Can Carriers Make Money on IP Telephony?

Bart Stuck and Michael Weingarten

In a word, yes. Packet switching really is the way for a carrier to be the low-cost voice services provider.

There are two diametrically opposed views on public-network Internet Protocol (IP) telephony. Some people, such as James Crowe, president and CEO of Level 3, and Joe Nacchio, president and CEO of Qwest, have an almost messianic belief in IP as an inherently low-cost vehicle for both data *and* voice transmission. Crowe has been quoted as saying that voice-over-IP calls cost 1/27th what circuit-switched calls do.

In the same vein, Sprint recently announced its ATM-based Integrated On-Demand Network (ION), which will provide multiple services and phone conversations over the same wire (see "Sprint's ION: The Devil Is in the Details," p. 41). Press reports claimed ION's packet telephony would increase the IXC's call-handling capacity to 17 times its current level, while promising rate reductions of 70 percent for voice calls and data-connect speeds 100 times faster than today's modems.

On the other hand, some people believe IP telephony's cost advantages are due mostly to the Enhanced Service Provider (ESP) status enjoyed by Internet service providers (ISPs). This regulatory classification exempts ISPs from paying the local access fees assessed on IXCs, and if it is removed, argues Jack Grubman of Salomon Smith Barney, there won't be a significant cost difference between IP and circuit-switched telephony (interesting, given that Salomon Smith Barney is Qwest's lead investment banker).

Grubman recently told *Barron's,* "If the playing field becomes level again, and I'm sure it will, the threat from the Internet, at least for domestic calls, largely will go away. If the entire cost advantage of voice over IP is a lack of access charges, we know that advantage will disappear one way or another. In the developed world, we don't view voice over IP as being that much of a threat."

What is the reality in the battle over packet-versus-circuit telephony, and what is hype?

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Starting Point: Circuit-Switched Voice

Currently, according to data provided by Merrill Lynch (see Table 1), IXCs face three basic cost elements for domestic circuit-switched long distance calls:

- Access is the single biggest element, at 46 percent of cost (the magnitude of the access figures suggests that Merrill Lynch is talking about switched rather than dedicated access).
- Sales, general and administrative expense (SG&A) is next at 32 percent.
- Network expense (including depreciation) is third at 22 percent.

For voice-over-IP (VOIP) to substitute for circuit-switched voice, it needs to generate substantial savings in one or more of these three areas. In today's environment, we are limited by current technologies but benefit from VOIP's access arbitrage advantage. Looking ahead to 2003, however, we assume that the arbitrage advantage will be eliminated, but that IP's other inherent benefits will have matured. These benefits include lower-cost multimedia broadband switching, voice traveling at low marginal cost on data lines and greater intrinsic flexibility than for circuit switching.

TABLE 1 Long Distance Industry Profit Structure (Using Switched Access)

	Cost per Minute (in $)	Percentage of Revenues	Percentage of Cost
Average Rate	.140	100.0%	—
Access	(.050)	(35.7%)	45.5%
Network Operations	(.015)	(10.7%)	13.6%
Depreciation	(.010)	(7.1%)	9.1%
Sales, General & Administrative	(.035)	(25.0%)	31.8%
Total Cost	(.110)	(78.6%)	100.0%
Net Profit	.030	21.4%	

Source: Merrill Lynch 3/4/98

TABLE 2 1998 Aggregate Capital and Operating Costs (Cents per Minute of Use)

	Circuit Switch	Packet Switch	Packet/Circuit Ratio
At 64-kbps Voice Coding:			
Switching	.62	.04	6.6%
Transmission	1.88	.94	50.0%
Interworking	N/A	.49	High
Estimated Operating Cost	2.50	1.47	58.8%
At 8-kbps Voice Coding:			
Switching	0.62	.04	5.3%
Transmission	1.88	.12	6.3%
Interworking	N/A	.61	High
Estimated Operating Cost	2.50	.77	30.8%

Access Savings Today

Looking at the potential savings by cost element, it is clear that in 1998, access arbitrage is the major economic driver behind VOIP. ISPs taking advantage of the ESP exemption can use flat-rated business local lines and thereby avoid long distance access fees. For an ISP paying $40 a month for a business local line and putting 20,000 minutes a month on that line (per Pac Tel arguments to the FCC last year in its ESP proceedings), the two-way access cost would be 0.4 cents, for a savings of 4.6 cents per minute.

