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ISTAR Tracker: Analysis of detection data to infer distinct entities and their tracks

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35 ISMOR

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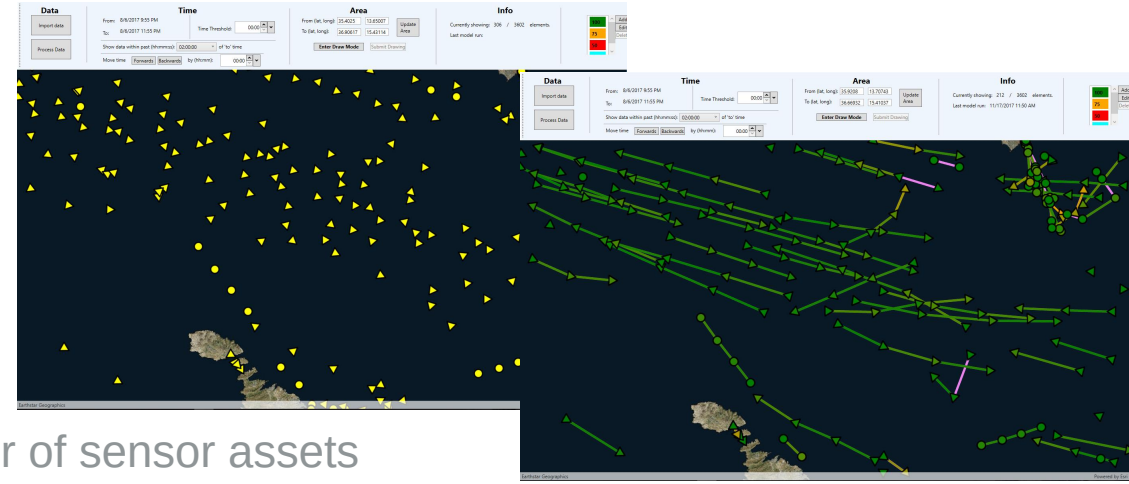
Overview



- Problem:
  - Revolution in ISTAR
    - Ever increasing number of sensor assets
  - Traditional techniques struggle analysing data from such wide range of sensors
- Solution, NSC ISTAR tracker:
  - Novel technique for analysis of multi-sensor detection data infer distinct entities and their most likely tracks
  - Robust handling congested areas where the detection interval is sparse
  - Probabilistic approach dealing with uncertainty
  - Demonstrate successful implementation in a toolset
- Applications:
  - New technique opens up radar tracking methods to new domains

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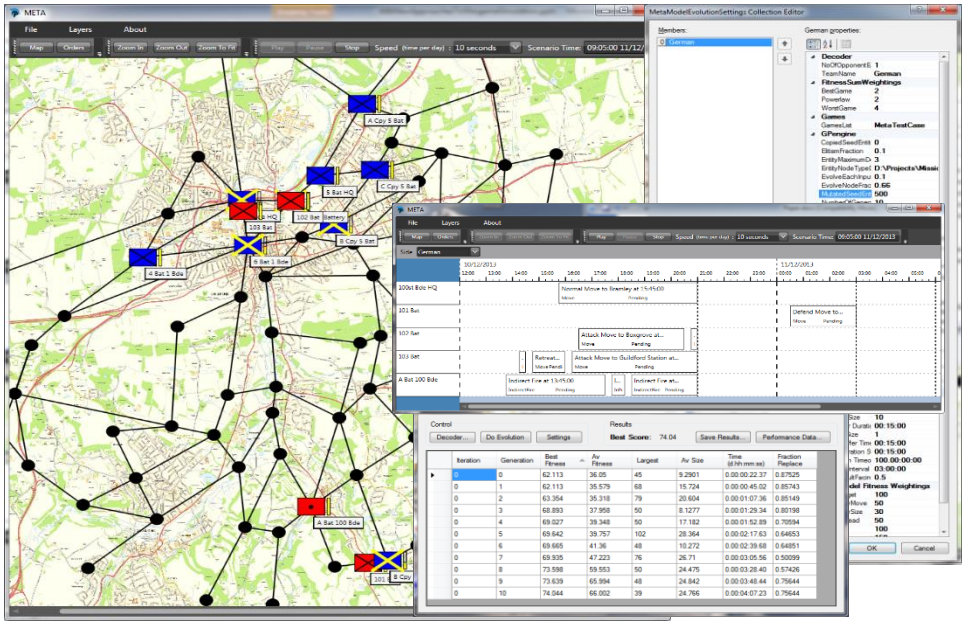
- Dr Stephen Lucek
- NSC SME with a strong record in development complex mathematical software
- NSC modelling and simulation lead for ASC



