DEFENCE R&D DÉFENSE

Observational Studies of a Joint Fire Support Coordination Cell

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Canada

JFS TDP in a Nutshell

- Technology Demonstration Project initiated in 2006
- **Aim**: To develop an effective and efficient Canadian Forces Joint Fires Support model.
  - Optimal target effect scarce resources
  - Reduce risks for fratricide and collateral damage
  - Faster response (shorter kill chain cycle)
  - Scalable, interoperable and adaptable JFS capability.
- **Deliverables**:
  - JFS Concept of Operations
  - JFS Testbed
  - JFS Statement of Requirements
  - Development of in-house JFS expertise

Top 5 focus issues for JFS

*Operators' stated needs**

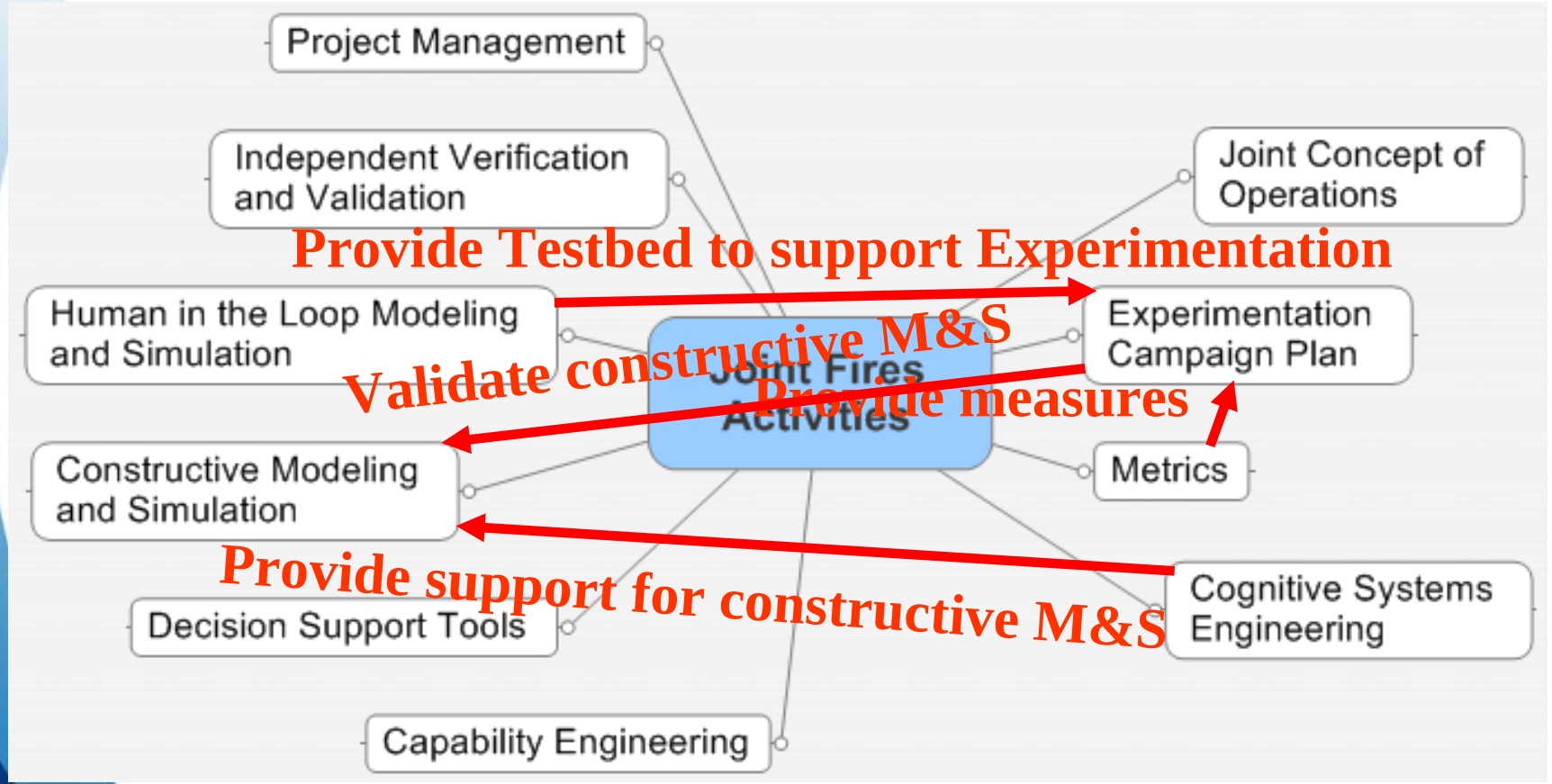
- One integrated workstation;
- Better SA;
- Improved Joint Battlespace Management;
- Additional tools for mission planning, rehearsal, execution and training;
- Improve coalition trust.

