Using FRAM to design a resilient traffic management system:

Which lessons can be learned from Air Traffic Control & Vessel Traffic Services?

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6th FRAM Workshop
Middelfart, Denmark
7 – 8 June 2012

Outline

- Motivation for study
- What is Vessel Traffic Service (VTS)?
- Stena Danica accident
- Accident analysis with FRAM
- Comparison of VTS with Air Traffic Control (ATC)
- FRAM analysis with ATC functions
- Conclusions

Motivation for study

- Historically technological/organisational changes in maritime domain influenced by aviation.
- However few cross-domain studies exist comparing traffic management in maritime (VTS) & aviation (ATC).
- FRAM used to describe functions of VTS & ATC during approach phase to assess resilience of each traffic management domain.
- Stena Danica maritime accident used as case study.
- Wanted to understand how accident may have been prevented if VTS functions replaced by ATC-like functions.

→ Identify lessons to be learned from ATC domain.

What is Vessel Traffic Service (VTS)?

- Shore-side service to the maritime community implemented by the Competent Authority.
- Improve the safety and efficiency of vessel traffic and protection of the environment.
- Information service, traffic organisation and navigational advice and assistance.
- Shaped by international guidelines, but implemented locally.

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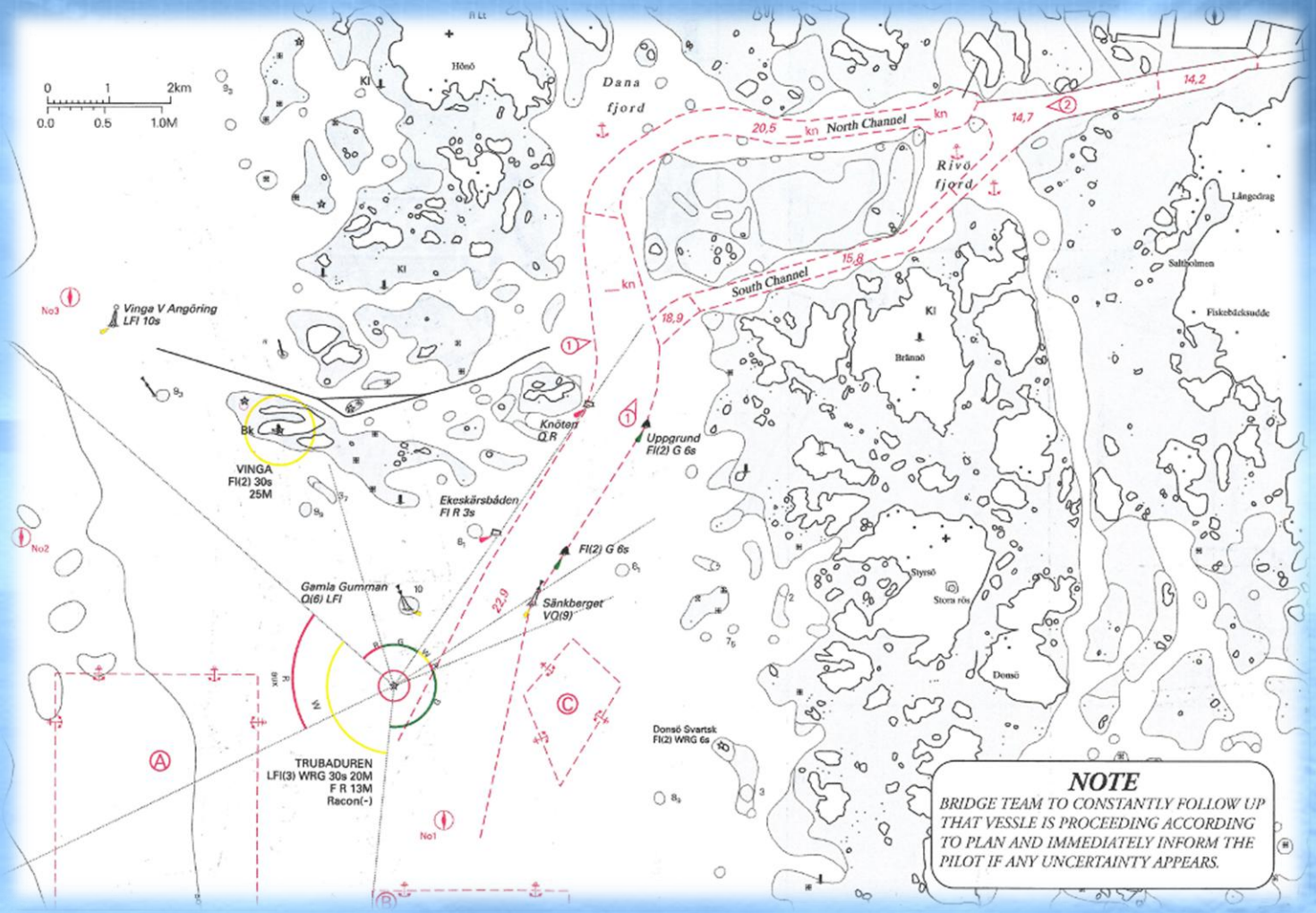
VTS centres & VTS operators



