

Development of Ship Situational Awareness in Ice

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Why?

Much work is being done to develop autonomous vessel technology but little of this work addresses autonomous vessel navigation in ice-covered waters

Developing the tacit skill to navigate safely in ice is a career-long endeavour for professional mariners

Development of autonomous systems has the potential to reduce risk and increase supply chain resiliency



Background

Humans are expected to be key navigational decision-makers for the foreseeable future (on ship or via. remote control)¹

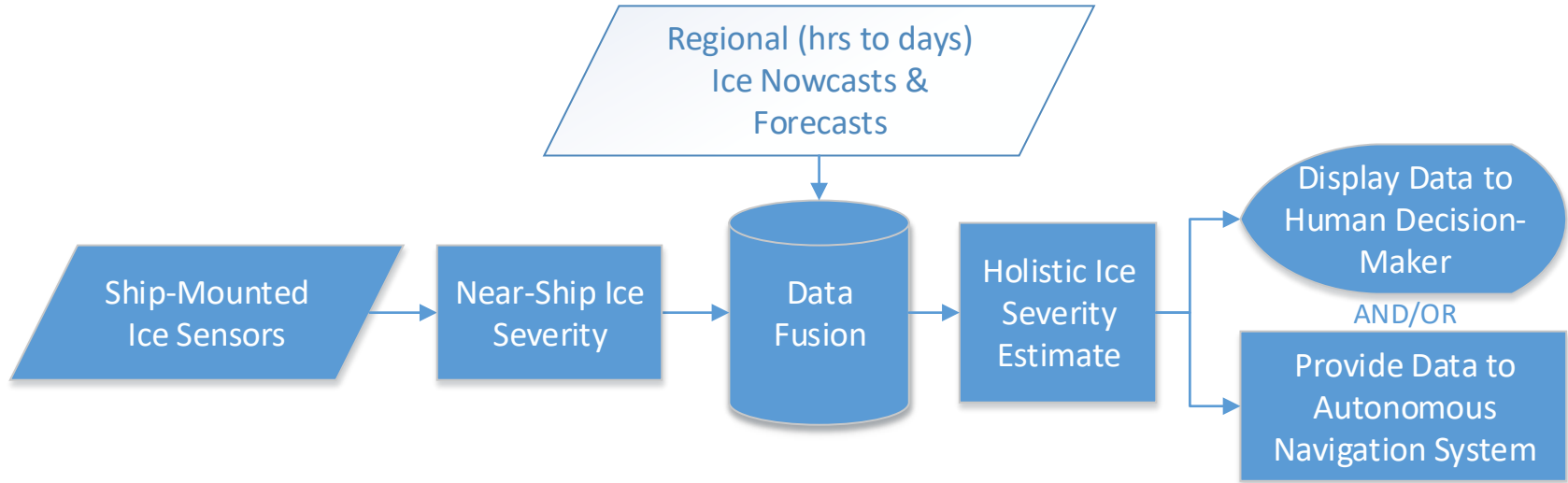
- Ice sensors can provide enhanced situational awareness for humans on a ship
- As ships begin to be remote-controlled, situational awareness for the remote operator is critical
- Eventually, sensors will provide information to routing algorithms for autonomous ships

IMO Degrees of Autonomy:

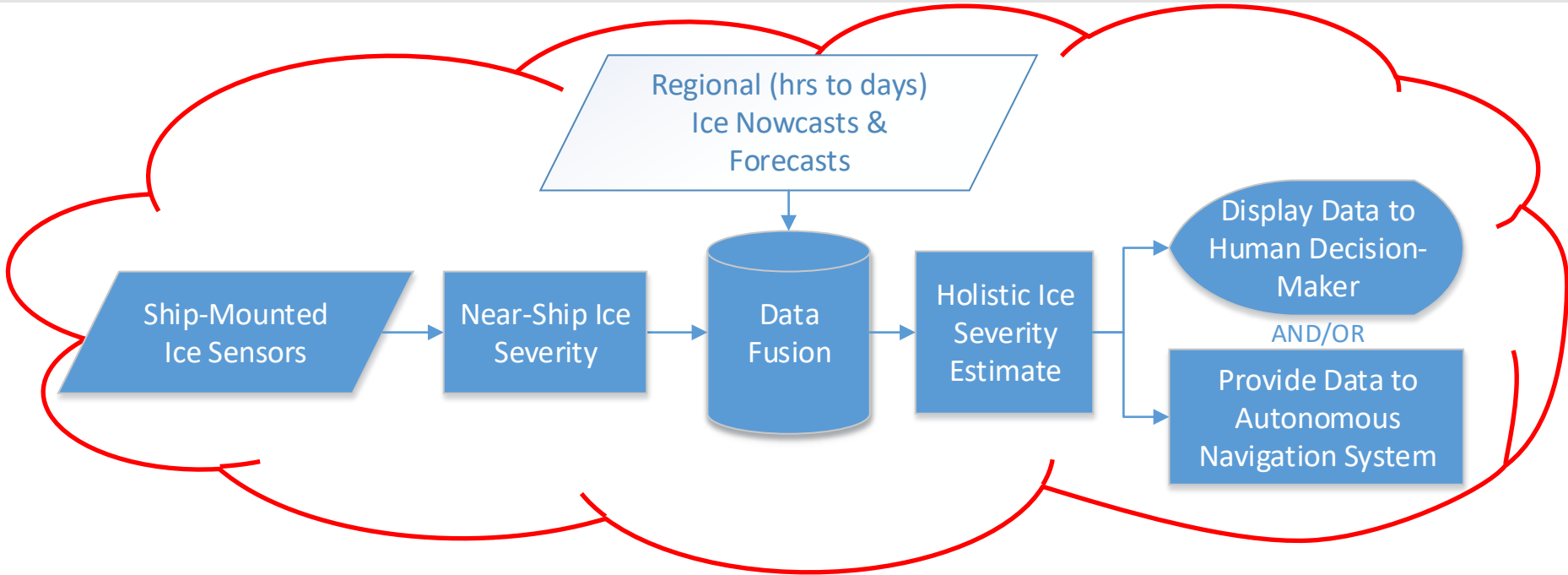
<http://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx>



Background



Background



“SITUATIONAL AWARENESS”
“PERCEPTION”

Ship-Mounted Ice Sensors

Sensor	Ice Data <i>(subject to ongoing research on sensor interpretation)</i>
LiDAR (★)	Concentration, Piece Size, Ridge Identification, Freeboard, Age (Forward-Looking)
Visual Camera (★)	Piece Size, Concentration (Forward and Side-Looking)
Electromagnetic Induction (★)	Thickness, Composition (Over the bow)
Visual Camera (★)	Pressure (Aft-Looking)
Whole Body Acceleration	Global Impact Load & Icebreaking Load
Propulsion Power	Total Ice Resistance



Garvin, M. (2020). 'Review of Technologies for Real-Time Shipboard Ice Severity Sensing', *RINA Smart Ship Technology Conference*

Displaying Data to Human Decision Makers

Decision Support System (DSS) Performance

- Simulator-based study of human-machine interface on ship bridge
 - How do humans respond to different information inputs, configurations, etc.?
 - How is operator performance influenced by DSS design?
- Learn how to:
 - provide pertinent information: what information is needed, when is it needed.
 - present information in a way that doesn't distract, overload, or erode skills.

Shore Control Center (SCC) “Information Ergonomics” for Remote Control

- How do humans achieve Situational Awareness when removed from the bridge?
- Developing SCC experimental capability (proposal phase).

Relling, T. (2019). 'A human centered approach to the future Vessel Traffic Services', *Norwegian University of Science and Technology*.

Zhu, T., et. al. (2019). 'Human factor challenges and possible solutions for the operation of highly autonomous ships', *Proceedings of the 29th European Safety and Reliability Conference*.

Dybvik, H. et. al. (2020). 'Exploring challenges with designing and developing shore control centers (SCC) for autonomous ships', *International Design Conference*

Summary

There is lots of interesting work to be done:

- Interpreting ice sensor data
- Data fusion to combine data from multiple sensors
- Understanding what ice information is “important”
- Understanding how humans interact with:
 - ice information on a bridge
 - information in a shore control center
- The types of ice information needed to support autonomous navigation

Thank you!

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