Nå

MilliAmpère – Norges første førerløse ferje

Egil Eide
Førsteamanuensis, *NTNU*

The Development of an Autonomous Shuttle Ferry in Trondheim

Associate Professor Egil Eide,
Department of Electronics Systems, NTNU

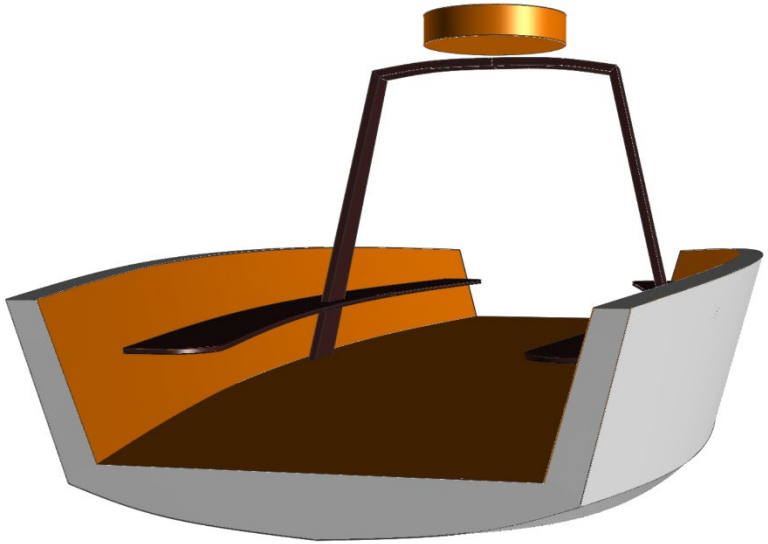
NTNU
Kunnskap for en bedre verden

- Technologically feasible
- Scalable and reconfigurable
- A new tourist attraction for Trondheim City
- Low environmental footprint and cheaper than bridge

NTNU
Kunnskap for en bedre verden

Department of Electronics Systems
Department of Engineering Cybernetics
Department of Marine Technology

NTNU AMOS
Centre for Autonomous Marine Operations and Systems



Concept

- **”On-demand ferry”** - push the button for the ferry to come
- Traveling time: **1 minute** → low latency
- Passengers: **12 persons**
- **Electrical propulsion**, **Automatic charging** of batteries
- Navigation: **High-precision GNSS (cm accuracy)** plus backup system
- **Anti-collision system**

Cable Ferry, Koster, Bohus Län, Sweden

Urban ferries in Norway

"Sundbåten" Kristiansund, Norway

"Kolbjørn III" Arendal, Norway

"Beffen" Bergen, Norway


Fosenkaia
Vestre Kanalkai
Ravnkloa
Vestre Kanalkai
Vestre Kanalkai
Kai 19
Kai 20
Kai 21
Frostakaia
Fjordgata
Munkegata
Taraldsgårdsveita
Jomfrugata
Credoveita
Olav Tryggvasons gate
706
706
706
E 6

Fløtmanns-båt i 20 år

En gammel tradisjon ble gjenopptatt i 1997. Siden har Fløtmannsbåten fraktet folk i rolig tempo mellom Fosenkaia og Ravnkloa i sommermånedene. I dag markeres jubileet under Kystens dag.

Ro, ro: Blide passasjerer på vei mellom Fosenkaia og Ravnkloa i «Fløtmann I». Foto: EGIL EIDE

»Trondheim

Fløtmannsbåt

– Det er idyllisk og trivelig å bli rodd over kanalen i sakte fart, sier Egil Eide i Kystlaget Trondhjem, i en pressemelding.

– Mange turister og trondhjemmere tar turen med Fløtmannsbåten over til Fosenkaia, og dette er en enkel og flott måte å oppleve havna og båtlivet midt i hjertet av byen, fortsetter han.

120 år tilbake

I sommer er det 20 år siden Fløtmannsbåten ble bygd og sjøsatt i forbindelse med byjubileet i 1997. Båten «Fløtmann I» er bygd på Fosenkaia av Vegard Rye Carlsen og var en gave til byens befolkning fra E.A. Smith.

Historien til fløtmann strekker seg over 120 år tilbake, og har sitt opphav i oppføringen av Brattøra og anlegget rundt jernbanen i begynnelsen av 1880-årene. Spesielt etter at St. Olavs bru ble revet i 1920, var båtforbindelsen en stor besparelse for folk som arbeidet på Brattøra, eller reisende som skulle til Trondheims vestlige områder.

Da sporveien kom var det bare Singsakertrikken som gikk til jernbanen, og det skjedde ikke før i 1927. I helgene ble båten mye benyttet av folk som la spasertur over Brattøra, og Fløtmannstrafikken besto frem til 1965. Turen har i prinsippet alltid kostet like mye som å ta trikken, og flere av byens borgere husker fortsatt at det kostet en 10-øring å bli rodd over kanalen.

