

Comparison of different information modelling approaches and styles

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National foreword

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English version

Comparison of different information modelling approaches and styles

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Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

This report is based on the ESPRIT Project 2072 ECIP Document R.HU.1.4.2.45.A (Row 12) which was produced in Work Package 1 of that project. The document was reviewed within the ECIP Work Package and accepted and delivered in October 1992. It was distributed within TC 117 WG 1 on 1994-01-09 and accepted at the TC 117 WG 1 meeting on 1994-02-16.

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Comparison of Different Modelling Approaches and Styles **Deliverable ECIP2/R.HU.1.4.2.45.A (row no.12)**

Gerhard Scholz
Wolfgang Wilkes

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Abstract

This report gives an overview of information models of the ECAD domain. The models are compared regarding their intent and style. More elaborated comparisons between EDIF version 2 0 0 and CFI and between different EDIF versions were already presented at EDIF conferences, which consider also the contents of the models in detail. They are attached as appendices, and the relationships of this work to the general standardization activities and plans for future work are outlined.

1 Introduction

Information models (IMs) provide a formal storage independent description of data in the area of interest. They may be primarily developed and used inside the respective domain (e.g. EDIF, CFI), but they are useful beyond that: especially when the domains of different standards overlap, information models are the means for bridging the gap between these standards. Considerations on interoperability can be started by comparing and merging / mapping the respective information models, thus avoiding the need to deal with different languages, which may have completely different syntax and paradigms. The language Express, developed as part of ISO 10303 [EXP91], has emerged as a standard for information modelling.

This report will compare different information models and focus on their approach to modelling and their modelling styles. Because most of the models are still under development, final results and conclusions cannot be given, instead the current status of work will be described. Updates will be given in a working paper, which is planned for early 1993.

Actual attempts to bring standards closer together have started between CFI and EDIF. To support these efforts, this paper deals mainly with the IMs of EDIF and CFI Design Representation (DR). A first comparison of IMs of EDIF version 2 0 0 [EDIF87] and CFI DR was presented at EDIF conferences in 1991 [Scho91]. An extended version of that comparison, published as a report of the University of Hagen [SWS91], is attached as appendix A. Currently EDIF has released a new version 2 9 0 with a completely modified connectivity description. Thus as a basis for an update of the EDIF/CFI comparison, the semantic changes within EDIF had to be examined. The result of this effort is gathered in a paper for the 6th European EDIF Forum [SchW92] and is attached as appendix B.

The main results of the work presented in the appendices will be summarized in chapter 3. Before, the current status of information models of the ECAD domain will be described in chapter 2. Finally, an outlook on future work will be given.

2 Survey of Information Models of the ECAD Domain

2.1 VHDL

Currently the most important standards of the ECAD domain are VHDL, EDIF, and CFI. Within the VHDL community, the major interest was oriented to descriptions of internal data structures (VHDL Intermediate Format, VIF), but not to information modelling. Wilsey has worked on a formal semantic definition of VHDL [WMS91, Wils92]. A recent paper [WiDa92] describes, how these concepts can be translated to Express or rather to Express with some proposed extensions. But the Express model itself is not finished yet. Another attempt to capture VHDL semantics by means of Express information models has been started within ECIP WP1. [Giu92] concentrates on the question, whether Express is capable of describing the behavioral semantics of VHDL. For that, a model of time is developed in Express, and it is shown, how it can be used for describing behavioral aspects of VHDL. Thus, this work is a prerequisite for the modelling of VHDL rather than the model itself. In parallel, a model of the structural part of VHDL was developed [ECIP92]. But it is still a first draft, which is currently under review by the VHDL experts of ECIP WP2. Thus, for the time being, no stable VHDL model exists, which could be considered for interoperability purposes.

