Image: Stockbooking

Living Lab 4: Physical Internet as enabler towards networked Warehousing as a Service (WaaS)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

What is ICONET?

ICONET was a consortium led research project that explored what was needed to make the Physical Internet a reality. The Physical Internet describes the application of the principles of the digital internet to real world logistical problems; through digital twinning, the real world is tracked using sensors and consolidated data and replicated as a real-time model that is used to deliver real-time decision making that makes optimal use of logistics capacities and infrastructure for the benefit of all participating users. By making better use of assets and resources the Physical Internet also reduces emissions thereby realising benefits to society as a whole.

The strategic goal of ICONET was to build a cloud-based Physical Internet framework and platform, which utilised leading edge technologies to deploy logistics solutions that demonstrate proof of concept. The 30-month project fulfilled the brief to extend state of the art capability for deployment of the Physical Internet through development of an experimental networked architecture and suite of core services, although having started in September 2018, and concluding in February 2021, the Covid pandemic paradoxically both disrupted the testing of these solutions and reiterated the value that they offer.

The research programme explored new business models that could be enabled by the Physical Internet that enhance intermodal transport, better use of existing port capacity, high volume freight corridor capabilities, warehousing and ecommerce services; these elements together form the basis of a new Physical Internet driven logistics marketplace that makes better use of existing assets and investments, improving the services delivered to logistics users, cutting costs, and reducing environmental impacts.

What is the Physical Internet?

The Physical Internet, abbreviated frequently to PI, allows for optimisation of transport and logistics through connecting fixed facilities, (such as warehouses), and dynamic infrastructure, (such as trucks), to the digital world, so that transport of goods can be ‘self-organised’ as transport flows, able to respond to real time demand and supply. A PI system can also, via real-time tracking, enable response to real world transport constraints and delays.

Physical Internet services

The aim of ICONET was to create a suite of experimental Physical Internet network services that optimise the flow, cost, and environmental performance of freight traffic, responding in real time to current network capacities, demands and constraints whilst complying with pre-agreed governance rules and service level agreements (SLAs) as determined by logistics service providers, their clients and relevant legislation. Orders are translated into physical transactions which are fulfilled and reconciled, and the process supported by established administrative processes (order, poof of delivery, invoice), in reference to pre-agreed conditions for trade (contractual terms and operating standards, service level agreements).

The ICONET vision is built upon three key pillars:

- To build new business models and the associated governance and other enablers required to facilitate collaborative Physical Internet operations by a range of supply chain actors;

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

- Generic case studies that would also be used to build simulation models for Physical Internet network design, so exploring the factors behind the number and placement of nodes or hubs such as ports;
- The design and testing of an open reference system architecture and platform for enabling the digital connectivity required to track, trace, and replicate the real world in order to deliver optimised solutions in real time. The platforms were effectively proof-of-concept integration IT architectures and infrastructures through which IT optimisation tools and services were simulated and tested.

