

# ***QinetiQ***

The Global Defence and Security Experts

# Automated Situation Assessment in Maritime Combat Systems

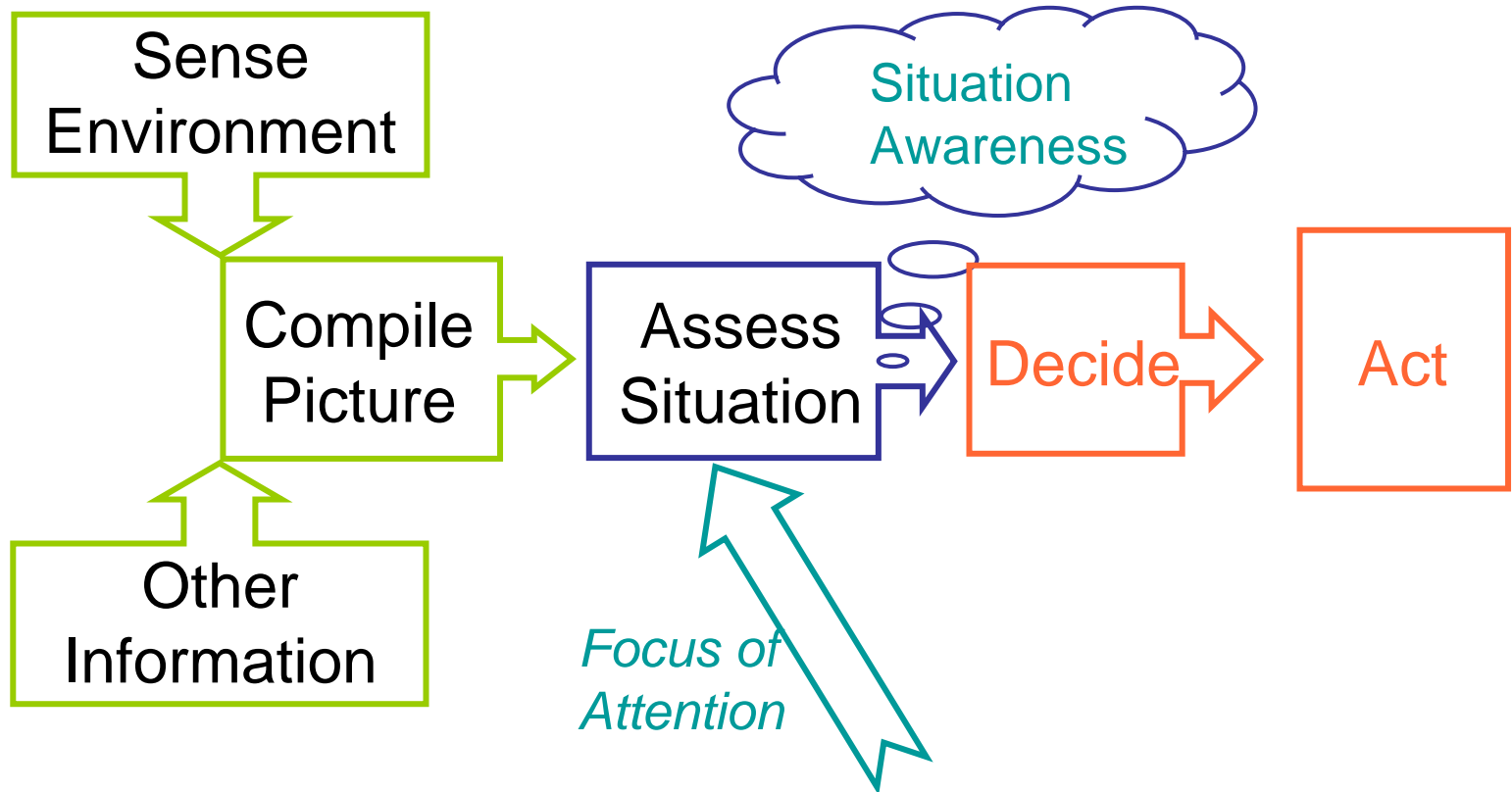
Presentation for 12<sup>th</sup> International Command and Control Research and Technology Symposium

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June 2007



# 01 Maritime CMS process



## 01 Situation Assessment

- Sensor and data fusion technology can deliver a picture with hundreds of contacts
  - where should operator attention be focussed?
- Command's effectiveness is limited by 'human' ability to:
  - manage and interpret large and increasing volumes of data
  - focus on many concurrent events
  - input assessments for network distribution
- ...but human knowledge gained from experience is the key to situation assessment
  - Can that knowledge be captured in a machine to provide automated assistance?