Markeres lørdag

I anledning byjubileet i 1997 gjenopptok Kystlaget Trondhjem denne gamle tradisjonen, og fikk bygd båten på Fosenkaia. Fortsatt frakter den passasjerer mellom Fosenkaia og Ravnkloa i sommermånedene. Jubileet markeres under Kystens dag lørdag 10. juni kl. 12.30 på Fosenkaia. Både båtbygger og fløtmannen fra 1997 vil delta.

Kystlaget Trondhjem har 430 medlemmer og er tilsluttet Forbundet Kysten, som har over 10 000 medlemmer fordelt på 125 kystlag.

BÅRD SANDE 959 14 260
baard.sande@adresseavisen.no

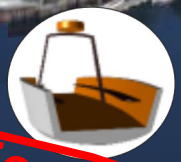
– Mange turister og trondhjemmere tar turen med Fløtmannsbåten over til Fosenkaia.

Egil Eide, i Kystlaget Trondhjem.

Autonomous shuttle buses - a key component for Smart City Urban Mobility

A new entrance for cruise tourists

Autonomous shuttle bus



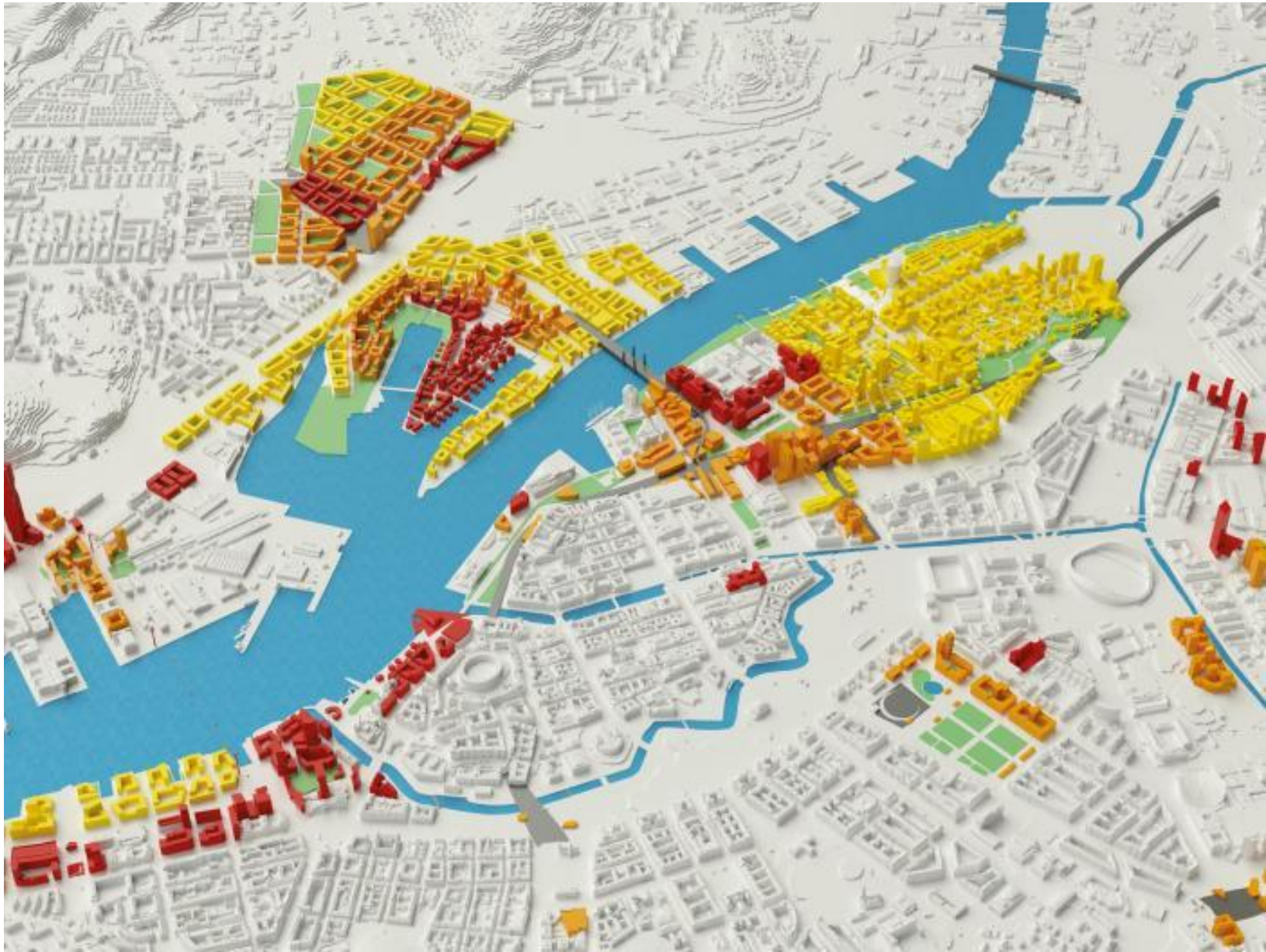
Ferry

To Nidaros Cathedral

Urban waterways: The next generation of autonomous transportation

"… autonomous ferries will be able to replace bridges and fossile-fuelled ferries in a clean and cost-effective way, increasing quality of life in urban areas and enabling development of areas previously not connected to the cities due to lack of infrastructure."
(Reaktor, Finland)

