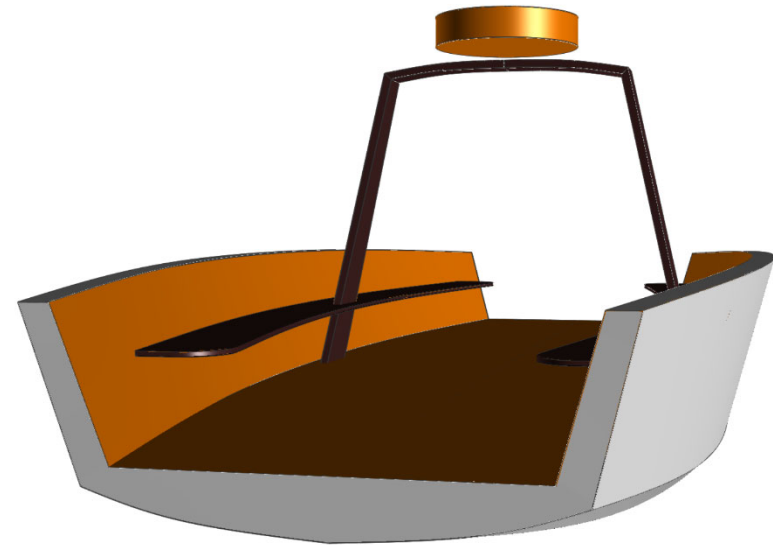


The Development of an Autonomous Shuttle Ferry in Trondheim

Associate Professor Egil Eide,
Department of Electronics Systems, NTNU

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





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**

Urban ferries in Norway

“Sundbåten” Kristiansund, Norway



“Kolbjørn III” Arendal, Norway



**“Beffen”
Bergen,
Norway**



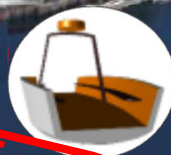
Autonomous shuttle buses - a key component for Smart City Urban Mobility



