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Clear Thinking on the Digital Divide

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As consumer products are introduced, adoption rates tend to vary across socioeconomic groups. In the case of computers and Internet access, these gaps have been termed by many the "digital divide." People with higher incomes and more education have substantially greater rates of access to technology. Likewise, whites and city-dwellers are more likely to have computers and Internet access than non-whites and those who live outside metropolitan areas. As with many other products and services, technology is not equally distributed.

Over the past five years, a series of digital divide reports by the U.S. Department of Commerce[1] has focused attention on the issue and led to a variety of programs aimed at increasing the number of Americans owning a computer and connected to the Internet. But in spite of a surfeit of data on the issue, interpretation of these numbers has yielded anything but consensus. On the one hand, liberals, seeking stronger government action have used the data to paint a pessimistic picture, pointing to figures that suggest the gaps between rich and poor and between whites and minorities are growing. In contrast, conservatives seeking to challenge any case for intervention, have painted a much more optimistic view, arguing that uptake rates are growing for even the poorest. As government considers how it might respond to gaps in computer and Internet access, it needs to base its decisions on clear thinking that objectively examines what has happened with past technologies, what is happening now, what is likely to happen, and what, if anything, justifies government action.

This paper places the issue of technological diffusion in historical perspective -- first, by analyzing the extent to which various technological divides have changed over recent years and, second, by comparing changes in the rate of penetration of these technologies with four earlier innovations -- telephones, radios, televisions, and VCRs. While history is not a perfect guide to the future, it can help us predict how rapidly technological adoption will occur.

For example, if today's social commentators were transported back 50 years when TV was in its infancy, they would have seen what might have been called a "TV divide" between rich television owners and poor non-owners. Yet 10 years later, the TV divide was essentially bridged as the number of Americans with television sets skyrocketed. On the other hand, if those same commentators were taken back 75 years, they would see another divide, this time over telephone service, that would not get bridged for more than 50 years, after government universal service requirements shaped the marketplace. Today, a key question is whether the so-called "digital divide" is more likely to follow the path of the TV or the telephone. **Historical comparisons suggest that while the current gaps in computer ownership and Net access have risen over the past few years, they will soon begin to narrow as most Americans adopt these technologies.**

With a better sense of digital divide trends, we can determine the proper role and timing of possible government intervention. **For the time being, there is no compelling rationale for the government to subsidize computer purchases and Internet access for individuals. Broad subsidization is not warranted at a stage when many non-users could afford to become users if they wished to. Instead, government should work in partnership with the private sector to support access to computers and the Internet in schools, community centers, and other public places.**

Moreover, even if technological gaps persist, this alone will not justify government intervention. Other technologies, such as the automobile, remain unequally distributed, yet no government reports have been commissioned to look at ways to reduce the number of carless households. The case for intervening to raise rates of computer ownership and Net access will only be made if we can establish more compelling reasons, such as boosting education and training and facilitating digital government. We believe that case can be made. As a result, **if it appears that in the longer run, the few people not on the Internet are offline not because they choose to be but because they can't afford it, public subsidies of personal access may make sense. But we are still several years away from knowing whether this will be the case.** This paper makes four recommendations for how governments should deal with differential access to computers and the Internet**. PPI proposes that Congress and the Bush administration**:

- **Create a program to fund nonprofit initiatives that leverage private sector funding and talent to provide disadvantaged communities and individuals with access to computers and the Internet.** Current federal digital divide efforts have largely failed to build on and leverage successful private-sector-led efforts across the nation. Allocating some funds on a matching basis can leverage and expand many of these very successful efforts.

- **Create regional technology access and distribution centers** where vendors could make their products and services available to community-based groups and at which follow-up support and technical assistance could be provided.

- **Create a digital brigade within AmeriCorps** to educate citizens in disadvantaged communities about technology.

- **Monitor gaps in broadband access** between different demographic groups and geographic areas.

Analyzing Adoption Rates of Computers and the Internet

For anyone familiar with statistics on inequality, it should come as no surprise that technology access is lower among those with lower incomes, fewer years of education, or who are non-white or living outside urban centers. Tables 1 and 2 provide statistics for those households with computers and online access, broken down into different demographic groups.

Table 1: Percent of U.S. households with a computer[2]			
	1994	**1997**	**2000**
Overall	24.1	36.6	51.0
White	27.3*	38.7*	53.5*
Non-White	15.5*	25.5*	39.4*
Earning less than $15,000 per year	7.7*	12.5*	19.2
Earning more than $75,000 per year	63.4*	75.9*	86.3
Less than high school education	4.7*	9.1*	18.2
College graduate	50.7*	63.1*	74.0
Metropolitan	27.6*	38.5*	53.4*
Non-metropolitan	18.1*	28.8*	41.8*

Numbers marked * are not supplied in the reports and have therefore been calculated by the authors, based on an analysis of the CPS data.

Table 2: Percent of U.S. households online[3]				
	1994 (modem)	**1997 (modem)**	**1997 (Internet)**	**2000 (Internet)**
Overall	11.0	26.3	19.4*	41.5
White	12.0*	28.1*	20.8*	43.0*
Non-white	6.1*	16.9*	11.9*	29.1*
Earning less than $15,000 per year	3.0*	7.6*	5.3*	12.7
Earning more than $75,000 per year	34.4*	62.3*	50.1*	77.7
Less than high school education	1.4*	4.8*	2.8*	11.7
College graduate	25.3*	49.5*	38.4*	64.0
Metropolitan	12.4*	28.2*	21.1*	43.0*
Non-metropolitan	6.4*	18.4*	12.5*	30.9*

Numbers marked * are not supplied in the reports and have therefore been calculated by the authors, based on an analysis of the CPS data.

Yet because of the substantial overlaps between these various categories, it is inadequate to simply break down technology access by each variable. After the release of the 1995, 1998, and 1999 digital divide reports, a common response was to suggest that perhaps the only important variable was income and that tabulations of other variables simply represented the existing well-known correlation of education, race, and locality with income.

