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Networked Appliances

What they are, how they work and challenges to adoption

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Outline

- Intro/Overview
- Market Info
- The Current State of Networked Appliances
- Key Problems
  - Naming and Accessing
  - Feature Interaction
  - The Standards Situation
- Summary

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What is a Networked Appliance?

(AKA: Internet Appliance or IP Appliance)

Networked Appliance (NA): n. A dedicated function consumer device containing a networked processor.

Examples:

Lamps  Coffee Makers  Alarm Clocks  Phones 

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Key Drivers for Appliance Technology

- Decreasing cost of 'network capable' electronics.
- Acceptance of the pervasion of computation into our everyday lives.
- Increase in online data availability.
- Consumer demand for more seamless integration of on-line services into their lifestyle.
- 'Always On' connectivity available to a significant fraction of households.
- Emergence of mass market opportunities that could make good use of Appliance Technology; Power Control, Service Model Sales for white goods, Pay Per Use etc. etc.

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Consumer Networked Appliances Examples

- Voice
- Messaging
- Support Telephony Services (CID, CWD, VM)
- Information retrieval
- Electronic Transactions
- Web surfing

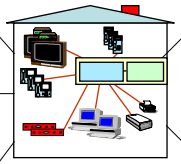
Internet Screenphones

Web Terminals

- Messaging
- Information retrieval
- Electronic Transactions
- Family Schedule
- Web surfing

Digital (IP) Phones

- Voice
- Support Telephony Services (CID, CWD, VM)



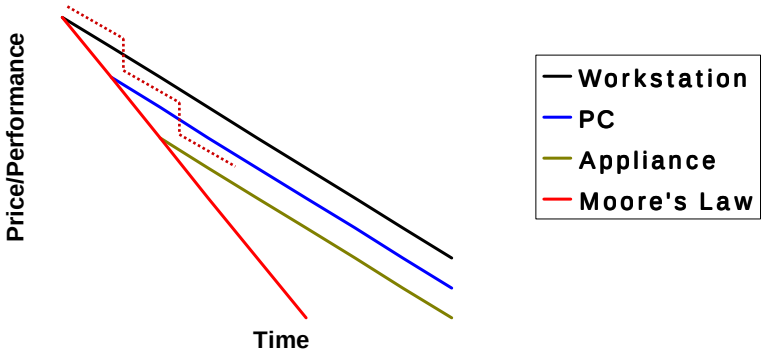
Wireless Web Pads

- Messaging
- Home control
- Information retrieval
- Electronic Transactions
- Web Surfing

Internet-Enabled TV Set-Top Boxes

- Entertainment
- Program Guide
- Messaging
- Telephony Feature Support (CID)
- Electronic Transactions
- Web Surfing

Moore's Law



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Sincoskie's Law

The dominant internet access device changes every six years.

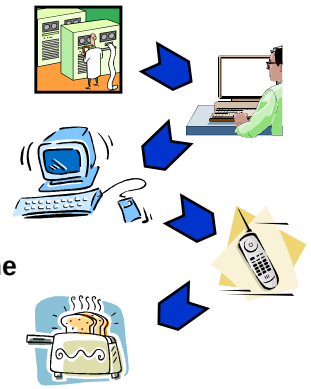
1984-1990 : minicomputer

1990-1996 : workstation

1996-2002 : PC

2002-2008 : smart cell phone

2008-2014 : appliance



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Moore's law:
Price of a wireless network appliance

Jan 1995	**$1000**	
Jul 1996	**$500**	
Jan 1998	**$250**	
Jul 1999	**$125**	**cell phone**
Jan 2001	**$62**	
Jul 2002	**$31**	
Jan 2004	**$16**	
Jul 2005	**$8**	**door lock**
Jan 2007	**$4**	
Jul 2008	**$2**	
Jan 2010	**$1**	**coat button**

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Wakeup service

Yes, Stan?

8:30 AM staff meeting

One hour drive

30 minutes to shower

30 minutes for breakfast

= **6:30 AM**

5:50 AM !!

Snow +10 minutes

Accident +20 minutes

Talked to your car...

It needs gas! +10 minutes

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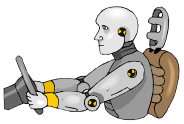
Internet Evolutionary Roadmap

1969-1985	1985-1995	1995-2000	2000-2005	2005-
ARPANET	NSFNET Internet Φ_0	Narrowband Internet Φ_1	Broadband Internet Φ_2	Appliance Internet Φ_3



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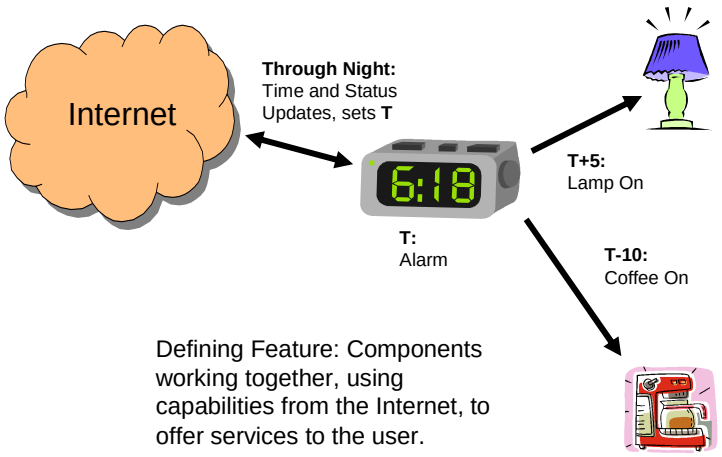
The Alarm is not Alone...



Defining Feature: Components working together, using capabilities from the Internet, to offer services to the user.

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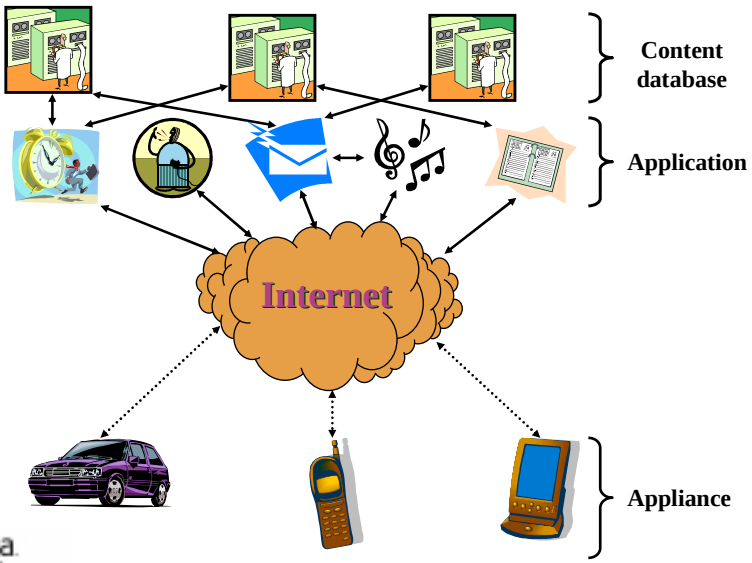
Appliance Service Architecture



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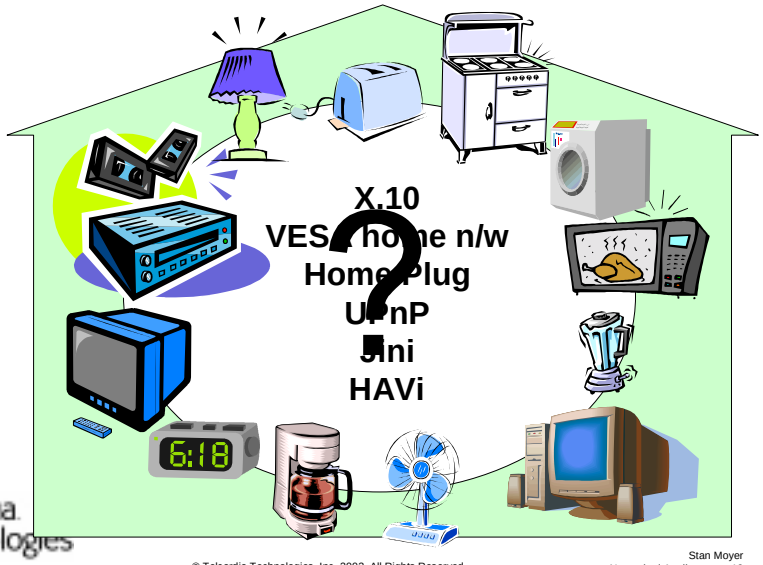
Networking Appliances Today...

A Multitude of Devices and Technologies...



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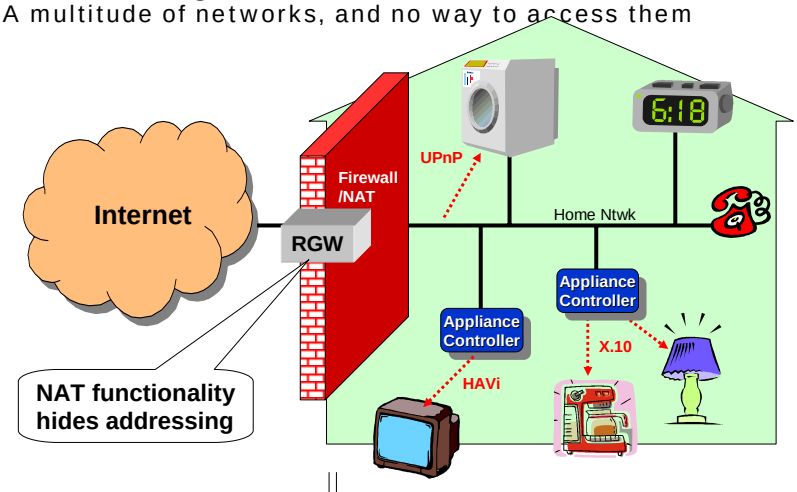
Accessing into the home...

A multitude of networks, and no way to access them



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So: Issues facing Networked Appliances today...

- We need mechanisms for securely accessing devices behind Network Address Translation (NAT) and/or firewalls.
- We need to be able to work across different physical infrastructures to enable direct device/device communication even when devices are connected using different technologies.
- We need to create systems which allow Networked Appliances to be able to 'play nicely' together, so that they don't interfere with each other operation.
- We need naming and actuation systems which can be applied as an 'overlay' on top of existing networks so they can be accessed from the Internet independent of physical connectivity.

Without these things, environments in which networked appliances can work together will be impossible to achieve until one in-home technology wins the war, and we don't want to have to wait that long!!

