

## Academic Network Infrastructure Development

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*Abstract. Academic networking segment is one of the most rapidly developing networks in the country. The Academy network AMNET is described like a complex and permanently extending system used as a basis for integrated information system deployment for support research and innovation activities in Moldova. The analysis of networking system behavior and possible solutions for its operation parameters perfection is outlined. Special attention is devoted to instrumental toolkits introduced for monitoring and control of network operation thus simplifying procedures of the networking infrastructure exploitation. Argued approaches for appropriate communication technologies selection and new communication equipment ordering as well as perspective services that plan to be installed and become assessable for AMNET users are described.*

### 1. Introduction

Information, computer and applied informational technologies can be defined as a qualitatively new phenomenon, leading to the revision of the very essence of interrelations among all structures of the society, including individuals. The process of organizing a new medium and of transition to a new social-economic formation named a new information society or global information one has begun. The information is understood as scientific-technical and social-economical process of optimum conditions creation for satisfaction of information needs of all of the structures of the society on the basis of organization of information systems with advanced infrastructure and the usage of perspective and flexible information technologies. An active interest is permanently increasing in the development of information technologies, networking infrastructure and telematics products in the Academy of Sciences of Moldova (ASM).

Currently, the process of forming a new society and transition to a new socio-economical formation is actively progressing; this society is being defined via the „informational society” term. Information, computing and networking technologies are a new phenomenon that directly promote changing and stimulation of permanent creational activities, including in research and innovation spheres.

The use of computer engineering in the research process began to develop at the moment when first computers appeared and greatly predetermined the progress of the improvement of data processing hardware and software. Analyzing the experience in the sphere of computer application in the Academy of Sciences of Moldova it might be concluded that it is typical for many actively working scientific centres and reflects the general tendency of data processing systems development in the world.

In early 90-ties first LAN segments on the basis of the popular Ethernet standard were created in ASM. The resources and services of global Internet became open and in the first place such services as E-mail and WWW servers' access. Multi-user servers on Intel microprocessors platform were installed in the Computer Centre of the ASM at that time and became available through Ethernet LAN. From this moment the process was started of rapid academic network development [1].

### 2. Basic structure of the Academic Network

The academic informational infrastructure is composed of several basic components and services. Among the main components are the following [2]:

- Networking infrastructure of the Academy of Sciences, which is consisting of:
  - a) Central communicational node, which provides steady connectivity of the Academy's networking infrastructure with external networks and subsystems, both in Moldova (connectivity with networks of the Universities, other networking segments related to science and education in Moldova, local commercial ISPs, etc.) and abroad for assuring access to international networks and global Internet as a whole;
  - b) high capacity highways (backbone's links) which provide remote access and interconnectivity of the main campuses of the Academy of Sciences and stand-alone buildings of academic institutions;

- c) high-speed links for connecting buildings inside the campuses of the Academy of Sciences of Moldova, created using LAN technology;
- d) intra-building LAN and sub-networks, which interconnect networking segments of various institutions of the Academy situated in the same building.
- Server nodes and server infrastructure of the Academy of Sciences, which unites the available server equipment for common use via the networking infrastructure. This component may be split into server equipment common for all the infrastructure, building-related servers' equipment and servers for various dedicated needs belonging to the Academy's subdivisions.
- Technological and instrumental software and available technological hardware-software complexes. This component includes programs developing software, graphical software, publishing software, CAD systems etc.
- Specialized informational systems for various purposes. This vast component is the substantial part of the kernel of the creating integrated informational system of the Academy of Sciences. Amongst it's parts are various informational arrays and subsystems based on using various technological and software support: WWW informational servers, FTP-servers, applied databases, bibliographical and librarian informational systems, document circulation automation and management systems in the scope of providing administrative support to the Academy of Sciences and its subdivisions, etc.
- Personnel training. This component is required and is important for the successful functioning of the whole informational system of the Academy of Sciences and for teaching the users to work in the new informational environment.