2.2 EDIF

For EDIF version 2 0 0, information modelling efforts started in 1990 by the EDIF European TSC Information Modelling Working Group (IMG). Version 0.3 of the IMG model was used for the comparison of appendix A. Continuing discussions within the IMG caused a lot of significant changes to the model and resulted in an improved and extended version 1.0 [IMG92]. The experiences of this reverse engineering approach, which identified a lot of vagueness and ambiguities in the description of the semantics of EDIF version 2 0 0, have influenced the recent EDIF versions, which have been developed in parallel with their corresponding information models. The current version 2 9 0 [EDIF92b] covers the connectivity and schematic descriptions of electronic design and is the result of reviews of intermediate versions 2 0 100 and 2 0 101 [EDIF92a]. Because this version is brand-new, the comparison of appendix B has been done on the basis of the 2 9 0 information model only (and some discussions with the authors), whereas the latest available EDIF syntax version was 2 0 101. The 2 9 0 version - maybe with slight modifications to version 3 0 0 - is expected to be stable for quite a while, because the following EDIF versions will be extensions for pcb layout and test, which hopefully will not affect the central concepts of version 2 9 0.

2.3 CFI

Starting in 1990, the CFI TSC DR is developing an 'Electrical Connectivity Information Model'. The paper of appendix A was based on version 0.7 of that model. Until version 0.9.4 in July 1992, the model was quite stable: there was a change from a previous to the recent Express version, the inclusion of constraints of the programming interface (PI) into the IM, and some minor improvements, but the main discussions until then were concerned with details of the PI functions, which are out of the scope of the IM. But prior to the CFI 1.0 release (which is scheduled by the end of this year), the IM was extended by completely new features like *encapsulatedView*, *portBus* and *netBus*. For the time being, version 0.9.6 is out for comments, and the currently known list of bugs indicates, that there will be further changes until version 1.0, which may affect not only the PI, but also the IM.

2.4 EIS

The EIS ECAD Domain Model [EIS90] is not a standard by itself, but it is a first attempt to integrate standards of the ECAD domain, namely EDIF and VHDL. It was developed as part of the DoD sponsored Engineering Information System program and includes (preliminary) specifications of mappings from and to EDIF and VHDL, respectively. The model was submitted for consideration to the CFI DR TSC. In contrast to the other IMs mentioned in this report, the EIS model is not an Express model, but used an entity-relationship-based formalism. In an earlier phase of the EIS project, domain models of EDIF and VHDL have been developed [EIS89a, EIS89b]. But they describe mainly syntax and thus will not be further considered here.

As the Express language specification became popular, a mapping to Express syntax was added to the EIS model, based on Express version N466 of March 1990. But because this mapping is done in a very mechanical way, it does not exploit the features of Express. For instance, constraints are not part of the model at all. Furthermore, the mapping of binary relationships to Express, which is expressed by two attributes, defining two 'one-way relationships', is doubtful from an Express point of view. In contrast to the statement of the authors of the EIS model document, an attribute of entity type in Express does not define a one-way relationship. As indicated by predefined Express functions, this relationship can be used from both sides (one direction using the explicit attribute, the other direction using a function). The recent Express version [EXP91] makes this clearer by a

better description of the predefined functions and the introduction of the `INVERSE` keyword, which allows to make the reverse direction explicit in the model. It should be noted, that this way of mapping was a known problem for the EIS people and is described as an issue requiring additional consideration.

3 Summary of the Appendices

The comparison of the EDIF and CFI IMs (appendix A) showed, that the different goals led to different modelling styles. The primary goal of the EDIF model is the description of the concepts underlying EDIF in a human readable form. Therefore the model has to identify a lot of detailed design objects described by EDIF and their attributes, relationships and constraints. In contrast CFI offers only a skeleton model by defining the central object types needed for connectivity descriptions and their relationships. The model is not committed to a specific standard, but serves as a basis for a programming interface, which should be used by different tools in different environments. Thus, the attributes attached to the objects depend highly on the specific application, which is supported in the model by an entity *Prop*, which offers a general mechanism for the integration of non-standardized data. By this means the model becomes more flexible, but the responsibility for semantic clarification is shifted from the modeller to the user.

The EDIF model is not concerned with any implementation details for design databases, it relies on the implicit Express concepts of unique object identification. Instead, the CFI model introduces a general supertype *BaseObject* with attributes describing objecttype and OID, thus providing an explicit reference point for the specification of the corresponding programming interface.

Further style differences have occurred concerning the partitioning of the model into separate schemas and the modelling of relationships. Concerning the latter point, the remarks of the appendix have been taken into account by later versions of the CFI model and are therefore out of date. But there is still a remarkable difference: the CFI model uses strong naming conventions for slot names indicating different types of relationships with different operational semantics. Without being forced by an associated PI, the EDIF models are less restrictive on that point.

