



An Ontology-based Standard for Transportation Planning

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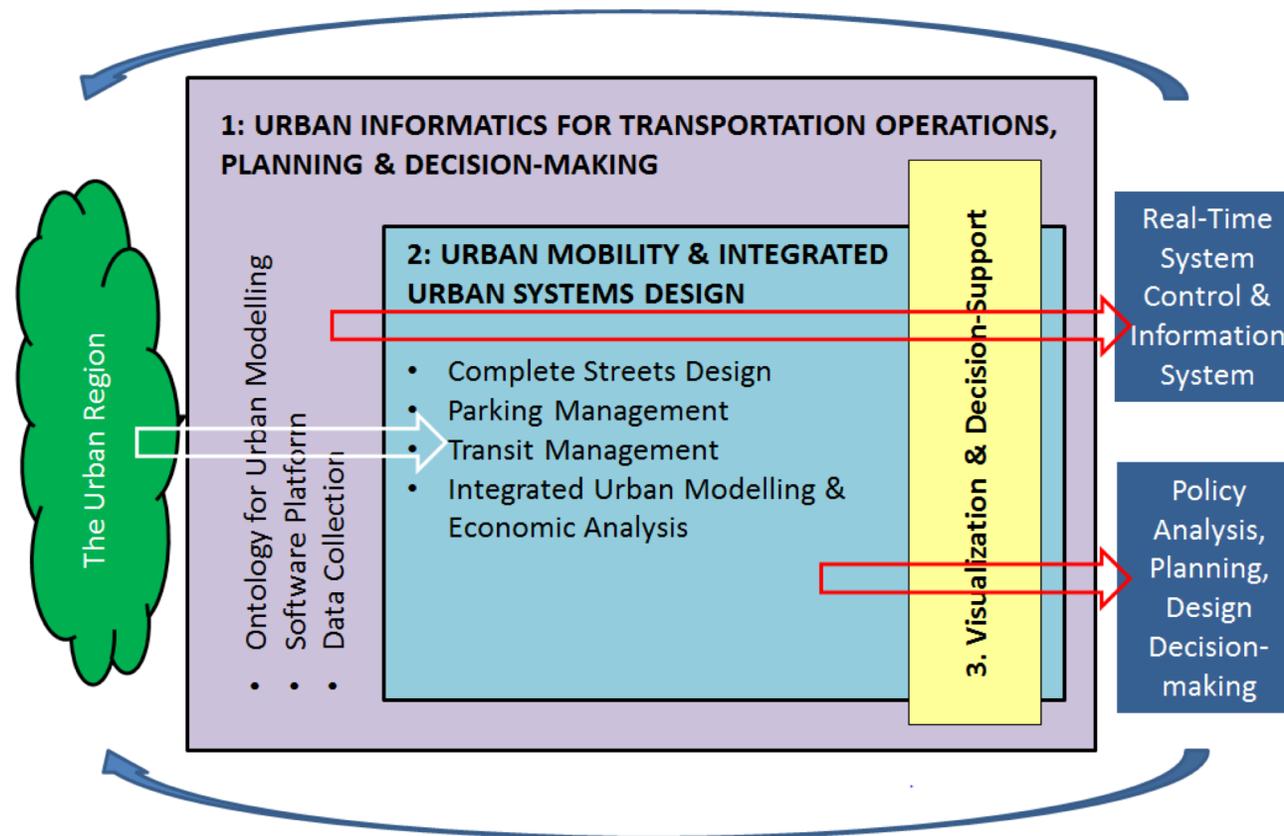
International Workshop on Formal Ontologies Meet Industry

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Background: iCity-ORF

iCity-ORF: Supported by the Ontario Ministry of Research and Innovation through the ORF-RE program.

