Adaptive Sharable Personalised Spatial-Aware Map Services for Mobile Users

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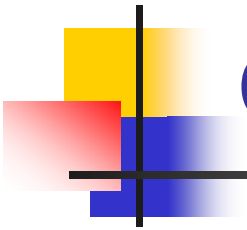
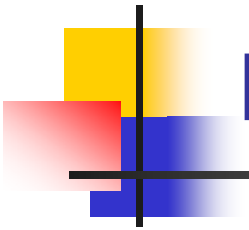


Outline

- **Motivation**
- **Research Objectives**
- **Related Work**
- **Method**
- **Conclusion**

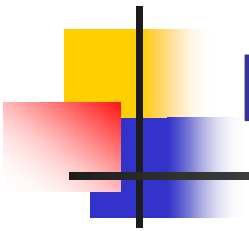


Motivation

- Spatial-Aware Map Services (SAMS) are now mainstream applications used to locate and track mobile users and business assets.
- Pervasive, portable, networked, devices enable nomadic users to seamlessly access spatial information services, anytime, anywhere.
- Typical components of SAMS for mobile users are:
  - Wireless networked access mobile devices
  - Interlinked to a location determination system such as a satellite GPS.
  - interlinked to local or a remote GIS that structures spatial content into layers of spatial objects, enable GIS applications to query and select spatial objects & to build customised spatial views that relate to particular applications and user tasks.
- Many commercial SAMS applications exist, e.g., SatNav systems for vehicle navigation tend to offer generic maps, that are location-aware, e.g., relate the current location to a destination
- These tend not to be user aware

Motivation: user awareness + spatial awareness

- User-aware applications are aware of several aspects:
  - Types of user or application task
  - Social model : privacy vs. shared
  - User Preferences or constraints for the application (personalisation)
- Non user-aware SAMS must either
  - Provide lowest-common denominator (LCD) content
  - Select content, e.g., maybe revenue driven
  - Must combine & include content for a range or all services
- Limitations: these either crowd too much information, much of which is unneeded, a particular problem for low-resource devices, or omit useful content because they adopt a lowest denominator approach.
- User-aware SAMS adapt content to user tasks & user preferences, e.g., content about footbridges for crossing over main roads can be included for pedestrians whereas it can be excluded for motorists.



Motivation: user awareness

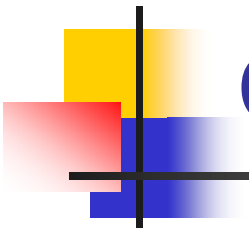
- Different users for the same type of application or user task may use different preferences.
- Users may be interested in filtering content that is presented to them, e.g., users may be interested in specific types of building by architecture or by function.
- Users may also prefer to customise the presentation of content, e.g., to include both local names of services and any translations of names relative to the visitors' home language in order to make content more understandable.
- Other preferences may relate to selecting higher quality, highly recommended services from set of possible services.

Motivation: ICT awareness for mobile users

- Many Web Content services assume:
  - always on, minimal bandwidth, Internet connections
  - Preset terminal profiles
- But in practice, access device characteristics, & local loop bandwidth, etc, varies
- Need to be able to adapt to ICT infrastructure (ICT awareness)

Motivation: user driven annotation

- User driven rather than provider driven annotation
- Users often wish to create and store spatial annotations,
  - e.g., good or bad routes to a particular destination, good or bad parking areas, etc.
- To annotate direct experiences in the field, in order to:
  - Create personalised spatial experiences
  - Reuse these spatial experiences, when they revisit an area and to
  - Share these with others.



Objectives

To develop and demonstrate a system:

- to dynamically adapt spatial content to users' tasks & to users' preferences
- to allow users to create their own markup for content , in situ
- to share this personal markup within social networks
- to allow mobile users to adapt ,create & share content

Survey: personalised location awareness

- GUIDE project supports direct input of user preferences.
- CRUMPET project, personal profiles are specified by combining a mix of persona models with direct and indirect input by the user such as observations of where and what users chooses to visit
- AmbieSense project situates each user task, within a use-case using case-based reasoning and location-awareness in order to make user recommendations.
- RECO (Pignotti et al, 2004) is similar to AmbieSense but instead of using case-based reasoning, situates each user task within a sequence, by learning a user's preferences over time, in order to make user recommendations.
- Tag Sharing Environment (Heuer, Gi-days 2008) focuses on how to selectively aggregate heterogeneous spatial information