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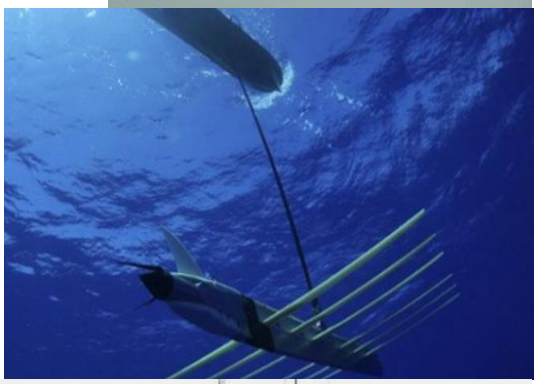
Context

- Revolution in ISTAR domain
- Ever increasing number of sensor assets used in support of UK and Allied military forces
- UXVs in infancy and have yet to be deployed in an integrated fashion
- To make sense of all the data gathered is a significant challenge
- Amalgamation of data to create a coherent picture is difficult
  - From a wide range of assets
  - With significant variations in sensor characteristics



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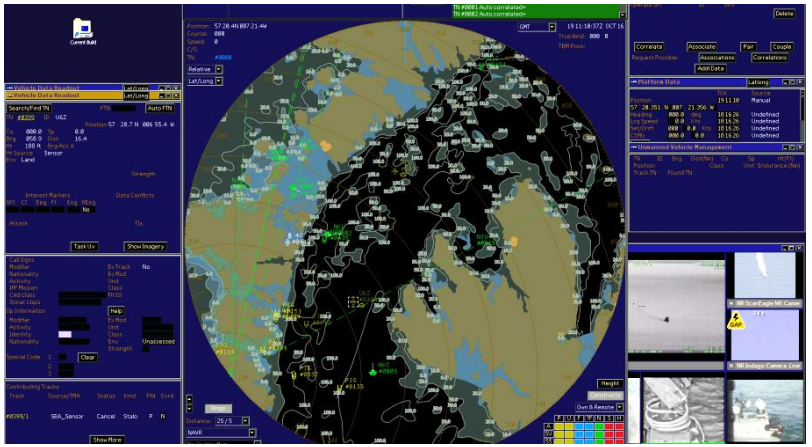
Unmanned Warrior 2016

- Maritime exercise,
- 50 different systems
  - underwater
  - surface
  - air
- More than 20 supplier organisations
- Over six weeks of unmanned activity off the coasts of West Wales and the Scottish Outer Hebrides
- Showed the potential off-board sensors can bring to force-wide situational awareness

Unmanned Warrior 2016

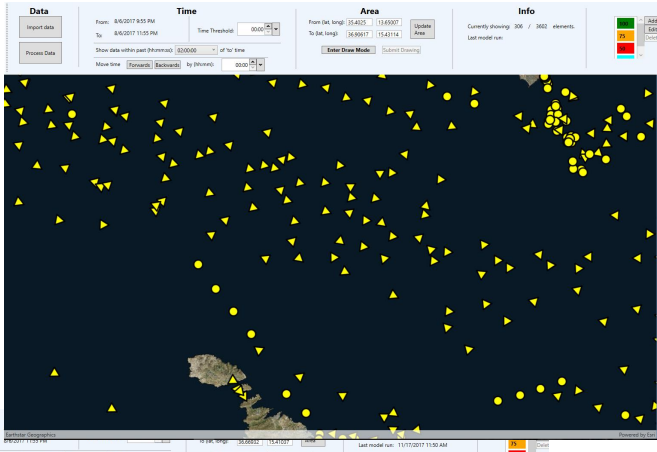
- Unmanned Warrior 2016 demonstrated the difficulty of analysing the data from disparate sensors
- Off-board sensors detections characterised by:
  - Intermittency
    - limited field of views,
    - high host mobility,
  - Some cases, errors
    - e.g. poor triangulation