A new entrance
for cruise
tourists

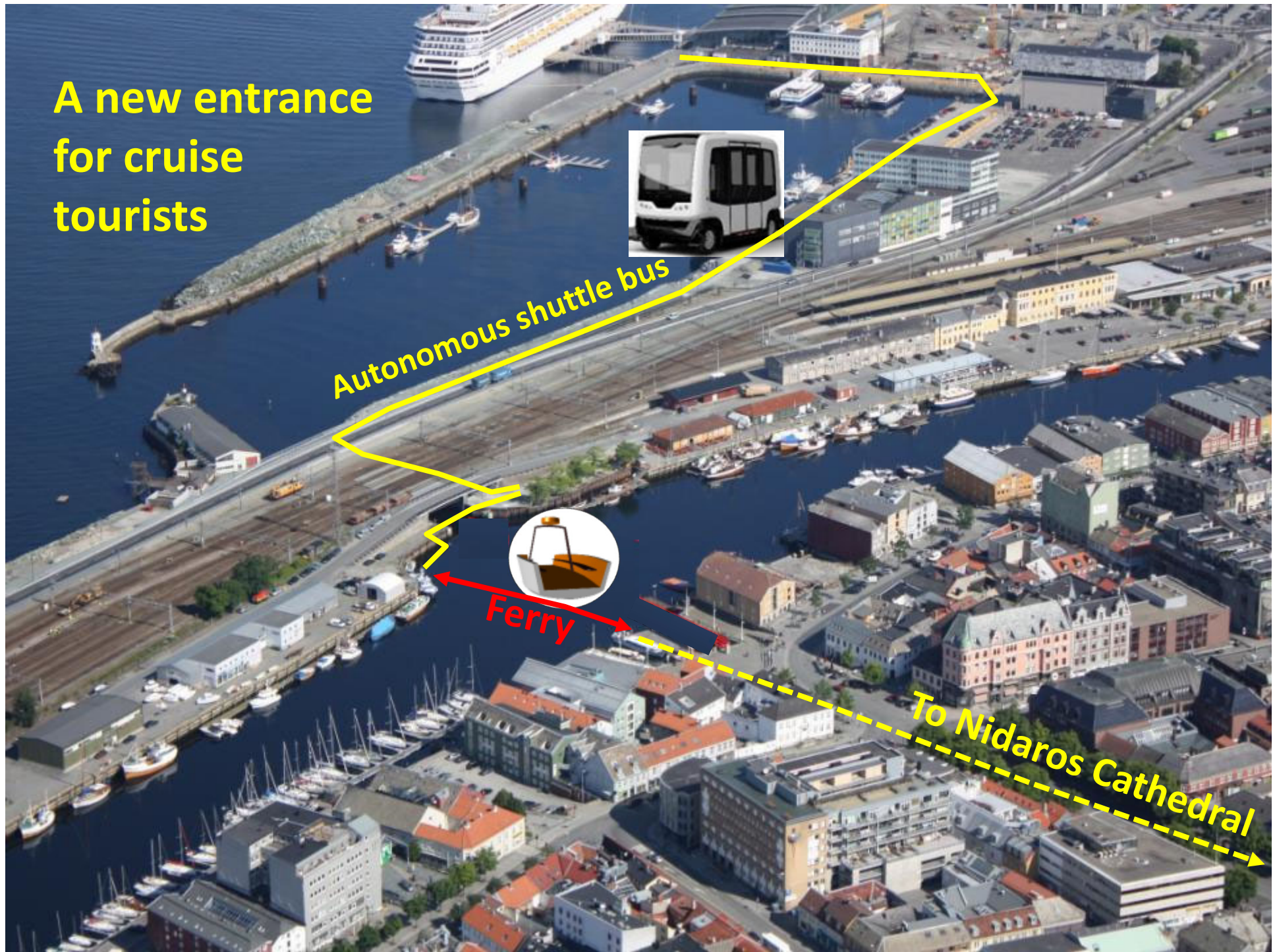


Autonomous shuttle bus



