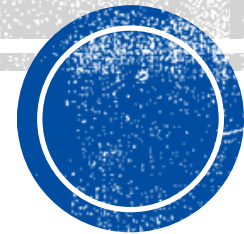


Challenges and Opportunities in Sensor Network Metrology (EURAMET TC-IM 1551)



Martin Koval

FORUM-MD: Workshop on Metrology for Complex Sensor Networks

(11 Feb 2025 - 12 Feb 2025)

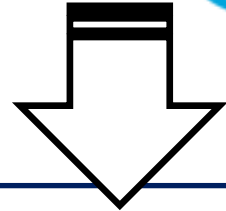
The aim of the project is to foster the development of a sensor network metrology (SNM) in EURAMET. The use of SNM ranges from smart buildings, smart cities, smart grids to autonomous driving, environmental monitoring and many more. This wide range of application areas offers novel opportunities in metrology but also leads to several new challenges.

The project will bring together activities and developments related to sensor network metrology to

- **Share knowledge, experience, and research results;**
- **Discuss running and potential future research projects;**
- **Organize seminars and provide advice for TCs, EMNs and EURAMET Members.**

TC-IM 1551 **(Project description)**

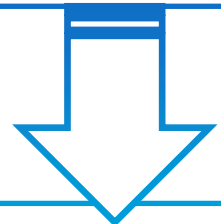




**Technical Committee for Interdisciplinary Metrology
(TC-IM)**



**Working Group on Metrology for Digital Transformation
(WG M4D)**



**Challenges and opportunities in sensor network metrology
(Project TC-IM 1551)**

Project TC-IM 1551



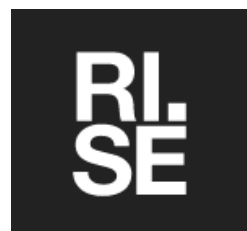
COORDINATING INSTITUTE:

- **CMI** (Czech Republic)



PARTICIPATING PARTNERS:

- **PTB** (Germany)
- **VTT-MIKES** (Finland)
- **NPL** (United Kingdom)
- **RISE** (Sweden)
- **SMD** (Belgium)
- **GUM** (Poland)



TC-IM 1551
(Project partners)



TC-IM 1551 (WPs)

	Name	Description
WP1	Ongoing survey for existing research on SNM	This WP will summarize and extract information from standards, normative documents, and realizations for the WPs of this project and for future needs.
WP2	Challenges and opportunities in SNM	This WP should identify continuously challenges and opportunities in SNM.
WP3	Knowledge transfer from current ongoing projects	Currently, ongoing projects which deal with Sensor Networks are focused on new approaches. This WP focuses on knowledge transfer a summary of the ongoing projects and creating communication channels for that.
WP4	Coordination and dissemination	WP deal with the coordination and dissemination of all relevant outcomes of WPs. The outcomes could be disseminated via workshops, webinars, guides, etc.



Network of Sensors: A collection of independent sensors that collect data but do not communicate with each other. Each sensor operates separately.

Sensor Network: An intelligent network of interconnected sensors that interact, share information, and collaborate to optimize the process.



Network of sensors

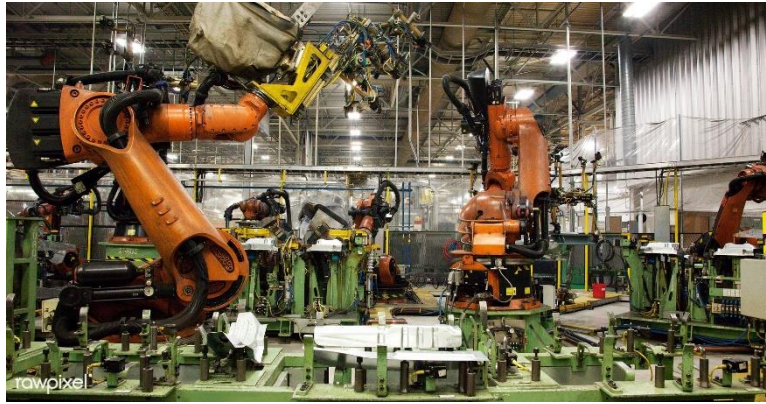
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Sensor Network(s)

