IoT enabling PI: towards hyper-connected and interoperable smart containers

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IPIC 2019

London (UK), July 11th

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No. 769119

Agenda

Presentation Sections

SUMMARY

Scope of this presentation is to present the paper "***IoT enabling PI: towards hyper-connected and interoperable smart containers***"

1. Introduction
2. Requirements for the realisation of an IoT-enabled PI environment
3. Tailoring the IoT architecture for PI
4. Interoperability issues
5. Validation activities

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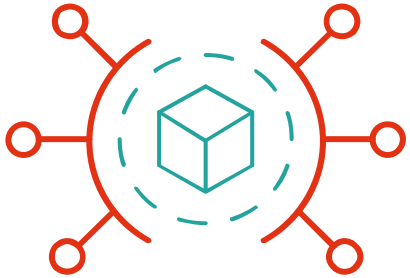

Introduction

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The Physical Internet

Physical Internet (PI) aims at:

- The optimization of logistics processes
- The implementation of a more cost-effective, eco-friendly, service-driven, sustainable supply chain

Exploiting the concepts of the Digital Internet (DI) to the physical world.

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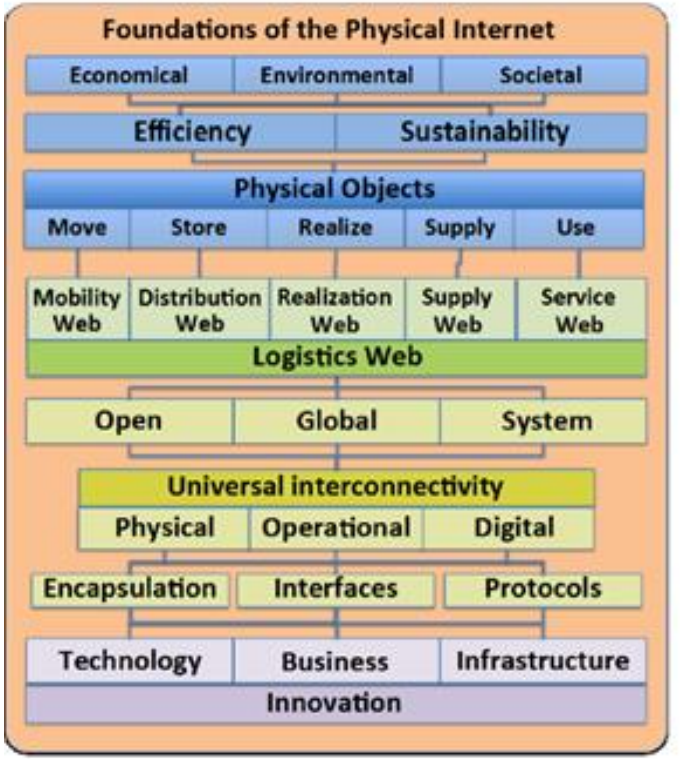
The Physical Internet

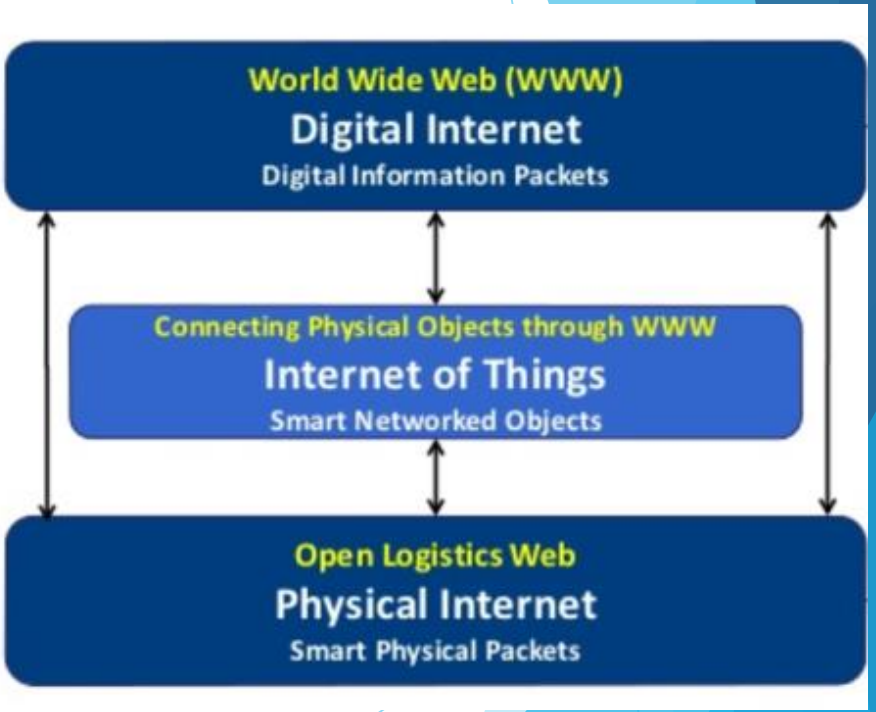
The PI envisions the realisation of an **Open Global Logistics System** founded on **physical, digital and operational interconnectivity and hyper-connectivity** through **encapsulation, interfaces and protocols**

The PI enables an efficient, **sustainable, adaptable** and **resilient Logistics Web**



Internet of Things as enabling technology

The Internet of Things enables the “virtualisation” of the physical objects, connecting these with the DI



Internet of Things as enabling technology

Goods routing and tracking (Where? and When?)

- Making PI-packet position available to all the stakeholders interested on the shipped goods (shippers, senders, receivers, customs, port authorities, canal authorities, etc).
- Enabling the implementation of the goods' routing services (as in the DI), the PI platform has to know the correct position of the goods.

Goods continuous monitoring (How?)

- Implementing the same service done by "CRC" in the DI, the goods has to be monitored to understand whether a packet is "corrupted" or not.

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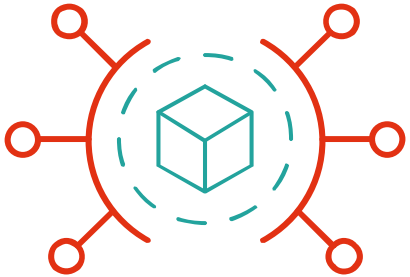

Requirements for the realisation of an IoT-enabled PI environment

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IoT-enabled PI environments requirements

Requirement Name	Requirement Description
IoT enablement	Need of the deployment of an IoT network to communicate to the PI ***open*** platforms the data collected from the field.
Modularity	Since the need of monitoring ***modular*** and ***encapsulated*** "PI packets" (packets, container, group of container), also the IoT environment has to be modular, enabling the continuous monitoring and the tracking of the goods.
Composability	The IoT environment has to be capable to compose several IoT modules, enabling the continuous monitoring and tracking of the ***encapsulated*** goods.
Interoperable	The IoT environment has to be interoperable at the ***open*** remote PI platforms layer (***interfaces***), as well as at the IoT devices level (***protocols***).

