# ISO/IEC JTC 1/WG 7
# Working Group on Sensor Networks

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# US NB Contributions (1 of 2) to ISO/IEC 29182 Sensor Network Reference Architecture

## Contributions toward all parts 1 - 7

# Sensor Networks from System Architecture Perspectives

# Agenda

- Problem Statements
- Solution Approaches
- Lessons Learned from a Case Study
- System Architecture for Standards Development
- Architecture Artifacts to Standard Mapping
- Architecture Artifacts Mapping: OVs ←→ SVs
- Example Artifacts Views
- Service Oriented Architecture (SOA)
- Conclusions

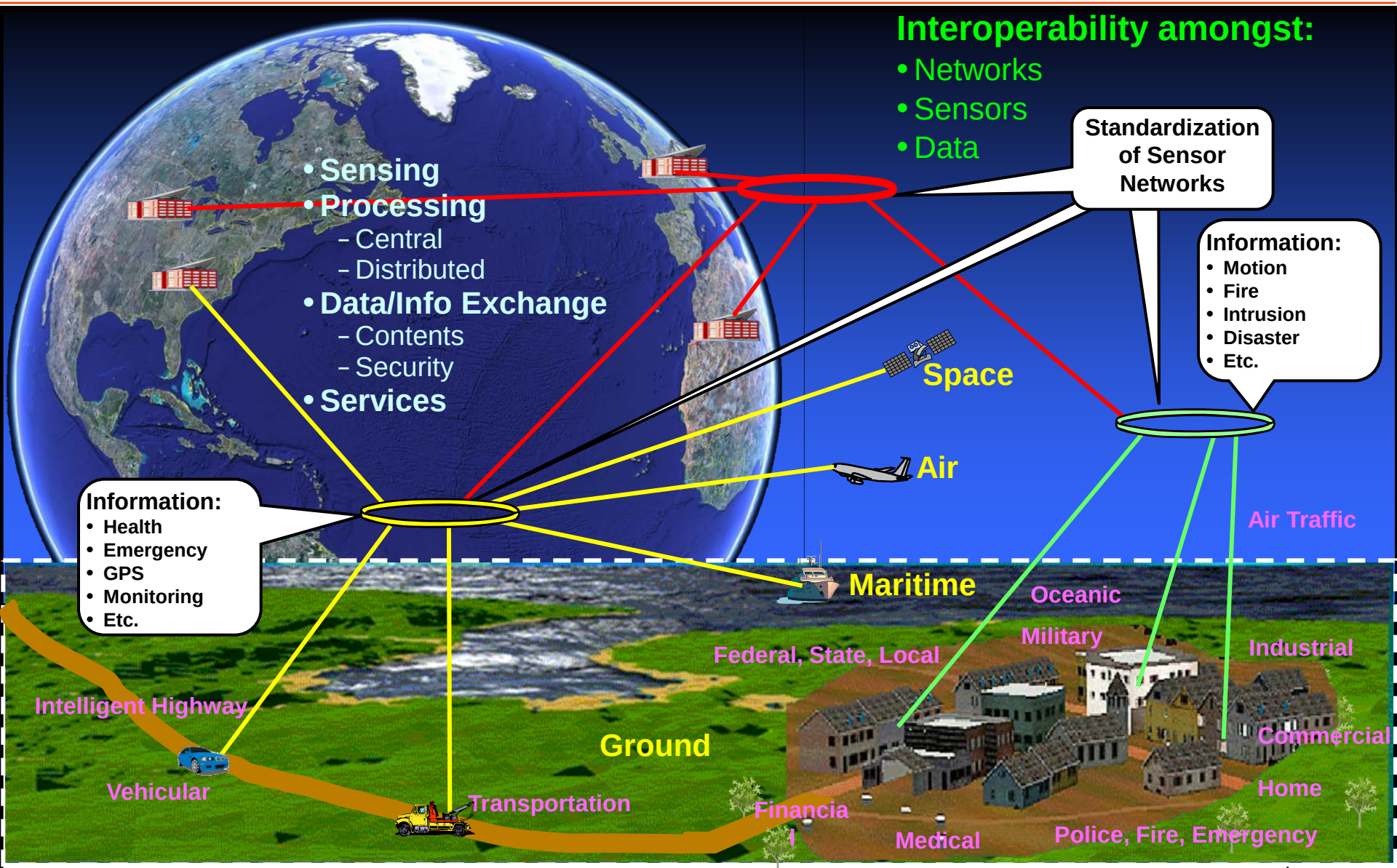
# Problem Statements

- **Diversified applications and market segments for the use of sensor networks complicate in establishing sensor network standards.**
  - Do we need sensor network standards for each application or market segment?
- **Types of standards exist for sensors and networks separately; however, the standards that make of sensors, networks, data/information interoperable does not exist.**
  - Sensors are built into stand-alone stovepipe systems without the concern of interoperability of interfaces and/or data.
  - Sensors and networks become more capable in terms of services they can provides, which lead to the necessity of standardization.
  - The desired future state is plug & play of sensors into any network.
- **There is no systematic approach in establishing sensor network standards.**
  - How will we identify: (1) current deficiencies in sensor networks; (2) requirements; (3) barriers; and so on?
  - What would be a good approach to have co-incidence views of sensors, networks, and data interoperability?

