U.S. TELECOMMUNICATIONS DEMAND:
A Macroeconomic View

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I. OVERVIEW

This paper attempts to develop an understanding of critical macroeconomic demand drivers in telecommunications and how they may interact to shape the future telecom industry. Our purpose in doing this is a belief that conventional bottom-up demand forecasts tend to focus excessively on historical trendline extrapolations for current services, and therefore lead to forecasts in which current volumes and price paradigms are anniversaried. In a deregulated post-MFJ world, this is dangerous.

We would like to get away from this approach, and replace it with a demand set that does not depend on maintaining current price paradigms. As one example, in a deregulated environment, it is unclear that we should assume that long distance will be a wholly minute-of-use (MOU) based charge while local service will be a fixed price per month -- since both underlying cost structures are similar. Cracks in the current paradigms are already being seen: i.e., fixed prices for (long distance) Internet connections, and MOU charges for (local) wireless and ISDN.

We also need a demand methodology that appropriately deals with new services like wireless, Internet, and video telephony. In the current trendlining methodology, new services typically are treated as add-ons to core products (usually in the later forecast years), with limited consideration of cross-product cannibalization. The result is that the later year forecasts may be unrealistically high, because there is a limit to how much people will spend on telecom as a percentage of their total household disposable income (i.e., if they spend a lot more on mobile telephony, some of this will come at the expense of wireline).

Looking at these issues, our conclusion is that we need a demand methodology that reverses the usual process. In this paper, we suggest an approach that begins with aggregate macroeconomic drivers and considers how new technology and alternative pricing strategies could affect the fraction of overall GDP that will be spent on telecom.

By choice we have not attempted to drive our demand forecasts down to the level of specific business/residential and specific product forecasts. However, this could be done at some later point, using a variety of gaming simulation and market elasticity assumptions.

II. SUMMARY OF FINDINGS

The telecommunications industry is nearing the end of a demand cycle that has driven aggregate revenue growth since World War II. During this period, industry growth was fueled by aggregate GDP growth as well as successive waves of secular demand increases; i.e., higher levels of household telephone penetration and toll minute of use (MOU) volume per phone. From 1947 to the MFJ, changes in price had a relatively modest influence in aggregate usage.

Our analysis leads us to conclude that the historical growth drivers have stalled since the MFJ. After 50 years of increasing telecom share of US GDP, the trend since 1983 has abruptly shifted to one of continuous decline (Figure 4). It would appear from the flat trends of household penetration and MOU volumes per phone that the industry has reached a saturation point. Even where real unit prices have been reduced (e.g., in LD), unit volume increases have not been able to offset the price reductions. As a result, the price reductions have decreased the real dollar size of the industry.

Looking at the future, we believe that the telecom industry can reverse this stagnation by stimulating the adoption of new uses for telecommunications (i.e., the Information Super-highway) that will result in an increase in the number of phones per household (or per employee), total MOUs and total bandwidth. However, for this to happen, the current narrowband MOU-based pricing structure needs to change. Many of the new potential applications will inherently involve either broadband and/or toll transmission. To the extent that the industry tries to price these services based on the current paradigm of $.20 for one minute of narrowband toll transmission, the adoption of the new applications will be impeded severely. As one simple example, we do not believe that movies on demand will ever become a major business unless the price drops to $2.00 for a two-hour movie (at which point it replaces movie rentals). Its effective 64 kbps-equivalent transmission price will have to be denominated in mils, not cents per MOU.

The advent of fiber optics and photonic technology makes this type of pricing possible, by creating a cost structure that can handle large bandwidth transmissions over long distances at low marginal cost. As this technology is deployed, it will become possible to price at levels that stimulate significant demand growth.

If this occurs, we become relatively bullish on the outlook for telecom growth. If telephony were able to grow its current 2.2% GDP share to 2.6% (the peak level achieved in 1983) over 10-15 years with 6% current GDP CAGR (compounded annual growth rate), this would translate into a telephony CAGR of 7-8% in current dollars (versus the past decade s 5%). If, in addition, telephony were to increase its share of GDP to regain historical trend line, this would translate into a telephony CAGR of 8-9% in current dollars (Figure 12).

We believe that the required shift in the industry paradigm away from narrowband MOU charges could indeed occur based on fundamental structural industry changes occurring under deregu-lation. This is because any integrated end-to-end competitor with low marginal cost and a small current share position will have strong incentives to change the pricing paradigm of the business they are entering; i.e.:

LECs, CATVs and CAPs entering the LD market

LECs and IXCs entering the CATV market

Broadband providers arbitraging differences between narrowband and broadband rates (i.e., someone buying transmission at movies-on-demand rates and reselling spare capacity for low priced narrowband toll service)

In this future environment, the key question is what would replace MOUs as the basis for most telecom pricing.[1] We believe that the MOU paradigm may be replaced by a bundled price per wire paradigm, in which customers will pay for a broadband connection into a telecom network, with pricing determined by total bandwidth peakload usage/ provisioning, with additional fees for using different services. In this environment, to the extent that there are MOU charges at all (perhaps due to the retention of interconnection fees among network providers), these MOU charges will be at much lower levels than today. This is very similar to the way the Internet operates, and we think that the industry could evolve in this direction. It is also consistent with the underlying cost structure and the game theory incentives of key players.

Those changes are tremendously important to all industry competitors, but particularly to IXCs, because their current pricing structure is almost entirely MOU-based. In the coming environment, the IXCs may face attack from integrated competitors that can change the price structure unilaterally toward fixed rate pricing. Because of this, an important goal for IXCs should be to obtain access to local network services that provide competitive bundled services at low marginal costs. This implies moving away from a concern with replicating the current narrowband network (which will not sustain the broad range of services needed), towards developing more capable systems that can support the needs of the Information Superhighway.

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[1] Currently, MOU-denominated fees represent 65% of total telephony revenues.

III. DETAILED DEMAND ANALYSIS

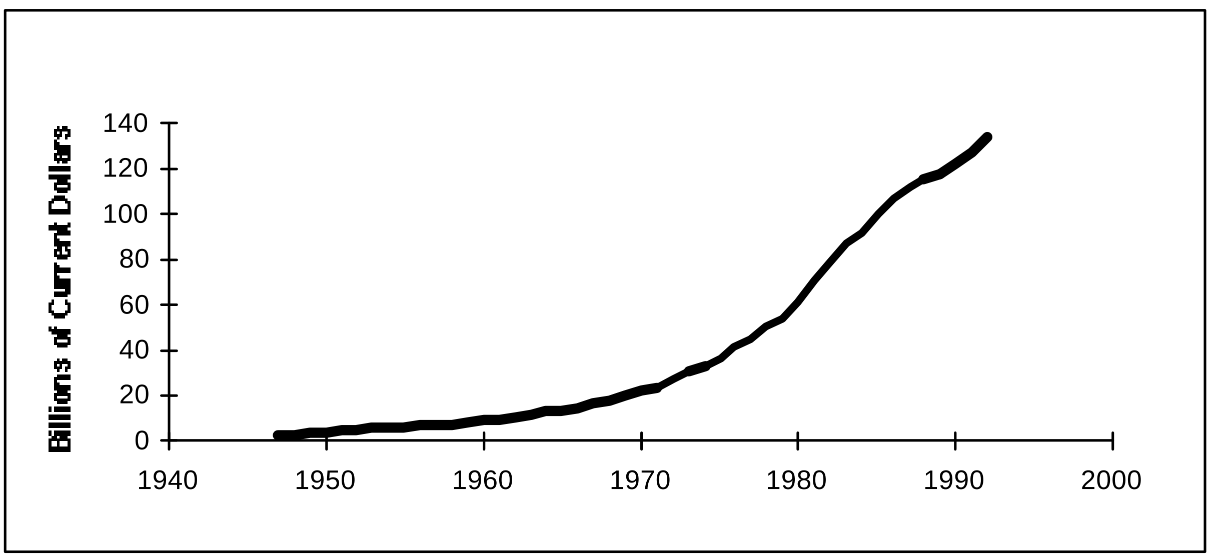
Our approach to demand side analysis is to begin with a review of historical trends, with an eye to considering the extent to which the aggregate telephony demand is shaped by macroeconomic variables like population and GDP, but also the extent to which historical growth is the result of price elasticity or secular growth drivers. Getting an understanding of the historical evolution and impact of those drivers allows us not only to explain the evolution of the telephony industry revenues before and after the MFJ, but also to anticipate the likely future evolution of that industry s demand and revenues.

III.1 HISTORICAL TELEPHONE REVENUE GROWTH

Looking at aggregate historical telecommunications trends, one observes two basic facts: (a) the telecommunications industry has grown at a relatively high rate for a long period of time, and (b) for some reason, this growth appears to have stalled.

Plotting industry revenues in current dollars (Figure 1), we observe that the industry has grown at 8.9% CAGR from 1947-92, and that the growth pace has slowed post-MFJ to 4.8% CAGR.

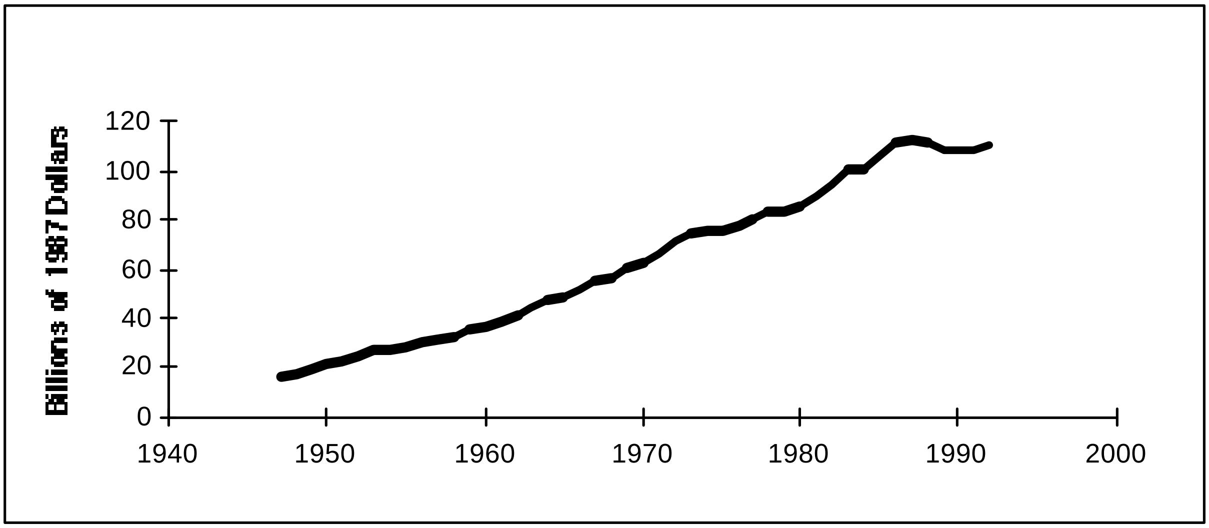
Figure 1
Telephone and Telegraph GDP Sector
Current Dollars Over Time



