

Boxes and Arrows for the Couch Potato



or, “How to
build a better
baby monitor!”

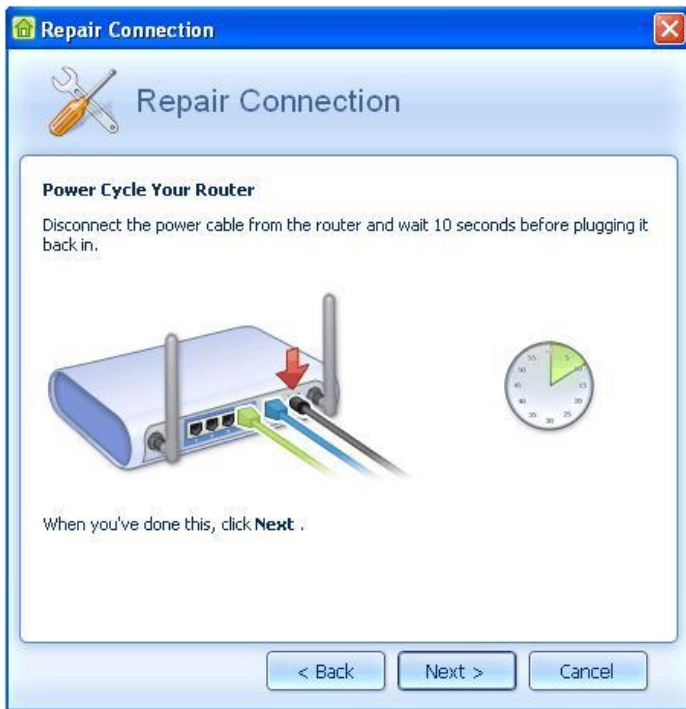
A Ben Greenstein rant

Let's suspend disbelief

- Pretend that every electronic device in your home knows how to join a network

Evidence this will soon be solved!

- Network Magic!
- Networked Refrigerated oven



Back to suspending disbelief...

- Pretend that all aspects of security are solved

Closer to a solution? WPS!



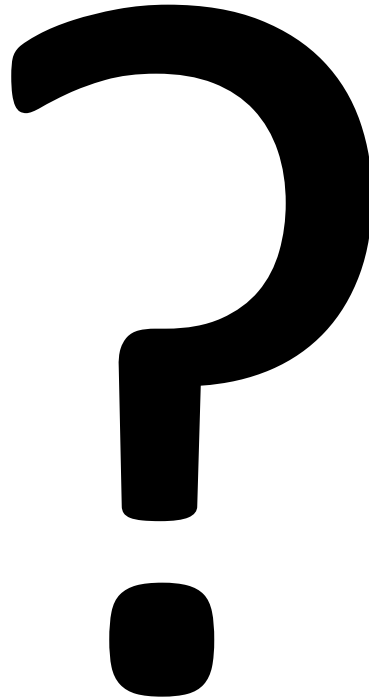
Oh, and Bonjour!

- Pretend all devices can discover each other

How could this ever happen?

- Standardization?
- The universe reduces to Apple, or Google, or MS, Cisco, or Comcast?

Then what?



Hopefully, not this!



Whirlpool GD5VVAXT

Interesting things happen when the network works!

- WAN
 - Web services, distributed video games
- LAN
 - Bonjour printers, iTunes, etc.
 - Streaming music and video
 - Network storage
- PAN
 - Wireless headsets, mice

How do we build useful distributed applications out of home electronics?

- Appliances
 - Oven, Fridge, Microwave, Dishwasher, Washer, Dryer, Coffee Maker, Toaster, Air purifier, Hot water heater, vacuum cleaner
- Entertainment
 - TV, DVR, Cable Box, Blu-ray, Amplifier, Radio, Speakers, Remote Control, xBox
- Mobile
 - Cell Phone, iPod, laptop, body sensors
- Home Office
 - Desktop, display, access point, printer
- Lights
- Infrastructure
 - Air conditioner, Security system, Garage door opener
- Exercise machines
- Web appliances
 - Digital picture frame
- Sensors
 - Smoke detectors, CO detectors, cameras, microphones, accelerometers, gyros, thermometers
- Robots

Guidelines

- Think in terms of services, not devices
- Reuse devices (think MacGyver)
- Think in terms of data movement, not control
- Keep interfaces as narrow as possible
- Use context

How it should work

- Dataflow graph describes application
 - Vertices = Services
 - Edges = Network links
- Configurator maps vertices to devices
 - Dynamically
 - Produces only valid configurations

Building a better baby monitor

Anyone := Dad, Mom, BigBrother;

