



NAVAL
POSTGRADUATE
SCHOOL

Maritime Operational Planning Tools Using Optimization to Create and Evaluate Maritime Courses of Action

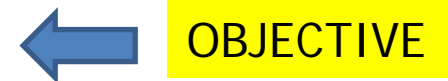
Captain Jeff Kline, USN (ret)
Presentation to
Chile and United States
Naval Operations Research
Symposium

Program's Purpose

- Produce, develop, evaluate and deliver complete, operational prototypes of various, optimization-based planning systems for supporting maritime staffs.
- Provide maritime planners fast “What If” tools to:
 - Create worst Enemy Courses of Action
 - Create “best of breed” Friendly Courses of Action
 - Evaluate risk vs resources, quickly

Research progression for Planning Aid

- 1) Faculty and officer team investigate mission-area issues; formulate and implement an optimization model; revise and improve
- 2) Faculty create a Graphical User Interface for maritime planners
 1. Based on Excel and Visual Basic, but uses non-standard licensed software
 2. Dedicated laptop
- 3) Planners evaluate usefulness and utility, and provide feedback
- 4) Team updates system; creates heuristic solver executed by Excel
- 5) Test Excel and visual basic version



NPS Maritime Planner Team

- Distinguished Professor Jerry Brown, PhD., member National Academy of Engineering
- Distinguished Professor Alan Washburn, PhD., member National Academy of Engineering
- Distinguished Professor Kevin Wood, PhD
- Associate Professor Matt Carlyle, PhD
- Associate Professor Javier Salmeron, PhD
- Senior Lecturer Jeff Kline, CAPT, USN (ret)
- Research Associate Carol O'Neal, CAPT, USN (ret)
- Research Associate Anton Rowe
- Research Associate Regina Kaiser, LT, USNR



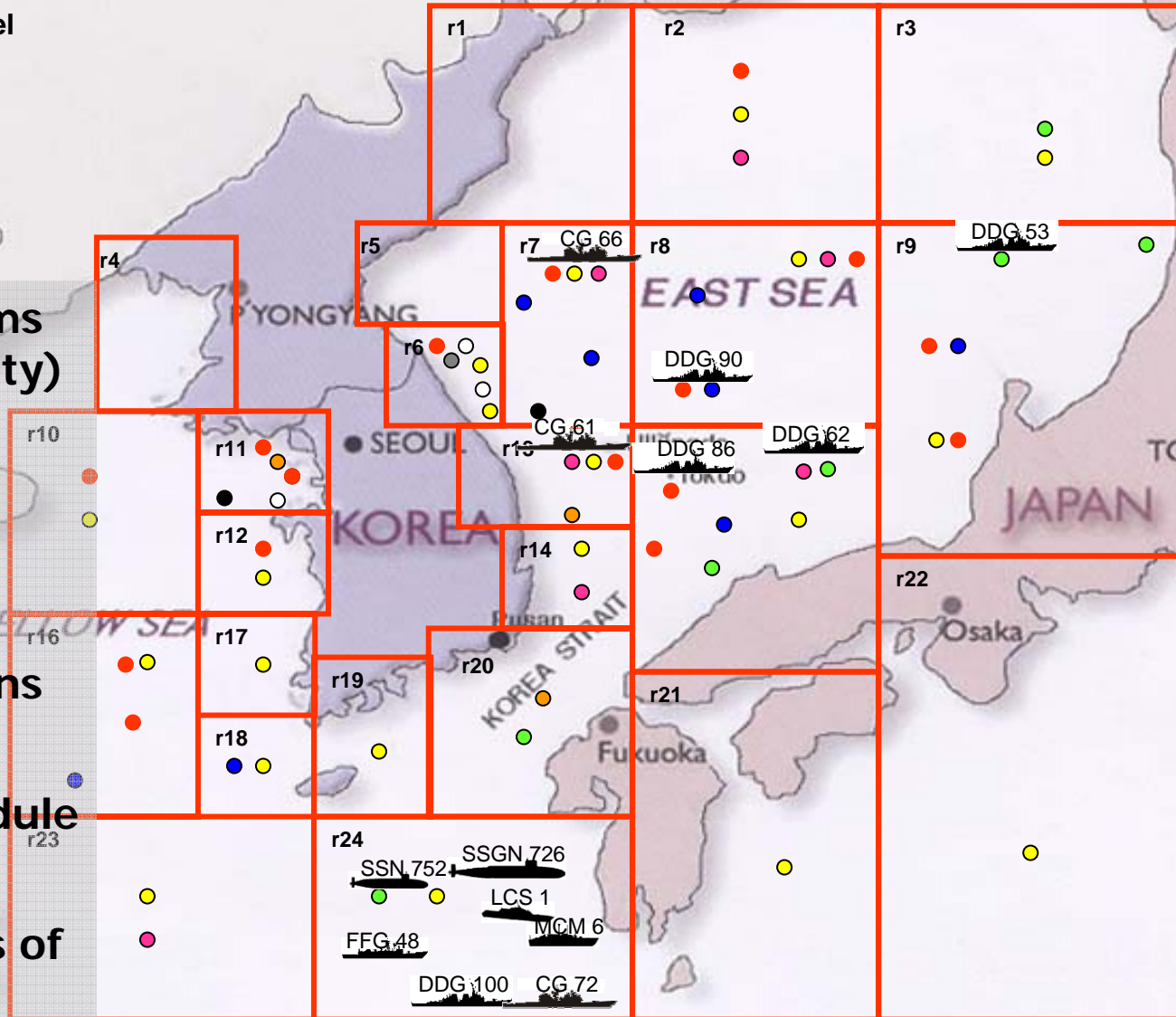
Examples of Maritime Operational Mission Planning Tools

