GILDER TECHNOLOGY REPORT

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THE LOW PRESSURE PARADIGM

Growth feeds on confidence and creativity, the willingness to plunge into the unknown.

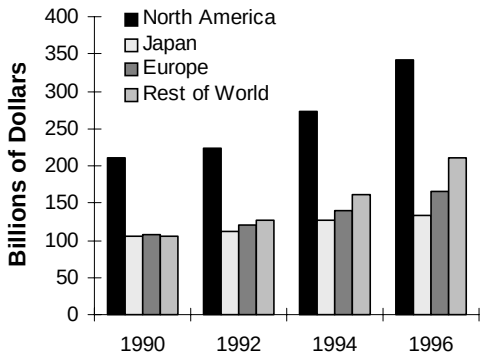
It's March in Paris. Bonjour tristesse: dirges to downsizing and population sloth and the dwindling reach of the Francophone. Still, the forsythia shines in the slanted sun, with promises of April in Paris to come, and Groupe Speciale Mobile, as it once was known, GSM, the pride of EEC industrial policy, is conquering much of the world, outside the US, Japan, and Korea, for the European wireless standard. Spreading through 97 countries, customer totals jumped from 15 million to 32.7 million in 1996. After a long dearth of European semiconductor successes, **Thomson** of France has parlayed its wafer fabs in Phoenix, San Diego and Carrollton, Texas, to leap up onto the list as one of the world's ten leading semiconductor companies. Now it is opening its fourth fab in Rousset. **Alcatel** (ALA), my sponsor, is by some definitions, the world's leading producer of telecom gear.

Rearing up before me are the radiant towers, spheres, and emerald glass walls of CNIT, the imperial mall in LaDefense near the center of the city. A mile or so up the Champs Elysee from the now dim Arc de Triomphe looms in echo a unique fifty story trestle of silvery glass offices that shimmers even larger than it is—an Arc de Trompe L'Oeil. It is as glamorous an urban center as exists in the world.

Above amphitheatrical steps from the mall, see-thru capsules on elevator cords lift me up the tower past cloudy vistas of Paris into the cyberworld of Alcatel's exposition of information technology on the 35th floor. It flaunts all the most fashionable acronyms and buzzes of modern digital communications, from WDM to ATM, and together with **Sharp**, the company is now adding a half-pound PDA with an integrated GSM phone. Alcatel is also the lead manufacturer of **Globalstar**'s (GSTRF) satellite communications equipment based on **Qualcomm**'s (QCOM) CDMA. Now, in a deal with **Motorola** (MOT), the company will add CDMA wireless cellular to its portfolio. In technology, Alcatel is moving fast toward the new paradigm.

Chart 1

Electronic Systems Production



Source: ICE

But I am in France, to address chairmen and CEOs of great European companies, from Thomson to **Rhone-Poulenc** (RP). I have to tell these impressive people that the new economics largely consigns this scintillating city to a technological backwater. That OECD figures now show a French comparative advantage only in the production of low tech goods—essentially wine, women, and song. That French productivity numbers, seemingly strong, actually reflect old paradigm productivity. Unlike subsidized cars and steel ingots that are lovingly counted, the software and microchip products and services of the new era change too frequently to be captured by a fixed unit of measure. For all the dazzle of the exhibit, France is sinking into euroschlerosis.

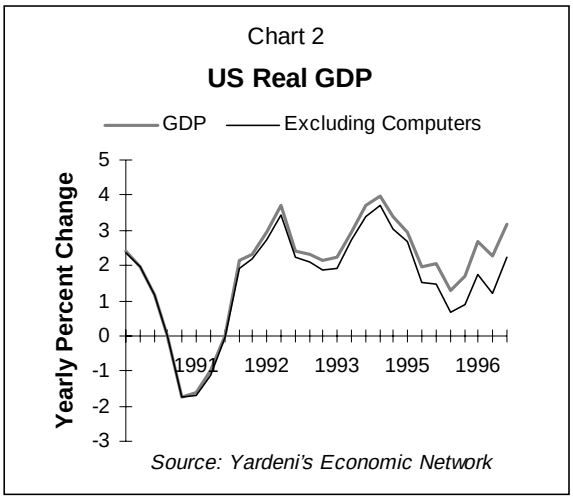
At night below the towers, young people in tattered clothes gather glumly in the shadows to shake down visitors and I find myself walking swiftly away from them. France's welfare state—gorging and gushing more than 50 percent of national income—is a giant circuit of recycled prosperity that can no longer be sustained. Joblessness remains over 12 percent in French terms (in a nation where

If there is magic in boldness, focus, technical knowledge, and vision, NextWave's Salmasi will command the future.

the proportion of people in jobs is 11 points below US levels). Youth unemployment is above 20 percent.

The answer given by the democratic processes of the country is less work and productivity. Send three million immigrants home to open jobs for the French. Then prop up and subsidize existing corporations, clutch and share existing jobs, reduce the week to 30 hours, begin retirement at age 55. A time division economy. Truck drivers already win their pensions at 55 and the French people want this standard extended to all.

The key idea of capitalism, creative destruction—the notion that old jobs and structures must give way to new ones, that old resources must be constantly recycled to new uses—is utterly alien in France. The newspapers all blare headlines about **Renault**. An unprofitable government run automobile company, it is preparing to privatize by attempting a long delayed and modest downsizing by 2,700 workers, in Belgium. No chance. Even President Chirac, the conservative French leader with a flair for entrepreneurial images, chastises the Renault leadership for contemplating such an outrage. With amazing perversity, the French put the blame not on socialist excess or corporate palsy or union power or continued protectionism but...get this...on technology. C'est une crise cybernetique. Computers, they say with consummate banality, are producing a crisis of employment and a widening gap between rich and poor.



