



# Paris Academic Network Project

## High speed metropolitan area network for research and educational

Stoned Elipot<sup>1</sup>, Jean-Paul Gautier<sup>2</sup>, Jean-Claude Girard<sup>3</sup>, Jacky Thibault<sup>4</sup>, and Bruno Mabboux<sup>5</sup>

<sup>1</sup> University Denis Diderot

<sup>2</sup> National Center for Scientific Research (CNRS)

<sup>3</sup> University Pierre et Marie Curie

<sup>4</sup> The National Conservatory of Industrial Arts and Crafts (CNAM)

## 1 The project

### 1.1 Purposes

In 1998, a study was set up and made an assessment of the current situation and of the eventual possibilities in term of constructions, services or technologies with a target of a very high rate network in order to fill the new needs in application (programs).

The innovating feature is the opening to a large field of possibilities for flows as well as protocols and offered services. The association of operational and experimental fields, the power of adaptation and reaction to the needs of the community and the economic aspect created a wide support from community, supervisions and local communities asked to take part

This appraisal allowed to develop the main lines of the scheme at the main different levels (functioning, technology and finances).

The strong points and objectives following from this are :

- a network made “for and with the concerned community”, able to come up to the expectations and to fit the new plans. A total mastery in transparency (for its management, the control of development, ...) is the guaranty for a network serving the community it was made for.
- an optic structure in “optical fibre” and DWDM (Dense Wavelength Division Multiplexing), ATM and gigabit protocols, services with added value and an administration forming a coherent whole open to a large scale of possibilities for output as much as for protocols and offered services.
- a financial cost which is competitive in investment and fair in functioning, considering the given prospects.

The key elements that led to define these objectives are as follow :

- the current communication structure does not help at all to fill economically and technically the present needs.



- the emerging needs in every sphere of activity and the associated demands (in output, QoS, ...) of the educational establishments can only be satisfied with the settlement of very high flow networks.
- the fastness of evolution in implementation requirements means that the great adaptability of basic structures and services associated can only be satisfied with the very strong interaction between users and suppliers of the structure.
- on Paris now exist alternative operators offering dark optic fibre; this fibre can be associated with the DWDM technology. The low cost of that association surely widened the field of possibilities in functioning (satisfying the current and new needs) and experimentation (towards new protocols or applications) without having limited rates or protocols.
- the ethernet gigabit is an excellent IP transport protocol of "best effort" type but ATM is still the protocol of the current applications that needs a quality in the services (for phoning, videoconference, ...) and allows going further towards external networks such as Renarter II (National network for Technology, Education and Research). Those two protocols have complementary fonctions which can easily help to develop the considered structure.
- the financial estimations reinforce greatly this strategy.

## 1.2 Technical solution

From a technical point of view, the proposed solution corresponds to a MAN based on the following elements:

- Five PoPs in Paris hosted on different sites of our community. They welcome network equipments linking the sites (dark fiber, DWDM, Gigabit and ATM equipments).
- Links between PoP in a ring topology.
- Links between PoPs and sites.

The gathering of PoP, including the network equipments, and interPoP links constitute the "heart of RAP"

With DWDM in the heart of RAP without modifying the physical architecture, the use of several wavelengths on a same paire of optic fibre provides :

- an alternative at N fibres working in parallel. The evolution does no longer submit to the offering of new fibres.
- an almost illimited flow.
- an evolution according to the new needs.
- the flexibility and fastness of the application.
- the possibility to build new networks dedicated to different technologies and flows existing altogether.
- transparency of flows and protocols.
- a low cost of the units of output (Mb/s).

As for services, according to the expressed needs, the following services will take place as RAP starts :

- resumption of RENATER activities (IP service "best effort")
- QoS based services taken into account by RENATER II (ATM, VPN, ...)
- new services :
  - virtual networks
  - voice, video, visio, tele, GTB, ... with QoS
  - IP multicast (audio, video, visio, tele, ...) with or without QoS
  - services with added value for the community (hidden web, News, ...)

The answer to the new needs and to the problematics of services on RAP led to an operational dual network, combining ATM and gigabyte technologies, based on a DWDM structure. DWDM allows the facility to build new networks thanks to new technologies. The sites will be linked through ATM (155Mbits) or ethernet (100Mbits) according to the willing of the various sites and schools. Interconnection of the two operational networks will be assured through the PoPs.

