Defense Information Systems Agency
Department of Defense

14th ICCRTS

"C2 and Agility"

Experiments with the Combat CAS:

Unifying Net-Enabled Teams

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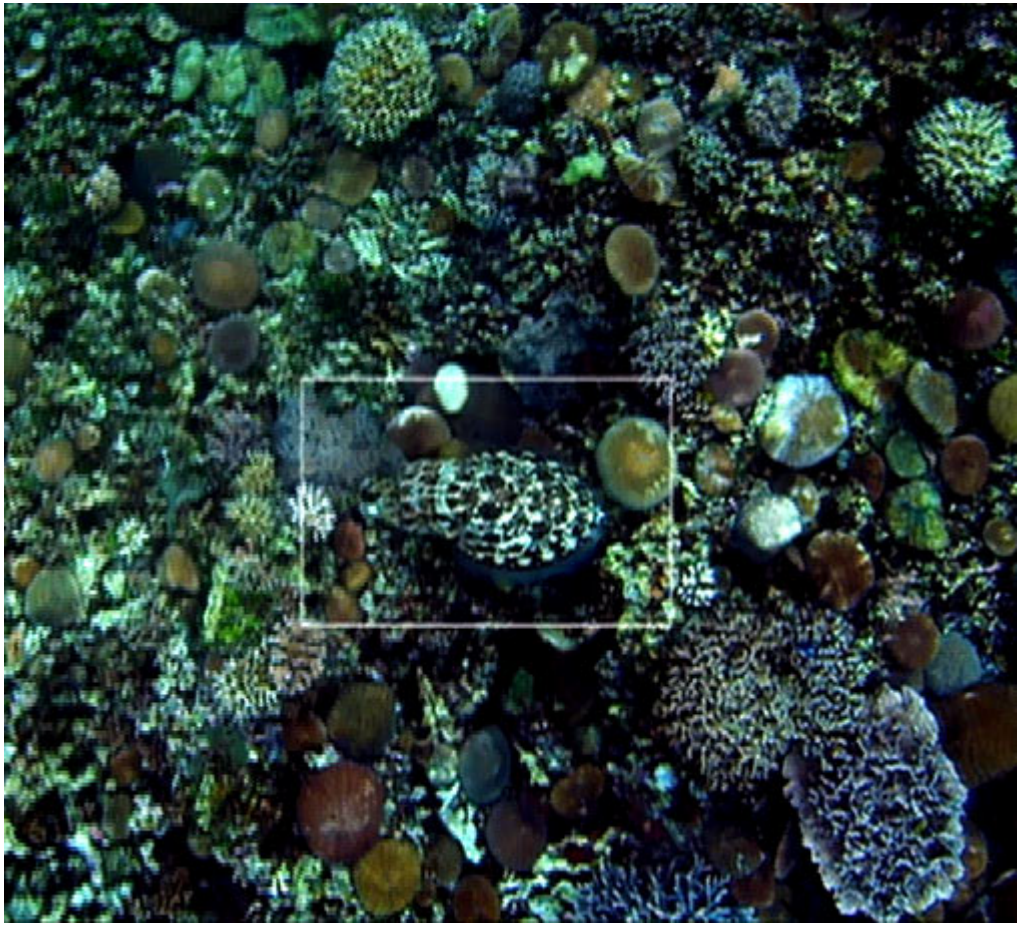
Properties of a Complex Adaptive System

A Complex Adaptive System (CAS) is a complex, self-similar collection of interacting adaptive agents:

- Agents act in parallel, reacting to each other
- The resultant order is emergent, not set from above
- CAS are resilient or agile in the face of perturbations
- CAS employ schema as a shared representation of the relevant aspects of the environment

