56K Modems

A Reality Check

INFONETICS RESEARCH

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Contents

Exhibits

II. The Technology Issues

III. The 56K Players

I. Introduction

Modem technology has broken the 33K (or Kbps) barrier, but users and ISP buyers are cautious: there are some Telco line issues, and two not-quite-compatible technologies vie for user and ISP acceptance.

A. Modem Speeds Pushed to 56K

Ingenious incremental advances in communications technology in the last 20 years pushed modem capabilities from their early 300 and 1,200bps rates to 2,400, then 9,600, 14,400, and on to a supposed limit of 28K. That limit was not the very last word, as shown when a further ingenuity nudged it to 33K—but there it *was* supposed to stop, limited by Shannon's engineering law about maximum signal and noise ratios.

But modems now on the shelves offer speeds approaching 56K, at least in one direction. Shannon's law was not violated, but it was side-stepped. Twice: there are two technologies—K56flex and x2—and not yet an industry standard.

B. Competing 56K Technologies

Two rival camps have developed approaches that are similar in the way they get around Shannon's law, but not similar—in fact incompatible—in the details of their execution. The International Telecommunication Union (ITU) will promulgate a standard, but not until next year, by which time millions of 56K modems will be up and running one technology or the other. Both camps plan to provide options for upgrading modems to the standard.

C. And the Winner Is . . .Everyone

In the long run, users, ISPs, and modem vendors win. Users get faster Internet surfing, ISPs get new customers as the Internet and World Wide Web become positively fun to use, and equipment manufacturers sell a lot of modems. The research firm IDC predicts that worldwide unit sales of 56K modems to

consumers and business will hit 14.5 million in 1997, rising to a whopping 70 million in 2001—a 48% compound annual growth rate over the 5 years.

In the medium run, by early 1998, there will be an industry standard, so the two-camp confusion will dissolve and easier decisions can be made.

In the short run, for ISPs especially, the terrain is rough, but with a little caution it can be traversed.

This paper examines the current 56K modem situation: the technology issues, the major players on each side, the standards issues, and finally, what users and ISP buyers should do.

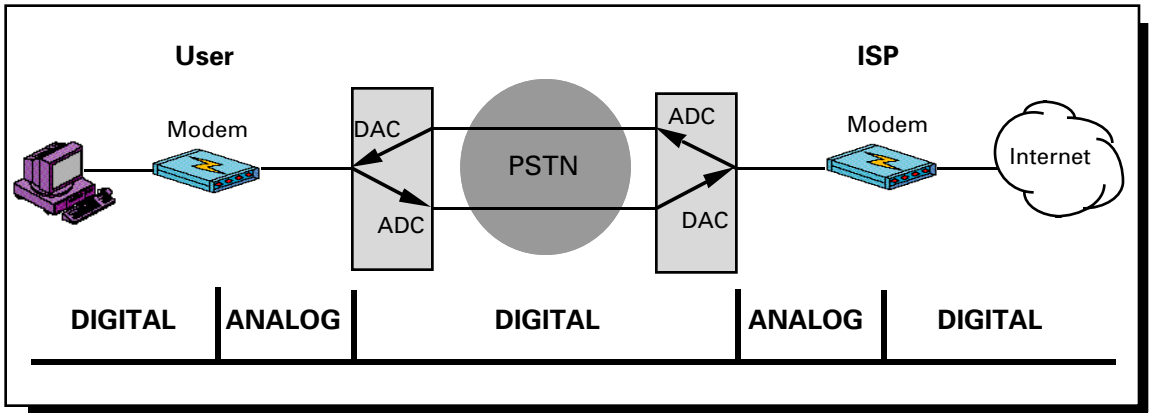
II. The Technology Issues

A. Real World Speeds

Regular modems, running at 33K or less, turn digital computer data into analog signals for phone line travel, with a similar modem at the other end, such as in an ISP's access server, turning the analog signal back to digital (see Exhibit 1). The process is symmetrical: digital-to-analog-to-digital going upstream to the Internet, and digital-to-analog-to-digital coming back down. In the stone age of modems, when speeds were 150 or 300bps, the phone lines were purely analog, and no other conversions took place. In today's phone system (the PSTN, or Public Switched Telephone System) much of the data actually travels digitally, resulting in a number of digital/analog conversions.

