Ontology Architecture: Top Ontology Architecture

OntologySummit2013:
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Track Title: Track-C: Building Ontologies to Meet Evaluation Criteria
Session Topic: Ontology Development Methodologies for Integrating Ontologies

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Business Object Reference Ontology

Larger Projects: Architecture

- In various disciplines, when working on larger projects there is a tradition of thinking in terms of an architecture
  - E.g. Enterprise / Systems / Software Architecture
- Firstly a meta-methodological point;
  - I suggest:
    - A good methodology for approaching large ontology projects should have an architectural component.
- Here I will use architecture in a loose sense
  - There is extensive discussion on what exactly an architecture is
    - which is not directly relevant to the points I want to make.
  - I would like to avoid this – however interesting a rabbit hole it seems.
    - I will try and do this by illustrating the points with examples based upon my experience with the development and application of top ontologies such as BORO, IDEAS and MODEM.

Why architecture? 1

- Conceptual (understanding) view
  - "In most successful software projects, the expert developers working on that project have a shared understanding of the system design. This shared understanding is called 'architecture.' "
  - "This understanding includes how the system is divided into components and how the components interact through interfaces."

    Who Needs an Architect? - Martin Fowler - quoting Ralph Johnson.
    www.in-ag.eu/uploads/media/whoNeedsArchitect.pdf

- Clearly it is good if the developers on large ontology projects have a shared understanding of the overall design.
  - And, what the components are (or should be) is an interesting question.

Why architecture? 2

- Instrumental view
  - "There is another style of definition of architecture which is something like "architecture is the set of design decisions that must be made early in a project."
  - I complain about that one, too, saying that architecture is the decisions that you wish you could get right early in a project, but that you are not necessarily more likely to get them right than any other."

    Who Needs an Architect? - Martin Fowler - quoting Ralph Johnson.
    www.in-ag.eu/uploads/media/whoNeedsArchitect.pdf

- Here there is a pragmatic concern about the economics of development
  - the cost of not making the right decision at the right stage.

Sensitivity to dependence

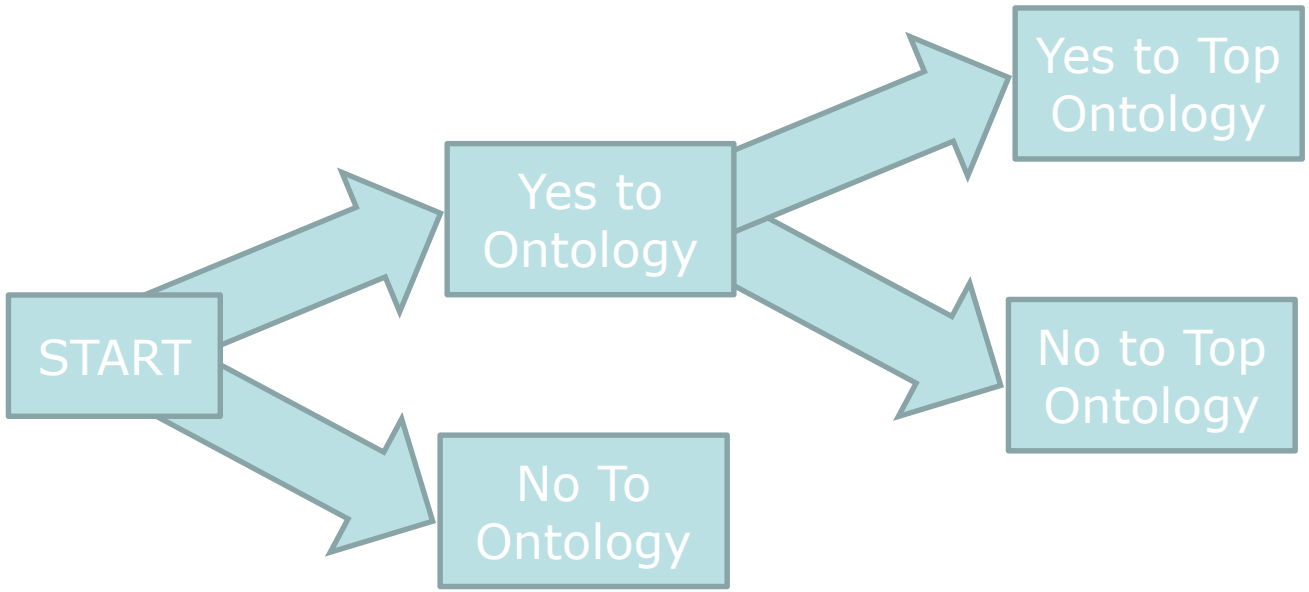
- Software engineering has been aware of the issue for some time:
  - E.g. Boehm, B. W., Software Engineering Economics, Prentice-Hall, Englewood Cliffs, NJ, 1981.
- Related to ideas in other disciplines
  - E.g. path dependence – 'history matters'.
- See also Wimsatt: Generative Entrenchment
  - "Developmental Constraints, Generative Entrenchment, and the Innate-Acquired Distinction." In Integrating Scientific Disciplines, ed. W. Bechtel, pp. 185–208. (1986).
- Theme is:
  - Managing the project involves managing the dependence between major components.
    - Major components are those where they have a dependence that matters.

