A Standard Model for Machine to Supervisory Systems Data Exchange

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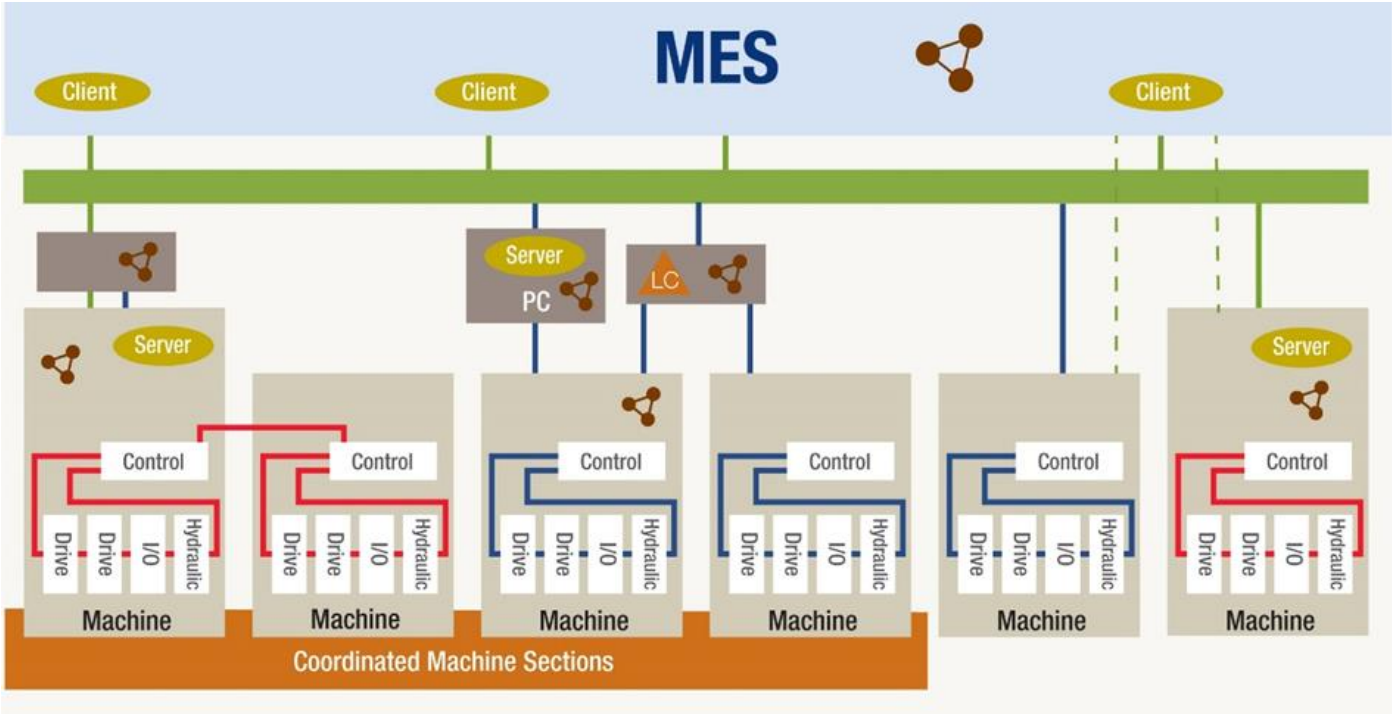
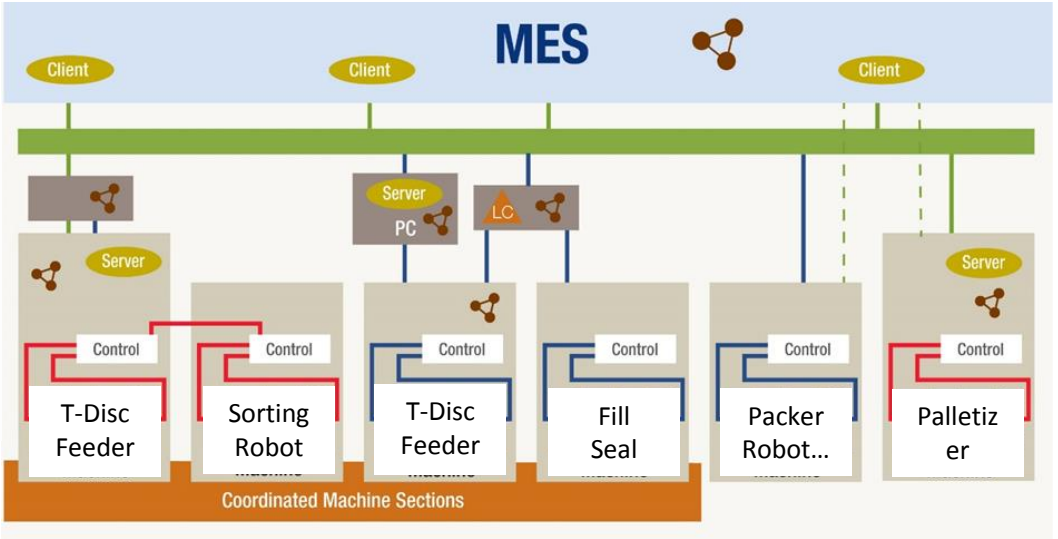
Machine to Supervisory Communication



