Overview of RIEDP Data Sharing Standards

(Reuse and Interoperation of Environmental Data and Processes)

Update to ISO/IEC JTC 1/SC 24

26 August 2019

Farid Mamaghani (farid@sedris.org)

Jean-Louis Gougeat (jlgougeat@sogitec.fr)

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

- Many utilize data in popular GIS formats to build simulation terrain data products (databases)
- Variations and different parameters used in the process of building these databases 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** 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 in these popular data formats
- Terrain data products are widely used in stand-alone or networked modeling and simulation applications, including visualization, training, analysis, rehearsal, testing (using traditional, VR, or AR visualizations)

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

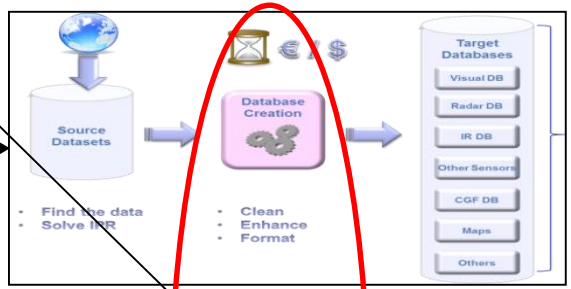
Distributed Simulation – Database Generation – Reuse – Correlation – Interoperability ….

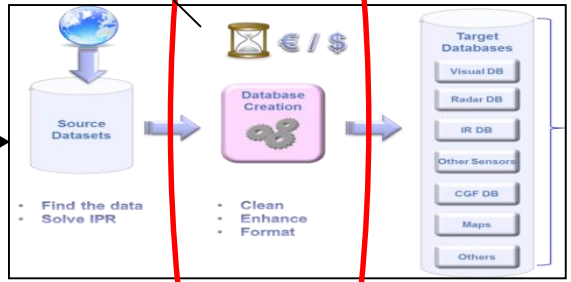
Duplication of efforts

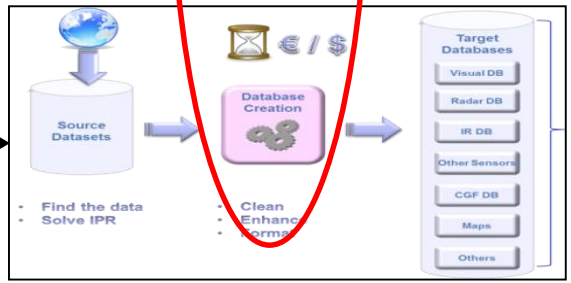
Duplication of Cost

Time to market

Requirements







Sim A - Provider 1

Sim B - Provider 2

Sim C – Provider 3

Consistency ?

Schedule ?

M&S Interoperability is even more critical in the International Arena with Multiple Providers and Multiple M&S Solutions

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

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

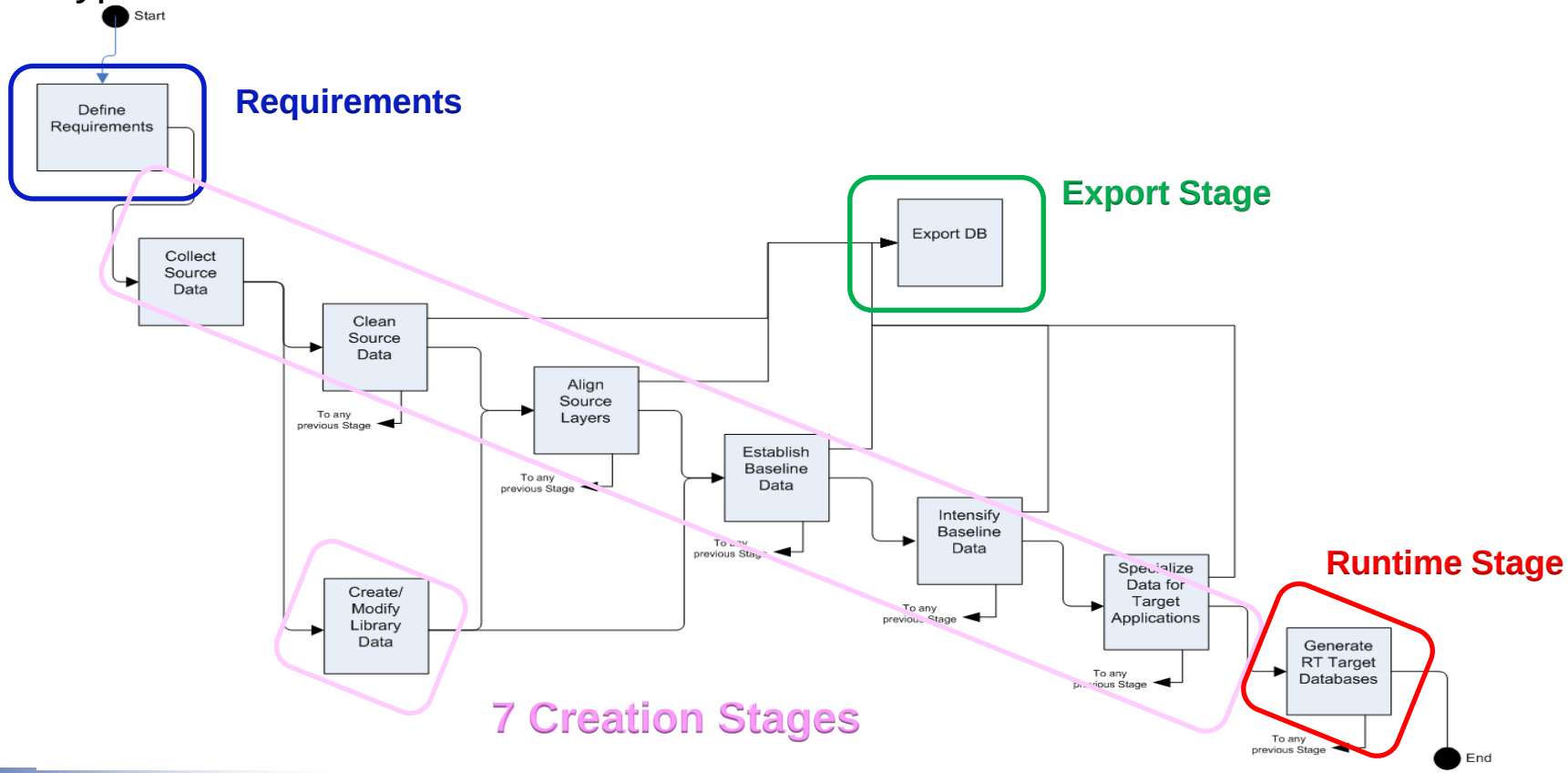
RIEDP Concepts and Standards (cont.)

