

UBI Challenge: Research Coopetition on Real-World Urban Computing

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ABSTRACT

This paper introduces the UBI Challenge that challenged the global R&D community to design, implement, deploy and evaluate novel applications and services in real world setting atop an open urban computing testbed. The paper first provides a procedural description of the UBI Challenge and then discusses the outcome so far with a special focus on the various issues introduced by the real world setting.

Categories and Subject Descriptors

K.0 Computing Milieux.

General Terms

Experimentation.

Keywords

Urban informatics, Testbed, City.

1. INTRODUCTION

The RoboCup [3][8] in robotics and the TRECVideo (TREC Video Retrieval Evaluation) [11][12] in content-based information retrieval are successful examples of employing an open challenge as a vehicle to advance a research field via coopetition (cooperative competition). While research teams compete for funding and papers in leading journals and conferences, they at the same time cooperate in these challenges for the significant benefits they offer. The challenges have established widely accepted experimental benchmarks that allow research teams to conduct comparative research on the fundamental problems of the fields on equal and transparent footing. The challenges also represent considerable savings from an individual research team's point of view, for establishing a large-scale benchmark such as the TRECVideo's video archive would be a very expensive if not an impossible endeavor to most research teams.

Challenges have also been organized by the ubicomp community, typically in conjunction of some international conferences. For example, the Ubicomp 2007 conference introduced the UbiComp Challenge that sought for submissions of how to implement an audience voting system to determine the winner of the "Best Presentation Award" in the conference [4]. The challenge was

introduced as "a new instrument to promote and encourage high quality research in the area of ubicomp". The central requirement was that the proposed solution should make clever and efficient use of ubicomp technology, and could actually be implemented by the proposers before and used at the conference. The challenge call was intentionally underspecified in terms of approaches and technologies to allow for a creative and innovative scientific solution employing all kinds of ubiquitous computing technologies and techniques that are appropriately addressing the problem space. The challenge was advertised to offer an excellent way to showcase tangible results of ubiquitous computing research and development to the approximately 500 attendees of the conference and was expected to scale up accordingly. The organizers believed that the experiences and findings from developing and running a system of this scale would provide valuable results to the ubicomp community.

Eventually, only four initial proposals were submitted. It was speculated that the high profile audience for the voting system and/or the workload involved in actually building and deploying such a voting system may have scared away researchers. Based on a committee review, two of the four initial proposals were invited to finalize their submissions. After a second round of reviews the system titled BlueVote [1] was deemed as the winner that was deployed at the conference with financial support from the organizers. There is no public final report on the challenge that would provide a (self-) assessment on how the challenge achieved its objectives and to what extent the challenge "promoted and encouraged high quality research" and "provided valuable results to the ubicomp community" as stated in the call. A later private correspondence with the director of the challenge emphasized the lessons learned from the practical aspects of real-world application deployment, e.g. infrastructure, meetings, site visits and time. Nevertheless, we can obviously conclude that the UbiComp Challenge did not have the same impact on ubicomp research that the RoboCup and the TRECVideo have had on their respective research fields.

Contrasting the UbiComp Challenge with the RoboCup and the TRECVideo allows identifying three important building blocks for a successful challenge: ownership, continuity and scope. The RoboCup and the TRECVideo have had dedicated owners that have been committed to the well-being of the challenge, maintaining, developing and organizing the challenge regularly, thus contributing to its continuity. While the scope of the UbiComp Challenge was intentionally underspecified to allow employing all kinds of ubiquitous computing technologies, audience voting still represents only a very thin slice of the wide spectrum of topics covered by the papers published in ubicomp conferences and journals. In comparison, the scopes of the RoboCup and the TRECVideo represent a much more comprehensive match with the fundamental research problems of their respective research fields.

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We would argue that it is impossible to reach a comparable match in any ubicomp challenge, due to the unrefined nature of the field. The dedicated owners, continuity and scope of the RoboCup and the TRECvid challenges have been essential in generating widespread and lasting interest on them over the years, when the UbiComp Challenge remained as a one-off exercise.

This paper introduces the 1st Open Ubiquitous City Challenge 2010-2011 (“UBI Challenge” for short, Challenge from now on) [13]. Our resourcing allowing, we are willing to serve as a dedicated host that provides the ubicomp community with a challenge of a reasonably broad scope and continuity. The paper is organized so that Section 2 first provides a procedural description of the Challenge. Section 3 then discusses the outcome hitherto, contrasting the Challenge with the RoboCup and the TRECvid challenges.

