Holo

Bringing autonomous vehicles to the roads (and skies) of Scandinavia (and beyond)

Automaticar
20.9.2022

About Holo

Based in Copenhagen, Denmark.

Founded in October 2016 by the Semler Group, Denmark's largest automotive distributor.

The Semler Group is a **104 year old** family-owned company that imports, sells and services VAG vehicles

The Semler Group is a diversified company operating in 8 countries:
Denmark, Sweden, Norway, Iceland, Finland, Lithuania, Estonia, Latvia

Holo is a 100% owned company in the group, but **operates independently**

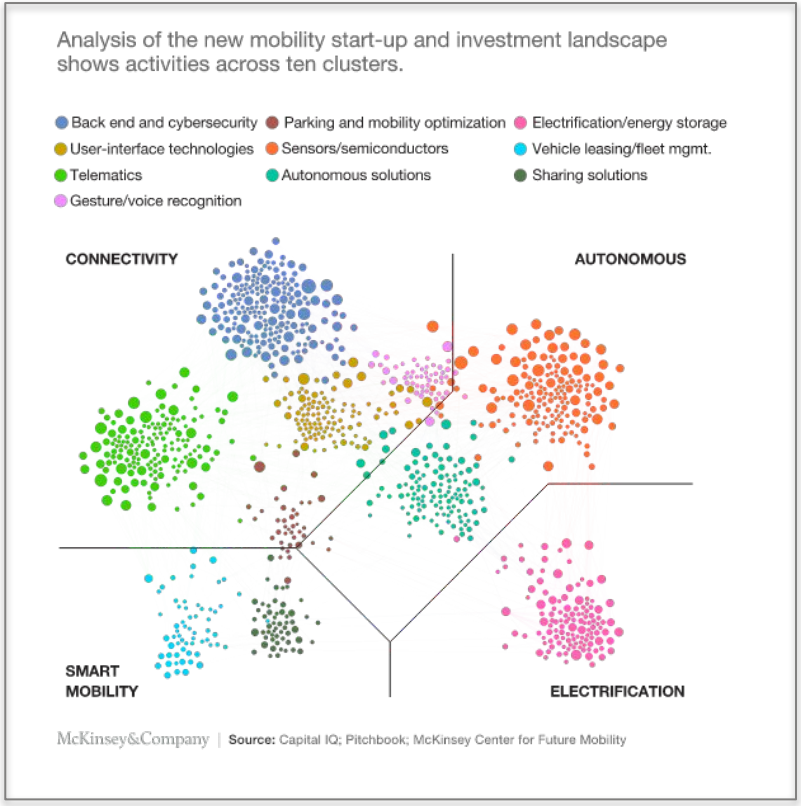
Holo was founded as a **response to the emergence of autonomous vehicles**.

Holo is the Semler Group's response to the original threat of autonomous and shared mobility

As described in the ACES framework from McKinsey in 2016/2017 the automotive industry is under threat from four different trends:

1. Connectivity
2. Electrification
3. Autonomy
4. Smart/shared mobility

Holo covers the latter two categories



Source: How the auto industry is preparing for the car of the future

A consistent vision for Holo - but an evolving strategy to get there

Vision

Holo wants to be part of building **a more efficient transportation and logistics system.**

Improving the current system will enable better quality service while utilizing fewer resources, resulting in better customer experiences and more sustainable transport and logistics solutions.

At Holo we believe that the current system can be improved by **adding autonomous vehicles** - on the ground and in the air

Original strategy (2016-2020)

Deploying 1st generation autonomous vehicles in various countries in Scandinavia.

Expectation: Level 4 driving without safety driver
Reality: Not possible - no business case and ability to scale.

Updated strategy (2020 -)

Scaling back on deploying 1st generation vehicles.

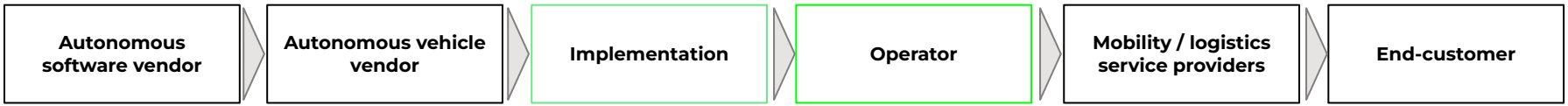
Focus

- Fewer and more focused projects with new and more mature technology
- Providing Holo's software, services and knowledge to other operators of autonomous vehicles.

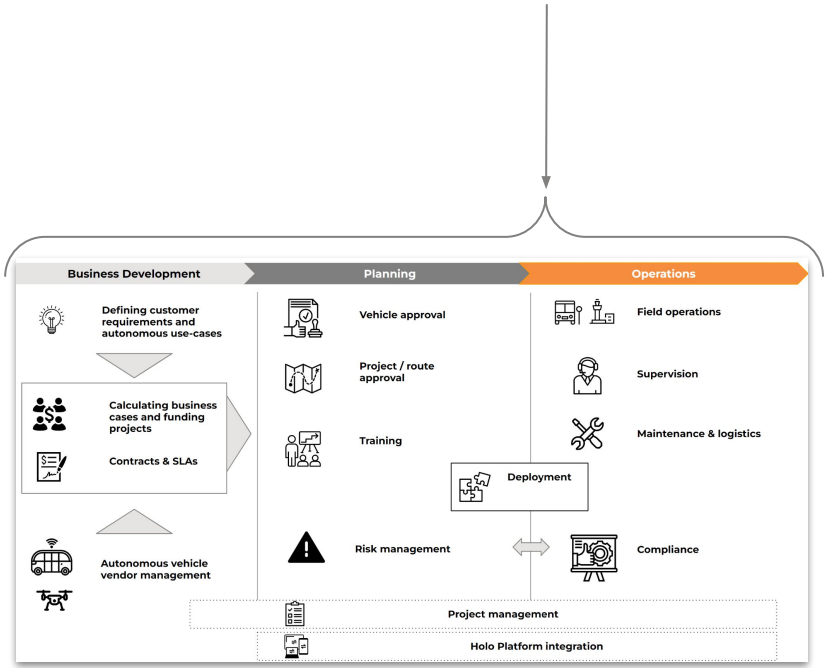
Holo is currently focused on these segments - seeing significant progress in developing all but one of them in the coming 1-3 years

	People transportation	Freight transportation	Other (Cameras, sensors and more)
holo Air	 		 
	Low priority - Not currently pursuing projects - technology and market not yet mature	**High priority** - technology available and customers willing to invest	**High priority** - Specialized use-cases being discussed with vendors and customers
holo Ground	 	 	 
	Medium priority - Working on one major lead, awaiting more mature vendors and customers before expansion	**High priority** - technology available and customers interested in pilot projects	**Medium priority** - Looking for vendors and projects

Holo's role is becoming increasingly important - as autonomous software and vehicles mature, they need to be implemented and operated



See breakdown below.



