Supporting Weapon Systems Assessments with Realistic Synthetic Environment Representations:

Where to Go for Authoritative Data

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M&S in Weapon System Acquisition

"As dramatic advances in the supporting technologies made [Modeling and Simulation] more powerful and less expensive, and as declining resources and changing priorities made it essential to find better ways to develop and field new systems, the use of these tools and improved processes that exploit their contribution has expanded rapidly."

Study on the Effectiveness of M&S in Weapon System Acquisition
Director, Test, Systems Engineering, and Evaluation (1996)

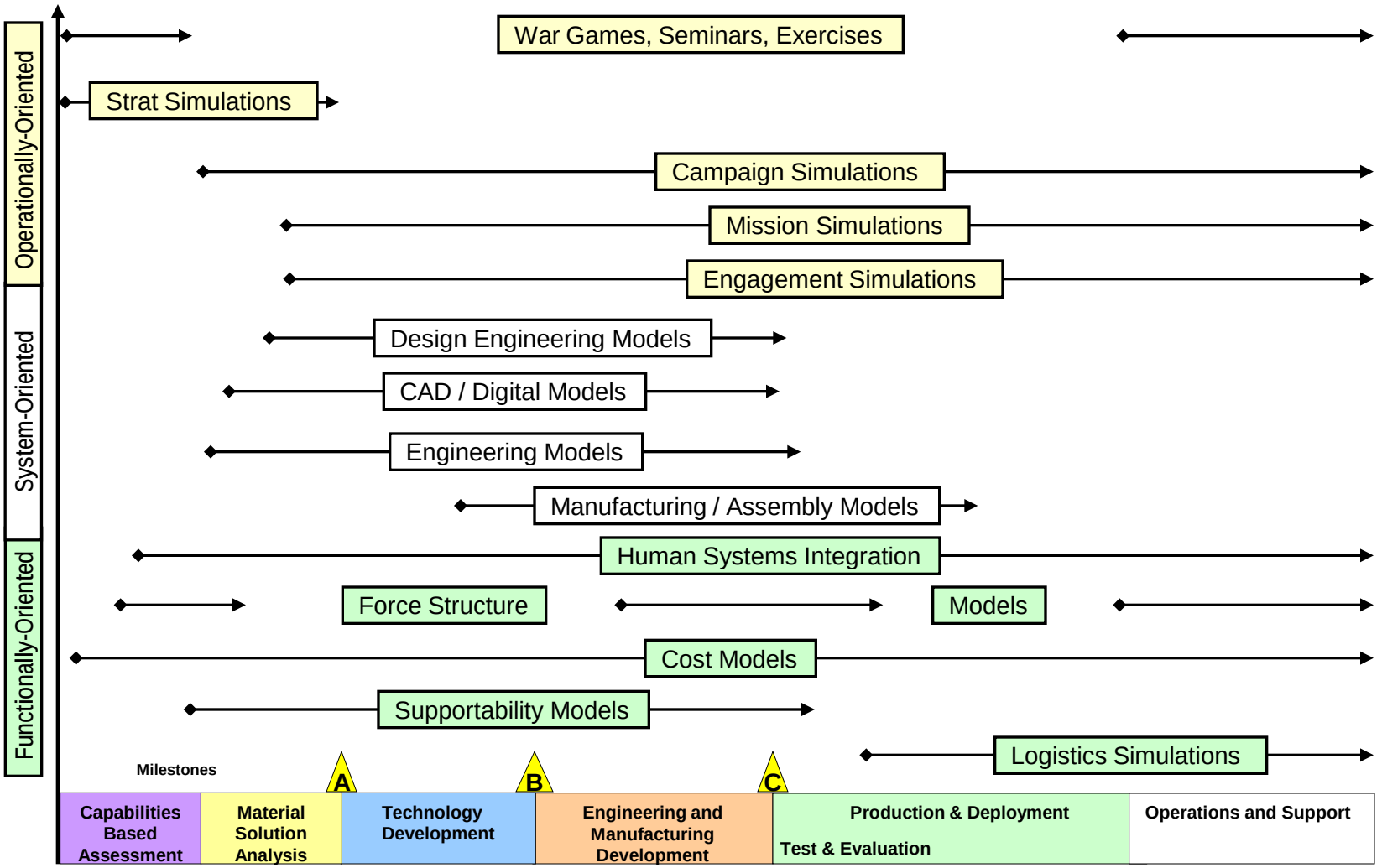
Discussion Topics

- **Modeling and Simulation in Acquisition**
- **DoD Modeling and Simulation Governance**
- **Authoritative Source Data (Producers)**
- **M&S Synthetic Environment (Providers)**
- **Data Trade Space and Risk Mitigation**

Discussion Topic

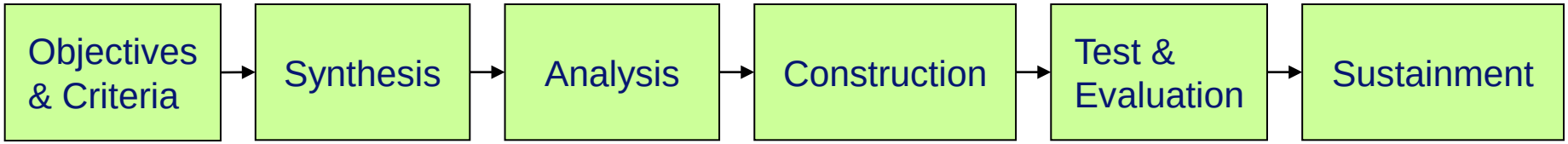
- **Modeling and Simulation in Acquisition**
- Modeling and Simulation Governance
- Authoritative Source Data (Producers)
- M&S Synthetic Environment (Providers)
- Data Trade Space and Risk Mitigation

