

The role of ports and their hinterland networks in the logistics of the future

Final report for the program 'Vital Logistics'
of NWO and TKI Dialog



Preface

Logistics of the future

In this report, we look back on the 'Towards Virtual Ports in a Physical Internet' project that was carried out in the period 2016 to 2021 and was subsidized by NWO and TKI Dialog. It was a collaboration of four parties: University of Groningen, Delft University of Technology, Port of Rotterdam Authority and Groningen Seaports. The project aimed to develop models and tools that can support ports and companies in the hinterland in a step-by-step transition to the physical internet, with fully open connected logistics networks.

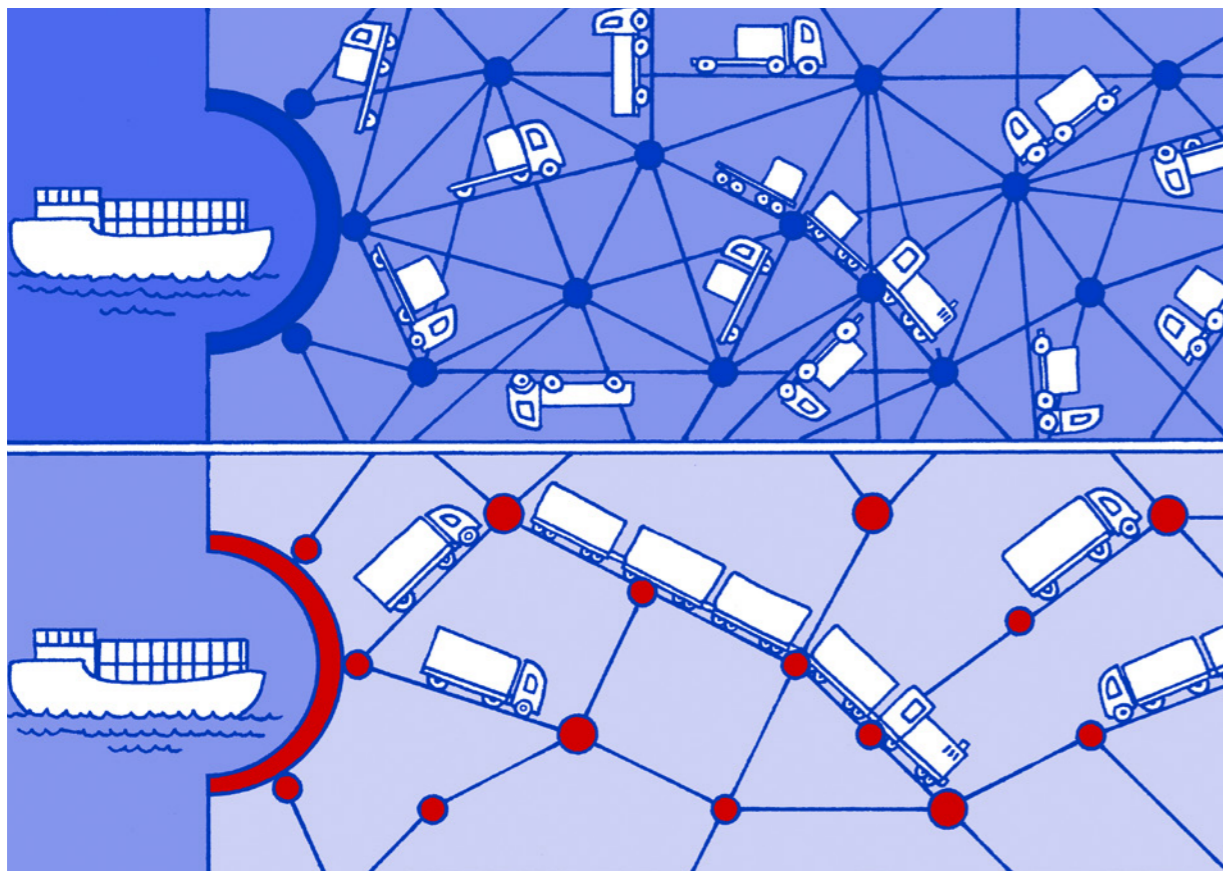
The project consisted of three work packages. The first work package investigated the role of ports within an open network. In the second work package, tools have been developed to support decision-making regarding the use of services in a physical internet hinterland network. And in the third work package, stakeholders took a look into the future by means of expert panels and challenges, among other things. In the project we learned about possible new areas of application of the physical internet and applications that can contribute to societal transitions, for example, in the field of sustainable energy and healthcare.

Physical internet is a relatively new concept within logistics that is continuously developing and about which many questions remain. Thanks to the collaboration between science and business, we have taken steps to break through the abstraction of the physical internet. We have also worked to transfer our passion for logistics, with the great innovations that exist in this sector, to a new generation. In this report we offer a glimpse into the various projects. Researchers, graduates and representatives from the field talk about their contributions and share with you the insights that have been obtained.

Iris Vis
Professor of Industrial Engineering, University of Groningen
Scientific project leader 'Towards Virtual Ports in a Physical Internet'



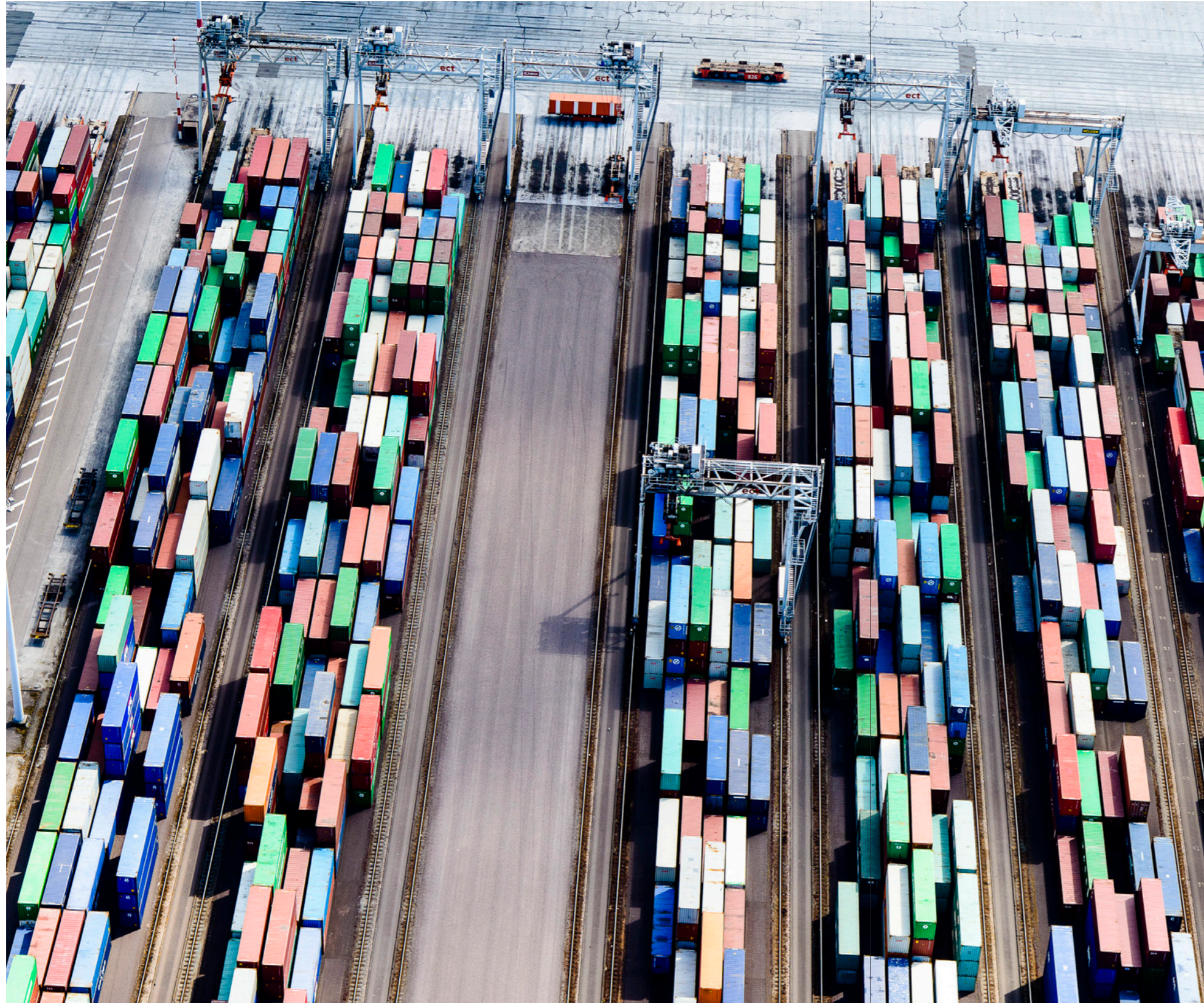
Iris Vis, Professor of Industrial Engineering, University of Groningen
(Photography: Reyer Boxem)



