From the Network of Networks to the System of Systems

An End of History in Telecommunications Regulation?

Eli M. Noam

As telecommunications are moving inexorably towards competition, deregulation, and fiber optics, the most fundamental questions for telecommunications policy are rarely asked: *After competition, what? After deregulation, what? And after broadbanding, what?*

Most observers focus on the present bottlenecks—technological, regulatory, and financial. Yet in the United States, the day is not far off when entry will be wide open; when fiber is widespread in most stages of most networks (we are now just haggling over the dates); when radio-based carriers fill in the white spots in the map of telecommunications ubiquity; when foreign carriers operate in America. In such an environment, what market structure can we expect? And what regulatory environment need we erect?

This article will argue that a central institution of the emerging telecommunications environment will be *systems integrators*, which collectively will form an interconnected *system of systems*. The impact of such developments on traditional regula-

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The conventional scenario for the evolution of impact of such developments on traditional regulation is the subject of this essay.telecommunications, offered by traditional state monopoly carriers around the world, is the inte-grated single super-pipe merging all communica-tions links into a single conduit controlled by themselves and interconnected internationally with similar territorially exclusive superpipes. This scenario of integration took no account of the organizational centrifugal forces that were exerting themselves, first in the United States and now increasingly in other countries. Instead of consolidating, the network environment keeps diversifying.

Take as an example local transmission, which was widely considered to be a natural monopoly's natural monopoly. Yet today, we can identify a wide variety of other potential and credible participants in rival local transmission: fiber-based metropolitan area networks; cable television providers; radio-based and cellular carriers; radio tails of electric utilities; building-based shared-tenant services; and other local exchange companies crossing franchise lines.

Similar lists can be made for other segments of the network, whether they are in domestic long-distance, international, mobile, or switching. These physical network elements become linked with

each other through various interconnection arrangements and form what I termed a few years ago the "network of networks."

The Role of Systems Integration

Yet this is not the end of the story. Competition begets diversity; diversity begets complexity; and complexity leads to efforts at simplification. This balkanized environment, so different from the technologists' model of the single superpipe, must be structured for the telecommunication user's benefit. There are several ways to integrate the numerous network pieces into a usable whole.

1. Users' self-integration. This is basically today's system for American residential users where choice is available. They arrange for their own long-distance company and equipment. Large users, too, often put together networks on their own, by leasing lines, buying and operating equipment, etc. Self-integration gets complicated very quickly as the number of carriers, services, prices, and equipment options multiplies. For most users, even large ones, it is not a practical option. A related technique is terminal-based integration, with the user's terminal equipment incorporating some built-in intelligence that can make the right choices among carriers on a real-time basis. The PBXs of large corporate users usually have a so-called "least cost routing" option. This concept has been extended to the residential market by one of Japan's long-distance competitors, DDI, which has persuaded millions of Japanese to buy special terminals and receive a database that can automatically pick the cheapest carrier for any given call. But this method, too, still suffers from the associated transaction costs once it goes beyond basic transmission.

2. Carriers' integration by expansion. Carriers could enter horizontally into new geographic markets or vertically into new services—by expansion, merger, or acquisition. Realistically, it is hard to imagine today any company that is big and varied enough to offer successfully all types of facilities and services—telecommunications, computers, enhanced services, and equipment—locally, domestically, and internationally. This has led to a variant, namely joint ventures among carriers, where several companies specializing in different market segments link up with each other through institutionalized cooperation. This is a likely scenario, and one which is emerging. We will discuss its problems further below.

3. Integration by systems integrators. Perhaps

the most promising scenario for putting together the various bits and pieces of networks and services is for a new category of "systems integrators" to emerge that provides the end user (corporate, governmental, affinity group) with access to a variety of services in a one-stop fashion. Such specialized integrators, whose predecessors are known as outsourcers or managed data services providers, might typically assemble packages of various types of services and equipment, customizing the packages to the specific requirements of their customers. They could operate a least-cost-routing system, switching users around from carrier to carrier, depending on the best deal available for a given time and route. An international market in transmission capacity is

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likely to emerge, consisting of future contracts and a spot market operating in real time.

The characteristic of "pure" systems integrators—for there will be various hybrids—is that they do not own or operate the various sub-production activities but merely select optimal price and performance elements, package them, manage the bundles, and offer them to the customer on a one-stop basis. Systems integrators are similar to general contractors in construction projects, travel packagers, or computer service firms. They relieve customers of the responsibility of integration for which expertise is required. To these customers, the identity of the underlying carriers and their technology might be unknown as transmission becomes a commodity.

