



The Environmental Scenario Generator

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Outline

- **INEARP Definition of Concepts**
- **ESG Functionality and Technology**
- **The ESG Deployed at AFCCC**
- **A Forward Look**

**Simulated Views of
Natural Environment
But ...**

**Can I compute realistic
flight performance ?**

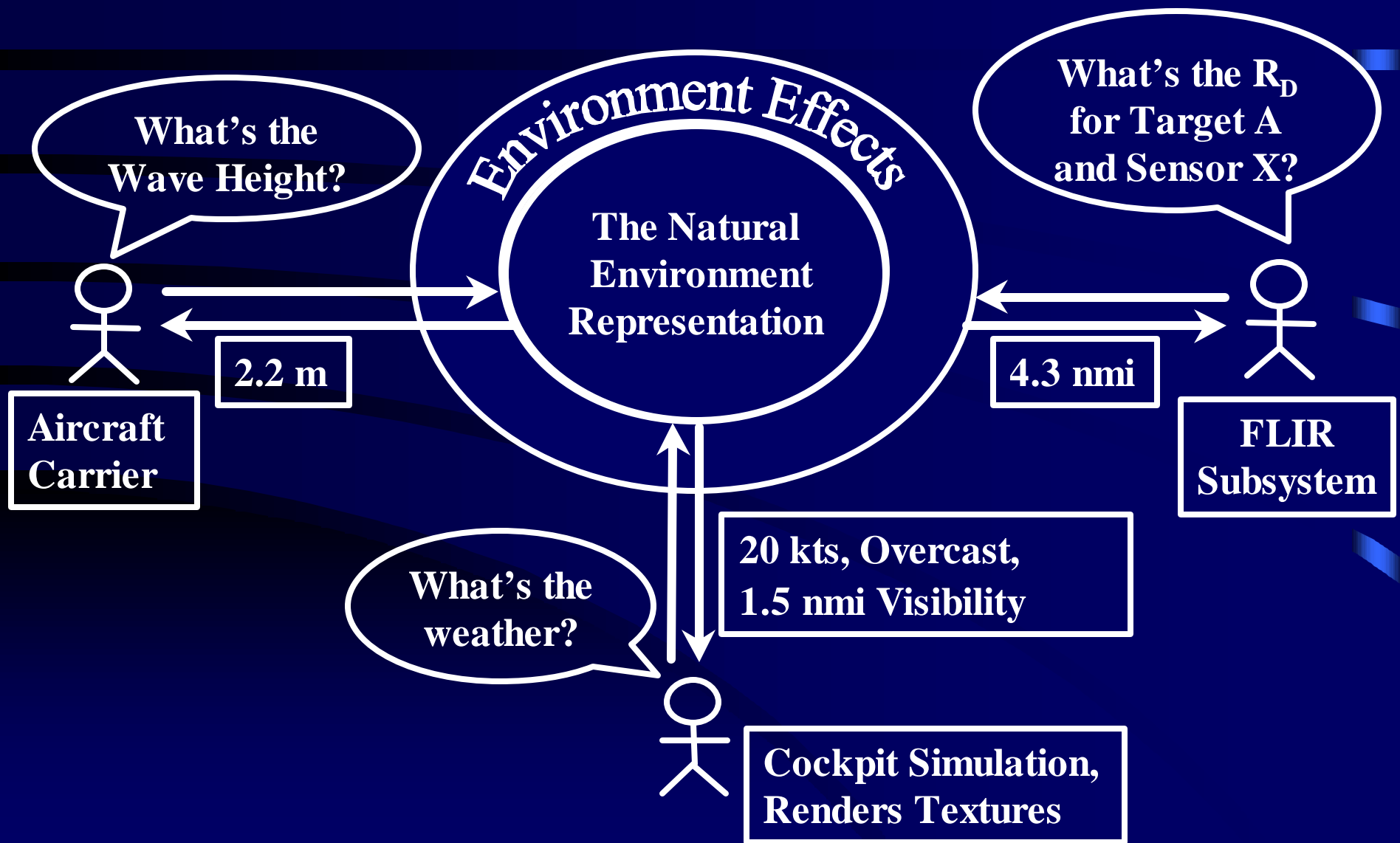
**Can I make sensor
performance computations
through these clouds ?**

Can I really see this light ?

**Is the ocean surface representation
consistent with the surface winds ?**

Microsoft FlightSim image courtesy of Tony Williams (NGIT)

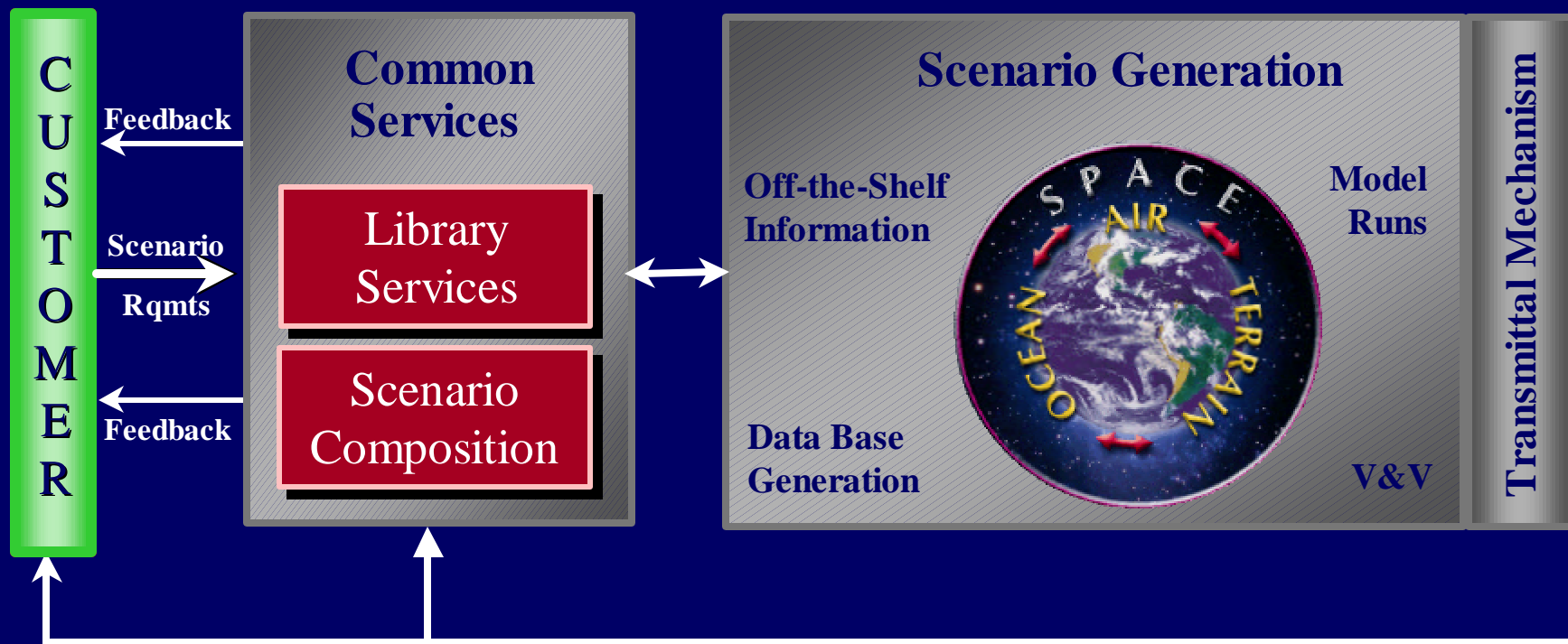
The Need for Consistent Environment



Integrated Natural Environment Authoritative Representation Process

Create a Natural Environment Representation that is Physically Consistent,
both within and among the Atmosphere, Ocean, Space, and Terrain
Domains, for Delivery to a Customer Application / System that meets the
needs of its Components.

