DEFENCE R&D DÉFENSE

Command and Control Experimentation using Distributed Simulation

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Recherche et développement pour la défense Canada
Canada

Outline

- Motivation for work
  - Hypothesis, objectives
- Experimentation Setup
  - Scenario, infrastructure
- Execution
  - What worked, what did not
- Lessons (to be) Learned
- Conclusions

MAR TP-1 Remit

1. C2 System Performance
2. Information Management
3. Tactical Picture Generation and Visualization
4. Simulation-based Development

Extension from Sonar systems to all warfare areas

VBE-B: Sonar

VBE-C: Surface/Air Warfare in Littoral working with Submarines

VBE-D: Technical tests on CFBLNet

Virtual Battle Experiments

- System level, Human in the Loop (HIL or HITL), experimentation using a virtual/synthetic environment to stimulate the system.
- Generally, stimulation is representative of expected battlespace inputs.
- A next step in the CD&E spiral from constructive simulation modelling of concepts
- Expected to be particularly useful for systems/concepts where the human has a large effect on performance such as combat systems.

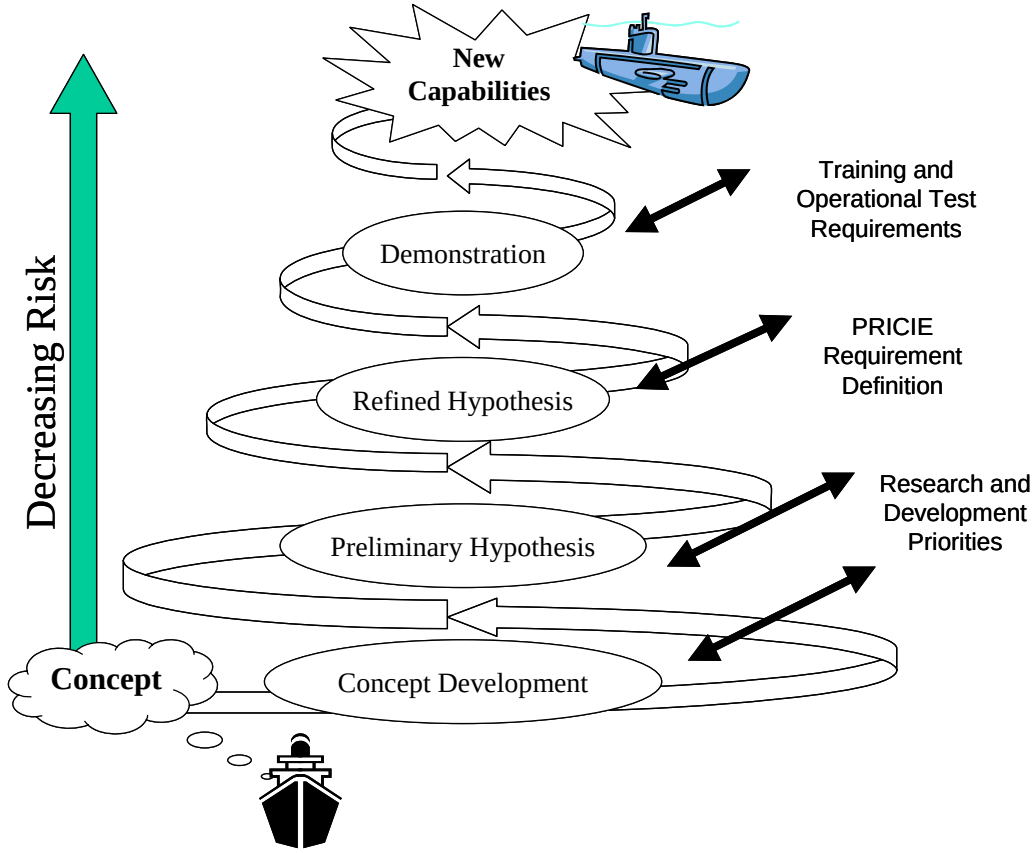
Concept Development and Exp.

TP-1 HIL study (VBE-E)

Use of small UAV

AG-1 OR study

Netcentric SWARM Defence



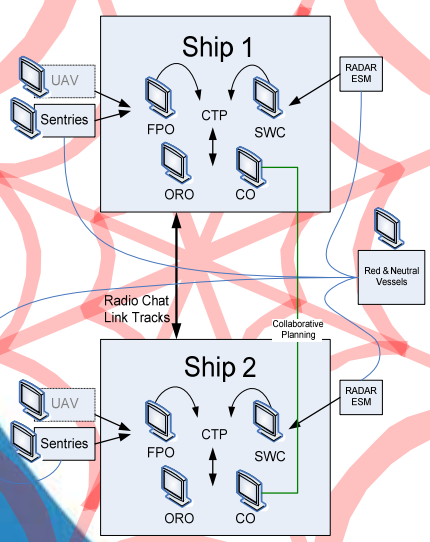
Virtual Battle Experiment - Echo (VBE-E)

TTCP MAR TP-1,
Distributed Maritime Systems C2 Experiment

- To use a virtual battle experiment to conduct a rigorous coalition-based experiment. AG-1 Hyp: UAV will improve defence against FIAC Swarms
- To investigate Distributed Command Team Decision-Making, Situation Awareness and Workload; and measurement techniques.

