# Location-aware applications in the city


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I am a PhD student in Computer Science and Digital Communications at the Pompeu Fabra University in Barcelona. I am in the middle of my second year and it is my pleasure to present you today the state of my thesis work.

By location-aware applications, I refer to system ran on mobile devices that are often multi-users and provide services such as tracking,location of others (loved ones, objects, pets)or tagging the environment. This picture shows the canonical example of  what I refer to as “location-awareness application”.

# Today

Scope

Past projects

Problems

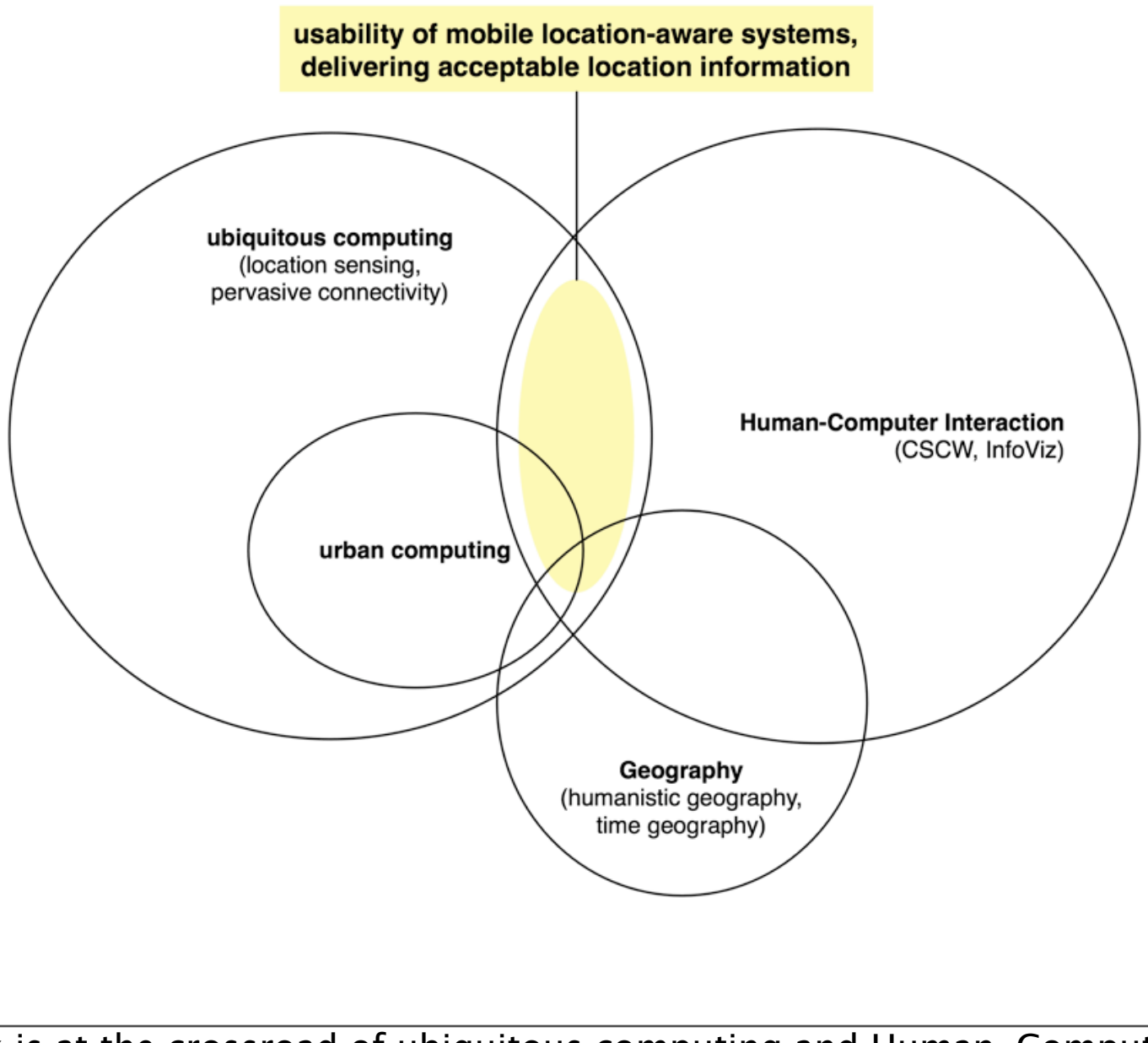
Questions

Approach

Studies

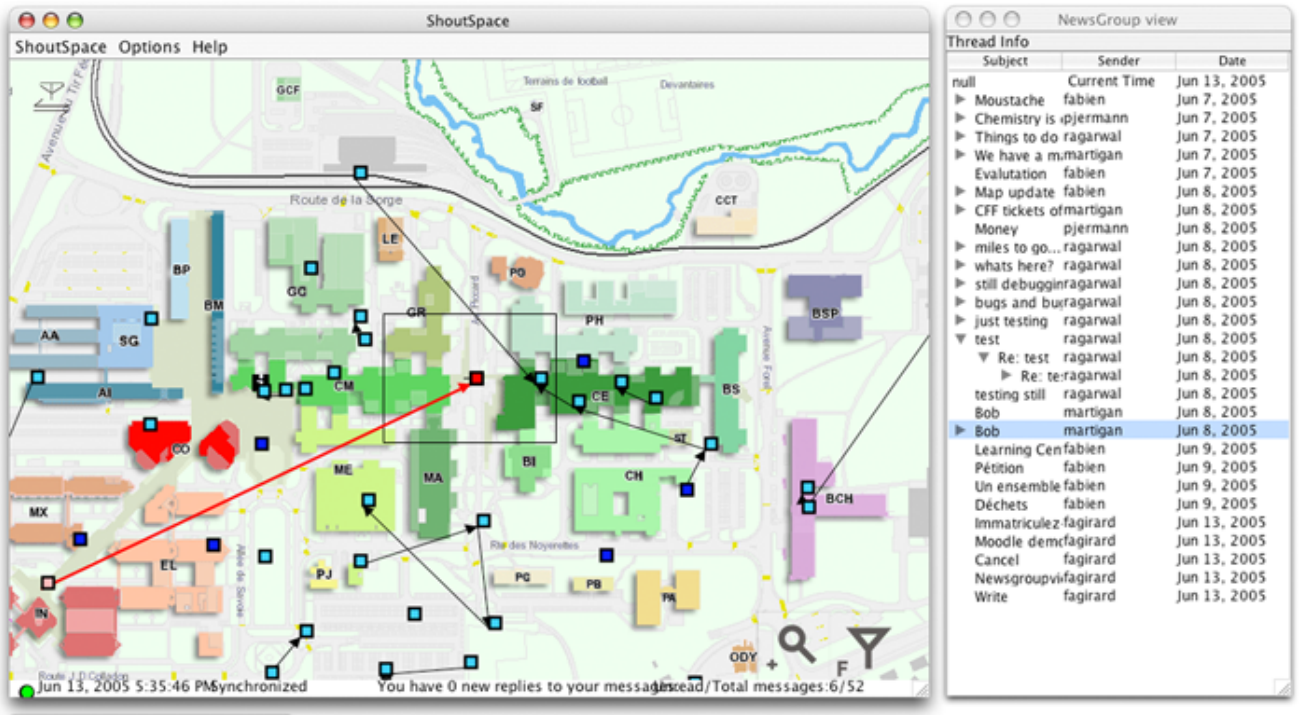
Firenze

# Scope




My research work is at the crossroad of ubiquitous computing and Human-Computer Interaction. More specifically, I am interested in the integration of location sensing and wireless technologies in environments supporting collaboration in urban spaces. I aim at studying the use of mobile location-aware systems to understand how to deliver acceptable location information.

