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Since the liberalization of the telecom market in 1985, new entrants have been able not only to make their own telecom networks, but also to interconnect with a local network of NTT, which up to then had been the domestic common carrier monopoly in Japan. These new entrants are known as new common carriers (NCCs), or according to the Telecommunication Business Act, as type 1 carriers. Almost 10 years have past since the the incumbent first opened access to its local networks. During the decade, there were new entrants in local networks, but they are not so competitive with NTT. However, in the long distance telecom market, 3 new interexchange carriers interconnected with NTTs' local networks and began to provide more competitive service than NTT. The 3 NCCs now possess relatively large shares in the long distance telecom market.

In the international telecom market, 2 new carriers have entered through interconnection with local NTT networks. In addition, microwave carriers who provide pocketbeeper and mobile telephone services, also started their businesses through interconnection with local NTT networks. Have these interconnections provided more efficient competition and better performance in the telecom market or not?

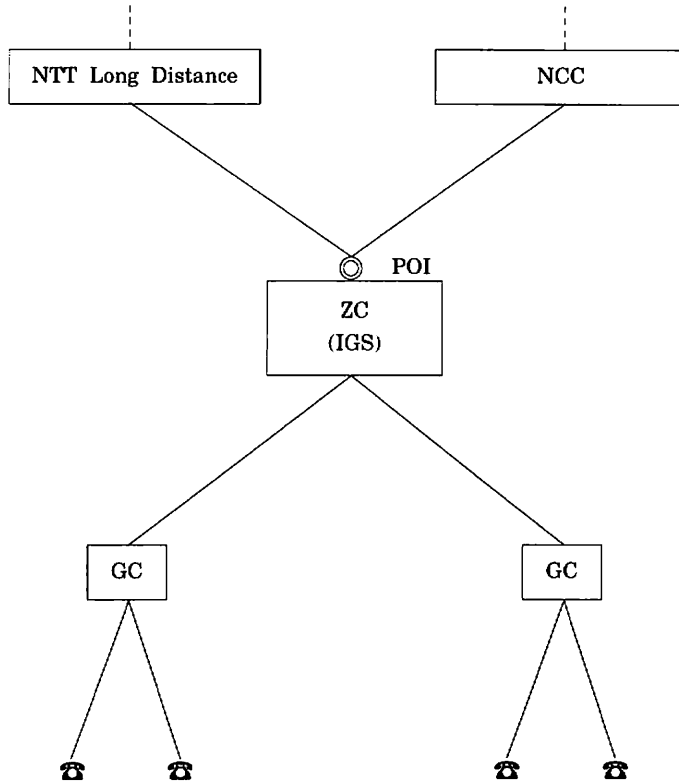
Actually, interconnection has raised problems not only of the technological difficulty of interfacing, or standardization among carriers, but also of the cost sharing of interconnection. There are sometimes cooperative relations in interconnection within the telecom market, such as that of domestic and international carriers, but there are uncooperative relations in other cases. In this paper, we are going to investigate interconnection problems in the telecom market in Japan, then analyze economic meaning of interconnection and future prospects in the telecom market.

1. Interconnection Problems in the Long Distance Telecom Market

When 3 long distance NCCs started their interexchange call services, they introduced new digital switches and interconnected with NTT's local networks through POI (Point of Interface) equipment. As described in Figure 1, subscriber traffic goes through NTT's toll switch (or ZC) in order to reach a POI. To do this, NTT's toll switch must identify a subscriber's number in order to interconnect its call with NCCs' network. It is easy for digital switches to identify subscribers who want to use NCCs' network, but not possible for old type cross-bar switches to do so. NCCs asked

Figure 1

Interconnection of Networks Between NTT and NCC



ZC: Zone Center
GC: Group Center
IGS: Interconnecting Gateway Switch
POI: Point of Interface
☎: Subscriber's Telephone

NTT to replace their old switches with new digital ones and sometimes criticized NTT for obstructing interconnection. They also asked NTT to disclose information on their network technology in order to make interconnection easily. This is a so-called technological problem of interconnection between NTT and the 3 NCCs. The identification problem was eventually settled, because NTT replaced most of their old switches with digital ones.

