The 2007 Lawrence D. Eicher Leadership Award

Smart Manufacturing using existing standards

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Chair, ISO/TC 184/SC 4: Industrial Data

PDT Europe

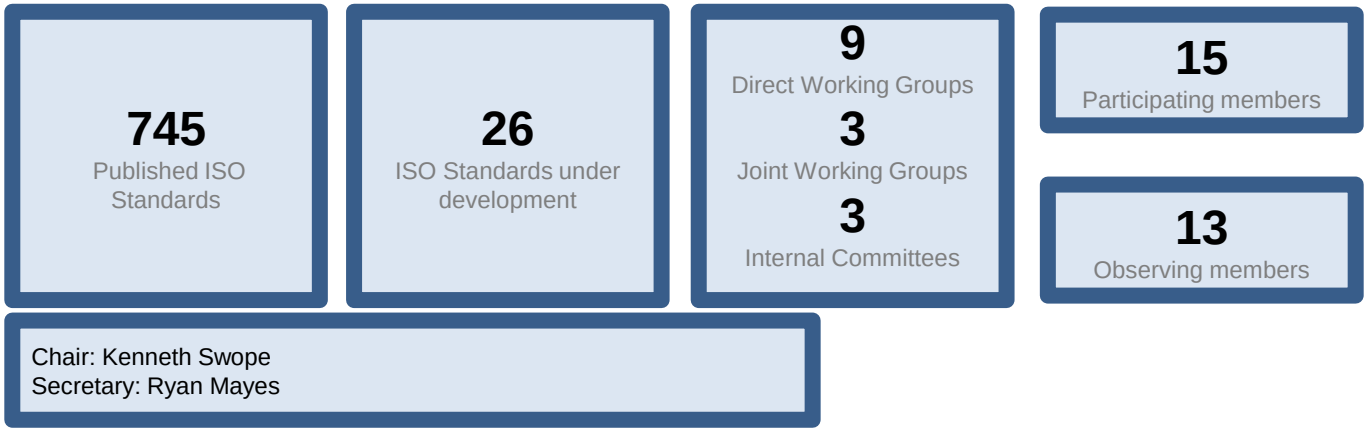
25 October 2018

ISO/TC 184/SC 4: Industrial Data

SCOPE:

Standardization of the content, meaning, structure, representation and quality management of the information required to define an engineered product and its characteristics at any required level of detail at any part of its lifecycle from conception through disposal, together with the interfaces required to deliver and collect the information necessary to support any business or technical process or service related to that engineered product during its lifecycle.

Note: Lifecycle includes recursive recycling to a terminal state.



What is Smart Manufacturing?

JWG21-TR-SMRM-N05-v14_2018-09-19

Technical Report:
Smart Manufacturing Reference Model(s)

CONTENTS

"Manufacturing that improves its performance aspects with integrated and intelligent use of processes and resources in cyber, physical and human spheres to create and deliver products and services, which also collaborates with other domains within an enterprise's' value chains.

Note 1: Performance aspects include agility, efficiency, safety, security, sustainability or any other performance indicators identified by the enterprise.

Note 2: In addition to manufacturing, other enterprise domains can include engineering, logistics, marketing, procurement, sales or any other domains identified by the enterprise."

"Smart manufacturing is extending manufacturing. It is characterized by independent actors sharing standardized information. The actors can pro-actively and re-actively act upon the information. The actors collaborate dynamically in network structures. This collaboration occurs among and within lifecycles, on both strategic and operational levels, providing added value for organizations. The scope is to develop a reference architecture for smart manufacturing.

