The SmartRoom Infrastructure: Service Runtime Reliability

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***Abstract*—SmartRoom is a system for automation of collaborative activities localized in a room: digital services are available for organizers and participants. The Smart-M3 platform sets up a networked knowledge sharing environment on top of which the service set is deployed. Our implementation uses dedicated Smart-M3 knowledge processors—infrastructural elements for SmartRoom services. In this abstract we introduce our design of the SmartRoom infrastructure and its key properties for reliable service construction and delivery.**

Keywords—Smart spaces, Smart-M3, Collaborative environment, Services, Reliability.

The SmartRoom system is installed in a space-constrained physical environment (a room) using locally equipped devices (WLAN connectivity) and external systems (corporate network and Internet). The environment runs on Smart-M3 platform [1], where Semantic Information Broker (SIB) maintains a smart space. A Smart-M3 based application consists of autonomous agents—knowledge processors (KP). They cooperate via information sharing in smart spaces [2].

The system advances the idea of Smart Conference system [3]. SmartRoom provides a set of digital services, where the core service types are Agenda and Presentation. They maintain public activity agenda and digital materials of the speakers, respectively. Other services are constructed either by augmenting the basic ones or as independent processes [4]. Participants primarily access the services using their personal mobile devices [5]. Conference is a key activity mode we consider for the automation in SmartRoom.

Each service is implemented as a KP or as cooperation of several KPs. Such infrastructural KPs form the SmartRoom infrastructure. It is responsible for service construction and delivery to participants. A participant accesses the services using her/his client KP, which personalizes the participation in SmartRoom.

The basic scheme that we suggest is shown in Fig. 1. The SIB is deployed either locally on a server computer in the room or on a remote machine (e.g., virtual) in the same corporate network. The conference mode is supported by the core services: Conference-service to handle the conference runtime, Presentation-service to display current speaker's presentation slides, and agenda-service to display the conference agenda.

Reliable operating of Smart-M3 applications is a particular issue, which implies specific implementation methods. The known bottleneck is a subscription query (one of operations for data exchange with the smart space): there is no guarantee for KP to receive every subscription notification. In SmartRoom the issue can result in incorrect behaviour. For example the first slide is not shown on the screen when the next presentation has been started. Obviously to avoid such failures the application should implement some additional mechanisms to ensure the operability correctness.

Our recent development considers the following properties that the SmartRoom infrastructure implements to achieve the runtime reliability.

Subscription control: An infrastructural KP performs additional timer-based checks for the service subscriptions [6]. Such checks can be implemented either in KP application code or in the underlying KP interface (KPI) [7]. (It provides networking primitives for KP interaction with smart spaces.) The latter approach makes the KP application code free from implementing timer-based checks as they are performed automatically on the KPI side. In SmartRoom, all services subscribe to their own notifications (specific RDF triples) [8]. As a result, if a notification was published in the smart space and the service has received no notification then the infrastructural KP proactively checks for unprocessed notification triples and continues the service operation.

Reconnection: A service restores its operational state and connection with the smart space. The problem concerns Smart-M3 platform components (e.g., SIB failure), network connectivity (e.g., temporary loss of connection), and infrastructural KPs themselves (e.g., abnormal leave due to crashing). When some of these problems occur, service must be restarted and reconnected to the smart space. The key issue is restoration of the previous state. Thus after reconnection the service continues its runtime from the point before the failure. Note that some failures happen when the current activity process must not be interrupted (delays are possible, however). Service reconnection is performed in automatic manner if possible. Manual intervention is always possible.

Online services: Services operate permanently and continuously, running on server computers and accessible from the smart space. We use Ubuntu Linux on our smart room server; it provides a convenient tool for launching applications as services (daemons): the Upstart event-based init daemon

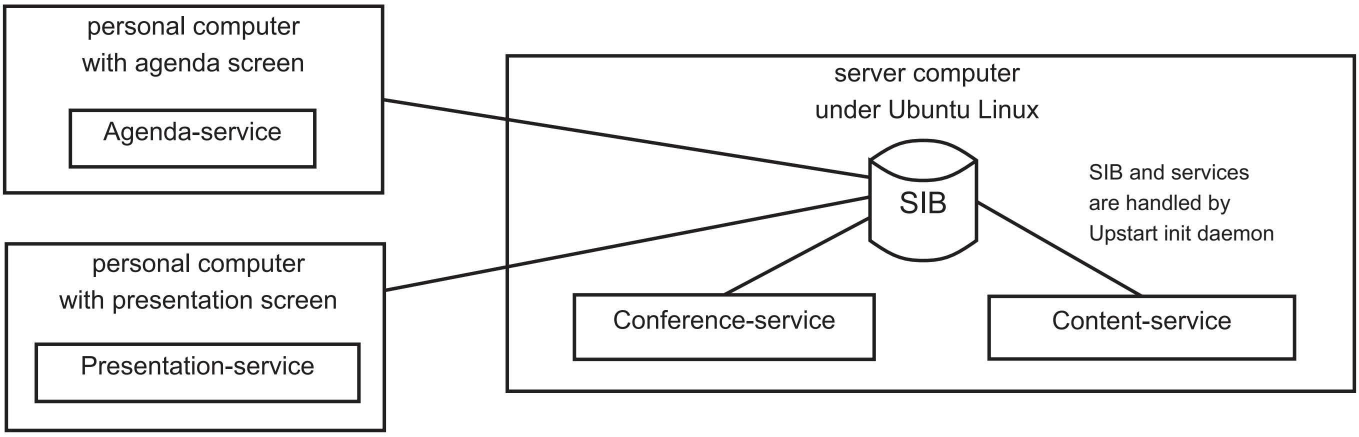

Fig. 1. Scheme of SmartRoom infrastructure on top of Smart-M3

(http://upstart.ubuntu.com). It handles running and stopping the services. Besides Upstart supports automatic respawning, i.e., whatever happens with the service, it will be relaunched again. It is possible to chain events (starting or stopping of particular services) and thus to set dependencies between services. For example, an augmented service is automatically launched whenever its master service is started.

Content management: SmartRoom exploits information from a multitude of sources. Every service produces and/or processes some specific content to be used in the smart space by other services and end-users. The straightforward solution when all data are copied into the smart space is not appropriate due to the scalability problem. A smart space is an information hub that *relates* multi-source information [2]. We suggest a specific service—Content-service—to store particular content from users and services and to share its pieces using well-known technologies like file sharing. Every service or client can upload content (text, image, audio, video) to Content-service, and the smart space needs only to keep a download link for use by other services. That is, the reliability increases due to the delegation of massive storage functions to a specialized content store on the infrastructure side.

The above properties are implemented in the SmartRoom infrastructure, providing additional resilience guarantees for service construction and delivery to end-users. The recent code and scripts are available as open source at http://sourceforge.net/projects/smartroom.

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