Source: Bureau of Economic Analysis of the U.S. Department of Commerce

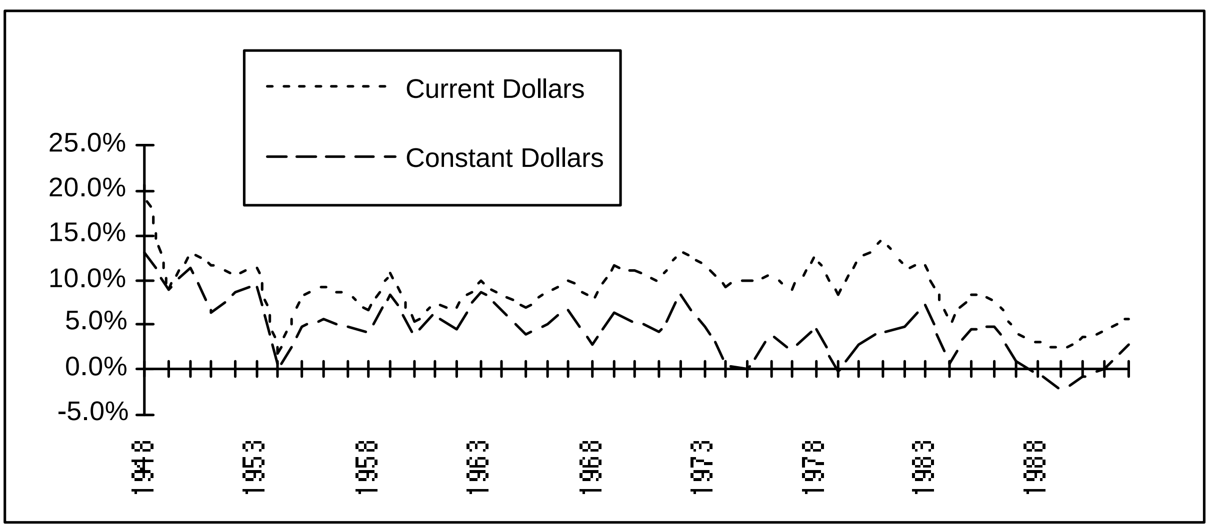
This deceleration is highlighted if we restate industry revenues in real terms (Figures 2 and 3). Since 1988 there has actually been a small decline in real revenues. Instead of real growth on the order of 5-6% per year seen from the 50s to the mid 70s, we are now experiencing close to zero real growth.

Figure 2
Telephone and Telegraph GDP Sector
Constant Dollars Over Time



Source: Bureau of Economic Analysis of the U.S. Department of Commerce; Monitor Analysis

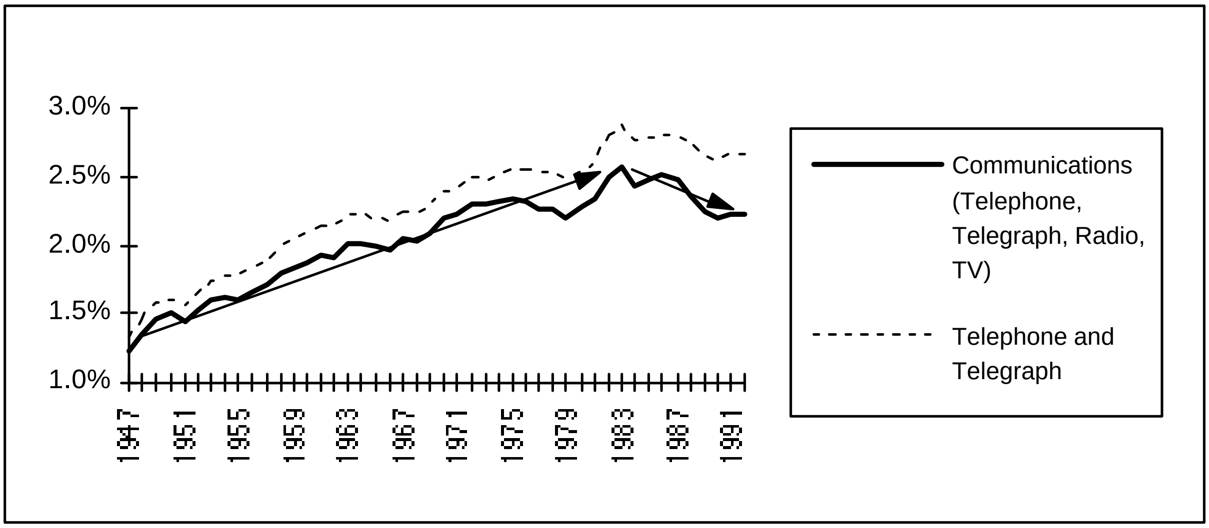
Figure 3
Telephone and Telegraph GDP Sector
Annual Growth Trends



Source: Bureau of Economic Analysis of the U.S. Department of Commerce; Monitor Analysis

The drop-off in growth is particularly striking if we compare telecom revenue to the overall U.S. GDP (Figure 4). From 1947 to 1983, the period of high real growth, the telecom industry increased its share of US GDP, growing from 1.24% to 2.58%.[2] Since 1983, however, a period corresponding to the drop-off in real growth rate, telephony s share of GDP has fallen to 2.23% in 1992. This decline exists even if we expand the definition of telecom from telephony to communications, the latter including radio and television.

Figure 4
Telephone/Telegraph and Communications Sectors
Share of GDP



Source: Bureau of Economic Analysis of the U.S. Department of Commerce; Monitor Analysis

It is easy to attribute the drop-off of the past 10 years to the impact of the MFJ in causing higher levels of competition and lower prices. However, there is one problem with this attribution. Looking at Figure 3, it would appear that the growth drop-off actually began in the mid 70s, not in 1983. This suggests that other factors besides the MFJ drove this decline. In Section III.2, we explore the drivers of the observed changes in aggregate telephony revenue.

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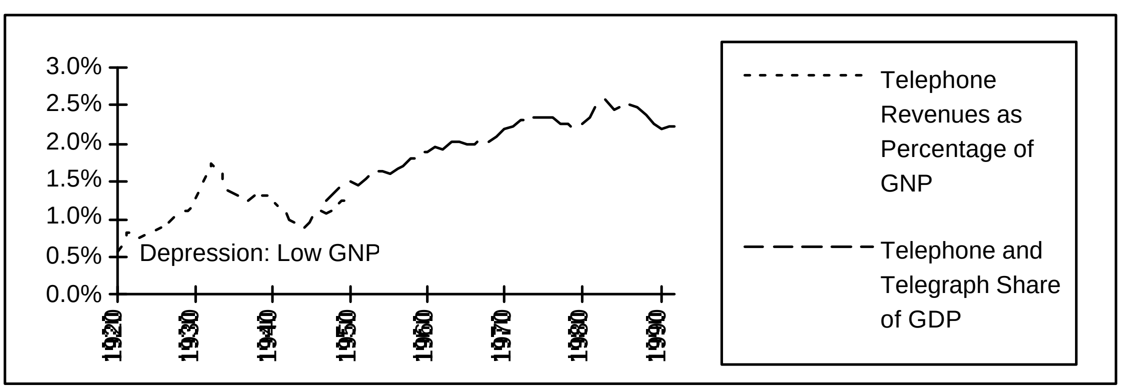
[2] The upward trend lasted so long that to find a discontinuity we have to go back as far as to the Great Depression, during which the deep drop of GNP distorted the telephone sector / total economic output ratio.



III.2 HISTORICAL TELECOM DEMAND EVOLUTION

III.2.1 Underlying Demand Drivers and Methodology

There are three basic drivers of aggregate telephony revenues: macroeconomic growth, telephone intensity and price elasticity effect:[3]

> Macroeconomic Growth. Nominal GDP growth is the initial reference point for growth of nominal telephone revenues. This is because if telephone intensity and pricing do not change, telephony revenues by definition should hold its share of GDP. Conversely, to the extent that we observe a change in telephone s share of GDP, this is indicative of a change in telephone intensity and/or price elasticity effect.
>
> Telephone Intensity. Telephone intensity refers to the secular drivers or secular growth in telephone usage in the society and economy, above and beyond that attributable to macroeconomic growth. If the US economy is becoming more telephone intensive, telephony should grow its share of the economy.
>
> Revenue Change Due to Changes in Pricing (Price Elasticity). As in any market, to the extent that real industry prices change upward or downward, there should be a corresponding (and offsetting) change in demand and, therefore, in revenues. A common way to measure the price-volume relationship is price elasticity of demand.[4]

In analyzing demand trends in any particular period, therefore, our basic task is to attribute the aggregate observed growth to some combination of these three drivers. It is straightforward to identify the growth attributable to macroeconomics; that is, if aggregate demand for a particular period grew at 9% while the economy grew at 5%, we would argue that macroeconomic growth accounts for 5%, leaving 4% to be explained by some combination of secular and price elasticity drivers.[5]

Separating out the effect of price elasticity from telephone intensity is more complicated. For much of the past 50 years, we have experienced growth in telephone intensity at the same time that prices have declined (with some notable exceptions; i.e., 1947-60, when LD cost allocations were rising). Accordingly, our approach is to calculate price elasticity for a number of time periods, reflecting periods of price decreases as well as increases, and for different telephone services, in order to be confident that we develop elasticity coefficients that eliminate the collinearity problem. Once we have obtained these elasticity coefficients, it becomes a relatively simple task to calculate

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3 For a detailed exposition of our demand methodology, see Appendix A.

4 Price elasticity of demand represents the percentage change in the total amount demanded caused by a small change in price, divided by the percentage change in price. Since price changes in one direction produce demand changes in the opposite direction, the price elasticity is normally negative, although its negative sign is often omitted.

5 The exact number is 4.8%, calculated as 1.09 / 1.05.

the impact of pricing changes. The net residual growth not explained by either macroeconomic growth or price elasticity can be attributed to secular growth in telephone intensity.

In some ways, our approach in making telephone intensity the plug figure might appear to be counter-intuitive. One might argue, for example, that there are some quite specific and easily measurable metrics of telephone intensity, such as the number of phones per household, per employee (or per capita), or the number of MOUs per line. The problem in using these measures, however, is that both macroeconomic growth and price elasticity have a demonstrable impact on these metrics; that is, as household income grows, one would expect to see an increase in telephone penetration and usage. By our definition, telephony intensity only refers to that fraction of the increase in these metrics not attributable to macroeconomics or price elasticity. Because of this, it is appropriate to calculate growth due to changes in telephone intensity as the plug .

III.2.2 Price Elasticity Analysis

Our analysis of price elasticity is shown below in Table 1 (Appendix B contains an explanation of our methodology and supporting charts).

