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Sistemska arhitektura raļ unalniġko integrirane proizvodnje (CIM) ï Storitve za izvajanje podjetniġkega modela in integracijo ï Evalvacijsko poroļ ilo

CIM Systems Architecture - Enterprise model execution and integration services - Evaluation report

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CIM Systems Architecture -
Enterprise model execution and integration services -
Evaluation Report

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CIM SYSTEMS ARCHITECTURE
ENTERPRISE MODEL EXECUTION AND INTEGRATION SERVICES
EVALUATION REPORT

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CIM SYSTEMS ARCHITECTURE
ENTERPRISE MODEL EXECUTION AND INTEGRATION SERVICES – EVALUATION REPORT

Foreword

European Standardization in the field of AMT is undertaken by CEN TC310, Advanced Manufacturing Technology. In turn, its working group CEN/TC 310/WG1, "Systems Architecture", hereafter referred to as TC310 WG1, is concerned with standardization work in the field of CIM Systems Architecture. This work is to be a pre-cursor and a contribution to the development of CEN and ISO standards in this area. In 1990 CEN/CENELEC WG-ARC (the precursor to TC310 WG1) completed the ENV 40 003, CIM Systems Architecture – Framework for Enterprise Modelling (Reference1 1). In 1992 WG-ARC completed an Evaluation of Constructs for Function View as defined in ENV 40 003 – that evaluation has been published by CEN/CENELEC as a Technical Report R-IT-06 (Reference 2).

In late 1992, WG-ARC was mandated (as shown in Annex A) to review national, European and international initiatives relating to Enterprise Model Execution and Integration Services[2] (EMEIS) required for the execution of manufacturing enterprise models. This work is to be seen as a step toward establishing the requirements for a European standard in this area. This Evaluation Report by TC310 WG1 constitutes evaluation part of the results of that review.

0 Introduction

As a step in preparing for the review of initiatives, CEN/TC 310/WG1 developed in May 1993 a checklist of requirements reproduced here as clause 2. Experience in this work and further development of WG1's thinking have been used in the development of Reference 3, Statement of Requirements fro EMEIS.

The checklist of clause 2 was used to review the contributions received in answer to the call for input issued in February 1993 (a copy of the call is attached as Annex B), as well as the material previously submitted by the AMICE consortium in June 1992.

Because of the varied nature of the contributions and because some refer to research work in progress, the WG decided that it would conduct an assessment exercise for understanding, rather than a detailed evaluation. These contributions are therefore summarised in clause 3, followed by a high-level review against the topics raised in the checklist.

Lastly clause 4 presents conclusions and proposals for future action.

1 Scope

This Evaluation Report reviews contributions received from projects in answer to a call for input on a Framework for Integrating Infrastructure. It should be read in conjunction with the Statement of Requirements which introduces the concepts used in the evaluation process.

In accordance with the mandate reproduced as Annex A, this report is concerned with:

- The "collection and evaluation of existing separate initiatives on Frameworks for ... Enterprise Model Execution and Integration Services" for the execution of enterprise models specific to CIM and model components.
- "As a requirement, such initiatives shall be in line with the ENVs developed through Mandate BC-62 and with ENV 40 003".

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1) References are contained in Annex C, Bibliography.
2) Previously called Integrating Infrastructure – the new term EMEIS has been adopted for increased clarity and to show the necessary linkage between model development and model execution.

This work is a preliminary step towards the drafting of a "European Standard (ENV in the first phase) defining the requirements [for a] Framework for the Enterprise Model Execution and Integration Services within the areas of CIM Systems Architecture" (with reference to work items M.0.1.4.1 and M.0.1.4.2. of CEN/TC310 N33 Issue A, August 1993.

The enterprise model(s) have to support integration of physical components, integration of applications and information, and, at the highest level, integration of business requirements. The use of such enterprise models requires supporting services, EMEIS.

The overall requirement for the EMEIS is:

- To support the execution of a model or model components for the day to day management of the enterprise, and
- To support the embedding of these model components into and within the supporting execution environment.

Particular requirements for the EMEIS are currently foreseen as the ability to support:

- On-going changes in the modus operandi of the enterprise,
- Life-cycle concerns for models and model components,
- Structures and objects composed of data of different kinds and from different sources,
- Co-ordination of the structures and objects.

