

# IALA Committee VTS47



shaping tomorrow with you

## Detection of Near-miss and Dynamic Hotspot

23<sup>rd</sup> September 2019  
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# Introduction



FUJITSU Human Centric AI

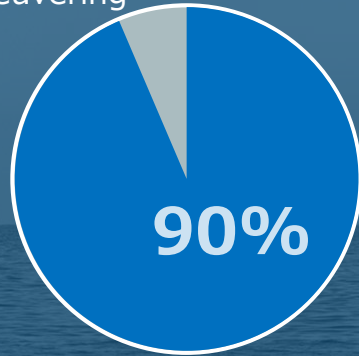
# Zinrai

# Motivation

## Human factors causing vessel accidents

for cargo ship and tanker of Japan (2014 - 2016)

Mistake in  
maneuvering



Mistake in  
recognition  
& judgment

**Role of ICT:  
Help recognition & judgment**

reference :  
Ministry of Land, infrastructure, Transport and Tourism of Japan (December, 2017)



# Law of Heinrich



# Situations Leading to Collision

## i. Near-miss

Trajectories of two or three vessels come close and intersect to raise the collision probability.

## ii. Dynamic hotspot

Vessels are populated densely enough to influence each other.



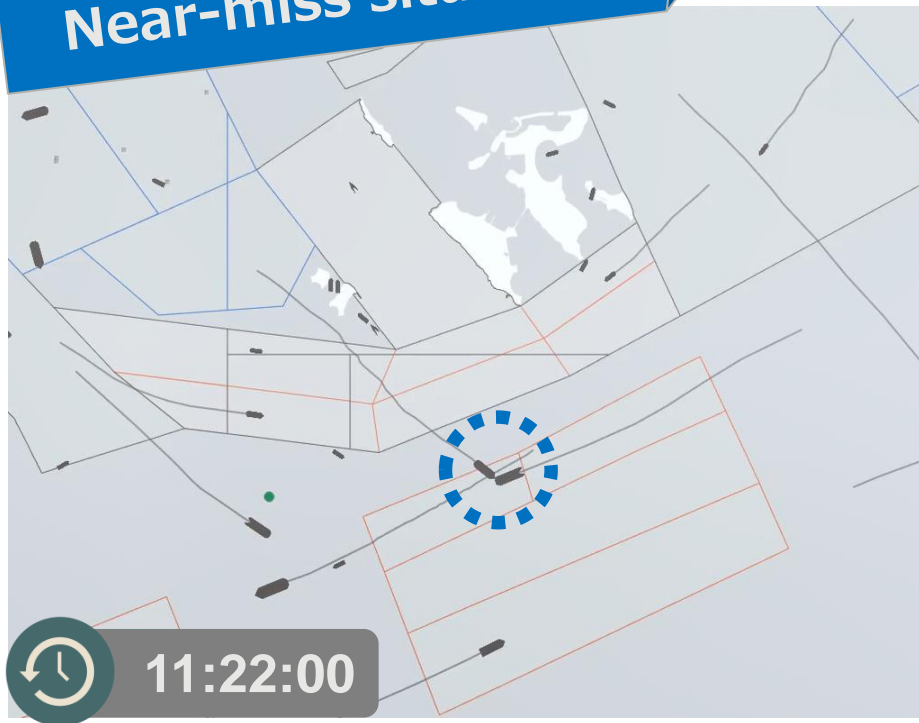
**Proactive traffic management**

# i. Near-miss Situation



# Management of Near-miss Risk at VTS (1)

## Near-miss situation



## Warning level



# Management of Near-miss Risk at VTS (2)

Advice level

Information level

Based on officers' experience



11:17:00



11:12:00



# Trade-off Problem of Current Technologies

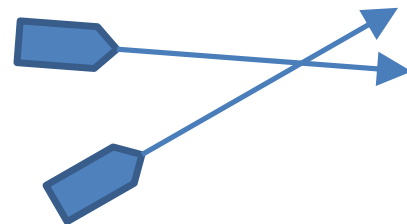
## ■ Distance between vessels

- Risk becomes higher when two vessels come close each other.



## ■ Vector crossing

- Risk becomes high when vectors of two vessels cross.



**False alert** increases when lowering the threshold, but  
**Detection failure** increases when raising the threshold.

## ■ Ensemble risk model

### ■ Integration of multiple risk calculation models

Realizing comprehensive risk evaluation

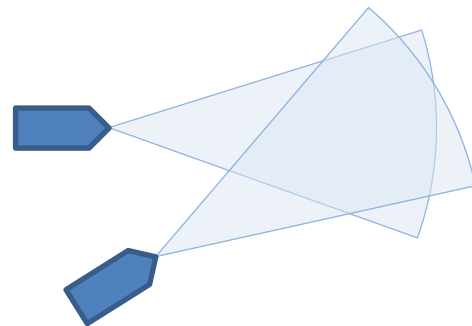
### ■ Range of potential trajectory

Probabilistic distribution according to vessel size and speed

### ■ Parameter adjustment

Relationship of vessels, vessel types, and the target water characteristics

- DCPA : Distance of Closest Point of Approach
- SJS : Subjective Judgment scales
- SYSROC : Synthetically subjective risk of collision
- CJ : Collision Judgment
- RiskLevel



