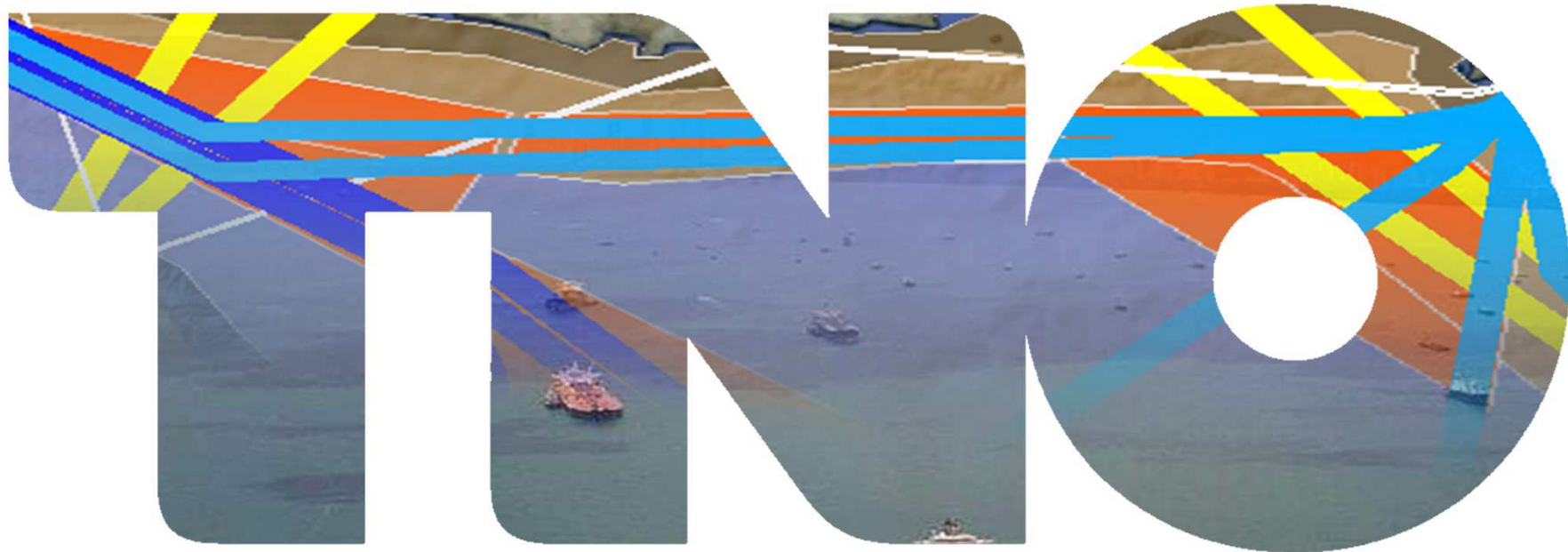




## Vessel Traffic Generator

Agent based maritime traffic generator





## Motivation

### Why (I)

- › Need for data sets to develop and validate Maritime Situational Awareness algorithms

### Problem

- › Real-world data (e.g. AIS recordings) has limitations
  - › Unknown intent
  - › Not all vessel information available (owner, crew, etc.)
  - › Not all vessels can be recorded (vessels without AIS devices)
  - › Real-world data is a fixed “scenario”

### Solution

- › Vessel Traffic Generator (VTG)





## Motivation

### Why (II)

- › Need for efficient generation of maritime scenarios for gaming and experimentation

### Problem

- › Manually creating complex scenarios is a time consuming task
- › No time available to define realistic background traffic

### Solution

- › Vessel Traffic Generator (VTG)



