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# THE TETHERLESS TELECOSM

**The future of wireless is the replacement of current dumb radios by smart digital radios.**

The last decade of the twentieth century has been the epoch of the personal computer, climaxing in 1996 when PCs outsold TVs in units for the first time in the US. Now a new form of PC is moving toward center stage in the telecosm. Envisage the most common personal computer of the coming era.

Believe it or not, the new PC won't do Windows (tm), but it may well do doors. Let me open some for you.

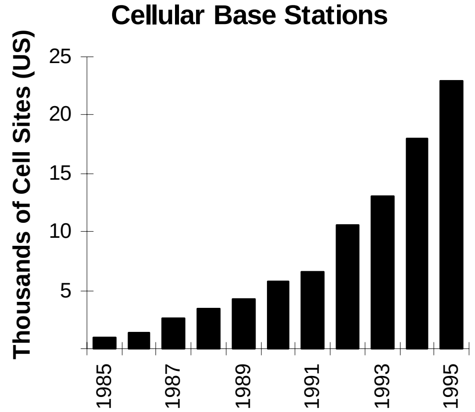
Begin by thinking of the human eye and comparing it to a radio. Like a radio, the eye is essentially a device for converting photons into electrons, pulses of electromagnetic energy into electrical currents. Geared for visible light rather than radio frequency signals, the eye is a receiving antenna. As radio technology moves up through the microwaves toward the infrared realm–with infrared wireless links from **Canon** (CANNY) now reaching 155 megabits per second–many of the differences are dissolving.

Yet, in the crucial index of performance, the radio is drastically inferior to the eye. While most radios can receive signals across a span of frequencies ranging from the kilohertz to the megahertz, from thousands to a few million cycles a second, the eye can grasp signals with a total bandwidth of more than 350 trillion hertz (terahertz). That is the span of visible light, from 400 terahertz to 750 terahertz, red to purple.

How is it that your eyes command 350 terahertz of bandwidth and your FM radio around 20 megahertz, 17 million times less? It is not chiefly the special powers of the retina and other optical faculties. Radio antennas can collect an even larger span of frequencies. The difference is mostly behind the receiver. Backing up the eyes is the processing power of some 10 billion neurons and trillions of synapses. Backing up the radio antenna is a lot of fixed analog hardware. The eyes are smart and aerobatic, while the radio is dumb and hardwired.

Chart 1

Cellular Base Stations




The future of wireless is the replacement of current dumb radios by smart digital radios that resemble eyes. With the coupling of radio technology with computer technology, the antenna can acquire a brain. Smart radios can eventually process gigahertz of spectrum (billions of cycles a second). They can sort out the frequency channels much as eyes sort out arrays of color, and pin down codes and sources of radiation much as the eyes descry different sources, shapes and patterns of light. For example, a smart radio could process phone calls, videos, teleconferences, geopositioning codes, speedtrap lasers, and emergency signals (depending on whether you want the police, or not).

The result will be a transformation of the

**Smart radios could reduce the capital costs of a wireless customer from an average of some $5,555 in 1994 to perhaps $14.**

nature of the spectrum. The current model is based on concepts of exclusive use, as in real estate. This model will give way to a new view. Rights to spectrum will roughly resemble drivers' licences for use on the highways. Today you use your three hundred terahertz eyes to survey the highway in front of you and avoid other traffic. As long as you do not collide with other users, pollute the air, or go too fast (use excessive power), you can drive anywhere you want. As radios are computerized, they will be able to "see" the radio frequency spectrum as your eyes see the roads. Smart radios will be licensed to drive in open spaces in the air as long as they don't collide with other radios, overpower them or pollute the airwaves.

The fulfillment of this dream is at hand. It is the broadband digital radio or software radio. Essentially, the radio used in cellular or PCS (Personal Communications Services) phones will be able to differentiate among frequencies; they will be able to tell which direction a signal is coming from and isolate it in space; they will be able to identify the language of codes and protocols and waveforms that it is using and download software translators. No longer caught in a dedicated set of channels, time slots, protocols, datatypes, and access standards, radios will be smart and agile rather than dumb and fixed frequency.

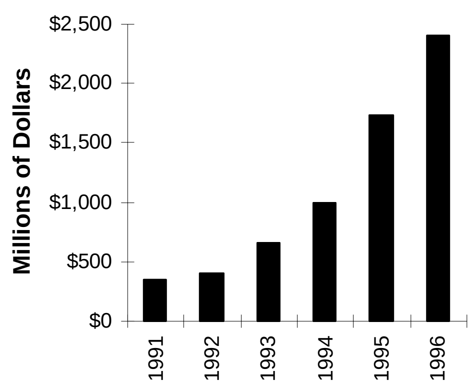


Chart 2
**Worldwide DSP Market**

This will not happen tomorrow. But like any technological vista, it illuminates the future. It opens the way to a new wireless paradigm that will be fully in place shortly after the turn of the century and that will offer a method for judging the evolution of companies and their prospects. In general, the companies on the path to broadband digital radios–the smart radio–will prevail over companies that hook their futures to hardwired machines linked to narrow spans of frequencies. Moore's Law, the doubling of computer power every 18 months or so, is enabling the creation of broadband cellular radios in which most of the processing occurs in digital form.