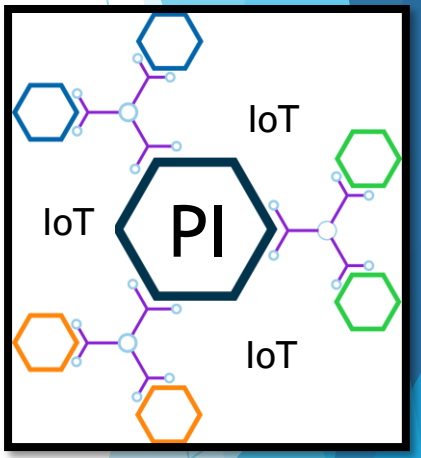
IoT-enabled PI environments requirements

Requirement Name	Requirement Description
IoT networks pervasivity	Each PI packed has to be continuously monitored, thus an IoT enabled PI environment has to provide a pervasive network solution, thus ubiquitously connecting the PI “packets” to the PI ***open*** platform.
Edge computing enablement	Edge computers can enable the local data processing (e.g., detection of an alarm), the cooperation of the PI IoT environment with different operators (e.g., truck drivers can understand the status of the transported containers) and external infrastructure (e.g., Intelligent Transport Systems).
Resilience on data loss	The PI IoT environment has to consider devices with local storage functionalities to maintain data whether the communication with the remote platform is not available (e.g., in the middle of the sea).

Issues to be addressed

2 main issues to be addressed:

- Definition a tailored IoT architecture for PI
- Interoperability
  - Open IoT environment for the open PI management platform



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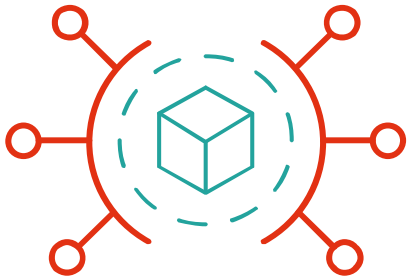
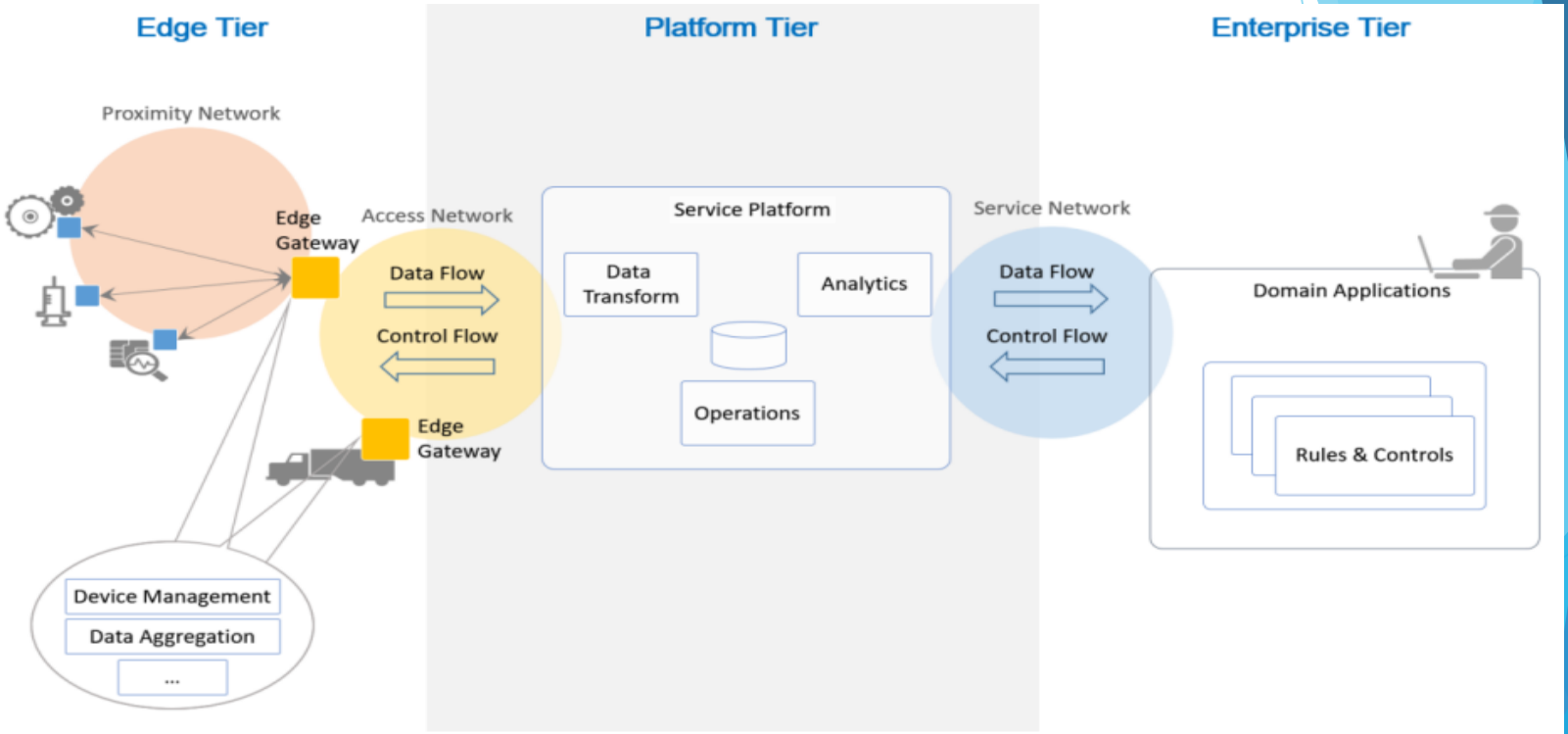