Implications to the R&D/Scientific Community

- Situation understanding;
- Knowledge management and information access;
- Business processes for knowledge management;
- Dynamic, real-time; constraint based re-planning;
- Information dissemination;
- Cross-domain exchange architecture;
- Risk mitigation.

* Defined by The July COI and confirmed by the Oct WG

JFS Activities



Studies Completed

- JFS Concept of Operations
- Doctrinal As-Is JFS
- Current actual As Is Architecture in Afghanistan (DoDAF)
- Process options in a netcentric environment (table-top comparison of C2 Structures)
- Cognitive process involved in Joint operations (CWA)
- Cognitive process involved in coalition operations
- Comparison of processes using Business Process Modeling (JESTER model)
- Development of a JFS Testbed
- Integrated Joint Fires Coordination (IJFiC) Experiments (tehcnological integration)
- **Human Factor series of experiments** (HF1; HF2; CAGE/HF3)
- S&T activities required to support future fires capability (TTCP JSA AG13)

Outline

1. Overview of HF1 Experiment Design
2. HF1 Settings
3. Data Collection and Analysis
4. Results
5. Future Work

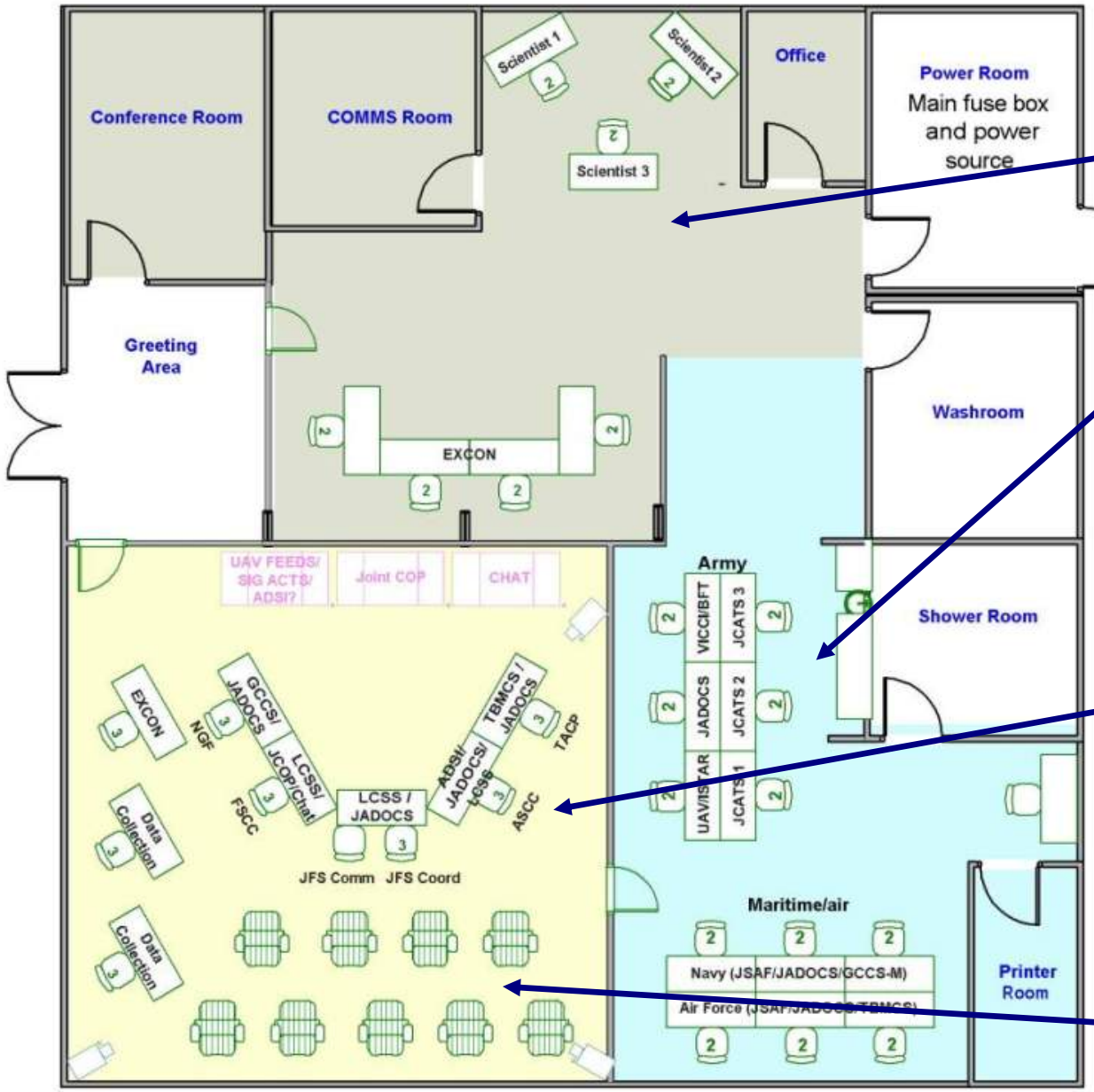
Human Factor 1 Objectives

- Assess the JFS capability provided by:
  - Joint Common Operating Picture
  - Coordination tool (JADOCS)
- Validate constructive model (JESTER)
- Provide baseline assessment of current in-service systems for future comparison.
- Provide guidance for future exploration.

Human Factor 1 Design

- Human in the loop experiment
- Operators manning a Brigade-level Joint Fires Support Coordination Cell and responding to the event happening in a synthetic environment.
- Mission: Responding to a falling state to establish conditions for aid and development work.
- Theatre: Fictitious country of West Isle and bordering country of East Isle.
- Threat: Various militias within West Isle – tens of thousands of warriors
- Blue Force: Multinational division acting under United Nations. Joint task force include land, air and naval assets.

