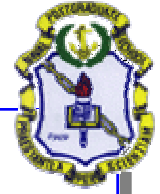

SCENARIO DESIGN FOR THE EMPIRICAL TESTING OF ORGANIZATIONAL CONGRUENCE

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William G. Kemple

Presented at CCRTS
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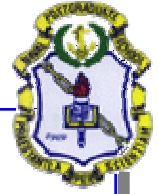
OBJECTIVES



- ESTABLISH EXPERIMENTAL CONDITIONS WITHIN WHICH TO DEMONSTRATE THAT CONGRUENCE SIGNIFICANTLY AFFECTS PERFORMANCE OUTCOMES

- **HYPOTHESIS** ~ *"the better an organization is matched to the overall mission, using a multi-variant set of workload and other congruence metrics, the better will that organization perform"*

  Congruence $\Rightarrow$ the **interaction** of organizational structure **and** mission/scenario
  (degree of structural **fit** between an organization and the mission)

- UNDER A2C2, A METHODOLOGY HAS BEEN DEVELOPED TO DESIGN AN ORGANIZATION THAT IS **CONGRUENT** WITH A **SPECIFIED** MISSION
  - who should own what assets, who does what, who sees what, etc.
  - extensive publications in past CCRTS Proceedings, SMC Transactions, …
  - limited empirical testing conducted in previous A2C2 experiments
    (usually via comparison with an ad-hoc organizational structure on one scenario)

APPROACH

- EXPLOIT FINDINGS FROM TWO PREVIOUS EXPERIMENTS CONDUCTED AT NPS
  - N6C (March 2001), C8 (October 2001)

STEP 1: SEEK TWO VERY DIFFERENT ORGANIZATIONAL STRUCTURES
- Functional (**F**) and Divisional (**D**)

