Some Thoughts on Next Generation Networks

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Some Thoughts on Next Generation Networks

- What do we want networks to do ?
- What are the factors that influence how networks evolve ?
- QoS and the EU project EuQoS
- IPv6 deployments and information sources (the EU project 6NET)

The Dangers of Predicting the Future

"There is no reason for any individual to have a computer in his home"

Ken Olsen, President of DEC

"640K ought to be enough for anybody"

Bill Gates

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What do we want Networks to do?

There are many suggestions of what future networks should do better than they do today (eg. from ETSI, ITU, companies, individuals, EC projects …… Google finds 17’200’000 results for Next Generation Networks !)

There is no common definition of a “Next Generation Network”, but there general agreement that they should:

- ***provide faster Internet access***

  (where is the bottleneck? … and is the problem really speed, or QoS guarantees, or prioritisation?)

- ***support more (all) services***

- ***support services in a more integrated way***

  (especially fixed-mobile)

What do we want Networks to do?

- bring services to customers in a way that is:

-> in accordance with the trend to separate the roles of the various stakeholders involved, eg. *Service Providers*, *Network Providers, Content Providers*

-> *interoperable* (seamless transition between different *networks* (at the physical layer and above) and different *services* - internationally)

-> *future-proof* (the easy incorporation of new services and network technologies)

- support levels of QoS

(in terms of delay, jitter, loss, reliability, availability)

What do we want Networks to do?

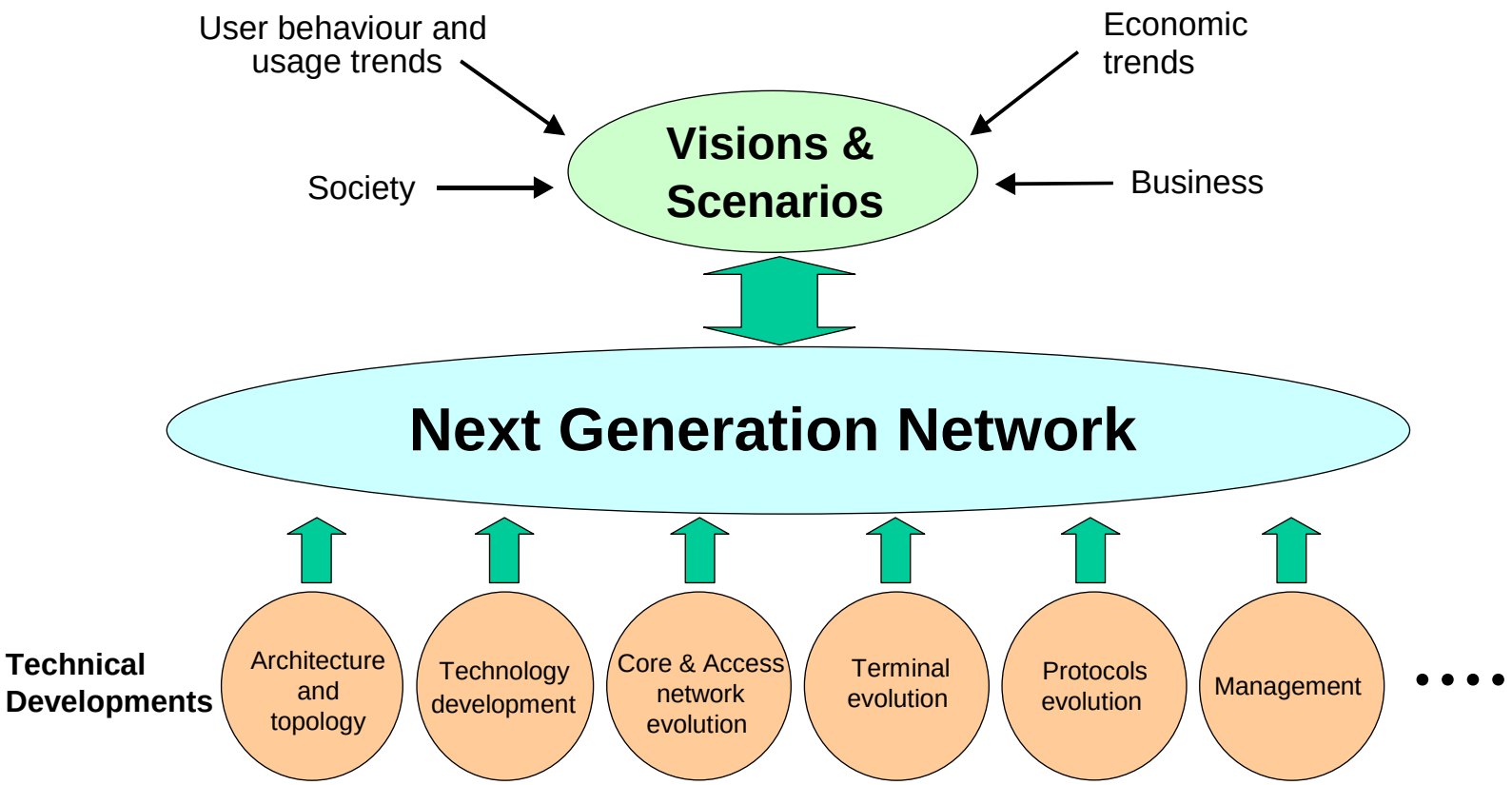
- support security

- be simpler/cheaper to operate/maintain/manage

Some Thoughts on Next Generation Networks

- What do we want networks to do ?
- **What are the factors that influence how networks evolve ?**
- QoS
  (the EU project EuQoS)
- IPv6 deployments and information sources
  (the EU project 6NET)

