



Tools to Support Real-Time Planning & Analysis In the AOC And Around the GLOBE

March 2016

UNCLASSIFIED



NewToolsNeeded 03/14/11



*Not everyone
needs the same tools!*





PSI Core Technologies



Fast Accurate Planning & Analysis

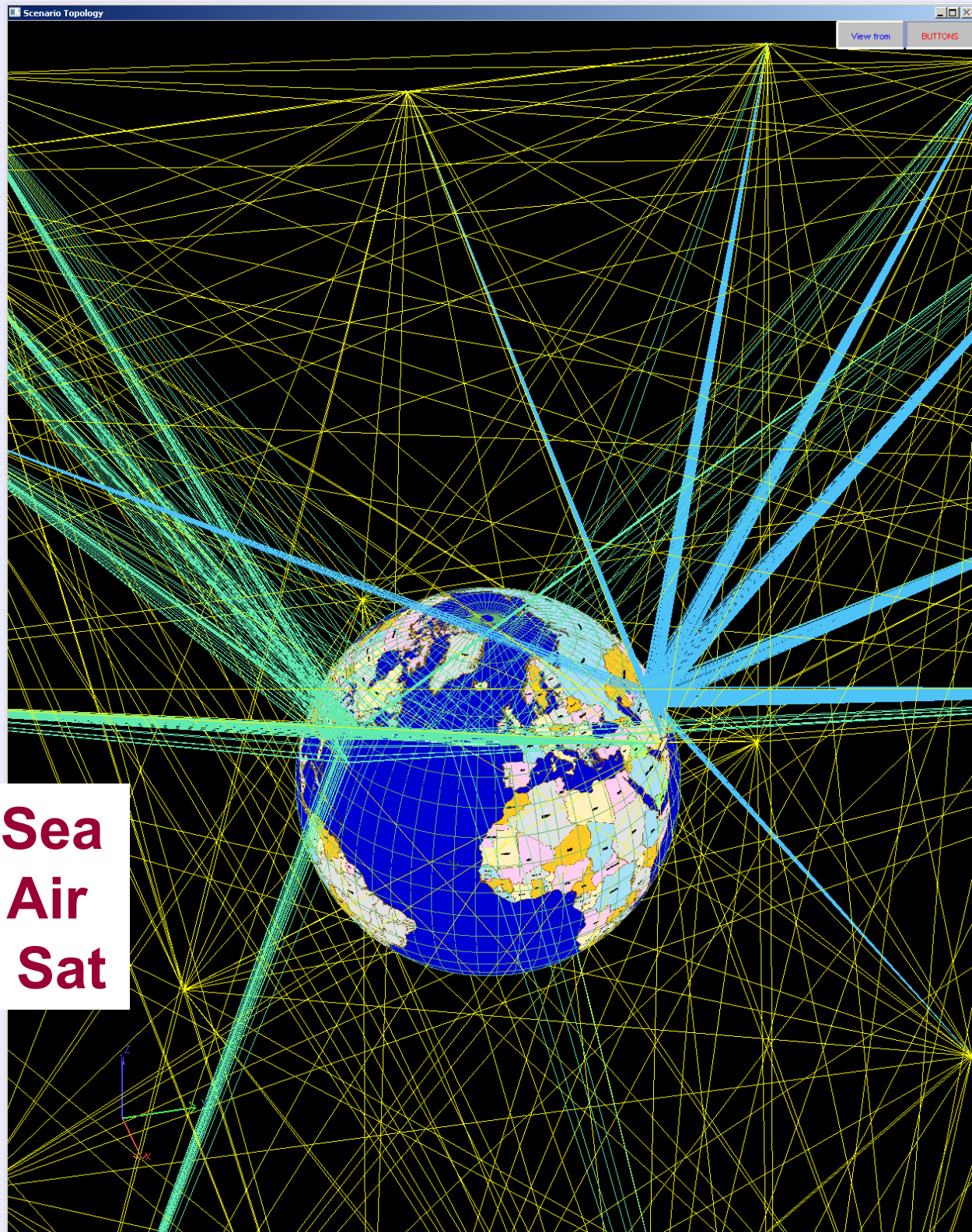
- **Combining High Fidelity Models of:**
 - Platforms - Air, Sea, Ground, Space
 - Equipment - Sensors, Comm, Computers, Weapons, ...
 - Decisions Processes
 - Environments
- **With High Resolution 3D Graphical Visualization:**
 - Dynamic Movement
 - High Fidelity Backgrounds
 - Accurate presentation of dynamics
- **And Fast Interactive Additions / Changes**
 - Scenario development / modification
 - Multiple simulation runs on fast parallel processors



Planning Global Scenarios

—
Using PSI's
GLOBAL
PLANNER

Green- Sat to Sea
Blue- Sat to Air
Yellow- Sat to Sat





Current Operational Considerations



Planning implies predicting future outcomes.

For complex systems, this requires:

- **Building detailed models for simulation;**
- **Running multiple simulations to analyze variations;**
- **Running many simulations to get optimal parameters.**

PSI uses CAD tools to produce simulations, analyze variation of results due to parameter changes, perform optimization runs on parallel processors.

These CAD tools can be used by Application Experts.



Current Operational Considerations



Major concern in the AOC – Giving the users what they really need - for planning tools.

This requires:

- Fast Accurate Simulations;**
- High Resolution Visualization;**
- Models easily understood by Application Experts;**
- Models selected from existing libraries (point & click) and automatically incorporated into simulations.**

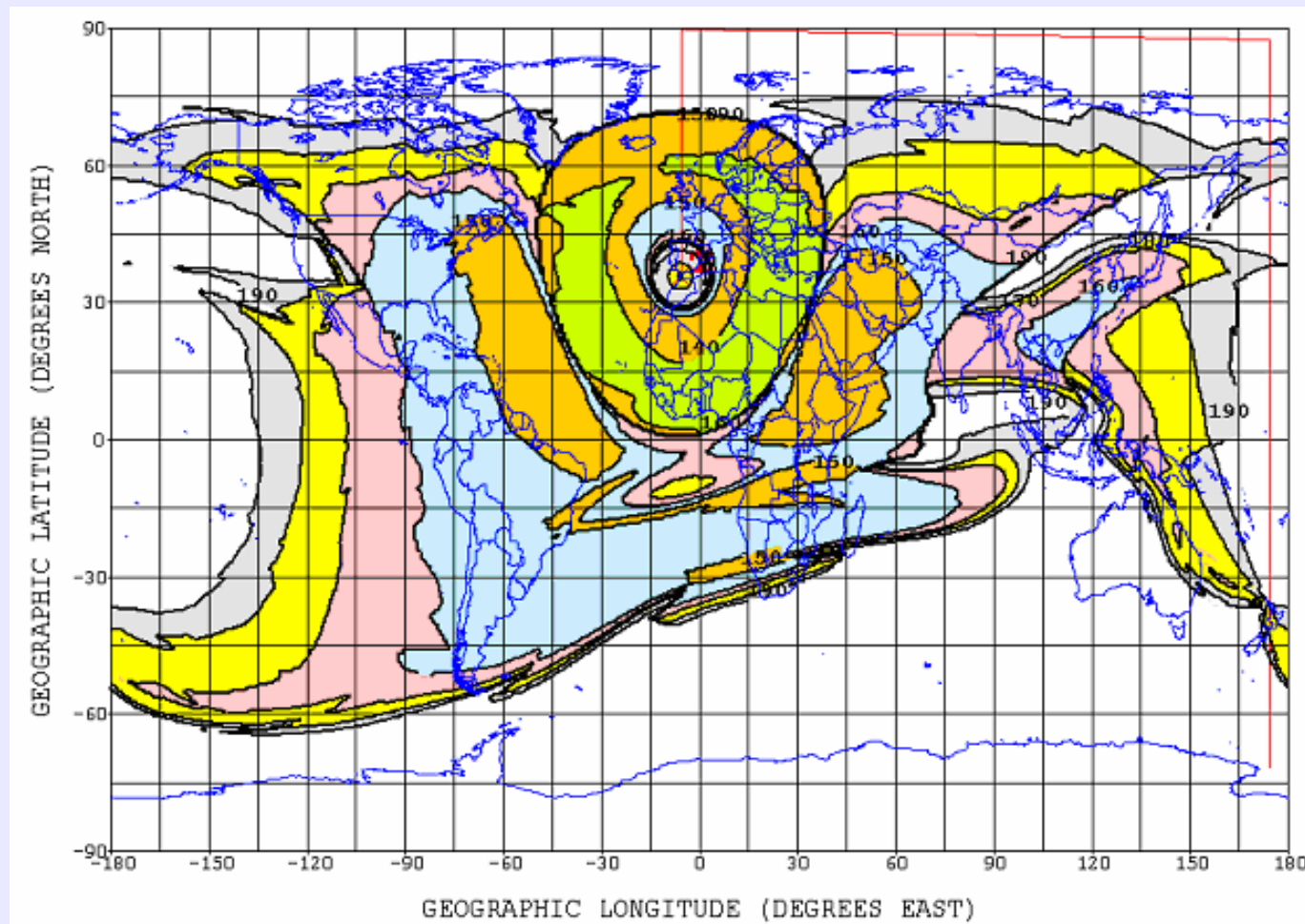
JANC & GLOBAL PLANNER are setting a totally new standard for future applications.



Current Operational Considerations



Visualization of the situation is critical



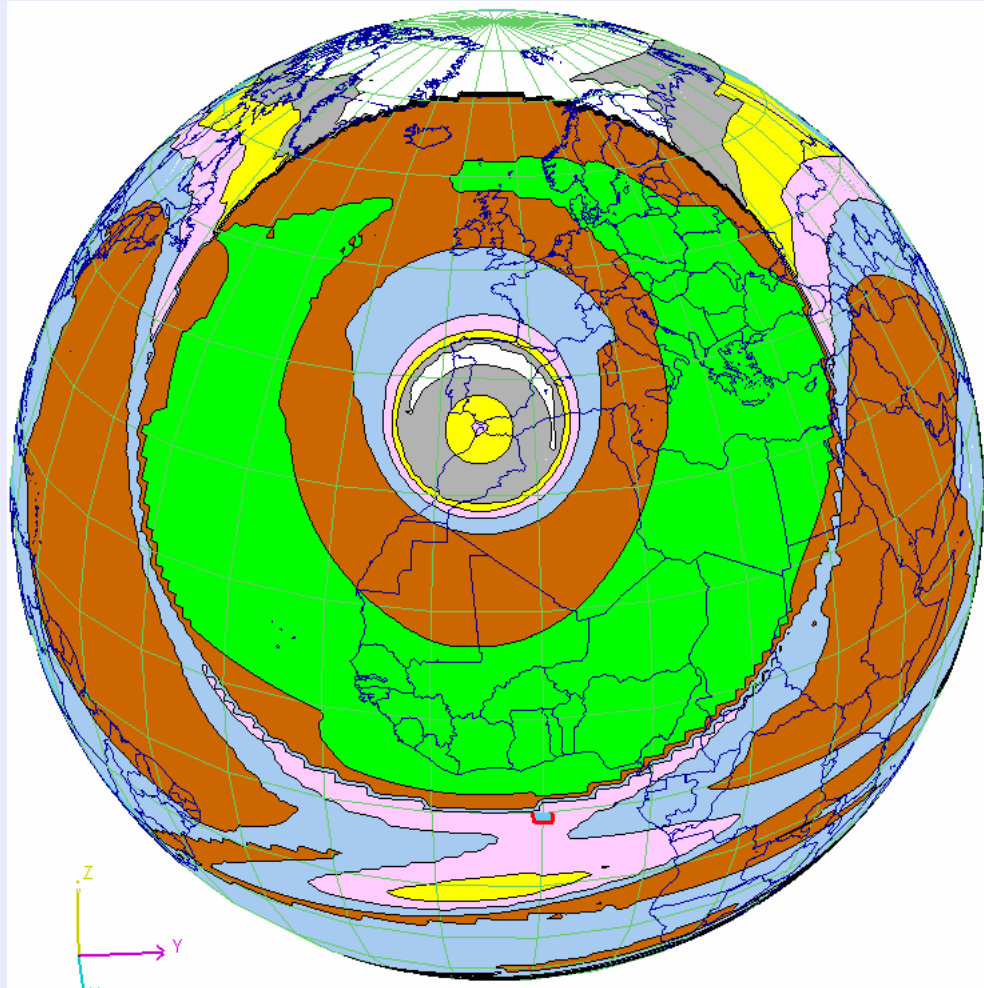
The above is a 2D HF coverage map from VOACAP.



Current Operational Considerations



3D Visualization – On the Globe - is critical



***The same HF coverage map from PSI's 3D ACAS
(Built for NASIC)***



Current Operational Considerations



***Planning implies predicting future outcomes -
How does one increase prediction accuracy?***

**Predictions are *conditional probability statements*,
e.g., What is the probability of having connectivity?**

Probability that connectivity exists at $T + \Delta T$

Must be Conditioned on Maximum Information

- To gain Maximum Accuracy!



Future Operational Considerations



How does one improve accuracy?

- The more information that one uses
The more accurate the probability statement.
- This is determined by the details
 - of the Models & Scenarios
- The ability to visualize potential variations in outcomes depends on the ability to vary parameters & run multiple simulations
 - very fast!

Bottom Line: Need Visualization, Speed & Accuracy



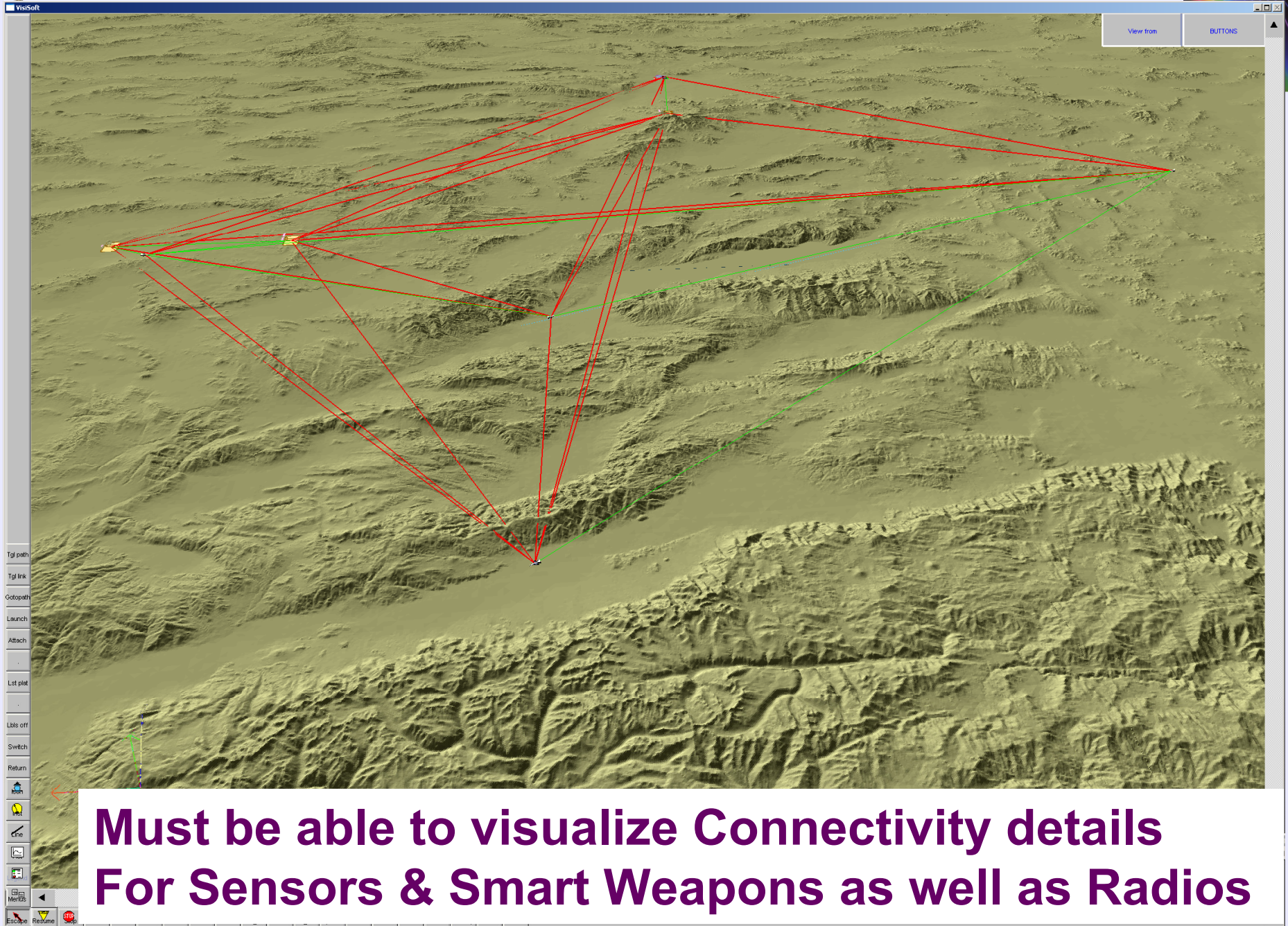
Visualization Of Mission Details



Must be able to *create* complex scenarios - fast!