Holo's has deep experience in all the processes needed to implement and operate autonomous mobility and logistics projects

More at https://www.letsholo.com/services

Business Development

- Defining customer requirements and autonomous use-cases
- Calculating budgets and funding projects
- Contracts & SLAs
- Autonomous vehicle vendor management

Planning

- Vehicle approval
- Project / route approval
- Training
- Deployment
- Risk management

Operations

- Field operations
- Supervision
- Maintenance & logistics
- Compliance

Project management

Holo Platform integration

Building a “route catalogue” to match customers of autonomous mobility and vendors of autonomous vehicles and software

Defining customer requirements and autonomous use-cases

Collecting information about potential locations for future autonomous mobility from municipalities, harbours, hospitals, PTAs, office parks etc.:

1. Transportation needs
2. Weather conditions
3. Service level required
4. Operational requirements
5. Road/network specifications
6. Integrations

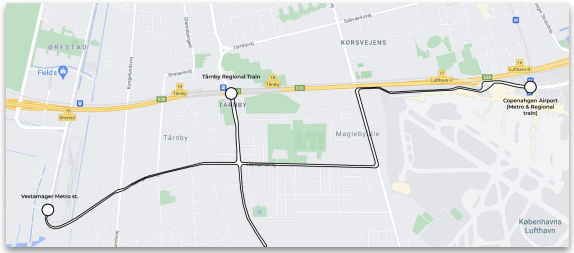
	January	February	March	April	May	June	July	August	Sep-tember	October	November	December
Avg. Temperature °C (°F)	-1.3 °C (29.7) °F	-1 °C (30.1) °F	0.1 °C (32.3) °F	3 °C (37.5) °F	6.4 °C (43.4) °F	9.9 °C (49.8) °F	11.6 °C (53) °F	10.8 °C (51.4) °F	7.9 °C (46.3) °F	3.9 °C (39.1) °F	1 °C (33.7) °F	-1.2 °C (29.9) °F
Min. Temperature °C (°F)	-3.6 °C (25.5) °F	-3.5 °C (25.8) °F	-2.5 °C (27.5) °F	0 °C (32.1) °F	3.1 °C (37.5) °F	6.8 °C (44.3) °F	8.7 °C (47.6) °F	8.1 °C (46.5) °F	5.7 °C (42.2) °F	1.9 °C (35.4) °F	-1 °C (30.3) °F	-3.5 °C (25.6) °F
Max. Temperature °C (°F)	0.9 °C (33.6) °F	1.2 °C (34.2) °F	2.6 °C (36.8) °F	5.8 °C (42.4) °F	9.3 °C (48.8) °F	12.7 °C (54.8) °F	14.4 °C (57.9) °F	13.5 °C (56.2) °F	10.2 °C (50.4) °F	6 °C (42.7) °F	2.8 °C (37) °F	1 °C (33.9) °F
Precipitation / Rainfall mm (in)	131 (5.2)	129 (5.1)	122 (4.8)	99 (3.9)	90 (3.5)	76 (3)	85 (3.3)	102 (4)	132 (5.2)	118 (4.6)	120 (4.7)	133 (5.2)
Humidity(%)	84%	80%	79%	76%	73%	75%	78%	81%	83%	84%	83%	83%
Rainy days (d)	13	13	13	12	11	11	11	11	13	12	12	13

Holo

Template - TOM

Holo Ground

Route Catalogue



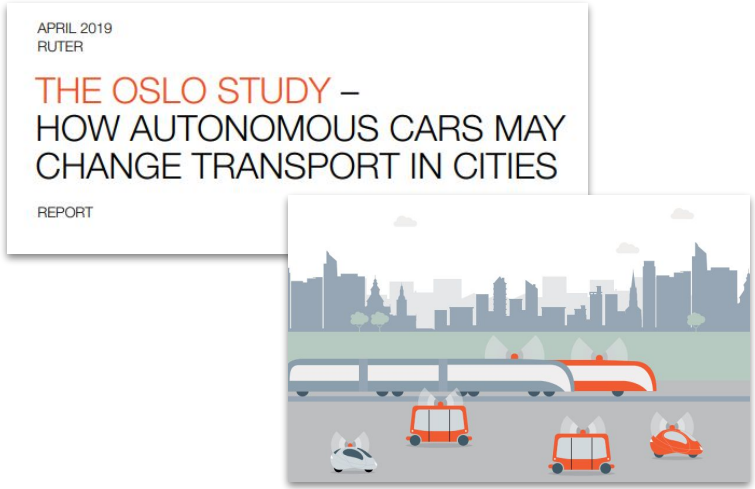
Mobility research for Oslo focused on autonomous vehicles shows great potential for improvement

Four main scenarios where today's passenger groups switch to shared, autonomous transport – both with and without ridesharing.

Based on the morning rush hours on a working day in Oslo and Akershus.

Main findings:

- In all of the scenarios examined, the number of cars can be reduced by between **84 and 93 per cent**
- The scenario that produces the biggest reduction in traffic is where users of public transport continue to do so while car-drivers switch to ridesharing. This will give a **14 per cent reduction in traffic**
- If today's public transport users switch to MaaS-based systems with ridesharing, the **journey time will be reduced by an average of 11 minutes**
- For private car-users, the average journey time will increase by 6 minutes without ridesharing and by 8 minutes with ridesharing
- Depending on the scenario, **the estimated fleet size necessary is somewhere between 16.000 and 55.000 autonomous vehicles** to cover the Oslo area



	BASE	1A	1B	2A	2B	3A	3B	3
	PRIVATE CARS 2020	FROM PRIVATE CAR TO CAR SHARING	FROM PRIVATE CAR TO SHARED TAXI	FROM PRIVATE CAR, BUS AND TRAM TO CAR SHARING	FROM PRIVATE CAR, BUS AND TRAM TO SHARED TAXI	FROM BUS AND TRAM TO TAXIBUS		FROM TRAM AND BUS TO TAXIBUS
						FROM PRIVATE CAR TO CAR SHARING	FROM PRIVATE CAR TO SHARED TAXI	
PERSON TRIPS	401,000	401,000	401,000	611,000	611,000	611,000	611,000	210,000
FLEET SIZE	352,000	33,000	26,000	55,000	40,000	49,000	42,000	16,000
FLEET SIZE COMPARED TO BASE (PCT. OF BASE)	-	9%	7%	16%	11%	14%	12%	5%

Source: New report How self-driving transport will affect the Oslo region

Holo can help select the right vehicle vendor, vehicle and autonomous software

Autonomous vehicle vendor evaluation

Commercial
Holo knows what a good setup should cost and what a fair contract looks like

Holo knows what additional services the vehicle vendor should be able to deliver to Holo or another operator

Hardware / vehicle
Holo knows what works in real conditions and what to look for in a vendor's solution

Holo has been an important partner for different vehicle vendors in homologation of vehicles in Scandinavia.