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)**

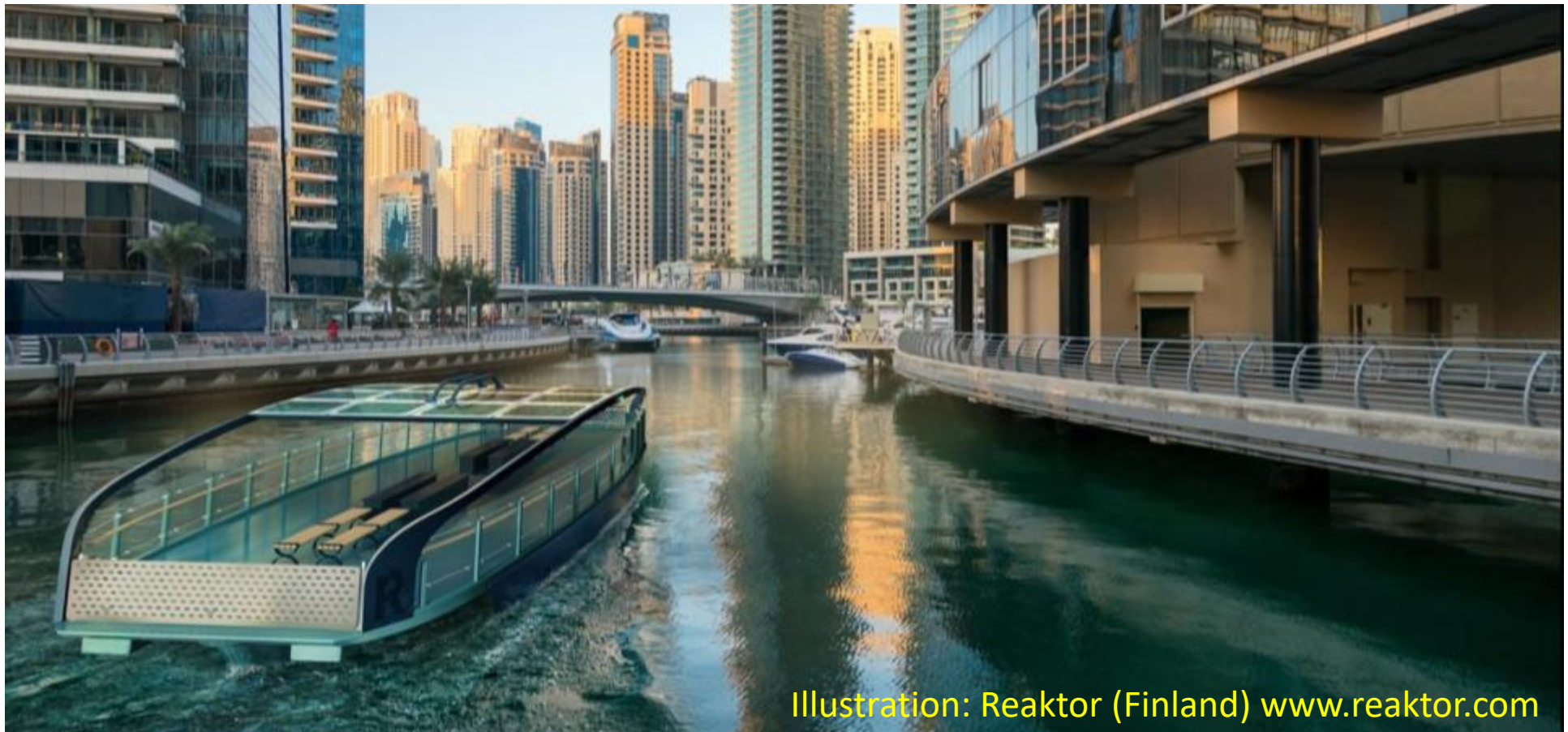
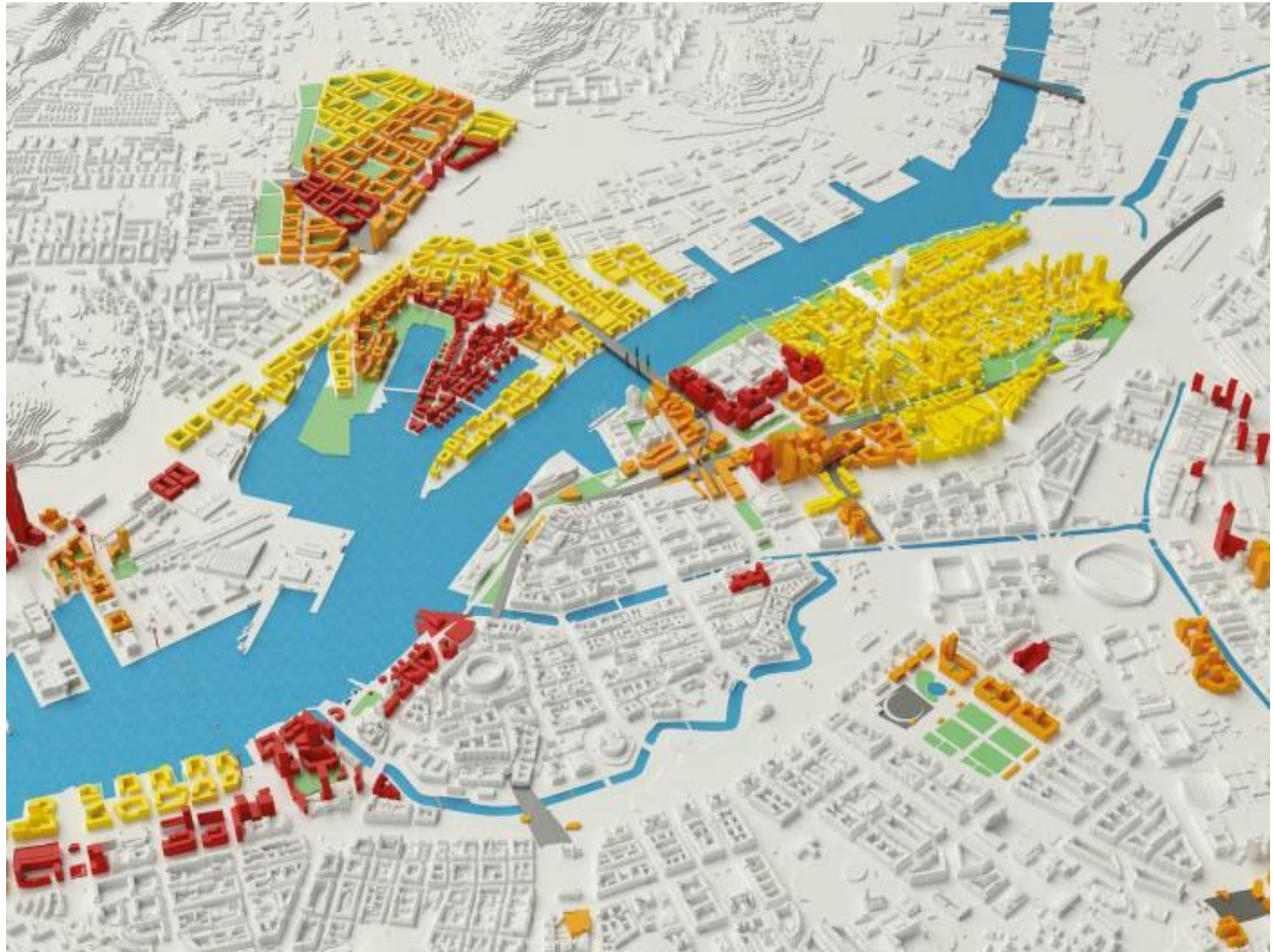