THE PSI SOLUTION



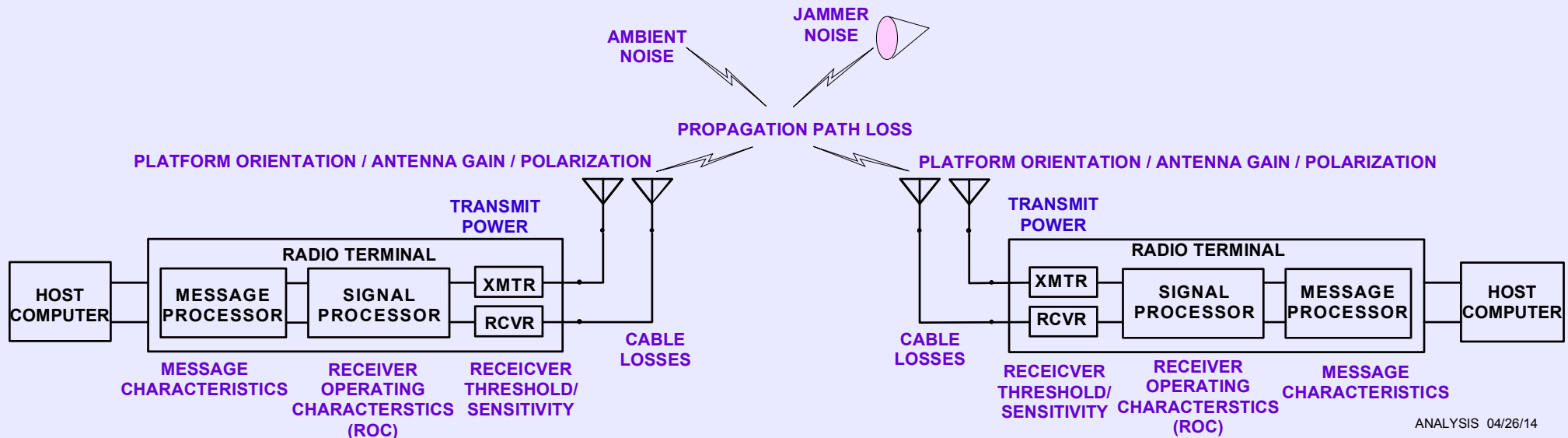


EXAMPLE OF A PSI SOLUTION



DETERMINING CONNECTIVITY:

**ACCURATE MODELS
MUST ACCOUNT FOR MANY FACTORS**

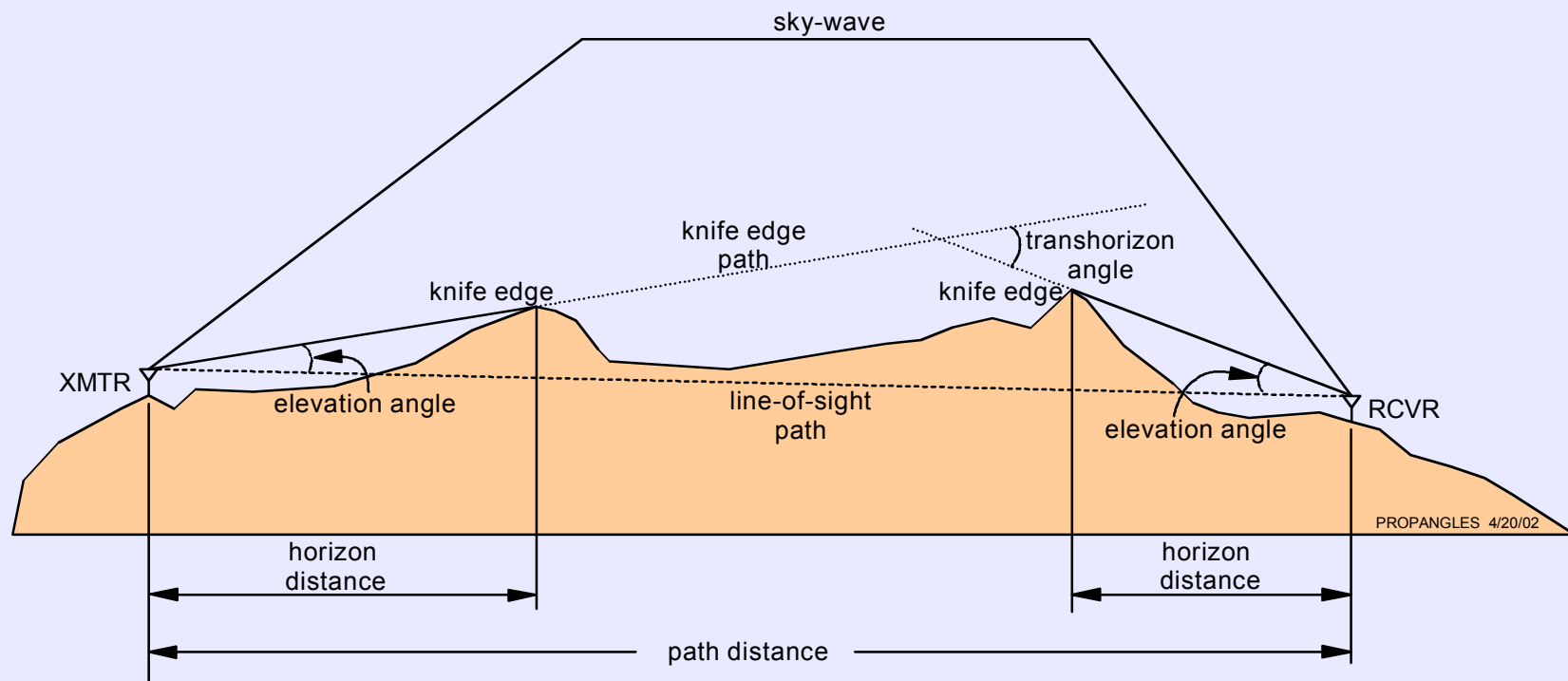


**DEPENDS UPON: POWER, CODING, SIGNAL PROCESSING,
PROPAGATION PATH LOSS, NOISE & OTHER FACTORS**



EXAMPLE OF A PSI SOLUTION

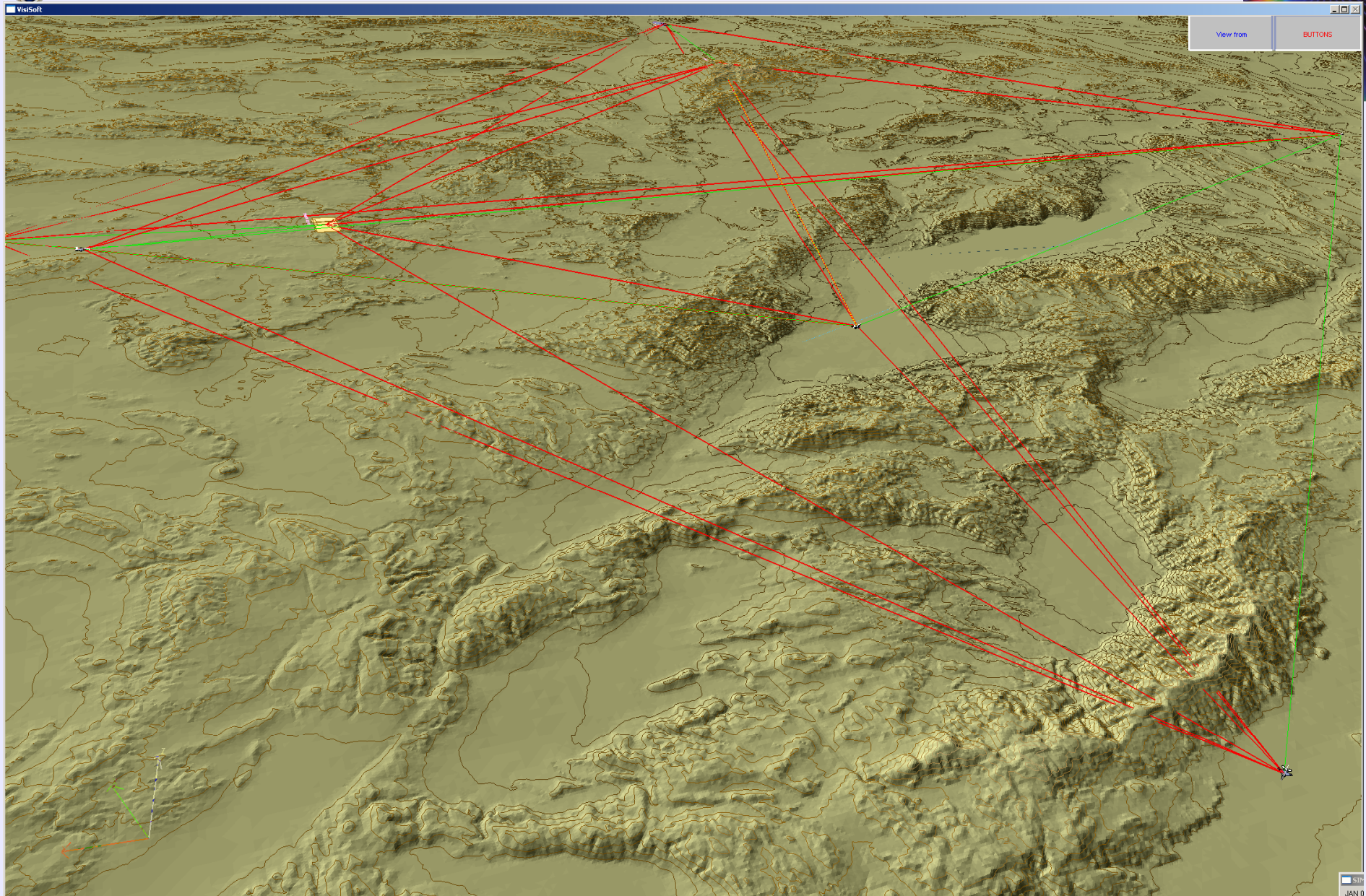
ACCURACY OF PROPAGATION PATH LOSS
DEPENDS UPON:
ANTENNAS, TERRAIN, FOLIAGE & OTHER FACTORS



CONNECTIVITY IS **NOT SIMPLY LINE-OF-SIGHT (LOS) !**



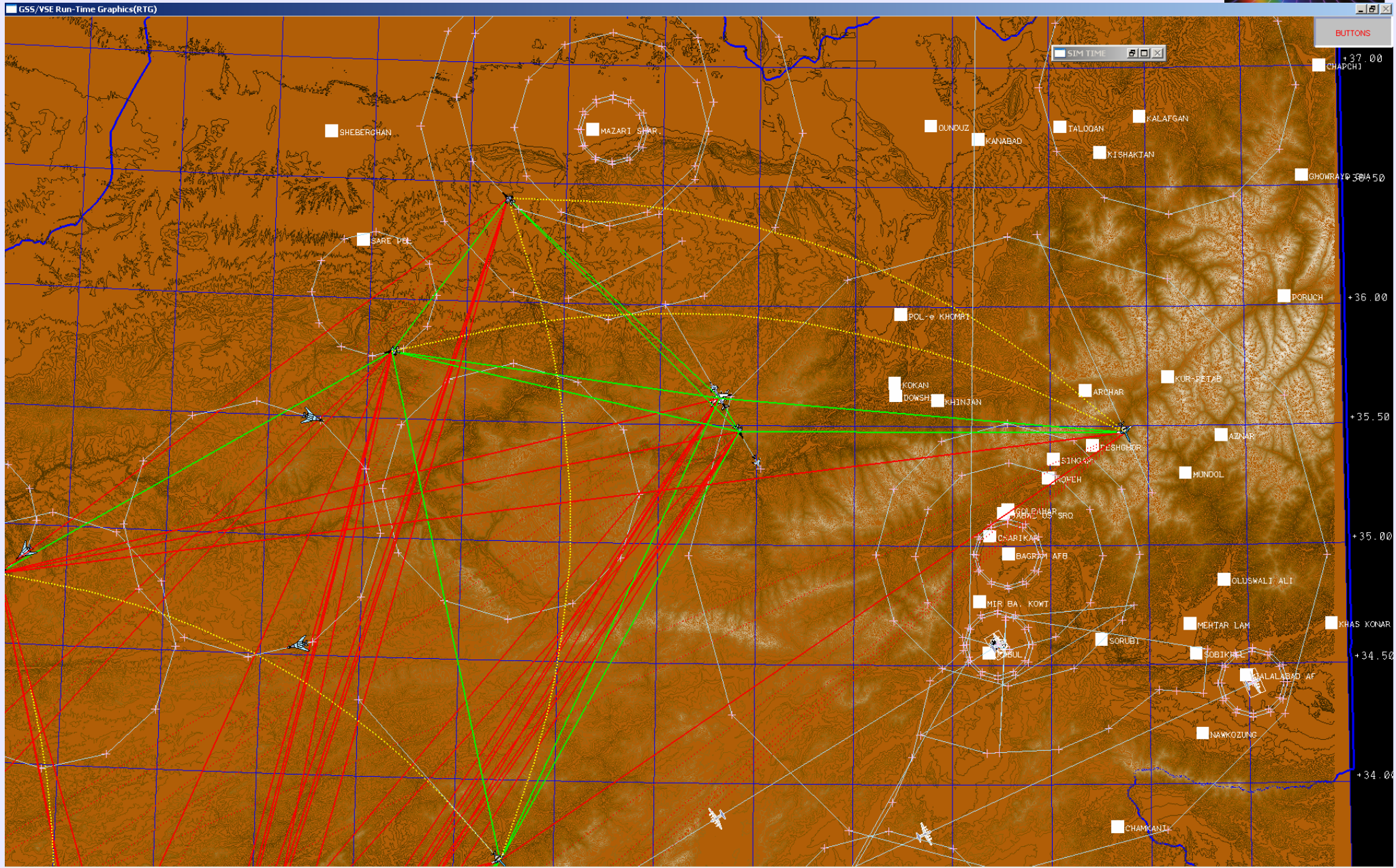
THE PSI SOLUTION



Must visualize connectivity from different angles (3D)