Tailoring the IoT architecture for PI

From the general point of view…



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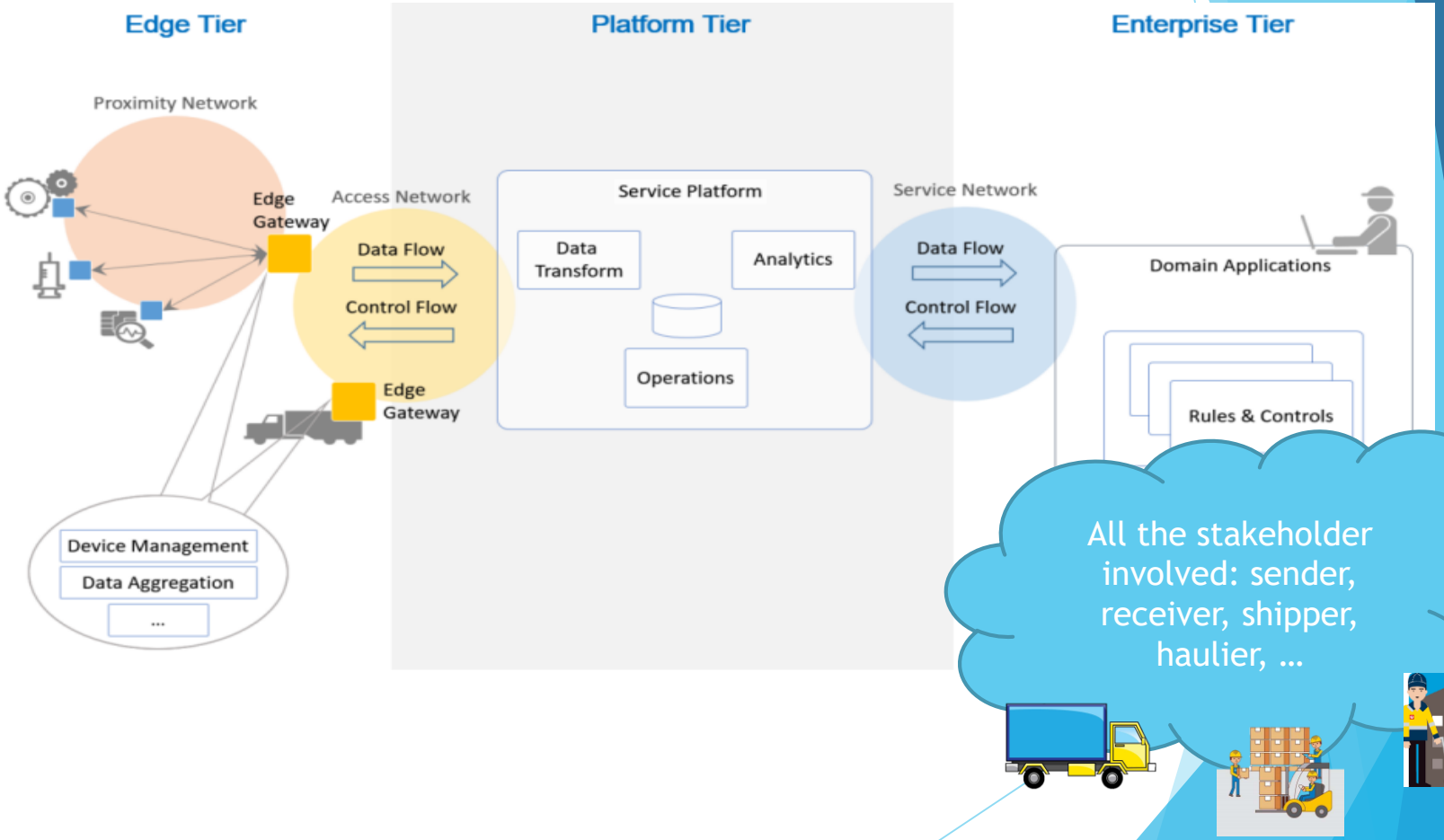

