

The Ubiquitous Web, UPnP and Smart Homes

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Our “Vision”

"The essence of this vision is the creation of environments saturated with computing and wireless communication, yet gracefully integrated with human users. Many key building blocks needed for this vision are now viable commercial technologies: wearable and handheld computers, high bandwidth wireless communication, location sensing mechanisms, and so on. The challenge is to combine these technologies into a seamless whole."

from the IEEE Pervasive Computing Magazine

“Smart Home - A Smart Home is a living space saturated with computing and communication, yet gracefully integrated with human occupants and visitors.”

Franklin Reynolds

Smart Spaces

- Smart Homes are part of a continuum of smart spaces:
 - Personal Space
 - **Smart Home**
 - Wireless Workplace
 - Public Space
- The popularity of local area networks (WLAN and BTH), home computers, game machines, digital media and mobile devices (phones, media players, etc.) provide the key technical “fuel” for smart space products. RFID and UWB and smart sensors will add more fuel.
- Vendors are increasingly interested in smart products for homes, but consumer interest is building slowly and applications are limited

Types of “Homes”

- Types of “Homes” and types of “Families” vary:
 - single family
 - multi-family
 - Mobile homes
 - Roommates
 - Apartments
 - dormitories
- Support for an “Extended Home”
 - other family residences
 - family car
 - remote access
 - etc.
- Shared or temporary residences such as hotels

Smart Home

Home automation (security, heating/cooling, fire alarms, lights, etc.)

Entertainment and Multimedia

Physical Home

Games and Smart Toys

Health Care

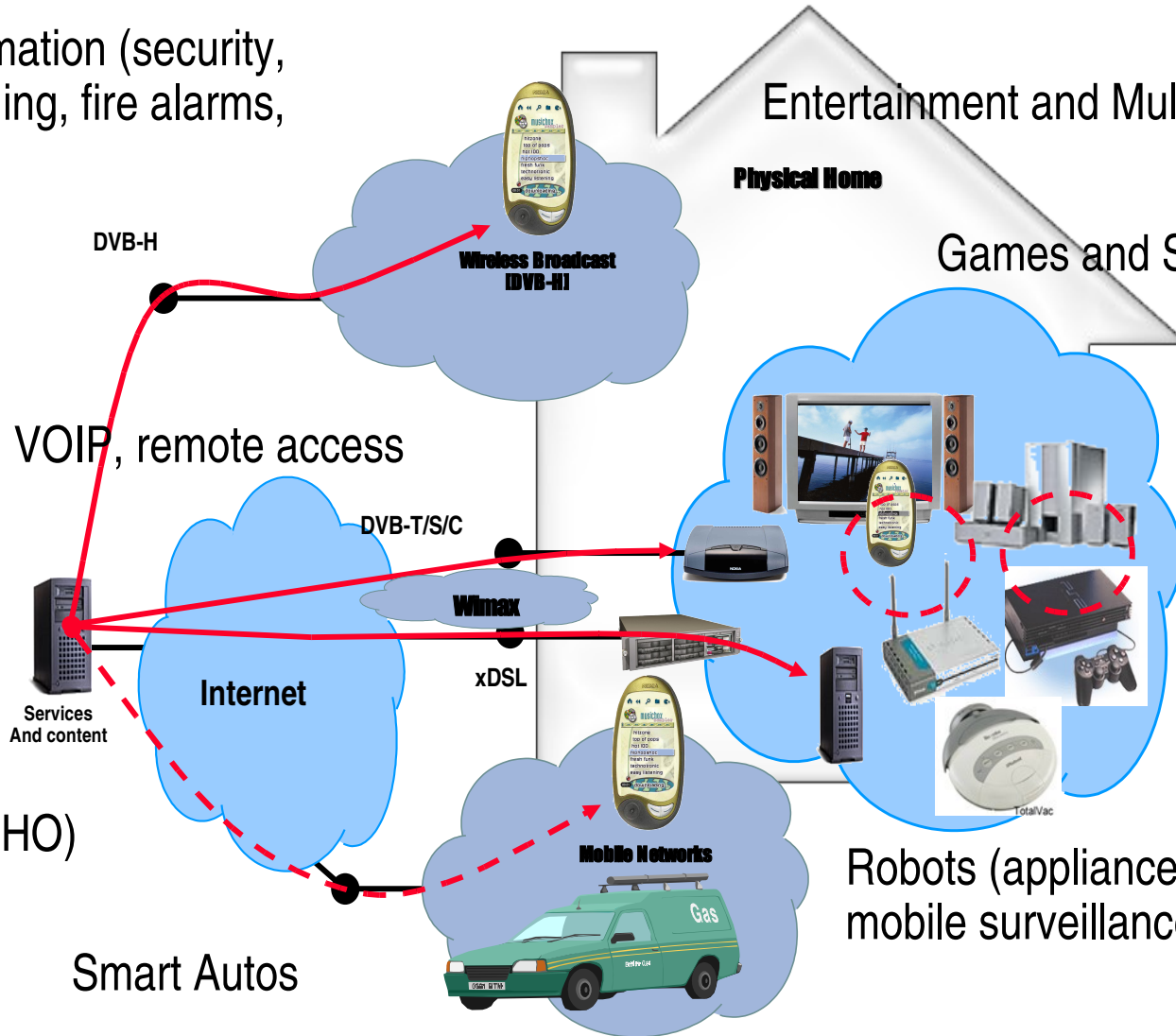
Education

Robots (appliances, mobile surveillance, toys, ...)

