European Commission

Versatile plug-and-play platform enabling remote predictive maintenance

Factories of the Future
Public Private Partnership

SERENA

Introduction to the Project

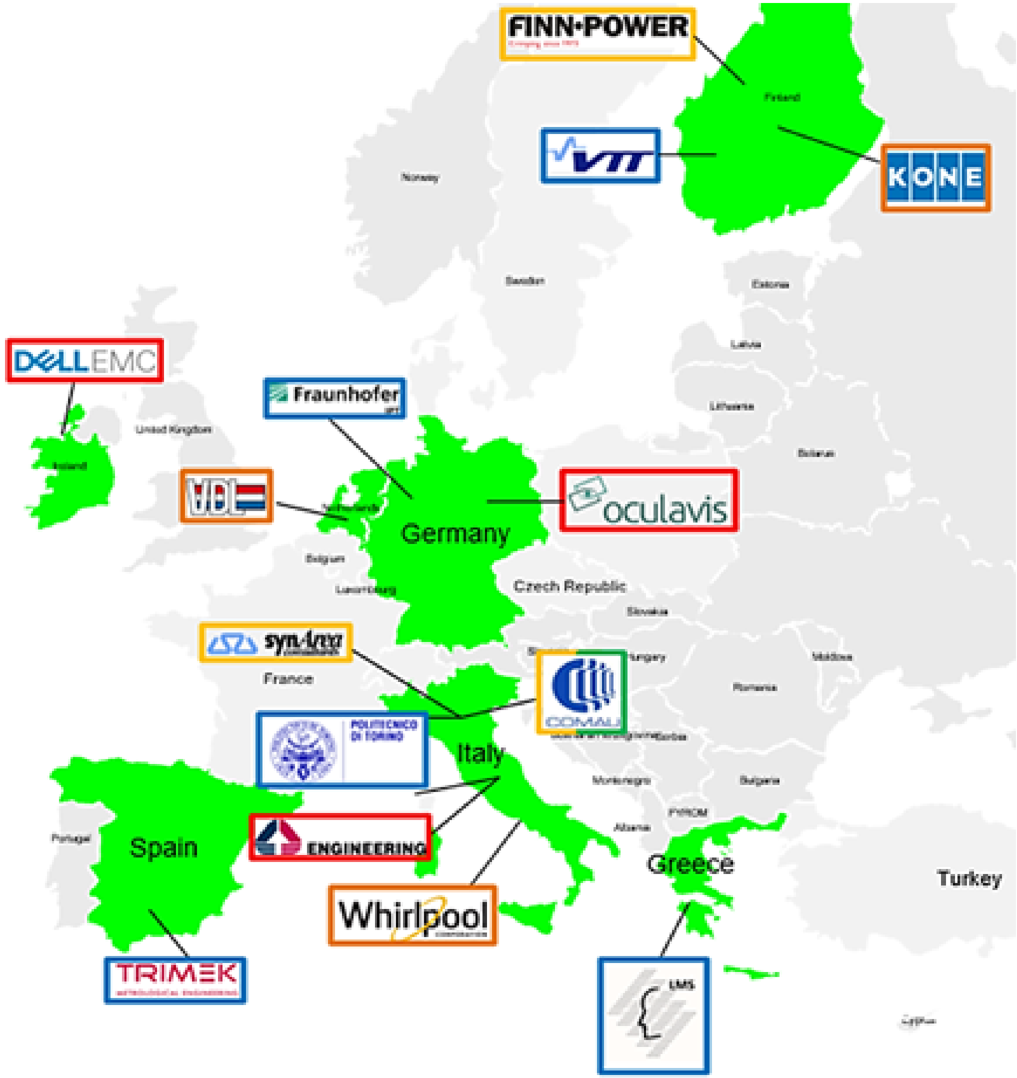
Presenter

Nikolaos Nikolakis

LMS
Laboratory for
Manufacturing Systems
& Automation

Introduction

- FoF-09-201
  - *SERENA*
- 36 months
  - *M26*
- 14 partners
- 7 EU member states



Problem

Reliability

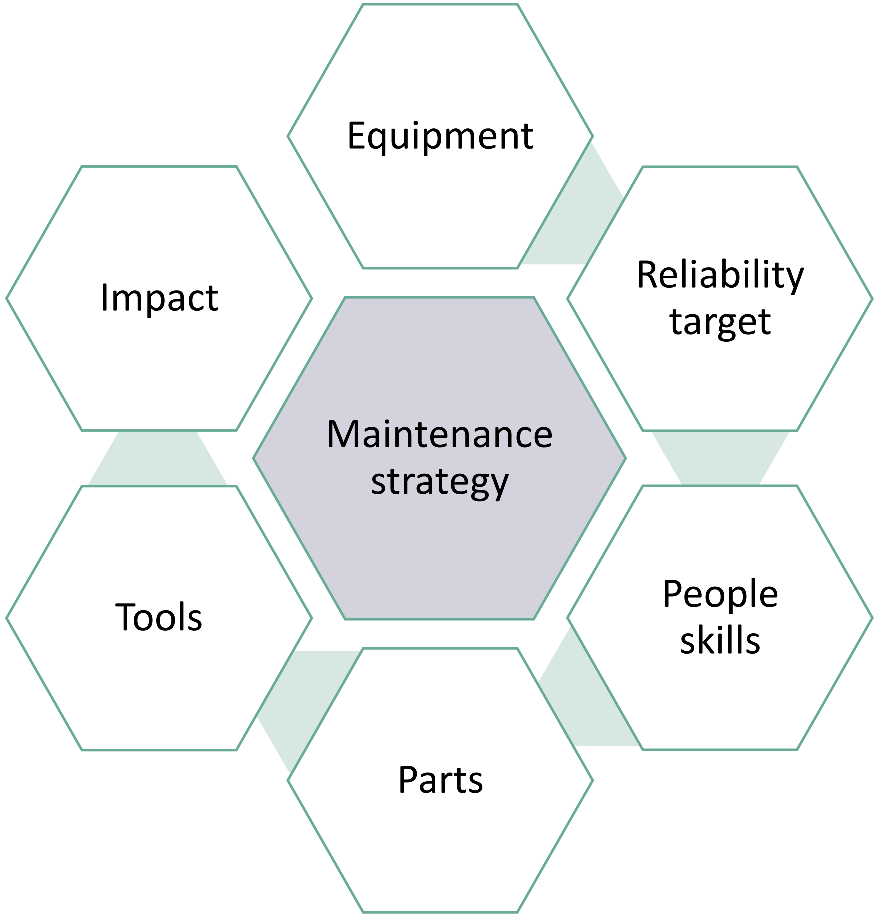
- growing complexity of manufacturing processes