Evolution Factors – from the NGN-I Project



Evolution Factors

User Behaviour and Usage Trends

Business Models

Economic/Political Factors

The Evolution of the Core and Access Networks

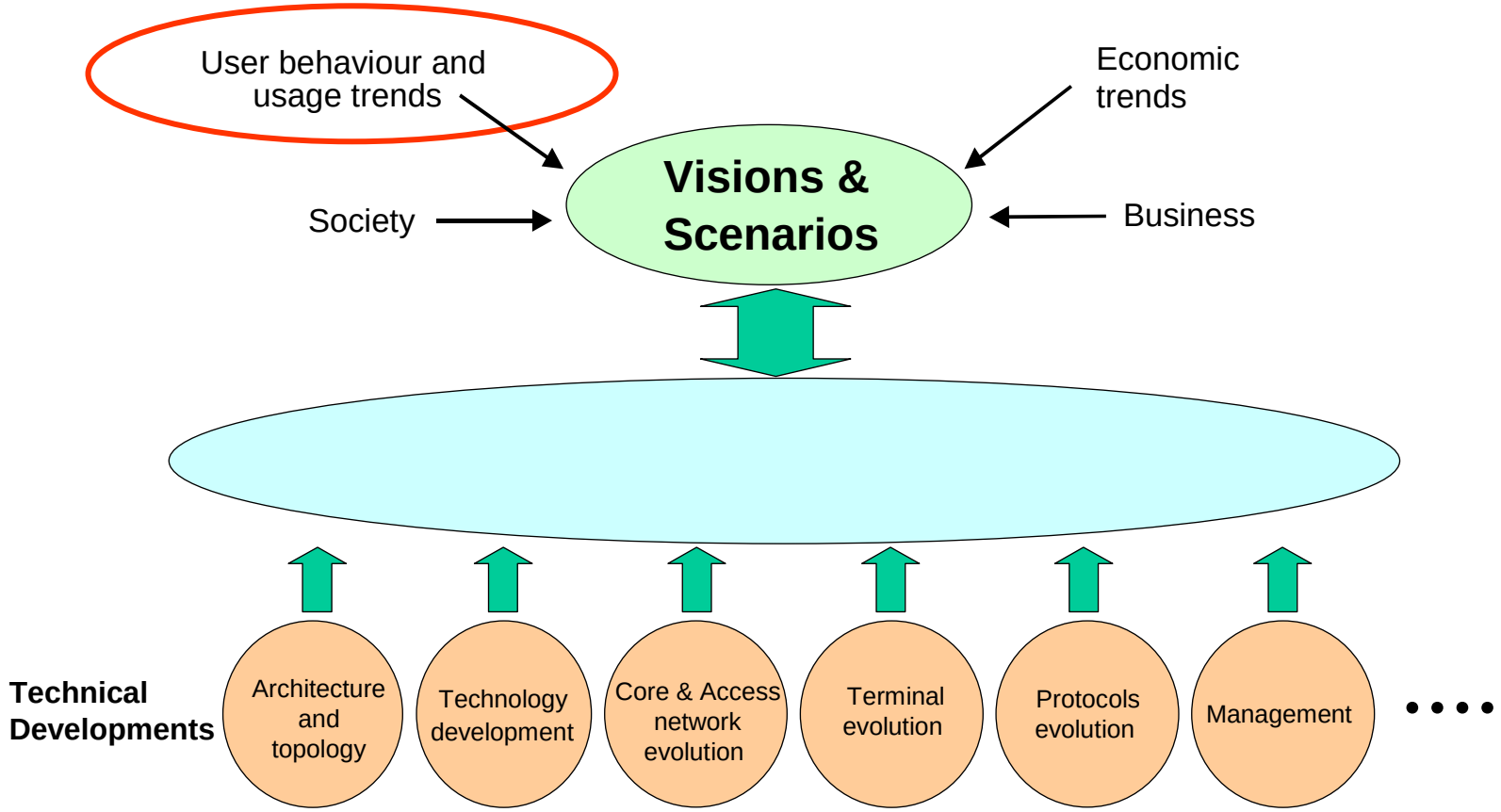
Technology Development

Architecture and Topology

Protocols Evolution

Network Management

Evolution Factors



User Behaviour and Usage Trends

- Increasing use of Internet-based services, but demanding more than just Internet access

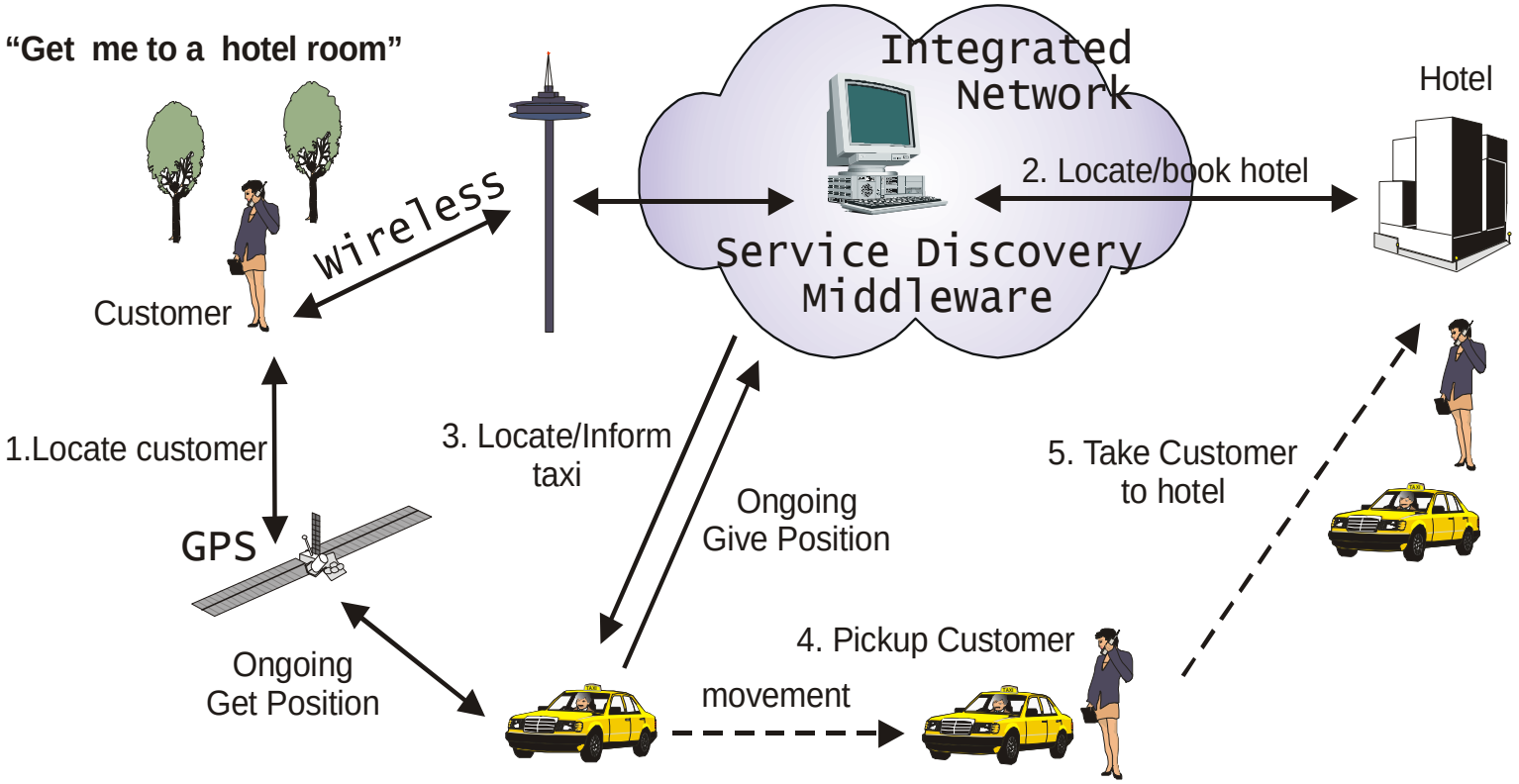
- Increasing emphasis on mobility and roaming
  Currently there are more than 1.5 billion mobile phone users globally.
  There are not enough IPv4 addresses to make them reachable at all times, plus: other handheld devices, medical diagnostic equipment, automotive gateways, etc.

