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CIM Systems Architecture - Enterprise model execution and integration services -  
Statement of requirements

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**ICS:**

35.240.50	Uporabniške rešitve IT v industriji	IT applications in industry
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English version

**CIM Systems Architecture -  
Enterprise model execution and integration services -  
Statement of requirements**

**iTeh STANDARD PREVIEW**

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Ref. no. CR 1832:1995 E

**CIM SYSTEMS ARCHITECTURE  
ENTERPRISE MODEL EXECUTION AND INTEGRATION SERVICES  
STATEMENT OF REQUIREMENTS**

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## **CIM SYSTEMS ARCHITECTURE ENTERPRISE MODEL EXECUTION AND INTEGRATION SERVICES STATEMENT OF REQUIREMENTS**

### **Foreword**

European Standardization in the field of AMT is undertaken by CEN TC 310, Advanced Manufacturing Technology. In turn, its working group CEN/TC 310/WG1, "Systems Architecture", hereafter referred to as TC 310 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 TC 310 WG1) completed the ENV 40 003, CIM Systems Architecture – Framework for Enterprise Modelling (Reference<sup>1</sup> 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<sup>2</sup> (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 Statement of Requirements by TC 310 WG1 constitutes the main outcome of that review.

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/TC 310 N33 Issue A, August 1993).

TC310 WG1 intends, within a relatively short time, to develop this note into a ENV under mandate IT-225B.

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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.

## 0 Introduction

The scope of the work and the overall requirement for an Enterprise Model Execution and Integration Services (EMEIS) are defined in Clause 1, which is followed by a short Clause listing the terms and definitions used for the purpose of this report.

Clause 3 presents the general case for business integration in the domain of manufacturing, and then introduces the enterprise model-based approach taken by ENV 40 003.

The report sets out in Clause 4 a simple reference model for Enterprise Model Execution and Integration Services. This reference model is used to present major EMEIS concepts in relation to each other and to the environment within which the enterprise model is developed, and to provide a consistent basis for discussion of specific issues and points of detail.

Clause 5 describes the general principles used in developing statements of EMEIS requirement.

Clause 6 reviews the role of the enterprise model in achieving integration of enterprise operations and the supporting requirements for integration of information and resources. It contains high level descriptions of the functionality required for Model Development Services, Model Execution Services and General IT Services.

Clauses 7 and 8 set out more detailed requirements, covering first those concepts that are to some degree CIM-specific and then the more general requirements for supporting IT. The latter are likely to be met by general IT standards, while the former are likely to lead to proposals for new CIM-specific standardization work items. It is important to note that the Framework for EMEIS is concerned with requirements, not mechanisms, but it does need place holders and generalisations for what those mechanisms provide.

The requirements of the various Clause of this Statement of Requirements, have been used to generate the checklist used for the evaluations and proposals for actions reported in the companion evaluation report.

## 1 Scope

This CEN Report is a Statement of Requirements. The Report describes a reference model and then details requirements for Enterprise Model Execution and Integration Services (EMEIS) expressed in terms of that model.

This CEN report also stands as an introduction to the companion CEN Report on CIM Systems Architecture: Enterprise Model Execution and Integration Services: Evaluation Report by setting out necessary concepts, the relationships between these and the requirements for the services which are needed to support integration and execution of enterprise models and model components.

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".

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) [standards.iteh.ai](http://standards.iteh.ai)

The overall requirement for the EMEIS is: [SIST CR 1832:2003](http://standards.iteh.ai)

- To support the execution of a model or model components for the day to day management of the enterprise, and [a83b59d32c68/sist-cr-1832-2003](http://standards.iteh.ai)
- 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.



## 2 Terms and Definitions

For the purpose of this CEN Report, the following terms and definitions apply.

### application program

A program capable of taking the highest level of control in a computer system, that is, it need not (but may) have another program call it – this is in contrast to a service, which executes only in response to a client request.

### building block

A concept or theory devised to integrate in an orderly way the diverse data on a phenomenon. For the purposes of information modelling, a building block is an information element that models generic elements of the field being modelled.

NOTE – Building block concern exclusively those elements that have a sense in the terms of the field they model. In other words, they get their legitimacy from the fact that they have counterparts in the field modelled (homomorphism).

- Requirement building blocks model enterprise elements;
- Design building blocks model elements of the field of the design modeller;
- Implementation building blocks model elements of the field of the implementation modeller.