Illustration: Reaktor (Finland) www.reaktor.com

Urban City Development: Riverside Project, Gothenburg





Courtesy: DNV GL

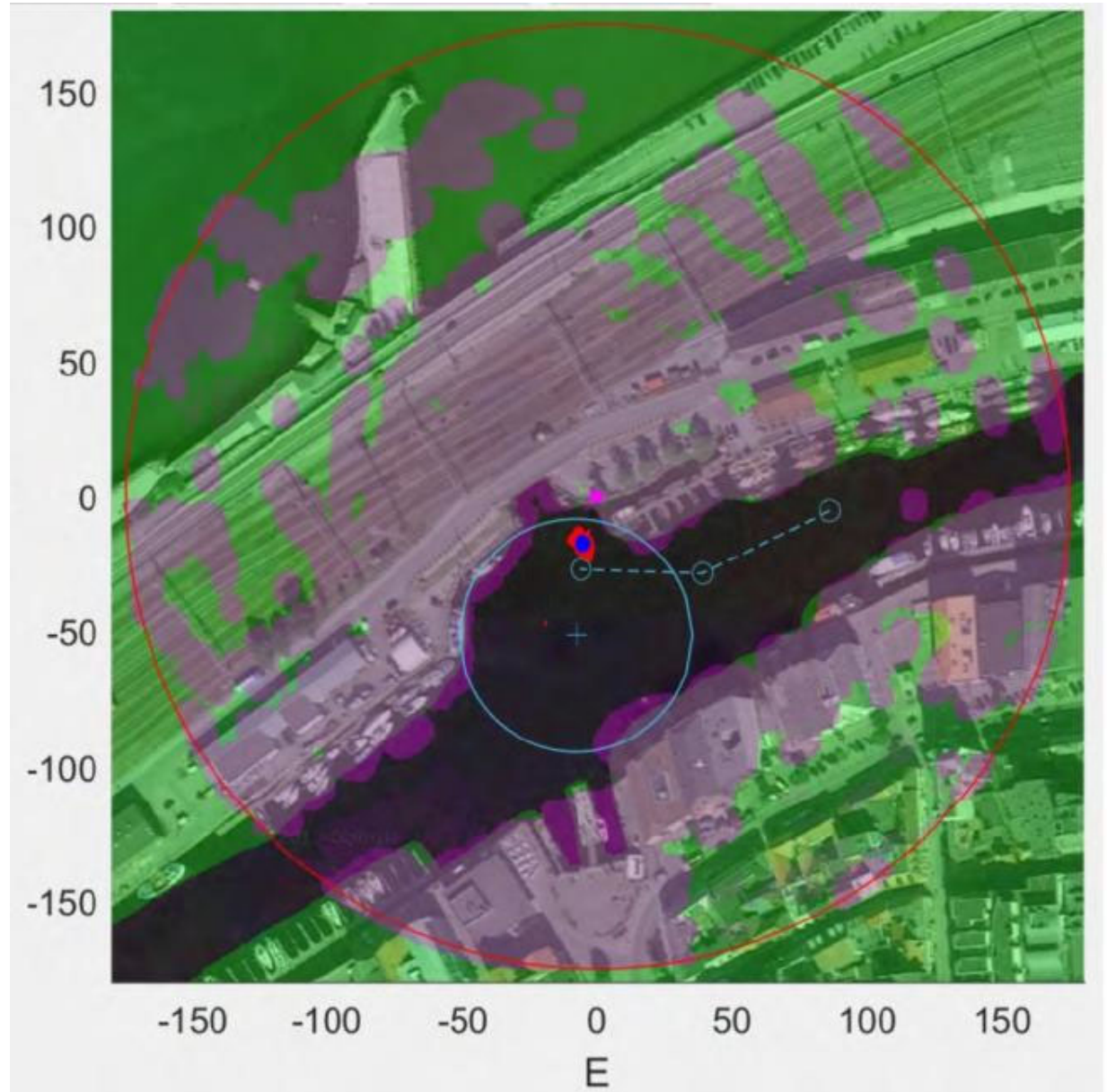
Time schedule

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.

