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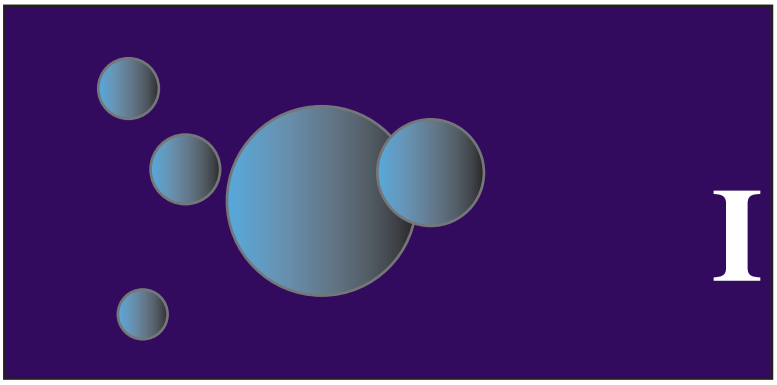
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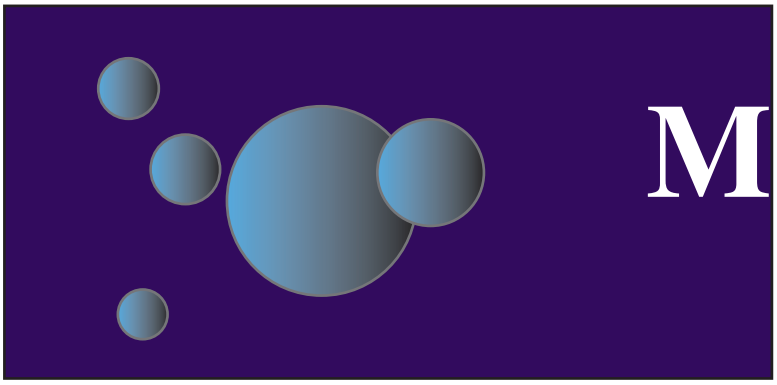
Market Area Focus will appear next in the November issue with a preview forecast of 2002 market conditions.

Management Briefing takes the first close look at market and regulatory conditions since the disaster of September 11th.

In the Know explores IPv6-related issues and the future role of IP technology.

Strategies makes recommendations on the way that various classes of vendors, as well as major market players, should address the opportunities of 2002.

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Management Briefing

This section has been edited for Internet publication; the full version is for subscribers only.

The industry, like the nation, continues to struggle to come to terms with the terrorist attack of September 11th, the Afghan war that has resulted, and the bio-terrorism that may or may not be linked to the same players. As a technology publication, we're going to continue to deal with the industry side of these issues, leaving the human dimension for those more qualified. We are concerned; we are not insensitive. We are also largely helpless.

The major issue facing the networking industry remains the incentive (or lack of incentive) behind CapEx for 2002. Three factors have emerged as weighing on the carriers in their planning for next year. They are **FCC action on advanced services**, **the economic stimulus package's impact on the industry**, and **271-based competition**.

Nothing further can really be known about the FCC's future decision on advanced services at this time, but there are some rumors floating around. Verizon's Tauke (and Verizon in general) seem to be taking the point on the issues relating to broadband regulation. The Tauke/Verizon position has been fairly consistent. They say that "competition" has to be looked at across all communications alternatives and not just within the telephone context. They also say that regulatory barriers have largely eliminated broadband ROI potential for ILECs, and that this has stifled second-tier competition among those who would provide service to users over DSL access. This position seems aimed at first defusing the critics of RBOC-freeing access reforms who have cited the anti-competitive nature of such a move, and second at changing the focus of competitive interest from down in the wire and dirt to up in the service/content stratosphere. We think that both positions are correct, and are in fact in the public interest. We also think the moves are tactically sound.

