ATM vs. IP/PPP

Why Frame is better than Cells at the network edge

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Introduction

There has been much excitement and talk over the years about the appropriateness of ATM for all manner of telecommunications applications. Many white papers and articles asserted that ATM was the unifying platform that would enable service providers to deliver voice, data, and video to subscribers over a consolidated link, platform, and integrated access device (IAD). Though many of the arguments put forth in favor of ATM are true, today, it is well understood that ATM's one-size-fits-all approach sacrifices link efficiency and generates scalability problems for networks. The main intent of this white paper is to dispel the notion that ATM is the best alternative for edge networks.

This paper will make two distinct points:

- PPP is more efficient than ATM for the last mile or network edge—the portion of the network from the Central Office to the user CPE. Because of the inefficiencies of ATM, a subscriber with a T1/E1 frame-based service such as Frame Relay or PPP will experience degraded service when converted over to a symmetric DSL solution.
- The architecture of ATM-based DSLAMs requires aggregation platforms that decrease operational efficiencies and increase operating costs associated with deploying the service.

What is ATM?

Asynchronous transfer mode, or *ATM*, was developed as a technology that would enable voice, video, and data transport over the same network while including rich management features and the quality of service (QoS) guarantees that voice and video require. ATM uses short, fixed-length (53-octet) packets called *cells* for transport to accomplish this. It uses *ATM adaptation layers* (AALs) to transport different traffic types and numerous bit rate service algorithms to ensure QoS. However, ATM creates many drawbacks at the network edge.

Lack of scalability hampers efficiency, raising costs

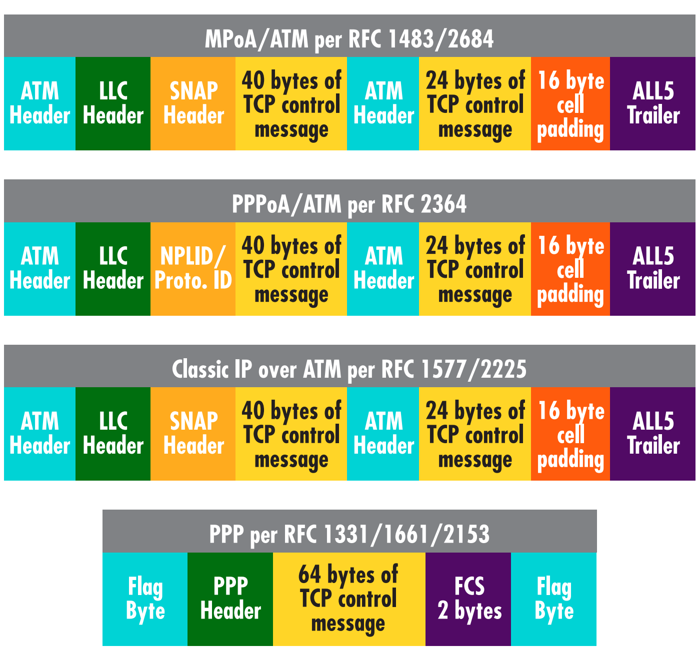
When ATM was first unveiled many people pointed to link inefficiency as a glaring issue. Supporters of ATM rebutted this argument by pointing out the operational efficiencies achievable by the consolidation of all services into one platform. Unfortunately, as networks grew with ATM deployments, this claim did not hold water. ATM switches and IP routers were overwhelmed by the large volume of PVCs generated by DSLAMs and IADs, and required additional platforms to scale.

The scalability problem ATM technology created caused the need for platforms to optimize, aggregate and concentrate edge network traffic. Hence ATM edge switches, edge routers, concentration routers, and PVC aggregation platforms came into service. This proliferation of platforms designed to deal with ATM's scalability issues quickly eroded the profits of those who deployed it. The approach of using ATM throughout the network, including the edge, forced the superimposition of an additional layer of encapsulation, usually in the form of PPP tunneling, to more effectively move traffic around. This encapsulation process added to traffic overhead and further reduced link efficiency.

With the addition of aggregation platforms, the need for management systems to control and configure these solutions followed. The impact on the service provider goes beyond the cost of adding and maintaining the additional management system. The greatest expense is in the integration of the management platform with existing OSS systems. This became easier as vendors incorporated the management system of aggregation equipment into their existing management platforms by creating multi-module management system. However, this also created a huge disincentive to acquire "best of breed" equipment from different vendors, forcing a reduction in choice for the operators.

