nto the...

exacloud

A New Paradigm for the Web and its Impact on Technology Investing

Applied Finance Group – Research Summit 2009 Las Vegas, Nevada – June 11-12, 2009 Bret Swanson – Entropy Economics LLC entropyeconomics.com – bretswanson.com

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"A high-entropy message requires a low-entropy carrier."

– George Gilder



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Internet's Three Phases

> Phase One – Arpanet in 1969

> Phase Two – Net comes to the masses in 1995 via email and World Wide Web

> Phase Three – Broadband means "the network is the computer" Video ushers in the Exaflood

2007 projection for 2015

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

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YouTube

update

- > receives uploads of I3+ hours of video every minute
- > receives 18,720+ hours of video each day
- > streams ~I50+ 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
- > Netflix would ship about 7 exabytes of HD video each year

Mobile revolution

- > 3 billion mobile phones / 1 billion new devices per year
- > 1.9 billion camera phones / Nokia largest "camera" company
- > I billion iPhone App downloads in six months / 40,000 Apps
- > "omnichronnectivity" yields constant content
 - creation and consumption / new iPhone video recorder

update exaflood

U.S. Consumer Bandwidth

U.S. Internet Traffic

— TB/month

1,500,000

1,250,000

1,000,000

750,000

500,000

250,000

2008

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U.S. ICT Investment

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 $\dots P = C \times V^2 \times F$

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)
 - > EPUs with millions of parallel arrayed processors (aka Googleplexes)

> 4G wireless with hundreds of parallel sub-frequency bands (aka OFDM)

massive parallelism and memory bandwidth for interactive video and multimedia

processing power of <u>GPUs</u> growing ~1.5-2x faster than <u>CPUs</u> ... single GPU now delivers 1.2 teraFLOPS

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

GPUs now adding programmability to match CPUs

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

processing power of <u>N</u>PUs growing ~1.5-2x faster than <u>C</u>PUs ... single NPU will soon deliver 100 Gbps

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

NPUs are *programmable* to match CPUs

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

processing power of <u>EPUs</u> growing ~1.5-2x faster than <u>C</u>PUs ... Googleplex can stream ~5 petabits per second

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

EPUs are programmable to match CPUs

"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

OTOY and AMDING 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

AMD/Otoy/LightStage Fusion Render Cloud

Burbank, California

IBM Roadrunner Los Alamos National Lab

Los Alamos, New Mexico

1,000 GPUs	I/20	19,500 CPUs
5 racks	1/100	6,000 square feet
150 kW	1/15	2.35 MW
~ \$4 million	1/33	\$133 million

I + petaflops = I.026 petaflops

OTOY / AMD 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

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

989

- 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

Monitor and mouse not included

20 MHz Intel® 80386[™] Microprocessor WGA Graphics
 2 MB RAM (16 MB Capacity) Cache Memory

Gor 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 I TB was an astoundingly cheap US\$177.99
- January 2009 I TB drive was an amazing US\$109.99

Cisco estimates that by 2013:

> Global IP traffic will total 667 exabytes for the year (close to my estimate of 1,000 exabytes)

> > Internet video will be 700 times the U.S. Internet backbone traffic of 2000

> mobile data traffic will grow 66-fold from 2008 (131% CAGR)

see Cisco's paper "Hyperconnectivity and the Approaching Zettabyte Era."

The Paralleladigm

the **exacloud** requires bandwidth and speed of

thankyou

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