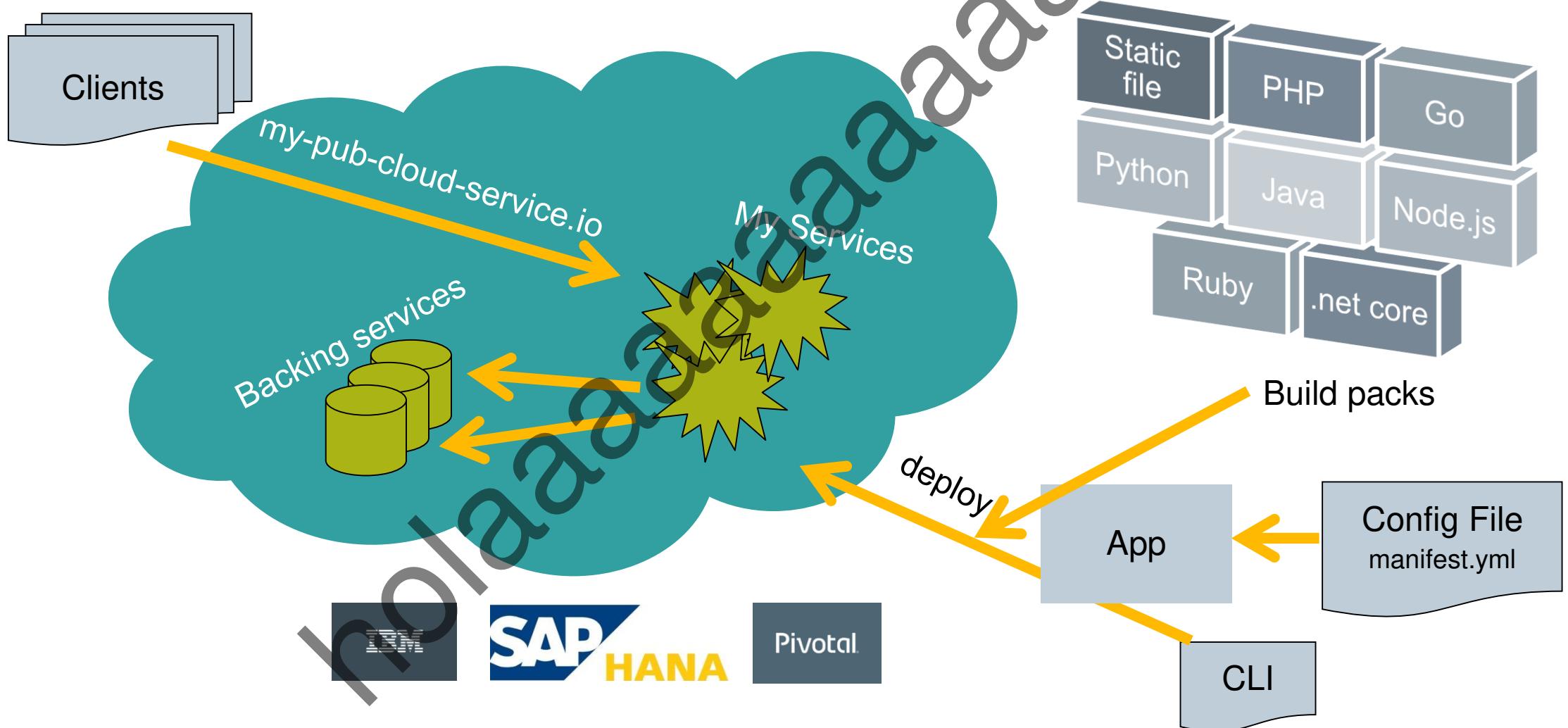
"Our purpose is to make Cloud Foundry the leading application platform for cloud computing worldwide."

Members (extract):

- Cisco
- IBM
- Pivotal
- SAP
- SUSE
- VMware

Cloud Foundry Overview

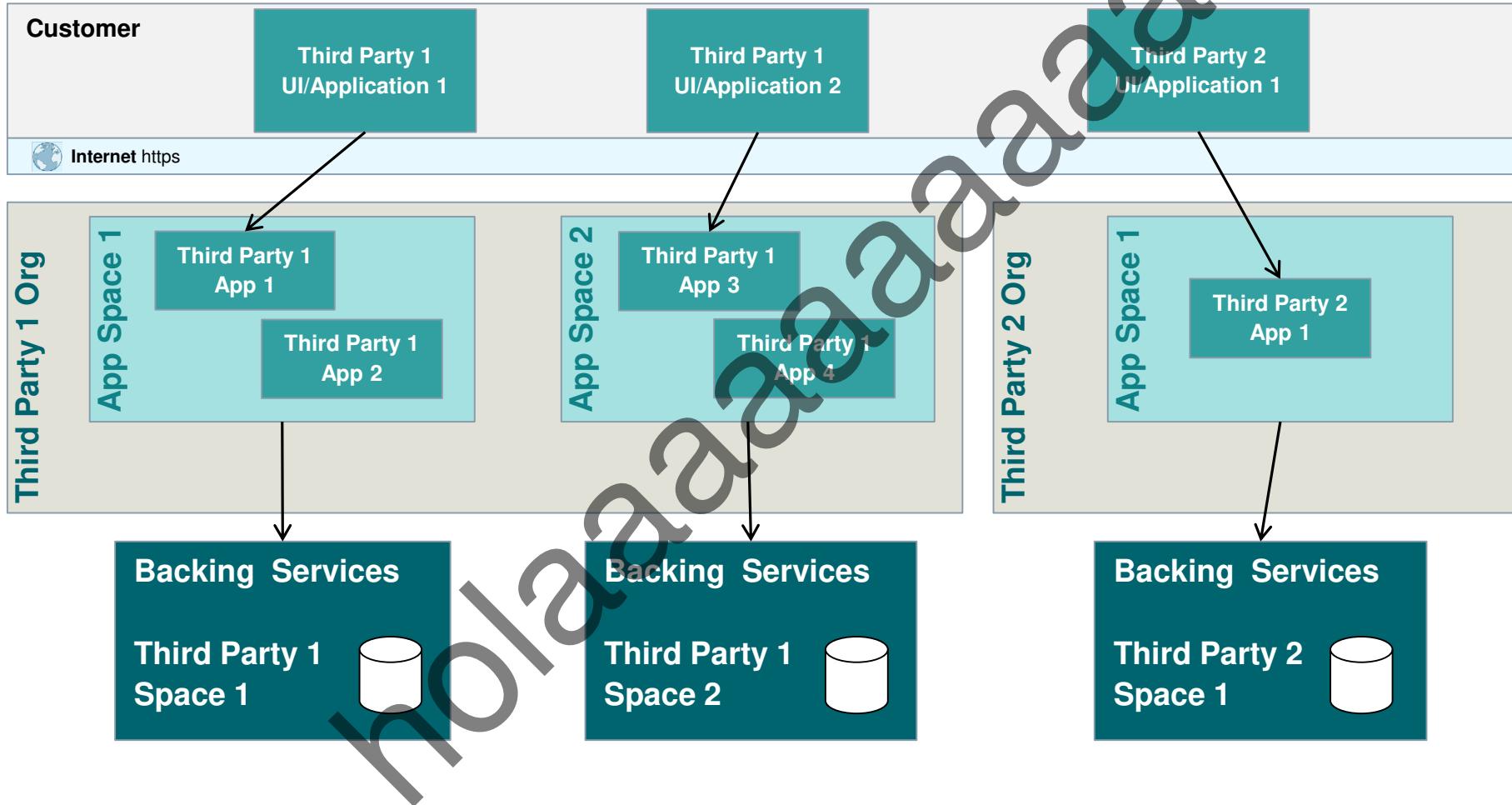
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Cloud Foundry

Org-Space concept

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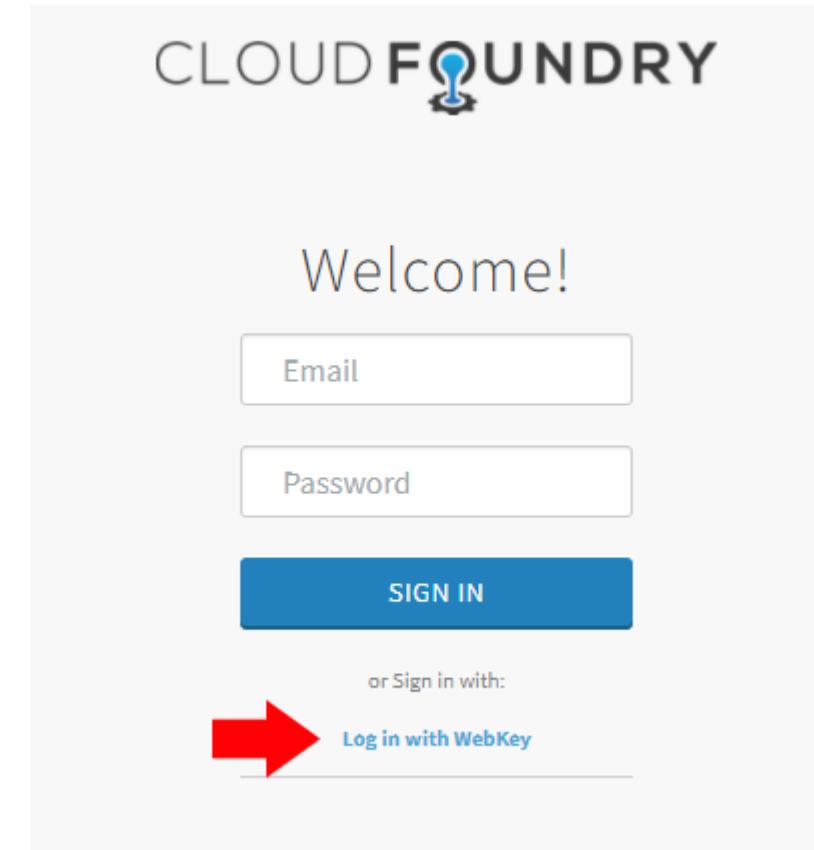
- Industrially hardened Stemcells
- Managed Buildpacks with a high level of security standard (e.g. CVE scanning)
- Managed Backing Services with automated backup capabilities (plan medium or higher)
- Separation of Concerns - clear separation of development and production environments)
- Positive Security Concept for Applications and APIs

Cloud Foundry

Step-by-step: Login

1. Optional: Set proxy configuration in CMD or bash
2. Define endpoint: cf api https://api.cf.eu1.mindsphere.io
3. Login using the command

```
cf login -sso
```
4. Visit <https://login.cf.eu1.mindsphere.io/passcode> to get an One Time Code
5. Login using the WebKey Link below the Cloud Foundry Login Form
6. Type in your MindSphere Credentials
7. Copy the One Time Code and use in the CF CLI
8. Select your assigned Cloud Foundry ORG (if asked)
9. Select a Cloud Foundry Space (if asked)



Cloud Foundry

manifest.yml



```
applications:
  - name: tokenapp
    instances: 1
    random-route: true
    memory: 50MB
    buildpacks:
      - nodejs_buildpack
    command: node app.js
```

Push your first app

1. `cd workshop\03_basic\010_token`
2. Edit the file **manifest.yml** file and change xx to your initials
3. Enter: `cf push`

Exercise: Can you guess the task? Just execute it...

cf api <https://api.cf.eu1.mindsphere.io>

cd 010_token

cf login --sso

cf marketplace

<https://login.cf.eu1.mindsphere.io/passcode>

cf push

cf services

cf logs mywebapp [--recent]

cf delete mywebapp

cf buildpacks

Cloud Foundry Essentials

Summary

What is Cloud Foundry?

Cloud Foundry is the leading application platform for cloud computing worldwide.

What is its advantage?

With CloudFoundry you have an easy way to run your application inside MindSphere



MindSphere Authentication & Authorization

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MindSphere - Authentication & Authorization

Learning Goals

How can I authenticate users
in MindSphere
&
which rights do the users
have?

- MindSphere Access
- Token
- Security Workflow
- Roles & Scopes
- App registration



holaaaaaaaaaaaaaa

- MindSphere 3.0 authentication & authorization is based on **OAuth 2.0**
- OAuth 2.0 is a standard protocol for authorization, defined in misc. RFCs (details see <https://oauth.net/2/>)
- One part of the definition are: **JSON Web Token (JWT)**

MindSphere - Authentication & Authorization

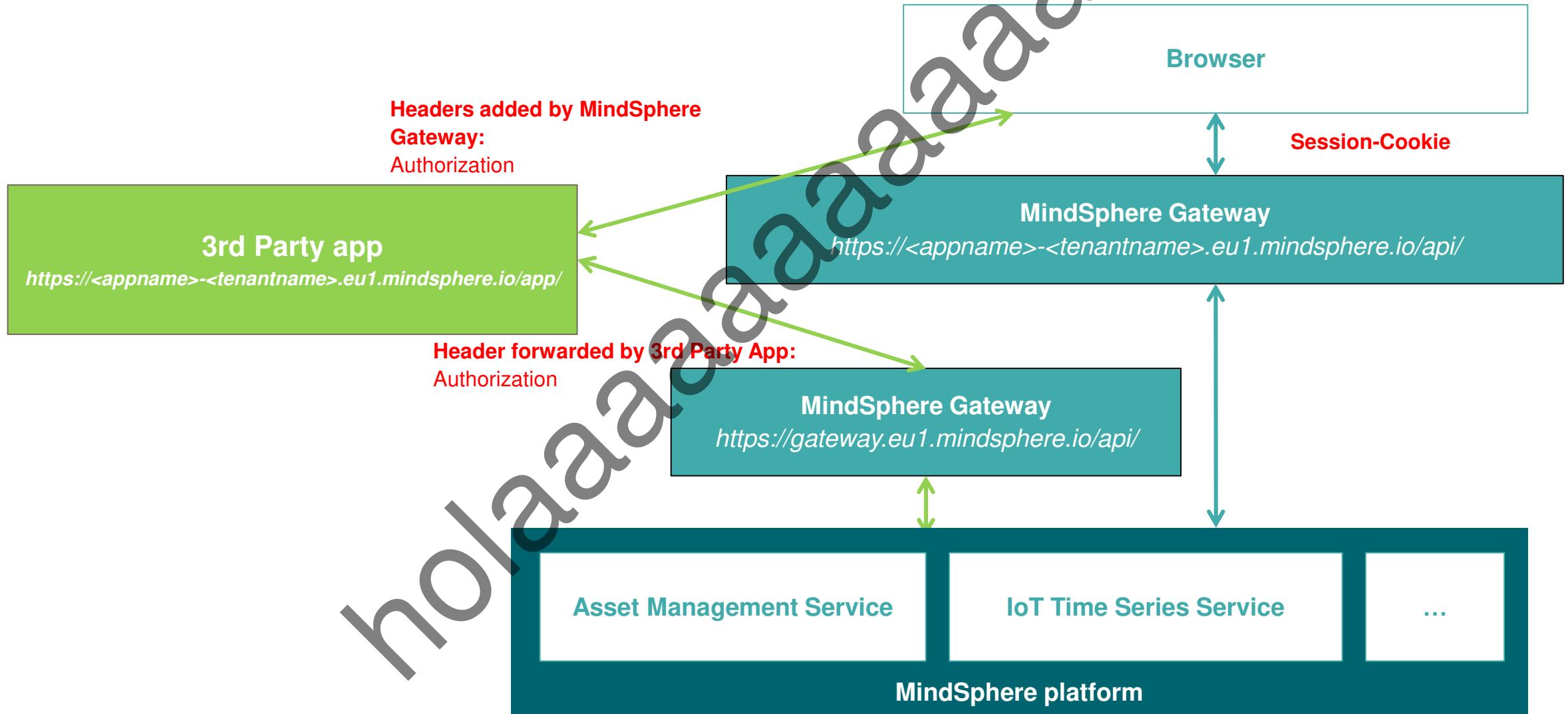
JSON Web Token



- JSON Web Token / JWT
 - Open standard (defined in RFC 7519) for access token for different claims
 - Important fields
 - iss: issuer
 - aud: audience
 - exp: expiration time
 - iat: issued at time
 - scope

MindSphere - Authentication & Authorization Workflow

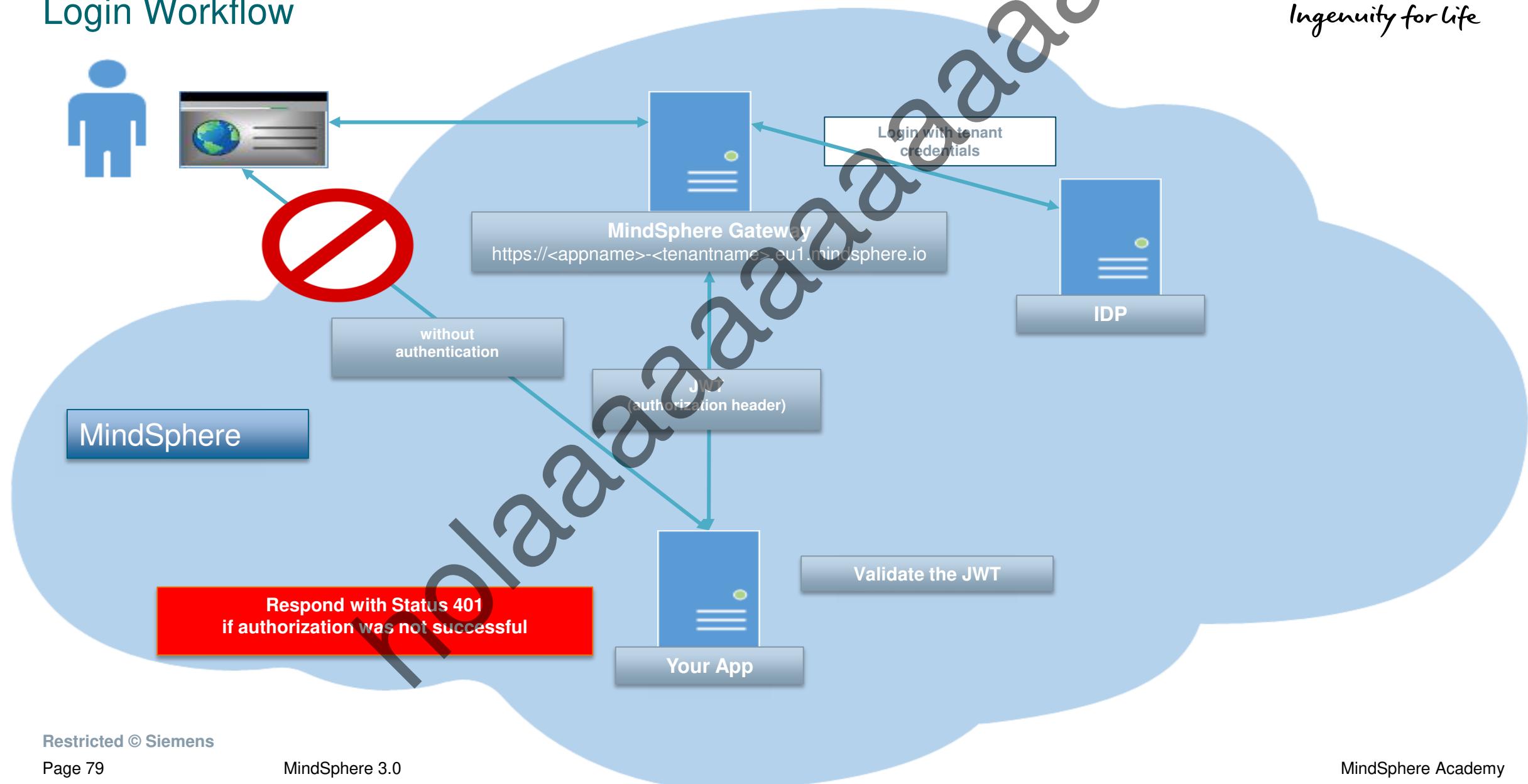
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MindSphere - Authentication & Authorization

Login Workflow

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MindSphere - Authentication & Authorization

Developer Cockpit

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- Functions
 - Register applications
 - Manage application
 - Manage Roles & Scopes
 - Upload apps to store



MindSphere Developer Cockpit

Dashboard Promoted Apps Roles & Scopes

Application Overview

Filter application by state Search application by name

Create new application Create new version

| Application | State | Version | Registration |
|--------------------|----------------|---------|--------------|
| SEW Drives | IN-DEVELOPMENT | 1.0.0 | Registered |
| 100_00_simpl_myweb | IN-DEVELOPMENT | 1.0.0 | Registered |
| TBApp1 | IN-DEVELOPMENT | 1.0.0 | Registered |

MindSphere - Authentication & Authorization

Roles & Scopes

- **Scopes**

- A scope is the smallest entity that describes a single permission
- e.g. `iot.tim.r`

- **Roles**

- A role is a collection of multiple scopes (permissions) that can be assigned to a user or another role
- e.g. `mdsp:core:iot.timUser`

- **Predefined User roles**

- Admin
- User

| Scope / Core Role | user | admin | | |
|---------------------------------|-------------------------------------|-------------------------------------|--|--|
| mdsp:core:iot.timAdmin | <input type="checkbox"/> | <input checked="" type="checkbox"/> | | |
| mdsp:core:iot.timUser | <input checked="" type="checkbox"/> | <input type="checkbox"/> | | |
| mdsp:core:iot.tsaUser | <input checked="" type="checkbox"/> | <input type="checkbox"/> | | |
| mdsp:core:em.eventmanager | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |
| mdsp:core:assetmanagement.admin | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |
| mdsp:core:im.useriamViewer | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |
| tbapp1.all | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |

MindSphere - Authentication & Authorization Exercise

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- Directory: 010_token
 - Push the application
 - Register the application
 - Find the bug

MindSphere Token App

Hello World

Token (JWT)

Copy token (JWT)

Decoded token

MindSphere - Authentication & Authorization

Summary

How can I authenticate users against MindSphere and which rights do the users have?

All calls have to go via MindSphere Gateway (direct or via 3rd party app).

Which rights do users have?

Application needs to be registered in MindSphere and has to have the right scopes



MindSphere Asset Management Service (Part I)

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MindSphere API - Asset Management Service

Learning Goals

**How do we read information
of the asset
&
how can we navigate
through the asset hierarchy?**

- Asset concept
- Requests to use



Base endpoint methods

GET: /api/assetmanagement/v3/assets

Purpose:

- Read Assets
- Filter Assets
- Get Asset Children
- Get Asset Details

Read the tenant's assets and their details, and navigate through the hierarchy

Roles / Scopes

| Role | Description |
|--|--|
| <code>mdsp:core:assetmanagement.admin</code> | Admin role allows users to create, read, update or delete assets, asset types, aspect types and files in Asset Management Service |
| <code>mdsp:core:assetmanagement.reporter</code> | Reporter role allows users to read assets, asset types, aspect types and files in Asset Management Service |
| <code>mdsp:core:assetmanagement.standarduser</code> | StandardUser role allows users to read or update assets and files, and to read asset types and aspect types in Asset Management Service |
| <code>mdsp:core:assetmanagement.subtenantuser</code> | SubTenantUser role allows users to read asset- and aspect types, read or update assets, and read, update or delete files in Asset Management Service |

Get all assets - Request

GET /api/assetmanagement/v3/assets

Read all asset for the logged in tenant.

