EXECUTIVE SUMMARY

This Heavy Reading report, "Next Gen DSL Equipment: The Path to Profitability," provides the most detailed and exhaustive competitive analysis of DSL equipment ever undertaken, at a critical moment in the history of broadband. In so doing, it provides deep insights into the likely winners and losers in the next stage of DSL deployment – a chapter that's beginning right now, and will likely see carriers rapidly migrate to new network architectures that promise to help generate new revenues from advanced, QOS-enabled IP services.

Much of this shift has been prompted by the DSL Forum's publication this past October of Technical Report 59 (TR-59), spelling out requirements and network architecture for delivery of next-generation DSL services. Research by Heavy Reading indicates that carriers will take this as a green light to charge ahead with deployment plans.

There is significant pent-up demand for equipment supporting advanced IP services. In many parts of the world, DSL rollouts have roared ahead, forcing carriers to upgrade infrastructure to cope with the resulting explosion of traffic with little prospect of a decent return on investment. Vendors have been addressing the problem by introducing new and upgraded equipment supporting advanced services, but carriers have refrained from deploying it – waiting instead for the DSL Forum to lay down standards for broadband's next big leap forward.

Now this has happened, and the moment has come to judge the equipment that vendors have developed – notably the latest DSLAMs (DSL access multiplexers) and B-RASs (broadband remote access servers). The latter category is now actually splitting into two classes of product – "metro" B-RASs, sitting deep inside networks and serving huge numbers of subscribers, and smaller "CO" B-RASs, which sit in central offices.

This report evaluates equipment in each of these categories in extraordinary detail – the same sort of detail that carriers themselves might use in an RFP process. Product information was collected from published sources and supplemented with interviews with vendors. Data was played back to vendors to ensure its accuracy. It was used to fill multiple product matrixes for each category, and then used to calculate overall scores, by applying weightings to key characteristics. The report ranks suppliers according to those scores. A total of 17 vendors were surveyed:

- Alcatel SA (NYSE: ALA; Paris: CGEP:PA)
- Allied Telesyn Inc.
- Cisco Systems Inc. (Nasdaq: CSCO)
- Copper Mountain Networks Inc. (Nasdaq: CMTN)
- CoSine Communications Inc. (Nasdaq: COSN)
- ECI Telecom Ltd. (Nasdaq/NM: ECIL)
- LM Ericsson (Nasdaq: ERICY)
- Fujitsu Ltd. (OTC: FJTSY)
- Juniper Networks Inc. (Nasdaq: JNPR)
- Laurel Networks Inc.
- Lucent Technologies Inc. (NYSE: LU)
- Marconi Corp. plc (Nasdaq: MRCIY; London: MONI)
- Network Equipment Technologies Inc. (net.com) (NYSE: NWK)
- Nortel Networks Corp. (NYSE/Toronto: NT)
- Redback Networks Inc. (Nasdaq: RBAK)
- Siemens AG (NYSE: SI; Frankfurt: SIE)
- UTStarcom Inc. (Nasdaq: UTSI)
“Next Gen DSL Equipment: The Path to Profitability” will be essential reading for:

- **Carriers** reviewing their supplier strategies for the next leap forward in broadband networks
- **Equipment vendors** looking to weigh up the precise capabilities of their competition's products
- **Communications chips manufacturers** looking to quantify the market opportunity among these vendors
- **Investors** trying to pick likely winners and losers in what is likely to be one of the fastest-growing fields in telecom

**PRODUCT MATRIX**

The report features 19 "product matrices," or tables of product information, comprising some 2,022 data fields. A further 23 tables (1,473 data fields) show how scores are derived from this data to provide an overall assessment of the relative merits of different equipment.

**DSLAMs**

Data on the following general features is given for each DSLAM: Chassis size without splitters, max weight fully configured, max power fully configured, max lines per chassis, power dissipated per direct line, max bitrate per line @ max lines, max bitrate per line unconstrained, max lines subtended, SONET/SDH uplinks.

Further data is then provided for ATM, Ethernet, and IP characteristics as follows:

**ATM DSLAM data collected:** Usable switch size, max number of PVCs, PNNI support, SPVC support, hybrid multicast support, MPLS support, T1/E1 IMA uplink.

**ATM DSLAMs evaluated:**
- Alcatel ASAM 7301
- ECI Telecom SAM 240/480
- Fujitsu FDX
- Lucent Stinger FS+
- Marconi AXH 2500
- Siemens Surpass hiX 5300

**IP DSLAM data collected:** Throughput, B-RAS functions (max number of PPPoA, PPPoE, and RFC1483 terminations, Radius client support), IP routing protocols, support for IP multicast routing, IGMP, MPLS.

**IP DSLAMs evaluated:**
- Alcatel ASAM 7301
- Lucent Stinger FS+
- Marconi AXH 2500
- Siemens Surpass hiX 5300
- UTStarcom AN-2000

**Ethernet DSLAM data collected:** Throughput, max number of Fast Ethernet and Gigabit Ethernet uplinks, support for L2 MAC bridging, VLAN IEEE 802.1q, priority IEEE 802.1p, EFMA 10Base TS and 2Base TL.

