
# ALICE/SENSE workshop during IPIC

## *"Detailed Roadmap Towards Physical Internet"*

## Definition of research areas

Activities performed in the frame of SENSE "Accelerating the Path Towards the Physical Internet". The SENSE project has received funding from the European Union´s Horizon 2020 research and innovation Programme under grant agreement No. 769967

# SENSE workshop during IPIC

## ALICE/SENSE workshop in Groningen
## 15:30h to 17:30h, 20th of June

**Agenda**

- 15:30h: General introduction
  - Introduction to SENSE
  - Presentation of storyline (6 steps) and currently identified research areas
- 16:00h: Brainstorming in working groups
  - Split-up in 2 - 4 working groups for detailed discussions about research areas
  - Input: Table with currently identified research areas grouped by network, node, system and governance
  - Output: New research areas, more detailed research areas
- 17:00h: Final sum up
  - Presentation of results from single working groups
- 17:30h: End of workshop

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# The SETRIS Project

**Budget: 1 Million €**

**Timeline: 30 months, Oct. 2017 – March 2020**

**The team:**

ALICE

PGBS

FM

IPBO

Poste

BG

FIT

ILIM

TU Delft

IML

KLU

ARMINES

DINALOG

VIL

VNL

CNC-ZLC

CNC-ITENE

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# Roadmap „Towards the Physical Internet“

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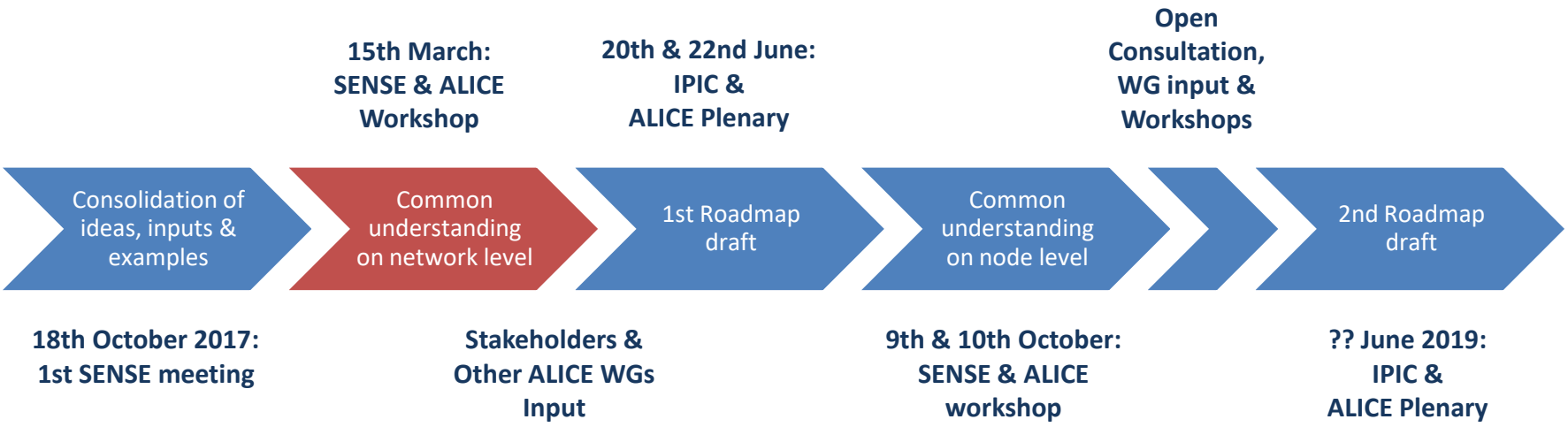


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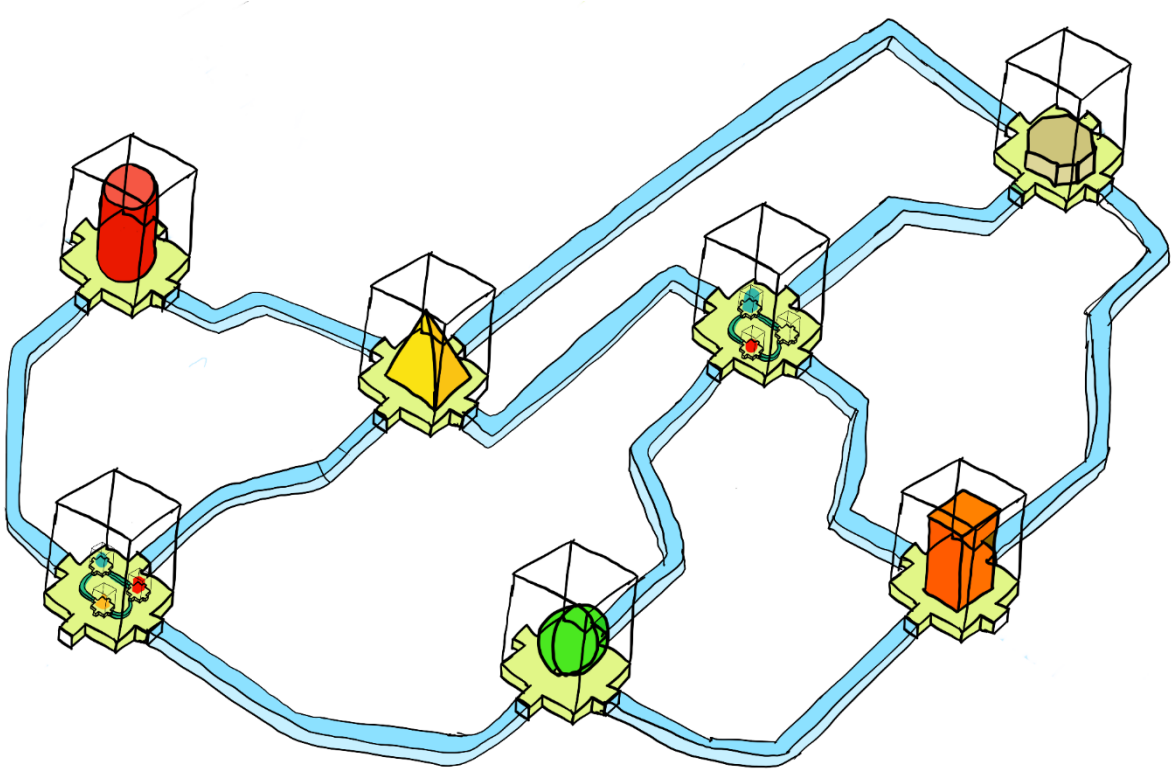
# Physical Internet on network level and on node level



