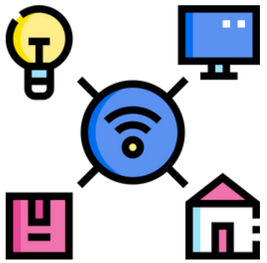
GDR GPL - Engineering Digital Twins

Defining and Developing SoS DTs to Bolster SoS Resilience

Meriem SMATI

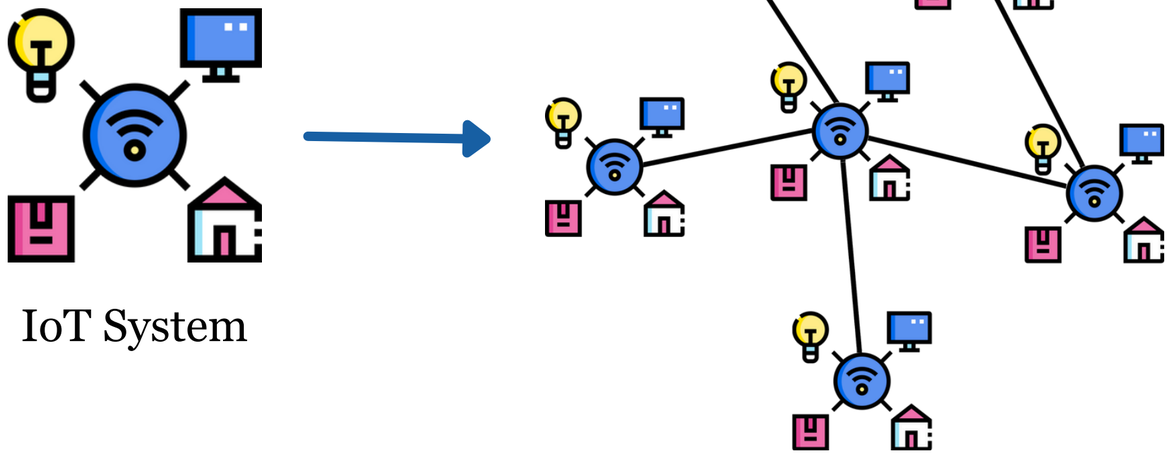
Supervising Team: Vincent CHEUTET, Christophe DANJOU, Jannik LAVAL
Contact: meriem.smati@insa-lyon.fr - meriem.smati@polymtl.ca