**Ethernet DSLAMs evaluated:**
- Alcatel ASAM 7301
- Allied Telesyn 7700
- ECI Telecom SAM 240/480
- Ericsson EDN 110/ESN 108
- Fujitsu FDX
- Lucent Stinger FS+
- Marconi AXH 2500
- Siemens Surpass hiX 5300
- UTStarcom AN-2000
M**ETRO B-R**AS**S**

The following data is given for each metro B-RAS:

**Equipment features:** Throughput, number/speed of ATM interface ports, number/speed of POS interface ports, number/speed of Ethernet interface ports, redundancy features (switch fabric, route processor, interface cards, I/O units, resource cards, VRRP), NEBS-3 certification, power consumption, weight.

**Session termination functions:** Number of virtual routers, number of sessions (PPPoA, PPPoE, PPPoFR, RFC 2684), VLANs over Ethernet IEEE 802.1q, PPPoE on Ethernet cards, auto-detection, dynamic interface configuration.

**VPN and tunnel support:** GRE, L2TP, LAC, LNS, IP in IP (RFC 2003), IPsec, tunnel switching. Support for the following MPLS VPN capabilities: BGP (RFC 2547bis), LDP, CR-LDP, RSVP-TE, Martini.

**Edge router functions:** Number of routes, support for OSPF, BGP4, IS-IS and RIP unicast routing protocols, support for PIM, DVMRP, MBGP and IGMP multicast routing protocols, support for IETF DiffServ (Expedited Forwarding, Assured Forwarding), support for traffic policing (RFC 2697, RFC 2698), support for hierarchical queuing (WFQ, WRR, number of queues), support for other QOS functions (IEEE 802.1p, RED/WRED+), support for policy routing (number of policies, rate limiters), support for IPv6, DHCPv6, and NCPv6.

**ATM functions:** Max number of virtual channels (PVC, SPVC, SVC), support for service classes (CBR, VBR-RT, VBR-NRT, UBR+, UBR, ABR), UNI and PNNI interfaces, PVC crossconnect, soft PVC support, multicast (NBMA), ATM ping.

**Service switching/subscriber management features:** Stateful firewall, NAT, NAPT, URL filtering, virus checking and removal, intrusion detection, PKI, service management system, web portal.

Metro B-RASs evaluated:

- Cisco 10008 ESR
- Cisco 7606
- Cosine IPSX 9500
- Juniper ERX 1440
- Laurel ST200
- net.com Scream 100
- Nortel BSN 5000
- Redback SmartEdge 800
- Redback SMS 10000

Four scorecards are given for different B-RAS applications: Access Integration, Ethernet Access, Advanced Services and Security Services.

**TR-59 COMPLIANT B-R**AS

The following data is given for each TR-59 compliant B-RAS:

**Equipment features:** Chassis size, power consumption, weight fully configured, Fast Ethernet and Gigabit Ethernet interfaces for content server connection, throughput.

**ATM features:** Number of virtual channels per subscriber, VC termination and aggregation, service categories (CBR, VBR-RT, VBR-NRT, UBR+, UBR), VP/VC crossconnect (AAL-1, AAL-2, AAL3/4, AAL-5).

**DiffServ and other QOS features:** Support for expedited forwarding (RFC 3246), assured forwarding (RFC3260/2597), CodePoint remarking (RFC2474), traffic policing (RFCs 2697, 2698, RED/WRED), BE and AF packet size reduction techniques (IP fragmentation, path MTU discovery, ML-PPP interleaving, TCP manipulation, other).

**Policy and traffic engineering features:** Downstream bandwidth allocation (ATM, PPP, Ethernet, IP), traffic policing (IP QOS field making upstream/downstream, policing of upstream subscriber traffic), CodePoint to upstream traffic engineered path mapping RFC 2474 (MPLS LSP, VLAN, ATM VP, other).

**Queuing and scheduling features:** Hierarchical scheduling requirements (ATM crossconnect, number of layers in hierarchy, number of subsequent ATM hops modelable), queuing behaviors (strict priority, WFQ, WRR), number of queues (per subscriber, per line card, per chassis).

**Subscriber session features:** LAC, LNS, RFC 2684, address allocation using DHCP, authentication using Radius, mechanism to push routing info to RG at PPP session start.
Products evaluated:

- Cisco products (various)
- Copper Mountain VantEdge
- Juniper E-Series
- net.com Scream Series
- Nortel BSN 5000
- Redback SmartEdge Series

**CO-Scale B-RAS**

The following data is given for each CO-scale B-RAS:

**Scaling – ATM and VLANs:** Active ATM VPs per chassis, active ATM PVCs (per chassis, per DS-3, per OC-3c, per OC-12c), VLANs per chassis, subscribers per VLAN, ATM VCs mapped per VLAN.

