IST-2000-28304

DELIVERABLE # 7

Interaction between handheld and stationary device in a home network

Editor: Igor Paulussen, Philips Research

Version: 1.0
Date: November 2002
Security level: Public

Project Number	:	**IST-2000-28304**
Project Title	:	**SPATION**
Deliverable Type	:	**IST**

CEC Deliverable Number	**: 28304/phi/prl/ip/007**
Internal Project Number	**: spation-P-IST-28304**
Title of Deliverable	**: Interaction between handheld and stationary device in a home network**
Contributing Workpackages	**: WP 2**
Nature of Deliverable	**: report**
Editors	**: Igor Paulussen, Igor.Paulussen@philips.com**

Abstract: This report marks the completion of milestone 2 with the interaction between a handheld and a stationary device in a home network. Starting from the user requirements we describe what functionalities should be provided by network middleware. To allow flexible communication between the handheld and a stationary device in the home system, we chose to develop our research platform based on UPnP. Additionally a first implementation of the user interface was developed and created on top of this research platform. This resulted in a demo shown on the Net-atHome conference and exhibition 2002 in Cannes, France.

Table of Content

1 Spation

SPATION is focusing on the technologies, infrastructure and user interfaces for networked home environments. The objective of this project is to find novel solutions for content/information management tasks such as moving, organising and retrieving information in a heterogeneous home system. This heterogeneous home system consists of a number of interconnected stationary devices and various hand-held devices; all these devices communicate with each other and have their own storage capacity. This corresponds to a distributed storage environment in which data may be present on a single physical location or copied onto various physical locations. To help users to find back their stored content in a distributed home network the actual location of content is shielded from the user and the combination of content analysis and metadata is used to support advanced retrieval queries. Special attention is paid to the applicability of these solutions in the consumer electronics domain.

Within the Spation project a few technical assumptions are made. The first one is that in the future every home device will have a network connection (e.g. Ethernet, WLAN etc.) and many have a substantial amount of storage (e.g. a harddisk). A second assumption is that the home network will be a combination of a wired and a wireless part. The third assumption is that the user probably doesn't suddenly replace all of his/her existing home devices with network connected home devices. So, in our vision the home network will gradually grow. When all home devices are interconnected, a home network is created with a lot of distributed storage and distributed functionalities. In this way the user can control functions of all devices on every device. Also the stored content is spread over the whole home network and it is not at a single physical location anymore (distributed storage). An advantage of this is that when a device runs out of storage space, the system can automatically find another storage place to store the content. From the previous, one can assume that the home storage system will be distributed and heterogeneous.

2 Home network user requirements

Users of the home network devices are not interested where something is stored but are only interested how they can easily find back their content (transparent retrieval). What the user wants is "*his/her content at his/her fingertips*". This can be interpreted as follows: The user wants to access all the distributed stored content at any time and at any place within the home. To sketch where Spation operates in this research field and what the research challenges are, we consider the following scenario quoted from deliverable 3:

Scenario: A New Personal Home Recorder

Dad enters the house with a newly bought Personal Home Recorder. The old personal video recorder just allowed him to record, watch and pause programs. The new DVD hard disk recorder combo has a bigger storage capacity and has more features. He bought it because it allowed him to record TV programs on DVD such that he can make his own archive. When he connects the new Personal Home Recorder, automatically all relevant information from the network such as the personal preferences and content are found.

The children will use the old personal video recorder now. He puts it upstairs in the bedroom of the eldest child. The new device has an option to automatically create a summary of stored content to quickly check the content of a program. The children were already used to using the old pvr in the living room, but they will quickly discover that now the new device is present the old pvr can also present summaries. Dad starts playing with his new device and discovers that the new device shows an improved overview of all the content. It even allows him to see what is stored in other devices and shows what movie the device of the children is currently playing.
Mom is playing with the system too; she's using the handheld to access it. She discovers that it's easy to watch a summary on the handheld. Then they decide to watch a movie.

The main focus of this scenario is on the use of a personal video recorder, video summarisation and service offering by other devices. This scenario poses several research challenges, like:

- *" …connects the new Personal Home Recorder, automatically all relevant information from the network such as the personal preferences and content are found..":* things that can be best done automatically should be done automatically: e.g. data synchronisation, automatic installation and setting of new features between new and old devices.

- *"…has an option to automatically create a summary of stored content..":* video summarisation as a built-in feature.

- *"….they will quickly discover that now the new device is present the old pvr can also present summaries..":* offering device services over the network.

- *"…. She discovers that it's easy to watch a summary on the handheld…."*: networked applications on different devices taking into account the length of the summary depending on the device that it is used on and on the type of task.

From this scenario, it becomes clear that a user wants to transparently use the applications and resources over the network. When connected to a network, devices can use features of each other (e.g., a video summarisation function), use resources of each other (e.g. a handheld responsible for showing stored content from a recorder on a TV) or use input methods of each other (e.g., the remote control or hand-held). This use must be free of administration, installation and search. One of the consequences is that the system has to fulfil technology requirements, like auto configuration and extensibility.

