Tinwisle Corporation

International Standards for System Integration

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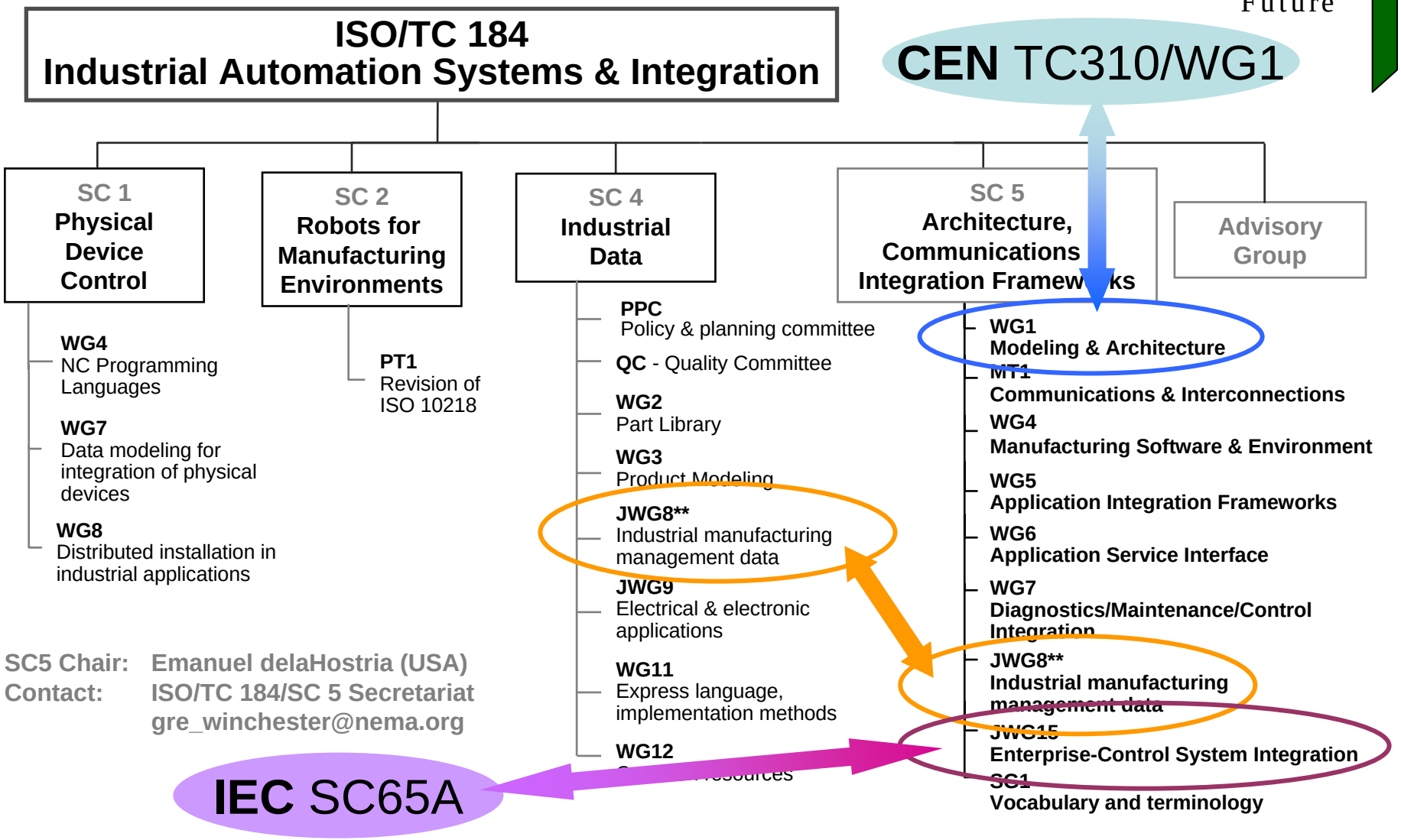
Convener ISO TC 184/SC 5/WG 1

International Standards for System Integration

- Context
- SC4 Success
- SC5 Interoperability
- SC5 Architecture
- Future Efforts

Who's standards

Context
Success
Interop.
Architect
Future



SC5 Chair: Emanuel delaHostria (USA)
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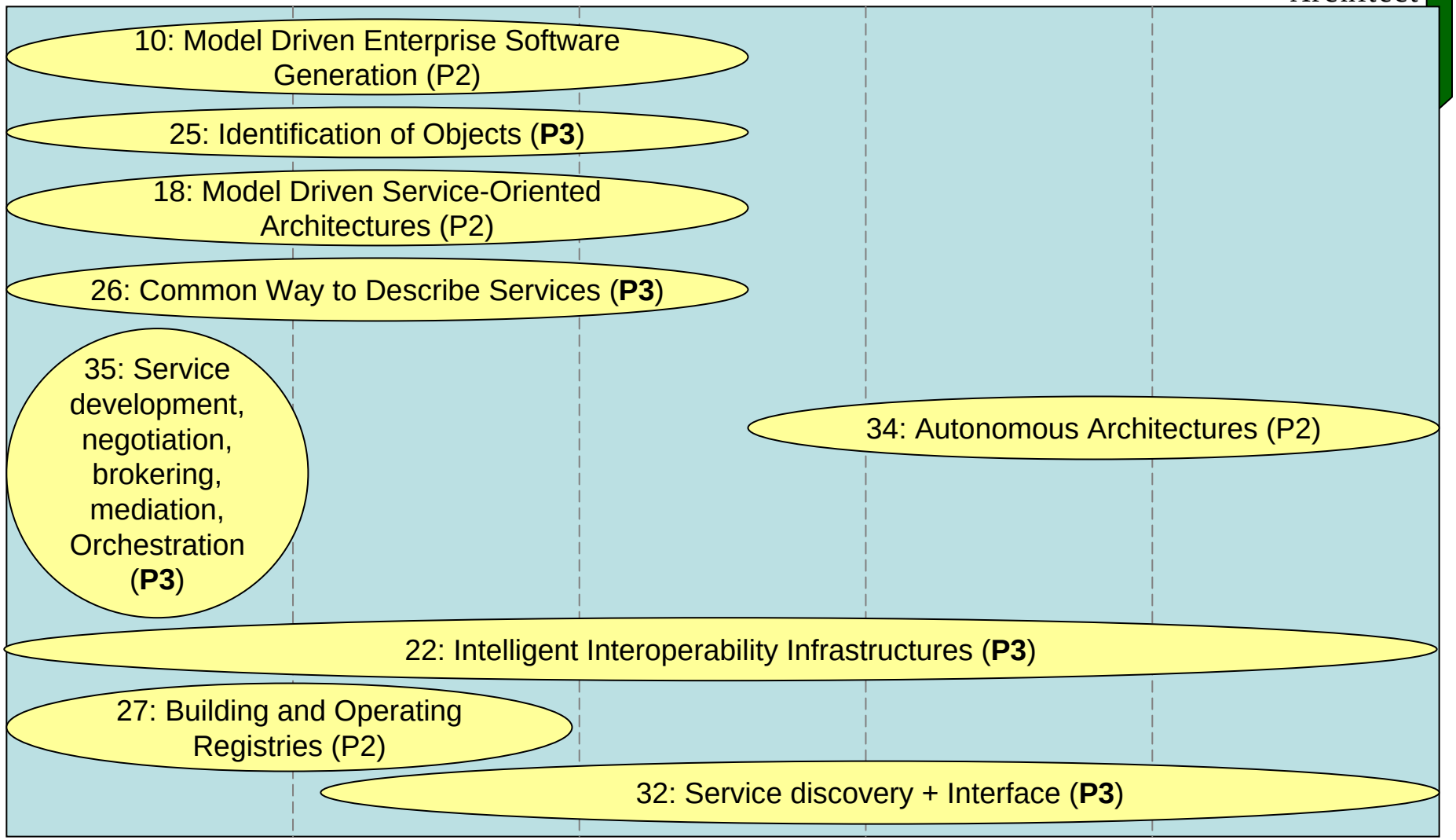
IDEAS Gap Analysis

Context
Success
Interop.
Architect
Future

- EC FP6 project (deliverable D3.4, .5, .6)
  - Interoperability Development for Enterprise Application and Software
- Gap – "missing pieces in research, technology and standardization to achieve a particular goal"
- 36 Gap categories in 3 domains – Enterprise Model, Architecture & Platform, Ontology

IDEAS Road map (Fig 13)

Context
Success
Interop.
Architect



NACFAM E-Manufacturing

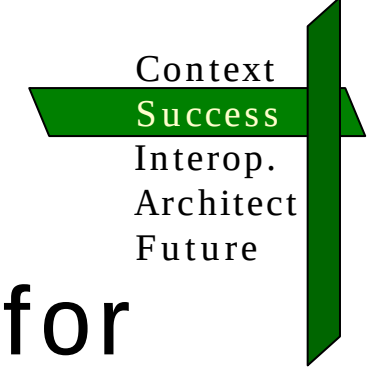
- Interoperability problem is more complex because it requires agreement on certain common principles and features before truly interoperable solutions can emerge.
- Solutions must…have the trust and acceptance of the industrial and software communities.
- Requires a mechanism to convene the right decision makers to produce the necessary agreement.

