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OUT OF THE CONFERENCE: Heat, Light, and Limits

Let us all bask in the heat and light of the Bernie Ebbers moment, the **WorldCom** (WCOM) efflorescence. Let us hail the coming of a broadband Internet, blasted free of the copper cages and regulatory blight of the global bureaucratels.

Wealth springs from a synergy of scarcity and abundance, released in an entrepreneurial vision. The paragons of a new era use its abundances to relieve its scarcities. Emblazoning the abundances is the plummeting price of a key factor of production, whether watts in the industrial age or MIPS and bits in the microprocessor age. By exploiting these amplitudes and plummeting costs, entrepreneurs and nations gain market share against all others and define the age.

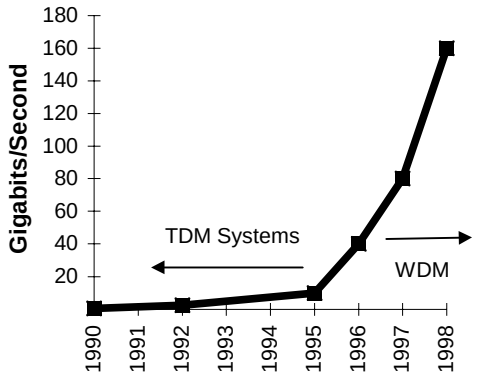
Unleashed by the limitless capacity of fiber optics and the creative cornucopia of the net, the new era will feed on the plummeting price of gigabits per second.

Unleashed by the limitless capacity of fiber optics and the creative cornucopia of the net, the new era will feed on the plummeting price of gigabits per second of Internet data. With one fiber thread now capable of containing three times the total traffic on the entire global telecom network three years ago, bandwidth is the new spearhead. Most powerfully wielding the spear is WorldCom.

With **MCI** (MCIC) in tow, WorldCom will be poised to usher in robust service for a broadband Internet. Starting now as the leader in cross-Atlantic IP fax and Internet phones, the company will expand to global IP business services and video conferencing. Think of WorldCom as the Standard Oil of the information era and Bernie Ebbers as the new John D. Rockefeller. Think of all the oil based industries unleashed by the collapse of oil prices under the Rockefeller aegis and you can get an idea of the forth-coming fruits of the WorldCom moment.

Chart 1

Commercial System Fiber Capacity



In economics–"the dismal science"–just as crucial as the bounties of abundance are the disciplines of scarcity, the defining limits. Our Telecosm Conference in Palm Springs last month focused on time, as the defining scarcity of the information era, and summed up the limits of time as the *speed of light* and the *span of life*. Successful companies use the technologies of the speed of light to extend the effective span of life by increasing efficiency in the use of time.

The most fundamental limits and scarcities arise from nature–the limits and liberties permitted by physical or biological law. From the principle of least action to the conservation laws, from the limits of light speed to Planck's quantum constant, the laws of physics impose curbs on reality. As much as the heralded abundances, these curbs have unleashed a rich panoply of theoretical paradigms and practical technologies. Both the architecture of the universe and its echoes in

A promising vessel of broadband paradigm technologies is Ortel, a vendor of high frequency gear, from WDM to microwave conduits for cable modems and cell extenders for CDMA phones.

the machines of man emerge as a series of miraculous escapes from rigid constraints to new degrees of freedom.

You may consider your copper cage as a bastion of monopoly profits and your voice revenues as a guarantor of prosperity. But copper dims in the face of a crystal palace and a scintillating global web in which voice becomes a mere trickle less than one percent of the bits. You may regard the ramifying complexities of your operating system as a citadel of dominance. But these desktop mazes may emerge as Maginot 7.O before the incandescent glitter of the Internet expanding its traffic 100 fold in 800 days while Java spreads through 80 million browsers to the world.

Isaac Newton's determinist dance and static universe yielded an industrial revolution based on the movement and transformation of matter from the outside and an intellectual revolution based on a calculus of material solidity. Quantum theory stripped the veils of solidity from the things of the world. From the emptied wombs of quantum matter emerged the microchip and Moore's Law. From the constraints of the speed of light and the quantum laser transpires the Telecosm.

Light shines newly as a constraint because until the last five years, lightspeed was an abundance–the ultimate velocity underlying the speed of computer and communications devices. Now lightspeed looms up as abruptly as a barrier as it did in physics at the beginning of the century. Just as the lightspeed limit forced Einstein to reconstitute the entire Cartesian time-space grid of classical physics, the lightspeed limit today is compelling the reconstitution of the time-space grid of information technology and topology.

The consequences abound. Look to the skies. To surmount the half second delay of roundtrip radiations from geosynchronous satellites–a bane even for voice and deadly to data–the sky is filling with low earth orbit satellites, 60 times nearer the earth. While **Iridium** (IRIDF) leads, with 34 birds aloft, several speakers hailed the coming later this year of the far more efficient **Globalstar** (GSTRF), based on code division multiple access (CDMA). The lightspeed limit also imposes a 30 millisecond delay across the continent, similarly hostile to the feedback links, acknowledgments, and error correction loops of data communications.

Time is the remorseless constraint. Hence the eclipse of complex connection oriented circuit switches and servers by connectionless packet routers and switches that are simpler and cheaper. With one-size-fits-all 53 byte cells switchable in hardware, ATM (asynchonous transfer mode) seemed the ultimate in a new form of RISC: reduced instruction set communications. But with performance doubling every forty months, ATM is giving way to frame relay switches that are doubling their performance every 10 months and even routing switches that double their performance every 20 months. WorldCom is the paragon of frame relay. **Cisco** (CSCO) and **Ascend** (ASND), endorsed at the Conference by venture capitalist John Doerr, continue to gain market cap and share against the ATM champions such as **Newbridge** (NN) and **Fore Systems** (FORE).

