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ARL

ISR asset visibility and collection management optimization through knowledge models and automated reasoning

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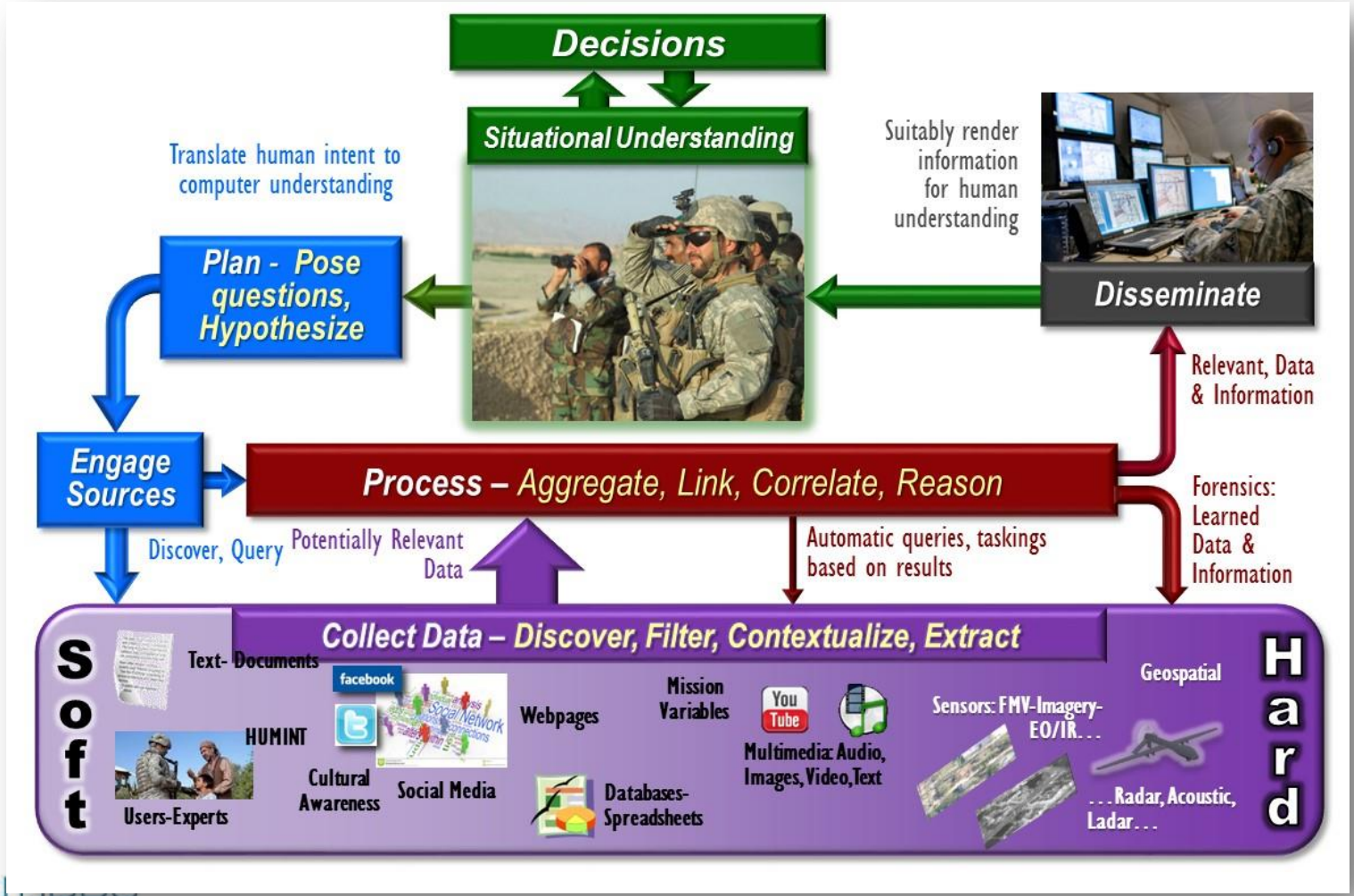
KSCO/ICCRTS (London, UK – Sept 2016)