- Increasing use of peer-to-peer applications and group communication

User Behaviour and Usage Trends

- End-user content creation
- Less-obtrusive hardware, that exploits the existence of more embedded sensors and communication between embedded devices
- Flexibility:
  - same data to be available on different devices
  - terminals and services to be transportable between networks
  - a “one-stop shop” for billing
- More cost effective services (SMS!)
- Services that are integrated, interactive, easy to use and with filtering features (Ambient Intelligence)

Ambient Intelligence



The criteria for service discovery can be the physical or network position (*Location-Based Services*), and can also exploit *User Profiling* technology

User Behaviour and Usage Trends

- Higher bandwidths (eg. for entertainment services, gaming, …)

- QoS (availability, reliability, speed, synchronisation, …)

- Security

Broadband and Mobility, QoS, IPv6

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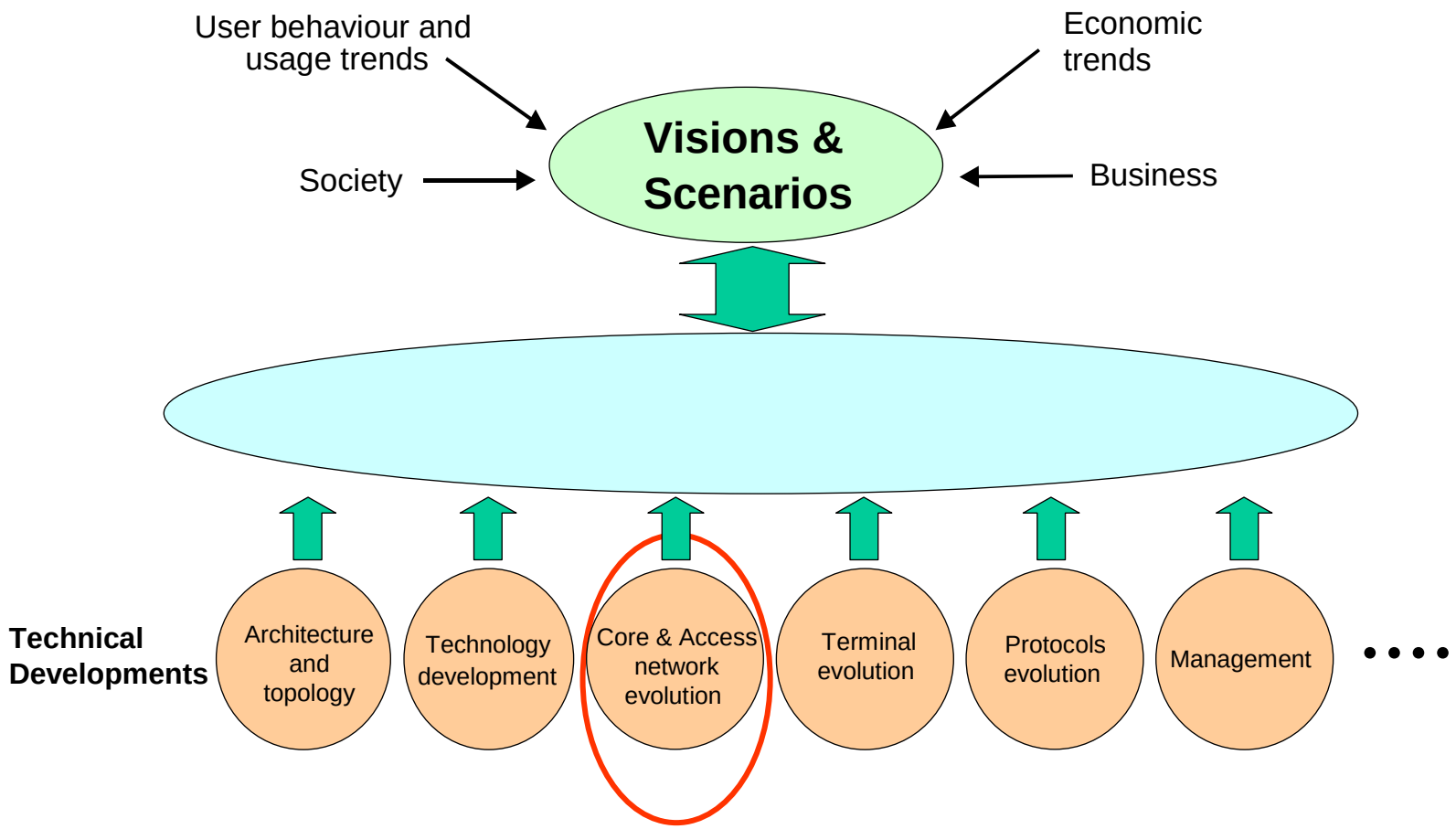

Broadband and Mobility

Broadband:

- Commercial offerings of wired access capacity to the Internet is doubling every 2 years for the same price
- A downstream throughput of 1 Mbit/s is now common for many residential users – a rate which was unimaginable for most people 10 years ago
- A similar increase over the next 10 years can be enabled by deploying optics ever closer to the end user. In this respect, optical metro networks with optical Ethernet in the “first mile” looks to be an attractive fixed-network scenario (also PONs)

… however, in parallel to wanting more bandwidth, users are wanting to communicate without being physically wired to the network

Broadband and Mobility

Mobility:

- Public GSM access networks have been installed to handle the huge demand for mobile telephony and Internet access, but the bandwidth is low compared with that available from a fixed access line
- GPRS and UMTS bring some improvement
- Ultra Wideband (155Mbit/s)
- Ad-hoc networks

…. but WLAN is emerging as a serious contender, with WiMAX following closely

Broadband and Mobility

Mobility:

- Developed for the private LAN area, WLAN is a simple and cheap technology that offers a bandwidth that even exceeds what is available on many wireline connections.
- WLANs have been installed by network operators to satisfy Internet access in public “hot spots”, thereby blurring the boundary between public and private networks.
- WLAN and WiMAX may first be introduced as multiservice public networks on a large-scale in developing regions.

Broadband and Mobility

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- What do we want networks to do ?
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- **QoS** and the EU project EuQoS
- IPv6 deployments and information sources (the EU project 6NET)

QoS

- The debate on QoS in the Internet has been running for more than 10 years, but only the “easy” solutions are implemented.
  - ➢ Overprovisioning (only a solution for the backbone)
  - ➢ Exploiting the capabilities of the lower layers (MPLS)
  - **?** Priorities (DiffServ)
  - **?** Explicit signalling (RSVP)
  - **?** NSIS

- Is there a business model ?
  - Who is willing to pay for it ?
  - What services do we expect the Internet to carry ?

- The same service used on a different terminal, or transmitted over a different access network, will require different QoS values

- Can it be solved with adaptive applications ?

