

# **Position Paper for CHI 2000 Workshop 11: The What, Who, Where, When, Why and How of Context-Awareness**

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Over the past year, I have been running a notebook usage logging experiment in my spare time. The data this has collected [1] has convinced me that all devices which travel with the user could benefit from being more aware of the contexts of user, and adapt their own behaviour accordingly.

The users I have studied use their notebooks in four main contexts – "Desk, Meeting, Home and Travel", yet neither the notebook or applications detect or react to these contexts.

I also believe that many web services would also benefit from some context awareness, the privacy issues related to this are fraught with issues both technical and social. Another project in HP Labs has been working in this arena –they aim to develop a invaluable infrastructure for future mobile devices.

## **What is context?**

From the perspective of the notebook, the location of the user is a context, as is their operational role. For example, in a meeting context there are two key roles – speaker and audience, both of which have different requirements of a system.

There also important is the notion of multiple hierarchical contexts, geographic (country, city, street, building, room), organisational and social. There is also the less obvious 'infrastructure' context derived from these values – specifically the networking and communications capabilities which adaptive devices need to make effective use of.

## **Whose context is important to whom, or what?**

Knowing the current context and roles of their owner would enable notebooks to choose operational policies to match expected needs. For example, in a meeting the standard policy to present presentations could be full screen, rather than in editing mode.

At a low level, context is critical to mobile computing devices being able to adapt their communications policies to balance user needs with what is possible or cost effective. For example, local area networks should be used over wide area wireless, and in an airplane all wireless communications should be disabled.

In the web arena, knowing the location of the user can be used for the provision of highly localised services, which may become more critical with WAP phone based access – by virtue of their smaller screen and constant mobility. A primary benefit to web service providers would seem to be the provision of region based advertising, which is only indirectly of value to end users. Location aware web services will have to offer significant value to all users, to justify the investment.

## **Where can an awareness of context be exploited?**

Context can be exploited in the users' device, or in the remote servers. Doing the processing in the local device avoids privacy issues, but will not work for those devices which are too thin to do any local work – such as cellphones.

In the local device, both the OS and applications can make use of it. If it was a ubiquitous technology, then mainstream PIM applications could be enhanced to store the context with data, enhancing information retrieval and gathering.

Thin devices can store context, even if they can not act on it. The Kodak Field Imaging System 265 digital camera can record the location a picture was taken – addressing a need of surveyors. One can

imagine future consumer cameras capturing not just location data, but any other available context information, such as who was in a room when a picture is taken.

### When is context useful?

I believe that it is more useful with devices which travel with the user, rather than relatively immobile devices. The latter do have a context, but it is often fixed and therefore implicit. An office desktop PC is in an office context. The more unconsciously portable a device is, the more a user carries it, and hence the more its context changes.

However, even fixed devices do have a static context which they are often unaware of –such as their physical location. If this information can be passed up to web servers, then the audience and value of location aware web services increases –creating an infrastructure of which highly mobile devices can take full advantage. Furthermore, fixed devices will also benefit from knowing who is using them, and adapting their behaviour dynamically, so some awareness of people would be valuable. Imagine a home PC which could differentiate adult and child users, or distinguish between individual family members. Such a PC would support multiple logins, without anyone having to understand the login process.

### Why are context-aware applications useful?

Many of the most urgent uses of context awareness may be in the 'vertical application' arena. Many mobile data capture tasks could be improved with some context awareness, automating away what is an otherwise error prone or neglected task. The context can be used to simplify future retrieval, or even create interesting new links between information items. The context can also be used during the retrieval process itself.

Context aware web services can be used to present data customised to the current location or activities. In this role the context is used as a filter, to only show those data items which are most relevant to the current context.

### When is context awareness a privacy issue?

- When the individuals are providing information about themselves without awareness of the fact, or without awareness of the uses to which the information will be made.
- When the provision of context goes against accepted cultural standards. CallerID is an example of this –a great benefit to most recipients; some callers view it as an invasion of privacy. The same goes for email and web browsing, neither of which are as anonymous as one would think.

Much of the privacy issue is related to people wishing to retain control of their own data. Local context processing is clearly one solution to this problem, but it is not sufficient to solve all possible tasks. In particular, would people ever be prepared to wear active badge style devices –such as wrist watches– which identified them to generic systems? We know that they are prepared to so in limited contexts – such as ski resorts– but a more widespread system would be anathema to most societies. Designing a system which would provide some context awareness while addressing most user concerns, will be an interesting problem

### How do we implement a generic supporting infrastructure for context-aware applications?

This is one of the interesting areas for discussion. The HP Labs' CoolTown project [2] is planning on, using Java and XML as the framework for applications. Full context awareness requires hardware to detect location, nearby users, and other semantic aspects which may be relevant. The CoolTown team is developing the notion of a "Beacon" [3], which can be a physical device using a technology such as IR, Near Field Radio, BlueTooth or merely a multicast IP service on a LAN. Beacons broadcast URLs pointing to information which the receivers can access to acquire physical or semantic context. This approach permits the user to acquire context data without revealing any personal information.

All communications systems capable of determining approximate location should be capable of informing the user (or trusted services) of this location. Currently this data is often retained by the 'service'. This is a requirement which needs to be evangelised to the hardware manufacturers, and to the

developers of successor specifications of wireless modem standards such as the ETSI GSM standard, which only provides country information.

What is critical is that applications should not have to care about how the information was obtained. Providing the data and 'quality of service' information –approximate accuracy, timestamp, etc- should enable an application to make use of the data regardless of source. As well as XML representations, one really needs a reference API to make full use of the data.

Adding geographic information to the Web is an interesting area for research, and is part of the W3C mobile working group work. If any of the workshop attendees also attended the February W3C meeting on the subject then relevant information perhaps be summarised –otherwise I can report some second hand information. One interesting piece of past work is the Poix format[4], a proposed representation of physical location. While it has some flaws, it could be a useful starting point for further work.

## Notes

As well as talk about context, I should be able to demonstrate some aspects of location aware web services using the Poix format. As this will just require my notebook and GPS receiver, I will bring the equipment with me if the time and interest permits.

## References

- [1] *The Secret Life of Notebooks*, Steve Loughran, Proceedings Chi 2000
- [2] HP Cooltown Web Site  
<http://www.cooltown.hp.com/>
- [3] *Creating A Web Representation For Places*, Deborah Caswell  
<http://www.cooltown.hp.com/papers/PlaceManagerv4.htm>
- [4] *POIX: Point Of Interest eXchange Language Specification*  
<http://www.w3.org/TR/poix/>