Top-Level Conceptual Architecture



Some Key Definitions in the INE - AR - P

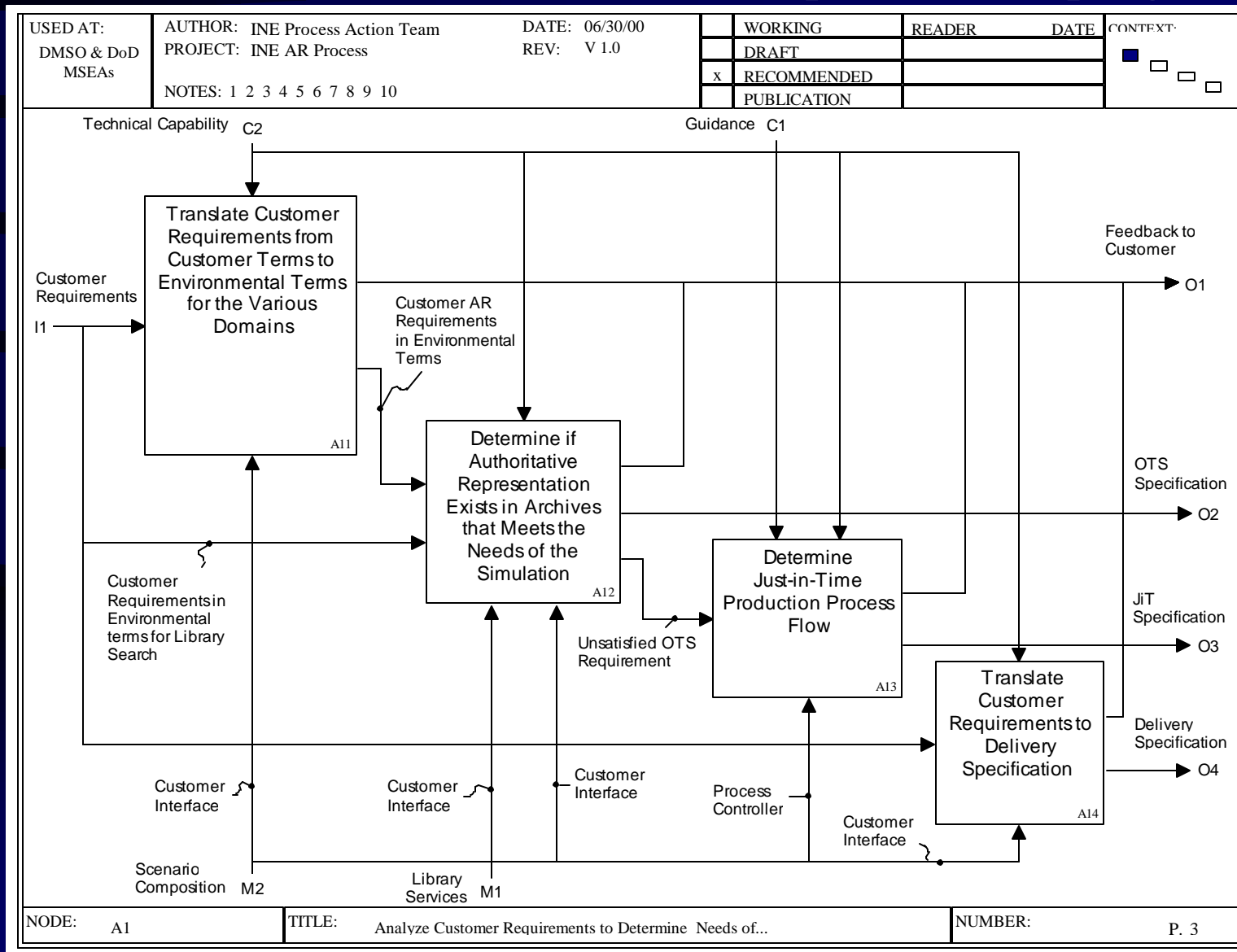
- **Integrated Natural Environment**
 - The natural environment includes all naturally occurring phenomena from “the dirt to the stars”
 - Expanded to include “cultural” features typically included in terrain databases (buildings, roads, etc.)
 - Integrated implies some requirements on the multiple domains
 - Domains should be physically consistent with each other
 - Domain representations should be structurally and syntactically consistent (Yes, this implies data model)
 - Consistent format would be nice too, but is not required
- **Authoritative Representation**
 - This does NOT imply “authoritative” (mandated) resources

Authoritative Representation

- The AR is the “best” (most appropriate) representation for the production of an INE data set
 - Simulation may use an alternate representation derived from AR
- The primary attributes of an AR specification include:
 - The resolution at which the AR is produced
 - The degree to which the domains are coupled
 - The physics packages that are employed
- The AR is determined by the INE providers
 - A collaborative discussion amongst the Resource Owners and/or other MSEA designated SME
 - NOT the M&S customer (and not the ESG System)
- Contributing Factors influencing AR
 - The environmental conditions requested
 - The degree of coupling between the domains
 - The intended use by the customer

INEARP IDEF0 Model

Full Model Available for Review at <http://www.inearp.org>



The Environmental Scenario Generator ?

A Clarification of Terms

- **What is the Environment?**

- **The sum total of all things that can be sensed**
- **The natural environment includes all naturally occurring phenomena from “the dirt to the stars”**
- **ESG, to date, is not focused on typical terrain database features such as buildings, roads, trees, textures, etc. but does include properties of the earth surface**
- **Natural environment representations facilitate meaningful interaction amongst simulation entities**

The Environmental Scenario Generator ?

A Clarification of Terms

- **What is the Environment?**
- **What is a Scenario?**
 - **A predetermined sequence of events that will be used to force the simulation along a desired path**
 - **A natural environment scenario is a specification of some sequence of environmental conditions in which the mission must be accomplished**

The Environmental Scenario Generator ?

A Clarification of Terms

- **What is the Environment?**
 - **What is a Scenario?**
 - **What is the Environmental Scenario Generator?**
- **The ESG project and system of technology and resources is principally about the specification, generation, and provision of the natural environment portion of the simulation scenario**
 - **The objective capability is to provide readily usable environmental representations that will affect the simulated entities, and therefore the simulation outcome, in a realistic manner**

The ESG Mission

- **Analyze Customer Requirements**
 - Capture and understand simulation objectives
 - Analyze fidelity and behaviors of simulation entities
 - Compose environmental scenarios
- **Scenario Search Mechanism**
 - Rapidly search archives for events of interest
 - Analyze candidate events in detail, relative to simulation objectives
- **Produce Integrated and Consistent Environmental Data**
 - Access mechanisms for data archives
 - Model execution in sequence required for domain consistency
 - Customized post-processing and packaging per simulation

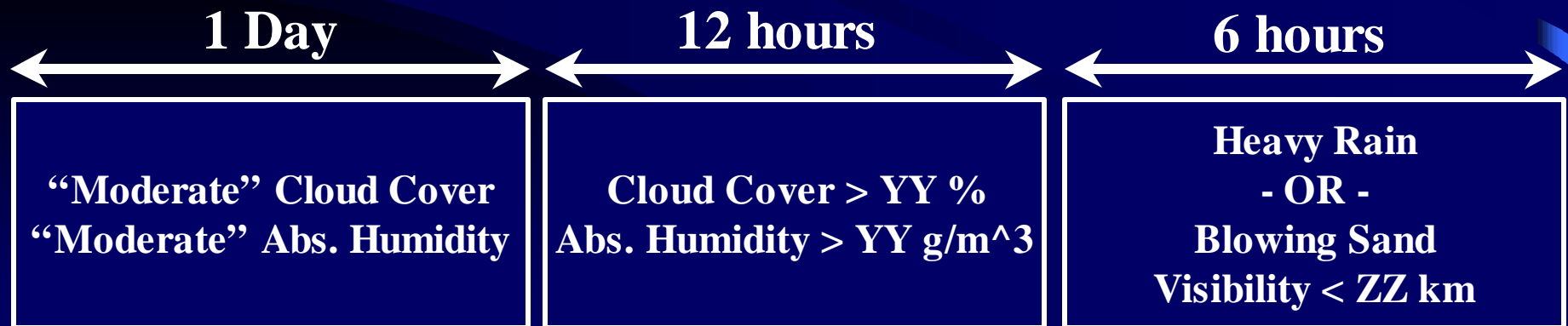
ESG Intelligent Searching: “Data Mining”

- **Search voluminous historical archives for events of relevance to the customer**
 - **Gridded Model Archives**
 - **Observational Data Archives**
- **Translate customer stated requirements into search terms supportable by available data archives**
 - **Customer asks for “Impacted Weapon Performance”**
 - **Translate into search parameters that will yield impacts**
- **Apply fuzzy-logic classification techniques to environmental data parameters to “score” events**

Military Effects Example: F/A-18 Hornet

Analysis of Forward Looking IR (FLIR) radar effects

- “Cloud Cover > XX % reduces ability of FLIR to penetrate.”
- “Cloud Cover > YY % renders the FLIR useless.”
- “Absolute Humidity > XX g/m³ affects the range FLIR can identify targets.”
- “Absolute Humidity > YY g/m³ severely affects the range FLIR can identify targets.”
- “Occurrence of Heavy Rain can severely degrade FLIR effectiveness.”
- “Occurrence of Moderate Sandstorms that reduce visibility below ZZ km can severely degrade FLIR effectiveness.”