While controlling for income does reduce some of the gaps between the races or places, the gaps still exist. Using a technique known as multiple regression analysis, we are able to statistically describe the independent contribution of income, education, race, and locality -- in each case, holding the other variables constant. Based on these findings (see Appendix), we make a number of observations about access to digital technologies:

- **Income, education, race, and locality each have a statistically significant effect on access to technology**. But on average, only one-fifth of the variance between households' ownership of computers and access to the Internet can be explained by the combined effect of these factors. In other words, there are many other unidentified factors that explain adoption of these technologies. Indeed, the fact that 22.3 percent of American households with incomes over $75,000 do not have Internet access indicates that factors apart from those we have looked at influence adoption rates.

- Notwithstanding this, **there is a positive correlation between household income and adoption of information technology**. In 1994, an extra $10,000 made a household 3.6 percentage points more likely to own a computer and 2.0 percentage points more likely to be online. By 2000, the correlation between income and computer ownership remained the same, while the figure for Internet access had grown to 3.3 percent.

- **Education has a substantial (and rising) impact**. In 1994, an additional year of schooling led to a household being 3.8 percentage points more likely to have a computer and 1.9 percentage points more likely to be online. By 2000, these numbers had grown to 5.0 and 4.7 percentage points, respectively.

- **Being non-white reduces the probability that a respondent's household will own a computer or have Internet access**. The correlation between race and technological access has grown markedly in recent years. In the case of computers (controlling for income, education, and locality), non-whites had a computer ownership rate that was 6.4 percentage points less than whites in 1994, but 10.6 percentage points less in 2000, while the gap in those online increased from 3.2 percent in 1997 to 10.8 percent in 2000.[4]

- **The rural-urban gap for computer ownership and Internet access remains substantial.** Living outside a metropolitan area is correlated with lower rates of technological uptake. The difference between rural and urban computer ownership has increased from 3.9 percent in 1994 to 5.2 percentage points in 2000. The gap for online access has risen from 3.3 percentage points in 1994 to 6.3 percentage points in 2000. But despite this, race (white / non-white) is now more highly correlated with access than locality (rural / urban).

- **A household's probability of having a computer increases by a greater amount if the respondent has an extra year of education than if they have an extra $10,000 of household income**. The effect of a year of education on computer or Internet access is about 50 percent higher than the effect of $10,000 of income. Along with the fact that the income correlation is stable, while the education correlation is rising, this suggests that cost may be becoming relatively less important in determining access.

- **Notwithstanding these gaps, demographic groups with below-average rates of access to technology are improving their position**. Poorer people, those with lower levels of education, minorities, and those who live in non-metropolitan areas all have significantly higher rates of technology access than they did three years ago. **Just exactly how fast they are improving their position, especially relative to upper income households, is a subject of great debate and something of a "glass is half-empty, half-full" argument.** While it is true that the absolute gap in access rates between low income (below $15,000 per year) and upper income (above $75,000 per year) households increased between 1994 and 2000, access rates for lower income households actually grew faster, because they started from a smaller base. Because upper income households started from a higher point, their larger jump in access translates to a smaller increase as a percentage of their base. So while it is true to say that access rates for poor households are growing faster (as a percentage of the number who have access) than access rates for rich households, it is also true to say that in the last few years, the gap between the two groups has widened.

While these findings provide an accurate summary of the differences in digital access over the past six years, they offer only limited assistance in predicting trends. In this case, the immediate past may not be prologue. One way of ascertaining what is likely to happen is to look at how Americans have adopted similar technologies.

Historical Adoption Rates of Other Technologies

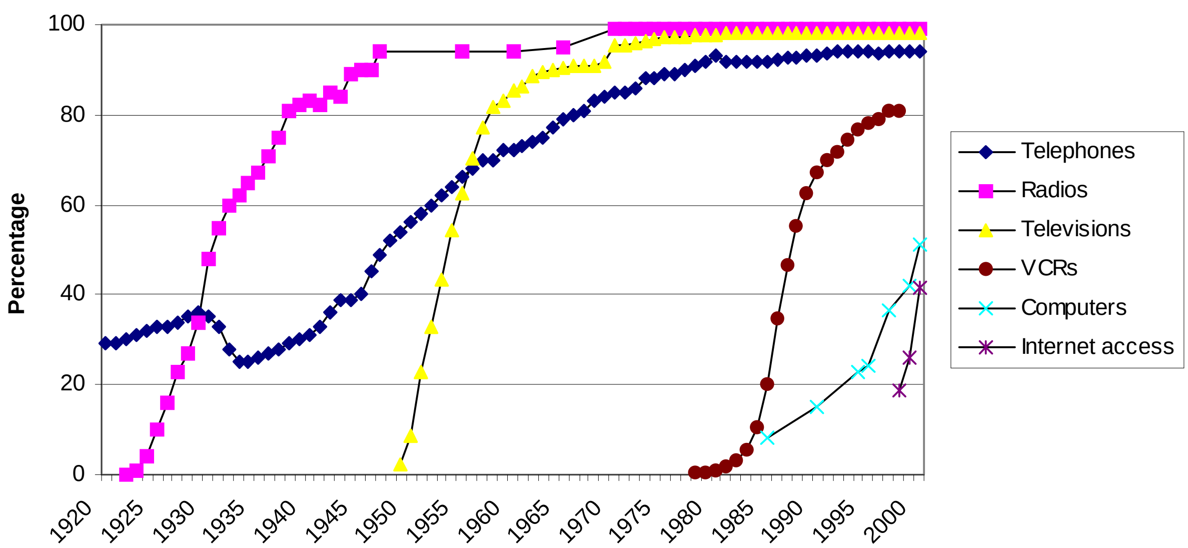
Studies of the adoption rates of new technologies by consumers are surprisingly sparse. The basic "S-curve" model suggests that for new products that eventually become ubiquitous, a graph of the percentage of people owning the product over time will climb slowly at first, accelerate, then slow again as the adoption rate nears 100 percent. Several factors, including price, government regulation, available content, and network effects, determine the point at which the trajectory begins to take off.[5]

Although equality of ownership between particular societal groups could conceivably vary as ownership rates increase, we can be confident that as the proportion of the population with a specified technology approaches 100 percent, differences in ownership rates must decline to near zero. Therefore, one way of considering how quickly the computer ownership and Internet access gaps are likely to close is to estimate how fast the technologies will be diffused through society. One way to do this is to examine the histories of other technologies.

For comparison, we have selected four technologies that played an important role in 20th century life -- the telephone, the radio, the television, and the VCR. These technologies share three characteristics. First, they were fundamentally different from technologies that preceded them.[6] Second, like computers and the Internet, they could be used both for entertainment and for more practical purposes -- such as communication (in the case of telephones) or education (in the case of radios, televisions, and VCRs). Third, data on penetration rates, and some data on equality of penetration, are available for each of the technologies.

