

THE INTERNET AT 40: WHERE WE'VE BEEN; WHERE WE COULD GO

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Why I'm here

- I am addicted to Viennese pasties & chocolate
- I've always learned a lot when I've come to Austria
- I can't think of a better place than here to talk about the Internet Revolution

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My Background

- B.S., geology, Caltech
- Ph.D., geophysics, MIT
- 1988 -- Congressional Science Fellow
- 4 years as Senator Gore's science advisor
- 4 years as IT policy guru at White House
- 1998-1999 -- Technologist at FCC
- 9+ years as IBM's Director, Internet Tech.
- Teaching at Georgetown since January, 2008
- Part of Obama campaign's tech policy team

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1 neighborhood, 3 revolutions

- Erwin Schrodinger – physics
- Friedrich A. von Hayek – economics
- Sigmund Freud – psychology
- Not only is the Internet revolutionary technology. It's a disruptive technology that will enable many more revolutions!

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My Classes

- What's Shaping the Internet
- E-government 2.0
- Creating a Culture of Innovation
- How to Predict the Future(s)

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My last visit to Vienna

- February 2008
- The Next Generation Internet and the Future of the Domain Name System
- Bumper Stickers

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In Washington, Words Matter

- The right words can:
 - Define an issue
 - Kill a project
 - Stir emotions
 - Mobilize people
- Examples:
 - Obama: “Change”
 - Estate tax > “Death tax”
 - Strategic Defense Initiative > “Star Wars”



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My Goals Today

- To take a bit about where the Internet was when I first got involved with it in 1988
- Talk about why we've made so much progress
- Then talk about Internet 2020
- Talk about how to make sure we get there

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In Washington, Numbers Matter

It helps to have hundreds of pages of data

But to make a point, you need two good, memorable “factoids”

(preferably true)

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How I'll do that

- By sharing a few key words and concepts about the evolution of the Internet
- By sharing some useful numbers
- By telling a few stories

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In Washington, Stories Matter

- A personal anecdote is worth a dozen policy papers—especially if other people (and the media) start repeating it.

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Looking back to 1988

- First US Senate hearing on the Internet
- Senator Gore's High Performance Computing and Networking legislation
- People thought he was a flake (or worse)
- No one came to the hearing

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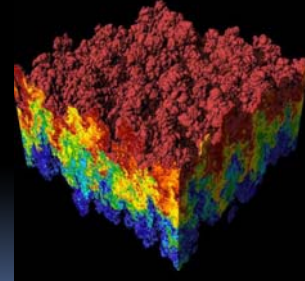
Looking back to 1988

The Internet was the NSFNET and regional academic network connected to it

A good connection: 1200 bits/second
Backbone of the NSFNET: 56,000 bits/second!

