



MARITIME UNMANNED NAVIGATION THROUGH INTELLIGENCE IN NETWORKS

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## Key facts about MUNIN

### Budget:

- Total: EUR 3.8 million
- Funding: EUR 2.9 million

### Time:

- Start: 01. 09.2012
- Duration: 36 months

### Partners:

- Fraunhofer CML
- MARINTEK
- Chalmers University
- Hochschule Wismar
- Aptomar
- MarineSoft
- MARORKA
- University College Cork

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Grant Agreement No 314286

## From mythology to technology

In Nordic mythology, Munin is a raven of the god Odin. His name means "mind" in Norse and he is sent out every morning to fly around the world. In the evening, Munin returns safely to his master and delivers the information that he has gathered independently during the day.

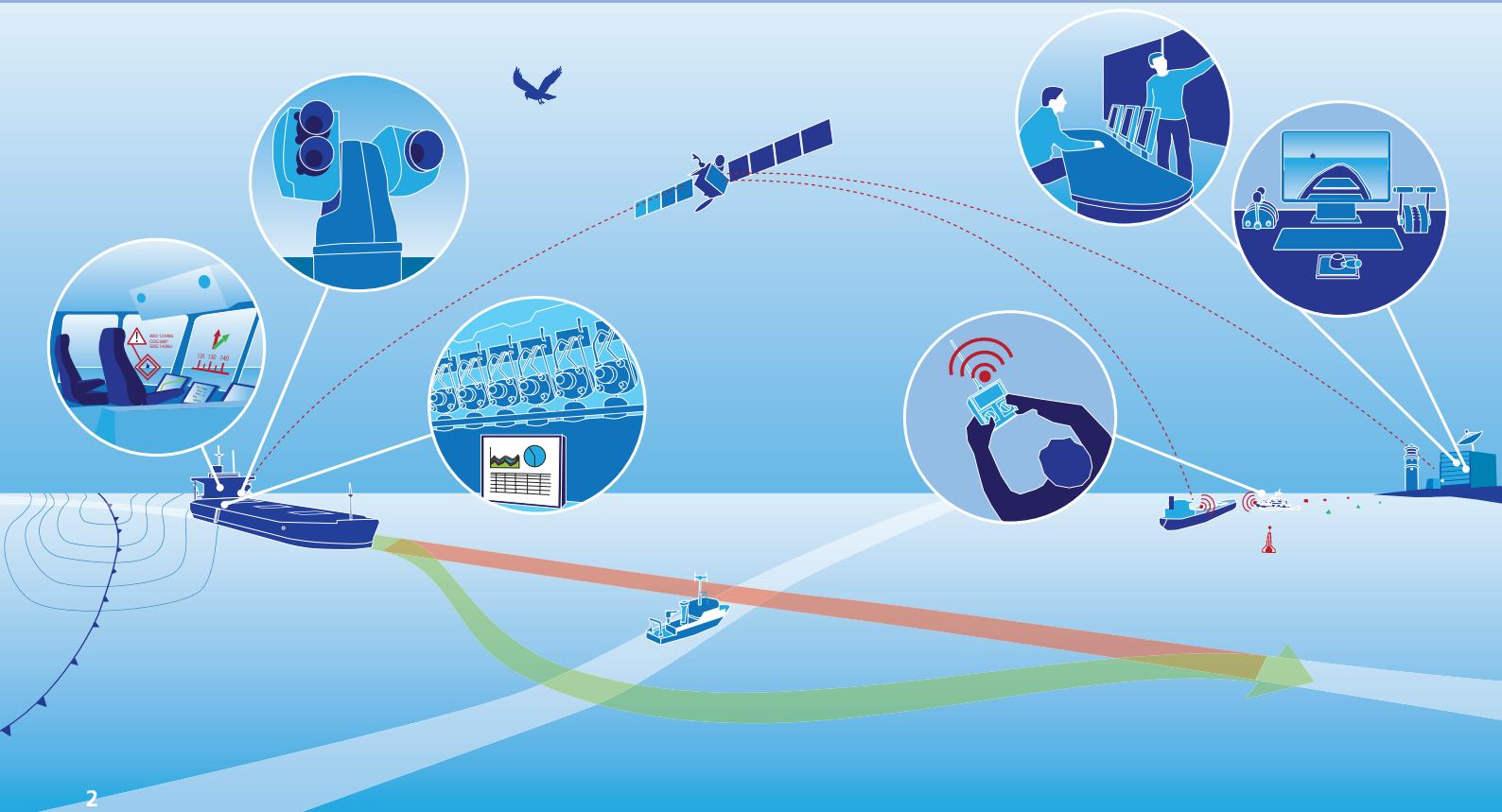
Like the raven, an unmanned vessel must act independently of its owner, but nevertheless must also deliver its cargo safely and reliably to its intended destination. The MUNIN research project was set up to develop and validate a concept and the required technology for this unmanned and autonomous vessel. While the name MUNIN references Odin's raven on the one hand, it is also an acronym for the project: *Maritime Unmanned Navigation through Intelligence in Networks*.