1. Context



IoT System

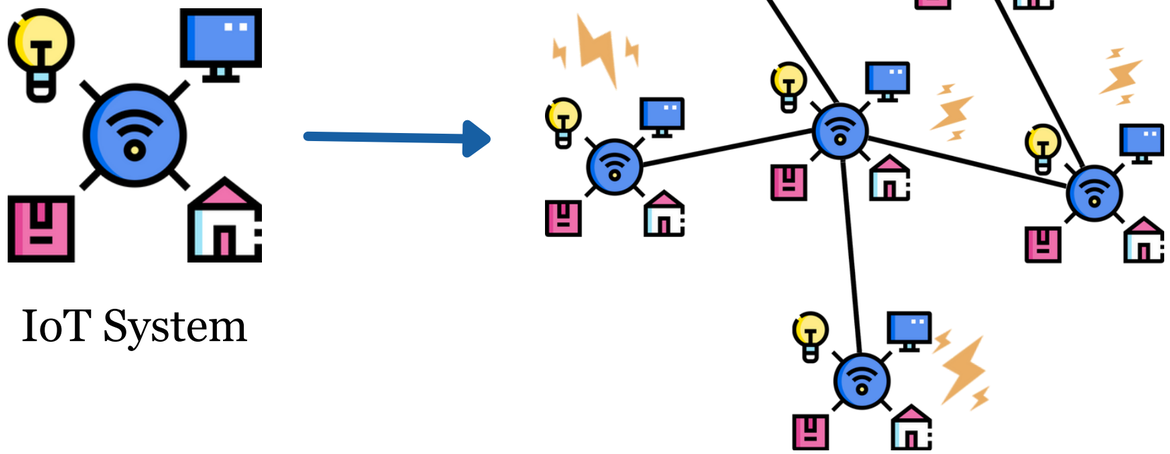
1. Context



IoT System

IoT SoS

1. Context

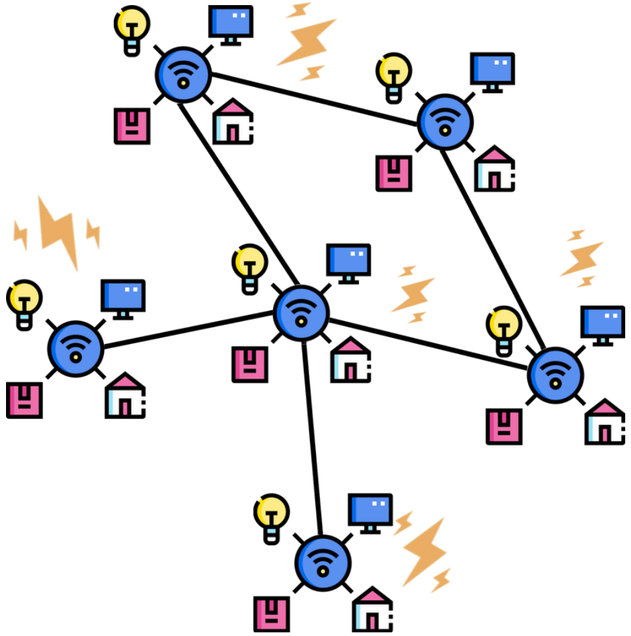


IoT System

IoT SoS

1. Context

IoT System

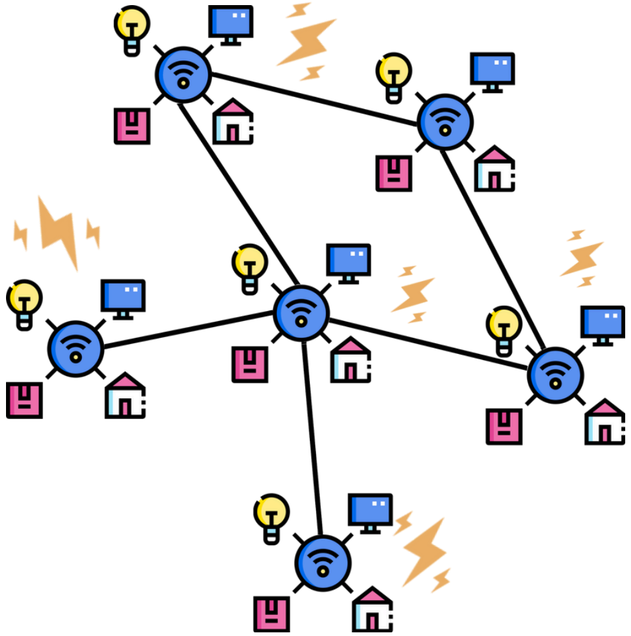