# Solution Approaches in Establishing Sensor Network Standards

- **Use system architecture approach leading to functional and physical architectures, which provide the co-incidence views of sensors, networks, and data interfaces and interoperability.**
  - Identify the current deficiencies, needs, barriers in sensor networks.
  - Evaluate and analyze commonalities and differences among the current sensor networks.
  - Develop sensor networks requirements and their concept of operations.
    - **The requirements will be application- or market segment-specific.**
- **Develop sensor networks standards that allows interoperability among sensors, networks, data/information, and user operational environment.**
  - The sensor networks standards should lead to a plug & play capabilities.
- **Provide reference architectures (RAs) to developers the ability to design, analyze, and tailor sensor networks.**
  - The architectures should be generated on the sensor networks standards to guide sensor manufacturers and network developers to:
    - **Quickly integrate into existing networks**
    - **Bridge gaps between networks**
    - **Enable efficient future networks**
    - **Sharing data with other communities/applications**
    - **Use the shared data to provide services**
- **The standards and RAs will bring benefits to the manufacturers & developers**
  - Save developmental and implemental cost
  - Minimize schedule risks in development and implementation

# Sensor Networks:
# Standards, Implementation, & Interoperability



# Case Study – Katrina Disaster 2005

- **Hurricane Katrina natural disaster made landfall August 29, 2005, and devastated the city of New Orleans, Louisiana.**
- **It caused manor damage throughout the State of Louisiana and Mississippi.**
- **Over 50 agencies from state and local first responders to federal and international participated in the recovery effort.**
  - This effort is still going on today nearly three years later.
- **Lessons learned included the need for:**
  - New classes of sensors
  - Standardized “networked sensors” or “sensor networks” applications
  - Ability to transfer data between diverse sensor types and user groups
  - Ability to integrate diverse networks and data flow
  - Ability to transfer and track real-time imagery across agencies with a variety of media and networks
  - Ability to communicate and direct resources in austere environments
  - Disaster prevention preparation and training
- **Pending study in netted sensors**
  - Identify failures and needs in Katrina natural disaster scenario
  - Build reference architecture for similar natural disasters
  - Evaluate the interoperability and identify the needs of netted sensors standards for effective and efficient response and recovery.

# System Architecture for Standards Development

- **Discussion on using system architecture for sensor networks standards development**
  - Architecture understanding
    - **Use the open group description of enterprise architecture**
  - Architecture artifacts to standards mapping
    - **System elements that map to standards illustrate system products that have technical standards current or forecast associated with them**
  - Architecture artifact mapping
    - **Description of the system architecture products that depends on standards**
  - System communication description[1]
    - **Depict pertinent information about communication systems, communication links, and communication networks.**
    - **Useful for document how interfaces are supported by physical media**
- **Systematic system architecture process**
  - Lead to functional, physical, information architectures of the current, existing sensor networks, if such architectures do not exist.
  - Allows to compare and contrast various sensor networks for commonalities and differences identification.
  - Help evaluating and determining sensors, networks, data, and service standards for interfaces and interoperability in sensor networks.
  - Determine the applications or market-segments that needs reference architectures.

[1] DoD Architecture Framework (DoDAF) v.1.5

# Architecture Understanding

- **There is a need to provide an integration framework that sits above individual architectures[2].**
- **An "enterprise framework" such as Zachman can be used as an integration framework.**
- **The purpose of the integration/enterprise framework:**
  - Allow the architect to understand how components fit into the framework.
  - Derive the architecture models that focus on enterprise level capabilities.
  - Define the conformance standards that enable the integration of components for maximum leverage and reuse.
- **Enterprise architecture (EA) includes the following:**
  - Business architecture
  - Information architecture
    - **Application architecture**
    - **Data architecture**
  - Technical architecture

[2] The Open Group Architecture Framework v8.1.

