University of Minho
School of Engineering

Single-core non-sheathed electrical cable with rigid conductor For General Purposes

Course in Information Visualization and Advanced CAD Systems

PhD Programme in Advanced Engineering Systems for Industry

Authors:

Ahmad Hariri, id7520

Mohammad Amin Salimi, id7533

Rui Oliveira, number id6911

Professors:

Prof. Ana Alice Baptista

Prof. João Pedro Mendonça

Index

Figures

Tables

1 Introduction

In the present digital era, information is one of the key elements on which industrial society relies on daily basis. With several products being develop constantly in different systems and for different purposes, it becomes a necessity to find ways that products information can be share between all interest stakeholders and that all get and understand that information the same way and with the same quality level.

To achieve that, the *World Wide Web Consortium (W3C)* have been working on a project entitle semantic web, with the purpose of providing a common framework where data could be share instead of documents, improving communication between machines and helping humans finding the required knowledge [1].

Associated to this project is the concept of Linked Open Data (LOD), which is a method for exposing structured data and metadata, allowing it to be share (or parts of it), connected and presented in a way that different representations of the of the same information can be found and catalogue [2]; [3].

The main aim of this study is related to illustrate and extend the Resource Description Framework (RDF) for a chosen product - A single-core non-sheathed electrical cable with rigid conductor. As a common product in wide range of industries such as Automotive, Telecommunications and Power, this report presents important details of the product by presenting the graph model of the product and tables that show details of each attribute that composes the product and its parts. This report tries to cover most important attributes of the product, which show noticeable attributes for designers and experts in order to achieve essentials information about required characters via easy and practical way. In order to illustrate in clear path, the product is divide to three parts: 1-Lable 2-Insulator 3-Copper Conductor, therefore each part has a diagram and an attributes table that represents it.

2 Product Contextualization

The product chosen for this exercise it is a single-core non-sheathed electrical cable with rigid conductor for general purposes (equipment, electrical housing installations, among other possibilities) from the manufacturer Hamedan, Wire and Cables industries. [4]

Figure 1 – example of an electrical cable [4]

These type of products usually are build according the purpose of usage, with different types off insulation, different number of coppers, different sizes (diameters), electrical proprieties, different colours, temperatures of usage, voltage and many others proprieties. The type of insulations also differs according cable types as there are versions that have more than one type of insulation (overlaid in layers) where the internal insulation layer (in contact with the copper wire) has different proprieties from the outsider insulation.

All along the exterior part of the cable, there is a printed label on the insulation that, due to legal requirements, helps to identify the electrical cable itself, namely it's diameter, number of strands, type of insulation, in specific products some required information (if its sheated or not for example) and manufacturer identification. Complying with a pre-defined pace (repeated length), all these information needs to be replicated over the entire length of the electrical cable. The process and material that is use to do the label is also that can be changeable due to legal requirement of the electrical cable itself or if the purpose of use requires additional information to recorded on the side of the electrical cable.

Although this is a very common and simple product, in fact this product is the combination of three different parts that compose and defines the final product.

2.1 Product description

Based on the manufacturer Hamedan online catalogue [4], the chosen product was a single-core non-sheathed cable with rigid conductor. Beside the specification's that are already mention on the catalogue, for design purposes, there was the need to further detailed the number and cross section area of the copper core, colour of the insulation and total length of the electrical cable. Additional, it was consider that the imprinted label imprint on the outside of the electrical cable insulation, from different colour of the insulation and it has to be repeat along all cable length.

Therefore, from the catalogue information, the following specifications were consider:

- Conductor: plain annealed copper wire;
- Maximum use temperature of the conductor (in °C): 70;
- Number of strands and nominal diameter (in mm): 1x1.13 (1strand of 1.13mm);
- Cross section (in mm^2): 1.0;
- Insulator: PVC/C;
- Insulator colour: Red;
- Thickness of insulation (in mm): 0.6;
- Overall approximate Weight (Gr/mm): 0.014;
- Total length (in mm): 1000;
- Label imprint pace (in mm): 100;
- Label imprint colour: Black;
- Label text: 1.0mm2 PVC/C

With this information regarding the product, it is possible to describe it and all the different parts that compose it.

3 Graph Model

In this chapter, it is presented the graph model that describes the above mention product. On each of the following figures it is show one of the parts that compose the final product, however an overall blueprint of the entire graph model is available in appendix. The mention graph model was built using draw.io [5] freeware.