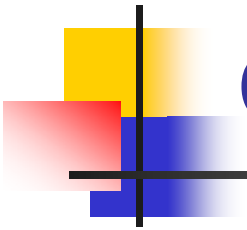
Survey: personalised location awareness

Web-based systems:

- OGC WPS (Web Processing Service) defines profiles for commonly used processes
- OpenStreetMap: static maps, can be localised not personalised
- Web 2.0, e.g., NAVIKI tags tracks and updates them on a server

Overall

- Few Web-based systems have any kind of strategy for dealing with volatile service access, very common for mobile users
- These are aimed towards provider service building blocks, not user task driven.
- No projects enables mobile users to personalise location aware information, creatie and share spatial markup tags, support mobile users.



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- **Survey Overview**
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Method: middleware

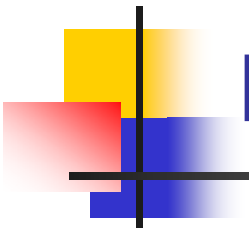
- GIS Architecture uses an extension of the CRUMPET system, called USHER (Ubiquitous System Here for Roamers) based upon a three tier client server architecture, which consists of client access devices, client proxy/mediators and generic and application specific spatial services.
- Implementation of the map server is based upon a spatial extension of MySQL to store and retrieve spatial data.
- Client calls the Geotools open source map API that supports advanced interactive map services via a client proxy which masks some of the complexity of the map retrieval and adaptation from the client device
- Framework design is based upon a Multi-Agent System

Method: Representing spatial tags

- Data structure of the mark-up information contains the information's spatial coordinates , name, a privacy field and the content.
- Using the privacy field, users can choose to keep the markup private to themselves, to share with others in a designated group or even to mark it up as public so that everyone who subscribes to markup updates can see it.
- Data storage design needs to consider how new mark-up data can be self-managed.
- Filters are used to select how to exchange new mark-up information according to the privacy field.
- A time of life field can be set (not shown), for use so that filters can also delete out of date information and retained highlighted data designated for permanent storage.
- Users can issue queries to search the mark-up information based upon category.
- Representations: XML->RDF->OWL

Method: Representing spatial tags

```
<rdf_:PointOfInterests
rdf:about="&rdf_;smap2008_Instance_11"

rdf_:hasContent="has nice meals and drinks"

rdf_:hasCreatedDate="20080605"

rdf_:hasLocationX="51.527615"

rdf_:hasLocationY="-0.051452026"

rdf_:hasModifiedDate="20080606"

rdf_:hasName="Good pub"

        rdfs:label="smap2008_Instance_11">

<rdf_:hasOwner
rdf:resource="&rdf_;smap2008_Instance_16"/>

<rdf_:hasType
rdf:resource="&rdf_;smap2008_Instance_2"/>

</rdf_:PointOfInterests>
```



