# Semantic Web Services
# SS 2016

# Mobile Services

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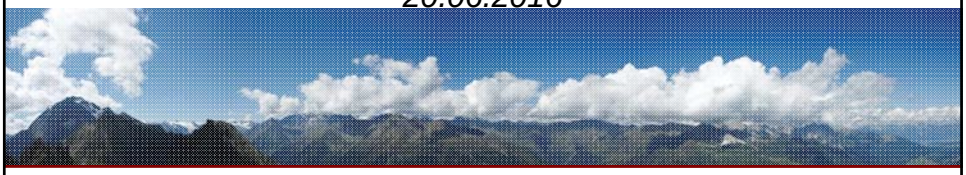
*20.06.2016*





## Where are we?

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| # | Title |
|---|---|
| 1 | Introduction |
| 2 | Web Science + TourPack project (separate slideset) |
| 3 | Service Science |
| 4 | Web services |
| 5 | Web2.0 services |
| 6 | Semantic Web + ONLIM APIs (separate slideset) |
| 7 | Semantic Web Service Stack (WSMO, WSML, WSMX) |
| 8 | OWL-S and the others |
| 9 | Semantic Services as a Part of the Future Internet and Big Data Technology |
| 10 | Lightweight Annotations |
| 11 | Linked Services |
| 12 | Applications |
| **13** | **Mobile Services** |

## Outline

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- Motivation
- Technical Solution
  - Preliminaries
  - Design Mobile Applications and Services
  - Mobile Platforms Overview
- Illustration by a larger example
- Extensions
- Summary

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What are mobile services and why do we need them?

# MOTIVATION

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## Motivation: People Buy More Smart Phones Rather than PCs

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Personal Computers, Sold

**236M**

**31%**
**(2009 compared to 2008)**

**Soon the number of smart phones will take over PC**

Smart Phones, Sold

**225M**

**28%** **(2009 compared to 2008)**

[Ref: Gartner , Competitive Landscape: Mobile Devices, Worldwide, 2Q09]

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## Motivation

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- The Mobile Web refers to using a mobile phone handset device incorporating a web browser to access the World Wide Web.
  - http://en.wikipedia.org/wiki/Mobile_Web
- Research and discussion on Mobile Web started in early 2000
  - Initially too expensive due to connection costs, few users, mostly top management in enterprises accessing emails with BlackBerry
- We can really speak of Mobile Web for everyone only since 2008 thanks to market revolution introduced by Apple's iPhone
- As by today the total number of mobile web users grew past the total number of desktop computer-based web users
- Number of services and applications accessible over mobile phones are constantly growing (in January 2010 more than 150,000 on Apps Store with more than 3,000,000,000 downloads)
  - Ref: http://www.apple.com/pr/library/2010/01/05appstore.html

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## What Made the Mobile Web to Take Off?

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- Devices become very well designed and offering new touch screen based ways to navigate the Internet, e.g. iPhone
  - But still this is not really the motivation why Mobile Web become real, the real reason is mostly the new marketing strategy adopted
- Created a Web2.0 market place for applications
  - User can easily search for applications matching their needs, install them and updated them
- Mobile operators lowering prices for the Internet data connection with device for the end-user, for regulatory as well as reasons connected with the sales of the smartphones
  - Flat rate, 3GB cost around 15 euro per month. Before you could pay more than 100 euro for the same amount of data
- There are many products similar to iPhone, not only in term of device capability, but also in term of marketing strategy

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## Why Mobile Web is so popular?

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*Internet access "on the go" provides advantages to many, such as the ability to communicate by email with others and obtain information anywhere, the web, accessed from mobile devices*

- Anytime and anywhere access
- Enables people to take advantage of Internet services even though usually they do not access Internet through a PC
- Make Internet access easy and cheap
- Brought new services on mobile phones

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## Example: Google's Mobile Services

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[http://www.google.com/mobile/]

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## Example Scenario I

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- SmartPhones are getting more and more powerful and offers wide functionalities


- Years ago this sounds like a futuristic scenario, now it's reality

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## Example Scenario II

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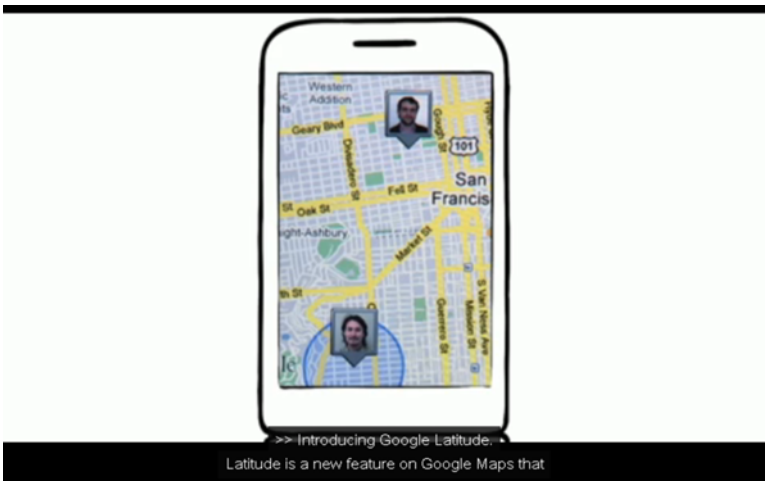