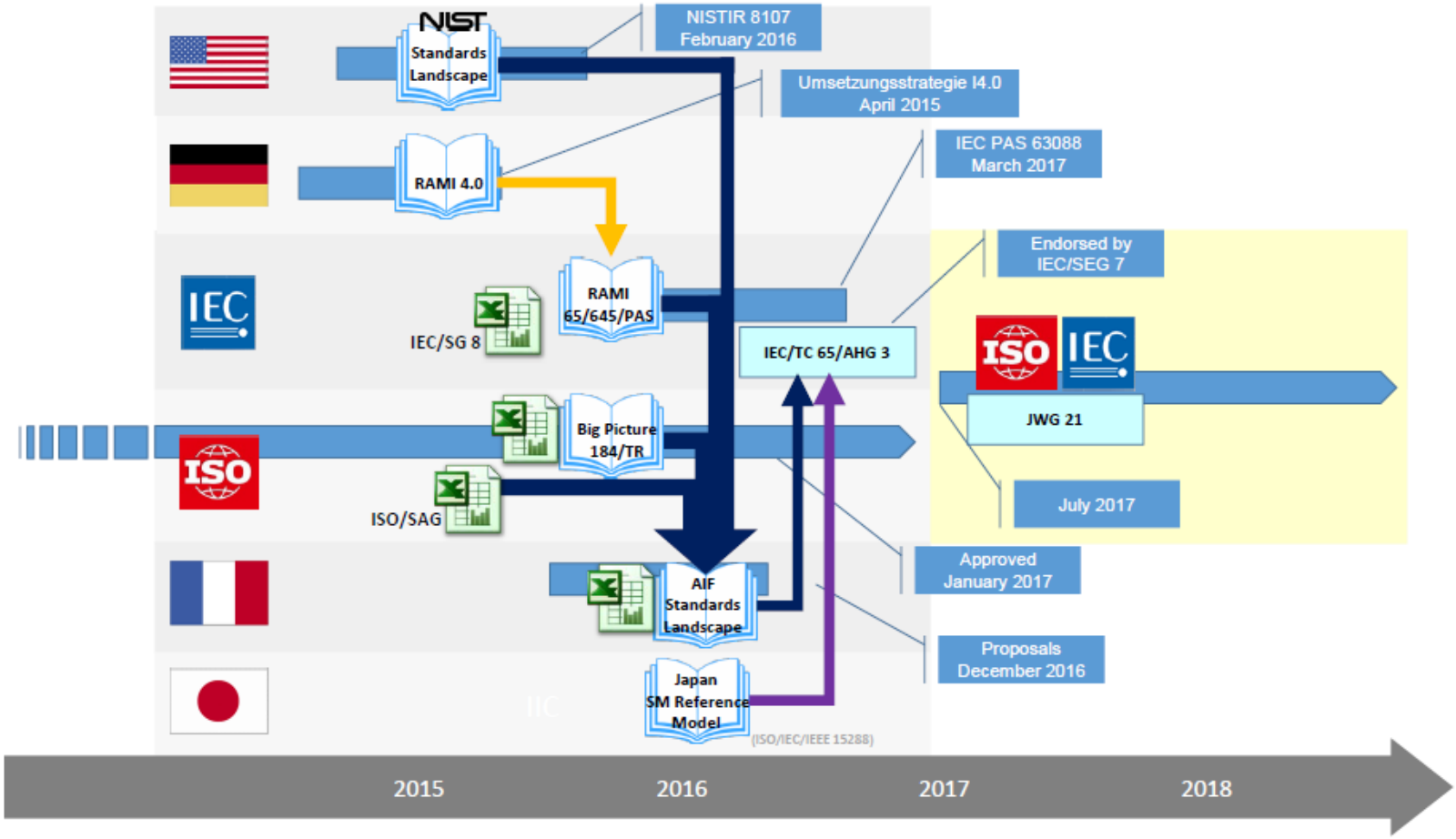
Note: examples of actors are companies, products, assets, processes and parts."

"Set of methodologies and technologies for making goods and providing services with manufacturing systems that are designed with learning capability and operated based on product/service requirements so that it can respond in real time to meet changing demands and conditions in the factory, in the supply network and in customer needs, and can improve itself continuously.

This is obtained by the intensive use of digital technology (including IoT) to integrate products, production systems and business activities through their life cycles and value chains, and increasing decentralized decision making."

