

Human-Network Interaction: Building Bridges Between HCI and Networking Research

W. Keith Edwards
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[Parks Assoc. 2006]

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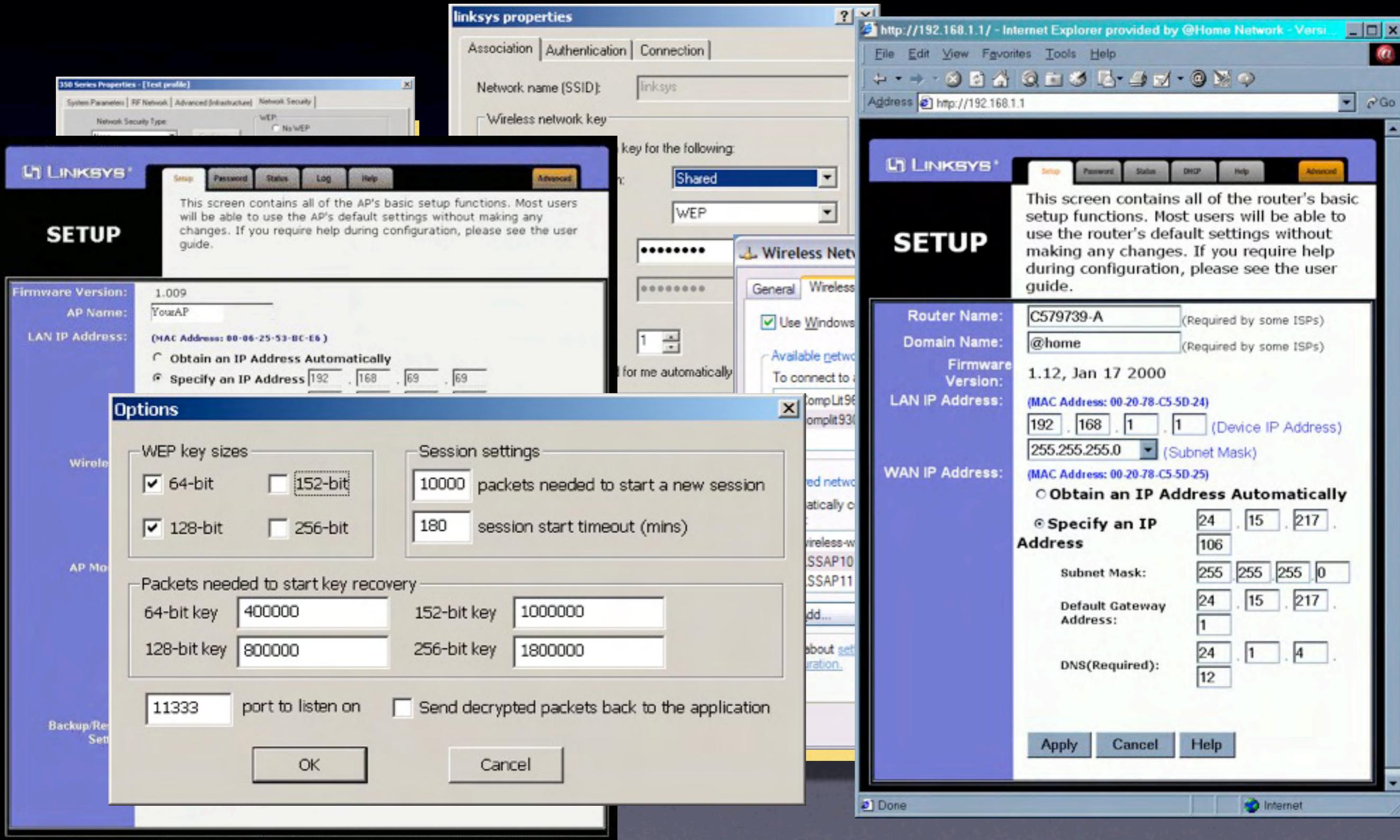
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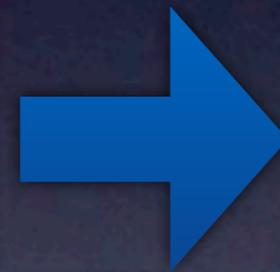
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A few motivating facts...