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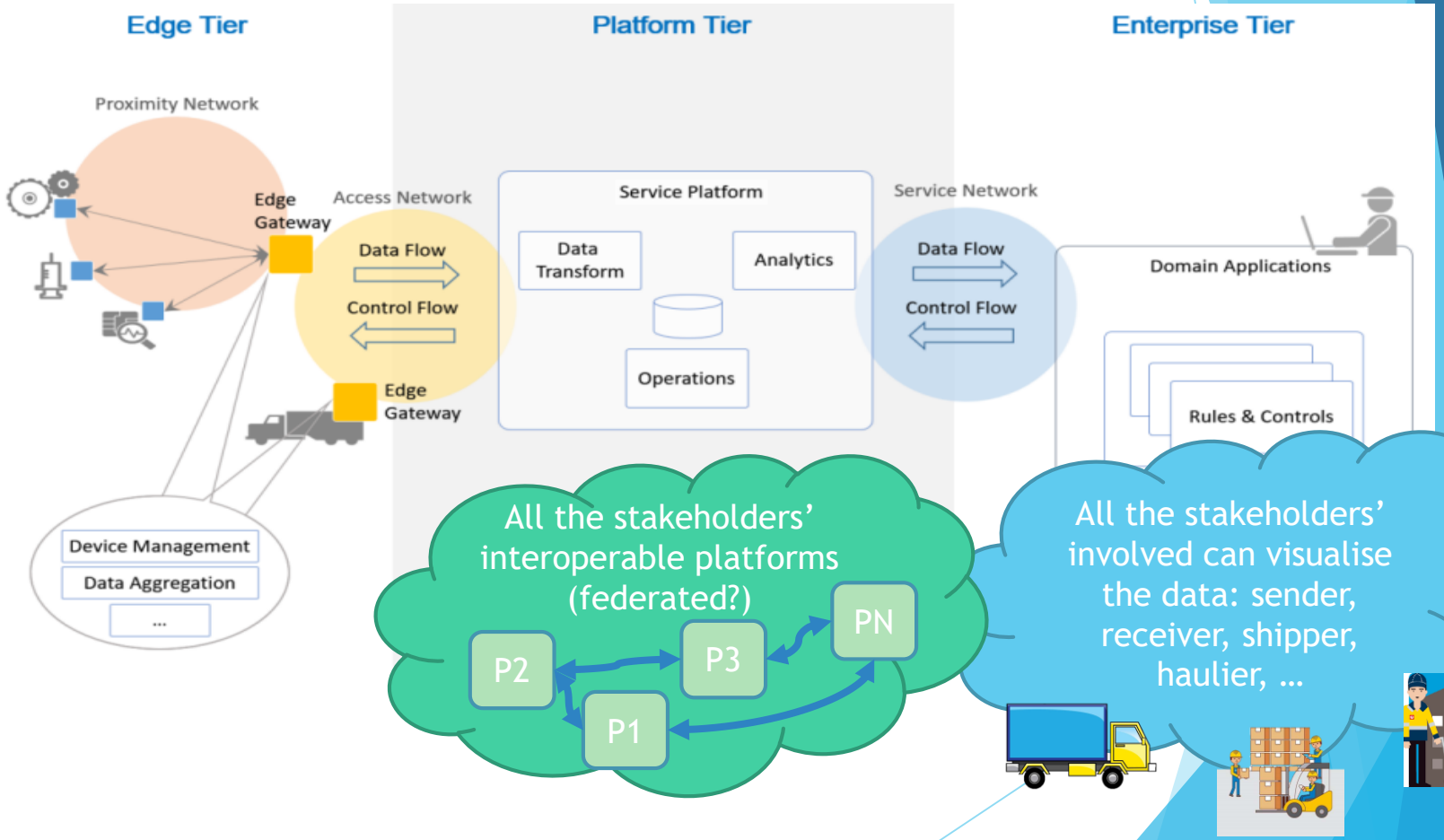
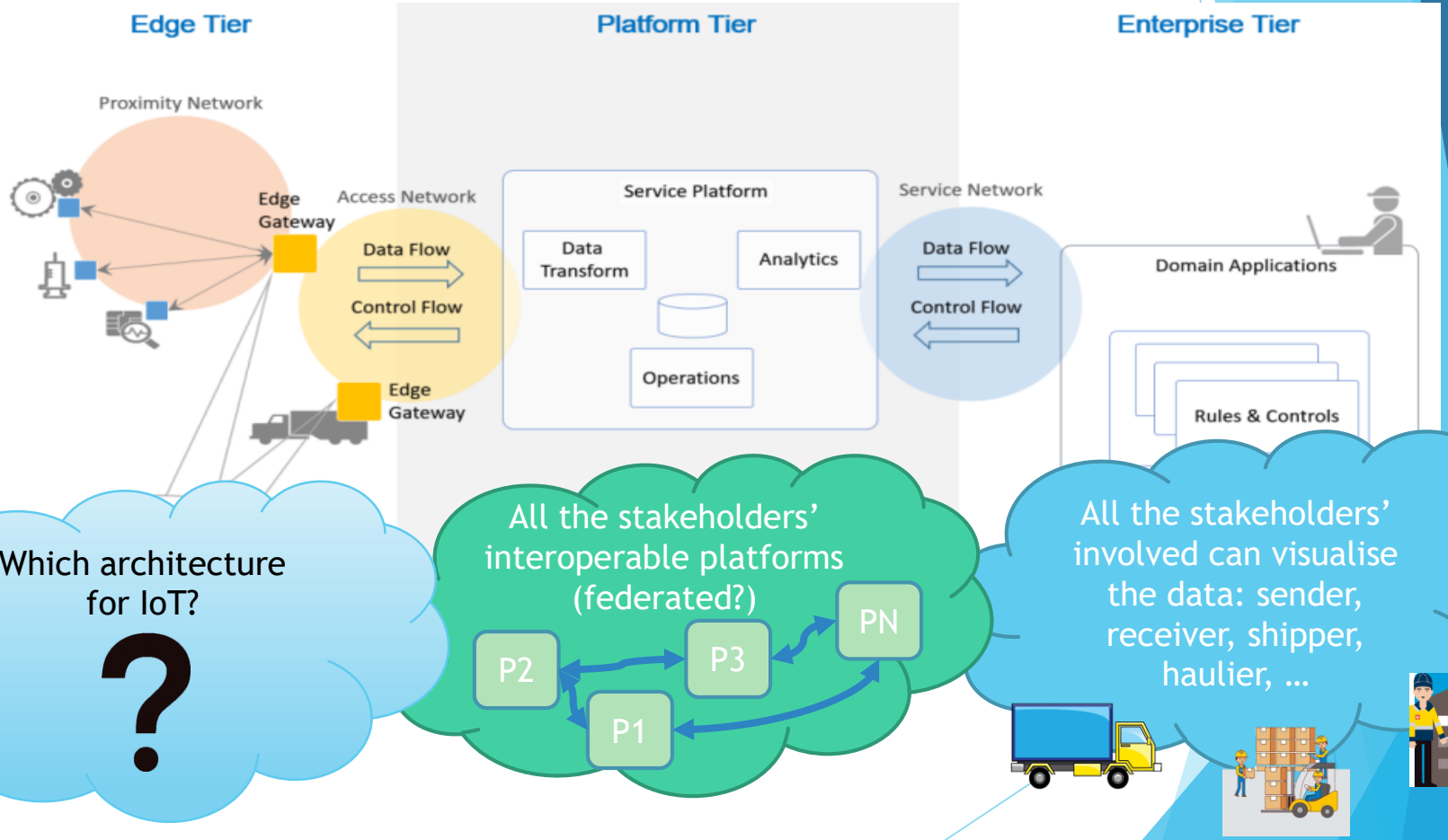
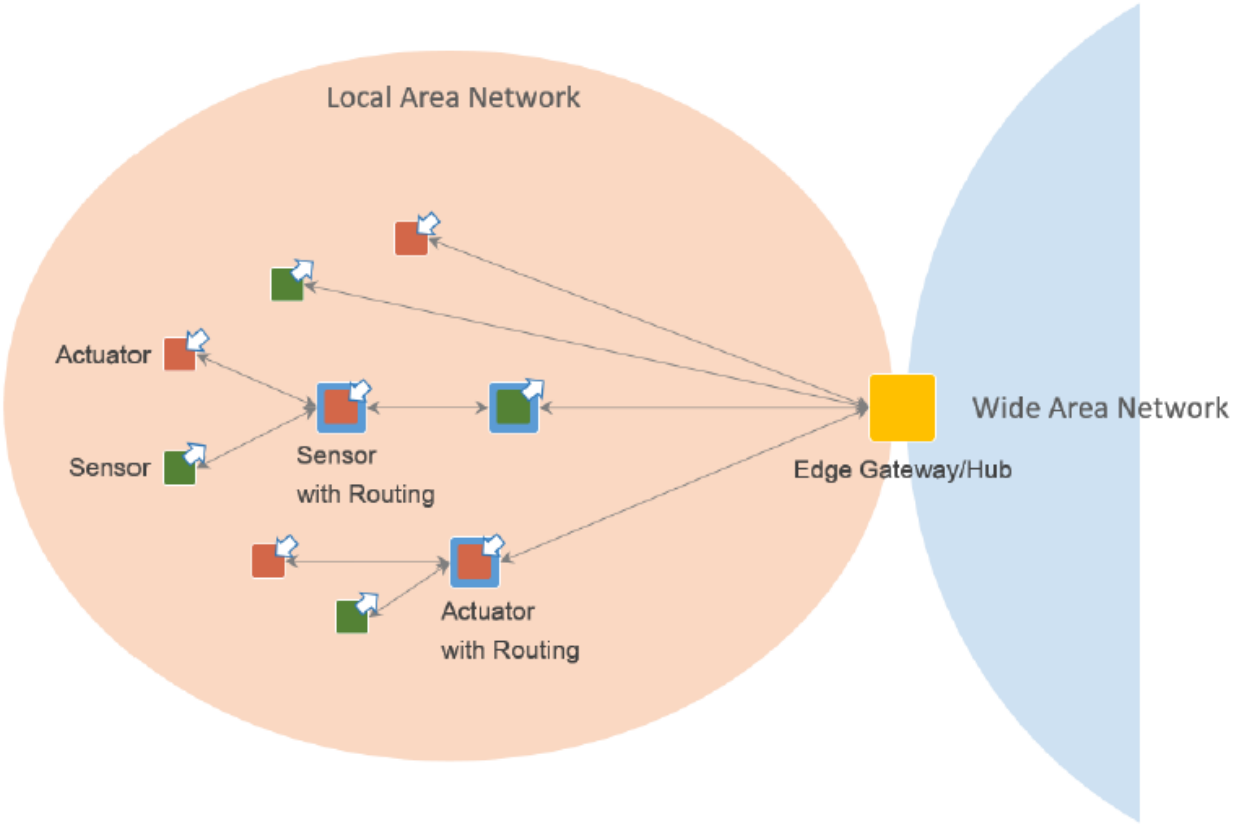


