Image: SONAE

# Living Lab 3: Reducing costs and stock outs in fulfilment of online retail and home delivery

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.

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;
- 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;



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

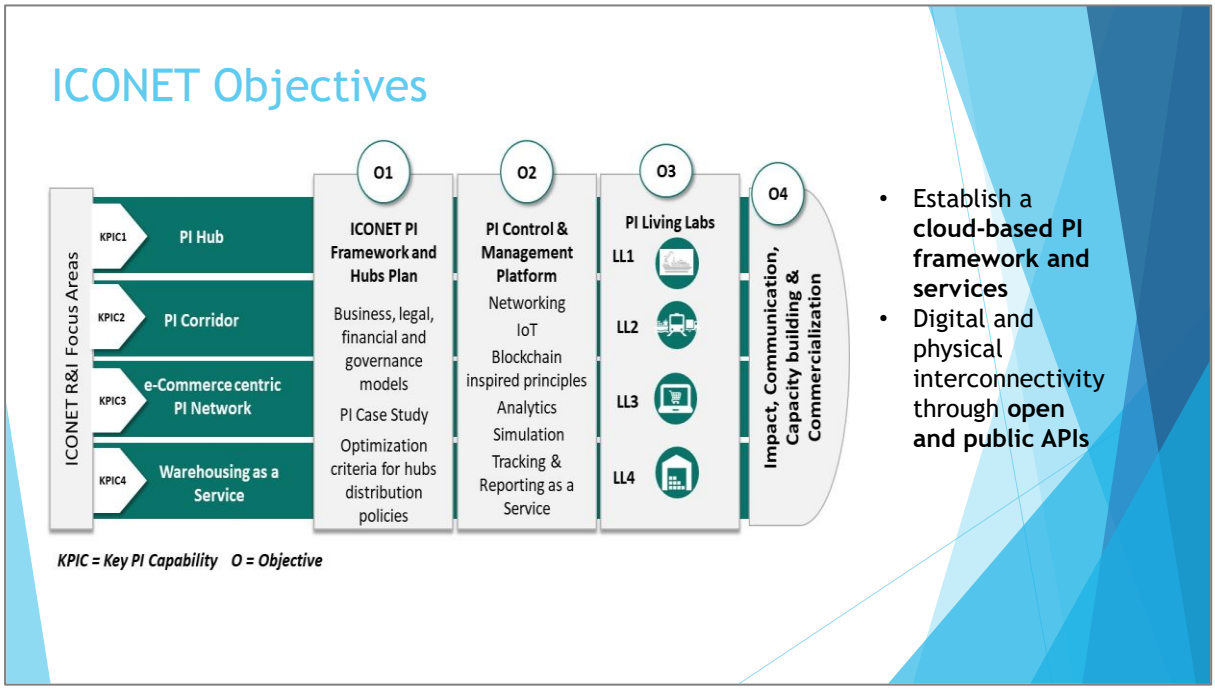
- The design and testing of an open reference system architecture and platform for enabling the digital connectivity required to track, trace, and replicate the real world in order to deliver optimised solutions in real time. The platforms were effectively proof-of-concept integration IT architectures and infrastructures, through which IT optimisation tools and services were simulated and tested.

## Living labs

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.



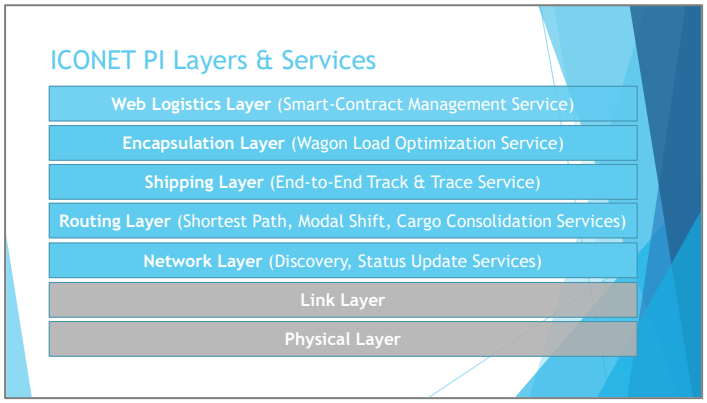



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 690588.

## 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 explaining 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.