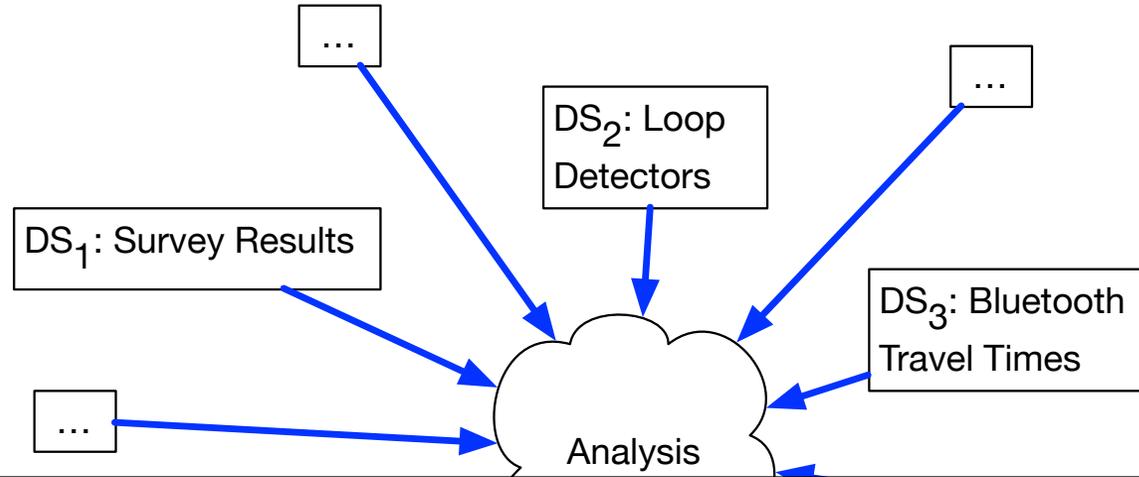


Example: ILUTE

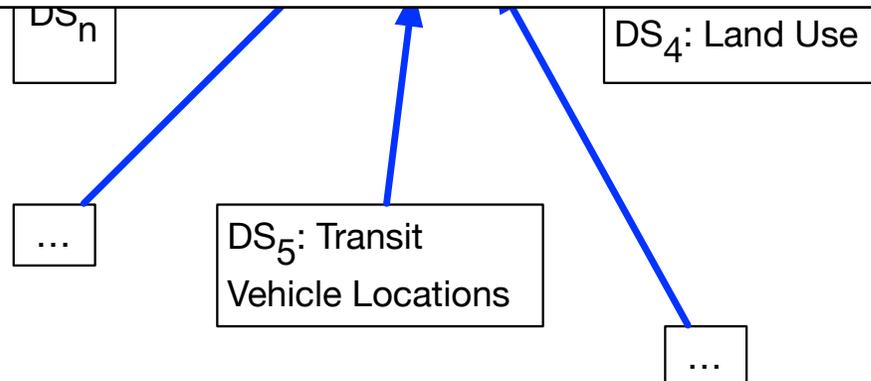


Integrated Land Use, Transportation and Environment model (simplified)

Transportation Planning



Collecting and combining this data is not straightforward



Transportation Planning Problem

- Problem:
 - Collected data is expensive, but often not reused
 - Multitude of transportation planning tools are in use by researchers and cities
 - No easy way to compare results as each has their own unique data models
- We need a standard for this data

Transportation Planning Standard: Requirements

- Requirements for a solution to the transportation planning problem
 - Must work with different tools, data formats
 - Must be easily extensible: tools and approaches are always changing
 - Must have a **unique** interpretation; incorrect and correct interpretations should be clearly identifiable (**Limitation of traditional standards**)
- Proposed Solution
 - An ontology-based transportation planning standard