Some of the first smart radios were built for the military. In Desert Storm, the cacophony of allied combat radios–some 15 of them using a variety of frequencies, modulation techniques, encryption codes, and waveform standards, such as AM or FM or PCM (pulse code modulation)–created a virtual Babel in the sand. Units needed a separate radio system for every radio (or radar) standard. As a result the Pentagon launched the Speakeasy project–one smart radio that could process all the different standards in software. Made by **Hazeltine** and **TRW** (TRW), the first prototypes were demonstrated successfully in 1994. Because standards change over time and hardware improves at a Moore's Law pace, a software programmable radio also saves money. Rather than upgrading the system in hardware every time the technology changes, software radios can be upgraded merely by downloading a new software module.

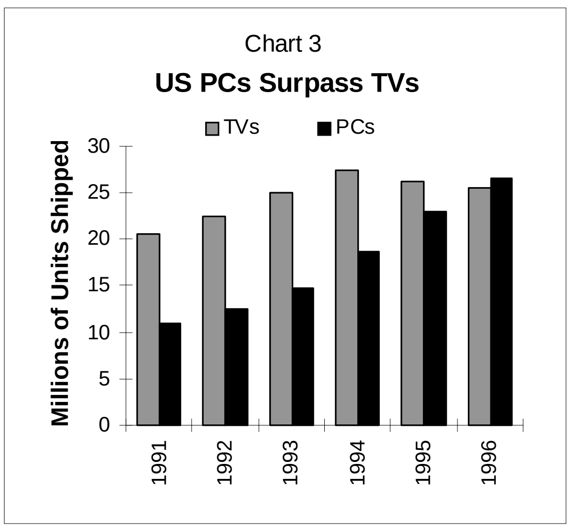
Speakeasy engineers have spread the word through the cellular industry. Stephen Bluth, now at **Bell South** Wireless (BLS), is leading an international effort to create smart radio standards–the MMITS project. Today, with the advance of an array of new digital technologies, including CDMA, TDMA, GSM, DECT 1900, SMR, PHS and a spate of others, every urban area is becoming a Desert Storm of incompatible radios. Not only are these systems unable to communicate with one another but they also require separate spectrum and base station equipment. All this redundant processing has raised the costs and reduced the universality of wireless and prevented cellphones from displacing wireline telephony.

The solution to complexity, however, is Moore's Law: put it on a chip. Reducing this Babel of complexity to silicon microchips, with hundreds of millions of transistors on centimeter slivers of sand that ultimately cost under $2 to manufacture, smart radios can radically simplify the cellular landscape. Freed of most wires, poles, backhoes, trucks, workers, engineers, and rights of way, cellular should be far cheaper than wireline.

For example, the conventional analog base station that receives your cellular calls and connects them to the telephone network requires a million dollar facility of a thousand square feet. This structure may contain a central office style switch to link calls to the public switched telephone network, huge backup power supplies and batteries to handle utility breakdowns, and racks of radios covering every communications channel and modulation scheme used in the cell. This can add up to 416 radios, together with all the maintenance and expertise that multiple standards entail.

In the near future, one wideband radio will suffice. Digital signal processors (DSP) ultimately costing a few dollars apiece and draining milliwatts of power will sort out all the channels, codes, modulation schemes, multipath signals, and filtering needs. Gone will be the large buildings, the racks of radios, the arrays of antennas, the specialized hardware processors, the virtual honeycombs towering in the air in time and space with exclusive spectrum assignments and time slots, and possibly even the battalions of lawyers in the communications bar. All can be replaced by a programmable silicon base station in a briefcase, installed on any lamp post, elevator shaft, office closet, shopping mall ceiling, rooftop, or even household. The result, estimated Don Cox of Stanford, the father of American PCS at Bell Laboratories, could be a reduction of the capital costs of a wireless customer from an average of some $5555 in 1994 to perhaps $14 after the turn of the century. That is a paradigm cliff of costs.

As smart radios are delivered in the first years of the new century, they will not only reduce costs, but also allow escape from the protocol zoo. Programmable in software, able to handle any popular protocols, basestations will transcend the bondage of air standards, where if you live in a GSM (Global Services Mobile) area you are forced to use GSM, and if you live in a CDMA (Code Division Multiple Access) area, your communications poor cousins visiting from Europe will have to give up their GSM phone and demand to borrow yours (will they ever give it back?). Under the new regime, different standards mean different software loaded into RAM (random access memory) in real time. Any cell can accommodate a variety of access standards, channel assignments, and modulation schemes and the best ones will win.




To get there from here, however, will require heroic achievements in the technology of radios. Every radio must combine four key components: an antenna, a tuner, a mixer, and a modem. Easiest is the antenna. Even though antennas too are converging with computer technology and becoming smart, for many purposes, a shirt hanger will do the trick (a wire fence collects millions of frequencies). It is the other components that deliver the message to the human ear.

Tuners usually employ the science of resonant circuits to select a specific carrier frequency or frequency band. The cellular band, for example, comprises 25 megahertz at around 850 megahertz. The PCS band comprises some 30 megahertz at around 1950 megahertz. A mixer converts these relatively high microwave frequencies into an intermediate frequency (IF) or to a baseband frequency, which can be converted to a digital bitstream.

Familiar in the PC world, a modem is a modulator-demodulator. In transmitting, it applies an informative wiggle (AM or FM say) to the carrier frequency. In receiving, it strips away the carrier, leaving the information.

