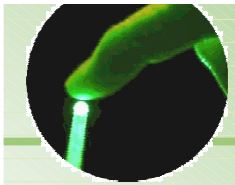
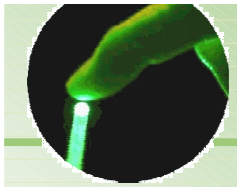



## BIG Broadband
### A New Philosophy

Bandwidth is getting cheaper faster than storage.
Storage is getting cheaper faster than computing.
The exponentials are crossing.

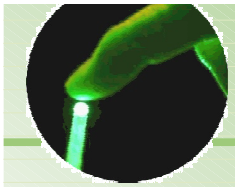
> *"A global economy designed*
> *to waste transistors, power, and silicon area*
> ***-and conserve bandwidth above all-***
> *is breaking apart and reorganizing itself*
> ***to waste bandwidth***
> *and conserve power, silicon area, and transistors."*
>
> (George Gilder, Telecosm, 2000)

www.ces.net/doc/seminars/20040525/ pr/customer_empowered_networking_thru_UCLP.ppt



## Big Broadband
### The case for 100 Mbps

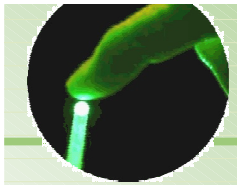
- **Dial-up speeds (28.8–56 Kbps) limit Internet Applications:**
  Text & Data (email & chat)
  Web Browsing with simple images
  Digital Music compressed with low quality sampling rates for small files
  Internet Telephone (VoIP)
- **Broadband (1-5 Mbps) supports More Applications:**
  Digital Music Downloads & Streaming with near-CD quality
  Digital Photography & Sharing of Photos
  Video Conferencing with video in a small window
  Video Streaming with low quality in a window
  Video Surveillance with small images or slow refresh rate
- **Big Broadband (100 Mbps) supports Even More Apps:**
  High Quality Digital Music
  **HDTV: 4-5 simultaneous streams** (1080i MPEG-2 needs ~20 Mbps)
  Download Movies in minutes instead of hours
  Video Conferencing that's almost like being there



## Big Broadband
### The case for 100 Mbps

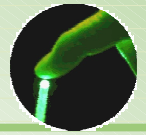
But is 100 Mbps enough?

- **Possibly multiple HDTV streams per TV**
  Simultaneous DVR recordings to watch later
  3-5 HDTV streams * 20 Mbps each = 100 Mbps, but what about Picture-in-Picture?
  Large HDTV displays can support Picture Marquee (4-9 streams per TV)
  **Example 1:** Sports fans can follow multiple games. (each in a window)
  **Example 2:** Surveillance cameras let parents monitor kids at play.
  The cost of digital cameras has fallen to the point where they are embedded in phones & PDAs, and CMOS image sensors will accelerate that trend. So, modern homes may eventually have dozens of surveillance cameras, with all streaming to parents at work.
- **Fast Channel Change**
  Consumers will want to "flip" through IPTV channels just like broadcast channels.
- **Video Compression can impact quality**
  MPEG-4 and WM-9 use less bandwidth than MPEG-2, but with tradeoffs.
  **Example:** Can't see fast moving golf ball leave the tee



# BIG Broadband
## The case for Gigabit-to-the-Home

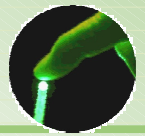
- **Download to Portable Device & Go**
  Downloading *The Matrix* (7.8 GB in MPEG2 DVD format, not HDTV) takes 11.5 hours at 1.5 Mbps, 10.5 minutes at 100 Mbps, 1 minute at 1 Gbps, and 6 seconds at 10 Mbps. Future portable devices with HDTV resolution will need even faster speeds.
- **Rich Peer-to-Peer Collaboration**
  Remote musicians perform together with the high bandwidth and short latency of fiber networks.
- **Third Wave Computing**
  Consumers starting to dust off their video archive to share it online. As more apps move from PCs to the Internet, there's less need for local hard drives except as a buffer. By moving data to trusted services, it is always secure, protected, and can be shared with family or authorized visitors.
- **Massively Parallel Computing Grid**
  Consumers sharing capacity of otherwise-idle PCs across high-speed grid networks enable massively parallel computing applications such as predicting the effect of global warming.
- **Organic LEDs & UHDTV**
  OLEDs will bring HDTV resolution to handheld displays. As nanotech materials make wall-size displays practical, the 1080p HDTV resolution won't be enough, so researchers are working on Ultra-high Definition TV, which needs bandwidth in the range of 10 Gbps.



# BIG Broadband
## Consider these False Predictions

**In case you don't think we need Gigabit-to-the-home…**

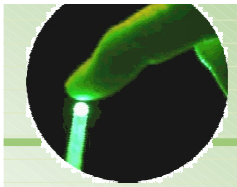
- **COMPUTERS**
  - ***"I think there is a world market for about five computers."*** – Thomas J. Watson Jr., chairman of IBM (1943)
  - ***"640K [of computer memory] ought to be enough for anybody."*** – Bill Gates, founder and CEO of Microsoft (1981)
- **INTERNET**
  - ***"Almost all of the many predictions now being made about 1996 hinge on the Internet's continuing exponential growth. But I predict the Internet will soon go spectacularly supernova and in 1996 catastrophically collapse."*** – Robert Metcalfe, founder of 3Com and inventor of Ethernet (1995)
- **INVENTION**
  - ***"Everything that can be invented has been invented."*** – Charles H. Duell, commissioner of the US Patent Office, recommending that his office should be abolished (1899)



# BIG Broadband
## Consider These False Predictions

**… CONTINUED**

- **TELEPHONE**
  - ***"Well-informed people know it is impossible to transmit the voice over wires and that were it possible to do so, the thing would be of no practical value."*** – Boston Post (1865)
- **RADIO**
  - ***"The wireless music box has no imaginable commercial value. Who would pay for a message sent to nobody in particular?"*** – David Sarnoff's associates responding to his urgings for investment in radio (April 1912)
- **TELEVISION**
  - ***"Television won't last because people will soon get tired of staring at a plywood box every night."*** – Darryl Zanuck, Movie Producer, 20th Century Fox (1946)
- **ELCTRIC POWER**
  - ***"Fooling around with alternating current is just a waste of time. Nobody will use it, ever."*** – Thomas Edison (1889)



# BIG Broadband
## For Mobile Devices (Download & Go)

Passive Broadcast → Interactive On-Demand → Mobile

**Downloading *The Matrix* (7.8 GB)**

| Delivery Method | Days | Hours | Minutes |
|---|---|---|---|
| **Dial-up** (56 Kbps) | **13** | | |
| **Pony Express** | **11**[a] | | |
| **Wireless** (512 Kbps) | **1.5**[b] | | |
| **DSL** (640 Kbps) | **1** | | |
| **Cable** (1.5 Mbps) | | **11.5** | |
| **T1** (1.54 Mbps) | | **11** | |
| **FedEx** | | **10**[c] | |
| **Ethernet** (10 Mbps) | | **2** | |
| **Fast Ethernet** (100 Mbps) | | | **10.5** |
| **Gigabit Ethernet** (1000 Mbps) | | | **1** |

**Download & Go**

[a] New York to California: extrapolated from record delivery time of 7 days 17 hours, traveling approximately 2,000 miles (from St. Joseph, Missouri to Sacramento, CA)
[b] Maximum 150 users per node
[c] Express delivery from New York, NY 10005 to Beverly Hills, CA 90210

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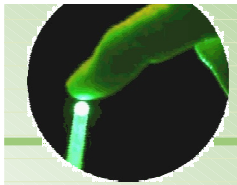
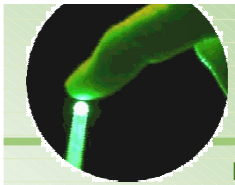


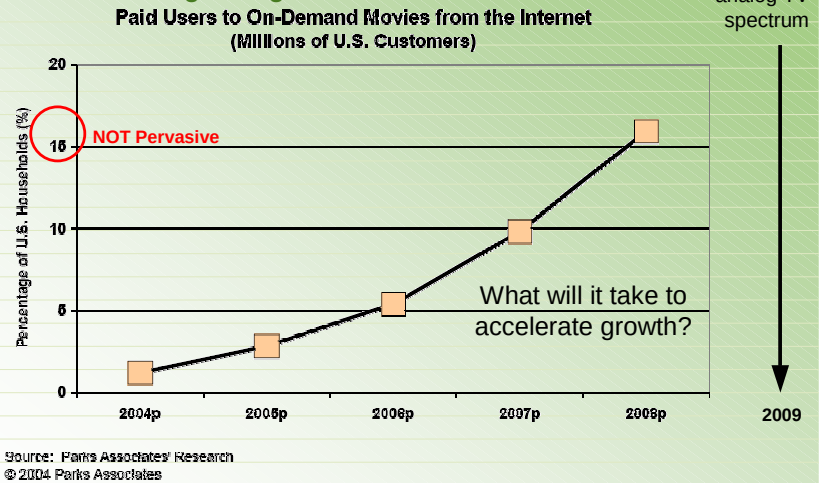
# BIG Broadband
## for Fast Channel Switching of IPTV

- **Broadcast TV sends dozens or Hundreds of Channels.**
  The TV tunes to a frequency – QUICKLY.
  Consumers scan the channels by clicking through.
- **Internet Television (IPTV) needs the same experience.**
  Establish connection with new Video Server (built-in delay)
- **Picture-in-Picture amplifies the effect.**
  Picture marquee would make it even worse.