Line Integration Real Life

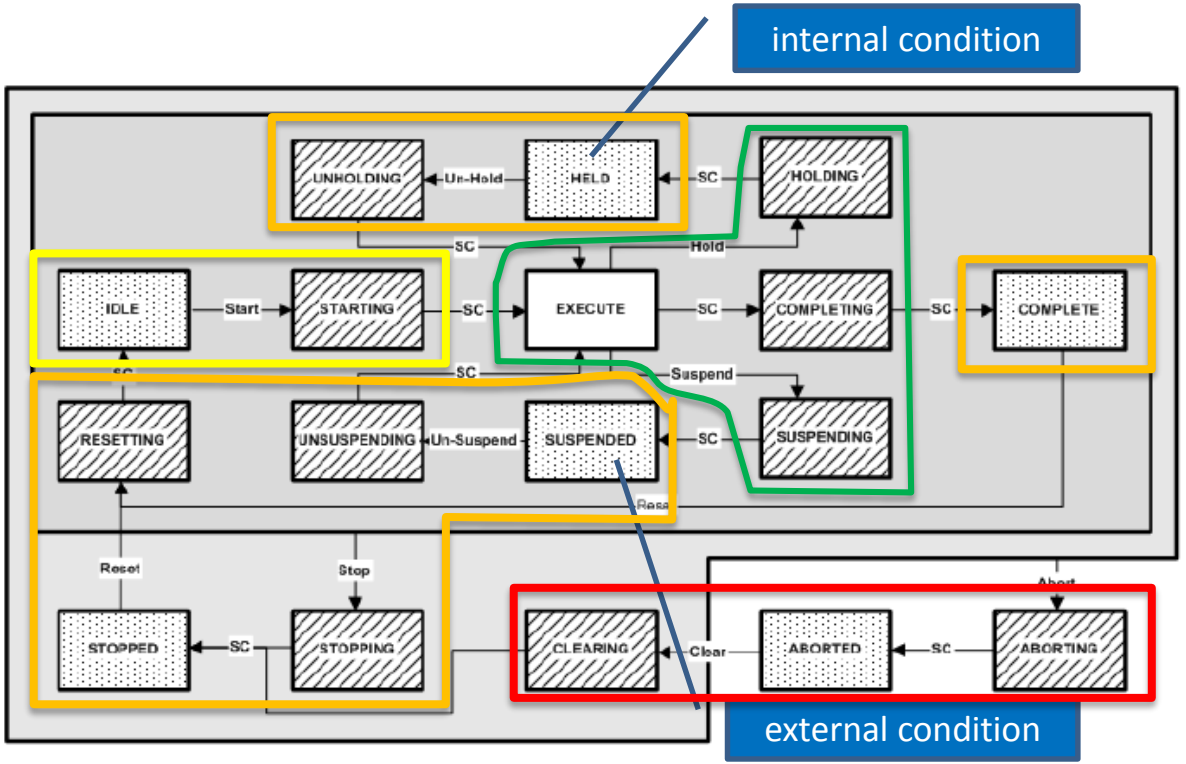
- ***Importance of a standardization of machine states***