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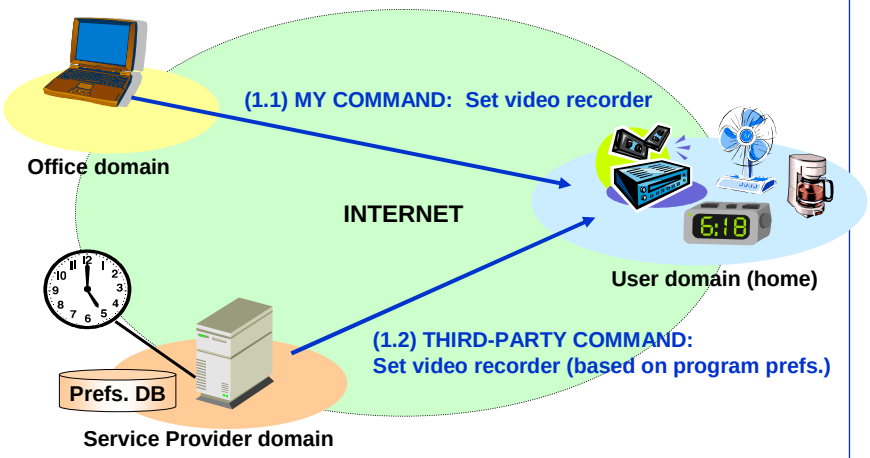
Networking Appliances Tomorrow...

Example (1) Remote Control



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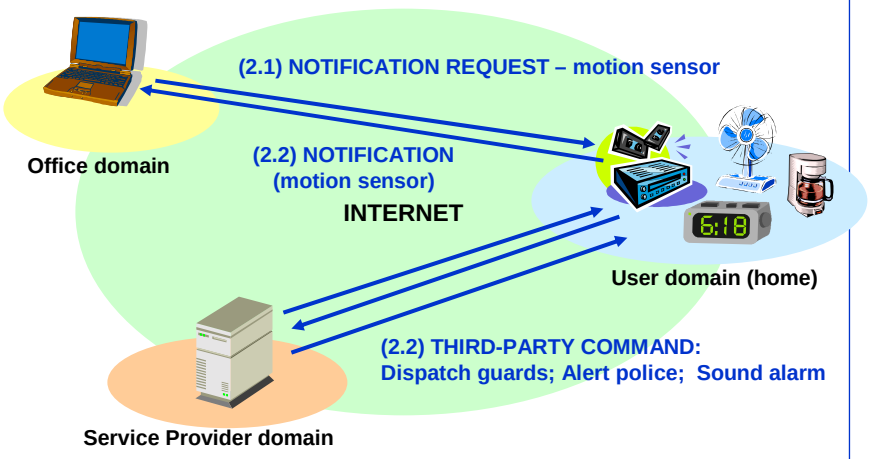
Networking Appliances Tomorrow…
Example (2) Remote Monitoring



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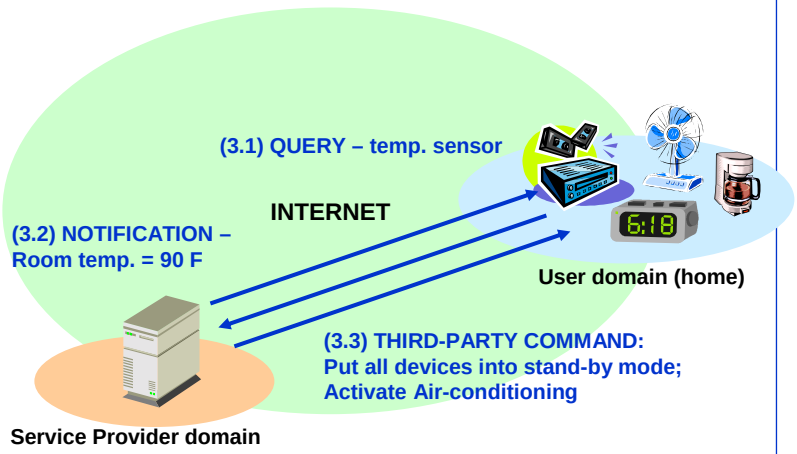
Networking Appliances Tomorrow…
Example (3) Event Notifications



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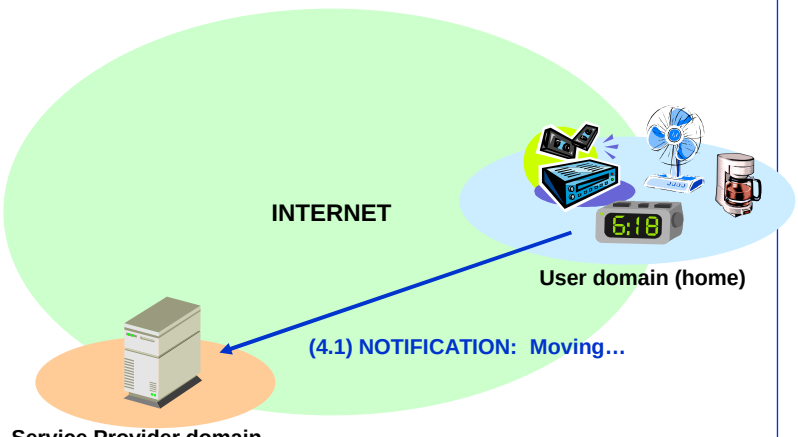
Networking Appliances Tomorrow…

Example (4)… Appliance Mobility & Configuration



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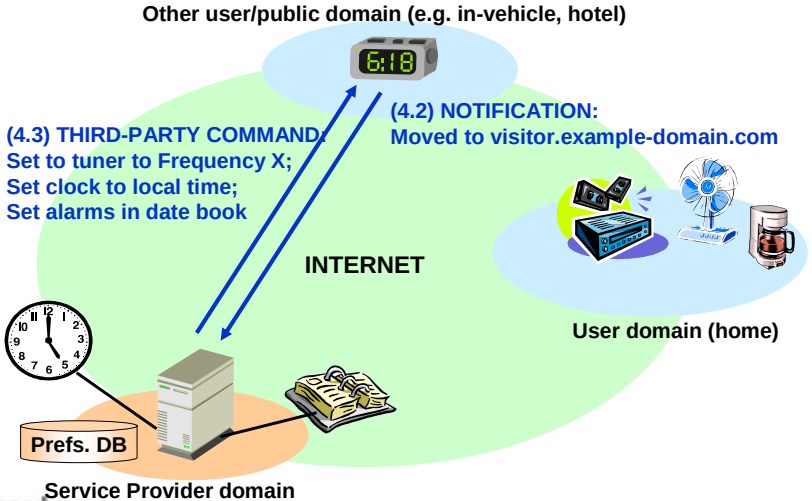
Networking Appliances Tomorrow…

Example (4)… Appliance Mobility & Configuration



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Internet Appliance Requirements

- Communication
  - Command and control
  - Query (status, capabilities, etc.)
  - Notification of events
  - Sessions/Media Streaming
  - Device mobility, Service portability
    - Location/domain registrations
- Security
  - Authentication needed (probably need encryption too)
  - Policy-based access
- Protocol 'Footprint' requirements
  - Must be lightweight
  - Preferably *connectionless* protocol

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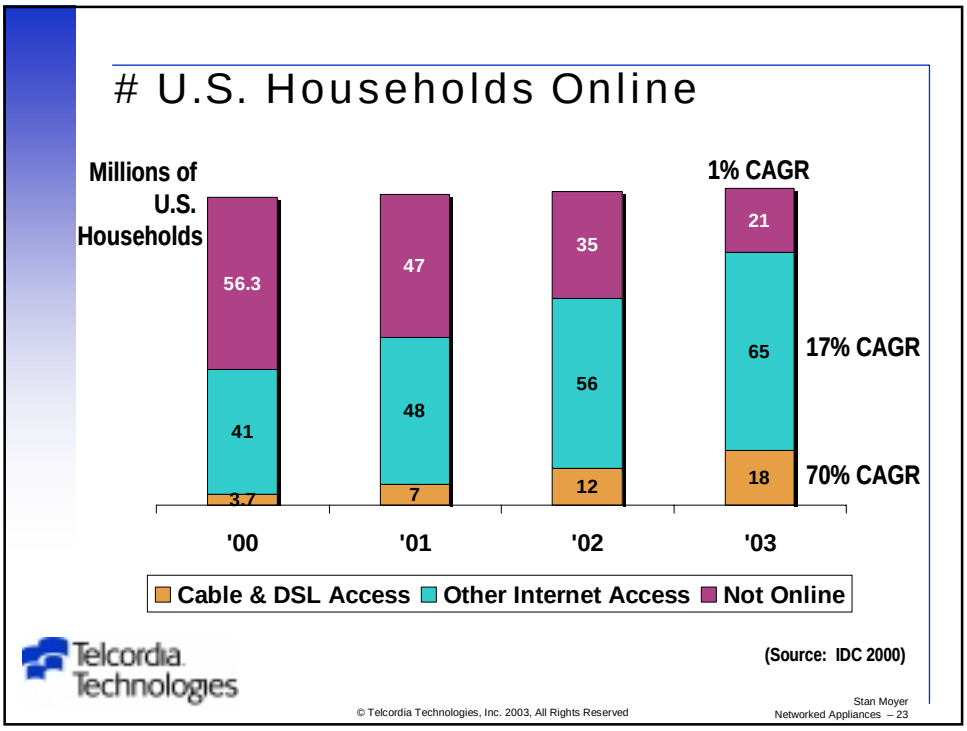
Market information...

…for the Home Networking Market

(one small part of the overall Networked Appliance Opportunity)


U.S. Households Online
Millions of U.S. Households
1% CAGR
17% CAGR
70% CAGR
56.3
41
3.7
47
48
7
35
56
12
21
65
18
'00
'01
'02
'03
Cable & DSL Access
Other Internet Access
Not Online
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(Source: IDC 2000)
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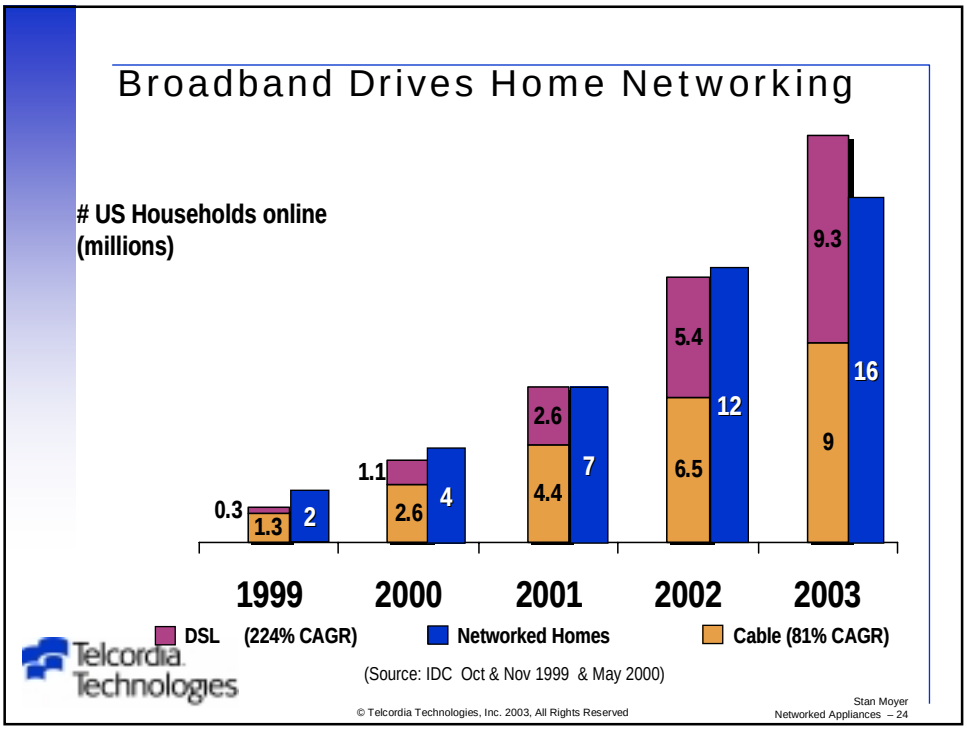
Networked Appliances – 23


