



SCENARIO DESIGN FOR THE EMPIRICAL TESTING OF ORGANIZATIONAL CONGRUENCE

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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



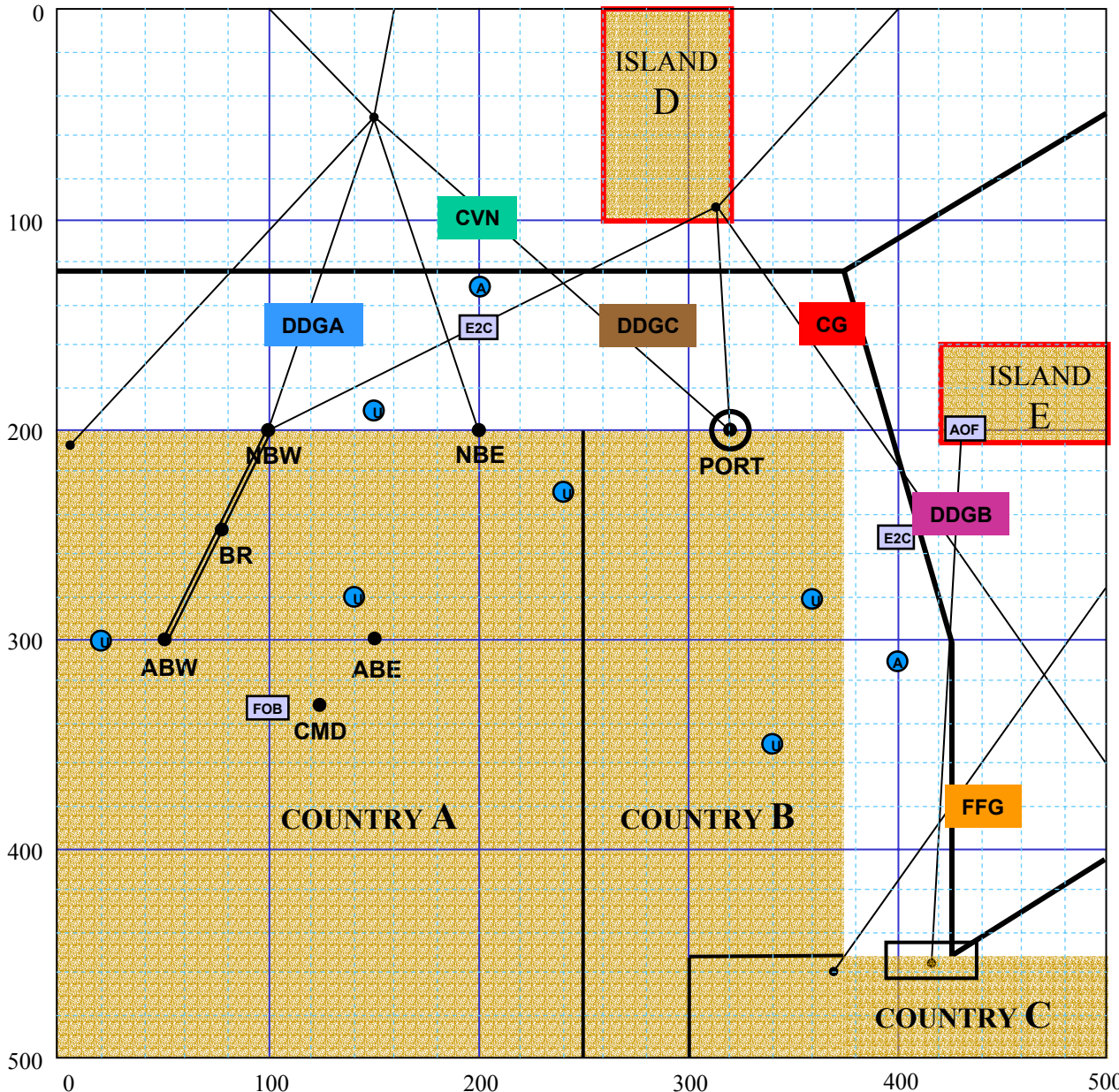
- EXPLOIT FINDINGS FROM TWO PREVIOUS EXPERIMENTS CONDUCTED AT NPS
 - N6C (March 2001), C8 (October 2001)