The cost of POI and other interconnection equipment was shared together by NTT and the NCCs. Half of interconnection-related costs was originally paid by NTT, because NTT was expected to support new entrants. Access cost into NTT's local network, that is traffic cost between GC and ZC, was determined at ¥10 between NCCs and NTT. NCCs agreed with the payment of 2 × ¥10 per each 3-minute long distance call in cases where calls were made between two Message Areas (MA) that each con-

tain a POI. In Japan, traffic inside a MA is categorized as local calls. If the traffic reaches an MA neighboring the POI, then the access cost was greater than ¥10.

In Japan, the line cost between each subscriber and the GC switch was covered by a monthly basic charge or monthly rental charge, although the revenue from basic charges does not meet the subscriber's line cost. So NTT, in the beginning, didn't care about the deficit of subscriber line service, and which has been subsidized by the revenue surplus of long distance calls. The problem continued to exist until 1994, whether a charge of ¥10 for one way access was adequate or not. Actually the access cost between GC and ZC was not determined through a detailed cost allocation by NTT between local calls and long distance calls.

The new access charge was introduced in April, 1994. In 1990, the Ministry of Post and Telecommunication (MPT) ordered NTT to separate the sector of long distance traffic from that of local traffic in order to promote fair competition between NTT and NCCs. At that time, NTT's local traffic business sector was limited to operation inside each prefecture (in Japan, there are 48 prefectures). Under this arrangement, each prefecture may be viewed as similar to a LATA (Local And Transportation Area) in the U.S.A.. NCCs were persuaded to limit their POIs to only one per each prefecture and to provide only interprefecture traffic.

According to this cost allocation of NTT's long distance and local traffic business sectors, and the market demarcation of long distance and local calls by the MPT, the access charge for a 3-minute call not within an MA, but within a prefecture was determined at ¥12.57 (or ¥25.14 for both sides) in 1994. The access charge for telephone directory assistance was ¥1.85 per call. In addition to the ordinary telephone service charges to subscribers, NTT public telephone service also asked NCCs to pay an access charge of ¥25.45 per a 3-minute call, and for ISDN service, ¥30. The ratio of access charges to total revenues of NCCs will be expected to 46.4% in 1994, which is higher than former ratio of 39.7% in '93. The interconnection problem between NTT and long distance NCCs has established a new rule of cost allocation and access charge, and new market boundary between long distance and local call business. According to this new rule, long distance NCCs and the long distance business sector of NTT both have equal access to NTT's local networks.

Although the new system of interconnection was introduced in 1994, the long distance business sector of NTT still subsidizes the deficit of the local business sector. Looking at the income statements of separate business sectors, and cost-revenue relation of different NTT telephone services from Table 1 and 2, we can confirm that cross-subsidization exists not only between the long distance and local business sector of NTT, but also among long distance and local calls, and monthly basic charges. Table 2 shows also that current profit of long distance calls subsidizes not only cur-

Table 1 Current Profit and Loss of NTT's Local and Long Distance Business Sector

¥100 millions

	1992	1993
Local Business Sector	− 1,757	− 2,230
Long Distance Business Sector	4,547	3,594

Table 2 Current Profit and Loss of Different Telephone Services of NTT

¥100 millions

	1991	1992	1993
Subscriber's Calls	5,285	4,451	2,707
Monthly Basic Charge	− 2,031	− 1,901	− 2,028
Local Calls	− 557	− 408	− 233
Long Distance Calls	7,975	6,798	5,114
Others	− 102	− 38	− 146
Public Telephone	− 234	− 297	− 160
Mobile Telephone*	291	− 31	—
Pocket Beeper*, etc	− 34	− 5	2
Others	− 1,801	− 1,685	− 1,553
Telepone Directory	− 1,842	− 1,732	− 1,603
Total	3,507	2,433	996

* Mobile Telephone and Pocket Beeper were separated from NTT in 1992.

rent loss of monthly basic charges and local calls, but also that of public telephone and telephone directory assistance.

Allocation of joint costs into the different telephone services of NTT was made using the method of Fully Distributed Costs (FDC) meaning that full costs, for example, inclusive of financial cost and unutilized equipment cost, are allocated in terms of traffic volume and the other indicators. The method of FDC itself was formulated during lengthy consultations between NTT and the MPT. Although the MPT approved cross-subsidization between not only long distance and local business sector, but also long distance and local calls, and subscriber line service from an accounting point of view, but they have not admitted price rebalancing. They asked NTT to rationalize its manpowers because they believed that there remained a lot of X-inefficency from the period when it had been a public corporation. Therefore, they thought that it was important for NTT to keep cross-subsidization.