Broadband Drives Home Networking
US Households online (millions)
0.3
1.3
2
1.1
2.6
4
2.6
4.4
7
5.4
6.5
12
9.3
9
16
1999
2000
2001
2002
2003
DSL (224% CAGR)
Networked Homes
Cable (81% CAGR)
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(Source: IDC Oct & Nov 1999 & May 2000)
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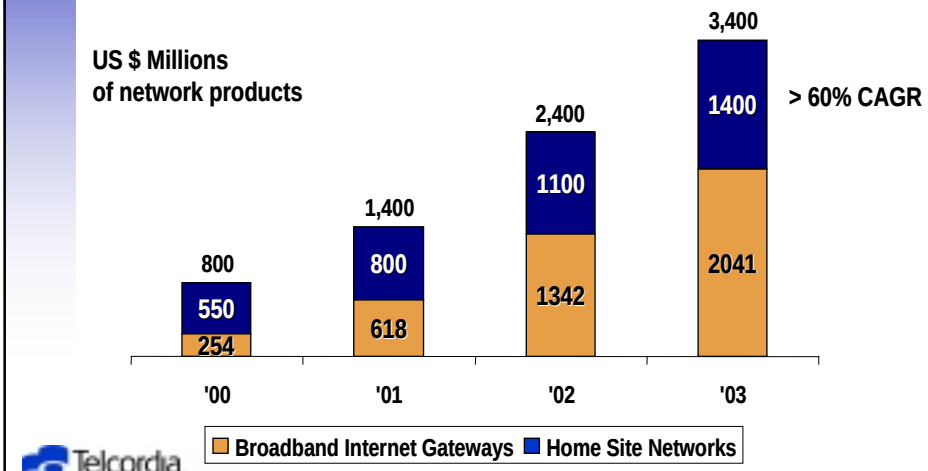
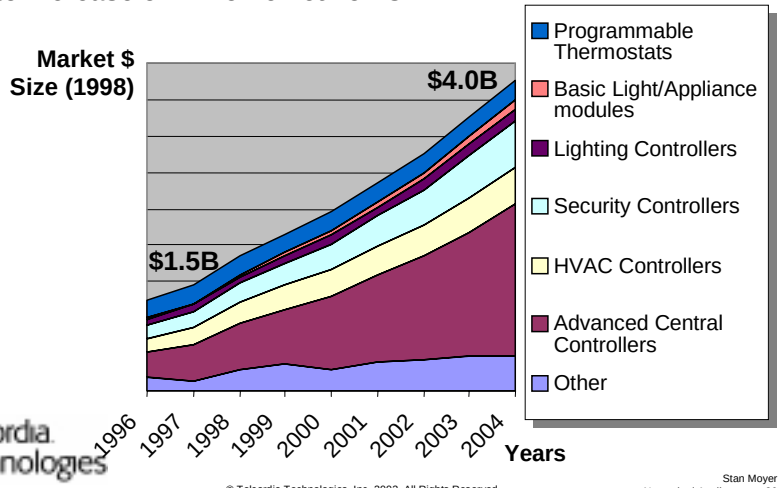
Dollars Spent on U.S. Home Networking



(Source: Cahners In-Stat Group 2000)

Home Automation & Control Devices

Large growth expected in advanced central controllers due to increase of in-home networks



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The Current State of Networked Appliances

In Different Application Environments

Typical Application Environments

Networked Appliances are a Generic Technology

- Well Established
  - **Automotive :** Modern cars have multiple internal networked systems working in concert for Engine Management, Environmental Control and Entertainment. Standards are typically I2C, CANBus, MOST etc.
- Emergent
  - **Personal :** PDAs, Modern Mobile Phones, Cameras etc. etc. are all starting to exhibit network functionality. Standards are typically 802.11b, USB, RS232, Bluetooth, iRDA.
- Embryonic
  - **Home Networks :** Very early signs of an emergent market, but no real concensus on standards, value proposition or commercial model yet. No established standards but a list of candidates as long as your arm.

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The Benefits

Why bother Networking Appliances?

- Shared wide area access
- Local area (i.e. in 'LAN') command, control and content distribution
- 'Emergent behaviors' created when multiple independent entities work together in concert (e.g. Car HiFi mutes when a phone call comes in).
- Ability to 'render' soft services onto pre-existent hardware (e.g. A home burglar alarm that can use the light switches around the house as sensors).
- Ability to share computational resources to reduce cost of individual components (e.g. Using your home PC to decode MP3s to be played back on your HiFi).

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A word of warning...

We're in danger of forgetting our customer

- We are *not* creating technology for the 20% of users who can understand it (if they can be bothered to), we need to create *inclusive solutions* that everyone can use. TV is *inclusive* because it offers *universal access*, these new capabilities need to do likewise.
- Dave's example; his Dad.

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So, what changes when we become inclusive?

How do we make sure it works for Dave's Dad?

- **Users are less Knowledgeable :**They don't know what encryption is, why a subnet mask is important or how to configure a NAT!
- **Low cost points :** Cost/Benefit analyses are much more difficult in home/personal scenarios.
- **Data type versatility :** Users expect the solution to work for voice, video and 'pure' data, they won't buy solutions which are limited by technical considerations if those solutions don't 'scratch their itch'.
- **Ease of installation :** Less educated users -> More ways to make things go wrong.
- **Extensibility :** 'Fork lift upgrades' are not an option for personal users!
- **Automatic Security :** Due to the number of users that there potentially are, any security shortfall immediately becomes a major limitation.

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The Claimed Successes of the PC revolution..

- Just over 50% of households have a PC, 75% of these will have home networks by 2005
  - Still just under 50% that don't, and the market is slowing
- Improvement in dissemination of data
  - Information overload – important stuff is missed in in all the volume
- More and more sophisticated capabilities
  - Less and less users exploiting the full capabilities of the devices – 80% of users use 20% of facilities
  - Users getting frustrated at what they know they *should* be able to do!
- Huge ease of use improvements from the early DOS-based interfaces
  - Have you ever *tried* putting your grandmother in front of a PC???

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We need to be careful!

We must not repeat the
problems of the PC in the Networked
Appliance space!

We need *simple, intuitive, reliable* and *easy to use*
devices, not feature laden monsters.

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We're already heading the wrong way..

An example from the Home Networking Environment...

It works

.

.

.

.

.

Plug it in

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But...early successes too!

- More computers than a jetfighter*
- No (user perceived) reboots
- Highly unfriendly environment (heat/cold/moisture/vibration/electrical noise)
- Local area networking
- Service integration
- Self diagnosis
- Intuitive UI (where applicable)

(*Source: http://fox.rollins.edu/~tlairson/$h$ightech/NYTCAR.HTML)

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Ease of Use does not necessarily imply simplicity under the hood!

Title 13 California Code 1968 "*Malfunction and Diagnostic System for 1988 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles with Three-Way Catalyst Systems and Feedback Control.*" filed on 11-15-85.

Requires cars sold in California to have a on-board computer processor for on-board self diagnostics of computer sensed emission related components, fuel metering device and EGR (exhaust gas recirculation system). A partial or total malfunction that exceeded exhaust emission standard would illuminate a MIL (malfunction indicator light) and provide on-board identification of the malfunction location. To provide malfunction location information, codes are stored in on-board computer memory. To read codes manufacturers use methods such as flashing MIL light or various serial data protocols.

(Source: http://www.odb-2.com/hist.html)
(See Also: http://dlis.gseis.ucla.edu/people/pagre/car.html)

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Why is this possible?

- Single integration agency (auto manufacturer)
- Well respected and accepted standards
- Safety critical environment demands through testing
- Single identifiable product with strong market presence – no opportunity for buck-passing
- Cost reduction imperative
- Good understanding of the capabilities of the technology built up over years
- User interfaces that are logical developments of existing approaches to product

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Comparison with Home Networking..

- Single integration agency (auto manufacturer)
- No defined integration path yet (individual users at best)

- Well respected and accepted standards
- Emerging and fluid standards

- Safety critical environment demands through testing
- Nope

- Single identifiable product with strong market presence – no opportunity for buck-passing
- Lots of fragmented pieces – plenty of 'it's their problem'

- Cost reduction imperative
- Good understanding of the capabilities of the technology built up over years
- No clear identification of the application yet, much less the technology to address it

- User interfaces that are logical developments of existing approaches to product
- By and large poor UIs based on 'traditional' computing technology

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REVIEW – STATE OF THE MARKET

1. Networking appliances together allows us to reduce their cost and achieve new functionality with them.
2. The whole area is emerging but the Automotive space, with its peculiar characteristics and restrictions, has shown the benefits that can be achieved – and even there the benefits are only just starting to be realised.
3. We see the 'Personal' space as the next major area of NA deployment with evidence just starting to emerge of useful applications to be achieved by networking 'PAN' devices.
4. We're in danger, in other NA application areas, of not considering our end user carefully enough, and re-creating the problems of the PC user interface in a whole new domain.

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Key Problems

Three key problems for illustrative purposes;

- Appliance Addressing and Access
- Feature Interaction
- Standards

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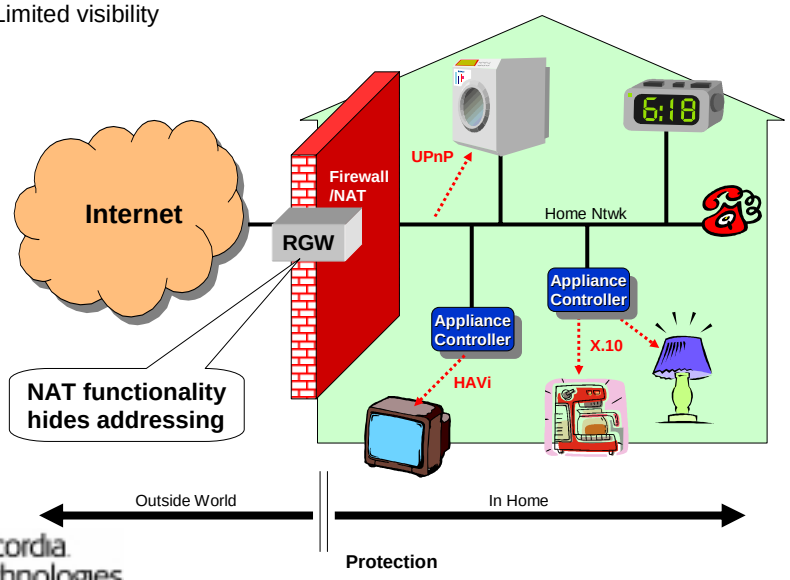
Problem 1 : Naming and Access

How can we access devices behind NATs and Firewalls in a secure, reliable and authenticated fashion?

