An Exponentially Expanding Future from Exponentially Shrinking Technology

Foresight Institute
New Conference on Advanced Nanotechnology
October 22, 2004

Ray Kurzweil
The Paradigm Shift Rate is now doubling every decade
Growth of U.S. Phone Industry

Data from: AT&T Labs
Estimated U.S. Cell Phone Subscribers

Data from: Cellular Telecommunications & Internet Association
Mass Use of Inventions

Years Until Use by 1/4 U.S. Population

Data from: The Millennium Notebook, Newsweek
Countdown to Singularity

Logarithmic Plot

Time to Next Event (Years)

Time Before Present (Years)

Source: Ray Kurzweil, KurzweilAI.net
Countdown to Singularity

Time to Next Event (Years)

Time Before Present (Years)

Source: Ray Kurzweil, KurzweilAI.net
Paradigm Shifts for 15 Lists of Key Events

Time to Next Event (Years)

Time Before Present (Years)

Logarithmic Plot

Source: T. Modis
28 Canonical Milestones

Logarithmic Plot

Source: T. Modis
Information Technologies (of all kinds) double their power (price performance, capacity, bandwidth) every year
# A Personal Experience

<table>
<thead>
<tr>
<th>Measure</th>
<th>MIT’s IBM 7094</th>
<th>Notebook Circa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2003</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>1967</td>
<td>2003</td>
</tr>
<tr>
<td>Processor Speed (MIPS)</td>
<td>0.25</td>
<td>1,000</td>
</tr>
<tr>
<td>Main Memory (K Bytes)</td>
<td>144</td>
<td>256,000</td>
</tr>
<tr>
<td>Approximate Cost (2003 $)</td>
<td>$2,000,00</td>
<td>$2,000</td>
</tr>
</tbody>
</table>

22 Doublings of Price-Performance in 36 years, doubling time: 19 months not including vastly greater RAM memory, disk storage, instruction set, etc.
Moore’s Law is one example of many....
Evolution of Computer Power/Cost

MIPS per $1000 (1998 Dollars)

Brain Power Equivalent per $1000 of Computer
- Human
- Monkey
- Mouse
- Lizard
- Spider
- Nematode
- Worm
- Bacterium
- Manual Calculation

Year

1900 1920 1940 1960 1980 2000 2020

Million

1000

1

1000

1

1 Billion

Monroe Calculator

IBM Tabulator

Burroughs Class 16

ASCC (Mark 1)

Zuse-1

Colossus

UNIVAC I

ENIAC

DG Eclipse

Apple II

Mac II

Macintosh-128K

Commodore 64

Gateway-486DX2/66

PowerMac 8100/86

Gateway GS-200

Mac G3/266

IBM 7090

IBM 704

CDC 7600

DEC PDP-10

IBM 1130

Whirlwind

IBM 7010

DEC VAX 11/780

IBM 360/75

Burroughs 5000

IBM 1620

IBM 650

DEC-10

DG Nova

SDS 920

IBM 7040

Mac IIx

IBM PS/2 90

Power Tower 1800e

AT&T Globalyst 600

Sun-3

Vax 11/750

Sun-3x

1971 Trend

1981 Trend

1991 Trend

2001 Trend
Transistors (Intel processors)

Data from: Intel Research

Doubling time: 2 years