Figure 1 illustrates the diffusion rates for each of these technologies. While the data set for radios, televisions, and VCRs is complete, the statistics for telephones, computers, and the Internet are incomplete. Nonetheless, it is evident that the uptake rate for telephones was substantially slower than for the other technologies. Although the rates for computers and the Internet now appear similar to radios, televisions, and VCRs, there is undoubtedly a much greater risk of a digital divide if their adoption rates come to approximate the rate of diffusion that occurred with telephones. The likelihood of such a scenario is discussed at the end of this section.

Figure 1: Proportion of households with various technologies

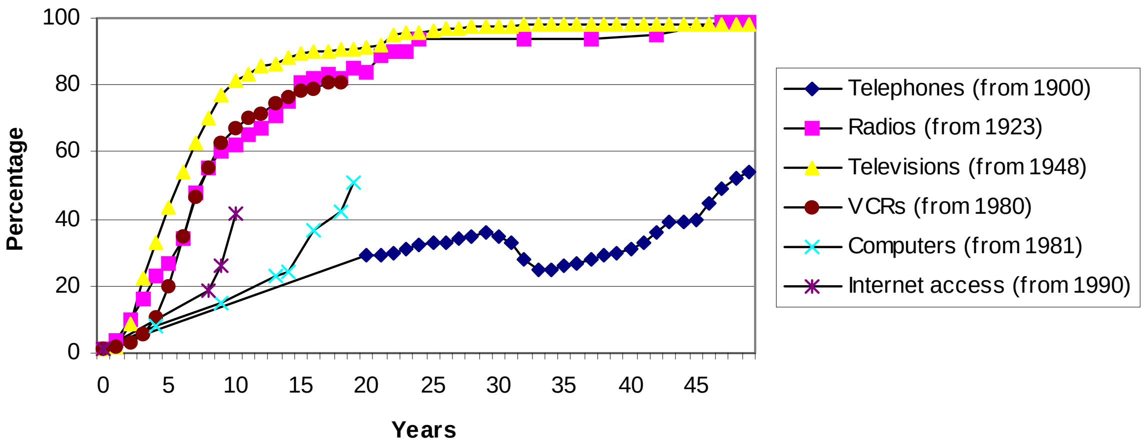


Data source: United States Bureau of the Census, *Statistical Abstract of the United States*, 1999.[7]

In order to properly compare the uptake rates of these different technologies, Figure 2 and Table 3 summarize how many years each technology took to achieve 50 percent and 90 percent penetration rates.[8]

On the basis of current trends in computer ownership, 90 percent of households will have computers in 2005. Trends in Internet access suggest that 90 percent of households will be connected even sooner -- in 2003, suggesting access through other devices such as TVs in addition to computers. Even if Internet penetration only grows as fast as television ownership (and its present exponential rate of growth cannot continue indefinitely, given the obvious upper limit of 100 percent), 90 percent of households will have Internet access by 2005. More conservatively still, if it grew at the rate of radio ownership, 90 percent would be connected by 2013; if at the same rate as VCR ownership, by 2018.

Figure 2: Proportion of households with various technologies (from 1% penetration onwards)



Data source: United States Bureau of the Census, *Trends in Telegraph*, 1998.[9]

Table 3: Rates of diffusion of different technologies [10]

Technology	Years until 50 percent penetration	Years until 90 percent penetration
Telephones (from 1900)	48	55
Radios (from 1923)	8	23
Television (from 1948)	5	15
VCRs (from 1980)	9	28*
Computers (from 1981)	19	24*
Internet (from 1990)	11*	13*

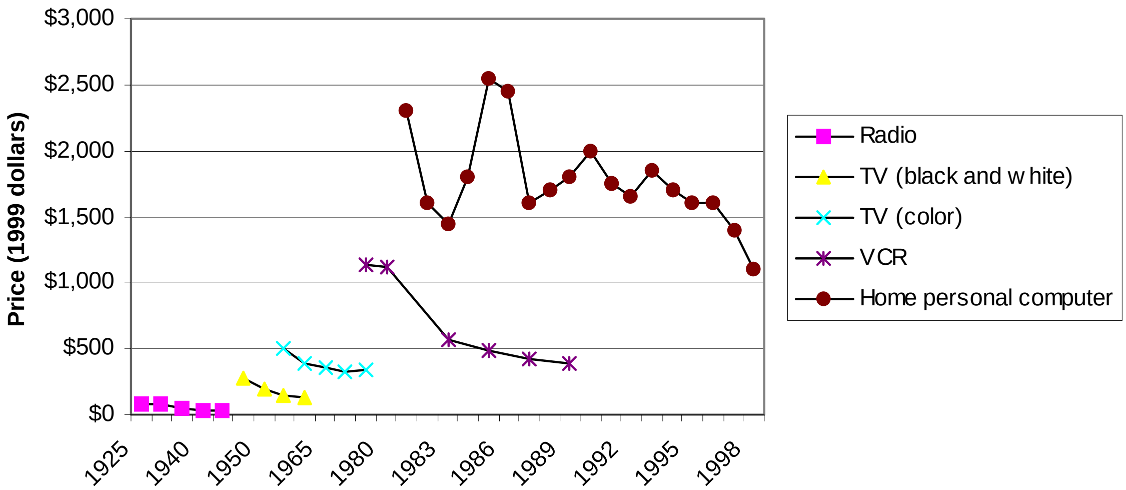
The only scenario under which connectivity would be substantially slower is if technological penetration occurred at the same rate as telephone connectivity. There are several factors that make this unlikely. First, an important difference between telephones and the other technologies in Table 2 is that telephones are principally a medium for interpersonal communication -- and so regular consumers will only purchase them if a sufficiently large number of other people they want to talk to also own telephones. Second, the initial infrastructure cost for telephones is significantly higher than for other technologies. Firms charged prices that allowed them to recoup the cost of installing telephone lines and exchanges. Third, the monopolization of the long-distance telephone market slowed the growth of the industry by keeping prices higher than they would otherwise have been.[11] Fourth, the spread of telephones was impeded by particular factors -- notably competition with automobiles and radios in the 1920s and the depression of the 1930s, which resulted in a particularly dramatic downturn in the ownership rate of telephones in rural areas.[12]

However, one commonality between telephones and the Internet that could slow adoption is the fact that (unlike radios, TVs, VCRs, and computers) both incur monthly costs. We turn to this factor next.