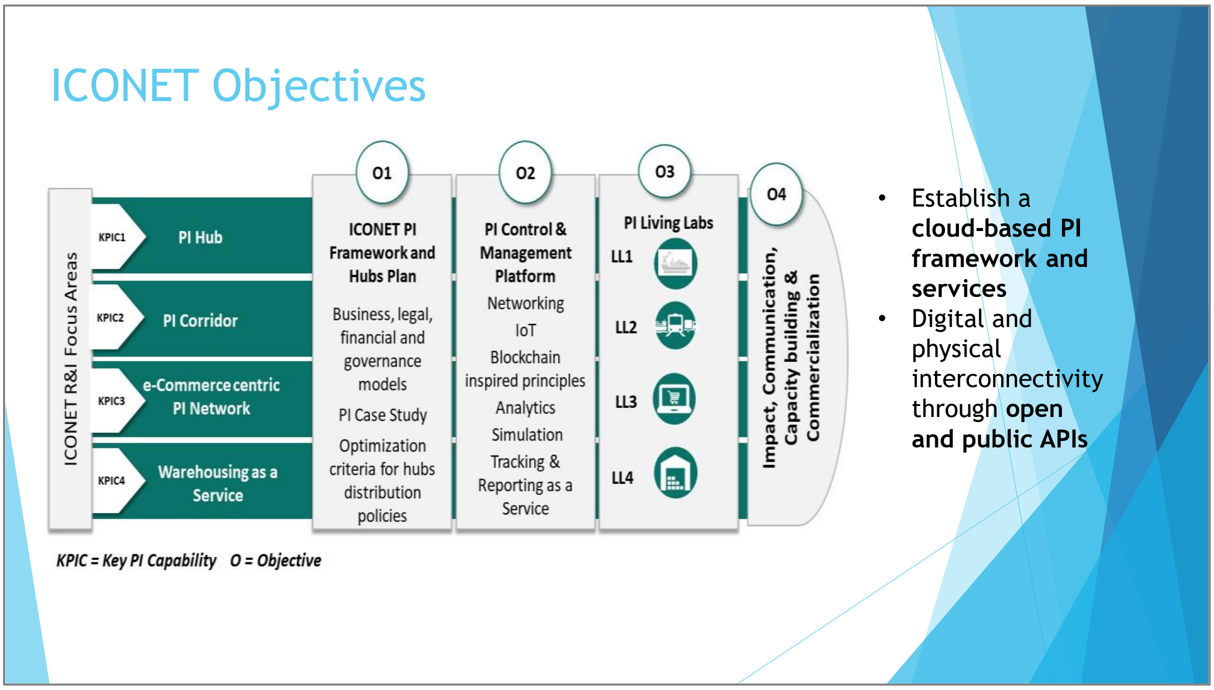
Living Labs as opportunities for proof of concept and collaborative learning

The business models were tested as Living Labs, which involved business partners willing to support the development and testing of Physical Internet concepts within their logistics operations and value chain. Each Living Lab tested the Physical Internet services and infrastructure required to make the Physical Internet a reality and simulated wider deployment to demonstrate the anticipated benefits. In doing so, each lab generated quantifiable realisable benefits to stakeholders, valuable insights enablers and barriers to implementation and success. The project set out for business cases for deployment of Physical Internet solutions:

- Living Lab 1: PI Hub - Port integration and network optimisation.
- Living Lab 2: PI Corridor - High volume corridors to test Synchro-modality as a service.
- Living Lab 3: E-commerce focused PI network solutions.
- Living Lab 4: PI enabled Warehousing as a Service (WaaS).

For each of the four labs, the ICONET project was tasked with making use of leading-edge technologies to build a test scenario deploying the control and management platform, services, and algorithms.

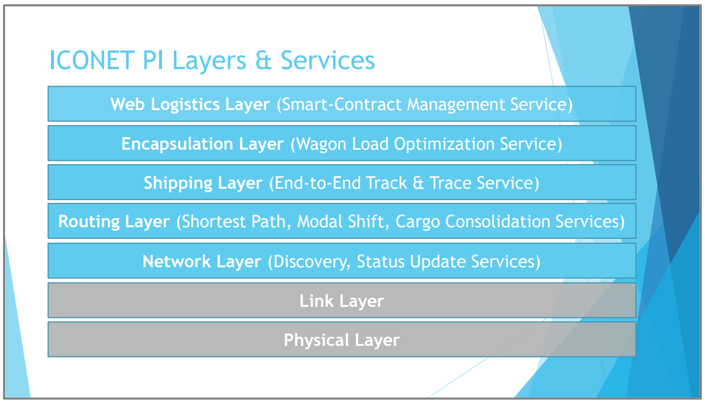
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.



Measurable Outputs of ICONET

The project delivered the Physical Internet framework, four tested and calibrated designs and templates for establishing hubs, corridors, e-commerce and WaaS. To facilitate deployment of the assessment tools developed, a generic simulation model was made available for any interested party to use, in order to allow them to assess, design and test bespoke applications for Physical Internet services. The simulation is available on request and a video demonstrating how the simulation can be used is available here.