These requirements were elaborated in the Statement of Requirements (Reference 3) and have been used as the basis for the checklist and evaluations that follow.

2 List of concerns as used for review of initiatives

The following questions were developed to support the evaluation exercise, the results of which are reported in clause 3. During the course of that exercise the TC310 WG1 found that some clarifications and additional questions would be required in any future evaluation. In the interest of consistency the questions that follow have not been changed, although the clarifications and additions are shown as footnotes.[3)]

2.1 Model

Q1 What visibility is there of concepts of **model, models, model components?**

Is the released model complete in itself requiring only run-time resources to be supplied? Is it one of a number of loosely coupled models that require communication between them? Is it rather a released component of a model (such as a plan fragment) which requires linking to other components before execution?

Q2 How does the model represent:

- Derived functionalities?
- Embedded processes (include control, timing and behaviour)?
- Necessary information and other resources?
- What else is represented explicitly in this approach (e.g. obligations as in Eiffel)?

The issue here is to represent:

- The functions – what has to be done,
- The process – when or under what conditions something has to be done,
- The information/resources – what is/are needed to do it.

3) One question missing completely is whether this modelling approach or IIS proposal attempts in any way to be transportable to usage in different areas? What's the extent of cross-applicability?

2.2 Release/integration/execution

Q3 What is the **level of integration?**[4)]

- (Lowest) Through communication between running model processes?
- Through shared data?
- Through shared use of common services? (which might themselves managed needed resources.)
- Through meta-models?
- Through shared semantics (data dictionary etc.)
- (Highest) Through semantic unification, e.g. through dynamic search and pattern matching as in Prolog?

Q4 What **binding paradigm** is used (concept, interpretation)?

- Where does the binding take place (in the model development environment; at run-time; both)?
- Is the binding obligatory and predetermined?
- How does the contribution characterise the binding being used? [TC310 WG1 should be open to both early and late binding]

Q5 What **modelling language** is used to represent the model(s) or model components?[5)]

- What attributes of the model does this language capture? (e.g. business processes; functionality; information structures; process and control information.)

Q6 Does the model support **predictability** of run-time behaviour (including performance)?

- Is the use of resources and methods pre-determined (so that ISO 9000 assurances can be given) or opportunistic (so that improved methods can be added and adopted dynamically by existing running models say)?

Q7 What is the paradigm used for **invocation of executable** model component?[6)]

- Eager evaluation (evaluate as soon as all resources are available),
- Lazy evaluation (evaluate only when unavoidable),
- Controlled evaluation, under the direction of some controlling process,
- Context-driven application protocol.

Q8 What **CIM-specific semantics** (or application-specific semantics) are visible during model execution?[7)]

- CIM ontology?
- CIM class library (including CIM application-methods?)
- CIM-specific notions such as consumable resources? Resources whose nature is changed during production?

Note – some visibility of CIM-specific concepts might be needed during run-time to allow professional responsibilities to be undertaken.

2.3 Lifecycle

Q9 Is the question of **lifecycle (of model(s),** of model component) addressed and, if so, how?

- Is the approach used linked to the binding mechanism used, e.g. by maintenance of a binding trail allowing components to be withdrawn or replaces and the consequences managed?

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4) An issue to be addressed in future is whether the mechanisms of integration relate to the model itself or to some other aspect of operational integration?

5) This question should be rephrased to say, is the need for a modelling language recognised, and is one specified?

6) One evaluation team felt that this question was not sufficiently clear; is it really a Q11 issue to do with API protocols?

7) Is this visible to the IT? Visible to the model? Visible to the user?

2.4 IT support

Q10 What is the **definition of service** in the contribution being evaluated? Take ISO TC184 SC5 WG1's definition as a reference concept here.

Q11 How are the "General IT Services" and other services **accessed**?

Q11.1 What is said about the assumed **execution environment** (e.g. a platform such as CORBA, XDCS, DCE, general client-server paradigm)?

Q11.2 Which services provide **desired execution environment properties**? (e.g. ability to distribute processes; ability to distribute data; ability to federate processes not previously constructed to be distributed from some larger component – wrappers come in here as described in AMBAS-SOOM; security; timing – clocks with known performance etc.)

