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Preface

Program Chairs' Message

The 4^{th} International Service Availability Symposium (ISAS 2007) continued with the tradition of its predecessors by bringing together researchers and practitioners from both academia and industry to address the problems of service availability. The unique characteristic of a strong academic and industrial partnership was vividly reflected in this year's event, from the Organizing Committee to the contributions and the participants. Recognizing the value of broadening the scope of ISAS 2007, we included new topic areas that cover model-driven design and human factors.

We received a total of 25 submissions, each of which was thoroughly reviewed by at least three members of the Program Committee. Due to the limited time allocated for the symposium, many worthwhile manuscripts unfortunately did not make it into the final program. Our sincere thanks go to the Program Committee for conducting a vigorous review process in a rather tight time schedule. The detailed reviews and their generous comments have shaped the contributions into an excellent program.

Supported by EU project HIDENETS, we organized a half-day post-symposium tutorial that connected the research contributions of the workshop with the industrial standardization efforts in the SA Forum. We are grateful to András Kövi for providing a tutorial on "Principles of HA Design for Planners."

We are indebted to the University of New Hampshire for providing the support and resources needed for hosting ISAS 2007 in Durham, New Hampshire. The local arrangement team led by Scott Valcourt did a tremendous job of assisting the planning and organizing and coordinating all the local activities. We would also like to acknowledge the involvement and support given by the Service Availability Forum and GI/ITG Technical Committee on "Dependability and Fault Tolerance."

We hope that you will find many contributions that are of interests to you, in these proceedings.

May 2007

Aad van Moorsel
Asif Naseem

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ISAS 2007 was organized by the University of New Hampshire, in cooperation with GI (German Computer Society) and Service Availability Forum.

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Table of Contents

Model-Driven Development and Human Engineering

Autonomous Decentralized System for Service Assurance and Its Application

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Abstract. The market and users requirements have been rapidly changing and diversified. Under these heterogeneous and dynamic situations, not only the system structure itself, but also the accessible information services would be changed constantly. Therefor, the integration of wired and wireless devices, control and information systems to achieve real-time, high-performance and high-reliability for heterogeneous service provision and utilization is becoming more and more important. The Autonomous Decentralized System (ADS) has been proposed for resolving the on-line property to achieve the step-by-step expansion, maintenance and fault-propagation prevention for high-assurance. In this paper, the ADS architecture, autonomous community and application example in the IC card system are discussed.

Keywords: Autonomous Decentralized System, Service Assurance, Autonomous Community, real-time, high-performance.

1 Introduction

The enormous growth of mobile and embedded devices in ubiquitous computing environment and their interaction with human beings offers rapidly evolving and frequently accessed information spaces for anyone, anywhere, anytime [1] [2]. Heterogeneous distributed architectures are required for such systems, where devices are interconnected by various types of communication links, and multiple tasks are concurrently run on the system. These devices may be battery constrained or subject to hostile environments, so communication noise and individual device failure will be a regular or common event. In addition, the configuration devices will frequently change in terms of mobility and task details. Finally, because these devices interact with the physical environment, they, and the network as a whole, will experience a significant range of service content dynamics [3] [4]. However, the conventional architecture is either overdesigned or fails to meet the specified constraints. Therefore, finding an effective architecture to meet the heterogeneous requirements under this dynamic changing environment is necessary.

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As the breakthrough over the conventional systems, Autonomous Decentralized System (ADS) has been proposed in 1977 [5] [6]. An autonomous decentralized system is defined as such a living thing which is composed of largely autonomous and decentralized components (subsystems). Their technologies have been developed in the various fields of transportation, factory automation, utility management, satellite on-board control, newspaper printing factory, information services, e-commerce, community service, and so on.

In this paper, the ADS concept and architecture are discussed and the application based on the autonomous community for IC card ticket system: Suica is shown to be effectively operated.

2 Requirements

2.1 Application Needs

Convergence of computer and communication technologies has created demand for ever-increasing levels of assurance. Now network users are demanding and expecting continuous delivery of services: they want always-on services and connections that are maintained without any internal system faults or failures [7]. And in order to maintain and attract new customers, service providers must offer personalized and efficient end-user service. The service assurance is characterized by the following properties:

- **Heterogeneity:** Systems react continuously to their environment at a speed imposed by the environment which lead often real-time capabilities. Reliability, robustness and safety constraints derive from situations where service continuation is impossible. Under the ubiquitous and sensed networked environment, various applications are integrated to achieve multiple requirements, but their requirement levels may be heterogeneous.
- **Adaptability:** The time for the design and commercialization of a system have to be done considering that the users requirements that derive from general trends in society related to aspects like individualization, globalization, mobility, fashion, etc., are always changing. Increasing individualization leads to more diversity in products and services, and therefore to the need for more adaptability in design. Growing needs for continuous service utilization and provision leads to online maintenance and testing.