Even better, if the ISP has CLEC status (e.g., MFS WorldCom), it can make money off the deal by combining the ESP exemption with interconnection fees. Here's how it works: At the originating side, the CLEC collects interconnection fees from the ILEC—fees that normally would be roughly balanced by those paid to the ILEC to terminate calls on the other end. However, any self-respecting CLEC can avoid paying these termination charges by reselling ILEC local phone lines, so that the call is being terminated by the CLEC, not the ILEC.

So, for example, if these originating-side interconnection fees are greater than or equal to 0.8 cents—based on the Pac Bell estimate above—the ISP's round-trip access fee is equal to or less than zero. The CLEC-ISP winds up with a 46 percent cost advantage over AT&T, MCI and others who use circuit switched lines (see Table 1).

Well, not quite. VOIP access savings, even without the reciprocal interconnection option, may end up being less than suggested above, for two reasons:

- An increasing share of business calls use dedicated rather than switched access, and thus incur substantially lower access fees, on the order of 1 cent per minute on the dedicated access side. So dedicated-to-dedicated calls have an access cost of 2 cents, not 5, and hybrid dedicated/switched access calls incur costs of 3.5 cents.
- In some jurisdictions, business local lines incur per-call and minute-of-use fees that are as high as long distance access fees. (Of course, to offset this, CLECs in these locations can arrange to provision lines from ILECs using largely flat-rated unbundled network elements.)

Accordingly, we'll assume the full ESP exemption savings (e.g., 0.4 cent access cost per minute, for a 4.6 cent savings) excluding reciprocal interconnection, but recognize that these don't apply everywhere.

Network Savings Today

Merrill Lynch's 2.5 cents per minute for long distance network costs comprises two basic subelements: switching (including control via Signaling System 7 Advanced Intelligent Network) and transmission (including muxing and electrical/optical conversion). There is no publicly available data on switching and transmission costs for long distance networks, but a rule of thumb in circuit-switched networks is that switching accounts for 25 percent and transmission/muxing for 75 percent. If so, switching costs .625 cents per minute and transmission/muxing 1.88 cents.

This is supported by our bottom-up calculations (not shown here), which suggest that the long-run incremental cost (LRIC) of a class 4/5 IXC circuit switch is approximately .62 cents per minute (originating and terminating sides included; LRIC includes depreciation of gross plant, plus a return on capital, plus cash operating costs).

With this starting point, VOIP has two major potential advantages over circuit-switched calls in 1998, and one disadvantage:

- Advantage 1 is lower switching cost (see Table 2). Compared with circuit switching's .62 cents per minute of use, our calculation using 1998 costs is that a packet switch's (IP or ATM) LRIC is about .04 cents per minute of use (MOU)—93 percent less than circuit switching. Level 3's James Crowe is right when he argues that IP switches have 1/27 the cost (3.7 percent).
- Advantage 2 is reduced transmission cost. Current circuit switches terminate in T3s, are muxed up to OC-X rates and then sent through add-drop multiplexers. In contrast, Cisco recently announced that its 12000 Series IP routers will directly terminate in OC-48 SONET-capable lines that can be routed into an optical fiber multiplexer employing Dense Wave Division Multiplexing (DWDM) of up to 100 distinct wavelengths per optical-fiber pair. This saves approximately 50 percent off the current 1.88 cents per minute for transmission/muxing, or 0.94 cents.

In addition, packet-based carriers that use reduced vocoding schemes may save on transmission costs as well. For example, VOIP with 8-kbps vocoding can reduce transmission costs a further eight times (from a 64-kbps circuit-switched channel), for a net cost of 0.12 cents per minute, and a savings of 1.76 cents over circuit switching. This can be done while still providing toll-quality

Sprint's ION: The Devil Is in the Details

Since we've concluded that converged voice/data networks make sense, does this make us publicists for the Sprint ION service? Well, yes and no.

We applaud Sprint's aggressive move to bring high-speed broadband services to residential and business customers over a converged voice/data platform. And offering the ability to have multiple simultaneous conversations (configured by the customer) is a nice touch.

However, we have several reservations.

First, charging customers $200 for a bit-meter seems strange. If you want to meter me, put in your own meter, as the electric, gas and water companies do. Also, if that meter is CPE, you had better make it tamper-proof—it seems pretty easy to add downstream and/or substitute chip sets that reduce the number of bits reported. Also, does $200 pay for just the bit-meter, or the requisite DSL card as well? If the latter, it's a good buy. If there's an additional charge for a DSL card, however, consumers may experience unpleasant equipment sticker shock.