QoS History:
Results from Previous EU-IST Projects

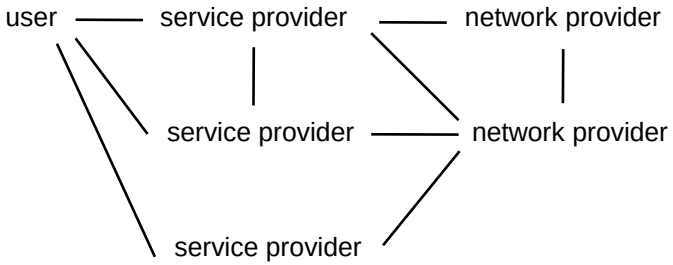
…. and there were others:

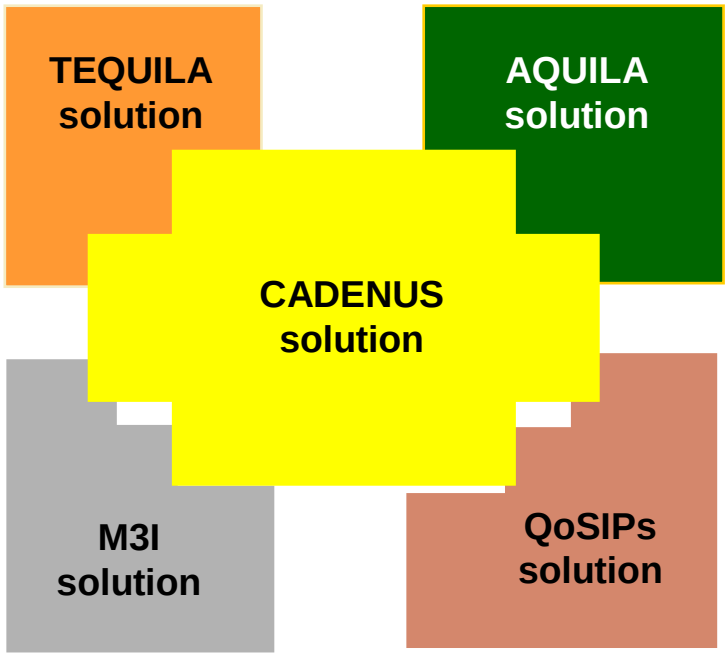
GCAP, SEQUIN, PROXiTV, BASS, Moby Dick, M3I, MANTRIP, DepAuDE, QoSIPS

So …. given that there were so many projects working on the topic for so long we should have some good results ….

QoS History:
Results from Previous EU-IST Projects

…. and we have …. lots of them
…. all different !





History:
Why is IP QoS so difficult?

The “definition” of QoS

Subjective and Qualitative:

– “high”, “medium”, “low”, “better”, “worse”, “good”, “fair”, “poor”

Yet QoS must be mapped onto measurable network attributes:

– Availability
– Throughput
– Loss
– Delay
– Jitter

History:
Why is IP QoS so difficult?

Many different mechanisms are available

Over-provision:

– only feasible in the home and in the core

Pre-reservation of resources (Traffic Engineering):

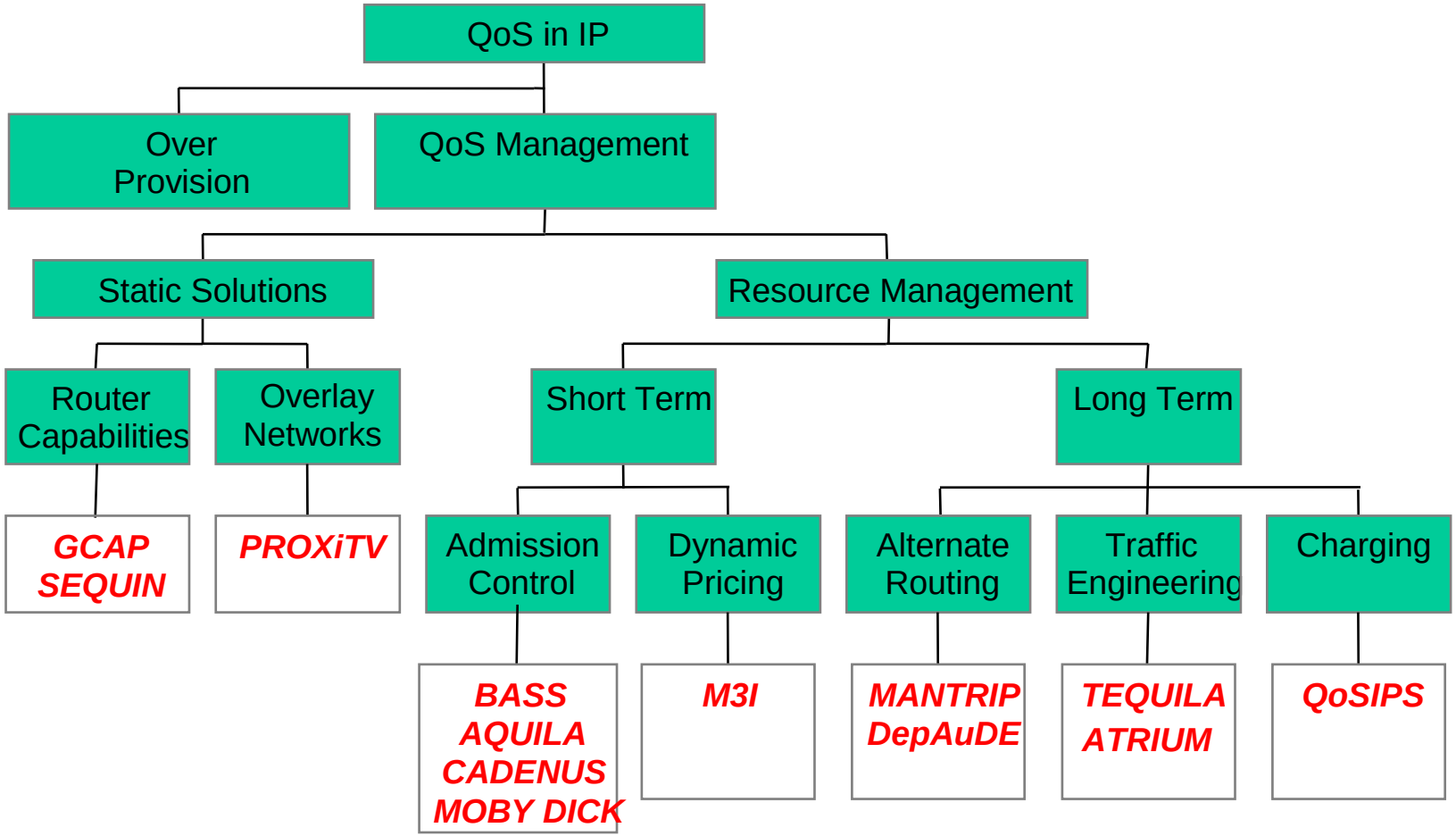
– ATM, RSVP

Prioritisation of services and/or users:

– DiffServ

– MPLS

History:
Why is IP QoS so difficult?



History: Why is IP QoS so difficult?

IP wasn't designed for QoS:

- Connectionless (invented by DARPA for error-prone (military) environments)
- So, if we want to provide QoS, we have to add something:
  - » What ?
  - » Where ?
  - » How do you get it through IETF ?
  - » How do we get a ROI ?

The Internet is Anarchy:

- Anyone can become an ISP
- An owner of a domain may not respect any QoS indicators that he receives
- There are many vendors - rfcs are not always observed

History: Why is IP QoS so difficult?

Bandwidth suddenly got cheap:

- We are using 10M links today for IP-based distributed conferences and getting the same quality than we got with 2M ATM links 10 years ago …. but for less money
- Over-provisioning seems to be the accepted solution for the core

Adaptive applications

Proliferation of terminal types

History:
Why is IP QoS so difficult?