Ontology Requirements

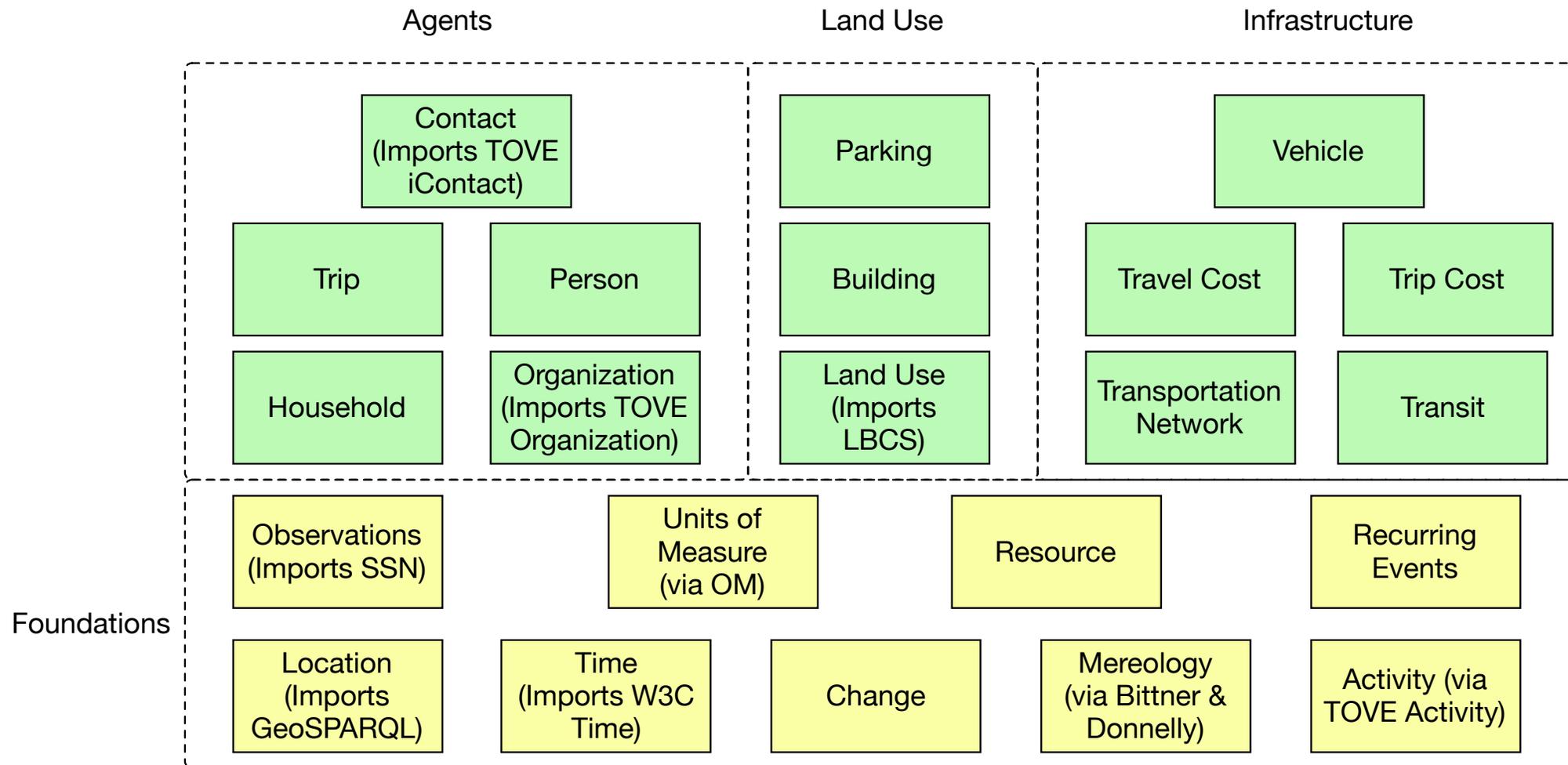
- Gathered from subject matter experts
 - Interviews
 - Datasets
 - Competency Questions:
 - Retrieve data to help researchers with analysis of
 - population, land use and travel demand data
 - historical data on subway incidents and bus bridging
 - road congestion data

Requirements

- Broadly, 3 key areas to be represented:
 - Land use
 - Infrastructure
 - Behaviour (agents)

iCity Transportation Planning Suite of Ontologies (TPSO) Overview

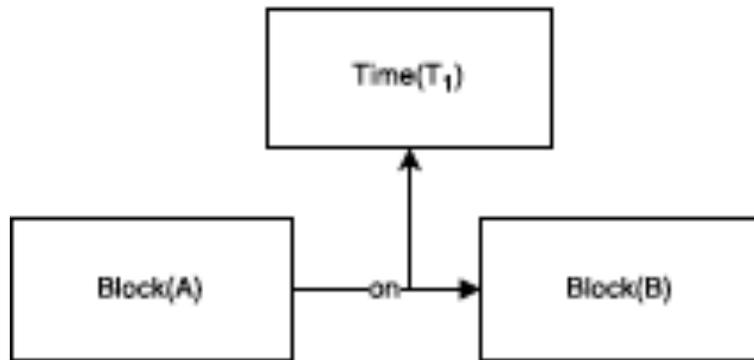
<http://ontology.eil.utoronto.ca/icity/UrbanSystem/>



