



# **Introduction to SEDRIStm for Managers**

*<http://www.sedris.org>*

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# About this tutorial

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***DESCRIPTION:*** Environmental data is an integral part of many of today's information technology applications. The use of environmental data will grow substantially as availability and access to such data increases, and as tools for manipulation of environmental data become less expensive and more sophisticated. This tutorial will provide an overview of the fundamental issues in environmental data representation, generation, and interchange. Topics will include: background on how environmental databases are created; why database creation is expensive; how environmental databases affect interoperability; the critical issues in interchange; the SEDRI approach; what SEDRI is and is not; SEDRI-based products and activities; an overview of the SEDRI technology components; and more. Demonstrations of selected SEDRI technology tools and applications will be included.

***WHO SHOULD ATTEND:*** Those interested in gaining a better appreciation of environmental data generation and consumption issues, interested in better understanding the SEDRI concepts, or those new to SEDRI. Project managers, policy and decision makers, systems engineers, and technology managers impacted by environmental data should attend.

***PREREQUISITE:*** General background in software technology and simulation is recommended

***WHAT TO EXPECT:*** The tutorial will provide the attendee with a foundation to understand the critical issues in environmental data representation, database creation, interchange, and SEDRI capabilities and technology components.



# Tutorial Outline

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- **What is SEDRIS?: SEDRIS at a Glance**
- **Why SEDRIS:**
  - **The Need for SEDRIS**
  - **Standards Development Background**
- **SEDRIS Technology Components (overview)**
  - **Data Representation Model (DRM)**
  - **Spatial Reference Model (SRM)**
  - **Environmental Data Coding Specification (EDCS)**
  - **SEDRIS Interface Specification**  
**(Read and Write Application Program Interfaces (APIs))**
  - **SEDRIS Transmittal Format (STF)**
- **The Role of SEDRIS Technology in Interoperability and Interchange**
- **Using SEDRIS:**
  - **Using SEDRIS for Data Interchange – A high level process**
  - **SEDRIS in Use today**
  - **Tools and Utilities**
- **Summary**
- **Getting more information**

## ***What is SEDRIS ? - SEDRIS at a Glance***





# **SEDRIIS Is ...**

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**Simply an Environmental Data Representation & Interface Solution**

**Solution for Environmental Data Representation, Interchange, and Specification**

**Sharing Environmental Data Responsibly with an Interface Specification**

**A method for unambiguously describing the environment**

**A mechanism to share and interchange the described environment**

**An infrastructure technology**

**A way of thinking about environmental concepts and their representation**



# **Tangibly - SEDRIIS Is ...**

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## **A suite of software products**

**Software Development Kits**

**Tools**

**Data sets**

**ISO Standards**

## **An organization**

**Managing the core software products**

**Providing education and support**

## **Associates**

**Users and developers of SEDRIIS products**



# Primary Goals of SEDRIIS

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## **Unambiguous representation of environmental data**

**Semantics and relationships of data elements**

**All environmental domains**

**Expressed in a data representation model**

## **Efficient interchange of environmental data**

**Sharing and re-use**

**Ease of access and software development**

**Tools and applications**



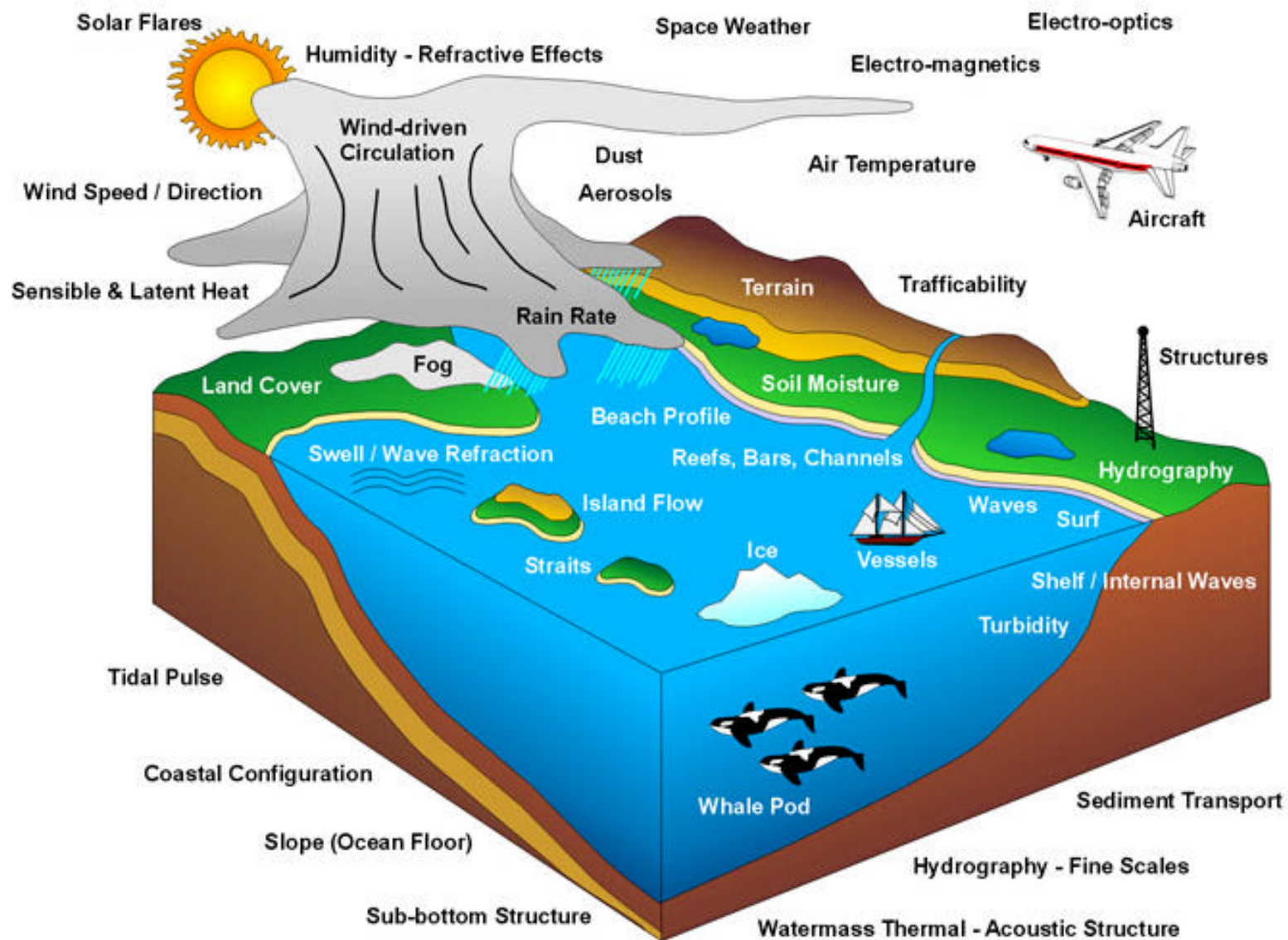
# SEDRIIS Objectives

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- *Articulate and capture the complete set of data elements and associated relationships needed to fully represent environmental data:*
- *Provide a standard interchange mechanism to pre-distribute environmental data and promote database reuse among heterogeneous applications.*
- *Support the full range of applications across all environmental domains (terrain, ocean, atmosphere, and space) and 3-D models of the physical environment.*



# All Environmental Domains





# SEDRIIS Is Not ...

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- A *repository* or a *library system* for environmental data
- An *authoring tool* or an *environmental database generation system*
- A specific *environmental database*
- An *archiving* or *data discovery mechanism*
- A *scenario generation system*
- An *application that converts databases*

... ***But*** you can use SEDRIIS technologies to do all of these!



# An Integrated Model of the Environment

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- Must preserve *real world* properties critical to predicting player and equipment performance
- Must be *realistic* and be ...
  - A best-approximation of a specific or typical place and time
  - Physically consistent:
    - Rivers: flow downhill
    - Terrain, atmosphere, ocean, and space: content agree
    - Roads: connected and consistently attributed
    - Cuts, fills, obstacles: appropriate to engineering practices
    - Structures: attached and appropriately aligned

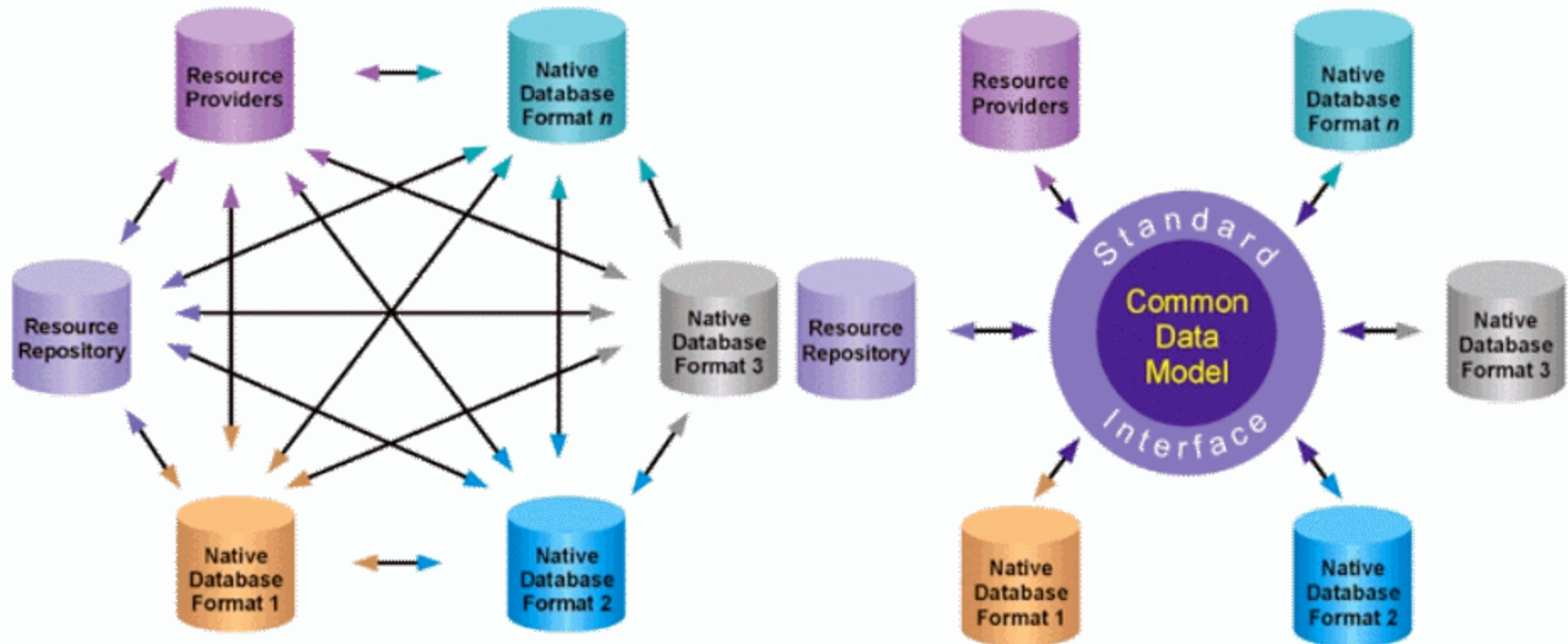
**Note:** *Maps are also approximations of the real world, but requirements are different ...*

- *Inaccuracies are accounted for through visual or cognitive interpretation*
- *Synthetic Forces can't adjust ... inconsistent representation causes errors*





# SEDRIIS Benefits



- No Standard Data Model
- Limited Support to Heterogeneous Simulation
- Indeterminate Interchange Mechanism
- Expensive Database Conversion
- Complete Representation
- Enables Interoperability
- Lossless and Consistent Interchange
- 100X Reduction in Conversion Costs





# Technology Components of SEDRIIS

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- ***Data Representation Model (DRM)***: Provides syntax and structural semantics for representing environmental data and databases (the “grammar” of the language)
- ***Environmental Data Coding Specification (EDCS)***: Provides “thing” level semantics (the “dictionary” of the language) (classify/attribute scheme)
- ***Spatial Reference Model (SRM)***: Unified and robust description of the coordinate systems, along with an accurate, efficient, and fast software implementation
- ***SEDRIIS Interface Specification***: (Read and Write Application Program Interfaces (APIs))
  - Allows ease of access
  - Lowers the barrier-to-entry in software development
- ***SEDRIIS Transmittal Format (STF)***: Platform independent storage and transmission of data



# Applying SEDRIIS Technologies

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## *Use:*

- *the DRM* to model environmental data
- *the DRM, EDCS, and the SRM* to specify environmental database content
- *the EDCS* as a stand-alone component
- *the SRM* as a stand-alone component
- *all SEDRIIS technology components* as an interchange mechanism
- *SEDRIIS tools* to examine environmental data
- *SEDRIIS technologies* as a base to develop new tools

***Why SEDRIS ?***

***The Need for SEDRIS***

***Standards Development Background***



# The Tough Problems

- *Get a total set of requirements*
- *Keep commercial processes and proprietary products involved but maintain an open exchange mechanism*
- *Different views of the environment*
  - Air, land, sea, space
  - Spatial location and orientation (coordinate system and datum)
- *Lack of underlying environmental framework*
  - No integrated reference model available
    - Representation
    - Naming / semantics
  - Existing Data Models are usually conceptual, future models which are non-integrated and don't address current data repositories and data interchange requirements

Business

Technical



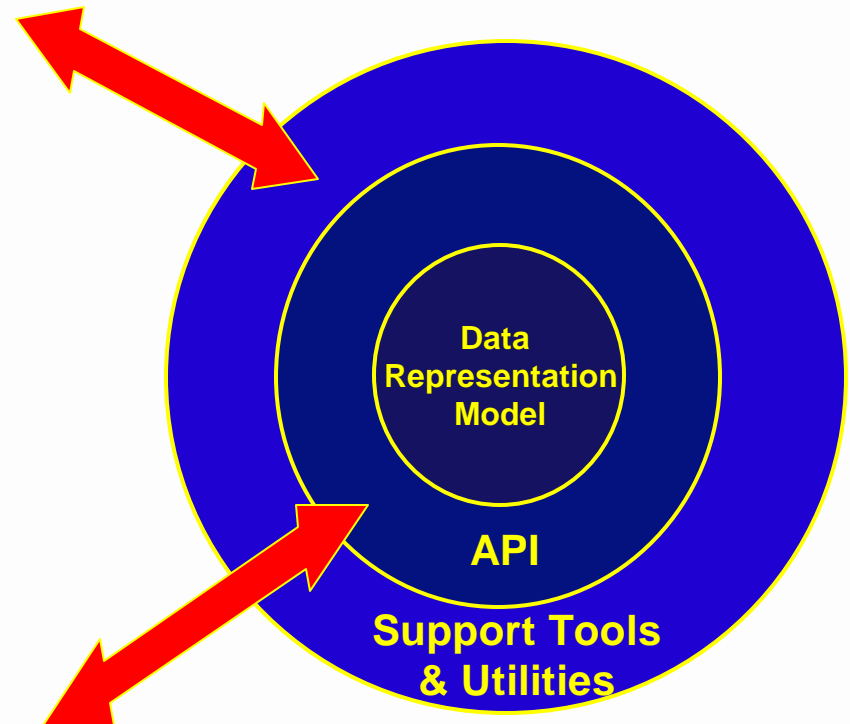
# How SEDRIIS has been Developed

- **SEDRIIS Associates** (key environmental database developers/users)

- Review and feedback
  - Data Representation Model
  - Interface Specification (API)
- Native-model mapping
- Interchange experiments
- Value-added tools/utilities

- **Core Team**

- Manage evolution
  - Data Representation Model
  - Interface Specification (API)
- Reference implementation(s)
- Transmittal Format
- Common tools & applications





# Industry Associate Developers ...

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- *3D Pipeline*
- *Accent Geographic, Inc.*
- *AcuSoft, Inc.*
- *Advanced Interactive Systems (AIS), Inc.*
- *The Boeing Company*
- *CAE - Canada*
- *Charles River Analytics, Inc. (CRA)*
- *DataMat S.p.A. - Italy*
- *ERDAS, Inc.*
- *Evans and Sutherland (E&S)*
- *Indra - Spain*
- *JRM Technologies, Inc.*
- *L3 Communications - Link Simulation & Training*
- *Lockheed Martin Information Systems (LMIS)*
- *Lockheed Martin Tactical Defense Systems (LMTDS)*
- *MultiGen - Paradigm Inc. (MPI)*
- *Northrop Grumman Information Technology (NGIT)*
- *Object Raku Technology, Inc. - Canada*
- *OKTAL - France*
- *ProLogic, Inc.*
- *Raytheon Company Electronic Systems*
- *Rheinmetall Defence Electronics GmbH - Germany*
- *Science Applications International Corporation (SAIC)*
- *SGI*
- *Sogitec Industries S.A. - France*
- *Tenix Defence Pty. Ltd. - Australia*
- *Terrain Experts, Inc.*
- *TerraSim, Inc.*
- *Thales Training & Simulation (TT&S) – United Kingdom, France*
- *Vcom3D, Inc.*
- *Veridian*



# More Associate Implementers

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## ***Government***

- ***U.S. Navy Modeling & Simulation Standards Steering Group (MS3G)***
- ***U.S. Army Communications Electronics Command (CECOM) Night Vision & Electronic Sensors Directorate (NVESD)***
- ***U.S. Army Training and Doctrine Command (TRADOC) Analysis Center - White Sands Missile Range***
- ***U.S. Naval Sea Systems Command - Dahlgren Division***
- ***U.S. Joint Warfare System (JWARS) Joint Program Office / CACI***
- ***Defence R&D Canada***
- ***Netherlands Organization for Applied Scientific Research (TNO)***

## ***Academia***

- ***University of Central Florida - Institute for Simulation and Training (UCF - IST)***



# Development / Implementation Tasks

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- ***Learn to speak SEDRIIS:*** enhanced Unified Modeling Language (UML) notation
- ***Generate mapping documents***
  - For native format(s) or assigned government format(s)
  - To ensure the data representation model and coding specification can handle all data requirements
- ***Develop software:*** to ***convert native data*** into SEDRIIS and back to check completeness of the interchange
- ***Participate in SEDRIIS Associates Meetings (SAMs) and associated experiments***
  - Exchange ideas
  - Cooperatively define and develop SEDRIIS technology
  - Share non-proprietary (native format) utilities and applications that support SEDRIIS interchange





# Other Participating Organizations

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- *BVR Systems Ltd. - Israel*
- *U.S. Defense Threat Reduction Agency (DTRA)*
- *Institute for Defense Analyses (IDA)*
- *The MITRE Corporation*
- *U.S. National Aeronautics and Space Administration (NASA)*
- *U.S. National Geospatial-Intelligence Agency (NGA)*
- *U.S. Naval Air Systems Command Training Systems Division (NAVAIR - TSD)*
- *U.S. Navy Space and Naval Warfare Systems Command (SPAWAR)*
- *U.S. Naval Oceanographic Office (NAVOCEANO)*
- *U.S. Naval Research Laboratory (NRL)*
- *SRI International*
- *U.S. Air Force Combat Climatology Center (AFCCC)*
- *U.S. Army Engineer Research and Development Command (ERDC) Topographic Engineering Center (TEC)*
- *U.S. Army Research, Development, and Engineering Command (RDECOM)*
- *U.S. Army Program Executive Office (PEO) for Simulation, Training and Instrumentation (STRI)*



# Supporting Organizations & Programs

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- *AEgis Technologies Group, Inc.*
- *Armed Forces Training Systems, Inc. (AFTS)*
- *U.S. Army Combined Arms Tactical Trainer (CATT) Program*
- *U.S. Defense Advanced Research Projects Agency (DARPA)*
- *U.S. Defense Modeling and Simulation Office (DMSO)*
- *Distributed Simulation Technology, Inc. (DiSTI)*
- *U.S. Joint Modeling & Simulation System, Joint Program Office (JMASS/JPO)*
- *U.S. Joint Simulation System, Joint Program Office (JSIMS/JPO)*
- *U.S. Joint Strike Fighter, Joint Program Office (JSF/JPO)*
- *Quantum Research International*
- *U.K. Combined Arms Tactical Trainer (UK-CATT)*
- *U.S. Air Force Weather Agency (AFWA)*
- *U.S. Army Model and Simulation Office (AMSO)*



## ... other Participants / Contributors

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- **Government Organizations:**

- *Defence Science and Technology Laboratory (DSTL) (United Kingdom)*
- *Defence Science and Technology Organisation (DSTO) (Australia)*
- *Netherlands Organization for Applied Scientific Research (TNO) (Netherlands)*
- *Defence Research Establishment (Sweden)*
- *Ministry of Defence (MoD) (Singapore)*
- *NATO Command, Control, and Consultative Agency (NC3A)*

- **International Membership Organizations:**

- *ISO and ISO / IEC Technical Committees and Sub-Committees*
- *Open Geographic Information Systems (GIS) Consortium (OGC)*
- *Digital Geographic Information Working Group (DGIWG)*
- *Simulation Interoperability Standards Organization (SISO)*
- *NATO (M&S Coordination Office, M&S Group, and Armaments Group)*



# Where SEDRIIS is headed

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**SEDRIIS will remain a DMSO-sponsored project until all ISO/IEC standards are completed**

**Then, the technologies will transition to another entity, based on the results of on-going evaluation of business approaches and impacts**

**Entities being considered include (but not limited to): another DoD or government organization; existing consortia; existing commercial organizations; establishment of new organization; academia; ...)**

**A fundamental criteria for transition is the guarantee to support existing and emerging customers and associates**

**A number of business criteria and evaluation factors are being used**

***Why SEDRIS ?***

***The Need for SEDRIS***

***Standards Development Background***



# Standards Development Objectives

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- ***Document technologies*** as recognized standards
- ***Obtain review, and feedback,*** from the broader international community
- ***Establish international standards***
- ***Promote software implementations:***
  - Software library for the Spatial Reference Model (SRM)
  - Data dictionary database and mapping software for the Environmental Data Coding Specification (EDCS)



# ISO / IEC Standards

- 18023: **SEDRIS** – multi-part -
  - **Part 1: Functional Specification**  
(includes the Data Representation Model and the Interface Specification)
  - **Part 2: Abstract Transmittal Format**
  - **Part 3: Transmittal Format Binary Encoding**
- 18024: **SEDRIS Language Bindings** – multi-part, initially -  
**Part 4: SEDRIS Language Binding to ISO C**
- 18025: **Environmental Data Coding Specification (EDCS)**
- 18026: **Spatial Reference Model (SRM)**
- 18041: **EDCS Language Bindings** – multi-part, initially -  
**Part 4: EDCS Language Binding to ISO C**
- 18042: **SRM Language Bindings** – multi-part, initially -  
**Part 4: SRM Language Binding to ISO C**





# Standards Process

## *Who is developing the Standard?*

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- **Developed by:**
  - Working Group (WG) 8, “*Environmental Representation*” of
  - Subcommittee (SC) 24, “*Interactive Computer Graphics, Image Processing and Integrated Environmental Data Representation*”
  - SEDRIIS Organization
- **Subcommittee 24 is part of the:** ISO / IEC Joint Technical Committee (JTC 1), “*Information Technology*”
- **ISO / IEC is a joint activity:**
  - International Organization for Standardization (ISO)
  - International Electrotechnical Commission (IEC)





# Other Standards Activities

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- ***Simulation Interoperability Standards Organization (SISO)*** has established product development groups (PDG) to ***review, promote, and establish SEDRIS -developed technologies as SISO guidance and / or reference products***
- PDGs have worked on EDCS and SRM to:
  - Review and input to ISO / IEC standards for EDCS and SRM
  - Adopt existing, and develop new, technical implementations of EDCS and SRM as SISO products
- For more information on SISO PDG activities visit the SISO web site at: ***<http://www.sisostds.org>***
- ***NATO Standardization Agreement (STANAG)*** development to adopt the ISO/IEC standards.
- ***ABCA Quadripartite Standardization Agreement (QSTAG)*** development to adopt the ISO/IEC standards.
- Work with the ***Federal M&S Standards Consortium*** established by the National Institute of Standards and Technology (NIST)

# ***SEDRIS Technology Components***

***Spatial Reference Model (SRM)***

*Environmental Data Coding  
Specification (EDCS)*

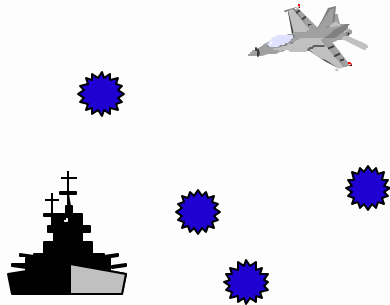
*Data Representation Model (DRM)*

*SEDRIS Interface Specification  
(Read & Write Application Program  
Interfaces (APIs))*

*SEDRIS Transmittal Format (STF)*

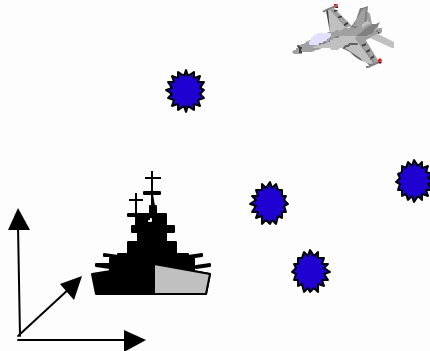


# Representation begins with Location ...



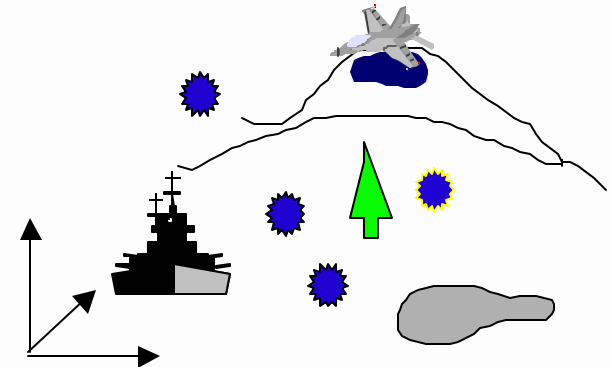
## Systems

The void ...



## Systems, *where?*

Start with locating your systems; sometimes that's about all you could afford in legacy simulations.