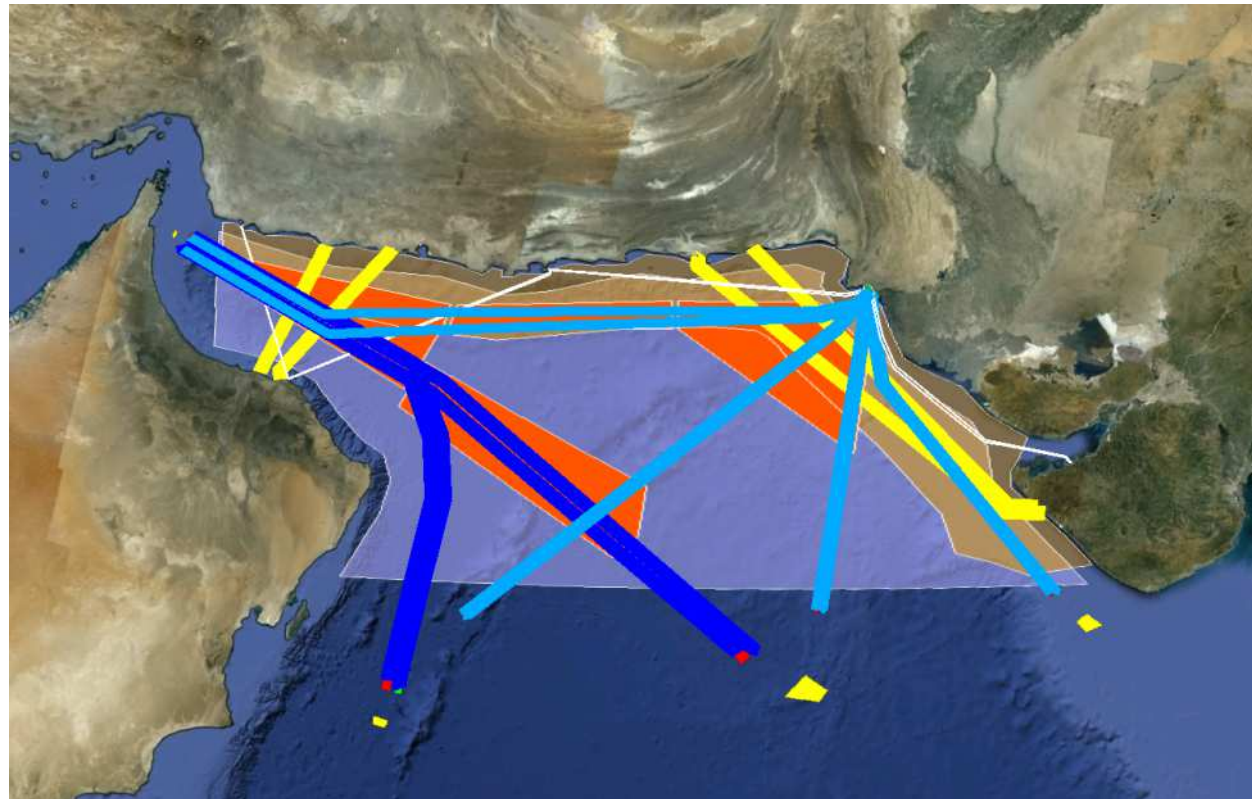
## Related work

1. Pattern Of Life capabilities of commercial tools (*DI-Guy AI, VR-Forces B-Have, ...*)
  - Simple background traffic, additional entity information (alibi, intent, ..) not available
2. Generating a maritime traffic scenario based on captured AIS data (*FFI and others*)
3. Agent-based Simulation of Maritime Transit (*Czech Technical University*)
4. Simulating Marine Asymmetric Scenarios for testing different C2 Maturity Levels (*University of Genoa*)