No parameters required:

| Parameter Name | Description | Example | Optional |
|----------------|-------------|---------|----------|
| - | - | - | - |

Get all assets – positive Response

```
{ "_embedded": {  
    "assets": [  
        {  
            "assetId": "7e2f0e528e204c41bd5a503e1a94cd62",  
            "tenantId": "academy2",  
            "name": "Democase_Location",  
            "etag": 2,  
            "externalId": null,  
            "t2Tenant": null,  
            "description": "Democase with a PLC and 3 Data Points",  
            "parentId": "555a9bfdd7b94ade8116992f56807c0d",  
            "typeId": "academy2.democase1",  
            "location": {  
                "country": "",  
                "region": "",  
                "locality": "Erlangen",  
                "streetAddress": "Schuhstr. 60",  
                "postalCode": "91052",  
                "longitude": 11.008239,  
                "latitude": 49.589216  
            },  
            "variables": [],  
            "aspects": [],  
            "_links": {  
                <HAL INFORMATION>  
            }  
        },  
        {  
            <NEXT ASSET>  
        }  
    ]  
}
```

truncated! there may follow more children
with the same format like above

Get all assets – positive Response

```
{ "_embedded": {  
    "assets": [  
        {  
            "self": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assets/7e2f0e528e204c41bd5a503e1a94cd62"  
            },  
            "parent": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assets/555a9bfdd7b94ade8116992f56807c0d"  
            },  
            "aspects": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assets/7e2f0e528e204c41bd5a503e1a94cd62/aspects"  
            },  
            "location": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assets/7e2f0e528e204c41bd5a503e1a94cd62/location"  
            },  
            "variables": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assets/7e2f0e528e204c41bd5a503e1a94cd62/variables"  
            }  
        },  
        {  
            "variables": [],  
            "aspects": [],  
            "_links": {  
                <HAL INFORMATION>  
            }  
        },  
        {  
            <NEXT ASSET>  
        }  
    ]  
}
```

HAL links section, important are parent, children, aspects, events ...

truncated! there may follow more children with the same format like above

Find Assets

GET /api/assetmanagement/v3/assets

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------|-----------|
| size | Specifies the number of elements in a page. Default is 10 | 100 | No |
| page | Specifies the requested page index. Default is 0 | 0 | No |
| filter | Specifies the additional filtering criteria | see next slide | No |
| sort | Specifies the ordering of returned elementsAppend ,asc or ,desc for sorting direction. Default is timestamp descending order | status,asc | No |

Find Assets

GET /api/assetmanagement/v3/assets?filter=<filter>

| Parameter Name | Description | Examples | Mandatory |
|----------------|---|---|-----------|
| filter | Supports all basic fields. Complex filtering possible. | {"typeld": "core.mcnano"} {"name": {"startsWith": {"value": "MCN"}}} | No |

Find Assets – Examples

Filter by tenantId and type:

```
GET /api/assetmanagement/v3/assets?filter={"tenantId":"academy2", "typeId":"core.mcnano"}
```

Search in the name:

```
GET /api/assetmanagement/v3/assets?filter={"name": {"contains": {"value": "MCN"}}}
```

Or and And

```
GET /api/assetmanagement/v3/assets?filter={  
  "typeId": {  
    "or": [  
      {"eq": "core.mcnano"},  
      {"eq": "core.mclib"}]],  
  "parentId": "864e19ddf02b49f48f96244258a83e16"  
}
```

Get root asset

GET /api/assetmanagement/v3/assets/root

| Parameter Name | Description | Example | Mandatory |
|----------------|-------------|---------|-----------|
| - | - | - | - |

Read the asset root of the logged-in tenant. This is the first asset in the hierarchy.

Get details for an asset

GET /api/assetmanagement/v3/assets/{id}

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------------------------|-----------|
| id | Asset id of the asset you want to read the details for | 7e2f0e528e204c41bd5a503e1a94cd62 | Yes |

Get details for one asset. Response content is similar to the requests shown before.

Exercise

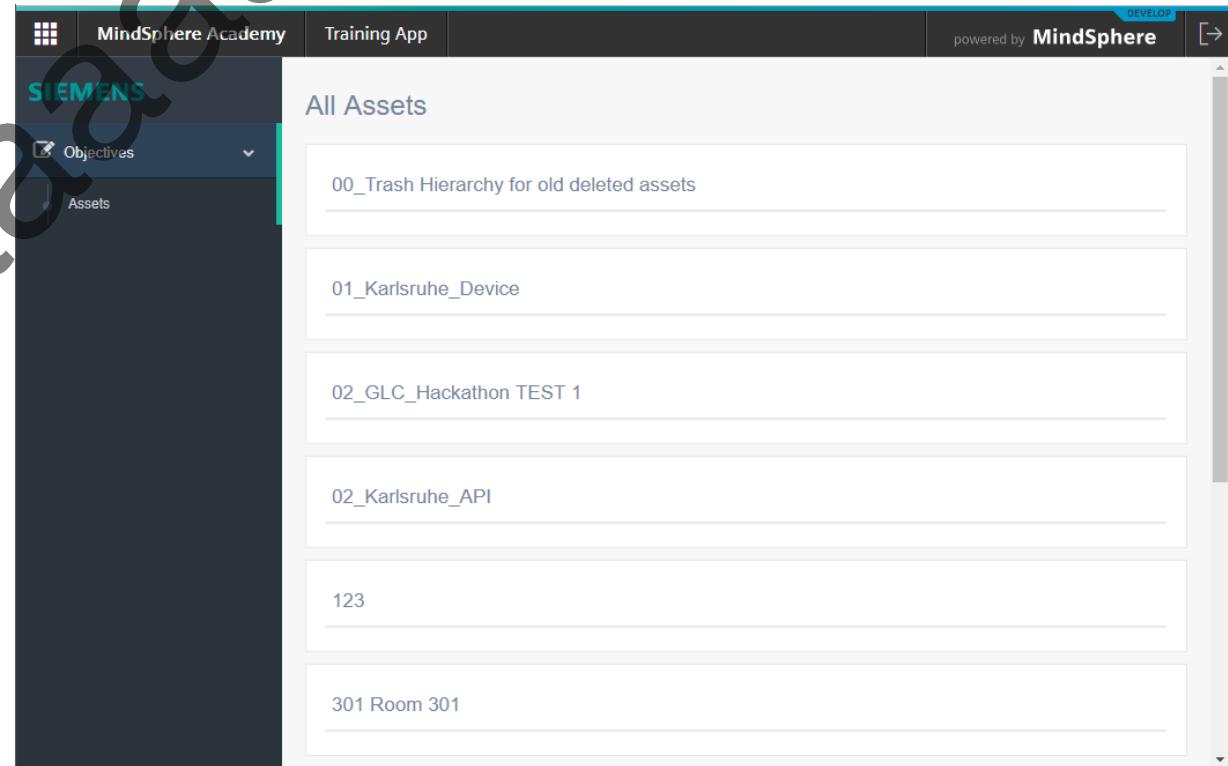
- Use the Postman Collection to investigate this API

holaaaaaaa



Exercise: 020_assets

- Deploy and register the app
- Make it running



MindSphere API - Asset Management Service

Summary

How do we read information of the asset?

There are several endpoints depending on the type of asset information requested

How can we navigate through the asset hierarchy?

The HAL structure tells from where to request e.g. parent and further information



MindSphere Asset Management Service (Part II)

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MindSphere API – Asset Management Service (Part III)

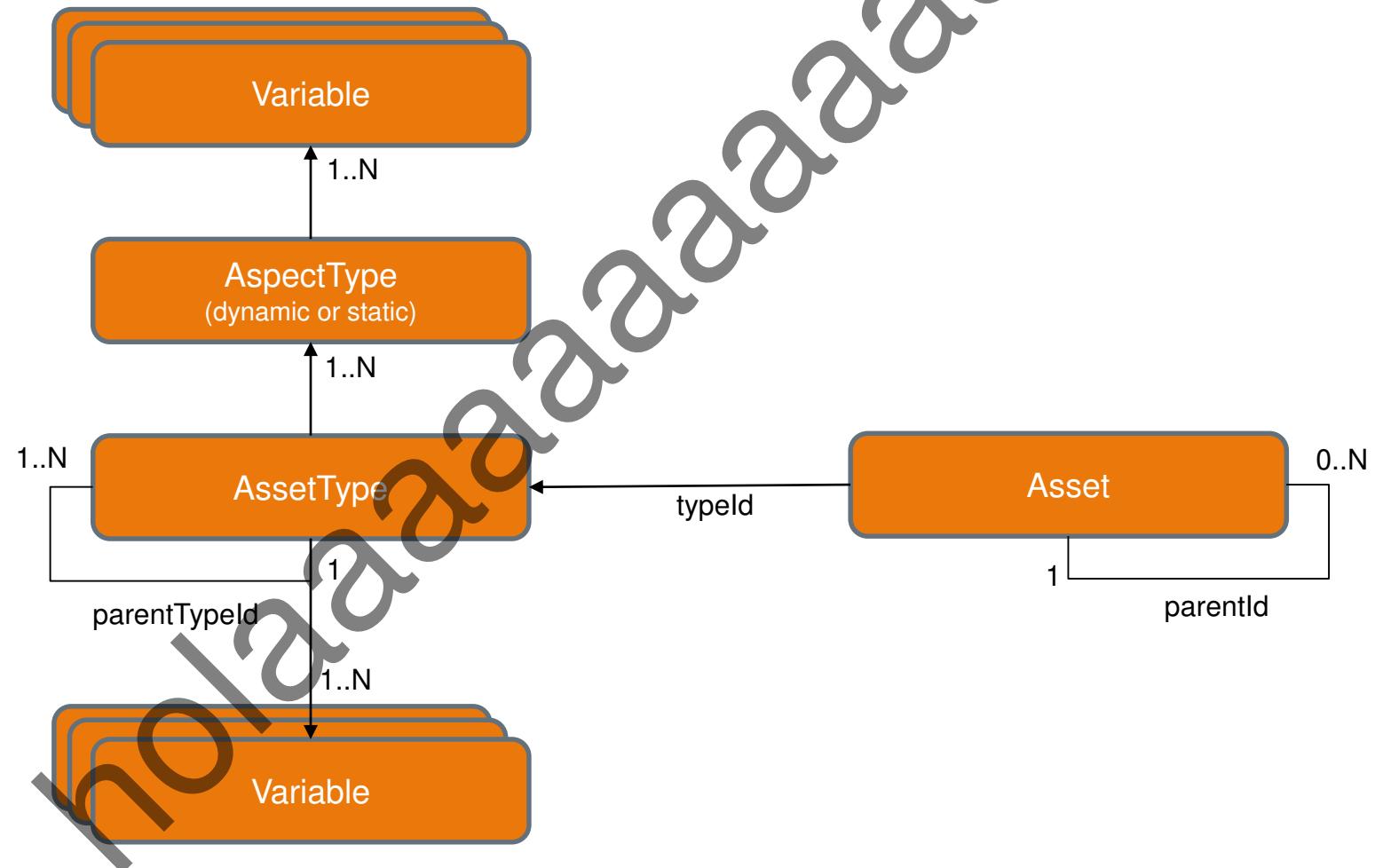
Learning Goals

How do we create and update assets and aspects in MindSphere 3.0?

- Aspect concept
- Aspect type concept
- Asset type concept
- Requests



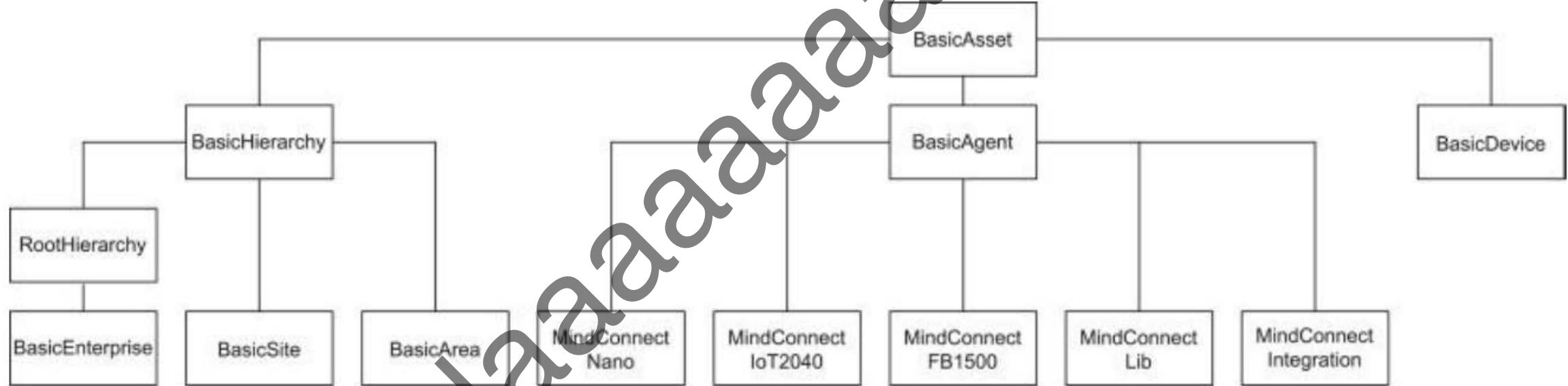
Overview



MindSphere API

Asset Management Service

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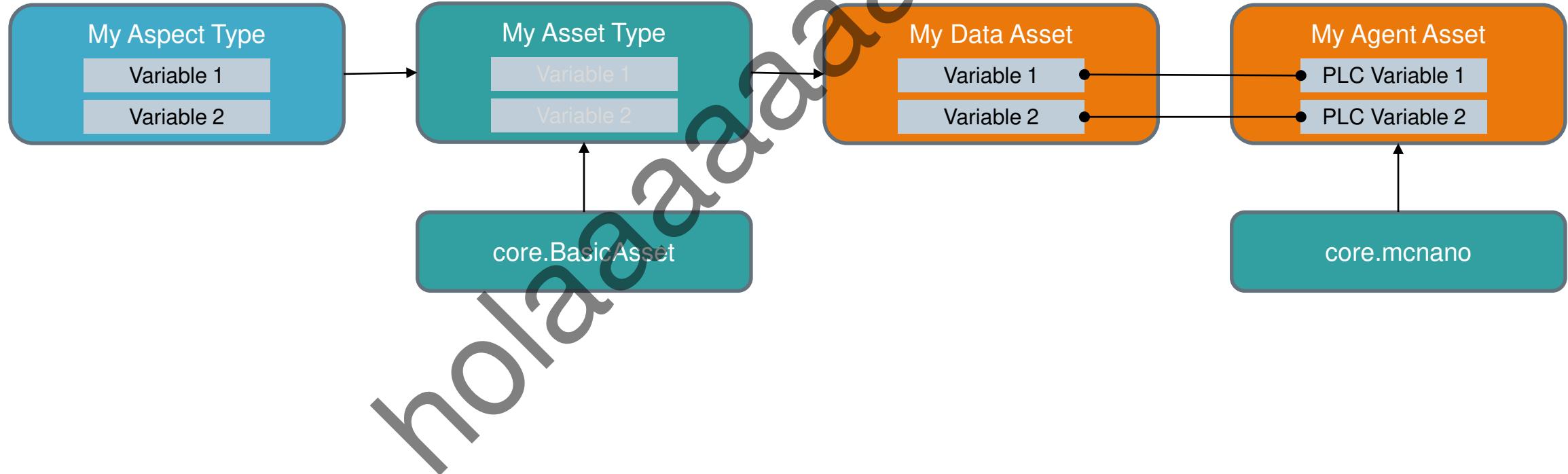


Demokit as example

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Minimal Asset Model with an Agent



Base endpoint methods for aspect types

GET: /api/assetmanagement/v3/aspecttypes

Purpose:

- Read all aspects types
- Paginate results
- Read single aspect type

Read the tenant's aspect types

Get all aspect types - Request

GET: /api/assetmanagement/v3/aspecttypes

Read all aspect types logged-in tenant

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------------|-----------|
| page | Specifies the requested page index | 1 | No |
| size | Specifies the number of elements in a page. Default 10 | 100 | No |
| sort | Specifies the ordering of returned elements | 'field1,field2,desc' | No |
| filter | Specifies the additional filtering criteria | tbd | No |

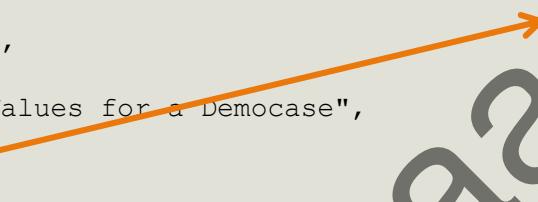
Get all aspect types – positive Response

```
{  
  "_embedded": {  
    "aspectTypes": [  
      {  
        "id": "academy2.plcvalues",  
        "tenantId": "academy2",  
        "etag": 0,  
        "name": "plcvalues",  
        "category": "dynamic",  
        "scope": "private",  
        "description": "PLC Values for a Democase",  
        "variables": [  
          <VARIABLES>  
        ],  
        "_links": {  
          "self": {  
            "href": "https://<mdsp-url>/api/assetmanagement/v3/aspecttypes/academy2.plcvalues"  
          }  
        }  
      },  
      <NEXT ASPECT-TYPE>  
    ]  
  },  
  <HAL INFORMATION>,  
  <PAGE INFORMATION>  
}
```

**truncated! there may follow more children
with the same format like above**

Get all aspect types – positive Response

```
{  
  "_embedded": {  
    "aspectTypes": [  
      {  
        "id": "academy2.plcvalues",  
        "tenantId": "academy2",  
        "etag": 0,  
        "name": "plcvalues",  
        "category": "dynamic",  
        "scope": "private",  
        "description": "PLC Values for a Democase",  
        "variables": [  
          <VARIABLES>  
        ],  
        "_links": {  
          "self": {  
            "href": "https://<mdsp-url>/api/assetmanagement/v3  
          }  
        }  
      },  
      <NEXT ASPECT-TYPE>  
    ]  
  },  
  <HAL INFORMATION>,  
  <PAGE INFORMATION>  
}
```



```
{  
  "name": "Pressure",  
  "dataType": "DOUBLE",  
  "unit": "hPa",  
  "searchable": false,  
  "length": null,  
  "qualityCode": false  
},  
{  
  "name": "Temperature",  
  "dataType": "DOUBLE",  
  "unit": "C",  
  "searchable": false,  
  "length": null,  
  "qualityCode": false  
}
```

AspectType

| Property | Type | Description |
|--------------------|--------|---|
| name | String | <i>Name of the aspect type</i> <i>maxLength: 128</i> <i>pattern: [a-zA-Z0-9_]+</i> |
| category | Enum | <i>[dynamic, static]</i> |
| scope | Enum | <i>[public, private]</i> <i>Visibility of aspecttype. Setting this property to public makes it available to other tenants. Private types are only visible to the user's own tenant</i> |
| description | String | <i>The description of the aspect type</i> <i>maxLength: 255</i> <i>pattern: [^\']*</i> |

AspectVariable

| Property | Type | Description |
|--------------------|---------|---|
| name | String | <i>Name of the aspect type minLength: 1, maxLength: 64, pattern: [a-zA-Z0-9_]+</i> |
| dataType | Enum | <i>[BOOLEAN, INT, LONG, DOUBLE, STRING, TIMESTAMP, BIG_STRING]</i> |
| unit | String | <i>Unit of measurement maxLength: 32, pattern: [^\']*</i> |
| searchable | Boolean | <i>Indicates whether sorting and filtering is allowed on this variable. Only usable for static properties. default: false</i> |
| length | Integer | <i>The max length of the variable's value. The length field is only used for variables of string or big_string dataType. Max length for string is 255 and max length for big_string 100000.</i> |
| qualityCode | Boolean | <i>Indicates whether the variable has quality code</i> |

Base endpoint methods for aspect types

PUT: /api/assetmanagement/v3/aspecttypes/{id}

Purpose:

- Create aspects types
- Update aspects types

Create or update tenant's aspect types

Create or update (modify) aspect types - Request

PUT: /api/assetmanagement/v3/aspecttypes/{id}

Parameters:

| Parameter Name | Description | Example | Mandatory |
|---------------------|--|------------------|-----------|
| id | The type's id is a unique identifier. The id's length must be between 1 and 128 characters and matches the following symbols "A-Z", "a-z", "0-9", "_" and "." beginning with the tenant prefix what has a maximum of 8 characters. | ten_pref.type_id | YES |
| Body JSON object | aspect type | see next slide | YES |

Create or update (modify) aspect types - **Body**

```
{  
  "tenantId": "academy2",  
  "etag": 0,  
  "name": "opc_demo1",  
  "category": "dynamic",  
  "scope": "private",  
  "description": "Values from OPC Simulator",  
  "variables": [  
    {  
      "name": "sin1",  
      "dataType": "DOUBLE",  
      "unit": "",  
      "searchable": false,  
      "length": null,  
      "qualityCode": false  
    },  
    {  
      "name": "sin2",  
      "dataType": "DOUBLE",  
      "unit": null,  
      "searchable": false,  
      "length": null,  
      "qualityCode": false  
    } ]  
}
```

Delete aspect types

DELETE: /api/assetmanagement/v3/aspecttypes/{id}

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|-----------------------------|------------------|-----------|
| id | The type's id to be deleted | academy2.type_id | YES |

Status Code 204 (No Content)

Base endpoint methods for asset types

GET: /api/assetmanagement/v3/assettypes

- Read all asset types
- Paginate results
- Read single asset type

Read the tenant's asset types

Get all asset types - Request

GET: /api/assetmanagement/v3/assettypes

Read all asset types logged-in tenant

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------------|-----------|
| page | Specifies the requested page index | 1 | No |
| size | Specifies the number of elements in a page. Default 10 | 100 | No |
| sort | Specifies the ordering of returned elements | 'field1,field2,desc' | No |
| filter | Specifies the additional filtering criteria | tbd | No |

Get all asset types – positive Response

```
{ "_embedded": {  
    "assetTypes": [ {  
        "id": "academy2.democase1",  
        "parentType": "core.mcnano",  
        "tenantId": "academy2",  
        "name": "Democase1",  
        "description": "Democase 1",  
        "scope": "private",  
        "variables": [ <VARIABLES> ],  
        "aspects": [  
            <ASPECT TYPE>  
        ],  
        "etag": 0,  
        "_links": {  
            "self": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assettypes/academy2.democase1"  
            },  
            "parent": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assettypes/core.mcnano"  
            }  
        }  
    }  
],  
<HAL INFORMATION>,  
<PAGE INFORMATION>  
}
```

Get all asset types – positive Response

```
{ "_embedded": {  
    "assetTypes": [{  
        "id": "academy2.democase1",  
        "parentType": "core.mcnano",  
        "tenantId": "academy2",  
        "name": "Democase1",  
        "description": "Democase 1",  
        "scope": "private",  
        "variables": [ <VARIABLES> ],  
        "aspects": [  
            <ASPECT TYPE>  
        ],  
        "etag": 0,  
        "_links": {  
            "self": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assettypes/academy2.democase1"  
            },  
            "parent": {  
                "href": "https://<mdsp-url>/api/assetmanagement/v3/assettypes/core.mcnano"  
            }  
        }  
    }],  
    <HAL INFORMATION>,  
    <PAGE INFORMATION>  
}
```

```
{  
    "name": "manufacturer",  
    "dataType": "STRING",  
    "unit": null,  
    "searchable": false,  
    "length": 255,  
}
```

