Applying and visualizing the FRAM for Arctic ship navigation

FRAMily 2017

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Topics for today's presentation

3 Topics

- The application of FRAM as a safety assessment tool for Arctic ship navigation
- The practical collection of data to inform safety assessments in the maritime domain
- A FRAM visualization technique

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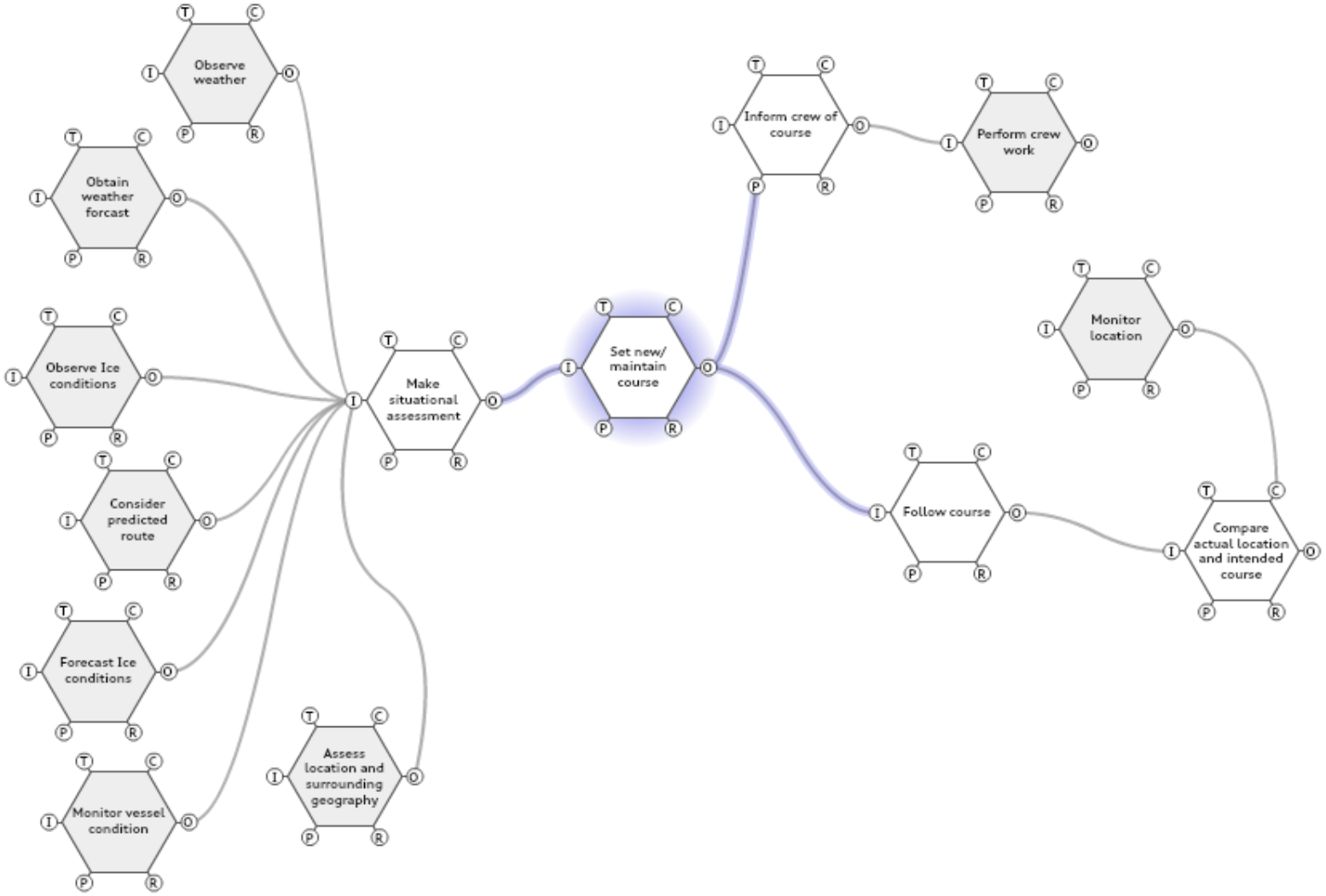
Arctic ship navigation model as imagined

Arctic Navigation Model

- As Imagined >

- Spoke informally with ship navigators to inform a model as done



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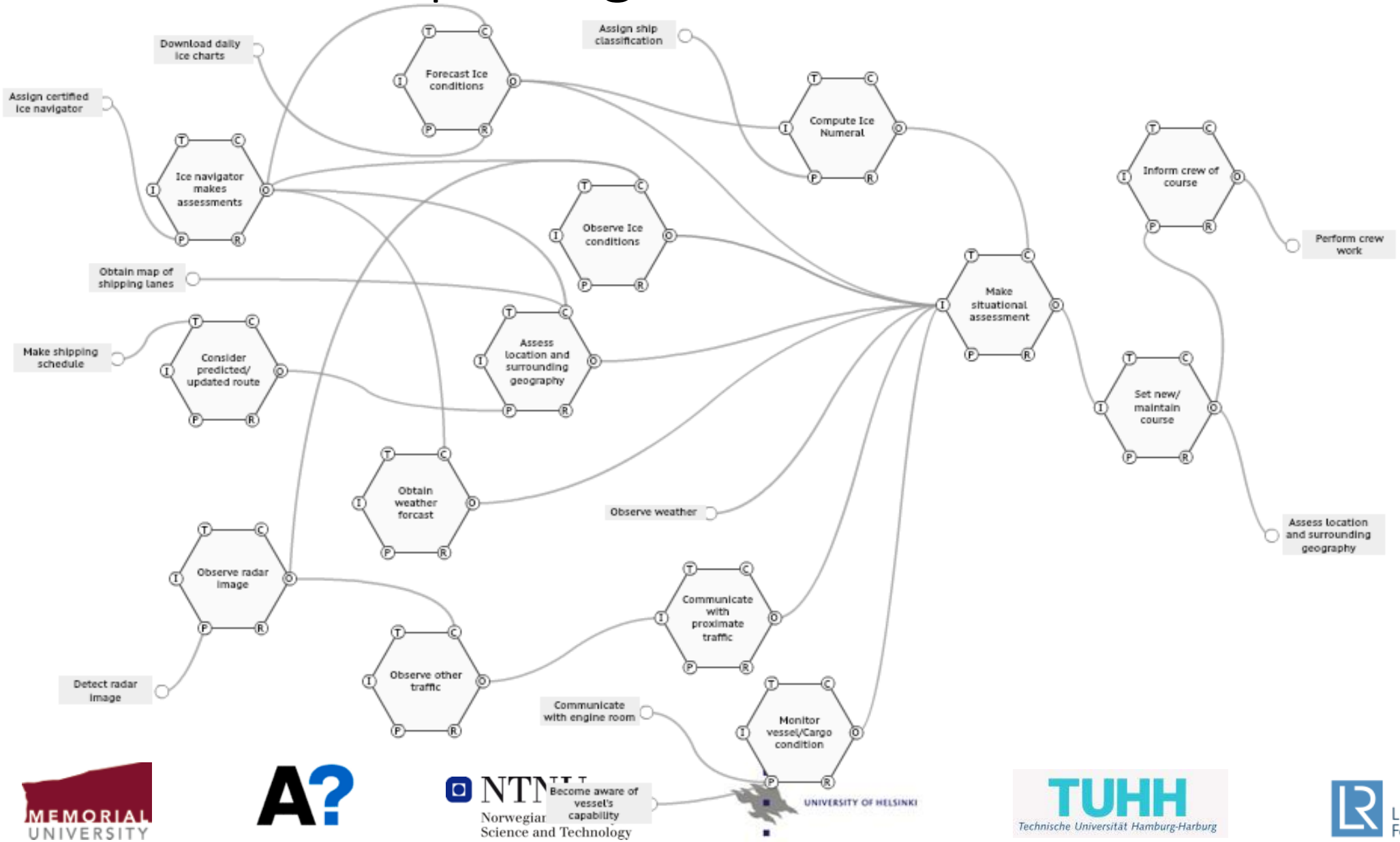
Arctic ship navigation model “as done”



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Practical data collection

Planned experiment with a Canadian shipping company

- Work with a single company (same ship, same crew, same operation, same safety culture)
- An agreement was reached with the company on the type of “experiment”
- Completed an ethics application to get experiment approved
- As part of the ethics application and process of informed consent we had to list all potential risks to the participants
- One risk is that we could not control how their manager would react to something they said and it could potentially affect their job status
- We could anonymize the data but because of the small sample size (8 maximum) an informed reader could potentially infer their identity

Practical data collection

Two get experiment approved

- Remove the manager from the recruitment process (It couldn't seem like a work directive – Participation had to completely voluntary)
- Deal directly with the ship by sending a recruitment letter

Results

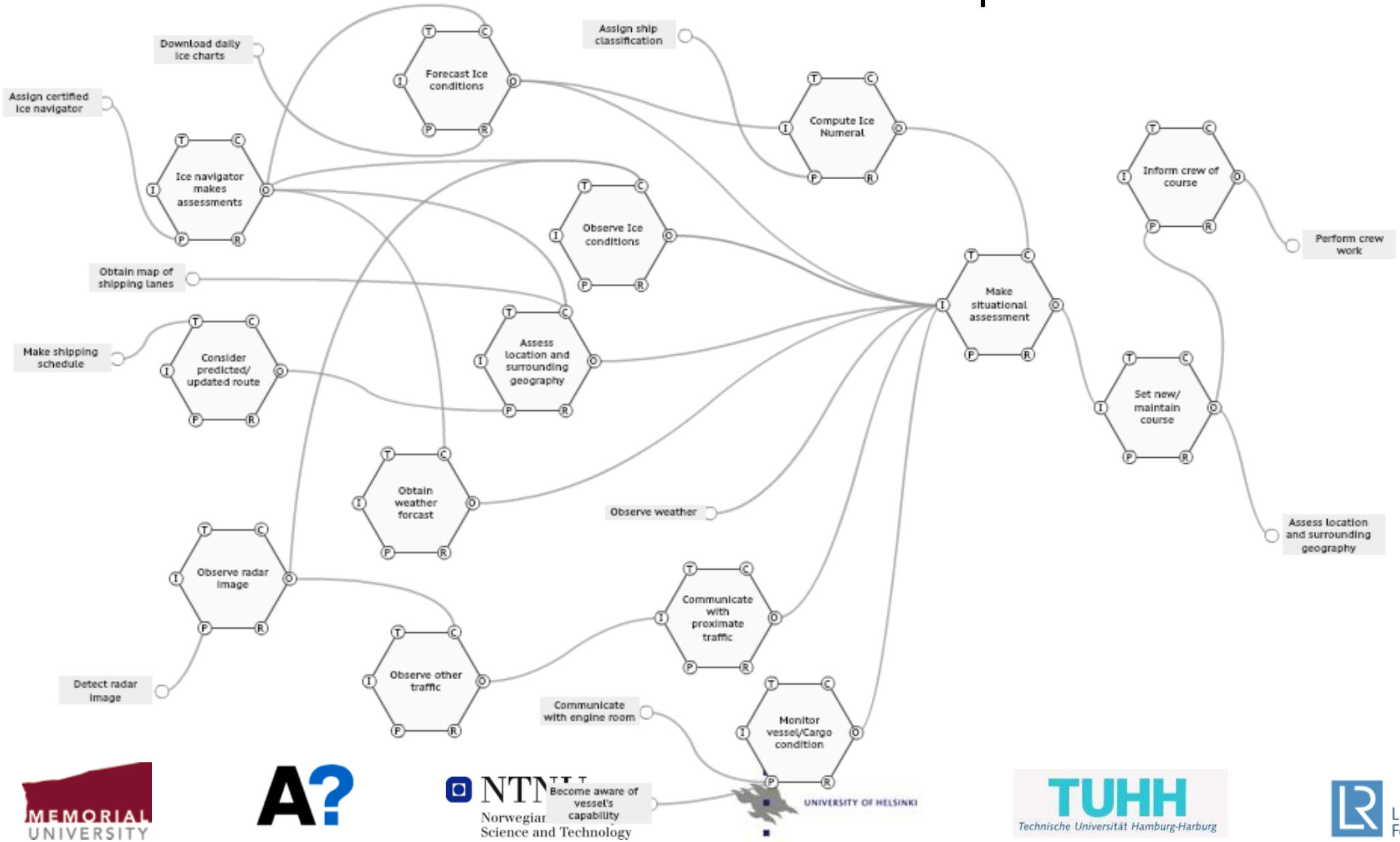
- No recruits (one captain was considering it)
- Potential reasons (did not see the value of FRAM, Did not have time (2 hours) or Did not want to accept potential risks)
- Were not required to give any reason for not participating

