

TOWARDS A TAXONOMY OF BUILT ASSET LIFECYCLE INFORMATION COUPLING

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Context and problem



A growing number of studies are focusing on the **application** and **technical** aspects of cyber-physical systems (CPS)s and Digital Twins (DT)s.



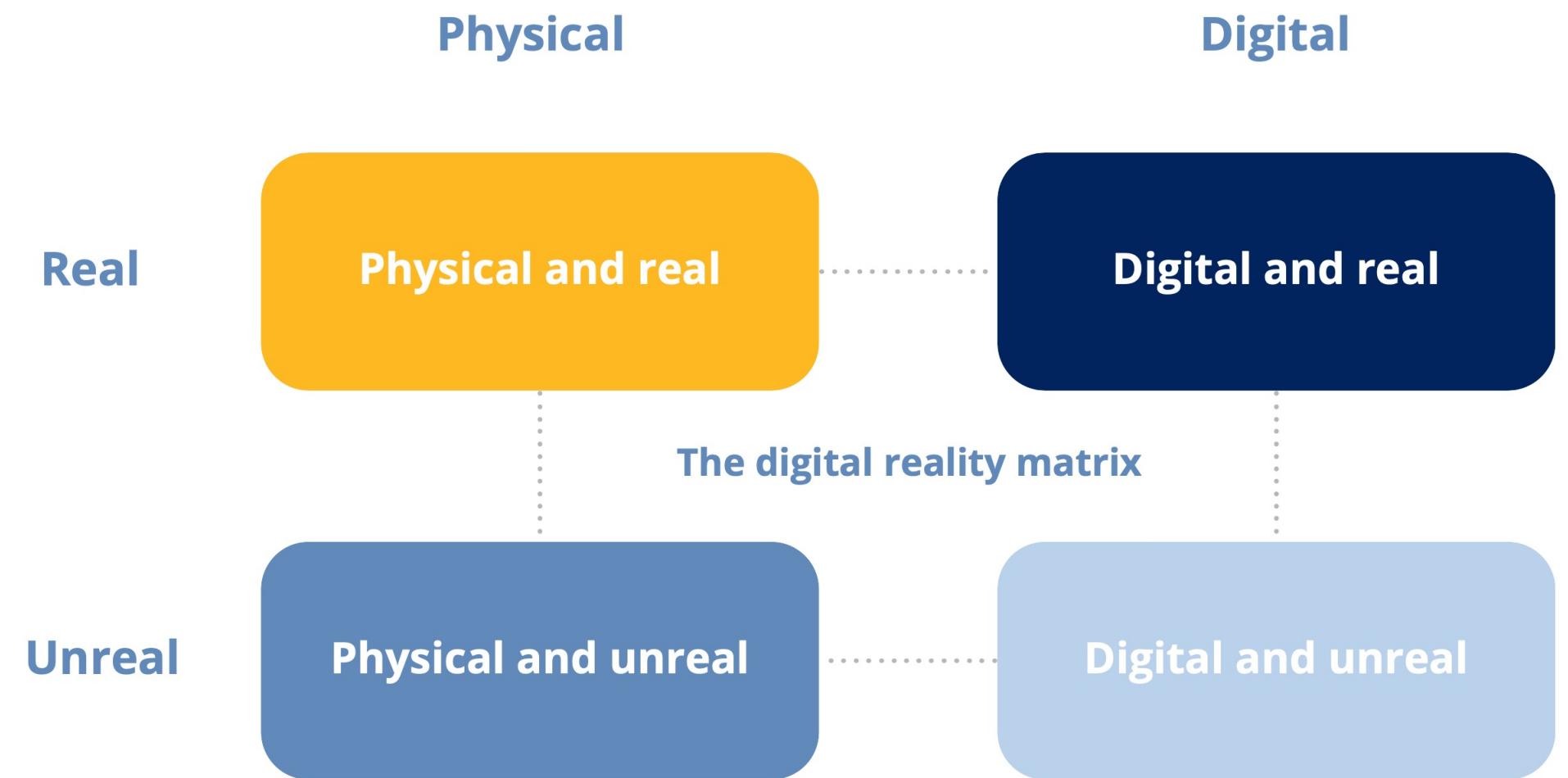
There is still a need to define the common basis of **terms**, **definitions**, **concepts**, and **dimensions** pertaining to lifecycle information coupling.



New constructs such as a **taxonomy** can put into relation the many components which comprise the **coupling of physical and digital of assets** and resources in the lifecycle phases of assets.