Asset type

| Property | Type | Description |
|---------------------|--------|---|
| name | String | <i>Name of the asset type</i> <i>minLength: 1, maxLength: 128, pattern: [A-Za-z_0-9\.\-_]+</i> |
| description | String | <i>The description of the asset type</i> <i>maxLength: 255</i> <i>pattern: [^\n]*</i> |
| parentTypeld | String | <i>unique identifier of the parent asset type</i> |
| scope | Enum | <i>[public, private]</i> <i>Visibility of assettype. Setting this property to public makes it available to other tenants. Private types are only visible to the user's own tenant</i> |

Asset variable

| Property | Type | Description |
|-------------------|---------|---|
| name | String | <i>Name of the aspect type minLength: 1, maxLength: 64, pattern: [a-zA-Z0-9_]+</i> |
| dataType | Enum | <i>[BOOLEAN, INT, LONG, DOUBLE, STRING, TIMESTAMP, BIG_STRING]</i> |
| unit | String | <i>Unit of measurement maxLength: 32, pattern: [^\']*</i> |
| searchable | Boolean | <i>Indicates whether sorting and filtering is allowed on this variable. Only usable for static properties. default: false</i> |
| length | Integer | <i>The max length of the variable's value. The length field is only used for variables of string or big_string dataType. Max length for string is 255 and max length for big_string 100000.</i> |

Base endpoint methods for asset types

PUT: /api/assetmanagement/v3/assettypes/{id}

Purpose:

- Create asset types
- Update asset types

Create or update tenant's asset types

Create or update (modify) asset types - Request

PUT: /api/assetmanagement/v3/assettypes/{id}

Parameters:

| Parameter Name | Description | Example | Mandatory |
|---------------------|--|------------------|-----------|
| id | The type's id is a unique identifier. The id's length must be between 1 and 128 characters and matches the following symbols "A-Z", "a-z", "0-9", "_" and "." beginning with the tenant prefix what has a maximum of 8 characters. | ten_pref.type_id | YES |
| Body JSON object | asset type | see next slide | YES |

Create or update (modify) asset types - Body

```
{  
  "parentType": "core.basicasset",  
  "tenantId": "academy2",  
  "name": "Democase1",  
  "description": "Democase v1",  
  "scope": "private",  
  "aspects": [  
    {  
      "name": "demo-sensors",  
      "aspectType": "academy2.democasetype"  
    }  
  ]  
}
```

Delete asset types

DELETE: /api/assetmanagement/v3/assettypes/{id}

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|-----------------------------|------------------|-----------|
| id | The type's id to be deleted | academy2.type_id | YES |

Status Code 204 (No Content)

Base endpoint methods

GET: /api/assetmanagement/v3/assets/{id}

Purpose:

- Read Assets
- Filter Assets
- Get Asset Children
- Get Asset Details

Read asset details

Get details for an asset

GET /api/assetmanagement/v3/assets/{id}

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------------------------|-----------|
| id | Asset id of the asset you want to read the details for | 7e2f0e528e204c41bd5a503e1a94cd62 | Yes |

Get asset – positive Response

```
{  
  "assetId": "7e2f0e528e204c41bd5a503e1a94cd62",  
  "tenantId": "academy2",  
  "name": "Democase_Location",  
  "etag": 2,  
  "externalId": null,  
  "t2Tenant": null,  
  "description": "Democase with a PLC and 3 Data Points",  
  "parentId": "555a9bfdd7b94ade8116992f56807c0d",  
  "typeId": "academy2.democase1",  
  "location": {  
    "country": "",  
    "region": "",  
    "locality": "Erlangen",  
    "streetAddress": "Schuhstr. 60",  
    "postalCode": "91052",  
    "longitude": 11.008239,  
    "latitude": 49.589216  
  },  
  "variables": [],  
  "aspects": [],  
  "deleted": null,  
  "_links": {  
    <HAL INFORMATION>  
  }  
}
```

Base endpoint methods for assets

POST: /api/assetmanagement/v3/assets

Purpose:

- Create asset

Create asset

Create asset - Request

POST: /api/assetmanagement/v3/assets

Parameters:

| Parameter Name | Description | Example | Mandatory |
|---------------------|-------------|----------------|-----------|
| Body JSON object | asset | see next slide | YES |

Create asset - Body

```
{  
  "name": "Millenium Falcon",  
  "externalId": "SN 123456-123-123456",  
  "description": "The ship of Han Solo and Chewbacca",  
  "parentId": "396698dd71304003993f7bbf97dc1dda",  
  "location": {  
    "country": "Austria",  
    "region": "Tyrol",  
    "locality": "Innsbruck",  
    "streetAddress": "Industriestraße 21 A/II",  
    "postalcode": "6020",  
    "longitude": 53.5125546,  
    "latitude": 9.9763411  
  },  
  "typeId": "core.basicasset"  
}
```

Base endpoint methods for assets

PUT: /api/assetmanagement/v3/assets/{id}

Purpose:

- Update asset

Update asset

Update asset - Request

PUT: /api/assetmanagement/v3/assets/{id}

Parameters:

| Parameter Name | Description | Example | Mandatory |
|---------------------|-------------------|----------------------------------|-----------|
| id | Unique identifier | 90848ae7f2304ef38caa016e57dafadc | Yes |
| Body JSON object | asset | see next slide | Yes |

Update asset - Body

```
{  
  "name": "Millenium Falcon",  
  "externalId": "SN 123456-123-123456",  
  "description": "The ship of Han Solo and Chewbacca",  
  "parentId": "396698dd71304003993f7bbf97dc1dda",  
  "location": {  
    "country": "Austria",  
    "region": "Tyrol",  
    "locality": "Innsbruck",  
    "streetAddress": "Industriestraße 21 A/II",  
    "postalcode": "6020",  
    "longitude": 53.5125546,  
    "latitude": 9.9763411  
  },  
  "typeId": "core.basicasset"  
}
```

Asset variable definitions for one asset - Request

GET /api/assetmanagement/v3/assets/{id}/variables

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------------|-----------|
| page | Specifies the requested page index | 1 | No |
| size | Specifies the number of elements in a page. Default 10 | 100 | No |
| sort | Specifies the ordering of returned elements | 'field1,field2,desc' | No |
| filter | Specifies the additional filtering criteria | tbd | No |

Get asset variable definitions – positive Response

```
{  
    "_embedded": {  
        "variables": [  
            {  
                "name": "manufacturer",  
                "dataType": "STRING",  
                "unit": null,  
                "searchable": true,  
                "length": 255  
            },  
            {  
                "name": "externalId",  
                "dataType": "STRING",  
                "unit": null,  
                "searchable": true,  
                "length": 255  
            },  
            {  
                "name": "t2Tenant",  
                "dataType": "STRING",  
                "unit": null,  
                "searchable": true,  
                "length": 36  
            }  
        ]  
    },  
    <HAL INFORMATION>,  
    <PAGE INFORMATION>  
}
```

Asset aspect definitions for one asset - Request

GET /api/assetmanagement/v3/assets/{id}/aspects

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------------|-----------|
| page | Specifies the requested page index | 1 | No |
| size | Specifies the number of elements in a page. Default 10 | 100 | No |
| sort | Specifies the ordering of returned elements | 'field1,field2,desc' | No |
| filter | Specifies the additional filtering criteria | tbd | No |

Get asset aspect definitions – positive Response

```
{  
    "_embedded": {  
        "aspects": [  
            {  
                "name": "Simulation",  
                "holderAssetId": "37b7cf99d221495fb631684ee1358b1d",  
                "aspectTypeId": "academy2.opc_demo2",  
                "aspectTypeName": "opc_demo2",  
                "category": "dynamic",  
                "description": "Simulation Values",  
                "variables": [  
                    {  
                        "name": "sin1",  
                        "dataType": "DOUBLE",  
                        "unit": "one",  
                        "searchable": false,  
                        "length": null,  
                        "qualityCode": false  
                    } ]  
                },  
                <ADDITIONAL ASPECTS>  
            ]  
        },  
        <HAL INFORMATION>,  
        <PAGE INFORMATION>  
    }  
}
```

Delete an asset - Request

DELETE: /api/assetmanagement/v3/assets/{id}

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|--|----------------------------------|-----------|
| id | Asset id of the asset you want to delete | 0281D4001C544AC0B62B4CCF549AC0D0 | Yes |

Status Code 204 (No Content)

Exercise: 030_aspects

- Deploy and register the app
- Make it running

The screenshot shows the MindSphere Academy Asset Management Service interface. At the top, there's a navigation bar with 'MindSphere Academy', 'Training App', and 'powered by MindSphere'. On the left, a sidebar has 'SIEMENS' branding and dropdown menus for 'Objectives' and 'Assets'. The main content area is titled 'All Assets' and features a search bar with 'Search for a asset name KarlsruheData' and a 'Search' button. Below the search bar, a card displays information for an asset named 'TrainingBoxNanoKarlsruheData'. It includes the 'Asset-ID: 01c3636d75f242cb828af1a87e1a1860' and 'Location: Siemensallee 84 76187 Karlsruhe Germany'. A section titled 'Aspects for Asset: 01c3636d75f242cb828af1a87e1a...' is shown, with a 'Sensors' section. Under 'Variables', it lists 'Variable Name: Pressure' with 'Unit: hPa' and 'Variable Name: Temp' with 'Unit: C'.

Exercise

- Use the Postman Collection to investigate this API
- Create your own asset under the hierarchy for this training
- Map datapoints from the existing agent to your asset



MindSphere API – Asset Management Service (Part III)

Summary

How do we create and update assets and aspects in MindSphere 3.0?

We can create and update asset types and aspect types with a put request

&

we can create assets with a post call and update them with a put request



MindSphere IoT Time Series Aggregates Service

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Aggregate Services

Learning Goals

How can we fetch timeseries data efficiently for visualization from MindSphere?

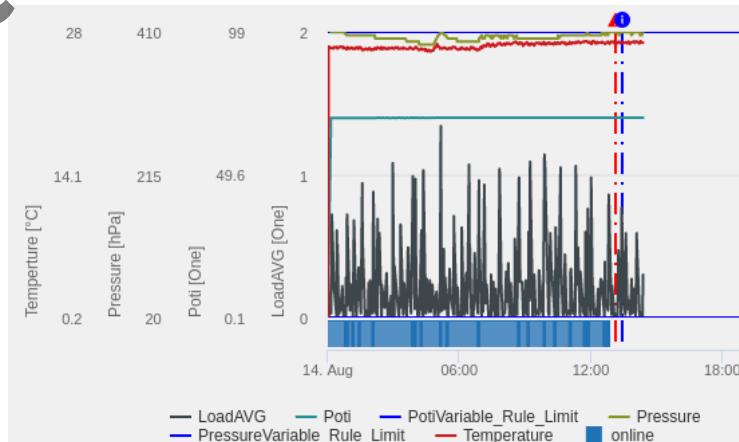
- Use Aggregate Service



holaaaaaaaaaaaaaa

- Retrieving aggregated data
- Precalculated aggregates
- Aggregation according to various values e.g.: *min, max, first, last, count*

Retrieve aggregated timeseries data suitable for e.g., visualization



For running analyses, use timeseries raw data instead!

Endpoints

| Request Method | Description | End Point |
|----------------|------------------------------------|---|
| GET | /api/iottsaggregates/v3/aggregates | Aggregated timeseries with an assortment summary of information |

Roles / Scopes

| Role | Description |
|-----------------------|--|
| mdsp:core:iot.tsaUser | Granting access to time series aggregates. |

Aggregated Data

... is available in precalculated intervals

2 minute 1 hour 1 day

... supports the following intervals

1-120 seconds 1-60 minutes 1-24 hours 1+ days 1+ weeks 1+ months

... should be an exact multiple of a precalculated aggregation interval (for best performance)

... is wall clock aligned

... is created based on arrival of data and time logic

Returned data

minimum value maximum value average sum count first value last value

Aggregated Data

1 hour interval

5:00 – 10:00

60-minute interval

5:30 – 10:30

an interval duration of
1 week must start and
end on a Monday

An interval duration of 7
days could start on any day
of the week

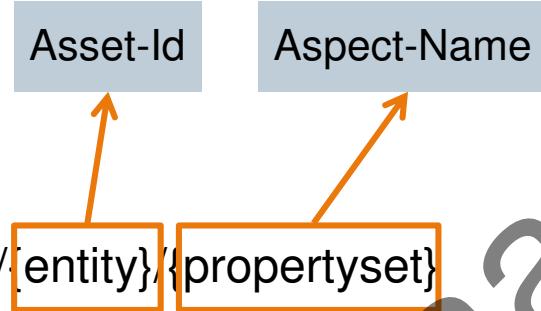
two-minute aggregated data is
created within two minutes
after the two-minute interval
has finished

hourly data is created within
eight minutes after the end of
the hour

daily data is created within fifteen
minutes after midnight in UTC time for
this release

Get aggregated Timeseries

GET /api/iottsaggregates/v3/aggregates/{entity}/{propertyset}



| Parameter Name | Description | Example | Mandatory |
|----------------------|---|----------------------|-----------|
| from | Beginning of the time range to read | 2018-01-31T00:00:00Z | Yes |
| to | End of the time range to read | 2018-01-31T20:00:00Z | Yes |
| intervalValue | Interval duration for the aggregates in intervalUnits | 1 | Yes |
| intervalUnit | Interval duration unit for the aggregates | hour | Yes |
| select | Properties and fields to select | Temperature | No |

select parameter can be used to select certain fields with **variableName.fieldName**

Get aggregated Timeseries Response (Body)

```
[{ "Memory": {  
    "minvalue": 3236,  
    "maxvalue": 3554,  
    "mintime": "2018-01-31T02:50:00Z",  
    "maxtime": "2018-01-31T00:10:00Z",  
    "firstvalue": 3554,  
    "lastvalue": 3301,  
    "firsttime": "2018-01-31T00:10:00Z",  
    "lasttime": "2018-01-31T04:00:00Z",  
    "average": 3320.125,  
    "sum": 79683,  
    "countuncertain": 0,  
    "countbad": 0,  
    "countgood": 24  
},  
    "starttime": "2018-01-31T00:00:00Z",  
    "endtime": "2018-01-31T04:00:00Z"  
}]
```

Exercise

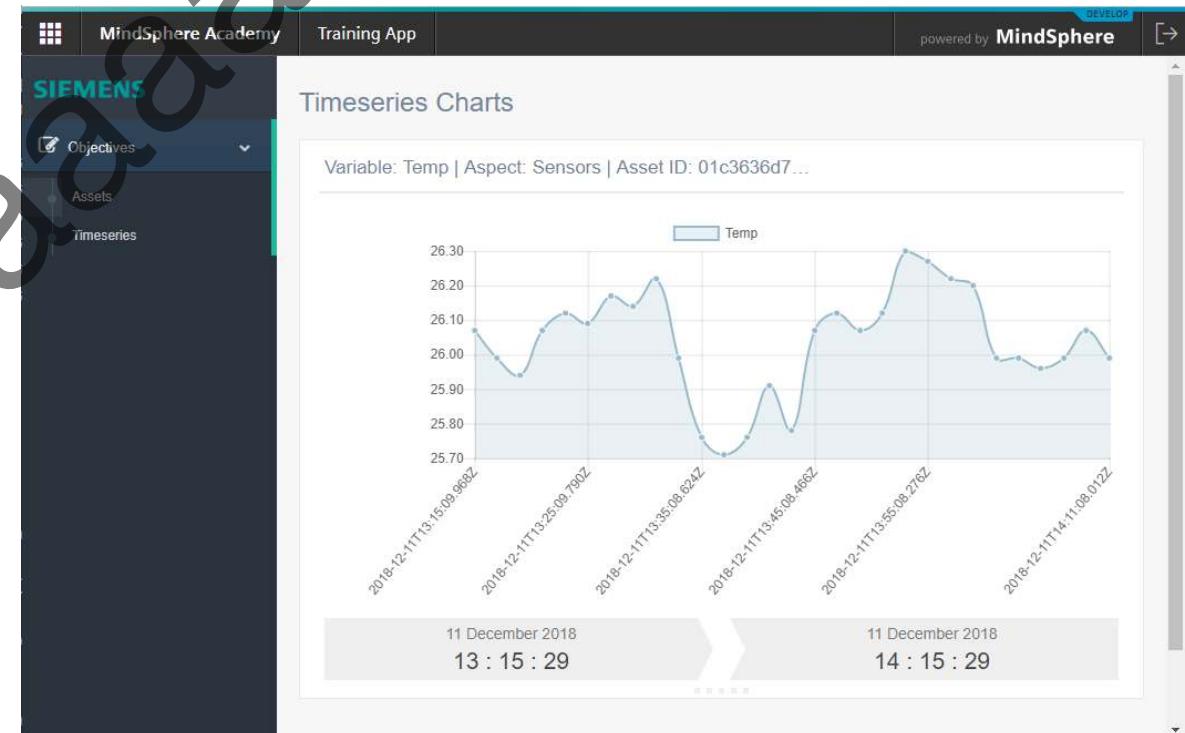
- Use the Postman Collection to investigate this API

holaaaaaaa



Exercise: 040_aggregated_timeseries

- Put the code snippet in the appropriate place
- Fill in the missing parts



Aggregate Service Summary

How can we fetch timeseries data efficiently for visualization from MindSphere?

With Aggregate Service we can reduce the amount of data points.



holaaaaaaaaaaaaaa

MindSphere IoT Time Series API

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IoT Time Series API

Learning Goals

**How can we search for raw
data
&
how can we create or update
data?**

- Search endpoint
- Result structure
- Create or update data
- Delete data

holaaaaaaaaaaaaaa



Basic Endpoint

/api/iottimeseries/v3/timeseries

Purpose:

- Retrieve raw data
- Filter on time range
- Filter specific aspect values

- Investigate on raw data
- Write your own analytics
- Export

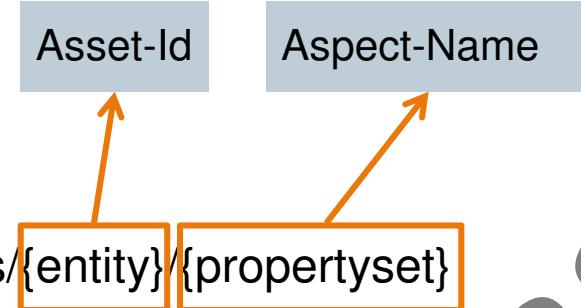
*Don't mix with aggregated
time series methods*

Roles / Scopes

| Role | Description |
|-------------------------------|--|
| mdsp:core:iot.timUser | Granting read access to time series. |
| mdsp:core:iot.timAdmin | Granting read, write and delete access to time series. |

Endpoints

| Request Method | Description | End Point |
|----------------|------------------------------|--|
| GET | /iottimeseries/v3/timeseries | Query time series data with a precision of 1 millisecond |



Get timeseries

| Parameter Name | Description | Example | Mandatory |
|----------------|---|----------------------|-----------|
| from | Beginning of the time range to read (exclusive) | 2018-01-31T00:00:00Z | No |
| to | End of the time range to read (inclusive) | 2018-01-31T20:00:00Z | No |
| limit | maximum number of entries to read | 1 | No |
| select | select fields to return | Temperature | No |

Get raw timeseries

Response (Body)

```
[  
  {  
    "_time": "2018-02-22T00:50:10.607Z",  
    "sin1": 25.815107,  
    "sin2": -44.914648427989135,  
  },  
  {  
    "_time": "2018-02-22T00:50:25.614Z",  
    "sin1": 30.61933,  
    "sin2": -44.454259707516634,  
  }  
]
```

Returns maximum
2000 records in a
response

Paging is implemented as a header called "link" (see RFC 5988)

link →<<https://gateway.eu1.mindsphere.io/api/iottimeseries/v3/timeseries/01c3636d75f242cb828af1a87e1a1860/Sensors?from=2018-12-01T05:33:13.332Z&limit=2000&to=2018-12-10T23:50:00Z>>; rel="next"

Endpoints

| Request Method | Description | End Point |
|----------------|----------------------------------|---|
| PUT | /api/iottimeseries/v3/timeseries | Write or update time series data for a single entity and propertyset. |

Create or update timeseries

PUT /api/iottimeseries/v3/timeseries/{entity}/{propertyset}

| Parameter Name | Description | Example | Mandatory |
|----------------|---------------------------------|----------------------------------|-----------|
| entity | unique identifier of the entity | b75549b996014c60809902662df158c7 | Yes |
| propertyset | name of the propertyset | simulation | Yes |
| body | timeseries data | see next slide | Yes |

Create timeseries

Request (Body)

```
[  
  {  
    "_time": "2018-02-22T00:50:10.607Z",  
    "sin1": 25.815107,  
    "sin2": -44.914648427989135,  
  },  
  {  
    "_time": "2018-02-22T00:50:25.614Z",  
    "sin1": 30.61933,  
    "sin2": -44.454259707516634,  
  }  
]
```

Endpoints

| Request Method | Description | End Point |
|----------------|----------------------------------|---|
| DELETE | /api/iottimeseries/v3/timeseries | Delete time series data for a single entity and propertyset within a given time range |

Delete timeseries

DELETE /api/iottimeseries/v3/timeseries/{entity}/{propertyset}

| Parameter Name | Description | Example | Mandatory |
|----------------|---|----------------------|-----------|
| from | Beginning of the time range to read (exclusive) | 2018-01-31T00:00:00Z | Yes |
| to | End of the time range to read (inclusive) | 2018-01-31T20:00:00Z | Yes |

Status Code 204 (No Content)

Exercise

- Use the Postman Collection to investigate this API

holaaaaaaa



IoT Time Series API

Summary

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How can we search for raw data?

GET request on the endpoint

How can we create or update data?

DELETE or PUT request on the endpoint

holaaaaaaaaaaaaaa

MindSphere Event Management Service

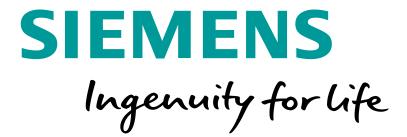
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MindSphere API – Event Management Service

Learning Goals

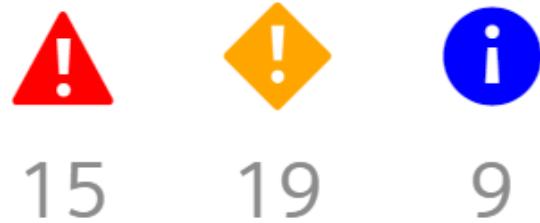
How can we view and create events in MindSphere?