In the old world of dumb radios, transceivers join all these components into one analog hardware system. Because this system is analog and hardwired, it cannot be tuned or programmed. Each radio can receive or transmit only a limited set of frequencies, channelized in a specific way, bearing information coded in a specific modulation scheme and exclusively occupying a specific spectrum space at a specified power range.

In the new world of smart radios, only the antenna and the front-end mixer are analog and hardwired. Channels, frequency bands, modulation schemes, protocols, all can be defined in software in real time. The radio becomes a programmable microwave eye–a device that can see whatever colors of RF (radio frequency) you want to send it.

The key to digital radio is the analog to digital converter. It takes a radio or intermediate frequency and samples it at least at a rate double the frequency in order to translate it into a series of numbers. Imagine a strobe light illuminating a dancer. The light will have to strobe at least twice as fast as the dancer moves or you will not be able to detect the dance. Indeed, in a phenomenon called aliasing, you may see a different slower dance, as you see a tire rotating slowly in the wrong direction on a film. In a similar way, an analog to digital converter (ADC) strobes (samples) the dance of inflected frequencies on the carrier wave. The resolution of the ADC is measured in bits, setting how high can be the number that defines the waveform, and in samples per second, determining how high a frequency the ADC can capture without aliasing.

Ultimately, early in the next century, the advance of analog to digital converters will dispense even with the mixer. Then the all software radio will be here. ADCs will be able to translate microwave frequencies directly from the antenna into a digital bitstream. **Alcatel** (ALA) has already accomplished this feat in the GSM cellular band at its labs in Marcoussis, France. But so far, this almost totally digital radio is a stunt rather than a product. That will change.

Most of today's ADCs cannot function reliably in real time at microwave frequencies (above 300 MHz). Therefore, mixers are vital. Whether digital or analog, a mixer is essentially a multiplier. As invented by W.H. Armstrong, the

**By far the most effective mixer is the paramixer invented by Steinbrecher Corporation, now owned by Tellabs.**

Chart 4

**ISDN Lines**

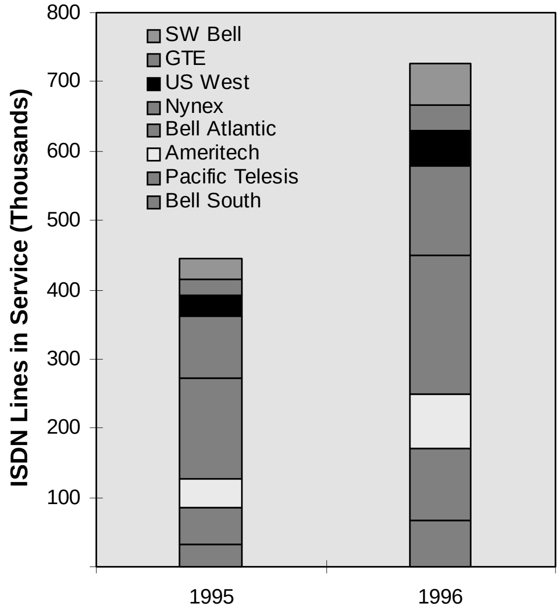
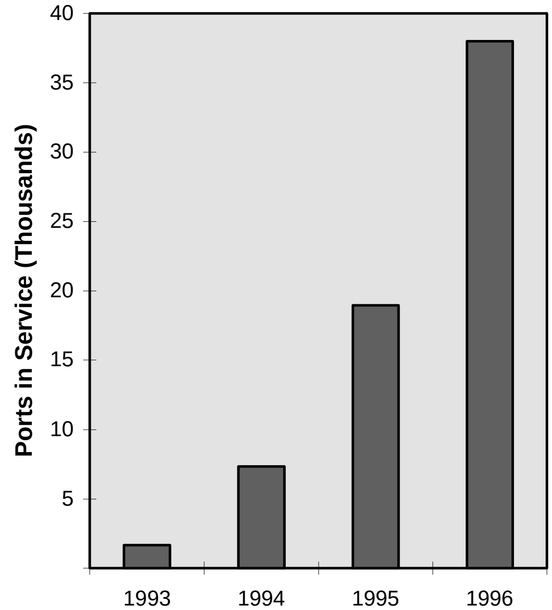



Chart 5

**US West Frame Relay Service**




**The death of telephony** *and the end of the traditional public switched telephone network (PSTN), long predicted by George Gilder, is at hand according to the Regional Bell Operating Companies (RBOCs). The RBOCs claim, and have the studies to prove, that phone networks originally designed to handle short voice calls, now averaging 3.8 to 5 minutes, are being swamped by data calls to ISPs which are averaging 17.7 to 20.8 minutes. Switches near ISPs are being overloaded by peak traffic four times greater than traditional peak business loads. The solution proposed by the RBOCs is to raise rates to ISPs. The ISPs, backed by the computer industry, counter that between 1990 and 1995 new access lines attributable primarily to Internet use have already generated some $3.6 billion in additional RBOC revenues. While the debate of who pays is moderated by the FCC, currently turning a deaf ear to the RBOCs, the solution lies not in fixing the PSTN but in bypassing the central office (CO) circuit switches and shifting data traffic onto packet-switched networks. A range of efforts are now underway. Pacific Bell has proposed that ISPs rent modem space directly within its COs, minimizing subscriber call routing within the PSTN. While some RBOCs are now packaging ISDN service with direct Internet connections, US West and MFS, with its subsidiary UUNET, have announced new xDSL services, which not only offer direct connections to the Internet bypassing the PSTN, but also promise higher speeds than the PSTN's ISDN offerings–see GTR, August 1996 (Chart4). As demand for frame relay services (Chart 5) and Internet connectivity explode, companies are moving to accommodate voice to data networks rather than the reverse. Voice over frame relay services by Intermedia, Ameritech and WorldCom; and MCI's VAULT system architecture, which bridges and combines traditional telephone networks and packet-switched networks, offer a hint of the future.*