### 1.3 Organisation

On the ground of organisation, we find the usual composition elements :

- A Direction (team taking decisions)
- A comity of users (team of customers advising thanks to their practical use of the system)
- A NOC (CORAP) insuring the operation of the network. This role needs an organisation combinating the gathering of all the people working on CORAP representing institutions and the providers of services in a same place. They will have to deal with the engineering of the network, public communication, relations with the schools, leading of the team, training policy and usual usual tasks.

## 2 Network to be deployed

After an invitation to tender in 2000 :

- TELCITE - a subsidiary of RATP, the Paris subway company - and GTIE - specialist in optic fiber deployment- will build the fibre infrastructure.
- ALCATEL provide DWDM equipments, ATM switches, switch-routers. ALCATEL is in charge of the operational activity inside the NOC CORAP.

The core network "Heart of RAP" will be operational in July 2001.

### 2.1 Physical network

Five PoP with respectively 37, 27, 16, 13, 11 connected sites are hosted on :

- University René Descartes
- University Pierre et Marie Curie
- Head office of the National Center for Scientific Research
- The National Conservatory of Industrial Arts and Crafts
- University Paris 4

### Dark Fiber

Most of the sites (80) will be connected with fibre to the optimum POP according to geographical and financial considerations, so they are not evenly distributed on the five POPs.

A total length of 346 km of optical links, single mode fiber G652, will be laid in the subway and the sewers.

The core network is a fibre ring of 28.6km connecting the POPs.

One important aspect is the very short length of civil engineering needed to laid out the fibre infrastructure: this account for a relatively low price.

### Leased lines

Twenty four "Small sites" ,in terms of needs or everlastingness, will be connected by 2Mbs leased lines to their nearest POP.

## 2.2 Core network

A BLSR ( Bidirectional Line-switched Ring) DWDM ring will be built on top of the core fibre ring. The Alcatel DWDM equipment chosen will permit this ring to have characteristics like OADM( Optical Add and Drop Multiplexer), optical pass-through and optical channel protection (Och protection).

A maximum of 32 protected wavelength is available in each PoP or a maximum of 64 unprotected wavelength is available.

In various point along the ring regeneration point will be needed.

At first the WDM architecture will serve as a base to construct two networks that we can see as two services offered by the optical layer. So an ATM network and an gigabit ethernet network will be setup in ring topology. A total of 10 wavelength are needed to build two Och protected services; in term of networks it's equivalent to 20 virtual optical networks.

In each POP an Alcatel ATM switch will have one OC12 link to each of its two neighbor, and an Alcatel giga switch-router will have one gigabit ethernet link to each of its two neighbor. Connection between the ATM world and the ethernet world will be made in each POP with an giga ethernet link between the two equipments.

## 2.3 Site connection

Sites will not be connected with DWDM technology, choice will have to be made site by site between ATM OC3 link and fast Ethernet optical link.

According to nature of its link to the POP each site will be free to choose from either an IP router with ATM or ethernet interface (and HSSI for the "small site"), a switch-router with ATM or ethernet interface or a plain ATM switch. No "customer premises" equipment is required. This policy is driven by the vision that RAP will favour strong community relationship.

### **3 Administration and economy of RAP**

#### **3.1 CORAP**

CORAP is the network operation center for RAP. It's operational Monday-Saturday from 8h to 22h, but the network is supervised 24h/24 all the week.

CORAP is based on internal resources ( Network design, Security, High level network services) and ALCATEL resources (facility management, Network management, hardware operations).

Nine persons will work for the NOC at the end of the deployment.

#### **3.2 Economy**

In term of invesment : 4.88 M Euros

- Physical infrastructure
- DWDM equipments, ATM switches, switch-routers for the core network
- Deployment
- Contribution to the site equipment

In term of yearly budget : 1.52 M Euros

- Physical Infrastructure (dark fiber, leased lines)
- Facility Management (CORAP)
- Maintenance

The contribution for a RAP partner to the yearly budget is based on the rate of his connection, the size of the establishment.