Who will be the telecommunications systems integrators? They are likely to range from today's resellers and value-added providers, computer systems providers, defense contractors seeking diversification, and corporate networks with excess capacity to carriers such as local exchange companies, long-distance and international telephone firms,

ALEXANDER GRAHAM BELL, MAKING THE FIRST CALL FROM NEW YORK TO CHICAGO GETS A WRONG NUMBER

cable television operators, and metropolitan area networks. They are also likely to compete vigorously with other systems integrators.

Today, systems integrators exist only for large customers and customer groups, but tomorrow things may be quite different. The next step is for systems integrators to put together individualized networks for personal use, or *personal networks*. This means individually tailored "virtual" network arrangements that serve individualized communications needs and provide easy access to frequent personal and business contacts, data sources, transaction programs, video and audio publishers, data processing and storage, bulletin boards, and personal information screening. A systems integrator is also likely to

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provide to residential users a *tele-mailbox*—a customer's telecommunications node at or near his premises—into which various communications flows terminate.

As these systems integrator-provided networks develop, they will access and interconnect into each other and form a complex interconnected whole sprawling across carriers, service providers, and national frontiers. The telecommunications environment evolves from the "network of networks," in which carriers interconnect, to a "system of systems," in which systems integrators link up with each other.

The Future of Regulation

This arrangement of customized networks bundled together and managed by systems integrators will provoke widespread changes in government regulation of telecommunications.

Regulation had been essential to the old system, partly to protect against monopoly, partly to protect the monopoly itself. Those rationales for regulation evaporate as the transition to competition moves forward. What must now be addressed is the appropriate scope, if any, for continued regulation of the era of the systems integrators.

Why do we have regulation of telecommunications? To some it is merely an exercise in capture and rent-seeking by powerful interest groups. To others, it is based on underlying public policy goals, including restriction of market power, free flow of information across the economy and society, and technological innovation. There is truth in both views, and they are not mutually exclusive. To assure these objectives, regulators and courts instituted a variety of regulatory policies, such as universal service with rate subsidies, common carriage, interconnection rules, quality standards, and limited carrier liability. But in a system of system integrators, the traditional forms of regulation may be outdated. New thinking is needed about which forms of regulation will remain, as well as what new regulatory issues may arise in the new environment.

In telecommunications, government regulation existed partly to affect the balance of power between huge monopoly suppliers on the one hand and small and technically ignorant users on the other. The political and administrative process was used to alter market outcomes. In return, the dominant carriers received protection from competition. Even where competition emerged with rival carriers, customers still had no expertise in dealing with a complex set of services and products. In a system of systems, on the other hand, the imbalance changes drastically. Now, systems integrators, competing with each other for customers, act as users' agents

toward carriers. They can protect users against carriers' underperformance and power, and get them the best deal. This would largely resolve traditional problems of price, quality, market power, security, even privacy. Business communications should be more effective than ever. Technological innovation is likely to be accelerated by knowledgeable buyers and marketers of services. Thus, assuming that users have a choice among systems integrators and that systems integrators have a choice among non-colluding suppliers of underlying services, the need for government intervention declines drastically.

On the other hand, not all traditional policy goals are fully resolved in a system of systems.

1. Universal service/affordable rates. The emerging systems of systems will exert competitive pressures on costs and therefore on many prices, thus making telecommunications more affordable to many. On the other hand, it will be impossible to maintain the traditional redistributive system of generating subsidies and transferring them internally within the same carrier from one class of users to another. Several things will disrupt this arrangement. In a network of competing carriers, an internal redistribution is not sustainable once other carriers without redistributive burdens target the subsidizing users as the most desirable customers. Furthermore, residential users may end up paying a proportionally higher share than large users, because cost shares in the substantial joint costs end up allocated inverse to demand elasticity—the Ramsey pricing rule—and large users have more options and hence greater elasticity. Thus, the trend that at present is described as a "rebalancing" of prices towards cost would go much further, burdening inelastic customers disproportionately. Nor can one expect to continue to rely on a system of access charges to provide the source of subsidies, since those charges imply access into "the" network, which will be a meaningless concept where alternative transmission is easily available.