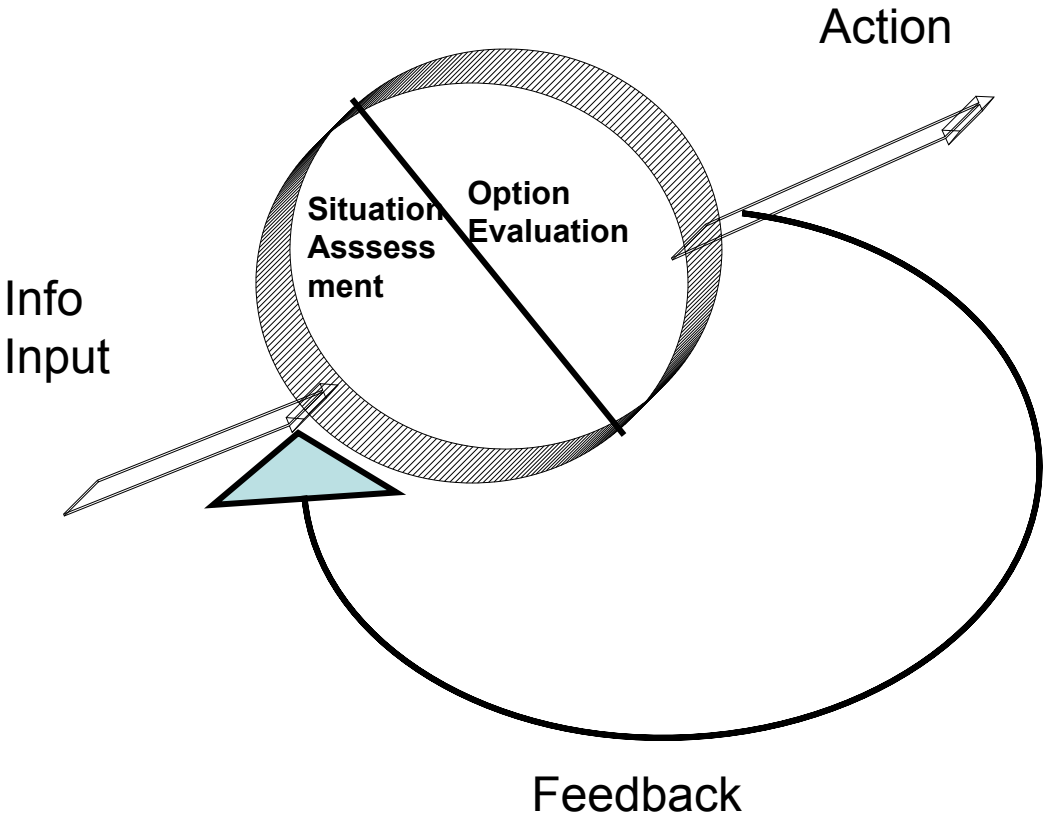
Migrating Geese as Natural CAS

Individual Cuttlefish Using Schema to Evade Predators



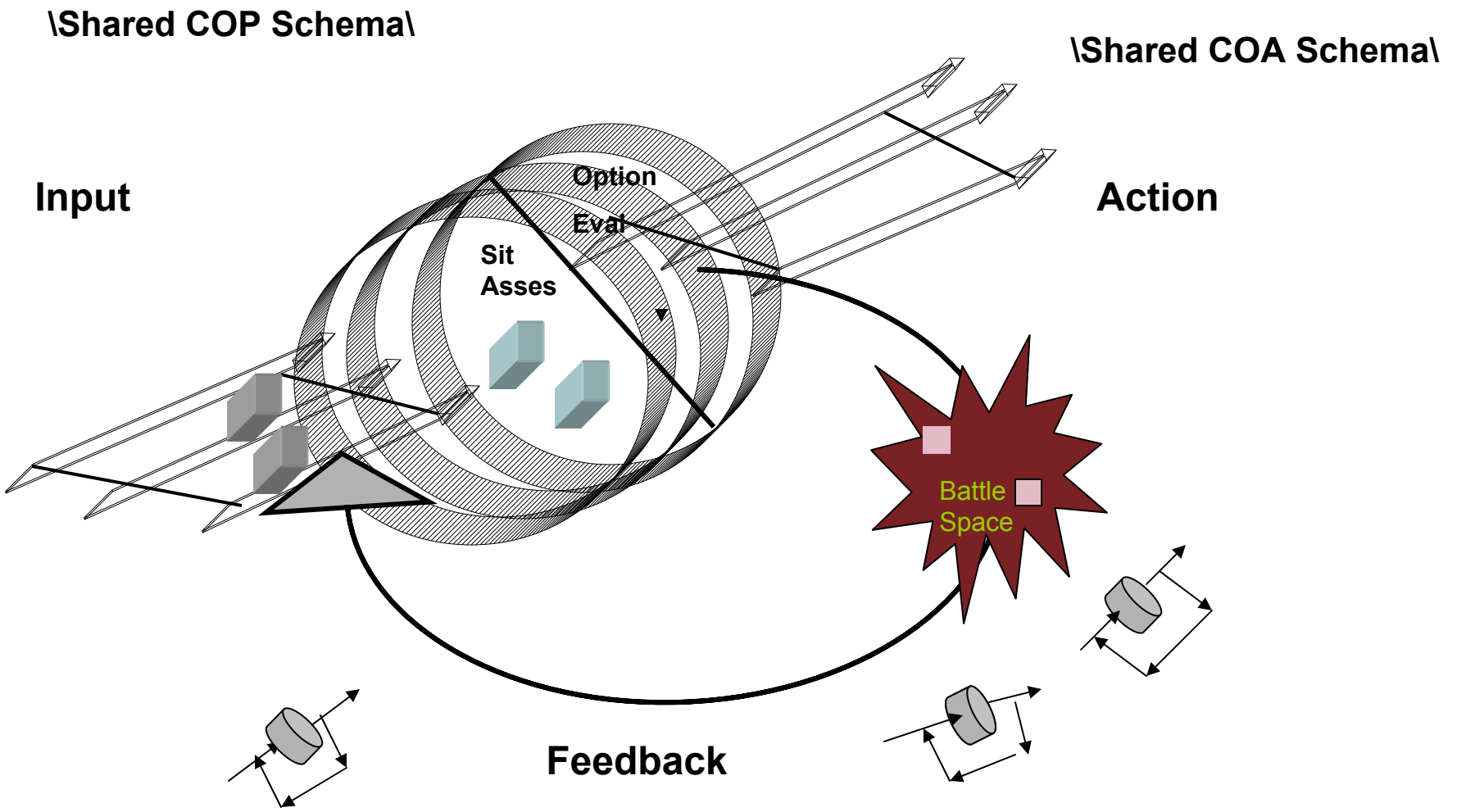
Individual Warfighter's Decision Process