Recent industry trends, reflected in analyst reports like one published by the Yankee Group, are now favoring the idea that competitors gain little or nothing from access to UNEs. That history, in the form of CLEC/DLEC failures, tends to establish this as an axiom may or may not have stimulated the change. That the Supreme Court, in dealing again with TELRIC pricing, seems poised to declare that the system unfairly subsidizes competitors and thus further diminish the wholesale/unbundling value proposition, may also have had an impact on this public attitude. Whatever the cause, it seems that the old age of RBOC subsidization of inherently unprofitable competitors may be coming to a natural end.

The FCC, of course, can do much to bring that age to a statutory end, and it's pretty doubtful that Powell's folks would open an inquiry on advanced services to do nothing at all. The question, then, is what they might do.

They absolutely have to take some steps to reinstate the exemption of data investment from wholesaling and unbundling—the exemption implied in 98-188, codified in the Bell Atlantic and SBC mergers, and overturned by the D.C. Court of Appeals in January of this year. At issue is whether the FCC would elect to restore the separate subsidiary exemption reflected in all these actions, or simply to exempt data without any subsidiary requirement.

The requirement that there be a separate subsidiary for data in order to enjoy protection from wholesaling and unbundling arose in the Kennard era, out of the conviction that the FCC lacked the statutory authority to act to exempt data services within the RBOC itself. What's now the question is whether the FCC's appeal to Section 706 mandates (and to its "regulatory forbearance" remedy) would somehow dodge the D.C. Appeals Court's objections, and if so whether it would not also justify just exempting data without the subsidiary. What is "forbearance" forbearing from, in short? Does that term give the FCC the right to waive specific Telecom Act requirements, in effect altering its legislative mandate? If not, is there any meaningful "forbearance" possible?

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The FCC issue plays in concert with the symphonic (if atonal) Congressional fugue on economic stimulation. Congressional compromise committee members are likely to have to reconcile significant differences between the House and Senate versions of the package, with the House version reading like the wish fulfillment of a thousand ultra-rightist constituents (forgive our judgmentalism here, dear readers). The essential elements of any stimulation would address capital investment, and that pretty much limits the desired scope to investment tax credit (ITC) and accelerated depreciation tweaking. The question is whether either, or both, will be present and in what form.

We think there is zero chance that no capital stimulus will find its way into the final bill. The minimum seems to be a measure to raise the small business limit for asset expensing (no industry impact) and to provide kind of depreciation bonus on multi-year assets (some impact on three- and five-year assets). We think this would generate a modest incentive for large, capital-flush, players to accelerate investment. Its impact on firms with cash-flow problems is greater, but most carriers are either flush or dying, so our industry doesn't contain too many ideal targets for this type of approach. The best-case play, with a 20% ITC and significant depreciation acceleration for all capital assets, would create about a three to five percent delta ROI in a major capital build-out.

Now, you can see the math problem here. Add a super-stimulation to an even modest FCC move and it adds up to RBOC broadband business case stimulation sufficient to restore the build-out. Either one, by itself, leaves the RBOCs with a broadband revenue model that just hits IRR at full economies, meaning that IRR is probably negatively impacted in the near term. Bad news.

The final egg in the nest, awaiting hatching, is the 271-based competition. RBOC planners, recognizing that there will be no Congressional action to open a pure data long-distance opportunity, have concluded that 271 relief for generalized entry into the long-distance market is the only remaining answer. That decision, reflected by the picking up of the application pace for all, completes the process of IXC destabilization that the whole Telecom Act mess inaugurated in 1996. No IXC can now hope to survive in anything resembling the form of the past, and all are now eagerly looking to the RBOCs (in the form of merger partners) for salvation.

What the RBOCs are looking to is the $120 billion per year in IXC revenues. Most of this would be "found money" in a CapEx sense, because the RBOC infrastructure could handle the additional service requirements with little incremental equipment and probably with virtually no incremental craft cost. That makes picking IXC corpses (to be inelegant) a better feeding strategy than hunting new prey—than the broadband build-out.