2.2 System Needs

The service assurance represents a shift from a technology-centric orientation to a customer-centric one in system design [8]. It includes providing high availability, but adds the requirements of service continuity and realtime. Neither scheduled maintenance nor unexpected failure ought to prevent or disrupt provision of service to a customer.

A service assurance solution requires a system be highly available and provide continuity of service. For satisfying the application needs of heterogeneity and adaptability, reliability, robustness and safety constraints derive from situations where service continuation is impossible and a certain degree of adaptive behavior, configuring and organization should be possible.

Application needs and technological background make more requirements of online expansion, fault-tolerance and online maintenance for the system. The online property is one of the major requirements of service assurance system. Current hardware/software design and integration technologies must be developed in order to cope with such challenges. The individualization in the users preferences will force that the new devices must be designed under the metrics of collaborative adaptive systems. The non-stop service utilization and provision will impose constraints on the design and implementation of systems for supporting online maintenance and testing. Moreover, due to the gigantic size of the future systems, the design and implementation will be done on a step by step development considerations.

3 Autonomous Decentralized System

3.1 ADS Concept

Autonomous Decentralized System (ADS) has been proposed to resolve the online property of on-line expansion, on-line maintenance and fault tolerance in a system, which means that the system can continue operation during partial expansion, maintenance and at the time of a partial fault [6]. The ADS is defined as the characteristics that each subsystem can control itself and coordinate with all of the other operating subsystems. Therefore the following two properties must be satisfied by each subsystem: Autonomous Controllability and Autonomous Coordinability.

3.2 ADS Architecture

Each subsystem has its own management system, the Autonomous Control Processor (ACP) to manage itself and coordinate with the others. The subsystem including its application software modules and ACP is an autonomous unit called "Atom". The self-contained subsystems including their respective ACPs are integrated into a system. In the ADS, all of the subsystems are connected only through the Data Field (DF); all data is broadcasted into the DF and the data itself logically circulates in the DF (see Figure 1). The data moves around the application modules in the Atom and the DF in the Atom is called the Atom Data Field (ADF). In the DF, each data is attached with its "content code" which is uniquely defined with respect to the content of the data. To protect the operation of the subsystems from variation in the system, each subsystem broadcasts a message containing the content code instead of the receivers address. The application module is specified only by input and output content codes, and it is executed by the ACP only when all of the necessary data with the proper input content codes is received from the DF (Data-Driven Mechanism). The necessary content codes for the Atom are determined dependently on the application functions within it.

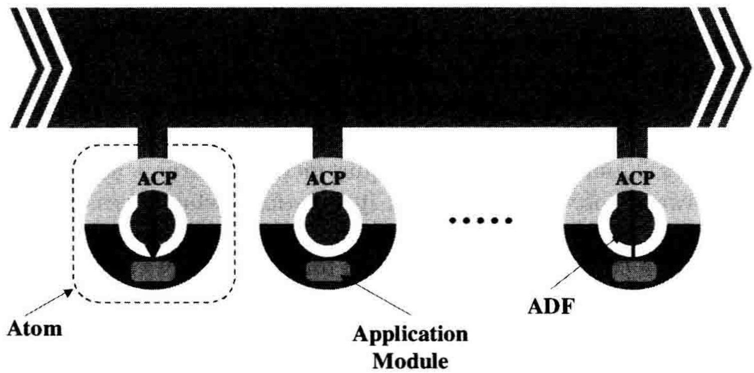

Fig. 1. ADS Architecture

4 Autonomous Community

Community services, which are extended from situation-aware services like location-based services. Community is constructed among the users, who have common preference or are in similar situation, and where services characterized by right now, right here and right me are provided and utilized in accordance with the cooperation of users. The widespread deployment and use of wireless data communications have made the location-based services possible to achieve these requirements.

Under the evolving market, users require the continuous and timely services based on their preference and current location. For effective service provision, service providers need the current requirement of the Local Majority. Service providers (SPs) require for carrying out the marketing on real-time and collect users' requirements to provide most suitable service for local majority at each time. Users' request should be sent to appropriate service providers according to their preference and location. The system that generates the service according to the situation on each occasion by collecting demands of users on real time in local area and provides suitable users with information to achieve real time and availability requirements.

Autonomous Community System consists of autonomous subsystems. Community, which is a dynamic group defined by a service, is created among these entities. In this community, entities that join a community are called members. Communication and process among members in the community realize the community service.

5 Application

5.1 Autonomous Decentralized IC Card Ticket System

A new real-time application of service assurance which has successfully been developed and implemented utilizing ADS architecture and Autonomous

Community concept is the IC card ticket system (Suica), introduced by East Japan Railway Company in November 2001 [9]. This world-wide largest control and information system is an integrated combination of wired and wireless systems, where a contactless IC card communicates by wireless with automatic fare collection devices (terminals) such as automatic fare collection system (AFCS), and the terminals communicate by wired with data collection servers. Nowadays, the integration of control and information systems is becoming more and more important. This integration not only make it possible for message to be exchanged between control and information system, but also makes it possible to create a adaptive integrated system that can satisfy the heterogeneous requirements of applications. The current number of card holders is approximately about 30 million and the number of transactions that are processed daily is in the order of 8 million [10]. And from March 18, 2007, this system is not only available for train system, but also available for other public transport systems.