Table 1
Price Elasticity Trends by Service Type

Service	1947-60	1960-73	1973-83	1983-92
	Elasticity			
Toll Calls	0.75	0.75	0.75	0.65
Interlata	N/A	N/A	N/A	0.75
Intralata	N/A	N/A	N/A	0.40
Local[6]	0.1-0.3	0.1-0.2	0.1-0.2	0.15

Source: FCC Statistics of Communications Common Carriers; U.S. Bureau of the Census; Monitor Analysis

For LD we see a surprisingly stable price elasticity of 0.75. In other words, if real prices decline 1%, market demand in the form of total MOUs will rise by 0.75%.[7] The elasticity for intralata toll calls and local telephony (0.4 and 0.15, respectively) appear to be much lower than for LD. We will discuss our thoughts on the reasons for these differences below. We believe that the lower values are due to market saturation, and that telecom price elasticity is approximately 0.75 wherever the underlying market is not saturated. A further validation of the 0.75 number is seen in Figure 5, where we see that the usage of alternative forms of communications follows about the same elasticity.[8]

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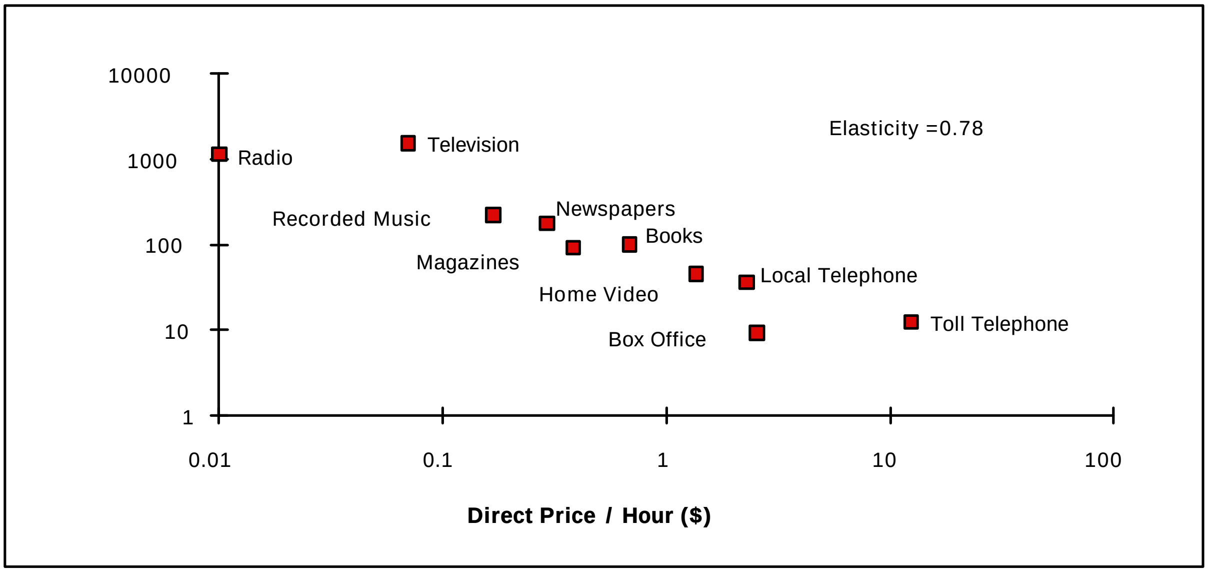
6 The intervals of confidence for local service elasticity from 1947-83 are too large to make the results significant. During this time, changes in real prices were small, making their impact on the number of lines difficult to isolate and measure.

7 As discussed in Appendix A, these numbers are only approximations. Exact figures will require the use of logarithms. In our analysis of historical demand periods, we have used logarithmic calculations.

8 The cross-elasticity e can be calculated using the following regression:

$$Log\ (Usage\ in\ Annual\ Hours) = a + e\ Log(direct\ price\ per\ hour)$$

Figure 5
Cross-Elasticity For Different Communication Media



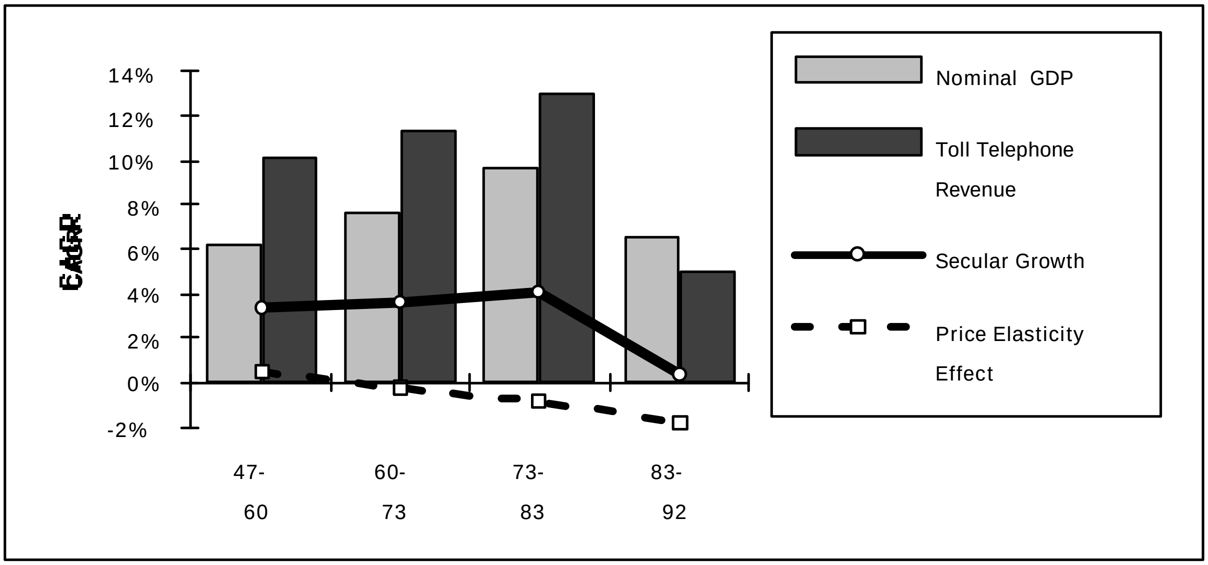
Source: Veronis, Schuler and Associates; FCC; Monitor Analysis

At a 0.75 elasticity, a percentage drop in price yields less than an equal percentage increase in volume. As a result, to the extent that prices are declining in a market, the expected increases in demand will not offset the price decline, so that aggregate industry revenues will drop. For example, let s assume a market with a volume of 100 and a unit price of $1.00, for total market revenue of $100.00. If industry prices were to drop 1% to $.99 with a 0.75 elasticity, I would anticipate market demand growing to 100.75 units. 100.75 units times $.99 cents per unit generates a total market revenue of $99.74, a drop of .26%. Hence, at current elasticity levels, telephony price reductions shrink industry revenues. To the extent that this conclusion is not widely recognized, it is because the effect is disguised by changes in other factors, such as secular trends.

III.2.3 Applying the Demand Methodology to Historical Aggregate Demand

Having developed the above methodology, we applied it to the aggregate telephone revenue trends seen in Figure 1. Instead of treating the 1947-92 time interval as a single unit, we separated it into four distinct periods, to better identify important changes in the drivers over time (i.e., are we seeing a slowing down or speeding up of telephone intensity over time?). These periods are 1947-60, 1960-73, 1973-83, 1983-92. The historical evolution of the growth factors is shown graphically in figure 6.

Figure 6
Demand Driver Contribution to Overall Telephony Growth



Source: FCC Statistics of Communications Common Carriers; U.S. Bureau of the Census; Monitor Analysis

Figure 6 indicates that the relative importance of the three basic telephony growth drivers has changed over time, particularly since 1983:

> In general, nominal GDP has been the main driver behind toll telephone revenue growth, accounting for about 75% of aggregate telephone growth. To some extent, the decline in aggregate telephone revenues in the 83-92 period is due to a decline in nominal GDP growth.
>
> The price elasticity effect had a limited impact on growth in the 47-73 time frame. This is because real toll rates were relatively stable during this period. Starting in 73-83 and increasing in 83-93, declining real toll prices combined with a 0.75 elasticity contributed to a -0.90% CAGR revenue decline in 73-83 and -1.75% in 83-92. Even in the post 1983 period, however, the relative magnitude of the elasticity effect was somewhat limited. This reflects the fact that price declines are offset by volume increases, albeit not entirely.
>
> Over and above the growth rates explainable by nominal GDP and price elasticity, telephone intensity secular trends contributed substantially to overall growth, on the order of 4% per year. This trend is surprisingly stable over the 35 year period from 1947 to 1983. After 1983, however, the secular growth driver essentially disappeared.

In summary, what we see is a picture of an industry that for a long period of time was fueled by a roughly 75/25 mix of GDP and secular growth, with price playing a relatively minor role. More recently, we observe price beginning to have a negative impact on revenues, but at a relatively minor level due to the offsetting corresponding volume growth at a .75 elasticity. What really has changed in the last decade is the virtual disappearance of secular growth. At least initially, this is surprising in a world that one would perceive as becoming more communications-intensive, and with the onset of new technologies like faxes and modems that should be causing more telephone demand. Why, then, are we not seeing growth faster than the GDP?

III.2.4 Reasons for the Drop-off in Telephone Intensity Growth

One possible explanation for the drop-off in telephone intensity growth is saturation. Most industries growing at rates above GDP typically do so by increasing their percentage penetration of an untapped market. In the early phases of penetration, growth typically is very rapid. Eventually, however, as the penetration level increases and the relative amount of untapped potential diminishes, there is a natural slowing of growth to the point where the industry approaches GDP growth levels, at best. This is the characteristic S-shaped curve.

In this context, we need to determine whether telephony has reached some type of saturation point. Figure 7 indicates that this may be the case, at least for current narrowband telephony. Essentially, we observe the telephone industry benefiting from successive waves of penetration curves, with each one inexorably slowing down. From the 1930s to the early 1960s, a major source of growth was increasing household penetration. By 1965, however, the growth in the number of local phone lines essentially ended except for business lines (perhaps driven by the growth of fax machine usage). This can explain our previously observed 0.15 elasticity for local telephony service.[9] Since the mid 60s, much of the growth came from growth in MOU-denominated toll charges per line. In the 1980s, this toll charges also appear to be reaching some level of saturation.