# Collaborative spatial annotation









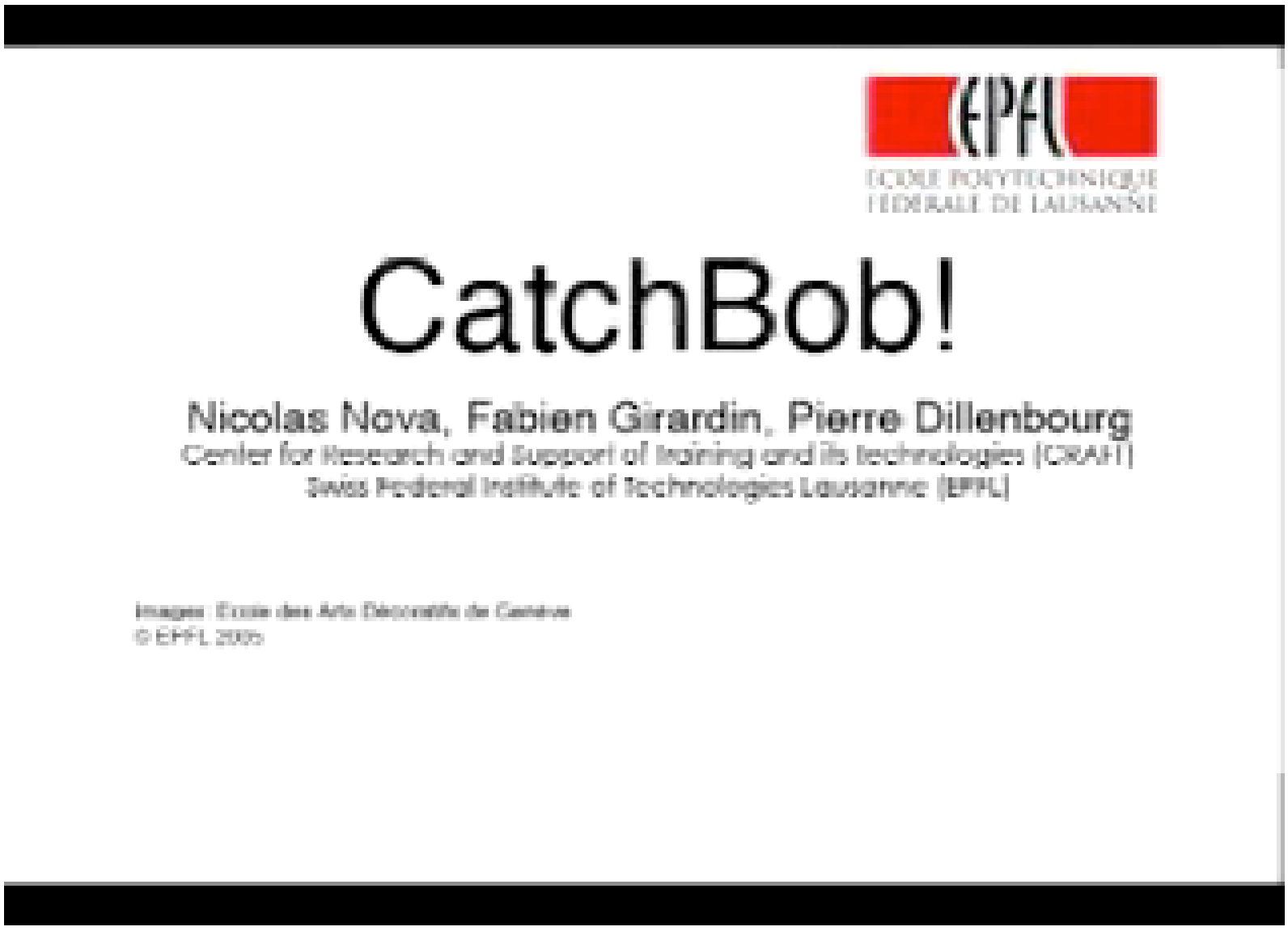


http://craftwww.epfl.ch/research/stamps/

http://www.shoutspace.eu/

With Mauro Cherubini at EPFL. Geographical messaging system. knowledge mapping and sharing. sharing useful information about the city. Research goal is to study the relation between the topology of the physical space and the semantic structure of the interaction space.

# Mutual location-awareness




http://craftwww.epfl.ch/research/catchbob/

With Nicolas Nova (EPFL). CatchBob! is an experimental platform in the form of a mobile game for running psychological experiments. It is designed to elicit collaborative behavior of people working together on a mobile activity. Running on a mobile device (iPAQ, TabletPc), it's a collaborative hunt in which groups of three persons have to find and circle a virtual object on our campus.