Now arrive Ebbers, and Joe Nacchio of **Qwest** (QWST), with new all-optical networks that reduce delay by eschewing circuit switches, amplifiers, and optoelectronic convertors and depend on wavelength division multiplexing of colors of light across asynchronous networks that do not require a constant clock. Optics can exceed the bandwidth and the bit error performance of copper wires by as much as 10 orders of magnitude. Ten orders of magnitude–a multiple of ten billion–can compensate for a multitude of absent switches in the dumb networks of the future.

The technologies of Ciena, **Lucent** (LU), and **British Telecom** (BTY) shone in Palm Springs speeches. Ciena, WorldCom's exclusive supplier of WDM equipment, will soon release systems that operate in WorldCom's backbone and across the Atlantic and the Pacific at 100 gigabits per second. **Uniphase** (UNPH) and **SDL** (SDLI) follow in their train, supplying crucial chips for the all optical equipment. **Oki Electric** in Japan is introducing a new mass manufacturing system using computer generated holograms for etching and mass producing optical network units for household and office connections. In MCI's network, **Hitachi** (HIT) is pioneering new all optical cross connect technology. Peter Cochrane is master of the famous optical laboratories at Martlesham Heath in Ipswich, UK, the source of many innovations in optics. At the Telecosm Conference, he declared his resolve to remove as many as sixty percent of the switches and forty percent of the people from the British Telecom network. But circuit switches are already mostly absent in the networks of Qwest and WorldCom.

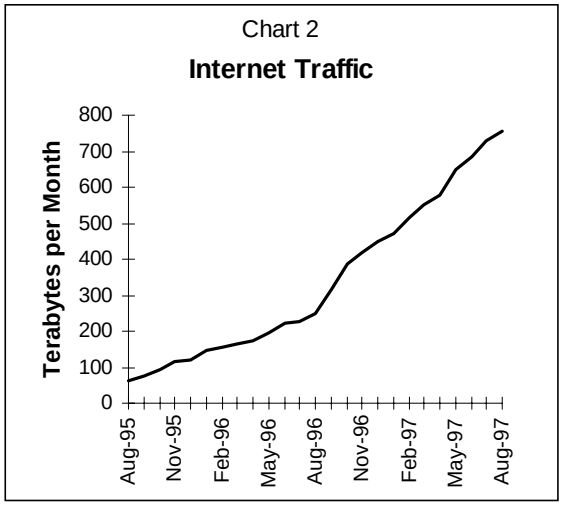
A promising vessel of broadband paradigm technologies is **Ortel** (ORTL), a vendor of high frequency gear, from pump lasers for all optical amplifiers in WDM systems to microwave conduits for cable modem systems, and cell extenders for CDMA phones. With a **Qualcomm** (QCOM) license, the company can help relieve the coverage gaps in pell mell rollouts of PCS. Now Ortel is investing $5 million in the heralded launch of **Tellium**, a high profile Bellcore team that is entering the market for WDM technology. Recovering swiftly from a cutback of orders from TCI, Ortel should prosper in the up-spectrum age.

The constraints of the speed of light also reach into the architectures of microchips. Under the lightspeed limit, electronic charges move just nine inches in a nanosecond (a billionth of a second). As tiny as they appear, microchips currently command as much as a quarter mile of infinitesimal wire traces and by early in the next century will command as much as seven miles of on-chip wire. Wires comprise 80 percent of the delay budget on most chips. Pins and backplane buses

comprise the bulk of delay in systems.

Addressing the pin problem is the heralded **Tessera** of San Jose**,** the owner of micro ball grid array techniques that allow the laying of chips directly onto the board without rows of relatively huge metal pins. Called chip-scale packaging, the result is devices 80 percent smaller and 20 percent slimmer than chips in the usual small outline packages and more robust and testable than bare "die" (unpackaged chips) "flipped" onto the board ("flip chips"). Licensed by everyone, from **Samsung** to **Texas Instruments** (TXN), and used in **Intel**'s (INTC) flash memories, Tessera's patented ultrathin elastomer layer on the "die" is immune to thermal warp in hot electronic systems (the showstopper for previous bare die technologies).

The secret scandal of semiconductor production is a multistep process, spanning oceans and continents, in which wafers are laid out, "scribed" and tested in the US, dispatched to Manila or Seoul for dicing by diamond saws and encapsulation in plastic packages, returned to the US for more tests and then distributed, perhaps back to Asia for assembly into systems. A new Tessera project would put contacts directly on the wafer (which may contain hundreds of chips). Tessera's technologies are large span of life winners, potentially reducing fab time by weeks.



After seven years of relatively quiet incubation, the company's salience today also illustrates the lightspeed crisis emerging in chip and bus communications. Coupled closely to microprocessors, the chip scale devices sharply reduce the length of wires and pins and buses. Such solutions will be indispensable to the new generations of ever smaller, lower power, and higher frequency digital cellular phones and PDAs that will comprise the most common PCs of the next era. A prime paradigm company fed by some $65 million in venture funds, Tessera will continue to prosper and soon enjoy a rich IPO.