The process is subject to many vagaries along the way: the digital-to-analog converters (DACs) and analog-to-digital re-converters (ADCs) are not perfect, and the analog segments of the connection are especially subject to electronic noise. As a result, many connections made with 28K or 33K modems rarely achieve those speeds—connecting at 26K, 19K, or even 12K on noisy lines.

Exhibit 1 **Standard Modem Connections**



People access the Internet using computers, which generally respond quickly to keystrokes, which accustoms users to prompt response times. This makes

Internet access at 28K and 33K seem sluggish, and 14.4K seem glacial. Access approaching 56K begins to make the Internet feel like an extension of the computer.

B. The Digital Loophole

The two competing versions of 56K modem technology drop the symmetric plan of digital-analog-digital both upstream and back, and instead convert only once each way: analog-to-digital upstream and digital-to-analog back. Both approaches take advantage of 1) improvements in the phone system, 2) a function of analog-digital conversion, and 3) the Internet-oriented nature of consumer modem use.

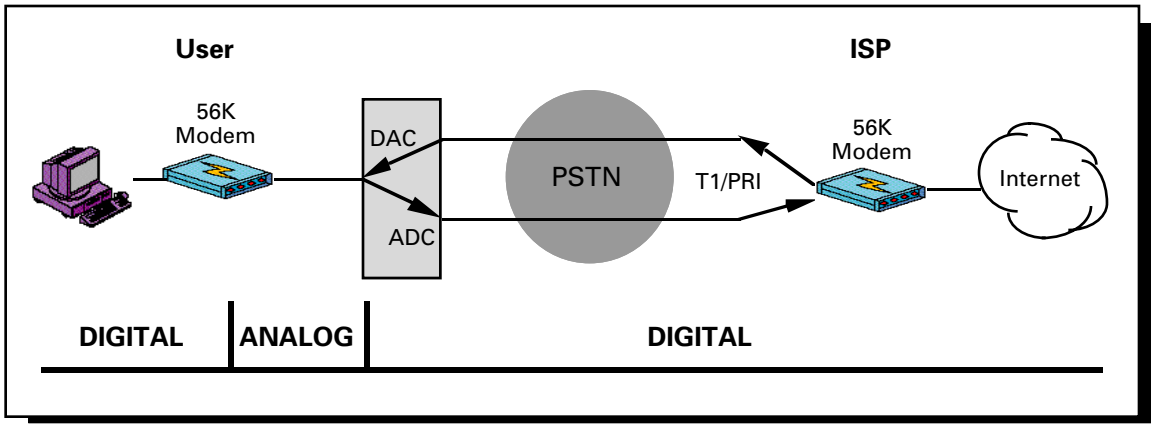
1) While modems convert a computer's digital data into an analog stream for the supposedly analog (voice) phone line, much of today's phone system is itself digital. In many areas of the country, the only remaining analog lines are the last few thousand feet from the local telephone branch (called the central office) to the user's home or office. This means that the analog signal need only travel that last leg. The rest of the path, to the ISP—within the ISP's network, and back to the local branch—can stay digital.

2) Furthermore, the cleanest conversion is digital-to-analog, needed on the last leg back from the ISP, and that means the downstream direction can be safely boosted to 56K.

3) And it is exactly that downstream part of the round trip that needs to be high speed: most user interactions are with the Internet, and consist of mouse clicks and short text going up, but long text and graphics coming down.

