



Into the...

exacloud

A New Paradigm for Web Cinema,
Video Games, and Virtual Worlds

Fiber to the Home Council – Asia Pacific '09

Melbourne, Australia – May 20, 2009

Bret Swanson – Entropy Economics LLC

entropyeconomics.com – bretswanson.com

The background of the slide is a blue sky with white, fluffy clouds. The clouds are more prominent in the upper and lower portions of the slide, framing the central white area where the text is located.

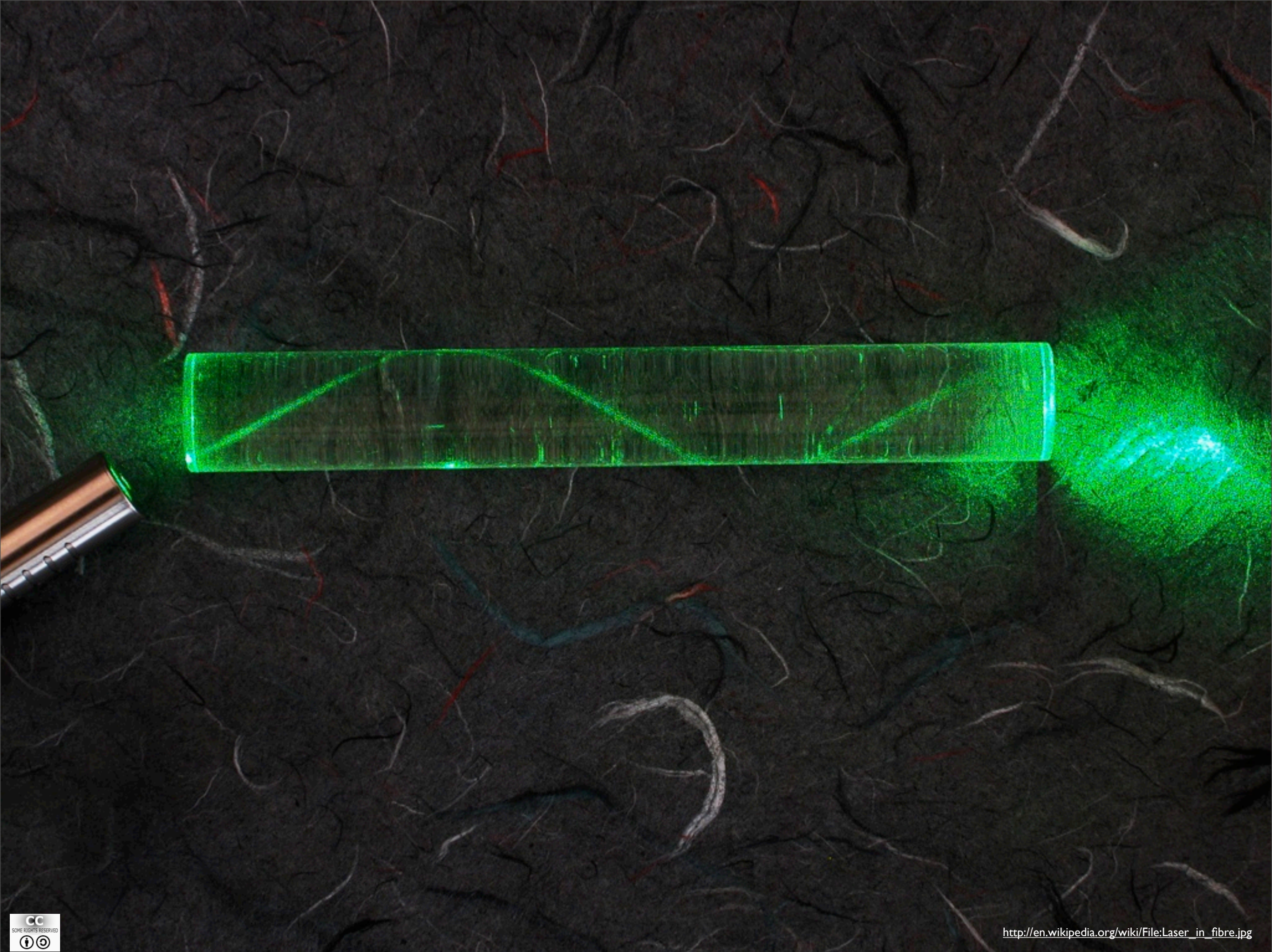
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GLOBAL INNOVATION + TECHNOLOGY RESEARCH

“A high-entropy message requires
a low-entropy carrier.”