Human Factor 1 Layout



Experiment Control
Data Collection

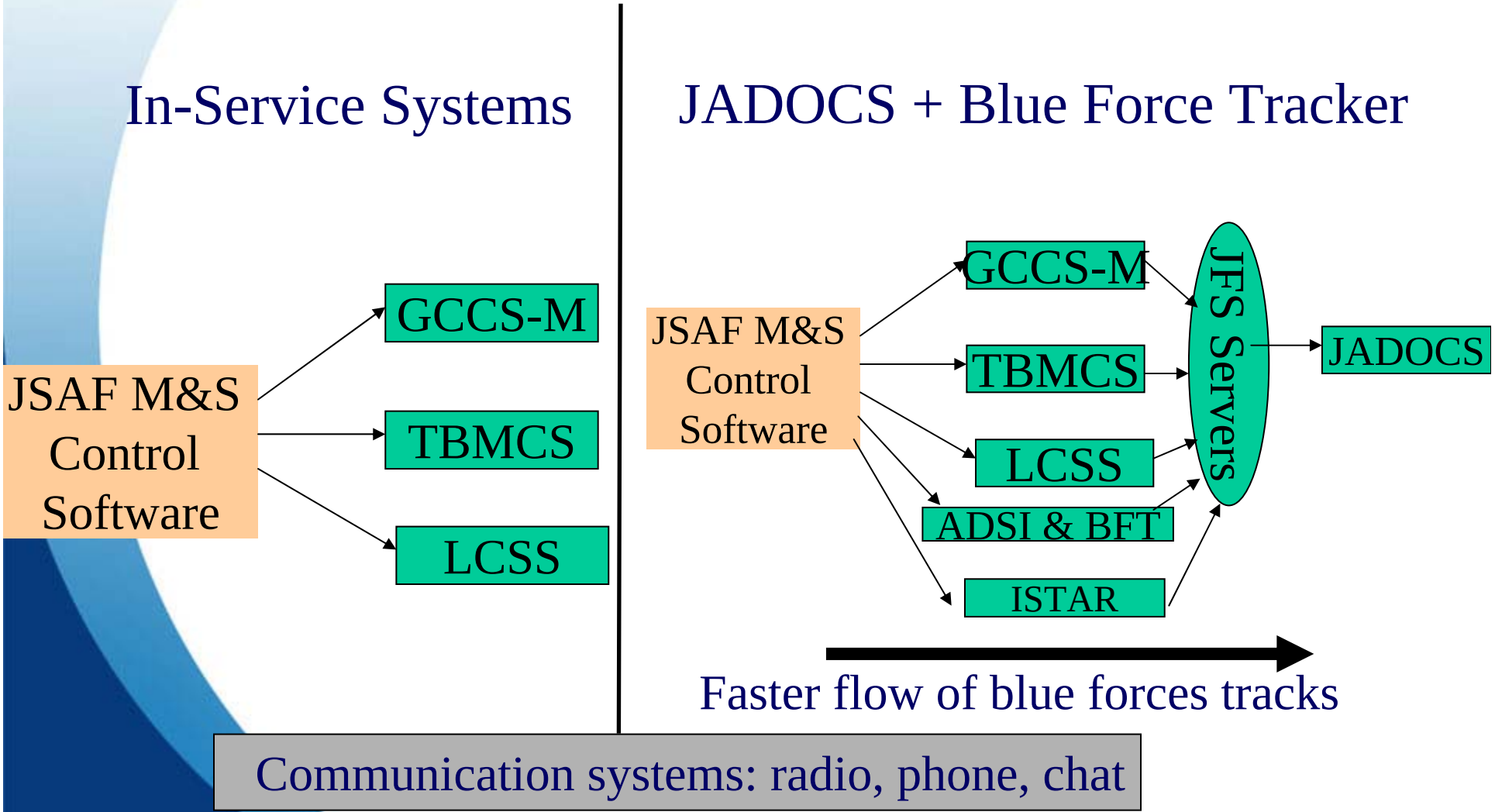
White Cell:
Lower and Higher echelon
Synthetic Environment

Team of 6 operators:

- Joint Fires Coordinator
- Joint Fires Communicator
- Airspace Coordinator
- Tactical Air Control Officer
- Fire Support Coordinator
- Naval Gun Fires Officer

Observers

Comparison of In-Service with JADOCS



Experiments Inputs

Other Data Sources

Target Information, maps, weather, etc.

ATO/ACO Commanders Intent, ROEs, Doctrine, JIPTL, TSS, etc

OPP

BDA Mission Requests

ISTAR

Video feed

Tasking for Target Visual Confirmation

GCCS-M / TBMCS / LCSS

Op Status

Situational awareness
Blue force tracking
Mission Status
Weapon Status

Coalition Feeds

Information Database

Joint Fire Coordination

Resource & Effect Requests

Mission Support	Additional Resource Requests	FOO FAC NOO
Emerging Targets/ Dynamic Targeting	Effect Request	CDI SOF
Time Sensitive Targeting	Effect Request	TIC CDI SOF ← FOO FAC NOO Soldier

Course of Action

Resource Tasking

Tasking Actioned

- Navy Task Force
- CAOC
- FSCC
- Individual Unit

SigInt

UAVs

Human Intel

CDI

If request initiated by FOO, FAC, NOO then assign best resource and forget.
Else responsible for eyes on, collateral damage and weapons release.