So, while standard modems must go through a number of conversions, the 56K technologies reduce the conversions to two, as shown below:

Exhibit 2 **56K Modem Connections**

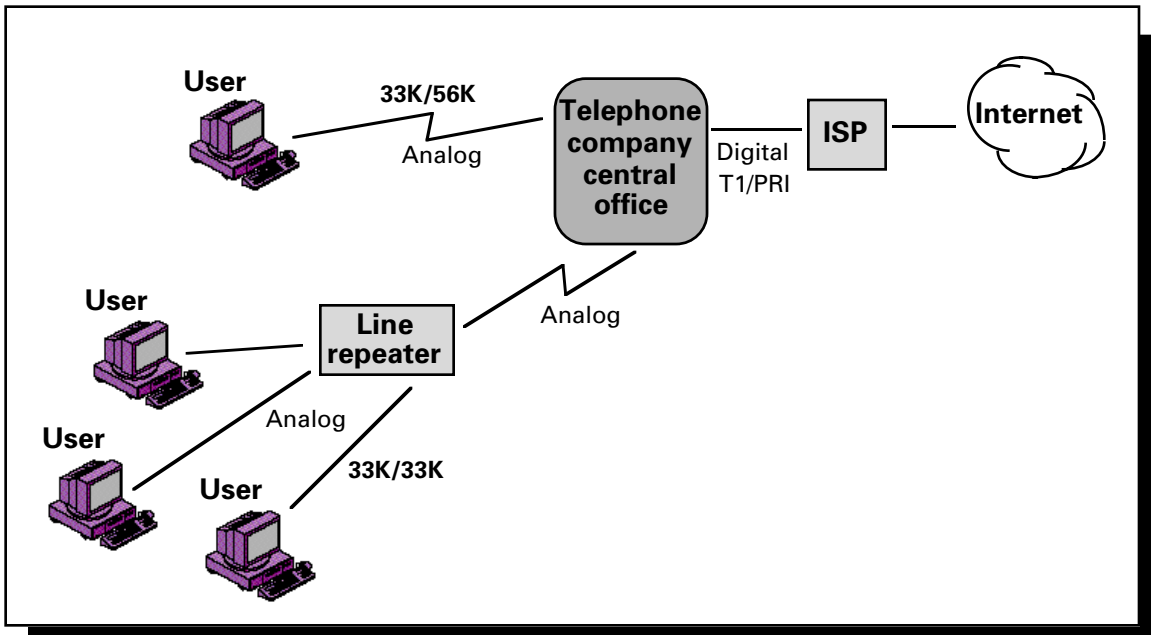


Until standards are achieved, both the user and ISP modems must use the same 56K technology, and the ISP's entire connection, notably a channelized T1 or PRI connection on the trunk side, must be digital.

In practice, as with the lower-speed modems, 56K may not be achieved—due to phone line characteristics, not because of any modem issues:

- The FCC has a rule (for quality of phone transmission) that limits signal strength, which in turn limits modem speeds to 53K.
- In some areas the phone company has installed line repeaters to extend a central office's reach (see Exhibit 3); being an analog link, they knock achievable speeds all the way back to 33K.

Exhibit 3 **Why Some Lines Can Only Achieve 33K**



Even if reaching 56K is an unattainable ideal, if a 28K modem were running at 25K on some line, a 56K modem would reach 50K, doubling download speeds. In the real world, 56K modems achieve speeds in the low 40s to over 50K, and with compression, higher effective rates are sometimes seen.

III. The 56K Players

A. The 56K Technology Originators

Three companies initially developed 56K modem technology:

- Lucent Technologies, the heir of Bell Labs, calls their technology *V.flex2*
- Rockwell International, the major seller of 33K chipsets, calls their technology *K56Plus*
- Texas Instruments supplies modem chipsets to US Robotics, which calls their 56K technology *x2*

TI/USR got to market first, but Lucent and Rockwell made their technologies each compatible with the other. Their joint 56K technology is called K56flex, and they have been joined by Motorola, Ascend, Cisco, Compaq and others, so that the fight is now between two camps: TI/USR vs nearly everyone else.

The battles are being fought from differing encampments: Rockwell and Lucent are prominent chipset manufacturers; USR is a major modem vendor. The fields of battle to which both camps sally forth are:

- **User modems** installed in PCs prior to sale or sold at computer stores
- **Access server** modems sold to ISPs

Since a near-56K speed can only be obtained when both the user's modem and the ISPs server modem use the same technology, both sides are racing to sign up allies.

For the end-user, it can be a difficult decision. But the end-user is only risking $75 to $250. For the ISP, with hundreds or thousands of modems to replace at a cost of thousands or millions, the decision is more challenging. Many smaller ISPs must buy new equipment because their old access servers cannot handle the digital connections required for 56K.