# BIG Broadband
## for Fast Channel Switching of IPTV

**IPTV growing but still Low Penetration**




Source: Parks Associates' Research
© 2004 Parks Associates

# BIG Broadband
## for Surveillance Video

- **Trend toward Higher Image Resolution**
  Better image Quality reveals more information
- **Trend toward Faster Frame Rate**
  Smooth motion
- **Trend toward More Cameras**
  CCD image sensors already in Cameras & PDAs
- **CMOS image sensors are even cheaper & smaller**
  On-chip pixel processing (great when most of the image is static)
  Expect facial and gesture recognition
- **Uncompressed SDTV = ~18 Mbps (for EACH camera)**
  Compression adds cost

# BIG Broadband
## for Rich Peer-to-Peer Collaboration

**TelePresence breaks the Distance Barriers**

**Distributed, Immersive Performance**

**Signing & Lip Reading for the Deaf**

**Collaborative Music Performance over Internet 2**

# BIG Broadband
## for Rich Peer-to-Peer Collaboration

... CONTINUED

**LIVE STREAMING:**

- **Latency is a Crucial Limiting Factor**
  - Only ~ 20-40 ms is unnoticeable (for universal interactive applications)

- **Tradeoff: Latency versus bandwidth**
  - Compression reduces bandwidth
  - But: high compression increases latency (e.g., interframe MPEG compression)

- **Approach:**
  - Experiment within this design space e.g. resolution, frame rate, SW/HW codecs vs. uncompressed audio & video

# BIG Broadband
## for Rich Peer-to-Peer Collaboration

**Live HD Video Streaming with No Latency Delay**

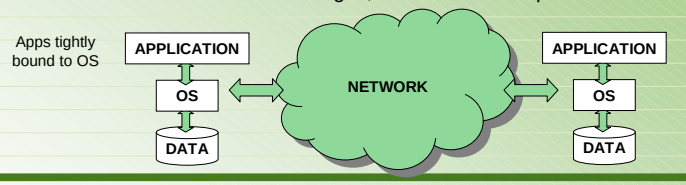
**1280x720 pixels**

# BIG Broadband
## for Third Wave Computing

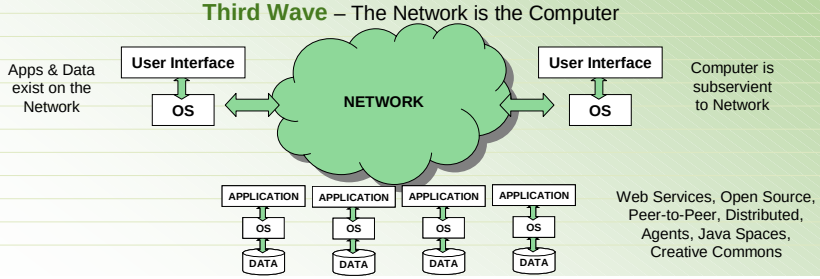
**INTERNET APPLICATIONS**

**First Wave** – Text & Data services such as e-mail & FTP

**Second Wave** – Images, sound & video improve Ease of Use




**Third Wave** – The Network is the Computer



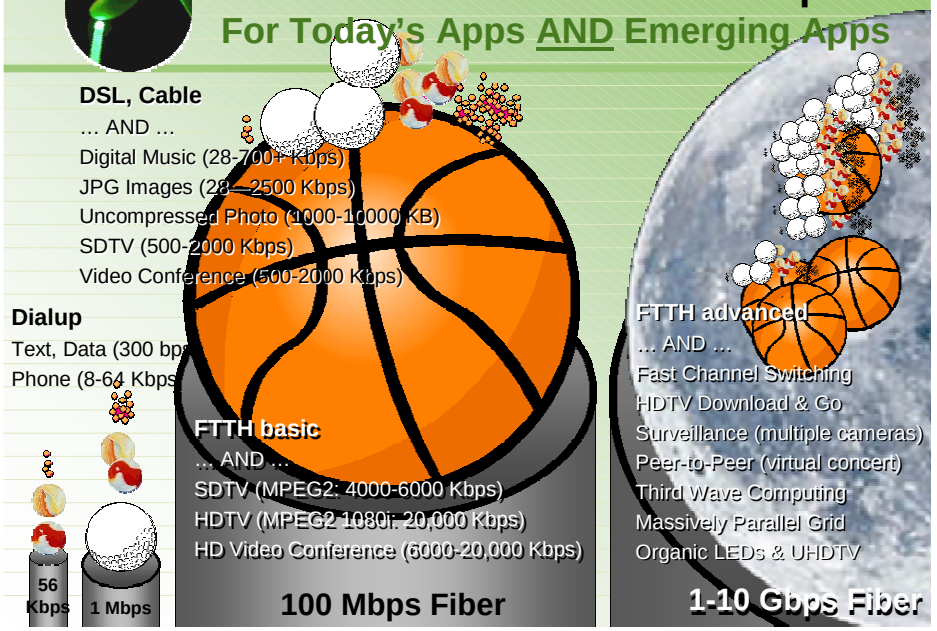

# BIG Broadband
## for Massively Parallel Computing Grid

- **The World Community Grid**
  - Many individual computers joined together to create a large system with massive computational power that far surpasses that of a handful of supercomputers.
  - Because the work is split into small pieces that can be processed simultaneously, research time is reduced from years to months.
  - The technology is also more cost-effective, enabling better use of critical funds.
  - Data access speed is a critical limiting factor, but connect them with a BIG Broadband network that's as fast as a computer bus, and remote data is accesses at local hard disk speeds
- **Examples:**
  - The World Community Grid joins together many individual computers, creating a large system with massive computational power that far surpasses the power of a handful of supercomputers. Because the work is split into small pieces that can be processed simultaneously, research time is reduced from years to months. The technology is also more cost-effective, enabling better use of critical funds.
  - Detect extraterrestrial intelligence through analysis of radio telescope data
  - Human Proteome Folding Project
  - UNAIDS, the Joint United Nations Program to Fight HIV & AIDS

# BIG Broadband
## for Ultra-High Definition Television

- **Japan Broadcasting Company**
  - Demo of Early Prototype
  - Over a 24 Gbps Fiber Network
  - 18 minute video = 3.5 TB storage
- **For Room Size Displays**
  - 450" (37') Diagonal
- **16x the Resolution of HDTV**
  - 7680x4320 pixels (vs. 1920x1080)
  - 32M total pixels (vs. 2M)
  - 60 frames/sec (vs. 30)
- **22.2 Channel Audio**
  - 10 at ear level, 9 above, 3 below

# BIG Broadband "Pipes"
## For Today's Apps AND Emerging Apps




# BIG Broadband
## Addresses Social Issues

- **Drive Universal Broadband Adoption**
  - We "invented" the Internet and once led the world in access
  - But we have now fallen to 16th in percent of homes subscribing
- **Economic Development**
  - Must regain our lost 60-year Tech Leadership (science grid)
- **TeleWork**
  - Improve Employment options while Reducing Traffic
- **TeleMedicine**
  - Contain Healthcare Costs with aging population
- **Distance Learning**
  - Must recover from a Crisis in Education
- **Bridge the Digital Divide**
  - Leaving people (and towns) behind will drain the economy
- **Improve National Security**
  - It's a matter of Survival