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)**

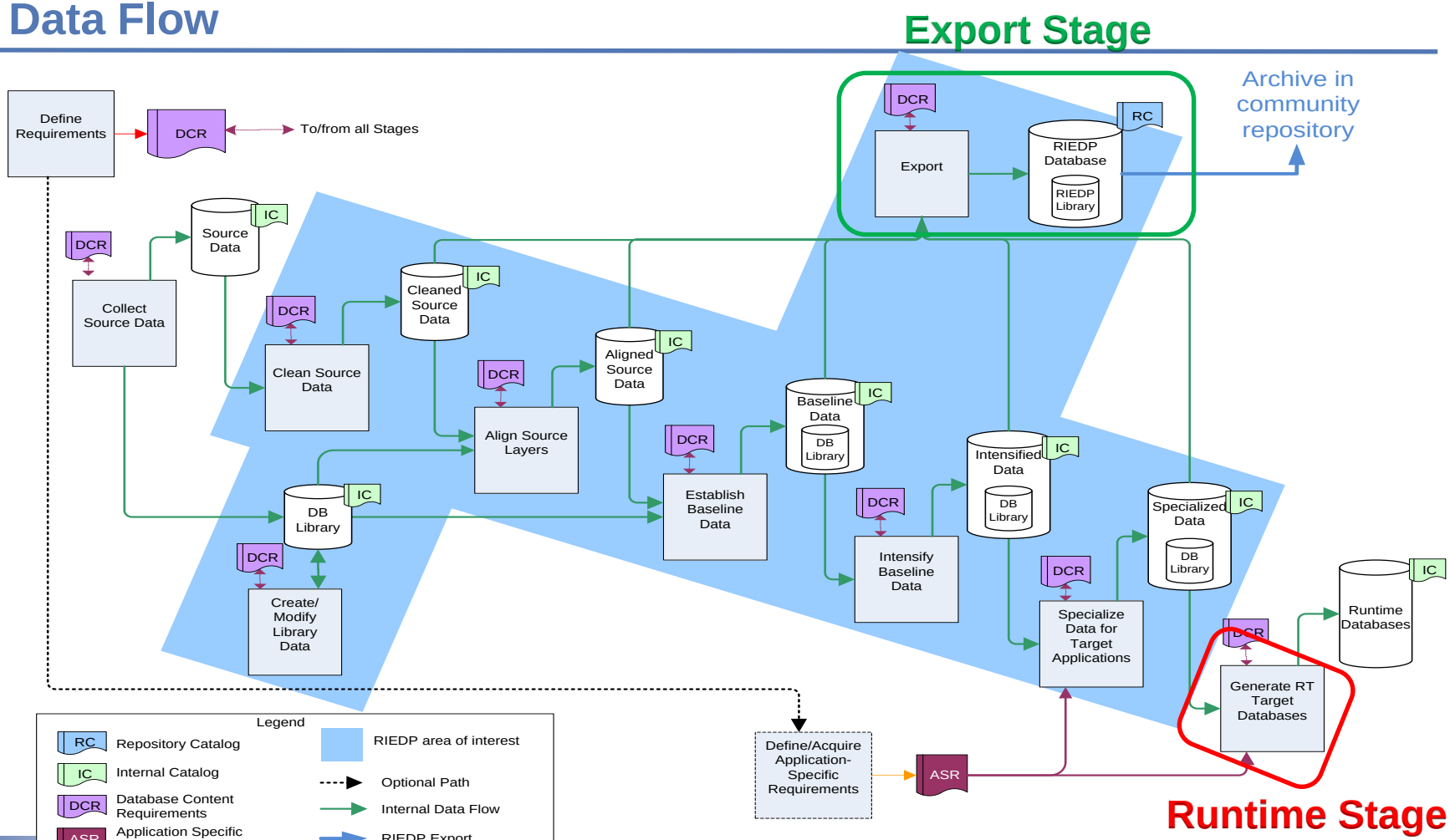
Process Flow

- Typical Generation Process for a Database

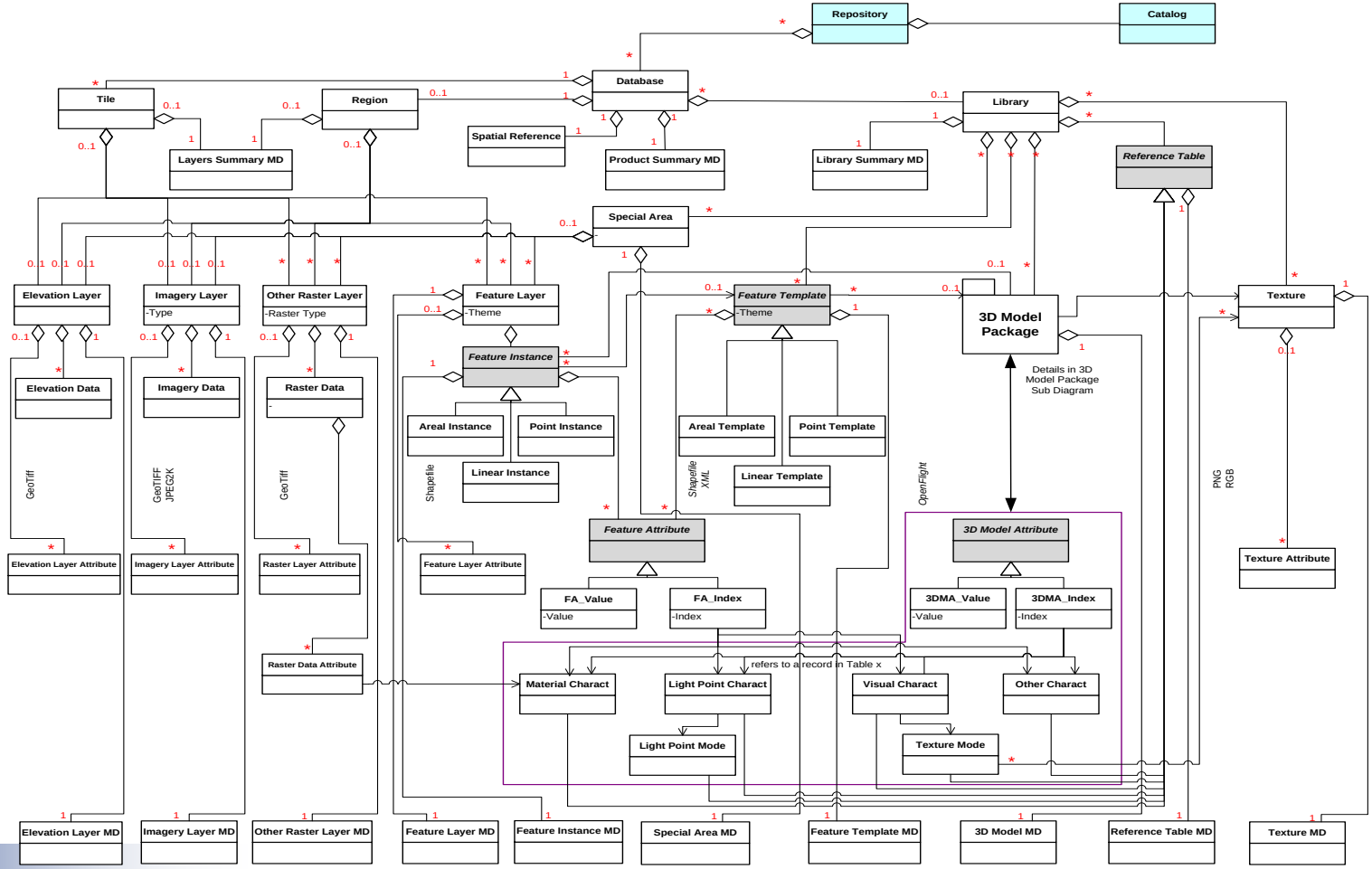


RIEDP Reference Process Model (RPM)

Data Flow

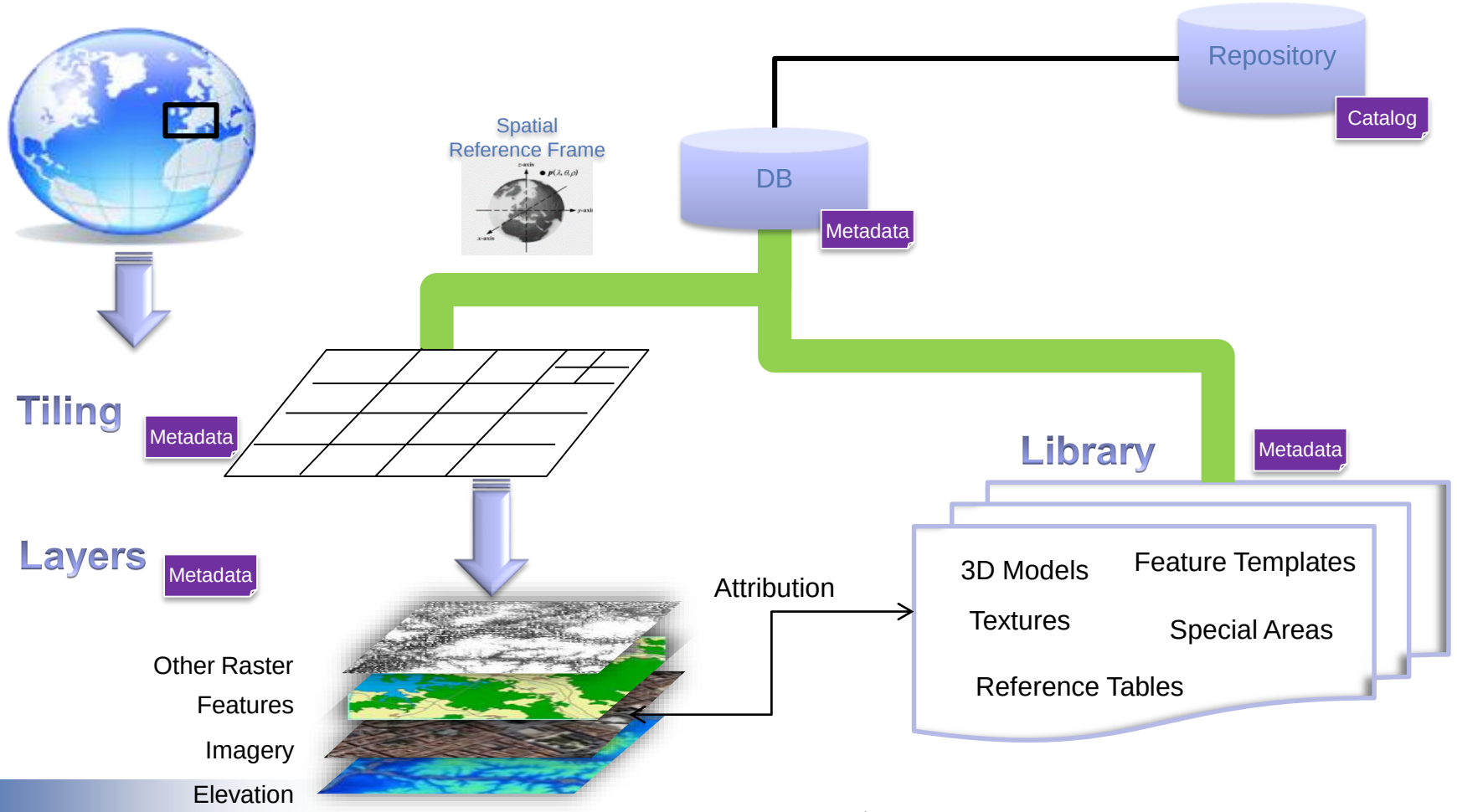


RIEDP Reference Abstract Data Model (RADM)

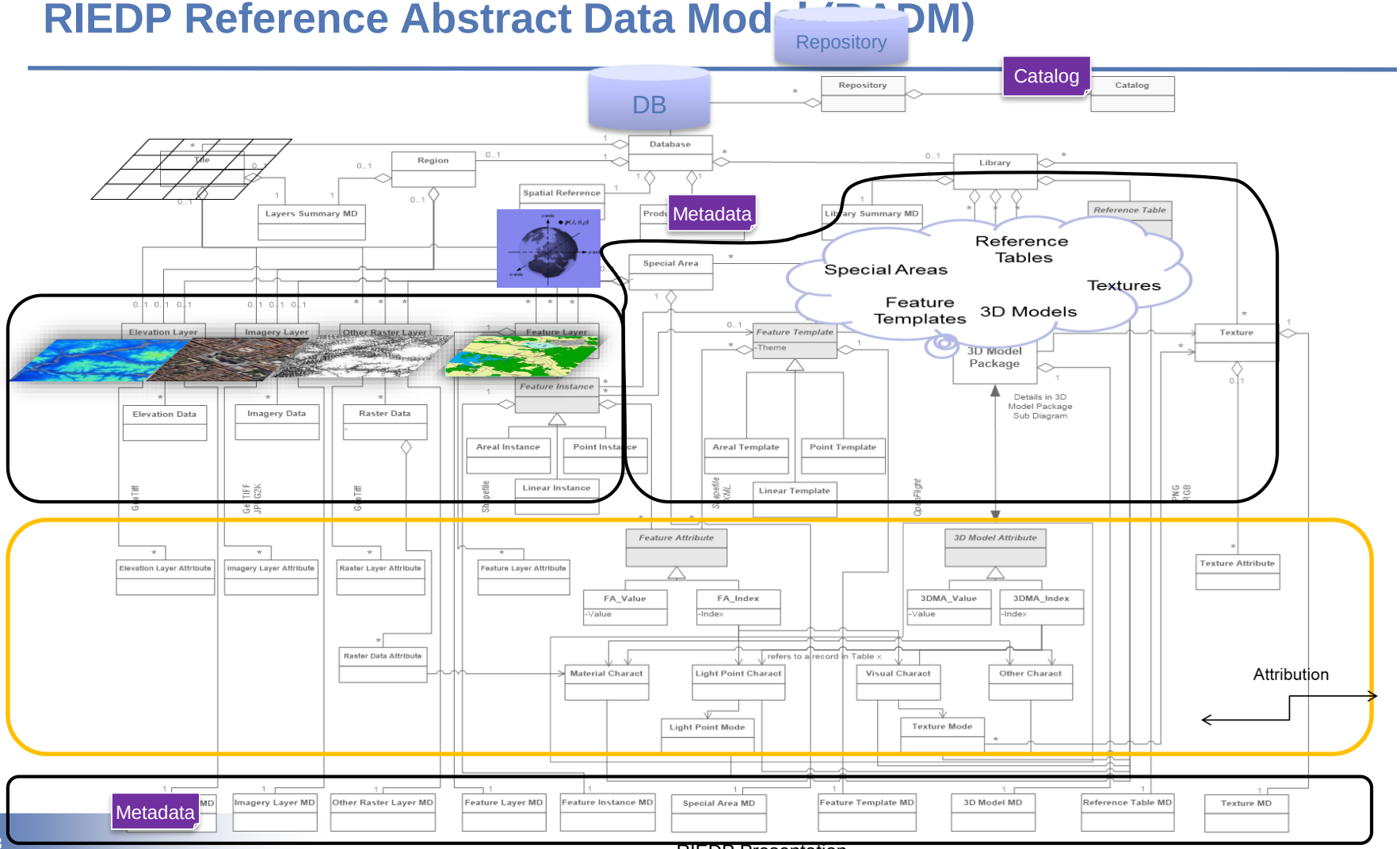


RIEDP Reference Abstract Data Model (RADM)