Individual Agent's Decision Loop



CAS Composed of Self-Similar Agents

Distributed Multi Agent Components of CAS



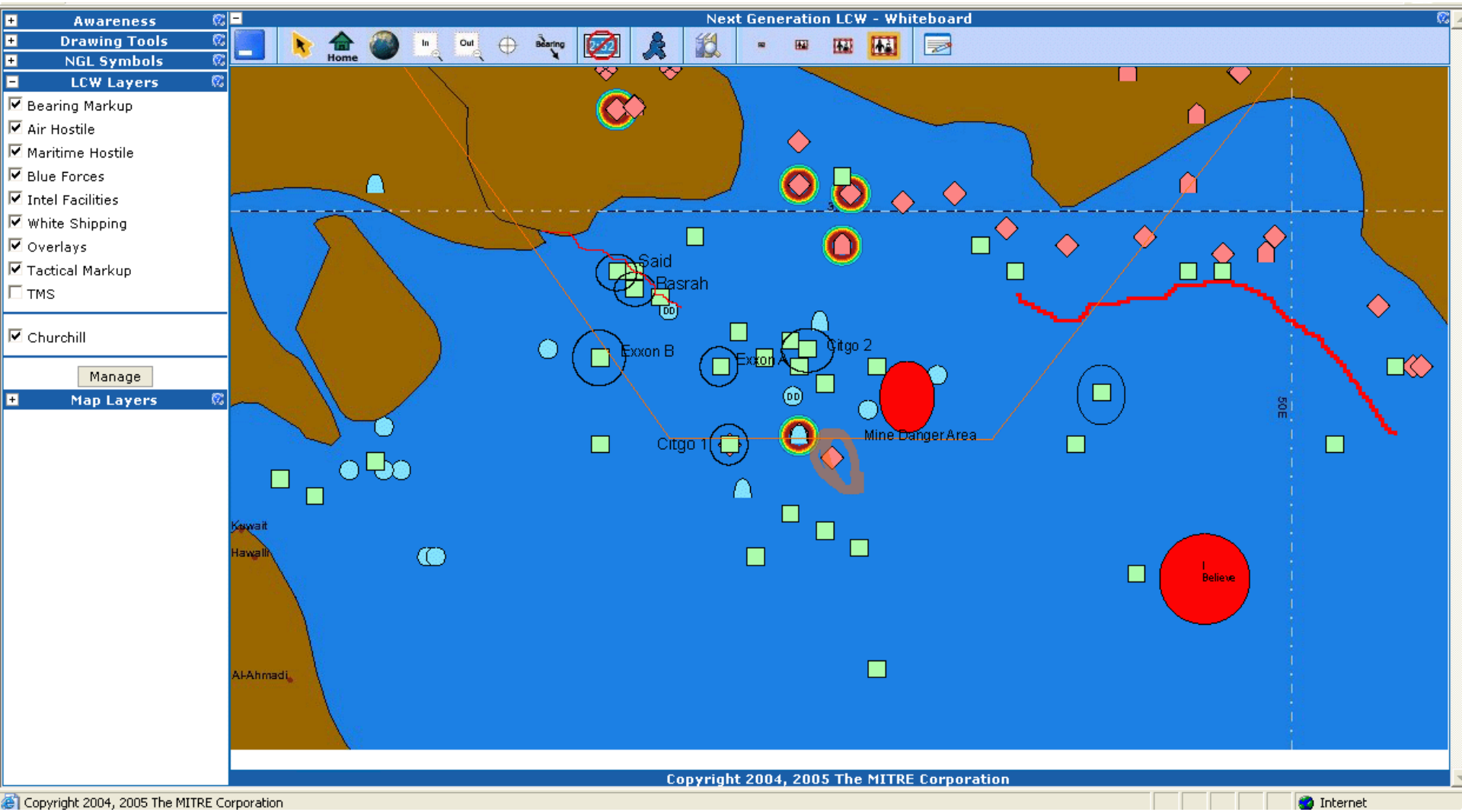
A CAS/Team View of Warfighting

- The sharing of schema and decision making processes,
- this staying on the same sheets of music for informational inputs, concerted action outputs and feedback of results by the individual agents
- leads to emergent properties for the CAS as a whole consisting of
- broadly shared situational awareness,
- widely shared plan view
- and increased combat effectiveness and agility
- over and above that achieved by more loosely coupled agents comprising a simpler multi agent system.

