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A Collective Intelligence Approach for the Composite PI-Containers Management

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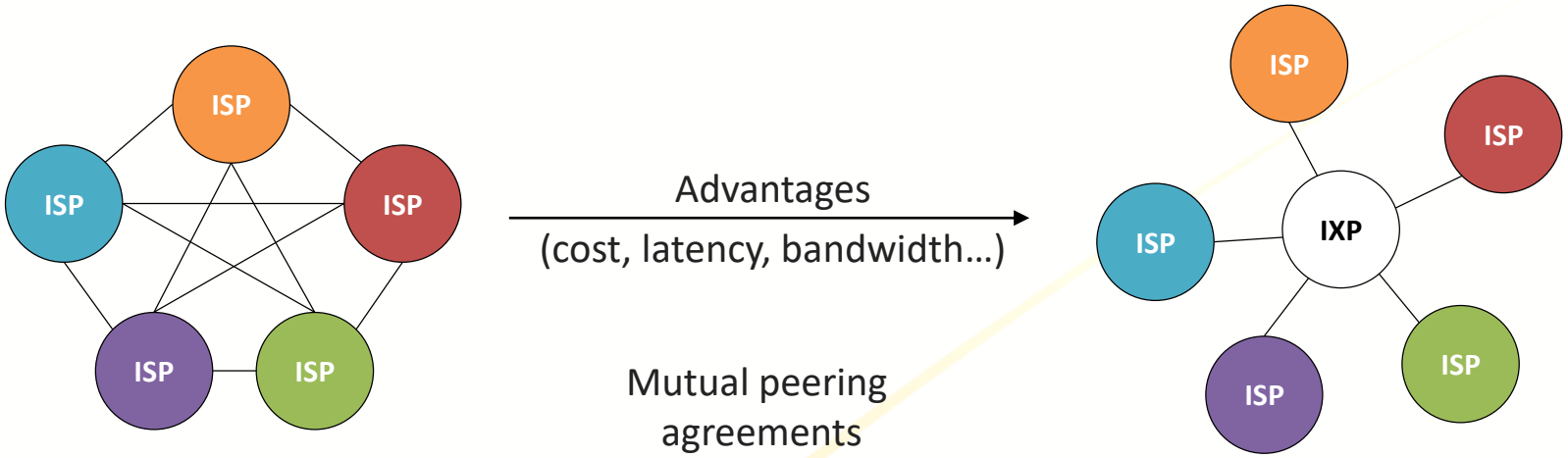
HYPERCONNECTED DIGITAL INTERNET WORLD

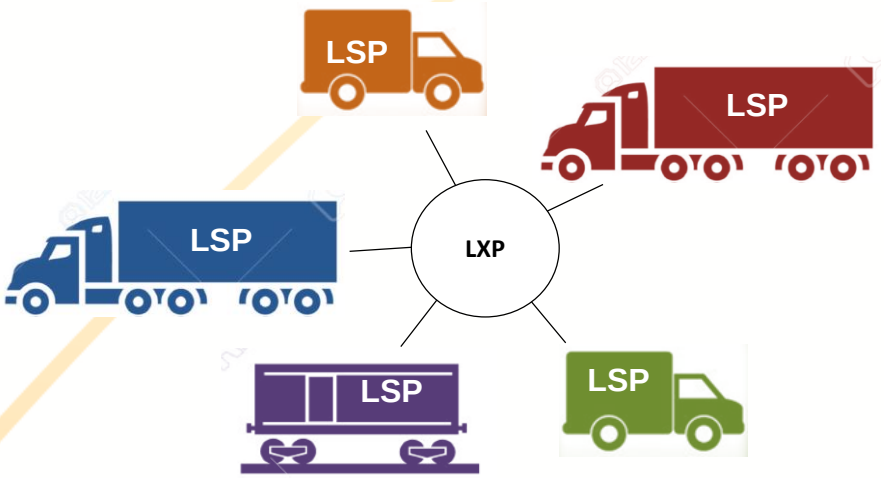
PI-HUBS … AS A LOGISTIC EXCHANGE POINT



Internet Exchange Point business alignment clashes

ISPs prefer an IXP that is not owned or operated by a competitor

The Internet Peering Playbook: Connecting to the Core of the Internet **[Norton, 2011]**