Main Components (conceptual)



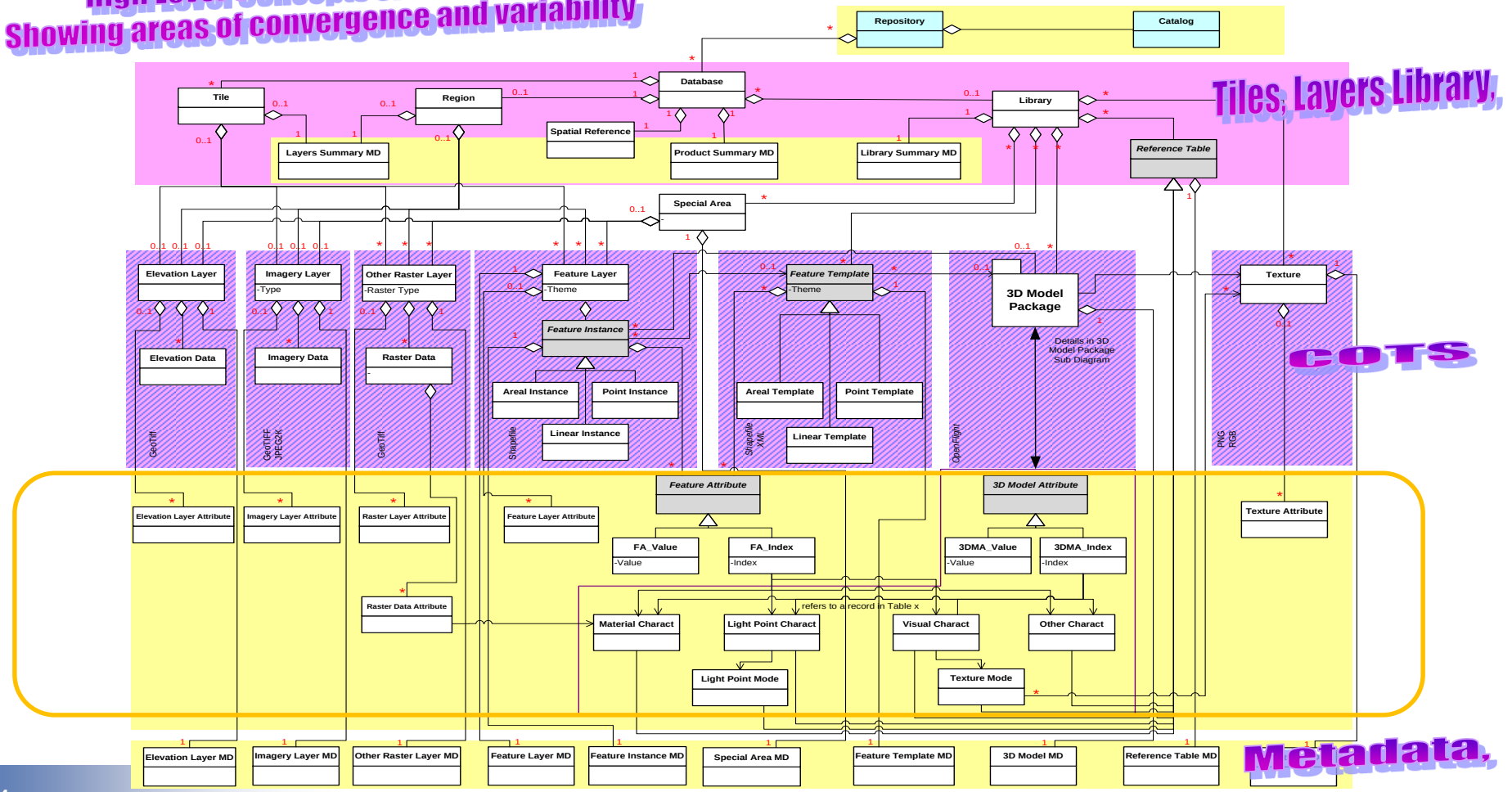
RIEDP Reference Abstract Data Model (RADM)



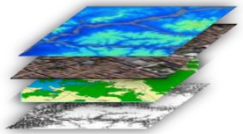
RIEDP Reference Abstract Data Model (RADM)

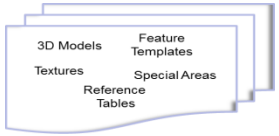
Convergence
Common format
Variability

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

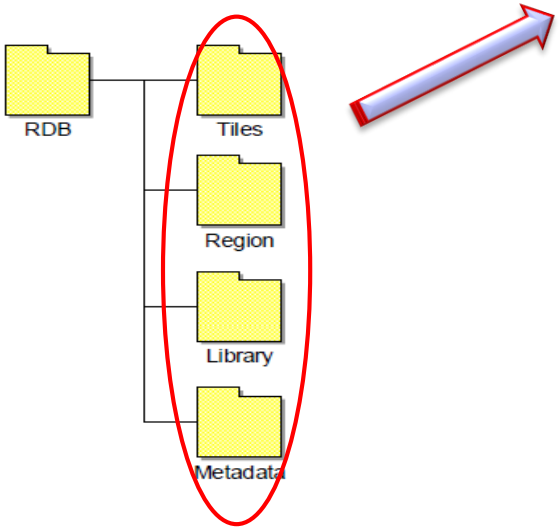
NOTE :

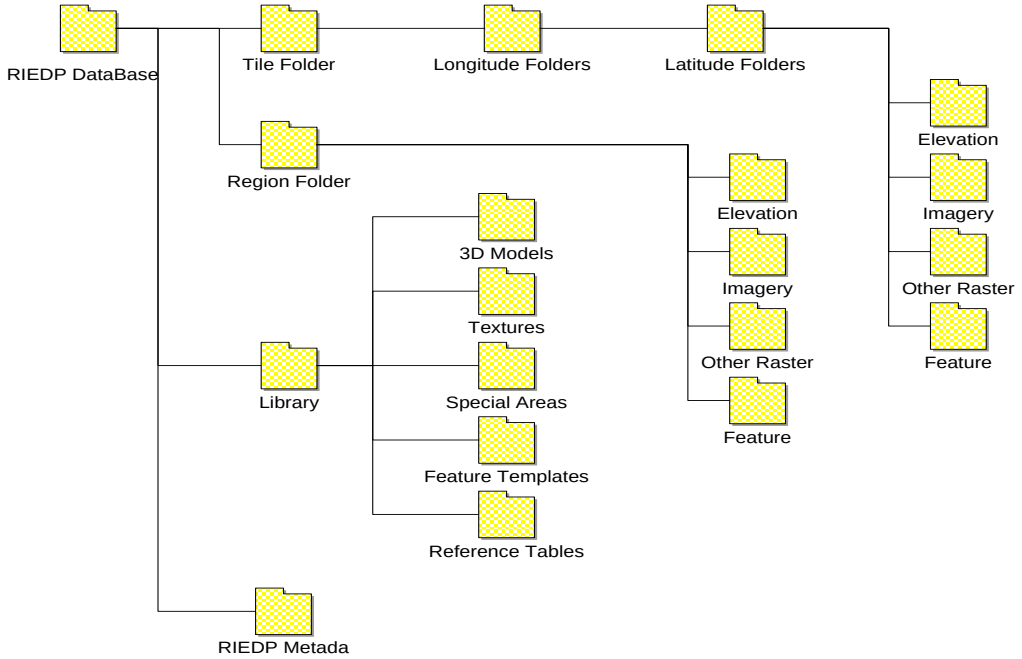
- RIEDP does NOT impose RIEDP-required Formats for use within a Data Producer's internal Processes