DSTO

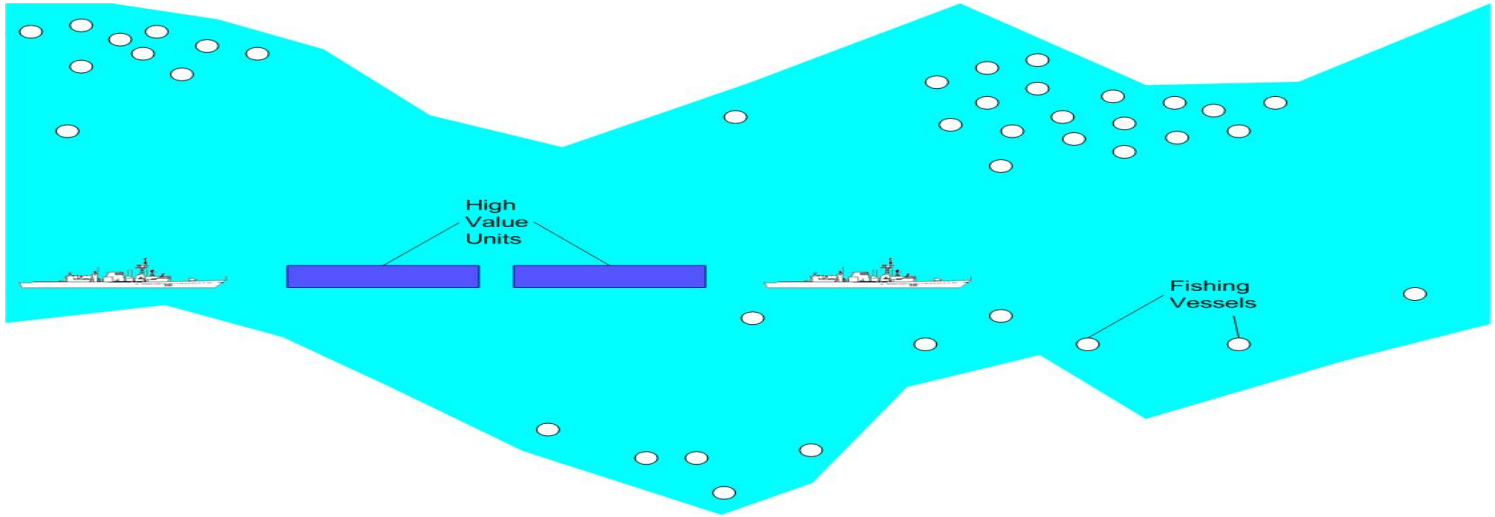
DRDC



Dstl

DTA

Scenario



Two allied warships tasked to escort two high value units (HVU) through a confined strait of water in a Force Defence operation

Intelligence reports indicate the threat of a terrorist attack using small arms or RPG

There are numerous fishing vessels and pleasure craft in the area

As the convoy transits the strait a swarm of fast inshore attack craft form up and attack one of the HVUs

Coalition Capabilities

- 2 Coalition (generic) Frigates
  - 76 mm main gun – airburst ammo
  - SPS-49 “like” surface search radar
  - 6 semi-stabilized 50cal Machine Guns
  - Max speed 30 knots, fully fueled
  - Upper deck sentry visual sighting

- Ship launched maritime UAV
  - 3-4 hour endurance
  - 30-120 knot speed
  - 64x unstabilized Electro-optic camera (sim by cockpit view from Microsoft Flight Sim)

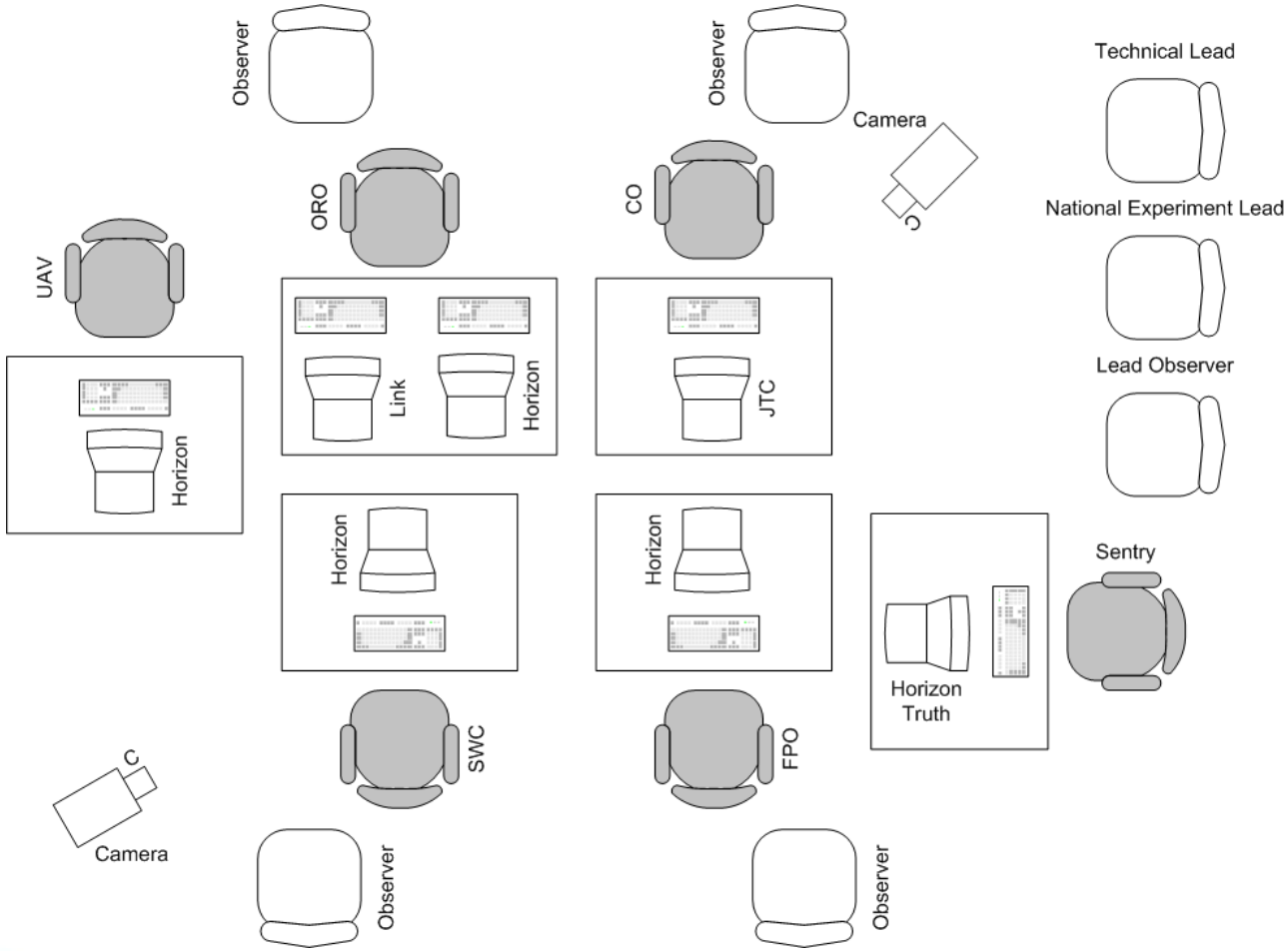
AG-1 OR Study Assumptions to be investigated.