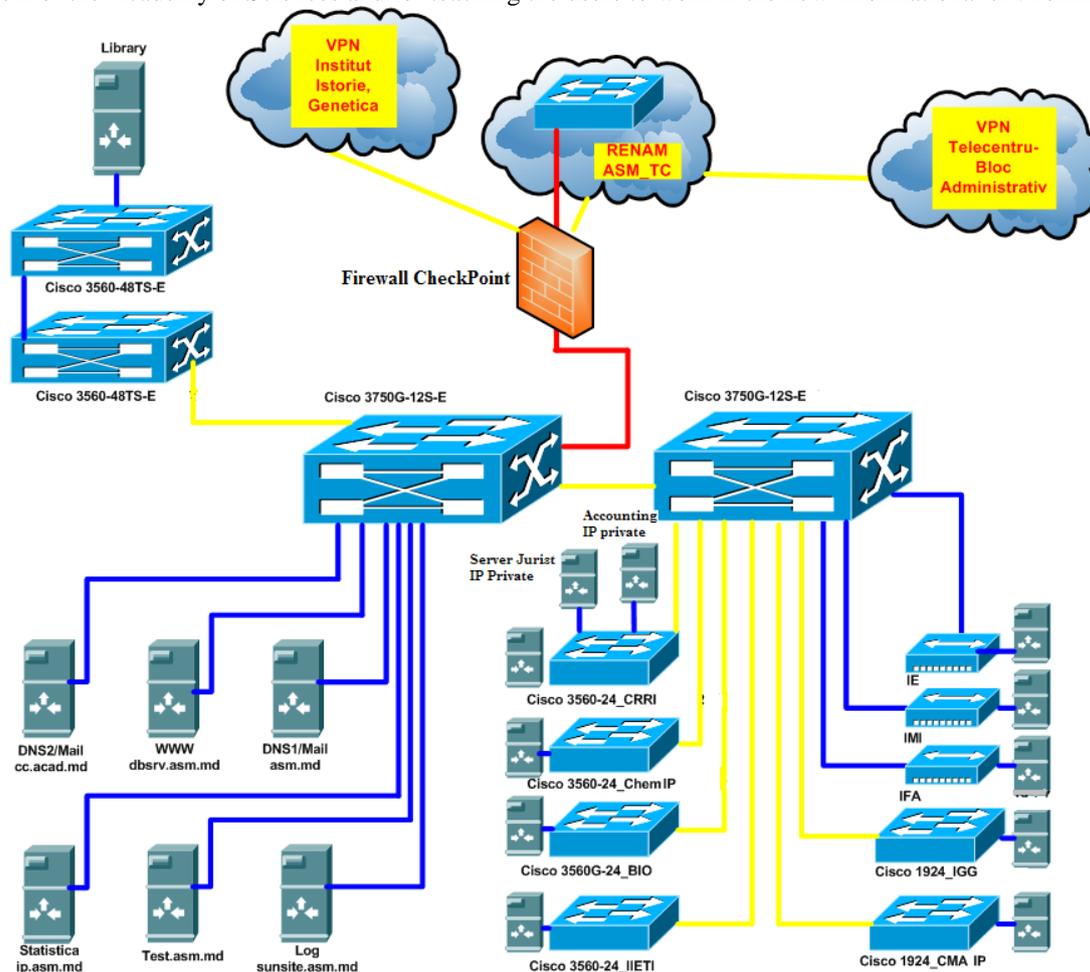


Figure 1. Communication infrastructure of "Telecentru" Campus

Among the main services that are available now for wide users' community of the Academic informational system have to be mentioned the popular and well-spread networking services that are using up-to-date Internet technologies like: E-mail; www; Gopher; FTP; TelNet; IRC; WAIS; Usenet. In the process of development of the networking components of the Academic informational system there is the possibility of increasing the number of available services for the users, mainly by implementing new specialized informational systems that have their own networking interfaces, and also due to implementation and using new services created and available in the modern Internet environment.