Works in Progress

NAVY MISSION PLANNER

- AD
- TBMD
- ASW
- SUW
- Strike
- NSFS
- MIO
- MCM
- Mine
- Intel

- Assigns platforms by day (Max utility)
- Allows multi-mission assignments
- Provides for requisite missions (Air Defense)
- Minimizes schedule changes
- Creates Courses of Action quickly

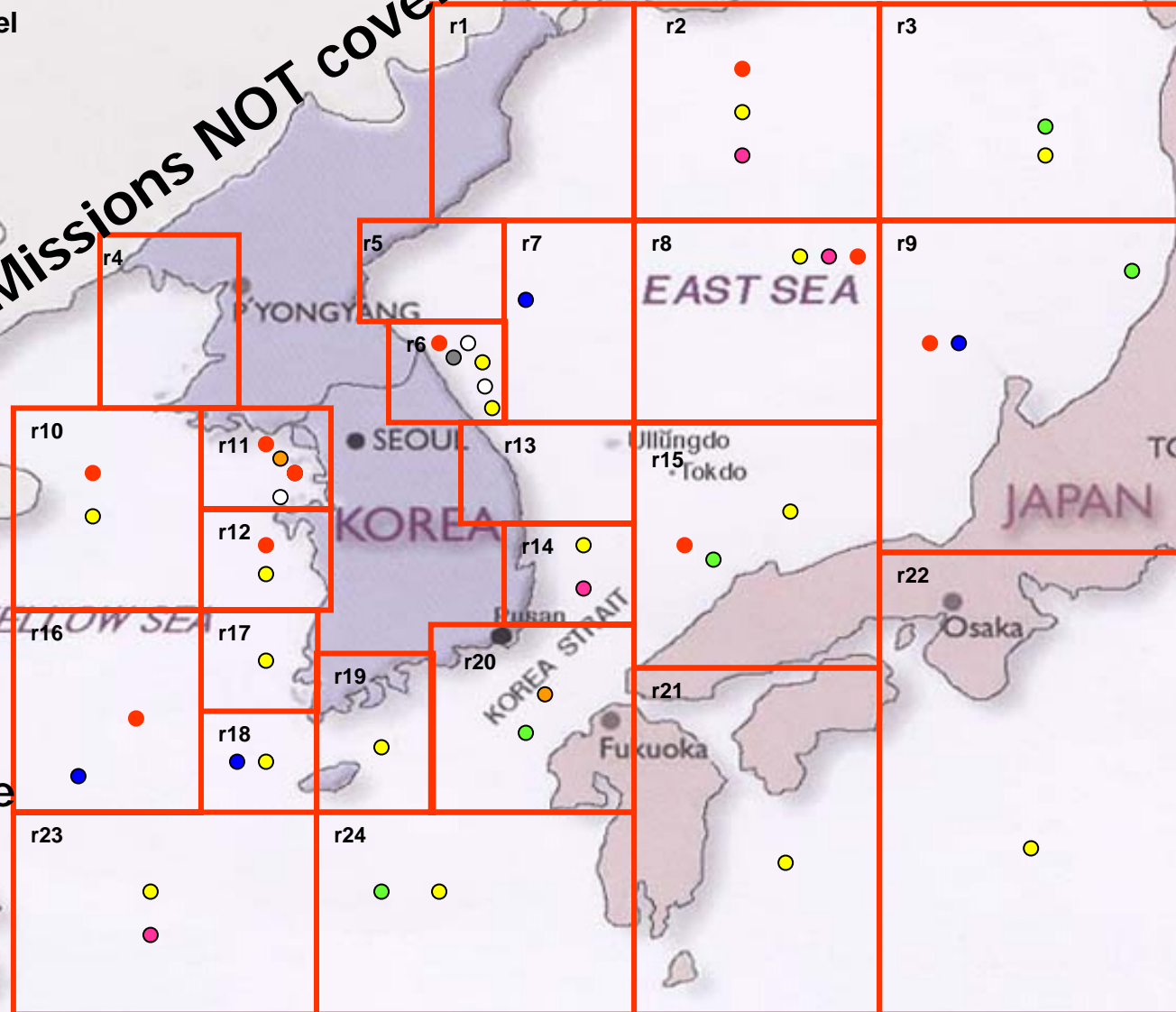


11/26/2009

NAVY MISSION PLANNER

- AD
- TBMD
- ASW
- SUW
- Strike
- NSFS
- MIO
- MCM
- Mine
- Intel

Shows Risk of Missions NOT covered



Model in first stage of development

11/26/2009

Microsoft Excel - NMP150.xls

File Edit View Insert Format Tools Data Window Help Adobe PDF

Type a question for help

NMP Excel View

Chart 1

	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	30-45N														
2	LAT		Arcs		Length(nm)										
3	35		r1	r2	77.3928064					123	35				
4	36		r1	r3	57.7271877					124	36				
5	34.5		r2	r3	90.0285421										
6	35		r2	r4	77.3928064					123	35				
7	33.56		r2	r7	74.2500426					124	34.5				
8	32		r3	r4	57.7271877										
9	36.25		r3	r5	75.2126261										
10	32.5		r4	r7	78.8893661										
11	32.5		r4	r5	86.4274004										
12	33.8		r5	r6	94.475617										
13	36		r5	r8	102.610545										
14	34.5		r6	r8	74.8078358										
15	37.5		r8	r9	70.8668399										
16	36		r9	r10	92.8046346										
17	37.5		r10	r12	72.9219361										
18	40		r11	r12	90.5605856										
19			r11	r13	90.0285421										
20			r11	r14	72.8339019										
21			r11	r15	115.359432										
22			r12	r14	110.292862										
23			r13	r14	115.359432										
24			r13	r15	71.4236887										
25			r14	r15	90.0285421										
26			r13	r16	150.04757										
27			r15	r16	165.654988										
28															
29															