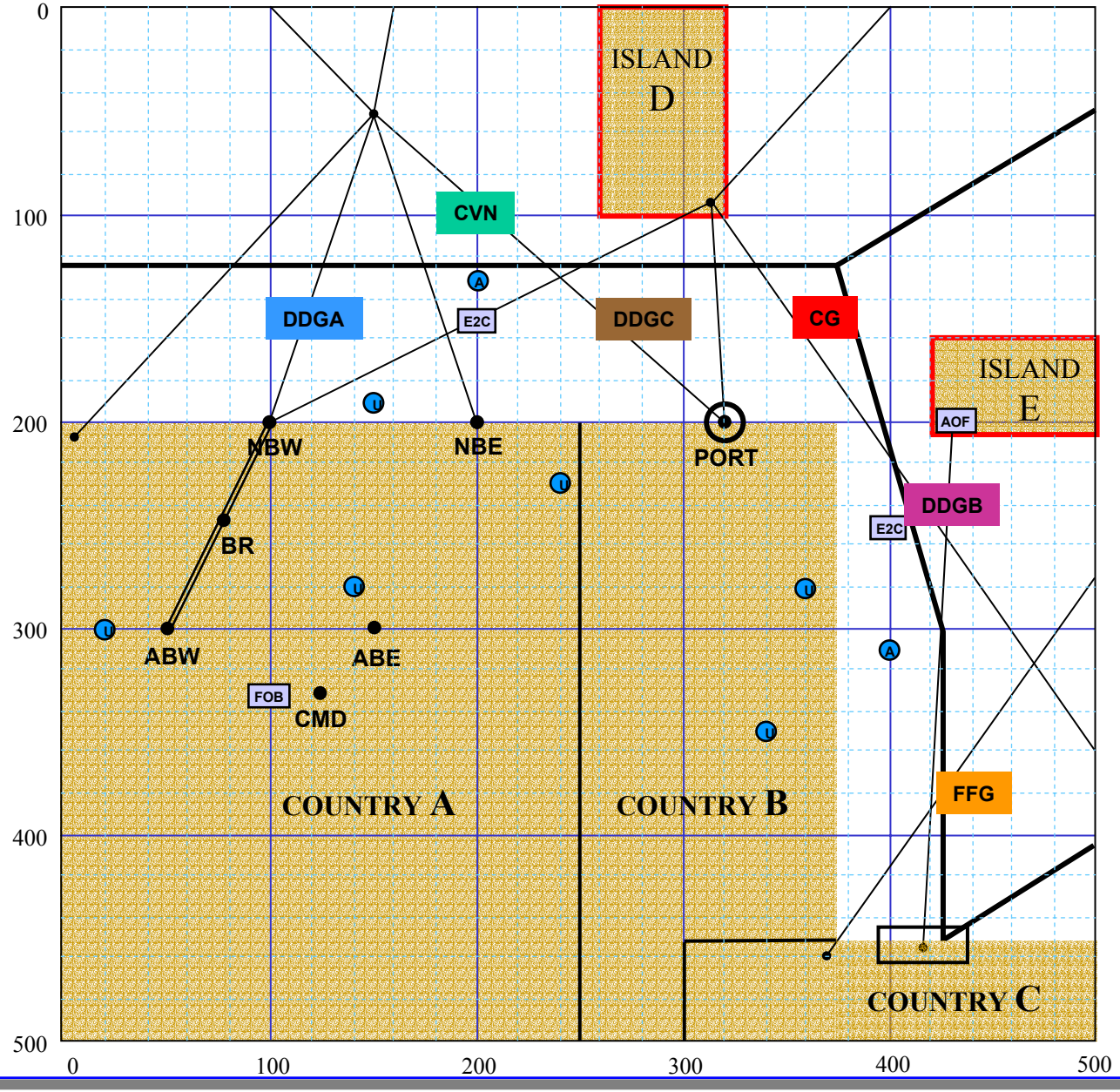
then

STEP 2: DESIGN **TWO** SCENARIOS TO EXPLOIT THE DIFFERENCES IN **F** AND **D**
- **f** congruent with **F** but measurably incongruent with **D**
- **d** congruent with **D** but measurably incongruent with **F**

- UTILIZE THE SAME MILITARY CONTEXT AS IN PREVIOUS EXPTS FOR **f** and **d**
  - DDD simulator reuse, ease of subject training, etc.

