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One-Way Networks, Two-Way Networks, Compatibility, and Antitrust

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Abstract

This paper develops some important concepts with respect to networks and compatibility. We note that the familiar concept of complementarity lies at the heart of the concept of compatibility. We further note the distinction between two-way networks (e.g., telephones, railroads) and one-way networks (e.g., ATMs, television). In the former, each component is complementary to every other component; the reverse combinations (B → A, compared to A → B) are distinct and different goods; also customers are identified with components. Accordingly in an n-component network there are n(n-1) potential goods, and an additional customer provides direct externalities to all other customers in the network by adding 2n potential new goods. In contrast, in the one-way network there are typically two types of components, and composite goods are formed only by combining a component of each type; there is no market demand for any reverse combinations; and customers are often not identified with components but instead demand composite goods. Thus, when there are m varieties of component A and n varieties of component B (and all A are compatible with all B), there are mn potential goods. An extra customer yields only indirect externalities to other customers, by increasing the demand for components of types A and B and thereby (because of economies of scale) potentially increasing the varieties of each component that are available in the market. Most industries involve vertically related components and thus are conceptually similar to one-way networks. Accordingly, our analysis of networks has broad applicability to many industrial frameworks. For example, a decision by a firm in a network industry to restrict compatibility is the form-equivalent of a decision to impose a vertical restriction (which can be viewed as tying, exclusive dealing, or a refusal to deal). We proceed by exploring the implications of networks and compatibility for antitrust and regulatory policy in three areas: mergers, joint ventures, and vertical restraints.

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One-Way Networks, Two-Way Networks, Compatibility, and Antitrust

1. Introduction

Network industries are common: telephone, ATMs, railroads, roads, and electricity, are just a few examples. An examination of antitrust issues in network industries requires a deeper understanding of the concepts of "compatibility" and "network externalities," and especially the role they play in determining market conduct and structure. This analysis leads us to conclude that compatibility and network externalities play a very similar role in non-network industries as long as there are significant complementarities between types of goods. Thus, we can utilize the significant economic and legal thought on vertical relations to analyze antitrust and related problems.

2. Compatibility and Network Externalities in Network Industries

2.1 Two-Way Networks

To establish our framework, let us first consider the simplest possible network: a central switch S with n spokes, SA, SB, SC, etc, as in Figure 1. If this is a telephone network, customers are located at A, B, C, etc., and the goods are phone calls ASB, BSA, ASC, CSA, etc. Each good, such as ASB, is composed of two complementary components, AS and SB, each of which can be thought of as "access to the switch".

A number of observations are in order. First, *all* components (AS, BS, etc.) are complementary to each other. Therefore any two of them can be connected to make a demanded composite good (such as ASB). Second, components AS, BS, etc., are complementary to each other despite the fact that in industrial specification terms they are very similar goods. Third, there is reciprocity or reversibility. Both ASB and BSA are feasible but different (though technologically very similar) because the spokes AS, BS, etc., can be traveled in both directions. Fourth, customers tend to be identified with a particular component. Fifth, composite goods that share one component, such as ASB and ASC, are not necessarily close substitutes. Sixth, there are ***network externalities***: the addition of a new spoke to an n-spoke network creates 2n new potential goods. The externality takes the form of the creation of new goods for each old customer. We could call it *an economy of scope in consumption*. Note that the *externality affects directly the utility function of each consumer*. There may be other secondary (indirect) effects through the markets (such as price changes), but this is not necessary or essential. Seventh, we have assumed in the definition of the network that its components are ***compatible***, so that their combination is of value. Compatibility may be automatic for certain goods (for example, sugar always dissolves in coffee), but for high technology products it has to be achieved by explicit or implicit agreement on certain ***technical standards***.

Two way networks, such as telephone, railroad, road, and electricity, exhibit most of the features of this simple example. In particular, they exhibit complementarity between most components of the network, reciprocity, identification of particular consumers with nodes, no close substitution between composite goods that share a component, and network externalities.[1] The feature that disappears in more complicated networks is the complementarity between any two components of the network and the symmetry of the externality.