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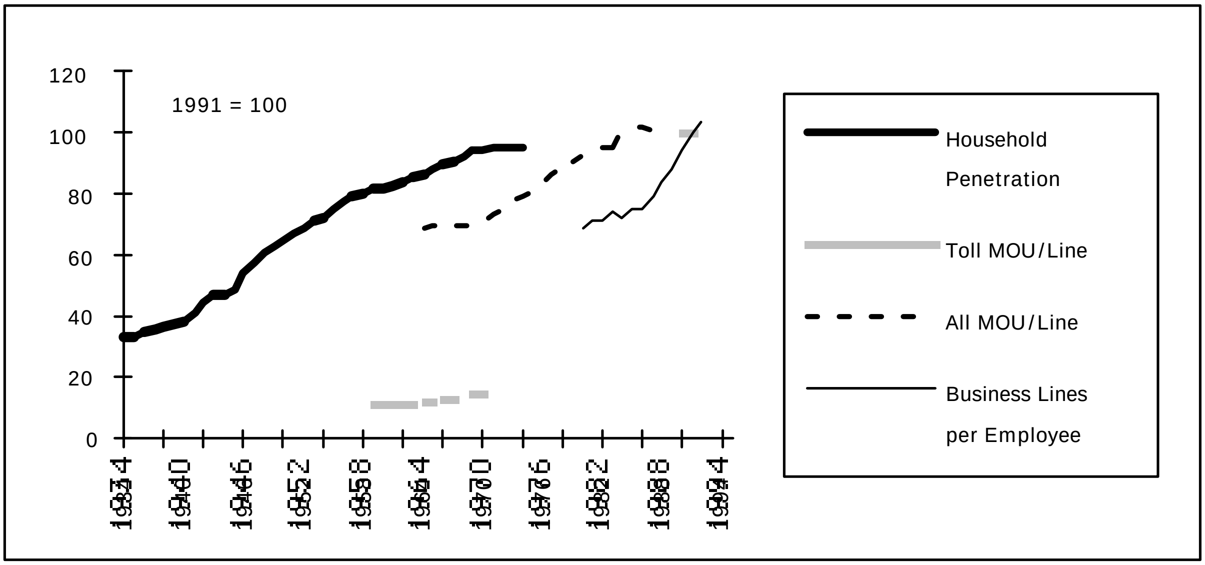
9 We believe that the observed 0.4 intralata toll elasticity, which is intermediate between the elasticities for LD and local, reflects consumer confusion about these charges (i.e., they tend not to be itemized; as a recent AT&T intralata toll add notes, "Your local phone company may be charging you more than you realize for local toll calls"). Since intralata toll is an MOU based toll charge, it theoretically should have the same elasticity as LD.

Figure 7
Telephony Penetration Waves



Source: FCC Statistics of Communications Common Carriers; U.S. Bureau of the Census; Monitor Analysis

In sum, the stagnation in telephony demand growth relative to GDP appears to be due to saturation of traditional narrowband telephony applications. Put another way, narrowband telephony is running out of steam.

III.3 PROSPECTS FOR INCREASING TELECOM DEMAND

If the telecommunications industry continues along the trendline of the past decade, it can expect to grow at a lower rate than GDP. Can this picture be changed, and if so, how? Given that of the three basic demand drivers, GDP is out of the industry s control, changing telecom demand depends on achieving improvement either in the price elasticity driver and/or telephone intensity. We therefore consider the prospects of either event occurring.

We are pessimistic about demand growth driven by changes in pricing. As we have already noted, to grow aggregate market size in a market with .75 elasticity, real prices would need to rise.[10] In all likelihood, this is unlikely to occur in the upcoming period of deregulation, since there will be a number of new entrants in both local and toll telephony. Even if it did occur, the elasticity effect with its offsetting volume decrease means that to obtain just a one-time 10% revenue growth would require a price increase of 50%. This most likely will be unacceptable to customers and regulators.

If pricing changes cannot grow the telecom market, this means that growth depends on increasing the level of telephone intensity. It has become the conventional wisdom in the industry that this

[10] Price declines in markets with elasticities below 1.00 lead to reduced total market size.

growth in fact will occur, due to the advent of the Information Superhighway. In this view, the introduction of new mobile, digital and broadband technologies will foster an information explosion (as in AT&T s You Will advertising campaign). If this occurs, telecom will become an increasingly central element of the economy, and should therefore grow its share of GDP.

In this context, the slowdown of the past decade becomes simply a speed bump on the information superhighway. Just as we have seen successive waves of penetration in telecom over the past 50 years (household phone line penetration, followed by MOU per line growth), we have just begun to see new waves of growth; i.e., the rapid increase of cellular subscriber penetration (albeit at very low MOUs per sub), CATV penetration, as well as enormous increases in subscriber usage to the Internet and America On Line.

To date, however, these new applications have been restricted to the level of small specialty usage. Even if these new applications take off as advertised, will they contribute to overall telecom growth, or simply cannibalize existing markets (i.e., there have been a number of recent studies indicating consumer resistance to paying a lot more for interactive multimedia services over and above their current phone and CATV bills)?

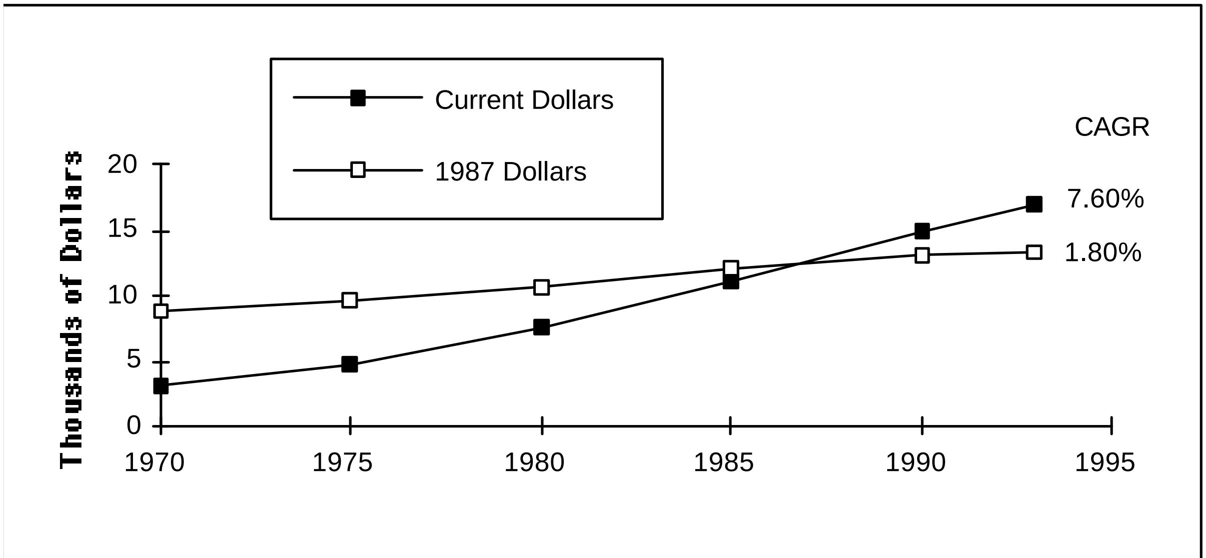
To try to deal with the issue of prospective secular growth away from the information superhighway idea, we avoided the bottom-up approach of considering the market attractiveness of each new application individually and then considering the degree of prospective cannibalization. Instead, as we did in our analysis of historical trends, we approach the question of future growth prospects on a top-down basis, beginning with broad macro-economic issues. In our construct, if we want people or companies to spend more on telecom as a proportion of their total spending, telecom has to somehow grow at the expense of something else. In Section 3.4, we consider the extent to which we believe that this replacement can occur.

III.4 DEMAND PROSPECTS FROM A MACROECONOMIC PERSPECTIVE

We begin our top-down macroeconomic analysis by looking at how people and business have been spending their money historically, and how these spending patterns have changed over time.

Looking at real personal consumption per capita from 1970 to 1993, we note that real individual spending has grown only at a rate of 1.8% per year (Figure 8). This means that for telecom spending to grow substantially, it will have to displace other expenditures.

Figure 8
Personal Consumption Expenditures Per Capita

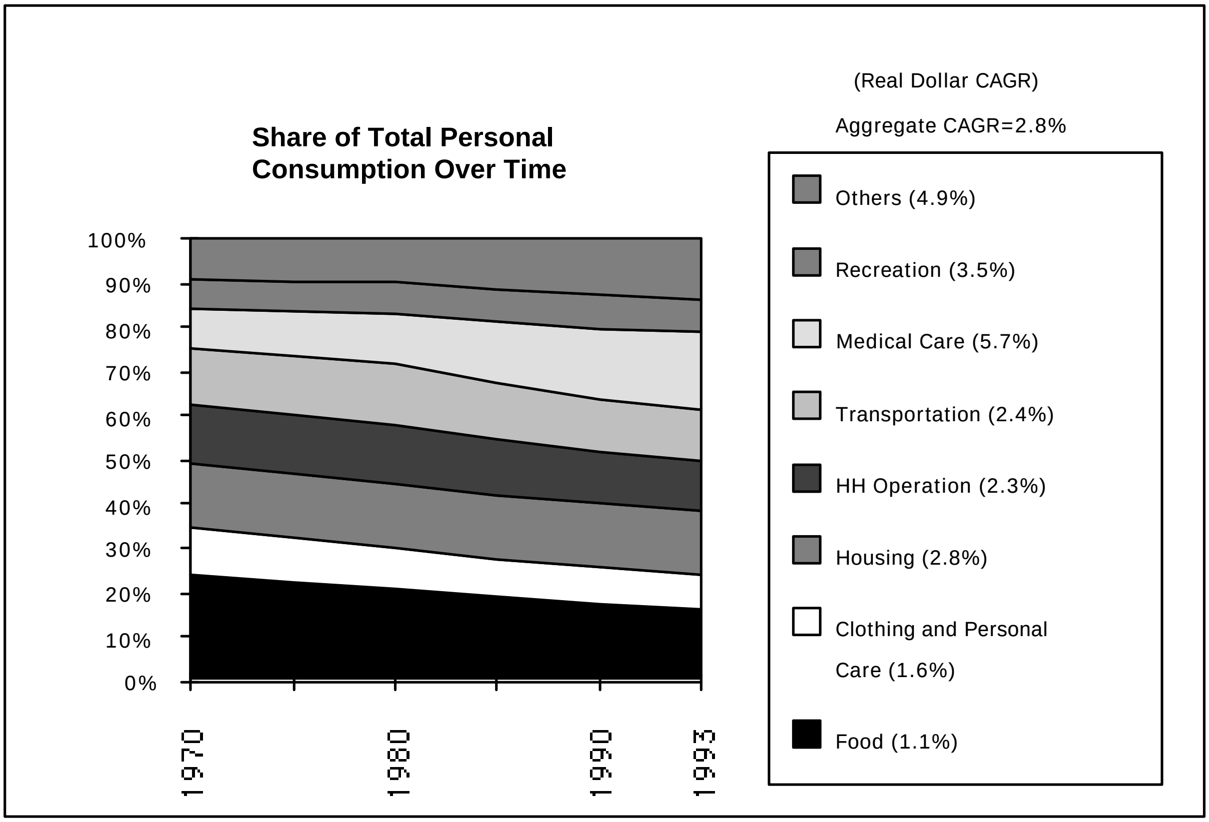


Source: U.S. Bureau of the Census; Monitor Analysis

Looking at real personal consumption expenditures by category from 1970 to 1993, we observe that all categories have grown in real terms, but some have grown slower than the 2.8% US average (Figure 9). In particular, the share of total expenditures for primary needs like food, clothing, housing, and transportation have been flat-to-declining.[11] This may reflect the fact that in an economy in which real consumption per capita has been rising albeit slowly, marginal increase in wealth tends to be spent on other areas once basic needs are satisfied. In contrast, there have been three areas that have gained share (by capturing a disproportionate fraction of the growth in overall spending): Medical Care, Recreation and Others (largely education, research, legal services). The last two reflect the transition to a service economy with greater wealth per capita. By far the largest increase in share is medical care, which now represents 15.1% of personal spending.

[11] Telephony is included in Household Operation, while CATV is included in Recreation.