- Type of attack craft – OR study assumed that near immediate visual identification of hostile intent.
- Interaction of national ROE in decision making
- Tactical employment of assets
  - Frigates
  - UAV

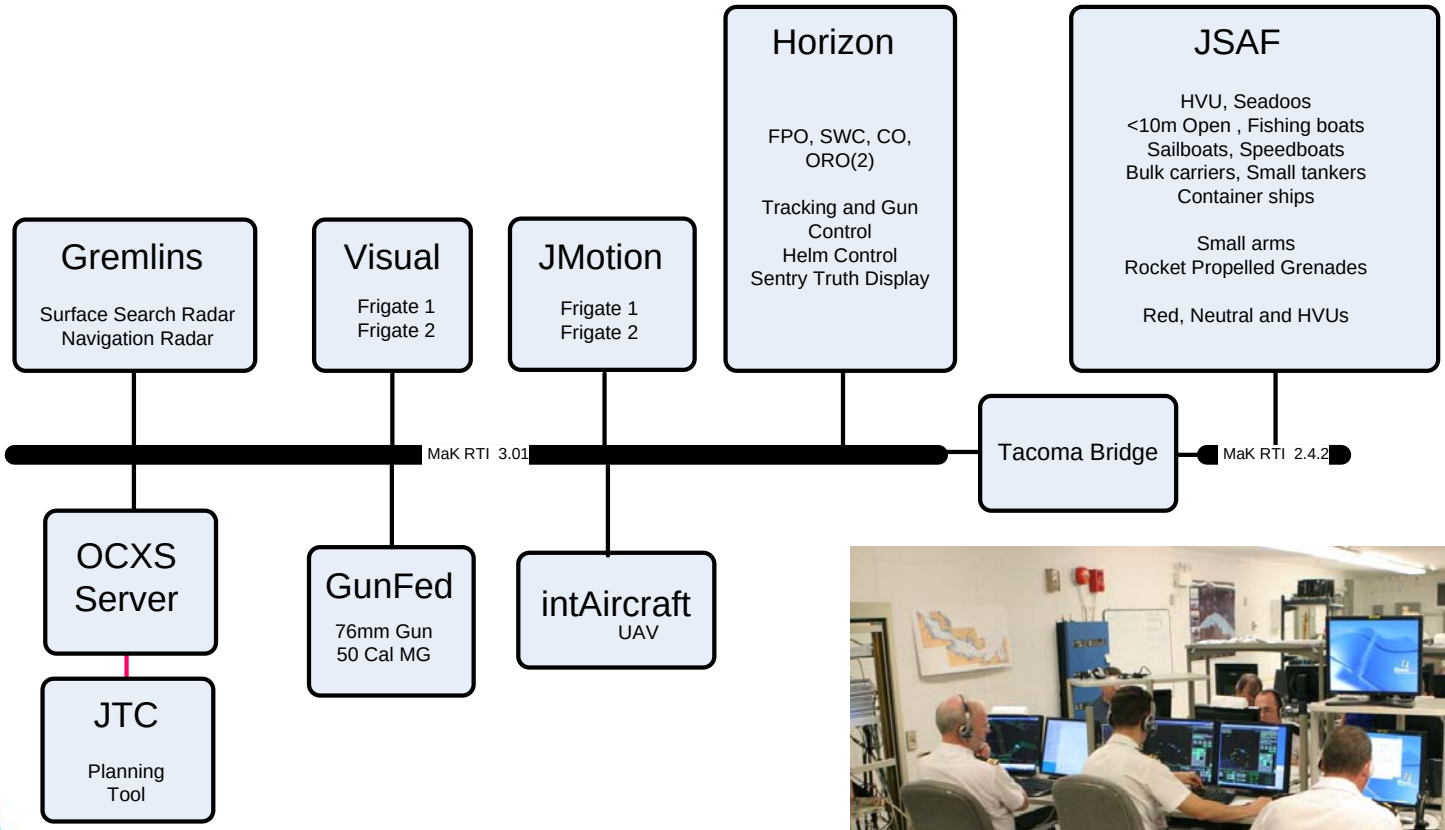
Threat Characteristics

- Small arms
- Multiple types of boats
- Swarms of ~10
- No weapons shown until attack begun