# BIG Broadband
## Toward Universal Adoption

**Goal:** *"This country needs a national goal for broadband technology… universal, affordable access by 2007."*
- President George W. Bush, Albuquerque, NM, March 2004

**Benefits:** *"Broadband will not only help industry; it'll help the quality of life of our citizens."*
- *Tele-Work*
- *Tele-Medicine*
- *Distance Learning*
- *National Security*
- *Jobs and Economic Growth*

- President George W. Bush, Albuquerque, US Department of Commerce, June 2004

**Government's Role:** *"The role of government is not to create wealth; the role of our government is to create an environment in which the entrepreneur can flourish, in which minds can expand, in which technologies can reach new frontiers."*
- President George W. Bush, Technology Agenda, November 2002

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# Big Broadband:
## Toward Universal Adoption

**... CONTINUED**

**Economic Environment:** *"We ought not to tax access to broadband. If you want something to flourish, don't tax it."*

- *Extend Internet tax moratorium to Nov.2007, possibly permanent*
- *Extend R&D tax credit, possibly permanent*
- *Accelerate depreciation for capital equipment*

- President George W. Bush, Baltimore, April 2004

**Regulatory Environment:** *"Broadband providers have trouble getting across federal lands. That's why I signed an order to reduce the regulatory red tape for laying fiber optic cables and putting up transmission towers."*

- *Improve access to Rights-of-Way*
- *FCC frees new fiber infrastructure from legacy regulation*
- *Verizon, SBC and Bell South to wire 20M new homes by 2007 (>$6B)*
- *Pending rewrite of 1996 Telecom Act*

- President George W. Bush, Baltimore, April 2004

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# BIG Broadband
## Toward Universal Adoption

**... CONTINUED**

**Beware of statistics & forecasts designed to impress:**

"**95%** of U.S. zip codes can access broadband today."
20% of the population has **No** access,
and others have no **Competition**.

"Broadband will be in **62%** of US households by 2010."
The FCC defines High-speed Internet access as
anything faster than 200 Kbps in any one direction.

Already, **75%** of South Korean households have broadband that is 10-20 * faster and costs 10-25 * less.

In 1992, the Bells promised fiber and speeds of >45 Mbps in each direction, in order to get regulatory concessions.

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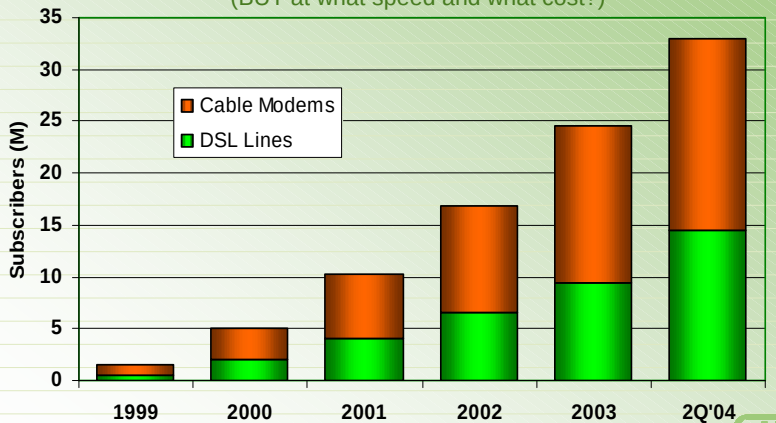
# BIG Broadband
## Toward Universal Adoption

**... CONTINUED**

"Broadband will be in **62%** of US households by 2010."
(BUT at what speed and what cost?)




**Source:** NCTA 2004 Year End Industry Overview
**Source:** FCC 2004

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# BIG Broadband
## for Economic Development

**In 2005, US lost its 60-year tech leadership because**
**We now rank 12th in Broadband Adoption per 100 Inhabitants**

| | DSL per 100 | Cable per 100 | Other per 100 | Total per 100 | Rank | TOTAL Subscribers |
|---|---|---|---|---|---|---|
| Korea | 14.1 | 8.5 | 2.2 | 24.9 | 1 | 11,921,439 |
| Netherlands | 11.6 | 7.4 | 0 | 19.0 | 2 | 3,084,561 |
| Denmark | 11.8 | 5.5 | 1.6 | 18.8 | 3 | 1,013,500 |
| Iceland | 17.4 | 0.2 | 0.7 | 18.3 | 4 | 53,264 |
| **Canada** | 8.6 | 9.1 | 0.1 | 17.8 | 5 | 5,631,714 |
| Switzerland | 10.8 | 6.5 | 0 | 17.3 | 6 | 1,282,000 |
| Belgium | 9.6 | 6.0 | 0 | 15.6 | 7 | 1,618,944 |
| Japan | 10.4 | 2.3 | 2.3 | 15.0 | 8 | 19,097,172 |
| Finland | 11.2 | 2.2 | 1.6 | 15.0 | 9 | 779,929 |
| Norway | 12.3 | 2.0 | 0.5 | 14.9 | 10 | 680,000 |
| Sweden | 9.5 | 2.6 | 2.5 | 14.5 | 11 | 1,302,861 |
| **United States** | 4.7 | 7.4 | 0.9 | 13.0 | **12** | 37,900,000 |

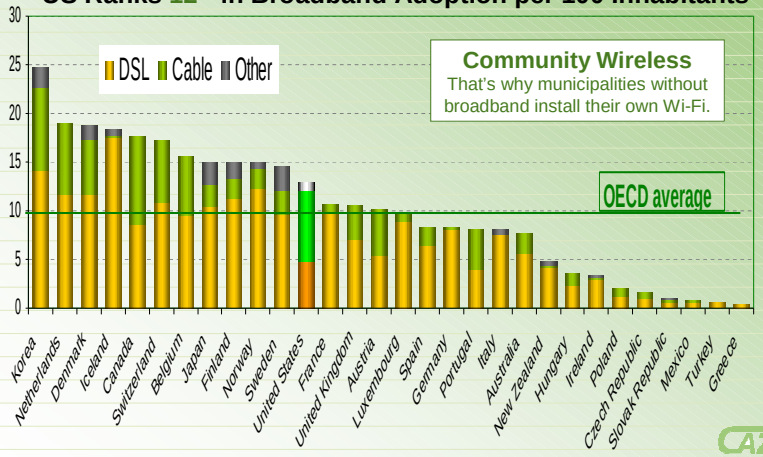
**Source:** Organization for Economic Cooperation and Development, Dec.2004

3rd in 2000

# BIG Broadband
## for Economic Development

The International Telecommunications Union (ITU) ranks the US in **16th** place.

### US Ranks 12th in Broadband Adoption per 100 Inhabitants




**Source:** Organization for Economic Cooperation and Development, Dec.2004

# BIG Broadband
## for Tele-Work

- **Traffic Issue**
  - Commute Time
  - Fuel Costs
- **Environmental Issue**
  - Emissions
- **Employer Issue**
  - Improve Productivity
  - Hire & Keep Talent
  - Reduce Offshoring Costs
  - Real Estate Costs, Travel
- **Employee Issue**
  - Family Values
- **National Security Issue**
  - Continuity of Operations

| APPLICATION | REQUIREMENT |
|---|---|
| Text | 300 bps |
| Telephone | 8-64 Kbps |
| Color Image | 25-**2,500** Kbps |
| Digital Photos | **1,000-10,000** Kbps |
| Digital Music | **128-700** Kbps |
| **Video Conferencing** | **512-2,000** Kbps |
| MPEG-4 VoD (Internet) | **250-750** Kbps |
| MPEG-2 (DVD, Satellite) | **4,000-6,000** Kbps |
| HDTV (1080i MPEG-2) | **20,000** Kbps |

