

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

(Nokia/MIT Project “SwapMe”)

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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 | .serənˈdɪpɪtē |

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*

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]

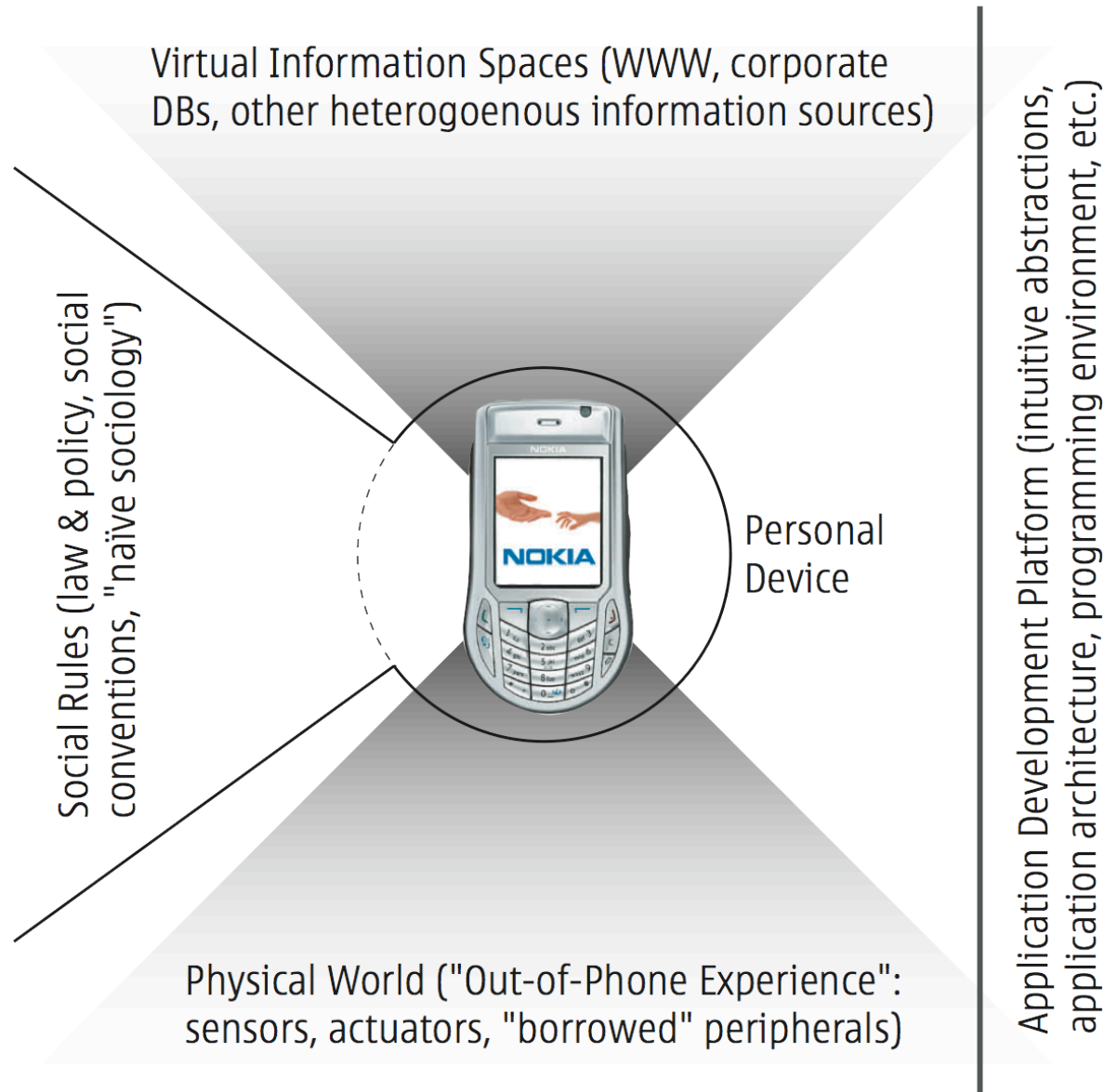
Policy-Awareness

- 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]