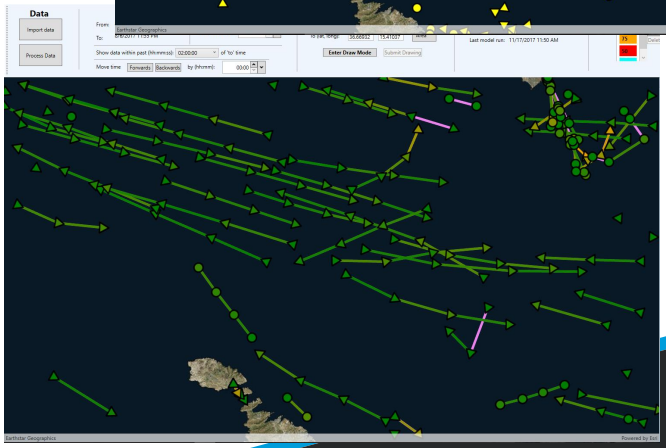


- A lot of detection data was lost because it couldn't be turned into tracks by current tracking algorithms

Novel Solution: ISTAR tracker

- Probabilistic approach turning disparate individual detections into easy to read continuous tracks
  - Global solution,
    - Best fit to the whole picture
    - Considers all the available information
  - Balances conflicting indicators
  - Deals with uncertainty
  - Supplies a confidence of that fit
- Robust algorithms
  - handle congested areas
  - sparse detection intervals





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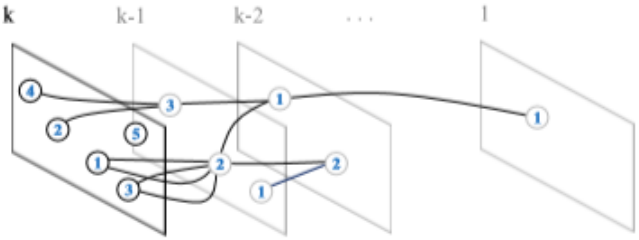
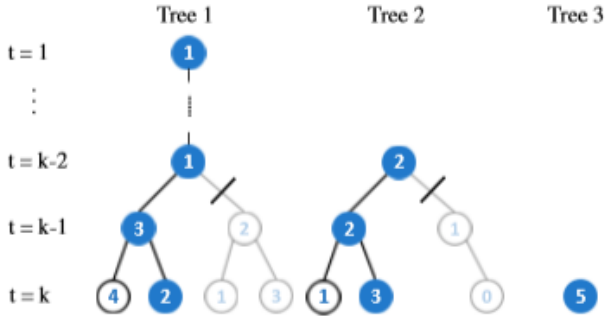
Multiple Hypothesis Tracker



