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# MODIDO: Principals and Methods

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## Abstract

MODIDO is a universal meta-model for the IoT domain, consisting of concepts that can be used to build a solution model for an IoT application. This solution can be edited using text notation and can be drafted through code generation. This article discusses the principles observed and methods used to build the MODIDO meta-model. Two principles are applied: the principle of universality and the principle of specificity. The two methods used are model architecture and layered development.

**Keywords:** Conceptual Model; Concrete Model; Layered Development; Model Architecture; MODIDO; Specificity; Universality

## 1. Introduction

When we began considering writing a thesis on the Internet of Things (IoT) in 2013, its definitions were numerous and disparate. A definition of the IoT simply frames it by setting limits and defining a boundary that delineates its meaning and scope. From this, the idea of unifying these definitions in their attachment to a single conceptual and universal model was born. The conceptual aspect of the model offers the possibility of a diversity of definitions and an extension and evolution of these. These extensions only extend the framework or the seat surrounding the essence of the IoT, allowing it to be freed from a strict and delimiting definition, allowing it to be seen in other alternatives defended by other protagonists and actors of the IoT. One of the advantages of a conceptual model is its ability to remain relevant and unchanged over a long period of time, despite the richness of methodological and technological innovations. However, when new visions are added to the scene, the model is forced to change its appearance and support different versions, marking its evolution over time and around which different visions gravitate and refer. The power of a conceptual model of the IoT lies in the attraction it exerts on a large number of modelers and professionals, in its ability to convince them to adopt it despite their differing opinions and definitions.

MODIDO [1, 2] is an attempt to propose a conceptual meta-model for the IoT field. It constitutes an abstract syntax for LIDO [3, 4] and dictates the scope of concepts that its concrete syntax must cover. This article discusses this model. It is divided into three sections. The first section outlines the construction principles of MODIDO. The second section highlights the methods of its adoption and use. The third and final section summarizes the previous two sections and offers perspectives on the evolution of MODIDO.

## 2. MODIDO's Construction Principles

The primary goal of MODIDO was to propose a universal conceptual model for the IoT domain. The following subsection presents this principle of universality.

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### 2.1. Universality Principle

Given the audience of designers and developers MODIDO aimed to reach, it must be sufficiently abstract to absorb all the details unnecessary for the comprehensibility and representativeness of an IoT model. A universal model must be a neutral, accommodating, and constructive abstraction of the specific models that designers and developers around the world produce for their local representations of the IoT. The universal model aims to strengthen the integration, breadth, and scope of the local, while the local aims to enrich the global with successful experiences of the specific. MODIDO offers six (6) different views of the IoT domain. These views were adopted from the strategic research article by Guillemin P. and Friess P. [4]. The first view, called the "Human-User View," focuses on the human as a user of the IoT application. The second view, called "Human-Object View," represents objects in the physical world attached to their ICT (Information and Communication Technologies) devices. These allow physical objects to integrate the digital world. The third view, called "Network View," considers the network and communication aspect in general. The fourth view, called "Localization View," focuses on the location of a physical object or a human using a location system such as GPS. The fifth view, called "Context-Time View," focuses on the context and time of interaction operations between humans and physical objects integrated into the digital world. The sixth view, called "Service View," is used to represent the services offered by physical objects to the IoT application or system. A seventh view has been added to the last six. This view focuses on security. Security has been integrated since it represents an essential and strategic aspect of future IoT conceptual models. Each of the seven (7) views is formed from a collection of concepts selected and drawn from a bibliographic study that was conducted at the beginning of our thesis. This bibliographic study revealed to us an enormous diversity in the opinions and points of view of researchers depending on the angle of view considered. The following subsection looks at the diversity of points of view.