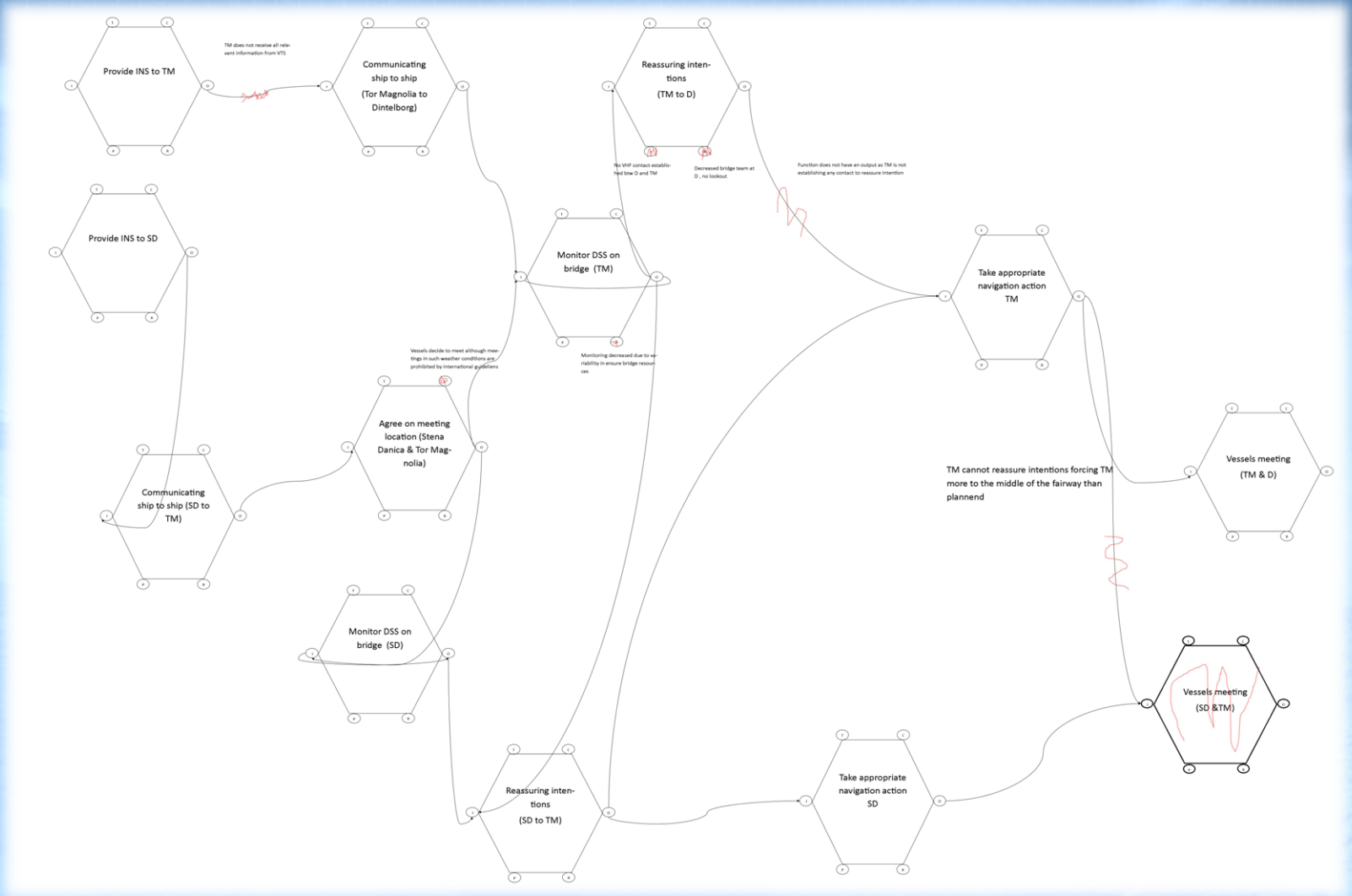



VTS area


0 1 2km
0.0 0.5 1.0M
Höno
Dana fjord
North Channel
South Channel
Rivö fjord
20,5 kn
14,7
14,2
15,8
18,9
22,9
Vinga V Angöring LFI 10s
VINGA Fl(2) 30s 25M
Knöten Q R
Uppgrund Fl(2) G 6s
Ekeskärsbåden Fl R 3s
Fl(2) G 6s
Gamla Gumman Q(6) LFI
Sänkberget VQ(9)
TRUBADUREN LFI(3) WRG 30s 20M F R 13M Racon(-)
Donsö Svartsk Fl(2) WRG 6s
Brännö
Styrsö
Stora rös
Donsö
Saltholmen
Fiskebäcksudde
Långedrag
No1
No2
No3
NOTE
BRIDGE TEAM TO CONSTANTLY FOLLOW UP THAT VESSLE IS PROCEEDING ACCORDING TO PLAN AND IMMEDIATELY INFORM THE PILOT IF ANY UNCERTAINTY APPEARS.

Danica's Grounding January 2008

2nd Iteration of the accident analysis



Accident Analysis with FRAM

- 23 functions identified (10 background, 13 foreground).
- Main source of variability affecting the overall outcome in functions “Provide Information Service” & “Ensure Adequate Bridge Resources”.
- VTS is Control and Resource, but has a conflicting role when it comes to traffic organisation

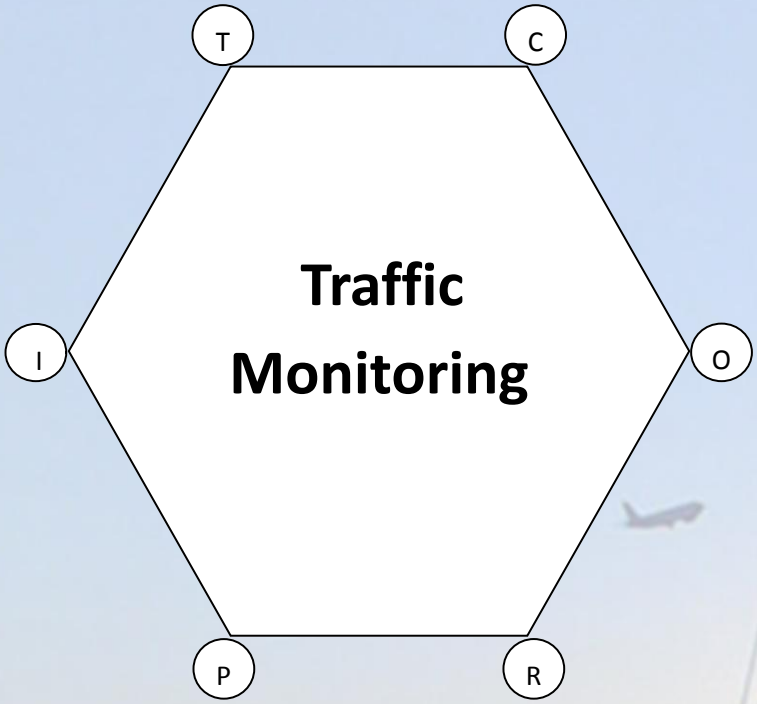
Comparison with Air Traffic Control

How might the Stena Danica accident scenario have evolved differently if existing VTS service was replaced by an ATC-type service (‘**Vessel Traffic Control**’) ?

Air Traffic Control on Arrival/Approach

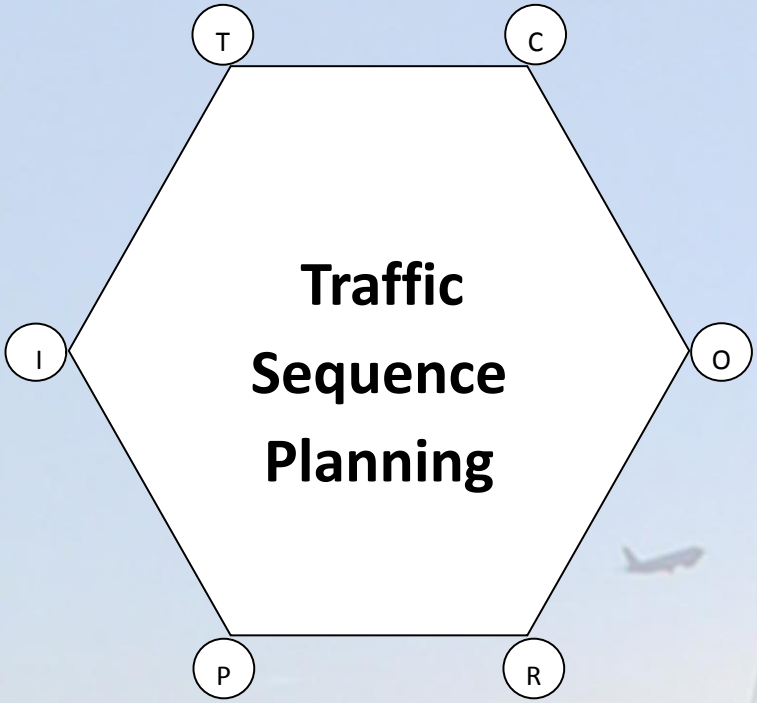
- ATCO starts to monitor aircraft ~200 Nautical Miles (NM) before it arrives at sector boundary.
- ATCO starts to plan early sequencing measures required.
- Flight 'activated' 8 mins or 40 NM before entering sector.
- More detailed sequencing plan formed to optimise aircraft spacing.
- ATCO can request changes to altitude, speed, heading & sector entry point.
- ATCO issues clearance to flight crew, which flight crew *must* acknowledge and follow.