Speaker := Radio, Home Phone, TV, Stereo, Dad's Cell Phone, Clock Radio, Mom's Cell Phone;

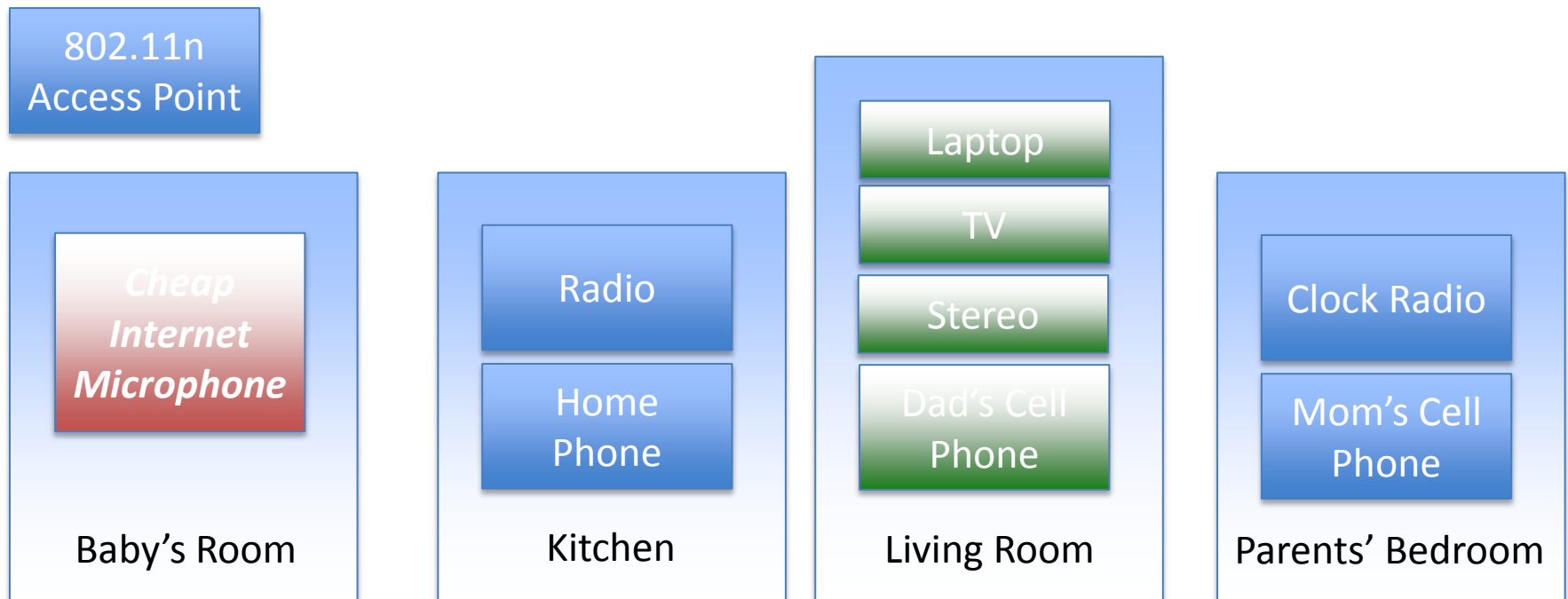
Display := TV, Laptop;

All Actuators:= Speaker, Display;

Microphone := Cheap Internet Microphone, Laptop;

Microphone(~baby) → isLoud → Speaker(~Dad | ~Mom);

Microphone(~baby) → isSilent → Alarm("Baby stopped breathing") → AllActuators(~Anyone);



A MacGyver Home Security System

// Anyone, Speaker, Display, AllActuators defined elsewhere

Motion := Motion Detector, Dad's Cell Phone;

Camera := Video Camera, Laptop;