- USE CONGRUENCE THEORIES TO “REVERSE ENGINEER” **f** and **d**

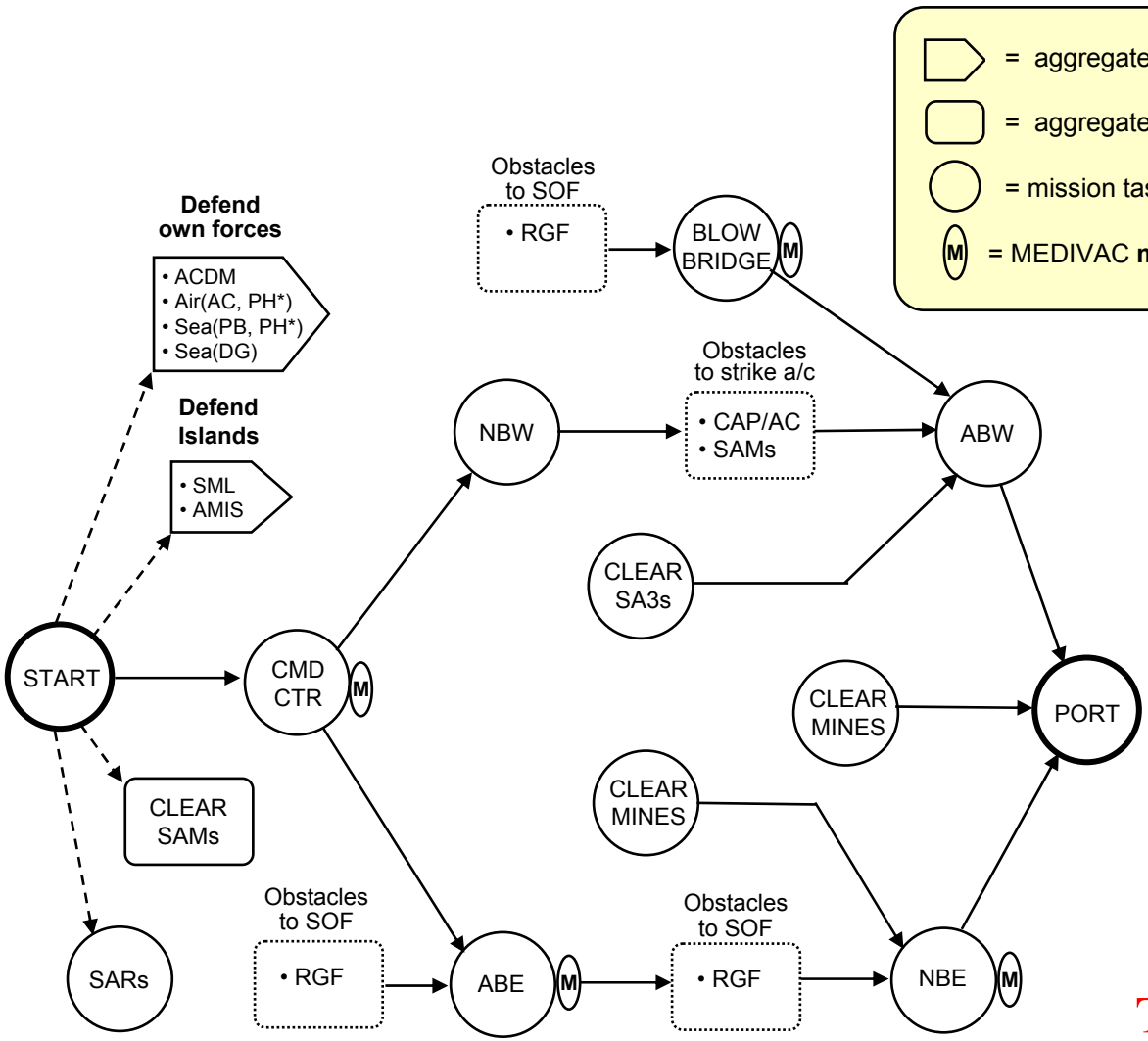
EXPERIMENT 8 SCENARIO AOR



- Country A has invaded B
  - remove A's forces from B
- Prepare for introduction of follow-on forces
  - Clear SAMs North of 325
  - Clear mines: NBE, PORT
  - Dominate air and sea
- Respond rapidly to high-priority unanticipated tasks and (combat) S&R
- Protect D and E from A's SCUD missile attacks
- Defend Task Force assets
  - vs. enemy air and sea

A course of action (COA) giving a specific sequence for accomplishing mission tasks has been developed by the CJTF.

FUNDAMENTAL TASK GRAPH A2C2 EXPT 8

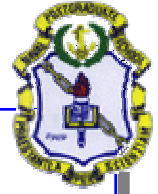


- PREREQUISITE requirements exist among key mission tasks (establishes mission ordering)
- OBSTACLES to own forces that inhibit access to mission tasks may be encountered (need clear enemy defenses)
- ENEMY THREATS to friendly nations *and* your own forces

THE MISSION IS THE HIGHEST PRIORITY!!

* indicates that these must be distinguished from neutral (or decoy) counterparts

TWO ORGANIZATIONAL STRUCTURES: D and F



TEAMS OF SIX PLAYERS EACH: FLAT HIERARCHY, EMPOWERED

- **FUNCTIONAL**: A DM is a warfare area commander and "owns" all appropriate JTF assets – a single warfare area that is theater-wide

- **DIVISIONAL**: A DM "owns" a single multi-function capable platform with all its subplatforms – multiple warfare areas in a defined geographical region

Functional

Divisional

DM		1	2	3	4	5	6
	Platform	STRIKE	BMD	ISR	AWC	SuWC/MINES	SOF/SAR
1	CVN	2F18S	xxx	1UAV	2F18A, E2C	1FAB, 1MH53	1HH60
2	DDGA	8TLAM	3ABM,4TTOM	1UAV	6SM2	1FAB, 2HARP	1HH60,1SOF
3	DDGB	8TLAM	3ABM,4TTOM	1UAV	6SM2	1FAB, 2HARP	1HH60,1SOF
4	CG	8TLAM	3ABM	1UAV	6SM2	1FAB,2HARP,1MH53	1HH60
5	FFG*	2F18S	xxx	1UAV	2F18A,E2C,4SM2	1FAB,2HARP,1MH53	1HH60
6	DDGC	8TLAM	3ABM,4TTOM	1UAV	6SM2	1FAB, 2HARP	1HH60,1SOF

* FFGs fixed wing aircraft are located on an island Air Operation Facility (AOF)
SOFs are pre-inserted and located on a Forward Operating Base (FOB)