**Market valuations of online service providers** *relative to their subscriber numbers have stabilized over the last several months (Chart 6).*

**Price performance gains** *for PC components have continued uninterrupted throughout 1996 (Chart 7). The dramatic improvements seen in the first half of the year–after years of DRAM stagnation–which led to our prediction of a boom in PC sales (see GTR, July 1996) have moderated as the strength of demand for processors remains strong. But, expect improvements to continue or accelerate as DRAM manufacturers shift production to higher density 64 megabit chips and Intel fights off challenges by Cyrix's MediaGX and AMD's K6 processors, as well as makers of cheap network computers.*

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Chart 6

**Market Cap Per Online Subscriber**

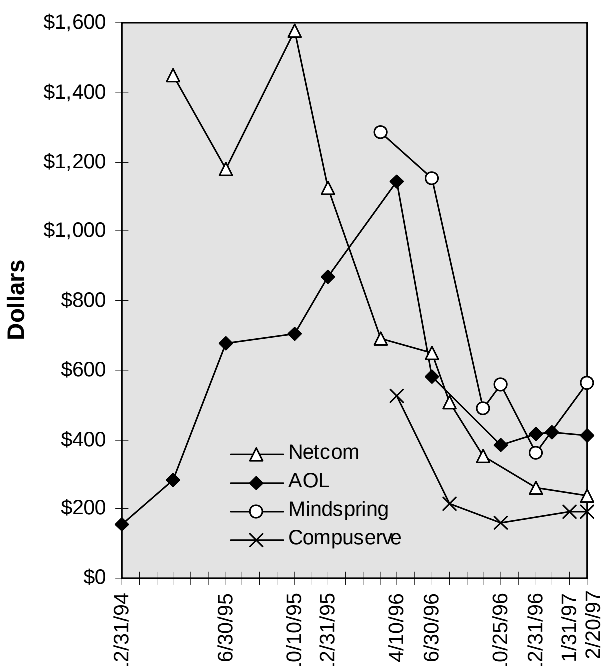



Chart 7

**DRAM and Processor Price-Performance**

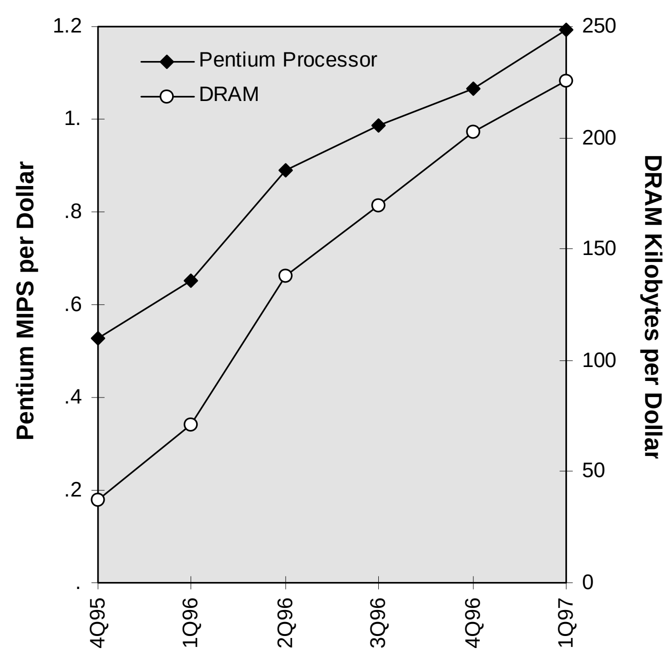


Chart 8

**Java Developers**

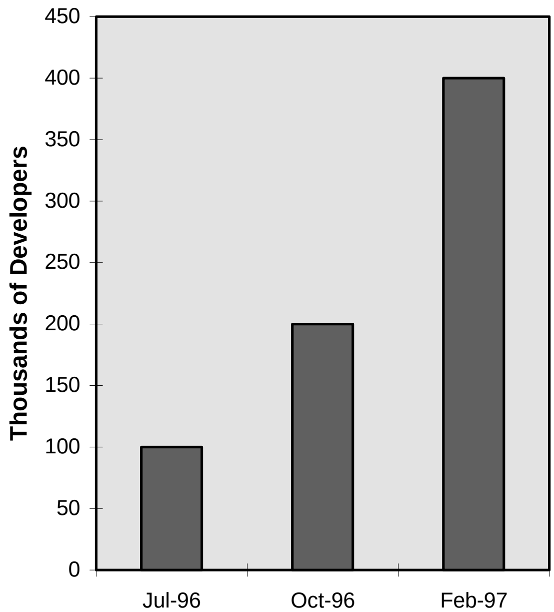
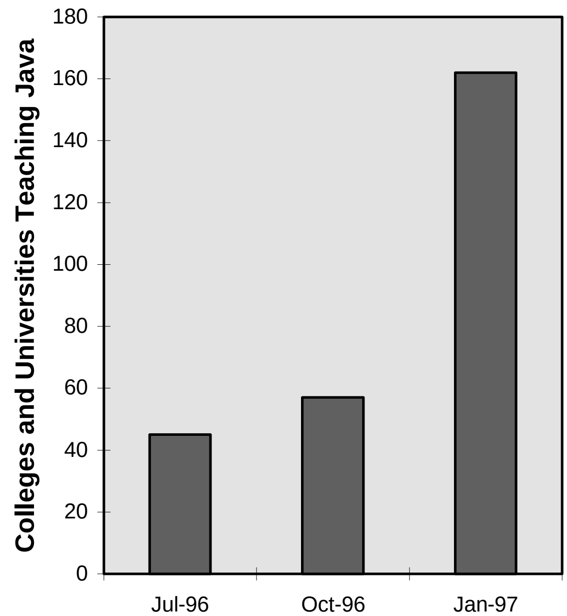



