True Digital™ Modem Technology White Paper

Introduction

Remote access telecommuting and dial-up Internet access are growing rapidly—worldwide port shipments of remote access servers (RASs) have grown 187 percent from 1995 to 1996 (In-Stat, 8/96). As telecommuting and Internet access have grown in popularity, end user expectations of fast and reliable communications have risen, causing Internet Service Providers (ISPs) and corporate network managers to search for more reliable and robust solutions.

RAS Forecast **Source: In-Stat**

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Units (k) % change	74 113%	213 189%	611 187%	1,231 102%	1,599 30%	1,828 14%	2,033 11%
Ports (k) % change	639 226%	2,220 248%	6,380 187%	1,370 115%	2,170 58%	2,795 29%	3,473 24%

Remote access vendors have responded by producing a new class of integrated RAS. These units consolidate communications servers and modems into one chassis using high-speed digital trunks instead of individual phone lines. While these solutions offer several benefits, most still implement obsolete analog modem technology that burdens service providers and end users with operational headaches. Analog modems and their pseudo-digital descendants account for roughly 60 percent of all technical support time spent by ISPs, corporate operations, and even remote access vendors.

Solving the problems of analog modems is the next evolutionary step in remote access.

Evolution of RASs

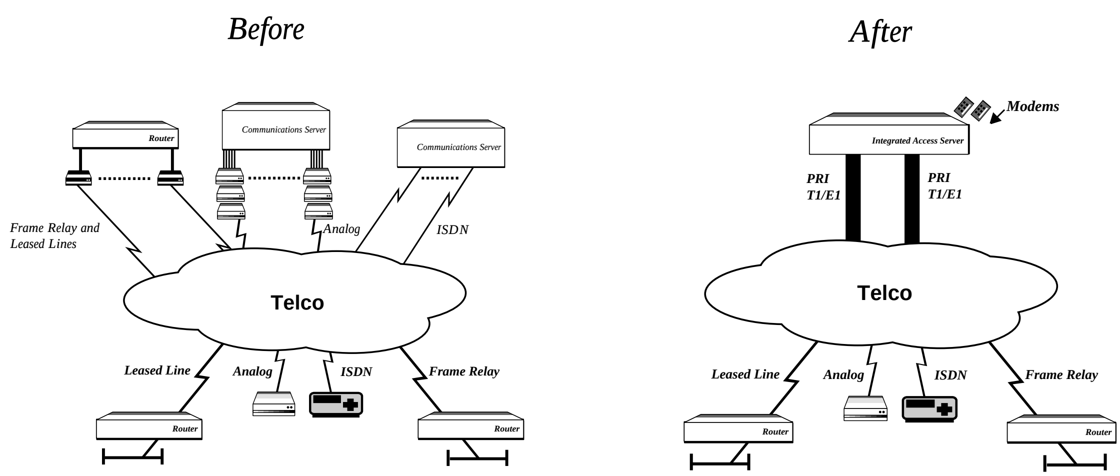
In the last five years, remote access has evolved from simple text-based terminal and proprietary "remote PC control" communications to interoperable remote LAN node and Internet communications using standards-based Serial Line Internet Protocol (SLIP), Point-to-Point Protocol (PPP), and Multilink PPP protocols.

The first generation of RASs were simply limited-function terminal servers such as those made by Xylogics, Xyplex, and Digital Equipment Corporation, with external modems attached. Second-generation communications servers like the Livingston PortMaster™ were designed specifically for remote access routing.

Third-generation RASs on the market today combine modems and communications servers into one chassis. These units integrate dial-in, dial-out, leased-line, and Frame Relay communications over high-speed digital T1/E1 and Primary Rate Interface (PRI) ISDN circuits. Integrated RASs improve manageability by consolidating all management tasks into a single administrative console. Integration also tends to reduce telephone line costs by combining the analog and ISDN calls into single or multiple T1/E1 or PRI hunt groups.