Accessing into the home...

Limited visibility



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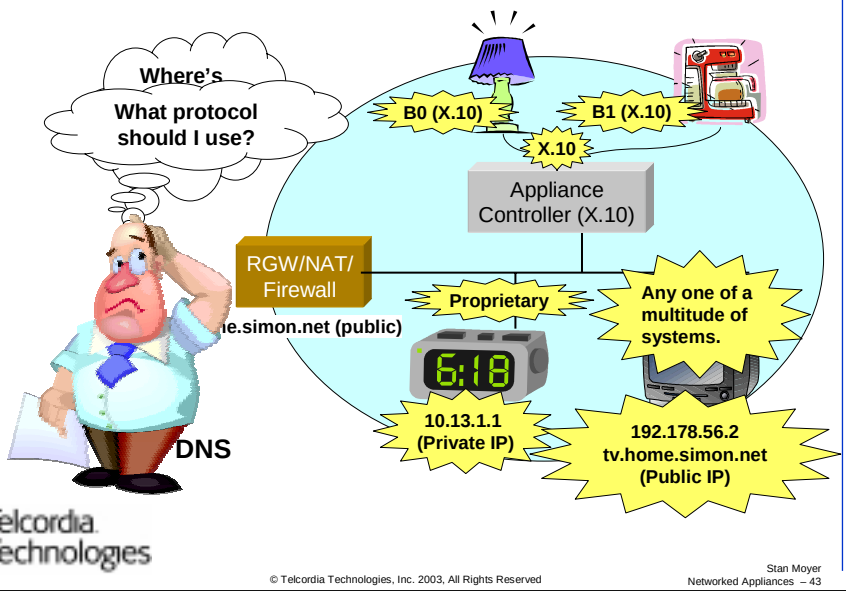
More access issues...

Addressing, Numbering, Protocols and Interfaces



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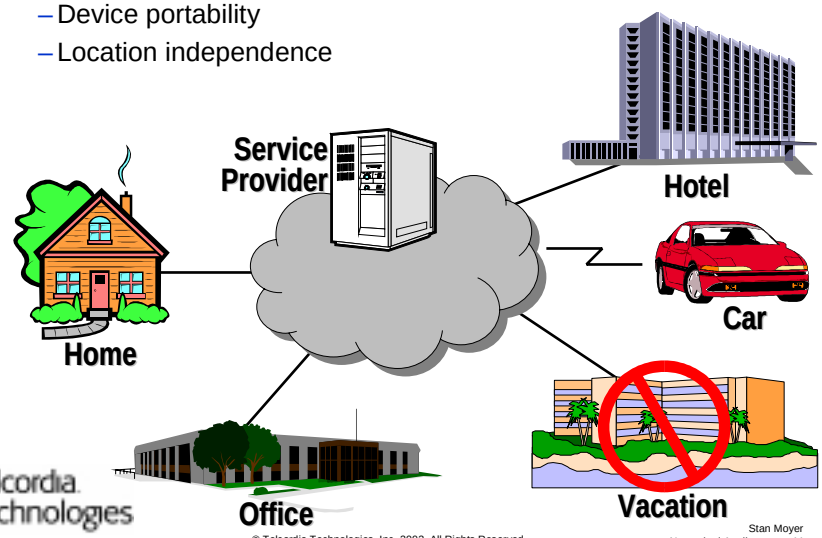
More Requirements

Services should follow me

- Device portability
- Location independence



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The Problem

Summary of Requirements

- Wide area naming and addressing
  - Must be globally unique
  - Portable within and across service provider domains
  - Must work through firewalls and/or NATs
- Device mobility
- Protocol transparency and independence
- Security (and privacy!)
- Must support heterogeneous device communication languages

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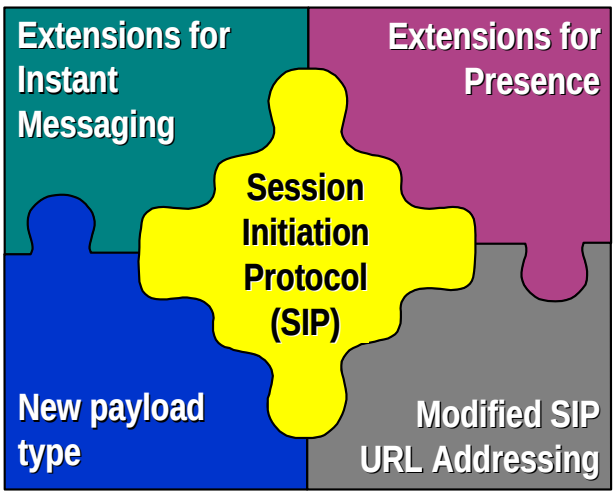
Proposed Solution



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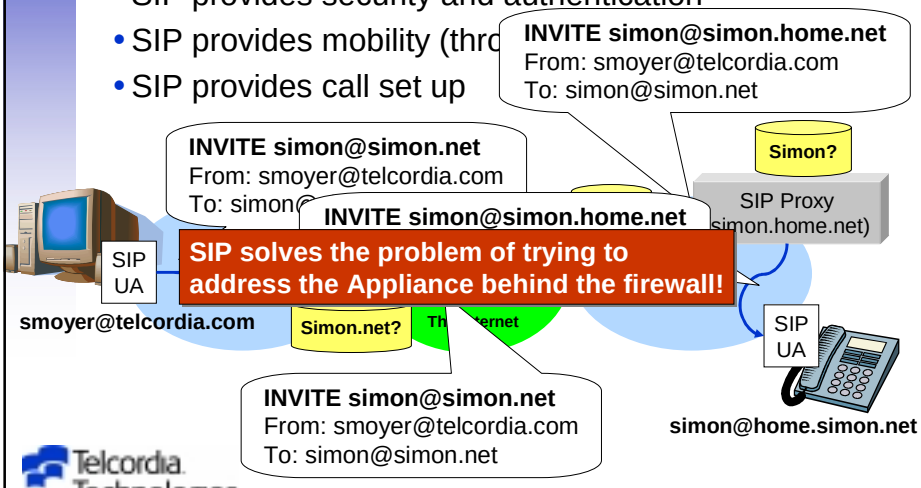
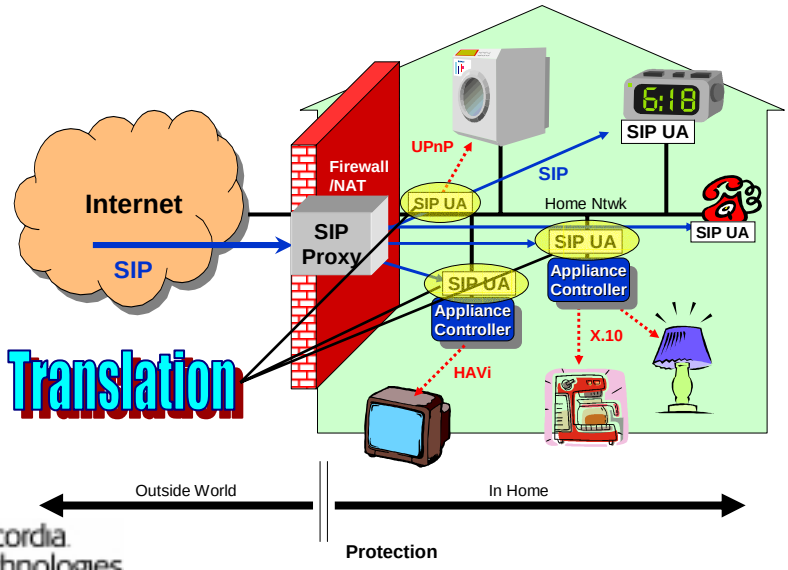
See http://www.argreenhouse.com/iapp for more info

Why Use SIP?

- SIP provides hop-by-hop address resolution
- SIP provides security and authentication
- SIP provides mobility (thro
- SIP provides call set up



Using SIP to Access Into the Home...



SIP needs modifications for use with NAs...

- *Issue*: SIP is a session protocol, it transports in the context of a *session* that is established (e.g. **INFO**).
  - Setting up and closing a session every time we want to access Networked Appliances will be costly, especially as communications will be short in duration with not much data.
  - What we really need is a **reliable datagram**.
- *Issue*: How to address devices.
  - DNS alone cannot deal with the multitude of addressing schemes which lay behind the Home RGW.
  - Information about devices in the home should be kept private
- *Issue*: SIP traditionally carries SDP payloads.
  - We need a way to express the command or request we want to send to the Appliance.
  - SDP does not satisfy this requirement.

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DO Headers

- New Addressing Methodology (in To: field)

```
DO [d=lamp?one/r=bedroom/u=stsang]@home.net
Via: ISP.net
Via: MyHostDomain.com
From:  simon@MyHostDomain.com
To:  [d=lamp?one/r=bedroom/u=stsang]@simon.home.net
Timestamp:  17:16 EST May 26 2000
```

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DO Body (Device Message Part)

- **Device Message Part** (MIME type)
- Generic carrier for Device messages/commands

```
DO [d=lamp?one/r=bedroom/u=stsang]@home.net
Via: ISP.net
Via: MyHostDomain.com
From:  simon@MyHostDomain.com
To:  [d=lamp?one/r=bedroom/u=stsang]@simon.home.net
CSeq:  1231 DO
Timestamp:  17:16 EST May 26 2000
Content-function: render
Content-type:  application/dmp
<xml><command>ON</command></xml>
```

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REGISTER Message extensions

Information required includes:

- Device Name
  - Example: 'lamp1', 'alarm clock 2', 'Simon's TV', 'Dave's phone'
- Device Location
  - Example: 'bedroom', 'Simon's bedroom', 'Master bedroom'
- Device Address
  - Example: X10 address, Generic CAL address
- Device Controller Address (if appropriate)
  - Example: 10.24.180.56
- RGW Address
  - Example: 192.53.67.12

We will define a new **Device Description Protocol (DDP)** MIME type to describe the Device (similar to how SDP describes sessions).