What might count as a large-ish ontology project

- Setting a context

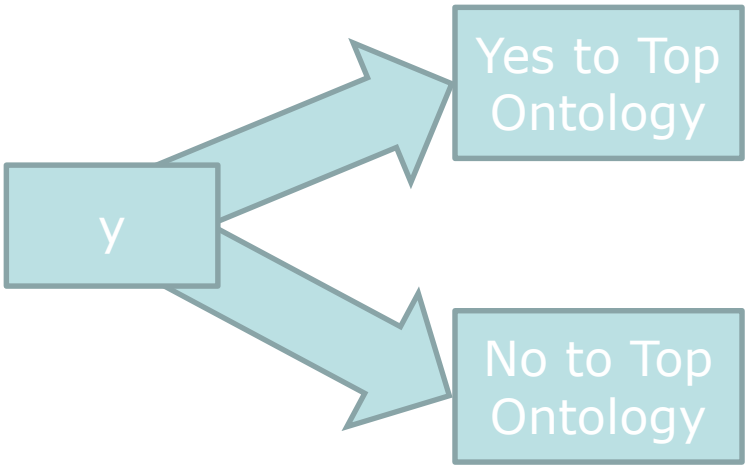
- Project footprint
  - 12 development teams
  - 9 sites
  - 6 applications
  - 3 continents

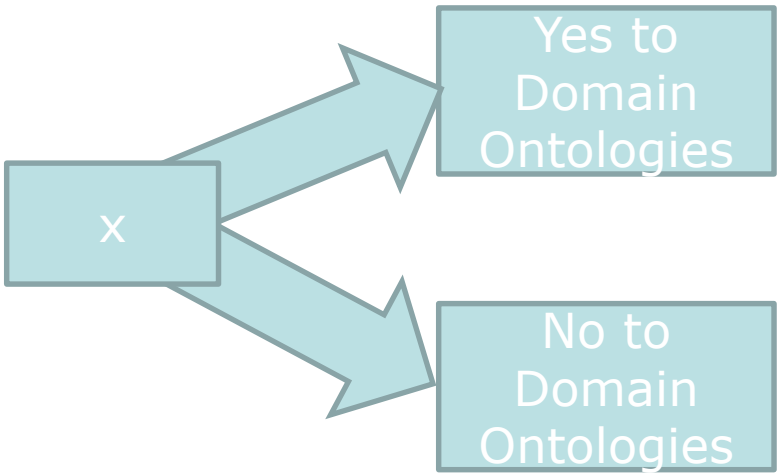
A couple of key early choices



Some obvious path dependence here.
No point in worrying about whether to have a top ontology, if you eventually decide not to have an ontology at all.
Nice simple ordering.

How to order these choices?





Other things being equal:
Does it make sense to decide whether you are going to have a top ontology, before deciding on whether to have domain ontologies?
Does it make sense to decide on domain ontologies first?
Would it be costly to build a range of domain ontologies and then decide that you need a top ontology?
Domain ontologies under a top ontology are a different proposition from ones that are not.