The gate control and transaction process have been integrated in this system. It is necessary for terminal AFCS devices to provide high performance and high reliability because of the nature of railway transportation service. However, it was difficult to realize both in the IC card ticket system because the short time and noise of wireless communication. For these reasons, technologies and applications that can meet these requirements have been introduced. In the system, IC cards and terminals are designed as autonomous subsystems and configured in autonomous decentralized architecture. As shown in figure 2, the system consists of three different sub-communities (Data Field) with various time ranges. These time ranges of data flows are varied according to needs and aims of both

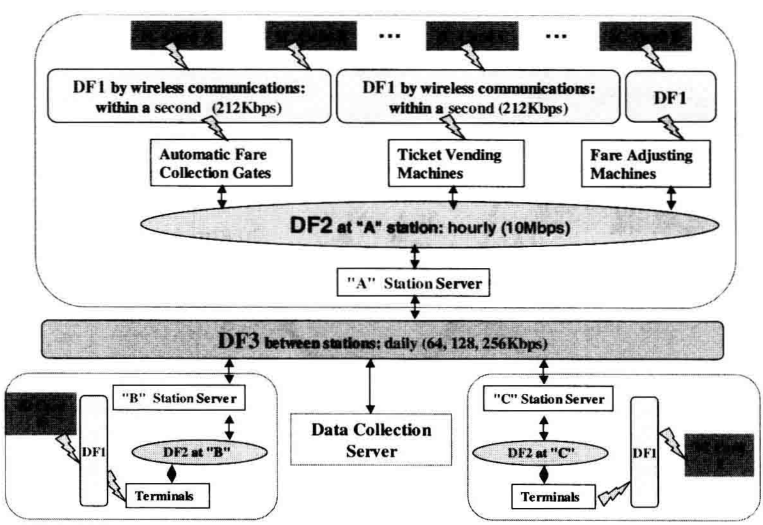

Fig. 2. Different Data Fields architecture

high performance and reliability. In the DF1, terminals use wireless communication with IC cards. The terminals and station server are linked to the station LAN and work on autonomous decentralized process through the DF2. Each terminal operates autonomously and failures at some terminals do not influence on the others. In addition, station servers are connected to a data collection server through the DF3, so if trouble occurs, the trouble does not expand into the whole system. Therefore, passengers can use all functions, derived from the Data Field, when they move between the stations.

5.2 Autonomous Decentralized Process

The development of the wireless IC card ticket system is concretely aimed at the high performance because it is very important to let passengers pass through gates as smoothly as possible, especially during the rush hours. As a result, the process must be finished within 200ms. Figure 3 shows the outline of the technology to process data at high-speed at the automatic gate for fare calculation. The passenger with a Suica commuter pass has to do is to pass this Suica card over the reader/writer (R/W) at the ticket gate, and the necessary fare adjustment is automatically carried out. Since long time is necessary for complicated calculations, a technology that adapt to the particular users situation by sensing mobility depended Autonomous Decentralized Algorithm is proposed. In this algorithm, the fares are autonomously calculated in two processes: the Pre-boarding Process upon entrance and the Post-boarding Process upon exit, followed by the autonomous cooperative process. This algorithm has succeeded in shortening each processing time.

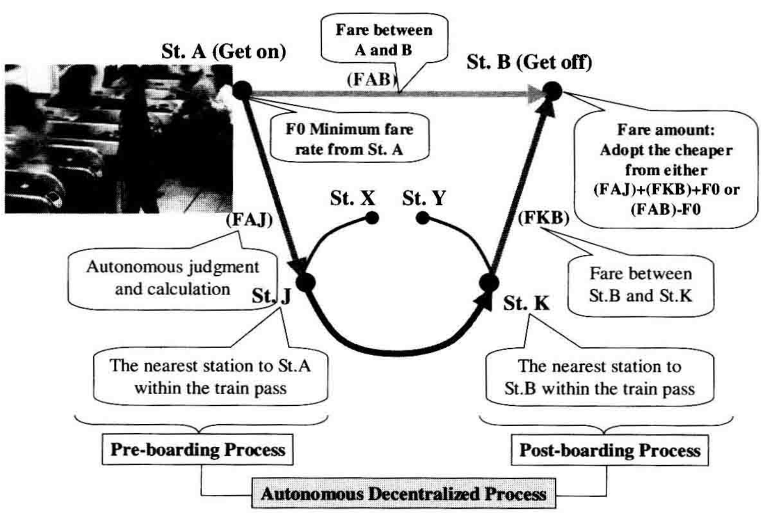

Fig. 3. Autonomous decentralized process