On figure 2 is shared an overall view of the entire graph of the product, with the link to the product's catalogue in the main circle at the centre of the graph. On this overall view it is possible to see three main groups, referring each one to a different part that composes the final product, an electrical cable.

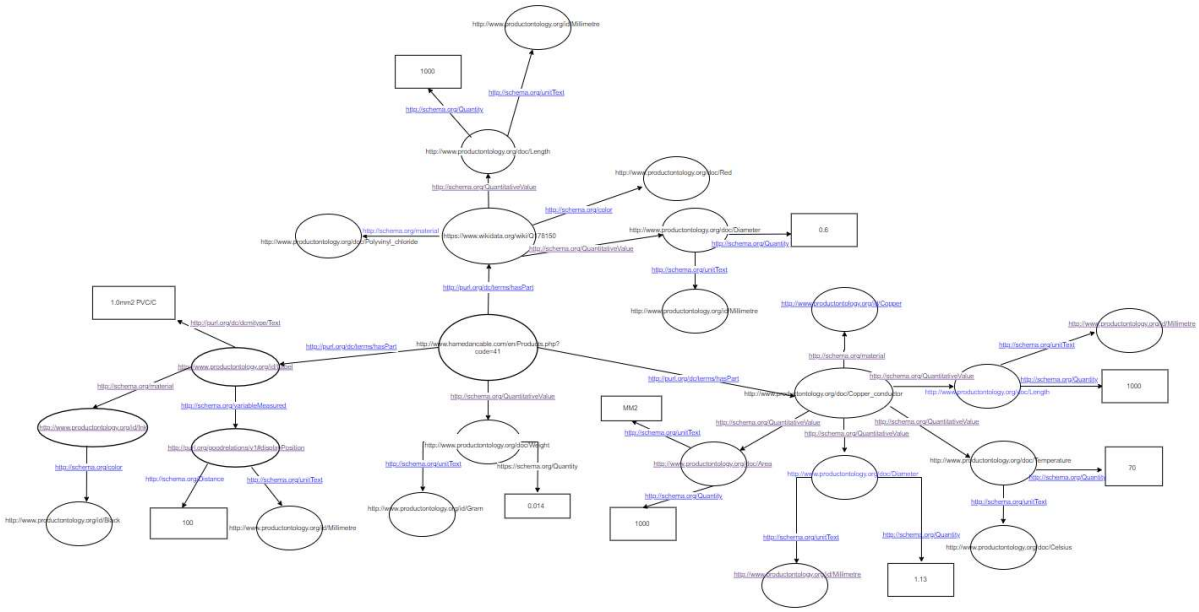

Figure 2 – Graph model for the electrical cable

Figure 3 provides a more detail view of the electrical cable and how the weight is specified.

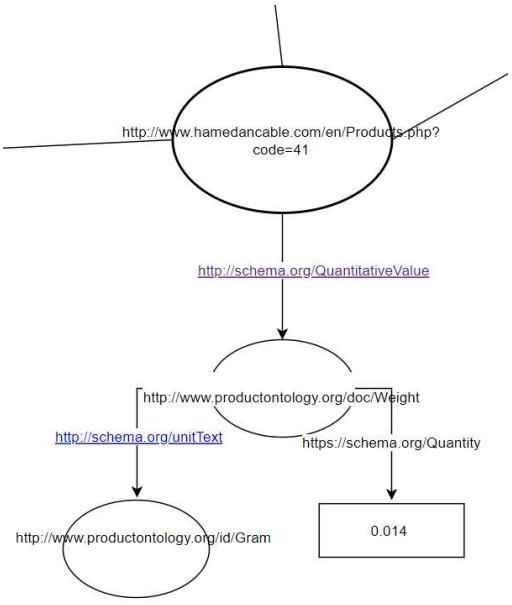

Figure 3 – Part of the graph model for the electrical cable weight

Figure 4 shows a view of the part call Conductor, which the core of the electrical cable. Here it is possible to information regarding type of material, length, diameter and operating temperature.