Support and other processes
Holo knows what processes are needed from the vehicle vendor to support the operation of the vehicle

Holo can spot gaps in the vehicle vendor's support setup that Holo may need to fill

Autonomous software
Holo knows what capabilities are the most important for the routes we are discussing with our customers

Holo know what safety features are needed for approval in Scandinavia

Additional software and tools (API / data / mapping)
Holo knows what data is needed for Holo to operate and document

Holo knows what additional tools for data management, mapping, remote control etc. are needed for Holo to support the route

Complex project approvals in Scandinavian & Baltic countries has prepared Holo for level 4 applications in the future

Project / route approval

Holo has identified the categories below for application content, applicable across the Nordic and Baltic countries.

Project approval: Application content

- Project descriptions and conditions
- Technical documentation/ application
- Autonomous system documentation
- Risk assessment

Test, validation and maturity documentation

Holo has unique insight into the difference in approval processes between Denmark and Norway for autonomous passenger vehicles

Lead time for approvals in DK: ~ 13 months

- Substantially more costly and time-consuming to conduct pilot projects in Denmark than in e.g. Norway or Sweden
- DK has several approval processes for pilot projects rather than a centralised approach
  - Approval at DRSA
  - Approval from third party assessor
  - Approval from DRD
  - Signed by Minister of transport
- Legislation has poor guidelines and no process for how to handle changes during pilot projects

Lead time for approvals in NO: ~ 3 months

- Norwegian approvals are granted by DRD, who handles the entire approval process (apart from registration)

  Registration can be done after approval is granted
- Legislation is supported by overall guidelines, but not necessarily detailed
- For vehicles with some degree of maturity the approval process in Norway is transparent and rather flexible

Lead time for approvals in SE ~ 3 months

- Swedish approvals are granted by Transportstyrelsen and the local road owner
- The approval process start with a meeting between the applicant and Transportstyrelsen. The meeting will determine the extent of the application
- The application must include:
  - A factory acceptance test of the vehicle
  - FMEA risk analysis of the route
  - A site acceptance test with a drivers instructor
- Legislation is supported by overall guidelines, but not particularly detailed

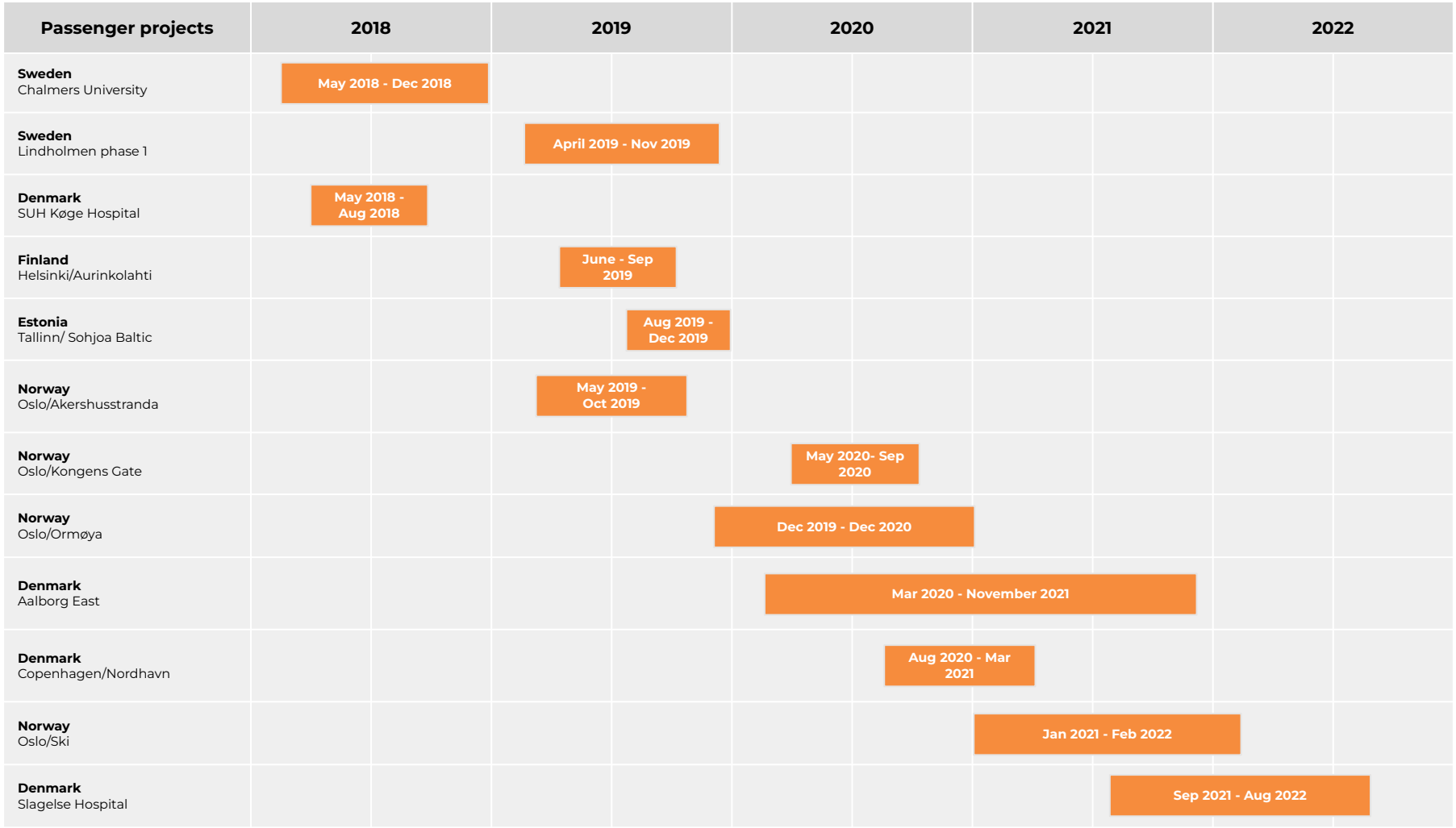
Tough regulation in Scandinavia makes Holo well-positioned to get autonomous vehicles on the road approved in other countries

Legislation in Scandinavia is level 4 ready, but has strict requirements for documentation.

