Connected Goods -pilot

Public report

Project within Accelerate Swedish Partnership
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Content

1. Summary

The goal of this project was to investigate the possibility of providing real-time insights into goods in transit and prove that this can be considered as already in storage, i.e. a "virtual warehouse". InnoTractor and Scania visualized a delivery flow within Scania's Inbound logistics, from supplier to production unit. Real-time data in an integrated system can increase both the productivity and the efficiency of goods handling. This can change the entire business structure and lead to a more sustainable transport system.

The research project aimed to investigate how new technology makes it possible to have real-time information about where goods are during the entire transport from suppliers to reception at a production unit in Skåne.
Currently, Scania lacks this insight into the supply chain and there are gaps and blind spots that mean that Scania does not know where the goods are during transport.
In the project, InnoTractor and Scania tested that the goods and pallets were given a digital identity and that this identity could be traced from listed starting points in Sweden to an end point in the Netherlands.

In addition to sending out an encrypted ID, radio devices (tags) are able to send information about environmental changes (e.g. temperature, humidity, fill rate, etc.) which can be analyzed in the cloud through AI (artificial intelligence). Bridges are installed at selected gates/docks/entrances of warehouses where goods are handed over. Usually 2-4 bridges are installed at these entrances to ensure all tags are energised swiftly and therefore all goods are detected.
Compared to alternative technologies (e.g. RFID) the bridges are relatively cheap, easy to install and less sensitive to disturbances and distance to the tags.
They are needed to receive the data, sent by the bridges, to send to our cloud.
Gateways send the data to the cloud via a 4G or 5G network connection.
The gateway will send the received data directly to the cloud in a secure way.
In the cloud the data will be decrypted to reveal the correct ID of the tag.
They can then predict much better when goods will arrive at the warehouse or production location.
For tracking purposes we use the exact same device as we use for sending tag ID data to the cloud; the gateway.
The key technolgy are the two cloud systems used: the Wiliot cloud for decoding the tag ID, which subsequently sends data to the Gravity cloud by InnoTractor which also receives data from the gateways and from the trackers and combines this to useful information which is presented in the Gravity dashboard and the Wiliot cloud for decoding of the tag ID.

The project proved that digitization of the logistics system enables prediction and an ability to create different transport scenarios, which can develop Scania's production planning. The tracking of goods and verified events like ready to ship, in transport and

arrived are also the basis for additional efficiency steps. The development of digitization in supply chains is expected to lead to a number of opportunities in research and development of new solutions. Digital technology can automate and streamline many of the processes involved in supply chain management, such as tracking inventory and managing logistics. Digital tools can provide real-time data on the location and status of goods as they move through the supply chain. Digital platforms can facilitate communication and collaboration between different members of the supply chain, such as suppliers, manufacturers, logistics providers and retailers. Digitization can enable the use of advanced technologies such as artificial intelligence and machine learning, which can lead to new and more efficient ways of managing the supply chain.

2. Sammanfattning på svenska

Målet med detta projekt var att undersöka möjligheten att ge realtidsinsikter om gods under transport och bevisa att detta kan betraktas som redan i lager, det vill säga ett "virtuellt lager". InnoTractor och Scania visualiserade ett leveransflöde inom Scanias Inbound logistik, från leverantör till produktionsenhet. Realtidsdata i ett integrerat system kan öka både produktiviteten och effektiviteten i godshanteringen. Detta kan förändra hela företagsstrukturen och leda till ett mer hållbart transportsystem.

Forskningsprojektet syftade till att undersöka hur ny teknik gör det möjligt att ha realtidsinformation om var gods befinner sig under hela transporten från leverantörer till mottagning vid en produktionsenhet.
I dagsläget saknar Scania denna insikt i försörjningskedjan och det finns luckor och döda vinklar som gör att Scania inte vet var godset befinner sig under transporten.
I projektet testade InnoTractor och Scania att varorna och pallarna fick en digital identitet och att denna identitet kunde spåras från listade startpunkter i Sverige till en slutpunkt i Nederländerna.

