



Stinger

The ATM-Based DSL Access Concentrator for the Next-Generation Public Network

Continuing advances in DSL and ATM technologies give today's carriers and service providers unprecedented revenue-generating opportunities and potential for growth. By transforming existing twisted-pair telephone wires into high-speed data connections, DSL provides customers fast, always-on access, and enables carriers and service providers to offer a variety of profitable services including voice, video and data. Concurrently, ATM technology is cutting expenses and enhancing performance by revolutionizing the way data is passed through the core backbone network. The performance and integrity of the DSLAM concentrator between customer DSL lines at the edge and ATM switches at the core is therefore critical for the entire network to operate at peak performance.



Stinger™ is Lucent Technologies' family of industry-leading, next generation DSL access concentrators and has been developed to provide optimal performance in this critical network application. Stinger is designed with a future-proof busless architecture that avoids the scalability and throughput restrictions imposed by proprietary bus designs. The system's dataflow is extremely flexible because Stinger is built around a high capacity ATM switch. Modular system architecture makes Stinger easy to expand and upgrade and provides complete system redundancy. Stinger's software features, processing power, and memory capacity can be easily upgraded to reflect future state-of-the-art technology. The result is the most expandable, scalable and robust DSL access concentrator available.

Stinger Overview

Designed for tomorrow's networks and traffic

The Stinger product family is a series of carrier-class DSL access concentrators designed for forward-looking carriers and service providers. It offers all of the benefits ATM brings to multiservice networks, including lower installation, operation, and maintenance costs, effective bandwidth management, high availability, and superior performance.

Addressing the needs of carriers implementing cell-based backbone networks, Stinger features the high-capacity traffic aggregation capabilities, full quality of service support, and robust "always on" performance expected of a true carrier-class product. It is also extremely easy to provision, manage, expand and upgrade. Part of a complete switched networking solution extending from end-user to end-user through the core, Stinger delivers greater throughput and lower system cost than any competing product.



Stinger FS



Stinger LS



Stinger RT

Unprecedented flexibility and capacity

The Stinger product family includes the high capacity Stinger FS and the smaller profile Stinger LS. The Stinger FS has a port density of up to 672 xDSL ports. This capacity yields over 2000 xDSL ports when 3 shelves are placed in a standard central office rack, providing the highest port density of any DSLAM on the market. There are two versions of the Stinger LS to accommodate 19 and 23 inch central office racks. Model 1 offers a port density up to 240 xDSL ports and Model 2 up to 336 xDSL ports. Both LS models are also offered in an environmentally hardened version, called the Stinger RT, designed for use in outdoor environments such as curbside cabinets.

All Stinger models support ATM and Frame Relay communication protocols over subscriber lines, as well as all of the most widespread DSL access technologies such as ADSL, G.lite, SDSL, HDSL2, SHDSL, and IDSL. VDSL support will be added to the portfolio in the near future. Stinger's flexibility makes it ideal for aggregating numerous connections originating from Lucent's CellPipe and DSLPipe products in addition to other 3rd party customer premises equipment (CPE).

In recognition of the statistical nature of data traffic, Stinger uses internal high-speed ATM switching instead of multiplexing for traffic aggregation. Switching makes the flow of internal traffic more efficient because no bandwidth is wasted on ports with intermittent or no data. Stinger supports as many as 8 virtual connections

per subscriber and can buffer over 150 cells per connection. This buffering helps keep bursty traffic flowing quickly and smoothly throughout the entire network.

A perfect interface for ATM backbone networks

Stinger is fully compatible with popular ATM core switches, such as the Lucent CBX 500 and Lucent GX 550. It is the ideal high-speed central office DSLAM for ingress to the main switch core. However, since Stinger is based on an ATM switch, it is also suitable for trunk-to-trunk switching and line-to-line switching to save on trunk costs. Numerous Stinger shelves can be connected together in any combination of star and daisy chain topologies.