# BIG Broadband
## for Tele-Work

**… CONTINUED**

### US Broadband Basics – Speed & Price

| Service | Provider | Monthly Fee | Start-Up Costs | Maximum Download Speed# | Maximum Upload Speed |
|---|---|---|---|---|---|
| ADSL | Verizon | $37.95 | $39.95 | 3.0 Mbps | 128 kbps-384 kbps |
| | Covad | $39.95 | $99.00 | 1.5 Mbps | 128 kbps |
| | Speakeasy | $39.95 | $99.00 | 728 kbps | 128 kbps |
| | Earthlink | $44.95 | varies | 3.0 Mbps | 128 kbps-384 kbps |
| | SBC | $49.95 | $99.00-$349.00 | 1.5 Mbps | 128 kbps |
| | Atlantech | $59.00 | varies | 1.5 Mbps | 128 kbps |
| | Bell South | $45.92 | $0-$115.00 | 1.5 Mbps | 256 kbps |
| | Bell South DSL-Lite | $34.95 | $0-$115.00 | 256 kbps | 128 kbps |
| Cable Modem | Comcast | $42.95 | $39.90-$149.99 | 4.0 Mbps | 384 kbps |
| | RoadRunner | $44.95 | varies | 5.0 Mbps | 384 kbps |
| | Charter | $42.99 | $74.00 | 3.0 Mbps | 256 kbps |
| | Earthlink | $45.95 | varies | 4.0 Mbps | 384 kbps |
| | Adelphia | $43.95 | varies | 4.0 Mbps | 384 kbps |
| | Cox | $49.00 | varies | 4.0 Mbps | 512 kbps |
| | TW/Brightline | $41.95 | varies | 5.0 Mbps | 384 kbps |
| Satellite | DirecWay | $59.95 | $600.00 | 500 kbps | 50 kbps |
| | Wildblue | $69.95 | $478.95 | 1.0 Mbps | 200 kbps |

# ADSL Speeds depend on customer's distance from provider's central office. Cable line speeds can vary due to bandwidth sharing. These speeds are maximum without sharing. Prices are based on customer also subscribing to phone service or cable TV service.

**10-20 times slower than in France & South Korea**
**10-25 times more expensive than in Japan**
**Notice the slow upload speeds.**

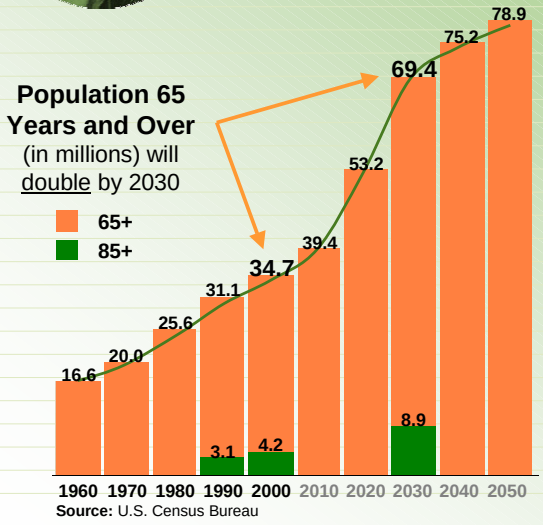
**Source:** U.S. Census Bureau

# BIG Broadband
## for Tele-Work

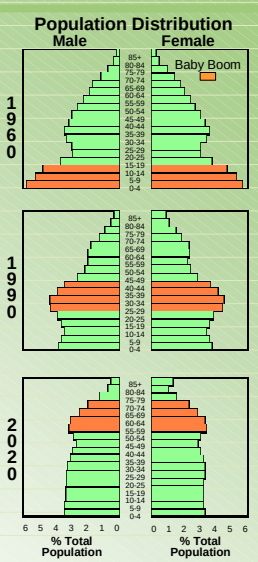

Loudoun Magazine Art Director Elizabeth Harding confers with CEO Brett Phillips, Deputy Editor Elizabeth Wilmer and Managing Editor Rita Walston while debating pros and cons of a candidate magazine cover. Participants could page through to discuss candidate covers.
*(mock-up screen shot)*


**TeleWork**
- **Collaborative documents**
- **Nonverbal communication**
- **More like "being there"**
- **Requires 512+ Kbps bandwidth in both directions**

# BIG Broadband
## for Tele-Medicine

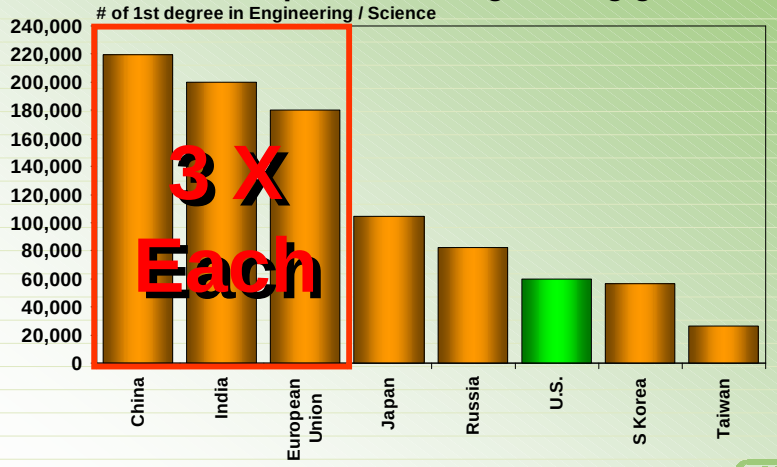



**Source:** U.S. Census Bureau




# BIG Broadband
## for Distance Learning

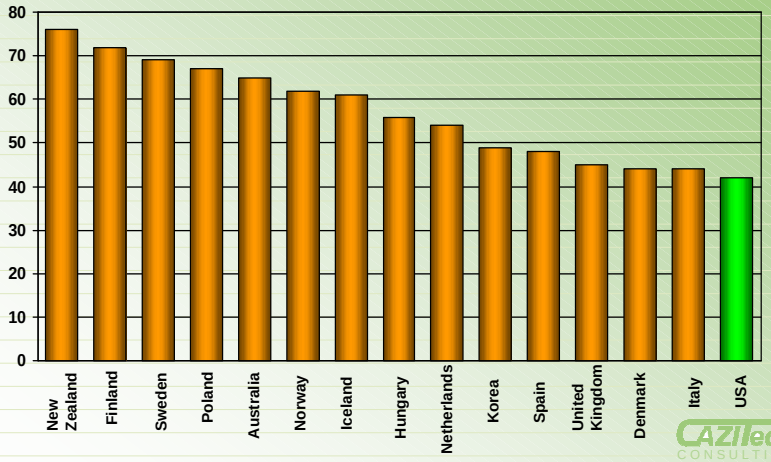
### Other nations outpace US in engineering graduates




**Source:** National Science Board, "Science and Engineering Indicators – 2004";
Table 2-33. Russia, India and S Korea data from University of Texas NCR Report 2004

# BIG Broadband
## for Distance Learning

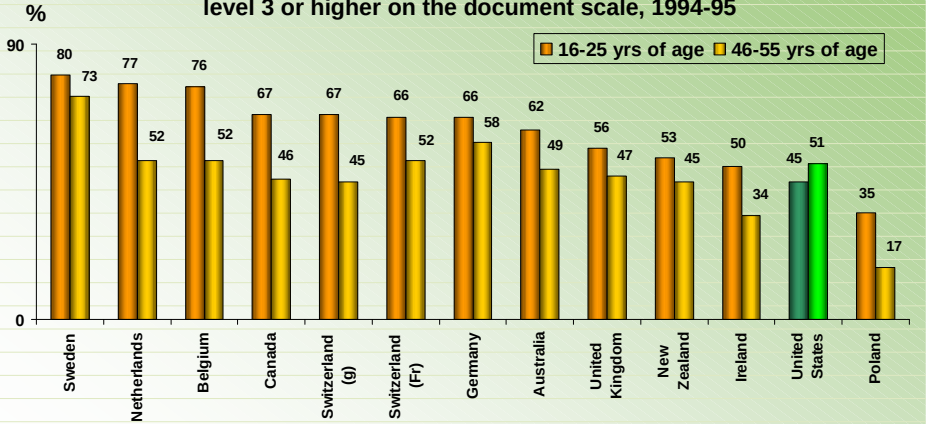
### Rates for entry into college / university , the U.S. ranks 14th*




**Source:** Organization for Economic Cooperation and Development (OECD),
Education at a Glance, OECD Indicators, 2003 Edition

# BIG Broadband
## for Distance Learning

### Percentage of the population scoring at IALS literacy level 3 or higher on the document scale, 1994-95




**Source:** Centre for Educational Research and Innovation, Organization for Economic Cooperation and Development, Education at a Glance OECD Indicators 1998

# BIG Broadband
## to Bridge the Digital Divide

**Of Every 100 Kindergartners:**

| Latino | (24 year-olds) | White |
|---|---|---|
| 62 | Graduate High School | 91 |
| 29 | Complete Some College | 62 |
| 6 | Obtain Bachelors Degree+ | 30 |