Visualization Technique

Using a case study to visualize the FRAM

- Cases with detailed information on functionality for Arctic shipping are very limited
- Actual current data has been difficult to collect
- The “smoking gun” for Arctic shipping safety case studies – The Exxon Valdez Grounding

Visualization Technique



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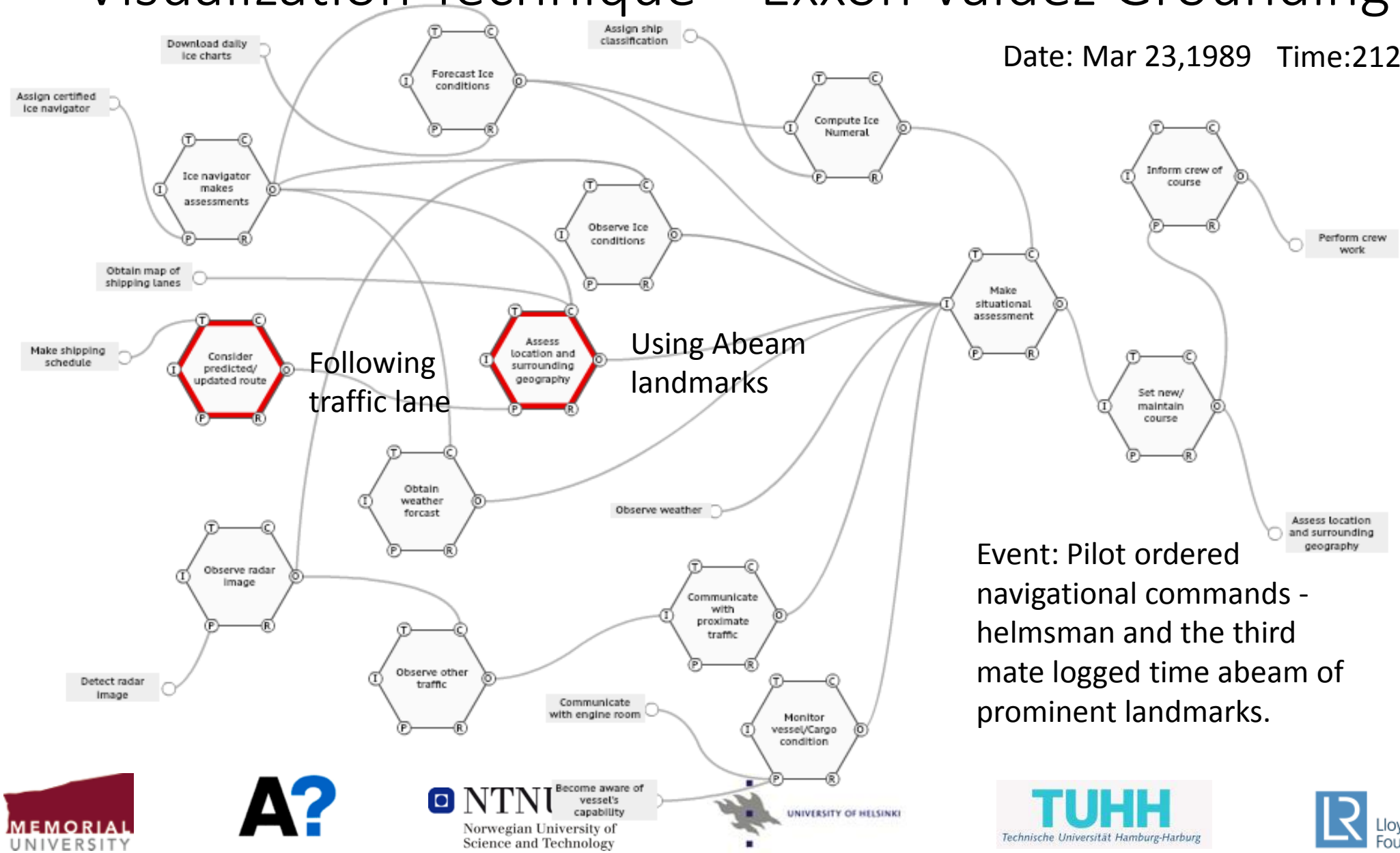
Visualization Technique – Exxon Valdez Grounding

Date: Mar 23,1989 Time:2121-2324



Event: Pilot ordered navigational commands - helmsman and the third mate logged time abeam of prominent landmarks.

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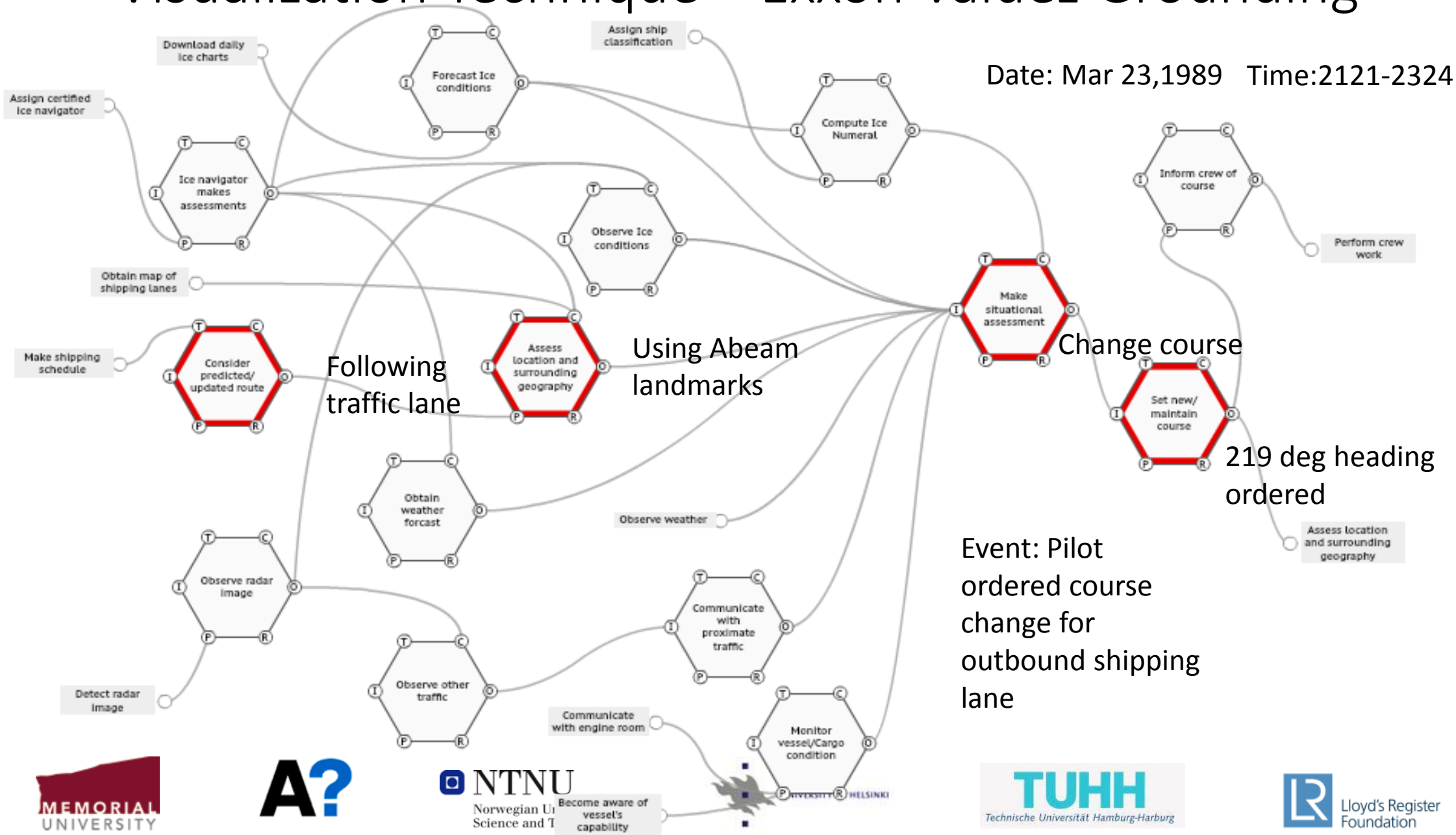
Visualization Technique – Exxon Valdez Grounding

Description

- “The third mate supervised the helmsman to ensure that all rudder orders from the pilot were correctly followed and also monitored the vessel's progress by logging the time abeam of prominent landmarks and navigation aids.” - NTSB (1990), Grounding of the Exxon Valdez on Bligh Reef