Researchers have a natural instinct to look for new solutions

Manufacturers have a natural instinct to sell new products

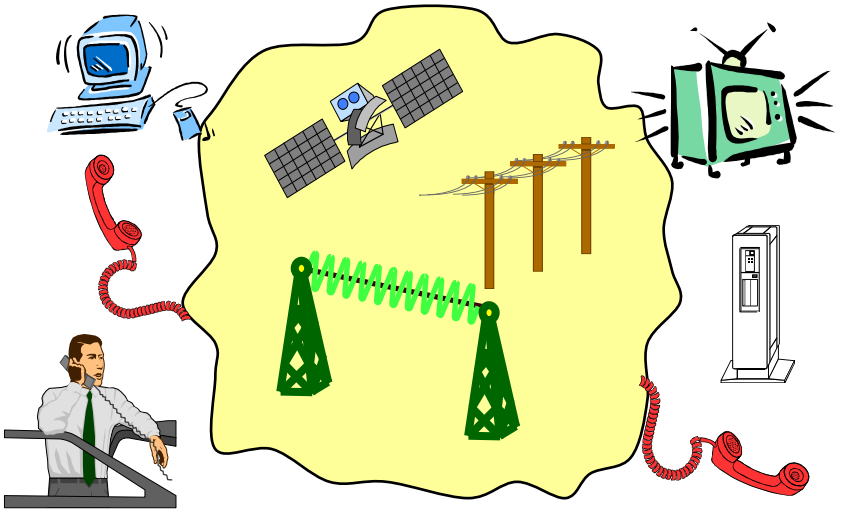
History:
Why is IP QoS so difficult?

- Technology doesn't stand still

  "everything that was on the fixed network 15 years ago is migrating to wireless (telephony, Internet), and everything that was wireless 10 years ago is migrating to terrestrial (TV)"

  GÉANT: switched –> routed -> switched

- Niche solutions become economic in specific parts of the network

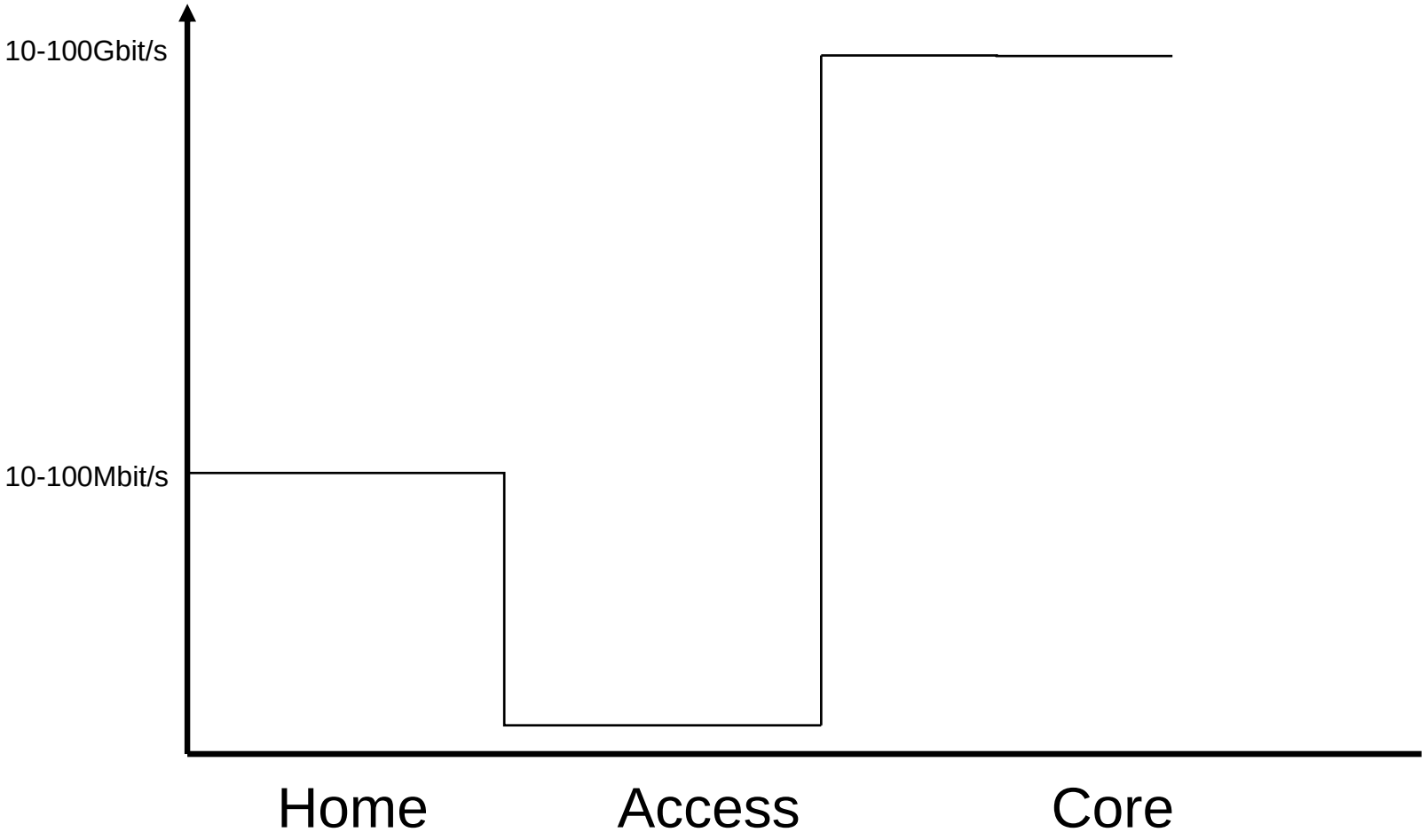


Why do NGNs need QoS ?

