

Event Characterization Fusing Hard and Soft Data via Semantic Models

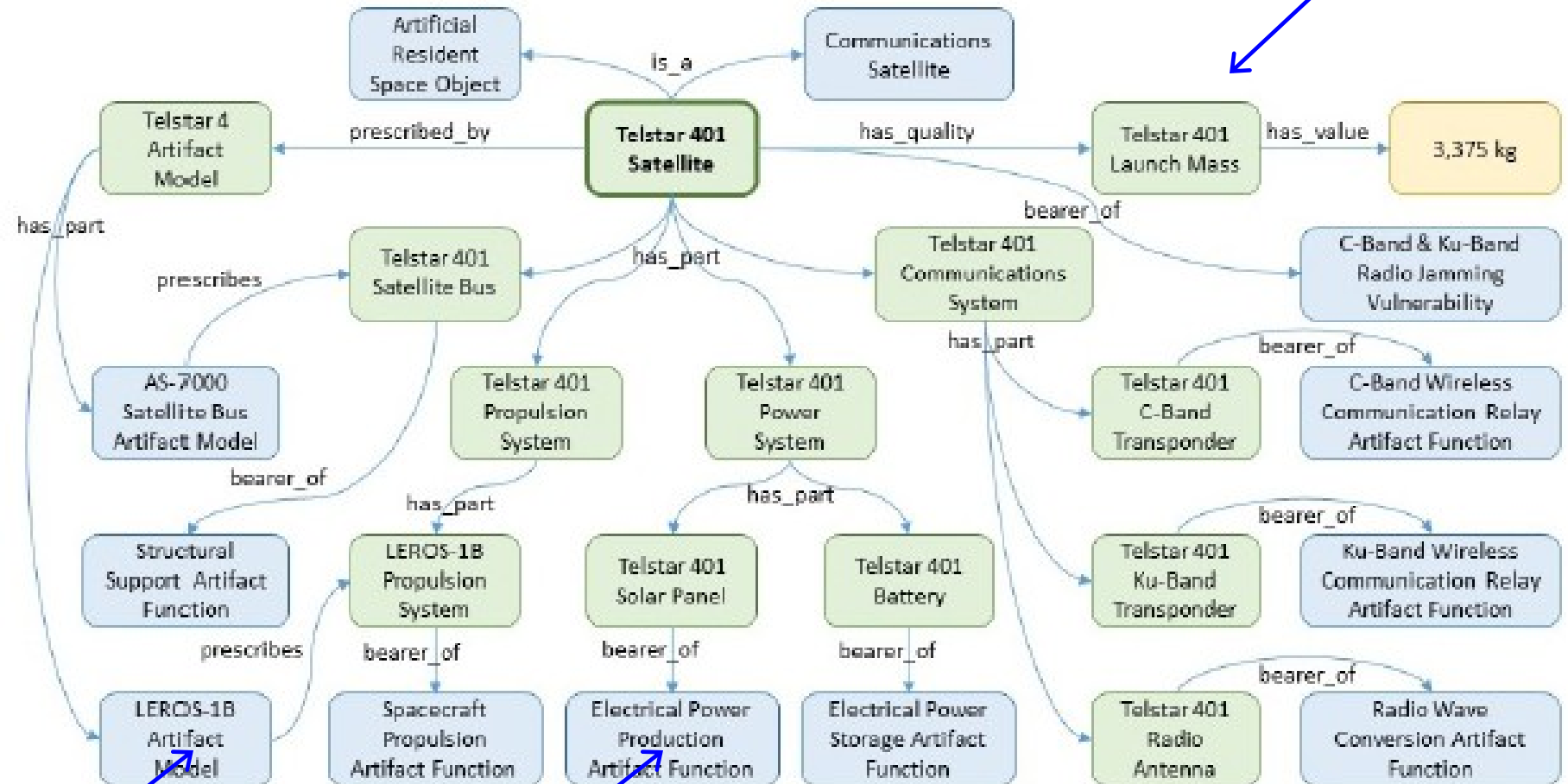
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- **Space event characterization using hard and soft data (physics-based & human-derived information fusion – PHIF)**
 - **AF Relevance:** predict events in order to protect assets by directly commanding and controlling space assets to mitigate intentional and non-intentional threats
 - **AFRL POC:** Ms. Carolyn Sheaff RIED, carolyn.sheaff@us.af.mil
- **Key Focus of Scientific Research**
 - **Science Goal:** By fusing both physics and semantic sources, a more accurate and reliable system is developed to characterize events
 - **Question:** Can fusing PHIF data create a comprehensive space operational picture for event characterization?
 - **Challenge:** fusion over multiple heterogeneous data and information sources has not been solved in a way that would enable prediction of space events impacting US assets