[http://www.youtube.com/watch?v=Q-Oq-9enE-k]

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Mobile Service for Mobile Platforms

# TECHNICAL SOLUTION

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Overview of basic concepts

# TECHNICAL SOLUTION: PRELIMINARIES

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## Mobile Service - Definition

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- "A radiocommunication service between mobile and land stations, or between mobile stations." – traditional, short
  [International Telecommunication Convention, Malaga-Torremolinos, 1973]
- "Radiocommunications services between ships, aircraft, road vehicles, or hand-held terminal stations for use while in motion or between such stations and fixed points on land." – official, by WTO
  [http://www.wto.org/english/tratop_e/serv_e/telecom_e/tel12_e.htm]
- "Any service that can be operated on a mobile device, such as both voice and data services, for example, roaming, SMS and MMS, video streaming, location-based services, etc." – technically oriented
  - We consider this one in the context of this lecture

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## Mobile Services vs. Web Services I

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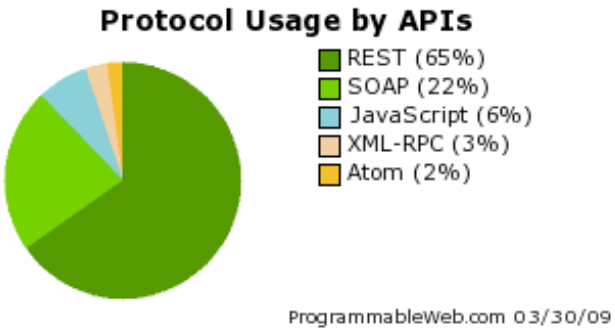
- Many Web Services and APIs were originally developed with server to server or server to browser in mind, not mobile applications

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## Mobile Services vs. Web Services II

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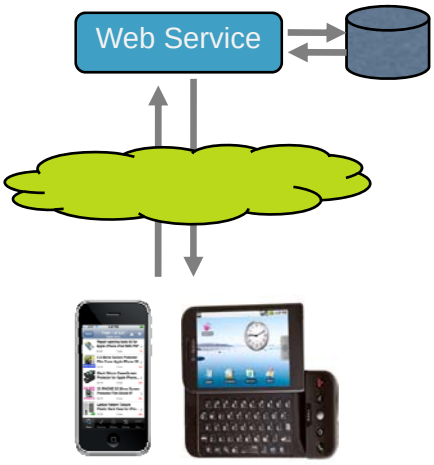
- Mobile platforms have their own set of challenges given:
  - Bandwidth
  - Memory and CPU Availability
  - Storage Capacity
  - Connectivity Options and Issues
  - Security
  - User Interaction and Display

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## Mobile Applications vs Desktop Applications

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- Less Computing Power
- Need to keep down power consumption
- Connection not 100% available
- Smaller display
- Different means of interactions
- Mobile services (GPS, SMS, …)
- A multitude of Operating Systems
- Event driven paradigm

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## Mobile Devices Constraints I

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- **Small screen size**
  - This makes it difficult or impossible to see text and graphics dependent on the standard size of a desktop computer screen.
- **Lack of windows**
  - On a desktop computer, the ability to open more than one window at a time allows for multi-tasking and for easy revert to a previous page. There are apps for the iPhone (e.g. Oceanus), as well as browsers such as Opera Minibut, allowing multiple windows, but sometimes a limited number, and not multiple windows in the same screen.
- **Navigation**
  - Most mobile devices do not use a mouselike pointer, but rather simply an up and down function for scrolling, thereby limiting the flexibility in navigation.

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## Mobile Devices Constraints II

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- **Types of pages accessible**
  - Many sites that can be accessed on a desktop cannot on a mobile device. Many devices cannot access pages with a secured connection, Flash or other similar software, PDFs, or video sites, although recently this has been changing.
- **Broken pages**
  - On many devices, a single page as viewed on a desktop is broken into segments, which are each treated as a separate page. Paired with the slow speed, navigation between these pages is slow.