- The nodes in PI are physical locations, like hubs, warehouses, etc.
- The network level describes how nodes are connected within the network to allow door-to-door transport

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# On node level we focus on design and operation of PI nodes including physical handling of goods

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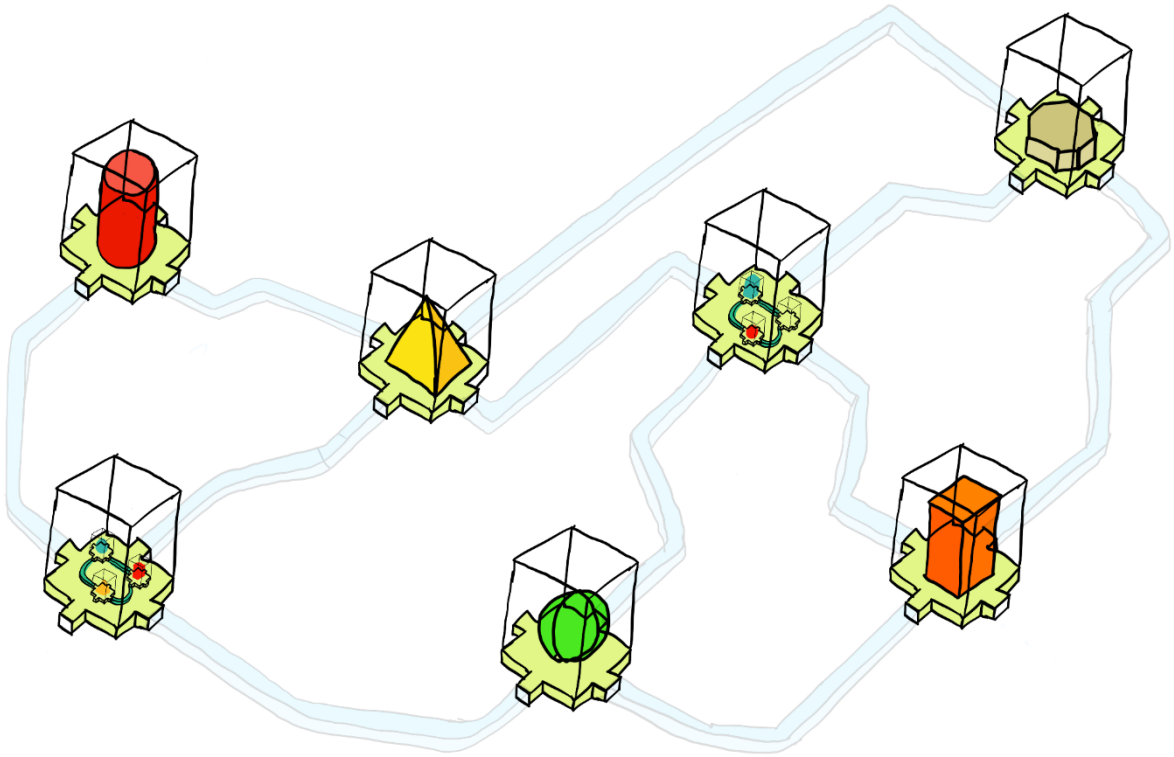

**Including the following topics:**

- Operation of PI nodes
- Boxes, containers and physical handling
- Value Adding Service providers
- Customs (and other public services) will be in the nodes (as function)
- PI node is always consisting of physical system and it system