2.1 Auto configuration.

Since a complete home network will not be bought at once, but will gradually grow by adding new devices it is important that adding devices is easy. That's why we need to investigate what requirements there are for auto configuration and how the personalised settings of the home network can be transferred to a new device.

2.2 Extensibility.

We need to investigate how new functions can be brought into the system and introduced to other devices. The question is to what extent the old personal video recorder can make summaries. Will the new PVR offer a summary computation service to the network, and how will it appear in the old PVR's user interface?

A handheld is used to give the user complete control over every home device in the home network. Because the handheld is a mobile device it can access home networks in different homes. One of the issues is that users don't want to change all the settings for the home networks in different homes all the time. To achieve that the home system is easy to use and does not require a system administrator to maintain it, a number of requirements need to be investigated, like the above mentioned *auto configuration* and extendibility. To avoid having to develop solutions for these problems for each application, the functionality that is common to most applications is made available in *middleware* stacks.

3 Middleware

It is important that adding devices is easy. In a PC network a system administrator is responsible for ensuring that all devices have unique IP addresses. In the case of a home network, we cannot expect a user to assign unique numbers to devices. Even worse would be to require the user to update software on existing devices when a new device is added to the network. To solve these problems most middleware stacks provide functionality to automatically detect the presence of new devices and to make sure that each device can be addressed uniquely. How well a home network can handle these problems, depends on the combination of the physical network connection, the network stack and the middleware stack. In our case the home network consists of CE devices, which poses the additional problem of limited resources such as processing power and display capabilities.

To allow a new device to be used in the network, there must be some mechanism that allows devices to detect what functionality a new device offers. Since a new device can offer functionality, which was not envisioned when the older devices were developed, this can be quite hard to achieve. In deliverable 2 an overview of available middleware solutions was provided. From several alternatives we chose UPnP as a basis for developing our demonstrator platform.

3.1 UPnP

The aim of UPnP is to create a plug and play network where no configuration is needed, so users do not need to have any network knowledge. Just plug in your device and use it. The device tells the network what it can do and it learns from the other available devices what they can do. In this way it is possible for devices to use each other's functionality. As easy as it is to plug in a device, it can also be removed from the network without causing major trouble in the network.

The advantages to use UPnP according to the conclusions from deliverable 2 are:

- UPnP is based on widely known Internet technology.
- It provides limited but simple device templates.
- It has a good balance between standardisation and implementation freedom.
- Low complexity.
- Low cost.

This gives UPnP high chances of being adopted as a middleware standard by many CE vendors.

To reach the auto configuration and extensibility goal, UPnP device discovery is used to automatically detect devices. To make the device discovery work, a UPnP contol point and a root device needed to be implemented. The control point and the root device running on the devices should work independently. This means that it doesn't matter in which order the devices are turned on. The device discovery is done automatically. The root device sends a broadcast message over the network that it is alive. This broadcast message is sent via a multicast. When the root device has broadcast its "alive" message it starts broadcasting its services also via multicast. The root device always broadcasts over the network "I'm available on the network." The control point always asks: "Who is available on the network?" When a service or device disappears a "bye bye" message is sent via multicast. As a fall back mechanism the alive messages of the devices can be monitored to detect the uncontrolled disappearance of a device. A control point can do specific searches on the network e.g. search for certain available devices or services. Search questions are always sent via multicast, answers are always sent by unicast.

As said we use UPnP as a basis for developing our demonstrator platform. For this home system we constructed over 8.5 thousand lines of java code for the contol point (running on the handheld) and 11 thousand lines of C++ code (running as a root device on a PC). With this implementation it is possible to interact between a handheld and the home network (as agreed in milestone 2). This code is used as a basis to build a research platform, which can be easily extended with future technical solutions. With this implementation we met milestone 2. Additionally a first implementation of a user-friendly user interface is designed and created on top of this research platform to easily test the research topics. In this way it's easier to understand and to explain the research concepts and research challenges to users of the system and to evaluate new content analysis algorithms. This first version of the user interface serves as a basis for further iterations of improved user interface designs. All together this resulted in a demo that was shown on the Net-atHome conference and exhibition 2002 in Cannes, France. On the exhibition we showed how to transparently access the content stored in the home network by using a handheld device.

4 Impression of the Net-atHome demo.

In the Net-atHome demo (Picture 1 and 2) the handheld (control point) automatically recognises the home devices by using the above-described UPnP device discovery mechanism.

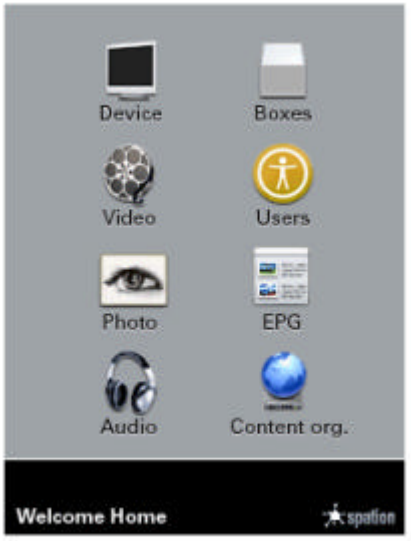
Picture 1: Net-atHome Booth

Picture 2: Demonstration to a visitor

The user interface on the handheld starts automatically with an opening screen (Picture 3)

The overview mode provides the user with a graphical overview of the available functions. Here the user can select functions to access:

- The several types of content in the home network, like video, photographs, audio and EPG.
- Users currently using the system.
- Devices and content organisation.