The project also produced a control and management platform, containing the services and functional capabilities shown below; the open standards architecture forms a blueprint that can be copied and reproduced to support any Physical Internet platform.



Each living lab delivered solutions that improved efficiency and efficacy of operations for end users, cut costs for participating companies, and reduced the CO_2 footprint of goods stored, handled, and transported. Beyond the demonstration of proof of concept, ICONET examined the pathways to commercialisation of the ICONET solutions, which included the development of education and knowledge transfer, the generation of detailed business case assessment tools, the establishment of an Advisory Board which brought industry experts together to guide and support the research, and wider outreach to other organisations, initiatives, and expert forums.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

Living lab 4: Enhancing the capability for Warehousing as a Service

For many large businesses, national or regional markets are often served by a single central warehouse, as such a solution provides efficiencies from fast stock turn, from the contribution to fixed warehousing overheads, from truck fill and multi-drop delivery. Some large businesses do operate second tier local hubs, but this is less common, whilst many smaller businesses tend to opt for centralised warehousing due to the need to gain the economies of scale offered by a single warehousing operation. Over the last twelve months, disruptions to transport and warehousing have underlined the benefits of a more flexible logistics network, and the benefits gained from moving and rebalancing inventories in response to both disruptions in supply and volatile demand. Shared warehousing and transport service would bring economies of scale via access to geographically dispersed but networked professionalised third-party warehousing solutions to many businesses unable to access such services. This living lab was designed to understand how a network of collaborative shared warehousing solutions could be enabled through the application of the Physical Internet, which would help sustain a networked and decentralised approach to stockholding and distribution accessible for businesses of any size.

The living lab was based around the business model operated by Stockbooking, a start-up that effectively acts as a booking platform for warehousing space, much as platforms such as AirBnB and Hotels.com service the short-stay accommodation market; the platform is a matching marketplace that finds available storage capacity for companies requiring flexible warehousing space, and users for warehousing service providers. The platform offers a range of warehousing solutions, temporary or more permanent, including smaller temporary warehouses that can be difficult to find when required. As such, WaaS represents another manifestation of the connected economy; underutilised resources are made more efficient and effective, in more flexible ways, through micromanagement of gaps between supply and demand; such micro-management of the warehousing market is only made possible through the granular data afforded by the connected economy. The Physical Internet will add a new depth to the information available to connected markets, enabling real-time and self-organised optimised logistical flows that further enhances the novel lean and agile capabilities inherent within marketplaces for connected, integrated, and shared logistics. Storing more stock closer to demand offers the possibility for lower environmental footprint and 'product miles' (the total distance that goods travel to reach the consumer).

The Stockbooking platform allows for business to business or business to consumer flows through a shared network of warehousing locations and associated transport providers that are available within the wider connected network; both smaller and larger businesses can use the same warehousing space and transport flows between them, and equally, the transport and warehouses themselves can be provided and used by both small local providers and larger logistics service providers. Stockbooking manages this market across France, drawing on both static and dynamic information on a network of warehouses across the country, aggregating demand for space, handling, and transport, and the supply of such services.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

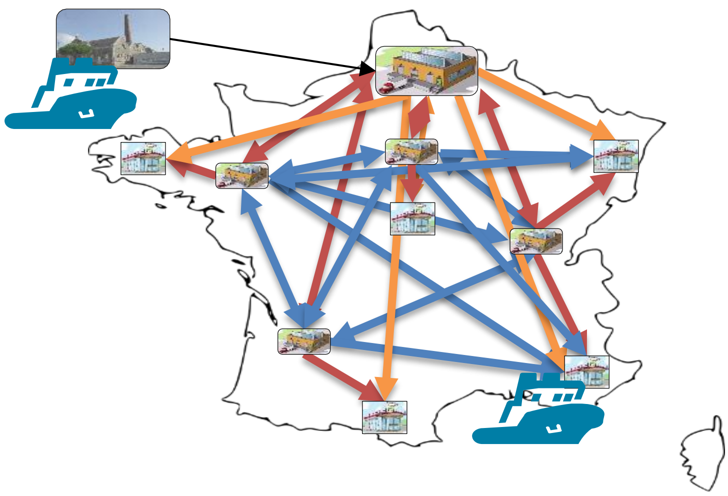
What did the Living Lab do?