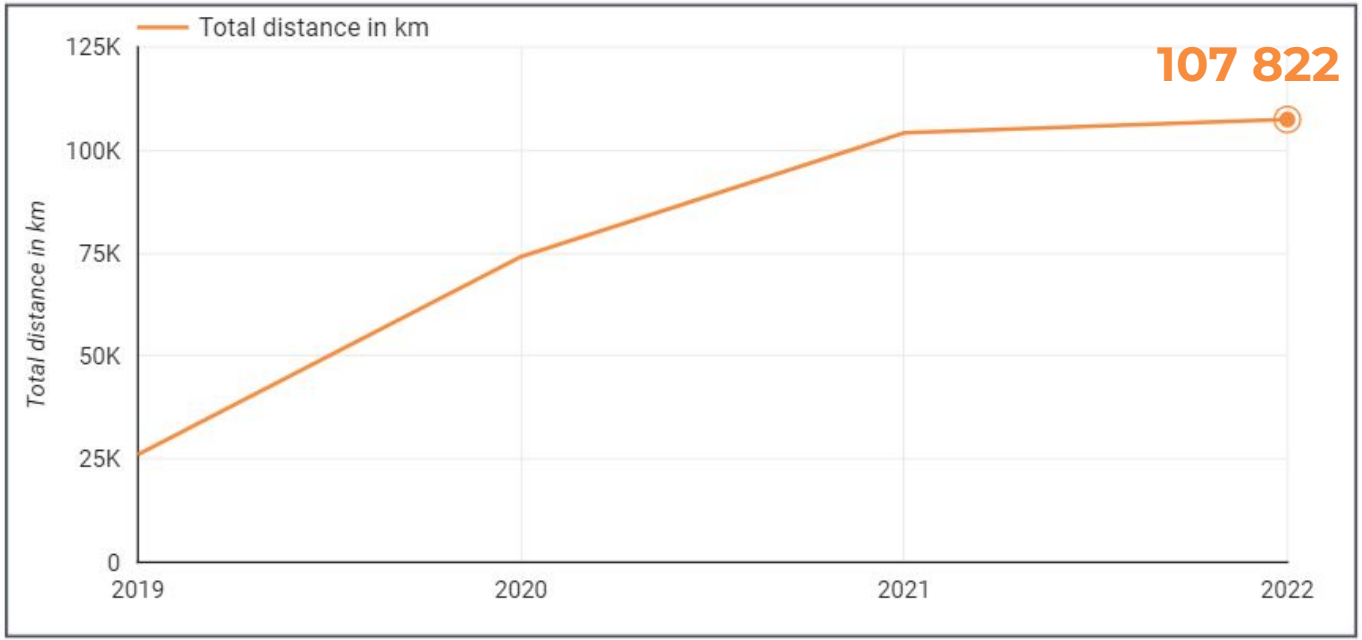
Because of these requirements, Holo has built detailed procedures for

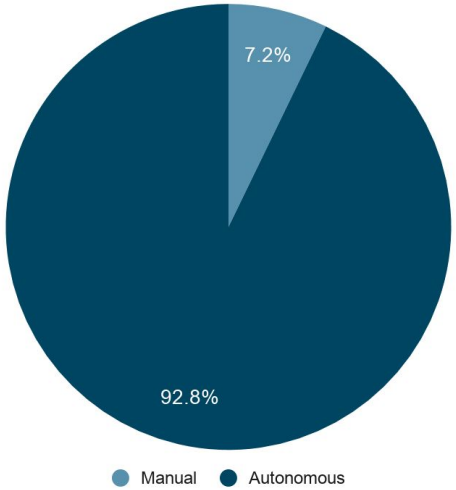
- Maintenance (e.g. checking redundant systems, maintaining sensors)
- Operations (e.g. safety driver behaviour and detailed data collection
- Supervision (e.g. remote support and monitoring)
- Incident management (e.g. securing incident sites, working with authorities, analysing incidents)

Holo is ready to be involved in approval processes in other European countries - previous work can be reused


Passenger projects
2018
2019
2020
2021
2022
Sweden
Chalmers University
May 2018 - Dec 2018
Sweden
Lindholmen phase 1
April 2019 - Nov 2019
Denmark
SUH Køge Hospital
May 2018 - Aug 2018
Finland
Helsinki/Aurinkolahti
June - Sep 2019
Estonia
Tallinn/ Sohjoa Baltic
Aug 2019 - Dec 2019
Norway
Oslo/Akershusstranda
May 2019 - Oct 2019
Norway
Oslo/Kongens Gate
May 2020- Sep 2020
Norway
Oslo/Ormøya
Dec 2019 - Dec 2020
Denmark
Aalborg East
Mar 2020 - November 2021
Denmark
Copenhagen/Nordhavn
Aug 2020 - Mar 2021
Norway
Oslo/Ski
Jan 2021 - Feb 2022
Denmark
Slagelse Hospital
Sep 2021 - Aug 2022

Holo's operational experience is substantial - adding more kilometers and passengers in real operational projects





Distance in total: + 107.800 kilometers* (*since Holo started receiving data)
Passengers in total: 68.219


ered by holo


HOLD AFSTAND
CL 52 074


SmartBus
navya


MANUAL DRIVING
EV 68360


Hei, jeg er Mads


Vis varsomhet ved f


MANUAL DRIVING
EV 89324


EV 89324


In partnership with


MANUAL DRIVING
EV 89298
nauvo
1012
EB


Ruter#


Ruter tel selv!