Visualization Technique – Exxon Valdez Grounding



Date: Mar 23,1989 Time:2121-2324

Event: Pilot ordered course change for outbound shipping lane

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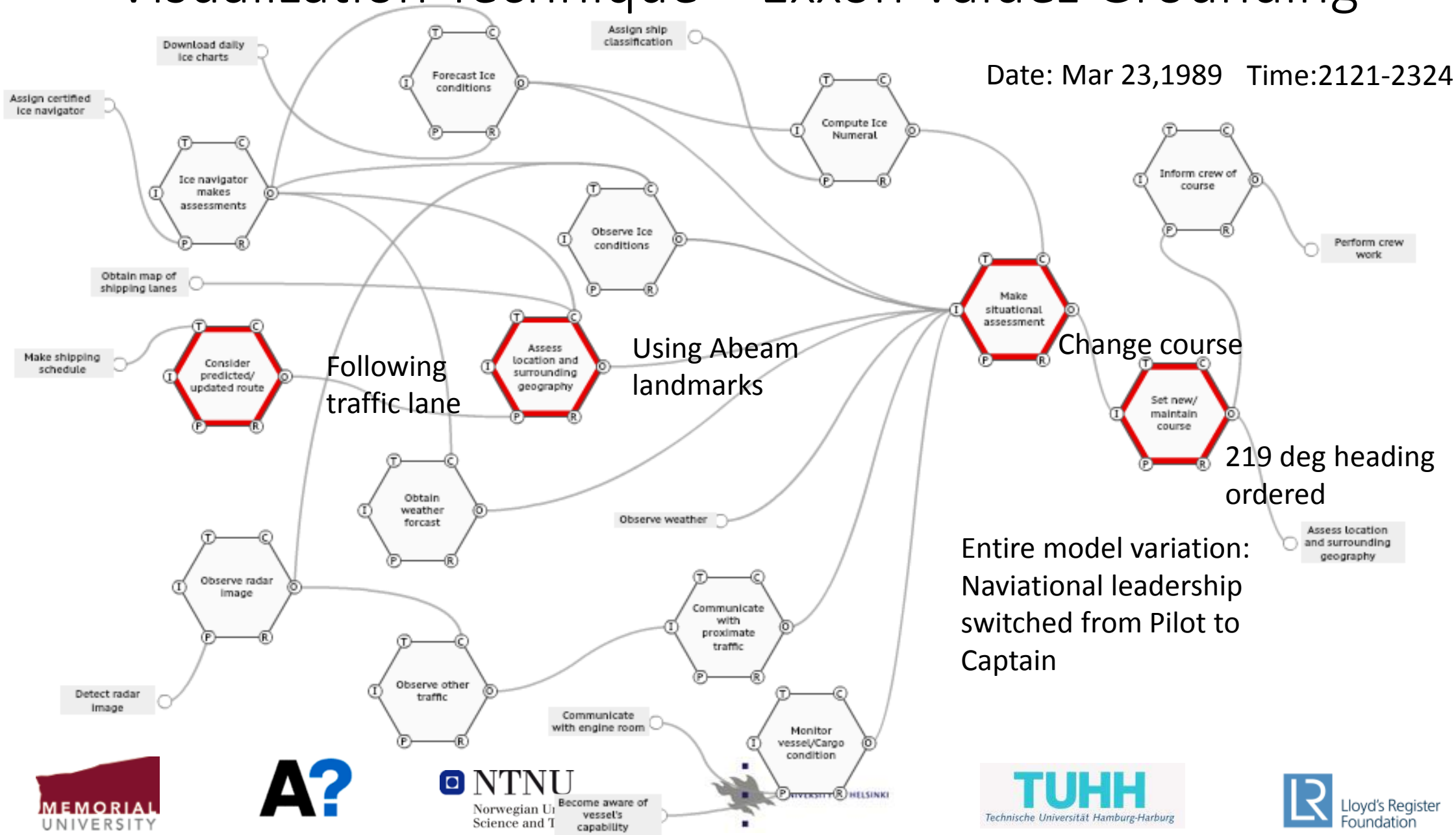
Visualization Technique – Exxon Valdez Grounding



Date: Mar 23,1989 Time:2121-2324

Entire model variation: Naviational leadership switched from Pilot to Captain

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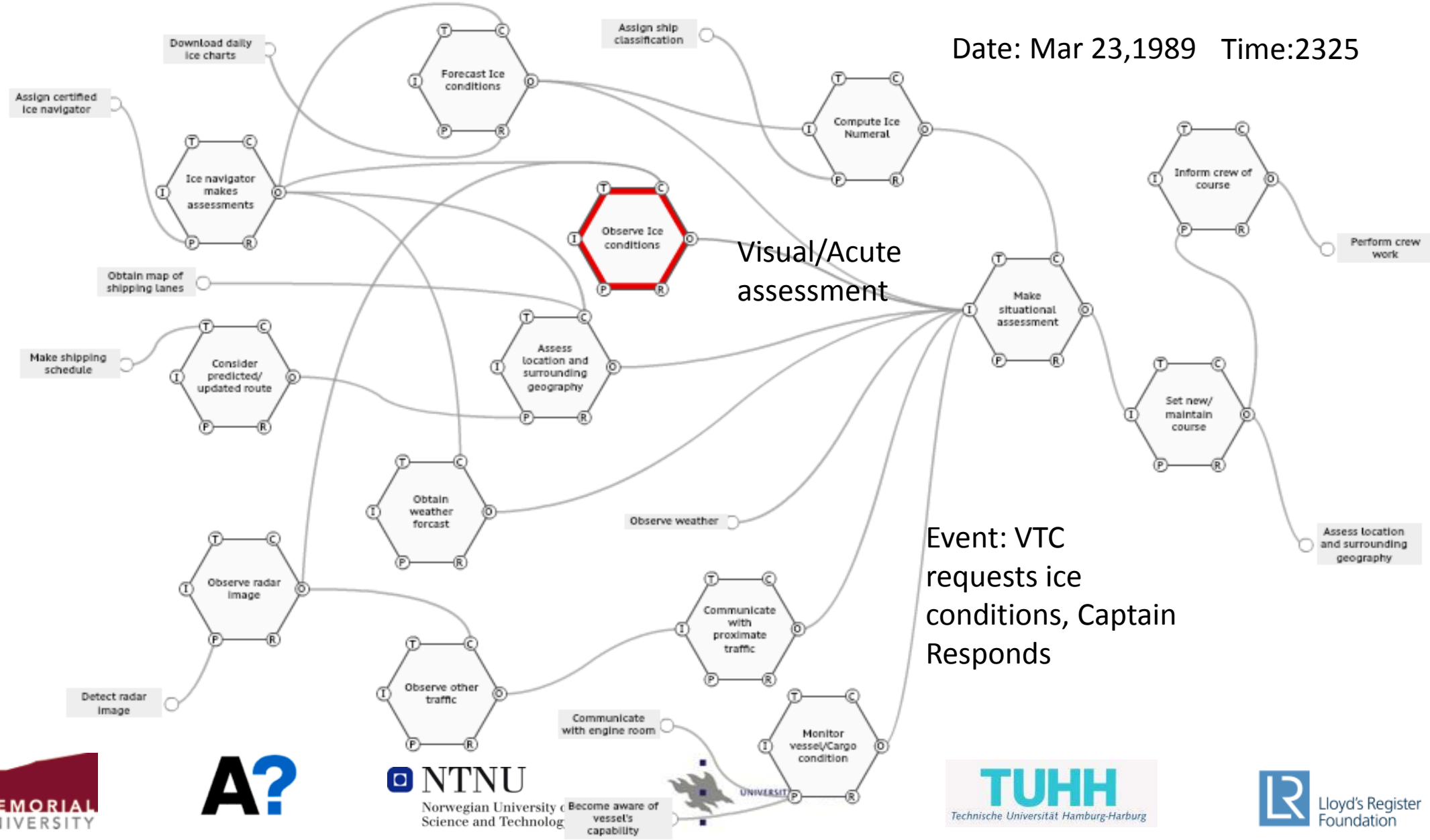

Date: Mar 23,1989 Time:2325

Event: VTC requests ice conditions, Captain Responds

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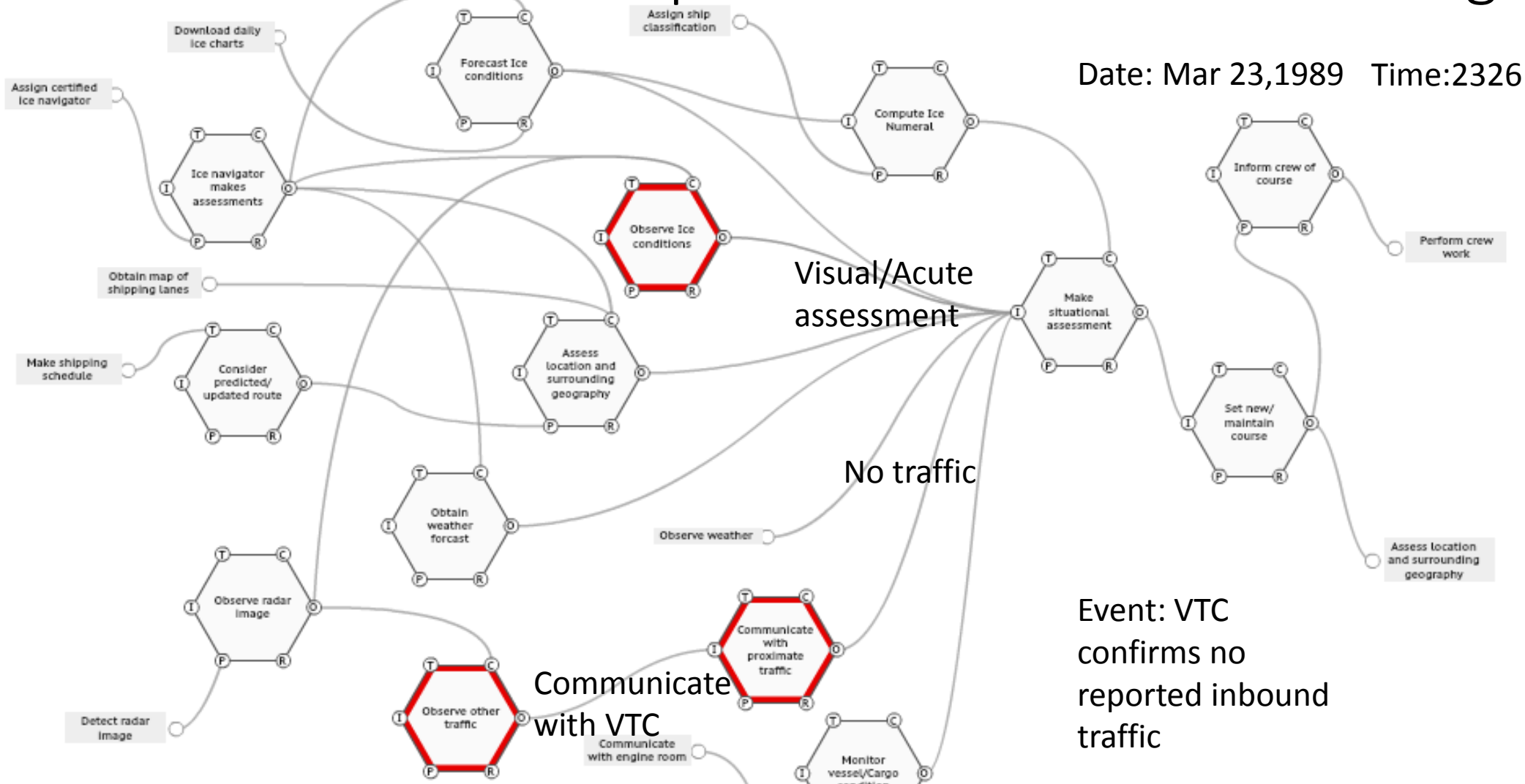