The RBOCs can do both, of course, at their low cost of money. But will they? It depends on how much ROI can be expected from the broadband applications, and that's where the interplay of FCC, Supreme Court, and Congressional stimulation come in.

Minimalist view—worst case. RBOCs go for the 271 business big-time, and there's little broadband action until very late in the 4th quarter. Best case, RBOCs still go for 271 business, but ramp up their DSL expectations significantly in anticipation of the FCC's ruling, resulting in a broadband ramp-up that's visible by about August, 2002.

The wild card here is the possibility of mergers between RBOCs and IXCs coming quickly. Assuming that the FCC and DOJ maintain their past stances, an RBOC would have to get 271 approval in pretty much the whole home region or the acquired/partner IXC would have to divest itself of its customers in the RBOC region as a condition for approval. Verizon could hope to meet that requirement as early as January, and SBC and BellSouth by the end of 2002. But might there be a relaxation of 271-retentivness? After all, no IXC is going to appeal a decision to admit the RBOCs instantly into long-distance markets if it facilitates IXC survival. CLECs are largely dead, so their objections are—dare we say—ephemeral.

RBOCs with merger plans might rethink their original and relatively broad regional toll requirements. In 1999 and 2000, RBOCs were envisioning ATM-based regional toll networks that functioned as a distributed voice tandem/toll switch. The latter requirement would clearly be reduced or eliminated were the RBOC to pick up an IXC. Would this impact the entire regional toll decision, possibly deferring or eliminating it?

We don't think so. The IXCs aren't exactly poster children for building infrastructure for corporate data applications (Sprint just trashed ION, for example). RBOCs have a better handle on how to make populist data services work, since their impressive growth of sales in frame relay and other data services has come largely from second-tier accounts, owing to their being barred from the national scene by lack of 271 approval. But it is very possible that the merger scenario would shift the priorities of the regional network considerably, reducing or eliminating the voice dimension and possibly accelerating IP interest.

Ah, IP! Exotic, mysterious, appealing drug for the masses. Combine RBOC/IXC merger with aggressive economic stimulation and ultra-favorable FCC treatment of data networking, and you cook up a decidedly IP-flavorful stimulus to regional networking for the Bells. That doesn't make a case for routed IP RBOC networks—in your dreams, IETF—but it does mean that MPLS evolution

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would be a higher priority.

That, of course, may well be behind the RBOC interest in seeing a clear ATM-to-MPLS migration strategy from their regional toll vendor candidates. Certainly there is less indication today than a year ago that voice gateways or Class 4 emulation are key requirements in the forthcoming procurements. Still, IXC toll switches won't completely eliminate the need for tandem switches in voice networks. Lack of credible IP revenue likewise won't completely eliminate the interest in MPLS. The balance of those issues will probably dictate the weight that RBOC planners would give MPLS migration versus voice capability—the ATM to MPLS balance, so to speak.

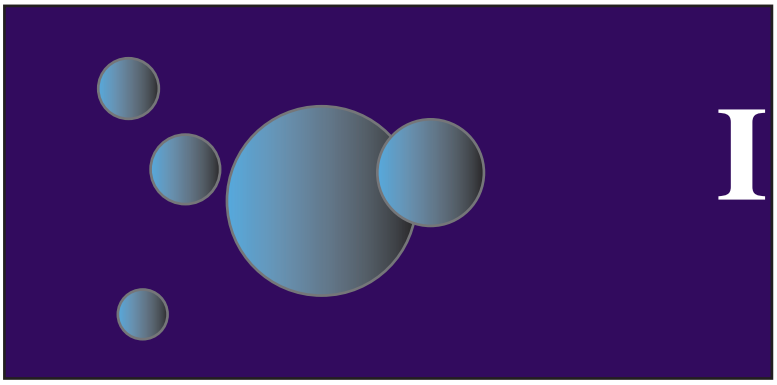
The thing that could alter that balance most convincingly would be the aggressive deployment of DSL. There are no mass-market data services with credibility other than IP. RBOCs who bet large on DSL are almost committed to at least consider the question of where IP services might then come from. That could alter the balance of the regional network technology focus in an IP/MPLS direction. So, of course, could competition to push frame relay customers toward IP-based services like IPFR, but we think that this latter impetus could develop only if the IXCs were willing to push the competitive buttons, which is doubtful if they're tidying up balance sheets to favor a merger.