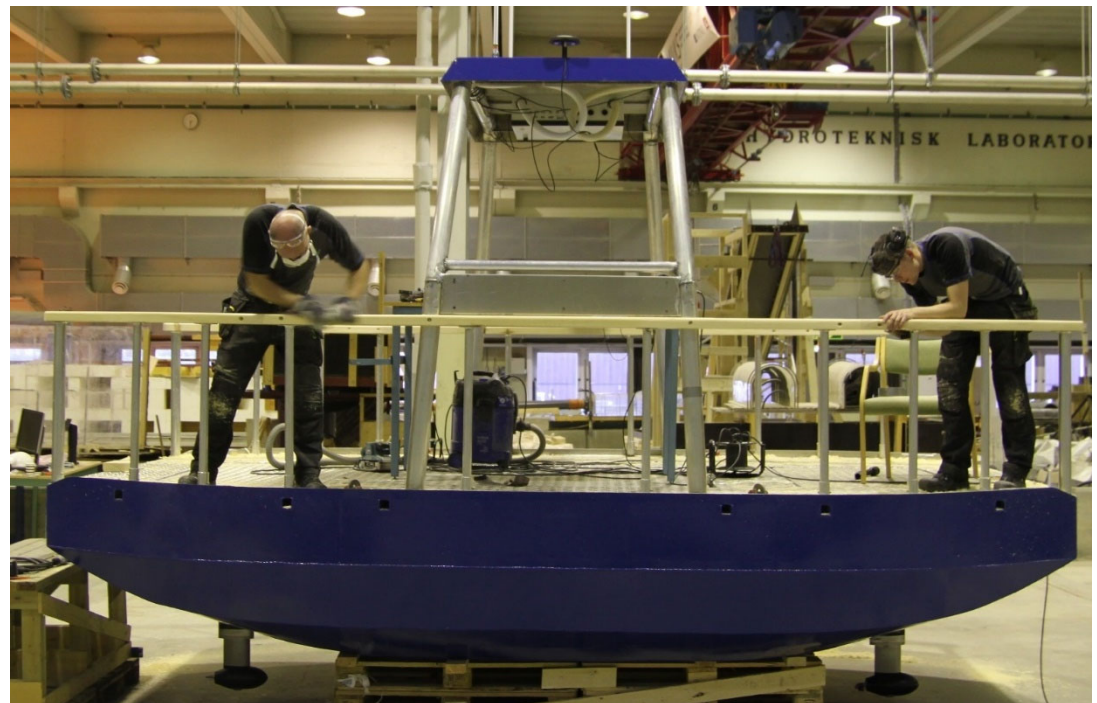
Phase 3 (2018/2019): **Full scale ferry** certified for passengers.

Phase 1: Monitoring boat traffic in the harbour



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**
- **Development of anti-collision system and safe remote control HMI**



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

«milliAmpère» (18.06.2018)