Infographic project (NWO)

Contents

Part 1: Introduction	8
Part 2: Work packages	
A. Concepts for the new role of ports	12
B. Models for the hinterland network	18
C. Stakeholder Engagement	22
Part 3: Valorisation	26
Part 4: Lessons learned and societal transitions	32
Part 5: Results	38
Partners	43
Colofon	44



Yard with containers in the port of Rotterdam (photography: Port of Rotterdam Authority)

About the project

The project "Towards Virtual Ports in a Physical Internet" is part of the research program "Vital Logistics" of NWO and TKI Dinalog (project number: 438-15-525). The initiative and leadership of the project lay with the University of Groningen (UG). Delft University of Technology was a scientific partner and the Port of Rotterdam Authority and Groningen Seaports participated as partners from practice.

The project consisted of three work packages

Workpackage	Workpackage Leader
Concepts for the new role of ports	prof. dr. ir. Lori Tavasszy (Delft University of Technology)
Models for the hinterland network	prof. dr. Kees Jan Roodbergen (University of Groningen)
Stakeholder engagement and societal impact	prof. dr. Iris Vis (University of Groningen)

Other participants in the project: dr. ir. Paul Buijs (researcher, UG), dr. Leandro Coelho (researcher, Université Laval, Quebec City, Canada and UG), dr. Gerlach van der Heide (researcher, UG), dr. Nick Szirbik (master thesis supervisor and manager PI Lab, UG), drs. Jon Hummel (project leader, UG), ir. Patrick Fahim (PhD candidate, Delft University of Technology), dr. Michiel Nijdam (member project group, Port of Rotterdam Authority) and ir. Henk Zwetsloot (member project group, Groningen Seaports). In addition, various graduate students contributed to the project.

Introduction

Physical internet: the logistics of the future

The physical internet is a vision of logistics in which the concepts of the sharing economy are central. Goods, containers, means of transport, warehouses and intermodal terminals are connected via an open network and can “themselves” determine their routes and make use of all available storage and transport capacity. An important part of the concept is formed by standardised, modular containers that can be clicked together and controlled autonomously with the help of intelligent software. Another important building block is interconnectivity. Standardised IT systems, protocols and certifications are an important precondition for automatic coordination and communication between the participants.

The founding fathers of the physical internet are Prof. Benoit Montreuil, Prof. Eric Ballot and Prof. Russell Meller, who introduced the concept in 2010. They saw the perfect metaphor for the logistics of the future in the way an e-mail message finds its way through the internet. In the digital internet, “information packages” find their destination quickly, securely and reliably, using an open network of servers, cables and satellite hubs. How this process works exactly is typically irrelevant for the sender and the recipient of an e-mail. The three researchers wondered why this is also not possible in the logistics sector.

Why research into the physical internet?

Transport and logistics cause 20% of all CO₂ emissions in the world¹. Recent research by the EU shows that the application of physical internet concepts can reduce the energy consumption of supply chain networks by up to 30%². A logistics concept that focuses on the optimal use of resources and the prevention of empty kilometres is a tempting perspective for a world that is struggling with the transition to clean energy and the reduction of harmful CO₂ emissions.

The physical internet is promising, but many questions still need to be answered before it can be put into practice. In the Netherlands, the Top Sector Logistics has already conducted a great deal of research into synchronicity, the concept in which a logistics service provider uses different transport modalities in a flexible way to carry out a transport assignment as efficient, effective and sustainably as possible. The physical internet goes a step further and focuses on the content of individual containers and real-time decision-making about routing, modality and transshipment points. Much research is still needed to determine how that will look like in practice.

¹ International Energy Agency, Transport Sector CO₂ emissions by node in the Sustainable Development Scenario, 2000-2030

² Source: ALICE, Roadmap Towards Zero Emissions Logistics 2050



Physical internet and the role of ports

Seaports and inland ports have traditionally been important hubs within international supply chains and will remain indispensable links in a physical internet era. However, it is expected that their role will change considerably. Transshipment is becoming more intricate with sea containers that have to be split up and re-bundled. Where possible, the physical handling of goods will be further automated and coordination with supply chain partners will be fully data-driven. The big question is: what will that look like in concrete terms? And what does that mean for the stakeholders?

“Researchers such as Montreuil, Ballot and Meller have built up a great deal of knowledge about the operation of open and sustainable logistics networks. However, little was known about the role of ports and their hinterland within such a network” says Iris Vis about the motivation for the project. “Our goal was to develop new insights for seaports, such as those in Rotterdam, and locally oriented ports such as Groningen Seaports and all parties in their hinterland network, to enable them to form a vision for the future and prepare for this with targeted measures.

Travel planner for freight

Project leader Iris Vis likes to also use a different metaphor for physical internet, namely that of people planning a trip by taking the bus, train or taxi. “As a passenger, you choose the best route to get from A to B and if there is a disruption, you look on an app to choose a different route. If you want to spend the night somewhere, you have another app to browse for that and choose a location for it. If containers or products are connected to each other via the Internet of Things and also have the right level of intelligence and the data, they can make their decisions at a local level, just like a traveller in public transport.”

“If we keep looking at the digital internet in our research into logistics networks, it can lead to design errors.”

The analogy with the digital internet

The term physical internet originated from a comparison with the digital internet. But to what extent does that analogy actually hold? Sharon van Luik answered that question. For her master's thesis "On the value of the digital internet / physical internet analogy", at the end of her master's study Complex System Engineering & Management at Delft University of Technology, she interviewed ten leading scientists from all over the world. "At a certain point the comparison ends," says Van Luik. "Actually everyone knows that, but the question is what will be the result if we continue with that comparison."

One point at which, according to her, the comparison is flawed is that a physical package other than a data package cannot be copied. If something goes wrong with an email while on the Internet, the message can simply be copied from the source and the journey begins again. "But that is of course not possible with a physical package. This means that the routing protocols from the internet cannot simply be applied in logistics networks. Another example concerns the comparison between the routers on the Internet and the distribution centers in logistics networks. Those routers are obliged to let all internet traffic through, otherwise they will not participate. That is as yet unthinkable in logistics, where every distribution center is in the hands of a logistics service provider with his/her own interests."

The use of analogies certainly has value, for example, to explain the idea behind the physical internet and to convince people of its usefulness, but that is the end of it, Van Luik concludes. "Then it is important to let go of the analogy. If we keep looking at the digital internet in our research into logistics networks, it can lead to design errors."



Sharon van Luik performed her master thesis study into the analogy with the digital internet

International cooperation

The first ideas for the project described in this report arose during a working visit in 2013 by Kees Jan Roodbergen and Iris Vis to Benoit Montreuil, then professor at Université Laval in Quebec (Canada). A little later, in 2014, Paul Buijs, a researcher at the University of Groningen, also went to work in Quebec for a while. The close ties that developed between Laval and the University of Groningen in those years came in handy during this project, says Paul Buijs. "We have profited intensively from each other's knowledge and exchanged students and researchers back and forth. Researcher Leandro Coelho came from Laval to Groningen and students from the University of Groningen followed the opposite route."

After the appointment of Benoit Montreuil in 2015 at the Georgia Tech Supply Chain & Logistics Institute in Atlanta (US), a close collaboration was also established with this institute. Among other things, this led to a joint port seminar in Savannah (see part 3) and a working visit by Jon Hummel, then project manager at the RUG, to the PI lab set up by Montreuil.