Förutom att skicka ut ett krypterat ID kan radioenheter (taggar) skicka information om miljöförändringar (t.ex. temperatur, luftfuktighet, fyllnadsgrad etc.) som kan analyseras i molnet genom AI (artificiell intelligens). Broar(Gateways) monteras vid utvalda portar/bryggor/entréer till lager där gods överlämnas. Vanligtvis installeras 2-4 broar vid dessa entréer för att säkerställa att alla taggar aktiveras snabbt och därför upptäcks allt gods.
Jämfört med alternativa tekniker (t.ex. RFID) är bryggorna relativt billiga, enkla att installera och mindre känsliga för störningar och avstånd till taggarna. De behövs för att ta emot data, skickad av broarna, för att skicka till vårt moln. Gateways skickar data till molnet via en 4G- eller 5G-nätverksanslutning. Gatewayen kommer att skicka mottagen data direkt till molnet på ett säkert sätt. I molnet kommer data att dekrypteras för att avslöja rätt ID för taggen. De kan då mycket bättre förutse när varor kommer till lagret eller produktionsplatsen.

För spårningsändamål använder vi exakt samma enhet som vi använder för att skicka tag-ID-data till molnet; porten. Nyckeltekniken är de två molnsystemen som används: Wiliot-molnet för avkodning av tagg-ID, som sedan skickar data till Gravity-molnet av InnoTractor som också tar emot data från gateways och från trackers och kombinerar detta till användbar information som presenteras i Gravity-instrumentpanelen och Wiliot-molnet för avkodning av tagg-ID.

Projektet bevisade att digitalisering av logistiksystemet möjliggör förutsägelse och en förmåga att skapa olika transportscenarier, som kan utveckla Scanias produktionsplanering. Spårningen av varor och verifierade händelser som redo att skickas, under transport och anlände är också grunden för ytterligare effektivitetssteg. Utvecklingen av digitalisering i försörjningskedjor förväntas leda till en rad möjligheter inom forskning och utveckling av nya lösningar. Digital teknik kan automatisera och effektivisera många av processerna som är involverade i supply chain management, såsom spårning av lager och hantering av logistik. Digitala verktyg kan ge realtidsdata om varornas plats och status när de rör sig genom försörjningskedjan. Digitala plattformar kan underlätta kommunikation och samarbete mellan olika medlemmar i leverantörskedjan, såsom leverantörer, tillverkare, logistikleverantörer och återförsäljare. Digitalisering kan möjliggöra användningen av avancerad teknik som artificiell intelligens och maskininlärning, vilket kan leda till nya och mer effektiva sätt att hantera försörjningskedjan.

3. Background

Transport accounts for a quarter of the EU's greenhouse gas emissions, with road transport accounting for the largest share (72% in 2019). Climate and energy policies in the EU have contributed to significant reductions in greenhouse gases in all sectors, except transport: total greenhouse gas emissions from transport increased by more than 33% between 1990 and 2019, and road transport emissions by almost 28%.
If the goal is for the transport sector to contribute to reaching the goal of 1.5 degrees, it is not enough to simply switch to more sustainable fuels - the transport sector must start the journey towards more efficient transport - regardless of the mode of transport.

The first step towards this is to gain a better understanding of how goods are transported. Today there is very little goods data available. With the digitization of the entire supply chain, new conditions are created to continuously improve efficiency, increase the degree of utilization and the degree of filling of goods transport. Real-time data in an integrated system can in the long run increase both the productivity and the efficiency of goods handling in the entire logistics system. This can change the entire business structure and lead to a more sustainable transport system.

In this project, InnoTractor and Scania have visualized a delivery flow within Scania's Inbound logistics, from supplier to a production unit. By doing this, the expectation is

that this will give Scania better deviation management in order to make transport more efficient in the long term.

4. Purpose, research questions and method

The research project aimed to investigate how new technology makes it possible to have real-time information about where goods are during the entire transport from suppliers to reception at a production unit in Skåne. Currently, Scania lacks this insight into the supply chain and there are gaps and blind spots that mean that Scania does not know where the goods are during transport. This has a negative impact on the business plan in the production facilities and in the spare parts business as it can delay production or repair. It also leads to unnecessary cost in tracking goods lost and high cost and emissions for emergency transport to secure parts n time.

In the project, InnoTractor and Scania tested that the goods and pallets were given a digital identity and that this identity could be traced from listed starting points in Sweden to an end point in the Netherlands.

A large part of the project consisted of discussions with Scania's staff and partners who performed the transport work. Both for adaptation of implementation and change management to be able to adopt the solutions and a simpler way of working.