In my evening talk to the European executives, I outline the unlimited promise of the telecosm for nations that privatize and liberalize their economies. Next to me at dinner is the chairman of a steel company. He tells me that computers destroy employment. Ridiculous, I blurt out, the US deploys three times as much computer power per capita as Europe and has created 35 million net new jobs in twenty years. The more computers the more jobs. Technology makes workers more productive and thus more employable. Technology creates wealth that endows new work. But the French executives demur. That was the way it was in the past. Now it is different. The steelman challenges me to prove the future will be better.

Can it happen here? Many Americans hope so. Europe provides the model for extending the US welfare state. Everywhere the key issue in the world economy is whether to permit the innovation and change that is essential to growth. Failure of growth will inevitably lead to wars, strikes, famines, and xenophobia. For example, if China cannot grow, as the environmentalists believe, then it will have to fight. If the world is zero sum, the best fighters rather than the best producers will prevail.

But the pessimism of the French executives is profoundly wrong. At any point in human history, a straight projection of population, production, and measurable resources would show a Malthusian result. By the laws of entropy, the world has always been running down and running out. Growth feeds on confidence and creativity—the willingness to plunge into the unknown. Creativity always comes as a surprise to us, or we wouldn't need it. If we could plan the future, socialism would work. The French problem is really a crisis of faith.

My mind keeps returning to Allen Salmasi's now delayed **NextWave** IPO in the US that I have touted in these pages. A supreme vessel of the CDMA wireless technology paradigm that Salmasi has been pursuing since his time as a college student in engineering at Georgia Tech, Purdue, and JPL some 25 years ago, it substitutes bandwidth in the 2 gigahertz microwave band for power and processing. In the face of what analyst Carl Aron calls "The Coming Wireless Ice Age," NextWave is committing itself to a project that will ultimately cost tens of billions of dollars to consummate around the world. This is the kind of venture that is utterly absent in Europe and rare anywhere outside the US. Together with GlobalStar and Qualcomm, earlier Salmasi companies, it is a sword of creative destruction aimed at the existing telecom establishment.

Proceeding through my pile of magazines and newspapers on the plane, I found nearly everyone—from Barron's and the New York Times to Forbes and Red Herring—disparaging the NextWave venture. They condemned this project for bidding some $5.5 billion in FCC spectrum auctions for licenses to serve some 160 million POPs (covered population) in cities around the US. In service to the interests of Qualcomm, of which Salmasi is a leading shareholder, and with funds from foreign investors, chiefly Korean, NextWave allegedly paid too much ($34 per POP) and violated the foreign ownership rules governing the auction. A reading of the company's S-1 document will show these charges to be ill founded. Indeed, the FCC has dismissed most of them.

The animus against NextWave comes from other sources. It is the French disease. Without collateral beyond the ideas and entrepreneurial confidence of its creators, NextWave violates the materialist superstitions that govern most investment and that underlie old paradigm economic data.

In the 1980s, Michael Milken's projects faced the same resistance. **McCaw**, **Turner** (TUR), **MCI** (MCIC), **NewsCorp** (NWS) and other such ventures all were deemed Ponzi schemes, built on teetering towers of debt, that would be toppled by the first recession or other setback. All endured recessions and other hardships and prevailed because they reflected a powerful investment paradigm: the transformation of the communications infrastructure of the 1970s and 1980s by cellular wireless, cable television, fiber optics, and direct broadcast satellites.

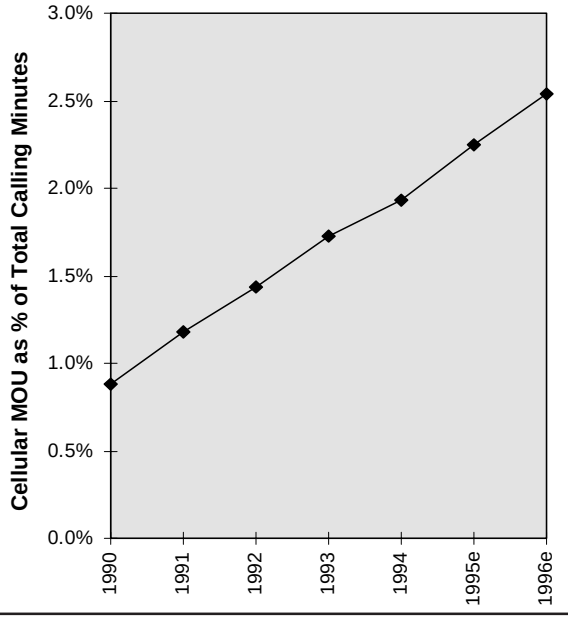
The next decade will see an even more far reaching reconstruction of the communications infrastructure. Analog wireless will give way to digital PCS based on spread spectrum; cable TV and other broadcast media will give way to Internet multimedia and interactivity; hybrid fiber optics and electronic network backbones will give

Wireless Growth Potential

In assessing the potential growth of the cellular, PCS (Personal Communications Services), and other wireless technologies discussed in the pages of the Gilder Technology Report, one must keep in mind that although wireless penetration and subscriber numbers have already seen large increases in the US, wireless usage still has tremendous growth potential. Chart 3 shows the minutes of use (MOU) of US cellular phone subscribers as a percentage of total telephone minutes of use. As competition between cellular and PCS providers increases and deployment of advanced technologies lowers provider costs, wireless telephone service will approach the pricing of traditional wireline service, leading to an explosion of wireless usage. This is clearly the calculation of long distance carriers, as AT&T outlines plans to compete directly with the RBOCs (Regional Bell Operating Companies) through wireless local loop service, Sprint PCS rolls out a nationwide wireless network and MCI contracts for 10 billion minutes from NextWave.