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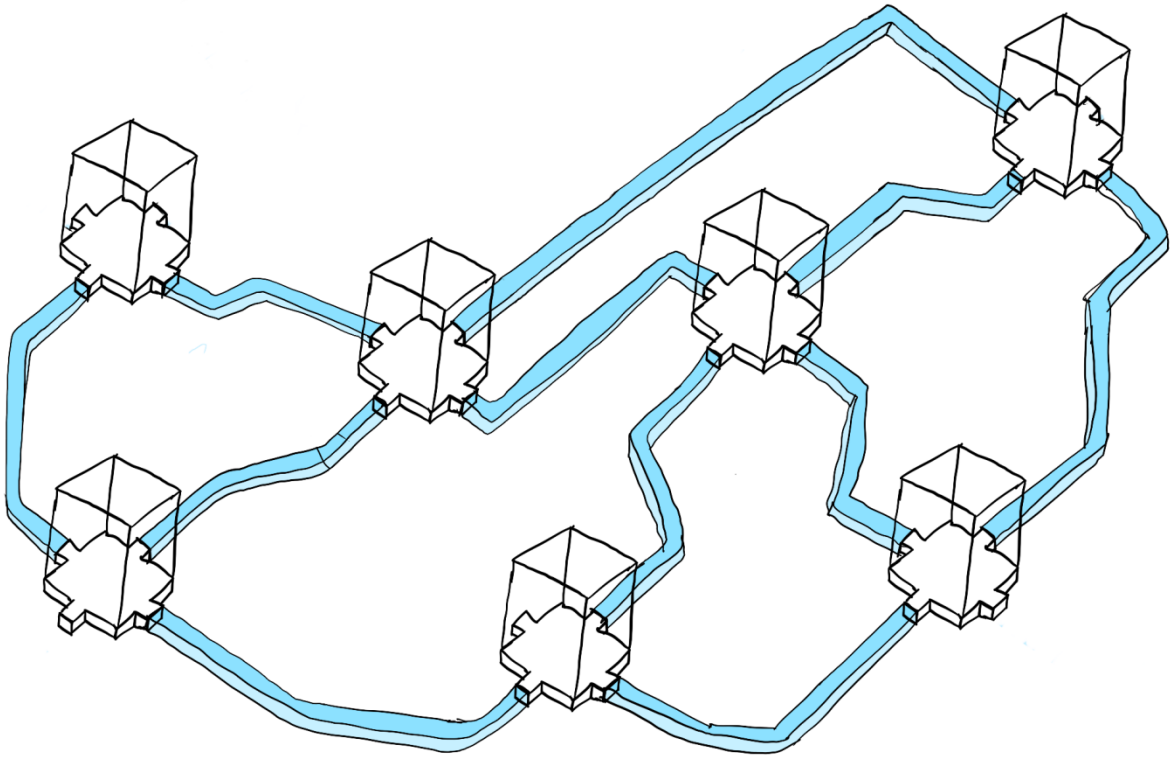
# On network level we focus on PI network design and operation



**Including the following topics:**

- PI network design and operation
- Role of PI nodes in the network
- Routing algorithms and connection of transport networks
- Establishing physical and digital connectivity

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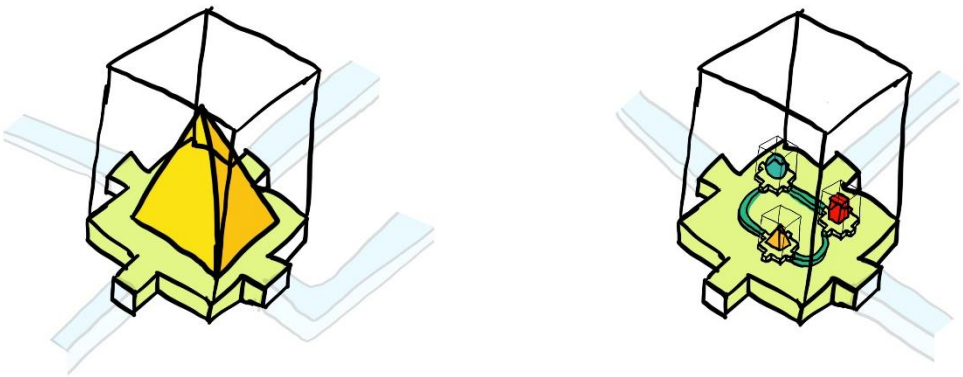
# Internal operations of nodes are hidden for network level



**Reduction of complexity**

- Comparison to Digital Internet and (private) Intranets
  - ➢ Internal organisation of networks is not linked to digital internet
- Same idea for PI allows Physical Internet and Physical Intranets (e.g. within PI nodes)

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# PI Network builds network of networks

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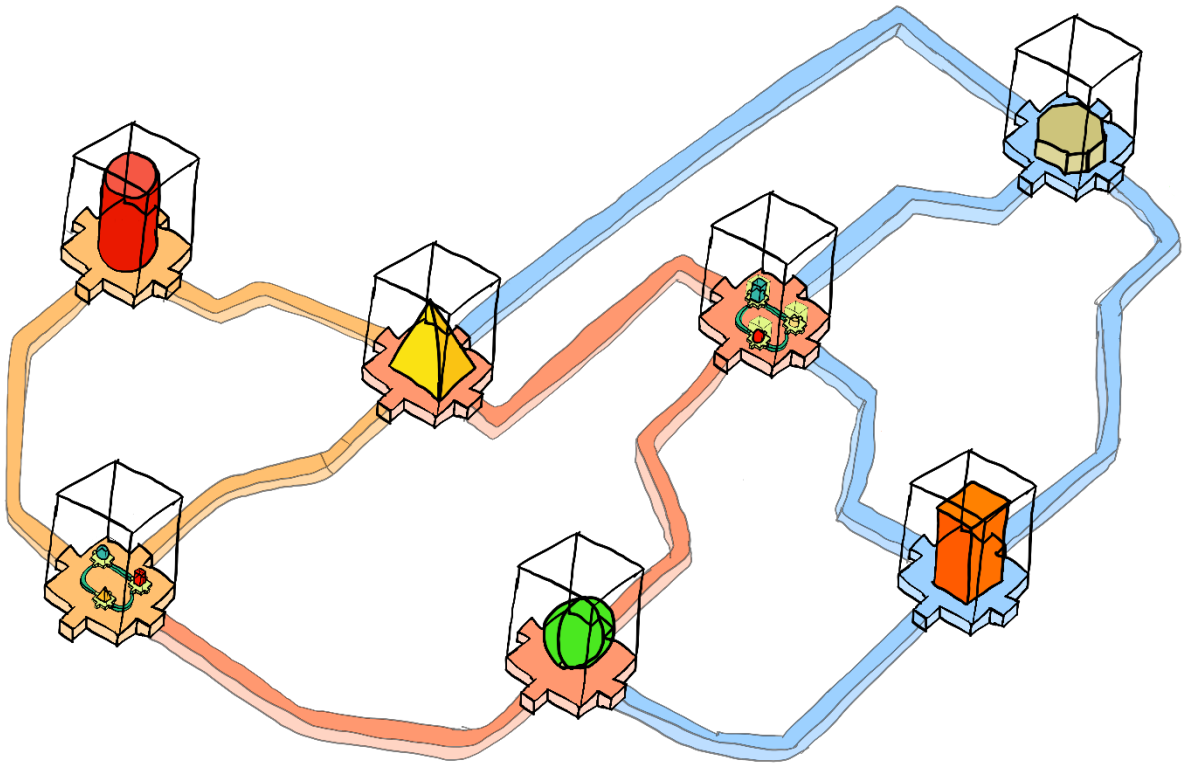