Urban City Development: Riverside Project, Gothenburg



Time schedule

Phase 1 (2016): Concept study, student projects. **Webcamera and radar** to register boat traffic i the harbour. Dynamic Position system to be tested onboard **ReVolt** from DNV GL in Trondheim Harbour.

Phase 2 (2017/2018): Autonomous **pilot ferry** for concept testing and to study behaviour of the other boat traffic.

Phase 3 (2018/2019): Full scale ferry certified for passengers.

Master Thesis Work 2016-2017

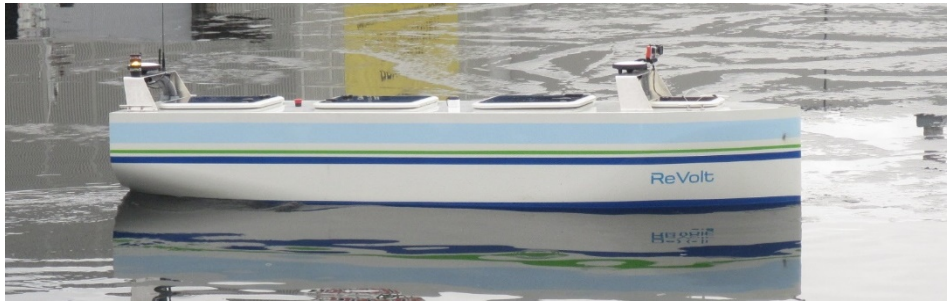
Henrik Alfheim

Kjetil Muggerud:

”Development of a Dynamic Positioning System for the ReVolt Model Ship”

Reported in Der Spiegel, Sächsische Zeitung, ZTV

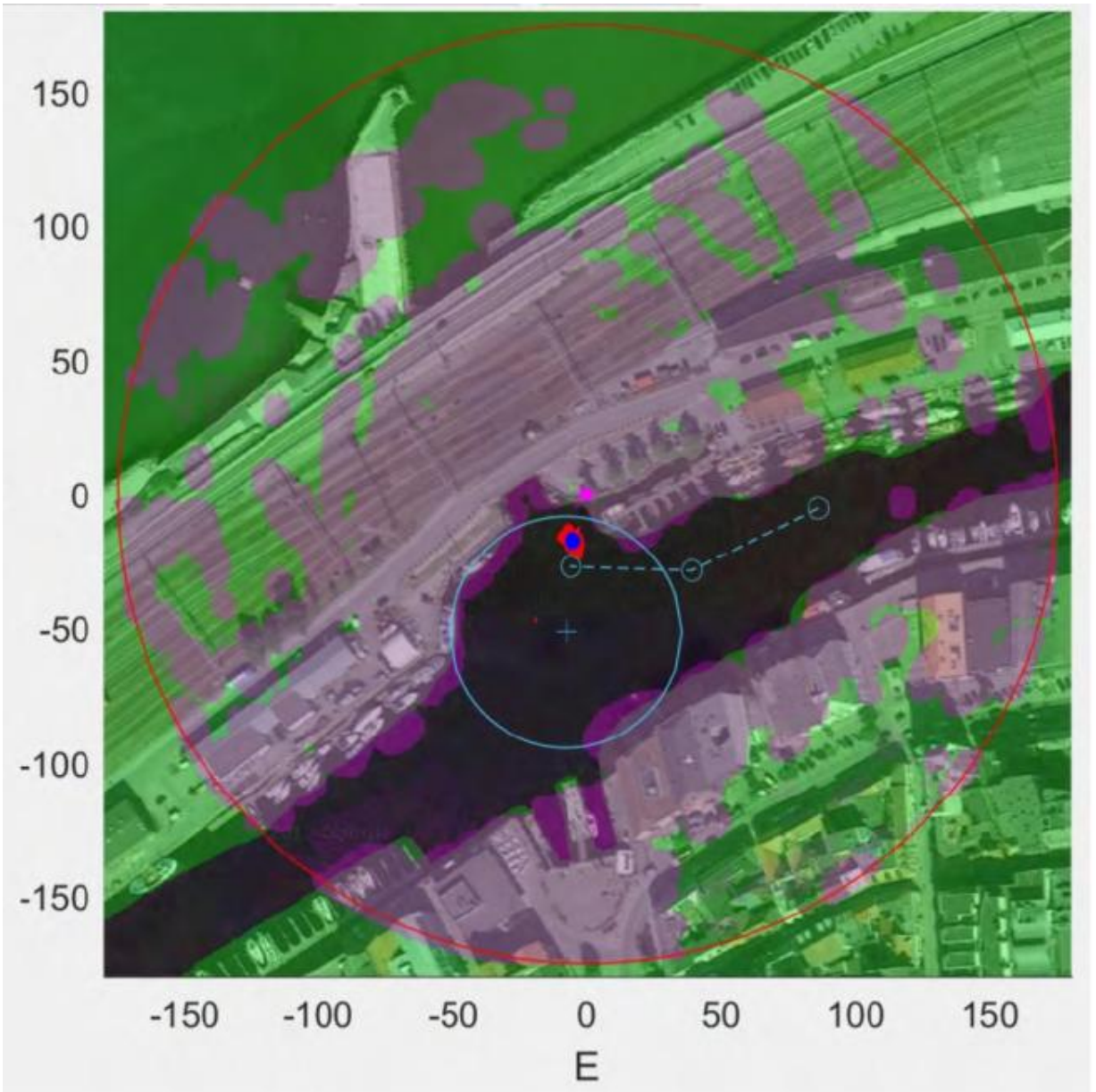
http://www.3sat.de/mediathek/?mode=play&obj=65614