The supply chain effect

- High costs of interoperability particularly impact small and medium sized suppliers
- They often have to maintain redundant and costly software packages in order to communicate with their large EOM customers.
- Large manufacturing companies have pushed costs onto SME's by requiring "standardization" around their preferred systems.

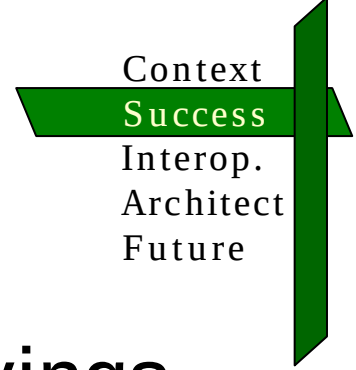
Source: Exploiting E-Manufacturing: Interoperability of Software Systems Used by U.S. Manufactures, NACFAM, Feb. 2001

Industrial Data – SC4



- ISO 10303 - STEP (Standard for the exchange of product model data)
  - EXPRESS language and bindings
  - Conformance and testing
  - Common resources
  - Industry specific application protocols
- Over 100 documents with more coming – including AP233 for system engineering information

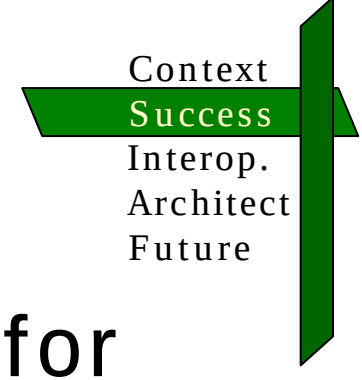
STEP success*



- Potential $928 million (2001$) savings per year by reducing interoperability problems in the automotive, aerospace, and shipbuilding industries in US
- ~ 17% ($156 million) of potential benefits quantified within scope of study are being realized
- Expect 75% benefit by 2010

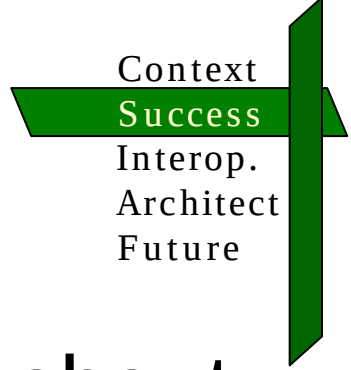
(* 2002 Gallaher study results)

Why STEP succeeds



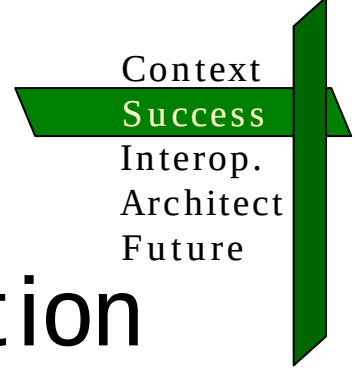
- Avoidance cost savings accounted for approximately half of the potential benefits of STEP
- 80% of avoidance costs were labor costs associated with the use and support of redundant CAx systems
- Mitigation costs resulting from file transfer and data reentry accounted for the balance of benefits

From data to process



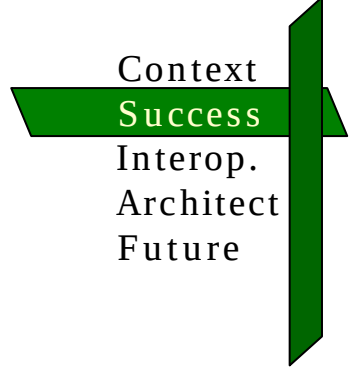
- The STEP domain is primarily data about a product's physical or logical structure
- Whereas SC4 has a data orientation, SC5 has a process orientation – how is the product created?
- SC5 focus is on process interoperability
  - Exchange of process specifications
  - Characterization of process elements
  - Integration of process features

Process description



- ISO 18629 - Industrial Automation system and integration – Process specification language
  - TC184 SC4/SC5 collaboration in JWG8
- Target is process information exchange
- Process information representation
- Process and model independence
- Lexicon, ontology, and grammar form PSL
- Different approach than ISO 10303
- 8 documents in various approval stages

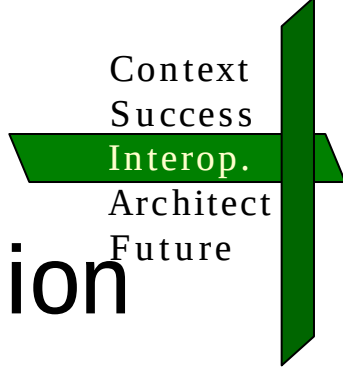
A ‘formal’ process




```
(forall (?occ)
(iff (occurrence_of ?occ make_harness_wire)
     (exists (?occ1 ?occ2 ?occ3)
        (and (occurrence_of ?occ1 extrude)
             (occurrence_of ?occ2 twist)
             (occurrence_of ?occ3 jacket)
             (min_precedes ?occ1 ?occ2
                  make_harness_wire)
             (min_precedes ?occ2 ?occ3
                  make_harness_wire))))
```

(Source: ISO/CD18629-44 Annex B)

Application integration

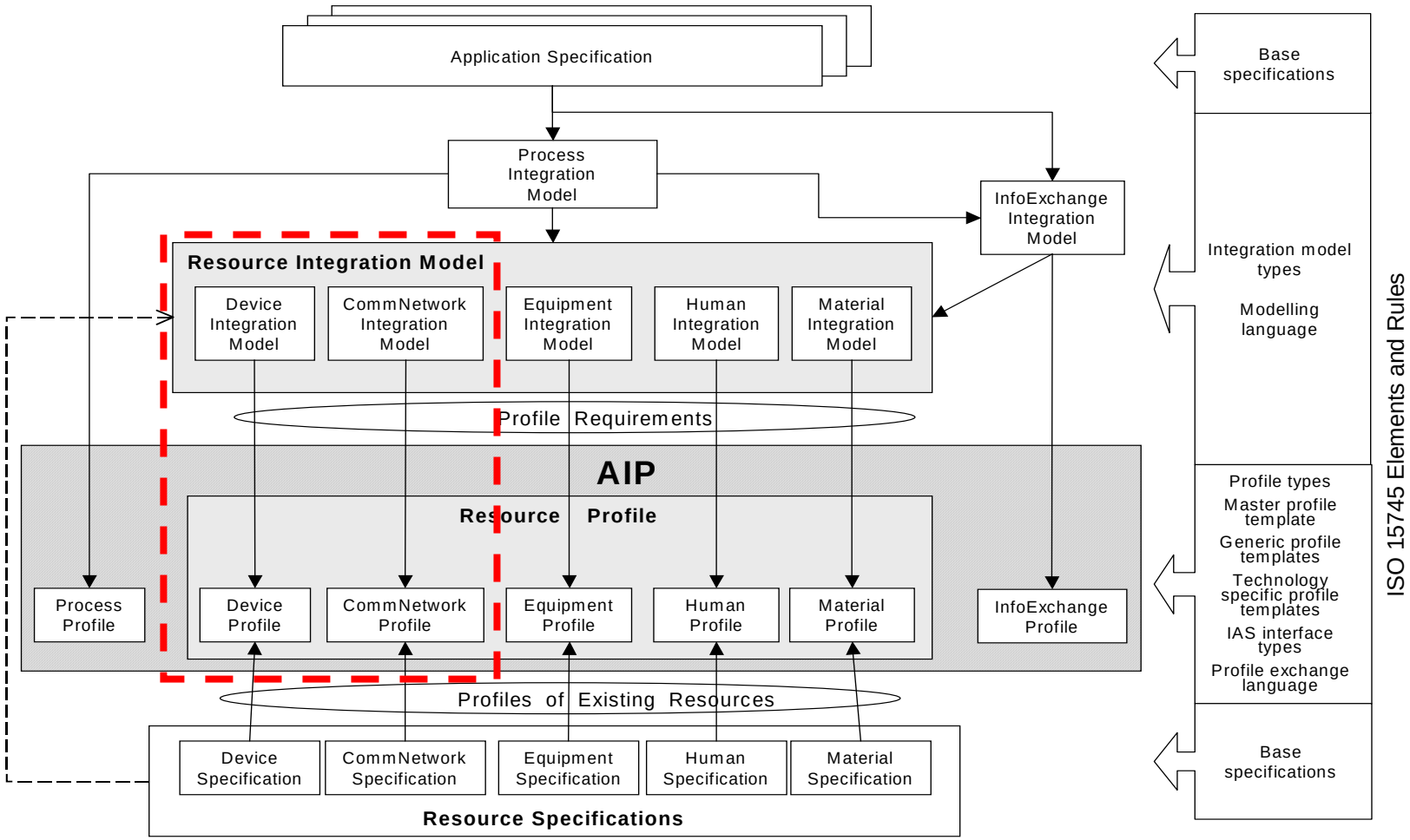


ISO 15745 – Industrial Automation system and integration - Open systems application integration framework

