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INTEGRATING THE TELECOSM

It has been a hot time in the paradigm this month. Indeed, Telecosm companies have heated up so much that to keep up with them I have actually had to start heavy lifting on the front page of the *New York Times*. My wife Nini says I get nervous if people begin agreeing with me–if I start to feel the "heat of the herd." Thermal noise is my sell sign. Well, I'm not ready to sell anything yet. But if you've been feeling lonely out there on the range, with no comfort but Scott McNealy and the Marlboro man, now is a time to watch out for the heat of the herd.

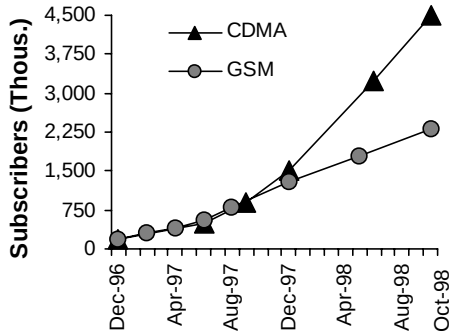
Sun's Java has emerged as the driving force behind a reordering of the Internet economy.

Java component software, Code Division Multiple Access (CDMA) wireless, cable modems (also increasingly CDMA), and All Optical Networks (AON), all are proving their mettle as ascendant technologies. These are key parts of the new paradigm in computers and communications that we have been developing in GTR. **Sun**'s (SUNW) Java offers software components that you can download over the Internet and use to animate web pages, conduct transactions in real time, or even link appliances–cellphones, digital cameras, printers, car speakers, whatever–as Java "objects." CDMA gives **Sprint PCS** (PCS) and its rivals the ability to offer superior noise free voice and convenient Internet access over cellular phone systems. Cable modems are increasingly the way to gain fast Internet access from your home. All Optical Networks allow messages to fly around the world or around your office entirely on wings of light.

From the back pages of business sections, these exotic ideas rumbled toward the front pages of major newspapers. Java even lurched for a day into the coveted right hand top slot of the *Times*. Meanwhile, Clayton Christensen, author of the *Innovator's Dilemma* (see, GTR 10-98) extended his theory of innovation–the dynamics of technological disruption–just in time to explain it all. Investors, too, may have an innovator's dilemma. When the herd catches up, do you buy more, or sell into the stampede?

Chart 1

CDMA Outpaces GSM in North America



Sources: NA GSM Alliance, CDMA Dev. Group

I say that this Telecosmic paradigm is such a fundamental change that, after carefully reading Christensen to grasp the crucial dynamics, you buy more. Christensen gives key insights on how technological change plays out in business strategy. But of course I'm already so hooked on the Christensen drug that I have been trying to sign up the eminent professor to supply it on a more regular basis. More on this in the new year.

Step one in last month's paradigm breakout was the emergence of Sun's Java platform and programming language, long disparaged as this report's most hype-laden enthusiasm, as the disruptive force behind a reordering of the Internet economy. Java continued its stream of successes in unexpected venues and markets outside the dominant Wintel regime.

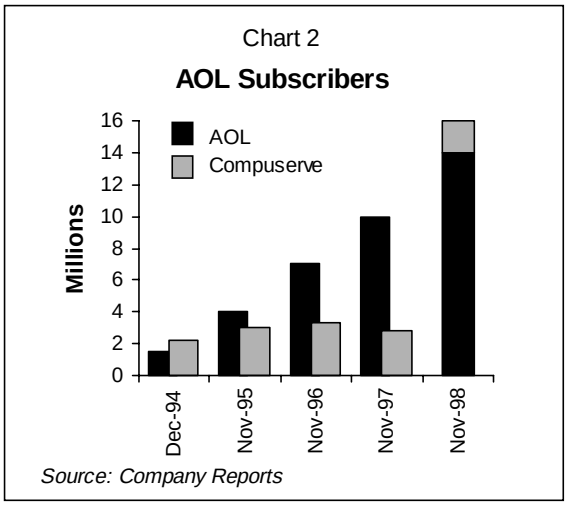
First, Northern California's Federal District Court granted Sun a complete victory in its suit against **Microsoft**'s (MSFT) proprietary Java extensions, giving Microsoft 90 days to get the offending code out of Windows 98. Then, **America OnLine** (AOL) and Sun gobbled up **Netscape** (NSCP). Sun's role in the transaction was to take over Netscape's server software business and to supply Java based Internet transaction,

Microsoft is joining Qualcomm to develop basestation software to accommodate a variety of wireless data devices.

animation and wireless access technologies. AOL sees Java as a way of delivering its services to the new generation of digital cellular phones full of Javatized computer features.

To many observers, inside Sun and out, these gains by Java seem diversionary, providing little income to Sun and distracting the company from its core business in workstations. But such cavils are typical in the early phases of Christensen disruptions, which typically crop up first in niche markets before expanding into the mainstream.

A case in point was the announcement by **Xilinx** (XLNX)–another charter telecosm company–of a Java based revolution in remote redesign of microchips. Using the company's *Silicon Expresso* technology, Xilinx customers will be able to use Java applets to reconfigure Xilinx gate arrays in microseconds over the Internet. An early niche customer is **IBM**'s Networking Hardware Division, using the Java devices for remote upgrades of customer equipment. But in a world of scarce silicon area, the Xilinx technique will ultimately enable system-on-a-chip designers to use the same chip for multipurpose products, whether in settop boxes, games, security systems, industrial process controllers, ATM machines, cellular base stations, or satellite communications systems.