Date: Mar 23,1989 Time:2326

Event: VTC confirms no reported inbound traffic

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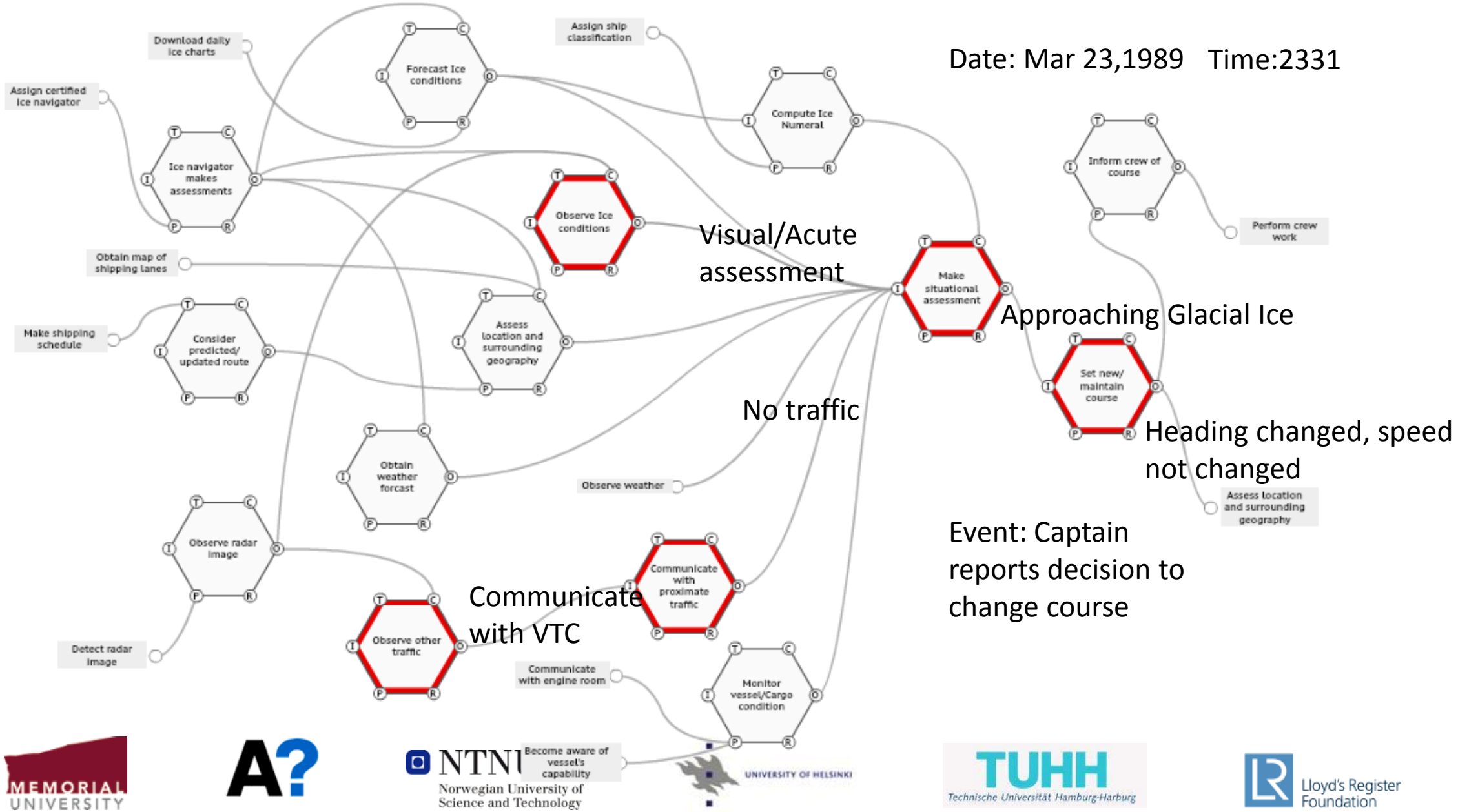

Date: Mar 23,1989 Time:2331

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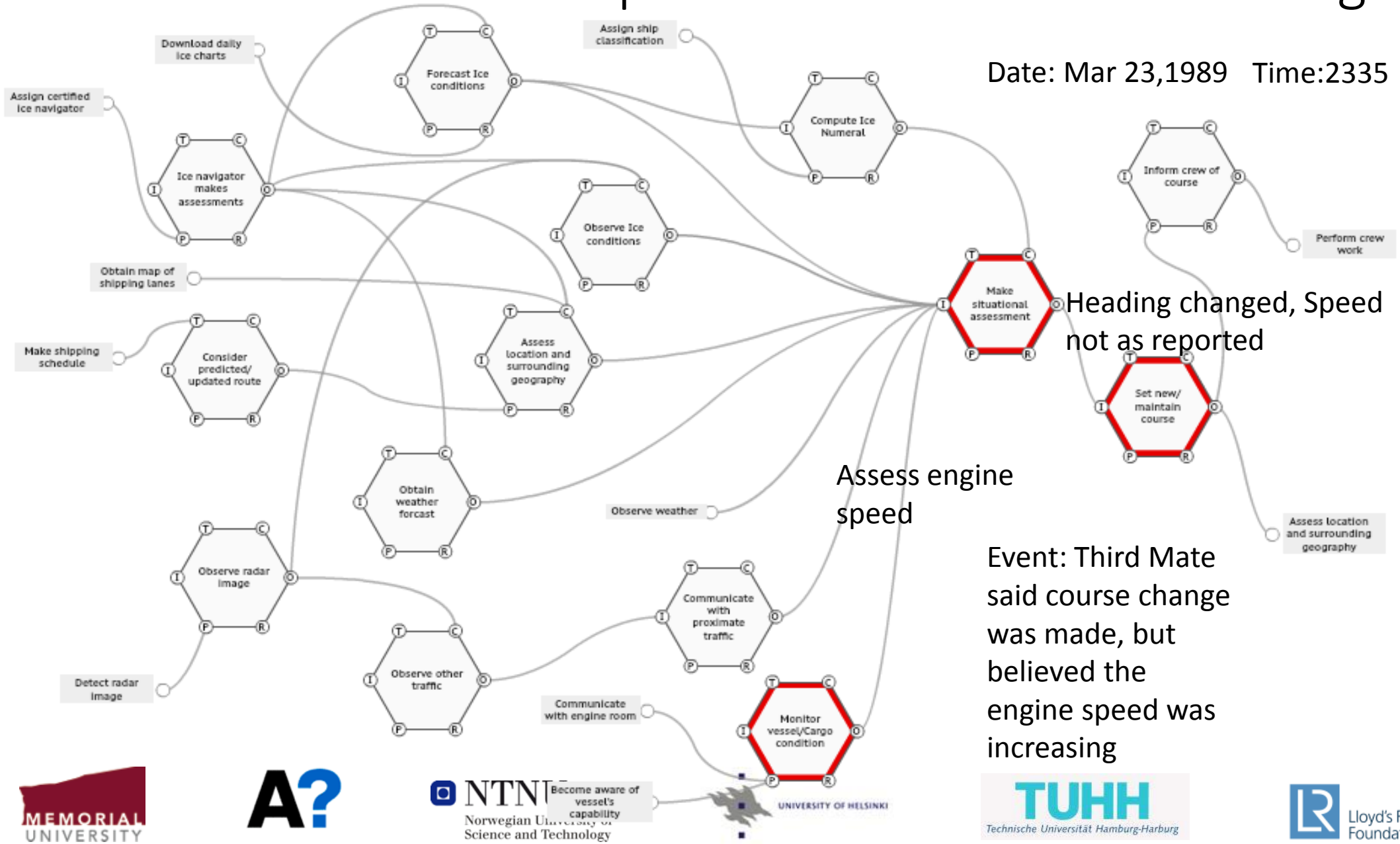

Date: Mar 23,1989 Time:2335

Heading changed, Speed not as reported

Assess engine speed

Event: Third Mate said course change was made, but believed the engine speed was increasing

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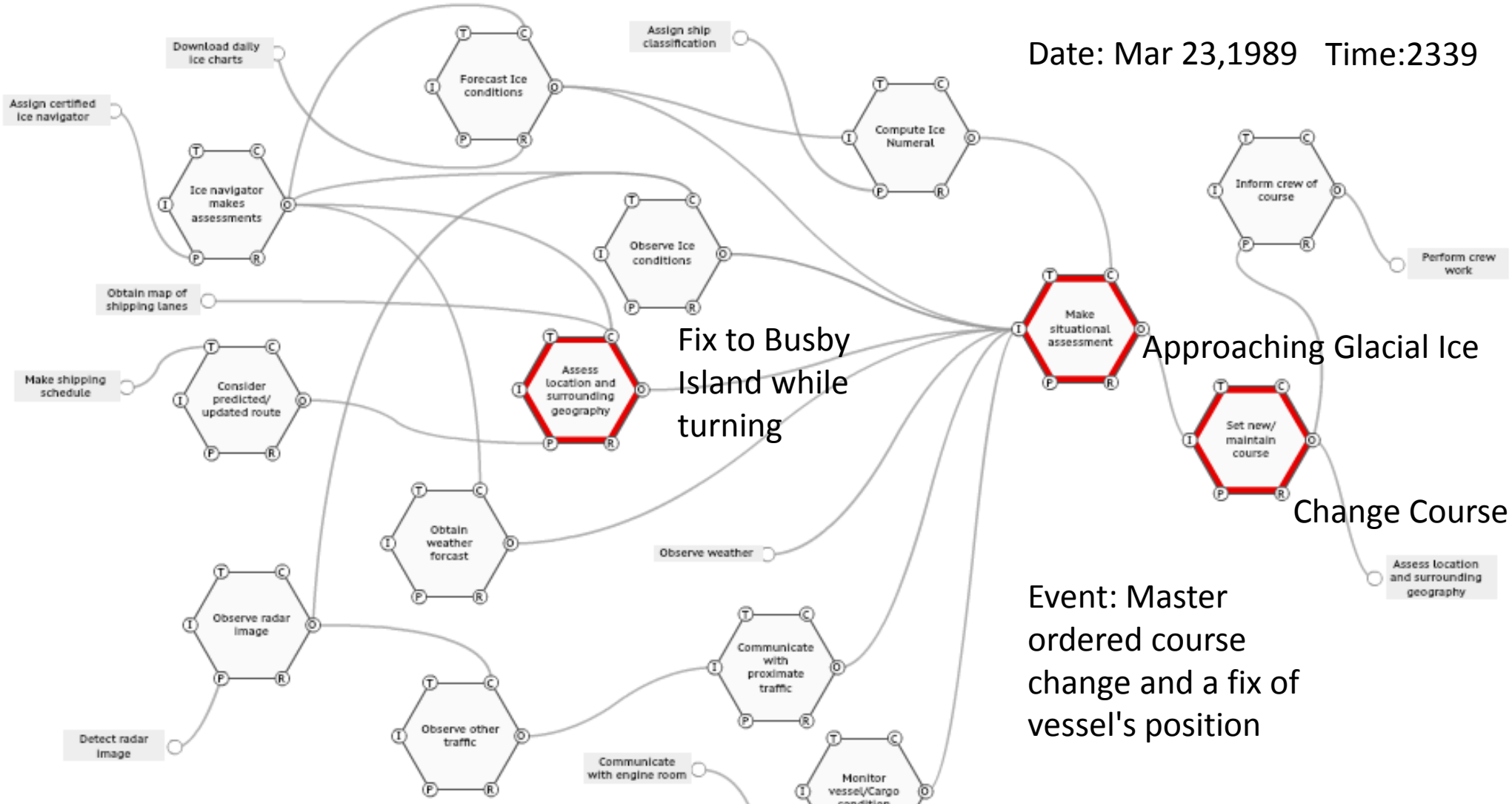