The most obvious benefit of integration was the elimination of external modems and the space, effort, and messy cabling they require for use with separate communications servers. Despite this integration, modem technology remained the weakest link in the remote access chain.

RAS Evolution



Evolution of Remote Access Modem Technology

During the same period, remote access modem technology evolved alongside its RAS counterpart. In the last five years, modem throughput has risen from 2400 bps to 33,600 bps; moreover, increased error correction and data compression have made remote node and Internet communications feasible over analog phone lines. Current advances in modem technology promise to take raw modem speeds up to 56Kbps and beyond, making modems a more viable long-term solution for remote access connectivity.

The first- and second-generation RAS approach to integrating modems was simply to attach external standalone or rackmount analog modems to individual communications server ports.

The third generation of integrated RASs are smaller and can be configured from a single interface. However, most integrated RASs on the market today still suffer from reliability, manageability, and heat problems because they employ obsolete analog modem technology.

Analog modems require complex and unreliable initialization string configuration and experience high heat dissipation, which results in low Mean Time Between Failure (MTBF) and inconsistent performance. These problems are difficult to resolve because analog modems cannot be diagnosed in real time—while a call is ongoing. As a result, support costs are high.

Many RAS vendors create end user confusion by calling their internal modem solutions "digital modems." However, analysis shows that these so-called "digital" modems are in fact "pseudo-digital" combinations of Rockwell-based analog modems and coder-decoder (CODEC) digital-to-analog converters. Pseudo-digital modems are burdened with the same core operational problems of pure analog modems. Ascend, Cisco, Gandalf, Microcom and others vendors offer such pseudo-digital modems.

Disadvantages of Analog and Pseudo-Digital Modems

- Unmanageability: Analog modem chips are single-function data pump devices. As a result, while a call is ongoing you cannot troubleshoot or diagnose problems in realtime as they occur. This limitation reduces troubleshooting analog modems to an educated guessing game, consuming technical resources and increasing the cost of operation. This is the most serious liability of analog modems.

- Finicky configuration: Analog modems require manufacturer-specific initialization strings, which are at best cryptic, and at worst impossible to configure correctly. Incorrect initialization strings cause innumerable compatibility and functionality problems.

- High power consumption and high heat dissipation: Analog modems are power hungry, usually consuming up to 6 watts per modem, which creates immense heat dissipation. When analog modem chips are deployed on high-density boards inside a RAS, the resulting severe heat dissipation causes lower MTBF.

- Inefficient performance: Pseudo-digital modems, which use analog modem chipsets, require a separate CODEC digital-to-analog converter chip to allow incoming calls in digital format over the T1/E1 or PRI phone line to be processed. This conversion increases call connection times and communications delay, resulting in decreased performance.

- Inconsistent performance: Due to initialization, MTBF, and CODEC problems, analog modems are inconsistent performers. They often fail, or do not perform as they should. Many ISPs and corporate remote access managers compensate for such inconsistent performance by "babysitting" their modems, consuming many costly hours of technical personnel time.

- No fault tolerance: Most analog modems and pseudo-digital modems are not swappable during use, which further prevents technical personnel from effectively troubleshooting problems. Moreover, service is severely disrupted when pseudo-digital modems must be removed from a RAS. In addition, because analog and pseudo-digital modems cannot be monitored digitally, they must be deployed on a fixed, one-to-one relationship with each T1/E1 or PRI channel. If a modem fails, the whole dial-in hunt group is disabled until the modem failure is detected by an administrator.

- High cost: Most pseudo-digital modem solutions are extremely expensive to deploy because their design requires separate and costly microprocessor, CODEC, static RAM (SRAM), and dynamic RAM (DRAM) chipsets.