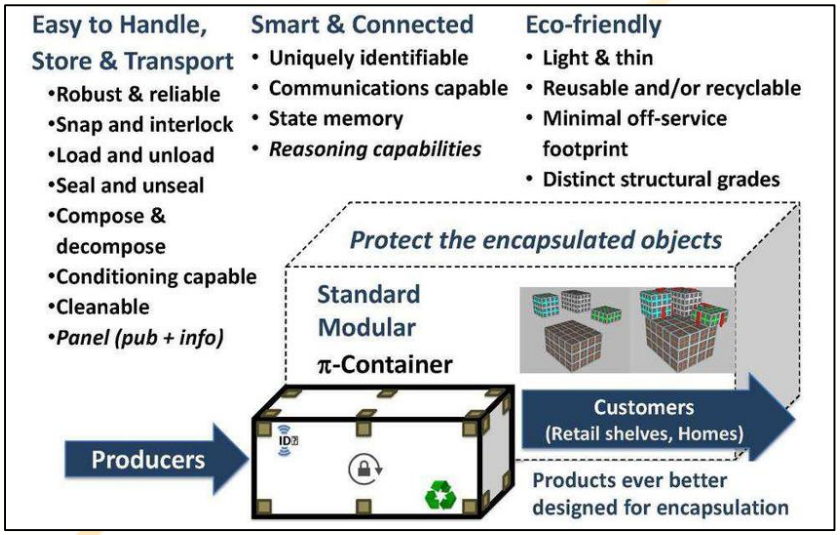


Physical Internet Vision

A carrier-neutral LXP

WHAT WE NEED … AND WHAT WE HAVE …

Preserve neutrality and strengthen mutual trust between all stakeholders at anytime and anywhere (Open global logistic infrastructure)



Key characteristics of Physical Internet containers **[source: Montreuil et al.]**

Smart PI-containers able to:

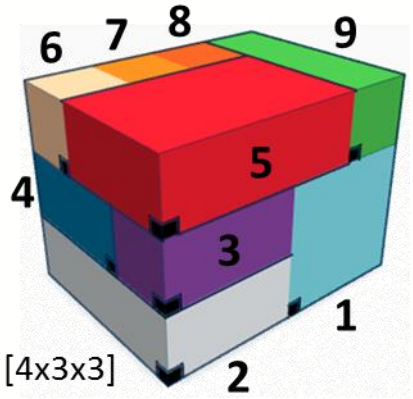
- Sense and measure its environment
- Store and process data
- Communicate with others

~~Stupid **IoT** products~~

↓

IoT with Individual Intelligence

AND WE CAN GET MORE …



Composite PI-containers

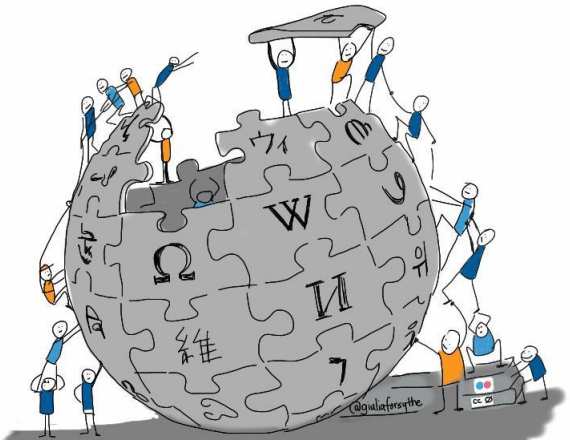
From the collaboration of individual intelligences emerges the collective intelligence

Definition (MIT Center for Collective Intelligence)

"Groups of individuals doing things collectively that seem intelligent"

Harnessing Crowds: Mapping the Genome of Collective Intelligence **[Malone, 2009]**

Ants colony and collective efforts [**Wheeler, 1965**]



Wikipedia
(content curators play a key role)

