From the Network of Networks to the System of Systems: An End of History in Telecommunications Regulation?

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I. Introduction

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 U.S., the day is not far off, historically speaking, when entry is wide open; when fiber is widespread in most stages of most networks (we are now just haggling over the dates); and 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*, who together will form an interconnected *system of systems*. What will happen to traditional regulation? This is the subject of this essay.

The conventional scenario for the evolution of telecommunications, offered by traditional state monopoly carriers around the world as their vision of the future, was the *integrated single superpipe* merging all communications 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 simultaneous organizational centrifugalism that was taking place, first in the U.S. and now increasingly in other countries. Instead of consolidating, the

network environment kept diversifying.

Take as an example local transmission, the segment 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 described a few years ago as the "network of networks".

II. 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. Thus, how will the actual user of telecommunications handle this balkanized environment that is so totally different from the technologists' model of the single superpipe? How can the numerous network pieces be integrated into a usable whole? There are several ways to do so.

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, and buying and

operating equipment, etc. My own university, Columbia, for example, employs 45 people in the process. 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 a *terminal-based integration*, with the user's terminal equipment incorporating some built-in intelligence which 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 Japan's aggressive DDI long-distance competitor, 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. This method, too, still suffers from the associated transaction cost 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 all types of facilities and services, and to do it well, locally, domestically, internationally, across services, in telecommunications, computers, enhanced services, and equipment. 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. Such a scenario is emerging. We will discuss its problems further below.

3. *Integration by systems integrators.* Perhaps the most promising way of putting together the various bits and pieces of networks and services is for a new category of 'systems

integrators' to emerge who provide the end user (corporate, governmental, affinity groups) with access to a variety of services, in a one-stop fashion. These specialized integrators, whose predecessors are known as outsourcers or managed data services providers, might typically assemble packages of various types of services and equipment, etc, and customize these 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. Likely to emerge is an international market in transmission capacity, 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 rather select optimal elements in terms of price and performance, package them together, manage the bundles, and offer it to the customer on a one-stop basis. They relieve customers from the responsibility of integration for which expertise is required. To these customers, the identity of the underlying carriers and their technology might be unknown and transparent as transmission becomes a commodity. Systems integrators are similar to general contractors in construction projects, to travel packagers, insurance agents, or to computer service firms.

Who will be the telecommunications systems integrators? They are likely to be a variety of participants. Some might be today's resellers and value-added providers, computer systems providers, defense contractors seeking diversification, and corporate networks with excess capacity. Others would be carriers themselves, such as local exchange companies, long-distance and international telephone firms, cable television operators, and metropolitan area networks.

All are likely to compete and to collaborate vigorously with each other.

Today, systems integrators exist only for large customers and customer groups. But tomorrow things may be quite different. The additional step would be for systems integrators to emerge that put together individualized networks for personal use, or *personal* networks. This means individually tailored "virtual" network arrangements that serve individualized communications needs and providing 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 provide to residential users with a *tele-mailbox* -- a customer's telecommunications node at or near their premise -- into which various communications flows terminate.

As these systems integrator-provided networks develop, they 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.

III. Regulation

Where does such an arrangement of customized networks and managed by systems integrators leave government regulation? In the recent past, policy debates centered on the opening of telecommunications, broadcasting, and cable television markets. Is competition sustainable? Is it advisable? Who gains? Who loses?

Regulation had been essential to the old system, partly to protect against monopoly, partly to protect the monopoly itself. In the transition to competition, what was left of regulation was seen as temporary, shrinking reciprocally with the growth of competition. In time, it would diminish to nothing.

At that point, what would happen? Advocates of competition were always a bit vague on that question. Can one expect the "system of systems" to be totally self-regulating, with no role for government?

The notion of an invisible hand mechanism, the idea that out of numerous decentralized sub-optimizing actions there would emerge, without any central direction, some overall and beneficial equilibrium, is perhaps Adam Smith's major insight as a philosopher.[1] Its importance goes way beyond economics.[2] Can electronic communications function in such a fashion, optimally arranging themselves in the absence of an overall plan or direction?

The mere notion is almost incomprehensible to telecommunications traditionalists. They argue that the more complex the technology and the network become, the more necessary it is to plan it in some centralized fashion. This type of argument was countered by the Austrian economist von Hayek half a century ago, when he pointed out that, to the contrary, the more complex and advanced an economy becomes, the less it is possible to guide it centrally.[3]

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[1] Adam Smith, *An Inquiry into the Nature and Causes of The Wealth of Nations*. 2 vols. Edwin Cannan (ed.). London: Methuen & Co., Ltd., 1904.