## Autonomy is within reach

MUNIN's object of investigation is the "autonomous ship", which, according to the European Waterborne Technology Platform, is described as a vessel with:

*„next generation modular control systems and communications technology that will enable wireless monitoring and control functions both on and off board. These will include advanced decision support systems to provide a capability to operate ships remotely under semi or fully autonomous control.“*

Existing ships are equipped with anti-collision, electronic positioning and satellite communication systems. New sensor systems, such as those based on infrared technology, are also becoming increasingly common. Much of the technology needed for autonomy is therefore already available.




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### Rationale behind the unmanned ship

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Autonomous vessels aim to improve competitiveness of operation. For a typical medium-sized bulk carrier, a 30% reduction in speed would result in a fuel saving of around 50%, even accounting for the extra voyage days. At the same time, however, a longer voyage time would be onerous on the sailors and a drain on the already limited number of seamen needed for other, more demanding tasks. Unmanned and slow steaming vessels are therefore an interesting option for economic, social and environmental reasons, particularly for deep sea transport.

#### Economic sustainability

Slower sailing speeds become economically viable if crew costs can be reduced at the same time. Reduced speeds result in longer voyage times which incur increased charter costs. For manned vessels, crew costs per trip also rise and at some point offset the savings made by the lower consumption of fuel. If staff costs can be reduced by the introduction of unmanned ships this will help to minimize total trip costs by the use of a slower sailing speed.

#### Social sustainability

Seagoing professions are increasingly perceived as unattractive these days. Factors such as long and monotonous sea passages, short and busy port stays and lengthy periods away from the social environment at home have caused a shortage of seagoing personnel. The concept of autonomous vessels transfers the demanding and interesting tasks from ship to shore. It means that mariners can control and monitor vessels remotely while ashore and still enjoy their normal social life on land.

#### Environmental sustainability

Slow steaming is a key factor in making maritime transport more environmentally-friendly. Autonomous vessels sidestep the inherent vicious circle of slow steaming, as the concept enables significant speed reductions without the need for additional crew. Autonomous shipping therefore enhances the attractiveness of slow steaming and the lower fuel consumption results in reduced exhaust emissions, such as carbon dioxide.