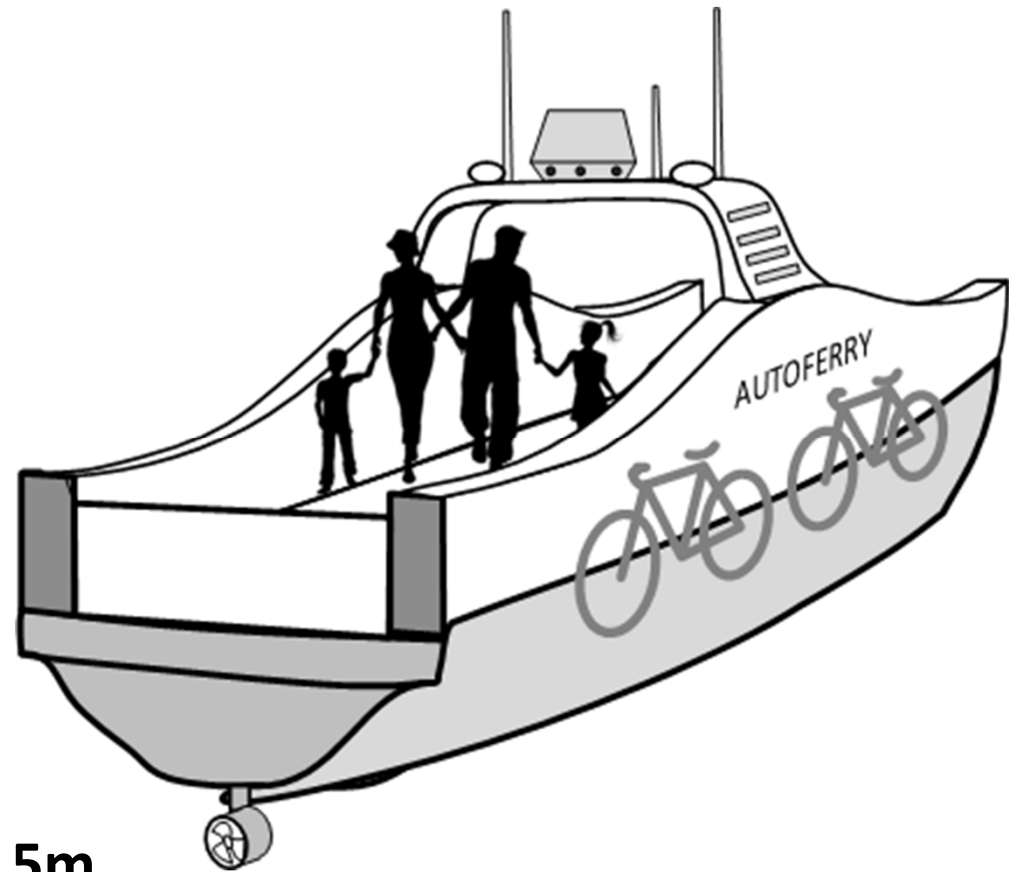


«milliAmpère»