ReVolt

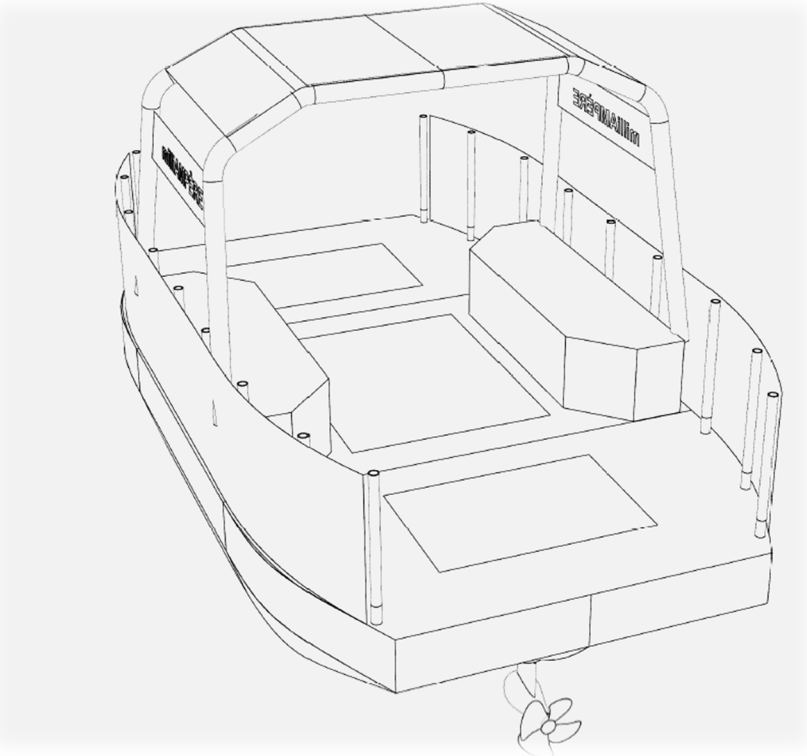
Phase 1: Monitoring boat traffic in the harbour

Tracking small boats in the Trondheim canal
Courtesy: Jesper Pedersen, Project Report, December 2018