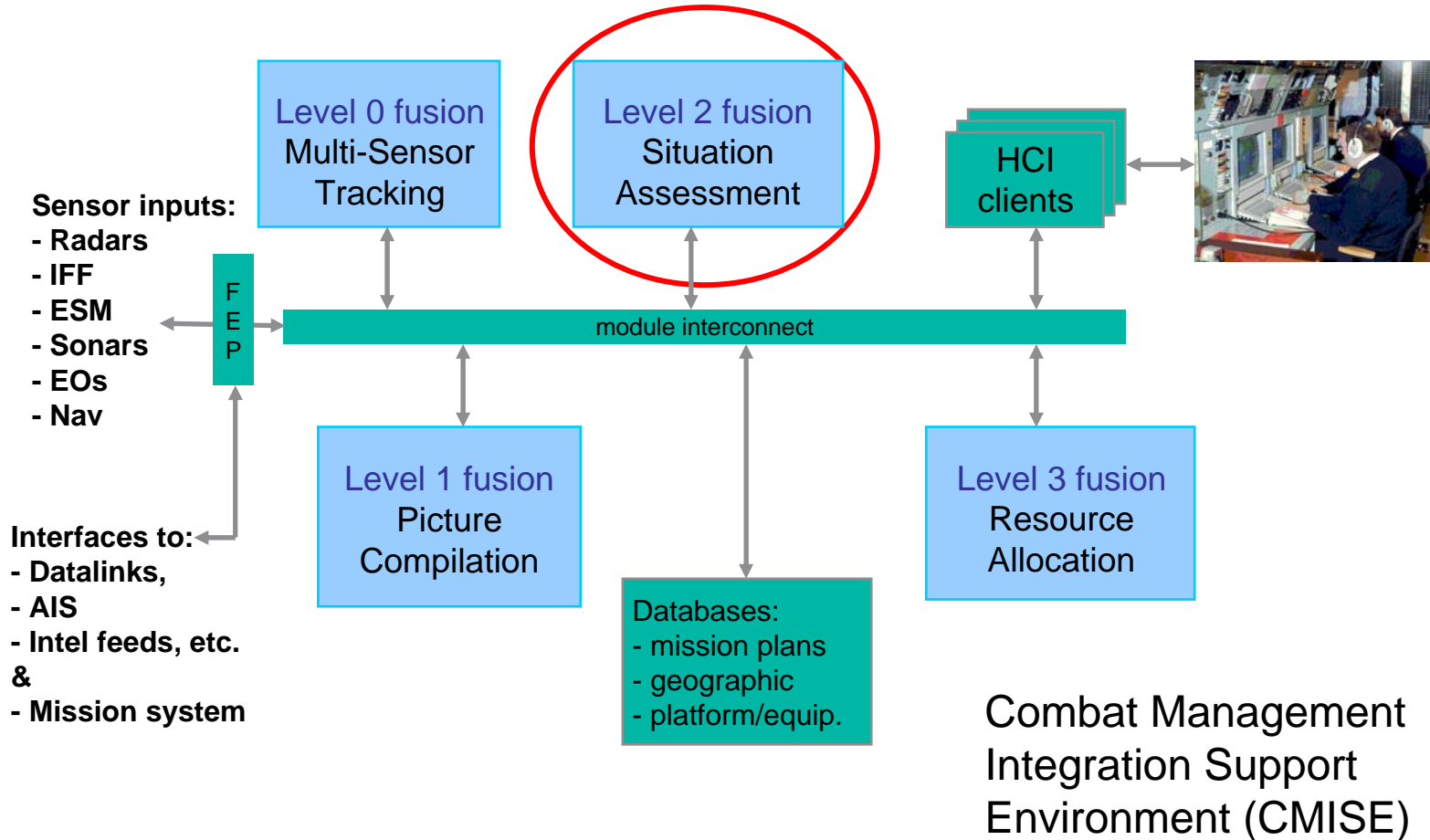
# The Hypothesis

Automated situation assessment enhances C2 through rapid systematic reasoning and relentless exploitation of all accessible information; making results available across the network.