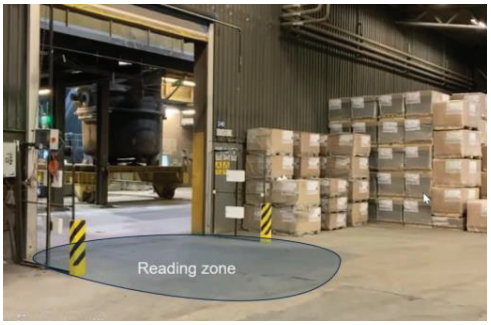
Method

Part 1: The identification part
Stock will be identified by battery-less Bluetooth enabled tags. These state-of-the-art tags will be placed on the goods and/or on the pallets the goods are transported on. The tags have a size of about 3 postage stamps and have an adhesive backing that allow them to be sticked on several surfaces. This adhesive is of a special kind to ensure they are durable and very hard to remove.
On the picture below you see one of the tags (white colour) placed on a piece of cardboard.

Next to sending out an encrypted identification ID, these tags are able to send information from which environmental changes (e.g. temperature, humidity, fill rate, etc.) can be derived in the cloud through AI (artificial intelligence). Although for this demonstrator

we only will use the identification ID sent by the tags. Since the tags are battery-less, they cannot run autonomously. They need to “harvest” their energy from the air which is provided by an external source; the so called “bridges”. These bridges can deliver power to the tags up to a distance of 10 meter. These bridges contain special antennas to direct radio waves in a specific pattern to the tags to energize them. The tags then send their information back to the bridge. The bridges also function as a repeater. This means that when data from tags is received, the bridge will resend this data amplified so that even over a longer distance the data can be received.

This battery-less Bluetooth computers technology is very new, introduced in the market in 2021 and this year available for pilots and commercial projects. Bridges are installed at selected gates/docks/entrances of warehouses where goods are handed over. Usually 2-4 bridges are installed at these entrances to ensure all tags are energised swiftly and therefore all goods are detected. Compared to alternative technologies (e.g. RFID) the bridges are relatively cheap, easy to install and less sensitive to disturbances and distance to the tags. Bridges are quite small in size, about 15cm in diameter and are very easy to install. (an example of a bridge is shown on the left).



The picture below gives an example of how bridges can be placed at gates

As a third building block of the solution we need gateways. They are needed to receive the data, sent by the bridges, to send to our cloud. As bridges amplify the signal, the signal of several bridges can be received by a single gateway.
Gateways send the data to the cloud via a 4G or 5G network connection. The reason for using a 4G or 5G network connection is that this eliminates the need to connect to a local (wifi) network. Connecting devices to a local (wifi) network will add a potential entry point for security breaches and disturbances which is not desired from the customer point of view. It also requires co-operation from local IT staff. Using the 4G or 5G network eliminates this necessity, simplifies maintenance as we operate completely stand alone. Below is an example picture of such a gateway. The size is about as big as a deck of a cards.

The gateway will send the received data directly to the cloud in a secure way. In the cloud the data will be decrypted to reveal the correct ID of the tag. Now we are able to correlate the tag ID to the proper goods that passed the gate.

The complete view of components will look like the picture below.

This solution will show the Customer the exact goods that flow into or out of a warehouse location.

Part 2 : the tracking part
Using a GPS tracker during transport Scania is able to (close to) real time follow the goods during transport. They can now predict much better when goods will arrive at the warehouse or production location. This will help them to plan their production much better.

For tracking purposes we use the exact same device as we use for sending tag ID data to the cloud; the gateway. But only in this case it will be configured to receive GPS data from an internal GPS receiver and send that information to the cloud instead of reading Bluetooth data.
Since we know exactly what goods were loaded into a trailer, we now can combine this data with GPS and inform Scania what goods are at what exact position during transport.

Part 3 : the cloud systems
The key part of the system is are two cloud systems we will use: the Wiliot cloud for decoding the tag ID, which subsequently sends data to the Gravity cloud by InnoTractor

which also receives data from the trackers and combines this to useful information which is presented in the Gravity dashboard. Both cloud systems are commercially up and running and ready for receiving and processing data.

This is where the added value is created by creating the overview from the raw data into 3 key data areas : Products ready to be shipped,
Products in Transit (including location and current holder) and
Products delivered.

These data areas are also enriched with key information like filling rate of transport, CO2 emissions etc. These services are characterized to be for Scalable, Secure and Reliable business solutions for many data points.