M&S in Acquisition

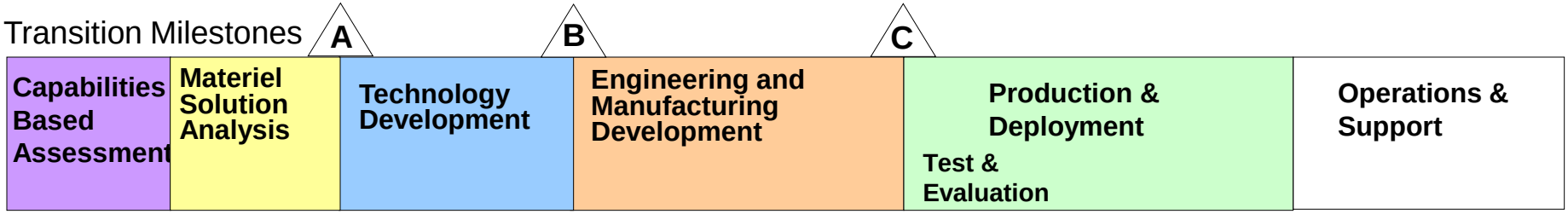


Engineering Design & DoD Acquisition Life Cycle

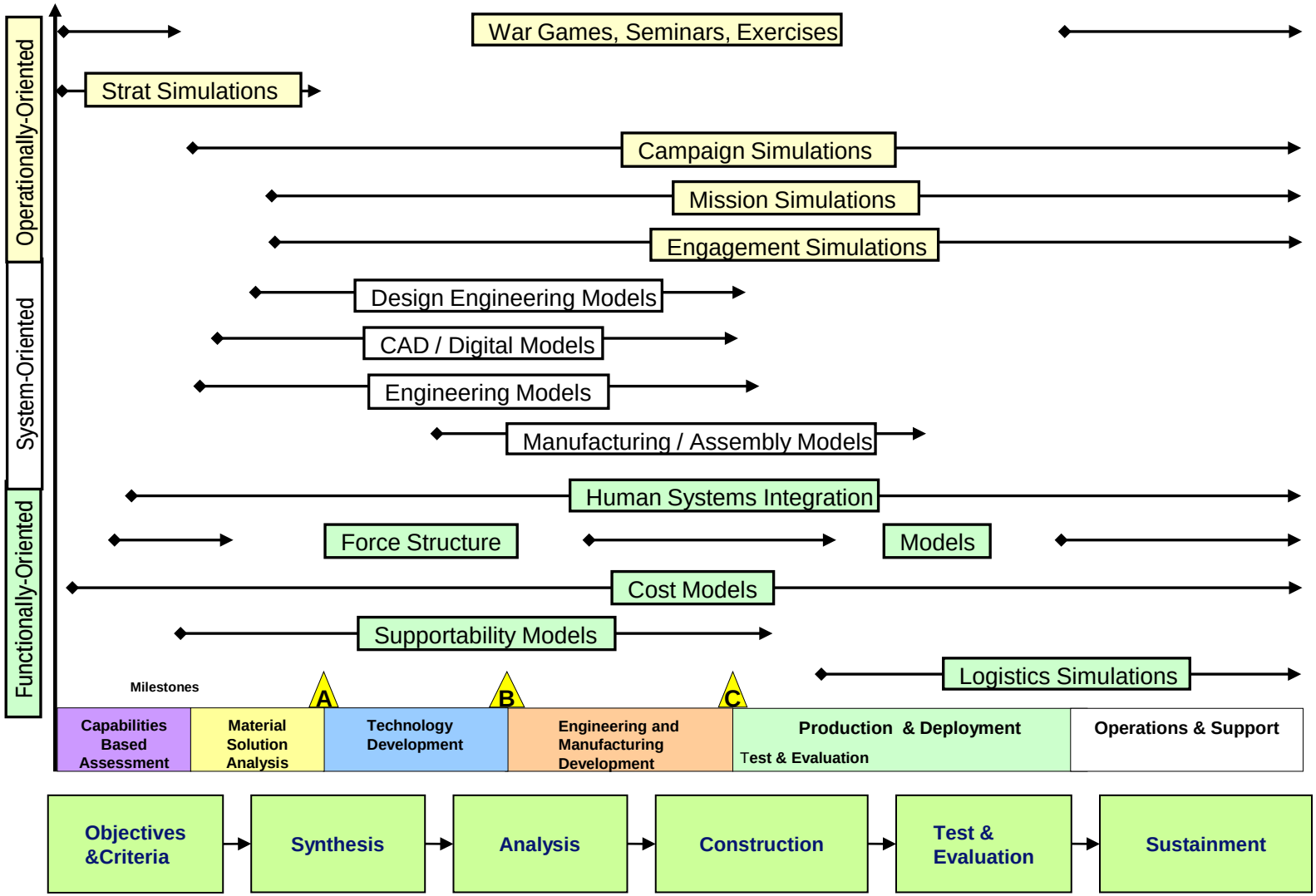
Systems Engineering:



DoD implementation of Systems Engineering:



M&S in Acquisition



Discussion Topics

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- Authoritative Source Data (Producers)
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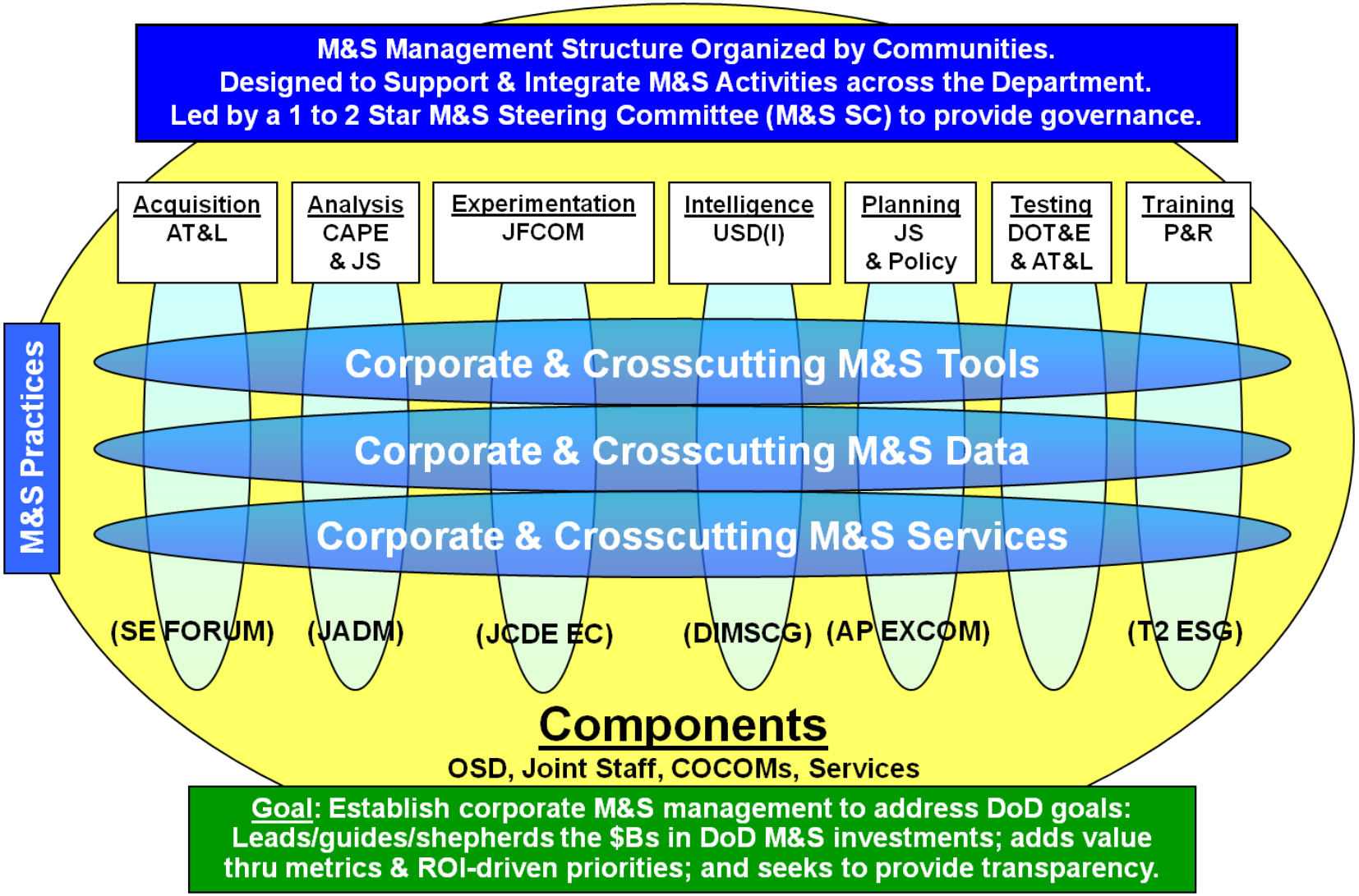
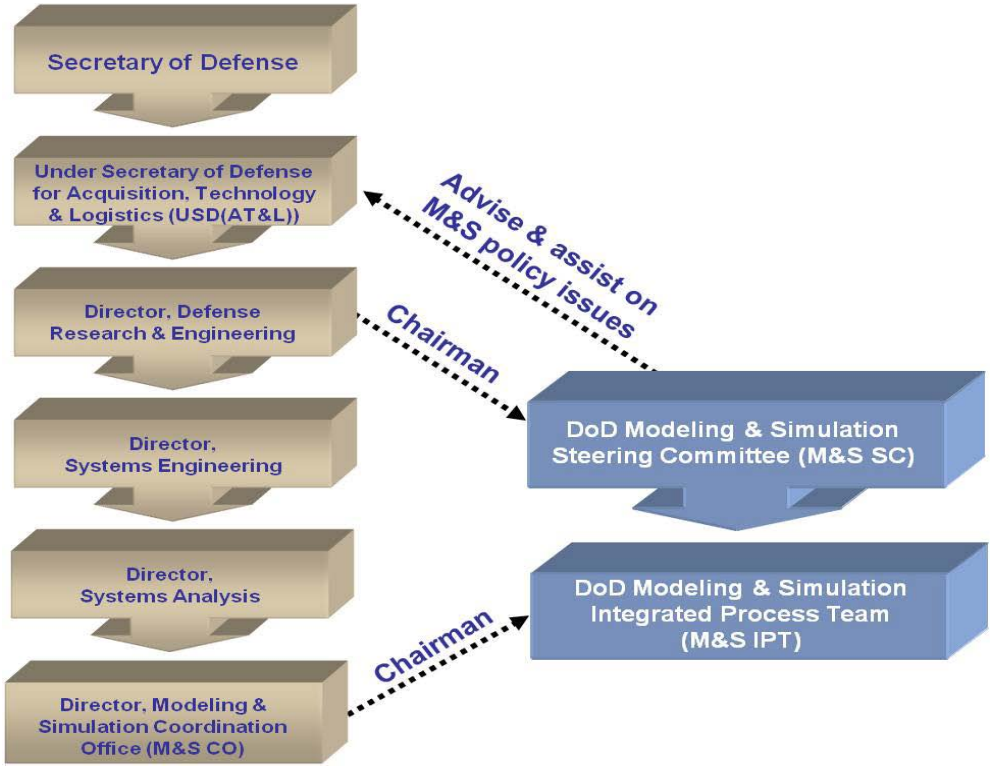
DoD M&S Governance



DoD M&S Governance

HR 487 Recognizes M&S as a National Critical Technology



- M&S Steering Committee (SC)
- M&S Integrated Process Team (IPT)
- M&S Coordination Office (M&S CO)
- M&S Information Analysis Center (MSIAC)