2. THE UBI CHALLENGE

2.1 Starting Premise and Objectives

The Challenge was at the same time inspired and enabled by the open urban computing testbed deployed at downtown Oulu, Finland. The testbed includes WiFi, Bluetooth, and IP-based wireless sensor networks across the city, and UBI-hotspots [6], a network of public interactive displays at indoor and outdoor locations around the city, accompanied by a middleware providing various computing resources and open APIs for application developers [5]. We have invested substantial resources in the testbed that allows us to deploy a wide range of applications and services in authentic urban settings for use by real people. Our goal is to enable urban computing research in authentic urban settings with real users and with sufficient scale and time span. Such studies are important because real world systems are culturally situated, and cannot be reliably assessed with lab studies detached from the real world context. By deploying a system for a sufficiently long time we can establish the technical and cultural readiness and the critical mass of users needed for determining whether the system can be deemed ‘(un)successful’ [2].

The first objective for the Challenge is exactly this – to provide the ubicomp community with an opportunity to transfer their ideas from labs into a real-world urban environment. This is very much in line with the increasing community support for the “in the wild” studies conducted for substantial amounts of time with large numbers of real users in real-world settings [2][9][10].

The second objective is to employ our testbed and the Challenge as a vehicle to stimulate global research collaboration on urban informatics in a very concrete manner. While many other disciplines have collaboratively invested in common testbeds bringing the community together, for example networking in computer science, there is no such activity among the ubicomp community. A successful Challenge would demonstrate the benefits of our open testbed for the broader ubicomp community.

The third, more ancillary, objective is to support developing metrics for evaluating urban infrastructure and applications in real-world settings. We argue that as of now our discipline does not have such widely accepted metrics at its disposal. We are hoping that the Challenge would produce a representative collection of ubicomp systems deployed in known and controlled real-world setting that would serve as experimental data needed for developing and validating such metrics.

2.2 Preparation

The Challenge was designed in collaboration with a number of leading international researchers on ubiquitous and urban computing, many of whom are now serving in the jury of the Challenge. The design phase produced a particularly valuable by-product in the form of the international UBI Summer Schools. The first summer school was arranged in May-June 2010, to promote the Challenge and to provide interested parties with a hands-on opportunity to familiarize themselves with our testbed. The five days long summer school comprised of six parallel workshops that enrolled 72 students from 20 countries. Given its great success it was decided to organize the second summer school in May 2011, just before the deployment phase of the Challenge. The third summer school will be held in May-June 2012. As another promotional activity the UBI Challenge Workshop 2010 was arranged at the UbiComp 2010 conference [7].

We had obtained valuable prior experience in organizing an open challenge from the national UBI Challenge 2010. Released in February 2010, it challenged both individuals and organizations to innovate and implement new services for the UBI-hotspots. A 4000 EUR grant was awarded to each proposal selected for implementation by a local expert jury. Participation was also stimulated by a raffle, so that a high end smart phone was raffled between all entries. By the submission deadline in May 2010 we received just nine valid proposals, of which the jury selected three for implementation: Battleship (a game proposed by two local exchange students), Diversus Oulu (an interactive multimedia art piece proposed by a local freelancer artist couple) and UBI Mixer (an interactive music mixing application proposed by an SME in Helsinki). Eventually, Battleship and Diversus Oulu were successfully deployed on the UBI-hotspots, UBI Mixer not. Incidentally, Battleship was the first service on the UBI-hotspots, which allowed two users on the opposite sides of a double-sided outdoor hotspot to explicitly interact (i.e. to play against each other). Eventually, the Battleship was deemed the winner, as it attracted seven times more usage than the Diversus Oulu and ranked fourth among all services during the evaluation period.

2.3 Execution

The final call of the Challenge was released in late October 2010 with submission deadline on November 31, 2010. Participation was stimulated by advertising that up to five proposals would be invited as finalists to implement and deploy their applications in Oulu, each receiving up to 10'000 € grant for covering expenses and a chance to report their study in a full paper in the upcoming MUM 2011 conference. The call “challenged the global R&D community to design, implement, deploy end evaluate novel applications and services in real world setting at downtown Oulu, Finland.” While the proposed application could be pretty much anything, it had to comply with few general requirements emphasizing real-world urban computing:

- The application was expected to provide a service to the general public or a reasonable subset of the general public.
- The service could be provided directly by the application, or the application could allow the municipality, a NGO or some other third party to provide a service to the general public.
- The service was expected to be available for use continuously or for a substantial amount of time, thus one-time installations did not qualify.