The Internet has Come Home



Talk Overview



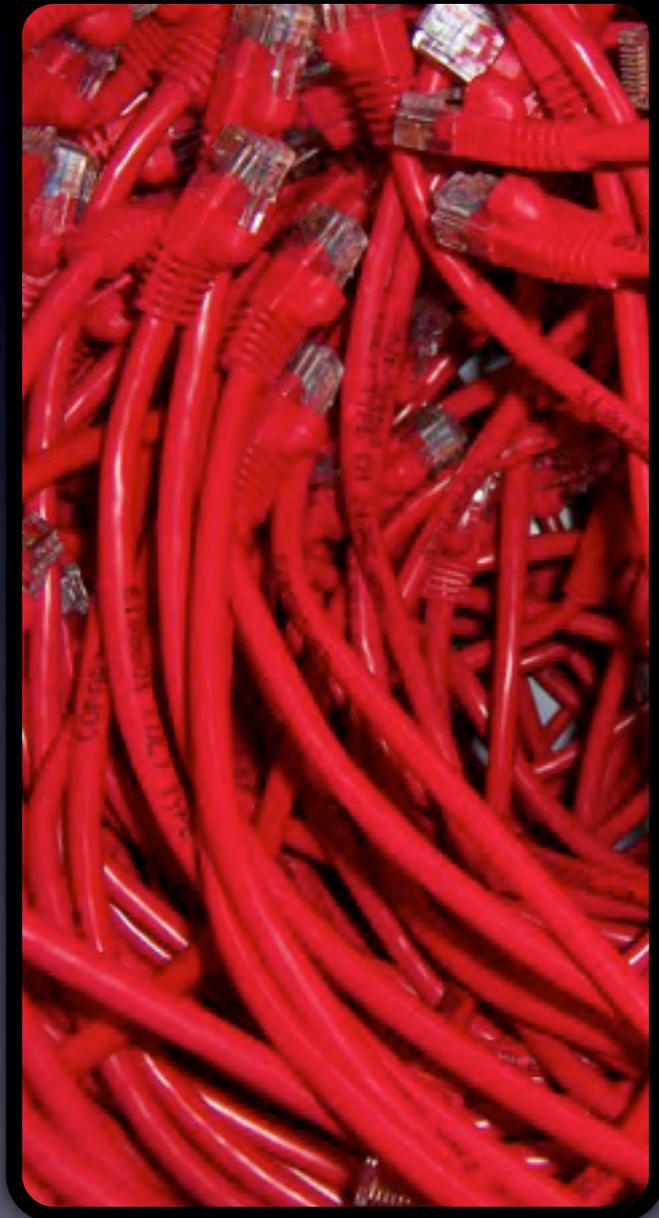
Networking



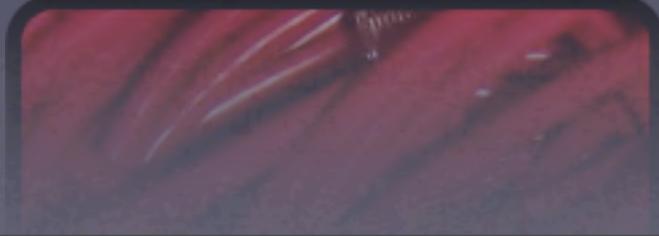
People



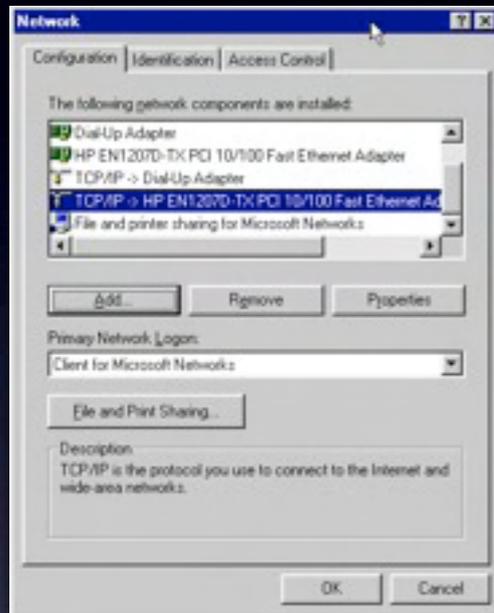
The Gap



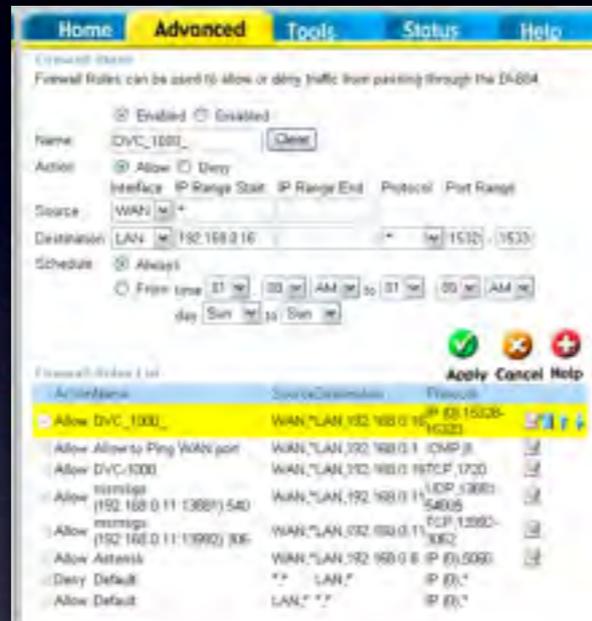
The Network



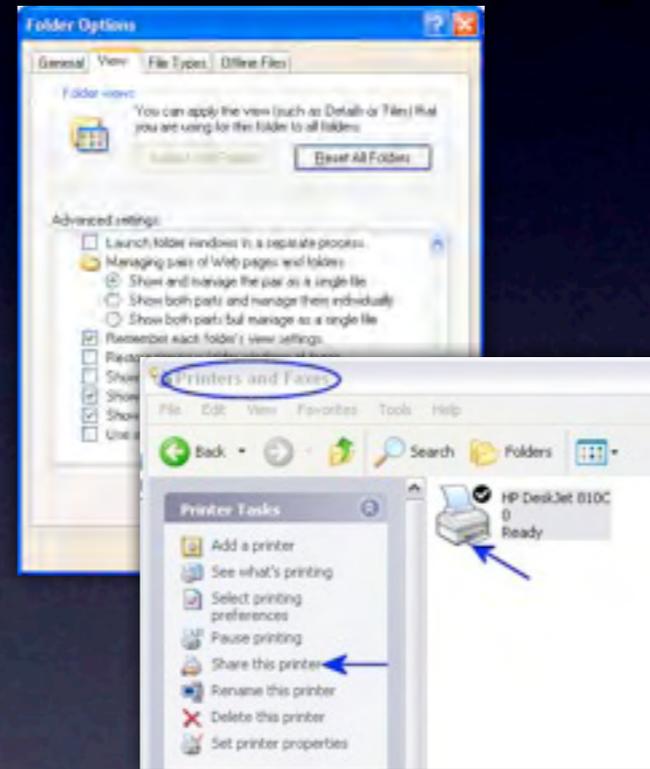
The Necessity of Configuration



Host



Network

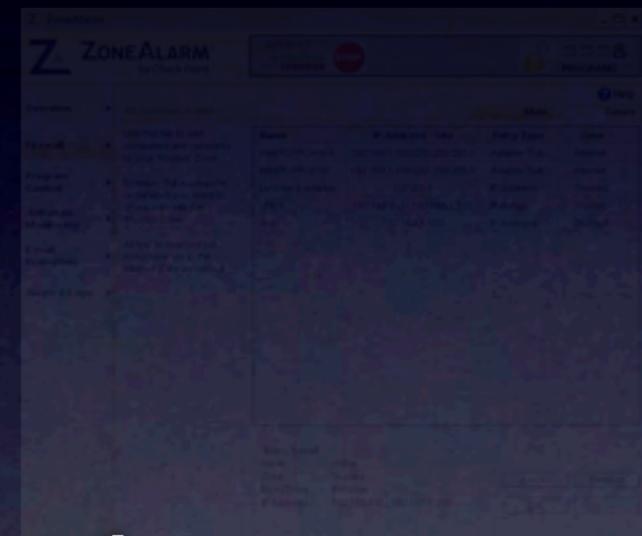
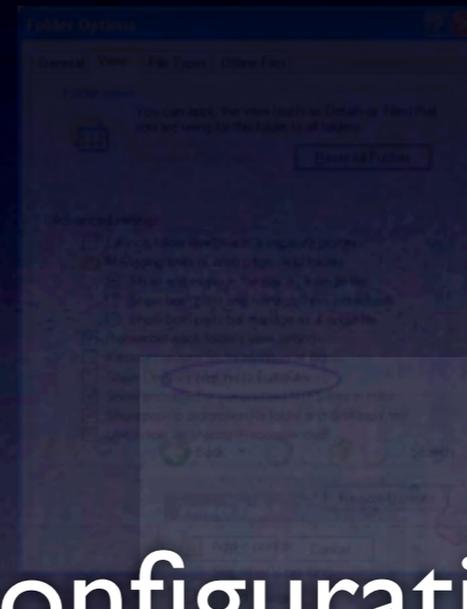
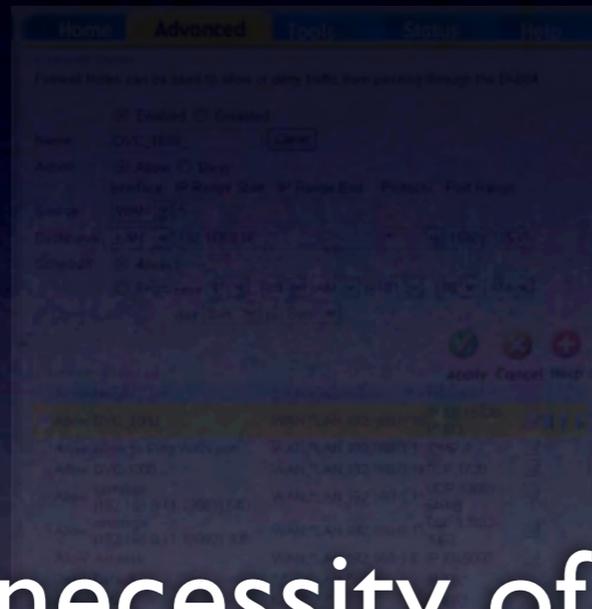
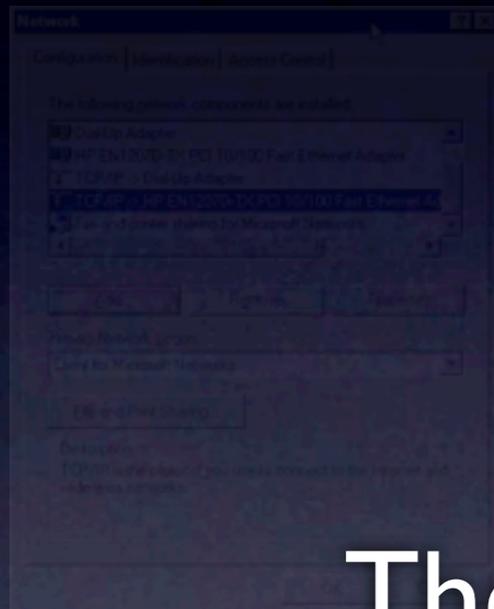