Automation

- 85% of data and information are unstructured

Production dead time

- Physical maintenance causes **costly disruptions**
  - poor maintenance strategies can reduce a plant’s productive capacity by 5 to 20 percent [1]
  - unplanned downtime is costing an estimated $50 billion each year [2]

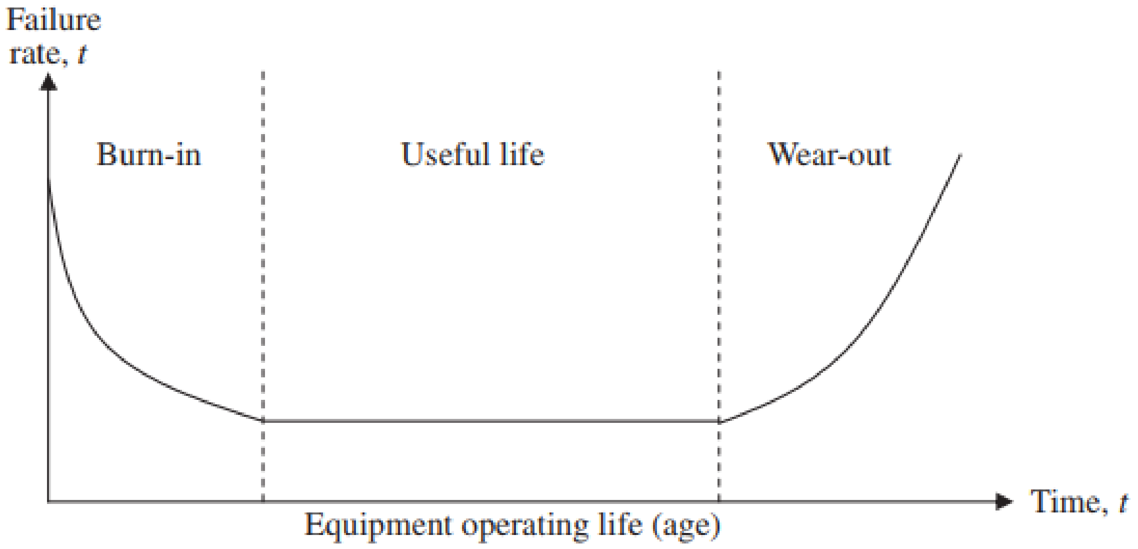


[1] http://www.ptc.com/product-lifecycle-report/iot-slashes-downtime-with-predictive-maintenance

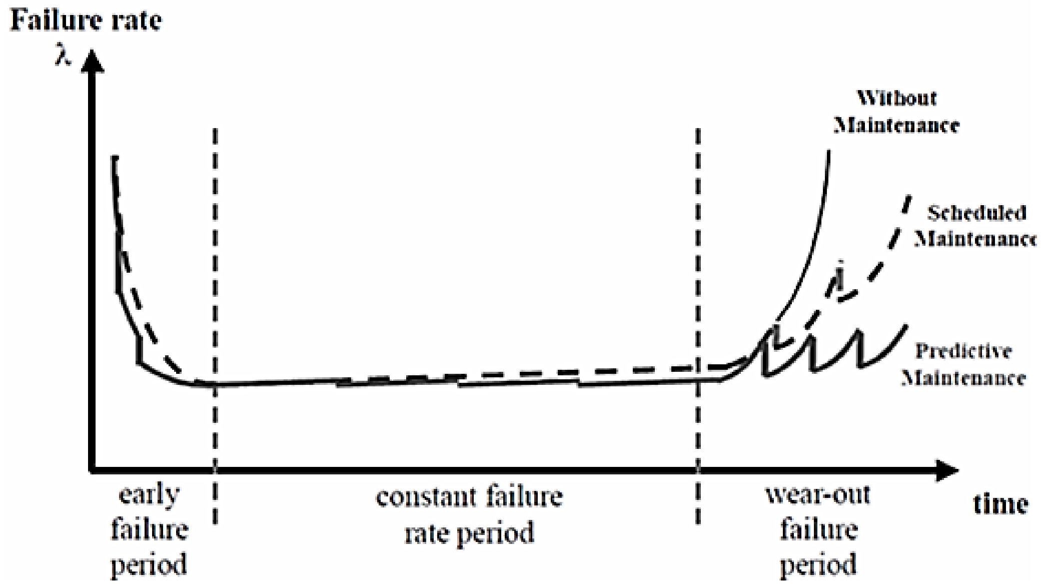
[2] http://partners.wsj.com/emerson/unlocking-performance/how-manufacturers-can-achieve-topquartile-performance/

Maintenance

- Time Based (Periodic Based/Preventive Maintenance):
  - Maintenance decisions based on failure (aging) time analysis
  - Failure time data statistically analyzed to identify failure characteristics