This regulation of the MPT is being regarded as protective of the 3 NCCs. Indeed, the 3 NCCs have rapidly increased their revenues and soon established nationwide networks, contrary to the initial expectations of many experts of telecom industry. They had believed that the 3 NCCs would only have cream skimming in profitable traffic areas such as between Tokyo and Osaka, the first and second largest city in Japan. However, the 3 NCCs invented very effective equipment, the so called Least Cost-Route Adapter (LCR) and leased it to NTT's subscribers with no charge. Subscribers with LCR can choose the least expensive carrier from among the 3 NCCs and NTT, and NCCs set their prices lower than that of NTT, so they could take away subscribers from NTT. LCR permitted subscribers to use NCC services without changing the dialing prefixes used by NTT, so the LCR adapter solved equal access problem among NTT and NCCs.

Due to this ingenious little technological invention, the 3 NCCs achieved rapid growth of sales, and greatly increased their market share. For example, NCCs controlled 54.4% of most highly traffic conurbation between Tokyo, Nagoya and Osaka in 1993. Their market share in total interprefecture traffic volume reached 29.1% in 1993. But high speedy growth of NCCs caused a decrease of profit of NTT's long dis-

Table 3 Interprefecture Traffic Volume

unit: 100 millions

	1989	1990	1991	1992	1993
NTT	116.9	114.6	109.6	105.8	107.3
	(100.0)	(98.0)	(93.8)	(90.5)	(91.8)
4 NCCs*	12.4	21.6	31.5	38.7	44.0
	(100.0)	(174.2)	(264.0)	(312.1)	(354.8)
Total	129.3	136.2	141.1	144.5	151.3
	(100.0)	(105.3)	(109.1)	(111.8)	(117.0)

* DDI, JT, TWJ, TT Net.

tance business sector, and made it difficult for NTT to subsidize the deficit of local calls and monthly basic charge using their large profit in long distance calls. Table 3 shows that although total volume of interprefecture traffic increased a little from 1989 to 92 by 11.8%, traffic volume of NTT sharply declined by 9.5% during this period. In Table 4, we can see that total revenue of NTT's long distance call charges decreased by almost 30% between 1989 and 93. It is especially noteworthy that revenues in the highly competitive market of traffic above 100 km has rapidly declined by a half during this period.

Table 1 shows that NTT fell into a delicate financial situation in 1993. NTT could not pay 10% dividends to their share holders from aftertax profit. As a first step of price rebalancing, NTT submitted a plan to the MPT for an increase in the price of public telephone and telephone directory assistance in October of 1993. In a subsequent step to price rebalancing in March of 1994, NTT asked the MPT for permission to increase the monthly basic charge by an average of 16.4%, and for another increases in telephone directory service charges. If the monthly charges are increased, then price rebalancing will be in some sense realized, and an increase in access charges for deficit making local networks will be avoided. The approval of an increase of basic monthly charge was accomplished in February of 1995 after almost 1 year since the application.

There are some reasons why the price rebalancing of NTT's long distance and local calls remained dormant for almost 10 years after the introduction of competition within telecommunications in Japan. One reason is related to the interconnection problem. NCCs didn't want a rebalancing of NTT's price,because rebalancing would strengthen the price reduction competitiveness of NTT's long distance business sector. They were also unwilling to accept the cost allocation manual which showed the deficit of local network business sector and the surplus in the long distance business sector of NTT. This is because they were afraid of an increase of access charge in the local networks of NTT.