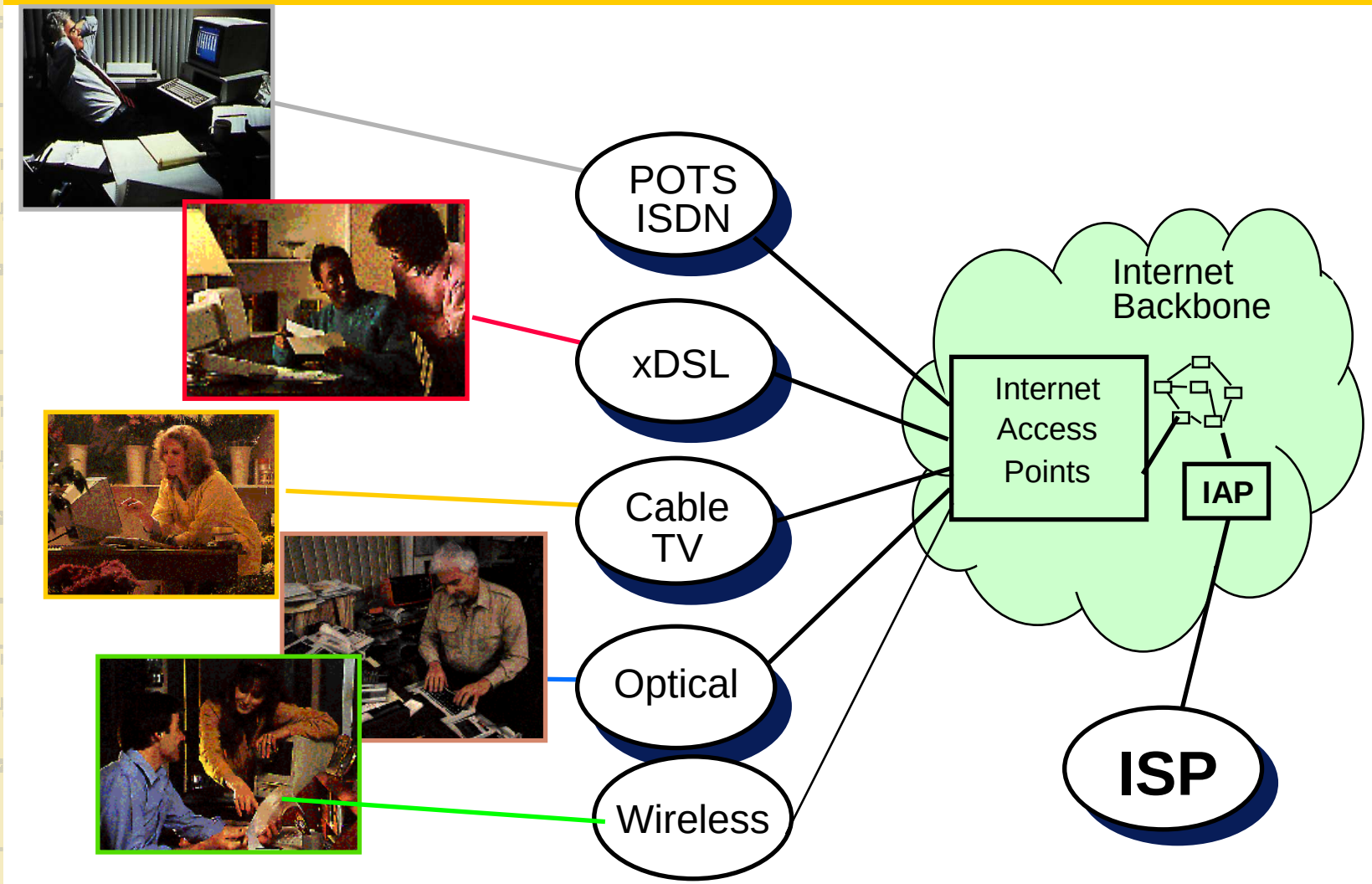
Convergence:

- Network protocol convergence:
  - » The majority of traffic is now IP-based data (Web, games, file transfer, e-mail, ... If we can carry all services (including voice) reliably over IP networks, then we save on equipment, training, maintenance
- Service level convergence:
  - » Including voice into an e-commerce session
  - » “Pop-up” data about a caller

Where do we need IP QoS ?



Where do we need IP QoS ?

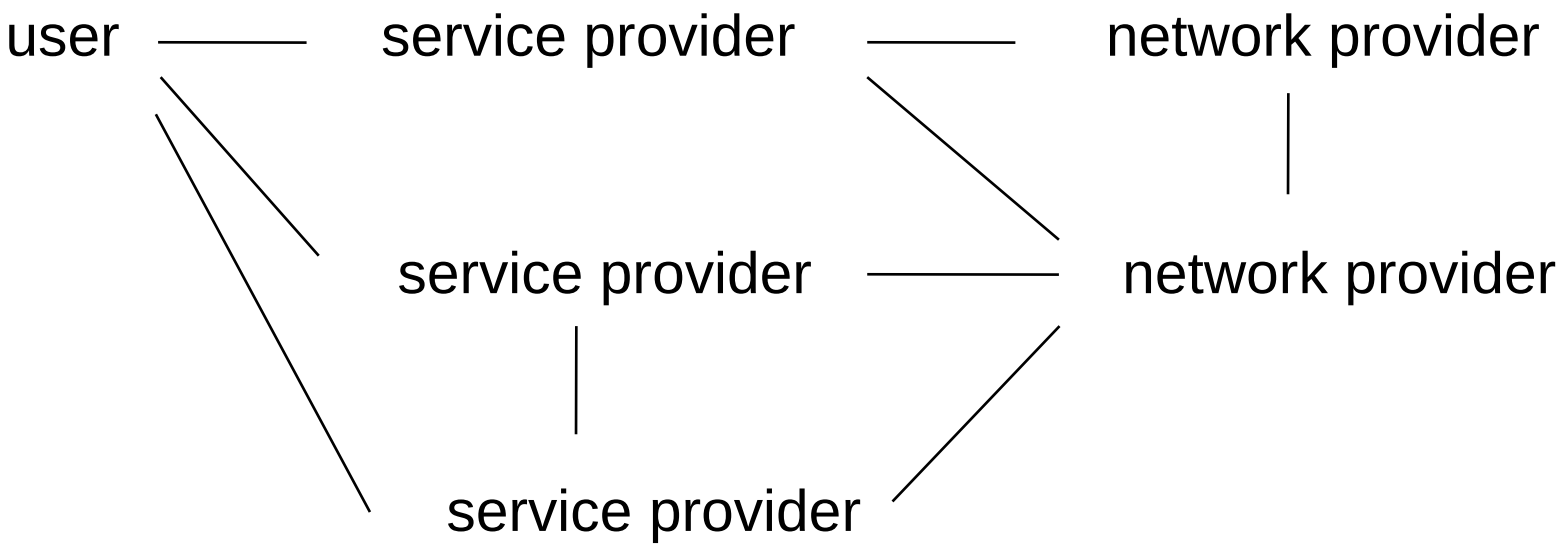


What should we be doing on QoS ?