Outline

- Context: Automated support to ISR activities
  - Multi-sensor integration
  - Collection management: Optimization of the utilization of ISR assets
- DRDC Total ISR Asset Visibility project
- DRDC - US ARL collaboration
  - Plug-and-play sensor interoperability (CAN-US)
  - Enhanced sensing sources to mission assignment
- Semantic representation of ISR domain-related concepts
- Summary

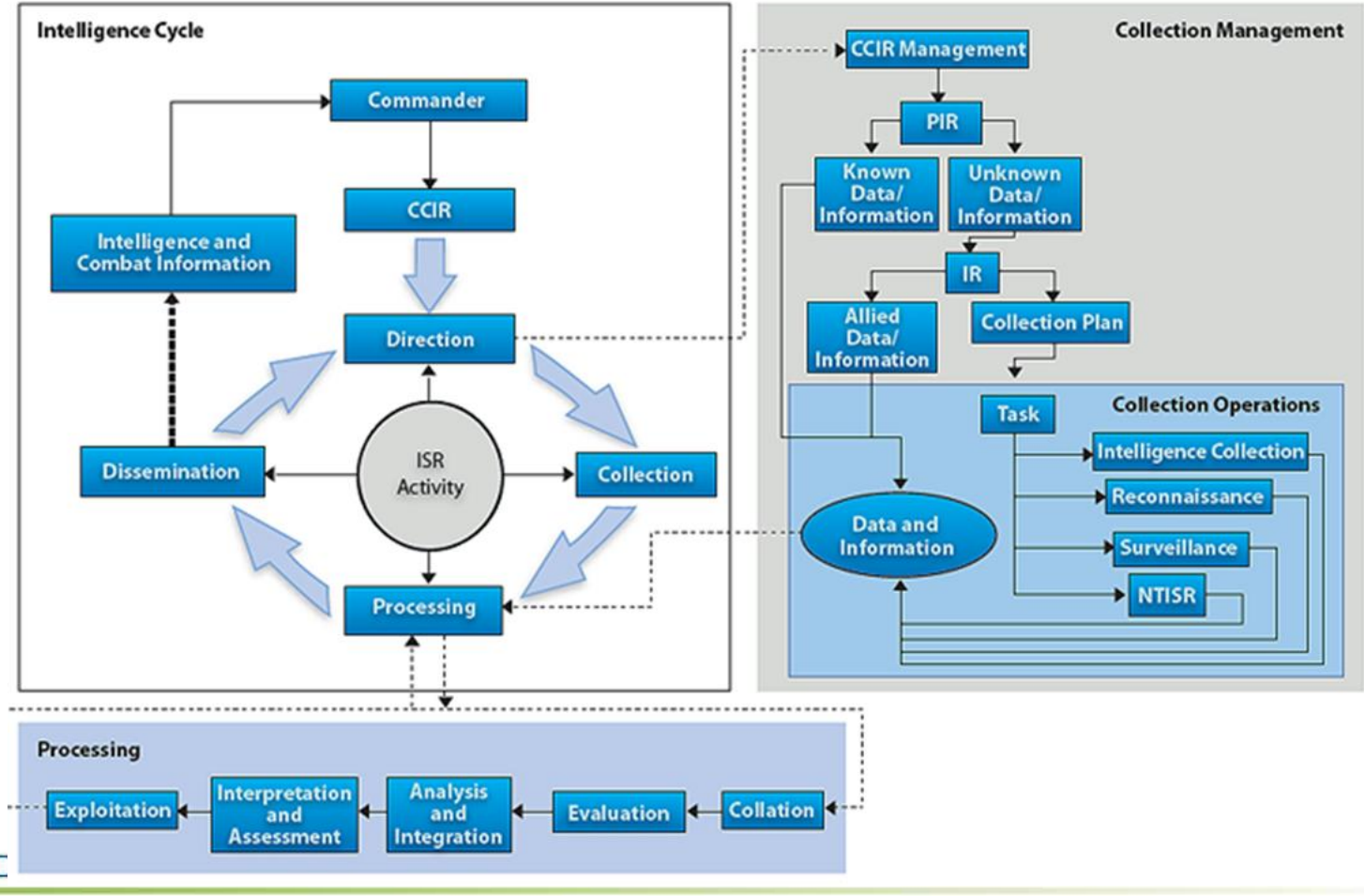
Obtaining mission-relevant information for situation understanding