Modeling & Simulation Executive Agents (MSEA)

- **DoD MSEAs for the Natural Environment**
  - **Air & Space Natural Environment: Dept. of the Air Force**
  - **Ocean: Dept. of the Navy**
  - **Terrain: National Geospatial-Intelligence Agency**

- **MISSION: "Enable M&S developers and users to represent the natural environment and its effects rapidly, thoroughly, and consistently in a manner that promotes cost-effectiveness, ready access, interoperability, re-use, and confidence."**

Service M&S Organizations

Army Modeling & Simulation Office
– Arlington, VA

Navy Modeling & Simulation Office
– Washington, DC

Marine Corps Modeling & Simulation Management Office
– Quantico, VA

Air Force Agency for Modeling & Simulation
– Orlando, FL

M&S Community of Interest Data Management Working Group

- Improve M&S data sharing and reuse technical solutions and best practices
- Coordinate, develop, and register M&S discovery and structural metadata
- Develop extensions to existing Data Standards
- Identify, research, and resolve M&S data issues (policy, governance, business model, and technical) with the M&S CO, M&S IPT, and M&S SC
- Enable rapid discovery, access, integration, production, mediation, and sharing of trusted data between M&S and Operational systems
- Coordinate M&S data requirements with DoD data governance organizations
- Implement the DoD Net-Centric Data & Services Strategy

Discussion Topic

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- **Authoritative Source Data (Producers)**
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Authoritative Data Source

- **Definition**

  Authoritative Data Source (ADS)

  A data source whose products have undergone producer data verification, validation and certification activities (1)

- **General Characteristics**
  - Generates data through accredited data generation systems, often managed by a Government Office
  - Executes mission responsibilities to catalog, distribute, and maintain currency of information content
  - Generated in accordance with standards-based content specifications
  - Supported by a persistent user / customer needs assessment process

[1] "Data Abstraction." *Army Data Transformation. Web. 05 Aug. 2010. http://data.army.mil/ADSL_Data_abstraction.html.*

Authoritative Planning Data

- **Planning Community Authoritative Data:**
  - Questionnaire distributed to members of Adaptive Planning Community
  - 57 ADS identified and rated based on importance, use, and value
  - 33 additional data sources/tools used by Planning Community were identified
  - Discovery metadata developed for 26 key data sources (on-going)
  - Examples of authoritative data shown below:

• Global Command and Control System – Joint (GCCS-J)	Joint Force Requirements Generator II (JFRG II)
• Global Decision Support System (GDSS)	Joint Operations Planning and Execution System (JOPES)
• Global Force Management Data Initiative (GFM-DI)	Meteorological and Oceanographic Environmental Databases
• Geospatial Infrastructure Data Environment (GIDE)	Ports and Airfields Consolidated Environment (PACE)
• Global Status of Resources and Training Systems (GSORTS)	Sustainment Generator (SUSGEN)
• Global Transportation Network (GTN)	Air Force World-Wide UTC Summary (AFWUS)

Environmental Representation Requirements Study

Problem:

- No DOD-wide Integrated Understanding of Environmental Data Requirements

Objectives:

- Characterize Environmental Data Requirements across M&S
  - 4 Services and Joint community
  - 7Communities enabled by M&S
- Characterize capabilities of environmental data producer/provider communities
- Identify and Prioritize Gaps in Support Capability
- Allow for More Informed Future Investment Decisions
- Ensure Future Projects are Aligned with Community Needs

Preliminary Findings - Consistent Environmental Issues:

- Environmental Data Discovery
- Data Consistency across Environmental Domains
- Dynamic Terrain
- Correlation of Environmental Data across Simulation Federates
- Time and Money Spent on Converting Source Data for Use in M&S Tools

Authoritative Threat Data

Authoritative Environmental Effects Data

Define Environmental Conditions

High Wind

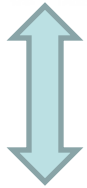
Clouds Develop

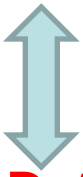
Precipitation Starts

Terrain Gets Wet

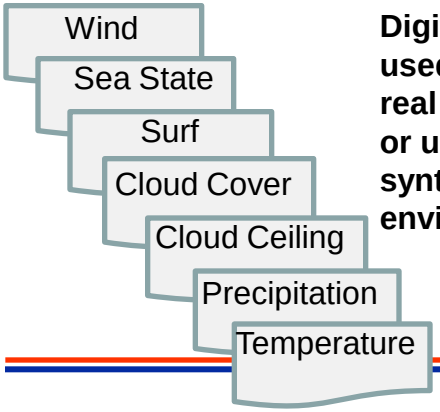
Surf Builds

Ocean Waves Form





Mine Data Resources



Digital databases, used to describe real environment, or used to create synthetic environment

Deliver Required Impacts

Plane Can't See Tank Through Clouds

High Waves Prevent Ship From Refueling. Noise From Waves Reduce SONAR Performance.

