#### Summary and suggestions

In general, the subproperties should inherit the .1-properties from their super properties. When the subproperty has a locally defined .1-property one should check if this property is a sub-.1-property. The only case is P67 and P138. P67.1 *has type* and P138.1  *mode of representation* seems to be unrelated. Should be discussed

Additional axiom for  P107 is possible if desired:

Original FOL: P107(x,y) ⇐ (∃z) [E85(z) ˄ P144i(x,z) ˄ P143(z,y)]

Additional  FOL: P107(x,y,w) ⇐ (∃z) [E85(z) ˄ P144i(x,z,w) ˄ P143(z,y)]

The full list of .1-properties and the shortlong paths they are connected to is given in the table below.

The shortcuts, their long paths and their FOL is discussed. As long as a shortcut property does not have a .1-property then the FOL can be kept as it is. In the opposite case an extra FOL axiom has to be added (P107) or some restrictions have to be added to the property definition (P62). See P62 and P107 below.

#### A list of the .1-properties and the shortcuts

In the table below the .1-properties marked in red need a closer inspection:

1. P62.1 is a part of the long path of P107 and a .1-property of the shortcut property P62 where the long path has a property with a .1-property (P138).
   1. P138 is a subproperty of P67 and one should discuss whether P138.1 *mode of representation*: E55 Type is a subproperty of P67.1 *has type*: E55 Type.
   2. The shortcut property P62 has a .1 property and there is one/two in the long path. Is there a connection between these properties? Cf. the P107 below.

1. P107 is a shortcut property with the .1-property P107.1 kind of member. In the long path we find P144.1 *kind of member*: E55 Type. Is it so that if in the long path the P144.1 is instantiated then P107.1 has to be instantiated as well and with the same range instance (type)? and the other way round? This has to be decided.

*Table 5: CIDOC CRM Properties of Properties (.1 Properties) Hierarchy*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **In the long path of shortcuts** | **Property id** | **Property Name** | **Property – Domain** | **Entity - Range** |
|  | P3.1 | has type | E1 CRM Entity. **P3 has note:** E62 String | E55 Type |
| P50  P51  P52 | P14.1 | in the role of | E7 Activity. **P14 carried out by (performed)**:E39 Actor | E55 Type |
|  | P16.1 | mode of use | E7 Activity. **P16 used specific object (was used for)**: E70 Thing | E55 Type |
| P195  P197  P198  P199 | P19.1 | mode of use | E7 Activity. **P19 was intended use of (was made for):** E71 Human-Made Thing | E55 Type |
|  | P62.1 | mode of depiction | E24 Physical Human-Made Thing. **P62 depicts (is depicted by)**: E1 CRM Entity | E55 Type |
| P199 | P67.1 | has type | E89 Propositional Object. **P67 refers to (is referred to by)**: E1 CRM Entity | E55 Type |
| P62  P199 | P138.1 | -   mode of representation | E36 Visual Item. **P138 represents (has representation)**: E1 CRM Entity | E55 Type |
|  | P69.1 | has type | E29 Design or Procedure. **P69 has association with (is associated with)**: E29 Design or Procedure | E55 Type |
|  | P102.1 | has type | E71 Human-Made Thing. **P102 has title (is title of)**: E35 Title | E55 Type |
|  | P107.1 | kind of member | E74 Group. **P107 has current or former member (is current or former member of)**: E39 Actor | E55 Type |
|  | P136.1 | in the taxonomic role | E83 Type Creation. P136 was based on (supported type creation): E1 CRM Entity | E55 Type |
|  | P130.1 | kind of similarity | E70 Thing. **P130 shows features of (features are also found on):** E70 Thing. | E55 Type |
|  | P137.1 | in the taxonomic role | E1 CRM Entity. **P137 exemplifies (is exemplified by)**: E55 Type | E55 Type |
|  | P139.1 | has type | **E41 Appellation**. **P139 has alternative form (is alternative form of)**: E41 Appellation | E55 Type |
| P107 | P144.1 | kind of member | E85 Joining.**P144 joined with (gained member by)**: E74 Group | E55 Type |
|  | P189.1 | has type | E53 Place. **P189 approximates (is approximated by)**. E53 Place | E55 Type |

#### The shortcut properties and FOL

1. 21 of the shortcuts in CRM are on the form <the long path> implies <the shortcut property>

1. Five of the shortcuts in CRM are on the form <the long path> is equivalent to <the shortcut property>. These are:

P125 *used object of type (was type of object used in)*,

P156 *occupies (is occupied by)*,

P167 *was within (includes)*,

P171 *at some place within*,

P172 *contains*

##### Case A 1

For all but two (P62, P107) of the shortcut properties in category A the shortcut property has no .1 property. The long path represents (contains) more information than the shortcut. Form a logical point of view the long path is stronger (true in less cases) than the shortcut. If we add extra information to the long path by the use of possible .1-properties The implication will still be true. For example:

 P1 *is identified by (identifies) is* a shortcut for the path from E1 CRM Entity through *P1 is identified by*, E41 Appellation, *P139 has alternative form* to E41 Appellation

FOL: P1(x,y) ⇐ (∃z) [E41(z)˄ P1(x,z) ˄ P139(z,y)]

P139.1 *has type* is used to specify P139. Since P139(x,y,w) implies P139(x,y) the following will be true for all w:

P1(x,y) ⇐ (∃z) [E41(z)˄ P1(x,z) ˄ P139(z,y,w)]

Therefore a shortcut property without .1 properties will always be a shortcut of the long path independently of the use of .1-properties (or sub properties) in the long path.

##### Case A 2

The shortcut properties P62 *depicts (is depicted by)* and P107 *has current or former member (is current or former member of)* has .1 properties. The reasoning above (case A 1) is only valid if these .1 properties are not instantiated.  There are three options:

1. The property can only be a shortcut when the .1 is not instantiated.
2. If we insist that the shortcut implication should be valid, also when the shortcut property has instantiated the .1 property, then we need to change the FOL so that the implication is valid for any instantiation if the .1. Below is the original FOL for P62 and then the new FOL

Original FOL: P62(x,y) ⇐ (∃z) [E36(z) ˄ P65(x,z) ˄ P138(z,y)]

New FOL: [E55(w) ˄ P62(x,y,w) ]⇐ (∃z) [E36(z) ˄ P65(x,z) ˄ P138(z,y)]

This is not a good solution

1. Define conditions for the relationship between the use of the .1s in the shortcut and in the long path. This is not always easy. However, for P107 is possible if desired:

Original FOL: P107(x,y) ⇐ (∃z) [E85(z) ˄ P144i(x,z) ˄ P143(z,y)]

Additional  FOL: P107(x,y,w) ⇐ (∃z) [E85(z) ˄ P144i(x,z,w) ˄ P143(z,y)]

My suggestion is solution 1 for P62 and 3 for P107

##### Case B

P125 *used object of type (was type of object used in)*,

P156 *occupies (is occupied by)*,

P167 *was within (includes)*,

P171 *at some place within*,

P172 *contains*

In these cases, the implication between the shortcut and the long path is bidirectional. The implication from the long path to the shortcut is as in case A 1 since none of the shortcut properties has a .1 property. In the opposite direction, form the shortcut to the long path, we get into a problem similar to case A 2 above. The implication from the shortcut property to the will only be valid if .1 properties are not used at the left side. So the FOL can be left as they are.

##### Conclusion

The FOL expressions for all the shortcuts except P62 are kept unchanged.

#### A more detailed overview

##### P1 is identified by (identifies)

 This property is a shortcut for the path from E1 CRM Entity through *P140i was attributed by*, E15 Identifier Assignment, *P37 assigned* toE42 Identifier.

OK, no .1 neither in the shortcut nor in the long path

It is also a shortcut for the path from E1 CRM Entity through *P1 is identified by*, E41 Appellation, *P139 has alternative form* to E41 Appellation

#### **1 properties in the long path:**

*P139 has alternative form* has the inherited .1 property:

P139.1 has type: [E55](about:blank) Type

(“Αθήνα” (E41) *has alternative form* “Athina” (E41) *has type* transcription (E55).

The shortcut has no .1 property which is ok. In general, some information in the long path is lost in  the shortcut

##### P2 has type (is type of)

This property is a shortcut for the path from E1 CRM Entity through *P41i was classified by,* E17 Type Assignment, *P42 assigned* toE55 Type.

OK, no .1 neither in the shortcut nor in the long path

##### P7 took place at (witnessed)

This property is a shortcut of the more fully developed path from E4 Period through *P161 has spatial projection*, E53 Place, *P89 falls within* to E53 Place.

OK, no .1 neither in the shortcut nor in the long path

##### P8 took place on or within (witnessed)

This property is a shortcut of the more fully developed path from E4 Period through *P7 took place at*, E53 Place, *P156i is occupied by* E18 Physical Thing.

OK, no .1 neither in the shortcut nor in the long path

##### P43 has dimension (is dimension of)

In the case that the recorded property is a result of a measurement of an instance of E18 Physical Thing, this property is a shortcut of the more fully developed path from E18 Physical Thingthrough *P39i was measured by,* E16 Measurement*, P40 observed dimension* toE54 Dimension.

OK, no .1 neither in the shortcut nor in the long path

##### P44 has condition (is condition of)

This property is a shortcut of the more fully developed path from E18 Physical Thingthrough *P34i was assessed by,* E14 Condition Assessment*, P35 has identified* toE3 Condition State.