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Creating applications dealing with mobile devices constraints

# TECHNICAL SOLUTION: DESIGN MOBILE APPLICATIONS AND SERVICES

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## Reference Architecture for Mobile Applications

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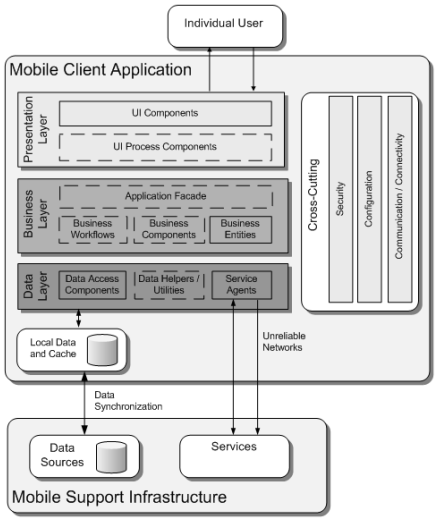
- Specialization of a three tier architecture
- Some parts of data (data sources) and some parts of logic (services) are accessed via remote connection




http://apparchguide.codeplex.com/

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## Presentation Layer

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- The presentation layer is responsible for all interactions with the user
- The most common ways to present data to mobile users:
  - HTML
  - Native UI

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## Business-Logic Layer

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- The business-logic layer is responsible for implementing the basic rules of the system according to the operating rules of the business
- This layer is in charge of accessing the data tier and for processing the data retrieved and sent to the presentation layer

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## Data Layer

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- The main function of the data layer is to provide fast, reliable access to data needed to run a system
- Additionally, the data layer is responsible for maintaining information about the relationships between data

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## Design Challenges

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- Authentication vs. Authorization
  - How to simplify Mobile User access to Web APIs and Services
- Speed Traps
  - How to avoid excessive number of requests that may saturate the available bandwidth to the device (and cause higher connection prices)
- Large Data Set Handling
  - How to handle large data set so as to reduce response time and bandwidth consumption
- User Interaction
  - How to deal with constraints posed by mobile devices displays, connections to provide and effective interaction to users

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## Authentication vs. Authorization

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- Definitions
  - Authentication is any process by which a system verifies the identity of a user who wishes to access it [http://mtechit.com/concepts/authentication.html]
  - Authorization is the process of giving someone permission to do or have something [http://hitachi-id.com/concepts/authorization.html]
- Security is an important concern over mobile connections where devices are used in more open environments
- Usual desktop solutions for authentication and authorization that requires complex interaction with remote services may constitute a complex overhead to mobile users
- Thus we need to adopt principles to simply, but still retain security of access to remote services through mobile devices
  - Authentication from the API provider based on API Key stored on the devices can avoid user to provide their authorization details.

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## Speed Traps

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- Connection in mobile environments is subject to different quality in different contexts
  - Connection could be on wifi, 3G or 1G based signal and bandwidth
  - Currently 5G is being developed and tried out e.g. in labs
- Connection is a scarce resource
  - Connection may not be always available
- Thus we need to adapt to connection quality and availability by
  - Segmenting functionality and/or calls to prevent bandwidth issues
  - Adopting polling techniques that adapts to the available bandwidth and connection
    - Create subset of calls and functionality when on slower bandwidth
    - Use notifications if possible
    - Modify polling interval based on need
  - Recovering from intermittent or lost connections

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## Large Data Set Handling – Overview

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- Data transmission is a costly resource
  - In term of performances, bandwidth and a service cost
- Transmission of large chunk of data is more error prone than small chunk of data
  - Quality of connection is not constant in a mobile environment
- Thus we need to minimize large data sets, by employing techniques such as:
  - Ask for only those elements that you require (Filtering)
  - Ask for only those items that you require (Paging)
  - Cache what you can locally instead of requesting the same data (Caching)

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## Large Data Set Handling – Filtering

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- Types of Request Filtering
  - Selection criteria for narrowing data set returned
- In general determine how efficient are the calls – reduce data waste
  - How much extra data, streaming, parsing is happening to access the data you use? How much data is being dropped on the floor?

```
<?xml version="1.0" encoding="utf-8"?>
<FindItemsAdvancedRequest xmlns="urn:ebay:apis:eBLBaseComponents">
  <!-- Standard Input Fields -->
  <MessageID> string </MessageID>
  <!-- Call-specific Input Fields -->
  <BidCountMax> int </BidCountMax>
  <BidCountMin> int </BidCountMin>
  <CategoryHistogramMaxChildren> int </CategoryHistogramMaxChildren>
  <CategoryHistogramMaxParents> int </CategoryHistogramMaxParents>
  <CategoryID> string </CategoryID>
  <CharityID> int </CharityID>
  <Condition> ItemConditionCodeType </Condition>
  <Currency> CurrencyCodeType </Currency>
  ...
  <ShippingLocation> CountryCodeType </ShippingLocation>
  <ShippingPostalCode> string </ShippingPostalCode>
  <SortOrder> SortOrderCodeType </SortOrder>
  <StoreName> string </StoreName>
  <StoreSearch> StoreSearchCodeType </StoreSearch>
</FindItemsAdvancedRequest>
```

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## Large Data Set Handling – Paging

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- Provide paging functionality to users
  - Cluster set of contents into pages (improves also UI usability)
- Not all calls have paging available
  - If the service you are calling does not allow to retrieve “pages” of data, using them on the device, will not anyway prevent transfer of large chunk of XML data (unless device support live XML stream parsing).
- Inform user of current location in set, easy access to next and previous sets (page)
  - Enable users to navigate through pages
  - Enable users to understand where they are in the collection of data

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## Large Data Set Handling – Caching Strategies