# Quantification of Risk according to VTS Ops

## ■ Quantified risk at timings of key VTS operations

Action level	Action content	Time to near-miss	Risk index
<b>Warning</b>	Warn potential collision	<b>3 minutes</b>	<b>0.7</b>
<b>Advice</b>	Give advice to manoeuver	<b>5 minutes</b>	<b>0.6</b>
<b>Information</b>	Provide information when detecting potential risk	<b>10 minutes</b>	<b>0.35</b>

*Relationship between key operations and corresponding risk index*

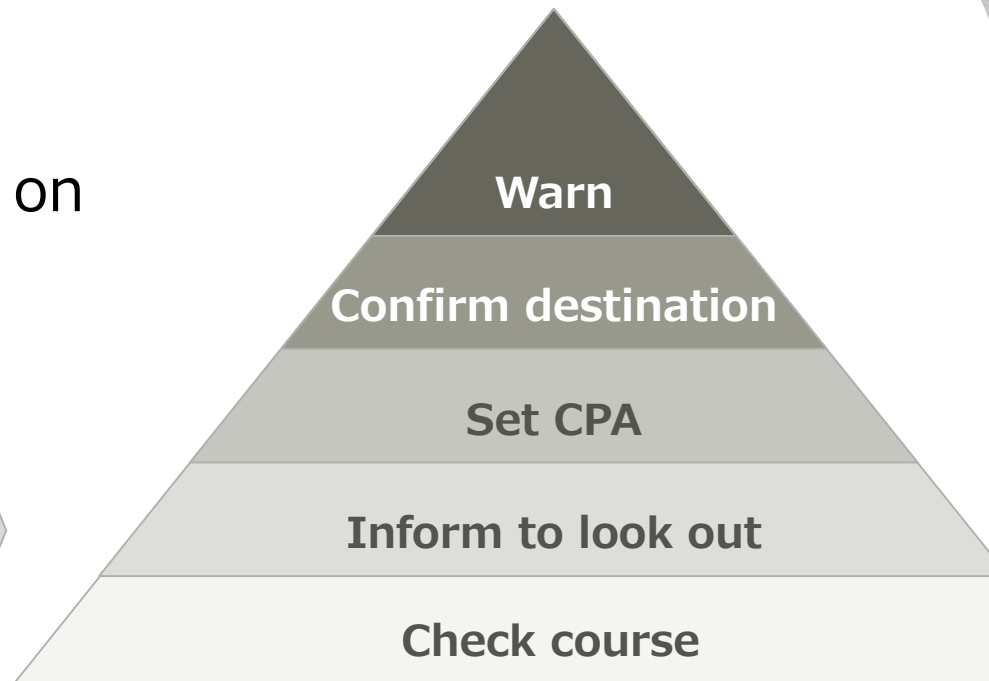
# Operations at Traffic Control Centre

## ■ Key operations:

Proactively obtain and give information to vessels based on VTS operational guidance