Length

Replot

Labels? y

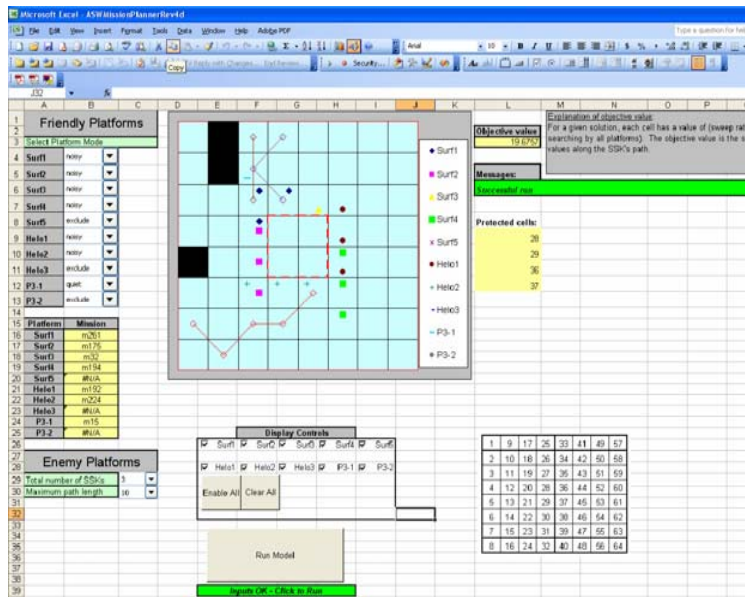
14/26/2009 Regions / CMCs / Ships / Missions / Commodities / Loadouts / Distances / Sheet1 / Sheet2

