

A Platform for User-Centred Evaluation of Context-Aware Adaptive Services

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Abstract: Context-aware services must exhibit a high level of responsiveness to changes in a user's physical, social and task context. Further, the usability of these services is significantly influenced by the user's ability to scrutinize and form a mental model of the service's adaptive behaviour. Erroneous or unexpected behaviour leads to ineffective and unpopular services. We have developed a platform that provides a 3D virtual representation of pervasive computing environments, allowing experiments to exercise services in a multi-user capacity that relates user activities to simulated sensors and actuators. Services can be easily integrated with data generated by large sets of varied sensors and actuators that, in the real-world, are expensive and logistically problematic to install and configure.

1. Introduction

Our platform aims to increase productivity in the user evaluation of context-aware adaptive services through the rapid and repeatable configuration of easily controlled ubiquitous computing experiments. A multi-player FPS game, Half-Life 2 (HL2), has been modified to provide a virtual 3D pervasive computing environment. Hammer 4, a map editor, allows developers to create a test environment according to their own experimental requirements. Sensors, e.g. pressure mats, located in the map generate XML encoded environmental data at run time. The proxy (figure 1) logs these messages before routing them to subscribing services. Data is stored in an instance of the open-source XML database, eXist. The proxy may filter or tailor data based on subscriptions provided by the service.

2. Running Service Experiments

A new experiment commences when a service contacts the proxy with an experiment configuration file. This configuration file contains an experiment id, a map name, a game-server address and data subscription information. The service is registered and the proxy creates a new database collection using sensor information parsed from the map file. The proxy invokes a new game-server on the remote host and subsequently establishes a connection with the simulation for experimental data transfer.

During an experiment, services may connect to or disconnect from the proxy, thus joining or leaving experiments respectively. Game-clients may also connect to and disconnect from a game-server at run-time. The game-server takes responsibility for gathering data from game-clients and distributing actuation commands to game-clients. The proxy can host more than one experiment at a time, but services connecting to the proxy are not required to subscribe to all experiments.

At run-time, messages flow between the virtual environment and the adaptive service. Data leaving the simulator becomes the contextual information on which

services base their decisions and thus respond to the user's needs. Services, on the other hand, send instructions to alter the state of the environment through device or entity actuation, e.g. opening a door. The proxy requires only a game-server connection since underlying game infrastructure ensures clients also receive updates.

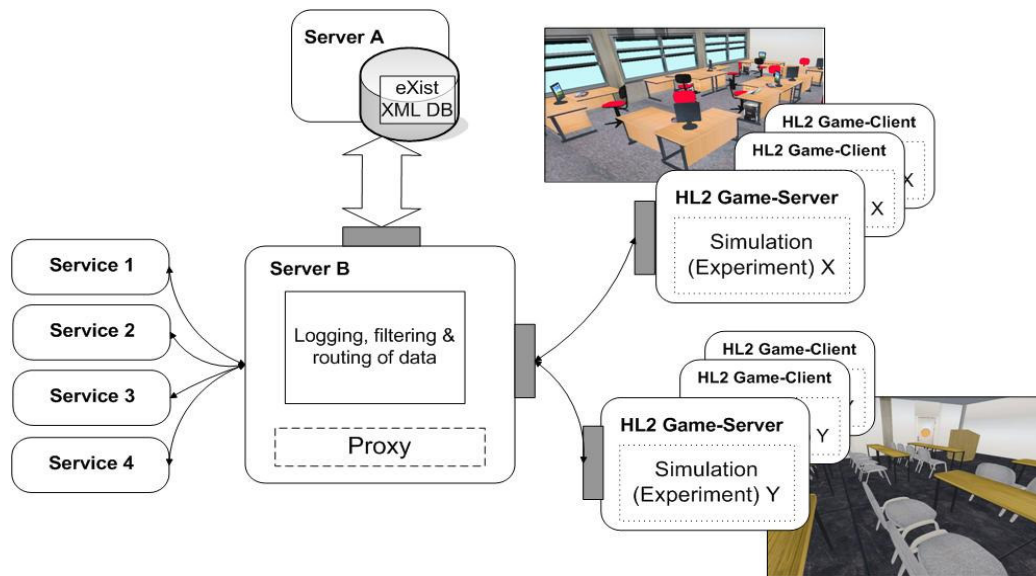


Figure 1 – Platform Overview.

3. Results

3.1 Mapping

An existing three storey office building features 104 rooms comprised of offices, computer labs and lecture rooms, which are furnished with 520 desks, 352 chairs and 257 replica desktop computers. An undergraduate intern, untrained in Hammer 4, completed this map in 22 working days.

3.2 Message Latency

The latency of messages, between a game-server, or game-client, and a service, is of the order of milliseconds when crossing up to four LAN connections.

4. Conclusions & Future Work

The system architecture has proved a viable solution. Services receive data in a timely manner while users do not suffer perceivable or adverse delays in service response times. Optimised mapping techniques continue to allow experimental environments to grow in size and complexity.

HEA funding had supported the platform development work to date [1]. Impending Enterprise Ireland funding focuses on progression towards an integrated design and evaluation tool for service developers in the wireless, mobile and pervasive computing markets.

5. References

[1] O'Neill, E. et al. A Testbed for Evaluating Human Interaction with Ubiquitous Computing Environments. Proceedings of IEEE 1st International Conference on Testbeds and Research Infrastructures for the Development of NeTworks and COMmunities (Tridentcom 2005).