The elements could be physical or logical, static or dynamic.

A building block that has a structure which can be interpreted or instantiated (in case of an object) by a computer system is defined to be a model component.

### construct

An element of a descriptive language and rules for the connection e.g., in a programming language, constructs are defined to describe programs.

NOTE – As far as possible, user-oriented constructs should be used or developed for the forming of models for computer integrated production. For the reasons of transferability of partial models, they should be standardized.

### construct set

A grouping of constructs.

NOTE – A set of constructs is said to be consistent when all the necessary constructs required for building a model are present in this set.

Each consistent set has its own assembly rules, defining how constructs are to be put together for building a model.

Identification of static relations between constructs is part of the constructs.

Types of constructs generate classes and subclasses.

The higher class correspond to generic constructs.

A subclass corresponds to a lower degree of genericity than its mother class.

**Enterprise Model Executions and Integration Services (EMEIS)**

A common set of services which reside within a computer integrated system and which supports execution of CIM implementation model components in the most effective manner.

NOTE – Enterprise Model Executions and Integration Services – EMEIS – can be refined into three basic components:

- The model execution services which interpret (or instantiate) the model, so converting it into a running application.  
These services are dependent on the modelling technique used.
- The CIM integrating services which are all the particular IT services that CIM would require above existing genuine IT services.
- The General IT Services which are not CIM dependent.

An EMEIS provides IT support for the use of models to manage the enterprise to achieve enterprise objectives.

In particular it supports:

- Execution of CIM model.
- Physical system integration.
- Application and information integration.
- Business integration.
- Generic functions.
- Reusability of model components.
- Specialisation.
- Separation of the functionality from the data.
- Offers for services.

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**entity**

Any concrete or abstract thing in the universe of discourse.

**executable model**

A model component which contains additional information to allow its embedding within MXS. It may be seen as a representation capable of being analysed semantically with:

- Behaviour defined for each semantic element.
- The conditions defined under which that behaviour is invoked (or can be considered for invocation).
- The resources defined that are necessary for this invocation to proceed.

**execution model**

A standard execution model for the interactions between components – so their behaviour can be predicted.

**execution environment**

A set of computing resources on which a model-based application will be executed.

**instance**

A single, actual occurrence of a particular object. Any level of the object class hierarchy can have instances.

NOTE – An instance can be considered in terms of a copy of the object type frame that is filled in with particular information.

The filling in process is called instantiation.

**instantiation**

The process by which an instance is created.

**integrate**

The method of ensuring the optimal interaction between all enterprise elements in order to achieve a given purpose in a given environment, set of goals and constraints. Integration is also the result of that process.

**manageability**

The extent to which the resources of a computing environment can be configured, monitored, diagnosed, maintained, and controlled economically.

**model**

The explicit expression of one's understanding of a system or situation. It can be expressed in mathematics, symbols or words, but it is essentially a description of elements and the connectivity between them.

**NOTE** – The purpose of model defines the selected elements and the connectivity contained in the model.

A model is a representation of something else.

A model which includes all elements, connection and behaviour of the real world system – which could in theory replace the real world – is called isomorphic.

**model component**

A building block which has a structure which can be interpreted or instantiated (in case of an object) by a computer system.

**NOTE** – A model component may be capable of execution as a stand-alone entity or may need to be combined with other model components and other resources before execution.

**model development services (MDS)**

The collection of services which in total provide the environment within which model components are developed and tested before release to the EMEIS for use as an executable model of an enterprise, or as part of such a model.

**NOTE** – The model is to be developed within the environment provided by MDS in accordance with the Framework for Enterprise Modelling.

**model execution services (MXS)**

The collection of services which (i) embed a model component into EMEIS, so converting it into a runnable entity and (ii) provide all the operations services that are particular to the execution of such runnable entities, or for the provision of other CIM-specific services, over and above the General IT Services which are not CIM independent.

**reference model**

A conceptual framework whose purpose is to divide (standardization) work into manageable pieces and to show at a general level how these pieces are related to each other [ANSI X 3].

**universe of discourse**

The collection of entities that ever have been, are, or ever will be in a selected portion of real world or postulated world of interest that is being described by the models.

### 3 Information Technology in support of enterprise objectives

#### 3.1 The business need for Information Technology (IT)

Information Technology is becoming an increasingly important factor in enabling enterprises within the manufacturing industry to achieve their business objectives. So much so that enterprises, in forming their corporate strategies, need to establish an information strategy to assist the development of both an infrastructure and a set of facilities for managing information. The capability of the technology, together with the availability or lack of appropriate standards can, and does, influence or inhibit the development of information and hence corporate strategies. A high level business need is for standards to help enterprises and people to work together in using information.

