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# IEC/TC 65 Automation Forum

## International Symposium on Measurement, Control Technology and Intelligent Manufacturing

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## Some IoT initiatives/activities; Organizations, Consortia, and TC 65 Contributions


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# Overview

- Some IoT related Organizations, Consortia
- Approaches, intersections and considerations of interest for Intelligent Manufacturing
- A useful view of Intelligent Manufacturing
- IEC TC65 Contributions

# Some Organizations and Consortia

- IoT related Organizations, Consortia and Special Groups have been created everywhere, either as new entities or as part of existing ones, by Governments, Industry Associations, Academia, Trade Associations and Standard Developing Organizations
- One will be reviewed, the other mentioned, both have recently published reference architectures and vocabularies:
  - National Institute of Standard and Technology Cyber-Physical Systems Public Working Group (NIST CPS PWG)
  - Industrial Internet Consortium (IIC)

# NIST Cyber-Physical Systems Public Working Group (NIST CPS PWG)

- NIST CPS PWG, June 30, 2014, ".. formed by NIST to facilitate broad collaboration and build a unified technical foundation that accelerates progress in CPS across all domains."
- CPS: "Smart systems that include engineered interacting networks of physical and computational components. CPS and related systems (including the Internet of Things (IoT) and the Industrial Internet) are widely recognized as having great potential to enable innovative applications and impact multiple economic sectors in the worldwide economy."

From "DRAFT  Framework for Cyber-Physical Systems Release 0.8 September 2015"