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A Demo for the Senators III



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A Demo for the Senators

```
>LOGIN  
>BOY, ISTHIS SLOW!
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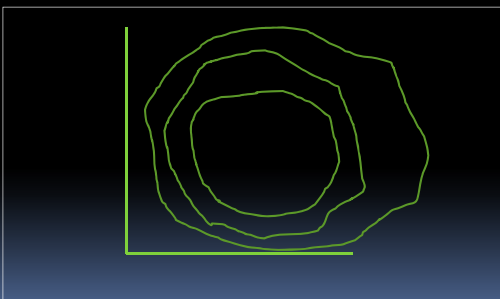
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Who Could have Imagined



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A Demo for the Senators II



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What Else We Didn't Imagine

- World Wide Web
- E-commerce
- User-generated content

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What We Did Imagine

- Researchers > Everyone
- Video entertainment
- Video-conferencing
- For more, see 2005 Pew Internet and American Life report, *Imagining the Internet*

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Common themes

- Government enabled, didn't dictate
- Maximize room for innovation
- Maximize competition and consumer choice
- Let technologies evolve (e.g. WiFi)

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What We Didn't Know

- Which standards would prevail
 - Although we suspect TCP/IP would win
- What to call it
 - Internet, "Information Superhighway," "Info Autobahn," "Information Infrastructure"
- Which medium would dominate
 - Telephone, DSL, fiber, cable TV, satellite, wireless

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So What's Next?

- We'll see at least as much change in the next ten years as we have seen in the last twenty
- PROVIDED we don't screw things up!!

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Seven Critical Decisions

- FCC Computer II and Computer III rulings in early 1980s
- US Defense Department decision to adopt TCP/IP for the .MIL unclassified networks
- Congress, first Bush Administration, and Clinton Administration favored opening up NSFNET (and let everyone connect!)
- FCC and ITU allocated frequencies for WiFi
- SSL widely deployed
- ICANN was made non-governmental and global
- 1996 Telecom Act protect ISPs from liability of Net abuse

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First Word

VISION

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Words from the Bible

"Where there is no vision, the people perish"
Proverbs 29:18

(Or at least you waste a lot of time and money.)

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Second Word

CLOUD

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VISION as Elevator Pitch

- We are entering the third phase of the Internet
 - As profound as the World Wide Web
 - The next 2-3 years will define the Next Generation Internet
- Standards and business practices are shaping the Net as much—or more—than law and regulation
- The Internet revolution is less than 15% complete
 - Number of users
 - Total bandwidth
 - Total amount of content
 - Number of devices
 - Number of applications

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Words that Didn't Work

- Application Service Provider
- Grid
- Distributed Computing
- Etc.

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Vision in a buzz phrase

"CHEAP REVOLUTION"

Coined by Rich Karlgaard, Forbes, April 2003

- Cheap, commodity hardware
 - Open source software (e.g. Linux)
 - Cloud computing
 - Do-it-yourself tech support
- COST SAVINGS OF 90 PERCENT**

