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ATM and the Internet - A Service Provider Perspective

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Abstract

The Internet as we know it today has been built mainly on leased lines. Since ATM has become available some parts of the Internet were shifted to an ATM based platform, mainly to make use of the added flexibility offered by ATM. The advantages and disadvantages of ATM and IP are heavily discussed amongst experts, leading to sometimes semi-religious disputes. A service provider must make decision on new technologies rather more emotionless. From this perspective a shift to a new technology like ATM is only feasible if either his customers require this technology or if there is a cost advantage. Today the major benefit of ATM is flexible bandwidth assignment, but the cost are still such that they prevent general use of the new technology. For the future ATM promises features that at least the current version of the Internet Protocol cannot offer. It remains to be seen if and when these features will be mature and at what price they will be delivered.

Keywords: IP over ATM, Internet Service Provision

The position of Internet Service Providers

From a commercial perspective the introduction or use of a new technology must be justified by either customer demand or because the innovation is more cost efficient. Through the new technology the IP service provider might be able to offer new services to his customers or bring the price of existing services down. ATM promises new transmission techniques that are not currently available on the Internet, or could be implemented only at very high cost. The question for an Internet Service Provider is if there is a demand for these new services, and if ATM services can be used in a way to reduce the operational cost of his network compared to using leased lines.

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In theory there is also the option of service providers buying leased lines and switches, and providing the ATM service themselves. This is an expensive way of providing the service. Not only does the provider loose the ATM cell headers as overhead, also this requires additional equipment, which is expensive even though the price for equipment is small compared to the cost for leasing lines. Therefore this will be limited to exceptional cases. In general IP service providers are likely to buy an ATM service from a public carrier, and can therefore be considered ATM users in this context.

ATM Today

The ATM services that are on offer today are mostly limited to continuous bitrate services (CBR) and variable bitrate (VBR) services. For the provision of an IP service both are in principle suitable. (For a detailed discussion see below.) Due to a lack of signalling standards these are the only traffic classes and services that ATM offers today to the IP service provider. For the provider this means that up to now the only technical benefit of ATM over leased lines is the fact that the assignment of bandwidth is not limited to the standard leased line transmission speeds any more, and that the allocation of ATM channels should be faster than with traditional leased lines. The customer only benefits if he has a requirement for dedicated bandwidth.

So far the cost of ATM services in Europe are too high to allow for general use of the new technology. In most cases the price per Mbit/s transmission capacity is higher on an ATM service than over leased lines. In addition to the cost, ATM leads to an additional overhead on IP level (see below for details). Therefore ATM is currently only in use in IP networks where there is a need for flexible bandwidth assignments, or where transmission speeds are required that are not otherwise available.

IP over ATM: Technical Problems

The first problem usually mentioned when using IP over ATM is the overhead. The ATM overhead consists of three parts, the ATM cell header (4 bytes for 48 bytes payload), the AAL header (for AAL5 this is 8 bytes per IP packet), and the padding to fill the last cell of an packet. The total overhead depends on the size of the IP packets. Values between app. 15% up to 30% and more can be observed. The overhead of the ATM cells should be carried by the ATM provider, such that the ATM bandwidth sold should not include the ATM header. This leaves the AAL header and the padding, which are not a severe problem for general IP traffic with an average packet size of app. 200-300 bytes. It also has to be noted that TCP / IP has a big overhead (40 bytes per packet), but for the foreseeable future these protocols will be needed by the applications.

Almost all applications that are in use over today's Internet require the TCP / IP protocol stack. Native ATM applications are being developed but are far from being used on a wide scale. Therefore IP is needed on the Internet for the foreseeable future, and if ATM is to be used as a transmission technology, it has to be added to the protocol stack rather than replacing parts of it. There are a number of problems with running IP over ATM, which are partly due to the fact that ATM is connection oriented while IP is connectionless.

VBR looks at first glance like a suitable traffic class for an IP service, because it offers a guaranteed sustainable cell rate (SCR) with the ability to peak to a defined peak cell rate (PCR). This in itself would be a significant advantage over the leased line approach. It has to be noted though that despite a VBR service is capable of bursting to the PCR, this is generally not noticeable on IP level. The reason for this is that the PCR can only be sustained for a defined number of cells (maximum burst size, MBS), after which the traffic needs to stop for some time to get the average down to the SCR level. Therefore VBR does not offer a significant technical advantage over CBR services if IP is used on top of it.