Source: ARL

Intelligence cycle and collection management

(from RCAF Sense Doctrine – adapted from NATO ISR Primer AJP 2.0)



Total ISR Asset Visibility (TIAV)

- **ISR asset visibility**
  - Awareness of ISR assets available
  - Collection planning and synchronization
- **Collection requirements visibility**
  - Optimization (multiple requests)
  - Make best use of collection capabilities
- **Data/information/intelligence visibility**
  - Effectively plan and execute ISR missions
  - Exploit collected data

DRDC Total ISR/EW Asset Visibility (TIAV) R&D project

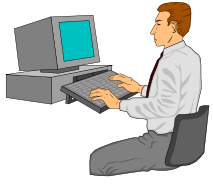
"Automated support for ISR/EW assets assignment that best meets an Army's tactical commander information requirements (IR)"

- Intelligence Cycle: **Tasking-Collection**-Processing-Exploitation-Dissemination
- Multi-Sensor integration: Sensor discovery, planning, tasking
- Automated support to ISR activities (IRM & CM processes)
  - Have we already collected data that meet IRs ?
  - What deployed assets best answer specific IRs ?
- Translation of high-level IR to ISR asset collection tasks
- Formal semantic representation of the ISR domain
- Algorithms/tools for the optimization of ISR asset allocation that satisfy collection requirements

Mapping the physical world to user needs

Automated support to IRM & CM

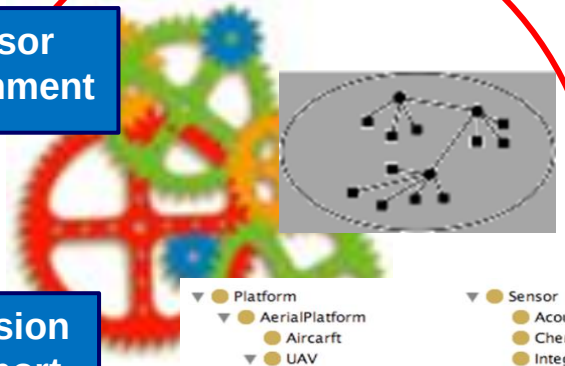
IRs / Tasks

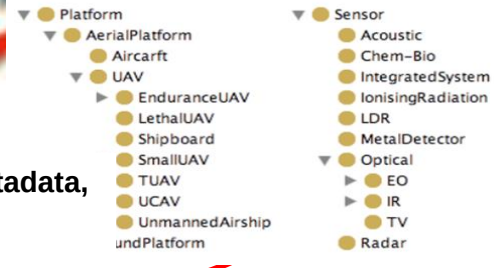


Collection manager
Analyst
Decision maker

Sensor assignment

Decision support





Ontologies, metadata, contextual information

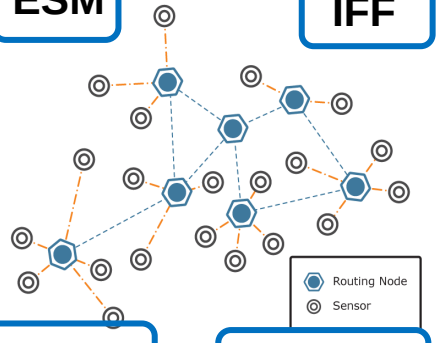
Database

Social media

EO/IR

ESM

IFF



Radar

Acoustic

Semantic characterization of platforms / sensors

Data consumer
Human language

Automated reasoning

Data production
Physical world

Coalition ISR Asset Interoperability (CIAI)