Java is also breaking out in Europe. A delegation of magnates from the EEC's Digital Video Broadcast project arrived at Sun Headquarters in late November to seek rights to a Java subset for settop boxes, wireless devices, and other consumer systems. A key to Java's versatility is the "Java Virtual Machine," a generic software computer platform included in browsers, settop boxes, handhelds, and other devices that often lack windows but want to view the world wide web outside. "We want to upgrade to the Java Virtual Machine," explained Jean-Francois Jezequel, head of marketing for **Canal Plus**, which has shipped some three million settop boxes with a proprietary system. Since **TCI** (TCOMA) has already adopted Java for US cable applications, the European initiative gives Sun an opportunity to make Java an international standard for digital TV. Because TVs hugely lag PCs in rate of technological advance, any digital TV standard will soon become more vital as a video standard for PCs.

Meanwhile, also in Europe, **Intentia** (Stockholm Exchange), the Swedish enterprise resource planning (ERP) software company on our Telecosm Technologies Table, used Java to blast its way out of its current gilded ghetto of AS-400 IBM minicomputer technology. AS-400 is a very stable but vulnerably mature IBM platform used by mid-sized businesses which are not sufficiently fun loving to relish the surprises in Microsoft's NT. An ambitious software company such as Intentia needs an escape valve from the minicomputer corral and Java is providing it. Intentia announced that it would soon introduce a Java based version of its popular Movex ERP package.

The dominant ERP program is **SAP**'s (SAP) R/3 which is a huge largely integrated package that entails prolonged and arduous customization. Christensen points out that **Andersen Consulting** alone earns $3.5 billion a year customizing SAP programs mostly for Forbes 100 companies. For most of the market, SAP constitutes technology overshoot. Intentia offers a far more modular alternative, optimized for the larger universe of small and midsized companies with global reach. Java gives Intentia software a route to easier portability to these diverse company environments. At the same time, Intentia hailed Java's compatibility with the wireless Internet access devices that this report has long hailed as the dominant PCs of the next era.

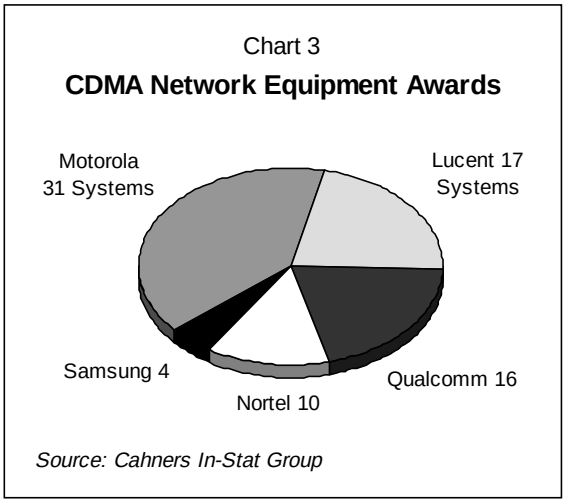
In Europe, most of these devices are based on the GSM (Global Mobile System) cellular standard. But as Bill Gates noticed in launching a new partnership with **Qualcomm** (QCOM) named WirelessKnowledge, the most impressive by far of these uppity cellphones are coming from this Telecosm favorite in San Diego. Early bet for the most popular handheld computer product next year is the stunning pdQ phone with a Palm [Pilot] 3 operating system and wireless modem scalable to 2 megabits per second. Among many convenient features that have made **3Com**'s (COMS) Palm the most popular personal organizer, the Palm system gives your cellphone email and webpage access, and a phone book from which you can make one click calls. Qualcomm has already begun mass production of pdQs in Sao Paulo, Brazil.

Although Microsoft hopes that all wireless devices will run Windows, Qualcomm will not be making any Windows CE pdQs unless Microsoft can get this now cumbersome system up to scratch for cellphones. The pdQ is now exclusively dedicated to 3Com's Palm, which is a moving target just upgraded to Palm VII with new Internet browsing features and Java. Of course, the GSM entente is trying to get a proprietary European solution under way. **Nokia** (NOKa) is now using **Geoworks** (GWRK) OS in its popular 9000 teleputer, but the Finnish titan is now joining with **Ericsson** (ERICY) and the other Europeans in a collective move to **Symbian**, the palmtop OS introduced by **Psion** of

the UK. Grasping that this tower of Babel is not susceptible to the usual Windows über alles strategy, Microsoft turned to Qualcomm to help spur the still sluggish arena of wireless Internet access and groupware services.

The Microsoft move reflects a general yearlong upsurge in the CDMA spread spectrum paradigm. The highlight was CDMA's adoption by the Europeans for the next generation of GSM. In 1998, Qualcomm doubled production of handsets, to a total of 7 million, and the CDMA virtuoso Koreans hiked deployment from 6 million to 12 million phones. In an upset, **Motorola** (MOT), long a laggard, surged into the lead in the list of top suppliers of CDMA infrastructure, with major contributions to SprintPCS facilities.

Motorola has also announced a new Java disruption in the networking space. Watch out **Nortel** (NT) and **Cisco** (CSCO). The only limitation is that the networks cannot reach farther than 15 feet. Called Piano, the wireless system uses Java to enable e-mail, web browsing, and a host of Internet and intranet functions within what they call the "personal network space." Included are file exchange, financial transactions, checkoutless retail purchases, wireless printing, and automatic ticketing or check-in at hotels, airlines, and theaters. Working seamlessly with Sun's Jini in larger networks, Piano requires no prior knowledge or special device drivers. If the needs of one device will be satisfied by the capabilities of another, then a transaction is performed and encrypted to provide wire equivalent privacy. If Motorola does not watch out, it will become a paradigm company again.