Now consider a slightly more complex network in Figure 2. A gateway S_AS_B connects two different switches S_A and S_B, which are the central nodes of two star networks. Let all spokes starting from S_A end at points A_1, A_2, etc., and, similarly, spokes starting from S_B end at points B_1, B_2, etc. Components A_1S_A, A_2S_A, A_3S_A, etc., are still all complementary to each other. However, only components connected to the same central node, such as A_iS_A and A_jS_A, can be connected directly to make a composite good such as $A_iS_AA_j$. Components connected to different nodes, such as A_iS_A and B_jS_B are complementary but require component (gateway) S_AS_B to create $A_iS_AS_BB_j$, a demanded composite good. Thus we have

[1] These features are not changed if there exists some component(s) of the network that is a part of all demanded goods as when the central switch S of the previous example is considered as a component, and each composite good ASB is composed of three components: AS, SB and S.

two types of externalities. "*Local network externalities*" (in the same star) are immediate as before. "*Long distance network externalities*" require the gateway $S_A S_B$.

2.2 One-Way Networks

Consider now *one-way networks*, such as ATMs, television (over-the-air and cable), electricity networks, retail dealer networks, Minitel, etc. First, in such networks, a combination of any two components does not create a demanded composite good. Essentially there are *two types of components*, type A and type B, and the combination of a component of type A with a component (or components) of type B creates a demanded composite good. Thus, the setup of a one-way network looks like Figure 2, but only the "long distance" composite goods, such as $A_i S_A S_B B_j$, make sense. The "local" composite goods give no utility and therefore are not demanded.[2] Second, a one-way network lacks reciprocity, since goods $A_i S_A S_B B_j$ and $B_j S_B S_A A_i$ coincide. Third, typically customers are not immediately identified with particular components or nodes. Fourth, typically in one-way networks, a composite good is a closer substitute with a good with which it shares a component than with goods with which it doesn't. Fifth, such networks exhibit a variant of consumption economies of scope. Let there be originally m components of type A and n components of type B that can be combined in a 1:1 ratio so that there are mn composite goods. Then the addition of one more good of type A creates n new composite goods, and the addition of one more good of type B creates m new composite goods. As before, the externality is in the creation of new goods. When customers are identified with components, the one-way network exhibits (in the old terminology) "long distance network externalities." Since this externality arises in the combination of components of *different types*, we call it *inter-product network externality*. When customers are not identified with components, their benefit from the addition of new products is indirect; they are now able to

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[2] For example, if A_is are ATM machines and B_js are banks, the combination of two ATMs by themselves (but not linked to a bank), $A_i S_A A_j$, gives no utility.