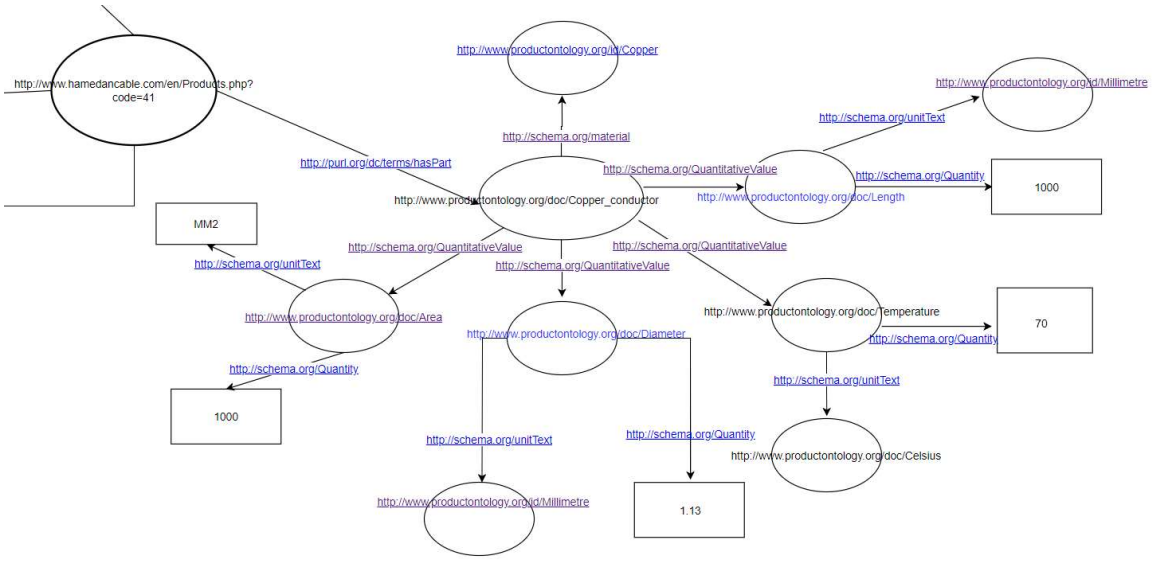

Figure 4 - Graph model for Conductor part of the electrical cable

Figure 5 displays a view of the part call Insulation, which is the cover of the electrical cable. Proprieties like type of material, length, diameter, thickness of material and colour define this part.