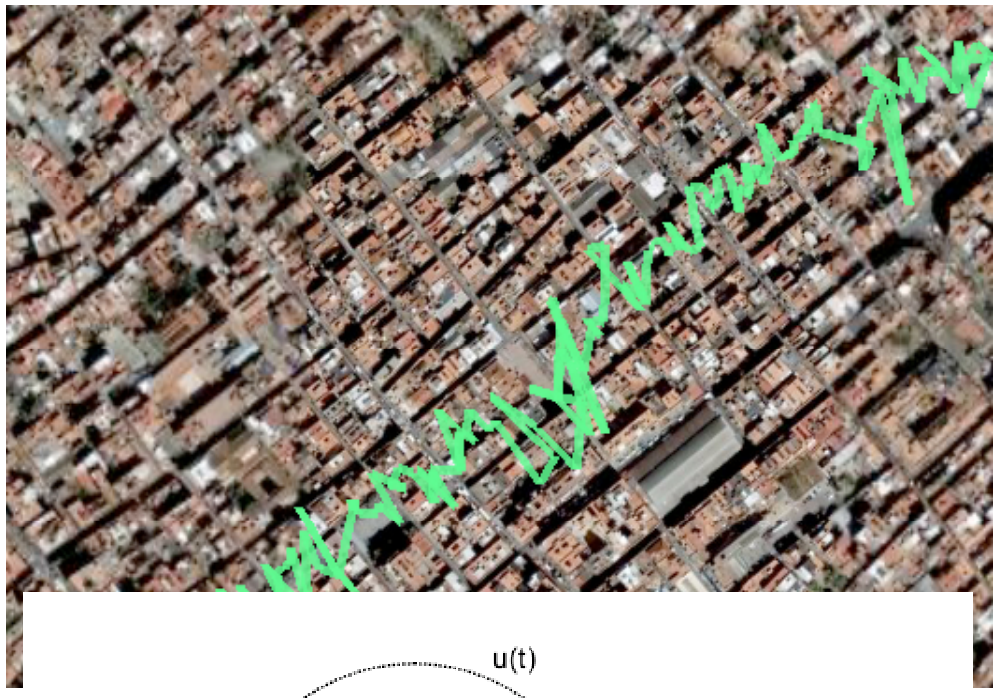
# World-wide air travel detection

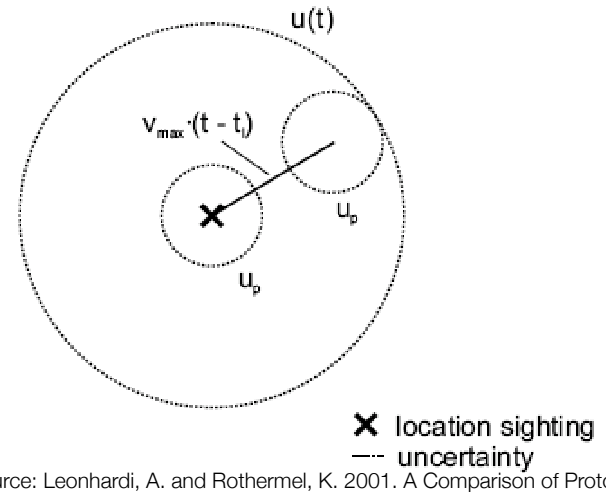


Simpliquity

As part of Simpliquity. Recognition of everyday physical motions. we demonstrate that mobile phones can recognize air travel based with an motion detection rule-based algorithm that checks for the user mobility from the surrounding GSM antennas.

# Location quality and timeliness



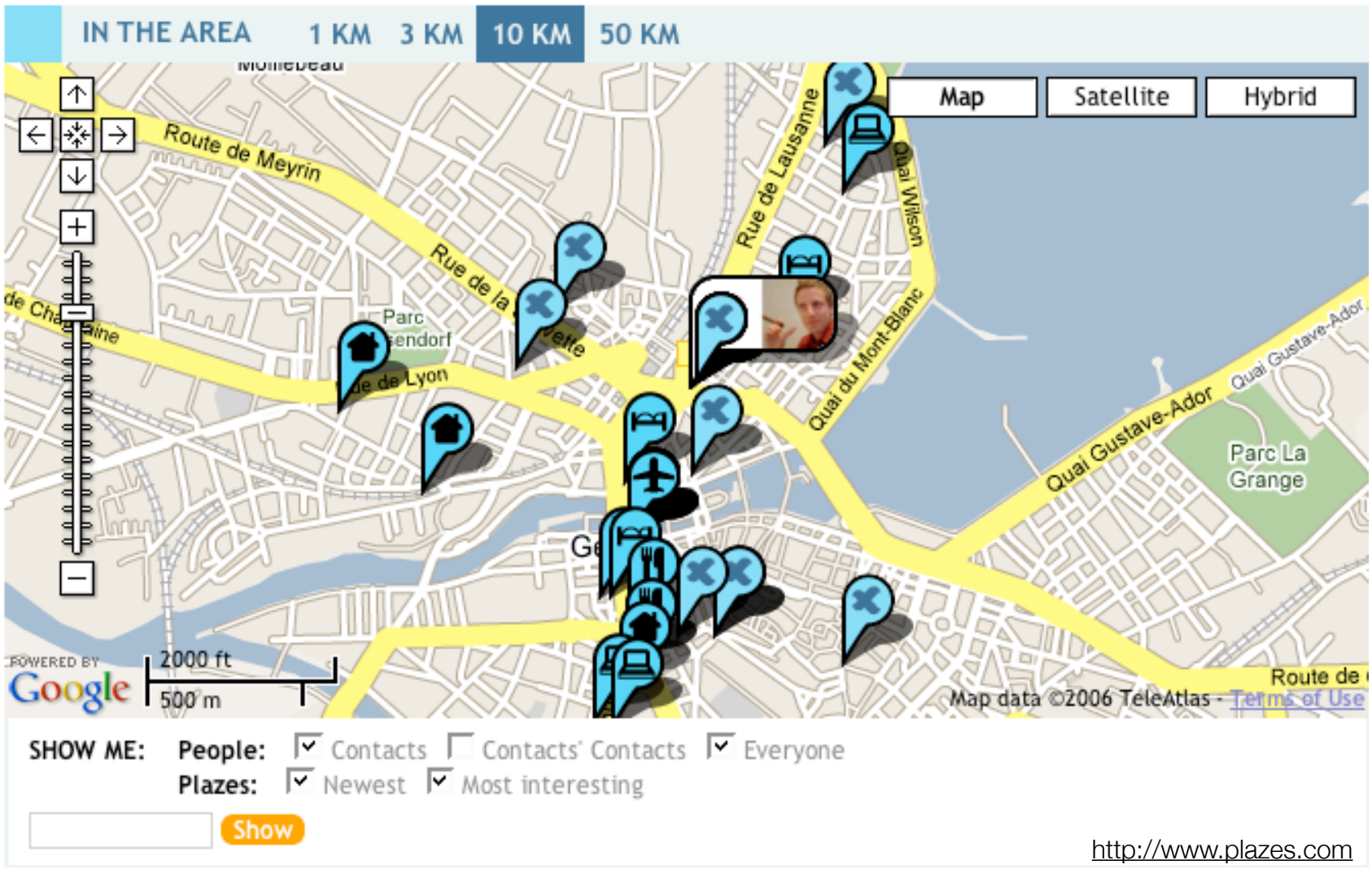



Source: Leonhardi, A. and Rothermel, K. 2001. A Comparison of Protocols for Updating Location Information. Cluster Computing 4, 4 (Oct. 2001), 355-367

Location awareness does not always come seamlessly (upper right pictures). Location sensing technologies face limitations and problems in terms of service coverage, stability (lower center), connectivity, mobility, cost, privacy and accuracy (upper right). Therefore, the advantage of location information can be obscured by these problems affecting the quality and timeliness of the data.