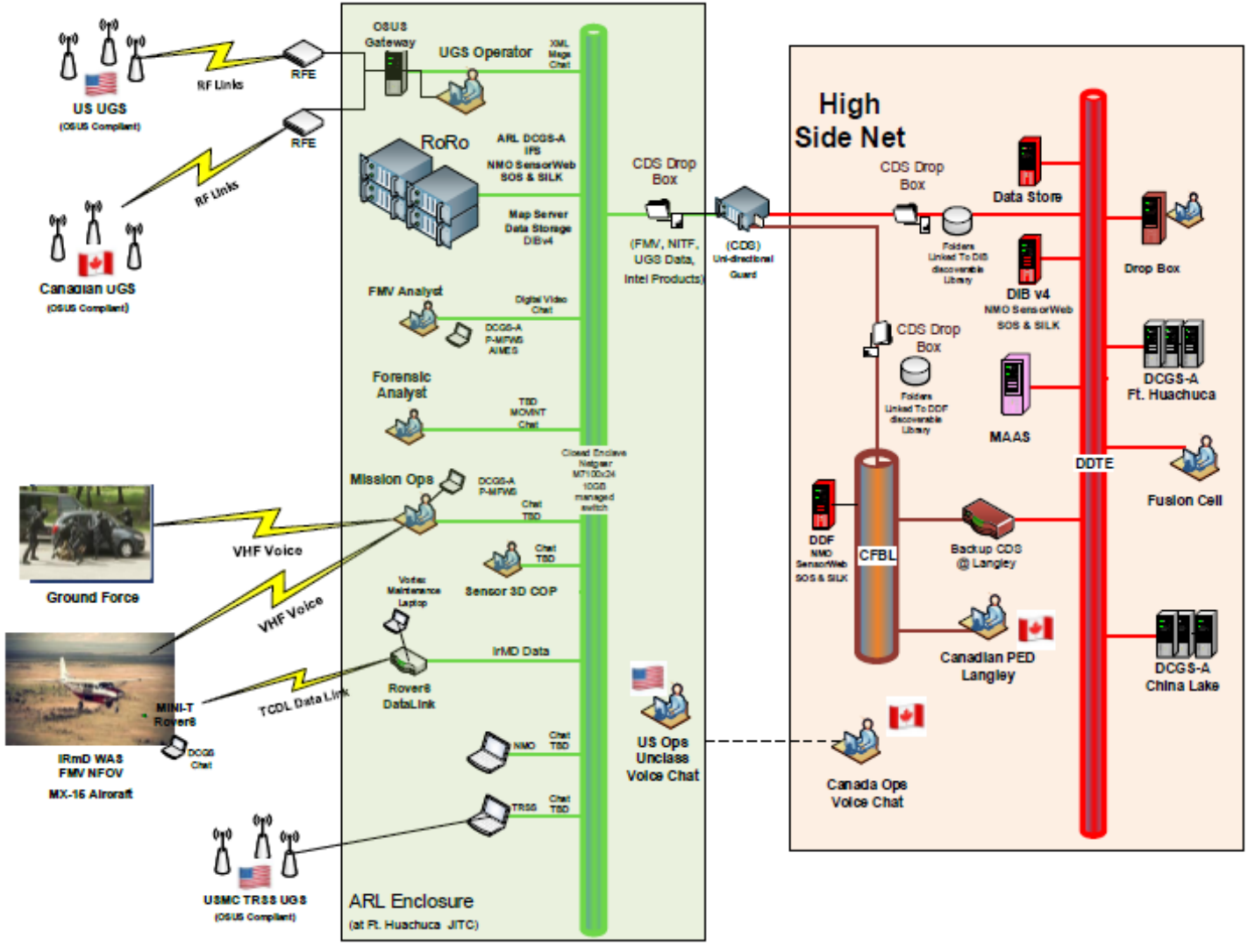
- DRDC-ARL collaborations:
  - Bi-lateral collaboration via the Coalition Warfare Program (CWP) on Coalition ISR Asset Interoperability (CIAI)
  - NATO SET-218 Task Group on Interoperability & Networking of Disparate Sensors and Platforms for ISR Applications