Space Object Ontology

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- Fusion 2016



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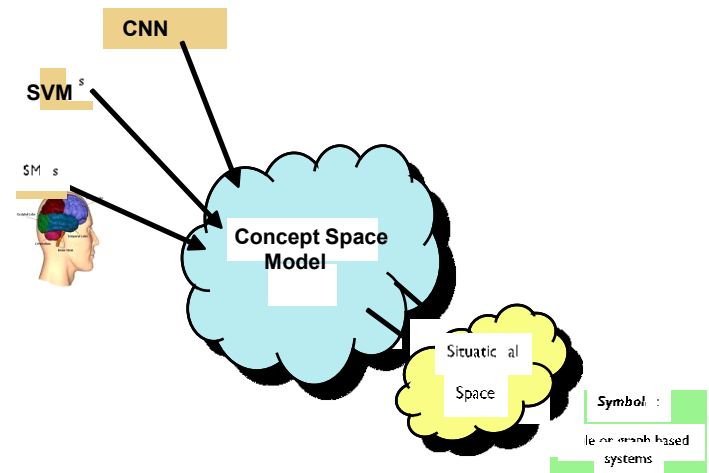
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- **Proposed New Theory**

- Novel event characterization approach using **Conceptual Spaces** and Operations Research optimization will be developed to estimate the most likely event
 - Proposed architecture provides the links between the ontology-tagged data, the data assigned to given events, and the **multidimensional associations** affected within the Conceptual Spaces framework
- **Transition: ARCADE, JMS Enterprise, NSDC**

- **Other performers on project**

- **Dr. Barry Smith** (Ontology)
- **Dr. James Llinas** (Founder, UB's Center for Multisource Information Fusion)



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New S&T Advances

Attain an increased/enhanced understanding of space-based events using hard and soft data

Modeling

Conceptual Spaces for how humans understand concepts

Algorithms

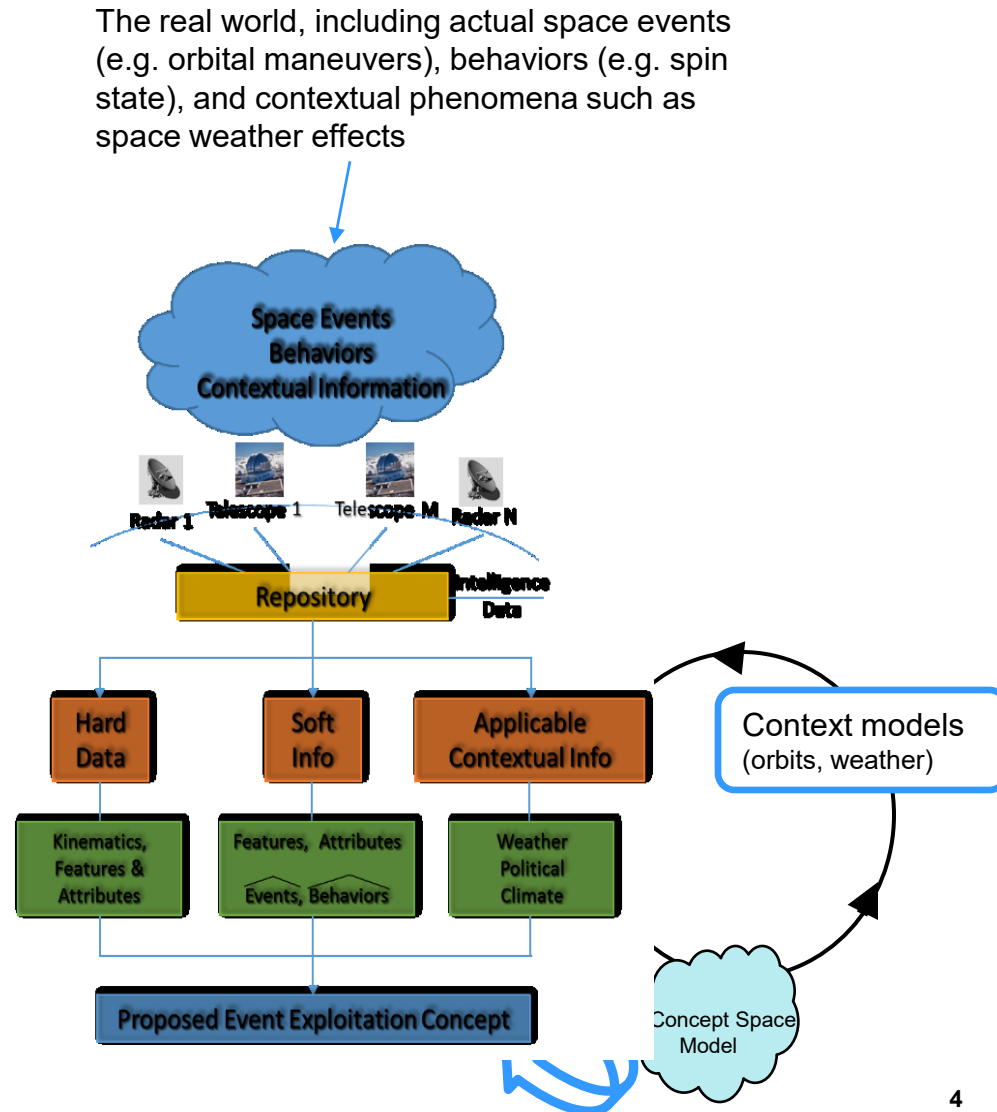
Space Object Ontology and other Common Core Ontologies, together with newly developed Space Process Ontology