Combat Scenario Overview

- **Persian Gulf setting where: Operation Storm Petrel involves**
  - **Two Blue Ships (DDGs) & JFACC air**
  - **protecting several oil platforms under attack by:**
    - **JTLS Simulation of twelve Red fast attack crafts, Zhuks and Boghammers, w/ surprising moves**
      - **Analogous to the Basrah terrorist incident of Spring 2004**
    - **Pirated Aircraft**

UDOP Screen Shot of Operation Storm Petrel Scenario



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Hypotheses:
(G) C2 Self-similarity increases CAS Agility

Warfighting team use of collaborative UDOP(User Defined Operational Pict) schema causes:

(H1) increased Situational Awareness(SA);
(H2) increased Shared SA(SSA);

(H3) increased Planning Quality(PQ);

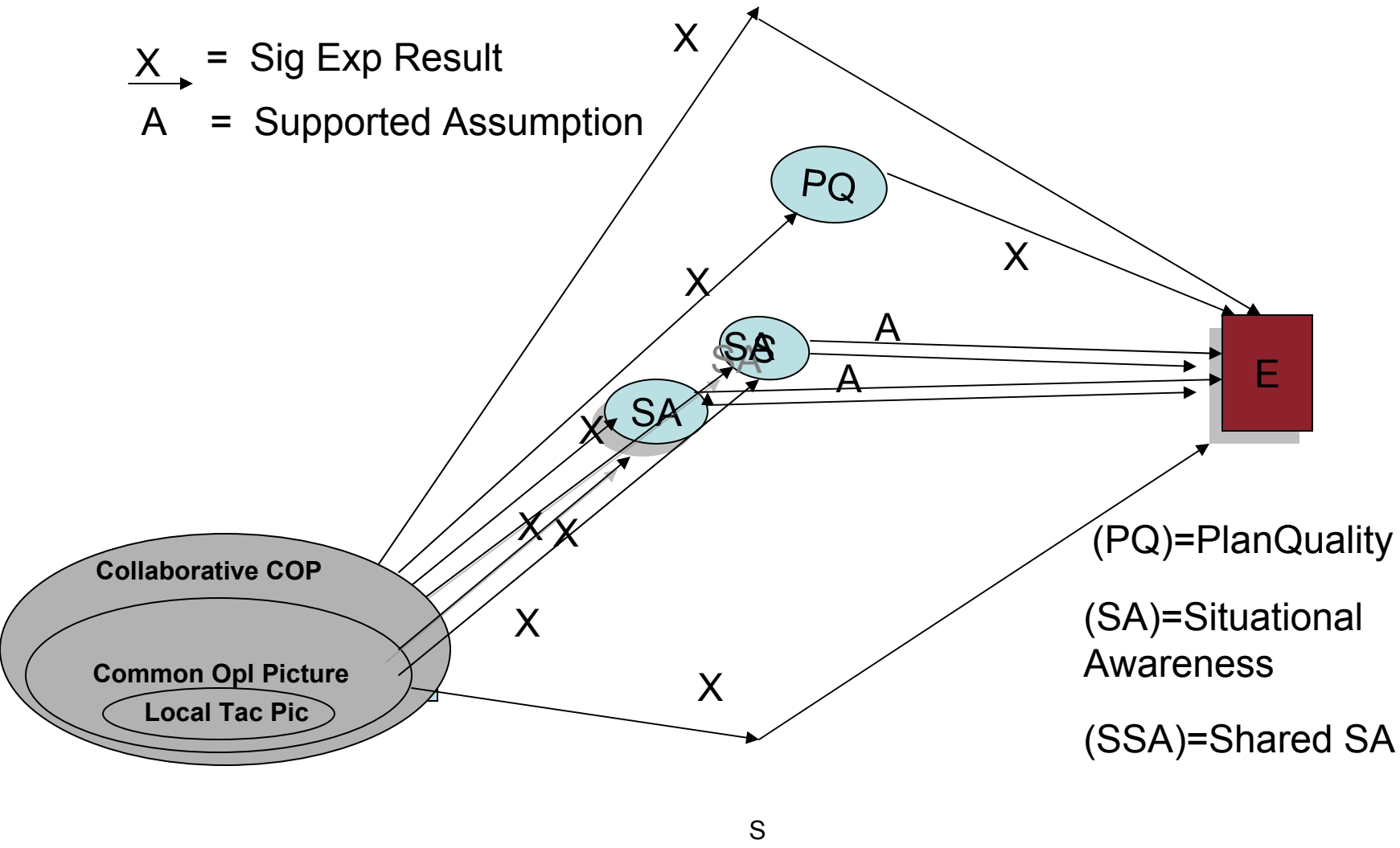
(H4) increased Combat Effectiveness(CE);

(H5)increased Agility, where (AG)=capability, in a timely manner, to recognize a relevant change in the situation and to respond appropriately.

(See Albert's FACT Summary re Agility,4/08)

The Role of Shared Schema in Impacting Combat Effectiveness of a WarfightingTeam via Improved Shared Mental Models of the Battlespace: Results from Six Controlled Experiments

Figure4



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Shared Info Schema → **Quality of Shared Mental Models** → **+ΔCombatEffectiveness**

Measurement Definitions for Operational Assessment of Collaborative UDOP

Situational Awareness (SA) = Proportion of mission critical set of warfighting platforms correctly identified by a warfighter (Ground Truth cf. COG @ t_i)

Shared Situational Awareness (SSA) = Proportion of overlap between pairs of Cognitive Operational Graphics(COGs) for complete warfighting team.

