The Basics of 4-Dimensionalism and the Role it Can Take in Supporting Large Scale Data Integration

4-Dimensionalism in Improving Analysis of Reference Data

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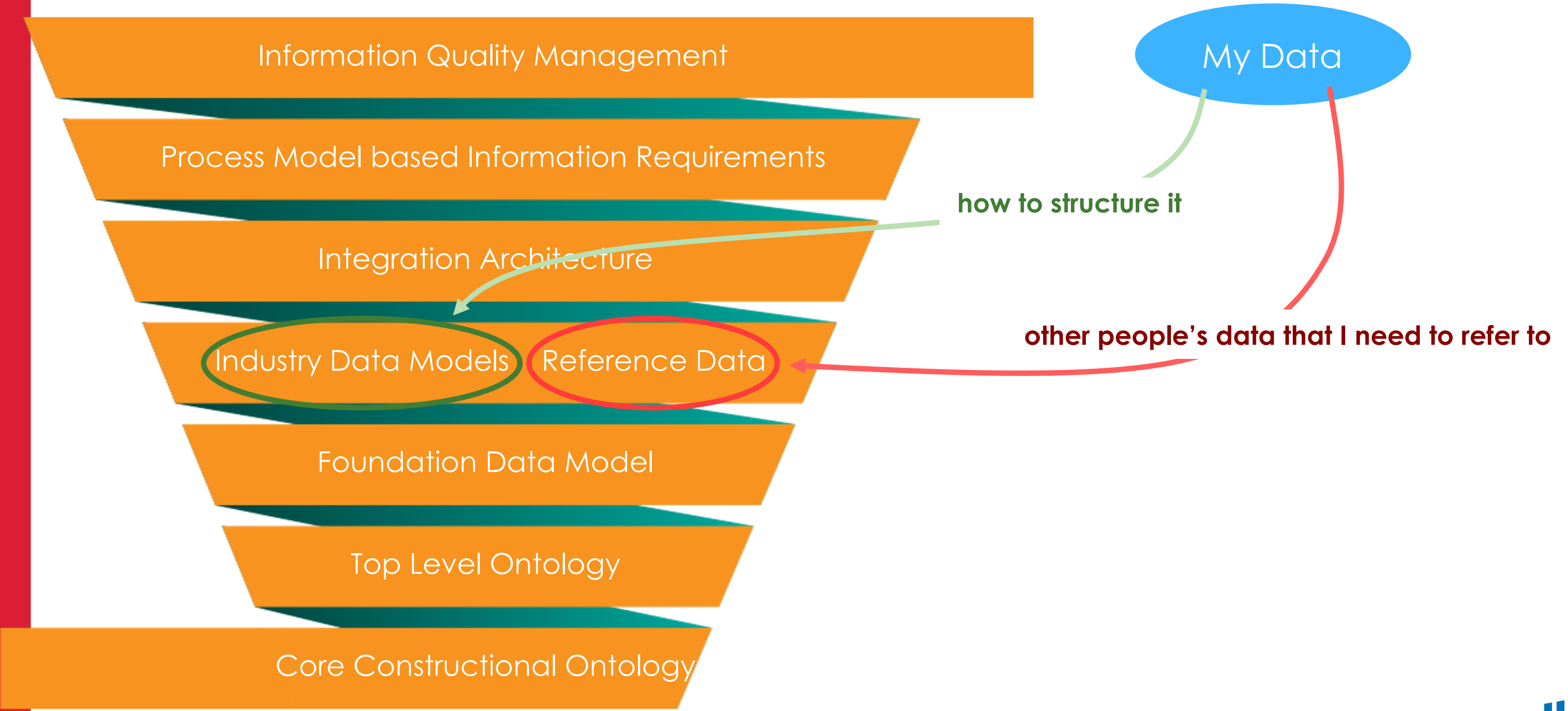
The Seven Circles of Information Management



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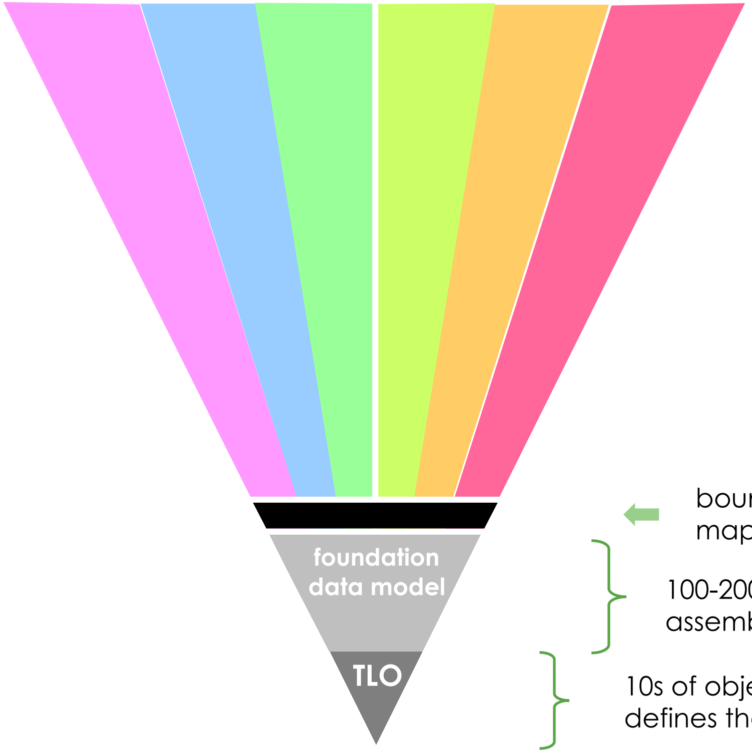
A reference data explosion



millions of reference objects created by experts in the domains – mechanical, electrical, process, materials, geographic, administrative, utilities, project planning, ….

boundary layer of **core terminology** – used by the domain experts above, and mapped on to the foundation below

100-200 objects which apply the TLO to industrial/scientific/government data – assembly, system, activity, state, event, property …

10s of objects, which philosophers and mathematicians discuss at length defines the 4D approach to space, time, matter, class, individual …

