

Update on RIEDP Products and Standards

(Reuse and Interoperation of Environmental Data and Processes)



Update to ISO/IEC JTC 1/SC 24 / WG 8

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Topics

- RIEDP Vision and Goal
- Background and Problems Addressed by RIEDP
- RIEDP Concepts and Standards
- RIEDP and SEDRIS – Similarities and Differences
- Conclusion
- Backup – Requirements, Database Creation Process, Future Trends

RIEDP : Reuse and Interoperation of Environmental Data and Processes



RIEDP Vision and Goal

Vision:

With minimal changes or effort, use popular GIS and simulation source data formats to share and exchange simulation data products

Goal:

Standardize the rules, methods, and semantics for sharing data from key stages of the simulation database generation process, while leveraging (those) existing source data formats commonly used in GIS and simulation applications



Background and Problems Addressed by RIEDP

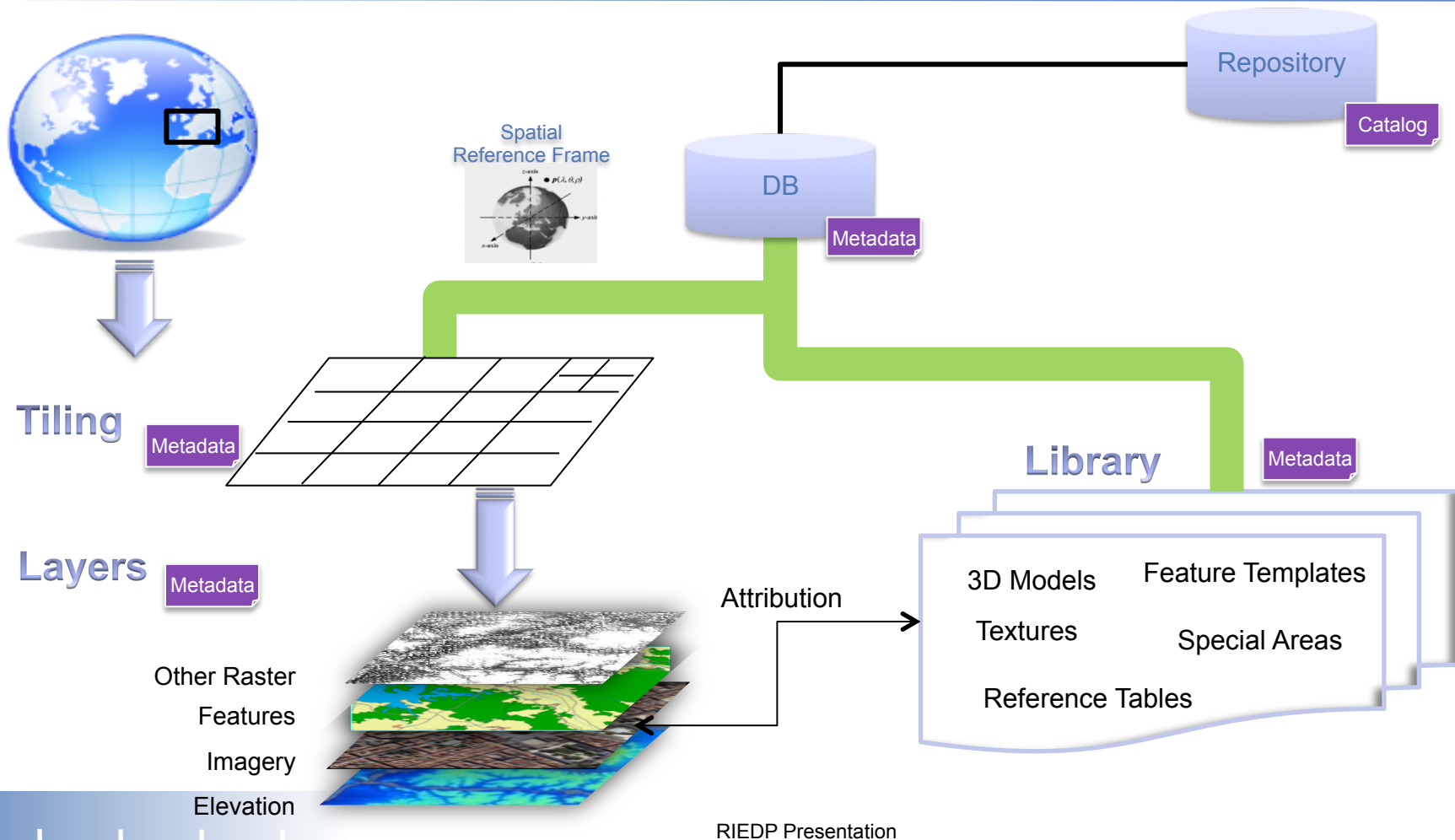
➤ Challenges

- ▶ **Environmental data products** are widely used in **stand-alone or networked M&S** applications, including visualization, training, analysis, rehearsal, testing (using traditional, VR, or AR visualizations)
- ▶ The process of building simulation environmental data products (or databases) requires various types of **source data, including (but not limited to) data in popular GIS formats**
- ▶ **Variations and different parameters** used in the databases building process can **significantly impact the interoperability** of the simulation systems that use these databases
- ▶ **Semantics** of the content in these formats are **not always uniform or standardized**

➤ RIEDP solution

- RIEDP provides a standardized **terrain data generation process model** that can be used as a reference, and identifies the stages from which data can be shared
- RIEDP defines **standard rules, methods, and semantics** for sharing the content using data formats that are common/popular today

Main Concepts Associated with Terrain/Environmental Data Generation





Key Topics and Problems in Database Sharing

When reusing data from a partner, you need to know

- How the database was built → Tasks performed or not
- How the database is represented → Conceptual Model
- How the database is spatially referenced → Spatial Reference Model
- How the database is structured → Physical data model
- How the database is organized on the media → Files/Folders/Hierarchies
- How well the database conforms to Standards → Compliance & Profiles
- Information about the data product → Metadata

No existing solution fully satisfies ALL of these requirements



RIEDP Concepts and Standards

RIEDP effort has:

- Identified/selected an initial set of common source formats
- Developed a Reference Process Model (RPM)
- Developed rules, methods, and semantics for expressing and sharing the data, which includes:
 - ▶ A Reference Abstract Data Model (RADM)
 - ▶ Innovative metadata storage methods
 - ▶ Rules for data organization
 - ▶ Set of Profiles for sharing application-specific data products
 - ▶ Definition of environmental/terrain objects and their characteristics, including material characteristics for different sensor models and different fidelities
 - ▶ Process-related attributes to support data sharing



RIEDP Concepts and Standards (cont.)

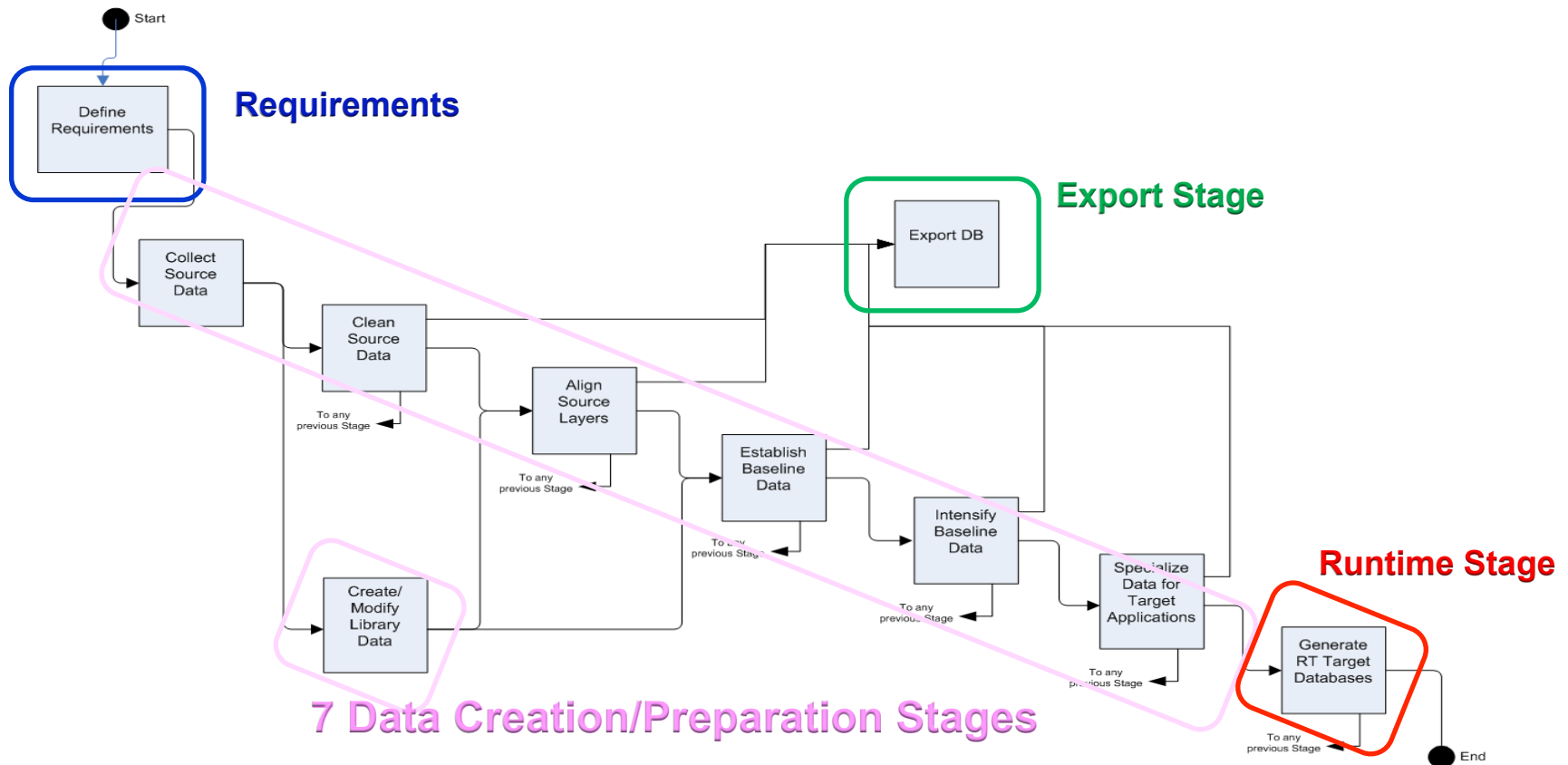
Within SISO's RIEDP Product Development Group, the work is embodied in two standardization products:

- **Product 1 – RIEDP Data Model Foundations** with two coupled parts:
 - ▶ **Reference Process Model (RPM)**
 - High Level model of the database generation process
 - ▶ **Reference Abstract Data Model (RADM)**
 - Database concepts and principles for Tiles, Layers, Library, Spatial Reference, Relationships, Metadata, ...
 - RADM leverages the SEDRIS DRM concepts and uses the SRM
- **Product 2 – RIEDP Detailed Features description:**
 - ▶ Identification for geo-specific **object instances and templates** (features, 3D objects, textures) **within the Library**, and the **linkage between instances and templates**
 - ▶ **Dictionary** for feature and attribute **semantics**, and **mapping** with existing dictionaries
 - ▶ Specifies **list of features, attributes, attribution rules (feature-attribute relations), range values, ... (EDCS used)**

RIEDP Reference Process Model (RPM)