## Systems, *and what else?*

Define the context within which systems engage; and that context can advantage, or disadvantage, ...

***Defining and using a consistent spatial reference framework is critical for M&S interoperability***

**System models (men, material, ...)**

**Environmental data, models, phenomena**



# Spatial Reference Model Requirements

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- ***Completeness:***
  - Include coordinate frameworks in common usage
  - Tie those systems together into a common framework
  - Educate the system developer  
(e.g., What's a horizontal datum? A vertical datum?)
- ***Accuracy:***
  - Generally higher than required for C4ISR systems
  - Typically better than 1 cm up past geo-synchronous orbit
- ***Performance:***
  - Computation speed - Never fast enough!
  - Support environmental data sets dominated by location data
  - Reduce costs for simulation using heterogeneous coordinate systems (spatial reference frames)



# Spatial Reference Frames

- ***Spatial Reference Frames (SRF)*** serve to locate coordinates in a multi-dimensional space (generally either two- or three-dimensional).
- Specified in two parts:
  - A geometric description (model) of a reference object embedded in (and serving to orient) that frame -- referred to as an ***Object Reference Model (ORM)*** an Earth Reference Model (ERM) is a special case of an ORM
  - A ***Coordinate System (CS)*** specifying how a tuple of values uniquely determine a location with respect to the origin of that frame. By extension, that tuple also specifies a location with respect to the reference object.

$$SRF = ORM + CS$$

**There are no “naked” coordinate systems (in SEDRIIS)**



# SEDRIS Spatial Reference Frames

**Today  
SEDRIS  
Supports  
151 SRFs**

Arbitrary ORM	Local Space Rectangular	LSR2	2D	
		LSR	3D	
Earth-Centered, Earth-Fixed	Geocentric	GC	3D	
Earth-Surface, Global	Geodetic	GD2	2D	
		GD	3D	
Earth-Surface, Local (Topocentric)	Local Tangent Plane	LTP2	2D	
		LTP	3D	
	GCS	GCS	3D	
Earth-Surface, Projection- Based	Mercator	M	2D	
		AM	3D	
	Oblique Mercator	OM	2D	Spherical ERM Only
		AOM	3D	
	Transverse Mercator	TM	2D	
		ATM	3D	
	Universal Transverse Mercator (60)	UTM	2D	
		AUTM	3D	
	Lambert Conformal Conic	LCC	2D	
		ALCC	3D	
	Polar Stereographic	PS	2D	
		APS	3D	
	Universal Polar Stereographic (2)	UPS	2D	
		AUPS	3D	
	Equidistant Cylindrical	EC	2D	Spherical ERM Only
		AEC	3D	
Earth-Centered, Rotating (Inertial & Quasi-Inertial)	Geomagnetic	GM	3D	
	Geocentric Equatorial Inertial	GEI	3D	
	Geocentric Solar Ecliptic	GSE	3D	
	Geocentric Solar Magnetospheric	GSM	3D	
	Solar Magnetic	SM	3D	

# ***SEDRIS Technology Components***

***Spatial Reference Model (SRM)***

***Environmental Data Coding  
Specification (EDCS)***

***Data Representation Model (DRM)***

***SEDRIS Interface Specification  
(Read & Write Application Program  
Interfaces (APIs))***

***SEDRIS Transmittal Format (STF)***



# An Environmental Data Coding Specification ...

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- *Unifies characterizations of environmental “things”*
  - Regardless of how represented:  
Feature or Geometry or Data Table or Model or ...
  - Whether individual primitives or structured collections of primitives:  
Furniture vs. Room vs. Building vs. Facility vs. Region
- *Separates enumerations from Data Representation Models*
  - Evolve at different rates for different reasons
  - It’s a big world to capture ...
- *Answers three types of questions:*
  - *What is it?* Classifications and Features
  - *What are its additional clarifying characteristics?* Attributes and Values
  - *What are its characteristic measures?* Units of Measure and Scale





# Classifications (and Features)

## 1. What is it?

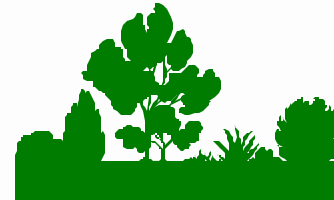
building, river/stream, air warning light, ocean floor



Animal?



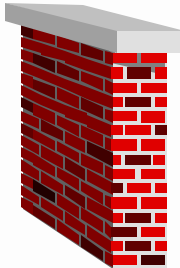
Water?



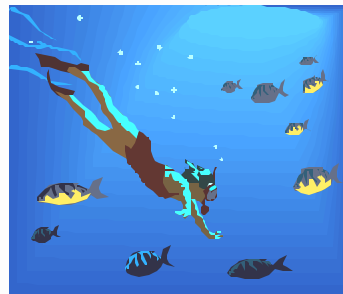
Vegetable?



Weather?



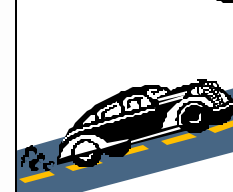
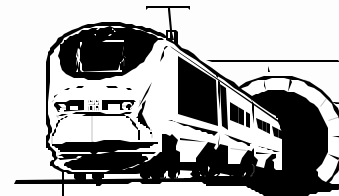
Structure?



Vehicle?



Mineral?



Celestial?



# Attributes (and Values)

## 1. *What is it?*

building, river/stream, air warning light, ocean floor

## 2. **Additional clarifying characteristics?**

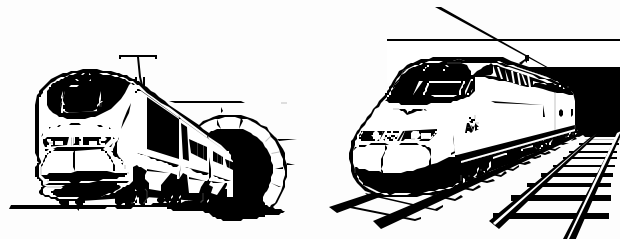
lighthouse, 1.5, red, coral



Vegetation Type?



Building Function?



Overhead Clearance?





# Units of Measure and Scales

## 1. *What is it?*

building, river/stream, air warning light, ocean floor

## 2. *Additional clarifying characteristics?*

lighthouse, 1.5, red, coral

## 3. *What are its characteristic measures and scales?*

kelvin, decametre, kilometre/hour; micro, tera, deci



**How fast?**

kilometres per hour



**How warm?**

kilokelvin

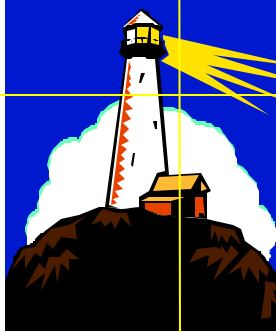
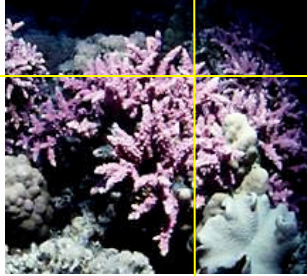


**How tall?**

decametres



# Putting EDCS Entries Together Clarify the Object's Description

<i>What is it?</i>	<i>How is the object characterized ?</i>	<i>How is the object measured?</i>
Classifications	Attributes	Units of Measure & Scales
Building	<p>With the <u>function</u> of a <i>Lighthouse</i></p> <p>Whose <u>height</u></p>	 <p>is 3.05 <u>decametres</u></p>
River Stream	<p>Whose <u>speed</u></p>	<p>is 1.5 <u>metres per second</u></p>
Ocean Floor	<p>Which is <u>composed</u> of <i>Coral</i></p> <p>Whose <u>density</u></p>	 <p>is 0.97 <u>kilograms per cubic decimetre</u></p>

<http://physics.nist.gov/cuu/Units/index.html>



# EDCS Approach

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- *Pure numeric codes*
- *Fully SI-compliant* – unit-type and scale separated
- *Groups aid search*
- *Full mappings provided:*
  - Digital Geographic Information Exchange Standard (DIGEST) Feature and Attribute Coding Catalogue (FACC)
  - Joint Meteorology / Oceanography Conceptual Data Model (JMCDM)
  - U.S. Imagery and Geospatial System (USIGS) Conceptual Data Model (UCDM)
  - World Meteorological Organization (WMO)
  - International Hydrographic Organization (IHO)
  - ...



# The 9 EDCS Dictionaries

- **Classification Dictionary - the type of an environmental object**
  - What is it, or how is it characterized? (BUILDING, RIVER, HARBOUR, ...)
- **Attribute Dictionary - the state of an environmental object**
  - What are its additional clarifying characteristics?  
(BUILDING\_FUNCTION, DEPTH, FREQUENCY, ...)
  - What constraints are enforced on values?  
(ENUMERATION, LOGICAL, STRING, INTEGER, REAL, ...)
- **Attribute Value Metadata Dictionary - attribute value metadata**
  - Characterization of the value of an attribute  
(VALUE\_SPECIFIED, MISSING, WITHHELD, ...)
  - Characterization of sets of attribute values  
(MAXIMUM, MINIMUM, UPPER\_BOUND, LOWER\_BOUND, ...)
- **Attribute Enumerant Dictionary - enumerates of an enumerated attribute**
  - A set of nominal, ordinal or partitioned values  
({ SHORT | MEDIUM | TALL }, { RED | GREEN | BLUE | .. }, ...)
  - Used to specify the values of enumerated attributes



# The 9 EDCS Dictionaries (*cont'd*)

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- **Unit Dictionary - the unit of measurement of a real valued attribute**
  - A precisely specified quantity in terms of which the magnitudes of other quantities of the same kind can be stated.  
(METRE, PASCAL, KELVIN, ...)
  - Used to specify real value types.
- **Unit Equivalence Class Dictionary - equivalence classed of EUs which measure the same quantity**
  - A partitioning of units of measure into a set, where members of a set measure the same physical quantity.  
(MASS, LENGTH, VOLUME, ...)
- **Unit Scale Dictionary - the scale factor to be used with an EU**
  - A multiplicative constant applied to a unit of measure in order to avoid both excessively large or small attribute values.  
(KILO, MILLI, NANO, ...)





# The 9 EDCS Dictionaries (*cont'd*)

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- **Organizational Schema Dictionary** - organizational structure for EC and EA dictionary navigation
  - Provided as an aid to help users of the EDCS standard identify groups of classification and attribute entries that may be related.
  - Sets of groups are defined to support efficient location of classification and attribute dictionary entries.  
(GENERAL, ...)
- **Group Dictionary** - the groups of ECs & EAs which compose an EO
  - Entries identify classifications and attributes that may be related and relevant, to a domain of interest.
  - These are called “members of a group”, and they may be members of multiple groups.  
(ATMOSPHERE, LAND\_TRANSPORTATION, PLANT, SPACE, ...)



# ***SEDRIS Technology Components***

*Spatial Reference Model (SRM)*

*Environmental Data Coding  
Specification (EDCS)*

***Data Representation Model (DRM)***

*SEDRIS Interface Specification  
(Read & Write Application Program  
Interfaces (APIs))*

*SEDRIS Transmittal Format (STF)*



# The DRM in relation to SRM, EDCS

---

- **The DRM provides the syntax and the structural semantics for the expression of environmental data**
- **It relies on the SRM for specifying location of environmental data, and**
- **It relies on the EDCS to capture the semantics of the environmental data**
- **In analogy to natural languages, the DRM can be thought of as the grammar, and the EDCS as the dictionary of words**
- **Semantics of the data depend on both the grammar and the dictionary**



# SEDRIIS Data Representation Model

---

- **Augmented Unified Modeling Language (UML) Notation**
  - Abstract classes are shaded
  - Arrows are used on one-way relationships
- **303 Classes:**
  - **Geometry** (surfaces: Point, Polygon, ...)
  - **Features** (abstractions: Point, Linear, Areal)
  - **Data Tables** (Property Table, Property Grid)
  - **Topology** (Feature/Geometry connectivity)
  - **Attributes/Components** (Colors, Locations)
  - **Organizers/Containers:**
    - ✍ Hierarchies (organize spatially, temporally, ...)
    - ✍ Libraries (collections of reusable objects, including Sounds, Images, and Map Symbols)
- **Associated Data Dictionary:**
  - Machine parsed
  - Automatically derives HTML and various software files



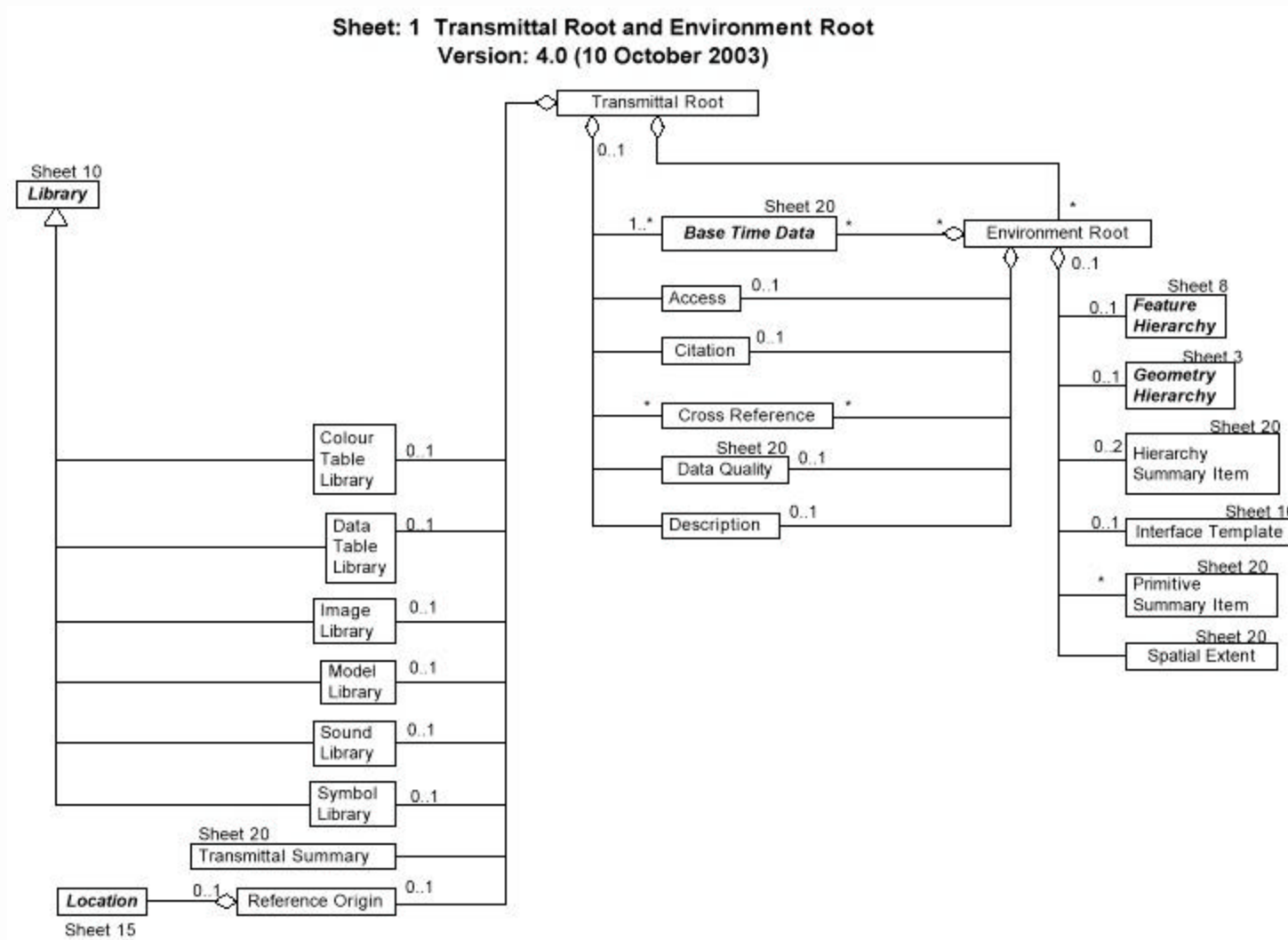
# The DRM is Composed of ...

---

- ***Geometry type objects*** Physical/surface representations of real world objects (e.g., 3D polygons, patches, lines, & points)
- ***Feature type objects*** Represent higher level abstraction of real world objects (e.g., areal, linear, and point features)
- ***Topology*** Concise, mathematical definition of inter-Feature or inter-Geometry object relationships
- ***Attributes*** (e.g., location, time, color, sound, width, etc.)
- ***Libraries*** Store copies of any instanceable object
- ***Explicit relationships*** Among feature objects, geometry objects, or between feature and geometry objects
- ***Organizational schemes*** Allows for well-described hierarchical configuration of geometry and feature objects



# Transmittal Root (example)



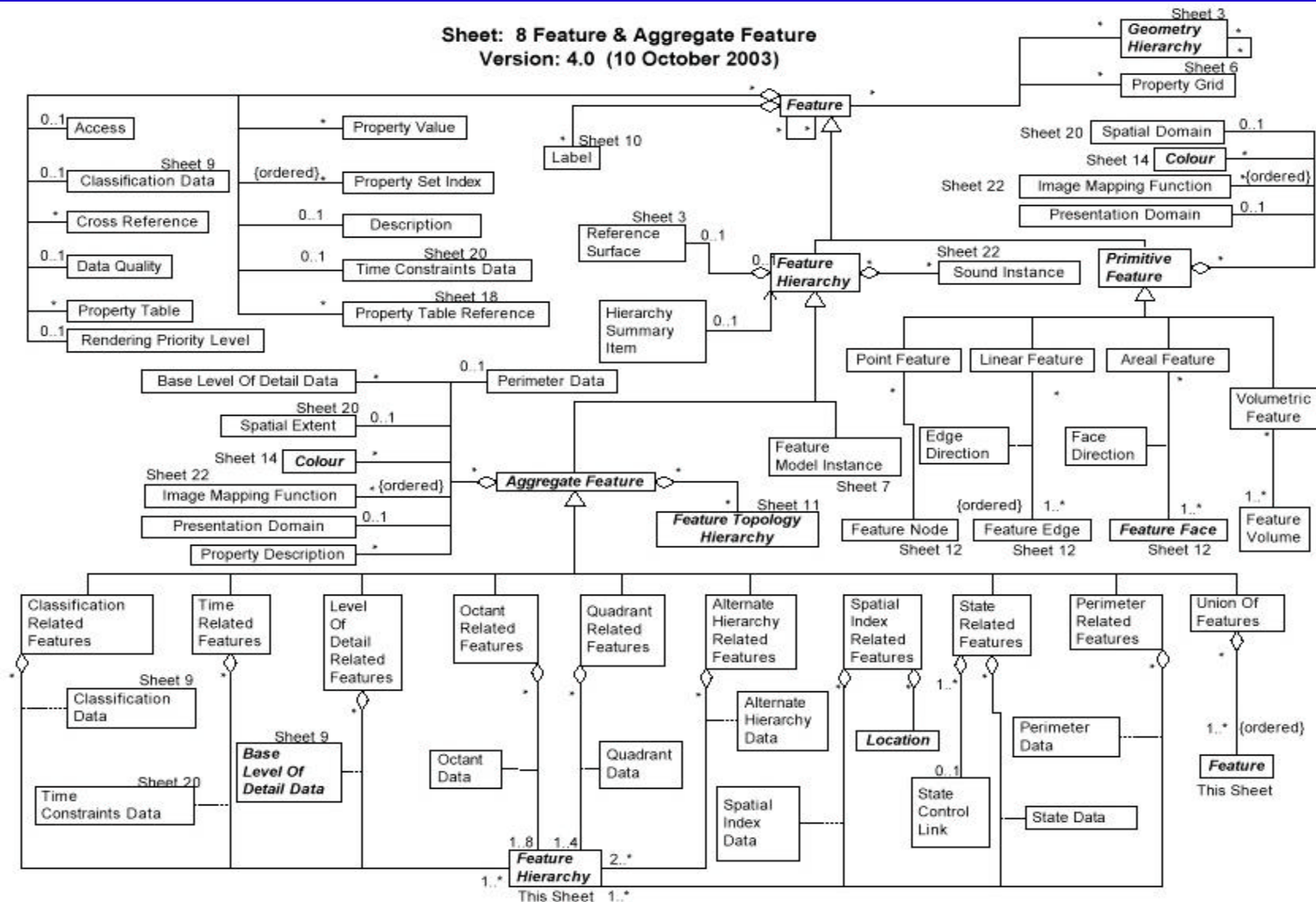


The diagram illustrates the relationships between various classes and their associated sheets. The classes are represented by rectangles, and the relationships are shown by lines with multiplicity and sheet numbers.

- Geometry** (Sheet 20) is a generalization of **Primitive Geometry** (Sheet 5).
- Geometry Hierarchy** (Sheet 5) is a generalization of **Geometry Model** (Sheet 22) and **Geometry Model Instance** (Sheet 16).
- Feature Hierarchy** (Sheet 8) is a generalization of **Feature** (Sheet 8).
- Reference Surface** (Sheet 8) is associated with **Feature Hierarchy** (Sheet 8) and **Feature** (Sheet 8).
- Property Value** (Sheet 6) is associated with **Feature Hierarchy** (Sheet 8) and **Feature** (Sheet 8).
- Access** (Sheet 20) is associated with **Geometry Hierarchy** (Sheet 5).
- Cross Reference** (Sheet 20) is associated with **Geometry Hierarchy** (Sheet 5).
- Data Quality** (Sheet 20) is associated with **Geometry Hierarchy** (Sheet 5).
- Description** (Sheet 20) is associated with **Geometry Hierarchy** (Sheet 5).
- Sound Instance** (Sheet 22) is associated with **Geometry Hierarchy** (Sheet 5).
- Geometry Model** (Sheet 22) is associated with **Geometry Hierarchy** (Sheet 5).
- Geometry Model Instance** (Sheet 16) is associated with **Geometry Hierarchy** (Sheet 5).
- Property Grid Hook Point** (Sheet 4) is associated with **Geometry Hierarchy** (Sheet 5).
- Aggregate Geometry** (Sheet 4) is associated with **Geometry Hierarchy** (Sheet 5).
- LSR Transformation** (Sheet 7) is associated with **Property Grid Hook Point** (Sheet 4).
- Spatial Extent** (Sheet 20) is associated with **Property Grid Hook Point** (Sheet 4).
- Location** (Sheet 15) is associated with **Property Grid Hook Point** (Sheet 4).
- Property Grid** (Sheet 6) is associated with **Property Grid Hook Point** (Sheet 4).
- Expression** (Sheet 16) is associated with **Geometry Model Instance** (Sheet 16).
- Stamp Behaviour** (Sheet 7) is associated with **Geometry Model Instance** (Sheet 16).
- Conformal Behaviour** (Sheet 7) is associated with **Geometry Model Instance** (Sheet 16).
- Overload Priority Index** (Sheet 7) is associated with **Geometry Model Instance** (Sheet 16).
- Rendering Priority Level** (Sheet 7) is associated with **Geometry Model Instance** (Sheet 16).
- Transformation** (Sheet 7) is associated with **Geometry Model Instance** (Sheet 16).



# Features (example)





# ***SEDRIS Technology Components***

*Spatial Reference Model (SRM)*

*Environmental Data Coding  
Specification (EDCS)*

*Data Representation Model (DRM)*

***SEDRIS Interface Specification  
(Read & Write Application Program  
Interfaces (APIs))***

*SEDRIS Transmittal Format (STF)*





# Definitions

---

- ***API (Application Program Interface):*** An encapsulation of functionalities common to many applications into reusable modules.
- ***API Implementation:*** The instantiation of an API's functionality in software that is bound to one or more software language.
- ***Transmittal:*** Environmental data realized as a collection of DRM-compliant instances that can be accessed through the SEDRI API.



# The SEDRIIS API

---

- The SEDRIIS API is an encapsulation of functionality which provides applications the ability to access DRM objects.
  - **Data Extraction** - provides searching methods to access DRM objects in a SEDRIIS transmittal.
  - **Data Insertion** - provides ability to create DRM objects in new or existing SEDRIIS transmittals.
  - **Data Representation Model** - provides access to meta-data about DRM classes, data types, and their allowable relationships.
- A set of ISO **C language** function definitions (bindings). Also implemented in C++.
- Why an API (not just a format specification) ?
  - Provides a consistent interface between a user's software application and SEDRIIS transmittals.
  - Decouples the user's application from the transmittal's format, allowing the DRM, the transmittal format, and the user's application to evolve relatively independently of each other.
  - Provides functions to simplify the navigation of complex transmittals.



# The EDCS and SRM APIs

---

The SRM and EDCS have **independent** APIs that are available for use separately, or in conjunction with the SEDRIIS API.

- **Spatial Reference Model API** - provides coordinate conversion of data from one spatial reference frame to another. Also includes conversions for colors. Implemented in Java, C++, and C.
- **Environmental Data Coding Specification API** - provides access to the nine dictionaries of integer codes, labels and definitions.

