OSD Data-to-Decisions Strategic Initiative

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Data-to-Decision Systems

Tactical Operations

- Low Latency
- Narrow Field-of-View
- Limited Fusion
- Automatic Target Recognition
- Data: ~MB-GB

Operations Intelligence

- Medium Latency
- Wide Field-of-View
- Hard Sensor Fusion
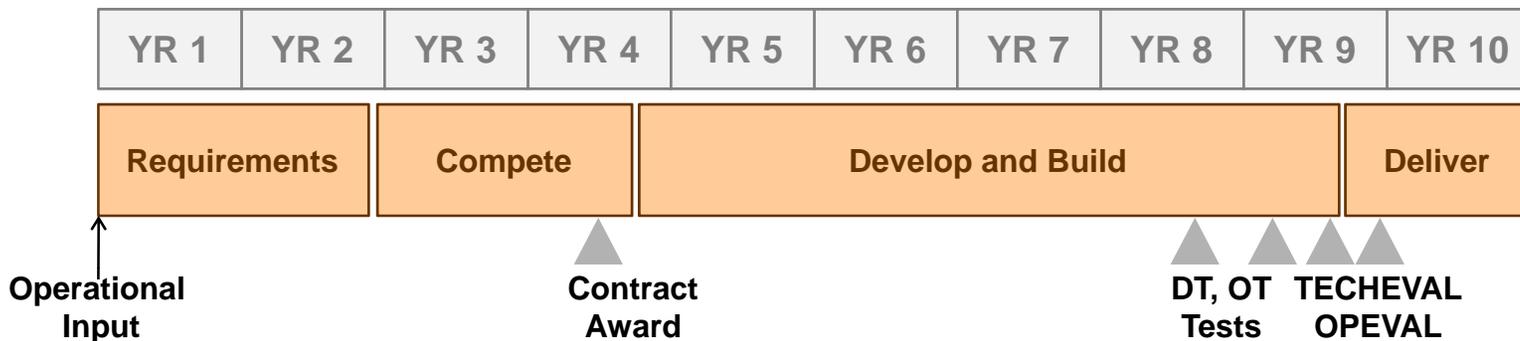- Assisted Target Recognition
- Data: ~GB-TB

Strategic Intelligence

- Long Latency
- Synoptic Field-of-View
- Hard/Soft Sensor Fusion
- Multiple Hypotheses
- Data: ~PB-EB

Current System Development Cycle

YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8	YR 9	YR 10

Requirements	Compete	Develop and Build	Deliver

Operational Input

Contract Award

DT, OT Tests

TECHEVAL OPEVAL

- **There is a continuous, compelling need for new Decision Support Systems**

- **Current development cycle is protracted, hard-wired and does not keep pace with changing countermeasures and threats**

- **Development approach does not integrate advances across the defense enterprise and excludes innovative small companies**

Historical Precedence for Rapid Development using Modularization

1950-1960	**1960-1970**	**2000+**
Vertical Integration "Brick and Mortar"	**Modular Integration**	**Horizontal Integration "Lego Model"**