We also are concerned about whether 100 percent usage-based pricing is appropriate. Since most network costs are fixed, pricing on a variable usage basis is economically inefficient and distorts consumer usage patterns. While we grant that a totally fixed-pricing scheme could lead to "overgrazing of the commons" and therefore to capacity shortages, there may be other solutions that avoid the usage distortion problem. These include class of service and overprovisioning, with the latter becoming feasible as the result of plummeting transport and IP switching unit costs (see "Will Bandwidth Ever Be Too Cheap to Meter?" *BCR,* January 1998, pp. 53–58).

Moreover, how much does Sprint propose to charge per bit, and how will this translate into total monthly bills for different user types? If a residential subscriber uses Sprint's ION box to drive video-on-demand for three different TVs, each running eight hours per day—plus lots of high-bandwidth calls on the Internet—will the user pass out when he or she sees the bill? Or will ION's aggregate bill compare favorably with what people now pay for local/long distance/Internet/CATV services?

Will Sprint charge the same price for voice and data? If so, the per-bit price will have to be very low to compete with fixed-price DSL/cable modem service. But then Sprint will be subsidizing any voice call that needs to be terminated on the public switched telephone network (at something like one to three cents per minute of use). If we're going to price by the bit, why not price differentially for voice and data (with only voice being able to go into the PSTN)?

We are not certain that per-bit pricing is defensible competitively. To the extent that DSL and cable modem providers continue on their current trajectories with fixed per-port prices, and we have access to fixed-rate local POTS lines, we know how we would respond (depending, of course, on the exact prices): Use DSL/cable modems for high-bandwidth requirements, POTS phone lines for local voice calls and Sprint ION service for toll voice only. Indeed, we would use ION for toll voice only if our DSL/cable modem provider had poor voice quality and/or tried to maintain current high voice prices. We therefore wonder if 100 percent variable pricing can survive in the long term.

Some other issues that will have to be resolved:

■ Will Sprint charge for inbound as well as outbound bits? Presumably, since most Internet and video connections mostly involve downloads. However, charging for inbound bits will double the billable bits for voice calls versus existing wireline practice—and subscribers will suddenly find themselves paying for unwanted telemarketing calls and Internet spam. We shudder to think about the level of customer complaints demanding refunds for unwanted inbound calls.

■ How will Sprint perform billing? Will ION provide auditable billing trails for each conversation (which could result in complex bills), or just tell you that you are responsible for paying for so many gigabits tabulated on your bit-meter? If the latter, will people rebel at having no way to challenge their bills or just accept the parallel with electric, water and gas meters? But with electrical, water and gas meters, all the usage is on-site, while a great deal of telecom's value to the consumer originates or terminates outside. This makes the ability to audit much more important.

■ How will Sprint measure bits? Since IP necessarily involves dropping packets, substantially more bits will pass through the originating bit meter than are received at the destination end. So do we measure dropped packets for each call (and it isn't clear how) and give bit credits? Or do we reflect this in the aggregate bit rate? Or do we simply charge for each bit passing the meter, with no consideration as to whether it gets through to the other end?

Similarly, what happens if we attempt to telephone someone, and the called party is out or the line is busy? Conversely, for incoming real-time calls, what happens if the bitstream gets recorded in the bit-meter but our CPE or inside wiring is not working for some reason (so that no conversation takes place)? Will Sprint charge for uncompleted calls?

■ Sprint's 6-Mbps advertised speed may be difficult to achieve via telco copper wire DSL phone lines over 18,000 feet, because of:

■ Real world operations issues (such as lack of skilled DSL telco and equipment vendor staff, incomplete and out of date telco paper and electronic records).

■ Incomplete understanding of business processes at each telco as it relates to managing copper wire phone lines.

■ Real-world technical issues such as lack of copper wire pairs that can handle DSL transmission rates (due to loading coils and bridge taps, greater than expected resistive losses, and near-end and far-end cross talk between cable pairs—see pp. 47–54).

In sum, Sprint's offer appears to use advanced IP telephony solutions but links it to a usage-based pricing scheme that could lead to operational and customer acceptance problems. It will be interesting to see how Sprint deals with these issues□

voice (see "Voice-over-IP Gateways: Sounding Good," *BCR,* February 1998, pp. 23–29).