The wild card is the economic stimulus package, still hostage to competing political interests as this issue goes to press. The Administration is clearly not interested in the package becoming the premier pork container of the decade, but Congress (particularly the House, all of which is up for re-election next year) always has trouble keeping politics out of legislation. We're hoping that rumors here are true; that the Congress is just using the legislative debate for "speechifying" in preparation for elections, and that the real legislation will be unencumbered by the junk. If that's true, and if the main points of ITC and accelerated depreciation are included, we can expect a fairly quick DSL build-out to begin late in 3Q02. If not, DSL is delayed until 2003 and the focus of 2002 CapEx will be strongly in the direction of traditional services.

We're discounting, as we're sure is clear to our readers, the chance that a major terrorist event would create a major disruption. This isn't just because we're not really qualified to judge the risk (a factor, to be sure). It's more that we are of the view that the nature of the incidents to date indicate that there is little terrorist capability to act on such a scale, and that the worldwide coalition against terrorism will reduce mass-action risks as time passes. Still, there is always a chance that the worst will happen, and should that be the case we'll have to reassess.

We want to again express our condolences to those who have lost loved ones in the events of this terrible fall, and to those who care for and guard us we express our thanks.

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In The Know

There are a lot of "burning questions" in the marketplace today, most of them in the business and regulatory arena. One that isn't is the question of the future nature of IP networking. We have the Internet today. It's based on a version of IP that won't scale to support the likely user population. The features for QoS and security are not optimum. The public network structure based on it (the interlinked ISP structure) isn't optimal from a business perspective, nor is it technically optimum. Yet we know the Internet is going to play a major role in shaping the future, and public IP services will play an even larger one.

What do we do? We think that there will be some basic changes in the structure of public IP services, in both the business and technology areas. We've talked a lot about business changes in the past, so this time we're going to look at technology issues. We'll cover some aspects of IP that we think will emerge, and some aspects of IP that we think need fixing.

To start with, though, let's frame the problem, or problems. We know that IP has to be the foundation for most future non-voice services, because only IP has the client ubiquity to serve that mission. We know that connectionless architectures are ideal for low-persistence relationships like hyperlink loading, but we know they've been challenged by requirements to produce specific QoS with credibility. We know that IP can carry secure traffic, voice traffic, and a bunch of stuff, but we don't know how to bring those capabilities to commercial realization and public acceptance.

We think we know that connectionless frameworks may eventually be the ideal answer to public voice transport in the long haul, at least. But that would add literally billions of new voice clients, and we don't think the current IPv4 address space is large enough even to support likely growth of the Internet. We also don't know how to make phone users believe they won't be targeted by a denial of service attack or a hacker just because they have VoIP—and maybe they'd be right.

We know there are standards groups worldwide, and we know there is an active standards process for IP. We don't know if the goals of that IP process are completely consistent with the public policy requirements that IP would have to meet were it to be considered seriously as a candidate architecture for the next-generation public network.

And that's the situation. Now, here are some thoughts.

The Good...

Two problems that absolutely must be fixed with IP are problems that are well within the scope of current IP standards evolution. They are the address space problem and the problem of non-Internet applications. Both are fixed by something called IP version 6.

The address space problem is a simple one. The current version of IP, IPv4, has 32 address bits, and with the division into Class A, B, and C addresses there are about 2 million distinct address ranges available, and with all the address space magnification strategies available, we could expect the address space to accommodate perhaps about 3 billion distinct users. The always-on DSL/cable modem population, worldwide, is likely to reach about 300 million users. There are already billions of phone lines, billions of devices that some hope will be IP-networked.

