T6Pro Architectural Overview

High-powered networks require a combination of speed and robust services support to provide for the intensive and fluctuating demands of their users. To meet these needs, the network has to provide data transmission at wire speed performance in a non-blocking fashion. This means that the underlying architecture has to be capable of simultaneously processing and forwarding Layer 2 switching information, Layer 3 routing information, and Layer 4 policy information without causing a single delay in the network. In addition, Layer 4-7 applications integration is a necessity and not just a nice-to-have.

T6Pro is the first ever standardized AdvancedTCA™ (TCA stands for Telecom Computing Architecture) carrier-grade IP Multilayer platform with non-blocking architecture specifically designed for the needs of Telecoms. The T6Pro provides a unique 99.999% availability with NO single point-of-failure. Its high reliability and redundancy features guarantee maximum uptime.

AdvancedTCA™, ATCA

The main objective of ATCA is to provide standardized platform architecture for carrier-grade and high-demand telecommunication applications. ATCA will complement existing solutions such as CompactPCI by providing a higher level of performance and scalability. Existing proprietary solutions are migrating to ATCA to benefit from the standardization and availability of the off-the-shelf, building-block solutions. The ATCA is designed to provide an open, multi-vendor architecture targeted at Central Office telecom applications.

T6Pro General Architecture

Built upon the logic of N-to-N point connectivity with dual-star topology and distributed management, the T6Pro has an architecture optimized for direct connectivity between all devices and provides hardware implementation of switching, routing, and services in at port level.

Each of the T6Pro HW platforms (Classic, Compact and Miniature Chassis types) uses the same architecture concept. In addition, all cards such as service cards, switching fabric and management (SFM/CPM) cards and application service cards (ASM) are interchangeable between chassis types. The T6Pro is

designed to meet the strictest Telecom standards and therefore all blades are hot-swappable modules. In addition, T6Pro is built to meet the **NEBS** criteria with rigorous architecture that guarantees the utmost-high reliability and availability figures in the industry.

In all T6Pro platforms, the first 2 slots (number 1 and 2) are allocated for switching fabric and management (SFM/CPM) blades. Nevertheless, the use of the 2 switching fabric blades is not mandatory if redundancy is not required when implementing a specific configuration. In this case, even a single switching fabric and management blade will be sufficient for the operation of the T6Pro. In certain configurations, there will not be any switching fabric blades at all and the T6Pro will operated on service blades only. For example, if there is a need for full redundancy in a configuration with just a few GigE ports, it is possible to populate a T6Pro Compact with only 2 service blades and still have all interfaces operational, one being "active" and the other - a "stand-by" interface.

The SFM/CPM blade makes the interconnections required between each and any of the service ports on the T6Pro. In case of more than one service blade, or, for the compact & miniature chassis types, more than two blades, the SFM/CPM blade is required to enable information and data flow between the various service blades.
An overview of the available service modules on the T6Pro is available further in this document.
To ensure maximum network availability, the T6Pro has logical-level redundancy with resilient links, IEEE 802.1d Spanning Tree, IEEE 802.1w Rapid Spanning Tree, IEEE 802.1S Multiple Spanning Tree, link aggregation, and dynamic routing protocols as well as hardware-level redundancy with hot-swappable modules and shelf managers, fan tray, and power entry modules.

Non-Blocking Switch Fabric

The core of the architecture is based on non-blocking crossbar matrix switch fabric providing a 720-Gbps switching backplane (15G per line x12 lines x2 full duplex x2 backplanes) or 576 Gbps switching capacity (12 slots x24G/slot x2 full duplex). The switch fabric is connected to each of the line cards at aggregate line rate of either 48 or 96 Gbps (slots 3-14 in T6Pro Classic or slots 2-5 in T6Pro Compact, respectively). All T6Pro ports have direct interconnectivity via the line cards.

The T6Pro supports the maximum theoretical line rates of 1,488,100 pps for 1000 Mbps Gigabit Ethernet ports, 148,810 pps for 100 Mbps Fast Ethernet, and 14,880 pps for 10 Mbps Ethernet at Layers 2, 3, and 4. Under the maximum occupancy of 240 Gigabit Ethernet ports, the T6Pro supports 357,144,000 pps or 357.1Mpps. The T6Pro supports a 10 Gigabit Ethernet blade (2 ports per blade) with a maximal line rate of 11,904,800 pps for a single 10 Gbps 10-Gigabit Ethernet port.

