



## Mobile and Ubiquitous Objects

### COMMUNICATION AWARENESS IN MOBILE DEVICES

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The University of Malaga's wireless communications and pervasive computing team is developing software tools to enhance distributed mobile applications' development and deploy-

ment phases (see figure 1).

From our group's experience in developing software for smart phones, we've noticed a lack of tools to assist testing and debugging communication-intensive applications. Most application developers use computer resident emulators to develop, analyze, and test new applications for mobile devices; however, the application's actual behavior

is always different in the target device. So, our first aim was to obtain tools based on wireless devices (the emulator doesn't simulate everything).

On the other hand, traditional methods for analyzing mobile data communications' performance in realistic scenarios were based on trials, using mobile devices only as modems with the applications running in a laptop.

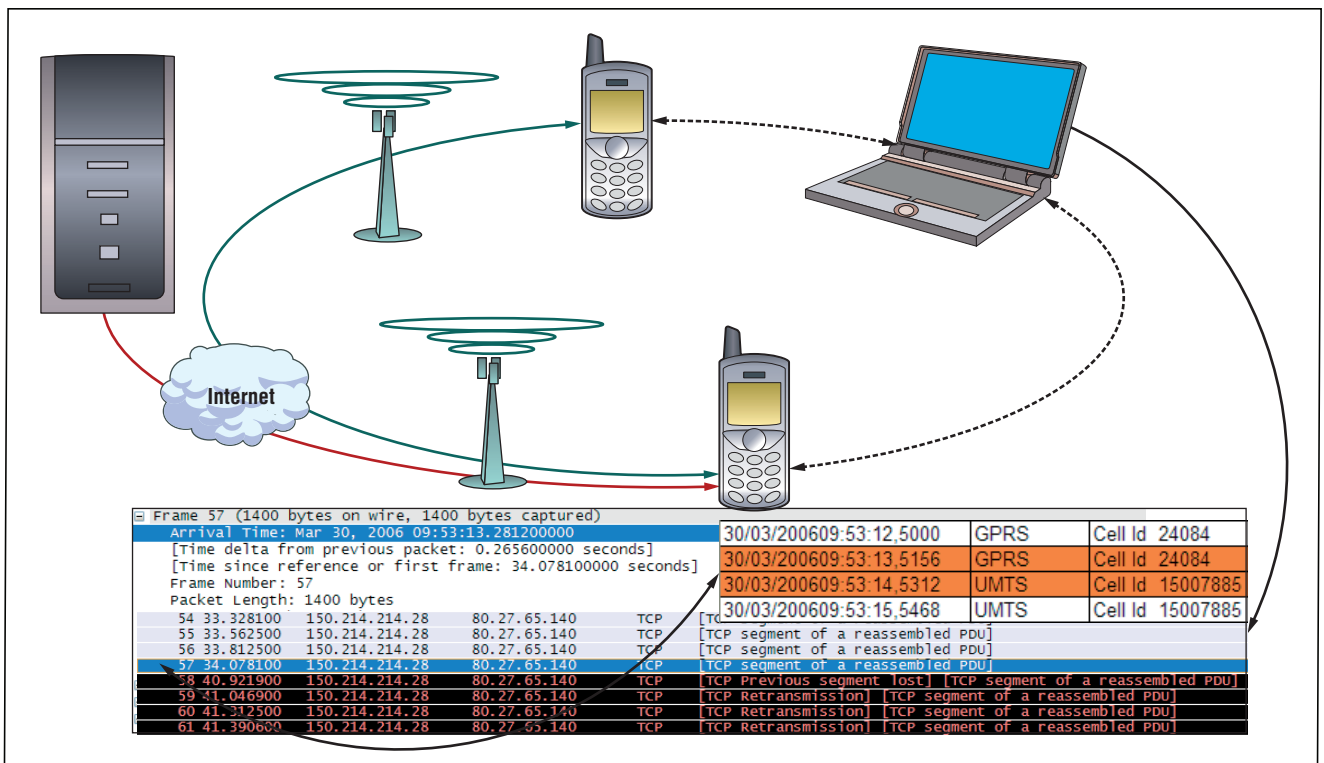


Figure 1. An example of communication awareness in mobile devices. Packet losses detection in handovers between General Packet Radio Service and Universal Mobile Telecommunications Systems could be used for cross-layer optimizations in heterogeneous networks.