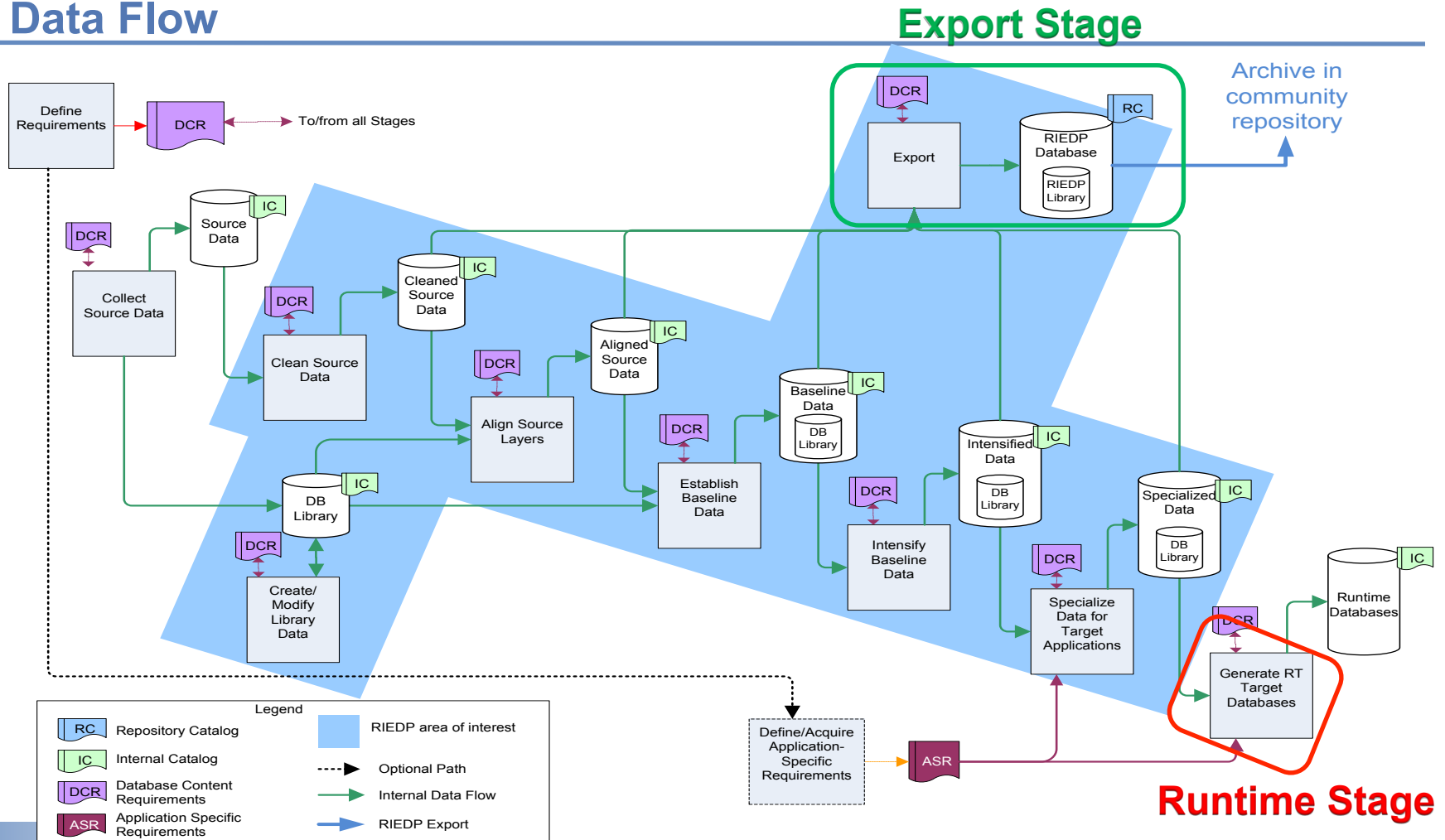
Process Flow

- Typical Generation Process for a Database

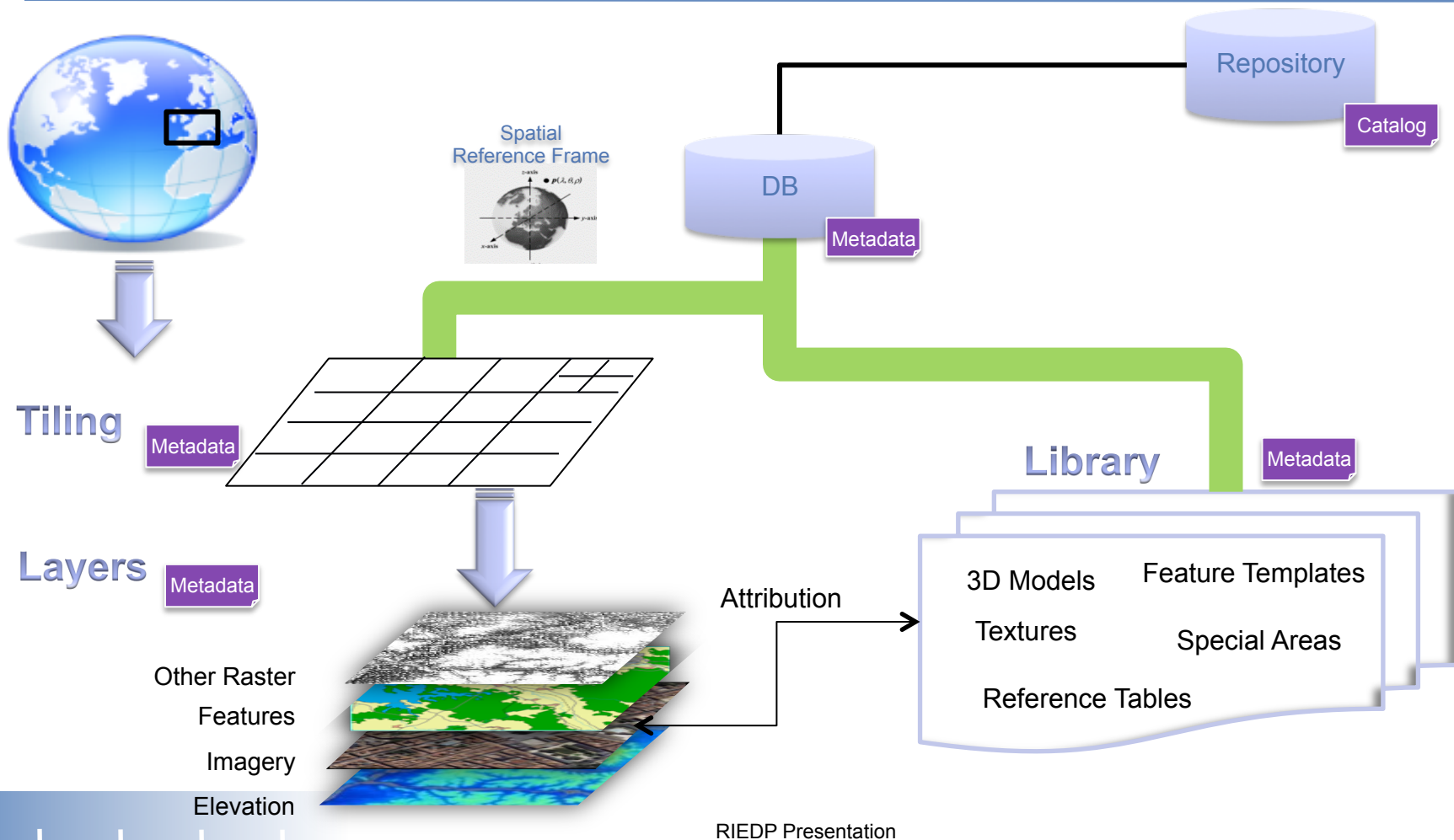


RIEDP Reference Process Model (RPM)

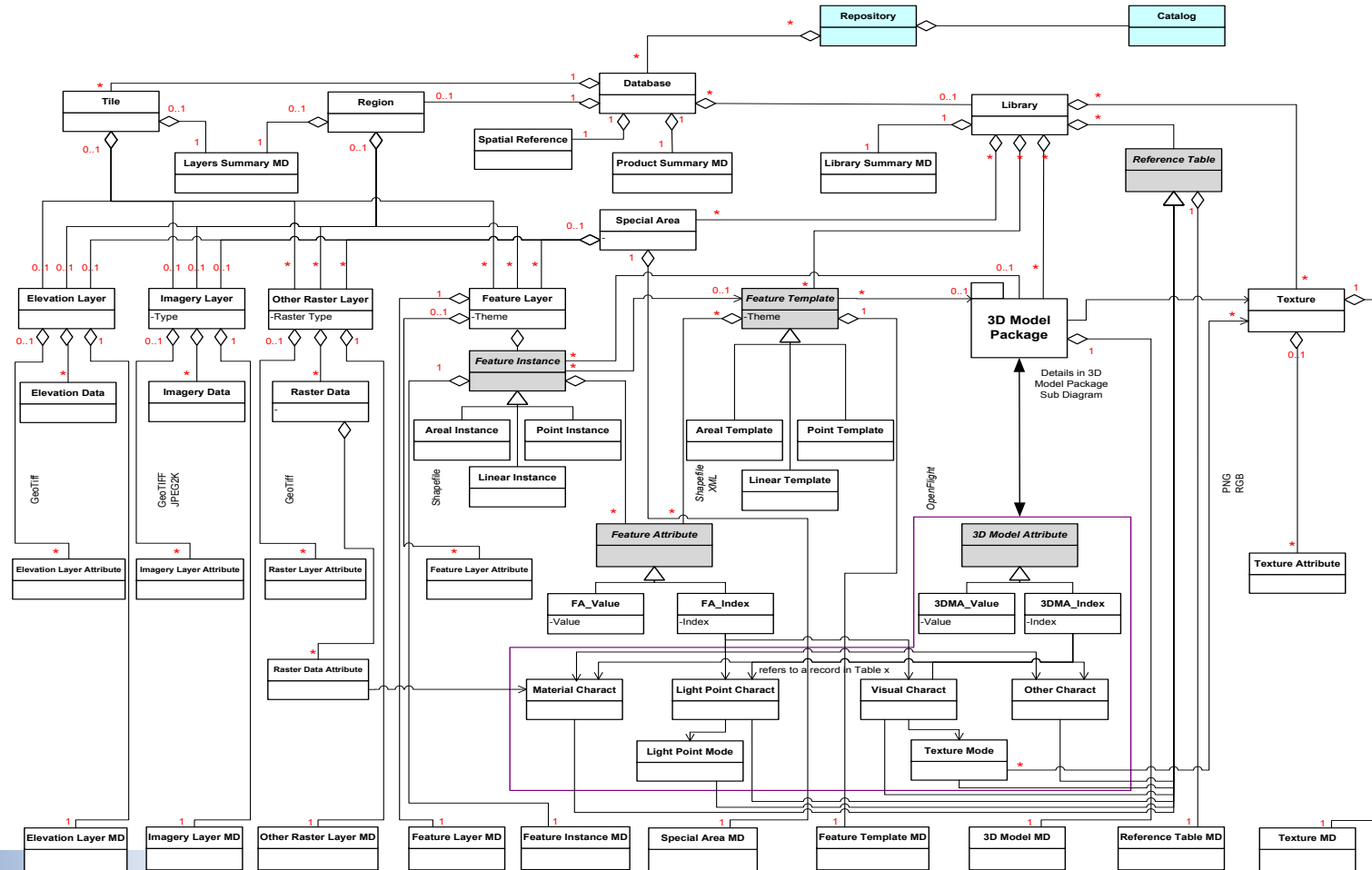
Data Flow



RIEDP Reference Abstract Data Model (RADM) Main Components (conceptual)

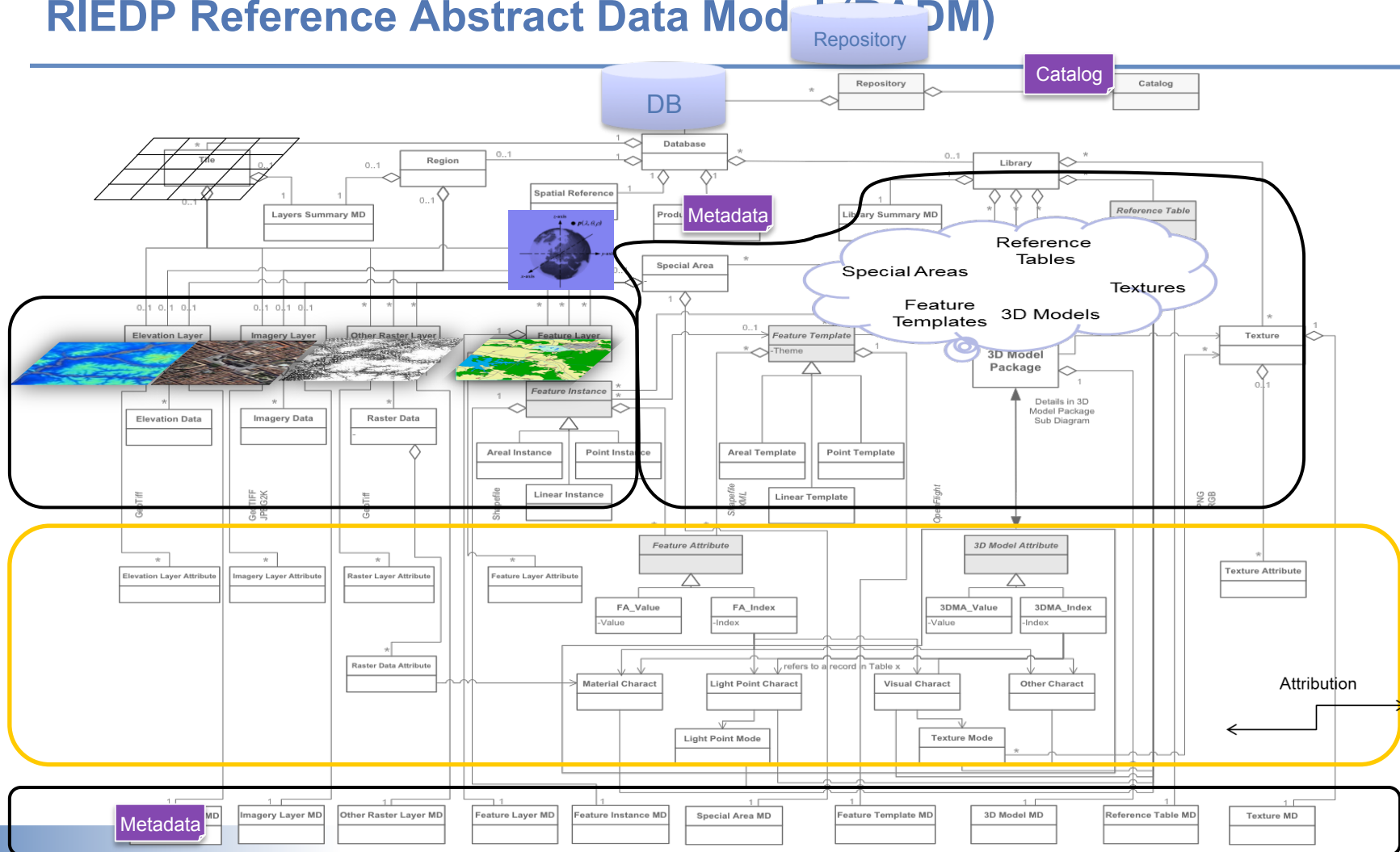


RIEDP Reference Abstract Data Model (RADM)