Representation in the context of Lifecycle Information Coupling - A brief background

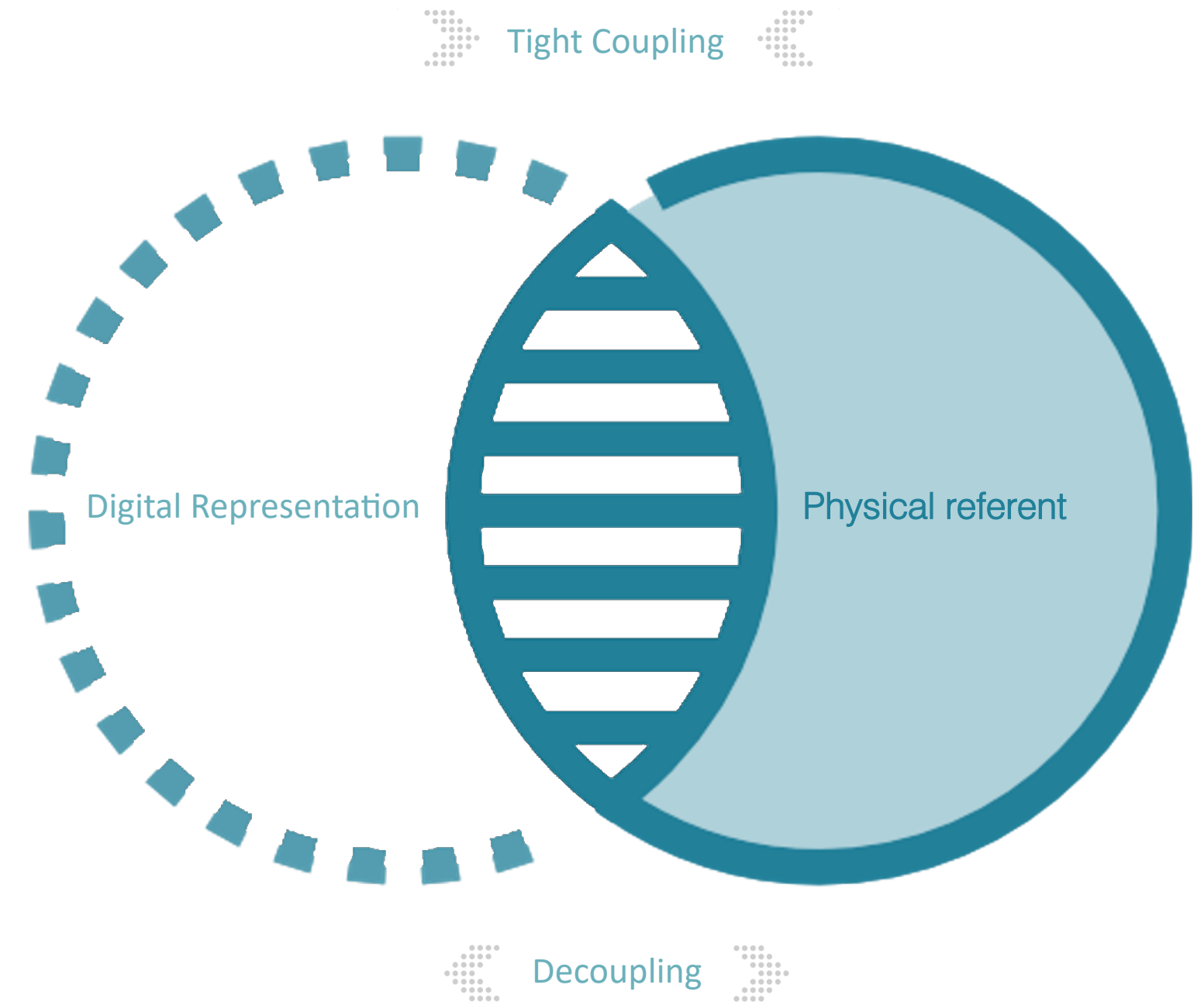
- The challenge is to define precisely how digital can be made real as physical and digital assets become increasingly coupled
- Rethinking the boundaries between – what is perceived *as-reality* and *unreality* would encourage a more diverse range of insights for increasing the coupling of the digital with the real, and the physical with the unreal (e.g. forms of play and fantasy) in specific contexts.