[2]Nozick, Robert, 1974, Anarchy, State, and Utopia, New York,: Basic Books: p 20-21.

[3]Friedrich von Hayek, 1942, *The Road to Serfdom*, Chicago: University of Chicago Press.

Recent experience in Eastern Europe seems to confirm Hayek.

On the other hand, there is the also the opposite and simplistic view that more advanced technology, merely by creating new options, makes all regulation unnecessary. But consider new chemical products or nuclear power generation -- complex technologies that are tightly regulated. Technology does not abolish negative externalities, though the means of dealing with them may change. Thus, we need to look at the question in greater detail.

Why do we have regulation in 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. There is truth in both views, and they are not mutually exclusive. To assure various policy objectives, such as the free flow of information across the economy and society and technological innovation, 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, what forms of such regulation, if any, are still necessary? Which are likely to continue, assuming that the underlying goals and forces remain? And what new regulatory issues, if any, may arise in the new environment?

In telecommunications, regulation by government existed partly to effect the balance of power between huge monopoly suppliers on the one hand, and small and technically ignorant users on the other hand. It inserted the political and administrative process to alter unconstrained market outcomes. In return, the dominant carriers received protection from competition. Even where competition emerged with rival carriers emerging, 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 these users' agents toward carriers. They can protect users against carriers' under-performance 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 and historically.

On the other hand, not all traditional policy goals are fully resolved in a system of systems. Let us turn to them now.

1. Universal service/affordable rates. The emerging systems of systems will exert competitive pressures on cost and therefore on many prices, thus making telecommunications more affordable to some. On the other hand, it will be impossible to maintain the traditional redistributive system of generating subsidies and transfering them internally within the same carrier from one category of users to another catagory. 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 likely customers. Furthermore, residential users may end up paying a proportionally higher share than large users, because cost shares in the substantial joint costs may end up allocated inverse to

demand elasticity -- the Ramsey pricing rule -- and large users have more options and hence greater elasticity. Thus, the trend which at present is described as a "rebalancing" of prices towards cost would go much further than that, burdening the inelastic customers. Nor can one expect to continue to rely on a system of access charges to provide the source of subsidies, since these 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, for various reasons of policy or politics, one wants to subsidize some categories of service or users, it is still possible to do so, only in different ways. One alternative mechanism might draw on general government revenue or on specialized communications charges such as a communications value-added tax. The moneys raised 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 accountable.

Systems integrators, by aggregating the 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. This is also likely to increase their attractiveness to customers over staying as customers of carriers, and this accelerates 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 carriers, would end up bearing a greater cost share. Also, systems integrators, absent some support mechanism, would deaverage prices for their customers, and

charge, for example, rural customers a price that reflects the greater cost in serving them.

Changing the redistributive system will be hard enough. But still harder will be the more fundamental financial problem of 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 this low cost on to their customers. Yet the bulk of cost in a capital intensive industry such as telecommunications networks is 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 oligopolisitic pricing. Because none of these scenarios is desirable or popular, they might lead back to various regulatory schemes. Examples are a re-regulation of market structure, pricing, and investment, or a usage-insensitive charge on systems integrators' and subscribers 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 non-discriminatory content-neutrality is required of the general "public" networks by law, common carriage regulation, and even common 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.[4] The implications is that common

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[4]See e.g., Richard A. Posner, *Economic Analysis of Law* (3d Edition), Boston: Little, Brown and Company, 1986; and Guido Calabresi, *Some Thoughts on Risk Distribution and the Law of*

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 good and information; promotion of basic infrastructure; reduction in transaction cost; and limited liability.

Yet, the institution of common carriage, historically the foundation of the way telecommunications are delivered, 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 non-discriminatory 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. The other challenge to common carriage are systems integrators. 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:

1. A common carrier cannot use differentiated pricing due to its non-discrimination

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Torts, 70 Yale Law Journal 499, 1961.

obligation and because it cannot prevent arbitrage. Non-common carriers' 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.

2. 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 carriers operations, but need not share their own unique features.

3. A common carrier cannot pick customers.

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

5. 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.

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

As a result, a systems integrator may provide services more cheaply, even though they use 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, such

as price-differentiation of customers, 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 doable nor desirable.

