Firmware for TSP3 Traffic Stream Processors

Ethernet-to-ATM Interworking and ATM Switching with "Triple-Play" Traffic Management for Broadband Access Equipment

Product Overview
BroadbandMaker™ foundation firmware, designed for Mindspeed’s TSP3 processors, provides the industry’s best value in high-performance, QOS-enabled access internetworking for development of “triple-play” (voice/video/data) access equipment. Fine-tuned to the needs of linecards in IP-DSLAMs and FTTx equipment, BroadbandMaker provides a combination of services and features that economically address the key transitions affecting the Broadband Access infrastructure:

- The migration from ATM to Ethernet in the access aggregation network.
- Demand for larger subscriber port bandwidths, in excess of 20Mbps (VDSL, ADSL2+, xPON).
- Replacement of “best-effort” data service with QOS capabilities which address the mixing of voice, video, and data in a multicast bandwidth expansion environment.

When used in concert with the M27481 TSP3 processor, BroadbandMaker provides Ethernet to ATM (E2A) interworking, ATM cell switching (A2A), and a combination of ingress and egress traffic management capabilities that ensure prioritized delivery of value-added services and flows to broadband customers. Flexible stacked VLAN tag mapping/manipulation/modification capabilities support a variety of network topologies, including VPNs/VPLS and hardware platform sharing by multiple service providers. Rich Multicast support, including IGMP snooping and hardware-accelerated data replication, provides a solid platform for developing IPTV solutions, with adequate bandwidth for delivering HDTV content for up to 63 ADSL2+/VDSL modems. BroadbandMaker also runs on the M27483, M27482, and M27480 TSP3 devices.

Performance
For cost-sensitive line-card applications, the M27480 and M27481 devices provide integrated SRAM to support 1280 channels at more than 2Gbps of aggregate throughput. This channel count is sufficient for remote DSLAMs, DSLAM linecards, and FTTx/PON OLT and ONU linecards. It is also well-suited for systems where the “channel” definition is VLAN-based. For example, if all Ethernet frames with a given VLAN tag id were mapped to a single ATM VCC, this would be managed as one BroadbandMaker connection, regardless of how many different Ethernet flows (DA/SA/protocol types) are using that VLAN id.
For larger numbers of connections (>1280), the channel memory is stored off-chip in SDRAM, and the throughput is reduced by approximately 50%.

Mindspeed performs regular firmware enhancements for performance maximization. Mindspeed's Application Engineering team can provide the latest detailed performance benchmarks consistent with your application specific combination of features and needs.

**Fine-Grained Egress Traffic Management**

BroadbandMaker provides egress scheduling and shaping for both ATM cells and Ethernet frames. For ATM, dual GCRA engines support per-connection provisioning of CBR, VBR-rt, VBR-nrt, UBR, and UBR+ flows. In addition, two standard flow-aggregation tunnel types are provided: class-based, with up to 8 packet-aware class-queues per tunnel, and flow-based, supporting an unlimited number of application specific flow queues. These tunnels allow multiple flows or classes to be merged into a single shaped flow, which may be a single VCC, or a group of VCCs, while allocating the tunnel's bandwidth on class or flow-based parameters. In addition, the class-based tunnel supports both a strict-priority mode for latency management of high-priority traffic, and a “fair mode”, which prevents complete starvation of lower-priority traffic. Per-connection shaped rates from less than 64 Kbps to full port rate are provided, with better than 1% accuracy. For Ethernet, each port may be set to send frames at a governed rate, with strict-priority scheduling of multiple priorities.

Other scheduling and shaping algorithms (e.g. multi-level hierarchical, MDRR, WFQ...) have been implemented and tested on the TSP3 platform. Customers may leverage these, or specify and/or develop their own to serve their unique needs.

**Flexible Classification and Mapping**

BroadbandMaker performs flow classification in multiple stages. First stage flow classification is performed in the TSP3’s programmable classification engine using a variety of fields, including stacked VLAN id, VLAN priority, Ethernet DA, ATM VPI/VCI (NNI or UNI), and custom headers. Subsequent classification is performed by the firmware, which may leverage the hardware classification engine. Custom cell and frame formats and headers can be readily supported through firmware modification.

For A2A mapping, incoming cell headers may be modified for either VC or VP switching.

For E2A mapping, BroadbandMaker supports 4 different mapping modes, which define the data transformation and egress scheduler configurations.

- **Routed Mode**: Ethernet frame carries IP datagrams. ATM transports IP datagrams with or without an optional (user-specified) RFC2684/1483 LLC routed header. The Ethernet header is removed for ATM transport.
- **Bridged Mode**: ATM transports the entire Ethernet frame, with or without an optional (user-specified) RFC2684/1483 LLC bridged header. In this mode, BroadbandMaker can autonomously learn the bindings between ATM VCCs (VPI/VCI) and the ethernet MAC addresses they transport.
- **AAL0 Mode**: Also referred to as “raw cell” mode, ATM cells are encapsulated in an Ethernet frame for transport over an Ethernet infrastructure.
- **System Tagged Mode**: Ethernet frame carries a "system-tagged" packet. ATM transports the packet encapsulated by the "system tag". This mode is useful for intra-system transport via an Ethernet infrastructure.