**PI Network build network of networks:**

- Seamless connection of existing (company) networks
- Definition of rules for cooperation which companies need to agree and fulfil
- Service level agreements, quality of service

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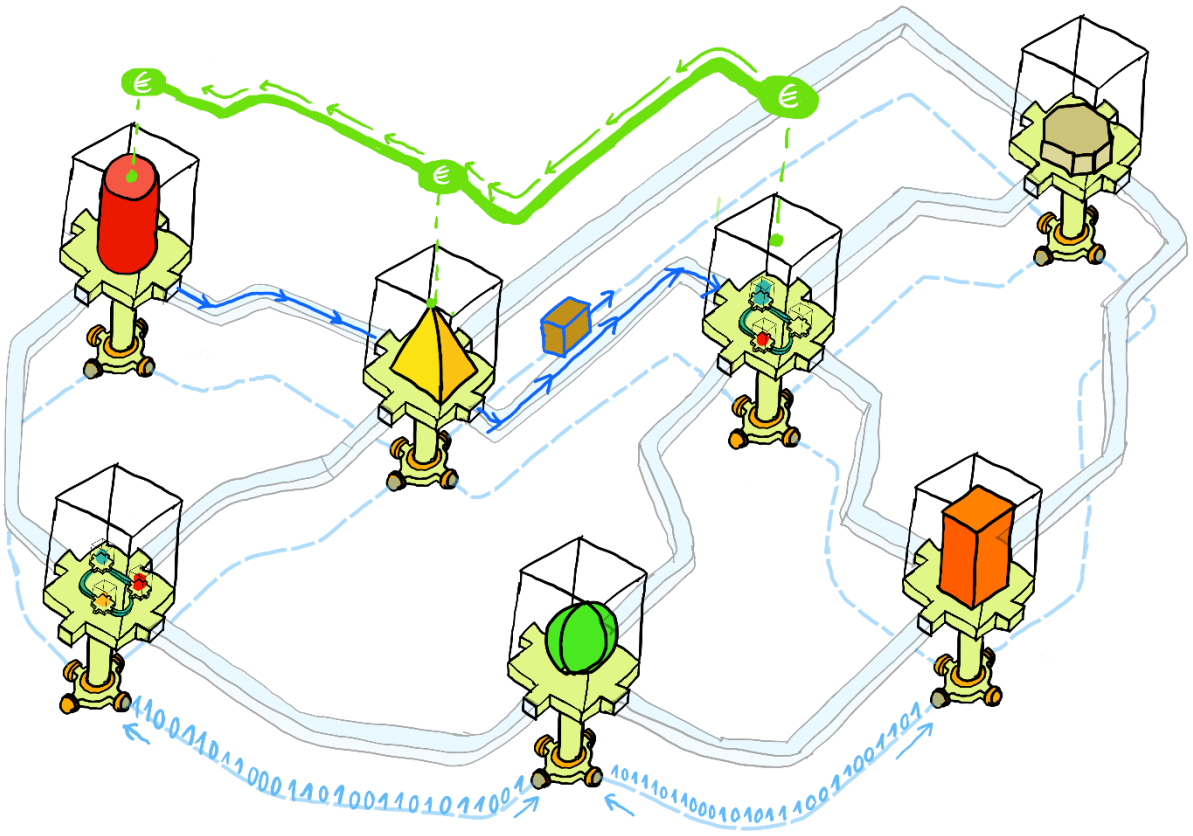
# PI combines flow of goods, information and money



**Combination of flows on three levels:**

- Transport (physical)
- IT (virtual)
- Money (financial)

The existing infrastructure will stay more or less the same

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# PI will still build on one network with different paths based on individual requirements

