

Advancing the state of the art in Systems support for Ubicomp

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1 Reflection on the state of the art

It has been 15 years since Weiser's seminal article captured the collective imagination and helped instigate the field of 'Ubiquitous Computing' [8]. While the world of computing has certainly moved on (consider the now truly pervasively deployed and increasingly capable mobile phone), the vision of Ubiquitous Computing still arguably remains contemporary and unchanged. Only recently have we begun to see researchers challenge the precepts of this vision and exploring new domains of application; opening a debate at the core of the discipline [6, 1].

While I see this as the positive and natural growing pains associated with any new discipline, this debate doesn't help the humble systems researcher, whose goal is to develop the infrastructures that enable these as yet unspecified systems of the future. It is not surprising then that we still find ourselves drawn in our papers to postulating somewhat safe scenarios, such as 'context aware services' and the 'smart home'. Yet, despite the safe rhetoric endemic in these scenarios, I would argue that we're really no closer to understanding the parameters of such systems or consequently providing infrastructure to support them than Schilit was over a decade ago [7].

Ubiquitous Computing promises a paradigm shift in how we interact with Computers; I argue that gaining traction on this problem will require a radical rethink in how we approach undertaking systems research in Ubiquitous Computing and how we harness the creativity of our community[4].

2 Talking about a Revolution

"A journey of a thousand miles begins with a single step."

Lao-tzu, The Way of Lao-tzu

Chinese philosopher (604 BC - 531 BC)

To design infrastructure for Ubiquitous Computing we must understand what it is that we are to support more clearly. What Ubiquitous applications are comprised of and what the common or intrinsic factors are. Essential in the search is establishing the role humans will play in these inherently socio-technical systems—establishing as Kindberg and Fox referred to it as 'the semantic Rubicon' [5]. In the absence of established reference scenarios or clear demands from Ubiquitous Computing 'users', it remains for us to search, hypothesise and experiment to establish this knowledge experimentally. At this stage, all hypotheses are equally valid (even our own!) and the more creative minds engaged on this search the better. To enable this, it is essential that we consider how we can:

- **Lower the bar for creating and evolving deployments.** Research prototypes are normally 'brittle', they are often tuned to execute in specific environments and may require significant

skilled intervention to configure them to run, seed them with data, calibrate them etc.[2] Additional effort is required both at design time and in packaging our technologies post-hoc to enable their uptake by others or successful redployment (e.g. elsewhere). Creating robust configurations of hardware and software (or even just useful components) that are adaptable to multiple settings and uses presents system researchers with an enormous challenge. How to enabling the gradual maturation and evolution of such systems over time as we 'make improvements' is at least equally challenging.

- **Increase the availability, visibility and usability of our technologies.** As a community this will require us to dedicate additional resources to making our work available to others, creating materials where necessary to make the technologies truly usable (documentation, tutorials, example applications, potentially hosting services etc.)
- **Reduce the skill level required to experiment creatively.** This requires that we develop tools and toolkits to allow prototypical Ubicomp environments to be more easily created, modified, used and exchanged. Toolkits such as ECT¹ make a start in this direction; considerable work is required to development, mature and support such tools—ideally we should be able to encourage the creativity of the hobbyist through technologies not significantly harder to master than web authoring or AJAX.
- **Open learning.** To make progress we must learn from our experiments, not just individually but collectively as a community. Ubiquitous technologies can only come about with wide deployment and adoption. This requires us to change how we work together to encourage adoption of frank, open exchange of ideas, learnings and technologies. This means a degree of sharing beyond the normal academic routes of publication; encouraging the exchange of smaller and less academic lessons—limitations to results, experience reports, open challenges, less promising or unexpectedly flawed lines of enquiry. This requires and honesty and objectivity that will not be easy to achieve.
- **Enabling sharing and remote engagement.** We must also share software and the knowhow and design patterns for successful use—this means being able to track, store, restore, share, examine, instrument, debug, tune, extend and repair the configurations of running distributed systems; this requires new mechanisms extending way beyond existing configuration management approaches found in traditional distributed systems. However, without the ability to do this, the burden of discovering how to bootstrap Ubiquitous environments will always rest with the end user, which poses too high a cost for the majority of potential adopters.
- **Establish common ground and metrics for evaluation.** As we work toward out deeper collective understanding of Ubiquitous Computing system fundamentals, we will be establishing best practice and identifying concrete problems that need addressing. These are important for establishing the 'grand systems challenges' for Ubicomp; allowing us to develop, compare and contrast solutions. With these challenges come metrics for performance evaluation and the ability to iteratively improve and move the solutions forward. This is essential for us as a scientific discipline.

¹<http://equip.sourceforge.net/>

3 Conclusion

To fully adopt these working practices requires significant changes in how we work together. However, I believe we can start incrementally from modest beginnings—we can start by establishing a set of online resources; opening a forum for discussion and common reference materials (e.g. pointers to software, reading lists, theses etc.). This approach has worked effectively for other communities^{2,3,4}.

References

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²<http://www.hcibib.org/readings.html>

³<http://dsonline.computer.org/portal/site/dsonline/index.jsp>

⁴<http://sourceforge.net/index.php>