Figure 9
Personal Consumption Expenditure Breakdown



Source: U.S. Bureau of the Census; Monitor Analysis

For telephony to grow its share of personal consumption, it has to displace at least one of the above categories. The total amount of the displacement does not need to be very large to have a major impact on telephone intensity, because telephony currently is only 1.8% of personal spending. By far the easiest way to make room for substantial telephony growth would be to slow down the growth of medical care.[12] If this category were to grow at the average for total personal expenditures of 2.8% rather than its 5.7% historical growth rate, it would free up 0.43% of total expenditures each year. If this spending were applied to telecom, this would support substantial growth.

What is the likelihood for constraining medical growth? It is problematic as to whether this will occur. There clearly is a general desire to begin managing health care costs , but substantial disagreement as to how to achieve it. It may be that the private sector trend towards HMOs will restrain spending even without legislation. However, even if we are able to manage health care costs, it may be that this will be largely offset by an aging of the US population, with more elderly people requiring more medical care. If so, the managing of medical costs may simply slow down

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[12] We assume that the remaining categories within Other, like education and research, are untouchable.

its rate of share increase, rather than stopping it. We tend to be equally pessimistic about reining in legal fees, a major component in the Other category now representing 1.2% of consumption.

This suggests that if telecom is going to grow its share of consumption, it will need to substitute for current expenditure categories. Here we believe that there may be opportunities for telecom to become a cost effective substitute for existing spending in a variety of categories. Basic categories include the following:

Replacement for Business T&E: A basic inherent function of telephony is to allow people to communicate without having to travel. Since current narrowband technology does not allow lifelike face-to-face interaction, there is still a very large business travel and entertainment component of the economy. In the future, however, the increased availability of bandwidth will make possible telecom experiences closer to reality (e.g., through high quality video telephony and interactive computer linkages), and therefore the use of telephony as a more appealing substitute for travel.

Substitution for Daily Commuting: Instead of people working in individual offices in large central facilities, they increasingly can work at home (the home office), using high bandwidth connections to central office servers and video telephony. This will begin to reduce the extremely costly and unproductive daily commute.

Replacement for Large Central Offices: If people are not commuting to large central offices, there will be less need for expensive office space. Offices of the future may consist of non-private workspaces that are assigned to individuals or groups based on short-term needs, with private files/property kept in locker facilities.

Increasing Outward Migration: Telecom can facilitate population migration to lower cost areas, reducing residential real estate costs. It allows employees to live further away from the office in less expensive areas. This is similar to the effect that the interstate highway system had in the 1950s and 60s.

Reducing Business Inventory: An important element in the current wave of business re-engineering efforts is inventory reduction, achieved by improving the transmission of information between manufacturers, suppliers, retailer, and even consumers. As an example, the information transmitted from the supermarket cash registers permits optimization of inventories in real time.

Substitution For Physical Delivery: Telecom can substitute for postal and courier delivery. We already have faxes and growing e-mail, but the list of possibilities can include others such as direct deposit, electronic payment of bills, ubiquitous E-Mail, and access to central servers (i.e., for bank records).

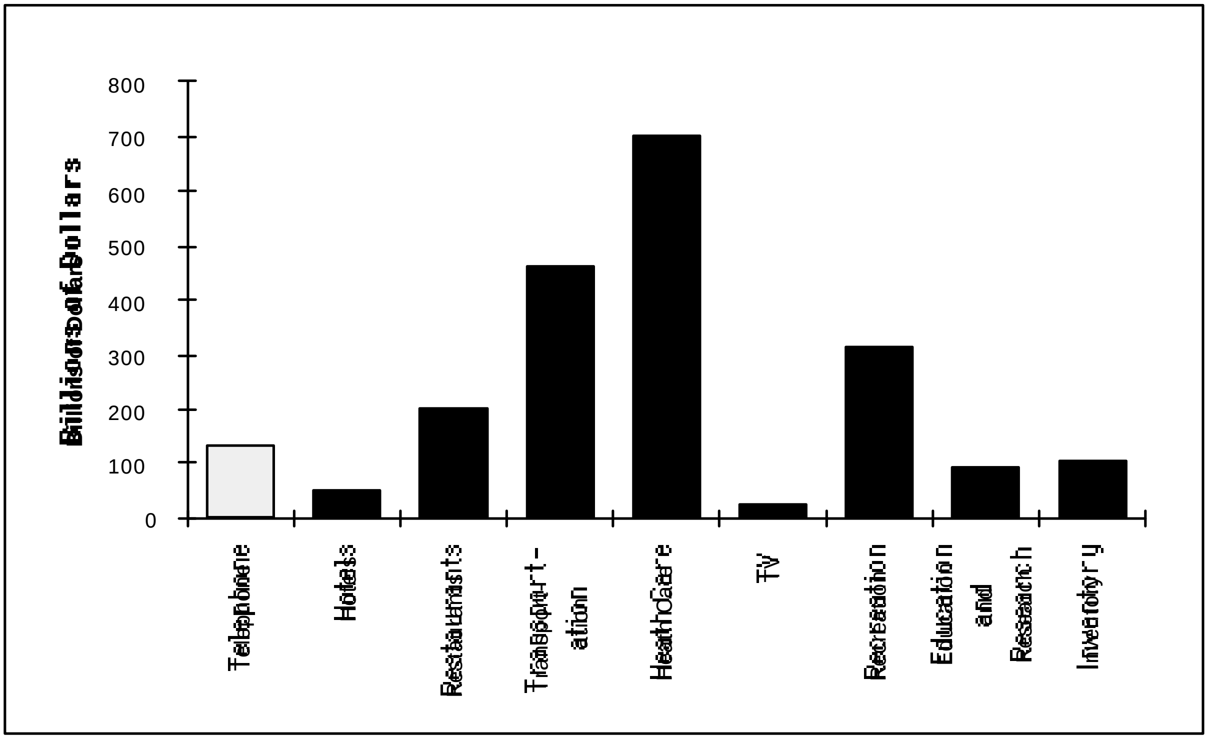
- Reducing Medical Costs: Telecom can reduce medical costs by reducing hospital costs (approximately 30% of total health care). Patients can be monitored at home, without using hospital beds. Also, expensive diagnosis devices can be made available to remote medical offices via telecom, reducing the need for large investments in medical equipment.

Lowering Education and Library Costs: A large fraction of college and university costs for lecturers, libraries and physical plant can be replaced with central servers, interactive tutorials and downloadable lectures. The on-line university is a reality in places like Mexico. The use of central servers could also extend to K-12.

Alternative for Physical News, Information and Entertainment Media: Almost every single form of paper media can be made available on-line. We are beginning to see on-line newspapers and magazines, on-line software delivery and books in electronic form. Movies on demand can substitute for video rentals.

As noted earlier, it is not our intention here to develop specific forecasts about the prospects for penetration in any specific application. However, as a back of the envelope calculation, we note that the dollar value of the potential telecom substitution categories shown in Figure 10 totals $2,000 billion per year, representing 33% of total US GDP. If by virtue of its cost effectiveness against these categories, telecom could obtain an average substitution of 5%, for a net gain of 1.65% of GDP, this means that telecom s share of GDP would grow from its current 2.23% to 3.88% (Figure 11). This would grow the absolute size of the industry by 74%. In this new scenario, individual households with 2.7 people per household will need more than the current single phone (the average household has 2.1 television sets), and business will need more than the current .44 phones per employee.

Figure 10[13]
1992 Revenues For Selected Economic Sectors
(Potential Telecom Substitution Categories)



Source: U.S. Bureau of the Census; Monitor Analysis

In Figure 11, we note that if the industry were able to obtain a 5% penetration of the sectors shown in Figure 10 over a 10-15 year time horizon with 6% current GDP CAGR, this would translate into a telephony CAGR of 10-12% in current dollars (versus the past decade s 5%).

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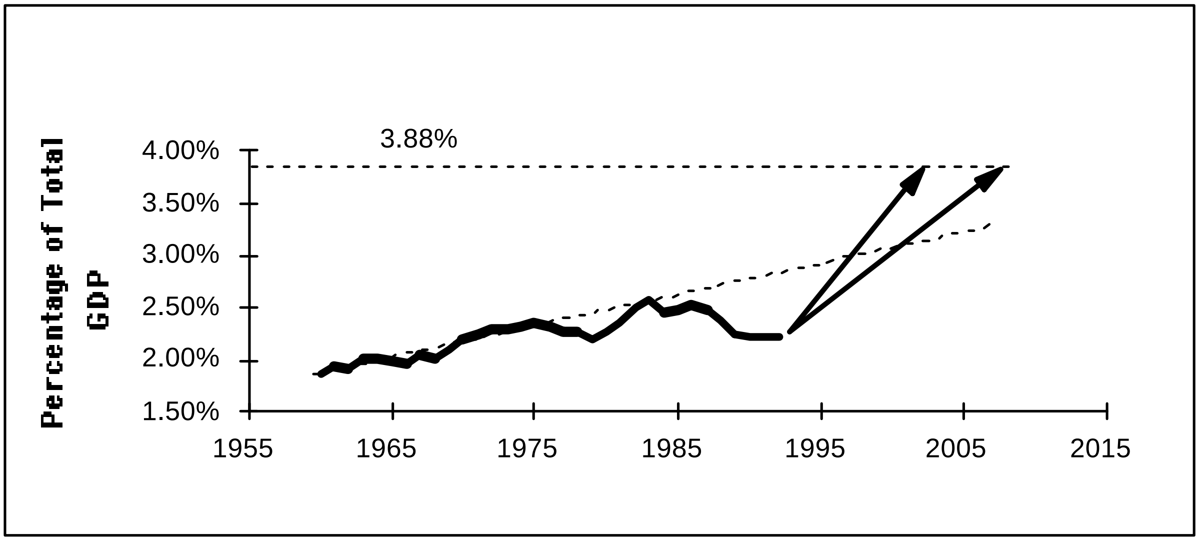
13 This figure is based on GDP and Personal Consumption Expenditures.