- Event data structure
- Request end points
- Read and write data



MindSphere API – Event Management Service

Overview



Representation of events that occur associated to assets

E.g. a measured characteristic of an equipment has reached a threshold indicating a failure

Tasks:

- Retrieve events
- Store events
- Modify events
- Understand event types

- Display Events in your app
- Acknowledge events in your app and change their status in MindSphere accordingly
- Create new events

MindSphere API

Event Management Service

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Event type hierarch



Event types

- are assigned to a custom event
- define a set of custom fields representing additional properties of the custom event
- custom fields have a data type and can be defined as **required** and **filterable**
- inheritance hierarchy of up to **4 levels**
- Scope: **global** or **local**
- **TTL: time to live** (after this number of days the event will be **automatically** deleted)

Roles / Scopes

| Role | Description |
|----------------------------------|---|
| mdsp:core:em.eventcreator | Role granting access to create events (create, read and update) in eventmanagement system |
| mdsp:core:em.eventmanager | Role granting access to manage everything in eventmanagement system |
| mdsp:core:em.eventviewer | Role granting access to read events and eventTypes in eventmanagement system |

Standard event data structure

```
{  
  "id": "9f3795fb-dfa3-447b-936c-a63f716d2686",  
  "typeId": "b7f9a843-a530-4159-989e-20645e2b647d",  
  "correlationId": "85ba8d01-f831-4354-94d0-354759e91de5",  
  "timestamp": "2018-02-01T11:00:00Z",  
  "entityId": "b75549b996014c60809902662df158c7",  
  "etag": 0,  
  "_links": {  
    "self": {  
      "href": "<base-url>/api/eventmanagement/v3/events/9f3795fb-dfa3-447b-936c-a63f716d2686"  
    }  
  },  
  "severity": 30,  
  "code": "",  
  "acknowledged": false,  
  "description": "Memory high",  
  "source": "Manual"  
}
```

Internal ID, required for retrieving/updating a specific event

Endpoints

| Request Method | Endpoint | Description |
|----------------|--|---------------------------------------|
| GET | /api/eventmanagement/v3/events | Find events based on a request filter |
| GET | /api/eventmanagement/v3/events/{eventId} | Get a specific event |
| POST | /api/eventmanagement/v3/events | Create a new event |
| PUT | /api/eventmanagement/v3/events/{eventId} | Update an existing event |

Find Events

GET /api/eventmanagement/v3/events

| Parameter Name | Description | Example | Mandatory |
|----------------|--|-----------------|-----------|
| size | Specifies the number of elements in a page. Default is 20 | 100 | No |
| page | Specifies the requested page index. Default is 0 | 0 | No |
| filter | Filter parameter | {"severity": 1} | No |
| sort | The order in which the elements are returned. Specify status, severity or timestamp for the field to sort by. Append ,asc or ,desc for sorting direction. Default is timestamp descending order | status,asc | No |

Find Events – Examples

Filter by entityId ("Asset"):

```
GET /api/eventmanagement/v3/events?filter={"entityId": "b75549b996014c60809902662df158c7"}
```

Filter by timestamp:

```
GET /api/eventmanagement/v3/events?  
filter={"timestamp": {"between": "[2018-01-31T00:00:00Z, 2018-01-31T23:59:59Z]"}}
```

Get all events:

```
GET /api/eventmanagement/v3/events
```

Get an Event by ID

GET /api/eventmanagement/v3/events/{eventId}

Example:

GET /api/eventmanagement/v3/events/fa884d56-0570-4e0c-8c12-dbcc8e7c780c

Create a new Event

POST /api/eventmanagement/v3/events

Example request (body):

```
{  
  "typeId": "com.siemens.mindsphere.eventmgmt.event.type.MindSphereStandardEvent",  
  "timestamp": "2018-01-31T11:00:00.000Z",  
  "entityId": "b75549b996014c60809902662df158c7",  
  "severity": 1,  
  "description": "Test event via API call",  
  "code": "TestCode01",  
  "acknowledged": false  
}
```

Update an existing event

PUT /api/eventmanagement/v3/events/{eventId}

Example request (body):

```
{  
  "id": "60d73e4e-5aac-4098-bb87-2be0577f8a66",  
  "typeId": "com.siemens.mindsphere.eventmgmt.event.type.MindSphereStandardEvent",  
  "correlationId": "0ccd7c42c0114dde8ed199f9bef64fe6",  
  "timestamp": "2018-01-31T11:00:00Z",  
  "entityId": "b75549b996014c60809902662df158c7",  
  "severity": 1,  
  "code": "TestCode01",  
  "acknowledged": true,  
  "description": "Test event via API call"  
}
```

Add historic data to an existing event

POST /api/eventmanagement/v3/events

Example request (body):

```
{  
  "typeId": "com.siemens.mindsphere.eventmgmt.event.type.MindSphereStandardEvent",  
  "correlationId": "0ccd7c42c0114dde8ed199f9bef64fe6",  
  "timestamp": "2018-01-31T11:00:00Z",  
  "entityId": "b75549b996014c60809902662df158c7",  
  "severity": 1,  
  "code": "TestCode01",  
  "acknowledged": false,  
  "description": "Test event via API call"  
}
```

Listing events will return only the **latest** of an event's history. But we can list the whole history of the event with **'history' query parameter set to true**.

The original event remains in the database and a new event is created with the same **entityId** and **correlationId** but a **different id**

Endpoints for bulk create events

| Request Method | Endpoint | Description |
|----------------|--|------------------------------------|
| POST | /api/eventmanagement/v3/createEventsJobs | Create events (asynchronous) |
| GET | /api/eventmanagement/v3/createEventsJobs/{jobId} | Get information about a create job |

Create events

POST /api/eventmanagement/v3/createEventsJobs

Example request (body):

```
{  
  "events": [  
    {  
      "typeId": "com.siemens.mindsphere.eventmgmt.event.type.MindSphereStandardEvent",  
      "timestamp": "2018-07-06T11:01:00.000Z",  
      "entityId": "b43703b007924c2889adc9da9f818a5b",  
      "severity": 1,  
      "description": "TB Bulk event 1",  
      "code": "tbe1",  
      "acknowledged": false  
    },  
    [...]  
  ]  
}
```

Result:

```
{  
  "id": "566a320e-c762-42f0-86c4-6249b0eedc27",  
  "state": "ACCEPTED"  
}
```

Create events (check status)

GET /api/eventmanagement/v3/createEventsJobs/{jobId}

Example response:

```
{  
  "id": "ce464d4f-59a7-4bb3-815b-9b70fe3931ac",  
  "state": "FINISHED",  
  "details": {  
    "resultDescription": [  
      [...]  
    ]  
  }  
}
```

Endpoints for deleting events

| Request Method | Endpoint | Description |
|----------------|--|------------------------------------|
| POST | /api/eventmanagement/v3/deleteEventsJobs | Delete events (asynchronous) |
| GET | /api/eventmanagement/v3/deleteEventsJobs/{jobId} | Get information about a delete job |

Delete events

POST /api/eventmanagement/v3/deleteEventsJobs

Example request (body):

```
{  
  "filter": {  
    "typeId": "com.siemens.mindsphere.eventmgmt.event.type.MindSphereStandardEvent",  
    "timestamp": {"between": "[2018-06-10T03:24:41.052Z,2018-06-22T23:59:59Z]"}  
  }  
}
```

Result:

```
{  
  "id": "566a320e-c762-42f0-86c4-6249b0eedc27",  
  "state": "ACCEPTED"  
}
```

Delete events (check status)

GET /api/eventmanagement/v3/deleteEventsJobs/{jobId}

Example response:

```
{  
    "id": "566a320e-c762-42f0-86c4-6249b0eedc27",  
    "state": "FINISHED",  
    "details": {  
        "resultCode": "200",  
        "resultDescription": "18482 events deleted."  
    }  
}
```

Endpoints for Event Types

| Request Method | Endpoint | Description |
|----------------|--|---------------------------------------|
| GET | /api/eventmanagement/v3/eventTypes | Find events based on a request filter |
| GET | /api/eventmanagement/v3/eventTypes/{eventId} | Get a specific event type |
| POST | /api/eventmanagement/v3/eventTypes/ | Create a new event type |

Find Event Types

GET /api/eventmanagement/v3/eventTypes

| Parameter Name | Description | Example | Mandatory |
|----------------|---|-----------------------|-----------|
| size | Specifies the number of elements in a page. Default is 20 | 100 | No |
| page | Specifies the requested page index. Default is 0 | 0 | No |
| filter | Filter parameter: id, name, owner, scope | {"owner": "academy2"} | No |
| sort | Sorting field Append ,asc or ,desc for sorting direction. Default is name ascending order | id,asc | No |

Create a new event type

POST /api/eventmanagement/v3/eventTypes

Example request (body):

```
{ "name": "MindSphereAcademyTrainingEvent",
  "ttl": 7,
  "scope": "LOCAL",
  "parentId": "com.siemens.mindsphere.eventmgmt.event.type.BaseEvent",
  "fields": [
    {
      "name": "courseId",
      "filterable": true,
      "required": true,
      "updatable": true,
      "type": "STRING"
    }
  ]
}
```

Restriction for event types

| Field | Restriction |
|-------------------------------|---------------------|
| ttl | max. 1825 (5 years) |
| name of the event type | max. 64 characters |
| field name | max. 64 characters |
| number of fields | max. 100 |
| inheritance depth | max. 4 |
| filterable fields | max. 10 |

Exercise

- Use the Postman Collection to investigate this API

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MindSphere API – Event Management Service

Summary

How can we view and create events in MindSphere?

Use Event Management Service for getting the state of the assets



MindSphere Express

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Express

Learning Goals

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How to use Express to set
up a simple REST API?

- REST Methods
- Query Parameters
- Middleware (e.g. for Authentication)

- Web application framework
- Thin layer upon Node.js for best performance
- Basic routing and static file delivery
- HTTP utility with middleware implementation to create robust APIs
- Most used framework for JavaScript web servers

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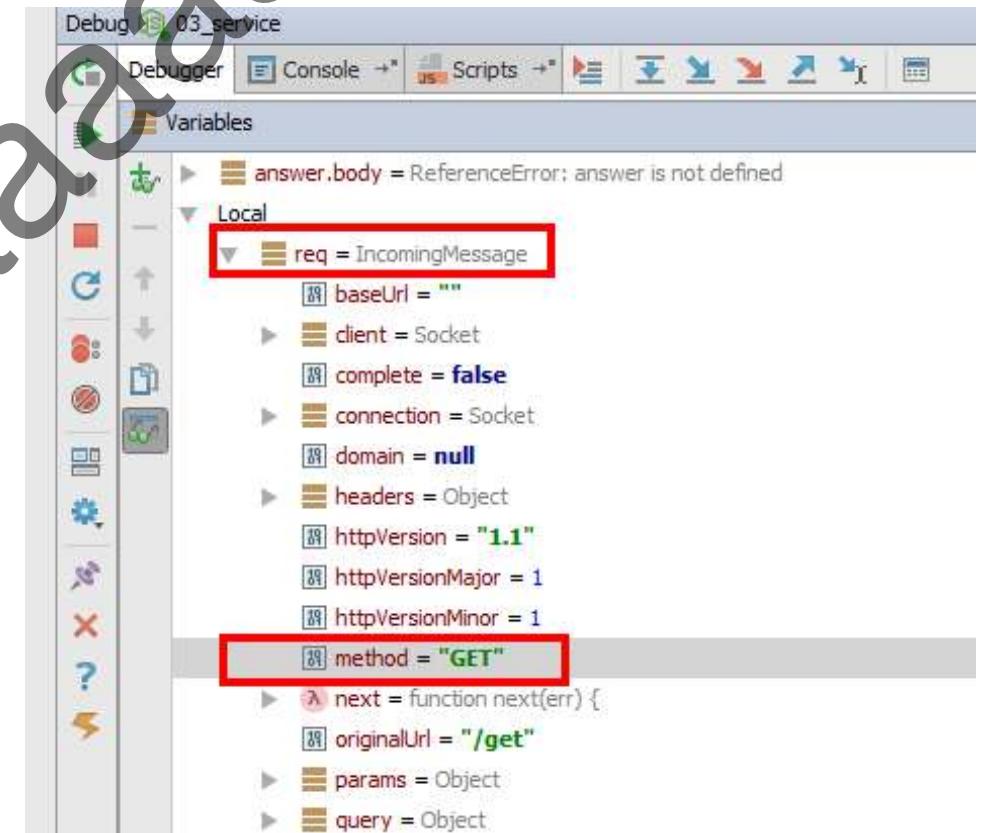
Detect the method of the incoming REST call easily by defining the endpoints

POST Request

```
app.post('/', function (req, res) {  
  res.send('Got a POST request')  
})
```

GET Request

```
app.get('/', function (req, res) {  
  res.send('Hello World!')  
})
```



Express

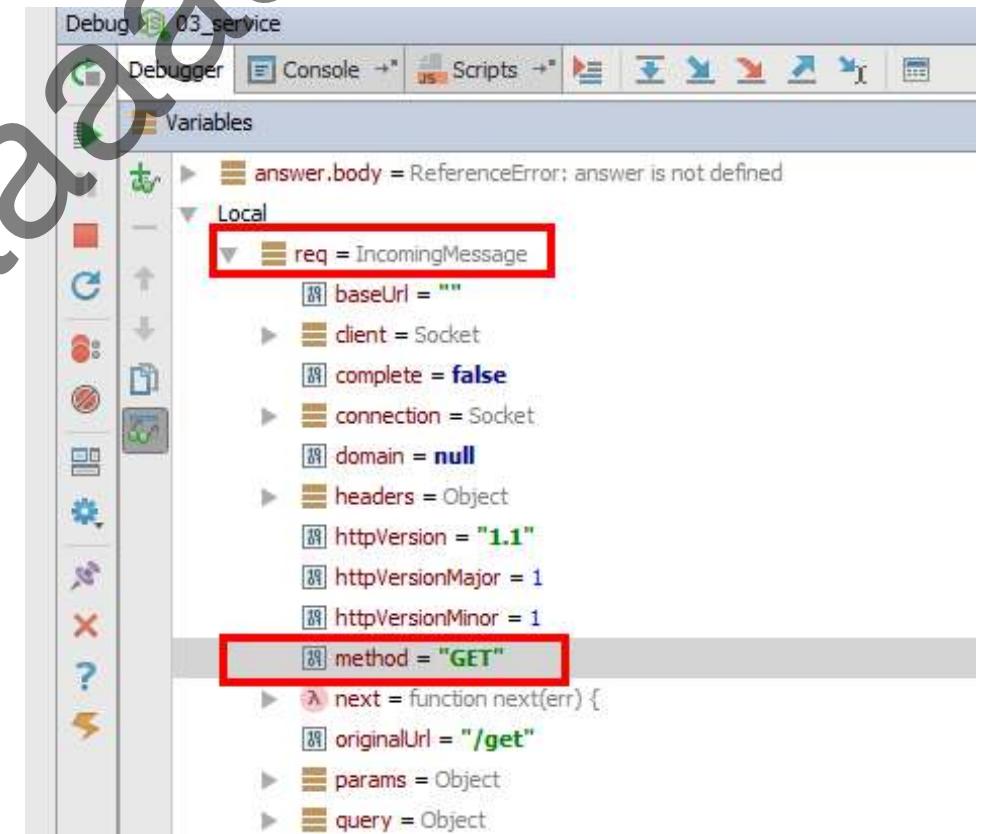
req and res

```
app.get('/', function (req, res) {  
  res.send('Hello World!')  
})
```

req contains all information of the incoming request
(e.g. parameters)

res can be used to send a response:

- res.end(<object>);
 - res.send(<object>);
 - res.json(<object>);
- sends as string
 - sends as string
 - sends as JSON



Req.param

```
app.get("/get/:param1/:param2", function(req, res, next) {
```

- http://localhost:6004/get/**value1**/**value2**
- req.param.**param1** = **value1**
- req.param.**param2** = **value2**

Req.query

```
app.get("/write", function(req, res, next) {
```

- http://localhost:6004/write?**name=peng**
- req.query.**name** = **peng**

More Information regarding express API and routing:

- <http://expressjs.com/en/4x/api.html>
- <http://expressjs.com/en/guide/routing.html#routing>

Supports static file hosting:

```
app.use(express.static('public'))
```

This serves all files which are located in the folder „public“.

```
app.use('/static', express.static('public'))
```

This serves all files which are located in the folder „public“ with <your URL>/static.

- Using **Express** middleware to distinguish between accessible and non accessible content
- The auth-middleware in this example validates the JWT token with the public-Key

```
// comment: /Status accessible without authentication
app.use('/Status', statusHandler);
// comment: middleware to check for authentication
app.use(authMiddleware.verifyReq);
// comment: /Config is only accessible if authentication via middleware was successful
app.use('/Config', configHandler);
```

Express Summary

How to use Express to set up a simple REST API?

Create endpoints for the different REST methods, fetch the query parameters of the incoming request, use the middleware feature to secure specific parts of your app

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MindSphere Backing Services

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Backing Services

Learning Goals

How can we use Backing Services within MindSphere?

- Available Services within MindSphere
- Create Service Instance
- Service Bindings



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Cloud Foundry Marketplace

Get all available services:

> *cf marketplace*

| service | plans |
|-----------------------------|--|
| <code>elasticsearch5</code> | <code>elasticsearch-m*</code> , <code>elasticsearch-xs*</code> |
| <code>logme</code> | <code>logme-m*</code> , <code>logme-xs*</code> |
| <code>mongodb32</code> | <code>mongodb-m*</code> , <code>mongodb-xs*</code> |
| <code>mongodb34</code> | <code>mongodb-m*</code> , <code>mongodb-xs*</code> |
| <code>postgresql10</code> | <code>postgresql-xs*</code> , <code>postgresql-m*</code> |
| <code>postgresql194</code> | <code>postgresql-m*</code> , <code>postgresql-xs*</code> |
| <code>rabbitmq36</code> | <code>rabbitmq-m*</code> , <code>rabbitmq-xs*</code> |
| <code>redis32</code> | <code>redis-m*</code> , <code>redis-xs*</code> |
| <code>redis40</code> | <code>redis-xs*</code> , <code>redis-m*</code> |

Backing Services

MongoDB

MongoDB

Detailed Serviceplan Info:

```
> cf marketplace -s mongodb32  
> cf marketplace -s mongodb34
```

MongoDB 3.2 & 3.4service

NO-SQL Database:

- No table- relations
- Easy to use with JSON documents
- Mongo -> use MyMongoDb -> db.mycollection.find()
- Fields can be added or removed, there is no object-relation



<https://www.anynines.com/>

Backing Services

PostgreSQL



PostgreSQL

Detailed Serviceplan Info:

```
> cf marketplace -s postgresql194  
> cf marketplace -s postgresql110
```

PostgreSQL 9.4 & 10.x service

SQL Database:

- Related Database
- For applications where data-relations are helpful (double-entry bookkeeping system)



Backing Services

RabbitMQ

RabbitMQ

Detailed Serviceplan Info:

```
> cf marketplace -s rabbitmq36
```

RabbitMQ 3.6 service

Message Broker:

- Exchanging messages between services
- Create distribution system for worker threads
- Multiple sender / receiver possible
- Complex request and reply patterns



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Backing Services

Redis

Redis

Detailed Serviceplan Info:

```
> cf marketplace -s redis32  
> cf marketplace -s redis40
```

Redis 3.2 & 4.0 service

In-memory DB:

- Used as Database
- Cache
- Message Broker

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Backing Services

logme

logme

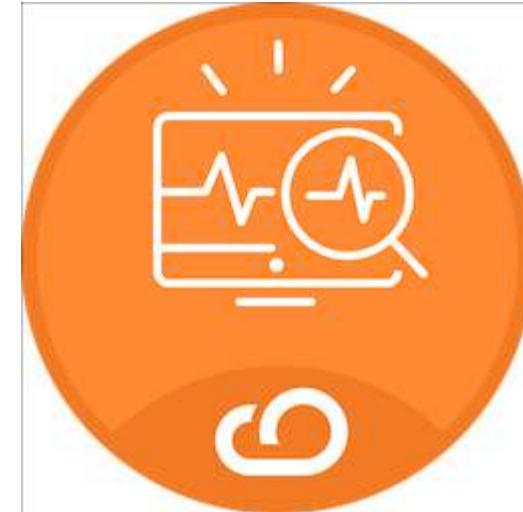
Detailed Serviceplan Info:

> *cf marketplace -s logme*

Dedicated ELK stacks to monitor applications and service instances

Elastic stack

- Elasticsearch
- Logstash
- Kibana



Backing Services

Elasticsearch

Elasticsearch

Detailed Serviceplan Info:

```
> cf marketplace -s elasticsearch5
```

Elasticsearch 5.x service

Elasticsearch

- Distributed search engine
- RESTful API
- Analytics engine

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MindSphere 3.0

Upgrades for MindAccess Plans – Backing Services

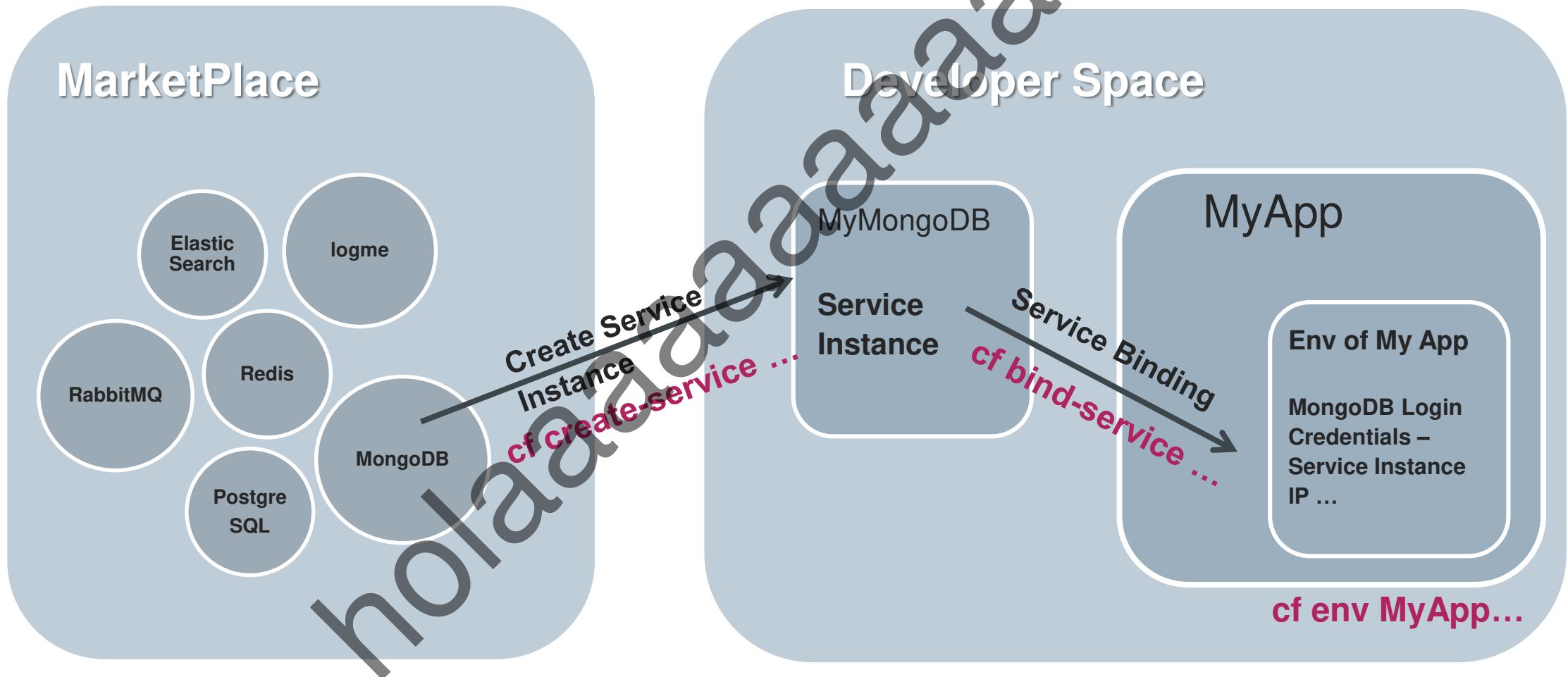
Backing Services comprise the following service types: PostgreSQL, Redis, RabbitMQ, MongoDB, ElasticSearch, LogMe and others¹. There are 2 Upgrade packages available in 2 different plan sizes, XS and M.