The another reason for the delay in rebalancing is that the formal cost allocation manual audited by accountants had been delayed. There were many disputes between NTT and MPT concerning the cost and revenue allocations for different telephone services. The revenue separation of long distance calls' into net long distance calls and local calls was particularly difficult to establish, because NTT insisted on separating revenues of long distance calls depending upon the ratio of fixed assets

Table 4 Shifts in Revenue of NTT's Long Distance Call Charge

¥100 millions

	1989	1990	1991	1992	1993
Above 100km	12,431 (100.0)	11,368 (91.4)	9,456 (76.1)	7,898 (63.5)	6,924 (55.7)
Total Long Distance	21,444 (100.0)	20,827 (95.7)	18,489 (86.2)	16,829 (78.6)	15,258 (71.2)

between long distance and local networks, while the MPT argued for separation through an allocation of ¥10 × 2 for all long distance call revenues to local call revenues. They said that the separation of NTT's long distance call revenues should be done in order to assess whether the price of local call of ¥10 would be adequate or not. Thus, MPT's revenue separation of long distance calls does not reflect the corresponding difference in long distance costs between net long distance and local calls. Therefore, local allocation of ¥10 × 2 in some cases exceed the cheapest price of long distance calls. In such cases, local access price was determined as ¥5 × 2. According to the MPT method of allocation, there is much less cross-subsidization from long distance calls to local calls. But, if NTT's argument were to be accepted, then the deficit of local calls would have been much larger. After some discussion, the MPT method was adopted, and this separation of long distance call's price is the policy used now. In this way, MPT has protected new common carriers via the cost-revenue allocation making.

NCCs also have asked for a discount of access charges for NTT's local networks, and demanded the introduction of a carrier's rate in place of the rate paid by final users (tariff). They insisted that they are big users of NTT's local network business sector, so the carrier's rate should be less than the standard tariff, in recognition of NTT's expenditures for marketing and sales promotion,for example. The tarrif must cover the full costs of the network, so NCCs asked NTT not to charge FDC prices, but rather to establish a more flexible pricing system, such as using incremental costs, and so on. It can be conceded that the incremental cost of NTT's local networks might be less than the FDC price and be almost zero price in some case, because NTT has enough capacity of transmission and switching in its local networks. Certainly NCCs are good customers for the local network business sector of NTT, but they have also snatched away many NTT customers. They have been successful insofar as they obtained former subscribers to NTT, not generated new ones, and NTT's deficit in subscriber's lines is financed by its long distance business sector, and not included in the access charge of NCCs' payment.

2. Growing Competition in the Local Telecom Market

As far as local network service is concerned, there have been up to now no powerful competitors to NTT. In Japan, both long distance and local call markets have been liberalized since 1985, so it is possible for any carrier to enter into these markets. Indeed, there are several local NCCs, among them, TTNet Inc., which was set up and

owned by Tokyo Electric Power Corporation (the largest power company in Japan) and is providing local telephone and private circuit service in the Kanto Area (Tokyo and their surrounding prefectures). Local Electric Power Corporation facilities also started new local network services in other areas of Japan with their equipment for distribution of electricity. Teleport type carriers and CATV carriers are also providing local telephone service in some areas. Although there are many local NCCs, they are so far not strong enough to compete with the incumbent carrier, NTT. One factor for under-development of local NCCs is the relatively cheap price of local calls with NTT. The price of a 3 minute call is only ¥10 inside a Message Area. TTNet is now providing flat rate telephone service not only in a NTT's MA but also in wider area. In average, price of a call of TTNet is estimated at ¥35.

Because of less competition in the local network market, long distance NCCs must depend upon local networks connecting subscribers of NTT, unless they are able to make their own local network. Therefore NCCs claim that local networks of NTT are bottleneck facilities. As already mentioned, local networks of NTT are not exactly bottlenecked, but for the moment, NCCs' operation must depend upon local networks of NTT. Interexchange long distance NCCs are qualified to make their own local network and/or interconnection with local NCCs. If there are too much sunk costs and too many risks for long distance NCCs to make large investments in local networks, and if local NCCs have few subscribers, then NTT's local networks can be said to be bottlenecking NCCs interexchange.

But, from another poin of view, interexchanging NCCs can benefit from access to local networks of NTT, if the access charge for local networks of NTT is cheaper than the cost of construction of their own local networks. This is one of the problems of introducing competition into the market of a so called natural monopoly. If NTT is a typical natural monopoly, then the construction of another local networks by new entrants will be double investment and ineffective from a resources allocation point of view. If the NTT access charge to their local networks rises above the stand-alone cost of local networks, then the access charge will not be sustainable against new entry. Actually, there may be no effective competitors in the local network market for the monent, because NTT would not raise their access charge above the stand-alone cost, and there would be characteristics of natural monopoly between local and long distance call services of NTT. In that case, interexchange NCCs would be better off not to construct their own local networks and pay for an access charge that is less than the stand-alone cost, but above the incremental cost of local networks. That should be an optimal resolution of the bottleneck problem in local networks.