From the general point of view…

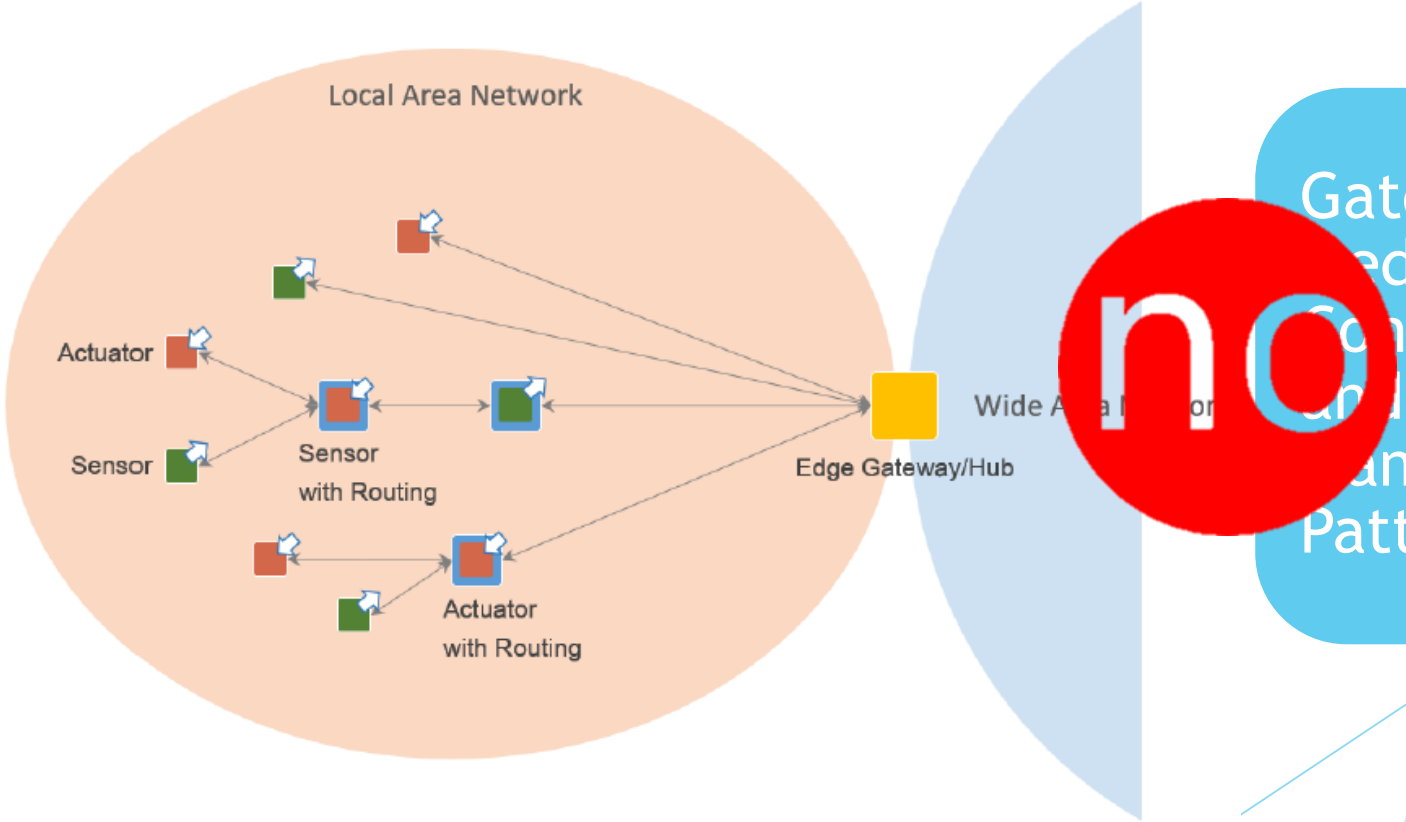


Can we use the regular IoT architecture?



Gateway-Mediated Edge Connectivity and Management Pattern

Can we use the regular IoT architecture?



Gateway-
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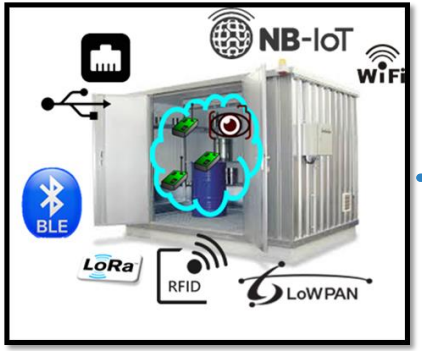
Pattern

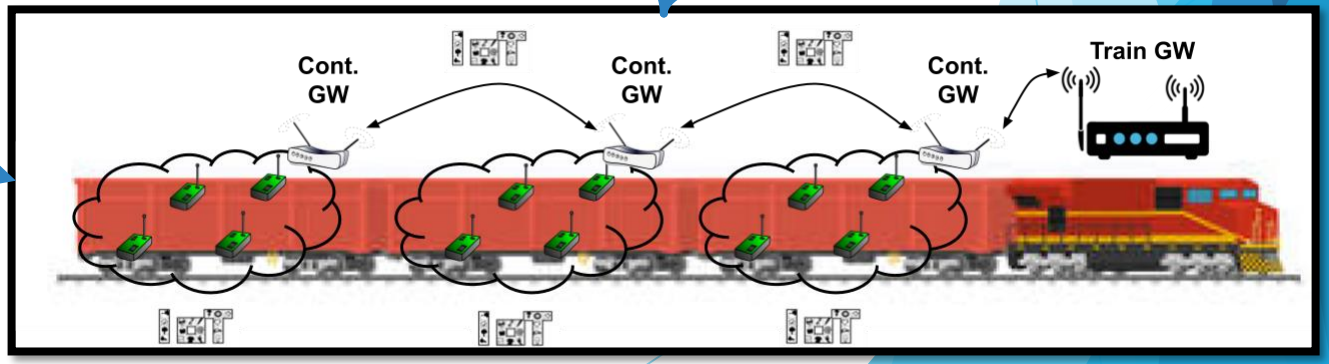
The operative scenario

All the stakeholders' interoperable platforms (federated?)