Date: Mar 23,1989 Time:2339

Fix to Busby Island while turning

Approaching Glacial Ice

Change Course

Event: Master ordered course change and a fix of vessel's position

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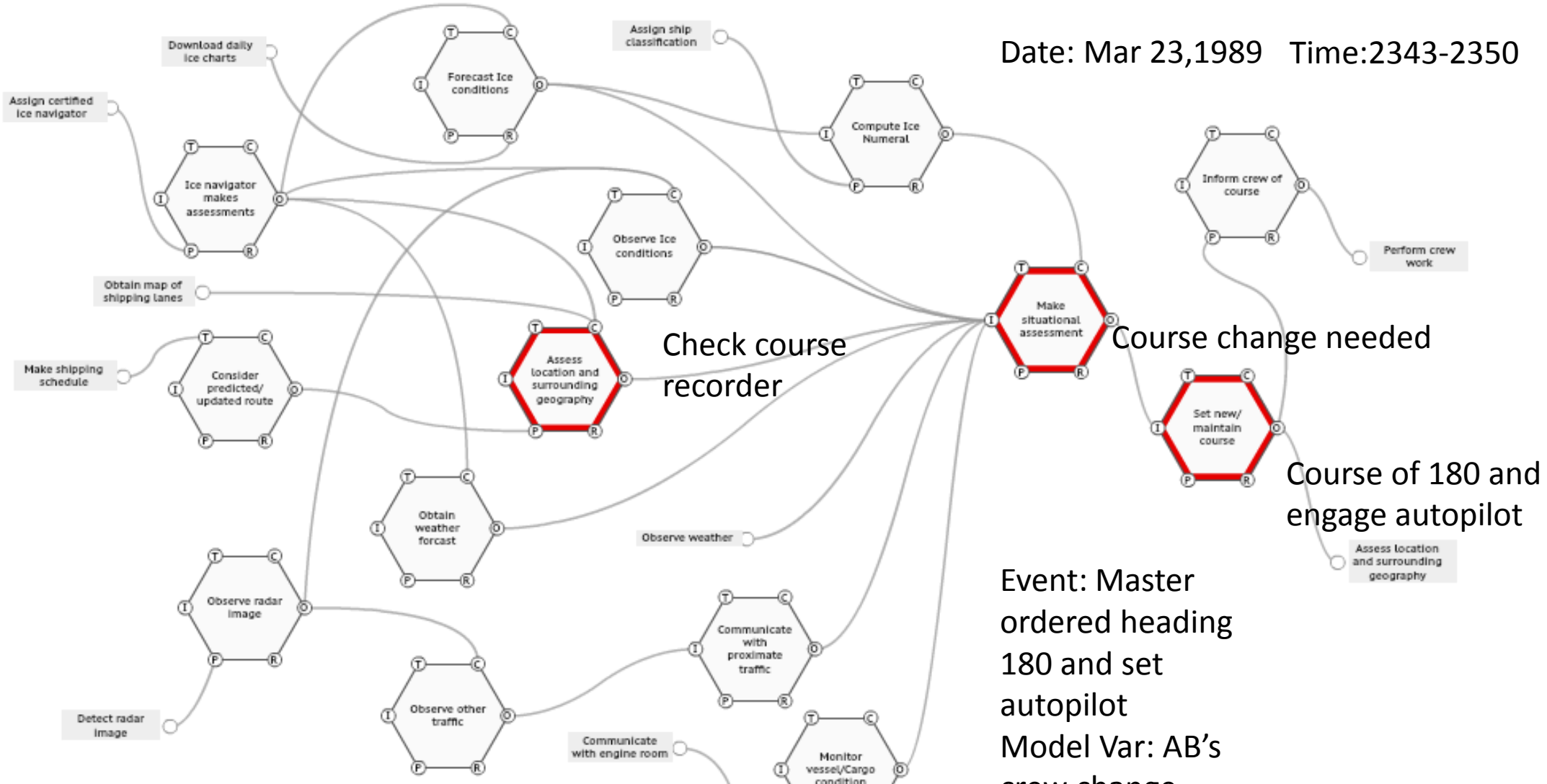

Date: Mar 23,1989 Time:2343-2350

Event: Master ordered heading 180 and set autopilot
Model Var: AB's crew change

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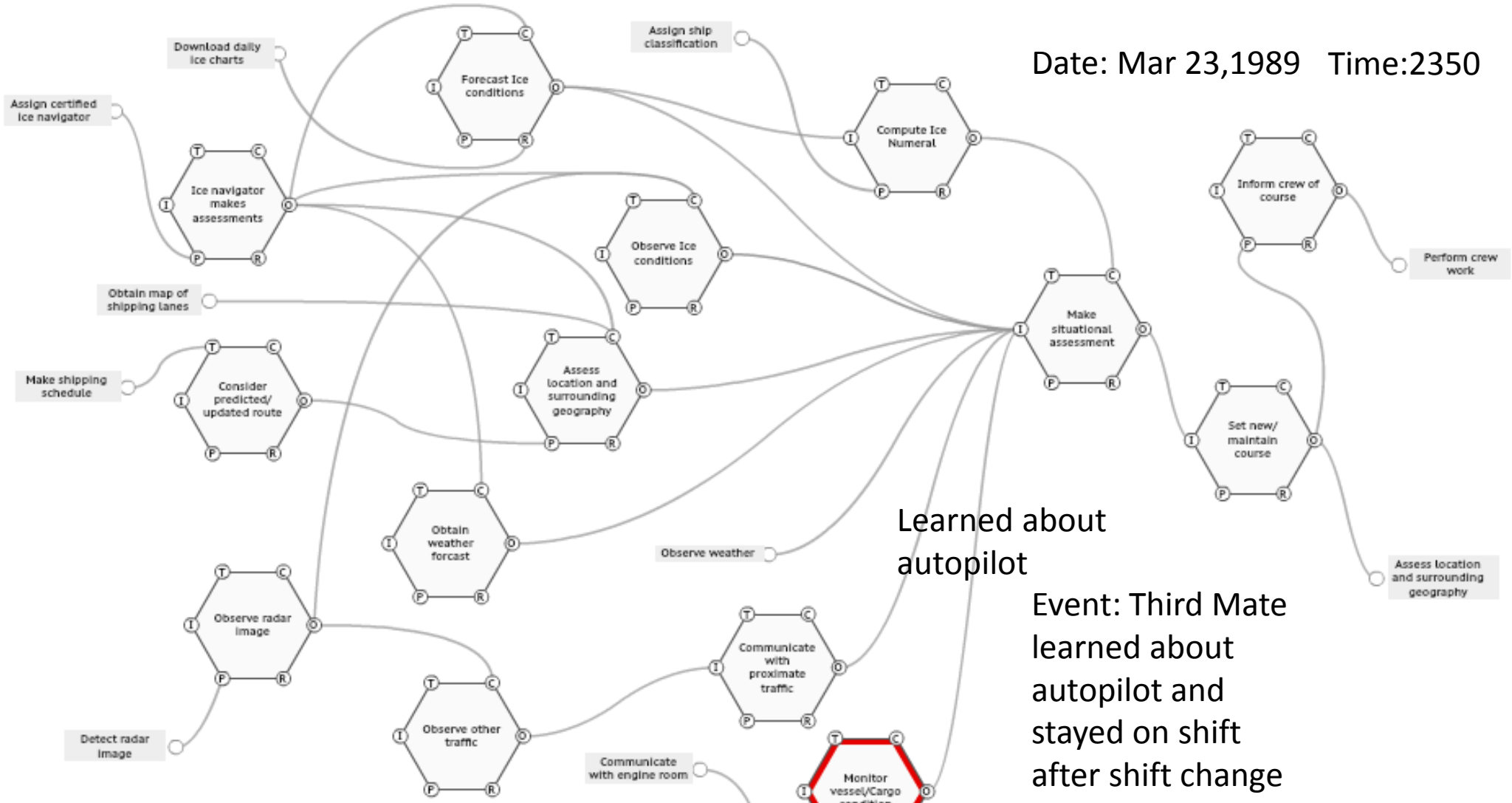