Just as important as bypassing pins, however, will be obviating multichip communications altogether by building single chip systems based on new computer architectures. The lightspeed limit of nine inches a nanosecond makes current chips the last generation that can be synchronized by a unitary clock. With gigachips inscribed with .10 micron geometries, likely to prevail within the next three years, a single clock cycle will be able to reach only 16 percent of chip area within the time of one gate delay. Driven by the lightspeed limit, asynchronous topologies are creeping from the network onto the chip itself. Thus comes to microelectronics a "relativistic" architecture with many local clocks. Einstein would term them microchip mollusks. **LSI Logic** (LSI) would call them Coreware cells.

In both computers and networks, the answer will be new architectures based on multiprocessing and bypass. Microprocessor architects will line up an expanding array of processors, as much as possible on single chips bearing scores of megabytes of on board memory. They will create direct access routes to main memory, such as Intel's Accelerated Graphics Port (AGP) and **Compaq**'s (CPQ) Servernet from Tandem. Similarly, wavelength division multiplexing represents the movement of multiprocessing to fiber communications and the spread of fiber constitutes a massive leap of communications power toward the highest reaches of the spectrum, light. Qwest and WorldCom are leaders here. But wireless too is moving up.

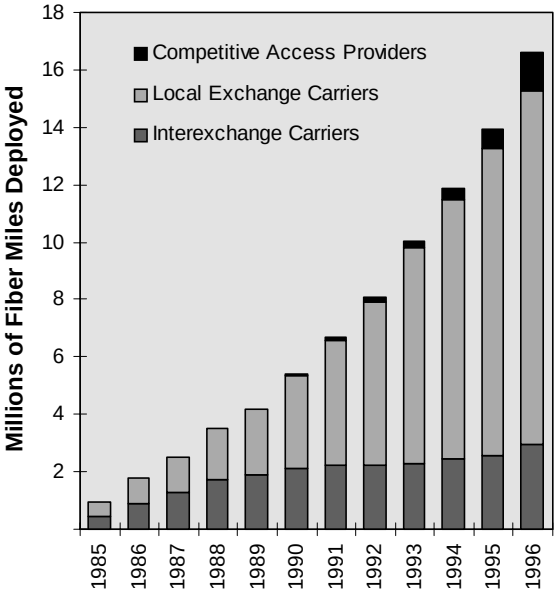
Last year, the 1.9 gigahertz frequencies assigned to PCS (personal communications services) seemed to represent an audacious move up spectrum. But the focus of the FCC and other regulators and auctioneers has blighted these domains. Now entrepreneurs such as Alex Mandl, the former **AT&T** (T) luminary now CEO of **Teligent**, told the Telecosm Conference that he was betting the company on some 400 megahertz of spectrum reserved in some 35 cities in the 24 gigahertz band. A key supplier in this realm has been **Innova** (INVA) of Seattle, a manufacturer of microwave radios. **CellularVision** (CVUS) and **CAI** (CAWS) are both struggling to supply two way communications service for Internet access at 28 gigahertz. **Winstar**'s (WCII) bypass technology, enabled by chips from **P-Com** (PCMS), runs in the 38 gigahertz band.

Coping with the lightspeed limit, technologists must find new sources of energy and degrees of freedom, moving up the spectrum from radio waves toward microwaves and light. By exploiting these degrees of freedom, companies can continue to improve the price-performance ratios of new technology, generating the value added that finances new ventures and transcends the previous economic constraints of money and capital. Accusing me, alarmingly, of "killing capital," Andrew Kessler of **Velocity Capital** in San Francisco offered the analogy of a meteorological low pressure area that sucks in activity from the high cost realms of industry. Swooping down the learning curves of a positive feedback economy, the masters of Moore's law and the law of the telecosm do not need outside funds; they finance them-

A prime paradigm company fed by some $65 million in venture funds, Tessera will continue to prosper and soon enjoy a rich IPO.

Chart 3

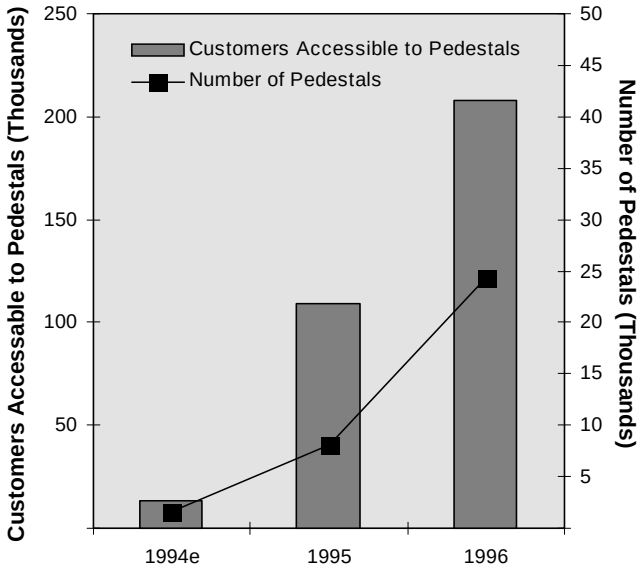
US Telco Fiber Deployment



Source: FCC

Chart 4

RBOC Fiber to the Curb



Source: FCC

Fiber deployed US Telcos *rose 19% in 1996, increasing by 2,677,500 fiber miles to 16,605,700 miles. The interexchange carriers (long distance) and local exchange carriers (RBOCs) fiber mile totals rose by 14 to 15% while competitive access providers (urban fiber systems) more than doubled their installed fiber miles from 1995 to 1996 (Chart 3). The combined fiber miles of WorldCom along with MFS (still listed separately by the FCC in 1996 totals) and its proposed merger partners Brooks Fiber and MCI would rival AT&T's fiber network, each with over 1.2 million fiber miles.*