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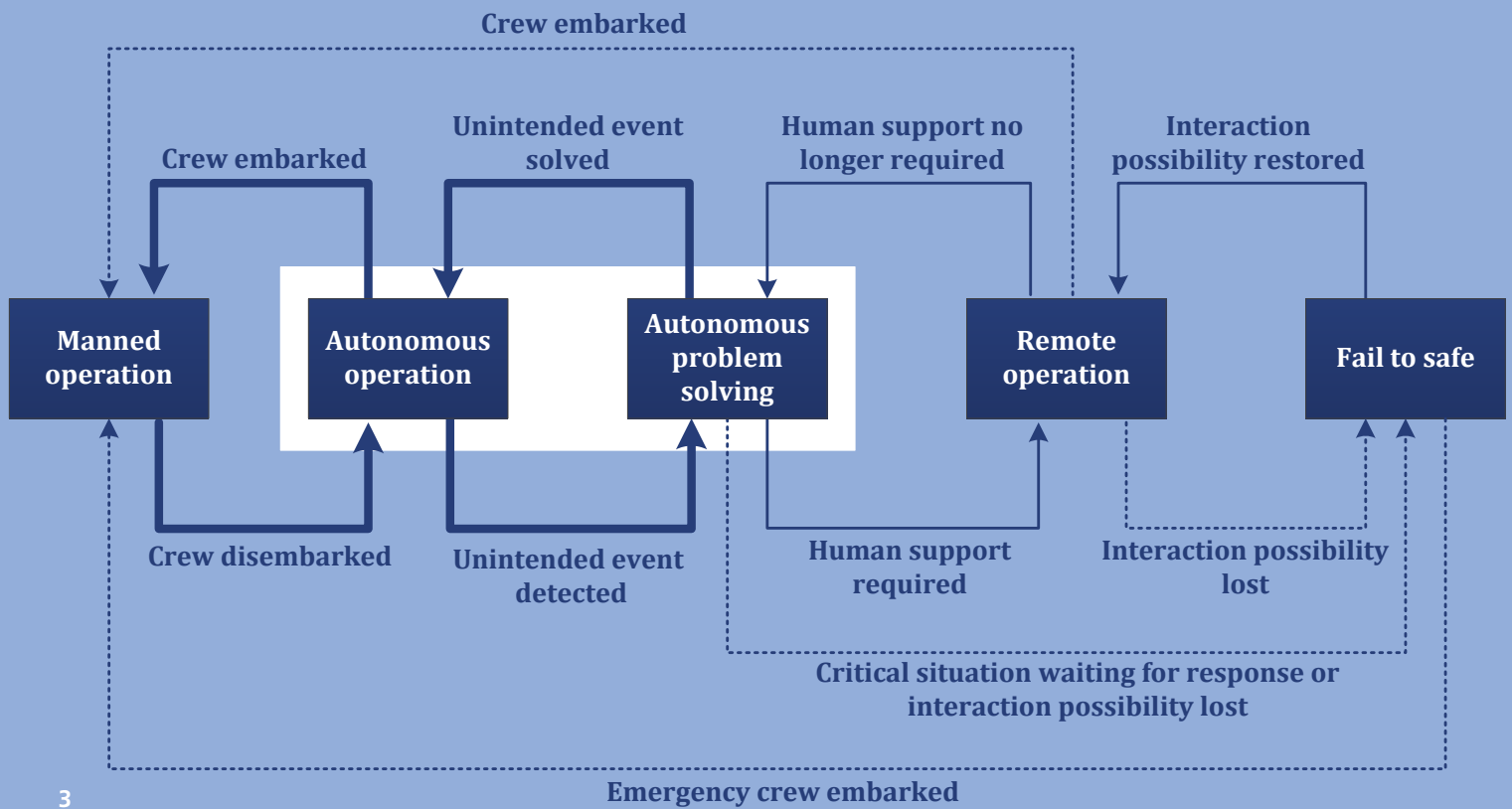
### Autonomous vessel equipment

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Unmanned shipping requires new technology on board and ashore. Firstly, the autonomous ship itself must be equipped with advanced sensor systems to detect and avoid obstacles. Furthermore, a positioning and navigation system to determine and control exact location, speed and course as well as route is also needed on board. The engine also requires advanced onboard control systems to operate the vessel and its equipment.

In addition to the vessel itself, a shore-side control center is also required. This is where the autonomously operating vessels are monitored by qualified personnel. This center also needs to have the capability to assist or even remotely operate the ship, in case of unintended and unforeseen events.