## 01 QinetiQ research: Technical approaches

- Early attempts to capture situation assessment knowledge resulted in fixed rule sets for specific cases
- Latest research (completed 2006) has explored two more powerful strategies:
- (1) Pattern matching based on user programmable patterns
  - Allows full user control of the automated assessment function
  - Enables patterns devised from off-line data analysis to be entered into the operational system
  - Generic pattern libraries ease the task of setting up
- (2) Machine learning strategies
  - Data Mining techniques: Cluster Analysis, Inductive Logic Programming, Sequence Analysis
  - Potentially can discover previously unknown patterns of behaviour or ways of recognising such patterns

# 01 Implementation of user programmable patterns



## 02 Automated Situation Assessment:

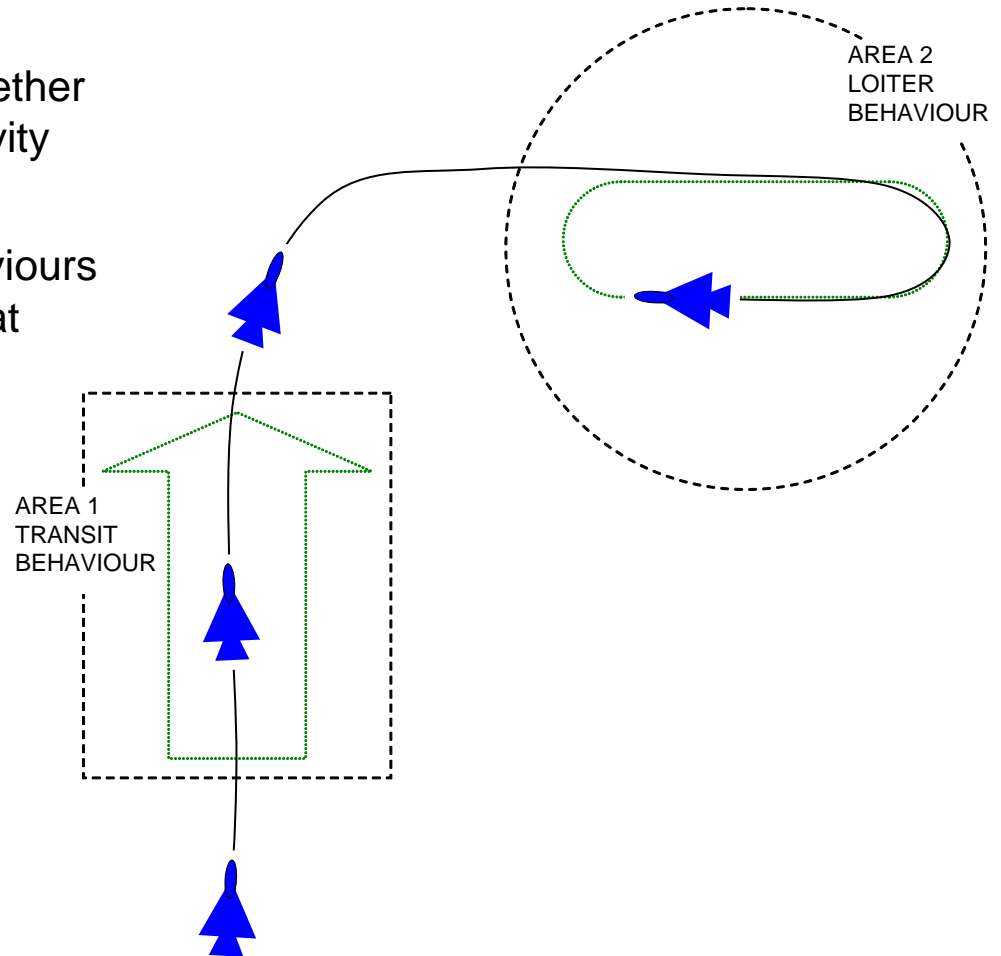
### – Pattern Definition





## 02 What is a Pattern?

- A pattern comprises one or more behaviour/area combinations, together with related identification and activity information.
- A combination of areas and behaviours may be used to identify the combat aircraft in this example