- No migration to 56Kbps modem technology: The latest developments in modem technology are pushing raw throughput speeds up to 56Kbps and beyond. However, for 56Kbps connections to work properly, the entire end-to-end communication path must contain only one analog signal conversion. Because the end user modem performs a digital-to-analog signal conversion to make the call initially, all subsequent communications must be processed in all-digital format. RASs that implement analog and pseudo-digital modem solutions are not able to support 56Kbps speeds without wholesale, expensive hardware upgrades.

Virtues of True Digital Modem Technology

Livingston's PortMaster 3 implements next-generation True Digital modem technology that eliminates the operational disadvantages of analog and pseudo-digital modems. Rather than combining analog modems and CODEC converters, all modem functionality is implemented in a single off-the-shelf Digital Signal Processor (DSP).

- Lower heat, greater reliability: True Digital modem technology generates up to 90 percent less heat than analog modems, creating higher MTBF rates and reducing support burdens.

- Realtime modem diagnostics: The chief operational advantage of DSP modem technology is its manageability in realtime. While servicing a call, an administrator can have a realtime view of all important statistical and diagnostic information. Even during an operational problem such as a failure to negotiate with a remote modem, Livingston's True Digital modems allow complete administrative and diagnostic access. This diagnostic capability eliminates modem support guessing games and provides significant operational savings.

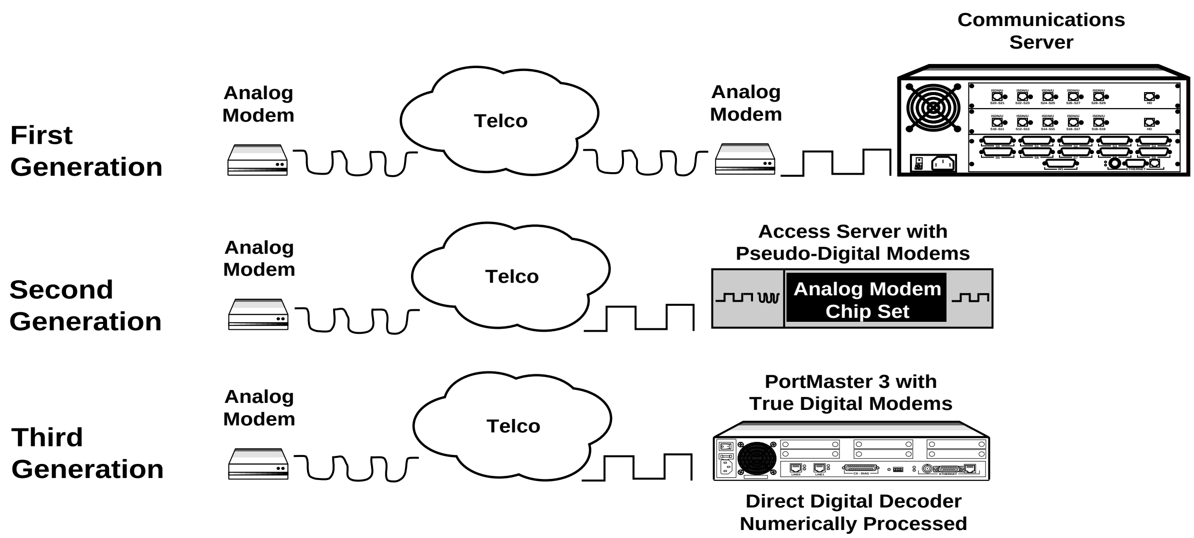
- Fast performance: All processing and V.34 protocol handling is done in pure digital format from the point that the call enters the RAS. The complete elimination of analog-digital conversion latency, combined with fast digital processing, allows DSP modems to significantly outperform analog and pseudo-digital modems.

- Fault tolerance: Livingston's True Digital modem technology enables fault-tolerant hunt group capabilities within the PortMaster 3 Integrated Access Server. Digital interfaces allow DSP modems to be pooled. The entire modem pool is accessed via a digital matrix switch from any dial-in channel on the T1/E1 or PRI circuit. Because DSP modems are multifunctional, a failed modem can be detected automatically by the PortMaster 3 and taken off line. On line sparing of modems within the pool prevents the hunt group from being disrupted.