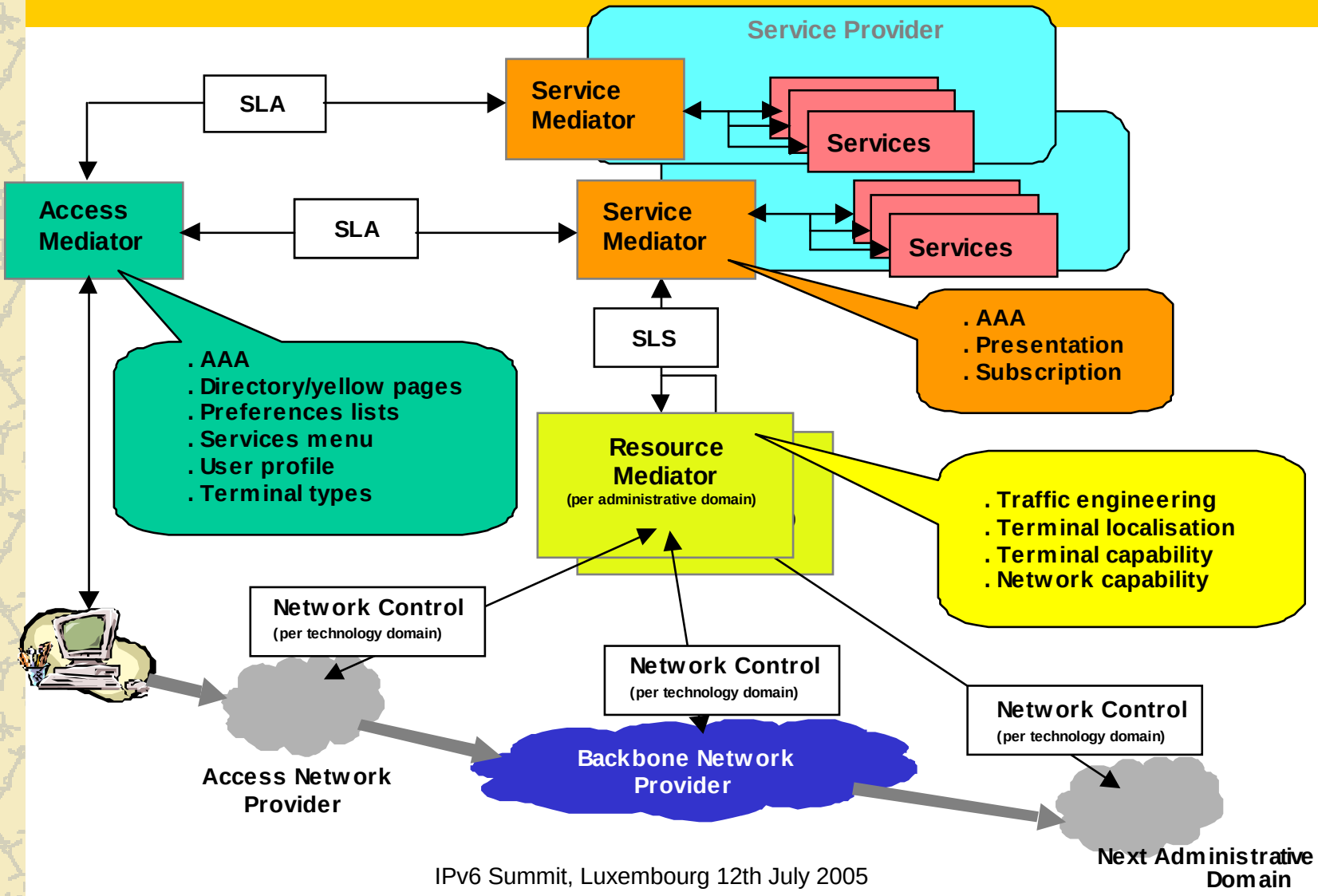
- **Agreeing where it is needed:**
  - Shared access networks (WLAN, CATV, PLC)
  - Places where concentration takes place (DSLAM)
  - Places that are under “my control”
  - Places which can earn new revenue
- **Not tweaking the Internet Protocol** itself to do something it wasn’t designed for
- **Putting the QoS support somewhere else** (as was done with TCP for guaranteeing reliable data transfer)
- **Using a conventional SLA approach** when negotiating QoS with peers

The CADENUS Approach

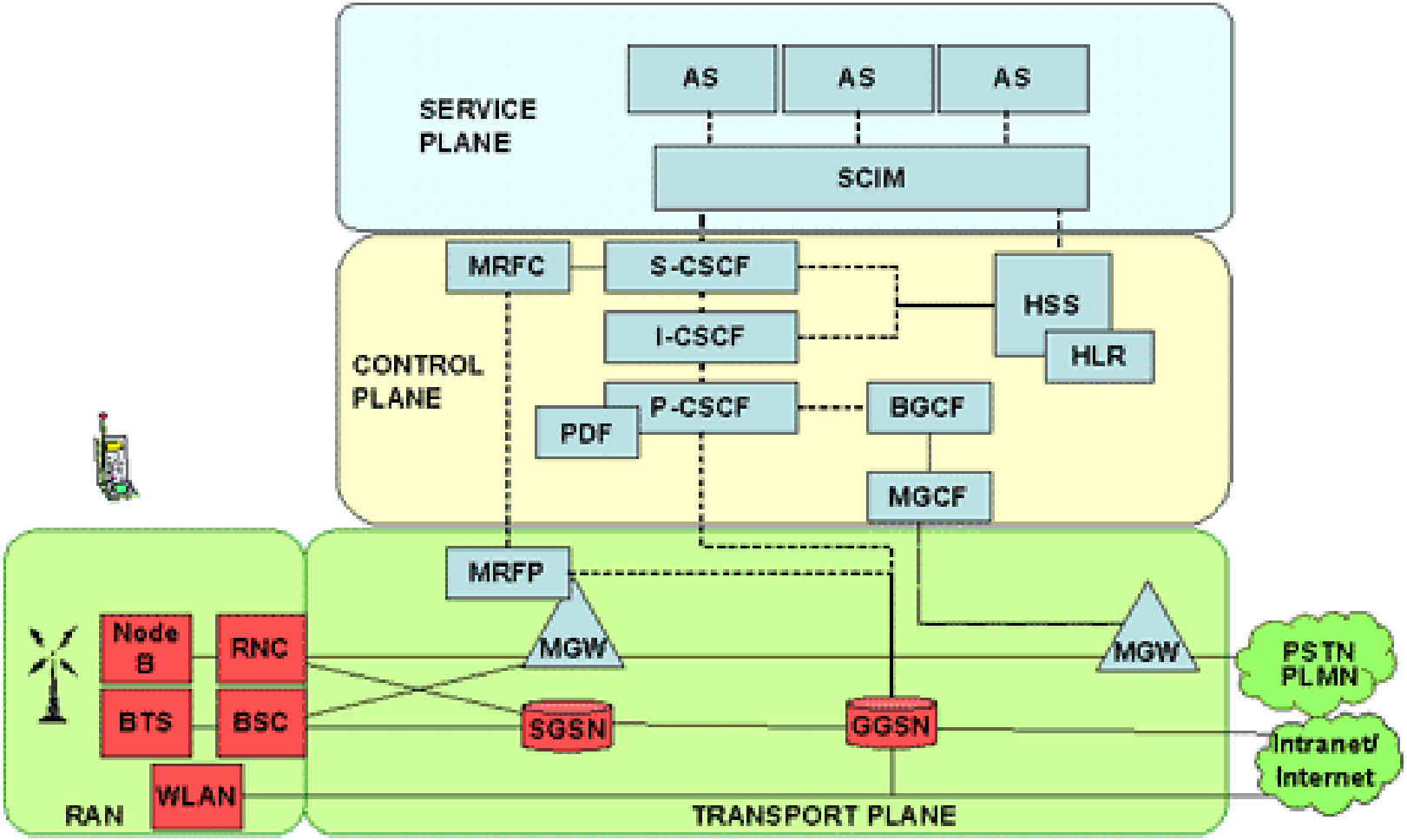
Multiple Service- and Network- Providers