- The aircraft is expected to follow a particular route and then follow a racetrack
- This can be represented as a single pattern containing two sequenced behaviours
  - A transit across area 1
  - A loiter across area 2



## 02 Relationship between patterns, areas and behaviours



- Pattern attributes include:
  - Platform identity (type, class or name)
  - Standard Identity
  - Platform Activity
  - Whether the pattern is of particular interest
  - Whether an alert is required on match/break
- Behaviour types include:
  - Loiter
  - Transit
  - Takeoff
  - Approaching/leaving
  - Pop up
  - Straight and level
- Each behaviour type has its own set of attributes
- Area types include:
  - Corridor
  - Polygon
  - Circle
  - Sector
- Each area type has its own set of attributes

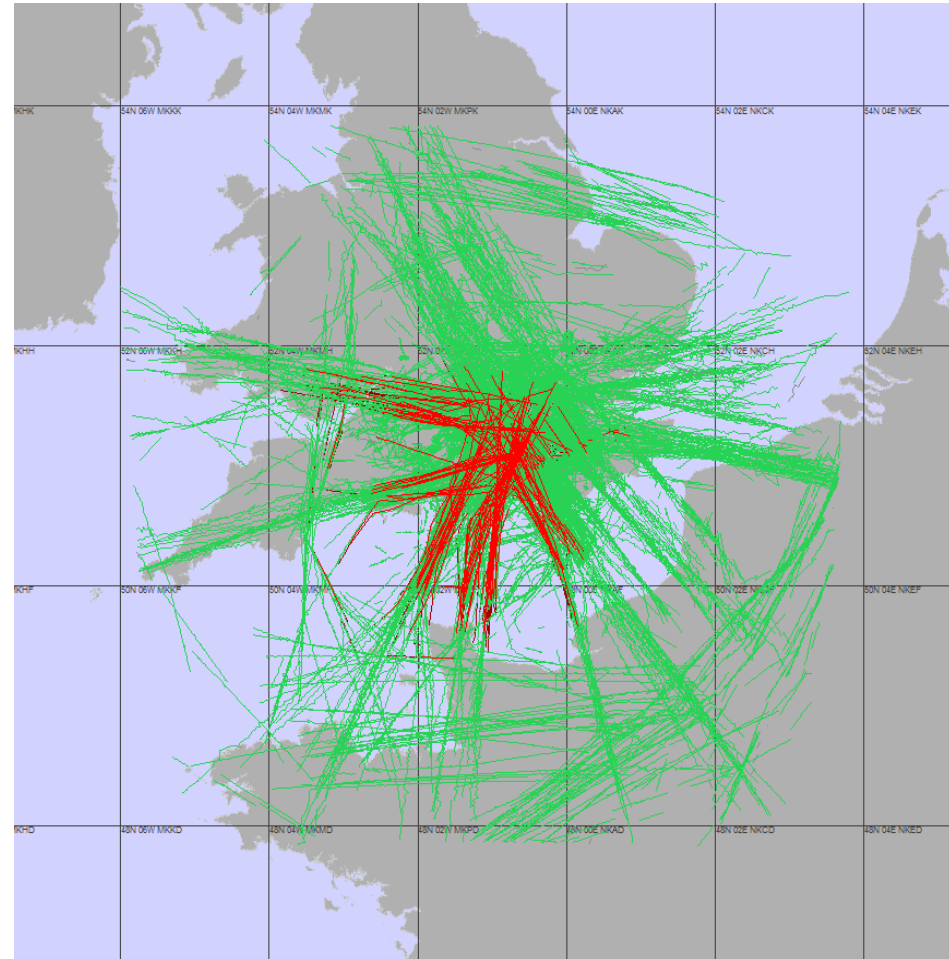
## 02 Example sources of pattern data

- Geographic
  - DAFIF data provide airports and air lanes
  - charts provide traffic separation zones and deep water channels
- Timed
  - Ferry time tables
- Intelligence
  - Air and surface plan data
  - Areas of suspected hostile activity
- Patterns learnt during previous operations
- Patterns learnt in theatre