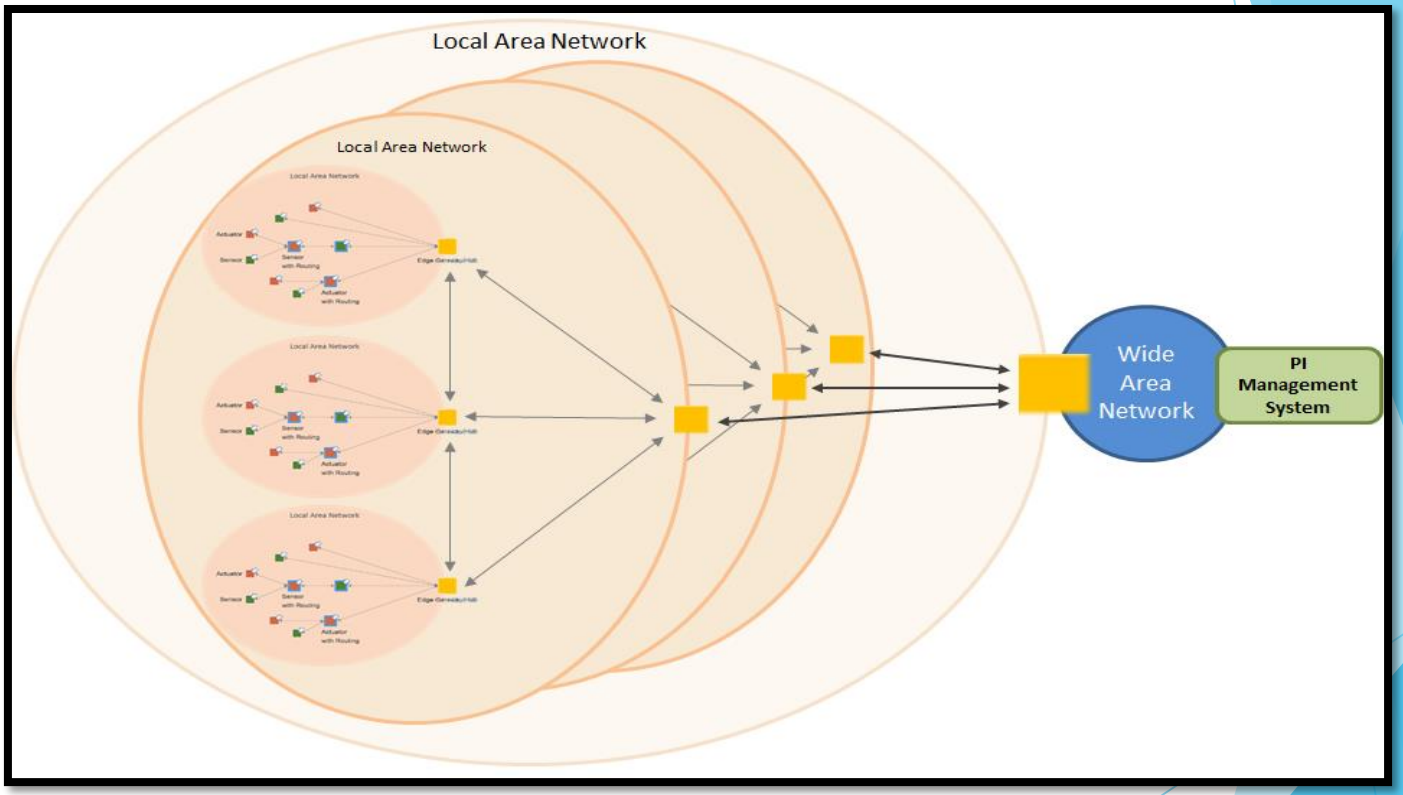
P2 P3 PN P1

Mobile connectivity provider GW



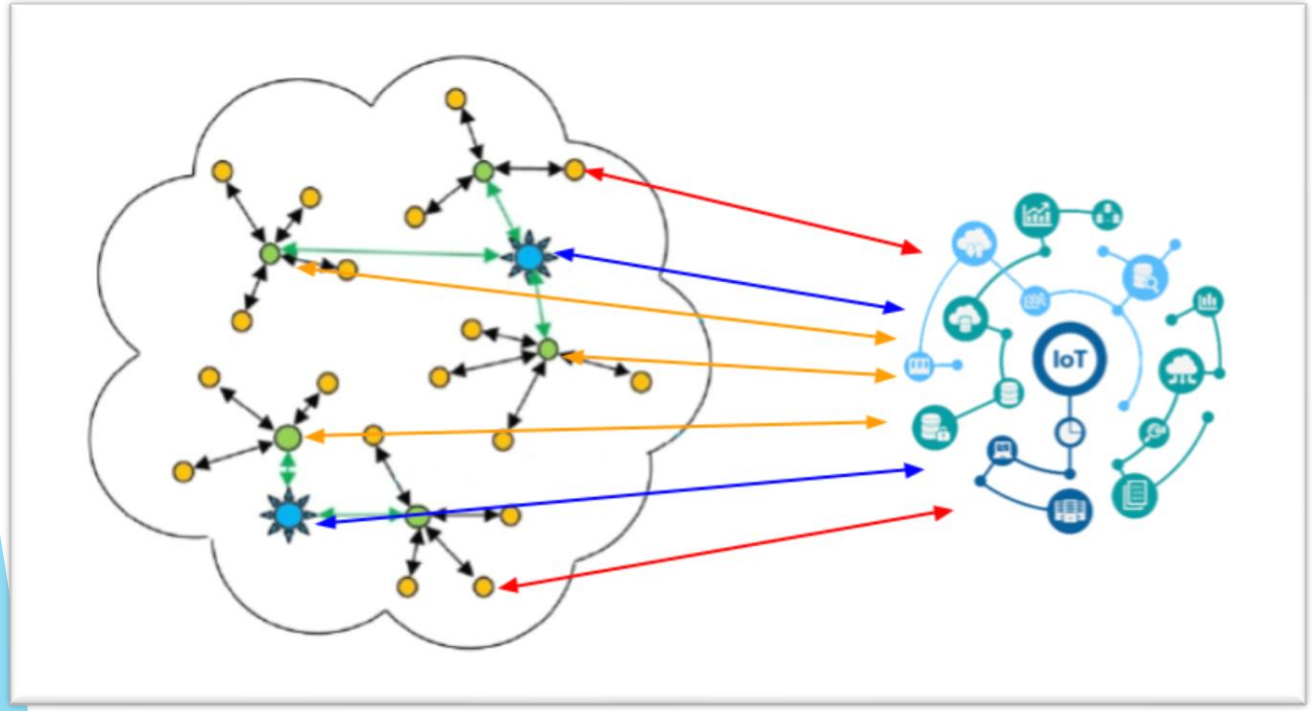


The IoT Architecture for PI



Recursive Gateway-Mediated Edge Connectivity and Management Pattern

The IoT Architecture for PI



Opportunistic routing…

Managed by objective functions:

- Organisational reasons
- Money saving
- Power saving

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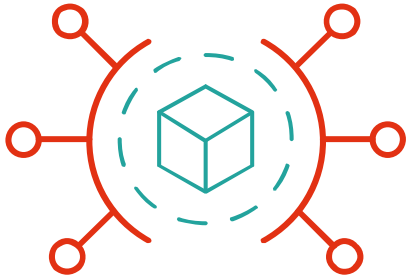