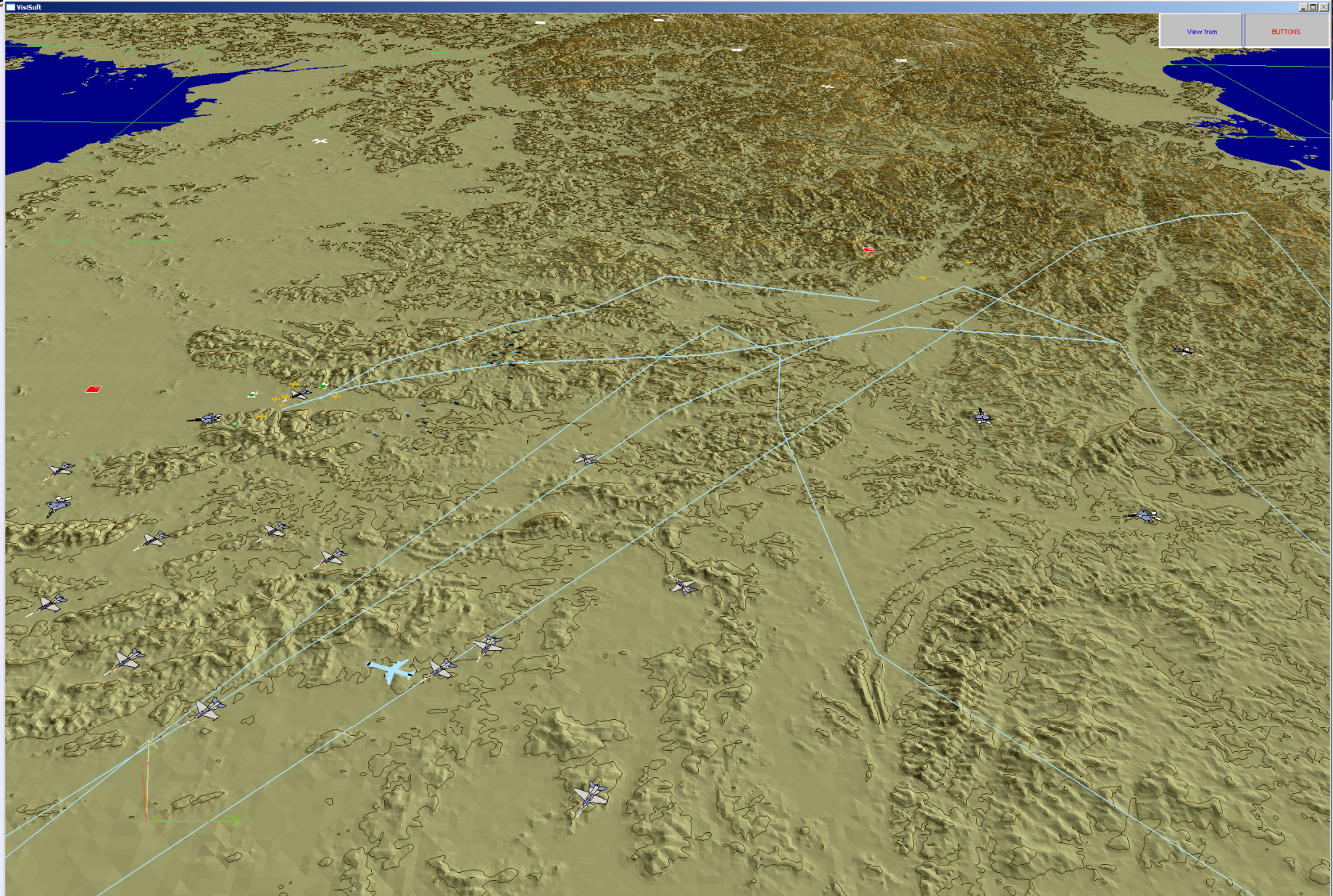


Visualization Of Detailed Scenarios





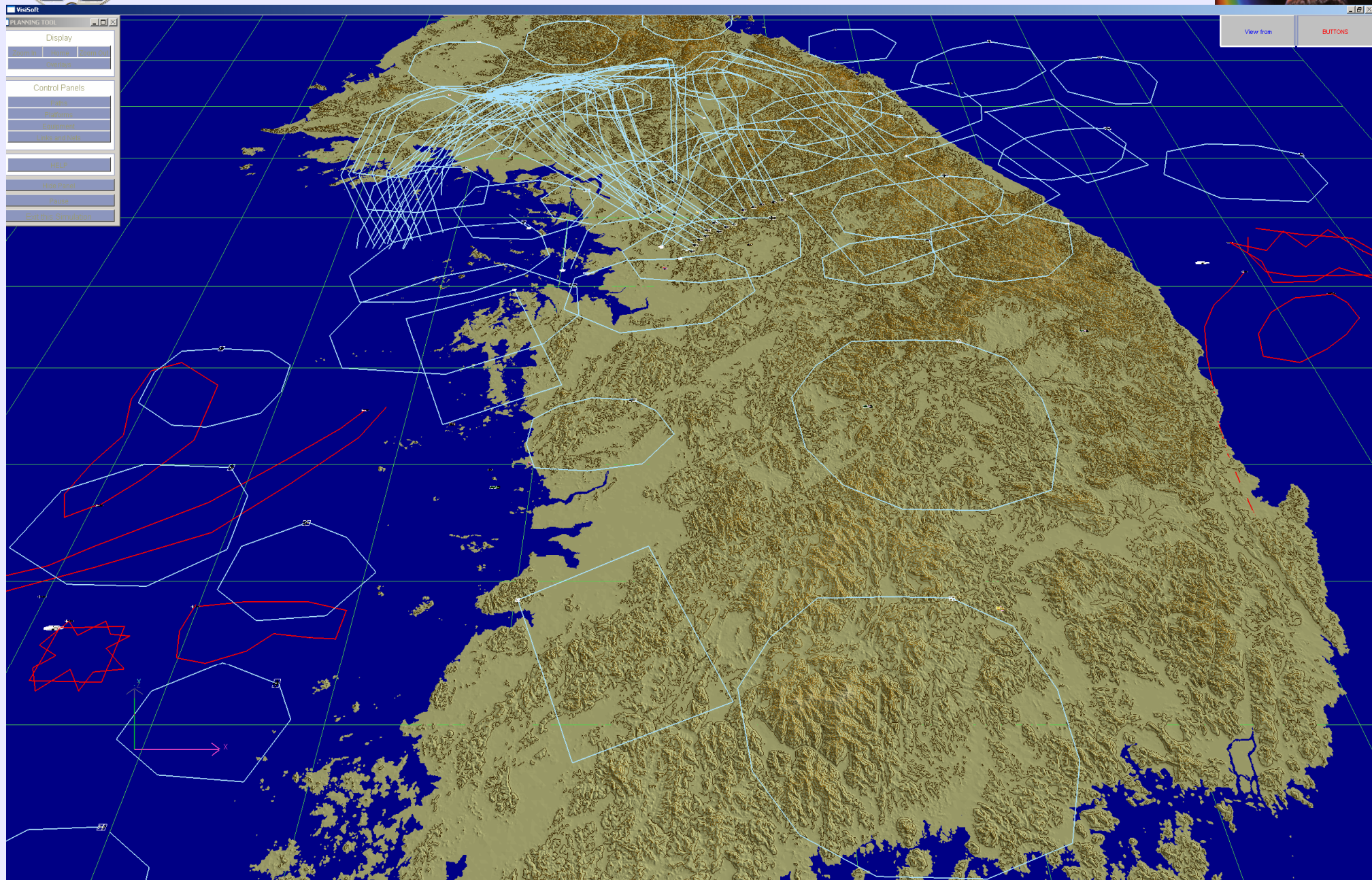
THE PSI SOLUTION



Scenarios must include Sensor & Weapon deliveries



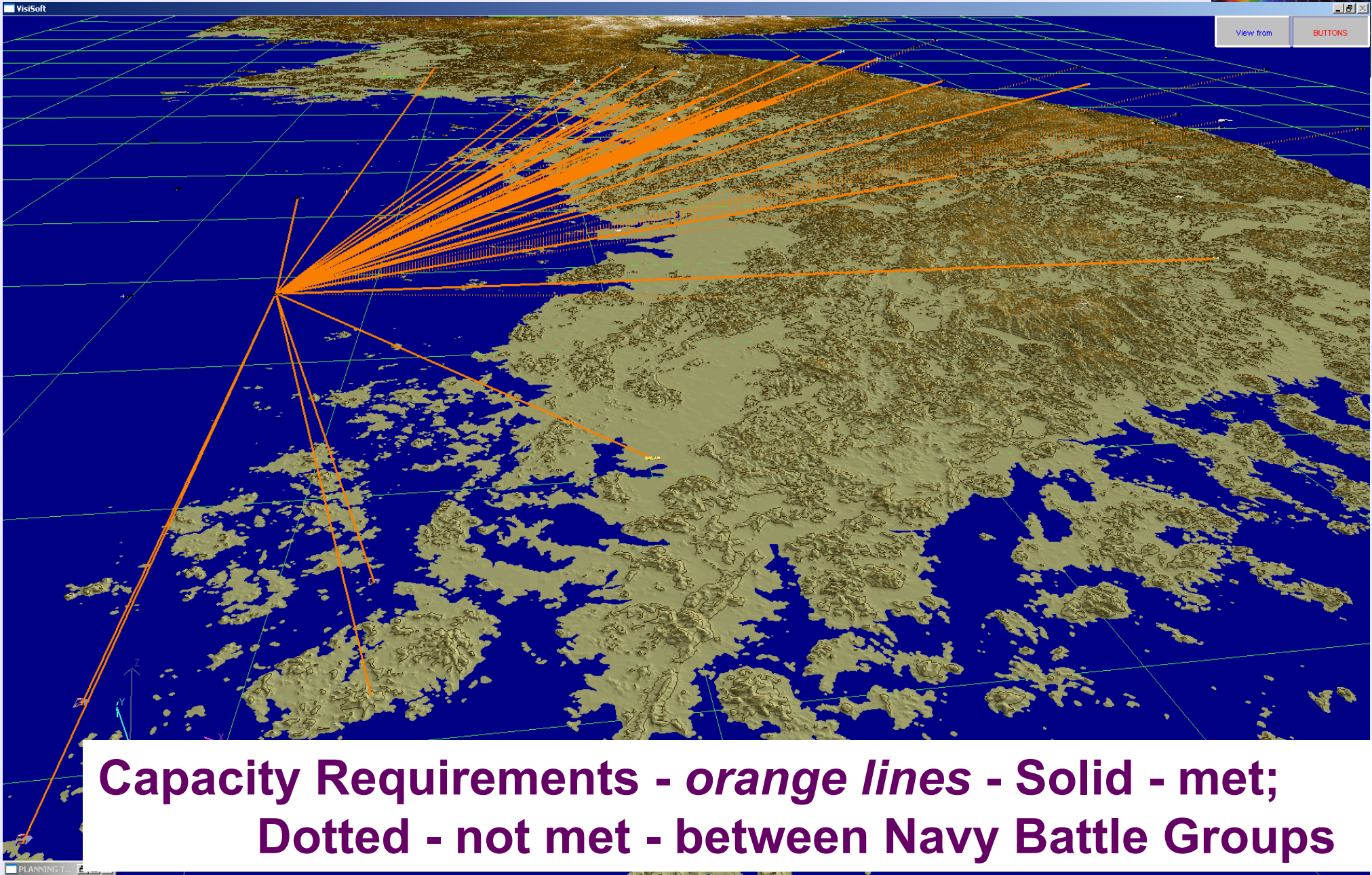
THE PSI SOLUTION



Must be able to modify complex scenarios – fast!



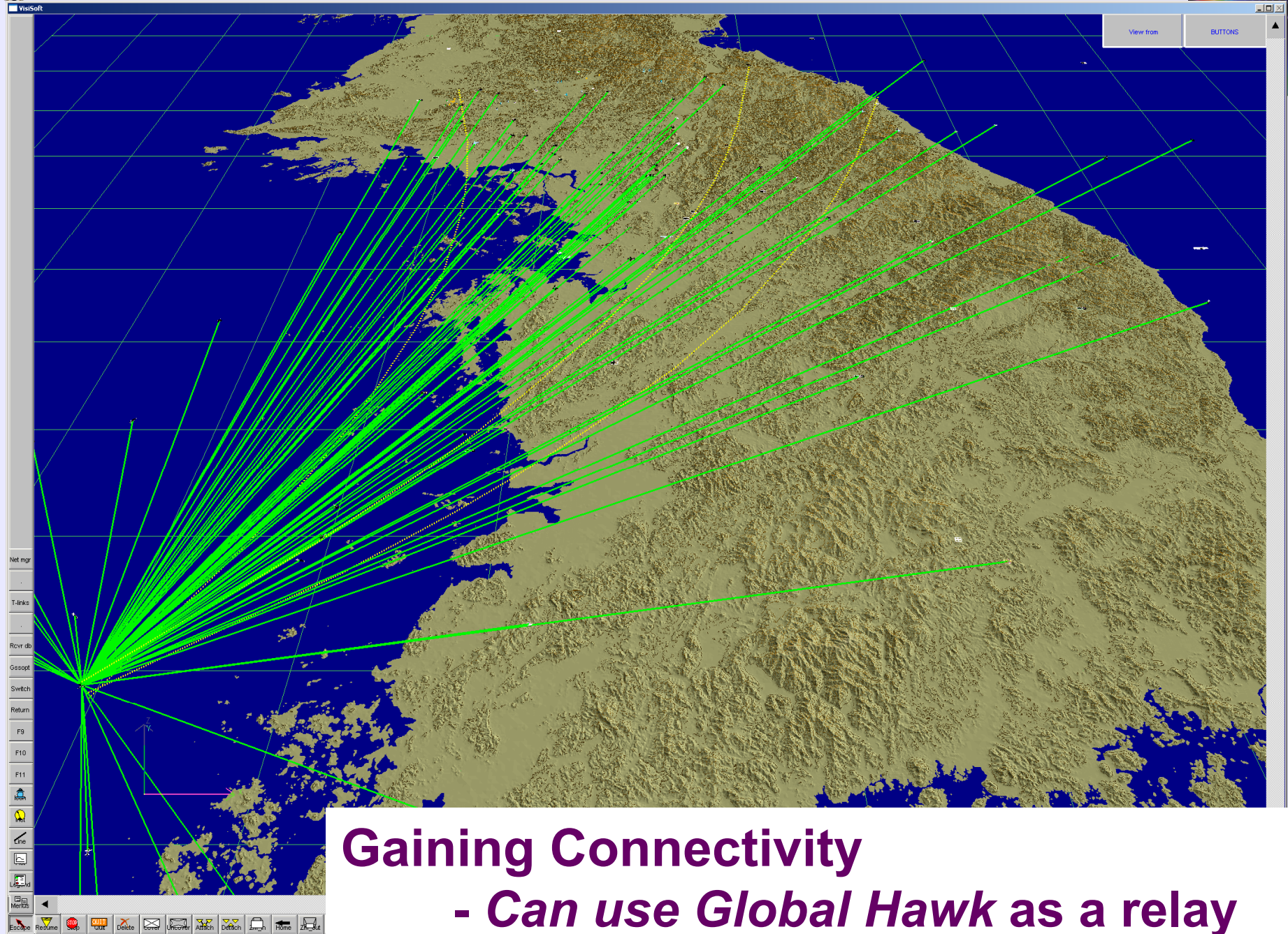
THE PSI SOLUTION



**Capacity Requirements - *orange lines* - Solid - met;
Dotted - not met - between Navy Battle Groups**



THE PSI SOLUTION



Gaining Connectivity
- Can use *Global Hawk* as a relay



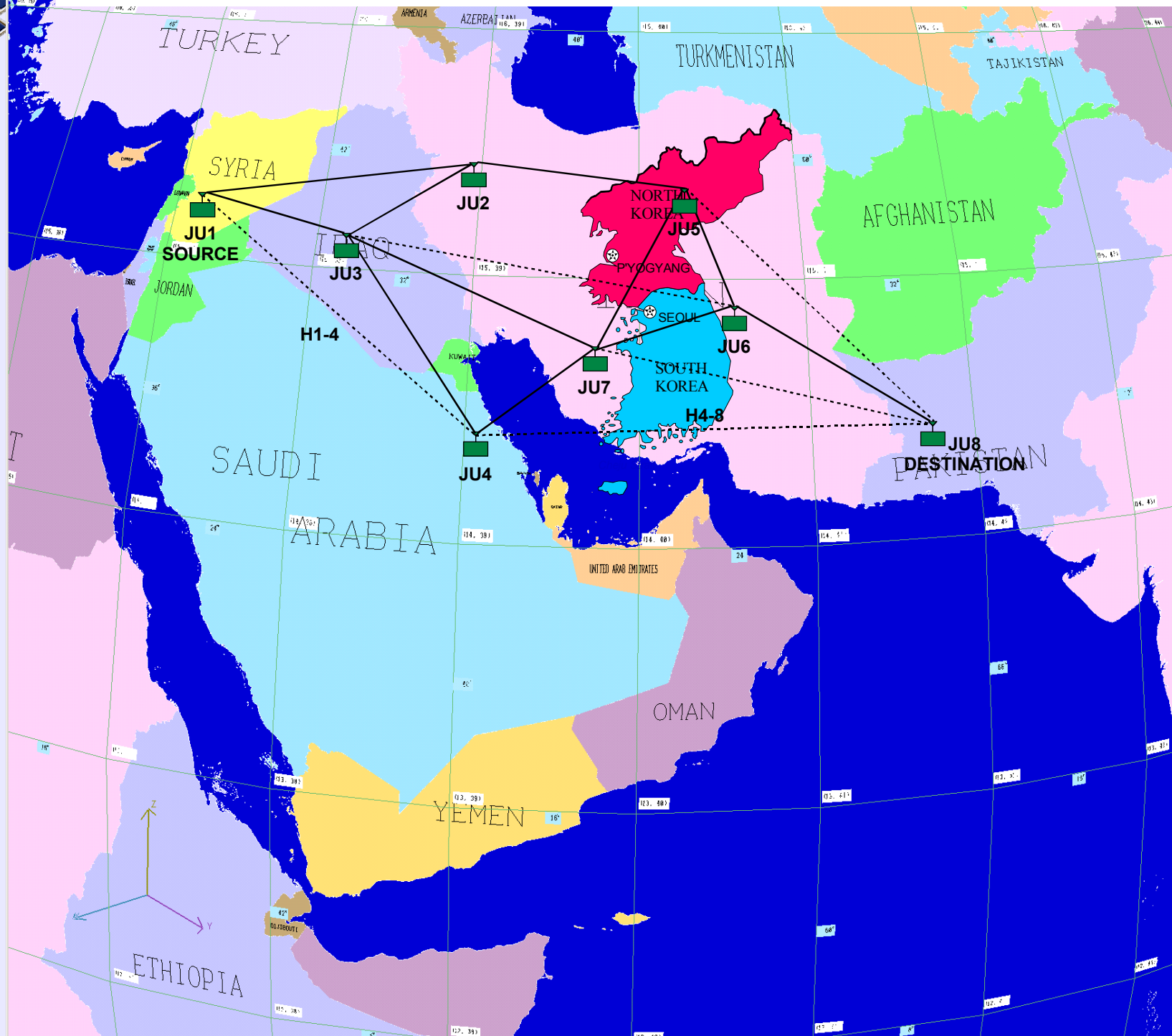
THE PSI SOLUTION



**Naval Battle Groups can talk across the peninsula
- using a relay (yellow lines) - e.g., *Global Hawk***

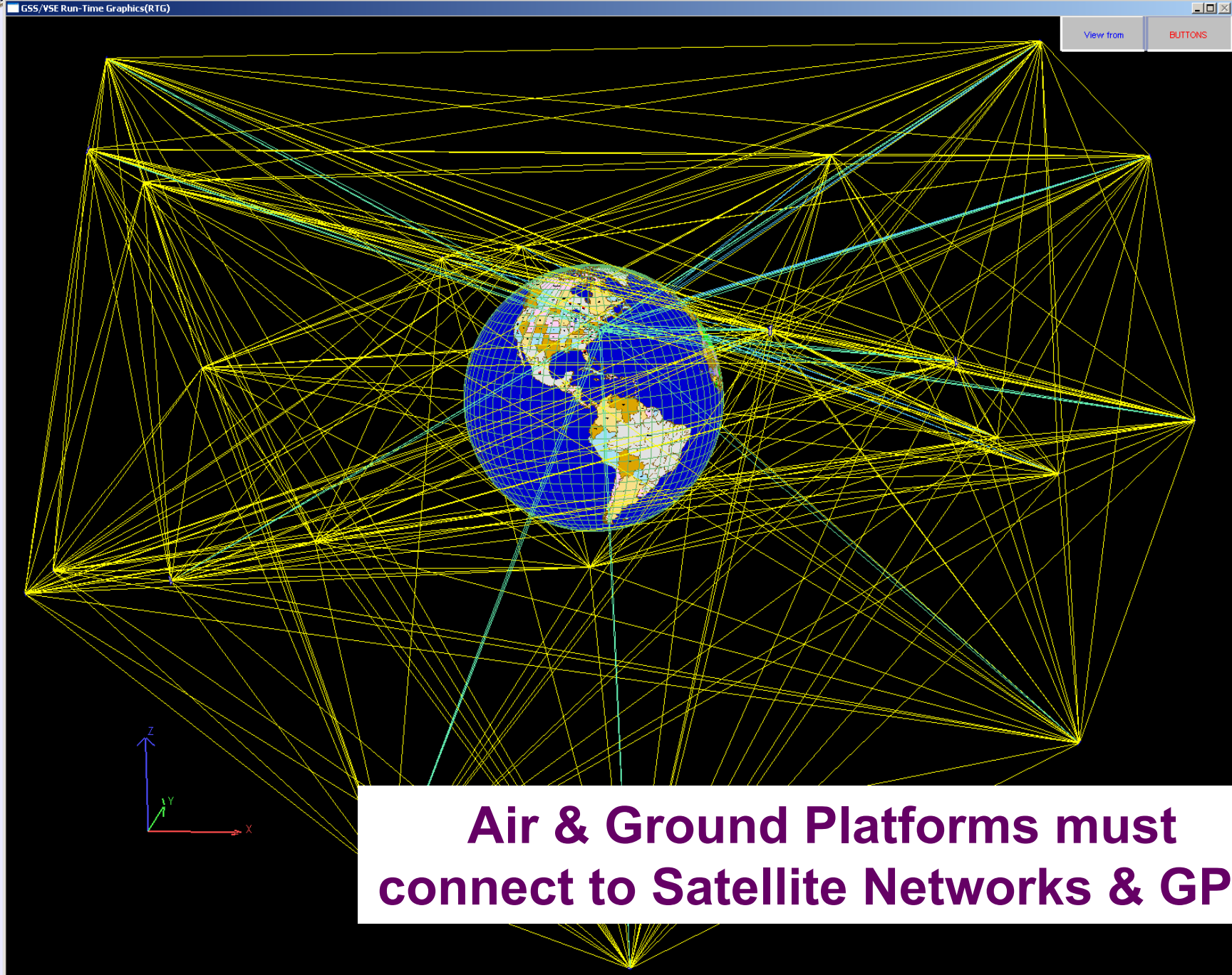


Scenario Sizes - Must Be Sufficiently Large





THE PSI SOLUTION



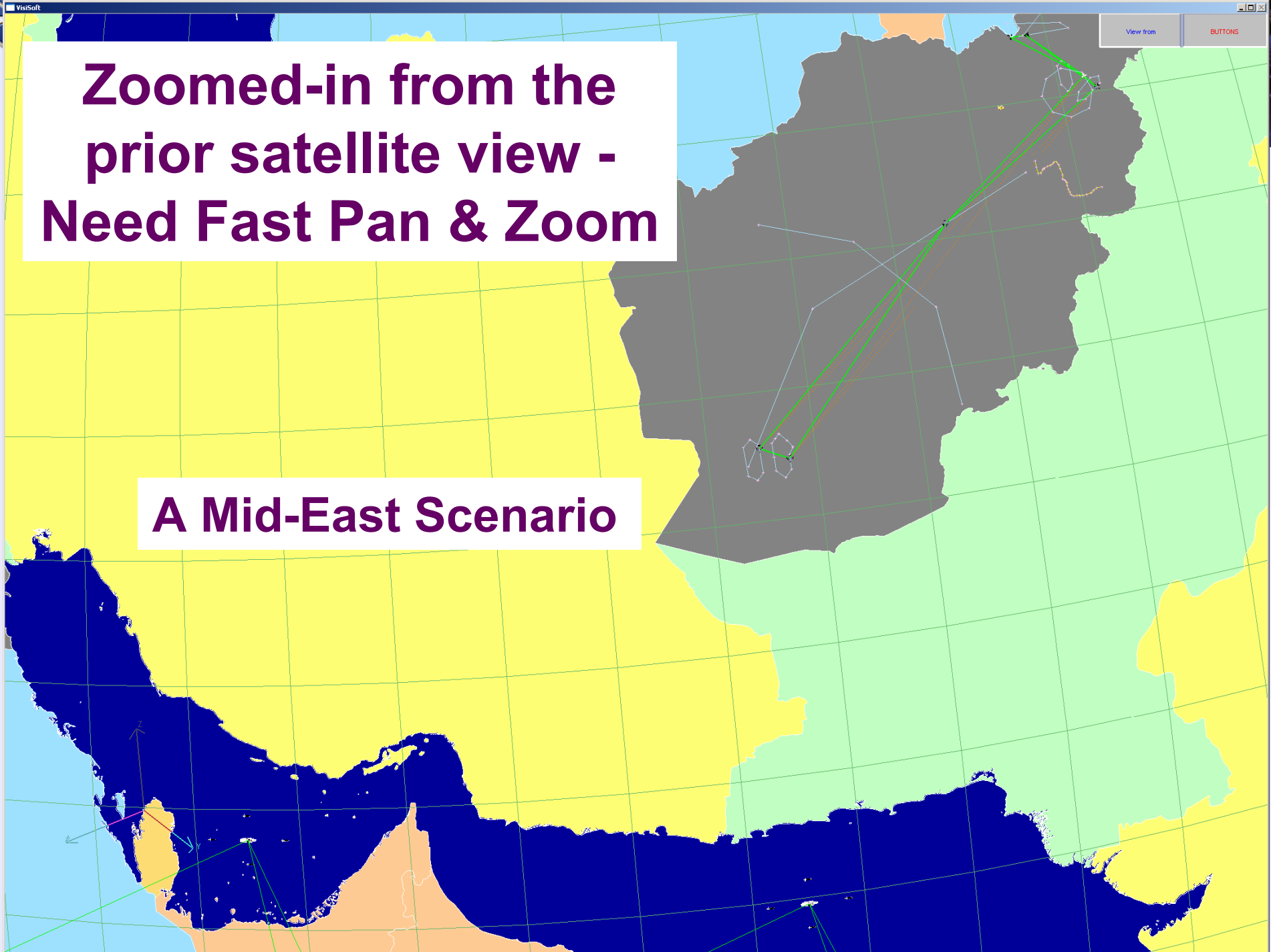
**Air & Ground Platforms must
connect to Satellite Networks & GPS**