OK, no .1 neither in the shortcut nor in the long path

##### P49 has former or current keeper (is former or current keeper of)

This property is a shortcut for the more detailed path from E18 Physical Thing through *P30i custody transferred through,* E10 Transfer of Custody, *P28 custody surrendered by* *or P29 custody received by* to E39 Actor.

###### 1 properties in the long path:

*P29 custody received by*  has the inherited .1 property:

P14.1 carried out by (performed): E39 Actor.

The shortcut has no .1 property which is ok. In general, some information in the long path is lost in  the shortcut

##### P50 has current keeper (is current keeper of)

This property is a shortcut for the more detailed path from E18 Physical Thing through, *P30i custody transferred through*, E10 Transfer of Custody, *P29 custody received by* to E39 Actor, if and only if the custody has not been surrendered by the receiving actor at any later time

###### 1 properties in the long path:

*P29 custody received by*  has the inherited .1 property:

P14.1 carried out by (performed): E39 Actor.

The shortcut has no .1 property which is ok. In general, some information in the long path is lost in  the shortcut

##### P51 has former or current owner (is former or current owner of)

This property is a shortcut for the more detailed path from E18 Physical Thing through *P24i changed ownership through*, E8 Acquisition, *P23 transferred title from*, or *P22 transferred title to* to E39 Actor.

###### .1 properties in the long path:

*P22 transferred title to* has the inherited .1 property:

P14.1 carried out by (performed): E39 Actor.

Could this property be used in the shortcut: No, it is not in accordance with event based modeling

The shortcut has no .1 property which is ok. In general, some information in the long path is lost in  the shortcut

##### P52 has current owner (is current owner of)

This property is a shortcut for the more detailed path from E18 Physical Thing through, *P24i changed ownership through*, E8 Acquisition, *P22 transferred title to* to E39 Actor, if and only if this acquisition event is the most recent.

###### 1 properties in the long path:

*P22 transferred title to* has the inherited .1 property:

P14.1 carried out by (performed): E39 Actor.

The shortcut has no .1 property which is ok. In general, some information in the long path is lost in  the shortcut

##### P53 has former or current location (is former or current location of)

This property is a shortcut. A more detailed representation can make use of the fully developed (i.e., indirect) path from E19 Physical Object*,* though*, P25i moved by*, E9 Move*, P26 moved to* or *P27 moved from* toE53 Place.

OK, no .1 neither in the shortcut nor in the long path

##### P55 has current location (currently holds)

This property is a shortcut. A more detailed representation can make use of the fully developed (i.e., indirect) path from E19 Physical Object*,* through*, P25i moved by,* E9 Move*, P26 moved to* toE53 Place if and only if this Move is the most recent.

OK, no .1 neither in the shortcut nor in the long path

##### P56 bears feature (is found on)

This property is a shortcut. A more detailed representation can make use of the fully developed (i.e., indirect) path *E19 Physical Object,* through*, P59 has section,* E53 Place*, P53i is former or current location of* toE26 Physical Feature.

OK, no .1 neither in the shortcut nor in the long path

##### P62 depicts (is depicted by)

This property is a shortcut of the more fully developed path from E24 Physical Human-Made Thing through *P65 shows visual item*, E36 Visual Item,P138 *represents* toE1 CRM Entity*.*

###### 1 properties in the shortcut:

P62.1 mode of depiction: [E55](https://docs.google.com/document/d/1zQwy8mp4BrwE3VeqJuc7j9z82CzYqZb5ZmIdrtVPM1U/edit#heading=h.3znysh7) Type

Examples:

* The 20 pence coin held by the Department of Coins and Medals of the British Museum under registration number 2006,1101.126 (E22) *depicts* Queen Elizabeth II (E21) *mode of depiction* Profile (E55).

###### 1 properties in the long path:

The P138 *represents* has two .1 properties,

 inherited from P67:

P67.1 *has type* link to an instance of E55 Type. This is intended to allow a more detailed description of the type of reference.

Examples:

* The eBay auction listing of 4th  July 2002 (E73) *refers to* silver cup 232 (E22) *has type* item for sale (E55). (fictitious)

P62.1 *mode of depiction* seems to be unrelated to  P67.1 *has type*

locally defined

*P138.1 mode of representation*  allows the nature of the representation to be refined.

Examples:

* The digital file found at <http://www.emunch.no/N/full/No-MM_N0001-01.jpg> (E36) *represents* page 1 of Edward Munch's manuscript MM N 1, Munch-museet (E22) *mode of representation* Digitisation (E55).
* The 3D model VAM\_A.200-1946\_trace\_1M.ply (E73) *represents* Victoria & Albert Museum’s Madonna and child sculpture (visual work) A.200-1946 (E22) *mode of representation* 3D surface (E55).

*P138.1 mode of representation*   seems to be unrelated P67.1 mode of depiction.