# Business Architecture Development Phase

- **Describe the current baseline business of architecture.**
- **Develop a target business architecture.**
- **Analyze the gap between the baseline and target business architecture.**
- **Select the relevant architectural viewpoints that will enable the architect to demonstrate how the stakeholder concerns are addressed in the business architecture.**
- **Select the relevant tools and techniques**

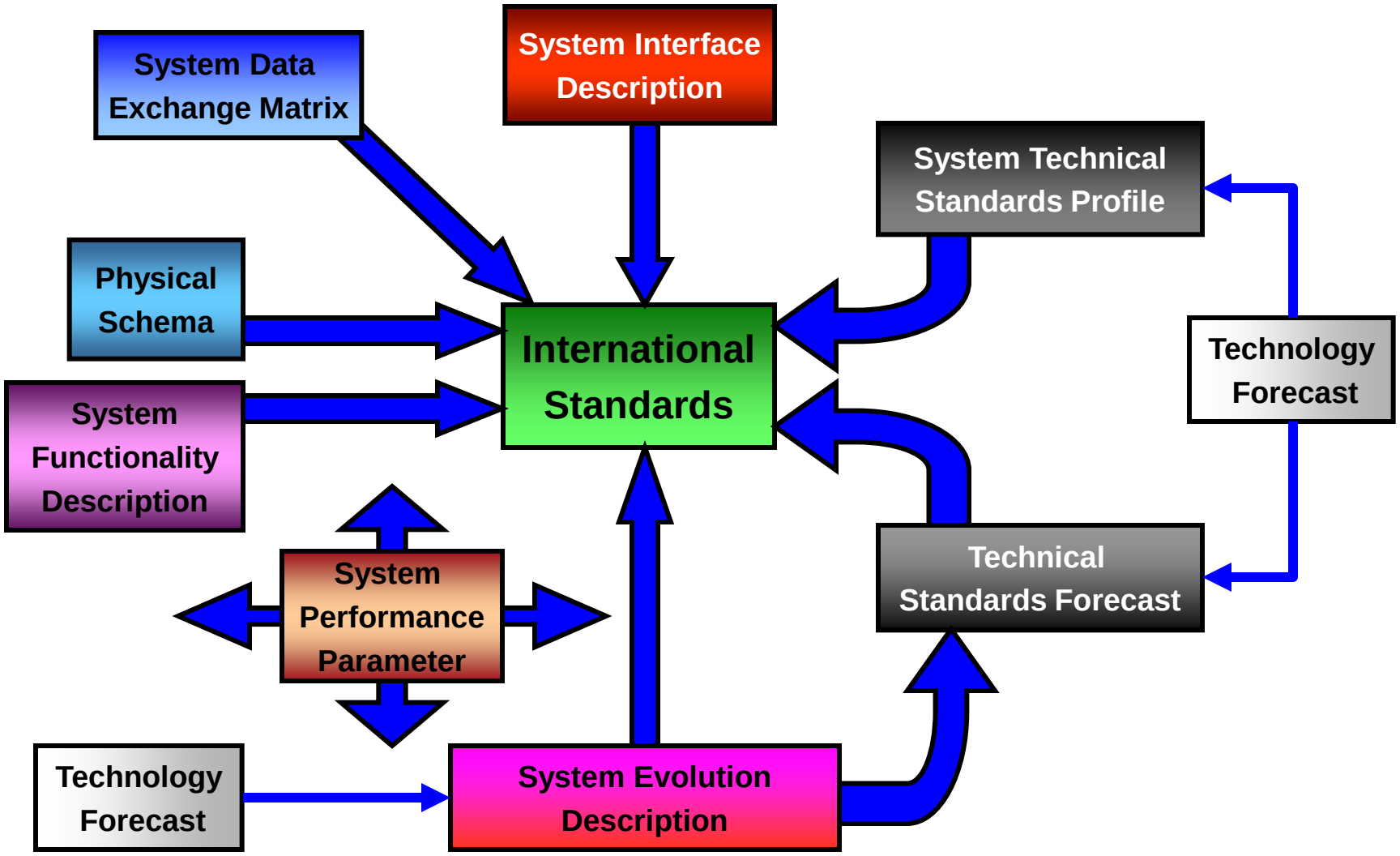
# Information Architecture Development Phase

- **This phase involves some combination of applications and data architecture.**
- **Application architecture**
  - Define major kinds of application system necessary to process data and support the business
  - What those applications need to do in order to manage data
  - Present information to human and computer actors in the enterprise
- **Data architecture**
  - Define the major types and sources of data necessary to support the business
    - **Understandable by stakeholders**
    - **Complete and consistent**
    - **Stable**
  - Define the data entities relevant to the enterprise
- **Select the relevant tools and techniques**