Application



Security

The Necessity of Configuration



The necessity of configuration leads to the potential for *misconfiguration*

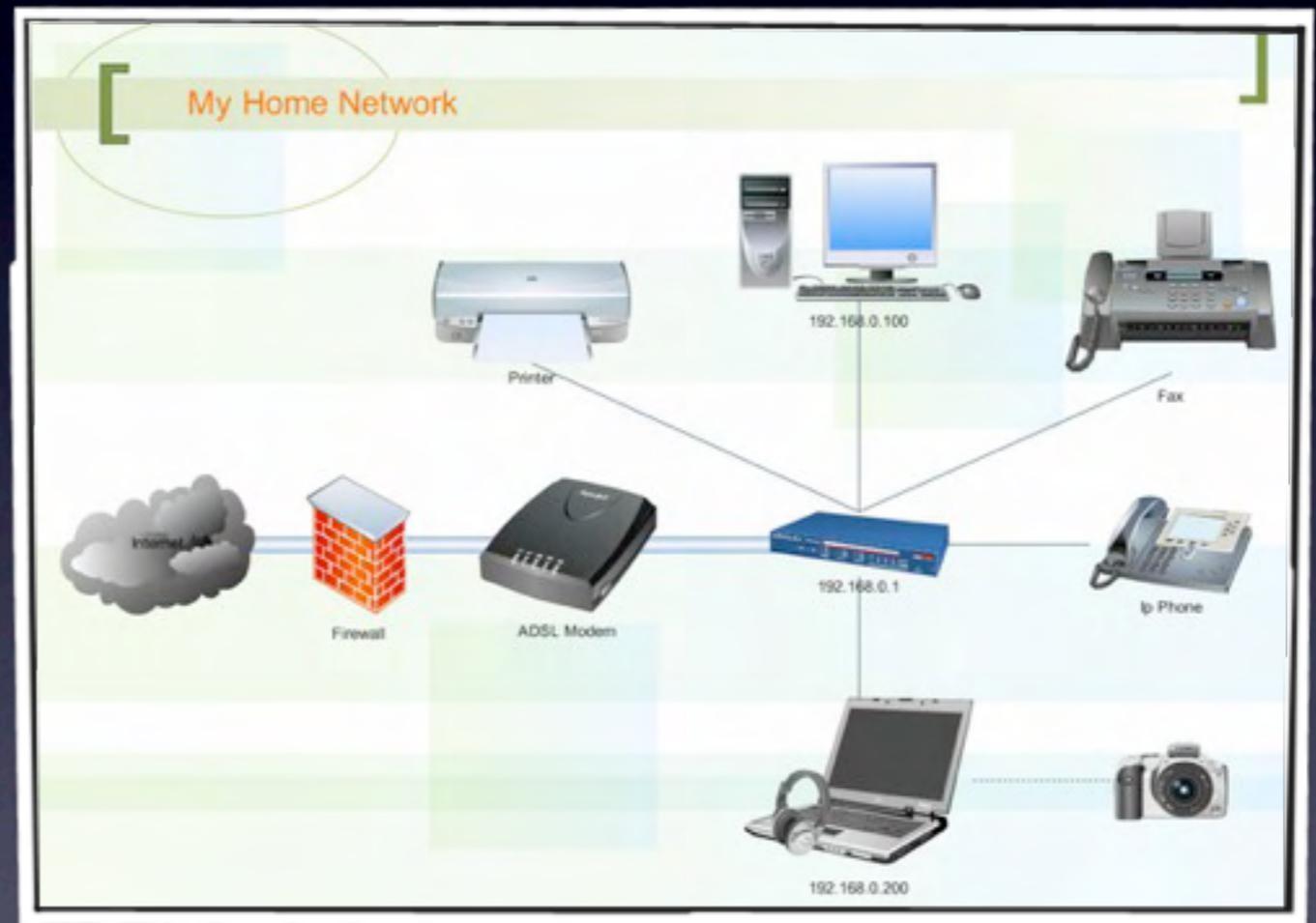
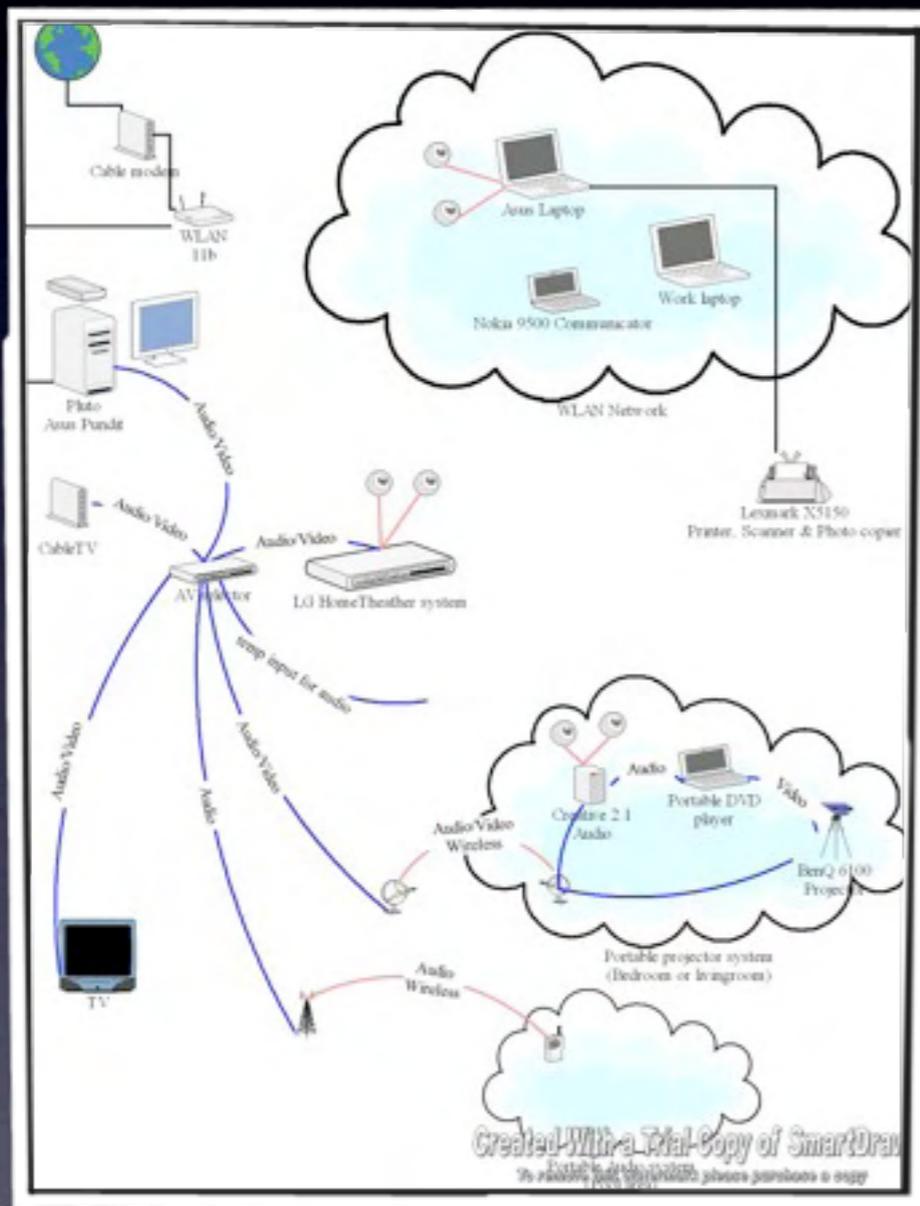
Host