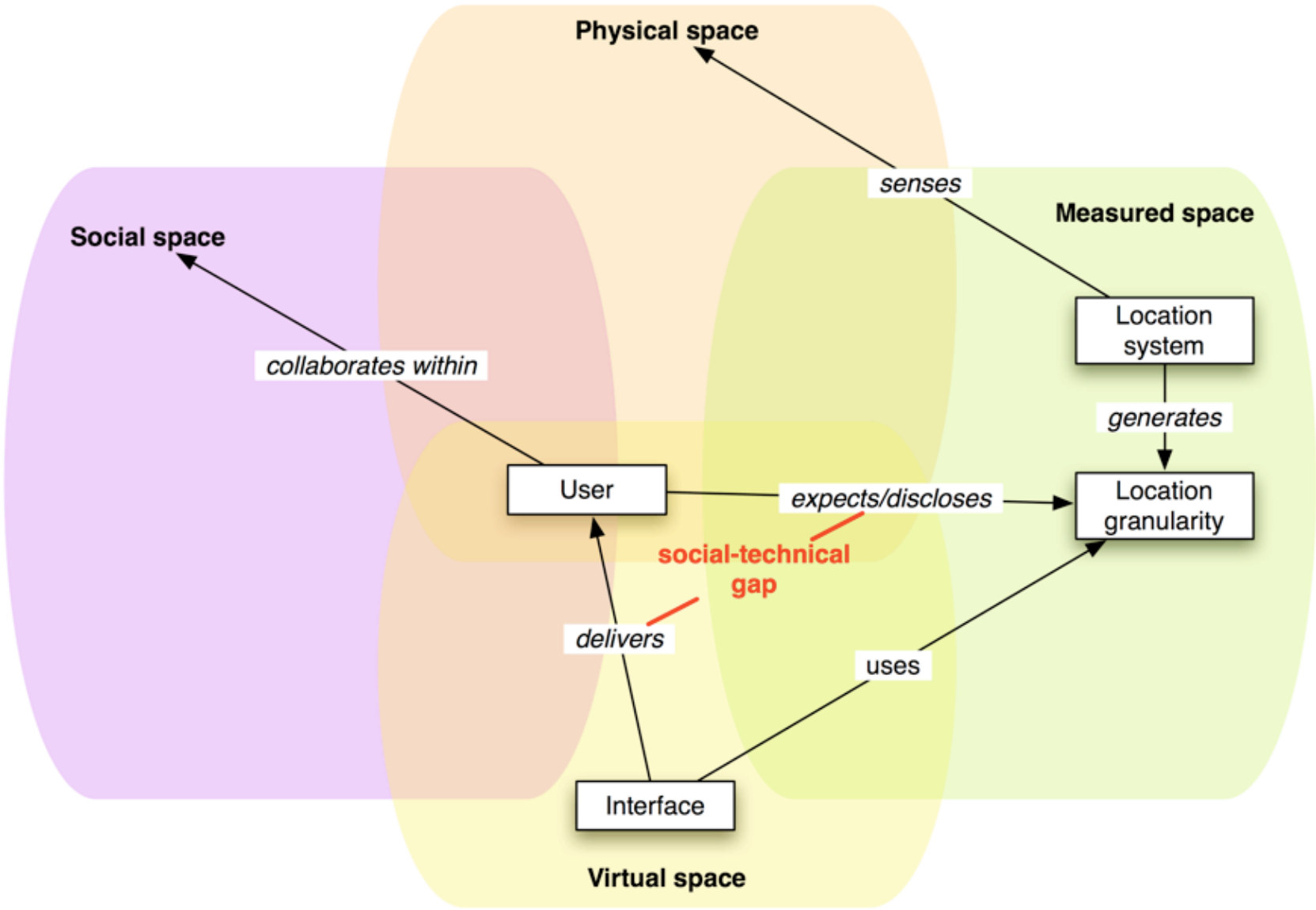
The difficulties to sense the physical space generate spatial uncertainty. Leonhardi, A. and Rothermel (2001) modeled this uncertainty has follow: a location sighting is performed with a precision of Up. The data are distributed at a miximal speed of vmax. In consequence, when the location information is updated the space in which the sensed person/object could be is in the space u(t)

# Location information granularity




Location information often carries a granularity that sometimes fails to be taken into consideration by designer of location-aware system. Here is an example of Plazes, a popular location-aware application. The airport of Geneva is located in the middle of the river simply because the city considers it as the center of the city. In addition, I am at the train station, while I only wanted to mention that I was present in Geneva in the morning. So how to mix location information that have different levels of granularity?

# The social-technical gap




My current (simplified) model of spatial uncertainty reveals 4 interconnected spaces. The physical (real-world), the measured space (what sensors perceived from the physical world), the virtual space (the digital representation of the measured space and the social space
(partially inspired by Managing Multiple Spaces, Dix et al. 2005).

A user lives between physical, virtual and social spaces. He/She relies on the interface delivering information delivered by location systems. These information are either sensed or self-disclosed by the users.

Location system systems deliver their measure of the physical world with a certain quality and timeliness. These information form a certain granularity of the location.

The spatial uncertainty lies on the mismatch between the granularity of the information expected by the user and the information displayed by the interface based on the data delivered by the measured space.