IoT SoS

We need to make the SoS **Resilient**

1. Context

IoT System

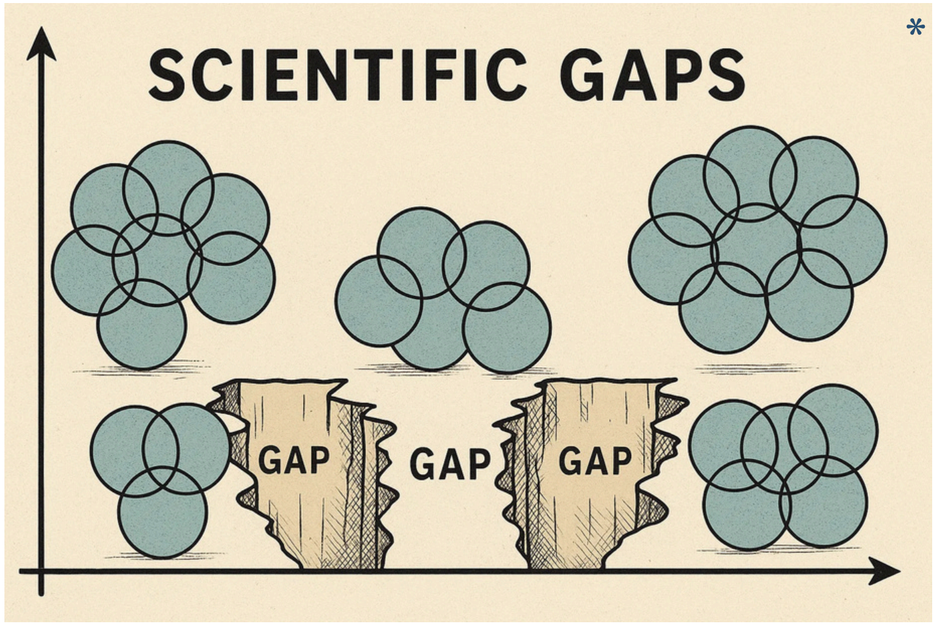


IoT SoS

We need to make the SoS **Resilient**

The use of Digital Twins to accomplish a resilient SoS