Vessel Traffic Control (VTC) functions



- VTC would monitor compliance with pre-determined trajectories (speed, course).
- All changes in trajectory would need to be cleared by VTC.
- Any potential traffic conflicts would be immediately rectified by VTC.
- No monitoring of vessel-to-vessel communication required.

Vessel Traffic Control (VTC) functions

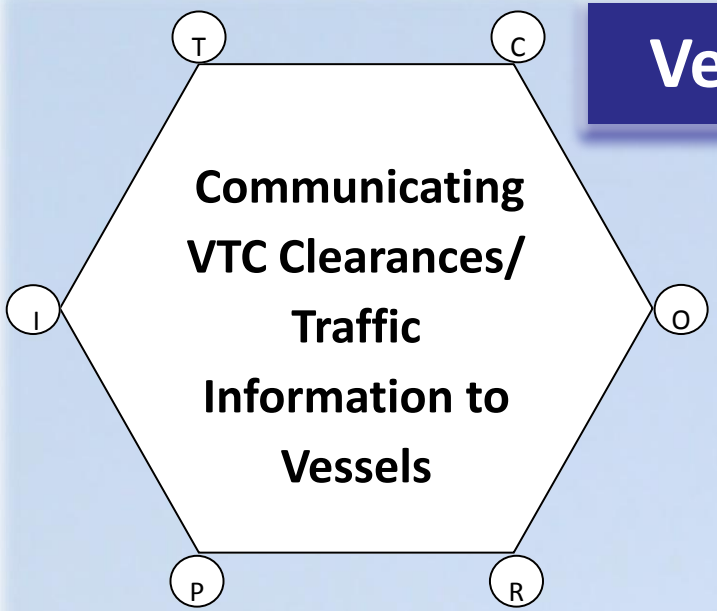


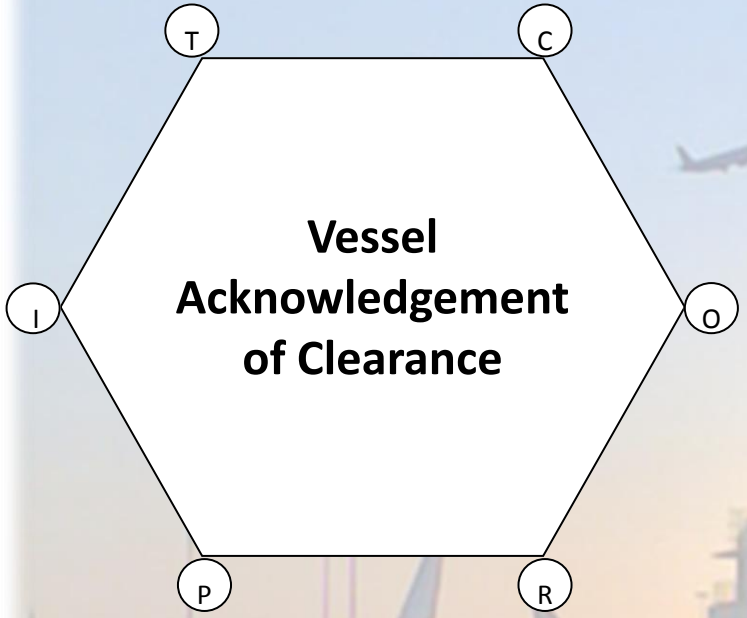
- Most optimum sequence meeting minimum separation requirements.
- Ensures no meetings in tight parts of fairway.
- Sequence plan constantly updated.
- Additional ‘sectors’ opened during busy traffic periods.

  OR

  Some traffic routed along alternative fairway.

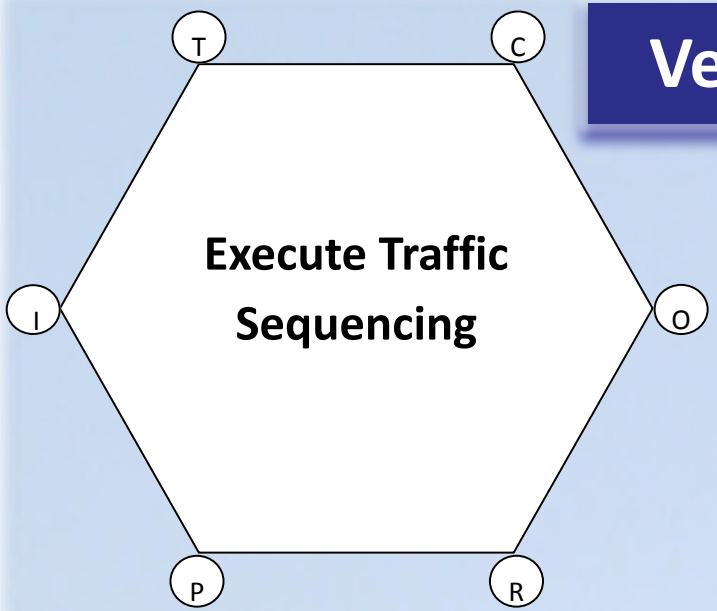
Vessel Traffic Control (VTC) functions

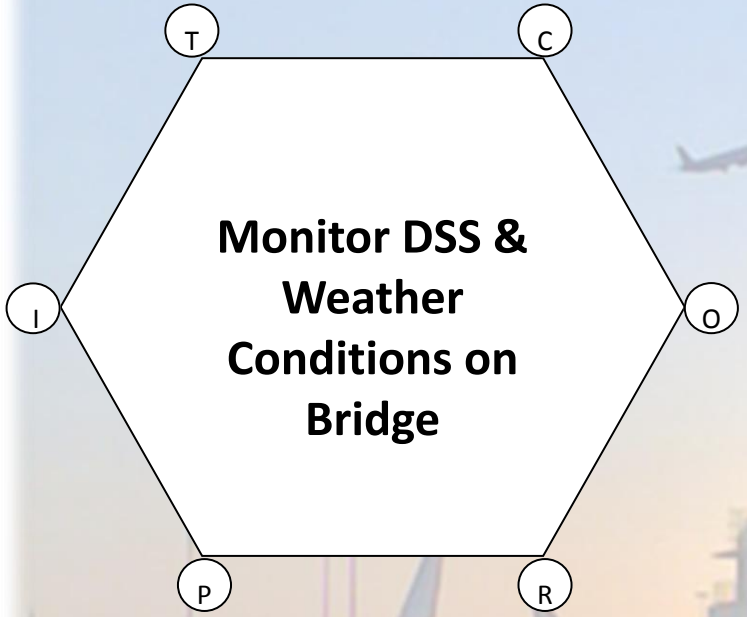




- **ALL** trajectory changes issued via verbal clearances by VTC.
- All communication in English.
- Additional information to enhance situational awareness also provided.
- Vessel Master or pilot obliged to acknowledge and respond to instructions.

