LinkIP Capabilities

The LinkIP is a highly efficient and flexible satellite networking services platform that was designed to be a highly capable IP transport and routing solution that maximizes satellite bandwidth efficiency. Although initially designed as a platform for satellite bandwidth management, it has evolved into a feature rich toolset that provides the following:

- Powerful IP policy based router – The LinkIP is a multi-port LAN-WAN router that uses a combination of tools from the Linux Advanced Routing and Traffic Control (LARTC) and a customized implementation of the Quagga routing suite
- Pseudo-wire for emulation of point-to-point and bridged network connections
- LinkShrink compression engine – a highly effective and flexible proprietary lossless compression system that is integrated into the router
- LinkCast transport – a custom high-efficiency protocol that provides Ethernet multi-destination capability with only a fraction of Ethernet's overhead
- Scanned Channel Assigned Networking (SCAN) – a hubless satellite bandwidth manager offered as a LinkIP option

The router is the heart of the LinkIP, and controls or is involved in the decision making process of all other LinkIP elements. The LinkIP router utilizes elements of Linux Advanced Routing and Traffic Control (LARTC), an advanced policy router built into Linux, and the dynamic and static routing tools offered by Quagga, a highly capable GPL licensed IPv4/IPv6 routing suite that operates on the Linux OS.

Multiple LAN & WAN Port Support

LinkIP LAN ports are those ports that connect to the local network's baseband equipment. The standard LinkIP is equipped with two 10/100/1000 Ethernet ports that have jumbo frame support. Additional LAN port types can be added, e.g. E-1 interface for TDM and cellular switching equipment.

WAN ports are the ports that interface with satellite modems. The standard WAN port is a high density serial synchronous interface that supports RS-530, RS-422, and V.35 interfaces. Serial ports are bi-directional; i.e. each port will support a modulator or a demodulator or a full modem. The LinkIP Edge will support up to four synchronous serial interfaces and the LinkIP Core will support up to 16. The LinkIP can be equipped with other WAN interface types, such as T1 / E1 and high speed serial interfaces such as HSSI and ASI. Although Ethernet can be designated as WAN interfaces, use of Ethernet ports as WAN interfaces result in some loss of the efficiency advantages of LinkCast (described below).

Because of it's multiple WAN port support, the LinkIP can be connected to multiple modulators and demodulators. That allows network configurations that use the routed multi-destination architectures described in the LinkIP data sheet.

LARTC

The LinkIP utilizes a customized implementation of Linux Advanced Routing and Traffic Control (LARTC). The policy routing tools native to LARTC provide a high degree of granularity for IP traffic shaping. Some of the LARTC tools included in the LinkIP include:

- Full IPv4 and IPv6 support
- ARP – Address resolution protocol
- Policy Routing
- Tunnelling (IP in IP, GRE, and others)
- IPSEC
- Multicast Routing
- VLANs
- Traffic Shaping:
    - Class based queuing
    - Fair queuing
    - Packet filtering
    - Load sharing
    - Net filter
    - iproute

Quagga

Dynamic routing in the LinkIP is achieved with LinkSat's highly customized implementation of the Quagga routing suite. It has implementations of all of the major dynamic routing protocols, including OSPFv2, OSPFv3, RIPv1, RIPv2, RIPng, BGPv4, and ISIS.

The Quagga architecture has a rich development library which allows a great deal of flexibility in implementing custom protocols and daemons. This has allowed LinkSat to customize the router to a high degree and facilitated addition of LinkShrink compression and LinkCast transport.

The Quagga routing daemons are configured using a command line interface, which is an integrated shell called VTYSHELL. LinkSat has implemented the VTYSHELL such that it configures very much like a Cisco router. Hence, if the operator is familiar with the IOS command set, they will feel very much at home with the LinkIP's VTYSHELL .

As of this writing, the following RFC's are supported in Quagga:

RFC1058	*Routing Information Protocol. C.L. Hedrick*
RFC2082	*RIP-2 MD5 Authentication. F. Baker, R. Atkinson*
RFC2453	*RIP Version 2. G. Malkin*
RFC2080	*RIPng for IPv6. G. Malkin, R. Minnear*
RFC2328	*OSPF Version 2. J. Moy*
RFC2370	*The OSPF Opaque LSA Option R. Coltun*
RFC3101	*The OSPF Not-So-Stubby Area (NSSA) Option P. Murphy*
RFC2740	*OSPF for IPv6. R. Coltun, D. Ferguson, J. Moy.*
RFC1771	*A Border Gateway Protocol 4 (BGP-4). Y. Rekhter & T. Li*
RFC1965	*Autonomous System Confederations for BGP. P. Traina*
RFC1997	*BGP Communities Attribute. R. Chandra, P. Traina & T. Li*
RFC2545	*Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing. P. Marques, F. Dupont*
RFC2796	*BGP Route Reflection An alternative to full mesh IBGP. T. Bates & R. Chandrasekeran*
RFC2858	*Multiprotocol Extensions for BGP-4. T. Bates, Y. Rekhter, R. Chandra, D. Katz*
RFC2842	*Capabilities Advertisement with BGP-4. R. Chandra, J. Scudder.*
RFC3137	*OSPF Stub Router Advertisement, A. Retana, L. Nguyen, R. White, A. Zinin, D. McPherson*