All these advances illustrate the progress of a disruptive technology, Java, that has failed as a desktop platform, failed as a suiteware language, failed in every usual test of fast performance, failed to penetrate most Forbes 1000 MIS departments, and commands only 89.5 percent marketshare in web development tools used by companies with fewer than 100 employees (a low margin business that hardly counts at all). The reason people accept this sluggish and defective system is that it is the most convenient pathway into the paradigm, out the window and onto the web. It is based on the proposition that it is more important to save the programmer's time and the customer's time than to save the microprocessor's time, when the microprocessor is overshooting customer needs, leaving it with plenty of time on its hands (Pentium's spend an estimated 80 percent of their cycles in wait states).

In October, we explained this Christensen paradigm of disruption, for which Java and wavelength division multiplexing (WDM) are key examples in the context of GTR. Disrupters prevail chiefly in a condition of technology "overshoot," such as suiteware codebloat (Microsoft) and "advanced intelligent networks" (**Lucent**, LU) and microprocessors that outpace the memory and peripheral technologies that surround them (**Intel**, INTC). When overshoot occurs, it becomes possible for companies to sacrifice state-of-the-art performance in favor of the convenience and low costs of simpler, less full featured devices. For example, at a time when performance is governed chiefly by Internet access speed, Intel and Microsoft have clearly overshot the needs of most PC purchasers for faster processors and more feature rich software suites.

In terms of pure disruption, though, handheld devices are the key area where Wintel products–Pentium processors and even Windows CE–have vastly overshot customer needs. It is these so-called "information appliances," mostly based on digital cellphones, that GTR has long predicted will be the most popular PCs of the new era. Radically inferior by most conventional measures to the desktop PCs and workstations that Intel and Microsoft are stressing in their plans, the new devices will sell in larger volumes. Thus they will experience a sharper learning curve (faster cost drops and performance hikes) than the sustaining desktop machines will.

Expect large market share gains by more compact and portable software (Java, Palm, Psion et al) and by cheaper, slower, lower-powered processors from **ARM** (ARMHY) and **National Semiconductor**/Cyrix (NSM) (which has been announcing a new single-chip system every day).

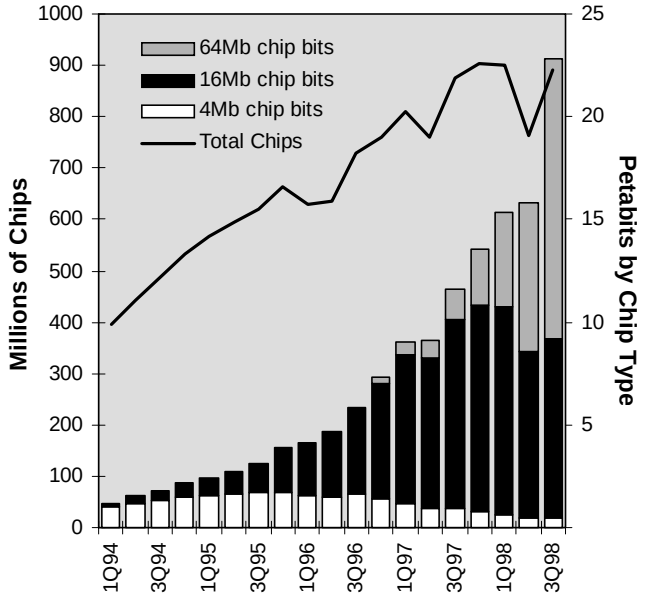
More usual in the telecosm, however, than technology overshoot is technology undershoot. Here the market needs more performance, not less, than mainstream technology offers. Under these circumstances, sustainers can reap the rewards of a fast ascendant mainstream market. Extending this insight in a new paper, Christensen and his colleagues at the Harvard Business School explain how what we might call the disruptech paradigm applies to the long perplexing issue of when to outsource technologies and when to keep them in house. In the process, he offers a powerful new way of identifying which companies will prevail in each particular phase of technological development.

The controlling factor is modularity. As a technology matures, interfaces between its various components become deterministic–predictable

CDMA will ultimately prevail in the noisiest arena outside a heavy metal concert: cable TV's lower forty megahertz.

Chart 4

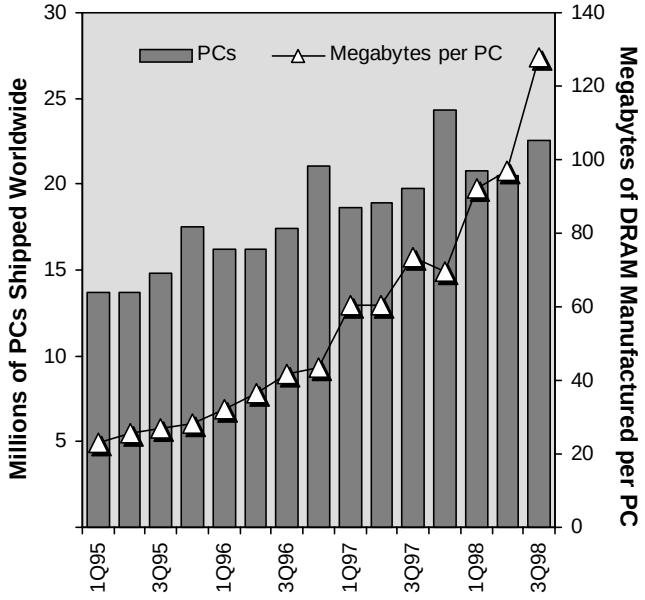
DRAM Chips and Bits Boom



Source: ICE, ICInsights

Chart 5

DRAM Bits per PC Unit Shipped



Source: GTG, ICE, ICInsights

MICRON CATCHES DRAM WAVE, AGAIN!