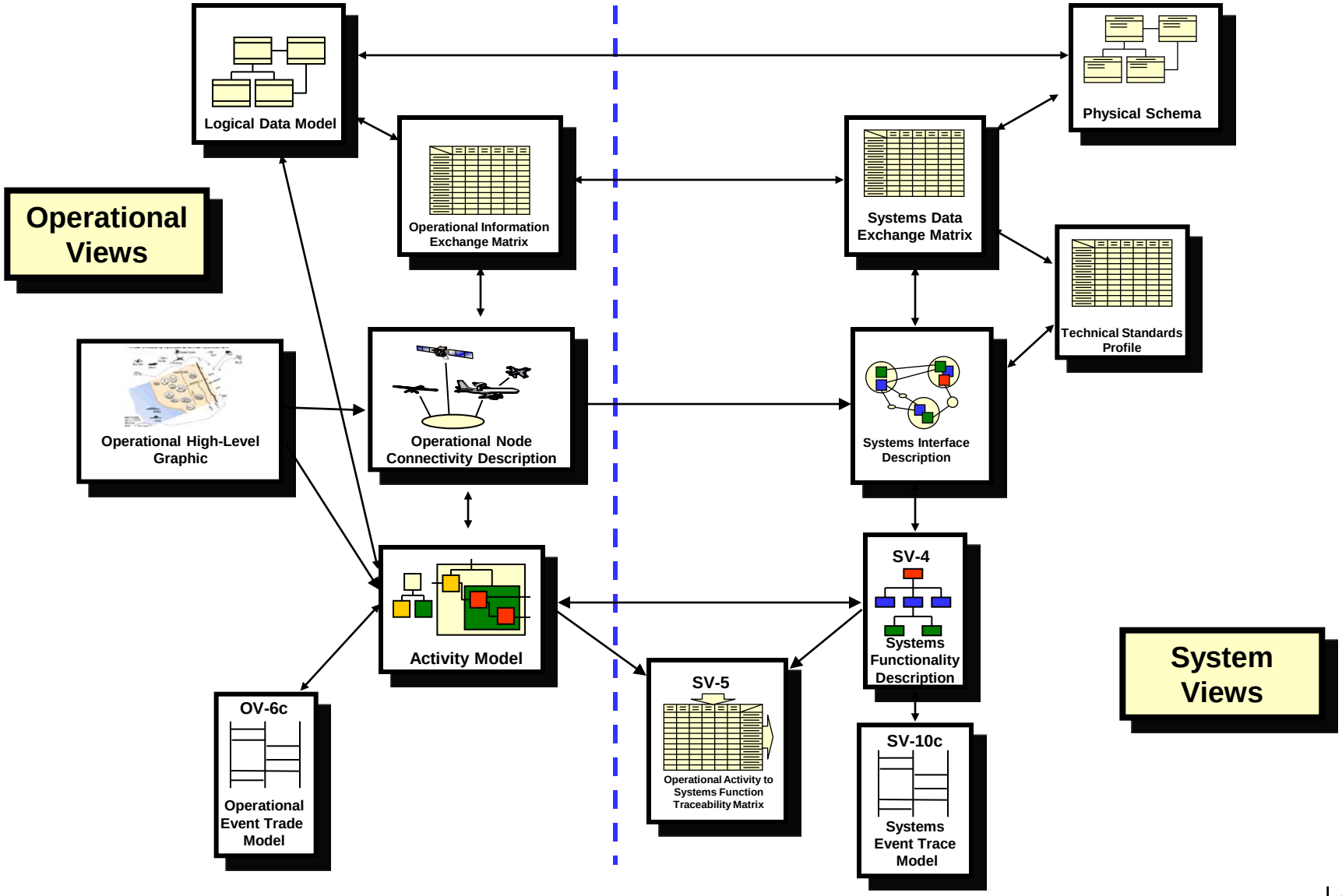
# Technical Architecture Development Phase

- Develop a technology architecture that will form the basis of the following implementation work
- Consider what relevant technology architecture resources are available
- Consider generic technology models relevant to your organization's industry "vertical" sector
- Build technology models relevant to common systems architectures.
- Select the relevant tools and techniques