RIEDP Presentation

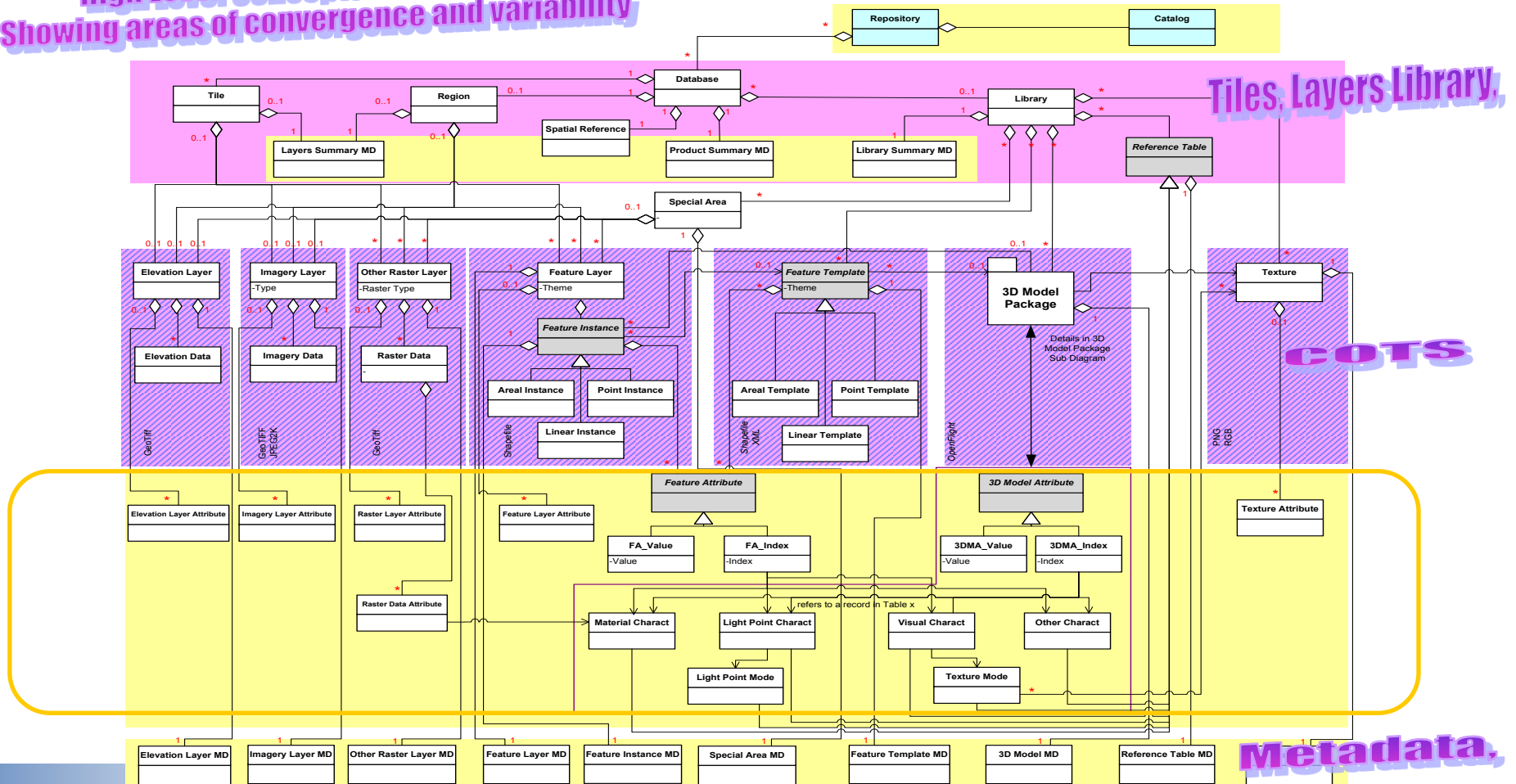
RIEDP Reference Abstract Data Model (RADM)



RIEDP Reference Abstract Data Model (RADM)

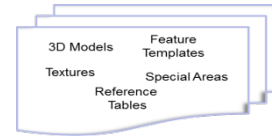
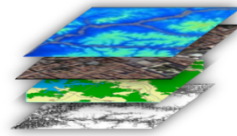
High Level Concepts of a Database
Showing areas of convergence and variability

- Convergence
- Common format
- Variability





RIEDP-exchange formats



The data formats required for RIEDP-compliant data exchange:

- **GeoTIFF** (revision 1.0 October 1995), for Terrain **Elevation** data.
- **Shapefile** (ESRI technical description White Paper July 1998), for instances, and possibly for classes of **Terrain Features** and **Vector data**.
- **GeoTIFF** (revision 1.0 October 1995) or **JPEG 2000** (ISO/IEC 15444 – Part 1) for Terrain **Imagery data**, as well as other raster-based data.
- **OpenFlight** (version 16.0 or higher), for **3D models**, both natural and man-made, placed on the terrain or dynamically included in the environment.
- **PNG** (ISO/IEC 15948:2004), **SGI RGB** or **SGI RGBA**, image formats for texture maps, used in portraying **object surfaces** and some **terrain surfaces**.
- In addition, XML (and associated XML schema) is used to provide those RIEDP-required data that is not supported through the above formats.

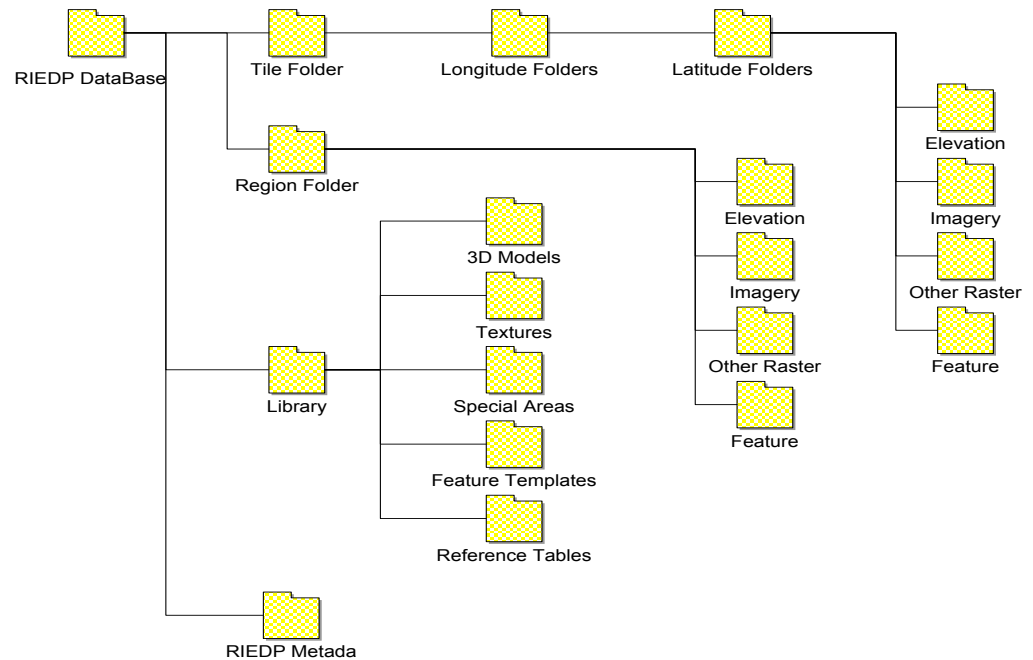
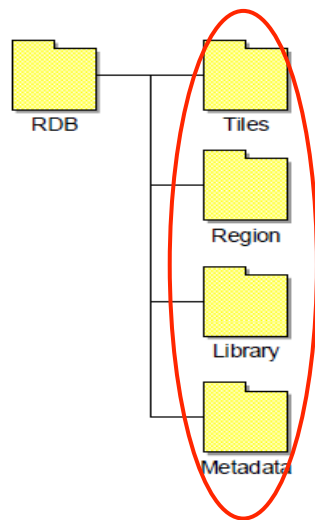
NOTE :

- RIEDP does NOT impose RIEDP-required Formats for use within a Data Producer's internal Processes