**Source:** US Bureau of Census, Current Population Reports, Educational Attainment in the United States; March 2000

**College Graduates by Age 24**

| | |
|---|---|
| Young People from High Income Families | 48% |
| Young People from Low Income Families | 7% |

**Source:** Tom Mortenson, Research Seminar on Public Policy Analysis of Opportunity for Post Secondary, 1997 in From: Latino Health Care Project, Report at Casey Journalism School for Children and Families

**BROADBAND at HOME**
<10% of HH w/ income <$25K
60% of HH w/ income >$150K

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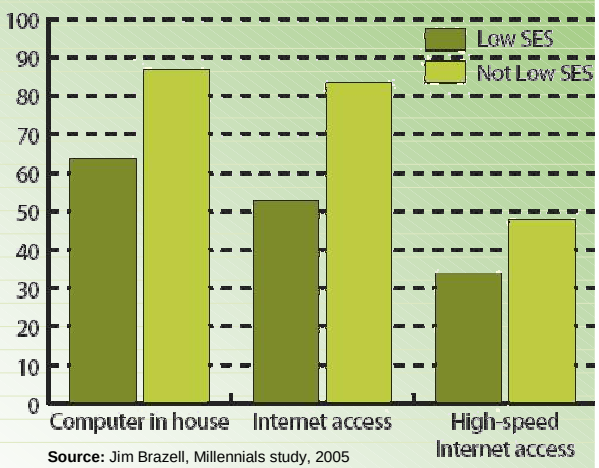
# BIG Broadband
## to Bridge the Digital Divide

**Technology for All**
Houston's Free Wi-Fi network for Low Income Neighborhoods

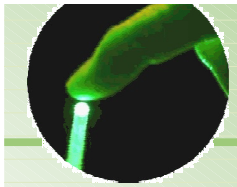
**MIT's $100 Computer**
Aimed at 3rd World countries, 500 MHz, 1GB flash, Linux Touch screen, Wind-up power, Rugged, Flexible, Wi-Fi mesh

**Source:** http://laptop.media.mit.edu/

By socio-economic status, percent of students with computers and types of Internet access in their homes...




**Source:** Jim Brazell, Millennials study, 2005



# BIG Broadband
## For National Security

**Wireless:** *"The spectrum that allows for wireless technology is a limited resource … and a wise use of that spectrum is to help our economy grow, and help with the quality of life of our people."* **- President George W. Bush**, Baltimore, April 2004

- Wi-Fi (802.11) in tens of thousands of hot spots (and entire cities)
  802.11n raw speeds approaching 500 Mbps at short distance
- WiMax (802.16) for >60 businesses or 100+ homes (T-1 speed)
  Possible extention of advanced ("3G") services
- Millimeter Wave (30-300 GHz spectrum) may yield 5Gbps in ~5 years
- But wireless has Security Risks
  Eavesdrop, Access, Denial-of-Service, etc.

**Broadband over Power Lines:** *"We need to get broadband to more Americans… One great opportunity is to spread broadband throughout America via our power lines."* **- President George W. Bush**, Albuquerque, US Department of Commerce, June 2004

- FCC has adopted BPL rules
- Utilities, hotel operators and others are moving beyond trials
- But wireless has Security Risks
  Eavesdrop, Access, Denial-of-Service, etc.

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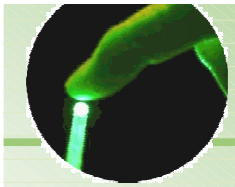
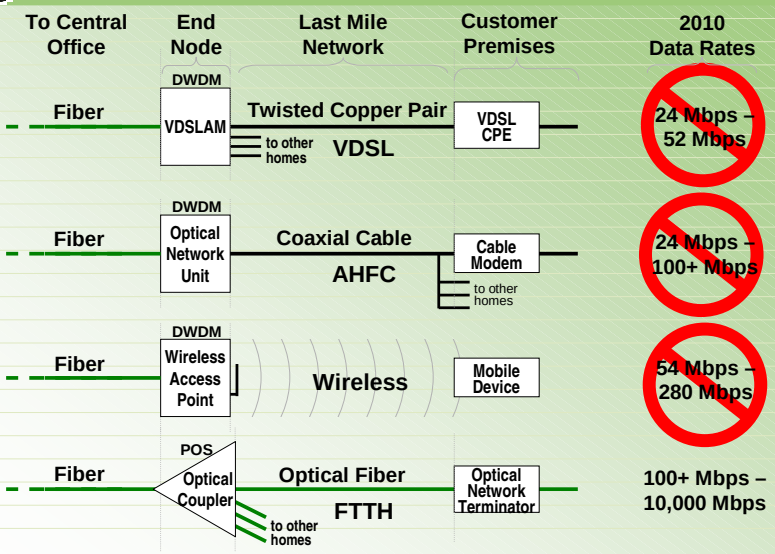


# Big Broadband
## For National Security

**… CONTINUED**

- **Remember Pearl Harbor**
  We were blind-sided because we couldn't monitor encrypted signals.
  Things improved when:
  1. We captured a Japanese black box and were able to decrypt transmissions.
  2. We started using the spoken Navajo Indian language so they couldn't monitor our transmissions.
- **The US is Falling Behind in Fiber Deployment**
  With short-term vision, we focus more on Wireless & Powerline as alternatives while much of Asia deploys fiber.
- **Fiber networks are More Difficult to Monitor (spy on)**
  No Electromagnetic Radiation, so requires Physical Connection
- **Fiber networks support Grid Computing**
  Can apply grid to solving social problems (biomed, global warming) … OR
  Can apply grid for military use (decrypt enemy transmissions)

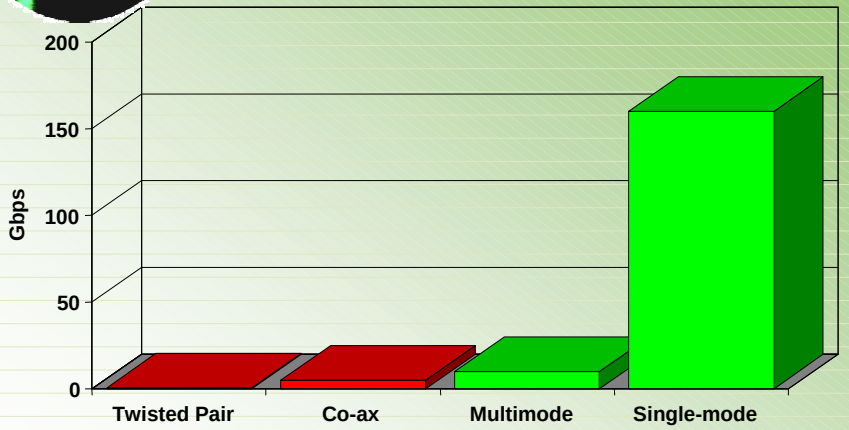
# BIG Broadband
## needs DEEP fiber (FTTH)




# FTTH technical tutorial
## Why FTTH?

- Enormous information carrying capacity
- Easily upgradeable
- Ease of installation
- Allows fully symmetric services
- Reduced operations and maintenance costs
- Other Benefits of optical fiber:
  - Very long distances
  - Strong, flexible, and reliable
  - Allows small diameter and light weight cables
  - Secure
  - Immune to electromagnetic interference (EMI)

# FTTH technical tutorial
## Why FTTH? More CAPACITY

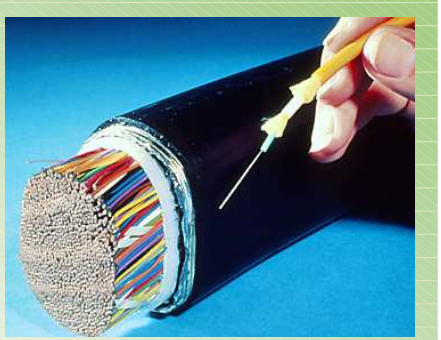



* Typical system capability for 100 m link

Source: Corning Incorporated

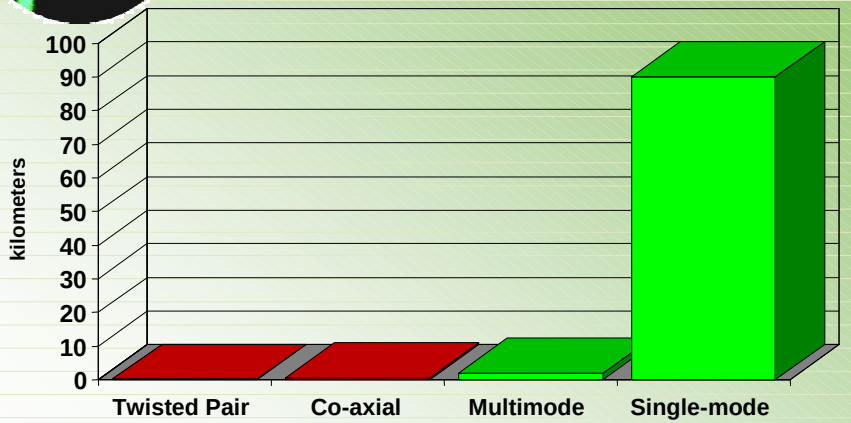
# FTTH technical tutorial
## Why FTTH? More CAPACITY