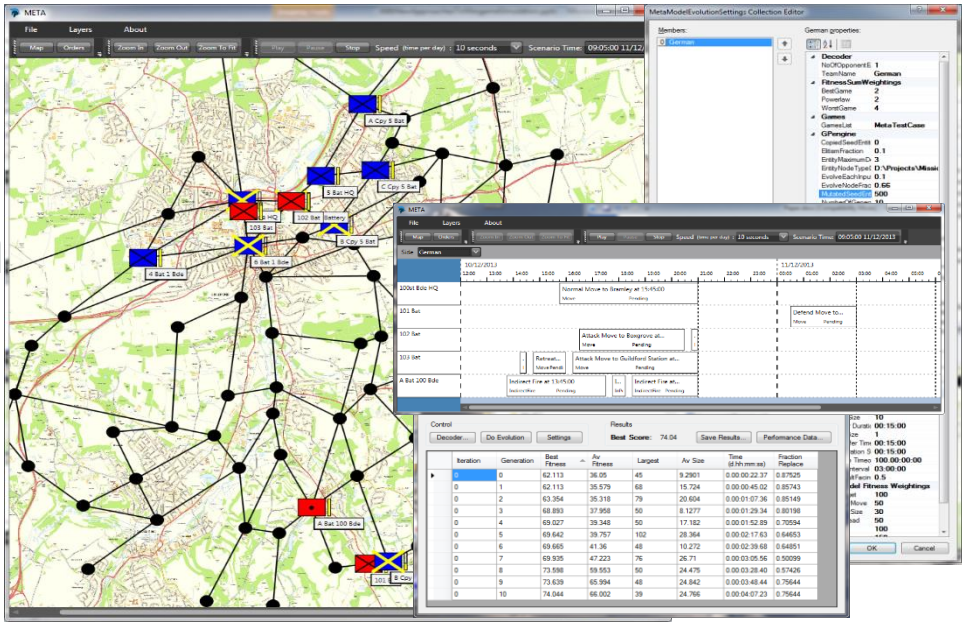
- Standard radar tracking technique
- Each radar update:
  - Every possible track is updated with every new update
- Over time, the track branches into many possible directions.



- MHT calculates the probability of each potential track. Only reports the most probable tracks
- Can work well in radar scenarios, but algorithms do not scale well to larger problem data sets
  - e.g. going from one to many sensors

Simulated Annealing

- Global optimiser
- Probabilistic approach
  - Similar to SA
- Good at scaling to solve big problems
- NSC experience in “generic problem” SA
  - Artificial intelligence applied to solving tactical problems in wargame simulations
- Does not need fine tuning to specifics of problem



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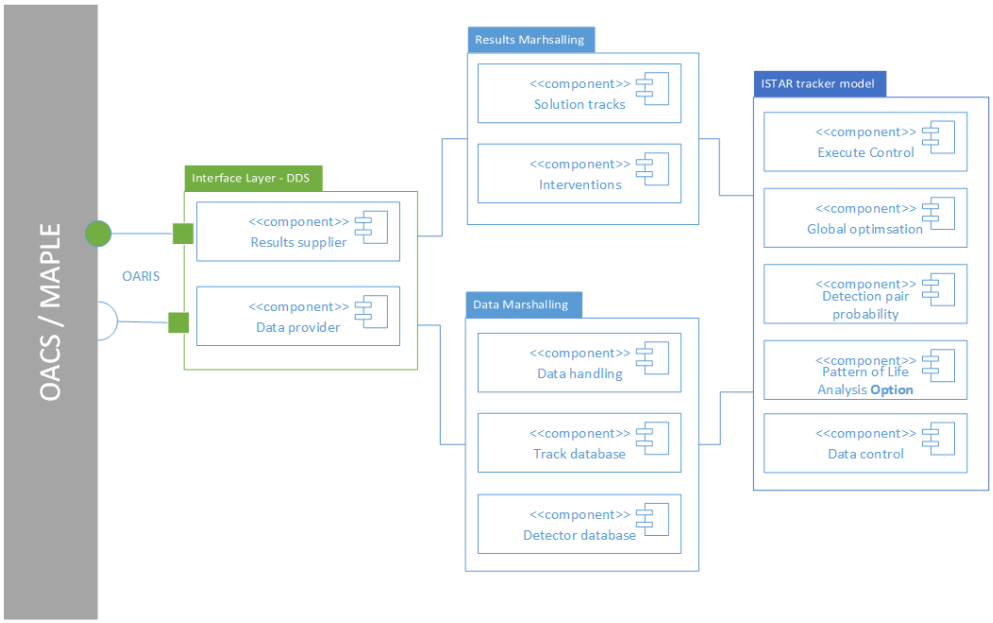
NSC ISTAR tracker toolset