Tele-presence, VOIP, remote access

Work (SOHO)

Smart Autos



UPNP Forum

- The UPnP™ Forum was formed by Microsoft in June 1999.
- Current membership exceeds 730 companies and individuals across multiple industries including consumer electronics, home and enterprise computing, computing services, home automation, home security, appliances, printing, photography and computer networking.
- The Forum provides an open process for companies to collaborate in the design of device and service specifications and protocol standards for the UPnP™ initiative.
- The principal goals of UPNP technology are to enable devices to connect seamlessly and to simplify the implementation of networks in home and corporate environments.

UPNP Technology

- IPv4 autoconfig
- XML based device and service descriptions
- SOAP – Simple Object Application Protocol
- SSDP – Simple Service Discovery Protocol
- GENA – General Event Notification Architecture
- Presentation Service – Web based User Interface to devices and services
- Device and Service Profiles include:
 - Internet Gateway Device and WLAN Access Points
 - Printers and Scanners, Media Servers and Players
 - Lighting and Home Heating
 - QOS, Security and Remote User Interface

Digital Living Network Alliance (DLNA)

- The 200+ members of the Digital Living Network Alliance (DLNA) share a vision of a wired and wireless interoperable network of Personal Computers (PC), Consumer Electronics (CE) and mobile devices in the home enabling a seamless environment for sharing and growing new digital media and content services.
- DLNA is focused on delivering an interoperability framework of design guidelines based on open industry standards to complete the cross-industry digital convergence.
- Initial emphasis has been on Digital Media Servers and Players
- Technology
 - Network media: CAT5 Ethernet and 802.11a/b/g WLAN
 - Protocols heavily based on IP and UPNP Forum standards
 - Media Product specifications based on UPNP Media Profile
 - Supported Media Formats are both standard and proprietary
 - DRM strategies are under consideration

Consumer Electronics

- CE companies don't like to sell products that are dependent on products from other companies
- Smart homes will be deployed incrementally
 - P2P applications and ad hoc, self-organizing protocols are preferred over solutions that require infrastructure
- CE products may be deployed for 5, 10, 15 even 20 years.
 - Backwards compatibility is important
- CE products are constantly changing (hopefully improving) due to competitive pressure and the need to motivate happy customers to replace their old stuff with new stuff
 - Future proofing is important
- There are lots of toolkits and protocols for building CE products
 - Interoperability is a challenge

Consumers are not trained

- Consumers make bad network and security administrators and they are not good systems integrators
 - No infrastructure services should be assumed
 - Whenever possible, systems should self-organize
 - Management should be simple AND intuitive
- Its hard enough to get everything to actually work – but it is particularly difficult when something stops working. Most people have no idea how to diagnose or repair a distributed system. There is a surprising dearth of good tools for diagnosing the source of a problem in a distributed system.
- Often, minimizing the cost of customer support, i.e., the frequency of customer support calls, is the key to commercial success

Security

- Homes will have visitors – limiting physical access to the network is not sufficient
- Roles and identities of owners, family members, visitors, attackers will change
- Solutions based on centralized, mutually trusted third parties are not always ideal for home networks
- Home security is not just privacy or confidentiality, it is also safety
- Anecdotal reports suggest that trained network security administrators make a significant number of errors – end users need simple and intuitive security policy management tools
- Perhaps security mechanisms and policy management tools should mimic the behavior of real-world security mechanisms...

Model Mis-Match

- Often there is no browser - the interaction is machine to machine instead of human to machine
- Not all interactions are request / response
- Some communication is one to many
- The real world is not easily modeled as a decentralized data store of pages
- device operations are not intrinsically idempotent
- devices may have modifiable state
- communication may cause observable and persistent side effects
- devices move from one network to another – IP addresses and DNS host names change – URLs must cope
- security risks include threats to physical safety

Service Discovery Should Be Ubiquitous

- Dynamic discovery of devices, services and content is essential
- Service Discovery protocols (UDDI, SLP, Bonjour, SSDP, etc.) are incompatible – it would be nice if we could at least standardize on some formats and vocabularies
- Discovery protocols for homes should be able to operate in a p2p mode, they should not require infrastructure like DNS servers to function
- Experience has shown the value of rich descriptions that are not limited to APIs (WSDL is not enough)
- UPNP has demonstrated the value of being able to discover the UI to a device or service
- Service Discovery should be integrated with URIs
[http://\(device=printer,color=yes\)/...](http://(device=printer,color=yes)/...)

HTTP and SOAP

- Embedded systems often need a better partial failure model than HTTP, in part, because device methods may not be idempotent or because of side effects. Though it is worth noting that in today's home applications, the semantics of HTTP are usually good enough.
- SOAP + HTTP is extremely verbose, but surprisingly, this is not a serious problem for most signaling needs in today's applications. As you would expect, the problems are on the low end and high end of performance requirements
- SOAP and XML Schemas give sufficient support for definition of rich data types
- WSDL or UPNP's FleXML provide can act as a reasonable IDL for applications not based on mobile code

User Interface

- Web browsers would seem to provide an excellent UI to devices, except they don't...
- Page-at-a-time model is not always natural when dealing with devices
- UI is a Very Important distinguishing feature and page-at-a-time does not provide enough control
- Browsers request pages, but sometimes devices want to announce state changes
- Clients frequently do a lot of work, not directly related to rendering, including multi-component interactions and coordination. How does that get deployed? It is hard to add new protocols to browsers for interacting with new devices at run time...
- Java, AJAX and similar recent ideas are interesting technologies but more work is needed

Summary

- Users are not very good System Integrators
- Smart Homes will be deployed in an ad hoc fashion and they will constantly change
- In the real world, security is about more than integrity and confidentiality of data
- Networked Device and Services are not naturally modeled as a user browsing Web pages
- Typical Consumer Electronics Companies have different business models than typical Web Content providers

Questions?

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