*Demand for DRAM jumped in 3Q98. Measured in memory bits shipped, demand doubled over 3Q97 and rose 45% from the previous quarter. Chip shipments neared all-time highs, as even the 88% quarterly rise (827% increase year-to-year) in high-density 64 megabit chip production could not meet demand and older generation 16 megabit production increased (***Chart 4***). The jump in demand was not merely a result of strong PC sales or seasonal factors but a reflection of an increase in demand per PC. The amount of DRAM produced worldwide divided by the number of PCs shipped (roughly DRAM per PC, but not necessarily shipped with a PC) rose 32% from 2Q98 and 74% over 3Q97 (***Chart 5***). While DRAM demand skyrocketed, supply was restricted. With continuing DRAM price drops during 1H98, Siemens, Fujitsu, Hitachi and Mitsubishi announced DRAM fab closures, while Toshiba and the South Korean vendors announced scaled back production plans or outright production cuts. The combined results of increased demand and limited supply was a stabilization and even rise in DRAM spot market prices (***Chart 6***). Taking advantage of the situation, after previously cutting production, the Korean manufacturers Samsung, LG Semicon and Hyundai are increasing 64 megabit production 40%, 36% and 25%, respectively, by year's end. Buoyed by a $500 million Intel investment and plans to upgrade the DRAM fabs acquired from TI, Micron Technology enters 1999 positioned to continue leading the revived DRAM market.*

KODAK: LEADER IN DIGITAL CAMERAS? (OR IS IT BARBIE?)

*Digital Camera Shipments increased some 62% in 1998 to surpass 3 million units worldwide, according to Nikkei Market Access (***Chart 7***). In Japan, which accounted for nearly 50% of worldwide sales, Fuji led the market with a 22.1% share followed by Olympus (19.8%), Seiko-Epson (13.7%) and Casio (11.2%). Casio's drop to 4th place from its 1st place share of 30.1% in 1997 was attributed to the popularity of new higher resolution models by its competitors. Expanding its leadership, Fuji has reportedly begun supplying 1.5 million-pixel cameras on an OEM basis to Toshiba, Victor Co. of Japan and Leica in Germany. In the 1 million unit US market, Sony led 1998 sales with its high-priced, low-resolution floppy-disk camera, as buyers favored convenience over image quality. That seems to be changing as ZD Market Intelligence figures for October 1998 show Kodak (33.7%, up from 18.2% in April) taking the lead from Sony (33%, down from 46.8% in March), followed by Olympus (10.2%), Agfa (9.4%), HP (3.2%) and all others (10.5%). But watch out for truly disruptive technology. Apparently left out of these figures are the GameBoy and Barbi "toy" cameras, which have been flying off store shelves. In Japan, Nintendo reportedly sold 500,000 cheap, low-resolution, black and white GameBoy digital cameras during their first few weeks of release alone.*

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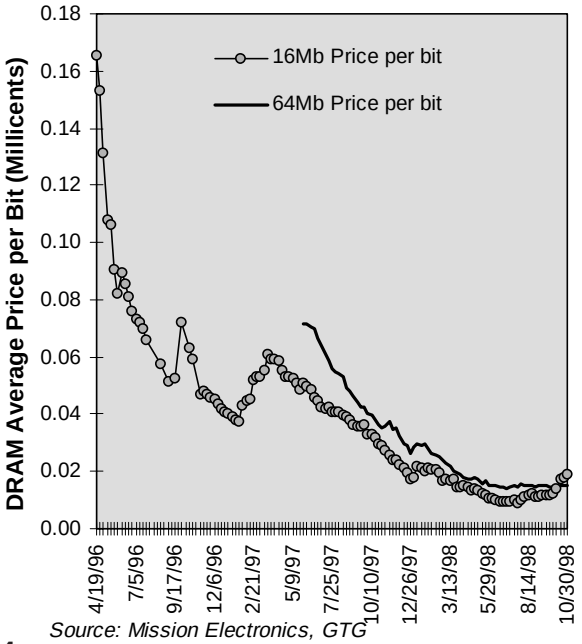
Chart 6