Experiment Timelines

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 1	Brief & Training						
	Rehearsal						
	Experiment Prototype						
Week 2	Rehearsal						
	Experiment Current						
	After-Action Review						

Experiment Hypothesis

- The JFS operators better perform JFS Coordination tasks and have better situation awareness when provided with a Joint Common Operating Picture and an integrated coordination tool compared to when they are limited to the decoupled in-service environmental C2 Systems.

→ Need to measure Situation Awareness and task performance

Data Collection

- The quality of the task outputs;
- The time required to accomplish the required tasks;
- The rate of errors made by the operators;
- The trust of the JFSCC operators in the adequacy and reliability of the C2 systems; and
- The JFSCC operators' situation awareness (SA) of the battlefield and their confidence in their SA.
- Background information on the experiment participants;
- Work environment adequacy; and
- Workload.

Data Collection Tools

- Captures screen snapshots every time changes occur
- Captures all data flow between systems
- Captures all keystroke
- Capture mouse clicks
- Automatic push and collection of survey data
- Recording of synthetic environment to provide ground truth.
- Ability for observers (SMEs, analysts) to capture impressions from subjects activities.

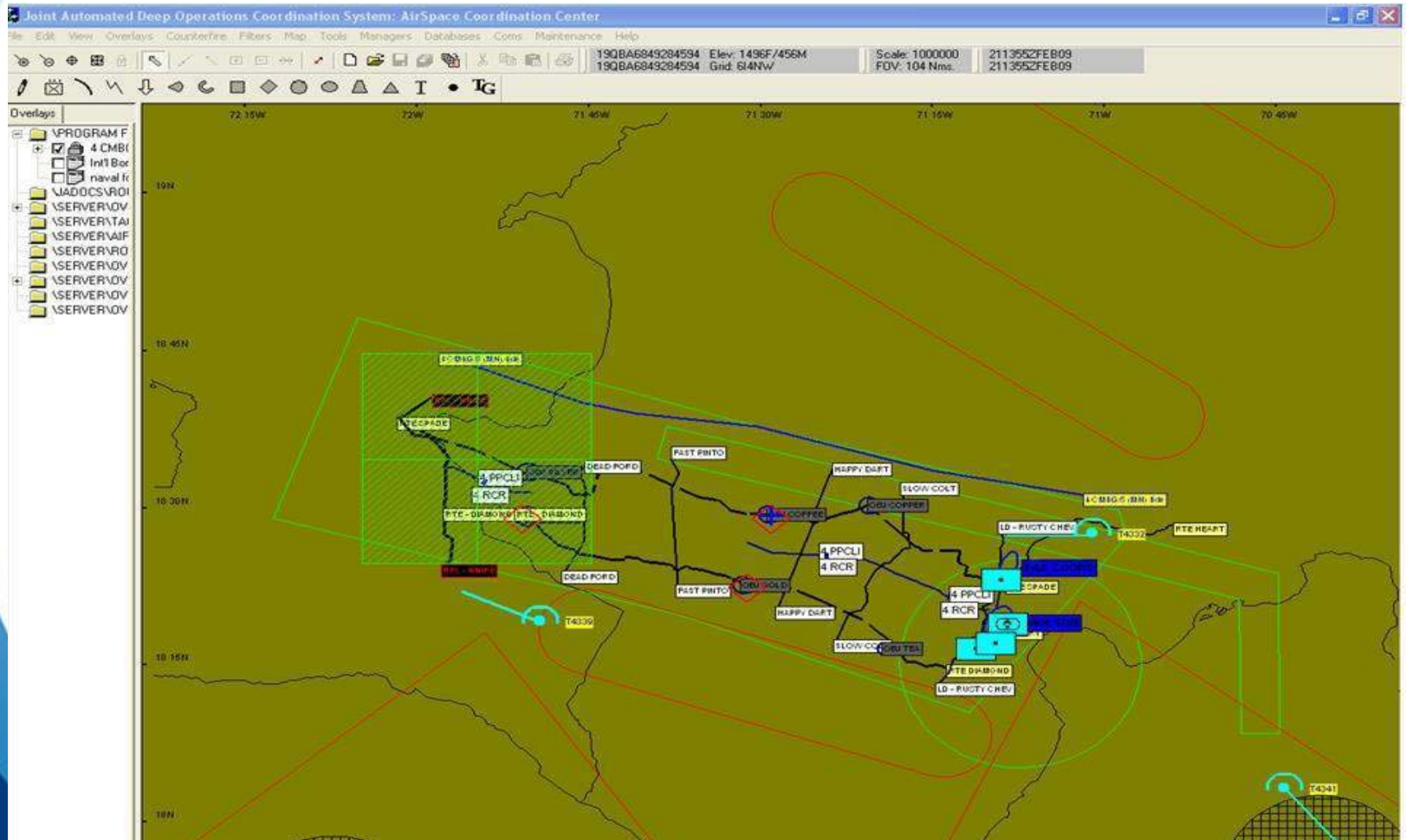
Data Analysis

- Webb's factors for ineffective collaboration:
  - Not requesting collaboration;
  - Lack of timely and relevant support for collaboration;
  - Lack of clarity of provided information; and,
  - Lack of follow-up, i.e., not implementing or using the provided information.
- Endsley 3 levels of Situation Awareness

Experiment Execution

Usage of C2 Systems

- Very positive view of single workstation with 3 screens: Communication, Managers, Map



HF1 Results