One possible starting point for the development of a strategy for IT is for a particular enterprise to interpret its mission statement in terms of business objectives, key business processes and existing resources. At an appropriate stage, this interpretation process would develop into an analysis of specific requirements for business functions, business systems and supporting services. The enterprise could then identify the strategy and the appropriate IT services and components necessary to support it.

The choice of particular capabilities required from IT services should be guided by lower level interpretations of the enterprise's strategic business factors and by more process and user-oriented considerations such as the need for timeliness of information and the ability to evolve.

It is at this stage in an IT development process that a significant interaction is likely to take place between the development of a Computer Integrated Manufacturing system and the development of the remainder of the business system and IT services.

#### 3.2 The case for integration enabled by IT

Reference 3, "The Corporation of the 90s", identifies the main challenge for the organisation of the 90s as achieving the benefits of integration (see below) while moving towards becoming an adaptive organisation. It analyses the many factors, drivers and management processes that are required for this to take place.

The following is a summary of some of the points selected or interpreted as being particularly relevant for CIM.<sup>3)</sup>

The benefits of integration by the use of IT are seen as enabling or improving:

- Operations within the value chain<sup>4)</sup> (use of teams; greater creativity, higher morale).
- End-to-end links of value chains between organisations (speeding up the flow of goods; including Just-in-Time and Electronic Data Interchange; making the boundary of the organisation permeable to IT; and creating a virtual organisation by including elements of other organisations).
- Value chain substitution via subcontract or alliance.
- Electronic markets enabled by IT (seen by TC 310 WG1 as less applicable to today's manufacturing).

3) Here, as elsewhere, a frame is used to indicate illustrative material and material supplied by projects for the evaluation process.

4) Value chain – a term introduced in, for example, Reference 4 to represent the collection of linked activities in a company which contribute to the value of the product or service as perceived by the buyer. Activities can be categorised as primary (production) or support (infrastructure).

All the above remove buffers and amplify expertise; they work by shrinking the effect of time and distance.

The need to integrate manufacturing processes and to become and then remain adaptive tend to be competing pressures. However IT will increasingly enable better organisational memory with greater capture of organisational memory expressed as "rules" – e.g. patterns of product or service use and performance. IT enables and requires changes in organisational and management structures. IT increases the rate at which information flows, hence the speed at which decisions are made and so increasing the overall ability of the enterprise to act or react.

The book identifies three stages in the deployment of IT:

- Automate,
- "Informate" – when automated processes and/or IT tools yield useful information as a by-product, opening up new markets, and
- "Transformate" – the process of organisation empowerment.

Successful organisational transformation requires:

- The development of a clear, visible mission,
- The alignment of corporate strategy (business and IT), Information Technology and organisational dimensions, and
- A robust IT infrastructure in place, including electronic network and well-understood standards.

### 3.3 Objectives for Computer Integrated Manufacturing (CIM)

CIM is defined in ENV 40 003 as the joint application of Information Technology and Manufacturing Technology to increase the productivity and responsiveness of manufacturing enterprises, whereby all functional, informational and organisational aspects of an enterprise are parts of an integrated whole.

ISO/TC 184's Strategic Policy statement (Reference 5) states that "integration is the whole set of means, allowing humans, equipment and software to share information and resources in order to make industrial systems able to realise optimal productivity, quality and flexibility simultaneously. Integration is therefore the method of ensuring the optimal 'interaction' between all enterprise elements".

It is expected that CIM will improve enterprise competitiveness through adaptability and flexibility of enterprise operation and organisation. CIM should ensure efficient use of enterprise assets and resources such as people, capital investments, information and time.

To ensure that all activities, data and resources of an enterprise are put in proper relationship to each other, it is necessary to model the enterprise in order to identify all these activities, data, resources and responsibilities in an unambiguous way. These items should be easily identifiable as modelled entities, one in relation to the other, and implementable. This should include possibilities for easy modification of the enterprise itself (for example, its structure, its modes of operation) as well as all the modelled items.