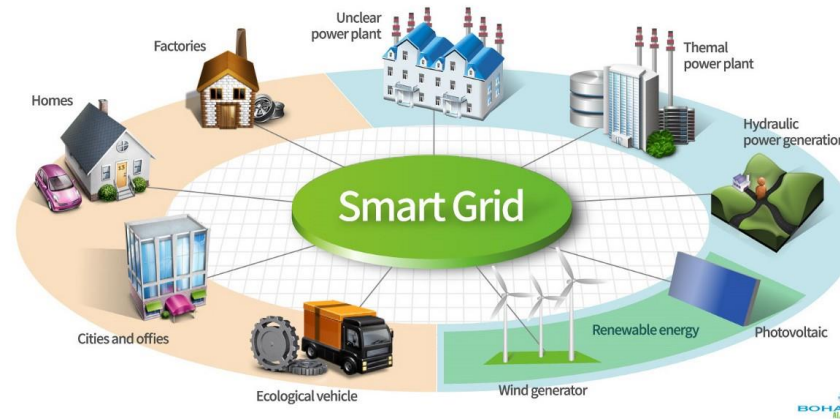
What is Sensor Network?





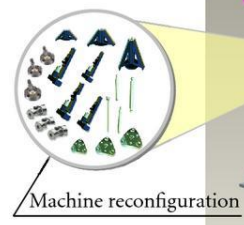
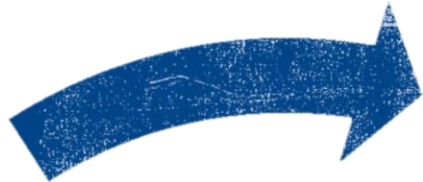
Backbone of all processes which need to be monitored and optimized

What is Sensor Network?