So seen as a shortcut of a given long path, P67 cannot have an instance of P67.1, see also in the beginning of this document.. Has to be discussed.

##### P105 right held by (has right on)

This property is a shortcut of the fully developed path from E72 Legal Object, *P104 is subject to*, E30 Right, *P75i is possessed by* to E39 Actor.

OK, no .1 neither in the shortcut nor in the long path

##### P107 has current or former member (is current or former member of)

This property is a shortcut of the more fully developed path from E74 Group*, P144i gained member by,* E85 Joining*, P143 joined* toE39 Actor*.*

###### 1 properties in the shortcut:

This property has P107.1 *kind of member*

###### 1 properties in the long path:

P144.1 *kind of member*: E55 Type.

Here the two .1 properties express the same information. So a FOL axiom has to be added.

##### P125 used object of type (was type of object used in)

This property is a shortcut of the more fully developed path from E7 Activity through *P16 used specific object*, E70 Thing, *P2 has type,* to E55 Type

###### 1 properties in the long path:

P16.1 *mode of use*

###### Comment

Here it is possible to imagine that the shortcut could have a P125.1 *mode of use*:E55 Type, but the range instance of P16.1 and P125 must be identical so the following additional FOL axiom would have to be added:

P125(x,y,w) ⇔ (∃z) [E70(z) ∧ P16(x,z,w) ∧  P2(z,y)]

The shortcut has no .1 property which is ok. In general, some information in the long path is lost in  the shortcut.

##### P152 has parent (is parent of)

This property is, among others, a shortcut of the fully developed paths from E21 Person through *P98i was born,* E67 Birth*, P96 by mother* to E21 Person*,* andfrom E21 Person through *P98i was born,* E67 Birth*, P97 from father* to E21 Person.

OK, no .1 neither in the shortcut nor in the long paths

##### P156 occupies (is occupied by)

This property implies the fully developed path from E18 Physical Thing through *P196 defines,* E92 Spacetime Volume, *P161 has spatial projection* to E53 Place. (strong shortcut)

OK, no .1 neither in the shortcut nor in the long paths

##### P167 was within (includes)

This property is a shortcut of the more fully developed path from E93 Presence through *P161 has spatial projection,* E53 Place, *P89 falls within (contains)* to E53 Place.

OK, no .1 neither in the shortcut nor in the long path

##### P171 at some place within

This property is a shortcut of the fully developed path from E53 Place*, P89 falls within,* E53 Place*, P168 place is defined by* to E94 Space Primitive through a declarative Place that is not explicitly documented, to a Space Primitive: declarative places are defined in CRMgeo (Doerr and Hiebel 2013).

OK, no .1 neither in the shortcut nor in the long path

##### P172 contains

This property is a shortcut of the fully developed path from E53 Place*, P89i contains,* E53 Place*, P168 place is defined by* toE94 Space Primitive

OK, no .1 neither in the shortcut nor in the long path

##### P195 was a presence of (had presence)

This property is a strong shortcut of the fully developed path from E18 Physical Thing through *P196 defines*, E92 Spacetime Volume, *P166 was a presence of (had presence)* to E93 Presence.

OK, no .1 neither in the shortcut nor in the long path

##### P197 covered parts of (was partially covered by)

This property is a shortcut of the more fully developed path from E93 Presence through *P161 has spatial projection*, E53 Place*, P121 overlaps with,* to E53 Place.

OK, no .1 neither in the shortcut nor in the long path

##### P198 holds or supports (is held or supported by)

This property is a shortcut of the more fully developed path from E18 Physical Thing through *P59 has section*, E53 Place, *P53i is former or current location* *of,* to E18 Physical Thing.

OK, no .1 neither in the shortcut nor in the long path

##### P199 represents instance of type

This property is a  shortcut of the more fully developed path from E36 Visual Item through *P138 represents*, E1 CRM Entity, P2 has type, E55 Type.

###### 1 properties in the long path:

The P138 *represents* has two .1 properties

inherited from P67

P67.1 *has type* link to an instance of E55 Type. This is intended to allow a more detailed description of the type of reference.

Examples:

* The eBay auction listing of 4th  July 2002 (E73) *refers to* silver cup 232 (E22) *has type* item for sale (E55). (fictitious)

defined locally

*P138.1 mode of representation*  allows the nature of the representation to be refined.

Examples:

* The digital file found at <http://www.emunch.no/N/full/No-MM_N0001-01.jpg> (E36) *represents* page 1 of Edward Munch's manuscript MM N 1, Munch-museet (E22) *mode of representation* Digitisation (E55).
* The 3D model VAM\_A.200-1946\_trace\_1M.ply (E73) *represents* Victoria & Albert Museum’s Madonna and child sculpture (visual work) A.200-1946 (E22) *mode of representation* 3D surface (E55).

P199 has no .1 In general, some information in the long path is lost in  the shortcut.. So this is ok.