1007


Ruter#
003
DR 88668
Ruter#
DR 88623

Holo's operational experience informed Toyota and Ruter's decision to choose Holo as operator for a new project in Norway

Ruter# sensible4 TOYOTA EUROPE

Members of the project

- Holo - responsible for project approvals, implementation and operating the vehicle
- Toyota Motor Europe - supplying vehicles
- Sensible 4 - autonomous software and modification of vehicle to include sensor stack
- Ruter - public transport authority responsible for communication to end-customers

Basic facts about the project

- Location: Ski, Norway
- Route type: Mixed traffic
- Project duration: 1 year (2021-2022)
- Number of vehicles: 2

Special characteristics

- Collaboration with OEM
- Type-approved vehicles with AD kits mounted
- Preparation for vehicles with different form factors and improved autonomous performance
- All-weather operations

Performance examples

The project in Ski was delayed due to Corona - but actual preparation work was faster than in previous projects

Q1 2020
Project Start

January 2021
Testing phase

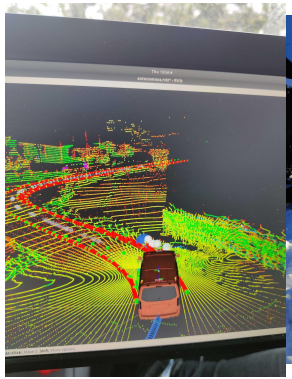
Testing the vehicle for 400 hours without passengers

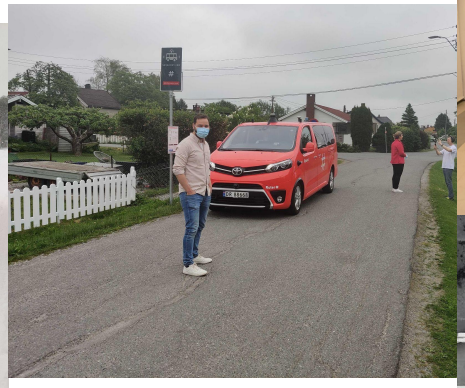
April 2021
Approval for autonomous driving

Start driving with passengers

~~**Q1 2022**~~
~~Approval for electric vehicles~~

Implementation of electric vehicles



Testing → *Winter driving* → *Preparing for passengers and informing local residents* → *Media appearances*

Holo Supervision has been developed to cover all aspects of autonomous operations

Supervision

Monitoring

- Vehicle performance
- Vehicle data
- In-vehicle data
  - *Issue counting*
  - *Passenger counting*
  - *Other equipment*

Troubleshooting

- Supporting safety drivers
- Escalating to vehicle vendor
- Issue logging with vendor
- Log file analysis
- Creating support tickets

Feature requests (Vendor)

- Autonomous software feature requests
- Vehicle hardware feature requests
- Vendor process improvement suggestions
- Vendor API improvement suggestions

Incident management

- Communication with emergency personnel
- Incident data collection
- Incident people management

Operational reporting

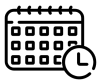
- Creating dashboards
- Uptime reporting
- Performance analysis
- Reports to customers and authorities (daily/weekly/monthly)

Remote control / assistance

- Remote control of autonomous vehicles
- Assistance in decision-making for autonomous vehicles

Route scheduling

- Defining and adjusting timetables
- Communication of delays, cancellations and updates



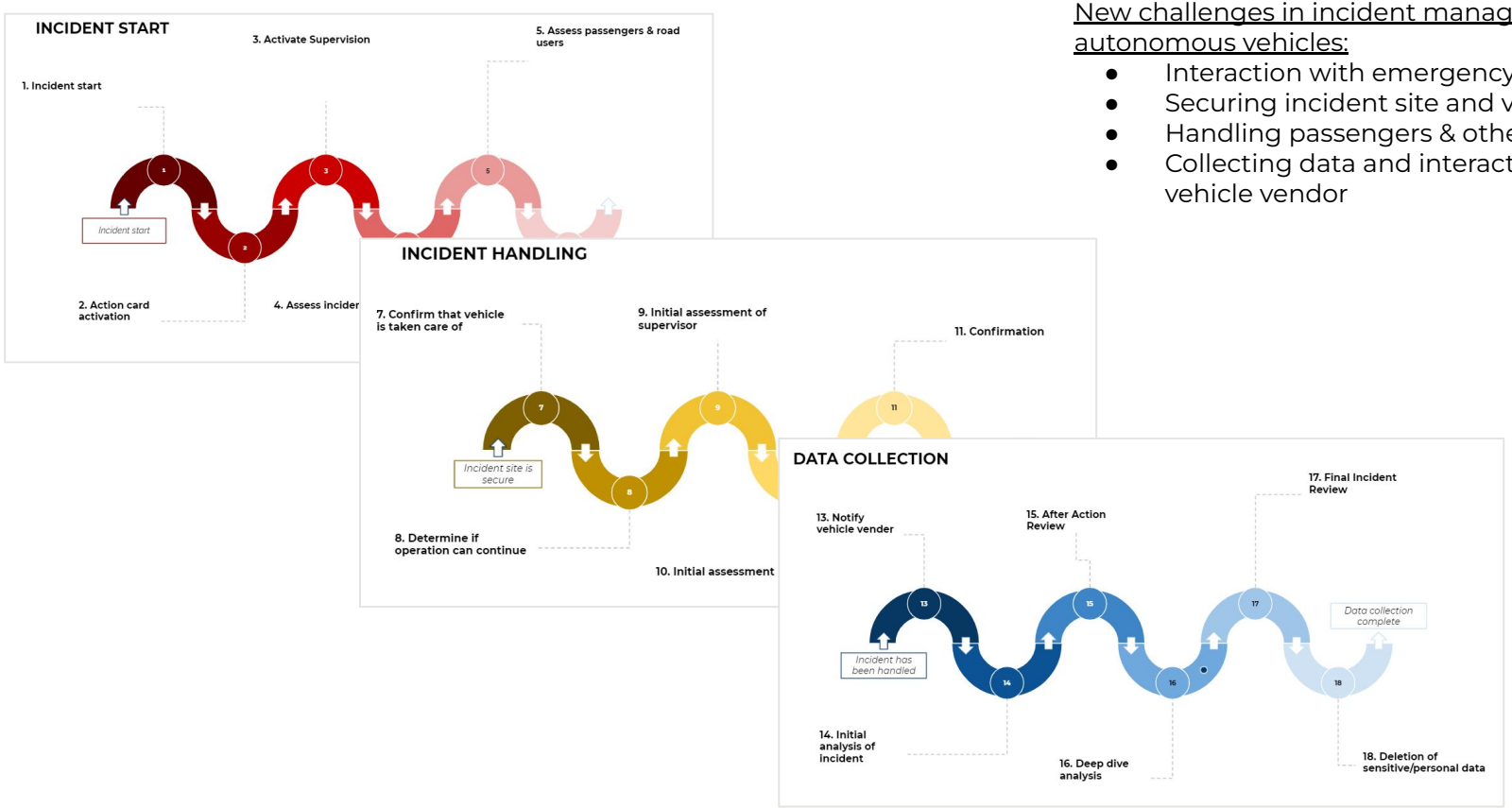
Shift scheduling

- Safety driver shift planning
- Back-up shift planning
- Maintenance shift planning
- Managing absences and illness