- KE

Chart 3



Metricom offers wireless Internet service at less than one watt of transmit power.

way to all optical networks. For two way communications, geosynchronous satellites will increasingly defer to low earth orbit systems such as Globalstar. NextWave not only partakes of the PCS model, moving up spectrum to the highest band readily managed by existing semiconductors; it also employs the most advanced PCS technology—Qualcomm's Code Division Multiple Access—allowing the use of all the available spectrum all the time. Unlike all time division systems, spread spectrum offers the promise of bandwidth on demand.

You can accomplish almost anything, so they say, if you are willing to give others the credit. A carriers' carrier, with MCI as part owner and key customer with a commitment to buy 10 billion minutes of service, NextWave plans to focus on technology and infrastructure, leaving the marketing and the credit to the telcos. It is the same strategy followed by a complementary CDMA venture of Salmasi's, the Loral-Qualcomm low earth orbit satellite project called Globalstar that will supply CDMA service to nearly every point on the earth's surface, in one fell launch giving CDMA more universal coverage even than Europe's GSM. Unlike Motorola's Iridium, currently floundering, Globalstar employs the terrestrial infrastructure of existing telcos. It extends their reach rather than competes with their services.

The Globalstar and NextWave people approach a foreign Telco or PTT by offering to give them new ways of gaining more customers and profits. Globalstar systems can share spectrum and infrastructure with local systems. By contrast, the Iridium people represent a bypass plan, to circumvent the local telcos and demand exclusive spectrum assignments. In exchange for access to spectrum in foreign nations, they can offer only bribes and blandishments.

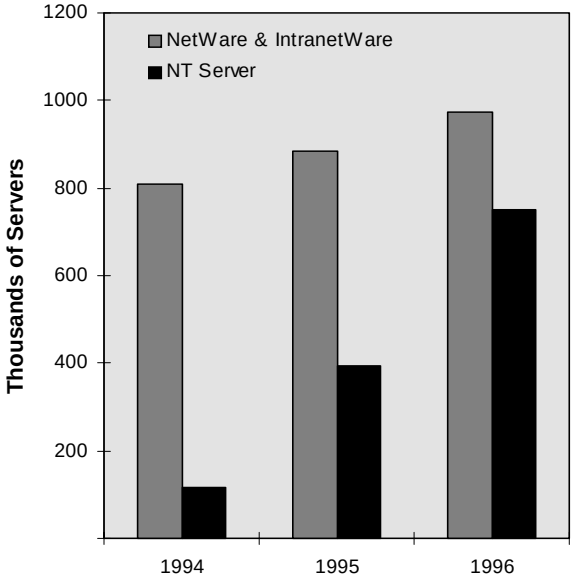
NextWave does not join the bitter urban fray selling cell phones and services in the teeth of six or more rivals in every city. It will specialize in supplying the best CDMA infrastructure to all comers, led by MCI with its renowned marketing prowess and 7 percent holding of NextWave's common shares. Although critics assume that NextWave overbid for its national footprint of mostly urban spectrum, **AT&T** (T) committed some $20 billion for McCaw and an additional $5 billion for PCS licences. At roughly $100 per POP, this adds up to perhaps three times as much per POP as NextWave. (If you believe all that analog capacity and TDMA technology is a long-term liability, AT&T's ultimate costs may even nullify their rich McCaw cash flow that derives from avoiding RBOC access charges and channelling long distance calls to AT&T). AT&T is now touting a secret breakthrough in TDMA wireless local loop technology that mostly duplicates existing CDMA capabilities already being proposed for Third World applications in India, China, and Brazil, where NextWave will likely crest.

At around $14 per POP, **Sprint PCS**, **PrimeCo**, and the other PCS firms bid much less than NextWave per POP in total outlays but a comparable amount on a discounted present value basis of outlays per POP, adjusted for population density. NextWave's POPs average 200 per square mile compared to 80 per square mile for its rivals. That translates into a $5 per POP difference in costs. NextWave's wholesale strategy eschews marketing costs, and under the FCC's entrepreneurial program, it pays no principal for the first six years. These concessionary terms on the debt translate into an estimated fair market value of $2.8 billion after the downpayment of $500 million, or a real cost for mostly premium urban POPs of $20.63. After four years and $1.5 billion of expenditures, the company should be cash flow positive. If there is magic in boldness, focus, technical knowledge, and vision, Salmasi will command the future. Investment in NextWave feeds not on old collateral but on a new paradigm.

As the European executives see it, economics is the dismal science of scarcity. In part, they are correct. Every industrial era is indeed marked by a defining scarcity. Focusing on the scarcity, however, countries, companies, and individuals narrow their horizons and becloud their futures. Many of my French friends even believe in material scarcity—a dearth of fuel, food, farmland, minerals, air, space. As Julian Simon has shown, however, all these material resources are dropping in price.