In summary, users must coordinate their distributed activities in spite of these problems generating (spatial) uncertainty. This reveals a techno-social gap (Ackerman, M., 2000, The Intellectual Challenge of CSCW: The Gap Between Social Requirements and Technical Feasibility)  that exposes the need to handle inadequate location information without undermining the benefits of location-aware systems. Systems cannot fully support the flexible, nuanced, and contextualized social world uncovered

# Motivation

*“Let’s do smart things with stupid technology today, rather than wait and do stupid things with smart technology tomorrow?”*

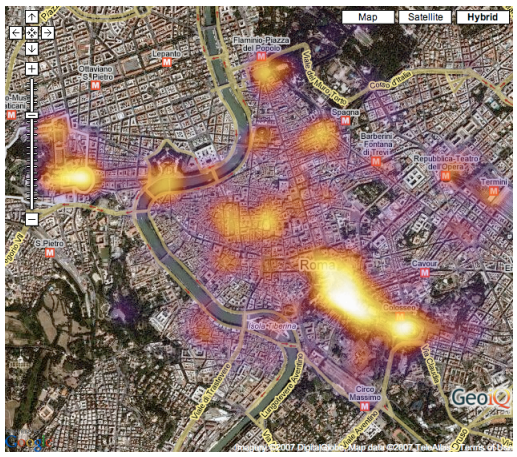
William Buxton

# Research questions

**How to build a collaborative location-aware system that takes into account the spatial uncertainty inherent to ubiquitous technologies?**

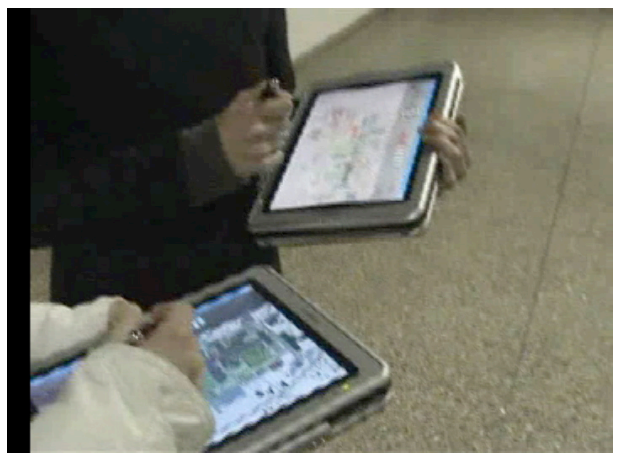
- what level of location information quality and timeliness must be delivered in order to be useful and relevant?
- what parameters influence successful spatial uncertainty visualization?
- what is the balance between implicit and explicit forms of human interaction with a location-aware system that communicates the inherent uncertainty of its location information?

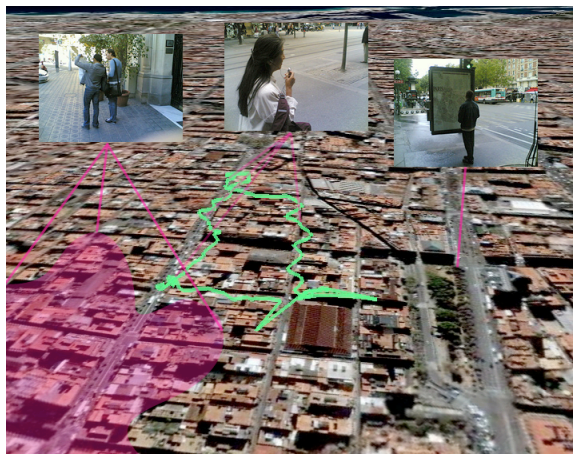
# Approach




case studies of the ubicomp of the present

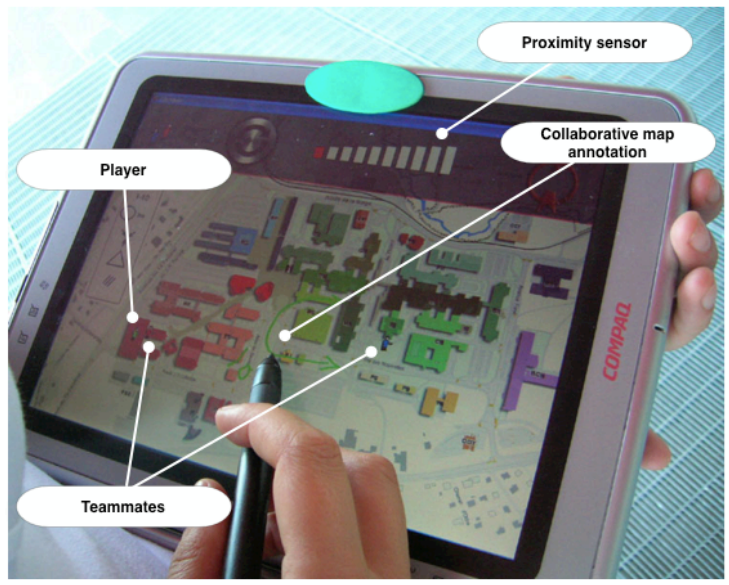
deploy real-world field experiments





In my approach, I study the authentic human and collaborative use of the ubicomp of the present and deploy real-world experiments to mature the practice of HCI evaluation. It aims at demonstrating the principles and lessons that can be applied more generally in systems for mobile work in vast work settings.

# Field experiment: CatchBob!




- Various players reactions to uncertainty: Believing, not understanding, overcoming
- Various sources of spatial uncertainty
- Players without a location awareness tool took better advantage of the annotation feature: picking up the relevant fact
- Automatic location-awareness ≠ Giving a location (act of communication carrying intentions)

CatchBob! is a collaborative pervasive game. Explore the sources of spatial uncertainty and analyze players' behaviors towards spatial uncertainty. Individual and collaborative aspects of spatial uncertainty.

I define three main sources of spatial uncertainty.
The location quality predicted through sensor measurements and observations. Uncertainty is generated by patchy location service, fluctuating signal strength, deviations in positioning, devices limited resources, but also from processing the measured data themselves.
The location timeliness indicated by the time that has elapsed since the location was acquired. The temporal accuracy of a location is influenced by the network connectivity, communication latency and location update mechanism.
Location presentation, i.e., the ways which deliver location information to the user. Geometric, symbolic and map representation can be misleading or ambiguous.