# NIST CPS PWG Subgroups

- The Cyber-Physical Systems Public Working Group is organized in 5 subgroups

Vocabulary and Reference Architecture

Use Cases

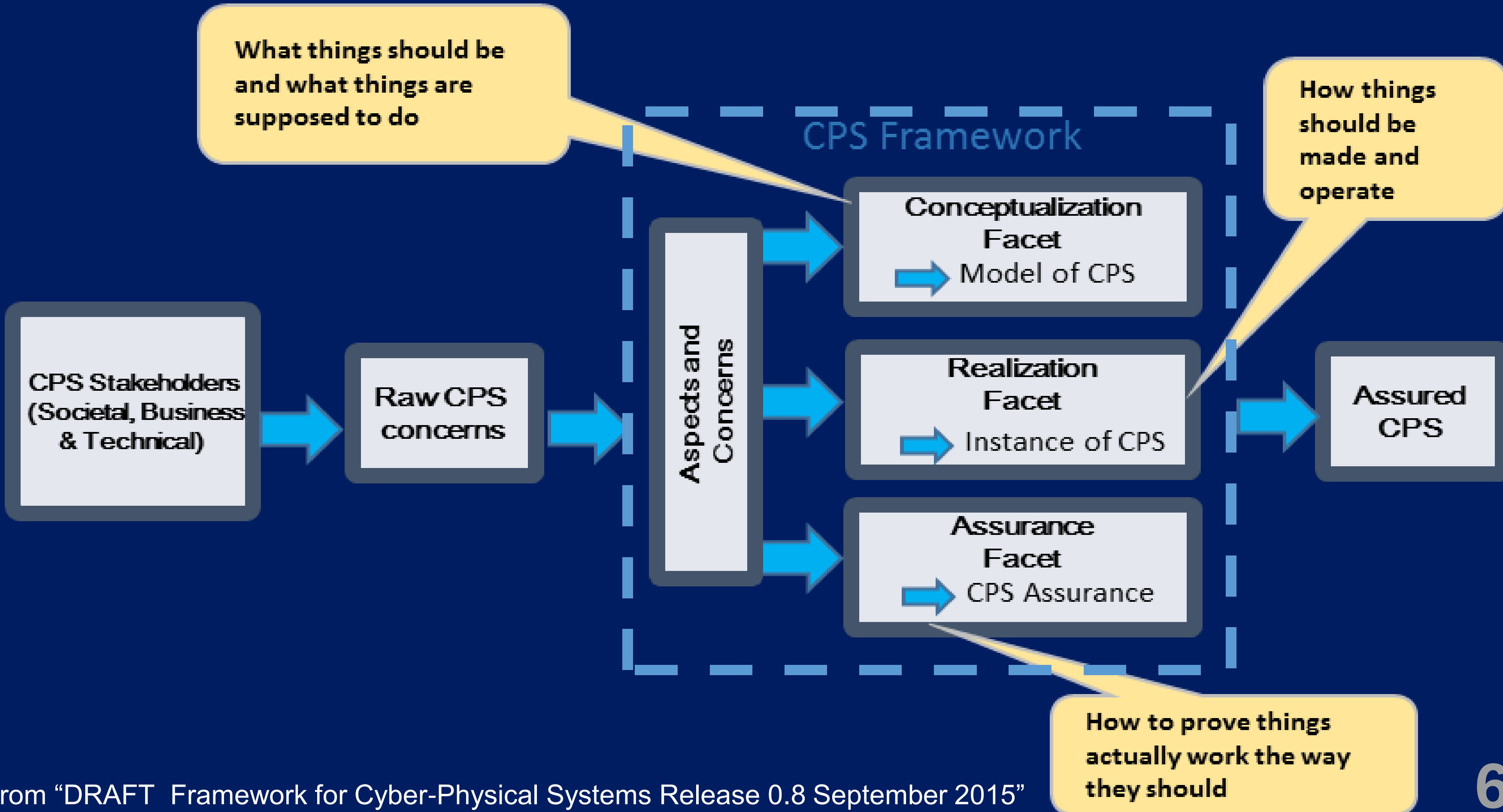
Cybersecurity and Privacy

Timing and Synchronization

Data Interoperability

# NIST CPS PWG, CPS Generational flow used to study and derive the Framework

- CPS creation: Stakeholders and Domains, Cross-cutting concerns, Aspects, and Facets (macro Phases)




From "DRAFT  Framework for Cyber-Physical Systems Release 0.8 September 2015"

# NIST CPS PWG Stakeholders and Domains

- Areas of deployment of CPS in which stakeholders may have domain-specific and cross-domain concerns.

- Advertising
- Aerospace
- Agriculture
- Buildings
- Cities
- Communities
- Consumer
- Defense
- Disaster resilience
- Education
- Emergency response
- Energy
- Entertainment/sports
- Environmental monitoring
- Financial services
- Healthcare
- Infrastructure (communications, power, water)
- Leisure
- Manufacturing
- Science
- Social networks
- Supply chain/retail
- Transportation
- Weather

From "DRAFT Framework for Cyber-Physical Systems Release 0.8 September 2015"

- This is an impressive list, by all accounts, and it may grow

# NIST CPS PWG Cross-cutting concerns and Aspects

- Cross-cutting concerns are concerns that cannot be confined to a particular stakeholder/domain, nor to a particular facet (macro phase)
- Aspects are convenient grouping of conceptually equivalent or related concerns.

- Concerns about function include sensing, actuation, control, communications. They are grouped under the “Functionality” aspect.
- Concerns about trustworthiness include cybersecurity, privacy, safety, reliability, resilience. They are grouped under the “Trustworthiness” aspect.

From “DRAFT Framework for Cyber-Physical Systems Release 0.8 September 2015”

# NIST CPS PWG Cross-cutting concerns and Aspects

- Identified aspects:
  - Functional
  - Business
  - Human
  - Trustworthiness
  - Data
  - Timing
  - Boundaries
  - Composition
  - Lifecycle
- So far, Trustworthiness, Data and Timing have been examined and characterized in depth by the CPS PWG, the others need more work.
- Orthogonality between aspects should not be expected

From "DRAFT Framework for Cyber-Physical Systems Release 0.8 September 2015"

# NIST CPS PWG Facets (like macro phases)

- Responsibilities in the system engineering process, and contain well-defined activities and artifacts (outputs) for addressing concerns.