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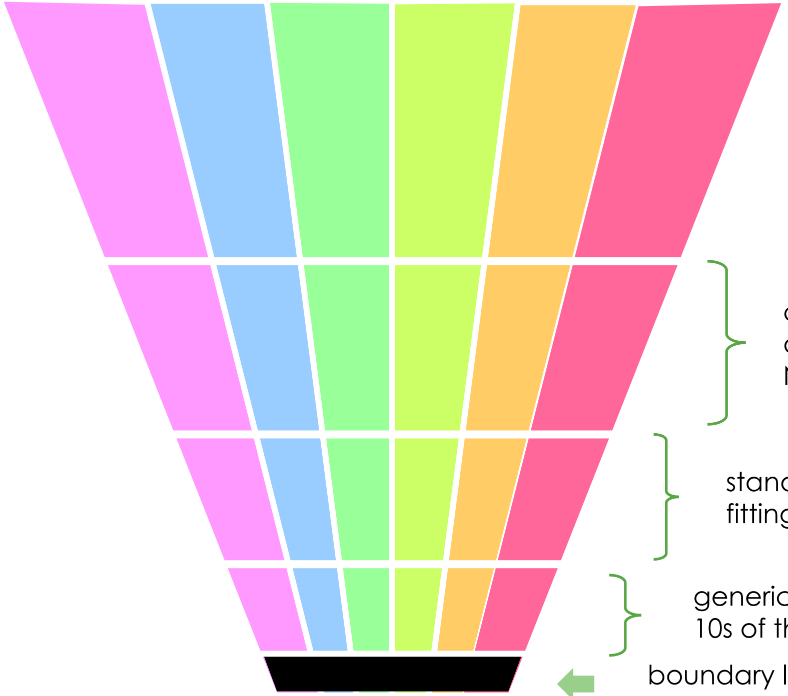
Layers of reference data



classes and properties defined by business – manufacturers, suppliers, service providers, etc.. This includes items in manufacturers' catalogues, and product breakdown information used for maintenance.

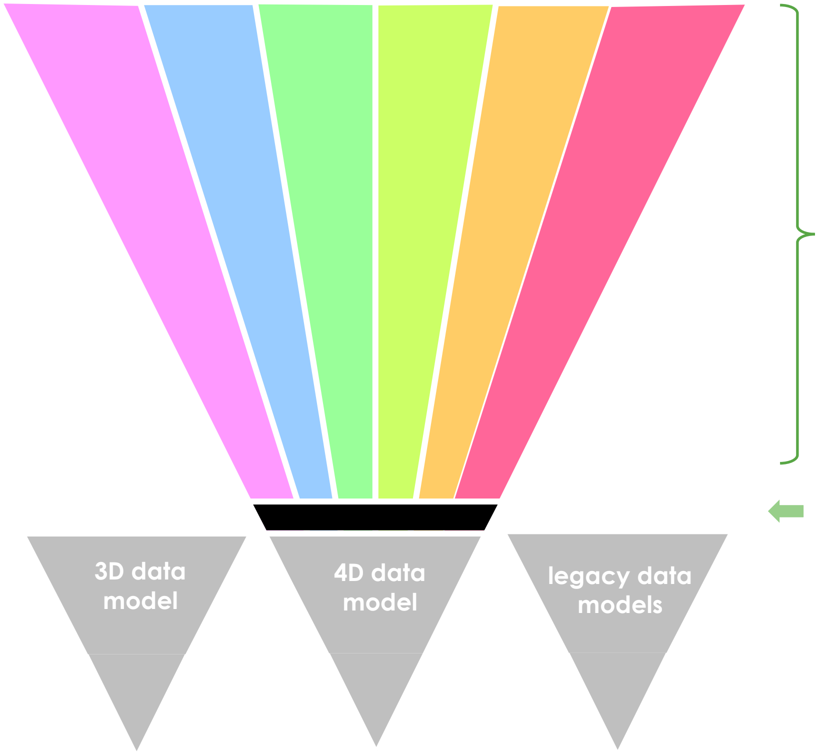
commodities for procurement or supply and their properties defined by trade associations, NATO, UN and large organizations – several million items in the NATO system alone

standard classes and properties from ISO, IEC, ASTM etc. – material grades, pipe fitting forms, fastener types, country codes, currency codes, units of measure

generic classes and properties from text books – pump, value, switch, pipe threat 10s of thousand just in the process industry

boundary layer of **core terminology** – used by the domain experts above, and mapped on to the foundation below

But we are not dictators



millions of reference objects created by experts in the domains – mechanical, electrical, process, materials, geographic, administrative, utilities, project planning, ….

boundary layer of **core terminology** – used by the domain experts above, and mapped on to the foundations ***pleural*** below – developed by ISO TC 184/SC 4

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Core terminology < 100 terms

activity
activity breakdown
artefact
assembly
assembly breakdown
assembly element
behaviour
breakdown
breakdown element
capability
collection
complete breakdown
component
component in a system
component in an assembly
engineered system
function
functional breakdown
functional requirement
kind
kind of physical quantity
kind of state
kind of state of an organization
kind of state of person
maintenance condition
material object
material product
method
network
network element
organization
part
partial breakdown
participant
particular
particular state
particular state of a person
particular state of an organization
system element
person
physical property
physical quantity
physical quantity value
plan
position in organization
presentation of a physical quantity value
process
product
product design
requirement
role
role in organization
service
shape feature
specification
sub-assembly
sub-system
system
system breakdown

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Start with words – then become formal

6.2.6
system
two or more things with interactions between them, giving the whole a **behaviour**

NOTE 1 ISO/IEC/IEEE 15288 defines **system** as:

"combination of interacting elements organized to achieve one or more stated purposes".

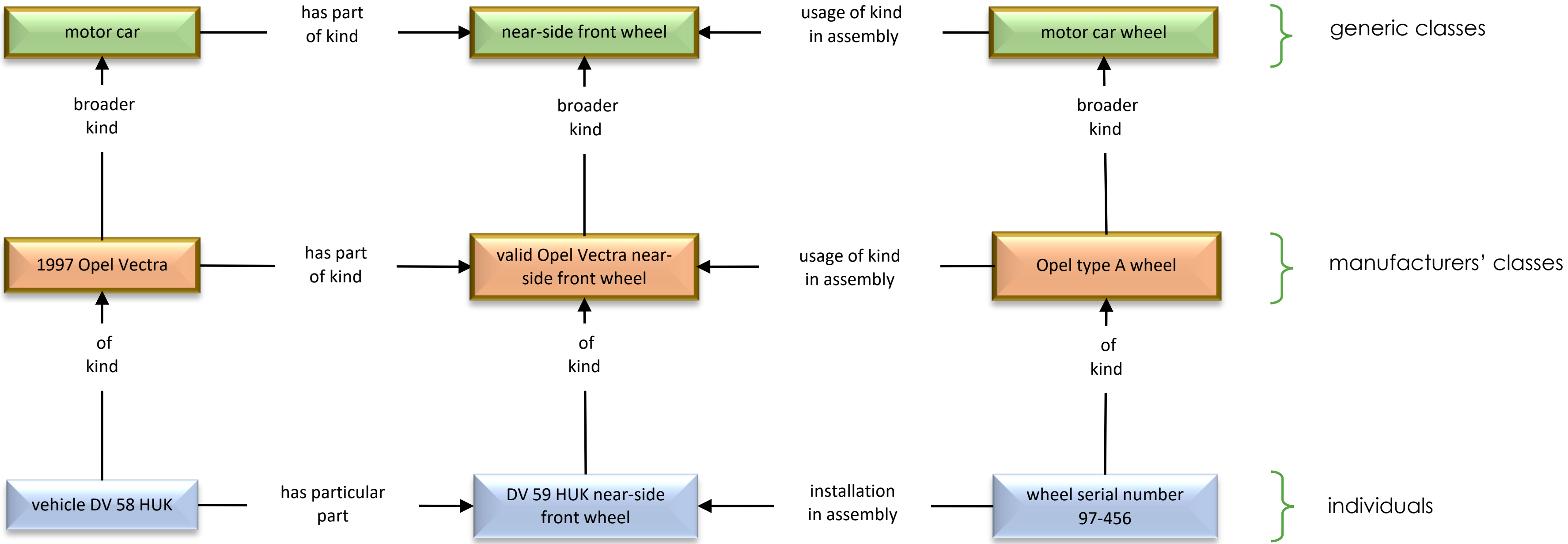
The part of the definition "organized to achieve one or more stated purposes" has been omitted so that the definition encompasses natural as well as engineered systems.