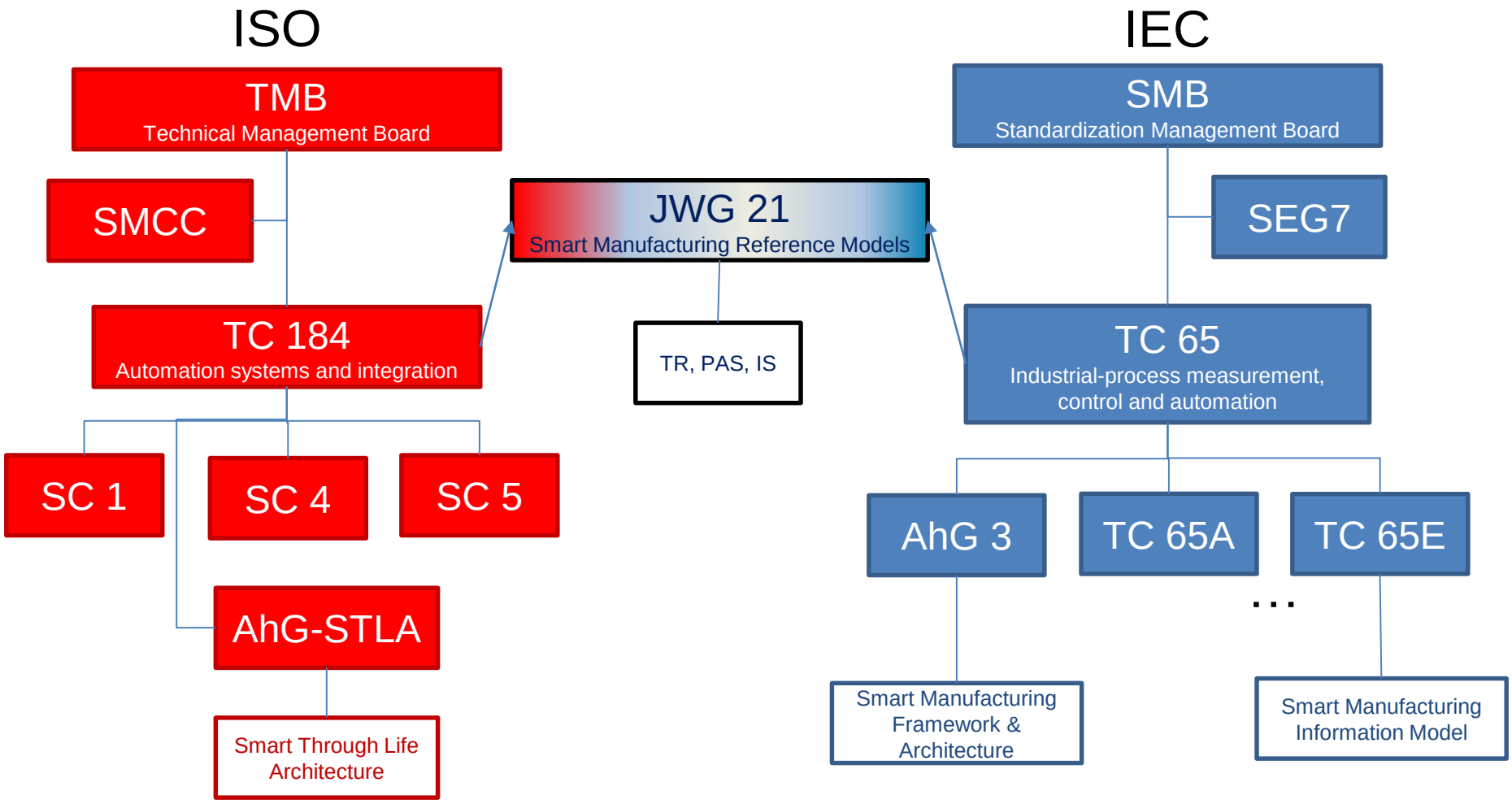
Industry Consensus continues to mature as Smart Manufacturing evolves