# Case study: Taxi drivers use of GPS

**Context**: Barcelona taxi drivers who use GPS navigation systems. Ethnographic study

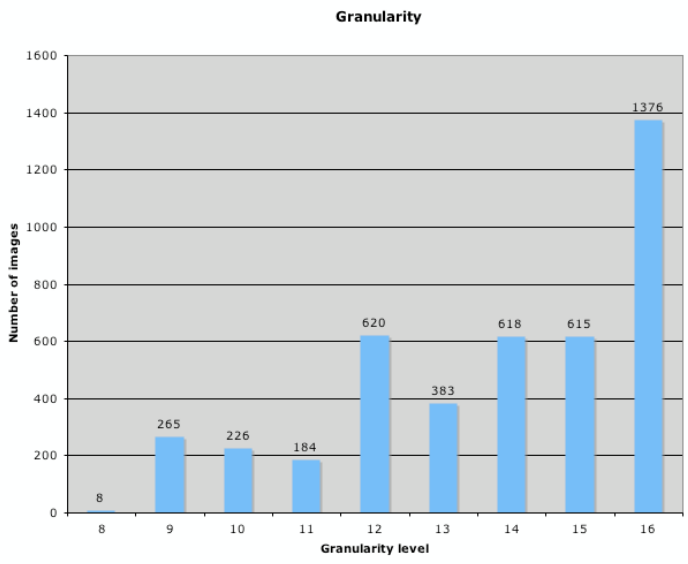
- **Aim**: identify the main issues embedded in the interaction of mobile workers with location information that fails to match a relevant quality
- **Aim:** Where and when is it used?
- **How:** focused ethnography, semi-structured interviews

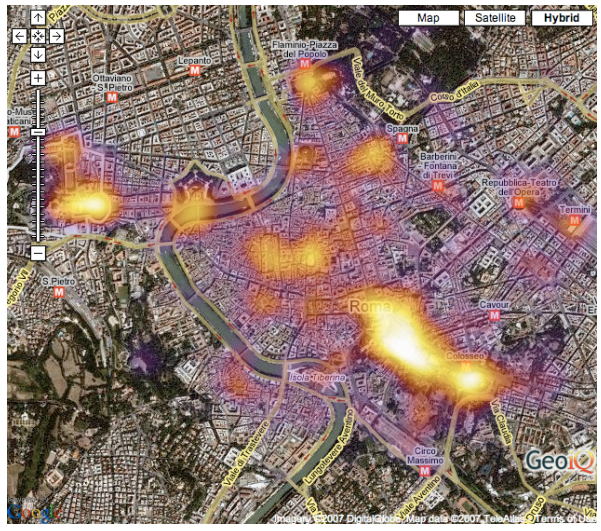
Work in progress. personal use of a a location-aware system (taxi drivers using their navigation system). Identify the main issues embedded in the interaction of mobile workeds with location information that fails to match a relevant quality.

# Case study: Tracing the visitor's eye

**Context**: evaluate the potential of using people-generated geotagged information to contribute urban understanding.

- **Aim 1**: identify users behaviors when explicitly disclosing location information (where, what, when, history of use).
- **Aim 2**: analyze how Flickr users take advantage of the accuracy feature to georeference their images



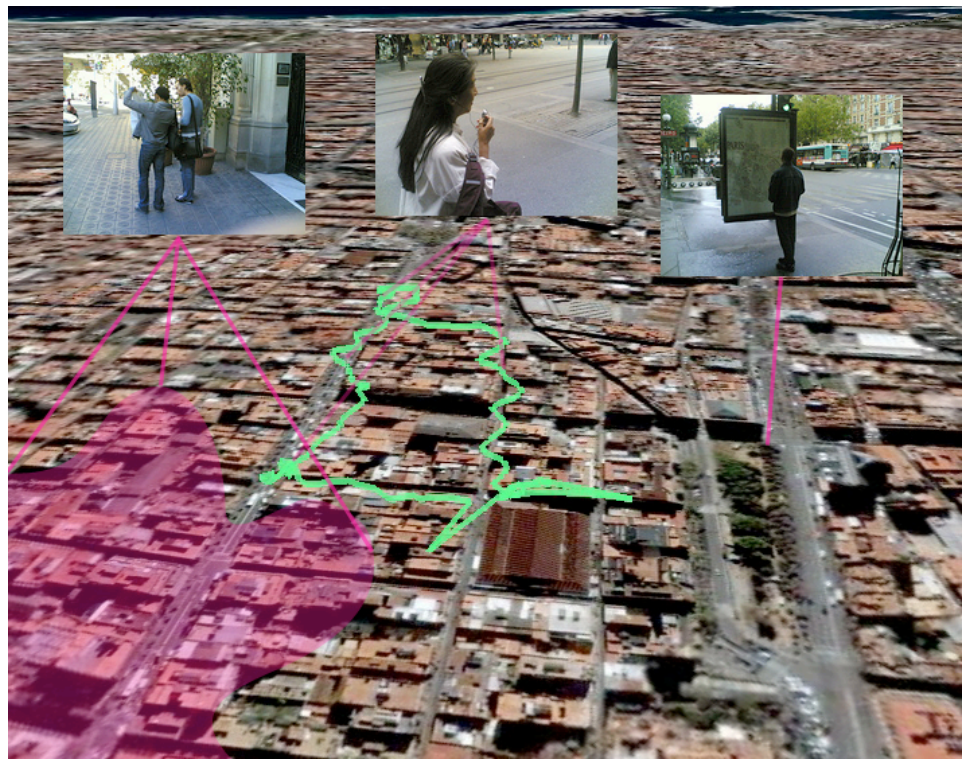

http://www.girardin.org/fabien/tracing/

Work in progress. Flickr: Collaborative platform to share geotagged information. Explicit Spatio-temporal data analysis. studying how people explicitly position and disclose spatio-temporal information in order to understand their use and need of quality of location information in a urban space. I collected over 1mio geotagged photos of 10 cities.
Spatio-temporal data analysis. Analyze the flow of visitors (within the city, in and out of the city), the areas of attractions