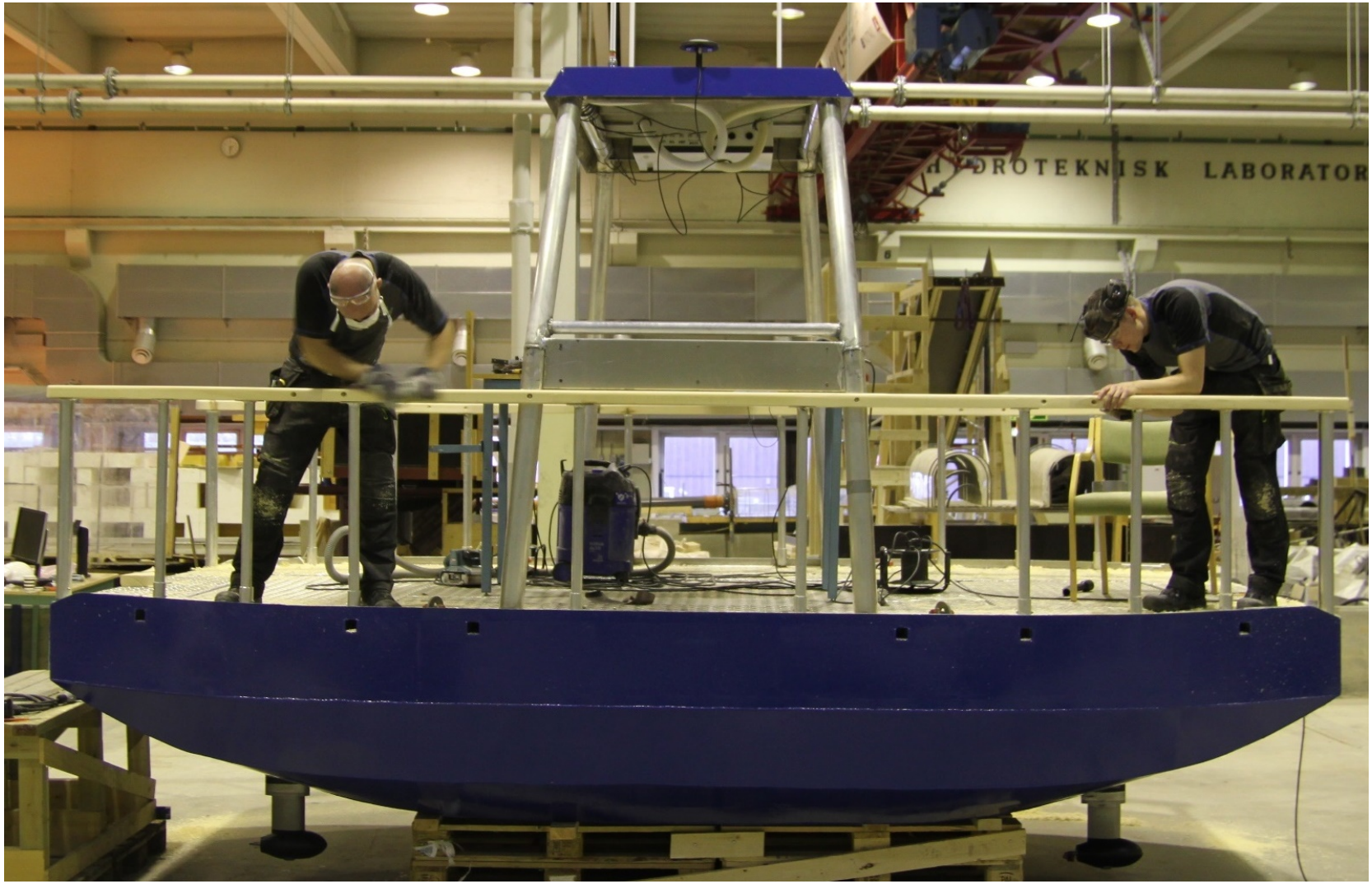


Phase 2: Prototype Ferry (development platform)

- **Funded by NTNU and AMOS**
- **Aluminum hull with scale 1:2 (5 m long)**
- **Testing of propulsion system, batteries and charging system**
- **Development of navigation system, DP system and automatic docking**
- **Testing of anti-collision sensors**
- **Development of anti-collision system**
- **Safe remote control including HMI**
- **Operational aspects**