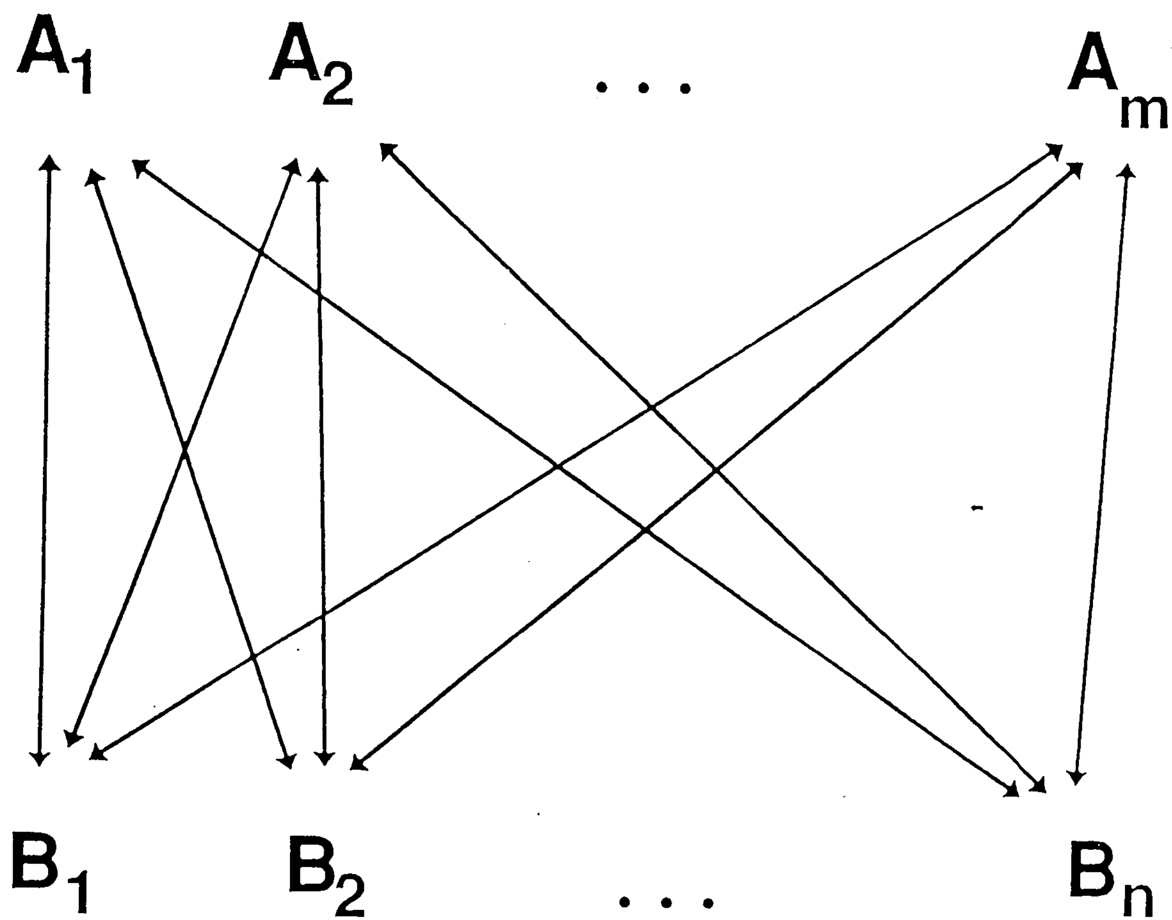

Figure 3

firm prefers incompatibility. Thus, when the demand functions for the integrated firms are unequal and the demand for hybrids is closer to the smaller of the two integrated demands, the smaller integrated firm wants compatibility, and the larger integrated firm wants incompatibility.[6] In such cases of conflict, the presumption is that incompatibility wins, as it is very difficult for any firm to predict and fix all incompatibilities that a competitor may introduce. When price discrimination in the form of mixed bundling is available (selling the combination of the two components of the integrated firm at a lower price than the sum of their prices when sold as components of hybrids), the same general results hold with respect to the incentives for compatibility.[7]

2.6 Technical Standards Setting

If coordination to a particular standard is costly, firms may produce incompatible components, even when the demand rewards from compatibility are substantial. However, the incentive for compatibility could be enhanced if coordination to a particular standard puts a competitor at a cost disadvantage.[8] Further, a firm with proprietary information, which may be disclosed in the standard-setting process or in the regime of compatibility, has little incentive to participate in the process.[9]

It also has to be noted that compatibility does not just make combined products *feasible*, but *it also defines the quality and variety features of the composite good*. In some products, the

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[6] Economides (1988, 1991).

[7] Matutes and Regibeau (1992), Economides (1993a).

[8] For an analysis of the strategic effects of raising the costs of competitors see Salop, Scheffman, and Schwartz (1984).

[9] Apple has argued that its proprietary design of the operating system of the Macintosh would be compromised if it disclosed sufficient information to establish compatibility standards. Baumol (1983) discusses an example of a railroad that would not interconnect so as not to disclose the names of its customers.

same firm, can either increase or *decrease* prices. Similarly, a full merger, from "parallel vertical integration" to "joint ownership," again can increase or *decrease* prices. In both cases, the essence of this result comes from the fact that both mergers exhibit both horizontal and vertical elements, since each merger puts under the same ownership some substitutes and some complements. Thus, under non-pathological conditions, mergers to monopoly in one-way networks or vertically-related industries can be welfare increasing. A similar result can be shown for two-way networks. For example, if every spoke in the single-star network of Figure 1 was initially owned by a different firm, mergers between the independent firms could decrease prices and increase welfare.