The common academic network AMNET infrastructure is the base for the development of the informational system of the Academy of Sciences of Moldova and includes the territorially distributed areas' sub-nets where the main research institutions and organizations of the Academy are located:

- The biggest Academic campus "Telecentru" (see figure1);
- The "Biocentru" campus;
- The main Administrative building of the Academy of Sciences. The scheme of the building LAN is shown in Figure 2;
- The subnets of other remote buildings of the Academy of Sciences.

All this subnets are part of the general networking infrastructure of AMNET, which is divided into the following subsystems:

- The Central communicational node, which provides the constant Internet access and connectivity to the remote institutions and buildings;
- Inter-building data highways for connecting the buildings inside the "Telecentru" an other campuses;
- Intra-building LAN that connect the sub-nets of the institutes and organizations;

AMNET Informational servers for common use are designated towards hosting the main informational systems of ASM.

### 3. New technologies implementation in AMNET

Outstanding and very actual task is updating and further development of academic campuses and buildings communication highways for ensuring their mutual effective interconnectivity. This task for the principal Campus of ASM - Campus Telecentru was practically resolved in 2002-2003 when were realized projects of fiber links installation for connecting all campus blocks and institutions in common fiber infrastructure and implementation of communication technologies base on optical data transfer medium utilization. As a result of this activity it became possible to implement in the Campus network a unique, fully linked communication environment that allowed flexible adaptation and easy introduction of various modern communication technologies [3].

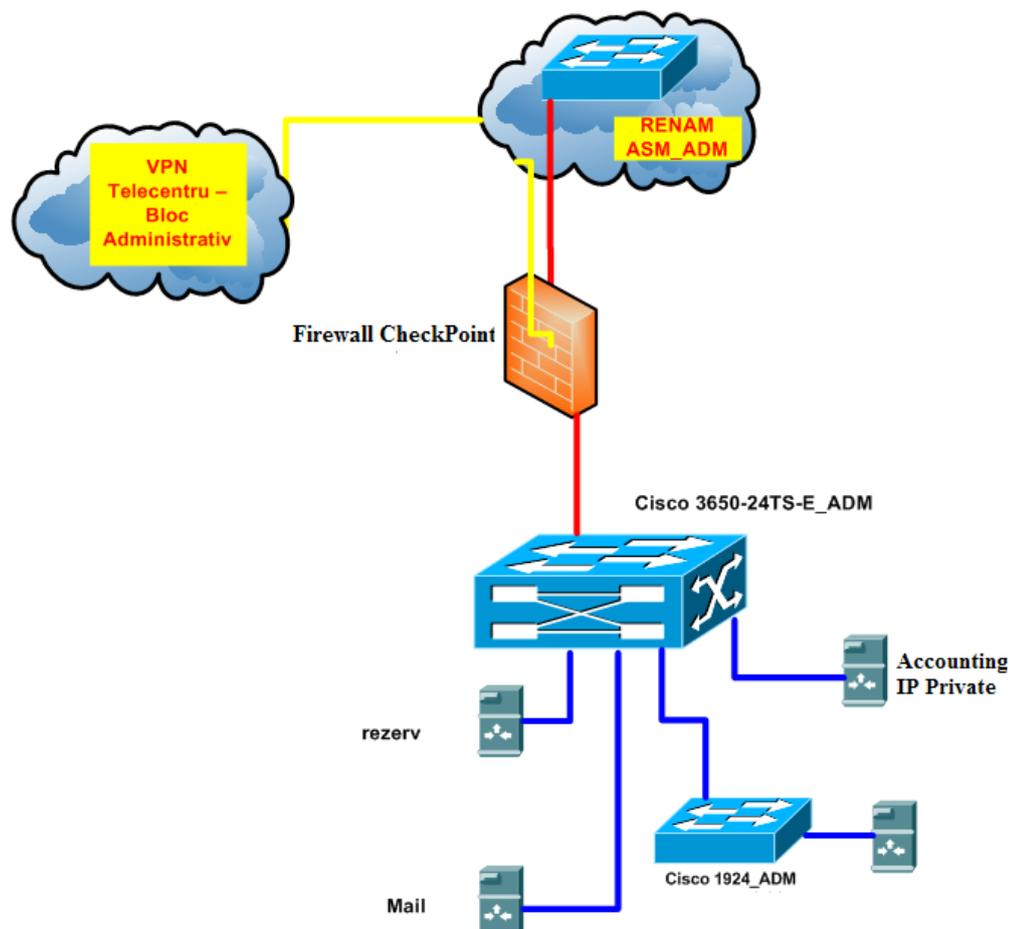


Figure 2. The Administrative building of ASM communication node scheme.