Journey to Smart Manufacturing

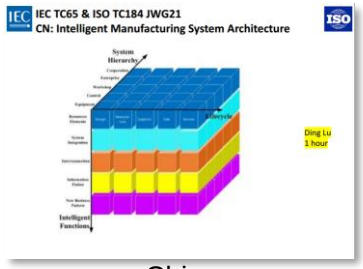


Joint Working Group 21

Teaming Model



Smart Manufacturing Reference Models



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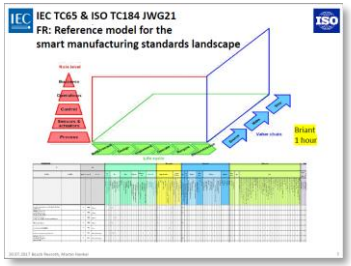

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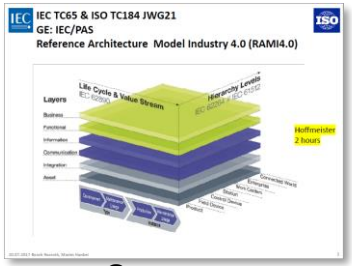

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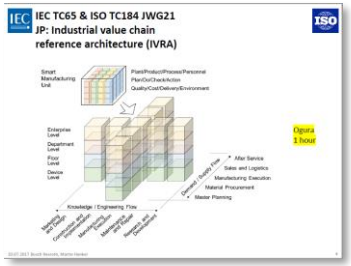

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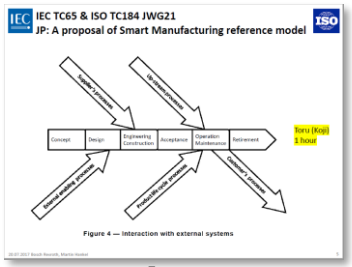

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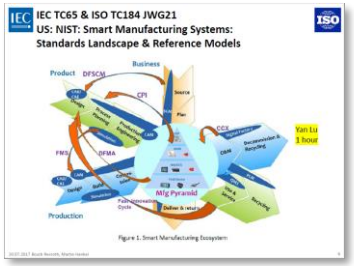

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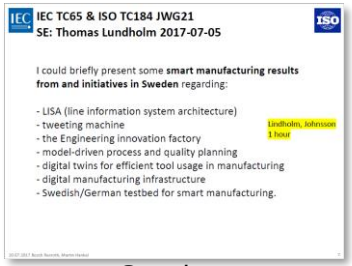

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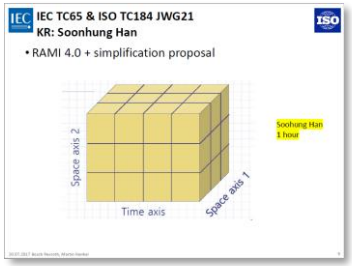
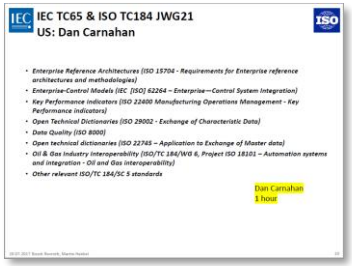
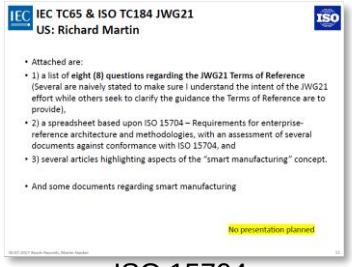