DESIGNING A SCENARIO "INCONGRUENT" WITH AN ORGANIZATION

CONGRUENCE MANIPULATION EXPLOITS ROLES and GEOGRAPHY, PLUS TASK REQUIREMENTS, ASSET CAPABILITIES and LOCATIONS

→ 1) INCREASE DM-DM COORDINATION

- Introduce tasks that require multi-DM processing
- Construct many of these tasks to be time-critical and/or unanticipated, with a finite time window within which assets must synchronize
- Introduce precedence/prerequisite and information-dependence (flow) structure among tasks allocated to different DMs ⇒ create dependence of one DM's processing upon another DM's success/activities
  (e.g., ISR for detection, obstacles to assets, mission task graph, …)

→ 2) CREATE WORKLOAD (TASK LOAD) IMBALANCE AMONG DMS

- Introduce temporal overload of tasks that must be done by one DM

3) OTHER MANIPULATIONS

- Create a set of tasks where inefficient asset utilization is "costly" (Provide team with limited assets that must be used efficiently)
- Reduce situational awareness within team and among DMs (Create tasks that cause DMs to adopt "tunnel vision")
- Insert tasks that "boundary-split" regions between adjacent DMs

MECHANICS OF SCENARIO DESIGN (1 and 2)

SCENARIO f: (congruent with organization **F**; incongruent with organization **D**)

1. INTRODUCE TASKS WITH HIGH RESOURCE REQUIREMENTS OF THE **SAME** TYPE (REQUIRE DIVISIONAL DMS TO COORDINATE)
   - e.g., task requiring multiple units of STRIKE

2. CREATE TEMPORAL OVERLOADS USING TASKS OF **DIFFERENT** TYPES **IN ONE GEOGRAPHICAL AREA** (e.g., simultaneous *air* + *sea* + *S&R* tasks)
   - increase the workload of a selected **divisional** DM

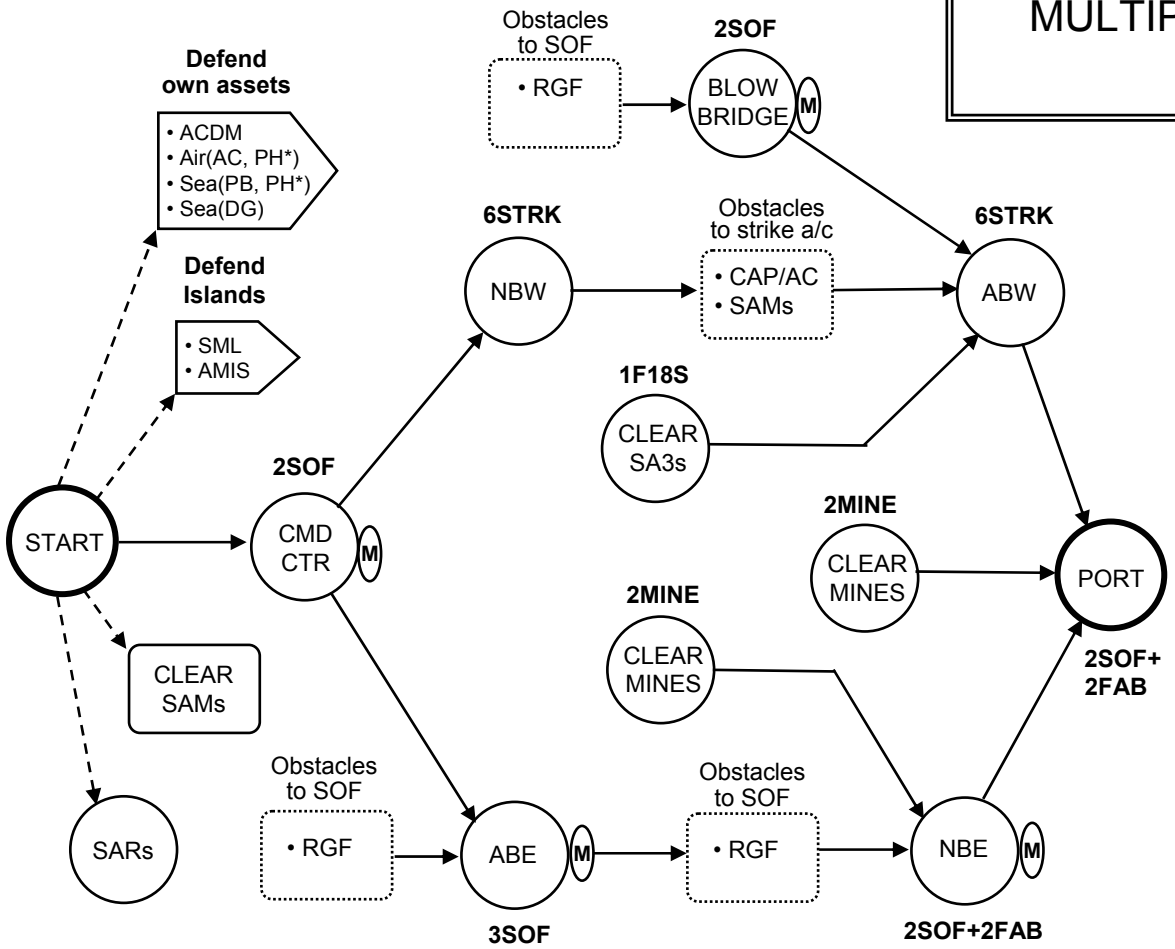
SCENARIO d: (congruent with organization **D**; incongruent with organization **F**)

