Building Policy- and Context-Aware Support for Semantic Web Applications

(Nokia/MIT Project “SwapMe”) 

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Keynote at the 5th International Workshop on Web Semantics, September 2006
Game Plan

- Semantic Web
- Some applications of Semantic Web I find interesting
- My current project
- Conclusions (maybe)
About the Semantic Web Vision
Observing the Current Situation

• Modern information systems (such as Web sites) decide several things for you:
  • how information is presented
  • how information is used (combined, manipulated, etc.)
  • (and sometimes) what things are automated
• “Pre-determined” presentation makes it difficult to
  • provide access to, say, visually impaired people
  • access the information using a “non-standard device”
    • e.g., cell phone
• (I find this offensive!)
• In addition: combining information sources is hard
  • automating this is very hard
  • automating unforeseen situations is next to impossible
“Smart Data”…

• Information, in more “raw” form, is appealing
  • not tied to specific rendering, specific device, specific browser, etc.
  • most importantly, not tied to a specific task

• Presentation can be determined dynamically, based on
  • user, device
  • context (task, environment, etc.)

• Combining information could be automated
  • Web 2.0 “mash-ups” are a step in the right direction, but they still require engineering
  • enter semantics and “Semantic Web data”…
Semantic Web: A Difficult Message

• Any specific problem (typically) has a specific solution that does not require Semantic Web technologies

• Q: Why then is the Semantic Web so attractive?
A: For future-proofing

Semantic Web can be a solution to those problems and situations that we are yet to define
ser·en·dip·i·ty | serənˈdipətē |
noun
the occurrence and development of events by chance in a happy or beneficial way: a fortunate stroke of serendipity | a series of small serendipities

(Source: Oxford American Dictionary)
About Serendipity

• This is the **defining** characteristic of the Semantic Web

• Serendipity in **interoperability**
  • can we interoperate with systems, devices and/or services we knew nothing about at design time?

• Serendipity in **information reuse**
  • when information has accessible semantics, this is easier…

• Serendipity in **information integration**
  • can information from independent sources be combined?
    • NB: issues of **identity** are amplified
  • even simple forms of reasoning can help
    • e.g., *inverse functional properties* of OWL
Identity Crisis?

• TimBL: “[...] everything of importance deserves a URI”
• Nice idea, but current reality is unfortunately different
  • many things **do not have** URIs
  • it is unclear how to choose URIs (w/ obvious consequences)
• Can we add something to RDF to help?
  • using something like `owl:sameAs` allows you to give “hints” to system (reasoner) on how to unify data
  • **inverse functional properties** allow automatic integration
    • these are like unique keys in a database
    • use a **reasoner** to do this
• (I call this “RDF++”)
Beyond Web Applications

• Modern PC applications are essentially just repositories for information (typically) in proprietary formats
  • operating **across application boundaries** is difficult at best
  • any two applications can be engineered to enable information exchange, but we cannot anticipate all possible “pairings”

• In addition to the explicitly represented information, these systems hold a lot of **implicit** information
  • implicit information is largely **inaccessible** to current applications
  • e.g., your calendar may indicate that you have a flight reservation from Boston to Krakow
    • **implying** that if you take the flight, you will then **be** in Krakow
    • (this will be useful)
Mobile & Ubiquitous Computing
Mobile Web Access Today

• Web access on mobile devices is available today
  • (in fact, some browsers are quite good…)

• Some **technical limitations** exist
  • network (narrow bandwidth, high latency)
  • display (typically small)
  • input (often no full keyboard)

• Content is designed for “standard devices”
  • (= PCs: high bandwidth, large display)
  • most (commercial) content is **rendering-oriented**
Some Issues with Mobile Web Access

• We can overcome the technical limitations, but the real limitations are of different nature…

• Mobile devices are used in “unusual” situations
  • when laptops, etc., are not viable (e.g., in the car)
  • typically, when paying attention to something else
    • mobile users are attention-constrained
  • browsing is not the ideal paradigm for information access

• What do we need?
  • (besides new kinds of user interfaces…)
  • information & content that’s not rendering-oriented
  • more automation (now, humans essentially do all the work)
Ubiquitous Computing (1)

• Ubiquitous Computing is an interoperability nightmare!
  • instead of occasionally connecting a handful of devices, dynamically connect/disconnect/reconnect possibly hundreds of devices

• Traditional approach to interoperability: standardization
  • anticipate everything about the future
    • and a priori agree on how to act
  • (or: force all interactions to a restricted set of possibilities)

• What about unanticipated situations?
  • how do you agree dynamically on how to behave in a situation that wasn’t covered by a standard?