Proposals had to use a given template that covered a range of topics from system architecture and user interface to marketing and business model. A proposal was also expected to identify the required HW/SW infrastructure. A proposal was allowed to involve any proprietary infrastructure, as long as any requirements posed by the proprietary infrastructure to the organizers were reported for subsequent analysis of technical feasibility. Eventually, 11 valid proposals were received, three from Finland, six from Europe and two outside Europe. Eight proposals were submitted by university research teams, one by a company and two by an individual. Although the call was completely open in terms of infrastructure, nine of the 11 proposals involved the UBI-hotspots.

All 11 proposals passed the first test, the assessment of technical feasibility by the researchers of the host organization to determine that the proposed application could be implemented with available resources. In December 2010 each jury member individually ranked the proposals in a decreasing order of merit according to their innovativeness, user value, feasibility and sustainability. The jury members also voted on each proposal whether it deserved to be invited as a finalist or not. The rankings were combined into an aggregate ranking. The top four proposals having also a positive balance in terms of finalist votes were then invited as finalists to implement and deploy their applications in Oulu. All four finalists were European university research teams.

Each finalist was appointed a local liaison researcher to serve as the first technical contact point. In Jan 2011 the liaison researchers provided their respective finalists with a detailed assessment of the original proposal in terms of technical, content related, cultural and any other issues. The objective was to inform the finalists about any potential problems they might face with their original proposal. This early examination proved to be a very useful, contributing to a number of fixes and changes in the final design of the services. Since all four proposals involved the UBI-hotspots, we provided the finalists with remote access to virtual UBI-hotspots so that they could start implementing their services on the actual UBI-hotspot platform at their home universities. It should be noted that three of the four finalists adapted their existing research prototypes into an entry to the Challenge, i.e. they were not invented for the Challenge.

The finalists arrived in Oulu between May 20 and June 10 to complete the implementation of their services. The second UBI Summer School was intentionally scheduled for the week preceding the May 30 implementation kickoff so that the finalists could combine the summer school with the kickoff, as three of the four finalists did. The finalists shared a large office space at the CIE research center on the University of Oulu Linnanmaa campus that was furnished with a half dozen of lightweight UBI-hotspots. In addition to the liaison researchers, the finalists had a professional translator and a Finnish M.Sc. student at their disposal for localizing their applications, and for conducting user studies and interviews in Finnish. One of the four liaison researchers served in turn as a so-called operative host that was always reachable in a particular number. Similarly, each finalist was provided with a mobile phone for communication with each other and the host. The finalists were arranged housing on nearby student housing complexes charged on their grants.

The finalists' services were deployed on the UBI-hotspots for use by the general public on July 7. The release of the services was arranged in form of a public media event that was reported by the

local main newspaper and a local radio. The services were placed in a new service category titled "New Cool Stuff" in the service selection menu of the UBI-hotspots. Further, the "Quick Launch Menu" providing one click access to listed services was dedicated to the Challenge services from July 7 till September 16. The removal of the services from the "Quick Launch Menu" from September 17 onwards allows us to explore how the usage volume of the services changes when they are no longer that visible and prone to plain curiosity driven use.

After the deployment the finalists started collecting research data with various methods. To give as rewards in user studies, the finalists could acquire movie tickets from the host charged on their grants. To serve as assistants in user studies, the finalists had access to so-called UBI Guides that the City of Oulu had hired to guide the general public in using the UBI-hotspots. Let's recall that a default UBI-hotspot is shared by a large number of services competing for the attention of the user. To minimize noise by other services, each finalist was provided with the opportunity to have one outdoor and one indoor UBI-hotspot allocated exclusively to their own service for two days. Quantitative data such as the log of all launches of a particular service on the UBI-hotspot is collected automatically by the testbed. The services are expected to remain operational at least till December 31, 2011, allowing the finalists to collect almost six months' worth of log data.

On August 17 each finalist gave to local jury members a 40-minute presentation that was recorded for later distribution to all jury members. Together with the organizers' internal report, the finalists' presentations and upcoming MUM 2011 papers constitute the documentation that the jury members will have at their disposal for the purpose of ranking the finalists. The finalists will present their work and the awards will be handed out in a special session dedicated to the UBI Challenge to be organized in the MUM 2011 conference in Beijing, China, in December 2011.

