CASTBA: Internet Traffic Measurements over the Spanish R&D ATM Network

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Abstract

Variability and unpredictability are probably the only well known characteristics of Internet traffic. These two aspects considerably hinder any serious attempt to model the Internet traffic behaviour. As a result, the dimensioning and the management of the underlying network resources are extremely difficult. New integrated services IP networks based on broadband transport technologies like ATM are not exceptions of this problem. Several issues, like network performance evaluation, applications quality of service requirements, users accounting, etc, over these networks are of increasing interest for both research community and network operation companies.

Most of the works on Internet traffic behaviour over broadband networks rely on theoretical studies of the IP protocols and applications over the ATM layers, but they are in practice slightly underwritten by measured results. This leads to the necessity of detailed measurements of IP services behaviour over the ATM high speed backbones, where the different user applications traffic mix is fully outstanding.

Integrated in the Spanish National Plan for R&D, the CASTBA project developed by the Department of Telematic Systems Engineering at the Technical University of Madrid has pursued the goal of characterising IP applications and services over the RedIRIS backbone. Throughout year 1997, the Spanish National Research Network (RedIRIS) has been upgraded to ATM technology, and at present there are 17 backbone nodes with 34/155 Mbps accesses to Telefónica´s GigaCom ATM Network.

Inside this framework, this paper presents an overview of traffic measurements and methodology considerations carried out in CASTBA [1] for drawing the achieved characterisation of IP services over an ATM backbone.

Contents

Objectives of the CASTBA project

Recently, the spanish academic network (RedIRIS) has experimented a technological transition from a just IP packed-switching architecture based on point-to-point leased circuits to a transmission infrastructure with ATM cell-switching and multiplexing, underneath the original IP network. Besides, this architectural change has led to a network structural and topologic transition.

Inside the framework of this technological transformation suffered by our academic network, common from the last two years for almost educational and research networks in other countries, there is an increasing concern for knowing about the behaviour of the new network architectures below traffic demanded by users at present.

However, the nature of current Internet traffic responds to complex patterns that aren´t well-known [9] [17], this complexity is mainly caused by the mix of services and network applications utilized by users, and by the aggregation of an increasing number of traffic flows with different characteristics and belonging to different subnetworks. This problem makes heavier onto the new high-speed transport networks (ATM), whose high capacity backbone links meet all mentioned factors.

Because of this reason, our goal has not been only to obtain traffic load and performance measurements over the RedIris backbone links, but also to analyse qualitatively the traffic at IP level. By this way, we have got essential data for evaluating the behaviour of the new ATM network architecture, and in addition to this, we´ve achieved an analysis of major characteristics of most popular IP services in the Internet, considering our national academic network as a representative testbed.

Our efforts have been shared with the CASTBA-C project from UPC (Technical University of Catalonia), where objectives have focused on measurements over the access network from UPC to RedIris backbone. The results of two projects are complementary, offering fundamental data about traffic carried by an access broadband network (UPC) and a high-speed backbone network (UPM) in RedIris. In this paper we present the results obtained by Department of Telematic Systems Engineering at the Technical University of Madrid over the RedIris ATM backbone.

The RedIRIS backbone

RedIris is a star network around the central node placed at Madrid (figure 1).

Figure 1: RedIris topology

Backbone network support the RedIris communication services and consists of 17 regional nodes, one for each Autonomous Community. Regional nodes are interconnected to Madrid by 34/155 Mbps ATM asymetric circuits through Telefonica´s Gigacom public network. Network users, research centers, and universities, are connected to their nearest regional nodes by dedicated lines with speeds varying from 64

Kbps to 2 Mbps. Besides, RedIris holds an external link from central node to Europe via TEN-34 (22 Mbps) and a 8 Mbps link to USA-MCI for intercontinental traffic. There is another 4 Mbps link to the spanish commercial network Ibernet.

All of the injected traffic to the ATM backbone is by Internet Protocol, using RFC1483 encapsulation (AAL5 adaptation layer protocol) [18].

Measurement infrastructure

Since traffic measurements have been taken as a whole over the 17 backbone links of RedIRIS, the network central node has been the location of our measurement equipments. Exactly, we placed our traffic analyzer [13] [14] between the access to GigaCom ATM switch and the central IP router of RedIRIS. In order to do not jam the network usual operation, two passive optical fiber splitters have been used, one for each transmission way (input and output traffic from regional nodes) onto the unique fibers pair that gathers overall traffic from nodes. This equipment connection scheme can be viewed in the figure 2.