2. Identified Challenges and Gaps

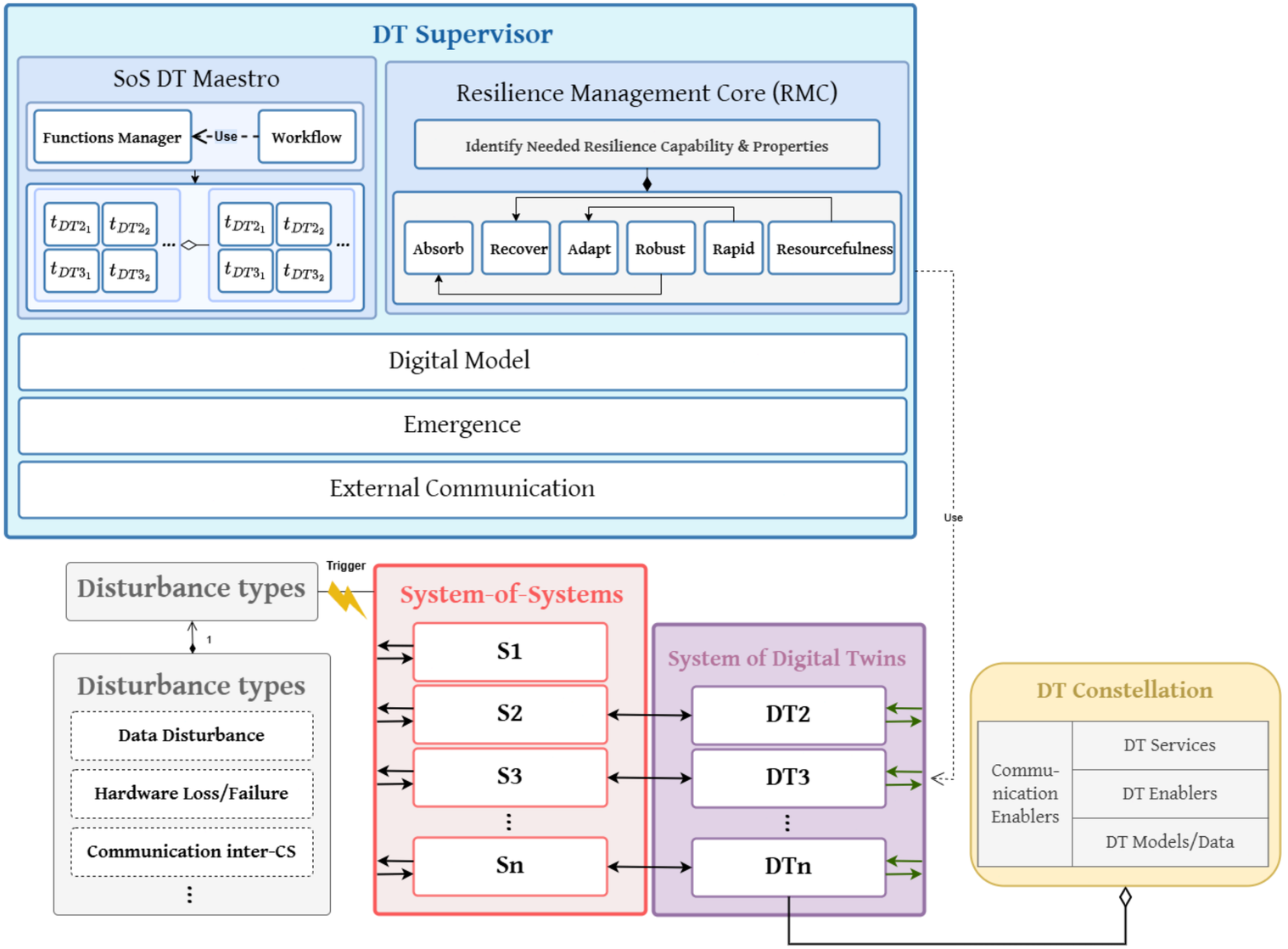


📄 No paper contributing to all the characteristics of resilience.

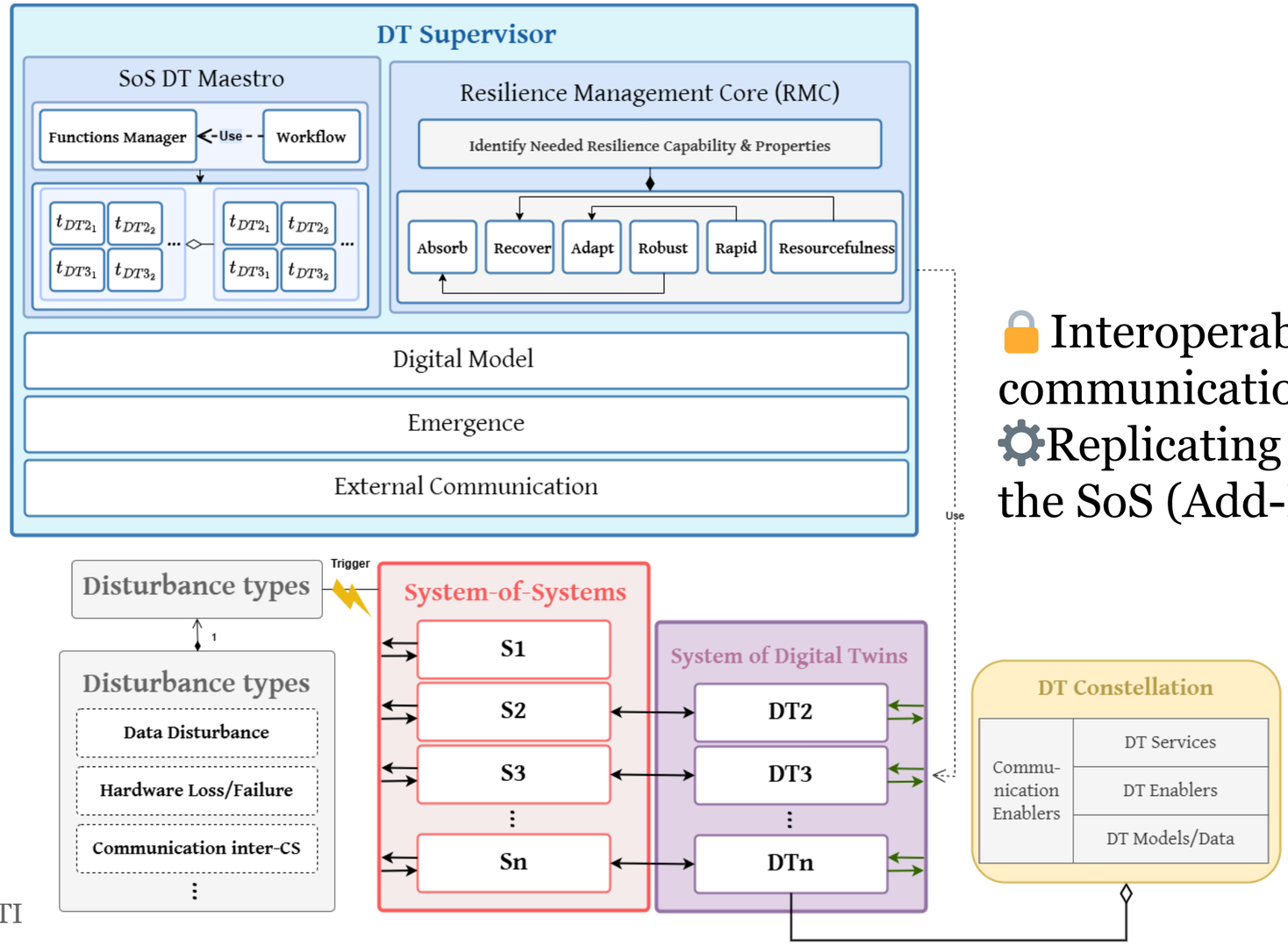
🚨No standard or architecture for DTs for SoSs.