Chart 9

**Universities Teaching Java**




**Java enters the mainstream**. *Although the hype surrounding Java has decreased and sales of general introductory Java books has subsequently slowed, this has been replaced by the interest of serious programmers. Sell-through of each of the nine Java programming titles in Addison Wesley Longman's professional publishing line has continued strong at between 2,000 and 3,000 copies a month. According to Mike Hendrickson, Senior Editor for Professional Publishing , such strong sell-through coupled with Microsoft's endorsement of Java and release of Visual J++, suggests the market for serious Java programming texts is now about 400,000 developers, essentially the same as for Visual C++ (Chart 8). Although he believes C++ is still dominant among current programmers, Java has clearly become a mainstream language of equal validity, and given Java's ease of use and more forgiving nature he believes its potential is even greater than C++. The mainstream adoption of Java is also demonstrated by the overwhelming support for Java by the academic community. Over 162 colleges and universities are now teaching Java as part of their computer science curriculum (Chart 9). Of course, Java was first seen as a means to enliven web pages using small applications or applets (Chart 10), but now the focus in universities, corporations and countless startup software companies is on developing mainstream applications.*

**Internet traffic** *flowing through the Network Access Points (NAPs) and Metropolitan Area Exchanges (MAEs), where Internet networks are linked for the exchange of data, continues to rise (Chart 11). We are able to calculate the traffic through the five major exchanges and some smaller ones, which also report data, but this does not represent the total of Internet traffic. Additional traffic which is carried entirely within one network is invisible to us, as is traffic exchanged at more than 100 newer exchanges, and that which is exchanged privately between two networks. Indeed, MCI, the largest Internet backbone provider, reports that as much as two thirds of the Internet traffic they carry is now transferred at private exchange points bypassing the NAPs and MAEs.*

-KE

Chart 10

**Web Pages With Java**

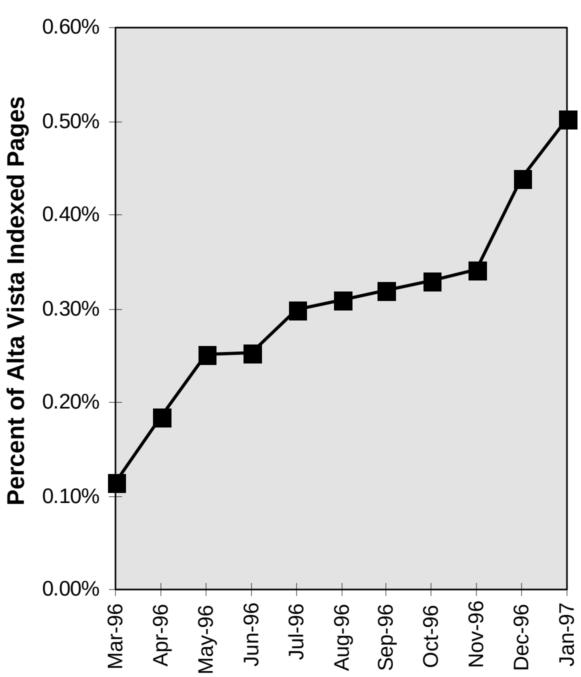
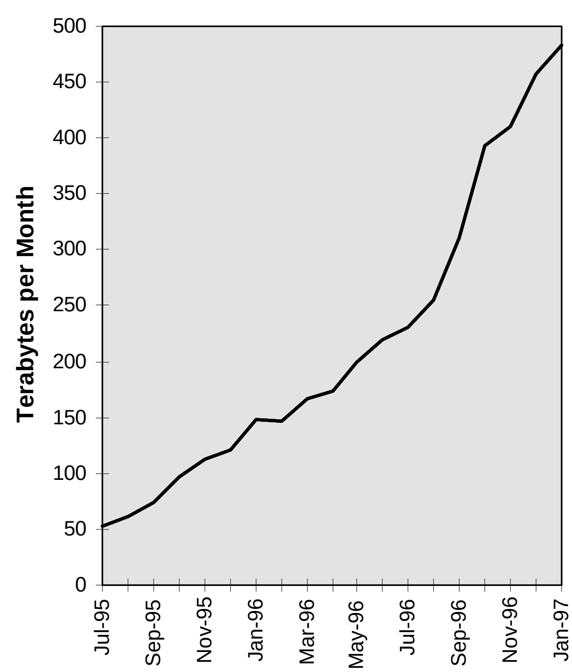



Chart 11

**Internet Traffic**



**With high powered DSPs and leading edge ADCs, Analog Devices is a paragon of the digital radio paradigm.**

father of FM, mixers are superheterodyne. They use local oscillators (LOs) to multiply the carrier frequency with a lower frequency. The key result is a frequency that represents the difference between the LO frequency and the carrier. This frequency is an intermediate frequency that holds all the information borne by the carrier but at a level that can be processed by existing ADCs.