- A single copper pair is can carry 6 phone calls
- A single fiber pair is can carry **over 2.5 million** simultaneous calls (64 channels at 2.5 Gbps)
- A fiber optic cable with the same bandwidth carrying as a copper cable is less than 1% of the size and weight



Source: Corning Incorporated

# FTTH technical tutorial
## Why FTTH? Longer DISTANCES

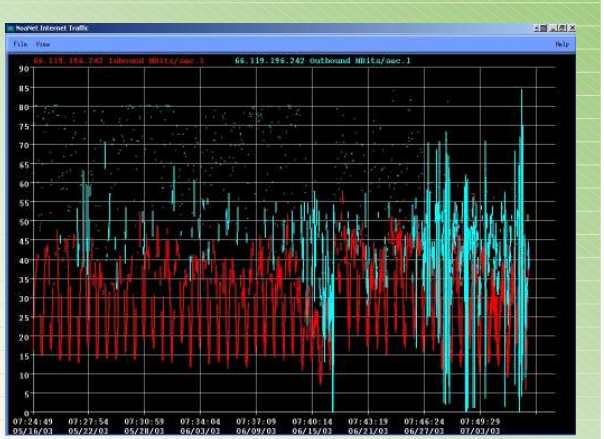



* Typical distance for 1 Gbps system capability

Source: Corning Incorporated

# FTTH technical tutorial
## Why FTTH? SYMMETRIC Services

- Outbound Internet bursting to 80Mbps
- Inbound Internet (download) averaging about 35-40Mbps
- Upstream is consistently twice the download



Source: Grant County Public Utility District

# FTTH technical tutorial
## Why FTTH? Fiber versus Copper

### Glass

- Uses light
- Transparent
- Nonconductive Dielectric Material
  - **EMI immune**
- Low thermal expansion
- Brittle, rigid material
- Chemically stable

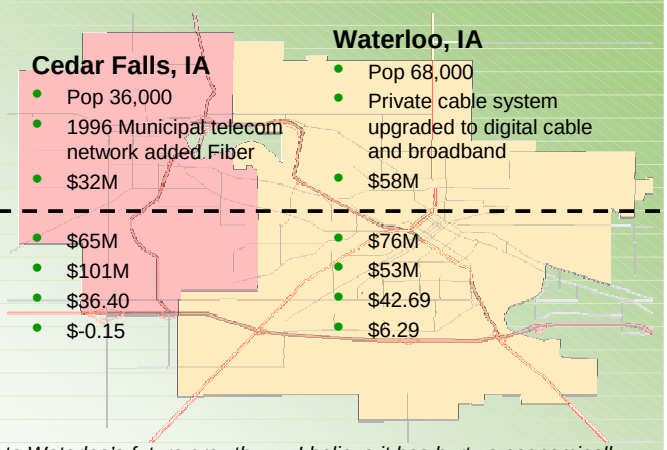
### Copper

- Uses electricity
- Opaque
- Electrically Conductive Material
  - **Susceptible to EMI**
- High thermal expansion
- Ductile material
- Subject to corrosion and galvanic reactions
- Fortunately, its recyclable

# BIG Broadband
## Deep Fiber Example

**Fiber Costs & Benefit**
(tale of two cities)

| | Cedar Falls, IA | Waterloo, IA |
|---|---|---|
| | • Pop 36,000<br>• 1996 Municipal telecom network added Fiber | • Pop 68,000<br>• Private cable system upgraded to digital cable and broadband |
| **1996 New Construction** | • $32M | • $58M |
| **2001 New Construction** | • $65M | • $76M |
| **2002 New Construction** | • $101M | • $53M |
| **Property tax rate / $1000** | • $36.40 | • $42.69 |
| **2003 tax increase** | • $-0.15 | • $6.29 |



*"Fiber optics is the key to Waterloo's future growth. . . . I believe it has hurt us economically not to be able to provide fiber optics to businesses locating in our city."*

– Waterloo Mayor John Roof

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# BIG Broadband
## Deep Fiber – Other Examples

### Who else is doing Fiber?

Cities that are building new access communications networks to serve residents and businesses include:

- **Avery Ranch (Austin)**
- **Loudoun County, VA**
- **Bristol, VA**
- **Provo, UT**
- **Tacoma, WA**
- **Salt Lake City, UT**
- **Palo Alto, CA**
- **Pittsburg, PA**
- **Nashville, TN**
- **Cedar Falls, IA**
- **Jacksonville, FL**
- **Dalton, GA**

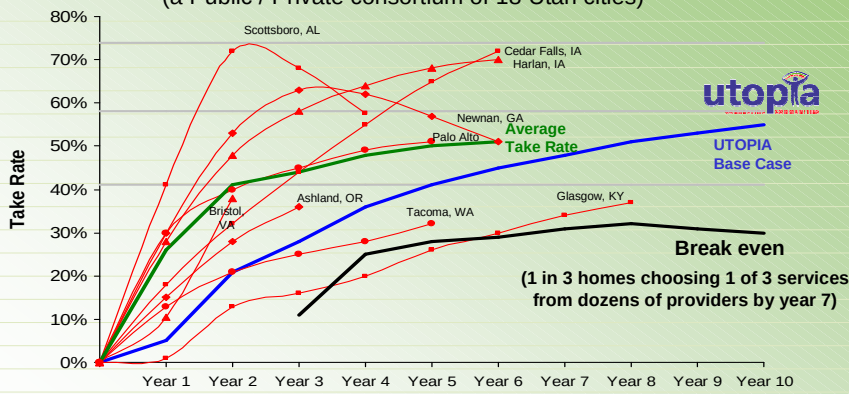
… and more than 400 more in 43 states

**Source:** Fiber-to-the-Home Council, May 2005



# BIG Broadband
## Deep Fiber as Public Infrastructure

**Utah Telecommunications OPen Infrastructure Agency**
(a Public / Private consortium of 18 Utah cities)




**Break even** = meet debt service, cover operating expenses and fund technology upgrades

**Source:** Dean & Company, SRI Survey



# BIG Broadband
## Deep Fiber as Public Infrastructure

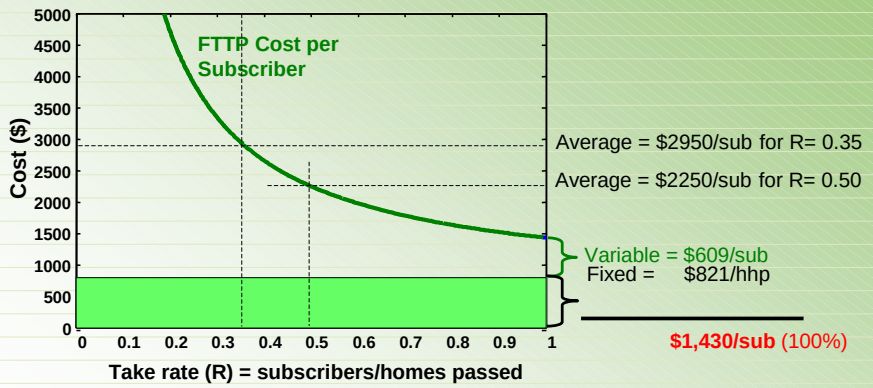
**Actual take-rates far exceed UTOPIA's projections**


**Source:** Provo City, Spanish Fork, SRI Survey



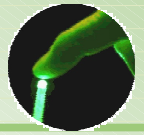
# BIG Broadband
## Deep Fiber Deployment Economics

**Fiber Cost vs. Take Rate**



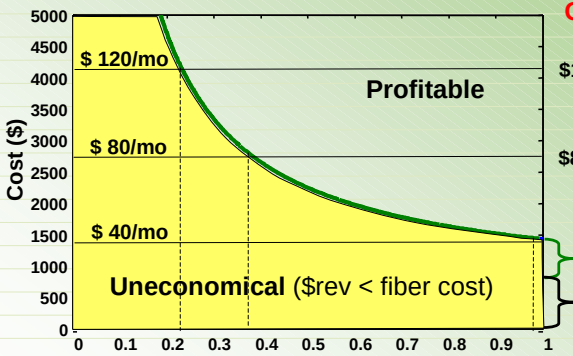

**Source:** Corning Cable Systems, 2003

Average cost is lower with more subscribers.