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Example Action

Temperature Query & Response

```
<?xml version="1.0"?>
<DMPAction>
  <Device>
    thermostat_device_id
  </Device>
  <Query>
    <Variable>
      Temperature
    </Variable>
  </Query>
</DMPAction>
```

```
<?xml version="1.0"?>
<DMPResponse>
  <Device>
    device-id
  </Device>
  <QueryResponse>
    <Variable>
      Temperature
    </Variable>
    <Value>
      65F
    </Value>
  </QueryResponse>
</DMPResponse>
```

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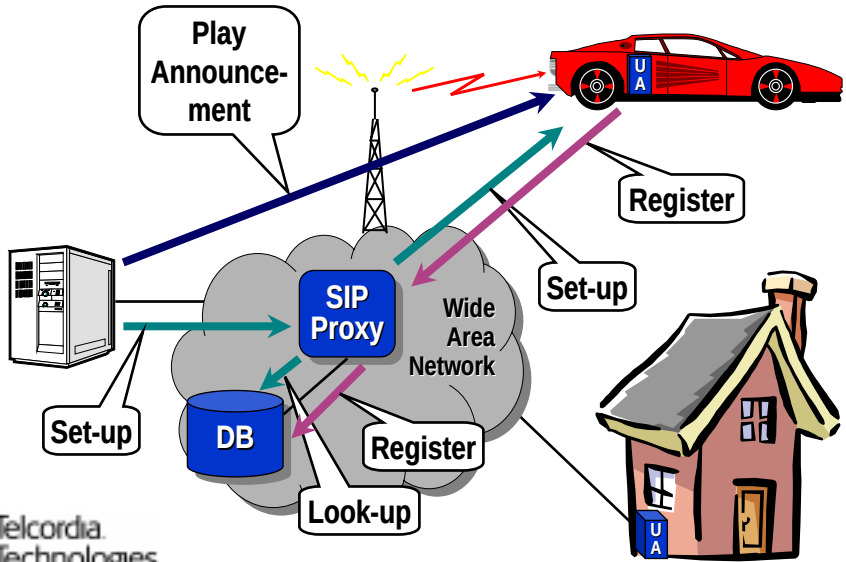
Service Portability Example



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Issues/Challenges

- Standardization of approach
- Proxy location (service provider, home, or both?)
- Provisioning and configuration
- Determining user location
- *Rendering* of information on available devices (i.e. dynamic service composition)
- Configuration/management of *realms*

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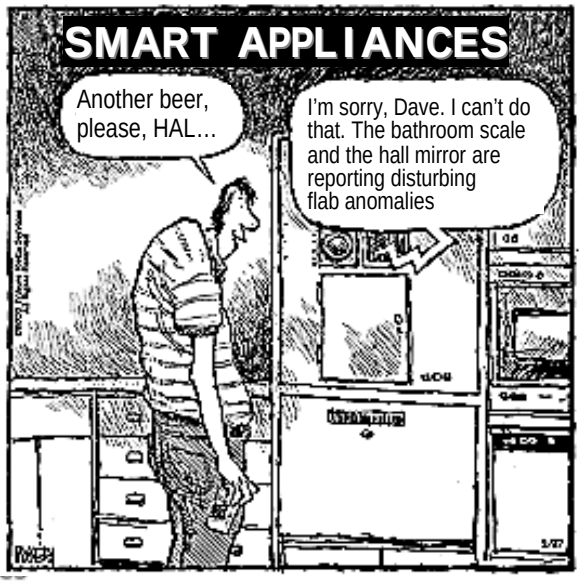
Problem 2 – Feature Interaction

How do we prevent multiple control entities in the home from competing with each other?

(With thanks to Mario Kolberg of Stirling University)

Is this what we really want?



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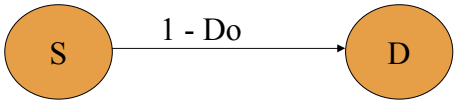
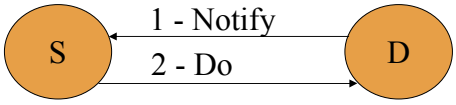
Classification (Pattern?) of Services

1. one service controls one device



2. e.g.: VCR service, coffee machine, picture frame
3. a service gets notified by one device and controls the same device as a consequence



e.g.: washing machine (load full → start wash)

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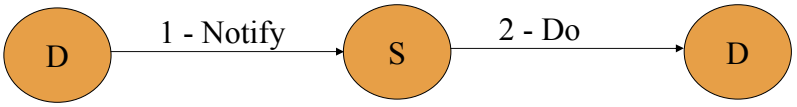
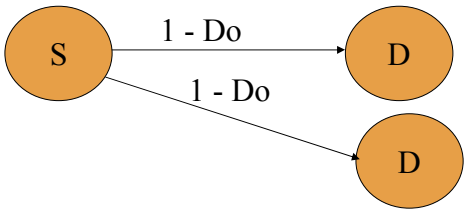
Classification (Pattern?) cont. ...

3. a service gets notified by a device and controls a different device as a consequence



e.g. thermometer → start air condition,
door opening → start camera

3. one service is controlling many devices



e.g. turn on all lamps,
lock door + start VCR

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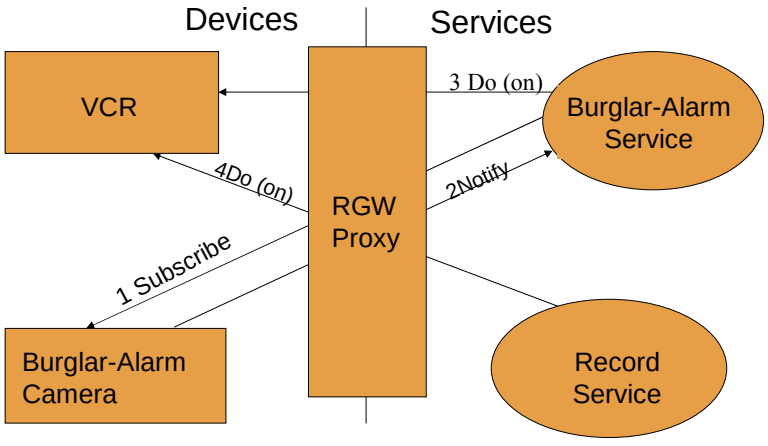
Burglar Alarm + VCR Recording



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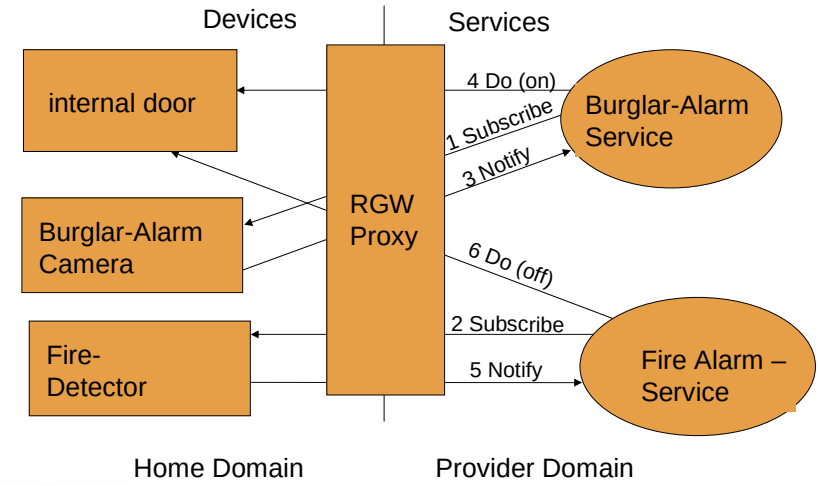
Fire Alarm + Burglar Alarm



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Service Interaction Examples

- VCR service + burglar alarm service controlling VCR
- Burglar alarm (lock doors) + fire alarm (open doors)
- On reaching a certain temperature in the house, the windows are opened (window service) and the air con is turned on (air con service)
- An 'away from home' service turns on the lights at random times during the day. This triggers the burglar alarm service.
- On reaching a certain temperature, the air condition service is triggered, this causes the temperature to drop which in turn triggers the heating service.
- The burglar alarm service disables all devices in the home. This prevents the fire alarm service from triggering when a fire breaks out.

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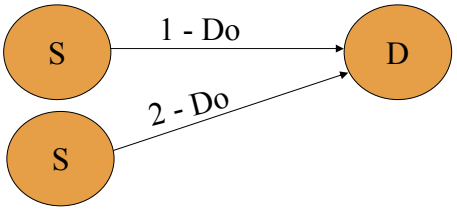
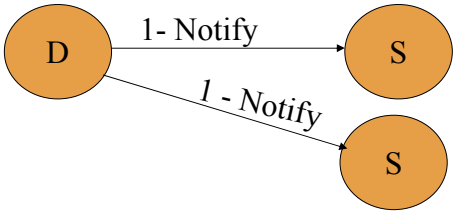
Classes of Service Interactions

1. Two (or more) service controlling the same device (Shared Action Interaction)



2. One event goes to different services which perform different conflicting actions (Shared Trigger Interaction)



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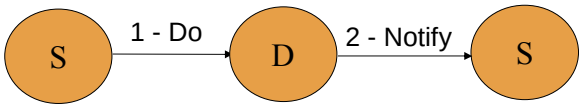
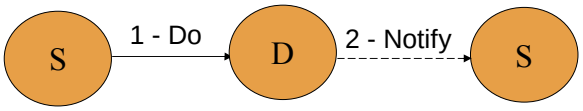
Classes of Service Interactions

3. A service performs an action on a device which triggers another service. The chain might involve any number of links (Sequential Action Interaction, loops)



4. The existence of one service prevents the other one from operating. (missed trigger interaction)



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To Conclude…

- Interactions between NAs will be a huge issue!
- Number of NAs involved can be large (compared with telephony)
- 'Do' may trigger two different kind of actions
  - instantaneous (turn on light)
  - continuous (start recording TV program)
  - Is using DO sufficient?
- When to start and stop looking for an interaction
  - There is no concept of call or session.
  - How to group the transactions?
- Fixing an interaction might trigger another one
  - There is no concept of call / session: How to stop the chain of events?
- What is the difference between a NA and a service?
  - NA = physical appliance which can perform commands equivalent to its traditional functions (light = on, off; VCR = play, stop, pause, record)

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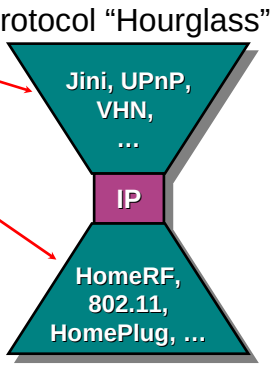
Problem 3 – The Standards Situation

We have too many standards, none of which are clear leaders …. Here are a few of them

Standards
Too many choices

Several kinds…

- IP-based
  - Services Layer
  - Physical Layer
- Non IP-based
- Gateway/Service Platform



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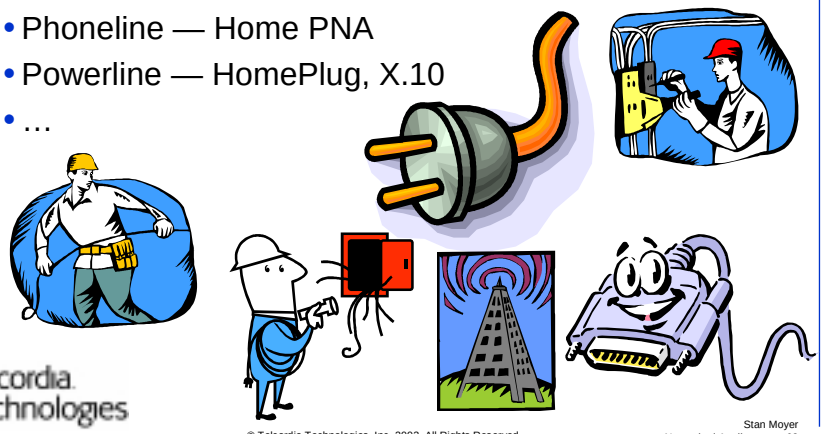
Physical Layer Technologies