The switch fabric is also connected to the PCI management bus, which allows the CPU to manage and administer all Layer 3 packet processors on the T6Pro.

The general architecture of the T6Pro fully populated and its building blocks is shown in the diagrams below:
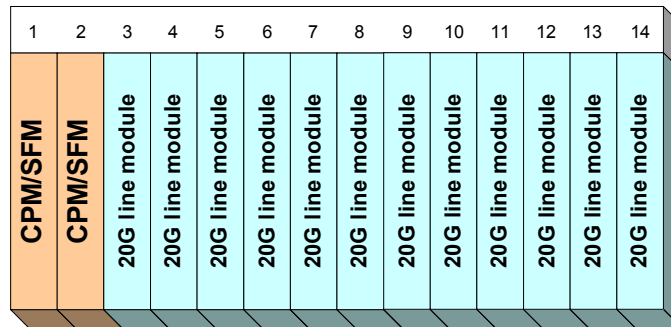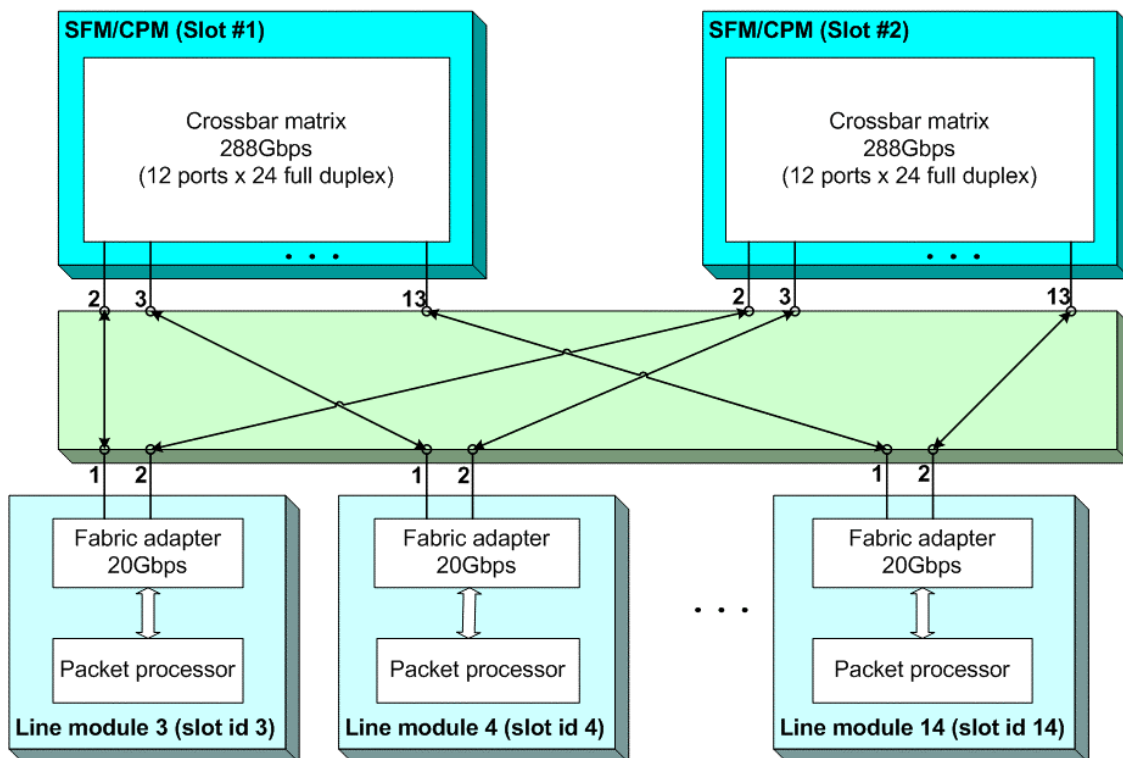
CPU Management and Switching Fabric Modules Overview

CPUs description

There are 2 CPU hierarchies; one at the SFM/CPM modules and the second - on each of the line cards.