• Hard-wired, not adaptable

• Limited to large contractors

• Protracted development

• Modular, closed standards

• Includes subcontractors

• Simplified development

• Modular, open standards

• Includes all innovators

• Rapid development

Enable Horizontal Integration for new Decision Support Systems by developing extensible module libraries that can be rapidly configured to solve new Decision Support problems
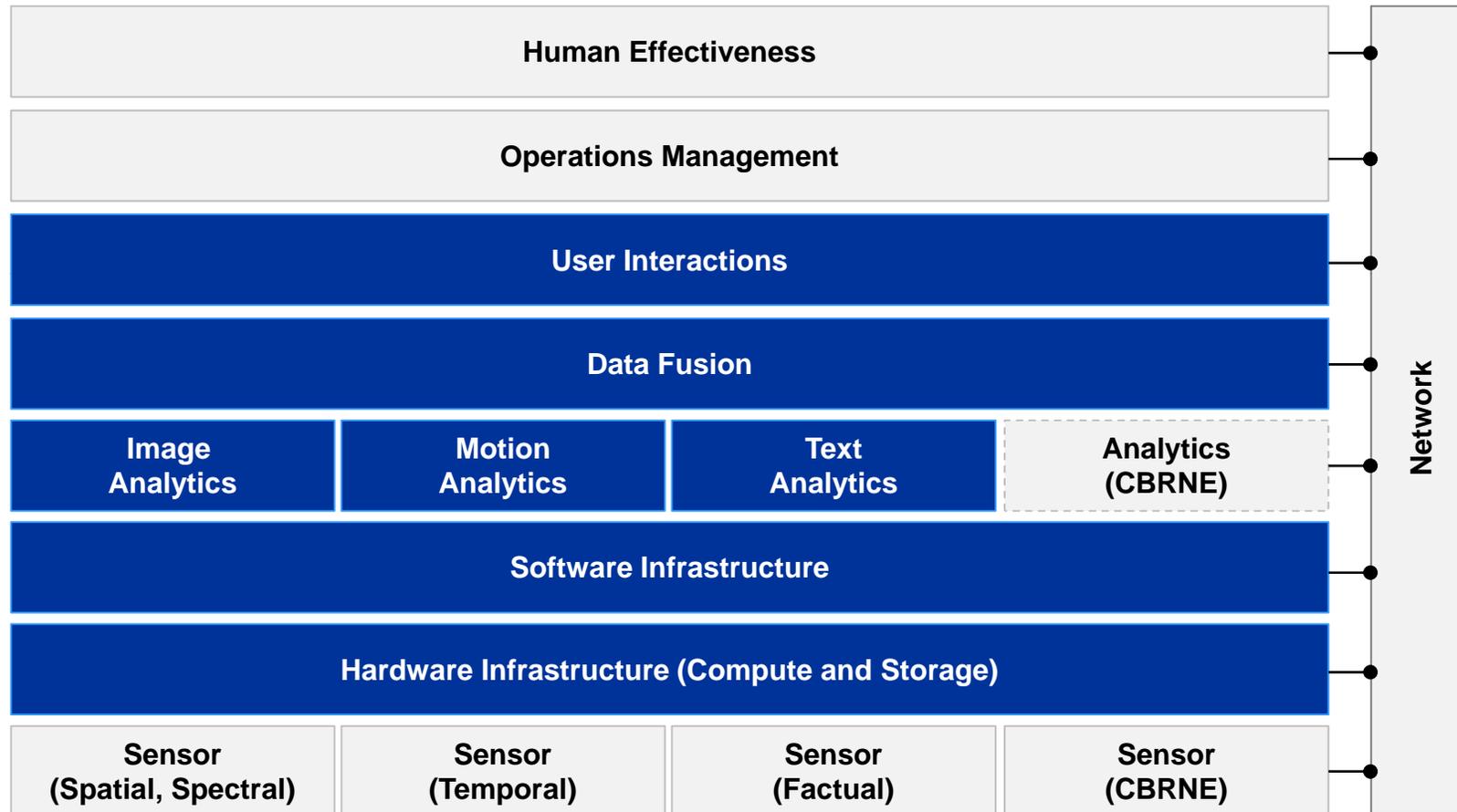
Outline

- Introduction

- **Broad D2D Goals**

- BAA Details

- Summary

Architectural Layers

Human Effectiveness

| Operations Management |

| User Interactions |

| Data Fusion |

| Image Analytics | Motion Analytics | Text Analytics | Analytics (CBRNE) |

| Software Infrastructure |

| Hardware Infrastructure (Compute and Storage) |

| Sensor (Spatial, Spectral) | Sensor (Temporal) | Sensor (Factual) | Sensor (CBRNE) |

Network

■ **Data-to-Decisions**   □ **Adjunct Technology**

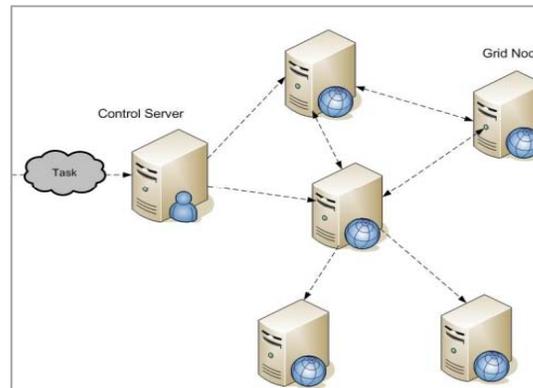# Hardware Infrastructure

• Embedded System

- On-board storage
- Tightly coupled data and algorithms
- Low-latency, low-bandwidth operations