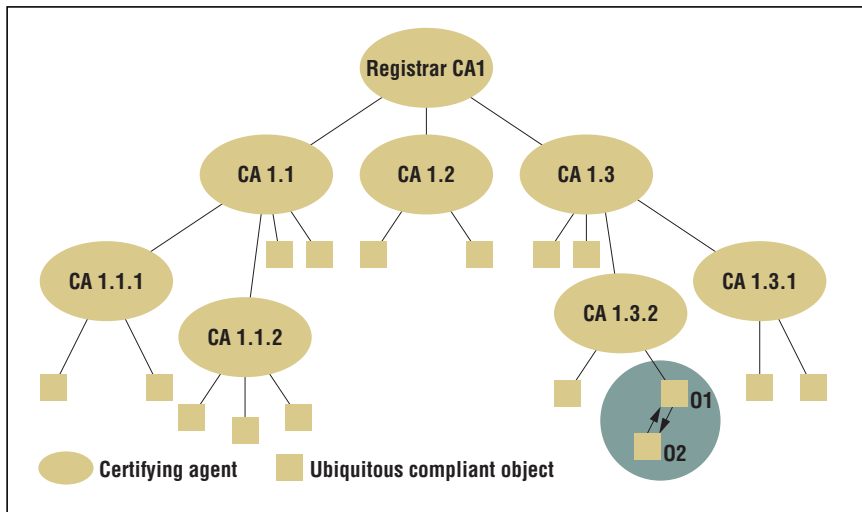


Figure 2. A certifying agent's tree structure.

Measurements based on this scenario are no longer interesting because

- current devices have enough processing power to execute both the application and the monitoring software inside the terminal, and
- many applications have been specifically designed for mobile devices, and porting them to the modem-laptop scenario only for evaluation purposes is too costly.

We provide a uniform solution to both problems by designing and implementing middleware for wireless-communication awareness that analyzes

- new communication protocols in mobile environments,
- correlation between mobility events (such as handover and roaming between different radio-access technologies) and communication performance,
- metrics for benchmarking communications in mobile applications, and
- security weakness and malicious applications in mobile devices.

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### UBIQUITOUS OBJECTS: A SECURITY-TOKEN-BASED AUTHENTICATION MODEL AND CATEGORIZATION AND IDENTITY

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Our research group is investigating two issues related to ubiquitous objects: creating a model to combat security risks and access-control problems and developing a protocol to facilitate communication between various objects.

#### Security

In ubiquitous computing environments, compliant objects can access resources and services anytime and anywhere. This leads to serious security risks and access-control problems because almost anyone with a mobile device can access these resources. Like any other significant computing system, autonomic systems must be secure. Many autonomic systems use new techniques and architectures whose security implications aren't yet well understood. Distributed system architectures connecting many

computers raise questions on how to better protect system information and resources. If autonomic systems are to reduce human administration costs, they shouldn't rely on humans to notice anomalous behavior resulting from security compromises.

Because many autonomic systems must deal with a constantly changing set of other systems as suppliers, customers, and partners, they need flexible new methods for reliably establishing trust, detecting attacks and compromise, and recovering from security incidents.

Our work proposes a new access model, which uses a hierarchical tree-based approach for authenticating ubiquitous objects. Based on security tokens, our authentication model operates in a multilevel security environment, which is modeled as a forest of hosts operating as certifying agents. CAs authenticate the ubiquitous objects for communication. CAs are arranged in the form of a tree. Each CA maintains information about its immediate descendants (which can be CAs or ubiquitous objects) registered with it (see figure 2).

Our model's central idea is to efficiently spread important information over several separate CAs so that the information is highly available, reliable, self-correcting, and self-protecting. We use mobile agents to implement this model. Its design is complete, and implementation is in progress. Figure 3 shows the CA's GUI.

#### Communication

Ubicomp's growth indicates that numerous users and objects will interact with one another simultaneously in the future. This poses the question of how to uniquely identify an infinitely increasing number of ubiquitous objects and standardize the data they're exchanging.