The digital reality matrix – adapted from Boellstroff et al (2016)

Lifecycle information coupling across domains - A brief background

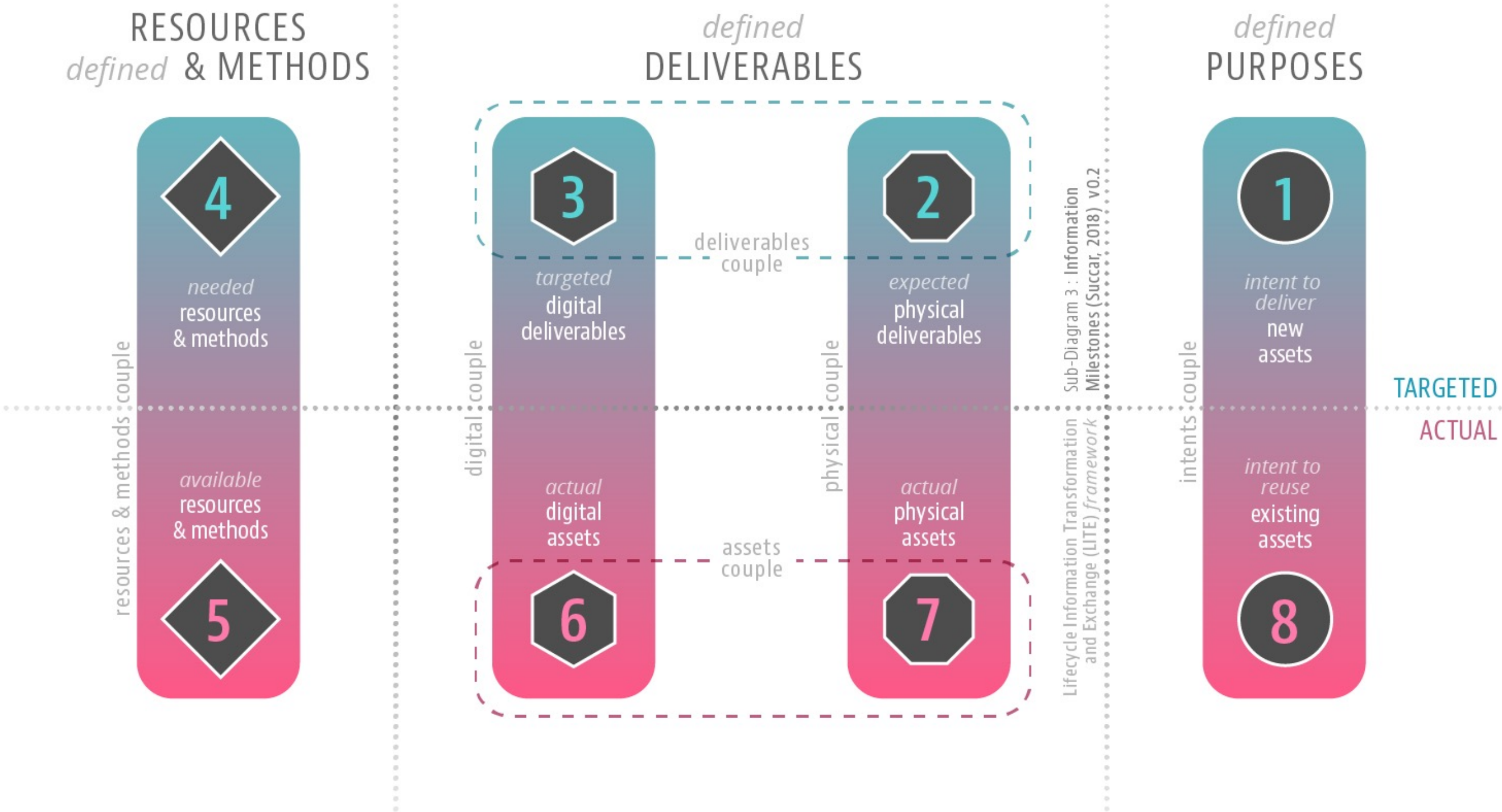
- *Asset coupling* means “development and/or maintenance of digital assets so they accurately match the physical Assets they represent” (BIM Dictionary 2021).
- “*Tight coupling*” in the simulation process is the state in which representations are highly dependent on physical referents.
- “*Decoupling*” in the simulation process refers to further distance or independency between representation and its physical referents.