NOTE 2 A interacting **part** of a **system** is a **system element**.

NOTE 3 A **system** has a **breakdown** into its **system elements**. A **system** can have other **breakdowns** into **parts** that are not **system elements**.

NOTE 4 A **system** can have **parts** which are not **system elements**. A **part** of a **system** can be all that is within a particular area or compartment. This part can be without a **function** as a whole, and can be neither a **sub-system** nor **component**.

Illustrate the meaning of words by examples



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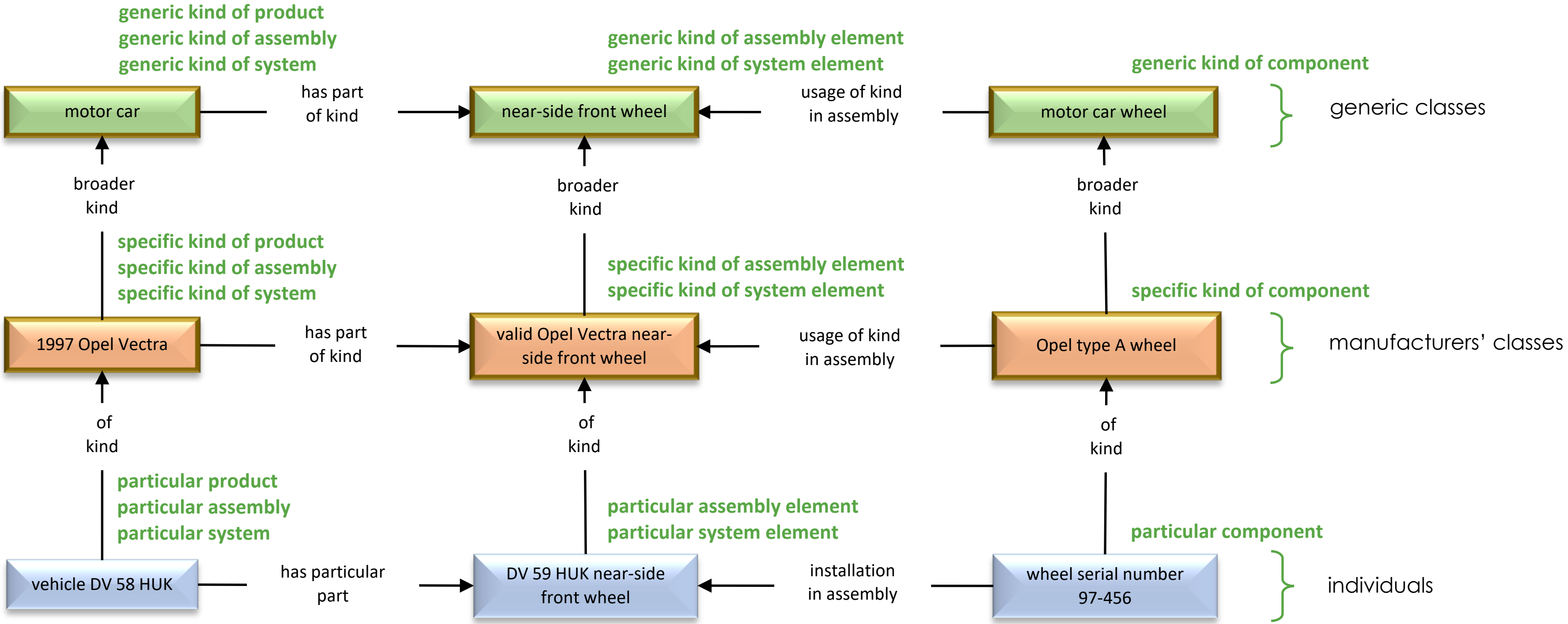
Use the core terminology



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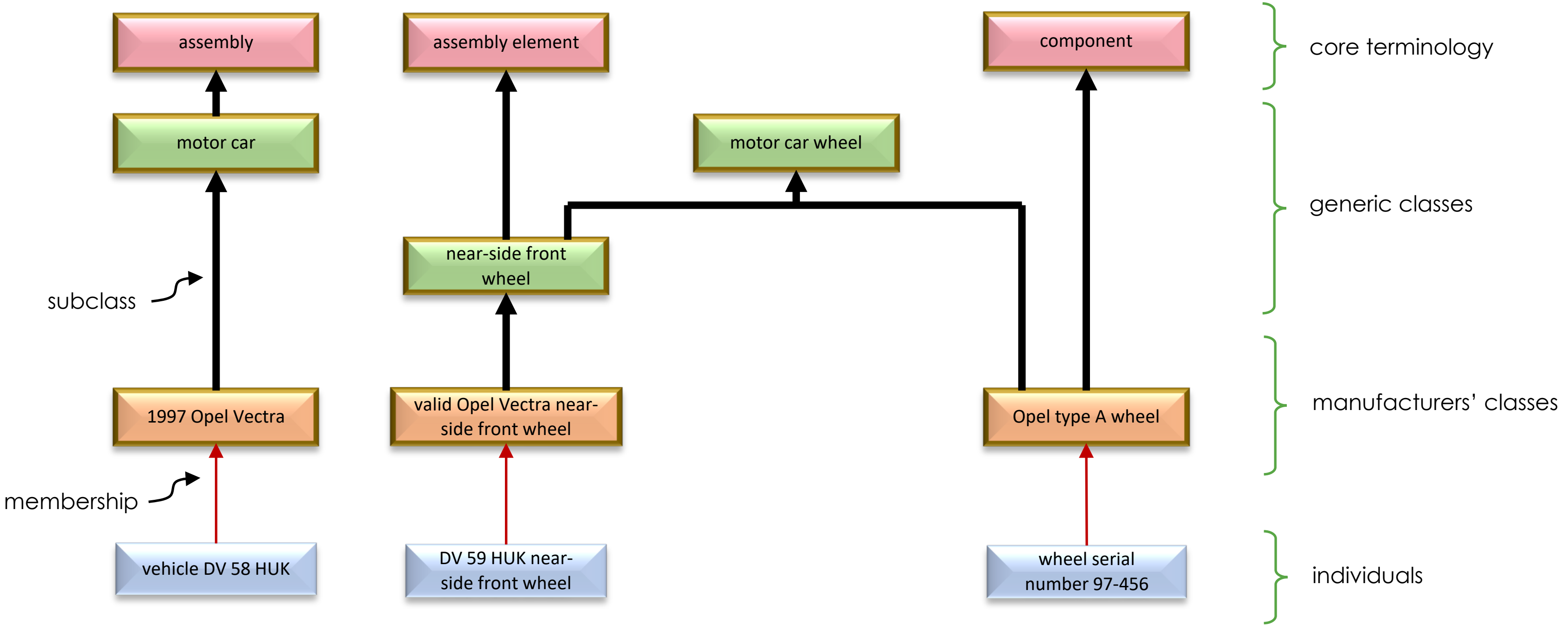
naïvely – in the absence of a TLO