Environmental Scenario Generator

Build 4.1.6

Login

Databases

Mining

Visualization

Order

System

Information

Help

Select Databases

ROI & Probes

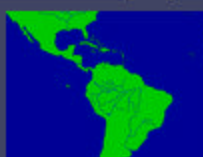
Parameters

Login:

slowe

Databases:

inwsa



Probes:

1 set

ROI:



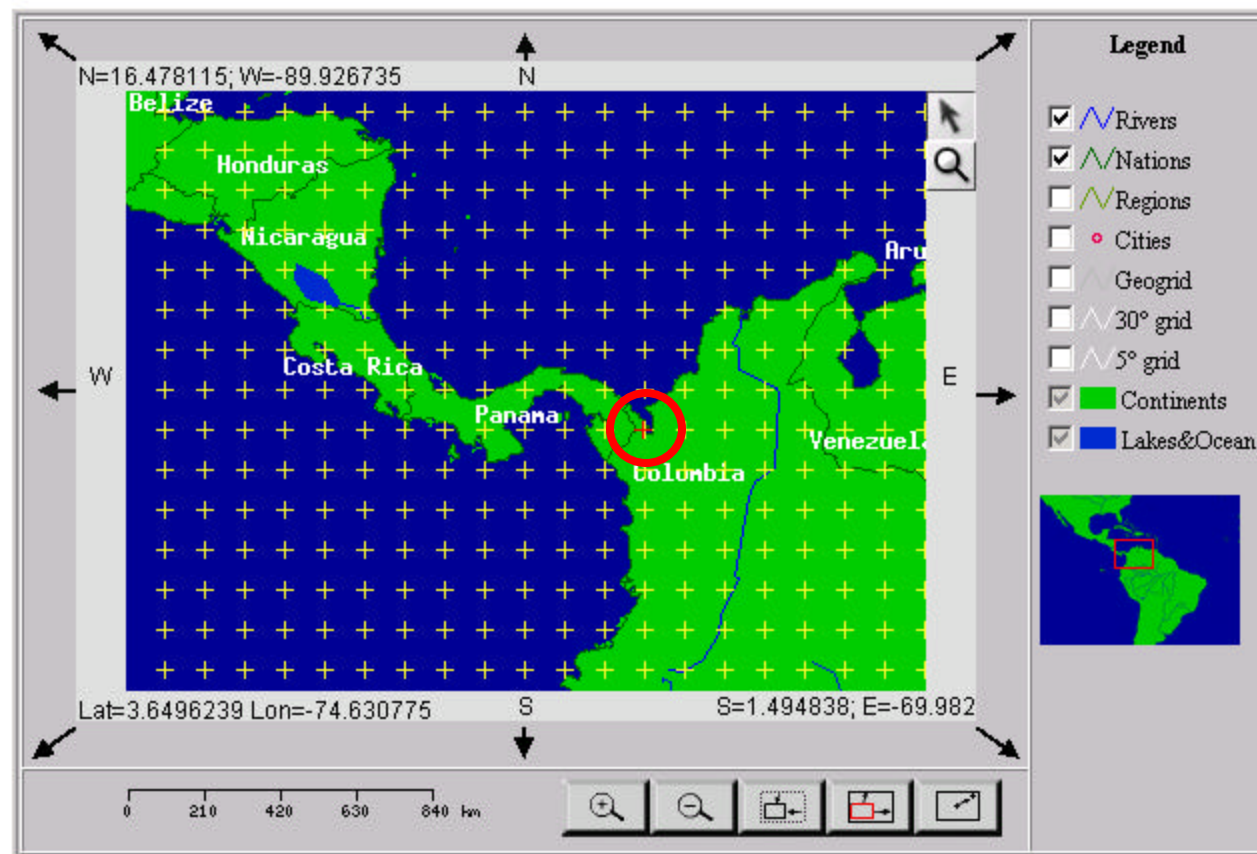
Parameters:

3 set

Scenario states:

2

Clear session



Legend

- ☒ Rivers
- ☒ Nations
- ☐ Regions
- ☐ Cities
- ☐ Geogrid
- ☐ 30° grid
- ☐ 5° grid
- ☒ Continents
- ☒ Lakes&Ocean



Set probes

Set ROI

Clear selection

ESG Web Interface Build 4.1 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <https://esgweb.afccc.af.mil/esg/index.html> Go

Environmental Scenario Generator

Build 4.1.6

Login Databases Mining Visualization Order System Information Help

Fuzzy State **Weather Scenario** Events

Temporal Extent

☐ Seasonal time intervals

Date Range: 19970101 to 19980630

Date from, inclusive (year month day): 1997 Jan 1

Date to, inclusive (year month day): 1998 Jun 30

Time window: 1 day

Weather Scenario Fuzzy States

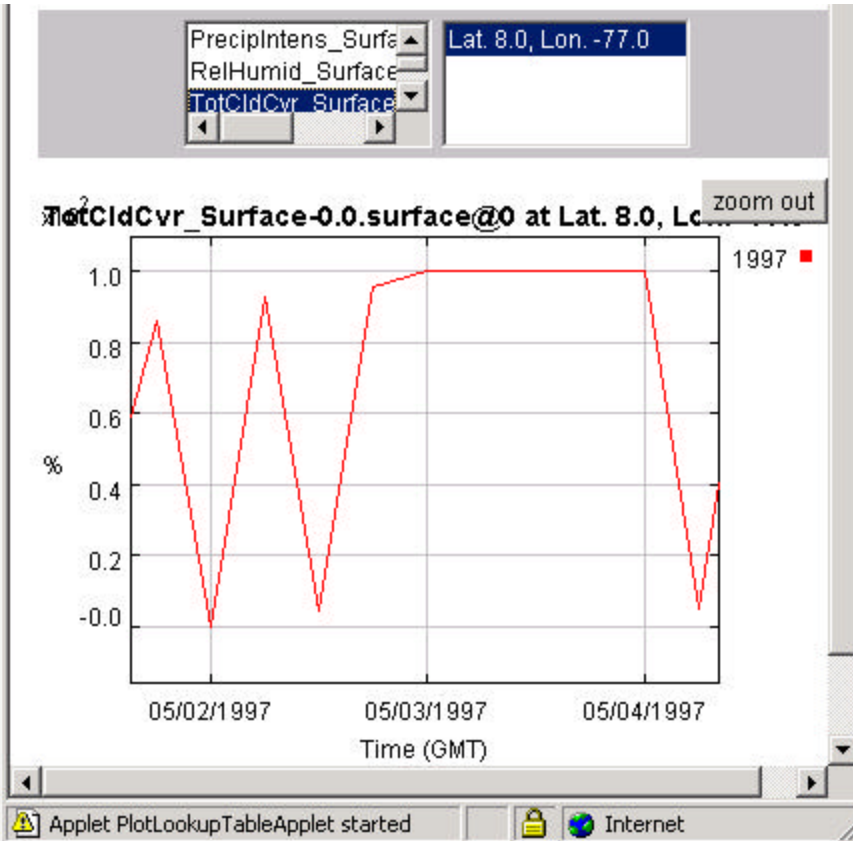
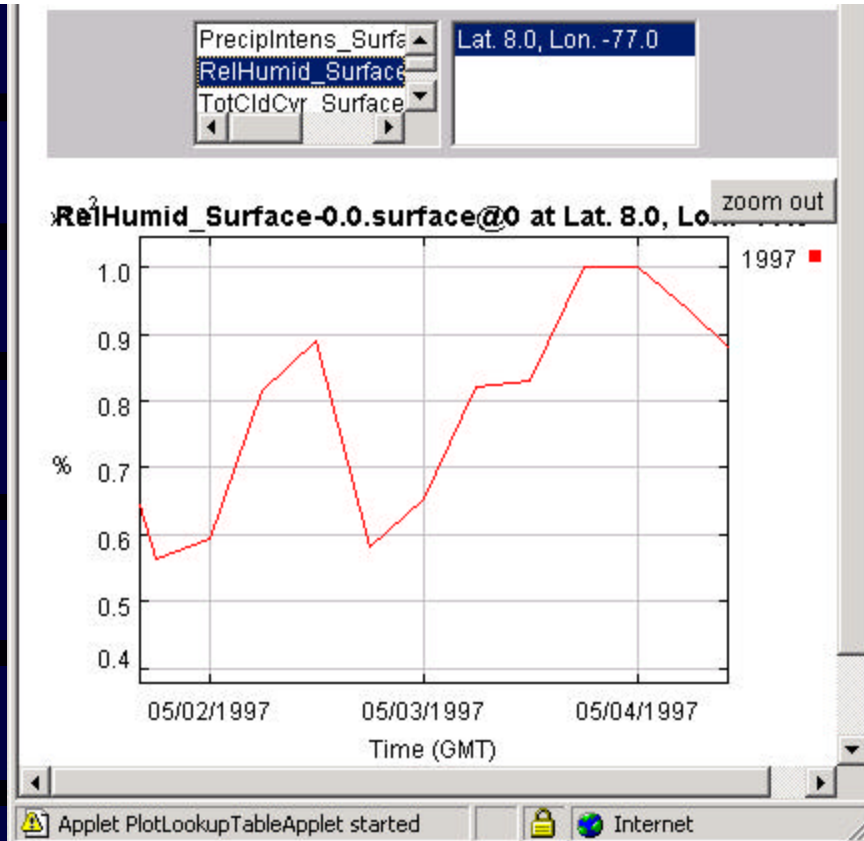
| Database | Parameter | Height | Units |
|----------|------------------------------------|---------|----------|
| jnwsa | Precipitation Rate | surface | kg/m/m/s |
| jnwsa | Relative Humidity | surface | % |
| jnwsa | Total Cloud Cover | surface | % |

