

Report on the Research Visit to Computer Technology Institute of Patras (CTI)

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Collaboration between Heriot-Watt University and the Computer Technology Institute of the University of Patras started in 2008 at the PERADA workshop held in Venice, Italy. Professor Nick Taylor gave a presentation on *Personal Smart Spaces*, of which a prototype is currently under development in the FP7 PERSIST STREP project. At the same workshop, Professor Achilles Kameas presented the concept of the *Activity Sphere*, developed in the FP7 ATRACO FET project. Discussions on these topics brought up questions such as whether a *Personal Smart Space* can benefit from utilising *Activity Spheres* to implement its tasks and whether a *Personal Smart Space* can provide an efficient underlying platform on which the *Activity Sphere* could operate. A PERADA funded research visit presented the opportunity to explore these questions in more depth.

A *Personal Smart Space* is based on a personal area network constructed from a variety of networked components which might range from mobile or wearable devices to smart dust (Taylor, 2008). *Personal Smart Spaces* are able to provide limited pervasiveness and context awareness at anytime and anywhere. Their ability to inter-operate with other smart spaces permits *Personal Smart Spaces* to automatically adapt environments to satisfy user preferences, to resolve conflicts and to facilitate a migration from smart places to smart regions. A user's *Personal Smart Space* can pro-actively initiate activities on their behalf based on their preferences, predicted intentions and their current context.

An *Activity Sphere* is defined as a high level description of a task to be performed. With the support of ontology matching, it defines the set of resources (user data, sensors, services and devices) required to achieve an individual goal within an AmI environment (Goumopoulos, Kameas 2008). It is based on the notion of "bubble", which has been used to describe a temporary space that can be used to limit the information coming into and out of the digital domain (Beslay & Punie, 2002). The digital domain itself constitutes a "digitization" of the definition of a personal space described as a "soap bubble" (Sommer, 1969). A bubble gathers together all the interfaces, formats and agreements etc. needed for the management of personal, group and public data and informational interactions and may be described as a semi-transparent membrane that can be tuned to function differently depending on the direction of the movement of data.

During the visit to CTI, several research challenges were explored including ways in which *Activity Spheres* can be activated and exploited inside a *Personal Smart Space* and how an *Activity Sphere* can benefit from the information that resides inside a *Personal Smart Space*. A *Personal Smart Space* is capable of monitoring the user's interactions with the environment that surrounds them (including the devices of their *Personal Smart Space*, fixed Smart Spaces and *Personal Smart Spaces* belonging to others) to learn user preferences and user intentions. These are used to proactively adapt the environment in the future when the user finds him/her self in the same environmental state. We explored the possibility of using an *Activity Sphere* to describe the user's interactions in a *Personal Smart Space* and the environmental state at the time of the adaptation.

We assume that all devices, services and resources have their own ontology which they advertise to the environment. These ontologies describe the characteristics, functionality, restrictions and requirements for using the device, service or resource in a proper manner. This allows for flexible pattern matching between devices that share the same characteristics and can be used to offer the same functionality. An *Activity Sphere* provides an abstract definition of the devices, types of services, types of resources and types of data required to accomplish a certain task. By defining a task in an abstract manner, the *Activity Sphere* is flexible enough to be implemented in a different context and using different services, devices and resources that serve the same or similar purposes.

Because the *Activity Sphere* is a high level description of a task to be performed, it allows the learning module of the *Personal Smart Space* to learn on high level descriptions of tasks and not specific instantiations. This means that a *Personal Smart Space* can create a high level description of the current state of the user's environment, check if it matches any of the learnt *Activity Spheres* by checking the properties and the types of services that are available and select similar services that perform the required operations without waiting for the precise services to be available for the proactive implementation of tasks.

An *Activity Sphere* can be implemented by matching the ontologies of the available resources with the description of the task included in the *Activity Sphere*. The *Activity Sphere* can then be regarded as active. During this period, the *Personal Smart Space* monitors the user and stores data on interactions with the resources for each active *Activity Sphere*. Such data is stored with the appropriate context information in which the interaction occurred. The *Personal Smart Space* is then able to learn more information about what the user wishes to achieve in that *Activity Sphere* and change or enhance its ontological description accordingly. Through learning techniques, the *Personal Smart Space* may also infer that an *Activity Sphere*

should be split into two or more *Activity Spheres* which can be active at different times. This will result in better, fine-grained personalisation of the *Personal Smart Space*.

The *Personal Smart Space* can decide when to activate or de-activate an *Activity Sphere* by cross checking several features with the available *Activity Spheres*. These include the context of the user, the proximity of other *Personal Smart Spaces* and the user's preferences and intentions.

To conclude, the research visit confirmed that there is much scope for synergy between the two paradigms and *Activity Spheres* would benefit *Personal Smart Spaces* and vice versa. The visit was successful and laid the foundations for continuing collaboration between Heriot-Watt University and CTI. A white paper is expected to be released soon that will present our research results in more detail.

REFERENCES

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