📈Few empirical applications of real DTs.

3. Contribution



3. Contributions



🔒Interoperability in DTs to replicate the communication between CSs.

⚙️Replicating the dynamics existant in the SoS (Add-Edit-Remove a CS).

References

[1] Smati, M., Laval, J., Cheutet, V., & Danjou, C. (2024, July). Enhancing Data Integrity with CSDT: A Solution to Predict Data Disturbance in IoT Systems. In *IFIP 21st International Conference on Product Lifecycle Management*.
[2] Andrew, S. and Christopher, C. (2001). On the systems engineering and management of systems of systems and federations of systems. Journal of Systems Engineering, 21(4):325–345.
[3] Mark W. Maier, 1998. "Architecting principles for systems-of-systems," Systems Engineering, John Wiley & Sons, vol. 1(4), pages 267-284.
[4] Michel Bruneau, Stephanie E Chang, Ronald T Eguchi, George C Lee, Thomas D O'Rourke, Andrei M Reinhorn, Masanobu Shinozuka, Kathleen Tierney, William A Wallace, and Detlof Von Winterfeldt. 2003. A framework to quantitatively assess and enhance the seismic resilience of communities. Earthquake spectra 19, 4 (2003), 733–752.
[5] Oakes, B., Gomes, C., Kamburjan, E., Abbiati, G., Ecem Bas, E., & Engelsgaard, S. (2024, September). Towards Ontological Service-Driven Engineering of Digital Twins. In *Proceedings of the ACM/IEEE 27th International Conference on Model Driven Engineering Languages and Systems* (pp. 464-469).
[6] Wenque Liu, Ming Shan, Sheng Zhang, Xianbo Zhao, and Zhao Zhai. 2022. Resilience in infrastructure systems: A comprehensive review. Buildings 12, 6 (2022), 759.
[7] Seyedmohsen Hosseini, Kash Barker, and Jose E Ramirez-Marquez. 2016. A review of definitions and measures of system resilience. Reliability Engineering & System Safety 145 (2016), 47–61.
[8] Royce Francis and Behailu Bekera. 2014. A metric and frameworks for resilience analysis of engineered and infrastructure systems. Reliability engineering & system safety 121 (2014), 90–103.
[9] Henry, D., & Ramirez-Marquez, J. E. (2010, July). 3.1. 1 A generic quantitative approach to resilience: A proposal. In INCOSE International Symposium (Vol. 20, No. 1, pp. 291-301).
[10] Grieves, M. (2014). Digital twin: manufacturing excellence through virtual factory replication. White paper, 1(2014), 1-7.
[11] Grieves, Michael & Vickers, John. (2017). Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems. 10.1007/978-3-319-38756-7_4.
[12] Kamwa, I., & Badrzadeh, B. (2024). From Buzzword To Solutions: Digital Twins in Power Systems [Editor's Voice]. IEEE Power and Energy Magazine, 22(1), 4-11.

* One image was generated by AI tools