Chart 4

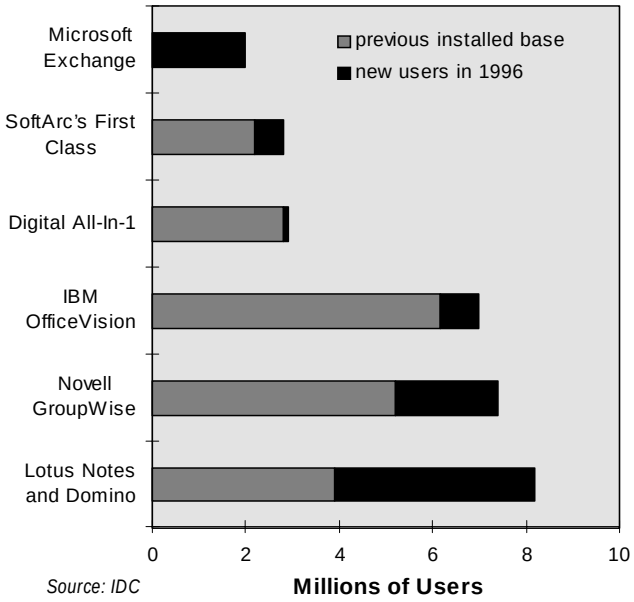
Microsoft's Challenge to Novell



Source: IDC

Chart 5

Groupware Collaboration Software



Source: IDC

Novell has led the market for network operating systems (NOS) with better than a 60% market share, which translates into an installed base of some 5 million servers and 60 million users. But, Microsoft's NT server, bundled with free Internet server software, has risen to challenge Novell, which was comparatively slow in adopting Internet/intranet technology (Chart 4). In the messaging and group collaboration software market (groupware), Microsoft's Exchange also burst onto the scene in 1996, placing third in numbers of new users, just behind Novell's GroupWise (Chart 5). Netscape, meanwhile, was responding to the challenge of Microsoft's free software with redoubled emphasis on the corporate intranet market and the addition of groupware functionality to their software. Novell and Netscape's alliance through the formation of Novonyx is a promising response to their common problem. Through Novonyx, Novell brings the proven Internet/intranet expertise of Netscape to its product line in order to maintain both its market position and the loyalty of its huge installed base; while Netscape gains the opportunity to spread its vision of internetworked collaborative computing through Novell's 1,450 Authorized Education Centers to some 200,000 Novell certified professionals, and to sell its software—for implementing that vision—through Novell's 30,000 value added resellers (VARs).

The era of teleputers, combining the traditionally disparate functions of televisions and telephones with computers in devices designed specifically for accessing the vast information, communications and entertainment resources of the global Internet, is dawning. In 1996, plans were announced or production begun by manufacturers of computers and terminals aiming thin client Network Computers, running suites of Java applications, at the corporate market; manufacturers of TVs and video games aiming Internet TVs and set top boxes at consumers; and makers of pocket organizers, PDAs, Handheld PCs, hardwired and wireless phones all adding email and full Internet connectivity to their products (Chart 6). Central to the new paradigm, teleputers will become increasingly ubiquitous in the coming years.

Digital Cameras The increase in color printer penetration, the ease of emailing images to friends, and the growth of personal web pages have freed photos from the confines of dusty shoe boxes in people's closets. The quadrupling of digital camera sales last year (Chart 7), suggests that the advantages of the instant "developing", photo editing, unlimited reproduction, and expanded distribution of digital images, have already begun to compensate for the temporary drawbacks of digital cameras' relatively high prices and low resolution images. The balance will increasingly tip in digital's favor since as much as 75% of the costs of current models are the image sensors and memory storage chips, which are subject to the price-performance benefits of Moore's Law. And with continued strong sales and an explosion onto the market of digital cameras from over 22 vendors, expect additional savings from mass production.

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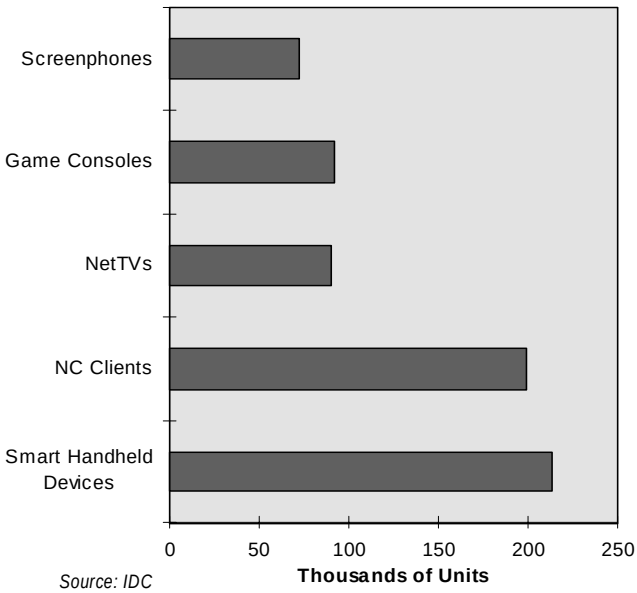
Chart 6

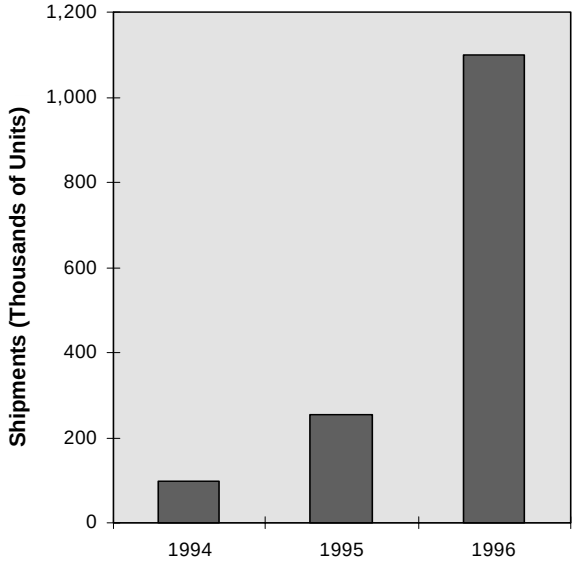
1996 Teleputer Shipments
With Internet Access