Even in simple networks, the incentives for mergers among the various elements of the network cannot be easily categorized. Small changes in the configuration of the remaining network can change the direction of the incentive of a firm to merge two components of the network, as measured by the difference between the post merger profits and the sum of the profits of the individual pre-merger components.[10] Further, gateways can be of no value (and even be a liability) to the existing participants of a network, but be of value to a potential entrant. To see this, consider the network of Figure 3, with all A_iS_A links owned by firm A and all B_iS_B links owned by firm B, which also owns the gateway S_AS_B. How much should firm A pay to acquire the gateway? After acquisition, any price that firm A can charge for use of S_AS_B it could have charged before on the links A_iS_A. Similarly, any price that firm B would charge for use of S_AS_B, it can already charge on links B_iS_B. Therefore, the strategic positions and the prices of the firms do not change. And, if S_AS_B carries a fixed cost, it is a liability to its owner. However, the gateway link can be sold at a positive price a third party because the third party will now have some monopoly power on the network.[11]

[10] See Economides and Woroch (1992).

[11] This argument is adapted from Economides and Woroch (1992).

3.1 Mergers

Mergers between firms that are vertically related in network industries -- either producers of different components in one-way network industries or operators of adjacent two-way networks -- have a presumption of beneficial social consequences. All of the usual arguments for the benefits of vertical integration -- improved coordination, elimination of double marginalization, elimination of inefficient substitution -- apply. In an important respect, the improved coordination can be a paraphrase for improved compatibility. Further, as Carlton and Klamer (1983) point out, such vertical mergers may encourage greater innovation, since an innovator will experience fewer difficulties in reaping the gains of compatibility-linked innovations.

Examples of these types of beneficial mergers in network industries are easy to conjure: for one-way network industries, mergers of hardware and software companies or mergers of firms producing separate components; for two-way network industries, the merger of end-to-end rail networks, airlines, and telephone systems.

There are, however, well-known potential competitive dangers to vertical mergers -- and, again, these potential pitfalls apply to network industries as well. Vertical mergers may be a means of perfecting a system of price discrimination, with its concomitant ambiguous consequences for social welfare. They may also be a means of quality discrimination, whereby a firm with market power distorts the quality levels provided to some customers so as to be able to charge higher prices to other customers;[13] here, the welfare consequences are likely to be negative. If the assumptions of constant returns to scale and easy entry are replaced by increasing returns to scale and/or difficult entry, vertical mergers may be a means of enhancing

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[13] See White (1977), Mussa and Rosen (1978), Donnenfeld and White (1988), and Bradburd and Srinagesh (1989).

As an illustration of the problem that has worried the ICC, consider rail links between cities A, B, and C as in Figure 4. Link AB is owned by firm 1; firms 2 and 3 each own a BC link. Here there are five goods: AB, B2C, B3C, and their combinations AB2C and AB3C. The novel element of this structure is that some components (B2C and B3C) have utility as "stand-alone" goods, as well as components of composite goods AB2C and AB3C. Suppose that the ability of firm 3 to compete in the "short haul" BC market is affected by its volume of AB3C traffic (because of economies of scale or scope). In that case, a merger between firms 1 and 2 could have anticompetitive effects in the BC market if the merged firm is allowed to favor its B2C subsidiary through price discrimination. If the merged firm is not allowed to price discriminate, it may find it preferable to foreclose B3C rather than to supply AB to it at the same price it charges to its subsidiary B2C. The ICC rules (the through-rates and joint rates) were designed to try to prevent the foreclosure of or price discrimination against firm 3.

In the past two decades U.S. policy toward vertical mergers has been quite tolerant. The last Supreme Court decision forbidding a vertical merger was in 1972.[17] During the late 1970s and throughout the 1980s and the early 1990s the two federal antitrust agencies -- the U.S. Department of Justice's Antitrust Division and the Federal Trade Commission -- adopted a merger enforcement stance that virtually ignored vertical mergers. The DOJ's 1982 and 1984 *Merger Guidelines* devoted a comparatively small amount of attention (as compared with the DOJ's 1968 *Merger Guidelines*) to vertical mergers, and the jointly authored DOJ-FTC 1992 *Horizontal Merger Guidelines* did not mention vertical mergers at all! We are aware of only one instance in the last decade which a merger with substantial vertical elements was halted by one of the federal enforcement agencies.[18]

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[17] U.S. v. Ford Motor Company, 405 U.S. 562 (1972).