Technological Cost

One of the key factors determining the speed at which technologies are adopted is the purchase price. Figure 3 shows the current dollar cost of several different technologies upon their introduction onto the market. These figures control for inflation, though not for improvements in quality.

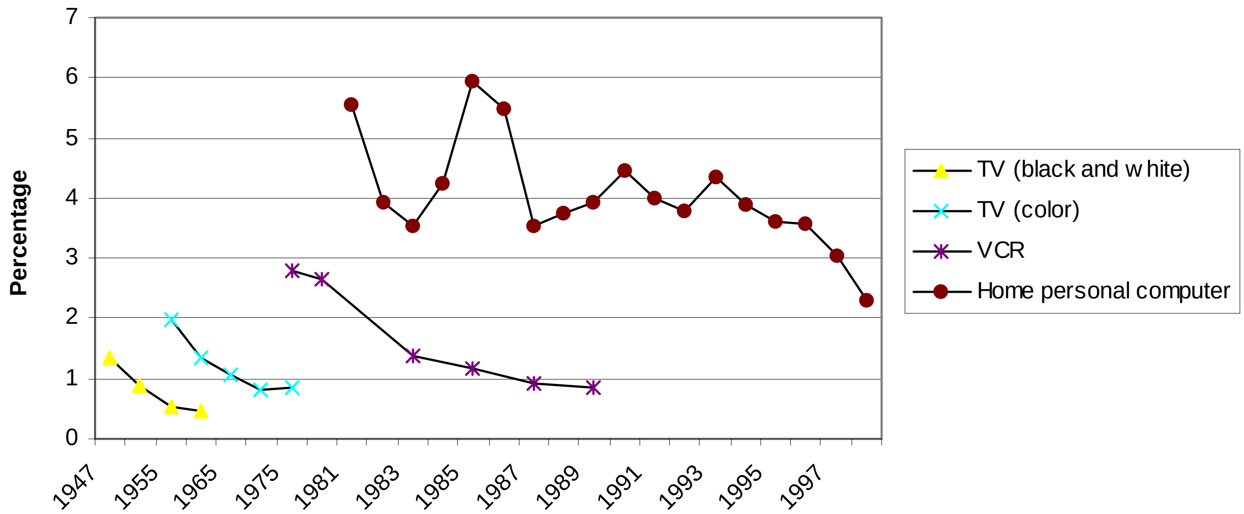
Figure 3: Average prices of selected electronic products



Data source: John Carey[13]

An alternative approach is to compare what proportion of earnings were required to purchase each of the technologies for a median household (see Figure 4).

Figure 4: Price of selected electronic products as a percentage of annual median household earnings



Data source: John Carey[14]

As both charts show, computers did not follow the pattern of the other electronic products. Unlike radios, televisions, and VCRs, whose prices fell rapidly in the years after their adoption, the average retail cost of a home personal computer actually rose in the years after its introduction, reflecting a greater consumer demand for quality improvements than for lower prices. However, quality improvements continued to be rapid throughout the 1990s as prices trended downwards.

While radios, televisions, and VCRs improved substantially in quality in the years after their introduction onto the market, the degree to which computers improved (in speed, memory, and disk size) far surpassed these other products. Nonetheless, given that the average price of a computer is now around $1,000, with some PCs available for around $300, price is less likely now to deter consumers from buying computers.

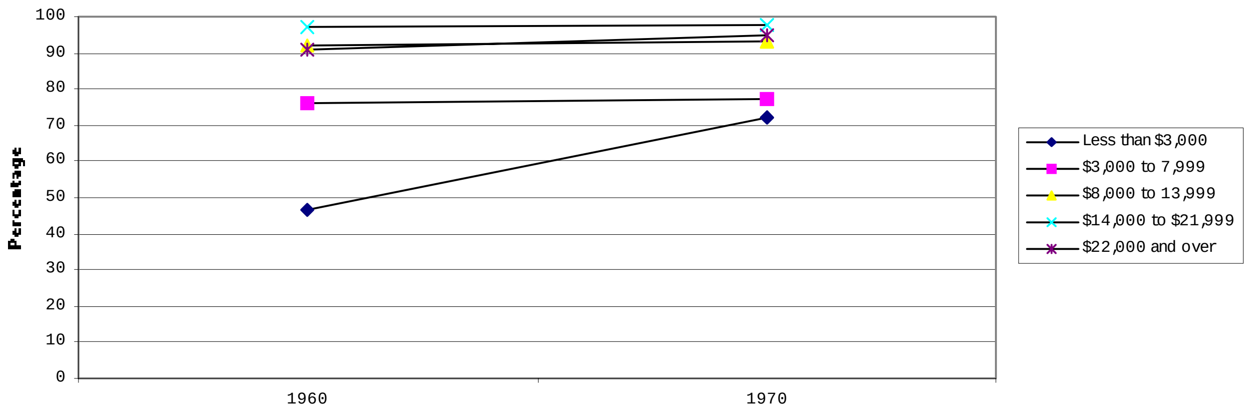
Compared to five years ago, Internet access costs are lower in inflation-adjusted dollars. As of August 2000, the average amount households paid was $21.28 per month, and free access to the Internet -- through companies such as Netzero.com -- is possible, at least for now. However, relative to radios, VCRs, or even computers that do not have fixed monthly costs, the fact that most Internet users pay some monthly fees is slowing adoption among low income Americans.

Equality of Ownership of Other Technologies

While past adoption rates provide some basis upon which to predict the rate of technological uptake, the best analogies for the digital divide will be found from data on adoption rates differing by income for earlier technologies. These statistics are less complete than the information on overall penetration rates but provide a useful illustration of the speed with which ownership gaps can be closed.[15]

In the case of telephones, the best available data come from the 1960 and 1970 censuses, since these data allow incomes to be adjusted for inflation.[16] During a period in which the average telephone ownership rate increased by 13 percent (from 78 percent to 91 percent), the gap between the bottom and the top income band narrowed rapidly. Whereas in 1960, this gap was 48 percent (94 percent to 46 percent), by 1970 it was just 29 percent (96 percent to 67 percent).