| | | Highly Available | Redundancy Instances | vCPU | RAM | Disk |
|---------------------|---------------|------------------|----------------------|------|--------|-------|
| Backing Services XS | ElasticSearch | No | 1 | 1 | 2 GB | 4 GB |
| | LogMe | No | 1 | 1 | 2 GB | 4 GB |
| | MongoDB | No | 1 | 1 | 0,5 GB | 3 GB |
| | PostgreSQL | No | 1 | 1 | 0,5 GB | 3 GB |
| | RabbitMQ | No | 1 | 1 | 0,5 GB | 3 GB |
| | Redis | No | 1 | 1 | 0,5 GB | 3 GB |
| Backing Services M | ElasticSearch | Yes | 3 | 2 | 4 GB | 50 GB |
| | LogMe | Yes | 3 | 2 | 4 GB | 50 GB |
| | MongoDB | Yes | 3 | 2 | 4 GB | 50 GB |
| | PostgreSQL | Yes | 3 | 2 | 4 GB | 50 GB |
| | RabbitMQ | Yes | 3 | 2 | 4 GB | 6 GB |
| | Redis | Yes | 3 | 2 | 4 GB | 50 GB |

1) Please see MindAccess DevOps Product Sheet and corresponding Supplemental Terms

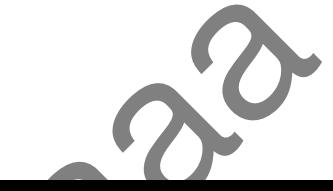
Backing Services

Instances and Service Binding



Backing Services

Instances and Service Binding



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```
System-Provided:
{
  "VCAP_SERVICES": {
    "mongodb34": [
      {
        "binding_name": null,
        "credentials": {
          "default_database": "mod81ed27",
          "dns_servers": [
            "172.16.30.15"
          ],
          "hosts": [
            "mod81ed27-mongodb-0.node.dc1.a9ssvc:27017"
          ],
          "password": "REDACTED2697171cbc8ac82734fa23c",
          "uri": "mongodb://a9s-brk-usr-2a7e893b6b45425d6d78ec2fcdf4691b6329ee68:REDACTED2697171cbc8ac82734fa23c@mod81ed27-mongodb-0.node.dc1.a9ssvc:27017/mod81ed27",
          "username": "a9s-brk-usr-2a7e893b6b45425d6d78ec2fcdf4691b6329ee68"
        },
        "instance_name": "mongo",
        "label": "mongodb34",
        "name": "mongo",
        "plan": "mongodb-xs",
        "port": 27017
      }
    ]
  }
}
```

Backing Services



Step-by-Step

Get all available services

> `cf marketplace`

Create service instance

> `cf create-service mongodb34 mongodb-xs mymongodb`

Bind service to an app

> `cf bind-service mywebapp mymongodb`

<https://www.anynines.com/>

Exercise: 130_mongodb

- Push the app and try to write and read data from a mongoDB

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Backing Services Summary

How can we use Backing Services within MindSphere?

Create a Services Instance
and do a Service Binding
against your app



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MindSphere Background processes

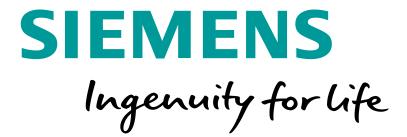
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Background processes

Learning Goals

How can a backend App get access to the API without being called by a Browser & why is this an important topic?

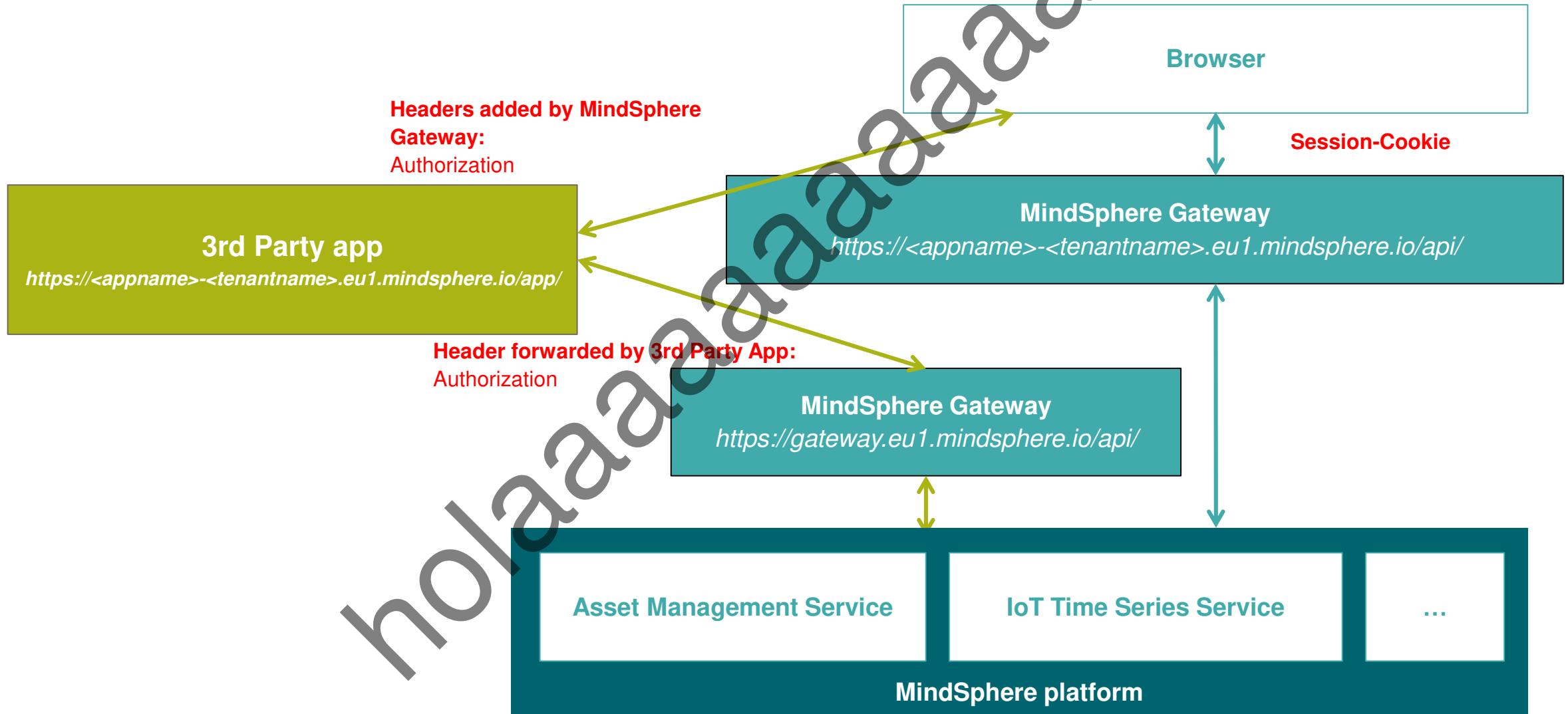
- Get ClientID
- Get ClientSecret
- Fetch JWT Token



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MindSphere - Authentication & Authorization Workflow

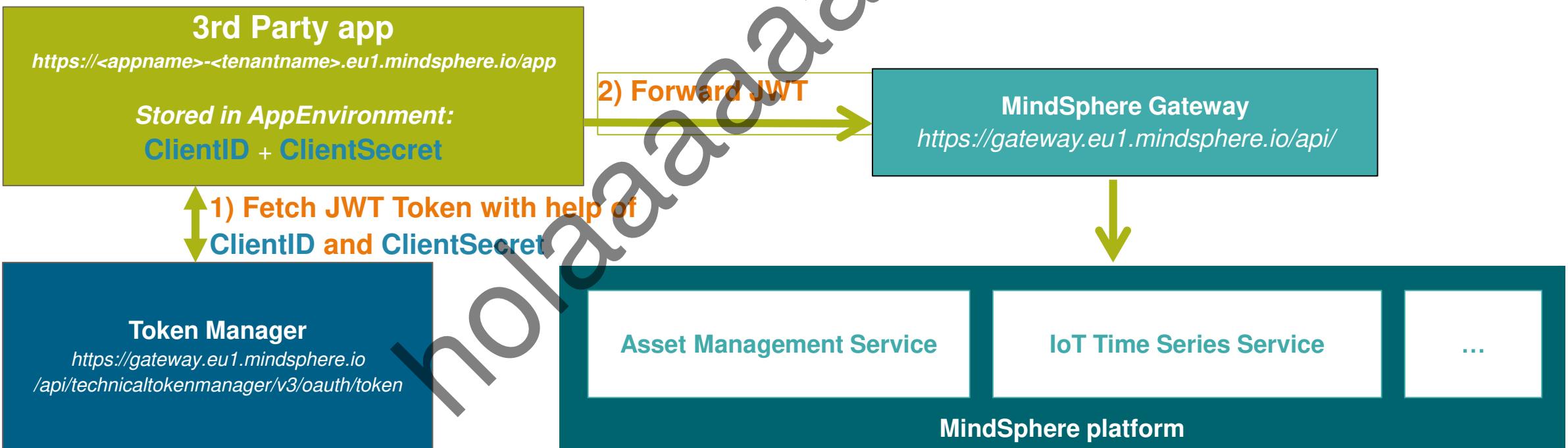
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Background processes

Background process without Browser Call

App is running independently without any Browser Call



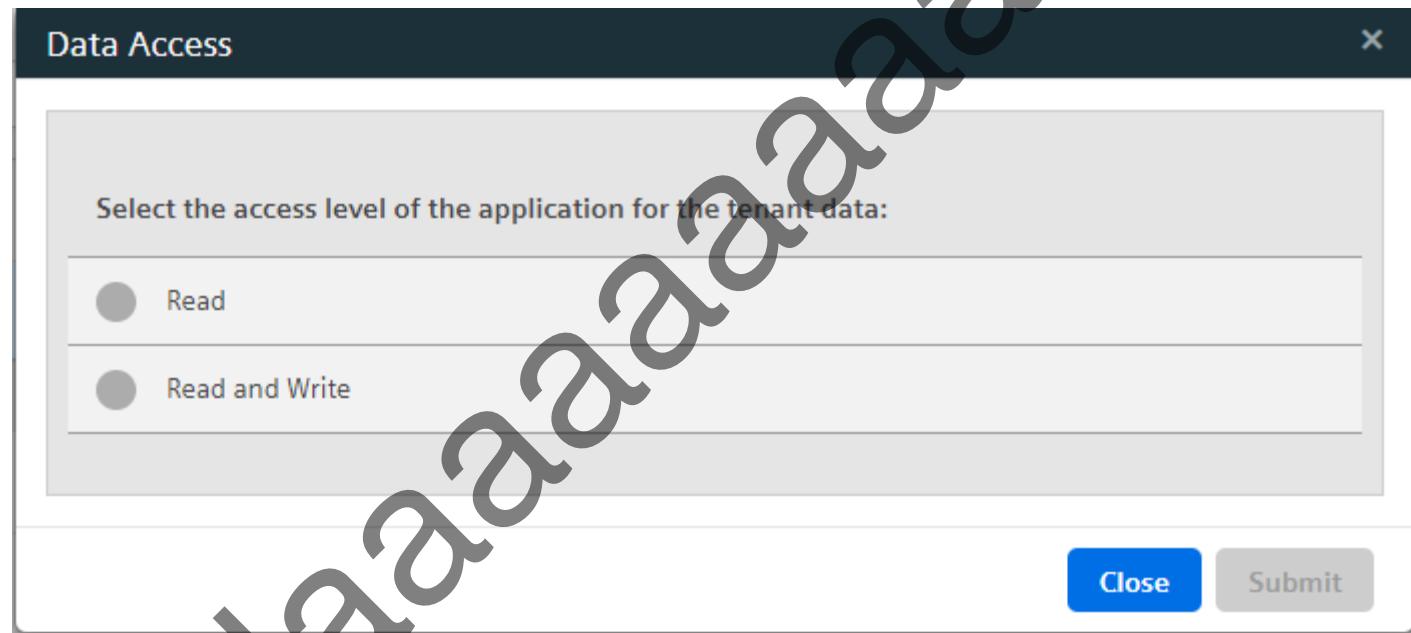
Background processes

Where do I get my Service credentials?

The screenshot shows the MindSphere Academy Developer Cockpit interface. The top navigation bar includes 'MindSphere Academy', 'Developer Cockpit', 'powered by MindSphere', and a user icon. The main menu has tabs for 'Dashboard', 'Promoted Apps', and 'Authorization Management', with 'Authorization Management' being the active tab. On the left, a sidebar lists 'App Roles', 'External App 1' (selected), and 'App Credentials'. The main content area displays 'External App 1' with version '1.0'. A large warning message states 'No access has been issued' with an exclamation mark icon, and a note: 'Use the Token Manager API to grant your application access to data of other tenants. This is relevant if an application needs to access data of a different tenant, e.g. to perform frequent data processing without any user interaction.' A blue button labeled 'Issue access' with a key icon is present.

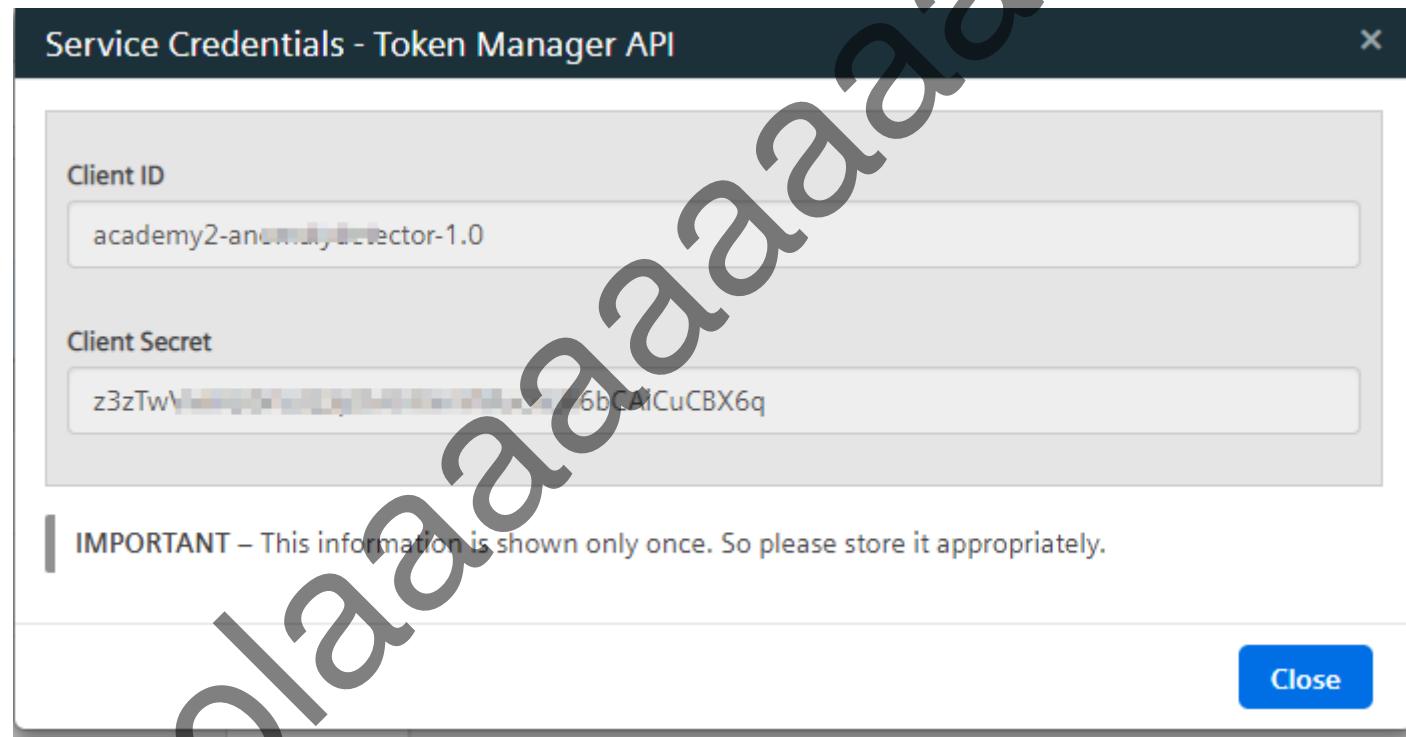
Background processes

Service credentials



Background processes

Service credentials



Background processes

Service credentials

The screenshot shows the MindSphere Academy Developer Cockpit interface. The top navigation bar includes the MindSphere Academy logo, Developer Cockpit, and powered by MindSphere. The main menu tabs are Dashboard, Promoted Apps, and Authorization Management, with Authorization Management being the active tab.

The left sidebar has two sections: App Roles and App Credentials. The App Credentials section is highlighted with a yellow background and contains the text "Acabackground". Below it, the "Academy Background App" is listed with version 1.0. A "Filter" input field is also present in this sidebar.

The main content area displays the "Academy Background App" details. The title is "Academy Background App". Below the title, the version is listed as 1.0. A "Revoke access" button is located on the right side of the credentials table.

The "Credentials" table has four columns: Access Level, Created By, Created At, and Modified At. One row is shown with the Access Level set to "Read", Created By as "john.doe@siemens.com", and both Created At and Modified At times as "Mon, Feb 11, 2019 04:55 PM".

Background processes

Store ClientID and ClientSecret to App Env

Store the ClientID and the ClientSecret into the Application Environment Variables

3rd Party app

<https://<app-url>.eu1.mindsphere.io/app>

Stored in AppEnvironment:

ClientID + ClientSecret

```
applications:  
  - name: techuser  
    buildpack: nodejs_buildpack  
    memory: 50MB  
    disk_quota: 250MB  
    command: node app.js  
    env:  
      "MDSP_KEY_STORE_CLIENT_ID": "app-demo1-1.0"  
      "MDSP_KEY_STORE_CLIENT_SECRET": "fgsdfgsdgsdfgsdgsdsdfgb3099"
```

manifest.yml of your App

Get a JWT

POST /api/technicaltokenmanager/v3/oauth/token

| Parameter Name | Description | Mandatory |
|------------------|---|-----------|
| X-SPACE-AUTH-KEY | This a header field. "Basic " + Base64 encoded string: "clientId:clientSecret" Like "Basic YWNhZGVteLjA6Y0ljUkMT3Rk1XaUJkNTZXdQ==" | Yes |
| Body | { "appName": "testapplication", "appVersion": "1.0.0", "hostTenant": "testhosttenant1", "userTenant": "testusertenant1" } | Yes |

Background processes

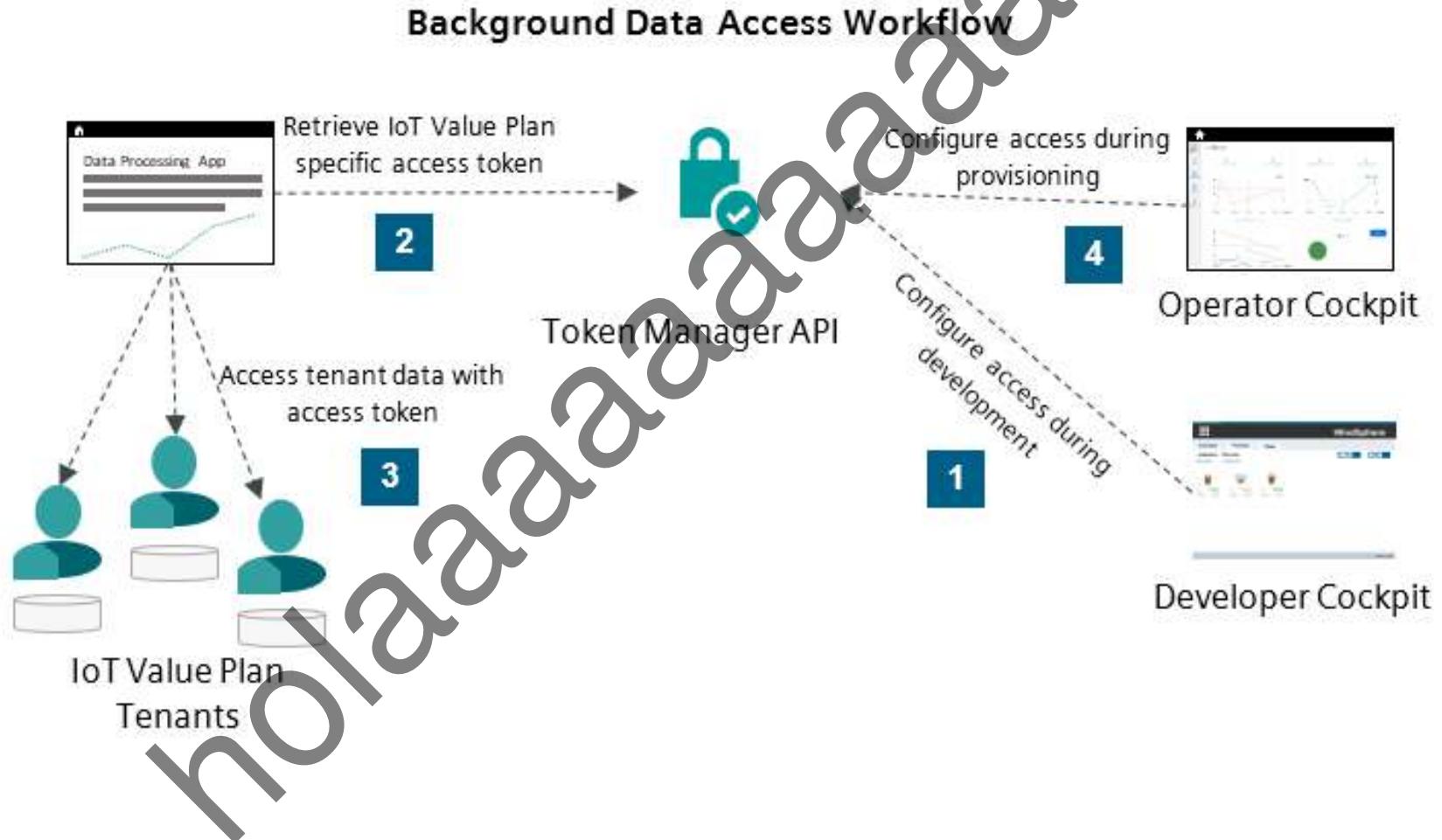
Fetch JWT with help of ClientID and ClientSecret

Response of this call