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The naïve hierarchy misses things – it is static

- What is constant through time

  Wheel serial number 97-456 is made as a **type A wheel**. It will remain a **type A wheel** throughout its life.

  A **near side front wheel** is always part of the same **motor car**.

- What changes through time

  No wheel is made as a **near side front wheel**. This is where a wheel is installed. A wheel can be installed in many places during its life.

  After 2021-04-07, **wheel serial number 97-456** is the same thing as **DV 59 HUK near side front wheel**. If one has a puncture, then so does the other! ☺

- What can happen

  A **type A wheel** can be validly installed on an **Opel Vectra**

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4D space time diagram

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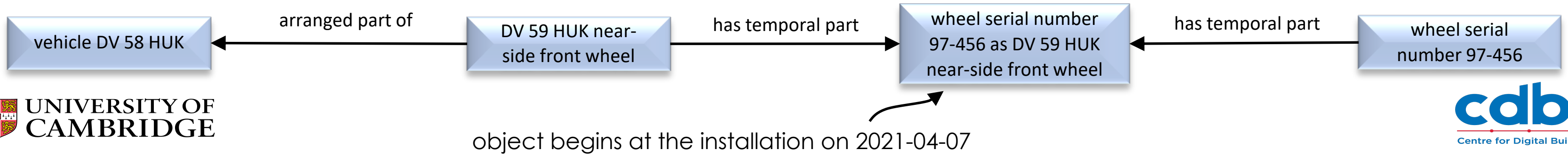
start with the individuals



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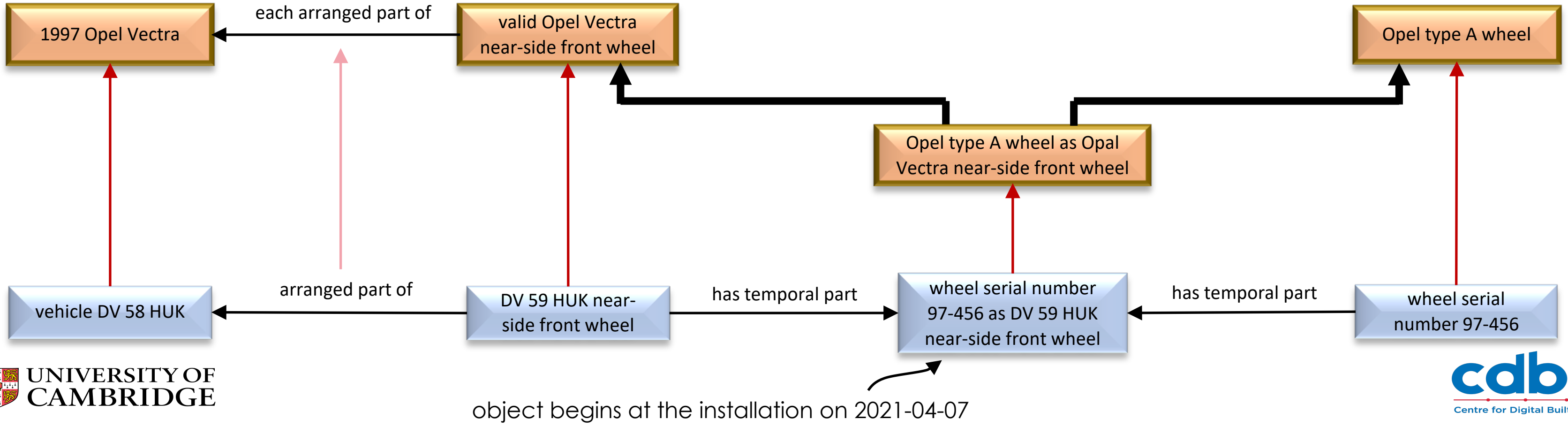
manufacturer's classifications and rules



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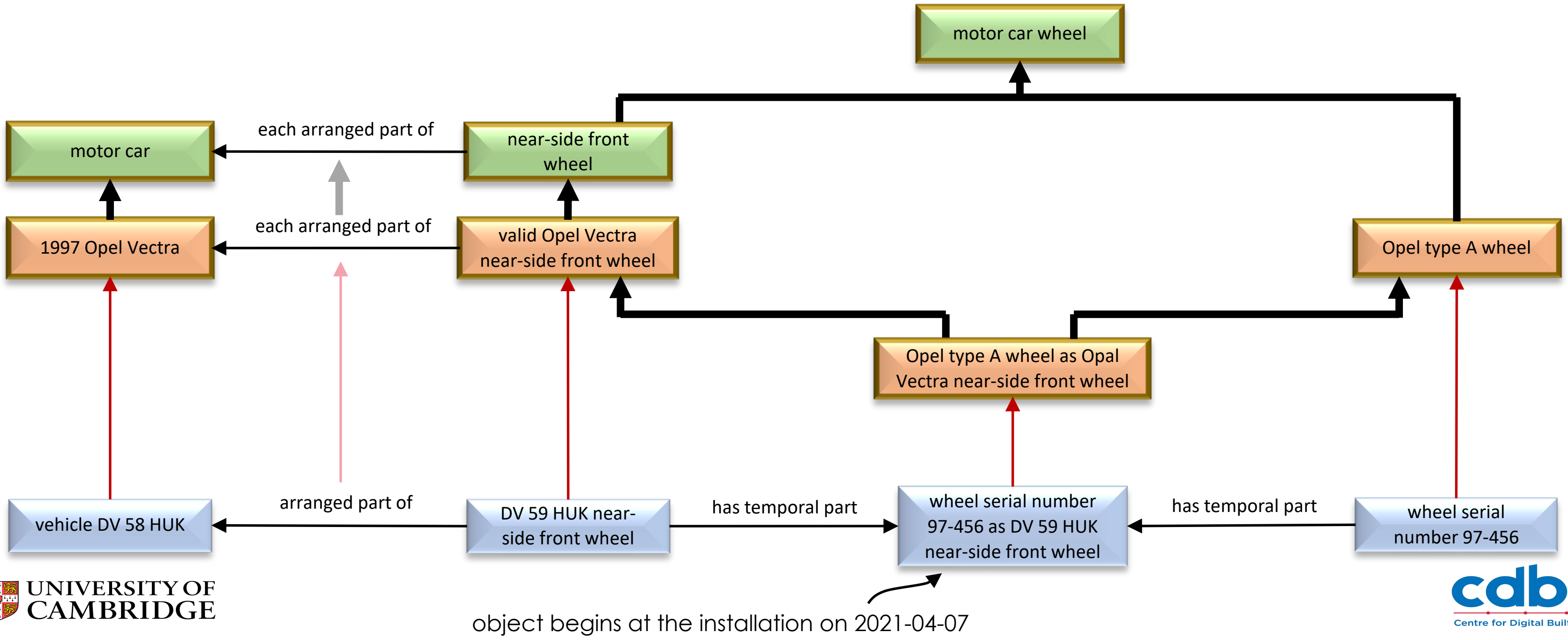
add in the text book terminology