Yet this need not spell the end of support schemes. If one wants to subsidize some categories of service or users for various reasons of policy or politics, it is still possible to do so, only in different ways. For example, one alternative mechanism to finance desired subsidies might draw on general government revenue, or, more likely, on some form of communications charges. One possibility might be communica-tions value-added fees that would be neutral with respect to the extent of integration, the nature of the carrier, and geographic location. The revenues might go to a "universal service fund" which would be used to support certain network providers or categories of users. This charge would replace the present hidden tax system and would make it visible and accountable.

Systems integrators, by aggregating the

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demand of many small customers, can provide them with a higher demand elasticity with respect to carriers, and thereby generate low prices and low shares in fixed costs. Systems integrators thus serve, in effect, as arbitrageurs in demand elasticity. That is likely to increase their attractiveness to customers over staying as "self-integrating" direct customers of carriers, and thus to accelerate the move to systems integration. On the other hand, those customers not able to obtain systems integrator service, perhaps because they are only reached by a monopoly carrier, would end up bearing a greater cost share. Also, systems integrators will use differential pricing, and charge, for example, rural customers a price that reflects the greater cost in serving them. Should the political system determine that the rural or poor customers should be supported, revenues for such a policy would have to be raised in other ways, as discussed above.

Reforming the redistributive system will be hard enough. Even so, it will be easier than dealing with the more fundamental problem of financing carriers in a system of systems. The advantage of systems integrators is that they pay to competing carriers a price based only on the latter's marginal costs and can pass that low cost on to their customers. Yet most costs in a capital-intensive industry such as telecommunications networks are fixed, and would not get compensated in such an arrangement. Carriers

would not break even. The long-term result would be either a disinvestment in networks, the reestablishment of monopoly, or oligopolistic pricing. Because none of those scenarios is desirable or popular, a possible result would be a reregulation of market structure, pricing, and investment. Another form of government involvement, based on arguments of public infrastructure, might be a publicly imposed financing scheme, for example, a usage-insensitive charge on systems integrators' and subscribers' access lines, dedicated circuits, etc., as a contribution towards carriers' fixed costs.

2. *The free flow of information.* In the traditional network environment, the granting of access and nondiscriminatory content neutrality is required of the general "public" networks by common carriage regulation and even common

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law. But common carriage requirements do not apply to systems integrators. They can institute restrictions on their systems, and exclude certain types of information, subjects, speakers, or destinations.

One of the central observations of the "law and economics" school of thought has been the fundamental economic efficiency of the common law. The implication is that common carriage, as the product of common law judges later codified by statutes, was an economically efficient institution. Among its purposes was reduction of market power; protection of an essential service; protection of free flow in goods and information; promotion of basic infrastructure; reduction in transaction costs; and limited liability.

Yet the institution of common carriage, historically the foundation of telecommunications, will not survive in a system of systems. To clarify: "common carriers" (the misnomer used to refer to telephone companies) will continue to exist, but the status under which they operate—offering service on a nondiscriminatory basis, neutral as to use and user—will not.

The blows to traditional common carriage do

not come from rival telecommunications carriers such as MCI, but from two new directions. The first is the increasing overlap between the common carrier system and well-developed mass media private contract carriers such as cable television networks, which in a remarkably short period have wired the nation with a second and powerful network system, and which are on the verge of entering point-to-point, switched, and mobile telecommunications services. Systems integrators represent a second challenge. As mentioned, common carriage does not apply to systems integrators.

In head-to-head competition between a common carrier and a private contract carrier or systems integrator, the former is at an inherent disadvantage:

• A common carrier cannot use differentiated pricing due to its non-discrimination obligation and because it cannot prevent arbitrage. Price-discriminating rivals can offer services to some customers at a low enough price to induce them to sign up, and use their contribution to revenues to underprice a common carrier for low-elasticity customers.

• A common carrier must serve a contract carrier or systems integrator, but not vice versa. There is no reciprocity. Competitors can use valuable parts of a common carrier's operations, but need not share their own unique features.

• A common carrier cannot pick customers.

• A common carrier cannot manage the competition among its customers and benefit from it.

• In putting together a service package, the systems integrator can pick and choose among the lowest-price component providers, while the common carrier is likely to offer only its own.

• Competition for transmission and other services will lower the price charged to systems integrators to marginal cost, which is likely to be lower than the average cost for both common and contract carriers of providing such services.