# BIG Broadband
## Deep Fiber Deployment Economics

### Fiber Cost vs. Take Rate




**Overlay revenue lines …**

**$120/mo supports $4320 avg cost**

**$80/mo supports $2880 avg cost**

Variable = $609/sub

Fixed = $821/hhp

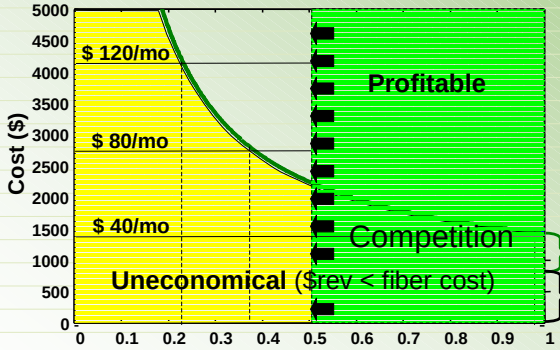
**Source:** Corning Cable Systems, 2003

Average cost is lower with more subscribers.



# BIG Broadband
## Deep Fiber Deployment Economics

### Fiber Cost vs. Take Rate




To satisfy stock holders, public companies need quick **Rate of Return**, **Monopoly Power** for high take rate, and **High RPU**.

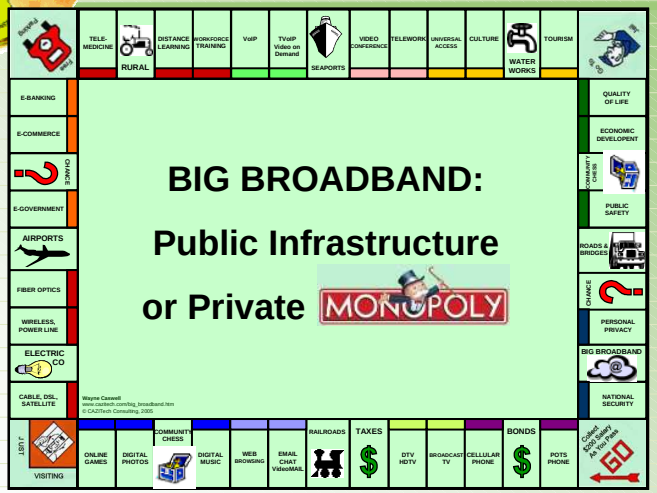
Variable = $609/sub

Fixed = $821/hhp

**Source:** Corning Cable Systems, 2003

Average cost is lower with more subscribers.
Usually need about 35% subscriber rate.

# BIG Broadband
## Municipal/Metropolitan Politics




**by Wayne Caswell**
wcaswell@CAZITech.com

# BIG Broadband
## faces Political Obstacles

**Public Infrastructure or Private Monopolies?**
(a variety of business models, objectives & opinions)

- **Municipal Networks** – 14 States have passed laws banning them.
- **Preserving Innovation in Telecom Act (H.R.2726)** - Texas Representative Pete Sessions (R-TX) introduced a pro-business bill that would ban municipal networks.
- **Community Broadband Act (S.1294)** – Senators John McCain (R-AZ) and Frank Lautenberg (D-NJ) responded with a bill specifically designed to allow municipal networks.
- **Broadband Investment and Consumer Choice Act (S.1504)** - Senator John Ensign (R-NV) proposed a revision of the 1996 Telecom Act with pro-incumbent provisions that would supersede the McCain/Lautenberg bill and impose barriers to municipal networks.
- **Unnamed draft from House Energy and Commerce Committee** - Chairman Joe Barton (R-Texas) and John Dingell (D-Mich) offered a committee draft to prompt debate. It defines "broadband Internet transmission services" (BITS) as packet-switched (regardless of network technology) and offering subscribers the ability to send and receive information such as VoIP & IPTV.

**Who Benefits vs. Who Pays?**

## US Senate Energy and Commerce Committee
## Briefings

http://commerce.senate.gov/hearings/index.cfm

| | | | |
|---|---|---|---|
| **Decency** | Thursday | January 19 | 10:00 AM |
| **Internet Pornography** | Thursday | January 19 | 2:30 PM |
| **Broadcast and Audio Flag** | Tuesday | January 24 | 10:00 AM |
| **Competition and Convergence** | Thursday | January 26 | 10:00 AM |
| **Video Franchising** | Tuesday | January 31 | 10:00 AM |
| **Video Content** | Tuesday | January 31 | 2:30 PM |
| **Net Neutrality** | Tuesday | February 7 | 10:00 AM |
| **Municipal Networks** | Tuesday | February 14 | 10:00 AM |
| **FCC Activities and Policy** | Wednesday | February 15 | 10:00 AM |
| **USF Contributions** | Tuesday | February 28 | 10:00 AM |
| **USF Distributions** | Tuesday | February 28 | 2:30 PM |
| **Wireless Issues/Spectrum Reform** | Thursday | March 2 | 10:00 AM |
| **Rural Telecommunications** | Tuesday | March 7 | 10:00 AM |
| **Voice-over Internet Protocol (VoIP)** | Tuesday | March 14 | 10:00 AM |
| **Wall Street Telecom Perspective** | Tuesday | March 14 | 2:30 PM |

## Public Infrastructure
(a variety of objectives)

(and business models)

- **Economic Development**
- **Bridge Digital Divide**
- **Public & Emergency Services**
- **Ease Traffic Congestion**
- **Homeland Security**
- **Open Competition**
- **ROW Access Fees**
- **Minimize Street Cuts**

## Who Benefits?

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## Residential Gateway
### The Vision

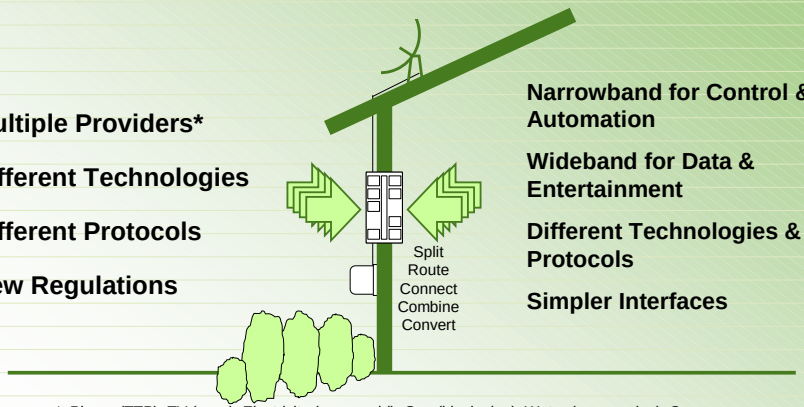
*Possibly the most important & valuable piece of real estate in the home*

**Multiple Providers***

**Different Technologies**

**Different Protocols**

**New Regulations**




**Narrowband for Control & Automation**

**Wideband for Data & Entertainment**

**Different Technologies & Protocols**

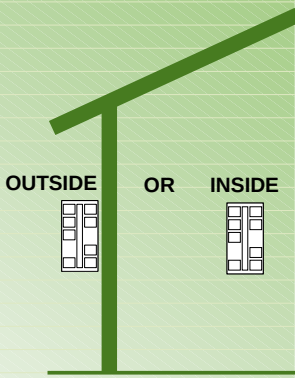
**Simpler Interfaces**

* Phone (TTP), TV (coax), Electricity (power grid), Gas (black pipe), Water (copper pipe), Sewer (plastic pipe), Delivery (trucks), etc. Each pays about $800-1500 / home for their infrastructure.