We're developing a protocol to address this question. We're proposing a standard format for the ubiquitous data that the various ubiquitous objects exchange. We've selected one ubiqui-

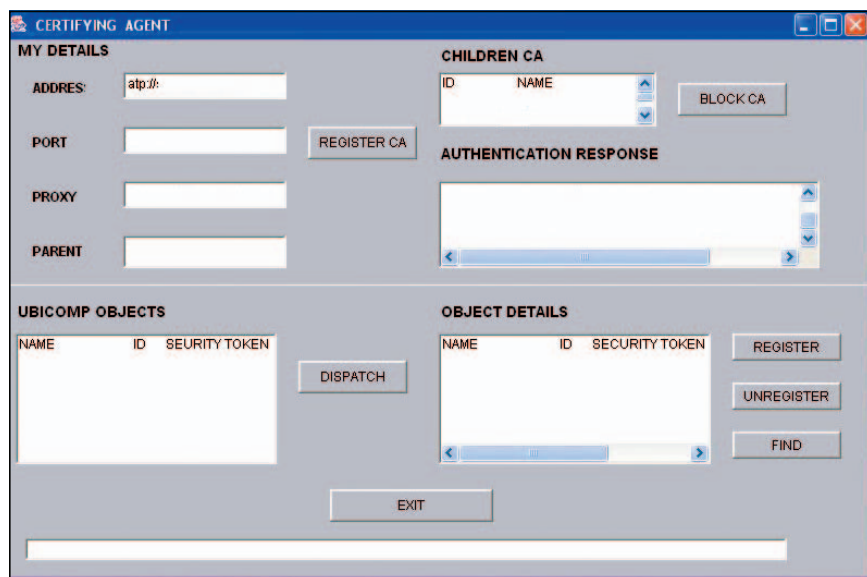


Figure 3. A certifying agent's GUI.

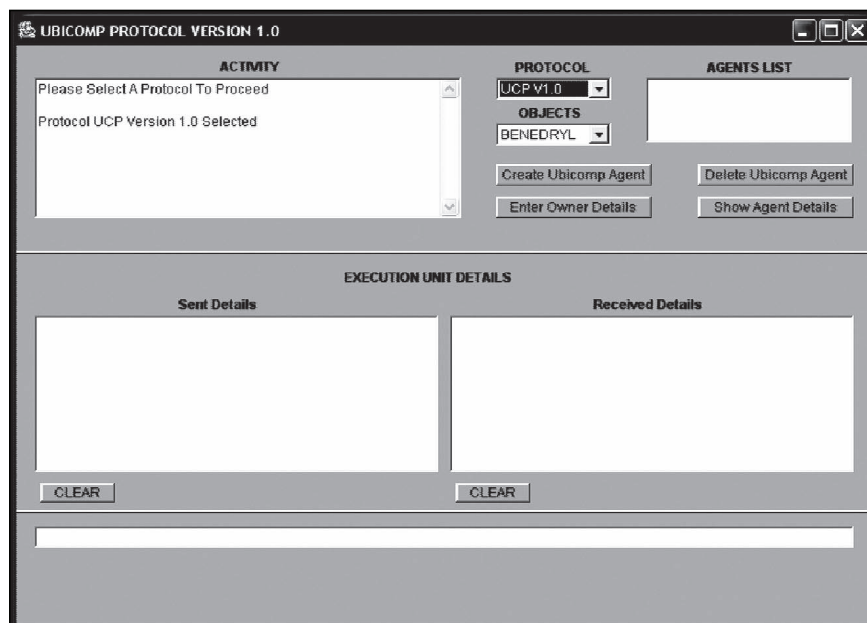


Figure 4. A refrigerator object's GUI.

tous application and are simulating the ubiquitous environment to demonstrate the communication among objects using our protocol. We considered the communication between a Refrigerator object and an Owner object (Mobile), which acts as the Owner of a Refrigerator object. The Owner object can query the Refrigerator about objects present in the Refrigerator. Additionally, the Owner object

will regularly receive critical information about the objects present in the Refrigerator. The object identity, classification, and protocol are scalable. We're conducting the simulation in the Mobile Agents paradigm.

Figure 4 shows the functional design for the Refrigerator object.

For more information on either project, contact Umakant P. Kulkarni at prof\_ard@yahoo.com. ■

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