The LECs *(local exchange carriers) have the largest base of installed fiber (74% of total Telco fiber miles). The LECs have moved beyond buildouts of their interoffice networks and are advancing fiber toward businesses and homes. RBOC fiber terminations on customer premises increased to 1,270,199 in 1996 and dramatically increased in capacity (see Chart 2 August 1997 GTR). Progress toward homes can be seen in efforts to bring fiber to the curb (FTTC). Fiber has been extended to 24,290 pedestal/curb locations within the local loop. With an average of 8.5 homes served per pedestal these systems now reach over 200 thousand customers (Chart 4). NYNEX's FTTC effort accounts for nearly half (103,700) of those customers.*

The CAPs' *(competitive access providers) installation of urban fiber rose 104% from 634,400 fiber miles in 1995 to 1,312,900 miles in 1996. The number of buildings served CAP fiber increased 114% to 22,898 (Chart 5). MFS, now part of WorlCom, leads the CAPs with 58% of the buildings served. Speeding efforts to bring fiber to the home/building, on September 27, 1997 Oki Electric Industry Co., Ltd. announced the development of new technology simplifying the production of the optical network units (ONUs), the household terminals on the end of each fiber. Allowing the mass-production of ONUs the advancement will significantly lower the cost of bringing fiber to homes.*

Digital Signal Processors *(DSPs), a central Telecosm Technology, continued their rise to prominence in 2Q97 with year-to-year unit sales increasing 46% and revenues rising 21% (Chart 6). Texas Instruments, with an estimated DSP market share of 45%, reported that DSP sales generated over 40% of its semiconductor revenue. In September, Tom Engibous, TI's CEO and President, said TI was investing $1 billion a year in DSP development and the company announced a $100 million venture fund dedicated to accelerating DSP linked efforts. TI anticipates a $50 billion DSP market by 2007.*

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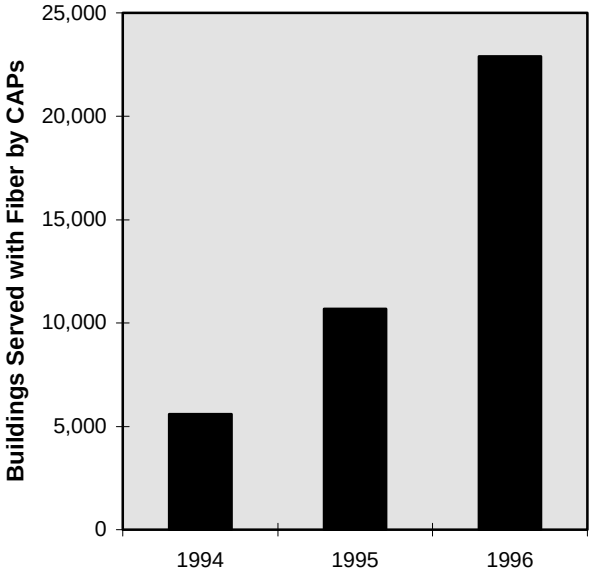
Chart 5