Coupling level of physical and digital assets

Enabling LITE Framework for investigation of Physical-digital coupling

- **Vertical Couples:**
 - *Intents Couple*
 - *Physical Couple*
 - *Digital Couple*
 - *Resources & methods Couple*
- **Horizontal Couples:**
 - *Deliverables Couple*
 - *Asset Couple*



LITE framework (Succar and Poirier, 2020, p. 8)

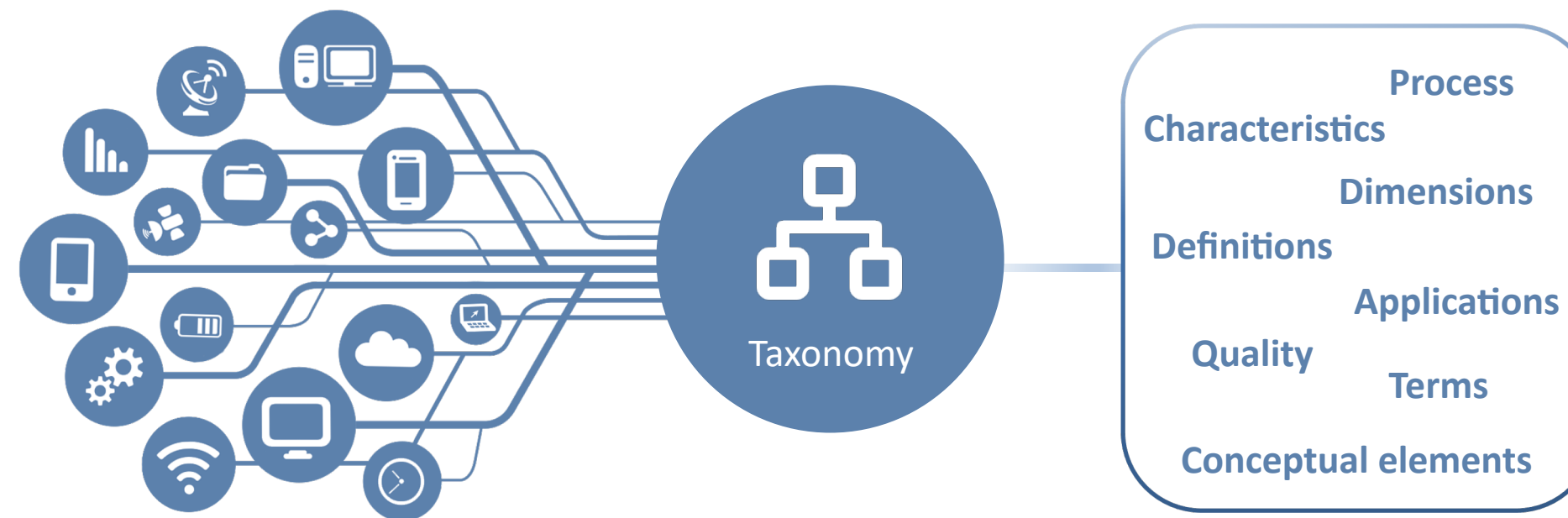
The need for a Taxonomy

- An increasing number of publications have proposed a taxonomy covering Digital Twins (DT)s and asset information management

Examples:

- The Taxonomy of Digital Twins – Van der Valk et al (2020)
- Blockchain for digital twins: Recent advances and future research challenges – Yaqoob et al (2020)

- The one deserving attention in this paper is that Built Asset lifecycle information coupling should not be limited to Digital Twins of physical assets