Base Machine Object – State Model

- State of the machine is important to operator and supervisory systems
- Shown at operator panel, traffic light on top of machine
- Difference state versus status
  - Status just indicates the state of a machine without any transient states
  - State is shown in a model with events leading via transient states to a changed state
  - State changes can be triggered by commands
- Machine State models are specific to the industry branch
- A simple Machine Status can be generalized for a common view by all systems

PackML machine state diagram



SC = State Complete

IDLE = Wait State

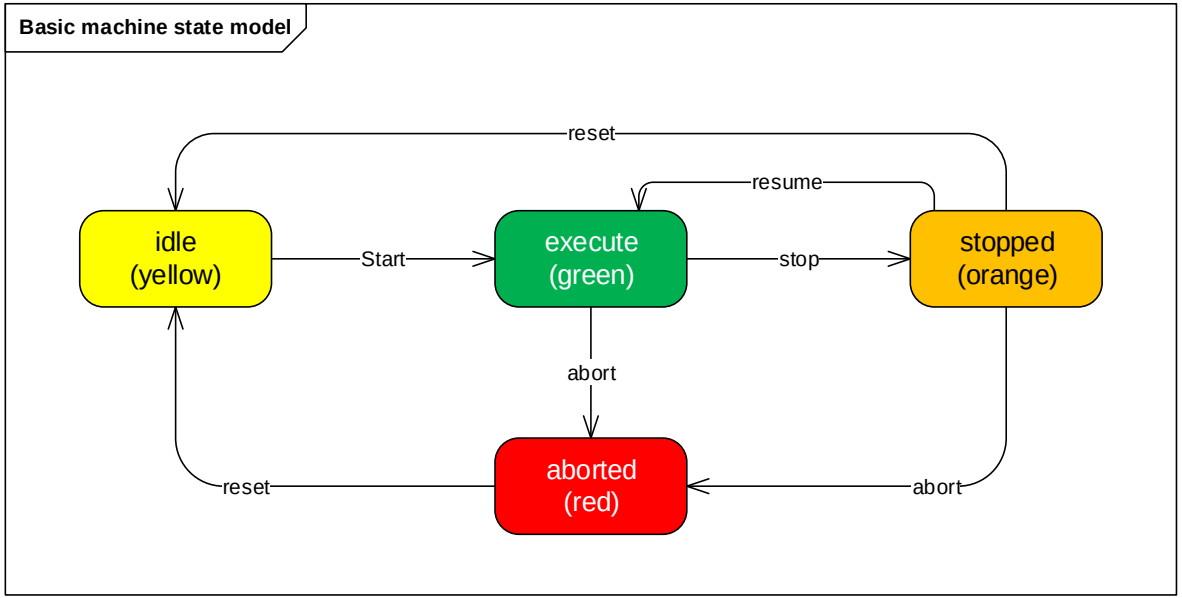
RESETTING ..ing = Acting State

EXECUTE = Dual State

Machine state comparision matrix

ANSI/ISA 88	PackML	Weihenstephan	GEM	MTConnect	Base Machine Status
	Machine States				Machine Status
execute	execute (6)	operating (128)	executing	active	green (execute)
pausing					green (execute)
paused					orange (stopped)
idle	idle (4)	idle (32768)	idling	idle	yellow (idle)
stopped	stopped (2)	stopped (1)		stopped	orange (stopped)
starting	starting (3)	starting (2)	initializing		yellow (idle)
suspending	suspending (13)	-			green (execute)
suspended	suspended (5)	prepared (4) lack (8) tailback (16) lack in branch line (32) tailback in branch line (64)	pausing	interrupted	orange (stopped)
un-suspending	un-suspending (14)	-			orange (stopped)
stopping	stopping (7)	stopping			orange (stopped)
aborting	aborting (8)	aborting			red (aborted)
aborted	aborted (9)	equipment failure (1024) external failure (2048) emergency stop (4096)		emergency	red (aborted)
holding	holding (10)	holding (8192)			green (execute)