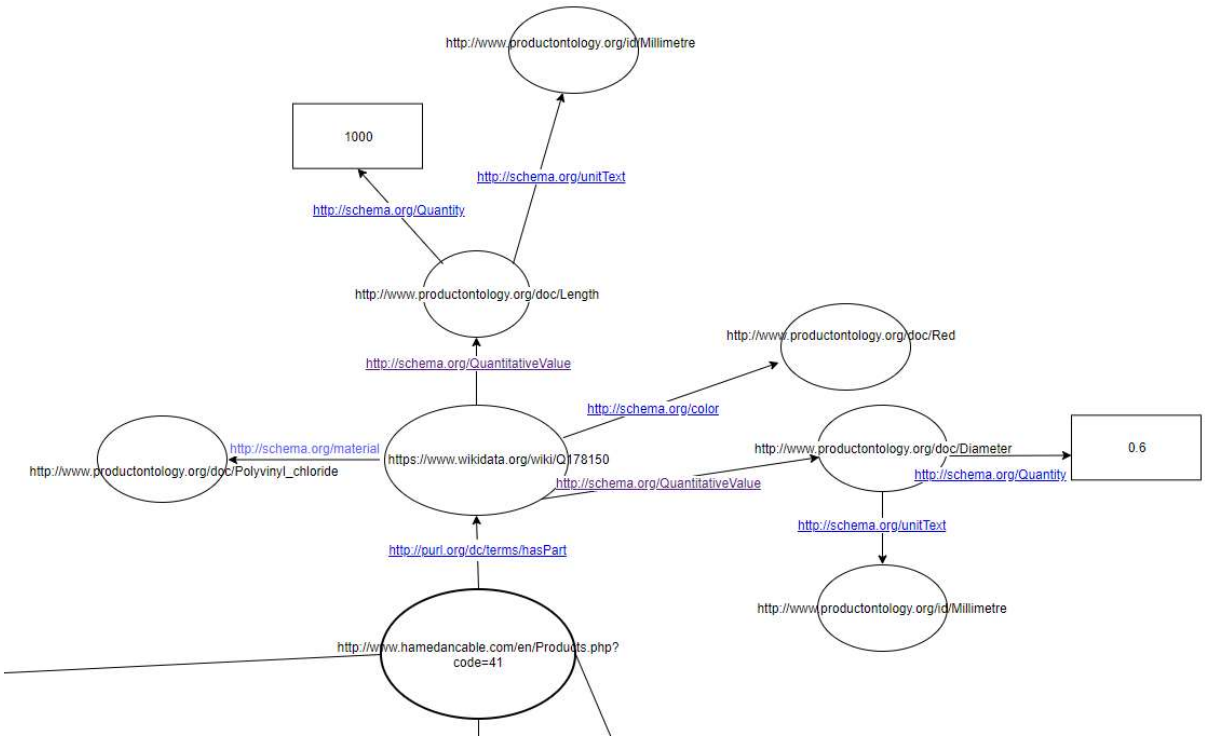

Figure 5 - Graph model for Insulation part of the electrical cable

Finally figure 6 presents a view of the part call Label, which is the label imprint on the cover that provides valuable information about the entire electrical cable. This part is define by proprieties like text, type of material, colour and pace (imprint repetition at a certain pace/length).

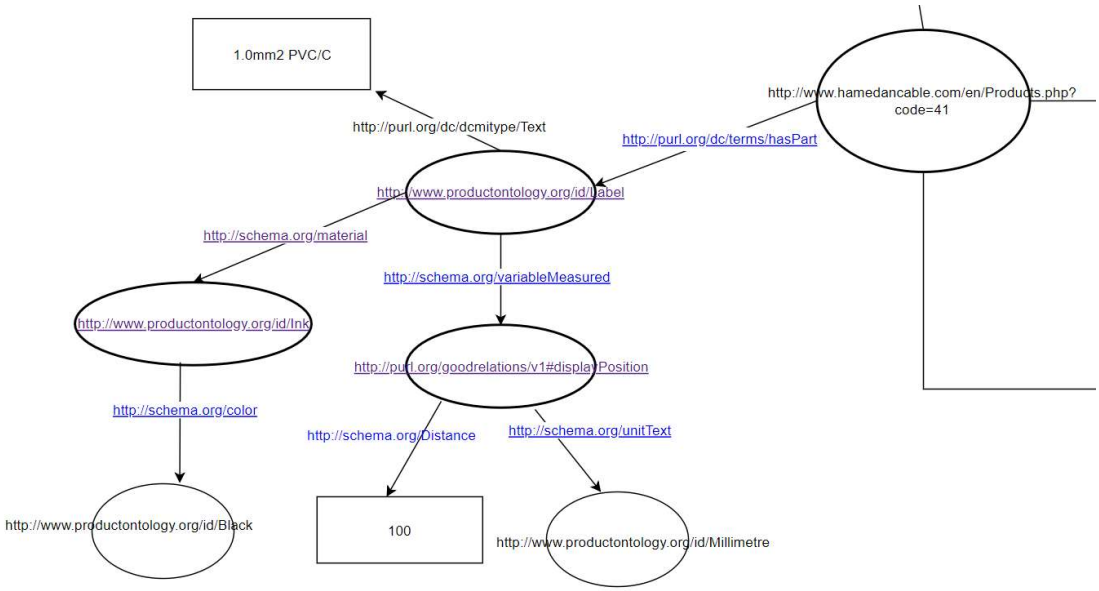

Figure 6 – Graph model for label part of the electrical cable

In the exposed graph model each part that composes the final product was showed, as well as the attributes that define each part and how these are describe with the metadata schematics.

4 Product attributes matrices

Based on the graph present in the previous chapter, the attributes and proprieties that composed each part of product and the final product itself will be presented in this chapter. On the following matrices, the attributes of each part will be further detail by their metadata schematics proprieties, restrictions and codifications.

Each of the following sub-chapters corresponds to one attribute matrix. There will be an attribute matrix for the final product, one for the conductor part, other for the insulation part and another for the label part.

For attributes and proprieties definitions, as well as Uniform Resource Identifier's (URI), the following database were consider (in order of preference): Dublin Core Metadata Initiative (DCMI) [5]; Schema.org [6], Productontology [7], GoodRelations [8] and Wikidata [9].

4.1 Attribute matrix – Main product

The attributes that describe the main product are show on table 1.