Delft University of Technology also interacted with Georgia Tech, for example, in the form of a project in which Patrick Fahim was a visiting scholar for a while in Atlanta as part of his doctoral research at Delft University of Technology. He also visited a former colleague of Prof. Montreuil, Dr. Marc Poulin at the Abu Dhabi School of Management.

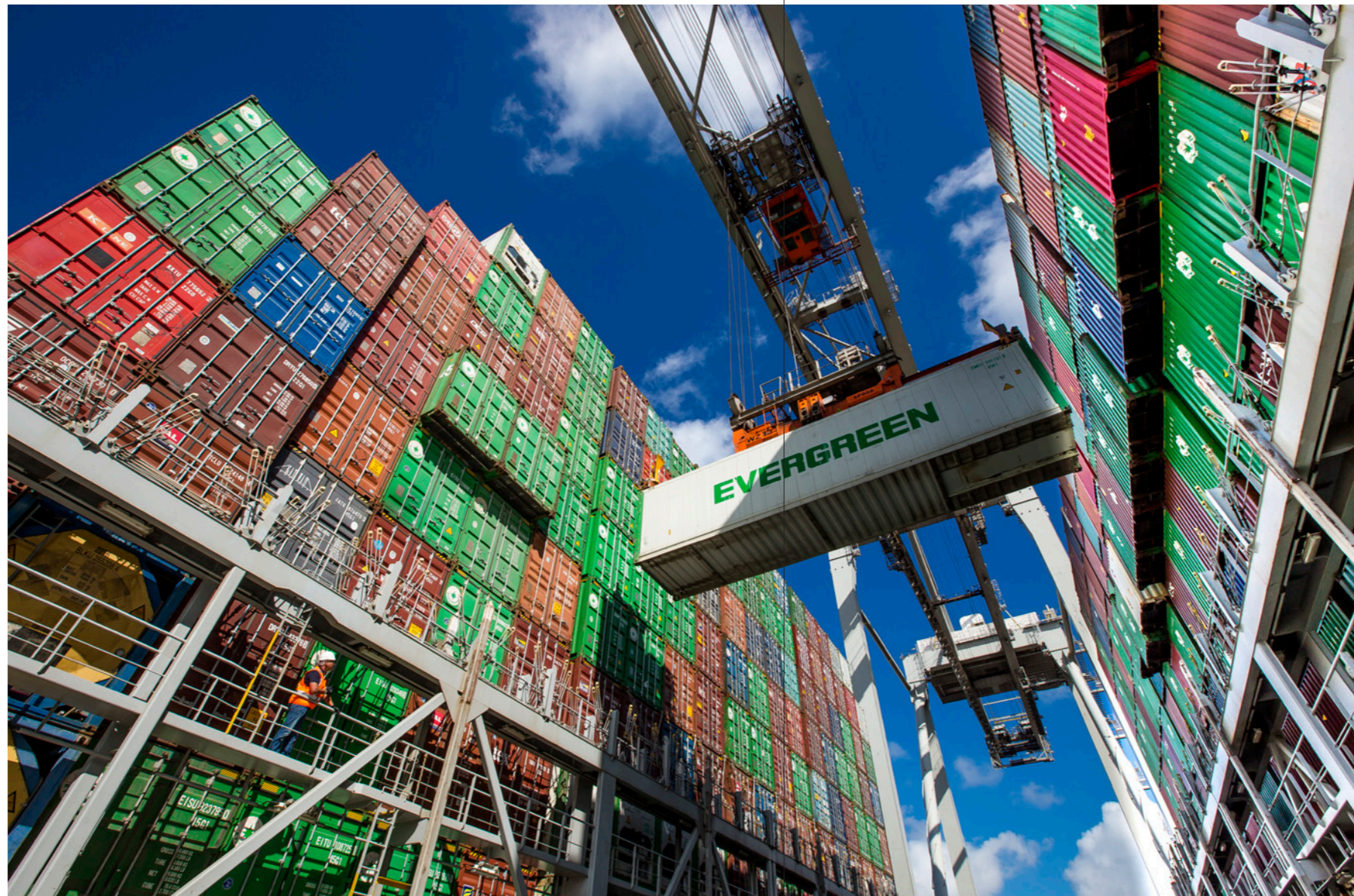
International cooperation was further shaped by a contribution to the development of the European innovation roadmap for the Physical Internet, in the context of the EU project SENSE, together with the European Technology Platform for logistics, ALICE. The project provided input for this roadmap and made grateful use of the community of experts for data collection, among other things. The interim results have been presented at the annual editions of the International Physical Internet Conference, as well as at other international conferences such as the Transportation Research Board and the World Conference for Transport Research.



Researcher Paul Buijs (left) is awarded the 'Physical Internet Generation Award' during IPIC2018 by Benoit Montreuil (Photography: Steffi van Wasen)

Concepts for the new role of ports

2a



Transshipment of containers
in the port of Rotterdam
(photography: Port of
Rotterdam Authority)

A characteristic of the physical internet is that in ports not only the trans-shipment of sea containers takes place, but that they may also be broken down and re-bundled here. Directing these intricate flows and real-time coordination with the hinterland will then become a core task.

But how does that look like and how can a port prepare for this? Under the leadership of Professor Lori Tavasszy and PhD researcher Patrick Fahim, research has been carried out on this at the Delft University of Technology, with the Port of Rotterdam serving as a study object.



Michiel Nijdam, head of strategy at the Port of Rotterdam Authority

“We may be the largest port in Europe, but for our 'customers', the shippers, we are only one link in their supply chain.”



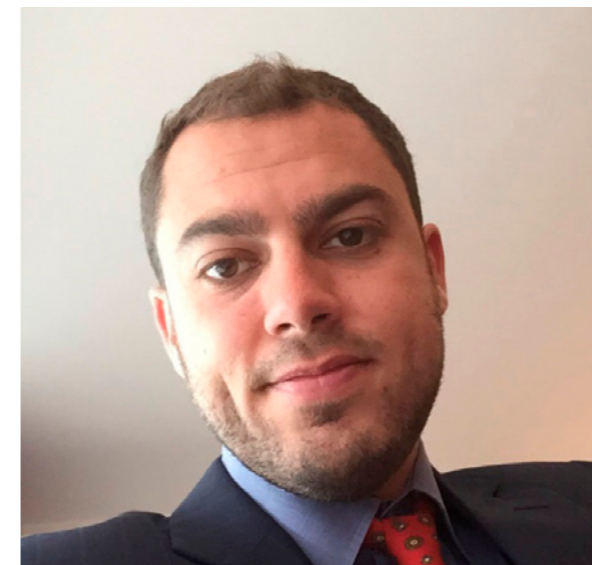
Pieter de Waard, corporate strategist at the Port of Rotterdam Authority

“The physical internet helps us to determine a vision of the future and to take already now the right measures for it.”

“Not the IT systems themselves, but the institutional resistance against them, will form the biggest bottleneck.”

**Port of Rotterdam:
a source of
inspiration**

Patrick Fahim of the Delft University of Technology played a pivotal role in the research into and at the Port of Rotterdam Authority during the project. “In addition to all kinds of quantitative research based on data and models, we have investigated to what extent companies and government agencies are aware of the changes that physical internet will bring to a port like Rotterdam. One of the conclusions was that companies are still very reserved when it comes to transparency and wanting to rely on new planning systems. Not the IT systems themselves, but the institutional resistance against them, will form the biggest bottleneck.”



Patrick Fahim, PhD candidate at the Delft University of Technology, who coordinated the research projects with the port of Rotterdam Authority

At the Port of Rotterdam Authority, they already see that the role of the port is changing, say Michiel Nijdam and Pieter de Waard. Both work in the corporate strategy department and advise the general management of the port authority on the policy to be pursued. “We may be the largest port in Europe, but for our 'customers', the shippers, we are only one link in their supply chain. In order to be able to fulfill this role as effectively as possible in the future as well, we will have to properly coordinate our processes and IT systems. The research has given us useful insights for this, and just as importantly: it has resulted in good contacts within the international physical internet community. This will continue to be a valuable source of knowledge for us in the future.”

Ports in transition: what are the scenarios?