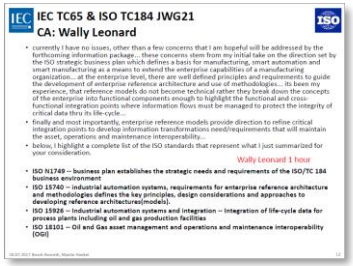
Korea



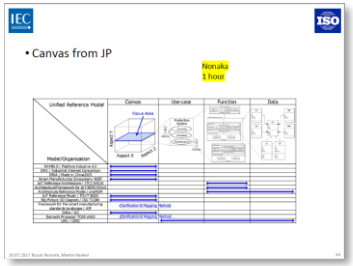
ISO Standards



ISO 15704



Canada



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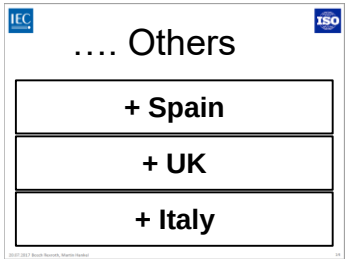
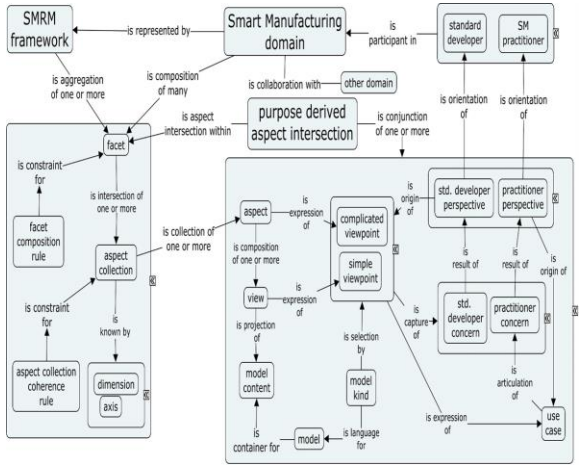
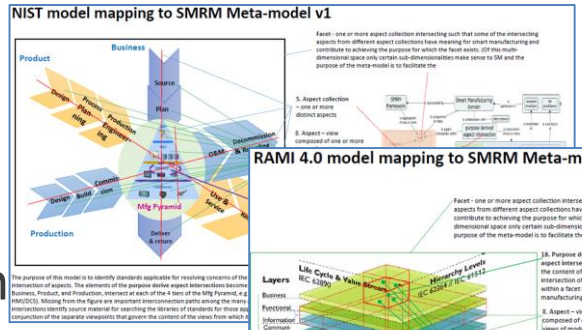
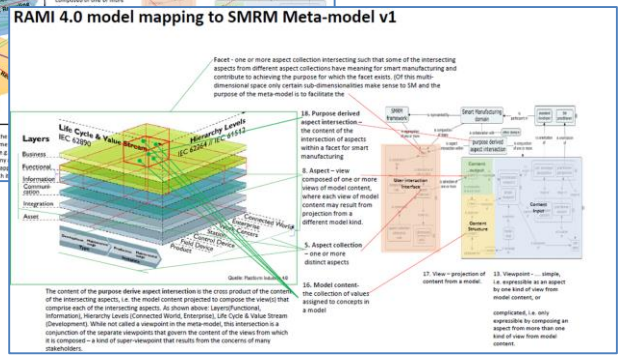


Next Steps

- Complete the Technical Report
  - Early 2019
- Map each model to a common architecture
  - 2019 - 2020
- Evolve the Technical Report to Technical Specification and ultimately a joint standard between ISO and IEC
  - 2020