# Architecture Artifacts to Standards Mapping

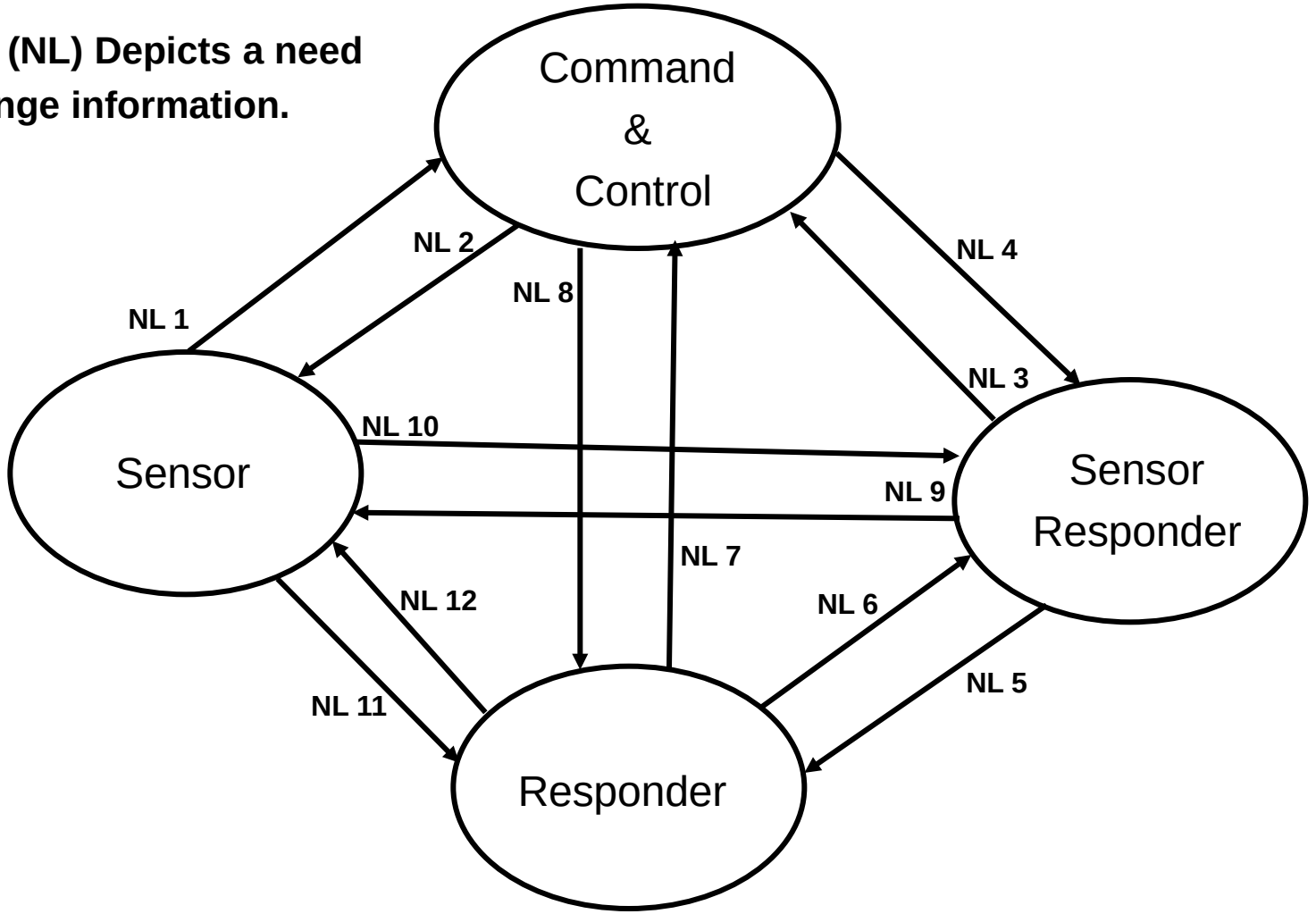


# Architecture Artifact Mapping: Operational Views ↔ System Views

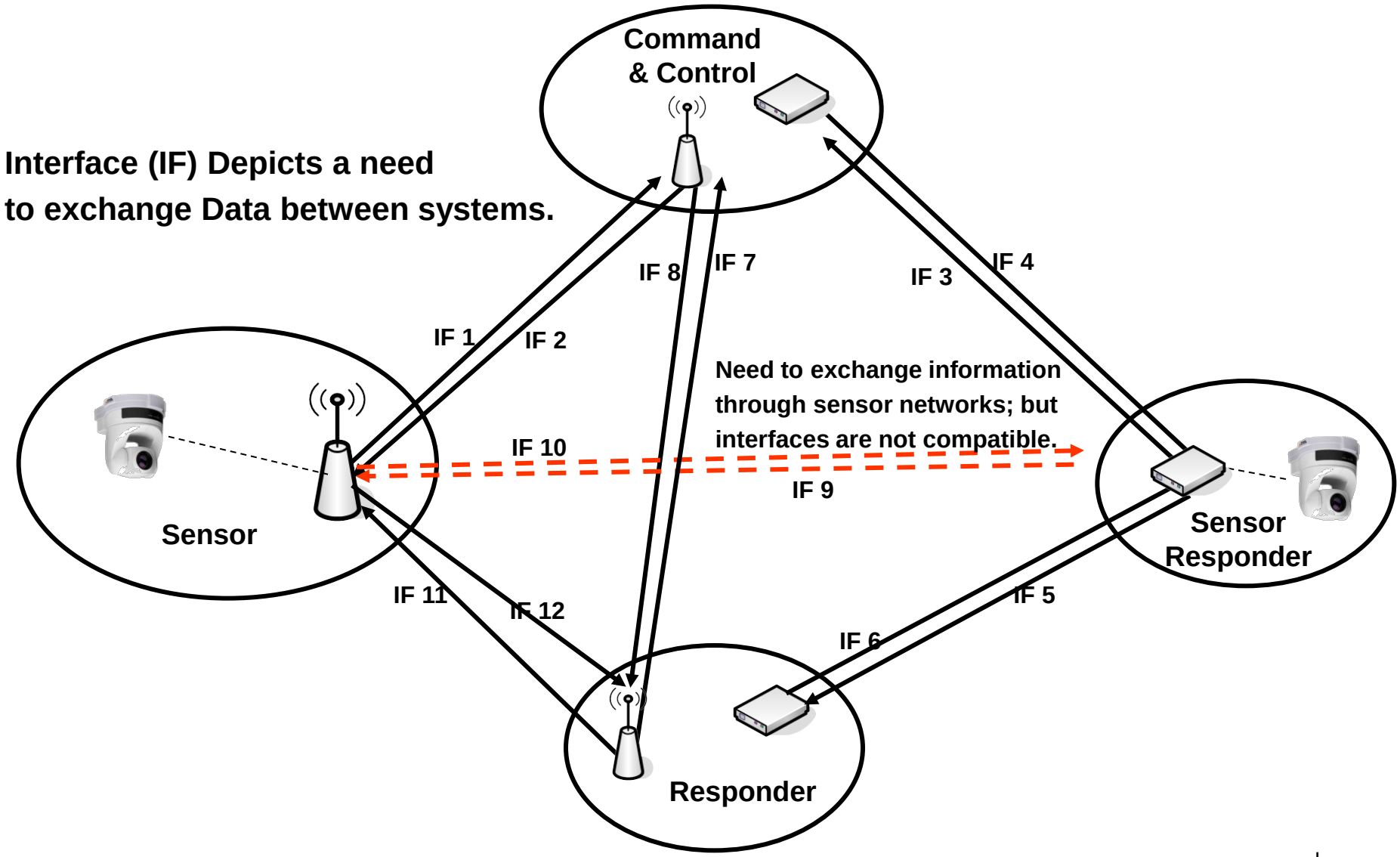