One of the sub-projects that was coordinated from the Delft University of Technology was the graduation project of Manuel Martinez de Ubago to conclude his study Transport, Infrastructure and Logistics. The research was carried out together with fellow graduate Jeff Voster, under the supervision of PhD candidate Patrick Fahim. They derived scenarios describing the changing role of ports. "I started with a framework in which I describe the different states of a port within the physical internet. This ranges from completely unconnected, as many ports still are, to hyperconnected. In the latter case, a port is fully vertically integrated within the supply chains of companies, but also horizontally linked with, for example, other ports in the region or the customs authorities.

During my research I discovered that you can split connectivity into three dimensions: governance, operational and digital. The first is about regulations, the second about physical processes and the third about IT systems."

How these dimensions will develop in the coming years - and thus what the scenarios will be - depends on many diverse, global factors. Martinez de Ubago, for example, mentions the rise of trade wars and protectionism, the melting of the polar caps and the continuation of technological developments such as 3D Printing. "Together with colleagues at Delft University of Technology and a group of international experts, I set up a Delphi study in which I clustered and weighed all these factors. In the most pessimistic scenario, the lack of global agreements means that ports can only be integrated at the shipping line level. The most optimistic scenario assumes that ports will already be fully PI-compatible by 2030 and will also be fully integrated with other ports ten years later."



Students of the Delft University of Technology present their project outcomes during the International Physical Internet Conference (IPIC) in 2018 with at the right Manuel Martinez de Ubago (Photography: Steffi van Wasen)

	Current state	Level 1	Level 2	Level 3	Level 4
Port connectivity	Unconnected terminals within ports. Unbalanced alliances in maritime shipping lines	Unconnected terminals within ports. Full integration of vertical supply chains by alliances	Intra-terminals connected horizontally: 'Physical Intranet' within port	Inter-terminals connected horizontally: Open ports	Global hub hyperconnectivity
Governance dimension	Current Incoterms. Unbalanced regulations for asset sharing platforms	Next incoterms (Rotterdam rules). Regulations for asset sharing platforms	Harmonized rules and standards for intra-port connectivity	Harmonized competition rules and standards in horizontally integrated ports	Governance processes and bodies for an open global PI network
Operational dimension	(Semi) automation of yard handling operations at terminals	Mode Hinterland synchronomodality	Automated crossdocking and reshuffling operations	Automated node service and response across networks	Fully autonomous PI network operations
Digital dimension	Tracking systems. Port Community Systems (PCS) at niche level	Full PCS with dedicated connection to hinterlands	Digital platform allowing for communication and Decision Making at port	Standardized digital platforms distributed in ports at regional level	Inter-network standardized digital platforms distributed at global level

The evolution of ports within the physical internet (Source: 'The future of ports in the physical internet, Manuel Martinez de Ubago, 2019)

Physical Internet in a European perspective

Physical internet is seen as an important enabler for achieving the sustainability goals and is, therefore, high on the innovation agenda of the European Union. The European advisory body ALICE (Alliance for Logistics Innovation through Collaboration in Europe) was established to advise countries within the European Union on the future of logistics and supply chain management. In the aforementioned report in which ALICE unfolds the roadmap for the next twenty years, it can be read that the implementation of physical internet can lead to a 30% reduction in traffic jams, emissions and energy consumption as early as 2030. So expectations are high.

Lori Tavasszy, Professor of Freight & Logistics at Delft University of Technology, is a scientific advisor within the ALICE platform and observes a high willingness within the EU to invest in research into the physical internet. "The research into the role of ports is completely in line with the European innovation programs that we will continue to be rolling out in the coming years. It involves major steps both technologically and in terms of behaviour and governance. The potential impact of the physical internet for ports is enormous and I am proud that we have provided the first step for this with our graduates and Patrick Fahim's PhD research."



Lori Tavasszy, professor of Freight & Logistics at the Delft University of Technology

Physical internet concepts for the hinterland network

Sharing economy and hinterland networks

Within the physical internet, all actors within ports and their hinterlands are interconnected. But what dynamics will arise within such a hinterland network and how do you ensure that freight moves through it in an optimal / sustainable way? Which IT systems should be in place? These were the topics formulated as part of the work package lead by Kees Jan Roodbergen, professor of Quantitative Logistics at the University of Groningen.

An important social development linked to the physical internet is that of the sharing economy. At companies such as Swapfiets, Greenwheels or Airbnb, the focus is no longer on owning resources, but using them. This trend is also on the rise in the business community and companies can book temporarily available warehouse and transport capacity via online platforms. An interesting research question is to what extent these exponents of the sharing economy also fit within the concept of physical internet. Postdoc researcher Gerlach van der Heide, who at the time worked at the University of Groningen, has conducted extensive research into this within the project, together with Kees Jan Roodbergen, Iris Vis and Paul Buijs.

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“Small and medium-sized companies in particular can benefit from this.”

Among other things, the four researchers developed a model³ that allows to calculate the benefits as a company is able to use a shared warehouse and transport network. “Stock management and transport planning are becoming a totally new game thanks to physical internet,” says Kees Jan Roodbergen. “In an ultimate form, warehouse space and transport capacity are available to everyone and as a company you are no longer tied to your own network of fixed warehouse locations. Because you use shared transport networks, you also get the freedom of movement to move stock at different times of the day.”

Van der Heide has developed algorithms that can be applied by companies to achieve an optimal level of service towards customers by means of dynamic stock movements, with minimal impact on CO₂ emissions. He calculated that companies can achieve a cost reduction of up to twenty percent with this. “Small and medium-sized companies in particular can benefit from this,” he explains. “For larger companies that already drive with full trucks between stock points anyway, the profit from a shared transport network will of course be less.”

He estimates that sharing transport capacity according to the principles of physical internet will take longer to be implemented than sharing warehouse space. “There are many flaws in the standardisation of transport containers, while sharing warehouse space is much easier and is already happening today.”



Gerlach van der Heide

³ Van der Heide, G., Buijs, P., Roodbergen, K.J., Vis, I.F.A. (2018). Dynamic shipments of inventories in shared warehouse and transportation networks, *Transportation Research Part E: Logistics and Transportation Review* 118, 240-257.

Barriers to the adoption of IT systems

In addition to logistics hubs and standardised logistics load carriers, a third element is also required to be able to put the physical internet into practice: the IT systems that connect the hubs and load carriers. "Consider, for example, sensors and GPS trackers that are connected to each other via the Internet of Things. A container that is empty can then report that it is available for use. An inland vessel that receives the notification can collect the container. That would make the logistics network a lot more efficient," says Andrea van Luyk.

During her master's thesis, for the study "Supply Chain Management" at the University of Groningen, Van Luyk researched the barriers to the adoption of such IT systems. She has focused on the port of Rotterdam and the associated hinterland. Both the shipping companies and the deep sea terminals that organise the overseas transport of containers understand the importance of innovation and have the means to invest. The situation is different in the highly fragmented hinterland, where she discovered no fewer than twelve barriers. "In the hinterland we deal with shippers, forwarders, inland skippers, transporters and inland terminals. They all have different interests, different IT systems and not all of them have the same amount of IT knowledge. Explain to an inland skipper in a sector with minimal margins how to recoup for such an investment in IT."

The government and/or port companies have an important role to play in breaking the deadlock. "They have an interest in a freight flow, which can enhance the attractiveness of the port and of the Netherlands as a transit country. Their task is to lend a helping hand to the parties in the hinterland and to facilitate the sharing of real-time data. Fortunately, the Port of Rotterdam Authority has already recognized this and is working on it."



Andrea van Luyk performed her master thesis research into IT-barriers



Railterminal Veendam (photography: Groningen Seaports)

Stakeholder Engagement

International supply chain networks consist of a multitude of links. Links to perform the physical transport (shipping companies, road transporters, inland skippers, etc.), links to coordinate matters (forwarders, logistics service providers, transport platforms) and links to observe regulations (government, customs). The expectation is that for all these parties a lot will change within the physical internet. But what exactly and how do the parties themselves view this? These were the main questions in the work package "stakeholder engagement" led by Iris Vis.

⁴ TransMission is a partnership of independent transport and distribution companies in the Benelux. The 18 branches all work under one name and work with one joint IT system. Central is the TransMission Service formula with uniform agreements between the branches that all guarantee a high service level.