But it turned out, that most of these style differences could be considered as extensions of the respective models, and that disregard for these extensions led to core models, which are quite easy to compare. This comparison of the respective contents has to be updated because of a lot of recent changes both in EDIF and in CFI.

The comparison of the different EDIF versions (appendix B) was a prerequisite for that update. Since the new EDIF version will not eliminate the EDIF version 2 0 0 standard at once, in fact the relationship of both EDIF versions to CFI has to be considered. The main observation concerning the connectivity part of the models was, that version 2 9 0 introduces the concepts of *cluster* and *signal*, which have no direct counterpart in the CFI model. It will be the subject of future investigations, whether and how the information provided by these entities can be captured by means of the CFI model.

4 Outlook

Considering the current activities in the ECAD domain, the major task on interoperability is not concerned with the harmonization of EDIF and VHDL, but with the harmonization of EDIF and CFI. Even though the EDIF version 2 0 0 has (besides others) been a basic input for the CFI DR IM specification, both groups have developed their standards independently, and there is a need to reconsider similarities and differences of the respective information models. Originally it was

planned to include this comparison in this deliverable, but because of the recent developments on both the EDIF and the CFI DR IMs, the final comparison has to be delayed. EDIF version 2 9 0 / 3 0 0 and CFI DR IM version 1.0 will provide more stable versions, where a meaningful comparison can rely on.

This comparison will be the next step of the harmonization efforts of WP1. It will include considerations on style and contents of the respective IMs including some proposals for merge or mapping, when conflicting concepts can be identified. It will be brought formally as a CFI 2.0 specification into the CFI community and shall serve as a basis for future work, which will be the extension of the CFI DR IM by models for specific view types, starting with the schematic view. The EDIF 2 9 0 specification of schematics shall serve as starting point for these extensions. Later, for other view types the specifications of EDIF versions 4 0 0 and 5 0 0, which are scheduled for autumn 1993, can be used.

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Appendix A

Information Models for Connectivity in Electronic Design

by Gerhard Scholz, Wolfgang Wilkes, Gunter Schlageter

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ABSTRACT

Within the last years, the need for information modelling was more and more recognized in the world of electronic design. During 1990 both the EDIF European TSC Information Modelling Working Group (IMG) and the CFI Technical Subcommittee Design Representation (DR) have started to develop an information model for VLSI design representation data using the language Express.

While the DR model is accompanied by a programming interface (PI) for tool access, the primary goal of the IMG model is to contribute to an understanding of the semantical concepts underlying EDIF.

Both groups started their efforts with modelling connectivity. While the DR model is still restricted to that area, i.e. it covers approximately the EDIF netlist view, the IMG model also includes parts of other views, namely schematics and masklayout. This paper compares the connectivity parts of both models to find out, where they harmonize and in which points they differ.

The comparison will show, that the basic entities (cell, view, port) are defined similar in both models, but that there are some differences in the connectivity of complex ports, which represent the concept of busses.

Although there are differences in style and wording between the two models according to their primary goals, the commonly used language Express facilitates the comparison of the overlapping areas of both models. Thus it becomes clear, that the use of Express contributes to communication and clarification in the area of electronic design.

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1. INTRODUCTION

A long established method of electronic design data handling was the storage in traditional file systems, where each tool uses its own particular ideosyncratic representation. With this approach "problems arise when the designer needs to span representations" [Katz85]. A lot of converters, filters and translators are needed for allowing a tool to use data produced by other tools. Making sure that the transformed data still describe the same circuit "is a difficult and error prone task, especially since the dependencies across the representations are not explicitly stored" [Katz85].