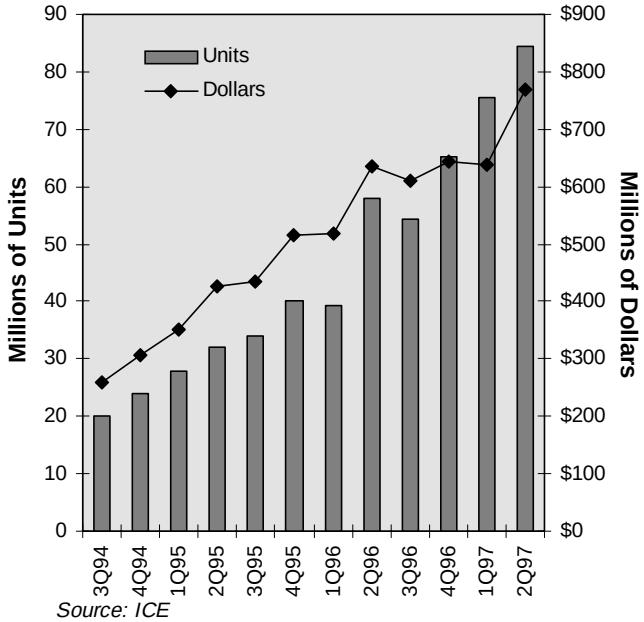
CAP Fiber to the Building



Source: FCC

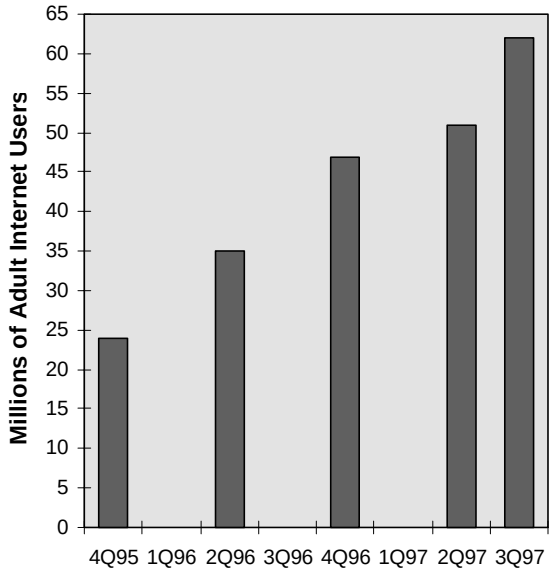
Chart 6

Digital Signal Processor Market



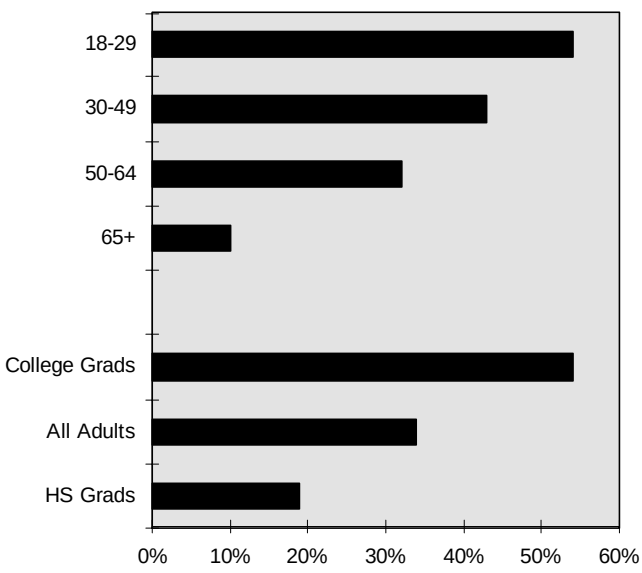
Source: ICE

Chart 7



Sources: IntelliQuest, Zogby International

Chart 8



Source: Zogby International

The number of Americans using the Internet continues its rapid climb. *The latest survey by IntelliQuest shows 51 million adults (age 16 and over) were using the Internet and online services as of 2Q97. With an additional 8.5 million intending to go online, IntelliQuest forecast the likelihood of 60 million by year's end. In September, Zogby International found that that forecast has already been surpassed. Zogby's survey showed 34% of US adults, over 60 million, are now online (Chart 7). Internet access is stratified by age and education with 54% of 18-29 year olds and 54% of college graduates already online (Chart 8). Only 19% of US adults had no interest in accessing the Internet, with not owning a computer cited as the main reason for lack of access. With sub-$1,000 PCs accounting for over 36% of August retail PC sales and first time buyers purchasing 35% of systems in August and September the access obstacle is fading. And in advance of the introduction of WebTV's second generation set-top box and competing products by NewCom and Thomson, the original WebTV was dropped to $99–after a $100 rebate–and is even being given away to subscribers of NVST's venture capital web site.*

Internet Commerce

The percentage of Internet users making online purchases has risen from 7% (2.45 million) in 2Q96 to 17% (8.5 million) in 2Q97, according to IntelliQuest. More dramatically, based on a median monthly online expenditure of $50, the annualized rate of purchases has risen over 250% in one year from $1.6 billion to $5.6 billion. Furthermore, over 54% of users shop online; researching prices or features of products, locating where to purchase products, and selecting products (Chart 9). The current gap between shopping and purchasing was also demonstrated by Plog Research's survey of online travelers. While 61% of those surveyed made a reservation after visiting a travel site (shopped) only 19% did their booking online (purchased), due to concern over security. Consumer behavior reflects the current expectations of business leaders. RHI Consulting's survey of US companies with more than 100 employees shows 50% now have web sites with 66% citing advertising, marketing and public relations as the primary use and only 4% citing electronic commerce.

Web Browser Wars

On the eve of Microsoft's release of the final version of Internet Explorer 4.0, Zona Research published the results of their latest browser census. The survey of browser usage in 279 enterprises found that Internet Explorer was the primary browser of 36% of respondents, while 62% use Netscape Navigator/Communicator. The results match (35%, 63%) the findings for browser usage on Windows platforms accessing the EWS server at the University of Illinois (over 200,000 accesses in September). Including Mac, Unix and other platforms, Netscape increases share to 65.5% and Microsoft drops to 32%. While Netscape remains the "primary" browser (browsers per capita averaged 1.47) of a loyal 62% in the Zona study, that finding is dramatically challenged by another survey response. When asked which browser was **used** *during the last 90 days only 51% cited Netscape and fully 44% responded Microsoft (Chart 10).*

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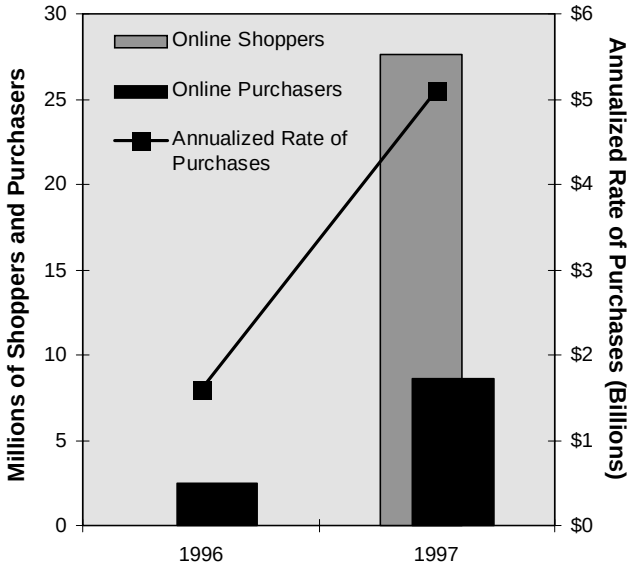
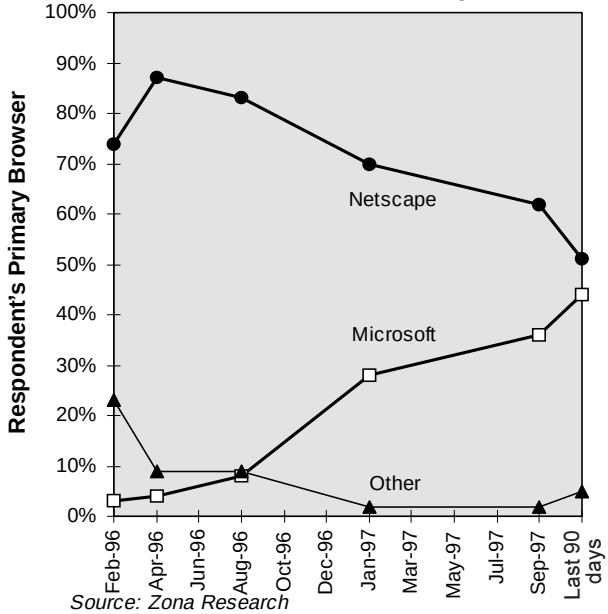
Chart 9