B. 56K Market Share Clamor

The current cacophony of alliance claims and victory announcements makes it difficult to find clear market signals amid the noise. Complete market statistics for current 56K unit shipments are not available, and may not be useful if they were—the market is in too great a state of flux. However, one statistic may be telling—the installed share of digital modems in access concentrators upgradable to 56K.

ISPs use access concentrators to handle the majority of modem connections in the Internet—mostly regular modems, but also ISDN in much smaller numbers. There are other older, smaller devices, but the vast majority of modem ports reside in access concentrators. For ISPs to add 56K service, they typically must upgrade new 56K modem technology (either download software or replace modem cards) into an access concentrator that has digital T1 or PRI connections. If the access concentrator doesn't have a digital T1 or a PRI connection, then it cannot be upgraded to 56K technology, but rather new equipment must be purchased.

In inspecting various available statistics related to digital modem port market share as of March 1997, it appears that a majority of digital modem ports in digital T1 or PRI access concentrators in the Internet are upgradable to K56flex (by replacement). This could push ISPs toward K56flex technology, which could in turn push user modems in the same direction.

Also somewhat revealing—although in flux—are the manufacturers and ISPs lined up in one camp or the other, or sometimes both. Exhibit 4 shows the technology alliances of the major retail modem vendors.

Exhibit 4 Client Modem Manufacturer Support

Client Modem Manufacturer	Supports K56flex (per K56flex players)	Supports x2 (per USR)
Best Data	✓	✓
Cardinal		✓
Diamond	✓	
Hayes	✓	✓
Motorola	✓	
US Robotics		✓
Zoom	✓	

At the ISP end of the 56K connection, access server manufacturers are mostly selling K56flex, as shown in Exhibit 5.

Exhibit 5 Access Server Manufacturer Support

Access Server Manufacturer	Supports K56flex (per K56flex players)	Supports x2 (per USR)
Ascend Communications	✓	
Bay Networks	✓	✓
Cisco Systems	✓	
Digital Equipment Corporation	✓	
Gandalf	✓	
Livingston	✓	
Microcom (Compaq)	✓	
US Robotics		✓

Boardwatch Magazine recently polled its ISP list to see what directions the dial-up access providers were moving. Most ISPs are holding back until things are clearer: as of late Spring 1997, 21% have actually made the move to 56K. But that 21% includes many of the largest ISPs. Exhibit 6 shows major ISP support, along with a few of the undecided majors.

Exhibit 6 Major Dial-Up Access Provider Support

ISP	Supports K56flex (per K56flex players)	Supports x2 (per USR)
AOL (35% BBN/K56flex, 65% ANS/x2)	✓	✓
AT&T WorldNet	✓	✓
Prodigy	✓	✓
NETCOM	✓	✓
CompuServe	✓	✓
Mindspring	✓	✓
EarthLink	✓	✓
MSN	✓	
PSINet	✓	
UUNET	✓	
IBM GlobalNet		✓
MCI		✓
Sprint	undecided (July 1997)	
GTE	undecided (July 1997)	
GoodNet	undecided (July 1997)	

Virtually all personal computers sold today include a modem, and most are now shipping with 56K technology. When buying a new PC, users should check that its internal modem technology is supported by their ISP.

C. 56K Performance

1. User Modems

Early tests by personal computer magazines (see the June 2, 1997 *PC Week* and the May 1997 *PC World*) indicate that K56flex and x2 technologies both achieve speeds in the neighborhood of 50K in real-world situations, if the local phone lines qualify (no telephone company remote concentrators, for example) and aren't too noisy. While not quite double the performance of 33K modems, 56K probably does double the average performance of 28K modems.

2. Access Servers

Although there was no essential difference between the performance of client modems using K56flex or x2, there may be a difference in applying 56K technology to remote access servers: tests conducted in June 1997 by the Tolly Group (and sponsored by Ascend) on two leading access servers, the USR Total Control Hub and the Ascend MAX™ 4048 server, showed the MAX™ 4048 consistently achieving higher data rates, especially as more clients were added to the servers' loads.