Scenario search Remove current state Clear scenario

Clear session

javascript:onClick=callHelp()

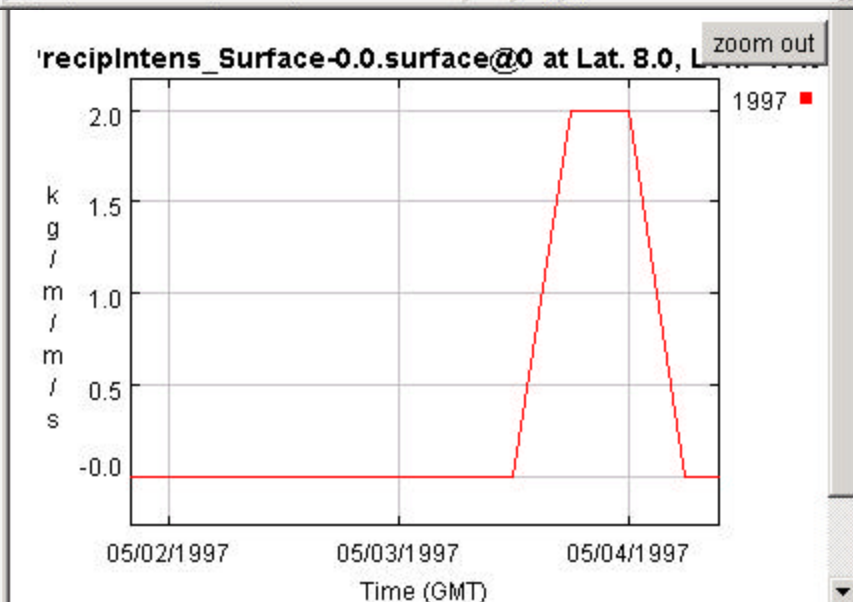
Internet



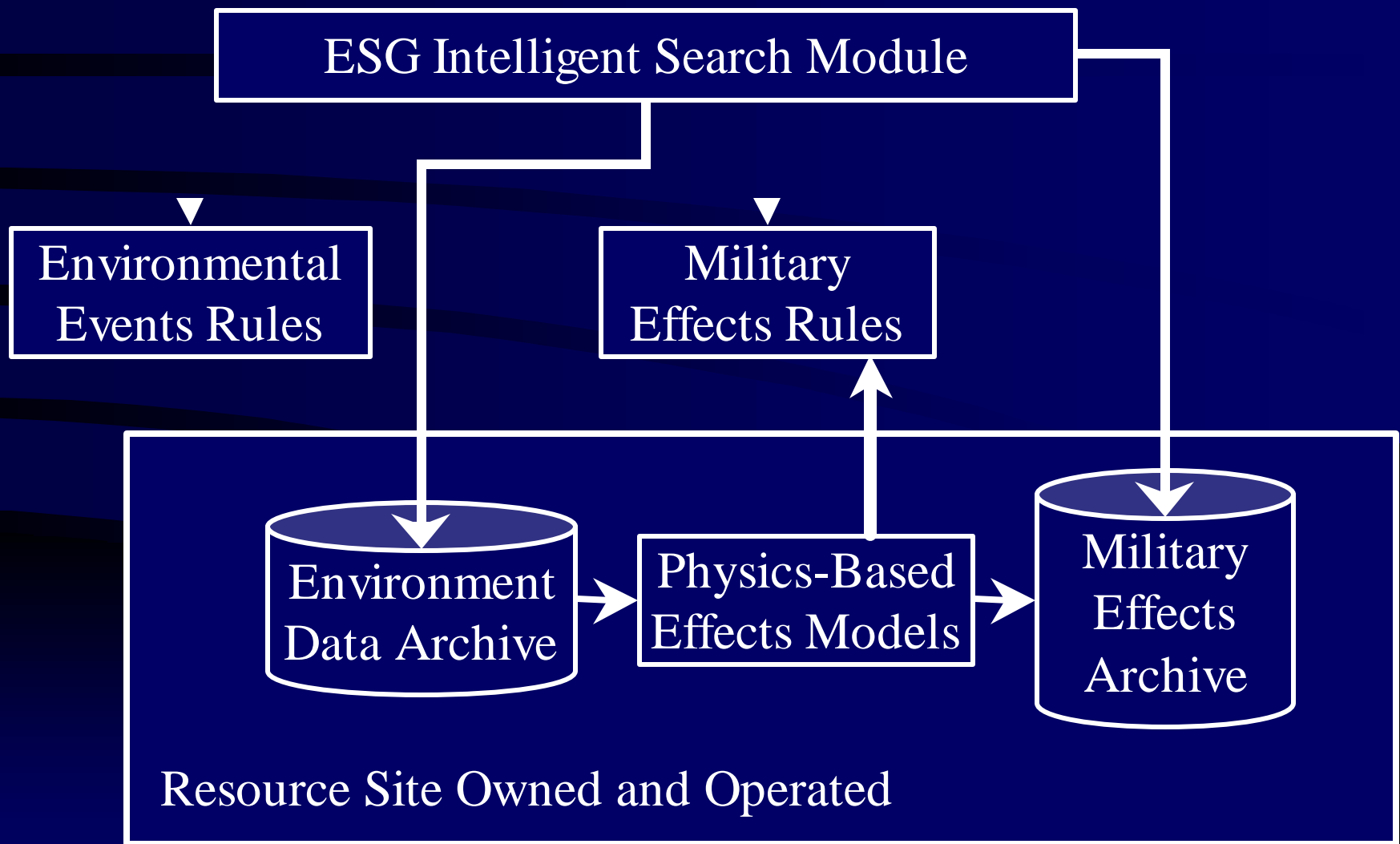
Within seconds ...

A reasonable event is
found that shows the
desired pattern.