Network

Application

Security

Topology



Topology

Topology shouldn't matter, but it does

- “Inside” versus “outside”
- Multiple DHCP servers
- Multiple subnets (breaks multicast discovery)

It's not just the end-user devices, but network core devices that users must manage

Security

“If you want security, you must be prepared for inconvenience.”

*General B.W. Chidlaw
12 December 1954*

- Conflated with topology
- Spread over multiple sites of activity (antivirus, host firewall, router firewall, ISPs)
- Default for most: NAT

This has let us get sloppy.



HACKERS CAN TURN YOUR HOME COMPUTER INTO A BOMB

... & blow your family to smithereens!

KABOOM! It might not look like it, but an innocent home computer like this one can be turned into a deadly weapon.

By RANDY JEFFRIES / Weekly World News

WASHINGTON — Right now, computer hackers have the ability to turn your home computer into a bomb and blow you to Kingdom Come — and they can do it anonymously from thousands of miles away!

Experts say the recent “break-ins” that paralyzed the Amazon.com, Buy.com and eBAY websites are tame compared to what will happen in the near future.

Computer expert Arnold Yabessou, president of the Washington-based consumer group National CyberCrime Prevention Foundation (NCCPF), says that as far as computer crime is concerned, we’ve only seen the tip of the iceberg.

“The criminals who knocked out those three major online businesses are the least of our worries,” Yabessou told Weekly World News.

“There are brilliant but irresponsible hackers out there who have developed technologies that the average person can’t even dream of. Even people who are familiar with how computers work have trouble getting their minds around the terrible things that can be done.

“It is already possible for an attacker to send someone an e-mail with an innocent-looking attachment connected to it. When the receiver downloads the attachment, the electrical current and molecular structure of the central processing unit is altered, causing it to blast apart like a large hand grenade.

“As shocking as this is, it shouldn’t surprise anyone. It’s just the next step in an ever-escalating progression of horrors conceived and instigated by hackers.”

Yabessou points out that these dangerous technologies have already:

- Vandalized FBI and U. S. Army websites.
- Broken into Chinese military networks.
- Come within two digits of cracking an 17-digit Russian security code that would have sent deadly missiles hurtling toward five of America’s major cities.

“As dangerous as this technology is right now, it’s going to get much scarier,” Yabessou said.

“Soon it will be sold to terrorists cults and fanatical religious fringe groups.

“Instead of blowing up a single plane, these groups will be able to patch into the central computer of a large airline and blow up hundreds of planes at once.

“And worse, this e-mail bomb program will eventually find its way into the hands of anyone who wants it.

“That means anyone who has a quarrel with you, holds a grudge against you or just plain doesn’t like your looks, can kill you and never be found out.”

Sickos can wreak death and destruction from thousands of miles away!

Arnold Yabessou.

Interactions Between Applications and the Network

- Does the network really stop at the “application layer”?
- Infrastructure doesn't provide good abstractions for some functionality
 - Multiuser game?
 - Household visitor?
 - Share a directory of photos?

End Result?



- High pain barrier: even “simple” things are hard; hard things are nearly impossible
- High barriers, low ceilings
- Implications for future applications inhibited because of fundamental issues with the network:
 - Health
 - Entertainment
 - Ubicomp
 - Smart home
 - Smart grid
 - ...



People



Menu

Dashboard

[Add Gadget](#) [Add Tab](#) [Restore Default](#)

Overview | Top Ten | Perspective Status | **Network Traffic** | Wireless Network | Syslog Event Logs | Demo | London Office

Top 10 - Network Traffic: Endpoints edit close

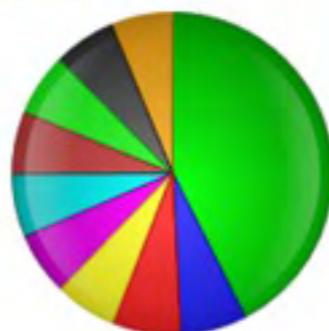
cisco2801.jetstreamnetworks.local



IP Address	Hostname	Pkts	KB	Pct
192.168.1.6	cisco2801	7298	2,271.88	99.95 %
192.168.1.139	vista-business	2845	684.36	30.11 %
192.168.1.133	sweety	369	116.72	5.14 %
192.168.1.123	perspective6	355	115.49	5.08 %
192.168.1.195	qa-xp-4	306	107.76	4.74 %
192.168.1.177	pt-soak-4	304	107.71	4.74 %
192.168.1.214	perspective2	293	107.10	4.71 %
192.168.1.91	mbazan-dt	285	106.96	4.71 %
192.168.1.154	float-dt	285	106.93	4.70 %
192.168.1.169	xp-pro-base	283	106.81	4.70 %

Top 10 - Network Traffic: Conversations edit close

cisco2801.jetstreamnetworks.local



Source	Destination	Port	Applk
192.168.1.139	vista-business	192.168.1.6	cisco2801 161 SNMP
192.168.1.133	sweety	192.168.1.6	cisco2801 161 SNMP
192.168.1.123	perspective6	192.168.1.6	cisco2801 161 SNMP
192.168.1.91	mbazan-dt	192.168.1.6	cisco2801 161 SNMP
192.168.1.148	perspective1	192.168.1.6	cisco2801 161 SNMP
192.168.1.154	float-dt	192.168.1.6	cisco2801 161 SNMP
192.168.1.169	xp-pro-base	192.168.1.6	cisco2801 161 SNMP
192.168.1.122	perspective4	192.168.1.6	cisco2801 161 SNMP
192.168.1.140	andromeda	192.168.1.6	cisco2801 161 SNMP
192.168.1.143	2003-r2-ent-cl1	192.168.1.6	cisco2801 161 SNMP

Network Interface List edit close

cisco2801.jetstreamnetworks.local

Interface	Transmit	Receive
FastEthernet0/0	5.53 Kbps	983.00 bps
Voice Encapsulation (POTS) Peer: 20004	0.00 bps	0.00 bps
Voice Encapsulation (POTS) Peer: 20005	0.00 bps	0.00 bps
Voice Encapsulation (POTS) Peer: 20006	0.00 bps	0.00 bps
Voice Encapsulation (POTS) Peer: 20003	0.00 bps	0.00 bps