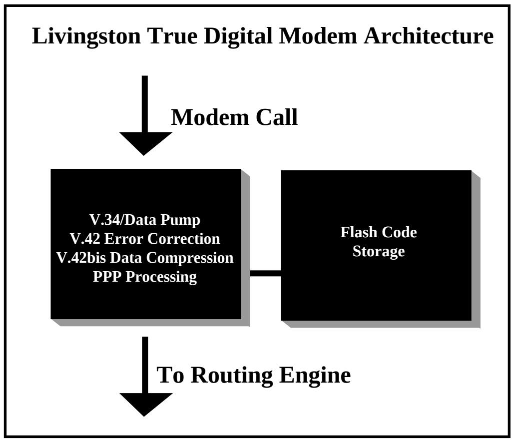
- Easy administration: DSP modems can be upgraded remotely from a central point, which significantly lowers the cost of implementing modem technology upgrades. Instead of physically swapping out modem hardware in every PortMaster 3, a single system administrator can upgrade all enterprise modems via software. True Digital modems will be upgraded to 56Kbps speeds and beyond as interoperable standards become available.

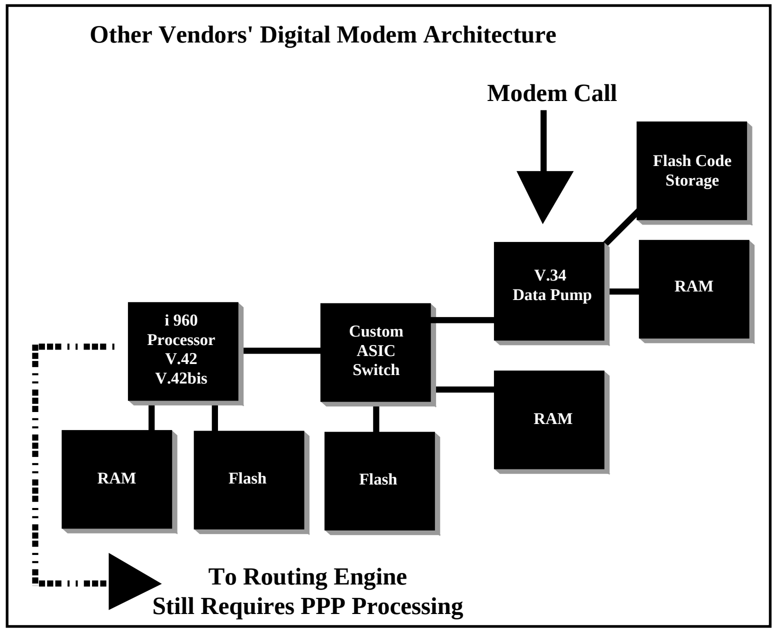
- Cost-effective multifunction DSP architecture: Unlike competing DSP architectures, True Digital modems use a single, multifunction DSP for all modem functions, including error correction and data compression. True Digital DSP processing power can also off-load communications functions (such as PPP framing) from the PortMaster 3's CPU, thereby boosting overall system performance.

Evolution of Remote Access Modem Technology



In contrast, MICA digital modem architecture requires several separate components to operate one modem connection. These components include an expensive i960 processor and custom application-specific integrated circuit (ASIC) chipset, as well as several DRAM and SRAM chips. As a result, MICA technology is more expensive, consumes more power, and dissipates more heat, thereby reducing reliability.





Conclusion

Livingston's True Digital modem technology is the next-generation RAS solution that best addresses the weakest link in remote access—analog modems. True Digital modems provide fast, reliable access and a future-proof migration path to new modem standards without obsolete modem hardware. For more information on Livingston products and technology, check out our web page at www.livingston.com.