The European PreStandard "Framework for Enterprise Modelling"<sup>5)</sup> (Reference 1) provides a standard for a framework, which will serve as a common basis for identifying and co-ordinating standards development for computer-based modelling of enterprises. Models generated using this framework will ultimately be

5) TC310 has requested that the life-time of this European PreStandard be extended for a further two years.

computer executable and enable the daily operations of an enterprise possibly to be run, monitored and controlled by such models.

### 3.4 ENV 40 003 "Framework for Enterprise Modelling"

Reference 1, ENV 40 003 "CIM Systems Architecture – Framework for Enterprise Modelling" constitutes a multidimensional framework. The framework gives the basis for the development of the methods and software tools required to describe and/or simulate an industrial system. Information Technology and Manufacturing Technology Components both have a place inside the Framework through their representation.

From all possible dimensions, the Framework for Enterprise Modelling has selected three for their ability to include the concepts needed for the modelling of enterprises:

- One dimension is concerned with the development and evolution of the model, starting from a statement of requirements to a processable model; this is the dimension of Model of an enterprise.
- One dimension is concerned with the structure and behaviour of a model which considers appropriate aspects of an enterprise; this is the dimension of View.
- One dimension is concerned with the degree of particularisation which identifies the set of possible models; this is the dimension of Genericity (evolution from general to particular).

Reference 2, "Evaluation Report of Constructs for Views according to ENV 40 003" has been published to form the basis for development of a European PreStandard on Constructs for Function View and other Views as defined in ENV 40 003.

### 3.5 Requirement for Enterprise Model Execution and Integration Services (EMEIS)

As stated in Clause 3.3, it is intended that the models or model components derived in accordance with ENV 40 003 (Reference 1) should ultimately be computer executable and enable the daily execution of enterprise tasks.

To enable such an approach, means have to be defined so that CIM System Integration can be realised through modelling. The mandate attached as Annex A identifies three levels of integration as being required:

- Physical System Integration,
- Application and Information Integration, and
- Business Integration.

Achieving this integration through modelling involves the need for design and development of a set of IT-based supporting services called the "Enterprise Model Execution and Integration Services" (EMEIS).

Each enterprise has its own specific requirements and its own specific solutions. However some functionality is generic and can be used in all CIM Systems. It is the objective of the EMEIS to provide the set of common services offering these generic functionalities to the user, supporting the execution of the CIM implementation model, and allowing the implementation of specific functions inherent to the particular CIM System required by the particular enterprise.

The first step in the standardization procedure, which is also the purpose of this Statement of Requirements, is the definition of a reference model and elaboration of EMEIS requirements in terms of that reference model (called in the Mandate of Annex A "an overall schedule for IIS") which will, subsequently, guide the development of the Framework for an EMEIS and further detailed standards or services, protocols and interfaces.

### 3.6 The requirements for representation of entities of an enterprise

Representation in a computer processable form of enterprise entities, corresponding to an area of concern or to an observer viewpoint, and the manipulation of those representations provides benefits as described below. The particular representations selected here correspond to the Views of ENV 40 003, but the general principles would apply whatever particular Views are chosen.

#### 3.6.1 Function

Representation of functions enables flexibility and the ability to adapt. It should also ease integration along the "within-enterprise value chain", e.g. more flexible couplings between design and manufacturing processes.

The visibility of required Information Objects (as foreseen in ENV 40 003) will help the process of "informating".

Control of the flow of information through linked functional processes is necessary for the automated response to product variations and for the increased rate of flow of information and the speed of decision making.

The representation by Information Objects of required Function, Information, Resource and Organisational objects enables empowerment and amplification of capability, both for the organisation and for the individual.

#### 3.6.2 Information

The representation of information is necessary for the "capture of organisational memory" and its re-use in systems which deploy that resource. In turn this allows greater managerial capability to be provided to end-users, so supporting flattening of managerial structures.

Representation of information is a pre-requisite for integration between enterprises, between an enterprise and its subcontractors, and for electronic trading. It is also necessary for a robust and manageable IT infrastructure.

#### 3.6.3 Resource

Representation of resources enables flexibility and the ability to adapt. It aids in the identification, removal or reduction of buffers. The representation of IT resources is one other pre-requisite for a robust and manageable IT infrastructure.

#### 3.6.4 Organisation

Representation of organisational roles and responsibilities enables flexibility and the ability to respond to short term variations. This is necessary to support the unfreezing, changing and refreezing of these organisational roles and responsibilities, hence enabling more fundamental and longer term restructuring ("Transformate") processes, e.g. management restructuring and relocation of manufacturing processes.