THE PSI SOLUTION



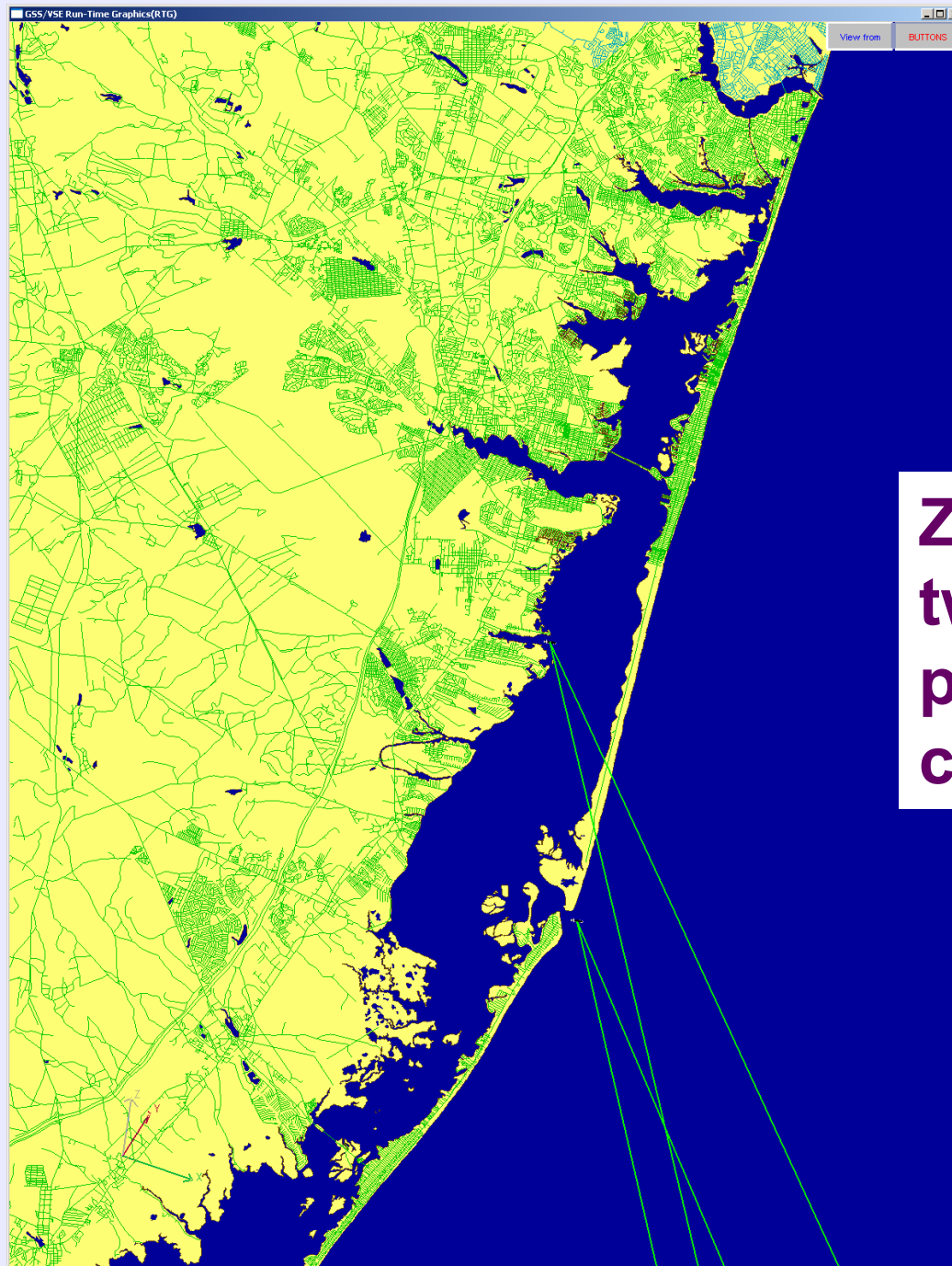
**Zoomed-in from the
prior satellite view -
Need Fast Pan & Zoom**

A Mid-East Scenario





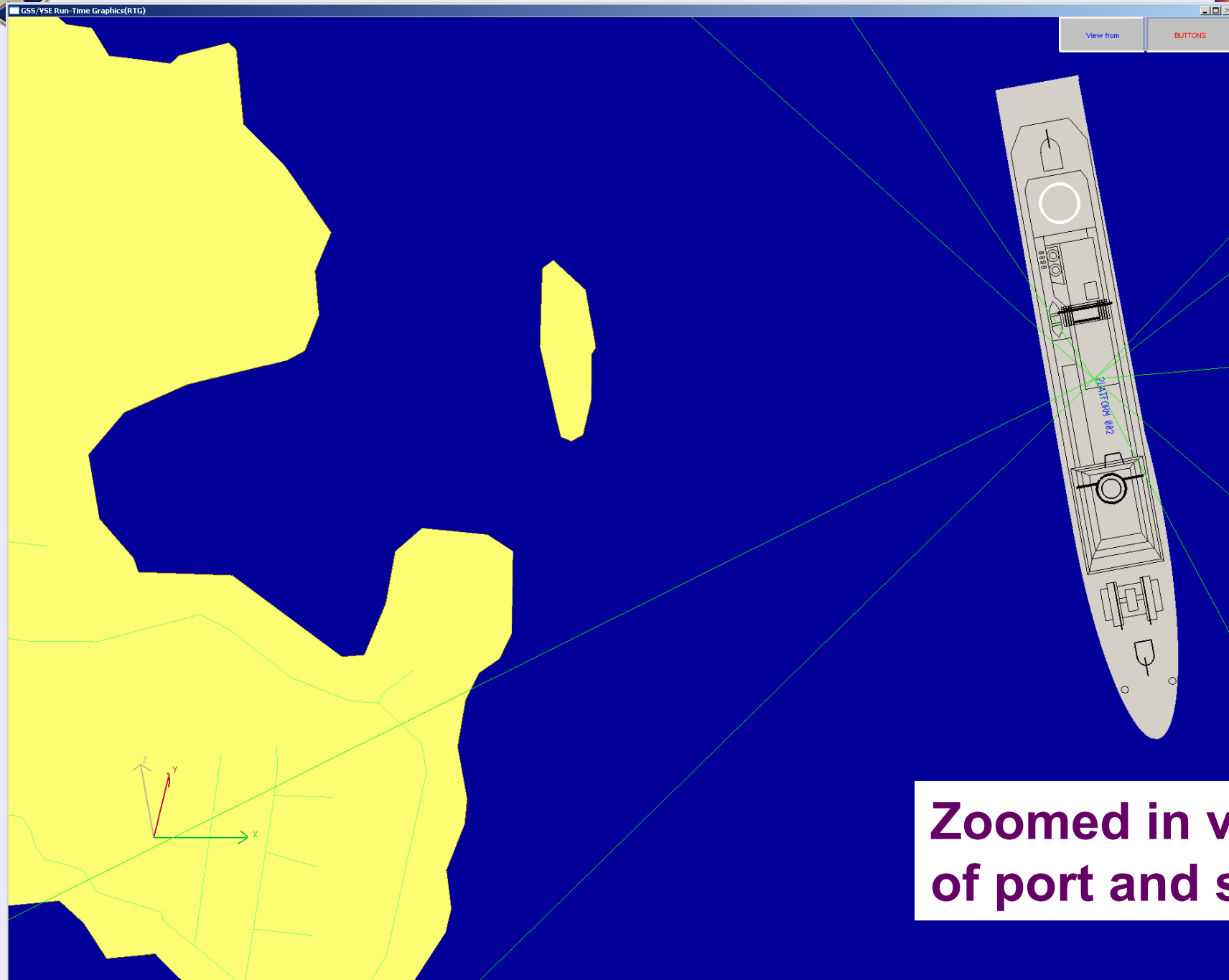
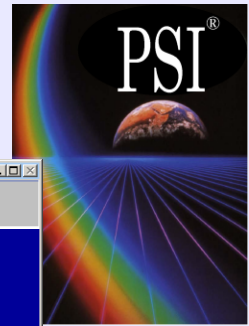
THE PSI SOLUTION



Zoomed-in view of two ships in a port with satellite connections.



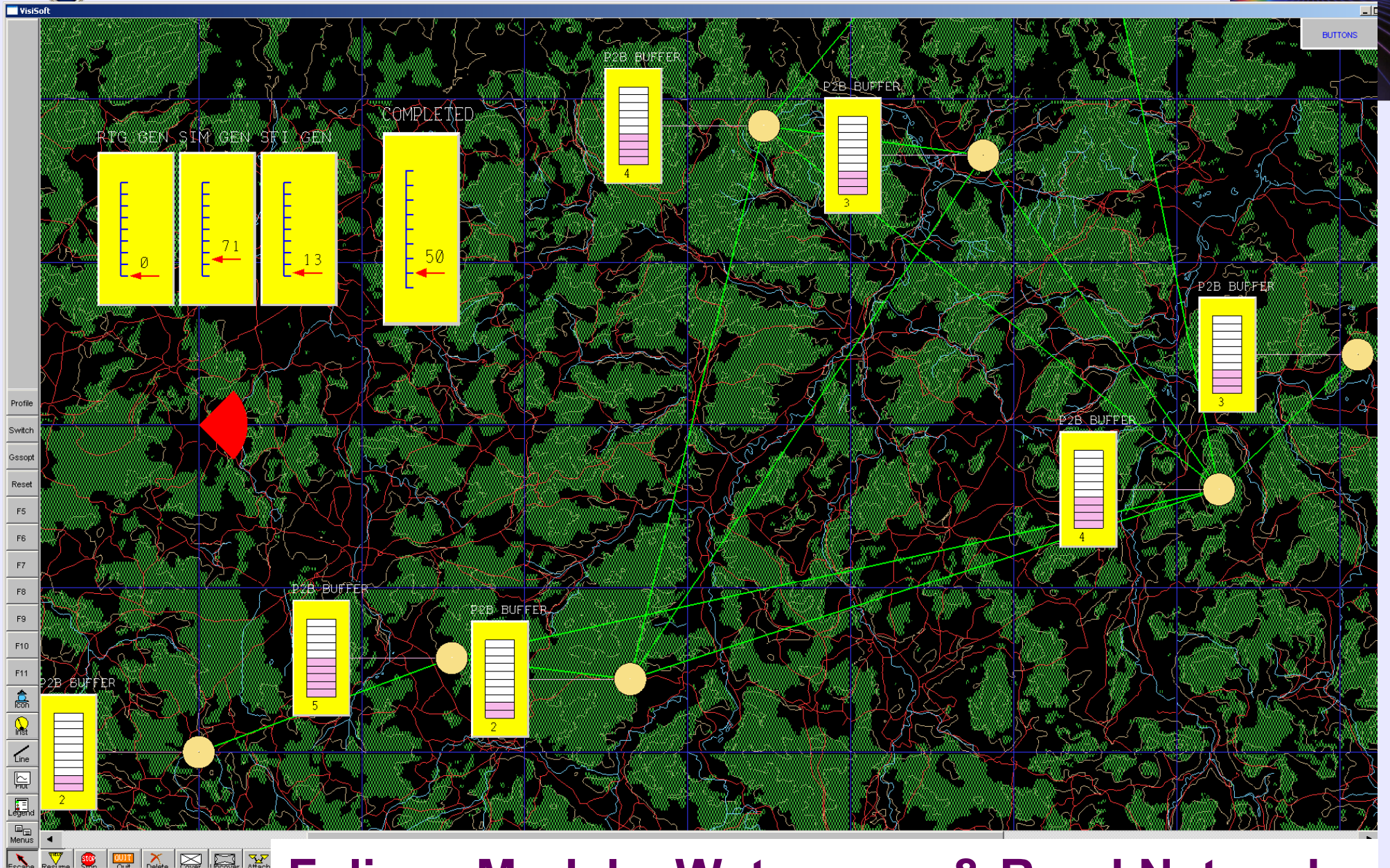
THE PSI SOLUTION



**Zoomed in view
of port and ship.**



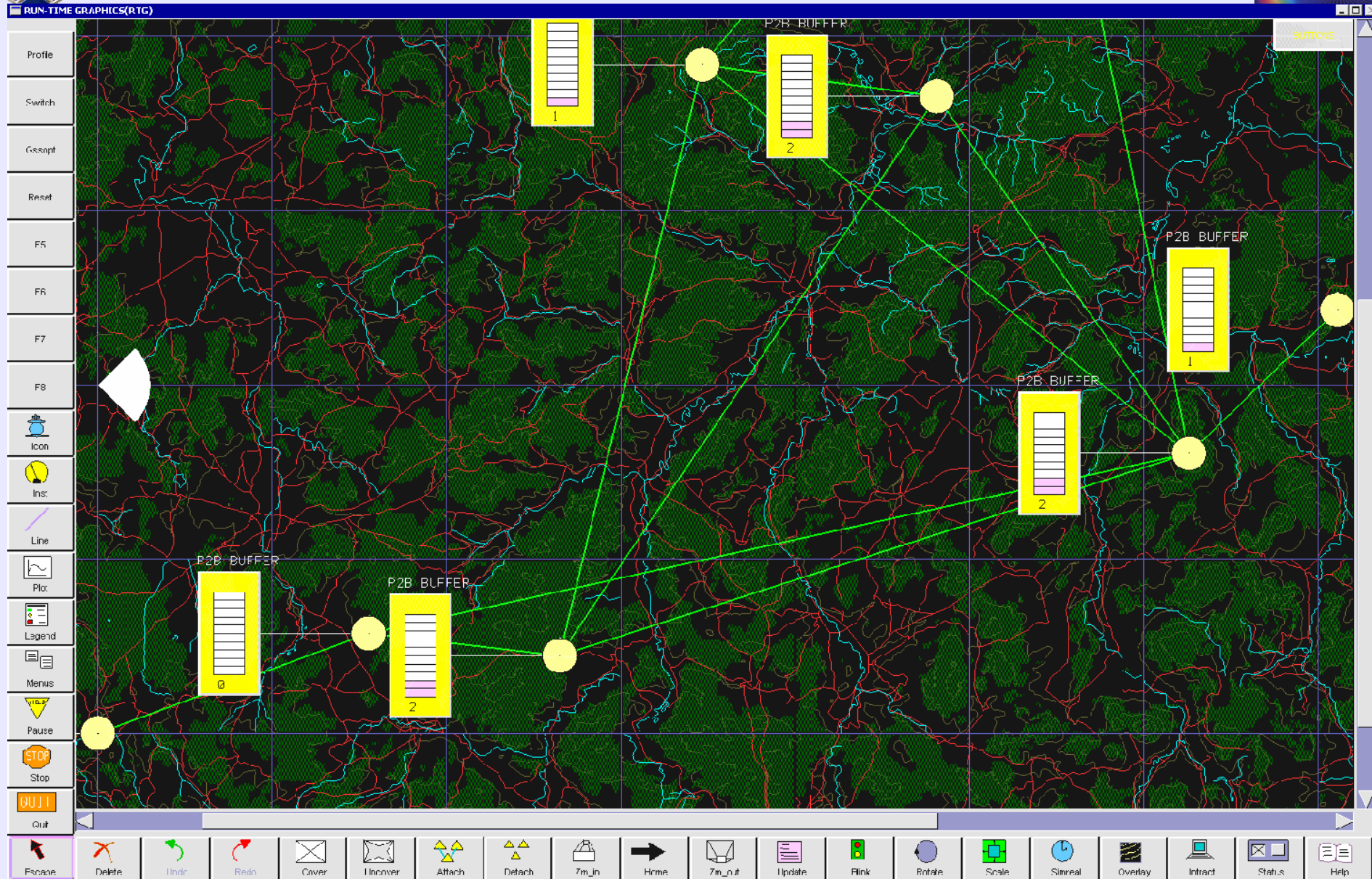
Instrumented Communications



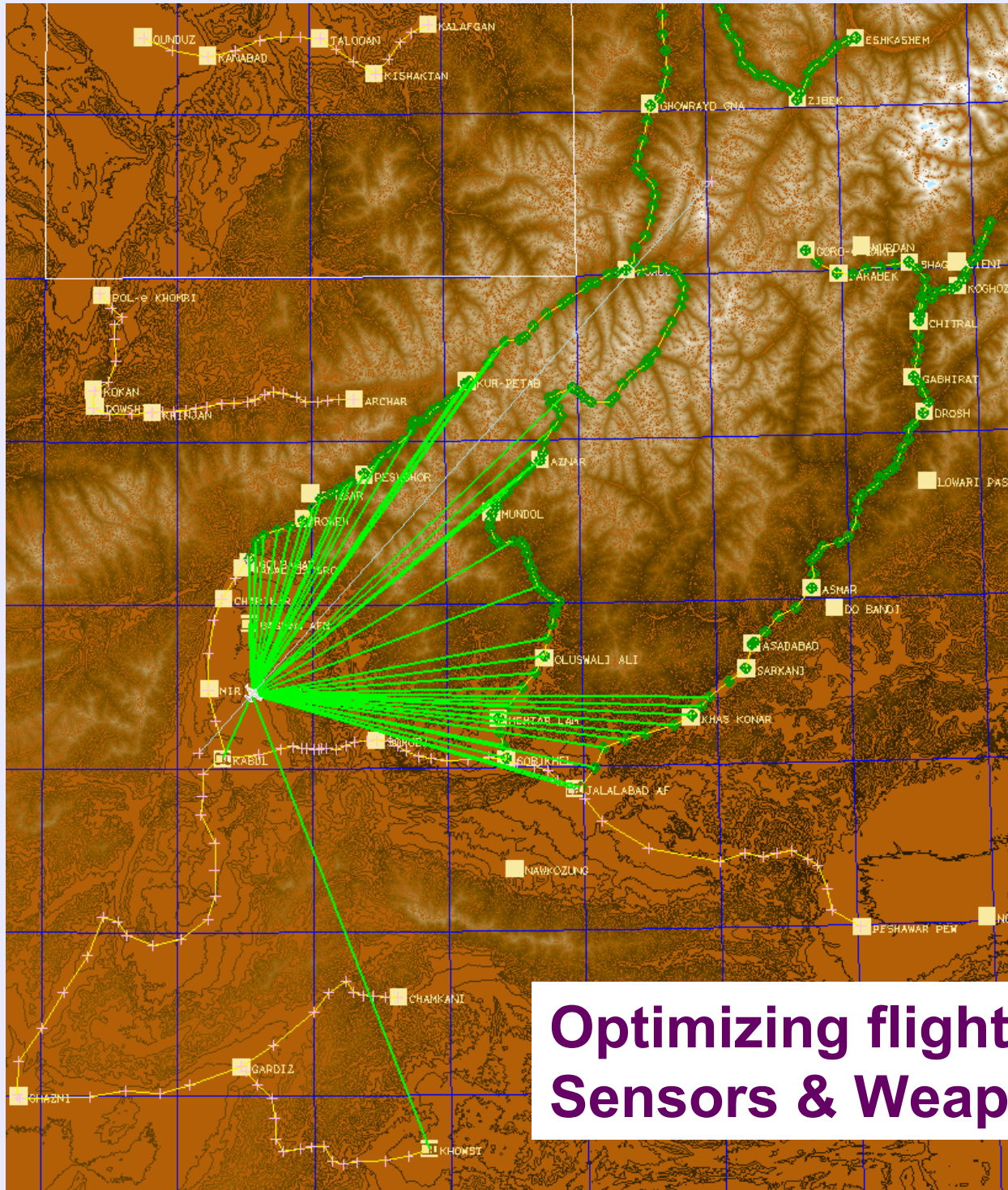
Foliage Models, Waterways & Road Networks



Instrumented Communications



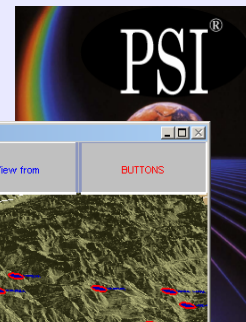
Foliage Models, Waterways & Road Networks