The next actual task is permanent and effective extension and development internal buildings' LANs and LANs of scientific institutions. The decision was accepted that development in this direction will be based on elaboration of many

separate projects of local networks upgrading, extension or in some cases full replacement by new cable and communication equipment. Generalized approach of new institutional and inter-building LANs and sub-nets creation is presented in the Figure 3. New projects are oriented on transferring all buildings' networking segments and institutions' LANs to utilization at the first stage 1 Gbps data transmission facilities with possibility of transforming these segments for adaptation of 10 Gbps data transfer technologies. Modern Gbit Ethernet technologies can use physical links based on optical cables as well as transmission medium build with utilization of twisted copper pairs in available new UTP type cables of 6 or 7 categories. As intermediary solution it was chosen decision to transfer all internal cabling infrastructures in the blocks to wide use of UTP category 6 cables. General methodology of new networking segments and LANs construction can be formulated as following [4]:

- Wide utilization of new communication medium that allows to realize 1-10 Gbps data transmission capacities;
- Orientation on use of widespread and well familiar to ASM specialists equipment produces by Cisco Systems Inc.;
- Utilization of the existent optical infrastructure and UTP based communication links with installation of new segments using modern UTP cables.

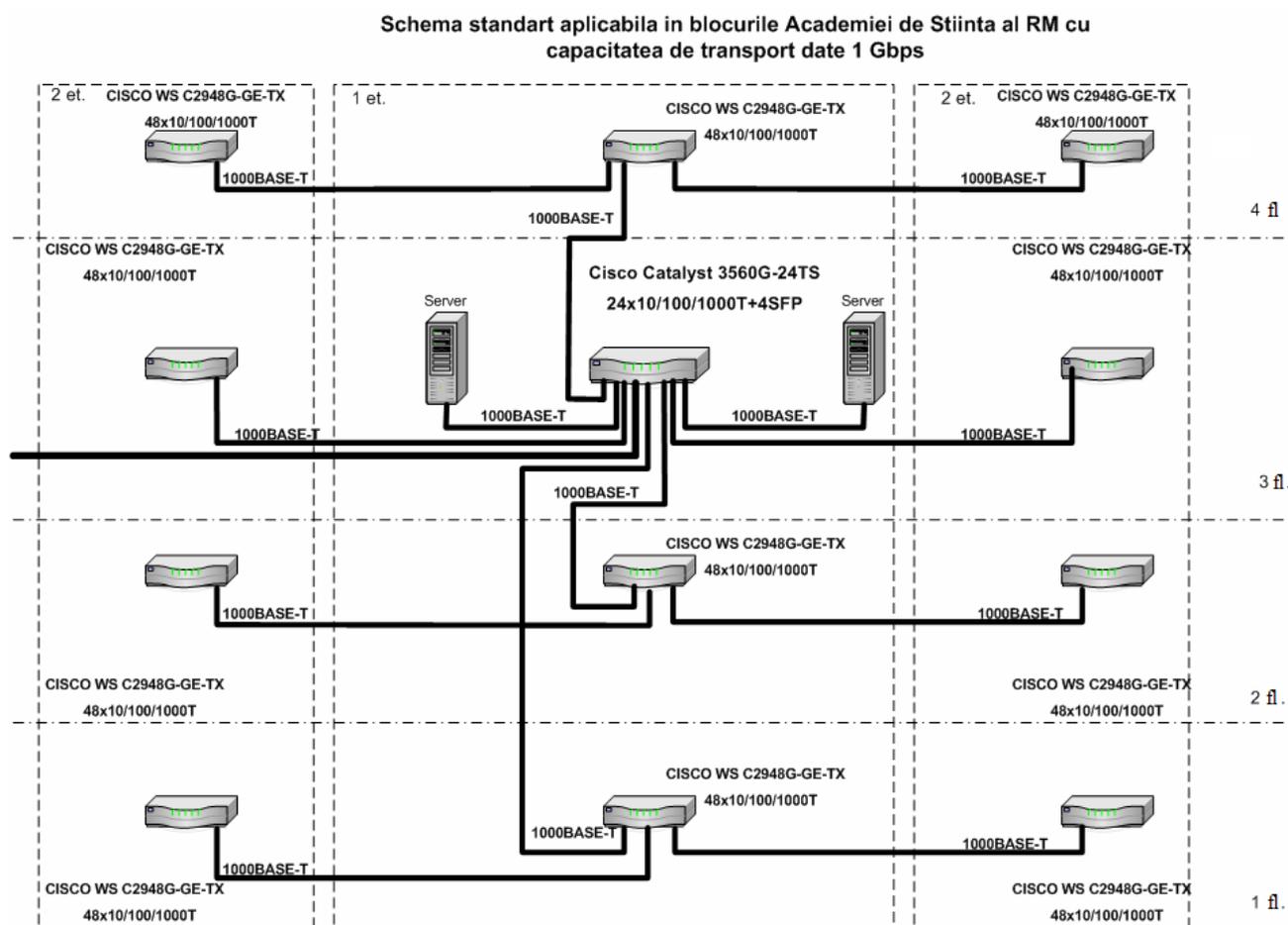


Figure 3. General scheme of ASM buildings' LANs implementation.

Significant contribution in the networking infrastructure of ASM development was realization of CRDF/MRDA project that was especially oriented on upgrading Academic informational system as a whole and in particular the replacement of old equipment in the network. Within this project modern communication equipment produced by Cisco Systems Inc. was purchased, which initially was focused on high speed communication links implementation as well as implementation of