**Scaling – Other parameters:** Number of virtual routers (VRs); L2TP tunnels per VR; L2TP tunnels per tunnel group, number of L2TP sessions per tunnel, policy-based networking (policy transactions per second, number of rules per chassis, number of rules per subscriber), number of VPNs per chassis, number of PPPoE sessions set up per second with Radius, number of layers in hierarchical scheduling.

In addition, CO-scale B-RASs were evaluated using a full set of scaling criteria plus density.

Products evaluated:

- Cisco 10008 ESR
- Cisco 7206
- Cisco 7301
- Copper Mountain VantEdge
- Juniper ERX 1440
- Juniper ERX 310
- Juniper ERX 710
- net.com Scream 100
- net.com Scream 50
- Nortel BSN 5000
- Redback SmartEdge 800
- Redback SmartEdge 400

**3G DLCs**

A chapter of the report is devoted to third-generation digital loop carriers, another category of products that promises to play a key role in the evolution of broadband infrastructure. Equipment from the following vendors is reviewed:

- Advanced Fibre Communications
- Alcatel
- Calix Networks
- Catena Networks
- Lucent
- Marconi
- Occam Networks
- UTStarcom

**Key Findings**

In addition to ranking vendors in product category targeting different applications, other key findings include:

Some carriers are keen to move towards more distribution of B-RAS functions. They should think again. Heavy Reading believes that distributing the B-RAS from the metro node to the central office (CO) introduces as many problems as it solves. The CO B-RAS concept does not fit with the most aggressive cost reduction network designs, such as those found in the Asia/Pacific region. It’s also worth noting that TR-59 is agnostic on B-RAS location.
Ethernet DSLAMs and Metro TR-59 B-RASs are a killer combination for supporting advanced services. It’s the most cost-effective solution because Ethernet DSLAMs have no Layer-3 capability (beyond IGMP proxy), use inexpensive Gigabit Ethernet uplinks and don’t distribute edge routing to the CO. Some vendors are already saying that Ethernet DSLAMs can fit into the TR-59 architecture by replacing ATM VCs with Ethernet VLANs in the DSLAM/B-RAS link.

Metro B-RAS session termination densities have skyrocketed, and now approach 1 million per rack. Metro B-RASs have risen to the challenge of scaling for mass DSL deployment with increased throughput, interface density, and session density. Theoretical throughputs of 100 Gbit/s to 1,000 Gbit/s per seven-foot telco rack are now feasible. Session density has increased even more quickly, by about a factor of ten in the last 12 to 18 months.

Broadband loop carriers will be key to the migration of voice services from TDM to packet infrastructure. All major carriers know that they will soon have to start the transition of Class 5 voice switches to VOIP because of legacy obsolescence, and BLCs offer the most graceful method. Any POTS line can be switched to POTS + DSL and packetized voice routed to the softswitch without a truck roll and at near POTS cost. This is why BLC architectures are now being considered by even the most conservative Western European telcos for further DSL deployment.

B-RAS router throughput figures are sometimes based on impractical numbers of chassis per rack. Two vendors claim six chassis per rack in back-to-back configurations. This appears impractical in at least one case where front-to-back airflow cooling is required and there are many electrical connectors on the rear of the chassis. Also, there’s little gain from six shelves per rack if that rack has to stand alone in the middle of a barn-sized office.

Most so-called IP DSLAMs are actually Ethernet DSLAMs; they don’t incorporate IP routing functions. Heavy Reading has coined the term “Ethernet DSLAM” for DSLAMs that boast Ethernet rather than ATM switching. They’re often called IP DSLAMs by vendors – a misnomer in that they rarely incorporate IP routing capability. Ethernet DSLAMs are used extensively in multi-tenant buildings in the Asia/Pacific region.

DSLAMs with integral B-RAS functionality are at an early stage of development. They’re unlikely to meet the demanding requirements of TR-59 any time soon. Some vendors claiming to support B-RAS functions in DSLAMs support a very limited set of functions, typically just PPPoE and RFC 1483 termination and aggregation.

Most ATM DSLAMs don’t have PNNI capabilities and thus can’t support sophisticated “soft PVC” network recovery methods. The use of soft PVCs allows a much faster ATM network recovery in the case of the failure of multiple ATM switches or links, because each DSLAM can initiate the reconnection of its PVCs using ATM signaling at a rate of many per second. In static PVC systems, all reconnections must be initiated by the central network management system, which is much slower. The use of PNNI also ensures the individual PVCs have the correct QOS capabilities through the network.

Beware claims of ATM crossconnect capabilities in CO B-RAS. In most cases, it’s for data only. Heavy Reading originally thought that this was another straightforward feature, and that the ability to crossconnect all AAL types was a standard ATM function. Not so. Many B-RASs based on edge routers have retrofitted ATM crossconnect functionality and can only handle AAL-5. This is an important differentiation, because you would want a B-RAS with an integrated ATM switch to pass through CES (circuit emulation services) traffic to a legacy ATM network.