Optimizing flight paths for Sensors & Weapon Delivery



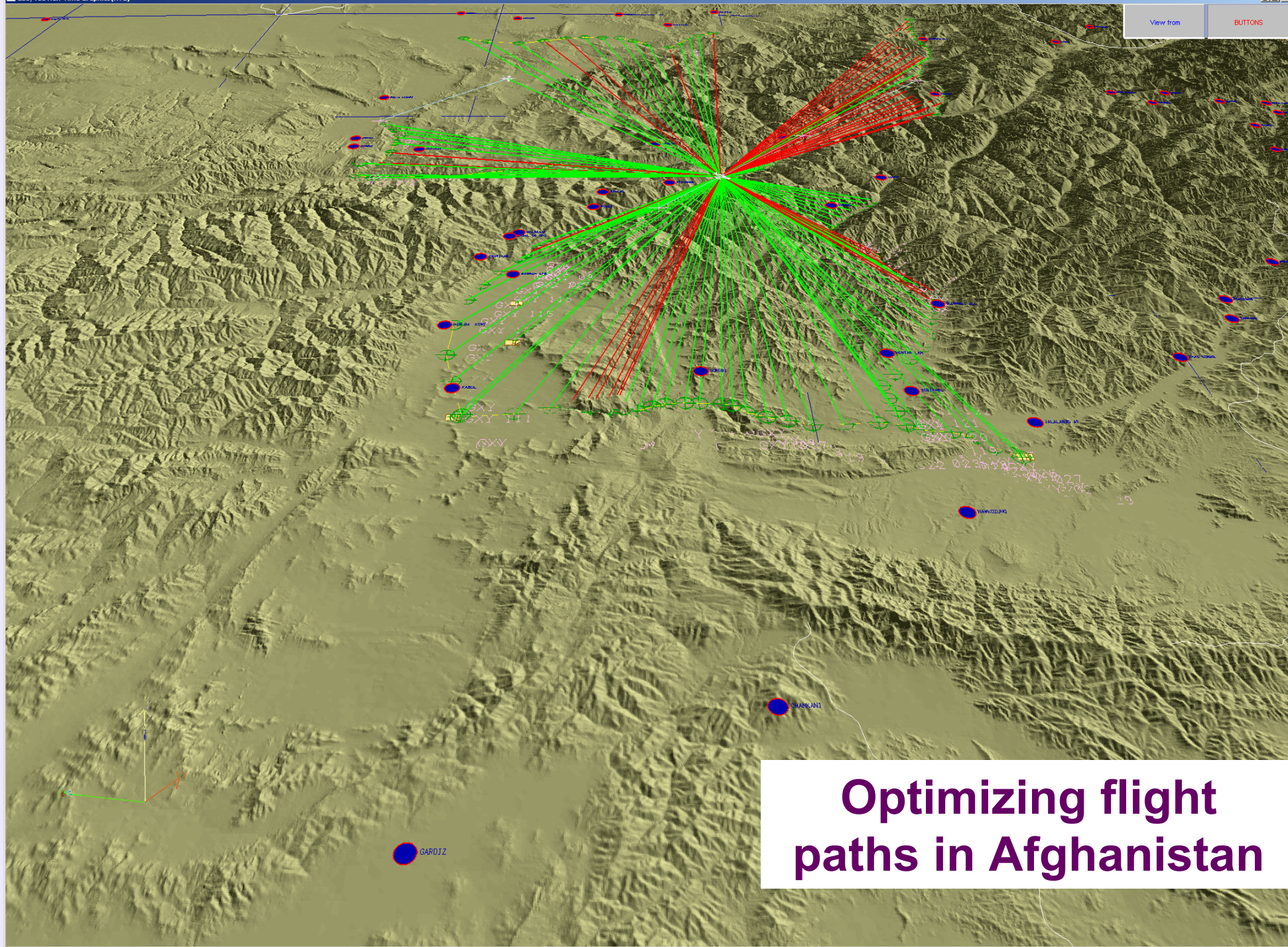
THE PSI SOLUTION



GSS/YSE Run-Time Graphics(RTG)

View from

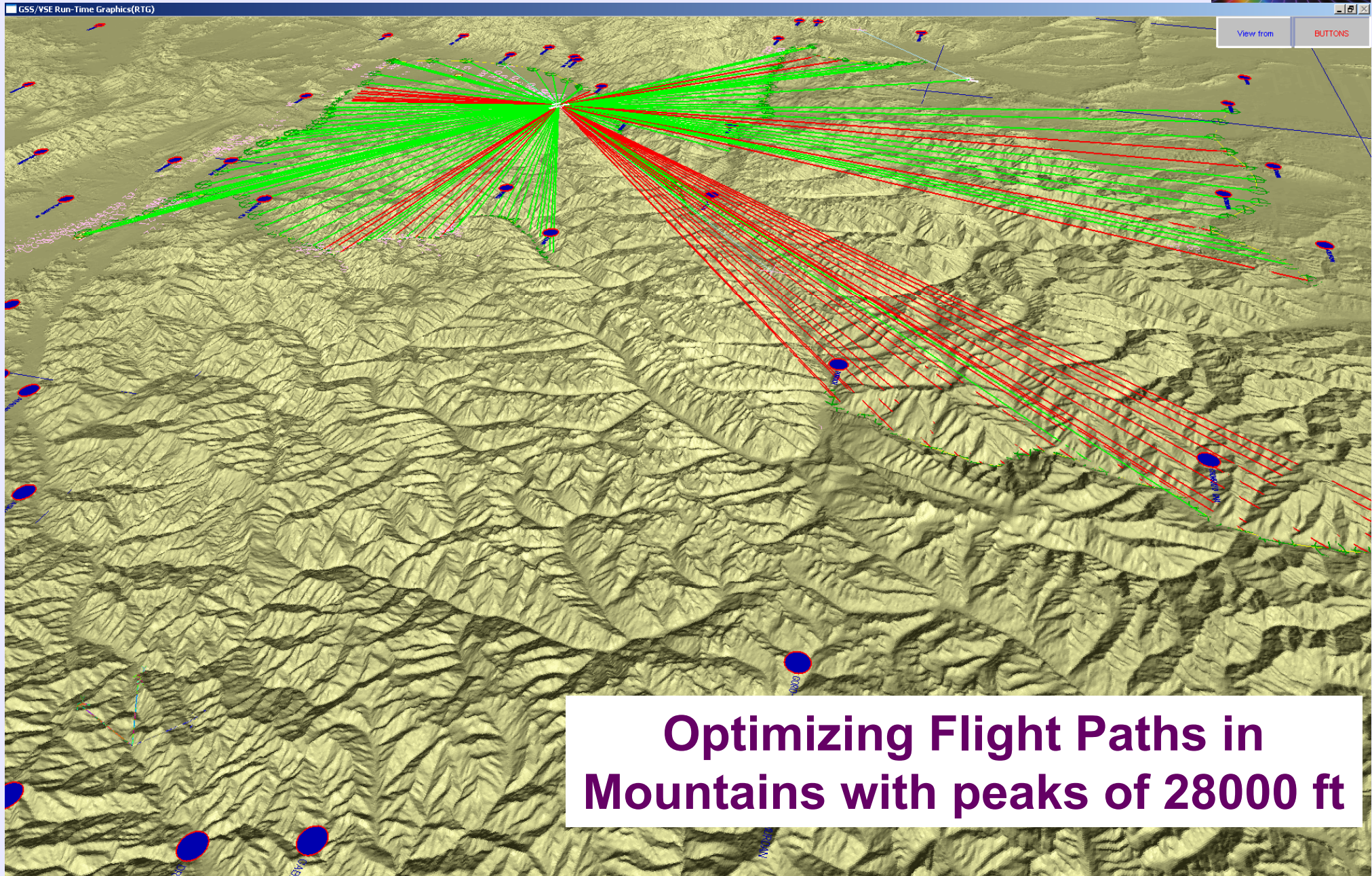
BUTTONS



**Optimizing flight
paths in Afghanistan**



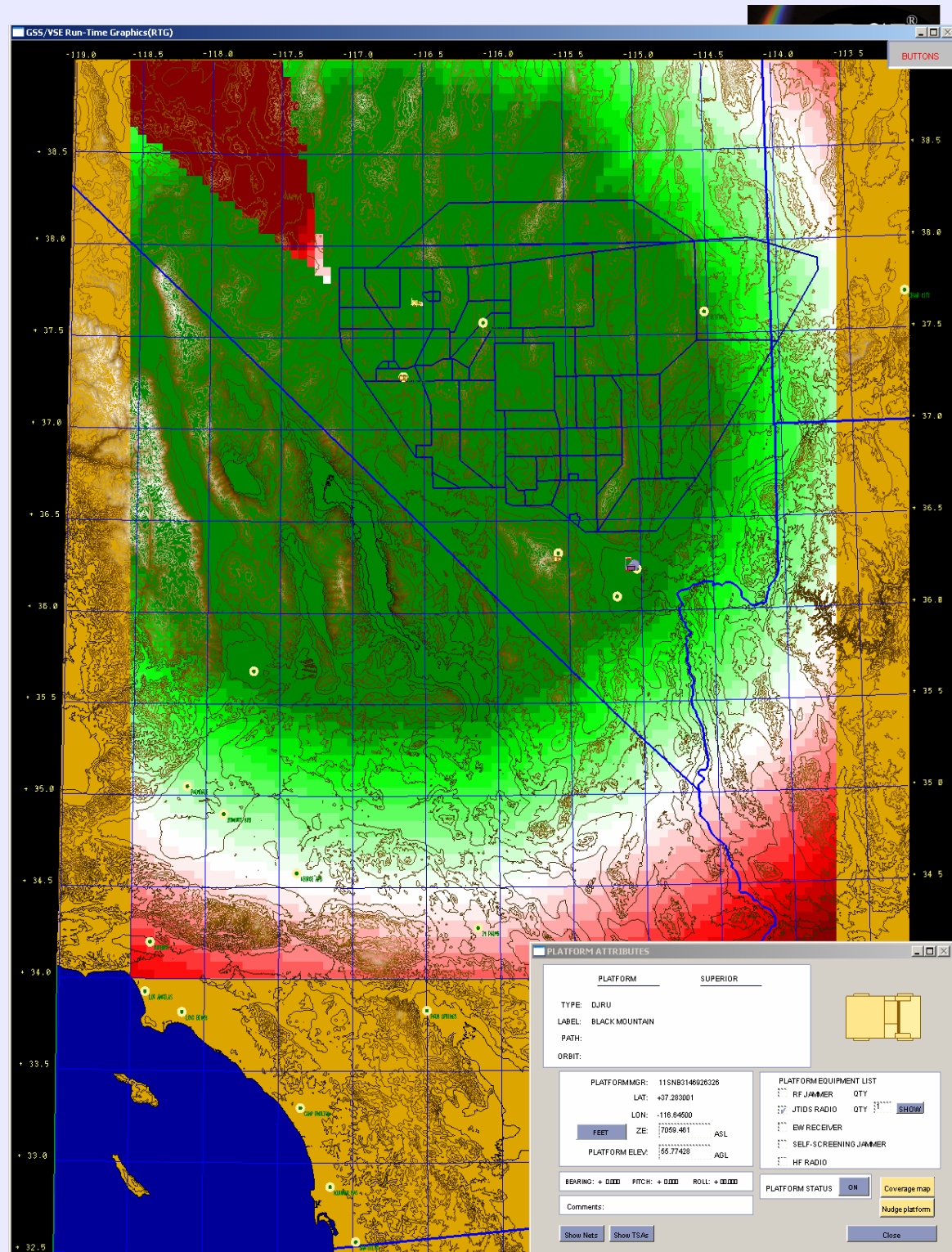
THE PSI SOLUTION



**Optimizing Flight Paths in
Mountains with peaks of 28000 ft**



Example of a Ground to Air Coverage Map from JEFX 09

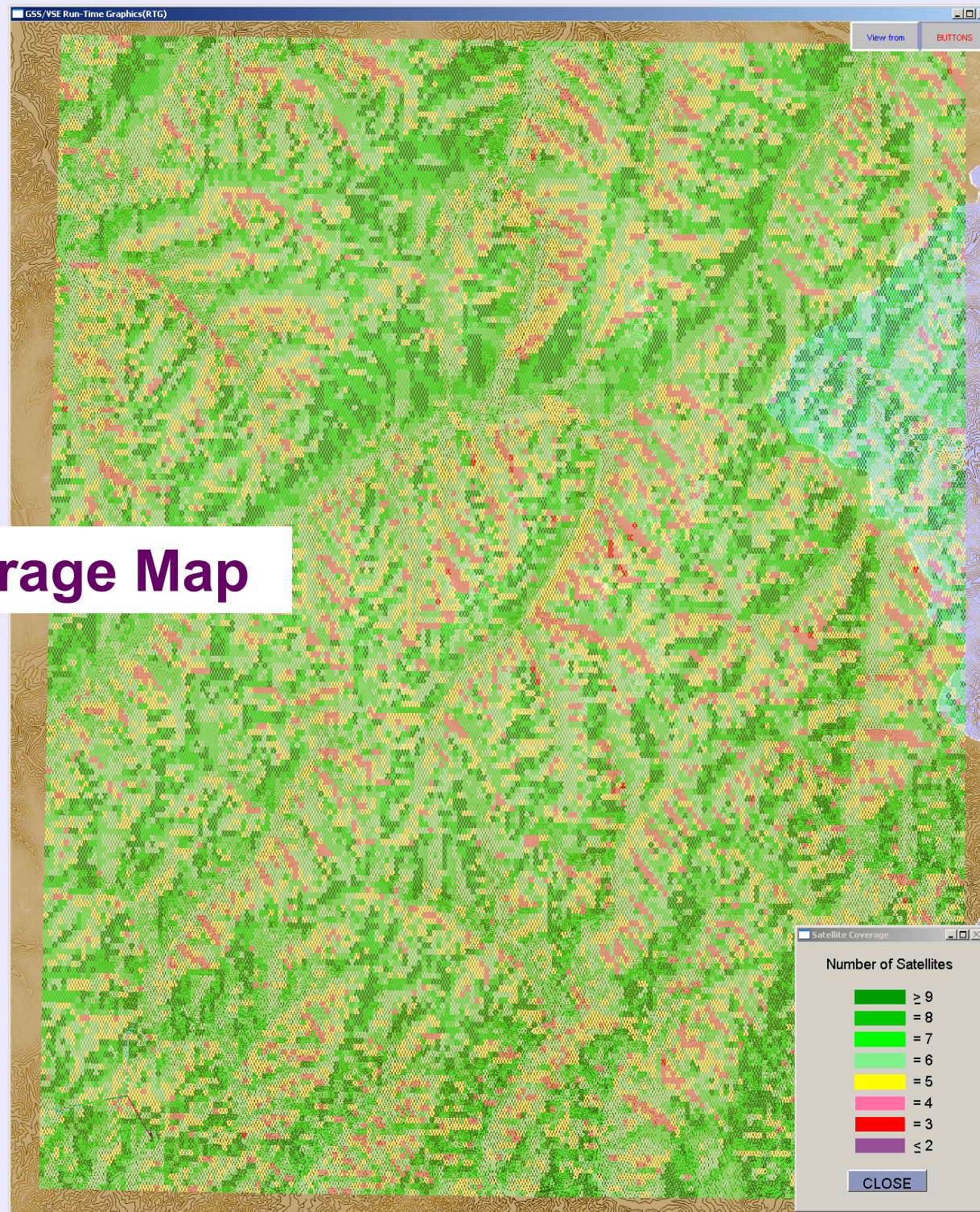




GPS SATELLITE COVERAGE



GPS Coverage Map



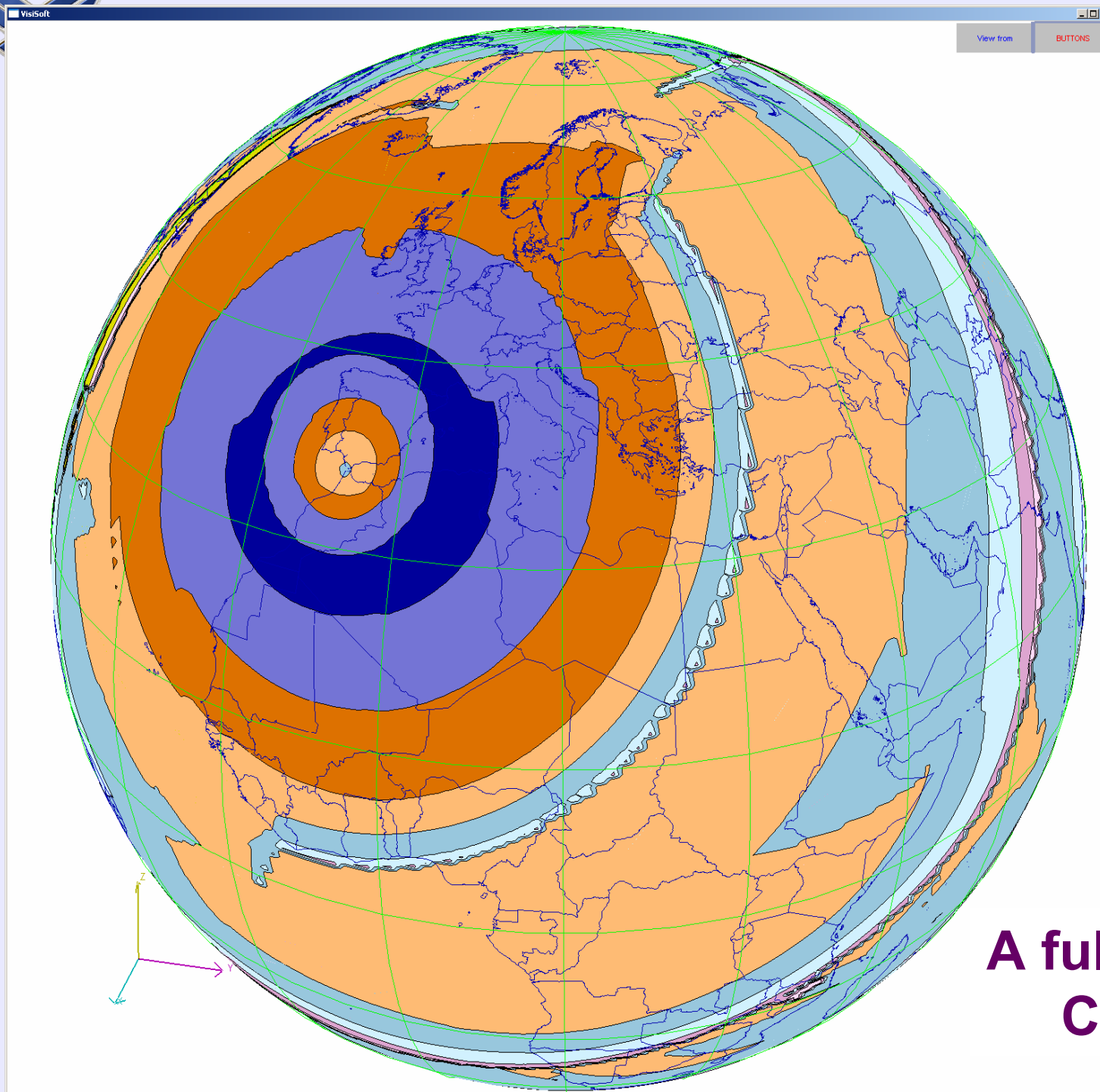


GPS SATELLITE COVERAGE



GPS Path Coverage

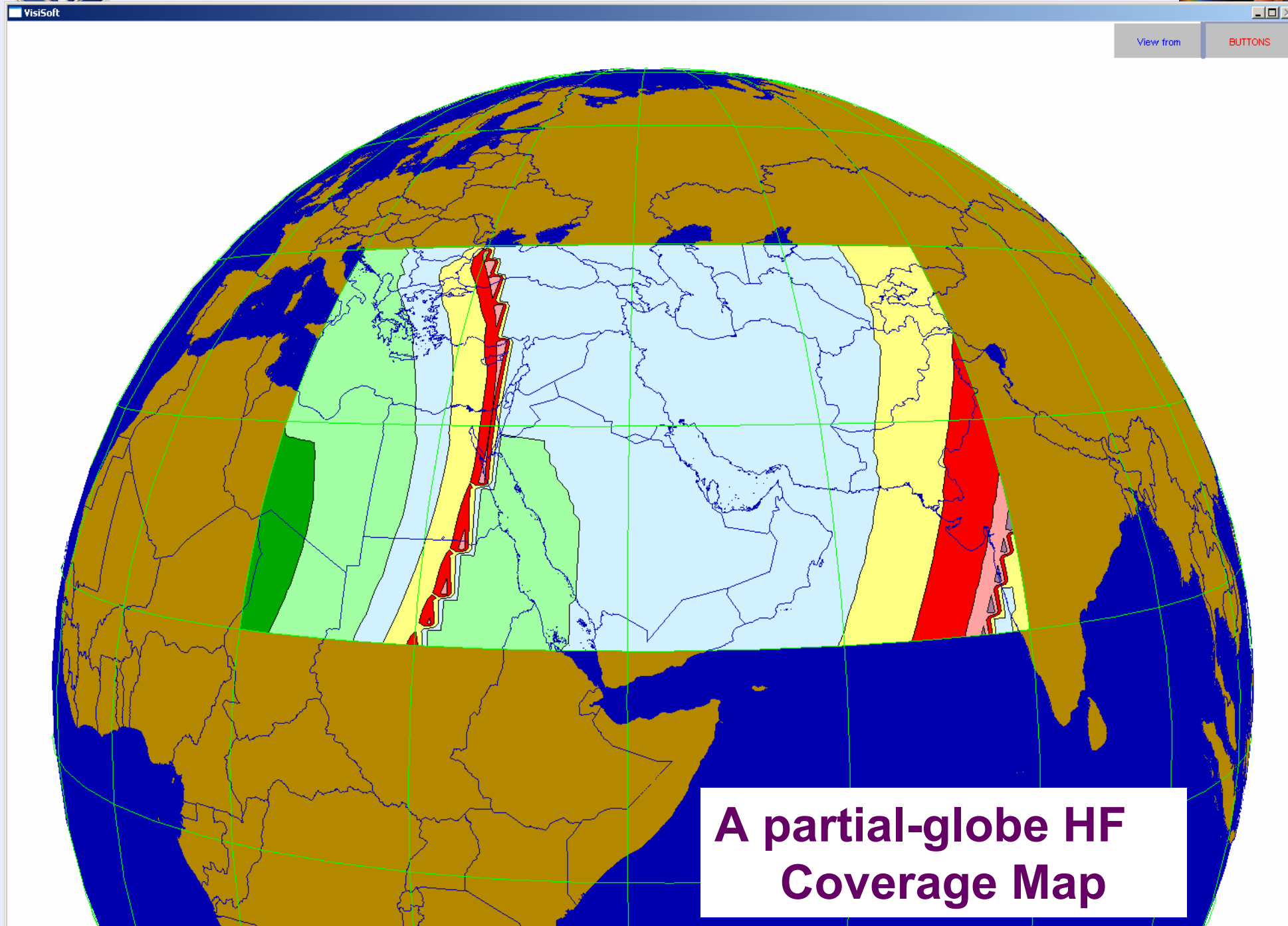
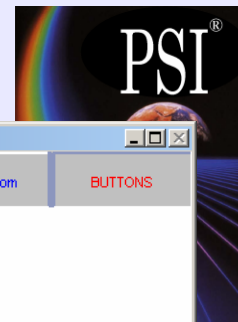
MAPPING HF & SATELLITE COVERAGE