- Wireless — 802.11x, HomeRF, Bluetooth, HiperLAN2
- Structured Wiring — 100Mbps Ethernet, IEEE 1394 (firewire)
- Phoneline — Home PNA
- Powerline — HomePlug, X.10
- …



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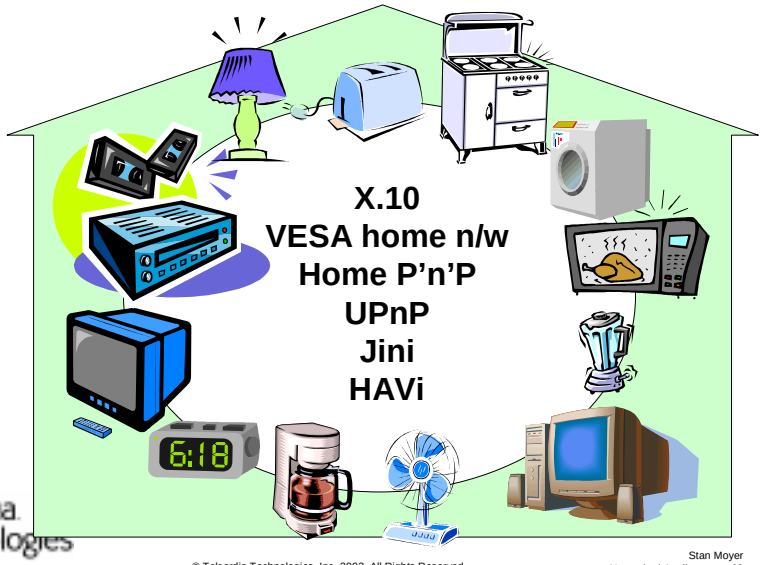
Service Layer…

A Multitude of Devices and Technologies…



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Non IP-Based Appliance Protocols

- X.10
- LonWorks
- OneWire
- Many domain specific
  - Healthcare
  - Industrial Control
  - HVAC
  - Alarm Systems

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Gateway/Service Platform Standards

- Open Services Gateway initiative (OSGi)
- Microsoft .NET
- Versatile Home Network (VHN)
- JAIN/Parlay
- MIDP
- Other proprietary

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Jini – What is it?

- Not an acronym
- Based on Java™ technology and enables devices to simply connect into impromptu networks, without extensive planning, installation, or human intervention
- Offers "*network plug and play*"
- Allows devices to be *flexible* and *negotiate the details of its interactions*

for more info, see http://www.cs.pitt.edu/~lilyzhao/jini/

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UPnP

Important enough to be considered independently

- From www.upnp.org: 'An architecture for pervasive peer-to-peer network connectivity of intelligent appliances, wireless devices, and PCs of all form factors'.
- Designed for Zero Config 'invisible' networking
- Runs over HTTP (in UDP or TCP form). Descriptions for devices expressed in XML, together with excitation methods via SOAP.
- Allows Discovery of Devices and a Description of a devices' capabilities.
- Some standardized device descriptions (e.g. Routers) but these have been relatively slow to arrive which has held back adoption. Slowly happening now!
- UPnP V2 will not be compatible with V1 but will mandate back compatibility so V2 will effectively interwork.
- Language and OS neutral but with Microsoft as a strong player has been (inappropriately) bound to Windows. Linux has good UPnP stacks, for example.

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UPnP
(continued)

- Limitations
  - No security intrinsically provided as part of the capabilities, and will not scale well outside of a LAN (e.g. for WAN access).
- Prognosis
  - Main competitor is JINI, but this has even more problems in the security area.
  - Probably will be the LAN device control standard of choice in time
- More Info
  - See http://www.upnp.org/download/UPnPDA10_20000613.htm

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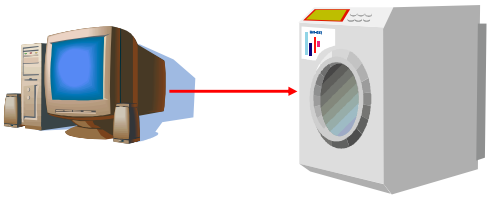
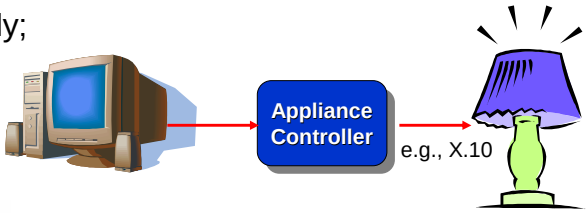
How do we communicate with Networked Appliances?

- Directly;



- Indirectly;



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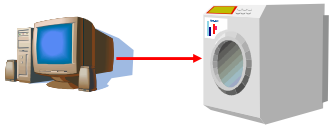
The Direct Case



- Can be used when the device is 'high powered' enough to represent itself to the network
- Brings with it concerns of security, ownership, User Interface etc.
- Means each separate device has a separate, unmultiplexed representation to the outside world – creates huge problems when there isn't a direct connection to the other end (e.g. When there is a NAT in the way)
- Is the only way to do things when the Appliance Controller (AC) architecture isn't standardized unless a proprietary AC is acceptable
- Has been used, for example, for washing machines via a GSM connection.

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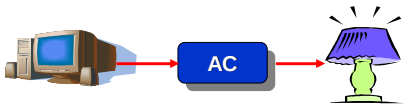
The Indirect Case



- Used when the protocols are not compatible with the network protocols or when the device is not powerful enough to represent itself on the network
- A single AC can represent many proxied endpoint devices
- Simplifies user interface and security issues by concentrating them into a smaller number of places (i.e. each device doesn't need to be configured).
- Can be used in environments where the local and wide area network links are the same technology but the addressing is different (e.g. IP and NAT)
- Use, for example, for connecting PDAs to the Internet, using a PC as the AC.
- The AC can support arbitrary functionality and can be extended to support new capabilities for the LAN.
- When the AC is extended to incorporate this arbitrary functionality it becomes a Gateway Device.

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The Crux of the problem

Gateway Capabilities

- Gateways allows arbitrary code to be run on a computational element and thus can act as Appliance Controllers
- They support multiple network interfaces
- Often serve to proxy security, authentication and related issues on behalf of devices within the LAN

- Devices providing these gateway capabilities often provide additional functionality themselves (e.g. PC, mobile phone).
- An emergent market;
  - Embedded use: OSGi
  - PC Network use: .NET
  - Automotive Use: GST
  - Mobile Phone Use: No frontrunner yet

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Example Gateway Technology : OSGi™

OSGi enables the delivery and management of services that can be accessed by *devices* that may be remote and/or have intermittent network connectivity. It defines a framework providing the capabilities required for these *dynamic* environments including a simple deployment model, remote management, and lifecycle management, amongst others.

see http://www.osgi.org/ for more info

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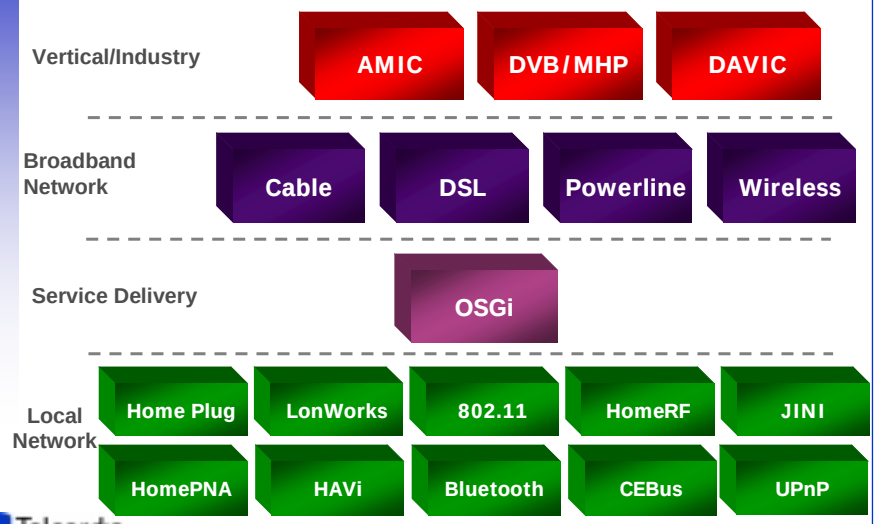
Where OSGi fits



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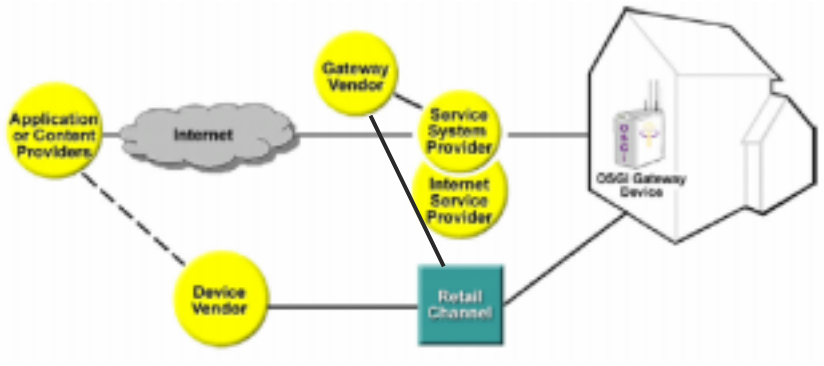
An OSGi deployment example



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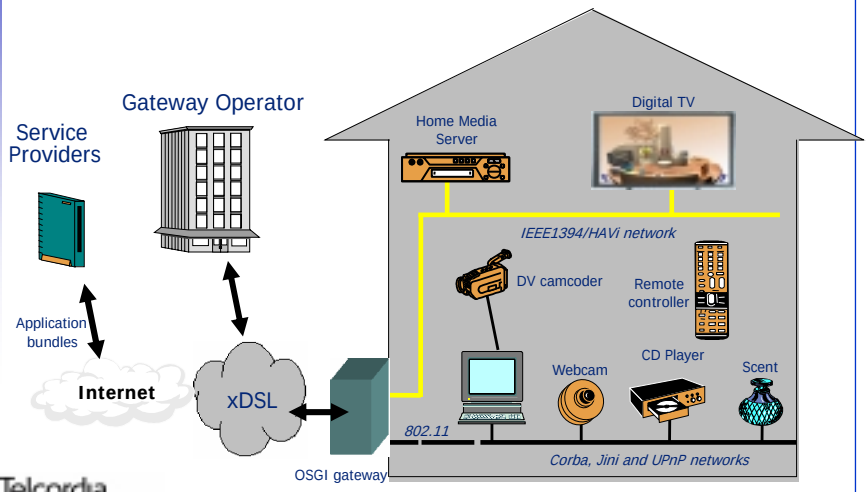
Net@Home demo
France Telecom/Thomson