## 03 Automated Situation Assessment:

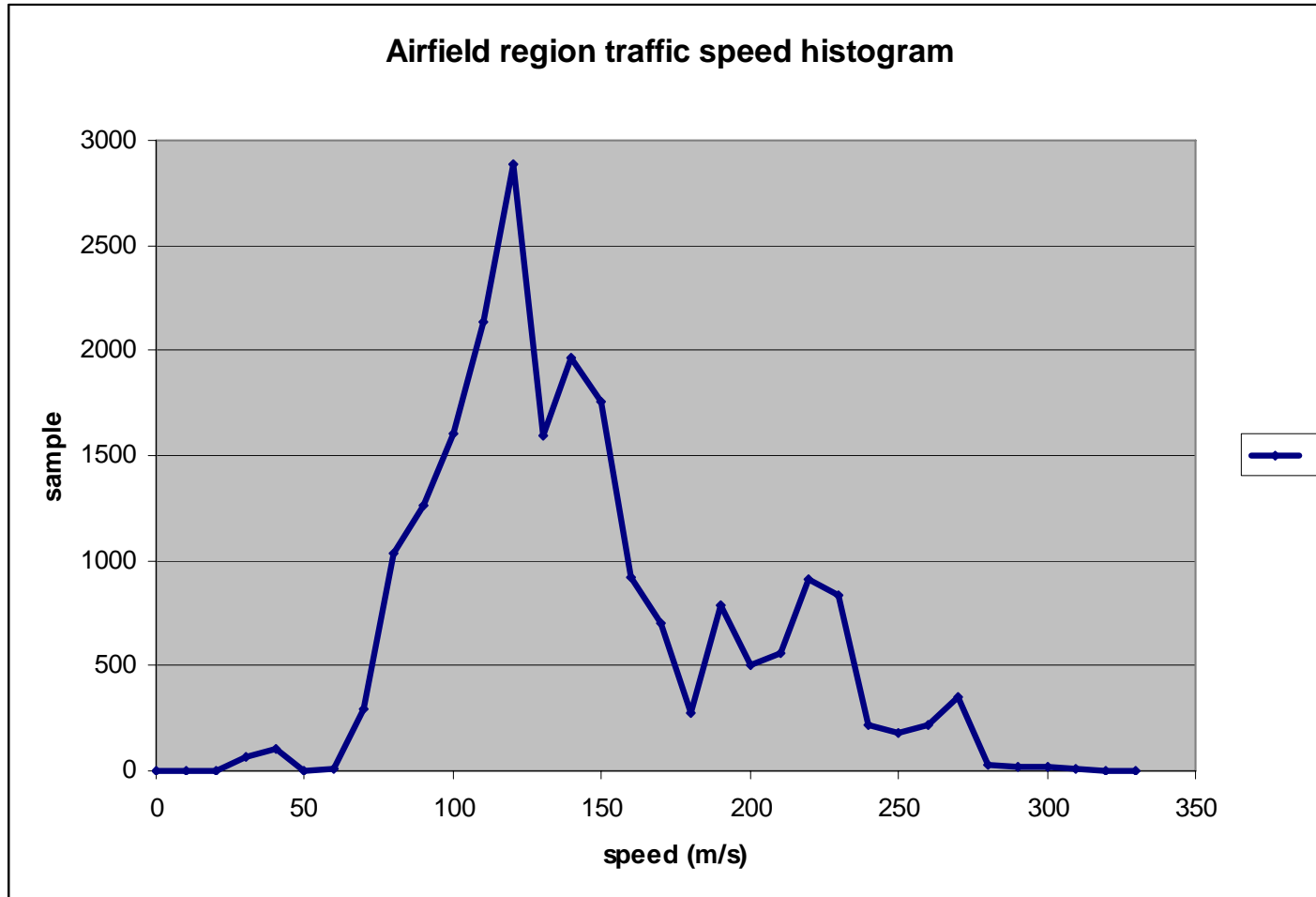
- Trials with live data



## 03 Trials example 1: Airfield monitoring and ID by origin

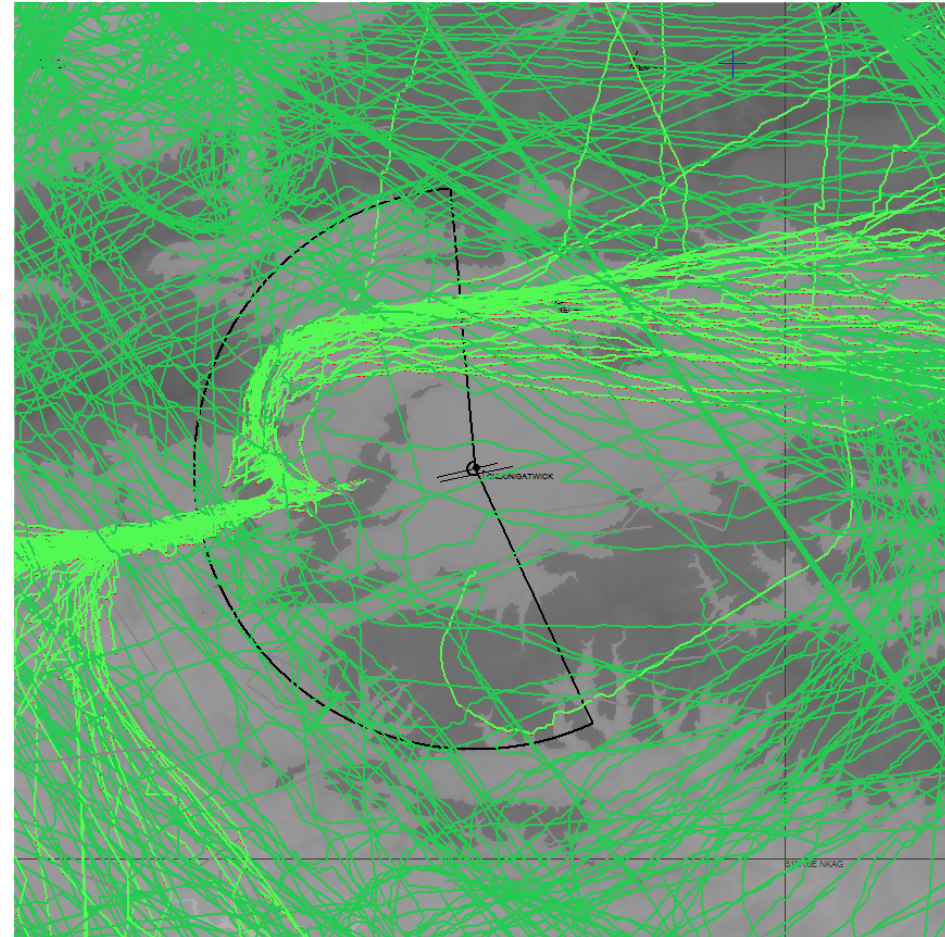
- Concept:
  - Monitors airfields and tags all aircraft taking-off with origin; generates alerts as required
- Evaluation:
  - Determine feasibility and performance
  - Requires sufficiently large set of examples
  - Civil airport (LGW) chosen:
    - Close enough for reasonable surveillance from available radar
    - Busy enough to provide many examples

## 03 Airfield traffic speed characteristics



## 03 Pattern and behaviour set-up

- Sector from end of runway
- 'Pop-up' behaviour
- Min and max speed criteria
- Results:
  - 95% of take-offs detected
  - No false alarms