various modern communication protocols and services. The project had started in 2007 and its work programme presumes that in the first half of 2008 all principal nodes of the network will be operating using new perfect communication hardware. The selected in the project communication equipment is fully compatible with the previously used and allows transferring obsolescent devices for utilization in other less important networking segments. General scheme of updated networking infrastructure that shows distribution of new Cisco equipment is presented in the Figures 1 and 2.

Campus "Telecentru" comprises the main networking segment of general academic networking infrastructure. This segment unites more than a half of all research institutions and other organizations of ASM including the biggest of them. All buildings and institutions in the campus are compactly located and for this networking segment implementation was proposed

adaptation of building Ethernet LANs based on utilization of multimode optical communication medium. The following components were selected for Campus "Telecentru" networking segment realization:

- Communication medium that is realized by using multimode and single mode fiber optics cable;
- Two stacked central campus switches Cisco Catalyst 3750G-24TS installed in the Central communication node;
- Buildings' LANs switches installation based on Cisco Systems Inc. equipment like Catalyst CISCO WS C2960G-24TS-E, CISCO WS C2960G-48TS-E, CISCO WS C3560G-24TS-S and analogous;

Campus "Telecentru" LAN directly connected to the Central communication node of AMNET that provides all necessary external interrelations of the Academic network and access to Internet. AMNET Central communication node has two fiber optics connections of 1 Gbps capacity to the metropolitan backbone of the National Research and Educational Network RENAM [5]. Fiber optics infrastructure of RENAM network provides the necessary connectivity of Campus "Telecentru" networking segment with other academic networking segments like LAN of Principal block, where ASM Administration located, Campus "Biocentru" LAN and other LANs of ASM separate buildings.