There are both cooperative and uncooperative characteristics of interconnection between NTT and interexchange long distance NCCs. However, recently cooperative new common carriers have appeared in the local network market. Mobile telephone providers are competitive in some sense with fixed local network carriers, but they are often of a more symbiotic nature. If there is an increase in mobile telephone subscribers, local network carriers will also benefit from such an increase, because they can afford to have more access charges from mobile carriers. At the same time, mobile telephone provider can benefit from the increase of subscribers of fixed telecom networks, in terms of network externality. This is particulary true today, as residential telephone service are turning from the media of family to personal communications, we can expect a rapid increase of mobile type telecommunications in near future.

In the mobile telephone market, there are two types of carriers, analog and digital network carriers. There are 3 analog/digital mobile carriers and another 2 new digital mobile carriers now, and they are competing fiercely each other. All carriers depend upon the local fixed networks of NTT. When traffic comes from fixed subscriber to mobile phone, then NTT collects the charge of mobile telephone calls, but when traffic comes from mobile phone to the fixed subscriber, the charge is collected by mobile telecom companies. The ratio of access charge to NTT in total revenues of all mobile telecom companies is estimated to have been less than 10% in 1993. Access charge is determined by user price, or tariff (FDC), not by some kind of incremental cost and/or like access charges of interexchange NCCs.

Interconnection between NTT's local networks and CATV will be discussed soon in Japan, because CATV wishes to provide cable telephony service. NTT cannot provide CATV directly, so CATV companies must interconnect with the local networks of NTT and/or other local NCCs, such as TTNet, and sometime with interexchange long distance NCCs if they want to provide nationwide cable telephony service through their cable TV networks. From the experience of development of cable telephony in United Kingdom, CATV companies or some kind of coalition of CATV networks and NCCs will be potentially strong competitors against the incumbent local network carrier, NTT. If the subscribers of CATV switch their telephone network from the telecom company to that of CATV company, then they replace the telecom local network with a CATV local loop. This kind of competition will happen in area of future multimedia service between telecom and CATV companies,even though there seems to be benefit in a consolidated network. In case of competition between telecom and CATV telephony, there is the same problem as in interconnection between NTT and long distance NCCs.

Another serious problem concerning interconnection of local networks is the case of virtual private network services in Japan. NTT initially planned to provide VPN service in 1989, but because of unresolved interconnection negotiations between NTT and the 3 long distance NCCs, NTT's VPN service was belatedly introduced in 1994. This means it took almost 5 years for NTT to provide intelligent network service after NTT announced its intention to do so. According to the approval of MPT, NTT must separate long distance and local VPN services in order to make competition equal for long distance NCCs. At the same time, NTT was asked to provide rerouting for local VPN service for NCCs. Here, a rerouting call is defined as a local one which uses only local networks of NTT in addition to the database of NCCs. If rerouting calls are permitted for NCCs by NTT, then NCCs can provide both long distance and local VPN services in Japan.

NTT insisted that rerouting calls is exactly the kind of service NTT should provide, for there is no network involving NCCs apart from database equipment. If carriers want to provide software defined network service through the lease of private lines from NTT and/or long distance NCCs, then such carriers in Japan are recognized as type 2 carriers according to the Telecommunication Business Act. Actually, several type 2 carriers already are providing VPN type services. The 3 long distance NCCs who petitioned for MPT to order NTT to interconnect with them are not type 2 but type 1 carriers.

According to the strictest interpretation of the regulations, long distance NCCs may not provide local VPN service. From the NCCs' point of view, the impossibility of

providing intelligent network service in local markets is a characteristics of bottlenecking in NTT's local networks. But if the assertion of NCCs is accepted as true, then every carrier which is able to set up database inside NTT's local networks should be able to provide nationwide software defined network service. Can this be called interconnection among carriers? Of course, from another interpretation of Telecom Business Act, as the 3 NCCs have their own switches and long distance networks, they are carriers and have the qualifications for interconnection with NTT.