Attribute	Term	Property	Description	URI	Wikidata equivalent propriety	Unit of measurement	Acceptable values
HasPart	Cooper Conductor	pto: Conductor	Indicates an item or Creative Work that is part of this item, or Creative Work (in some sense).	http://purl.org/dc/terms/hasPart	https://www.wikidata.org/wiki/Property:P527		
HasPart	Insulation	Wiki: Insulator	Indicates an item or Creative Work that is part of this item, or Creative Work (in some sense).	http://purl.org/dc/terms/hasPart	https://www.wikidata.org/wiki/Property:P527		
HasPart	Label	pto: Label	Indicates an item or Creative Work that is part of this item, or Creative Work (in some sense).	http://purl.org/dc/terms/hasPart	https://www.wikidata.org/wiki/Property:P527		
Weight	Weight	pto: weight	The weight of an object is related to the amount of force acting on the object, either due to gravity or to a reaction force that holds it in place.	http://www.productontology.org/doc/Weight	https://www.wikidata.org/wiki/Q25288		string
Value	Unittext	Schema: Unitext	A string or text indicating the unit of measurement.	http://schema.org/unitText		http://www.productontology.org/id/Gram	
Value	Quantitative value	Schema: Quantitative value	A point value or interval for product characteristics and other purposes.	http://schema.org/QuantitativeValue			string

Table 1 – Attribute matrix of the main product, an electrical cable wire

4.2 Attribute matrix – Copper Conductor Part

The attributes that describe the copper conductor are show on table 2.

Attribute	Term	Property	Description	URI	Wikidata equivalent propriety	Unit of measurement	Acceptable values
Conductor	Cooper Conductor	Pto: Conductor	Copper conductor has been used in electrical wiring since the invention of the electromagnet and the telegraph.	http://www.productontology.org/doc/Copper_conductor	https://www.wikidata.org/wiki/Q124291		string
Material	Material	Schema :Material	A material that something is made from, e.g. leather, wool, cotton, paper.	http://schema.org/material	https://www.wikidata.org/wiki/Q214609		http://www.productontology.org/id/Copper
Value	Quantitative value	Schema: Quantitative value	A point value or interval for product characteristics and other purposes.	http://schema.org/QuantitativeValue			string
Unitext	Unittext	Schema: Unitext	A string or text indicating the unit of measurement.	http://schema.org/unitText			string
Length	Length	Pto: Length	In geometric measurements, length is the most extended dimension of an object.	http://www.productontology.org/doc/Length	https://www.wikidata.org/wiki/Q36253	http://www.productontology.org/id/Millimetre	[1,∞]
Diameter	Diameter	Pto: Diameter	The diameter of a circle is any straight line segment that passes through the centre of the circle and whose endpoints lie on the circle	http://www.productontology.org/doc/Diameter	https://www.wikidata.org/wiki/Q37221	http://www.productontology.org/id/Millimetre	1.00
Cross section	Cross section	Pto: cross section	Area is the quantity that expresses the extent of a two-dimensional figure or shape.	http://www.productontology.org/doc/Area	https://www.wikidata.org/wiki/Q845080	mm2	1.00
Temperature	Temperature	Pto: Temperature	Temperature is a physical quantity expressing hot and cold.	http://www.productontology.org/doc/Temperature	https://www.wikidata.org/wiki/Q11466	http://www.productontology.org/doc/Celsius	Maximum use temperature of the conductor<70 ℃

Table 2 - Attribute matrix for copper conductor part

4.3 Attribute matrix – Insulation Part

On table 3 are presented the attributes that describe the insulation part.

Attribute	Term	Property	Description	URI	Wikidata equivalent propriety	Unit of measurement	Acceptable values
Insulation	Insulation	Wiki: Insulator	element whose internal electric charges do not flow freely, and which therefore does not conduct an electric current	https://www.wikidata.org/wiki/Q178150	https://www.wikidata.org/wiki/Q178150		String
Material	Material	Schema :Material	A material that something is made from, e.g. leather, wool, cotton, paper.	http://schema.org/material	https://www.wikidata.org/wiki/Q214609		http://www.productontology.org/doc/Polyvinyl_chloride
Colour	Colour	Schema: colour	The colour of the product.	http://schema.org/color	https://www.wikidata.org/wiki/Q1075		http://www.productontology.org/id/RED
Value	Quantitative value	Schema: Quantitative value	A point value or interval for product characteristics and other purposes.	http://schema.org/QuantitativeValue			string
Unitext	Unittext	Schema: Unitext	A string or text indicating the unit of measurement.	http://schema.org/unitText			string
Length	Length	Pto: Length	In geometric measurements, length is the most extended dimension of an object.	http://www.productontology.org/doc/Length	https://www.wikidata.org/wiki/Q36253	http://www.productontology.org/id/Millimetre	[1,∞]
Weight	weight	Pto: weigh	The weight of an object is related to the amount of force acting on the object, either due to gravity or to a reaction force that holds it in place.	http://www.productontology.org/doc/Weight	https://www.wikidata.org/wiki/Q25288	http://www.productontology.org/id/Gram	[0.009 ,0.116]
Diameter	Diameter	Pto: Diameter	a diameter of a circle is any straight line segment that passes through the centre of the circle and whose endpoints lie on the circle	http://www.productontology.org/doc/Diameter	https://www.wikidata.org/wiki/Q37221	http://www.productontology.org/id/Millimetre	[2-5.6]