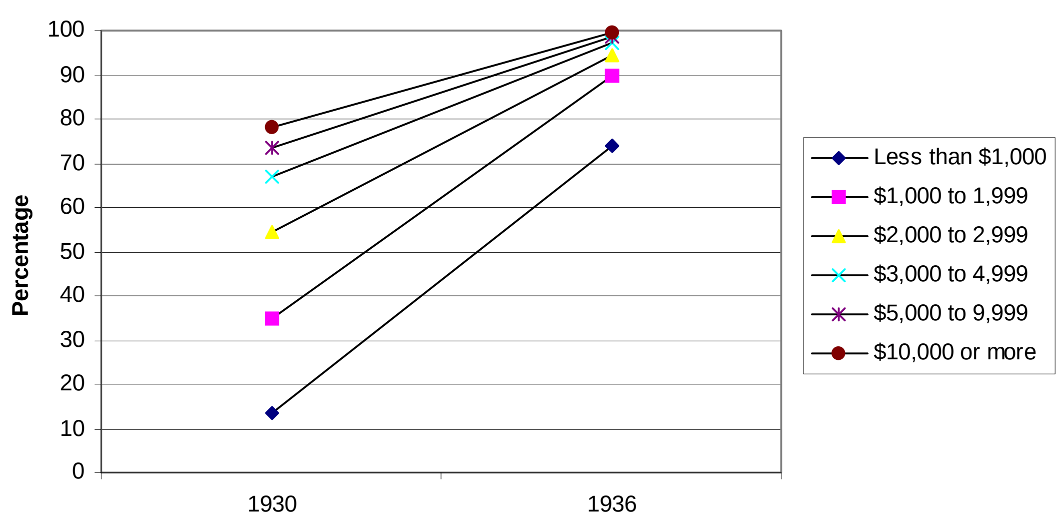
Figure 5: Proportion of households with access to a telephone, by income (1970 dollars)



Data source: Authors' analysis of data from U.S. Bureau of the Census, *Decennial Census*, 1960 and 1970.

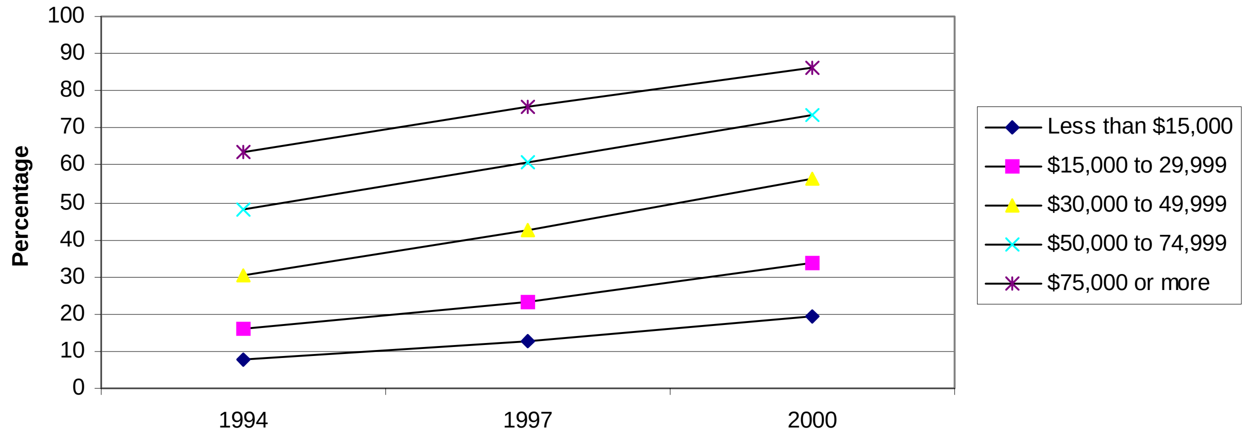
The trend for radio was even more rapid. As Figure 6 shows, households in the bottom income category were 64 percent less likely to have a radio in 1930 than those in the top income category (who were at least 10 times wealthier). In 1936, the gap between these two groups had closed to 25 percent. Although the income bands are not adjusted for the deflation that took place over this period, the trends are nonetheless dramatic. Despite the Great Depression, the "radio divide" closed substantially in just six years.[17]

Figure 6: Proportion of households owning a radio, by annual income



Data sources: Columbia Broadcasting System, *Vertical Study of Radio Ownership*, 1933; Columbia Broadcasting System, *Radio in 1936, 1937*.

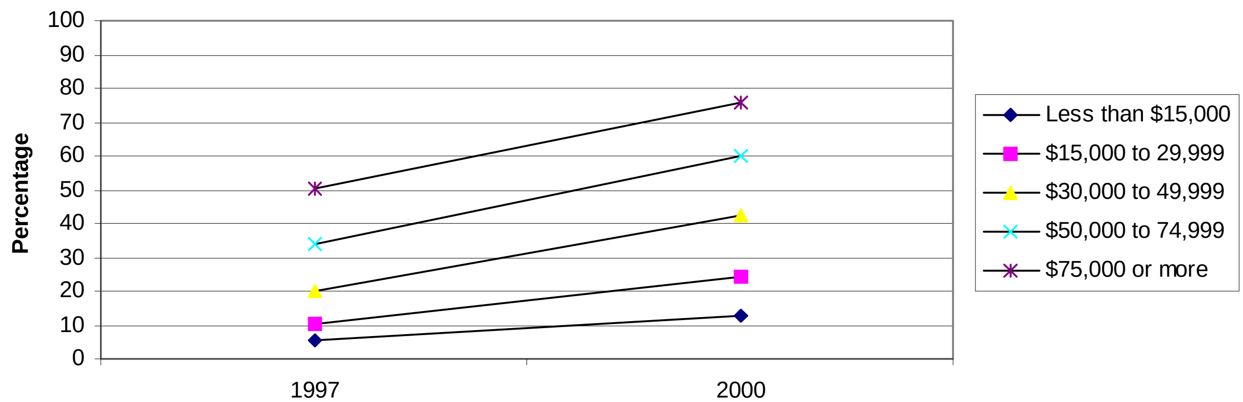
Figure 7: Proportion of households with a computer, by annual income



Data source: Authors' analysis of data from U.S. Bureau of the Census, *Current Population Survey, Computer Ownership Supplement* (1994, 1997, 2000).