Top ontology - two considerations

- Conceptual
  - "Find a scientific man who proposes to get along without any metaphysics... and you have found one whose doctrines are thoroughly vitiated by the crude and uncriticized metaphysics with which they are packed" (Charles Peirce, Collected Papers 1.129).
  - In other words;
    - There is going to be a top ontology anyway; Do you want to manage it directly (or manage the results of a heterogeneous framework on a piecemeal basis)?
- Instrumental
  - The shape of the top ontology will influence the shape of the data on the ground.
  - You can:
    - manage this influence, harmonizing the data structure across the project, or
    - live with and translate between heterogeneous variety.

Having said yes to a top ontology

- What is the next step
  - One obvious choice
    - Buy or build?
- The choices when building a top ontology can provide a way of assessing existing ontologies
- One dimension of design choices for a top ontology are the metaphysical (or meta-ontological) choices.
  - Designed (built) top ontologies can be classified by these design choices.

A range of meta-ontological (metaphysical) choices

- Perdurantism versus endurantism
- Presentism versus eternalism
- Absolute versus relative space, time and space-time
- Modally extended versus unextended individuals
- Materialism and non-materialism
- Extensionalism versus non-extensionalism – I – Universals
- Extensionalism versus non-extensionalism – II – Particulars
- Topology of time – branching or linear.

References – for the choices

- Partridge C (2002) Note: A Couple of Meta-Ontological Choices for Ontological Architectures. LADSEB CNR, Padova, Italy
- Stefano Borgo, Aldo Gangemi, Nicola Guarino, Claudio Masolo, Oltramari A (2002) WonderWeb Deliverable D15: Ontology RoadMap. Ontology Infrastructure for the Semantic Web. Laboratory For Applied Ontology - ISTC-CNR, Trento
- Masolo C, Borgo S, Gangemi A, Guarino N, Oltramari A (2003) WonderWeb Deliverable D18: Ontology Library. Ontology Infrastructure for the Semantic Web. Laboratory For Applied Ontology - ISTC-CNR, Trento
- Semy SK, Pulvermacher MK, Obrst LJ (2004) Toward the Use of an Upper Ontology for U.S. Government and U.S. Military Domains: An Evaluation. The MITRE Corporation, Bedford, Massachusetts

Strong interdependence

- There is a strong network of interdependence between these choices
  - This makes it difficult to have a simple ordering, where one comes before another.
- Here the dependence issue is not so much order, but compatibility.
  - E.g. Presentism and endurantism go together;
    - Presentism and perdurantism make uneasy bedfellows.
- There are a number of different compatible sets of choices

How to rate the 'sets of choices'

- One can try and make an assessment of the economic costs.
- However, there are a range of other criteria to supplement this. One helpful resource is Kuhn [see below]. He took an empirical approach and studied the characteristics of successful improvements in scientific theories, uncovering this list of six features:
  - Kuhn TS (1977) Objectivity, value judgment, and theory choice. In: The Essential Tension: Selected Studies in Scientific Tradition and Change. University of Chicago Press, pp 320--339

Making good meta-ontological choices

- Kuhn's six criteria
  - Generality: where the scope of the improved theory increased.
  - Simplicity: where the improved theory is less complicated (it is typically more 'deeply simple' in the complexity theory sense).
  - Explanatory power: the ability of the improved theory to give increased meaning.
  - Fruitfulness: the ability of the improved theory to meet currently unspecified requirements or to be easily extendable to do so.
  - Objectivity: the ability of the improved theory to provide a more objective (shared) understanding of the world.
  - Precision: the ability of the improved theory to give a more precise picture of the world.
- Making the ontological choices explicit provides an opportunity to take a position that improves on a number of features; explanatory power and objectivity are obvious candidates.

- For more detail see
  - "Guidelines for Developing Ontological Architectures in Modeling and Simulation" in Ontology, Epistemology, and Teleology for Modeling and Simulation Philosophical Foundations for Intelligent M&S Applications Andreas (Ed.) 2013.