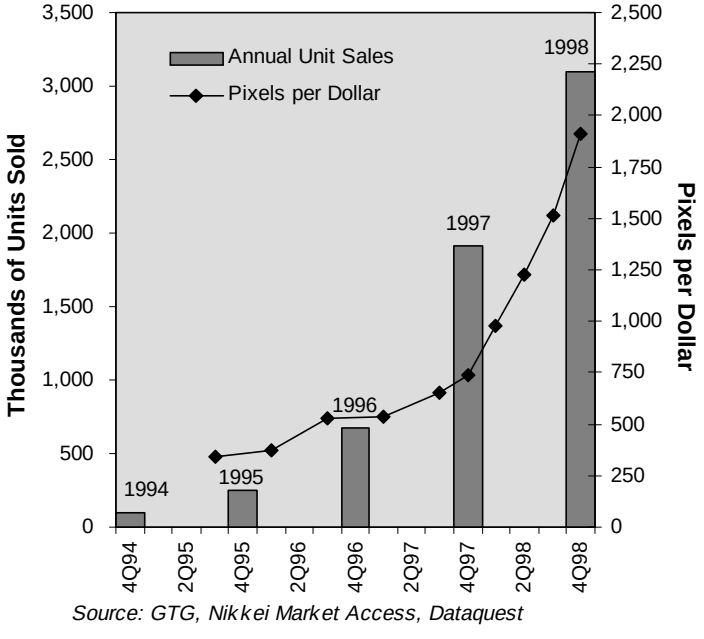
DRAM Prices Stabilize



Source: Mission Electronics, GTG

Chart 7

Digital Camera Sales Rise With Value



Source: GTG, Nikkei Market Access, Dataquest

Chart 8

Internet Shopping Climbs

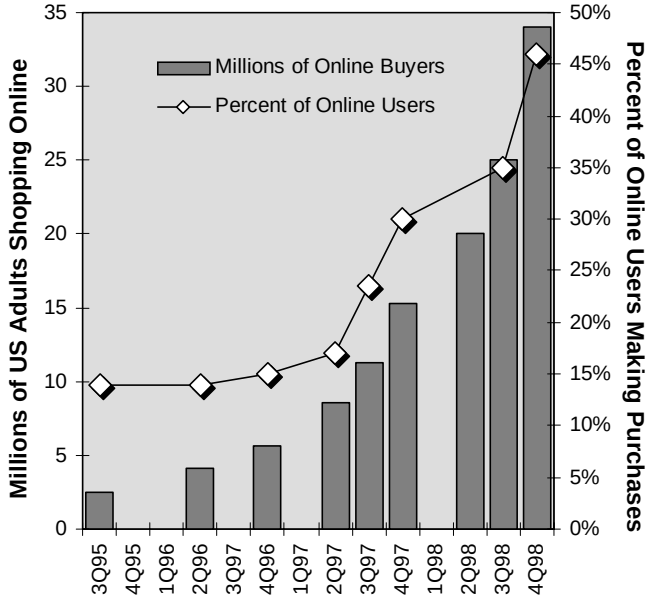
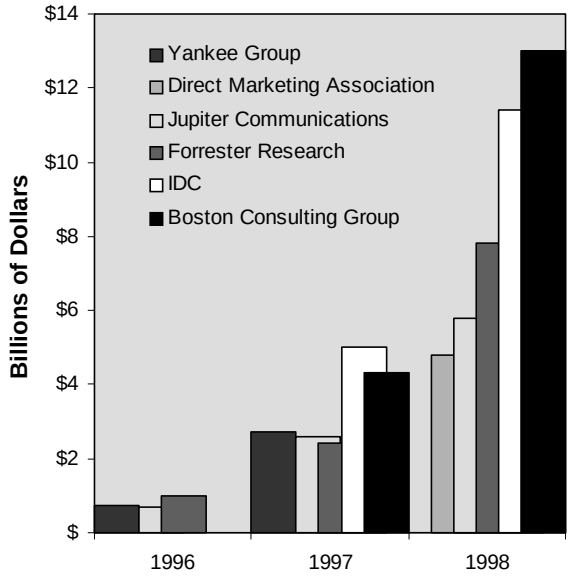


Chart 9

Retail/Consumer Sales on Internet



CHRISTMAS COMES EARLY FOR INTERNET MERCHANTS

*Internet Shopping exploded to new highs in 1998 both in millions of shoppers online and as a percentage of Net users (***Chart 8***). As previously reported here, counting those who have ever made an online purchase, the totals rose to 15% of all Americans or 60% of online households as early as last summer (according to a Wirthlin poll and PSI Global, respectively). Those figures have been confirmed by a recent Louis Harris survey for Dell reporting 69% of Americans who use computers with an online connection had used the Internet to shop. But, the Harris figures drop to 43% when focused on holiday shopping plans, VISA puts the figure at 46%. With nearly 100% of those who have made online purchases expressing satisfaction there is a boom of repeat shopping. But VISA reports a full 60% of those planning to holiday shop online have not previously purchased online, and AOL reports that each week 20% of those making purchases on AOL are doing so for the first time.*

*The dramatically fast increase in online shopping has made calculations of retail Internet sales difficult, with estimates ranging from under $5 billion to $13 billion for 1998 (***Chart 9***), varying by different measurement methods. The Boston Consulting Group conducted a study for shop.org which surveyed 127 online retailers and estimated 1998 retail sales at $13 billion. Included in the total are Dell's "retail" sales (some $6 million/day throughout the year) though some 90% of Dell's Internet sales are commercial. Also included are online trading commissions from Schwab and others (***Chart 10***).*

*Regardless of definitions of retail or consumer, when all e-commerce is included the totals more than triple (Forrester Research $7.8b consumer, $17b total; eMarketer $4.5b, $15.9b; Keenan Vision $40b total). According to ZD Market Intelligence over 10% of all businesses have adopted e-commerce (***Chart 11***) much of it business-to-business. Intel has joined heavy-weights Dell, Cisco, Boeing online. Within 1 month of coming online this summer sales rose to and remained at some $1 billion per month, with Intel's 4Q98 online sales expected to total $2.5 billion. When ActivMedia released its 5th Annual Real Numbers behind the Net Profits study in 1998 showing $21.8 billion in 1997 online sales their numbers blew away previous estimates. Expect a similar upside surprise this year.*

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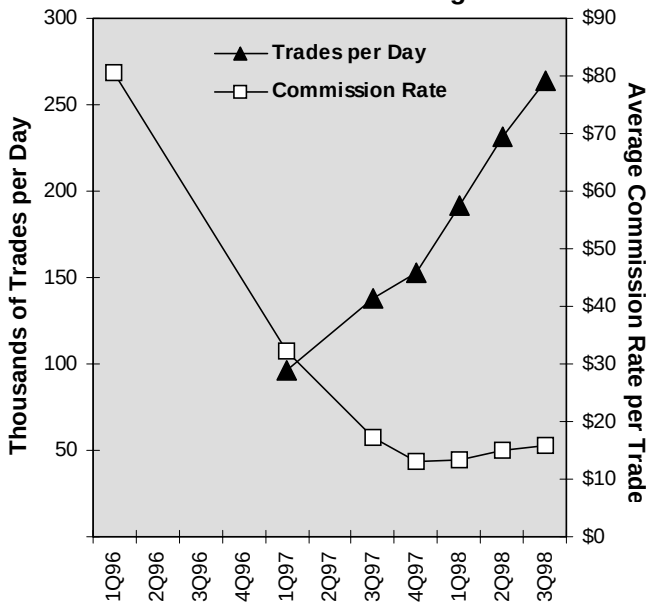
Chart 10