*VTS guide*

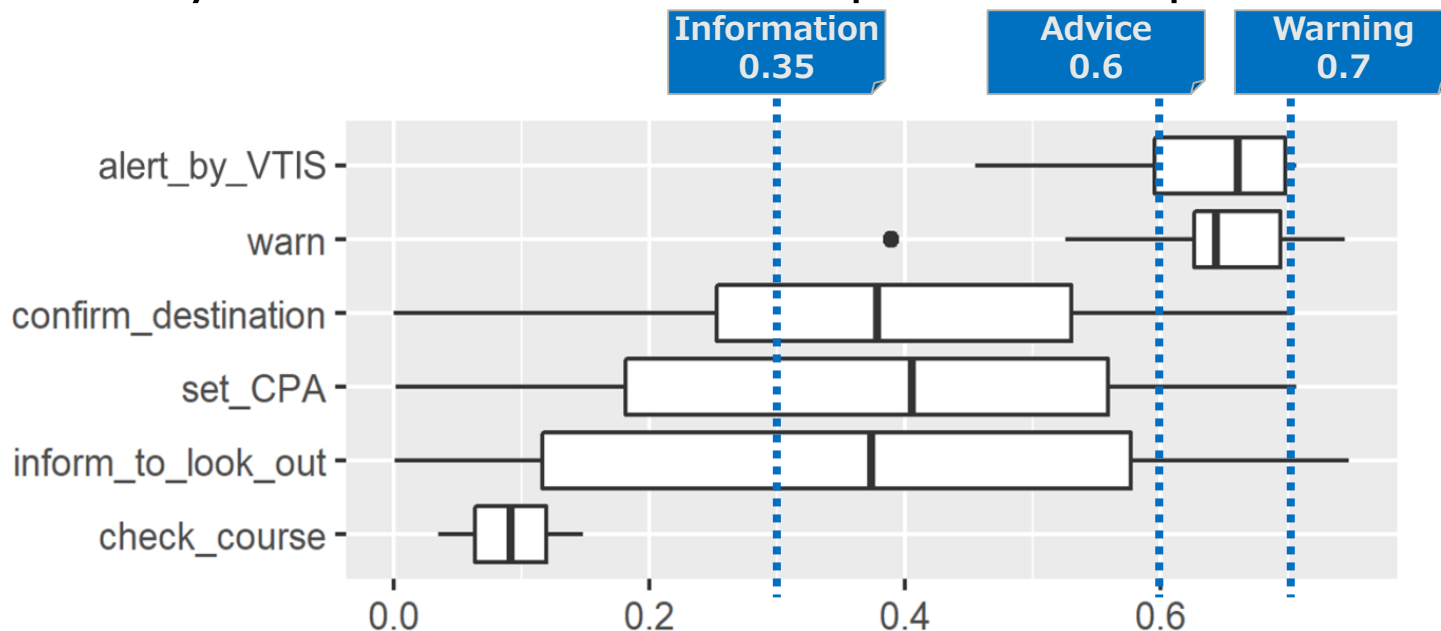


*Actual operations*



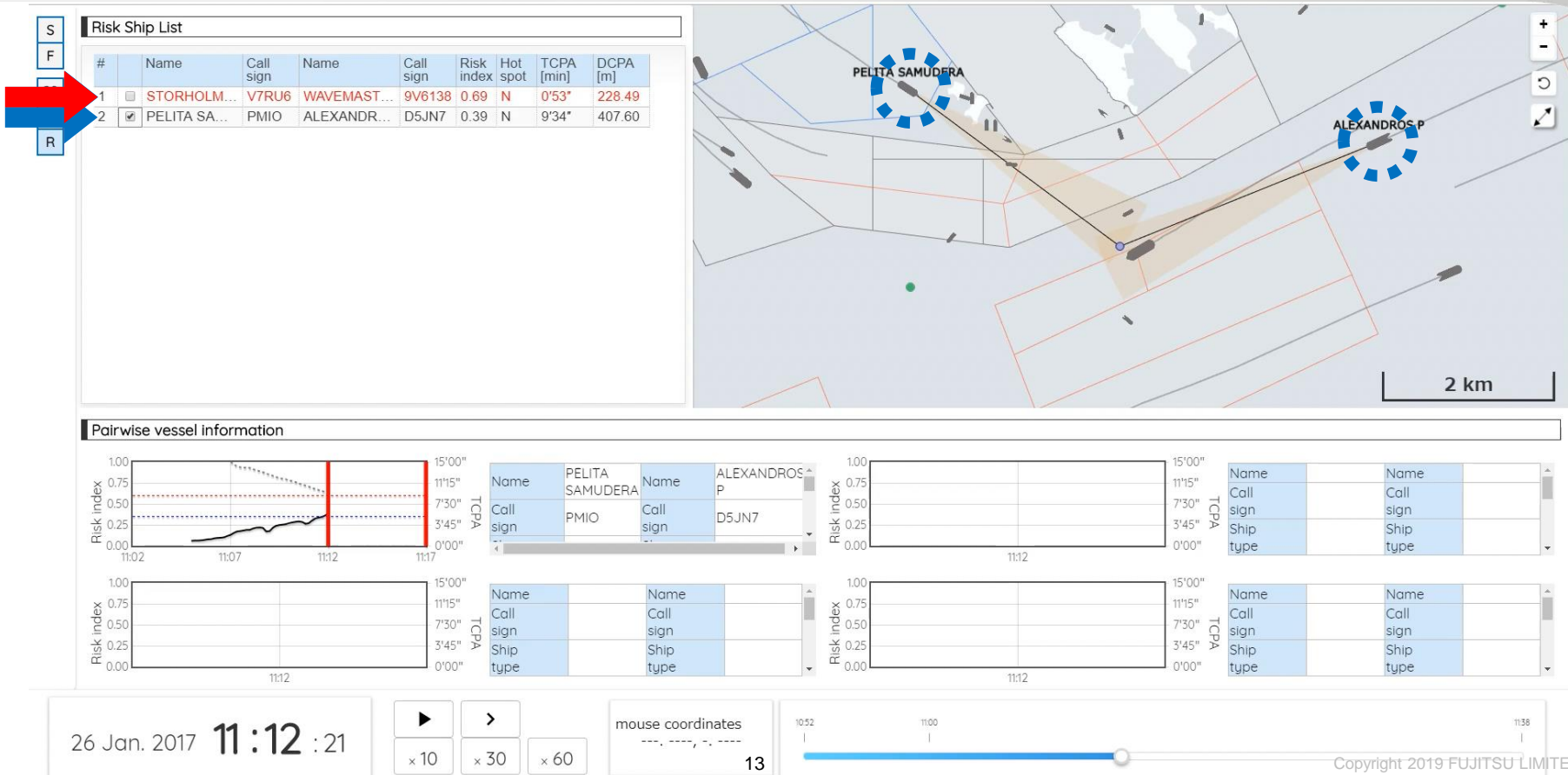
# Distribution of Risk Index at Each Operation