## Living lab 3: making home delivery more effective and efficient

Growth of online and omnichannel retail has changed the sector; in 2010, only 53% of 'internet users' across the EU had bought or ordered goods or services for private use in the previous 12 months[1]. By early 2020 this had risen to 72%, and the Covid pandemic has accelerated the trend so that this is estimated to have risen to around 90% for 2020[2] as a whole, and whilst there are signs that the online shopping market may shrink a little in 2021, the forecast decline is marginal (4%) and so these channels and higher levels of demand are here to stay. This growth has resulted in a corresponding growth in home delivery and the resulting pressures have been prompting a rethink of last mile logistics.

Like many 'bricks and mortar' retailers, Portuguese grocery retailer SONAE has established a home delivery offer and this has been fulfilled through local ecommerce delivery hubs. SONAE today use regional warehouses, consolidation hubs, and 'dark-stores'

[1] Eurostat: https://ec.europa.eu/eurostat/statistics-explained/pdfscache/46776.pdf
[2] Statista: https://www.statista.com/statistics/795571/year-on-year-increase-in-b2c-e-commerce-sales-in-europe/



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

(micro-fulfilment and preparation stores). Click and collect ('click and collect' being defined as where customers order online but collect in person) is also offered in more than 170 stores and a drive-through collection available in key locations. Sonae offers same-day delivery to customers across all of Portugal, which helps deliver a share of over 70% of the online retail market.

Despite the outstanding success of their online retail business, SONAE still face many challenges including stock outs, (non-availability resulting from inability to supply a customer order from stock), high costs of picking and packing, local urban transport impacts and constraints, and difficulties with meeting target lead times. And of course, whilst Covid has seen dramatic increases in demand for their online services, with their demand in 2020 up by almost 200%, with spikes and peaks, particularly during the lockdowns. Sonae was able to respond to this pressure by reinforcing partnerships with local logistics service providers, including some that were previously moving people rather than goods. 2020 also saw high growth in the value of orders placed, and in the segments of customers buying online such as older customers. Of course, this rapid growth also exacerbated the need to address wastes and delays, which meant urgently optimising all the network and related services.

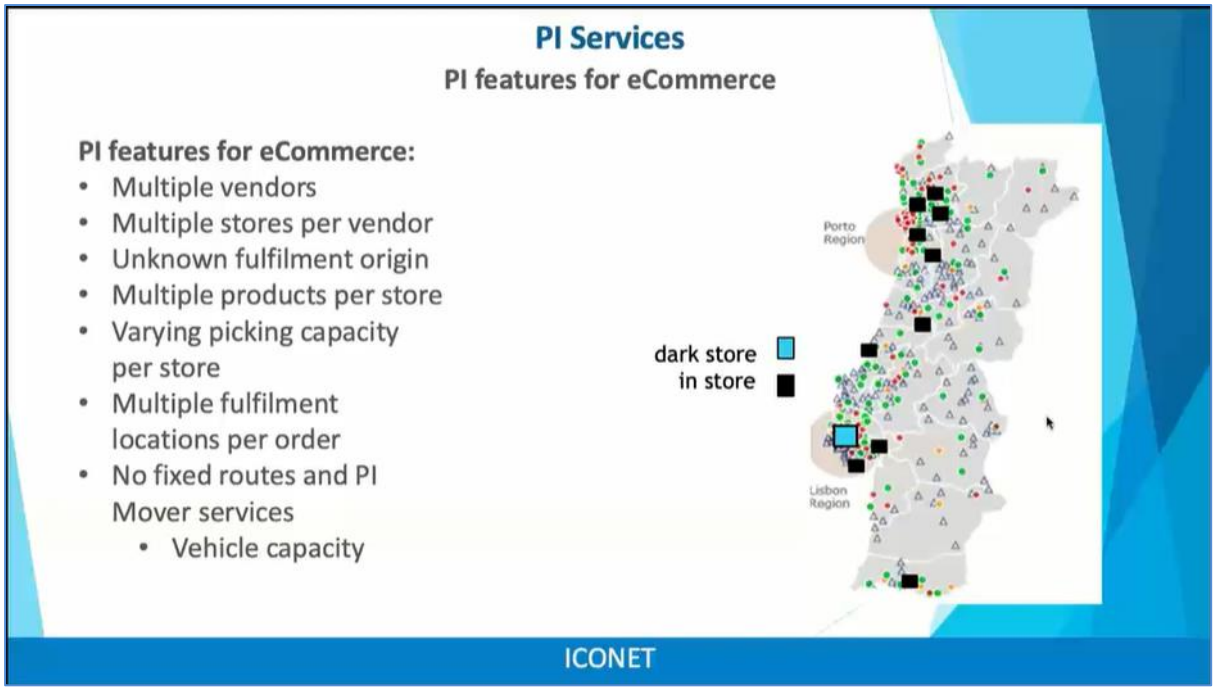
## What did the Living Lab do?