RIEDP Data Organization

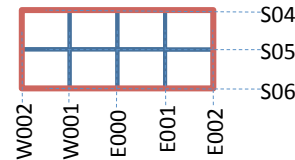
Physical Organisation on the Media

- Layers in Tiles or Region Folder
- Library
- Metadata



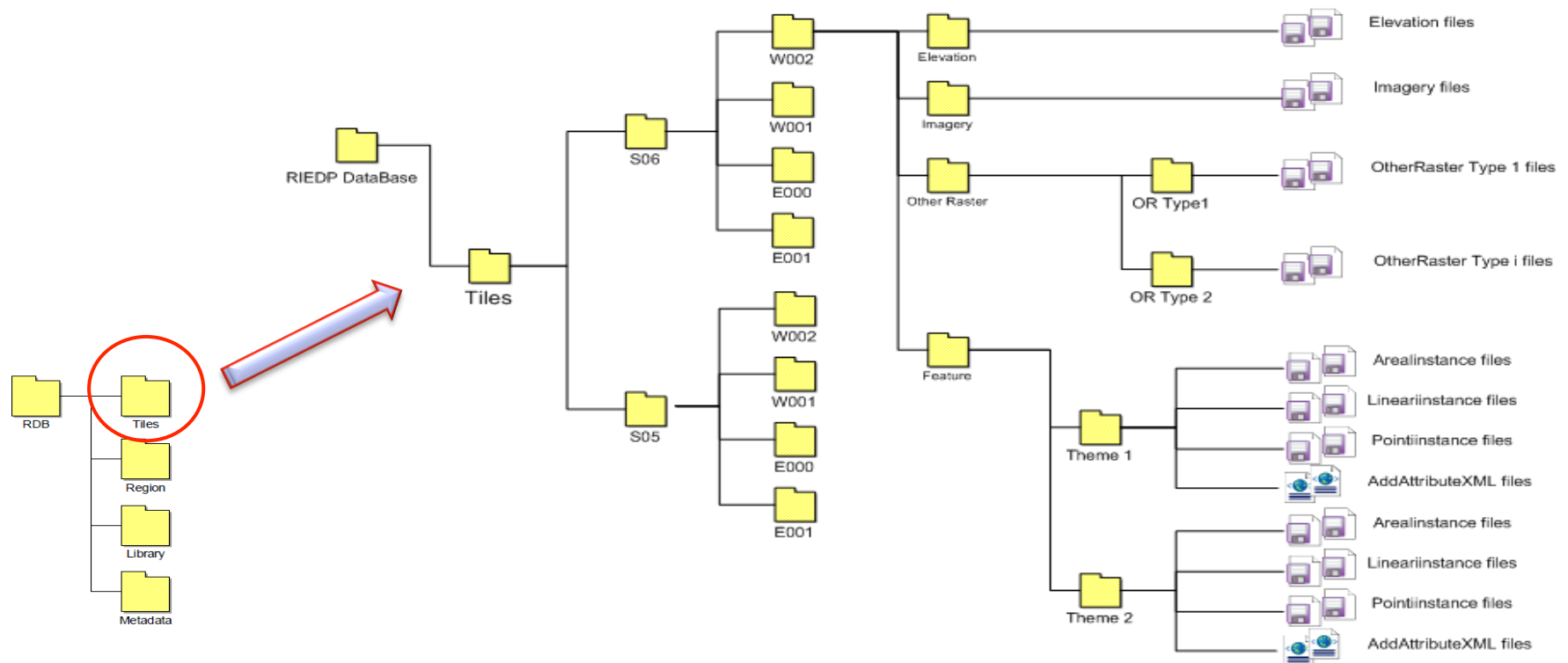
RIEDP Data Organization

Details of Tiles Folders



Tiling Example

- Area : S06W002 – S05E001

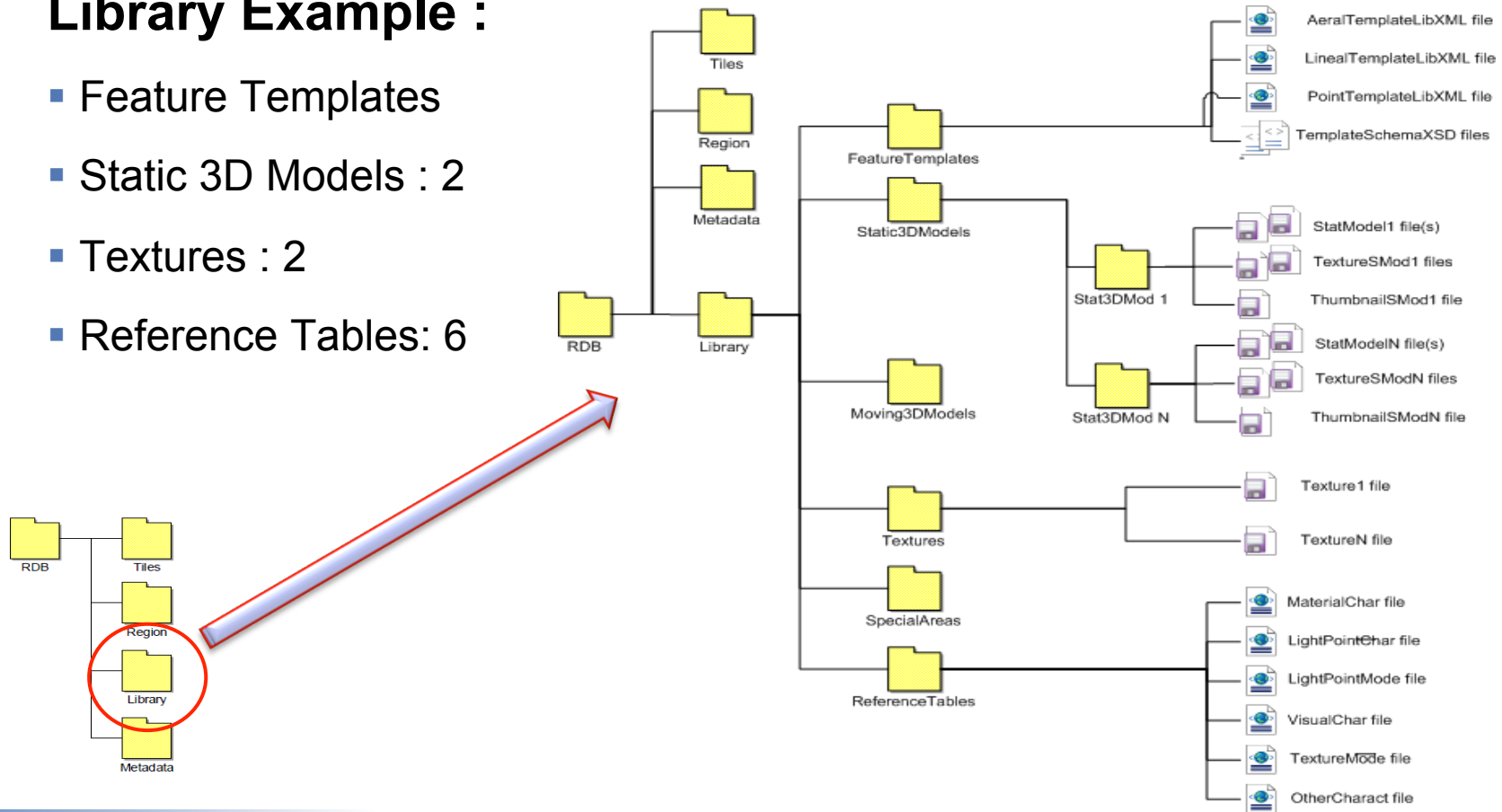


RIEDP Data Organization

Details of the Library

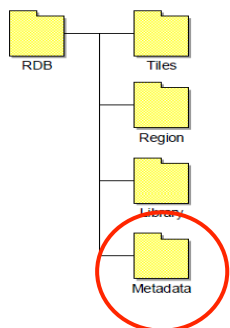
Library Example :

- Feature Templates
- Static 3D Models : 2
- Textures : 2
- Reference Tables: 6

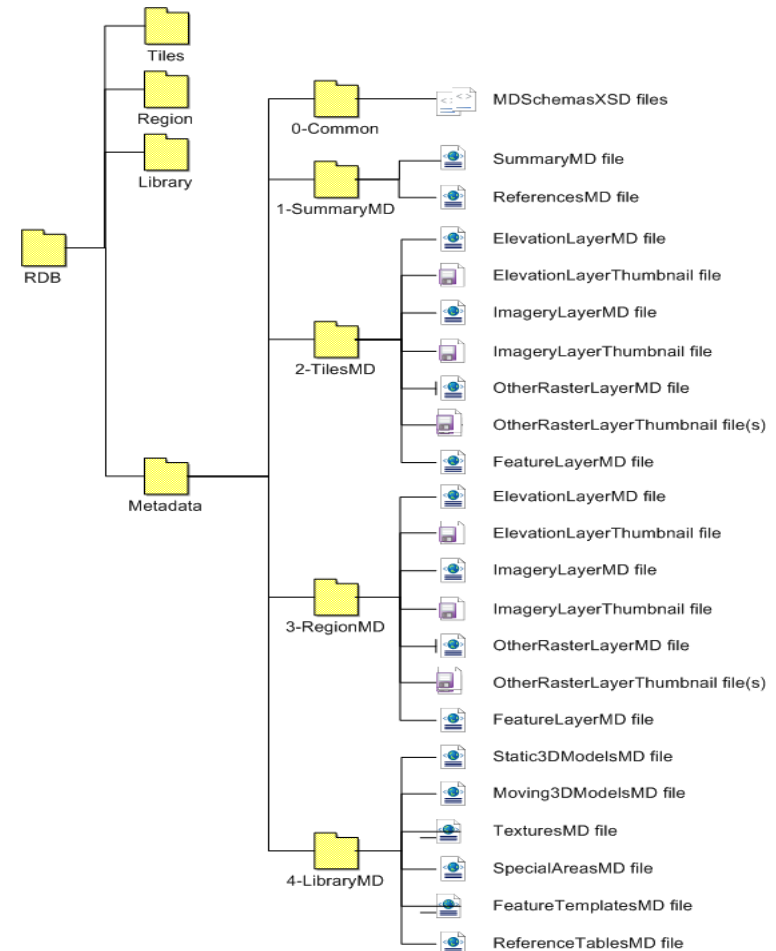


RIEDP Metadata - Organization

- Successful data exchange relies heavily on the appropriate use of metadata
 - Structured metadata
 - Based on XML files for each component of the RADM
 - According to rules captured in XML schemas



Metadata



RIEDP Metadata - Examples

Metadata

XML file for Elevation

```
<?xml version="1.0" encoding="UTF-8" standalone="true"?>
- <ElevationLayerMetadata xsi:noNamespaceSchemaLocation="../0-Comm
  - <WholeLayer>
    - <WholeLayerMD>
      <Description>Description of the Layer</Description>
      <Provider>Name of the Provider</Provider>
      <License>Conditions of the License</License>
      <Security>Unprotected</Security>
      <Date>2017-04-22</Date>
      <Quality>Medium</Quality>
      <Resolution>0,5 m</Resolution>
      <Thumbnail>Thumbnail.file</Thumbnail>
    </WholeLayerMD>
  </WholeLayer>
- <TileExcepts>
  - <Except>
    <List>Tile1;Tile2</List>
    - <ExceptTileMD>
      <Description>Description1</Description>
      <Provider>Provider</Provider>
      <License>License</License>
      <Security>Unprotected</Security>
      <Date>2017-04-22</Date>
      <Quality>Medium</Quality>
      <Resolution>0,5 m</Resolution>
    </ExceptTileMD>
  </Except>
- <Except>
  <List>Tile1;Tile3</List>
  - <ExceptTileMD>
```

Associated XML Schema

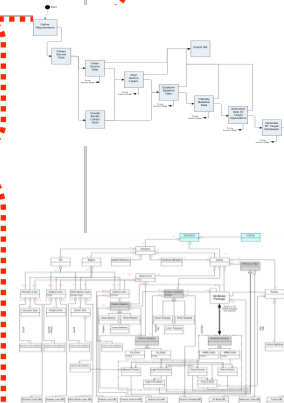
```
1 <?xml version="1.0" encoding="utf-8"?>
2 <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" attributeFormDefault="t
3
4
5 <!-- ***** -->
6 <!-- Déclarations -->
7 <!-- ***** -->
8 <xs:include schemaLocation="Declarations.xsd"/>
9
10 <!-- ***** -->
11 <!-- Elements -->
12 <!-- ***** -->
13 <xs:element name="ElevationLayerMetadata">
14 <xs:complexType>
15 <xs:sequence>
16 <xs:element name="WholeLayer">
17 <xs:complexType>
18 <xs:sequence>
19 | <xs:element name="WholeLayerMD" type="typeSimpleRasterLayer"/>
20 </xs:sequence>
21 </xs:complexType>
22 </xs:element>
23 <xs:element name="TileExcepts" minOccurs="0" maxOccurs="unbounded">
24 <xs:complexType>
25 <xs:sequence>
26 <xs:element name="Except" minOccurs="0" maxOccurs="unbounded">
27 <xs:complexType>
28 <xs:sequence>
29 | <xs:element name="List" type="typeListString"/>
30 | <xs:element name="ExceptTileMD" type="typeSimpleRasterLayer"/>
31 </xs:sequence>
32 </xs:complexType>
33 </xs:element>
34 </xs:sequence>
35 </xs:complexType>
36 </xs:element>
37 <xs:element name="FileExcepts" minOccurs="0" maxOccurs="unbounded">
51 </xs:sequence>
52 </xs:complexType>
53 </xs:element>
54 </xs:schema>
```


RIEDP Profiles



- RIEDP-compliant Data Products shall conform to one of the RIEDP Profiles
- A Profile specifies:
 - A stage in the RPM
 - Mandatory and Optional Data in accordance with the RADM

| Profile | Profiles name | Basic-Cleaned Basic-Aligned Library-Only Basic-Baseline Single-content-Baseline Feature-based 2D map Raster-based 2D/3D map Ground Mapping Radar Rendering Mission Command Automated Reasoning Visual Rendering Visual Rendering w/ aerial imagery | | | | | | | | | | | |
|---------|--|---|-------|-------|-------|-------|-------|-------|--------|-------|--------|--------|---------|
| | | 1-BCP | 2-BAP | 3-LOP | 4-BBP | 5-SBP | 6-FMP | 7-RMP | 8-GMRP | 9-MCP | 10-ARP | 11-VRP | 12-VRIP |
| RPM | Exporting Stages | | | | | | | | | | | | |
| | Clean Source Data | ✓ | | | | | | | | | | | |
| | Align Source Layers | | ✓ | | | | | | | | | | |
| | Establish Baseline Data | | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Intensify Baseline Data | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Specialize Data for Target Application | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| RADM | DB | Product Summary Metadata | R | R | R | R | R | R | R | R | R | R | R |
| | | Spatial Reference | R | R | - | R | RI1 | R | R | R | R | R | R |
| | Tile / Region | Layers Summary Metadata | R | R | - | R | RI2 | R | R | R | R | R | R |
| | | Elevation | | | - | R | | R | R | R | R | R | R |
| | | Imagery | R>=1 | R>=2 | - | R | - | R | - | R | O | - | R |
| | | Other Raster | | | - | O | - | - | O | O | O | O | O |
| | Library | Feature instance | | | - | R | | - | R | R | R | R | R |
| | | Library Summary Metadata | - | - | R | R | RI2 | RI2 | - | RI2 | RI2 | R | R |
| | | 3D Model | - | - | | R | - | - | O | - | O | R | R |
| | | Texture | - | - | | R | - | - | - | - | - | R | R |
| | | Special Area | - | - | R>=1 | O | R>=1* | - | O | O | O | O | O |
| | | Feature Template | - | - | | RI3 | | RI3 | - | RI3 | RI3 | R | R |
| | | Reference Table | - | - | | RI4 | | RI4 | - | RI4 | RI4 | R | R |