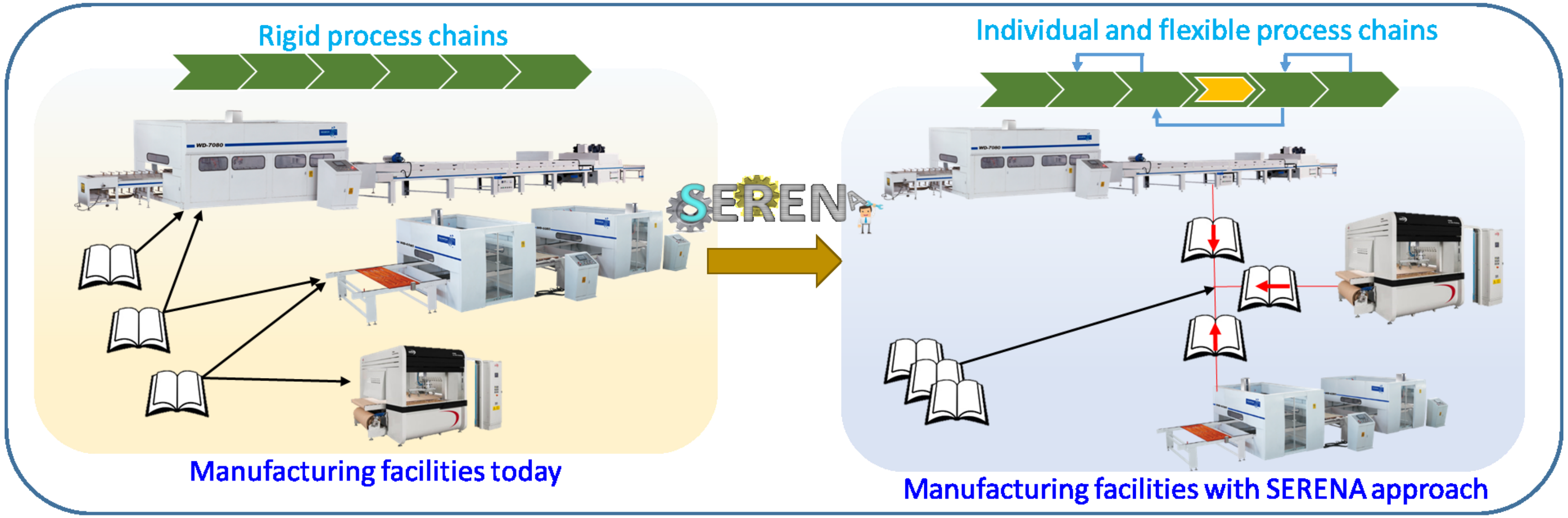
- Condition Based (Predictive Maintenance):
  - Maintenance decisions determined through condition monitoring process
  - Operating condition based on deterioration model



Motivation

SERENA aims to:

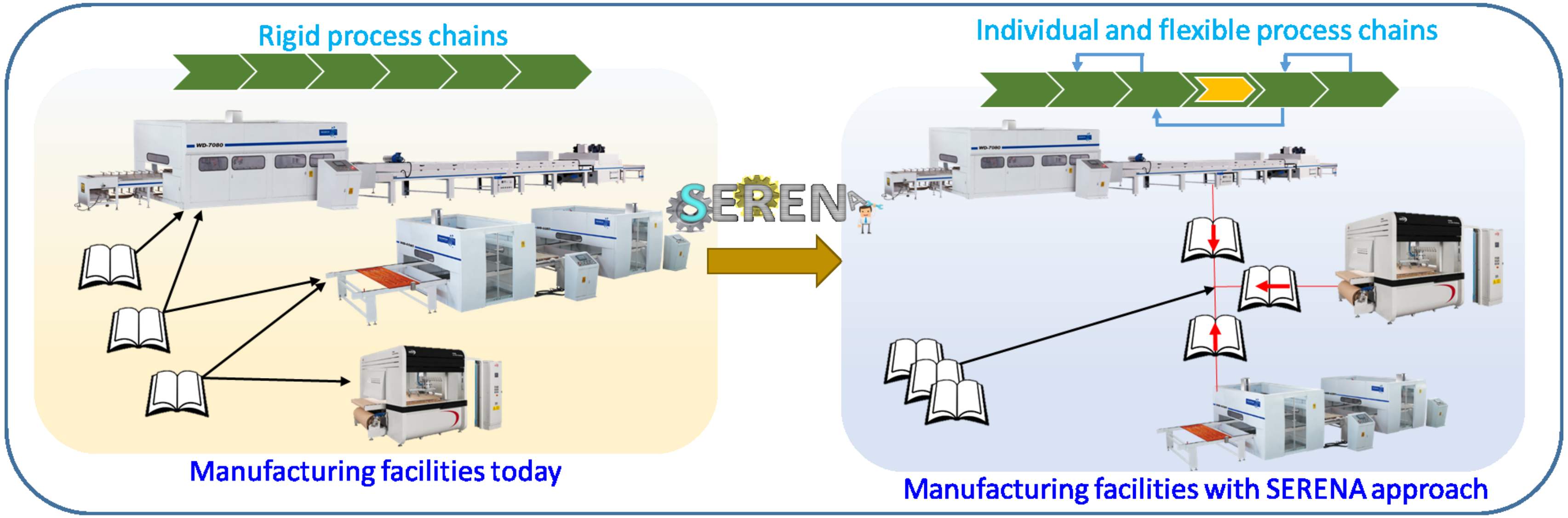
- Provide a **platform** to aid manufacturers in simplifying their maintenance burdens
- Transfer the latest R&D results in **predictive maintenance**
- Using AI methods for predictive maintenance
- Reduce costs, time and improving the productivity of their production processes


Rigid process chains
Individual and flexible process chains
SERENA
Manufacturing facilities today
Manufacturing facilities with SERENA approach

Motivation

Objectives:

- Gather and process **data** from **different sources** and sensors
- Separate ‘**smart data**’ from ‘big data’
- Apply a **two-tier** approach for predictive **analytics**
- Provide human operator support using **AR** devices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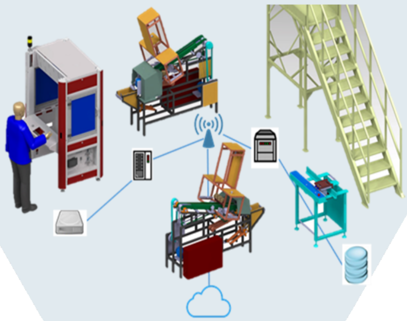
Applications

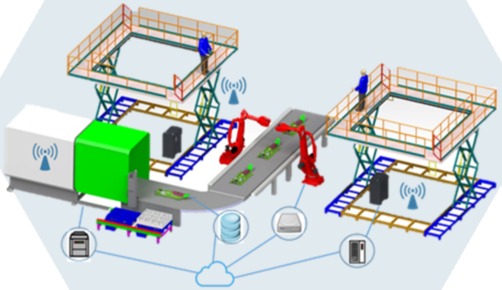
Metrological Engineering



Key characteristics
- Unexpected failures
- Need of experts for maintenance within other industries

Needs
- Easy maintenance
- Measurement quality
- Cost of maintenance

Steel Parts



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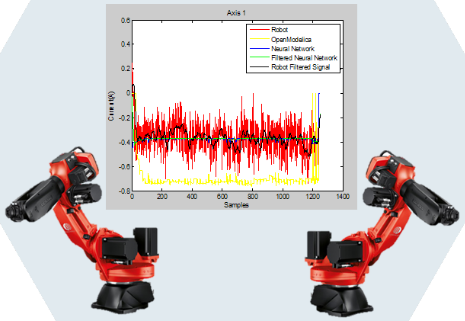
Robotics



Key characteristics
- Unexpected failures
- Production breakdowns
- Expert maintenance personnel

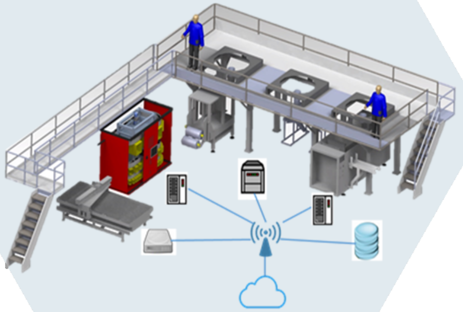
Needs
- Equipment monitoring
- Robot operating conditions
- Data security/privacy

White Goods

Key characteristics
- Unexpected failures
- Production breakdowns
- Expert maintenance personnel

Needs
- Equipment monitoring
- Robot operating conditions
- Data security/privacy

Elevators Production



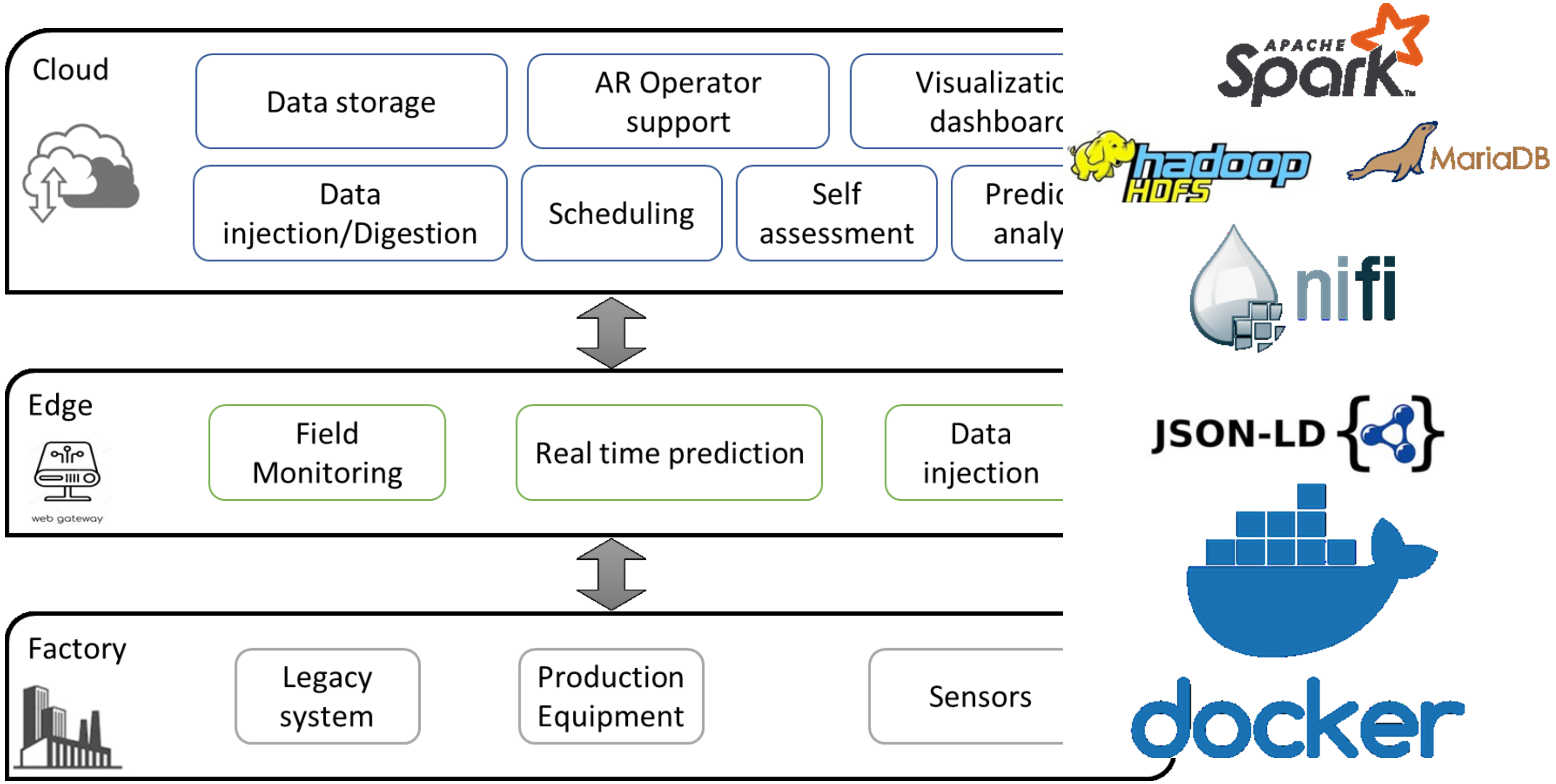
Key characteristics
- Unexpected failures
- Production breakdowns
- Need of machine provider experts