May 2 – 4, 1997



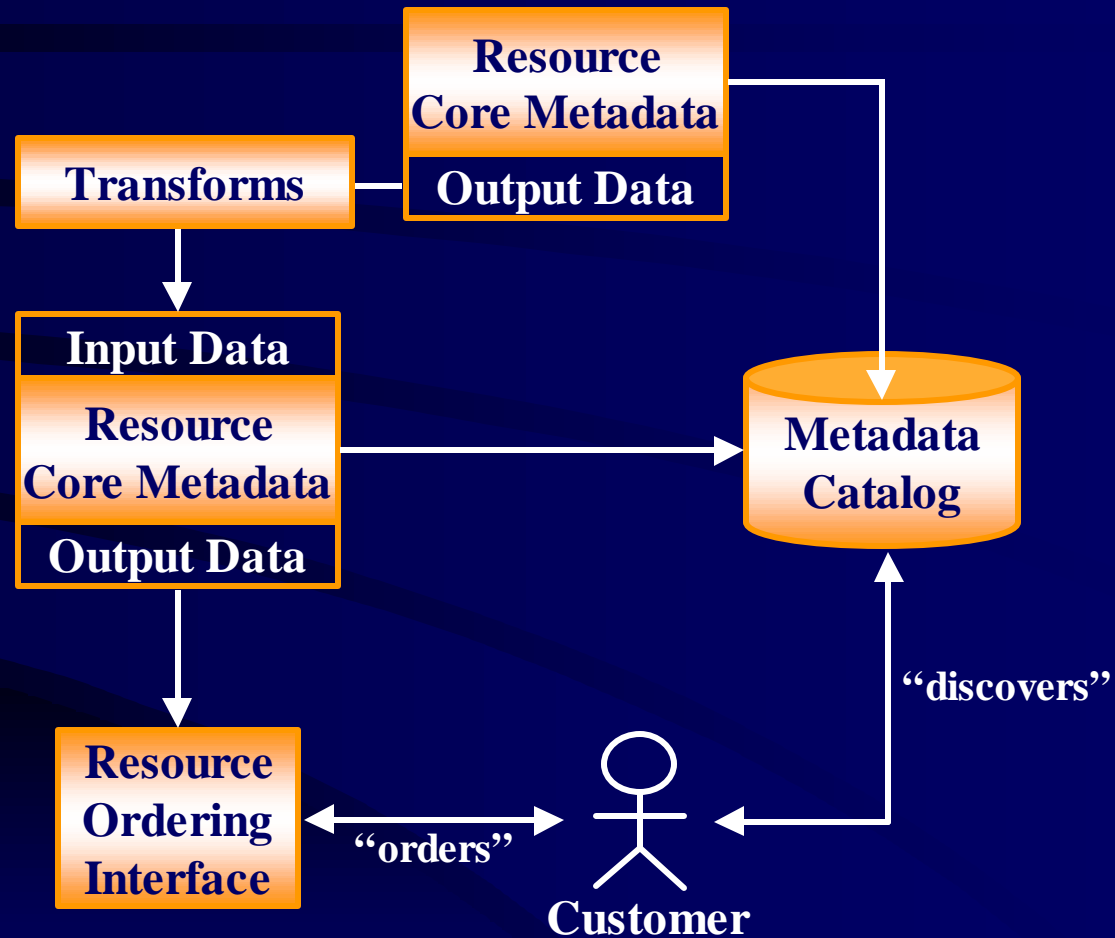
ESG Intelligent Searching Architecture



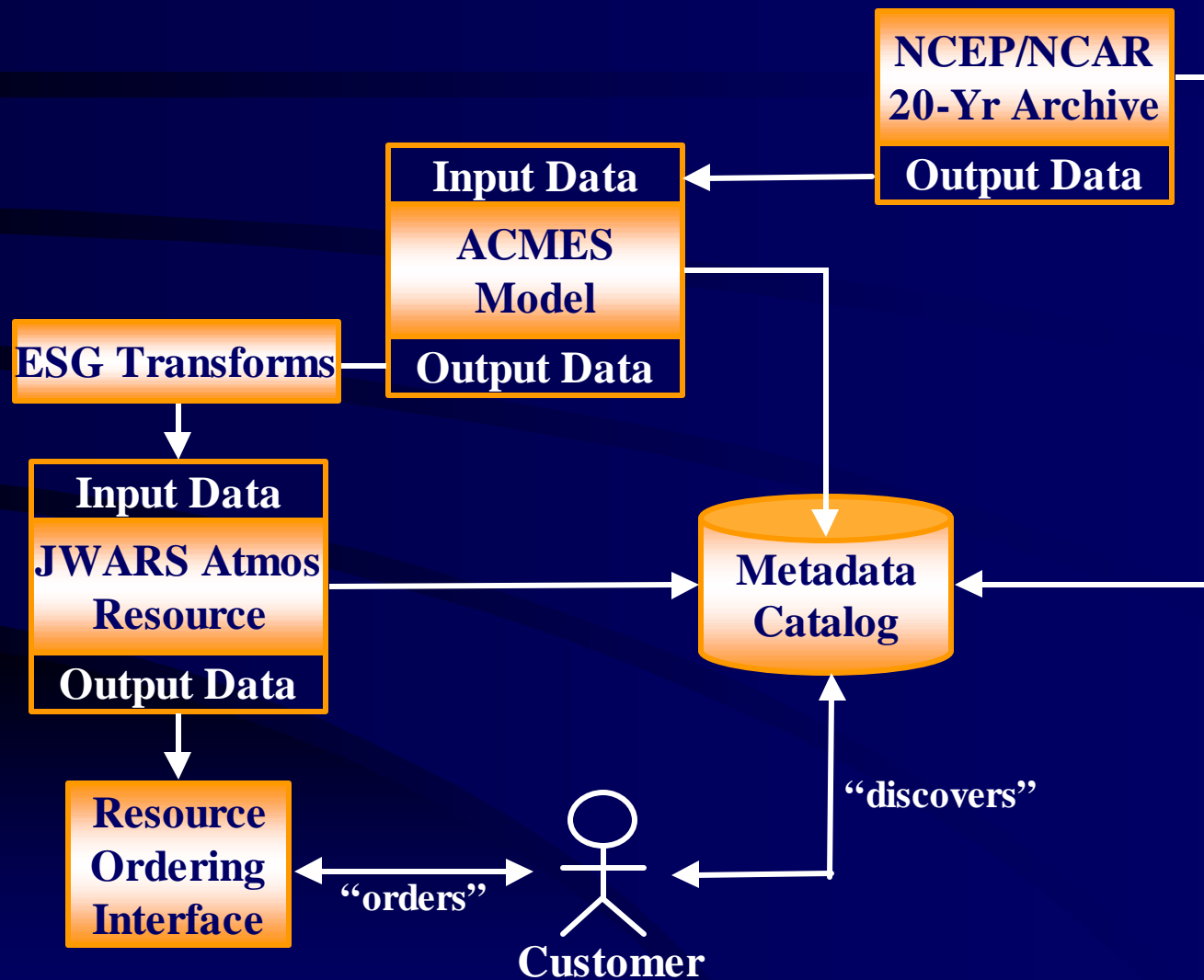
ESG Data Production Capability

- **Focused Support to the Simulation Community**
 - Unique consistency and representation requirements
 - Integration amongst multiple provider communities
 - Historical scenario production (vs. day to day forecasts)
- **ESG Provides ...**
 - Consistent Metadata registration of both data and models
 - Specification of model inputs
 - Process Control feature supporting resource dependencies
 - Flexibility in linking resources together through the use of a common data model and data transformation services
 - Domain, language, and format neutral architecture