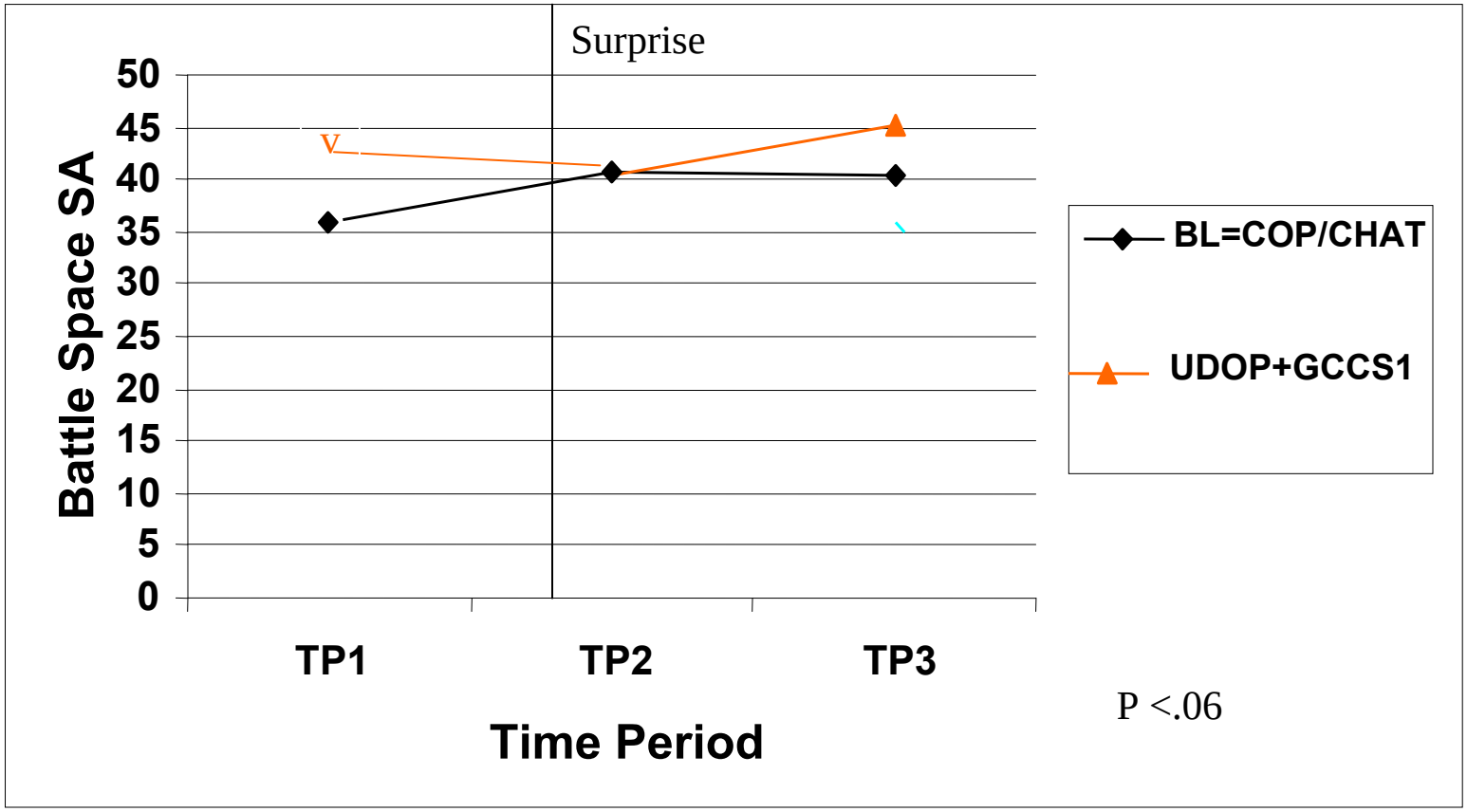
Speed of Command ($t_d = t_c + t_r + t_a + t_b$), where total speed of command is the sum of time to size up situation + time to plan + time to act + time to complete decision cycle with battle damage assessment

Combat Effectiveness (CE) = Combat Effectiveness Ratio= red platform losses / (red + blue + neutral losses)