Alerts In Process edit close

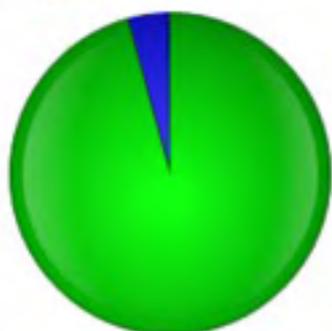
Multiple Targets

[Reset](#) [Reset All](#)

Date	Alert	Policy	Device	Action
9/4/2008 9:49:43 AM	CPU High	Desktop Po...	192.168.1.154	No
9/4/2008 9:48:37 AM	CPU High	Desktop Po...	192.168.1.138	No
9/4/2008 11:00:05 AM	Desktop Po...	Desktop Po...	192.168.1.93	n/a
9/4/2008 10:59:59 AM	Desktop Po...	Desktop Po...	192.168.1.91	n/a
9/4/2008 10:58:59 AM	Server Poli...	Server Poli...	192.168.1.178	n/a
9/4/2008 10:58:34 AM	Server Poli...	Server Poli...	192.168.1.160	n/a
9/4/2008 10:57:17 AM	CPU runnin...	Server Poli...	192.168.1.122	n/a
9/4/2008 10:57:07 AM	Server Poli...	Server Poli...	192.168.1.122	n/a
9/4/2008 10:52:54 AM	Server Poli...	Server Poli...	192.168.1.27	n/a
9/4/2008 10:51:08 AM	Server Poli...	Server Poli...	192.168.1.3	n/a
9/4/2008 10:50:42 AM	Server Poli...	Server Poli...	192.168.1.2	n/a
9/4/2008 10:50:37 AM	Networkin...	Networkin...	192.168.1.163	n/a
9/4/2008 10:50:22 AM	Networkin...	Networkin...	192.168.1.254	n/a
9/4/2008 10:49:21 AM	Network A...	Networkin...	192.168.1.14	n/a
9/4/2008 10:45:21 AM	Desktop Po...	Desktop Po...	192.168.1.252	n/a
9/4/2008 10:45:05 AM	Desktop Po...	Desktop Po...	192.168.1.118	n/a
9/4/2008 10:43:48 AM	Desktop Po...	Desktop Po...	192.168.1.154	n/a
9/4/2008 10:43:28 AM	Desktop Po...	Desktop Po...	192.168.1.150	n/a
9/4/2008 10:43:08 AM	Desktop Po...	Desktop Po...	192.168.1.141	n/a
9/4/2008 10:42:42 AM	Desktop Po...	Desktop Po...	192.168.1.138	n/a
9/4/2008 10:42:32 AM	Desktop Po...	Desktop Po...	192.168.1.125	n/a
9/4/2008 10:42:22 AM	Desktop Po...	Desktop Po...	192.168.1.114	n/a
9/4/2008 10:09:43 AM	CPU High	Desktop Po...	192.168.1.116	No
9/4/2008 10:06:10 AM	CPU High	Desktop Po...	192.168.1.107	No

Top 10 - Network Traffic: Applications edit close

cisco2801.jetstreamnetworks.local



Application Name	Port	Prot	Pkts	KB
SNMP - Simple Network Management Protocol	161	UDP	5505	2,165
ICMP FCHO	2048	ICMP	1567	91

Top 10 - Network Traffic: Domains edit close

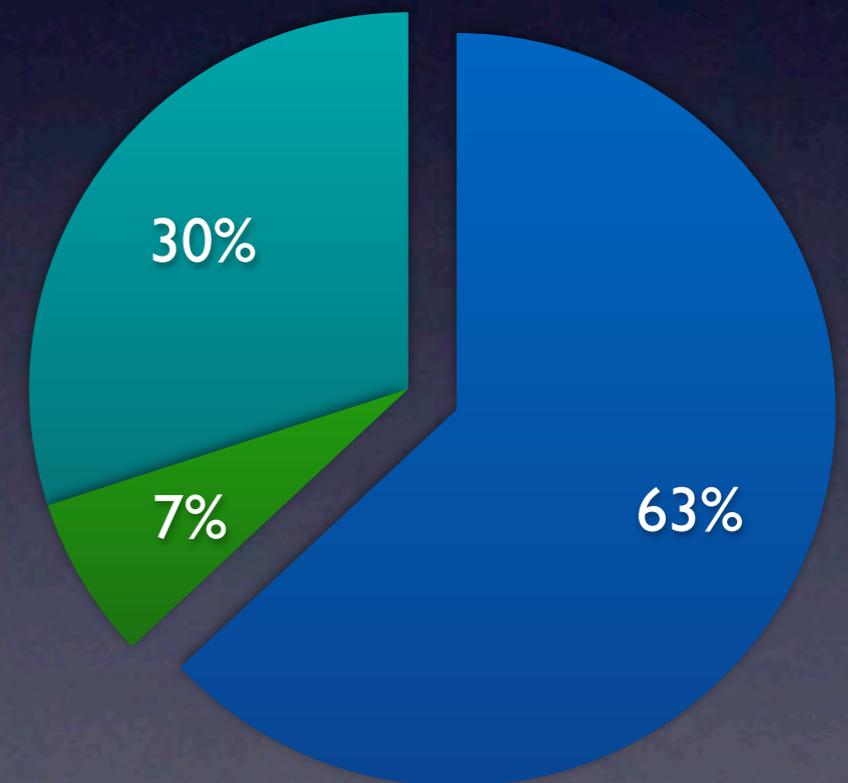
cisco2801.jetstreamnetworks.local



Domain	Pkts	KB	Pct
jetstreamnetworks.local	7319	2,272.96	100.00 %
unknown	13	0.61	0.03 %

Motivation

- **The network is a means to an end.**
- In other words:
 - People want what the Internet affords.
 - They just don't want the network.



“We want the Internet. Unless you have something better.”