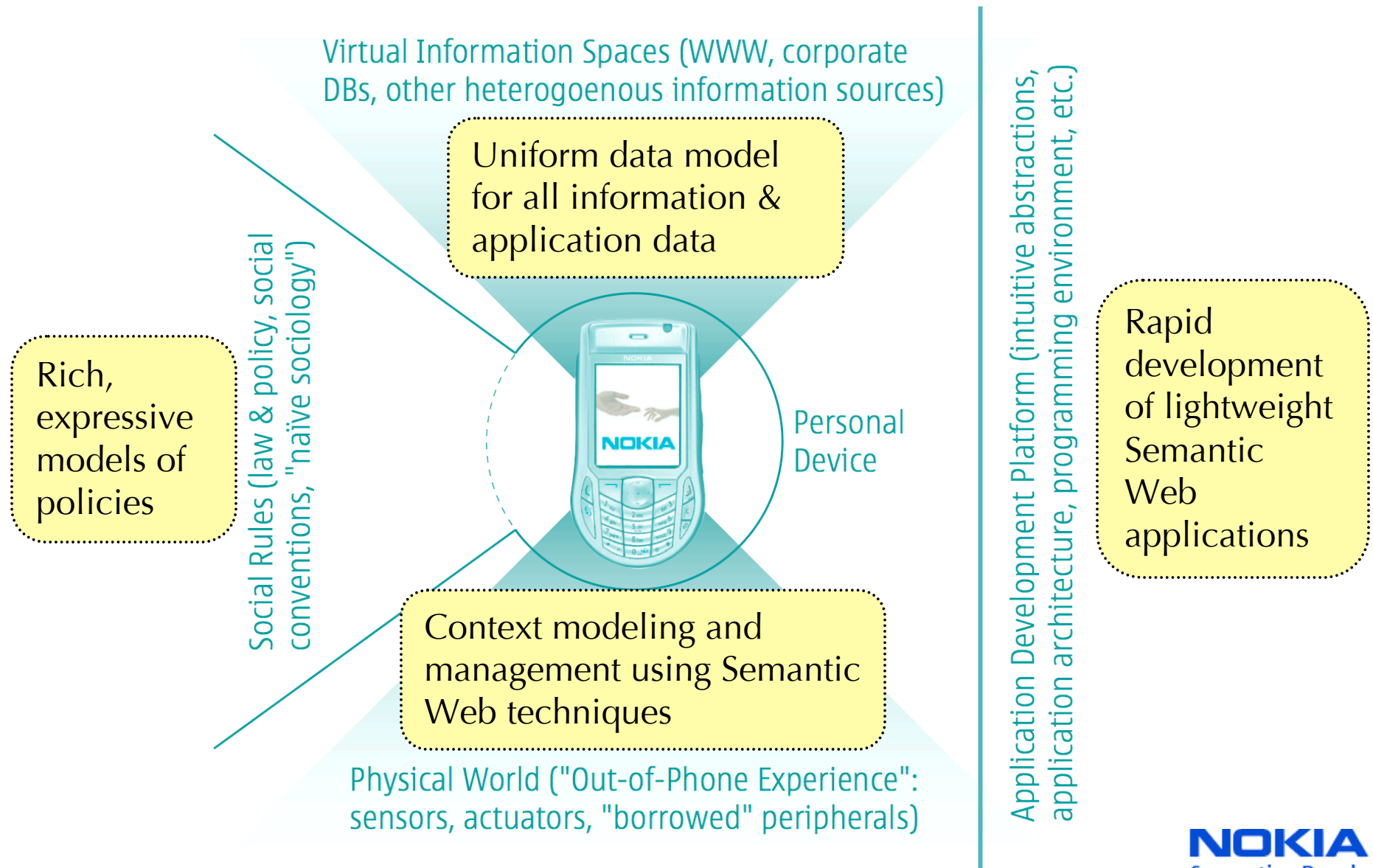


NRC Cambridge & Project “SwapMe”

Mobile Ecosystem (NRCC's Mission)



Mobile Ecosystem & "SwapMe"

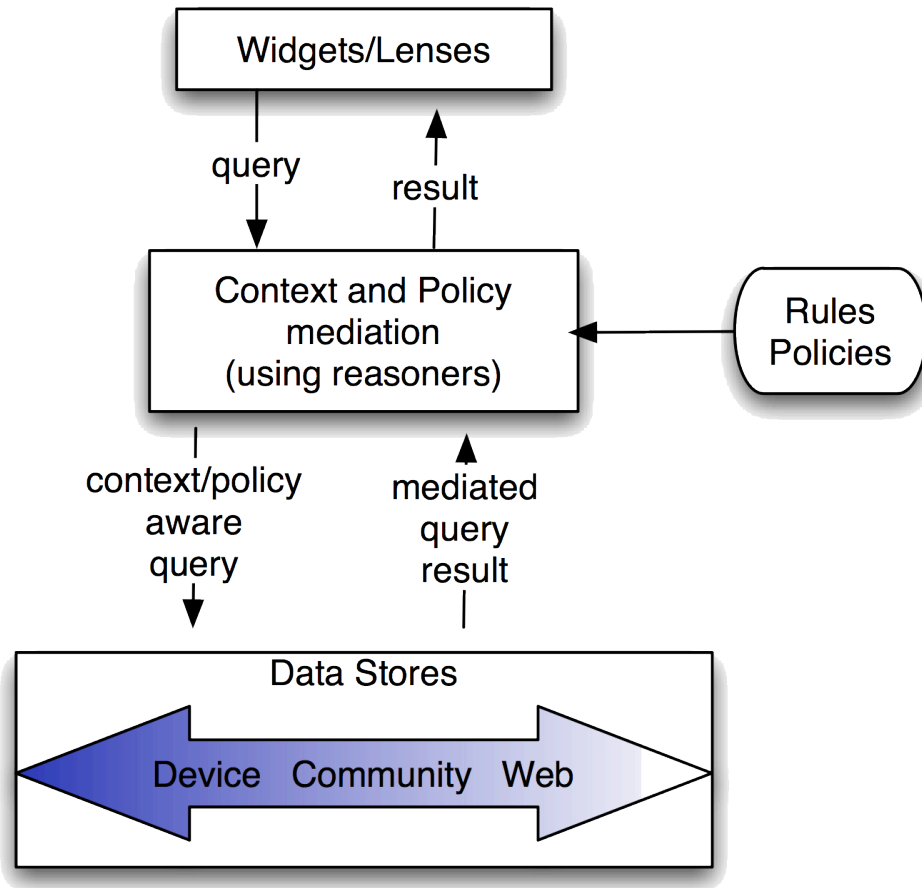


Goals of Project “SwapMe”

- 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
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