ISO/TC 184/SC 4
Industrial Data

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iso.org

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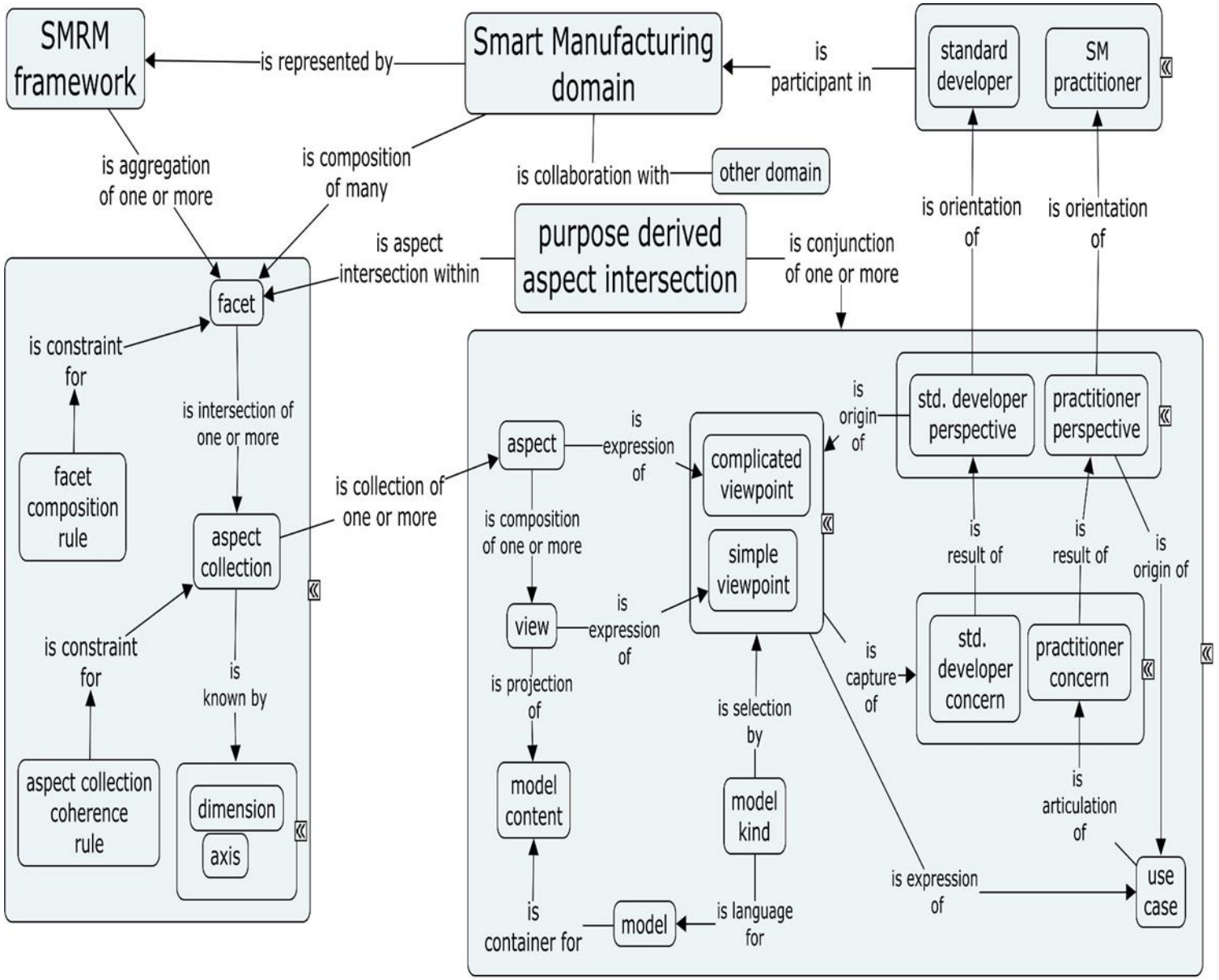
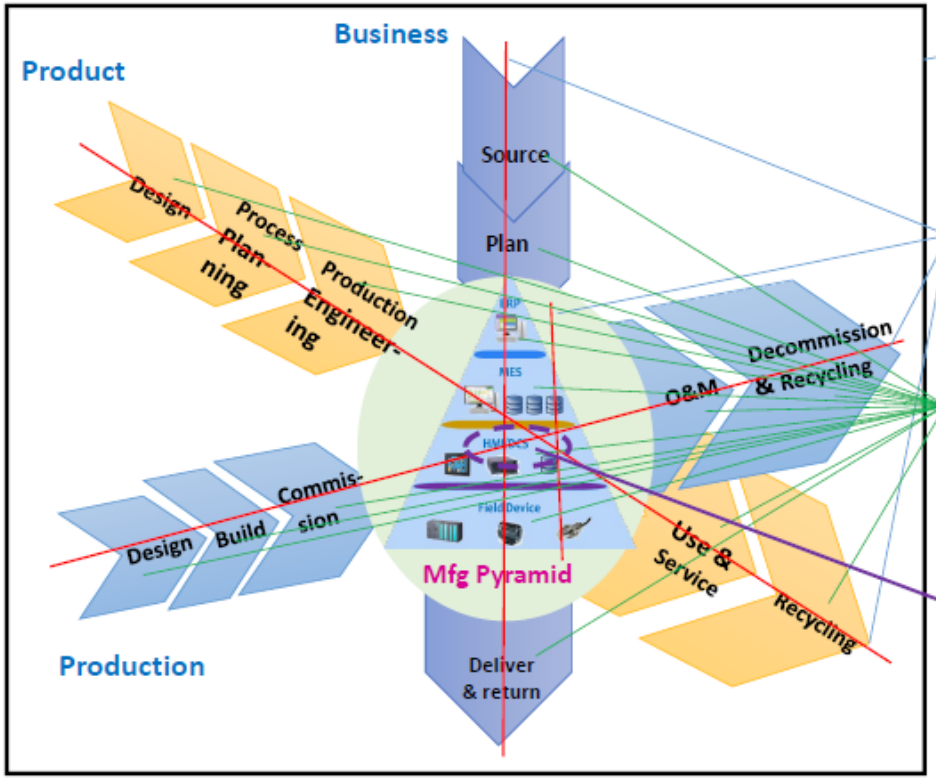