Needs
- Decrease cost
- Increased throughput
- Product quality & safety

Generic Architecture

Functionalities:

- Communication broker
- Edge Gateway
- Orchestration and Registry
- Data Store
- Predictive analytics service
- Visualization
- Scheduling



SERENA Architect and Data Model

Presenter

David Bowden

DELL EMC

Infrastructure Requirements

- Lightweight micro-services architecture
  - Learn from: OpenIoT, Fiware, Arrowhead
  - Connectivity mainly HTTP REST – but also MQTT
- One common data model to tie everything together
  - MIMOSA, SSN, ….
- Deploy anywhere
  - Bare metal servers, VMs, Private Cloud, Public Cloud
- Plug-n-play
  - Application agnostic
  - Plug out one technology – plug in another one

- Architecture extends from the cloud to the IoT gateways on factory floor
- Distributed and flexible deployment
- Simple to operate
- Secure, scalable, robust
- Provide high-level data context – smart data
- And… and… and…

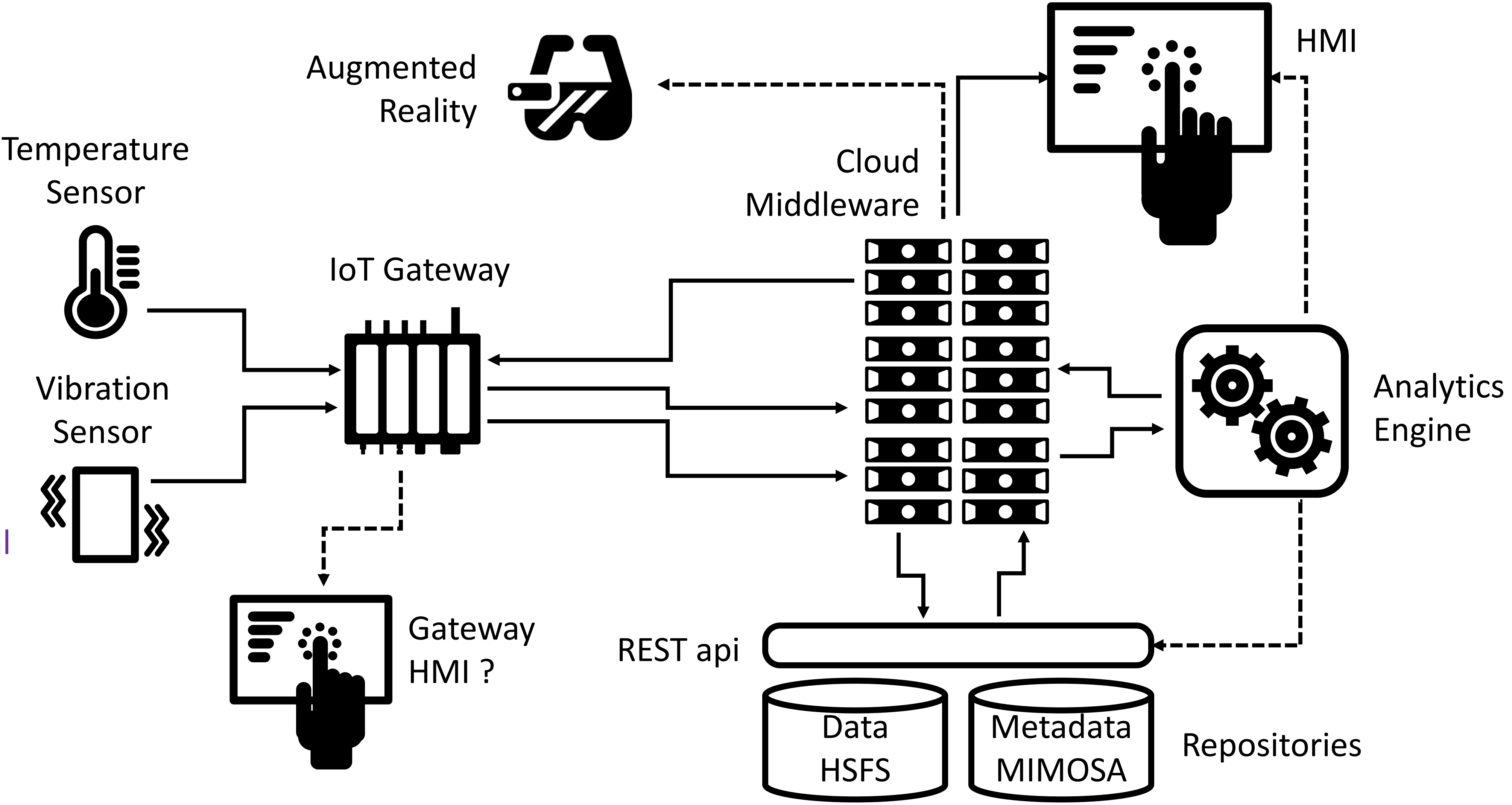
Docker Swarm

MIMOSA

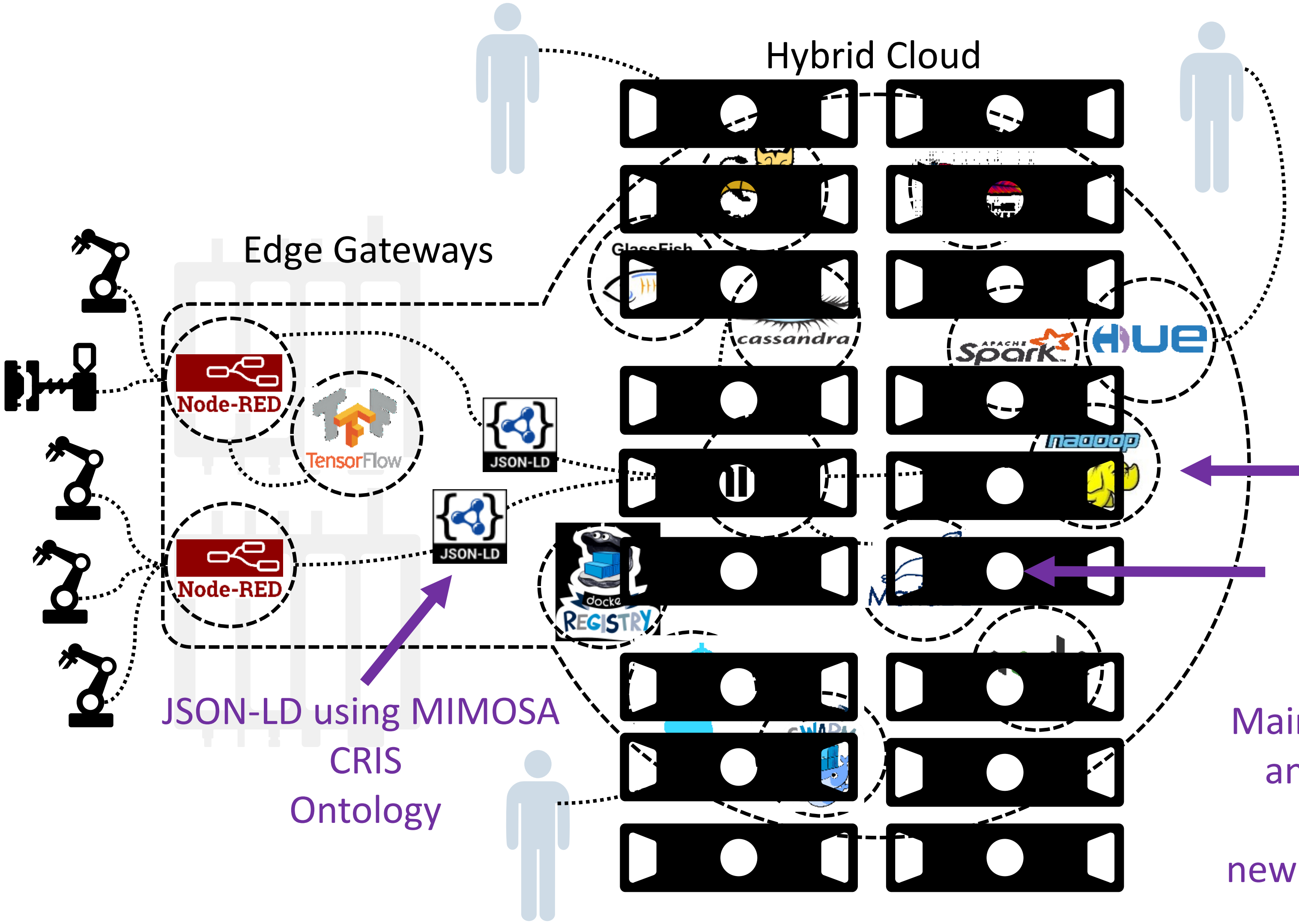
JSON-LD ⟷ (RDF)

High-Level SERENA Data Flow Architecture

- Kone
  - Punching Tools
- Comau
  - Robots
- Whirlpool
  - Injection moulding
- Trimek
  - Metrological equipment
- VDL
  - Steel part rolling mill