• Grid Cluster

- Centralized storage
- Data moved to compute nodes
- Tightly coupled algorithms
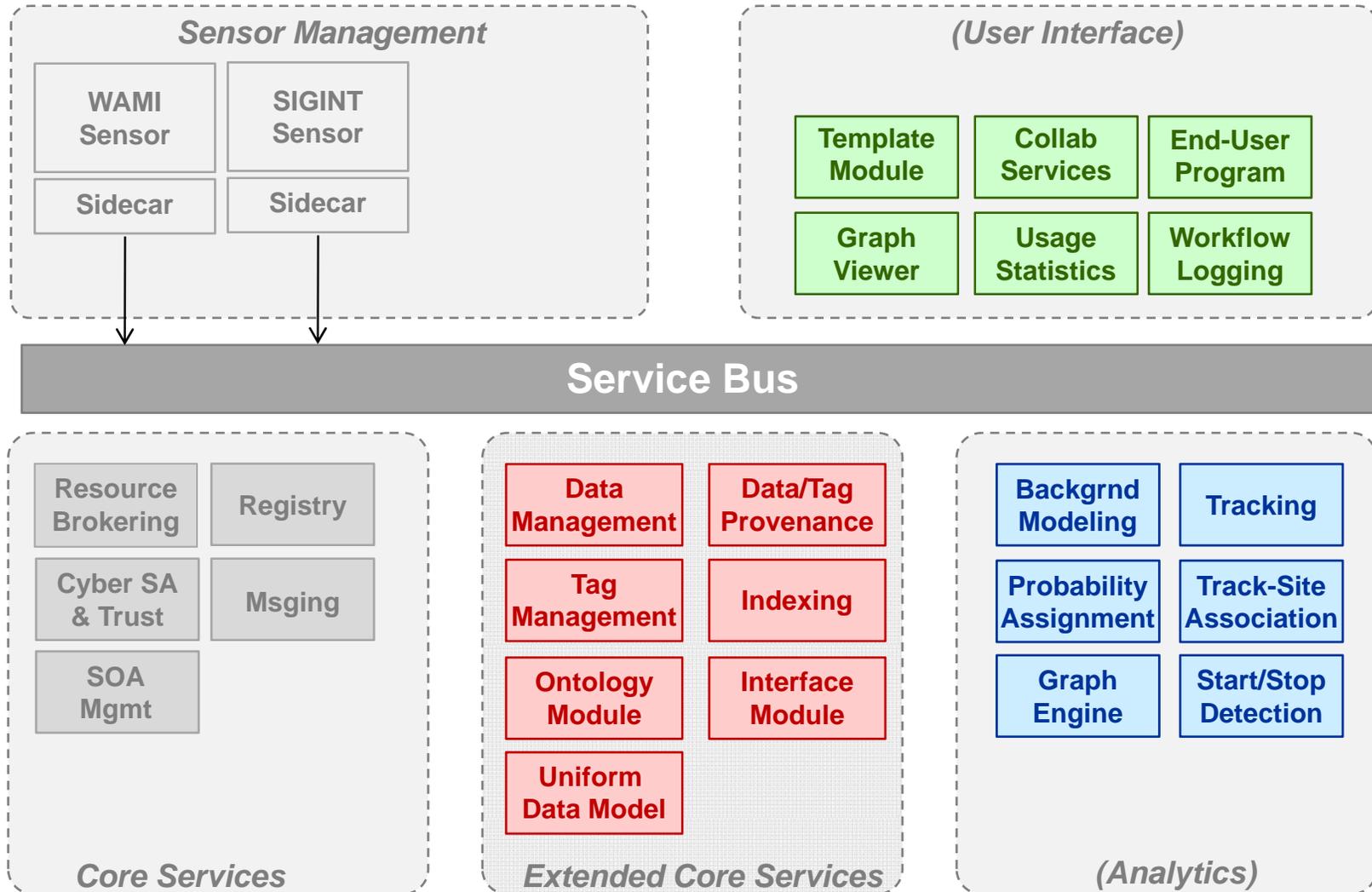- Parallel file system limits large data use