20

Stakeholders: how to add value in the physical internet?

Paul Buijs and Iris Vis have organised many meetings over the years at which the concept of physical internet was discussed with representatives from various sectors. For example, via the Smartport knowledge platform or linked to conferences of the top sector Logistics. With the help of round table discussions and online surveys, an overview was made of which visions exist on the physical internet. "We generally saw two types of reactions from the participants at these kinds of meetings," says Buijs. "On the one hand, people think that physical internet already exists, referring to Amazon, for example, and on the other, people find the idea of a fully open and connected network so extreme that they don't expect it to ever happen."

The physical internet offers society as a whole great opportunities, but it can actually be a threat to individual stakeholders, as was shown during the meetings. What are the revenue models? If logistics becomes a commodity, this will have a depressing effect on the price and the question is who can still earn money with it. Buijs: "This can have major

consequences, especially for the traditional logistics service provider with its own trucks and warehouses. Are they flexible enough with their assets to adapt to this? And what will their added value in the future be? Perhaps they should fully concentrate on their coordinating role, i.e. on the exchange of supply chain data and the use of smart software. Another option could be that they specialise in one logistics task and then become part of a network such as TransMission⁴."

The sessions also yielded many new research questions for which it is necessary and interesting to also involve researchers from other disciplines such as law and behavioural and social sciences.

Stakeholders investigated further: customs

Regular research has been conducted into the possibilities of the physical internet for international logistics chains. But studying the role of customs was a new aspect. Niek Hacquebord focused on this stakeholder during his study Technology and Operations Management at the University of Groningen. According to him, the physical internet can have major consequences for this government agency. "One of the principles is that goods find their way through the supply chain themselves. But suppose a sea container decides at the last minute that it should be unloaded in Rotterdam instead of in Antwerp. Does the Dutch customs have all the information needed to assess the risks and if needed to set up an inspection in time? "

Hacquebord has proposed a solution with two main components: "data pipelines" and "smart containers". With a data pipeline, a digital file can be built up from a shipment. Each party in the supply chain that carries out actions records them in that file. "The smart container can also continuously add data to it, such as the GPS coordinates or the humidity in the container. When given access to the file, customs will have all the information necessary for a risk assessment. Because that information comes directly from the source, the quality and reliability are high."

Customs can gradually start with data pipelines and smart containers. In the first phase, the data from the file can be used to validate declarations without having to request additional data. In the second phase, the data is used to automatically compile declarations. Because the data comes from the source, the chance of errors and fraud is small. Hacquebord: "In the third phase, there is no longer any such thing as a declaration, simply because all data from the data pipeline is used for the risk assessment. This means that new systems with new risk profiles are needed, if only because customs can then take data into account that was not available before."

"Physical internet has big consequences for customs."



Niek Hacquebord

"Physical internet gives direction to innovation strategy."



Winfred Kooij of Dutch Customs

The puzzle of Dutch customs

Winfred Kooij and Stef Pastoor are members of the coordination group Innovation of Dutch Customs. They expect a multiplication of the number of declarations. After all, when the physical internet becomes reality, many barriers to importing or exporting goods will disappear. "Due to the developments in e-commerce, we are already seeing the number of declarations exploding in our face. We used to have a container with one shipment of a thousand refrigerators. The same container will soon contain a thousand shipments with one refrigerator. That means 999 extra declarations", Pastoor says. Hacquebord's research has initiated the thinking process within Dutch Customs to the highest level. The physical internet gives direction to the innovation strategy, says Kooij. "Pilots with smart containers, blockchain technology and other new technologies are already being worked on at various locations. The physical internet is the umbrella under which all these developments converge. Compare it to a large puzzle with many small puzzle pieces of which it was unclear how they fit together. The physical internet makes the pieces of the puzzle bigger and better fitting, so that we get an increasingly complete picture of the future."

"Number of declarations will multiply."



Stef Pastoor of Dutch Customs

Societal Impact and Knowledge Dissemination

3

One of the objectives of the project was to involve other stakeholders in the research in addition to ports, such as representatives from the business community, customs and healthcare. Both in the phase of knowledge (co-) creation and in the phase of knowledge sharing, interaction took place between all relevant parties and an active form of citizen science was applied. In order to introduce the principles of physical internet to the people who will later be actively involved with it, there was a program for primary and secondary education.



Participants Port Logistics
Workshop in Savannah (US)

International kick-off during port conference in the US

The project had already officially started, but the unofficial kick-off of "Towards Virtual Ports in a physical internet" was during the international conference Port Logistics Workshop. This took place on April 2017 in Savannah, the port city in the state of Georgia on the east coast of the US. Professionals from the business community, government and academia came together here for the first time to specifically discuss the future role of ports within the physical internet and to share research agendas. The project was presented in Savannah by Victor Schoenmakers, strategy director of the Port of Rotterdam Authority.

A topic that was high on the agenda in Savannah was the recording and exchange of logistics data. The pace of digitisation is high and the life cycles of IT systems are short. Which protocols must be developed to make this data universally applicable and future-proof so that the new generation of IT systems can also work with it? The conference was organised by the University of Groningen, TKI Dialog and the Georgia Tech Supply Chain & Logistics Institute, where Benoit Montreuil works.

Physical internet comes to you

A selection of the events and meetings organised by the project team or in which the project team participated, to discuss and share knowledge with the professional field:

- Smartport Summit, 2016, Rotterdam.
- IPIC 2016, Atlanta, US.
- Let's Gro festival, 2016, Groningen.
- IPIC 2017, Graz, Austria.
- Binnenvaartcongres, 2017, Groningen.
- Topsector Logistics Conference, 2017, Aalsmeer.
- Port Logistics Workshop, 2017, Savannah, US.
- International Physical Internet Conference 2018, Groningen.
- International Cargobike Festival, 2019, Groningen.
- Conference Harbor Masters, 2019, Groningen.
- Transportation Research Board Freight Day, 2019, Washington, US.
- International Physical Internet Conference 2019, London, UK.
- Transportation Research Board Freight Day, 2020, online.

Refer to part 5 of this report for a full overview of all presentations that have been given during those events.



First PI lab in the Netherlands at the University of Groningen with at the left Nick Szirbik (Photography: Reyer Boxem)

Young people are the future

An important objective of the research project was to get pupils from primary and secondary education to 'think along' about the logistics of the future and to invite them to come up with new concepts themselves. From the University of Groningen, Iris Vis and Jon Hummel led Web Experience, an educational program aimed at primary and secondary education. "We showed children that logistics is a fun and innovative field. That it is much more than the trucks they see driving on the road," says Iris Vis. Under the supervision of students from the University of Groningen, students from groups 7 and 8 of "Openbaar Onderwijs Groningen", the first years of the HAVO and the Technasium, worked in groups on various decision problems. They could choose to work from different angles, such as economic, technical, or legal, related to topics, as for example, urban

distribution. A report, vlog or 3D print was made to present outcomes, in order to further develop their digital skills. They were also invited to present their findings during IPIC2018 and present the results to alderman Ton Schroor of the municipality of Groningen. One of the groups came up with an original proposal for the use of the Park & Ride places, an idea that has attracted a lot of attention within the Municipality of Groningen. Other students gave advice within their project to Benjamin Derksen, the CEO of webshop Frank. He said: "I was amazed by the detailed and elaborated plans that the children had about future-proof logistics solutions. It is refreshing to look at professional challenges from a child's perspective."

(Source: Report Web Expedition Groningen, 2018)

The PI Lab: meeting place for students and businesses

A year after the start of the research project, the first Dutch physical internet lab was opened at the University of Groningen. "Here at the Faculty of Economics & Business, we continuously have master students who are doing graduation research into the physical internet. They have a meeting place with the PI Lab where they can exchange ideas and make use of the available knowledge and facilities," says assistant professor and "PI lab leader" Nick Szirbik. "We were the first in the Netherlands, but such labs have been around for some time in other countries. At Georgia Tech in Atlanta, for example, there is an even bigger one. But ours is really good too. There are

super-powerful computers here on which students can perform heavy calculations or simulations. Large screens hang on the wall to view the results properly."