Sensing

Hard data, e.g. radars and telescopes, and soft data, e.g. HUMINT and OSINT (open-source intelligence)

Systems Software

CUBRC's OSCAR (for Ontological Semantic Concept Alignment and Refinement) tool



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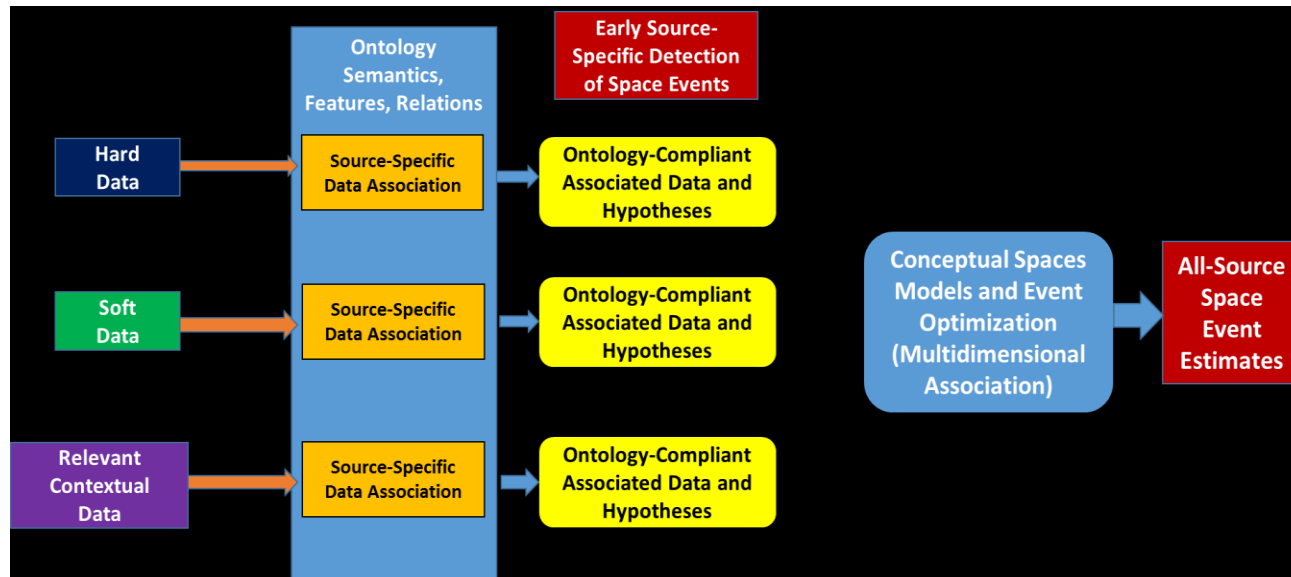
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- Sensor data is used to produce the hard data, which is transmitted to a location and stored in a repository
- Intelligence information (e.g. HUMINT), similarly, is transmitted to a location and stored in a repository
 - For example, available thrusting capability
 - It may also provide estimates of events and behaviors (e.g. a thrusting maneuver) that may be both spatial and temporal in nature
 - Space weather and other contextual information is an important third – largely soft – information source
- Contextual information includes space weather models populated in real time
 - Contextual data may also incorporate other aspects, such as the current political climate, threat levels, and so forth

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- All of this data/information will be ingested into the ontology framework



- Each type of data and information (hard, soft and contextual) will be subject to its own source-specific process of tagging with ontology terms via association processing, in what is in effect an Ontological Alignment step
 - CUBRC's OSCAR (for Ontological Semantic Concept Alignment and Refinement) tool facilitates the transformation of siloed data stores into unified knowledge-bases by exploiting the logical relations between ontology terms
 - Soft data in the form of text will be transformed into structured data by applying standard Natural Language Processing tools

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- **Coordination/Synergy**
 - **AFRL collaboration**
 - **AFRL RI through CUBRC InRHYTHM contract**
 - **Past projects to be leveraged**
 - **IARPA Knowledge Discovery and Dissemination (KDD program) funded to CUBRC**
 - **Data coordination**
 - **NOFS data collections**