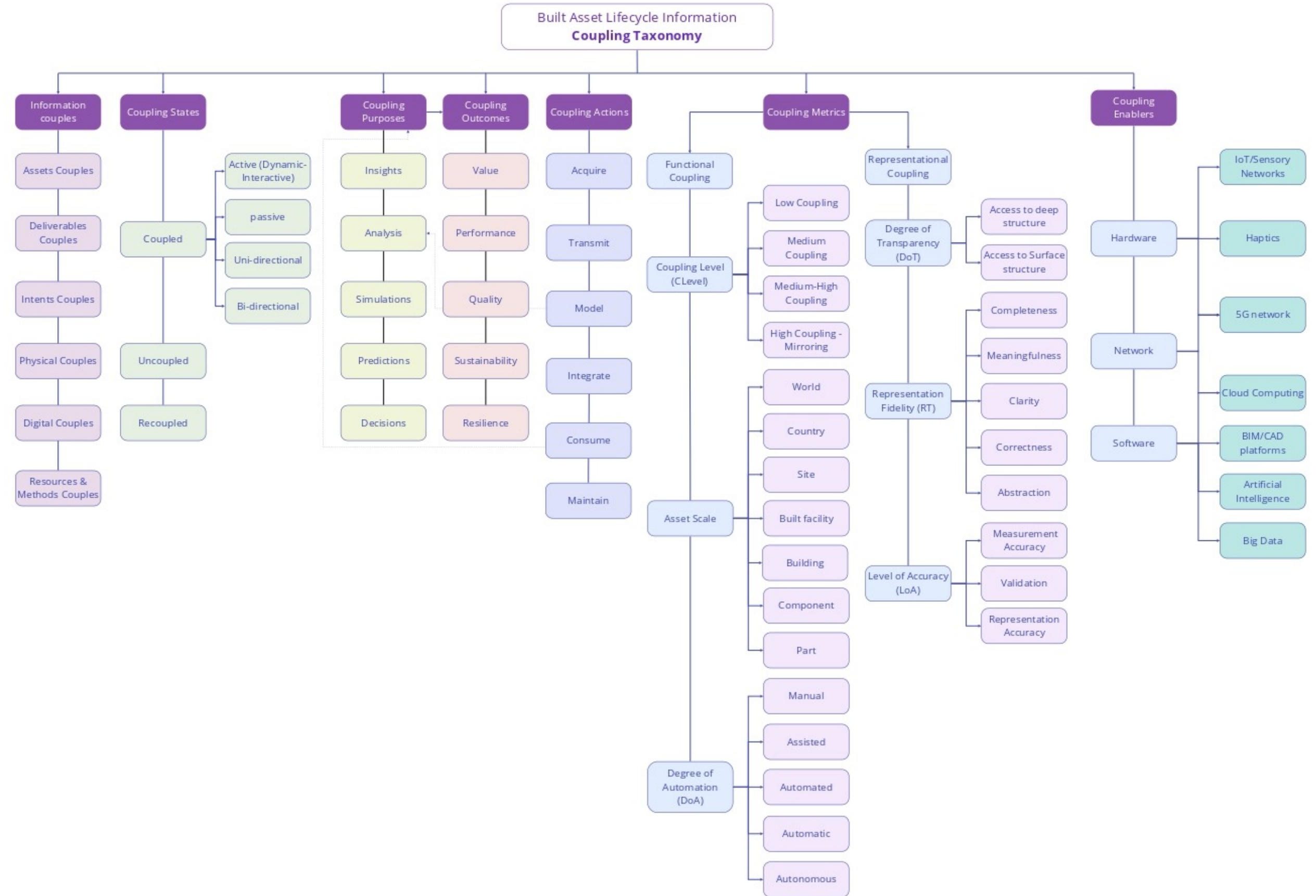


Requirements for formation of Built Asset Lifecycle Information Coupling Taxonomy

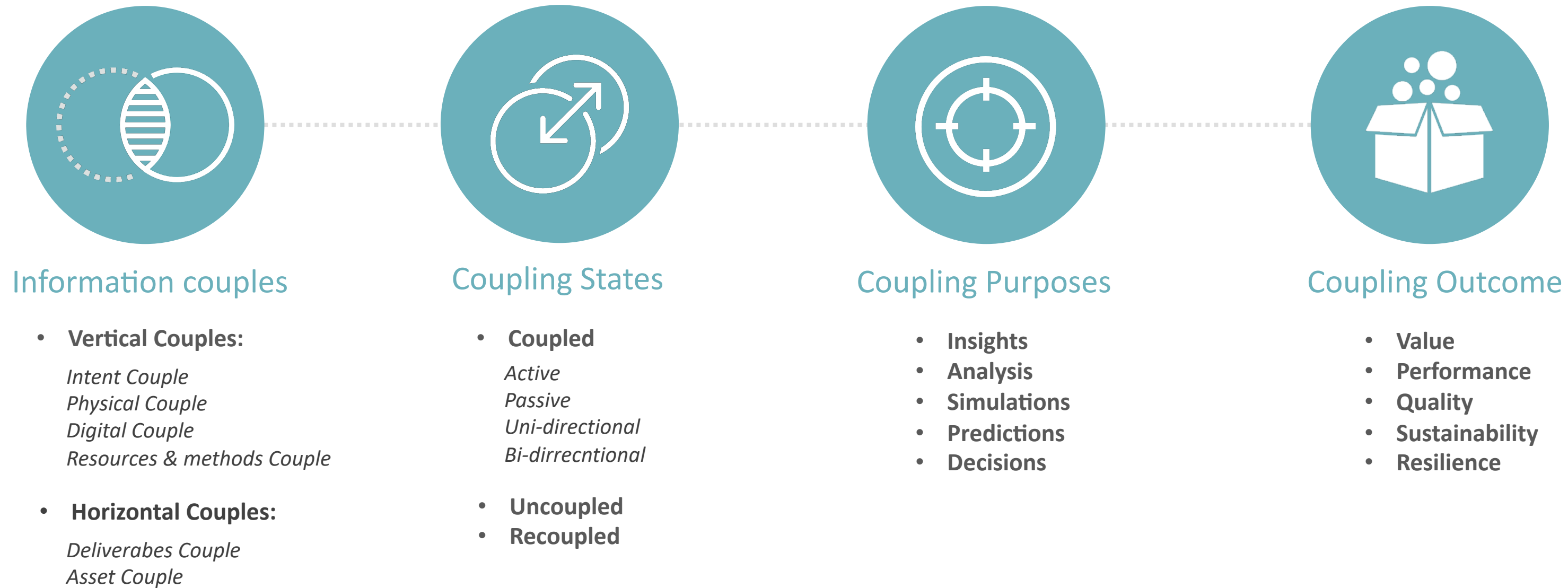
A Taxonomy for Built Asset Lifecycle Information Coupling