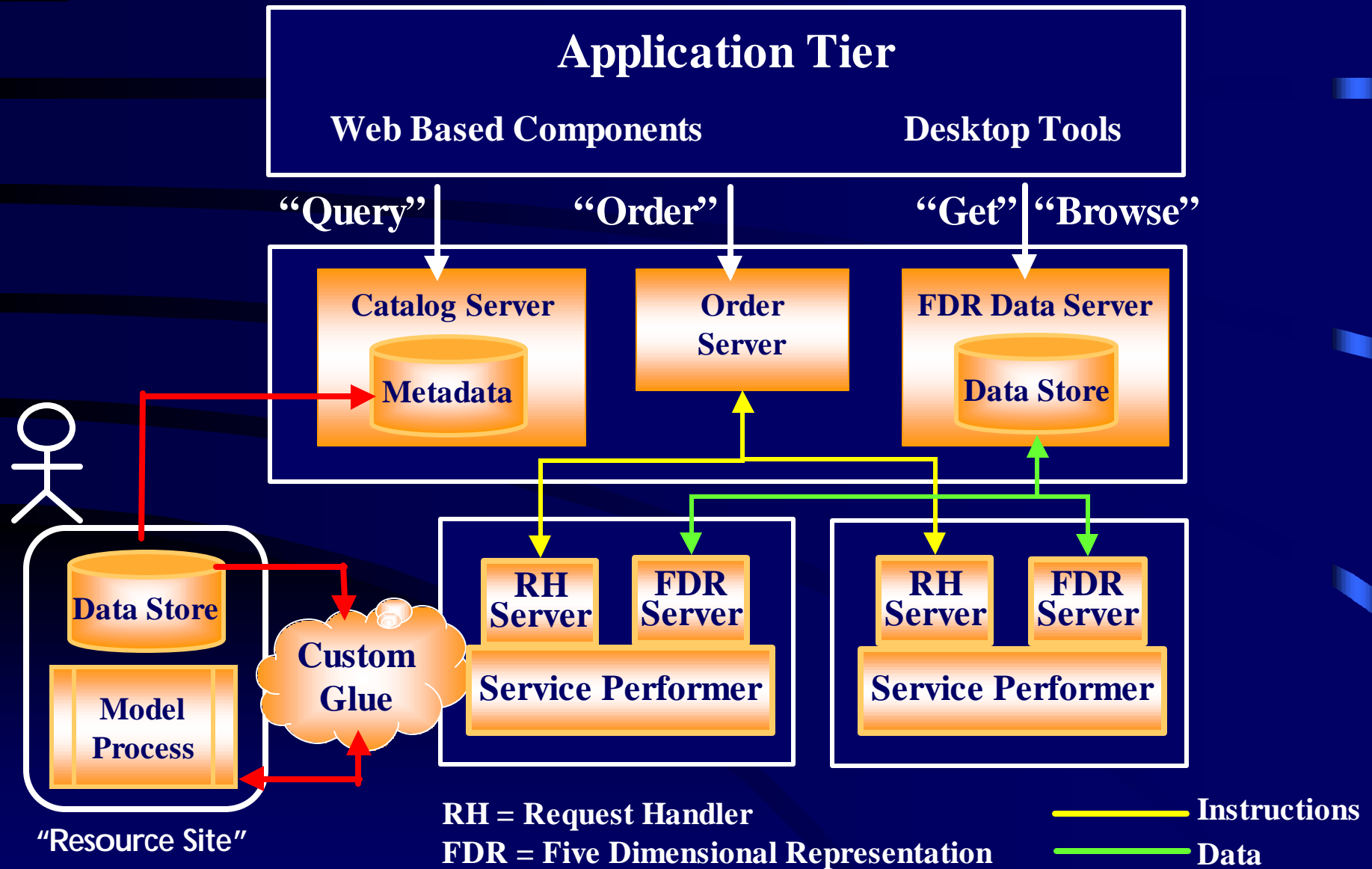
ESG Resource Registration



Example ESG Resources



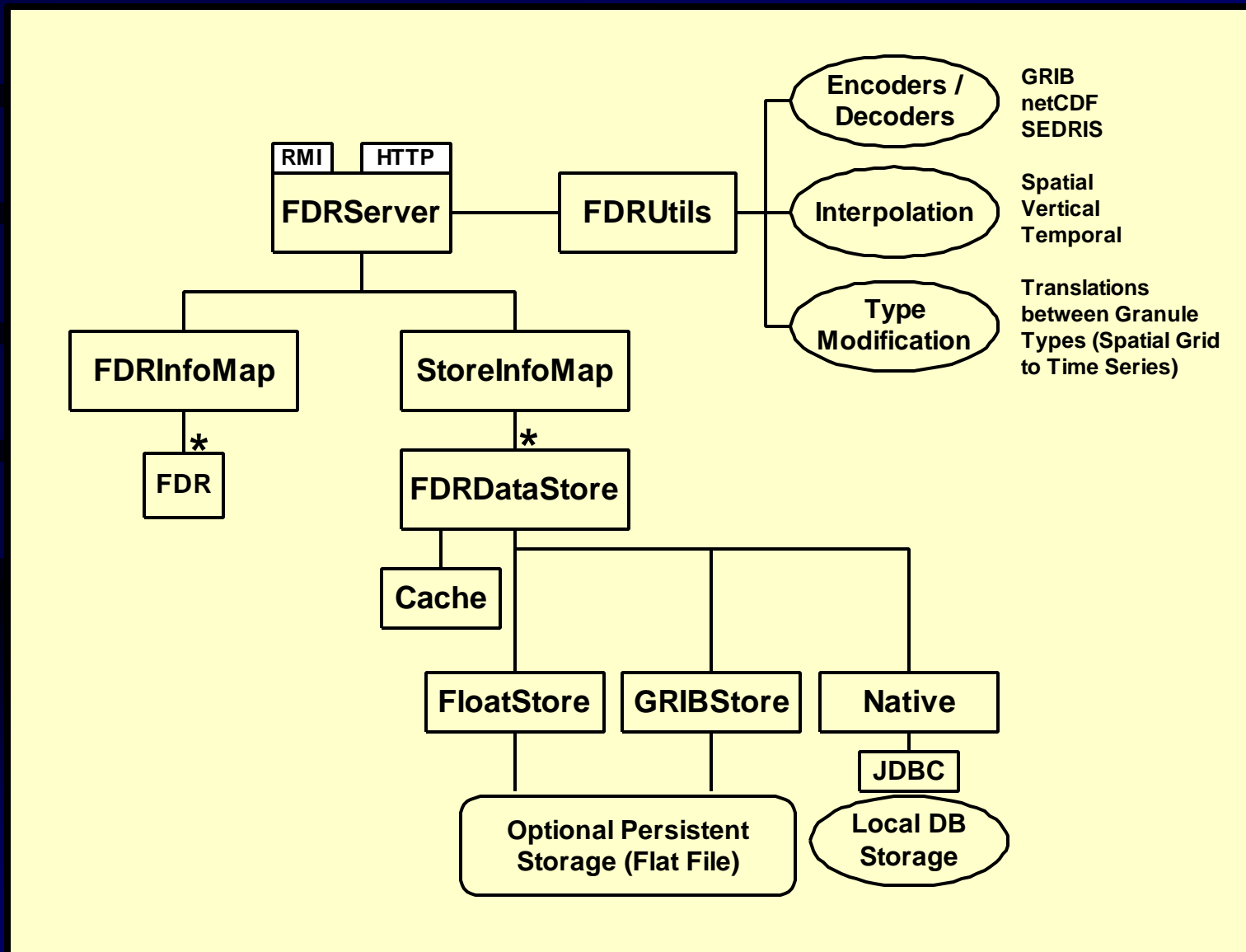
ESG Resource Access Architecture



FDR Server

- **Five Dimensional Representation (FDR) is a physical data model well suited for METOC data types**
 - **Currently support Spatial Grids, Time Series, Profiles, Points**
 - **In all cases, an FDR Data Set represents a 5D “data cube”**
 - (x,y,z) Spatial Dimensions, Time, Parameter/Entity
 - Most API functionality consistent across all data types
 - **Does not actually contain data, just its structural description**
 - **Implemented in Java and XML Schema**
- **FDR Server represents an ESG Application Data Server based on the FDR Data Model**
 - **Binds FDR data objects to their data**
 - **Server API interface to manage/access FDR objects and data**
 - **Pure Java/XML implementation provides lightweight platform independent deployment, license free (< 1 MB Source)**

FDR Server Architecture



ESG Functionality at AFCCC



Mapping of Customer Requirements to the best available off-the-shelf or custom-produced resources for M&S