– *George Gilder*

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Summing these trends, in 2007 we projected these U.S. estimates for 2015:

■	Movie downloads and P2P.....	100	exabytes
■	Video calling and virtual windows.....	400	exabytes
■	Cloud computing and remote backup.....	50	exabytes
■	Net video, gaming, and virtual worlds.....	200	exabytes
■	Non-Internet “IPTV”.....	100+	exabytes
■	Business IP traffic.....	100	exabytes
■	Other (phone, Web, e-mail, photos, music).....	50	exabytes
■	Total.....	1,000	exabytes = 1 zettabyte

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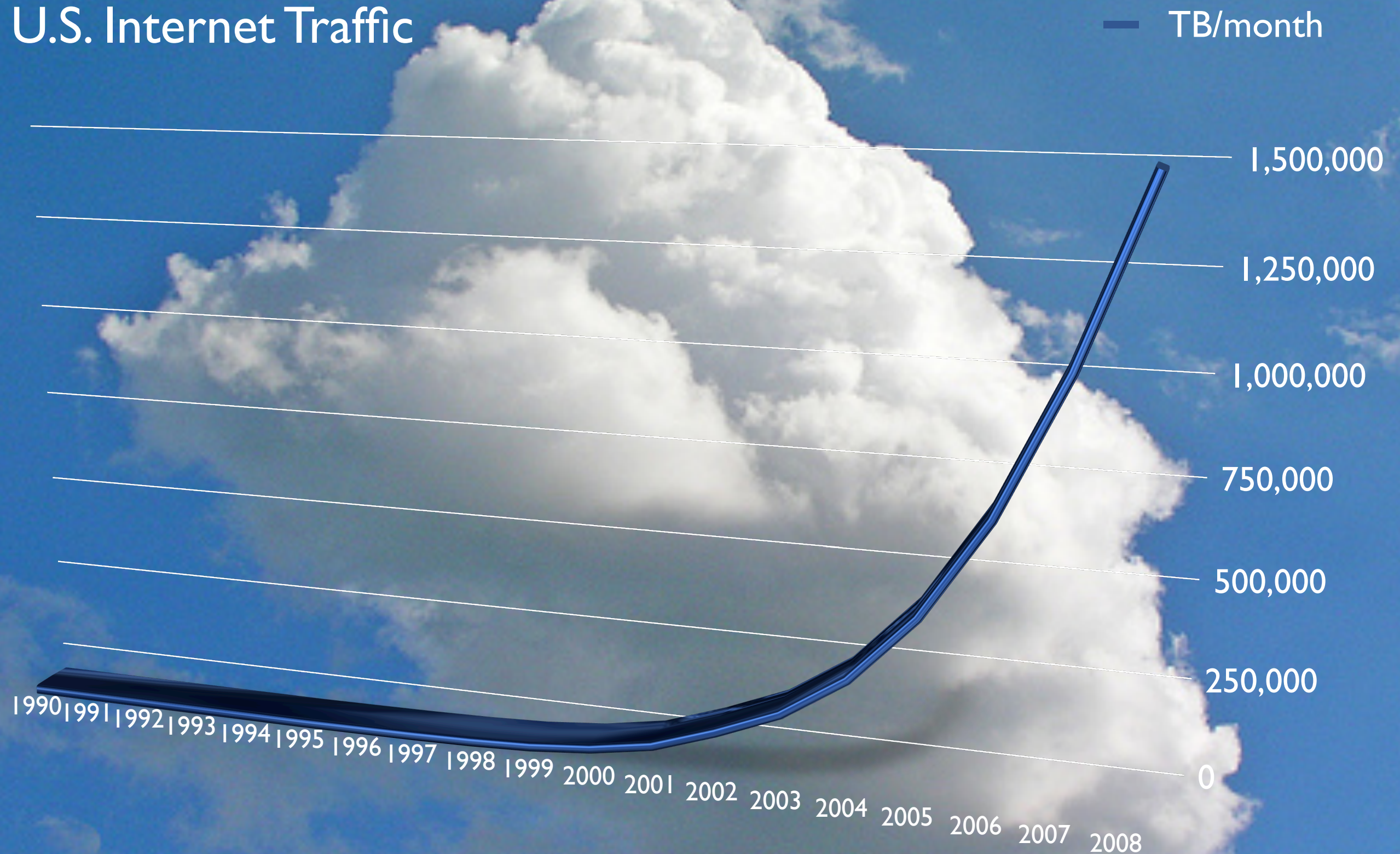
YouTube

- > receives uploads of 13+ hours of video every minute
- > receives 18,720+ hours of video each day
- > streams ~150+ **petabytes** per month
- > streams ~3.5 **terabytes** every minute / every 13 min. = 1992
- > HD YouTube would mean more than 18 **exabytes** per year, equal to total U.S. Internet traffic of 2008