Like the CBX 500 and GX 550 ATM switches, Stinger provides usage parameter control (policing), congestion control, bandwidth management and quality of service (QoS) guarantees. By ensuring a consistently fast and smooth traffic flow, Stinger DSLAMs enable carriers to offer—and easily fulfill—customer Service Level Agreements (SLAs).

Engineered to keep networks up and running

The redundant modular architecture Stinger employs is designed for the rapid detection, diagnosis and mitigation of line and equipment problems. In the event of a module or port failure, Stinger can automatically raise an alarm and bring a backup online. The defective module or port is automatically

taken offline and can then be hot-swapped at the network manager's convenience.

To ensure line integrity, network managers can locally or remotely command an optional test module in the Stinger chassis to perform a wide range of broadband copper loop tests. This enables immediate loop trouble shooting within the chassis without relying on an external, third party device.

Line protection features within the Stinger modules help to keep mishaps at bay by isolating the modules from outside forces such as foreign voltages and current surges. Other features that help keep the network up and running include redundant trunk interfaces, a distributed power system, and a heat-sensing fan assembly that automatically adjusts airflow to maintain an even internal temperature.

Features and Benefits

Flexibility

The Stinger family supports all of the major types of DSL. These technologies may be intermixed in the same chassis in any combination. One Stinger unit can also support a mix of OC-3/STM-1, DS3/E3 and T1/E1 IMA trunk interfaces. This level of flexibility allows Stinger to handle all of today's traffic and to accommodate future traffic protocols not yet standardized.

Highest Density

One Stinger FS chassis can handle up to 672 DSL ports. A cluster of three Stinger FS chassis'

offers the highest port density available within a single central office rack (2016 ports per rack). Both models of the Stinger LS and RT offer high density in a smaller footprint, and each is sized for optimum density in its specific application. In the future, higher density line cards will further increase the port capacity of all Stinger models.

High Availability

The Stinger family is designed for continuous operation with no interruption of service. All models offer optional 1:1 protection on control and trunk modules, as well as 1:n redundancy for subscriber ports on line modules. All system modules are fully hot-swappable. Hot swapping permits rapid restoration of full capacity in the unlikely event of a failure. Other redundant features include a fully distributed power system and redundant line filters.

Stinger also supports PNNI, a dynamic ATM routing protocol which enables service providers to build self healing ATM networks. If an ATM switch or link becomes disabled, Stinger is able to automatically re-route the circuits around the fault utilizing standards-based PNNI protocols, including soft permanent virtual circuits (SPVCs). A

SPVC is an ATM circuit that consists of a Permanent Virtual Circuit (PVC) on the subscriber port and a Switched Virtual Circuit (SVC) on the trunk port. By utilizing SVCs in the ATM network, Stinger has the ability to provision end-to-end circuits from a single system, greatly reducing the cost to provision a DSL loop.

Quality of Service

By offering Service Level Agreements based on Quality of Service (QoS) classes, carriers can maximize their revenue potential with diverse pricing levels for different broadband applications (i.e. voice, video, and data). For example, a video conferencing service requiring a steady uninterrupted amount of bandwidth would be priced higher than basic Internet access, which can accommodate bursty traffic. Stinger's family of DSL access concentrators support the full ATM Forum Traffic Management specifications (V4.0), with four distinct levels of Quality of Service classes: Constant Bit Rate (CBR), Real-Time Variable Bit Rate (VBR-rt), Non Real-Time Variable Bit Rate (VBR-nrt), and Unspecified Bit Rate (UBR). Stinger can be upgraded with additional software to support future QoS classes such as Available Bit Rate (ABR).