Intelligent Searching for Meaningful Environmental Events

Inter-Domain Production Coordination

Online Data Analysis of all Resources

Delivery Profiles supporting Custom Formats, Terminology, and Units

Operational System at AFCCC

<https://esgweb.afccc.af.mil/esg>

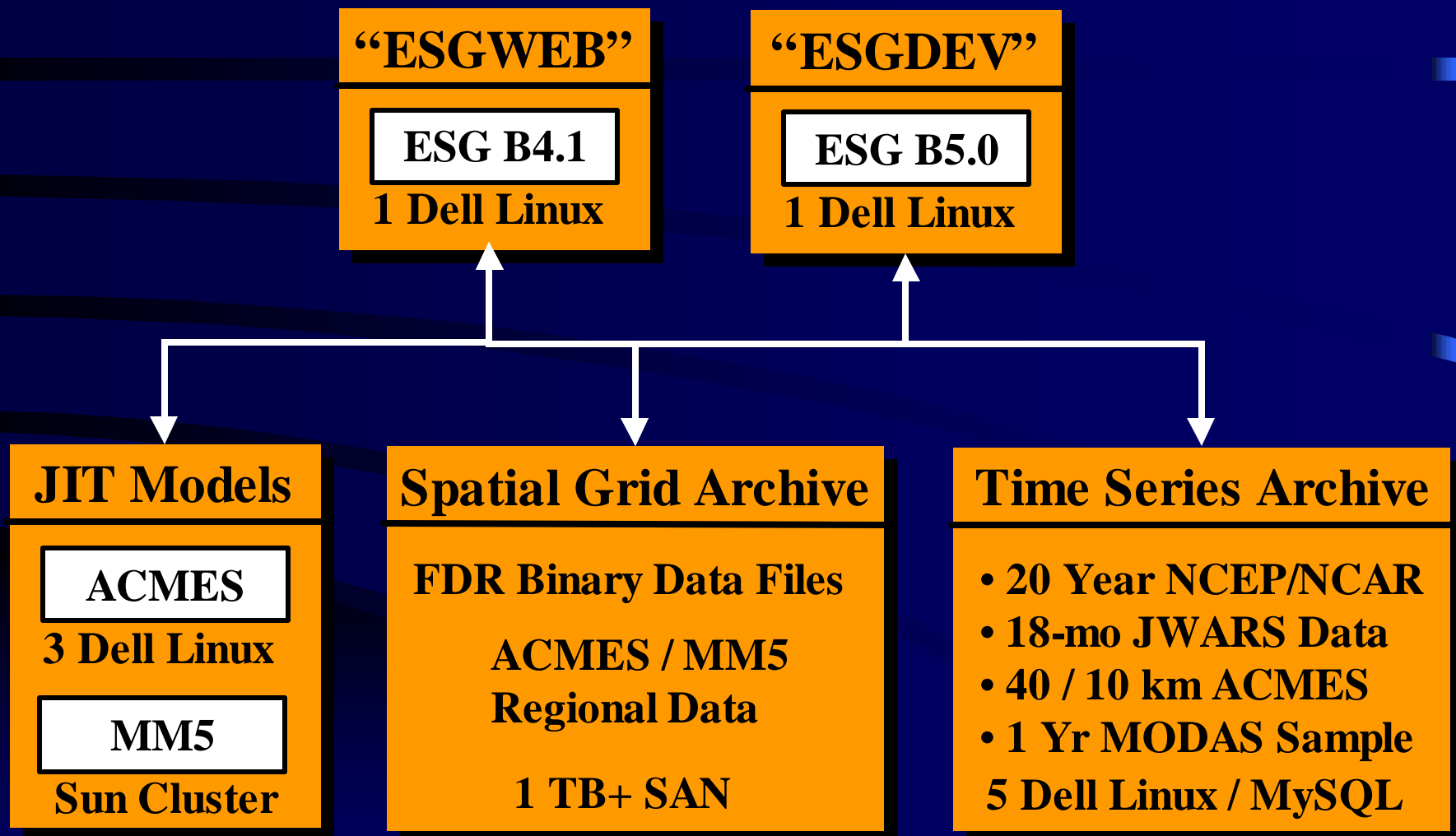
For Access Contact:

ASNE/MSEA or

esghelp@saic-ine.com

***Demonstrated application in
atmosphere, ocean, and space
domains***

ESG Resources at AFCCC



All on ONE Dell Rack – Total Cost <\$100K

ESG Customer Support

- **Joint Warfare Systems**
 - 18 Month Atmospheric Data Sets
 - SWA, EASIA, NW S. America, Europe, and more in process
 - Preparing for growth in JWARS users as they transition
- **JMASS**
- **JSB**
- **SMC**
- **NAVAIR**
- **TAWS**
- **HPAC**
- **WxFX**
- **NWC Global Wargames**
- **EnviroFed**

JWARS Atmospheric Data Set

Surface Fields

Spatial Resolution: 1.0 Deg
Temporal Resolution: 6 hr
Vertical Resolution:
 Six Isobaric (mb) levels
 Levels: 1000, 925, 850, 500, 250, 100
 Three Cloud Layers
 “Low” : Base < 2000 m
 “Mid” : 2000 m < Base < 6000 m
 “High” : Base > 2000 m
 Surface

Isobaric Fields

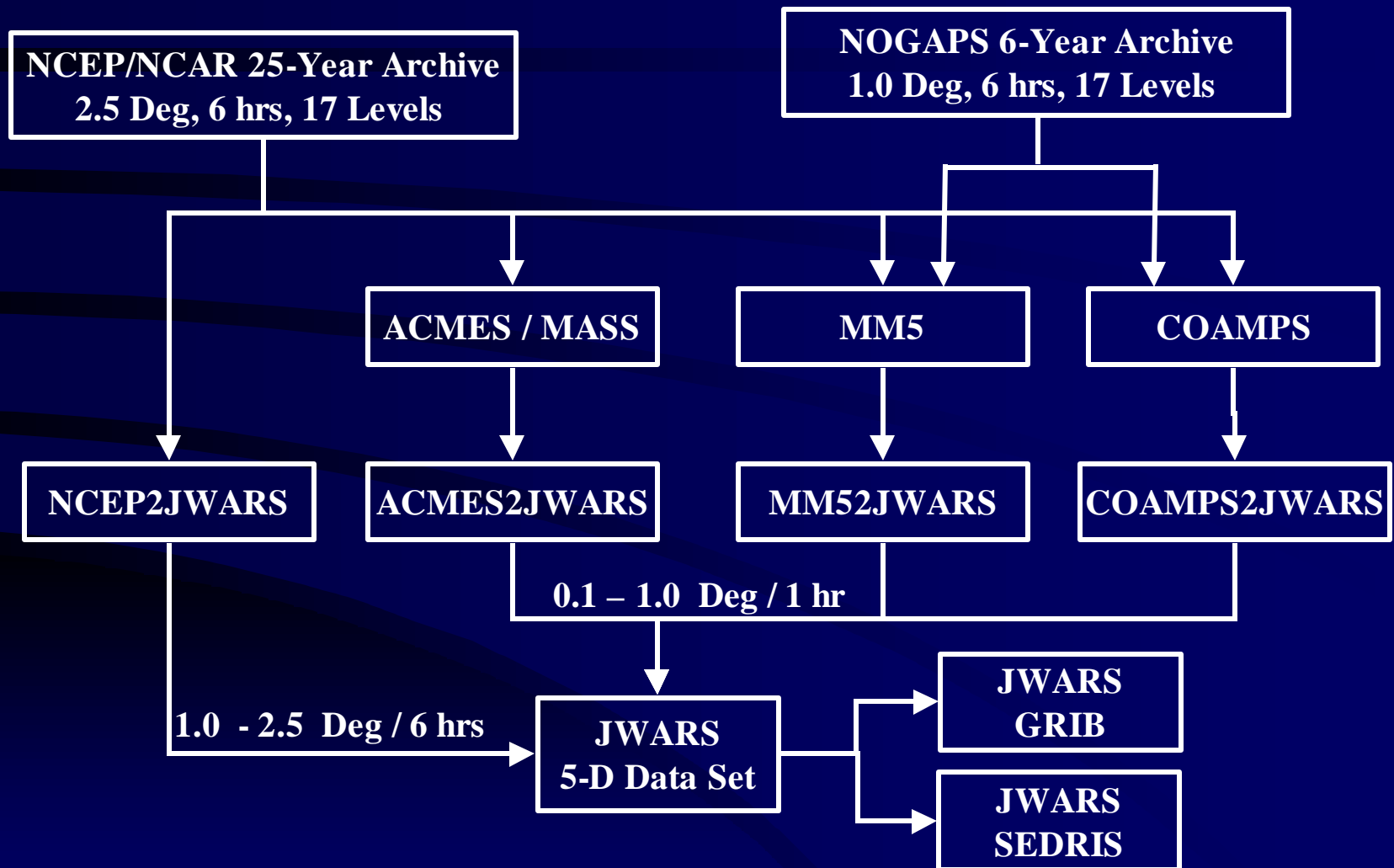
Geopotential Height
Relative Humidity
Temperature
Wind U Component
Wind V Component

Cloud Fields

Cloud Amount
Cloud Base
Cloud Top
Cloud Type

Blowing Sand
Blowing Snow
Cloud Ceiling
Density Altitude
Dewpoint Temperature
Elevation
Evaporation Duct Height
Fog
Icing Intensity
Illumination
Pasquil Stability Index
Precipitation Intensity
Precipitation Type
Pressure Altitude
Pressure Reduced to MSL
Sea State
Snow Depth
Surface Duct Height
Temperature
Thunderstorm Probability
Total Cloud Cover
Total Precipitation
Turbulence Intensity
Visibility
Wind Chill
Wind Gust Speed
Wind U Component
Wind V Component