ATM has proven to be cost prohibitive for smaller markets to deploy for numerous reasons. Even today, with lower DSLAM costs, the capital required to deploy ATM in many medium-sized markets far outweighs the return. To deploy an ATM-based DSLAM solution, the service provider needs to acquire an ATM PVC aggregation platform and edge routing equipment needed to convert from ATM WAN interfaces to typical Ethernet-based LAN interfaces, requirements that significantly add to the cost-per-port equation when a small number of ports are involved. This likewise translates into additional costs in the form of more employee training, multiple management platforms, multiple service and support contracts, numerous spares, and elevated network engineering efforts required to address multi-layer redundancy issues. The resulting costs outstrip the benefits of providing the service.

Figure 1. Protocol overhead for 64-byte IP control message



Throughput analysis of PPP versus ATM from the DSLAM to the subscriber

The ATM "cell tax" makes ATM an inefficient transport method for data-only networks. We have already seen that ATM is a tedious and inefficient way of deploying IP access due to the huge number of PVCs that are generated by such an approach. Let us now look at the cost ATM brings in terms of efficiency.

Data encapsulated in ATM typically uses AAL5. An ATM cell bearing AAL5 has the following overhead.

ATM Cell	ATM Cell Header		ATM Payload
53	-5	=	48

IP is transported over ATM in many ways, all of which use AAL5. One can use "Classic IP over ATM", PPP over ATM (PPPoA), or Multi-protocol Encapsulation over ATM (MPoA). Regardless of the means used to transport IP over ATM, the amount of overhead used is the same since LLC or LLC/SNAP headers are used to encapsulate the start of the data and an AAL5-specific trailer, plus padding is added at the end of the IP data. See figure 1 for protocol details of the different encapsulation types using a sample 64-byte IP control message.

Message Type	Length	LLC/Snap Header	AAL5 PDU Trailer	Total ATM Payload	Cells Required	Octets of Padding	Total Bandwidth Consumed	Overhead
Control messages	64	8	8	80	2	16	106	39.62%
Typical Internet packet size	250	8	8	256	6	22	318	21.38%
Average other traffic	256	8	8	272	6	16	318	19.50%
File/graphics transfer	1500	8	8	1516	32	20	1696	11.56%

Table 1. ATM Overhead Calculation

Table 1 shows the overhead impact created by the use of ATM encapsulation. Different packet sizes are examined including the average Internet package size. In all cases, the smaller the packet size, the more bandwidth that is wasted on encapsulation and therefore the lower the throughput of the connection.

On the other hand, PPP has a much lower overhead than ATM (see table 2). If the idea is to provide an Internet access service over the local loop, using ATM instead of PPP can mean a difference in overhead of more than 18%. In other words, if the last-mile solution employs ATM, *there will be a loss of throughput due to bandwidth inefficiency of* ***at least 18%***.

Overhead differences between ATM and PPP have a significant impact when converting subscribers from T1/E1 links requiring IP encapsulated services DSL loops. When replacing a traditional T1/E1 circuit that is used for Internet access with a symmetric DSL solution such as G.SHDSL, an ATM-based service will actually reduce the bandwidth available to the customer by 18%. With

Message Type	Length	Flag Bytes	Address Byte	Control Byte	Protocol Bytes	Frame Check Sequence	Total Bandwidth Consumed	Overhead
Control messages	64	2	1	1	2	2	72	11.11%
Typical Internet packet size	250	2	1	1	2	2	258	3.10%
Average other traffic	256	2	1	1	2	2	264	3.03%
File/graphics transfer	1500	2	1	1	2	2	1508	0.53%

Table 2. PPP Overhead Calculation*

*Assumes frames can be negotiated in excess of 1500 using LCP.

PPP the loss of bandwidth is 0%, assuming that the subscriber is already using PPP or Frame Relay over the T1/E1. If ATM is used, the subscriber will probably notice a degraded level of service.

Conclusion

In conclusion, ATM has failed to deliver on many of its promises. The use of ATM in the local loop for DSLAM based IP services has numerous drawbacks:

- Compared to PPP, ATM uses 18% more overhead, reducing overall throughput to the subscriber.
- When converting a subscriber from a frame-based protocol over T1/E1 lines, the subscriber will notice a degradation of service.
- The need for ATM PVC aggregation platforms increases the cost and increases operational inefficiencies.

You will be better off with a PPP-based DSLAM than an ATM-based DSLAM if the intention is to increase operational efficiency, increase throughput to the customer when replacing T1-based services, and deploy an overall more scalable solution.

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