A Framework Supporting Interaction of iTV Applications and CE Devices in Home Network

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Abstract

The paper proposes a framework that extends existing interactive DTV platforms. This framework allows DTV applications to interact with consumer electronic devices in a home network in a manner which is independent of the types of devices or the underlying home networking technologies.

1. Introduction

Interactive DTV (iDTV) platforms are on the verge of fostering a new generation of television programming and content. Examples of prominent standard iDTV specifications are MHP (Multimedia Home Platform), OCAP (OpenCable Application Platform), and ACAP (Advanced Common Application Platform). Such platforms allow interactive content, generally in the form of Java programs, to be downloaded to an iDTV receiver via a DTV (terrestrial, cable or satellite) broadcast. Interactive content includes electronic programming guides, program-related applications, games, etc.

At the same time, home networking technologies that allow devices to automatically interoperable with one another are beginning to become mainstream. Examples of such home networking technologies are OSGi (Open Services Gateway Initiative), UPnP (Universal Plug And Play), Home Plug, etc.

Despite the obvious benefits to consumers, work in these two areas has largely remained separate. We believe there is a unique opportunity to bridge the gap between the iDTV and home networking domains. We propose a framework that extends existing iDTV platforms allowing iDTV applications uniform access to a home network and its devices.

2. Basic concept of DTV Home Network Framework

Based on the motivations described in the introduction, a framework should satisfy the following requirements:
- it should not explicitly depend on any specific home networking technologies (i.e., UPnP, OSGi, etc.);
- it should not be limited to specific devices or services, i.e., it should support all types of devices and services;
- it should provide generic functionality for interaction between iDTV applications and home network devices and services.

We propose a DTV home networking framework (DTV-HNF) that provides a high level of abstraction of home networking technologies, devices, and services. DTV-HNF ensures general functionality for interaction of iDTV applications with CE devices in the home network; for example, mechanisms for device and service discovery, capability negotiations and eventing.

3. Service plug-ins

Because DTV-HNF does not depend on any functionality specific to any device or the underlying networking technology, interactions with each device are implemented by a corresponding service plug-in. A
service plug-in is a special software unit downloaded to a DTV receiver or set top box from the broadcast carousel [1,2]. The service plug-in provides program interface for iTv applications to use the functionality of the device, i.e., the interface of each device service is supplied by corresponding service plug-in.

If an iTv application needs to interact with a given device, it first queries the framework for a service object that represents the selected device. The service object is created by a corresponding service plug-in. If the service plug-in for the selected device is not currently installed on the platform, it is downloaded from the carousel and installed on the iTv platform. The service plug-in is selected based on information characterizing the associated device (such as its manufacturer, model number, etc.). Subsequent interactions between the iTv application and the device are handled by this object. The service object exposes a set of actions that have input and output arguments. Actions can then be performed in a manner similar to that specified by UPPnP [3].

Service plug-ins are grouped into service categories. Each category declares a set of actions and their input/output parameters that are provided by the associated service object. When an iTv application needs to find a device that offers a specific service (e.g., hardcopy printing), it queries the framework for a list of appropriate devices and then uses the published device information (manufacturer, location in the home or in the home network, etc.) to select a device.

4. Network plug-ins

General support for the underlying network (e.g., UPPnP, OSGi, etc.) is provided by network technology plug-ins. A network plug-in provides network-level interfaces required to communicate with devices and services of a particular home networking framework. An iTv platform may have multiple network plug-ins, one each for UPPnP, OSGi, HAVi, etc. We assume that network plug-ins are normally preinstalled on iTv platform, but they may be also dynamically downloaded from the broadcast stream.

When an iTv application requests a list of devices within a given category, the iTv-HNF forwards this request to all network plug-ins, combines the subsequent search results, and then returns those results to the requestor.

A service registry available in the broadcast carousel provides the information needed by each network plug-in as it resolves requests for devices associated with a given service category.

5. Carousel service registry

The carousel service registry is transmitted in the broadcast carousel and provides the following information:
- parameters or mechanisms for searching a device or a service in the network; for example, UPPnP services can be discovered or filtered based on the keyword ‘UPnP’. An application can also search for services based on certain capabilities; for example, a printing service
- locations from which service plug-ins for selected devices can be obtained.

6. OSGi lighting control prototype

The proposed DTV-HNF architecture was implemented in a prototype that simulates control of household room lamps by an iTv application. In this prototype we assume the controlled devices are connected to an OSGi home network [4].

The prototype consists of the following components:
1. Several applications, each of them simulates a lamp that can be turned on and off remotely.
2. Residential gateway simulation implemented using OSCAR [5], a free OSGi implementation.
3. iTv receiver simulation implemented using free DASE implementation, authored by NIST [6].

In this prototype an iTv application (i.e. an Xlet) requests a list of available lamps in the home network and then displays user interface controls that allow the user to turn the lamps on and off.

7. Conclusions

The proposed DTV home network framework allows iTv applications to control networked CE devices in a uniform manner, devices of different functional types and connected to different types of home networks are managed uniform and consistently. This allows the creation of iTv applications capable of interacting with any type of CE device. The framework also eliminates the need to pre-install device-specific drivers; the required software is installed from the broadcast carousel “on the fly”, as devices appear on the home network and iTv applications request interaction with them.
8. References