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Ready NUM

Area Antisubmarine Planner

- Optimizes 4W grid search coverage of multiple sensors and platforms

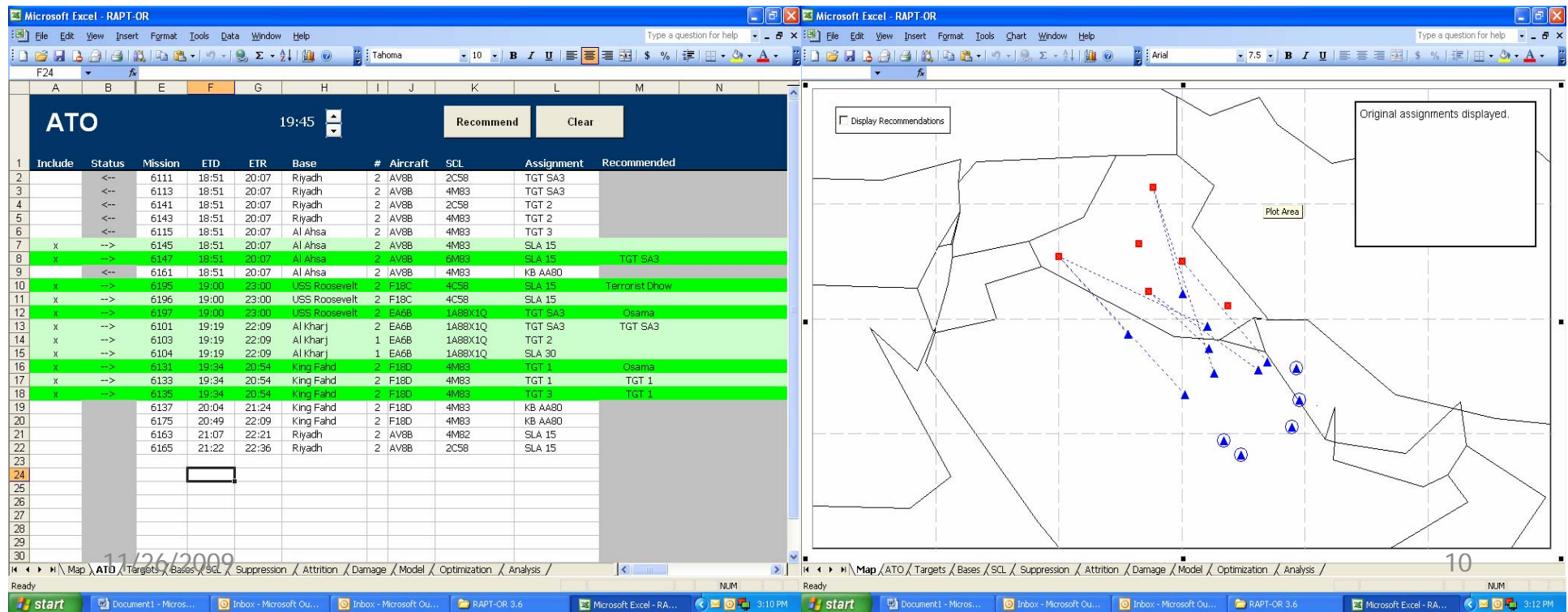


- Two-sided: generates red submarines actions in response to active searchers

- Vision to integrate acoustic performance models