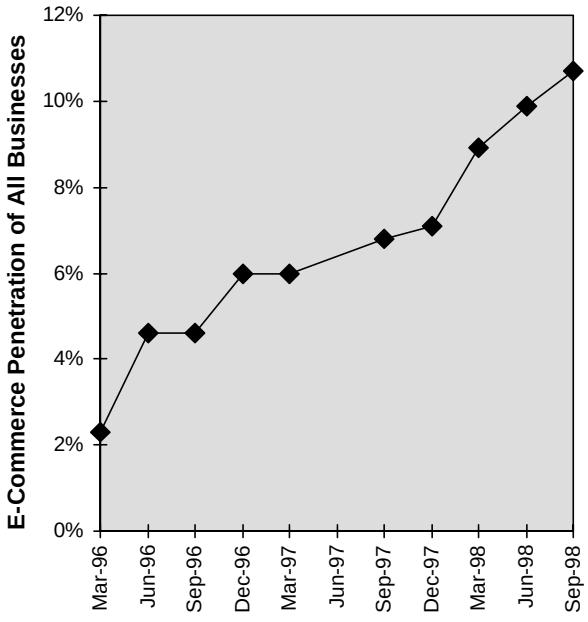
Online Stock Trading



Source: Piper Jaffray

Chart 11

Business Adoption of E-Commerce



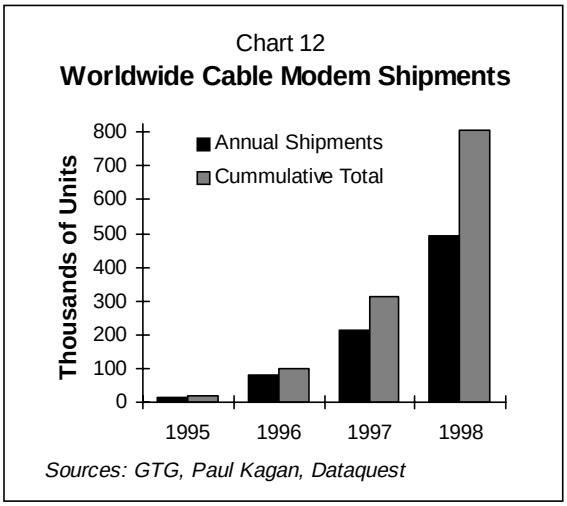
Source: ZD Market Intelligence

Terayon has allied with Broadcom and CableLabs to incorporate Terayon CDMA technology into the industry's cable modem standard.

enough to be standardized, opening the door to low cost makers of generic components. As rival companies pile in, prices and margins drop. Dominant systems manufacturers can no longer safely assume that they will be the low cost component producers. Under these circumstances, outsourcing is often desirable, if not imperative.

Christensen's insight is that modularity becomes feasible for the same reason that disruption from below becomes feasible. The key is technology overshoot–the tendency of established companies to push their sustaining technologies to the point that they overshoot the needs of their market. Overshoot enables rivals to win by sacrificing performance in order to achieve the low costs and convenience of modularity and outsourcing.

The opposite of modularity is *integration*. In the case of *under*shoot, modularity and outsourcing can become counterproductive. When a technology undershoots market demand, each component of the system must often be adapted interactively to every other component to squeeze every possible performance benefit out of the system. In this situation, a single company that can design and fabricate the entire system or large portions of it is likely to be the strongest competitor. Examples of undershoot, with integration potential (and possible mergers) abound today in such fields as voice over IP, Internet access, wireless data, and all optical networks.



In other words, there are times when you want to be a sustainer, extending the technology mainstream rather than disrupting it from below. Such is the case today with CDMA. Sustainers steadily advance the state of the art. This is what you want in a market where the prevailing strategy of the leading providers–the RBOCs–has been to protect their wireline markets by a wireless policy summed up as "more money for less service." This is classic undershoot and CDMA from such providers as Sprint PCS is meeting this challenge of replacing wires rather than supplementing them.

CDMA can also help sustainers in undershoot situations beyond cellphones. Since spread spectrum is preferred wherever noise is the key problem of a communications system, we believe that CDMA will ultimately prevail in the noisiest arena outside a heavy metal concert: cable TV's lower forty (or fifty) megahertz. This span of frequencies cable TV shares with cordless phones, AM radios, garage door openers, Citizens Band radios, and scores of other low frequency devices.

In cable TV, these bottom frequencies are currently used for upstream communications back to cable central, the headend. One of our favorite companies therefore has been **Terayon** (TERN), the CDMA cable innovator, introduced in our triumphalist CDMA issue of January 1997 ("Telecom Coup") and of the Telecosm conference in 1997.

Until now, however, Terayon's success has been confined chiefly to overseas, in Brazil, Europe, and Israel, and in Canada, where **Shaw Communications** (STV) has been working with **@Home** (ATHM). Now, however, Terayon has announced an alliance both with **Broadcom** (BRCM), the leading cable modem chip supplier, and with CableLabs, to incorporate Terayon CDMA technology into the industry's DOCSIS (data over cable system interface standard). DOCSIS is the industry standard that allows cable modems from different companies to interoperate with one another.

The DOCSIS forces initially spurned Terayon as an excessively complex and novel technology to incorporate in a modular industry standard. Still classic undershooters, however, cable modems could not long do without the advantages of state of the art CDMA. Terayon CDMA's unique immunity to noise enables full two way systems running upstream at 10 megabits per second or above (compared with a usual 256Kbps upstream rate) or it allows extension of cable modems to areas with unregenerate cable coax. These are lines that previously could not handle broadband data at all without expensive reconditioning or replacement.