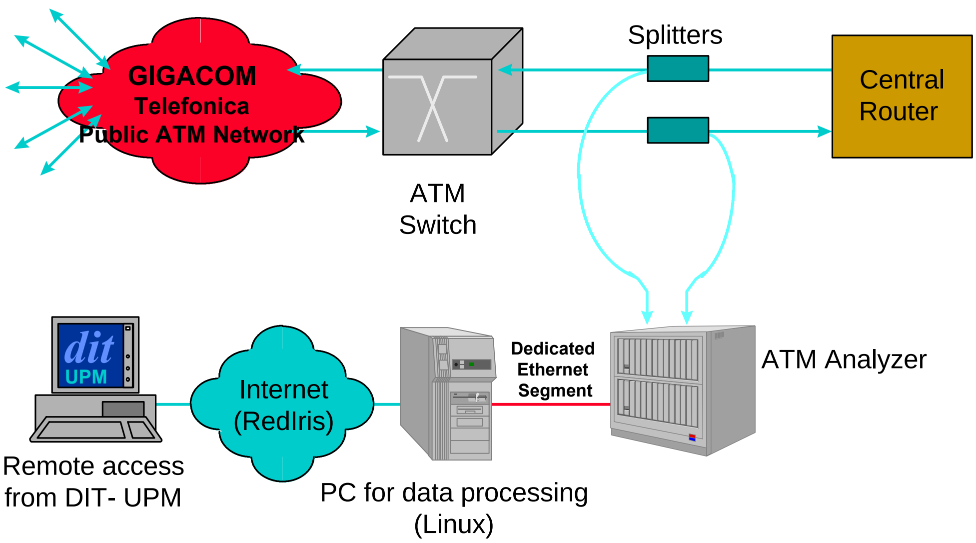

Figure 2: Measurement points location

Methodology

In CASTBA we have carried out two types of traffic measurements over the RedIRIS backbone. The first set of measurements has been guided towards the procurement of quantitative traffic and network performance data [6] [7] [16]. Putting together the methodology developed for this type of measurements and traffic data obtained by its application, essential knowledge about the academic network behaviour has been achieved with respect to its quality of service performance (IP packet´s delay and loss) and to the accurate backbone links dimensioning (average utilisation, traffic matrix, etc). Into our methodology we have appointed these measurements as **traffic load and performance**.

The second group of measurements deployed in CASTBA have pursued the characterisation of commonly used internet services and applications by means of their traffic generation patterns [8] [10]. The methodology developed for this type of measurements has made the **capture and analysis of traffic** from RedIRIS backbone, and it has allowed us to describe certain characteristics of IP traffic (packet fragmentation, per service profiles of packet size distributions, IP over ATM overhead traffic, daily and weekly evolution of traffic per service, etc).

Traffic measurement results

Packet fragmentation

This measurement characterizes the fragmentation degree of IP packets carried by RedIRIS backbone network. Figures shown below correspond to link ATM-MAD-CAT (Madrid - Catalonia) and belong to days 23, 29, 31 May 1997, and 1,2,3,4 June 1997, with 28 hours and 45 minutes of overall captured traffic for each transmission way (input and output traffic from Catalonia).

	% packets without fragmentation	mean number of fragments per segmented packet
Output traffic	99,92%	5,90
Input traffic	99,66%	5,69

Results from other backbone links show the same low fragmentation degree in from-source IP packets travelling through RedIRIS backbone network. More than 99% of captured IP packets don´t suffer segmentation (MF bit and Offset of IP headers are equal to zero). Besides, we obtained figures for the mean number of fragments belonging to a fragmented packet, producing 6 segments per packet.

Packet size

By this measurement we have characterized the statistical distribution of IP packet size carried by RedIRIS backbone. Results shown in following graphs correspond to link ATM-MAD-CAT (Madrid - Catalonia) and belong to days 17 to 21 November 1997, with 34 hours and 13 minutes of overall captured traffic for each transmission way.