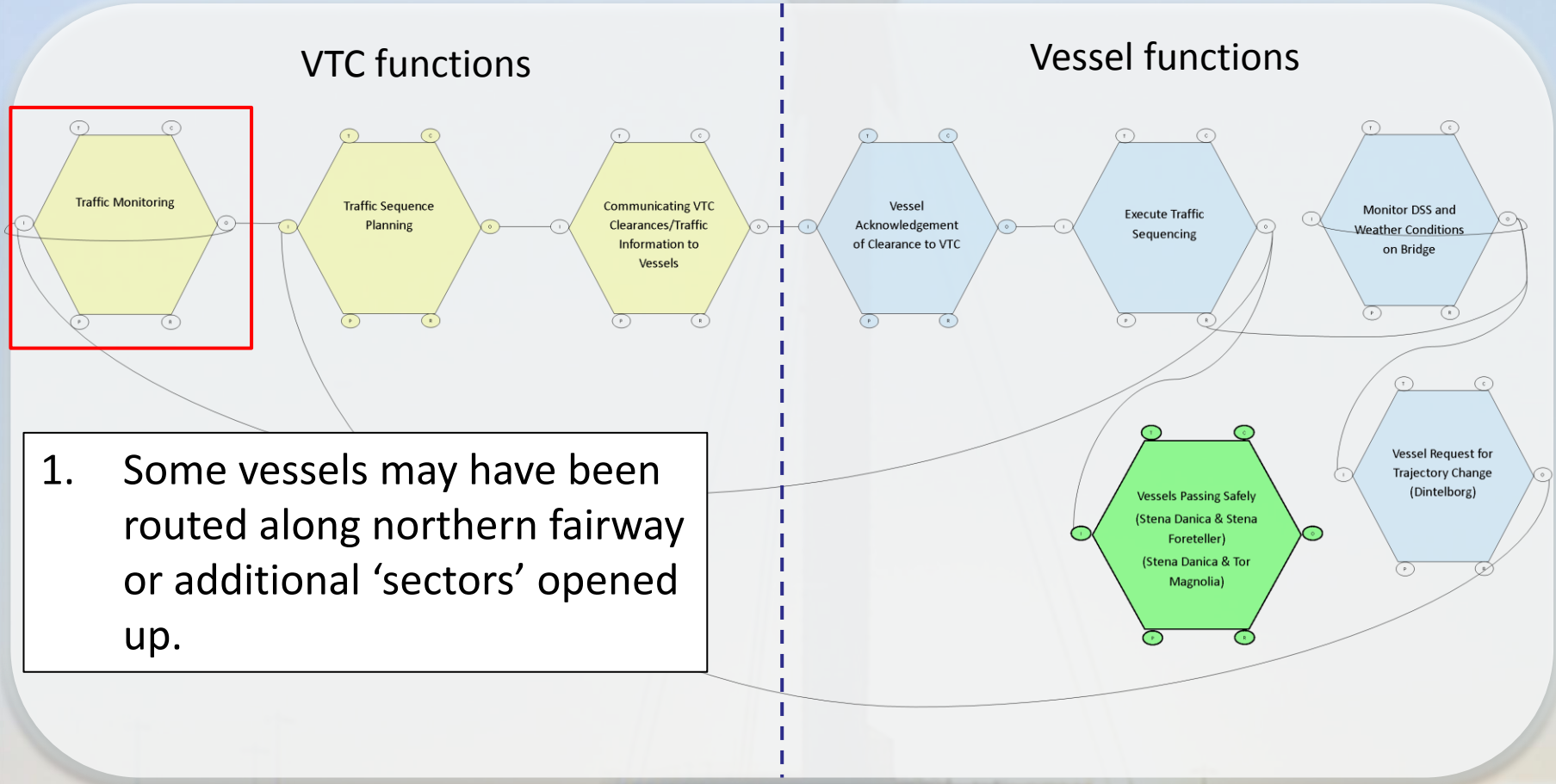
Vessel Traffic Control (VTC) functions





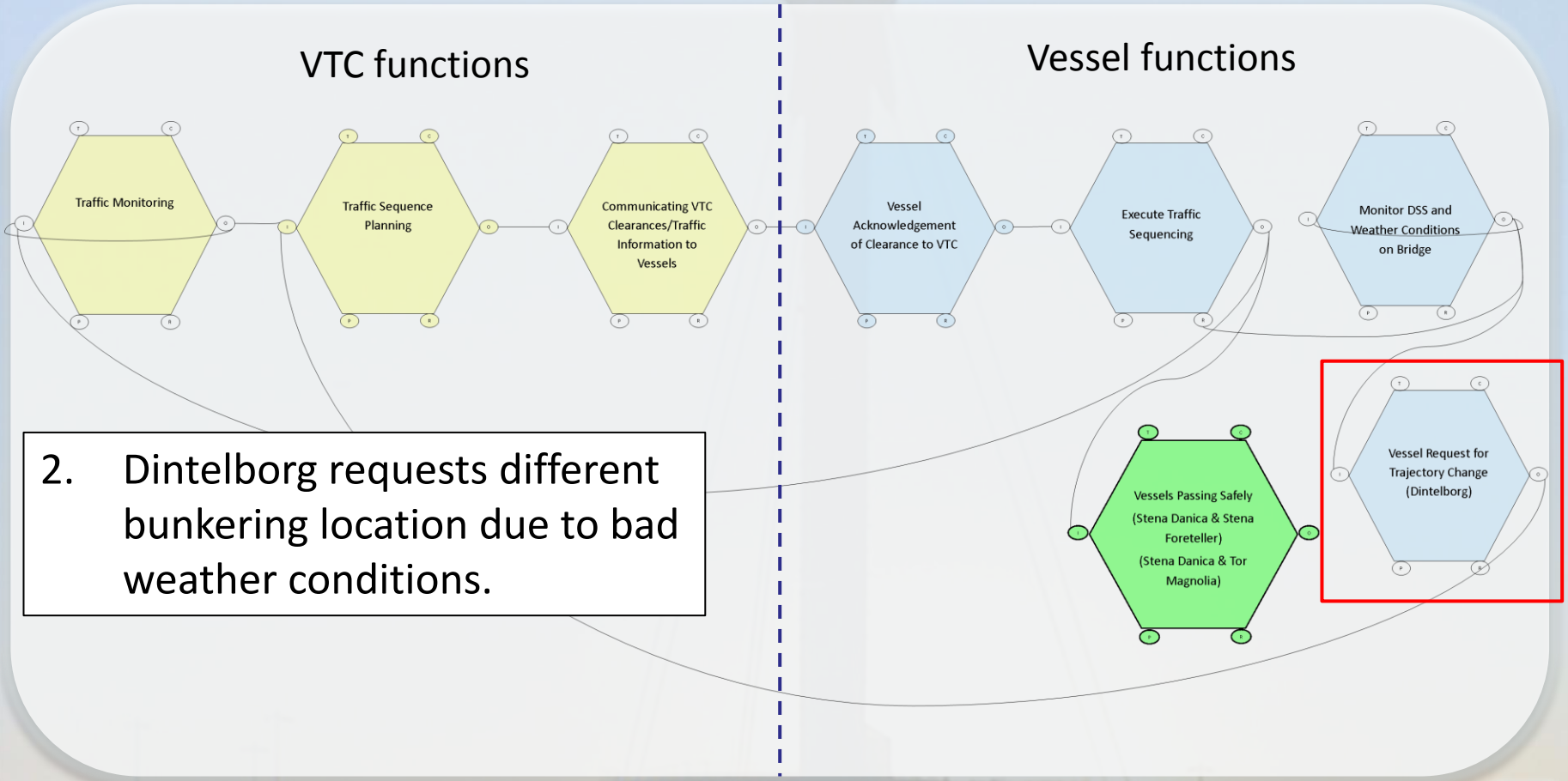
- Vessels follow instructions provided by VTC to form requested traffic sequence.
- All speed & course clearances obeyed.
- Monitor DSS & weather during navigation procedures.
- Report to VTC if change in trajectory required.