By far the most effective mixer is the paramixer invented by Steinbrecher Corporation of Burlington, MA, now owned by **Tellabs** (TLAB) and renamed Tellabs Wireless. This device can range gigahertz of frequencies with a spur-free dynamic range (a range of volumes without spurious crackles or harmonics) that could capture the sound of a pin dropping at a heavy metal rock concert. For a fully digital superbroadband radio a cascade of these still costly devices is still the best bet. The leading vessel of this technology since it was conceived a decade ago by MIT professor Donald Steinbrecher, Tellabs' Burlington, MA operation will introduce the Steinbrecher Minicell in May for wireless local loop and interior cellular applications.

Tellabs has had trouble selling its wideband radios for cellular applications, for which they may be overdesigned. With the increasing spread of CDMA, which ordinarily uses only one to three channels, the initial gains from a broadband radio are small. But for a wireless local loop, with many thousands of Third World customers using all available channels, a broadband base station could offer large efficiencies. Replacing a large number of costly custom radios, with one programmable device, the minicell may find its niche.

As ADC technology continues to advance, however, it will relieve pressure on the mixer, opening the way to still cheaper and lower power solutions. With the expiration of Steinbrecher's patent on the paramixer, the business is opening up. **Watkins-Johnson** (WJ) has created a tiny mixer device in gallium arsenide the size of your smallest fingernail. So has **Minicircuits** of Long Island. "It has 50 percent less performance than Steinbrecher's but it costs only 10 percent as much. Many customers say 'it's a deal,'" observes former Steinbrecher CEO Douglas Shute, now contemplating a startup.

AD converters are now edging toward microwave frequencies. Both **Analog Devices** (ADI) and **Comlinear**, a **National Semiconductor** (NSM) company, have introduced 40 megasamples per second products at a resolution of 12 bits. This allows more of the mixing to move into digital multipliers. The first of the digital downconverter chips came from **Harris Corporation** (HRS) of Melbourne, FL. Harris now has parlayed its expertise in RF and mixers to create a sophisticated programmable machine that demonstrates the management of multiple modulation schemes in one cellular radio. Introduced on the floor of the RF & Wireless Symposium in late February in Santa Clara, the Harris smart radio showcases its programmable HSP50214 digital down converter chip and is run from a PC. With an array of display windows, the machine is designed to allow configuration and testing of smart transceivers from a Windows PC.

With high powered digital signal processors, leading edge ADCs, and even a new cheap mixer from inventor Barrie Gilbert, Analog Devices is a paragon of the digital radio paradigm. At the CTIA (Cellular Telephone Industry Association) meeting in San Francisco during the first week of March, Analog is introducing a wideband smart radio tuned to the cellular band but applicable through the PCS band as well. A reference design to be used by infrastructure manufacturers, it displays an array of new chips from Analog comprising a specialized ADC called the 6600, tunable filters called the 6620 and the 6640 that function as a digital tuner, a SHARC DSP chip that performs the modem and channel coding role (any DSP will do), and a "sinfully cheap" Watkins-Johnson mixer chip. Incorporating an automatic gain control and a received signal strength indicator, the ADC is customized for smart radio applications.

The antenna is from Radio Shack (most any will do). From a Windows PC using Visual Basic, Analog engineers can move from one cellular channel to another and from GSM to CDMA to DECT 1900 to IS-136 to the Japanese Personal Handyphone standard (PHS). As manufacturers around the globe converge on a single intermediate frequency of 70 megahertz, the reference radio could adapt to any cellular band, from 850 megahertz and on up. All you would have to do is change or retune the mixer. According to Analog infrastructure strategist Tom Gratzek at the Analog communications center in Greensboro, NC, customers say "Shazaam."

Interest is acute at all major telecom equipment manufacturers, from **Ericsson** (ERICY) to **Motorola** (MOT), and champions include every telecom company that thinks it may have guessed wrong in the GSM, TDMA, CDMA wars. Bell South, for example, is slipping into a TDMA (Time Division Multiple Access) ghetto, but it dreams of deploying smart radios that can play any popular standard and allow it to filch (i.e. service) CDMA customers. Also a TDMA orphan, **AT&T** (T) could buy cheap all-purpose base stations that allow it to sell any favored brand of service. Ericsson is using the technology to create indoor GSM base stations that can fit in a closet, and if worse comes to worst (as it will), also offer CDMA, perhaps initially as an overlay for data.

Going over the cliff of costs, the industry can introduce radically new products. We are now entering a new era when a new form of PC will be dominant. Tetherlessly transcending most of the limitations of the current PC era, the most common PC will be a digital cellular phone.