The aim of the living lab was to demonstrate the operational efficiencies made possible by adding Physical Internet capability to a multi-client warehousing platform such as the one offered by Stockbooking. The ICONET team focused on two specific outputs: quality of service and environmental impact. Service quality metrics targeted were lead time, truck fill rate, and overall logistics costs, whilst improved environmental sustainability involved focusing on reducing total distance driven, transport delays, and CO_2 emissions. The improved efficiencies were modelled around two business cases to demonstrate operational efficiencies made possible through collaborative logistics in the fast-moving consumer goods sector (FMCG).

Collaboration in a centralised network

The first business case involved simulating several retailers collaboratively using the same network of warehouses to service their retail outlets across France; this network modelled a central warehouse located in the Paris region, supporting a network of regional distribution centres, serving a network of retail outlets across France, and fed by imports entering the country. In this scenario, all flows were routed initially via the central warehouse before redistribution to the regional hubs and retail outlets.

The model considered the warehouses within the network, their fixed capacities and dynamic available space, and the capacity and flow characteristics of the French transport network including both road and rail. As would be expected in solving such a transport optimisation problem, the best transport solution involved consideration of best route and best collection and drop off pattern, balancing distances driven with achieving flow of goods and high vehicle fill rates; in this case it does so by looking at the network of possible routes between all retail and warehouse locations, much as the digital internet routes data through all available nodes and channels although here distances are constrained as a key driver of efficiency. The Physical Internet allows optimal 'self-routing' of goods, as the platform decides on the best routing solution in real time on a hub by hub and stage by stage basis.