High Surf Prevents Landing On Beach

Tank Gets Stuck In Mud

JFCOM ADS Directory

Need	Acronym	System	Acquisition_Authority	AA_PMO	Date_Available
TBM_GBM Early Warning_JAMD COI	AADC	Area Air Defense Commander	Navy	NAVSEA	4Q_FY09
Container ITV Information	ACAMS	Army Container Asset Management Systen	Army	AMC LOGSA	3Q_FY08
Arrival of Forces in Theater	ADAMS	Allied Deployment and Movement System	NATO		
Equipment Movement Information	ADAMS	Allied Deployment and Movement System	NATO		
Movement Schedules	ADAMS	Allied Deployment and Movement System	NATO		
Passenger Movement Information	ADAMS	Allied Deployment and Movement System	NATO		
Unit Movement Information	ADAMS	Allied Deployment and Movement System	NATO		
Blue Track	ADSI	Air Defense System Integrator	Navy	SPAWAR	
Electromagnetic Spectrum Management_Pl	AESOP	Afloat Electromagnetic Spectrum Operatio	Navy		
Army Equipment Locations	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	1Q_FY11
Army Fires Plans	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	4Q_FY09
Army Unit Consumables List	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	1Q_FY11
Army Unit Locations	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	4Q_FY09
Battle Damage Assessment Data	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	1Q_FY11
Fixed Targets	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	
GPS Impacts on Weaponeering	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	
Gray Track	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	
Mobile Targets	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	4Q_FY09
Red Track	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	
USMC Fires Plans	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	4Q_FY09
USMC Unit Locations	AFATDS	Advanced Field Artillery Tactical Data Sys	Army	PM BC	
Track Management_Association	AFCCIS	Air Force Command and Control Informati	Air Force		1Q_FY10
Air Force Unit Equipment List	AFEMS	Air Force Equipment Management System	Air Force	754 ELSG/LRE	2Q_FY13
Gray Track	AMDPCS	Air and Missile Defense Planning and Con	Army	PEO-C3T PM C-R	1Q_FY09

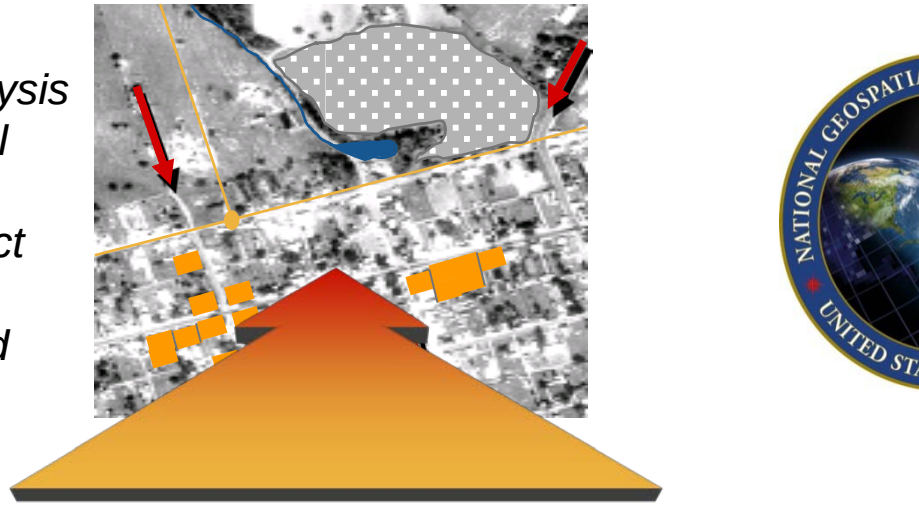
The Joint ADS Directory provides a Systems / Tools view of the Authoritative Data, but does not include mapping to the organization responsible for producing the data.

Authoritative Geospatial Data

National Geospatial-Intelligence Agency (NGA)

GEOINT:

The exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence, and geospatial information."



Imagery | *Imagery Intelligence* | *Geospatial Information*

Discussion Topic

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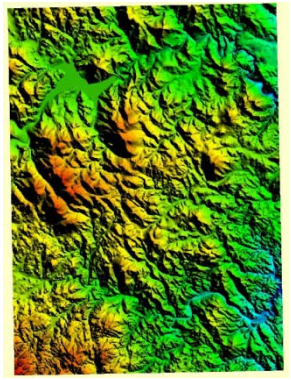
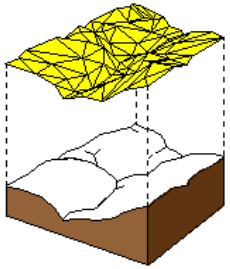
Synthetic Environment Generation

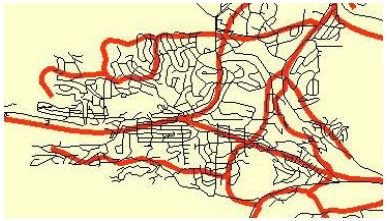


Digital Elevation Model (DEM)

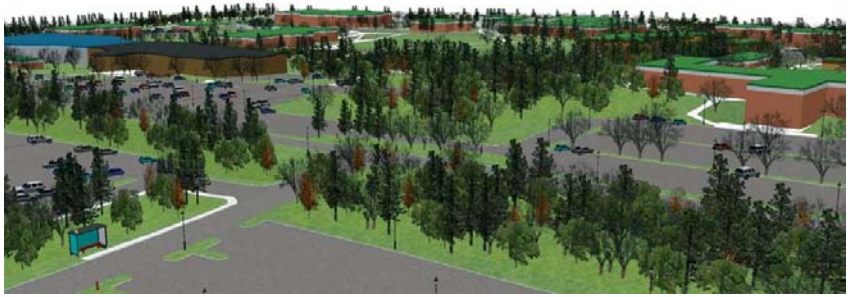


Creation of a Triangular Irregular Network (TIN) from the elevation data.