Q11.3 What other **less IT or execution environment oriented services** are visible?

- General process managers such as:
  - Presentation managers (a service providing the appropriate presentation for a resource to be used in carrying out some operation),
  - Flow/activity managers (interpreting control information and initiating appropriate processes),
- Resource managers.
- Are there CIM-specific services too? (e.g. access to STEP or EDI services)
- What "less IT oriented" services are identifiable?

Q11.4 When are **services invoked** (e.g. context-driven application protocol, explicit API etc.)?

Q11.5 How might the contribution **define Enterprise Model Execution and Integration Services**?

Q12 How is the "**Level**" between the **model and its executing environment** (the one in which the model is executed, its execution environment) described?

3 Evaluation of initiatives against the concerns

The general format of this clause is that an extract or summary of material provided by a project is presented, followed by a brief statement of findings from the evaluations. Six contributions have been examined. They are:

- CIMOSA,
- Ulrich Flatau: EMEIS entities,
- MIDA,
- PISA,
- TOVE, and
- Information Systems Architecture

The contributions themselves are enclosed within framed text boxes and have an internal numbering scheme starting with an initial corresponding to the project or author of the proposal.

3.1 CIMOSA

3.1.1 Contributions (from Reference 4)

C1 Entities within an integrating infrastructure (II-entity)

C1.1 Functional representation of an integrating infrastructure

The functional representation is of an IIS is aimed at locating and positioning main functions which will fulfil the set of collected requirements and is composed of five entities, each if which consists of a set of services provided by IT components.

Borders between entities are independent of the IT components that will provide the identified services for those entities. In other words, if some IT components are changed, borders between entities are still valid.

Those IT components will later be identified as a combination of:

- Existing services available as International standards (De jure standards),
- Existing services available as industry standards (De facto standards),
- Deliverable from other research projects,
- New services to be specified and proposed for standardization.

Entities of the functional representation leave open the choice of particular IT components but allow to position them.

According to these principles and rules, the CIMOSA Framework provides a functional representation of an integrating infrastructure. This representation has a similar level of abstraction to the "ODP computation viewpoint".

Five entities have been selected because:

(i) "it is a well established fact that existing applications usually mix the following functional areas":

Data management, corresponding to **information**

Interactions with human beings and with devices, requiring **presentation**

Functions which serve **business** needs (e.g. computation for "production planning", sequencing of operations for "shop floor control",...)

IT industry trends show that data management and interactions issues can be removed from the processing area.

(ii) Many of the IT services required by the above functional area can be provided in a common manner, and also a common management capability is required for all the functional areas and common services. This leads to:

Common provision of base services

Common management of systems resources.

Starting from these facts and abstracting from the industry trends, [CIMOSA has] formalised the following entities:

Information Entity,

Presentation Entity,

Business Entity

to address the functional representation of item (i).

The **"Common Services Entity"** is [then] introduced to locate where there are solved issues which are common to the previous entities. Most of those issues are raised by the distribution, by communications and by associated transparencies.

Standardized management functions are now [regularly used] in the area of Network Management (e.g. in OSI or TCP/IP communications), and Operating System Resources management (e.g. printing system, licensing system,...) Therefore the **System Management Entity** is introduced to extend those functions to the management of new "things" introduced in an integrating infrastructure (e.g. "things" as new services to be specified and proposed for standardization).

The functional decomposition therefore results in a representation having 5 entities ...[which] are defined in the following subsections (C1.3-C1.7).

Each entity may have interactions with any other entity. Interactions are identified and specified between the individual services defined within the entities.

The 5 entities are supported by traditional IT means (e.g. Operating systems, networking sub-systems,...). The access to those IT means is not restricted to the entities. The description of those means and the access to them, is out of the scope of [this proposal for a] Framework for integrating Infrastructure.

C1.2 Link between the modelling and the Integrating Infrastructure

In accordance with the "Framework for Enterprise Modelling" and the present Framework, the basic principle of the Enterprise control is through the "execution" by the Integrating Infrastructure – and more especially by the Business Entity – of the Particular Enterprise Model.

The detailed procedure for setting up the executable model is not in the scope of this Framework but it will be the matter of a further specific standard.