The solution to the address space problem is a new version of IP, called IPv6. This new version would provide a whopping 128-bit address space. This is enough (according to an analysis completed in the mid-90s by Christian Huitema) to accommodate between $8x10^{17}$ and $2x10^{33}$ nodes even with plenty of reserved space. By comparison, our 3 billion distinct IPv4 users would be $3x10^{9}$ in the same notation, and growing that space an additional 3 billion times would generate $9x10^{18}$ addresses, which is at the low end of the estimate! Clearly there's plenty of room here.

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The problem that IPv6 has presented to the marketplace arises out of the success of IP. In the old days of the Internet, a new version of something like the basic communications stack could be propagated to everyone with relative ease because all the hosts were run by professionals (many by graduate students and researchers who had no enormous time pressures on them). Now, changing software in all the PCs, servers, and other stuff is simply not going to happen.

But this doesn't have to be a barrier. It's possible to interwork IPv4 and IPv6 so that the former is effectively contained in an address space of the latter. IPv4 can be tunneled through IPv6 networks, but this still limits the users to the IPv4 address space so that, in itself, that doesn't solve the problem. It does create a migration strategy to a full-blown version of IPv6 that could then solve all the address problems in the world—and then some.

There's another way to get Ipv6 out, though. There is no technical reason why all IP networks have to be part of the Internet. Private networks aren't always, and in the past many more were not. However, the single address space administration of the Internet means that even if you have multiple networks you'd have a common address space, and it would be a serious pain to have to figure out which network a given host was on in order to attach to that network and access that host. But if the application isn't really for public, Internet-like, access then a separate IP network would be fine. That means that IPv6 could be used for applications of IP that were not the Internet.

There's more. I can create an IPv6 backbone and then tunnel through it using MPLS. The tunnels could be routes for IPv4. Thus, the Ipv6 backbone could be used to support the current Internet. If that IPv6 backbone were designed as, for example, the new baseline transport network of a big wholesale carrier like Enron, the whole thing would make sense.

IPv6 brings other advantages. In IPv4, the limited number of TOS bits makes it hard to provide a wide range of service classifications. IPv6 offers more TOS bits for classification, but it also introduces the concept of "flows", which are RSVP-like or tunnel-like relationships that represent persistent traffic patterns for which a service guarantee is to be made. This doesn't create quite what would be called "connections" in the pure sense, but it does provide a measure of connection behavior that would be suitable for many of today's connection-mode applications.

For all its benefits, IPv6 still presents real issues. More properly, there are public IP issues that neither IPv4 nor IPv6 really address. Primary among them is the question of fault tolerance and availability. IP networks are highly resilient because of their adaptive routing, but as networks get bigger the process of converging on a new topology after a failure gets similarly big. As a result, the recovery time on IP networks is relatively long by voice or even ATM standards—seconds instead of tens of milliseconds.

Part of this problem can be attributed to the growth in routing table size, which has doubled since measures to increase the efficiency of address assignment in IPv4 took hold. Some of that problem might be addressed by intelligent application of some of IPv6's features, like hierarchical routing. But it seems clear that better response to network trunk failures may be needed before an IPv6 network could hope to displace standard TDM or ATM connection-mode networks.

MPLS is touted as a mechanism to supply traffic engineering in IP, but the IETF implementation of MPLS makes it a kind of feature of IP, an adjunct to RSVP behavior, rather than a sub-network protocol running beneath IP. That means that even a development like GMPLS for generalized optical routing (see *In the Know* in this issue) wouldn't necessarily create fast recovery time under IP. It's possible that RPR might offer this, but the nature of RPR recovery versus IP/Layer 3 recovery isn't yet defined.