## ■ Dependency on individual skills in proactive operations



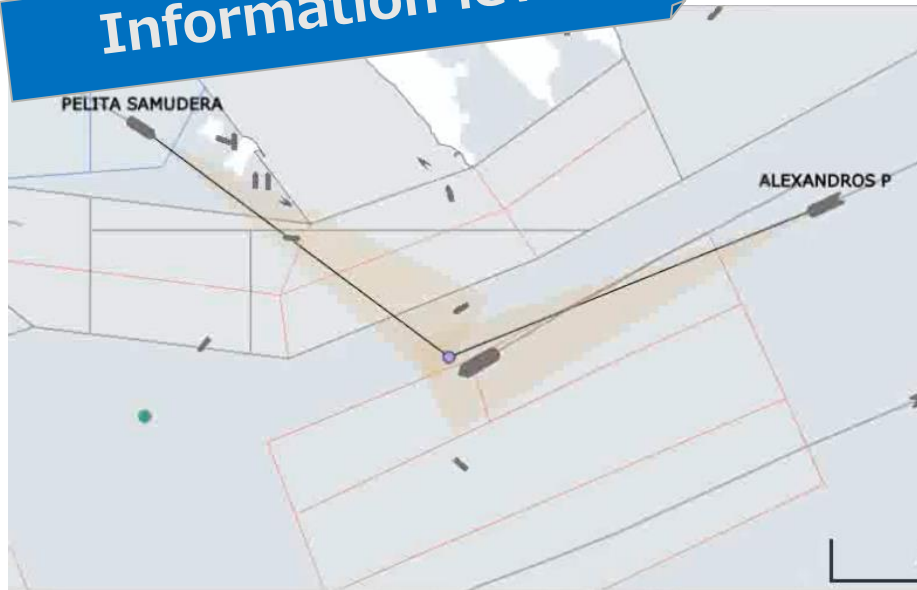
*Relationship between actions by POCC officers and risk index*

# Technology Helps Managing Near-miss (1)

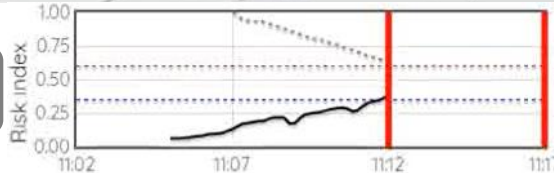


# Technology Helps Managing Near-miss (2)

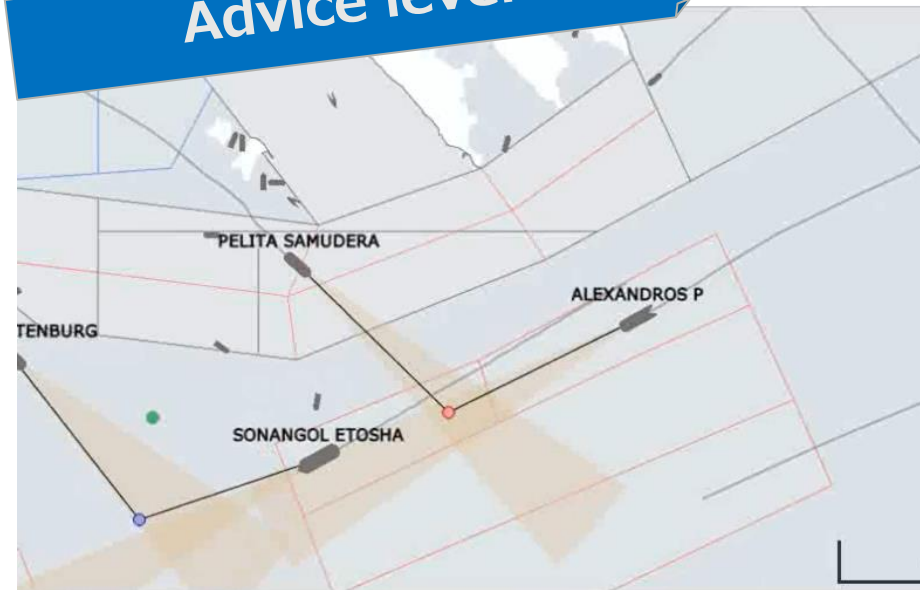
## Information level



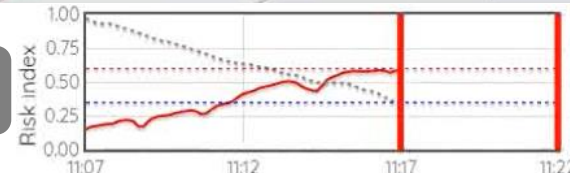
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## Advice level