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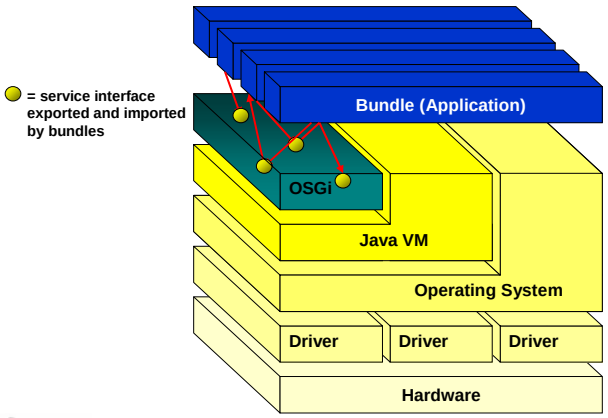
The OSGi system



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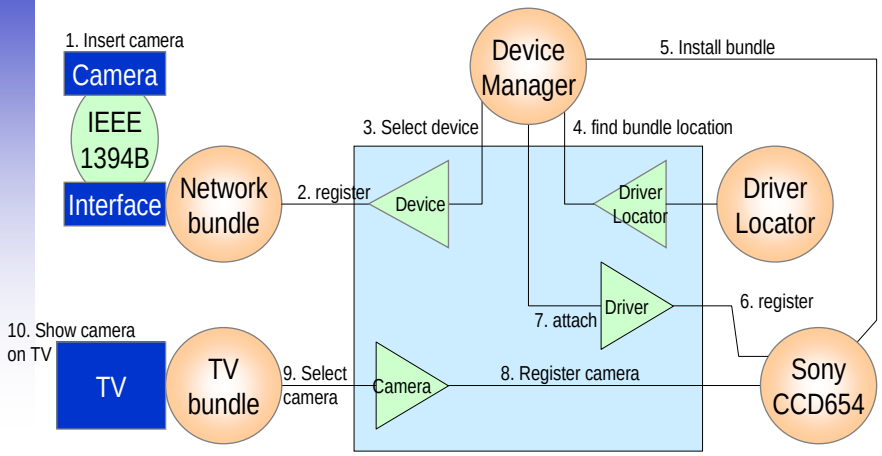
OSGi Device Access



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OSGi Jini Service

- Jini services are usable as OSGi services and vice versa
- Jini services should not compromise OSGi Service Platform security
- A bundle can export an OSGi service as a Jini service
- A bundle can use an OSGi service that represents a Jini service

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OSGi UPnP Service

- Limited to device control of UPnP
  - Aspects concerning the TCP/IP layer are not addressed
- OSGi services can be transparently made available to UPnP networks
- Possible to restrict the use of UPnP to a selection of the possible networks
- Bundles can listen to UPnP events
- Bundles can make a service available to UPnP controllers
- Bundles can control UPnP devices

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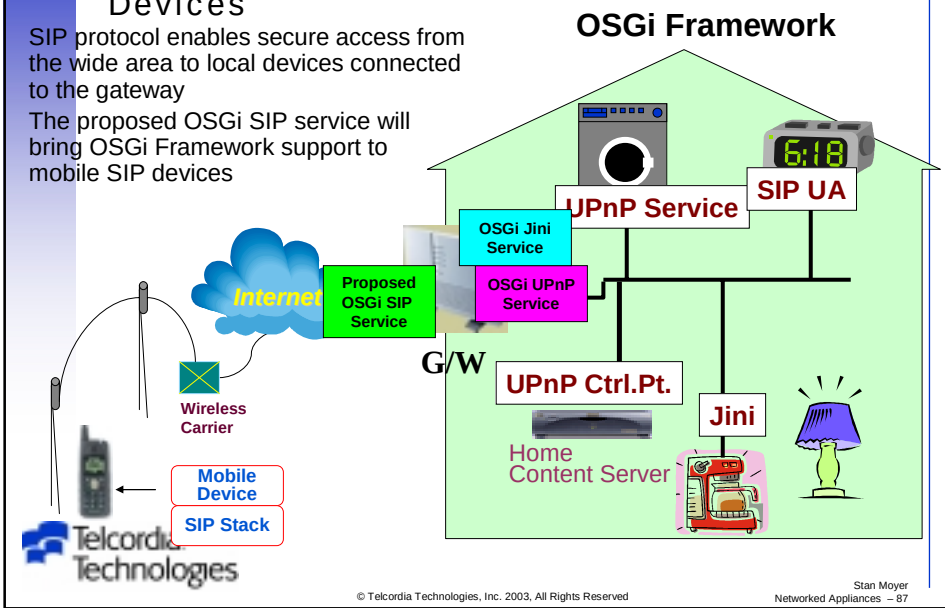
OSGi and SIP for Appliances

Secure WAN Communication of Diverse Devices

SIP protocol enables secure access from the wide area to local devices connected to the gateway

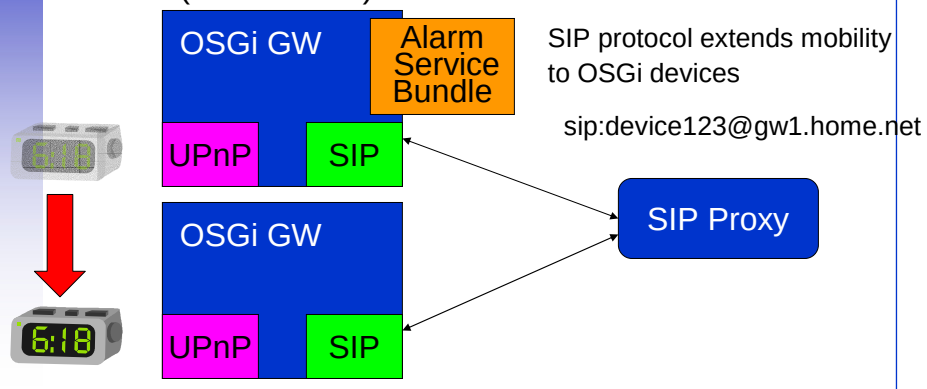
The proposed OSGi SIP service will bring OSGi Framework support to mobile SIP devices



OSGi and SIP for Appliances

Use case 2: Device / Service Mobility using SIP

UPnP Device (Alarm Clock) moves from GW1 to GW2



SIP protocol extends mobility to OSGi devices

sip:device123@gw1.home.net

UPnP device in GW1 is registered with SIP proxy as SIP device. Upon relocation to GW2, it re-registers with SIP proxy, given it a new location

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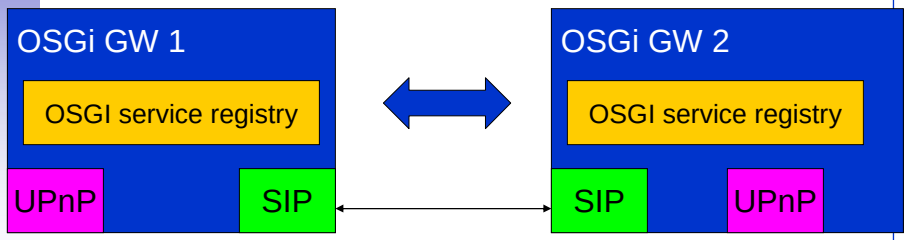
Implications: Home gateway devices can roam to foreign gateways without service interruptions

OSGi and SIP for Appliances

Use case 3: Inter-gateway Bridging



Use SIP to import/export OSGi devices from/to service registries

Implications: Home devices/services accessible as local devices/services on the car gateway and vice-versa

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To summarize OSGi

- OSGi represents a set of extensions to base JAVA to allow it to be used for large scale deployments where considerations of Reliability, Portability, Dynamicism, Security and Scalability are of paramount importance.
- It is very well suited to Gateway and Appliance Control applications and early deployments have proven it's commercial viability.
- It consists of a core *Framework* and a number of optional *Services*. Many services are standardized by the OSGi.
- The capabilities of the OSGi make working in long lifetime dynamic systems much less painful as much of the co-ordination responsibility is taken away from the programmer.
- **Most importantly – independent organizations can write services for deployment in an OSGi environment; A *bundle market* is enabled.**

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Another technology... Microsoft® .NET

- a set of Microsoft software technologies for connecting information, people, systems, and devices
- enables a high level of software integration through the use of Web services—small, discrete, building-block applications that connect to each other as well as to other, larger applications over the Internet.
- See http://www.cetus-links.org/oo_dotnet.html for more information

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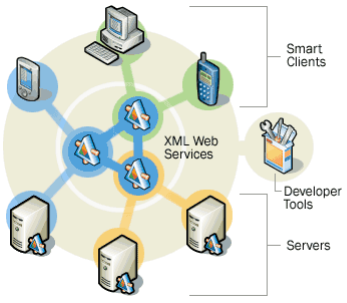
Microsoft® .NET (continued)

Web Services

- Small, reusable applications written in XML
- Allow data to be communicated across the network between otherwise unconnected sources that are enabled to host or act on them – e.g.,
  - Client-to-client
  - Client-to-server
  - Server-to-server
  - Server-to-service



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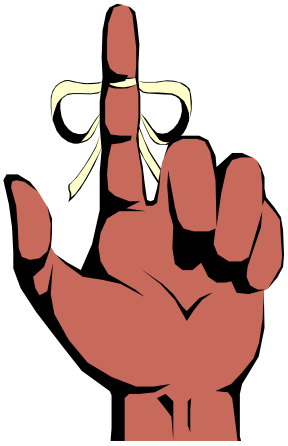
Networked Appliances Summary

- Networked appliances/devices are coming
- A lot of existing work/standards to choose from
- The solution is not complete – still not ready for the mass market
- Therefore, lots of research opportunities still exist in this space
- Also, still no killer application or well-defined business model



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Call for Papers — IEEE Communications Magazine

In-Home Networking Series

Sample Hot Topics:

- Requirements for Home Networks
- Wide Area Network support for Home Networks
- Home Networking Protocol, Programming Environment & Transmission Standards
- Home Media (Wireless, twisted pair, coax, optical fiber, RF,...)
- Home LANs (IEEE 1394, HomePNA, HomeRF, Bluetooth, HomePlug)
- Home Automation Networks (CEBus, LonWorks, X10)
- Home Intranet (IP address allocation, directory services, routing, IP proxies, ...)
- Device Discovery and Control Paradigms (HAVi, JINI, UPnP, Salutation, OSGi, ...)
- Residential Gateways (architecture, technology, NAT, features, ...)
- Security (Harmonization of Link Layer Security Services, Authentication and Authorization, Integrity, Software Security, Digital/Intellectual Property Rights Management, Firewalls, ...)
- Field Trials and Demos
- QoS Measurement/Modeling
- In-Home Network Management
- Network and Multimedia Applications and Appliances (Home & Small Business)
- Application Management and Behavior as a Result of Networked Knowledge
- In-Home Network Service Management and Delivery
- Applications and Appliances for Special Needs (e.g., Elderly, ill, Handicapped etc.)