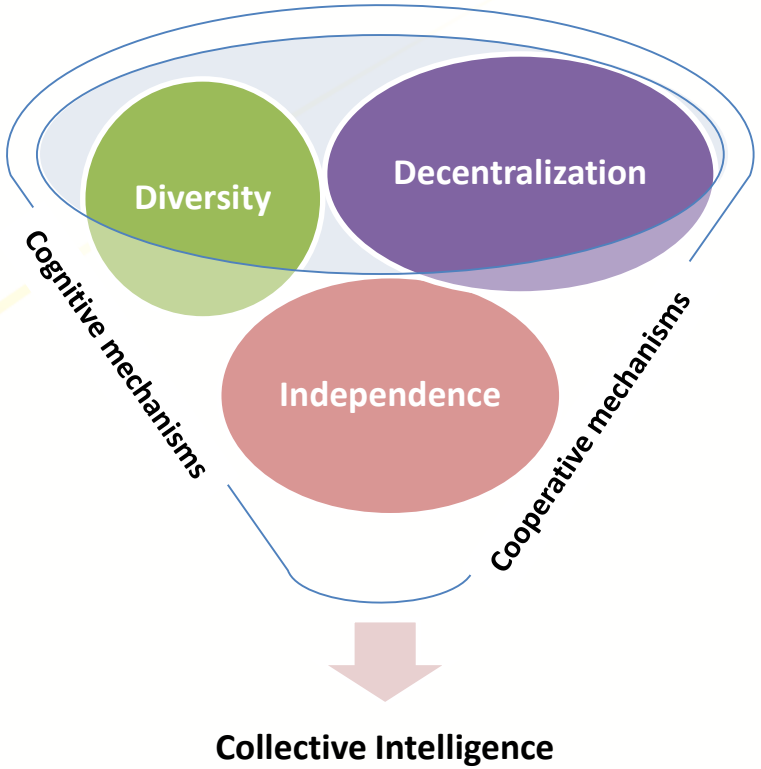
COLLECTIVE INTELLIGENCE

Cognitive mechanisms

- basic processes (acquisition, memory or representation)
- perceive its environment
- develop its own knowledge

Cooperative mechanisms

- Interaction between individuals
(to solve the problem)
- Information sharing, confidence, feedback/control
(to develop synergy and decision-making emergence)

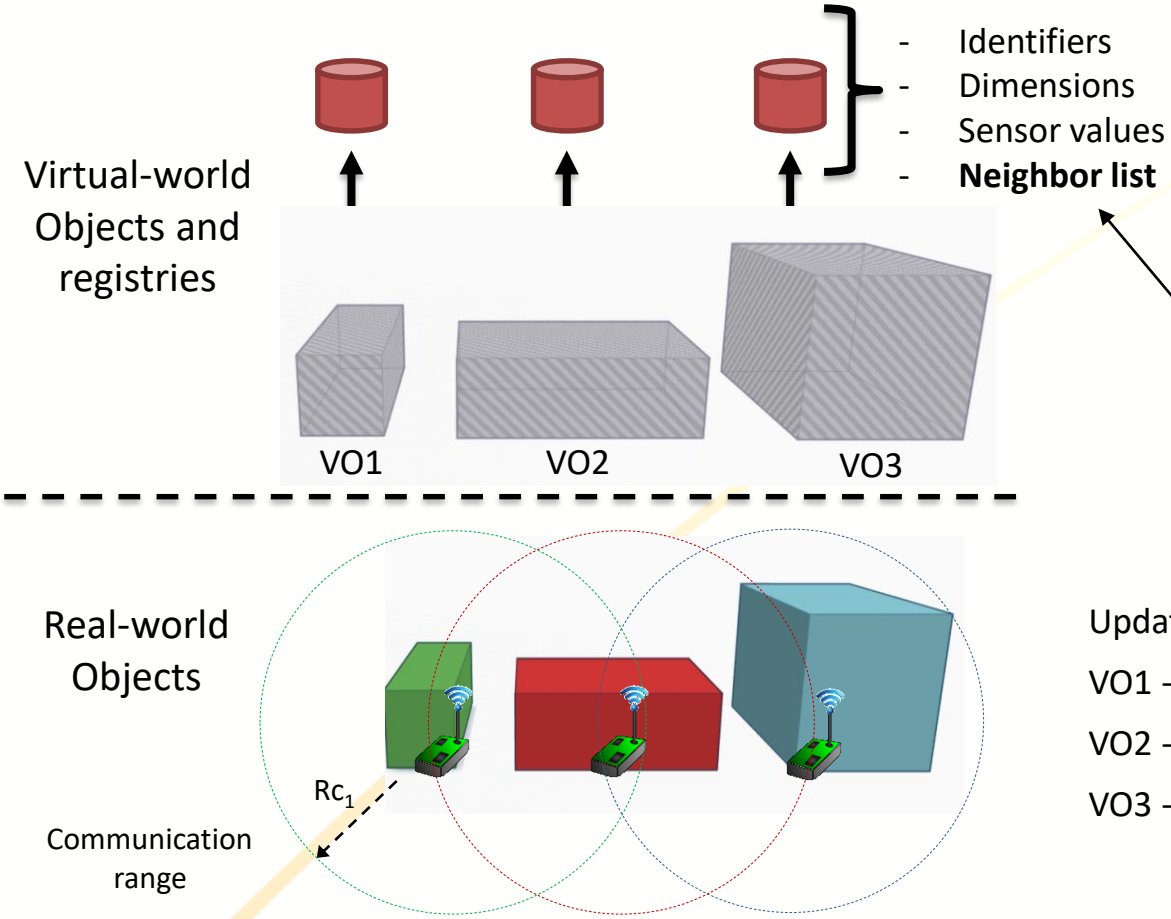


Surowiecki machine - *The wisdom of crowds* **[Surowiecki, 2004]**

Enablers of CI

- Diversity and Decentralization (variety of opinions, specialized or localized knowledge)
- Independence (not influenced by others)