RIEDP Data Organization

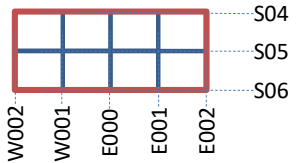
Physical Organisation on the Media

- Layers in Tiles or Region Folder
- Library
- Metadata



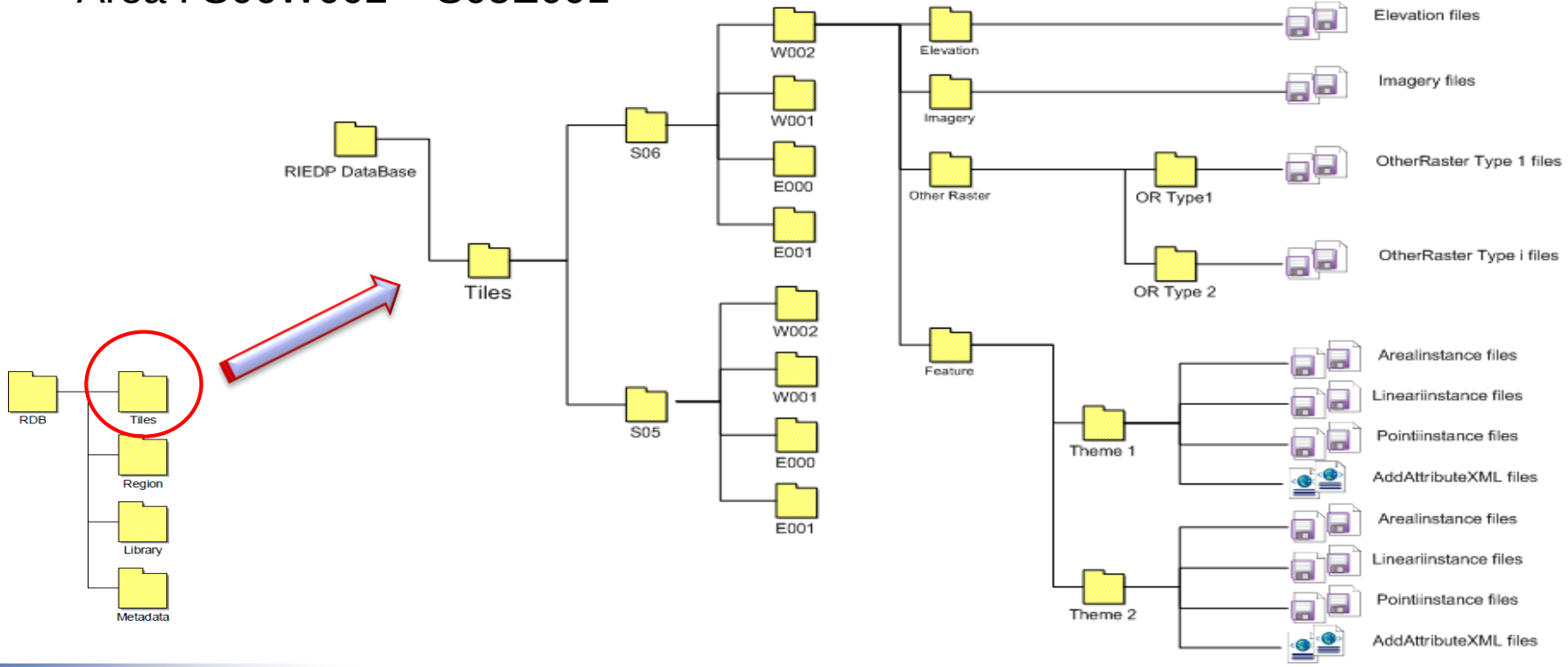


Details of Tiles Folders

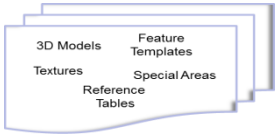


Tiling Example

- Area : S06W002 – S05E001

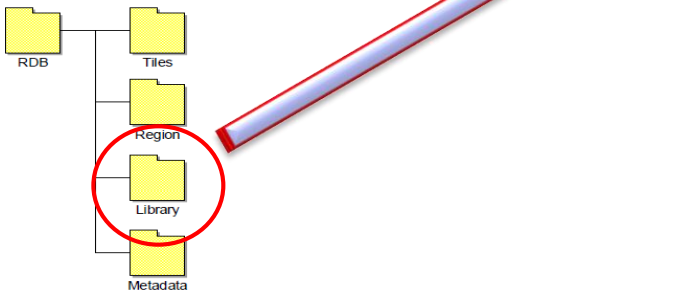


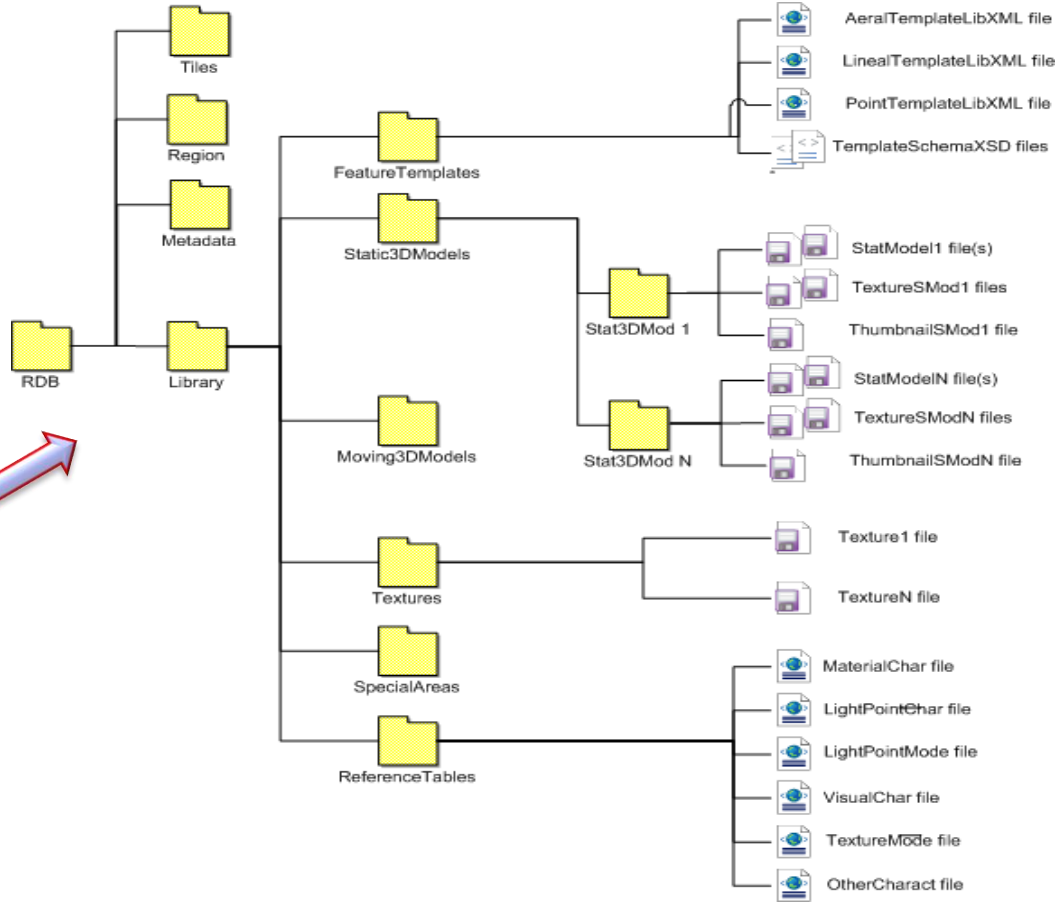
Details of the Library



Library Example :

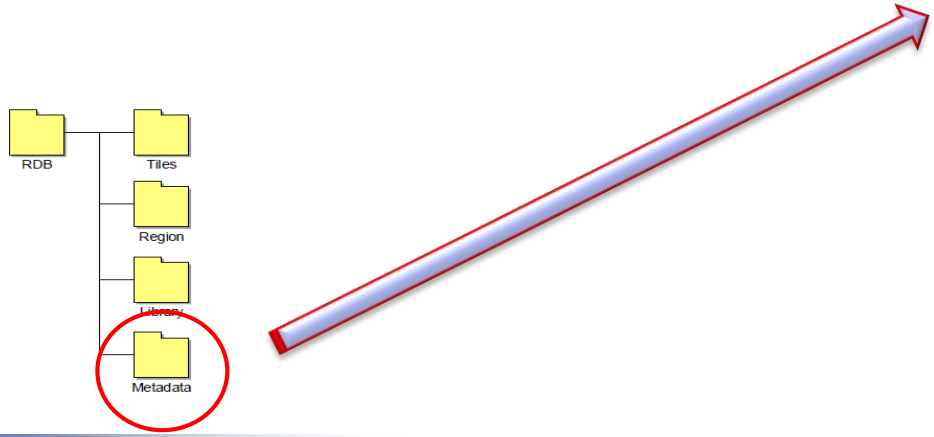
- Feature Templates
- Static 3D Models : 2
- Textures : 2
- Reference Tables: 6

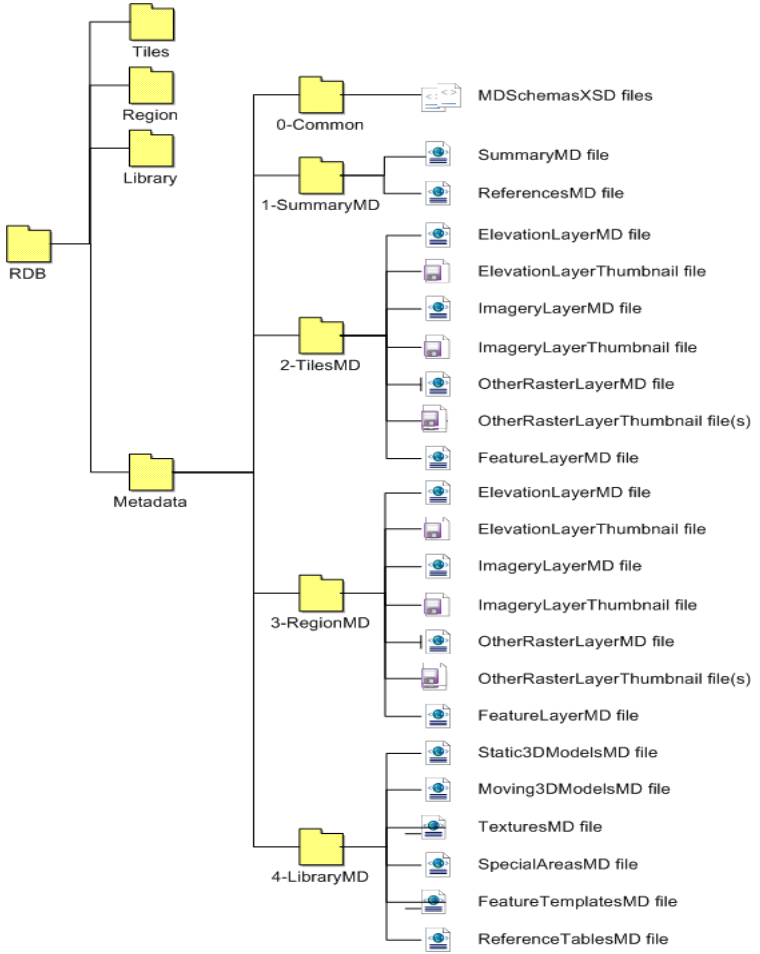




RIEDP Metadata - Organization

- 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





RIEDP Metadata - Examples

XML file for Elevation

```
<?xml version="1.0" encoding="UTF-8" standalone="true"?>
- <ElevationLayerMetadata xsi:noNamespaceSchemaLocation="../0-Commo
  - <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>
```