- There are three identified facets:
  - Conceptualization
    - What things should be and what are supposed to do
  - Realization
    - How things should be made and operate
  - Assurance
    - How to prove things actually work the way they should

From “DRAFT  Framework for Cyber-Physical Systems Release 0.8 September 2015”

# NIST CPS PWG
# What is different about CPSs (by design)

- Beyond conventional product, system, and application design traditionally constructed in the absence of significant or pervasive interconnectedness
- CPS devices may be repurposed beyond applications that were their basis of design (e.g. the smart phone)
- May have “brokers” and other infrastructure-based devices and aggregators that are owned and managed by third parties, resulting in potential trust issues
- Noted for enabling cross-domain applications – e.g., the intersection of manufacturing and energy distribution systems, smart cities, and consumer-based sensing (crowd)

From “DRAFT  Framework for Cyber-Physical Systems Release 0.8 September 2015”

# NIST CPS PWG
# What is different about CPSs (by design)

- Designed to interact directly with the physical world, hence more urgent need for emphasis on security, privacy, safety, reliability, and resilience, and corresponding assurance for pervasive interconnected devices and infrastructures

- CPS should be composable and may be service based. Components are available that may be combined into a system dynamically and the system architecture may be modified during runtime to address changing concerns.

From “DRAFT  Framework for Cyber-Physical Systems Release 0.8 September 2015”

# Some Organizations and Consortia available references

- NIST Cyber-Physical Systems Public Working Group (CPS PWG) Draft Framework for Cyber-Physical Systems, Release 0.8, for public comments, due November 2, 2015. www.cpspwg.org http://www.nist.gov/el/nist-releases-draft-framework-cyber-physical-systems-developers.cfm
- The Industrial Internet Reference Architecture http://www.iiconsortium.org/IIRA.htm
- Industrial Internet Vocabulary Technical Report http://www.iiconsortium.org/vocab/index.htm

# Approaches, intersections and considerations of interest for Intelligent Manufacturing

- Messages we can read in the NIST CPS effort and attitude:
  - Economy of scale
  - The separation of concerns is in question
  - A System of Systems
  - Convergence of network traffic must be considered
  - So many other fields and players, Industrial Automation needs to be closely involved in IoT

# Economy of scale, again

- The Industrial Automation market is relatively small compared to consumer markets, like say automobiles
- We are the field that makes consumer goods, we certainly make many more things than what we use to make them
- The challenge is once again to specialize for our requirements and take advantage of the Economy of Scale; we did it for Ethernet

# Concerns, no longer separated

- We traditionally separated concerns because our modelling, analytics, know-how and technology would not allow us to handle the complexity
- Separation of concerns has always been a useful engineering simplifying methodology, often the only way forward
- They have never been separated
- IoT brings this front page
- Too much complexity at once? There is a risk.

# Concerns, no longer separated

- Security and Safety
- Energy Efficiency and Environment
- Manufacturing and Reliability
- Quality and Flexibility
- Maintenance and Product life story
- Diagnostics and Control

IEC TC65 has been considering the new challenges

# Convergence, no longer separated traffic

- Time Sensitive Networks (TSN)
  - “TSN allows maintaining determinism with the confidence of being able to satisfy the requirements of less demanding traffic sharing the medium. The meaning of convergence in TSN is the successful convergence of critical control, non-critical control, and data streams on a single network.”

Definition adapted by the author over popular ones, to make important points

# A useful view of Intelligent Manufacturing

- The two main areas:
  - Design: Drive all the product/services life phases from product/services requirements virtualized in/linked with the product/service (and next will be from desired function)
  - Operational Feedback: analysis while operating on all product/services life phases, and improvements synthesis for the ‘next cycle’ or for the current product/service.

# A useful view of Intelligent Manufacturing

- The story was always easy to sell, the difficulty was the execution
- Why now?
  - Enabling Technologies

# Smart Automation

- Smart Automation
  - Use of the system to improve itself

# Smart Automation: enabling technologies, main driving forces

- Smart Automation main driving forces

  - virtualization
  - co-design and composition
  - connectivity
  - distributed intelligence
  - sensing
  - flexibility
  - safety
  - security
  - processing power