- Framework identifies:
  - Elements and rules for integration requirements using integration models
  - Application interoperability profiles as interface specifications
- UML based integration models
- XML schemas for profile templates

Profiles for integration

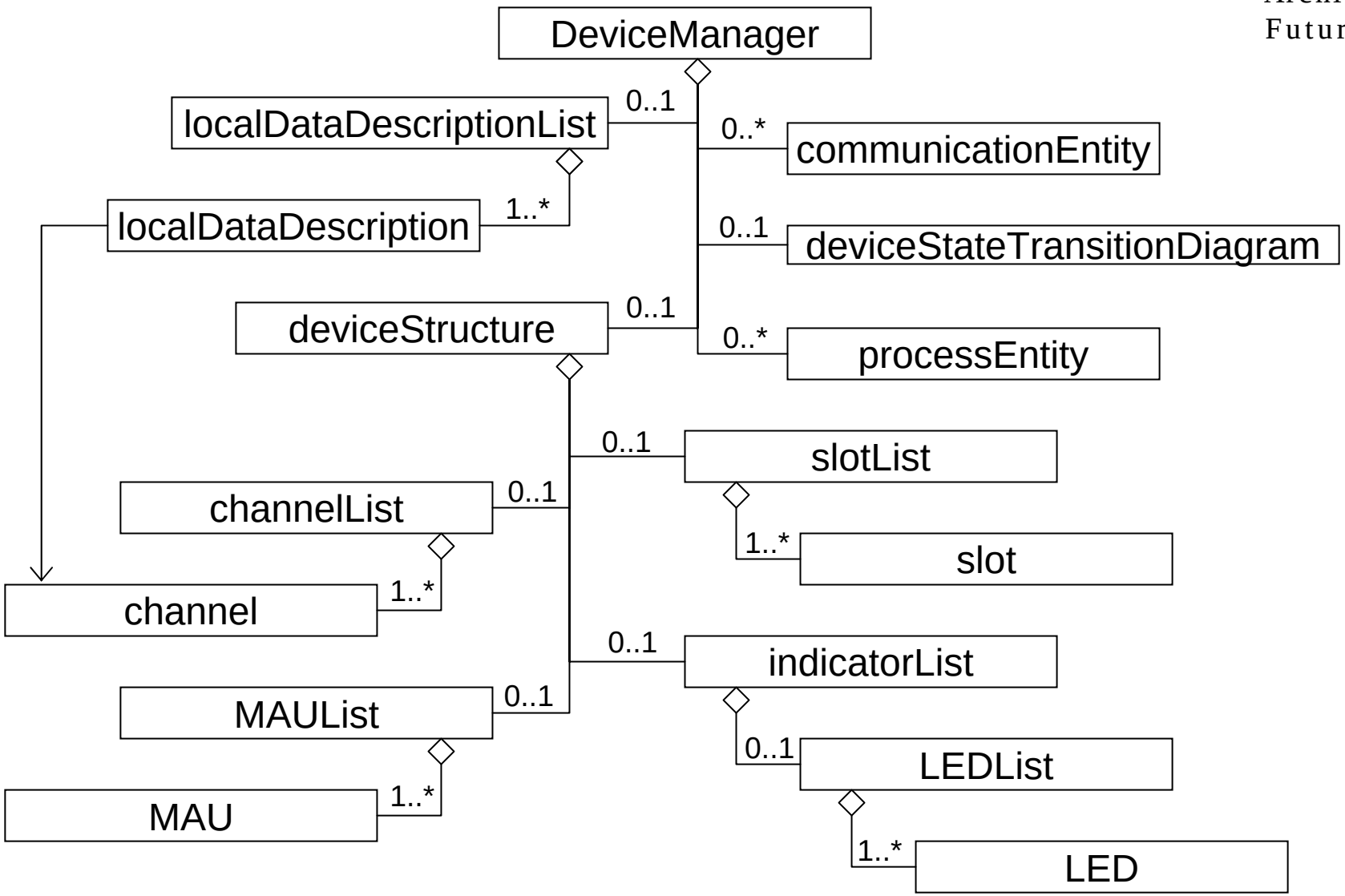
Context
Success
Interop.
Architect
Future



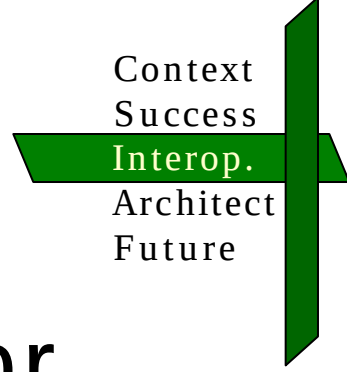
Source: ISO 15745-1 Figure 2. Profile development using ISO 15745

CANopen DeviceManager

Context
Success
Interop.
Architect
Future



Software capability

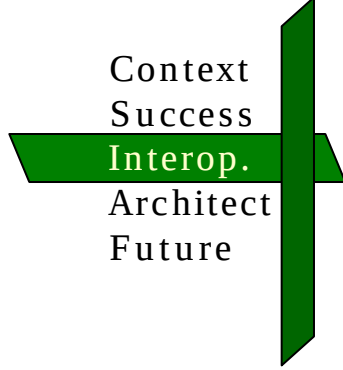


ISO 16100 – Manufacturing software capability profiling for interoperability

- Characterization of software interface requirements
- Software unit capability elements & rules
- IDEF0 process descriptions, UML models and XML profile schemas

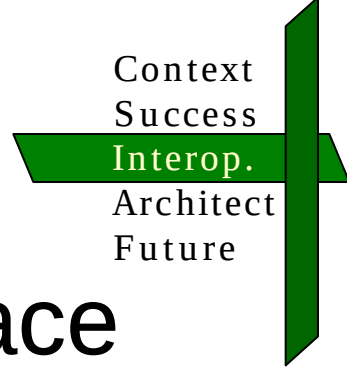
"Manufacturing software units shall interoperate with one another, in support of a manufacturing activity, when the services requested by the former can be provided by the latter, using the same operating environment."

Capability classes



- Manufacturing Capability classes
  - Domain, Application, Information, Process, Resources, Activity, Function, Software Unit
- Software Capability classes
  - Computing system, Environment, Architecture, Design Pattern, Datatype, Interface/Protocol
- Role Capability class

Testing services



ISO/DIS 20242 Service interface for testing applications

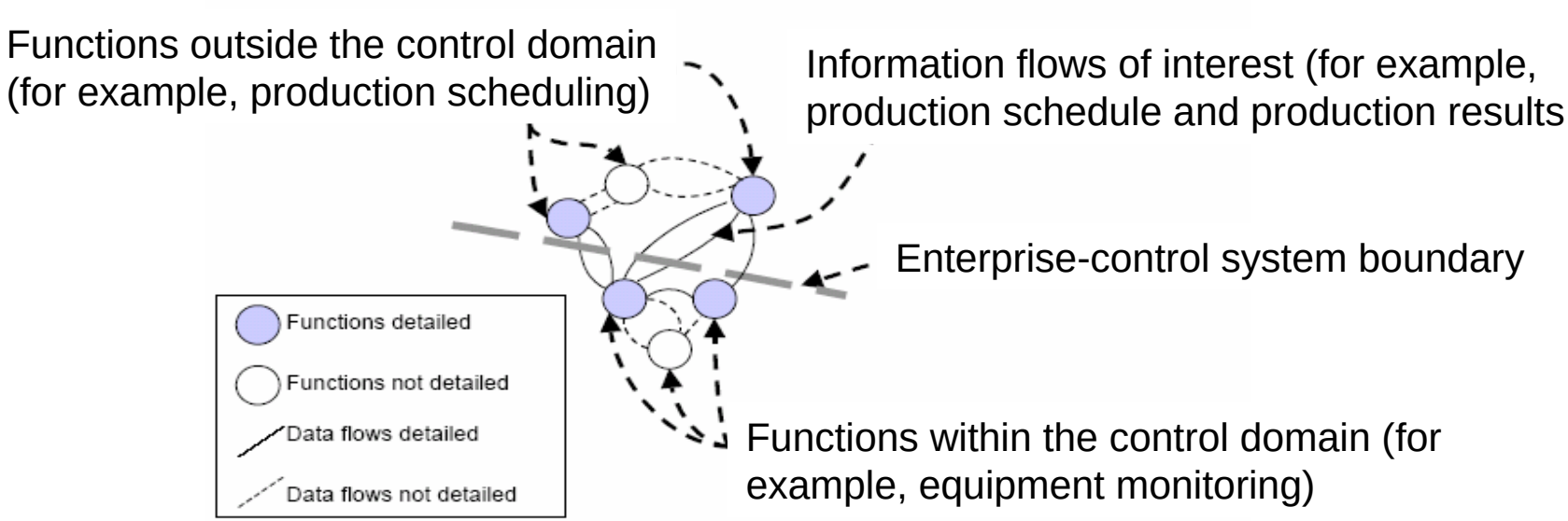
- A platform adapter called the **Resource Management Service Interface**
- A generic device driver with a generic device interface called the **Virtual Device Service Interface**
- A device capability description called the **Device Capability Profile Template**
- Driven by automotive component testing