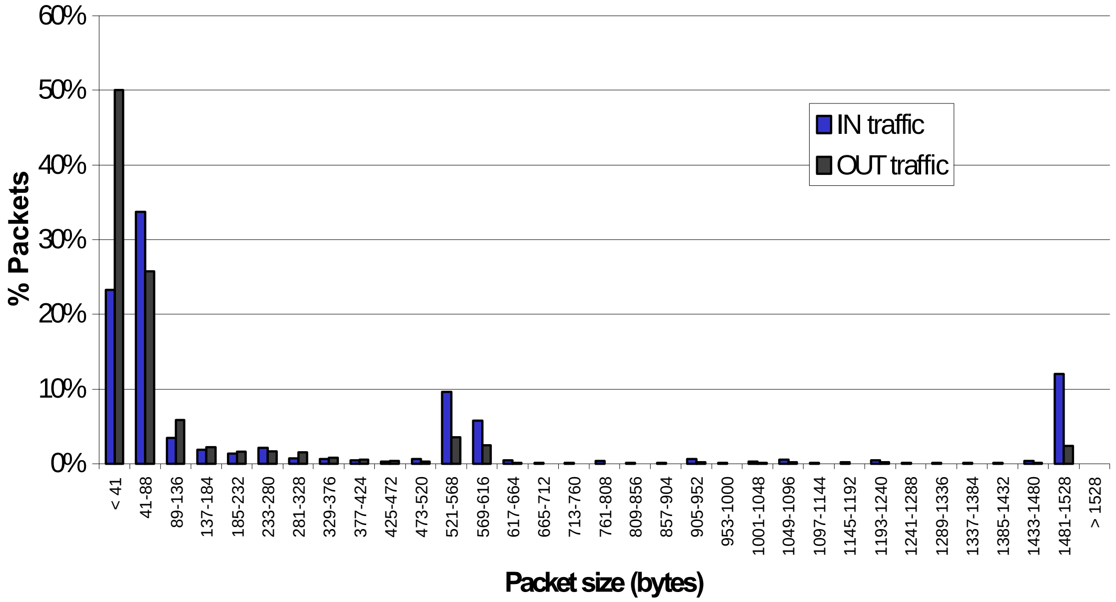

Figure 3: Packet size into backbone network

In *figure-3* we observe three main groups of packet sizes: small packets (from 1 to 3 ATM cells), large packets (32 cells) and medium sized (12 and 13 cells). Note that percentage of small packets is high, more than 75% of outgoing packets and more than 40% of ingoing packets from regional node are smaller than 100 bytes.

In following graphs we show different IP packet size distributions. These results could contribute to the characterisation of commonly used internet services and applications by means of their traffic generation patterns [2] [11].