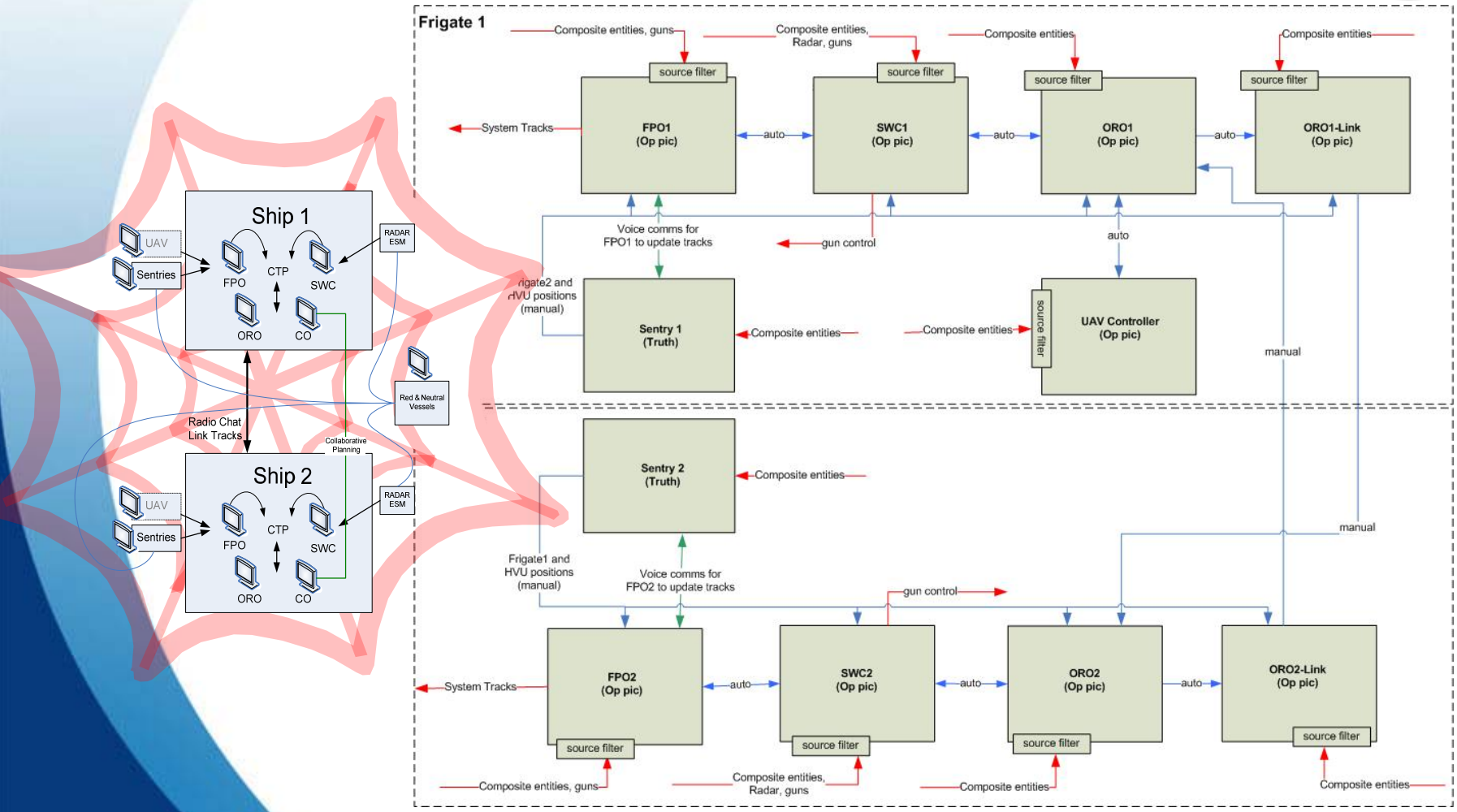
Simulated Ops room Layout



Simulation Infrastructure



Federation Infrastructure



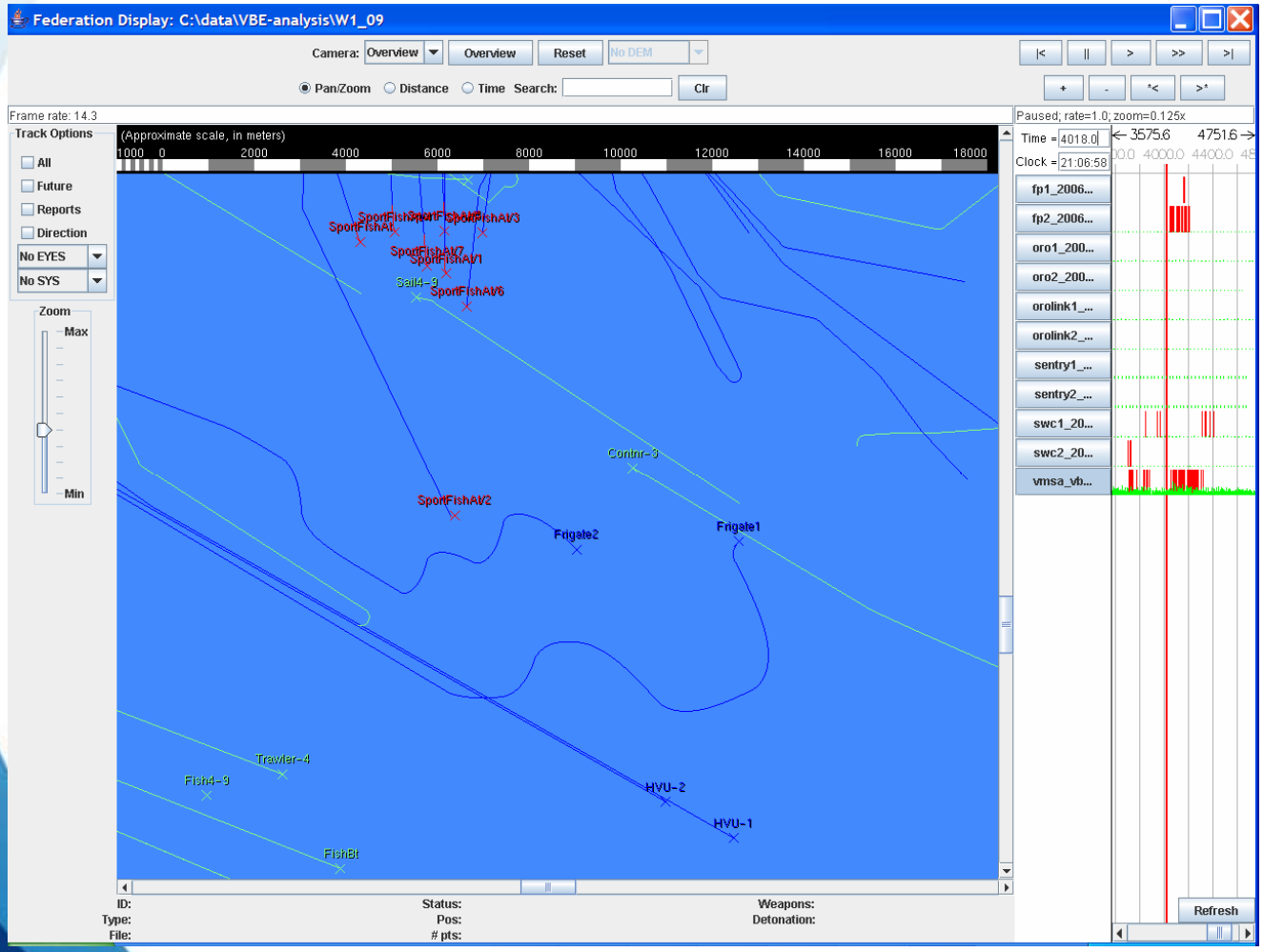
Data Collection

- Communications (Teamspeak/Chat)
- Interactions and workload (PDA)
- Behavioral notes - documented significant events and behavioral state
- Questionnaires
  - situation awareness (CARS)
  - workload (NASA TLX)
  - shared awareness
- Audio/video recording of entire room
- Simulation and C2 system Datalogging

Analysis

- MOP/MOE Analysis
- Analysis of HF data
- Analysis of VBE infrastructure
  - WAN studies of simulation and network requirements
- Analysis of Experimentation Procedure
  - Comparison to TTCP GUIDEx

Analysis Software



OBJ: Dist. Rigorous Coalition Exp

15 runs (7 sets of Base/UAV)

5 distributed runs CA/UK with 80-85 ms latency

Demonstrated procedures and potential

Insufficient runs for rigorous conclusions – therefore Objective not fully met

Standardized Training
Technical Issues resolved before Participants involved
Better fit of simulation fidelity
Improved Scenario description, ROE etc.
Robust network and known QoS
Not all nations can handle schedule slips

VBE-E Time Line

April 2005 – VBE Proposal to Panel

Oct 2005 - Draft Exp Plan – Panel Approval

Jan 2006 - CFBLNet application – brief by AS

1 Apr – Original low BW link (not achieved)

Oct 05 – May 06 Low level development

May-Aug 06 - High level development by CA

Jul-Aug – MOU for loan of TacLane

14-18 Aug - Pilot Study

21-25 Aug - Team Meeting (CA)

25 Aug - Scheduled Hi BW Network

Aug – Integration and implement changes from Pilot/TM

6 Sept – Ship final(?) federation

18-21 Sept – CA/UK training

18 Sept – UK on line

19 Sept – CA/UK on line

22 Sept – VTC on status – NZ pulls out with not enough time left

24 Sept – AS on line

25-28 Sept - AS(/NZ) training

2 -6 Oct – Week 1 (5 CA-UK, .5 UK/AS)

10-13 Oct – Week 2 (CA in AS for 10 runs)