VTG approach

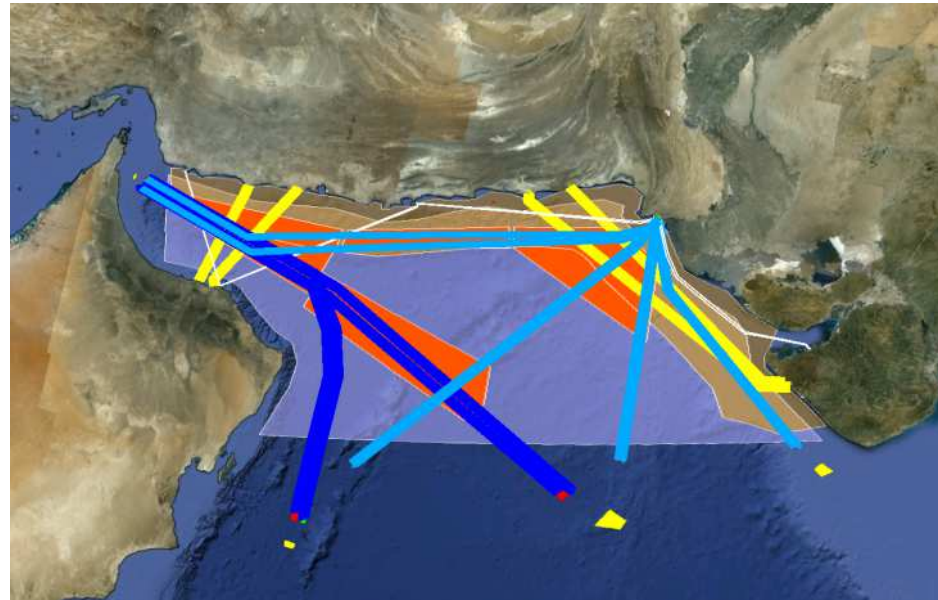
## The Vessel Traffic Generator Approach





## VTG scenario definition

- › Sketch-based scenario creation
  - › Defining harbours, sealanes, ferry routes, fishing area's using lines and polygons
  - › Adjust desired densities (min/max/avg) per vessel type (ferry, fishing boat)
  - › Authoring can also be done using a KML editor such as Google Earth





## Vessel generation

- › Vessels are generated within the AOI based on sketched scenario
  - › AOI is seeded initially at scenario at specific time
  - › International traffic is spawned regularly at AOI edges to maintain desired densities
  
- › Alibi generator
  - › Each ship has an alibi (origin, destination, ...)
  - › Alibis are generated only when needed
  - › Provide statistically accurate context while simulating only area of interest
  
- › Extensive dynamic attribute set for each generated vessel
  - › State (attacking, fishing, loitering, ..)
  - › Crew (names) and vessel properties (dimensions, maintenance condition)
  - › Sensor signature
  - › Intent (smuggling, pirating, illegal fishery)



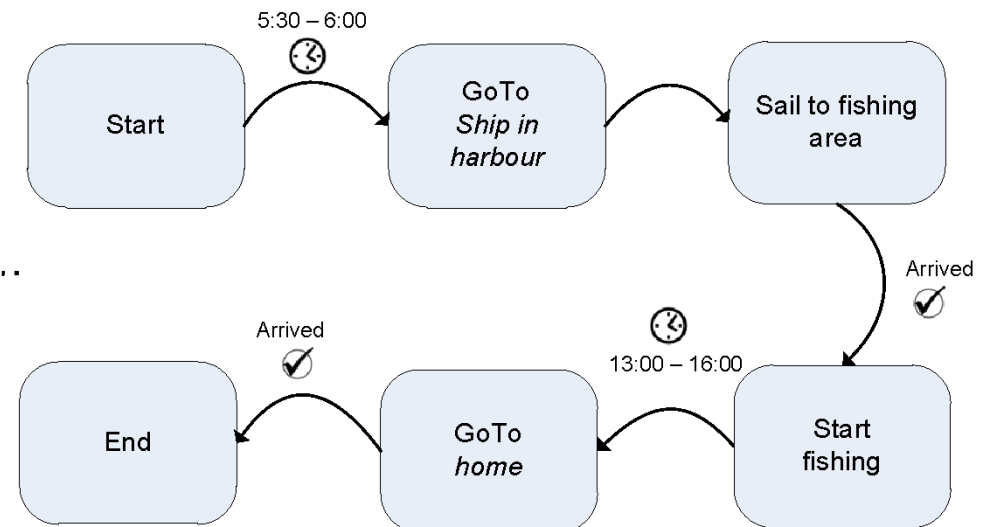
Vessel behaviour definition

Behaviour definition using Daily Motion Patterns (DMP)



DMP specifies:

- › When
- › What (plan)
- › How (fishing pattern)
- › Resources: cargo, AIS, ..