[18] This involved the merger of the Showtime and Movie Channel cable services. The initial proposal for this merger also involved (vertical) ownership by three of the six major moving picture distributors. This version of the proposed merger was challenged by the DOJ. For more

In the two-way network regulatory area, during the 1970s and 1980s Interstate Commerce Commission regularly approved end-to-end railroad mergers, the Civil Aeronautics Board (and, later, the U.S. Department of Transportation) approved end-to-end airline mergers (and even, arguably, approved some airline mergers with substantial horizontal elements[19]), and the Federal Communications Commission approved the merger of small, non-competing local telephone systems.

Is this tolerant public policy stance toward vertical mergers sensible? We believe that the answer is a cautious yes. The efficiency advantages to vertical integration do seem to be substantial in many instances. Nevertheless, there are the market power and social welfare dangers mentioned above, which inspire some caution. A case-by-case approach, with a moderately strong presumption toward approval, does seem sensible.

3.2 Joint Ventures

Where dominant firms are present in one-way or two-way network industries, these firms are likely *de facto* to set compatibility standards.[20] In instances where a dominant firm is absent but where compatibility can yield significant social gains, a coordinating mechanism may well be necessary.[21] Regulatory agencies, trade associations, and industry joint ventures can all serve as this mechanism. We will focus primarily on joint ventures. Agreements reached

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details, see White (1985).

[19] At least, the DOJ so argued in its comments to the U.S. Department of Transportation, opposing the merger of TWA and Ozark and of Northwest and Republic.

[20] This initial conjecture by Braunstein and White (1985) was later demonstrated in formal models by Farrell and Saloner (1986) and Katz and Shapiro (1986).

[21] Though there are models (e.g., Economides [1988, 1989] and Matutes and Regibeau [1988, 1992]) that show that non-cooperative oligopolists will choose compatibility as their profit-maximizing choices, these models assume a frictionless world. In a world with frictions, a coordinating mechanism may be necessary.

the latter could well be the competitive "mavericks" of an industry that has otherwise achieved some level of oligopolistic coordination.[23] Fourth, the joint venture might involve the actual production and pricing of one or more goods or services, with collusive pricing of those goods or services by the joint venture.

A somewhat realistic example of a one-way network -- commercial banks and their automated teller machine (ATM) networks -- can illustrate some of these concerns and complexities. For the purposes of this example we treat ATMs as having the sole function of dispensing cash to bank depositors.[24] It is useful to think of the bank's home office where the deposit is "located" as an upstream entity, equivalent to "the manufacturer" in many models; the ATMs (along with the tellers at the bank's home and branch locations) then become the points of "retail" distribution for dispensing the cash. *Cet. par.*, the greater is the number of ATMs to which a depositor has access (i.e., that are compatible with his/her bank account), the greater is the convenience experienced by the depositor.[25]

Because of the economies of scale in the operation of an ATM, a bank will always be limited in the number and extent of its own ATMs (and hence will be limited in the convenience) that it can provide to its depositors. If the bank can provide its depositors with access to their

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[23] Arguably, it is this sort of "maverick" situation that was the Supreme Court's concern in Radiant Burners, Inc. v. Peoples Gas Light & Coke Co., 364 U.S. 656 (1961) and American Society of Mechanical Engineers, Inc. v. Hydrolevel Corp., 456 U.S. 556 (1982)

[24] Real-world ATMs also accept deposits and offer other services. The acceptance of deposits might make an ATM network appear to be a two-way network: Depositors can receive cash from banks and also send cash to banks. But such a system would lack the other crucial feature of a two-way network: that any two components can be combined to form a meaningful composite good. Accordingly, even this more realistic ATM system would be best considered as a one-way network (i.e., it is more akin to a manufacturer-retailer or hardware-software system than to a telephone or railroad system).

[25] This is akin to the idea that the greater and more widespread are the number of retail outlets at which a consumer can buy his/her favorite brand of soft drinks, the greater is the convenience to the consumer.

banks might use it as vehicle to discipline a "maverick" bank in their city -- either by excluding it entirely or by adopting an interchange technology that is more costly for that bank than for the others. Finally, if the joint venturers decide that they want to charge fees specifically for ATM withdrawals, the joint venture itself could become the collusive vehicle for the setting of those fees (rather than letting each bank decide individually on its ATM withdrawal fees).