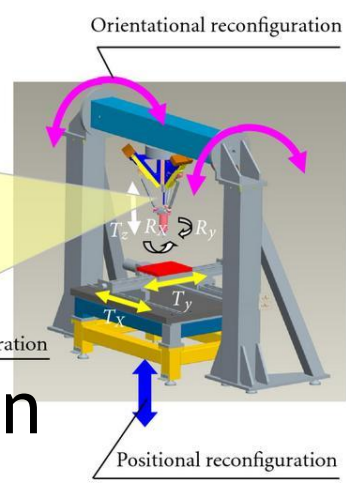




Process



Digital Twin



Monitoring/
Optimization

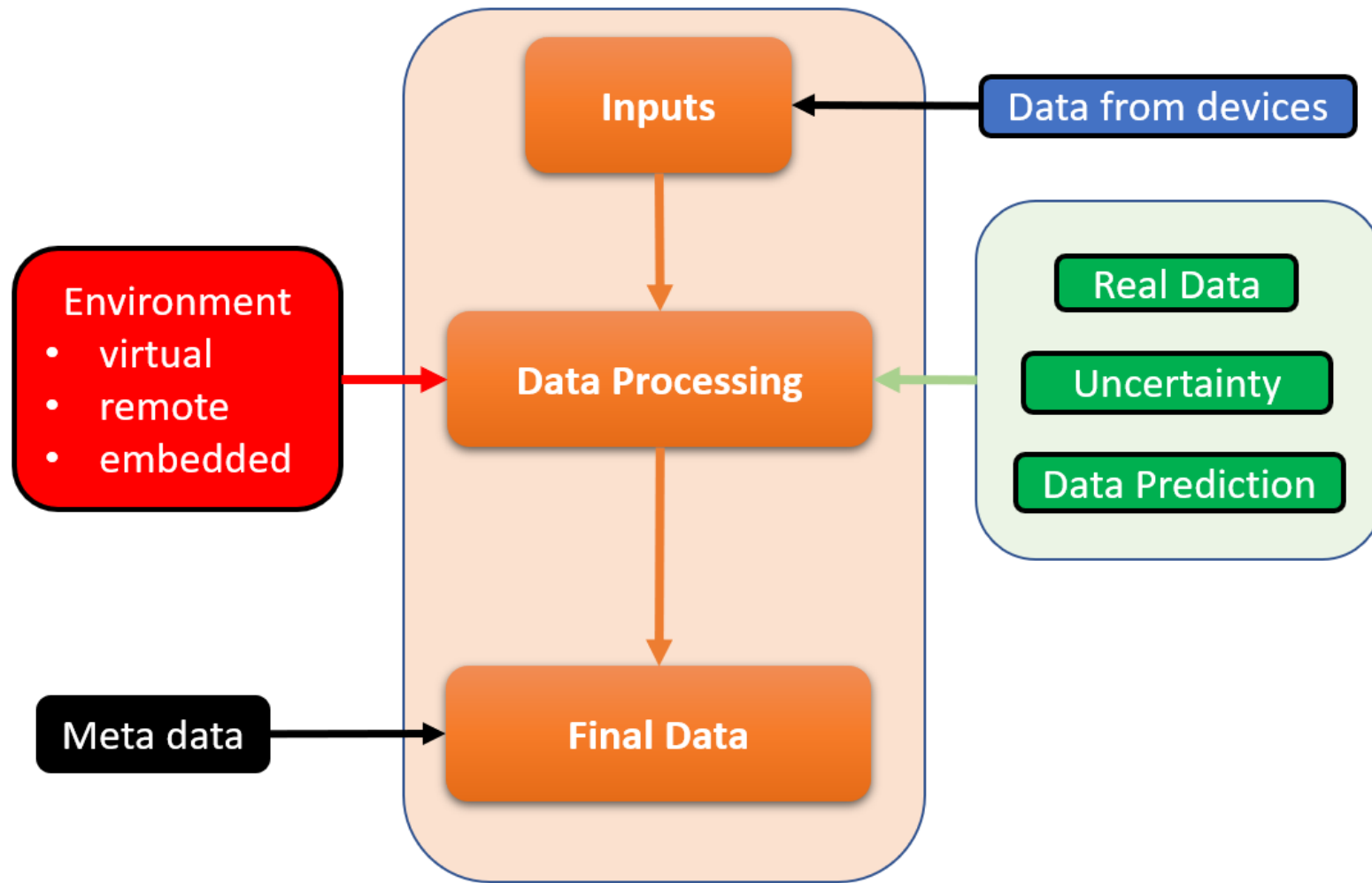


Sensor
Network



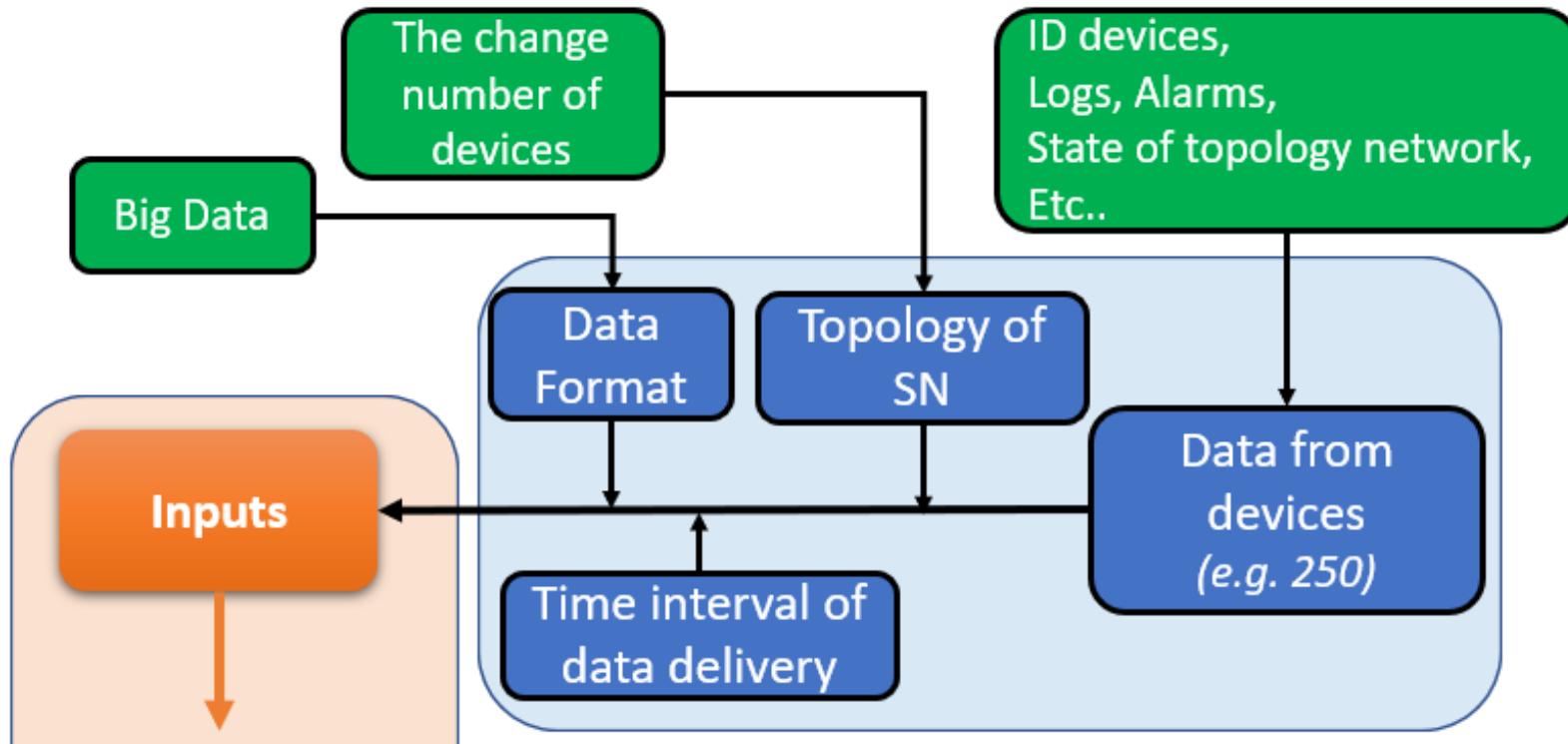
The role of Sensor Network





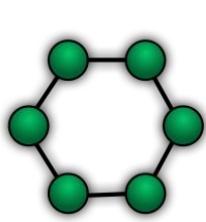
Basic model of Sensor Network