- Comparison between baseline and C2 prototype:
  - Faster and better handle for three tasks: dissemination of target information, CDE, and clearance of airspace
  - Large reduction of human errors (2 vs 0 fratricide incidents)
  - No significant difference of Situation Awareness but large difference between the adequacy of operators' confidence
- Recommended improvements:
  - Better handling of ACO and ACRs in JADOCS
  - Incorporate Gantt chart for synchronization matrix
- Feedback:
  - "JADOCS was invaluable to clear fire, avoid fratricide and integrate constraint (NSL). A truly outstanding capability. Never had such capability in 20 years of artillery."

Task Performance Comparison

Tasks	Comparison	Comments
Determination of Engagement Requirements	No significant differences	
Dissemination of Targeting Information	Better with Prototype	More reliable, quicker and no redundancy with Prototype
Selection of Firing Platform	No significant differences	
Request of Air Clearance	Better with Prototype	Alert system informed relevant operators
Development of Clearance Measures	Comparison not possible	Same tools used during both weeks
Assessment of CDE	Better with Prototype	Better distribution of CDE workload with Prototype
Development of Engagement Plan	No significant differences	

Human Errors Comparison

Type of Error	Frequency Prototype	Frequency Current	Expected Comparison
Wrong key stroked	2/2 days	0	Higher frequency for Current C2 system since it required more typing.
Imprecise verbal interaction	0	2/2 days	Higher frequency for current C2 system since operators relied more on verbal interaction.
Misreading	0	1/2 days	Higher frequency for current C2 system due to lower quality of the information display and the request for “eye-balling” between C2 systems.
Lack of attention on relevant information	0	1/2 days	Higher frequency for current C2 system due to the lack of alert systems.