- Built model & GUIs
- Representative data sets:
  - AIS/ADSB
  - Removed identifiers
    - used for model validation
  - Congested areas
  - Sparse detections
    - Thin detections in time (e.g. only report at ½ hourly intervals)
- Use open architecture
  - Facilitate incorporation into C2 systems
- Graphical User Interface
  - Displays routes and certainty
  - Allows interrogation of model results
    - Understand how it is working



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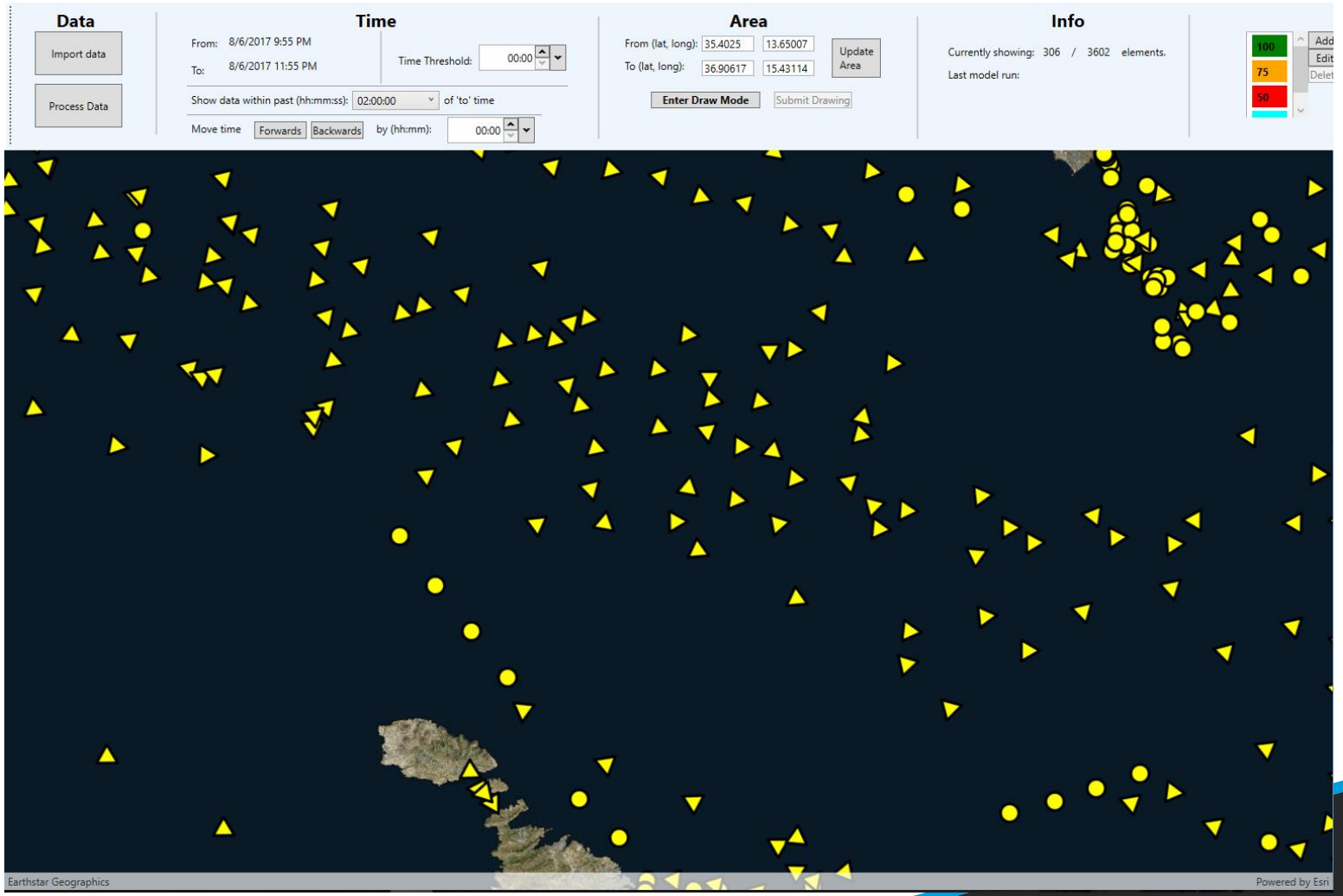
Tool screenshot - Detections