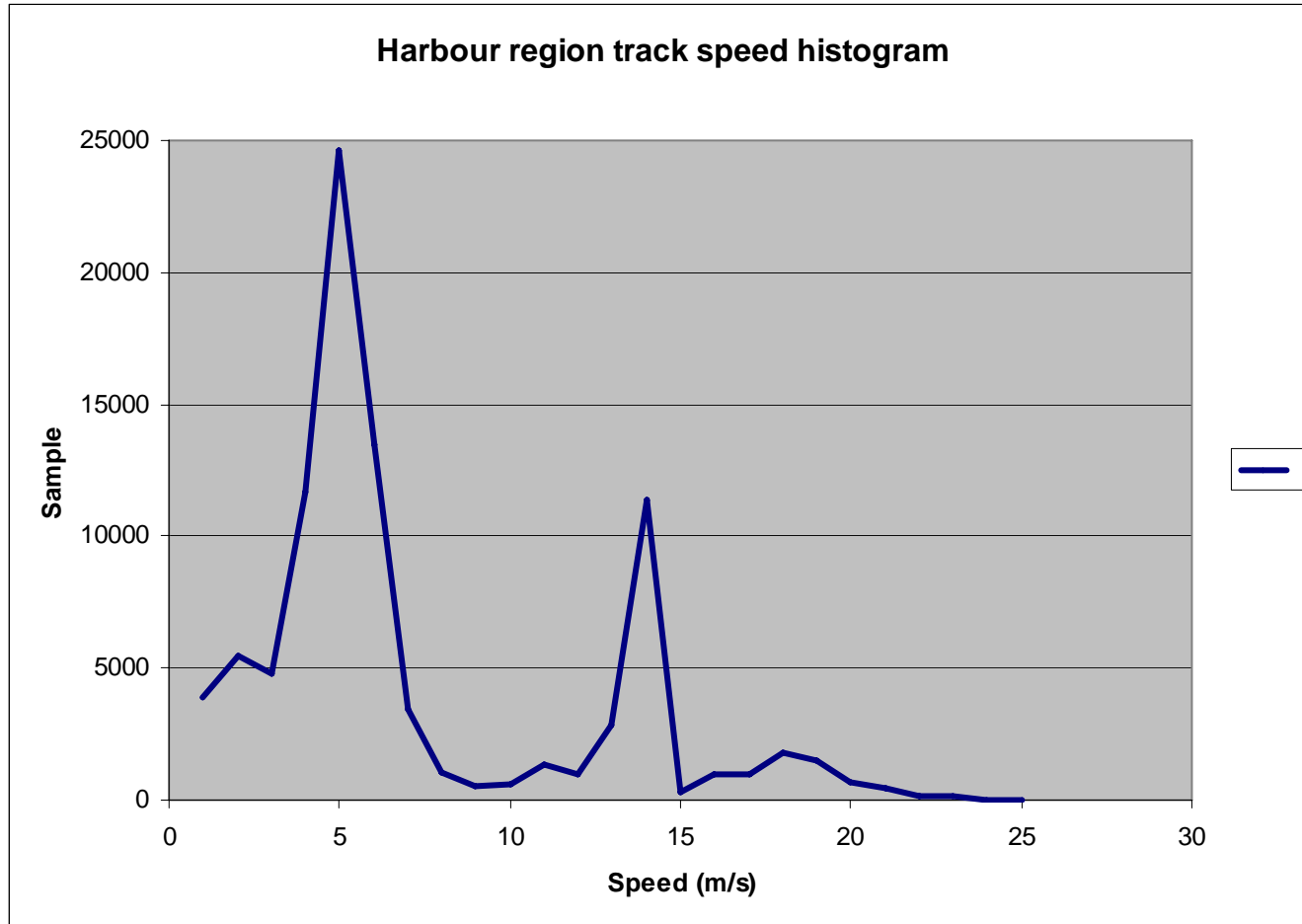
## 03 Trials example 2: Harbour and surface traffic monitoring; ID by route and behaviour

- Concept:
  - Monitors harbours and tags all vessels leaving with origin;
  - Monitors traffic behaviour and identifies benign vessel movements;
  - Highlights vessels not conforming to expected routes and behaviours





## 03 Harbour traffic speed profile



# 03 Two vessels highlighted leaving harbour

The screenshot displays a maritime surveillance interface. The main map shows a harbour area with several vessels. Two vessels are highlighted with red circles and white arrows, indicating they are leaving the harbour. The map includes labels for 'RYDE\_FER', 'BUOY20', and 'BUOY31'. A radar scan is visible over the water area.