# Field experiment: Enhancing urban tourism experience

**Context**: Give an awareness to citizens and/or tourists on their behaviors and surroundings in a urban space.

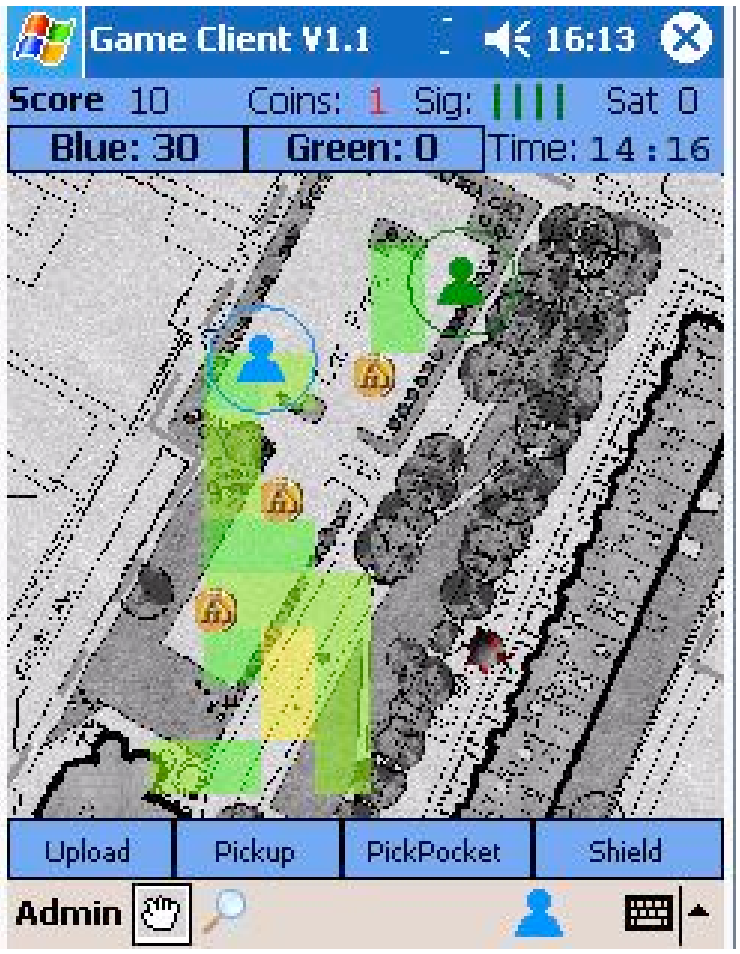
- **Aim 1**: Evaluate design strategies to manage spatial uncertainty based on what has been learned in the first 3 studies
- **How**: Compare approaches (Does it work?)
- **How**: Study the contextual impact of the approach (Where and when?)



I plan to setup a collaborative pervasive system used in the scale of a city to analyze the integration of location information granularity in the design of the application, to evaluate strategies to manage spatial uncertainty. (design-science research). To do so, I will perform comparison between several approaches and study where and when do they apply).

# Design strategies

- Seamful design (when to reveal, hide the limitations of a technological solution)
- Assist not automate
- Location is more than GIS information
- Influence the middleware design
- Ambiguity as resource for design
- Sense of history
- Hackability

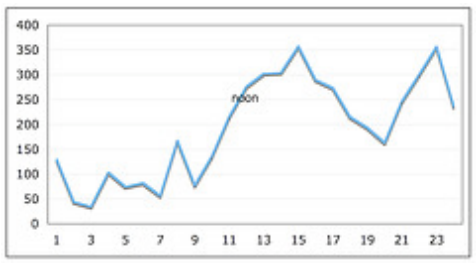


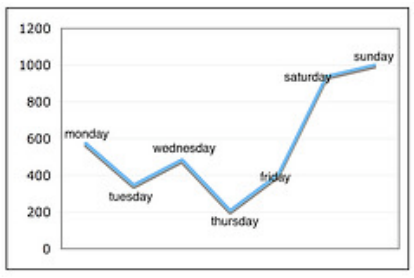

I consider different design strategies. Seamful design (right picture) suggests the reveal the limitations and problems of a system for users to act upon them. As seen in CatchBob! automating location awareness has its impact on the use of the information. Finally, “Location is more than GIS information”. It’s more than geographical coordinates, it can also be whether a user is indoor/ outdoor, whether the movile device can hear you’re on busy street. It’s about richer information. A good example is Jabberwocky (left picture) that allows to see the presence of familiar strangers in the vicinity, anonymized.

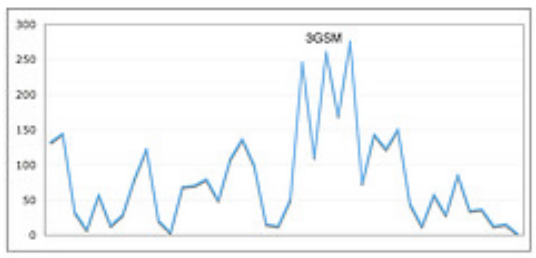
# Articulation

| Type | Context | Objective | Method |
|---|---|---|---|
| Field experiment 1 | collaborative pervasive game | Explore the sources of spatial uncertainty and analyze players' behaviors towards spatial uncertainty | mixed, exploratory |
| Case study 1 | sharing and geotagging photos | Identify the uses of location information granularity | descriptive, exploratory |
| Case study 2 | taxi drivers use of GPS | Identify the main issues when a location-aware system does not match expectations (co-evolution) | ethnographic, exploratory |
| Field experiment 2 | collaborative urban-scale environment | Analyze the integration of location information granularity in the design of the application. to evaluate strategies to manage spatial uncertainty. | mixed |