So VOIP has some compelling advantages. Unfortunately, there is also one major disadvantage—the need for interworking with the public switched network. That requires converting circuit-switched calls into packets for transmission via IP, and reconverting back at the terminating end. This is an active area of product development, with companies large (e.g., Lucent, Nortel, Cisco, HP, Stratus) and small (e.g., ADC Software, DGM&S) developing solutions to meet this need that grows more pressing as the Internet continues to expand.

TABLE 3 1998 Aggregate Cost Comparison (Cents per Minute of Use)

	Circuit Switch	Packet Switch	Packet/Circuit Ratio
At 64-kbps Voice Coding:			
Access	5.0	.4	8.0%
Network	2.5	1.5	58.8%
Sales, General & Admin.	3.5	3.5	100.0%
Total	11.0	5.4	49.1%
At 8-kbps Voice Coding:			
Access	5.0	.4	8.0%
Network	2.5	.8	30.8%
Sales, General & Admin.	3.5	3.5	100.0%
Total	11.0	4.7	42.7%

TABLE 4 2003 versus 1998 Access Costs (Cents per Minute)

	Circuit Switch	Packet Switch (over Data lines)	Packet/Circuit Ratio
1998 Cost per MOU	5.0	.4	8.0%
2003 Cost per MOU	2.0	.5	25.0%
Ratio: 2003 vs. 1998	40.0%	125.0%	

TABLE 5 2003 versus 1998 Network Costs (Cents per Minute)

	Circuit Switch	Packet Switch	Packet/Circuit Ratio
Year 2003 At 64-kbps Voice Coding:			
Switching	.44	.01	2.3%
Transmission	.75	.12	16.0%
Interworking	N/A	.01	High
Estimated Operating Cost	1.19	.14	11.8%
Year 2003 At 8-kbps Voice Coding:			
Switching	.44	.01	2.3%
Transmission	.75	.02	2.7%
Interworking	N/A	.02	High
Estimated Operating Cost	1.19	.05	4.2%
1998 Cost per MOU:			
at 64 kbps	2.50	1.47	58.8%
at 8 kbps	2.50	.77	30.8%
Ratio: 2003 vs. 1998:			
at 64 kbps	47.6%	9.5%	
at 8 kbps	47.6%	6.5%	

Our calculation is that the current price of an IP gateway adds approximately .61 cents per minute of use (origin plus termination), or far more than the cost of packetized switching. This is something IP enthusiasts tend to gloss over when they talk about 27-times efficiencies versus circuit switching. If we don't use voice compression and limit our gateway functionality to TDM circuit switching/IP protocol conversion, our net savings would be on the order of 20 percent, for a net cost of 0.49 cents.

Note that we have said nothing about the need for VOIP networks to interface with SS7. This is no oversight. Although suppliers such as Cisco are working on such interfaces, we believe the routing and caller identification service profile functionality in SS7 is easily supported or supplanted by IP-based networks, in which caller service profile or caller identification (ID) information is included in network-based services and call routing is done by IP routers. We see SS7 interworking as a red herring.

Similarly, we have said nothing about added costs for Quality of Service (QOS) or Class of Service (COS) solutions. Our assumption is that these will be included within the core IP software- and hardware-platform functionalities we are describing.

Adding up the advantages and disadvantages, Table 2 presents an aggregate network capital and operating cost comparison (we assume operating costs drop in proportion to capital costs). At equivalent 64-kbps voice-coding rates, packet switching costs about 59 percent of circuit switching; at 8 kbps, packet is just 31 percent the cost of circuit.

This sounds significant, but even a large reduction in switching and transmission costs will have only a limited effect on the overall cost of delivering service (remember network costs represent only 20 percent of the total long distance charge). On a per-minute basis, the aggregate savings is 1.03 cents at 64 kbps (the vocoder rate used by Qwest) and 1.73 cents at 8 kbps. This allows us to reduce Merrill Lynch's 14-cent total long distance price (see Table 1) by 8 to 12 percent—nice, but not the basis for declaring apocalyptic cost transformation.

The issue of SG&A is even simpler to calculate for today's networks. With both VOIP and circuit-switched voice operating on the same minute-of-use basis, the SG&A costs remain the same. While large circuit-switched operators have a theoretical scale advantage over smaller competitors, this is offset by the cost of complexity—witness AT&T's current focus on reducing its bloated SG&A costs, or SBC claiming economies of scale while not realizing significant staff reductions in its Pacific Telesis acquisition.

Summary: Cost Differential Today

Table 3 presents an overall conclusion for 1998. At 64 kbps, packet switching costs 51 percent less than circuit switching (57 percent lower at 8 kbps). Most of the savings comes from access, but these savings will not be equally applicable in all geographic areas or for all customers (particularly dedicated access accounts). The network savings, while not insignificant, are secondary.