• Cloud Computing

- Distributed storage
- Applications moved to compute nodes
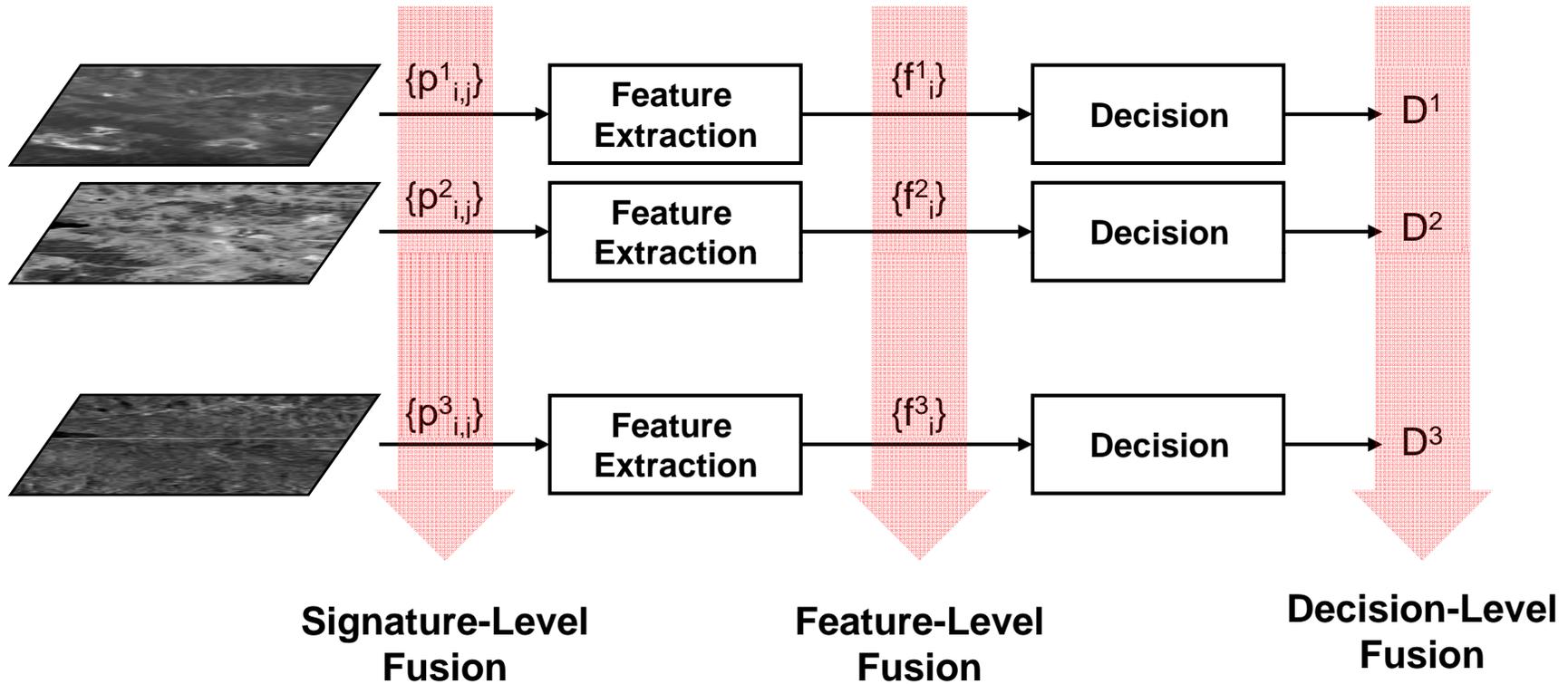- Order-independence through map/reduce

Software Infrastructure

Sensor Management

WAMI Sensor	SIGINT Sensor
Sidecar	Sidecar

(User Interface)

Template Module	Collab Services	End-User Program
Graph Viewer	Usage Statistics	Workflow Logging

Service Bus

Core Services

Resource Brokering	Registry
Cyber SA & Trust	Msging
SOA Mgmt	

Extended Core Services

Data Management	Data/Tag Provenance
Tag Management	Indexing
Ontology Module	Interface Module
Uniform Data Model	

(Analytics)

Backgrnd Modeling	Tracking
Probability Assignment	Track-Site Association
Graph Engine	Start/Stop Detection