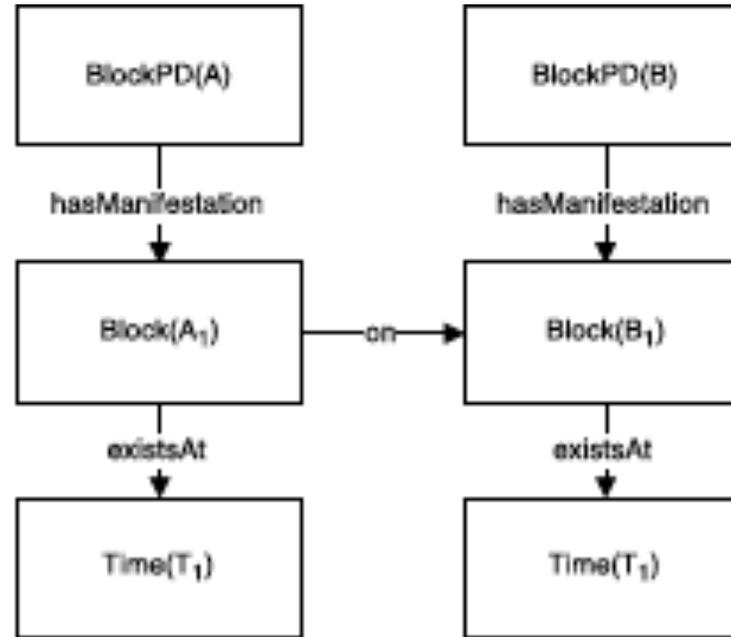
Design Decisions

- OWL2
 - Project requirements
- Reuse where possible
- No top-level ontology
 - Bottom-up approach
 - Reuse of foundational, generic ontologies as needed
- *4D approach** to capturing change
 - *a pragmatic decision rather than an official ontological view
 - Use the notion of temporal parts when change is required