Cable prevails over telephone ISDN and DSL solutions for the same reason Ethernet prevailed in offices. Both are shared media that push all the intelligence to the edges of the network where intelligence belongs. While the microcosm offers smart switches as a remedy for inadequate bandwidth, the telecosm offers dumb bandwidth as a substitute for smart switches. Consider for example the problem of sending a movie or a software upgrade to ten million homes. A smart network would switch the movie like a telephone call step by step down branching wires separately to each household. A dumb network would broadcast the bits everywhere and depend on smart terminals to capture the contents and download it.

Last month, in my role doing angelic visitations as an investor at **garage.com**, I encountered a company called **Digital Fountain** that uses intelligence at the terminal radically to facilitate the broadcast model. Invented by a professor of computer science at Berkeley, this firm's software accomplishes the amazing feat of rendering a broadcast holographic

(with each part containing a dim image of the whole). If a software package contains a gigabyte of information, a customer can tap into a broadcast at any time and download any random gigabyte (plus a small overhead) and get the entire program, film, or other digital product. No longer would downloads need to be scheduled or coherent. Just turn on a digital fountain in the sky and computers can receive your information in any order or intermittent sequence. The user can tune at random and regardless of interruptions can receive an entire coherent entity.

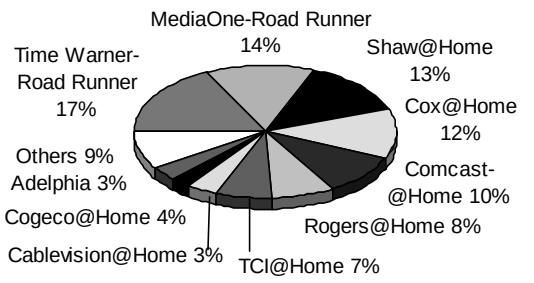
In the Telecosm, engineers invent increasingly clever ways to use dumb networks to supply information and services to the increasingly smart devices on their periphery. Impelling the telecosm is an increasingly widespread recognition that in a world of dumb terminals, such as telephones and TV sets, networks had to be smart; but in a world of smart terminals, such as computers, networks should be as dumb as a stone.

The most important dumb networks are passive all optical systems. Deployed underseas by **Global Crossing** (GBLX) and various schools of PTT whales, and used in point-to-point connections by **Qwest** (QWST), **MCIWorldCom** (WCOM), **Level 3** (LVLT), **Williams** (WMB) Communications and their peers, all optical technology has to be dumb. A simple waveguide channelling light pulses cannot simultaneously do much smart processing.

Chart 13

North American Cable Modems

1998: 513,000 Subscribers



Source: Kinetic Strategies

Today, fiber optics is afflicted with profound undershoot. Optical suppliers cannot provide a fast photonic packet switch, a robust optical cross connect switch, a cost effective add-drop multiplexer, an all-optical EDFA (erbium doped fiber amplifier) that can evenly boost the full range of wavelengths in leading edge WDM systems. Thus in optics, there will be need for integration. Even **Uniphase** (UNPH) with its beautifully executed component strategy is increasingly producing integrated products such as entire EDFA modules. "We are forced to integrate by our customers," Uniphase CEO Kevin Kalkhoven avers.

Most of the major telecom suppliers, however, view all-optical technology as a way to improve the existing switched telephone network rather than to replace it. As Christensen explains, for the telcos, this approach is inevitable. In their copper cage, they are trapped by literally a trillion dollars worth of installed base around the world, virtually all of it in electronics or optoelectronics that can be rendered obsolete by cheap dumb optics.

Two companies, however–fully free of significant entanglement with the established base of telecom gear–are now moving aggressively into the field of telecommunications. They are the historic originator of fiber optics, **Corning** (GLW) Glass, and a venerable energy company, **Enron** (ENE).

Corning scientist Frank Hyde in 1934 invented fused silica, the first fiber pure enough to be used in communications. In 1978 Corning used this process to create the first single mode fiber (still dominant today) in volume. For most of the last three decades it has been the most salient company producing fiber optic line. Yet pressed by rivals in Japan and around the globe, it has never made very much money on the stuff. Corning's problem was that it saw itself as glass and silica company rather than a communications force.

In the last year, however, it has sloughed off its breast implants, chucked its specimen bottles, thrown its famous Corningware glass into the hands of a Borden affiliate for $603 million, and emerged as a macho photonic giant. Acquiring the Optical Corporation of America (OCA) in 1997, establishing a St. Petersburg optics laboratory with 30 top Russian scientists, and expanding by 60 percent its domestic its R&D, the company now seems ready to make some deserved dough in optics.

In 1998, Corning's optical fiber market share has grown from 29% to 35% globally and to 50% of the North American market.

In the last year, Corning's share of the optical fiber market has grown from 29 percent to 35 percent globally and to 50 percent in North America, far ahead of second place Lucent. Corning's new LEAF (large effective area) fiber and its undersea cousin *Submarine* LEAF have been adopted by Level 3, Williams Communications and **IXC Communications** (IIXC) for their nationwide fiber buildouts (Qwest went with Lucent's rival TrueWave product). Corning's new fibers will support the latest WDM systems from Lucent (80 channels), Nortel, and the 96 channels of **Ciena** (CIEN). The company is working to capture an additional band of usable frequencies from 1570 to 1625nm (the long band) to expand the number of potential "colors" still further.

Integrating beyond fiber, Corning has also become the world's largest supplier of erbium-doped fiber amplifier (EDFA) modules (using components from Uniphase, **JDS-Fitel** [Toronto Exchange], and others). On June 3, Corning announced its FiberGain module will be incorporated in Nortel's next generation WDM amplifier. These units, which can amplify 80 or more WDM channels or frequencies of light simultaneously, in a single fiber, are critical in all long distance fiber optic networks.