Construction phase Summer 2017



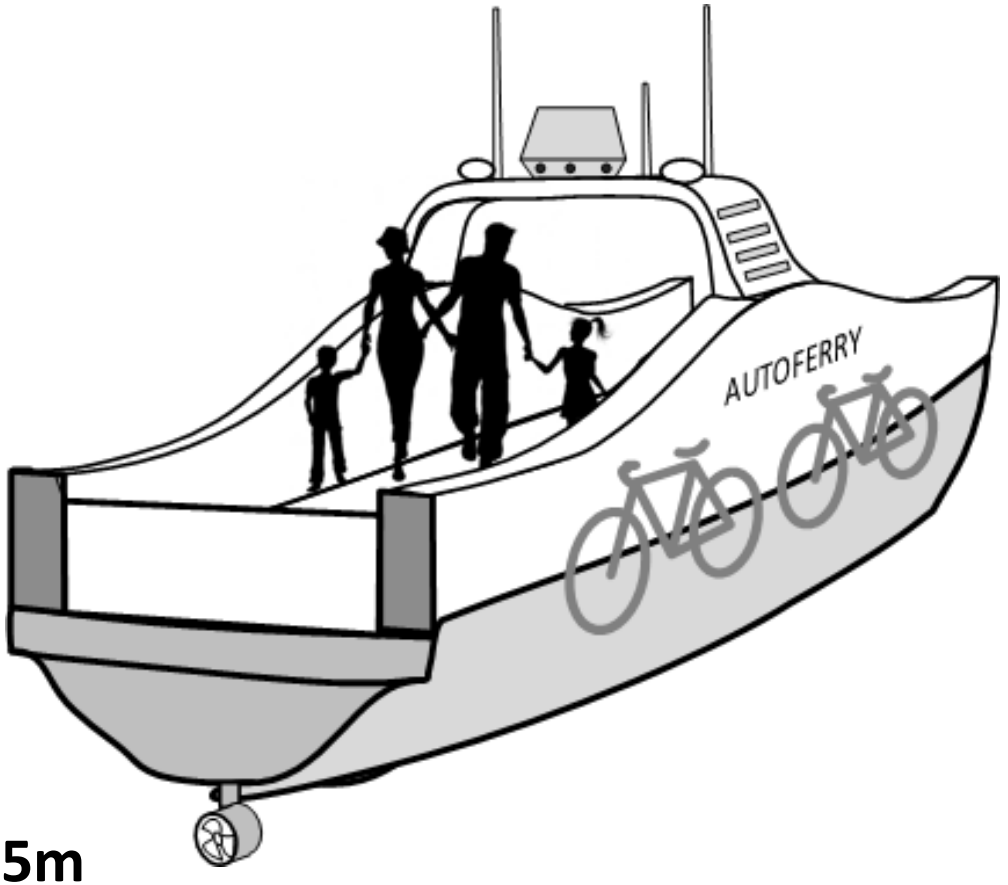
First technical sea trials. 11 Nov 2017

- Batteries, thrusters, OBC and Remote control installed and tested
- Navigation sensors (RTK GNSS and IMU) installed
- Dynamic Position software installed and tested
- Development of automatic docking summer 2018
- Testing of anti-collision sensors in Trondheim Harbour fall 2018

«milliAmpére» (18.06.2018)

«milliAmpére»

Phase 3: Full Scale Ferry



- 12 PAX
- Size: LOA: 8–10m x Beam: 3.5m
- Automatic battery charging (induction)
- Propulsion: 2 x 10kW azimuth thrusters
- RTK GNSS-compass + Radar + Camera + LIDAR system
- AIS and 2-way wireless communication including video

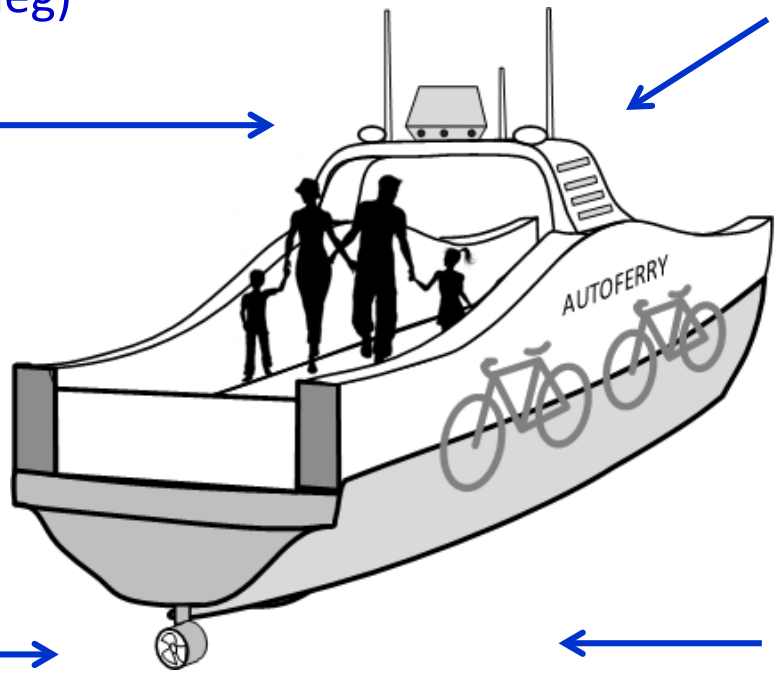
Sensors & Communciation Systems

Navigation, COLAV, docking:

- GNSS, (GPS,Galileo, Glonass)
  (RTK – Real Time Kinematic)
- LIDAR («laser radar»)
  (SLAM – Simultaneous Localization and Mapping)
- Radar
- Ultra Wideband short range radars)
- Optical cameras (360deg)
- Stereo cameras
- Ifrared (IR) cameras

Communication:

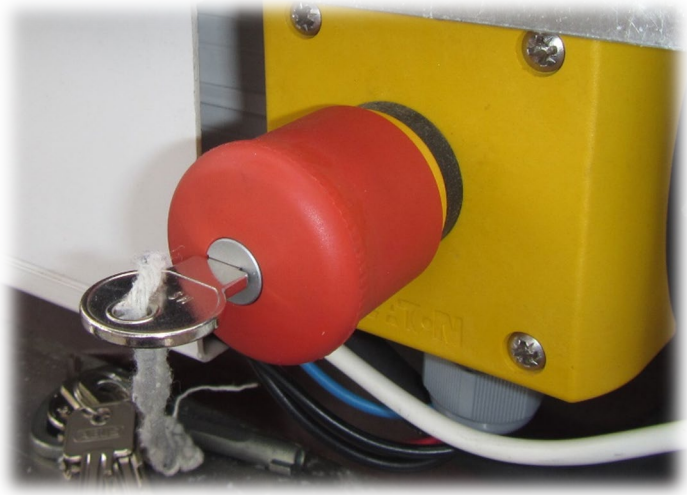
- **Narrowband:**
  - AIS
  - data telemetry
  - RTK (DGPS)
- **Wideband:**
  - Video
  - Sensor data



