Xelerator™ Solutions: IPv6 Service Card

Introduction

The Internet Protocol version 6 (IPv6) is the new generation IP protocol. The new IP version receives more and more traction as requirements on scalability, security and mobility become increasingly important in IP networking.

Although IPv4 has proven to be robust and interoperable, a number of issues in its design called for a new version with a new header format. The main features being changed relative to IPv4 are:

- Larger address space (32 bit —> 128 bit)
- Fewer header fields
- Extensibility by the concept of extension headers
- More efficient hierarchical addressing and routing infrastructure
- Enhanced and simplified multicast
- Automatic IP address configuration
- Built-in security, with IPsec
- Better support for QoS and traffic engineering. A Flow Label field allows routers to identify packets belonging to a flow even when the packet payload is encrypted
- Native mobility support with Mobile IP

The Xelerator™ family of Network Processors (NPUs) — X10s, X10d, X10q are specifically designed to support wire-speed processing of IPv6. The full programmability of all forwarding-plane formats in the X10 allows for simple modification of fields and formats. This is future-proof as a "best common practice" becomes established for IPv6, in the same way it already has for IPv4.

Furthermore, the extensible format of the IPv6 header puts requirements on the NPU to be flexible enough for processing of extension headers. This requirement has been addressed in the design of the X10, which can traverse header-by-header with its flexible sequential processing model. This is done without compromising the wire-speed performance inherent in the NPU. In addition, new formats of extension headers are easily accommodated, since the X10 has no hard coded packet formats.

Designed for Distributed Systems

The work of a router may be divided into a control plane and a forwarding plane. The control plane includes node-related control and management functions, whereas the forwarding plane does the per-packet processing of packets passing through the node.

Examples of control-plane applications are routing protocols, such as IS-IS, OSPF and BGP, and management protocols such as SNMP and Telnet CLI. These types of protocols are more suited for implementation in a general purpose CPU than in an NPU.

The IPv6 Service Card with X10 handles the IPv6 forwarding plane, while it receives control data from the control plane. For instance, the forwarding table from the routing protocol process is used to take the per-packet decision concerning which outgoing interface to use.

For IPv6, protocols such as BGP+, Neighbor Discovery, Stateless Auto Configuration, Router Renumbering and DHCPv6 reside in the control plane, but they generate information in the form of different SRAM or TCAM tables used by the X10 NPU in the forwarding plane. Also, queuing parameters for the Traffic Manager are generated by the control-plane protocols.

Service-card Solution

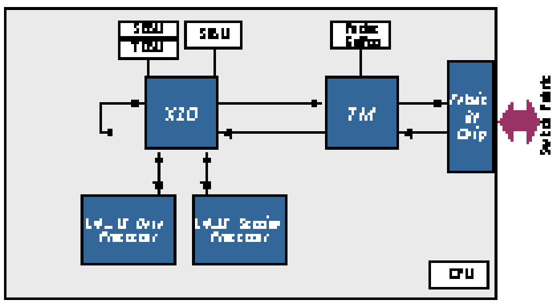
An IPv6 Service Card based on Xelerated's X10 Network Processor provides upgrade solutions to legacy systems by introducing IPv6 on a special-purpose card in the system. Typically, this card occupies one of the slots in the system in the same way as a regular line card does. The difference is that the service card does not have an interface connector, but receives its traffic from any of the line cards via the switch fabric, and sends packets to the appropriate line card after processing the packets.

Xelerated can provide tailor-made IPv6 Service Cards for different types of systems with need to enhance its IPv6 capabilities. Xelerated's Integration Support Library (ISL), which is independent of operating systems, provides easy integration of the control functions for the X10 your control-plane software.

Design challenges

IPv6 implementations are complicated by the fact that multiple very wide look-ups are needed. In particular IPv6 multicast and IPv6 multifield Access Control Lists (ACLs) constitute long look-ups.

To perform forwarding of multicast packets in general, a look-up based on both the source address (S), and the Group identifier (G) is needed. This [S,G] look-up will then yield an interface group that is due to receive copies of the packet.



A service card for centralized IPv6 processing, equipped with dedicated L4-L7 processors for handling IPsec encryption and key exhange.

In order to do multifield classification for Access Control Lists (ACL) or DiffServ, a number of fields in the packet headers need to be combined. The multifield classification is done by a 304-bit 6-tuple consisting of:

- Protocol identifier (8 bits)
- IP source address (128 bits)
- IP destination address (128 bits)
- The source's TCP or UDP port number (16 bits)
- The destination's TCP or UDP port number (16 bits)
- The traffic class field (8 bit)

The X10 is especially well-suited for these types of complex operations with multiple SRAM/TCAM lookups, which may be combined to obtain the long look-ups needed via four lookaside interfaces.

Another design challenge is that the IPv6 protocol mandates support for IPsec in end systems, which therefore require encryption engines and key exchange protocols. The four SPI-4.2 interfaces on the X10 enable efficient solutions for high-speed processing of IPsec together with special encryption engines or L4-L7 processors. See the service-card figure for one such solution.

An alternative to having special IPsec processors on the same board is to use special system boards for this, or to perform it in the control plane processors.

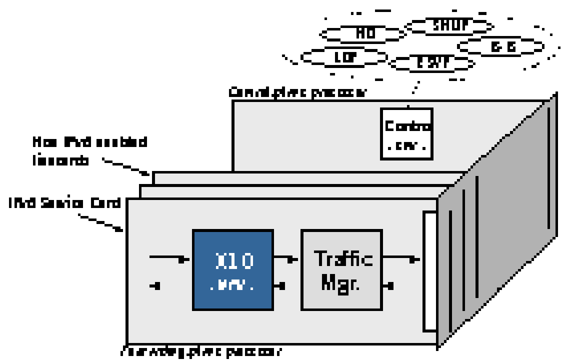
Standards

The forwarding-plane functions for the following standards are implemented in Xelerated’s IPv6 Service Card:

IETF

- RFC 1981 Path MTU Discovery for IPv6
- RFC 2080 RIPng for IPv6
- RFC 2373 IPv6 Addressing Architecture
- RFC 2460 IPv6 Specification
- RFC 2461 Neighbor Discovery for IPv6
- RFC 2462 IPv6 Stateless Address Autoconfiguration
- RFC 2463 Internet Control Message Protocol for IPv6
- RFC 2473 Generic Packet Tunneling in IPv6

- RFC 2545 BGP-4 Multiprotocol Extensions for IPv6
- RFC 2740 OSPF for IPv6
- RFC 2893 Transition Mechanisms for IPv6 Hosts and Routers
- RFC 3056 Connection of IPv6 Domains via IPv4 Clouds
- RFC 3306 Unicast-Prefix-based IPv6 Multicast Addresses
- draft-ietf-ngtrans-isatap-04.txt Intra-Site Automatic Tunnel Addressing Protocol (ISATAP)



Separation of control and forwarding planes in a distributed system. The IPv6 Service Card enables legacy systems to be upgraded to support high-speed IPv6 while integrating smoothly with the existing control system.