With the growing complexity of designs it became more and more important to exchange portions of a design between different departments of a vendor or between different vendors. For this sake, standardized interchange formats have been derived, e.g. EDIF [EDIF87]. These formats reduce the number of translators required for communication of n tools with each other from approximately n^2 to $2n$. But these formats serve as an aid, but not as a solution for the exchange problem: Until now, no format exists, which is best suited for describing all aspects of a design, so different interchange formats are used in parallel. Thereby the problem of interoperability of tools is shifted to the problem of interoperability of exchange formats. Another problem arises from the specification of the exchange formats itself: their semantics are not clearly specified, and for unequivocal use of the formats, sender and recipient have to harmonize their understanding of the syntax constructs used. For instance, in the EDIF reference manual [EDIF87] a lot of constraints are not covered by the syntax, but are only described informally and partly incomplete and not easy to detect within the about 400 manual pages. Meanwhile four volumes of 'EDIF Questions and Answers' have been published, which try to clarify some unclear aspects which have been raised by users.

Having this scenery in mind, the need for an implementation independent design representation was recognized, which was propagated using the term 'information modelling'. It should give a neutral, unequivocal and understandable description of the objects in the area of interest, of their relationships, and of the rules and constraints associated with these objects [WiUn90]. For this purpose, the language 'Express' was developed in the frame of ISO. Express is not specifically dedicated to the area of electronic design, but is defined "to deal with the information that is consumed or produced during product manufacturing" [EXP91] in general. The language aims to become a standard, but the work is currently not finished, so today different versions of Express are in use [EXP90a,EXP90b,EXP91].

The paper in hand is an extended version of [Scho91]. It describes and compares two of the major efforts to model the electronic CAD objects, namely the work of the EDIF IMG and the work of the CFI TSC DR. We start with a short description of both organizations and their current status of work (chapter 2), before we describe their connectivity models separately (chapter 3: IMG, chapter 4: CFI). In chapter 5 the general style of the two models will be compared. A more detailed comparison of the entities modelled and their relationships will be presented in chapter 6. In chapter 7 a short summary of the results will be given.

2. MODELLING EFFORTS WITHIN EDIF AND CFI

The Electronic Design Interchange Format EDIF in its version 2 0 0 [EDIF87] is not fixed for all times. Several Technical Subcommittees (TSCs) are working on extensions, which will be integrated in later EDIF versions. The problems described in chapter 1 have been recognized within the EDIF community itself, and are reflected by two major decisions: all proposals for EDIF extensions shall no longer be given as syntax constructs using the LISP oriented EDIF syntax, but shall be worked out in the form of an information model using Express. Additionally, an information model describing the concepts underlying EDIF 2 0 0 shall be developed. For the second task, the EDIF Information Modelling Working Group (IMG) as part of the EDIF European TSC was founded in the end of 1989. An overview about the state of the work one year ago was given in [WHLS90]. That presentation was based on version 0.2 of the model [IMG90]. Meanwhile version 0.3 was produced [IMG91a], and the current work is concerned with the next version [IMG91b] having a broader scope and major improvements especially in those parts describing connectivity of cells by ports and nets.

The aim of this modelling work is on the one hand the clarification of the concepts underlying EDIF. On the other hand the resulting Express model is useful beyond the scope of EDIF and can contribute to the interoperability of different standards. In a first step, it gives the basis for comparing different concepts, to find out where they harmonize and in which points they differ. As Express evolves as a de facto standard for information modelling, this is especially true when two Express models can be compared.

Another Express model concerned with connectivity is developed in the CFI TSC 'Design Representation' (DR) within the last year [DR91]. The CAD Framework Initiative CFI was organized in 1988 as a not-for-profit member corporation by all important US companies in the area of electronics. Its mission is: "Development of worldwide industry standards for electronic design automation tools and their supporting framework environments that will remove barriers to integration" [CFI91]. A version 1.0 of the CFI standards is scheduled for the fourth quarter of 1991. The CFI work is divided in different TSCs, one of it being the TSC DR. The current model of the CFI TSC DR is in the process of being approved as part of the version 1.0 of the CFI standards.

3. THE EDIF IMG MODEL

Until its version 0.3, the IMG has used Express version N496 [EXP90b]. But this Express version failed its goal to be ratified as a standard, so the IMG has decided to rely on the latest Express version N14 [EXP91] furtheron. This paper focuses on the connectivity parts of the model, therefore some entities are presented only partial (leaving some attributes or subtypes out), other entity or type definitions are completely left out of consideration.¹

¹The model is still under development, so the next IMG model version 0.4 may have deviations from the description here.