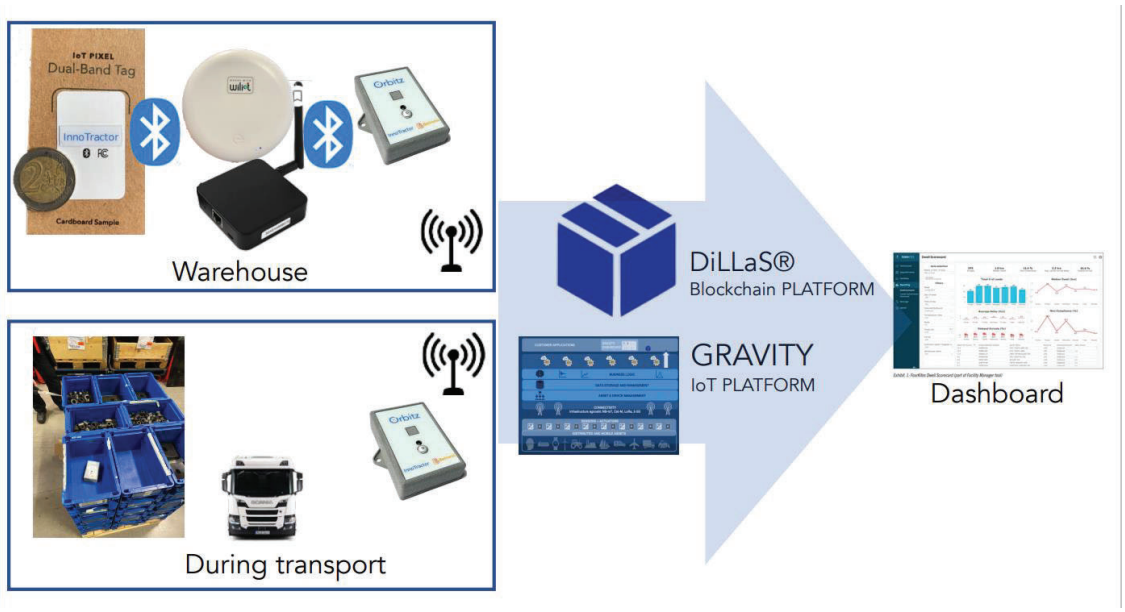
5. Objective

The goal of this project was to investigate the possibility of providing real-time insights into goods in transit and prove that this can be considered as already in storage, i.e. a "virtual warehouse". The overall goal was to give Scania insight into, and grip in the incoming supply chain. The research project would show that with new technology it is possible to have updated real-time information on where goods are and that their movements and storage take place in a cost-effective manner. The project would also show that the tracking of goods is possible when the transport is done with multiple suppliers and modalities in a way that tracking is not dependent on any specific supplier, route or modality and therefore universal and scalable.

In collaboration with Scania, InnoTractor would ensure that the goods were given a digital identity and that this identity can be traced from listed starting points in Sweden to an end point in the Netherlands.

6. Results and deliverables

What did we do?
The overview of the solution looks like this. Tags and orbits were mounted in Ages (Vänamo, Sweden) and collected at Scania, Zwolle (The Netherlands). The transport took different routes dependent on which carrier that got to transport the shipment. The transport was tracked and visualized in a web based dashboard were Scania could in real-time follow the different shipments. Any operational deviation in the pilot was alerted by InnoTractor.