Method: Interaction Protocols

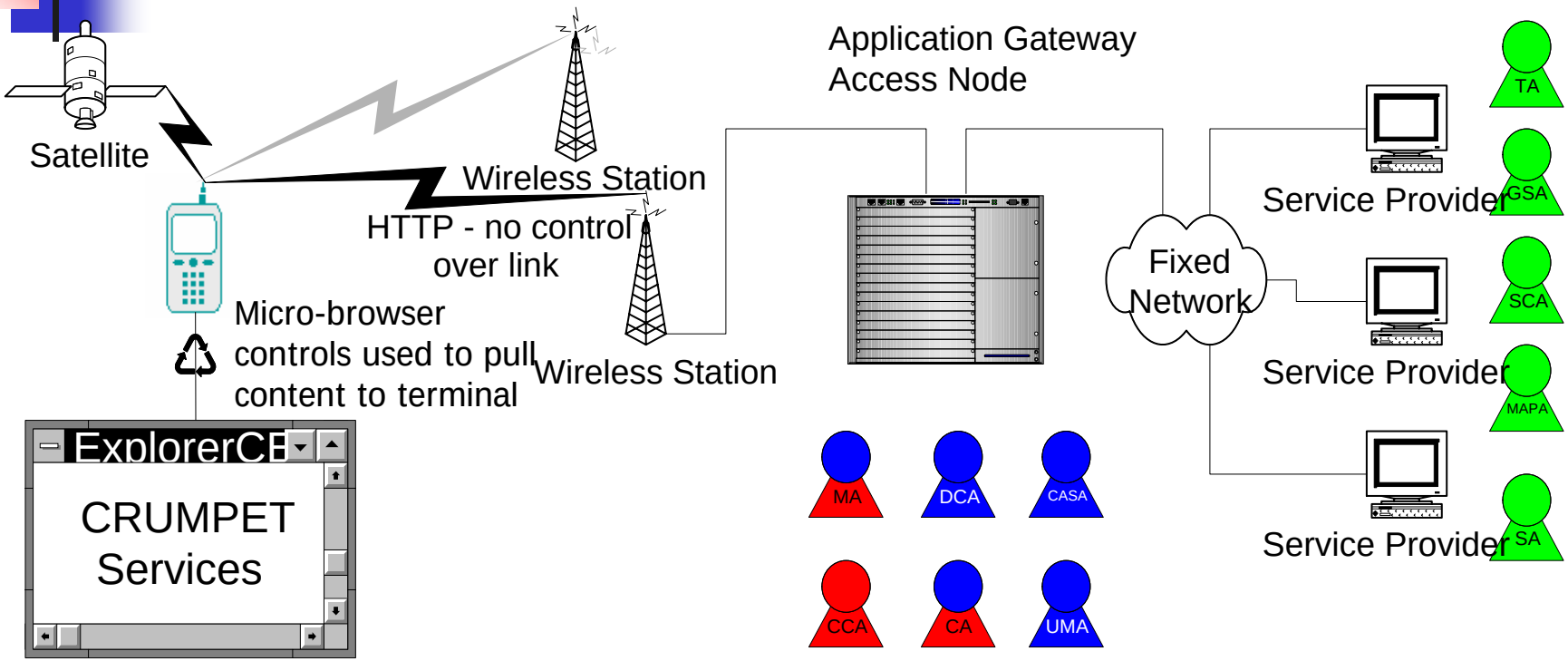
Multiple Interactions need to be supported

- Request-(Ack)-reply: download content updates
- Notify-whenever condition is true: upload newly created user markup to a remote data server, this then triggers download to any subscribed clients
- Broker: combine multiple services into a single service which is simpler to interact with
- Etc.