The following SNMP support RFCs are also supported:

RFC1227	*SNMP MUX protocol and MIB. M.T. Rose*
RFC1657	*Definitions of Managed Objects for the Fourth Version of the Border Gateway Protocol (BGP-4) using SMIv2. S. Willis, J. Burruss, J. Chu, Editor*
RFC1724	*RIP Version 2 MIB Extension. G. Malkin & F. Baker*
RFC1850	*OSPF Version 2 Management Information Base. F. Baker, R. Coltun*

LinkShrink

LinkShrink is LinkSat's proprietary lossless low-latency data compression system that was designed specifically for LinkSat's Routed Multi-Destination solution. Compression is achieved by identifying repeating patterns of ones and zeros. The compression system operates between the physical layer and link layer. It is protocol independent and hence is not affected by what is being done on layers above or below it, e.g. WAN optimization at the application layer. Its high-performance data compression algorithms typically achieve 60% or more bandwidth savings on compressible data. Head to head tests with other satellite equipment manufacturers' compression systems using same data files consistently show LinkShrink achieving much higher levels of compression.

The LinkShrink compression system is tightly integrated into the LinkIP router. The system actually consists of multiple compression engines, including packet header as well as low latency stream, and zero latency stream compression engines. LinkShrink makes compression decisions on a packet by packet basis. Each packet is handled by the compression system based on the characteristics of TOS, IP protocol, UDP port, TCP port, as well as combinations of these. The Ethernet headers are stripped off first, and the source / destination address information saved. The resulting datagram may be sent through a stream compression engine depending on its characteristic. If the requirement is for maximum compression it is sent through the standard stream compressor. If the packet is sensitive to latency, such as a voice signaling packet, it is sent through the zero latency stream compression. The resulting packet is then encapsulated in the LinkCast protocol and routed out to the satellite modulator.

Compression can be set up or bypassed on a per WAN-port basis, and can be set up or bypassed on an IP flow, IP source or destination address, or packet type basis. Packet prioritization is achieved by using the router's QoS capabilities, or can be set by IP protocol, UDP port, TCP port, and on combinations of UDP port and TOS. Although already extremely low, throughput latency and packet jitter can also be controlled by adjusting the level of compression.

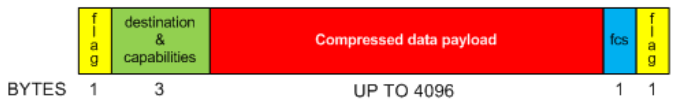
As with any compression system, compression levels achieved by LinkShrink depend on the type of data. Compression ratios of up to 6:1 can be achieved with highly compressible data, for example VoIP, TCP and UDP file transfers, and uncompressed voice. Ratios of 1.5:1 or better can typically be achieved with compressed voice in VoIP networks, e.g. from media gateway equipment and on A-bis and A-ter links.

LinkCast

LinkSat has developed a unique over-the-satellite transport that has full dynamic routing capabilities of Ethernet over a multi-destination satellite network, at a fraction of the overhead of Ethernet. LinkShrink strips the Ethernet header off the IP datagram and does a stream compression (LinkShrink) of the IP datagram. The compressed datagrams are then aggregated by destination IP address then encapsulated onto LinkCast frames. A single LinkCast frame can thus transport multiple IP datagrams far more efficiently than by transporting single IP datagrams over-the-satellite using Ethernet frames.

Ethernet Frame

LinkCast Frame



This enables the use of LinkSat's highly efficient Routed Multi Destination (RMD) network architecture. LinkCast enables the network operator to take advantage of the full benefits of dynamic routing within the RMD network by effectively turning the satellite into an Ethernet switch. Packets at each node are filtered by the LinkIP in much the same manner as an Ethernet controller filters Ethernet frames not destined for its MAC address. The LinkIP routes packets for its LAN out its Ethernet port(s) and discards received packets bound for other sites in the satellite network.

Conclusion

The LinkIP is a highly flexible satellite networking tool that can provide a bandwidth efficient alternative to SCPC for new network deployments, and can also dramatically improve throughput and routing efficacy in existing SCPC networks. Most satellite networking solutions work on the RF layer, employing schemes like TDMA or digital carrier cancellation. The LinkIP's bandwidth savings are achieved on the data link and network layers. This, and the fact that it can interface with virtually any existing SCPC satellite modem makes it an ideal candidate for existing SCPC network retrofits, 2G and 3G cellular backhaul networks, and multimedia data networks.