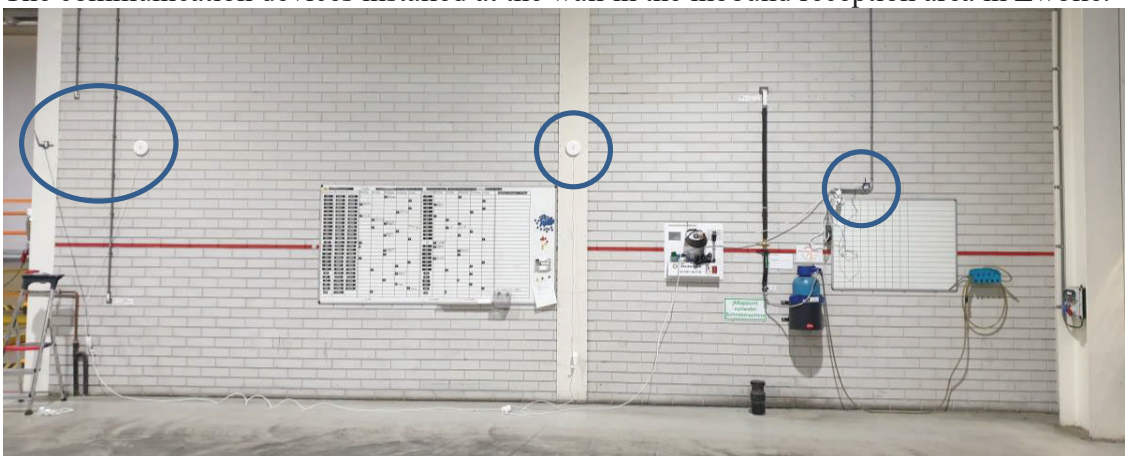


Step 1
Loading at the supplier Ages, Sweden.
The supplier put tags on boxes and pallets and placed tracking devices in the boxes, which turned out to be simple and was perceived by them as not a burdensome step in the workflow, i.e. no noticeable deviation for the supplier. The insight for the project is that the technology enables the supplier to confirm the actual dispatch time of the goods from their warehouse without having to add new manual activities.

The staging areas looks like this….

Offloading at Scania's factory in Zwolle, the Netherlands.

The communication devices installed at the wall in the inbound reception area in Zwolle.



The recipient lifted the tracking devices out of the boxes, which turned out to be easy and was not perceived by them to be a burdensome step in the workflow, i.e. no noticeable deviation for the recipient.
The insight for the project is that the technology enables the recipient to streamline operations by eliminating the manual activity of registering incoming documents. The supplier thereby has the opportunity to obtain proof that the goods arrived (or did not arrive) at the recipient, which speeds up and simplifies the handling of deviations.

Step 2 The tracking part

Connection between tags/mobile device, between tags/fixed device, and between device/cloud solution and connection levels
All connections have been shown to be fully functional.

Multiple routes

The positions of the goods have been excellent to follow every 15 minutes during the trucks' journey regardless of modality.

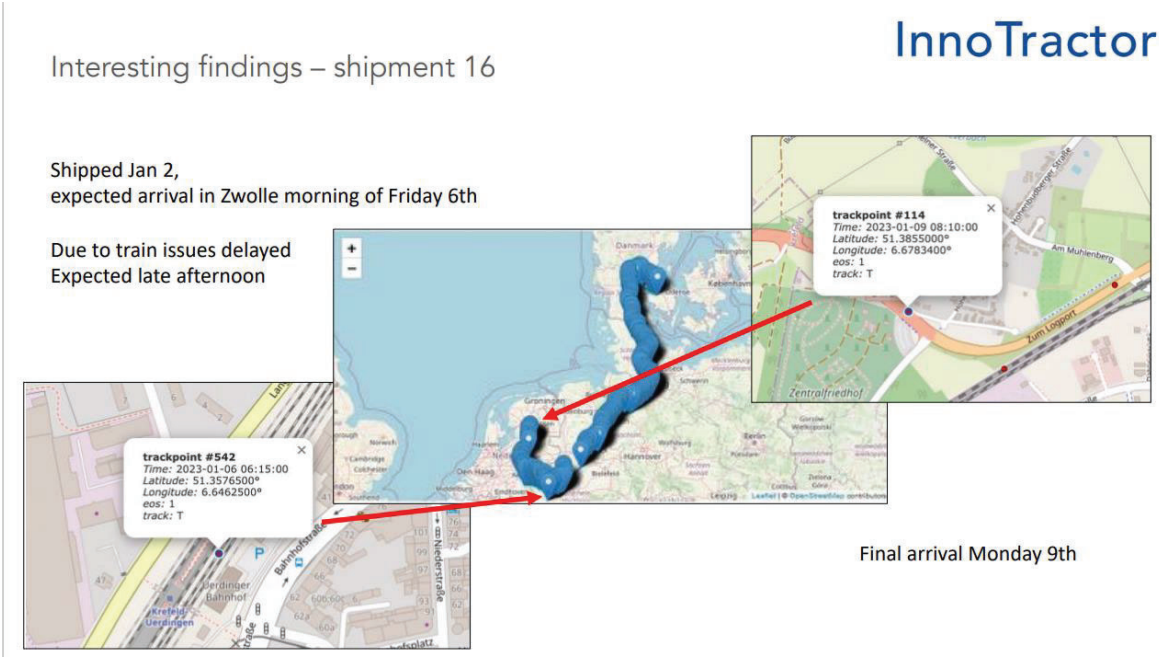
In the pilot we evaluated following deviations
Deviations from planned routes
With an update frequency of 15 min for the positioning, the project was able to draw conclusions about possible deviations from planned routes, breaks and longer interruptions.