Source: IDC

Chart 7

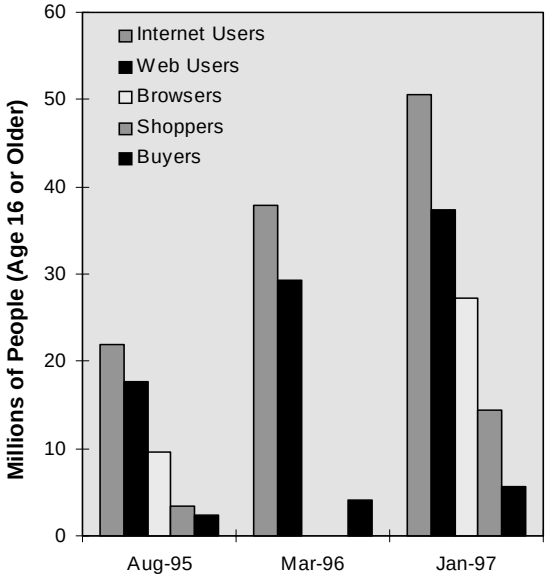
Digital Still Cameras



Source: Dataquest

Chart 8

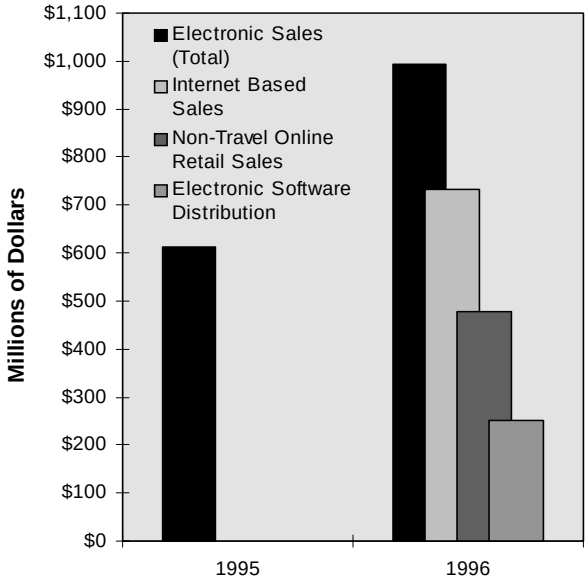
US and Canadian Internet Usage



Source: Nielsen Media Research

Chart 9

Electronic Commerce



Sources: Cowles/Simba, Jupiter Communications, IDC.

Twenty three percent of all persons over 16 years of age in the US and Canada–more than 50 million people–have used the Internet in the past month and still have access today, according to the latest results of the CommerceNet/Nielsen Media Internet Demographics Survey conducted in December 1996 and January 1997. This is 2.3 times the number of people using the Internet in the 3 months prior to the Fall 1995 survey. Similar increases were seen for Worldwide Web usage (2.1 times higher), the number of people who spent time searching for information about a particular product or service, what I call "browsers" (2.8 times), and the number of web users making a purchase of a product or service online (5.6 million or 2.3 times). Significantly though, the number of people I term shoppers, those who searched prior to making a purchase, shot up from 3.4 to 14.5 million or 4.3 times (Chart 8). Clearly, the greatest short-term opportunity lies in turning the 8.5 million shoppers who didn't buy online, into online buyers. This potential will be unlocked as users gain confidence in the security of online transactions as a result of the implementation of any one of numerous safeguards–such as electronic cash, in which buyers use stored electronic cash unlinked to any personal account or credit information, thereby limiting risk to the cash value alone, and Secure Electronic Transaction (SET) protocols now being finalized by Visa and Mastercard to allow secure credit card transactions over the Internet.

The total value of electronic sales–including those generated through the Internet, commercial online services, CD ROM catalogs, interactive television, kiosks and screen phones–rose to nearly $1 billion in 1996. Internet based sales amounted to $733 million of the total according to Cowles/Simba Information. Jupiter Communications calculates non-travel online retail sales at $478 million. And electronic software distribution generated $250 million in revenues according to IDC (Chart 9).

As individuals and businesses have become acclimatized to the online world and are beginning to feel secure about spending money and transacting business online, banks and financial institutions have done the same. Currently, according to the Online Banking Report, there are over 2,000 banks with a presence on the Web, and at least 54 of those have Internet based account access available to their customers. Online banking customers–individuals or small businesses that have signed up to receive access to their checking accounts (bank, credit union, non-bank, thrift) via a computer (over the Internet, an online service, or through direct dial-up)–have shot up ten-fold from, 250 thousand in August of 1995 to an estimated 2.5 million in December, 1996 (Chart 10).

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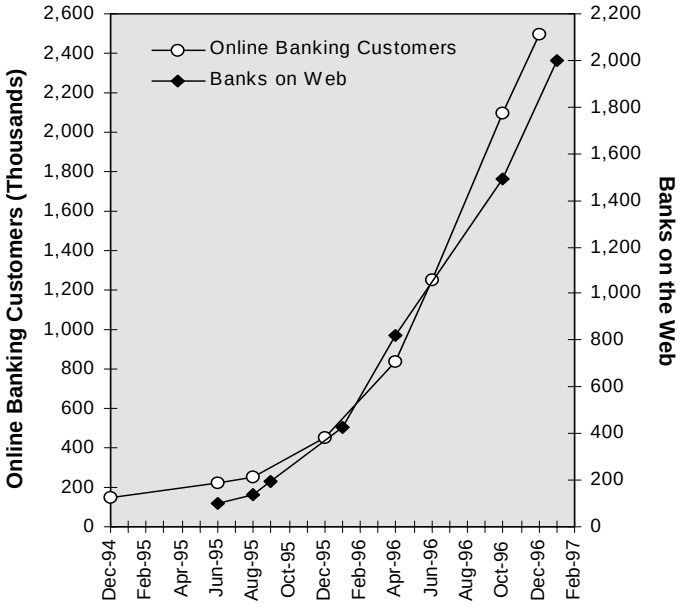
Of course, wherever consumers are present advertisements are sure to follow (Chart 11).