⇒ not “future-proof”
Ubiquitous Computing (2)

- Connections with public and/or untrusted devices
- We may need to “borrow” functionality from other devices
  - uniform representation of functionality is useful
  - this implies that we need to be able to represent and reason about contracts, payments, etc.
- The Ubiquitous Computing vision is largely contingent on getting unanticipated “encounters” of devices to work
- Today, ensuring interoperation introduces a high cost
  - any interaction has to be specifically designed/engineered
  - heavy emphasis on application-specific standardization
  - spontaneous interoperability is impossible
What Do I Propose?

• Semantic Web technologies
  • role of serendipity is critical in “ephemeral” use cases (e.g., in ubiquitous computing)
  • Many problems in mobile and ubiquitous computing are (ultimately) problems of representation

• Context-awareness

• Policy-awareness
Context-Awareness

• “context” = information about “current situation”

• Can guide decisions about selection and prioritization
  • (of what information gets presented and how)

• Automation & autonomy
  • knowing the context can ease service discovery
  • contextual information can be used to limit choices in planning

• Semantic Web formalisms and techniques are beneficial in implementing context-awareness [Lassila & Khushraj 2005]
Policy-Awareness

- Ability to represent, reason about, and **enforce** policies
- Policies: representations on how to act in a future situation
  - can control data access and usage (security & privacy)
  - support autonomous behavior
- Trying to determine context benefits from policy-awareness
  - e.g., access to some information permitted given that it is **only** used for context-determination
- Semantic Web languages have been used to build sophisticated policy solutions [Kagal 2004]
NRC Cambridge & Project “SwapMe”
Mobile Ecosystem (NRCC’s Mission)

- Virtual Information Spaces (WWW, corporate DBs, other heterogeneous information sources)
- Social Rules (law & policy, social conventions, "native sociology")
- Physical World ("Out-of-Phone Experience": sensors, actuators, "borrowed" peripherals)
- Application Development Platform (intuitive abstractions, application architecture, programming environment, etc.)

Nokia
Connecting People
Mobile Ecosystem & “SwapMe”

Virtual Information Spaces (WWW, corporate DBs, other heterogenous information sources)

Uniform data model for all information & application data

Rapid development of lightweight Semantic Web applications

Personal Device

Application Development Platform (intuitive abstractions, programming environment, etc.)

Social Rules (law & policy, social conventions, “naive sociology”)

Context modeling and management using Semantic Web techniques

Physical World ("Out-of-Phone Experience": sensors, actuators, "borrowed" peripherals)

Rich, expressive models of policies
Goals of Project “SwapMe”

- Have software do more on behalf of users
  - ubiquitous support for Semantic Web data (acquisition, transformation, storage, querying, reasoning, etc.)
  - support for context- and policy-awareness
  - framework for “thin”, task-specific applications
- Offer users flexible, context- and policy-aware means to
  - access any information (local and remote)
  - manipulate & interact with data and environments
- We are particularly interested in information integration
  - (“mash-ups”, but done without any programming)
Policy- and Context-Aware Architecture

Abstract Idea:

Concrete System (so far):

- Visualization, interfaces
  - OINK (cf. my talk later today)
  - other “Semantic Web browsers”
- Integration
  - “RDF++”
  - implemented using Wilbur
- Context-awareness
  - [Lassila & Khushraj 2005]
- Policy-awareness
  - (work in progress)
Conclusions

- Semantic Web useful w/ information integration and access
  - e.g., via context- and policy-awareness
  - this goes beyond the “mere” Web
- “Selling” the idea of the Semantic Web is not easy
  - understanding that it is about serendipity helps...
- Some hard problems
  - ubiquitous computing
  - mobile information access
  - Semantic Web application development
    - (we need platform support)
- Nokia/MIT project “SwapMe” attempts to realize all this
Questions? Comments?

• More information
  • mailto:ora.lassila@nokia.com
  • http://wiki.nrcc.noklab.com/SwapMe

• Thanks to the SwapMe project team
  • Tim Berners-Lee
  • Felix Chang
  • Daniel Jackson
  • David Karger
  • Deepali Khushraj
  • Ralph Swick
  • Danny Weitzner