Radar
← 360° camera + IR
GNSS →
Stereo cameras →
Light beacon →
← LIDAR

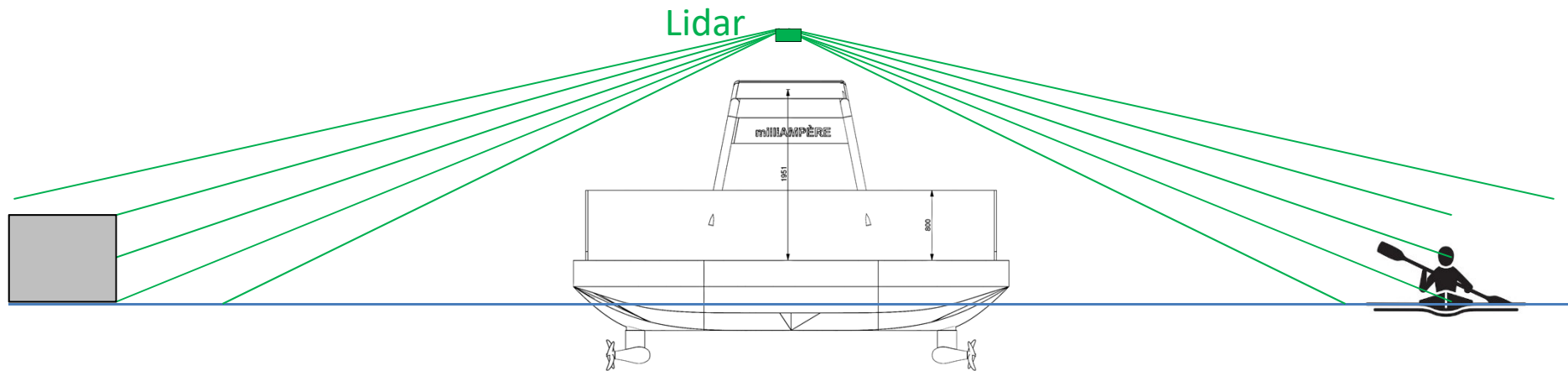


Phase 3: Full Scale Ferry

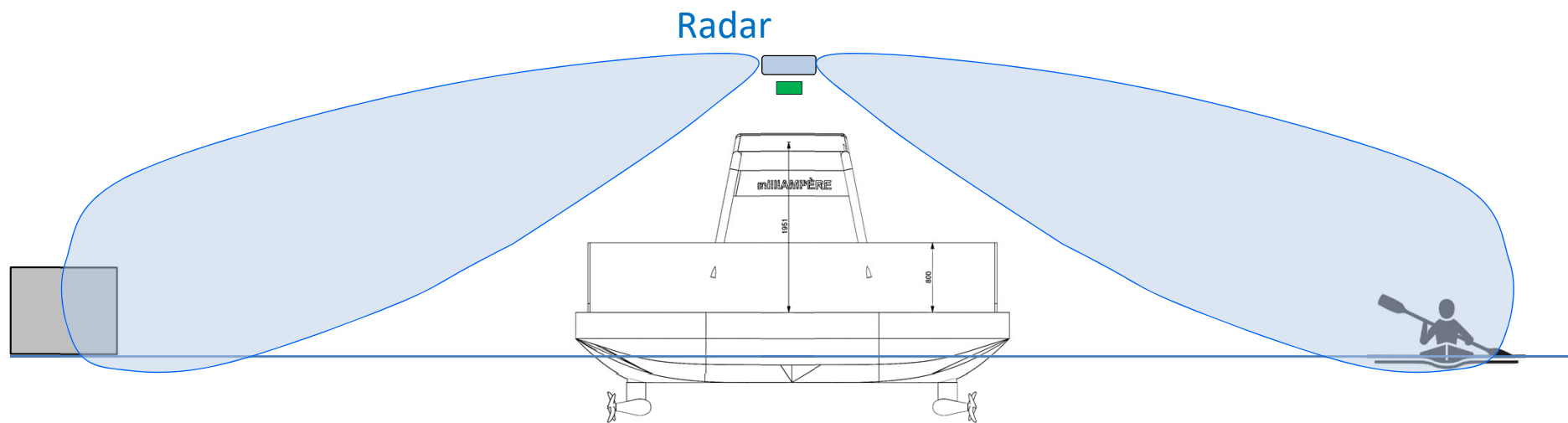


- 12 Passengers
- Size: LOA: 8–10m x Beam: 3.5m
- Automatic battery charging (induction)
- Propulsion: 4 x 4kW azimuth thrusters
- RTK GNSS-compass + Radar + Camera + LIDAR system
- AIS and 2-way wireless communication including video

