WHITEPAPER

Lucent Technologies
Bell Labs Innovations

PortMaster 4
Integrated Access Concentrator:

Defining Carrier-Class Server Architectures

TABLE OF CONTENTS

INTRODUCTION

The increasing demand for Internet Protocol (IP)-based applications is forcing a radical change in the design of remote access server (RAS) equipment. Equipment that was originally developed for the consumer-oriented Internet service provider (ISP) market must now be re-engineered to support much heavier traffic and higher bandwidth service demands.

The expanded requirements of emerging technologies such as digital subscriber line (xDSL), Internet Telephony (Voice over IP or VoIP), and asynchronous transfer mode (ATM) transmissions further complicate the picture. Moreover, RAS equipment is now appearing in new environments such as the Central Offices (COs) of regional Bell operating companies (RBOCs), Postal Telephone & Telegraph (PTTs), new competitive local exchange carriers (CLECs), national ISPs operating large-scale points of presence, and corporations with large campuses and/or multiple locations.

In response to these trends, several major network equipment suppliers have announced a new generation of multi-service RAS they refer to as "carrier-class" concentrators. They tout high port densities, performance and reliability as key attributes of this new class of product. But for these products to effectively coexist in a CO and deliver new, high bandwidth services, they should be more than just a larger RAS. They should feature next-generation, future-proof architectures and the intelligence to flexibly accommodate fluctuations in all types of traffic.

Many of these new access concentrators, however, are based on traditional architectures that, in fact, do not deliver true carrier-class capabilities. With the launch of its PortMaster® 4 Integrated Access Concentrator, Lucent Technologies has defined the standard for carrier-class remote access concentrators with a product that supports any service, any port, any time operation. This is made possible through a superior design in three key areas:

- Switched-based architecture for multi-service support
- Integrated, fully distributed processing for scalable port density and performance
- Fault tolerance for reliable, continuous operation

This paper provides details on how the architecture of the PortMaster 4 specifically addresses these design criteria.

SWITCHED-BASED ARCHITECTURE

Moving data efficiently through the chassis is an important consideration in designing a carrier-class platform. The PortMaster 4 features an advanced ATM cell switching fabric to eliminate all/any congestion and arbitration delays, deliver low, deterministic latency and eliminate single points of failure. Many other designs, however, still use a traditional architecture based on Time Division Multiplexer (TDM) buses that still have these inherent pitfalls.

A TDM bus provides limited scalability, can be susceptible to bus congestion under heavy load, and can be a single point of failure. Because of the way it determines the order in which packets are routed, it cannot guarantee the time it takes to move data through the chassis (also referred to as latency). Inconsistent, or undeterministic, latency adversely affects performance and is a serious shortcoming when the RAS must support time sensitive applications such as voice and video.

Eliminates Single Points Of Failure

TDM-based designs mandate that each interface module installed in the chassis access the shared TDM bus, in a predetermined, specific time interval. While one module is transmitting data, all other modules must remain idle. If any one of these interfaces between a module and the TDM bus malfunctions, it becomes the single point of failure, interrupting service for the entire chassis.

Compared to older TDM-based designs, the architecture of the PortMaster 4 features the combination of an advanced 5 Gbps ATM cell switching fabric and a passive backplane. The ATM cell switching technology provides a highly reliable cross-connect matrix. The passive backplane architecture, in which all active components are removed from the backplane create a highly reliable system. Together, they allow for redundancy at the ATM switching fabric, eliminating single points of failure.

Further, the PortMaster 4's backplane creates a series of dedicated connections between the System Manager Module (SMM) and all slots within the PortMaster 4 chassis. These point-to-point connections establish permanent virtual circuits (PVCs) between the ATM cell switching fabric resident on the SMM and every line interface module, allowing completely independent operation of all modules in the chassis. This peer-to-peer, PVC, relationship virtually eliminates the arbitration inherent in traditional bus architectures especially at high utilization rates.