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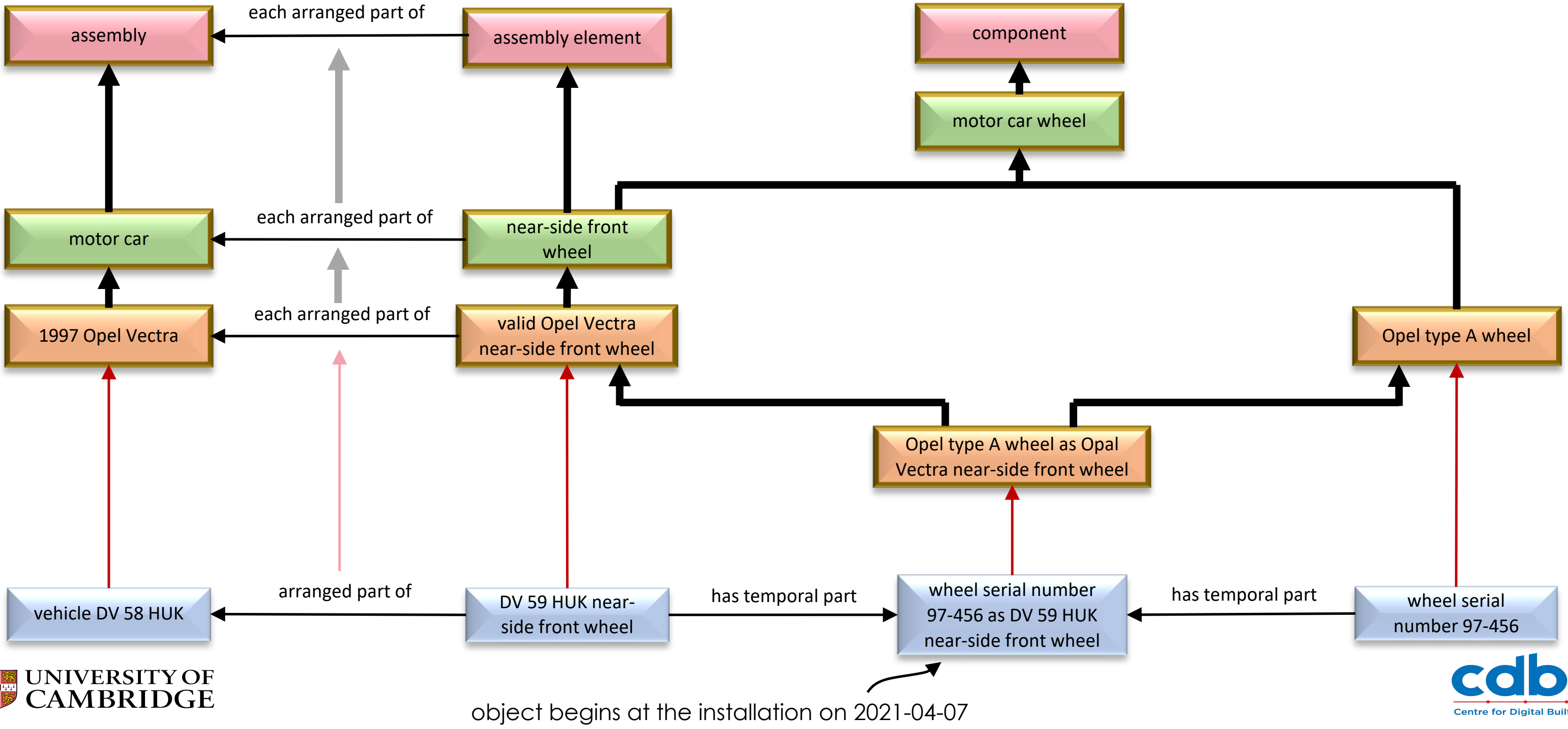
add in the core terminology