The interconnection problem of VPN service is relatied to the regulations. In 1990, NTT was ordered by the MPT to separate its long distance business sector from its local business sector. According to the stipulations of the separation, the long distance business sector was to provide only interprefecture calls, just as long distance NCCs do. But if NCCs can provide both local, and intraprefectural call service as well, then the separation of NTT's business sector would be meaningless. The market demarcation between inter and intra-prefecture telecommunications would be difficult to assert and inefficient to regulate, because there would be economy of scope between long distance and local telephone calls.

Another problem of VPN interconnection is pricing. NCCs argue that they want to use local networks of NTT at the discounted price which has already been adopted for final NTT customers. They also want to determine the price of local VPN service by themselvs. But NTT insists that local calls fall under NTT service, so it is NTT who should determine the price of local calls. NTT is not going to supply their local networks service to the 3 NCCs at a discounted price, because NCCs are not final customers who will create additional revenues for NTT. It will be very important for competitive carriers to capture the major customers of intelligent network services which will be introduced following after VPN in the near future. The problem of interconnection for such services as VPN is difficult to resolve from the competition point of view. Today, competition is moving from the long distance telephone market to local markets. In 1995, MPT will have to establish some lasting guidelines that will determine the future conditions of these markets.

3. Conclusion

So far we have dealt with the interconnection problems among various carriers. Carriers who want to interconnect with other carriers, are in some cases cooperative, but in another cases competitive. Many new common carriers must for the moment depend upon the local networks of NTT in Japan, however they are not prohibited from making a bypass through NTT's local networks. Therefore NTT's local networks are definitely not bottlenecks. However, NTT's nationwide networks are seen as an infrastructure of telecommunications, and as such, must be effective and efficient. As a part of this requirement, it is very important to expedite successful interconnection among various carriers. We summarize several methods to make interconnection more feasible, as follows.

At first, local networks of NTT must be separated into some parts in order to make interconnection more easily. Local networks should consist of subscriber line (or local loops), local switches, and transmission between local switches and toll switches. It should possess some additional equipment, such as batabases for software defined

network services and specific equipment for interconnection with mobile communications. In 1995, personal handyphone system (PHS) service will be offered by 3 new companies which will depend upon NTT's local networks. PHS companies will not construct local loops, but only microwave antennae in the streets. For PHS, NTT must furnish local loops from microwave antennae to local switches, special interconnection equipment for PHS, and a control center for PHS service inside NTT's networks. Under this kind of arrangement, PHS companies are not type 1 carriers according to the regulation. They supply only a part of local networks and must depend upon the other parts of the local networks supplied by NTT. This is an interconnection not among type 1 carriers, but between network carriers and new telecom service providers (according to regulation, they might be defined as "type zero carriers"). This kind of interconnection will have to be admitted from now on.

Secondly, in relation to PHS service, as large amount of investments and many risks will be incurred not by new PHS companies, but by the common carrier, NTT, some kind of risk pooling system between PHS companies and NTT will have to be introduced. Moreover, risk pooling must be reflected in the level of access charges. This is a case of cooperative relationship between carrier and vender. In the case of PHS service, NTT should not have to bear all risks with large amounts of investment. In order to increase the number of PHS subscribers, it is better for the designated price system to induce an increase in number of subscribers, not in amount of traffics by implementing, for example, lower basic rental charge and higher traffic charge. This kind of price system is outside FDC price regulations and FDC type access charges. Deregulation of prices will be necessary for new telecom services.

As far as the division of local networks into separate parts is concerned, it is important for CATV to interconnect with some parts of local networks. This is because multi-channel CATVs will construct local loops, not local swithes, if they want to supply cable telephony service. This kind of interconnection will differ from that of interexchange and local networks. In this and for PHS cases too, the access charge will have to reflect the separation into parts of local networks and be determined not by FDC system, but by long run marginal cost. Both telecom carriers and CATV companies should settle their access charges in terms of long run marginal (or incremental) costs which include any type of capacity factor, because they will benefit each other. This is the third method to make interconnection more efficient.

Lastly, method and the level of access charge of interconnection should not be managed by regulater. If the interconnection is decided by regulater in favour of NCCs, then the market will be distorted by regulation and the incumbent carrier will lose incentive to make technological innovation. This kind of danger might appear in the area of intelligent telecom services. Competitive interconnection sometimes will introduce protective regulation for new entrants. Of course, although it's important to control monopoly power by the incumbent carrier who threatens to 'bottleneck' traffic, regulation should not interfere with the technological progress of telecom industry.

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