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- To minimize API round trips leverage caching and storage
  - Cache in memory (volatile memory of the mobile device)
  - Cache in onboard light weight database or file (persistent memory of the mobile device)
  - Off device persistence (persistent storage service over the Web)

| Memory Cache | Onboard | Off Device |
|---|---|---|
| • Memory Intensive<br>• Non-persistent<br>• E.g. data key for last viewed item | • Space Limitations<br>• Persistence across sessions<br>• E.g. user Information | • Requires Connection<br>• Reuse across users<br>• E.g. statistics, look up tables |

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## User Interaction

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- Besides issues related to connection aspects, adoption of mobile devices poses challenges for the User Interaction
  - Asking for new information using synchronous call, due to bandwidth limitations may totally block user interactions with the application
  - Re-requesting already accessed information may end up in making slower the interaction
- Thus we need to employ techniques that hide the limitations of mobile devices and mobile connections by
  - Caching of information for future retrieval and navigation
  - Executing web service parsing and display in background when possible to prevent UI blocking
  - Using JIT and Information on Demand to maximize small layouts and minimize web service calls

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# MOBILE PLATFORMS OVERVIEW

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## Smartphone OS Competitive Landscape – Status 2009-10

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| | iPhone OS (Apple) | BlackBerry OS (RIM) | Window Mobile (Microsoft) | Android (Google) | Symbian (Nokia) |
|---|---|---|---|---|---|
| Platform | • Closed | • Closed | • Open | • Open | • Open |
| Source Code | • Closed | • Closed | • Closed | • Open | • Open (in future) |
| 2009 WW Market Share [Gartner] | • 14.4% | • 19.9% | • 8.7% | • 3.9 | • 46.9% |
| Smartphone traffic share [AdMob] | • WW: 46%<br>• US: 39% | • WW: 5%<br>• US: 7% | • WW: 1%<br>• US: 1% | • WW: 25%<br>• US: 46% | • WW: 21%<br>• US: 1% |
| Pros | • Early momentum<br>• Data hungry early adopters<br>• Powerful distribution channel | • Strong reach (particularly in US) | • Manufacturer / carrier agnostic | • Manufacturer / carrier agnostic<br>• Open source innovation | • Massive global reach<br>• Open source innovation |
| Issues | • Apple dependant | • BlackBerry dependent<br>• Distribution | • Distribution | • Late to market<br>• Uncertain consumer demand | • Limited reach in US<br>• Distribution |
| Application ecosystem [Distimo] | • iTunes Apps Store<br>• >185K apps<br>• More than 3B downloads | • BlackBerry App World<br>• 5,5k apps | • Windows Marketplace<br>• 1k apps | • Android Market<br>• 50k apps | • OVI Market<br>• 7k apps |

[Gartner, http://www.gartner.com/it/page.jsp?id=1306513, 02/2010]
[Distimo, http://www.distimo.com/uploads/reports/Distimo%20Report%20-%20January%202010.pdf]

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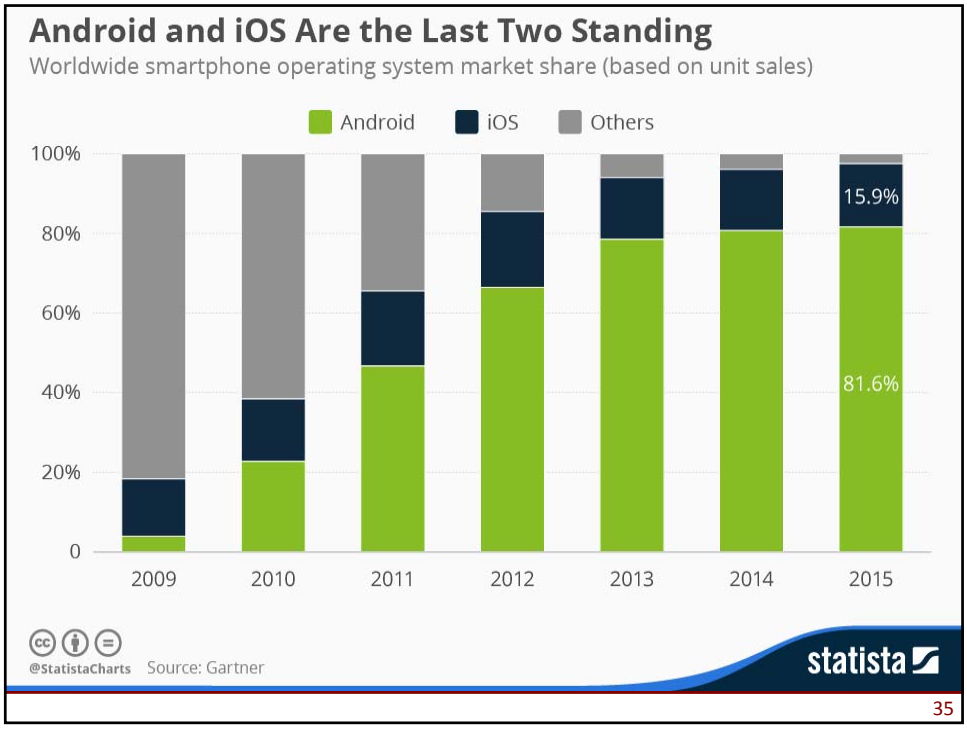