held	held (11)	held (16384)		feed hold	orange (stopped)
un-holding	un-holding (12)	-			orange (stopped)
completing	completing (16)	-			green (execute)
complete	complete (17)	-			orange (stopped)
resetting	resetting (15)	-			orange (stopped)
clearing	clearing (1)	-			red (aborted)
			setting up		

ODVA Common Machine State Diagram



Simplified model for status

Targeted Machine Types

Machine Classes classified by NAICS

Machinery classes	NAICS Code
Food Product Machinery Manufacturing	333294
Packaging Machinery Manufacturing	333993
Plastics and Rubber Industry Machinery Manufacturing	333220
Machine Tool (Metal Cutting Types) Manufacturing	333512
Oil and Gas Field Machinery and Equipment Manufacturing	333132
Engine, Turbine, and Power Transmission Equipment Manufacturing	33361
Conveyor and Conveying Equipment Manufacturing	333922
Paper Industry Machinery Manufacturing	333291
Semiconductor Machinery Manufacturing	333295
Mining Machinery and Equipment Manufacturing	333131
Printing Machinery and Equipment Manufacturing	333293
Mounting and Handling Machines	not classified

Applications for Data Use

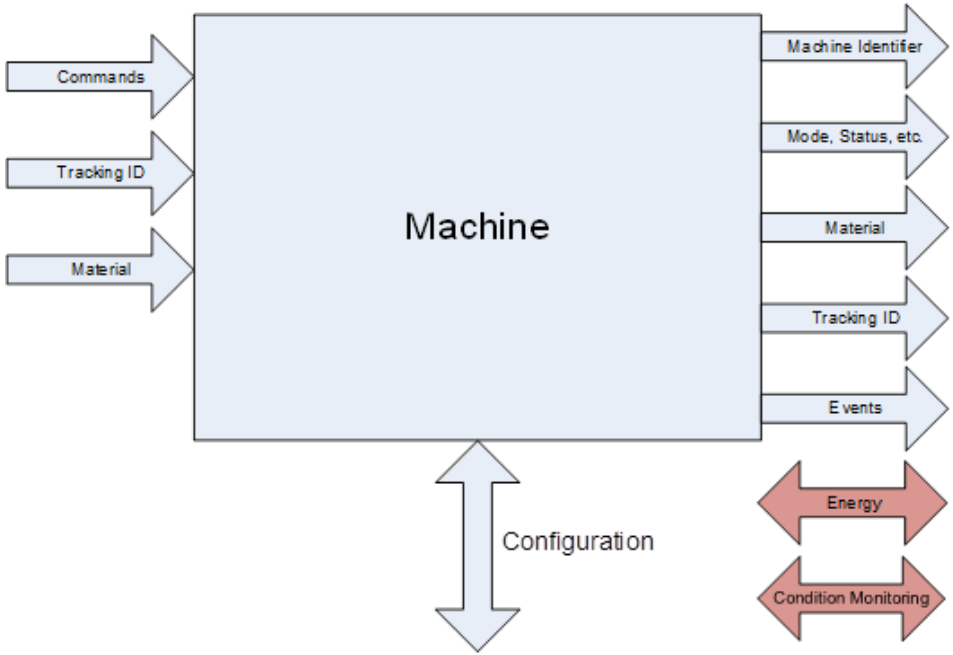
- *Administration*
- *Alarms & Events*
- *ANDON*
- *Batch/recipe management*
- *Condition Monitoring*
- *Data Exchange*
- *Energy Management*
- *Laboratory Management*
- *Machine Data Access (MDA)*
- *Maintenance Management*
- *Material Management*
- *Order Management*
- *Performance Management*
- *Process Data Access (PDA)*
- *Quality management*
- *Time-series data (historian)*
- *Tool Management*
- *Traceability & genealogy*
- *Version Management*
- *…and many more*