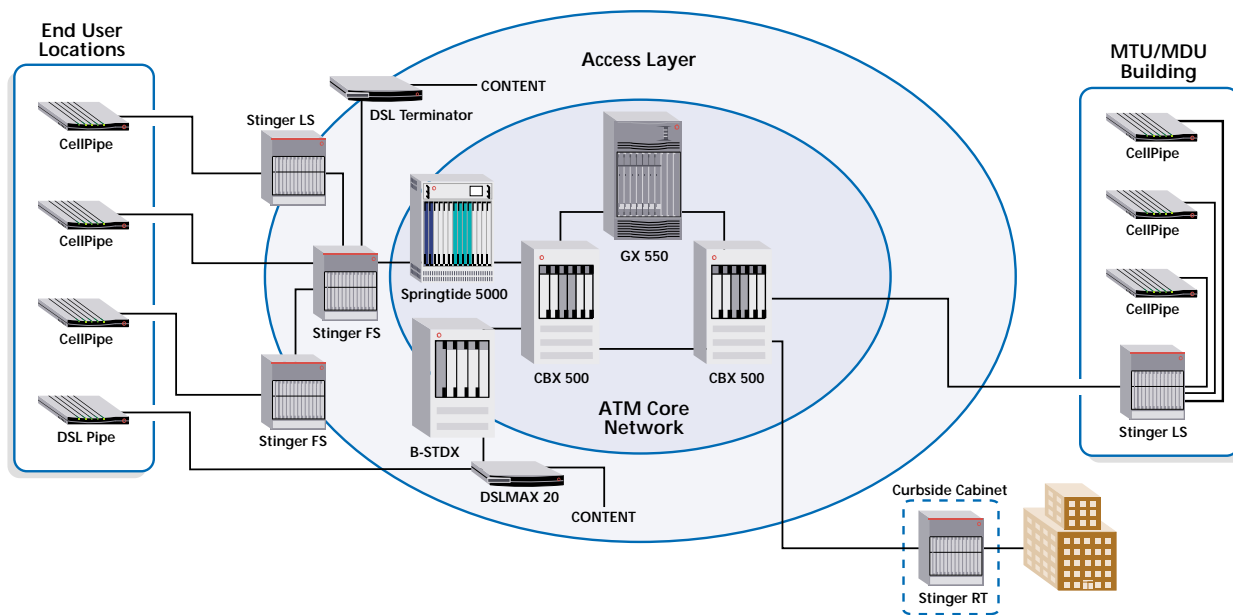
Ease of Installation

Because Stinger is a completely self-contained system, installation is quick and painless, and can usually be accomplished in under an hour. The addition of the optional loop test module further simplifies the process by enabling prequalification of loops without having to wire in an external test head. Stinger's user interface is essentially identical to that of Lucent's family of ATM switches and remote access devices. This efficient interface minimizes installation time and reduces installer training.

Fewer Truck Rolls

Stinger is built on proven technology and highly reliable components. In the rare event of a failure, troubleshooting can be performed remotely while the Stinger remains up and running on the backup module. The faulty component can be hot swapped at the next scheduled maintenance visit. With the installation of the optional integrated copper loop test (CLT) module, customers can prevent unnecessary technician service calls by remotely testing the loop for faults. When coupled with Lucent's Loop Care software, service providers can locate the type and location of loop fault enabling the correct technician to be dispatched to the exact point of failure.

Figure 1 – Broadband Access Network



Stinger is part of a total solution that spans all network layers. The GX and CBX product families create the core backbone, while DSLAM products such as Stinger and DSLMAX 20 provide access to the core. Customer sites employ customer premise equipment (CPE) such as the CellPipe for ATM access and DSLPipe for Frame Relay access.

Provisioning

Tens of thousands of DSL lines are being deployed around the world every day. Rapid provisioning of DSL lines is therefore essential for service providers to keep up with customer demand. Stinger, when coupled with the Navis management system, provides a very intuitive, user-friendly interface for provisioning DSL circuits. Navis Provisioning Manager enables a single step, point and click, end-to-end provisioning of a complete circuit across the network.