Date: Mar 23,1989 Time:2350

Learned about autopilot

Event: Third Mate learned about autopilot and stayed on shift after shift change

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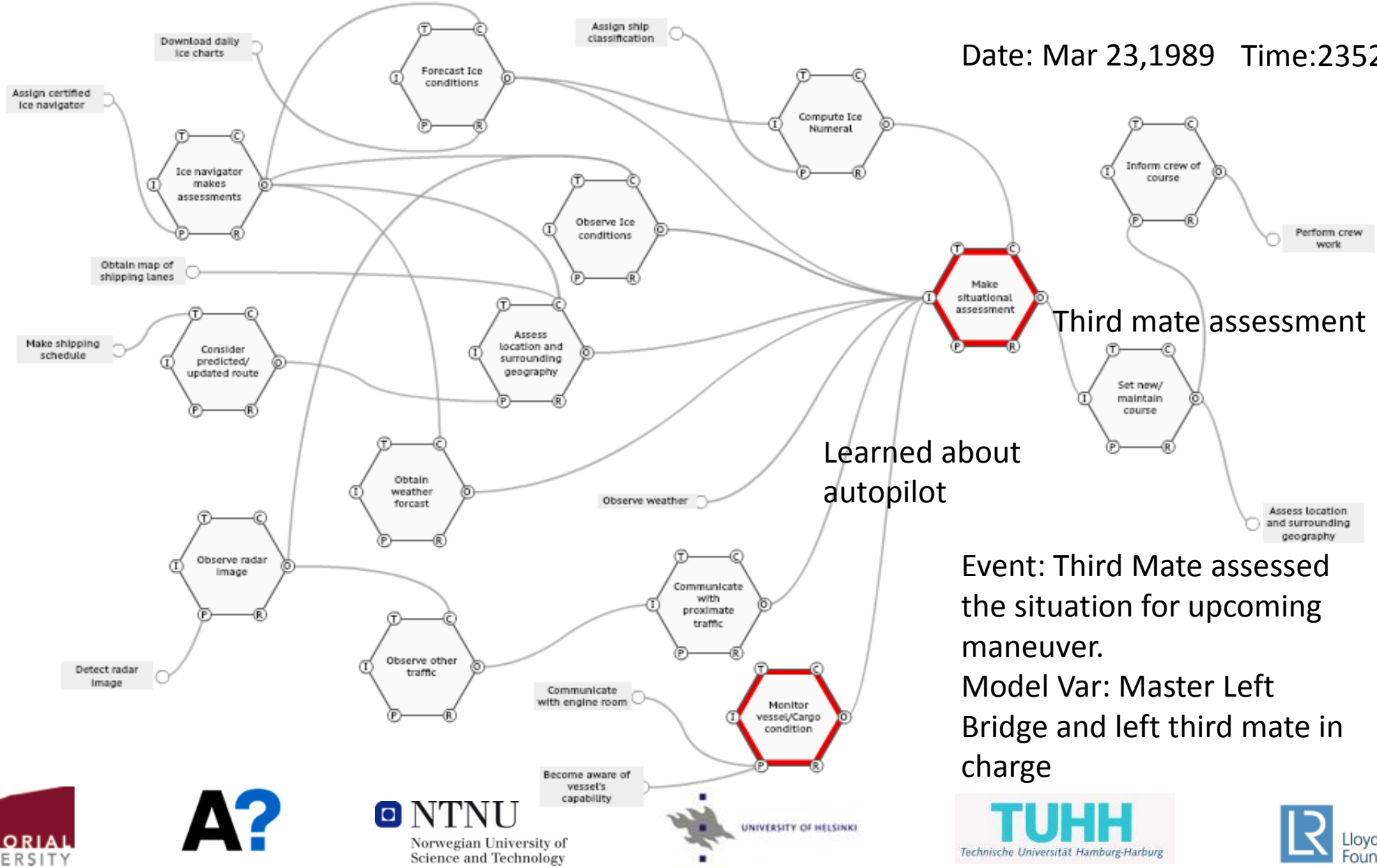

Date: Mar 23,1989 Time:2352

Third mate assessment

Learned about autopilot

Event: Third Mate assessed the situation for upcoming maneuver.
Model Var: Master Left Bridge and left third mate in charge

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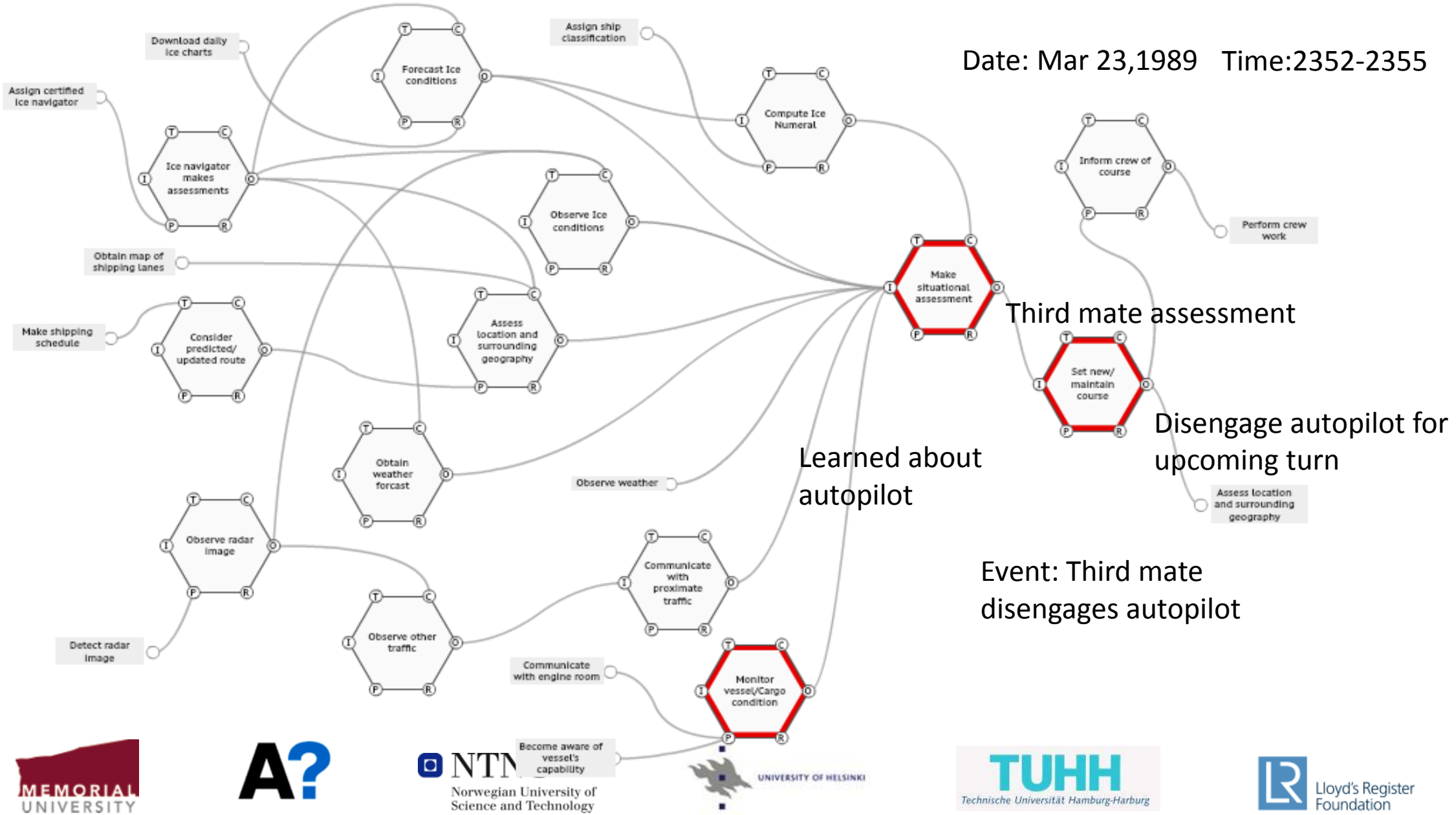

Date: Mar 23,1989 Time:2352-2355

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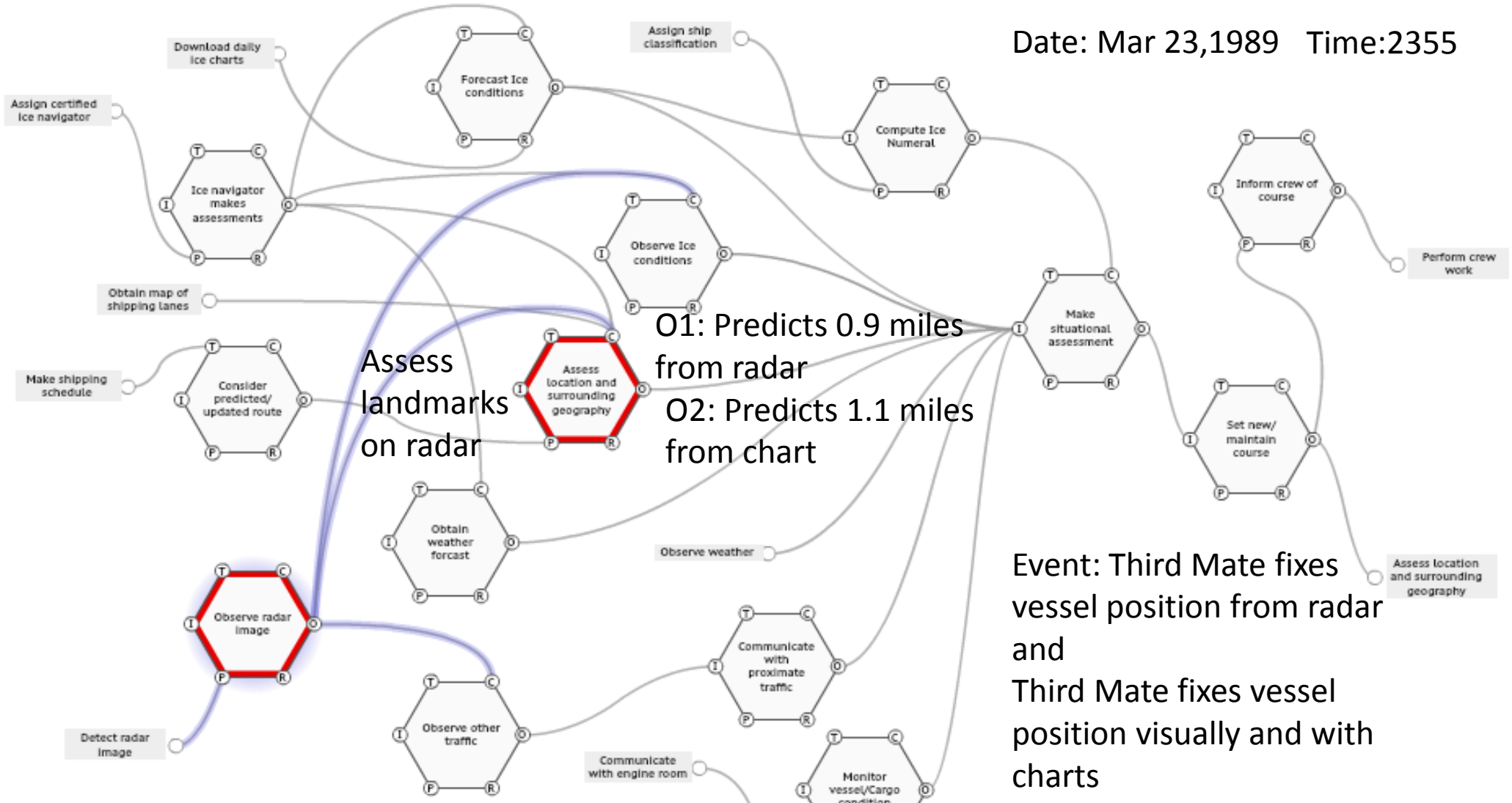