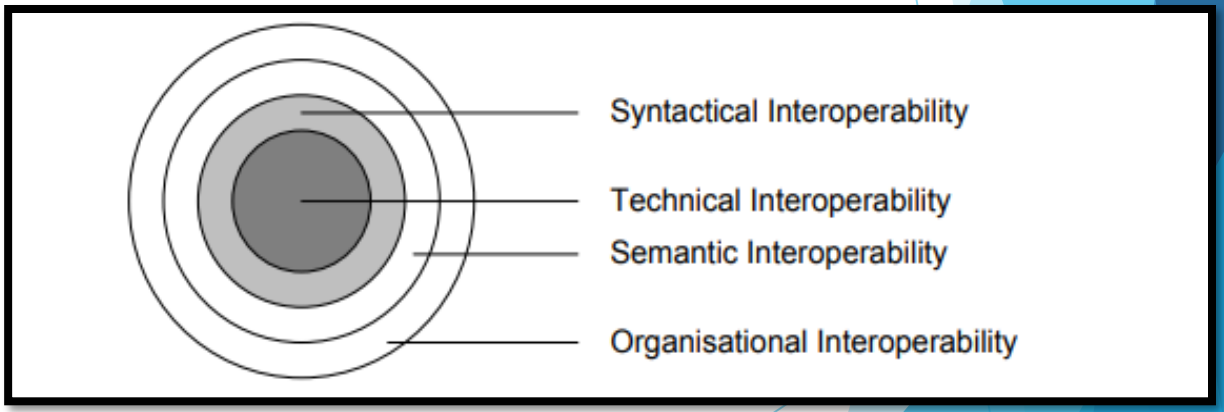
Interoperabilty

Interoperability Definition

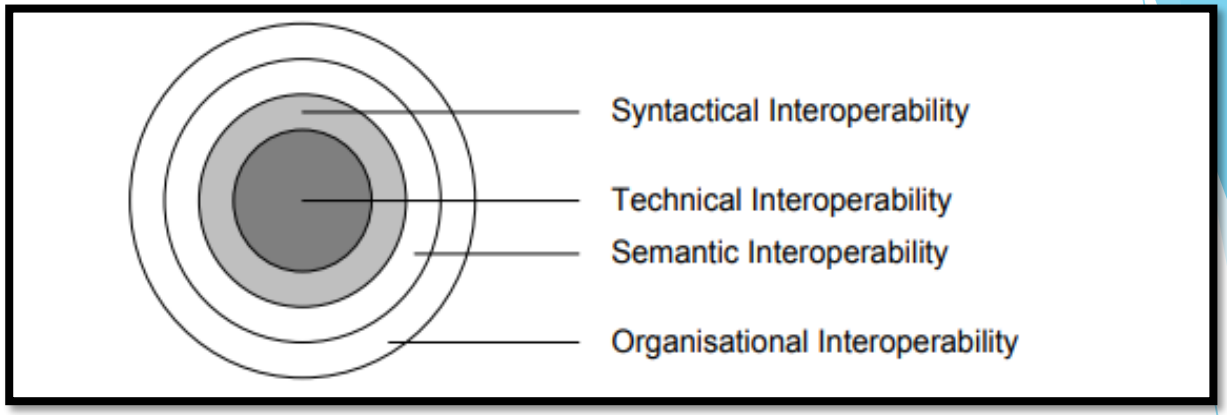
Interoperability can be defined as a measure of the degree to which diverse systems, organizations, and/or individuals are able to work together to achieve a common goal.

Classification is provided by **ETSI** and **AIOTI**

Defined four levels.



Interoperability Definition



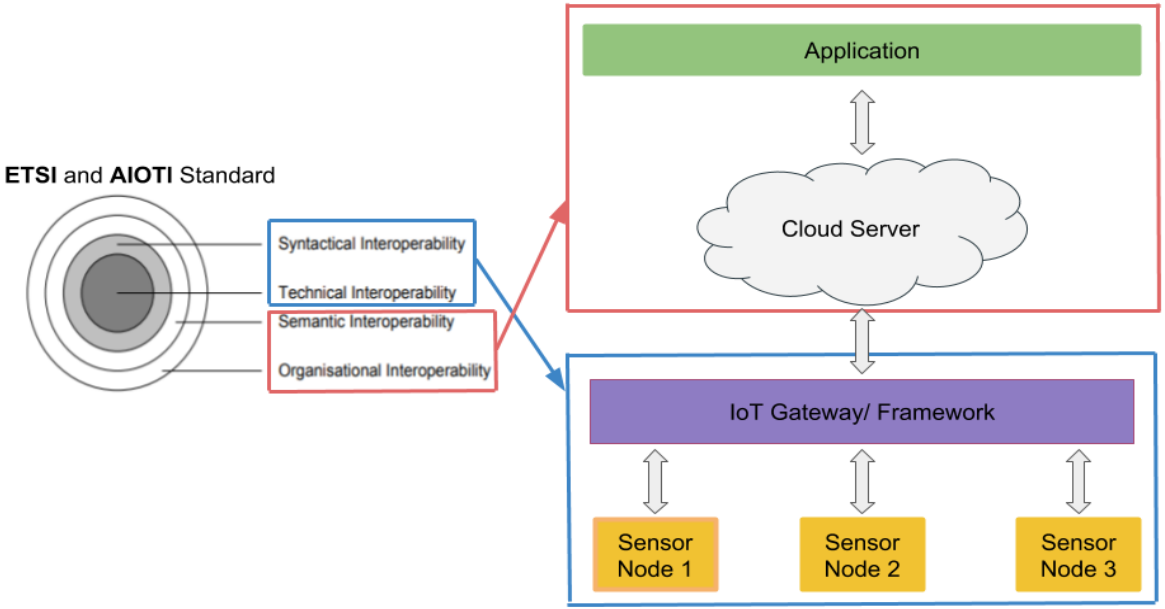
Technical Interoperability: it refers to the protocols and the infrastructure needed for those protocols to operate.

Semantic Interoperability: is usually associated with the meaning of the exchanged content.

Syntactical Interoperability: associated with data format and encodings, e.g., RDF, JSON, XML, etc.

Organizational Interoperability: refers to the ability of **effectively communicate and transfer meaningful information between organizations.**

The path toward an interoperable PI



Common language for PI: Unique and global dictionary and ontologies

Defined set of (standard) formats

- JSON/XML

Defined set of (standard) protocols

- Multi-protocols gateways

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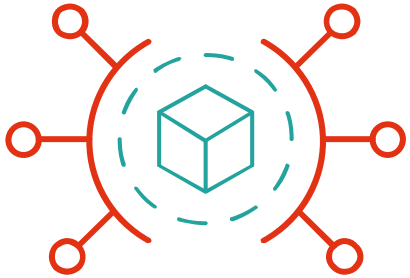


Validation activities

The Smart PI-Container

Smart Container is:

A container…

… that installs a battery powered gateway…

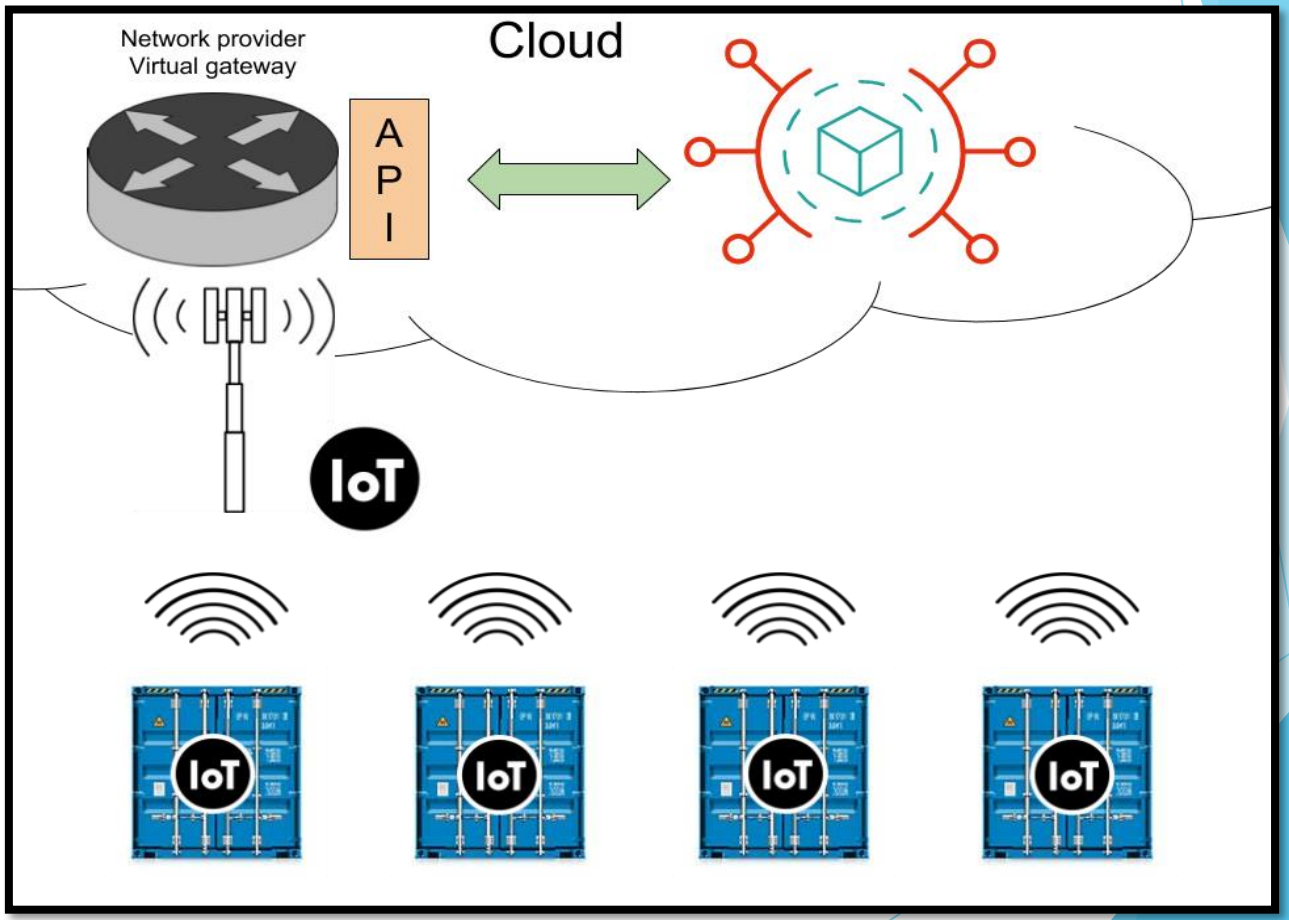
… capable to manage several and different sensor nodes …