Base Machine Data Structure

Machine Data Flow

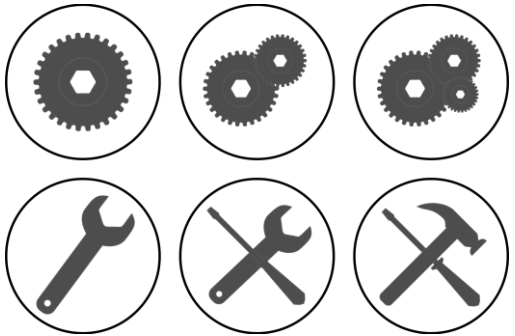
Base Machine Data Structure

- Machinery Configuration
- Input Data
  - Commands
  - Tracking ID
  - Material
- Output Data
  - Machine Identifier
  - Mode, Status
  - Material
  - Tracking ID
  - Events



Machinery **Configuration** Data

- *AssetID*
- *EquipmentType*
- *MachineVendorId*
- *EndUserDescription*
- *VendorName*
- *VendorModel*
- *VendorMachineSerialNumber*
- *VendorContact*
- *VendorInstallDate*
- *VendorDescription*
- *Utilities*



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- *AssetID*
- *EquipmentType*
- *MachineVendorId*
- ***EndUserDescription***
- *VendorName*
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- *VendorContact*
- *VendorInstallDate*
- *VendorDescription*
- *Utilities*

EUDescript[xx]

- Country
- State/Province
- City
- Facility
- Level
- Cell/Quadrant/Zone
- Machine ID
- User Defined
- User Defined
- User Defined

Machinery **Configuration** Data

- *AssetID*
- *EquipmentType*
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- *EndUserDescription*
- *VendorName*
- *VendorModel*
- *VendorMachineSerialNumber*
- ***VendorContact*** →
- *VendorInstallDate*
- *VendorDescription*
- *Utilities*

VendContact[xx]

- Street number
- Street Name
- City
- State/Province
- Country
- ZIP/Postal Code
- Contact Name
- Phone number
- Phone extension
- Email address

Machinery **Configuration** Data

- *AssetID*
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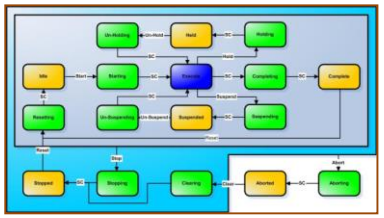
- *EndUserDescription*
- *VendorName*
- *VendorModel*
- *VendorMachineSerialNumber*
- *VendorContact*
- *VendorInstallDate*
- *VendorDescription*
- ***Utilities***

Utilities[xx]

- *ID*
- *Name*
- *Value*
- *Units*
- *ScalerValue*
- *ScalerUnits*

Machinery **Input** Data

- *State*
- *CommandRate*
- *CommandRateUnit*
- *TrackingID*
- *ResetCounts*
- *Material*



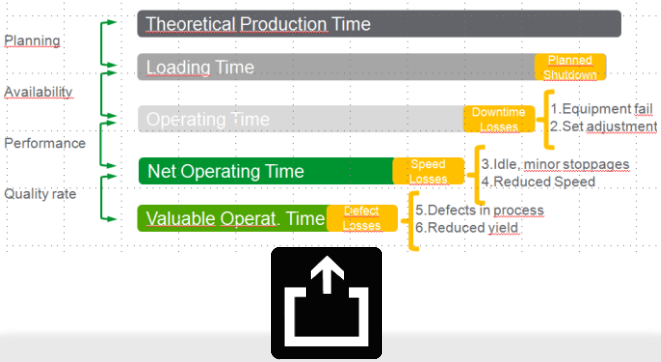
Machinery **Input** Data

- *State*
- *CommandRate*
- *CommandRateUnit*
- *TrackingID*
- *ResetCounts*
- ***Material***