Reliable communication links and a robust communication architecture ensure that the onshore and offshore components are appropriately connected. Unmanned vessels also need a special communication link when berthing crews are boarding and disembarking.



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### MUNIN's operational modes

Autonomy always means more uncertainty in terms of how an operation is performed. This uncertainty needs to be limited to reduce the required complexity of the sensor and control systems.

MUNIN is therefore not designed for an unmanned voyage from berth to berth, but for unmanned deep sea transport, e.g., from pilot point to pilot point. Approaching and berthing is still intended to be done by a conventional crew on board.

This kind of operation requires four new modes: "autonomous operation", "autonomous problem-solving", "remote" and "fail-to-safe". While the latter ensures that damage is avoided even in the case of an emergency, the "remote" option enables mariners ashore to interact with the vessel at all times.

However, in normal operational mode during deep sea transport, the preferred modes are "autonomous operation" and "autonomous problem-solving", where the ship performs repetitive tasks itself and is only monitored by the mariners ashore.

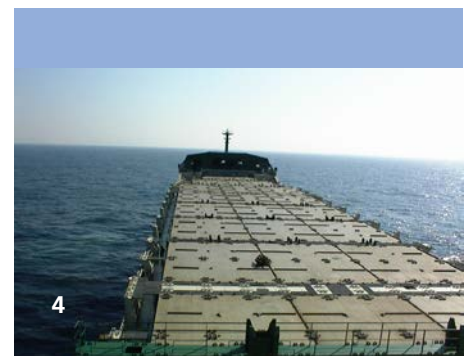
### MUNIN's short-term outlook

Even if the unmanned ship may still be a distant dream, autonomous operations support can still be an important step forward for shipping. Investigations indicate that about 75% of maritime accidents can be attributed to human error and a significant proportion of these are caused by fatigue and attention deficit.

Technology that has been developed and validated for the unmanned ships can also be used to relieve conventional ships' crews of tedious and repetitive tasks. Watchkeeping at sea and monitoring machine performance are two tasks where more automation is possible. While supporting the crew in time-consuming and often undemanding tasks, automation may also improve general performance: Computers use sensor systems that can identify small objects which would otherwise go unnoticed and computer analysis can often detect machinery degradation long before humans can.

In terms of advancing maritime safety, MUNIN will provide much improved surveillance technology that can be used in

the vicinity of the ship. This will allow for better object identification, for example. Furthermore, highly functional detection and situation assessment capabilities will aid human operators in dealing with complex situations. This will help to avoid situations where human fatigue or lack of awareness lead to maritime accidents.





### Contacts and further information

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### MUNIN's scope

The idea behind MUNIN is to update parts of the current fleet to autonomous vessels. This principle ensures rapid implementation and exploitation of results. However, it also entails operating vessels in areas where manned ships continue to operate.

MUNIN will investigate the following issues:

- Small objects detection
- Autonomous route finding
- Autonomous collision avoidance
- Reliable technical systems
- Predictive maintenance concepts
- Shore-side control center
- Communication architecture
- Legal implications
- Liability issues

Prototypes of the proposed solutions will be implemented and connected to state-of-the-art maritime simulators. This integrated simulator environment will validate the proposed concepts based on predefined scenarios. Furthermore, it will allow the public to experience the autonomous vessel during a final event in the summer of 2015.

### MUNIN's consortium

The MUNIN consortium consists of eight partners with both scientific and industrial backgrounds located in Germany, Norway, Sweden, Iceland and Ireland. It is coordinated by the Fraunhofer Center for Maritime Logistics and Services CML in cooperation with MARINTEK.

While the research partners deal with the technical, business and legal aspects, the industry partners represent different business areas of the ship supplier market and link MUNIN to current market demands. The project partners therefore ensure full coverage of all research areas and will reflect upon the latest operational, technical and legal aspects in relation to their shared vision of an unmanned and autonomous ship.

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