ICT Aware Spatial Aware Services

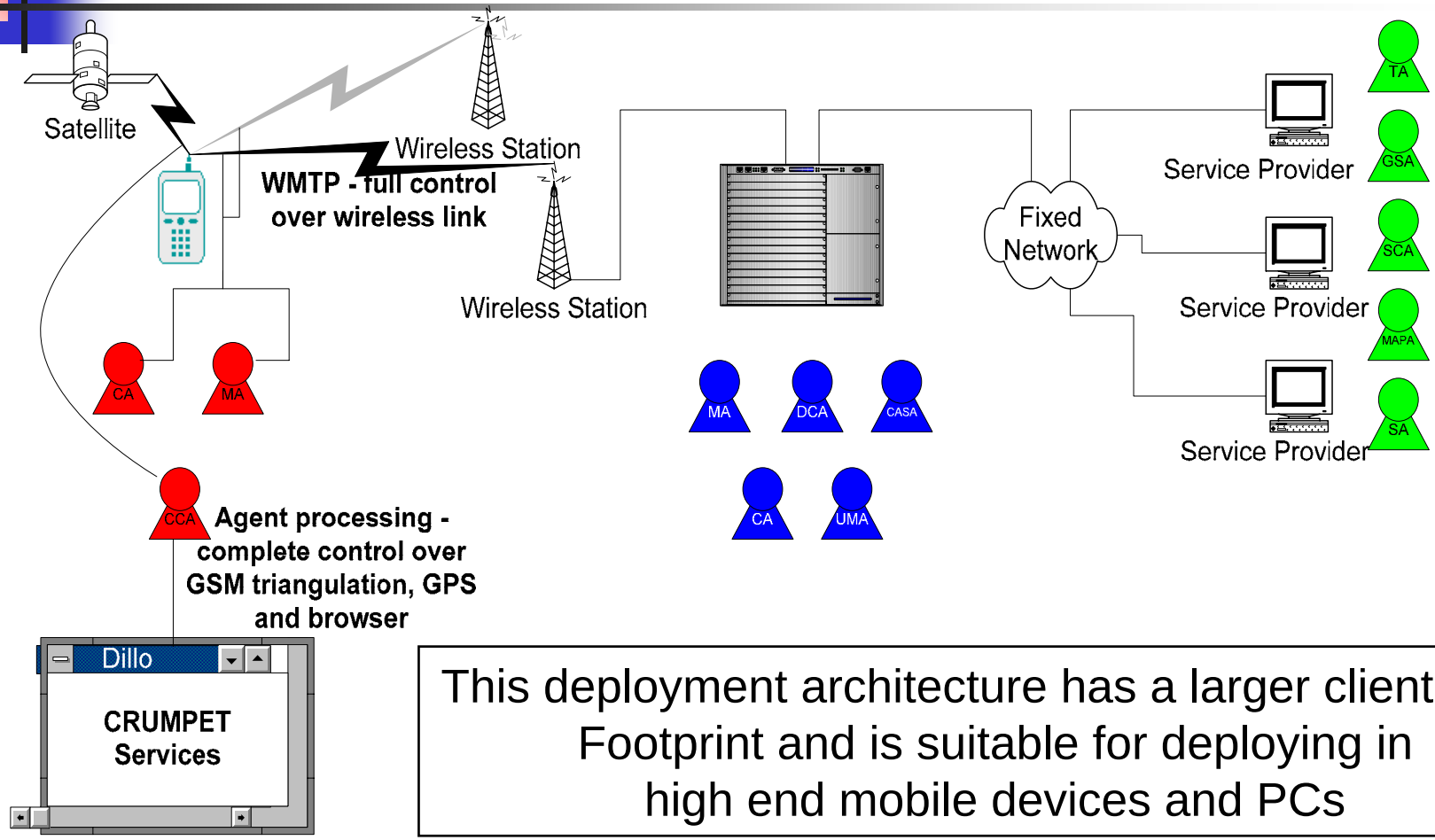
- On higher resource access devices with volatile network connections some inital map data can be precached onto the access device using a fat client-server architecture but this requires the device to have more application pre-configuration before it can be used.
- On lower resource access device, thin-client server systems, with a more stable, higher bandwidth, connection, a Web browser client can pull (map) data on demand
- A variant to handle on demand map access over slower links is oriented to mobile users. normally be interested in a a specific area of the map, & just accessing map parts that have changed & is of user interest.

Mobile service Design: thin client architecture



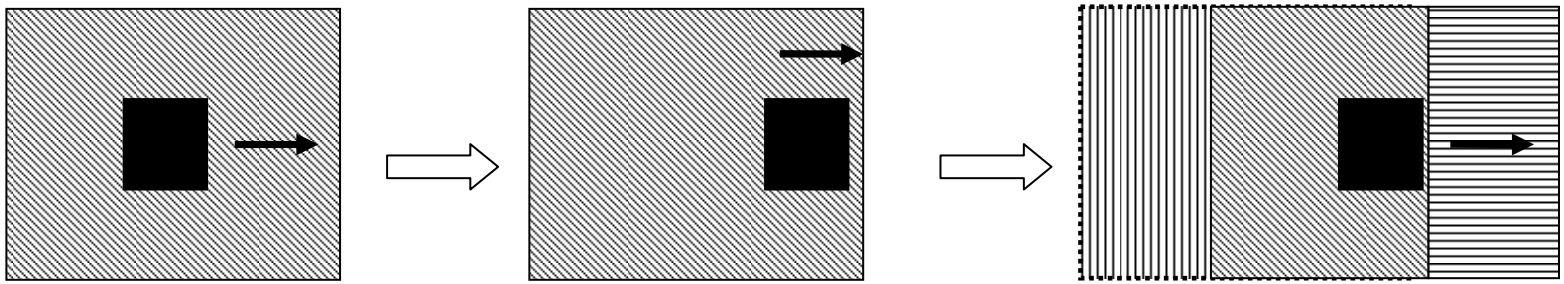
This deployment architecture has a very small client-side footprint and is
suitable for deploying in low end mobile devices and suitably equipped mobile 'phones