One of the lab's objectives is to also inform business people about the underlying principles of physical internet. "The concept is still very unknown, even at companies where our students conduct research. That is why we want to develop a kind of crash course with which we can quickly update managers from the business world." Another ambition of Szirbik is to do something with gamification. According to him, the technology around physical internet lends itself perfectly to researching in a playful way how it could work in practice. "You make a simulation model of a logistics network and participants have to program the 'bots' in such a way that they fulfill the role of stakeholders as realistically as possible. Great fun and very educational."

IPIC 2018: Groningen the 'place to be'

In the summer of 2018, the fifth International Physical Internet Conference (IPIC2018) took place in Groningen. Iris Vis: "When the opportunity arose to bring this event to the Netherlands, we jumped at the opportunity. It was a great way to further introduce the physical internet to the business community and government, and to hear what they thought about it. The other way around, international guests could experience which innovations have been developed in the Netherlands in recent years. It was of course also a perfect opportunity to present our project. The feedback we received was very useful and could be used immediately, so it worked both ways."

In total, more than 300 participants from 19 different countries took part in the event. The organising committee had compiled a full program for them with keynotes, research updates and round tables, interspersed with excursions to Groningen Seaports and the Shared Smart Factory in Emmen. A special moment was the opening of the Groningen-Eelde Freight Hub, from which the city center of Groningen could be supplied in a "physical internet-like" way.



one of the plenary meetings during IPIC2018
(Photography: Steffi van Wasen)

Students and researchers from all over the world spoke during the "talent lab". After their poster presentations in which they shared their findings, a number of them received "student awards" from Albert Veenstra, scientific director of TKI Dialog. Talent from the business world was featured during the "start-up & venture awards" where start-ups from all kinds of countries held pitches about their propositions within the physical internet.

Start-up pitches during IPIC 2018

- Dubistr – the Netherlands (winner jury award)
- Silent Sensors – UK
- Farm'd – US (winner audience award)
- Aeler – Switzerland
- CommaTech – China



Winner Jury Award start-up pitches during IPIC2018: Dubistr
(Photography: Steffi van Wasen)

Lessons learned and societal transitions

4

The physical internet is not a goal in itself but a means from which society as a whole can benefit. During the project, therefore, an explicit search was also made for applications outside the primary logistics process that match societal trends, such as the aging population and the energy transition.



Offshore wind
Eemshaven
(photography:
Groningen
Seaports)

Groningen Seaports and the hydrogen economy

The port sites managed by Groningen Seaports, where modalities such as water, road and rail come together, form one of the future nodes in the physical internet. "The physical internet is about automating logistics flows that use this node. This can make an important contribution to our CO2 targets," says Henk Zwetsloot, responsible for digital innovation within Groningen Seaports and advocate of the physical internet. "This concept shows what logistics networks could look like in the future and which steps we need to take to realise that vision of the future."

Groningen Seaports wants to play an important role in the hydrogen economy. Also in that perspective, Zwetsloot looks at the ideas from the physical internet. "Energy is nothing more than logistics. Energy is also about transport and storage. With hydrogen, we can also use several modalities for the transport of energy. We can transport it in the form of hydrogen gas, but also in the form of electricity or heat."

Little research has so far been done on "multi-commodity" energy systems, in which the use of multiple energy carriers is optimised at the same time. "That is as if we were to link TenneT's high-voltage grid to Gasunie's gas transmission grid: unthinkable at the moment. But that does happen in logistics. We can learn from the way in which multimodal transport is used there," says Zwetsloot.

In addition, hydrogen can become an important fuel for the transport sector. The first hydrogen ships are under construction. Research is being conducted at the University of Groningen into the required hydrogen supply chain. "Where should the filling stations for those ships be located? How does the hydrogen get to those filling stations? Similar research has previously been done on hydrogen filling stations for road traffic. Perhaps we can also use those filling stations as a buffer to absorb fluctuations in the supply and demand of hydrogen. Insights from the physical internet can help."



Hydrogen fuel station Delfzijl
(photography: Groningen Seaports)

"Important contribution to CO₂-targets."



Henk Zwetsloot of Groningen Seaports



Job Gawel presents his thesis about physical internet in healthcare

Opportunities for healthcare with hubs at the hospital

The ideas of the physical internet are not only applicable in port logistics, but also in the healthcare sector. Job Gawel, therefore, concluded his bachelor's degree in Industrial Engineering and Management with a study at Vegro, a supplier of medical aids such as anti-bedsores mattresses. "From the depot in Nieuwleusen, near Zwolle, Vegro travels daily to the Northern Netherlands to deliver or collect anti-bedsores mattresses at hospitals, nursing homes and patients at home. They are cleaned in the depot, after which they are returned to patients. The question was whether we could apply the concept of

physical internet to make this operation more efficient and reduce transport costs."

The physical internet indicated various solutions. Talks with Vegro and their customers pointed Gawel in the direction of one promising proposal. "Those conversations showed that many patients move from the hospital to a nursing home and are then cared for at home. A new mattress is ordered with each transfer, while it is much more efficient to have the mattress move with the patient. The proposal is to create a new hub close to, or rather in the centrally located hospital," says Gawel, who was asked by Vegro to elaborate on this proposal after his thesis. "Vegro was already working on the implementation of a track and trace system, a prerequisite for the proper implementation of this proposal. Vegro has now actually plans to establish a hub at the University Medical Center in Groningen."

“By applying physical internet-like concepts to this, there is still a lot to be done.”

A follow-up project in the Netherlands within the Top Sector Logistics is Pioneer, for example, in which new concepts for e-commerce and the 'last mile' are studied. "By applying physical internet-like concepts to this, there is still a lot to be done," says Kees Jan Roodbergen, who is leading the project. Another project is SMiLES, a living lab of the University of Groningen in collaboration with 20 companies, applied university and vocational educational institutions in the Northern Netherlands. The possibilities of applying concepts from the sharing economy within the physical internet are investigated.

Iris Vis: "Whether it concerns the sharing economy, urban distribution, standardisation of containers or technological innovations such as blockchain, if you look around you, you can actually see the steps towards physical internet emerging everywhere. The knowledge and developments in all these areas continue and sooner or later it will come together. It doesn't matter whether we call it physical internet. Then it is just there and we have grown towards sustainable logistics systems."

And what next? Follow-up projects

'Towards Virtual Ports in a Physical Internet' (2016-2021) has provided interesting insights into the future role of ports and their hinterland networks. Nevertheless, the project was only one of the building blocks in the larger whole of knowledge, tools and applications in the field of physical internet, which is being worked on in a national and international context. New initiatives and issues have emerged from the project that can be followed up further in the coming years.



Kees Jan Roodbergen, professor of Quantitative Logistics at the University of Groningen

Results

Scientific Articles

2018

- Van der Heide, G., Buijs, P., Roodbergen, K.J., Vis, I.F.A. (2018). Dynamic Shipments of Inventories in Shared Warehouse and Transportation Networks. *Transportation Research Part E* 118, 240-257.

2019

- Fahim, P., Martinez de Ubago, M., Rezaei, J., Tavasszy, L. (2019). Future Development Paths of Ports in the Physical Internet. working paper.
- Fahim, P., Rezaei, J., Tavasszy, L., Montreuil, B. (2019). Port Selection in the Physical Internet. working paper.
- Qu, W., Rezaei, J., Maknoon, Y., Tavasszy, L. (2019). Hinterland freight transportation replanning model under the framework of synchronomodality. *Transportation Research Part E: Logistics and Transportation Review* 131, 308-328.

2020

- Lin, X., Nishiki, Y., Tavasszy, L. A. (2020). Performance and Intrusiveness of Crowdshipping Systems: An Experiment with Commuting Cyclists in The Netherlands. *Sustainability* 12(17), 7208.
- Rezaei, J., Pourmohammadia, N., Dimitropoulos, C., Tavasszy, L., Duinkerken, M. (2020). Co-procurement: making the most of collaborative procurement. *International Journal of Production Research* 58(15), 4529-4540.
- Van Luik, S., Fiebig, T., Fahim, P.B.M., De Waard, P., Tavasszy, L. (2020). On the value of the Digital Internet/Physical Internet analogy. *Journal of Supply Chain Management Science* 1 (3-4), 87-103.
- Van Duin, J. H. R., Vlot, T. S., Tavasszy, L. A., Duinkerken, M. B., & van Dijk, B. (2020). Smart Method for Self-Organization in Last-Mile Parcel Delivery. *Transportation Research Record*, 0361198120976062.

