Active Badge System using CORBA (extended abstract)

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This paper presents the design and implementation of a new CORBA-based software for Active Badge System (ABS) originally designed at ORL in Cambridge UK [3]. Since the system was designed and constructed some drawbacks in its architecture and functionality have been identified during its exploitation in the real office environment.

At the beginning of the new software design a conceptual model of existing ABS has been evaluated in the context of requirements of ABS front-end applications. This led to the following conclusions.

The granularity of the existing ABS is large, i.e. it consists of a relatively small number of heavy-weight objects. This made the system reconfiguration and management of the persistent data difficult. The system data were passed by value enabling inconsistencies in the system state. End applications operated on messages in the internal format of the ABS wire protocol. The scalability of the original system was significantly restricted by the centralized processing of location information. The experience has shown that an additional middle layer between the ABS system core and front-end applications is needed, which would provide more abstract view of information about equipment and user location and history of its changes. The implementation of the existing system in ANSA causes that it is not compliant with today modern software technology.

The existing Active Badge software mainly supports a model of the system built around three relationships: 1) badge to badge holder, 2) sensor to place (called a sensor group) and 3) sighting that is a temporal relationship between a badge and a sensor. All other dependencies are inferred from these relationships.

A detailed analysis of that system leads to the conclusion that there are two categories of relationships between the system components: static (e.g. representing allocation of badges to badge holders) and dynamic (e.g. describing the temporal location of badges). Each of this categories has a different mechanism of its maintenance during the system activity, which, however, may be supported by two uniform mechanisms modeled as object-oriented frameworks.

The construction of the new ABS software is not only justified by novel implementation platforms, such as CORBA [1], but rather by the new object oriented structuralization of the system functionality. In general, its new architecture corresponds to the three-tiered model of the modern software built of: servers, business objects and light-weight (WWW, Java) user interfaces.

The proposed architecture of the new CORBA based Active Badge System core software is based on the following assumptions:

- All components of the system will be represented as relatively light-weight CORBA objects. This concerns both the hardware components as well as logical components such as static or dynamic relationships. This approach will significantly increase the number of possible system configuration and distribution variants. Encapsulation of system data inside the distributed objects will enable passing information by references. Moreover, this will enable easy application of object-oriented approach to ensure information persistency, for instance object databases, such as ObjectStore.
- The system should be structured in a layered way and each layer should provide consistent view of the system. First of all, the new system will hide the internal format of the ABS wire protocol behind object interfaces. Furthermore, the physical structure of the system should be separated from its logical configuration, etc.
- It should provide a different view of the system related to: system administrator requirements, spatial information accessibility and temporal location of badge holders.
- It should represent four basic types of static relationships, i.e badges to badge holders, sensors to networks, networks to network groups (a network group is composed of sensor networks managed by the single dedicated machine, called a poller), and sensors to places mapping, in a uniform and elegant way. The last two relationships, which represent the different system views may be combined into one object called domain.
- The different level of location granularity should be provided. A badge holder should be localized in the area of the given sensor, in the place defined as a group of sensors installed in a particular room or site, in a network, network group or a domain. It results in five different dynamic relationships that temporally map the badge holder to these five different grains of location. An attribute of each relationship is a sighting quality that corresponds to the number of messages received from a badge in a given area (a sensor, place, network, etc.) The new system additionally should distribute processing of this location information.

Each static relationships is supported by a dedicated object manager responsible for its maintenance providing operations for creating, removing and updating managed components. The dynamic relationships handling is much more complex and is performed by generic sighting processor related with particular location granularity entity such as sensor, place, network, domain, etc.

The proposed system structuralization is consistent with event processing techniques [2] based on filters and dispatchers. The filtering mechanism requires specification of conditions that refer to the different location granularity. A dedicated language will be constructed to enable easy specification of the various filtering conditions. The network of connected filters and dispatchers will be used to recognize even very complex situations.

In more detail, the layered architecture of the new CORBA based software consist of:

Core of the software. Two main functions performed by the ABS core are: management of static and dynamic relationships between system components, providing location information to the upper layers (business objects and user interfaces layers) and enabling reliable execution of commands for badges and sensors. There are objects representing hardware components of the systems (e.g. sensors, networks of sensors, network groups – concentrators of ABS wiring), spatial elements (e.g. places and domains), badges and their holders (e.g. users and equipment) as well as dynamic relationships between stational and mobile elements of the system.

Business Objects. This layer will use and process the information received from the system core and will provide more abstract and specific services, such as creating traces containing history of changes of dynamic relationships, collecting statistical data about mobile component behaviour or constructing more complex sets of places and attaching sighting processor to them enabling observation of events in their space etc.

User interfaces. This layer will be composed of a wide range of light-weight (mainly Java-based) user applications that will present to the user information provided by the core and business object layers as well as they will enable the user to interact with the system components.

The presented requirements result in the object model of the software presented in the article. Next the employed implementation techniques are described. The implementation of the system is based on a multithreaded ORB environment and is structured in a way which provides easy scalability through distribution of the system components around the network. Future directions of the ABS system development are also presented including concept of the intelligent sensor and the wonder room.

References

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