We think that IPv6 is promising as the foundation for future public IP services. We think that public IP services based on connectionlessness will be a key element in long-haul voice and in the Internet. We're just not sure how this is going to happen at the business level.

...the Bad...

Most of the routers being built today could be made to handle IPv6, so support for the new standard isn't the real problem. The difficulty lies in getting IPv6 integrated with an existing network, or justifying a new network based on it. The options, in essence, are to convert existing IPv4 networks to IPv6, or to create entirely new IPv6 networks.

We're told that migrating a running ISP network to IPv6 wouldn't be an easy task. Certainly there would be issues of incremental investment and subscriber service disruption, and these issues would deter any player from taking the step unless there were a clear benefit.

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What's a clear benefit? Either a clear promise of significant incremental revenue, or a clear risk of losing customers because the old IPv4 space runs out of gas. Right now, we're not in immediate danger of the latter, and there's no clear signs of future service bucks on the horizon either. Stalemate.

Maybe not completely. A player with relatively little current IPv4 investment could invest in IPv6 networking, particularly if that player were to be a wholesale carrier who planned to sell tunnels as circuits to retail players. That same carrier could then use the IPv6 network for long-haul voice.

Well, they could if there were good long-haul voice support under IPv6. We've been focusing too much on edge conversion to IP, since that's where the box count and revenue is the highest—if it could have been made to work. There are a lot of questions still to be answered on what could be called "trunk VoIP". One is whether we really want per-conversation datagram flows across the IP network, or whether we could have switch-to-switch composite flows. In the typical VoIP model, everybody is focusing on consumers originating IP voice flows so there's not much of a choice. If the TDM or ATM voice circuits were converted to IP at a tandem/toll gateway, though, it might be more reasonable to simply address all the packets to the destination gateway and let the two gateways sort out the calls. It's analogous to the VPI/VCI routing of ATM.

This model of IPv6 deployment would work for Enron and its ilk, as well as for players like the RBOCs who have yet to make a significant IP infrastructure investment. We think it would be a very smart play, though it might present some headaches at the point where the IPv6 network had to link with IPv4. There may be work going on for this kind of inter-network gateway, but we've not been able to track it.

The challenge, of course, is whether any of this could be done in the current economic situation and within the current regulatory framework. We don't want to dwell on these issues in this piece, but a modernization investment in IPv6 is probably rational only with the expectation of a generalized market recovery. We are still uncertain as to how that might play out, and there's a good chance that Wall Street is even more uncertain.

The Internet is the real uncertainty. We can map a user from an auto-assigned (DHCP-assigned) IPv4 space to an IPv6 address fairly easily, so a kind of NAT function could translate user addresses into the new space, utilizing the RFC 1918 private address space for the local IP address if necessary. That would accommodate an unlimited number of new users, but the problem is that we need to have IPv4 **server/content** addresses for any station that has to be reached via a DNS as long as the user runs an IPv4 stack. If we could somehow reclaim all those old IPv4 addresses and offer them only to content and server systems, we might be able to get by on IPv4 addressing for Internet content, keeping the clients at the IPv4 level. If not…

…and the Ugly

If not, we're facing a major overhaul of the Internet at some point in the future, or the fragmentation of the Internet into multiple application networks with different address spaces. Either option could significantly impact the profitability of the IP carriers and players at some largely unpredictable time. Either could derail a sudden growth spurt in public broadband services.

The smart thing to do here, but an expensive choice, is to create an IPv6 network that parallels the current IPv4 Internet, then let users migrate to the new one at their own pace. This would almost certainly create an interval in which multiple hosts or multiple connections per host would be required. New hosts would probably move onto the IPv6 network only, creating a positive incentive for users to migrate to the new network. Interconnect between the IPv4 and IPv6 networks could make the "old" hosts visible to the new users, but dualism at this level could reduce the rate of migration.