Below the map is a control panel with various options:
 

- Point
- Bearing
- Groups
- Remove Tracks Of No Interest

 A grid of icons for different vessel types (Air, Surf, Sub, Land, Space) and a 'New air threat v0324' indicator are also present.

Two data panels are open on the right side:

**Standard Identity Explanation**

System Proposed Id of	v0094	is	SUSPECT	Operator override
Force Id of	is			
TPB	No Statement			
Datalink EW	No Statement			
Datalink ASW	No Statement			
Local assessment of v0094	is SUSPECT			
Poss	Prob	Conf		
Radar	Unknown			
IFF	No Statement			
RRB	No RRB			
Own ESM	No Statement			
Sonar	No Statement			
Airplane	No Statement			
Plans	No Statement			
RMP	No Statement			
Behaviour	No Statement			
EO	No Statement			
PILOTS	Suspect			

**Vehicle Data**

Track No	v0094	Standard Id	S	Platform Id	P	IFF
Track No		Unit Id				1
						2
Platform Activity	No Statement					3
Position	50-47.0N 001-06.3W	[Lat/Long]				4 Invalid
Bearing	186	Limits				RRB
Distance	4.5	nm				
Course	162	Speed	11.6	kts	Height	ft
Last Updated (hh:mm:ss)	10:35:16	Track Status	Live			
CPA	Distance	nm	Bearing	at time		

Buttons for 'AIS' and 'Pattern' are visible at the bottom of the vehicle data panel.

# 03 Vessel not conforming to patterns remains highlighted

The screenshot displays a maritime surveillance interface. On the left, a map shows a coastal region with several radar returns. A vessel, identified as 'v0066', is highlighted in red and labeled as 'New air threat v0197'. The vessel's track is shown as a red line. Other radar returns are labeled with identifiers like 'RYDE\_FER', 'BUOY91', and 'BUOY20'. The interface includes a menu bar at the top with options like 'File', 'Symbology', 'Overlays', 'Coverage', 'Plots', 'Centre', 'Range', 'Zoom', 'History', and 'Sources'. At the bottom left, there are controls for 'Point', 'Bearing', 'Groups', and 'Remove Tracks Of No Interest', along with a 'Correlate' button. The right-hand panel, titled 'Standard Identity Explanation', provides a detailed analysis of the vessel's characteristics.

**Standard Identity Explanation**

Exit Explain Display

System Proposed Id of **v0066** is **SUSPECT** Operator override

Force Id of is

TPB	No Statement	
Datalink EW	No Statement	
Datalink ASW	No Statement	

Local assessment of **v0066** is **SUSPECT**

Poss	Prob	Conf
█	█	

Radar	Unknown	
IFF	No Statement	
RRB	No RRB	
Own ESM	No Statement	
Sonar	No Statement	
Airplane	No Statement	
Plans	No Statement	
RMP		
Behaviour	No Statement	
EO	No Statement	
PILOTS	Suspect	█

Real emitter could be simulating

De-correlate

Track No	Unit Id	
	Fast Patrol Boat	1
		2
		3
		4 Invalid
	RRB	

Platform Activity **No Statement**

Position **50-44.1N 001-03.0W**

Bearing **167** Limits

Distance **7.5**

Course **138** Speed **22.5** kts Height  ft

Last Updated (hh:mm:ss) **10:44:52** Track Status **Live**

CPA	Distance	nm	Bearing	at time

## 04 Summary

- Automated Situation Assessment has been demonstrated using a user-programmable pattern matching approach.
- Potential benefits include:
  - Reduced operator workload
  - Alerts to focus attention on contacts of interest
  - More effective use of resources – particularly air assets
  - Improved situation awareness
  - Applicable across land, sea and air environments
- Next steps:
  - Sea trial (September 2007)
  - Research into machine learning for pattern discovery

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