Assess landmarks on radar

O1: Predicts 0.9 miles from radar

O2: Predicts 1.1 miles from chart

Date: Mar 23,1989 Time:2355

Event: Third Mate fixes vessel position from radar and
Third Mate fixes vessel position visually and with charts

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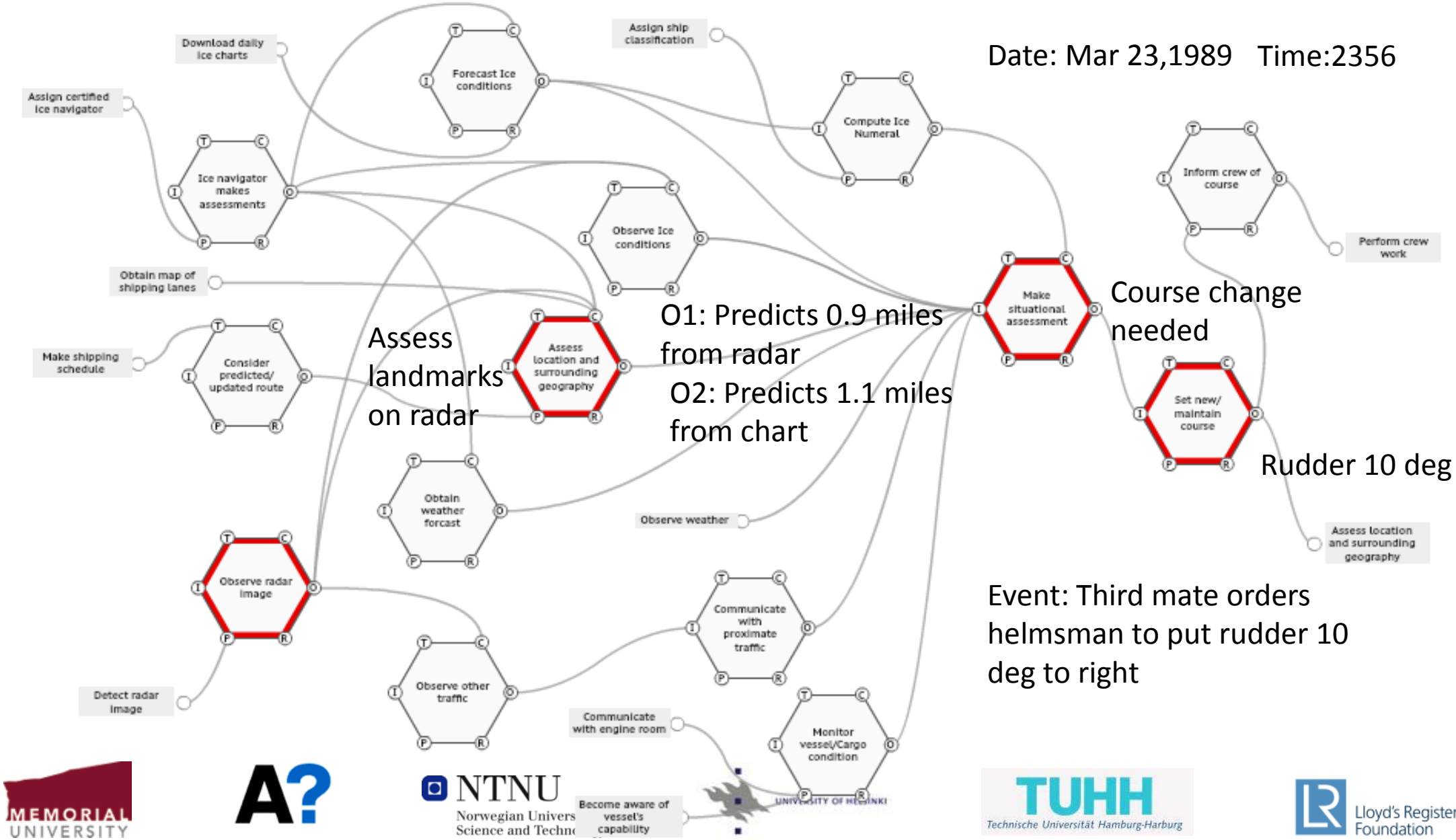

Date: Mar 23,1989 Time:2356

Assess landmarks on radar

O1: Predicts 0.9 miles from radar

O2: Predicts 1.1 miles from chart

Course change needed

Rudder 10 deg

Event: Third mate orders helmsman to put rudder 10 deg to right

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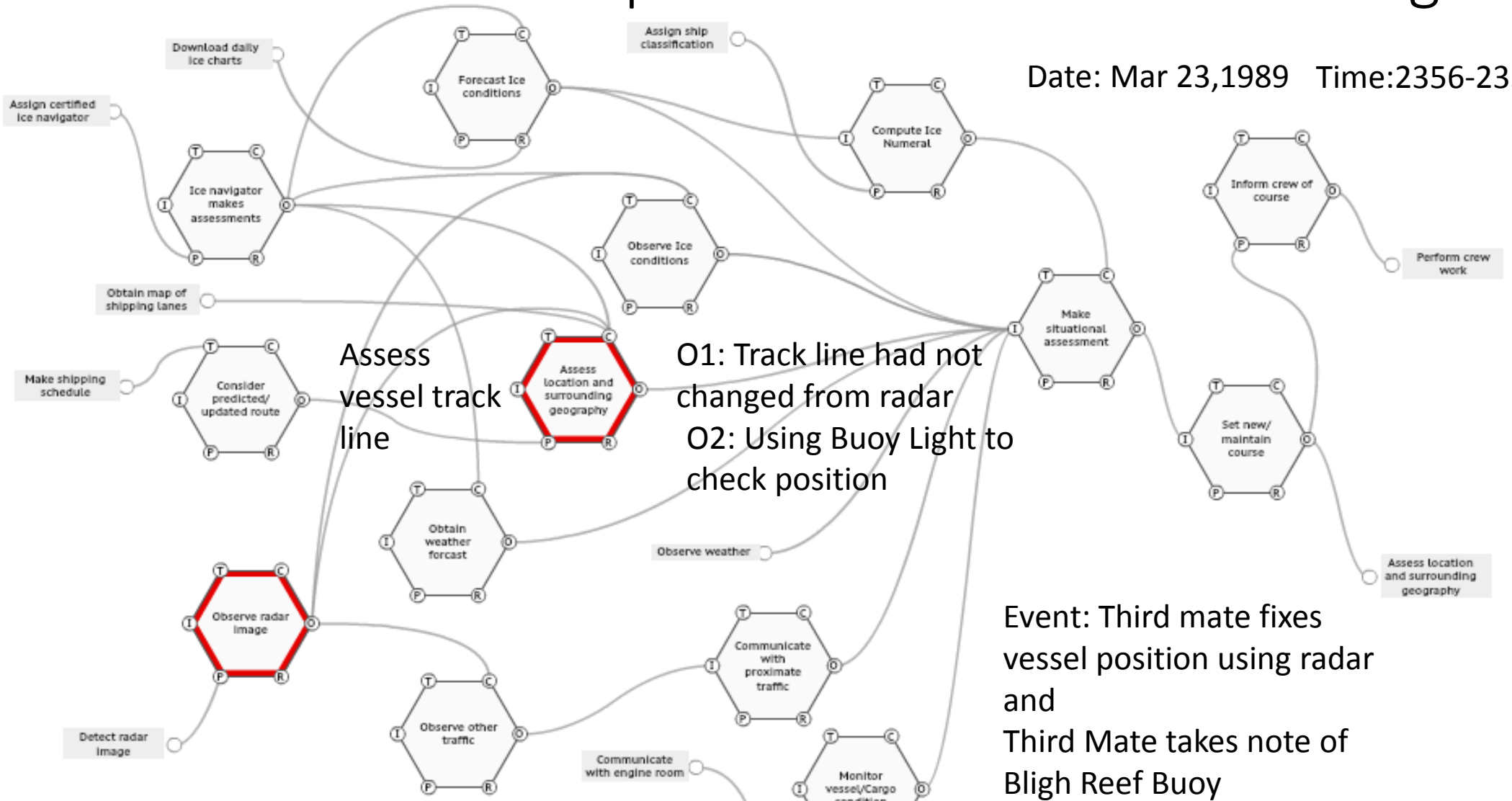

Assess vessel track line

O1: Track line had not changed from radar

O2: Using Buoy Light to check position

Date: Mar 23,1989 Time:2356-2358

Event: Third mate fixes vessel position using radar and
Third Mate takes note of Bligh Reef Buoy

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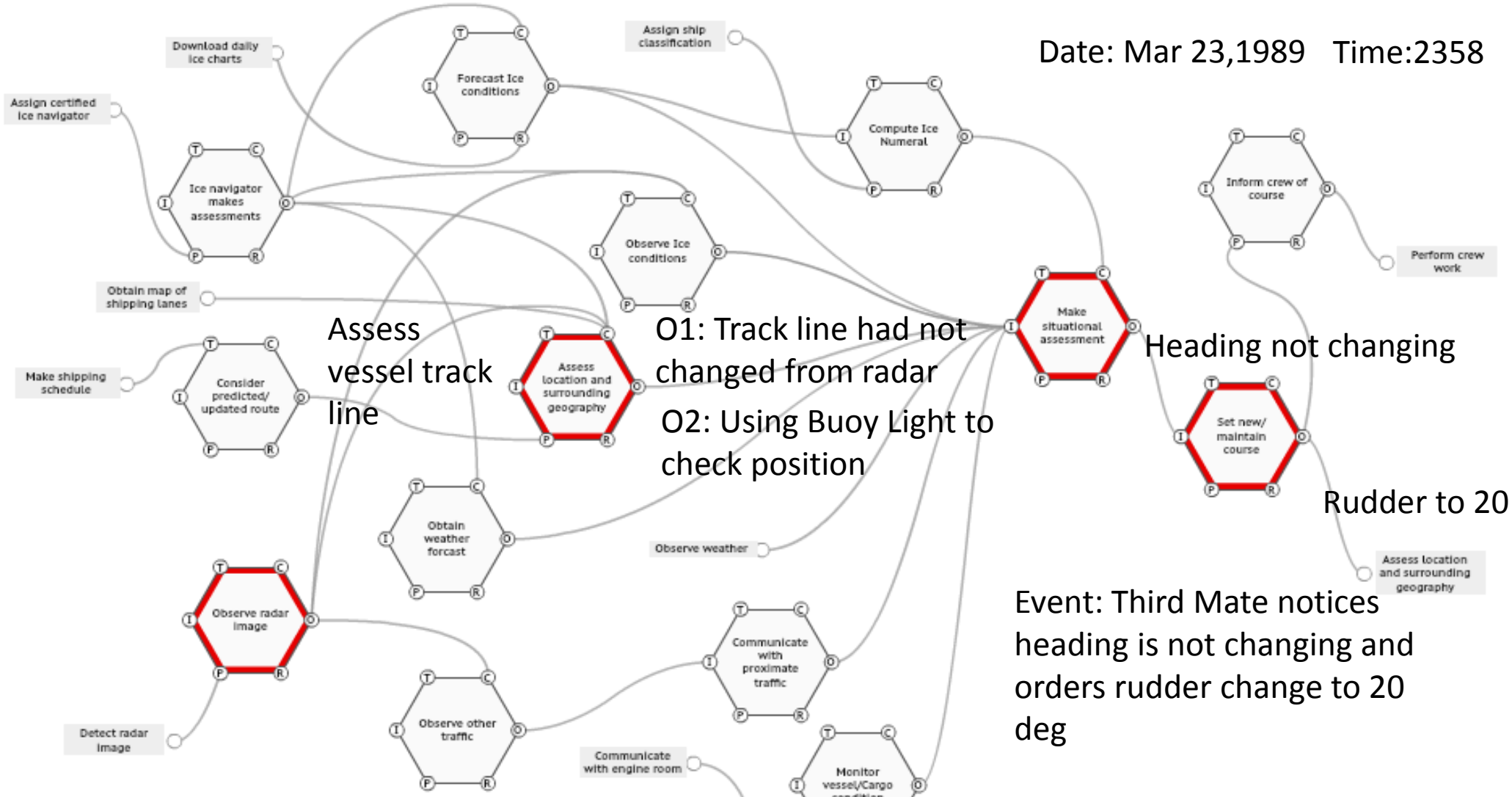