SONAE and VLTN worked together to design a more efficient network that utilised the greater flexibility made possible by the Physical Internet. The solution was designed to demonstrate the benefits of Physical Internet enabled networked solutions in home delivery and last mile logistics. The specific aims were to address fulfilment processes and operational costs, and so enable a growth and expansion in the retail offering, reducing costs but critically also increasing revenues through reduction in lost sales.

The simulated solution looked at the picking and packing network across the Porto region, including the northern Warehouse, the micro-fulfilment centre, preparation stores, click and collect pick-up-points, current physical stores, and the network of suppliers. Applying a networked solution meant comparing local store picking for all orders with a more mixed model utilising picking across a wider network, optimised by the Physical Internet enabled sortation and routing capabilities. The system solution had to consider optimal van delivery routes, order preparation location, (picking and packing), and the packaging of orders (or 'encapsulation', jargon for the fit of SKU, or individually ordered products, to boxes used as packaging for transport and delivery).



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




The Physical Internet enabled distributed network solution involved order preparation and collection from a wide range of types of location; the first step was mixing together the use of the retail stores today nominated as preparation stores for online sales, the micro-fulfilment and the northern warehouse, as this living lab is located in Porto Region. The networked solution added stores used today for local e-commerce fulfilment (click and collect, an omnichannel solution where the customer orders online, the local store picks and prepares the order, and the customer drives to the store for a scheduled slot at the collection point). The transport solution utilised vans for last mile local delivery, suitable for urban residential areas and the Porto Region, allowing for serving multiple customers and drops during a single journey. Delivery vehicles were freed up to start and end journeys at any points within the network, and to fit with the new order preparation model, collection made possible from the wider range of preparation points nominated.

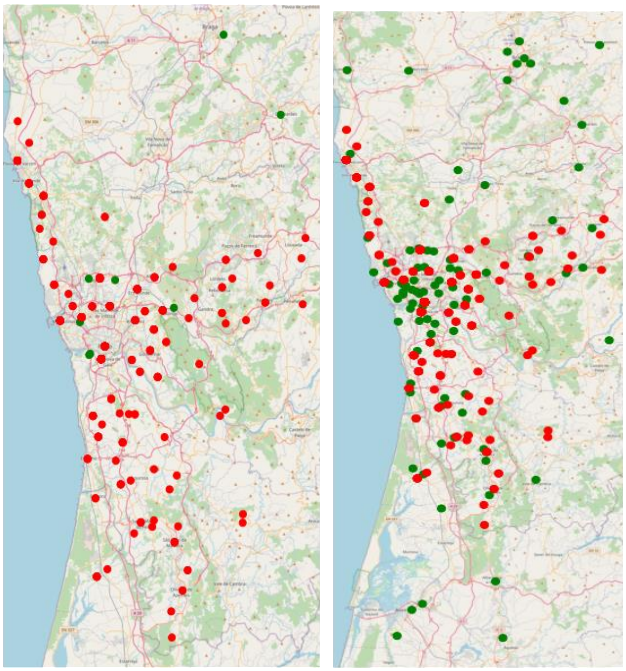
The Physical Internet solution added to the optimisation through dynamic and real response; the consolidated order fulfilment platform allowed for greater network discovery – more possible ways of fulfilling orders – and the real time data from the Physical Internet allowed real-time responses to disruptions, including both traffic congestion and delays and queuing within the order preparation network. By knowing the real time status of every known bottleneck in the system, including each preparation centre and delivery vehicle, and the status and target delivery time of every order in transit, the Physical Internet solution reduces uncertainty and unreliability and in doing so enables a far more efficient utilisation of assets within the processes, such as drivers, pickers, vehicles, and order preparation centres.

In addition to the PI modelling, which looks ten years ahead, the team also applied some of the thinking to solve more immediate challenges raised by the pandemic, identifying additional stores for order preparation and pick-up-points by working out which locations and facilities should be used, and through applying a dynamic allocation solution that sent the order to the most appropriate facility, depending on available capacity and



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

demand. So, excluding any consideration of physical internet capability, a modelling approach was taken to identify how home delivery preparation and fulfilment capacity in the Porto region could be expanded to respond to the current pressure of the market. Five large stores were ranked as potential and optimised preparation stores and five as pick-up-points from a range of 79 possible candidate stores. This new service would build upon the existing seven preparation stores (including the micro-fulfilment locations) and regional warehouse already supplying online orders serving the region. This study expanded the existing networking service by adding new nodes in the network, (preparation stores and pick-up-points) through adding capability at stores that hadn't previously prepared orders and allowing click and collect from more stores within the area. The map below left shows the location of the online retail customers (in red) that were considered during the simulation, and existing network of preparation stores for these orders (in green), whilst the map on the right shows the potential network of preparation stores (in green). The order pickup and routing solution for this redesign was applied, using similar basic principles used for the more future orientated modelling already discussed.