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



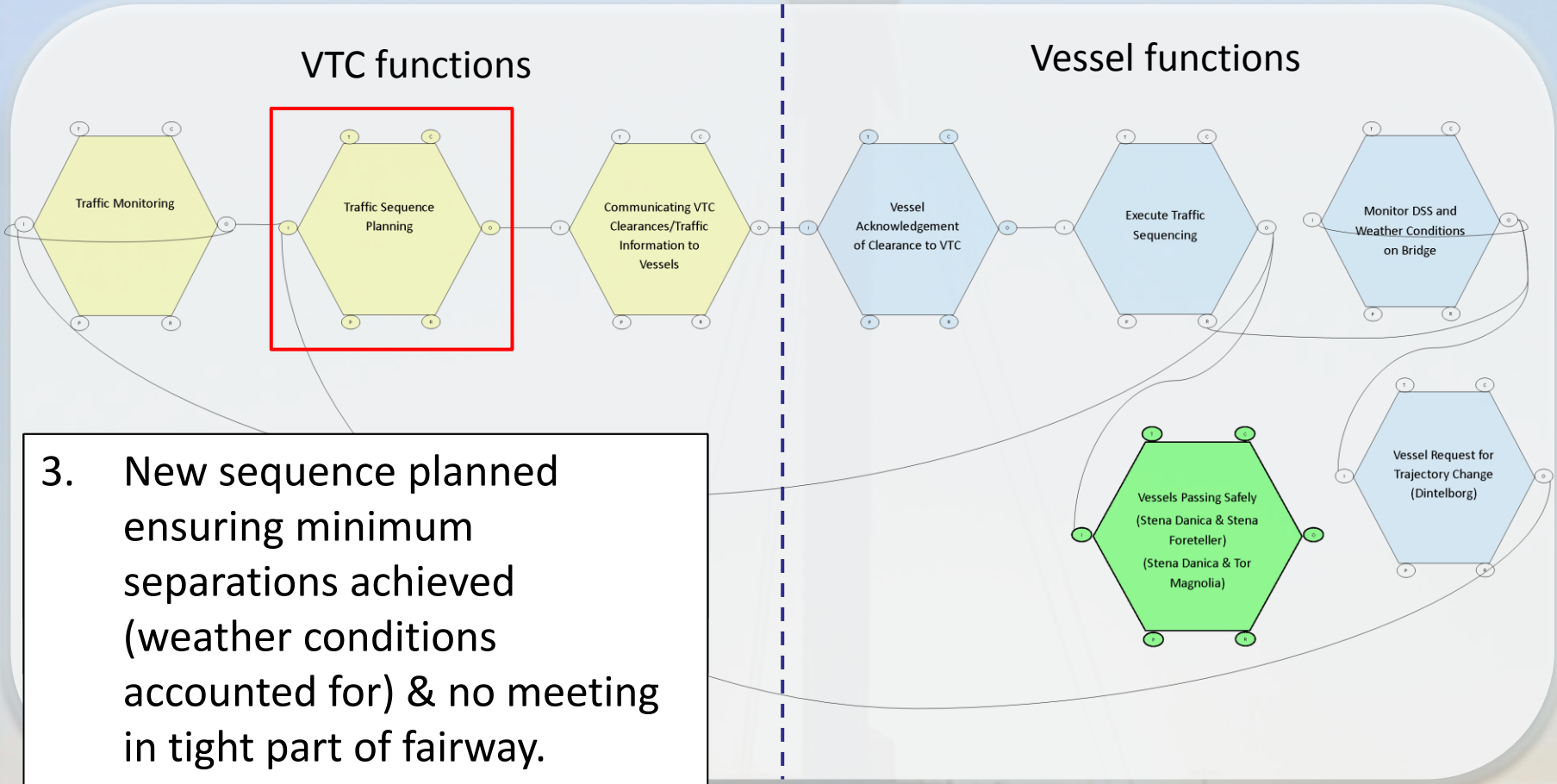
1. Some vessels may have been routed along northern fairway or additional ‘sectors’ opened up.