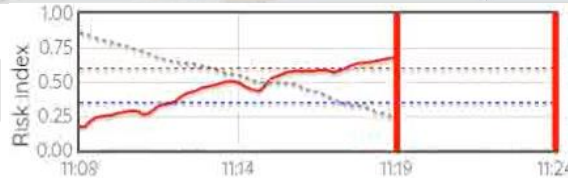
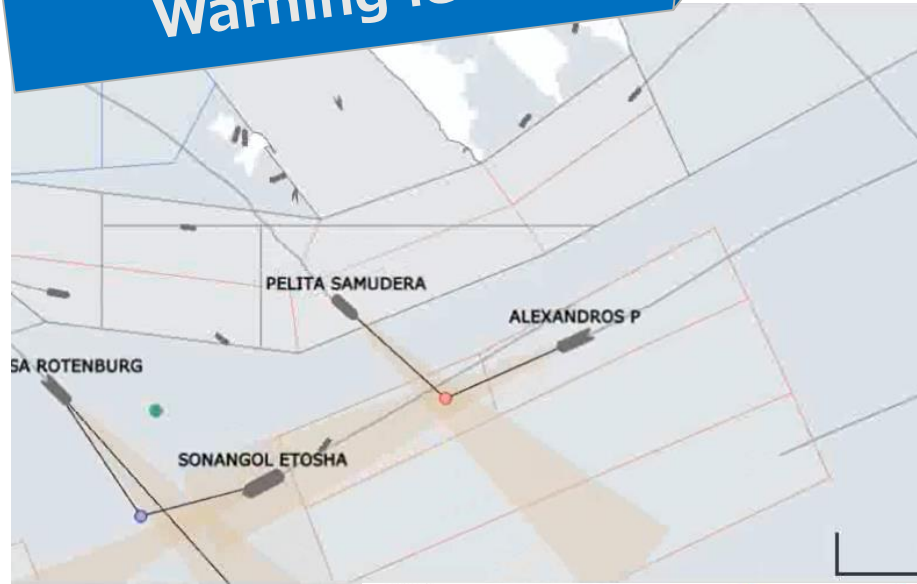


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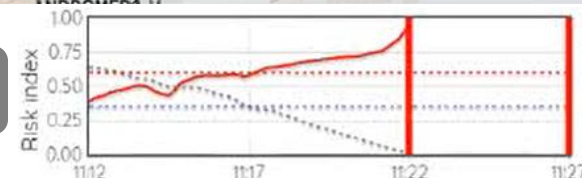
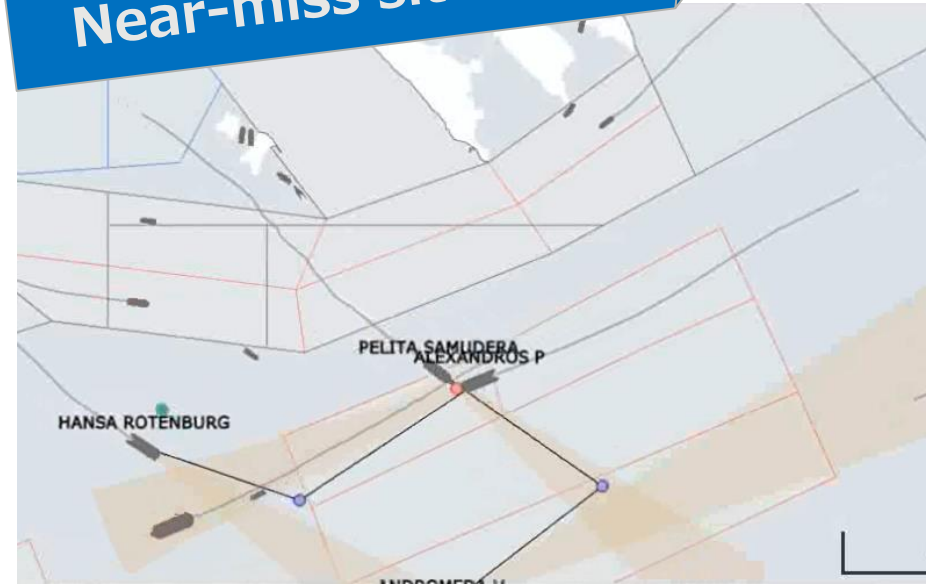