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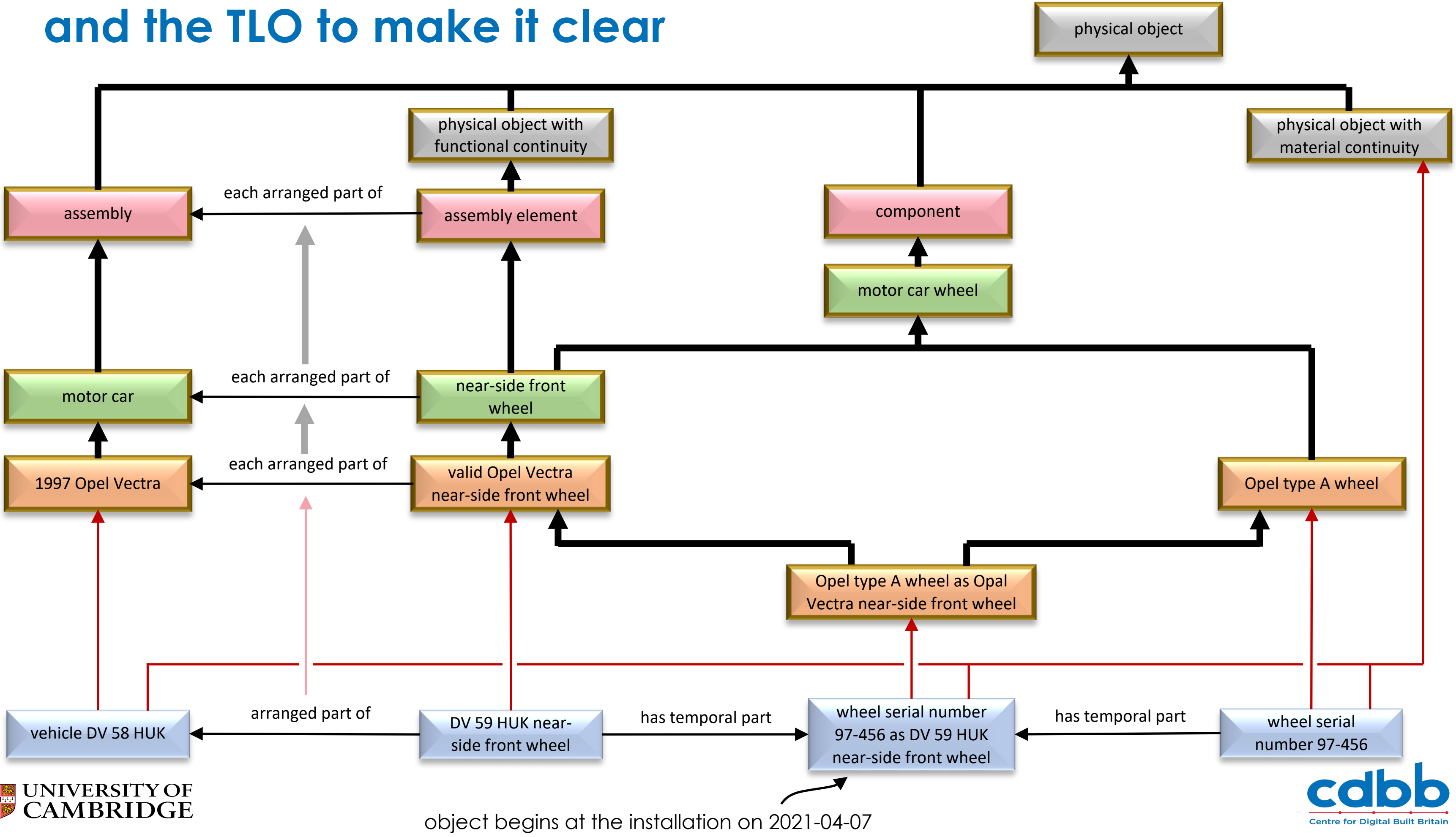
and the TLO to make it clear



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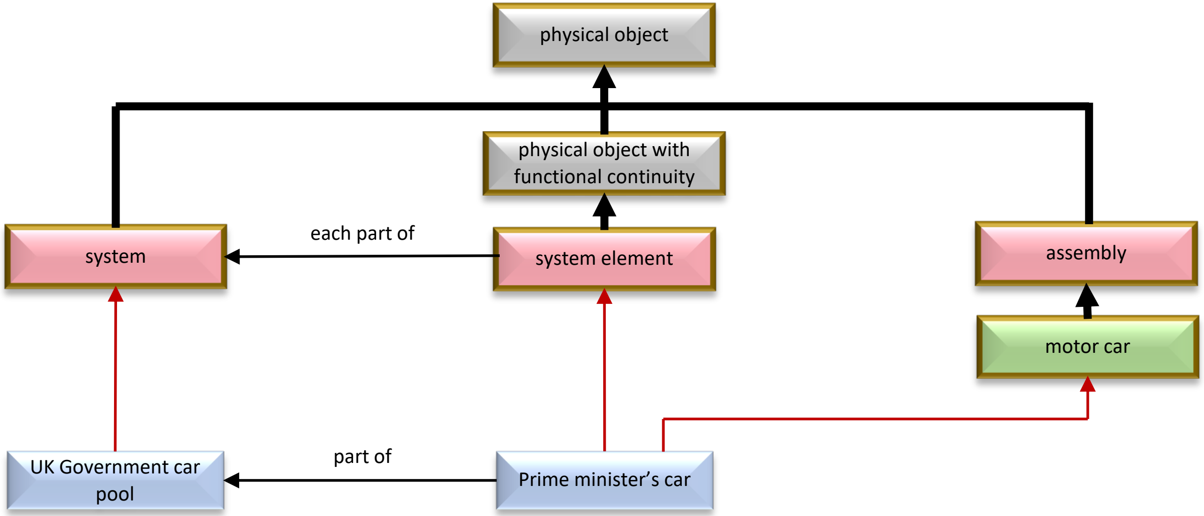
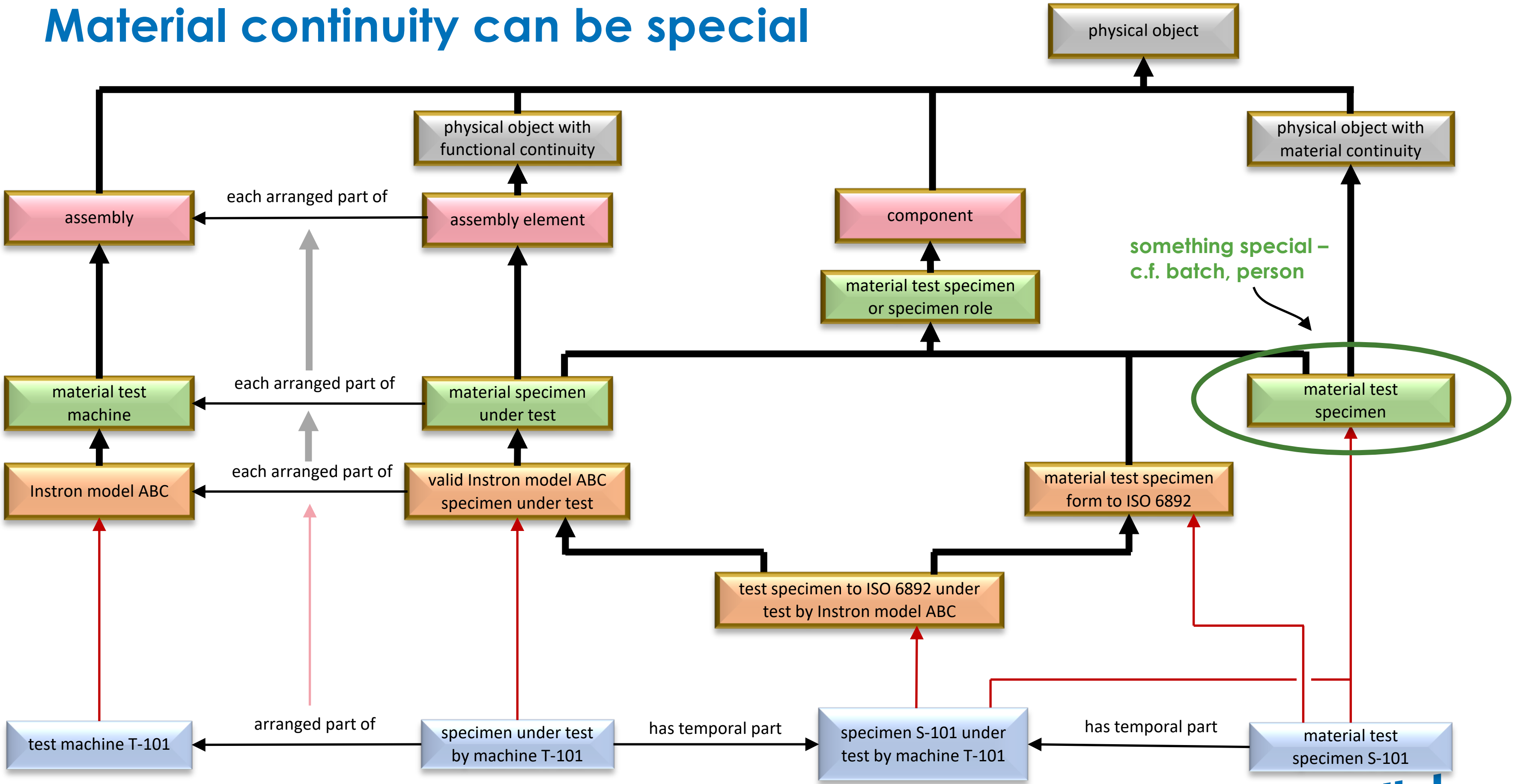
When does a motor car not have material continuity?