SMRM framework
is represented by
Smart Manufacturing domain
is participant in
standard developer
SM practitioner
is aggregation of one or more
is composition of many
is collaboration with
other domain
is orientation of
is orientation of
is aspect intersection within
purpose derived aspect intersection
is conjunction of one or more
facet
is constraint for
is intersection of one or more
facet composition rule
aspect collection
is collection of one or more
is constraint for
is known by
aspect collection coherence rule
dimension
axis
aspect
is expression of
complicated viewpoint
simple viewpoint
is origin of
std. developer perspective
practitioner perspective
is composition of one or more
is result of
is result of
is origin of
view
is expression of
is capture of
std. developer concern
practitioner concern
is projection of
is selection by
is articulation of
model content
model kind
is expression of
use case
is container for
model
is language for

NIST model mapping to SMRM Meta-model v1



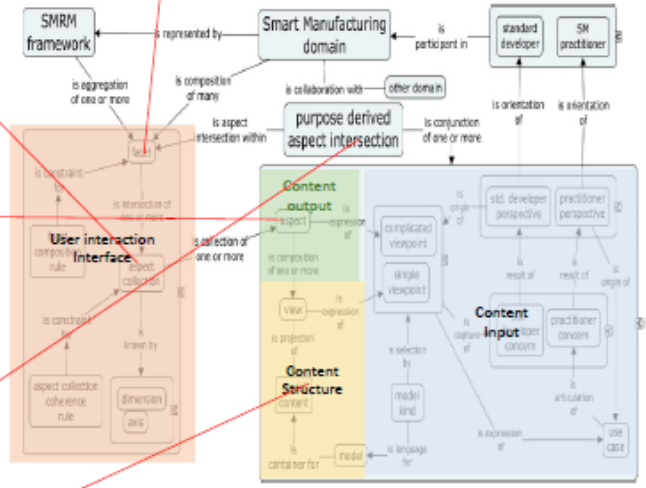
Facet - one or more aspect collection intersecting such that some of the intersecting aspects from different aspect collections have meaning for smart manufacturing and contribute to achieving the purpose for which the facet exists. (Of this multi-dimensional space only certain sub-dimensionalities make sense to SM and the purpose of the meta-model is to facilitate the

5. Aspect collection – one or more distinct aspects

8. Aspect – view composed of one or more views of model content, where each view of model content may result from projection from a different model kind.

18. Purpose derived aspect intersection – the content of the intersection of aspects within a facet for smart manufacturing

16. Model content- the collection of values assigned to concepts in a model (see below)



17. View – projection of content from a model.

13. Viewpoint - .... simple, i.e. expressible as an aspect by one kind of view from model content, or complicated, i.e. only expressible by composing an aspect from more than one kind of view from model content.