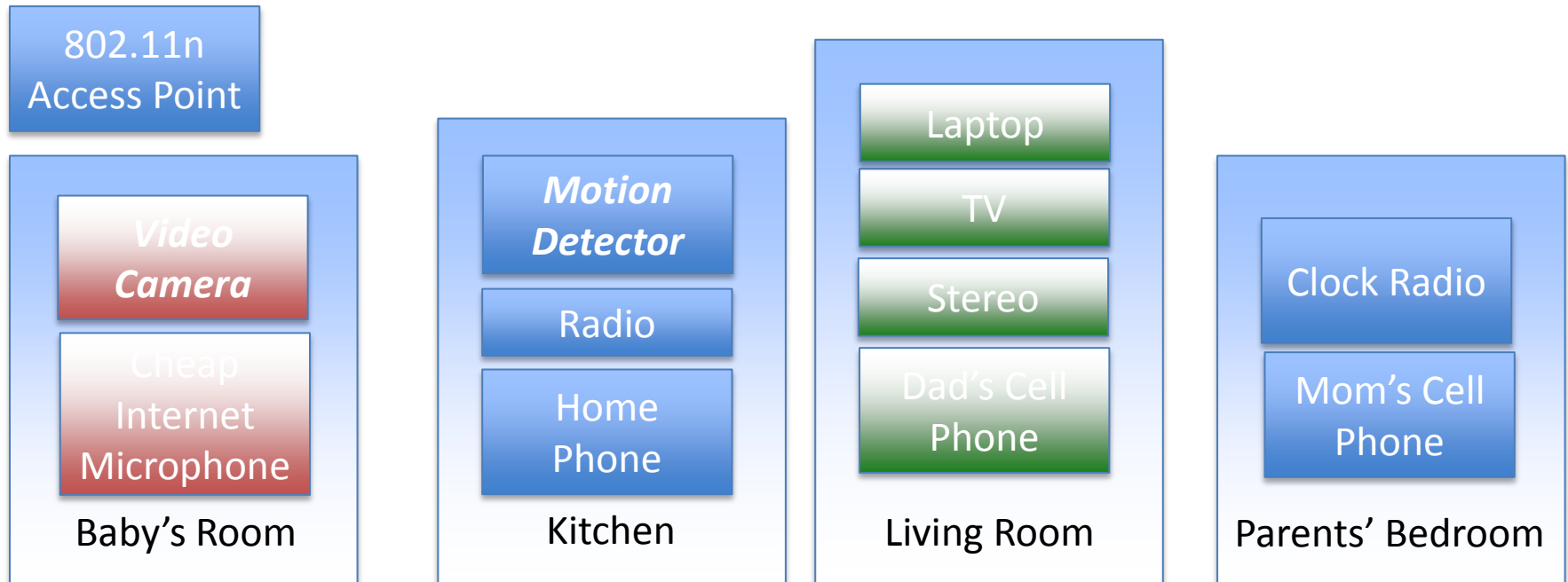
Microphone := Cheap Internet Microphone, Laptop;

FreakOut := Alarm(INTRUDER) → AllActuators();

Microphone(!Anyone) → **isCreeping** → Speaker(~Dad|~Mom) → FreakOut;

Camera → **PersonDetector(!Anyone)** → FreakOut;

Motion(!Anyone) → **PersonDetector(!Anyone)** → FreakOut;



Other apps

- Did I take my medicine?
- What does cooking chicken soup cost me?
- Home theater with mood lighting
- Automatic home movie capture
- Etc. etc.

What we need

- Context
- Libraries
- Distributed systems stuff
 - Resource assessment and service models
 - Configurator (placement & optimization)
 - Scheduling, replication, leader election
- Universal agreement on interfaces
- GUIs
- Networks that work

There are an iTunes store full of apps to build. Two metrics to help prioritize...

What people do

Activity	Hours
Sleeping	8.6
Working	3.73
Watching TV	2.77
Eating and drinking	1.11
Purchasing goods and services	.77
Socializing and communicating	.71
Grooming	.67
Housework	.58
Caring for household members	.53
Food prep and cleanup	.52
Educational activities	.47
Organizational, religious, civic activities	.33
Sports, exercise, recreation	0.33
Telephone, mail, email	0.21

How people die

Table 1.1. Unintentional Home Injury Deaths. Average Annual Number, Percentage and Rate (per 100,000 persons), All Causes, U.S., 1992-1999.

Cause of Death	Number	Percentage	Rate
Fall	5,961	33.0	2.25
Poisoning	4,833	26.8	1.83
Fire/Burn	3,402	18.8	1.29
Choking/Suffocation	1,092	6.1	0.41
Drowning/Submersion	823	4.6	0.31
Firearm	590	3.3	0.22
Natural/Environmental	427	2.4	0.16
Struck By/Against	285	1.6	0.11
Miscellaneous	230	1.3	0.09
Unspecified	215	1.2	0.08
Machinery	127	0.7	0.05
Cut/Pierce	60	0.3	0.02
Overexertion	3	<0.1	<0.01
Motor Vehicle	0	0.0	0.00
Pedal Cyclist, Other	0	0.0	0.00
Pedestrian, Other	0	0.0	0.00
Transport, Other	0	0.0	0.00
TOTAL	18,048	100.0	6.83

Data Source: National Vital Statistics System, 1992-1999.