Application of Satellite Imagery onto the surface of the TIN

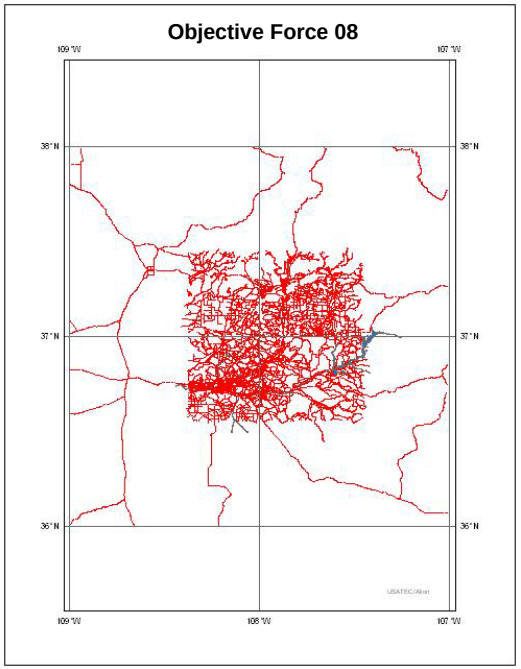


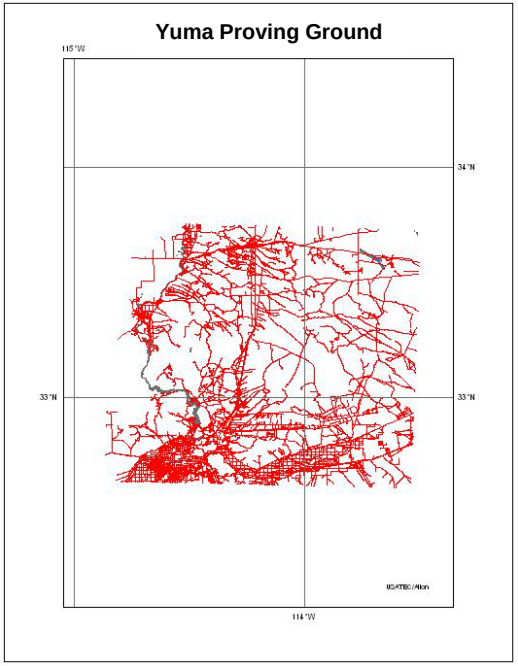
Collection and creation of Geospatial features (i.e. roads and buildings)

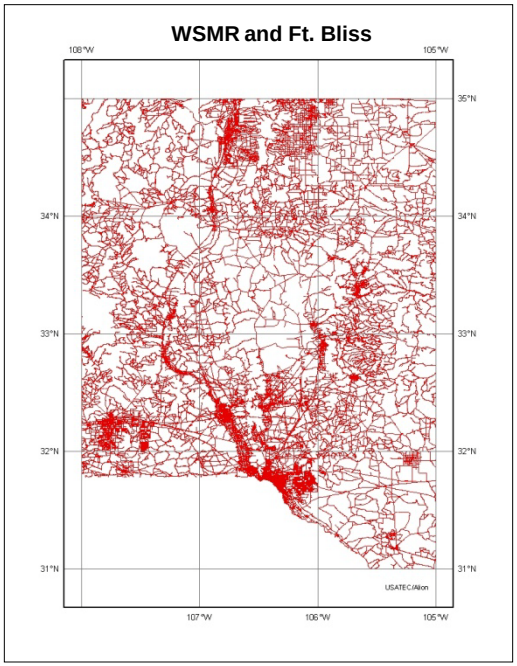


Completed database featuring elevation data, with overlaid imagery, and integrated GIS features compiled together into a synthetic environment.

Synthetic Environments – Cost







Objective Force 08

Customer – TRADOC
Community – Analysis
Size – 4 Geotiles
Content – Geotypical
Time – 1 Month
Cost – $40K

Priority = $
Insurance = $

Developmental Testing

Customer – ATEC
Community – Testing
Size – 1 Geotile
Content – Geospecific
Time – 1 Year
Cost – $280K

Geospecific Insets = $
High-Res Models = $

Test Article Database

Customer – Program of Record
Community – Acquisition
Size – 12 Geotiles (3 x 4 degrees)
Time – 3 Years
Cost – $1 Million

Geospecific Insets = $
High-Res Models = $
IFSAR Overflights = $
Enhanced DEMs = $
Multiple Formats = $

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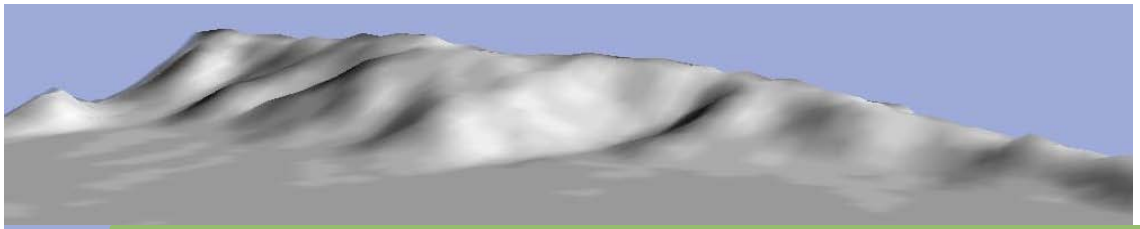
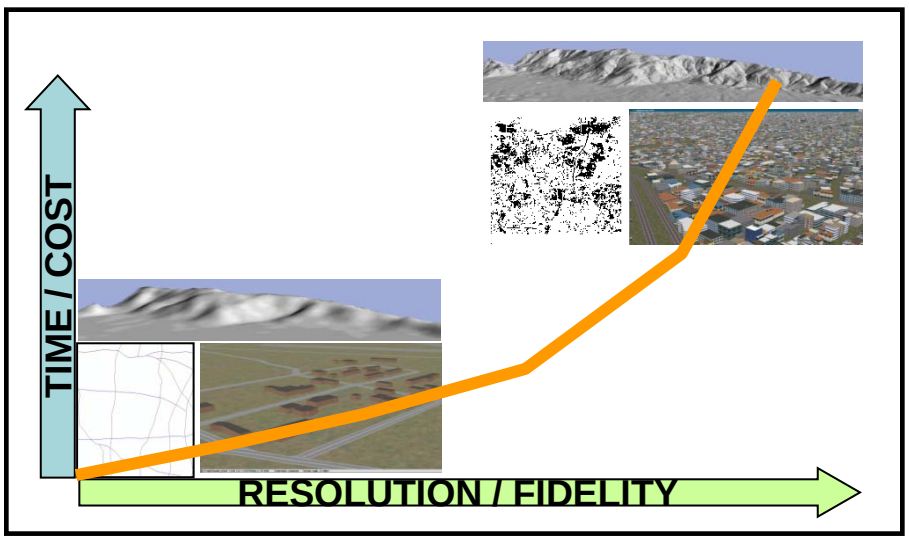
Geospatial Issue – Resolution