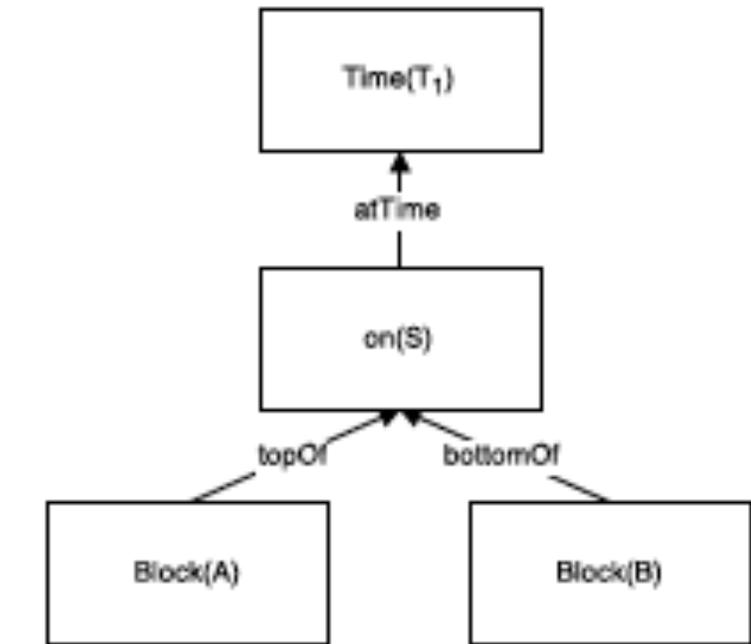
Change over time in OWL



Traditional: $on(A, B, T_1)$

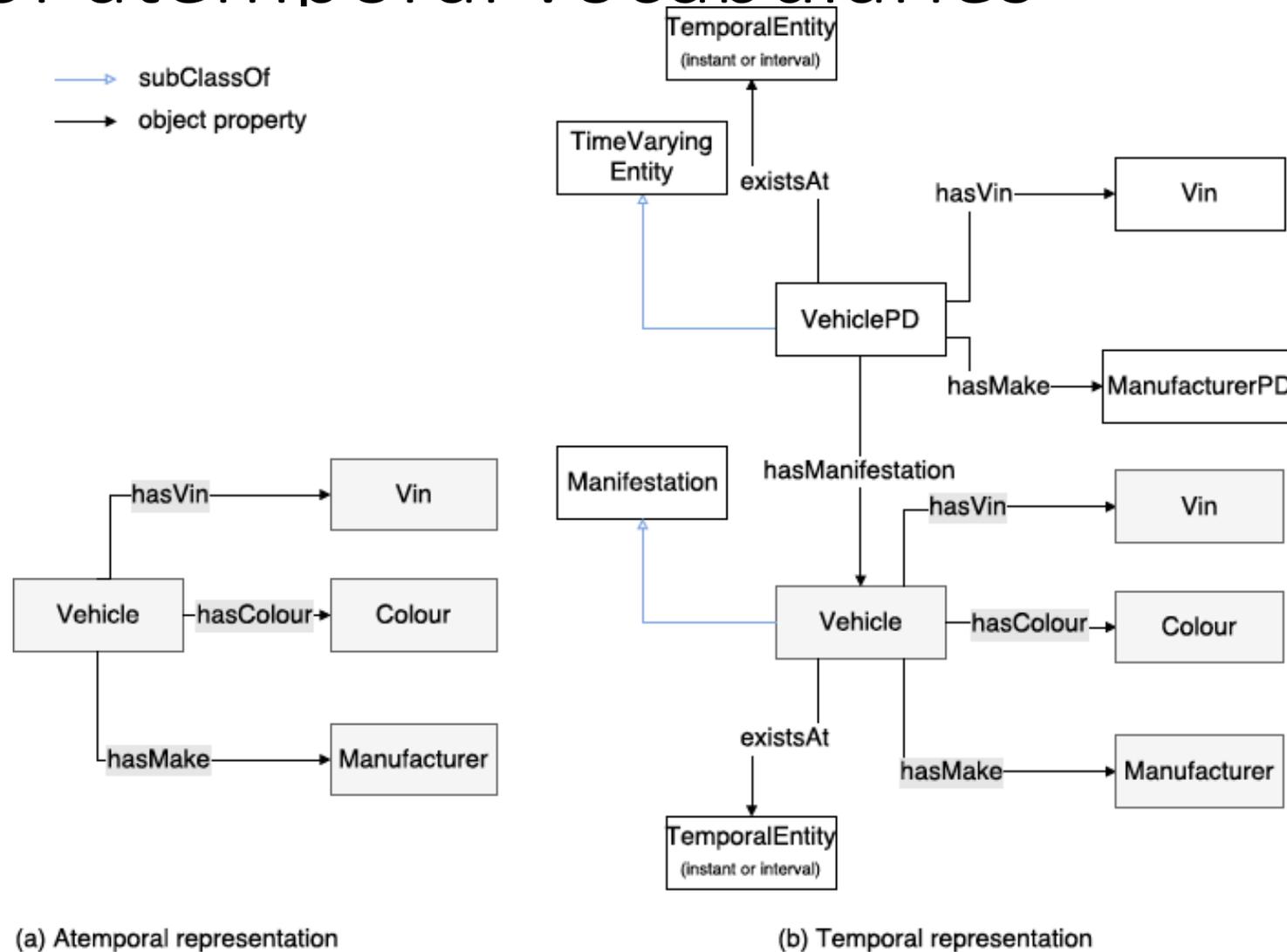


4D: $on(A_1, B_1)$

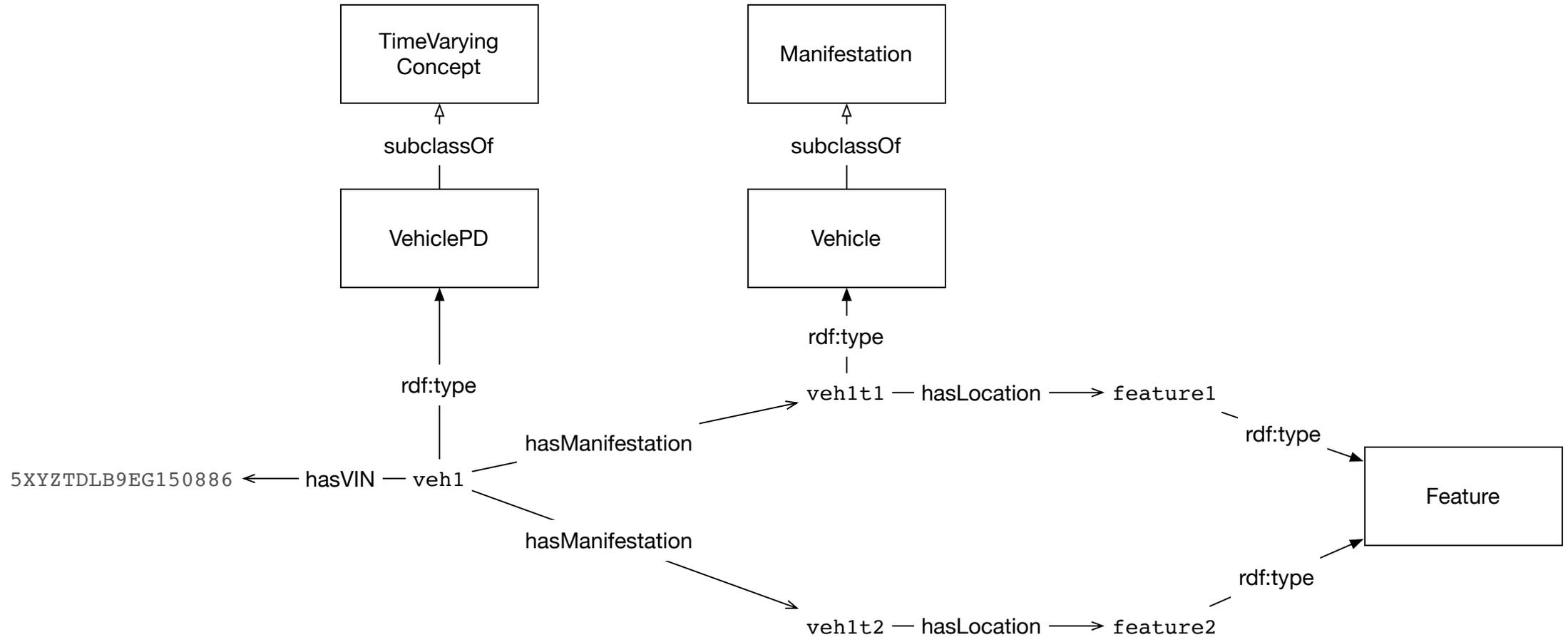


N-ary Relations: $topOf(A, S)$, $bottomOf(B, S)$, $atTime(S, T_1)$

Change over time example: reuse of atemporal vocabularies



Change over time example

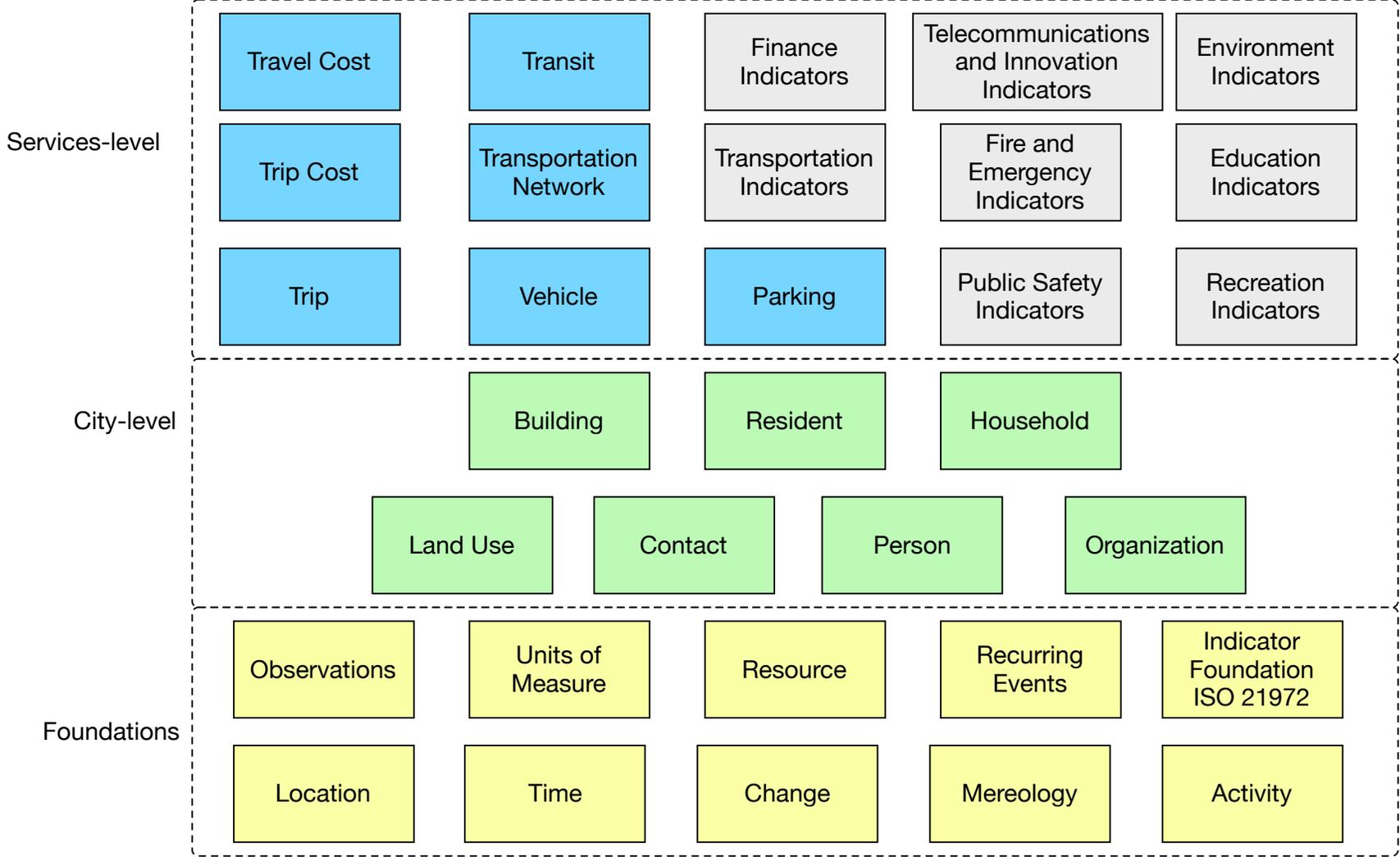


Evaluation

Evaluated in the context of iCity-ORF project

- ✓ Consistency checking
- ✓ Mapping datasets into RDF using the ontology-based representation
- ✓ Competency questions, proof-of-concept implementations:
 - What subway incidents occurred during the month of August 2019?
 - What buses were not located on their route after a subway incident?
 - What is the reading of the loop detector on road segment X?
 - Explore the attributes of travel behavior data:
 - What is the distribution of types of people travelling from zone A to zone B?