Mobile Service Design: fat client architecture



This deployment architecture has a larger client-side Footprint and is suitable for deploying in high end mobile devices and PCs

SAMS for Mobile Users



The current displaying map

The map's moving direction

The current stored map data

The change of current map status

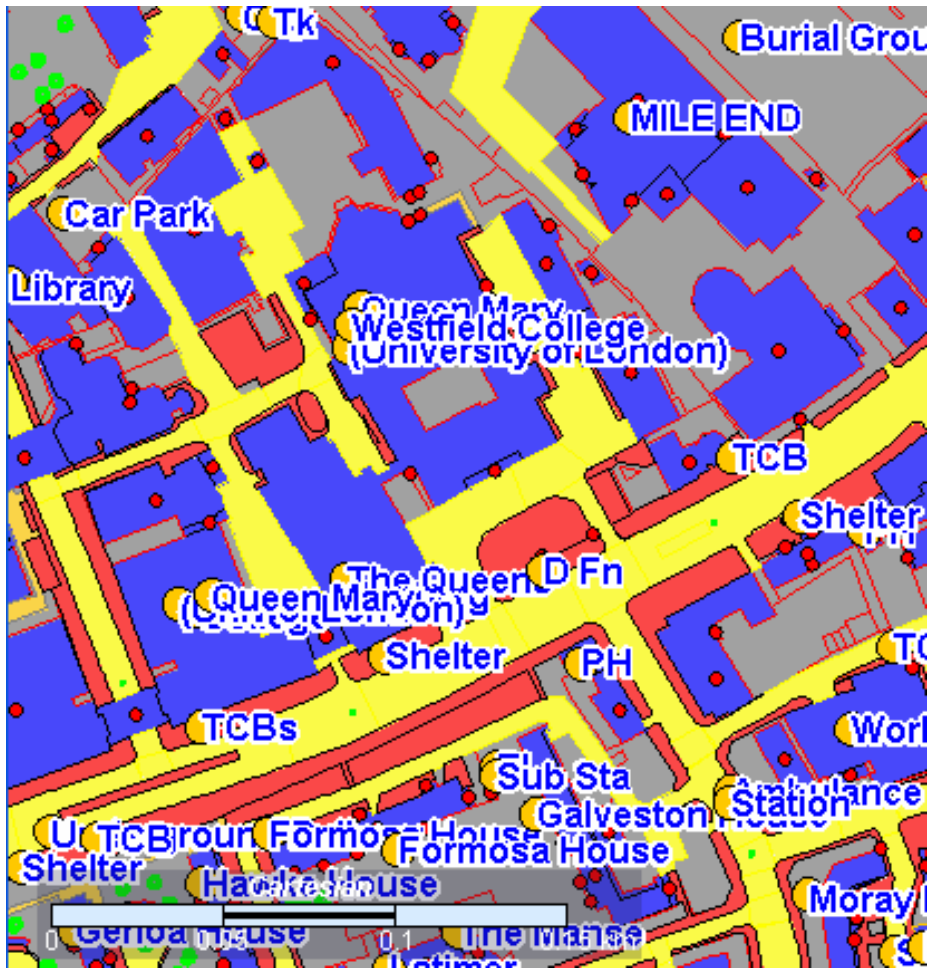
The old map data to be moved

The new added map data

SAMS for Mobile Users

- Initially, map data centered on the user's current location and their surrounding areas, will be accessed and loaded to the mobile terminal based on the user's location.
- According to the user's movement direction and distance, new map data will be added and part of the old map data will be deleted to economise local storage space and to keep the user's current location at the center of the map.

User Aware Spatial Aware Services



User-aware Spatial-aware: Pedestrian Mode

User-aware Spatial-aware: Driver Mode Map

Conclusion

- Many Spatial aware map services can adapt spatial content to be location aware.

These also need to be:

- ICT aware to support mobile users
- User aware (spatial tasks and movements)
- Customisable by end users

Open research questions

- Will a single GIS framework combine support for all sub-types of location-awareness, user-awareness, ICT awareness?