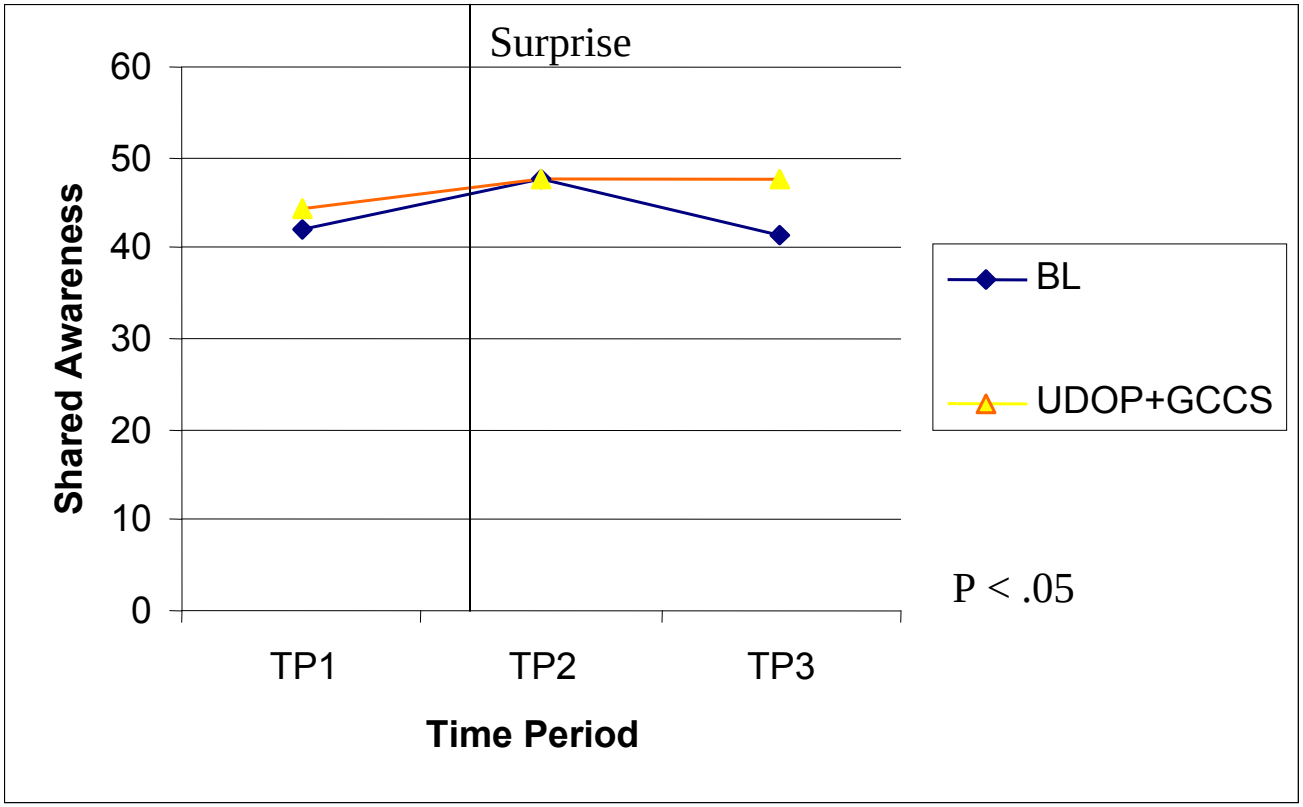
Agility (AG) = ΔCE (sustained or increased CE) when responding to relevant change in the situation.

N.B. Results presented here are a selection of the significant findings from Hiniker & Entin, 2006 11th ICCRTS Experiment Paper, re-examined explicitly to consider concept of Agility.

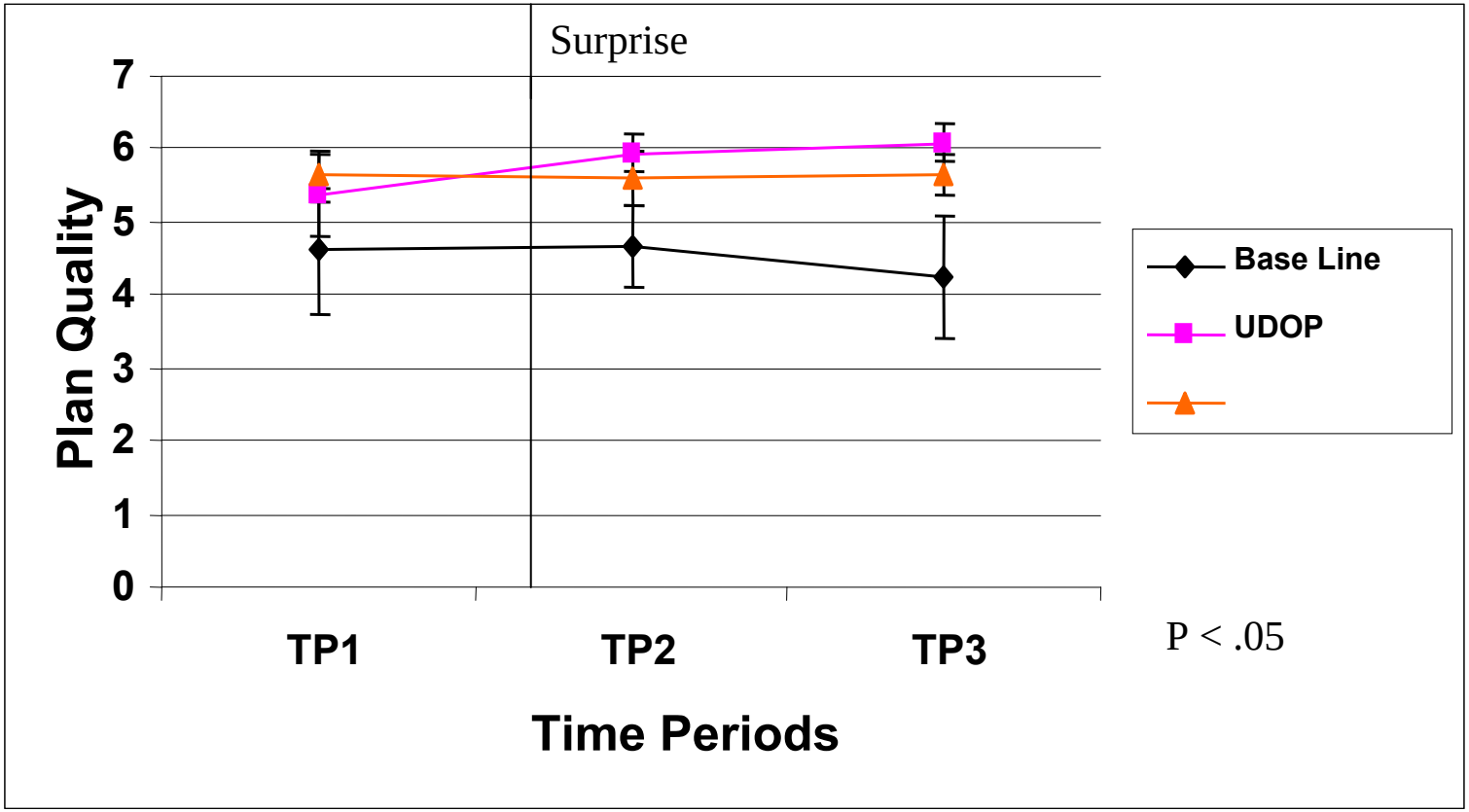
H1: Collaborative UDOP Causes Increased Situational Awareness