We believe this data is sound, but conclusions must be drawn with care; the results may not measure differences between K56flex and x2, but rather may show that the Ascend MAX™ 4048 system design produces a higher throughput.

IV. Standards

A. The ITU Standards Process

The K56flex and x2 camps have both created interest groups to show that large numbers of ISPs and network manufacturers will use their respective 56K technologies. But it is the International Telecommunication Union (ITU), a UN-backed standards organization, that will have final standards say.

The ITU expects a preliminary draft specification to be ready in September, 1997, and if the September goal is met, a final draft specification is to be ready for an approval process in January, 1998. (The preliminary draft will probably not prompt manufacturers to immediately develop products.) Historically, when there are competing technologies being offered, the standards bodies usually compromise at some point between the two.

B. Upgrading 56K Modems

Probably, everyone who buys either technology before the standards *gel* will need to upgrade. Buyers should be clear about what a vendor means by upgrading, and exactly which equipment qualifies. Users and ISPs should investigate the potential upgrade paths and the costs involved.

V. Reality Check: Go For It

A. Advice for Users

For a cutting-edge technology, 56K modems are remarkably inexpensive; some minor brands have been sighted below the $100 level, and standard brands are usually under $200. As with the sound and fury of the 28K standards war, when the dust settles, users are found to be winners.

Users and businesses can comfortably buy now, as long as their ISP supports the user's technology choice, because

- Performance is not an issue: both technologies are equally adept
- The 56K modems will almost certainly be upgradable to the eventual standard, at which point the two technologies will be interoperable
- In the worst case, having to buy a new 56K modem in 1998, the number of hours saved in the meantime will pay for it several times over

Certainly anyone needing to buy a modem has no reason to choose 33K: prices for the 56K models are not much higher, and if for whatever reason 56K isn't as yet available, these modems give great 33K performance in the meantime.

Users also need to test the telephone lines used for modems, and query their ISPs about support for either or both technologies. Some industry Web pages offer an immediate test to determine whether the connection to that Web page will allow 56K technology to operate; the sites can be used to pinpoint line difficulties if a 56K modem seems unable to come up to speed.

B. Issues for ISPs

For ISPs, the issue is more complicated: some Internet observers forecast an ISP shake-out just because of this upgrade, others think they'll sail through as easily as they did the 28K wars. Many ISPs are in a wait-and-see mode, which is properly cautious—until other ISPs upgrade and start stealing customers.

ISPs should thoroughly explore the upgrade paths for their access servers:

- Some upgrades can be done by software download
- Some upgrades require board swaps, which in some cases are free
- Some access servers or concentrators cannot connect to digital T1 or PRI lines, and must be replaced

Certainly ISPs should carefully check the amount of hand-holding a vendor is willing to supply. Supporting many users with new 56K modems may create serious help desk problem for ISPs.

C. International Advice

Internet users around the world want faster access. The players, products, and issues are the same, with some additional focus on ISP capabilities and local phone conditions.

Remember that for 56K to work, not only must the ISP offer the same 56K technology as the user's modem, it must be able to carry a digital signal throughout the connection.

As in the US, local phone lines may include analog remote concentrators that reduce maximum capacity to 33K, and they may be even more subject to noise. International users should also try the Web sites that offer line capacity tests.

International ISPs face the same issues as their US-based counterparts: carefully check access concentrator upgrade paths for pitfalls, and determine whether current access concentrators offer or can offer digital-only data handling.

D. Recommendations for Manufacturers

We recommend that network manufacturers push the standards efforts and end the confusion as early as possible. This will accelerate market growth: manufacturer sales to ISPs grow, ISPs' revenues grow, and users—businesses and consumers—use and enjoy the Internet more.

Modem manufacturers should clearly display information on their Web sites to educate users and ISPs about 56K technology, telephone line quality, and upgrade paths and policies.

E. Conclusions

The new modems work. Expect speeds in the low 40s to low 50s, roughly twice the real world speeds of 28K modems. And expect to upgrade to the ITU standard.

The price of progress is change, and in the co-joined world of personal computers and the Internet the change is regularly tumultuous. This change, like the advance to 28K and 33K modem speeds, will eventually work to user, ISP, and modem vendor advantage.

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