Analytic Infrastructure

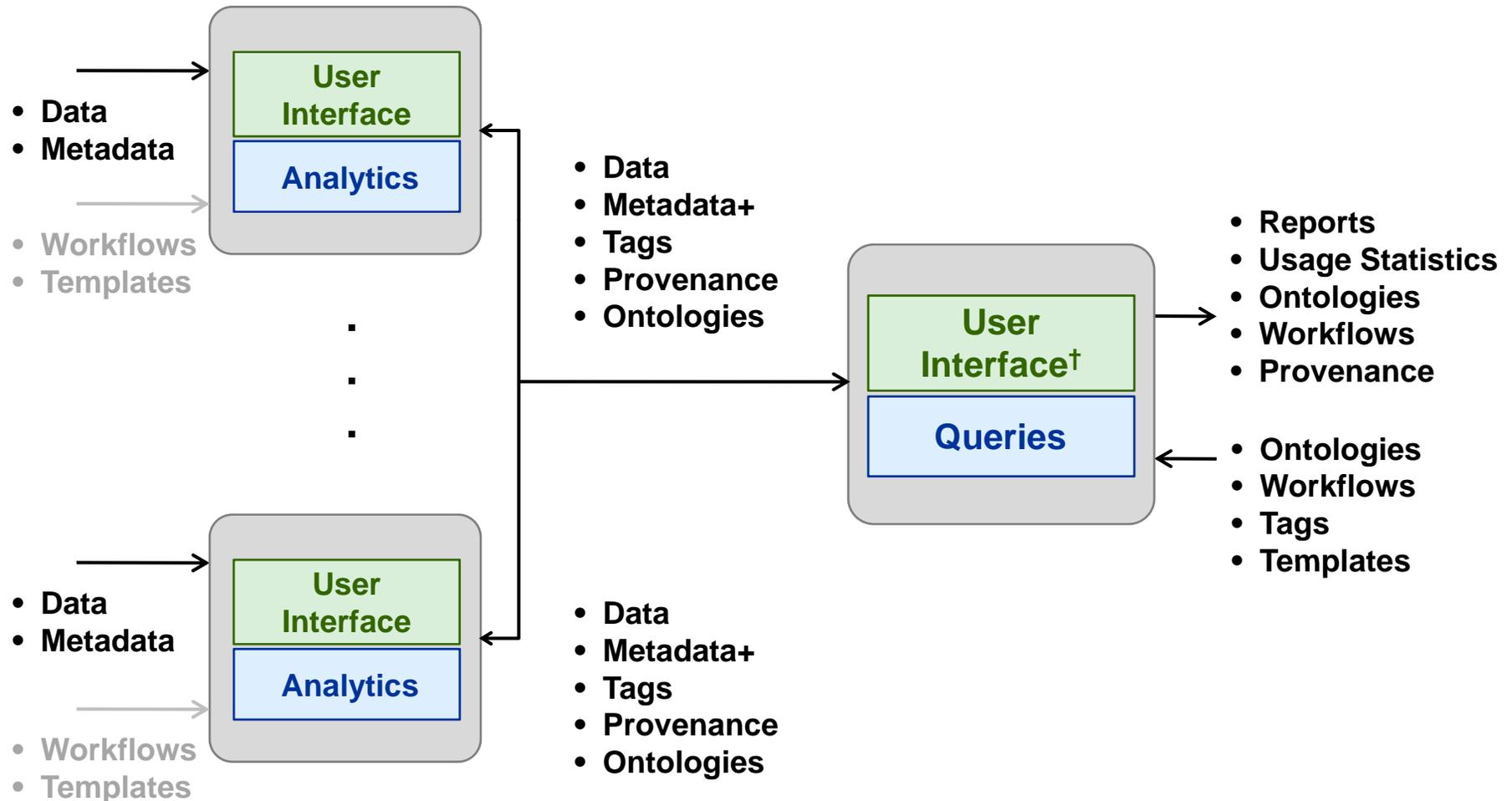| Challenge	Example Sensors	Example Analytics
• Spatial analytics	• SIGINT • Range profiles (HRR) • Imagery (EO,IR, SAR) • Lidar	• Reconstruction • Segmentation • Classification
• Spectral analytics	• Hyperspectral • Multi-spectral	• Atmospheric distortions • Spectral mixing
• Temporal analytics	• GMTI • Wide Area Motion Imagery • Acoustic UGS • SIGINT	• Robust tracking • Activity recognition • Patterns of life • Motion dynamics
• Factual analytics	• Text • Websites • News	• OCR • Speech • Machine translation • Language understanding