RIEDP leverages/reuses existing Standards

Use resources from existing standards (SISO, ISO, NATO, OGC, IEEE)

- Specification of Geographical Information (OGC, IEEE)
- Specification of Entity Identification (SISO SWG Enumerations)
- Specification of Position and Orientation Data (ISO/IEC SEDRIS/SRM)
- Identification of Objects / Features and their Attributes (ISO/IEC SEDRIS/EDCS)
- Definition of a Representation Model of the Environment (ISO/IEC SEDRIS/DRM)
- Specification of Metadata (ISO 19115, DCMI, DDMS, FGDC, EDS)
- Alliance M&S Standards Profile (NATO MSG)

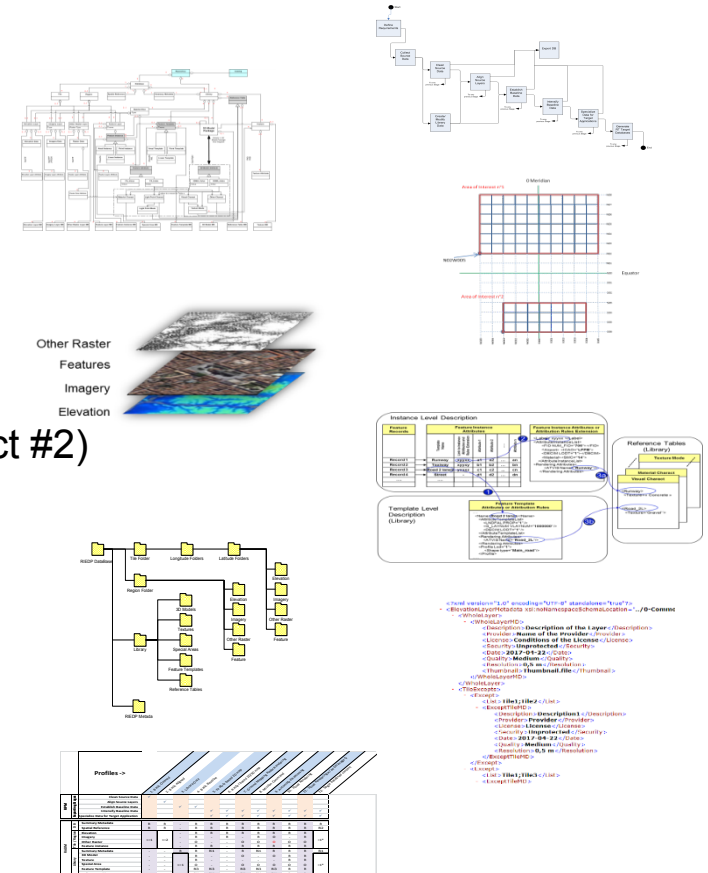
Complement this foundation for M&S applications (RIEDP focus)

- Make use of “de-facto” standards from the Military and GIS communities
- Consider also video-game industry “de-facto” standards
- Develop additional elements to address M&S-specific needs



RIEDP provides what is needed to share Environmental data :

- A Reference Process Model
- A Reference Abstract Data Model
- A Spatial Reference Frame
- A List of Formats from the GIS and M&S worlds
- A Semantic through attributes and attribution rules (product #2)
- An Organization on the Media
- A Metadata structure
- A set of Profiles





RIEDP and SEDRIS – Similarities and Differences

Commonalities

- Open Standard for Exchange of Environmental Data

Main specificities

- | | |
|--|---|
| ➤ SEDRIS is designed to address all types of environmental data | ➤ RIEDP focuses on a subset and application-specific data |
| ➤ SEDRIS is not designed to describe the database generation process | ➤ RIEDP is designed to specifically address the database generation process |
| ➤ SEDRIS defines a binary format (STF) | ➤ RIEDP relies on existing COTS formats |
| ➤ SEDRIS provides APIs and Tools | ➤ Use of RIEDP relies on existing COTS Software & Tools |

RIEDP and SEDRIS are complementary efforts

- RIEDP uses SEDRIS concepts, capabilities, and standards
 - RIEDP Reference Abstract Data Model (RADM) → Influenced by and similar to SEDRIS DRM
 - Reference Frame → SRM is used for position and orientation
 - Attribution → EDCS will be used (candidate) (Product # 2)

RIEDP and SEDRIS – Similarities and Differences (cont.)

| Concept / Capability | RIEDP | SEDRIS |
|---|--|---|
| DB Generation Process | High level, but comprehensive | None |
| Data Model | Abstract at Concept Level; At Data Level dictated by formats | Explicit at Concept and Data Levels |
| Supported Format(s) | Popular GIS and sim formats (e.g., Shapefile, OpenFlight, GeoTIFF) | SEDRIS Transmittal Format (STF) |
| Volumetric Data (e.g., weather, ocean, space, CAT scan, etc.) | None | 3D Volumes, + Time, + Multiple Attributes |
| Polymorphic Representations | Link from features to 3D models | Multiple forms of representation of same object, all fully related and integrated |
| Topology | None | Both for Features and Geometry |
| Data Organization / Hierarchy | Limited to fixed theme and hierarchy | Any combinations of 13 types: by theme, by time, by space partition, by LOD, by state, by classification, ... |
| Metadata | Specific | Specific |
| 3D Models | Supported through the format | Fully supported |
| Animation | Supported through the format | Fully supported |
| Library | 3D Models, Feature Templates, Textures, Reference Tables | Symbol, Sound/Audio, Color Table, Image, 3D Model, Data Table, Property Set Table |
| Profiles | 12 use profiles | Limited |



Take away

- RIEDP
 - ▶ Takes **benefit of the lessons learnt** from all initiatives
 - ▶ Reuses and relies on **existing standards** (such as SEDRIS ISO/IEC standards and PNG ISO/IEC standard), as well as popular **formats used in the community**
 - ▶ Represents the **best common denominator** by providing a Reference Process Model (**RPM**), a formal Reference Abstract Data Model (**RADM**), relying on use of **existing Formats**, specifying **unique Profiles**, and focusing on **metadata and attribution semantics**
 - ▶ **Does not impose internal solutions** on producers
 - ▶ Provides a **common data sharing approach** that relies on a formal abstract data model (RADM), along with specific metadata and attribution (Product #2)
- This allows the **best sharing** of data, **independently from target applications** implementation, with a current scope addressing static terrain and visual system data



Take away (cont.)

- RIEDP Product 1, Data Model Foundations, was published in 2018
- RIEDP Product 2, Detailed Feature Description, is under development and expected to be published in 2021, with following key topics being worked:
 - ▶ List of Features (and themes)
 - ▶ List of Attributes (including enumerants, applicable units, scale)
 - ▶ Feature-Attribute relationships
 - ▶ Attributions related to Material, Light, and Sensor characteristics for different user levels
 - ▶ Attributions related to database generation process

Conclusion

- Thank you for your attention !
- Any questions ?
- Backup slides contain additional information on requirements, data generation process, and future trends



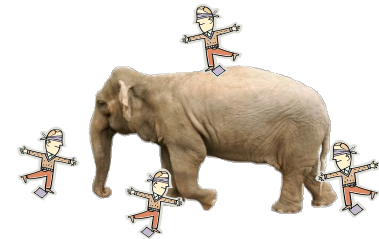
Environmental Data Requirements



Modeling and Simulation Requirements

Modeling and Simulation a very heterogeneous world

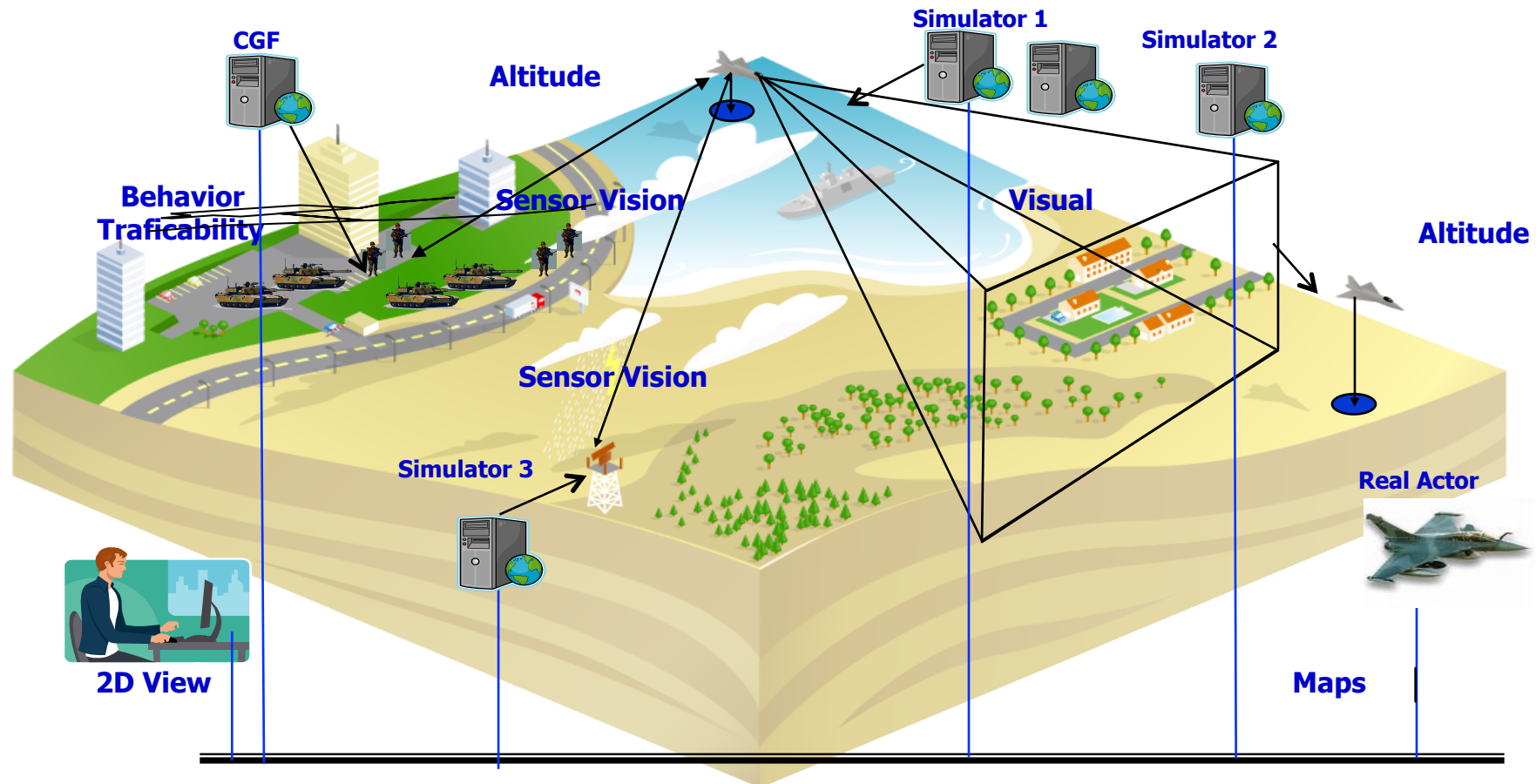
- Various Communities
 - ▶ Engineers & Military End-Users
 - ▶ Industry & MoDs
- Various Requirements
 - ▶ From Analysis to Training and Mission Rehearsal
- Large Range of Simulation Tools
 - ▶ L, V, C, and Combinations via Distributed Simulation
 - ▶ Based on Models from the Real World Phenomena
 - ▶ Networking with Information Systems



Standardized Representation(s) of the Environment must reflect and support this diversity