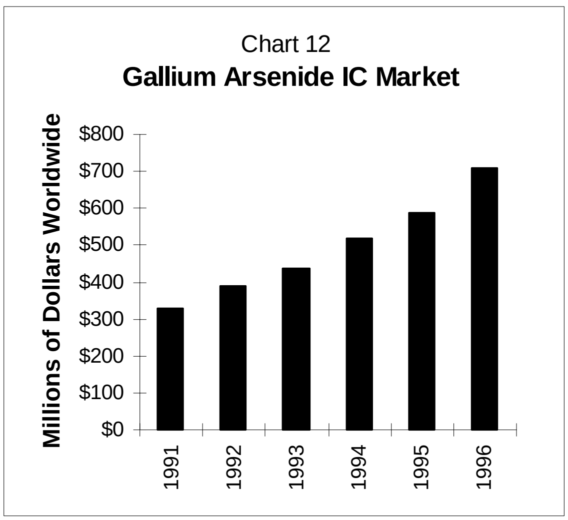
It will be a dataphone, as faithful readers of this report will recognize. It will be as portable as your watch and as personal as your wallet. It will recognize speech and convert it to text. It will plug into a slot in your car and help you navigate streets. It will consult electronic yellow pages and give directions to the nearest gas station, restaurant, police headquarters, or hotel. It will collect your news and your mail and if you wish, it will read them to you. It will conduct transactions and load credit into a credit chip on a smart card, which can be used like cash. It can pay your taxes, or help you avoid them, or soothe you with soft music as you do your calculus homework. It will take digital pictures and project them onto a wall or screen, or dispatch them to any other dataphone or computer. It will have an Internet address and a Java runtime engine that allows it to execute any applet or program written in that increasingly universal language. Or it will dock if necessary in a more powerful machine to perform more demanding functions. It will link to any compatible display, monitor, keyboard, storage device, or other peripheral through infrared pulses or radio frequencies.

And, oh yes, it will unlock your front door or car door, unroll your garage door, or even play Jim Morrison songs, if you are old enough to care for those swinging Doors of the Sixties (amazingly enough, my teenage daughters still do).

Sorry, though, **Nokia** (NOK), your model 9000, which comes closest today to this new machine, will not cut it, at least in the US because it is based on Europe's increasingly obsolescent GSM standard. Also offering the right form factor but the wrong access standard is the **IBM**-BellSouth Simon, which is based on the US analog cellular system (AMPS) or CDPD (cellular digital packet data). The most common PC will not be a GSM (Global Services Mobile) or CDPD device, because it will need soon to provide bandwidth on demand while draining the lowest possible power, whenever it is not plugged in. Thus the first PC of the new paradigm will probably have to be CDMA (code division multiple access), built from the bottom up to provide bandwidth on demand, according to TCP-IP internet standards, at a handful of milliwatts of communications power (see GTR, January 1997).

Among the companies soon to supply such machines, resembling the popular **US Robotics** (USRX) Pilot, are **Sony** (SNE), **Qualcomm** (QCOM), **Lucky-Goldstar**, and **Samsung**. In cooperation with Alcatel, the European giant which has just announced a CDMA program, Qualcomm base stations will soon contain a GSM link that can allow such CDMA dataphones to tie seamlessly to GSM systems in Europe. This will permit European carriers to use CDMA to expand capacity without jeopardizing their GSM customers.

These advances will ultimately converge with the broadband digital radio. By drastically enhancing efficiency in the use of spectrum, broadband digital radios will lend new force to the industry's move up the frequency ladder toward bandwidth abundance. They enable the seamless convergence of the cellular band not only with the PCS band but also with an array of other applications such as the low powered ISM (Industrial, Scientific, and Medical) bands at 2.4 gigahertz and 5.8 gigahertz, the 18 gigahertz band of **Associated Communications**, the 28 gigahertz band of Multichannel Multipoint Distribution Service (MMDS) used for wireless cable, and the 38 gigahertz band of **Winstar** (WCII). This up-spectrum bias assures the continued success of companies pressing the frontiers of microwave integrated circuits, low noise amplifiers, power amplifiers, and other devices that function in the gigahertz.




This is the spectronic paradigm, in which most of the industry, from personal computers to cellular phones move on into the microwaves and are discussed more in terms of megahertz and gigahertz than in the usual metrics of MIPS and bits. The spectronic paradigm tends to favor the manufacturers of gallium arsenide, indium phosphide, and silicon germanium devices. Even as **Phillips** (PHG) and other firms push silicon bipolar and even CMOS chips toward microwave frequencies, the industry will move on to yet higher domains of spectrum where gallium arsenide and indium phosphide tend to prevail. For the power amplifiers needed in every cellphone, for example, gallium arsenide is fundamentally superior to all the silicon variants. Pushed by the advance of the spectronics paradigm, the current ride of **Vitesse** (VTSS), **Anadigics** (ANAD), **Triquint** (TQNT) and other gallium arsenide innovators is likely to continue.

The major long term threat is silicon germanium. Pioneered by IBM fellow Bernard Meyerson and tested and sampled by Analog Devices, silicon germanium combines much of the manufacturability of silicon with the high frequency operation of gallium arsenide. IBM has recently contracted with Hughes communications division to develop silicon germanium microwave devices.