Deviations regarding the handling of tags/devices
No deviations were noted in this regard.

Deviations regarding the integrity of the goods (that the same goods as loaded arrive)
No deviations were noted in this regard.

Part 3 : The cloud systems

System support
The system we used in the pilot is not yet intuitive enough for an operational implementation. However, there are other commercially available systems (eg Fourkites) that can be applied and improve the user experience. Visualization of deviations with required information



Track & trace functionality of goods in transport (on article level)

Cybersecurity tests have not been performed during the project, but the InnoTractor solution provides end to end security at the highest level. In addition to this the event information (handover between parties with timestamps) has also been logged in the blockchain which ensures immutable event logging.

7. Dissemination and publications

7.1 Dissemination

How are the project results planned to be used and disseminated?	Mark with X	Comment
Increase knowledge in the field	x	Demos, Combient Foundry
Be passed on to other advanced technological development projects	x	HITS
Be passed on to product development projects	x	Scania and Rio
Introduced on the market	x	Scania and InnoTractor
Used in investigations / regulatory / licensing / political decisions		

8. Conclusions and future research

Supply Management
The pilot had a slightly more complicated setup than if it were to be implemented in Scania's inbound transport. Despite this, it was nothing that burdened the process, it was rather clear that this has the potential to make the process more efficient and reduce manual work. Which will likely lead to reduced errors in the handling of goods.

By being able to visualize, it will also in the long run mean that Scania can develop our management of our inbound flows. A digital twin of the entire warehouse and flow contributes to better ETA analysis and deviation management. In the long run, this will lead to shorter lead times and reduced stocks. Digitization of the logistics system also enables prediction and an ability to create different transport scenarios, which can develop Scania's production planning.

Not least, this development enables Scania as a company to describe a real environmental impact, for example emissions of CO_2 and ensure that the articles come from the right supplier. Which helps us live up to climate commitments within science based targets.

The tracking of goods and verified events like ready to ship, in transport and arrived are also the basis for additional efficiency steps. Think about automatic payments, micro-insurance, automatic RTI (returnable transport item) administration and more.

Continued research
The development of digitization in supply chains is expected to lead to a number of opportunities or research and development of new solution.

• Increased efficiency and speed:
Digital technology can automate and streamline many of the processes involved in supply chain management, such as tracking inventory and managing logistics. This can lead to faster and more accurate decision-making, as well as reduced costs and improved responsiveness to changes in demand.
• Improved visibility:
Digital tools can provide real-time data on the location and status of goods as they move through the supply chain. This can help companies identify bottlenecks and potential problems more quickly and make adjustments to improve performance.
• Better collaboration:
Digital platforms can facilitate communication and collaboration between different members of the supply chain, such as suppliers, manufacturers, logistics providers and retailers. This can lead to a more effective and efficient coordination of activities.
• Increased innovation:
Digitization can enable the use of advanced technologies such as artificial intelligence and machine learning, which can lead to new and more efficient ways of managing the supply chain. An example is prediction of events.

But it also comes with the potential for increased cyber security risk, as more data and processes are digitized, it also has the potential to be disrupted by cyber-attacks.

9. Participating parties and contact persons

Scania CV AB

Scania is a global company that manufactures trucks, buses and engines, with sales and service in over 100 countries. We also offer financial services in many markets, with production units in Europe, South America and Asia. Scania has roughly 50,000 employees globally and is part of the TRATON group
Contact
Henrik Nilsson
Robert Landau
Elisabeth Hörnfeldt

InnoTractor
InnoTractor are a young, experienced IoT company which believes that everything that can benefit from an internet connection will get one. Its mission is to enable zero waste supply chains in e.g. the food, pharma/health and high value goods sectors.
Their (international) customers are looking to digitize existing or create new services and we help them realize their innovative solutions. Our software solutions are targeted to be used by customers with many products/assets to help them contribute to a cleaner, more efficient and better world.

With InnoTractor solutions their customers get real-time visibility on their processes and supply chain. This enables them to identify the problem areas and reduce product loss, improve planning and production, optimize their warehouse management systems and improve the operations with e.g. less admin and more sustainable / circular processes.

InnoTractor offers business solutions as a service, using its products Gravity (IoT SaaS platform), DiLLaS™ (distributed ledger SaaS platform), Orbitz (IoT devices), and Telbase (CRM and IoT billing SaaS platform).

Contact
Frank Hermans
Maurice van Tholen
Bas Van Den Heuvel