Chart 10

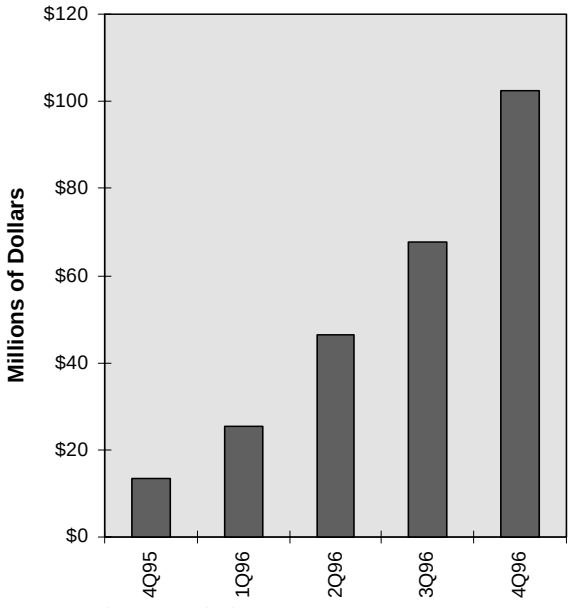
Online Banking



Sources: Online Banking Report, Find/SVP

Chart 11

US Web Ad Revenue



Source: Jupiter Communications

In an entrepreneurial world, low pressure zones concentrate energy in spirals of growth, twisters of creative destruction.

In a world of material abundance, scarcity devolves onto the residual resource, which is time. Time to market, turnaround time, time to retirement, network latency time, memory delay time, computer cycle time—all the temporal preoccupations of business and technology conferences. But all these measures of time reduce to two key limits: the speed of light and the span of life.

As the ultimate velocity, the speed of light has always seemed to be a source of abundance. But today it is the governing scarcity and constraint in the design of electronic machines. Electromagnetic fields move 19 centimeters (nine inches) a nanosecond, cross the continent in 20 milliseconds, reach a geosynchronous satellite in a quarter of a second. Such numbers remorselessly constrain the entire evolution of electronic and photonic technology.

Operating in cycle times near billionths of seconds, computer technology enforces a nanosecond ruler. Unless memory cells are directly coupled to the central processor, computer performance will be dominated by wait states and memory access. Roughly rendered, the lightspeed barrier means decentralized small devices will be everywhere—the smallest computers will be the fastest. Networks will be cellular, governed by luminal time.

The span of life is biological time. It reduces to the programmer's time, the designer's time, the engineer's time, and finally and most important, the customer's time. In an era of material scarcity, you could squander these people's time. The customer's time was an externality, like air or water in the industrial era, that could be wasted and polluted at will. By all means line up the customers in a queue, make them cultivate paper acres of arid formland, waste their minds in imbecile titillations or bloody natters of "news" designed to catch their eyeballs for ads that are mostly irrelevant to them. Make programmers constantly port, compile, and debug their code for new systems. Make everything incompatible. Waste time and gain a proprietary edge. Save the microprocessor's time. That has been the rule of the Wintel era. In the new era, however, biological time is the most precious resource and saving the customer's and creators' time is the key goal of business to which everything else must be sacrificed.

So that is what is scarce—lightspeed and lifespan. The defining abundance, however, is not material resources. In every era, the definitive abundance is revealed by the price of a key factor of production plummeting over a cliff of costs. Like a waterfall going over a cliff, the key resource releases a surge of kinetic energy into the economy as the price drops. From horsepower to kilowatt hours, the countries, companies, and individuals that exploit the ever cheaper resource gain marketshare against all others and end up casting the character of the age.

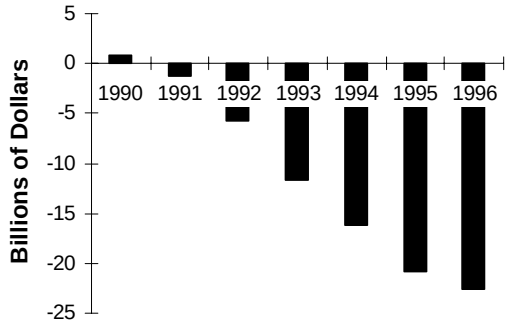
Over the last forty years, the key resource was transistors, translated into MIPS, dropping in price 48 percent a year, and bits, dropping in price 68 percent a year. Forty years ago, a single transistor, with supporting circuitry, might cost $7; a worker in a wafer fab could make five a day. Today a transistor costs a few millionths of a cent. A single semiconductor fabrication line can process in a pipeline some 90 trillion transistors a year, 250 billion a day, and 50 billion a day per worker. If you measured productivity by counting transistors per worker, it has risen 5 billionfold since 1956, a millionfold since 1980.

By dominating the production and use of this resource over the last four decades, the US, Japan, and other Asian vendors of silicon made dramatic gains in marketshare against the Europeans. Transistor prices continue to decline at the same pace and assure large markets for companies that exploit this plummeting cost.