# Management of Near-miss Risk at VTS (3)

## Warning level

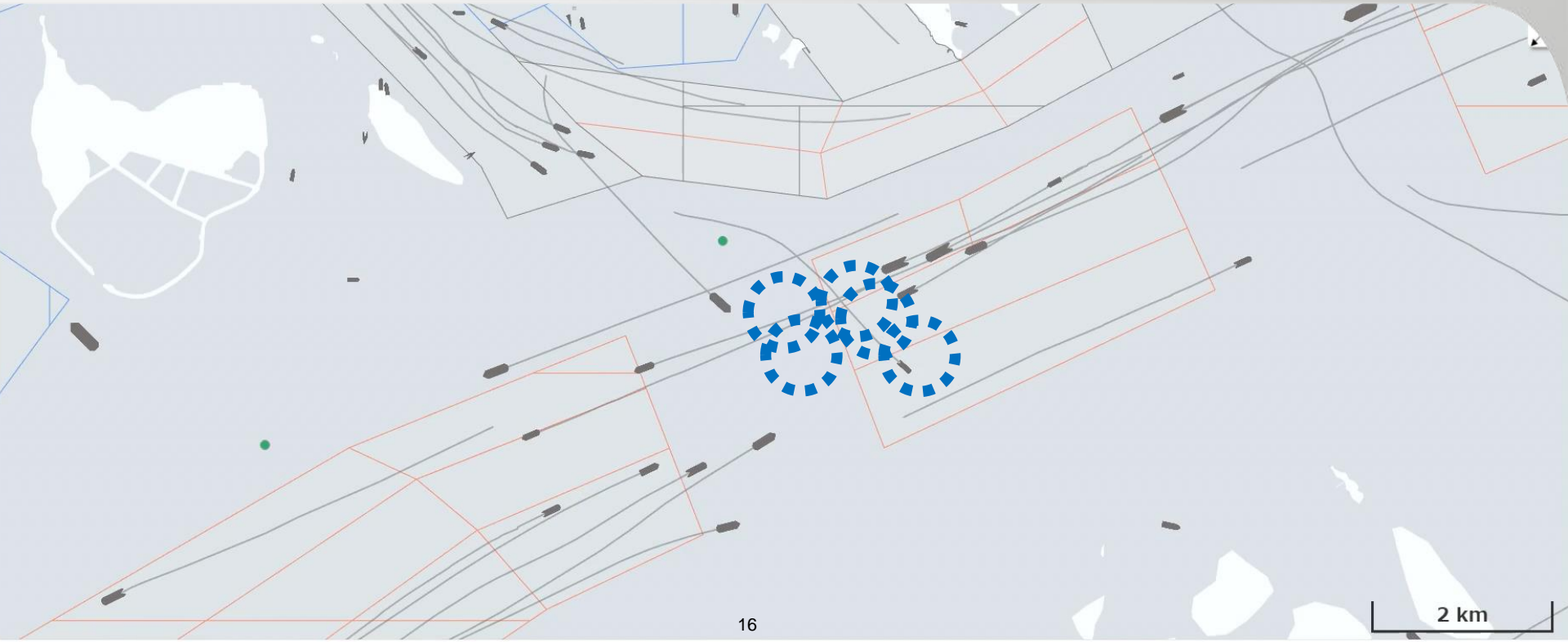


## Near-miss situation



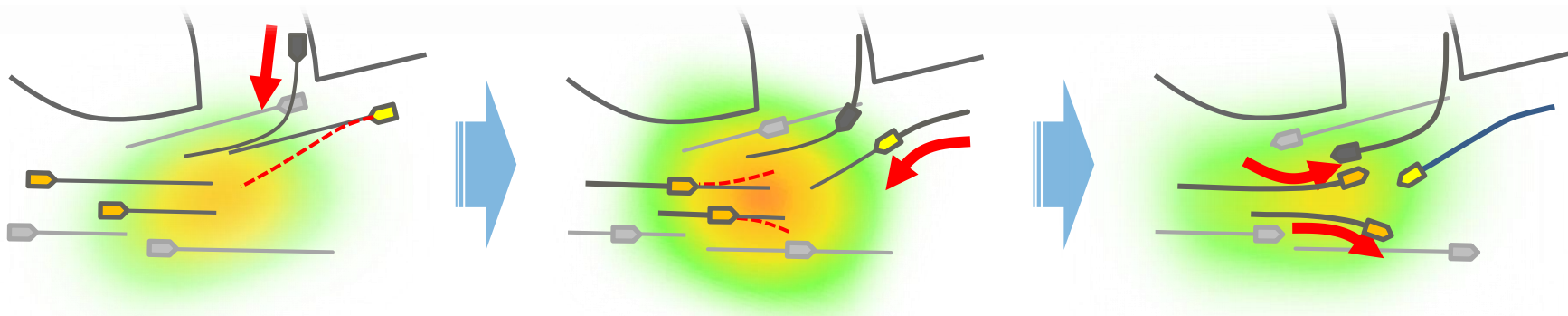


## ii. Dynamic Hotspot



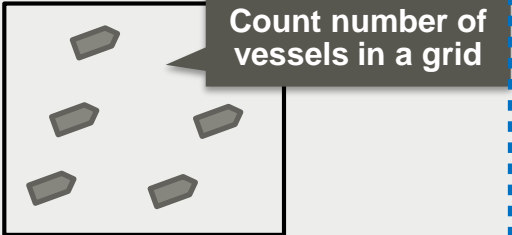
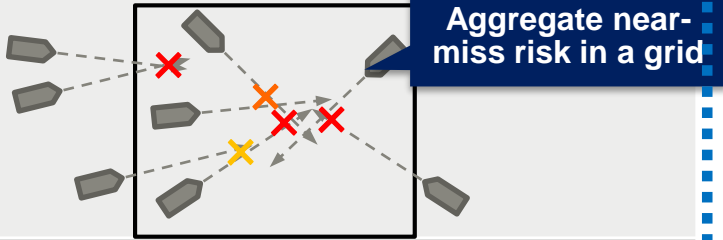
# Challenge regarding Dynamic Hotspot

- Dynamic and complex situation with high collision probability
- Movement of one vessel has spillover effect to others
- Hard to resolve by individual decision of vessels.