Interoperability

While Lucent is capable of providing service providers a complete end-to-end network solution, Lucent recognizes that customers want the ability to mix and match equipment from multiple vendors. To accommodate this requirement, Lucent has created the Wired for DSL program where equipment vendors can submit equipment for certification of interoperability with Stinger. Over 20 CPE and voice gateway vendors have participated in the program and successfully certified dozens of pieces of network equipment to be interoperable with Stinger.

Upgradeability

Stinger's modular architecture permits easy and cost effective upgrades to the system's ATM switching capacity and throughput. Numerous new Line Interface Modules will be added to Stinger's portfolio as new types of DSL emerge and

existing DSL technologies increase in density. The entire ATM switching fabric can be upgraded by simply replacing the Control Module. Diverse types of new trunk modules will be added to increase system throughput and provide for even more flexible network configurations. These easy upgrade paths future-proof Stinger thus protecting your investment.

Scalability

The Stinger architecture is designed for scalability so that service provider's DSL access networks can easily grow based on customer requirements. In locations of high potential demand, service providers can reduce trunk costs by subterminating Stingers via trunk-to-trunk switching in star or daisy-chained configurations. Planned future scalability will allow for over 9000 subscribers on one or two OC-12 trunks.

Applications

Carrier Networks

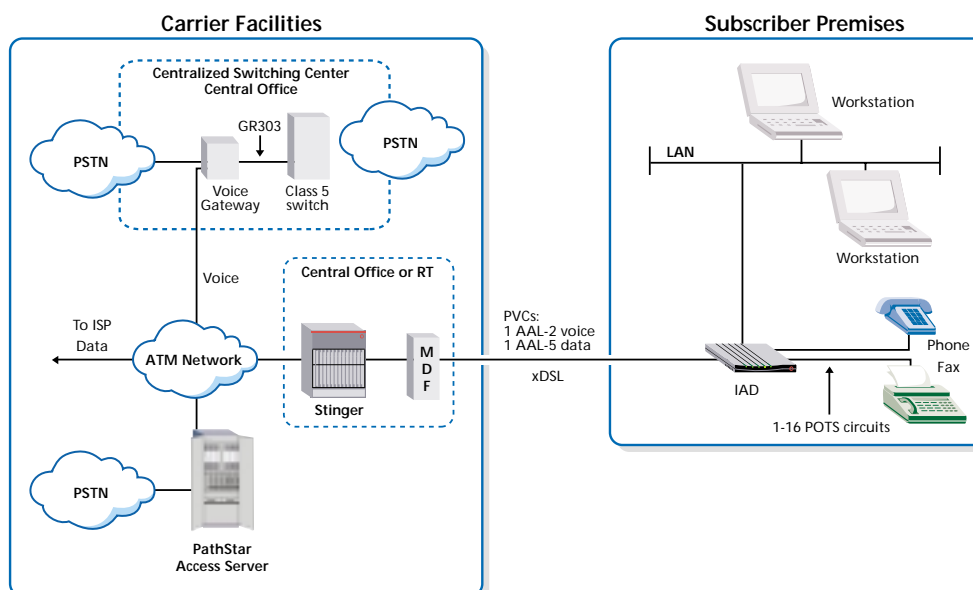
Leading carriers of today and tomorrow will rely on infrastructures that can smoothly integrate legacy networks with new network topologies. An excellent example of this trend is the way DSL technology enables residential and business users to utilize high-speed ATM and Frame Relay transmissions to connect with ATM backbone networks through existing telephone lines. Carriers who

build their ATM backbones on Lucent GX 550, CBX 500 and B-STDx core switch products and use Stinger as their access layer DSLAM are assured of the highest performance ATM has to offer. Figure 1 shown below illustrates how the Stinger family fits into a secure provider's broadband network.