… in charge of dispatching remotely geo&time-referenced information regarding:

The presence of goods

The status of the goods

Evaluated architecture



Needed devices

The *FLEXX tracker* will allow to:

- tracking the PI-containers

The *Micro-FLEXX gateway* will allow to:

- track the PI-Container along the corridors
- monitor the presence of connected PI-packets encapsulated within it (e.g., monitoring pallets within the container, in a “groupage” configuration)
- collect added value environmental data inside/outside the container, exploiting short range IoT protocols.

KPI to be evaluated

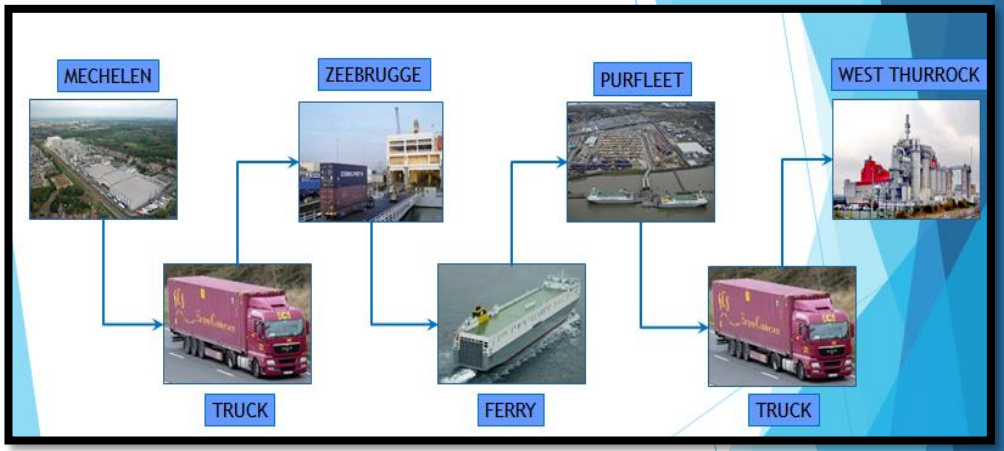
KPI ID	KPI Name	KPI Description
KPI_01	Goods monitoring	Continuously monitor product position, time and quality, which will allow a better control of the logistic efficiency, and of damaged, lost and stolen products (answering to the following 3 questions: When, Where, How?).
KPI_02	Product safety	Improve the product safety, especially for perishable products (e.g., food or pharmaceutical products).
KPI_03	Real time reporting	Make real-time goods' information available and for all stakeholder involved in the transaction.
KPI_04	Support decision making processes	Supporting the planning activities and managing emergencies more quickly.

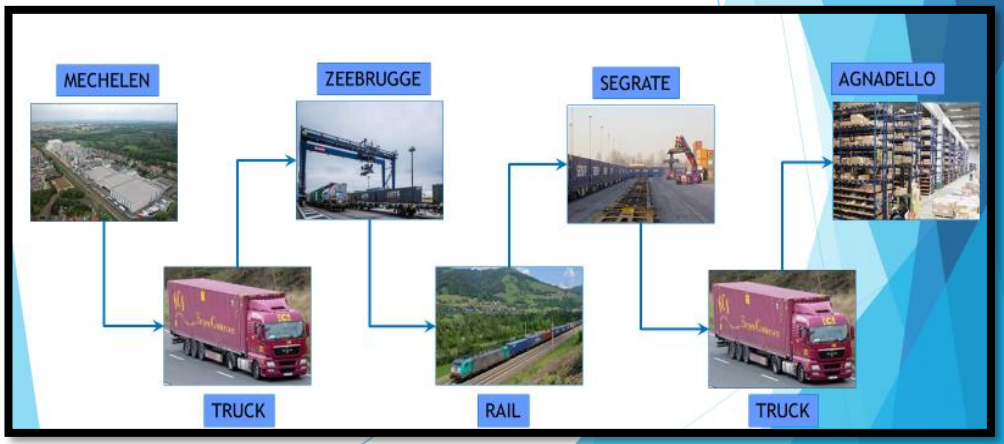
Evaluation scenario

Living Lab 2 (LL2) of the ICONET project, called Corridor-centric PI Network.

Realisation of the PI corridors

- enhancement of the reliability of intermodal connections
- Realisation of the synchromodal corridor





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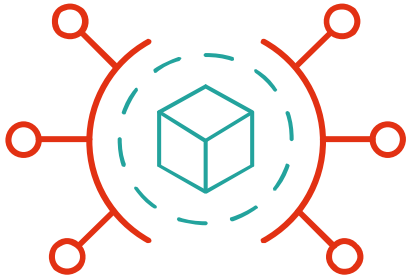

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Strength & Expertise

STARTUP SUMMARY

OFFERING	Internet of Things solutions for Industry 4.0 and Intelligent Transport Systems
LOCATION / INCORPORATION	Pisa; Inc. 2015
LAST FUNDING	50 k€ - Dec. 2017
STATUS	Market expansion
CLIENTS	ENEL, Controls, DBA, AVR
EMPOYEES	3
WEB-SITE	www.ngs-sensors.com

SPIN off
Impresa Spin-Off della Scuola Sant'Anna

- Building Internet of Things ecosystems
- Proprietary hardware and software
- Embedded and distributed data processing
- Smart Camera

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Team and advisors

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