Key challenge: Knowing **when and where** hotspot will appear and specifying **involved vessels**

# Dynamic Hotspot Prediction Technology

Type of hotspot	Density-based	Risk-based
Features	Macroscopic	Microscopic
Forecasting	Long-term	Short-term
Uncertainty	Large	Small
Calculation	Density of vessels 	Aggregation of near-miss risk 
Use case	Planning	Short listing of cautious vessels Hotspot prevention

# Technology Helps Managing Dynamic Hotspot

S  
F  
20  
10  
R

## HotSpot Information

#	Center Longitude	Center Latitude	Hotspot Risk	Number of ships
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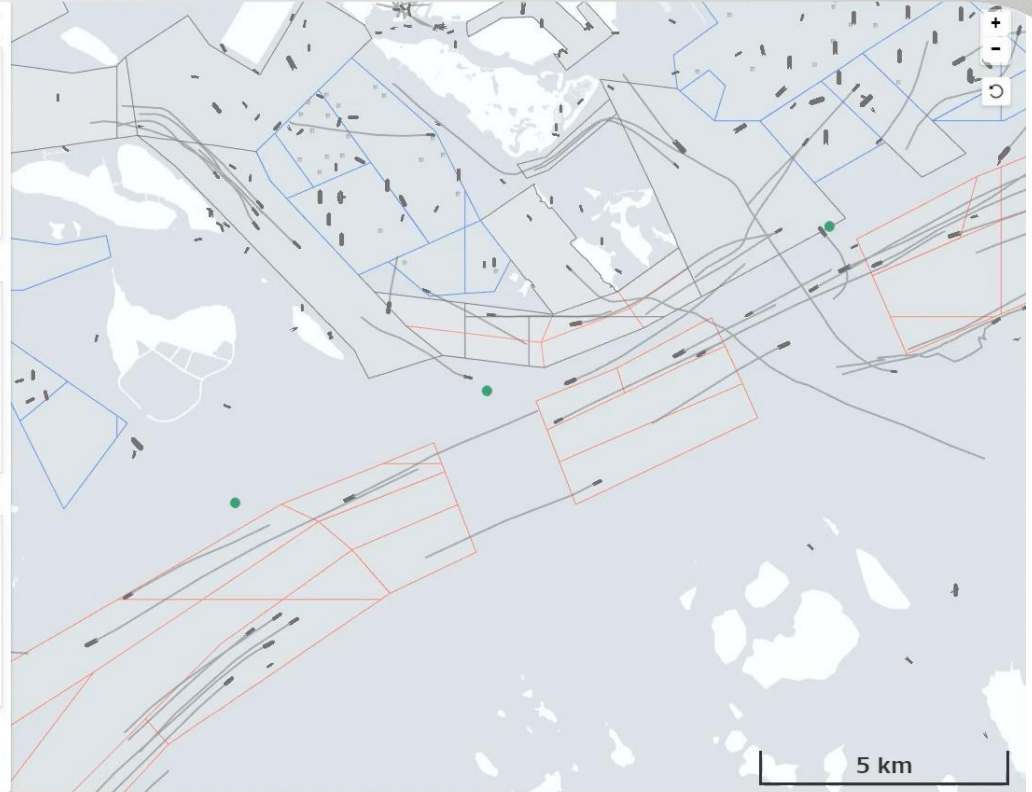
## Risk Ship Information

#	Name	Call sign	Name	Call sign	Risk index	Hot spot	TCPA [min]	DCPA [m]
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## Ship Information

#	Name	Call sign	Ship type	Ton[t]	SOG[knot]	Destination
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Risk detection



12 Apr. 2017 16:50 :35



x 10



x 30

x 60

mouse coordinates

---, ---, ---

19

16:40

17:00

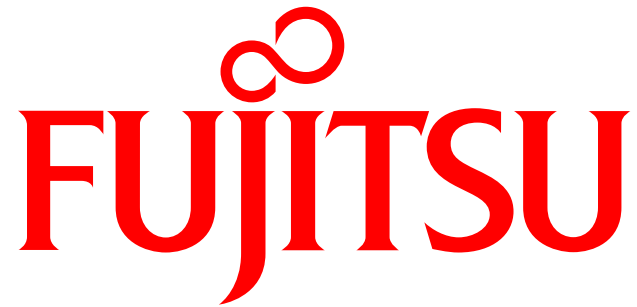
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# Proactive Detection of Situations