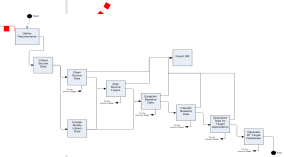
Associated XML Schema

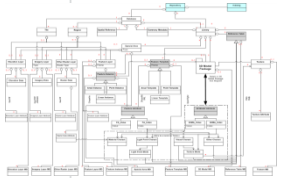
```
1  <?xml version="1.0" encoding="utf-8"?>
2  <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" attributeFormDefault="u
3
4
5    <!--***************-->
6    <!--Déclarations-->
7    <!--***************-->
8    <xs:include schemaLocation="Declarations.xsd"/>
9
10   <!--***************-->
11   <!--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
		Profiles Id	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	R
		Spatial Reference	R	R	-	R	Ri1	R	R	R	R	R	R	R
	Tile / Region	Layers Summary Metadata	R	R	-	R	Ri2	R	R	R	R	R	R	R
		Elevation	R>=1	R>=2	-	R	R=1*	R	R	R	R	R	R	R
		Imagery			-	R		-	R	-	R	O	-	R
		Other Raster			-	O		-	-	O	O	O	O	O
		Feature instance			-	R		R	-	R	R	R	R	R
	Library	Library Summary Metadata	-	-	R	R	Ri2	Ri2	-	Ri2	Ri2	Ri2	R	R
		3D Model	-	-	R>=1	R	R>=1*	-	-	O	-	O	R	R
		Texture	-	-		R		-	-	-	-	-	R	R
		Special Area	-	-		O		-	-	O	O	O	O	O
		Feature Template	-	-		Ri3		Ri3	-	Ri3	Ri3	Ri3	R	R
		Reference Table	-	-		Ri4		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)

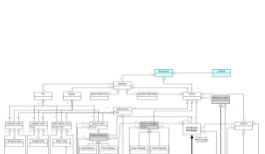
Complement this foundation for M&S applications (RIEDP focus)

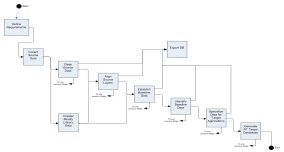
- Make use of “de-facto” standards from the Military and GIS communities
- Consider also video-game industry “de-facto” standards
- Develop additional elements to address M&S-specific needs

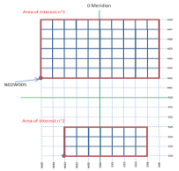
Summary

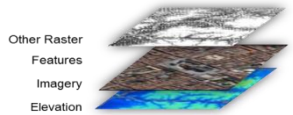
RIEDP provides what is needed to share Environmental data :