 - What is the distribution of mode types that people use to arrive at zone C?
 - ...

More Recently...



Moving Forward

- Working toward standardization
 - City Data Model (ISO WG11 Smart Cities NWIP)
 - Coordination with transportation standards efforts (ISO and beyond)
- An iterative development process
 - New applications will serve to inform and improve the ontology
 - Esri Canada: working to standardize road network terms, create a knowledge graph that adopts the ontology to merge Esri data with transportation planning data
 - Expanding from the transportation planning domain to consider other city services

Questions?

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iCity TPSO links to individual ontologies

- Activity:
<http://ontology.eil.utoronto.ca/icity/Activity/>
- Building:
<http://ontology.eil.utoronto.ca/icity/Building/>
- Change:
<http://ontology.eil.utoronto.ca/icity/Change/>
- Household:
<http://ontology.eil.utoronto.ca/icity/Household/>
- Land use:
<http://ontology.eil.utoronto.ca/icity/LandUse/>
- Mereology:
<http://ontology.eil.utoronto.ca/icity/Mereology/>
- Monetary Value:
<http://ontology.eil.utoronto.ca/icity/MonetaryValue/>
- OM:
<http://ontology.eil.utoronto.ca/icity/OM/>
- Organization:
<http://ontology.eil.utoronto.ca/icity/Organization/>
- Parking:
<http://ontology.eil.utoronto.ca/icity/Parking/>
- Person:
<http://ontology.eil.utoronto.ca/icity/Person/>
- Public Transit:
<http://ontology.eil.utoronto.ca/icity/PublicTransit/>
- Resource:
<http://ontology.eil.utoronto.ca/icity/Resource/>
- Location:
<http://ontology.eil.utoronto.ca/icity/SpatialLoc/>
- Time:
<http://ontology.eil.utoronto.ca/icity/Time/>
- Transportation Network:
<http://ontology.eil.utoronto.ca/icity/TransportationSystem/>
- Travel Cost:
<http://ontology.eil.utoronto.ca/icity/TravelCost/>
- Trip:
<http://ontology.eil.utoronto.ca/icity/Trip/>
- Trip Cost:
<http://ontology.eil.utoronto.ca/icity/TripCost/>
- Vehicle:
<http://ontology.eil.utoronto.ca/icity/Vehicle/>