Table 3 –Attribute matrix for Insulation part

4.4 Attribute matrix – Label Part

On table 4 are shown the attributes that describe the label part.

Attribute	Term	Property	Description	URI	Wikidata equivalent propriety	Unit of measurement	Acceptable values
Label	Label	pto: Label	A label (as distinct from signage) is a piece of paper, plastic film, cloth, metal, or other material affixed to a container or product, on which is written or printed information or symbols about the product or item. Information printed directly on a container or article can also be considered labeling.	http://www.productontology.org/id/Label	https://www.wikidata.org/wiki/Q722218		String
Text	Text	Text	A resource consisting primarily of words for reading.	http://purl.org/dc/dcmitype/Text	https://www.wikidata.org/wiki/Q234460		Text
Material	Material	Material	A material that something is made from, e.g. leather, wool, cotton, paper.	http://schema.org/material	https://www.wikidata.org/wiki/Q214609		
Ink	Ink	pto: Ink	Ink is a liquid or paste that contains pigments or dyes and is used to color a surface to produce an image, text, or design.	http://www.productontology.org/id/Ink	https://www.wikidata.org/wiki/Q127418		
Color	Color	color	The color of the product.	http://schema.org/color	https://www.wikidata.org/wiki/Q1075		http://www.productontology.org/id/Black
Position	Label_Position	Display position	The position at which the option or element should be listed in a menu or user dialog, lower numbers come first	http://purl.org/goodrelations/v1#displayPosition	https://www.wikidata.org/wiki/Q17334923		String
Pace	Pace	Variable Measured	The variableMeasured property can indicate (repeated as necessary) the variables that are measured in some dataset, either described as text or as pairs of identifier and description using PropertyValue.	http://schema.org/variableMeasured	https://www.wikidata.org/wiki/Q1924249		
Position	Label_Position	Distance	Properties that take Distances as values are of the form '<Number> <Length unit of measure>'. E.g., '7 ft'.	http://schema.org/Distance	https://www.wikidata.org/wiki/Q126017		String
Position	Label_Position	Unit Text	A string or text indicating the unit of measurement. Useful if you cannot provide a standard unit code for unitCode.	http://schema.org/unitText	https://www.wikidata.org/wiki/Q47574	http://www.productontology.org/doc/Millimetre	

Table 4 – Attribute matrix for label part

5 Conclusions

From the presented report one can understand that when detailing a simple product like an electrical cable using structure, standardize and proper vocabulary it can becomes complex. However, the advantage of using such vocabulary means that every computerized system and any human are communicating information between themselves in a define and concise manner, linking to each information the proper data can describe and contextualize that same information, so that the receiver understands exactly what the sender means.

For this, it should be mention that Linked open data plays an important role to provide required data for experts in e-information technology domain. So for a simple product which is stated in this report, several attributes are illustrates to provide clear understanding of allocated properties. As there is wide range type of cables in all around the world with different practical aspects, it is essential to define more accurate linked-data and by generating understandable data that leads to provide higher efficiency for all interest stakeholders.

Although detailing a product and its attribute using linked open data and RDF's may not a simple and easy process, one can recognize the potential of such processes, with special remark for the fact the same information can share with several stakeholders and clearly understood by all. Nonetheless, the amount of available databases, the several possible definitions for some general attributes and the lack of such definitions for more specific products, attributes and industries, may be drawback for a more widespread usage of such type of data.

6 References

[1] http://www.obitko.com/tutorials/ontologies-semantic-web/semantic-web.html. [Online].

[2] http://www.obitko.com/tutorials/ontologies-semantic-web/semantic-web.html. [Online].

[3] http://linkeddata.org/. [Online].

[4] http://www.hamedancable.com/en/Products.php?code=41. [Online].