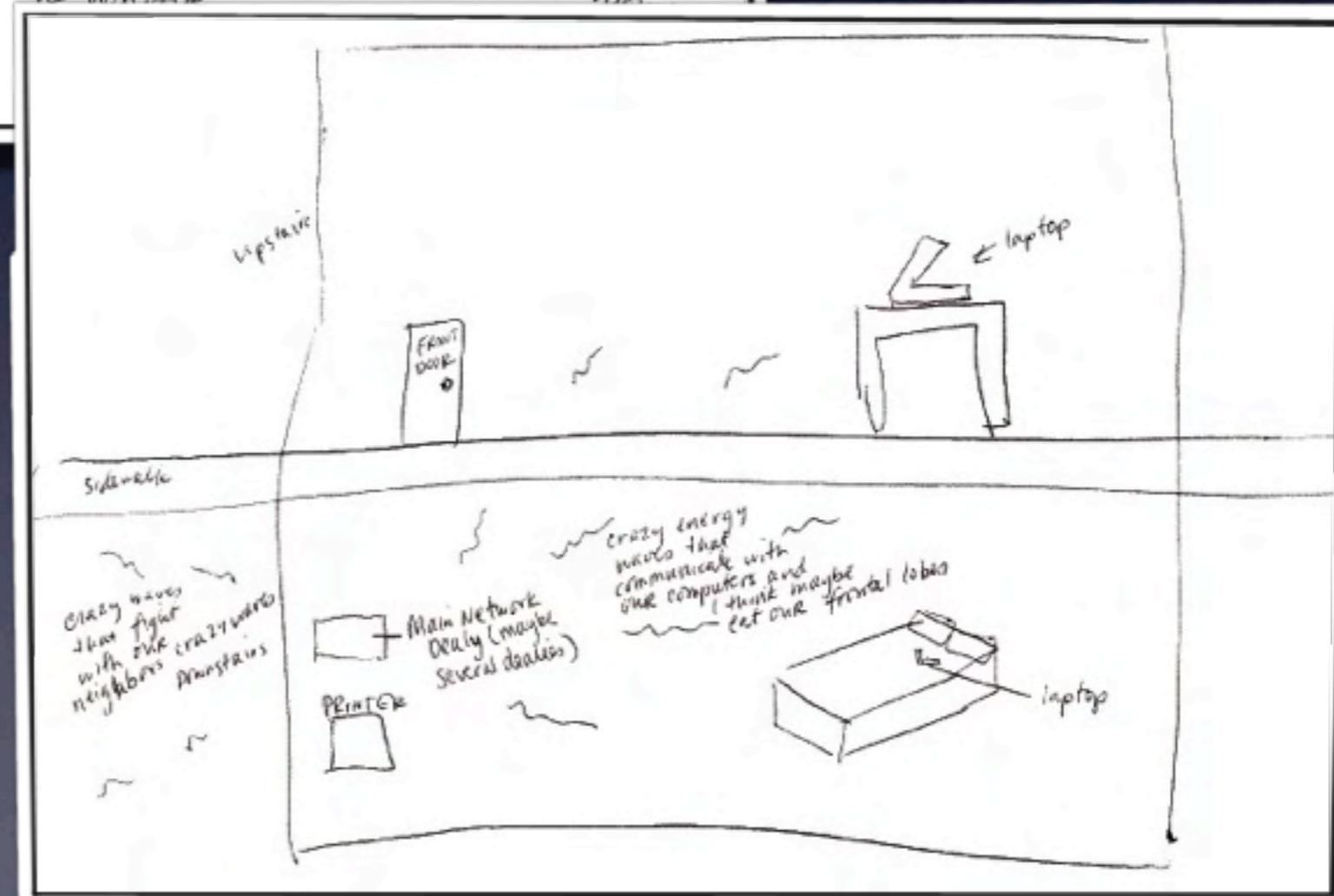
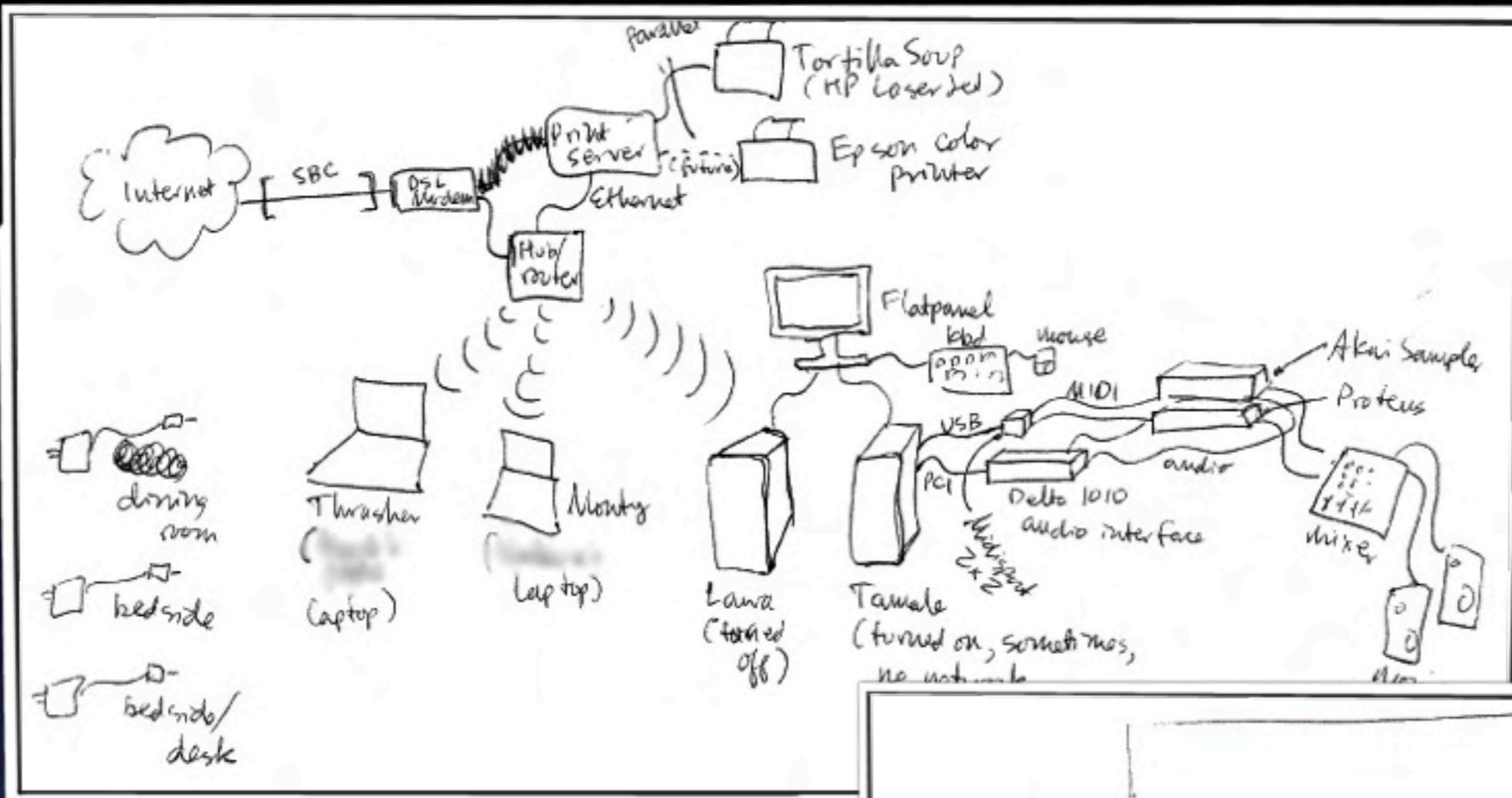
US Internet Adoption, April 2009
Source: Pew

Poor Conceptual Models



*“The Work to Make a Home
Network Work,”
ECSCW 2005*

*“Reflecting on the Invisible:
Understanding End-User Perceptions of
Ubiquitous Computing”
[Ubicomp 2008]*



“The Work to Make a Home Network Work,”
ECSCW 2005

“More than meets the eye: transforming the
user experience of home network management,”
DIS 2008

Deeply Personal, Deeply Personalized

- Is a one-size-fits-all network even possible?
- High variance may make automating some aspects difficult
- May argue against “outsourcing”

“Home Networking and HCI:What Hath God Wrought?”
[CHI 2007]

“How Smart Homes Learn:The Evolution of the Networked Home and Household”
[UbiComp 2007]

