2. EXPERIMENTAL TEST BED

The network test bed, fig. 1, is composed of 4 Juniper M10 routers, with GbE interfaces, full mashed using the fiber cable of the experimental ring Roma-Pomezia-Roma (50 Km). This backbone network is completed by 3 edge Cisco 3845 routers, connected with 3 of the 4 Juniper routers by means of GbE fibre transmission. The test bed is completed with a ADSL2+ systems for the access part of the network in order to investigate a real current access scenario; the ADSl2+ consists of an Alcatel DSLAM (ISAM 7324) that allows us to achieve a 24 Mbit/s link in downstream that is a minimum profile to support HD IPTV services.
For its configuration such a test bed represents a segment of Wade Area Network with a core and an access part. For the access part we also took into consideration fibre access, in particular with Fiber to the Buiding (FTTB) architectures. In particular we assume a simple configuration based on a router (connected in fibre to the core) inside the building with the users connected by means of UTP copper cable. In our set up the router is represented by a Cisco one. Furthermore we also investigate about a Wavelength Division Multiplexing (WDM) PON, that can be considered as an evoluion of a Passive Optical Network where the ONUs are connected to the OLT by means of a tree topology and each ONU is linked to the OLT with a GBE wavelength.

The seven routers were set up according to OSPF (Open Shortest Path First), MPLS and BGP (Border Gatway Protocol) protocols. A network generator/analyzer could be inserted between two M10 to overload the link with a total traffic around 1 Gb/s, and this permitted to analyze the QoS in the presence of network congestion. The reliability of such a network was evaluated by means of QoS measurements both with network tests (objective measurements) and with subjective, or perceived, tests (subjective measurements). In particular network tests were carried out by using a network analyzer software, ETHEREAL (now WIRESHARK), that allows us to evaluate some network parameters like throughput, jitter e data loss. To measure the perceived QoS we used a group of reviewers and each one was equipped with a slider; short movies were showed to the reviewer group and each reviewer, during the video show, could manifest his perception by turning the slider that recorded a value between 0 and 100 (0 for bad and 100 for perfect). It's noticeable that in a good perceived video the result of the slider is a constant line equal to 100.
As a reference we consider the only document that today defines the minimum QoE (Quality of Experience) standards in DSL connections: DSL Forum TR-126.

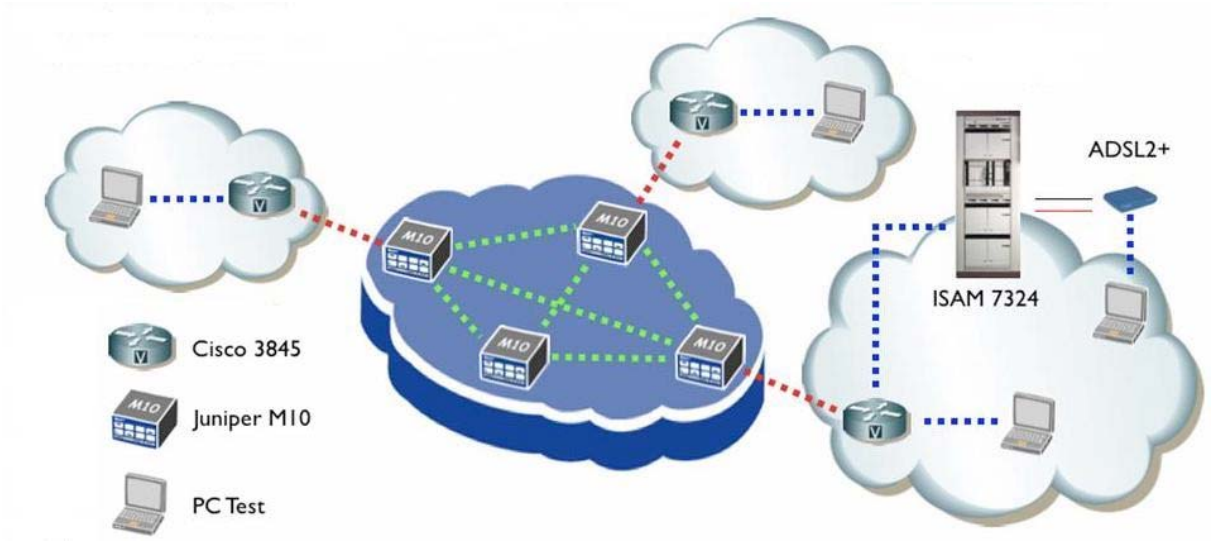

Figure. 1 – Test bed design. The routers are fiber optic connected with GbE interfaces, the Pcs and

ISAM are connected to the routers with a FE UTP cable. The modem is connected to the ISAM by a simple twisted pair cable.

Examples of video streams used for tests were all 28 seconds long MPEG2 coded, audio and video and include both HD and standars television.

- MPEG2 720x**576p** 16/9, **9,29 Mbit/s**, average 29.97 fps, 30 MB per ***24500*** *pks IP(standard TV)*
- MPEG2 1920x**1080i** 16/9, **20 Mbit/s** average, 29.97 fps, 80MB per ***62000*** *pks IP(High Definition TV)*
- Audio: MP2 192 Kbit/s e 48 kHz.