A boundary standard

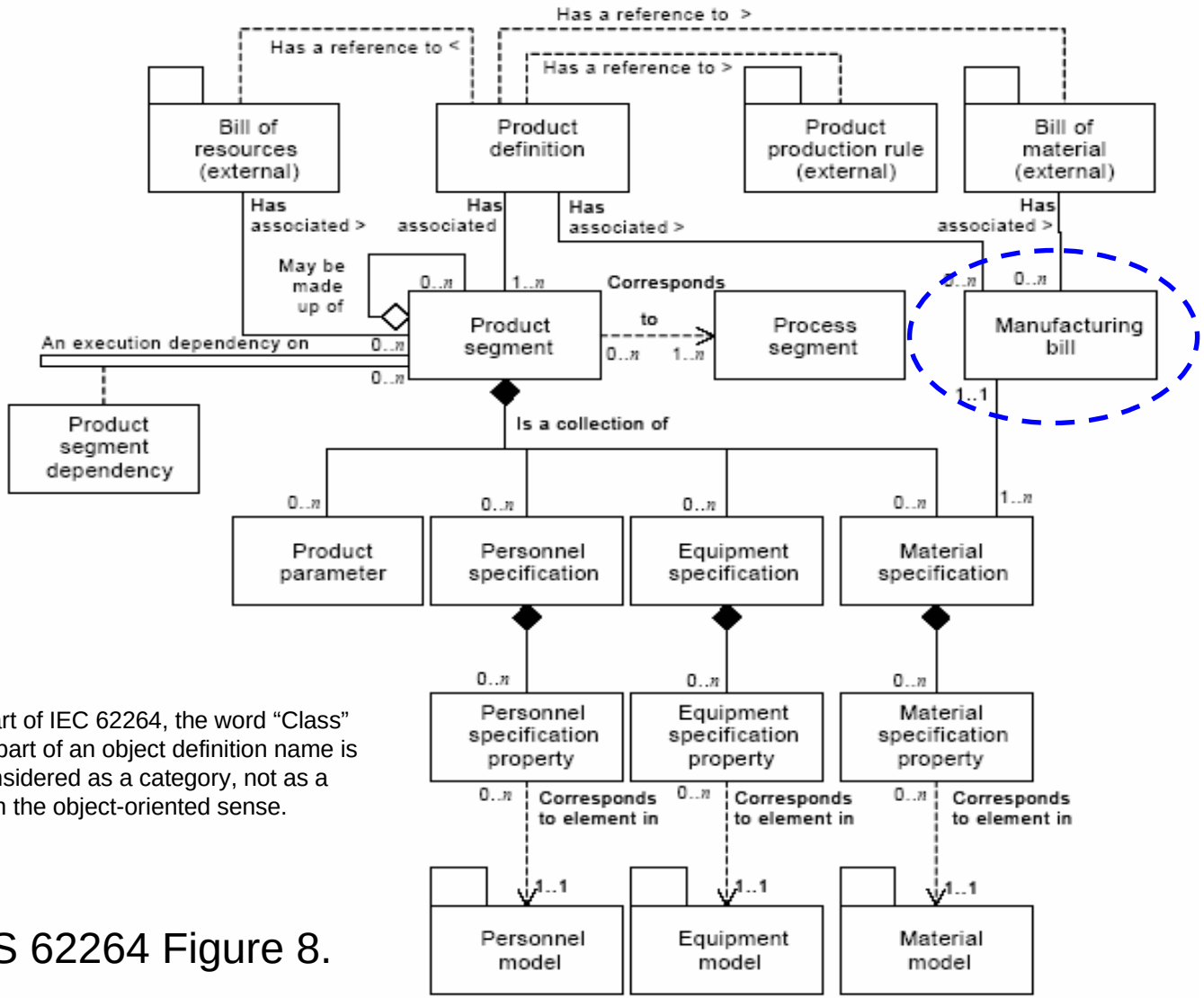
Context
Success
Interop.
Architect
Future

ISO 62264 Enterprise-control system integration

- Object models for interfaces between enterprise business systems and manufacturing control systems



Product definition model



In this part of IEC 62264, the word “Class” used as part of an object definition name is to be considered as a category, not as a “Class” in the object-oriented sense.

IS 62264 Figure 8.

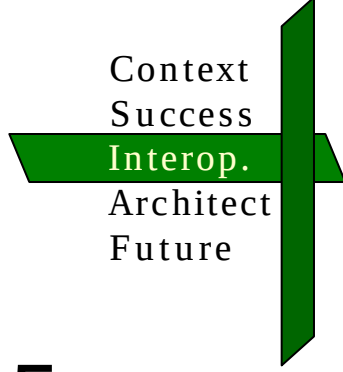
Class model attributes

Table 51 – Attributes of manufacturing bill

Attribute name	Description	Example
ID	A unique identification of a *manufacturing bill*.	10000827
Description	Contains additional information of the *manufacturing bill*.	"All materials required in the manufacturing process for a single widget."
Material class	Identifies the associated *material class* or set of *material classes* required for production. Only the material class or the material property is usually defined.	{Polymer sheet stock 1001A, rivets}
Material definition	Identifies the associated *material definition* or set of *material definitions* required for production.	{Sheet stock 1443a , rivet-10002}
Quantity	Specifies the amount of resources required for production.	{1.0, 26}
Quantity unit of measure	The unit of measure of the associated quantity, if applicable.	{Sheets/piece, number/piece}

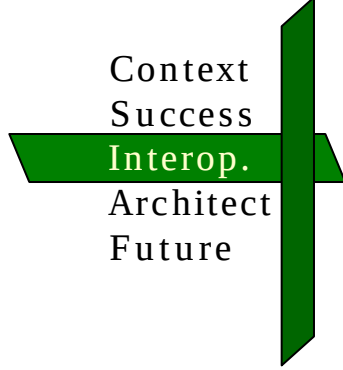
Notice in the examples that there is an implied ordering of the set members. The standard makes no provision for enforcement of correspondence for this ordering between attributes.

MES & ERP integration



- IS 62264 is better known as ISA95
- Selected by SAP and others as basis for MES to ERP information integration
- But, Part 3 : Models of manufacturing operations, is slower to emerge
- Diversity in implementation results in incompatibility among vendor solutions
- A middle-ware market will evolve