Architecture

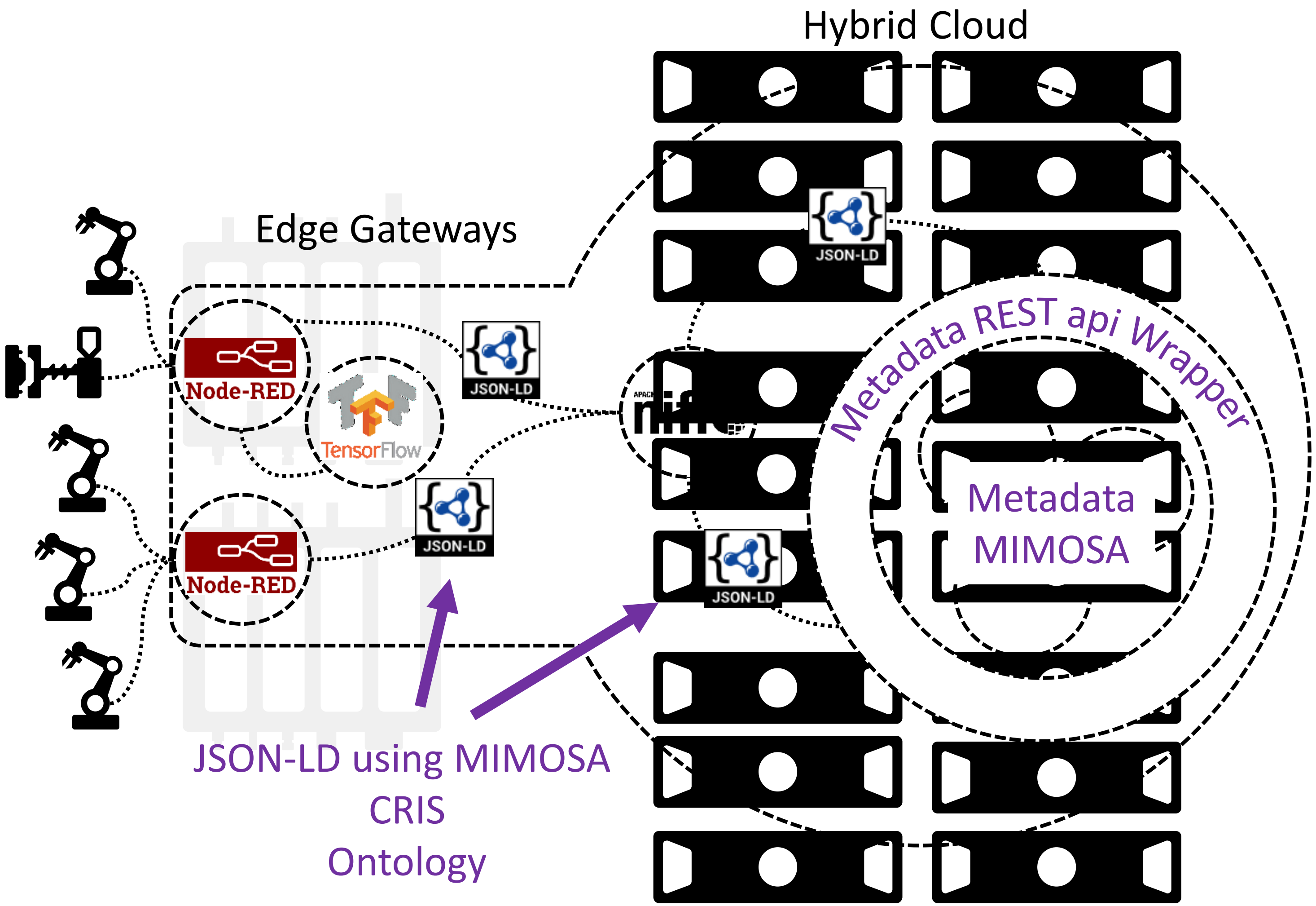


Data on HDSF in JSON format

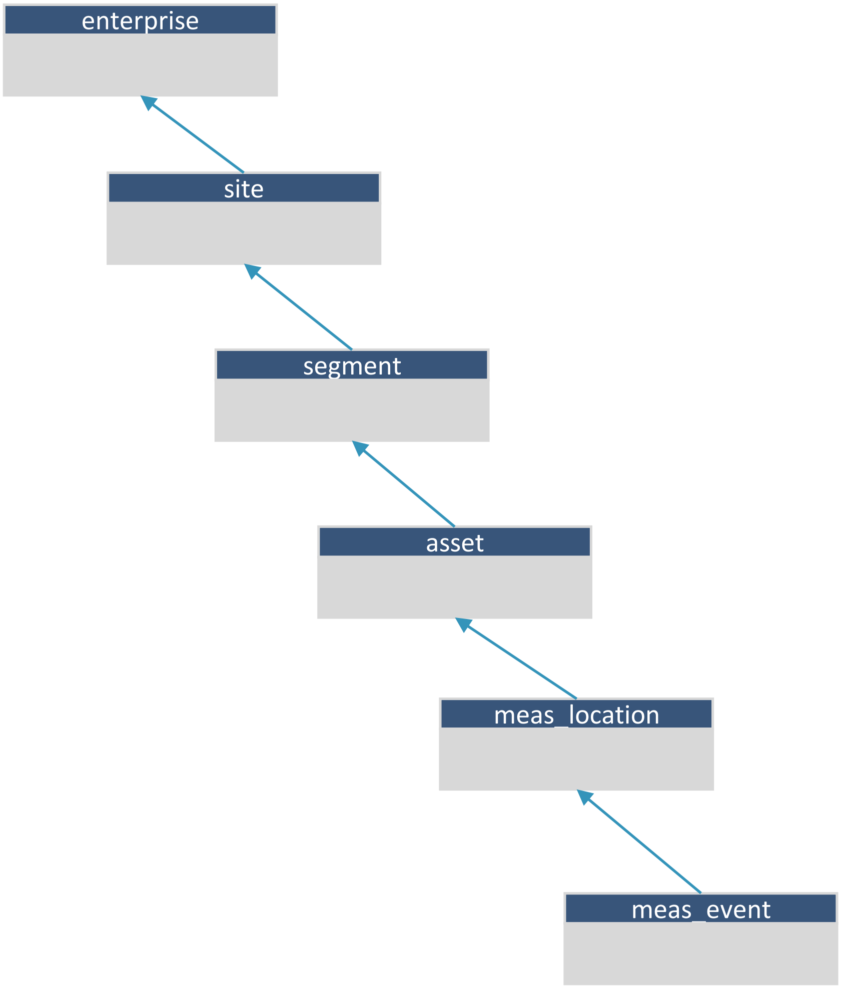
Metadata in MIMOSA
CRIS
Version 3-2-3
Main Segment Asset Hierarchy
and associated type tables
+
new type constants to support
SERENA