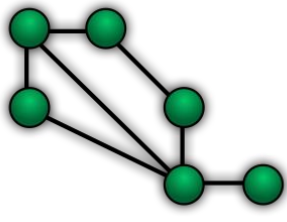


Inputs of Sensor Network

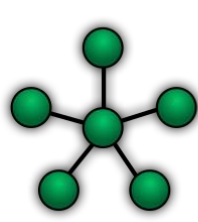




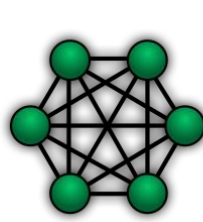
Ring



Mesh



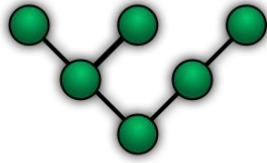
Star



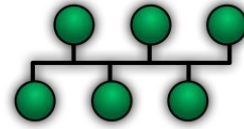
Fully Connected



Line

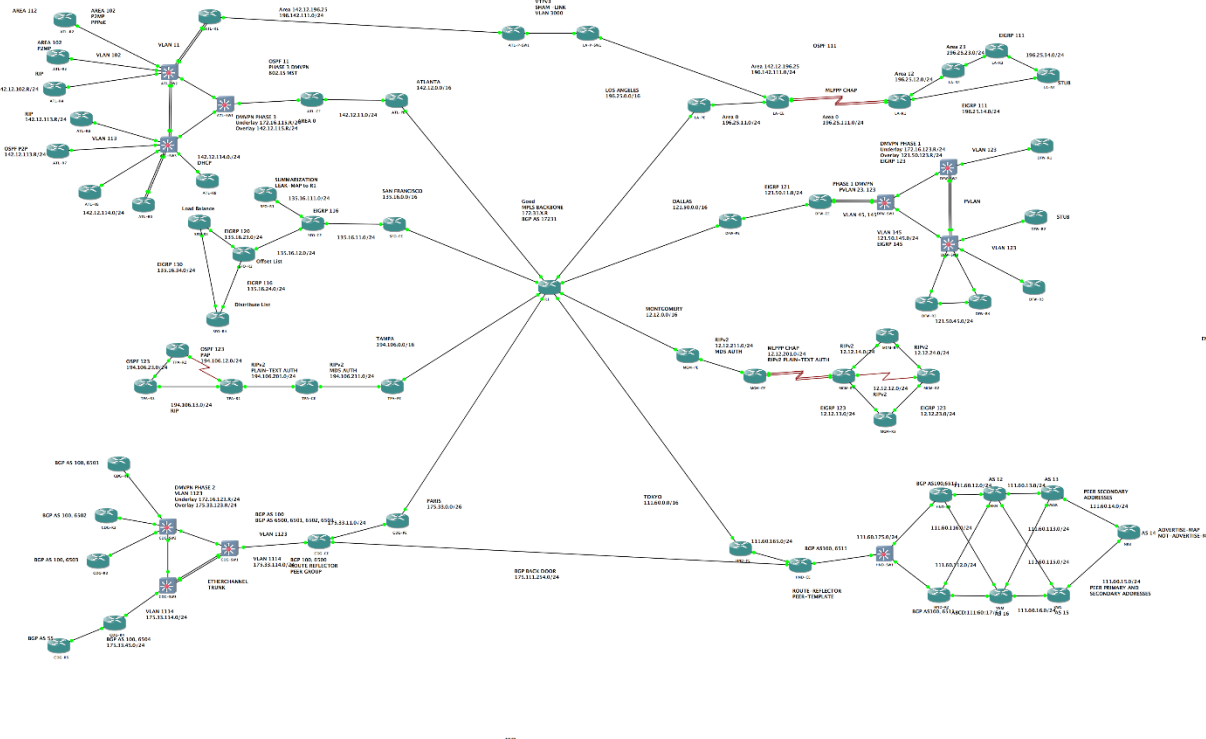


Tree



Bus

The different types of topology



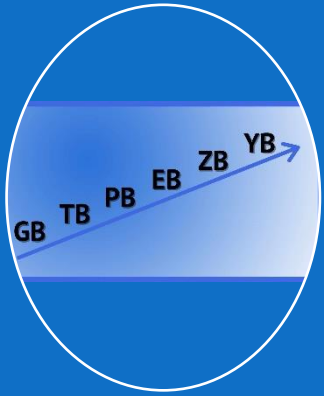
Topology in real field

Topology of Sensor Network





Value



Volume



Veracity



Variety

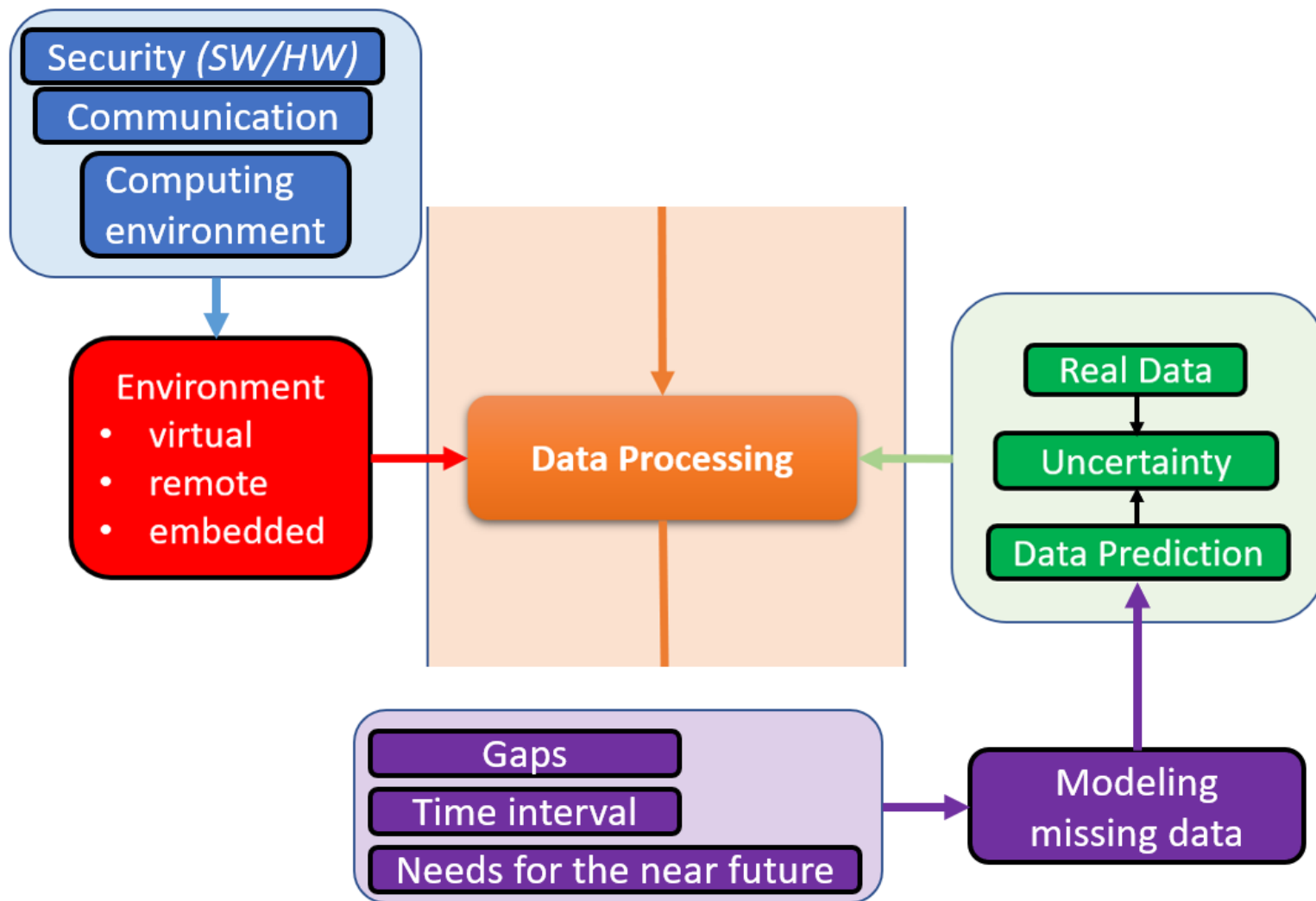


Velocity



**(Big) Data
5V model**





Data processing of Sensor Network



Sensors/Devices



Real data
Data prediction



Data modeling

Gaps,
Time interval,
Needs for future



Uncertainty

LPU

Monte Carlo

Shannon's Entropy

Fuzzy Theory

Bayesian Statistical Models

Data preprocessing





Computing Environment



Data



Sensors



Comm.