Thus, Grubman is right when he suggests that if access arbitrage (including international settlements) is removed, there is no compelling reason to switch to VOIP. However, as shown below, this only holds true using 1998 assumptions. With different assumptions, we reach different conclusions.

2003 VOIP Savings versus Circuit Switched

By 2003, we anticipate that switched-access arbitrage will diminish in importance, as the ESP exemption disappears and/or access rates drop to true underlying cost. The FCC's April 10, 1998, Order suggests that this will happen sooner rather than later, especially for POTS-to-POTS calls using IP protocol conversion.

However, we believe that the convergence between voice and data via packetized networks will offset the disappearance of a gap in switched access costs. As a result, VOIP will continue to enjoy a substantial advantage over circuit-switched voice. Indeed, as voice/data convergence occurs, we see standalone circuit-switched voice becoming economically nonviable.

We anticipate two significant changes in the cost landscape between now and 2003 (see Table 4). First, even if the ESP exemption disappears, we believe a combination of market forces and FCC regulatory action will still push access rates closer to underlying cost (in our scenario, down to 2 cents per minute round-trip for switched access). This is essentially what the FCC promised to oversee in last year's Access Reform Order. As a result, access becomes a smaller fraction of overall cost.

Second, we anticipate a major reduction in long distance access charges for voice as the result of voice/data convergence. In our 2003 scenario, we anticipate that as PCs become increasingly ubiquitous in homes and offices, a growing share of "phone lines" will be used to transmit data, video and voice on a 24-hour "on" basis, much as CATV or office LANs work today.

Since each of these lines will be synchronously transmitting at T1 to perhaps even 10 Mbps (Ethernet levels) or 25-Mbps Asynchronous Transfer Mode (ATM), the lines arguably will be provisioned largely for multimedia rather than voice (e.g., most bits handled will be data and image bits, not voice, especially if the voice is coded at 8 kbps or 5.3 kbps for toll-quality speech in 2003).

The exact provisioning of these access lines will vary—optical fiber, dedicated ILEC copper wire access lines, broadband wireless, DSL or coaxial cable CATV modem. Irrespective of the access method, however, since voice requires real-time, noncongested transmission, and most data does not have such stringent requirements, it is possible to give voice priority without increasing overall port size. In these situations, therefore, voice access has zero marginal cost.

This won't be entirely true for all situations. For example, if a customer with an XDSL modem calls a destination with a POTS-only phone (this will become an increasingly rare occurrence over time), there still will be marginal terminating access cost. To account for this, we assume that 50 percent of all calls require switched terminating access, but that the other 50 percent are terminated on dedicated channels with zero marginal cost. In other words, an originating converged data user would incur zero marginal voice access costs at the originating side, and 50 percent of 1 cent terminating side access—for a weighted average access cost of 0.5 cents.

The result indicates that even though circuit-switched access drops substantially below 1998 rates (to 2 cents per minute), packet-switched access retains a 4:1 net savings, as a result of voice getting a free ride over shared omnibus data lines. (It does, however, rise somewhat from the 1998 ESP exemption-based levels.)

In our 2003 scenario, we anticipate several differences from 1998 (see Table 5). The result is a substantial decline in packet costs, which will be 5 to 12 percent of circuit-switching costs, even after adjusting for cost declines in the latter. Indeed, if we further assume that much of the packet switching and transmission cost gets a free ride on a converged data network (leaving only the voice-specific interworking costs), packetized voice is close to cost free.

Switching

Due to Moore's Law effects, the unit cost of IP switches will decline dramatically (over our five-year period, there will be slightly more than three Moore's Law doublings). As a result, our packet-switching cost of .04 cents per minute will drop by a factor of eight, to .005 cents. At the same time, we forecast class 4/5 switches to drop by a factor of 28 percent, to .44 cents. As a result, the net spread in switching cost will increase on a percentage basis: Packet will drop from 6.6 percent the cost of circuit in 1998 to just 2.3 percent in 2003.

However, as the result of voice/data convergence, the effect is even greater. As with access, voice in our 2003 scenario gets a free ride except for the terminating side of calls to POTS recipients. So as not to add too many digits to Table 5, well stick to .01 cents.

Transmission

We assume that improvements in DWDM will push pure unit transmission costs down by a factor of three doublings (with increases in laser

In every scenario, costs for packet-based services keep declining

Real economic factors, not regulation, drive VOIP

speeds, number of colors and advances in optical add-drop muxes, this probably is conservative).