- 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**

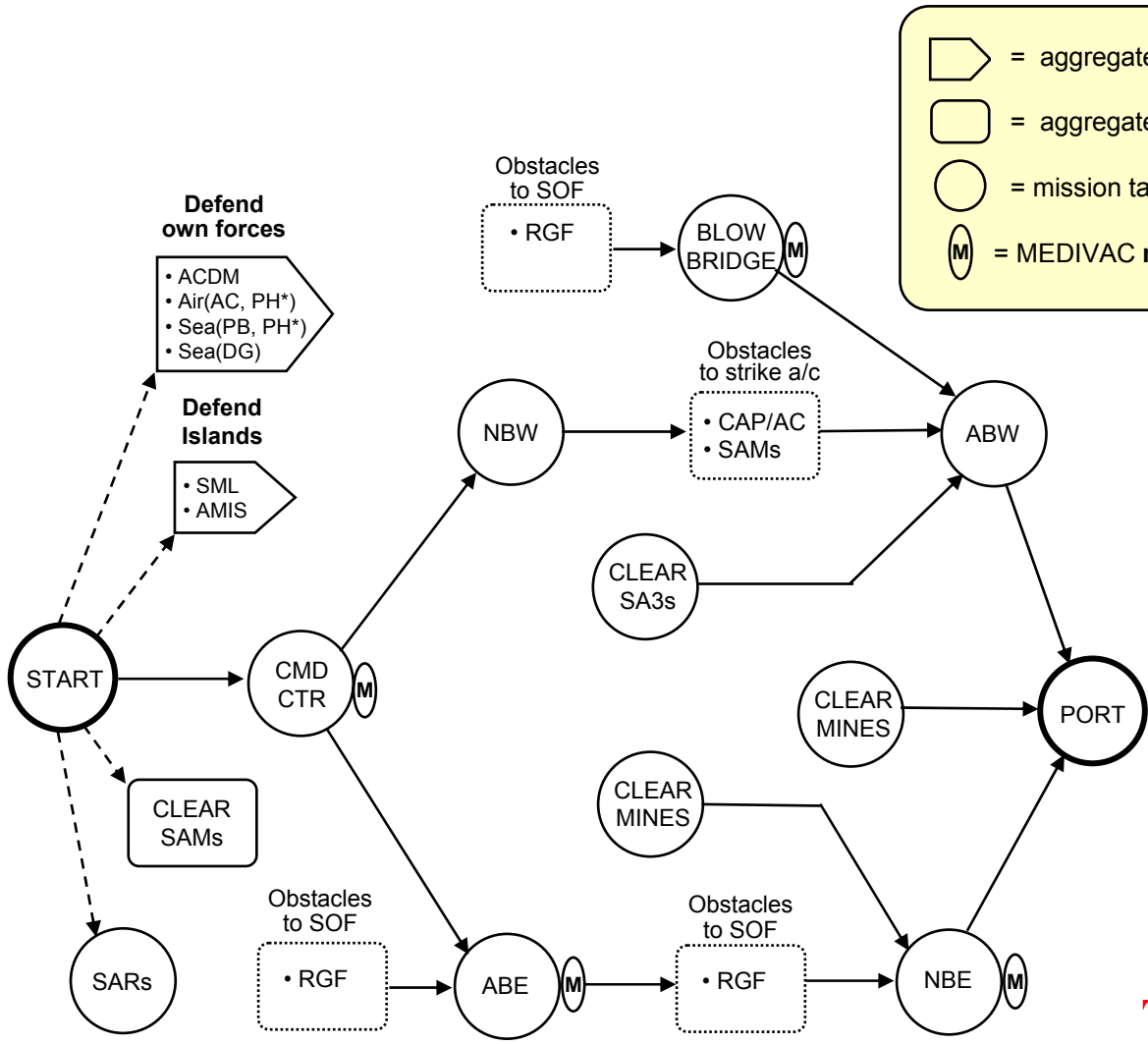
EXPERIMENT 8 SCENARIO AOR



- 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



= aggregated defend task, showing **possible** subtasks
 = aggregated encounters task, with **possible** subtasks
 = mission tasks (that must be done); known in advance
 = MEDIVAC **may** spawn as a result of performing task