2021

- Fahim, P. B., An, R., Rezaei, J., Pang, Y., Montreuil, B., & Tavasszy, L. (2021). An information architecture to enable track-and-trace capability in Physical Internet ports. *Computers in Industry*, 129, 103443.

Awards

2017

- Pioneer Award IPIC2017 voor Iris Vis

2018

- 1st Prize Student Contest IPIC 2018 (student team Delft University of Technology)
- Physical Internet Generation Award 2018 voor Paul Buijs
- Nominatie "Vrouw in de media Award – provincie Groningen" voor Iris Vis met artikel over PI.

2019

- Physical Internet Builder Award 2019 voor Lori Tavasszy

Selection of presentations

2016

- Smart Port session – stakeholder round table Physical Internet
- Vis, I.F.A. en Kidd, M.: Hyperconnected Ports & Canals: their new roles in the physical internet, International Physical Internet Conference 2016, Atlanta, USA.
- Buijs, P. "Voorbeeldtoepassingen voor 5G in logistiek en distributie" @ Let's Gro festival, Nov 2016, Groningen

2017

- Van der Heide, G. Optimal ordering and transporting of inventory in small PI-networks, International Physical Internet Conference 2017.
- Fahim, P. Pi and Ports (PI&P): A Conceptual Framework and Future Development Paths, International Physical Internet Conference 2017.
- Vis, I.F.A. Physical Internet: Logistieke ontwikkelingen op de radar, Keynote NVB Binnenvaartcongres.
- Vis, I.F.A., Buijs, P. Physical Internet: slimme pakketjes vinden zelf de weg naar uw voordeur,

Topsector Logistiek Congres 2017.

- Schoenmakers, V. Working together on the best possible port, presentation port of Rotterdam at the seminar in Savannah.
- Buijs, P., Hendriks, B. Triple X – Triple P vision, Pub lecture.

2018

- Fahim, P. The role of maritime ports in the physical internet, Patrick Fahim, IPIC 2018.
- Van der Heide, G. Dynamic shipments of inventories in Physical Internet networks, IPIC2018
- Bakir, I., Ursavas, E. Capacitated Intermodal Hub Network Design with Ring-Star Topology, IPIC2018
- Van der Heide, G. Optimal Orders and Shipments in Physical Internet Networks, at opening Physical Internet lab
- Van Luyk, A. PI as a solution to port congestion issues: the role of IT and networking activities, open project meeting during pre-program IPIC2018.
- Vis, I.F.A. Introduction project, Iris Vis, open project meeting during pre-program IPIC2018.

2019

- Buijs, P. Introduction to the Physical Internet, modularity and containerization in city logistics at International Cargobike Festival in Groningen.
- Zwetsloot, H. Presentatie congres Havenmeesters.
- Tavasszy, L., keynote at Shanghai Tongji University for opening of WCTR research center.
- Tavasszy, L. several presentations to present PI as vision for the logistics of the future: e.g., Washington, Transportation Research Board Freight Day session invited speaker, Ningbo Port Authority, China (visit with MIT Center, April), London, IPIC2019: Workshop with PhD's and roadmap workshop with ALICE (July).

2020

- Tavasszy, L., The physical internet & its relevance to the global goods movement, Webinar by Lori Tavasszy, TRB via <http://www.trb.org/Main/Blurbs/180687.aspx>
- Tavasszy, L., Ports in the Physical Internet (PI) – An exploration, poster presentation by Patrick Fahim at TRB2020
- Tavasszy, L., Contribution of research to logistics innovation in the physical internet, Keynote on Logistics Start-Up Day, Kühne Logistics University Hamburg, 5-6 Feb 2020



Bachelor and Master Theses

2016

- Mair am Tinkhof, J. (2016). Important factors that influence contracting to path the way for the Physical Internet. M.Sc. Technology and Operations Management, University of Groningen.

2017

- Arends, T. (2017). Empty SMC flows within a PI setting: A design science research. M.Sc. Technology and Operations Management, University of Groningen.
- Kilinc, S. (2017). The Physical Internet - Investigating the requirements and needed functionalities of an envisaged PI-system for high-value and long-distance fresh food transportation. M.Sc. Technology & Operations Management, University of Groningen.
- Reinke, J. (2017). Drivers for supply network sharing. M.Sc. Supply Chain Management, University of Groningen.
- Vorsterman van Oijen, J. (2017). Designing a step-by-step approach for a warehouse with aspects of the Physical Internet. M.Sc. Technology and Operations Management, University of Groningen.

2018

- Assen, P. (2018). An extension of the CLSR-mhub in slum-like areas: A study in the context of the Physical Internet. M.Sc. Technology and Operations Management, University of Groningen.
- Bijl, A. (2018). Integrating B2C Parcel Delivery with B2B City Distribution. M.Sc. Technology and Operations Management, University of Groningen.
- De Vries, M. (2018). Last mile delivery within the Physical Internet: Design of a City Logistics Smart Rack-μhub for large-sized shipments. M.Sc. Technology and Operations Management, University of Groningen.
- Gawel, J.H. (2018). Efficient Distribution Network Design for Healthcare Equipment Through Implementation of the Physical Internet. Integration project for Industrial Engineering and Management, University of Groningen.
- Louwerse, B.M. (2018). Designing a PI inspired extension for fresh food delivery in Favelas. M.Sc. Technology and Operations Management, University of Groningen.
- Luppens, K. (2018). The effect of location agent density controlled by pallet availability on the

- performance of a Physical Internet inspired system. M.Sc. Industrial Engineering and Management, University of Groningen.
- Oude Vrielink, A. (2018). Integrating deliveries to consumers and businesses and returns using micro-hubs in city distribution. M.Sc. Technology and Operations Management, University of Groningen.
- Postma, J.F. (2018). Maintenance of Smart Modular Containers in the Physical Internet: A Design Science Research. M.Sc. Technology and Operations Management, University of Groningen.
- Schaap, G.J. (2018). A digital infrastructure design for physical internet connection in favelas. M.Sc. Technology and Operations Management, University of Groningen.
- Van der Heide, L.M. (2018). A heuristic for the Location Routing Problem with Stochastic Demand and a maximum workday recourse. M.Sc. Econometrics and Operations Research, University of Groningen.
- Van Luyk, A. (2018). Towards a Physical Internet: An investigation of barriers to IT adoption. M.Sc. Supply Chain Management, University of Groningen.
- Zulanaite, D. (2018). Food distribution in the Physical Internet: The next step towards the realization of food distribution in the Physical Internet. M.Sc. Technology and Operations Management, University of Groningen.

2019

- An, R. (2019). Visibility in Physical Internet Port. Master Thesis, TU Delft.
- Caminada, S.J. (2019). Game and Choice Based Simulation: The design of a methodological framework using the case of the Physical Internet inspired "Freight Transportation Game" Game and Choice Based simulation. Master Thesis, TU Delft.
- Hissink, R. (2019). The shipment of bulk cargo in the Physical Internet. M.Sc. Technology and Operations Management, University of Groningen.
- Karampelas, D. (2019). Evaluating cooperation policies for rail utilization in the port to hinterland freight transport system. Master Thesis, TU Delft.
- Kastanya, G., A predictive model for parcel classification in the context of last-mile delivery, MSc thesis TU Delft
- Kreijkens, M. (2019). Collaboration in the physical internet. M.Sc. Technology and Operations Management, University of Groningen.

- Louter, T. (2019). A simulation study on standardized containers and the interplay between routing efficiency and material handling. Master Thesis, University of Groningen.
- Martinez de Ubago Alvarez de Sotomayor, M. (2019). The future of ports in the physical internet. Master Thesis, TU Delft.
- Vlot, Th, Power to the parcel: A method for self-organisation in last-mile parcel delivery, MSc thesis TU Delft
- Voster, J. (2019). Freight & Hubs: Strategies for the Role of Maritime Ports under the Development of the Physical Internet, Freight & Hubs. Master Thesis, TU Delft.
- Wicaksono, S. (2019). Exploring the market potential of bicycle crowdshipping. Master Thesis, Tu Delft.