Diagnostics/Maintenance

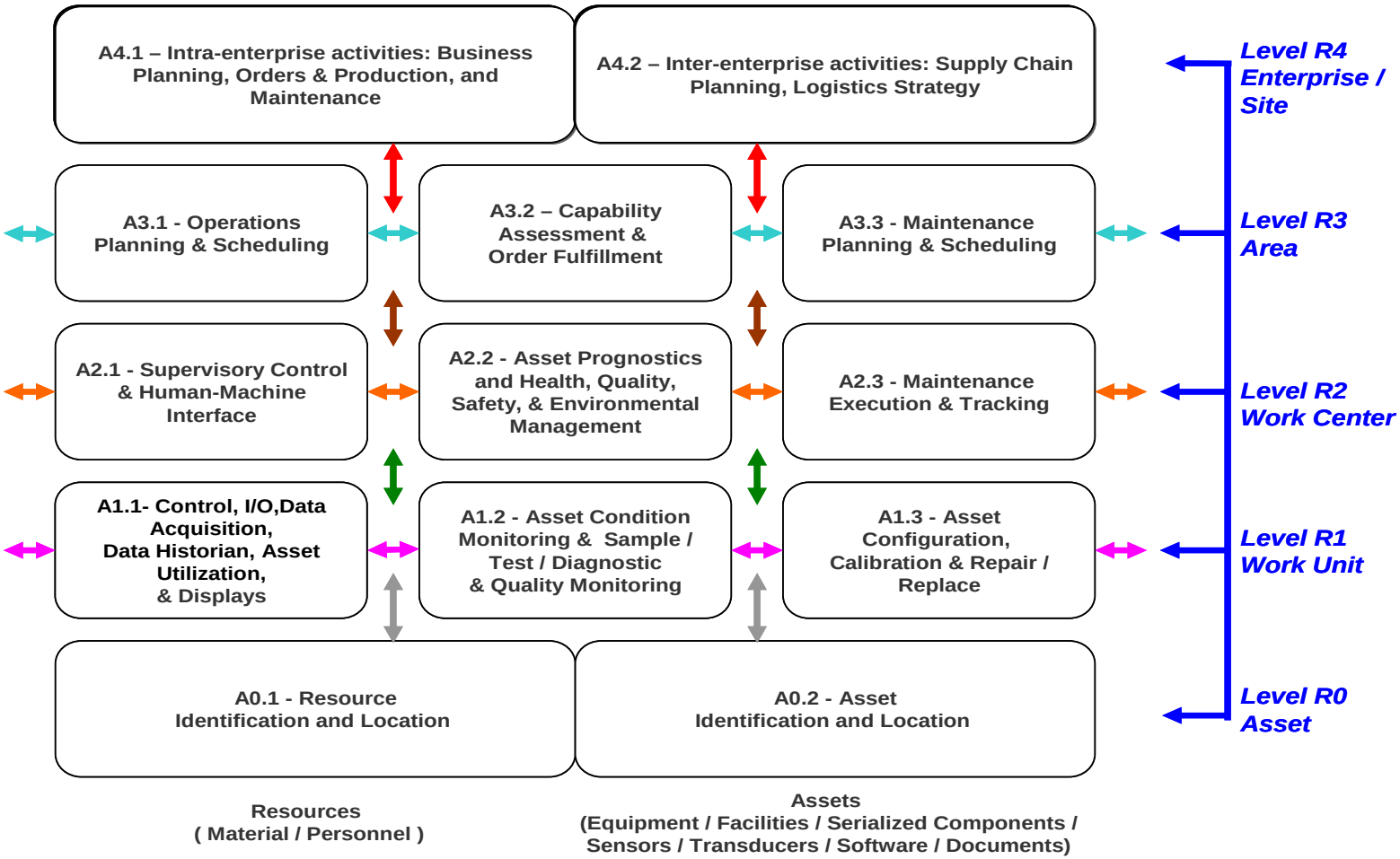


ISO/WD 18435 - Diagnostics, capability assessment, and maintenance applications integration

- application integration reference architecture for equipment & automation devices
- application interoperability profile templates based on selected international & industry standards

Operation levels

Context
Success
Interop.
Architect
Future

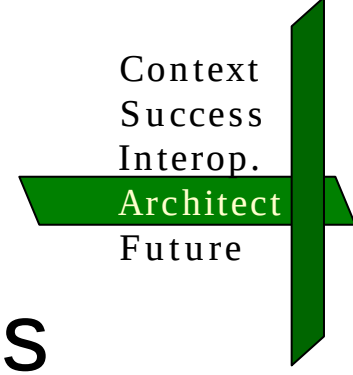


Basic concepts & rules

ISO 14258:1998 Industrial automation systems - Concepts and rules for enterprise models

- Identifies basic concepts for: life-cycle, recursion, and iteration
- Identifies concepts for structure and behavior representation using views
- Places focus of standards for interoperability on inter-process communication.

Generalizing standards

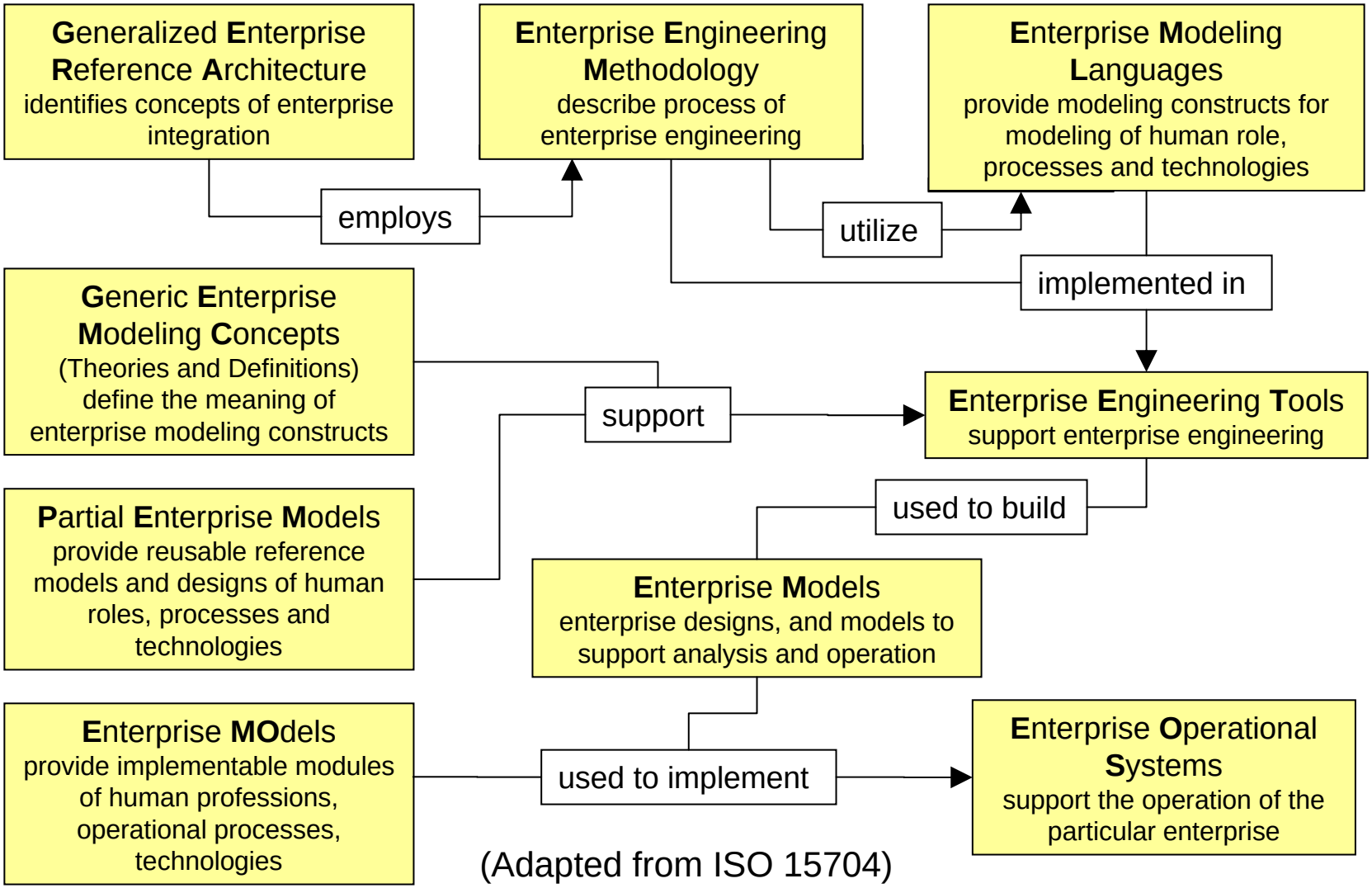


ISO 15704:2000 – Requirements for enterprise-reference architectures and methodologies

- Merging of previous work - PERA, IEM, GRAI GIM, CIMOSA, and GERAM
- Presents principles for enterprise architecture
- Extends ISO 14258 with concepts for life history and genericity.