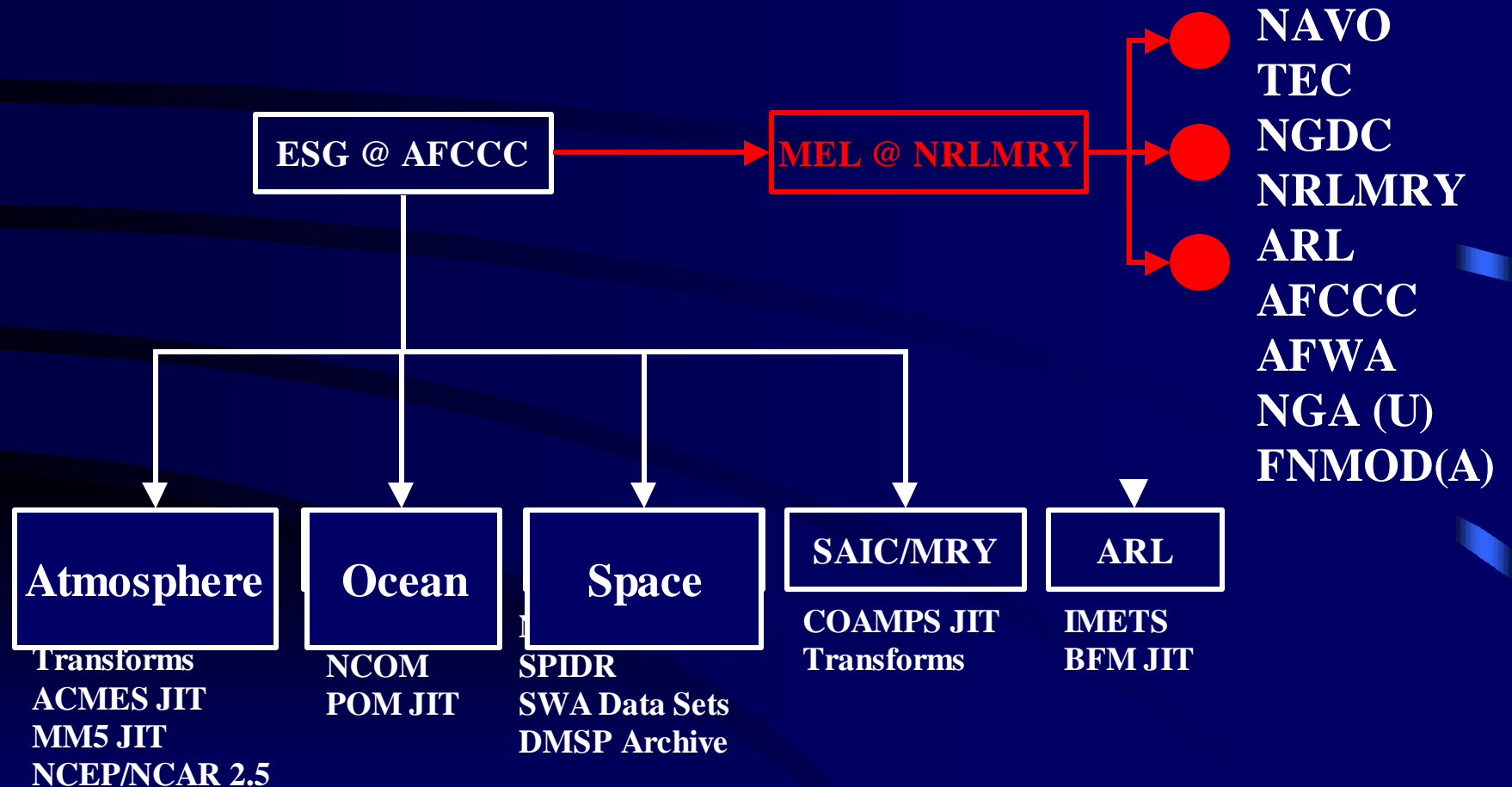
JWARS Atmosphere Production



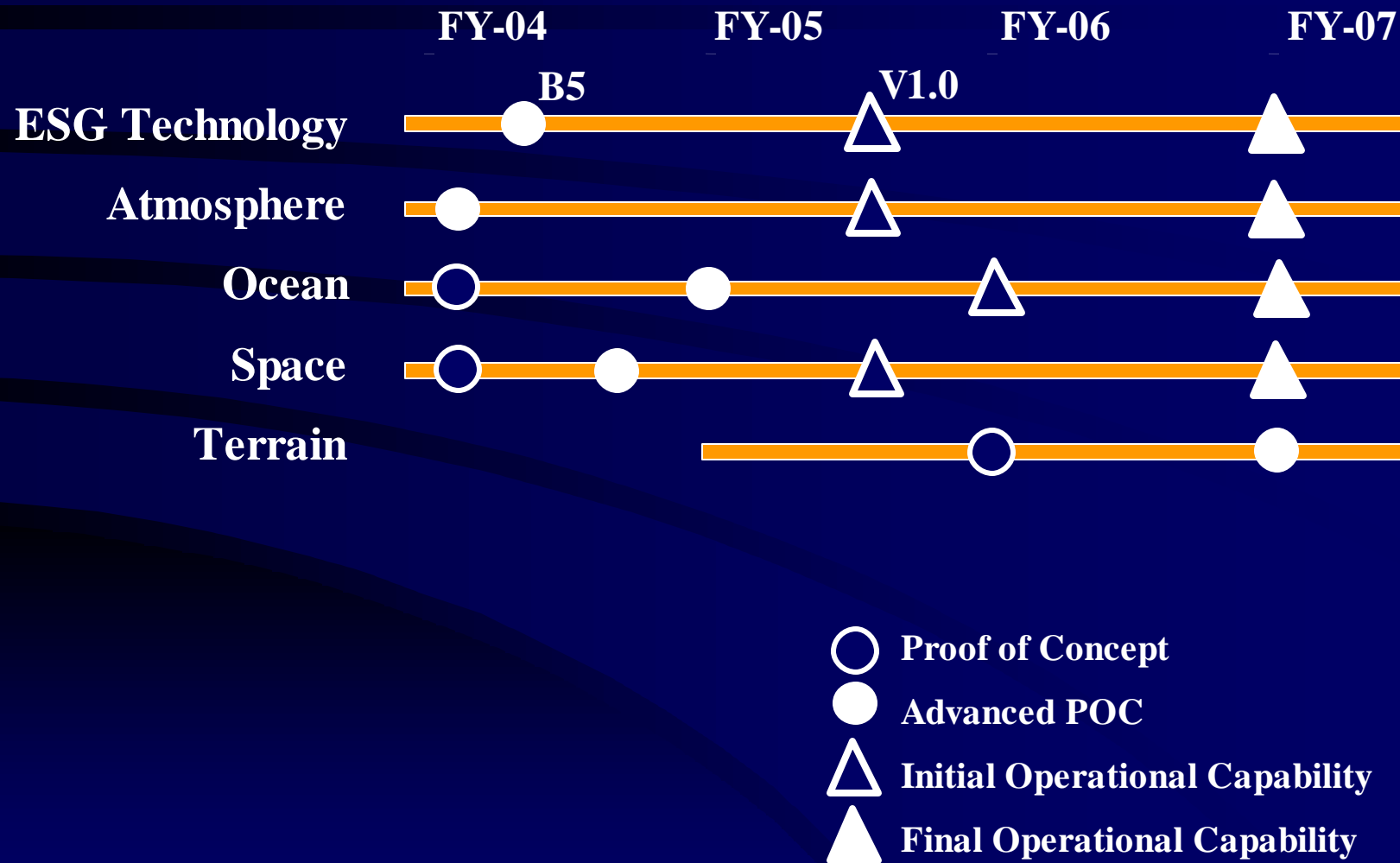
ESG Build 5 – High Level Features

- **Customer Requirements Module**
 - Capture of structured requirements for SME analysis
 - User Profiles for known requirements elements
- **Project Tracking**
 - Logging of all decisions, states of process
 - Interim products (events, visualizations, etc.)
 - Delivery Coordination
- **New Customer Modules**
 - Integration of web-based WxFX Module
 - Integration of GIS interfaces w/ weather overlays
 - Improved IDL/GMT web-based visualization tools
 - Option for use of desktop VISAD based visualization tool (IDV)
- **Built atop updated ESG Infrastructure**
 - All resources in single ESG Catalog
 - All ordering (from real-time to offline) atop same architecture

The ESG Landscape



ESG Transition by Domain



Some Final Thoughts

ESG is *not* about developing ...

- **Standards / Formats**
- **Historical Data Archives**
- **Environmental Models / Algorithms**
- **Military Simulations**

ESG is developing real application capability that leverages existing environmental data resources, standards, and tools to provide custom database solutions for the DoD M&S community.

P.S. Along the way, we are learning a LOT about standards, formats, data archives, environmental models, and military simulation.

Questions ?

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<https://www.dmsso.mil>

<https://msea.afccc.af.mil>