

Semantic Gadgets: Pervasive Computing Meets the Semantic Web

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Mobility Makes Things Different

- **Device location is a new dimension**
 - more information about the user and the usage context available
 - new applications & services are possible
- **Devices are different**
 - reduced capabilities: smaller screens, slow input devices, lower bandwidth, higher latency, worse reliability, ...
 - trusted device: always with you & has access to your private data
- **Usage contexts and needs are different**
 - awkward usage situations (e.g., in the car while driving)
 - specific needs ("surfing" unlikely)
 - you are always "on" (= connected)
- **Dilemma:**
 - the Internet - by design - represents a departure from physical reality
but mobility grounds services & users to the physical world

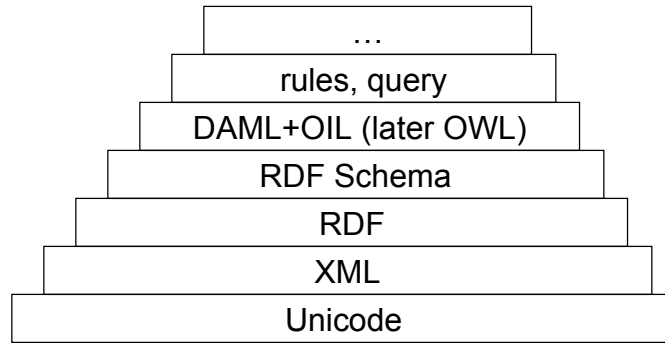
Some Enablers of Mobile Internet

- **Access to services from handheld terminals**
- **Dynamic synthesis of content**
- **Context-sensitivity**
 - location is one dimension of a “context”, but there are others
- **New Technologies**
 - Artificial Intelligence
 - machine learning: automatic customization and adaptation
 - automated planning: autonomous operation
 - “Semantic Web”
 - intelligent synthesis of content from multiple sources (ad hoc & on demand)
 - explicit representation of semantics of data & services
 - Ubiquitous (aka Pervasive) Computing
 - (a paradigm shift in personal computing)

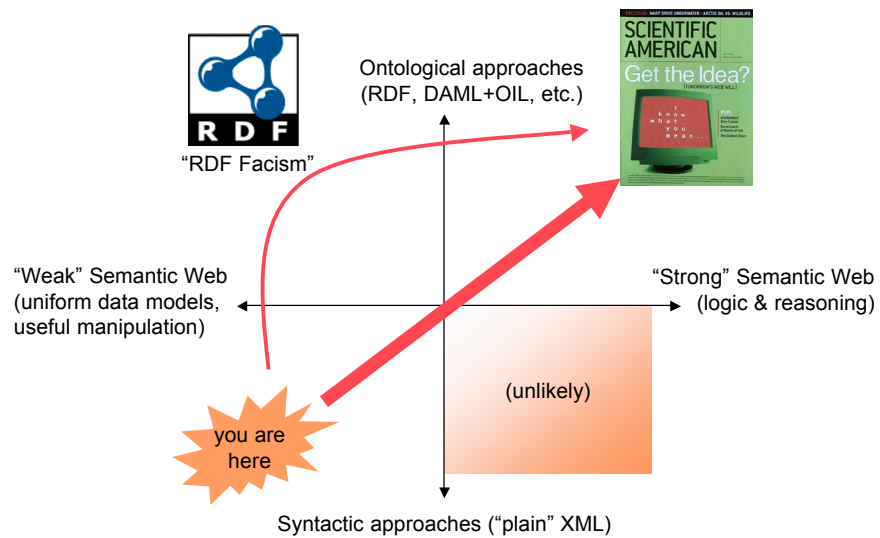
Semantic Web: Motivation & Features

- **Current WWW was built for humans, not for machines**
- **“Semantic Web” is like a global KB**
 - (cf. use of the WWW as an infrastructure)
 - better security & privacy will allow us to reason about trust, enabling completely new kinds of services and businesses
 - content-with-semantics paves way for the use of software agents
- **Hyperlinks with meaning**
 - agents can navigate the WWW by following semantic links
- **What will happen when data comes with semantics?**
 - data from different sources can be combined
 - new, perhaps unforeseen opportunities and functionality will result
 - machines can meaningfully use the WWW and perform tasks on our behalf (“machine-understandable” content)

Semantic Web: Data Format “Layer Cake”



Semantic Web: Characterizations



Is it enough to just use XML?