The SFM/CPM module has faster CPU with 800 MHz CPU, 512 MB RAM and 64MB Flash memory. In addition, plug-in Compact Flash (similar to PCMCIA card) is available on each SFM/CPM.
The Line card module has a CPU with 200 MHz CPU, 256 MB RAM and 16MB Flash memory.

Switch fabric description
The core of this module is the crossbar matrix. Each crossbar matrix has 12 ports, each designated to a slot in the T6Pro 14-slot classic chassis and every 2 designated to a slot in the T6Pro 5-slot compact chassis. The crossbar matrix connections are carried over by redundant backplane buses. Each crossbar matrix is capable of operating with 288-Gbps capacity.
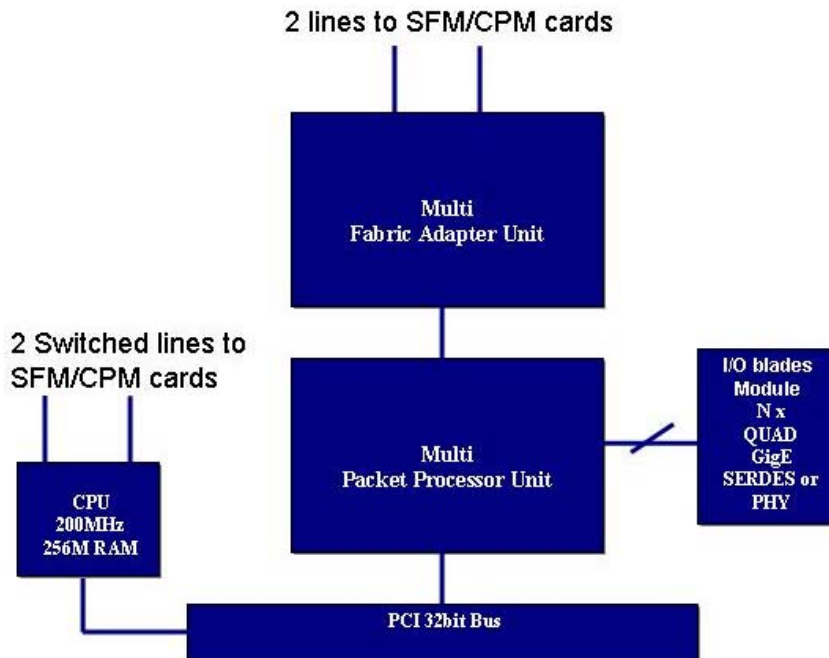
Switch Modules Overview

T6Pro service modules (line cards) include 3 card types:
1. All GigE cards – where either 20-port unpopulated miniGBIC (SFP) boards or 20-port 10/100/1000BasreT boards are available.
2. 10GigE cards – 2-port unpopulated XENPAK boards
3. Mixed cards – for Fast Ethernet and Gigabit Ethernet ports. These cards are used with a patch connections panel.

The functional architecture of the modules is similar. All cards have media interfaces (RJ-45 copper, SFP LC/ MTRJ and XENPAK SC fiber, etc.), which are connected to the Layer 3 packet processors. The Layer 3 packet processors provide wire-speed Layer 2 switching, Layer 3 routing, classification services and Layer 4 services. Each packet processor adjoins memory buffers. Traffic destined to other interfaces on some other packet processor is sent via the switch fabric adaptor either to a different packet processor on the blade or via the main switch fabric (at SFM/CPM blade) to other cards, after the initial policy decisions have been implemented.

The figure on the following page shows the functional architecture of a 20-port GigE line card.

2 lines to SFM/CPM cards

Multi Fabric Adapter Unit

2 Switched lines to SFM/CPM cards

Multi Packet Processor Unit

I/O blades Module N x QUAD GigE SERDES or PHY

CPU 200MHz 256M RAM

PCI 32bit Bus

For other service card types, the functional architecture is the same with the exception of the I/O modules (either 10GigE SERDES or PHY for 10/100BaseTX services).

10 Gigabit Ethernet Modules Overview

The T6Pro provides 2-port 10 Gigabit Ethernet connections via removable optical transceiver; the XENPAK LAN PHY. XENPAK optical modules are available only for single-mode applications for now, nevertheless in the near future multimode and copper based transceivers will be available as well.