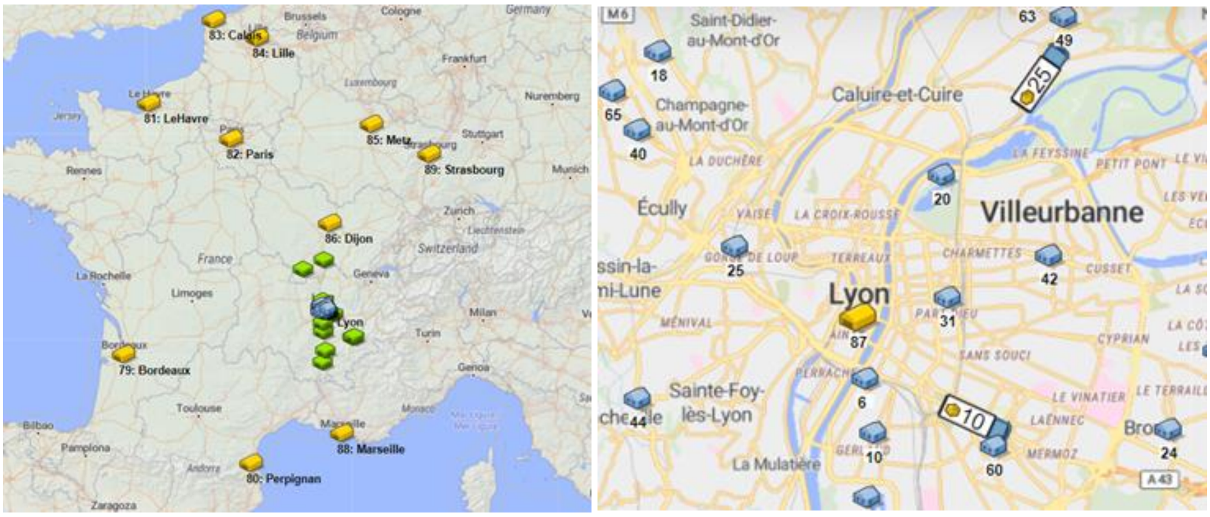


Case 1: centralised network

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

Collaboration in a regionalised and decentralised network

The second scenario modelled flows for a comparable month-long period, whilst altering many other aspects of the network; the month was a peak demand period, all imports entered France through only one port, FMCG goods were mixed with fashion goods (clothing), and finally, most importantly, goods are not primarily directed first through a central warehouse. In this business case, the entire network of regional distribution centres is dynamically utilised as storage space for the regional retailers, with the aim being to supply from nearest distribution centre. All goods that had entered the market in the decentralised scenario were packaged and ready for sale, unlike in the centralised network which included a centralised repackaging operation in the central warehouse. Since this new decentralised network is flatter than a centralised network, the focus was at the regional level; several retailers in the Lyon region shared this network, which, because of the shift away from consolidated long-distance flows, were effectively forced to collaborate and gain efficiencies at a more granular level through the integration of smaller order sizes that would travel shorter distances from warehouse to store or end customer.



Case 2: decentralised regional network

This second scenario makes even more use of the localised, stage by stage, load by load transport and stocking point optimisation. By removing the centralised structure and warehouse, regional hubs must together address significant imbalances in inventories at the regional level, whilst prioritising the best mix of storage and transport within the regional area. The decentralised solution forces higher real-time integration between retailers, arguably is more demanding of Physical Internet infrastructure, and demands a more intense interrogation of available storage space, lead times and pricing; this latter point is an issue we shall return to later when considering the implications of such a highly integrated network, as the emergence of real-time logistics markets challenges some deep-rooted assumptions about contracts, pricing, and rates. Both the first and second case simulation included a machine learning supported forecasting capability that helped to stabilise network planning, making use of a form of 'neural network' (defined, in lay terms, as 'a

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

series of algorithms that endeavours to recognise underlying relationships in a set of data through a process that mimics the way the human brain operates'[1]).

What were the results and what was learnt?

Whilst the two scenarios and business cases modelled were not directly comparable, the differences in strategic outcomes can be compared and lessons learnt. The first key outcome was a clear improved order to delivery lead time in the regionally optimised scenario; average lead time reduced from just over nine hours to just over three. However, there was a trade-off for lead time, which was a relatively lower fill rate of 74% in the regional scenario compared for 82% for the centralised case; it is worth qualifying this result though, as a 74% transport fill rate is significantly better than the widely quoted European industry average of 57%[2]. As could be expected given the localised focus of the second business case, the regional and decentralised solution generated a cut in distance travelled per case of just over 7%, which delivered a corresponding reduction in CO_2 emissions. Therefore, whilst the costs of handling, storage and transport were all relatively lower in the regionalised solution, the greatest benefit was derived from cost of transport; overall, total logistics costs were 21% lower in the decentralised scenario, demonstrating the benefits that are there to be gained from use of real-time granular data provided by Physical Internet enabled supply chains.

Future research projects and commercial deployment of Physical Internet solutions should focus on both the technical deployment and investment in new technology, both of which require further testing. Furthermore, several challenges emerged in the modelling, some technical and others cultural; standardisation of data will not in itself be fixed by the Physical Internet, as it requires the same protocols for the collection and transfer of data that hinder all collaborative logistics activity. Therefore, the study highlighted the importance of standardised protocols for enabling data consolidation in a collaborative network; some use of machine learning was by the ICONET platform services to help identify, translate, and standardise data, but the study underlined that the need for standardisation remains to ensure the robust information required to deliver the reliability needed to build trust in a collaborative network. Which itself leads to the more challenging barrier to collaboration, which as always, is the trust and openness required. The competitive nature of logistics contracting is such that opening a network and sharing data is a significant step; contractual and legal safeguards will help build trust, but a reliable and robust service will be the proof that changes mindsets; the breakthrough will therefore come through pushing past the 'which came first, chicken or egg' problem of needing robust data to prove that sharing robust data will deliver such a dramatic change in operational performance and costs.

---

1 https://www.investopedia.com/terms/n/neuralnetwork.asp#:~:text=A%20neural%20network%20is%20a,organic%20or%20artificial%20in%20nature.