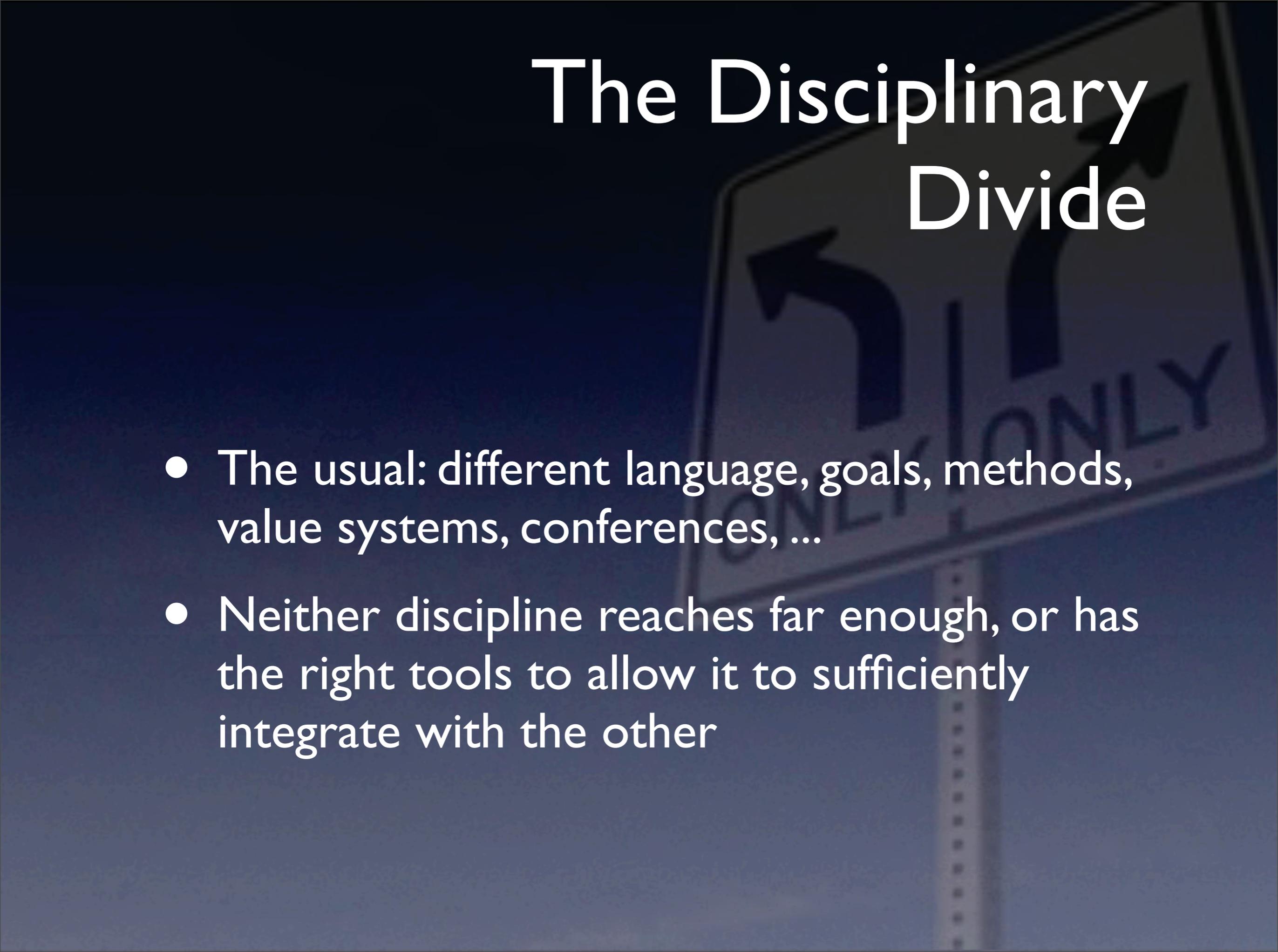
End Result?

- We've made networking a deeply confusing affair
 - “Scary” upgrades, reboot-and-pray troubleshooting, blinky light user interfaces
- One-size-fits-nobody
 - Neither sufficiently understanding nor addressing the routines in the household that impact the network

Some Reflections on the Gap



The Disciplinary Divide



- The usual: different language, goals, methods, value systems, conferences, ...
- Neither discipline reaches far enough, or has the right tools to allow it to sufficiently integrate with the other

Some Approaches for Research



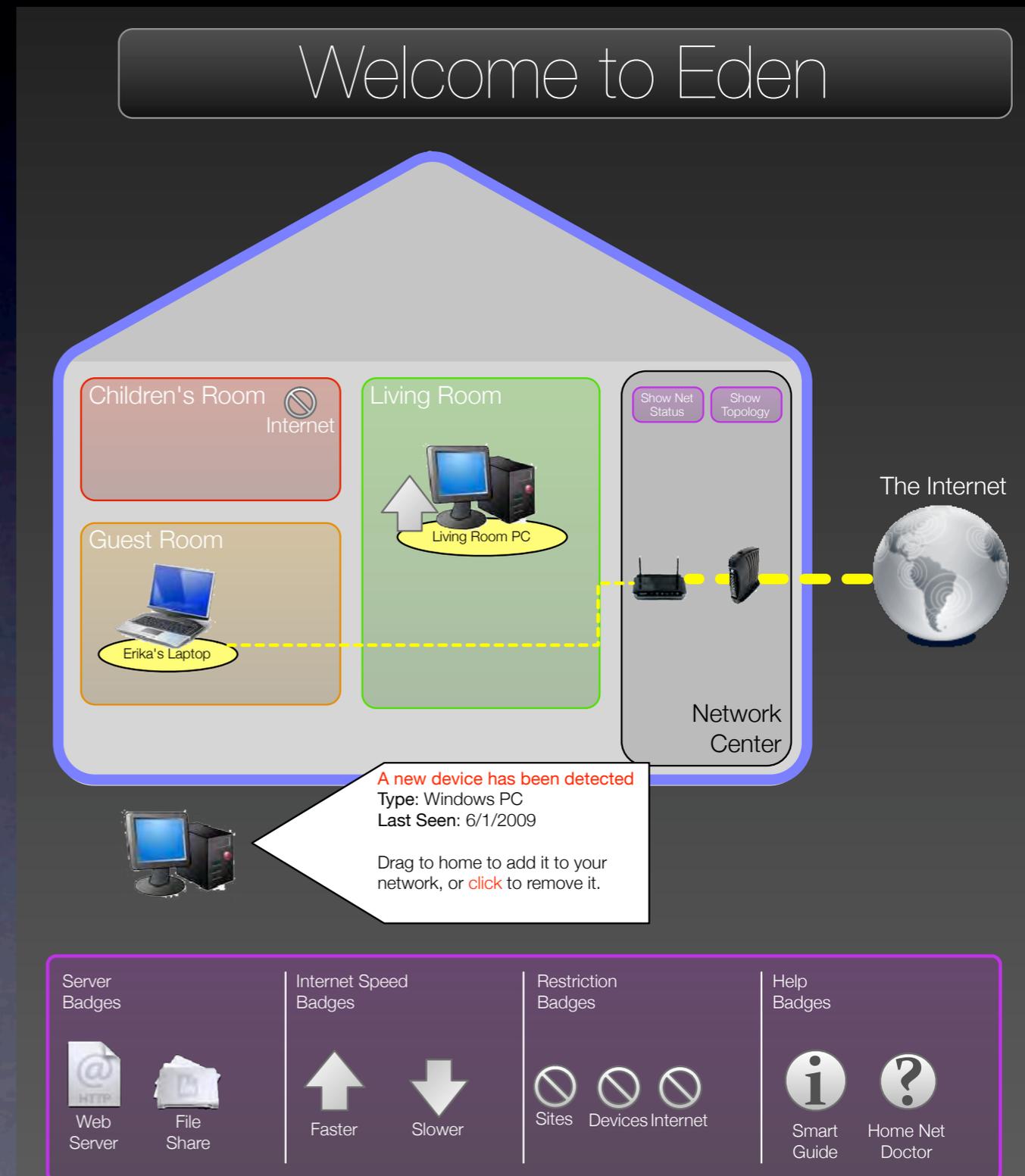
Helping the Network Help Itself

- There will always be some aspects of networking that require human agency or control
- But for everything else, *can we make it just work?*
- Key: knowing what's in which category