This last pricing issue is quite complicated and warrants further discussion. An "upstream" bank may well have a legitimate concern as to how a "downstream" ATM sets prices for the withdrawal services by that bank's depositors. (This concept, of course, provides the basic rationale for the benevolent view of resale price maintenance.) Within an ATM joint venture, can each bank separately negotiate the necessary understandings with the other members of the joint venture? Would the prices faced by consumers at various ATMs thereby become too variable and too confusing?[28] Are the efficiency interests of the joint venture best served by having the joint venture collectively set the prices at some uniform level? But won't these prices approximate the joint monopoly level (if the joint venture has market power)? We see no easy answers to these questions.[29]

Further, even if each bank and ATM remain free to set its own prices, a joint venture with market power could levy a tax on each transaction; so long as the proceeds of the tax are not returned to the joint venture members in proportion to their transactions, the tax could be the vehicle for the joint venture to reap (and distribute) monopoly profits.[30]

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[28] We note, however, that the Coca-Cola Company does not appear to be unduly concerned that consumers are likely to face varying prices for its cans of cola across vending machine outlets, convenience stores, supermarkets, and discount warehouses. Is a bank more likely to be concerned about the uniformity of the prices for deposit withdrawals at ATMs? Why?

[29] Further discussion of these issues with respect specifically to ATMs, with differing views, can be found in Gilbert (1991) and Salop (1990, 1991).

[30] This argument can be found in Lewis and Reynolds (1979).

should give more attention to the complaints of excluded rivals[31] and of disadvantaged members and to the pricing practices (if any) of these compatibility joint ventures.

3.3 Vertical Restrictions

Decisions by firms to restrict compatibility -- to some vertically related firms (but not others) or to the firm's own vertically integrated subsidiary -- have close analogies with traditional and familiar vertical restraints or restrictions. Indeed, most of the traditional vertical restraints could be re-interpreted as incompatibility by fiat, rather than incompatibility due to technology (or to technological decision), but the economic effects in either case are likely to be quite similar. Our discussion applies to both two-way and one-way networks.

In essence, a decision by a firm to restrict compatibility -- and thereby limiting the ability of some other "upstream" or "downstream" firms to interconnect with the original firm or to have their products (components) be combined with those of the original firm -- can be seen as an act of tying (from the perspective of the customer) or of exclusive dealing or refusal to deal[32] (from the perspective of the rival firms).[33] As one-way network examples, suppose that a camera firm develops a new camera that is compatible only with film that is produced by its own subsidiary[34] (or by one or a few cooperating firms), or a computer manufacturer develops

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[31] Arguably, the complaint by Sears that a Utah bank subsidiary was prevented by Visa (a joint venture of thousands of banks) from being able to issue Visa cards might fall into this category. In response, Visa has claimed that Sears, as owner of a rival general purpose credit card (Discover) might gain an unfair competitive advantage by joining Visa and learning about its technological and competitive strategies.

[32] One variant of a refusal to deal is the "essential facilities" doctrine. For a discussion, see Reiffen and Kleit (1990), Werden (1987), and Ratner (1988).

[33] Though we present these practices in terms of a single firm's decisions, they could also apply to the practices of a compatibility-oriented joint venture, discussed in the text above.

[34] These kinds of allegations were raised in Berkey Photo v. Eastman Kodak Co., 603 F. 2d. 263.

We believe, however, that there are distinct and interesting differences between two-way and one-way networks.

Turning to antitrust policy, we specifically examine vertical mergers, compatibility-oriented joint ventures, and vertical restraints. Our linking of compatibility with complementarity provides a framework for analyzing these antitrust issues and showing that, as with most vertical relationships (through merger, integration, or contract), there are strong arguments for the beneficial nature of most compatibility and network arrangements but that, under some circumstances, anti-competitive consequences can arise. Our policy prescription can be summarized as one of general tolerance and encouragement of these arrangements but with enforcement powers available to curb anti-competitive practices and arrangements.

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