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



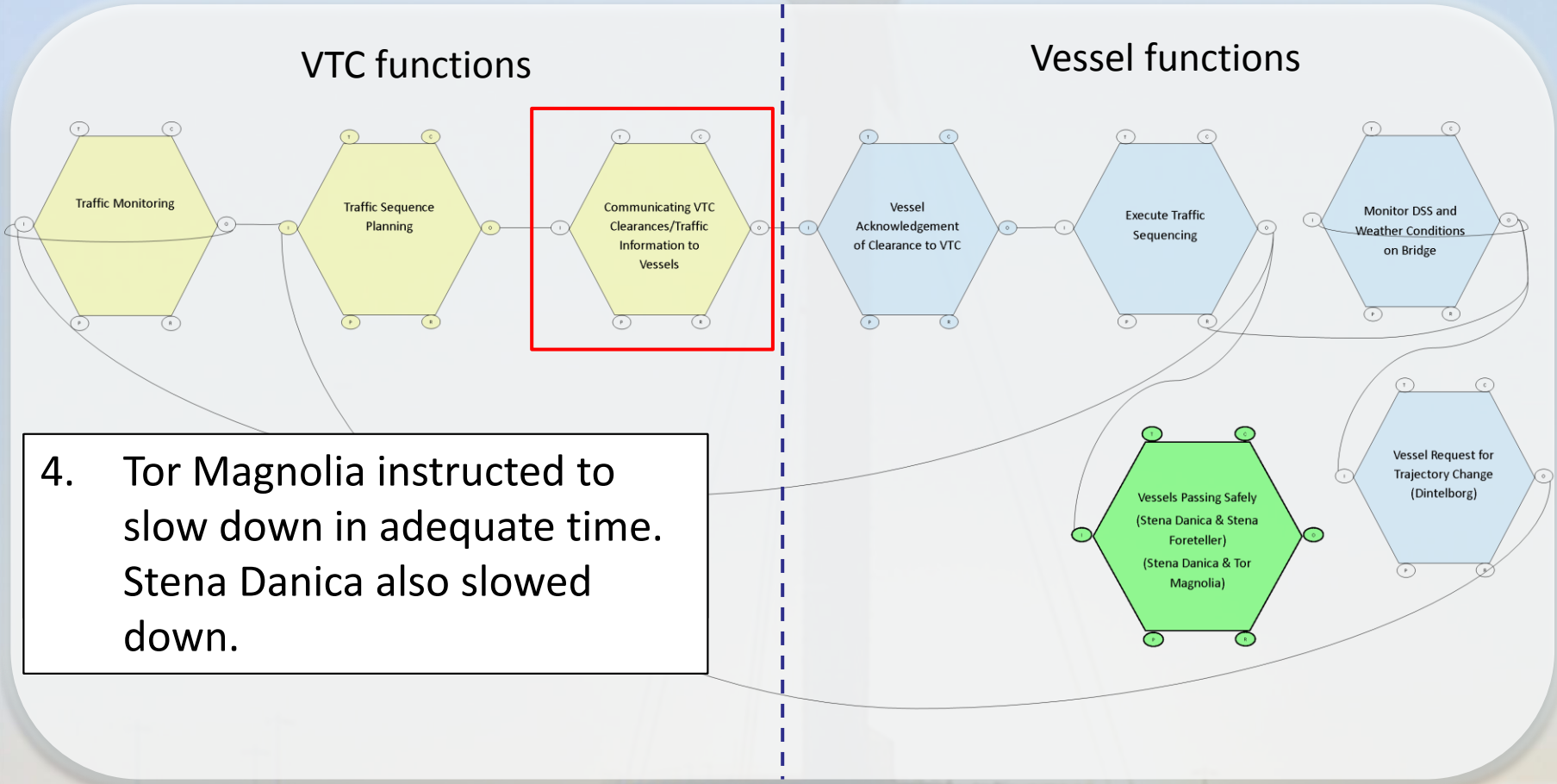
2. Dintelborg requests different bunkering location due to bad weather conditions.

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



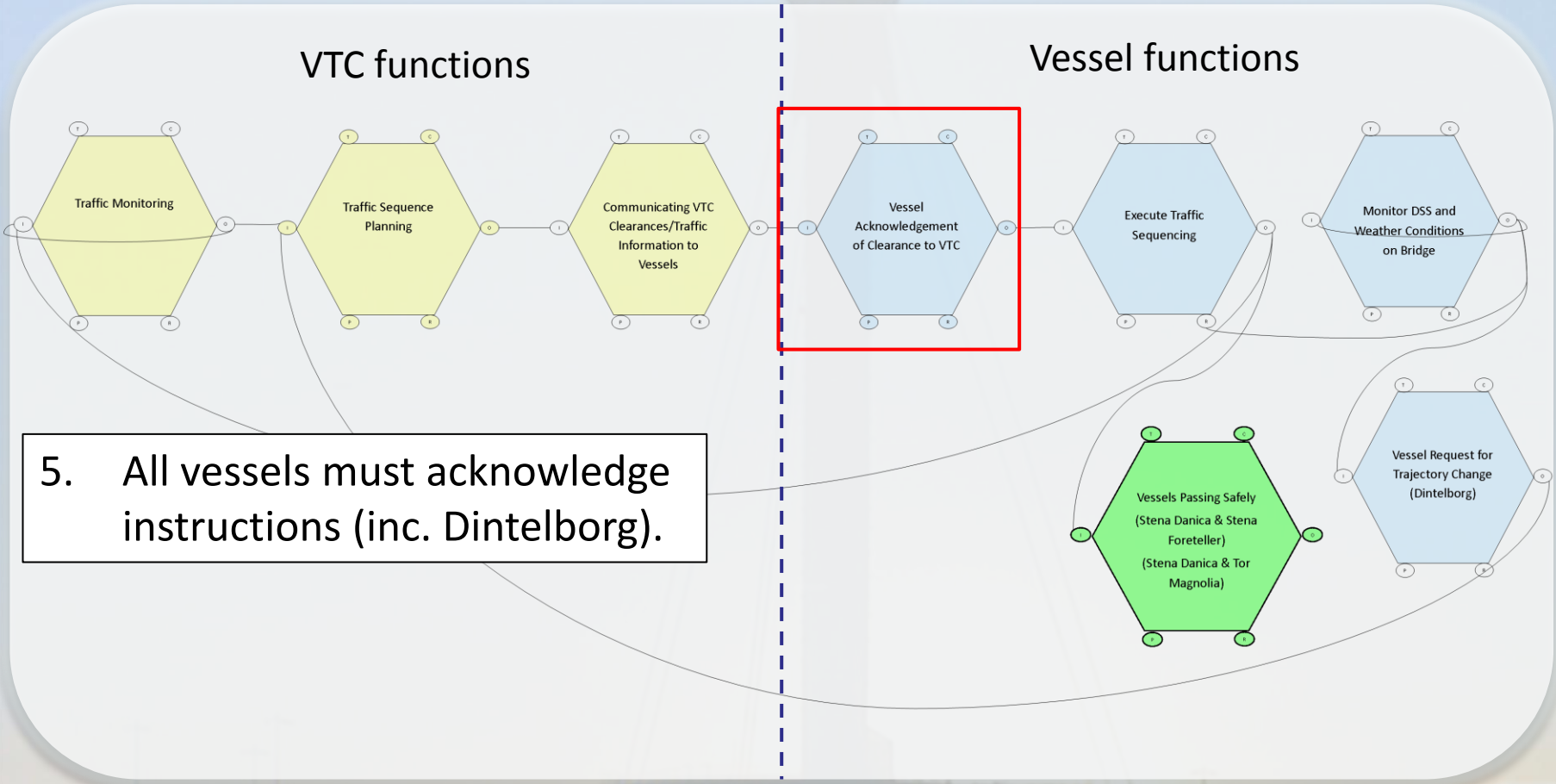
3. New sequence planned ensuring minimum separations achieved (weather conditions accounted for) & no meeting in tight part of fairway.