Material continuity can be special



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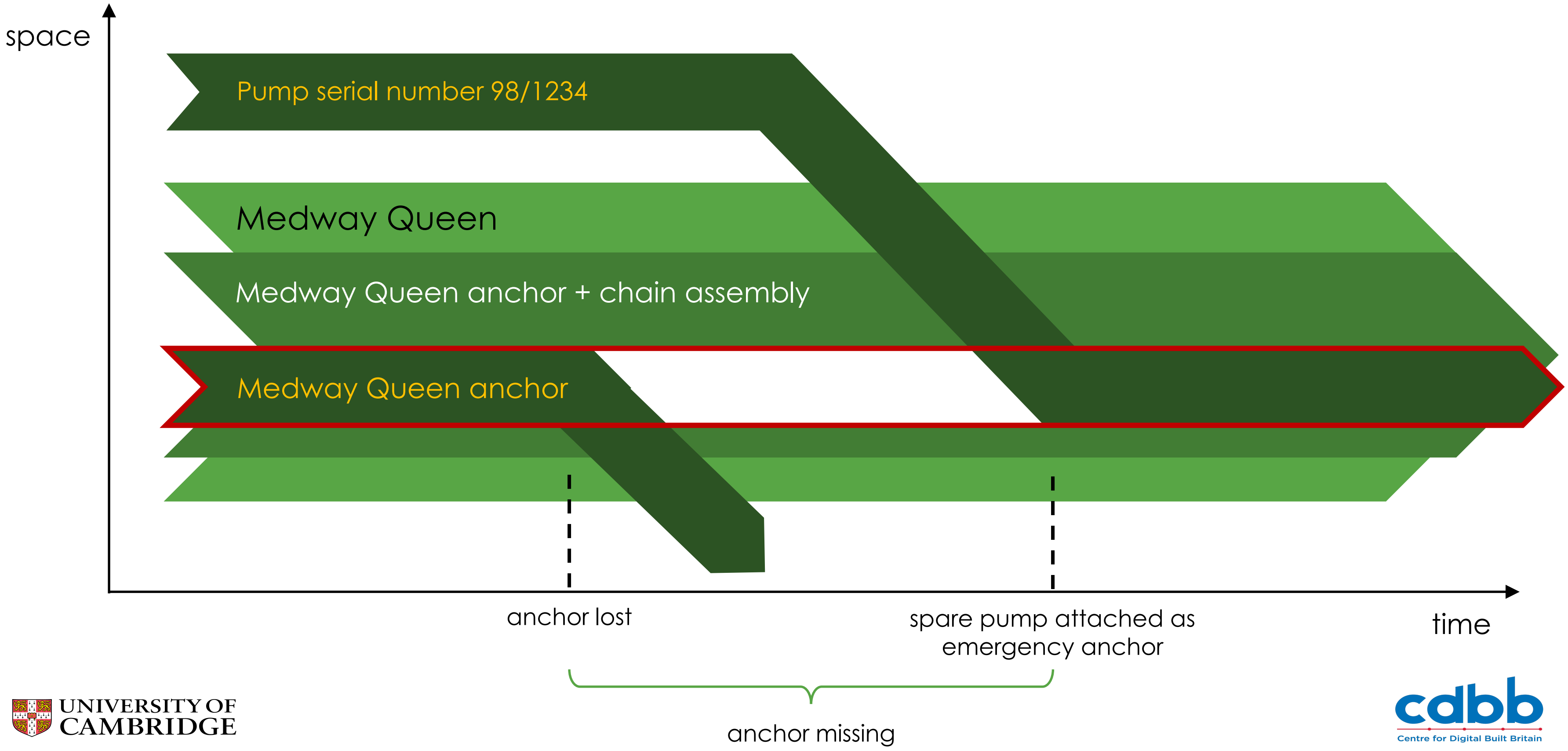
Pumps and anchors