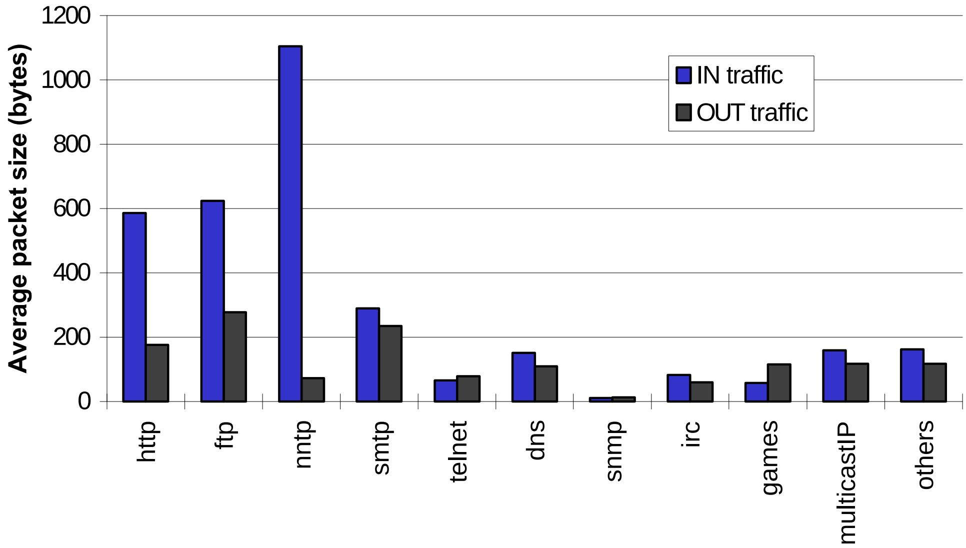

Figure 4: Average packet size per service

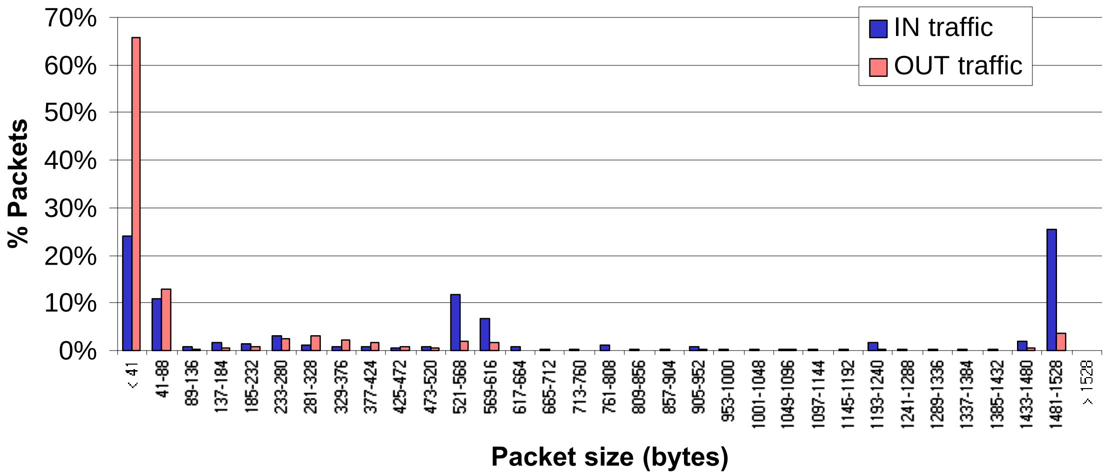

Figure 5: HTTP packet size

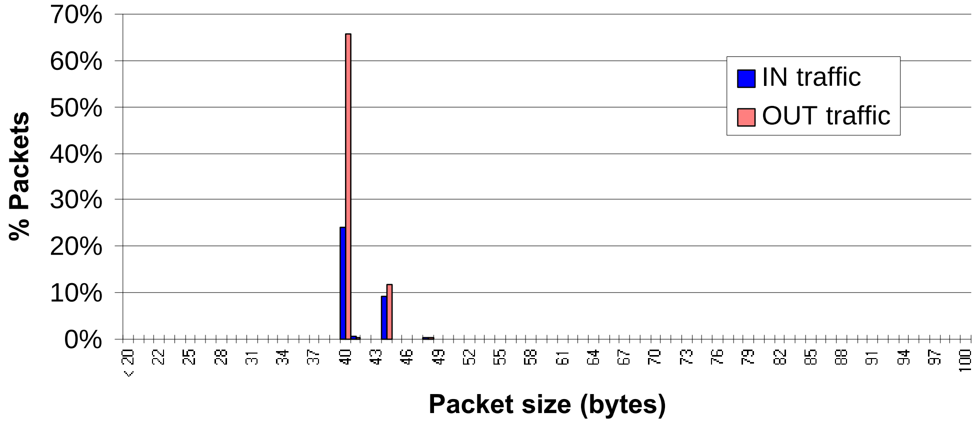

Figure 6: HTTP small packets size ZOOM

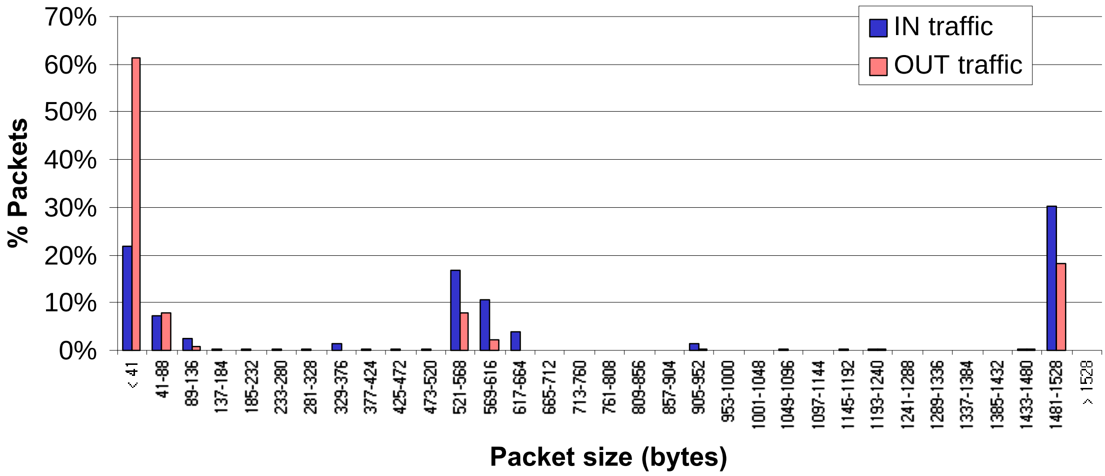

Figure 7: FTP packets size

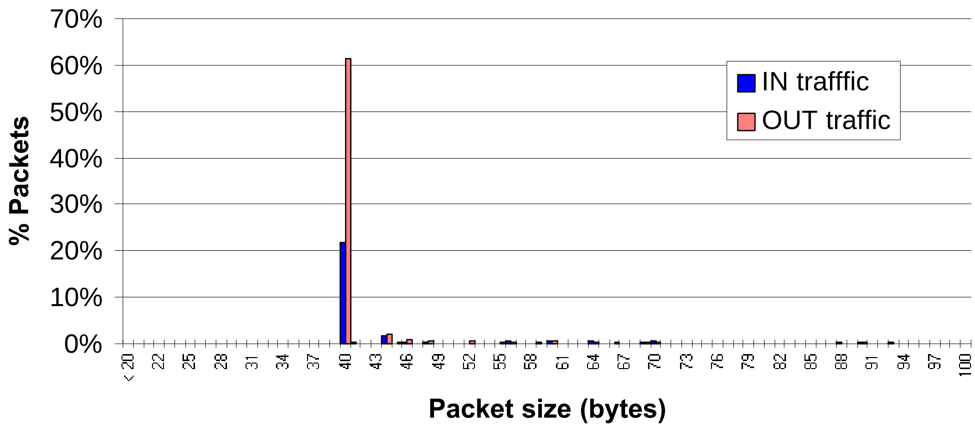

Figure 8: FTP small packets size ZOOM

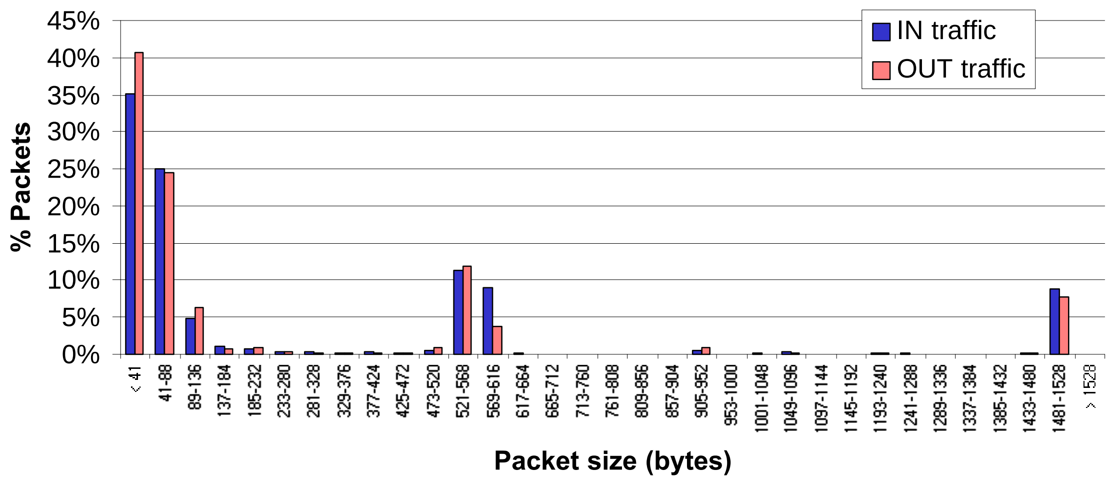

Figure 9: MAIL (SMTP) packets size

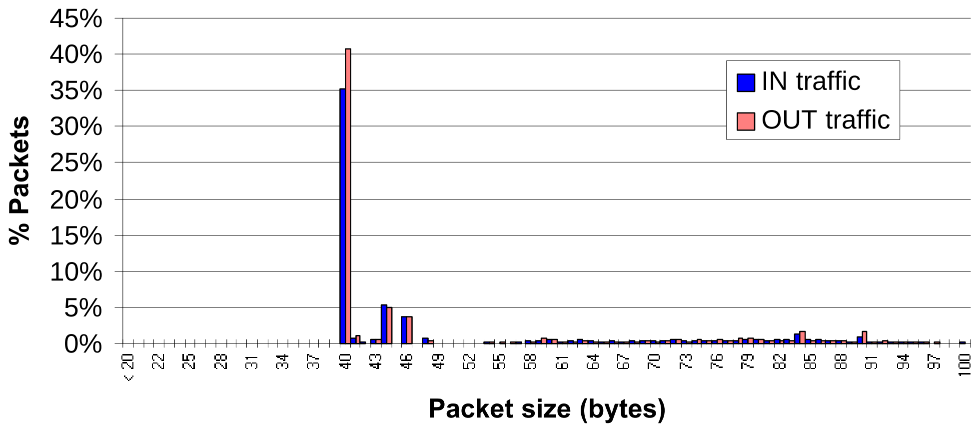

Figure 10: MAIL (SMTP) small packets size ZOOM

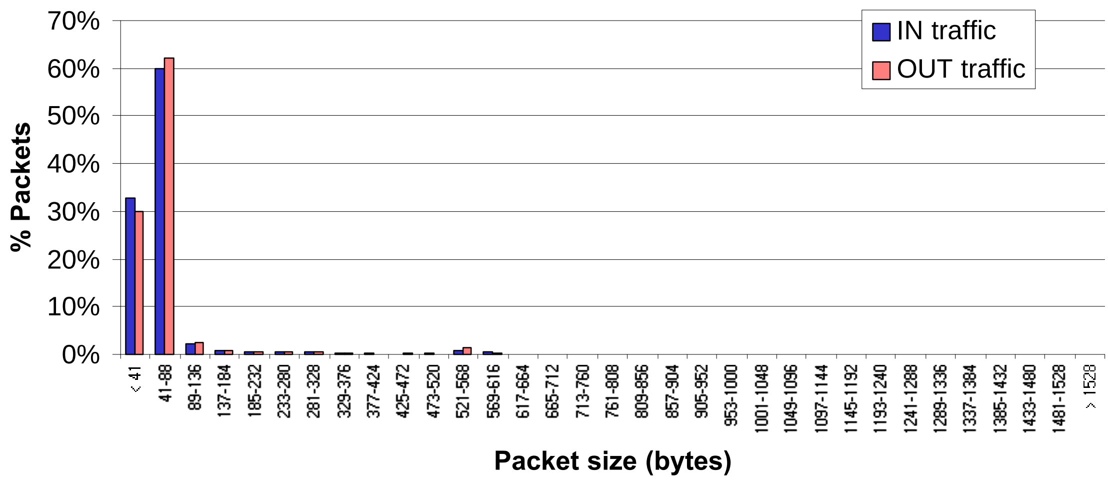

Figure 11: TELNET packets size