# Firenze: Flickr

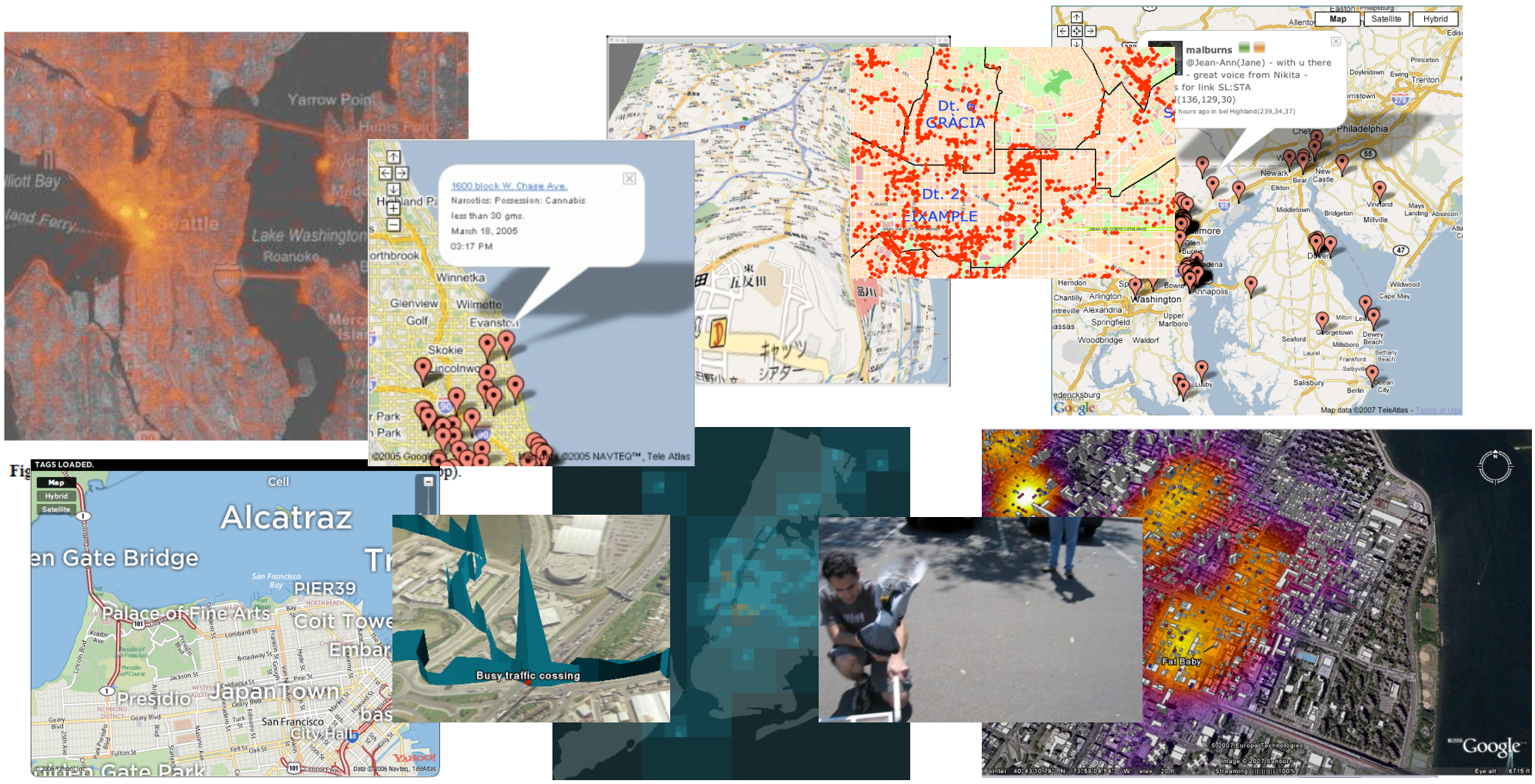




Context for studies 3 and 4. Spation-temporal analysis. Test Flickr as a contemporary open platform where location and time sensitive data can be uploaded and accessed. It might also be interesting to mix this type of explicit disclosure of location information with implicit data from WiFi/GSM networks. Develop proofs of concept of to characterize people, the types of their visits, their usage of the city (points of interests, flow pattern), reveal the temporal signature. 85910 photos, 3368 photographers.

# Firenze: bottom up data

Classify different approaches to collect data on city dynamics (e.g. local search queries, Flickr, geospatial web, Twitter, Jaiku, Plazes, dopplr, RF-based)




http://tagmaps.research.yahoo.com/

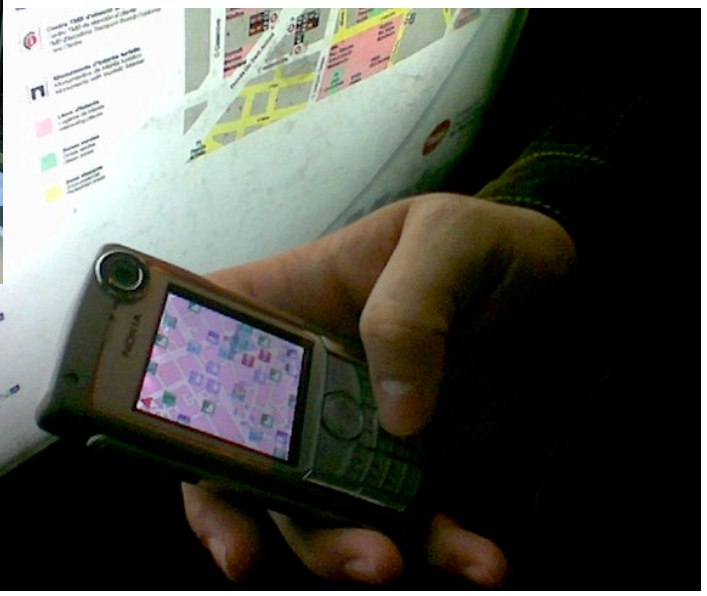
http://fortiusone.com/

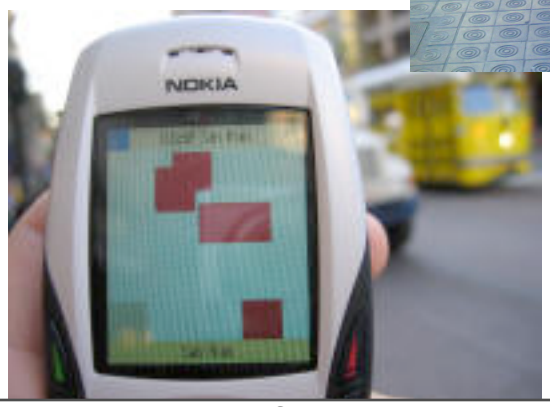
Flickr is a starting point for

# Firenze: feedback loop

Think of how these time and space sensitive information can be accessed and delivered to tourists



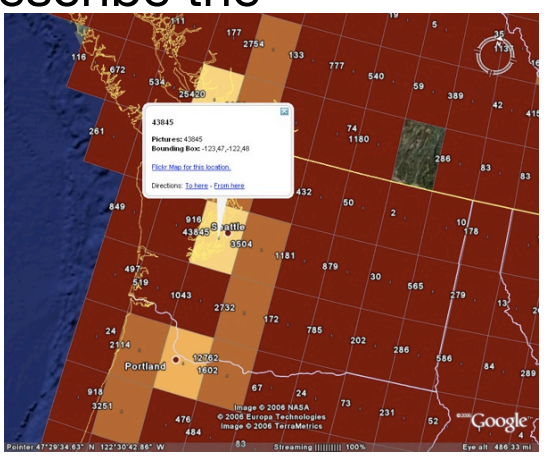





As a context for my 4th and final experiment

# 2-weeks stay expected outcomes


- Origine-Destination (within the region and outside)
- Nationalities (2900 visitors, 400 citizens. 1202 N/A, 818 italians, 440 americans, 220 british, 100 germans)
- Extended abstract for the UbiComp2007 Late Breaking Results
- Document describing a proof of concept, highlighting the potentials and limitation of the Flickr approach to be sent to Florence. Describe the requirements to move further.



# Thank you

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