**A full-globe HF
Coverage Map**



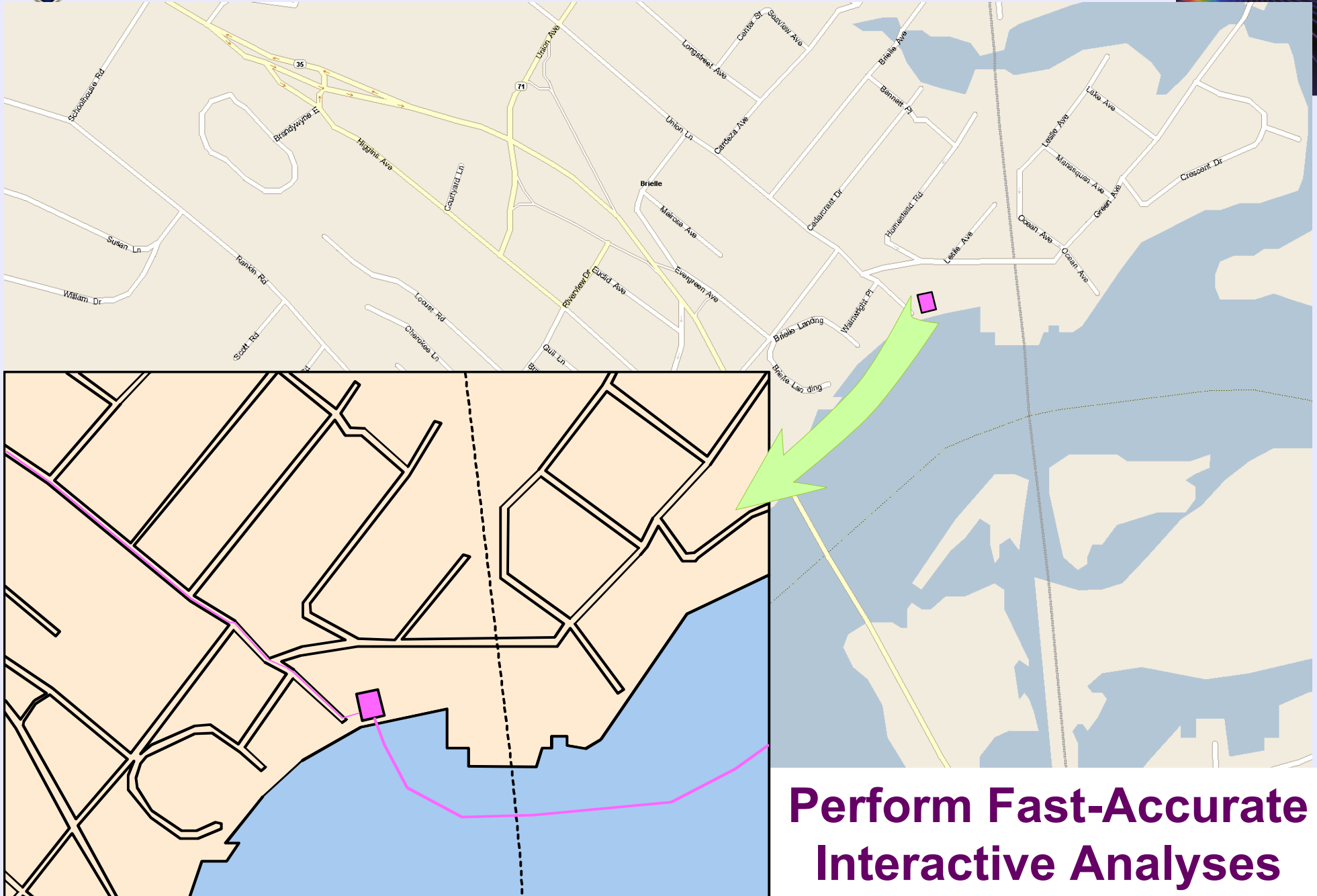
MAPPING HF & SATELLITE COVERAGE



A partial-globe HF Coverage Map



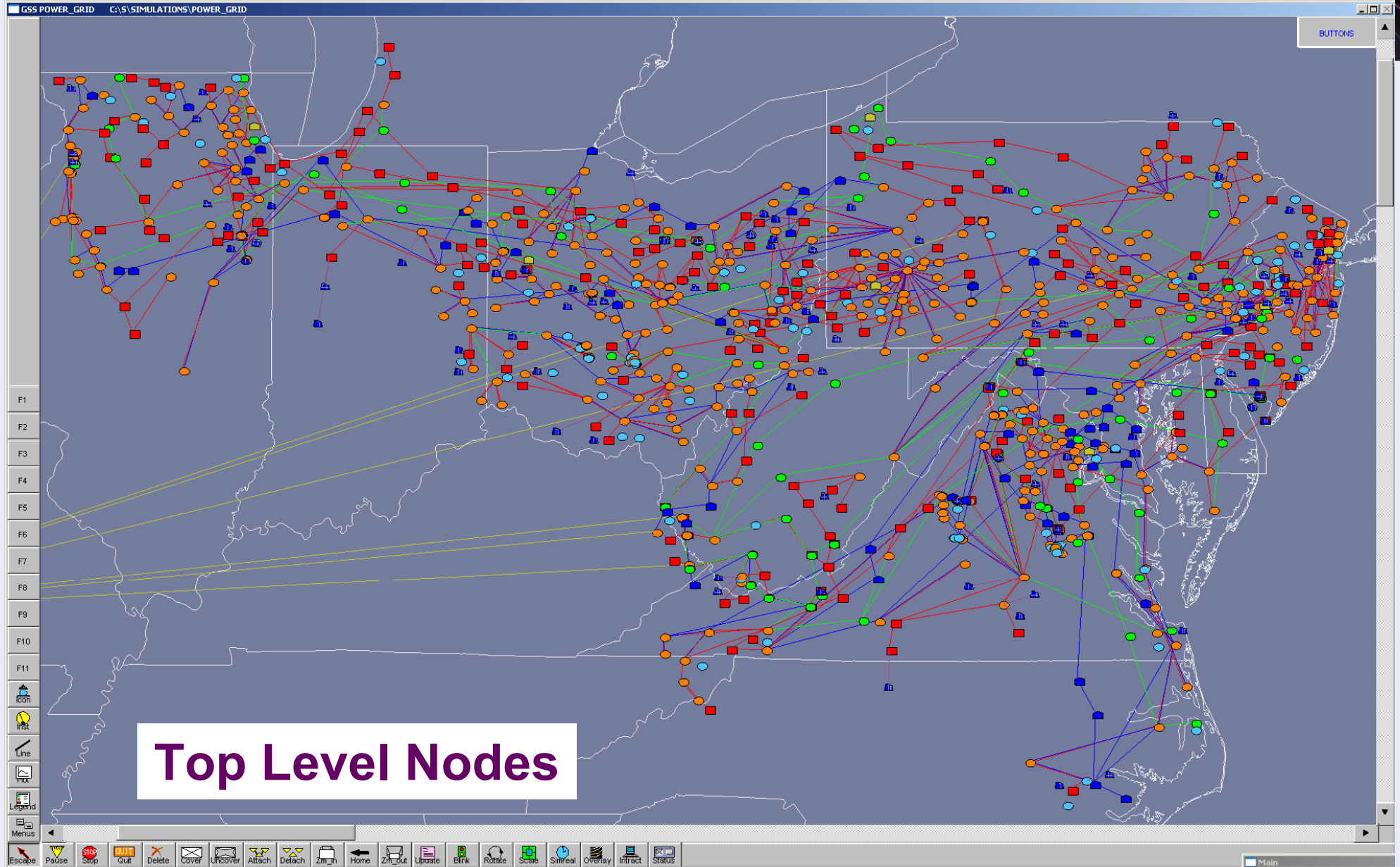
HIGH RESOLUTION (Cm) MAPPING



**Perform Fast-Accurate
Interactive Analyses**

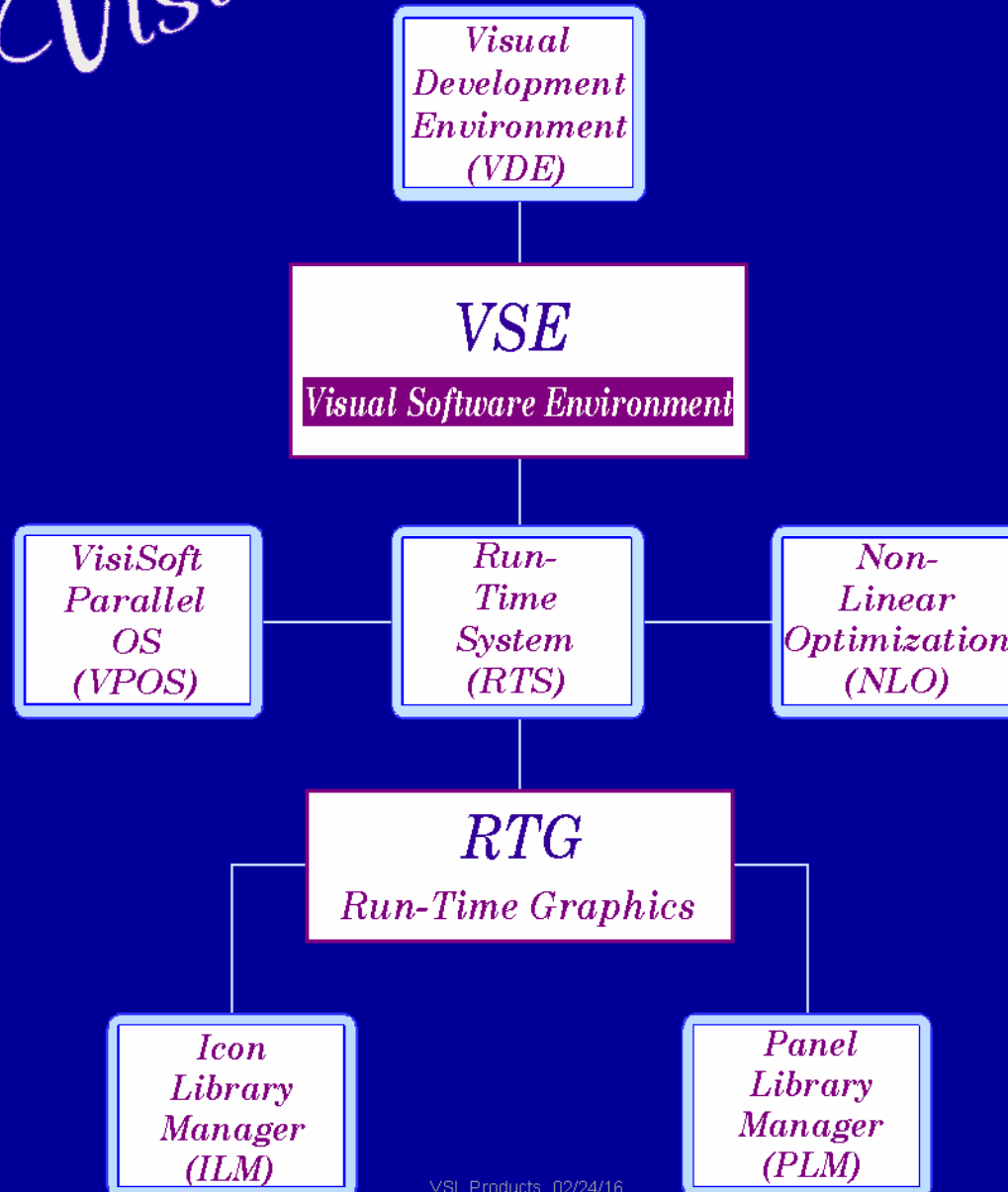


POWER GRID MODELING





VisiSoft®



VSI_Products 02/24/16



**For
High
Productivity
Software
Development
With Very
Fast Run-Time
Speed**

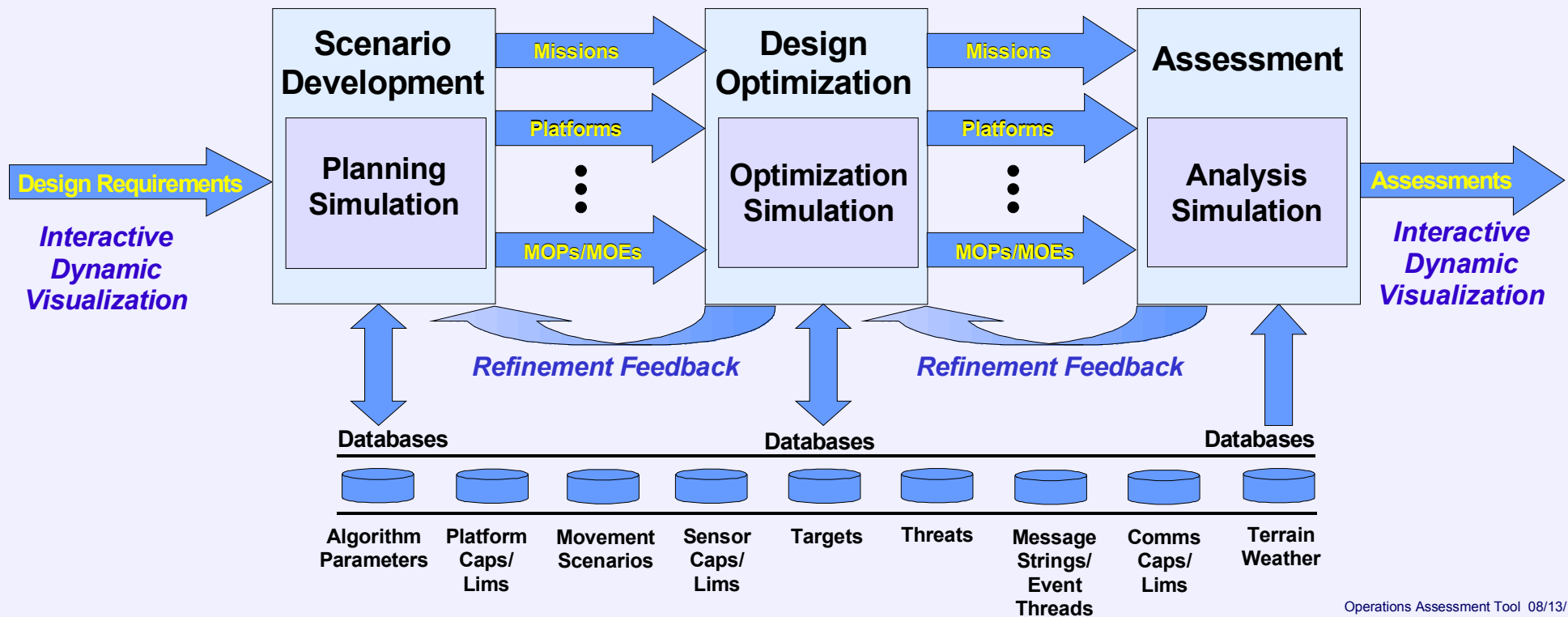


CAD SIMULATION ENVIRONMENT



**Tools for rapidly Building & Modifying Complex Scenarios,
Optimizing Parameters, Measuring Performance & Effectiveness,
and Analyzing & Solving Problems using 3D Visualization.**

CAD SIMULATION TOOLS for ANALYSIS, PLANNING & DESIGN OPTIMIZATION



Operations Assessment Tool 08/13/12

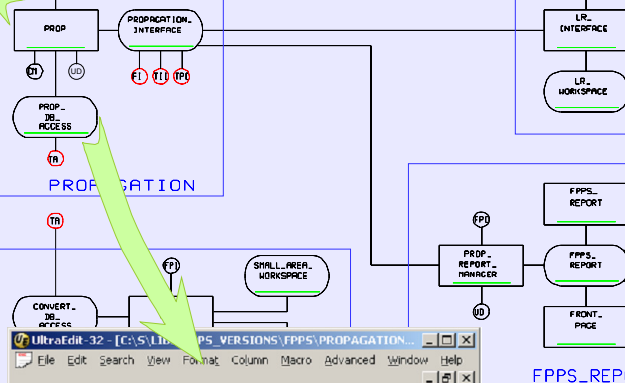
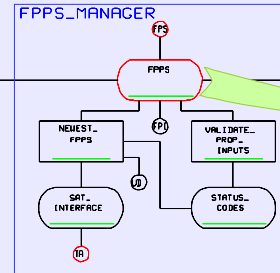