By contrast, circuit-switched voice will still need electronic muxes to interface with the optical network, and these will not drop at the same rate. As a result, we assume that voice muxing costs will decline by a cumulative 30 percent. Assuming a 1998 50:50 cost mix, this suggests that 2003 circuit-switched voice transmission costs will decline 60 percent, while 2003 packet-switched transmission costs will decline 88 percent. Once again, however, we assume that the marginal cost of voice in a converged voice/data world is close to zero.

Interworking

Unit interworking cost will drop substantially, due to Moore's Law effects. As a result, unit costs will drop from 1998's 0.61 cents for 8-kbps systems to 0.08 cents, and from 1998's 0.49 cents for 64 kbps to 0.06 cents.

By 2003, the need for interworking will be reduced even more, as more customer premises equipment (CPE) runs on TCP/IP. For our prototypical advanced converged voice/data user base, we assume that all customer CPE codes directly in TCP/IP, eliminating the need for originating side protocol conversion. On the termination side, we assume 50 percent TCP/IP termination-side CPE, 50 percent requiring protocol conversion. As a result, unit costs drop an additional factor of four, so that the 2003 net interworking costs will be 0.02 cents for 8-kbps systems and 0.015 cents for 64-kbps systems.

TABLE 6 2003 versus 1998 SG&A Costs (Cents per Minute)

	Circuit Switch	Packet Switch	Packet/Circuit Ratio
1998 Cost per MOU	3.5	3.5	100%
Cost per MOU	3.5	.9	25%
Ratio: 2003 vs. 1998	100.0%	25.0%	

TABLE 7 2003 versus 1998 Overall Costs at 8-kbps Vocoding (Cents per Minute)

	Circuit Switch	Packet Switch	Packet/Circuit Ratio
1998 Cost per MOU:			
Access	5.0	.4	8.0%
Network	2.5	.8	30.8%
Sales, General & Admin.	3.5	3.5	100.0%
Total	11.0	4.7	42.7%
2003 Cost per MOU:			
Access	2.0	.5	25.0%
Network	1.2	.1	4.2%
Sales, General & Admin.	3.5	.9	25.7%
Total	6.7	1.5	22.4%
Ratio: 2003 vs. 1998	60.9%	31.9%	

2003 SG&A Savings

In our 2003 scenario (see Table 6), we anticipate that customers for converged voice/data offerings increasingly will purchase ports on a fixed-price per-month basis. This is significant; if customers are purchasing on a flat-rate rather than a minute-of-use basis, customer service and billing costs drop substantially.

Also, much more customer service and ordering transactions will be done over the Internet, rather than requiring lots of live OSS service. Finally, SG&A costs will be amortized over data revenues, giving voice a free ride. As a result, we assume that VOIP *marginal* SG&A drops by 75 percent by 2003, based on data covering most of the cost.

Summary: Cost Differential in 2003

Adding up the above costs, we arrive at an overall 2003 conclusion in Table 7. Assuming that 8-kbps voice over IP is provided as part of a converged voice/data services offer and that this offering is flat-rated, VOIP in 2003 has extremely low costs, even assuming that the advantage of the ESP exemption disappears.

Conclusion

Having thought through the possible key drivers behind VOIP, we are left with a sense that those people who assume that the end of the ESP exemption means the end of VOIP are being shortsighted. Yes, the ESP exemption is what's fueling VOIP *today,* but it arguably is not what will fuel it in the future. Instead, what really will drive VOIP will be:

- Continued Moore's Law effects for IP switching and transport.
- Voice getting a free ride on converged voice/data networks.
- The prospect of flat-rated fees leading to a reduction in SG&A.

We clearly are not there yet, and it's possible that we may not be there by 2003, especially if network service and equipment providers are not proactive in developing advanced solutions and pricing these solutions on flat-rated bases consistent with the flat-rated underlying cost structure of the future networks.

We also acknowledge that circuit-switched technology (*a.*) works quite well for voice calls, (*b.*) is heavily depreciated and (*c.*) does not require people to do things as complicated as programming a VCR.

On the other hand, in a society where microprocessors are poised to become as ubiquitous as electric motors, we believe that converged, IP-based video/data/voice networks ultimately will be created. As the old AT&T commercials used to predict, "You will"—starting with businesses and with applications such as fax and international long distance calling, but eventually covering all voice usage□