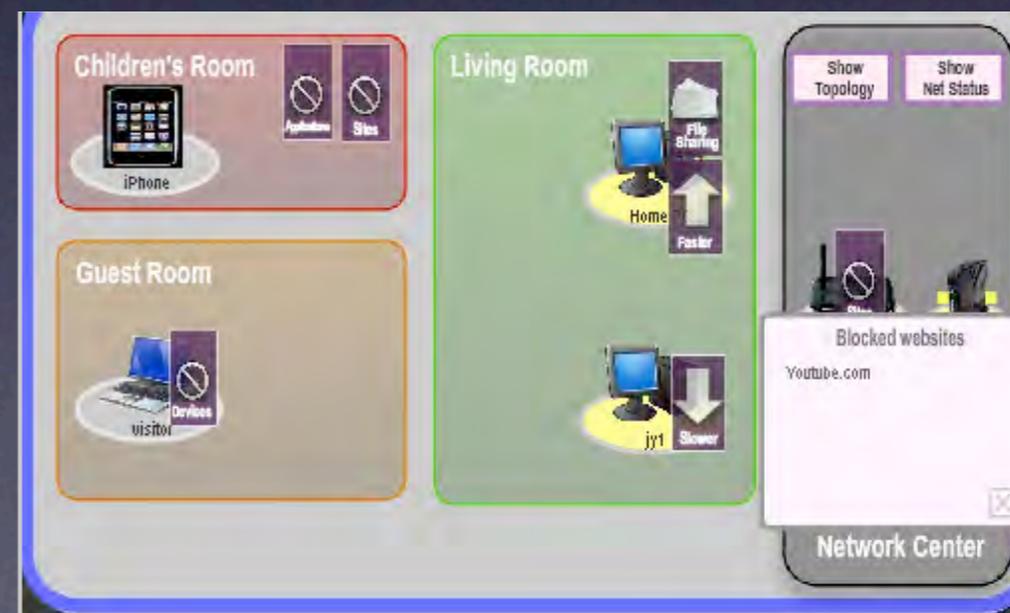
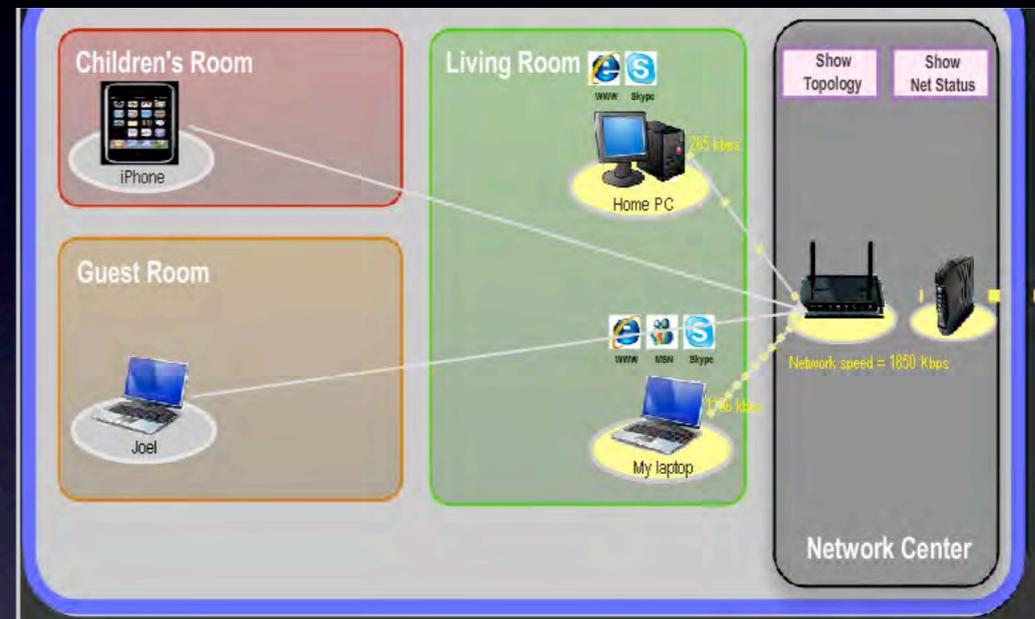
“Moving Toward the Middle: The Case Against the End-to-End Argument in Home Networking,”
[HotNets, 2007]

Helping People Help Themselves

- What's the equivalent of the desktop metaphor for networking?
- Not *just* a UI problem. Also may require support from the network in order to do it well.



Eden Home Network Management System



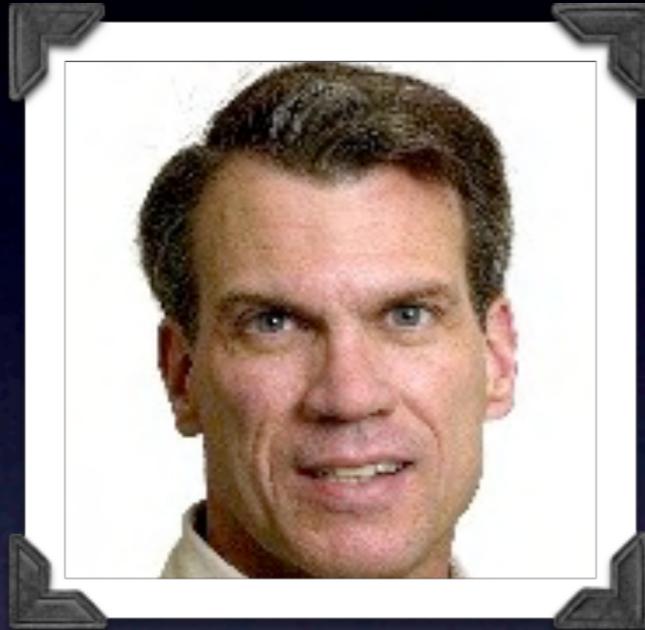
*“Eden: Supporting Home Network Management Through Interactive Visual Tools,”
UIST 2010*

Helping People Help Each Other

- Collaboration is key
- How do we support with tools?
- Deep questions around personalization and privacy
- Opportunities to leverage social networks to help with computer networks?

Acknowledgements

Ken Calvert



Beki Grinter



Nick Feamster



Erika Poole



Marshini Chetty



Jeonghwa Yang



Tony Tang

One Last Thing...

- Know of any good students interested in a postdoc working on home networking stuff at Georgia Tech?
- Knowledge of OpenFlow and network measurement, good Linux skills, and enthusiasm for working with HCI people a plus
- Send email to *keith@cc.gatech.edu*

Thank you!