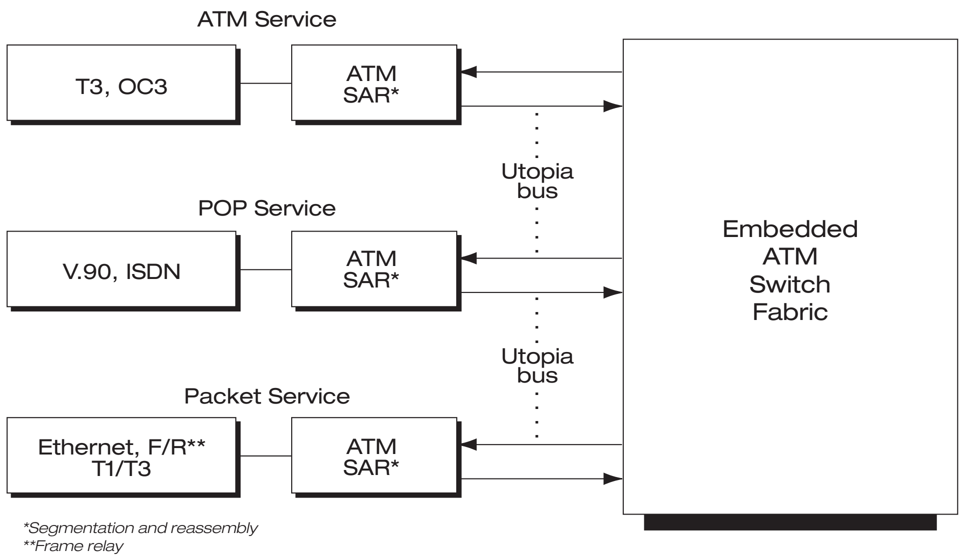
Allows For Unparalleled Scalability

Some TDM-based RAS designs tend to allow only a fixed amount of scalability. They utilize active components, mounted directly on the backplane, that operate at non-adjustable, fixed speeds. This, in effect, limits port capacity and the ability to add new high bandwidth technologies to the chassis. As customer migrate to higher density and higher bandwidth services, some so-called carrier-class architectures address these scalability limitations by increasing the bandwidth of the TDM bus. However, this requires costly upgrades and/or a new chassis and access modules. And, it does not provide for backward compatibility of existing equipment.

In contrast, the ATM cell switching design of the PortMaster 4 does not limit scalability, either in port density or technology. Used in conjunction with its distributed processing architecture, the ATM fabric provides a minimum of 155 Mbps (OC3) high speed, dedicated bandwidth to each slot. (Some older designs only provide 155 Mbps to the entire chassis.) With the PortMaster 4, there is never a problem with bus congestion or bandwidth contention. And, to allow migration to higher speed services such as ATM egress, one slot of its chassis supports 622 Mbps (OC12) of dedicated bandwidth.

Provides Deterministic Latency

In TDM-based designs, all modules are synchronized to the RAS' internal clock. The shortcoming in this design manifests itself when a number of clock sources must be synchronized. For example, one T1 connection may receive data with an external clock source, say the T1 line, which must be re-synchronized with the bus clock and perhaps re-synchronized once more as it reaches the destination interface. This unpredictable nature of such clock sychronization results in inconsistent and generally higher latency. Performance is adversely affected and the ability to support time sensitive applications such as voice and video is far less than optimal.



With a full T3's worth of dial up, PortMaster 4 still uses only 2% of available bandwidth. The PortMaster 4 delivers sustainable performance regardless of traffic load and provides an easy migration path to future broadband services and higher densities.

Unlike TDM-based designs, the PortMaster 4's backplane is clock independent. Plus, the ATM cell switching fabric provides independent, dedicated bandwidth to each slot. By having each slot operate independently, with no bus contention, the PortMaster 4 can predictably guarantee the time it takes to move data through the chassis. This is known as deterministic latency. This predictable, fixed low latency makes the PortMaster 4 ideal for emerging applications such as voice or fax over IP.

Fully Distributed Processing

The PortMaster 4's fully distributed processing architecture works together with its switch-based design and virtual backplane to deliver superior performance at any density. With distributed processing, the performance of the PortMaster 4 scales linearly as connections increase.

Each individual access module uses a hardware accelerator to connect modem Digital Signal Processing units (DSPs) and High-Level Data Link Controllers (HDLC) to an on-board 155 Mbps PCI bus. This accelerator grooms link layer data from the packet and then sends it directly to static random access memory (SRAM). A distributed central processing unit (CPU) on the module uses configuration parameters that it receives for the given port from the SMM to construct an 8 byte PVC descriptor (or header) for the link layer data.

The PVC descriptor is only used within the chassis and contains ATM specific traffic info:

- Digital Signal 0 (DS0) to external interface mapping information
- Virtual Path Identifier (VPI)
- Virtual Connection Identifier (VCI)
- Payload type
- General flow control (GFC)

Features	Lucent PortMaster 4	Other RAS Products
Full distributed processing	Yes	No
Packet forwarding	Yes	No
PPP framing	Yes	Yes
Packet filtering	Yes	No
Stac compression	Yes	No

Competitive RAS Matrix.
Unlike other products that claim to be carrier-class, the PortMaster 4 provides full distributed processing.

The PVC descriptor is then appended to the link layer data held in SRAM. This identifies which internal PVC (as specified by the local distributed forwarding table) will be used to forward the data across the PortMaster 4's cell matrix.

To complement this efficient, distributed packet forwarding technique, each PortMaster 4 access module can offload other traditional RAS functions from the chassis' CPU, including routing filtering, point-to-point protocol (PPP) framing, and Stac-based compression encryption. Whenever an access module is added to the chassis, more CPU power is also added to ensure the highest level of performance. This technique delivers full media rate routing, even under the most heavily loaded conditions.