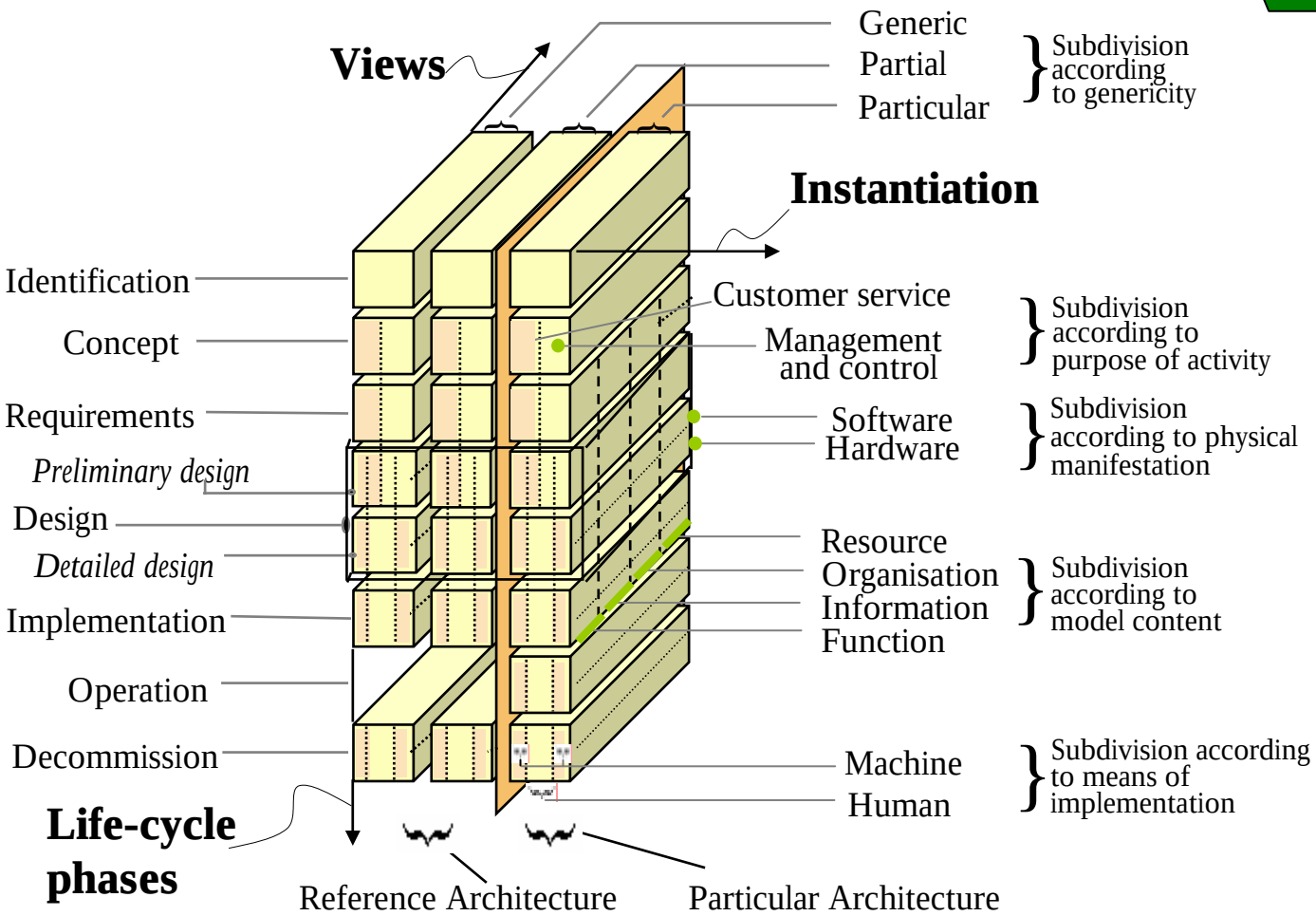
Scope of GERAM

Context
Success
Interop.
Architect
Future



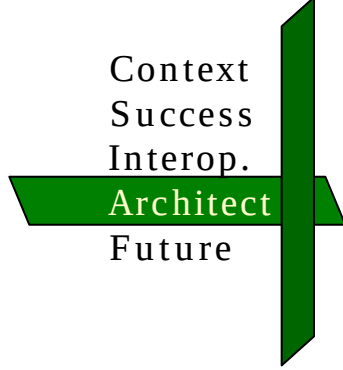
(Adapted from ISO 15704)

GERA framework



Source: ISO 15704:2000 Annex A and Figure 10, The GERA modelling Framework of GERAM [GERAM V1.6.3 http://www.cit.gu.edu.au/~bernus](used with permission)

Unified model framework

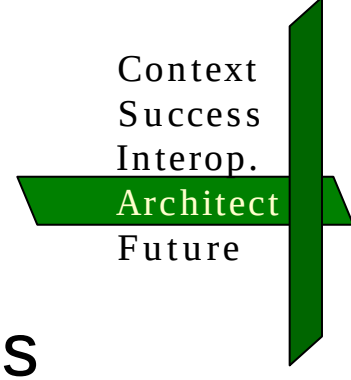


ISO/FDIS 19439

- Enterprise integration: Framework for enterprise modelling

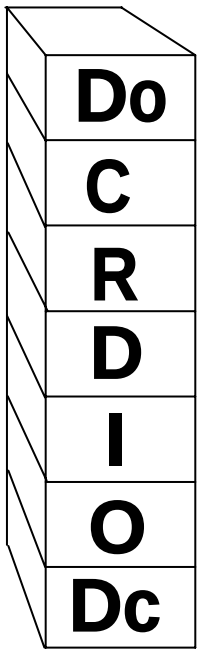
- Based upon CEN ENV 40003:1990
- Objective is to further enable model based execution using enactable models
- Aligned with IS 15704 (a GERA model)
- Articulates 3 dimensions of enterprise modeling as a framework: Phase, View, and Genericity

Model phase -



the purposive ordinant dimension ordered by coordinates corresponding to the phases of the enterprise model life-cycle.

Enterprise **model phase**:



- **Domain** identification
- **Concept** definition
- **Requirements** definition
- **Design** specification
- **Implementation** description
- domain **Operation**
- **Decommission** definition

Identify

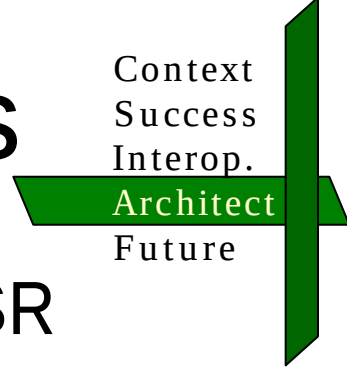
Elaborate

Use

Dispose

Emphasize model development process for process oriented modeling.