Maintenance control

- Daily maintenance / inspections / cleaning
- Logging of mechanical issues
- Scheduling maintenance (planned, preventive and reactive)

Holo’s process for incident management is an example of the deep operational experience that has been accumulated through projects



<u>New challenges in incident management for autonomous vehicles:</u>

- Interaction with emergency vehicles
- Securing incident site and vehicle
- Handling passengers & others in traffic
- Collecting data and interacting with vehicle vendor

Healthdrone, Funen

More at
https://www.letsholo.com/healthdroneproject

The use case

Odense University Hospital has two satellite hospitals, one in Svendborg and one on Ærø. They saw a need for a fast transportation connection between the hospitals where blood samples and medicine could be transported.

The route

The route connects the three hospitals on Funen. All the hospitals are located in an urban environment and requires extra fail safe equipment on the drone.

The route from OUH-SVE-ÆRØ is about 65 kilometers long.

The drones

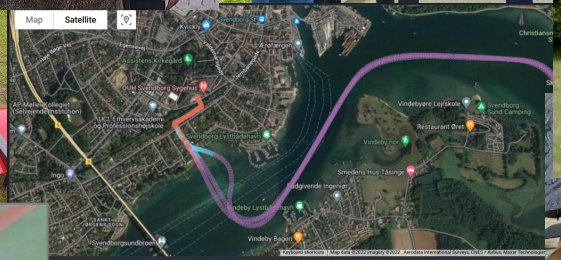
A Rigi Tech drone has been customised for the project.

The drone can fly the distance on a single battery charge, and a fail safe with parachute has been integrated in the drone for urban flights,

INDLAND

I dag testes droneleve-ring af blodprøver, men om et par år skal droner flyve læger ud til skade-steder

Mandag formiddag flyver sundhedsdronen ud på sin jomfrurejse. Den skal fragte blodprøver og medicin.



Building on the experience of the Healthdrone project Holo landed its first commercial drone logistics project in 2021 - flying in 2022

Members of the project

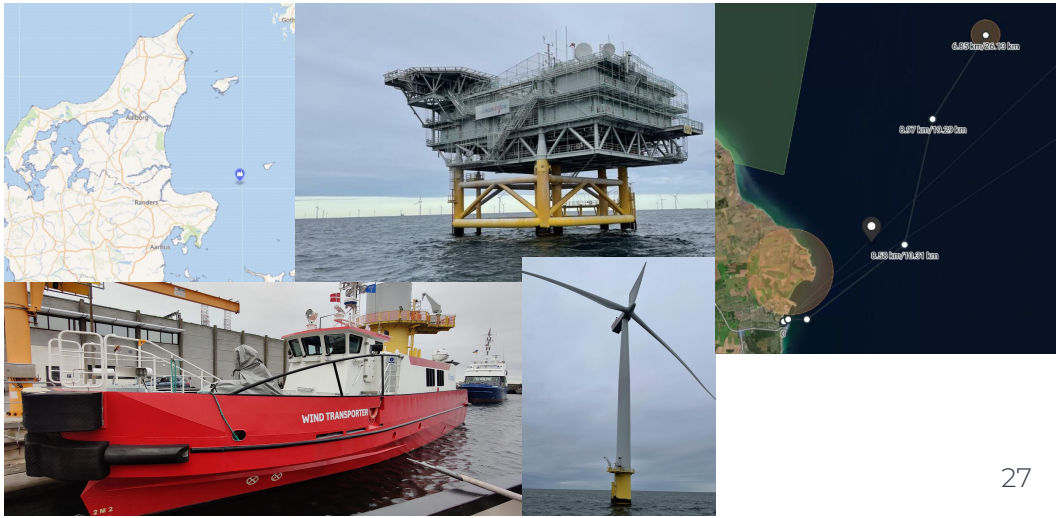
- Holo - responsible for project approvals, implementation and operating the vehicle
- Rigitech - supplying drones (hardware & software
- DSV - Logistics partner for Ørsted, building experience with flying drones
- Ørsted - End-customer, setting requirements for logistics off-shore

Basic facts about the project

- Location: Anholt Offshore Wind Farm, Denmark
- Distance on-shore to off-shore: 25.6 km
- Typical payload: Spare parts
- 3 project phases with increasing complexity (2021-2022)

Special characteristics

- Contract on commercial terms
- Off-shore
- Holo acts as logistics operator in DSV's existing network



The first phase of the DSV/Ørsted project has been completed - with more major milestones happening this year

Q2

Phase 1 - OSS Flights
(landed)

Q4

Phase 2 - Wind turbine flights

Q4

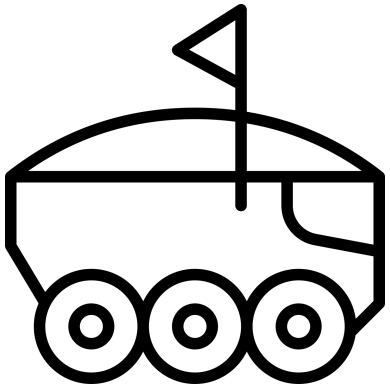
Phase 3 - Drone hoist

2023

Scaled operation

Freight robot project

To be announced



1. Partner introductions	2. Use case definition	3. Vehicle vendor selection	4. Planning & approvals	5. Operation	6. Documentation & analysis
- Introduction to partners - Eco-network understanding - Scoping partner goals and integrations	- Stakeholder alignment - Site inspections and identification of potential pitfalls - Use case definition	- Vehicle vendor comparison (matrix) - Identification of most suitable vendor for pilot - Contacts and SLAs	- Assistance in permits and dispensations (CE markings) - Operational planning (uptime) - Pin point of necessary ops integrations	- Training based on permits and vehicle - Ops support: Supervision, monitoring, maintenance, incident management	- Final operational report with learnings - Real time data dashboards - Root-based data driven analysis of operational performance