Mobile revolution

- > 3 billion mobile phones / 1 billion new devices per year
- > 1.9 billion camera phones / Nokia largest “camera” company
- > 1 billion iPhone App downloads / 35,000 Apps
- > “omnichronnectivity” yields constant content creation and consumption

U.S. Internet Traffic



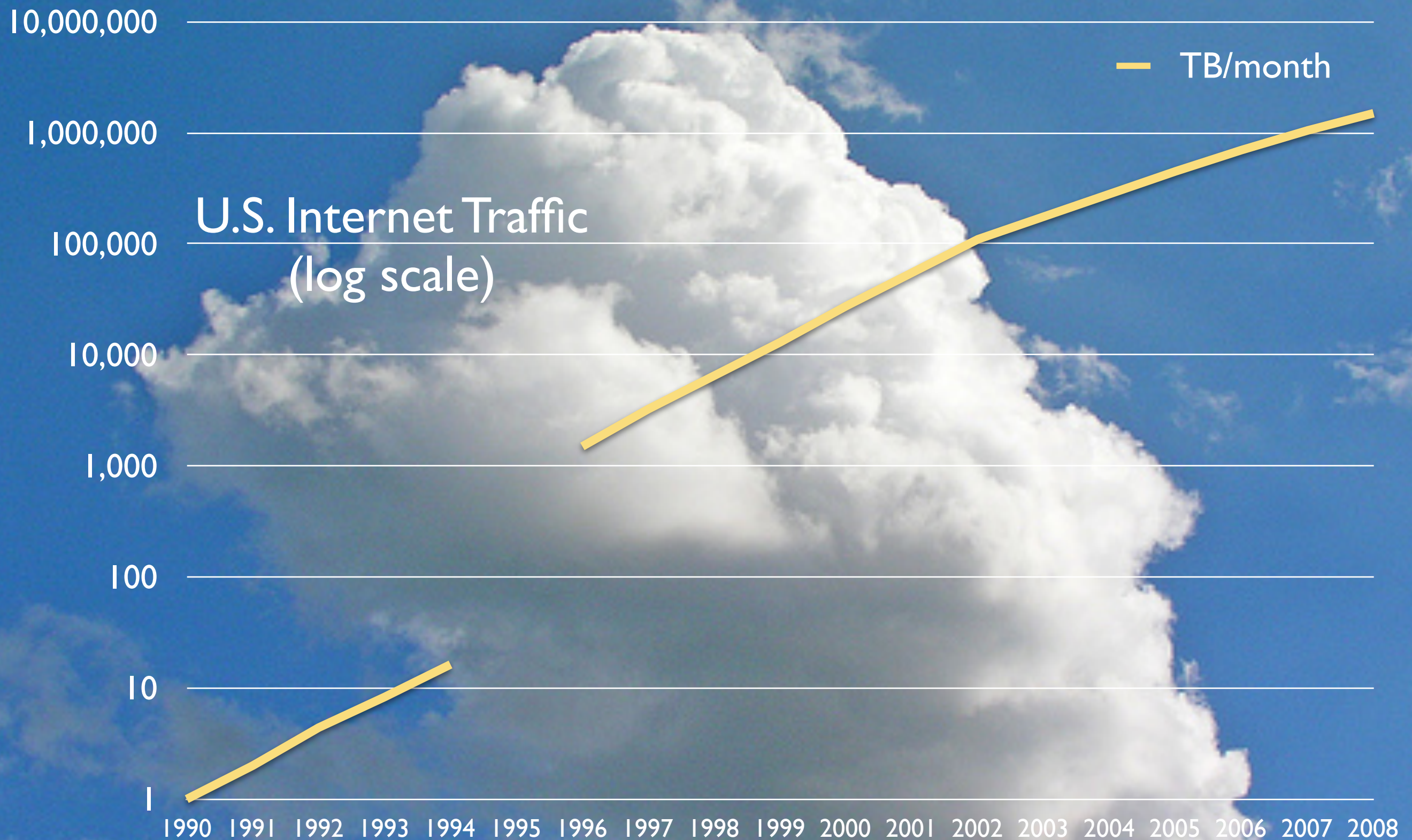
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Source: MINTS



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The Paralleladigm



Massive parallelism of:
optical fiber with **WDM**

> new single-fiber record of 32 terabits/second on 320 λ over 580 km

Overwhelmed the serial nature of the existing **CPU** computer paradigm

> Von Neumann bottleneck limits memory bandwidth

> Too slow for optical packet networks, 3D graphics and HD video

> Too darn hot ... $P = C \times V^2 \times F$

The Paralleladigm



Massive parallelism of:

- > optical fiber with **WDM**

Spawns, complements, accommodates, and requires massive parallelism of:

- > GPUs with 800 parallel “stream processors” in 10 cores

- > NPUs with 100s of parallel “task optimized processors” (TOPs)

- > EPU with hundreds of thousands of parallel arrayed processors
(also known as data centers or Googleplexes)

GPUs

graphics processors



massive parallelism and memory bandwidth
for interactive video and multimedia

processing power of GPU's growing ~1.5-2x faster than CPU's
... single GPU now delivers 1.2 teraFLOPS

CPU's now going multi-core and parallel
... GPU's already there

GPUs now adding programmability to match CPU's

NPU's

network processors



massive parallelism and memory bandwidth
for converged fiber-speed multimedia networks

processing power of NPU's growing ~1.5-2x faster than CPU's
... single NPU will soon deliver 100 Gbps

CPU's now going multi-core and parallel
... NPU's already there

NPU's are programmable to match CPU's

EPU_s

exa processors



massive parallelism and memory bandwidth
for global content delivery and cloud computing

processing power of EPUs growing ~1.5-2x faster than CPU_s
... Googleplex can stream ~5 petabits per second

CPUs now going multi-core and parallel
... EPU_s already there

EPU_s are programmable to match CPUs

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"When the network becomes as fast as the processor, the computer hollows out and spreads across the network."

– Eric Schmidt, circa 1993

“The Network is the Computer.”

– Sun Microsystems

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 **OTOY** and  **AMD** building **Fusion Render Cloud**
Petaflops supercomputer with 1,000 GPUs

Renders: up to 8,000 x 8,000 compressed images
@ up to 120 frames/second into any Web browser

Streams: any interactive video experience
... at any resolution ... to any device

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AMD/Otoy/LightStage Fusion Render Cloud

Burbank, California

1,000 GPUs
5 racks
150 kW
~ \$4 million

1+ petaflops

1/20
1/100
1/15
1/33

=

IBM Roadrunner Los Alamos National Lab

Los Alamos, New Mexico

19,500 CPUs
6,000 square feet
2.35 MW
\$133 million

1.026 petaflops

exacloud



OTOY



Fusion Render Cloud

Video games

- > preview before purchase
- > rolling release, constant updates
- > no DVDs, no piracy
- > play on any device, from home theater to mobile phone

Virtual worlds

- > fully interactive 3D immersive experience, evolves over time

Cinema 2.0

- > interactive entertainment
- > video game or motion picture? Or both?

40 hours vs. Right Now photorealistic 3D ... rendered in *real-time*

<http://www.pcgameshardware.com/aid,655742/Ruby-20-Screenshots-and-video-of-the-new-Radeon-tech-demo/News/>



LightStage

Ultra high-resolution capture and rendering
of 3D photo-realistic real-time images
for movies, TV, and the Web



Emily

exacloud

How much bandwidth does the **exacloud** need?

How much bandwidth do you have?

- > **exaworld** could stream 100+ **PB** per month per 1 million users
 - > 100 million users would mean 100 **exabytes** per year
 - > twice as large as today's world Internet
- > much more with video games, Cinema 2.0, other applications

The Paralleladigm



the **exacloud** requires bandwidth and speed of

- > optical fiber
- > fiber-speed NPUs
- > traffic management
- for
- > capacity
- > connectivity
- > latency
- > reliability
- > security

1989

- the “most powerful computer ever!”
- 20 MHz
- 2 MB RAM
- for “only” \$8499.00 (\$15,000 in '08 USD, €10.000, AUD 20,000)
- “monitor and mouse not included”



Tandy 5000 MC Professional System

NEW FOR 89 8499⁰⁰

Monitor and mouse not included


- 20 MHz Intel® 80386™ Microprocessor ■ VGA Graphics
- 2 MB RAM (16 MB Capacity) ■ Cache Memory

Our most powerful computer ever! The Tandy 5000 MC Micro Computer is strictly business, from the look of its 256,000-color VGA graphics to the tactile feel of its newly-designed keyboard. Its Intel 80386 processor operates at a lightning-fast 20 MHz, and a memory cache controller provides RAM-fast access to your data. IBM® Micro Channel™ compatible architecture provides a 32-bit wide data path for virtually simultaneous data transfer between peripherals. Will operate MS-DOS® 3.3, MS® OS/2, SCO® XENIX® 386 and network operating software. The 5000 MC's technology, performance and price all add up to an incredible value. VGA graphics, serial and parallel ports and mouse support included.

2009 The Hard Drive Dilemma

- 1992 – 1 TB was around US\$5,000,000
- July 2008 – 1 TB was an astoundingly cheap US\$177.99
- January 2009 – 1 TB drive was an amazing US\$109.99

Hitachi 1TB USB External Hard Drive



USB 2.0
1TB

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Down
Under

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