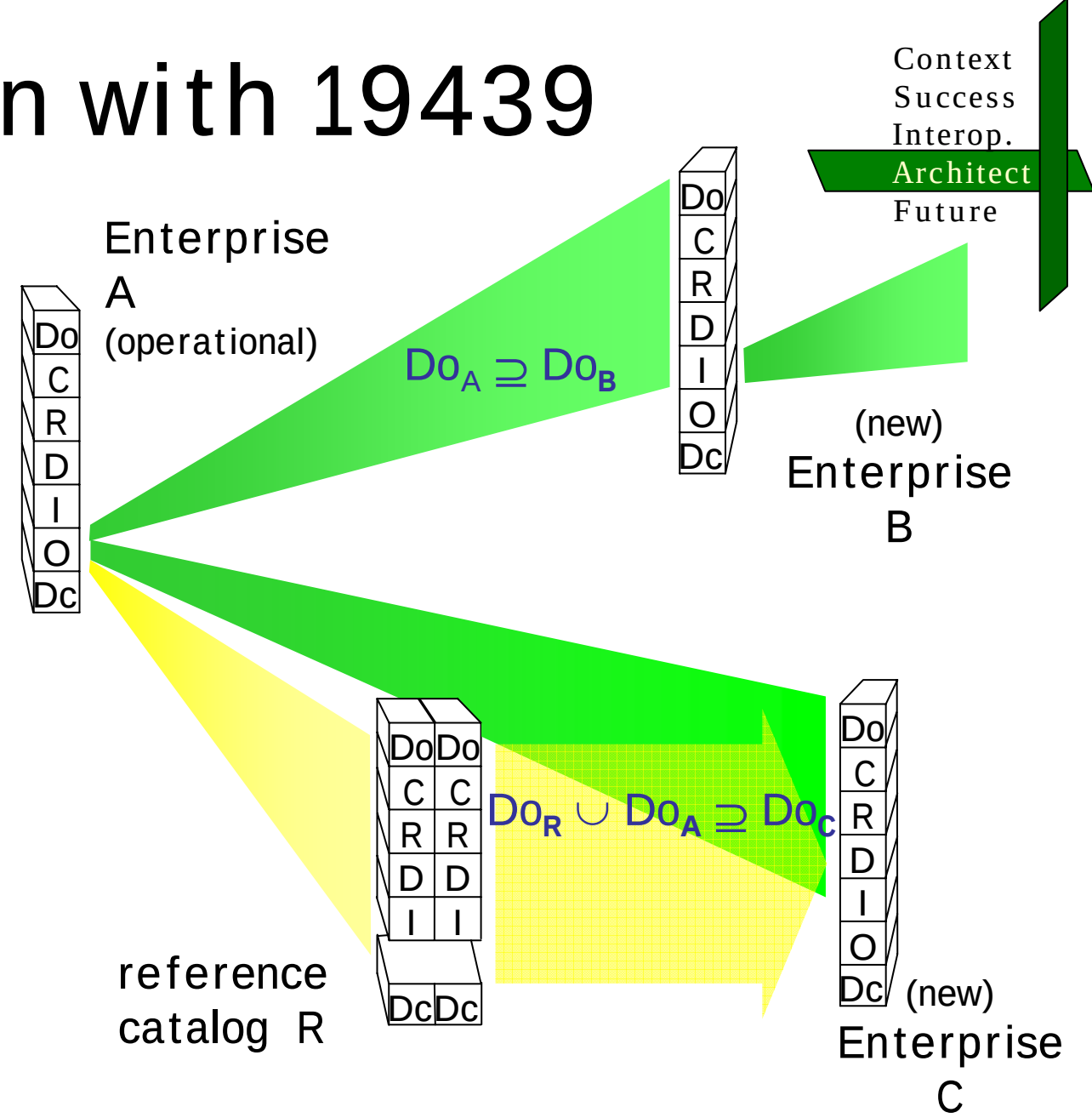
Many possible coordinates



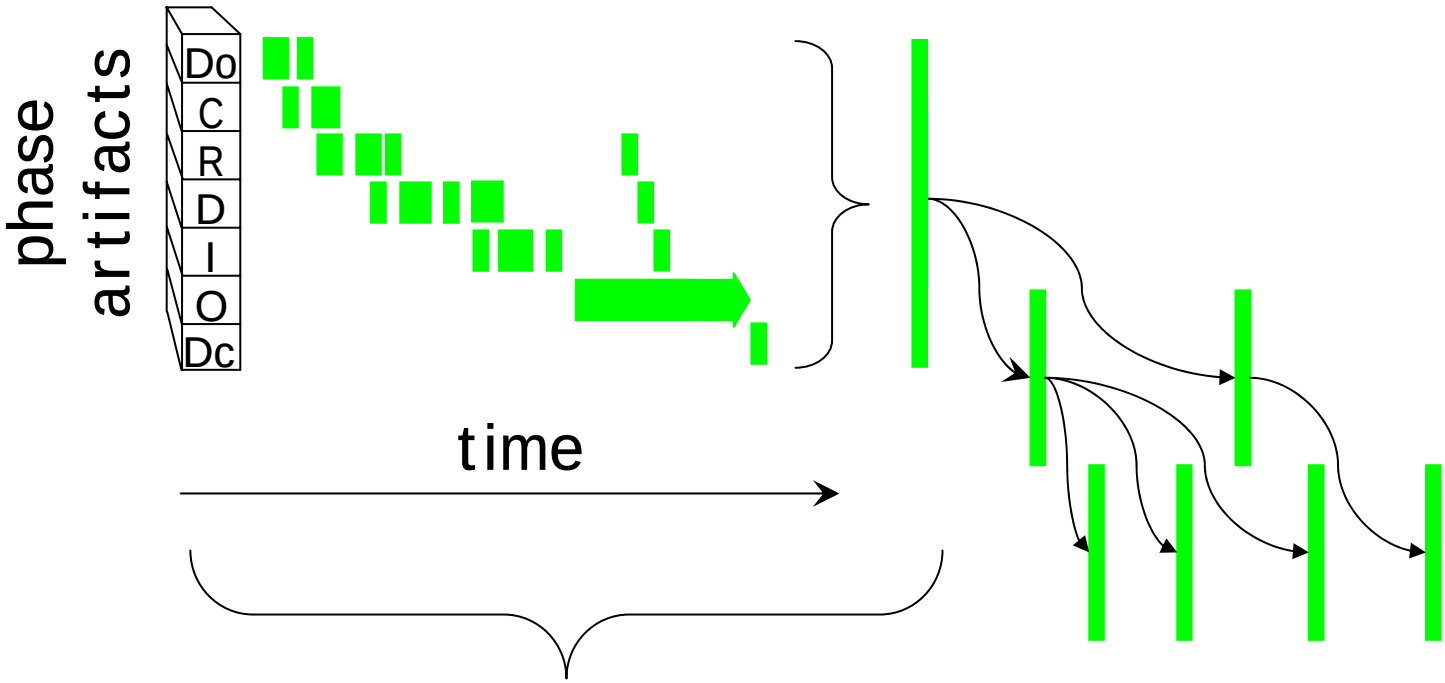
15288 Stage		19439 Phase		C4ISR Guidance
Concept		**Domain**	⟷	**Focus**
		Concept	⟷	**Scope**
Development		**Requirement**	⟷	**Characterize**
		Design	⟷	**Determine**
Production	⟷	**Implementation**	⟷	**Build**
Utilization				
Support		**Operation**	⟷	**Use**
Retirement	⟷	**Decommission**		

Recursion with 19439

Enterprise operations can model new enterprises either from its own particular models or using reference constructs and partial models.



Life history with 19439



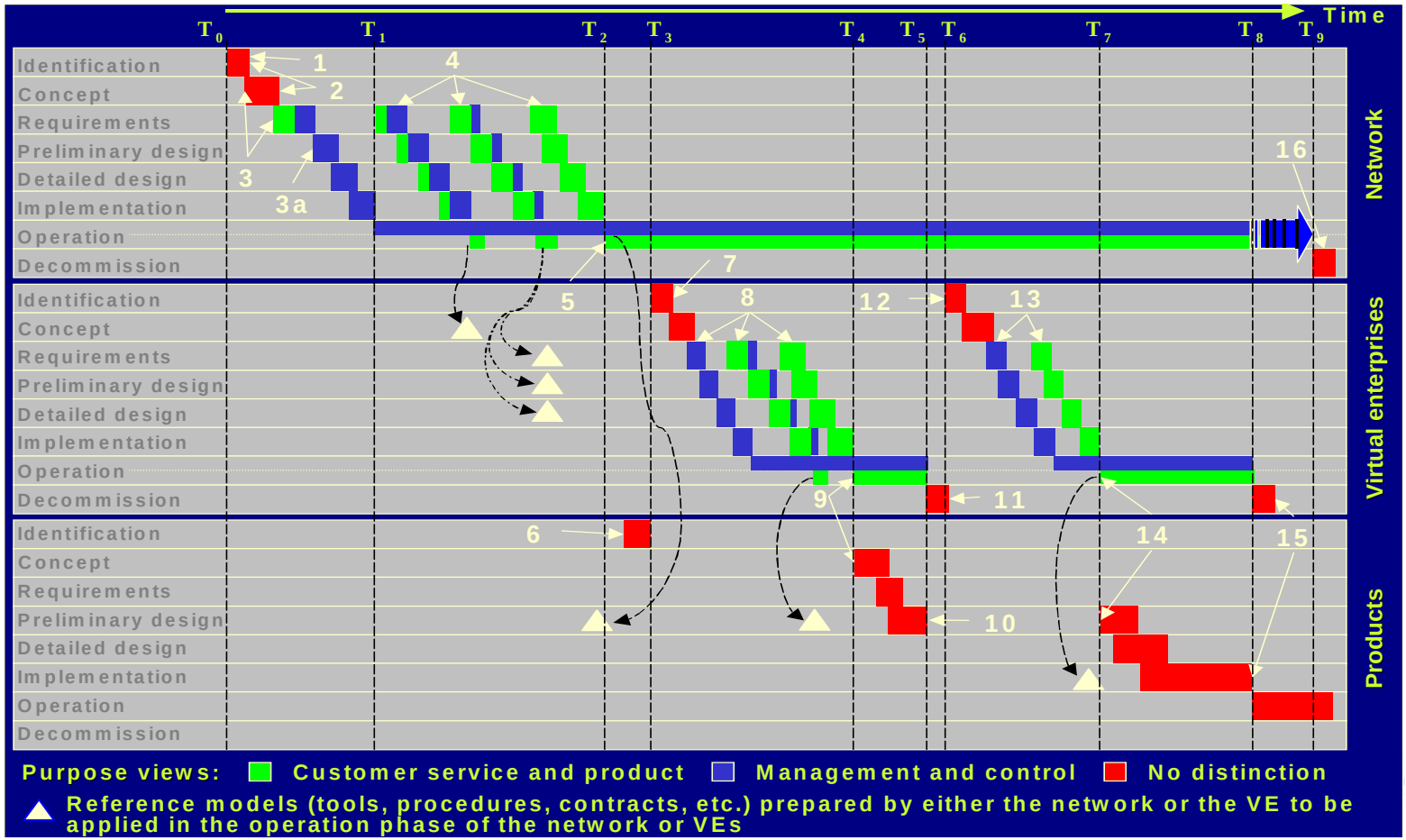
a complete life-cycle

a life history pictogram of related life-cycles

(point-in-time system set)

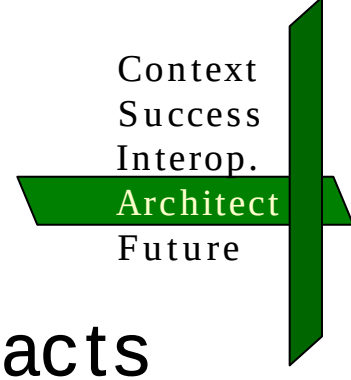
Adapted from P. Bernus, Griffith University, Australia

3 linked life-cycles



Source: J. Vesterager, P. Bernus, J. Pedersen & M. Tolle, The what and why of a Virtual Enterprise Reference Architecture, in E-work and E-commerce: Novel solutions and practices for global networked economy. B. Stanford-Smith and E. Chiozza (Eds) IOS Press, Amsterdam (2001) Used with permission

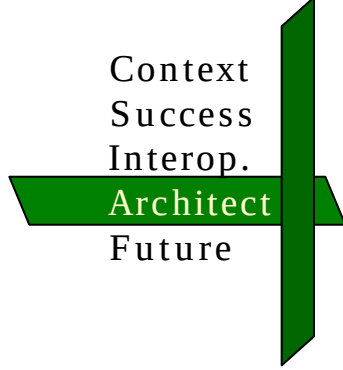
Model View -



an unordered ordinant dimension with pre-defined coordinates that partition facts in the unified model relevant to particular interests and context.