The VisiSoft Development Environment



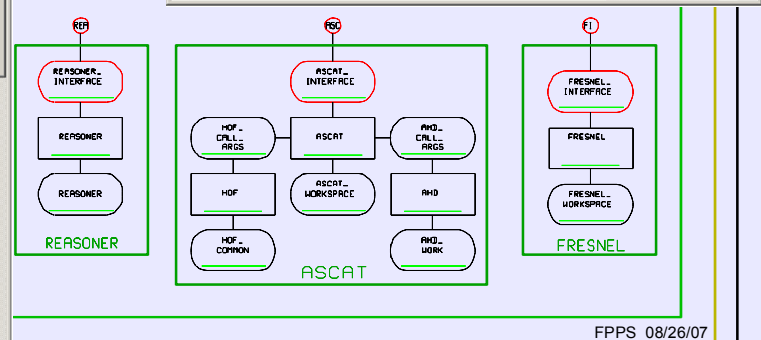
PROPAGATION PREDICTION

```
1 FPPS
2 ERROR_CODE=0
3 IF SYSTEM_ACTION IS INITIALIZATION
4   EXECUTE INITIALIZE_FPPS
5   EXIT THIS RULE
6 ELSE IF SYSTEM_STATE IS NOT INITIALIZED
7   EXECUTE INITIALIZE_FPPS
8   EXECUTE GET_ERROR_MESSAGE
9   EXIT THIS RULE
10
11 IF SYSTEM_ACTION IS A TRANSFORMATION
12   CALL SMALL_AREA
13 ELSE IF SYSTEM_ACTION IS A PROPAGATION_CALC
14   CALL PROP
15   EXCESS_PATH_LOSS = EXCESS_PATH_LOSS + BIAS
16 ELSE IF SYSTEM_ACTION IS A REPORT
17   CALL PROP_REPORT_MANAGER
18 ELSE ERROR_CODE = ERR_SYSTEM_ACTION
19
20 EXECUTE GET_ERROR_MESSAGE
21
22 INITIALIZE_FPPS
23 CALL USER_PARAMETERS
24 EXECUTE INITIALIZE_SAT_DATABASE
25
26 IF ERROR_CODE IS UNDETECTED
27   SYSTEM_STATE = 1
28 ELSE EXIT THIS RULE
29
30 IF REPORT_SELECTION IS OPEN
31 AND SYSTEM_ACTION IS NOT INITIALIZATION
32   MOVE SYSTEM_ACTION TO TEMP_SYSTEM_ACTION
33   MOVE 'I' TO SYSTEM_ACTION
34   CALL PROP_REPORT_MANAGER
35   MOVE TEMP_SYSTEM_ACTION TO SYSTEM_ACTION
36 ELSE CALL PROP_REPORT_MANAGER
37
38 INITIALIZE_SAT_DATABASE
39 IF SYSTEM_STATE IS INITIALIZED
40   EXIT THIS RULE
41
42 DISPLAY 'DATABASE IS ',DATABASE
43 MOVE DATABASE TO DATABASE_NAME
44 DISPLAY 'DATABASE_NAME IS ',DATABASE_NAME
45 IF DATABASE_NAME DOES NOT EXIST
46   ERROR_CODE = ERR_DATABASE_NOT_FOUND
```



```
1 FPPS INPUT DATA
2 1 SYSTEM_PARAMETERS
3 2 SYSTEM_ACTION CHAR 1
4 3 ALIAS_VALID_SYSTEM_ACTION VALUE 'C','R','X','Y'
5 4 ALIAS_INITIALIZATION VALUE 'I'
6 5 ALIAS_TRANSFORMATION VALUE 'X','Y'
7 6 ALIAS_PROPAGATION_CALC VALUE 'C','R','I','P'
8 7 ALIAS_REPORT VALUE 'T'
9
10 2 ALGORITHM_CHOICE INTEGER
11 3 ALIAS_VALID_ALG_CHOICE VALUE 6,7,8,9
12 4 ALIAS_GET_ELEVATION VALUE 1
13 5 2 PATH_PROFILE_ONLY_FLAG CHAR 1
14 6 ALIAS_SET VALUE 'Y'
15 7 2 LOS_ONLY_FLAG CHAR 1
16 8 ALIAS_SET VALUE 'Y'
17 9 2 PROCESS_FOLIAGE_FLAG CHAR 1
18 10 ALIAS_SET VALUE 'Y'
19 11 2 REPORT_SELECTION CHAR 1
20 12 ALIAS_VALID_RPT_SELECTION VALUE 'F','S','N'
21 13 ALIAS_OPEN VALUE 'F','S'
22 14 ALIAS_FULL VALUE 'F'
23 15 ALIAS_SUMMARY VALUE 'S'
24 16 2 PAD CHAR 04
25
26 1 COORDINATE_SYSTEM CHAR 1
27 2 ALIAS_VALID_COORD_SELECTION VALUE 'I','M','L'
28 3 ALIAS_LATLON VALUE 'L'
29 4 ALIAS_MGRS VALUE 'M'
30 5 ALIAS_INTERNAL VALUE 'I'
31
32 1 XMTR_POSITION
33 2 XMTR_REL_POSITION
34 3 XMTR_REL_X REAL
35 4 XMTR_REL_Y REAL
36 5 XMTR_REL_Z REAL
37 6 2 XMTR_MGR_POSITION CHAR 15
38 7 2 XMTR_GEO_POSITION REAL
39 8 XMTR_LAT REAL
40 9 XMTR_LON REAL
```

```
1 COORDINATE_DATA
2 1 START_X REAL
3 2 START_Y REAL
4 3 END_X REAL
5 4 END_Y REAL
6
7 ELEVATION_DATA
8 1 START_TERRAIN_HEIGHT REAL
9 2 END_TERRAIN_HEIGHT REAL
10 3 START_EFFECTIVE_HEIGHT REAL
11 4 END_EFFECTIVE_HEIGHT REAL
12 5 START_HORIZON_DISTANCE REAL
13 6 END_HORIZON_DISTANCE REAL
14 7 START_ELEVATION_ANGLE REAL
15 8 END_ELEVATION_ANGLE REAL
16
17 FOLIAGE_DATA
18 1 START_ANTENNA_HEIGHT REAL
19 2 END_ANTENNA_HEIGHT REAL
20 3 START_FOLIAGE_DISTANCE REAL
21 4 END_FOLIAGE_DISTANCE REAL
22 5 START_ANTENNA_REFERENCE CHAR 01
23 6 END_ANTENNA_REFERENCE CHAR 01
24 7 PAD CHAR 02
25
26 PROFILE_DATA
27 1 TERRAIN_PROFILE QUANTITY(1000) INTEGER
28 2 NUMBER_OF_SAMPLES INTEGER
29 3 INTERVAL REAL
30 4 STA_TERRAIN_GRID_SIZE REAL
31 5 PATH_MIN_ELEV REAL
32 6 PATH_MAX_ELEV REAL
33 7 TERRAIN_IRREGULARITY REAL
34 8 FPPS_ERROR_CODE INTEGER
```



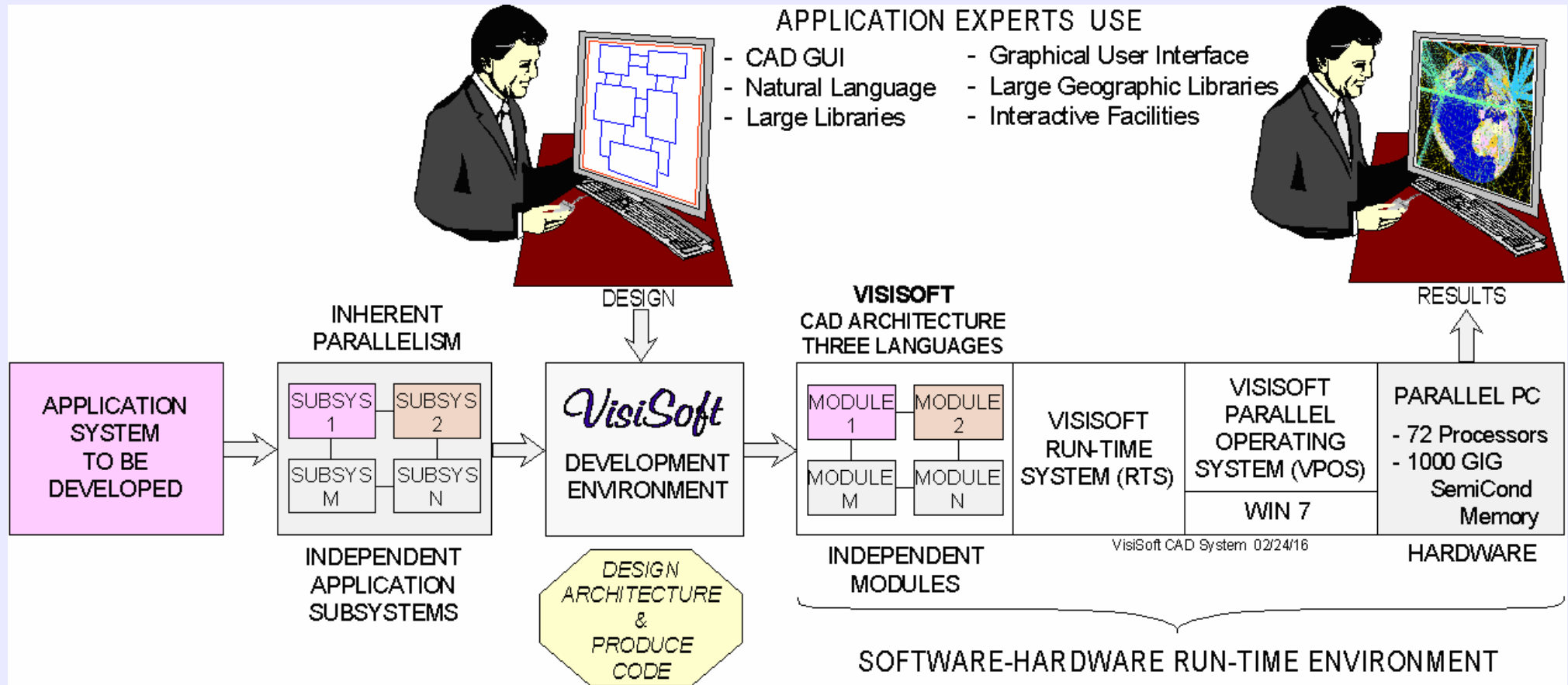
DOUBLE_CLICK
Engineering
Drawing
TO EDIT CODE

DATE	MODEL	PROCESS/RES

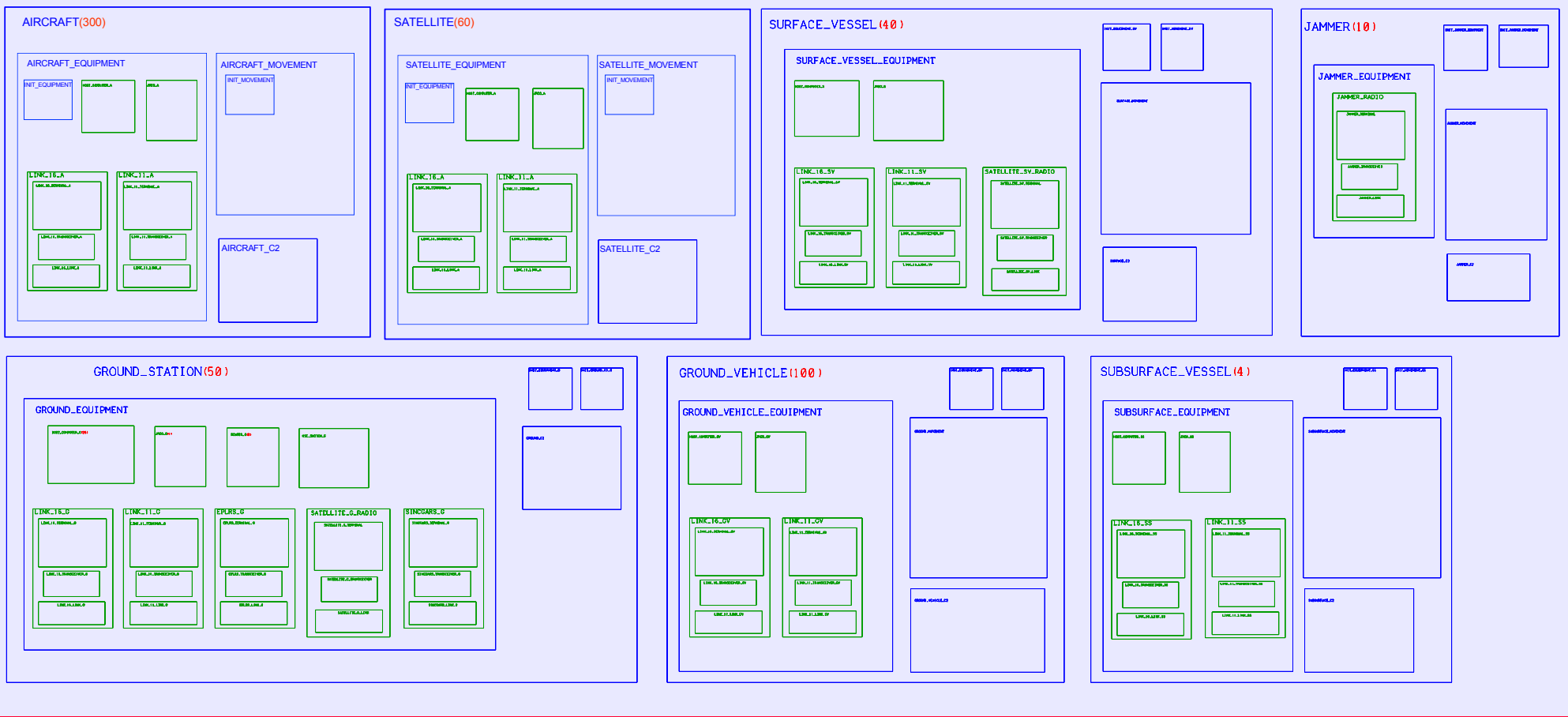
CONTRACT:		COMPANY:	
DR:		MODEL:	
CHK:		PROPAGATION_PREDICTION	
ENG:			
APPD:			
NEXT HIGHER ASSY:		SIZE:	FSCM NO: DWG NO:
DATE: 05/01/04		TIME: 11:00:10	PAGE:



MULTIPLE PLATFORM SIMULATION



Application experts use this CAD system directly!

[illegible]