# ***SEDRIS Technology Components***

*Spatial Reference Model (SRM)*

*Environmental Data Coding  
Specification (EDCS)*

*Data Representation Model (DRM)*

*SEDRIS Interface Specification  
(Read & Write Application Program  
Interfaces (APIs))*

***SEDRIS Transmittal Format (STF)***



# SEDRIIS Transmittal Format (STF)

---

- *A file format developed to store SEDRIIS data*
- *The data organization is derived directly from the DRM.* Objects are stored and retrieved in direct 1-to-1 relationship with the data created by the producer
- *A binary format which is machine architecture and word order independent*
- STF transmittals consist of multiple files but are named by one main 'root' file
- The STF SEDRIIS API Implementation provides the functionality of extraction and insertion components of the SEDRIIS API



# Transmittal Format - Requirements

---

- ***Platform Independence:***
  - Both software and files
  - Adapts to platform's word order
- ***Fully Support the SEDRIS Data Representation Model:***
  - Full expressive power of the DRM
  - Data driven via DRM support functions
  - Completely loss-less with respect to objects instantiated by the data provider
- ***Space Efficient Media Storage:***

Minimal overhead with respect to the size of the SEDRIS objects stored
- ***Run-time Efficiency:***
  - Efficient with respect to both memory and processing time
  - Heavier emphasis on extraction performance than on insertion
- ***Insulate Developers from Implementation Details:***

Format and software can evolve independently from applications
- ***Leverage Existing Format Standards where it makes sense:*** Images and Data Tables



# STF Design Features

---

- ***File based storage on media:***
  - Structure of data on physical media is the responsibility of the platform operating system, not the STF
  - STF transmittals use can hierarchical directory structure to organize files
- ***In essence, implements a simple persistent object database system:*** STF is intentionally *not* a full object-oriented database management system
- ***Abstracts system services to simplify portability:***
  - Marshals system resources
  - Supports platform specific tuning to enhance performance
- ***Supports “composite” objects to reduce overhead***
- ***Supports quick culling when search filters include rules specifying the object type***

***The Role of SEDRIS Technology in  
Interoperability & Interchange***





# Interchange vs. Interoperability

---

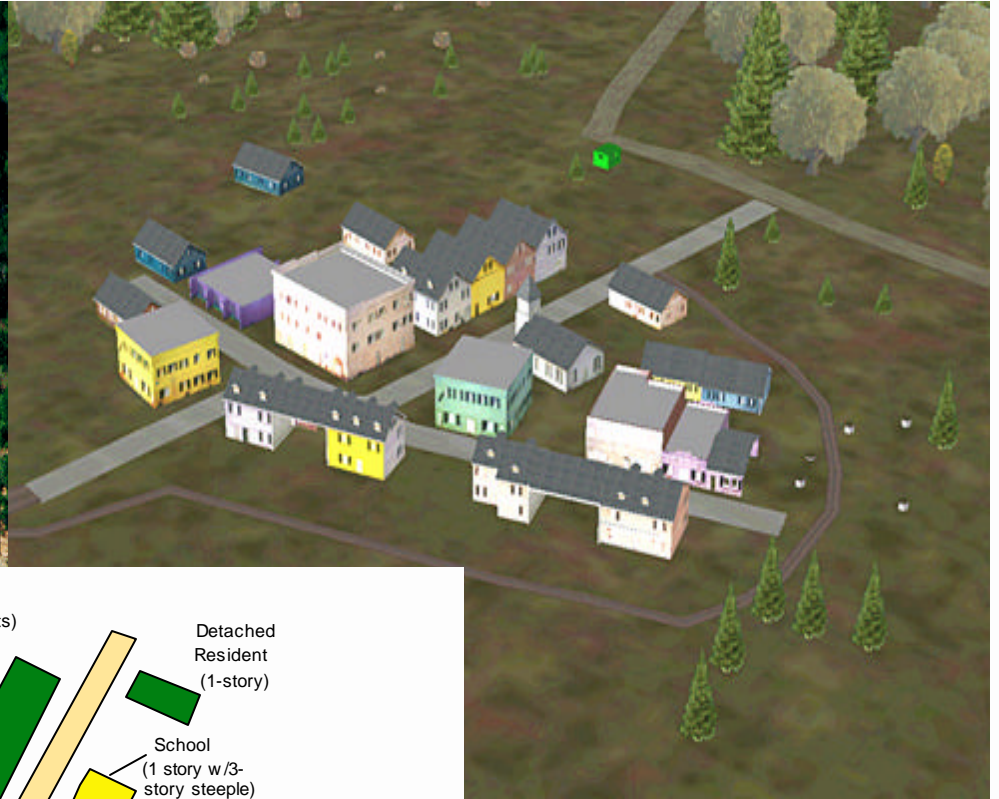
- *Interchange of data does not guarantee interoperability*
- *Two forms of data interchange:*
  - Dynamic Interchange (network packets)
  - Static Interchange (set parameters, databases, geometry)
- *Robust interchange is critical to interoperability*
- *In the simulation domain, interoperability is achieved if:*  
the perception of same event is similar when it is viewed /experienced from different simulators / simulations
- *Resolution of perception, not necessarily data resolution, is key*



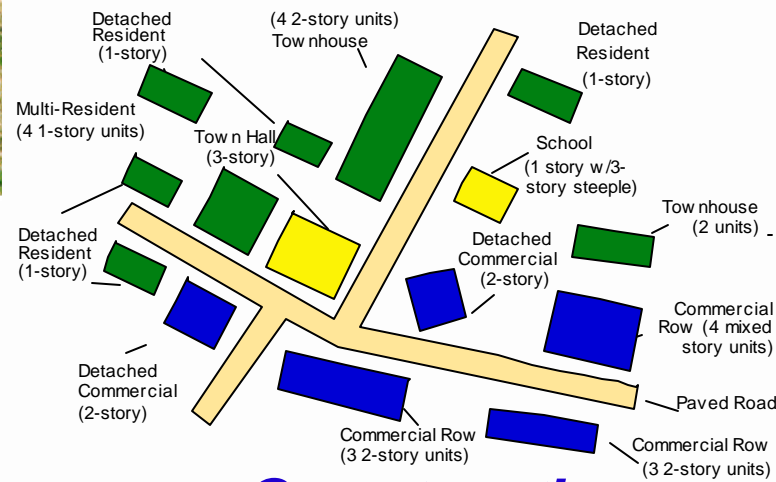
# The Interoperability Challenge



*Live*



*Virtual*



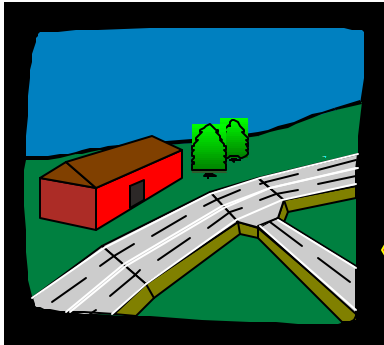
**Constructive**

Introduction to SEDRIIS for Managers

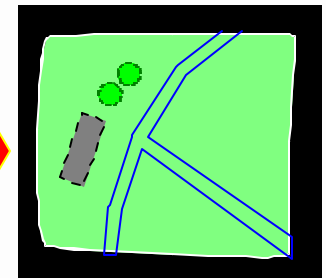


# Different Views of the Environment

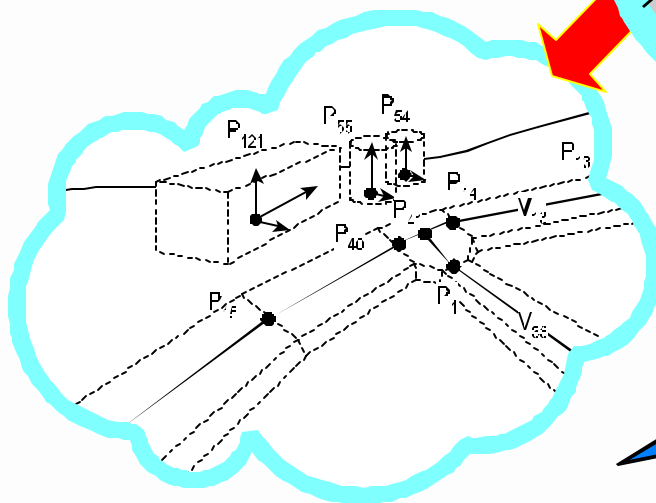
**Visual Database**



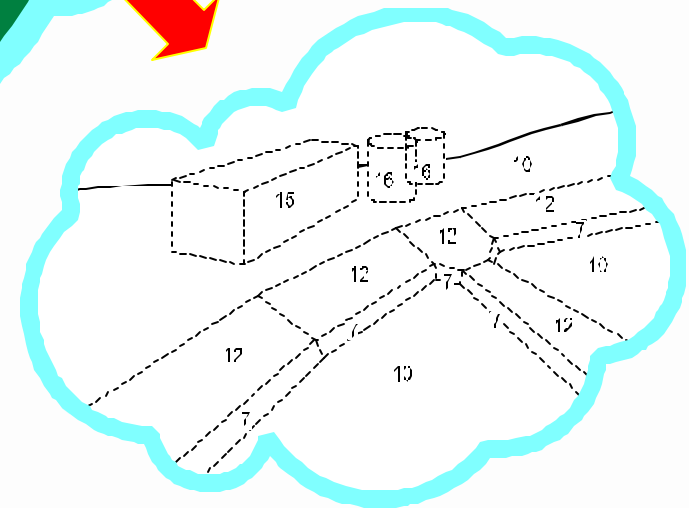
**Electronic Maps**



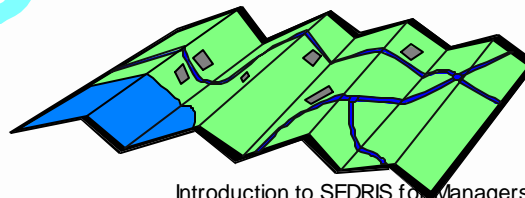
**Mobility Database**



**CGF Database**



**Paper Maps**





# Same Object - Differing Views

---

- What we think of an object *depends on our use, interaction, and perception of that object*
- For example, a bridge is
  - an obstacle to sail boats with long masts
  - a connector in road networks
  - a target during warfare
  - a load bearing structure to an engineer
- These differing views are also *reflected in the way simulation applications expect and require environmental data about the same object*
- *SEDRIIS is designed to support this requirement*



# Six Interoperabilities of Data

---

- **Data Sources:** Authoritative, timely
- **Data Integration:**
  - Internally consistent, complete
  - One truth, many perceptions
- **Data Models and Dictionaries:**
  - Formats (and APIs) are *not* the issue
  - *Shared semantics and an integrated data model are key to success*
- **Data Dynamics:** Things change. Does your data? Authoritatively?
- **Data Access:** Can you get what you want, when / where you want it?
- **Data Analysis:** Data is almost useless; information is crucial to success







# Six Data Interoperabilities & SEDRIIS

- ***Data Sources & Data Integration:***

- Policy issues outside of SEDRIIS; addressed by customers
- SEDRIIS provides technical support for data consumption strategies from individual data types through fully integrated datasets

- ***Data Models and Dictionaries:***

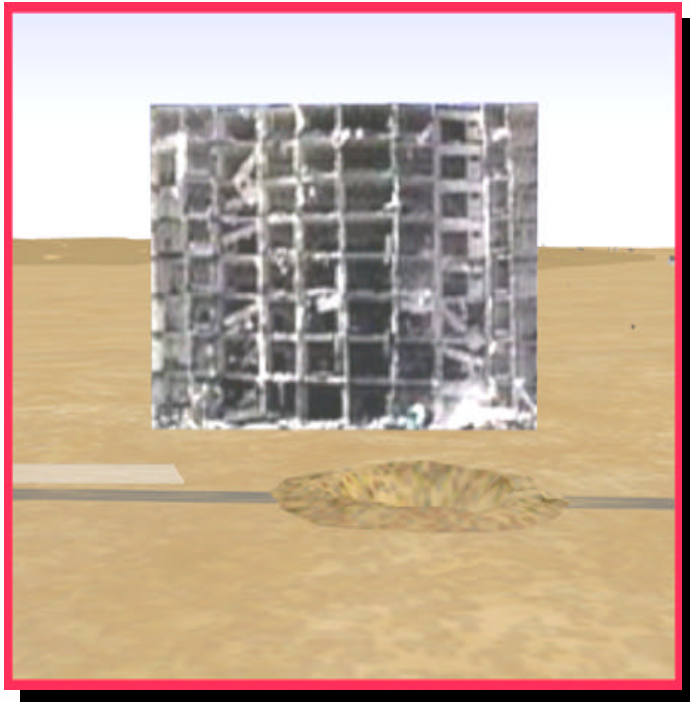
- Shared semantics and an integrated data model are key to success
- Data Representation
- Interchange Specification is focus (not format)

- ***Data Dynamics, Access, & Analysis:***

- Necessarily application-type specific
- The critical precondition to interoperability success remains data integration based on a common data model and data dictionary defining unambiguous (and model-independent) semantics



# Structures Data

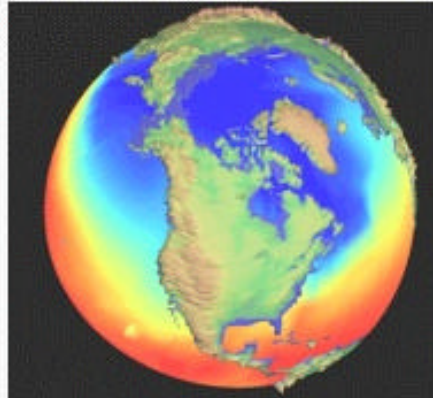


**... and Structural Damage**

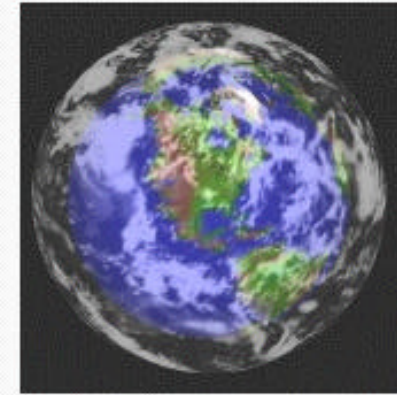


# Weather Effects Data

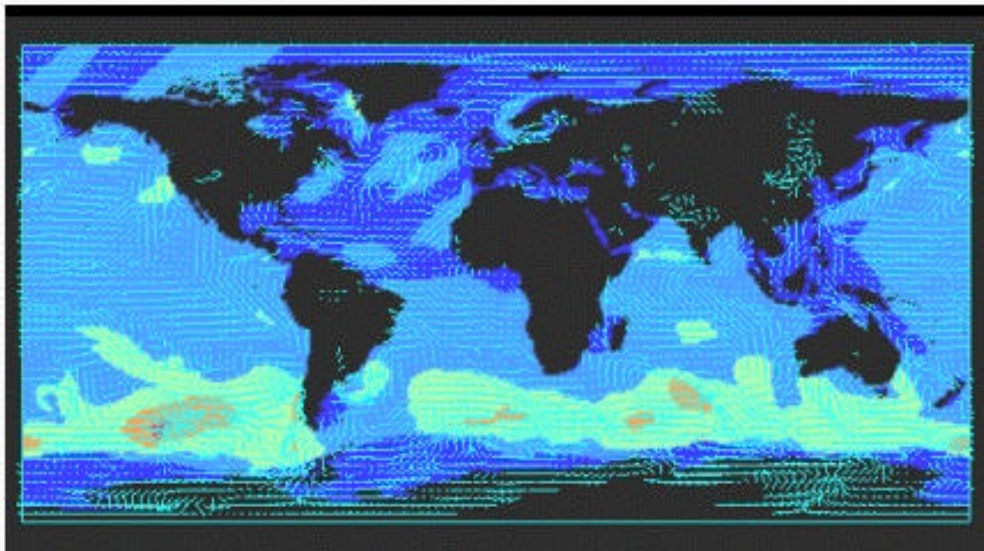
*... predicting the future environment in military planning (e.g., IMETS)*



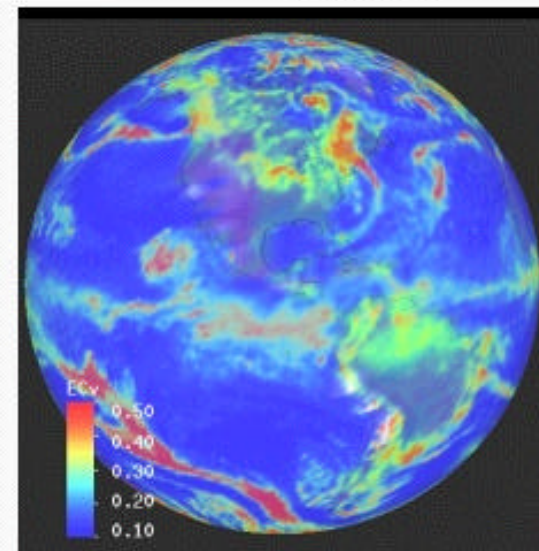
**Sea Surface Temperature**



**Clouds**



**Sea State & Surface Winds**



**Visibility**





# Meteorological / Oceanographic (METOC) Data

---

- *Sampled values representing a continuous phenomenon*
  - Gridded data, linear profiles, regional observations
  - Uniformly spaced time samples
- *Complete representation usually requires assembling data from multiple sources and multiple files*
  - 3-D, multi-quantity grids often disassembled into 2-D, one - quantity files
  - Observations, analysis, forecasts, scientific models
- *Each source may use a different format*
  - Ad-hoc based on sensor, numeric application, textual report, ...
  - International standards: World Meteorological Organization (WMO)



# Atmosphere-Ocean Variables ...

---

- *Temperature*
- *Dew point*
- *Relative Humidity*
- *Wind U, V*
- *Precipitation Rate*
- *Precipitation Type*
- *Extinction Coefficient*
- *Extinction Amount*
- *Extinction Type*
- *Cloud Height (Base)*
- *Cloud Top*
- *Cloud Cover*
- *Cloud Type*
- *Surface Duct Height*
- *Evaporation Duct Height*
- *Surface Duct Intensity*
- *Evaporation Duct Intensity*
- *Ducting K*
- *Time of day (for ephemeris)*
- *Sea State*
- *Salinity*
- *Gulf Spectra*
- *Surf zone spectra*
- *Number of Waves*
- *Number of Frequencies*
- *Breaker Type*
- *Breaker Angle*
- *Sea Surface Temperature*
- *Wave Direction*
- *Wave period*
- *Wave Height*
- *Current Velocity*
- *Tide Level*



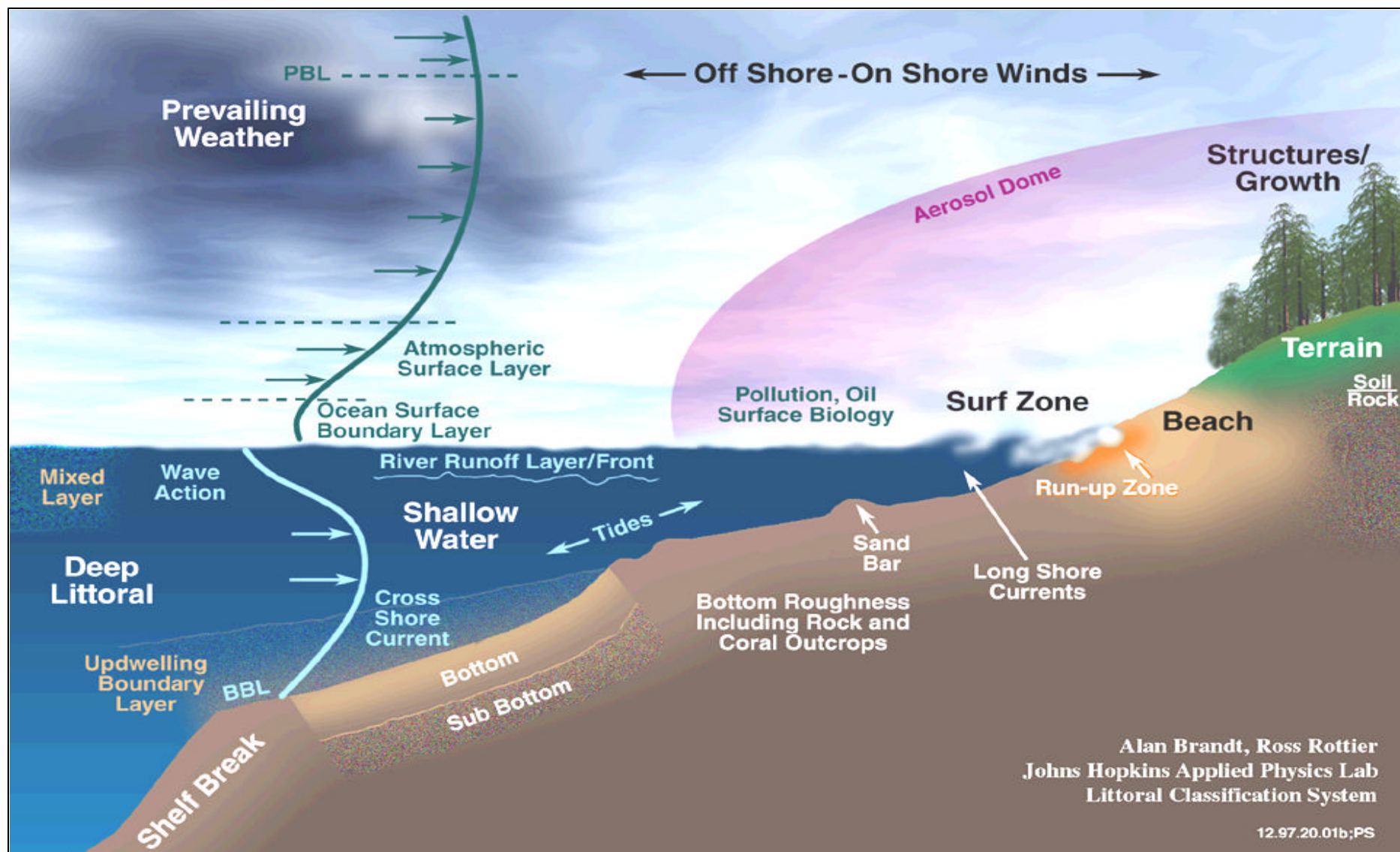
# METOC Data Sets

- *Atmospheric Forecast Data*
- *Atmospheric Observations*
- *Ocean Forecast Data*
- *Ocean Observations*
- *Climatology*
- *Bathymetry*
- *Marginal Ice Zone*
- *Space Observations*





# Integrated Littoral Environments

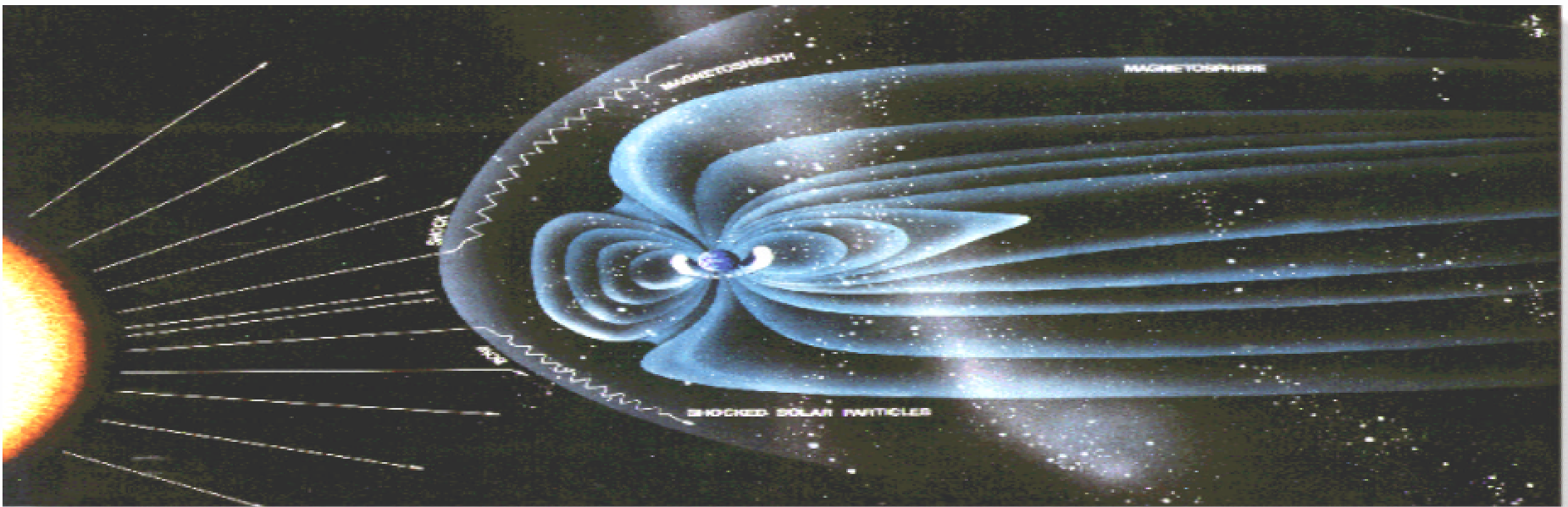






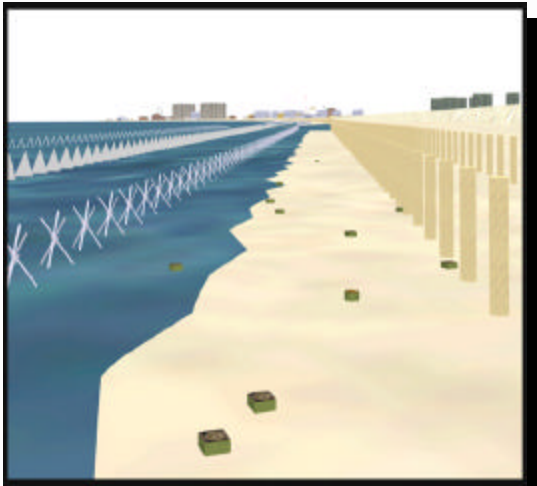
# Space Data Sets

- *Ionospheric Scintillation*
- *Electron Density Profile*
- *Solar Energetic Particles*
- *Solar Electromagnetic Emissions*
- *Magnetospheric Plasma*
- *Geomagnetic Fields*
- *Solar Wind*
- *Auroral Emissions*
- *Interplanetary Magnetic Fields*
- *Auroral Precipitating Particles*
- *Cosmic Rays*
- *Auroral Electrojet*
- *Total Electron Count (Vertical)*
- *Neutral Density*
- *Trapped Energetic Particles*