When comparing this data to the trends in computer ownership and Internet access (Figures 7 and 8), two things should be noted. First, the graph of computer ownership covers a six year period -- less than the period of analysis for telephones, but the same as for radios (the Internet data is over an even shorter period -- just three years). Second, the endpoint for telephones and radios is an average penetration rate of around 80-90 percent, while the endpoint for computers is an average ownership rate of 51 percent and, for the Internet, 42 percent. We return to this issue shortly.

Figure 8: Proportion of households with Internet access, by annual income



Data source: Authors' analysis of data from U.S. Bureau of the Census, *Current Population Survey, Computer Ownership Supplement* (1994, 1997, 2000).

Unlike the telephone and radio data, the figures on computers and the Internet data both show a *widening* gap between ownership rates for those earning less than $15,000 and those earning more than $75,000. In the case of computers, the gap rose from 56 percent (1994) to 67 percent (2000), and for Internet access, from 45 percent (1997) to 63 percent (2000). If the data on penetration rates provided cause for optimism that the digital divide will soon close, these figures could be interpreted as suggesting the opposite -- that the digital divide, on an income basis, is getting larger.

Yet the more convincing interpretation is that these two trends can ultimately be reconciled, since they focus on different stages of the S-curve. At the endpoint of the period in question, the *average* ownership rate of telephones and radios was 80-90 percent -- compared with 51 percent for computers and 42 percent for Internet access. Moreover, although starting from a smaller base, the rate of adoption of the Internet grew more quickly for low income households compared to upper income households from 1997 to 2000. It therefore seems quite conceivable that equality of technological ownership could worsen at ownership rates of 40-70 percent, before improving at ownership rates of 80-90 percent. **If this theory is correct, current trends suggest that inequality of computer ownership and Internet access should begin to diminish within the next one or two years as adoption rates for higher income households flatten out and the adoption rates for lower income households start to increase more rapidly.**

Is There a Justification for Government Intervention in Fostering Equal Access to Computers and the Internet?

Since 1998, when the term "digital divide" was coined, the quality of statistics in the digital divide reports has improved substantially. Yet a clear argument has not been made in those reports for government intervention to assist those who do not have computers and Internet access -- and why the government should make that a higher priority than, say, intervening to assist those who do not have cars has not been made. We believe that three tests need to be met before government should intervene to remedy a digital divide. It must be established that there are gaps based on demographic variables, that some sort of gap is likely to endure, and that government intervention is the best solution.

There is no doubt that the first test for government action has been met -- technology gaps do exist. There are gaps in ownership of computers and access to the Internet on the basis of income, education, race, and locality. Moreover, with one exception,[18] each is a more powerful predictor of technology access than was the case six years ago. However, projections of penetration rates, combined with data on the equality of ownership of earlier technologies once ownership rises above 80 percent, tell a different story. **By the end of 2002, we predict that the gaps by income, education, and race will have finally begun to narrow.**

This suggests two possible rationales for government action. The first is to speed up the adoption rates so that gaps narrow. This rationale makes less sense if the Internet follows the route of the TV, but considerably more if it follows the telephone's path. The second rationale is to wait to see how far market forces lead to universal adoption and then determine if intervention is necessary to help low income households afford access. This is essentially the rationale for today's universal service subsidies for telephone service for the poor and households in high-cost (e.g., rural) areas.[19]

But even if intervention is needed either to speed up adoption or to address persistent gaps based on income, it is still not clear that there is a public policy purpose served by intervening. In broad terms, the rationales for government intervention seem to fall into four broad categories -- labor market outcomes, networks and social capital, benefits for children, and the delivery of government services online.

Labor Market Outcomes. Many digital divide reports open with statements like "the personal computer and the Internet are increasingly critical to economic success and personal achievement"[20] or "now, more than ever, unequal adoption of technology excludes many from reaping the fruits of the economy."[21] Some advocates would have us believe that anyone without a computer is doomed to economic and personal failure. Such language is hyperbolic -- the causal link is not so clear.

In their study of the effect of computers on inequality in the labor market, Autor, Katz, and Krueger find that "the shift towards college-educated workers, and away from high-school educated workers, was greatest in industries that experienced the greatest rise in computer use."[22] Moreover, they conclude that "the growth in the computer investment ratio can 'explain' approximately one-third of the increase in within-industry skill upgrading in U.S. manufacturing from the 1970s to the 1980s."[23] Similarly, Allen concludes that technology variables account for 30 percent of the increase in the wage gap between college and high school graduates.[24] While others have questioned these figures and suggested that the rise in inequality in white-collar jobs may also be due to other factors,[25] computers appear associated with the growth in wage inequality from the 1970s to the mid-90s.

Yet although these findings point to the importance of computers in changing the nature of the labor market, they do not answer the question of whether workers are less vulnerable to these shifts if they are competent in front of a keyboard, having owned a personal computer. At best, we can say that such a story does seem to make sense and might therefore justify intervention to help low-income, poorly educated Americans gain information technology skills.

Networks and Social Capital. Another rationale for government intervention might be to address so-called network problems. Austan Goolsbee and Peter Klenow have demonstrated that people are more likely to buy their first computer if they live in areas where a high proportion of households own computers or if a high fraction of their friends and family own computers -- even controlling for other factors that might also affect computer ownership.[26] They have found that if ownership rates are 10 percent higher in one city than another in a given year, the gap will be 11 percent the following year, assuming all else stays constant.

They explain this effect on the basis that the number of experienced and intensive computer users creates a "spillover" effect for non-users. They conclude that the effect is most probably related to the use of email and the Internet -- consistent with the view of computers being the hub of an information and communications network.

A related factor is the potential for dense computer networks in a particular area to create public benefits. For example, high levels of Internet connectivity might allow busy residents to become more involved in local affairs. However, it should not be assumed that high computer ownership and Internet connectivity will strengthen the social capital of a region. Harvard University professor Robert Putnam poses the problem thus:

> Will the Internet in practice turn out to be a niftier telephone or a niftier television? In other words, will the Internet become predominantly a means of active, social communication or a means of passive, private entertainment? Will computer-mediated communication "crowd out" face-to-face ties?[27]

Putnam is cautiously optimistic about this question, citing evidence that shows Internet users spending less time in front of the television. However, substantially more evidence is warranted before one can conclude that boosting Internet access rates will build social capital or that the benefits of network effects warrant intervention.

