Service Space Portability Validation Modeling the Vehicular Context

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Abstract. Devices in our proximity getting sophisticated and they provide more and more services to their user and surroundings. Interconnecting solutions between devices and services being developed constantly to address the interoperability in a multi vendor ecosystem. This paper describes the set of service interconnect approaches and present study to validate of their portability. A prototype implementation of a music player service on an internet tablet controlled by an input service represented by a driving wheel and a mobile phone was created to evaluate the different architectural design portability.

Keywords: Service Oriented Architecture, Transport Independency, NoTA, Network on Terminal Architecture, M3, Keyboard service, Music service, UPnP, Vehicular networks.

1 Introduction

Consumer electronic interoperability requires novel and visionary approach of system design. The concept of smart space emerged to describe systems addressing the interactions in such environments. A smart space is a multi-user, multi-device, dynamic interaction environment that enhances a physical space by virtual services [1], These services form a collaborative software systems. Industry standardization allows interoperability by device certification. It is time taking process involve conformity check against the DLNA/UPnP standard set of services and devices [2]. An alternative solution to industrial standardization addresses the challenges arise from the dynamic nature of smart spaces [3]. This complementing approach to standardization is the M^3 concept [4] proposal over the Network on Terminal Architecture [5] (NoTA) as a smart space application development platform. NoTA service interconnect solution in itself has some capability to orchestrate a collaborative software space. As a result of improving onboard computers in cars the need aroused to apply these approaches to vehicular context.

Prototyping simple audio rendering control service assisted with an input service form the contribution which allowed evaluating the portability of the different smart space approaches.

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2 Related Work

A first step towards smart space service interoperability is the description of the collaboration software approaches [6]. This work provides a general overview by explaining the collaborating-software design space without investigating a solution which takes account the special need of the vehicular networks. One of the challenges is that automotive networks may randomly overlap each other; meanwhile some of their services should be kept separate and others designed to take advantage of the possible collaboration. Another challenge is that the product cycle of the car itself is much longer than the product cycles of the consumer electronic devices, which nevertheless are expected to be compatible with the embedded car systems. There is also certain constrains on the embedded car memory and networking capabilities when compared to the existing consumer electronic devices.

A simple audio rendering control service assisted with an input service can be implemented using various interconnect techniques and approaches. The major service collaboration designs were studied and explained in general level, before their application to the vehicular environment is shown.

2.1 Service Interconnect in Smart Spaces

Interconnected services in smart spaces depend on service discovery mechanisms. Smart spaces themselves can be discoverable for other smart spaces to join either enabled by proximity protocols by or out of band techniques such as a short range radio communication outside the wireless or wired transport layer of the space itself. The network transport layer and the underlying network topology are transparent for a smart space.

Collaborating services can be implemented as blackboard design pattern, multi agent system or adding various levels of these two properties together adapted to the performance requirements and the task that the system has to perform. This study focus on the portability aspect of an audio rendering control service of three distinct smart space interconnect design approach: device and protocol based interoperability (e.g. UPnP[7]), service based interoperability (e.g. NoTA [8]), or ontology based interoperability (e.g. M3).

2.1.1 UPnP Audio/Video (AV)

The UPnP protocol relies on standardization process which may take relatively long time, however certain areas the result are already available and accepted widely by the industrial players. The UPnP Forum has already specified protocols which enable electronics devices, to discover and use each other's services. The UPnP AV architecture has as a goal to solve the selection and controlled discovery of media content. It introduces service elements as shown in Figure 1.

Media Server is a device hosting and offering content for browse/download, while also accepting content uploads. Media Renderer, a device that can render (e.g. "play") content offered by a Media Server. Control Point is an entity that coordinates the communication between the Media Server and Media Renderer. UPnP uses Simple Service Discovery Protocol. The foundation for UPnP networking is established over IP addressing. From Network Simulation [9] UPnP protocol performance over Ethernet in Desktop environment for smart space scale well in terms of response times between services. The UPnP advertisements generated wireless radio wake ups

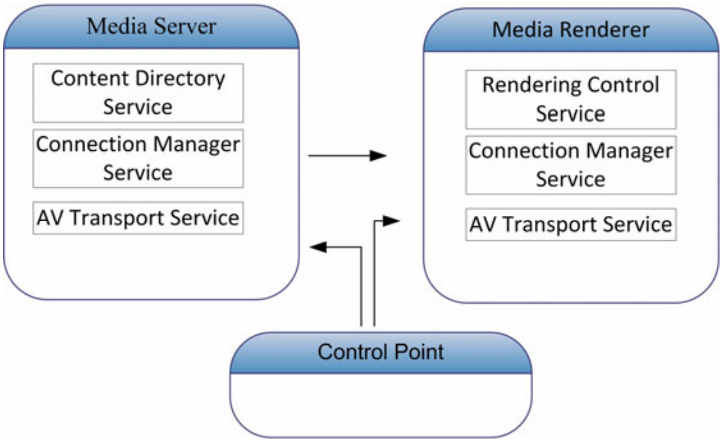

Fig. 1. UPnP A/V architecture

realized in form of penalty on power consumption. [10] UPnP low power architecture purpose to address this issue. [11] The remaining service interoperability issues such as digital media formats and control commands are resolved by guidelines and specifications of the Digital Living Network Alliance (DLNA). Unfortunately even DLNA certification may not means a fluent service interoperability in the home or mobile domain.