PROPOSED MANAGEMENT FRAMEWORK



Update and maintain its neighbor list

VO1 -> Rc_1 (VO2) Rc_2 (VO2,VO3)

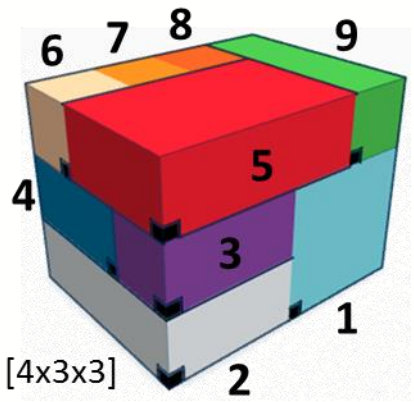
VO2 -> Rc1 (VO1,VO3) Rc2 (VO1,VO3)

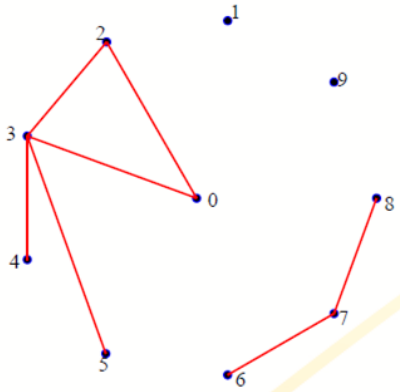
VO3 -> Rc1 (VO2) Rc2 (VO1,VO2)

Virtual Object (VO) exploitation:

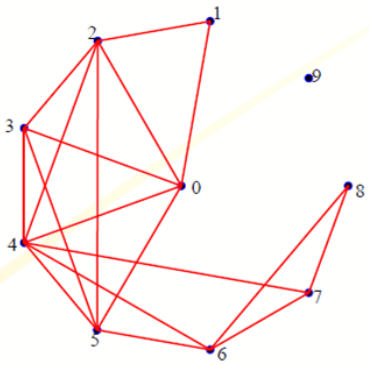
- business view (generate a positive business)
- security view (mutual trust and confidence between stakeholders)
- operational view (optimize and accelerate processes)

AND WITH COLLECTIVE EFFORTS …

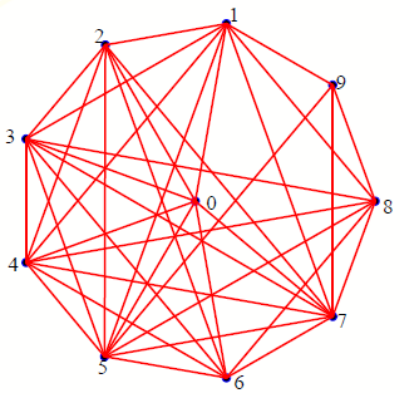




Rc_1



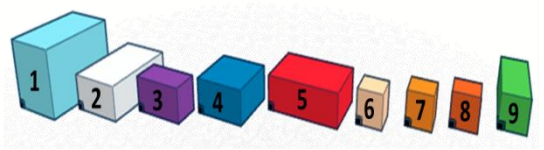
Rc_2



Rc_3

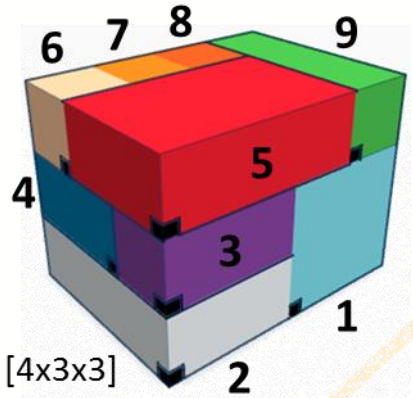
- Identify of the number of unitary PI-container that composed the composite π-container (coop.)
- Detect and identify the PI-containers in their neighbourhood (cog.)
- Collect and forward data throughout the network to aggregate information (coop.)
- Resolve a neighbourhood conflict (cog. + coop.)