As a result, a systems integrator may provide services more cheaply, even though it uses the carriers' underlying transmission facilities!

It is unlikely that the common carriers will simply sit by in such a situation. They will operate their own systems integrators, and they will move to contract carriage themselves, partly based on the argument of "meeting competition." And that is, indeed, what is already starting to happen.

This kind of erosion of common carriage is unavoidable in the long term. The only way to prevent it might be to force systems integrators to

become common carriers, but this would have to be inevitably extended to most private networks, contract carriers, media, and enhanced service providers. This seems neither practical nor desirable.

Where alternatives are stark, the possibility of a mixed system suggests itself. There are several possibilities for a hybrid system. But none of them is likely to stem the long-term dynamic of shrinking common carriage, both across carriers and industries, and within mixed firms. In the long term, common carriage will not survive.

As a result, the system of systems would have the capacity for a large number of voices, yet it might still result in a narrower spectrum of information, because systems integrators and carriers would not want to be identified with certain types of uses and users. Take for example birth control information offered by an abortion clinic hotline. Faced with negative publicity and pressure, service providers with discretion in the choice of customer may drop the service as a business decision. Competition may not resolve this problem since all carriers will be under similar pressures. It is of course likely that "alternative" carriers and systems integrators will emerge to serve such uses. Yet this solves only part of the problem. The need for the various systems to access each other, and for information to travel over numerous interconnected carriers, means that the restrictiveness of any one of the participants would require everyone else to institute content and usage tests before they can hand over traffic, or they must agree to the most restrictive principles. Information travels across numerous subnetworks until it reaches its destination, and nobody can tell one bit apart from another. If each of the networks and systems integrators sets its own rules about which information is carried and which is not, information would not flow easily. Transaction costs would rise. The reason for common carriage generally, whether in transportation or communications, is to foster infrastructure and reduce transaction costs. As such, it is similar to other societal arrangements to encourage economic transactions, by devices such as legal tender status for currency, negotiable instruments in commercial transactions, and limited liability for corporations. Thus, even if common carriage erodes, its neutrality principles will remain important, and may survive in other regulatory forms.

3. *Interconnection and compatibility.* As various discrete networks grow, they must cooperate in terms of technical standards, protocols, and boundaries. Yet interconnectivity is not normally granted by incumbent firms. That is the lesson of decades of American experience. Requirements such as open network architecture, comparably efficient interconnection, or collocation have been part of the evolution

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towards competition. In effect, these provisions regulated in order to deregulate, at least in the transitional phases. Similar problems are likely to arise in the emerging system of systems. At issue will be the rules of interconnection for multiple hardware and software subnetworks and their access into the integrated whole.

New Problems?

There are several possible regulatory problems associated with systems integrators.

1. Integrator power? If there are strong economies of scale and scope in systems integration, only a few large firms would survive. In theory, integrators with market power might sell only a full range of services to the end user, charge monopolistic prices, force a carrier to enter into exclusive arrangements, or control access to the "tele-mailbox." These are fairly standard problems of vertical extension of market power in one stage of production into other stages. Without such underlying market power no market distortion would be sustainable. Such problems can be dealt with through regular antitrust enforcement.

The underlying question, though, is whether market power in systems integration is likely. Sources of market power might include the ability of a large systems integrator to get advantageous rates from carriers or to set aside proportionately less spare and redundant capacity by averaging out demand spikes across its more numerous cus-

tomers. On the other hand, any customized service operation requires close attention to and contact with customers, and this factor does not favor large-scale firms. Generally, it is hard to imagine that the nature and shape of economies of scale are similar for each layer of the hierarchy of communications services, from basic transmission up to computer-based applications. Thus, integrator power is unlikely.

2. Carrier power? Traditional carriers have some advantages in systems integration. They include the coordination of planning, advance information, established goodwill, and reduced transaction costs for operations, all under one corporate roof. Carriers functioning as systems integrators could favor their own services or equipment. Furthermore, they have the foundation of a major transmission element. However, this base is also a burden. To be truly competitive as a systems integrator, a traditional carrier's systems integration operation must be willing to compete against its own carrier, use alternative carriers, etc., and in effect become independent. While this might be conceivable, it might require significant rethinking by these carriers. Such rethinking has recently begun in the telephone industry. The Rochester Telephone Co. has proposed to separate itself into a carrier (R-Net) open to all, and a services operator (R-Com); Ameritech proposed to separate its carrier from its switching functions, subject to several conditions.