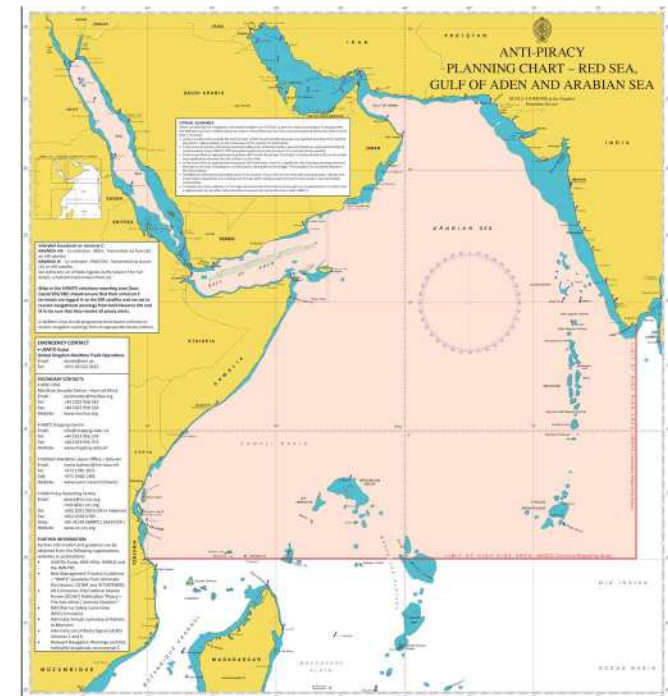
Example fishing ship DMP





# Simulated vessel reporting

- › Automatic Identification System (AIS) generator
  - › Automatic reporting for AIS capable ships
  - › Position report (messages 1, 2 & 3)
  - › Ship static & voyage related data (message 5)
  
- › Alpha report generator
  - › Reporting presence to NATO Maritime Command when entering High Risk Area





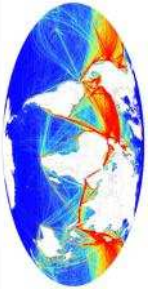
## VTG implementation

- › Framework:
  - › MAK VR-Forces 4.1.1
  - › HLA 1516e, Time Managed
  - › Real-Time & Non Real-Time mode
  
- › VTG plugin for VR-Forces
  - › Logic for generating ships based on scenario and DMP definitions
  - › GUI tools for defining scenarios and inspecting vessel attributes
  
- › Daily Motion Pattern
  - › State machine based
  - › User-editable definitions file (XML)



