

Generating Structured AutomationML Models ...

... based on IEC 62264 Information

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Introduction

We will present ...

- our approach for the **modeling of IEC 62264** information
- our approach for defining **formal transformation rules** between IEC 62264 and AutomationML models
- our **workflow** for applying these transformations
- our take on the basic **structure of an AutomationML document**, derived from IEC 62264 vocabulary

IEC 62264 aka ISA-95

ISA-95 » ISO/IEC 62264

Initially an ANSI/ISA series of standards



Setting the Standard for Automation™

Later adopted by ISO/IEC

- Initial version 2003
- Current version from 2013+



IEC 62264

NISTIR 8107

Current Standards Landscape for Smart Manufacturing Systems

Yan Lu
KC Morris
Simon Fréchet

This publication is available free of charge from:
<http://dx.doi.org/10.6028/NIST.IR.8107>

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

MOM level: Manufacturing operations management, or MOM, refers to applications that control plant level operations. Table 13 shows some important MOM level standards. IEC 62264 is an international standard for enterprise control system integration and is based upon ISA 95. IEC 62264 defines activity models, function models, and object models in the MOM domain. Business to Manufacturing Markup Language (B2MML), published by the MESA, is an implementation of IEC 62264 to link ERP and Supply Chain Management (SCM) systems with manufacturing systems such as Manufacturing Execution Systems (MES). ISO 22400 defines key performance indicators (KPIs) used in manufacturing operations management. QIF is a suite of standards enabling the flow of information within computer-aided quality measurement systems. PMML from DMG could be applied at this level to support MOM functions.

Table 13: MOM level standards

Standards	Description
IEC 62264	Enterprise-control system integration – defines manufacturing hierarchical model, and describes the manufacturing operations management domain and its activities, the interface content and associated transactions within Level 3 and between Level 3 and Level 4 and Level 3 objects. This standard is based upon ANSI/ISA-95.
IEC 62541	OPC Unified Architecture - an industrial M2M communication protocol for interoperability developed by the OPC Foundation.
IEC TR 62837	The report on Energy efficiency through automation systems provides a framework for the development and adaptation of documents in order to improve energy efficiency in manufacturing, process control and industrial facility management.
ISO 22400	Automation systems and integration -- Key performance indicators (KPIs) for manufacturing operations management, specifies an industry-neutral framework for defining, composing, exchanging, and using key performance indicators (KPIs) for manufacturing operations management (MOM), as defined in IEC 62264-1 for batch, continuous and discrete industries.
DMIS	Dimensional Measuring Interface Standard (DMIS) is to provide a standard for the bi-directional communication of inspection data between computer systems and inspection equipment.
QIF	QIF is a unified XML framework standard for computer-aided quality measurement systems. It enables the capture, use, and re-use of metrology-related information throughout the PLM/PDM domain