The purpose of this model is to identify standards applicable for resolving concerns of the various aspects of smart manufacturing, particularly those standards that apply at the intersection of aspects. The elements of the purpose derive aspect intersections become the Smart Manufacturing Landscape. Three sets of life cycle phases, one each for Business, Product, and Production, intersect at each of the 4 tiers of the Mfg Pyramid, e.g. {Business manufacture, Product manufacture, Production manufacture, Manufacture HMI/DCS}. Missing from the figure are important interconnection paths among the many aspects of smart manufacturing useful in capturing its digital thread. In total these intersections identify source material for searching the libraries of standards for those applicable at the intersection, i.e. the Smart Manufacturing Standards Landscape is a conjunction of the separate viewpoints that govern the content of the views from which it is composed and an articulation of the standards pertinent to that context.

RAMI 4.0 model mapping to SMRM Meta-model v1

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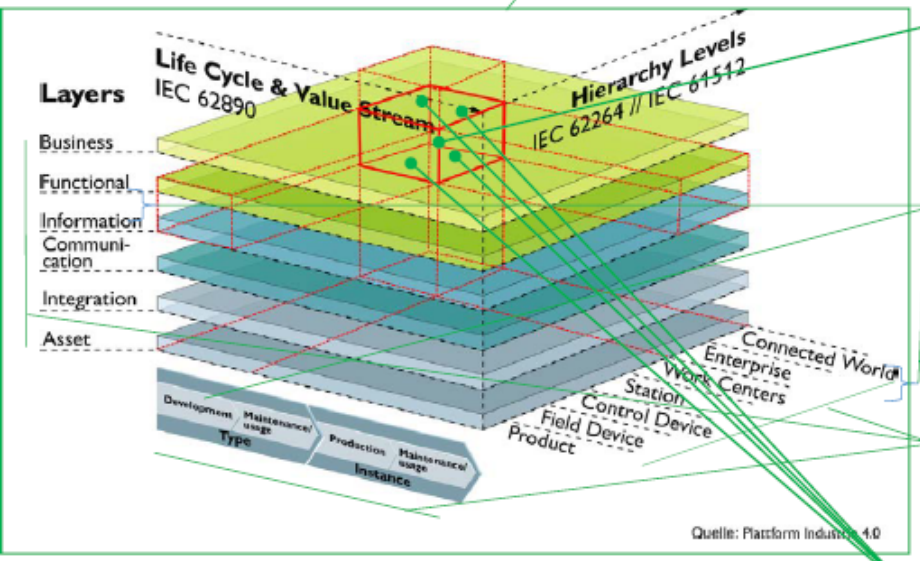

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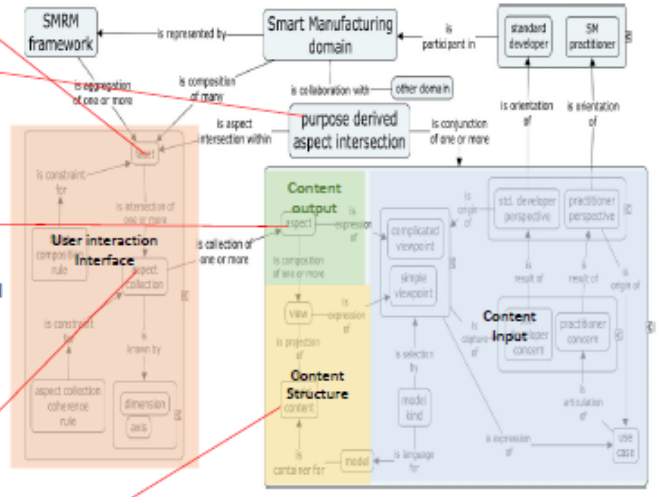

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complicated, i.e. only expressible by composing an aspect from more than one kind of view from model content.

The content of the purpose derive aspect intersection is the cross product of the content of the intersecting aspects, i.e. the model content projected to compose the view(s) that comprise each of the intersecting aspects. As shown above: Layers(Functional, Information), Hierarchy Levels (Connected World, Enterprise), Life Cycle & Value Stream (Development). While not called a viewpoint in the meta-model, this intersection is a conjunction of the separate viewpoints that govern the content of the views from which it is composed – a kind of super-viewpoint that results from the concerns of many stakeholders.