Integrated voice and data solutions with Class 5 or packet switch

An inherent capability of ADSL is that a single analog voice channel may be carried along with digital data over the copper loop. By digitally encoding voice traffic, multiple voice channels can be carried with data over the same loop. With the availability of new ATM-based Integrated Access Devices (IADs) such as Lucent's new CellPipe family of IADs, both packetized voice and data can be carried across an entire ATM network. In the example shown in Figure 2, the IAD initiates two ATM virtual circuits—one for data and one for voice. Both PVCs are switched through Stinger, and into the ATM network. The single voice PVC carries the traffic from up to 16 analog POTS inputs, terminating at the carrier's CO in a voice gateway or packet switch such as Lucent's PathStar. The voice gateway forwards the traffic to a Class 5 switch using a GR-303, TR-008, or V5.2 protocol for access to the PSTN. The data PVC initiated by the IAD carries traffic to an ISP or other specified destination.

Figure 2 – Integrated Voice and Data



Stinger Hardware Architecture

Modular architecture delivers high performance and scalability

A forced-air-cooled chassis houses a variety of easily removable, yet tightly integrated modules to give Stinger high port density and scalability. The Stinger chassis derives its high performance, extreme scalability and versatility from four basic types of modules:

- **Switching and Control Module (CM)**—The CM provides the high-speed switching fabric at the heart of Stinger, as well as support for quality of service (QoS) and system control functions such as initialization, virtual connection establishment, configuration and management.
- **Line Interface Module (LIM)**—Diverse LIMs are available for Stinger, each type supporting a different DSL line code, with 24-48 ports per LIM type. In addition to providing aggregation of virtual channels for transfer to the Control Module's switching fabric, each LIM also participates in implementing QoS functions and the system control functions described above.
- **Trunk Module (TM)**—Diverse types of trunk modules including DS3/E3, OC-3/STM-1, and T1/E1 are available for Stinger. Trunk ports can be assigned for independent use, or redundant operation in any combination.
- **Line Protection Module (LPM)**—Line protection modules provide the subscriber line connectivity to Stinger. Redundant versions of the LPMs offer support for 1:n port redundancy and 1:n LIM redundancy. Non-redundant LPMs are

also available providing a lower cost option. In both cases, either 24-port or 48-port versions are available.

The Stinger chassis can also house optional modules that perform special functions:

- **Copper Loop Test (CLT) Module**—The CLT module enables loop testing and qualification of all copper pairs terminated on Stinger LPMs.
- **Path Selector Module (PSM)**—The PSM enables LIM redundancy and provides external access to all copper pairs terminated on Stinger LPMs. This enables externally attached test sets to test and qualify the loops. The PSM also provides the functionality of a redundant LPM.
- **T-1000 Module**—The T-1000 is a future module which will provide Layer 3 functionality to the Stinger, enabling the termination of PVCs and PPP sessions. This will allow the Stinger to aggregate large numbers of sessions from subscriber CPE devices before passing the traffic off to the backbone network. The T-1000 will also provide routing, authentication, and VPN support.

networks that makes the best use of industry standards like SNMP v1 and SNMP v3, as well as Lucent's unique call-logging data transport architecture. With call-logging, managed devices automatically "push" device and interface information to the network management system, thus assuring reliable and timely updates of network status. Another key NavisAccess feature is the ability to encapsulate information from thousands of interfaces into a compact service view that significantly increases the manageability of large networks.

Using the optional Loop Care software module, NavisAccess includes support for copper loop testing and analysis, via the Stinger CLT card and other supported external test heads. With this module, DSL operators can access all aspects of Stinger service activation—loop qualification, provisioning and monitoring—from one easy-to-use interface. A single point for every operation also implies significant improvements in service fulfillment time, troubleshooting and operator training.

Navis Provisioning Manager (NPM) is an application designed to simplify and speed up service provisioning across all the devices that make up the service provider network. With device adapters for the Stinger, ATM core switches, and other devices, NPM has the ability to create virtual circuits across the network in a single step. NPM can also link up to higher-level order processing systems, providing a seamless interface between order taking and provisioning the service, a key requirement for success in rapidly expanding DSL market. In association with NPM, NavisAccess provides further automation; for instance, lines activated by NPM are automatically monitored by NavisAccess.