2.1.2 Network on Terminal Architecture

The NoTA Release 3 is modular services interconnect system architecture for mobile and embedded devices. NoTA device consists of Service Nodes (SN) and Application Nodes (AN) that communicate through logical Interconnect (IN). NoTA node

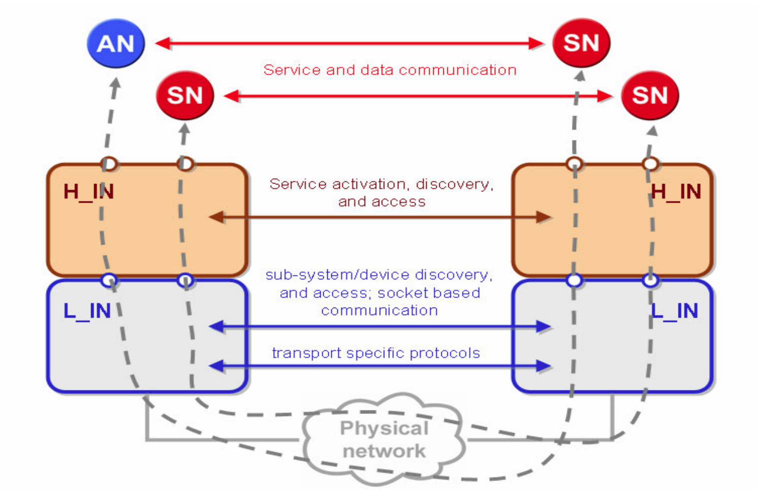

Fig. 2. NoTA service interconnect architecture

interconnect address system is independent from IP protocol enabling those embedded devices to join the network which are not capable to contain the IP addressing protocol.

A NoTA layered architecture containing high level and low level interconnect as a result service implementations interconnected over different transports, including TCP/IP, Bluetooth or a hardware specific protocol for intra-device communications. The service level of NoTA is abstracted over the transport, so that the same service implementation can be used over several backend upon performance permitting. Nota Interconnect Architecture is shown on Figure 2.

NoTA use a dedicated Resource Manager Node where SNs register themselves to advertise their services. ANs and SNs query the resource manager for available services.

2.1.3 M^3 Concept

M^3 [12] makes it possible to mash-up and integrate information between all applications and domains spanning from embedded domains to the Web. M^3 is independent of transport mechanisms. M^3 is designed to provide information interoperability by means of ontology sharing as opposed to a standardization process. Nodes which communicate via M^3 using the same ontology are compatible and any later entity using the same ontology are compatible as well. Interoperability layers are shown on Figure 3.

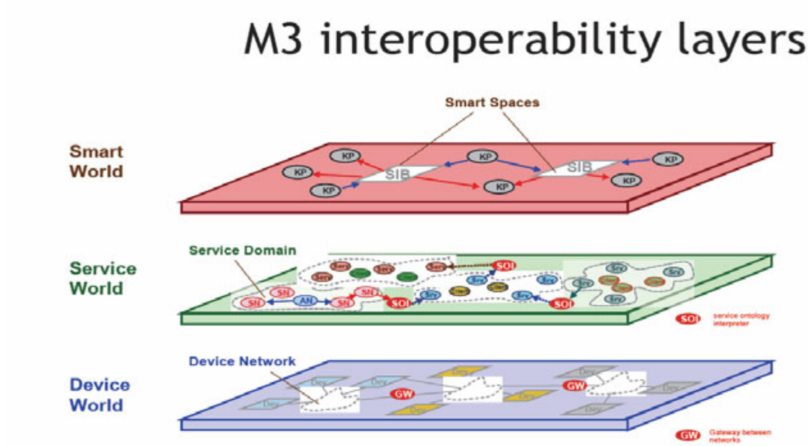

Fig. 3. M^3 Interoperability layers

The architecture of M^3 is that underlying service implementations can publish information to M^3 space and if needed operate completely independently. If the service implementations only publish information to M^3, they naturally are not able to benefit from future semantic level services. If the service implementations subscribe and react to information on the M^3, they can be benefit from future developments. For service discovery and smart space access it uses the Smart Space Access Control Protocol. Ontology could describe the Audio control between services. The control logic implemented by the reasoning engine called the Knowledge processor, meanwhile the information stored in the Semantic Information Broker according to the ontology model.