IEC 62264 » Part 2 Models

Production

Inventory

Maintenance

Quality

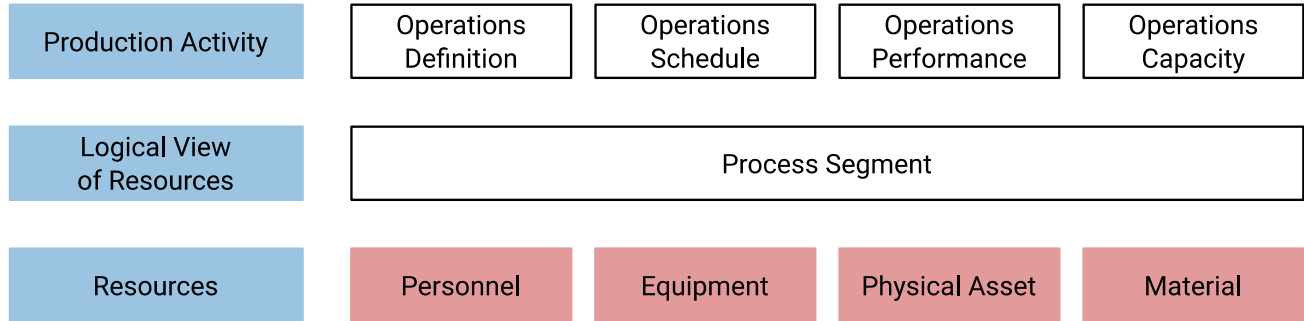
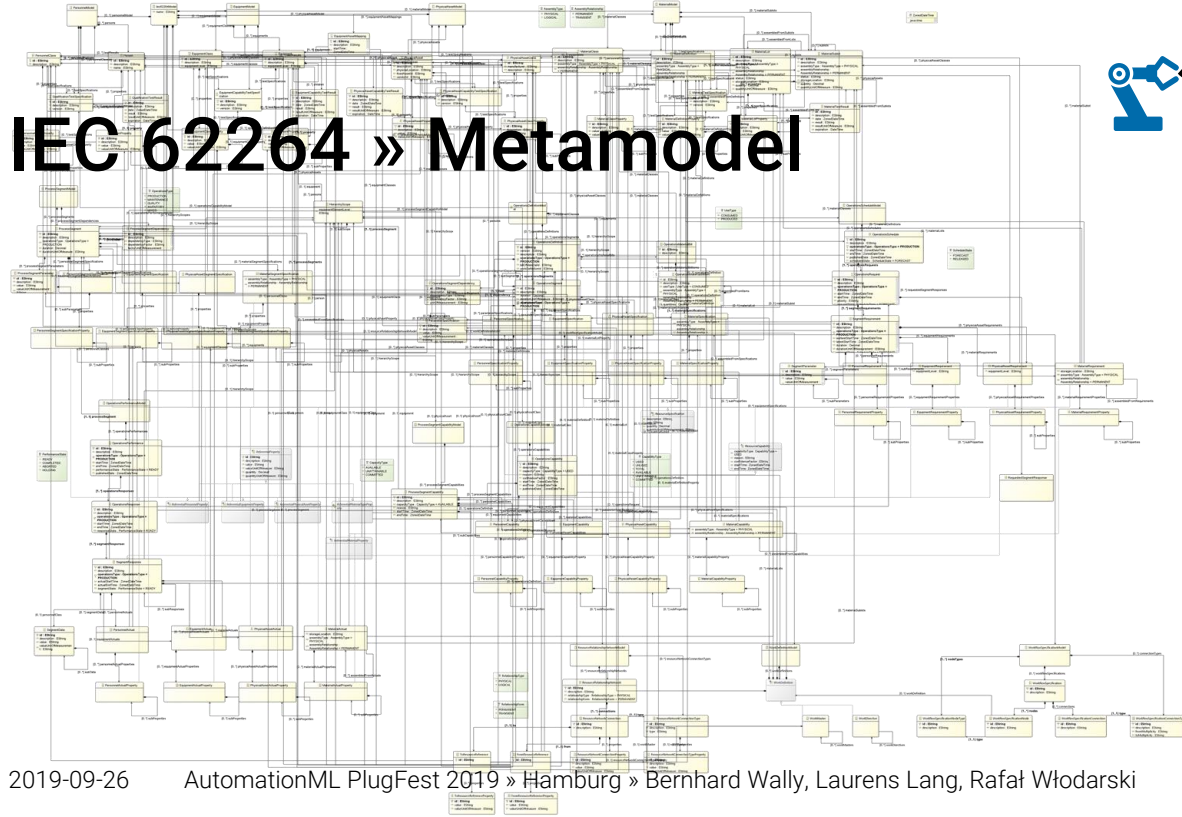


Image derived from OPC Foundation, "Companion Specification ISA-95", 2013

IEC 62264 » Metamodel



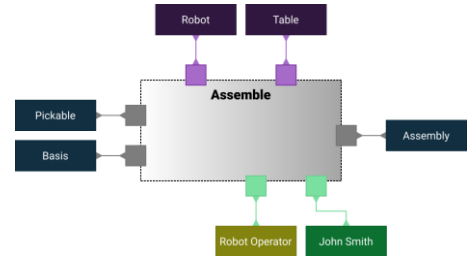
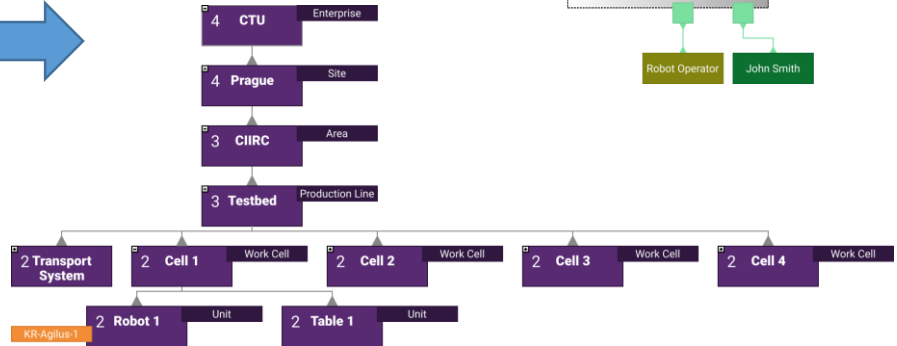
IEC 62264 Designer