PSI Core Technologies

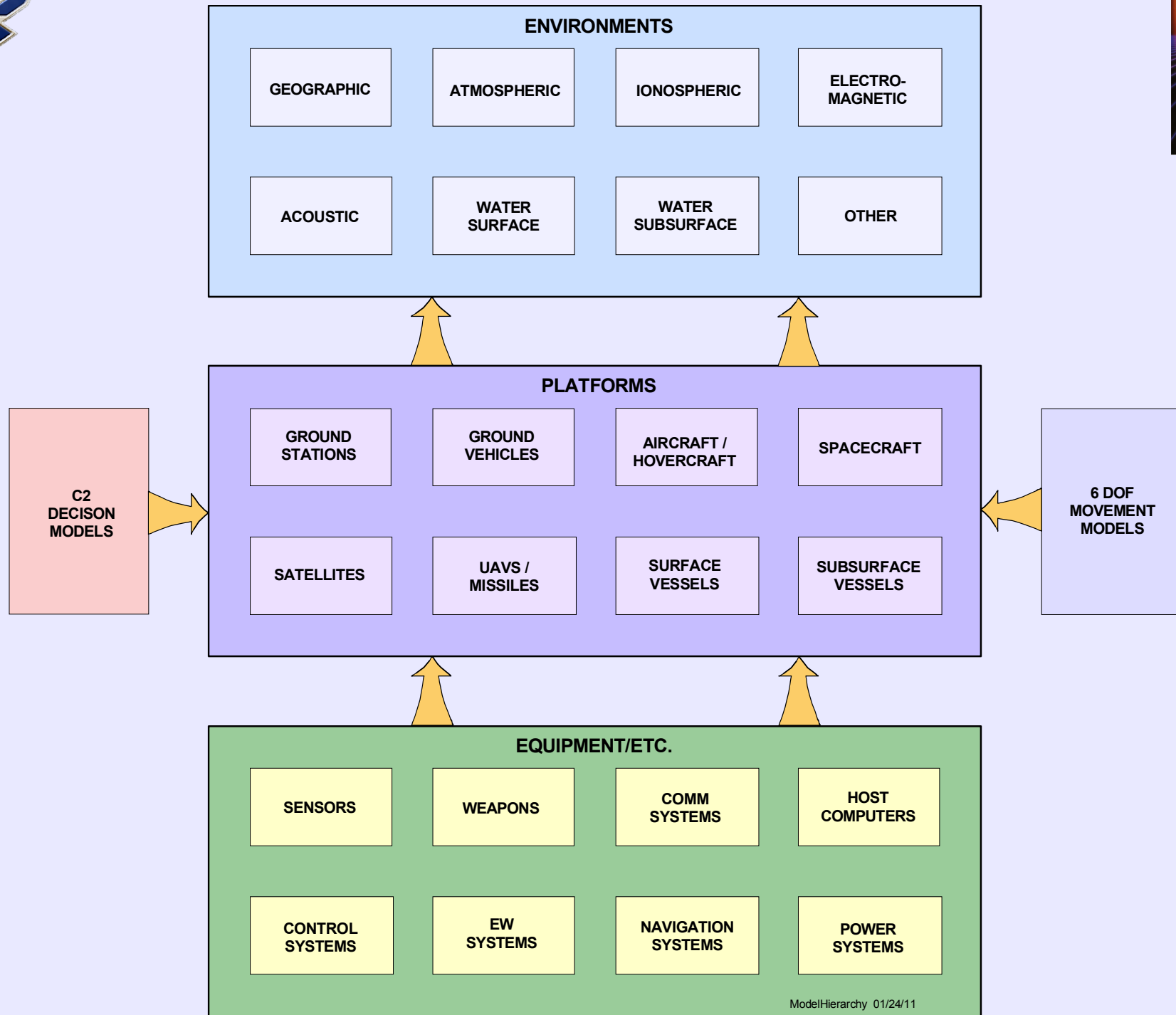


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MODEL HIERARCHY



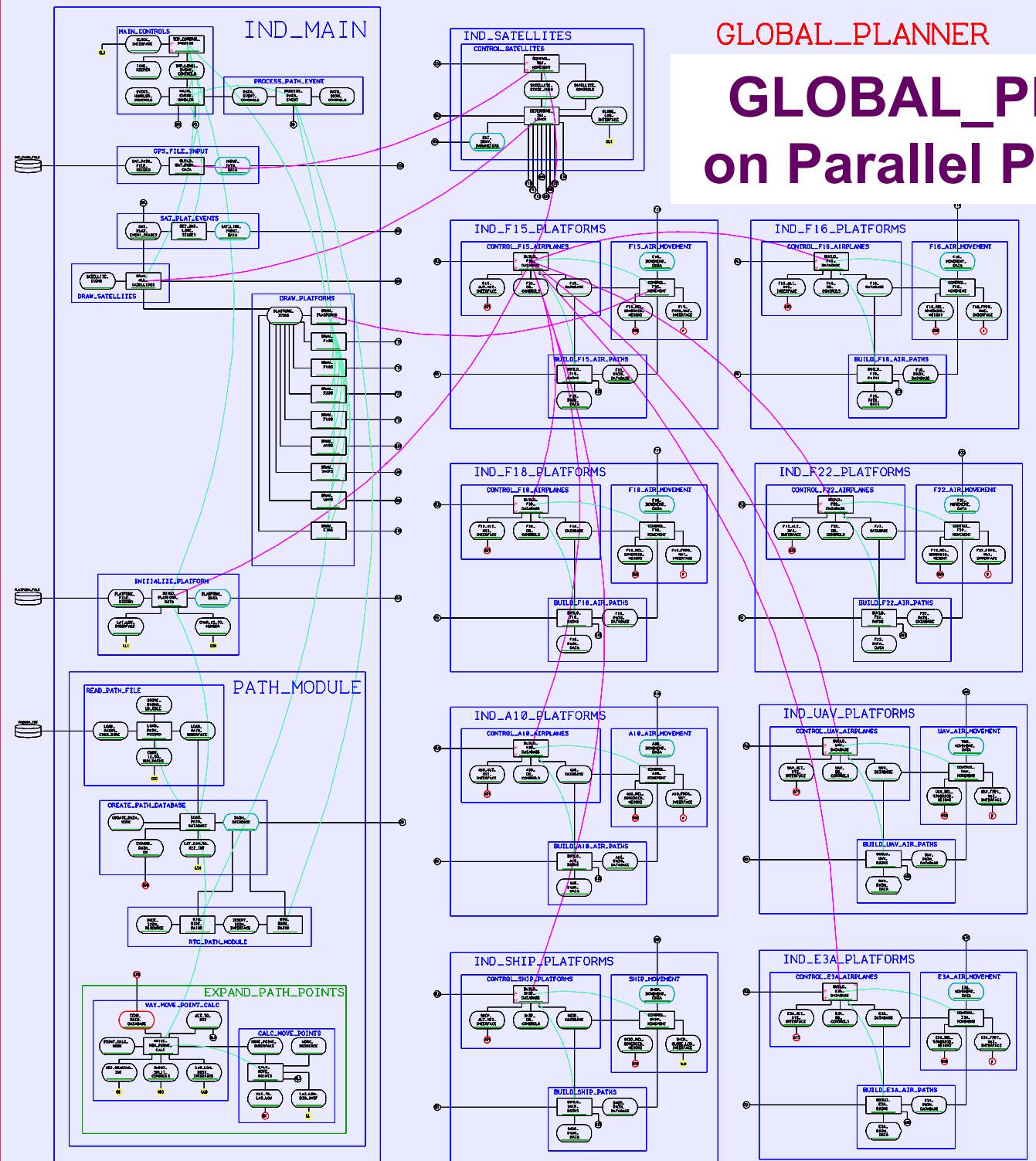
ModelHierarchy 01/24/11





GLOBAL_PLANNER

GLOBAL_PLANNER on Parallel Processors

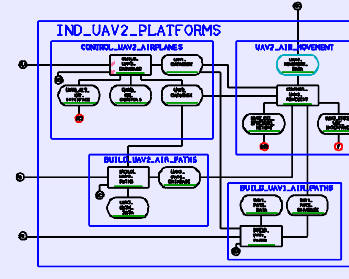
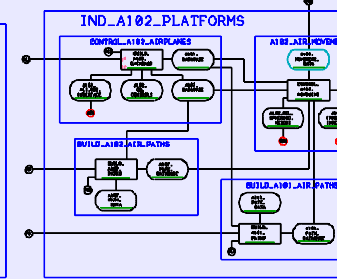
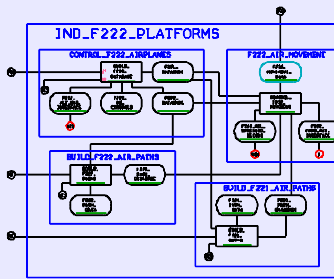
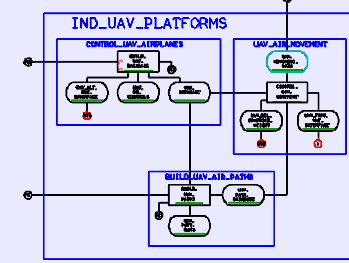
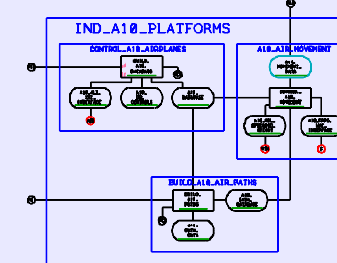
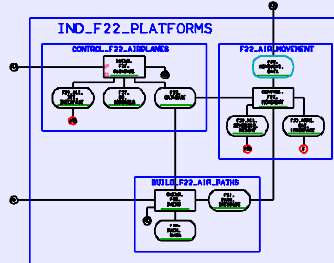
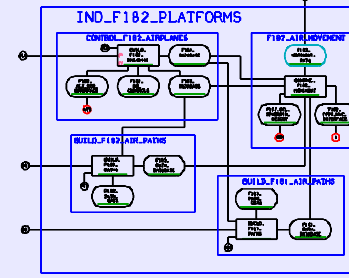
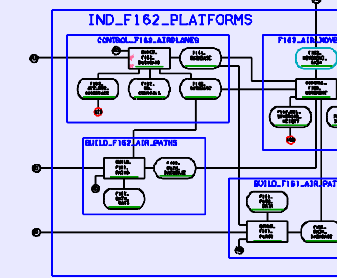
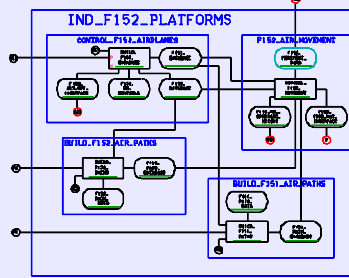
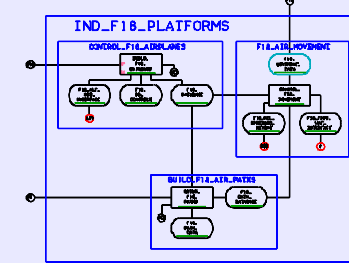
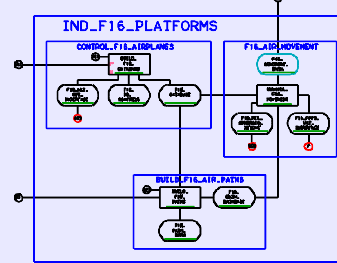
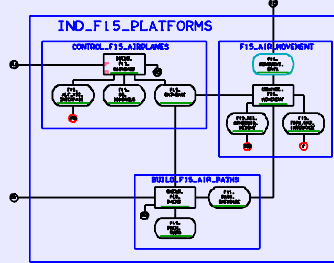
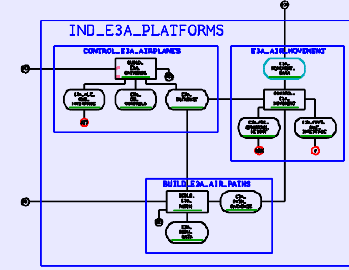
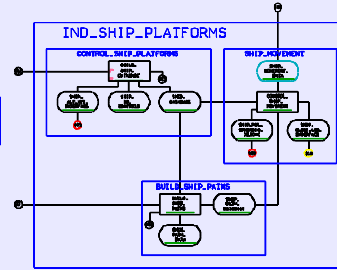
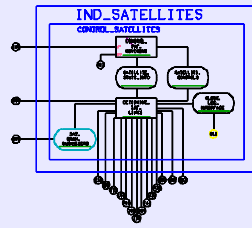
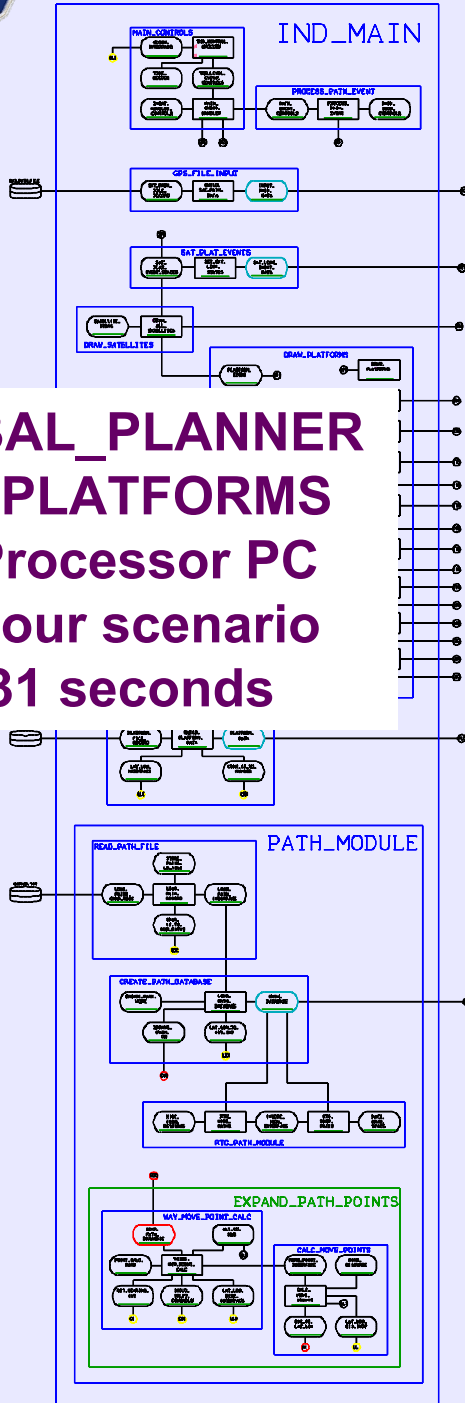




GLOBAL_PLANNER



GLOBAL_PLANNER
153 PLATFORMS
16 Processor PC
12 hour scenario
2.31 seconds

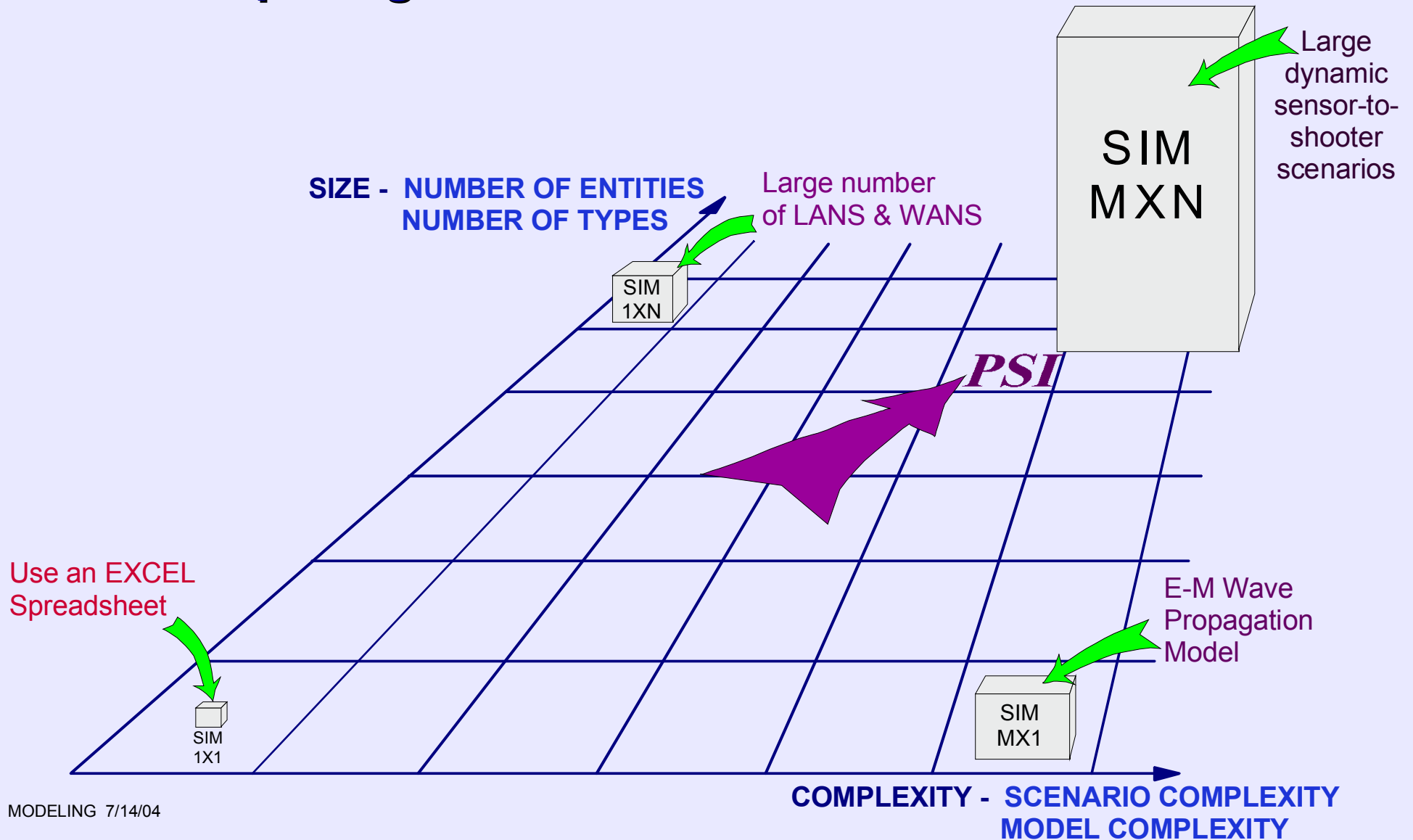




HIERARCHICAL ICONIC MODELING



Comparing Simulation Sizes



MODELING 7/14/04

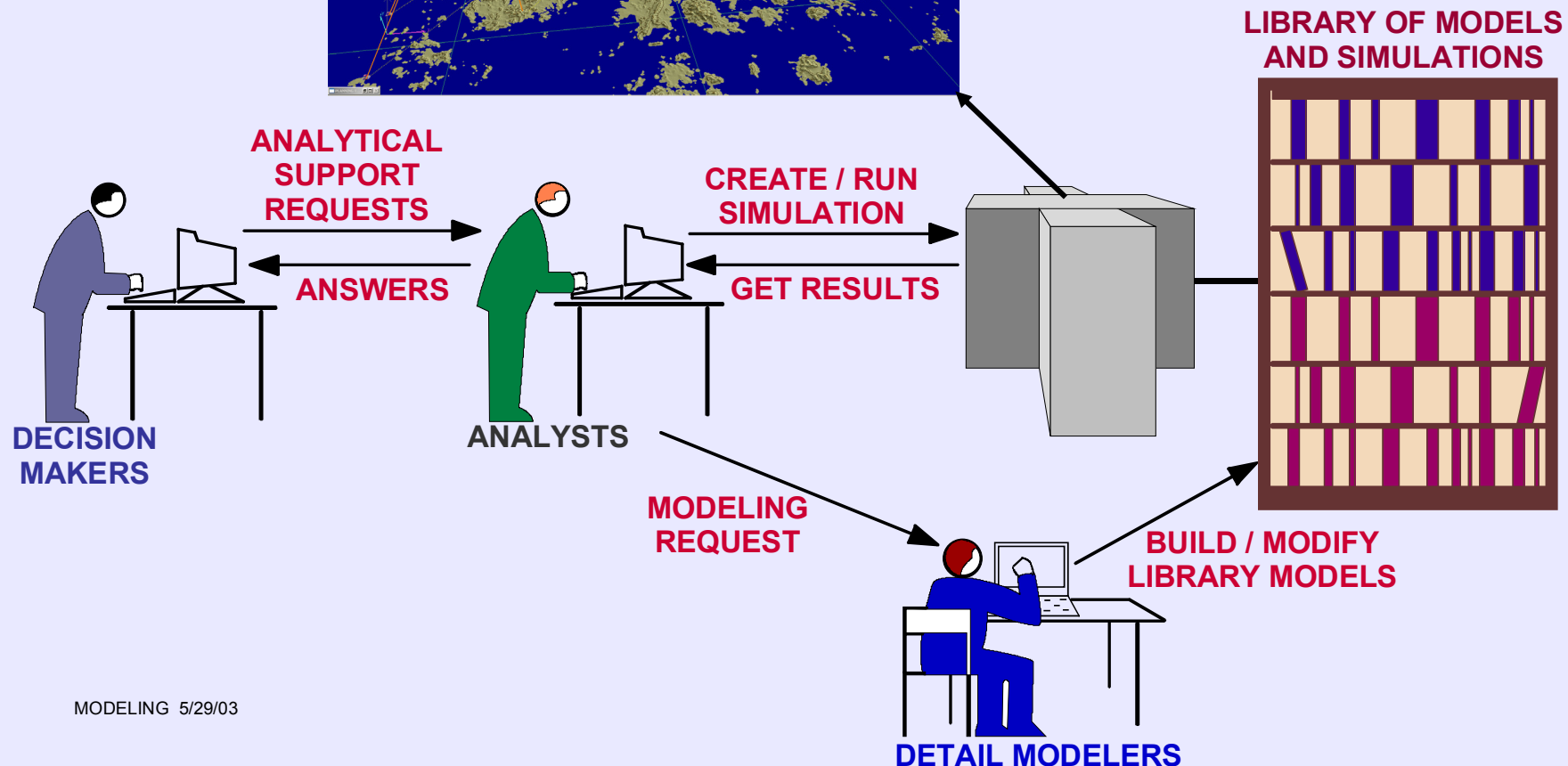
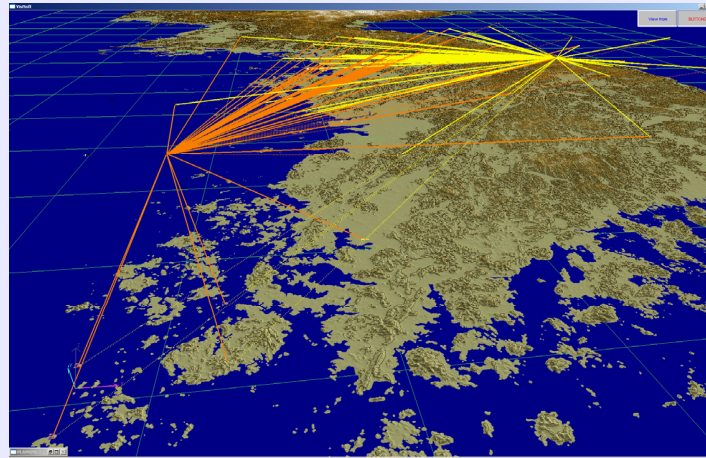


HIERARCHICAL ICONIC MODELING



Infrastructure ==> Simplicity of Effort

The big screen



MODELING 5/29/03



Automatic Development of Simulations

PLATFORM ATTRIBUTES

PLATFORM: SUPERIOR

TYPE: F16
LABEL: VIPER 02
PATH: VIPER 02
ORBIT: 175 OF 999

PLATFORM MGR: 42SXG2497387125
LAT: +37.822987
LON: +70.41998
FEET ZE: 9584.237 ASL
PLATFORM ELEV: 32.8084 AGL

BEARING: +85.301 PITCH: +2.663 ROLL: +00.000

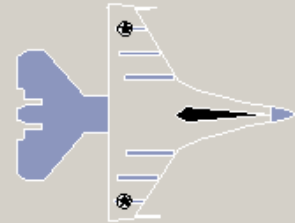
Comments:

PLATFORM EQUIPMENT LIST

- ☐ RF JAMMER QTY
- ☒ JTIDS RADIO QTY 1 **SHOW**
- ☐ EW RECEIVER
- ☐ SELF-SCREENING JAMMER
- ☐ HF RADIO

PLATFORM STATUS **ON**

Buttons: Toggle Platform Path, Show Platform Nets, Show Platform TSAs, Close



Selecting Models & Parameters

EQUIPMENT

- ☐ RF (UHF) JAMMER
- ☒ JTIDS RADIO
- ☐ EARLY WARNING RECEIVER
- ☐ SELF-SCREENING JAMMER
- ☐ HF RADIO

Buttons: Set as Default, Save, Cancel

L16 ANTENNA SELECTION

Platform Label: PLATFORM 002
Type: A10

TX RX BOTH

OMNI ☒ ☐ ☐

SUPP ☒ ☐ ☐

PATTERN 1 ☐

PATTERN 2 ☐

PATTERN 3 ☐

Antenna Gain (dB): 1.5

Antenna Height (M): 6

ACCEPT



PSI Core Technologies



High Productivity CAD Software Development & Simulation Environment

- **Supports Rapid Development of:**
 - High Fidelity, Easy to Understand Models
 - Simulations and Planning Tools
- **Powerful Run-Time Facilities:**
 - Extremely Fast Execution Times
 - High Resolution Graphics
 - Dynamic Interactive Interfaces
 - Built-in Optimization
- **Large and Growing Base of Models**



NewToolsNeeded 03/14/11



*Not everyone
needs the same tools!*





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