- **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)



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



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

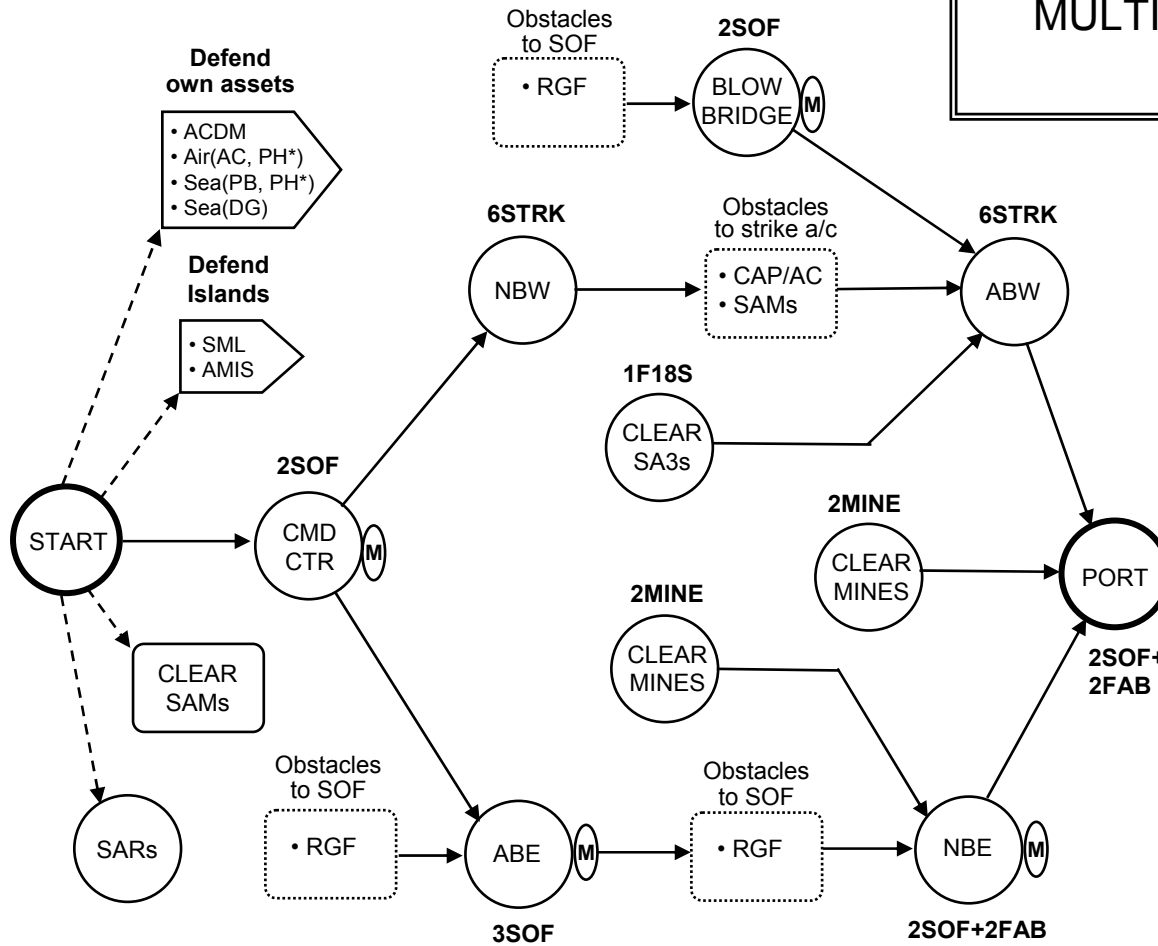
SCENARIO d: (congruent with organization **D**; incongruent with organization **F**)

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
 - GC DL, 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