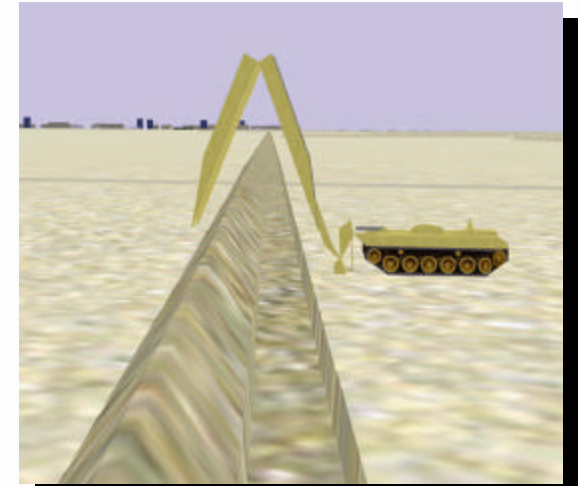
# Military Operations Effects Data



**Obstacles**



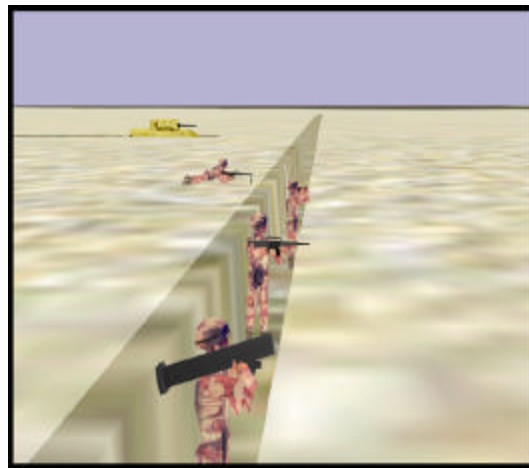
**Survivability Positions**



**Anti-Tank Ditch Breaching**



**Minefield Breaching - Blade**



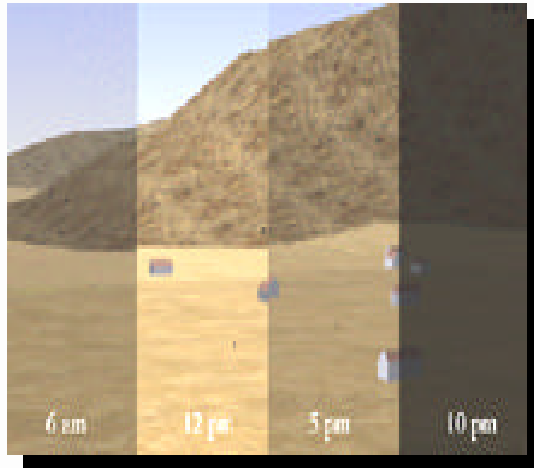
**Infantry Trench**



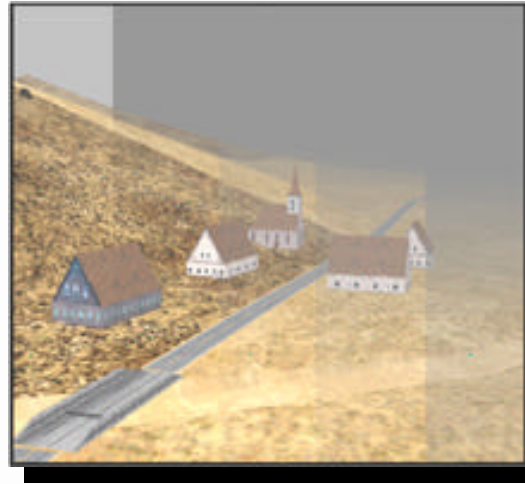
**Cratering**



# Atmospheric Effects Data



**Time-of-Day**



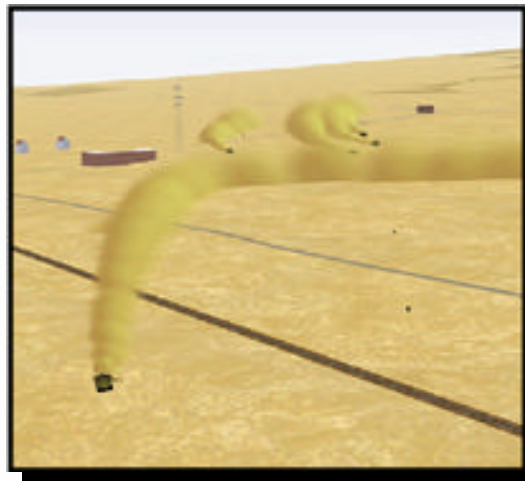
**Precipitation**



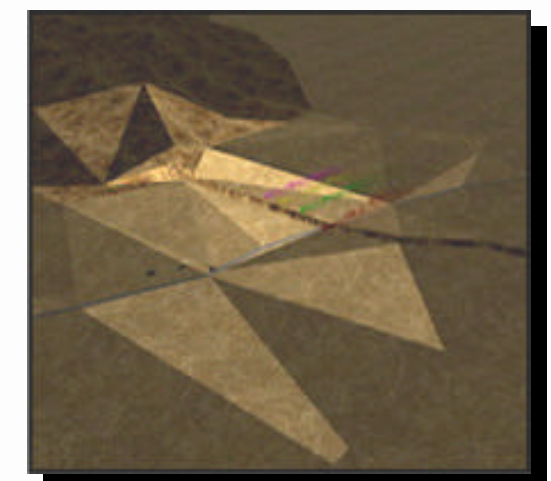
**Haze**



**Clouds**



**Vehicular Dust**



**Signal / Illumination Flares**

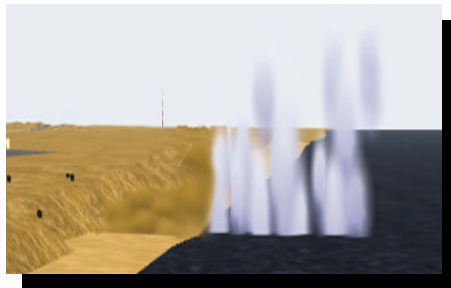




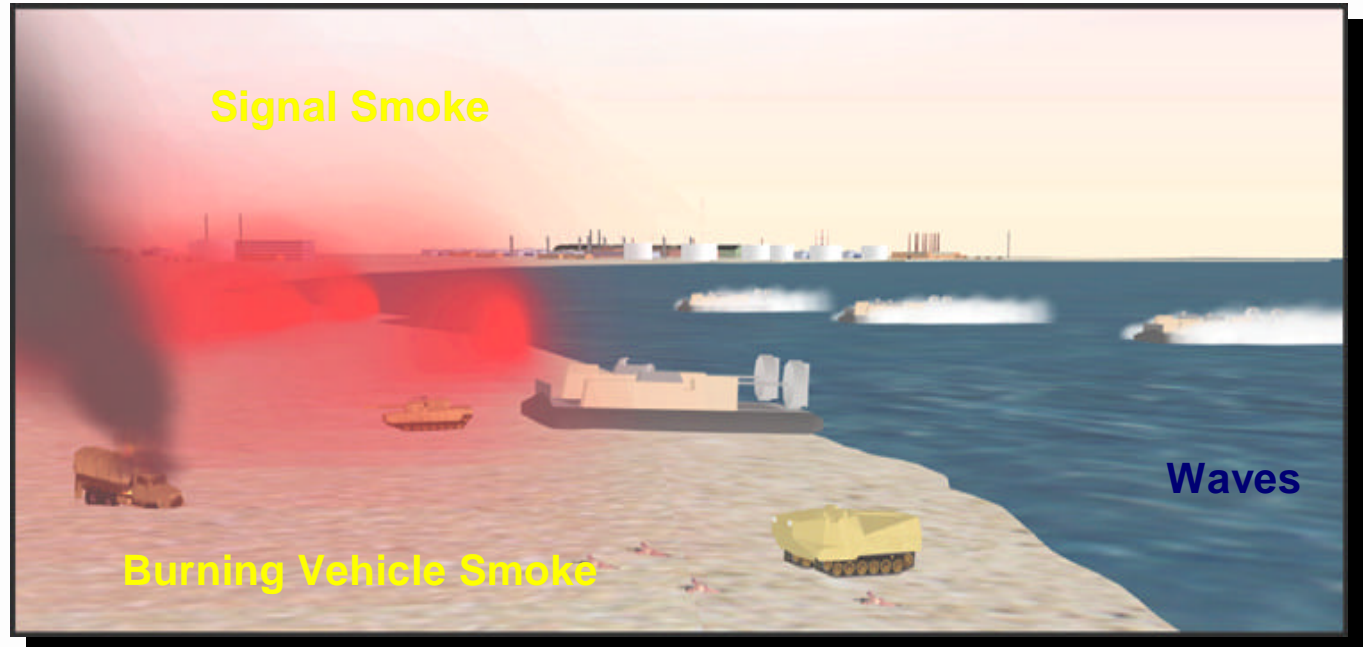
# more Effects and Impacts Data



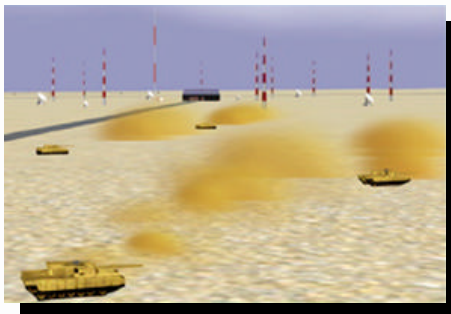
**Gridded Weather**



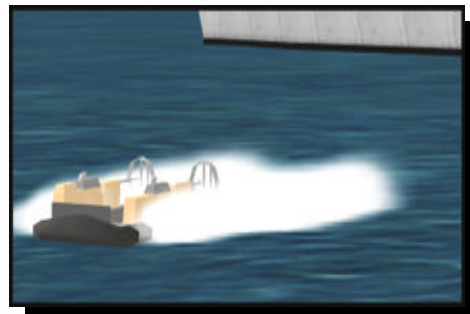
**MICLIC Explosion**



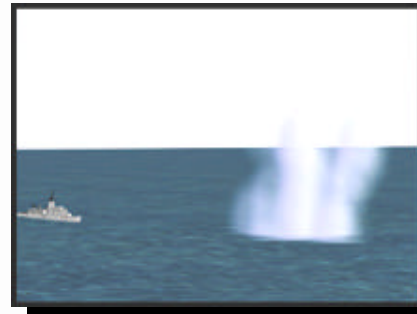
**Natural Illumination (Haze / Horizon Glow)**



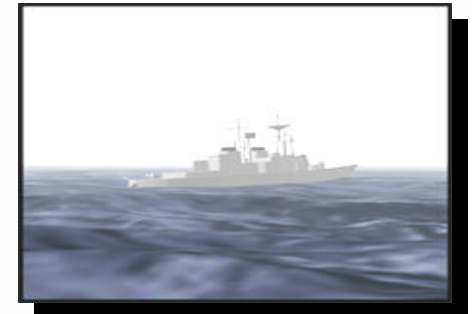
**Muzzle Dust**



**LCAC Spray**



**Deep Water Mine**



**Sea State**





# Computer Generated Forces Data

---

- ***Terrain surface, bathymetry, water surfaces***
  - Used for vehicle placement and movement, and line of sight
  - Regular grid with overlaid polygons
  - Triangulated Irregular Network
  - Use geometry capabilities of SEDRIIS, TIN representations may use topology as well
- ***Abstract feature data***
  - Used for mission planning and vehicle movement planning
    - Route generation
    - Obstacle avoidance
  - Use feature and topology capabilities of SEDRIIS



# Geo-Typical Environments Data

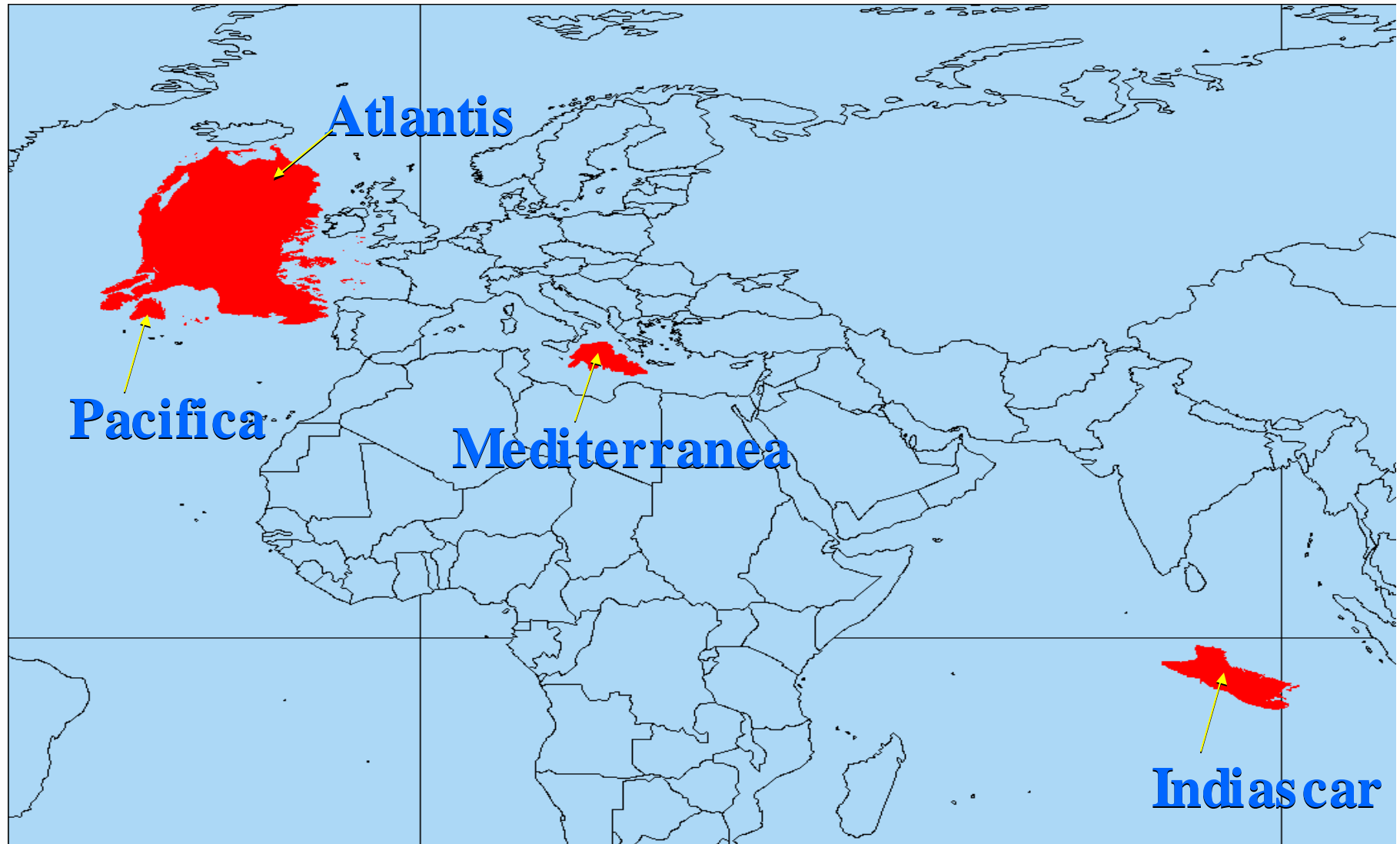
---

***offer advantages over geo-specific production  
if you need it fast and really complete***

- **Provide synthetic landmasses on which U.S. and Allied Forces can conduct computer-aided exercises**
- **Politically neutral**
- **Rich data coverage (fully attributed)**
- **Can be customized for specific exercises**



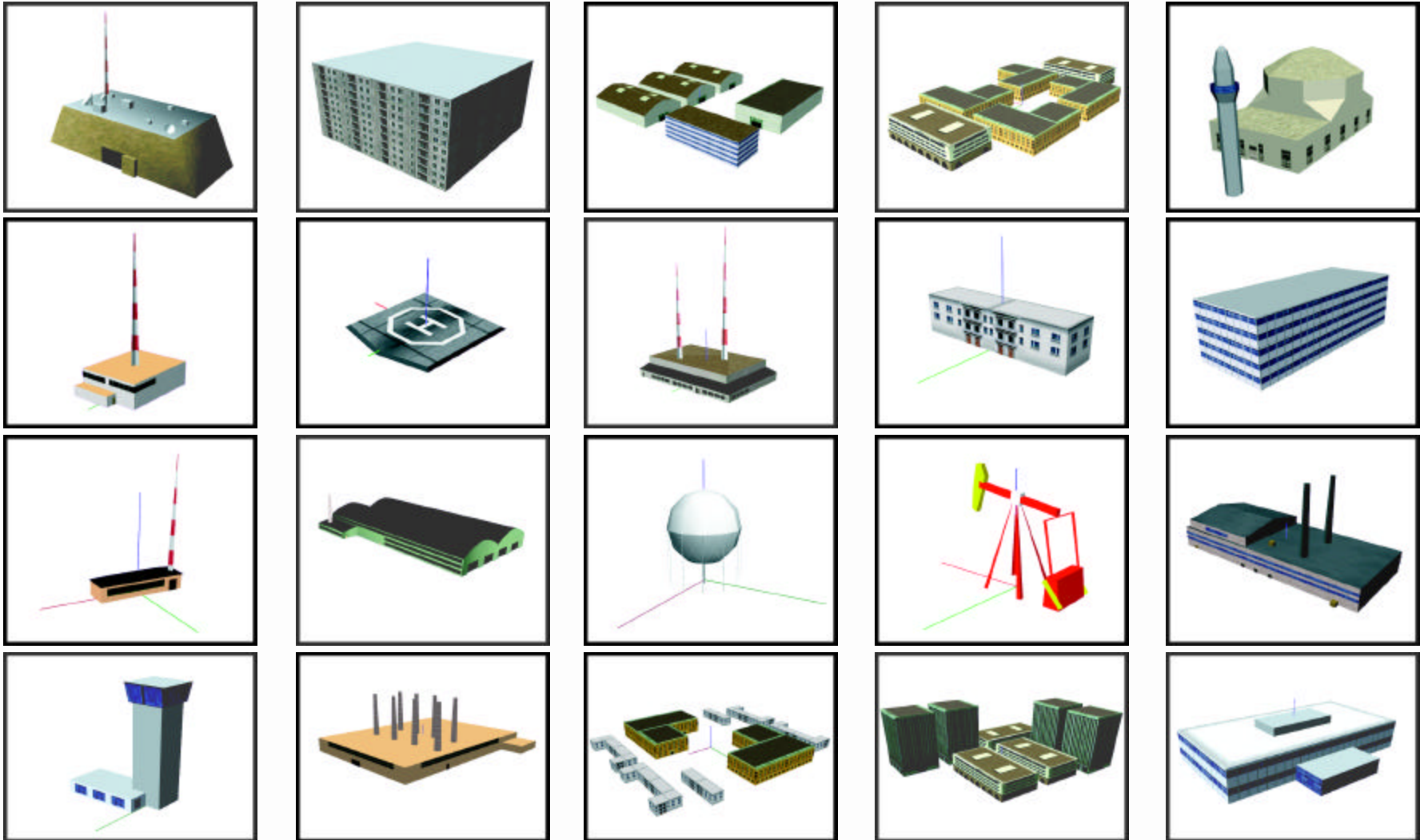
# Synthetic Exercise Environment (SEE)





# Geotypical Cultural Features Data

## *... Dealing with Data Shortfalls*





# Interoperability & Interchange

---

- **Key Concepts:**
  - *Interchange of data does not guarantee interoperability*
  - *But robust interchange is critical to interoperability*
  - *To interchange data successfully and without ambiguity, a powerful and expressive representational schema is needed*
- **SEDRIIS facilitates interoperability by providing both a powerful data representation model and a robust data interchange mechanism**

# ***Using SEDRIS***

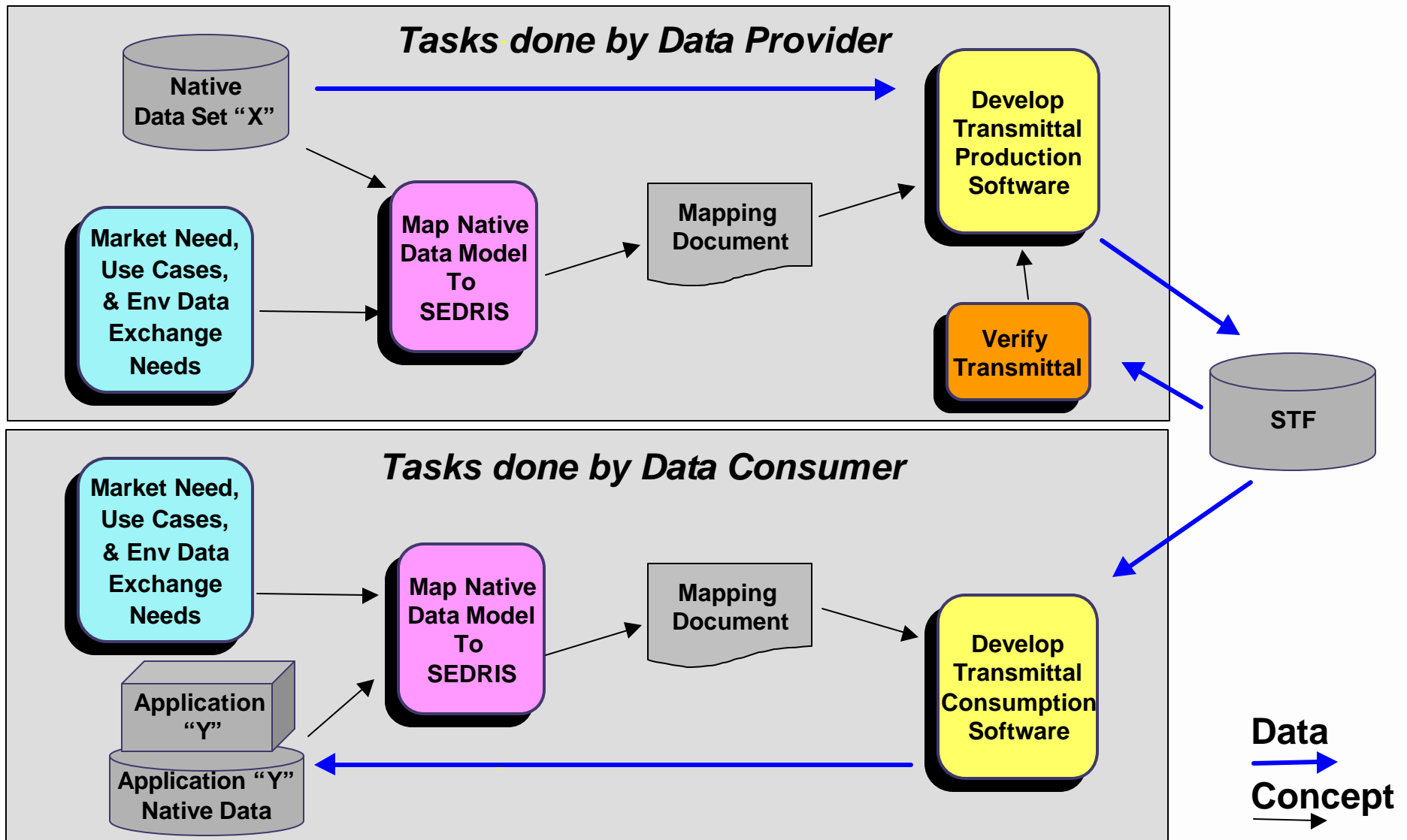
***Using SEDRIS for Data Interchange –  
A high level process***

***SEDRIS in Use today***

***Tools and Utilities***



# Steps in SEDRIIS Production and Consumption Process





# Creating a Transmittal

---

## ***Step 1: Native Requirements & Data***

***Analysis:*** Define use or application plus data exchange requirements

## ***Step 2: Develop Mapping Document:*** Use DRM, EDCS and SRM

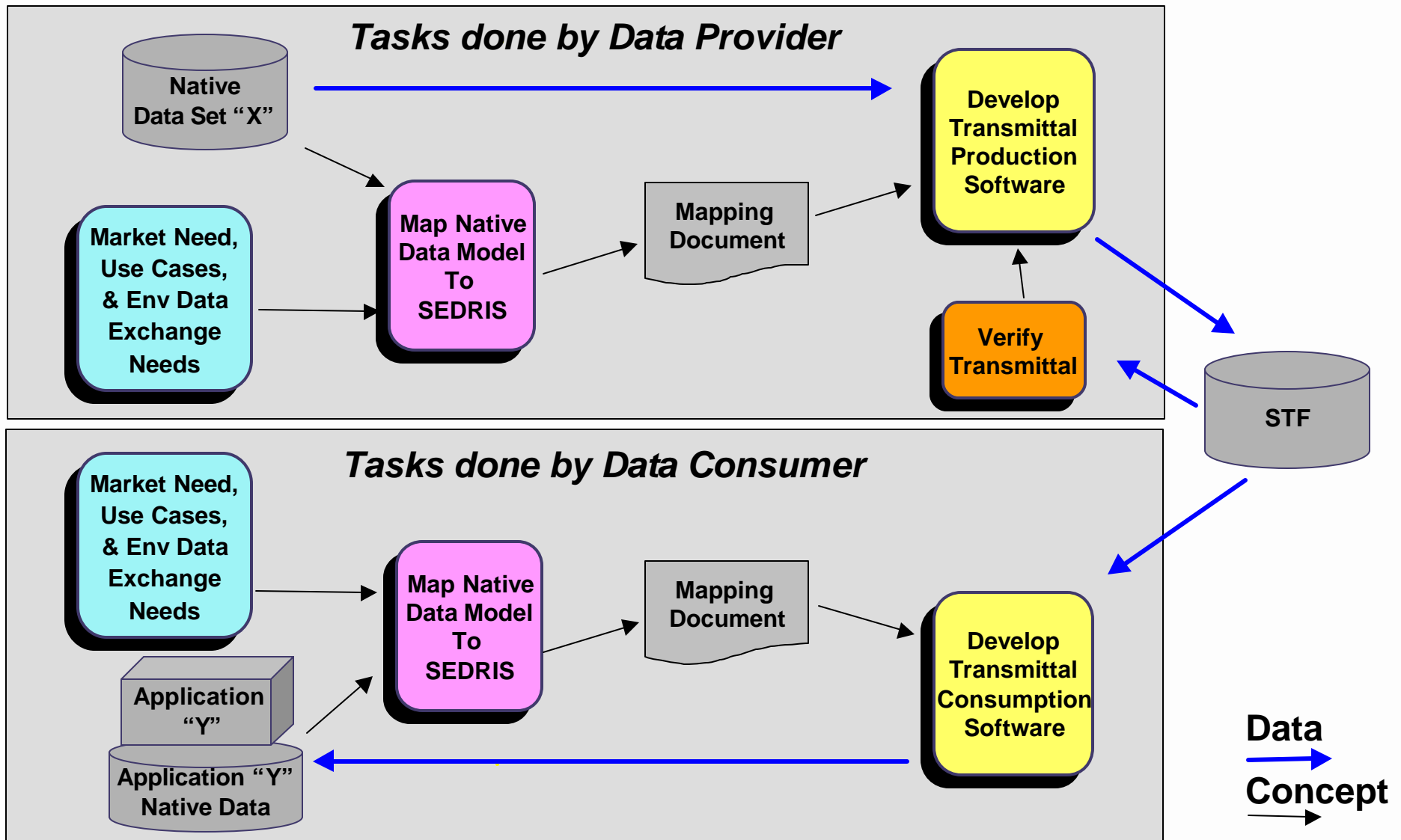
## ***Step 3: Develop Production software:*** Add in API and STF