Built Asset Information Coupling Taxonomy includes seven high-level components:

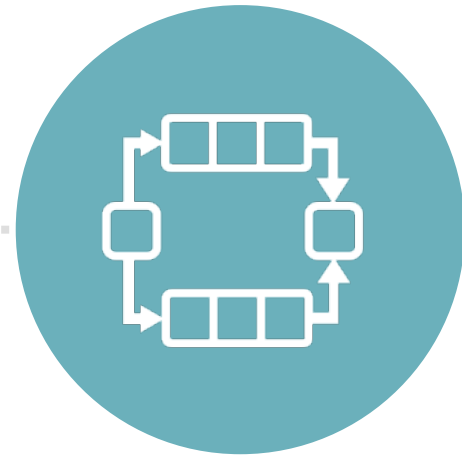
- Information Couples
- Coupling States
- Coupling Purposes
- Coupling Outcomes
- Coupling Actions
- Coupling Metrics
- Coupling Enablers



Components of Built Asset Lifecycle Information Coupling Taxonomy



Components of Built Asset Lifecycle Information Coupling Taxonomy



Coupling Actions

- **Acquire**
- **Transmit**
- **Model**
- **Integrate**
- **Consume**
- **Maintain**



Coupling Metrics

- **Functional coupling**
Coupling Level
Asset Scale
Degree of Automation
- **Representational coupling**
Degree of transparency
Representation Fidelity
Level of Accuracy



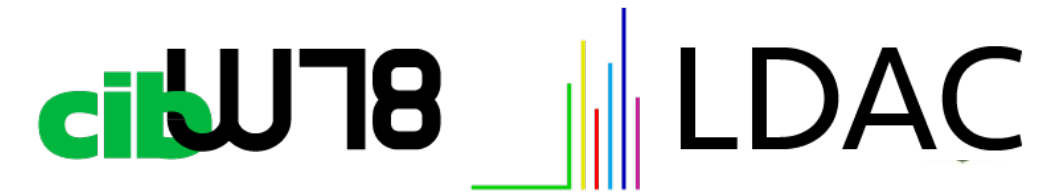
Coupling Enablers

- **Hardware**
IoT/sensory Networks
Haptics
5G network
- **Network**
Cloud Computing
5G network
- **Software**
BIM/CAD platforms
Artificial Intelligence (AI)
Big Data
Cloud Computing

Discussion and Conclusion

- A broader vision was adopted to understand **key components** and **characteristics** that enable asset couplings across lifecycle phases of a built asset.
- Built Asset Lifecycle Information Coupling Taxonomy will offer **practical benefits** in industrial level (e.g. information management tools for automation)
- The **conceptual superiority** of the coupling concepts over the 'academically pervasive' DT concept
- Further development and extension of taxonomy can reduce the complexity of this evolving field of research.
- Limitations:
 - Some of the key components of the proposed taxonomy need to be **tested and verified** through information-uses.
 - More dimensions and characteristics need be defined and added to address current gaps in the context of CPS and DT.

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Thank you

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