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



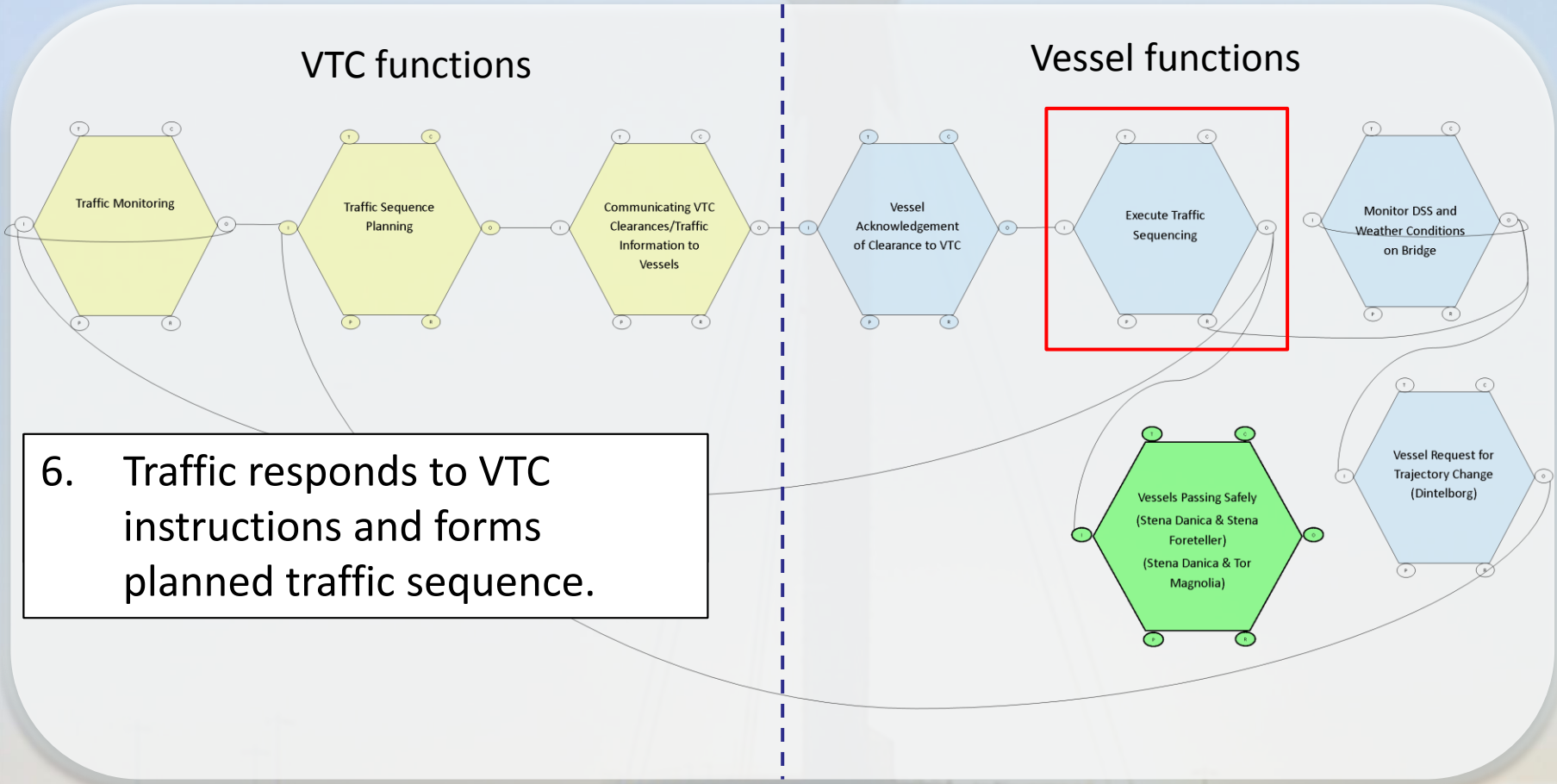
4. Tor Magnolia instructed to slow down in adequate time. Stena Danica also slowed down.

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



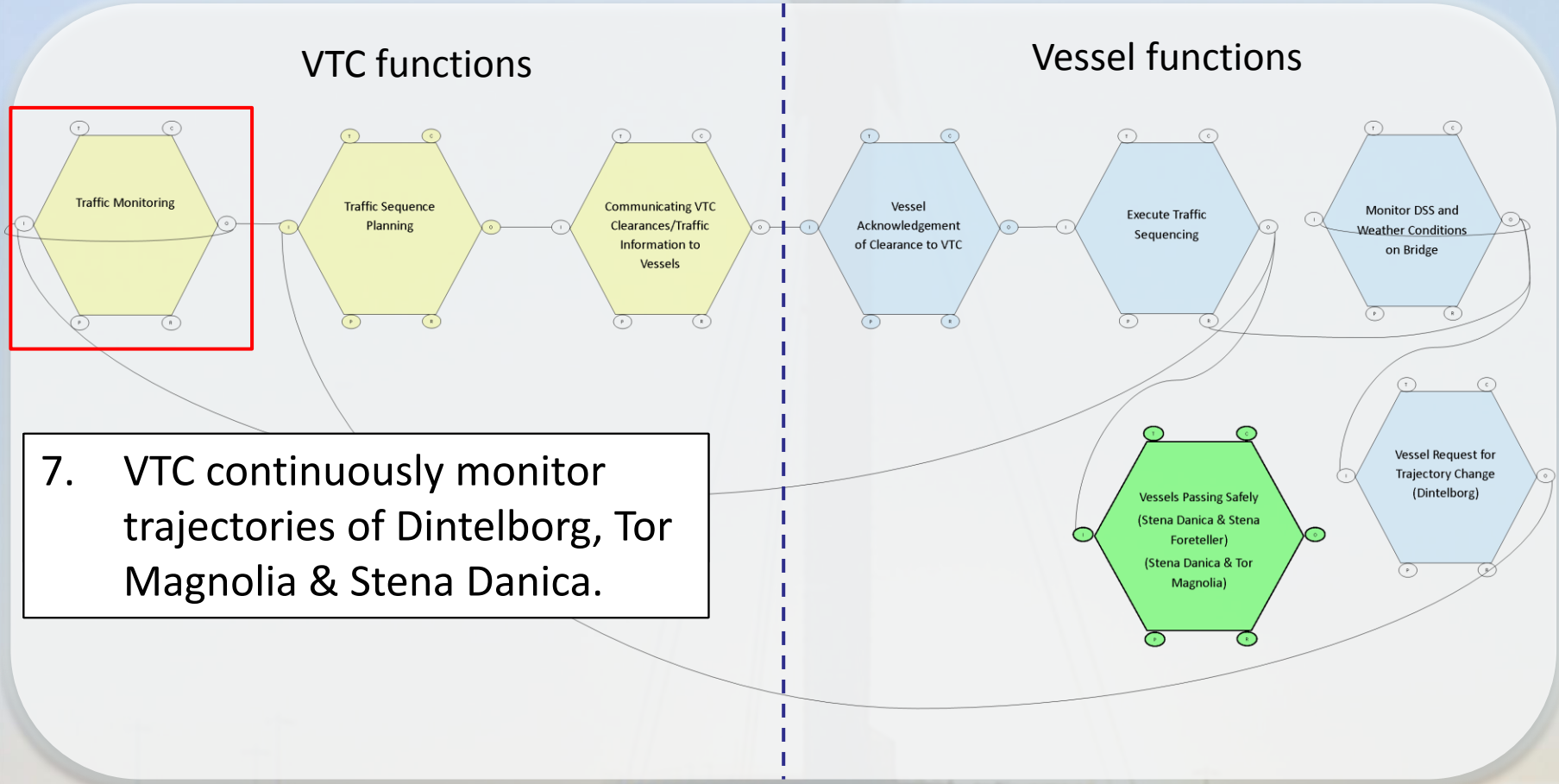
5. All vessels must acknowledge instructions (inc. Dintelborg).