IP traffic is comparatively tolerant to packet losses, but even a small cell loss on the ATM layer can bring the useful IP throughput down to almost zero. This is because IP packets are mapped through an ATM adaptation layer (AAL) into cells. One single IP packet can be up to 9k bytes and more, which fills up a large number of cells. If only one of the cells needs to be discarded in the ATM network, the whole packet needs to be retransmitted. Therefore ATM networks need to have a very low cell loss rate, to make the use of IP possible. A cell loss rate of 10^-9 is acceptable, with 10^-8 the loss is noticeable, but working is still possible, from 10^-7 and more the losses are experienced as problematic. There are techniques under development where the AAL has knowledge of the IP layer structure and can discard whole packets if needed (early packet discard, EPD). These are not yet generally in use.

Other problems come with multicasting, where the ATM approach is different to IP, because ATM is connection oriented. These can be solved, but require significant changes from the IP approach.

None of these problems means that ATM would not be suitable to carry an IP service, but as long as the use of ATM does not bring a significant commercial advantage and as long as it is not really needed by the customers, service providers will use the simple and well known technology of leased lines whenever possible.

ATM in the Future

A number of ATM services that are under development today look attractive to the provision of an Internet backbone. Switched virtual circuits (SVC) combine the advantages of quality of service of the CBR and VBR classes with the quick availability of transmission capacity on the Internet. The signalling standards are still under development, and more time will be needed to advance the working technology to operational standards. From an Internet perspective this tendency is seen with mixed feelings: The need for high quality of service on demand is certainly acknowledged, but it will lead to usage based charging, a model so far disliked in the Internet world. From a provider perspective though the demand will drive the development, and there is little doubt that this service will be used if the prices are reasonable.

As mentioned above, VBR services do not provide the level of flexibility users are used to on the Internet. On IP level, the bandwidth increase to the peak cell rate is far too short to be even noticed. The available bitrate service (ABR) of ATM seeks to offer this flexibility by making the full physical speed available if no other virtual circuit is using it. This traffic class is also under development. Whilst this comes close to the wishes of the

Internet users, it is unclear if and how PNOs will make this service available. From past experience it can be seen that PNOs are not necessarily offering this additional free bandwidth. This can be seen with the Frame Relay services on offer today: In theory PNOs could offer very high peak rates, in practice they are reluctant to offer more than twice the average rate for peak traffic, even if there is still spare bandwidth available. If the same approach is chosen on ATM ABR services, this will limit the usefulness of ABR, despite it will still be more attractive than VBR for the provision of Internet capacity.
Another possibility is that ATM will be used end to end, with applications running natively on ATM. There is still a long way to go for this to happen. Firstly, addressing issues will have to be resolved. Not only would that require to change from the IP numbering scheme to a new architecture, but there are already two schemes in use, E.164 and NSAP, which will make address translation necessary. Then, ATM routing is also far from being deployed in a service environment.

Possible Directions of the Internet

As of today it is not clear how the Internet will develop. It can already be seen that ATM is being used in parts of it, which points out clearly that there is a need for technical additions to the current IP protocol. This need comes from the desire to get quality of service, which cannot be achieved over the current Internet. The Internet will certainly not remain a pure IP over leased lines infrastructure, and as can be seen today there is scope for ATM.

Sometimes voices can be heard that IP will disappear altogether in the end. But for ATM to take over the full functionality of today's Internet many more issues would need to be addressed. The multicasting structure of the Internet cannot be easily transferred to an ATM network, because ATM is connection oriented and has therefore a different technical approach to multicasting. Up to today, there are almost no native ATM applications, and even if ATM is used as a transmission technology IP is used to route the traffic. It is very questionable if ATM will ever take over the Internet completely, neither is it obvious that this is desirable. But we are certainly years away from even having major parts of the Internet running without IP. And certain parts of the Internet will probably never be replaced: The domain name system is one if those.

But what about IP next generation?

The next version of the Internet Protocol that is currently under development will not only address the size of the address field, but also try to deliver the quality of service needed. The resource reservation protocol is the attempt of the Internet community to solve the problem of lacks of bandwidth guarantees in the IP protocol. As with ATM, it will take a long time to get the new protocols to a standard where they can be deployed in an operational environment. The market will decide in the end which way the Internet will go. Fast availability is certainly a key issue here.

Summary and Conclusion

Currently the benefit of ATM for Internet service providers comes with the flexible bandwidth assignment possibilities. As the price for ATM services in Europe is still very high, ATM is only being deployed where there is a need for bandwidths that cannot be obtained otherwise. The traffic classes available today do not offer specific benefits to the Internet provider.

As to the future, the market will decide what role ATM will play on the Internet. This depends on what PNOs are going to offer and to what prices, and if there is a general need for the services from the Internet perspective.

Author Information

Michael H. Behringer holds the position of Senior Network Engineer at DANTE. His responsibilities include the planning and development of network services on EuropaNET and on the TEN-34 high-speed network, parts of which are based on ATM. In the TEN-34 project he is specifically responsible for the co-operation with JAMES on testing ATM backbone facilities.