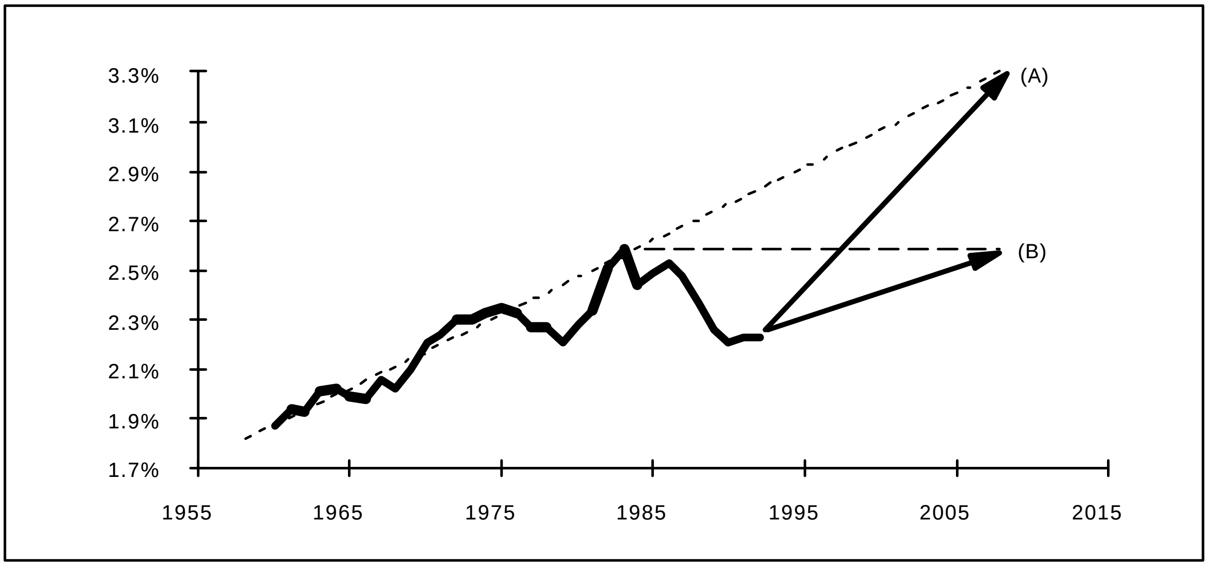
Figure 11
Telephone and Telegraph Share of GDP
Growth Patterns with 5% Substitution



Source: Bureau of Economic Analysis of the U.S. Department of Commerce; Monitor Analysis

It is interesting to relate this magnitude of change to historical trends. As shown in Figure 12, if one grew from telephony s current 2.2% GDP share to 2.6% (the telephony peak level achieved in 1983) over 10-15 years with 6% current GDP CAGR, this would translate into a telephony CAGR of 7-8% in current dollars (versus the past decade s 5%). If, in addition, telephony were to increase its share of GDP to regain historical trend line, this would translate into a telephony CAGR of 8-9% in current dollars. These numbers are substantially in line with the 10-12% CAGR range that we obtained by assuming 5% penetration of selected GDP components.

Figure 12
Telephone and Telegraph Share of GSP
Possible Growth Patterns to Previous Trendline Levels



Source: Bureau of Economic Analysis of the U.S. Department of Commerce; Monitor Analysis

If growth in this range occurs, the telecom industry will be growing at approximately twice the rate of the last 10 years (7-12% versus 5%).

It is interesting to consider how this growth can be achieved. Looking at the above estimates, we would disagree with those who wax eloquently about the information superhighway and picture a world in which everybody is continuously hooked into a enormous cyberspace on multiple channels playing interactive holographic video games. The problem with this picture is that it ignores practical economic realities. In a US economy with low real per capita income and spending growth, there may not be enough money to pay for this vision of the future any time soon. Instead, if the information superhighway is to take off and spur a new wave of telecom growth, in all likelihood, it will have to come from more mundane but more realistic direct substitution.

III.5 ACHIEVING THE GROWTH POTENTIAL: REQUIREMENTS

To achieve renewed secular growth, we need to consider what actions are needed to trigger the next wave of substitution. Generally speaking, we believe there are two important drivers. The first is the introduction of new technology. A number of the new telecom applications require some combination of new mobile, digital and/or broadband capability. Until networks, servers, and CPE/software are established that support these new capabilities, there cannot be substantial growth. As an example, AT&T has been trying to sell video telephony services since the Picturephone debut at the New York World's Fair in 1964 without notable success so far. There appears to be two technical barriers to penetration:

- The lack of attractive CPE equipment -- until unit costs drop to the point that most telephone customers invest in video telephones, there will not be a critical mass of people who can receive a VT call.

  The lack of ubiquitous broadband transmission capability. Some video telephony entry strategies call for transmission at 384 kbps. This is not yet broadly available.

The second critical driver is price. Many of the new applications inherently will be using far more bits per second of information than current voice telephony. In addition, an increasing fraction of these information bits will be transmitted by wireless means, as the idea of seamless mobility takes hold. This means that per minute of use, customers operating in an information superhighway mode inherently will be communicating with fat minutes; that is, many more bits transmitted per MOU and/or communication by an as-yet high cost-high price wireless network.

This suggests an inherent internal contradiction. To the extent that customers are being asked to replace their current limited use of lean minutes (average phone use is 1,400 MOUs per month) with a significantly expanded use of fat minutes, we believe that it is unlikely that this will occur broadly unless the price of fat minutes declines. As one example, movies on demand will not be a competitive business unless the price drops to $2.00 for a two-hour movie (at which point it replaces movie rentals). At this price, its effective 64 kbps transmission price will have to be denominated in mils, not in cents per MOU.[14]

In conclusion, we believe that to foster the potentially explosive growth of the Information Superhighway, the industry needs to move to a different pricing mechanism that effectively reduces unit MOUs by a quantum amount. To some extent, this statement may contradict our previous argument that with a 0.75 historical elasticity, price reductions are not fully offset by volume increases. However, we believe that this 0.75 level essentially refers to the historical elasticity of small annual percentage changes in a period of limited technological changes (i.e., the same POTS service). It therefore may not be applicable to very high price discounts in a period of substantial technological change. Furthermore, the .75 elasticity assumes an environment in which consumers are charged on a price per MOU basis, with zero or low fixed costs per month. It may not apply to an alternative pricing structure that encourages new uses by changing the pricing paradigm from MOUs to a structure in which customers pay a higher fixed cost per month with lower marginal costs. It is possible that some form of price reduction or price structure changes could result in a win-win situation in which consumers benefit from lower marginal price per MOU while total industry dollar size increases. Examples of rapid growth based on a

[14] Another argument supporting the need for price reductions to stimulate new uses is the fact that the elasticity through many forms of communications and entertainment is uniform (Figure 5). This means that consumers value most potential new telephony uses according to the entertainment time provided. In other words, two uses with very different bandwidth requirements would not be perceived by the consumer as having a significantly different value. Each substitution in entertainment will only become significant to the extent that telecom per-MOU rates become lower than current cost per minute, in most cases much lower than existing LD rates.

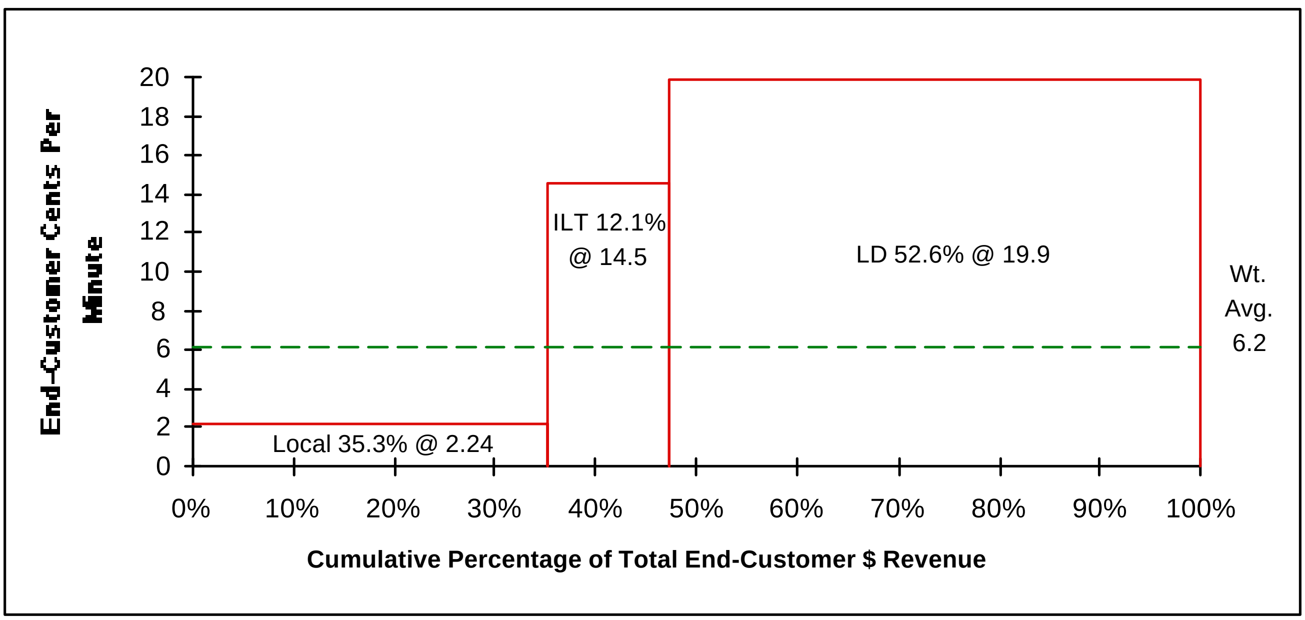
new pricing paradigm include: (a) CATV usage (fixed cost per month for a given service level; in contrast, pay-per-view service has languished), (b) business telephony private line and dedicated access service, and the Internet (fixed cost per month for a given bandwidth level).

III.6 IMPACT OF STRUCTURAL INDUSTRY TRENDS

At issue is whether the required change in the pricing paradigm will actually occur on a broadly expanded basis. One could argue that it might not, and that telecom competitors will instead choose to retain the current MOU pricing structure. This is because:

> A large fraction (65%) of current end-customer telephone pricing is MOU-based (Figure 13). The notion that customers should pay a high MOU charge for toll charges and low priced fixed fee for local service has been an integral part of the industry for most of the past century, as a means for subsidizing universal service. It is therefore reasonable to expect substantial inertia in prices, perhaps even imposed by regulators.
>
> Taking a conservative approach reduces the prospective severity of cross-supplier competition, and limits the risk that reductions in MOU charges will result in reduced market size because of insufficient price elasticity.

Figure 13
1992 Telephony End Customer Pricing Structure



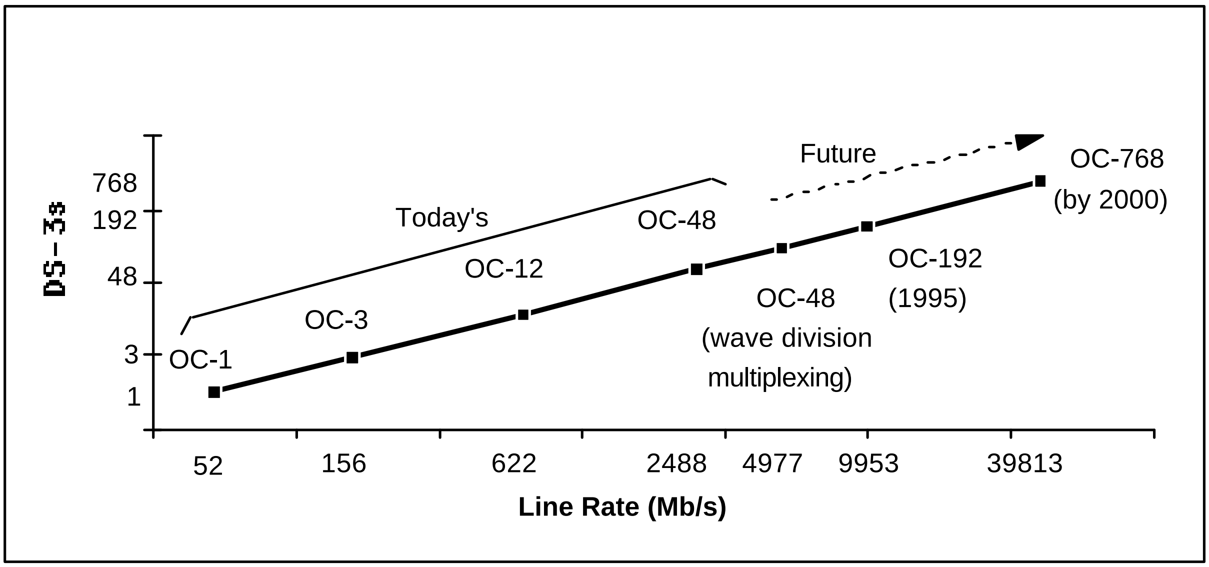
Source: FCC Statistics of Communications Common Carriers; Monitor Analysis

On balance, however, we believe that the structural evolution of the industry inexorably will cause a transformation away from MOU pricing:

The increasing availability of transmission capacity (fiber, fiber/coax and compressed digital wireless) will reduce the cost of marginal 64 kbps-equivalent MOUs substantially (Figure 14 illustrates the large increase in maximum SONET transmission speeds).