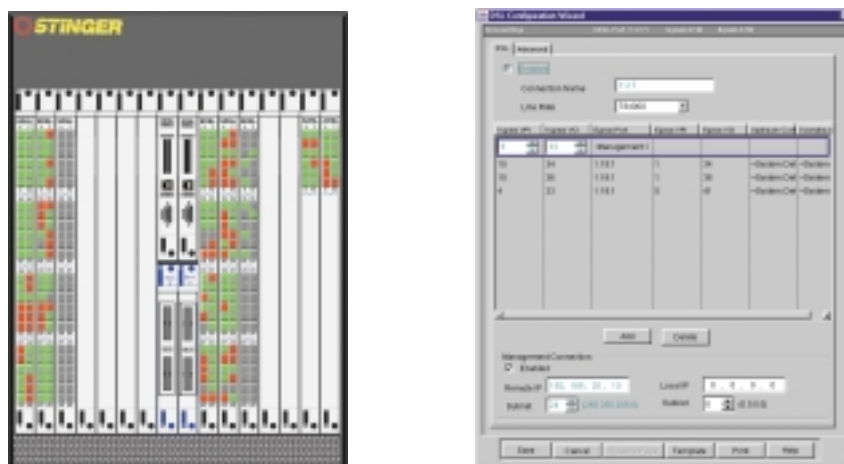
Network Management

Comprehensive configuration, provisioning and monitoring via Lucent NavisAccess

The NavisAccess suite of management applications for the Stinger provides comprehensive software support in all stages of DSL deployment and operation. See Figure 3.

NavisAccess is a powerful and versatile network management system for DSL

Figure 3 – NavisAccess: Graphical User Interface



Stinger Evolution

With the introduction of Stinger in 1999, Lucent produced the most advanced DSL access platform on the market. Numerous features such as complete system redundancy, integrated testing and switching, and future upgradeability are still not available in many competing DSLAMs today. The market responded, taking Stinger to the industry-leading market position in SDSL DSLAM revenue within just 7 months. Since the introduction of the original Stinger FS, Lucent has expanded the Stinger family with the Stinger LS and RT enabling expanded deployment options. Dozens of new Stinger modules have also been introduced, adding new capabilities and flexibility to the Stinger family.

Going forward, Lucent will continue to build on the industry-leading Stinger platform and introduce new members to the family. New Line Interface Modules with greater port density and running new DSL technologies (such as VDSL) as well

as higher capacity and more flexible Trunk Modules will be introduced over time. Lucent will also release additional Stinger chassis models targeted at specific applications, such as in the Multi Tenant, Multi Dwelling Unit (MTU/MDU), Digital Loop Carrier (DLC), and hotel markets.

In addition to building out Stinger's physical assets, software development will continue to increase network reliability, simplify circuit provisioning, and more tightly integrate network elements. Enhanced PNNI and end-to-end provisioning are two examples. PNNI provides Stinger with the ability to use the topology and resource availability of the entire ATM network to more efficiently and reliably route ATM calls with less management intervention. Similarly, end-to-end provisioning greatly simplifies the deployment process by requiring only one management interface for the access and core network to provision a data circuit. By making the network smarter, Lucent enables service providers to reduce costs and increase customer satisfaction by shortening the service

installation interval. Subsequent developments along these lines include support for Switched Virtual Circuits and ILMI. These features will further simplify the provisioning and operations of the ATM network, including the customer premise equipment.

Lucent's vision is for present and future broadband services to be seamlessly created and transported across the entire network without requiring direct management intervention. Just like with today's generation of analog modems, end users should be able to procure an inexpensive DSL modem from their local electronics store and install the modem utilizing simple plug-and-play procedures. The entire installation process, including the service provider's provisioning of service, should take just a short amount of time, not days, weeks or even months as has often been the case with DSL. The result of Lucent's development effort and vision is that a service provider can be assured that Stinger will offer today's as well as tomorrow's most full-featured, flexible, and future-proof access vehicle.