BroadbandMaker also provides support for VLAN insertion and stripping, and can simultaneously handle a variety of frame types (e.g. 0, 1, or 2 VLAN tags).
Other classification, mapping, and encapsulation/data transformation options are readily available through a combination of the TSP3’s programmable classification engine and custom firmware. Classification options include TCP/UDP port number, IP TOS, MPLS labels, Ethernet type, IP protocol, and many others.

**Congestion Management**

Congestion management techniques are available for managing both Ethernet and ATM traffic. Each connection is assigned to one of 8 buffer classes on the M27481 and ‘480, or one of 16 buffer classes on the M27483 and M27482. Each class may be assigned a user-specified number of buffers, preventing lower priority flows assigned to one class from consuming buffers assigned to higher priority traffic in another class.

Queue admission algorithms applied to incoming Ethernet frames include per-buffer class and per-connection Early Packet Discard (EPD), WRED, or discard on buffer class exhaustion. Ethernet frames are checked for valid FCS. Queue admission algorithms which may be applied to incoming ATM cells include dual-GCRA policing, AAL5-packet-aware per-buffer-class EPD, and Partial Packet Discard on buffer-class exhaustion.

**Integrated Gigabit Ethernet with Flow-Control**

BroadbandMaker leverages the M27481’s and ‘480’s dual integrated Gigabit Ethernet interfaces, and supports multi-rate flow control using 802.3x PAUSE frames. As a result, simple Gigabit Ethernet connectivity may be used for intra-system connectivity in TSP3-based systems, even when the traffic rate is significantly less than 1 Gbps. The integrated Gigabit Ethernet MACs also support jumbo frames.

**Rich Statistics**

BroadbandMaker provides a rich set of statistics, including all of the standard MIB counters for the Ethernet interfaces, and per-connection and per-port packet and byte counters for the E2A and A2A services.

**OAM Support**

BroadbandMaker provides a “filter and route to host” capability for incoming traffic from the Ethernet or ATM interfaces, and allows the host to insert cells or frames into the outgoing traffic streams. CRC-10 generation and checking is provided for OAM cell flows. Other OAM processing features include AIS/RDI alarm state processing, continuity check, and loop-back processing.

**External Memory: Simple and Inexpensive**

The TSP3 family keeps memory requirements simple. The M27481 and ‘480 require only a single 64MB to 256MB pool of widely available DDR SDRAM for both channel context and buffer storage. The M27482 and M27483 use a single block of QDRII SRAM for channel storage, and DDR SDRAM for buffer storage.

**Configuration Flexibility**

BroadbandMaker has been architected to leverage the TSP3 family’s interface flexibility, minimizing design-in complexity.

The M27481 and ‘480 may be configured to boot from a ROM at system initialization. The device may then be managed and configured via Ethernet, UTOPIA/POS, or PCI, allowing for remote control of the BroadbandMaker application from a central system controller. Multiple TSP3 devices may be managed from a single system host, reducing system complexity and cost.

**Broad Set of Applications**

BroadbandMaker is designed to address the needs of a broad set of systems, including:

- DSLAM Linecards & Remote DSLAMs
- Both ATM and IP
- “Triple-play” enabled
- xPON OLT Linecards
- xPON FTTC/FTTN ONUs
- Ethernet Switches
- ATM WAN links: multiport T3/E3, SDNET/SDH, IMA over T1/E1/xDSL,
- Multiservice Switch Linecards
- QOS-assured Ethernet
- ATMoNG-SONET
- Switch/Router Linecards
- ATM, xDSL
- Wireless Infrastructure
- VoIPoAAL5 processing arrays
- Backplane/Control Plane SARing

A few example TSP3 BroadbandMaker applications are shown in Figures 1 through 3.
What is a Foundation Application?
Mindspeed's foundation applications are architected and designed to be far more than “reference” code. They are built on the architectural underpinnings of the routing industry’s most successful solution for ATM linecards and ATM/MPLS interworking, the production-quality PortMaker™ Traffic Stream Processor applications. Recognizing that a “one-size-fits-all” application cannot possibly meet the needs of the wide array of access equipment developers, Mindspeed's engineers have crafted a malleable platform on which customer’s specific needs can be readily supported, while simultaneously keeping development time to a minimum.

Foundation applications are system tested, and not simply unit-tested, to ensure that the application operates cohesively. The foundation application customer may then leverage Mindspeed’s consulting service team for custom feature development, focused system testing, and maintenance. Alternatively, customers may take on those tasks, with the assistance of Mindspeed’s world-class support team. Mindspeed's foundation applications carry no licensing charge, and source code development training is complimentary.

Product Demonstrations and Evaluations
EVMs for the TSP3 devices are available, and BroadbandMaker demonstrations are available on request.