This increased capacity will require new mux/demux elements. However, the new wireline elements represent a fixed cost, not a per-MOU cost, and the new wireless capacity additions will have low marginal cost per MOU. Therefore, the new available capacity will enable a change in the pricing paradigm away from high MOU charges.

Figure 14
Maximum Sonet Transmission Rates Over Time



Source: ***Telephony***

- The deregulation of telecommunications will lead to a number of new market entrants in each segment of telecom. We particularly anticipate multiple competitors in LD and wireless in each MSA.[15] With multiple competitors, surplus capacity and low marginal costs, the free market mechanisms in the long run will tend to drive prices down to long-run marginal cost -- in other words, towards low MOU charges for toll as well as for local calls.

The entry of end-to-end access providers (LECs, CATVs, CAPs, wireless) into long distance could trigger the shift away from MOU pricing by changing their effective price elasticity to above the 1.00 break-even levels. We previously argued that at the current observed .75 interlata elasticity, price cuts are not sufficiently offset with increased volume. However, it may be in the interest of a fully integrated telephone competitor (i.e., a LEC) in a deregulated environment to cut prices, particularly if the

[15] Local residential wireline and CATV are more problematic. If there are only two wires to the home, prices may be subject to oligopolistic pricing.

integrated competitor has low initial share of the toll market and a relatively captive set of LD access customers.[16]

This is because integrated competitors obtain their revenues from access in addition to direct end-customer revenues. When a LEC cuts end-customer price, it has the same 0.75 elasticity price-volume tradeoff as an established IXC (and it therefore would tend to gravitate to higher prices). However, if a LEC cuts end-customer price, the IXCs are faced with two choices: keeping the higher price and losing share, or meeting the new LEC price. Either way the LEC wins:

- If the IXCs choose to keep their prices high, the LEC gains share. The incremental volume, added to the LEC s base .75 market elasticity in all likelihood will increase the overall LEC elasticity above the 1.00 breakeven point.

- If the IXCs choose to match LEC price discounts, they will stimulate additional market demand. Unlike the IXCs, however, who at .75 elasticity are net losers, their LEC supplier does not have to drop its access price at all. The net result for a LEC is higher market volume at the same access price, for a net gain.

In Table 2, we have calculated the economics for a LEC discounting end-customer prices by 10%, 20% and 30% versus current market prices with .75 market elasticity, assuming that the IXCs match the price discounts and that access prices are not reduced. The results indicate that the LECs have an incentive to cut prices.

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16 The only options that an access customer like AT&T can employ to lower access fees are (a) an FCC change in the separations process favoring LD, and (b) having the ability to move customers from one local network to another. The first is problematic, the second may be difficult if AT&T finds itself facing an oligopolistic LEC-CATV duopoly and does not have a local build option.

Table 2
Impact of LEC Entry into LD
With Different End-Customer Discount Levels
(Assuming Constant Access Prices and .75 Market Elasticity)

Assumptions	*Initial Price*	*Price drops 10%*	*Price drops 30%*	*Price drops 50%*
Total market LD minutes	1000	1082	1307	1682
Access costs (cents/MOU)	8	8	8	8
Percentage of LD by non-integrated provider	98%	98%	98%	98%
LD market price (cents/MOU)	20	18	14	10
Price elasticity of demand	0.75	0.75	0.75	0.75
LD market revenues				
Integrated provider (LEC) access revenues	$78	$85	$102	$132
Integrated provider (LEC) direct LD revenues	$4	$4	$4	$3
Total integrated provider (LEC) revenues	**$82**	**$89**	**$106**	**$135**
Non-integrated provider (IXC) gross revenues	$196	$191	$179	$165
Non-integrated provider (IXC) access costs	$78	$85	$102	$132
Non-integrated provider (IXC) net revenues	**$118**	**$106**	**$77**	**$33**
Total LD market revenues	$200	$195	$183	$168
Integrated provider (LEC) share of revenues	41.2%	45.6%	58.0%	80.4%
Non-integrated provider (IXC) share of revenues	58.8%	54.4%	42.0%	19.6%

III.7 CONCLUSIONS

Our analysis of the last ten years since the MFJ leads us to conclude that the historical growth drivers have stalled. After 50 years of increasing telecom share of US GDP, the trend since 1983 has abruptly shifted to one of continuous decline (Figure 4). It would appear from the flat trends of household penetration and MOU volumes per phone that the industry has reached a saturation point.

Looking at the future, we believe that the telecom industry can reverse this stagnation by stimulating the adoption of new uses for telecommunications (i.e., the Information Superhighway) that will result in an increase in the number of phones per household or employee, total MOUs and total bandwidth. However, for this to happen, the current narrowband MOU-based pricing structure needs to change. Many of the new potential applications will inherently involve either broadband and/or toll transmission. To the extent that the industry tries to price these services based on the current paradigm of $.20 for one minute of narrowband toll transmission, the adoption of the new applications will be impeded severely.

The advent of fiber optics and photonic technology makes this type of pricing possible, by creating a cost structure that can handle large bandwidth transmissions over long distances at very low marginal cost. As this technology gets deployed, it will become possible to price at levels that stimulate significant demand growth.

If the re-stimulation occurs, we become relatively bullish on the outlook for telecom growth. Revenues in current dollars could grow at a CAGR of 8-12% versus the past decade s 5%.

We believe that the required shift in industry paradigm away from narrowband MOU charges could indeed occur based on fundamental industry structural trends under deregulation. Essentially, any integrated end-to-end competitor with low marginal cost and a small current share position will have strong incentives to change the pricing paradigm of the business they are entering or arbitraging.

In this future environment, we believe that the current MOU paradigm may be replaced by a bundled price per wire paradigm, in which customers will pay for a broadband connection into a telecom network, with pricing determined by total bandwidth peakload usage/provisioning, with additional fees for using different services. In this environment, to the extent that there are MOU charges at all (perhaps due to the retention of interconnection fees among network providers), these MOU charges will be at much lower levels than today. This is very similar to the way the Internet operates, and we think that the industry could evolve in this direction. It is also consistent with the underlying cost structure and the game theory incentives of key players.

If this occurs, it is tremendously important to future industry structural evolution. Only those parties that have developed access to networks providing a variety of services with low marginal costs will be able to compete effectively. Thus, it is important for competitors to understand the nature and ramifications of the potential market changes, and then to undertake infrastructure plans consistent with these. In this context, to the extent that the new demand requirements will require a wider variety of services at low marginal cost, competitors will need to move away from reinventing the current narrowband copper network, and instead develop more capable networks able to support the needs of the Information Superhighway.

APPENDIX A

DETAILED DESCRIPTION OF THE DEMAND MODEL

We constructed a demand model to better understand the demand drivers and the telephone share of GDP. Our demand model is based on the idea that revenue growth rate of telephony in current dollars can be explained as the result of adding three different factors:

Economy growth. The indicator that measures economic growth is the nominal GDP.[17] We are using GDP to explain the revenue growth rate of telephony *in current dollars,* and therefore the GDP should be also in current dollars. Other factors, such us penetration and relative pricing, remaining constant, the CAGR of nominal GDP should be the CAGR of telephony revenues in current dollars.

Percentage revenue change due to changes in pricing. A change in pricing in one direction, produces a change of volume (MOU) in the opposite direction. Thus, an increase in pricing, produces by a corresponding decrease in volume. The ratio of the percentage change in volume *caused by the change in real pricing* to that percentage change in pricing is called price elasticity of the demand.

The price elasticity can be calculated using regressions that isolate the change in volume due to the change in real price from the change caused by economic growth or penetration. If the real price, or relative to the CPI, changes by 1%, the volume (MOU) demanded will change by e %, where e is the elasticity.

The combined effect of the change in price and the corresponding change in volume result in a change of revenues. If the demand is price inelastic ($e<0$), the change in volume is smaller than the change in price, and therefore revenues decrease with the reduction in price. If the demand is elastic ($e>0$), the change in volume is larger than the change in price, and therefore revenues increase with the reduction in price. In this last case, to make a price decision, the telephone provider will still have to compare the increase in revenues to the increase in cost necessary to offer and service more minutes.

Secular growth. With this factor we try to measure the telephone intensity, i.e., the extend to which telephony is increasing its penetration in the economy. The measure of this factor is growth of minutes net of changes in real pricing effects (elasticity) per real GDP.[18]

In recent years, a good proxy of the secular growth is the number of telephone lines per real GDP. This is because apparently we have reached saturation in MOU per line, and

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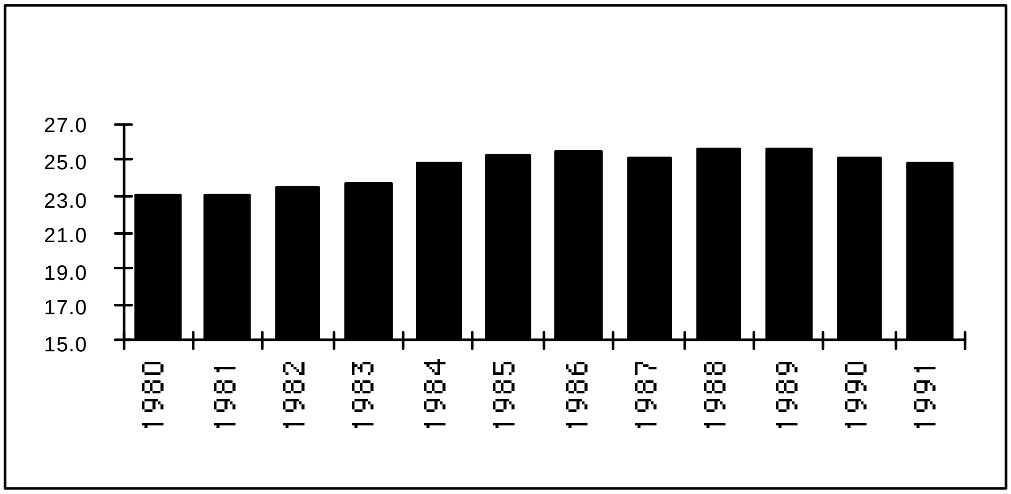
[17] Nominal GDP, or GDP in current dollars, is the Gross Domestic Product measured in dollars of that year.
[18] Real GDP, or GDP in constant dollars, is the Gross Domestic Product measured in dollars of a given, fixed year.

telephone intensity is therefore reflected directly in number of lines. Therefore, if the number of telephone lines grew at the same pace as real GDP, telephony would not be increasing its penetration in the economy, and therefore the ratio of lines to real GDP would be constant and the CAGR of lines to real GDP would be zero.