### 2.2. Principle of Specificity

MODIDO is divided into six (6) views in addition to the security view. These views each represent a perspective. A perspective represents a discipline or an important aspect of IoT. Within a perspective, we can have different points of view specific to a given IoT reality. For example, from the security perspective, we can have two or three specialists with different points of view regarding a solution to a problem specific to them. The same difference can be observed from a network or location perspective. The aim is not to tolerate relativity but to give each participant the freedom to express their point of view using the same concepts that MODIDO provides. Since MODIDO concepts are universal and therefore global, the personal and individual point of view of the participant can be understood and taken for a specific experience by all those interested in its application, hence the contribution, hence the interest of a language formed of universal concepts and hence the feedback from the specific and its contribution to the universal. The angles of view that we can have of the IoT cannot be definitively defined in their number or in their nature. These angles evolve according to our knowledge and our vision of the IoT. To this end, we can draw up profiles of participants as diverse and numerous as possible according to, among other things, their knowledge and their visions, hence a number of points of view increasing from one generation to another of participants and hence an increasingly indisputable interest in more abstract concepts allowing to accommodate their number and their specificities. This situation highlights the interest in universal concepts, which are reinforced by the acuity of communications, exchanges, and publications of specific experiences. We conclude that the universal unites and that the field and reality of the IoT diversifies and enriches. In the following section, we address the methodological aspect inherent in the construction of MODIDO.

## 3. The Methodological Aspect in the Construction of MODIDO

In this section, we will discuss two methodological aspects of the construction of MODIDO. The first, which will be discussed in the following subsection, concerns a layered design methodology for solutions based on MODIDO, and the second, which will be explained later, concerns the model architecture into which MODIDO is integrated.

### 3.1. Layered Development

For the development of an IoT solution, MODIDO represents a first conceptual layer, part of which is adopted as a derivative of the model for the construction of such a solution. This derived part, made up of IoT objects, is simply a less abstract model, and a second, more concrete layer of the solution. On top of this layer, a textual notation is added, representing a third syntactic and technical layer useful for code generation, which represents a fourth, more technological layer. The first layer is universally stable and can be reused whenever a specific, concrete solution is needed. This last solution represents a less stable but reusable layer for a third layer where the textual notation can be reworked, for example, by switching to a graphical notation. Graphical notation is more stable than code generation, which itself can change the language in which the generated code is produced. Ultimately, this layered development ensures that, when a layer is completed, it not only serves as a basis for the next development phase but can also change

without compromising the development phase because it will always respect the contract agreed between the two. Changes in a layer are local to the layer and in no way affect the upper or lower layers.

### 3.2. Model Architecture

MODIDO is derived from the meta-meta-model and is a derivative of MOF (Meta Object Facilities) [5] and conforms to it. MOF is a meta-meta-model proposed by the OMG (Object Management Group). UML (Unified Modeling Language) [6] is also based on a meta-model conforming to MOF. Moreover, MODIDO is expressed in a UML syntax. If we classify the levels from top to bottom and from the most abstract to the most concrete, MOF is the first and highest level in the architecture. MODIDO represents level two of the architecture. The solution model represents the third level, and the generated code represents the fourth level of the architecture. Each level is a derivative of the previous level and conforms to it. MOF is self-derivable. It is an architecture in four (4) models. We can even consider the executable of the solution as a fifth (5th) concrete model. Indeed, the generated code needs a virtual machine (JEE) for Java code or a DotNet infrastructure for Csharp (c#) code and an X-WINDOWS graphical interface of LINUX or WINDOWS. All these layered models work in a pipeline to start sequentially from a set of concepts or ideas and arrive in five (5) stages at an executable representing a concrete and sensitive reality.

## 4. Conclusion

In this article, we have presented the principles and methods that guided us in the construction of the MODIDO universal meta-model of IoT. There is no contradiction between the universal and the specific, but rather a dialectic in which each part feeds off the other without losing its own existence. The universal can be considered the other solution or the other alternative solution different from our own. The universal allows the specific to express themselves without confronting or adopting each other, but rather to understand and learn from each other. It is the knowledge of the alternative, the different, and the distant that pushes us to self-criticize, to rethink, and to try other paths that seemed distant, idealistic, and fanciful. The conceptual places us at a crossroads of paths and it is up to the specific to choose one that is most adapted and most adequate to our reality, and which perhaps leads to other crossroads and other bridges allowing us to emancipate our solutions and consequently our realities. The scope of MODIDO is even more extensive as the textual and graphic notations that support it are diverse and diversified.

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