[5] https://www.draw.io/. [Online].

[6] http://purl.org. [Online].

[7] https://schema.org. [Online].

[8] http://www.productontology.org. [Online].

[9] http://www.heppnetz.de/ontologies/goodrelations/v1.html. [Online].

[10] https://www.wikidata.org/wiki/Wikidata:Main_Page. [Online].

[11] http://www.linkeddatatools.com/introducing-rdf. [Online].

[12] http://www.linkeddatatools.com/introducing-rdf-part-2. [Online].

Appendix 1 – Full Graph model of the product

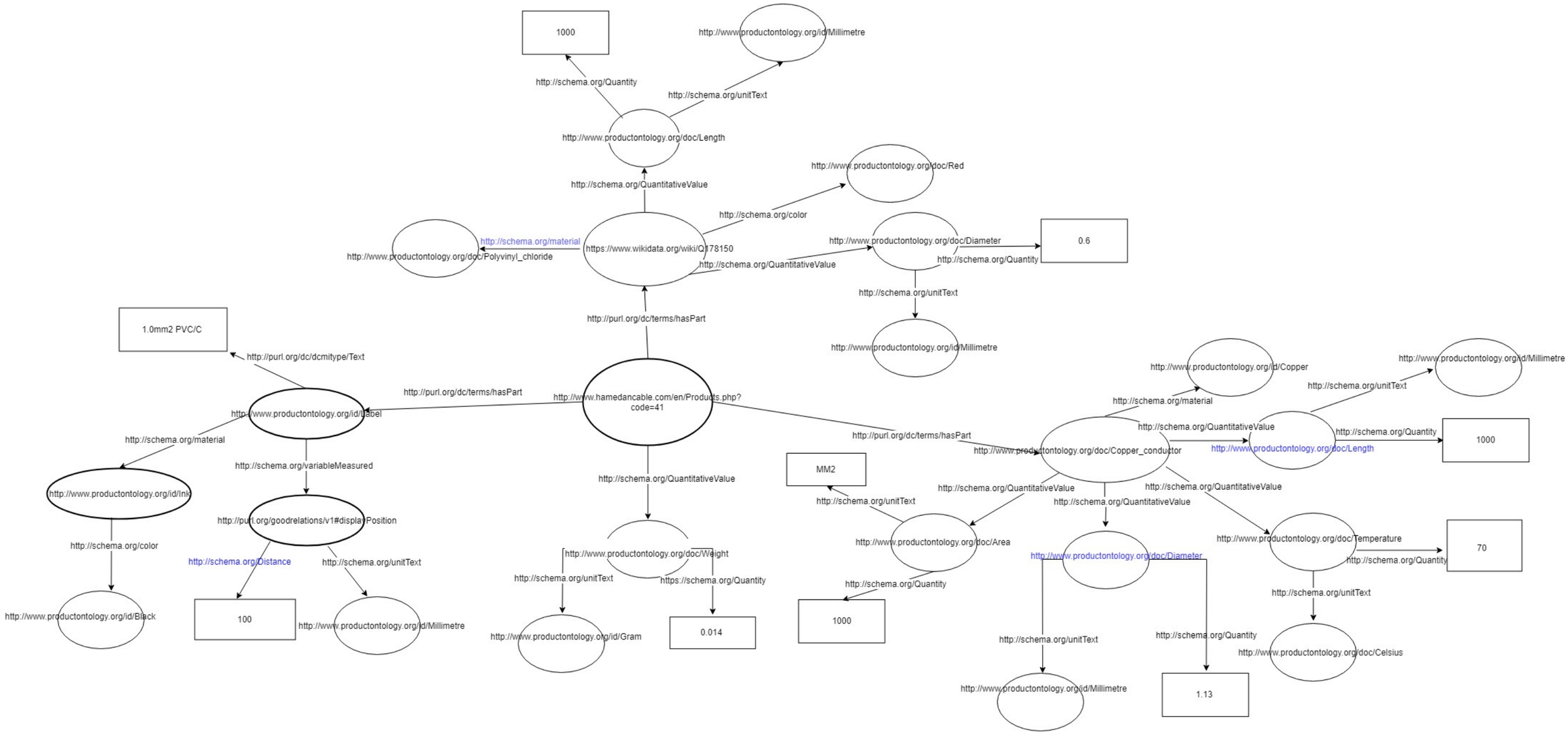

Figure 7 – Complete graph model of the electrical cable