FRAMEWORK IMPLEMENTATION

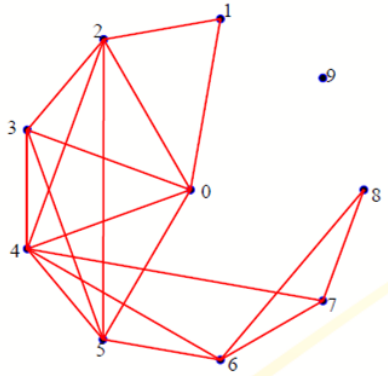


[2x3x2] [2x3x1] [2x1x1] [2x2x1] [3x2x1] [1x1x1][1x1x1][1x1x1][1x3x1]

List of items (Id, Dimensions)



Real Arrangement



Neighbor graph obtained collective intelligence

Constraints based on neighborhood relations between nodes:

$$((x_i + lx_iL_i + wx_iW_i + hx_iH_i) - xn_i)(x_i - xn_i) = 0, \forall i = 1..m$$

$$((y_i + ly_iL_i + wy_iW_i + hy_iH_i) - yn_i)(y_i - yn_i) = 0, \forall i = 1$$

$$((z_i + lz_iL_i + wz_iW_i + hz_iH_i) - zn_i)(z_i - zn_i) =$$

$$V_{ij}\sqrt{((xn_i - xn_j)^2 + (yn_i - yn_j)^2} \quad \forall\{i,j\} = 1..m+1$$

Constraints bas… …bility conditions:

$$Right[\quad \ldots + hx_iH_i)] \geq 0, \forall\{i,j\} = 1..m$$

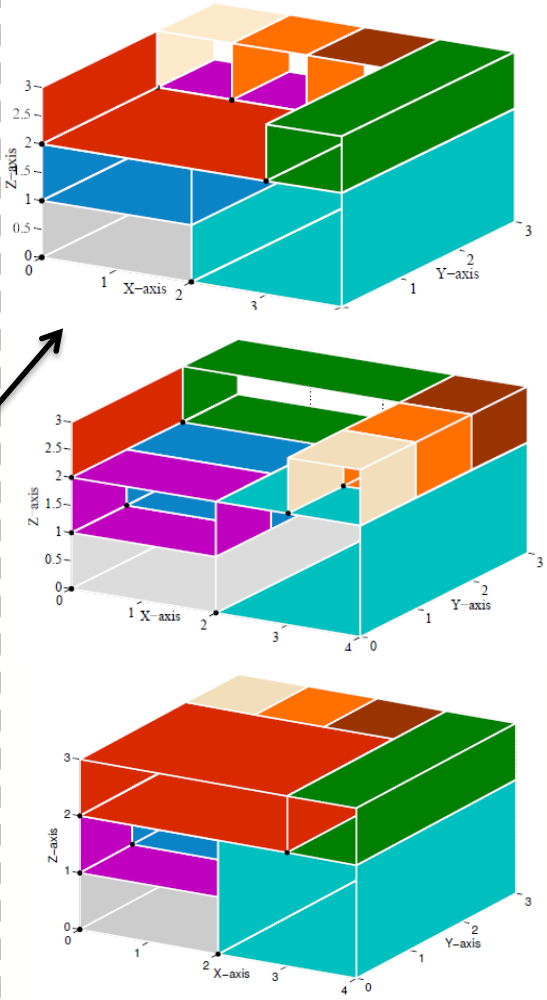
$$Left_{ij}[\quad \ldots x_jL_j + wx_jW_j + hx_jH_j)] \geq 0, \forall\{i,j\} = 1..m$$

$$Behind_{ij}[y_j - (y_i + ly_iL_i + wy_iW_i + hy_iH_i)] \geq 0, \forall\{i,j\} = 1..m$$

$$Front_{ij}[y_i - (y_j + ly_jL_j + wy_jW_j + hy_jH_j)] \geq 0, \forall\{i,j\} = 1..m$$