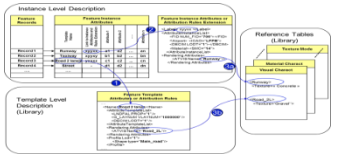
- A Reference Process Model
- A Reference Abstract Data Model
- A Spatial Reference Frame
- A List of Formats from the GIS and M&S worlds
- A Semantic through attributes and attribution rules (product #2)
- An Organization on the Media
- A Metadata structure
- A set of Profiles

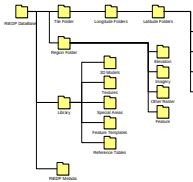












RIEDP and SEDRIS – Similarities and Differences

Commonalities

- Open Standard for Exchange of Environmental Data

Main specificities

- SEDRIS is designed to address all types of environmental data
- SEDRIS is not designed to describe the database generation process
- SEDRIS defines a binary format (STF)
- SEDRIS provides APIs and Tools

- RIEDP focuses on a subset and application-specific data
- RIEDP is designed to specifically address the database generation process
- RIEDP relies on existing COTS formats
- Use of RIEDP relies on existing COTS Software & Tools

RIEDP and SEDRIS are complementary efforts

- RIEDP uses SEDRIS concepts, capabilities, and standards
  - RIEDP Abstract Data Model → 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 and comprehensive	Specific and comprehensive
3D Models	Supported through the format	Extensive support
Animation	Supported through the format	Extensive support
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, has been published
- RIEDP Product 2, Detailed Feature Description, is under development and expected to be published in 2020, 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 ?

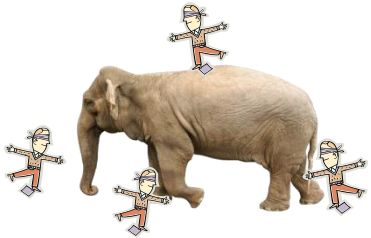