Data Fusion

$\{p^1_{i,j}\}$ → **Feature Extraction** → $\{f^1_i\}$ → **Decision** → D^1

$\{p^2_{i,j}\}$ → **Feature Extraction** → $\{f^2_i\}$ → **Decision** → D^2

$\{p^3_{i,i}\}$ → **Feature Extraction** → $\{f^3_i\}$ → **Decision** → D^3

Signature-Level Fusion

Feature-Level Fusion

Decision-Level Fusion

User Interface Layer

- **Analysts (Single Source)**

- **Aggregators (All-Source)**

User Interface

Analytics

- **Data**
- **Metadata**

- Workflows
- Templates

- **Data**
- **Metadata+**
- **Tags**
- **Provenance**
- **Ontologies**

User Interface

Analytics

- **Data**
- **Metadata**

- Workflows
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- **Data**
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- **Tags**
- **Provenance**
- **Ontologies**

User Interface†

Queries

- **Reports**
- **Usage Statistics**
- **Ontologies**
- **Workflows**
- **Provenance**

- **Ontologies**
- **Workflows**
- **Tags**
- **Templates**

†End User Programmable

D2D Technology Assessment

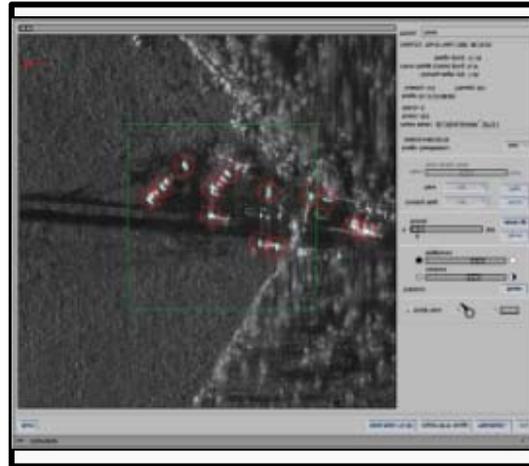- **Moderately Mature**
- **Driven by IT Industry**

- **Immature**
- **Driven by Defense**

- **Moderately Mature**
- **Driven by IT Industry**

Data Management Layer	Analytics Layer	User Interface Layer

- **Current assessment is that unstructured data analytics is the most challenging and critical component of D2D**

- **Strategy first focuses resources on analytics with increasing focus on data management and user interfaces later**

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Implementation Plan

- **Pick series of high-priority challenge problems that require multi-sensor data**

- **Create a consortium focused on each challenge problem, where success is defined at the consortium level, not at the individual contractor level**

- **Emphasize data collections with unclassified sources that can be widely distributed, but test on operational data**

- **Build an open architecture, government-owned testbed, running a Service-Oriented Architecture on distributed nodes**
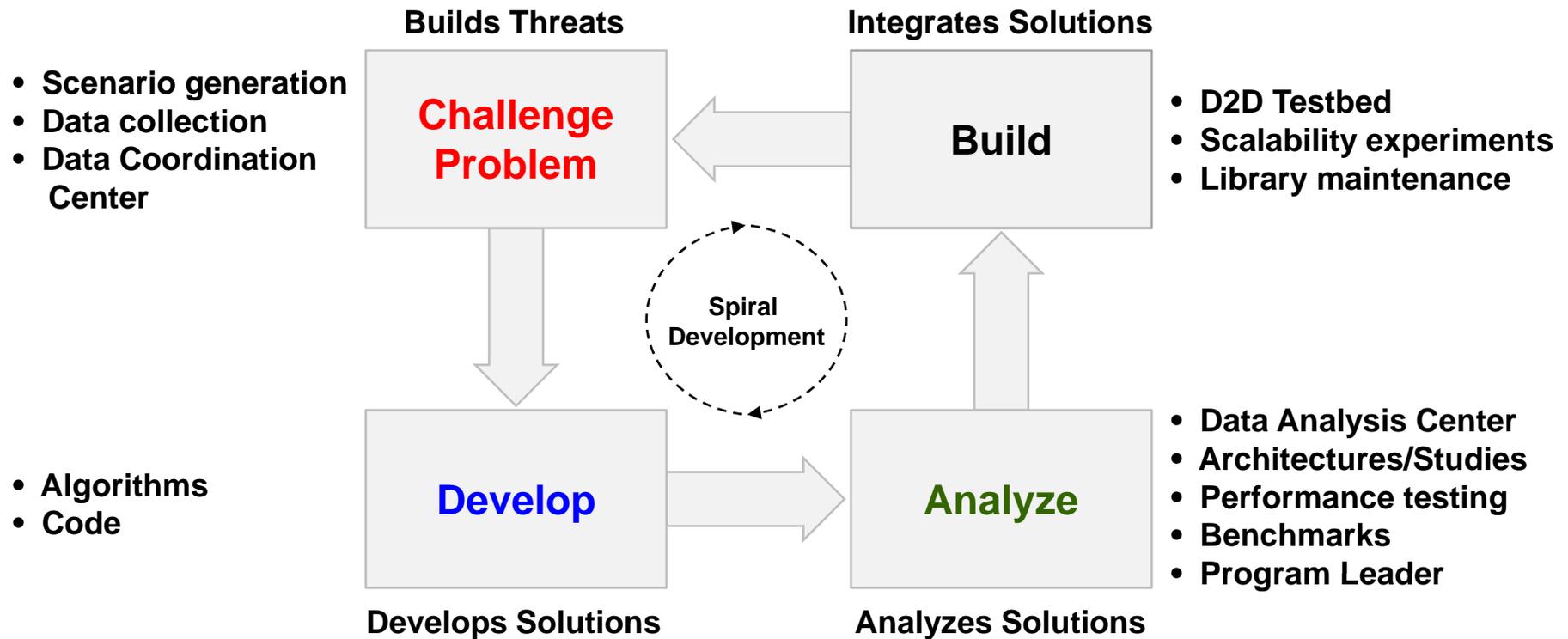
Motion Analytics