```
{  
    "access_token":  
        "eyJhbGciOiJSUzI1NiIsImtpZCI6ImtleS1pZC0xIiwidHlwIjoiSldUIh0.eyJqdGkiOiI4YTZjM2Y5ODM0NGE0MjhjOTYwNTlkNDViZTM2MjdjOCIsInN1YiI6ImEwNTgyNjA0LTJlZmEtNDEzM040DcwLWI5NzI3ZTA4ZWI0OCIsImF1dGhvcml0aWVzIjpbInVhYS5ub25lI10sInNjb3BlIjpbInVhYS5ub25lI10sImNsawVuDF9pZCI6ImEwNTgyNjA0LTJlZmEtNDEzM040DcwLWI5NzI3ZTA4ZWI0OCIsImNpZCI6ImEwNTgyNjA0LTJlZmEtNDEzM040DcwLWI5NzI3ZTA4ZWI0OCIsImF6cCI6ImEwNTgyNjA0LTJlZmEtNDEzM040DcwLWI5NzI3ZTA4ZWI0OCIsImdyYW50X3R5cGUIoIjbg1lbnRfY3J1ZGVudGlhbHMiLCJyZXZfc2lnIjoiYjJhNTY1ZmEiLCJpYXQiOjE1MDQ3NDM5NjEsImV4cCI6MTUwNdc0NzU2MSviaXNzIjoiaHR0chM6Ly9zYWctZGVsMi4zcmRwlhbWRldi5taW5kc3BoZXJlLmlvL29hdXR0L3Rva2VuIwiemlkIjoic2FnLWR1bDIiLCJhdWQiolsiYTA1ODI2MDQtMmVmYS00MTMyLTg4NzAtYjk3Mjd1MDh1YjQ4I119.F8P6JYK6pIYknjuN-2H8jOrIEMuRF41XgEmvDVpQH71BnRqxoS2sOpJ7cVr5Suc-7P-  
5gvLC19bDo0VaC4sgkGfkTKnZKevL9TaKQalr8C1TkzbYIN7WIHe_wDGesPMKm51tm6NpJ1XwXNIMdzfFK65_zliop201UOOQTMwozp  
zQP2S-HhjDf4VDOql1V5e_wmP_5ug7TDYqAmb9VqXI3BNELtVi-iA3i5PrJG47-pmmzsHjTIpd8MUJLeG-17tYW18MdwRn-  
jE9VOazVtSKvbvaTvEBinDaku1DsOGipf5Wi_kZNX1Hdahhv1PNt.84muHkSJGiF5OfW9mPHvV1a",  
    "token_type": "bearer",  
    "expires_in": 3599,  
    "scope": "mdsp:core:Default3rdPartyTechUser",  
    "jti": "8a6c3f98344a428c96059d45be3627c8",  
    "timestamp": 1550072054141  
}
```

Example Response. Forward the JWT as a Authorization Header with the API Request

Background processes



Exercise: 160_technicalUser

- Create app
- Create token
- Check logfiles



```
C:\Windows\System32\cmd.exe
2017-10-13T15:24:57.32+0200 [RTR/0] OUT
2017-10-13T15:24:57.52+0200 [RTR/0] OUT mybackendapp-tb-sag-del2.appsdev.mindsphere.io - [2017-10-13T13:24:57.519+0000] "GET /write12 HTTP/1.1" 404
146 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/61.0.3163.100 Safari/537.36" "192.168.0.126:54312" "10
.9.38:61846" x_forwarded_for:"213.70.98.21, 192.168.0.129, 155.56.80.250" x_forwarded_proto:"https" vcap_request_id:"fed93c6b-ae14-4b2e-55ff-1cf58bb031
" response_time:0.002799308 app_id:"61bcda05-e6c2-415c-8e99-24a8f5f9b092" app_index:"0" x_b3_traceid:"3a45d1d9a8952c78" x_b3_spanid:"3a45d1d9a8952c78"
b3_parentspanid:"-"`
2017-10-13T15:24:57.52+0200 [RTR/0] OUT
2017-10-13T15:24:57.68+0200 [RTR/0] OUT mybackendapp-tb-sag-del2.appsdev.mindsphere.io - [2017-10-13T13:24:57.678+0000] "GET /write12 HTTP/1.1" 404
146 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/61.0.3163.100 Safari/537.36" "192.168.0.126:47350" "10
.9.38:61846" x_forwarded_for:"213.70.98.21, 192.168.0.129, 155.56.80.250" x_forwarded_proto:"https" vcap_request_id:"6ba970c9-6d24-4f86-5cca-ef13010c10
" response_time:0.002033824 app_id:"61bcda05-e6c2-415c-8e99-24a8f5f9b092" app_index:"0" x_b3_traceid:"a93cbc0204d51dc1" x_b3_spanid:"a93cbc0204d51dc1"
b3_parentspanid:"-"`
2017-10-13T15:24:57.68+0200 [RTR/0] OUT
2017-10-13T16:19:24.82+0200 [APP/PROC/WEB/0] OUT Assets successfully fetched
2017-10-13T16:19:24.82+0200 [RTR/0] OUT mybackendapp-tb-sag-del2.appsdev.mindsphere.io - [2017-10-13T14:19:24.707+0000] "GET /assets HTTP/1.1" 200 0
2857 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/61.0.3163.100 Safari/537.36" "192.168.0.129:50752" "10
.9.38:61846" x_forwarded_for:"213.70.98.21, 192.168.0.126, 155.56.80.250" x_forwarded_proto:"https" vcap_request_id:"ff5f711f-825a-4c7b-7ea7-4620be9c1c
" response_time:0.116217062 app_id:"61bcda05-e6c2-415c-8e99-24a8f5f9b092" app_index:"0" x_b3_traceid:"76d101ab824c292c" x_b3_spanid:"76d101ab824c292c"
b3_parentspanid:"-"`
2017-10-13T16:19:24.82+0200 [RTR/0] OUT
2017-10-13T16:19:43.96+0200 [APP/PROC/WEB/0] OUT Assets successfully fetched
2017-10-13T16:19:43.98+0200 [APP/PROC/WEB/0] OUT database connected
2017-10-13T16:19:44.00+0200 [RTR/1] OUT mybackendapp-tb-sag-del2.appsdev.mindsphere.io - [2017-10-13T14:19:43.871+0000] "GET /assets?filter=Asset&pr
etty HTTP/1.1" 200 0 490 "-" "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/61.0.3163.100 Safari/537.36" "192.1
.0.129:47146" "10.1.9.38:61846" x_forwarded_for:"213.70.98.21, 192.168.0.126, 155.56.80.250" x_forwarded_proto:"https" vcap_request_id:"11c63d13-2f9a-4
f-5990-ad868d88feba" response_time:0.132341021 app_id:"61bcda05-e6c2-415c-8e99-24a8f5f9b092" app_index:"0" x_b3_traceid:"36b411de9f676a6e" x_b3_spanid:
6b411de9f676a6e" x_b3_parentspanid:"-"`
2017-10-13T16:19:44.00+0200 [RTR/1] OUT
```

Background processes

3rd Party App view without Browser Call



Other („old“) way

Disclaimer:

Only possible on developer tenants

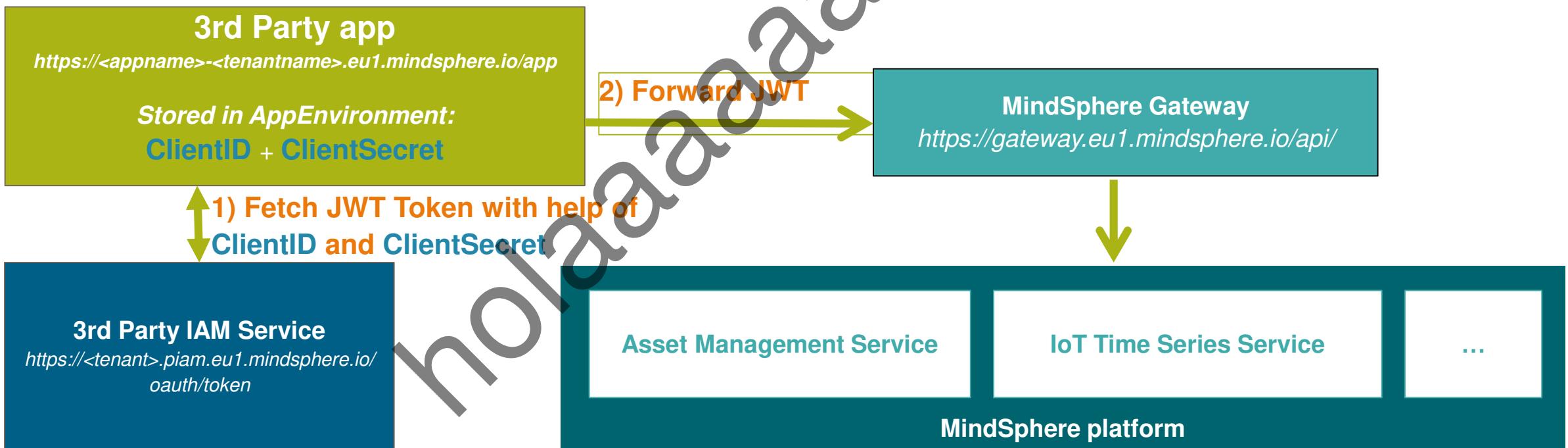
No way to connect to data in IoT value plans

holaaaaaaaaaaaaaa

Background processes

3rd Party App view without Browser Call

App is running independently without any Browser Call



Background processes

Service credentials

In order to create *Service Credentials*, you have to generate a service request via GTAC with following content:

Subject: [Request for new Service Credentials] Self hosted Application

Dear MDSP Support,

please create new Service Credentials for the tenant with the following parameters:

Tenantname: <your mindsphere tenant>
Account type: <Developer or Operator depending on your account type>
Service Credentials ID: <preferred name for the Service Credentials set>

To develop/operate I purchased the following products:

(specify Soldto number for relevant products)
MindAccess Developer Plan: [enter Soldto]
MindAccess Operator Plan: [enter Soldto]
Outbound Traffic Upgrade: [enter Soldto]
Further Services: [enter Soldto]

Background processes

Store ClientID and ClientSecret to App Env

Store the ClientID and the ClientSecret and (optional) the 3rd Party IAM into the Application Environment Variables

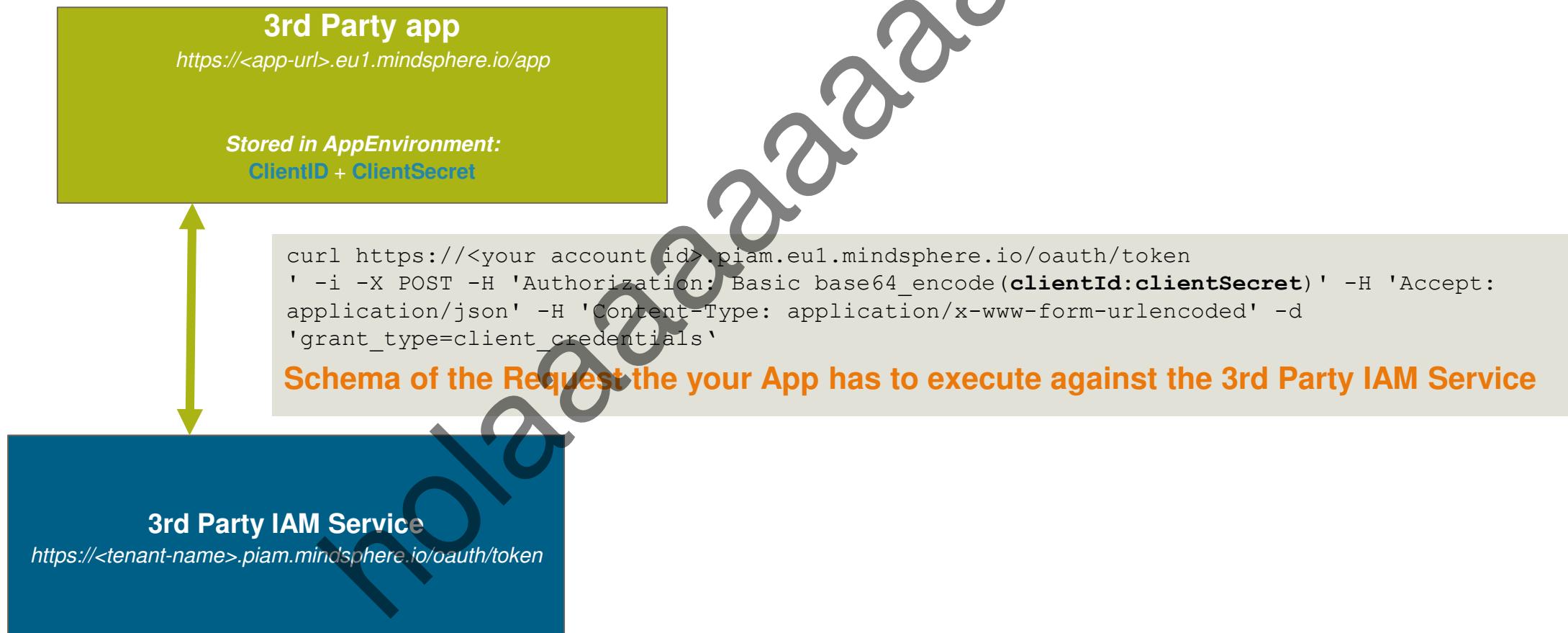


```
applications:  
  - name: techuser  
    buildpack: nodejs_buildpack  
    memory: 50MB  
    disk_quota: 250MB  
    command: node app.js  
env:  
  CONFIG: '{  
    "clientSecret": "tfE3RJzR3jdAxH3mvJPRbDPuUvW=",  
    "clientId": "sb-na-cba9d0a7-ab23-4fc8-95f4-673a024b3099",  
    "securityServiceUrl": "https://<tenant-name>.piam.eu1.mindsphere.io/oauth/token?grant_type=client_credentials"  
  }'
```

Background processes

Fetch JWT with help of ClientID and ClientSecret

Your App should execute this fetch JWT Job and take the JWT out the response and forward this JWT as a Authorization Header to get access to the API



Background processes

Fetch JWT with help of ClientID and ClientSecret

Response of this call

```
{  
    "access_token":  
        "eyJhbGciOiJSUzI1NiIsImtpZCI6ImtleS1pZC0xIiwidHlwIjoiSldUiIn0.eyJqdGkiOiI4YTZjM2Y5ODM0NGE0MjhjO  
        TYwNTlkNDViZTM2MjdjOCIsInN1YiI6ImEwNTgyNjA0LTJlZmEtNDEzMj04ODcwLWI5NzI3ZTA4ZWI0OCIsImF1dGhvcmI  
        0aWVzIjpbInVhYS5ub25lIl0sInNjb3B1IjpbInVhYS5ub25lIl0sImNsawVudF9pZCI6ImEwNTgyNjA0LTJlZmEtNDEzM  
        i04ODcwLWI5NzI3ZTA4ZWI0OCIsImNpZCI6ImEwNTgyNjA0LTJlZmEtNDEzMj04ODcwLWI5NzI3ZTA4ZWI0OCIsImF6CCI  
        6ImEwNTgyNjA0LTJlZmEtNDEzMj04ODcwLWI5NzI3ZTA4ZWI0OCIsImdyYW50X3R5cGUIOiJbG1lbnRfY3JlZGVudG1hb  
        HMiLCJyZXZfc2lnIjoiYjJhNTY1ZmEiLCJpYXQiOjE1MDQ3NDM5NjEsImV4cCI6MTUwNDc0NzU2MSviaXNzIjoiaHR0cHM  
        6Ly9zYWctZGVsMi4zcmRwLwlhbWRldi5taW5kc3BoZXJlImlvL29hdXRoL3Rva2VuIiwiemlkIjoic2FnLWRlbDIiLCJhd  
        WQiOlsiYTA1ODI2MDQtMmVmYS00MTMyLTg4NzAtYjk3Mjd1MDh1YjQ4Ii19.F8P6JYK6pIYknjuN-  
        2H8jOrIEMuRF41XgEmvDVpQH71BnRqxoS2sOpJ7cVr5SUc-7P-  
        5gvLC19bDo0VaC4sgkGfkTKnZKevL9TaKQalr8C1TkzbYIN7WIHe_wDGesyPMKm51tm6NpJ1XwXNIMdzFFK65_zliop201  
        UOOQTMwozpzQP2S-HhjDf4VDOql1V5e_wmP_5ug7TDYqAmb9VqXI3BNELtVi-iA3i5PrJG47-pmmzsHjTIpd8MUJLeG-  
        17tYW18MdwRn-jE9VQazVtSKybygIvEBinDqku1DsQGjPf5Wj_kZNXLhdahhpy1PNt84muHkSJGjF50fW9mPHyV1g",  
        "token_type": "bearer",  
        "expires_in": 3599,  
        "scope": "uaa.none",  
        "jti": "8a6c3f98344a428c96059d45be3627c8"  
}
```

Example Response. Forward the JWT as a Authorization Header with the API Request

Background processes

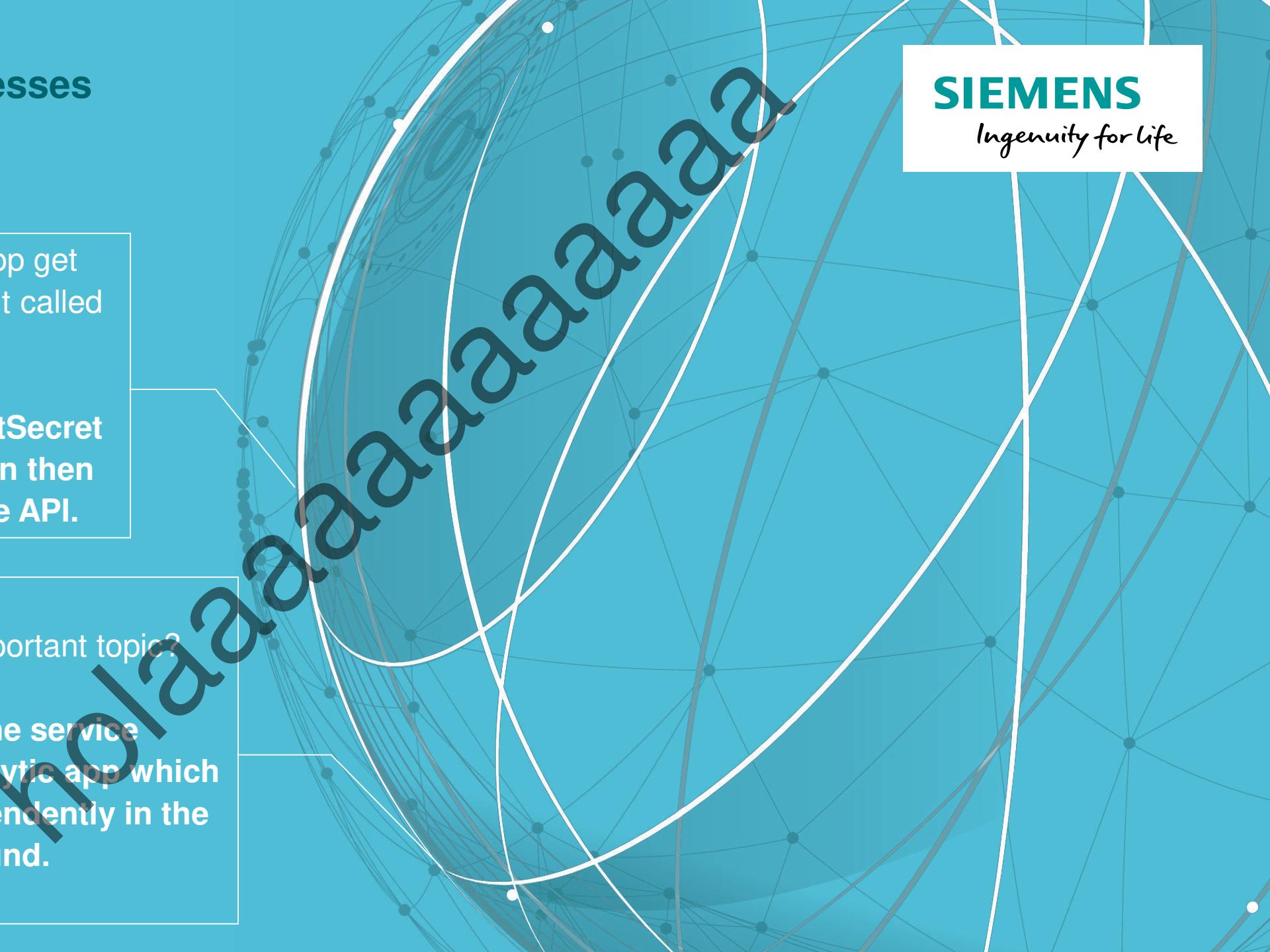
Summary

How can a backend App get access to the API without called by a Browser?

Use ClientID and ClientSecret to fetch JWT which can then be used to access the API.

Why is this an important topic?

We can use the service credentials for analytic app which have to run independently in the background.



MindSphere Debugging applications

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Debugging applications

Learning Goals

SIEMENS
Ingenuity for life

How can I debug my
MindSphere applications?

- Remote Debugging
- Tipps for running apps locally

Debugging SSH Access



Connect to your running CloudFoundry applications directly via SSH

SSH Access is by default **disabled**, but can be enabled per space

Role Space Manager is required to enable it

```
vcap@9936b32a-92b3-4083-5fa2-9b3f: ~
Using username "cf:b60c8670-040e-455e-a11e-e1bbc17f5393/0".
cf:b60c8670-040e-455e-a11e-e1bbc17f5393/0@ssh.cf.eui.mindsphere.io's password:
vcap@9936b32a-92b3-4083-5fa2-9b3f:~$ ls -l
total 4
drwxr-xr-x 1 vcap root 38 Jul 4 10:23 app
drwxr-xr-x 3 vcap vcap 14 Jul 4 10:22 deps
drwxr-xr-x 2 vcap vcap 6 Jul 4 10:23 logs
drwxr-xr-x 2 vcap vcap 124 Jul 4 10:23 profile.d
-rw-r--r-- 1 vcap vcap 60 Jul 4 10:23 staging_info.yml
drwxr-xr-x 2 vcap vcap 6 Jul 4 10:23 tmp
vcap@9936b32a-92b3-4083-5fa2-9b3f:~$
```

Debugging

SSH Access - Step by step

1. Log into Cloud Foundry by using the CLI:

```
cf login --sso
```

2. Check if SSH is enabled:

```
cf space-ssh-allowed {SPACE_NAME}
```

3. (If not): Enable SSH per space with:

```
cf allow-space-ssh {SPACE_NAME}
```

4. Enable SSH for your application:

```
cf enable-ssh {APP_NAME}
```

5. Connect to your application:

```
cf ssh {APP_NAME}
```



Debugging

SSH Access - Step by step with proxy

1. Log into Cloud Foundry by using the CLI:

```
cf login --sso
```

2. Check if SSH is enabled:

```
cf space-ssh-allowed {SPACE_NAME}
```

3. (If not): Enable SSH per space with:

```
cf allow-space-ssh {SPACE_NAME}
```

4. Enable SSH for your application:

```
cf enable-ssh {APP_NAME}
```

5. Get your application identifier:

```
cf app {APP_NAME} --guid
```

6. Retrieve the SSH endpoint:

```
cf curl /v2/info
```

In our case: ssh.cf.eu1.mindsphere.io:8443

7. Get your one-time-password:

```
cf ssh-code
```

8. Build your SSH connection string:

```
cf:{APP_GUID}/{APP_INSTANCE_INDEX}  
@{SSH_ENDPOINT}
```

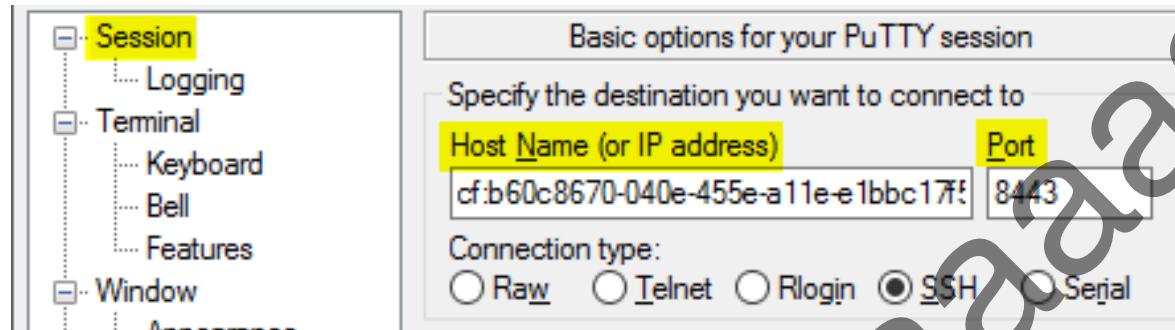
e.g.