Docking system
System monitoring

Batteries
Propulsion
Charging system

Safety first



- Dual systems (redundancy)
- COLAV system (stop and hold?)
- Emergency stop, MOB
- Evacuation – life
- Hull design – damage stability
- Fire detectors – fire extinguising system
- Signals, lights, lane marking

- Passenger supervision – 2-way video to Shore Control Center

Success Criteria

Safety

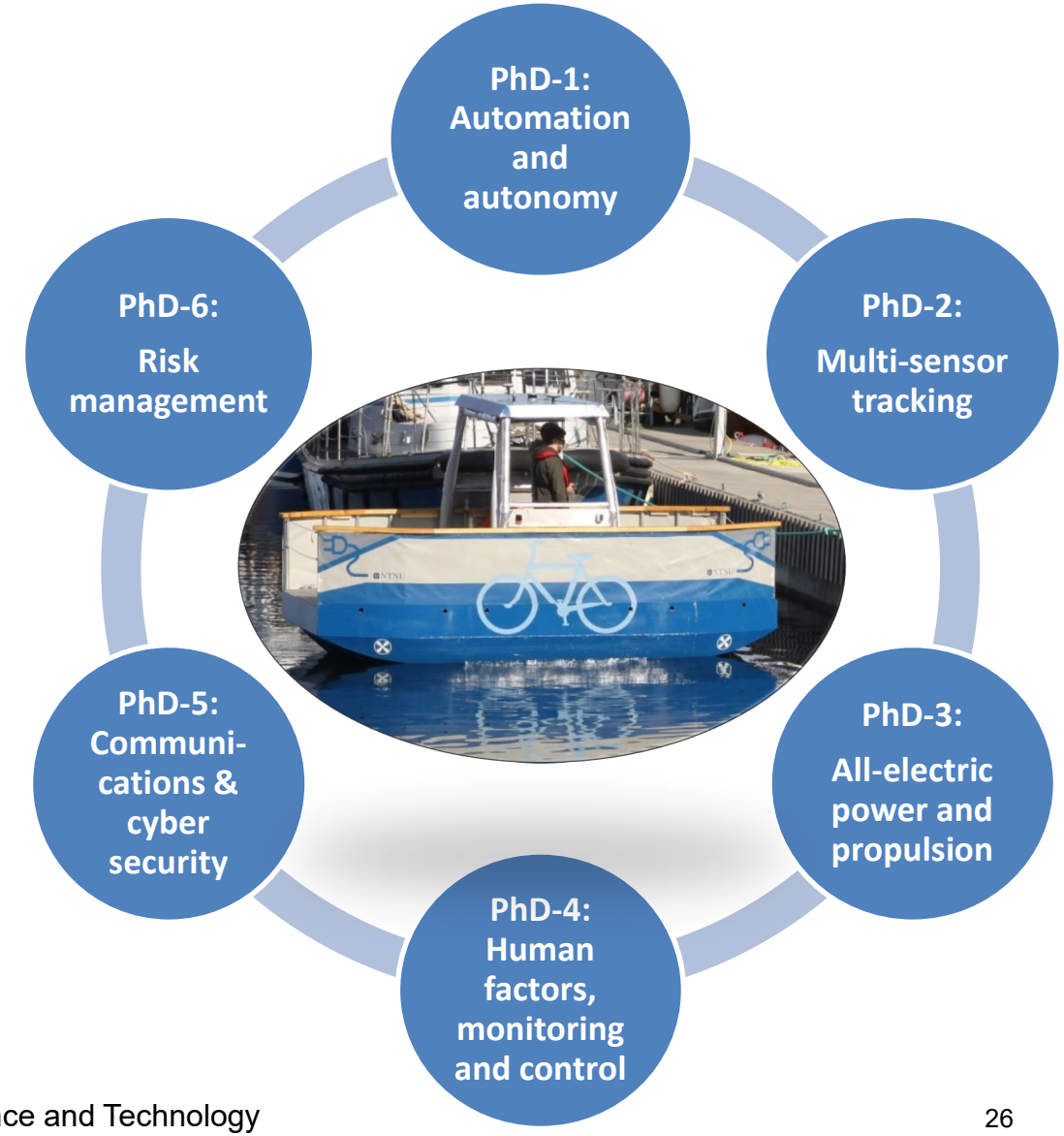
- Risk assessment
- Automatic registration of passengers
- Robust anti-collision system
- Redundant navigation systems
- Monitoring and remote control