Preliminary Tracking Requirement
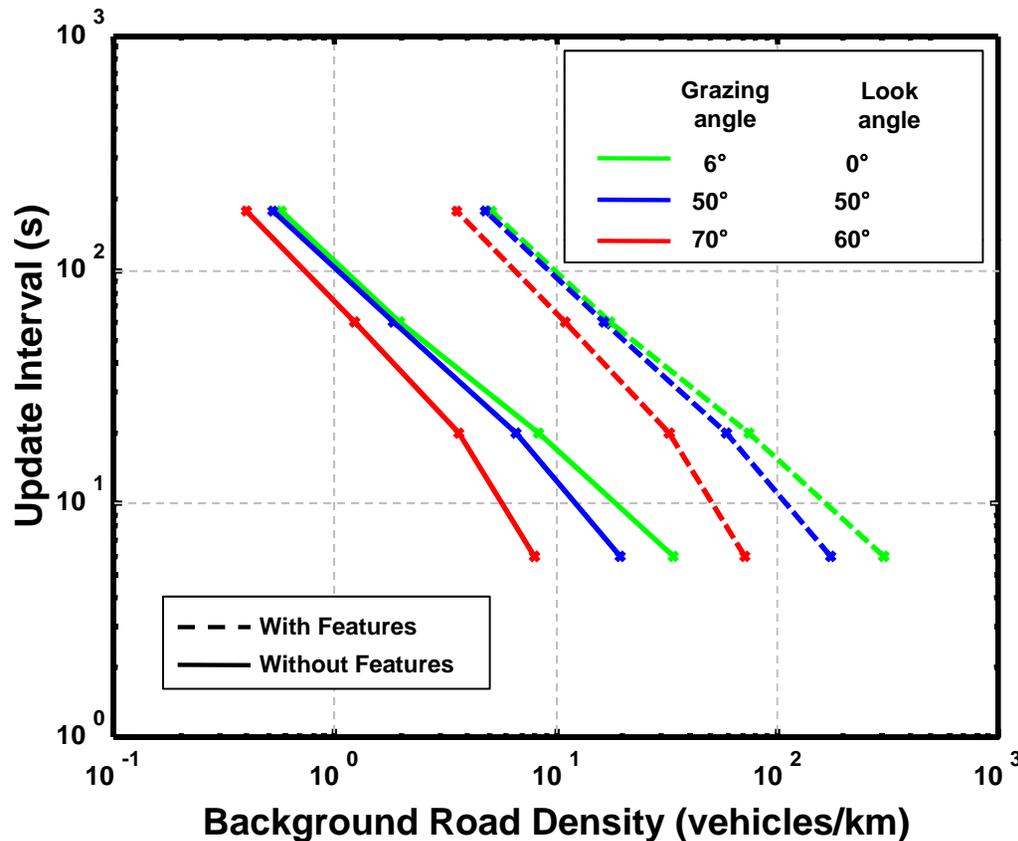
Challenges