Benefits for Children. Government intervention could be justified if it is determined that children gain a substantial benefit from having a computer and Internet access at home. Again, there is surprisingly little evidence on the extent to which technological access boosts children's skills levels, but it seems reasonable (certainly more so than in the case of adults) to assume that having a computer in the home improves a child's learning, particularly those in middle and high schools.

As a means of addressing this problem, at least one state, Maine, has proposed purchasing laptop computers for most high school students in the state. In conjunction, government might choose to minimize the inequality between those who have home computers and those who do not by devoting additional resources to computer education in the classroom or to providing computer facilities in after-school care centers.

Delivery of Government Services Online. The delivery of government services online offers the potential for substantial administrative savings through lower transaction costs.[28] Yet if the government has an obligation to provide a service to all citizens, government agencies cannot cease providing the same services through physical offices -- lest it discriminate against those who are not connected to the Internet.

As a result, as Internet access approaches 100 percent in certain areas, it may be economically justifiable for government to subsidize Internet access for the remaining residents, in order that everyone can benefit from the administrative savings. In practice, it is difficult to imagine this occurring in the near future. Delivery of government services online might justify intervention at a later stage, but it appears a relatively weak argument in the current environment.

What Should Governments Do?

There are reasons, some more legitimate than others, to justify intervention to boost access to computers and the Net. But even so, it's not clear what government should do or when government should do it. Much of the answer depends on how fast technological uptake is expected. If the Internet follows an adoption rate like televisions or radio -- which rapidly reached near-universal usage rates -- efforts to subsidize individuals are premature. It would be better to wait until the market sorts out who is on the Internet and then determine if the remaining individuals are not online because of cost. However, if the takeup rates are likely to follow the path of the telephone, taking 40 or more years before usage is near-universal, and with most of the non-users being deterred by the price, public policies subsidizing Net access for low income individuals may make sense.

From the analysis presented here, it does not appear that Internet adoption rates will be as slow as telephone rates. Moreover**, given that current adoption rates are still quite rapid and show little sign of slowing, there is no strong case for government to now subsidize the purchase of computers or Internet access for low income Americans.** Additionally, there is a risk that subsidies might lock in technologies that become obsolete in a few years' time -- as occurred with the French government's support of the Minitel system.[29]

Yet there is an appropriate role for government now that is more limited. There are a range of issues that impede technology adoption in low income areas. It is essential that individuals in these communities see the relevance of technology to their daily lives -- and this enlightenment is best done experientially. Public policy must be aimed at ensuring not only that all Americans have access to the tools provided by the emerging information technology revolution but, just as important, that they all have the skills to use these tools. Therefore, we propose that government:

Provide Matching Funds to Support Private Sector Community Information Technology Alliances. Government initiatives should stimulate community-based groups to improve their technological capabilities, integrating the Internet and related technologies into their operations. Nonprofit organizations, sponsored by the private sector, should help schools and community-based organizations adopt and use information technologies. There is increasing interest in applying this model to wiring communities and to helping disadvantaged individuals use these technologies, including creating after-school programs to help children get connected. In addition, such efforts need to focus on ensuring that community leaders, teachers, and staff working in schools and in out-of- school programs are connected to the Internet, able to use email, and mentored in their use of technology.

However, to have a significant impact, these efforts need to be much larger. Federal funding should go to those organizations that are best linked to disadvantaged communities and can best leverage private funds. There are a host of private-sector-led efforts that have been established, both locally and nationally. Among these are Tech Corps,[30] PowerUP,[31] NetDay,[32] and the Giving Back Fund.[33] For example, the Rhode Island Tech Corps chapter has enlisted 460 volunteers to help 76 schools develop and implement IT plans for using computers and the Internet.[34]

But for the most part federal funds have gone either directly to schools and other government organizations or to nonprofit organizations with few or no links to the private sector. The two main federal programs aimed at boosting digital access -- the Technology Opportunities Program[35] in the Department of Commerce and the Community Technology Centers program in the Department of Education[36] -- have made little attempt to build upon and leverage the substantial private sector funding, leadership, and grassroots involvement that has emerged. More can be done to encourage private sector involvement. **Congress should create a separate initiative that funds programs which leverage private sector funding to help disadvantaged communities and individuals access computers and the Internet.** For example, the programs described above, and others that have substantiated involvement from the private sector, should be able to apply for federal funding to match the funds they raise from the private sector.

Create Regional Technology Access and Distribution Centers. As well-intentioned as corporate technology giving is, it is difficult for technology vendors to work effectively with the myriad of community-based groups that need their support. Similarly frustrating is the lack of qualified intermediaries or distribution centers at the regional level through which technology vendors can offer their products and services. In addition, donated computers often need refurbishing and support. Federal funds should be provided to create regional technology access centers where vendors could make their products and services available to community-based groups and where follow-up support and technical assistance could be provided. Organizations that might qualify as these centers include community colleges, urban universities, and nonprofit resource clearinghouses.

Create a Digital Brigade Within AmeriCorps to Educate Citizens in Disadvantaged Communities About Technology. Lower-income areas in rural and urban America need an equivalent of the 1960s Peace Corps initiative in order to be able to understand and respond to the challenge of the digital economy. This new digital brigade of AmeriCorps would be composed of individuals who understand the promise and the potential of technology -- but as users and innovators and not merely as IT or technical specialists. These individuals would work in the most challenging low-income communities to help them improve their community efforts, communications, education, and businesses. A "boot camp" and Internet support network could be developed to prepare and support Corps volunteers as they serve this mission and their country. Large information technology consulting firms would contribute training resources and provide experts in Internet-enabled business processes.

Monitor Gaps in Broadband Access. Over the next decade, the larger differences in access may turn out not to be between those who have access to the Internet and those who do not, but between those who have high-speed access and those without it. In August 2000, 10.7 percent of American households connected to the Internet used broadband service. Of these, the most popular technologies are cable modems (50.8 percent) and Digital Subscriber Lines (DSL), over phone lines (33.7 percent). Because of the cost of broadband, households using it tend to be richer. Because it is more available in urban areas, the users tend to live in metropolitan areas. They also tend to be white and better educated.[37]

But because so few Americans have broadband, it is too early to make any policy recommendations about broadband access for individuals. We can confidently state that access by business to high speed "broadband" telecommunications is critical if a region wants to grow or attract a wide variety of businesses. However, because the demand for broadband is most heavily concentrated in larger and mid-size metropolitan areas, telecommunications companies have rightly initially focused most of their investment in these areas. For most rural areas, lack of demand combined with higher costs means that telecommunications companies often cannot make an adequate return on investment to justify the demand.