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## iPhone OS (Apple)

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- Pros
  - Strong user growth and data-hungry user base
  - Application store creating a vibrant app ecosystem with great momentum, in 2009:
    - More than 85K applications (~20% free)
    - More than 1 million downloads
  - Powerful technology enablers (e.g., multi-touch, GPS, accelerometer)
- Issues
  - App approval process is largely a black-box to developers
  - Apps viewed as competitive to Apple are often shut down
  - Downloads highly dependent on "featured" or "top download" promotion in store
  - App store is the only authorized distribution channel
  - Apple / hardware dependent
- Developments
  - NDA requirement: Apple finally removed the onerous NDA requirement
  - Flash: signs pointing towards development of iPhone flash player
- Development resources
  - http://developer.apple.com/iphone/index.action
  - http://iphoneincubator.com/blog/

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## BlackBerry OS (RIM)

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- Pros
  - Large reach and data-hungry user base
  - Developers not limited to single distribution channel
- Issues
  - Developer momentum appears to be shifting to iPhone
  - Less reach outside of North America
  - Application distribution more difficult today vs. iPhone's app store
  - Users more email focused vs. web consuming iPhone users
  - RIM / hardware dependent
- Developments
  - BlackBerry Application Center scheduled to debut w/ BlackBerry Storm OS v4.7
  - In September 2015, Blackberry launched a new smartphone called Priv on the Android platform.

- Developer resources
  - http://crackberry.com/

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## Windows Mobile

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- Pros
  - Strong user reach
  - Manufacturer agnostic
  - >18K apps (2010), and growing
- Issues
  - Current version in market (Windows Mobile 6) lacks support for some popular technology enablers (e.g., multi-touch, GPS, accelerometer)
  - Next-gen version will be late to market
  - Less developer enthusiasm vs. that for iPhone and Android
  - Application distribution more difficult today vs. iPhone's app store
- Developments
  - Microsoft to launch "Skymarket" applications marketplace for Windows Mobile 7 (planned for launch in 2H '09)
  - Speculation that Windows Mobile 7 will support revamped UI and multi-touch
- Developer resources
  - http://www.microsoft.com/windowsmobile/en-us/business/developers.mspx

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## Android (Google)

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- Pros
  - Open source => could help accelerate pace of innovation
  - Manufacturer-independent => could help accelerate consumer adoption
  - Technology support (e.g., touchscreen, GPS, accelerometer, video and still cameras)
- Issues
  - Late to market relative to iPhone
  - At least initially, demand is expected to trail iPhone demand
- Developments
  - 1st Android phone (T-Mobile G1) went on sale on Oct. 22 2008
  - Sept. '08: Officially released v1.0 of SDK in Sept
  - Aug '08: Awarded $3.75MM to 20 developers in the Android Developer Challenge
  - Current market leader
- Developer resources
  - http://android-developers.blogspot.com/
  - http://code.google.com/android/documentation.html

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## Symbian (Nokia)

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symbian OS

- Pros
  - Massive global reach in the last decade
  - Like Android, being open source could help accelerate pace of innovation
- Issues
  - Limited reach in the US
  - Application distribution would be more difficult vs. iPhone's app store
- Developments:
  - June '08: Nokia announced plans to acquire full ownership of Symbian and start the Symbian Foundation, which will be an independent force for the future development of Symbian OS. They stated that Symbian OS (including the platforms S60, UIQ and MOAP(S)) will become open source in the first half of 2009
  - Nokia eventually entered into a pact with Microsoft in 2011 to exclusively use its Windows Phone platform on future smartphones. Its mobile phone business was eventually bought by Microsoft in an overall deal totaling €5.44 billion (US $7.17 billion). [source: Wikipedia]
- Developer resources
  - n/a

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m:Cuidad

# ILLUSTRATION BY A LARGER EXAMPLE

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## m:Ciudad – Vision
## An example of an approach for user-generated mobile services

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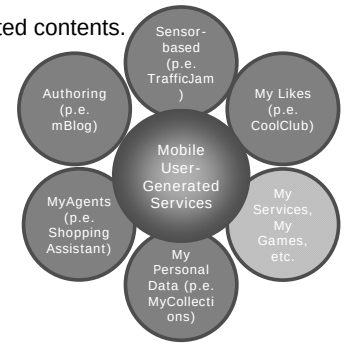
m:Ciudad, a step torwards Mobile User-generated Content and Services. A service infrastructure for the mobile platform for:

- Instantaneous, on-the-go service creation and provision. The mobile user as a prosumer: producer, provider and consumer of services and their associated contents.
- Fixed versus mobile service convergence in a wide sense: one worldwide user-powered content network.
- Efficient context utilization. Automatic/manual context-aware content generation and publication.
- Discovery, access and mobile-to-mobile communication in a very distributed, volatile platform (such as the mobile one, with the service “not-always-on” paradigm).