The huge fortunes of the new era, however, will ride a new factor of production over a new paradigm cliff. Readers of this report know well that the key abundance of the next era, plummeting over its historic cliff of costs, is bandwidth, or communications power, measured in hertz or cycles per second. In order to measure the cost of this bandwidth, you do not merely calculate the cost of the new broadband equipment; you measure the increase in network traffic against the cost of the equipment. By GTG's estimates, while communications equipment sales have roughly doubled, US Internet traffic alone has risen 140 fold over the last three years, from approximately 15 terabytes a month in April 1994 when the net was privatized to more than two petabytes per month in March 1997. For the curious, a petabyte is a million gigabytes.

Chart 12

US Trade Balance
Electronic Computing Equipment



Source: US Department of Commerce

The price of bandwidth is in the process of collapsing, falling between two and ten times as fast as the price of transistors. As costs drop, companies capture profits, enlarge investment, lower prices, and expand market share.

Andrew Kessler of **Velocity Capital Management** offers a clear scheme for grasping this process. In a meteorological metaphor, the plummeting price of a key resource—the sudden evacuation of costs—creates what might be termed a low pressure area in the economy. Low pressure systems pull in weather from elsewhere. Economists have long favored equilibrium—economies gravitating toward perfect balance, blue skies and moderate weather. This remains the French ideal. In equilibrium models, lower prices normally signify lower value and decreased productivity. Investment flows toward the high pressure, high priced regions. Kessler boldly turns the existing picture on its head. Lower prices of key factors of production signal greater value and opportunity. In an entrepreneurial world, low pressure zones concentrate energy in spirals of growth, twisters of creative destruction.

To old paradigm analysts in Europe, the low pressure

Internet Traffic

Internet traffic transiting through the major US Network Access Points (NAPs) and Metropolitan Area Exchanges (MAEs) has continued to rise steadily throughout February and early March, 1997. Chart 13, while reflecting the same underlying data presented in previous reports, has been adjusted to show each month's rate of traffic flow (based on a 30.42 day month), rather than the total traffic per calendar month. This adjustment has been made to allow for month to month comparisons of traffic rates and to eliminate the possible misperception that Internet use/traffic decreased from January (31 days) to February (28 days) or jumped artificially from February (28) to March (31 days). The "saddle" seen in the Spring of 1996, resulted from an underreporting of traffic flowing through new ports added to MAE East. Similarly, current data for traffic at the Sprint NAP has shown a decrease as a consequence of non-reporting of data following a recent capacity increase. This serves to remind us that though this data serves as a reference for trends in Internet usage, the data does not represent total Internet traffic.

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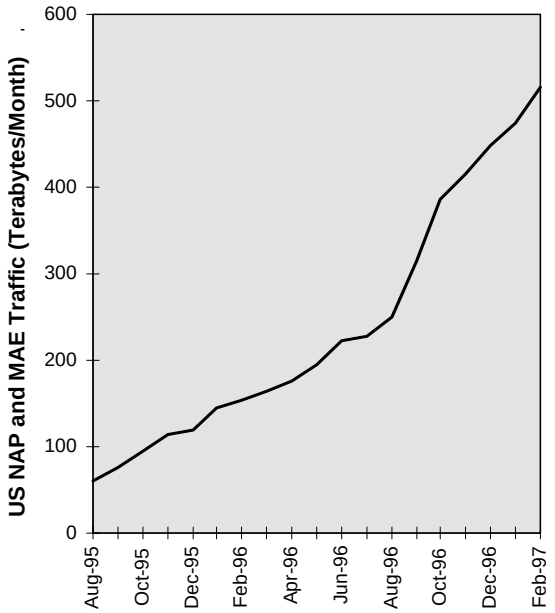
Chart 13

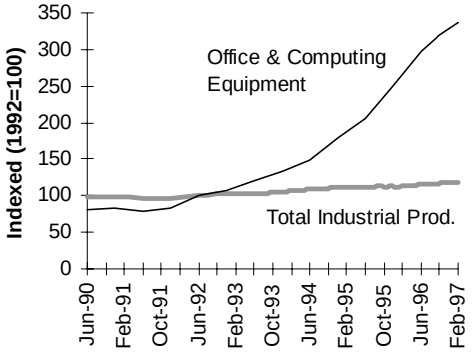


The key source of the new low pressure area in the world economy is the rampant spread of the Internet.

paradigm seems false because low pressure zones tend to run a capital surplus, which necessarily means a deficit in trade. As the price of the key factor of production plummets, wealth flows in from around the globe to take advantage of the opportunity. Rising faster in the low pressure area than outside, income growth pulls in imports, both capital and consumer goods. Thus between 1992 and 1996, a period of surging US global economic marketshare growth, the US trade gap also surged. Between 1990 and 1996, the US trade balance in electronic and computing equipment dropped from a $.8 billion surplus to a $22 billion deficit, while US computer production increased 312 percent, or more than 15 times as much as overall industrial output. Overall high technology output rose 80 percent during that period, to a 1996 level of $420 billion. Dwarfing the $21 billion negative shift in high technology trade was a some $200 billion rise in US high technology production led by computers. The technology trade gap mostly signified the influx of low margin components to allow production of high margin systems and software, expanding US marketshare in the global high tech arena.

Chart 14

US Industrial Production



Source: Yardeni's Economic Network

The key source of the new low pressure area in the world economy is the rampant spread of the Internet. The Internet lowers the price of transactions, the cost of price information, the cost of search, the cost of auction pricing models. As economist Edward Yardeni shows, it promises a "deflationary price spiral."