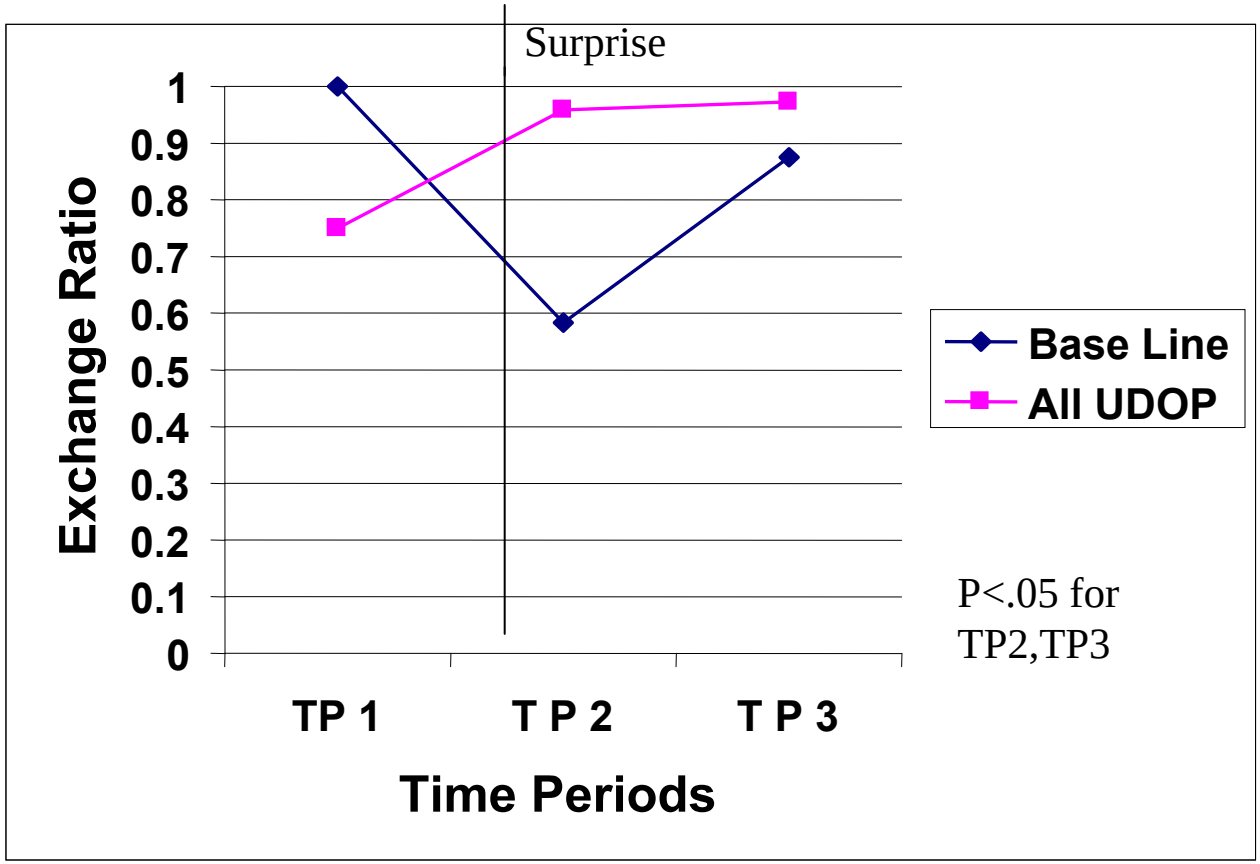
H2: Collaborative UDOP Causes Increased Shared Situational Awareness



H3: Collaborative UDOP Causes Increased Planning Quality



H4: Collaborative UDOP Causes Increased Combat Effectiveness



H5: Collaborative UDOP Causes Increased Agility for Teams.

oComparing team performance before and after the Surprise attack by red, one finds no diminution in Combat Effectiveness when the teams using the Collaborative UDOP are confronted with this relevant change in the battlespace situation; teams using Baseline Tech lose effectiveness:

o UDOP Has CE = .75 before Surprise and .96 (avg) after, gain is .21

o Baseline has CE = .99 before Surprise and .73 after, loss is -.26.

oMechanisms supporting this greater Agility with UDOP are .02 greater SA, .04 greater Shared SA and .12 greater Planning Quality for teams using UDOP compared with Baseline after Surprise.