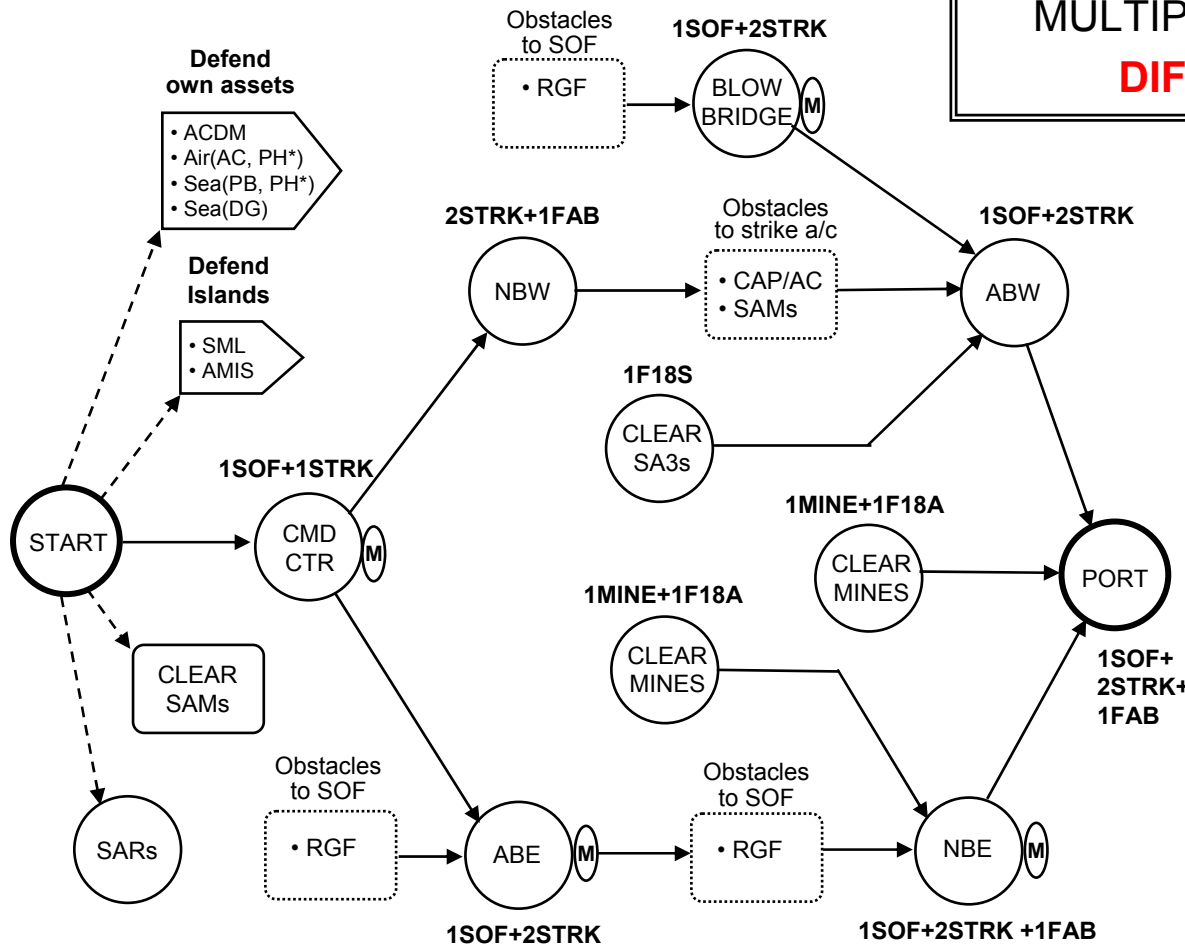
 - other unanticipated tasks via HELP

* 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