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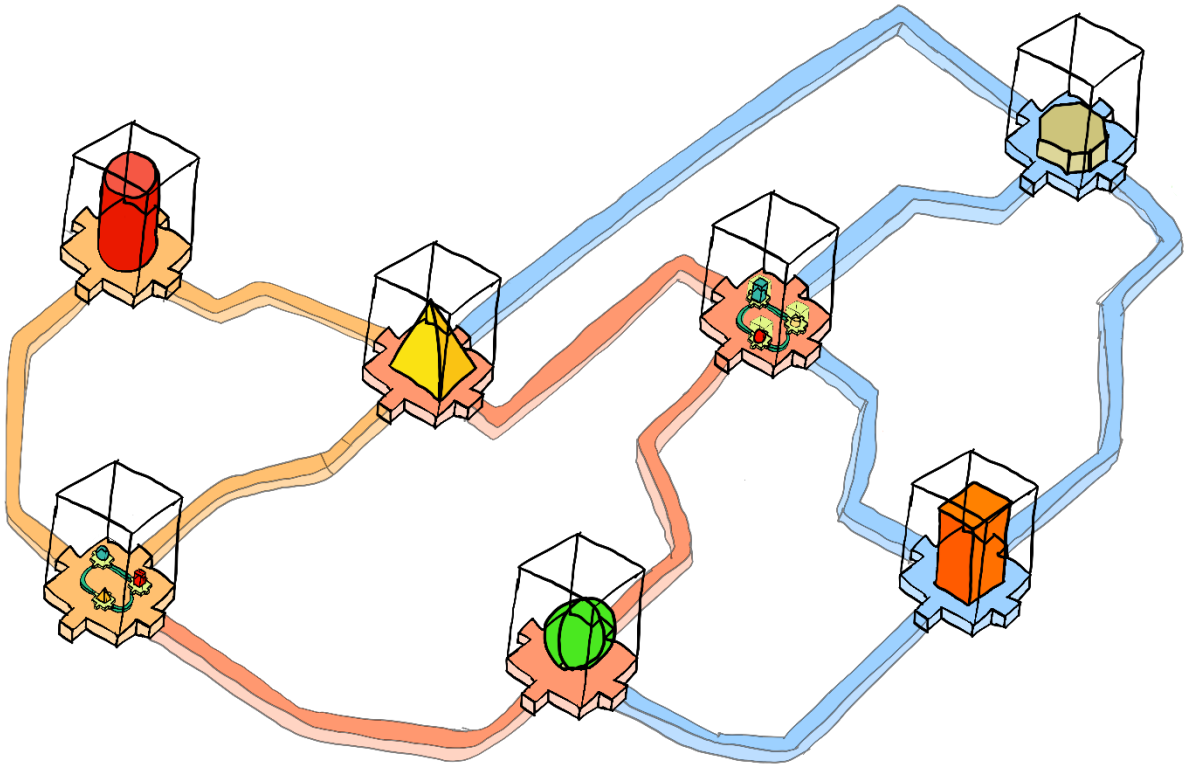
**Full network available**



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# PI will still build on one network with different paths based on individual requirements

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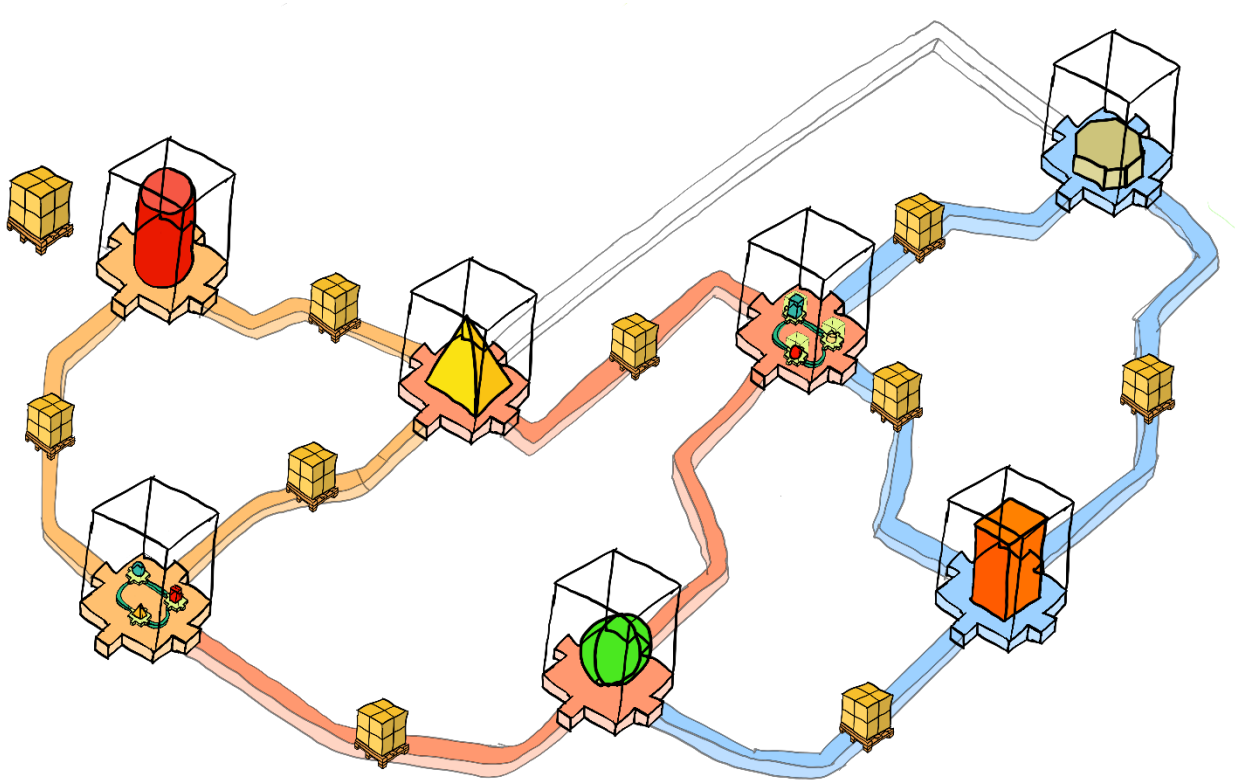

**Subset of network for transport of pallets**

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# PI will still build on one network with different paths based on individual requirements