DTED1 ~ 90 m



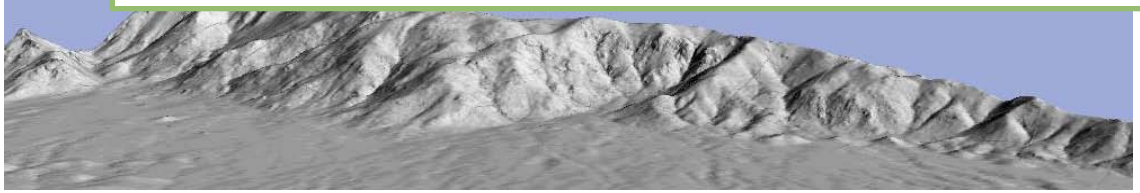
Elevation Data 1º	
Level (m)	Storage (MB)
0 (~900)	0.28
1 (~90)	2.8
2 (~30)	25.5
3 (~10)	230
4 (~3)	2067
5 (~1)	18600

30 m

10 m

3 m

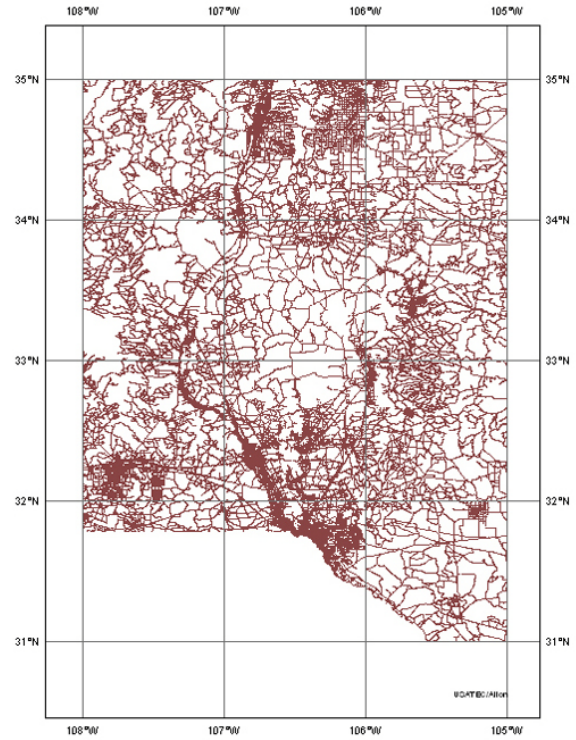
- Resolution vs Time / Cost



DTED5 ~ 1 m

Geospatial Issues – Scale and Availability

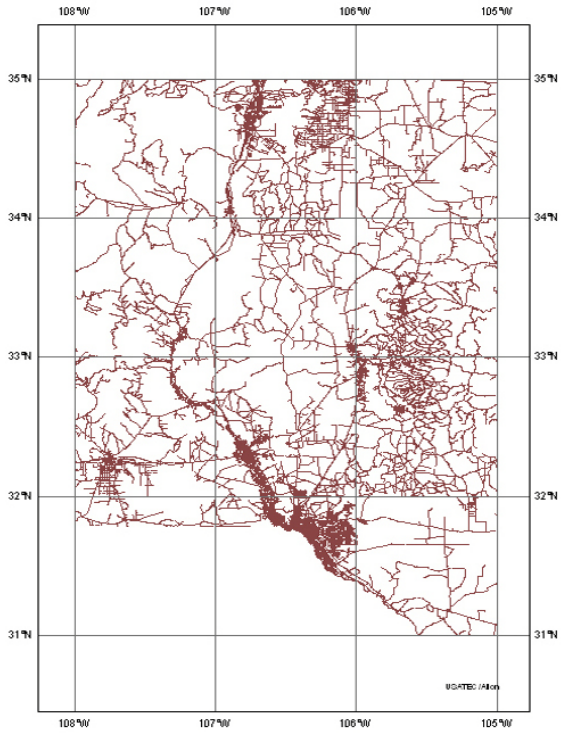
Test Article Database



Feature Type	Occurrences
All line segments	164357

Road Length	Measurement
Linear KM	69846.1

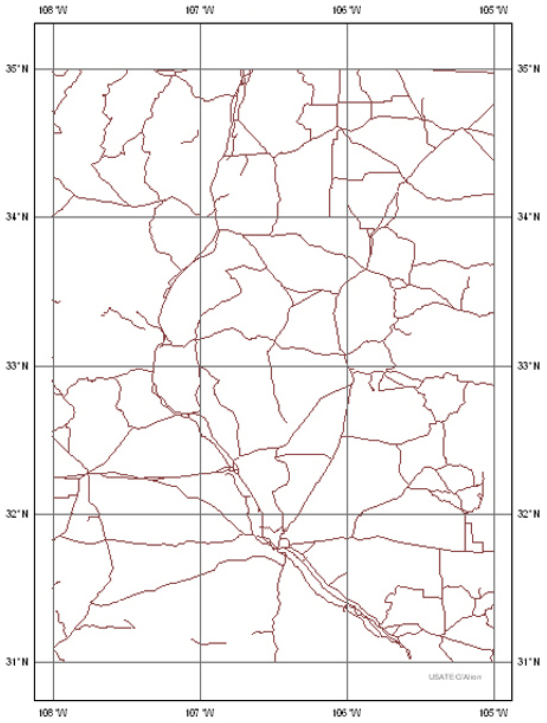
VMAP1



Feature Type	Occurrences
All line segments	59280

Road Length	Measurement
Linear KM	40116.3

VMAP0



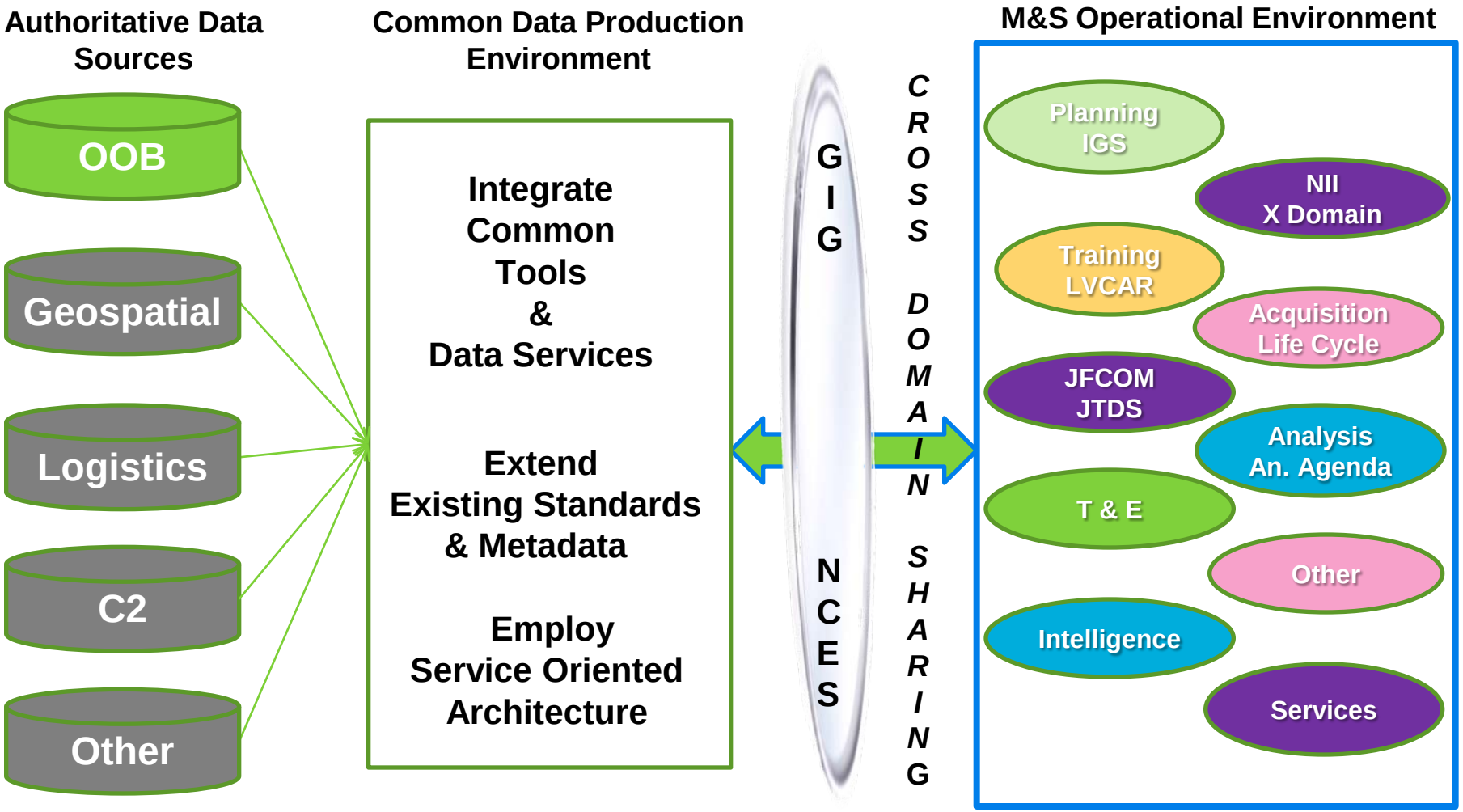
Feature Type	Occurrences
All line segments	632

Road Length	Measurement
Linear KM	7372.6

Geospatial Issue – Data Quality

Rapid Data Generation

DoD M&S SC Governance



Summary

- **M&S is a *National Critical Technology***
- **M&S is *Applied Continuously Throughout the Acquisition Life Cycle***
- **M&S is *Used Extensively in Systems Engineering***
- **Many Organizations Produce Authoritative Data for Use in M&S**
- **Authoritative Data are Typically Not Simulation Ready**
- **Systems Engineering Often Requires Realistic Operational Environment Representations**
- ***Significant Cost-Benefit Trade Offs Exist*** (Geospatial Example):
  - Elevation data and imagery spatial resolution
  - Feature data content and coverage limitations, both spatial and attribute data
  - Model and simulation performance parameters

For Additional Information

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DoD Net-Centric Data Strategy

- **DoD Directive 8320.02 "Data Sharing in a Net-Centric DoD":**
  - Establishes policies and responsibilities to implement data sharing, in accordance with "DoD Net-Centric Data Strategy" (DoD CIO, May 2003)
- **Key elements of policy:**
  - Data shall be made visible, accessible, and understandable to any potential user in the DoD to support mission objectives
  - Data assets shall be made visible by creating & associating discovery metadata for each asset
  - All metadata shall be discoverable, searchable, and retrievable using DoD-wide capabilities
  - Data assets shall be made accessible by making data available in shared spaces
  - Data assets shall be made understandable by publishing associated semantic and structural metadata in a federated DoD metadata registry
  - To enable trust, data assets shall have associated IA and security metadata, and an authoritative source for the data shall be identified when appropriate
  - Semantic and structural agreements for data sharing shall be promoted through communities (e.g., communities of interest (COIs)) consisting of data users (producers and consumers) and system developers
  - Data interoperability shall be supported by making data assets understandable and by enabling business and mission processes to be reused where possible
  - Data sharing concepts and practices shall be incorporated into education and awareness training and appropriate DoD processes