## ***Step 4: Validate Transmittal:*** Add in tools and applications





# Steps in SEDRIIS Production and Consumption Process





# Consuming SEDRIIS Transmittals

---

***Step 1: Native Analysis:*** What are your data requirements?

***Step 2: Mapping Document:*** Map to your data requirements

***Step 3: Learn SEDRIIS:***

- Extraction capabilities
- Necessary DRM, EDCS, & API knowledge

***Step 4: Create consumption software:*** Taking advantage of the common services

# ***Using SEDRIS***

***Using SEDRIS for Data Interchange –  
A high level process***

## ***SEDRIS in Use today***

***Training Applications***

***Analysis Applications***

***Simulation-Based Acquisition***

***Resource Repositories & Production Capabilities***

***Entertainment***

***Other International Applications***

***Simulation Runtime Applications***

***Evolving Applications***

***Tools and Utilities***

***SEDRIS in use Today***  
***Training Applications***



# SEDRIIS Use in WARSIM

---

## ***SEDRIIS Interfaces:***

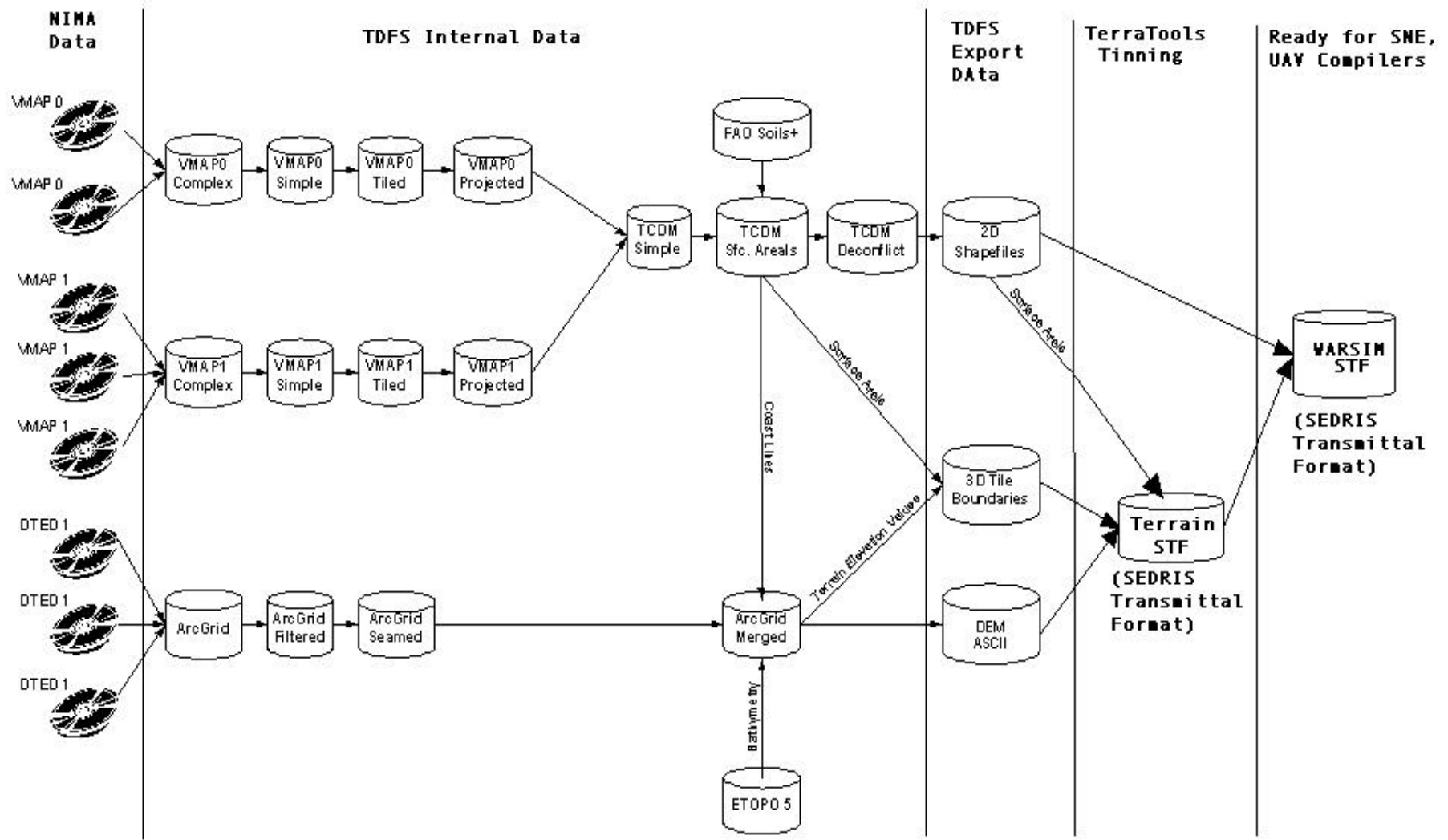
- Standard interfaces improve COTS reuse
- Minimizes reliance on proprietary format - Reduces “sole source” dependency
- Cost avoidance ~\$500,000 - Cost for IOC GOTS tools development

## ***Coordinate Services:***

- Direct reuse of Spatial Reference Model
- Significant risk mitigation / schedule reduction
- Proposed as AMIP standard - Potential for enhanced interoperability
- Direct cost avoidance ~\$350,000
- Schedule risk is minimized because coordinate services are required very early in the software development cycle (Build One)



# Terrain Data Fusion System (TDFS)





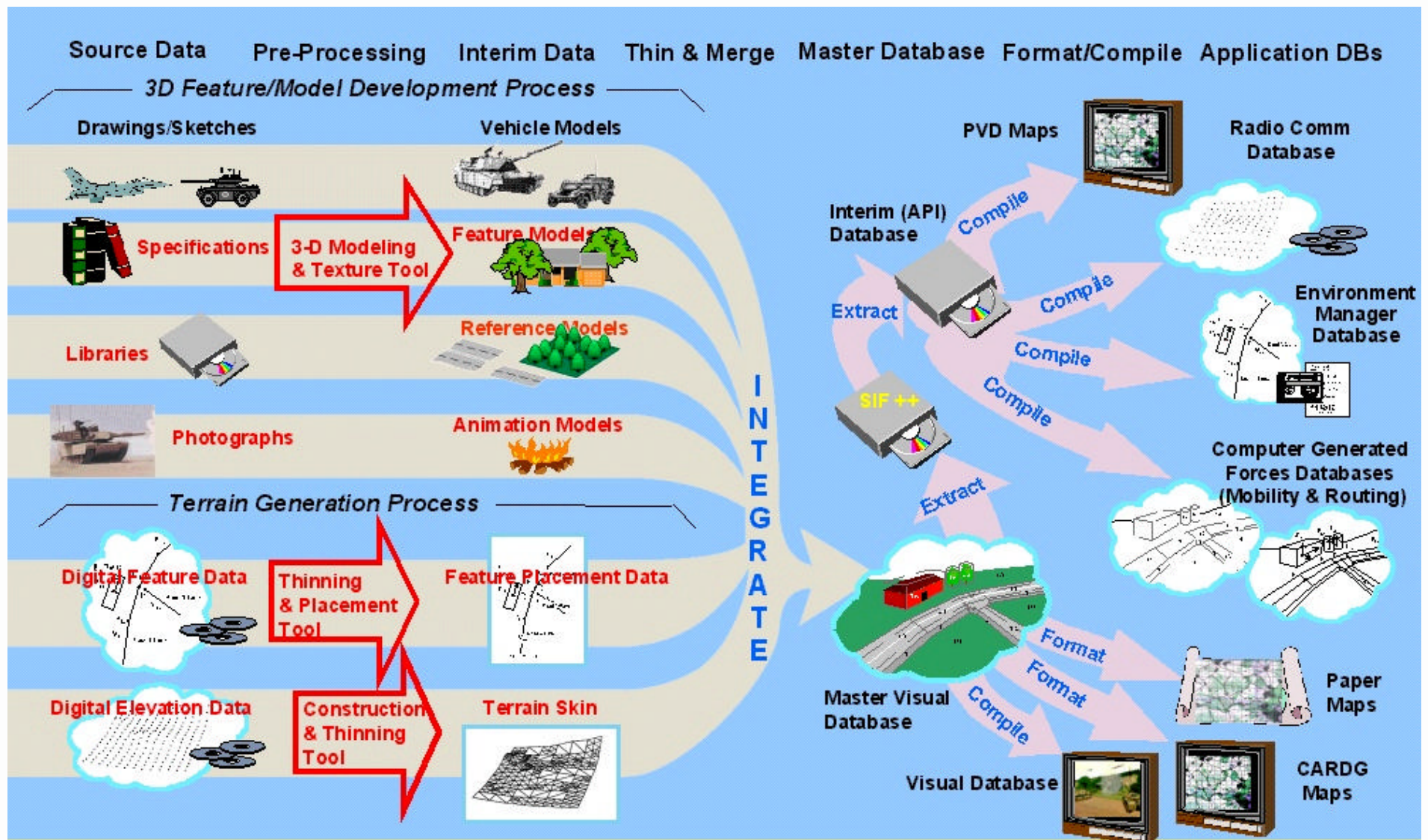
# Close Combat Tactical Trainer (CCTT)







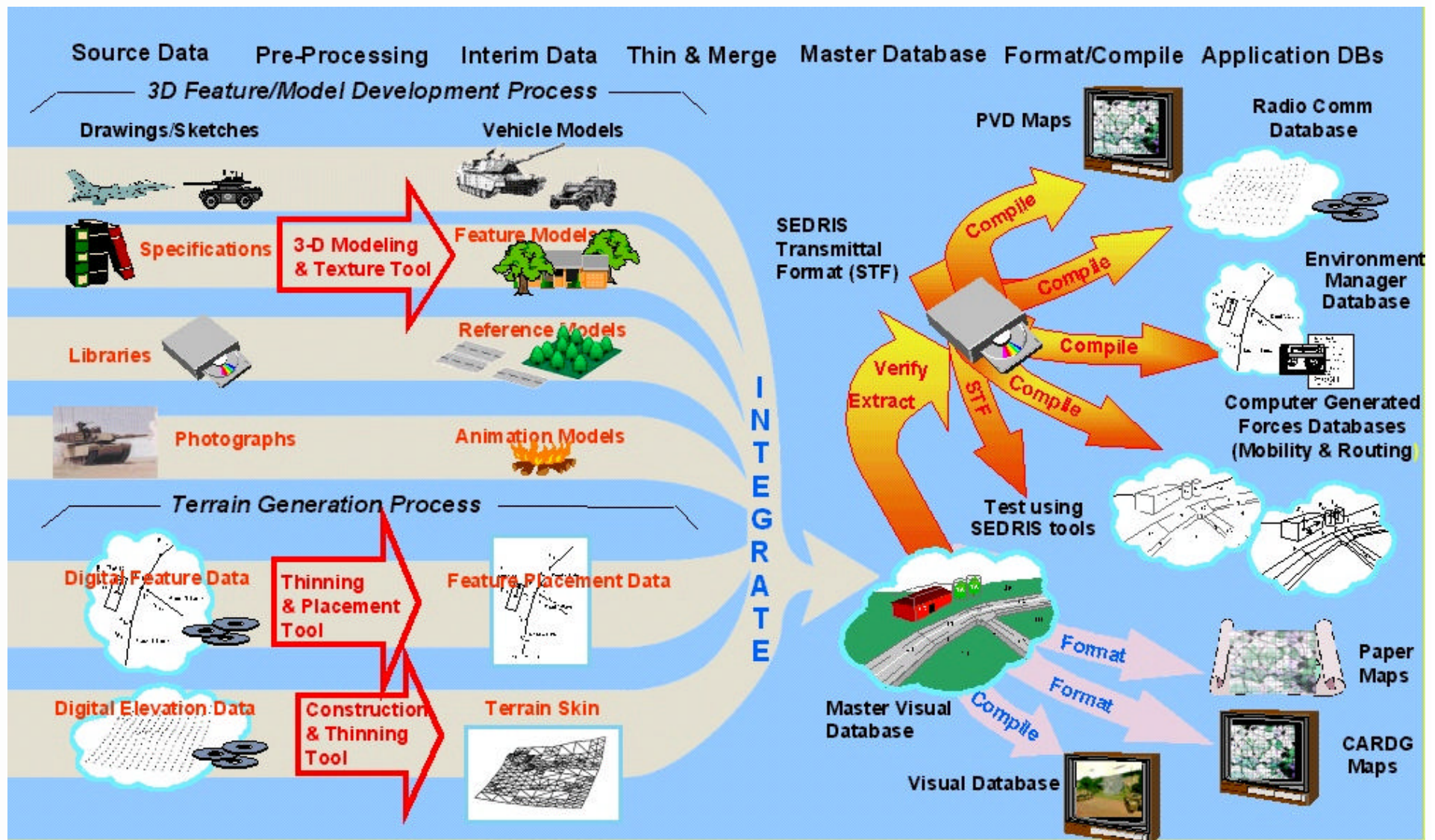
# Prior CCTT Database Generation





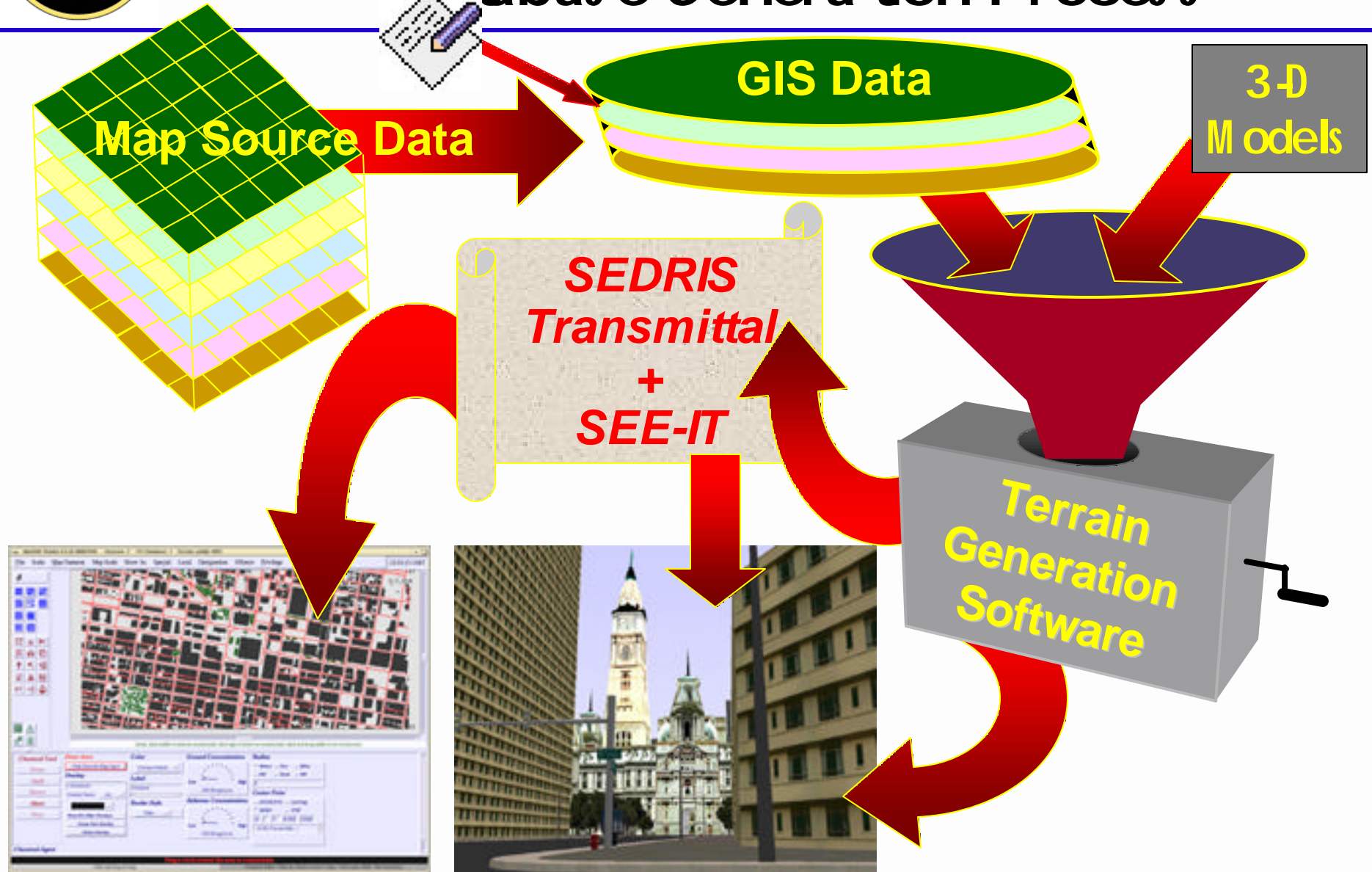


# CCTT Database Generation with SEDRIS





# Virtual Cities Database Generation Processes







# Social Hall, Salt Lake City



***SEDRIS in use Today***

***Analysis Applications***

***Joint Warfare System***





# SEDRIIS Import

---

- *Investigating use of SEDRIIS as a common import mechanism for:*
  - Feature Data
  - Weather Data
  - Space Data
  - Terrain Surface Data for Route and Mobility Reasoning
  - Support for the modified GeoViewer application
- *Both JWARS data loading and integration through JDS will be studied*



***SEDRIS in use Today***

***Simulation – Based Acquisition***



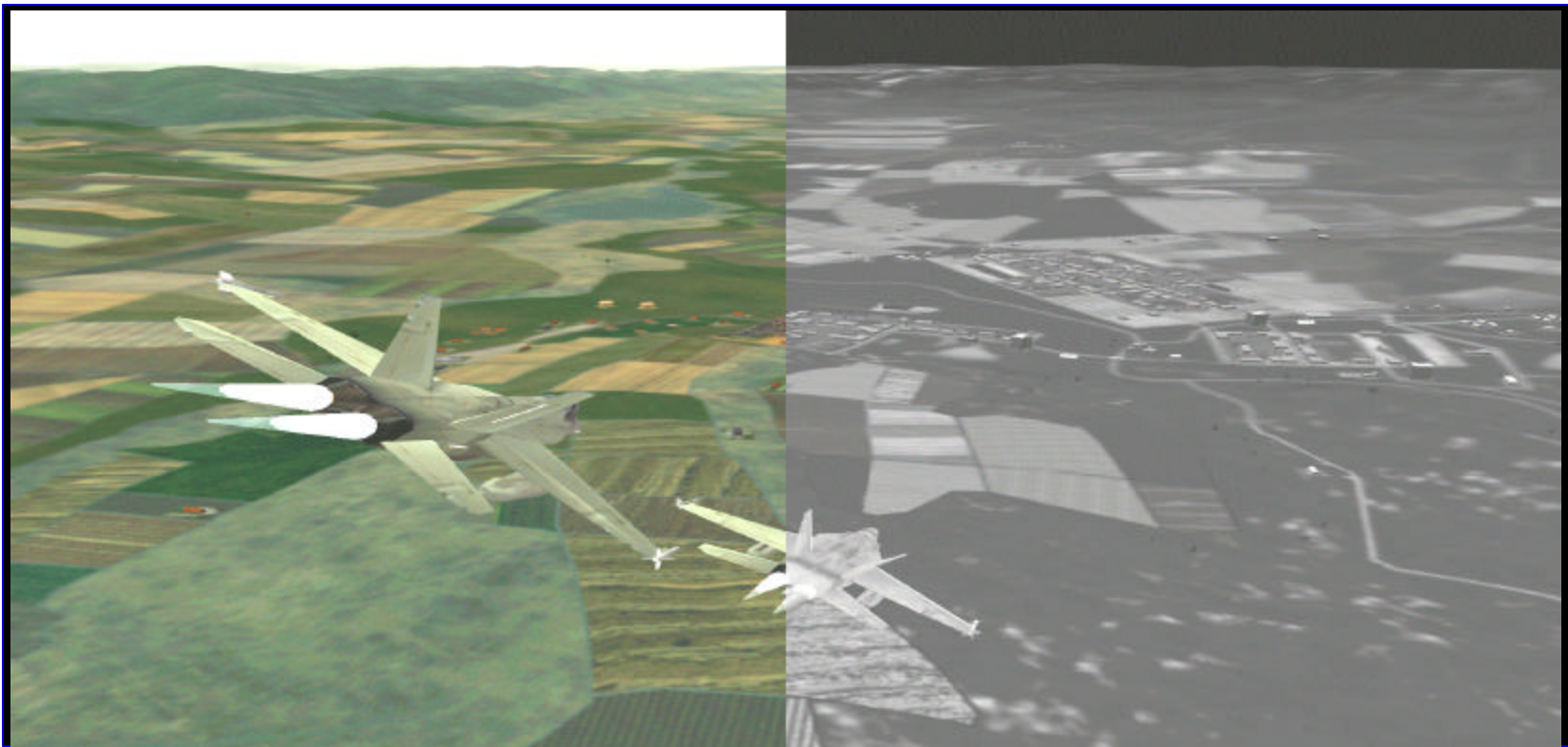


# Joint Strike Fighter Generic Composite Scenario Multi-Spectral Data Base



# Multi-Spectral Database (MSDB)

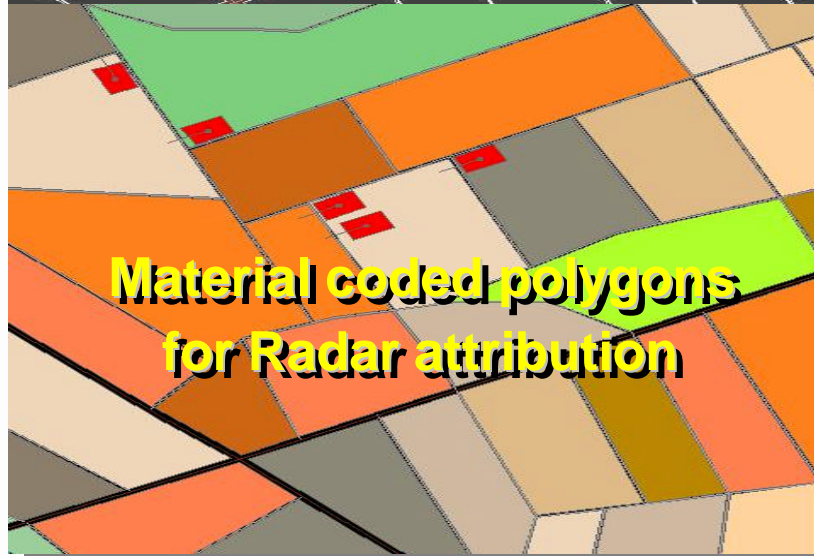
- Developed to *complement requirements evaluation*
- *Visual database design*
- *Correlated views of RADAR, Infra-Red and out the window (OTW) visuals* in that order of priority