By contrast, while other traditional RAS architectures claim to support fully distributed processing, their implementations are limited to the simple task of PPP framing. That means that all packet forwarding, filtering and compression processes cause inefficient bi-directional packet flow across a shared bus architecture, adding to bus congestion and increasing variable latency, even under normal operational loads.

FAULT TOLERANCE FOR CONTINUOUS OPERATION

The PortMaster 4 distinguishes itself among carrier-class remote access platforms by providing fault-tolerant, continuous operation through a mature operating system, the previously discussed passive backplane, advanced power distribution, and an efficient thermal design. Up to 3 N+1 AC power supplies, 4 hot-swappable cooling fans, and hot-standby modem DSPs eliminate all single points of failure.

Lucent Technologies ComOS®

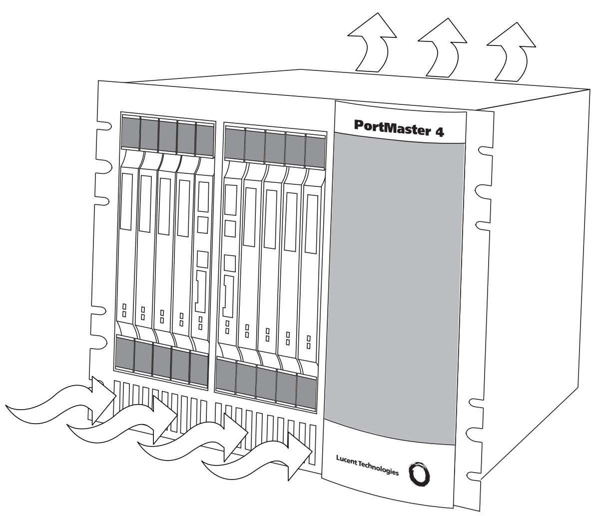
Lucent Technologies ComOS remote access operating system supports thousands of network service providers and millions of Internet users worldwide. Refined over nearly a decade of use in 78 countries, ComOS interoperates in virtually any environment. It supports every commonly used protocol with no additional charges or license fees. Lucent's relentless pursuit of perfection has delivered a complete, robust, yet incredibly easy to use remote access operating system.

“Virtual” Backplane Architecture

The PortMaster 4 uses a unique passive “virtual” backplane architecture, which removes all active components from the backplane, to create a highly reliable chassis. In addition, this passive backplane design makes the PortMaster 4 technology independent, by facilitating the addition of new features to support services such as video conferencing and switching without wholesale upgrades to the wiring or the chassis itself.

Advanced Power Distribution

The PortMaster 4 operates from a native -48 volts DC power source, distributing power directly to all modules installed within the chassis. Each module has an on-board DC-to-DC converter to supply the required operating voltages. Redundant, load-sharing AC power supplies can also be installed in the chassis to deliver N+1 power distribution.



The PostMaster 4 includes front-loading cards, field-replaceable cooling fans, advanced thermal design, and redundant hardware to maximize system uptime.

Optimum Heat Dissipation

An advanced thermal design that includes intelligent thermal sensing and front-to-back air flow ensures optimal heat dissipation in the PortMaster 4. The unique front-to-back air flow system allows multiple chassis to be safely stacked directly on top of each other within a standard telco cabinet. A built-in digital thermometer measures the heat characteristics of each installed module. Should unexpected problems such as power or fan failure occur and temperatures reach unacceptable levels, the SMM will automatically shut down modules, preventing damage to the unit.

True Digital™ Modems

The PortMaster 4 uses Lucent True Digital™ DSPs for V.90 modem connectivity. True Digital modems emit less heat for dramatically improved reliability and feature automatic self-configuration and real-time diagnostics. As an added advantage, Quad T1 or Tri E1 modem modules are “over-populated” with modems. That is, the modules contain more DSPs than the total number of usable ports. This creates a pool of "hot" spares, for additional reliability. The Lucent DSP design also allows for software upgrades to allow for future support for emerging technologies, without expensive, time-consuming hardware upgrades.

CONCLUSION

Before investing in any carrier-class product, network planners should give careful consideration to the product’s architecture. Can the platform provide multi-service, high-speed bandwidth support? Does it support flexible, ultra-high port density? Does it deliver linearly scalable performance? Does the platform provide high reliability and fault tolerance for continuous operation?

The Lucent Technologies PortMaster 4 was designed to meet all of these requirements and more. Lucent understands the stringent demands of CO environments, large-scale points of presence, and corporations with large campuses and/or multiple locations. The PortMaster 4 has changed the face of carrier-class remote access. Its unique hardware design, reliable ComOS operating system and “any service, any port, any time” operation truly place it in a class by itself.

Lucent Technologies
Remote Access Business Unit
4464 Willow Road
Pleasanton, California 94588-8519
Tel: (925) 730-2500   Fax: (925) 730-2510
website: http://www.lucent.com/dns/portmaster

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