Even with IPv6, there may still be a major issue that blurs the technical/business boundary. That's the issue of service quality and the service model. The problem is that the Internet has historically been a "best-efforts" service. IP applications tend to grow their utilization dynamically to fill available space, so they rely on access or network congestion to throttle them. If a service provider builds more capacity into an IP network to support premium applications, they have to be sure that capacity won't end up just fattening the collective larder, so to speak, and being absorbed by best-efforts users. That would compromise the original business objective.

Fixing this problem may be as much a political issue as a technical one. Traffic engineering capabilities in IPv4 and IPv6 could theoretically restrict routes to premium traffic, but a better solution would be to meter traffic at the access point to limit the users' ability to call on network resources (by presenting packets for carriage) to the level of resources they've paid for. Essentially this would create a kind of glass ceiling for best-efforts traffic, but that's a hot political issue with the Internet community. Which brings us to our last point.

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The technology issues related to the migration to IPv6 can be dealt with, providing that we have a rational forum in which to do it. That opens the question of the role of the Internet, the role of public IP overall, and the rights and obligations of the public sector to regulate something that proposes to be the central communications vehicle of our time.

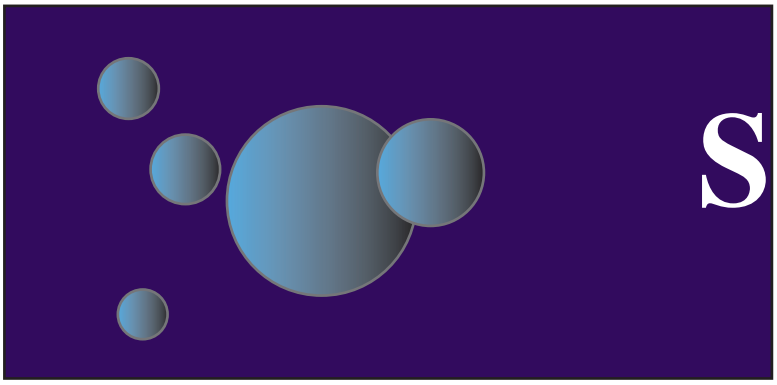
The public carriers may appear as dinosaurs, but they've created a stable network that spans the globe and connects billions. At least some of that stability can be said to be derived from regulatory oversight, and from a statutory framework for interconnection and settlement. In short, things the Internet has yet to get—and may never have. The question we all have to answer is whether public IP services can develop outside the Internet to offer this kind of structure, whether the Internet can grow to offer it, or whether the market would accept a communications industry that didn't have it.

We sort of believe that we have to separate the Internet from public IP, to make the former an application and the latter a network. Within the application of the Internet, we can allow all the current processes to operate freely. Within the framework of the public network, we have to make public policy goals count more than they do now. That's a political hot potato, too. Can it be made to happen?

Frankly, we don't know the answers to these questions, and we're not sure that they can be answered in the near term. That means that we may go some time before we have a framework in which the technical merit of an IPv6 solution could be realized.

We hope the market will still be of a mind to consider it when that happens.

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Strategies

We find ourselves in the unique (possibly unique, anyway) position of having been virtually the sole predictor of this year's networking crunch two years ago, and now being virtually the sole predictor that the crunch is going to pass in 2002. In past issues, and in *Management Briefing* this month, we've covered what we think the market dynamic driving this change will be. Here, we want to look at how the major players in the market should be positioned to deal with the developing conditions.

For those who find summaries comforting, let's summarize for a moment the essential market issues. Congressional action to bolster broadband modernization is dead, and the FCC's moves to step in and fill the gap won't operate nearly as fast or effectively. Thus, broadband modernization is delayed to late 3Q02. RBOCs will file aggressively for 271 relief, destabilizing the IXCs further and putting the whole $120 billion in IXC revenues up for grabs. Economic stimulation by Congress will combine with this to ramp up CapEx next year (by the RBOCs, primarily) to modest gains over this year.

So, what does this mean? **We're afraid that this section is for subscribers only; sorry, Internet readers!**

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