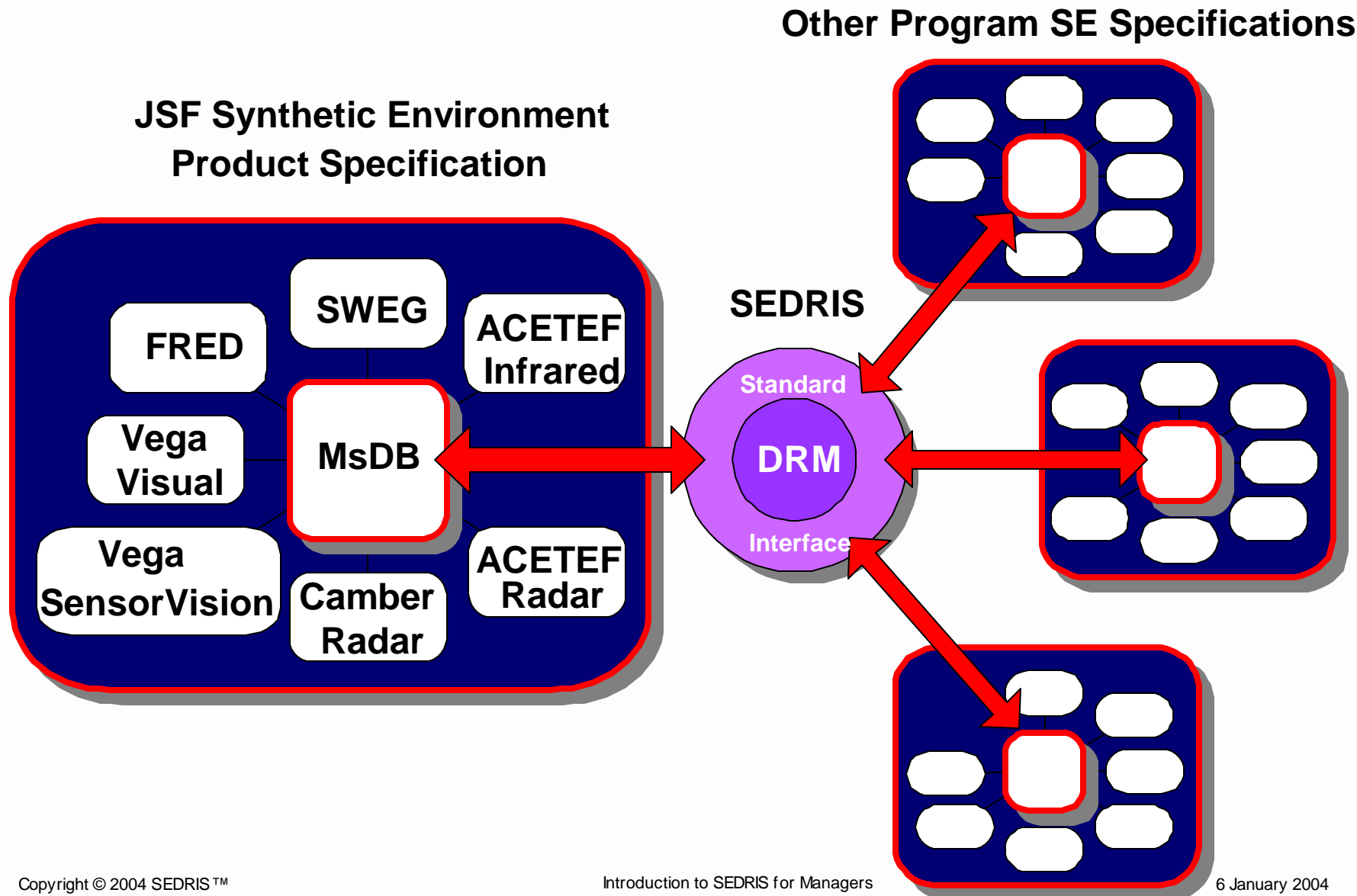


# Multiple Representations, Multiple Uses





# Sharing the MsDB through SEDRIS





# Joint Modeling and Simulation System

**JMASS uses SEDRIS in the import of Ocean, Terrain and Weather Data.**



***SEDRIS in use Today***

***Resource Repositories***

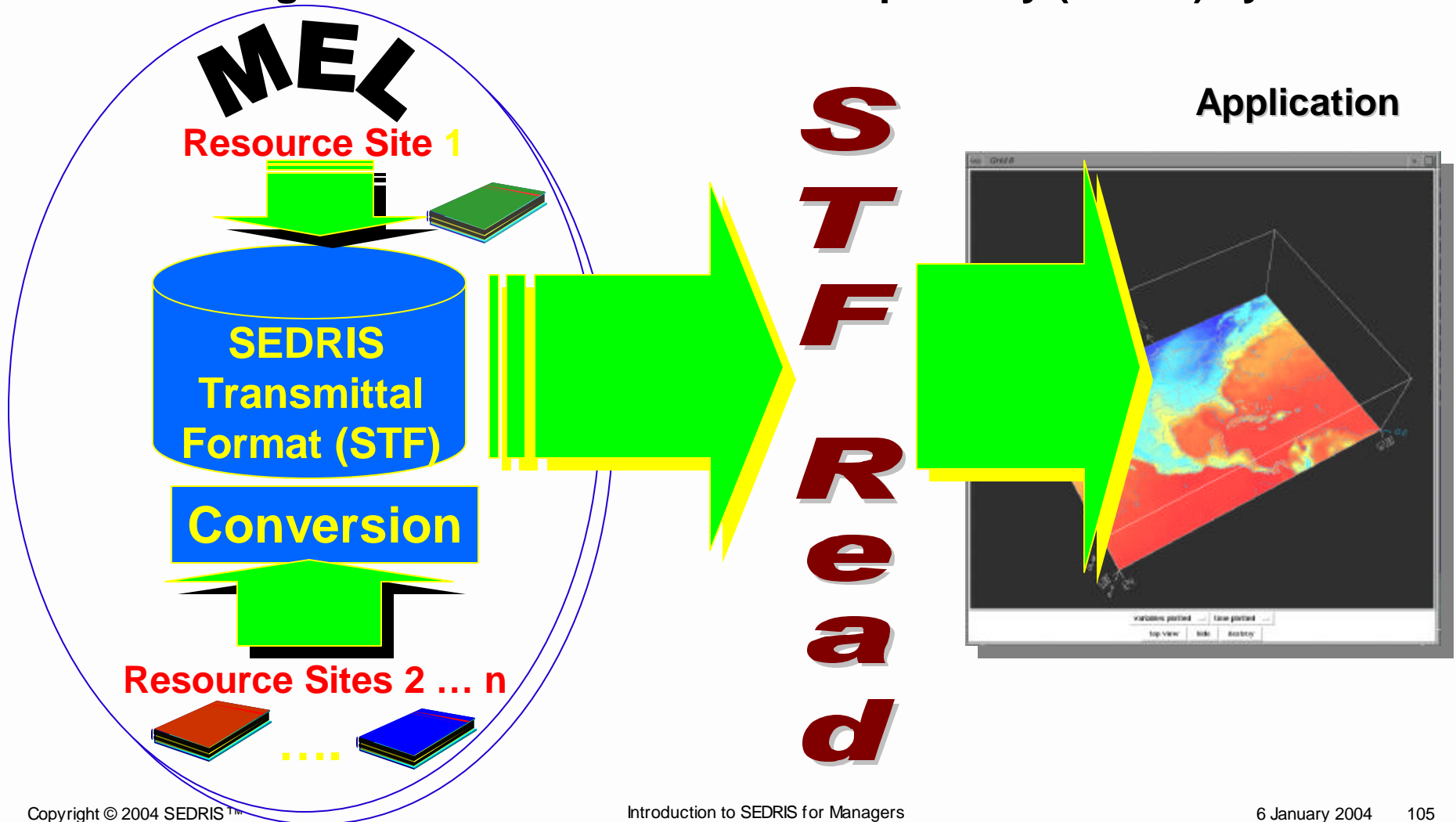
***and***

***Production Capabilities***



# Environmental Data Interchange

The Master Environmental Library (MEL) component of the Modeling and Simulation Resource Repository (MSRR) system





# Integrated Natural Environment Authoritative Representation Process (INEARP)

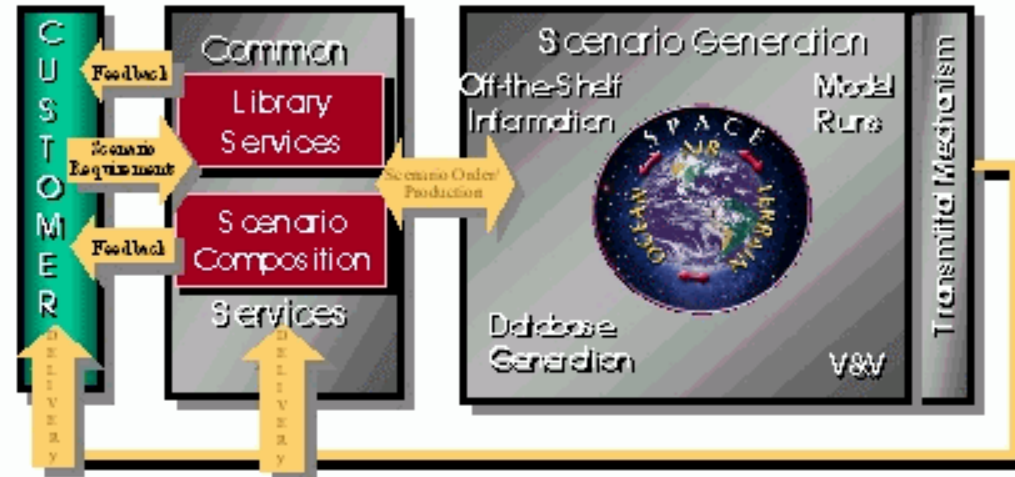
## Requirement

Scenario-driven physically consistent,  
cross-domain authoritative “ground truth”  
of the natural environment

## Goals

Readily accessible infrastructure for obtaining authoritative  
environmental representations. Robust capability to cost  
effectively acquire required environmental scenarios.

Quality product and timely delivery.



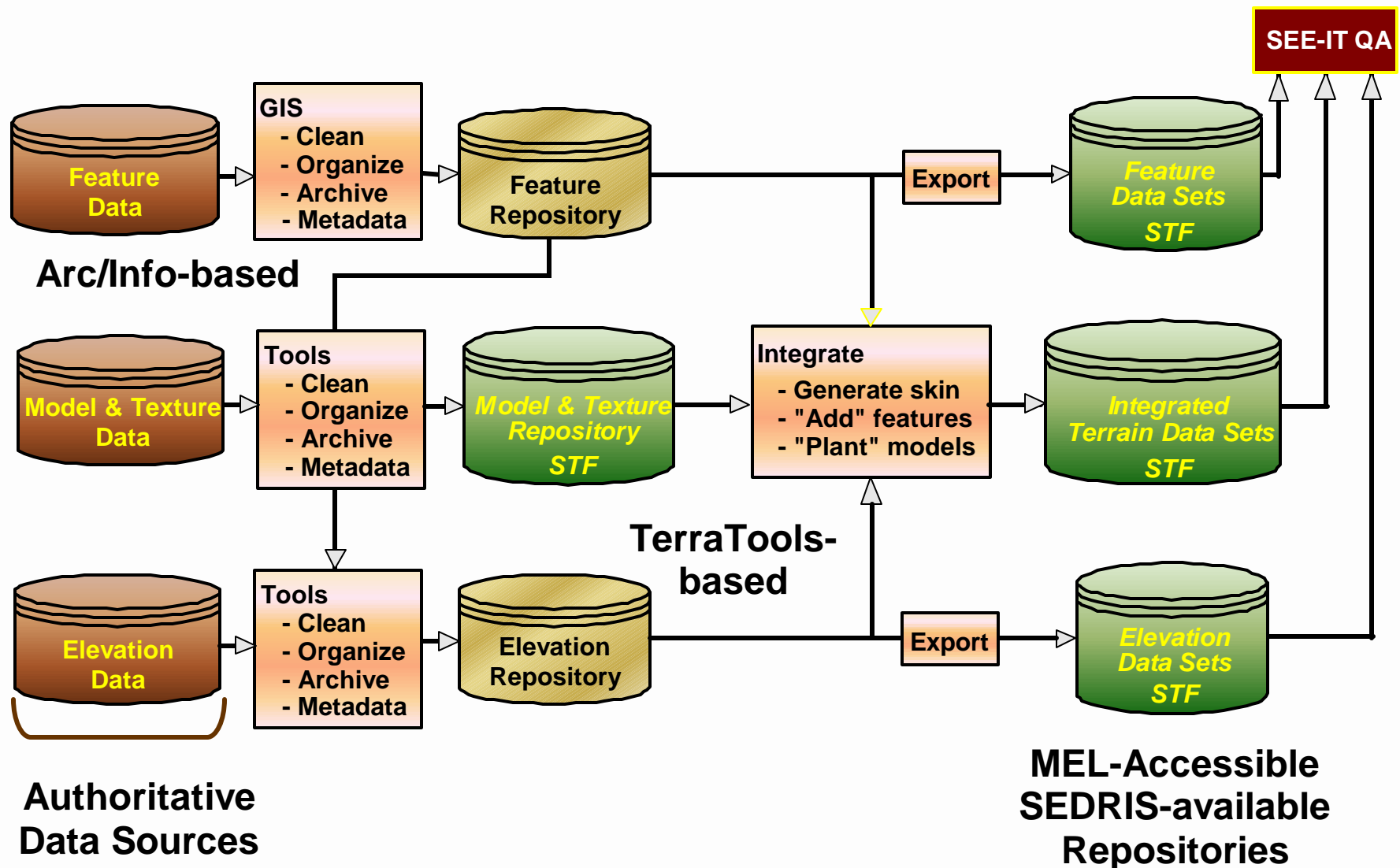
**Modeling and Simulation Executive  
Agents for Terrain, Ocean and  
Atmosphere & Space**

**Partners with DMSO in development and  
implementation of the Integrated Natural  
Environment Authoritative Representation  
Process (INE ARP). Serving as focal point  
for integrating Service and Agency  
participation in the INE ARP**





# Terrain Scenario Generation & Archiving







THE INSTITUTE FOR CREATIVE TECHNOLOGIES

# *SEDRIS in use Today* *Entertainment*





# Entertainment Issues

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- **Entertainment simulations:**
  - No standard way of interchanging data
  - No standard method of networking
  - Military spending roughly \$1 B U.S. on training technology
  - Commercial revenues of \$1.2 B U.S. on arcade games and \$540 M U.S. on online games
- ***Solution:***
  - ***Establish standards as viable commercial approaches***
    - SEDRIS technologies can be used for representation and exchange of data across a wide variety of available formats
    - Use existing or emerging standards in networking
  - ***What's in it for the commercial market?***
    - Access to more complex data
    - Lower costs for developing such data
    - Lure of actual military simulation data and 'players'



# Applied Entertainment Technology

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- **Emergency response training and analysis (DoD support)**
- **Military operations in urbanized terrain (MOUT), Military operation in built-up areas (MOBA)**
- **Asymmetric threat evaluation and response**
- **Visual surveillance and monitoring**
- **Rapid generation of complex environments**
- **High visual realism at relatively low cost**

***SEDRIS in use Today***

***more***

***International Applications***



# EuroFighter (EF2000) Development

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- SEDRIS specified as enabling technology for review in the EF2000 mission planning and training subsystems
- SEDRIS Associates involved with EuroFighter include:
  - *Indra - Spain*
  - *TT&S - United Kingdom, France*
  - *Sogitec - France*
  - *CAE - Canada*
  - *Rheinmetall Defence Electronics GmbH - Germany*
- Other key players: *Meteor - Italy*



## **Other Procurements / Activities**

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- **NATO Helicopter Program - Sogitec**
- **Tornado GR4 Fast Jet - TT&S**
- **Nimrod Maritime Patrol Aircraft - TT&S**
- **NATO M&S Group Federation Projects**
- **European Union Technology Exploration Projects (EUCLID) - TT&S, others**

***SEDRIS in use Today***

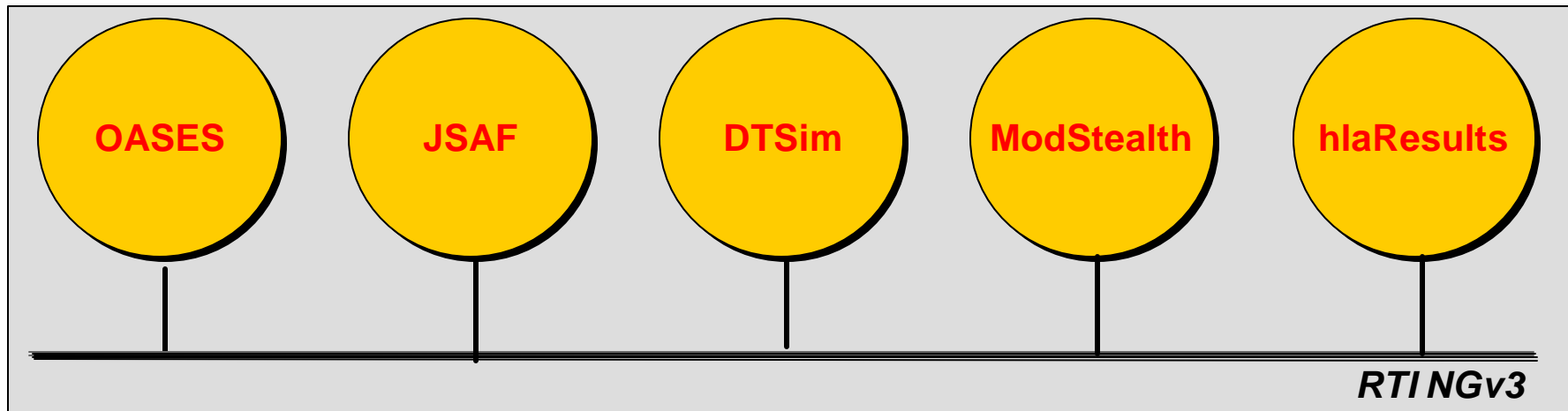
***Simulation Runtime Applications***





# The Environment Federation

## *Applying the SEDRIS Data Representation Model and Environmental Data Coding Specification ...*



- OASES:** Provides dynamically changing values for key environment data elements to the rest of the federation
- JSAF:** Receives dynamic terrain and environment data; changes the logical environment in which simulated forces operate, thus changing the behavior of simulated forces
- DTSim:** Provides changes to the terrain based on precipitation (OASES) or actions taken by simulated forces (JSAF)
- ModStealth:** Receives dynamic terrain and environment data; renders appropriate 3-D visualization of the synthetic environment
- hlaResults:** Data collection, playback, and analysis tool for HLA federations



# SEDRIIS at Runtime

## Unambiguous representation of environmental data

***Data Representation Model:*** Complex data elements in object-based model

***Environmental Data Coding Specification:*** Well-specified data element definitions / semantics

***Spatial Reference Model:*** Completeness, accuracy, performance

Experimental  
Application  
(at runtime)

## Efficient interchange of environmental data (pre-simulation runtime)

***Interface Specification:*** Platform and language independent APIs, with reference implementation

***Transmittal Format:*** Assures architecture neutral data exchange, when required

Tools and applications: Inspect, evaluate, verify, transform, ...

Replaced by RTI  
(at runtime)

# ***SEDRLS in use Today***

## ***Evolving Applications***

***U.S. National Geospatial-Intelligence Agency (NGA)***

***Geospatial Intelligence Database Integration (GIDI)***

***U.S. Navy Tactical Environmental Data Services (TEDServices)***

***U.S. DoD Test and Training Enabling Architecture (TENA)***

# ***Using SEDRIS***

***Using SEDRIS for Data Interchange –  
A high level process  
SEDRIS in Use today***

## ***Tools and Utilities (Applications)***

***Excluding database conversion tools, more than a dozen different tools and utilities have been developed based on SEDRIS technologies.***

***Examples include:***

***SEE-IT***

***Model Viewer***

***Side-by-Side viewer***

***SEDRIS Navigator***

***Wind Map***

***Ocean Profile viewer***

***Acoustic Ray Trace viewer***



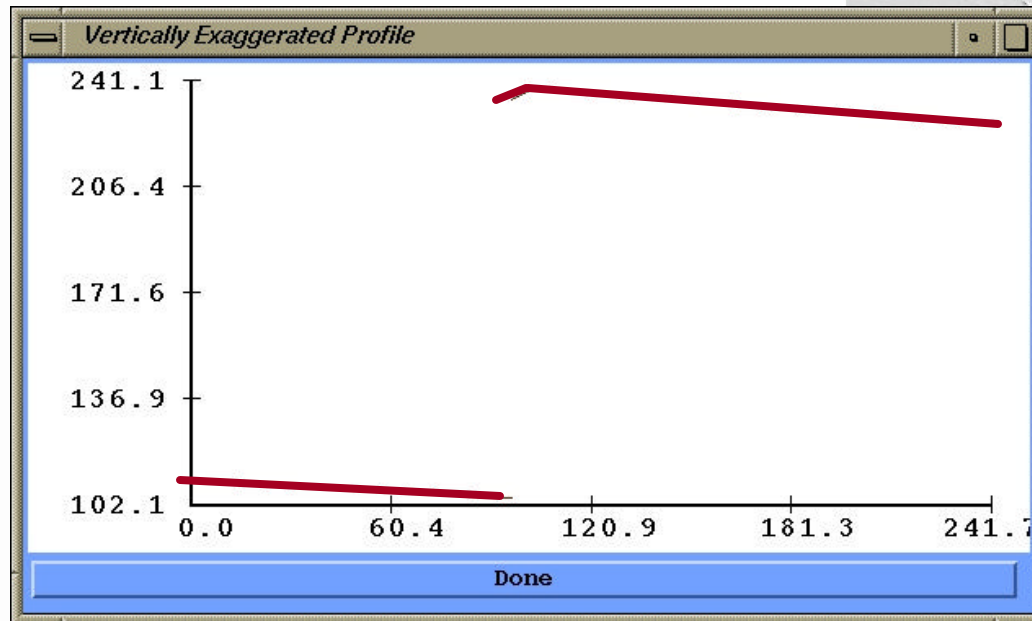
# Synthetic Environment Evaluation - Inspection Tool (SEE-IT)

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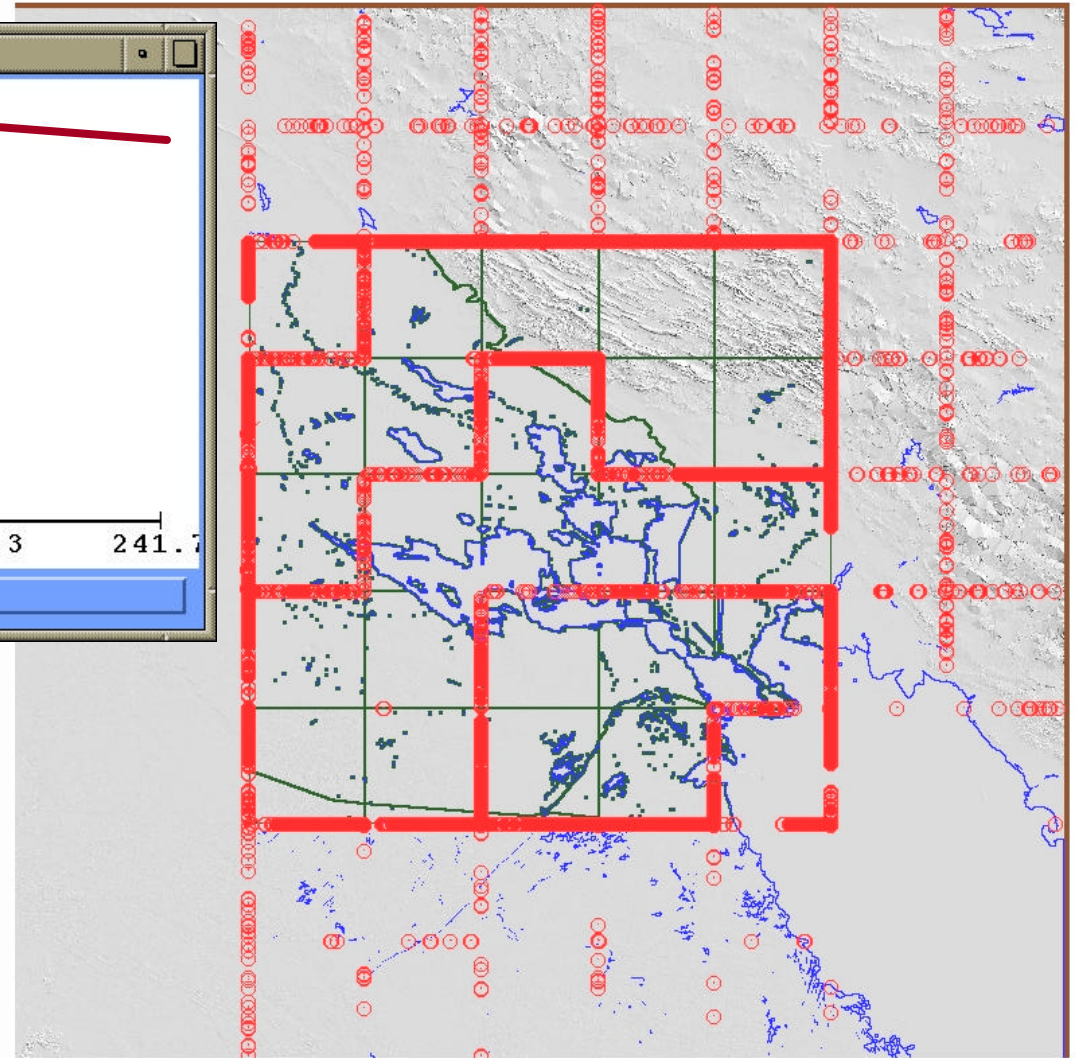
- **Topology:** Holes, elevation mismatches, “T” vertices, incorrect 2-D surface area
- **Polygons:** Duplicate, highly sloped, narrow, small area, or sliver polygons
- **Networks:** Disconnects - Road segments with excessive slope, sharp turns, incorrect elevations, width changes, or that intersect NO-GO areas
- **Models:**
  - Gaps and skews between bridge segments
  - Bridge segments without associated road networks or that include road network ends, intersections, or width changes
  - Static models placed on high slope surface polygons or on a collection of polygons that have high slope variance
  - Static models, other than bridges, that have bounding volumes which intersect or otherwise overlap road network locations



# Vertical Tear Locations



**Cross section of a  
single tear instance  
With a magnitude of  
135m**

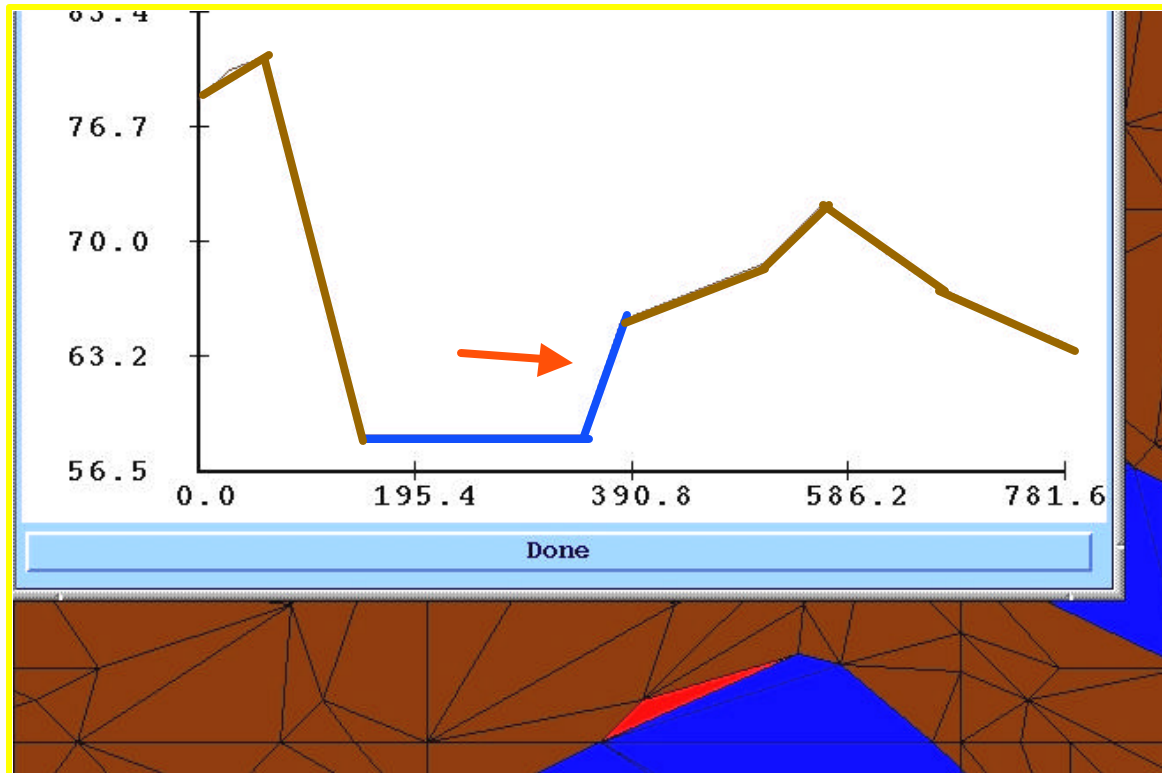


**900Km X 900Km terrain skin**





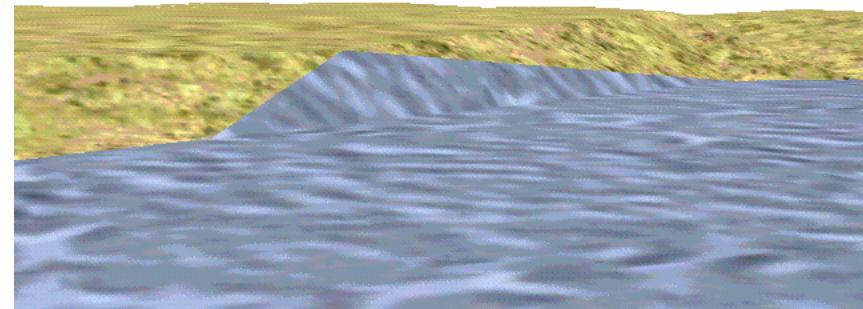
# Water Surface Polygon with High Slope



**SEE-IT locates  
a water surface  
polygon with  
very high slope**

...