```
cf:b60c8670-040e-455e-a11e-  
e1bbc17f5393/0@  
ssh.cf.eu1.mindsphere.io:8443
```

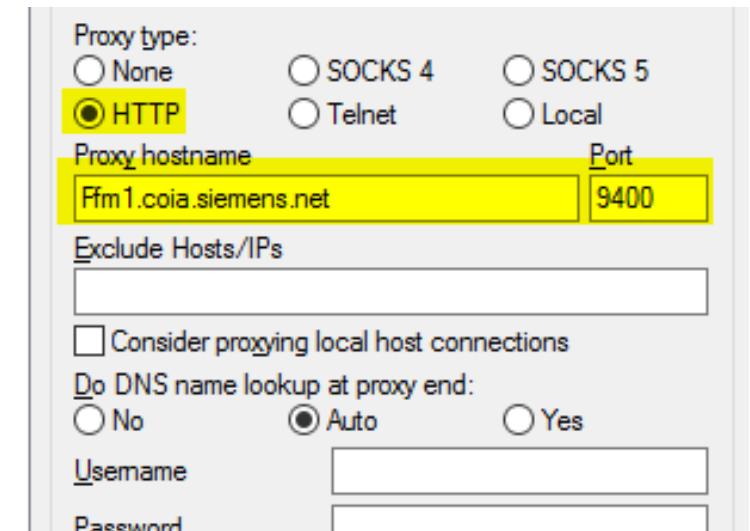
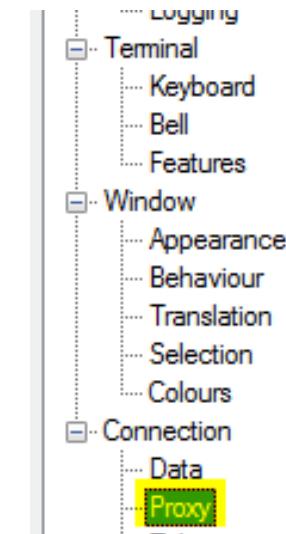
Debugging

SSH Access - Step by step with proxy

Session Configuration (from last steps):



Proxy configuration:

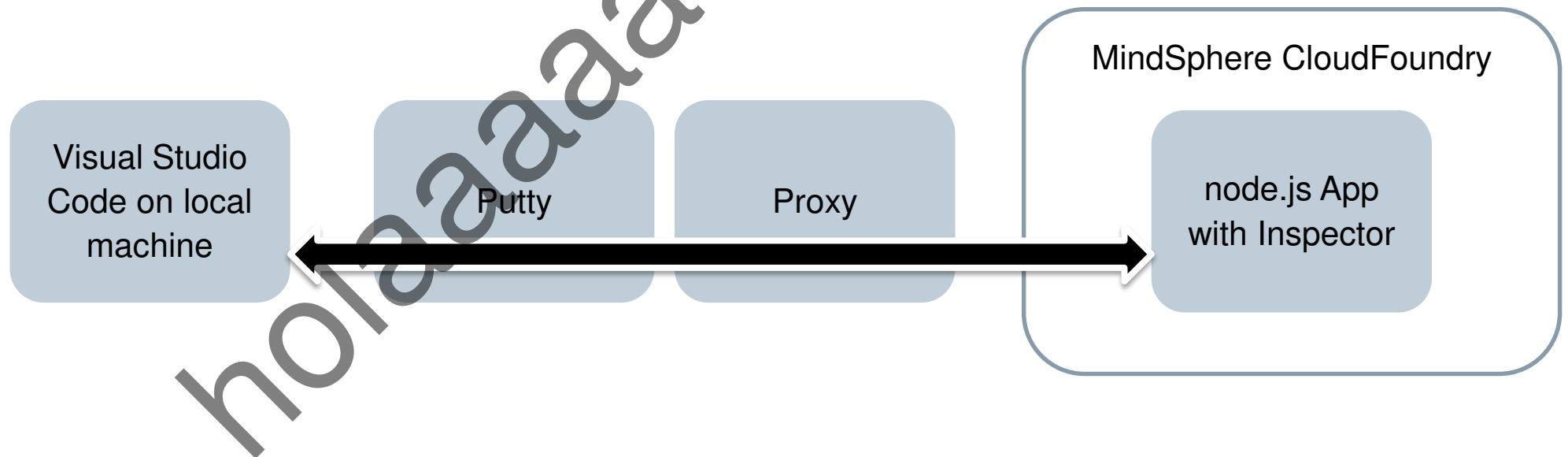


Debugging

Remote debugging

Example:

Remote debugging of node.js application with Visual Studio Code via Proxy



Debugging

Remote debugging

1. Enable Inspector in your nodejs application

```
node --inspect app.js
```

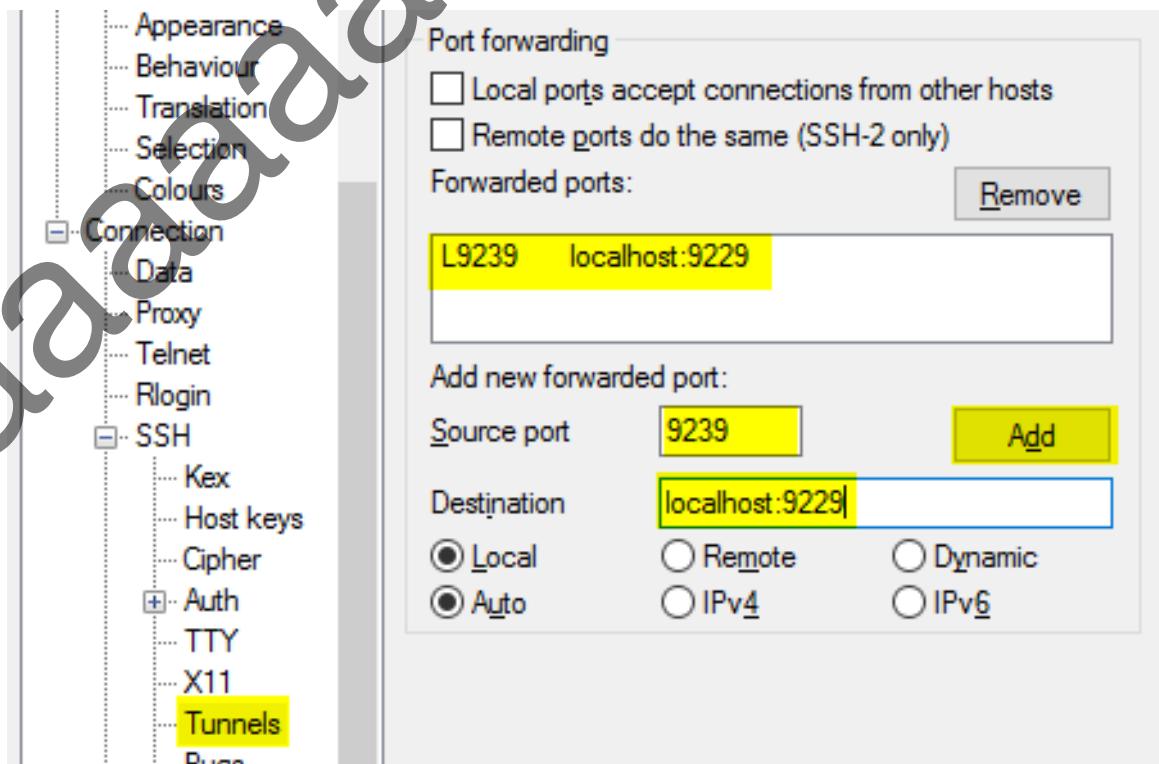
2. Check the port from the logfile

3. Create a SSH tunnel with Putty

4. Configure Visual Studio Code:

```
launch.json
```

```
"configurations": [  
  {  
    "type": "node",  
    "request": "attach",  
    "port": 9239,  
    "name": "Remote debugger"  
  }]
```



Debugging applications

Summary

How can I connect to a running CloudFoundry App?

Use SSH to connect

How can I debug my apps?

Use remote debugging and tunnel the connection through SSH



MindSphere Notification Services

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Notification Services

Learning Goals

How can we send messages from MindSphere?

- Understand the concept
- Know the needed elements
- Learn how to send a message in a simple way



holaaaaaaaaaaaaaa

Endpoint methods **GET**, **POST**, **PUT**, **DELETE**

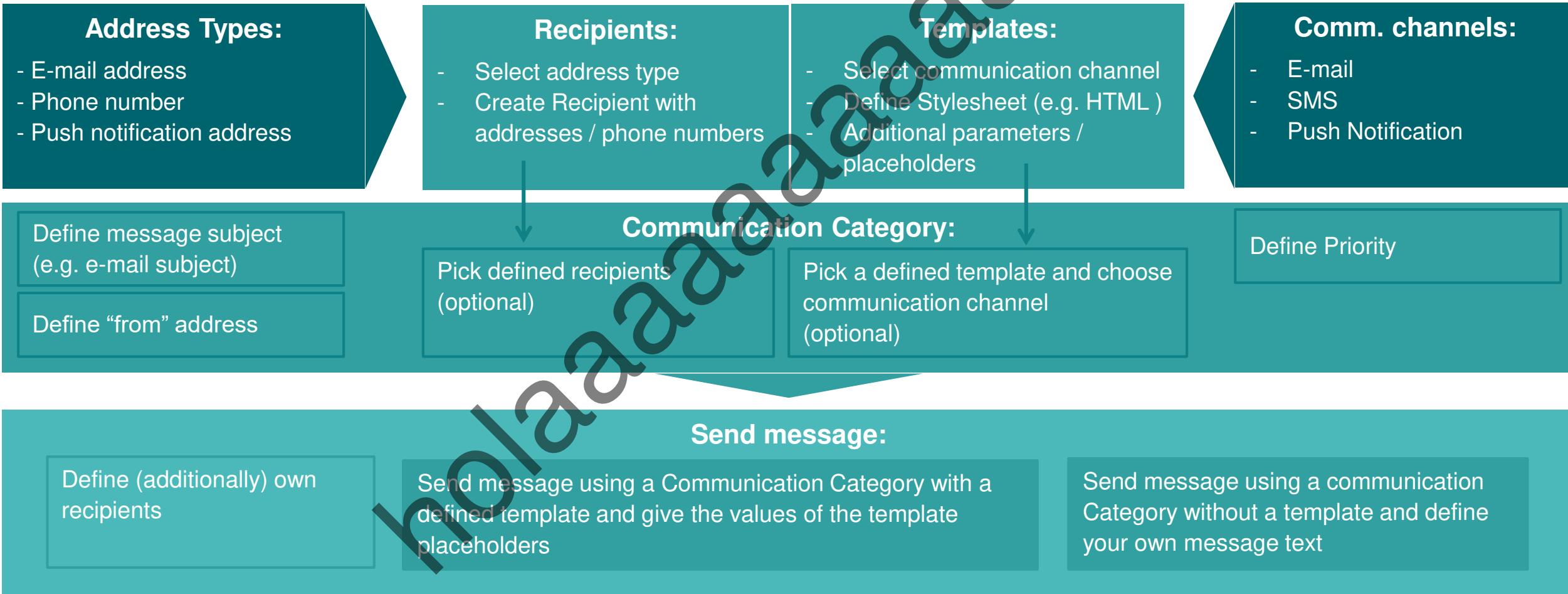
Different endpoints to use

Purpose:

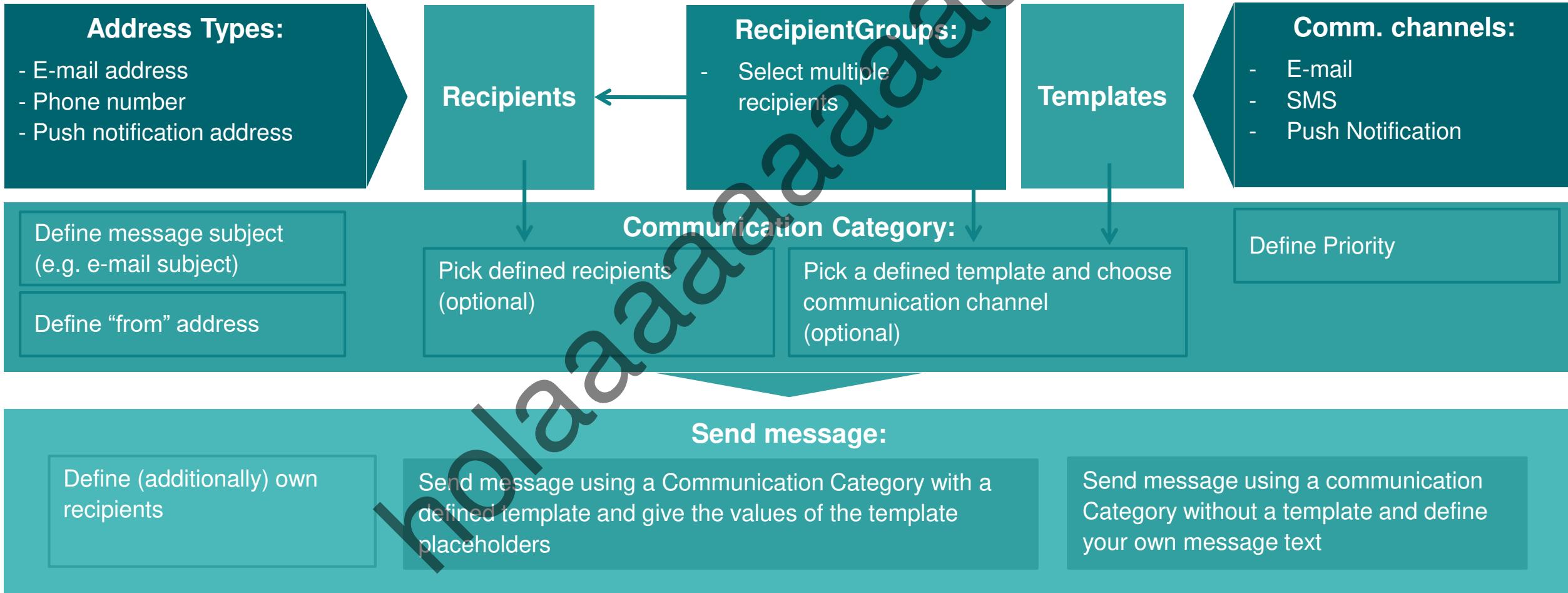
- Define recipients
- Define templates
- Define communication categories
- Send messages
- Check message status

Send messages via different communication channels

Schematic overview



Schematic overview



Roles / Scopes

Needed scope to use Notification services:

mdsp:core:nose.user

This scope is only available for service credentials (background processes).

Get Address Types - Request

GET: /api/notification/v3/recipient/addressstype

No parameters required:

| Parameter Name | Description | Example | Optional |
|----------------|-------------|---------|----------|
| - | - | - | - |

Get Address Types – positive Response

JSON format

```
[  
  {  
    "id": 1,  
    "recipientAddressTypeName": "Personal Mail"  
  },  
  {  
    "id": 2,  
    "recipientAddressTypeName": "Office Mail"  
  },  
  ...  
  {  
    "id": 5,  
    "recipientAddressTypeName": "Office Number"  
  },  
  {  
    "id": 6,  
    "recipientAddressTypeName": "Other Number"  
  },  
  {  
    "id": 7,  
    "recipientAddressTypeName": "Push Notification"  
  }  
]
```

MindSphere API

Notification Services – Recipient



Create Recipient – Request

POST: /api/notification/v3/recipient

Parameter with JSON format

| Parameter Name | Description | Type | Optional |
|----------------------------------|--|----------------------------------|----------|
| recipientname | Name of the recipient. | String | No |
| recipientdetail | Recipient details | Array of objects | No |
| recipientdetail.[].address | Recipient address, like email, telephone number, push notification configuration details etc. | user@siemens.com | No |
| recipientdetail.[].addresstypeid | Recipient address type. Use the 'List Address Types' API to get the appropriate address type ID. | <i>1 (stands for e-Mail)</i> | No |

Create Recipient– positive Response

42
Recipient ID, needed for later usage

Get Recipient - Request

GET: /api/notification/v3/recipient/{id}

Parameter with JSON format

| Parameter Name | Description | Example | Optional |
|----------------|--------------|---------|----------|
| id | Recipient ID | 1 | NO |

Get Recipient – positive Response

JSON format

```
{  
  "recipientid" : 1,  
  "recipientname" : "MindsphereUser",  
  "isactive" : "Y",  
  "recipientdetail" : [ {  
    "address" : "user@siemens.com",  
    "addresstypeid" : 1  
  } ]  
}
```

Search Recipient - Request

POST: /api/notification/v3/recipient/search

Parameter with JSON format

| Parameter Name | Description | Example | Optional |
|----------------|------------------------------|---------------------------|----------|
| name | Recipient name to be matched | { "name" : "user" } | NO |

Search Recipient – positive Response

JSON format

```
[ {  
    "recipientid" : 1,  
    "recipientname" : "MindsphereUser",  
    "isactive" : "Y",  
    "recipientdetail" : [ {  
        "address" : "user@siemens.com",  
        "address typeid" : 1  
    } ]  
} ]
```

Found string within the recipient name

MindSphere API

Notification Services – Recipient

Update Recipient - Request

PUT: /api/notification/v3/recipient

Parameter with JSON format

| Parameter Name | Description | Type | Optional |
|----------------------------------|--|---|----------|
| recipientid | Id of the recipient to be updated | | No |
| recipientdetail | Recipient details | Array of To update the recipient address details like email, telephone etc. To delete address, include the address with actual address type and "" as value for address. E.g.: <pre>{ "address": "", "addresstypeid": 1 }</pre> | No |
| recipientdetail.[].address | | | No |
| recipientdetail.[].addresstypeid | Recipient address type. Use the 'List Address Types' API to get the appropriate address type ID. | 1 (stands for e-Mail) | No |

List communication Channels - Request

GET: /api/notification/v3/communicationchannel/

Lists all available communication channels. Needed for template creation.

No parameters required:

| Parameter Name | Description | Example | Optional |
|----------------|-------------|---------|----------|
| - | - | - | - |

List communication Channels – positive Response

JSON format

```
[  
  {  
    "commChannelId": 1,  
    "commChannelName": "Email"  
  },  
  {  
    "commChannelId": 2,  
    "commChannelName": "SMS"  
  },  
  {  
    "commChannelId": 3,  
    "commChannelName": "Push Notification"  
  }  
]
```

Create Template - Request

POST: /api/notification/v3/template/

2 parameters: File (e.g. html file) and template information as with JSON format

| Parameter Name | Description | Example | Optional |
|----------------|-------------------------------------|-----------------------|----------|
| templateFiles | Template as html file | <i>see next slide</i> | NO |
| templateInfo | Template description as JSON object | <i>see next slide</i> | NO |

Create Template - Request

POST: /api/notification/v3/template/

Example html file

```
<html>

  <head>
    <title>Mail from MindSphere</title>
  </head>

  <body>
    Hello <span th:text="${firstName}"></span> <span th:text="${lastName}"></span>.<br/>
    Welcome to MindSphere.
  </body>

</html>
```



Thymeleaf

Create Template - Request

POST: /api/notification/v3/template/

Example JSON data

```
{ "templateParam": [
    {
        "paramName": "firstName",
        "defaultValue": "Firstname",
        "placeHolderName": "firstName",
        "paramTypeId": 4
    },
    {
        "paramName": "lastName",
        "defaultValue": "Lastname",
        "placeHolderName": "lastName",
        "paramTypeId": 4
    }
],
"templatesetName": "EMail Test",
"templateChannelAndFile": [
    {
        "communicationChannel": 1,
        "fileName": "mail.html",
        "operation": "ADD"
    }
]} ]}
```

Create Template – positive Response

Status 201 created

```
{  
  "templatesetId": 21,  
  "templatesetName": "EMail Test",  
  "templateList": [  
    {  
      "templateId": 61,  
      "commChannelId": 1,  
      "commChannelName": "Email"  
    }  
  ]  
}
```

Additional API calls to work with templates

| | | |
|---------------|--|--|
| POST | <code>/template/</code> Use this api to create templates for a new template set using templateFiles and templateInfo. | |
| GET | <code>/template/templatecontent/{templateId}</code> Use this api to get template content for a requested template ID. | |
| GET | <code>/template/templateidlist/{templatesetId}</code> Use this api to get list of template IDs for a requested template set. | |
| GET | <code>/template/templatelistdetails</code> Use this api to get all template sets along with associated template details. | |
| GET | <code>/template/templatesets</code> Use this api to get list of templateSetDTOs for matching template set name. | |
| GET | <code>/template/templatesets/{templatesetId}</code> Use this api to get templateSetDTO for a requested template set Id. | |
| DELETE | <code>/template/{templatesetId}</code> Use this api to delete a template set for a requested template set Id. | |
| PUT | <code>/template/{templatesetId}</code> Use this api to update details of a template set. | |
| GET | <code>/paramtype/</code> Use this api to get all available param types. | |
| GET | <code>/templateparam/{templatesetId}</code> Use this api to get available template params for a requested template set id. | |

Listing Communication Categories - Request

GET: /api/notification/v3/communicationcategories/

Lists all Communication Categories of the tenant.

No parameters required:

| Parameter Name | Description | Example | Optional |
|----------------|-------------|---------|----------|
| - | - | - | - |

Listing Communication Categories – positive Response

JSON format

```
[  
  {  
    "msgCategoryId": 662,  
    "msgCategoryName": "Training Team Test with template and recipients",  
    "priority": 5,  
    "recipients": [],  
    "templates": []  
  },  
  {  
    "msgCategoryId": 672,  
    "msgCategoryName": "VisualFlowCreatorTestCategory",  
    "priority": 5,  
    "recipients": [],  
    "templates": []  
  }  
]
```

Fetching Communication Categories - Request

GET: /api/notification/v3/communicationcategories/{id}

Lists details of a specific Communication Category.

| Parameter Name | Description | Example | Optional |
|----------------|--|---------|----------|
| id | Catergory ID of the category you want to fetch the details for | 662 | NO |

Fetching Communication Categories – positive Response

JSON format