- Typical answer: yes (though incorrect)
- Short answer: no
- 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)

XML is not “machine accessible meaning”

林克昌 根留台灣 可能增高

在愛戴音樂心奔走之下，華裔指揮家林克昌根留台灣的可行性又提升了幾分。兩廳院主任李俊、國家音樂廳樂團副團長黃奕明日前親赴林克昌、在聖芳濟所拜會，並提出多場客席邀約。此外，台灣省立交響樂團團長陳溫雄也早「下訂」，邀請林克昌赴台中縣峰，從八月十日起訓練省交，為期長達一個月。

在台灣諸多公家樂團中，陳溫雄是以實際行動表達對林克昌肯定的樂界人士之一，曾多次公開表示對林克昌指揮才華的讚佩，而且幾乎每個樂季都邀請林克昌客席演出。

此外，林克昌上個月赴俄羅斯與頂尖的「俄羅斯國家管絃樂團」灌錄了柴可夫斯基晚期三大交響曲以及「羅密歐與朱麗葉」、「斯拉夫進行曲」、「義大利總想曲」，最後的DAT母帶也在前兩天寄回台灣。製作人楊忠衛與林克昌試聽之後，都對錄音效果一尤其音質表現感到相當滿意，楊忠衛估計呈現了七分林克昌指揮神韻。

俄羅斯國家管絃樂團首席布魯尼日前也讚譽林克昌的指揮藝術有三大特點：一是控制自如的彈性速度；二是強烈的動態對比；三是宛如呼吸歌唱的旋律處理。這些對錄音師而言都構成很大挑戰。俄國錄音師雖然採用多軌混音，但定位、場面都有可觀之處。

- (thanks to Frank van Harmelen, VUA)

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
- **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

Role of Standardization

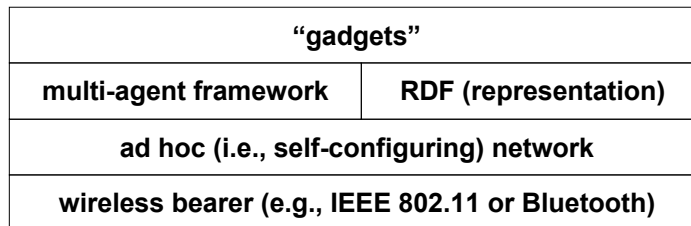
- **Open standards are a prerequisite for interoperability**
- **Many initiatives for device, service & capability discovery**
- **But, standards will "only get us so far"**
 - beyond, we need "reasoning"
 - many emerging standards are in trouble because of vocabularies
 - CC/PP, P3P (adoption hindered 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**

NRC/ATG UbiComp Architecture (1999)

- **Agent-based approach to “smart environments”**
 - agents represent devices, users, and the room
 - discovery and exchange of capabilities, goals, etc.
 - RDF metadata as the basic representational framework
- **Simple architecture with the following components:**
 - sensory agents
 - represent devices which accept user input (speech, gestures, etc.)
 - manipulation agents
 - represent devices which are capable of causing physical actions such as dimming lights, closing shades, projecting slides, etc.
 - problem solving agents
 - input “fusion”, goal formation
 - planning
 - action delegation to manipulation agents

NRC/ATG UbiComp Architecture (1999)

- **Ad hoc connectivity**
 - (original implementation used a fixed network w/ X10 for physical control)
 - designed to use a wireless, ad hoc network
- **Layered architecture**



Semantic Gadgets...?

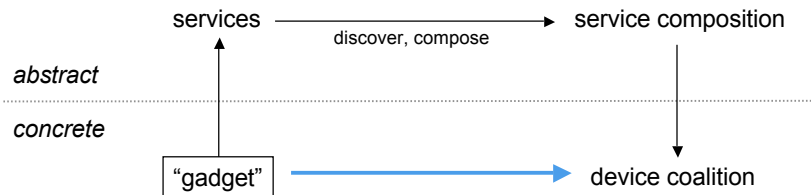
- **Combine ubiquitous computing & the Semantic Web**
 - device capabilities and service functionality explicitly represented
 - everything is addressable (using URIs)
 - Semantic Web is the basis for “semantic interoperability”
- **Critical components**
 - connectivity: wireless, ad hoc networks + service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

Semantic Gadgets: Device Coalitions

- **All devices advertise their services**
- **A device can extend its functionality by**
 - discovering missing functionality offered by another device
 - contracting the use of the service
- **Everything can be discovered**
 - including “reasoning services” or who is going to develop overall plans for integrating devices into larger, task-oriented “teams”
 - (we are still working on this...)

Semantic Gadgets: Coalition Formation

- **Abstract the physical world as “services”**
 - notion of “Web Services” is useful here
 - no real distinction between physical and virtual functionality)
- **DAML-S: Semantic Web Services**
 - modeling Web Services and their semantics using DAML+OIL
 - addresses service discovery and composition



Questions?

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