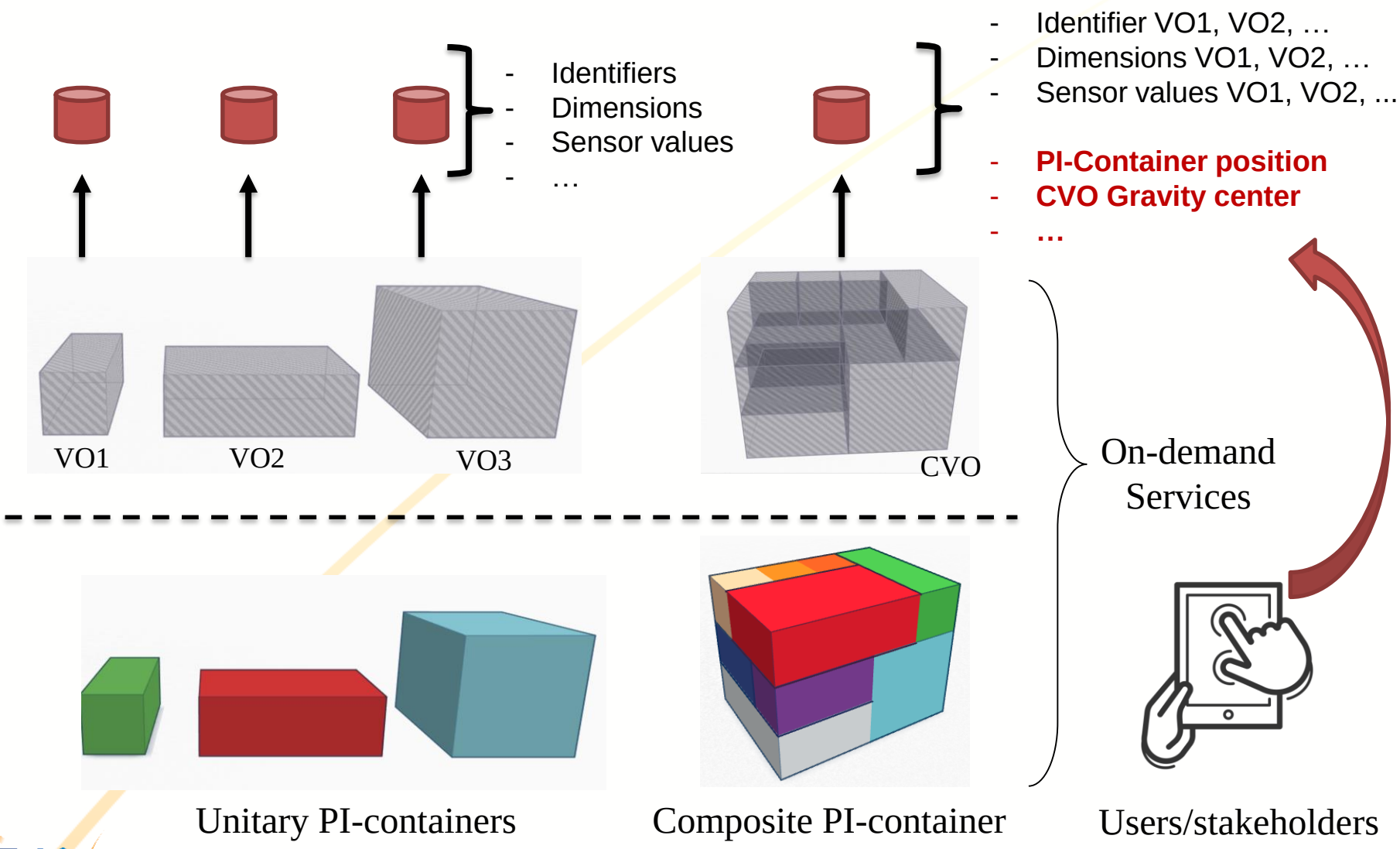
CSP solver

Feasible solutions



Containers monitoring through the Physical Internet: a spatial 3D model based on wireless sensor networks
International Journal of Production Research **[Tran-dang et al., 2017]**

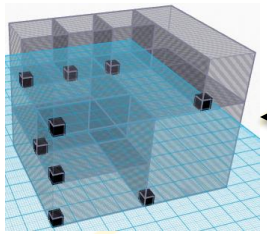
PROPOSED MANAGEMENT FRAMEWORK



NEW INDIVIDUALIZED CUSTOMER-SERVICES

Truckers – Operators interfacing

(Business and security views)



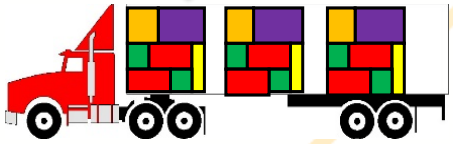
1

1

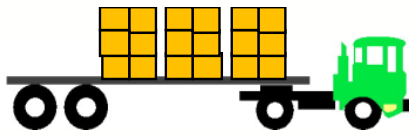
- Inventory control of incoming and outgoing goods
- Assist in physical checking of goods (transportation condition monitoring)
- Detect problems for security purposes (shocks, opening tentative, incompatibility between goods)
- ...

2

2



Inbound flows



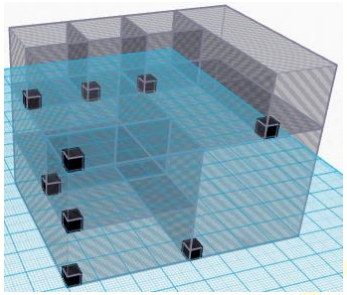
Outbound flows

PI-Hub

NEW INDIVIDUALIZED CUSTOMER-SERVICES

Composite PI Container – Robots interfacing

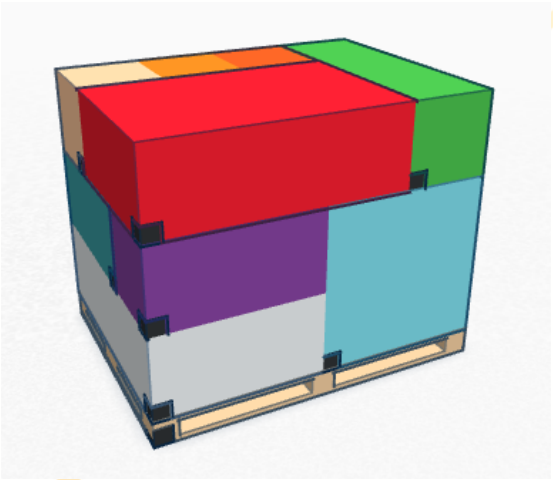
(operational view)