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Summary of Significant Findings for the Warfighter

- **Warfighters' hot wash inputs: Opinions favored new Collaborative UDOP Tech over Baseline Tech and included suggestions for improvements**

- **Warfighting teams' measured performance in simulated combat trials was superior when using Collaborative UDOP**

- **Warfighting conclusions are that the Effectiveness and Agility of teams using new Collaborative UDOP Tech is superior to that using the current Baseline Tech.**

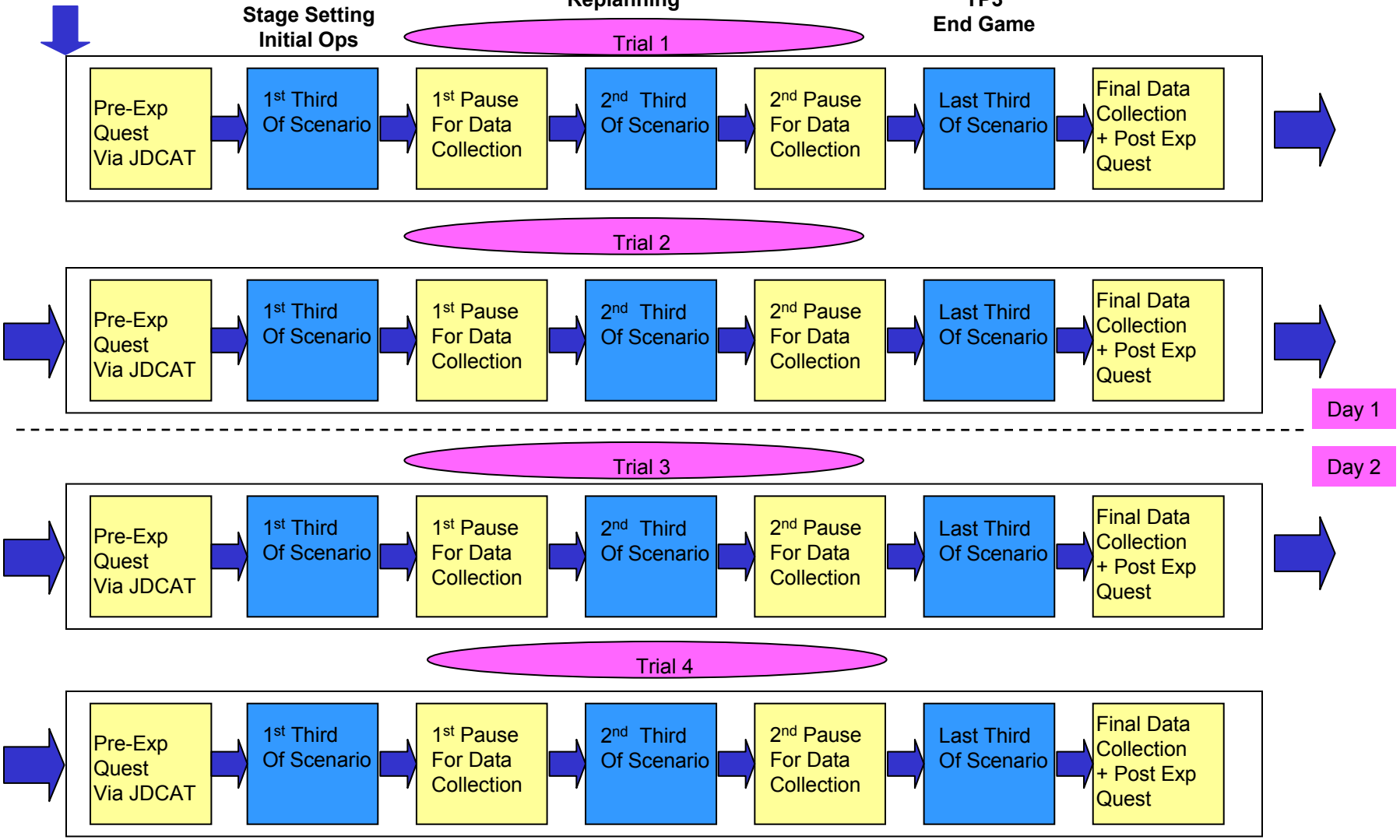
General Conclusions

- **Collaborative UDOP technology permits a distributed team to preserve the self-similarity of the group decision process, to the individual decision process, that is often present in a natural face-to-face team.**

- **Such self-similarity makes the team more effective and agile in its actions.**

Back Up Slides

UDOP Collaborative Replanning Experimental Design



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