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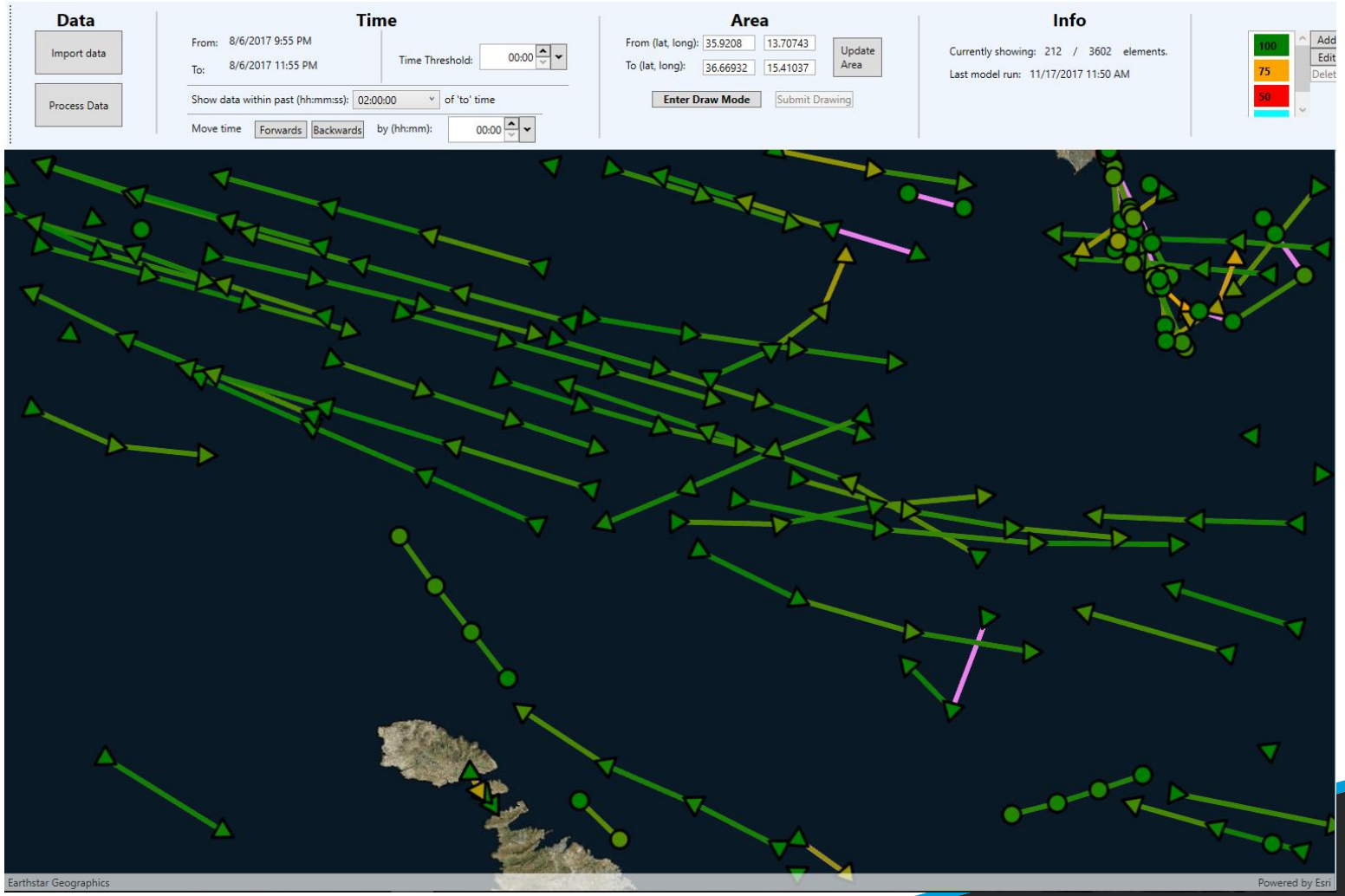
Tool screen shot - Results