**m:Ciudad micro-services**

m:Cuidad was an EU project in 2007-2011, with participation of EU lead telco industry

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## m:Ciudad – Research Challenges

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- Ontology template-based service creation; (inter-user service composition from worldwide available services).
- Service deployment; viral service advertising; service sharing; service taxonomy, service usage policies.
- Event-based content capturing (context-aware); Local and remote content & context tools; automatic tagging; content taxonomies.
- Semantic / fuzzy search; distributed recommendation; user-term driven service/content search. Translation from folksonomy to service ontology.
- IMS role; SIM/USIM role; seamless roaming treatment; QoS; Security.
- Service execution environments; service business models; service business protection, rich user interfacing.
- Business models, privacy, identification, dynamic billing.

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## Microservices Scenario: Traffic Jam Killer

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**Motivation:**

Share knowledge about the fluidity of the traffic and presence of mobile radars with friends.


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## m:Ciudad – Underlying Magic

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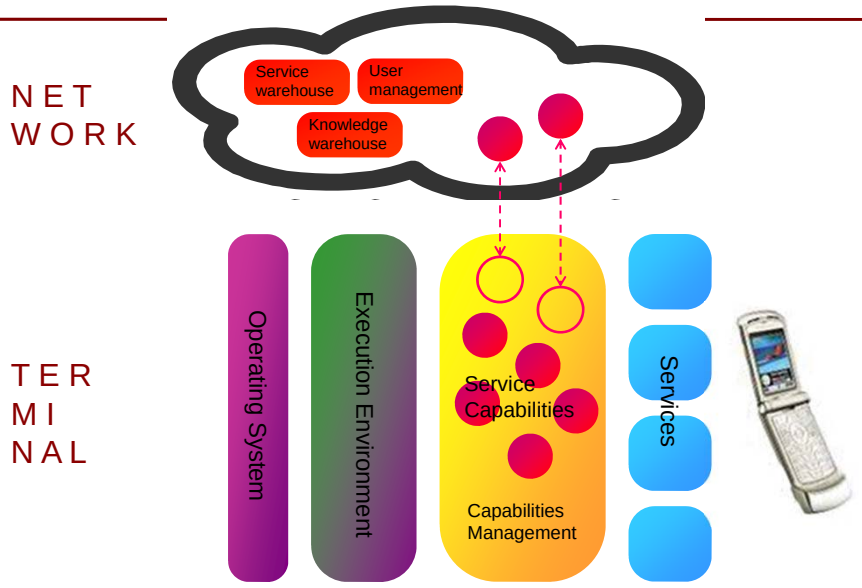


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## Architecture - detailed building blocks

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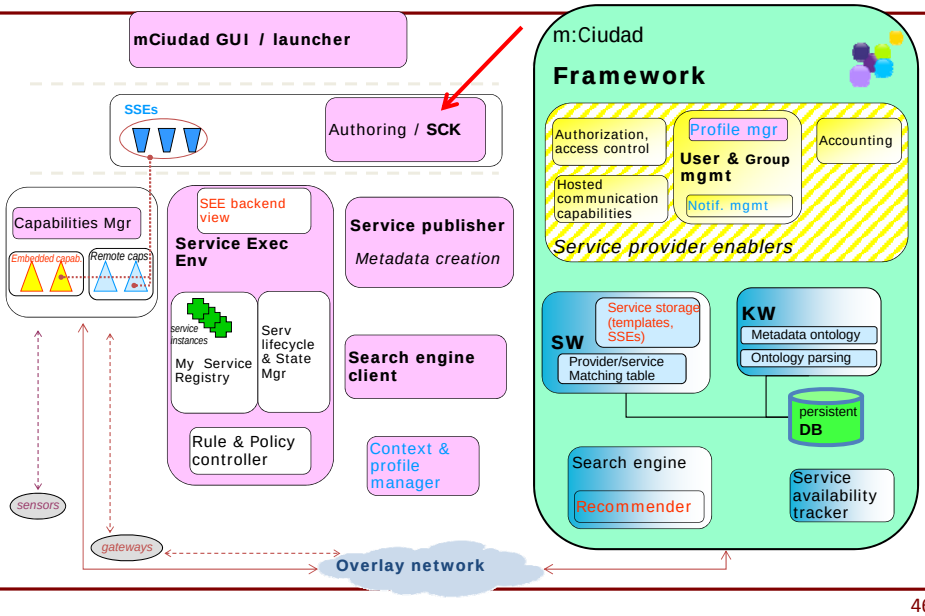


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## Microservice description language