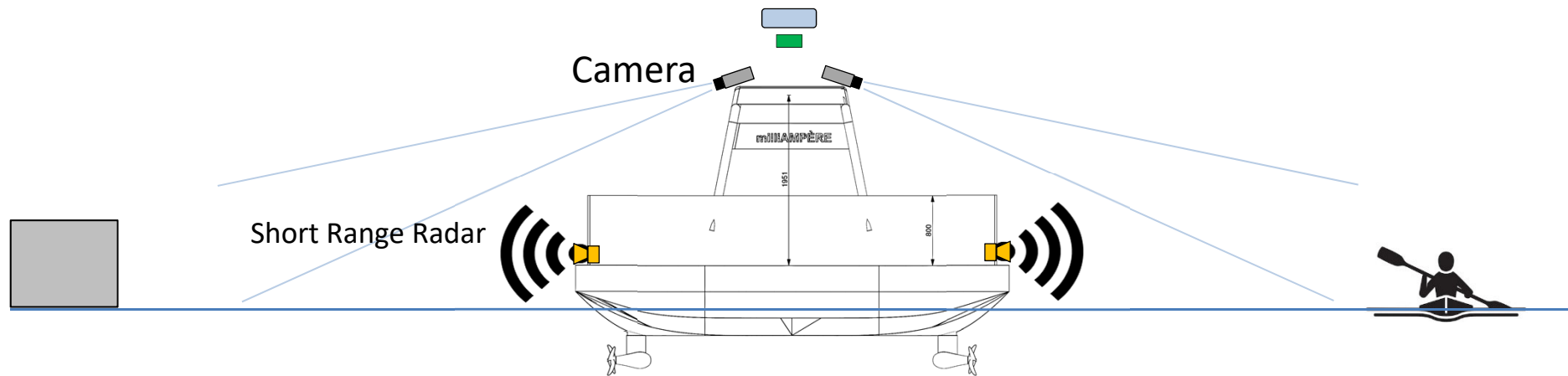
Anti Collision Sensors



Anti Collision Sensors



Anti Collision Sensors



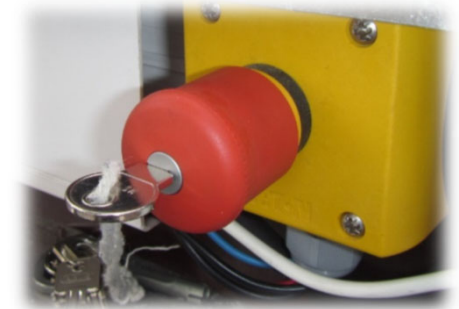
Success Criteria

Safety

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

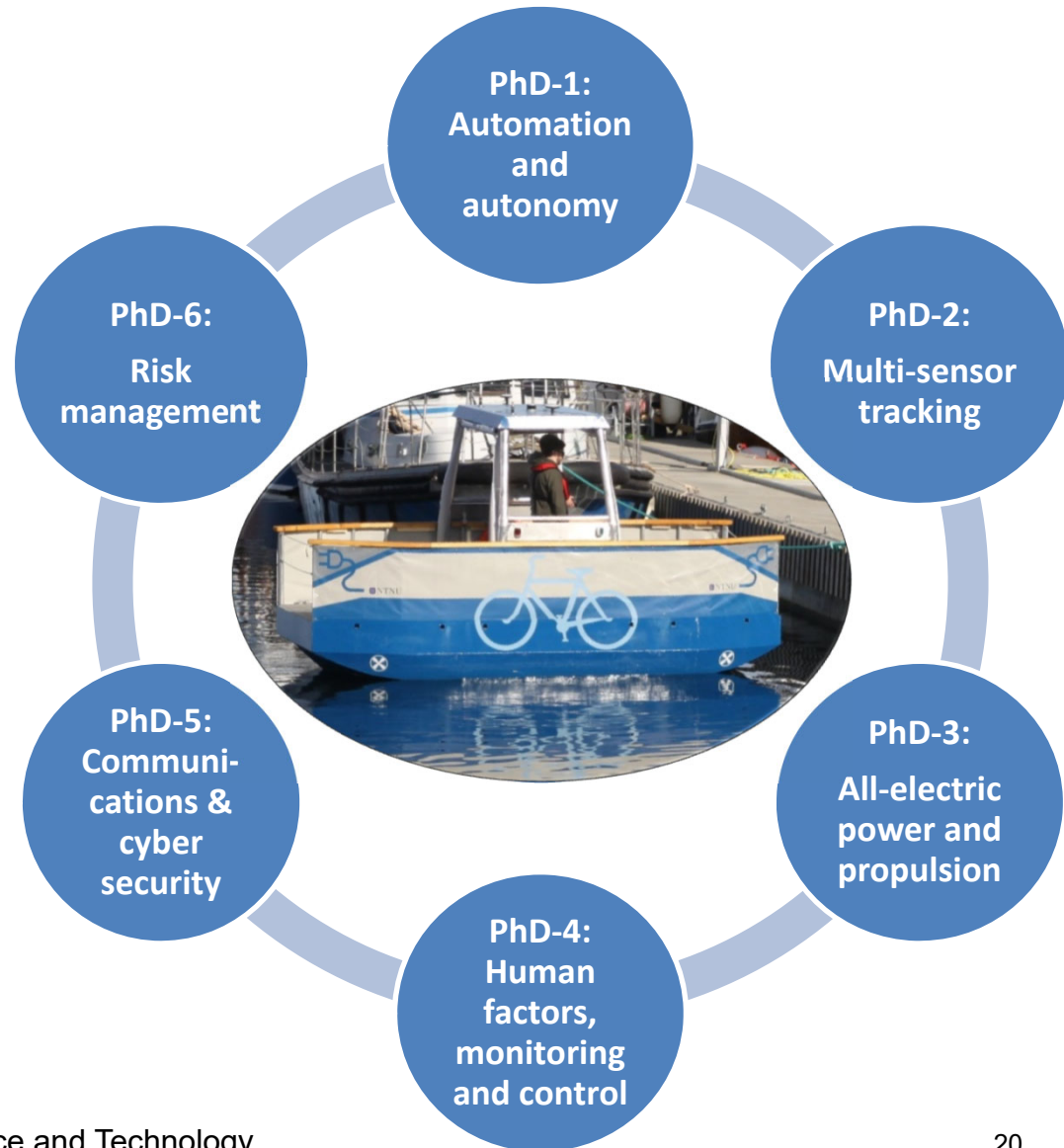
Reliability

- 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**