Source: IntelliQuest

Chart 10



Source: Zona Research

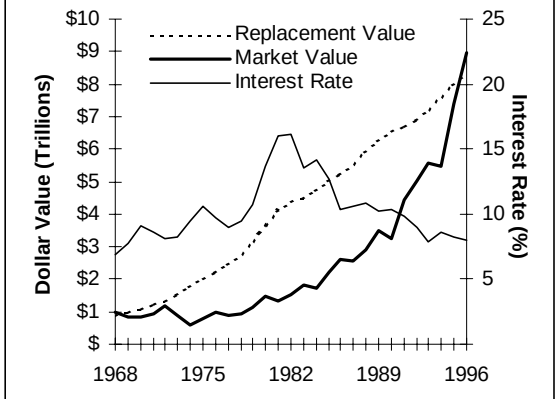
WorldCom's identification of fiber optics as the catalytic technology of the new era and its raptorial response to the Internet as the ascendant vector of growth rendered all the market positions of its telco rivals as irrelevant.

selves through the cashflow released by their plummeting costs and through acquisitions based on their soaring equity prices.

WorldCom is exemplary. From origins in 1983 in a Hattiesburg, Mississippi coffee shop as LDDS, WorldCom currently commands the backbone fiber network of WilTel, installed in its abandoned mazes of natural gas pipelines. To this foundation, it has added the MFS bypass network linked to key office buildings in 23 states and running the Internet National Access Points MAE East and West. Further keys to the kingdom include UUNet, ANS, and Compuserve internet access, IP fax, and phone technology, and the optic lines of **Brooks Fiber** (BFPT) in 34 cities. Now Ebbers is reaching out for MCI without a serious glitch in the ascent of his stock.

Financed by Michael Milken in the late 1970s and early 1980s, MCI's original national fiber network began with a funding program of some $2 billion at a time when MCI was a microwave company commanding revenues of $280 million. If the tender is completed, WorldCom will command more than a million two hundred thousand miles of fiber in the US alone, comparable to AT&T, and will be globally dominant in the strategic vectors of frame relay business services and Internet communications. Bernie Ebbers is emerging as the first American entrepreneur to operate in the grand visionary scale of Milken himself.

Chart 11
Corporate Valuation Gap



At the Conference, Milken presented a chart showing a portentous crossover in the markets, with the share prices of American companies moving above their physical replacement costs for the first time since 1972. It is a watershed moment that implies an overvalued stock market. But showing that US market caps are still unexceptional by international standards, Milken ascribed the crossover largely to the failure of the National Accounts to measure the new assets of American companies.

With capital spending on plant and real estate dropping from over 40 percent of the total during the 1960s and 1970s to merely 28 percent today, tangible assets, buoyed by inflation, have given way to intangible assets, borne in the minds of inventors and entrepreneurs. Not on companies' balance sheets are their intellectual property, their learning and experience, their superior capital structures, their higher efficiency equipment, their global reach, and the barriers to entry implicit in the positive feedback loops of the new economy. Milken's presentation implied that investors would founder by applying the rules of either the 1970s or the 1980s to investment opportunities of the late 1990s.

Nathan Myhrvold and Bill Gates dubbed this Internet era the "friction free economy." Explaining the new rules of the road ahead is Ted Lewis. Former editor of both *IEEE Software* and *IEEE Computer*, and columnist in these venerable magazines and the new *IEEE Internet*, Lewis titles his new book, *The Friction-Free Economy.* In it, he illuminates the strategies of Bernie Ebbers and Scott McNealy in a brilliant exposition of the economics of learning curves and positive returns.