- Backup slides contain additional information on requirements, data generation process, and future trends

Environmental Data Requirements

Modeling and Simulation Requirements

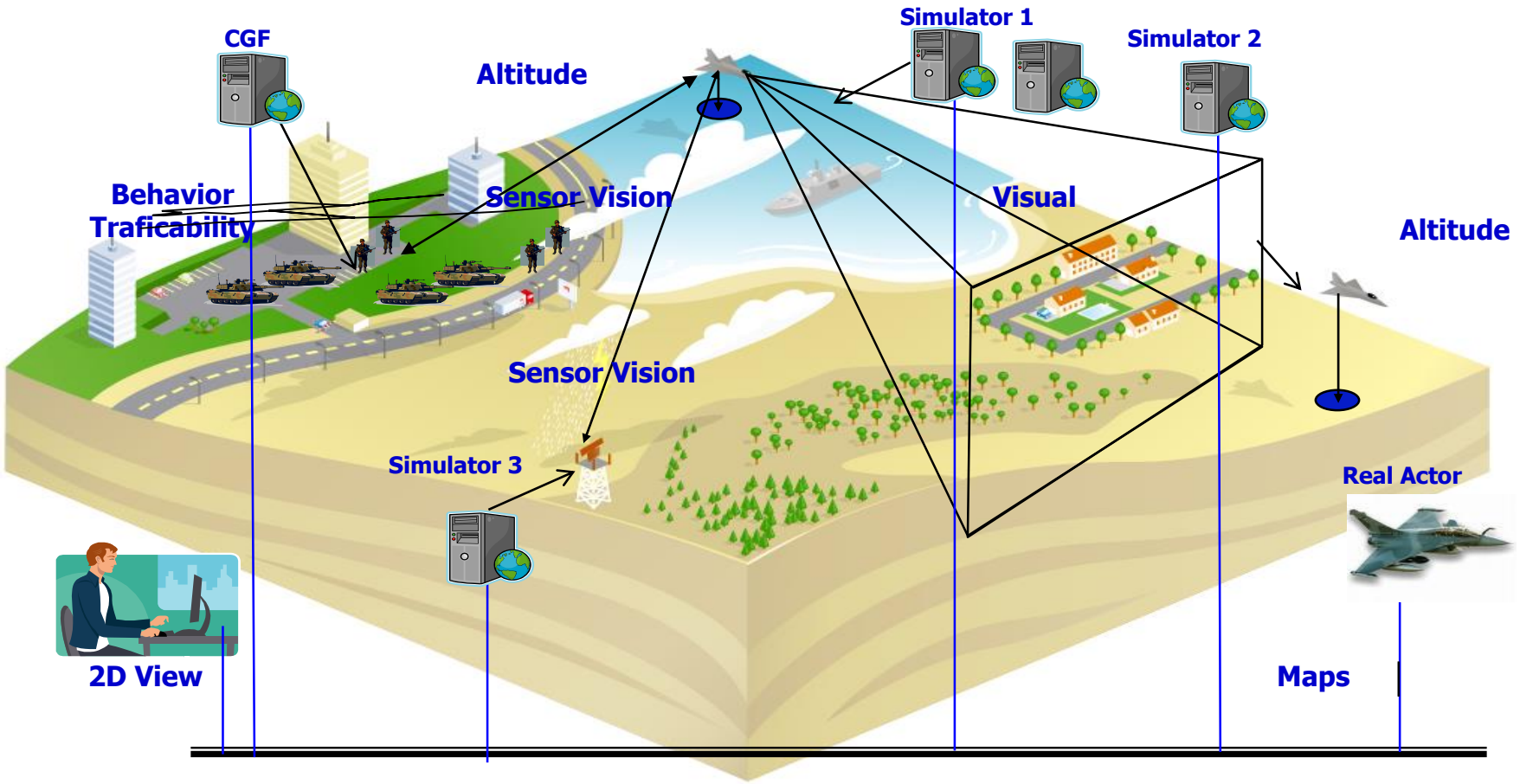
Modeling and Simulation a very heterogeneous world

- 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



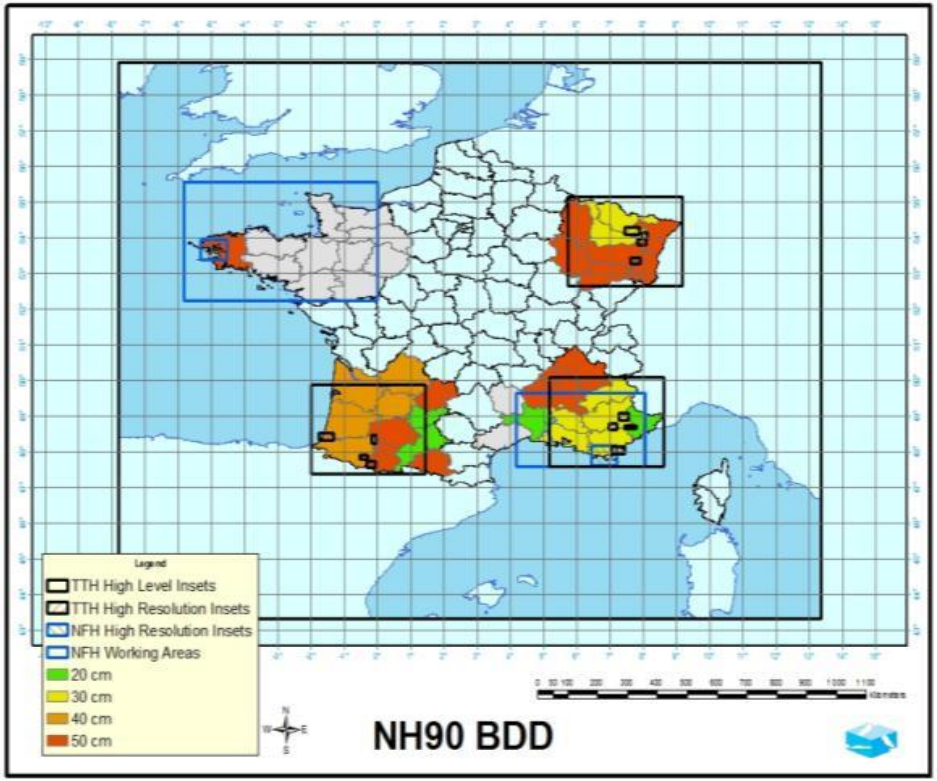
Standardized Representation(s) of the Environment must reflect and support this diversity

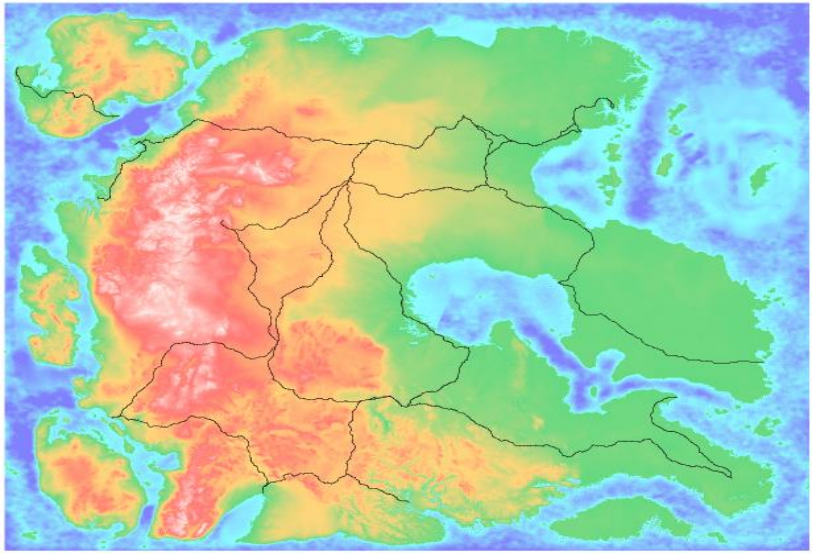
Various Systems and Participants



Environment Requirements for an Aircraft Simulator

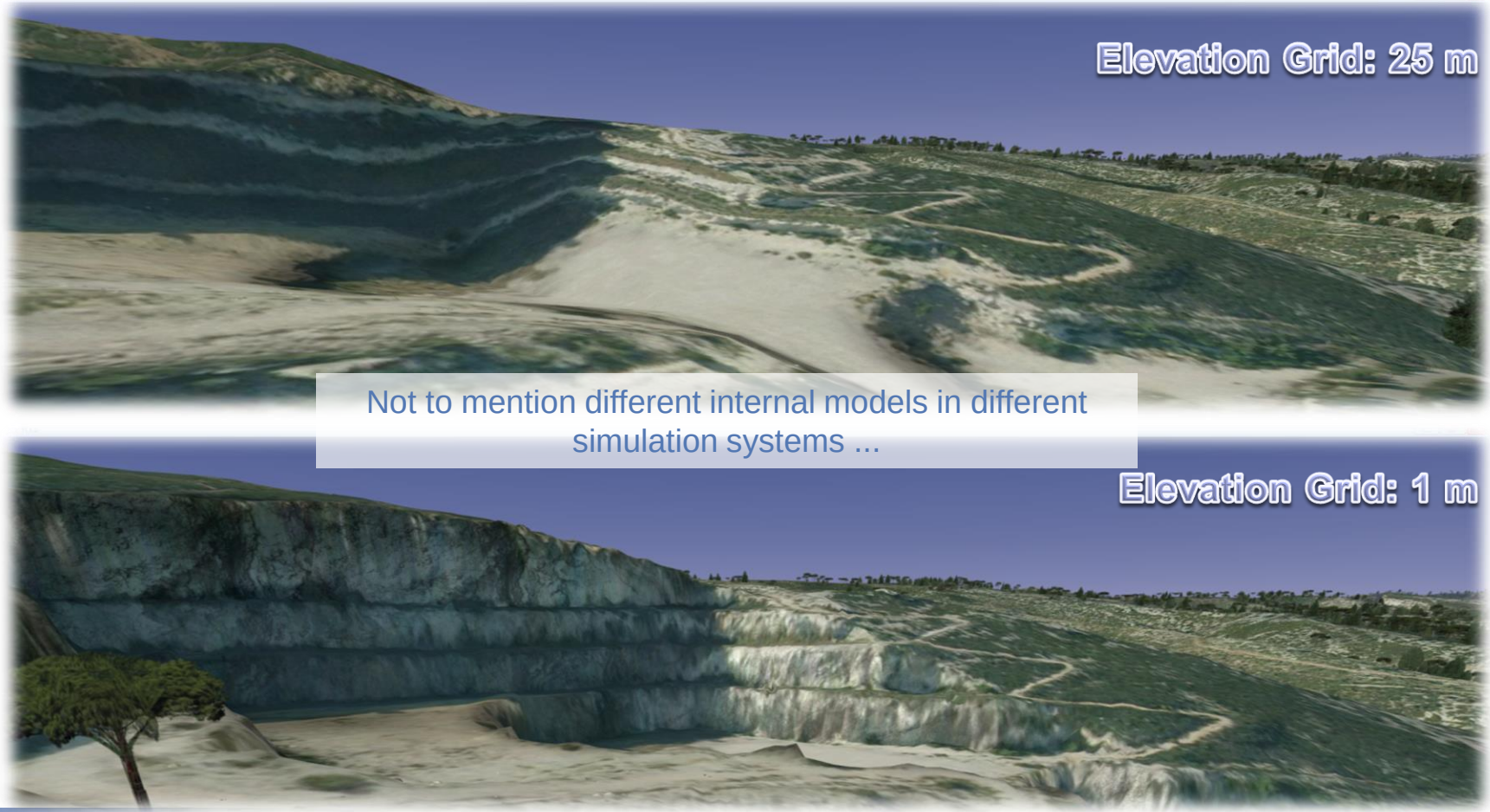
Requirements / Large Areas





NATO “Missionland”
2000x2000 km

Requirements / Fidelity



Requirements / Consistency

Building the Simulator Database

Database Requirements

€ / $

Source Data

Database Creation

Target Databases

- Visual DB
- Radar DB
- IR DB
- Other Sensors
- CGF DB
- Maps
- Others

- Find the data
- Solve IPR

Not Easy

- Clean the data
- Correlate the data
- Create missing data
- Format the data
- Intensify the data
- Specialize the data

Operate !

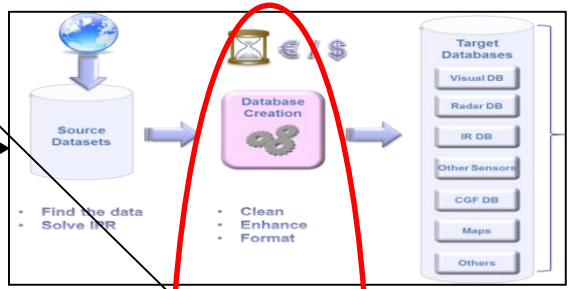
Additional issues for Distributed Simulation
Reuse – Correlation – Interoperability ….

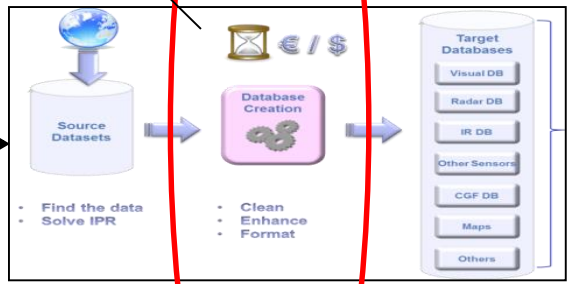
Duplication of efforts

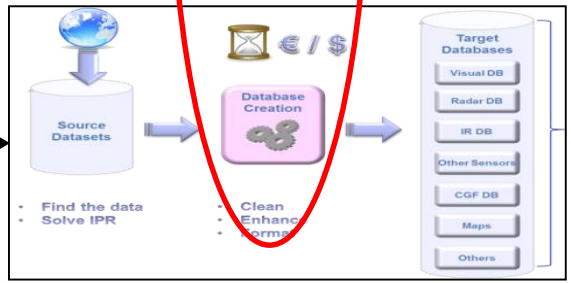
Duplication of Cost

Time to market

Requirements







Sim A - Provider 1

Sim B - Provider 2

Sim C – Provider 3

Consistency ?

Schedule ?

M&S Interoperability is even more critical in the International Arena with Multiple Providers and Multiple M&S Solutions