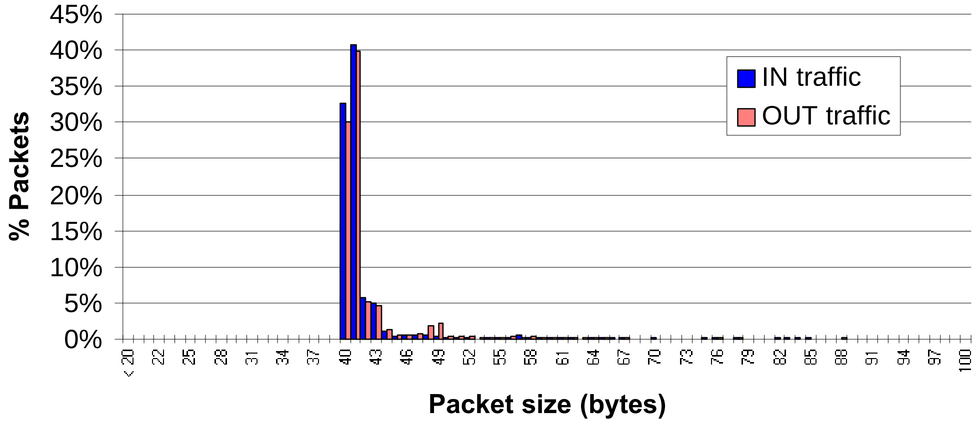

Figure 12: TELNET small packets size ZOOM

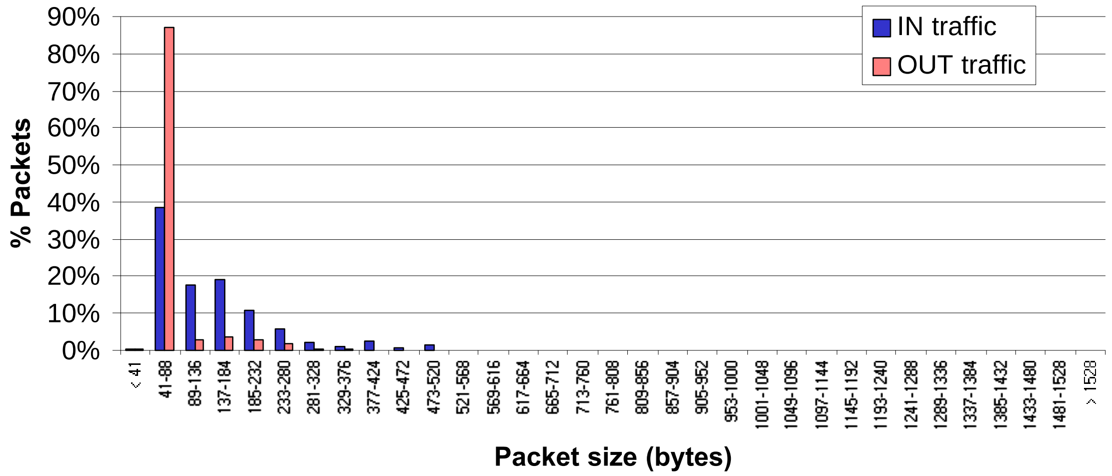

Figure 13: DNS packets size

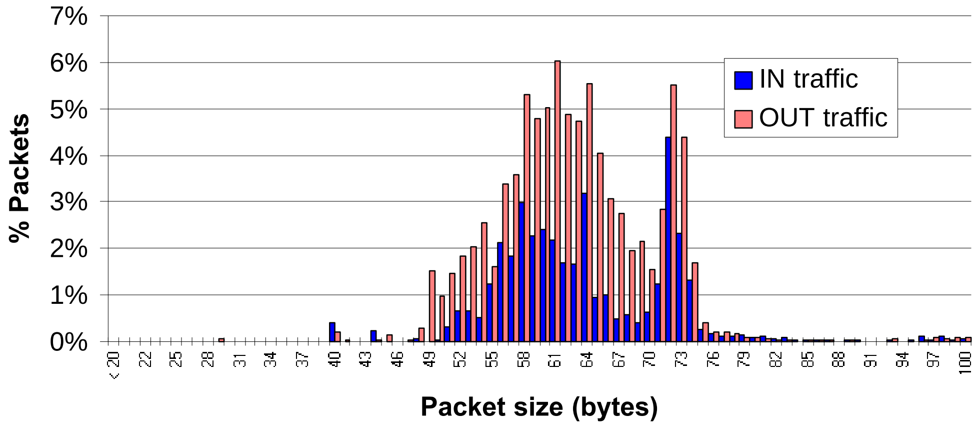

Figure 14: DNS small packets size ZOOM

IP over ATM overhead traffic

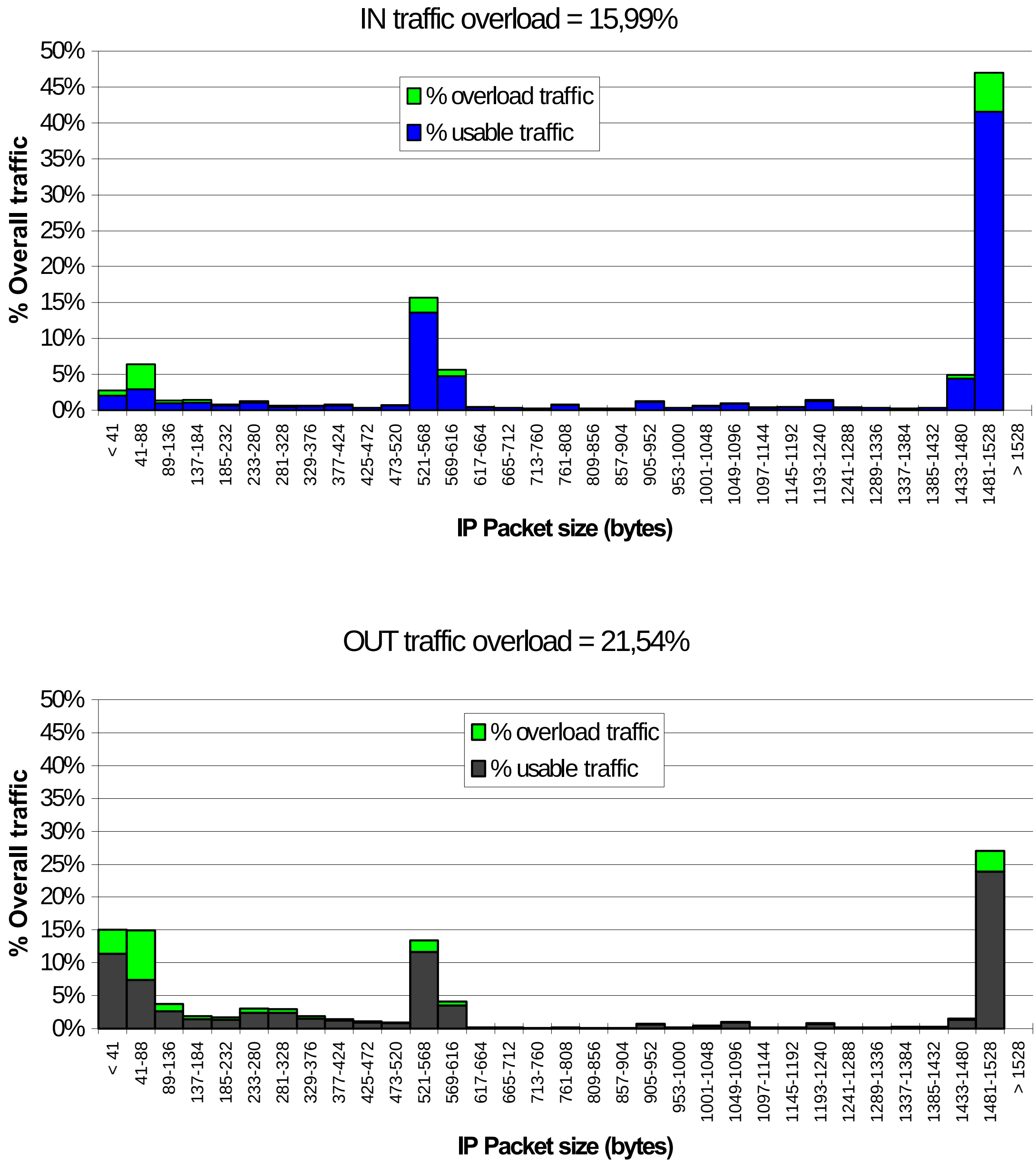

Figure 15: IP over ATM overhead

With respect to measurements of IP protocol over ATM overhead, it stands out the inefficiency introduced by ATM and AAL5 layers. We observe that bandwidth overhead for small packets is comparable to that for large packets in terms of input traffic, but bigger for output traffic from regional node.