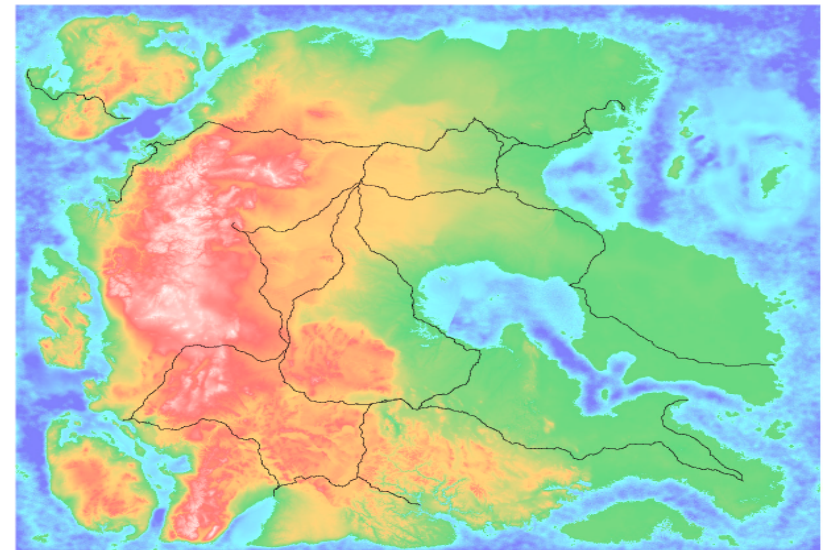
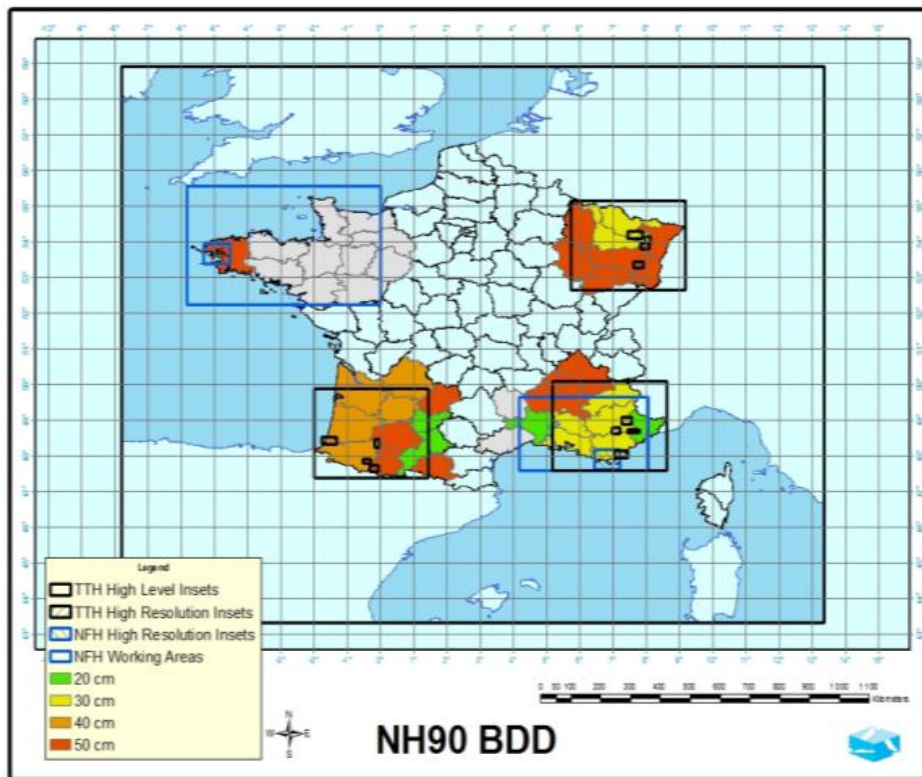
Various Systems and Participants



Environment Requirements for an Aircraft Simulator

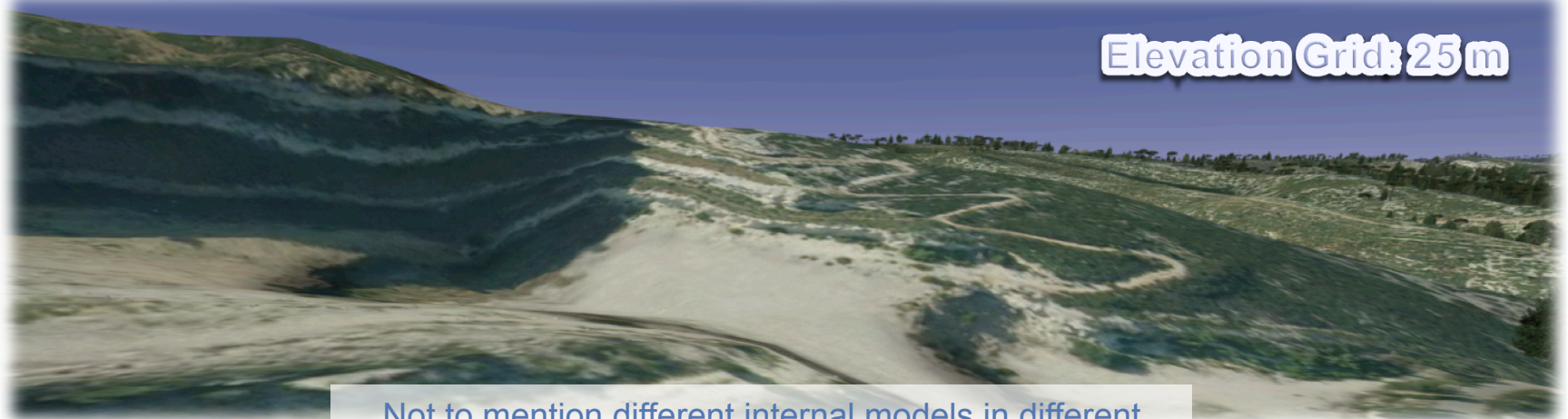


Requirements / Large Areas



NATO "Missionland"
2000x2000 km

Requirements / Fidelity



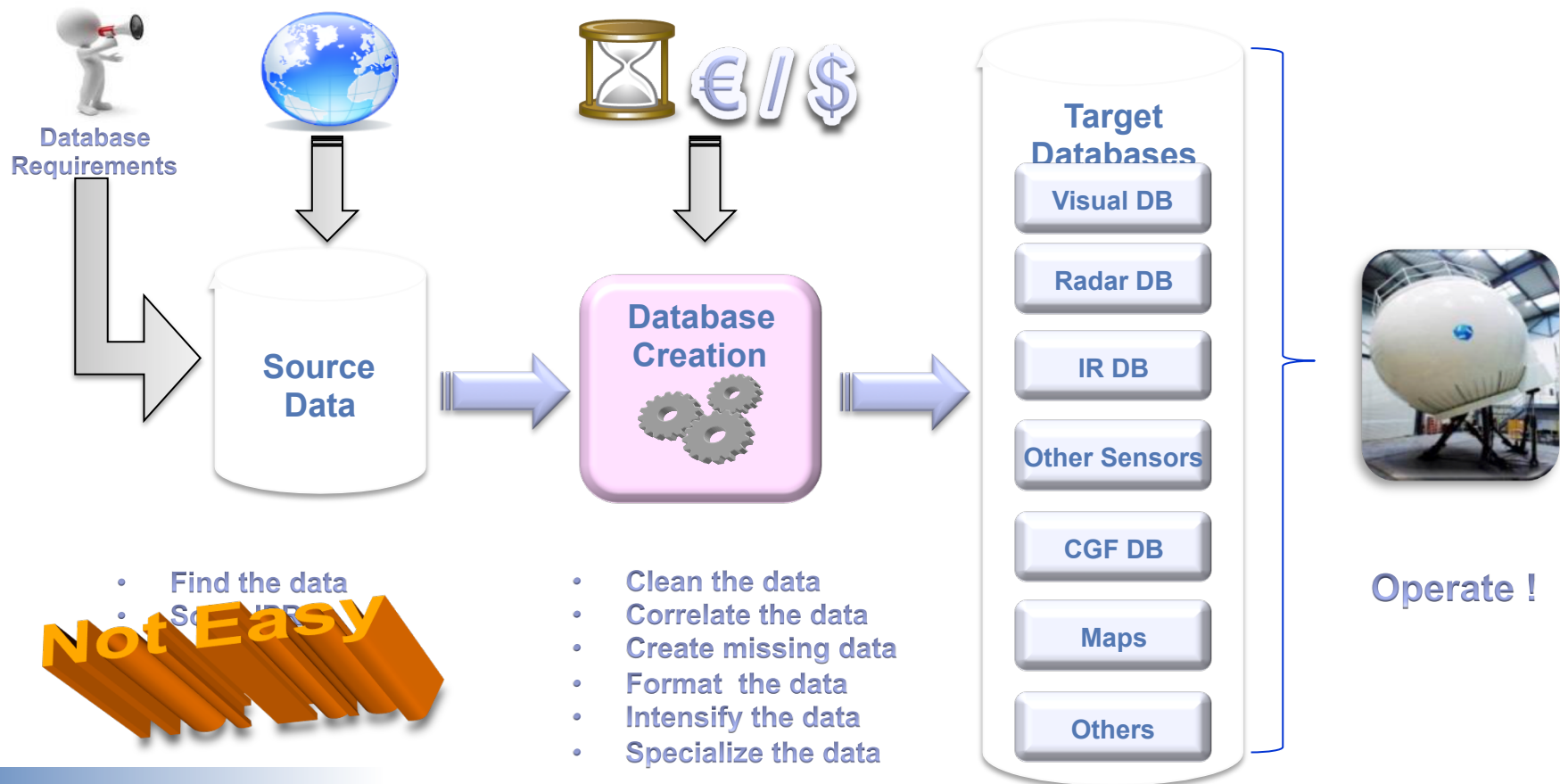
Not to mention different internal models in different simulation systems ...



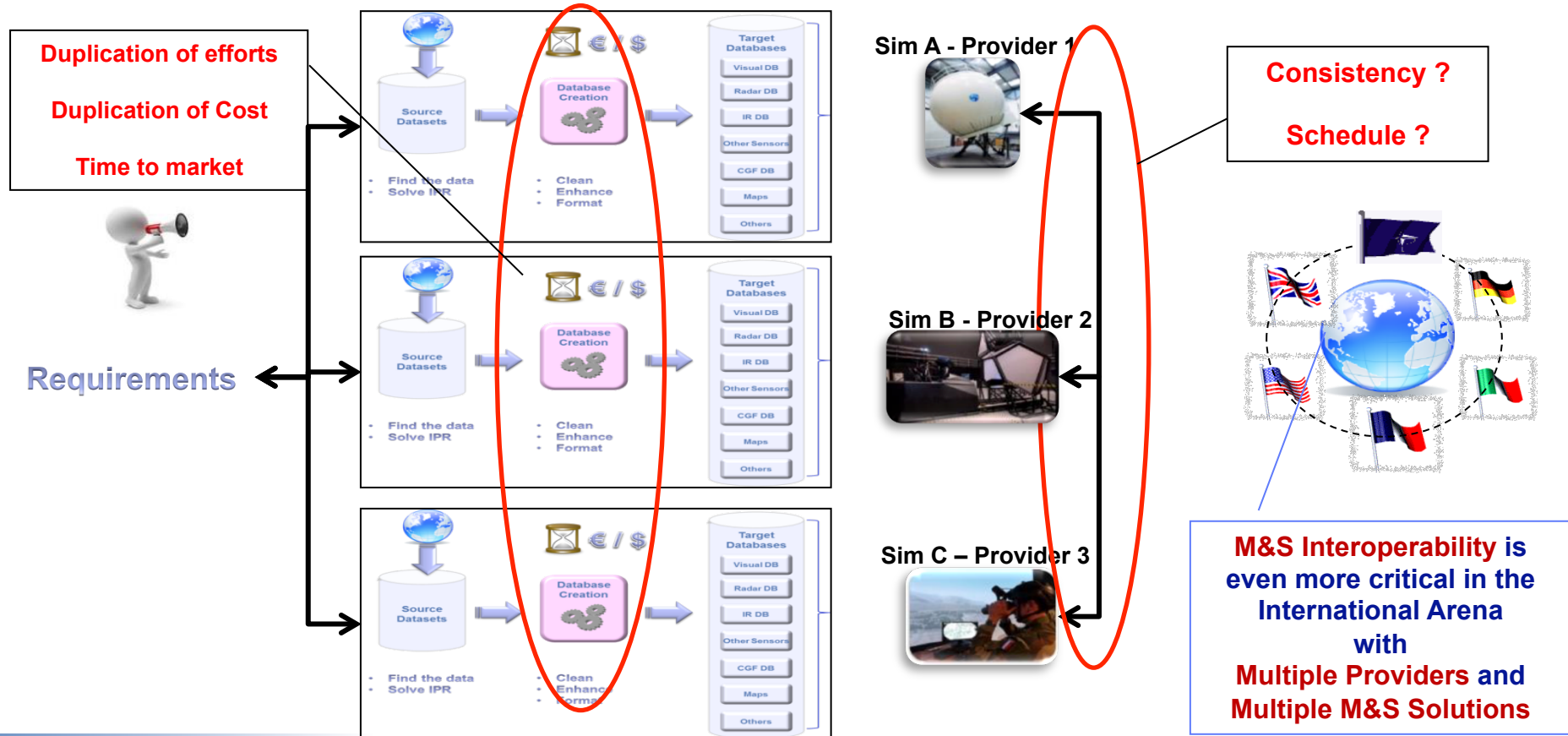
Requirements / Consistency



Building the Simulator Database



Additional issues for Distributed Simulation Reuse – Correlation – Interoperability





M&S Interoperability

What it is Not

- The same Product and associated Solutions for everyone
 - ▶ Does not work, certainly not in the international arena
 - ▶ Puts innovation at risk
 - ▶ What product to choose? Single solution sufficient ?

