

Semantic Gadgets: Device and Information Interoperability

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October 2003

Outline

⇒ **Semantic Web**

- **Ubiquitous Computing**
- **Semantic Web & Ubiquitous Computing**

Motivation for the Semantic Web

- **Problem: Web was built for humans**
 - human interpretation needed to “understand” content (it does not scale)
 - consequently, automation is difficult
 - it is particularly difficult to automate “unforeseen” situations
- **Rough solution: make the Web friendlier for machines**
 - we need “machine-understandable” content (not “machine-readable”, we already have that)
 - (note: by “machine-understandable” we mean content with *accessible formal semantics*)
- **The Web is more than just a “library”**
 - think of it as infrastructure for services & functionality
- **Drivers**
 - automation (e.g., in search), interoperability (e.g., in e-commerce)
 - but: compelling business models are still missing

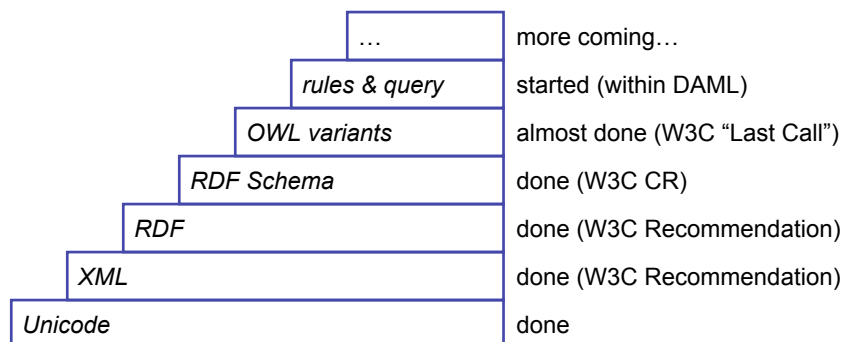
Is It Enough to Just Use XML?

- **Short answer: no**
 - the typical - albeit incorrect - answer is “yes”
- **Long answer: XML offers a way to introduce new syntax (new names, tags, ...), but no way of introducing or coordinating semantics**
- **XML has a tree-like data model**
 - if your (representational) problem does not lend itself to be a tree, you lose (sorry)
 - (and this is even before we get to the “semantics” part)
- **Hype (from a Sun white paper): “The industry is clearly focusing in on [XML] as the *lingua franca* to enable Web services...”**
 - not only is XML not a *lingua franca*, it is not even a *lingua*

Semantics via Sharing

- **Controlled vocabularies**
 - interoperability improves if the same term is always used to denote the same thing (e.g., instead of arbitrary keywords, choose from a list)
- **What is an “ontology”**
 1. a controlled vocabulary
 2. a concept taxonomy
 3. other relations between concepts
 - Gruber: “A specification of conceptualization”
- **Library scientists are good with this stuff**
 - e.g., Dewey Decimal System is an ontology

Stepping Towards the Semantic Web



- **Semantic Web is built in a layered manner**
- **Not everybody needs all the layers**

Interoperability of Services

- **Semantic Web, via ontologies and reasoning, will improve interoperability of information systems**
- **This can be applied to “services”**
 - semantic description of service interfaces enables automatic discovery, composition, etc.
 - DARPA’s DAML-S activity (Stanford, CMU, Yale, SRI, BBN, Nokia, ...)
 - analog to “Tower of Babel” (from Genesis 11:1-9)
 - will Web Services succeed without the Semantic Web? (I think not)
- **Substitution of “equivalent” services**
- **Web Services are a good abstraction of all kinds of functionality**

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What is Ubiquitous Computing?

- **Proliferation of computing into everyday objects**
- **User interaction with the environment**
 - (as opposed to interaction with some specific device)
 - pushing many tasks into the periphery of users' attention
- **Observing some general trends**
 - + handheld computing devices, wireless communication
 - + internet connects "everything"
 - but, technology is not necessarily becoming easier to use

What is Ubiquitous Computing? (contd.)

- **Smart rooms: earlier focus on "static" configurations**
 - how people really live and work has largely been ignored
- **Our goal: "things should just work"**
 - devices should "figure out what to do", form communities and collaborate
 - environments are "dynamic": changes should cause minimal disruption
- **Maybe, in some ways, ubiquitous computing has already happened...**

Nokia Series 60 vs. MIT Oxygen H21

Nokia 3650



- Fits in your pocket
- Works world-wide
- Java MIDP, Symbian OS 6.1
- Video camera 640x480
- IR, Bluetooth, Tri-band GSM
- MMC Memory card slot
- Volume: Millions
- Battery: standby 8 days; talking 4 hours (recharge 1 hour)

MIT Oxygen H21



- Portable
- Works on campus
- Java, Linux
- Ditto
- IR, plus expansion slots
- 2 PC card slots
- Volume: Dozens
- Considerably less...

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Role of Standardization

- Open standards are a prerequisite for interoperability
- Many initiatives for device, service & capability discovery
- But, standards will “only get us so far”
 - beyond, we need “reasoning”
 - many emerging standards are in trouble because of vocabularies
 - CC/PP, P3P (adoption hindered by lack of vocabularies)
 - proliferation of (specialized) XML DTDs
 - Dublin Core (4 years, 15 attributes!)
 - lack of tools for maintaining (e.g., merging) vocabularies
 - (enter the Semantic Web)
- “Serendipitous” interoperability

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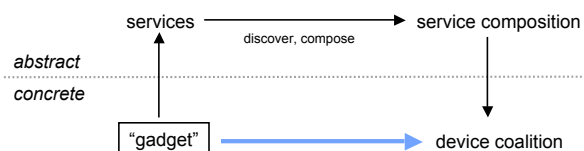
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Semantic Gadgets...?

- **Combine ubiquitous computing & the Semantic Web**
 - device capabilities and service functionality explicitly represented
 - everything is addressable (using URIs)
 - Semantic Web as the basis for “semantic interoperability”
- **Critical components**
 - connectivity: wireless, ad hoc networks + service discovery
 - representation: models of devices, services, users, environments, etc.
 - reasoning, learning, planning
- **Other useful technologies**
 - sensors, context-awareness, mobile code, ...

Device Coalitions

- **All devices advertise their services**
 - devices can extend their functionality by discovering missing functionality offered by other devices
 - everything can be discovered
- **Abstract the physical world as “services”**
 - notion of “Web Services” is useful here (no real distinction between physical and virtual functionality)
- **DAML-S (OWL-S): Semantic Web Services**
 - modeling Web Services and their semantics using W3C’s OWL
 - addresses service discovery and composition



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Questions?

- <http://www.nokia.com/research/semanticweb>
- <mailto:ora.lassila@nokia.com>

Thanks to: Dana Pavel, Mark Adler, Janet Cerniglia

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