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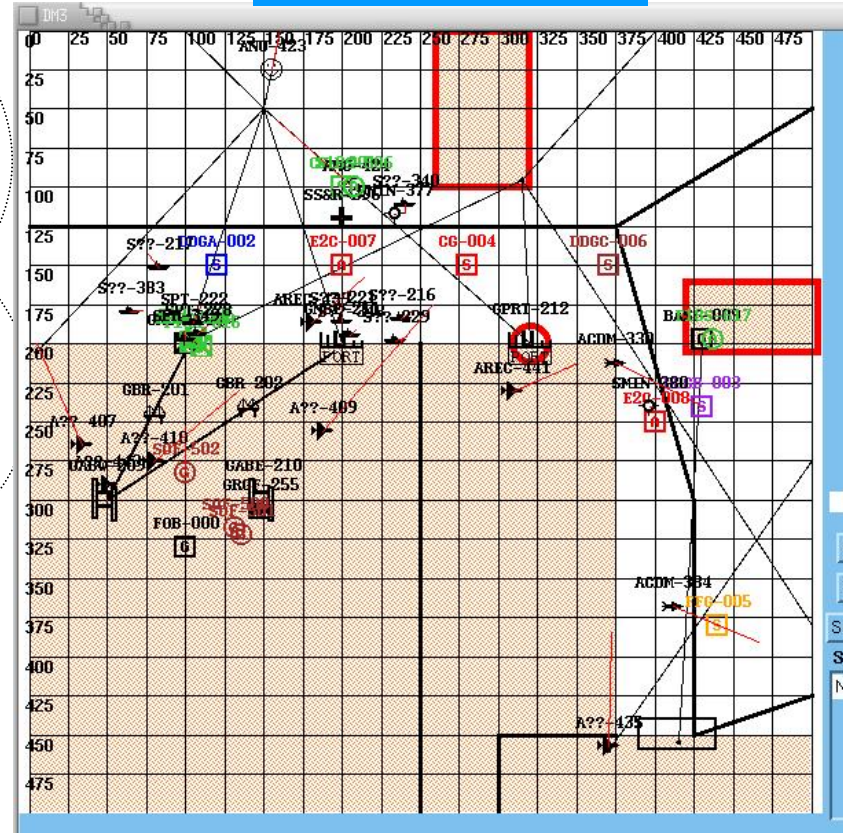
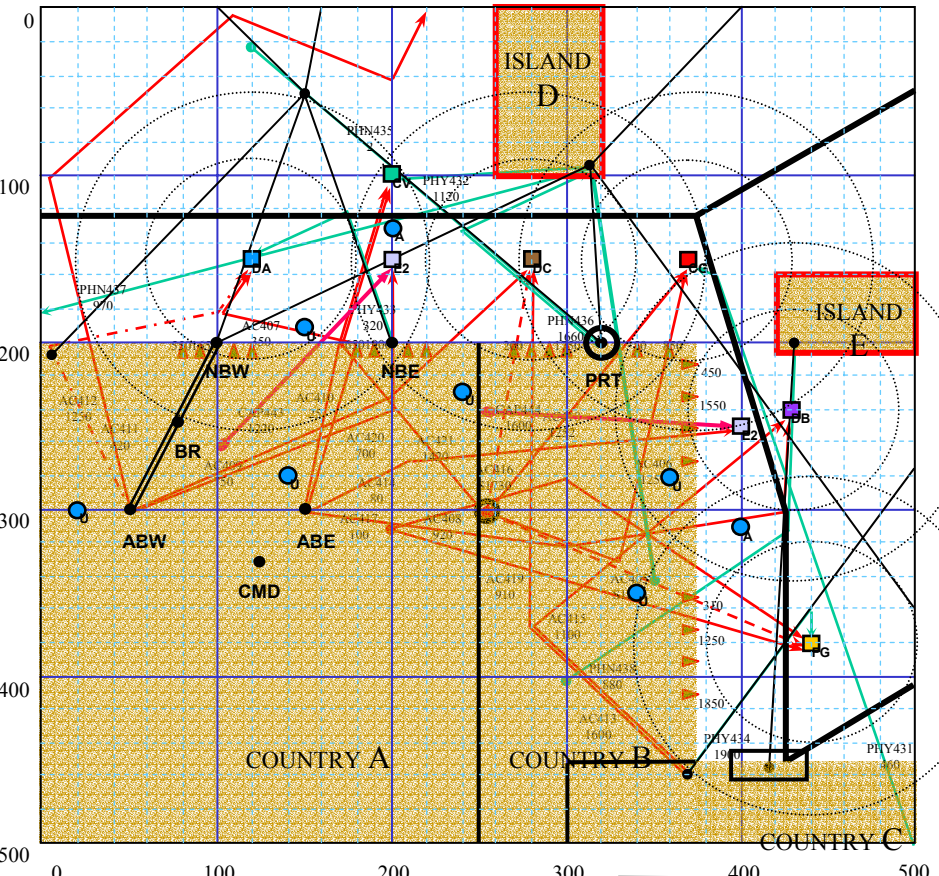
TASK SPATIAL AND TEMPORAL DESIGN