Submissions due July 1 (for Nov. issue)
See http://geocities.com/stanmoyer/call_for_papers.htm for details

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2004 IEEE CONSUMER COMMUNICATIONS AND NETWORKING CONFERENCE
"Consumer Networking: Closing the Digital Divide"
(Precedes the CES 2004 International Consumer Electronics Show: www.cesweb.org)
Las Vegas, Nevada (Venue to be announced) USA / 5-8 January 2004
Sponsored by the IEEE Communications Society

see http://www.ccnc2004.org/

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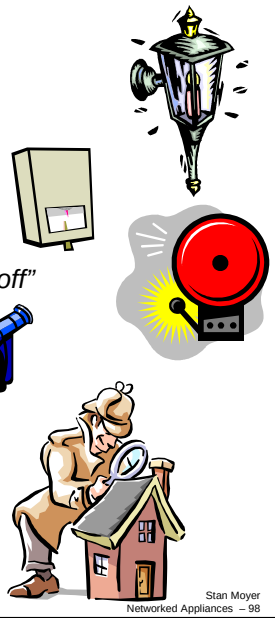
Back-up Viewgraphs

Different Communication Modes

- Control
  - *"Turn on the outside light"*
- Queries
  - *"What is the temperature in the house?"*
- Asynchronous Events
  - *"Notify me when the security alarm goes off"*
- Media Streaming
  - *"View the baby-sitter cam"*
- Discovery
  - *"What device can meet requirement X?"*



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Assumptions

- Local area network (connectivity, naming, addressing, etc.) is already configured at the IP layer
  - Manually
  - Automatically (a la Zeroconf)
- Wide-area IP connectivity exists
  - "Always on"
  - Reliable
- Firewall and/or NAT may exist between wide area and local area

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Why Use SIP?

Huge SIP Momentum in Internet Telephony Today....

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SIP is also being considered for Instant Messaging

Why not...

HTTP

- No support for event notification
- Poor mobility support
- Requires TCP

SMTP

- No event notification
- No support for sessions/media streaming
- Not necessarily associated with immediate processing

A new protocol

- Do we need yet another protocol?

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What is the Talisman System?

- A location-aware service infrastructure
  - Highly scalable
  - Highly available/reliable
  - Secure and private
  - Applicable to multiple physical location technologies
  - Application-neutral

- **W**ho, **W**hat, **W**here, **W**hen, **W**hy?

$= W^5$

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Applicable Sensor Technologies

- Local RF/Acoustic Location
- Transaction side-effects (e.g. Credit card scans)
- Automatic Face recognition
- Presence/Security scanners
- GPS reporting
- Mobile phone location
- Manual entry
- Which?????

All of them, please…

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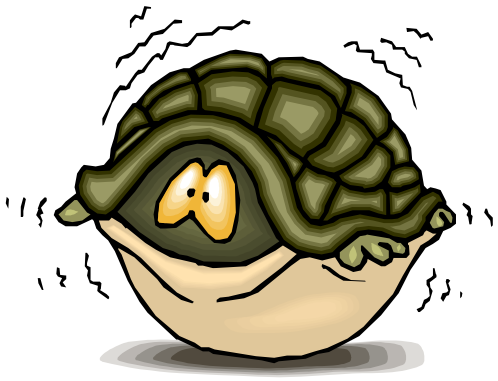

I **do not** want everyone knowing where I am…

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Wait a minute...

- Want to know where the nearest pizza store is?
- Want that important phone call diverting to you in your meeting?
- Want your slide presentation to pop up automatically when you approach the lectern?
- Want the lights in your office to come on and the door to unlock when you get there?
- Want to be found under an avalanche?
- Want capabilities and services enabled only when you're around?
- Want to start your car without the keys, with the seat in the right position for you?
- Want to be able to get to your hotel room without having to stand in line?

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Well, OK, perhaps **sometimes** it's alright…

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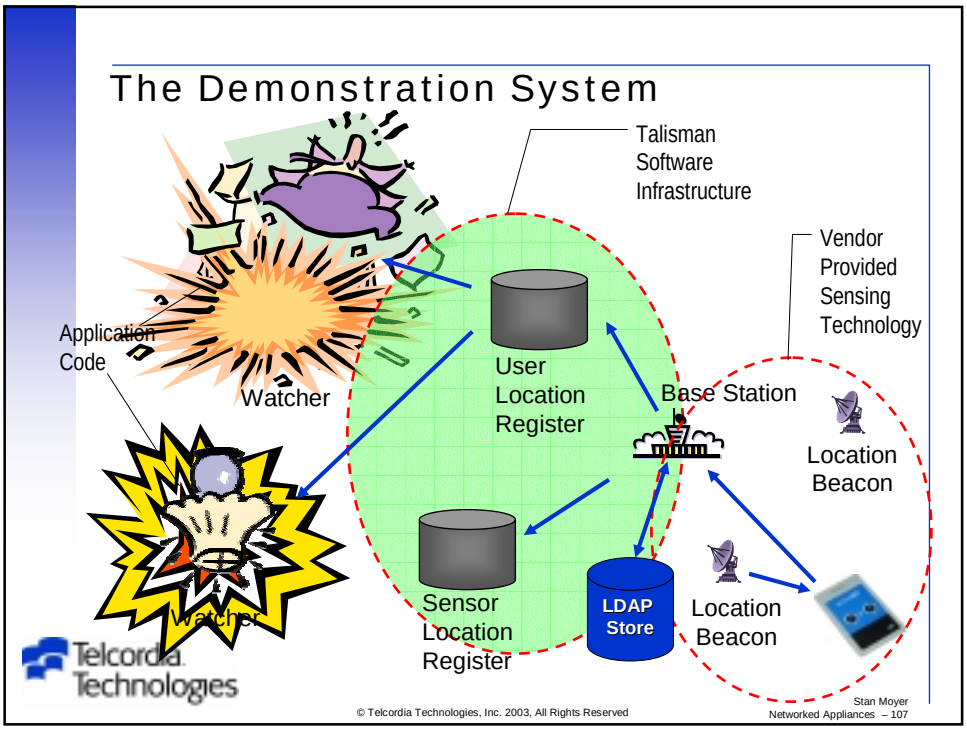
The Demonstration System
Talisman
Software
Infrastructure
Vendor
Provided
Sensing
Technology
Application
Code
Watcher
User
Location
Register
Base Station
Location
Beacon
Watcher
Sensor
Location
Register
LDAP
Store
Location
Beacon
Telcordia
Technologies
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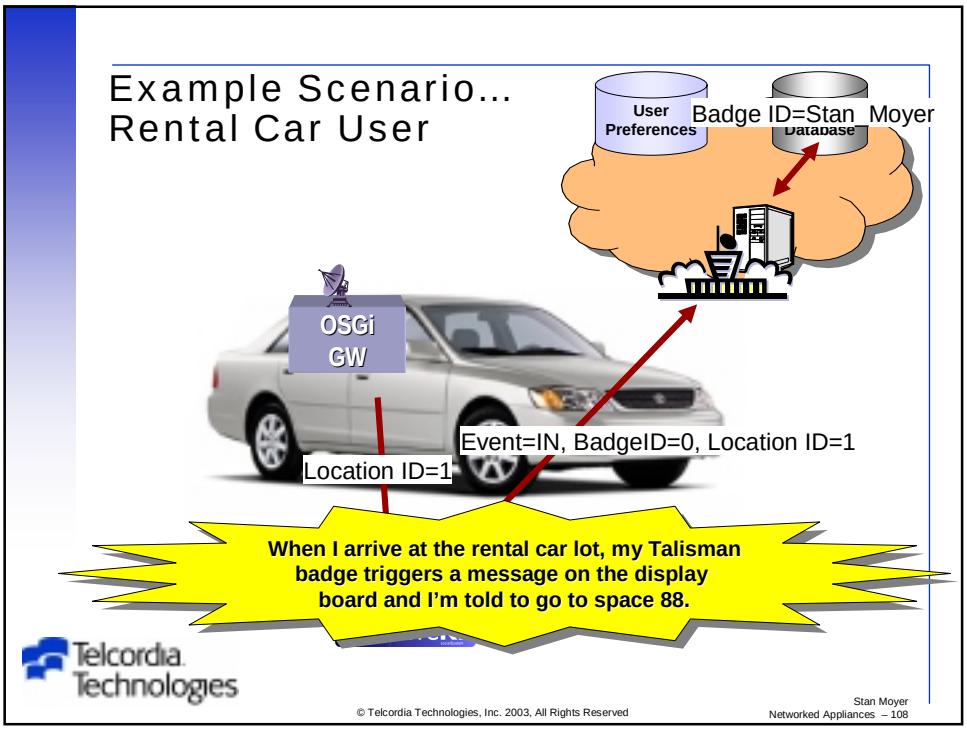
Stan Moyer
Networked Appliances – 107


Example Scenario...
Rental Car User
User
Preferences
Badge ID=Stan Moyer
Database
OSGi
GW
Event=IN, BadgeID=0, Location ID=1
Location ID=1
When I arrive at the rental car lot, my Talisman
badge triggers a message on the display
board and I'm told to go to space 88.
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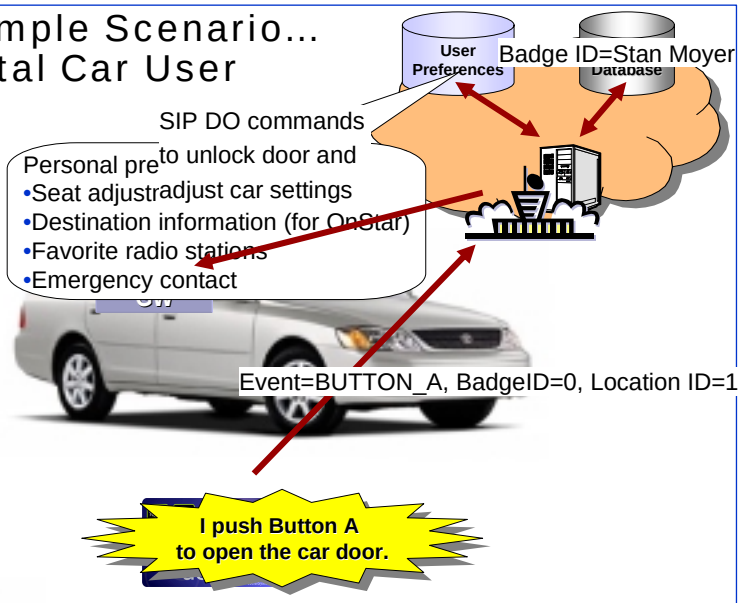
Networked Appliances – 108

Example Scenario... Rental Car User



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