2020

- Alebeek., S. van (2020), Auction based coopetition in the landside air cargo supply chain: Mathematical model and solution method, MSc Thesis TU Delft
- Brysch, M. (2020). Air Cargo in the Physical Internet. M.Sc. Technology and Operations Management, University of Groningen.
- De Jong, S.E. (2020). The introduction of the central planning facilitator into the Physical Internet system, from a strategic-business perspective. M.Sc. Technology and Operations Management, University of Groningen.
- Duurling, K. van (2020), An agent-based model evaluating last-mile solutions for parcel delivery in an urban area, MSc Thesis TU Delft
- Gehling, C. (2020). A security-driven design for high value cargo transport within the Physical Internet. M.Sc. Technology and Operations Management, University of Groningen.
- Genius, A., (2020) Implementation of Receiver Preferences in a Parcel Locker Network for Last Mile Deliveries, MSc thesis TU Delft
- Hacquebord, N.F. (2020). The physical internet: a new grand challenge for customs authorities?. M.Sc. Technology & Operations Management DD, University of Groningen.
- Ijaz, M., (2020), Development of a Game to Encourage Data sharing in Supply Chain, MSc Thesis TU Delft
- Meulblok, V. (2020), Research into the potential effects of a receiver-led consolidation policy on costs, CO2 emissions and vehicle movements: A

- case study for PostNL, MSc Thesis TU Delft
- Mientjes, G.B. (2020). Maritime ports: policy focus in the uncertain future of physical internet. M.Sc. in Transport Infrastructure and Logistics, TU Delft.
- Schutte, N. (2020), Collaborative ground handling of air freight at Schiphol, MSc Thesis TU Delft
- Slump, W.R. (2020). PI Cross-docking: applying autostore design principles. M.Sc. Technology and Operations Management, University of Groningen.
- Son, K. van (2020), Usability of Physical Internet characteristics for achieving more sustainable urban freight logistics: barriers and opportunities revealed by dominant stakeholder perspectives, MSc Thesis TU Delft
- Valdivia, D. (2020), Software Architecture for a Self-Organizing Logistics Planning System, MSc Thesis TU Delft
- Van Luik, S. (2020). Exploring the value of the analogy between the physical internet and the digital internet. M.Sc. in Complex Systems Engineering and Management, TU Delft.
- Wissink, H. (2020). Designing centralization in the Physical Internet, from an operational perspective. M.Sc. Technology and Operations Management, University of Groningen.

In the press

2015

- Logistiek (printed version): Physical Internet gooit Logistieke netwerken om.

2016

- Logistiek.nl: Physical Internet: wat is het?
- Supply Chain Magazine: Physical Internet gaat er komen, hoe dan ook
- Logistiek (printed version): Juiste software maakt of breekt nieuwe technieken

2018

- Dagblad van het Noorden, Vrachtvervoer gaat op de bus en trein lijken, Dagblad van het Noorden.
- Logistiek (printed version), Groningse leerlingen aan zet in de stad.
- Warehouse totaal.nl: Groningse leerlingen uitgedaagd door logistiek vraagstuk.
- Logistiek.nl: Groningse leerlingen denken mee over stadsdistributie.
- Dvhn.nl: Is nachtelijke bevoorrading een goed alternatief voor de binnenstad van Groningen.
- Logistiek.nl: Physical internet lab moet logistiek van de toekomst versnellen.
- NRC.nl: pakketjes communiceren straks met elkaar.
- Logistiek.nl: physical internet is een kwestie van tijd.
- Regiogroningenassen.nl: allereerste goederenhub geopend in Noord-Nederland
- Scienceguide.nl: de lessen van het internet
- Logistiekprofs.nl: Groningen verlicht druk op binnenstad met logistieke hub
- Rtvdrenthe.nl: Goederenhub geopend in Eelde
- Emmerce.nl: Groningen krijgt mogelijk overslagcentrum
- Oogtv.nl: goederenhub Eelde gaat woensdag open.
- Rtvnoord.nl: schone busjes moeten vrachtwagens uit stadscentrum verdringen.
- Dvhn.nl: goederenhub in Eelde maakt logistiek logisch.
- Gic.nl: eerste goederenhub in Noord Nederland op Groningen airport Eelde.
- Dinalog.nl: after movie 5e international physical internet conference
- Dinalog.nl: de lessen van het internet voor de logistieke sector
- Dinalog.nl: ipic 2018 brengt physical internet tot leven
- Dinalog.nl: conference ipic 2018 registration is open
- Dinalog.nl: verdure samenwerking GeorgiaTech, Dinalog en VIL
- Dinalog.nl: Groningse leerlingen aan slag stadsdistributie

- Dagblad van het Noorden, Peinzen op het pluche: hoe blijft binnenstad bereikbaar?, 6 maart.
- Logistiek (printed version), Physical Internet voor logistieke sector is een kwestie van tijd.

2020

- Auf dem Pfad zum physischen Internet, interview met Lori Tavasszy.
- What's next for mobility? <https://www.topdutch.com/stories/whats-next-for-mobility>.

Innovation roadmaps

Physical Internet Roadmap (national input to the SENSE project), refer to www.etp-logistics.eu

Selection of Educational Activities

2016

- Vis, I.F.A., Course Port and Hinterland Logistics, Master of Global Management – supply Chain Management – Antwerp Management School.
- Vis, I.F.A., PhD course Freight and Transport Management in Graduate program Operations Management and Logistics.
- Vis, I.F.A., Port of Rotterdam and international logistics, summer school UNIVERSITY OF GRONINGEN Understanding the Netherlands.

2017

- Vis, I.F.A. and Van der Heide, G., Introduction and modelling PI, LDE Winter School Rotterdam.
- Buijs, P. Horizontal collaboration in logistics and the physical Internet, full day class at Second LogDynamics Summer School, hosted by The International Graduate School for Dynamics in Logistics (IGS) at the University of Bremen during a five day program focused on Cooperative Control of Supply Chains. About 20 MSc and PhD students from around the world participated.

2018

- Vis, I.F.A. Physical Internet & aspects of IT Law.
- Buijs, P. De logistiek van morgen, College Carroussel presentatie voor ruim 200 VWO 4 scholieren.
- Vis, I.F.A., Connected maritime systems, Data Science for the Board Room, course jointly organized by University of Groningen Business School and Venturn.

2019

- Vis: Physical Internet & Van der Heide: Physical Internet Modelling during OML course Freight Transport Management.
- Vis: colleges Physical Internet Master IT Recht.
- Lori Tavasszy gave several lectures to present PI als vision for the future such as Delft, Introduction lecture MSc Program TIL 2019-2021, TU Delft (120 students), The Hague, Ministry of Infrastructure and Waterways & KiM, lecture on TRAIL PhD projects on Synchronomodality.

Corporate communication

2016

- Havenbedrijf Rotterdam: Simply borrow the competitors ship

Movie

2016

- The Physical Internet as a solution for a more efficient logistics system (<https://youtu.be/LXIRRAV19E>)

2018

- Meet the future CEO: <https://youtu.be/4alZnzxIPr0>
- Aftermovie IPIC2018

Organisation of conferences

2017

- Port Logistics Workshop 2017 in Savannah.

2018

- International Physical Internet Conference 2018 (<https://www.pi.events/IPIC2018/>).
- First PhD doctoral workshop Physical Internet.
- IPIC 2018 pre-event.

Organisation of Competitions

2018

- Webexpeditie Groningen: 200 kids in the ages 10-18 worked on assignments Webexpeditie Groningen to come up with PI inspired solutions for city logistics in the city of Groningen. Kick-off with lecture, supervision by student assistants of University of Groningen, final presentations during IPIC2018.
- International competition City Logistics Physical Internet Assignment for master students, winners were presented during IPIC2018.
- Coordination for the Startup and Venture Award IPIC2018.

Partners



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PROJECTPARTNERS

University of Groningen, Delft University of Technology,
Port of Rotterdam Authority, Groningen Seaports

MORE INFORMATION

<https://www.rug.nl/cope/projecten/havens-in-physical-internet>

QUESTIONS, REMARKS, SUGGESTIONS?

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