# Example: Operational Node Connectivity Description

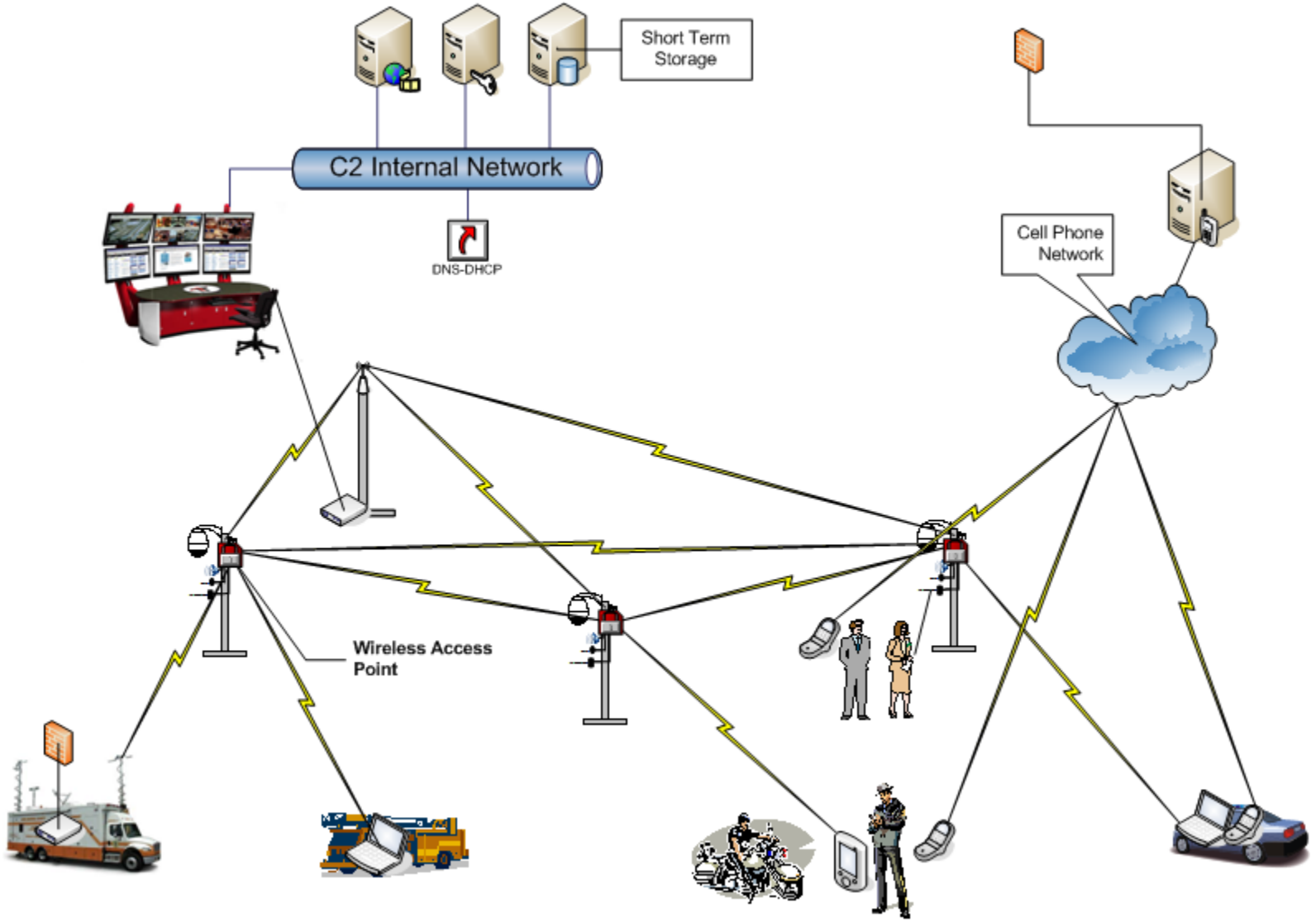
**Needline (NL) Depicts a need to exchange information.**