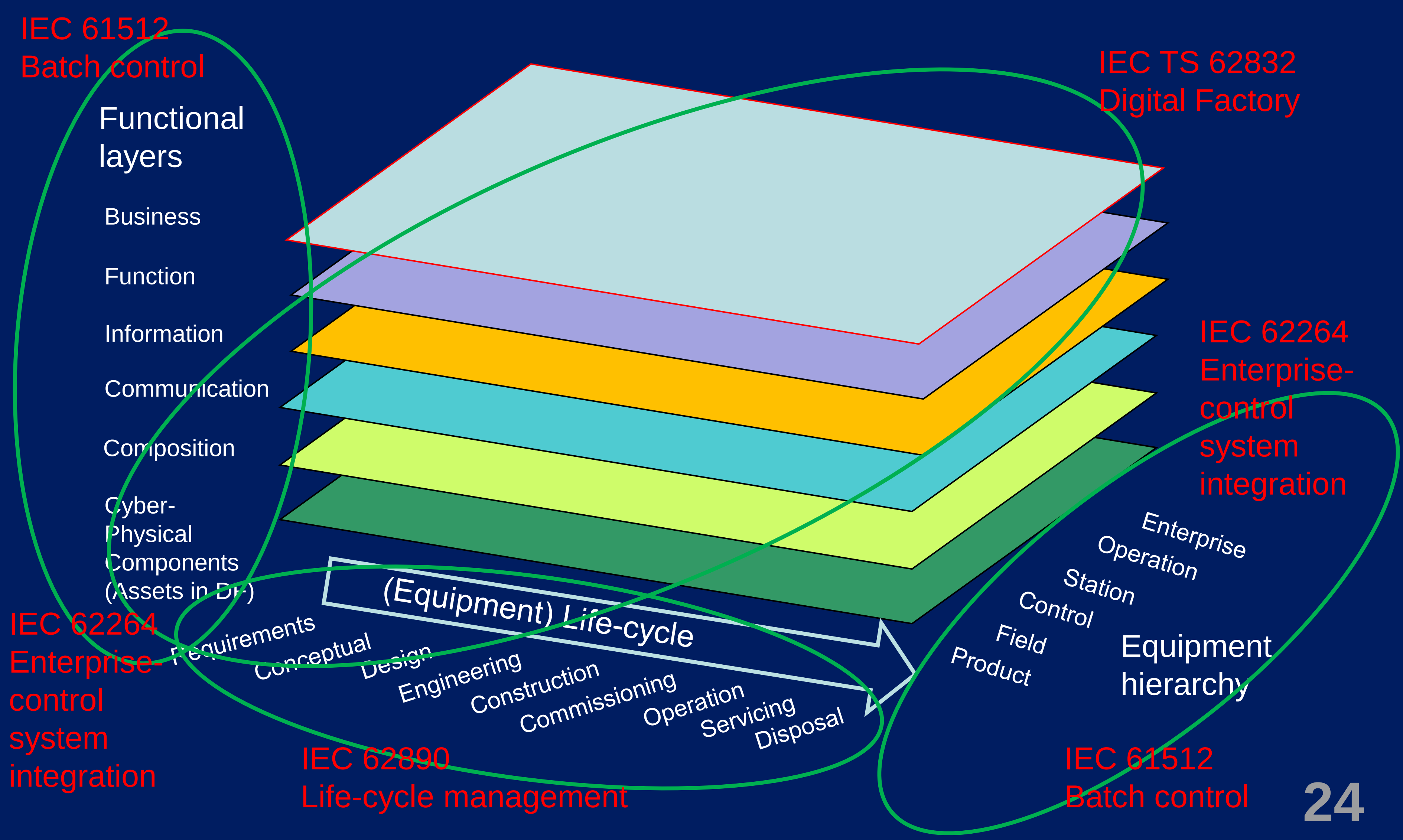
# Virtualization: TC65 IEC TS 62832 Digital Factory

- The Digital Factory framework defines models for the following items:
  - production system assets;
  - relationships between production system assets;
  - flow of information about production system assets.
  - examples of production system assets are components, machines, devices, software or control systems.

- This modelling framework does not cover building construction, input resources (such as raw production material, assembly parts), consumables, work pieces in process, nor end products.

- It applies to all types of production processes (continuous, batch or discrete) and any sector (for example aeronautic industries, automotive, chemicals, wood).