As a result, in order to jump-start broadband development in rural areas, funding for the Department of Agriculture's Rural Utilities Service should be expanded to co-invest with telecommunications providers in rural broadband for business applications. Currently, only $670 million, or 13.3 percent of the RUS budget, is spent on telecommunications, and most of this is for plain old telephone service. In 2000, S. 2307, sponsored by Sens. Dorgan (D-N.D.) and Daschle (D-S.D.) and others, would have established a loan program to foster the deployment of broadband telecommunications by rural utility providers.

In addition, the federal government should continue to monitor usage rates of different Internet technologies. At present, most analysis of the digital divide lumps dial-up access and broadband access together. But as the predominant uses of the Internet change in future years, the government needs to focus on the question of who has broadband.

Conclusion

It's easy to forget that the Internet and the World Wide Web are still in their infancy -- a decade ago, there were less than 50 Web sites in existence. At such an early stage, we would expect differential rates of takeup by different groups of Americans. But that doesn't mean that public policy should not work to increase Americans' access to these key technologies. We believe that the best way to do this for now is to help expand community access, especially by leveraging private sector funding, leadership, and volunteers.

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Appendix: Determinants of whether a household has a particular computer technology (Ordinary Least Squares regression)

Variable	Computers			Modem		Internet	
	1994	1997	2000	1994	1997	1997	2000
Overall proportion of households with the technology	25.47%	36.62%	51.14%	11.05%	26.28%	19.37%	40.66%
Income ($10,000 increments)	3.64% (0.00087)	3.93% (0.00079)	3.59% (0.00071)	2.00% (0.00062)	3.39% (0.00075)	2.71% (0.00068)	3.30% (0.00072)
Education (years)	3.78% (0.00068)	4.50% (0.00074)	5.04% (0.00075)	1.92% (0.00050)	3.68% (0.00069)	2.94% (0.00063)	4.67% (0.00073)
Race (0=non-white; 1=white)	6.41% (0.0048)	8.09% (0.0058)	10.59% (0.0063)	3.23% (0.0033)	7.00% (0.0051)	5.57% (0.0046)	10.76% (0.0060)
Locality (0=non-metro; 1=metro)	3.86% (0.0043)	3.81% (0.0052)	5.15% (0.0056)	3.29% (0.0029)	4.82% (0.0046)	4.62% (0.0041)	6.26% (0.0054)
R^2	0.1806	0.2038	0.2168	0.1000	0.1745	0.1395	0.1952
N (households)	50969	47547	47504	50969	47547	47547	47504

Data Source: Authors' analysis of data from Bureau of the Census, *Current Population Survey, Computer Ownership Supplement* (1994, 1997, 2000)

Notes on Appendix:

[a] Robust standard errors in parentheses. All coefficients are statistically significant at the 1 percent level.

[b] The dependent variable is whether a household has a computer, a modem, or access to the Internet from home.

[c] All coefficients are calculated based on CPS household weightings.

[d] In 1994, respondents were not asked whether they had access to the Internet.

[e] In 2000, modem ownership had become irrelevant, since a significant proportion of households did not use a modem to access the Internet.

[f] Income has been recoded from standard CPS bands into a scale with an increment of $10,000.

[g] Education has been recoded from CPS bands into number of years of schooling.

[h] Race has been recoded from CPS categories into a white / non-white dummy variable.

Endnotes

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2. Sources: NTIA reports, 1995, 1998, 1999, 2000, cited in note 1.

3. Sources: Same as Table 1.

4. Since the rate of Internet access is higher for Asians than forwhites, the white / non-white gap we report is actually smaller than the gap between blacks and whites or the gap between Hispanics and whites.

5. John Carey, "The First 100 Feet for Householders: Consumer Adoption Patterns," in *The First 100 Feet: Options for Internet and Broadband Access*, eds. Deborah Hurley and James Keller (Cambridge: MIT Press, 1999).

6. Unlike, for example, satellite TV v. cable or DVD player v. VCR.

7. Data for telephone ownership before 1980 was reduced by 6 percent to make the graph continuous with subsequent years. This accords with the FCC acknowledgment (1975) that their data overstated the proportion of telephone households. FCC, *An Economic Study of Standard Broadcasting* (Washington, D.C.: 1946).

8. Since the data for three of the technologies does not go back far enough, we have relied on other sources to estimate the year in which 1 percent of households had telephones, computers, and the Internet.

9. Federal Communications Commission, *Statistics of Communications Common Carriers* (Washington, D.C.: 1975); Knowledge Industry Publications (1982. The Home Video and Cable Yearbook, 1982-1983; John Carey, op. cit.).

10. Note: Asterisk represents projected figure, based on a best-fit trendline. Trendlines for VCRs and computers are polynomials of degree four, while the trendline for Internet access is an exponential function.

11. Claude Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley: University of California Press, 1992).

12. Ibid.

13. Carey, op. cit.

14. Carey, op. cit. Median earnings data from United States Bureau of the Census, "Historical Income Tables -- Families," 2001. Historical data on monthly telephone costs are also not availible.

15. We have focused solely on income, since there is virtually no data on adoption rates of most technologies by education, race, or locality.

16. While it is not possible to compare these figures with prior or subsequent census years, Figure 5 nonetheless provides a useful overview of how access to a telephone became substantially more equal during the 1960s. The data in this table is drawn from a sample of 19,793 responses from the 1960 and 1970 censuses, maintained by the Integrated Public Use Microdata Series (IPUMS) project at the University of Minnesota. Income data is total family income, and 1960 incomes were inflated according to the CPI-U.

17. Unfortunately, comparable data is unavailable for television ownership. The 1950 census did not ask respondents whether they owned a television. By the 1960 census, differences between households were relatively minimal, since 85 percent of all households owned televisions. Likewise for VCRs, relevant data on

ownership by income is unavailable.

18. The impact of income on computer ownership fell slightly between 1997 (when it was 3.93%) to 2000 (when it was 3.59%). See Appendix.

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