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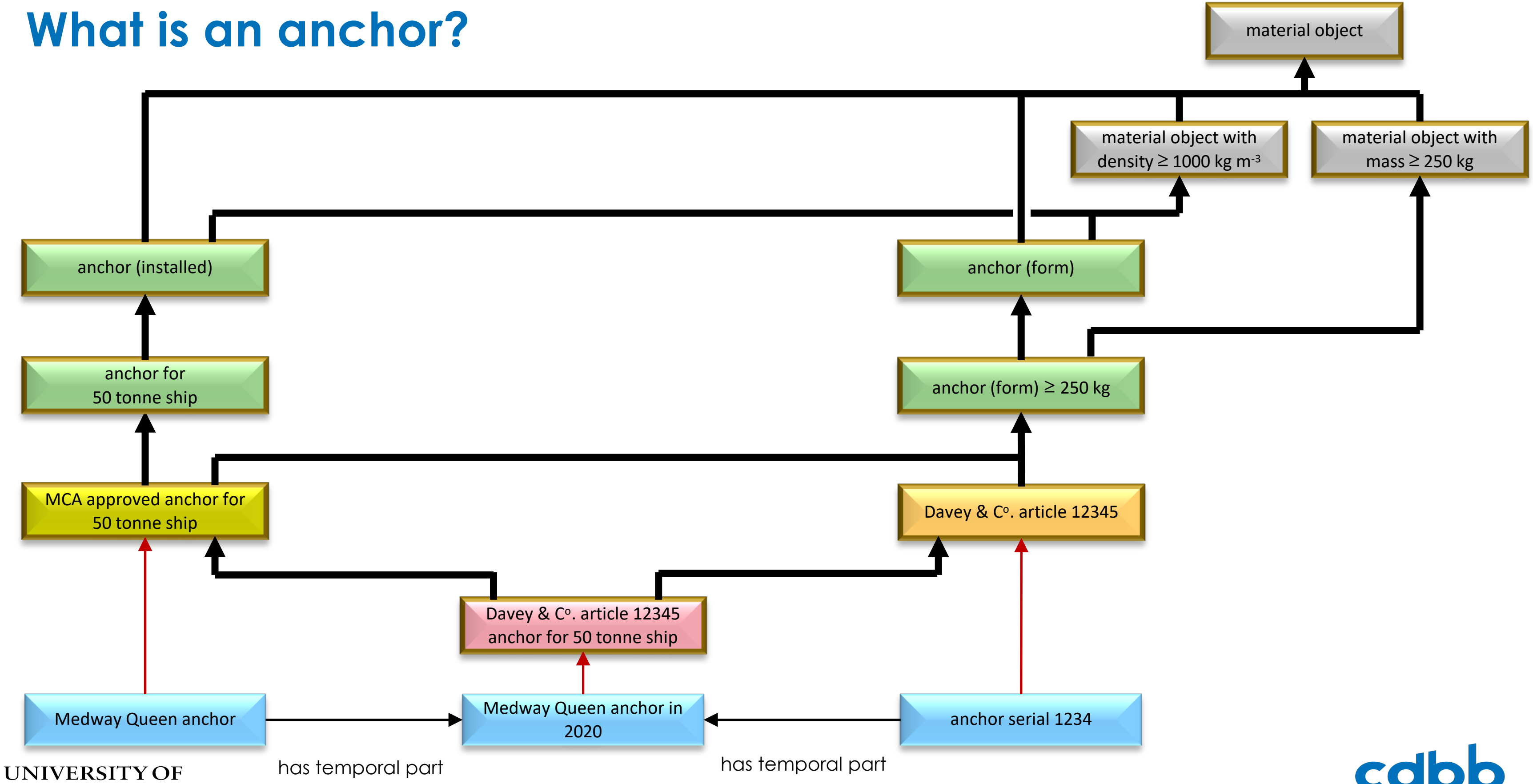
What is an anchor?



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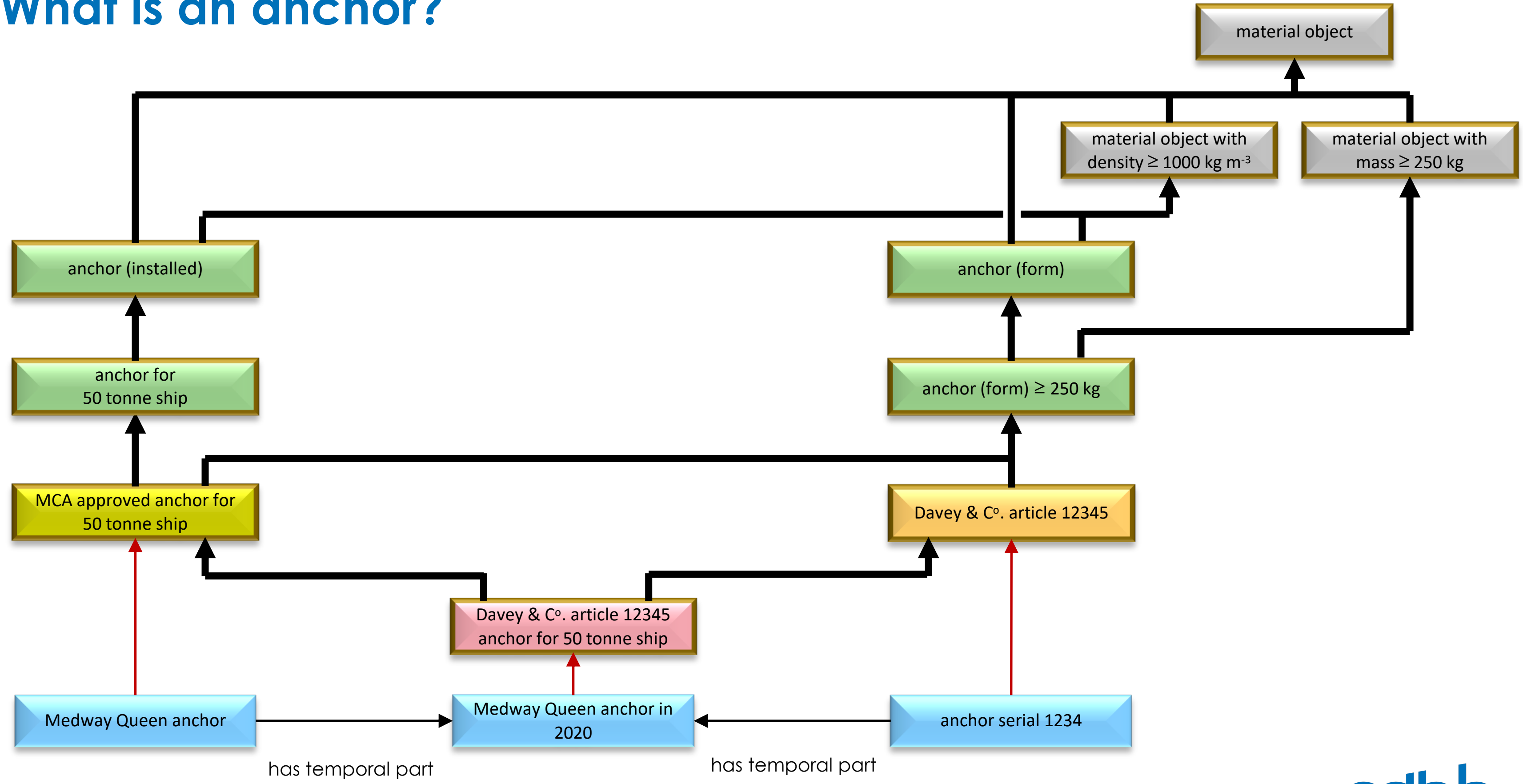
What is an anchor?



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Conclusions

Space-time diagrams are a key tool

Top level ontologies provide key objects – material continuity vs functional continuity

Engineering terminology at the interface to the TLO is needed

Placing existing reference data under the TLO, via the engineering terminology:

- gives clarity;
- enables use with different industrial data models;
- is a step towards formal/automated validation and reasoning.

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