- A prescriptive partition of model content with distinct aspects considered sufficient for most discrete manufacturing
- View content varies with life-cycle model phase
- Function, Information, Resource, and Organization views

Model Genercity -



an ordered ordinant dimension that reflects 19439 as a “standard” framework.

Enterprise **genericity level**:

- **Generic** - reusable modeling language constructs
- **Partial** - prototype models of industry segment or industrial activity

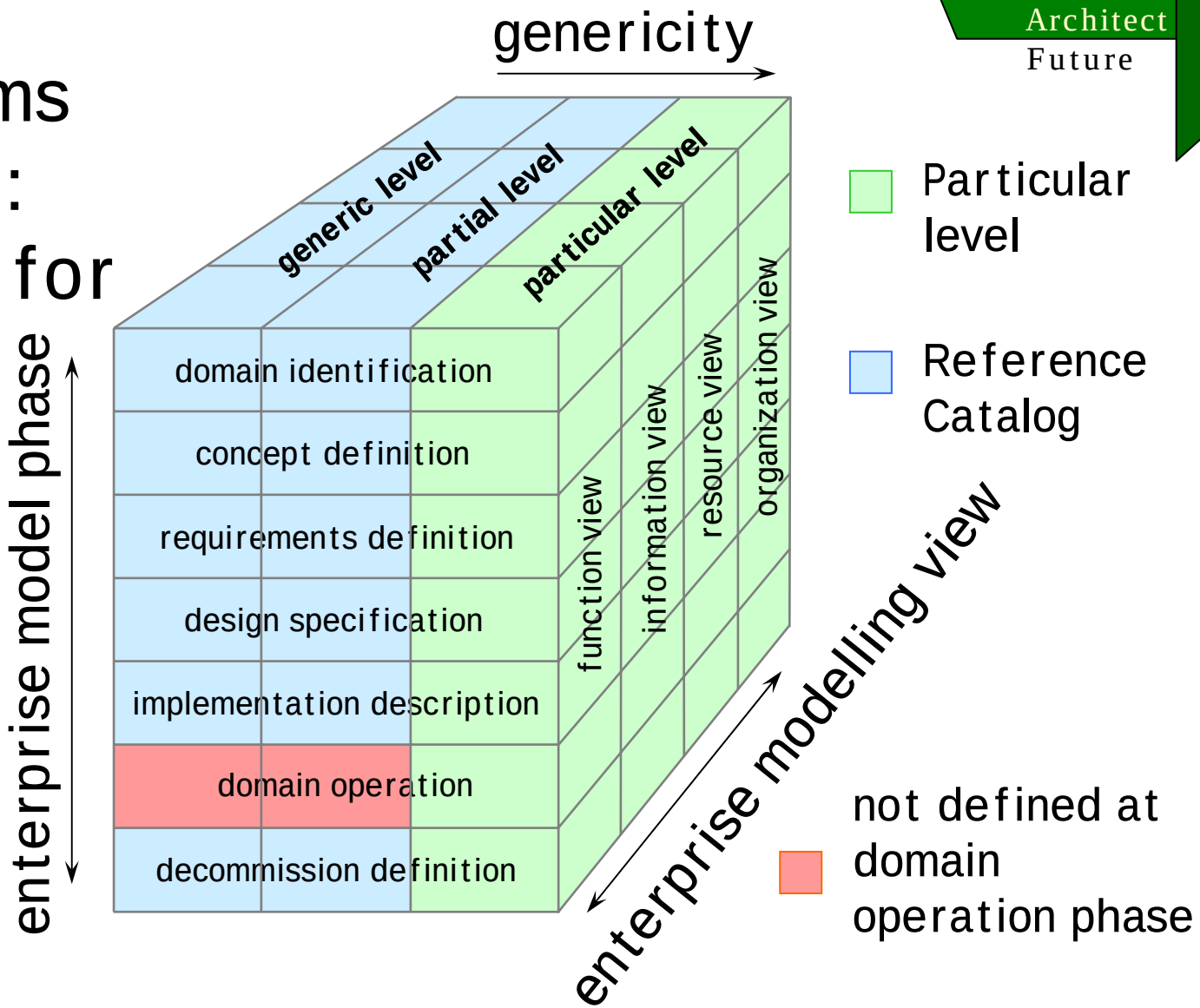
Reference catalog

- **Particular** - models of a particular enterprise domain

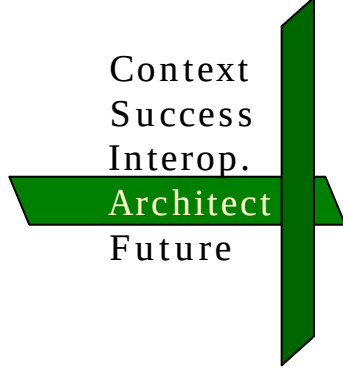
Graphic 19439 dimensions

Context
Success
Interop.
Architect
Future

CIM Systems Integration: Framework for Enterprise Modelling



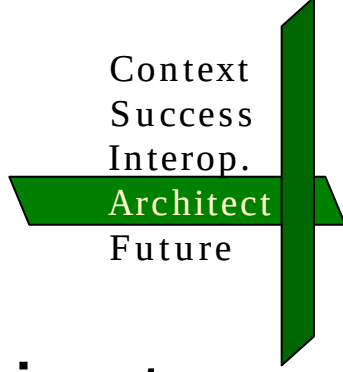
Modelling constructs



ISO/DIS 19440 Enterprise integration – Constructs for enterprise modelling

- Based upon CEN ENV 12204:1996
- Aligned with 15704 (an EML artifact)
- Articulates modeling constructs for manufacturing automation
- Organization and specialization using templates into structures for a specific purpose

Constructs of 19440



Domain

Business Process

Enterprise Activity

Event

Enterprise Object

Object View

Product

Order

Resource

Functional Entity

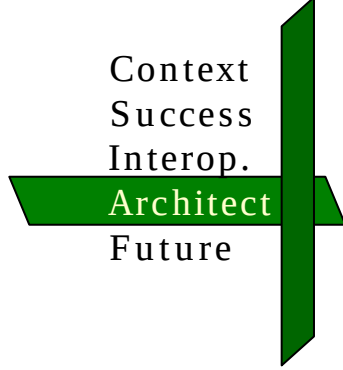
Capability

Organizational Unit

Organizational Role

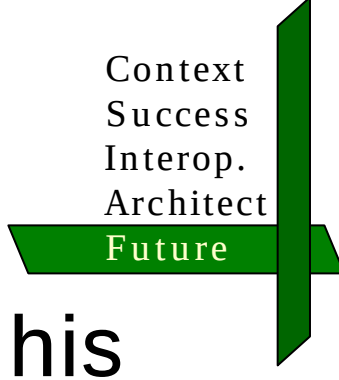
Decision Centre

Construct across phases



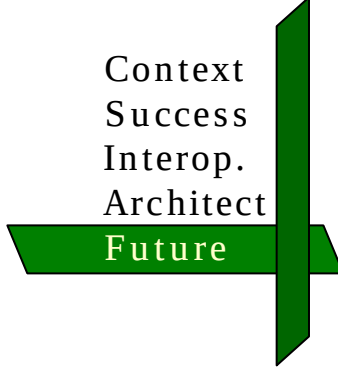
Construct label	EO (Enterprise Object)
Identifier	<model-unique string>
Name	name of the Enterprise Object instance
Design Authority	[<identifier> "/" <name>] of Organizational Role or Organizational Unit with authority to design or maintain this particular instance
Body ***A1 Descriptives relevant for all enterprise model phases***	
Description	short textual description
Nature	PHYSICAL | INFORMATION
Attributes	[<property_name><property_value>]* – elements representing properties and their values for the entity represented by the Enterprise Object instance
Constraints	[<constraint>]* imposed on selected named Attributes of the Enterprise Object instance
A2 Descriptives relevant for different enterprise model phases	
A2.1 applicable at concept definition and later phases	
Not applicable	
A2.2 applicable at requirements definition and later phases	
Integrity Rules	[<integrity rule>]* applicable to ATTRIBUTES of the Enterprise Object instance in the requirements definition phase

WG1 Future actions



- ISO/FDIS 19439 to enter ballot this summer with 2005 publication expected
- ISO/DIS 19440 to enter ballot this summer - comment resolutions to occur 2005 – 2006 & publication in late 2006
- ISO 15704 systematic review begins this summer with revision target 2007
- NWIP for Process Analytics View using 19439 framework and 19440 constructs

Future SC5 Efforts



- Simulation tool integration requirements and criteria
- Use case for multiple standard use
- Coordinated asset registry
- Activity integration across levels
- Terminology harmonization
- Database of software unit capability
- Automation security