Looking at the reverse side of a vertical relationship, a carrier could conceivably provide

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preferential service to its own systems integrators. In a competitive environment in a commodity service it is not economically rational to limit sales to one's own outlets. And where market power exists in the carrier's service segment, regulators are likely to assure nondiscriminatory service.

Thus, the competitive advantage of the established reputation of traditional carriers should not be overestimated. One must resist the temp-

tation to think in narrow telecommunications terms when it comes to integration. Traditional carriers may have the edge in basic transmission and switching. But as communications include more and more "upper level" services, they are more often than not in uncharted waters. A customer might well prefer a computer firm to a telecommunications carrier, reasoning that it is easier to migrate down rather than up the hierarchy of communications. This might be the reason why computer-based firms are serious players in the systems integration business, for example DEC, IBM, or Electronic Data Systems. DEC, for example, replaced Sprint as the systems integrator for Citicorp's global network. Other systems integrators include high-technology firms such as General Electric, or defense contractors with a desire for civilian diversification and experience in large-scale turnkey projects. For example, Martin Marietta was a bidder for the federal government's huge FTS-2000 network.

In conclusion, it does not seem likely that a carrier would be dominant in systems integration. At any rate, if extension of market power were to become a real problem, protections could be instituted.

3. International asymmetry? The system of systems works as long as it is competitive in each of its stages, or as long as regulation establishes nondiscrimination. However, in an international setting neither of those conditions is likely to be met. Most countries lag behind the United States and Japan in the evolution of networks. The traditional monopoly carrier is almost always firmly entrenched and operating in all stages of communications. Consequently, systems integrators cannot truly compete against governmental or semi-official Public Telecommunications Organizations (PTOs) in systems integration, except in market niches. This might be considered to be an internal issue for these countries, except that it has a global anticompetitive impact. That is because some of these PTOs are aggressively pursuing international systems integration themselves, while at the same time holding gate-keeper powers over entry into their own home markets. Thus, the PTO of an important European country could restrict the effectiveness of an American systems integrator to offer global services, while at the same time entering the more liberalized environment in America. It could also operate to

benefit the interests of allied equipment manufacturers.

Of course, other countries's PTOs can play the same game, and as a result, a new trend of international carrier collaboration has emerged in which major PTOs enter into joint ventures of systems integration. Potentially at least, these alliances of dominant national carriers could create international cartels, and barriers to competitive entry of other systems integrators, whether in their home countries or internationally. It has the anticompetitive potential of "whipsawing" in which a one-sided liberalization across frontiers permits the remaining monopolist to appropriate fully the previously shared monopoly profits. To prevent this it is essential to press internationally for nondiscriminatory access, lease, and interconnection arrangements that are neutral as to the nature or the nationality of the systems integrator. The United States, being the largest and most interesting market for systems integrators, can exercise leadership in pressing for such reciprocity.

Such an effort is likely to be aided by the openness of the evolving network system, which by not stopping at national frontiers will erode national regulation. Telecommunications will transcend the territorial concept, and the notion of each country having full territorial control over electronic communications will become anachronistic. As communications are becoming distance-insensitive, system integrators will reroute and arbitrage traffic in more cost-effective ways, thereby undermining attempts to set rules administratively for prices and service conditions.

Conclusion

The purpose of this article is not to analyze the various merits of policy options, but rather to point out that the introduction of vigorous competition will not be the "end of history" as far as regulation is concerned. Government is not likely to disappear from this area. In the 1980s, telecommunications policy was centered on open entry. That was correct then and now. But in the 1990s second-generation issues involving the integration of the various network parts will be at the forefront.

The coming era of systems integration will demand changes on the part of regulators. Those changes include: 1) permitting a system

of competitive systems integration to emerge and removing the roadblocks to its operation; 2) moving out of those areas of regulation which can be handled by the new system of systems itself; 3) restructuring traditional forms of regulation; and 4) identifying and dealing with potential problems in the system of systems, such as the free flow of information, interconnectivity, international reciprocity, and the viability of the underlying network infrastructure. Dealing with such issues is a unique undertaking because many of them are new. None of the developments anticipated in this article are happening overnight, though some are already manifest. But that should not lead us to ignore them. Opening telecommunications competition will prove to have been the easy part. Dealing with the consequences will be the next and more difficult challenge.

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