## What were the results and what was learnt?

The Physical Internet living lab solution changed the focus on centralised distribution to a more decentralised and dynamic stocking, picking and fulfilment network. The improvements in performance that the simulated PI-enabled fulfilment network delivered are, to put it simply, game-changing; for example, stockouts, so inability to supply product due to non-availability, was running at 25% (based on the specific dataset used for the modelling), a level that would be considered high for a grocery retailer, but within the simulated PI network these stockouts were in effect virtually eliminated (barring the



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

impacts of unforeseeable external disruption). Cutting stock outs is well known within the grocery sector to greatly increase customer satisfaction and loyalty, reducing the likelihood that customers migrate to competitors. Furthermore, this 25% increase in order fulfilment represents a significant increase in revenue and therefore margin on product flowing through the system and assets within the SONAE retail network.

The shift from local to networked fulfilment also increased the fill rate of vehicles by 29%, and the average distance per order lower, so from a total system perspective the environmental impact is reduced, even though the total distance travelled was increased through the deployment of an ongoing milk-run type collection and delivery routing solution. The transport cost per order was reduced by 24%, again demonstrating the overall benefits of greater consolidation of movement, including environmental benefits to both retailer and customer. The combination of a wider network and optimised routing allowed for better avoidance of congestion, and of course fewer delivery vehicles on the road means that in the networked scenario, the retailer contributed less to urban traffic congestion themselves.

Perhaps the most striking finding was the improved core function – that is, order fulfilment, - achieved through use of more robust information. The elimination of much uncertainty within the network ultimately means less planning based on forecasting assumptions, and more based on real demand; the result of that is a retail system and last mile delivery solution more agile and able to dynamically respond and deploy capability in response to arising real-time consumer behaviour and network constraints.

The Living Lab future modelling was constrained by the operational impacts of Covid on people and resource, given the understandable focus on responding to the crisis and huge jump in demand; however, more usefully, the additional modelling also demonstrated the immediate solutions available to SONAE in responding to the need to feed the population through the Covid crisis, and the modelling helped the company do just that, and build the network that was required to sustain the increased demand for online shopping and home delivery.

More broadly, both the future orientated and immediate solutions modelled demonstrated the possibilities for migrating to a more robust order fulfilment solution that can support the future growth and maturation of both online sales and the attention given to the impacts of urban logistics. The lab also demonstrated that the use of more real time and granular information further highlights the need for real-time accuracy, availability, and reliability of that information.

## What should happen next?

Living lab three demonstrated how the Physical Internet can transform last mile logistics and home delivery through the creation of a more decentralised and distributed networked solution. The enhanced collection and delivery network modelling has already supported the first steps towards expanding the SONAE home delivery capability, a rapid, valuable, and much appreciated effort on the part of the transport and logistics teams within the company.



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

Looking further ahead, it is clear that much waste can be removed from final delivery networks through the reduction of uncertainty and subsequent better use of deployed people and assets, and the cost and environmental implications confirm findings from many other research projects including SELIS[3]. The opportunity for retailers and service providers is dramatic and compelling, not so much through cost reduction, - albeit that will always be important, as will the environmental benefits of lower transport costs and distance travelled per customer order, -but rather through near elimination of lost sales resulting from stock outs. The implications of such a jump in revenue flowing through the deployed network of capital means is a huge jump in RoCE, and an improvement in the bottom line that no C-level decision maker can ignore.

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, and addressing in more detail the possibly more challenging commercial barriers to collaboration between a network of commercial entities, including addressing legal barriers to data sharing and open resource planning. However, the business case is clear and compelling, and those companies involved in home delivery and last mile logistics should be able to generate a return relatively quickly should they embrace and push forward with a Physical Internet platform solution similar to that described; the customer benefits and gains for local governments and communities resulting from the reduction in delivery vehicle traffic within urban areas also mean that the end result is a win-win-win scenario for all stakeholders.

[3] http://www.selisproject.eu/



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.