"The Internet," he writes, "is the 'killer' application that will continue to boost the sales of computer hardware and software...[the Internet is] the 'got to have it' tool and toy for the next century." Spreading market prices and proliferating new products, it lowers the cost of capitalism and raises the comparative price of socialist policy. Portentously, France commands about one tenth as many Internet users per capita as the US does.

In the new era, the key measure of economic potential will be the spread of the Internet. As OECD studies reveal, Internet growth in any country correlates closely with the degree of competition in the telecom arena. The new paradigm dictates privatization of telecom and the opening up of communications markets to the next waves of entrepreneurial progress. It means welcoming the processes of creative destruction, recycling resources from a Renault to an Alcatel, a Thomson-Rousset, and a thousand other firms.

Although with rising ambivalence, the US still mostly welcomes such changes. Simultaneously with Renault, **Apple** (AAPL) announced a layoff of 4,100 in Cupertino and Americans wondered what took them so long. After returning from France, I traveled to San Francisco to visit Paul Baran, the man who originally conceived the packet switched and routed digital network that has evolved into the Internet. Here, one man can overthrow empires and reshape the world economy.

Living at the heart of Silicon Valley in a walled and radiantly flowered community a few minutes down Middlefield Road from **Netscape** (NSCP), he sits at the epicenter of his creations. Linking his home PCs and PowerMacs to the Internet through the Palo Alto CableTV Cooperative are modems from **Com21** which he founded and now chairs. To run multimedia programming down twisted pair wires, the RBOCs now propose to use

ASCENDANT TECHNOLOGY	REPORT(S) Volume: No.	COMPANY (SYMBOL)	Initial Reference Price	Price as of 3/26/97
Erbium Doped Fiber Amplifiers, Telecommunications Infrastructure, Wave Division Multiplexing (WDM)	II: 2, 3	*Alcatel* (ALA)	16 3/4	23 3/8
Analog to Digital Converters (ADC), Digital Signal Processors (DSP), Silicon Germanium	II: 3	*Analog Devices* (ADI)	22 3/8	24
Erbium Doped Fiber Amplifiers, Wave Division Multiplexing (WDM)	II: 2	*Ciena* (CIEN)	23 *	31 1/16
Low Earth Orbit Satellites (LEOS)	I: 2 II: 1, 3	*Globalstar* (GSTRF)	43 1/2	57
Telecommunications Equipment, Wave Division Multiplexing (WDM)	II: 1, 2	*Lucent Technologies* (LU)	47 1/8	52 1/4
Internet Software	I: 1, 3, 4 II: 1	*Netscape Communications* (NSCP)	53	32 1/8
Code Division Multiple Access (CDMA)	I: 1, 2 II: 1, 3	*Qualcomm* (QCOM)	38 3/4	61 1/4
Java Programming Language, Internet Servers	I: 1, 2, 3, 4 II: 1	*Sun Microsystems* (SUNW)	27 1/2	30 1/2
Servernet System Area Networks (SAN)	I: 1	*Tandem Computers* (TDM)	9 1/2	11 1/4
Optical Equipment, Smart Radios, Telecommunications Infrastructures	I: 1 II: 1,2,3	*Tellabs* (TLAB)	29 1/8	40
Digital Signal Processors (DSP), DRAM	I: 2, 3, 4	*Texas Instruments* (TXN)	47 1/2	81 1/8
Gallium Arsenide Integrated Circuits (IC)	I: 2 II: 3	*Vitesse* (VTSS)	21 5/8	30 1/8
Code Division Multiple Access (CDMA) Testing Gear	II: 1	*Wireless Telecom Group* (WTT)	10 3/8	9 7/8
Field Programmable Logic Chip	I: 3	*Xilinx* (XLNX)	32 7/8	50 7/8

** 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.

Discrete Multitone (DMT) technology, conceived by Baran for Telebit and now the leading Digital Subscriber Loop (DSL) method, taken up and perfected by **Amati Corporation** (AMTX) down the road in Palo Alto. Stratacom, recently purchased by **Cisco** (CSCO) for $4 billion, began as a spinoff from Baran's Packet Technologies Inc.

Metricom (MCOM), a Baran company with investments from Bill Gates, among others, offers wireless Internet services through Baran's neighborhood and at campuses across the country. Baran's company, Equatorial was the first to use spread spectrum commercially. It served as a way of delivering information from satellites below the noise floor required by the FCC. It is now, in the form of the CDMA of Qualcomm and Globalstar, the world's fastest growing communications technology and the basis for the flourishing unlicensed wireless systems, like Metricom, operating at less than one watt of transmit power in the ISM (industrial, scientific, medical) bands.

Collectively, the visionary concepts of this once myopic and still modest engineer offer the foundation of an effort to reinvent the Internet in increasingly wireless form and reshape the communications policies of the nation.

In Baran's first Internet recommendation to the Air Force in 1964, he commented that his concepts would allow "handling the expected exponential growth in the transmission of digital data." Declaring that "it would be possible to build extremely reliable communications networks out of low-cost unreliable links, even links so unreliable as to be unusable in present type networks," he estimated that the price of the system would be $60 million. That was some 20 to 30 times less than existing military communications systems without any of these features. It was two orders of magnitude cheaper than new analog circuit switched systems then being proposed by the three services under the guidance of AT&T. Baran defined the cliff of costs of a global Internet low pressure system.

The system of communications that Baran attacked in the early 1960s at Rand was the imperial establishment of AT&T. Today ironically, NextWave, together with some of the new companies launched by Baran, face that same communications monolith. As long as AT&T clings to the high pressure paradigms of the past, its overthrow is still crucial to the advance of US telecom.

George Gilder, March 26, 1997

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