Situation Awareness Comparison

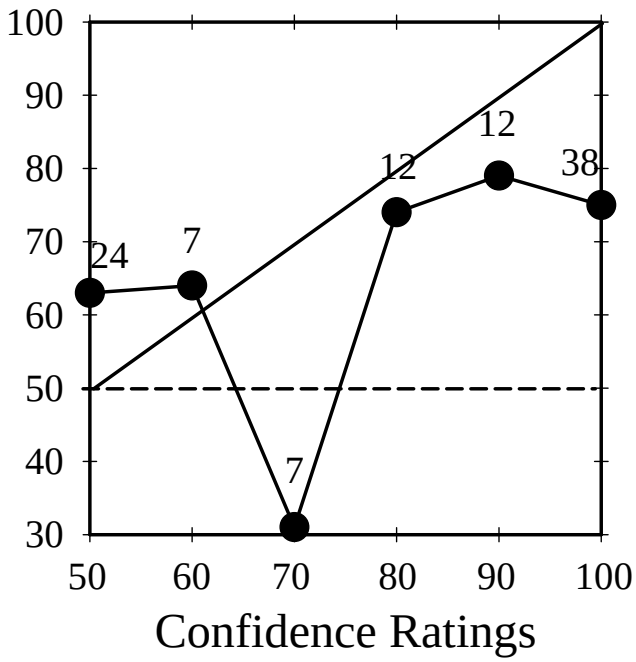
- For the SA data, the analysis revealed null effects of C2 systems (Enhanced = 69% vs. Legacy = 68%), time of day (Midday = 69% vs. End of Day = 68%), and the interaction between the C2 systems and time of day.

Effect	*df Effect*	*MS Effect*	*df Error*	*MS Error*	*F-value*	*p-level*
C2 System	1	9.21	9	99.87	.09	.76
Time of Day	1	15.94	9	149.00	.11	.75
Interaction	1	211.23	9	70.87	2.98	.12

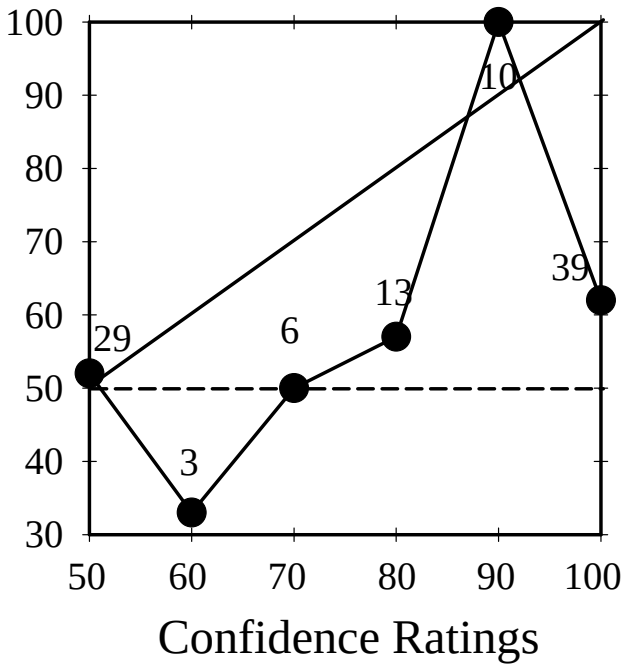
SA Confidence Comparison

More adequate confidence with Prototype.
Adequacy of confidence in own SA has been shown to be an important predictor of behavior.

Prototype



Current C2



Conclusion

- JFS Human Factor 1 Experiment has shown that Joint COP and Collaboration tools can:
  - Increase task performance
  - Reduced risk of human errors
  - Improved the operators adequacy of confidence in own SA
- Based Webb's framework for ineffective collaboration, the following aspects are improved:
  - Lack of timely and relevant support for collaboration; and,
  - Lack of clarity of the provided information.

Additional Benefits of HF1

- Establishment of a Canadian Joint Battle Lab that support Joint Experimentation
- Realistic operational environment with limited "experiment control":
  - Provides an environment for the operators to "think out of the box"
  - Explore new Tactics, Techniques and Procedures
  - Find ways that tools can support his tasks
- The JBL provides a single point where operators, engineers and scientists can collaborate on Force Development.

Forthcoming Work

- JFS Human Factor 2 experiment extended the HF1 analysis to a Tactical Operational Centre responsible for:
  - Target Development
  - Target Planning
  - Target Execution
- JFS HF3 / Coalition Attack Guidance Experiment explored battlespace management and coalition issues. Involved Australian, Canadian and US operators and various tools from Army Battle Command Systems.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