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 ?

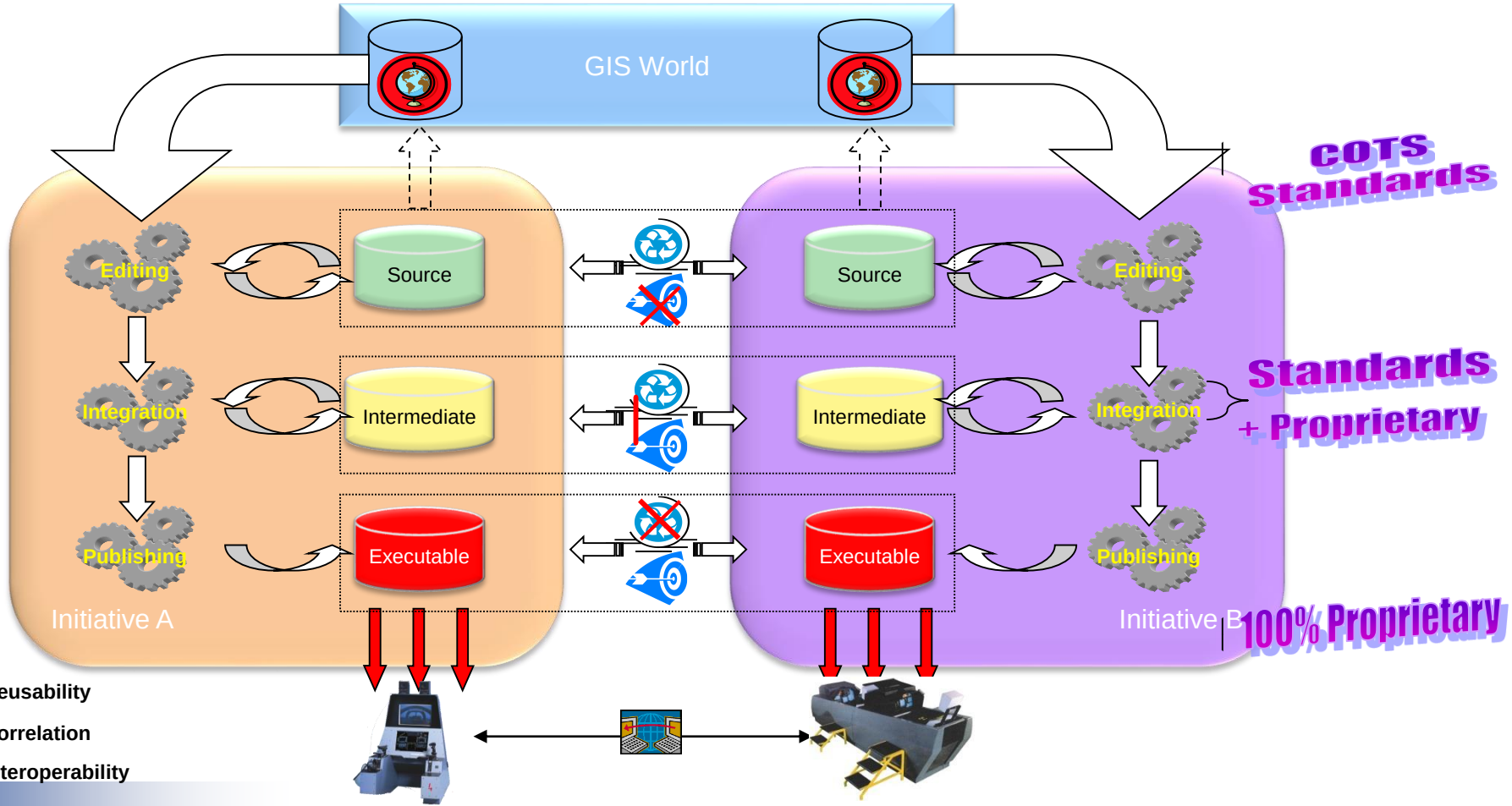
What it is

- 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)

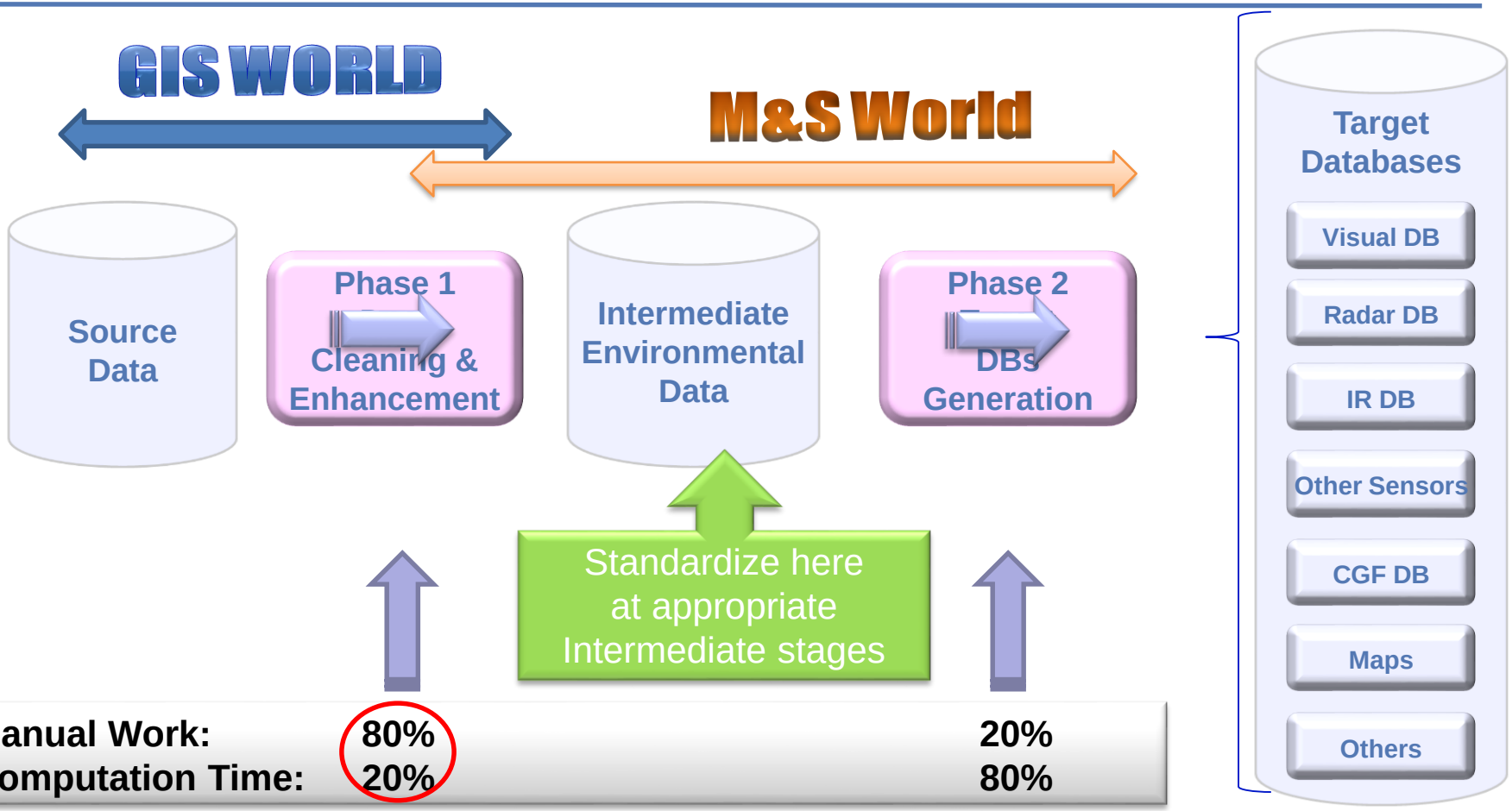
Interoperability relies on Appropriate Standards

Database Creation Process and associated Issues

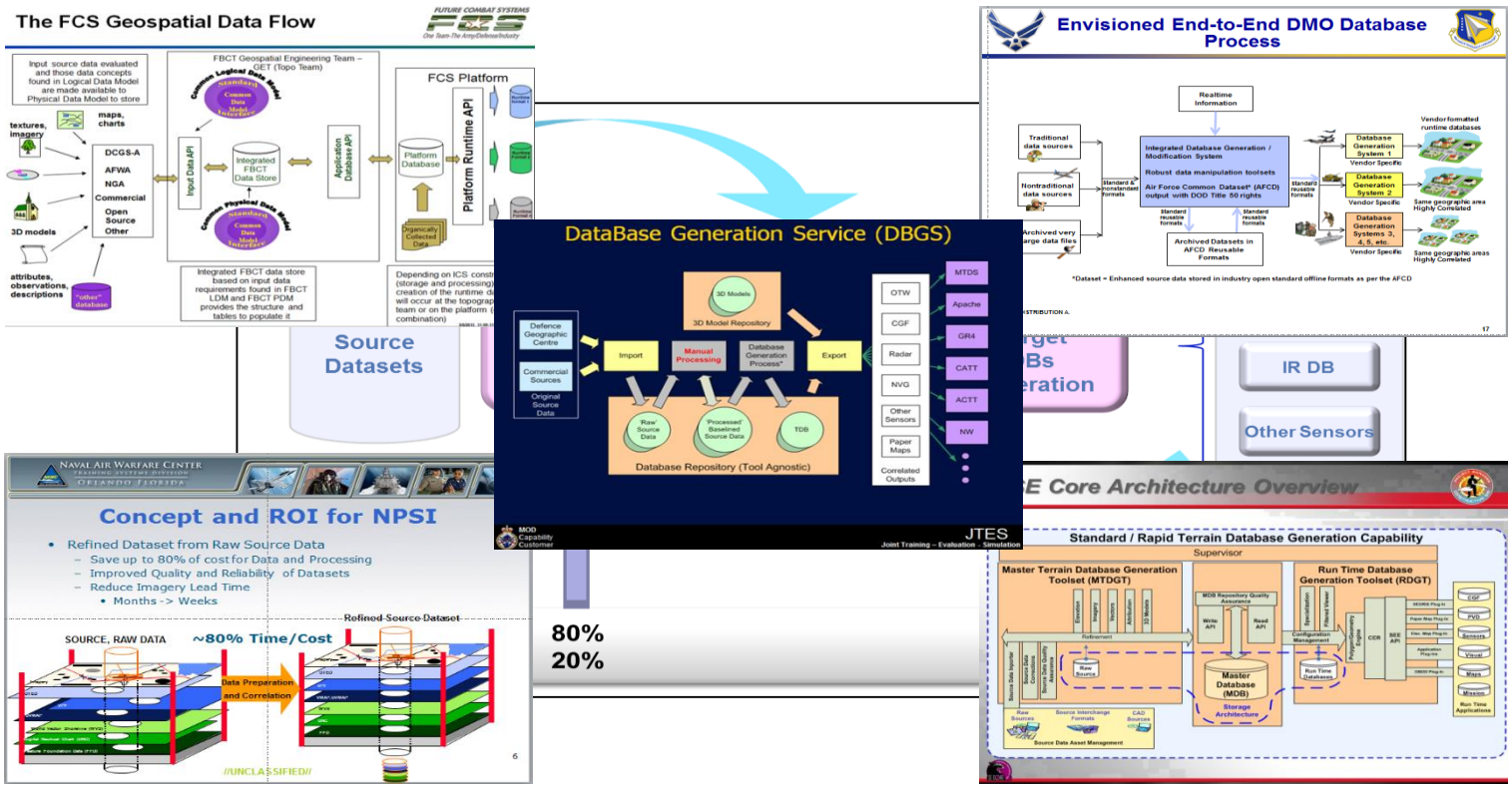
Generation Processes vs Correlation and Reuse



Data Transformation Process – Two main phases



Database Generation – A universal Process



Source Data - Geographic Formats

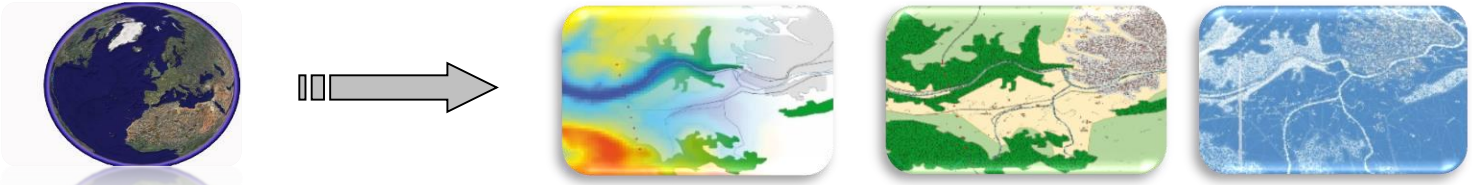
GIS World

- **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, …

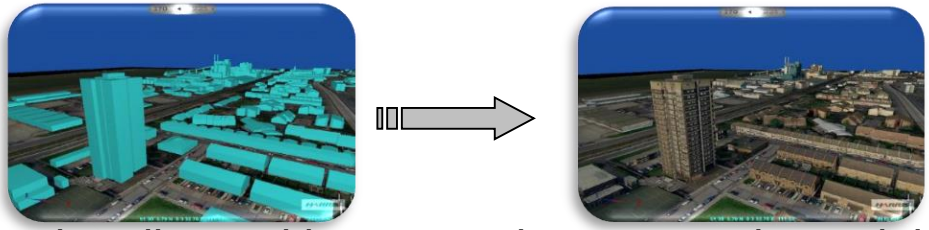
Source Data Imagery Formats

World of Photography

- **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



- 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)

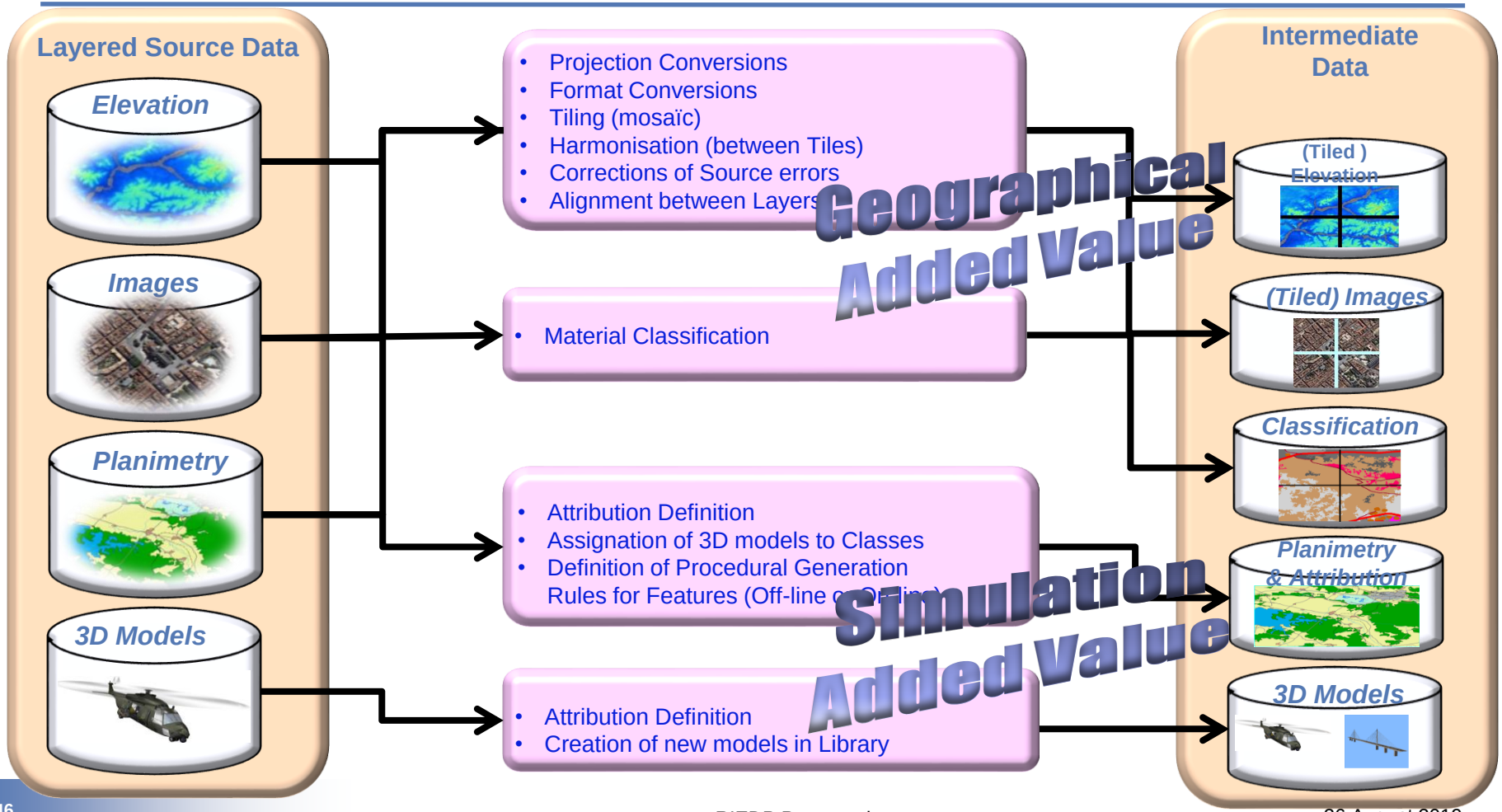
Application to simulation

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

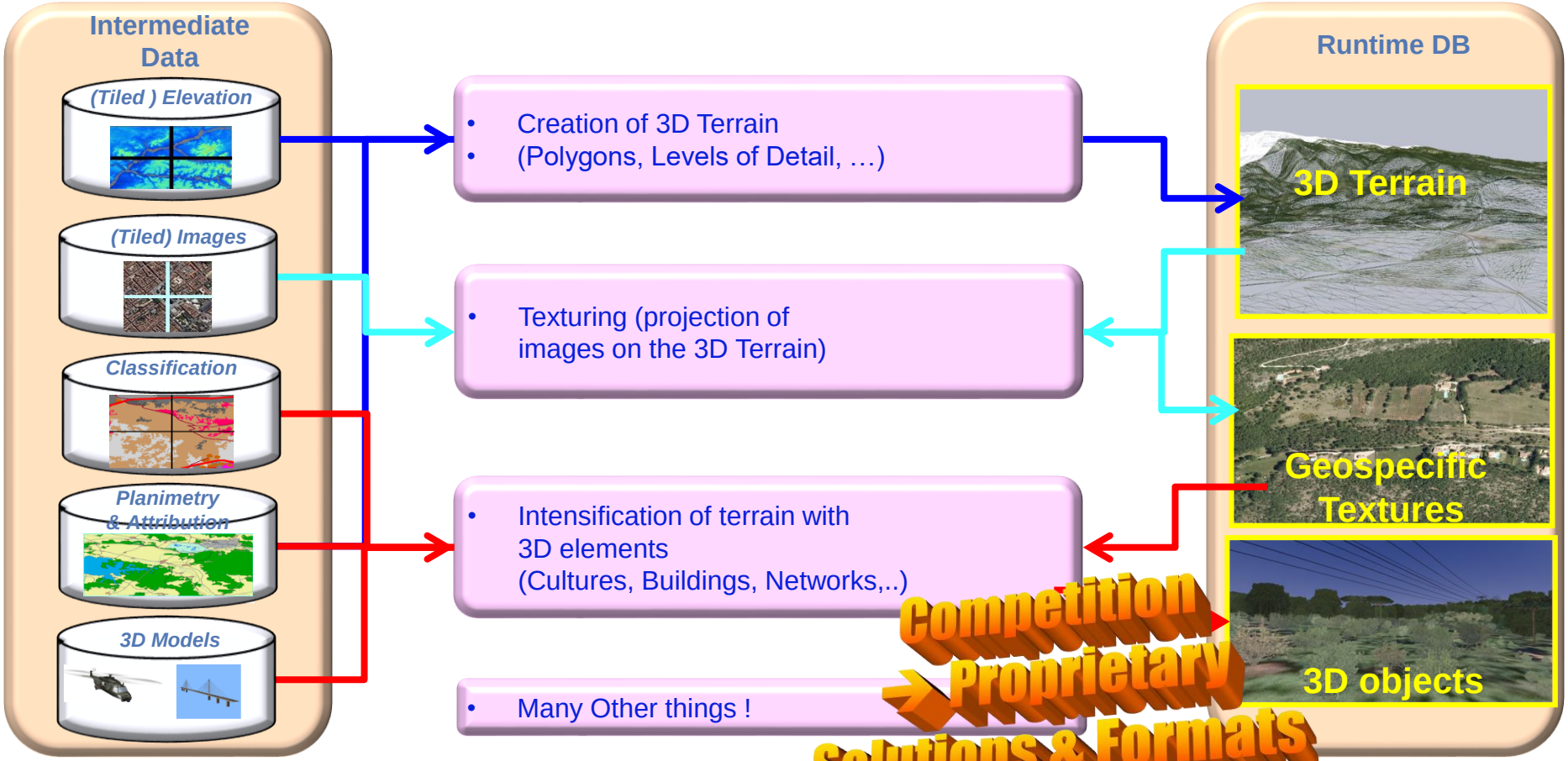


- Dedicated to 3D Objects Modeling for Visual Systems

Phase1 : Generation of the Intermediate Data



Phase 2 : Generation of Target DBs



Future trends

Back to the Future

Major Trends in Geospatial Data

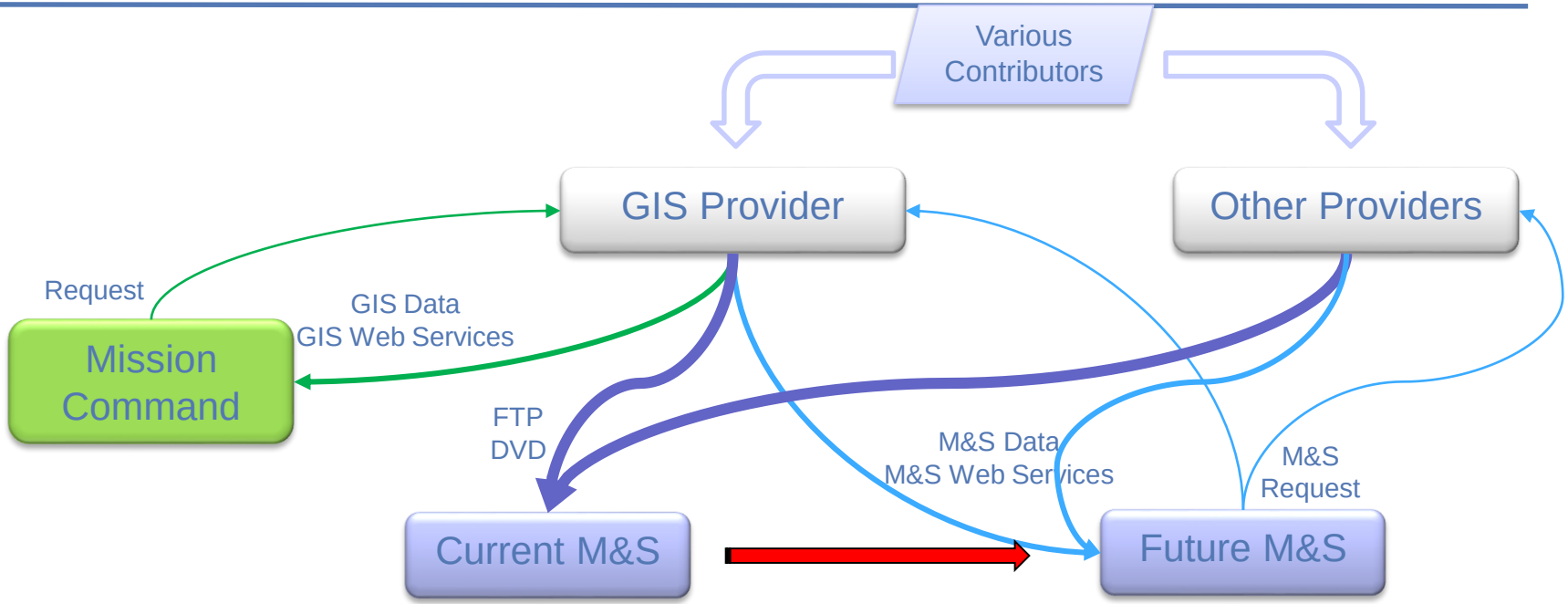
- Data in the Cloud
- Multi Source-Based (Crowd, UAV, …)
- Impact of Regulations: IPR, Security, Quality

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

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

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