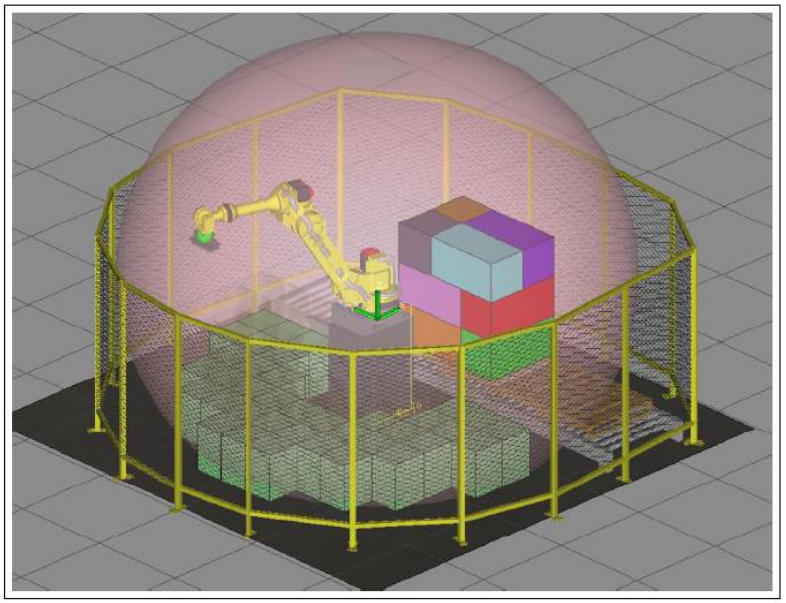
- Automatic picking sequence generation
- Automatic guidance information generation
- …

1

2



Composite PI-container

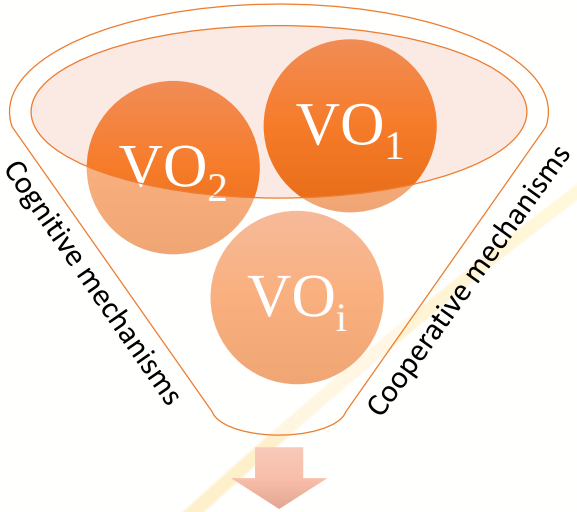


Loading/Unloading motion execution

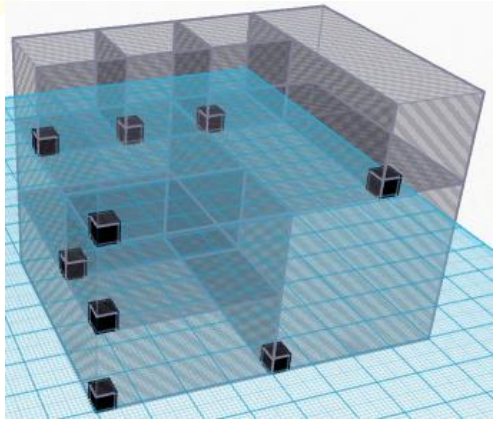
CONCLUSIONS

- IoT + CI = Collective Intelligence of Things (CIoT)

VO_i
- Id i
- Dimensions (L_i, W_i, H_i)
- Neighbor list



Virtual 3D layout generator (CSP)



CVO
- Identifier VO1, VO2, …
- Dimensions VO1, VO2, …
- PI-Container position
- …

- From Collective Intelligence emerges new added-value services

Physical Internet / Collective Intelligence ➡ Synergy development

QUESTIONS, COMMENTS … AND COLLABORATIONS ARE WELCOME !