3. DISCUSSION

The Challenge has clearly achieved its first objective of providing the four finalists with an opportunity to transfer their ideas from labs into the real world. None of them had prior history of exposing a research prototype to the general public in this extent. The real world deployment also subjected their work to public scrutiny in popular media, as the local main newspaper published four distinct articles on the Challenge during the summer. The articles sparked a plenty of discussion in the newspaper's discussion forum, but the finalists seemed to cope well with the sometimes brutal feedback. While the Challenge has certainly brought us hosts and the four finalists together on urban informatics in a very concrete manner, it will take time for any significant collaborative fruits of this get-together to ripen. Similarly, more time will be needed to incorporate the four cases into our ongoing work on developing the metrics.

Referring to the ingredients of a successful challenge, scope is very relevant here, as the Challenge spans a particular portion of ubicomp research, urban computing, along two related dimensions: application of particular ubiquitous computing technologies (our testbed) in a particular urban space (downtown Oulu, Finland). These dimensions give rise to two important aspects to consider: validity and scalability. It should be noted that the scope was not limited by a requirement for a proposal to address a specific problem or topic. Indeed, it would be a very

worthwhile exercise to assess the relative pros and cons of an open challenge versus a problem/topic driven challenge.

We have to consider the validity of the studies conducted in the context of the Challenge. It is obvious that the studies possess ecological validity as the setting is a real-life situation under investigation. However, their internal validity is threatened by the many confounding variables introduced by the real-world setting, for example the many other services of the UBI-hotspots. Of particular interest is the external validity of the studies, i.e. to what extent the results of the studies generalize. While the underlying testbed is highly realistic and situated within a city, it is at the same time culturally and geographically biased. Specifically, the testbed is situated in Northern Europe, and it can be argued that the personalities and reactions of Finns would be different to say, Portuguese or Chinese, and similarly Finnish weather is distinct from that in other countries. This, however, is a problem that any realistic urban computing testbed would face, since by definition it would be situated in a specific location with people of a specific culture.

To generate and maintain widespread interest, it would be desirable to be able to scale up the Challenge in terms of the number of participants to comparable levels with those of the RoboCup and the TRECVID. However, while it is fairly straightforward to duplicate a large digital video database for distribution to a large number of participants carrying out the computation independently at their own machines, it is much more difficult to duplicate, slice or multiplex singular physical real-world resources, such as downtown Oulu and our testbed infrastructure, between multiple concurrent studies.

The importance of the (physical) location deserves further consideration. Participation in the TRECVID can be executed completely in your own lab. In the RoboCup participants prepare their entries in their home labs and then get together for about a week to compete in different categories. However, urban computing is characterized by real world realism, which is substantial in our case, since the testbed is a part of the fabric of the city. This comes with a tradeoff, however. While we could have participants deploy their services atop the testbed remotely, together with automatic logging of quantitative usage data for evaluation purposes, we believe it is more beneficial for the researcher to be physically present on the site. This is due to the high realism and dynamism of the city, which is very difficult to convey remotely. In our experience, visiting the site makes a big difference in developing the application as well as collecting qualitative data and interpreting the results. The participants' substantial stays at the site also contribute to the collaborative targets, unless they are just 'parachuted' to the site to do their work and leave. It is a particular risk for a site (culture) specific challenge like ours that calls for identifying various ways for the participants to gel between themselves and with the hosts at different levels to breed collaboration.

In terms of cost-benefit analysis, the Challenge is expected to provide participants with savings in the overall cost of conducting an experiment of comparable magnitude. We argue that any research lab conducting urban computing research is likely to carry out a number of studies and deployments. Arguably, the most expensive resource required for deployment is researcher's time, which is typically used for managing the deployment and collecting data during a study. Our experience shows that

researchers' time is drastically reduced in deploying and testing an application atop our testbed, due to the fact that there is a rich set of readymade tools and resources. Even though there is a learning curve associated with becoming familiar with a testbed, the substantial reduction in researcher time required for successfully deploying a system across the city provides a substantial benefit for researchers, as costs are overall reduced.

The UBI Challenge is the first of its kind ever arranged by the ubicomp research community. Thus, at the end of the day, it will be very important to conduct a thorough assessment of the outcome in various respects such as a cost-benefit analysis of the investment and the effort, the quality of the contributions, and the benefits for the participants and the organizers. The assessment will lay the foundation for specifying a subsequent challenge, if a collective interest and necessary resources to organize one in the future exist.

4. ACKNOWLEDGMENTS

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