What it is

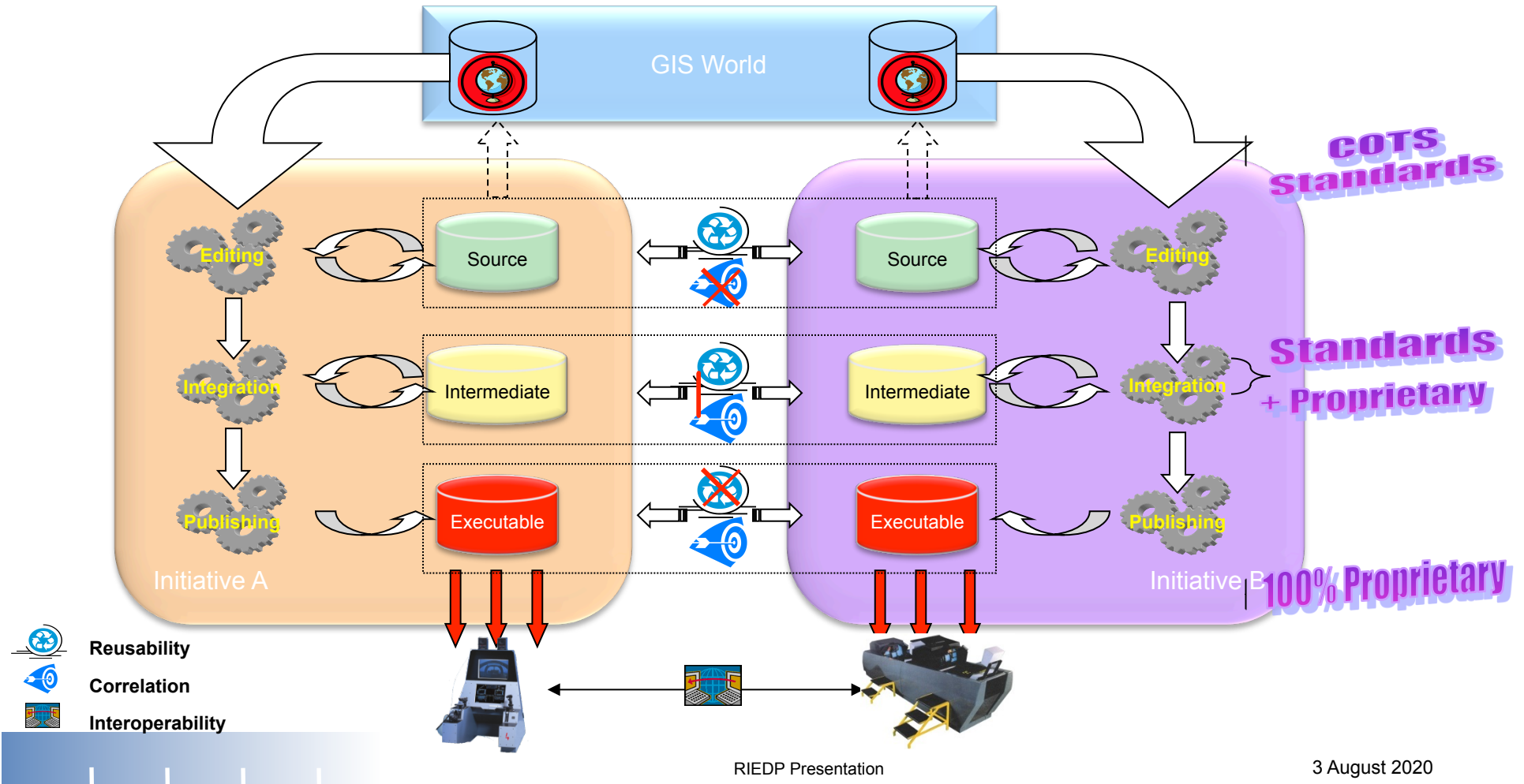
- Consistency in Modelling, associated Data and Semantics at Component Level
- Allowing Components to work together at System & System-of-Systems Levels
- Fostering Multiple-Provider Solutions (e.g. : I/ITSEC/OBW Federations)

Interoperability relies on Appropriate Standards

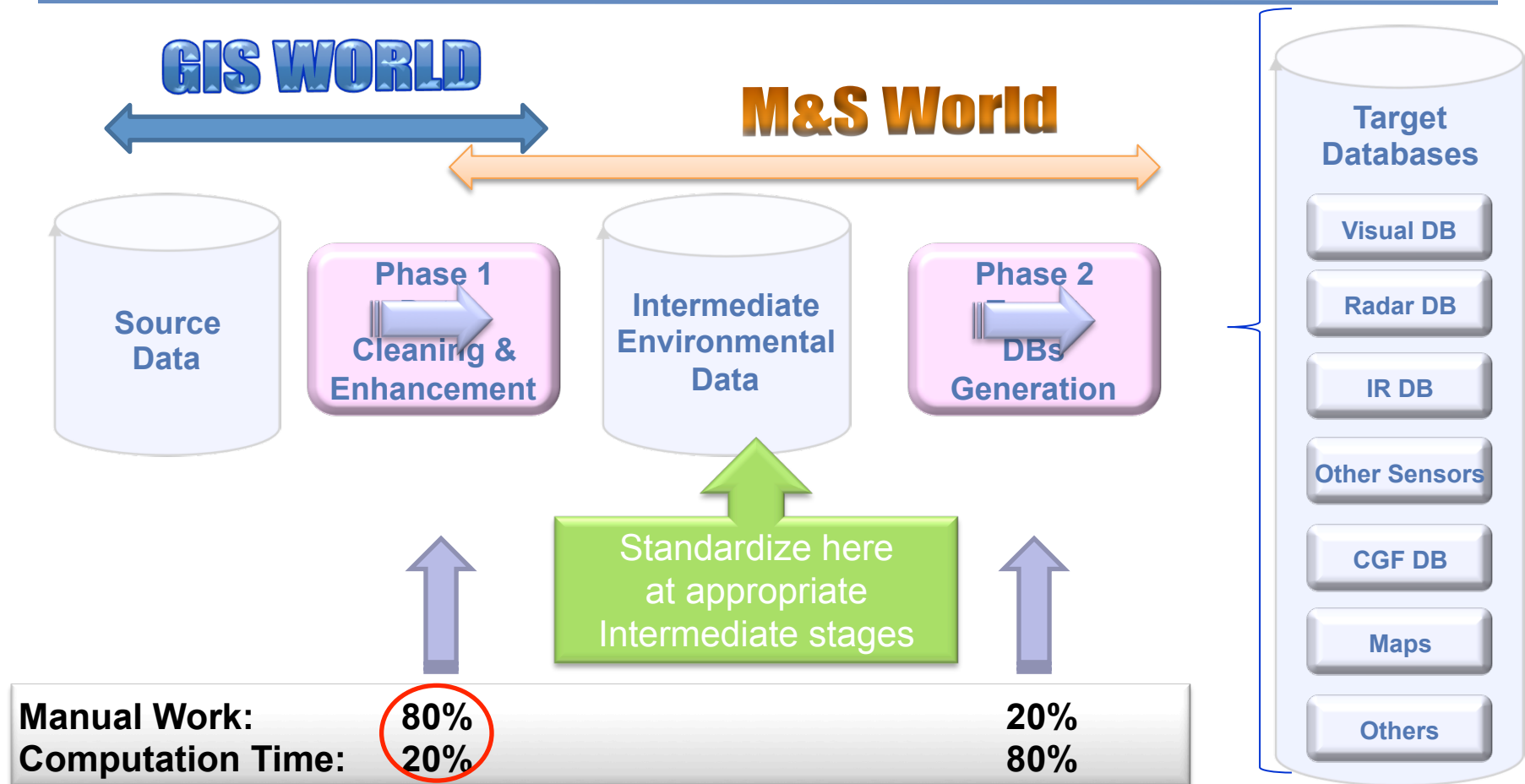
Database Creation Process and associated Issues



Generation Processes vs Correlation and Reuse



Data Transformation Process – Two main phases



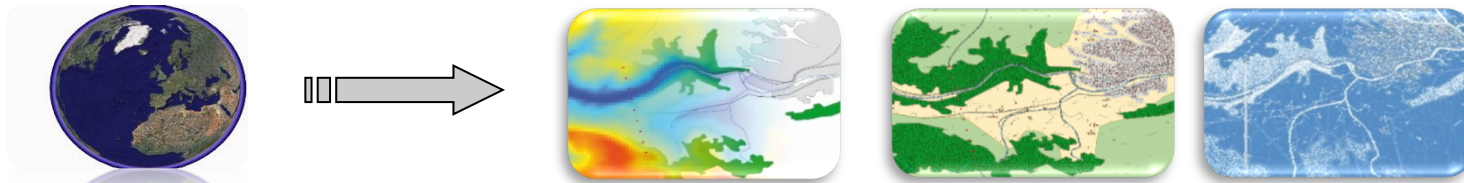
Source Data - Geographic Formats

- **DTED** : Military terrain elevation data format, Mil-PRF-89020B
- **DFAD** : Military vector format, SUPP1C2/3C, Edition2, Nov 1988 (obsolete)
- **VMAP** : Military vector format, Mil-V-89033
- **SHAPEFILE** : de-facto standard created by ESRI,
- **GEOTIFF** : Public format for Geo-referenced imagery
- **GML** : Public format from Open Geospatial Consortium
- **KML** : created by Keyhole, Inc, acquired by Google in 2004, standard OGC KML

Open Street Map ?
Geopackage ?

Application to simulation

- Used for Altimetry (DTED), Features (SHAPEFILE) (roads, rivers and building positions), Geo-referenced satellite imagery (GeoTiff).

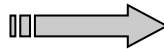
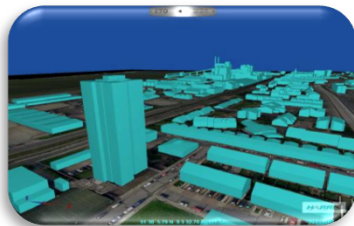


- Contributing to consistency between Simulators target applications
 - ▶ Visual System, CGF, ...

- **BMP** : developed by Microsoft & IBM
- **ECW** : developed by Earth Resource Mapper
- **JPEG** : created by a WG in partnership with ISO & CEI
- **JPEG 2000** : common standard from ISO & UIT-T, ref ISO/CEI 15444-1
- **RGB** : developed by Silicon Graphics Incorporated (SGI)
- **TIFF™** : developed by Adobe.

