Beyond the e-Navigation implementation plan: Development towards the unmanned merchant vessel?

e-navigation underway, M/S Pearl Seaways, 28 - 30 January 2014

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E-guided vessels: The 'autonomous' ship
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MUNIN

Key facts

- European FP7 project from Sep 2012 to Aug 2015
- 8 partners with 2.9 million € funding
- Focus:
  - Develop a concept for an unmanned merchant vessel
  - Validate concept in a simulator set-up
Rationale for unmanned vessels
Sustainability and short term use

Current challenges of maritime shipping:

- Highly competitive industry
- Lack of young professionals
- Rising ecological awareness

Autonomous ship as a long-term solution to:

- Reduce operational expenses
- Attract professionals
- Reduce environmental impact
Feasibility restriction
Remote control not sufficient

> 150,000 USD/Month
Definition
MUNIN's autonomous ship

Autonomous ship
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.

Autonomous ship
No persons on board for whole or part of the voyage. The ship, with partial help from remote control, must be able to manage the voyage on its own.
Use Case
Dry bulk carrier on deep-sea-voyage

Reasons:
- Long deep-sea-voyage
- Low risk cargo
- Slow steaming attractiveness
State-of-the-project
Prototype implementation begins

1. Scenario definition
2. Technical specification
3. Prototype implementation
4. Proof-of-concept
5. Assessment
6. Future concepts
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MUNIN Vision
Still manned operation in coastal waters
Main Challenge
Unmanned, but not out-of-the-loop

If x else
a --> 2.5
b =! 3.04
... {notify}
$ship\_env
waiting...
New systems enabling autonomous navigation during deep-sea voyage

**Advanced Sensors System**
- Electronic lookout
  - Detect small objects
  - Detect weather phenomena

**Autonomous Navigation System**
- Op. decision-making
  - Avoid collisions
  - Ensure stability in harsh weather

**Shore Control Centre**
- Human element
  - Monitor voyage and vessel
  - Problem-solving
Operational modes on-board
Restricted interaction must be respected

- Manned operation
- Autonomous execution
- Autonomous control
- Remote control
- Fail to safe

Crew embarked
- Crew disembarked
- Unintended event solved
- Unintended event detected
- Human support no longer required
- Interaction possibility restored
- Human support required
- Interaction possibility lost

Emergency crew embarked

Critical situation waiting for response or interaction possibility lost
Autonomous execution
The main operational mode

- Ship system activities
  - Follow predefined voyage plan
  - Observe environment
  - Measure ship conditions
- Shore Control Centre
  - Monitor ship status
- Communication
  - Periodic updates ship-to-shore

UAV: Autonomous execution
SCC: Remote monitoring
Autonomous control
Handling of known events

- Ship system activities
  - Autonomously adapt voyage plan
  - If required: Involve Shore Control

- Shore Control Centre
  - Ensure safe operation
  - If required: Acknowledge decision

- Communication
  - Event-based data exchange

UAV: Autonomous control

SCC: Monitoring/Investigation
Remote control
Intervention in a special situation

- Ship system activities
  - Provide navigational data
  - Control is overridden by Shore Control

- Shore Control Centre
  - Directly operates ship (remote bridge)
  - If required: Acknowledge decision

- Communication
  - Direct link (communication tunnel)
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Prioritized e-Navigation solution

- **S1**: improved, harmonized and user-friendly bridge design;
- **S2**: means for standardized and automated reporting;
- **S3**: improved reliability, resilience and integrity of bridge equipment and navigation information;
- **S4**: integration and presentation of available information in graphical displays received via communication equipment; and
- **S9**: improved Communication of VTS Service Portfolio (not restricted to VTS stations).
MUNIN needs improved sensor systems and automatic small and large target detection. This could also assist OOW and outlook of conventional ships.
All mandatory ship reporting must be handled by shore control center in MUNIN. This can also be pattern to relieve officers of administrative burdens.
As no crew is available to correct errors, improved and higher quality sensor and data fusion becomes necessary, including advanced object detection, AIS, GPS, other ship sensors as well as any other source that is available.
Shore control centre will normally be in charge of several ships. When something unexpected happen, they will need to be able to rapidly assess the situation as well as status of other ships. This can also be very useful onboard!
Keeping track of technical condition of equipment, operational consequences in case of failures and planning of maintenance is critical for MUNIN. This is functionality that can also be used in conventional shipping operations.
MUNIN will rely on a shore control center to supervise and control unmanned ships. Functionality here can also be used to assist OOW of conventional ships, e.g., during nighttime or when little is expected to happen onboard.
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## Outlook
### MUNIN on tour

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<td>MUNIN @ e-navigation underway 2014</td>
<td>Pearl Seaways, DK/NO</td>
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<td>12.-14.05.2014</td>
<td>Scientific session on MUNIN during COMPIT 2014</td>
<td>Redworth, UK</td>
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<td>10.09.2014</td>
<td>MUNIN workshop „Short-term application“ during SMM</td>
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<td>10.-11.06.2015</td>
<td>MUNIN final promotion event</td>
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<td>Jun 2014</td>
<td>In-situ test of Advanced Sensor System</td>
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<td>Sep 2014</td>
<td>1st Full-scale simulation test</td>
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Conclusion

Maritime Unmanned Navigation through Intelligence in Networks

Is MUNIN an e-Navigation test-bed?
Thank you for your attention