As the technology advances, the broadband

**Pushed by smart radios, the current ride of gallium arsenide innovators is likely to continue. But watch out for IBM's new silicon germanium.**

## CABLE MODEMS AT 6 MONTHS

Chart 13

**Cable Modem Availability**

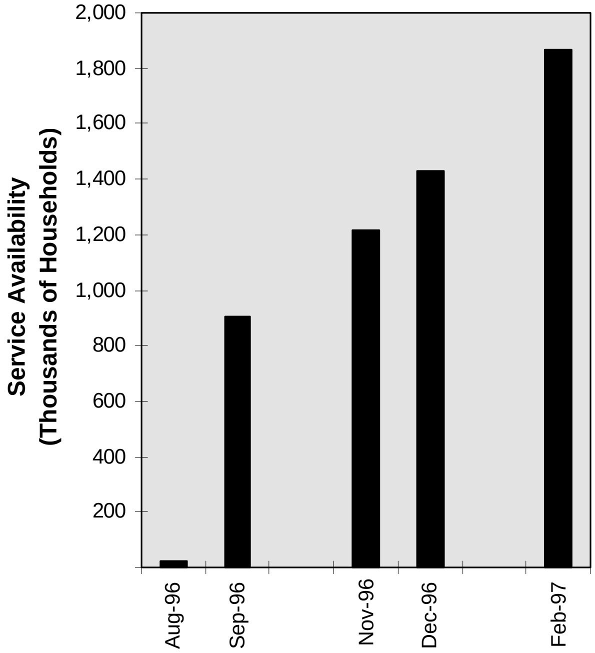
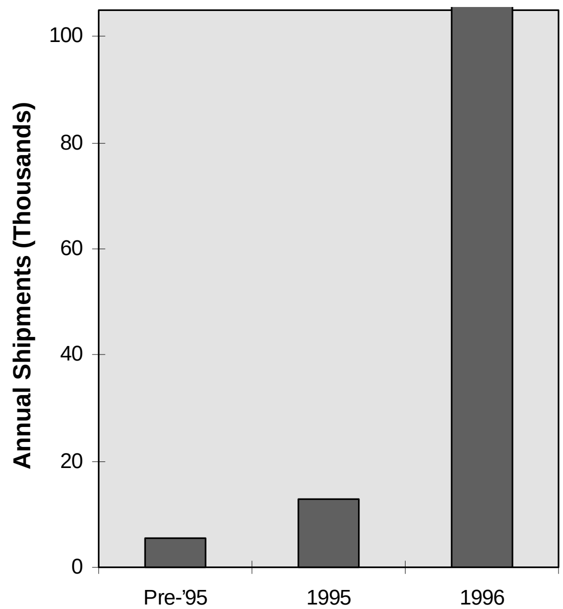



Chart 14

**Cable Modem Shipments**




*Availability of cable online services continues to expand with additional deployments of TCI's @Home service in Hartford, TimeWarner's RoadRunner in San Diego, and Continental Cablevision's Highway 1 in Detroit suburbs. With the announcement of new systems and the expansion of existing service areas the number of homes passed by cable systems offering broadband cable modem Internet access has grown to nearly 2 million in just 6 months (Chart 13).*

*Coincident with commercial service roll outs, the cable modem market exploded and shipments rose to over 100,000 units (Chart 14). In 1996, Zenith's early lead in shipping cable modems to trials and initial deployments was surpassed by Bay Network's LANcity cable modems' dominance in the first commercial rollouts, and, after initial missteps, Motorola began strong shipments which bring it within striking distance of the two leaders. In 1997, manufacturers are further increasing production to meet demand. As we go to print, LANcity is tripling the workers in the stock room and increasing its testing capacity from 400 to 1,200 modems per day.*

*Terayon's S-CDMA (synchronous code division multiple access) cable modem technology also advanced in February 1997, with the announcement by Jupiter Telecommunications Co., Ltd. and Sumitomo Corporation of a joint field trial, running Internet data services over a television cable network in Japan. The trial will be held over Urawa Cable Television Network's pure-coaxial network without plant upgrades, to demonstrate the effectiveness of Terayon's product in the high-noise upstream environment of CATV plant in Japan, without any noise filtering. Success in field trials, and fulfillment of Terayon's existing contracts for modems promises to transform the cable landscape with broadband Internet access becoming a near universal offering of cable networks.*

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radios will be ideal to offer video teleconferencing, World Wide Web, and other image rich wireless content, including CDMA bandwidth on demand. Data, not voice, will be the critical application. As people brandish their dataphones around the globe, linking to convenient displays through IR connectors, users can break out into a tetherless telecosm where they can work or play, study or pray, anywhere they go.

A major supplier of wireless in Third World countries may be **NextWave**, the aggressive CDMA vendor for PCS, now preparing an IPO for mid-March led by Smith Barney. As a "carrier's carrier" providing only infrastructure and network services and leaving the sales and marketing to the locals, NextWave will join its complementary sister company in space, **Globalstar** (GSTRF), at the heart of a CDMA fabric of culture-independent worldwide communications. Watch Motorola's TDMA Iridium, with its effort to bypass all local infrastructure, sink like a stone.

The new paradigm of wireless bursts the chains of geography. People who want leading edge computers and communications can get them wherever they may live. Using GlobalStar, **Teledesic** and other Low Earth Orbit (LEO) satellite systems that will be available as the smart radios roll out, students in the Third World can study or work in the First World. Teachers and entrepreneurs in the First World can serve and employ people around the globe. Imagined gaps between the information rich and poor will collapse in an infoscape equally accessible to all.

*George Gilder, February 21, 1997*

*After much consideration, we have decided to allow ForbesASAP exclusive rights to publish an 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 secondary wave of impact after initial publication.*


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