## Residential Gateway
### The Alternatives

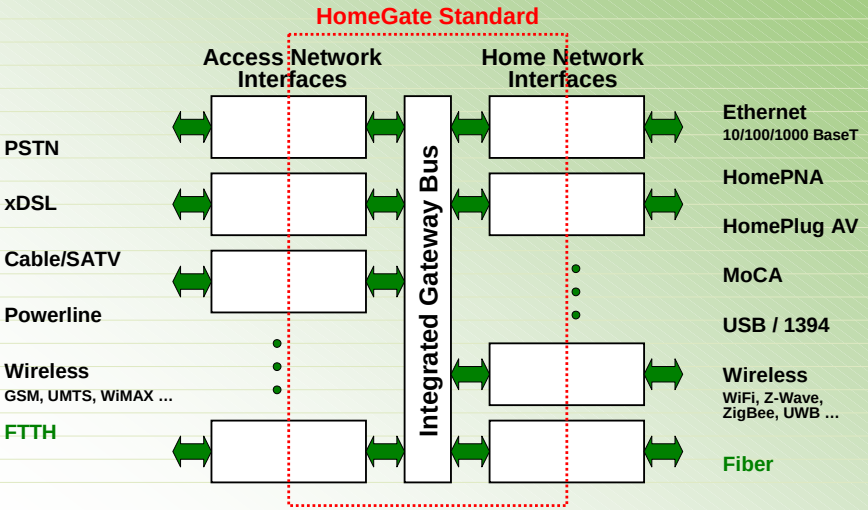
*Possibly the most important & valuable piece of real estate in the home*

| | |
|---|---|
| **Whole-Home Gateways** | Any WAN, Any LAN, Any Service or Application |
| **Multi-Service Gateways** | Service-Specific RG + Data, Voice, Video, or Telemetry |
| **Data-Centric Gateways** | Modem + Router + LAN (integrated product) |
| **Virtual Gateways** | Modem + Router + LAN (discreet products) |
| **Non-RG CPE** | Modems, Hubs, Switches, Bridges, Wireless APs, STBs |



# Residential Gateway
## The Architecture

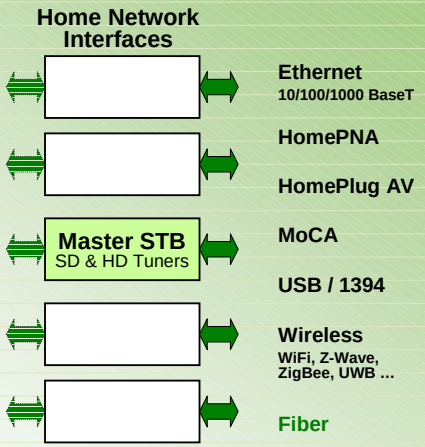
*Plug-in modules enable flexible configuration*




# Residential Gateway
## and the Master Settop Box

*Specialized plug-in Adds Value to legacy TVs*
*(assign a channel to each TV or each video source)*

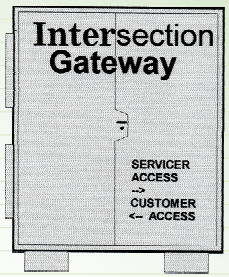
- **Digital & HDTV Tuning for all TVs**
- **PiP and CallerID on all TVs**
- **Parental Control on all TVs**
- **On-Demand & Interactive TV for all TVs**
- **Transcoding to optimize Resolution**
- **Video Telephony & Closed Captioning**
- **Avoid Cabling Upgrades (RG-6, cat.5)**
- **Access PC Apps**
  - Web Browsing, Email, Chat
  - View Photos & Videos
  - Listen to Music
  - Use PC (or remote) storage for DVR function
- **Access Home Control Apps**
  - Comfort (HVAC, lighting)
  - Convenience (automation)
  - Cost (energy savings)
  - Security (view surveillance cameras)



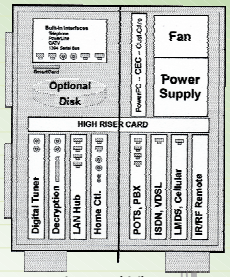

# Residential Gateway
## Integrated or Distributed Design

**Modular:** 800-8,000 sq.ft. house, apartment, or commercial building

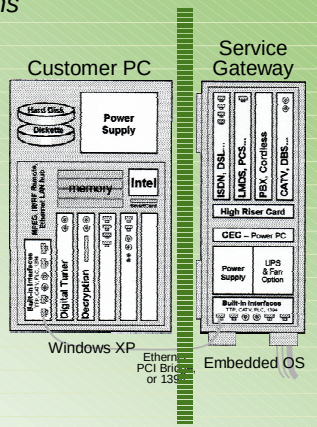
*Two Early IBM Designs*




External View




Internal View




**Flexible:** 8-, 16-, or 32-bit, Mount Inside or Outside (-40C - +60C), surface mount or in-wall

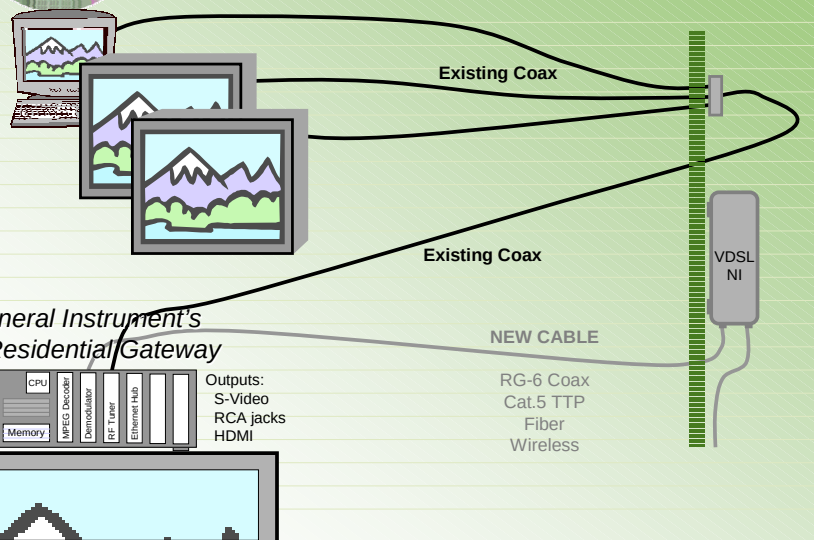
64-bit passive backplane

Pluggable Power Supply (110v/220v, few/many slots)

Pluggable CPU & Control Logic

PCI High-Riser Card

# Residential Gateway
## Integrated or Distributed Design




*General Instrument's N3 Residential Gateway*

# Residential Gateway
## Marketing Challenges

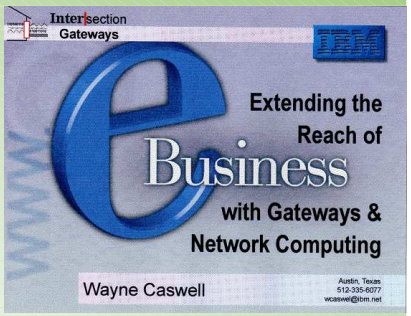
*Match your Terminology to your Audience*

RG benefits span across sectors, so it's critical to **find the right messages** for each.

IBM had bad experiences in consumer markets, so any proposal with the term ***Residential*** was ignored.

***Inter|section Gateways***, associated with an e-business strategy, was more palatable.

Today's ***Service Gateway*** designs are tied to specific services and use software from OSGi (the Open Service Gateway Initiative).




***Consumers*** *want access to All Services – without new devices or wiring for each*
***Service Providers*** *want access to Al Consumers – regardless of their devices, wiring & protocols*


## Wayne Caswell

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www.cazitech.com/big_broadband_links.htm


Wayne Caswell is a retired IBMer and home networking pioneer with extensive IT experience in development, systems engineering, marketing, and strategy. He helped pioneer the Residential Gateway concept, influenced RG standards, and served as the Marketing Chairman of the HomeRF Working Group, an initiative that converged voice, data and entertainment networks into a single wireless specification that ultimately lost in the market to Wi-Fi. After IBM, he founded CAZITech Consulting, an independent practice that helped organizations of all sizes discover and exploit new opportunities in technology convergence within broadband, wireless and home networking markets. Wayne is now exploring new ways to influence the future of these technologies with a resume of experience that includes strategic planning, business development, and market and competitive analysis. Wayne has a BS degree in Technology Management from American University and is a member of the Austin Wireless Alliance, CABA, the FCC Consumer Advisory Committee, and World Future Society, among other associations.

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