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The screenshot shows a web browser window displaying an article from The Wall Street Journal. The article title is "The Internet Industry Is on a Cloud -- Whatever That May Mean" by Geoffrey A. Fowler and Ben Worthen. The text discusses the ambiguity of the term "cloud computing" and how various companies are using it to describe their services. It mentions that the term was first used by Google's Eric Schmidt in 2006. The article also includes a quote from Oracle's Larry Ellison and a small illustration of a cloud with a question mark inside it.

Examples of Cloud Computing

- Academic grids as a prototype of the cloud
- Amazon, Google, Microsoft building huge data centers and offering online apps
- Amazon's Elastic Compute Cloud
- Gmail – “the entry drug for cloud users”
- Flickr, YouTube
- Online back-up
- SalesForce.com
- Akamai delivers 15-20 percent of Internet traffic
- BOINC grids more powerful than supercomputers

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Third Word

GAME CHANGER

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Akamai - Visualizing the Internet

Active Streams: 328,788
 HTTP Hits per Second: 2,783,746
 Visitors per Minute: 34,486,397

http://www.akamai.com/html/technology/visualizing_akamai.html

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Cloud Computing

Why it matters:
 This is the 3rd phase of the Internet
 This is the 3rd phase of COMPUTING

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Let it rise
 Information technology is turning into a global “cloud” accessible from anywhere, says Ludwig Siegle (interviewed here). What does that mean for the way people conduct business?

The Third Phase of the Internet

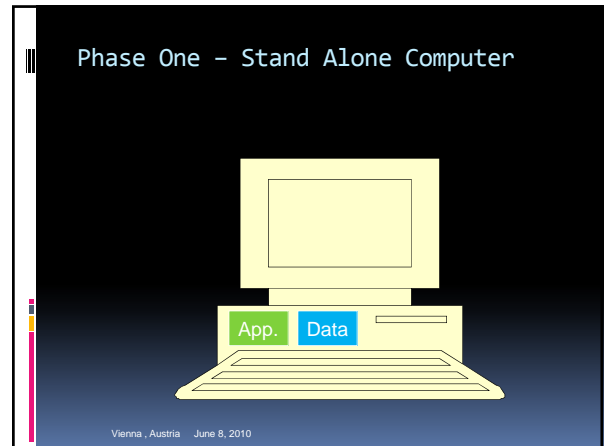
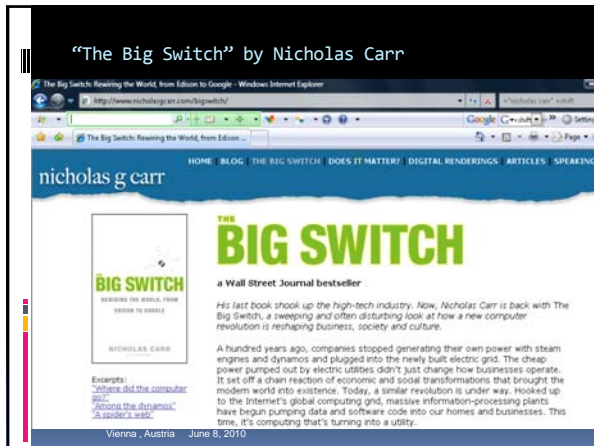
Phase 3
Collaboration

Phase 2 - Content

Phase 1 - Communicating

1969 1980 1990 2000 2010

Capability

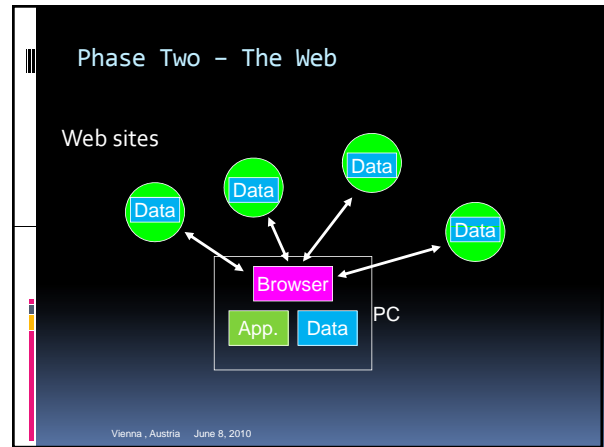


This is a VERY big deal

Gartner Says Cloud Computing Will Be As Influential As E-business

Special Report Examines the Realities and Risks of Cloud Computing (June 26, 2008)

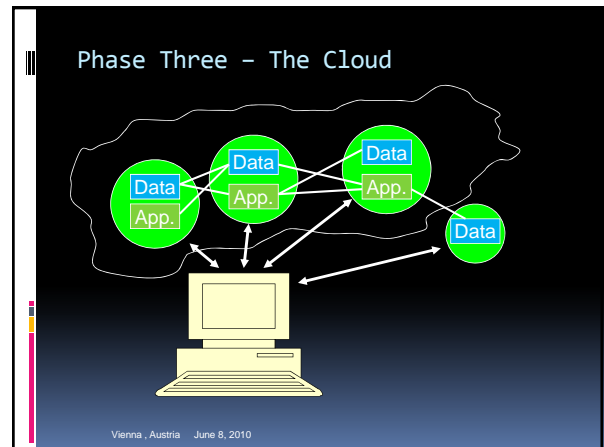
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Fourth Word

MANY-TO-MANY

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Fifth Word

THINGS

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Sixth word

EXAFLOOD

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The Internet of Things

Why it matters:
100 billion devices, not just 1.4 billion PCs

Impacts?
Increased need for ubiquitous wireless
A flood of new data from sensors, etc.
New uses for the Cloud

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Estimating the Exaflood
(Swanson and Gilder, 2008)

U.S. IP Traffic Projection
(log scale; adjusted Cisco estimate through 2011;
Swanson estimate for 2015)

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The Cloud + The Internet of Things

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What's in the Exaflood?

Rough estimate of annual U.S. IP traffic, by application, circa 2015

Movie downloads and P2P	100 exabytes
Video calling and virtual windows	400 exabytes
"Cloud" computing / remote backup	50 exabytes
Internet video, gaming, virtual worlds	200 exabytes
Non-Internet "IPTV"	100 exabytes, or more
Business IP traffic	100 exabytes
Other (phone, Web, e-mail, photos, music)	50 exabytes
total	1,000 exabytes = 1 zettabyte

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Seventh Word

COLLABORATION

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The Crowd and the Cloud

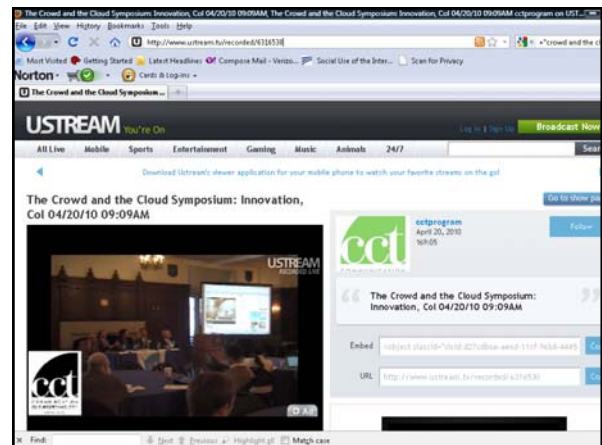
- April 20, 2010 Symposium at Georgetown
- Examined how Cloud computing enables:
 - Crowdsourcing
 - Collaborative Bibliographies
 - Rapid response (DARPA's Red Balloon experiment)
- Webcast available
 - Don't miss talk by Jeannette Wing, NSF and CMU

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Example: Social Media

Facebook, Twitter becoming platforms for communication and collaboration replacing e-mail spurring innovation crowdsourcing sorting the Exaflood

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Social Media Matters

It got Obama elected!!
Our first Internet President
"How Obama REALLY did it," Sept.-Oct. 2008 issue of MIT's Technology Review

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Eighth Word

CONSUMERIZATION

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Consumerization of the Workplace

Doug Neal, CSC Leading Edge Forum:
From Consumerization to the Cloud – the
accelerating rate of IT change
30 November 2009

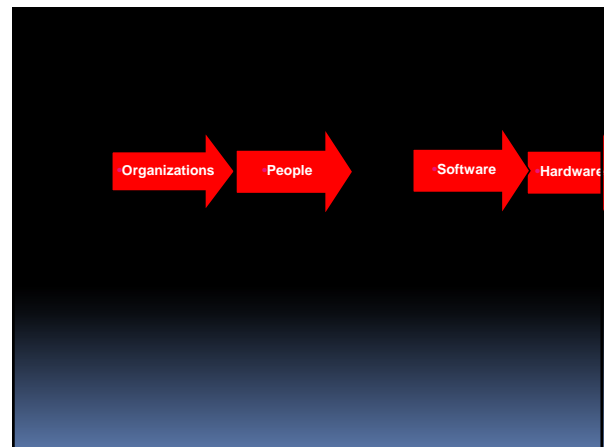
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Consumerization of the Workplace

- Your employees want to use the best tools
 - Facebook
 - LinkedIn
 - Google apps
- They're work life and family life are merging
 - Calendars
 - Instant messaging
 - Video, Skype
- They want reliability, portability, the Cloud

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Ninth Word

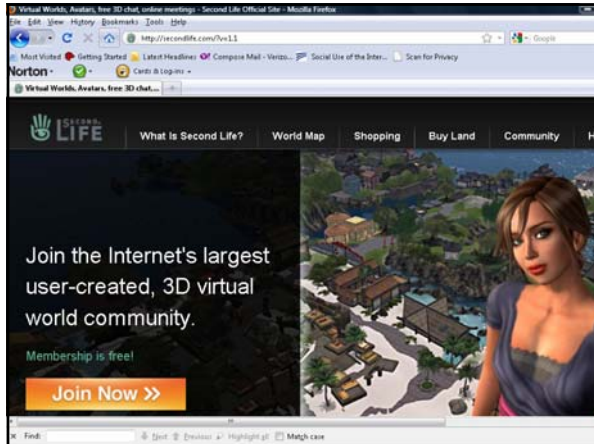
PEOPLE

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Tenth Word

EMOTION

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Eleventh Word

PREDICTIONS

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Emotions online

- Love (or Lust)
- Fear
- Envy
- Distraction
- Anxiety

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BIG, Hairy Audacious Prediction #1

Within 5 years, 80% of all computing and storage done worldwide could happen "in the cloud"

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Killer Apps of the Net

- Communication
- Content
- Collaboration
- Community > Commitment

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BIG, Hairy Audacious Prediction #1

Within 5 years, 80% of all computing and storage done worldwide could happen "in the cloud"

(But it might take 10 years)

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BIG, Hairy Audacious Prediction #2

Within 5 years, 100 BILLION devices and sensors could be connected to the Net

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The Last Word

POLICY

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Not-quite-so-audacious Prediction #2

Within 10 years, 100 BILLION devices and sensors will be connected to the Net

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Why Not?

- Technical
 - Agreement and adoption of key standards
 - IPv6, DNSsec, IPsec, Grid standards
- Business practices
 - Cooperation around open standards vs. proprietary lock-in; open source software
- Culture
 - Users have to learn to “trust the cloud”
 - CIOs and their teams have to adapt to new roles
- Policy

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GOVERNMENTS’ FIRST CHALLENGE

- How to be an early adopter of new technologies? (such as Cloud computing, social media, sensors)
- To do list:
 - Fix procurement
 - Move to open standards, Avoid lock-in
 - Explore open source software
 - Address security
 - Change culture and reorganize

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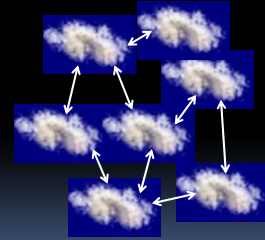
Updating policies for the Cloud

- Privacy
 - Search warrants, wiretapping in the Cloud?
- Transparency
- Online copyright