Conclusions and future work

Into the framework of CASTBA project, our working group has developed an IP-over-ATM traffic measurement methodology that has led us to determine what are the performance and traffic load of RedIRIS backbone, and besides to characterize traffic patterns for different services and application protocols commonly used into the internet [2]. With respect to the obtained results for packet size distributions profiles on different IP protocols, they could be applied to the parameters specification in traffic source models [9] [17] and to traffic control mechanisms at the backbone access points.

The traffic analysis methodology presented here, has taken each captured IP packet as its analysis basic unit. Now we are re-designing our methodology towards an IP-flow based one [4], rather than IP-packet based, so we´ll be in disposition to achieve new required traffic measurements dealing with IPv6 and QoS objectives in the future integrated-services internet [3].

On the other hand, developed measurement software has been designed in such a capture system [13] [14] independent manner as possible, so we think our traffic analysis methodology can be reused in future onto other ATM traffic capture systems. In this sense, an open research area into our department is the building of a new low-cost traffic capture system based on PC´s and commercially avalilable ATM cards. There are significant works on this topic, see [12] , [15], and [5].

Finally, these improvements will lead us to carry out more detailed studies about the utilisation of the academic network by the users (universities and research centers), determining what are their requirements on demanded applications, on bandwidth allocation and network performance from RedIRIS backbone communications service.

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