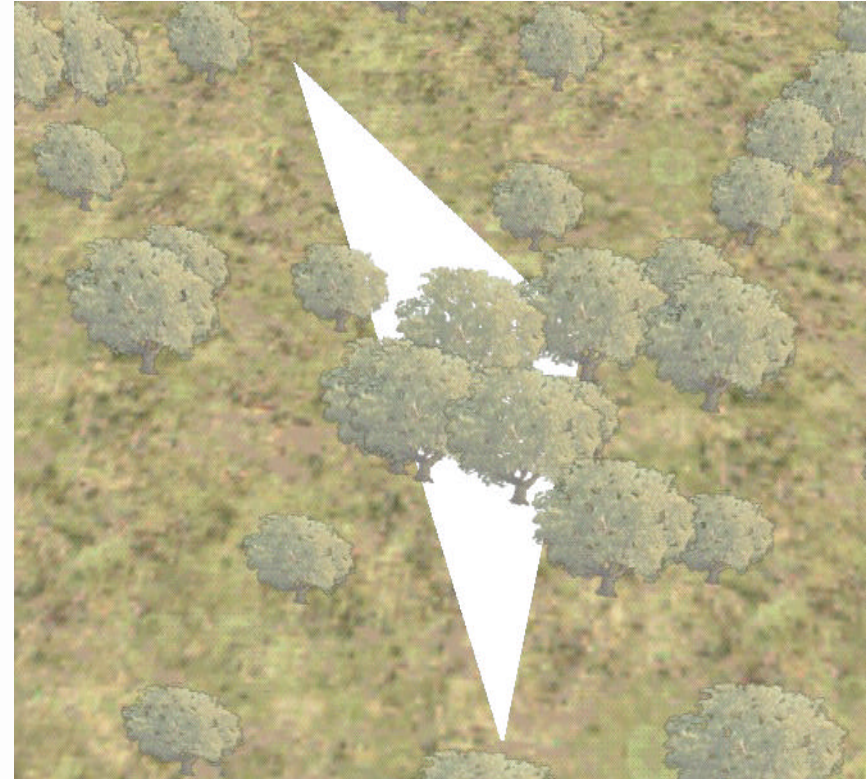
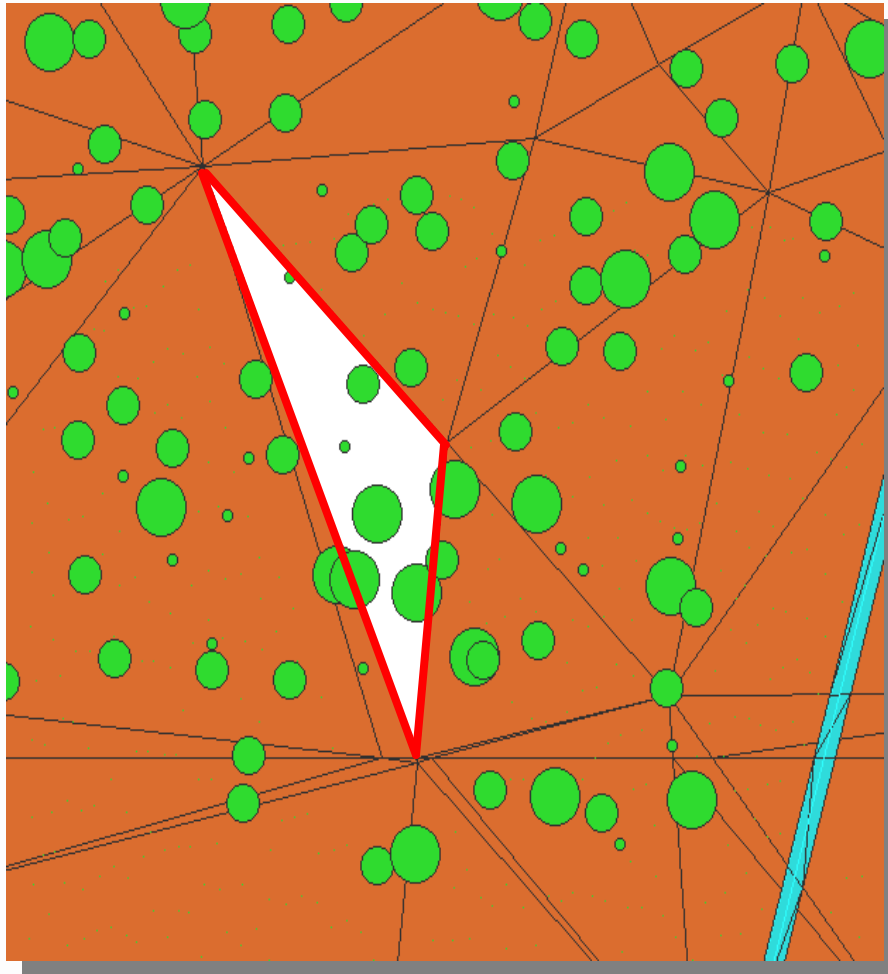
**which also appears in the  
out-the-window view**







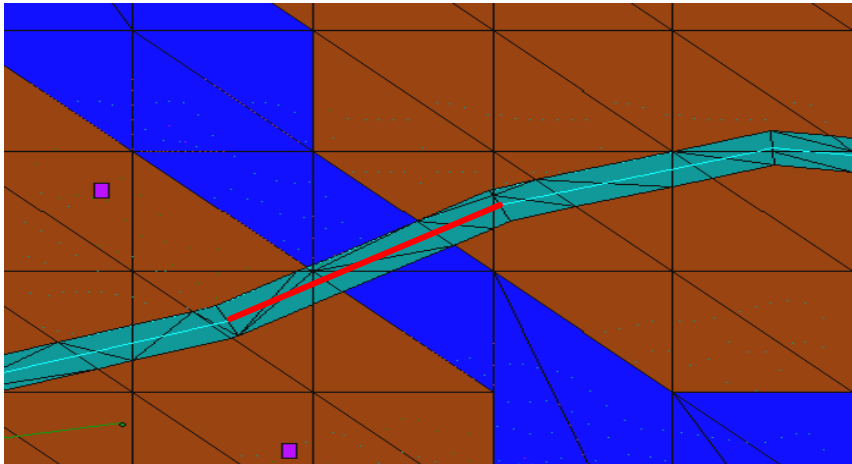
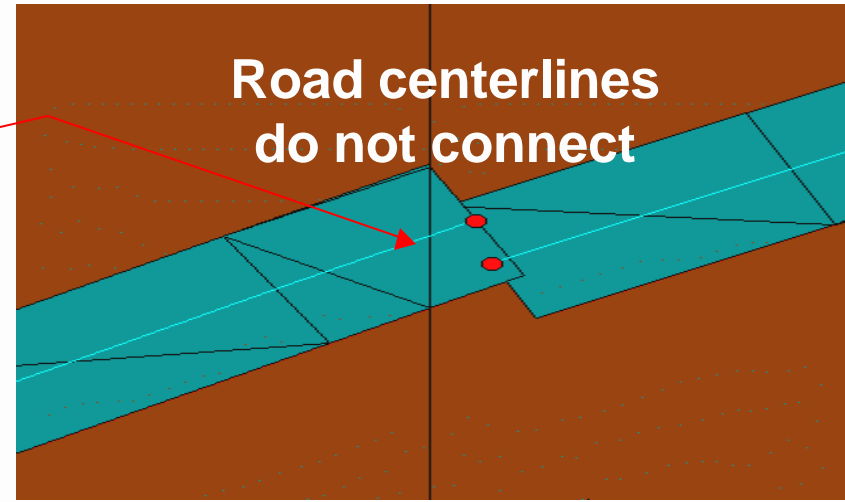
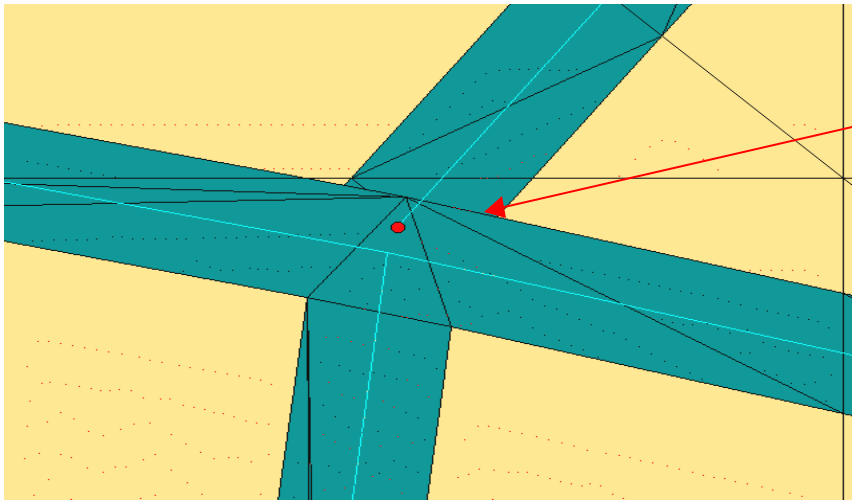
# Topological Hole in the Terrain Surface



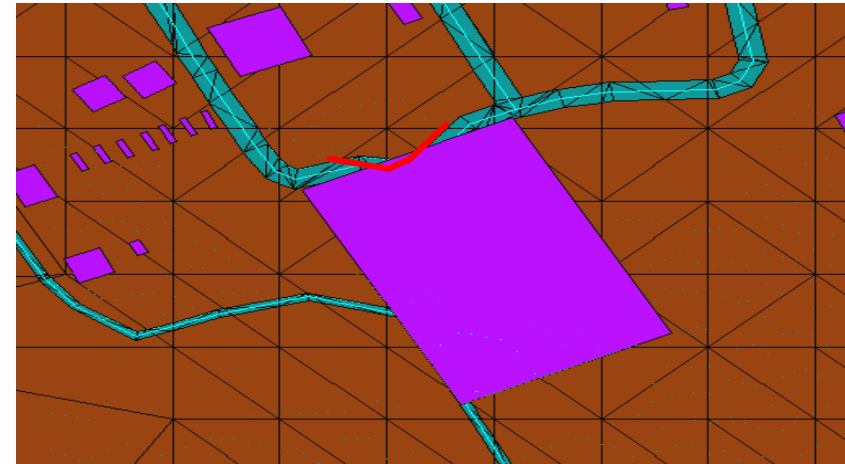
**Also appears in the  
out-the-window view**



# Connectivity Problems



**Road intersects water  
feature without a bridge**

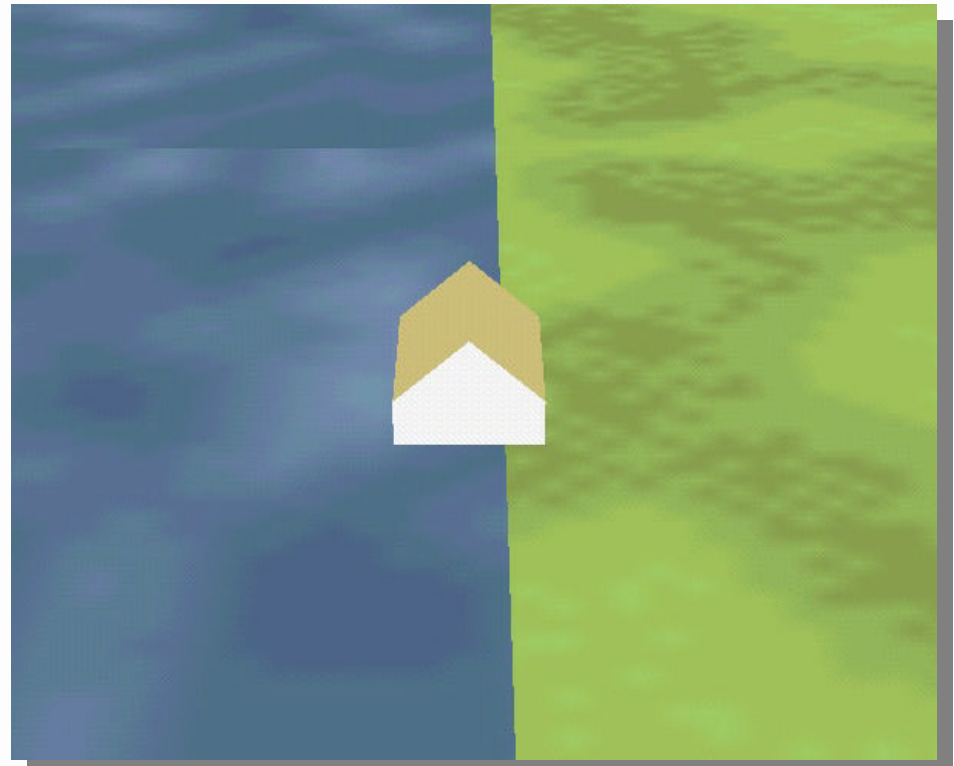
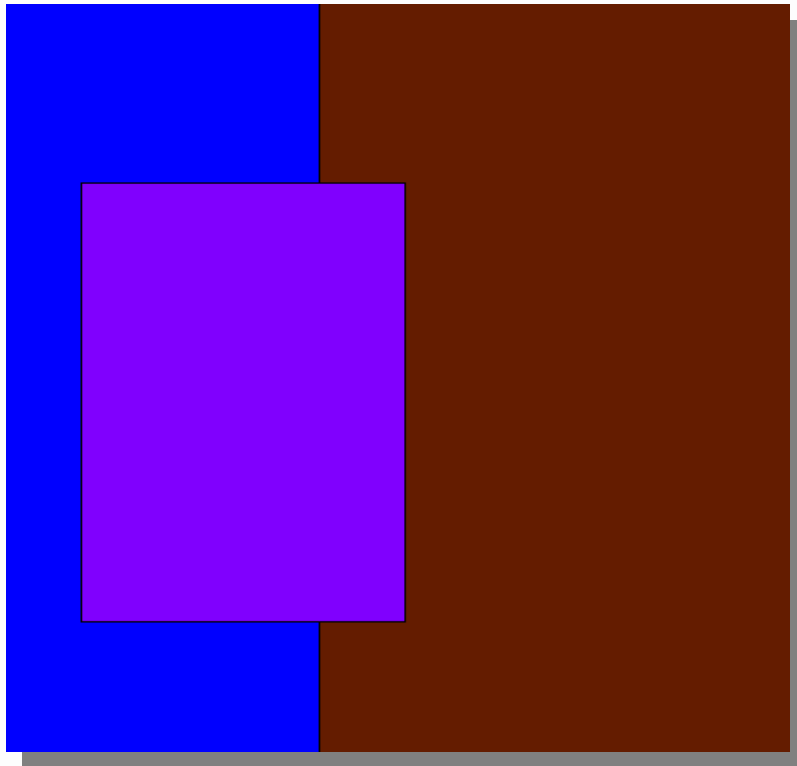


**Road intersects a model  
bounding volume**



# Model Placed on both Land and Water

---

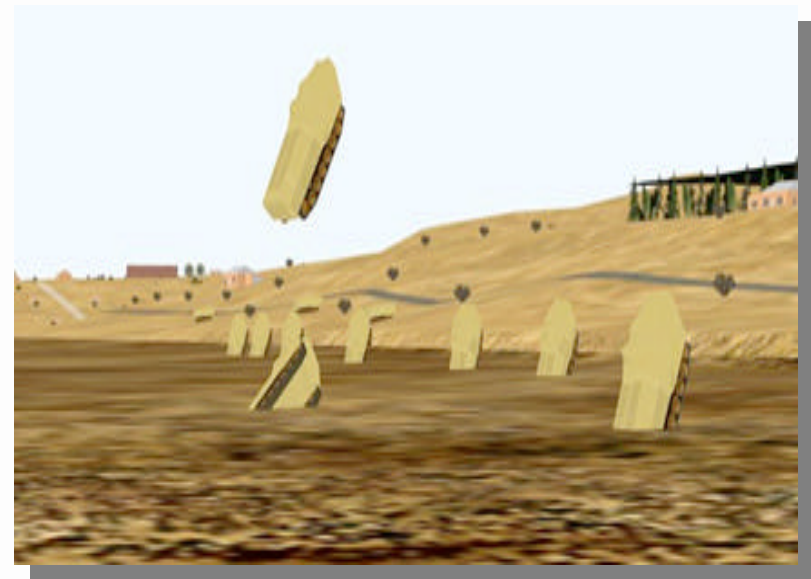
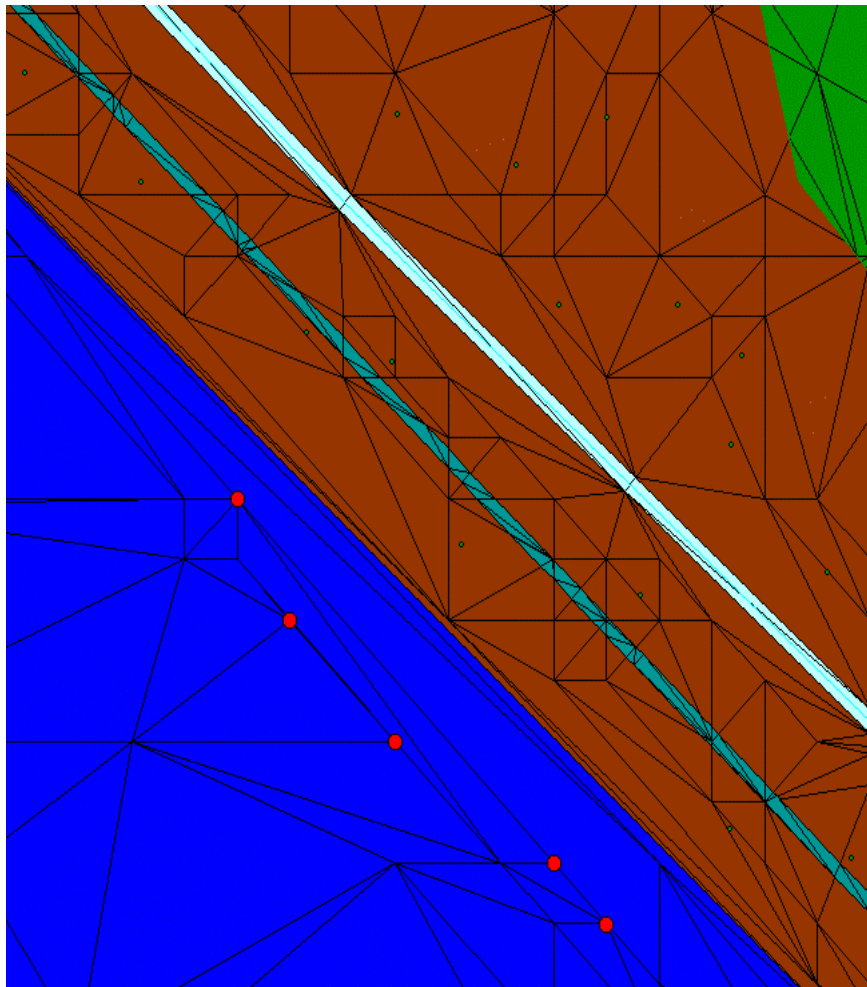


**Also appears in the  
out-the-window view**



# 'T' Vertex Topology

## Bathymetric Data Surface



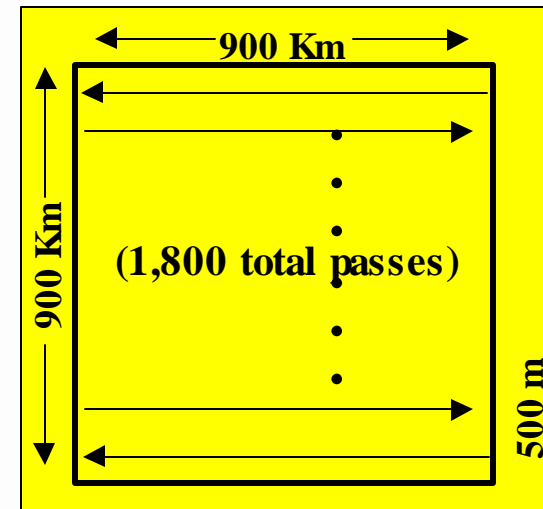
## Resulting ModSAF Behavior



# Comparison with Current Practice

## Current Practice:

- Send a vehicle back & forth across the database to locate vehicle-specific problem areas
- Parameters:
  - One pass each 500 meters
  - 900Km x 900Km database
  - Vehicle speed is 'S' KMPH
- Time required to traverse the database:  
 $(1,800 \text{ passes} * 900\text{Km} / \text{pass}) / \text{"S" KMPH}$



SAF Speed (KMPH)	20	40	60	80	100	200
Time - hours	81,000	40,500	26,973	20,250	16,200	8,100
Time - days	3,375	1,688	1,124	844	675	338
Time - years	9.25	4.6	3.1	2.3	1.8	0.92

(Using multiple vehicles reduces time requirements linearly, but many other problems remain ...)

**SEE-IT: Required 45 minutes to examine the entire 810,000Km<sup>2</sup> database (about 2.5 million polygons plus numerous non-polygonal features inspected)**

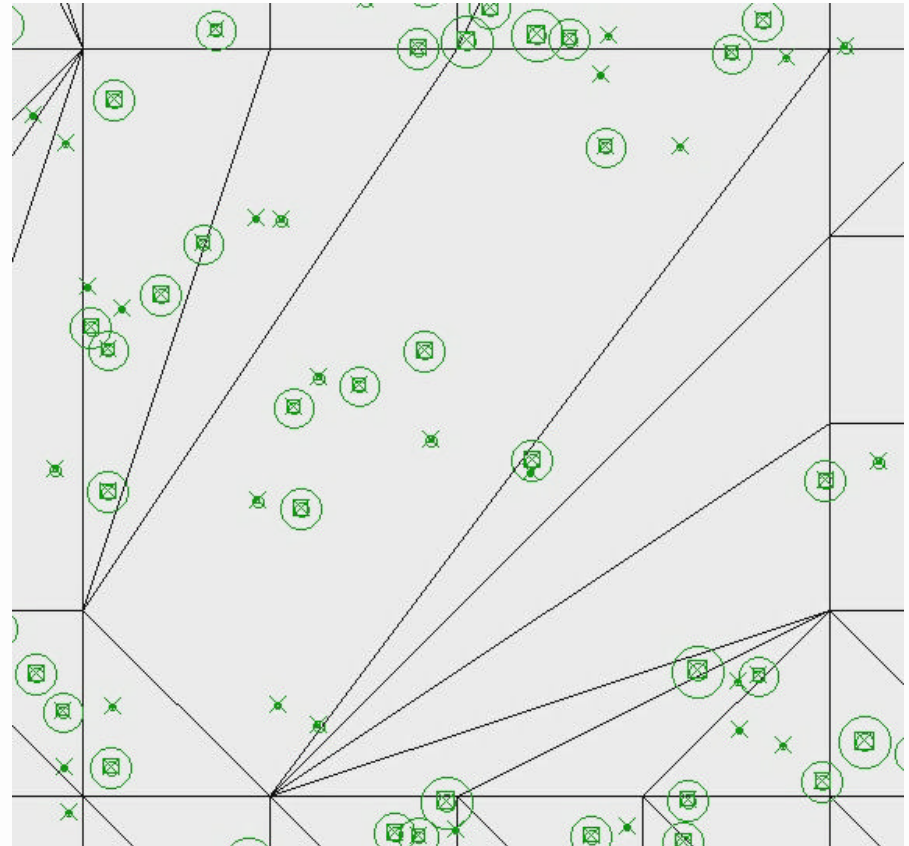
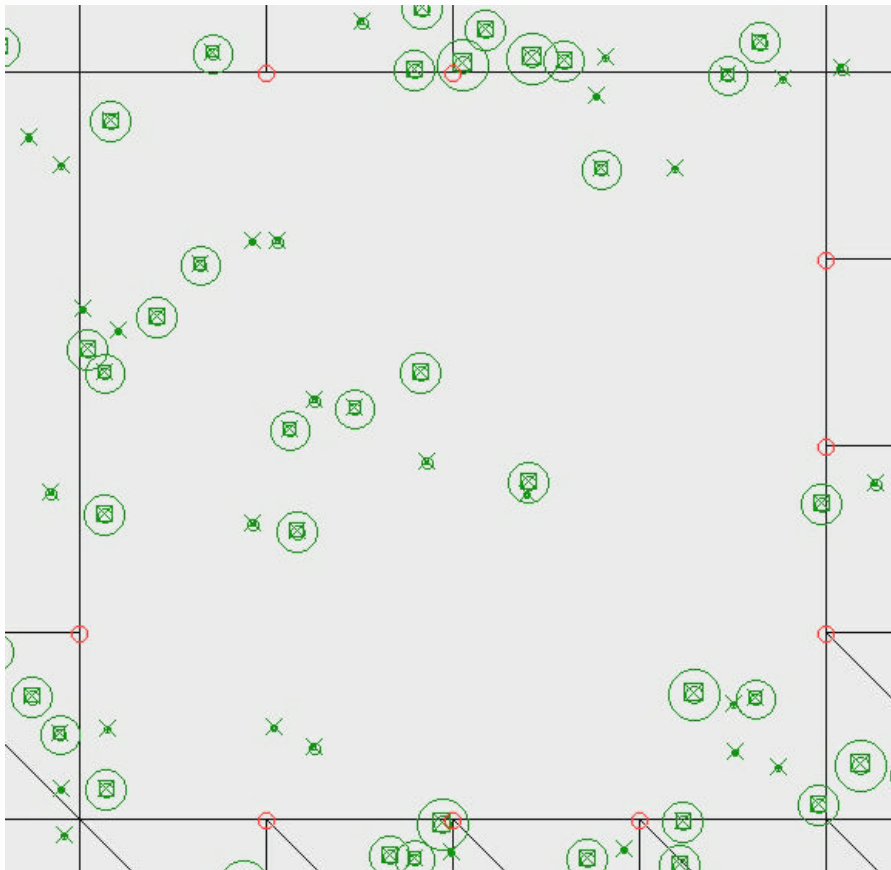
**A factor of over 100,000X improvement!**