- Liability for cloud service providers
 - Who's responsible for illegal activities?
- International data flows
- Competition policy

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The Cloudy Skies Scenario

- Distinct clouds
- Interconnected
- Cloud applications aren't interoperable
- Little common middleware (e.g. no single sign-on)
- Lots of missed opportunities



Three Possible Futures

1. The Clouds Scenario
2. The Cloudy Skies Scenario
3. The Blue Skies Scenario

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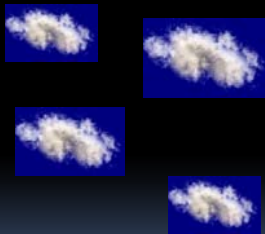
Blue Skies Scenario

- A "cloud of clouds" like the network of networks
- Truly interoperable clouds services
- "Mix and match"
- Common middleware
- Seamless
- Almost infinite opportunities

Sky's the Limit!!

The Clouds Scenario

- Different, distinct, proprietary clouds
- Non-interoperable standards
- The cable television network business model; bottlenecks and monopolies



10 Ps of Cyberpolicy

- Privacy
- Piracy
- Pornography
- Protection
- Pricing
- Policing
- Psychology
- Procurement
- Payments
- Protectionism

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7 critical decisions

- What Cloud services will big customers (esp. governments) buy?
- Will right Cloud standards we developed and adopted—at the right time?
- Will there be one Internet of Things (or many)?

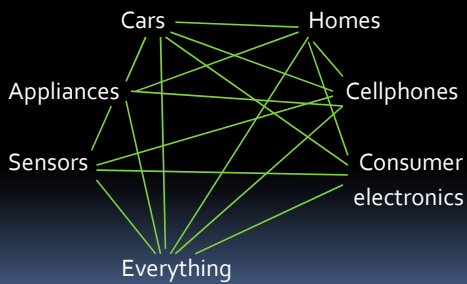
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Even Worse

	Cars	Homes
	BMW's Fords GMs	
Appliances		Cellphones
Sensors		Consumer electronics
Brands 1, 2, 3, ...		Apple SONY

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One Internet of Things



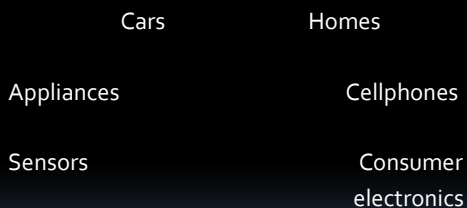
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7 critical decisions

- What Cloud services will big customers (esp. governments) buy?
- Will right Cloud standards we developed and adopted—at the right time?
- Will there be one Internet of Things (or many)?
- Will iPhone apps, closed systems, and "walled gardens" shut down innovation online?
- Will Cloud service providers we held liable for piracy, fraud, cybercrime?
- Will privacy laws limit movement of data in the Cloud?
- Will security requirements lock down the Net & the Cloud?

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Many Internets of Things



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Privacy/Security Tension

PRIVACY ↔ SECURITY

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More Tension

PRIVACY  CUSTOMIZATION
(and more profits)



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The Fundamental Choices

- Are we building a network or a computer?
 - Less regulation or more?
- Mental model?
 - Telephone
 - Broadcast television
 - Computer
 - Paper

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Part of the answer

TRANSPARENCY

PRIVACY  SECURITY

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Conclusions

- The Internet Revolution is less than 15% complete
- The Internet Revolution will be as disruptive as the printing press, but:
 - Much faster
 - Totally global
 - More unpredictable
- When in doubt, empower the user!

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We Have 3 or 4 Years

- If we make the right choices:
 - The Internet continues to grow
 - Bandwidth explodes
 - Wireless everywhere
 - 10x, 100x more applications
 - Internet of Things > Invisible Computing
- If we blow it:
 - Internet becomes Cable TV
 - Innovation shuts down

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