1 Dec – HF team analysis

5-9 Feb 07 – PT to finalize report

21 Threats to a Good Defence Experiment

	❶ Ability to Use Capability	❷ Ability to Detect Change	❸ Ability to Isolate Reason for Change		❹ Ability to relate Results to Operations
			Single Group	Multiple Group	
❶ Treatment	1 Capability not workable: Do the hardware and software work?	5 Capability variability: Are systems (hardware and software) and use in like trials the same?	11 Capability changes over time: Are there system (hardware or software) or process changes during the test?	N/A	18 Nonrepresentative capability: Is the experimental surrogate functionally representative?
❷ Players	2 Player non-use: Do players have the training and TTP to use the capability?	6 Player variability: Do individual operators/units in like trials have similar characteristics?	12 Player changes over time: Will the player unit change over time?	15 Player differences: Are there differences between groups unrelated to the treatment?	19 Nonrepresentative players: Is the player unit similar to the intended operational unit?
❸ Effects	3 No potential effect in output: Is the output sensitive to capability use?	7 Data collection variability: Is there a large error variability in the data collection process?	13 Data collection changes over time: Are there changes in instrumentation or manual data collection during the experiment?	16 Data collection differences: Are there potential data collection differences between treatment groups?	20 Nonrepresentative measures: Do the performance measures reflect the desired operational outcome?
❹ Trial	4 Capability not exercised: Do the scenario and Master Scenario Event List (MSEL) call for capability use?	8 Trial conditions variability: Are there uncontrolled or unmonitored changes in trial conditions for like trials? Look for intervening variables not recorded.	14 Trial conditions change over time: Are there changes in the trial conditions (such as weather, light, start conditions, and threat) during the experiment?	17 Trial condition differences: Are the trial conditions similar for each treatment group?	21 Nonrepresentative scenario: Are the Blue, Green, and Red conditions realistic?
❺ Analysis	N/A	9 Low statistical power: Is the analysis efficient and the sample sufficient? 10 Violation of statistical assumptions: Are the correct analysis techniques used and error rate reduced?	• The purpose of an experiment is to verify that *A causes B.* • A valid experiment allows the conclusion, A causes B, to be based on evidence and sound reasoning… – by reducing or eliminating the 21 known threats to validity.		

OBJ: Exam UAV usefulness

Review of MOE set – Hostile Range, Response Lag

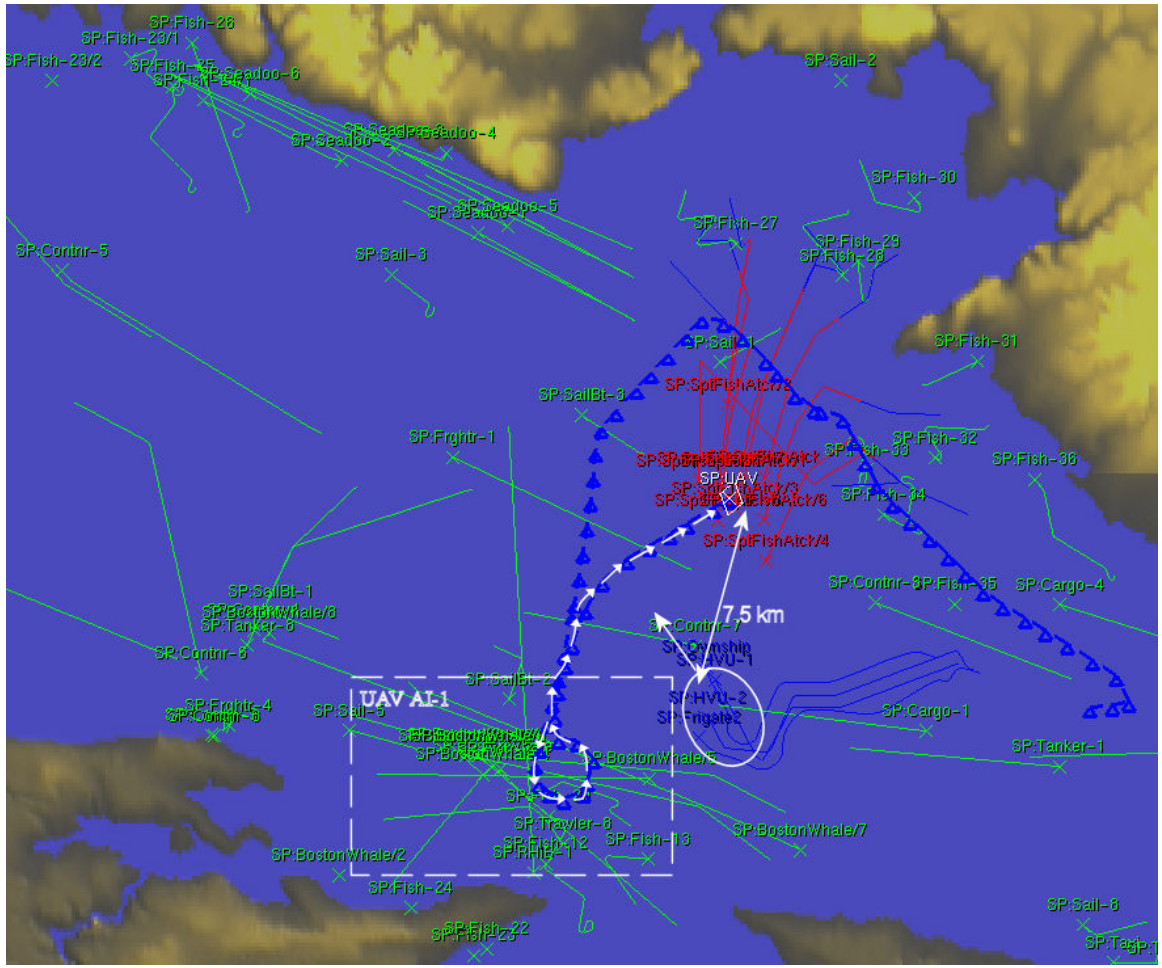
Narrowed to 4-5 run sets from the second week due to problems in data sets

FlightSim models gave UAV detection realism over OR study

Met Objective with results that are indicative of improved performance with UAV, and moved forward the understanding of what/how UAVs can be used.