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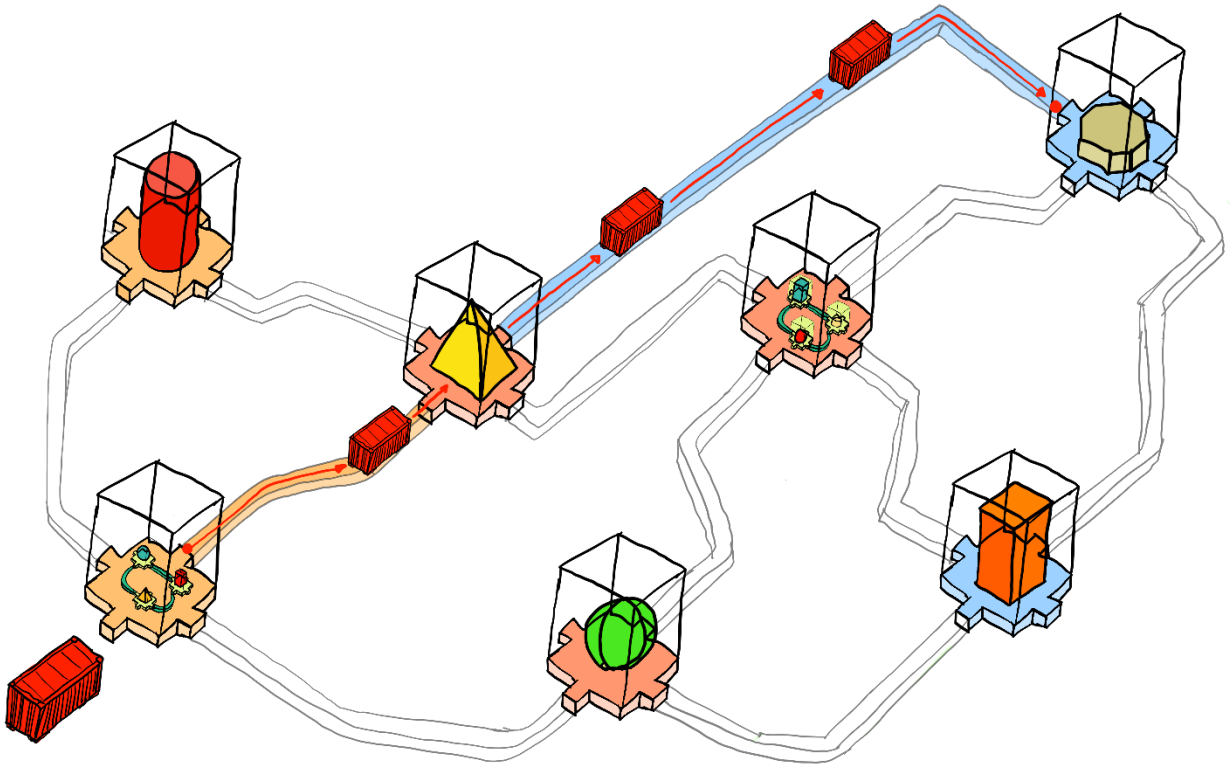
**Subset of network for transport of containers**



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# PI will still build on one network with different paths based on individual requirements

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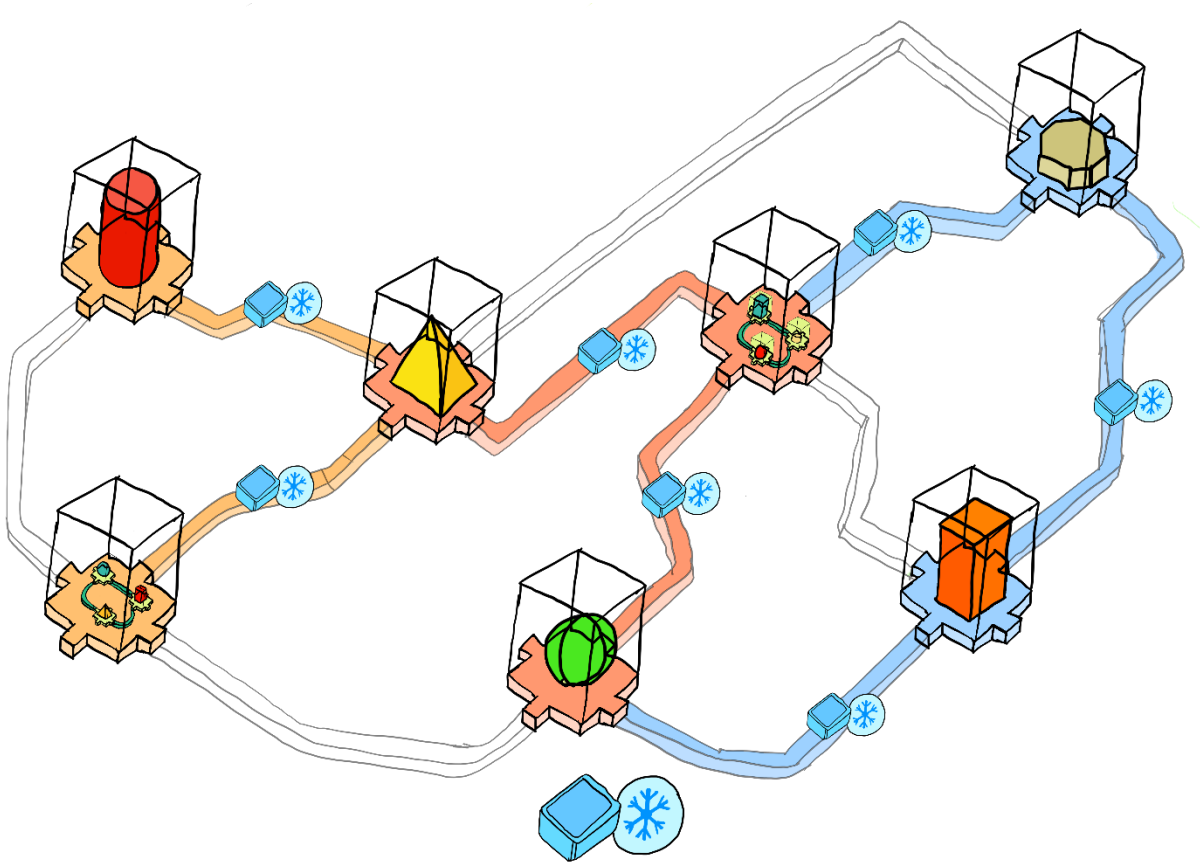