# Example: System Interface Description



# Example: System Communications Description

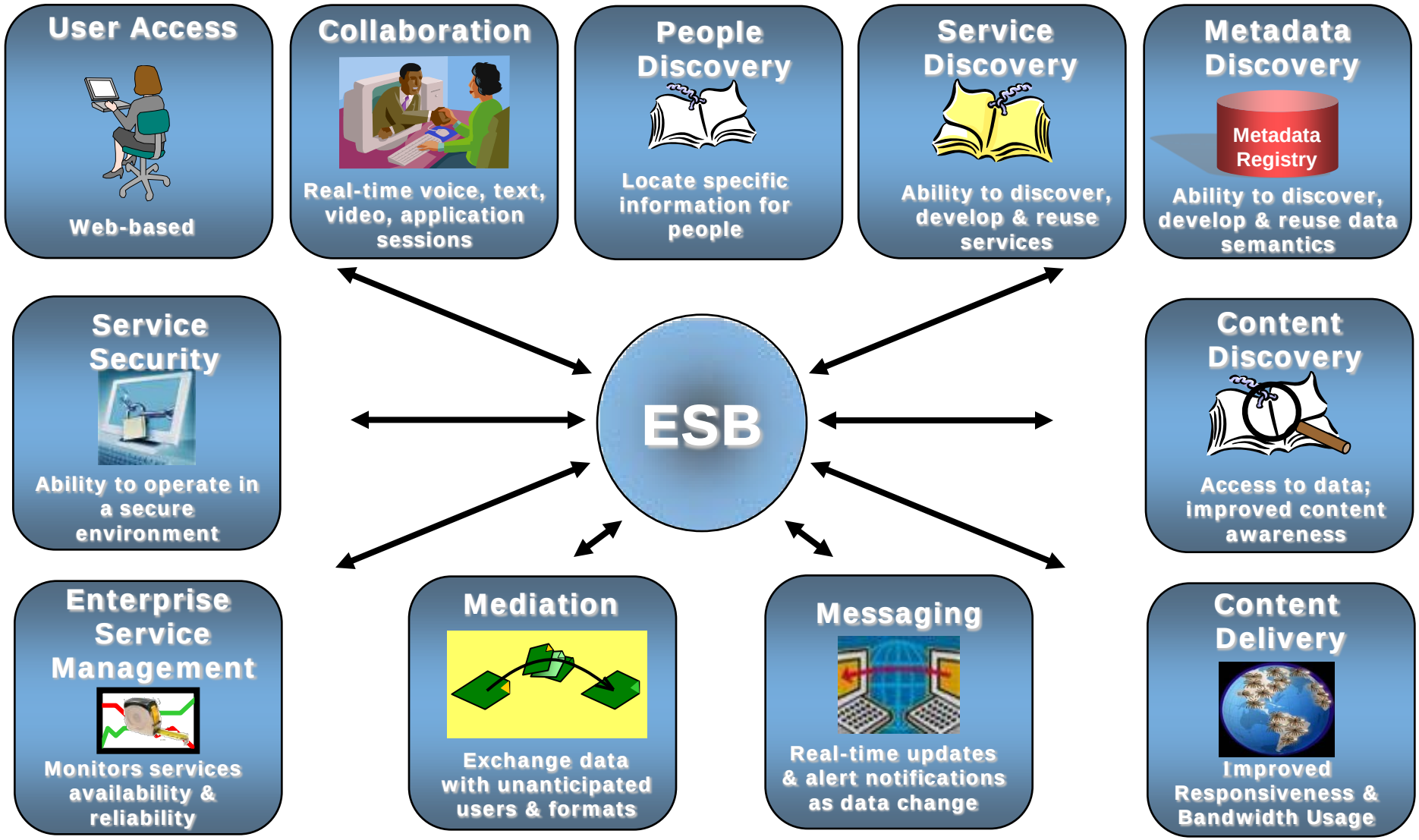


# Application of Service Oriented Architecture (SOA)

- **Service Oriented Architecture**
  - is a computer system's architecture style for creating and using business processes, packaged as services, throughout lifecycle.
  - defines and provisions the IT infrastructure to allow different applications to exchange data and participate in processes[3].
- **Interoperability between different systems and programming languages provides the basis for integration between applications on different platforms through a communication protocol.**
- **Establish and maintain data flow to a federated data warehouse.**
  - This allows new functionality developed to reference a common business format for each data element.