Holo Platform consists of a number of different components

Frontend

Holo user interfaces

Safety steward app

Analytics

Supervision UI

External user interfaces

Remote control by vendor

Fleetio

Fleet Maintenance Management

External user interfaces

Trapeze

Flextrafik

movia

Dispatch Mgmt configuration

Booking interface

Backend

Traffic management integrations

Ruter#

movia

PTA integrations

Emergency vehicles

Standard data integrations

Holo API

holo Platform

Flutter

python

Google Cloud Platform

Dispatch management integrations

Dispatch logic

Hardware

Vehicle integrations

Passenger vehicles (Navya, S4)

Freight vehicles

Drone vehicles (Rigitech)

Holo in-vehicle hardware & sensors

Holo video hardware

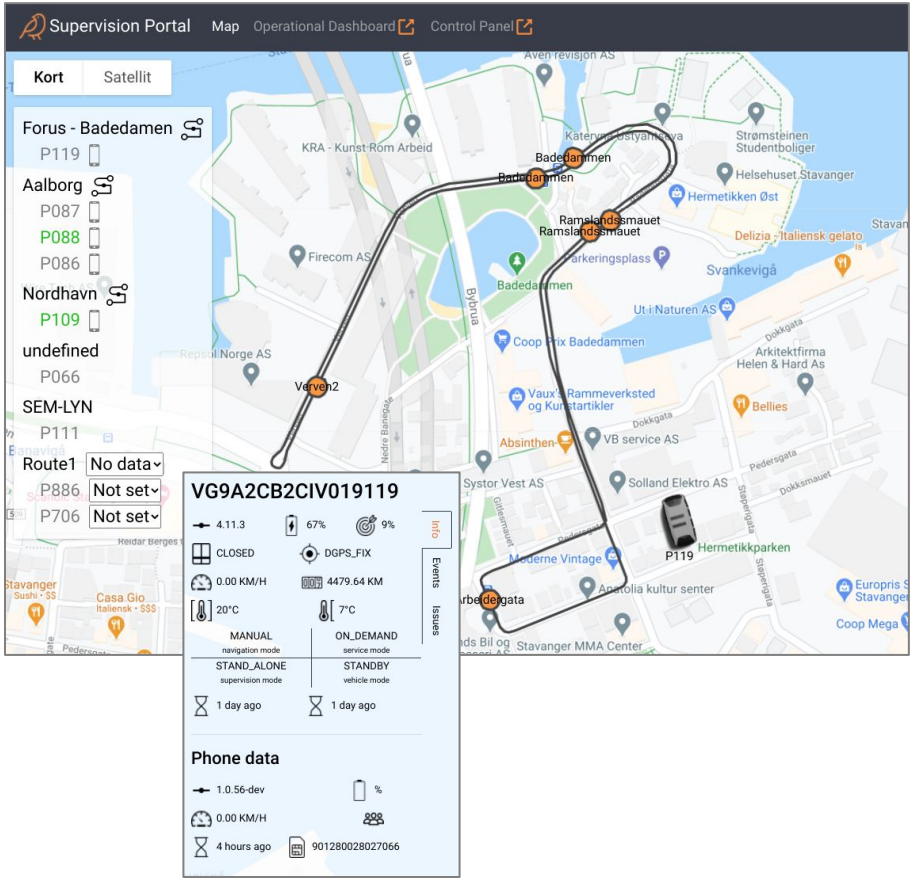
Holo telemetry sensor

Infrastructure integrations

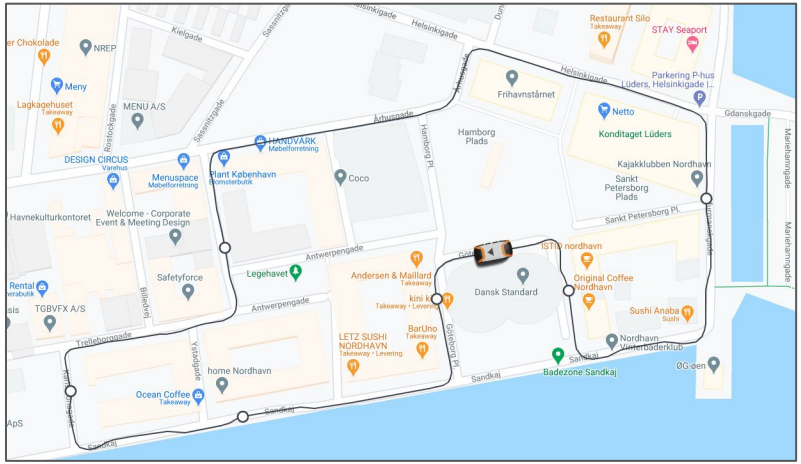
Interactive signs

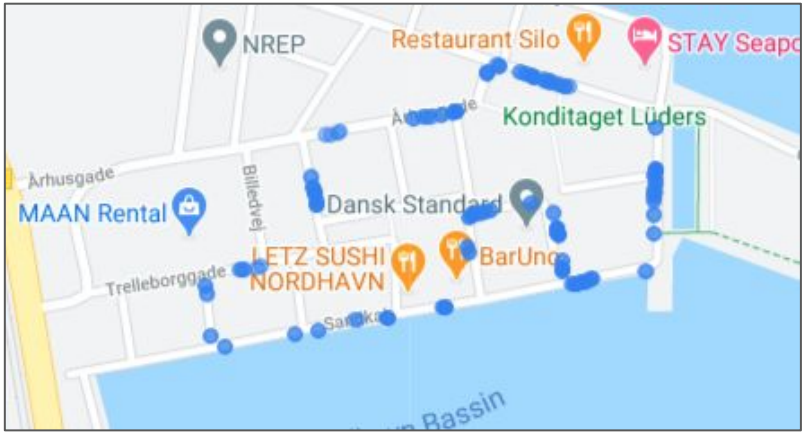
Traffic lights

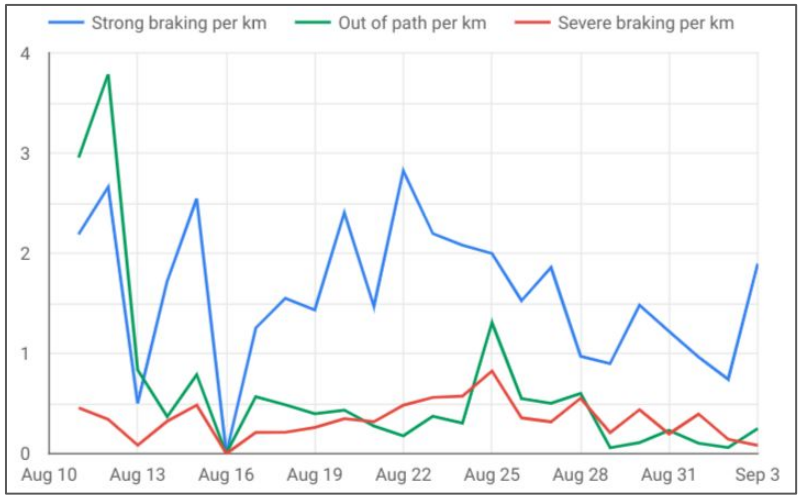
Holo’s Supervision UI makes it possible to monitor autonomous vehicles on the ground and in the air in real-time