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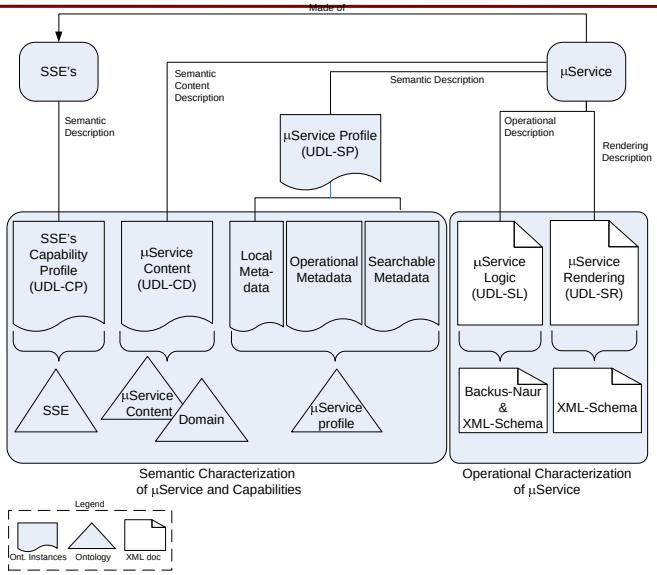




## Architecture of Knowledge Warehouse

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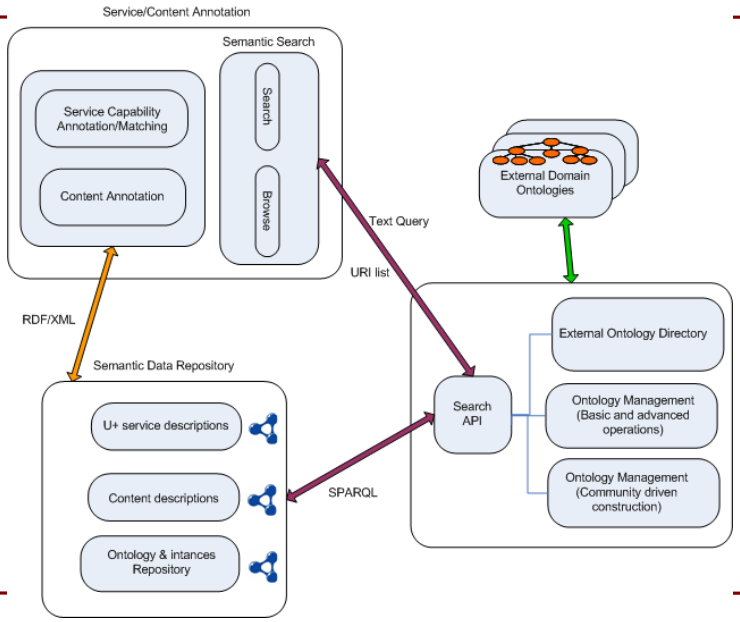

## Service Creation Kit – First Mock-up and Approaches: "Block-based" and "Question Answering"

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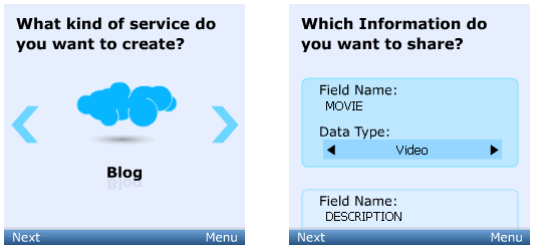
### Version 1

- Visual C++, Windows Mobile
- Goal: Study on Block approach usability


### Version 2

- Flash Lite, Windows Mobile
- Goal: Wizzard approach, Carroussel UI

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## User Survey – Study Set Up

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- Goal: improve understanding of users' needs, experiences, and expectations on user-generated mobile (micro-)services
  - From a knowledge management point of view
- Method: survey, distributed on the Web
- 38 questions, incl. video demonstrations
- Distributed via professional and interest mailing lists, social networks
- Answers being collected since June 2009
- Participants: 138 persons (52 fully completed)
- Plus several face-to-face usability tests with persons (to confirm the findings)

Danado, J., Davies, M., Ricca, P., Fensel, A. "An Authoring Tool for User Generated Mobile Services". In Proceedings of the 3rd Future Internet Symposium (FIS'10), 20-22 September 2010, Berlin, Germany; Springer Verlag, LNCS 6369, pp. 118-127 (2010).

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## User Survey – Need for Our Technology

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- Ca. 2/3 of users feel the need to adapt services or apps they use
- Ca. 1/3 of users feel the need to create their own services and apps

**User profile:**

- Almost all between 20 and 50 years old, Europeans
- ca. 70% male, 30% female
- Majority is a researcher or engineer with a Master degree, also large shares with a Bachelor or a PhD
- Daily average internet usage is 5 hours
- Half of the respondents access the internet via mobile

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## Evaluations – Mobile Service Creation

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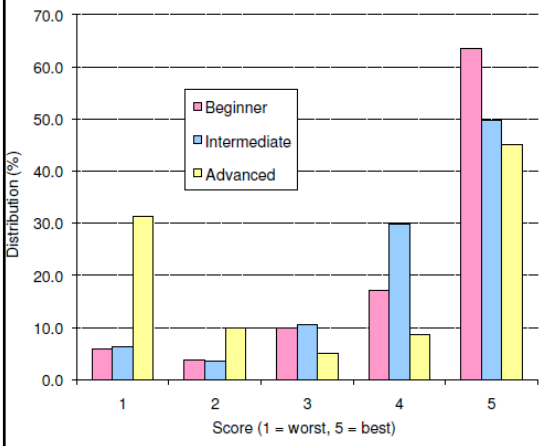
- Customisation – drag&drop (matching blocks) – end-user programming




• Davies, M., Carrez, F., Heinilä, J., Fensel, A., Narganes, M., Danado, J. "m:Ciudad -- Enabling End-User Mobile Service Creation", International Journal of Pervasive Computing and Communications Emerald Group Publishing, Vol. 7 Iss: 4, pp. 384-414 (2011).