**Subset of network for transport of frozen goods**

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# Possible effects during the transition towards the PI

**For carriers**

- Better connection of internal and external networks based on open protocols/standards
- Higher efficiency for internal operations based on open protocols/standards
- Less required assets because of better asset utilisation
- Mid- and long-term capacity planning not needed

**For shippers (customers)**

- Higher flexibility in transports
- Ad-hoc scaling of needed transport capacities
- Visibility of goods in transport
- Increase of the service level (more outreach because of more networks)

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# Possible effects during the transition towards the PI

**For hubs/terminals/ports**

- Tactical planning (decision about next link)
- Connection of (former separate) networks

**For Logistics Service Provider**

- More flexibility in planning and execution
- Main contact point to use PI
- Easier use of external resources (on demand)

**For society**

- Higher efficiency in transport
- Expected less emissions because of higher efficiency
- Expected higher resilience because of connected networks (no single-point-of-failure)

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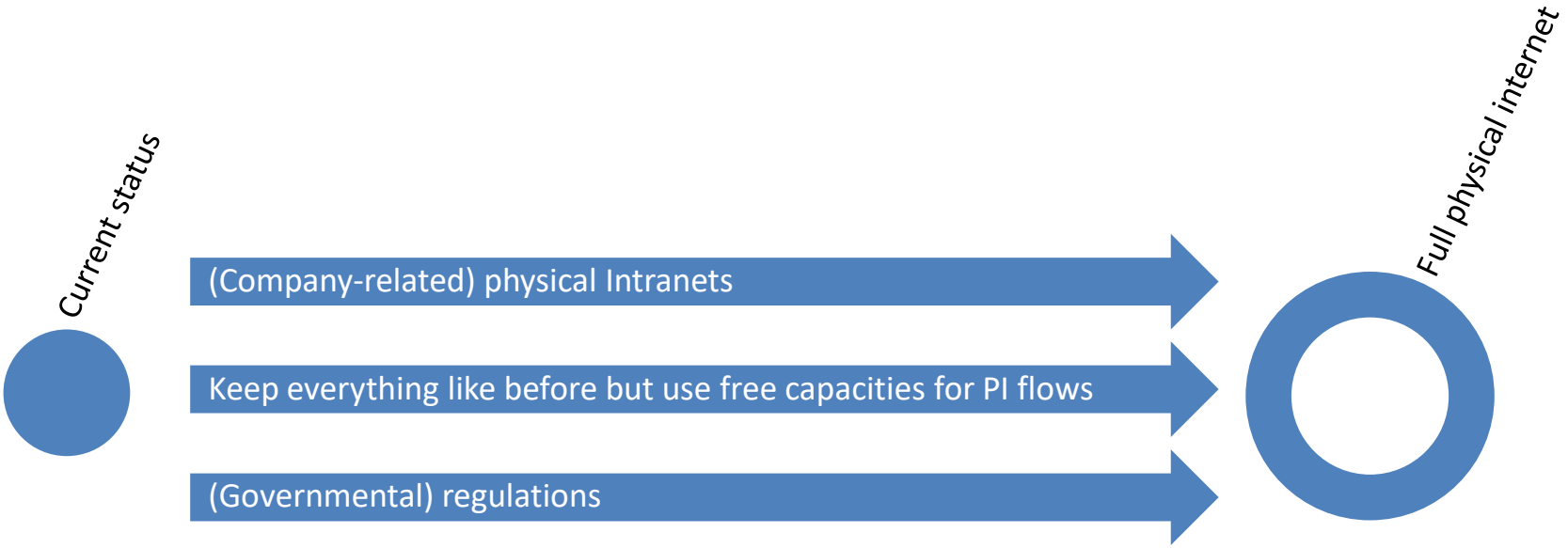
# Possible scenarios on the way to PI

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# PI storyline: Shipper wants to send via PI

**Step 1: Get offers for shipping price according to schedule and quality requirements**

- PI system must provide the capability to provide this cost from source A to destination B via forward looking capability that understands:
  - system load factors during the time frame in which the shipment will occur,
  - what lanes might be possible for use, and
  - various carrier and node costs that would be incurred to ship the shipper's products along each conforming path.
- Service providers, node operators and transport operators, need to provide service costs, service levels, quality, etc. to PI "management system".

- *Provided in Digital Internet by TCP and quality of service protocols*
  *-> PI will need similar protocols to handle this service.*

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# PI storyline: Shipper wants to send via PI

**Step 2: Shipper accepts a particular shipment quote/scenario**

- Shipment plan needs to be integrated into the PI's forward planning system so that execution activities can be planned and PI loads updated by lane to allow for the ongoing planning of other activities and shipments.

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# PI storyline: Shipper wants to send via PI

**Step 3: Injection of loading unit into the PI**

- Transport of loading unit starts from first PI node
- If location of loading unit is outside of PI network, then pickup of loading unit will be managed by operator of first PI node
- Set up of all service providers along the path for receiving and moving the loading unit along to its destination.