IEC 62264 Designer

platform/resource/IEC62264.design/description/IEC62264.odesign

- IEC62264
 - IEC62264-Viewpoint
 - IEC62264 Model
 - Default
 - Personnel
 - Default
 - Equipment
 - Default
 - Physical Assets
 - Default
 - Material
 - Default
 - Process Segment
 - Default
 - ProcessSegment
 - Personnel
 - PersonnelClass
 - Person
 - Gradient white to white
 - Equipment
 - Physical Assets
 - Material
 - Gradient white to white
 - Process Segment Material Flow
 - Default
 - ProcessSegment
 - Bordered MaterialClassConsumable
 - Bordered MaterialClassConsumed
 - Bordered MaterialClassProduced
 - Bordered MaterialDefinitionConsumable

From Declaration
to Graphical Editor



IEC 62264 ↔ AutomationML

IEC 62264 ↔ AutomationML

Transforming
IEC 62264 **Model**
into
AML **CaexFile**

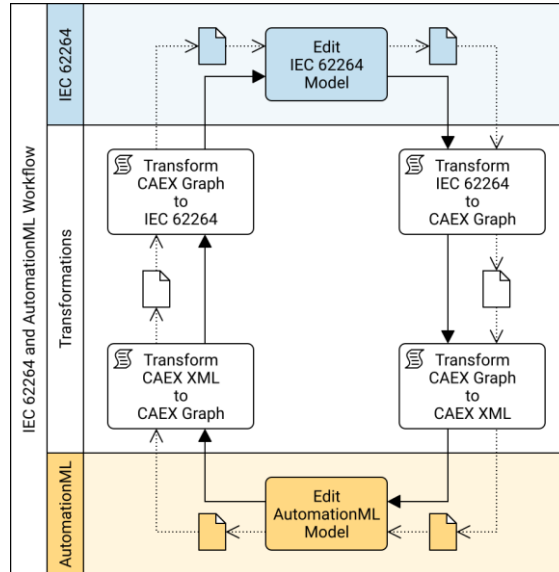
```
rule Model2File {  
  from  
    model: IEC62264!Model  
  to  
    file: CAEX!CaexFile (  
      superiorStandardVersions <- Sequence{'AutomationML 2.10'}  
      fileName <- model.name,  
      version <- version,  
      sourceDocumentInformations <- sdi,  
      instanceHierarchies <- hierarchy,  
      roleClassLibs <- roleClassLib,  
      systemUnitClassLibs <- systemUnitClassLib,  
    ),  
    version: CAEX!Version (  
      version <- model.version  
    ),  
    sdi: CAEX!SourceDocumentInformation (  
      lastWritingDateTime <- sdi.currentDateTime()  
    ),  
    -- ...  
}
```

IEC 62264 ↔ AutomationML

Transforming
IEC 62264 **Equipment**
into
AML **Internal Elements**

```
unique lazy rule Equipment2InternalElement {
  from
    equipment: IEC62264!Equipment
  to
    ie: CAEX!InternalElement (
      id <- ie.randomUUID(),
      name <- equipment.id,
      description <- thisModule.genDescription(equipment.description),
      attributes <- Sequence{idAttr, eqLvlAttr, equipment.properties},
      externalInterfaces <- Sequence{ei, eiEac},
      internalElements <- equipment.children ->
        collect(e | thisModule.Equipment2InternalElement(e)),
      roleRequirements <- Sequence{rr, equipment.equipmentClasses ->
        collect(ec |
          thisModule.EquipmentClass2RoleRequirement(ec, equipment))}
    ),
    rr: CAEX!RoleRequirement (
      baseRoleClass <- rr.getRoleFamilyFromLib('LIBIEC', 'Equipment'),
      mappingObject <- mo
    ),
    -- ...
}
```

IEC 62264 and AML » Workflow



AutomationML Structure