As an example, we give below a procedure to set up a model in two main steps.

The first step results in a model expressed in a Formal Language. This procedural work can be aided through an IT tool (Computer Aided Enterprise Engineering).

Then in the second step, an "Interpreter/Compiler/ Translator" converts this last model into the "Executable Enterprise Model" which is composed of a set of function calls.

The "Executable Model" is processed in the Business Entity, supported by the services of other entities, which finally delivers the flow of Enterprise controls.

The "Interpreter/Compiler/Translator" may be integrated in the "Computer Aided Enterprise Engineering", or also be attached to the Business Entity.

The "Computer Aided Enterprise Engineering Environment"[8] – not detailed in this Framework – is a set of functions which can be supported by the same platform as the Integrating Infrastructure or by another and specific one. The CAEEE is related to the CAEE (Computer Aided Engineering Environment) of Figure C1 but should make available enterprise information during model engineering time. The IIS should be used for model engineering as well.

8) Called Model Development Services (MDS) elsewhere in this report.

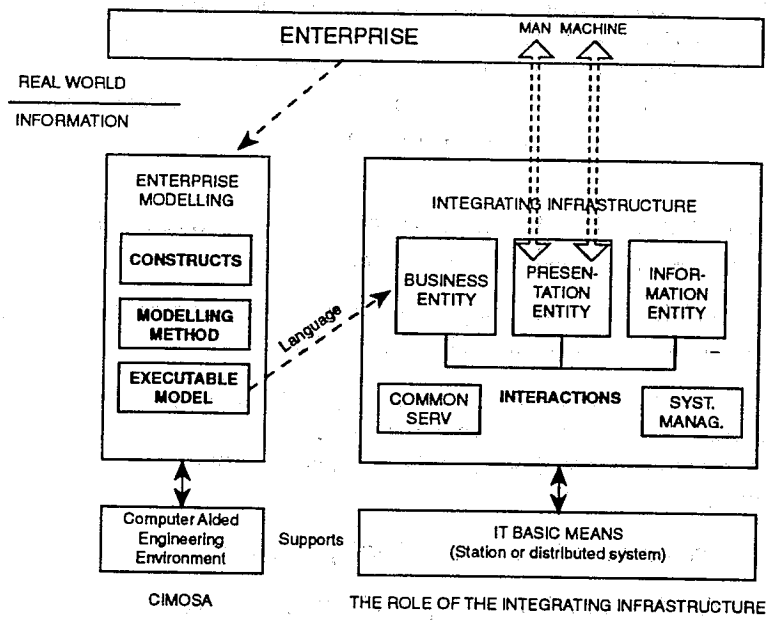

Figure C1: The role of the Integrating Infrastructure (from CIMOSA)

The easiest adaptations of the Enterprise model along the Enterprise Life Cycle are obtained through using a common IT platform for the CAEEE and the Integrating Infrastructure.

C1.3 Business Entity

GOAL: Provide generic functions to initiate, monitor and control the Enterprise operations, in accordance with the particular Enterprise model, by processing the corresponding executable model.

Functions:

- To support the co-ordination, the sequencing, the synchronisation of the Enterprise operations,
- To support event driven enterprise operations,
- To manage the resources of the enterprise,
- To support flexible change of enterprise operations,
- To allow human interventions to deal with exceptional events (with the aid of the "Presentation entity").

According to the ultimate goal for CIM, complex applications will be decomposed into a set of models and elementary functions. Models are the place where the knowledge of the enterprise is captured, whatever are the means to represent this knowledge. Models include the description of the behaviour of the enterprise. The Integrating Infrastructure provides generic functions to control the enterprise operations according to the models (i.e. according to the behaviour described in the models). Elementary functions are supported by components which are particular to each enterprises. Those components are resources from both manufacturing and IT environments.

NOTE: In existing industrial automation systems, the knowledge of the enterprise behaviour is encapsulated in relatively complex applications. At operation time, the control and elementary functions are processed by those applications.

The Business Entity locates places where the control of the enterprise operations is processed. At the ultimate goal, this entity will provide generic functions to perform this control.

Additionally, the Business Entity provides those functions to perform resources management which are closely related with the control of enterprise operations. Those functions are