- *Provided in Digital Internet by several layers:*
  - *IP protocol for between node management*
  - *TCP for across network management.*

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# PI storyline: Shipper wants to send via PI

**Step 4: Movement within PI**

- As the loading unit moves through the PI network, it will interact with PI nodes
- Each node will have been notified through the IP equivalent control protocol of the loading unit and its scheduled arrival and will have responded based on its current state whether it can accept the shipment based on its original commitment.
- Loading unit will move seamless across several (company) networks / PI network?
- Amount of PI nodes involved in one route will be naturally limited by 5-10 PI nodes
  - -> Six degrees of separation

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# PI storyline: Shipper wants to send via PI

**Route changes due to equipment breakdown, poorer performance, unexpected loads, etc. or even better offers**

- Changes will be communicated upstream in real time before the prior node sends the loading unit downstream and also during transport.
- Prior node determines whether there are congested links and route via other links to ensure that the delivery of a loading unit occurs per its QoS requirements
  - *Analogous process from Digital Internet and its routing protocol approach*

- PI will allow this rerouting and update the shipment's routing based on this reassessment. Should the problem create a potential failure to meet the original deliver or QoS requirements the shipper will be notified and they will need to make a decision as to how to proceed.
- PI (TCP analogous protocol most likely) will update the shipment's information and the loading unit will be moved onwards according to the updated data.

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# PI storyline: Shipper wants to send via PI

**Step 5: Arrival at last PI node on route**

- Once the loading unit arrives at the last PI node, the final distribution will occur like the final delivery does for DI packets.
- *This is done in the DI via the ISP's headend system.*

- Last PI node does not need to be the final destination:
  - Certified transport to real address (shops, domestics), with special services like individual delivery times, unboxing, cleaning, etc.
  - In PI this would be done via the rules that are extent in the final node, be these city delivery regulations or some other rule set governing the "last mile."

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# PI storyline: Shipper wants to send via PI

**Step 6: Loading unit delivered, start of invoicing and payment process**

- Invoicing and payment process will operate in a manner similar to how mobile phone roaming charges are handled. Using a forward services logging process all services provided will be accounted for, the costs summed up and the shipper charged.

- When the shipper makes payment to the financial service entity operating in the PI, each service provider will be paid

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# Main building blocks of PI

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## PI Nodes

- Handling of assets and goods
- Value adding services

## PI Network Services

- Planning and routing
- Information exchange
- Interconnectivity (in network)

## Access to PI System

- User interface

## Govern. & System Design

- Business model
- Finance and trust
- System borders of PI

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# Main building blocks of PI
# Current research areas

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## PI Nodes

- Physical handling of assets and goods
  - Autonomisation/Automation
  - Boxes and containers
- Transport vehicles
- Value adding services from nodes

## PI Network Services

## Access to PI System

## Govern. & System Design

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# Main building blocks of PI
# Current research areas

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## PI Nodes

## PI Network Services

- Forecasting & planning
  - Forecasting / Forward looking capabilities
  - Real-time network status
- Routing algorithms and principles
  - Node-to-node transport (hop-to-hop)
  - Network transport (door-to-door)
  - Detection of congestion and problems
  - Rerouting based on contracts
  - PI protocol stack
- PI planning system
- Price-cost-payment system
  - Secure logging and payment process

## Access to PI System

## Govern. & System Design

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# Main building blocks of PI
# Current research areas

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PI Nodes

PI Network Services

- Connection/Interface to PI system
- User interaction
- Seamless connection between PI and other networks
  - Last mile, urban logistics

Access to PI System

Govern. & System Design

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# Main building blocks of PI
# Current research areas

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PI Nodes

PI Network Services

- Governance and business models
  - Different pricing models: flatrate vs. per distance vs. per item
- Data sovereignty, privacy and trust
- Trustees?
- Architecture of PI system
- Ad-hoc contracting

Access to PI System

Govern. & System Design

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# Collection of current research areas

**PI Nodes**
- Physical handling of assets and goods
  - Autonomisation/Automation
  - Boxes and containers
- Transport vehicles
- Value adding services from nodes

**PI Network Services**
- Forecasting & planning
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**Access to PI System**
- Connection/Interface to PI system
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**Governance & System Design**
- Governance and business models
  - Different pricing models: flatrate vs. per distance vs. per item
- Data sovereignty, privacy and trust
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- Architecture of PI system
- Ad-hoc contracting

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# Brainstorming in working groups

**16h – 17h: Brainstorming in working groups**

- Split-up in 2 - 4 working groups for detailed discussions about research areas
- Input: Table with currently identified research areas grouped by network, node, system and governance
- Output: New research areas, more detailed research areas

- Based on the collection of current research areas please discuss the following questions:

Do you agree to this research areas?
What do you thinking is missing?
Which topics are the most urgent ones?

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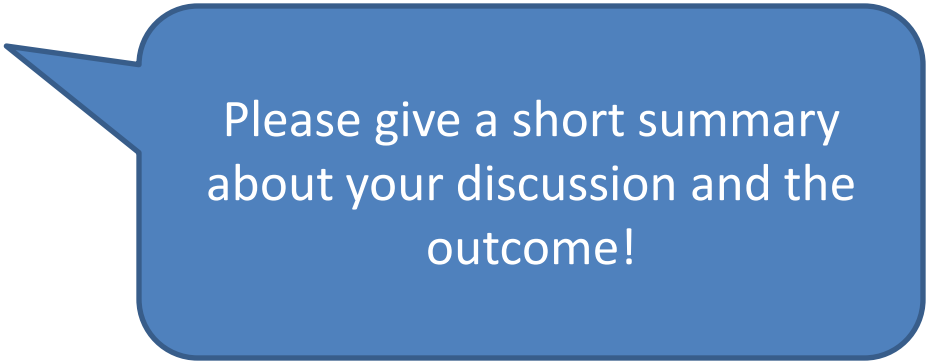
# Final sum up

**17h: Final sum up**

- Presentation of results from single working groups




- Thank you for your help

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