# Digital Factory and the equipment

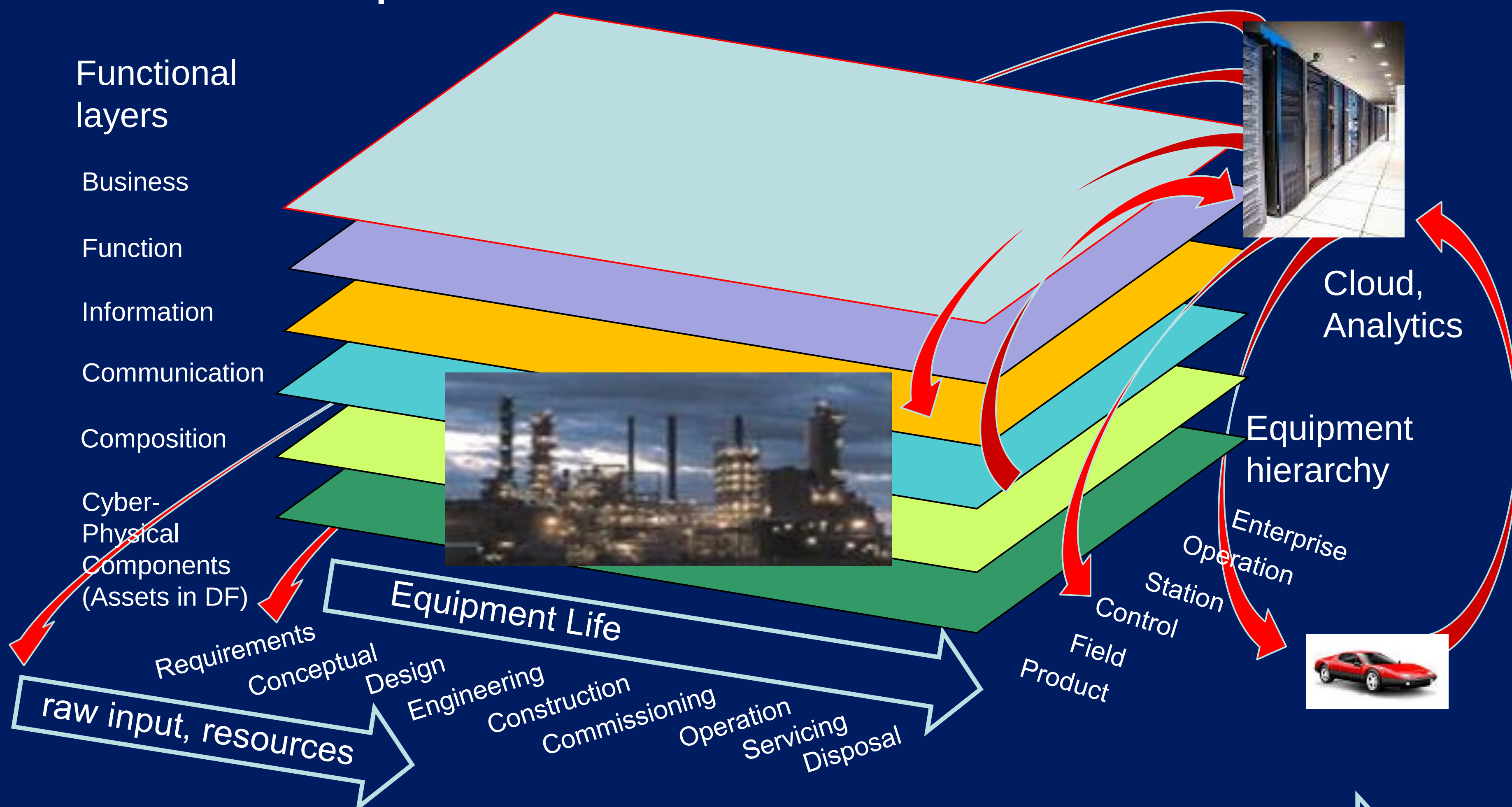


# Enabling Technologies

- Enabling Technologies, what do they enable?
  - They enable the logical connectivity between any point in a 3-D space: Functional layers,  Equipment hierarchy and Life cycle, that is, the potential is there to have analysis, simulation, synthesis, and execution relationships between very diverse points in the life of a system, including tuning requirements
  - The information exchanged can be
    - Descriptive, Diagnostic, Predictive, Prescriptive

# The Computational Driving Factor

- Product Requirements now, the Function in the future



# Product Ontologies

- Too many, lacking interoperability, and often private
- Oriented toward selling, not toward making, nor maintaining
- Missing the life story of the Product
- Not computationally suitable

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# THANK YOU!

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