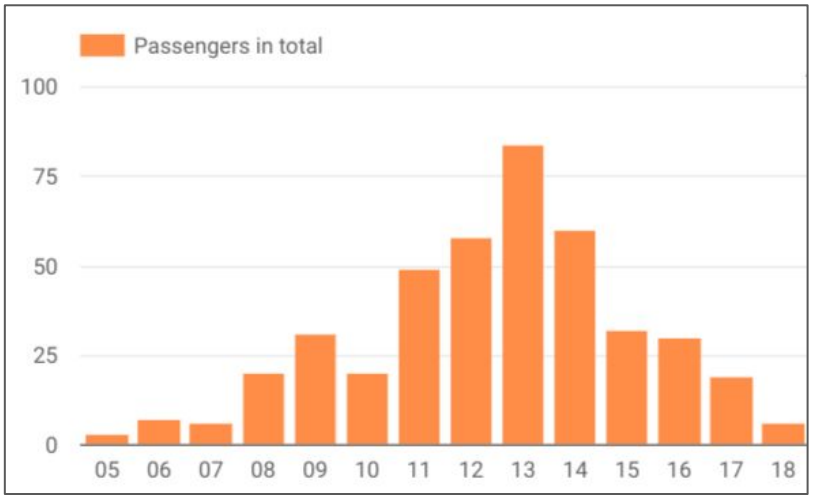


Holo’s operational dashboards are used to analyse route performance in detail







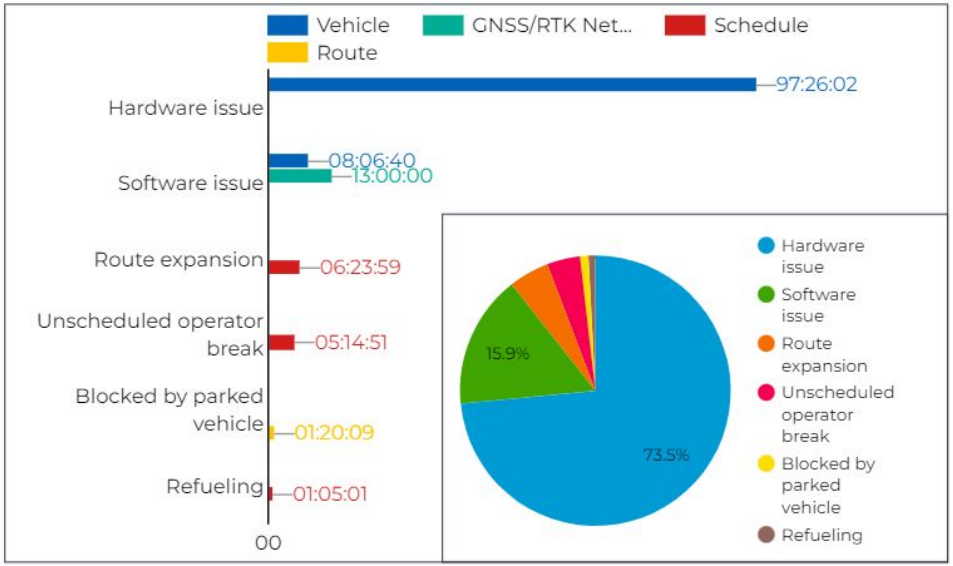


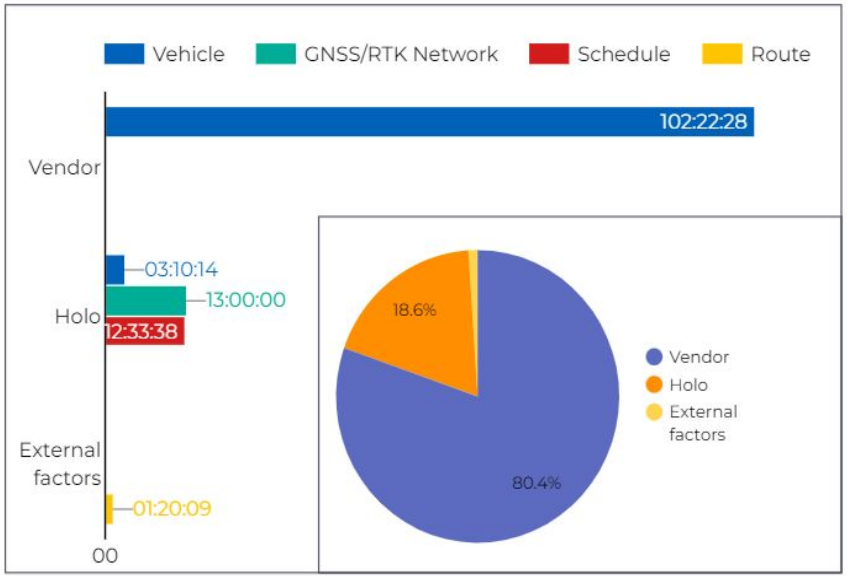
Holo's operational dashboards are used to analyse route performance in detail

Downtime causes

Uptime
60.86%

Downtime
39.14%





Holo can act as an innovation partner for companies developing autonomous software and autonomous vehicles - the “extended R&D department”

Go wider
Holo can help deploy software and vehicles to new locations and in new use cases

Go deeper
Holo can help with testing specific functionalities in real life - from V2X, to new methods for preparing to routes and integration with different systems

Go longer
Holo can help in adding kilometers and hours to the experience with both software and vehicle, in order to stress test and find faults

For companies interested in working with autonomous vehicles Holo can deliver services across the value chain

More at https://www.letsholo.com/services

Business Development

- Defining customer requirements and autonomous use-cases
- Calculating budgets and funding projects
- Contracts & SLAs
- Autonomous vehicle vendor management

Planning

- Vehicle approval
- Project / route approval
- Training
- Risk management

Operations

- Field operations
- Supervision
- Maintenance & logistics
- Deployment
- Compliance

Project management

Holo Platform integration

Contact

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