**Proactive traffic management  
to realize safer maritime traffic**



shaping tomorrow with you

# Use Case for Vessel



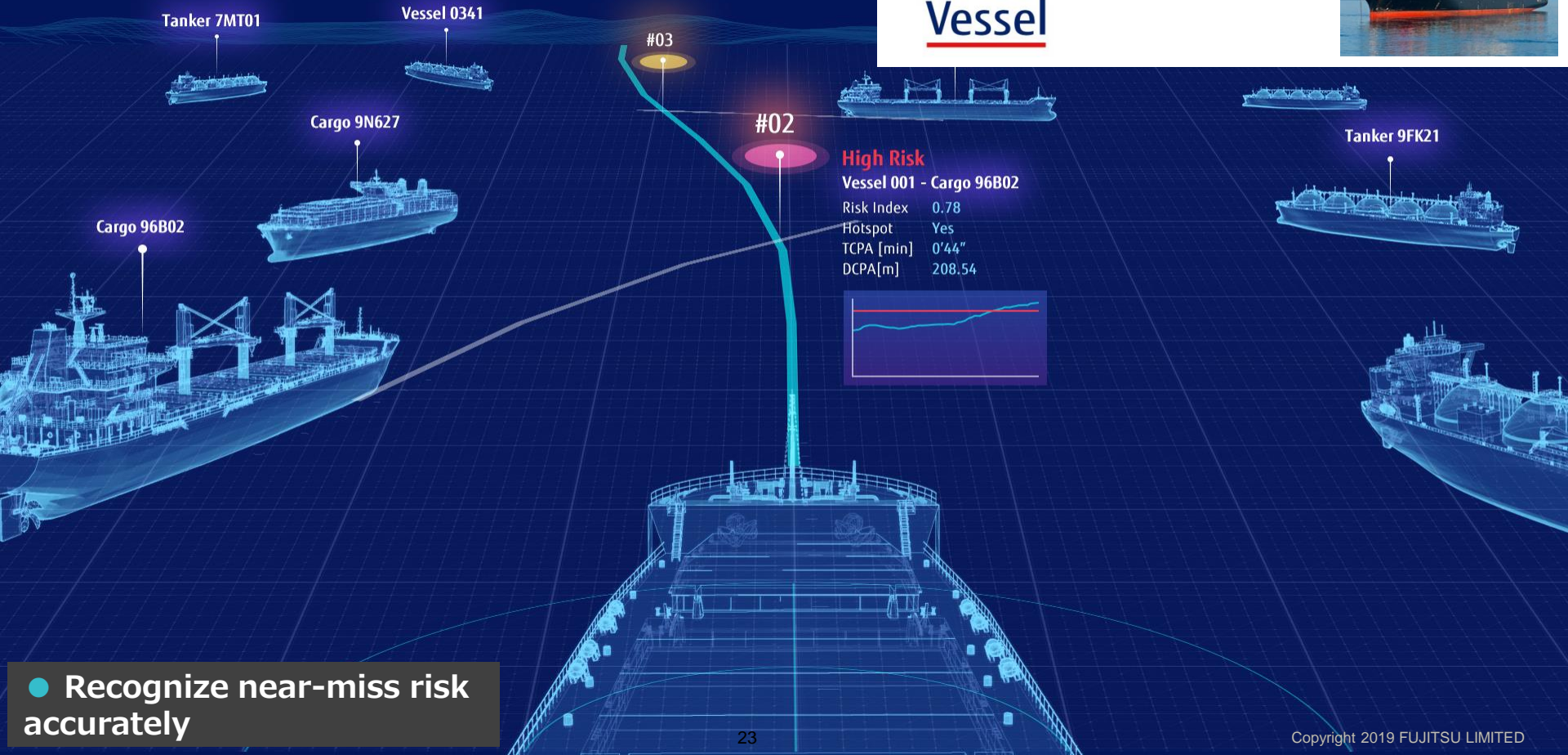
**Too many** alerts from on-board equipment

**Last-minute** maneuvering

**Miscommunication**  
between vessel and shore



# Use case for Vessel



## High Risk

Vessel 001 - Cargo 96B02

Risk Index 0.78

Hotspot Yes

TCPA [min] 0'44"

DCPA[m] 208.54



● Recognize near-miss risk accurately



## Use case for Vessel



#01

### Hotspot Information

Center Longitude 103.8350  
Center Latitude 1.1900  
Hotspot Index 7.48  
Number of ships 15

#02

### Hotspot Information

Center Longitude 137.4493  
Center Latitude 1.0650  
Hotspot Index 6.78  
Number of ships 13

Vessel 001

5mile

10mile

● Plan and adjust how to maneuver strategically

# Use Case for Vessel

**Too many** alerts from on-board equipment

**Last-minute** maneuvering

**Miscommunication** between vessel and shore

**Optimize** to minimum alerts

**Strategic** maneuvering

**Intuitive** communication between vessel and shore