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The Cargo Carousel System (CCS)

The Business Case for Transformational Innovation

(Please view this 60-second video before reading further)

As many supply chain organizations have spent years cutting costs and eliminating waste, incremental improvements are leading to diminishing returns. This is driving the need for supply chain executives to seek more innovative solutions. Companies that continue to rely on traditional supply chain models will struggle to remain competitive but with so much new technology how does one decide the best investment for the greatest return or quantify the benefits in a way that justifies spending the money? Mistakes can be costly and must endure the test of time. Decisions today may be out of touch with tomorrow as innovation and technology continue to disrupt in a constantly changing marketplace.

The Cargo Carousel is a "system" that is utilized end-to-end throughout the value chain; not just in transport or storage or retail or last-mile delivery but, throughout the *entire* chain. It transforms the value chain with a flexible and scalable system that represents a complete solution that is easily installed and modular by nature so customers can quickly adopt, see immediate benefits and ROI's, and add to their systems as their needs increase. Best of all, there is virtually no change to current processes so the need to train employees is basically eliminated.

The CCS is a framework developed to slide into an existing ISO intermodal container or truck trailer and can be built to fit into *any* sized container, trailer or truck box. The ISO intermodal container represents the most versatile application due to its already available stacking and handling capabilities. Each "module" within the framework of the CCS replaces a wooden pallet and is a cubic design which can also be built to fit any application desired. Each module is suspended from the Carousel to better absorb shock and protect contents. From a rack built to hold trays of produce to an enclosed rod to hang clothes on, the CCS can increase the efficiency, flexibility, scalability and sustainability of the entire supply chain.

Transport – the CCS allows deliveries and pick-ups at the same time without ever leaving the dock whether you're transporting upstream or down. This can eliminate empty back hauls by combining the supply and reverse chains (shelf pulls, store returns, perishables, recyclables, freight damage, etc.) into one. Double-stacking pallets will often crush products underneath but the CCS eliminates partial loads by utilizing the entire available space and protecting merchandise far better than plastic wrap. Green House Gas (GHG) emissions are minimized to save on increasing, government mandated carbon pricing taxes.

Storage – the CCS eliminates the need for aisles that are reserved for forklifts to maneuver. Stacked side-by-side and end-to-end, the CCS offers automated deep storage and retrieval that is unparalleled in the industry and, since each module within the CCS stops at the *exact* same location for loading and unloading, robotic forklifts can combine GPS with RFID (Radio Frequency Identification) to easily identify the location of any tagged merchandise for unmanned pick & pack, put away, cross-docking or staging.

Retail – the CCS does not require loading docks. This allows inventory to be stored much closer to the customer in temporary clusters of CCS containers stacked right in the parking lot of the store or on trailers backed up to bay doors. Containers can be added or removed to other locations as necessary

adding flexibility and scalability to absorb seasonality without committing to permanent and costly structures that are underutilized in the off-season.

Last-mile delivery – adding a keypad or card reader to the CCS and creating openings at both ends allows store employees to load from one end while customers or couriers with authorization unload at the other end for customer pick-up or quick courier delivery. Creating an opening at only one end allows pre-stocked containers to be positioned *anywhere* for customer or courier pick-up that is quickly replenished by simply swapping out the empty container with a newly pre-stocked unit. Again, multiple units can be utilized at any location(s).

Pool Distribution – this brings together all of the benefits offered by the CCS. Each module of the CCS is opaque, lockable and sealable eliminating the need for a unique pool operator. Dimension-based pricing with a variable for weight allows pooling with multiple manufacturing, trucking, storing and retailing operations simultaneously and continuously while minimizing the need for route optimization programs. With its reverse chain capabilities, there are no more excuses for empty backhauls, partial loads or *any* wasted space on *any* leg of the value chain.

Visibility – although different interpretations and definitions abound, one way to think of supply chain visibility is: The right information, in actionable detail, on events, orders, inventory, and shipments, up and down, and end to end, updated and presented in real time. This definition – ambitious by intention – sets the goal of having visibility through every tier of the supply base, with every supply chain partner, in real time. Software alone cannot achieve this but, when coupled with the CCS's sensor and satellite communication capabilities (IoT), true control tower visibility is achievable throughout the value chain.

Bringing the Cargo Carousel System into the greater supply chain planning process offers tremendous strategic and performance potential. By leveraging the Cargo Carousel System as a callable capability and incorporating it into downstream transportation and upstream supply chain workflows, companies can improve asset utilization, use fewer trucks, drive fewer miles, have fewer empty backhauls/partial loads, reduce fuel costs, enhance distribution/retailing operations and increase recycling and sustainability by an order of magnitude. The simplicity of the Cargo Carousel System makes it difficult to fully grasp its ability to reduce cost while simultaneously boosting performance.

Contact us:

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