Application to simulation

- Texture for Terrain or objects



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- Adding visual realism, without complex geometric models

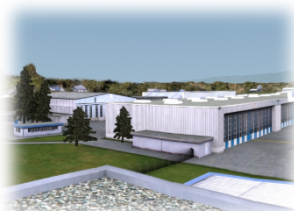
Source Data - 3D Models

Worlds of Game and Architecture

- **OpenFlight™** : created by MPI., now Presagis , de-facto standard
- **COLLADA** : created by Sony CE (PS3) as an interchange format for 3D interactive application, now Khronos Group
- **VRML** : Virtual Reality Modeling Language, ref ISO/IEC 14772-1 & -2
- **X3D** : ISO/IEC standard, Computer graphics and image processing - Extensible 3D (X3D)

Application to simulation

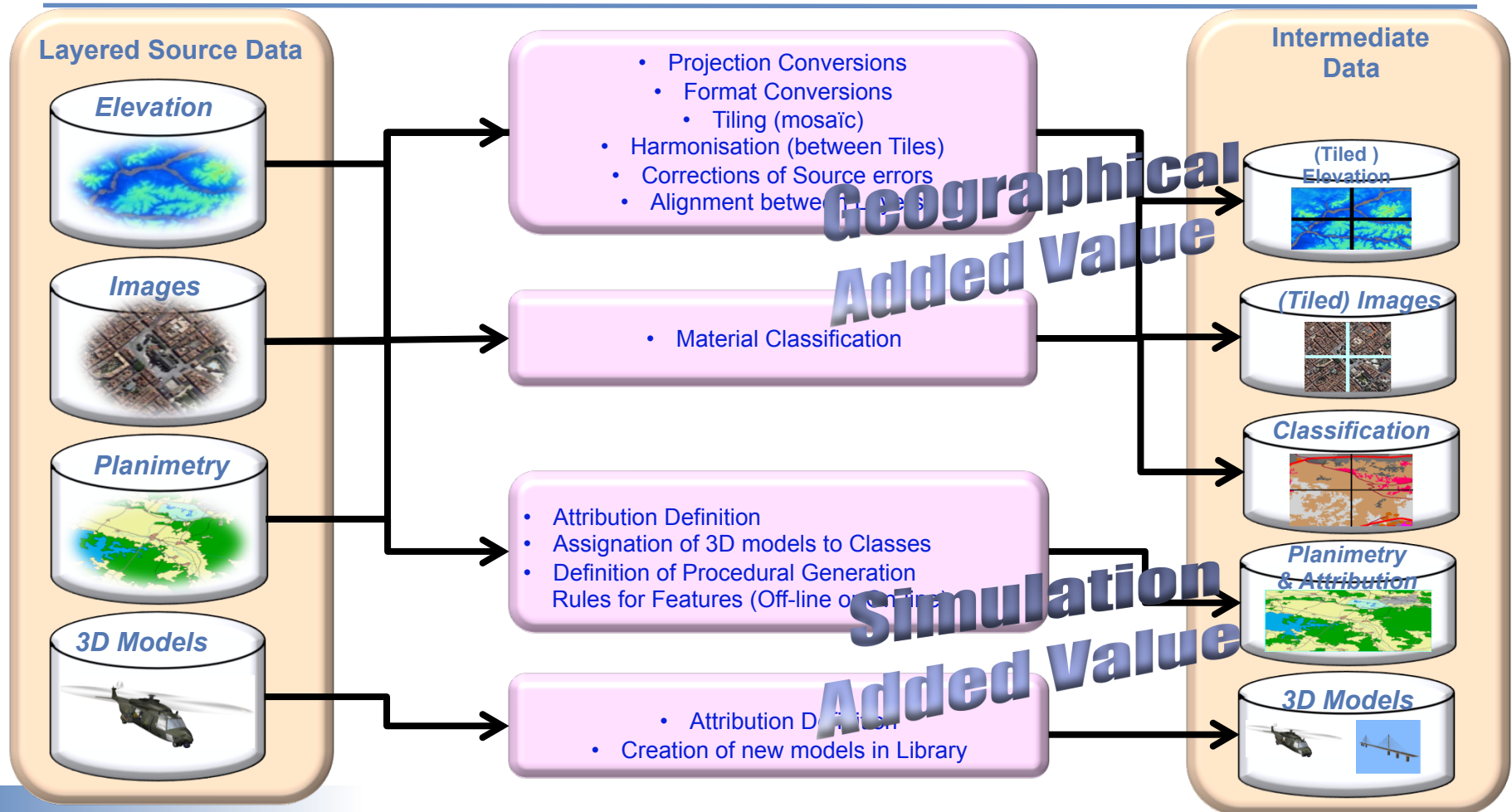
- Formats from 3D modelers (3DS™, Maya™, Creator™, ...)



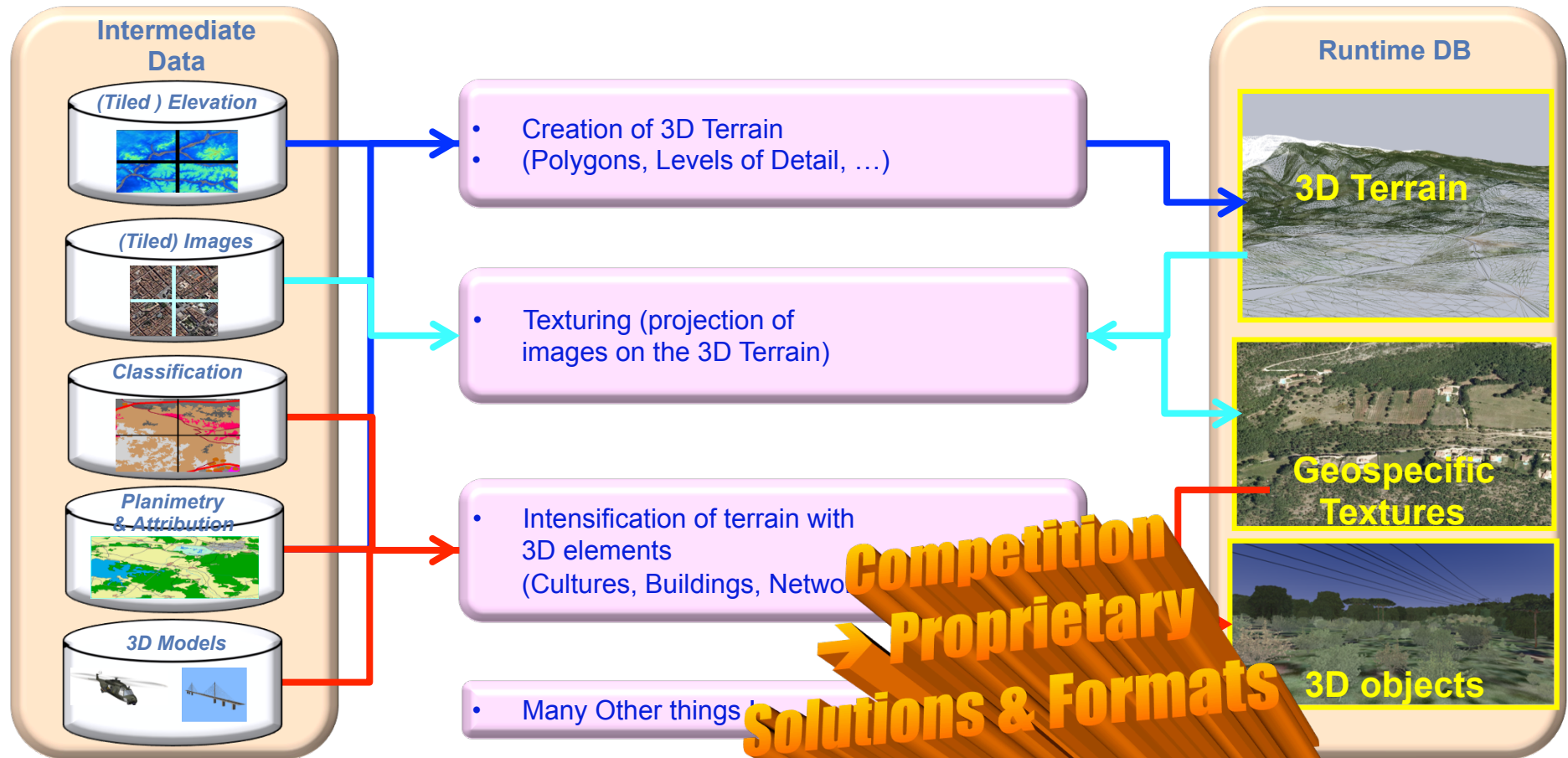
- Dedicated to 3D Objects Modeling for Visual Systems

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Phase1 : Generation of the Intermediate Data



Phase 2 : Generation of Target DBs



Future trends





Back to the Future

Major Trends in Geospatial Data

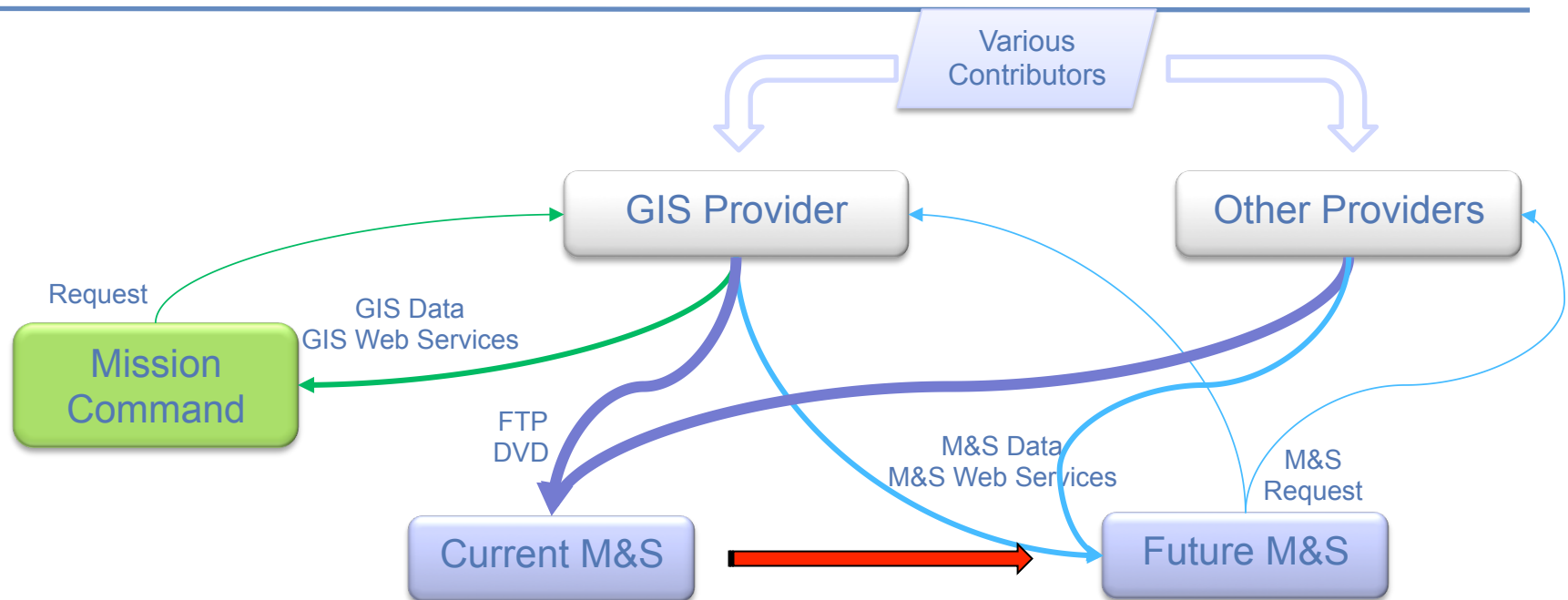
- Data in the Cloud
- Multi Source-Based (Crowd, UAV, ...)
- Impact of Regulations: IPR, Security, Quality

Key aspects

- The Cloud must become clever in order:
 - ▶ To allow Data Collection from non-Expert as well as Expert Contributors
 - ▶ To deliver the Data according to Various Consumers' individual needs
 - ▶ To take into account System of Systems Interoperability Requirements
- Consequence for M&S
 - ▶ M&S Requirements
 - ▶ Platform dependant
 - ▶ Leveraging Data & Tools from Geospatial and other COIs

*« Data doesn't know
what it's used for » (JS)*

Future Trends - Impact on M&S Better Environmental Data Sources



Current M&S Requirements

- GIS Data as is : Elevation, Vectors, Imagery
- Additional information (Sensors, ...) from other Providers
- Do not address details such as : Curbs, Door Knobs,
- Access to data : Downloading from servers (FTP)

Future Requirements

- M&S oriented Data: Cleaned, Aligned, Multispectral, Customized,
- Interested in details : Curbs, Door Knobs, Multi spectral
- Address Regulations Issues (IT Security, IPR, ..)
- M&S Oriented Web Services: Consistent, in realtime (?)

M&S as a Service (MSaaS) for Environmental Data

- This is for mid-term Future
 - ▶ 10 years, may be less ?
- This requires appropriate standards
 - ▶ DataModel, Interface, Metadata, ...

*+ additional Technologies
/ Performance ...*

**RIEDP is paving the Way by establishing the Foundations
allowing efficient sharing of Environmental Data**