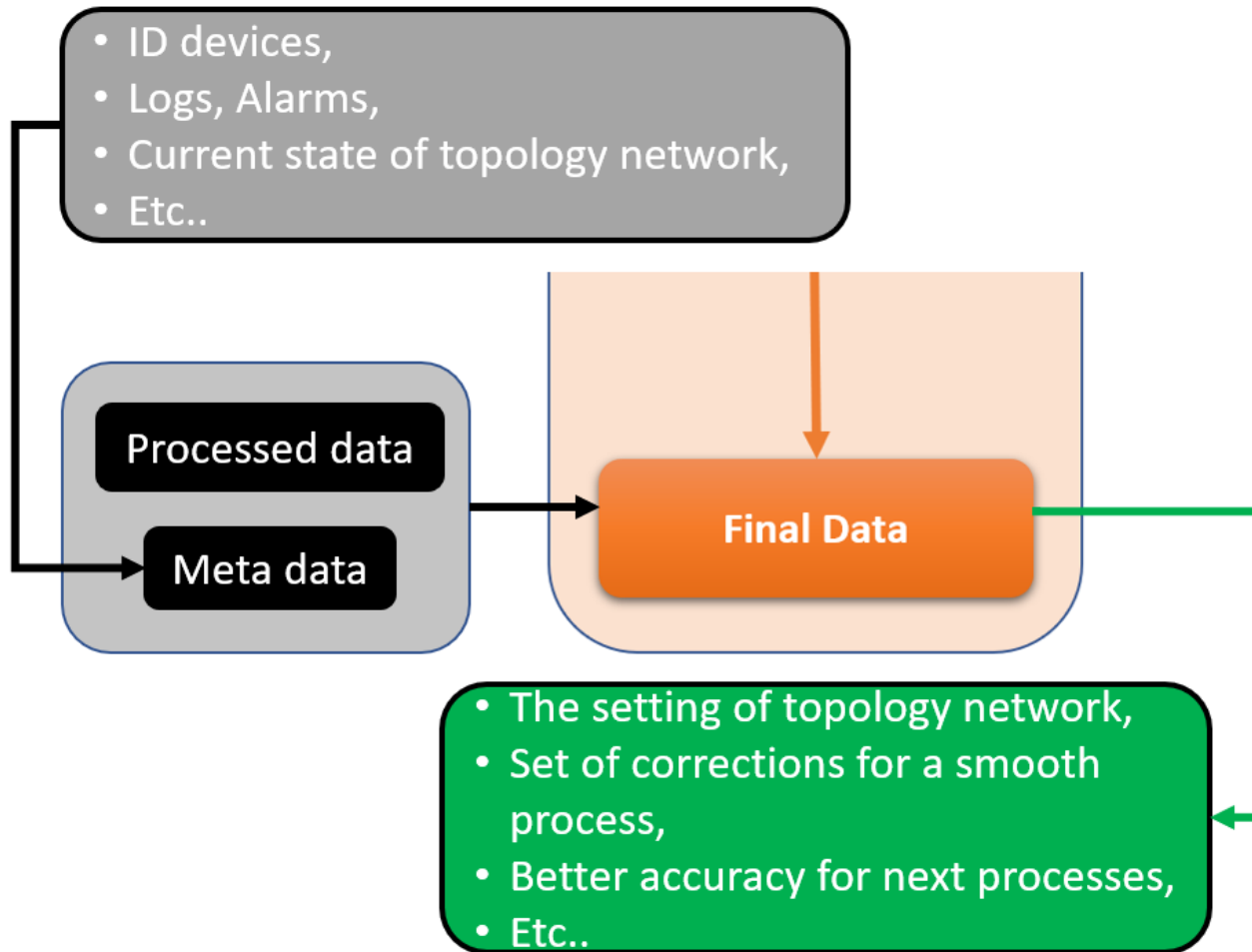
Security



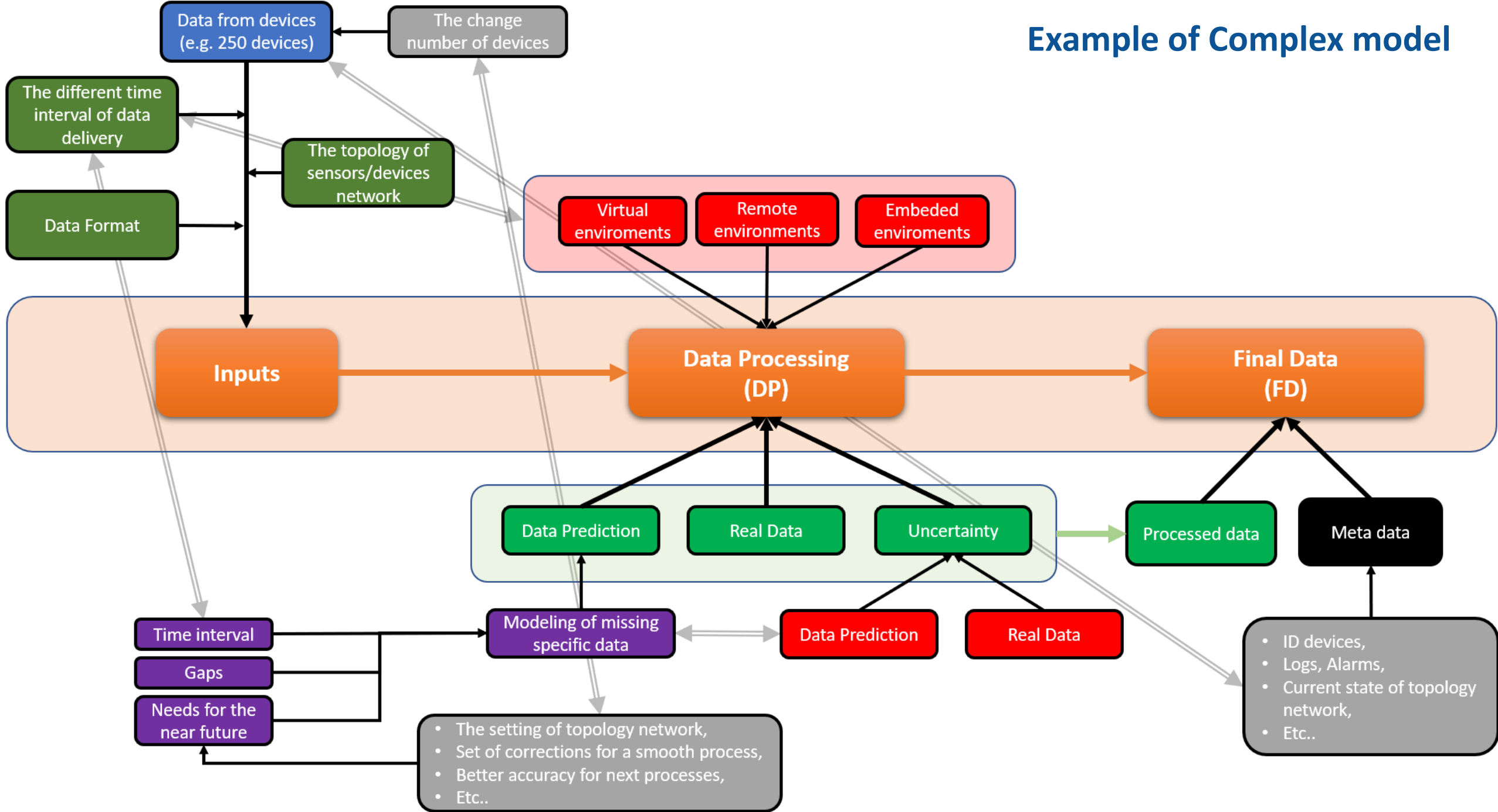
Environment

The chain is only as strong as the weakest link.





Example of Complex model



- **Low cost sensors (energy efficient),**
- **Data quality,**
- **ML/AI,**
- **Data Transmission and Latency,**
- **Self verification/monitoring,**
- **Remote calibration,**
- **Cybersecurity,**

**Challenges for (near)
future**



Thank you for your attention

Ing. Martin Koval , Ph.D.

Czech Metrology Institute

Digitalization in metrology

mobil: + 420 725 504 983

e-mail: martin.koval@cmi.gov.cz