2 World Economic Forum (2009). Supply Chain Decarbonization. The role of logistics and transport in reducing supply chain carbon emission.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

What should happen next?

Shared and networked warehousing represents a fundamental shift away from dedicated, closed, and sub-optimised logistics. This shift to a shared service requires more precise and standardised data, firstly in terms of relatively static information, such as warehouse capacity, but also increasingly in terms of dynamic information, such as availability of real time warehouse storage capacity. It means that every asset owner must start to think of their assets as part of a greater system, one in which their own asset is only optimised when it is as open as possible for scrutiny, not only in terms of capacity, but also in terms of operational performance; over time, warehouses (and transport providers) within the network will be judged on their service levels and costs, and inevitably, competition should drive up performance and cut prices, assuming no artificial constraints or barriers to entering the market. Such transparent competition should be welcome to service users but may be less so to the less efficient incumbent service providers. Such a challenge does however suggest that even those warehousing and transport service providers that today are delivering less competitive service levels would benefit from exposure to greater transparency as a driver to tackle underlying waste and inefficiencies within their business that in any case, if left unaddressed, will inevitably disadvantage them over time.

Secondly, the transformation of warehousing from a relatively closed and dedicated contracted service to a shared, open, and dynamic market will also allow for demand management to optimise utilisation through price rationing; in other words, instead of fixed rates for storage and transport, a dynamic system would better manage supply of services and available capacity through dynamic pricing. Today, some grocery suppliers pay their retailers an increased notional rent for end of aisle space in a supermarket space. In future, retailers and suppliers in a dynamic and shared warehousing network would pay changeable rates that reflect both forecast and real-time actual demand, so select from warehouse service prices that fluctuate according to lead time for booking that space and the overall demand on capacity. This would mean that both utilisation and the overall service yield on warehousing assets is optimised, just as dynamic pricing has been used with great success for many years to maximise the return on assets in other sectors including car rental, passenger air travel, and hotel accommodation.

Like many shared economy business models, both WaaS and the wider ICONET concept make better use of existing logistics assets and investments; the net result is that service users will be able to trade off price, lead time, and other service levels when considering booking warehousing space, learn by testing providers, and potentially even through transparent review of users and performance data. Consider how AirBnB shows how pricing and performance both become more transparent in a shared and open marketplace. Equally, like asset owners that sell their space through AirBnB, warehousing service providers will have to continually review the overall cost to serve customers, alongside pricing, to ensure an optimised return on investment. Just as today's warehouse managers monitor warehouse utilisation, including rack fill and use of staff, managers operating in an open network will potentially be able to benchmark their performance with others within a competitive network, with all the drawbacks and the benefits that brings,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

including pressure on underperforming assets and the opportunities to continuously learn and improve.

The study also highlighted gains not reported in the high -level modelling outputs; for example, operational improvements highlighted included reductions in stock outs for retailers using the service. Other gains that are more difficult to quantify were also identified, including an increase of revenues per warehousing operator as a consequence of additional and incremental use of the service. Perhaps the most interesting benefit suggested for service providers is the use of the performance data itself within a wider network as a means of improving access to investment capital, whether from banks or the wider investment community. Which also points to the opportunity for secondary markets that will arise from a networked WaaS, including pay per use booking services (including platform and software components), and subscription-based service provision for data collection and reporting. The logistics market itself will be transformed, which will in turn mean a change in mindset by users and providers alike, a paradigm shift that may prove to be both the biggest opportunity and barrier the industry has encountered as a result of digitisation of the sector.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

ICONET Partners

For more information, please visit our website, www.iconetproject.eu
More detail is also available in the project's Transferability Framework that is available for download here: https://www.iconetproject.eu/transferability-framework-capacity-building-programme/

If you wish to ask further questions of the teams involved in this project, please contact Stephen Rinsler (steverinsler@elupeg.com). The views expressed in this document are not necessarily those of the EU Commission; the Consortium and the EU Commission/INEA are not responsible for any use that may be made of the information contained within this report.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.