Material_In[xx]
- ID
- Name
- TrackingID
- Scaler

Machinery **Output** Data

- *RemoteEnabled*
- *Mode*
- *State*
- *Status*
- *TrackingID*
- *Consumed*
- *InProcess*
- *Produced*
- *Waste*
- *EventActive*
- *EventDescription*
- *EventID*
- *ResetCountsDone*



Machinery **Output** Data

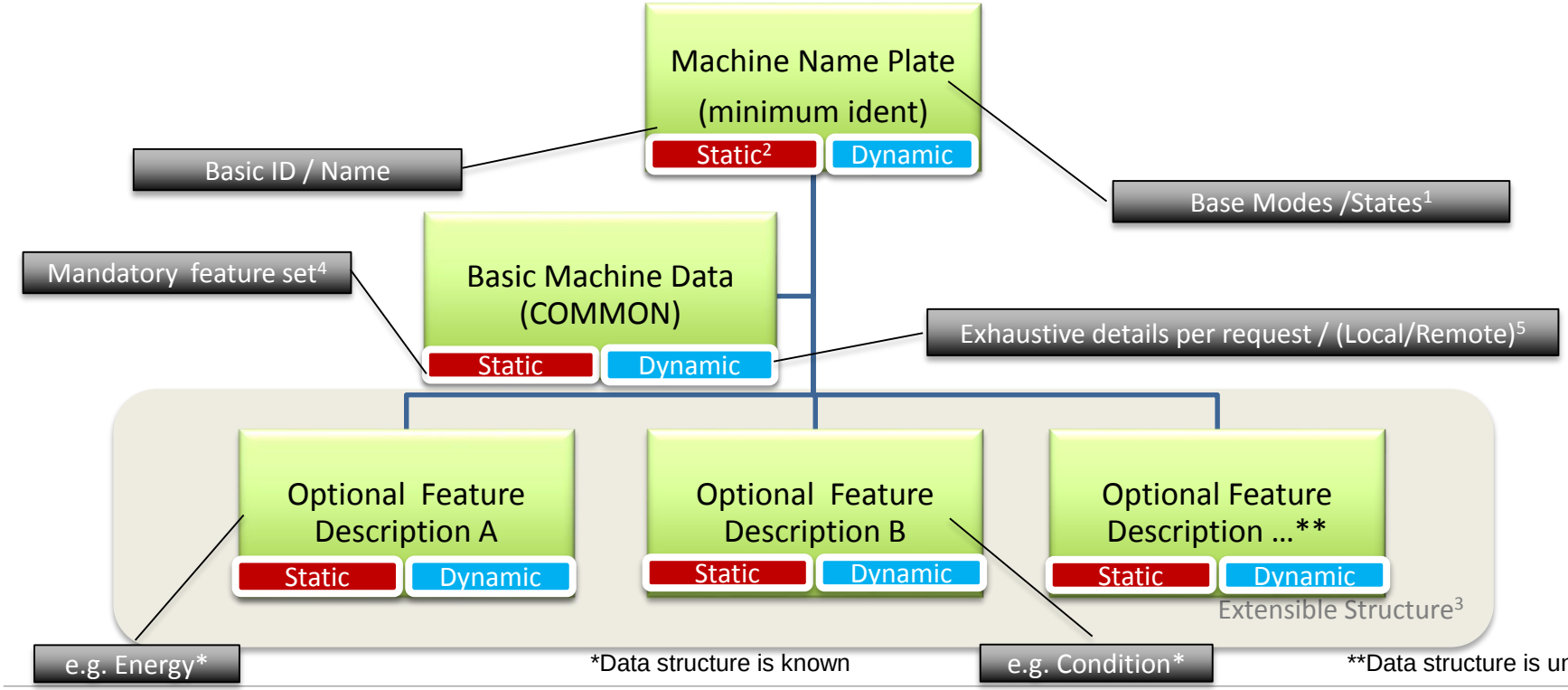
- *RemoteEnabled*
- *Mode*
- *State*
- *Status*
- *TrackingID*
- ***Consumed***
- ***InProcess***
- ***Produced***
- ***Waste***
- *EventActive*
- *EventDescription*
- *EventID*
- *ResetCountsDone*