Reliability

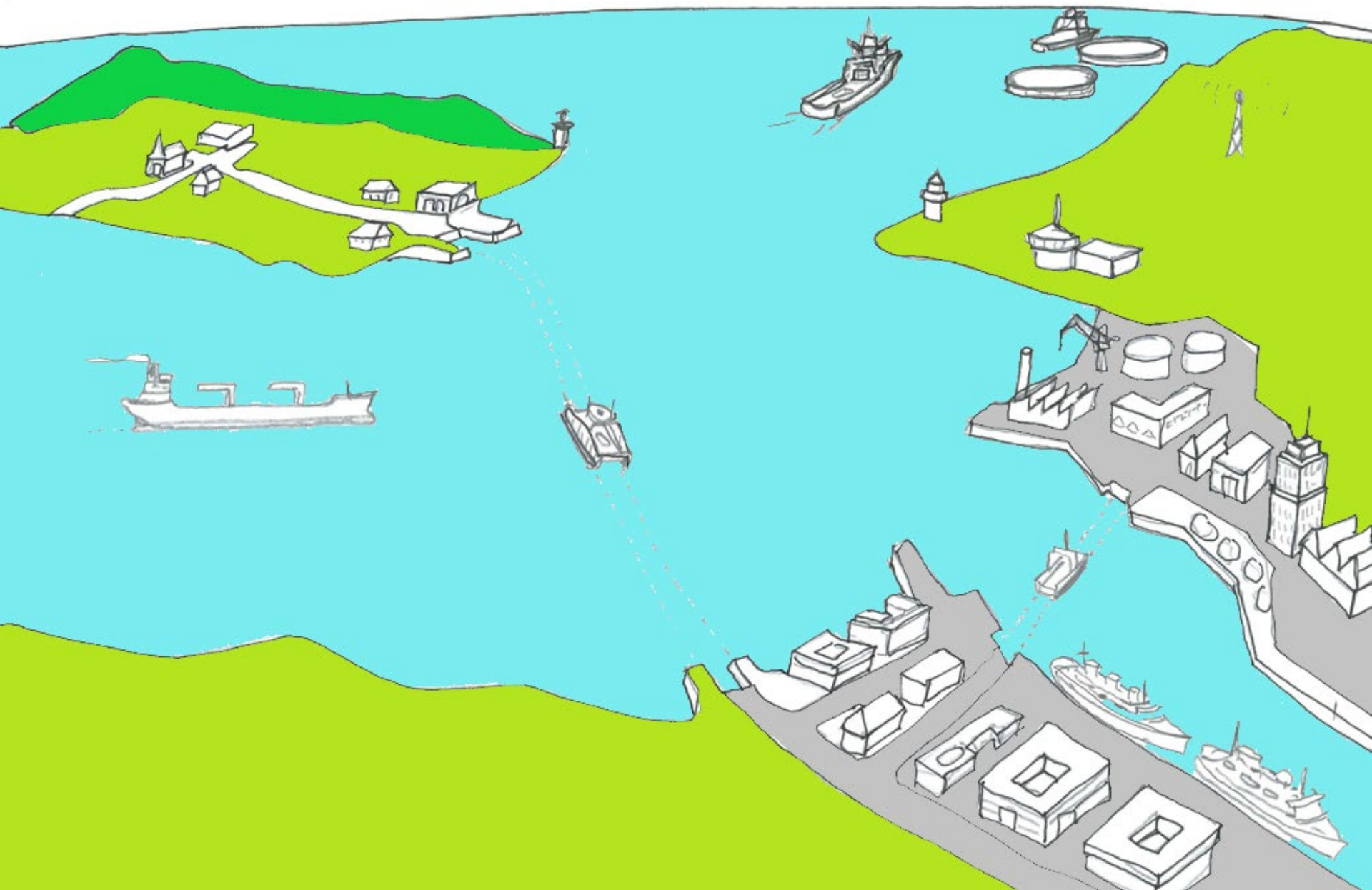
- Easy to use
- Work all around the year
- Efficient transportation – low latency
- Robust design – low probability of errors
- Minimized need for maintenance

Autoferry Project (NTNU Digital Transformation)

- **19 researchers** from three faculties and all three NTNU campuses: Trondheim, Ålesund and Gjøvik
- **Six new PhD positions** (+ 3 already started)
- **External project partners** Trondheim Harbour, DNV GL, Maritime Robotics and Kongsberg Seatex
- **International collaborators** from all over the world



From Urban ferries to Coastal ferries



Long Term Goals

- Develop an integrated solution, ensuring a safe and robust urban transportation system
- Develop solutions for efficient operations and maintenance, logistics, customer service and support
- Build trust, confidence and social acceptance for the new technologies
- Build a roadmap to commercially viable and scalable solutions