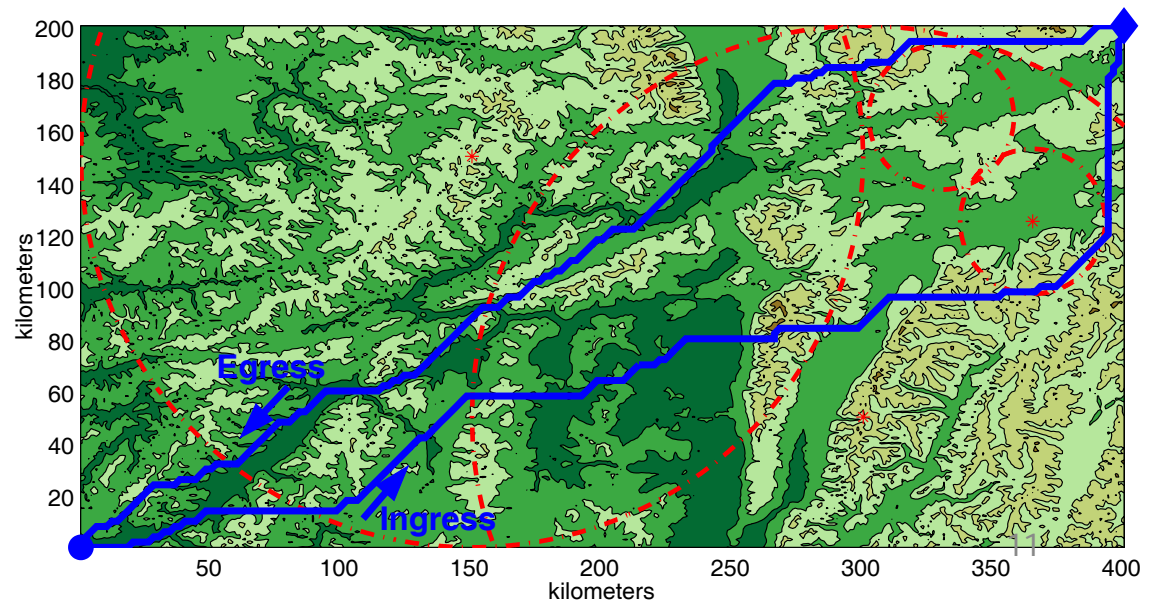
Rapid Asset Pairing Tool-Operations Research: RAPT-OR

- Time critical target response aid
- Revises air packages automatically from an existing Air Tasking Order
- Maximizes damage while minimizing Air Tasking Order turbulence
- Excel-Based.