1. INTRODUCE TASKS WITH RESOURCE REQUIREMENTS OF **DIFFERENT** TYPES (REQUIRE FUNCTIONAL DMS TO COORDINATE)
   - e.g., task requiring 1 unit each of SOF, STRIKE and AIR

2. CREATE TEMPORAL OVERLOADS USING TASKS THAT NEED **ONE** RESOURCE TYPE SPREAD OVER A **LARGE GEOGRAPHICAL AREA**
   - e.g., an enemy *air* wave simultaneously targeting several platforms
   - increase the workload of a selected **functional** DM

TASK GRAPH - A2C2 EXPERIMENT 8 - Scenario f

MAJOR TASKS REQUIRE
MULTIPLE RESOURCES OF
SAME TYPE



TASK RESOURCE REQMTS

SDG: *2 ASuW*
SPT, SPH: 1 ASuW
SGUN: 2 FAB
SSAR: *2 SAR*
SMIN: *2 MINES*

GEVA: *2 SAR*
GCDL, GSML: 1 STRK
GSAM: *2 TLAM (from 2 different platforms)*
GSA3: 2 STRK (1 F18S)
GSA6: 2 TLAM (from 2 different platforms)
GRGF: *3 STRK*

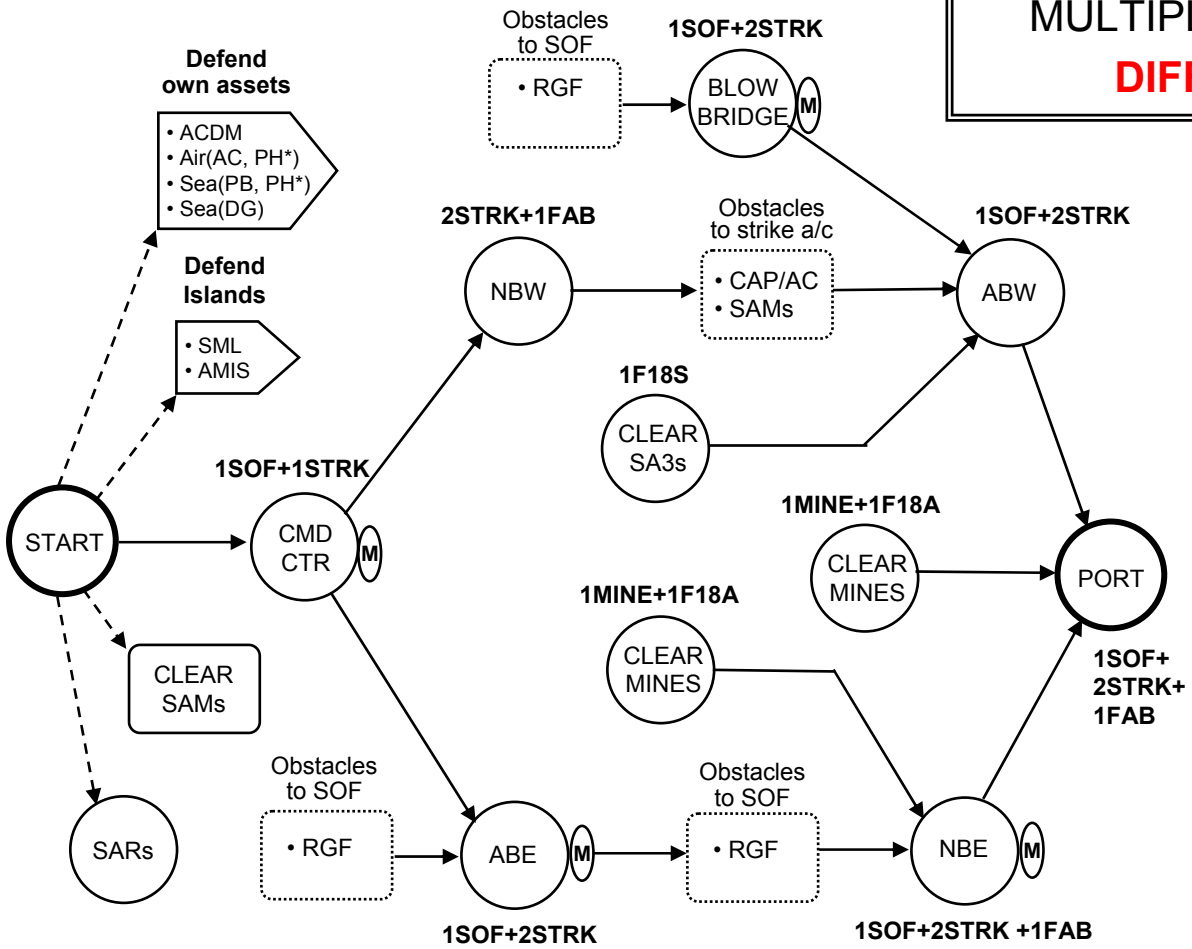
AAC, APH, ACDM, AXOC: 1 AAW
ACAP: *3 AAW*
AMIS: *1 ABM*