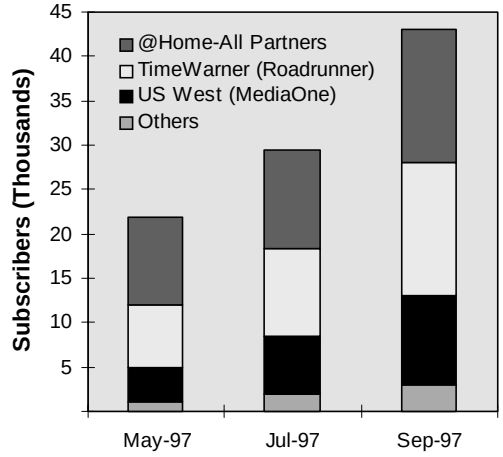
In a world of increasing returns, "Change in market share is proportional to existing market share." Following Brian Arthur, he posits a lockin effect that countervails the diminishing returns of conventional theory. Companies such as **Microsoft** (MSFT) or **Netscape** (NSCP) that can "mainstream" their product can unleash a spiral of gains, which top out at a market share near 73.9 percent (that's Lewis's number). But unlike Arthur, Lewis believes that dominance is as likely to lead to vulnerability as to monopoly. He adds a corollary: "Change in market share is proportional to the amount of market share that remains available to a company"—to the amount of slack in the market. As market share rises, Netscape learned and Microsoft will soon discover, there is less further market to capture and more market to defend from targeted attack on a weakest point. Market share will continue to grow, therefore, only as long as market momentum rises. When growth stalls, the leviathan becomes vulnerable to attack from below. Lewis explains how this plight is now afflicting Microsoft in its resistance to the threat of Java. Other victims are AT&T and the RBOCs.

Java was a major preoccupation of the Telecosm Conference, from Scott McNealy's seething and scintillating keynote to a rousing debate between Mark Ryland, former leader of Microsoft's Active X team, and a constellation of Java champions. Entering vigorously into the fray were Marc Andreessen of Netscape, Kim Polese of **Marimba**, John Patrick of **IBM**, and Patrick McNaughton of **Starwave**, joining from the audience. In Lewis's book, he presents a strategy that could thwart Microsoft dominance and explain WorldCom's achievement.

You concentrate your forces on the weakest point of a larger enemy. You gain share in a selected niche. You redefine the market arena. You parlay your niche gains into dominance in a redefined market. WorldCom, for example, is redefining the market as Internet communications, including telephony. While the other telcos

Chart 12

Cable Modem Subscribers



Cable Modems Accelerate

As the highest bandwidth pipe into homes, cable modems continue their successful rollouts across the US and Canada. Cable systems offering broadband Internet access now pass nearly 4.5 million homes, up 20% in two months. With experience, the installation process has been streamlined and the early need for two-installer crews–one for the cable setup, one for the computer–has been eliminated. Subscriber numbers are now climbing 50 percent every two months (Chart 12). While critics point out that the total of some 43,000+ cable modem subscribers is under one percent penetration of homes passed, cable modems already account for 5 to 6 percent of home Internet access in areas served. Actual cable modem usage–as measured by TCI@Home traffic through the Sprint NAP–increased over 150% in the last two months. Overseas, deployments have kept pace with North American developments. Bay Networks' LANcity has shipped over 100,000 modems worldwide and expects to maintain their market leadership through the coming transition to interoperable industry standard cable modems.

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Cable modems have suddenly become the prevailing broadband access technology for the Internet, now serving some 6 percent of Internet subscribers where available.

dither, WorldCom is already the leader in frame relay business services, bypass, and IP voice telephony and fax.

In any battle between two firms, any company within a factor of 1.7 of the other's share is within "shooting range." WorldCom already holds some 60 percent share in the Internet space, which is the relevant market because it is growing at least ten times faster than other telecom markets.

Similarly, Lewis shows that between **Sun** (SUNW), IBM, and Netscape, the Java entente is well within shooting range of Microsoft. The Java forces are redefining the market as portable software components available on the net for a large range of digital appliances, from cellular phones and smart cards to network computers and PCs. In the friction free economy, where as Lewis asserts, some 50 percent of revenues must come from products less than 18 months old, Microsoft is already slipping into a dangerous nostalgia for desktop bloatware.

The key to overthrowing the king is to define vectors for the fastest growing new markets and gain a hold on them. WorldCom's identification of fiber optics as the catalytic technology of the new era and its raptorial response to the Internet as the ascendant vector of growth rendered all the market positions of its telco rivals as irrelevant. Assuming continued competence in execution, WorldCom is perfectly poised to become the global telecom leader.

Today, the rules of friction free dynamics should be applied not only to Microsoft, but to Cisco, Compaq, Intel, **Ericcson** (ERICY) and other firms that seem preeminent in the existing economy, but that may be maladapted to the new one emerging. In the friction free economy, key paradigms of the Telecosm and of the Conference were CDMA, WDM, and Java. Key themes were the coming explosion of bandwidth and dissolution of bloatware. These concepts entail a move up spectrum and a move toward single chip systems and parallel processing, in both computers and communications. The friction free economy dictates an adaptive software environment optimized for the net.

Despite all the predictable setbacks, the simultaneous rise of Java and the Internet through their first 800 days–with a million downloads of the Java Development Kit and millions of books sold and half a million developers–remains unprecedented in the history of software. Parallel architectures are similarly ascendant. At the annual Hot Chips Symposium at the end of August, as *EE Times* reported, "designers sought every possible opportunity to execute operations simultaneously, whether at the task, thread, instruction or even sub-operation level…The pursuit of parallelism appears to have replaced the quest for wider superscalar chips and higher clock speeds as the road to application performance…CPUs will increasingly resemble highly parallel microcode engines."

Digital Equipment Corporation's (DEC) estimable Alpha team, who used superscalar heroics to create the world's fastest microprocessor, attested that because of the lightspeed latency effect, Alphas spend most of their time in wait states. As many as 15 out of every 16 opportunities to issue an instruction are lost. At the Telecosm Conference, David Patterson explained how many of these problems could give way to an intelligent RAM architecture. He favors use of parallel vector processors programmable through the means familiar in vector Cray supercomputers. But the ultimate arena for new experiments in parallelism is communications. In this realm, WDM represents only a first step toward networks of add drop multiplexers, cross connects, splitters, couplers, and switches, all made of mostly passive optical components operating in parallel at the speed of light.