Deck Sentry modelling insufficient
Radar detection too good – no shadowing
Benign environment – lack of land threat
Damage model inconsistent
UAV Operator competency

Reconstruction and Tactical Analysis



Simulation Infrastructure

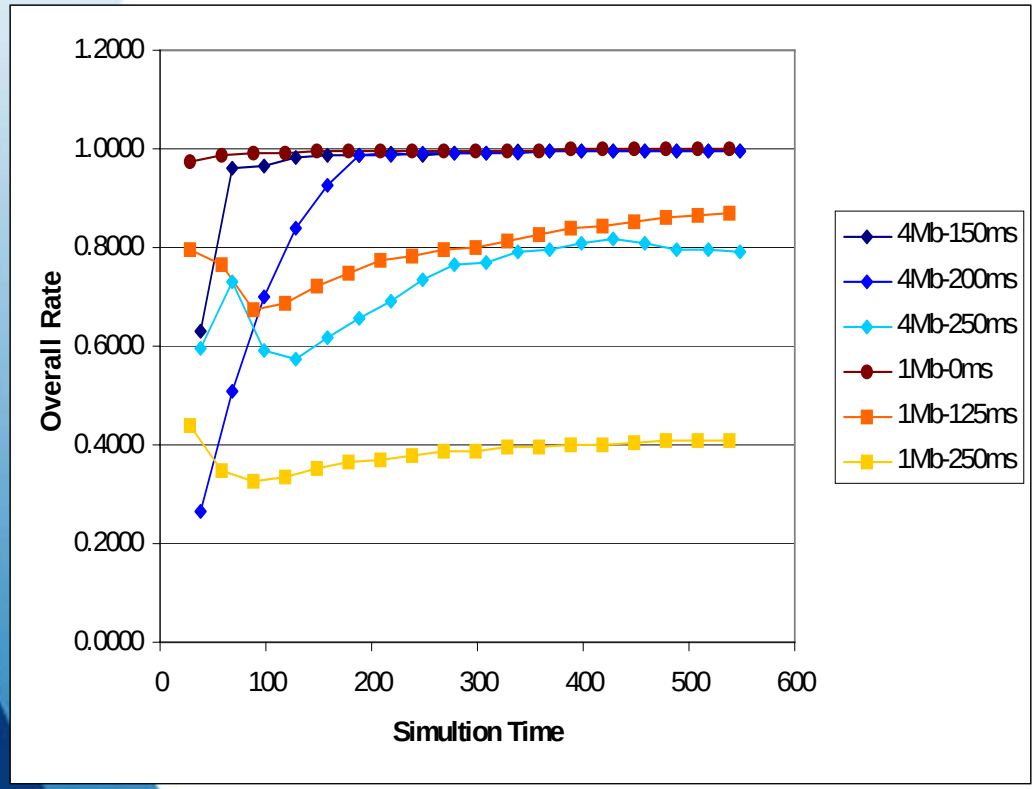
1. Bridge to JSAF for scenario generation
2. Gunnery Plugin and GunFed
3. Radar equation based Radar federate
4. VisGrem federate for visual sightings
5. Visual models for FlightSim
6. Detailer federate and Analyzer software pkg

1. Radar still not sufficient for littoral environments
2. Damage assessment inconsistent
3. Sentry reports insufficient
4. Pushed Horizon track management to edge
5. Pushed FlightSim close edge of usefulness

The Blindingly Obvious

- Distributed C2 simulations are complex systems so expect emergent behaviour and budget lots of time on the network for debugging and integration.
- Need to think Joint in Littoral waters (land, sea threats)
- Participants will play the system. Ensure there are consequences in the simulation if players do not restrict themselves to actual capability.
- A full system description and review with qualified military operators should be conducted early. The simulation needs to support all combat system functionality. (egs: “suspect” category; “warning shots”)
- GOTS/COTS systems can be very powerful, but are also complex and require significant investment to understand and use properly.

Technical/Network Issues



- Network requirements and quality of service are critical. (and unknown)
- Technical and configuration documentation is required to decrease workload and set-up time.
- Infrastructure for security requirements need to be determined early.

Planning/Development

- Pilot study should come after integration testing and include the complete analysis stream.
- The entire responsibility for organizing, designing and developing multi-location experiment should not rest solely on the lead-nation (or one location).
- Get the network up long enough beforehand to do network integration + pilot + training before the experiment. (8 weeks)
- Timelines need to be flexible to cope with setbacks and the resources of all of the players.