- CIAI Objectives: Optimizing the utility of coalition ISR assets through two research thrusts:
  - Standards for unattended systems interoperability
  - Knowledge representation and reasoning for enhanced sensing source allocation and relevant information collection

Part 1: ISR interoperability within unattended systems

- Aim: Demonstrate coalition ISR asset interoperability using OSUS
- OSUS – Open Standard for Unattended Systems
  - Open architecture for UGS interoperability
  - Software plug-in interfaces for sensors/algorithms/radios
  - Mission programming for controlling ISR assets
  - Common lexicon (XML schema)
- Experiment during Enterprise Challenge 2016
  - DRDC SASNET sensor selected as one coalition asset
  - Development of a Canadian OSUS controller with SASNET plug-in
  - Flexibility to control each other's assets (using OSUS controller)
  - Autonomous cross-cueing of U.S. and Canadian assets

CAN-US ISR interoperability experiment (EC-16)



Part 2: Sensor allocation and information collection

- Maximize the utilization of ISR collection assets by developing novel ISR concepts/algorithms/tools to satisfy information collection gaps
- Related R&D projects:
  - DRDC: Total ISR Asset Visibility (TIAV)
  - US ARL: Mission-Informed Needed Information – Discoverable, Available Sensing Sources (MINI-DASS)
- Research interests:
  - Semantic knowledge representation (ontologies) for the ISR domain
  - Novel algorithms/tools for IR interpretation, source selection, and information collection

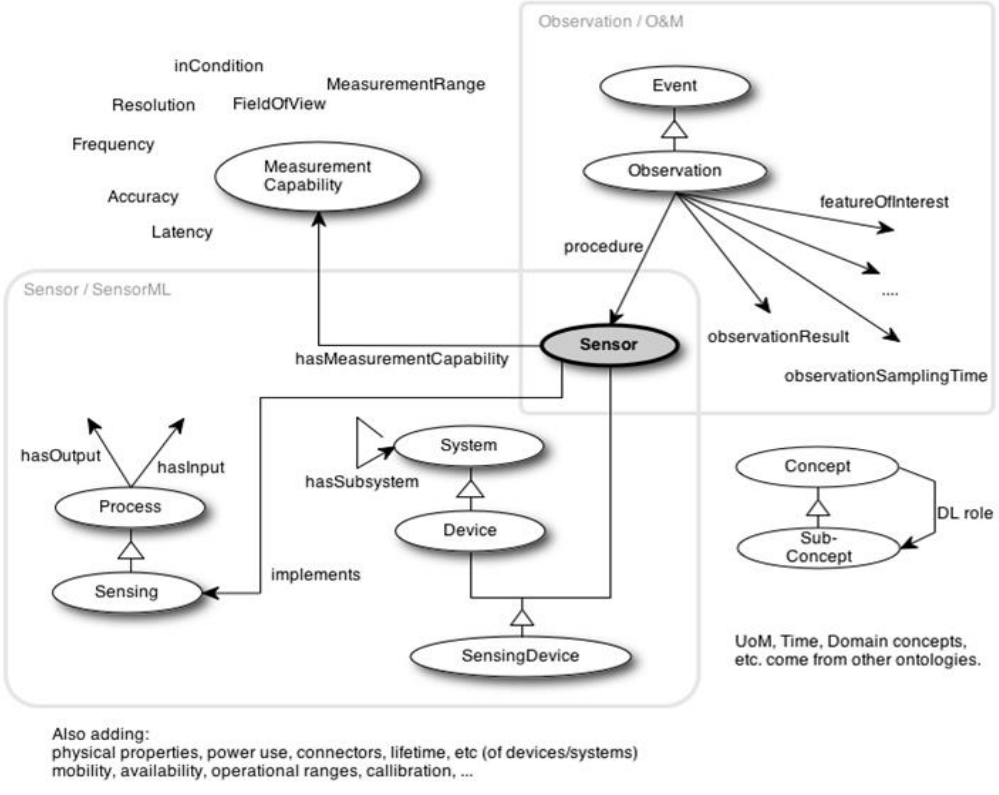
Mapping high-level IRs to sensors: semantic challenges