Orientation on Cisco Systems Inc. equipment is explained by several obvious factors. First of all this is de-facto the most widely used in Moldova and in the world communication equipment and there are qualified specialists among AMNET maintaining staff that are prepared especially for this type of equipment exploitation. The second factor is that in the academic network already are installed many Cisco devices and newly creating segments need to ensure compatibility with existing ones. Simultaneously AMNET as a whole has effectively to interrelate with upper level networking segment that is represented by RENAM network where all nodes are equipped with Cisco Systems routers and switches. CISCO equipment is fully and comfortably managing by using special control protocols, can be distantly monitored, is correctly executing complete range of standard communication and controlling protocols, has all needed assortment of security ensuring tools. Also Cisco devices have many useful extensions in comparison with current specifications of the standards that are complementing standard features of communication equipment. Cisco Systems Inc. equipment is very convenient for configuration virtual local sub-networks (VLAN) and virtual private networks (VPN). Cisco IOS is absolutely compatible with popular open source software that is often used for traffic monitoring and data flows control, e.g. with such toolkits like Nagios, Cacti, Wathermap and Netflow. Cisco switches ensuring realization complete set of QoS (Quality of Service) modes of operation in IP networks (see figure 4). QoS regimes are very important for offering such kinds of services like videoconferences, video on demand, various VoIP and multimedia transmission protocols including popular IP telephony services realization.

## One command per interface to enable and configure QoS; modify global and interface settings to make QoS for VoIP work

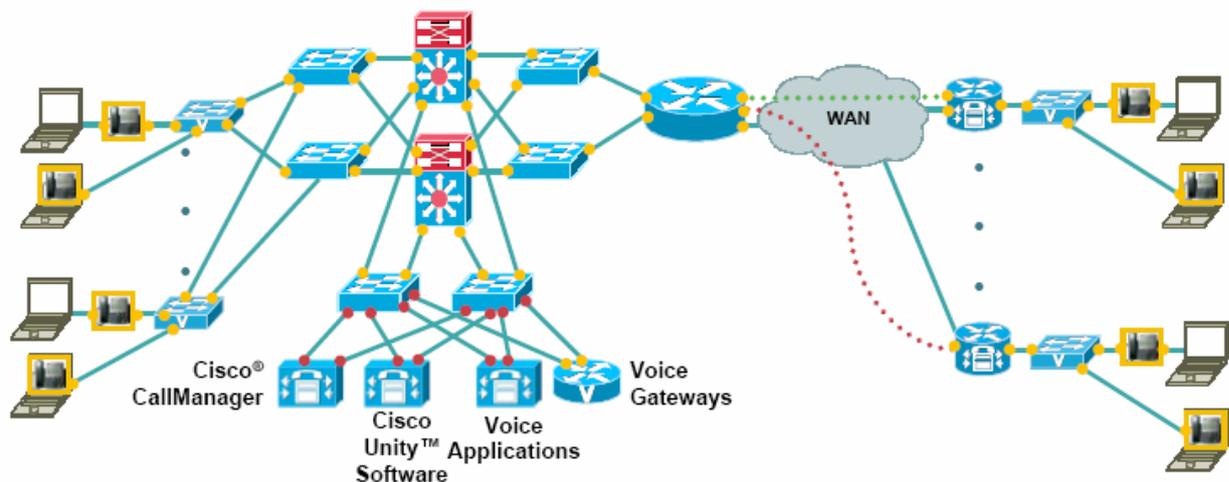


Figure 4. Cisco Systems QoS solutions.

Obtained within CRDF/MRDA grant realization and proposed for installation in principal AMNET nodes new CISCO switches has effective features for traffic control at every separate port level. This characteristic is especially useful from the point of view of increasing the level of operational security, avoiding influences of every target incident on general operation of AMNET networking infrastructure. In particular this feature is serviceable for:

- determining and isolation every security violation incident, e.g. floods generation by viruses and by spamming machines;
- isolation of every target source of network operation overloading and information about such kind of incidents, supporting procedures of finding of the reason that originated influences on network functioning;
- Automated system operation recovering after determination and reparation of causes influenced on network operation.

For monitoring the network operation and controlling every separate sub-network and local networking segment special software is installed at the servers in the Central communication node that allows personnel that are responsible for network administration distantly manage network operation.

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