Personnel

- Difficult to get military operators, and once you have them you are tied to a schedule. Need to tie to national projects early on.
- Consistent training must be implemented for all observers and participants
- All experimentation sub-teams need to be specified and engaged from the beginning of planning
- Technical support and EXCON roles need to be different people;
- EXCON needs to be physically separate from participants.
- Sentry interactors needed either much more detailed instructions and training or more realistic display

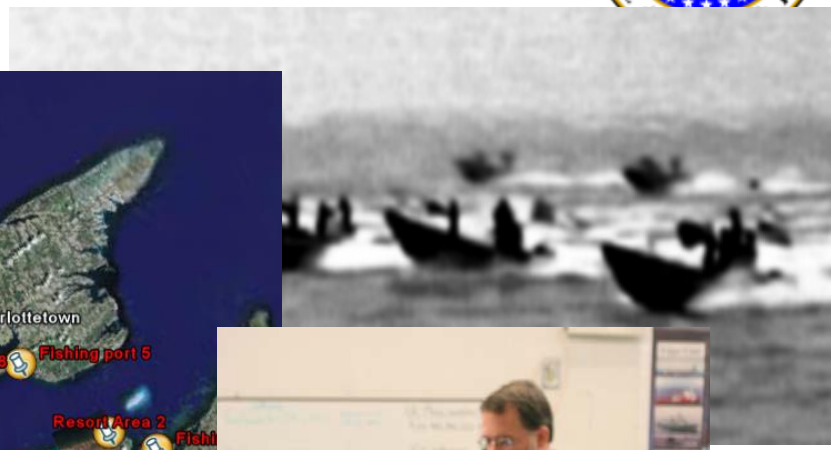
Overall Accomplishments

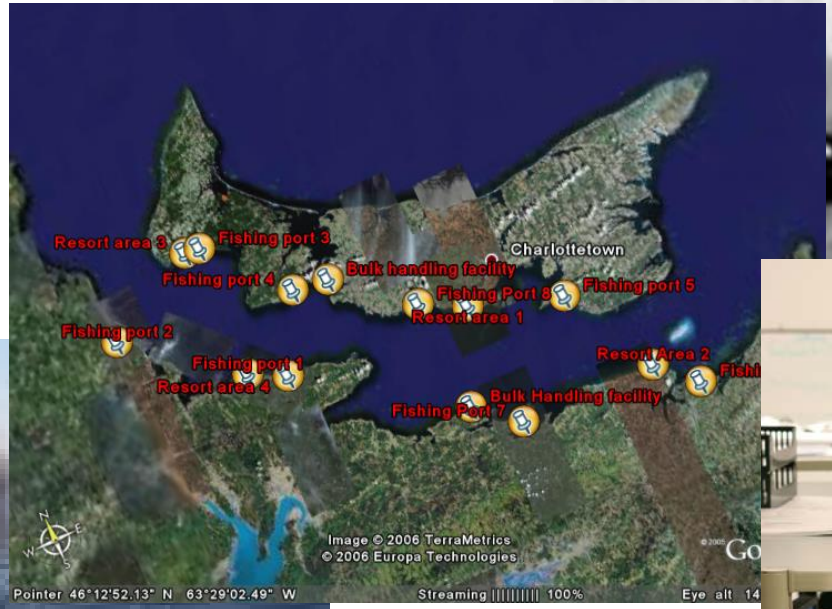
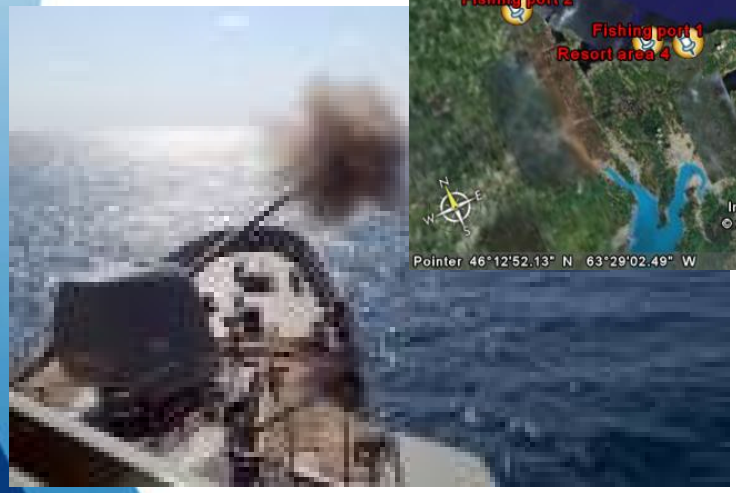
- Demonstration of technology that provides:
  - the link between OR/System studies and real world trials
  - the ability to study coalition issues in controlled environments
- Provided information on the usefulness of small UAV for Force Defence.
- Provided information on Network/Crypto requirements for distributed simulation
- Demonstrated VBE useful for tactical/concept development experimentation.

Conclusions

- Distributed coalition experimentation is feasible and cost-effective, but not cheap
- Need to investigate Infrastructure Performance problems
  - Network QoS required
  - Impact of Encryption on Simulation
  - Time-managed vs Real-time operation on WAN
- Impact of schedule/resource slippage can be much higher on smaller partners.

Questions?????




Resort area 3
Fishing port 3
Charlottetown
Fishing port 4
Bulk handling facility
Fishing Port 8
Fishing port 5
Resort area 1
Fishing port 2
Fishing port 1
Resort area 4
Resort Area 2
Bulk Handling facility
Fishing Port 7
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