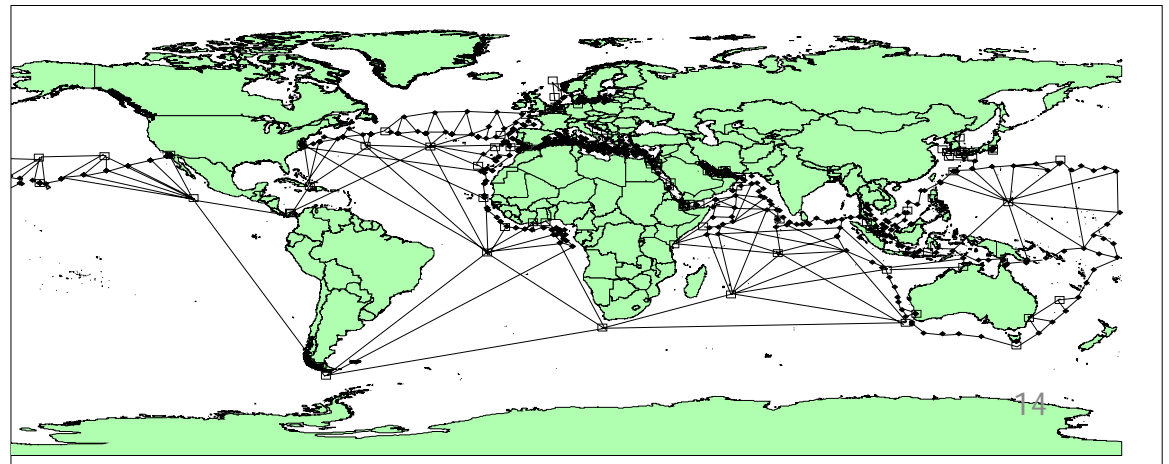
AIR Penetrator

- Route planning tool for Unmanned Air Vehicles or manned aircraft
- Minimizes cost or risk given air defenses and fuel and time constraints
- Fast solutions allow for updating in real time
- Excel based



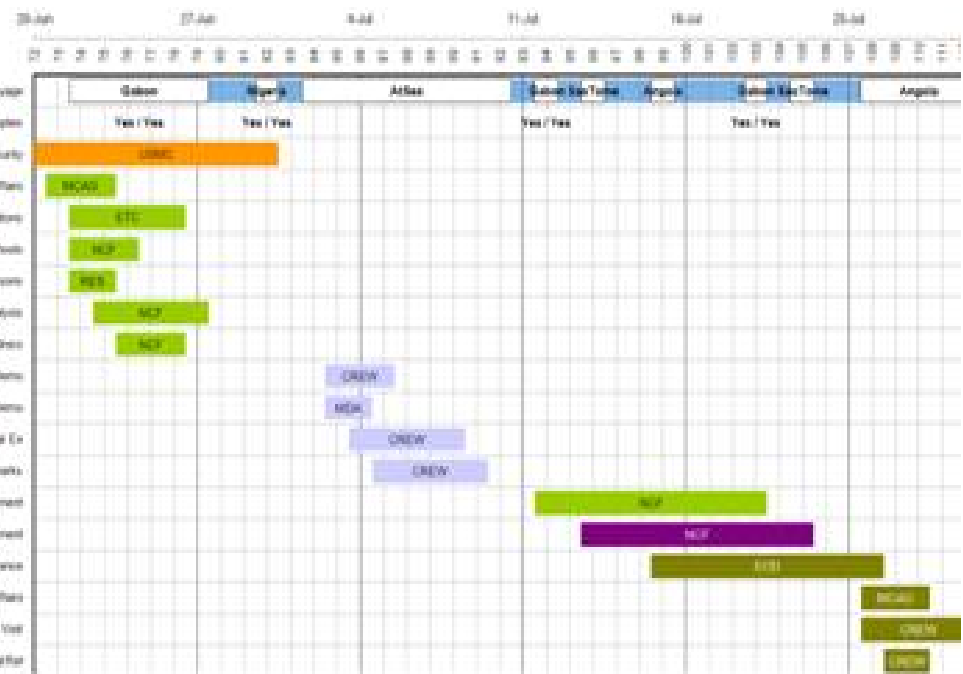
Combat Logistics Force employment planner

- **World-wide CLF employment and sea route planner**
- **Ensures coverage of deployed battle groups and resupply of station and shuttle ships**
- **Up to a 180-day planning horizon**



Global Fleet Station Mission Planner

- Peace time mission planning and optimization tool
- Provides best schedule to employ expeditionary partnership teams
- Maximizes “coverage” and engagement value for time and logistics constraints



Joint Defender: TBMD Planner

JDEF

Dashboard

Map

Korea-Japan

Korea-Japan
Korea
Tokyo
Seoul

Measure... Info...

Welcome
Dashboard
Inputs
Outputs
Setup

Solve

Accept

Clear

Platforms...

Positions...

11/26/2009

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Ready

**Defender-Attacker
two-sided
optimization**

Model provides:

- Worst Enemy
Course of Action
- Best Friendly
Course of Action
- Evaluates defense
across the
Defended Asset List

Model Excel-Based

Naval Postgraduate School

NPS: The Navy's Corporate University



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Joint Defender Demonstration