Figure A-1
MOU Per Line Trends



Source: FCC Trends in Telephone Service

Secular trends and revenue changes due to changes in pricing are somehow interrelated. Thus, high prices can reduce or even stop penetration. On the other hand, price declines can stimulate penetration, specially if new uses and substitution for other products are attractive.

In short, we have modeled telephony revenue growth as follows:[19]

CAGR (telephony revenues in current dollars) =
CAGR (minutes net of price elasticity effects/real GDP) +
+ CAGR (nominal GDP) +
+ CAGR (revenue) caused by price change[20]

An interesting conclusion from the previous relationship is that the difference in growth rate between telephony revenues and GDP (and therefore the change of telephony share of GDP) can only be caused by two factors:

Increase or decline in penetration: secular trends

---

[19] This equation can be derived mathematically.
[20] The correct way to add three CAGRs is:
(1+CAGR(a))*(1+CAGR(b))*(1+CAGR(c))-1

Changes in the price-volume curve: real price variations and corresponding volume variations

To model the revenue growth of a given carrier, it is necessary to introduce a fourth factor: market share. Changes in market share will translate into changes in company-specific revenues. Adding this new factor, we can model company-specific telephony revenue growth:[21]

CAGR (carrier s revenues in current dollars) =

CAGR (minutes net of price elasticity effects/real GDP) +
+ CAGR (nominal GDP) +
+ CAGR (revenue) caused by price change +
+ CAGR (provider s market share)

[21] This factor made AT&T's revenues in current dollars flat during from 1984-92. The industry revenue growth of 5.2 % CAGR was exactly offset by a decline of market share at 5.2% CAGR .

APPENDIX B: TELEPHONY ELASTICITY CALCULATIONS

Other things being held constant, changing the price of any good will produce a corresponding change in demand. If other factors do not hold constant, the observed changes in demand will not reflect only the changes due to price variations. In these cases, regressions can be uses to isolate the effect of the changes in price.

A common way to measure the price-volume relationship is the price elasticity of the demand. Elasticity is a general concept that measures the responsiveness of one variable to changes in another variable. Price elasticity of the demand represents the percentage change in the total amount demanded caused by a small change in the price, divided by that percentage change in price. In other words, it is the ratio of (1) the percentage change in the volume demanded caused by a small change in pricing to (2) the percentage change in price, when all other factors are held constant. Since price changes in one direction produce demand changes in the opposite direction, the price elasticity is normally negative. For simplicity, the elasticity number is normally given as a positive number, the negative sign being implicit.

Figure B-1
Generic Demand Curve

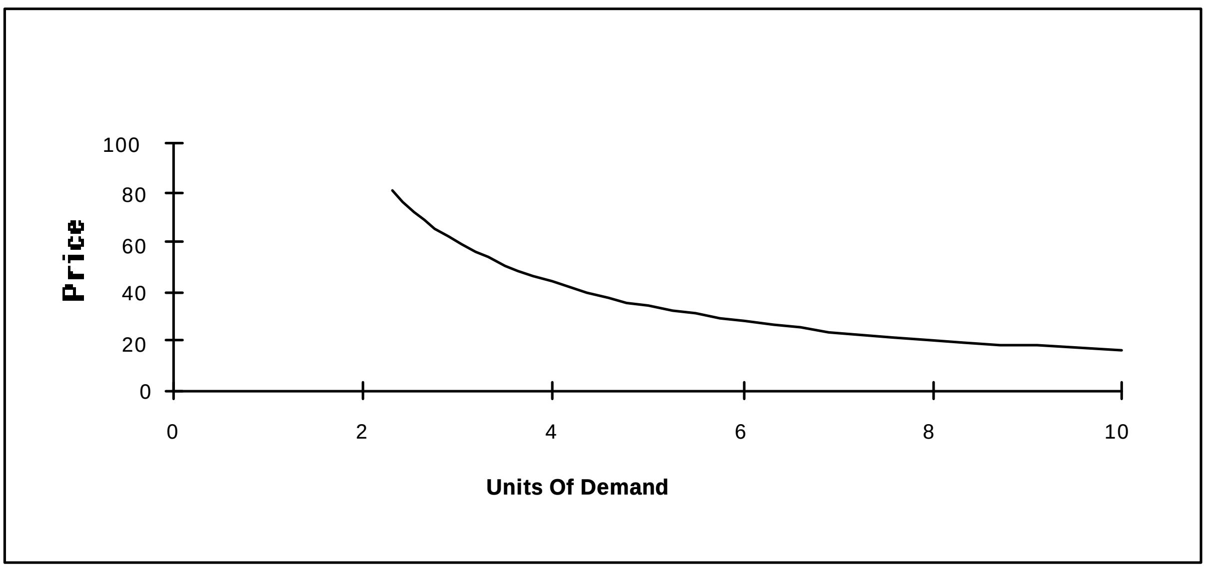
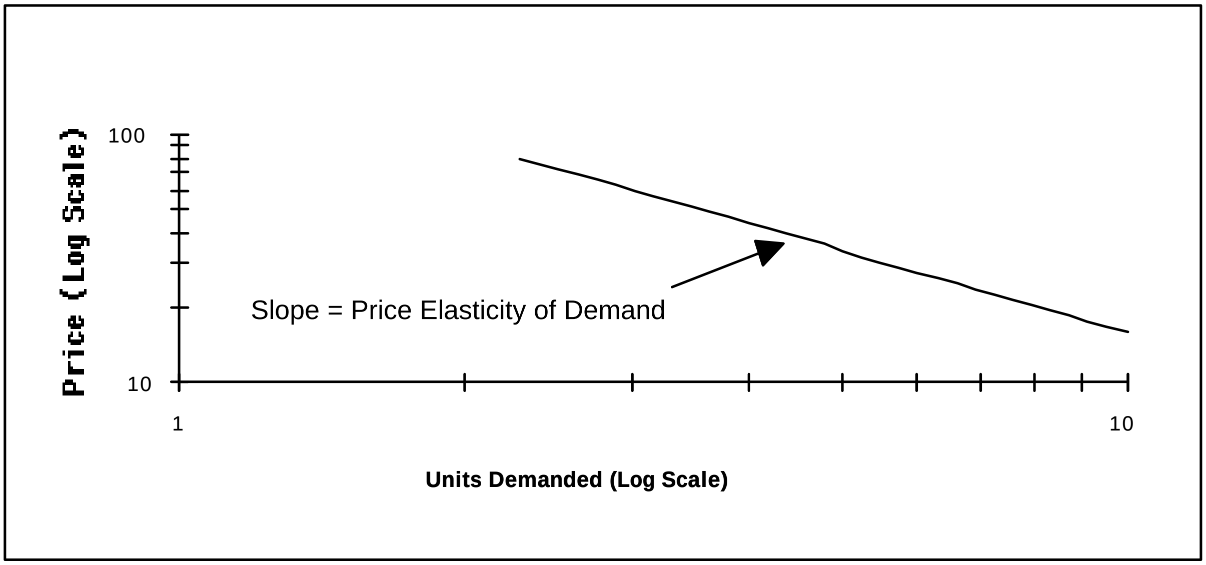
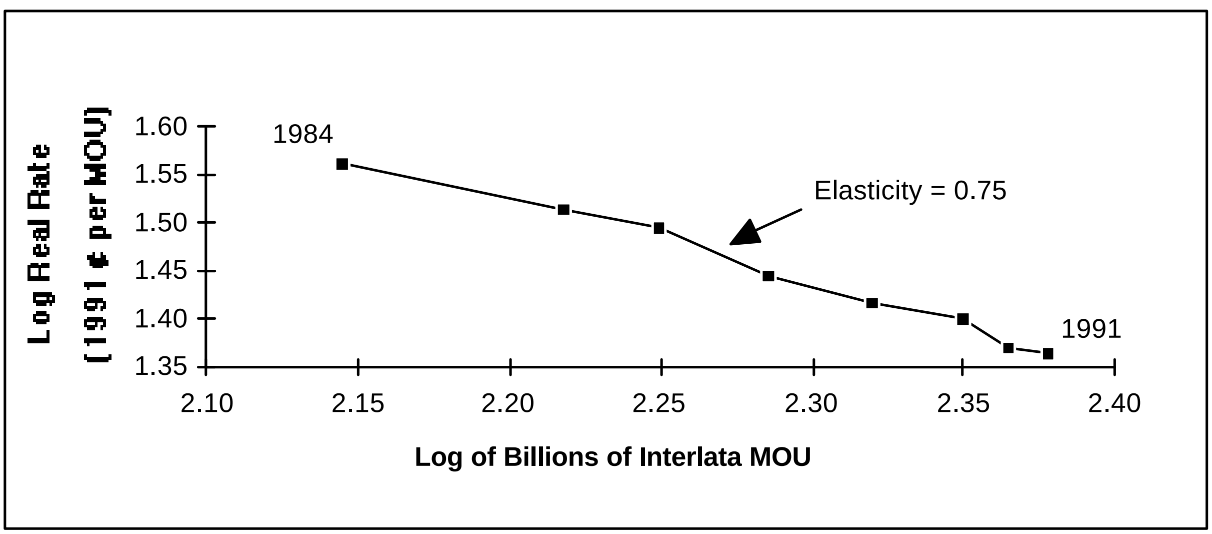


Figure B-2
Generic Demand Curve
(Log Scale)



Using regressions of post-MFJ telephony demand, we have found an interlata long-run price elasticity of about 0.75. An elasticity of 0.75 means that, other factors being constant (such as population and disposable income), a reduction of 1% of the interlata real rates, will be accompanied by an increase of 0.75% in the number of interlata minutes.

Figure B-3
Interlata Toll Elasticity
1984-1991



Source: FCC Statistics of Communications Common Carriers; Monitor Analysis

Regarding intralata toll service, we have found an apparent intralata long-run price elasticity of about 0.4. An elasticity of 0.4 means that, other factors being constant (such as population and disposable income), a reduction of 1% of the intralata real rates, will be accompanied by an increase of 0.4% in the number of intralata minutes.

These elasticities are similar to the long-run long distance price elasticities found in the literature, e.g., 0.63 (Taylor and Taylor), 0.68 (FCC), 0.72 (J.P. Gatto), 0.5 (Jon Breslaw).

The lower intralata price elasticity (0.4 vs. 0.75) can be explained by:

> Low *perceived* intralata rates (attention focused on LD).
>
> Intralata usage may be driven by factors other than price (e.g., increasing dispersion of the population, change in local call radius).

Our regression equations are of the following type, similar to the ones found in the literature:

$$\log MOU = a + e \log(\text{rate in real dollars}) + c \log(\text{real GDP}) + d \log(\text{number of lines})$$