Material_Out[xx]

- ID
- Name
- TrackingID
- Available
- IdealRate
- RawTotal
- Scaler
- Total

Extended Machine Data Structure

General Machine Information STRUCTURE



Benefits

Basic ID / Name: UUID

Each object (structure) needs a unique identifier.

In case of a machine the Universally Unique Identifier (UUID) would be the combination of the

- *OEM Machine Serial Number and the*
- *End User Asset Number*

```
SN + AssetNumber -> UUID
```

General MI Strucutre

Benefits

Definition Static and Dynamic Data

Static Data

Static data does not change over time and therefore can be stored outside the device. The minimum data set would be the identification data set that enables any client to uniquely identify the device. All other information could be stored outside and represented by a link.

Dynamic Data

Dynamic data are subject to changing over time. This makes it likely that this data will be stored in the device. The minimum set of dynamic data needs to be stored locally. Additional data can be store remotely. The mandatory set of dynamic data (Common) should be stored locally.

General MI Strucutre

Benefits

Extensible Structures

Extensible structures are structures that can be extended from a predefined data set and offer a very flexible way to fulfill varying and future requirements.

Some reasons to introduce these are:

- Enable low cost devices to offer full information support.
  This works by reducing the info to be kept in the device to the mandatory data set.

- Other data may be stored outside the device and referenced by a link.

- Common data does not need to be stored in the device and inconsistent copies cannot occur.

General MI Strucutre

Benefits

Mandatory / Optional Features

Manadatory Features are …

- are listed in the mandatory set of machine information.
- Only supported features are listed.
- Predefined features can reference a public available description. (PackML)
- Worldwide available on a public server (e.g. B2MML or Javascript styles).

Optional Features are …

- …described by a unique tag name
- …in XML file either local or pointed to by URL
- …static or dynamic
- …local or remote

General MI Strucutre

Benefits

Local / Remote: Linked Information

Linked Information
would reside on a server in an XML data file
(e.g. //Server/dir/machine/uuid/ODVA.desc.xml). relative path names and permalinks are permitted.

URI to server

- //Server/DIR/Machine/UUID/ODVADESC.xml

This file contains all the non local informations

- Concept of Local / Remote
- see car registration in Europe

OVADESC.xml contains list of known features

- As Tag e.g. ODVA_energy: <supported>
  d.h. supports odva energy management
- General: just list things which are supported

General MI Strucutre

Benefits

XML Description

XML files

- *contain syntax and semantics, but also pure text readable by humans, not by machines*

OVADESC.xml

- *contains list of extended known / unknown features*

```
<EXT feature: A>  „Name"
< URI struct>
„Description"
        .
        .
   < /URI struct>
   <DATA  >       „Data"
        . „Dynamic or static"
        . „Local or remote"
    </ DATA>
```

General MI Strucutre

Benefits

Benefits of a Standard Method for Machinery-to-Supervisory Information Exchange

- For machine builders, optimization of machinery integration (OMI™) will create additional value through simplified communication from machines to supervisory systems such as SCADA and MES.
- By transforming data into information, OMI will:
  - Provide tools for dynamic decision-making to maximize machine productivity and improve machine performance
  - Enhance maintainability of machinery assets
  - Create more value from machines

OMI will Emerge as a natural sweet spot to help manufacturers meet their overall business objectives, including workforce, profitability and sustainability goals.

General MI Strucutre


ODVA
2015
INDUSTRY CONFERENCE
AND 17TH ANNUAL MEETING
ODVA'S 20TH ANNIVERSARY 1995–2015

Thank you!