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



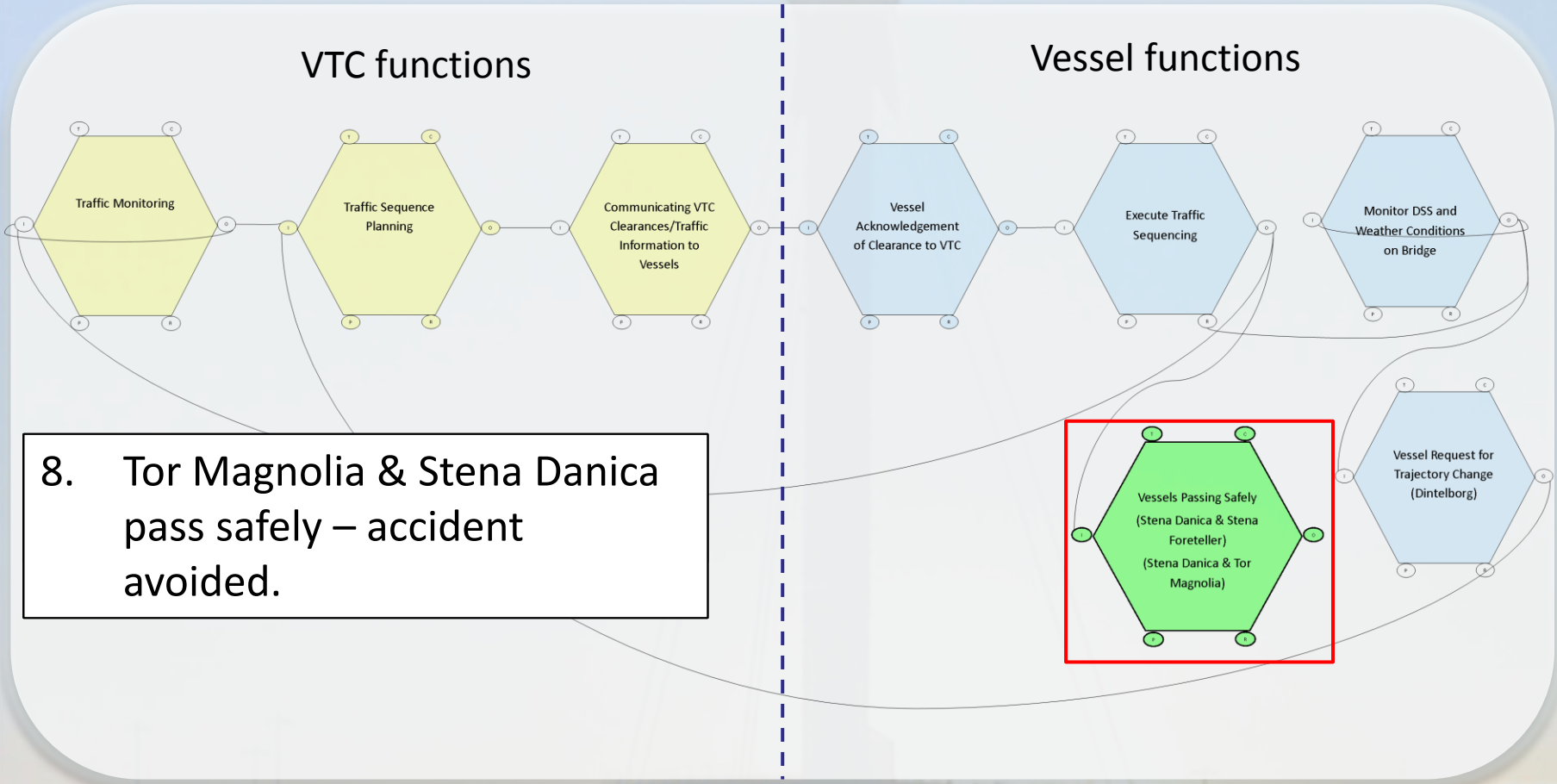
6. Traffic responds to VTC instructions and forms planned traffic sequence.

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



7. VTC continuously monitor trajectories of Dintelborg, Tor Magnolia & Stena Danica.

Instantiation of incident with presumed Vessel Traffic Control (VTC) functions



8. Tor Magnolia & Stena Danica pass safely – accident avoided.

Conclusions

- Accident avoided due to authority of VTC to fully control all vessel movements.
- VTC instantiation less complex as only one function required for communication, navigation, etc ➡ centralised control service ➡ reduces dependencies.
- Current VTS at Gothenburg similar to ATC in **uncontrolled** airspace, although VTS at other ports more similar to ATC (e.g. Port of Rotterdam).

Potential Issues

- Traditional split between ship and shore organisation
- Legal framework is stated on international level, but allows local implementation leading to a general need for standardisation in language and procedures before organisational change can become a focus

What is next?

- Validation of the first iteration of VTC model with VTS operators
  - Study visits at VTS centres coupled with observations and interviews
  - Focus groups with ATCos and VTSOs
- Define resilience conerstones (Learning, Anticipating, Monitoring and Responding) for ATC and VTS domain

Discussion Questions

- How can we differentiate between “good” and “bad” variability when FRAM is used for the design of a system that does not yet exist?
- How do we know that we have reach a good level of detail in the model?

Acknowledgements

- Fru Mary von Sydow, född Wijk Donationsfond
- Region of Västra Götaland

- Fulko van Westrenen, umantec
- Patrik Bergviken & ATC Landvetter Gothenburg
- Anders Brödje & Swedish Maritime Administration