Enron Communications like Corning has no telecom installed base. But **Mars** candy and **Toys R Us** (TOY) could make the same claim. Enron differs

TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	Reference Date	Reference Price	Price as of 12/3/98
Cable Modem Service	*@Home* (ATHM)	7/31/97	19 1/2	52 7/8
Silicon Germanium (SiGe)	*Applied Micro Circuits* (AMCC)	7/31/98	22 11/16	36 3/8
Analog to Digital Converters (ADC), Digital Signal Processors (DSP)	*Analog Devices* (ADI)	7/31/97	22 3/8	27 1/4
Dynamically Programmable Logic, SiGe, Single Chip Systems	*Atmel* (ATML)	4/3/98	17 11/16	13 13/16
Single-Chip Broadband Data Transmission	*Broadcom Corporation* (BRCM)	4/17/98	24 *	91 7/8
Digital Video Codecs	*C-Cube* (CUBE)	4/25/97	23	28 3/8
Erbium Doped Fiber Amplifiers, Wave Division Multiplexing (WDM)	*Ciena* (CIEN)	10/9/98	8 9/16	17 5/8
Fiber Optic Cable, Components, Wave Division Multiplexing (WDM)	*Corning* (GLW)	5/1/98	40 15/16	40 1/16
Submarine Fiber Optic Networks	*Global Crossing* (GBLX)	10/30/98	29 5/8	39 5/16
Low Earth Orbit Satellites (LEOS)	*Globalstar* (GSTRF)	8/29/96	11 7/8	17 5/8
Business Management Software	*Intentia* (Stockholm Exchange)	4/3/98	29	33 11/16
Wave Division Multiplexing (WDM), Fiber Optic Equipment	*JDS Fitel* (Toronto Exchange)	5/1/98	19 1/4	21 7/8
Broadband Fiber Network	*Level 3* (LVLT)	4/3/98	31 1/4	34 5/8
Single Chip ASIC Systems, CDMA Chip Sets	*LSI Logic* (LSI)	7/31/97	31 1/2	19 1/16
Telecommunications Equipment. WDM, CDMA, SiGe	*Lucent Technologies* (LU)	11/7/96	23 9/16	88 1/4
Telecommunications, Fiber, Internet Access	*MCI WorldCom* (WCOM)	8/29/97	29 15/16	60
Single-Chip Systems, Silicon Germanium (SiGe)	*National Semiconductor* (NSM)	7/31/97	31 1/2	16 5/8
Telecommunications Equipment, WDM, CDMA, SiGe, Cable Modems	*Nortel Networks* (NT)	11/3/97	46	46 3/16
Point to Multipoint (7-50 Ghz), Spread Spectrum Broadband Radios	*P-COM* (PCMS)	11/3/97	22 3/8	3 1/8
Code Division Multiple Access (CDMA)	*Qualcomm* (QCOM)	9/24/96	38 3/4	53 7/8
Broadband Fiber Network	*Qwest Communications* (QWST)	8/29/97	20 3/8	41 13/16
Linear Power Amplifiers	*Spectrian* (SPCT)	7/31/98	14	13 1/2
Nationwide CDMA (Code Division Multiple Access) Wireless Network	*Sprint PCS* (PCS)	12/3/98	15 3/8	15 3/8
Java Programming Language, Internet Servers	*Sun Microsystems* (SUNW)	8/13/96	27 1/2	72 15/16
Broadband Wireless Services	*Teligent* (TGNT)	11/21/97	21 1/2 *	32
CDMA Cable Modems	*Terayon* (TERN) +	12/3/98	31 5/8	31 5/8
Digital Signal Processors (DSPs)	*Texas Instruments* (TXN)	11/7/96	23 3/4	81
High-Speed Copper Networking	*Tut Systems* (Private)	Anticipated IPO		
Wave Division Multiplexing (WDM) Modulators	*Uniphase (UNPH)*	6/27/97	29 3/8	62 3/16
Field Programmable Gate Arrays (FPGAs)	*Xilinx* (XLNX)	10/25/96	32 7/8	56 13/16

\+ New Addition * Initial Public Offering

Added to the Table: Terayon.

Note: This table lists technologies in the Gilder Paradigm, and representative companies that possess the ascendant technologies. But by no means are the technologies exclusive to these companies. In keeping with our objective of providing a technology strategy report, companies appear on this list only for these core competencies, without any judgement of market price or timing.

from them, but resembles WilTel, in having a rich parent with major rights of way in pipelines around the world. With 15 thousand route miles of single mode fiber already in place or leased (about as much as Qwest), Enron Communications now has agreed to work with Cisco Systems and Ciena to make the network disruptive.

Eliminating all the SONET and electronic switching and muxing equipment in established telco networks, Enron's system will extend pure IP on glass to metro as well as backbone networks. On the edges, Cisco 12000 routers will connect directly to WDM terminals using OC-48C network cards. Any need for Quality of Service (QoS) assurances will be met with bandwidth. Restoration will not be a problem (if there is adequate bandwidth) since TCP/IP has automatic rerouting capabilities in case of network interruption.

In Christensen terms, all optical networks combine integrative and disruptive effects. Thus they resemble the integrated circuits of the microcosmic era, which combined slow transistors and other components on a single sliver of silicon. The new all optical networks will integrate relatively slow switches and other components on a seamless seine of silica. By integrating inferior components in innovative ways, both ICs–the one on the chip and the one on the continent–gained the power to disrupt the existing establishments of computers and telecom.

George Gilder (with Jeff Dahlberg) December 3, 1998

After much consideration, we have decided to allow ForbesASAP exclusive rights to publish an occasional adapted text from the reports some six to eight weeks following receipt by GTR subscribers. In practice this will mean there is a possibility of a second wave of impact after initial publication.

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