- other unanticipated tasks via HELP

* indicates that these must be distinguished from neutral (or decoy) counterparts

TASK GRAPH - A2C2 EXPERIMENT 8 - Scenario d

MAJOR TASKS REQUIRE MULTIPLE RESOURCES OF **DIFFERENT** TYPES



TASK RESOURCE REQMTS

SDG: *1 ASuW + 1 AAW*
SPT, SPH: 1 ASuW
SHOS: 1 SAR + 1 FAB
SSAR: *1 SAR + 1 FAB*
SMIN: *1 MINES + 1 F18A*

GEVA: *1 SAR + 1 F18A*
GCDL, GSML: 1 STRK
GSAM: *1 TLAM + 1 SOF*
GSA3: 2 STRK (1 F18S)
GSA6: 2 TLAM (from 2 different platforms)
GRGF: *2 STRK*

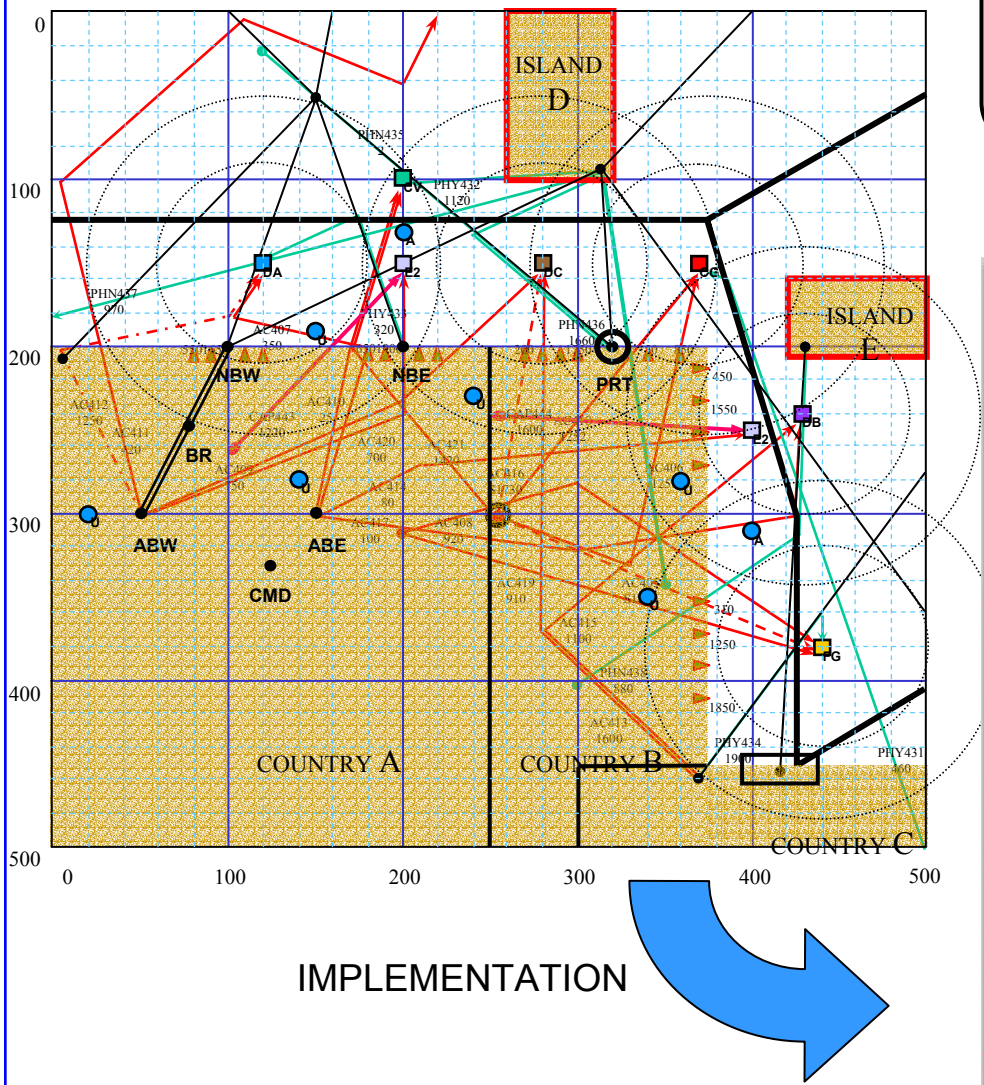
AAC, APH, ACDM, AXOC: 1 AAW
ACAP: *2 AAW*
AMIS: 1 ABM

- other/unanticipated tasks via HELP

* indicates that these must be distinguished from neutral (or decoy) counterparts

TASK SPATIAL AND TEMPORAL DESIGN

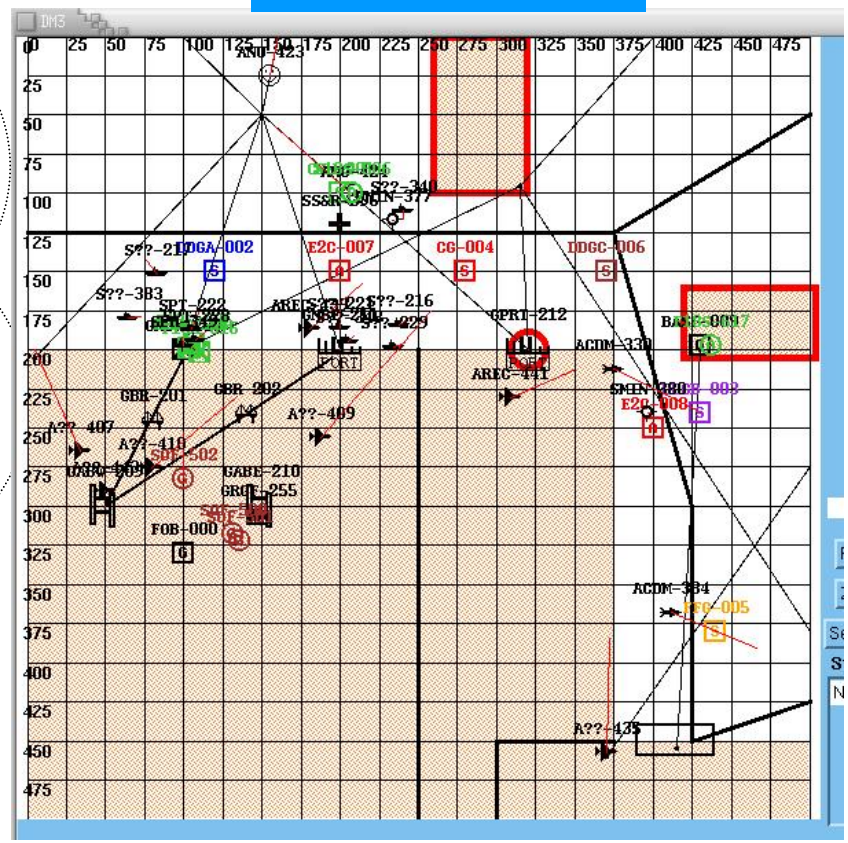
Ex: Scenario f, air tasks design



IMPLEMENTATION

Task types, arrival times, & paths are adjusted to meet design requirements
- each DM experiences 2-3 periods of overload within a given scenario