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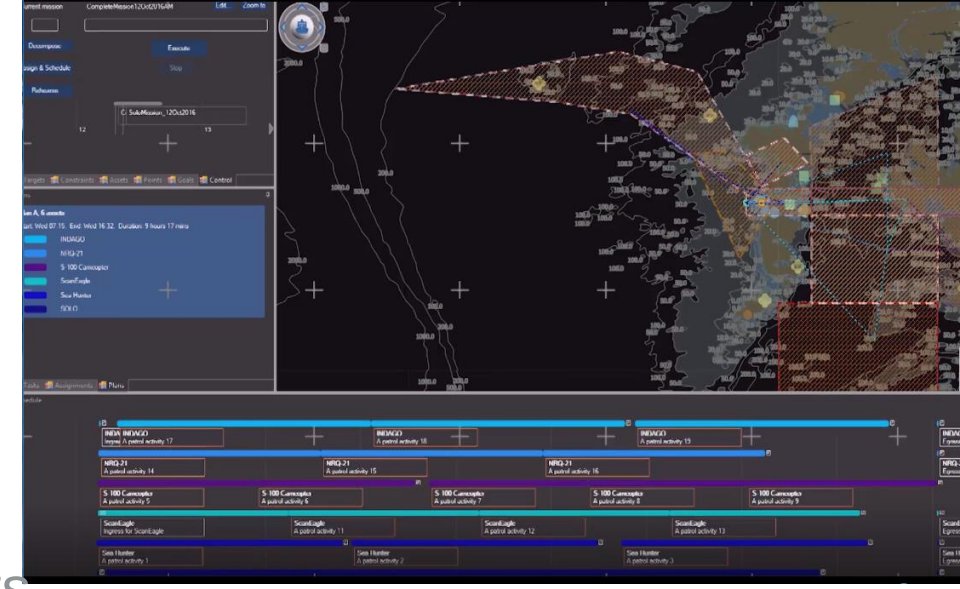
Results

- Correctly identified routes in green
  - shaded by certainty
- Misidentifications in purple
- 98% accuracy on trial data,
  - exact accuracy values will depend on the sparsity and congestion of the data considered, and so are difficult to quantify
- Quick ~ 1s on standard i7 laptop for previous example

New technique



- Opens up radar tracking methods to new domains
- Probabilistic approach handles uncertainty & other information feeds in wide variety of contexts
- Not constrained on detection information for velocities / courses
  - Can be calculated from routes as they are generated
- Probabilities from any source, not just time and space calculation
  - Textural analysis
  - Pattern of life analysis
- Take feeds from (and be used in conjunction with) other tracking techniques
  - e.g. Real-Time Multi-Modal Person Tracking for CCTV

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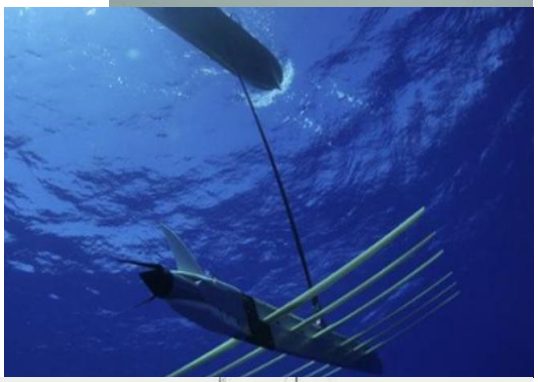
Applications

- Initial development focus on maritime domain, but
- Tool useful in any context where tracking entities (People/Vessels/Vehicle/Aircraft) from multiple detection feeds
  - Increasing fidelity of situational awareness
  - Reducing operator workload
- Ships Ops room, MIFC, NMIC
- Brigade or Divisional HQ
- Joint level: fusing information from existing systems to generate a genuine common operating picture
- CCTV control Room
- Particularly useful in land domain
  - more congested & more sensors



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