- **Robust Trackers**

- **Statistical Trackers**

- **Activity-Based Intelligence**

- **Indications & Warnings**

- **Movement Dynamics**

- **Map Making**

- **Production Estimation**

Program Organization

- **Scenario generation**
- **Data collection**
- **Data Coordination Center**

Builds Threats

Challenge Problem

Integrates Solutions

Build

- **D2D Testbed**
- **Scalability experiments**
- **Library maintenance**

Spiral Development

- **Algorithms**
- **Code**

Develop

Develops Solutions

Analyze

Analyzes Solutions

- **Data Analysis Center**
- **Architectures/Studies**
- **Performance testing**
- **Benchmarks**
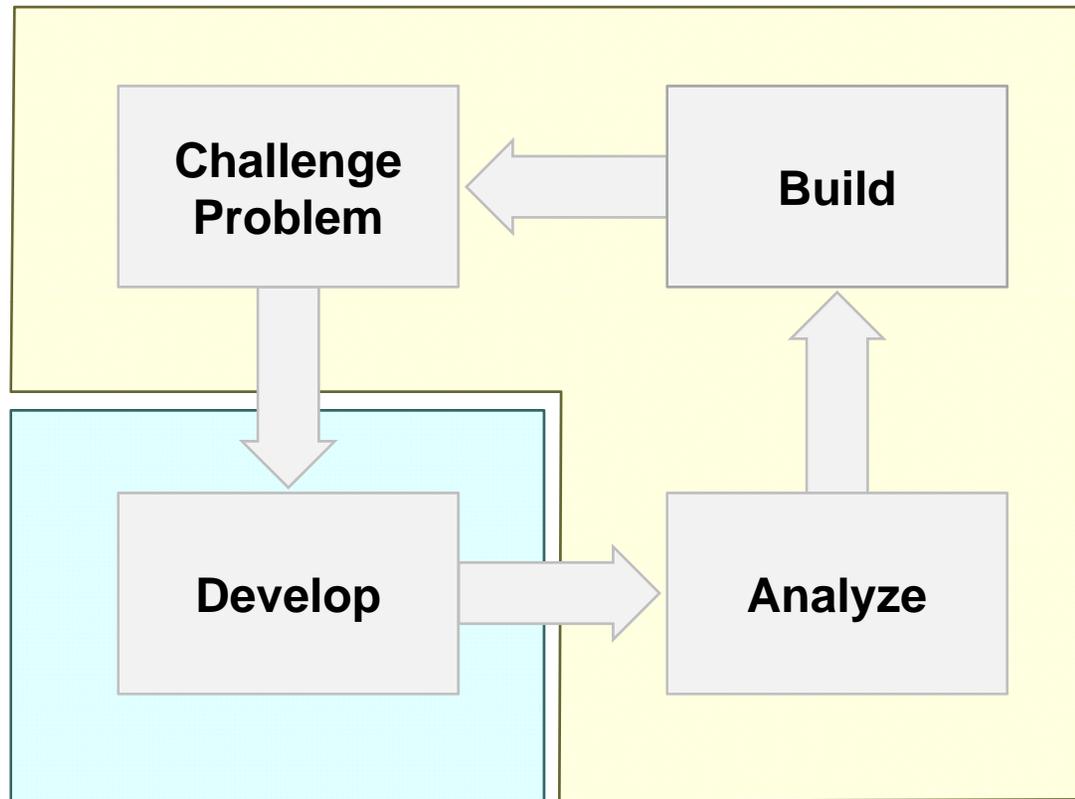- **Program Leader**

Development consortium should be an integrated team conducting translational research

Program Organization

Consortium:
Industry
Academia
Labs
FFRDCs/UARCs

Government Team:
AFRL
ARL
NRL
MIT LL

Challenge Problem → Develop → Analyze → Build → Challenge Problem

- **Primarily 6.2 funding**
- **Opportunistic, innovative**
- **Criterion: Innovation, openness**

- **Primarily 6.3 funding**
- **Mission critical, infrastructure**
- **Criterion: speed, access, analyses**

Summary

- **The Data-to-Decisions program develops technology for the rapid development of flexible new Decision Support Systems**

- **Program consists of a series of relevant challenge problems that advance the underlying technology in data management, analytics and user interfaces**

- **Execution is through a consortium that addresses the challenge problems in a coherent and integrated team approach**

- **Major research initiatives focus on developing extendable analytic approaches and advanced user-interface modules**