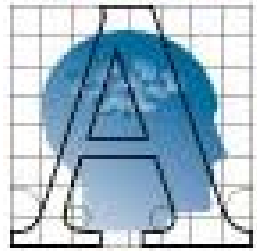
DDD Simulator



MODELING CYCLE FOR EXPERIMENT 8

N6 & C8 scenarios and structures

Create two distinct structures – **Divisional** and **Functional**



Scenario design cycle

UCONN
- evaluate
- analyze
- improve

need

theoretical design req's & measures

operational "realism"

can

NPS
- operationalize
- practical specifics
  - ✓ operational
  - ✓ DDD

GMU

Task load

Final DDD Scenarios

1. Organizations
- **F: Minimize** overlap of resource capabilities
- **D: Maximize** overlap of resource capabilities

2. Scenario - Coordination
- **f:** tasks requiring multiple resources of **same type**
- **d:** tasks requiring multiple resources of **different types**

3. Scenario - Task load
- **f:** load **single geographical** area over multiple functions and time
- **d:** load **single functional** area over a wide geographical region and time

SOME DATA FROM A POST-EXPERIMENT SURVEY

EXPERIMENT 8 WAS CONDUCTED IN AUGUST AND NOVEMBER 2002

- **PLAYER RATINGS*** OF FACTORS THAT AFFECTED PERFORMANCE

	D Teams		F Teams	
"What made playing these scenarios difficult for you?"	d	f	f	d
Need for Coordination	**4.3**	**5.5**	**3.7**	**5.4**
Task Load	**4.1**	**4.6**	**3.7**	**4.4**
Secondary Task Demands	4.6	4.5	3.0	3.5
"How proactive vs. reactive did you feel you were when playing each scenario?"	5.1	3.6	4.7	4.2

* Note: Ratings used a 7-point scale

- IN WHICH SCENARIO DID YOU FEEL THAT YOUR TEAM PERFORMED "BETTER"?
  - 96% of Divisional participants reported "better" in congruent (d) scenario
  - Only 52% of Functional participants reported "better" in congruent (f) scenario

SUMMARY & CONCLUSION

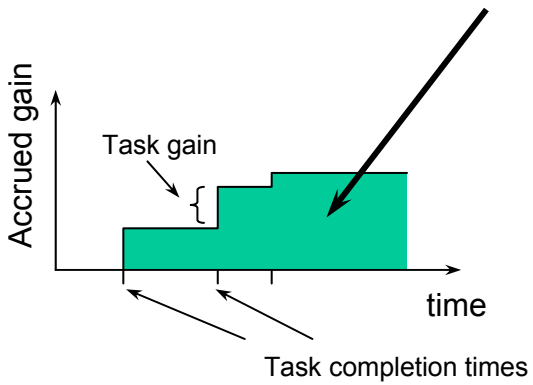
- MODEL-BASED EXPERIMENTAL AND SCENARIO DESIGN
  - Integrated scenarios, organizational structures, and congruence metrics
  - "Reverse engineered" f and d using congruence theories

- SO, DO CONGRUENT ORGANIZATIONS **PERFORM** BETTER?
  - Model-based performance and process measures of congruence effects exist
  - Can associate nature of incongruence with asymmetric performance decrements e.g., F ⇔ d and D ⇔ f.

- **YES!** – EXTENSIVE RESULTS ARE FOUND IN COMPANION PAPERS

Example: Accrued Task Gain metric (gain = value*processing accuracy)

AREA UNDER CURVE IS A MEASURE OF **OVERALL** PERFORMANCE



	d	f
D	45.8	33.6
F	33.5	42.8

On average the CONGRUENT teams significantly outperformed the NON-congruent teams
- better time-accuracy tradeoff
- but . . .