Picture 3: User interface start screen

This start screen represents the first level in the user interface and is always the starting point of the system. By pressing one of these buttons the next level is entered.

4.1 Video

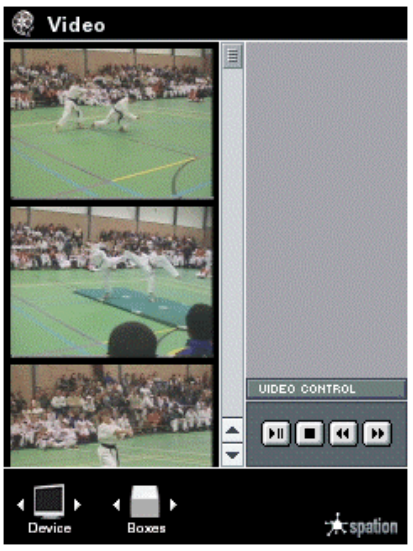
When the video button on the start screen is pressed, the UPnP control point implemented on the handheld contacts the root device. A list of all available video content within the home network is sent back to the handheld and is shown to the user (Picture 4). When the assumption is made that the storage space is "infinite", it is even more important that the user gets a clear overview over all stored content. E.g. depending on the family profile certain programs can be recorded automatically. The UPnP based platform allows us to investigate the applications of content analysis algorithms and what meta-data is needed for efficient retrieval. In this way the user can more easily decide which program he/she wants to watch. For this purpose three different functions based on content analysis algorithms were developed:

Picture 4: Stored video overview

- Browse
- Summary
- Trailer

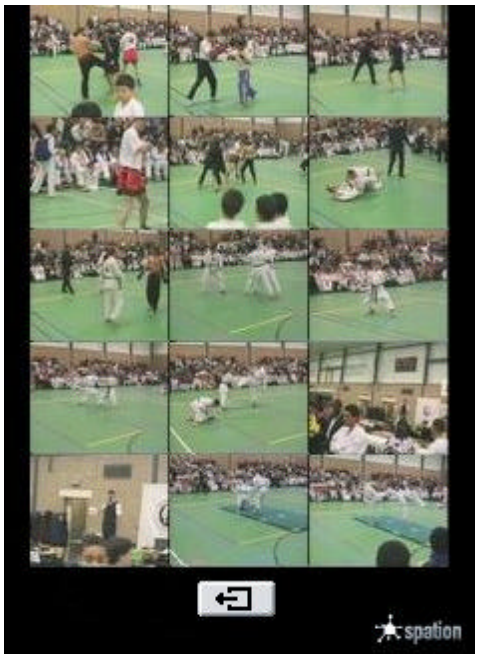
4.2 Browse

The Browse button will give access to browsing a particular piece of stored content within the home network. An algorithm running on the root device performed analysis on the content. The control point doesn't have to perform these computations, but makes use of this service offered by the root device. For the user this means he can browse through key frames (thumbnails) of a selected program on the handheld (Picture 5). An algorithm such as a scene change detection algorithm selects these key frames during recording. Using this method every start frame of a scene change becomes a key frame. This browser also allows playback of a video file from a certain position represented by a key frame. The key frames are stored on the recording devices within the home network and can be accessed by the handheld using UPnP. The transfer of the key frames to the handheld is arranged via the Soap protocol.



Picture 5: Video browsing

4.3 Summary



Picture 6: Video summary

The summary button provides a pictorial overview (Picture 6). In this case, a content analysis algorithm selects a small set of images from the video content that represents the content as well as possible. The summary function shows the 15 most relevant pictures of the video content, using a clustering algorithm. Again the analysis is done on the root device and the less powerful handheld just requests and shows the results.

4.4 Trailer

The trailer button provides a short video clip, for example 30 seconds, of the content. The trailer is automatically generated using a content analysis algorithm that selects scenes from the video content and concatenates them. The purpose of these functions is to help the user to decide whether this was indeed the piece of content he was looking for, or to help the user to judge whether or not he would like to see the entire content. The video is analysed during recording. The information about the parts in the video with for example the most action is stored as playlist. When the user wants to see the trailer of a program only the part of the video that is stored in the playlist is played.

5 Conclusions

An implementation of UPnP on the handheld and home system allows flexible communication between a handheld and home system. With this implementation milestone 2 has been successfully achieved, serving as a platform for further research. By developing the first implementation of the user interface the system allows us to evaluate how easy it is to move, organise and retrieve content. Content analysis algorithms can be hooked up to the system and offered as UPnP network services. In this way the functionality can be explored and tested in the user interface and new functions can be added easily.