Ex: Scenario f, air tasks design

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



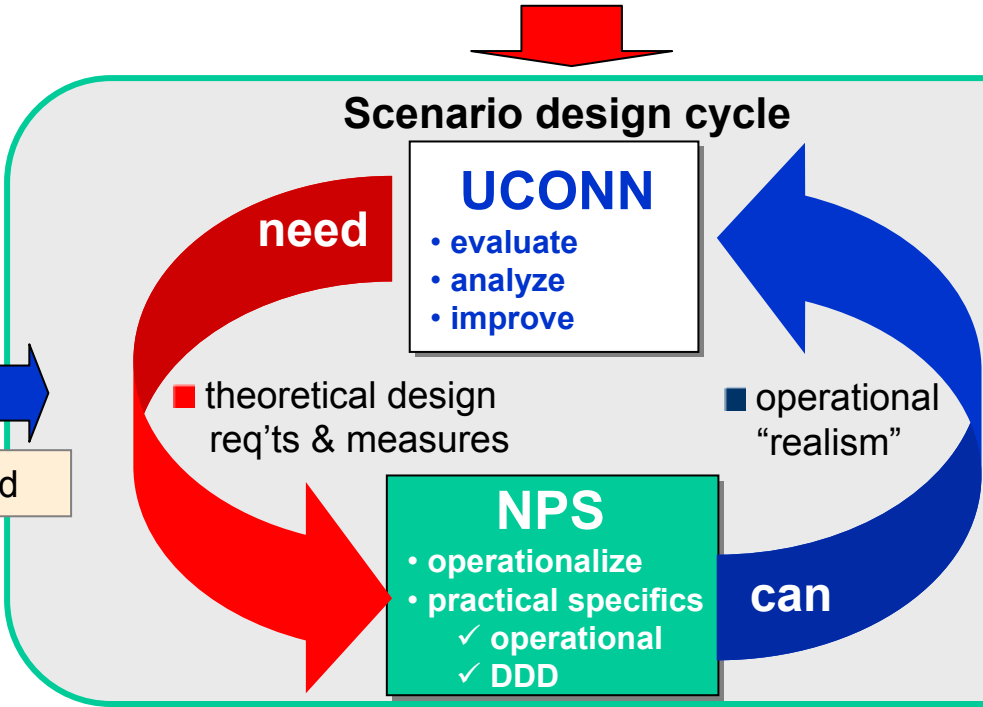
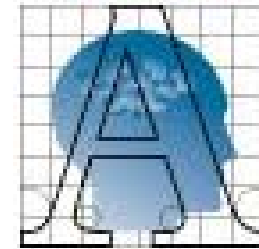
IMPLEMENTATION

MODELING CYCLE FOR EXPERIMENT 8



N6 & C8 scenarios and structures

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



- ### 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

Final DDD Scenarios

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

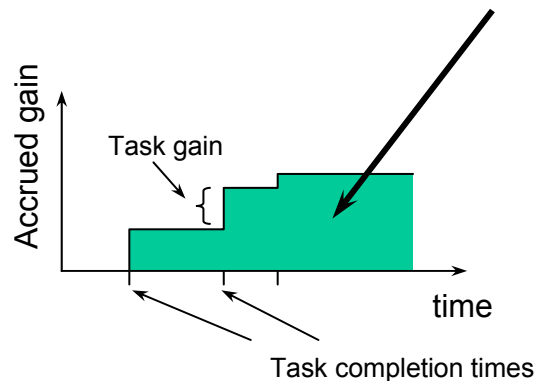
SUMMARY & CONCLUSION



- 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., $F \leftrightarrow d$ and $D \leftrightarrow f$.
- **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 . . .