[3] Wikipedia

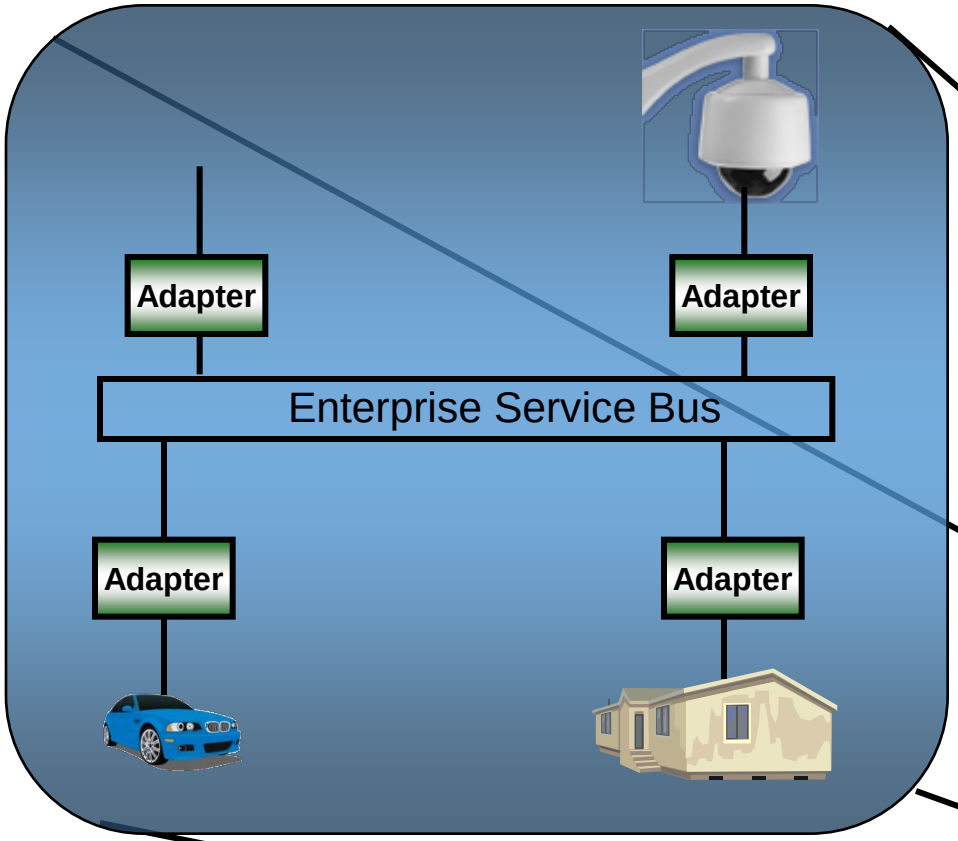
# Service Oriented Architecture[4]




[4] A Day in the Life of an NCES Developer DISA Customer Conference NCES Overview Ken Fagan

**ESB = Enterprise Service Bus**

# Legacy Systems on Service Bus




- **Although the current sensor network may require adapters; the future sensors networks will have build-in adapters in sensors and networks.**
- **The future state of the sensor networks will have common sensor network interfaces for sensor interoperability, leading to "plug & play" of networked sensors.**

# Conclusions

- **Systematic system architecture provides a method for identifying the needs areas and building foundational basis for developing the sensor network standards.**
- **International standards are required for sensor networks to enable interoperability for user environments, including services provided by sensors.**
- **Standards provide the capability to build open architecture in which we build requirements and models for sensor networks.**
- **Sensor networks standards is an enabler to build interoperable sensors and networks that brings benefits to user communities and industry by reducing:**
  - Cost
  - Schedule
  - Risk

# Conclusions

- **Howard Choe, “Sensor Networks from System Architecture Perspectives,” presented at ISO/IEC JTC 1 SGSN  Workshop #1, Shanghai, China, June 25, 2008.**
- **DoD Architecture Framework (DoDAF) v.1.5.**
- **The Open Group Architecture Framework v8.1.**
- **Wikipedia on SOA.**
- **A Day in the Life of an NCES Developer DISA Customer Conference NCES Overview Ken Fagan**