```
{  
    "msgCategoryId": 662,  
    "msgCategoryName": "Training Team Test with template and recipients",  
    "subject": "This is a test message from training team",  
    "from": "training-team.test.tenant-id@mindsphere.io",  
    "priority": 3,  
    "recipients": [  
        {  
            "recipientId": 1443,  
            "position": "TO",  
            "recipientName": "User",  
            "recipientDetails": [  
                {  
                    "recipientId": 1443,  
                    "address": "user@siemens.com",  
                    "recipientAddressTypeName": "Office Mail",  
                    "commChannelName": "Email"  
                }  
            ]  
        }  
    ],  
    "templates": [  
        {  
            "templateId": 961,  
            "commChannelName": "Email",  
            "templatesetId": 968,  
            "templatesetName": "Training Notification 1"  
        }  
    ]  
}  
"createdby": "tenant-id"
```

Create a new Communication Category - Request

POST: /api/notification/v3/communicationcategories/

Creates a new Communication Category. Parameters with JSON format:

| Parameter Name | Description | Example | Optional |
|-----------------|---|--|----------|
| msgCategoryName | Name of the category | <i>Training Team Test with template and recipients</i> | NO |
| subject | Subject / Description of the category | <i>This is a test message</i> | NO |
| from | Source of the message. E.g. for E-mail it will be extended with <tenant-id>.mindsphere.io | <i>training-team.test</i> | NO |
| priority | Communication Category Priority(Values : 1,3,5) | <i>3</i> | YES |
| Recipients[] | Fixed recipient(s) | <i>"recipients": [{ ... }],</i> | YES |
| templates[] | Templates to be used for this category and communication channel | <i>"templates": [{ ... }],</i> | YES |

Create a new Communication Category - Request

POST: /api/notification/v3/communicationcategories/

JSON data

```
{  
    "from": "academy2",  
    "msgCategoryName": "trainingCategoryWithoutRecipientWithTemplate",  
    "priority": 1,  
    "subject": "MindSphere Academy Training please ignore",  
    "templates": [  
        {  
            "commChannelName": "EMail",  
            "templateId": 50,  
            "templatesetId": 20,  
            "operation": "ADD"  
        }],  
        "recipients": [  
            {  
                "position": "TO",  
                "recipientGroupId": 0,  
                "operation": "ADD",  
                "recipientId": 42  
            }]  
    }  
}
```

PUT request also available

Unsubscribe recipient from Communication Category - Request

POST: /api/notification/v3/communicationcategories/unsubscribe/recipients

```
{  
  "msgCategoryId": 0,  
  "recipients": [  
    {  
      "recipientId": 0  
    }]  
}
```

Send message without Template - Request

POST: /api/notification/v3/publisher/messages

Sends a message depending on the data in the body.

Very flexible call, see examples

Parameters with JSON format:

| Parameter Name | Description | Example | Optional |
|----------------|--------------|------------------------|----------|
| body | Message data | <i>see next slides</i> | NO |

Send message without Template - Request

POST: /api/notification/v3/publisher/messages

Example 1: Plain text, recipients configured in MessageCategory

```
{  
  
  "body": {  
    "message": "This is a test message"  
  },  
  
  "messageCategoryId": 653  
}
```

Send message without Template - Request

POST: /api/notification/v3/publisher/messages

Example 2: Template with placeholders, recipients configured in MessageCategory

```
{  
  "body": {  
    "firstName": "Jon",  
    "lastName": "Doe"  
  },  
  
  "messageCategoryId": 91  
}
```

Send message without Template - Request

POST: /api/notification/v3/publisher/messages

Example 3: No MessageCategory, everthing defined in the call

```
{  
  
  "body": {  
    "message": "Sample message as mail body"  
  },  
  "recipientsTo": "user1@siemens.com",  
  "from": "academy2",  
  "subject": "MindSphere Academy Training (please ignore)",  
  "priority": 3  
  
}
```

Get message status - Request

POST: /api/notification/v3/audit/searchauditstatus

Find out the message status for messages of a specified ID and a specified timerange

Parameters with JSON format:

| Parameter Name | Description | Example | Optional |
|-------------------|---|-----------------------|----------|
| messageCategoryId | Communication Category you want to check the status for | 653 | NO |
| startTimeRange | Start time range you want to check the status for | "2017-05-30 16:40:05" | NO |
| endTimeRange | End time range you want to check the status for | "2017-08-31 11:25:20" | NO |

Get message status - Request

POST: /api/notification/v3/audit/searchauditstatus

Find out the message status for messages of a specified ID and a specified timerange

Parameters with JSON format:

| Parameter Name | Description | Example | Optional |
|----------------------|--|--|----------|
| messageCategoryRange | { "messageCategoryId" : 653, "startTimeRange" : "2018-03-27 00:00:00", "endTimeRange" : "2018-03-27 10:00:00" | How a real request JSON parameter could look like. | NO |
| startTimeRange | | | NO |
| endTimeRange | | | NO |

Get message status – positive Response

Get back the status of the single messages within the given time range

JSON format

```
{  
    "messageCategoryId": 91,  
    "startTime": "2018-03-27 07:57:54",  
    "endTime": "2018-03-27 07:57:55",  
    "status": "COMPLETED",  
    "fromUser": "Academy2TU",  
    "fromApp": "",  
    "recipients": []  
},  
{  
    "messageCategoryId": 91,  
    "startTime": "2018-03-27 08:03:55",  
    "endTime": "2018-03-27 08:03:55",  

```

How to send SMS messages?

You need:

- a communication category
- a template
- recipients with phone numbers

"html" template with Plain
Text

```
{ "msgCategoryId": 90,  
  "msgCategoryName": "trainingCategorySMS",  
  "from": "academy2.academy2@mindsphere.io",  
  "recipients": [ {  
      "recipientId": 34,  
      "position": "TO",  
      "recipientName": "Thilo Boehm",  
      "recipientDetails": [ {  
          "recipientId": 34,  
          "address": "+491732325250",  
          "recipientAddressTypeName": "Office Number",  
          "commChannelName": "SMS"  
        } ] } ],  
  "templates": [ {  
      "templateId": 49,  
      "commChannelName": "SMS",  
      "templatesetId": 19,  
      "templatesetName": "SMS Test"  
    } ],  
  "createdby": "academy2"  
}
```

Exercise

- Use the Postman Collection to investigate this API

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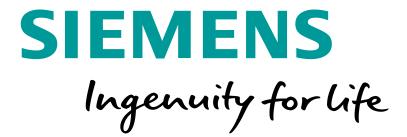


Notification Services

Summary

How can send notifications from my application?

Create a Communication Category and send the message. Optionally, you can create Recipients and Templates to use them within the Communication Category



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MindSphere Data Flow Engine

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Data Flow Engine

Learning Goals

How can we implement data workflows?

- Data Flow Engine API
- Workflow concept
- Workflow steps



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Endpoint methods **GET**, **PUT**, **DELETE**

Different endpoints: /api/dataflowengine/v3/

Tasks:

- GET dataflow
- PUT dataflow
- DELETE dataflow

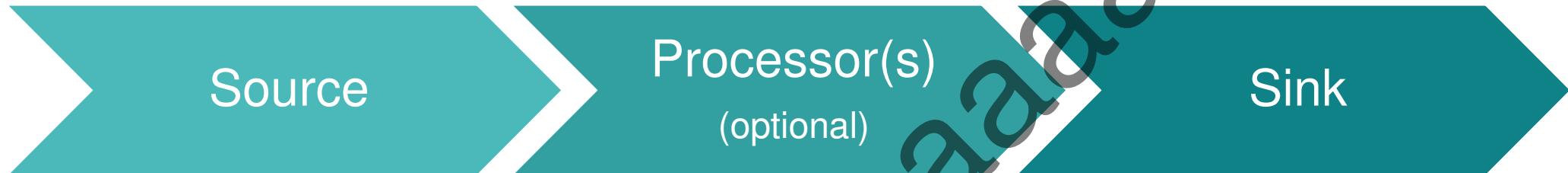
Get informed
Analyze incoming data
React on conditions

The engine implemented based on the Spring Cloud Dataflow architecture
Check: <https://docs.spring.io/spring-cloud-dataflow/docs/current/reference/htmlsingle/>

MindSphere API

Data Flow Engine Steps

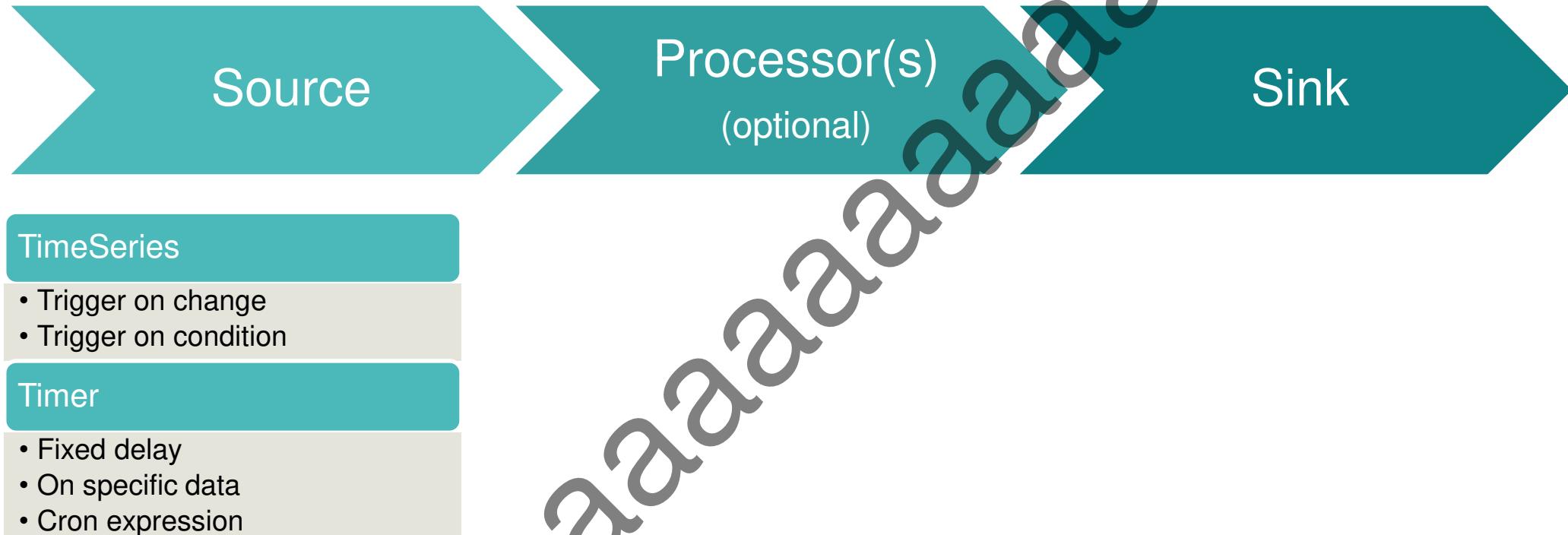
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MindSphere API

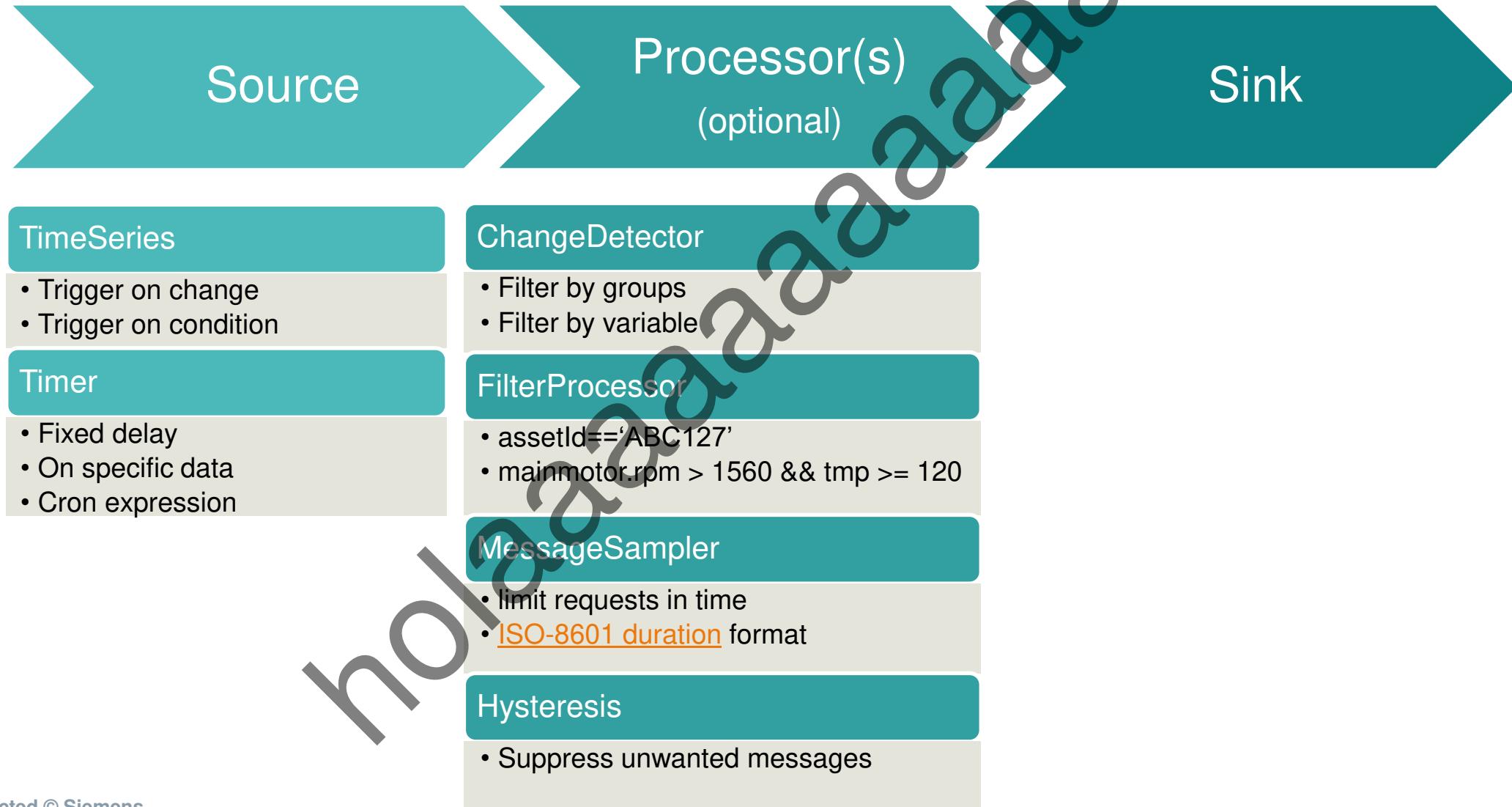
Data Flow Engine Steps

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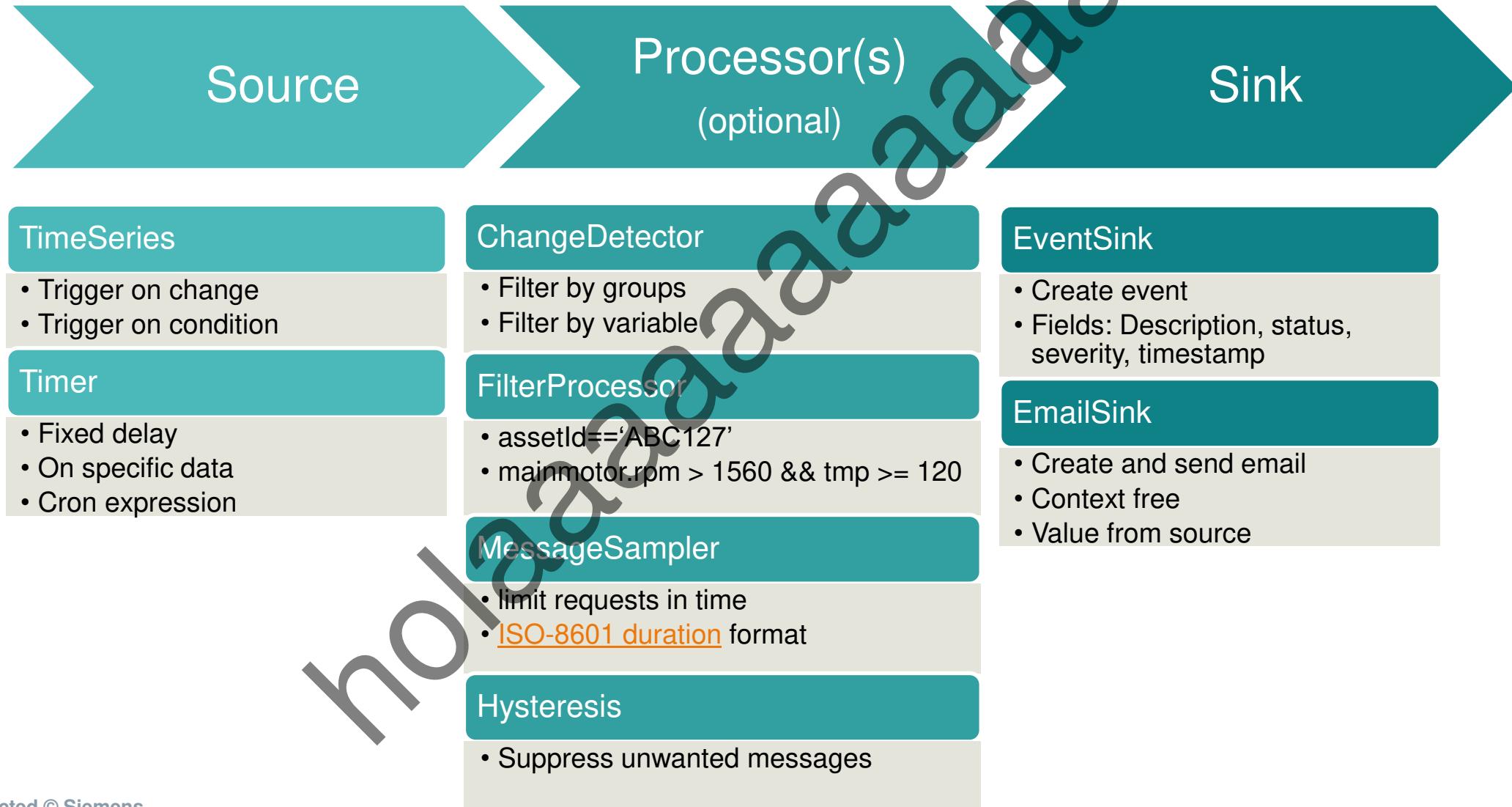
MindSphere API

Data Flow Engine Steps



MindSphere API

Data Flow Engine Steps



Stream definitions - Request

GET: /api/dataflowengine/v3/streams/definitions

Lists all streams (workflows) of the tenant.

No parameters required:

| Parameter Name | Description | Example | Optional |
|----------------|-------------|---------|----------|
| - | - | - | - |

Stream definitions

JSON format

```
{  
  "_embedded": {  
    "streamDefinitionResourceList": [  
      {  
        "name": "TBStream4",  
        "dslText": "TimerSource --fixed-delay=60 | EventSink --entity-id-path=\"'01c3636...828a860'\"",  
        "status": "deployed",  
        "statusDescription": "All apps have been successfully deployed",  
        "_links": {  
          "self": {  
            "href": "https://gateway.eul.mindsphere.io/api/dataflowengine/v3/streams/definitions/TBStream4"  
          }  
        }  
      }  
    ]  
  },  
  "_links": {},  
  "page": {}  
}
```

Create events

POST /api/dataflowengine/v3streams/definitions

Example request (body):

```
{  
  "name": "Stream1",  
  "definition":  
    "TimeSeriesSource --entities='[{"id": \"524c43829a934509b5389d3f352f9ac9\"}]' |  
    FilterProcessor --expression='newProperties.Temp > 30' |  
    EventSink --entity-id-path=\"524c43829a934509b5389d3f352f9ac9\""  
      --timestamp-path=_time",  
  "deploy": true  
}
```

Delete streams

DELETE: /api/dataflowengine/v3streams/definitions/{name}

Parameters:

| Parameter Name | Description | Example | Mandatory |
|----------------|-------------------------------|---------|-----------|
| name | The stream name to be deleted | Stream1 | YES |

Roles / Scopes

| Role | Description |
|--|--|
| <code>mdsp:core:dataflowengine.standarduser</code> | DataflowEngine standard user role with all read scopes |

<https://developer.mindsphere.io/>

Data Flow Engine - Apps

Sources

TimeSeriesSource 

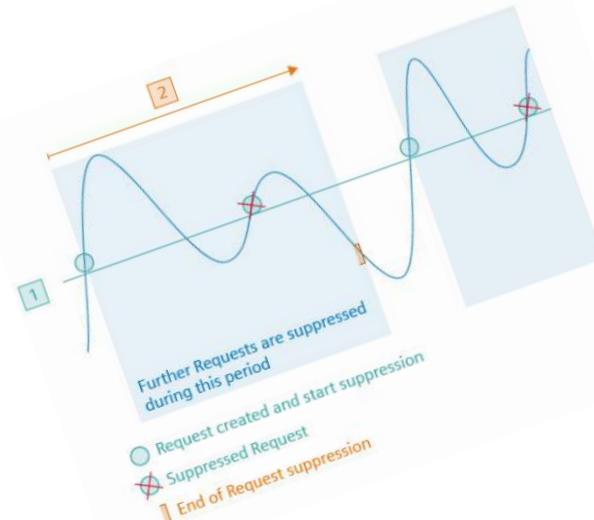
App name: TimeSeriesSource

App type: source

| Property | Type | Description | Example |
|----------|--------------|--|--|
| entities | String(JSON) | ID set of entity or entities to subscribe for. | <pre>--entities= [{"id":"f7012b9215b448228de f9726deffcf9"}]</pre> |

Note

Those messages are in exactly the same format as time series data arrives from IoT through TimeSeriesSource. The `entityId` refers to the ID of the asset and the `propertySetName` refers to the name of aspect. The aspect variables are collected in an array under `newProperties`.



Data Flow Engine

Summary

How can we run workflows in the background?

We build a data workflow that subscribes to a data source, processes the data and passes it to a sink.



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MindSphere Documentation

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Developer documentation at www.mindsphere.io/developer

The screenshot shows the developer documentation landing page. On the left, there is a sidebar with four categories: **Code examples**, **Tutorials**, **API description**, and **UI Elements**. The main content area features the Siemens logo and the title "MindSphere Developer Documentation". It includes a brief introduction about MindSphere's mission to connect the physical world with the digital world, followed by a "Table of contents" section and a diagram illustrating the MindSphere Application Platform architecture.

The screenshot shows the DataflowServer interface within the Developer Cockpit. The sidebar on the left lists **API references**, **Developer Cockpit**, **App example**, and **SDKs**. The main panel displays the DataflowServer configuration, showing a list of default endpoints and runtime applications. A specific application named "DataflowServer" is highlighted with a yellow background, showing its configuration details.

User documentation at www.mindsphere.io/documentation

The screenshot shows the MindSphere Documentation Area. It features a grid of six documentation sections: **Getting connected to MindSphere**, **How to use Asset Management**, **How to Use FleetManager**, **How to Operator Cockpit**, **How to use Developer Cockpit**, and **Connectivity**. Below this grid is a dark-themed sidebar titled "MindSphere Documentation Area" containing links to various product manuals and system guides.