2.2 Comparison

Comparing these three given approach to smart spaces interconnection design, many common features are noticeable and a few key differences also exists. These observation were taken account when selected the prototype service interconnect scenario for portability validation. Features of service interconnect approaches are elaborated on Table 1.

Table 1. Brief comparisons of the smart space interconnect approaches

	UPnP	NoTA	M^3 concept
Underlying protocol	Http	BSD sockets	HTTP or NoTA
Addressing	Dynamic (requires discovery)	Interconnect Address (RM - SID) and depends on underlying transports	SSAP
Power Saving	UPnP low power –since 2007	By design principles	Depends on the underlying transport, priorities allows suspension
Input Service	Not standardized, Control point is a kind of input service	Custom keyboard service	Activity instance
Audio player service	Media Renderer	Custom audio player	Subscriber to an activity
User authentication	Only at radio access point level	With custom made authentication service	Via Local policies
Dependency on external components	TCP/IP, UDP, HTTP, XML, and SOAP	Bluez (SDP, HCI, L2CAP, RFCOMM), or DHCP, TCP/IP	Same as NoTA and DBus, Expat, Uuid, Avahi, Python

3 Portability Validation

Smart space portability validation using approaches compared earlier in general level assuming a desktop environment. Prototype evaluation required to implement six scenarios over two use cases and look into feasibility, performance and developer friendliness during remapping the services in the similar service space over different device platforms. This chapter focuses on to comparing the different smart spaces designs and their portability to vehicular environment.

3.1 Prototype Implementation

All of the approaches supports, simple communication over wireless radio connection between devices shown on Figure 4.. Upon UPnP network is established using the wireless radio connection available UPnP renderer and control point were available by default on the network and interconnected without any further setup. The service discovery took longer time compare with the others and initial setup of the UPnP media server service also requires a few steps as configuration from the end user. Implementation over Nota network requires definition of the input service and audio player service and a translator service between those. The end user involvement is limited to the selection of the services or starting application which utilities the available services. Connecting over M^3 requires the ontology definition from the system designer to establish service interoperability and also require deciding the transport for M^3. For this study the implemented is decided to use the transport over NoTA and TCP/IP.

Fig. 4. Audio rendering services in an internet tablet and a Symbian OS Smartphone controlled by input services on a mobile phone established using the three distinct service interconnect approach

For simulating a vehicular environment a wheel controller attached to a laptop used for the setup instead of the Symbian OS mobile phone.

3.2 Lessons Learned

It required remapping of the service interconnection of the initial setup to enable the vehicular setup. Using UPnP protocol for connecting the services over the network initially though as the easiest service interconnect possibility as UPnP renderer still exist, however control point have to be hand adjusted. UPnP does not support the concept of a standard input device as its core and by implementing one as a device extension the portability of smart space is compromised. The loss of power as described earlier is more important in this setup - where a vehicle may be standstill and as a result battery operated - than in a home environment which would raise question for UPnP approach to vehicular smart spaces compare to other domains. Porting of the Nota network setup required a definition of another input service and a translator service along with it. The difference came from the fact that initial Symbian OS setup supported Graphical UI type of input service and understood the notion of key event with various statuses such as pressed or released. The translator service can understand the longpress from the input service and translate to audio renderer as fast forward within a song. The wheel keyboard attached to linux computer may treat input source as input pipe without the notion of input item states. The two way of input result two distinct input service. One named as the keyboard service which send the last event as pressed key and one named as the button service which send the latest event and the state related to it. These two services can share a common translator service, which assign a timeout for any non released keys however it results in a very complex design for control transitions. The M^3 ontology handle the best the system porting and at knowledge processor level elegantly resolves all the issues during the porting. However this setup involved dependencies on external libraries and overall developer friendliness of the M^3 system itself is a bit less than working with NoTA only setup due to its complexity to set up the working prototypes.

4 Discussions and Future Work

Portability validation experiment established requirements towards smart interconnect architectures for wider platforms deployment over vehicular Operating System [13].

The implementation of UPnP low power profile does eliminate some of the technology obstacles for vehicular context; however portability to vehicular networks would require standardization and design a vehicular specific extension.

End-user using a system built upon a vehicular network demands full control and coordination between all the available services. M^3 concept follows the blackboard design pattern which is well suited orchestrating the software and service collaboration. The conclusion based on these experiments is the recommendation of open source M^3 smart space in automotive context. The author believes that the development setup and portability of M^3 due to many of external component dependency is improving rapidly over the time.

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