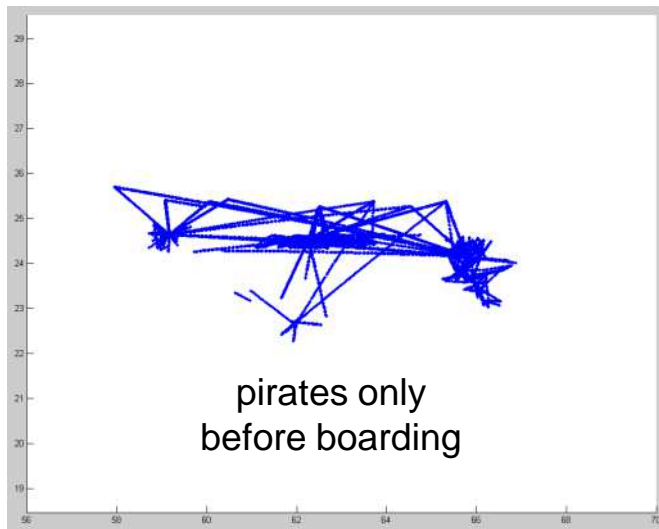
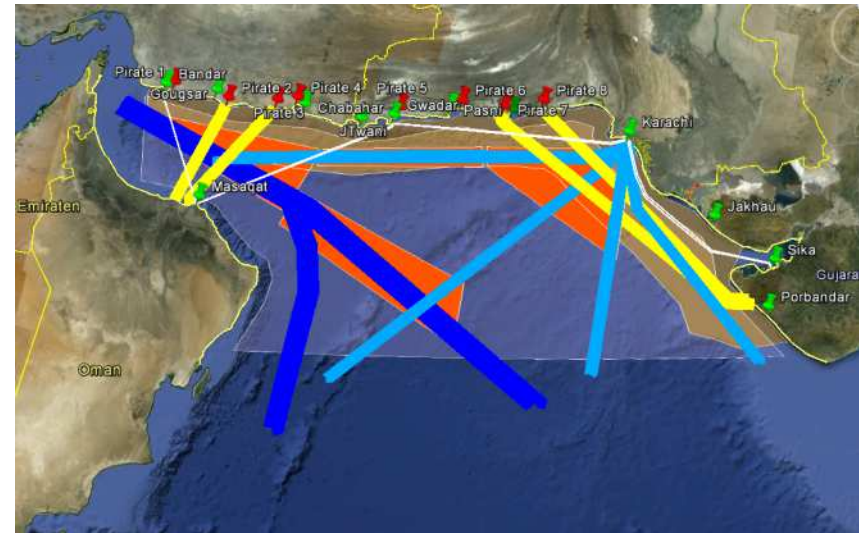
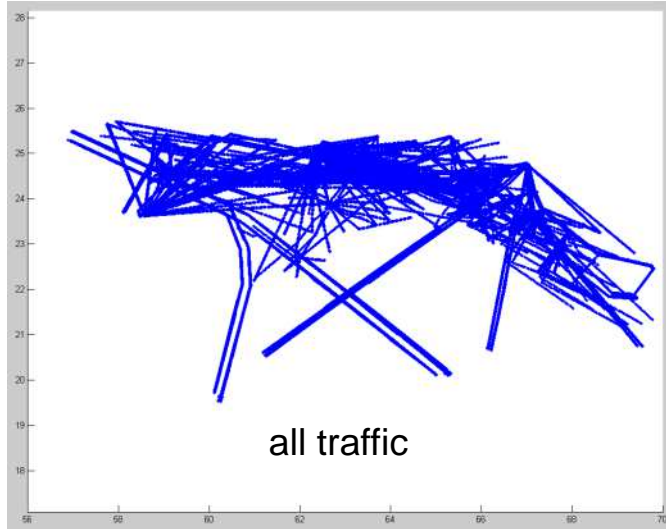
- › Each vessel is generated based on a template
  - › A template defines all ranges of attributes for a specific vessel type
  - › Vessel attributes defined using expressions
    - › **Speed** {slow=kts(3.0), typical=kts(rndRange(5.0, 15.0))}
    - › **Flag** {IN=40,JO=5,OM=15,SA=25,RU=3,YE=7,CN=5}
- › Report generator (AIS & Alpha)
  - › HLA (RPR-FOM + AIS BOM) , Time Managed

# Results





Example dataset (5 days)





## Results

### Vessel Traffic Generator

- › Generates ground truth data
  - › State
  - › ....
  
- › Observer model provides perceived world
  - › Visual
  - › Sensors (Radar, ..)
  - › AIS reports
  - › Alpha report

### Ground truth data

- › Enables validation of Maritime SA Modules



## Results

- › Demo: movie clip



## Future work

1. Improve ship dynamics and trajectories
2. Define vessel behaviour inside harbours
3. Validate Daily Motion Patterns with SMEs
4. Use more real-world data (sealanes, harbours, ferry time tables, ..)