• Davies, M., Carrez, F., Urdiales, D., Fensel, A., Narganes, M., Danado, J. "Defining User-Generated Services in a Semantically-Enabled Mobile Platform". In Proceedings of 12th International Conference on Information Integration and Web-based Applications & Services (iiWAS2010), 8-10 November 2010, Paris, France, ACM (2010).

The observations included that it is the best to raise the complexity level of the user interaction with the user experience level.

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# EXTENSIONS



## Why Semantics can play an important role?

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- To solve interoperability issues among different platforms
- To support more accurate and Web-scale service/application discovery
- To support transparent integration of different services
- To provide dynamic binding to services according to user profiling (e.g. Location)

## Currently researched topic: semantic reasoning on mobile phones

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- Massive spread of mobile computing in our daily lives led to the situation where the phones altogether comprise a substantial computational volume.
- Using semantic APIs and reasoners on current mobile devices is becoming possibility.
- That puts away the load from the server, allows more decentralized solutions, and potentially allow better handling of privacy and security issues.
- Currently researched issues in this area include evaluation of performance and energy efficiency aspects of such solutions, design and application of different architecture solutions.

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## Semantic reasoning on mobile phones: example of current research

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Studies were made – with two Android devices – on the performance of reasoning with typical ontologies and typical reasoners, some outcomes e.g. look as follows:

Comparison of classification time (in seconds) for two Android devices. *OOM*: Out Of Memory; *UDT*: Unsupported Data Type.

| | | HermiT | JFact | Pellet |
|---|---|---|---|---|
| DBpedia | A1 | 5.13 | UDT | 63.15 |
| | A3 | 8.87 | UDT | 115.30 |
| GO | A1 | 487.98 | 435.60 | 83.97 |
| | A3 | OOM | OOM | OOM |
| NCI | A1 | 2020.48 | OOM | OOM |
| | A3 | OOM | OOM | OOM |
| Pizza | A1 | 10.43 | 3.42 | 20.77 |
| | A3 | 14.88 | 4.90 | 33.22 |
| Wine | A1 | 361.38 | 1609.32 | 131.80 |
| | A3 | 511.97 | 2196.05 | 194.12 |

Errors for uncompleted tasks in the DL ontology set.

| Reasoner | Classification | | Consistency | |
|---|---|---|---|---|
| | T/O | Other | T/O | Other |
| HermiT(PC) | 13 (7.1%) | 5 (2.7%) | 1 (0.6%) | 0 (0%) |
| HermiT(A1) | 20 (11%) | 11 (6%) | 0 (0%) | 2 (1.1%) |
| HermiT(A2) | 28 (15.4%) | 13 (7.1%) | 0 (0%) | 2 (1.1%) |
| JFact(PC) | 18 (9.9%) | 31 (17%) | 8 (4.4%) | 18 (9.9%) |
| JFact(A1) | 26 (14.3%) | 39 (21.4%) | 18 (9.9%) | 33 (18.1%) |
| JFact(A2) | 23 (12.6%) | 42 (23.1%) | 24 (13.2%) | 31 (17%) |
| Pellet(PC) | 20 (11%) | 7 (3.9%) | 5 (2.7%) | 0 (0%) |
| Pellet(A1) | 26 (14.3%) | 13 (7.1%) | 6 (3.3%) | 0 (0%) |
| Pellet(A2) | 33 (18.1%) | 12 (6.6%) | 7 (4%) | 0 (0%) |
| TrOWL(PC) | 1 (0.6%) | 1 (0.6%) | 0 (0%) | 0 (0%) |
| TrOWL(A1) | 9 (5%) | 12 (6.6%) | 13 (7.1%) | 7 (3.9%) |
| TrOWL(A2) | 18 (9.9%) | 6 (3.3%) | 18 (9.9%) | 6 (3.3%) |

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# SUMMARY

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## Summary

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- Mobile Web is now a reality
- The are a pletora of different platforms but they all share common challanges imposed by the mobile environment
  - Less Computing Power
  - Need to keep down power consumption
  - Connection not 100% available
  - Smaller display
  - Different means of interactions
  - Mobile services (GPS, SMS, …)
  - …
- Such challenges can be overcame with proper design
- There is lot of space for innovative applications and for beneficial adoption of Semantics

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## Questions?

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