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

What are the implications? The system of systems might have the capacity for a large number of voices, yet it would 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 by a hotline of an abortion clinic. Faced with negative publicity and pressure, service providers with discretion in the choice of customer may drop the service as a business decision. 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 or accept 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 bit. If each of these networks and systems integrators sets its own rules about which information is carried and which is not, information would not flow easily. The reason for common carriage generally, whether in transportation or communication, 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, if common carriage erodes, its neutrality principles remain important for economic efficiency and free speech and may be protected in other ways.

*3. **Interconnection and compatibility**.* The economic rationale behind the tension between the integrative and pluralistic forces is most pronounced on the front where they intersect: the rules of interconnection of the multiple hardware and software sub-networks and their access into the integrated whole. As various discrete networks grow, they must inter-operate 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. Regulatory requirements such as open network architecture, comparably efficient interconnection, or collocation were part of the evolution towards competition. In effect, these provisions regulated in order to deregulate.

Many of these interconnection requirements are likely to be temporary, to be superseded in a competitive system by contractual arrangements. Yet optimal interconnectivity would not always be self-generating. For example, a system integrators may pick different technical

standards and protocols, either for reasons of sub-optimization, as part of competitive strategy, or due to vertical links into equipment manufacturing and carriage. In the past, while manufacturers competed, including in standards, carriers cooperated (being territorial monopolists) to maintain technical compatibility. In a system of systems, economic theory suggests that it is impossible to say in advance whether a convergence to compatible standards will take place. Where it does not occur one must weigh the cost of incompatibility against the benefits of flexibility.

IV. New Problems?

What new type of problems might be 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, if real, could be dealt with through regular antitrust enforcement.

But in any event, is market power in systems integration likely? Sources of market power might be 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 customers. 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 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. Will there be a role for traditional carriers in systems integration? Traditional carriers have some advantages. These 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 segments of service 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 re-thinking 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, couldn't a carrier provide preferential service to its own systems integrators? In a competitive environment in a commodity service it is not economically rational to limit one's sales to one's own outlets. And where market power exists in the carrier's service segment, regulators are likely to assure non-discriminatory service.

Thus, the competitive advantage of the established reputation of traditional carriers should not be overestimated. One must resist the temptation 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 in 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 EDS. Digital, for example, replaced Sprint as the systems integrator for Citicorp's global network. Other systems integrators are high technology firms such as GE, or defense contractors with a desire for civilian diversification and with experience in large-scale turnkey projects. For example, Martin Marietta was a bidder for the U.S. federal government's huge FTS-2000 network.

Thus, it does not seem likely that a carrier would be dominant in systems integration; and if extension of market power is real, other 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 non-discrimination. However, in an international setting neither of these conditions is likely to be met. Most countries lag the U.S. and Japan in the evolution of networks. The traditional monopoly carrier is almost always firmly entrenched, and operating in all stages of communications. In consequence, systems integrators cannot truly compete against these 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 anti-competitive impact. This 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' 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 anti-competitive potential of "whip-sawing" in which a one-sided liberalization across frontiers permits the remaining monopolist to fully appropriate the previously shared monopoly profits. To prevent this it is essential to press internationally for non- discriminatory access, lease, and interconnection arrangements that are neutral as to the nature or the nationality of the systems integrator. The U.S., 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 helped along by the openness of the evolving network system, which will not stop at national frontiers, and in the process erode national regulation. Telecommunications begin to 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 the most cost effective ways. This undermines attempts to administratively set rules for prices and service conditions.

V. 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, and government is not likely to disappear from this area. In the 1980s, telecommunications policy was centered on open entry. This was correct then and now. But in the 1990s second-generation or issues involving the integration of the various partial networks and services will be at the forefront.

This means dealing with the impact of the systems integrators that will emerge, as this article has argued, as a central elements of the future telecommunications structure. It means, first, permitting a system of competitive systems integration to emerge and removing the roadblocks to its operation. Second, to move out of those substantiated areas of regulation which can be handled by the new system of systems itself. Third, to restructure traditional forms of regulation, especially the present mechanism of internal redistribution. And fourth, to identify and deal with potential problems in the system of systems, such as informational free flow, interconnectivity, international reciprocity, and the viability of the underlying network infrastructure.

None of these developments anticipated in this article will happen overnight, though some are already manifest. But this should not lead us to ignore and avoid understanding them. Opening telecommunications competition will prove to have been the easy part. Dealing with the consequences will be the next and more difficult challenge.