The 2-port 10-GigE line card functionality is similar to the one of the 20-port GigE card, and provides the complete bandwidth of 20Gbps non-blocking (40Gbps full duplex) at wire speed.

Mixed Ethernet Modules Overview

Mixed cards contain both 10/100BaseTX ports in a very dense configuration as well as GigE ports. BTI-96TX8G is a 96-port 10/100BaseTX module and 4-port 10/100/1000BaseT and 4-port 1000BaseX unpopulated miniGBICs (SFP). While the GigE ports are available on the front panel of the blade, some of the 96 10/100BaseTX ports (72 of them) need a patch connection panel (Rack, 19'',

Mount) in order to connect that large number of ports.

Application Switching Modules (ASM) Overview

ASM offers some unique powerful network processing capabilities for a wire-speed Application Routing Switch. Various applications can be supported by ASM, to name a few:

- Next Generation IPv6
- NAT and Private NAT services
- Load Balancing and Load Sharing services
- Content delivery (L4-7) services

The ASM blade has the potential for empowering any SW application to meet any specific requirement. Thus puts it in a position to be able to fulfill any need service provider a service provider may have.

This module will be available in the second half of 2004 (2H/04).

Overview of the Opportunities Offered by the Other Module Types

As the T6Pro architecture is based upon the ATCA technology, there is an option to plug in any desired blade that is designed for ATCA platforms and applications. The most commonly used blade is the servers blade. For example, Intel™ manufactures ATCA tailored solutions (as well as NOKIA, Motorola and many others), and these blades could be simply plugged-and-played into the T6Pro. In fact, any server blade from any ATCA-approved vendor can be simply plugged in to the T6Pro. This is the first step in the implementation of the ATCA vision of "Any-Card to Any-ATCA-Chassis" with no rate and service type limitations.

Power Feeding Overview

One of the basic limitations of CompactPCI is the amount of power that can be dissipated per board. CompactPCI have adopted the practical upper limit of 50 watts per board using forced air-cooling. T6Pro enables the use of any board with power dissipations of up to 200 Watts.

With power dissipations potentially being in the 3-kiloWatt range for a single shelf, circulating logic voltage levels no longer make sense. Distributing traditional supply voltages such as 5 or 3.3V at 600 to 1000 Amps is not practical. Moreover, the proliferation of the operating voltages within modules requires the distribution of a single higher voltage. Because T6Pro is targeted at core central office applications, it uses the traditional dual, redundant -48VDC feeds available in central office locations. Dual -48VDC feeds are available to the rack at the power conditioning and distribution panel in the standard fashion,

and then are distributed to individual shelves. Each board will use local DC-DC converters (one or more) to provide logic level voltages for use on that board. A sophisticated method of power management has been implemented to provide redundant feed to any card on the T6Pro chassis. It also supports live insertion and removal (Hot Swap) and provides early System Management power after a card has been inserted.

The central dual feeding option is available in the T6Pro classic and compact shelf types, where, in the miniature chassis, an add-on accessory is provided to comply with central dual feeding option.

When AC feeding is required, there is an option to use an external 4-PSs drawer (rack mountable, 19''). Each of the AC PS units is hot-swapable and can be operated in N:M redundancy. The PS units' assembly can be gradual, i.e. the service provider can use 2, 3 or 4 PS units according to the required power dissipation. This AC feeding is available with both T6Pro classic and compact chassis types.

Summary

The following there is a summary table offers complete overview for the various **T6Pro** configurations:

T6Pro chassis type	Classic	Compact	Miniature	Notes
Size	12U	4U	2U	19" width, other ATCA platforms are emerging with 6U, 8U, 14U, etc.
Max # of slots	14	5	2	
Max # of CPM/SFM modules	2	2	-	
Max # of line modules	12	4	2	In compact - slot #2 can be used for a line module when working with a single SFM module in slot #1
Support dual line module in fabric-less configuration (mesh)	No	Yes	Yes	In slots 1 & 2 only.
Redundant fans support (option)	Yes	Yes	Yes	In classis - requires additional fan trays.
Redundant power feed (48v DC)	Yes	Yes	Yes	
Redundant power entry module (option)	Yes	Yes	Future Option	External AC PS drawer