Assess vessel track line

O1: Track line had not changed from radar

O2: Using Buoy Light to check position

Date: Mar 23,1989 Time:2358

Heading not changing

Rudder to 20 deg

Event: Third Mate notices heading is not changing and orders rudder change to 20 deg

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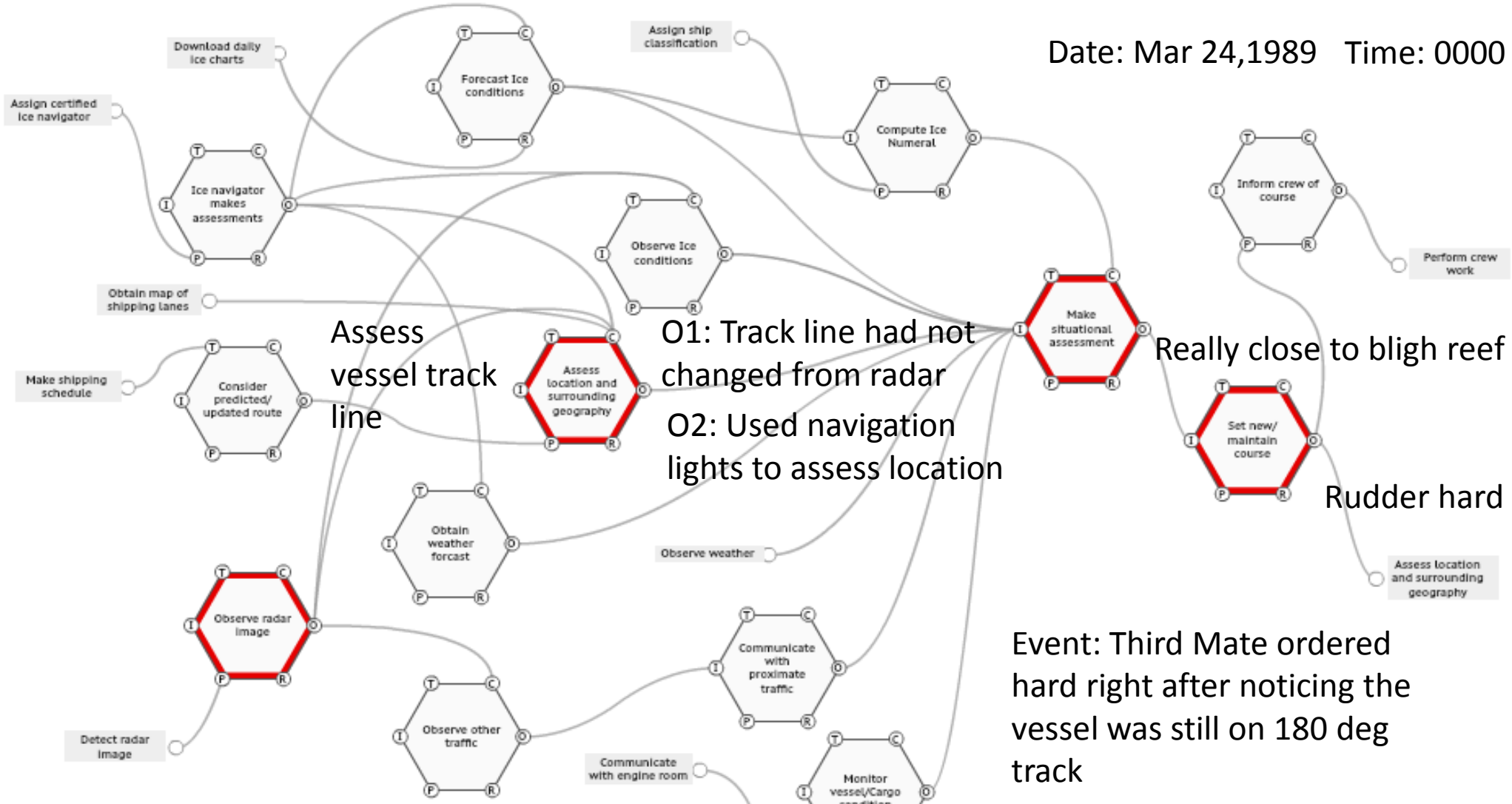

Date: Mar 24,1989 Time: 0000

Assess vessel track line

O1: Track line had not changed from radar

O2: Used navigation lights to assess location

Really close to bligh reef

Rudder hard right

Event: Third Mate ordered hard right after noticing the vessel was still on 180 deg track

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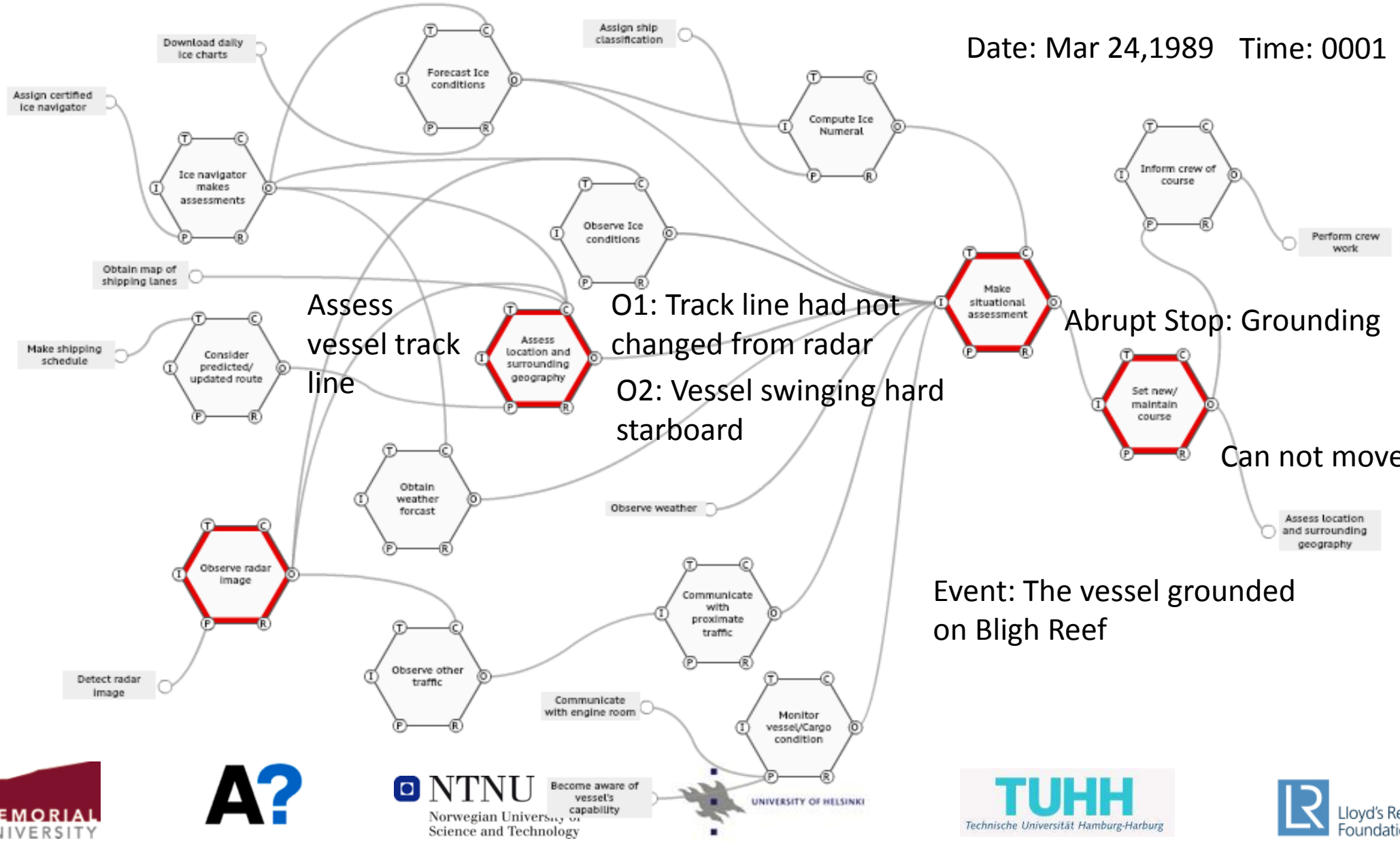

Date: Mar 24,1989 Time: 0001

Assess vessel track line

O1: Track line had not changed from radar

O2: Vessel swinging hard starboard

Abrupt Stop: Grounding

Can not move

Event: The vessel grounded on Bligh Reef

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Current and future work

- Measuring system performance for Arctic navigation
- Tracking functional signatures
- Trying to identify trends in functional signatures the promote high or low performance

Acknowledgements

- Lloyd's Register Foundation for funding the research project
- Supervisory Committee for being supportive in the pursuit of this work

Discussion Questions

- Are there practical barriers that impede the collection of data to inform a FRAM?
- Do you think this is an effective visualization technique?