- High-level expressive language for query-answering and information collection
  - Characterize the Ws
  - Identify appropriate source(s)
- Information collection vs information retrieval challenges
  - Collection task: What source can best answer a specific user's IR ?
    - Model the source capability to collect/provide the information
      - E.g. Detect a vehicle; identify a person
  - Query-answering: Look for sources that may contain specific data
    - Source monitoring
- Enhanced content-based source description
  - Metadata (time, location, credibility, ...)
  - Content (events/object recognition, change detection)

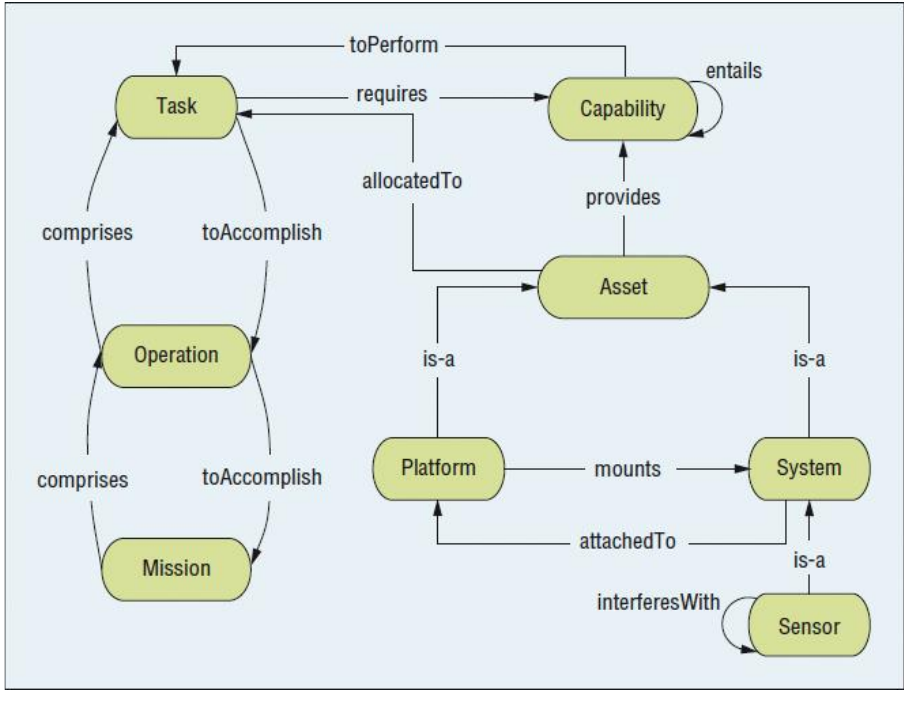
Semantic representation of ISR concepts for TIAV

- Support for automated reasoning
  - ISR asset assignment (Tasking / IRs), Query-Answering, Information Fusion (PED)
- ISR key concepts:
  - Sensors capabilities, properties (performance, limitations), mobility
  - Data/information (sensor output / observations) type, quality, interpretability
  - ISR mission & tasks, information requirements
  - Context, environmental characteristics
  - PED perspective (exploitation/SA): categories of actions, events, etc.
- Leverage existing models
  - Ontologies (SSN, ISR/SAM)
  - NATO ISR-related STANAGS (data models/schemas)

Leveraging ISR related ontologies



Semantic Sensor Network Ontology (SSN)



Sensor Assignment to Mission (SAM) ontology

Summary

- Ongoing efforts for automation of ISR activities (collection management)
- Initial effort: Demonstrate CAN-US sensor interoperability using OSUS
- Automation of ISR asset allocation
  - Semantic representation of ISR domain concepts
  - Characterization of sources of information
- Linkages between information requirements, information management and information collection
- Semantic representation of ISR concepts constitutes the foundation for enhanced Total ISR Assets Visibility and PED
- Future work will look at novel algorithms/reasoning for information collection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