None of the leviathans are obviously well situated for these paradigmatic opportunities. But the cable TV industry can benefit from the new dominance of bandwidth over switching. Cable is already a parallel communications system based on the up to eight gigabit per second potential of cable coax. Cable modems have suddenly become the prevailing broadband access technology for the Internet, now serving some 6 percent of Internet subscribers where available, while the DSL systems of the phone companies are still

ASCENDANT TECHNOLOGY	REPORT(S) Volume: No.	COMPANY (SYMBOL)	Reference Price	Price as of 10/3/97
Cable Modem Service	I: 2, 3 II: 7, 8, 9	*@Home* (ATHM)	19 1/2	26 5/8
Erbium Doped Fiber Amplifiers, Telecommunications Infrastructure, Wave Division Multiplexing (WDM)	II: 2, 3, 4, 7, 9	*Alcatel* (ALA)	16 3/4	27 9/16
Analog to Digital Converters (ADC), Digital Signal Processors (DSP), Silicon Germanium	II: 3, 7	*Analog Devices* (ADI)	22 3/8	35 1/16
Java Thin Client Office Suite, Rapid Application Development (RAD)	II: 6, 7	*Applix* (APLX)	4 1/2	8 9/16
Digital Video Codecs	II: 5	*C-Cube* (CUBE)	23	32 7/16
Erbium Doped Fiber Amplifiers, Wave Division Multiplexing (WDM)	II: 2, 7, 9, 10	*Ciena* (CIEN)	23 *	55 1/2
Low Earth Orbit Satellites (LEOS)	I: 2 II: 1, 3, 4, 8, 10	*Globalstar* (GSTRF)	21 3/4	54 1/4
Single Chip ASIC Systems, CDMA Chip Sets	II: 8, 10	*LSI Logic* (LSI)	31 1/2	31 3/4
Telecommunications Equipment, Wave Division Multiplexing (WDM)	II: 1, 2, 7, 9, 10	*Lucent Technologies* (LU)	47 1/8	86 1/4
Single Chip Systems	II: 8	*National Semiconductor* (NSM)	31 1/2	41 1/16
Internet Software	I: 1, 3, 4 II: 1, 4, 6, 7, 8, 10	*Netscape Communications* (NSCP)	53	36 3/8
Wave Division Multiplexing (WDM), Satellite and Wireless Systems, Code Division Multiple Access (CDMA)	II: 10	*Ortel* (ORTL)+	20 3/4	20 3/4
Code Division Multiple Access (CDMA)	I: 1, 2 II: 1, 3, 4, 7, 8, 9, 10	*Qualcomm* (QCOM)	38 3/4	64 1/2
Nationwide Fiber Network	II: 9, 10	*Qwest Communications* (QWST)	40 3/4	47 1/2
Java Programming Language, Internet Servers	I: 1, 2, 3, 4 II: 1, 5, 6, 7, 8, 10	*Sun Microsystems* (SUNW)	27 1/2	46 3/4
Optical Equipment, Smart Radios, Telecommunications Infrastructures	I: 1 II: 1, 2, 3, 9	*Tellabs* (TLAB)	29 1/8	54 3/4
Digital Signal Processors (DSP), DRAM	I: 2, 3, 4 II: 5, 8	*Texas Instruments* (TXN)	47 1/2	133 1/2
Wave Division Multiplexing (WDM) Modulators	II: 7, 9, 10	*Uniphase (UNPH)*	58 3/4	77 3/4
Code Division Multiple Access (CDMA) Testing Gear	II: 1, 2, 7	*Wireless Telecom Group* (WTT)	10 3/8	9
Telecommunications, Fiber, Internet Access	II: 9, 10	*WorldCom* (WCOM)	29 15/16	38 1/16
Field Programmable Logic Chip	I: 3	*Xilinx* (XLNX)	32 7/8	47 3/4

+ New Addition * Initial Public Offering

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.

mired in tests. (In some markets with aging wire, such as Boston, the tests are failing miserably).

Cable modem leaders are set to prosper, with **Broadcom** building the current chips and **Bay Networks** (BAY) assembling the devices through its LanCity subsidiary. Recently anointed by *Red Herring* as the most promising new technology company, Broadcom is moving fast toward an expected IPO. It bet wrong on ADSL (asymmetrical digital subscriber line), the phone companies' broadband solution, spurning **Amati**'s (AMTX) discrete multitone parallel approach (Amati has now agreed to merge with **Westell Technology,** WSTL). Now Broadcom's cable modem forte faces a challenge from **Terayon** (see, GTR, January 97), which uses CDMA for full duplex broadband communications on cable TV plant without expensive upgrades. How ever this rivalry turns out, the takeoff of cable modems renders the cable industry still undervalued despite the Catch 22 of both federal regulation as a monopoly and devastating competition from digital direct broadcast satellite.

But many of the prime opportunities of the age are richly valued, and investors must have the humility to be late. Even some companies that seem overvalued today by conventional measures (WorldCom, Qwest, Ciena, Sun, and Qualcomm, together with their key suppliers) remain ready to ride a tsunami toward dominance in the new era. Moving up spectrum, to higher frequencies and shorter wavelengths, you release new energies of growth and new degrees of freedom. This is the rule of physics and it is the rule of enterprise.

George Gilder, October 6, 1997

Telecosm Conference transcripts may be ordered online at www.gildertech.com for $345 each or by calling (212) 206-5521.

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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