JSON-LD using MIMOSA
CRIS
Ontology

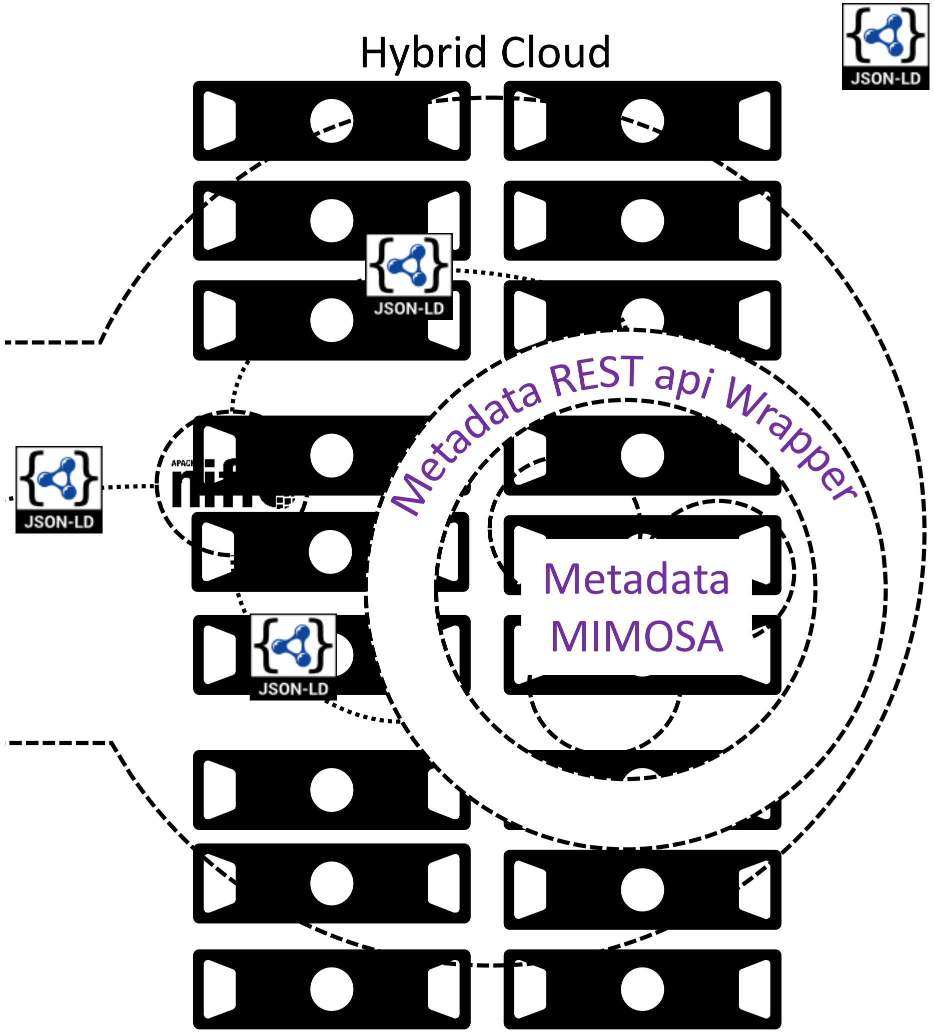
MIMOSA Metadata Service



JSON-LD using MIMOSA CRIS Ontology



Metadata REST api Wrapper



```
{
  "@context":"http://serena:9000/context/base.jsonld",
  "@id":"serena:asset/0000019000000191/487",
  "@type":"Asset",
  "asset_org_site":"0000019000000191",
  "asset_id":"487",
  "asset_type":{"@id":"serena:asset_type/0000000000000000/6/6","name":"Segment, Top"},
  "user_tag_ident":"24a",
  "name":"Segment, Top, 24a",
  "long_description":"This is the top segment or die of a rolling mill",
  "serial_number":"3355DL-688666554",
  "segment":{"@id":"serena:segment/0000019000000191/423","name":"Rolling Mill"},
  "segment_site":"0000019000000191",
  "segment_id":"423",
  "as_hyp_events":[
    {"@id":"serena:as_hyp_event/0000000000000000/6/266","name":"Segment, Unbalanced"}
  ],
  "meas_locations":[
    {"@id":"serena:meas_location/0000019000000191/429","name":"Diameter"},
    {"@id":"serena:meas_location/0000019000000191/414","name":"Temperature, Surface"},
    {"@id":"serena:meas_location/0000019000000191/415","name":"Angle, Shaft"},
    {"@id":"serena:meas_location/0000019000000191/416","name":"Speed, Shaft"}
  ]
}
```

JSON-LD Context

- At the top of every JSON-LD message is a @context statement
  - But what is it?
  - And what does it do?
- The @context is a resolvable reference to a JSON-LD master JSON-LD document
  - It defines the meaning of the of the other JSON-LD terms in the message
  - For example – “serena:” is a prefix alias:
    - “https://serena:9000/serena/1.0"
  - Can be fully expanded to:
    - “https://serena:9000/serena/1.0/segment_type/0000000000000000/6/2"
  - This is important when converting to other semantic formats
    - Such as RDF (Resource Description Framework)

```
{
   "@context":"http://serena:9000/context/base.jsonld",
   "@id":"serena:segment/0000019000000191/401",
   "@type":"Segment",
   "segment_site":"0000019000000191",
   "segment_id":"401",
   "segment_type":
   {
      "@id":"serena:segment_type/0000000000000000/6/2",
      "name":"Rolling Mill“
   },…
```

JSON-LD IDs

- SERENA IDs come from the MIMOSA database
  - The MIMOSA database is used as the underlying metadata repository
  - In effect it is the controlling agency
  - We could have generated the IDs some other way
    - But then we would have had to map those IDs to the MIMOSA IDs – so using MIMOSA IDs is simpler

"@id": “https://serena:9000/serena/1.0/asset/0000019000000191/425"

- By breaking the ID down we can see where the parts come from
  - The first part is the protocol and IP address of the metadata server
    - As it is known to the other services in the SERENA system
  - The middle part just identifies this ID as the SERENA system
    - And provides a version number
    - IDs are immutable – if the version number changes – existing IDs **do not** change
    - This part is optional – but helps with future changes
  - The last part is constructed from the MIMOSA database primary keys
    - “00000190” is an ID allocated by mimosa.org
    - But as SERENA is a PoC it has not been registered with mimosa.org
    - For a production implementation it should be registered!

Although we can show where the
parts of the ID came from
It is an ***atomic token***
e.g. a single irreducible unit

Acknowledgements

https://www.serena-project.eu/contact/

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