# Repairs ...

**SEE-IT locates a polygon  
with 9 T-Vertices ...**



**... and applies *automatic*  
repairs, creating a new STF**





# Model Viewer

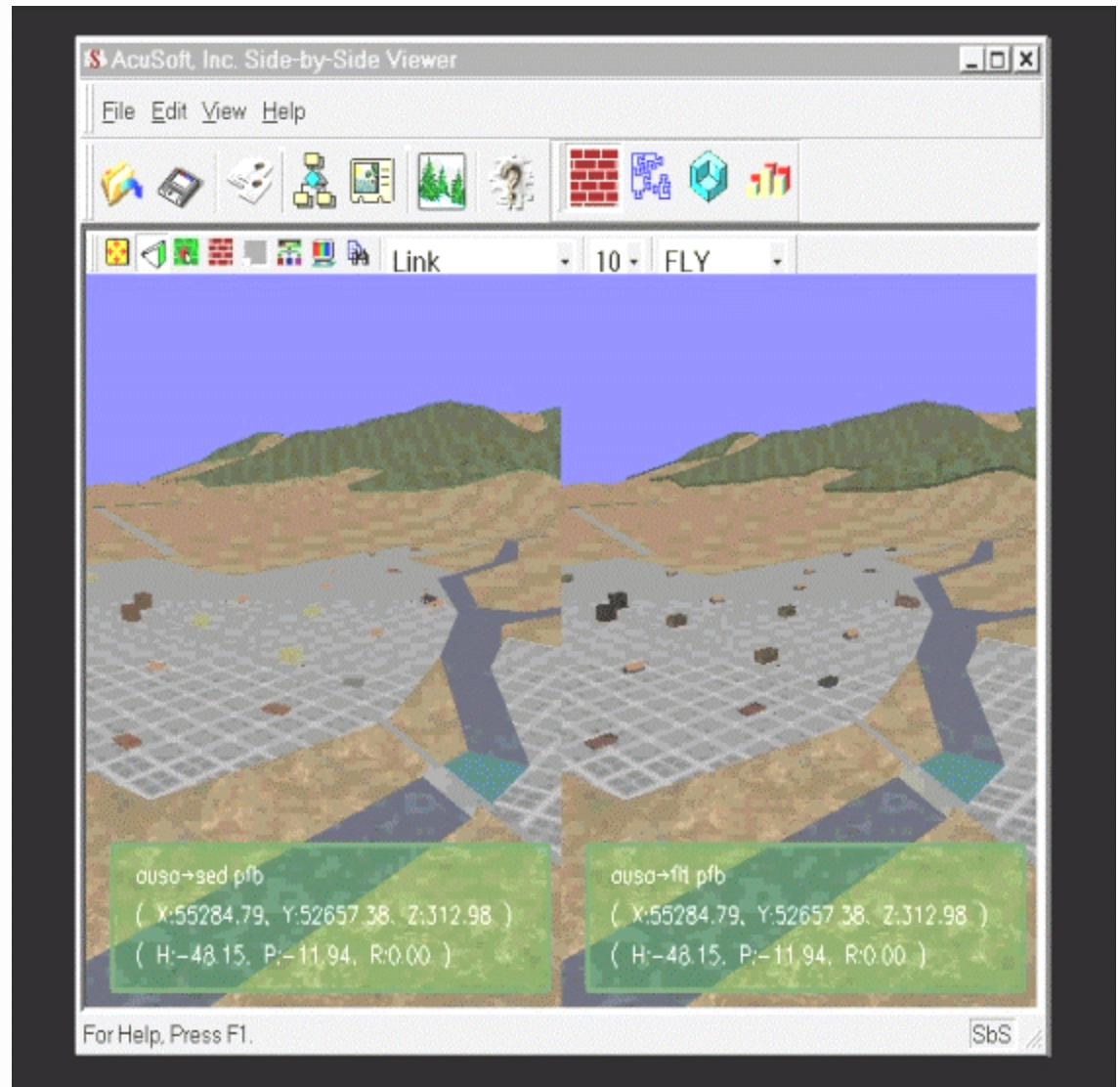
- *Allows visual examination of 3-D icon (models) in SEDRIS transmittals*  
3-D models are often used in visual system applications
- *Provides the means to review levels of detail, states, and animation of special effects*
- *Allows for display of textures in a transmittal*





# Side-by-Side viewer

- Simultaneous viewing of multiple databases, up to hardware limit
- Independent or synchronized navigation modes
- Designed for database comparison
- Modular design to accepting user specific processing plug-in

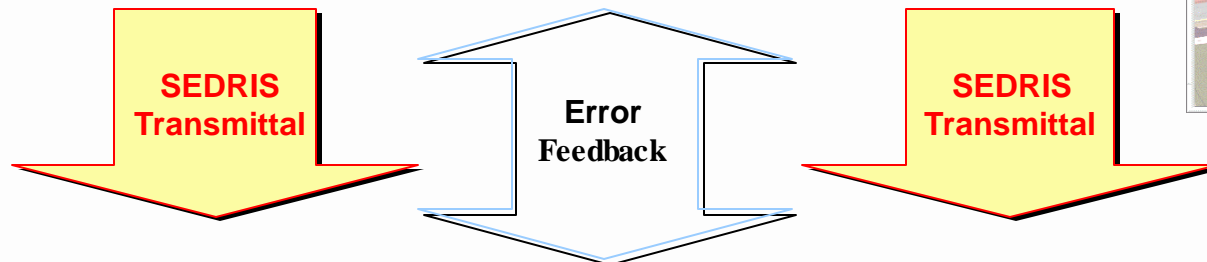
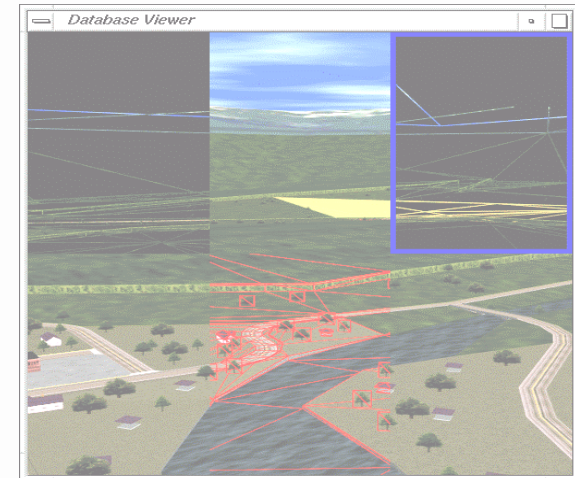




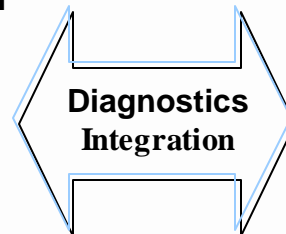
# Coupling SEDRIIS diagnostics & DBGS

## DBGS

- Database generation using process Flowgraph GUI
- Inspection and editing of source geospatial data
- Rapid incremental recompilation
- “Just enough GIS” automatic processing



- Terrain skin error detection
- Geometry and attribution errors
- Identify SAF terrain anomalies
- User customizable analysis



- Innovative visualization tool to compare multiple databases
- Visually highlighting of database errors
- Automated database structure analysis
- End-to-end database verification and validation

## SEE-IT

## Side-by-Side Viewer



# SEDRIIS Navigator

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- ***A client-server based application*** that allows viewing of databases across the Internet (or local intranets)
- ***Runs in conjunction with standard Internet browsers or as a stand-alone application***

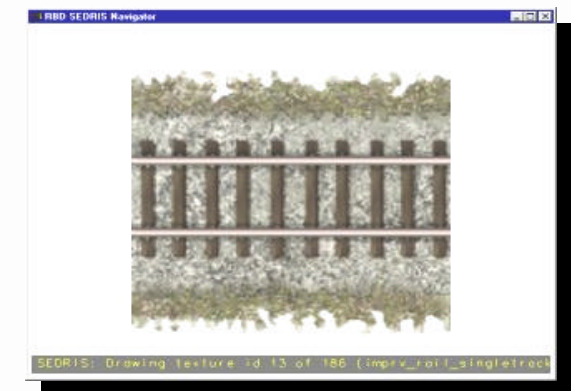
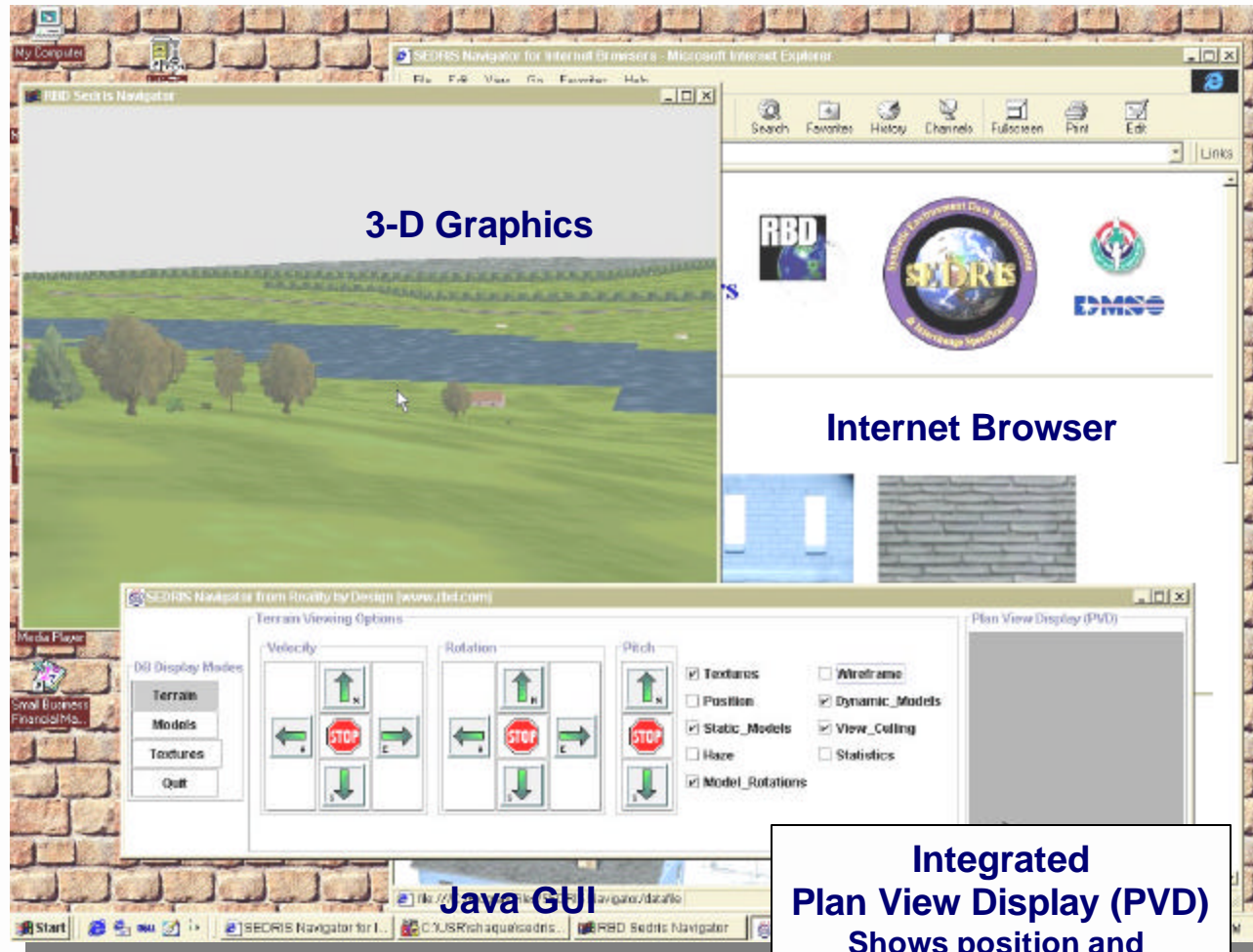
Supported on PC (Win98 / NT), SUN, Linux, SGI

- ***Viewing modes:***
  - Items in a SEDRIIS Model Library
  - Entries from a SEDRIIS Texture Library
  - Terrain skin and Geometry Model Instances
- ***Display options:***
  - Cross platform: OpenGL (Win32, SGI, Linux)
  - Textured, wire frame, shaded (averaged texture)
- ***Java-based Graphical User Interface***





# Display Components

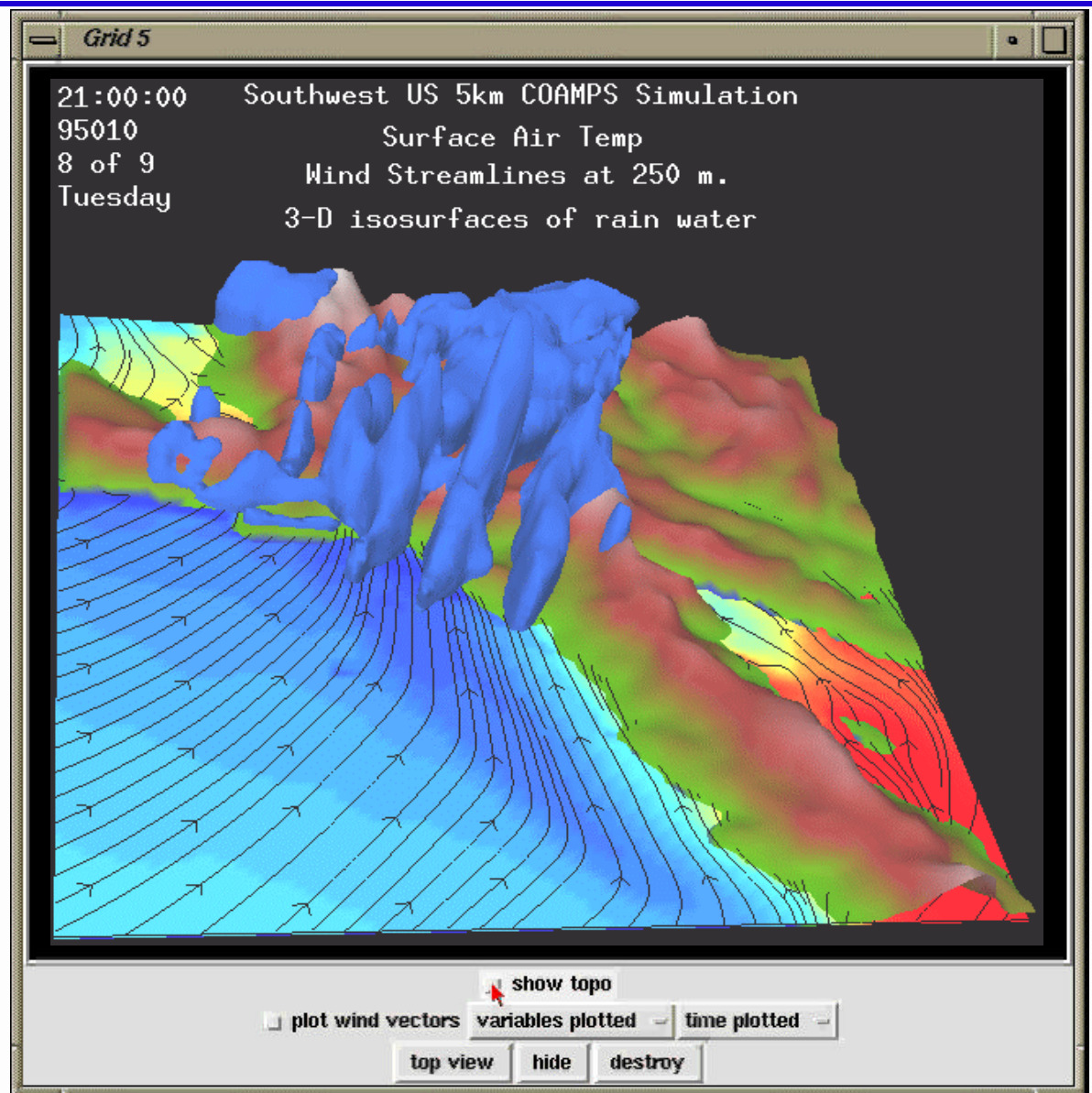


**Integrated  
Plan View Display (PVD)**  
Shows position and  
orientation with respect  
to SEDRIS Spatial Domain



# Wind Map

**SEDRIS Transmittal Format can carry the content of various meteorological databases. The wind map program reads multiple data from a SEDRIS transmittal, via the SEDRIS API, for display using a graphics viewer.**

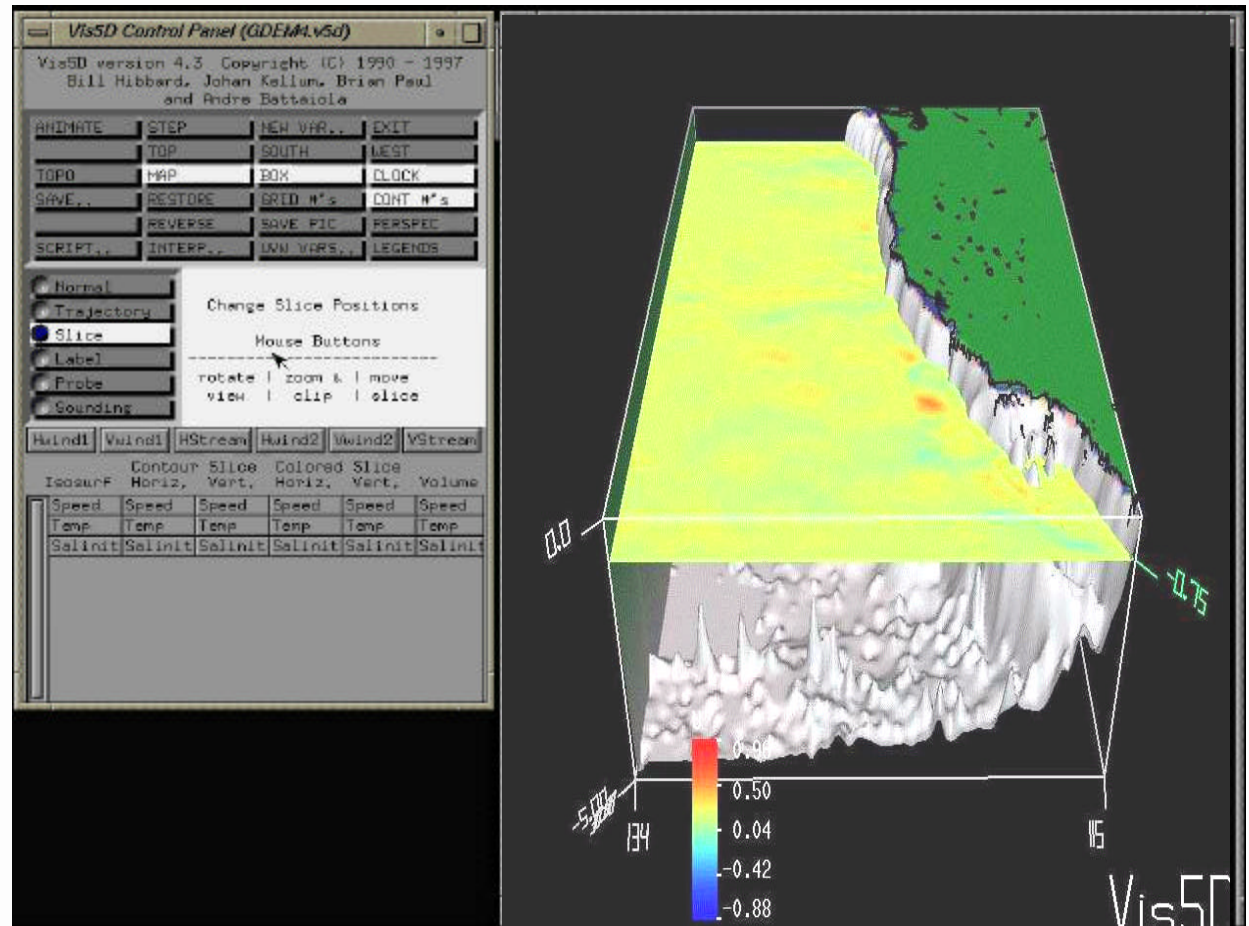






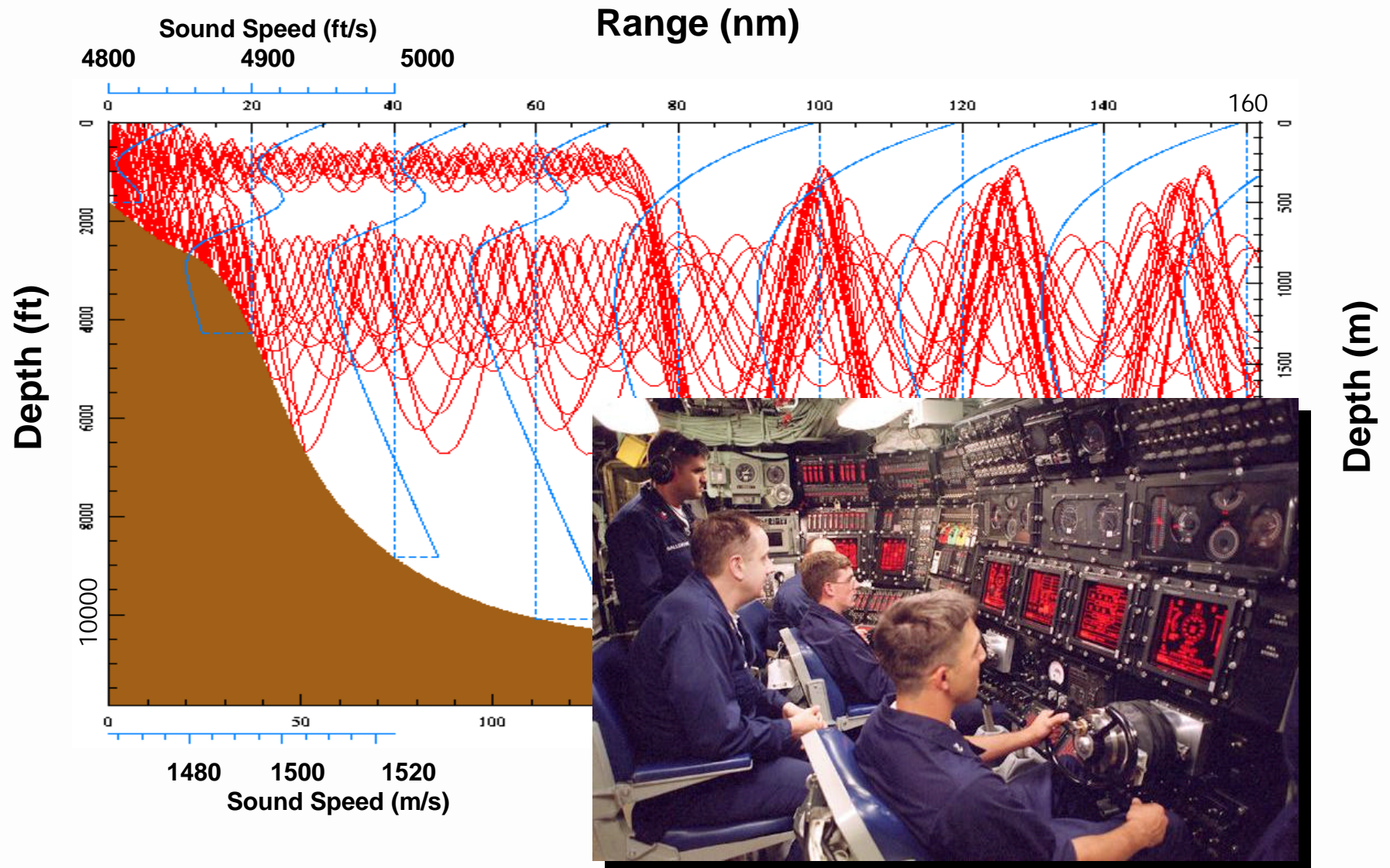
# Ocean Profile viewer

The SEDRIS API can be used to extract data from a transmittal to drive applications. The user selects a rectangular ocean surface area from the transmittal. The application uses the API to extract bathymetry, sound speed, temperature, and salinity in the selected ocean volume for visualization.





# Acoustic Ray Trace viewer





# Summary

---

- ***An unambiguous representation of environmental data***
  - Semantics and relationships of data elements
    - Expressed in a data representation model, with an
    - Associated data coding specification
  - All environmental domains
- ***An efficient interchange of environmental data***
  - Promotes sharing and re-use
  - Ease of access and software development (API)
  - Tools and applications
- ***Undergoing international standardization  
(Your participation is Welcome!)***
- ***Currently in use, rigorously tested***
- ***Powerful representational and interchange technology***



## ***Getting more information ...***

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- Visit the SEDRIS web site (<http://www.sedris.org>), *where you'll find detailed information on:*
  - SEDRIS technology components (EDCS, SRM, DRM, API)
  - Proceedings from past conferences
  - Download SEDRIS SDK releases
  - Tools
  - Papers, references, videotapes of tutorials, and more
- Get answers to questions through the help line:
  - [help@sedris.org](mailto:help@sedris.org) (technical topics)
  - [se-mgmt@sedris.org](mailto:se-mgmt@sedris.org) (other topics)
- Attend commercial courses
- Attend annual ***SEDRIStm Technology Conferences***