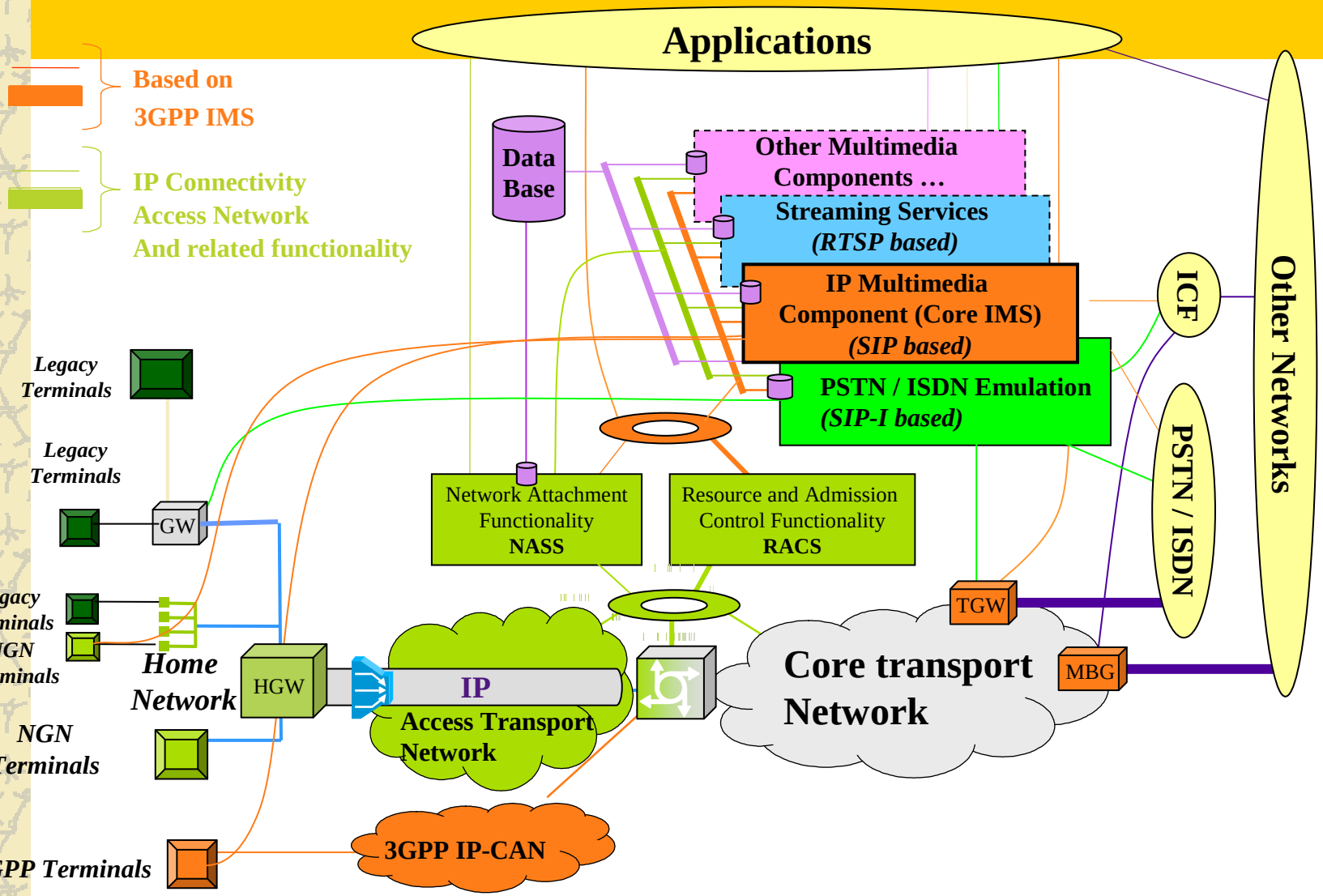
The CADENUS Approach



IMS

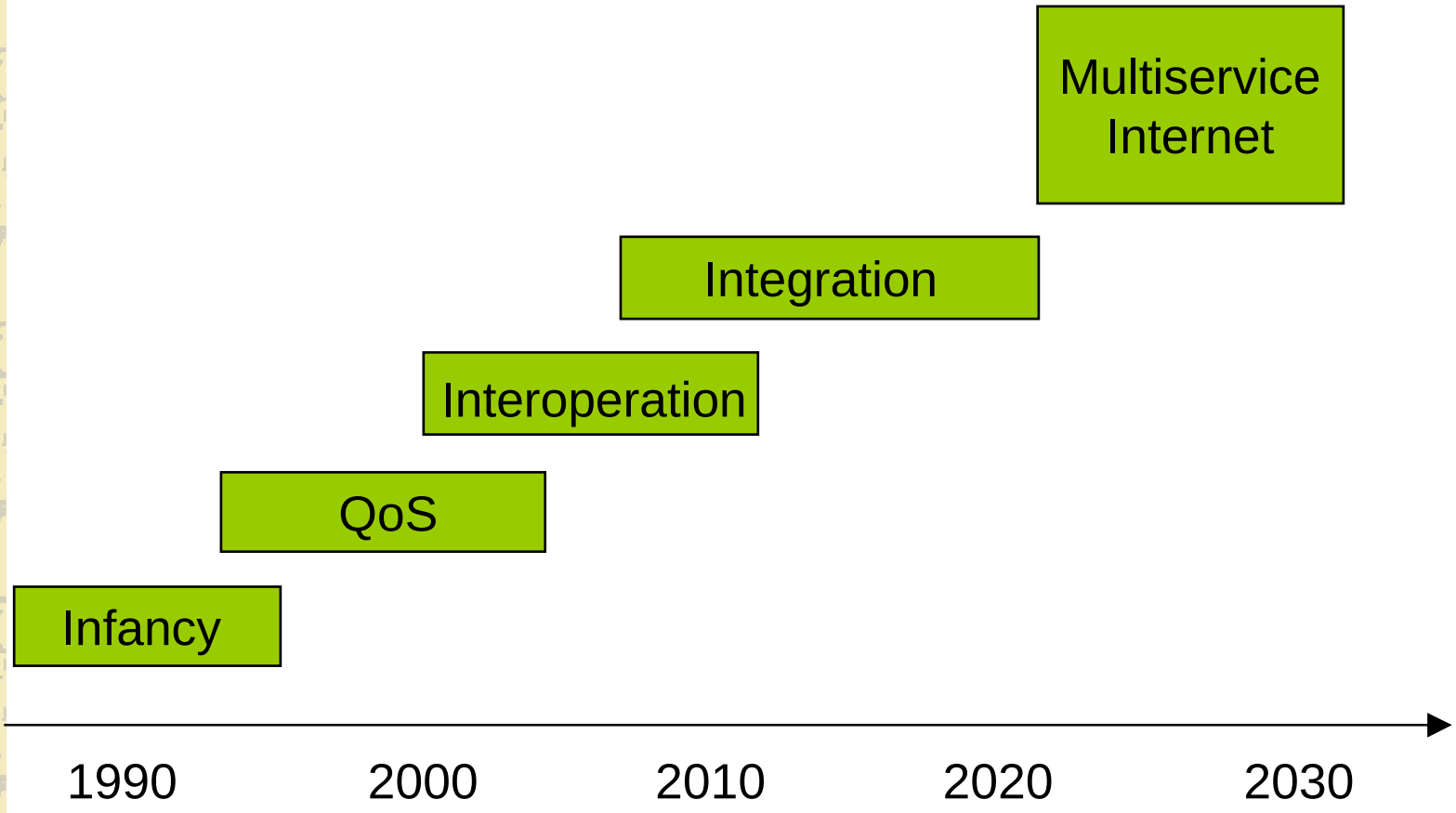

SERVICE PLANE
AS
AS
AS
SCIM
CONTROL PLANE
MRFC
S-CSCF
I-CSCF
P-CSCF
PDF
HSS
HLR
BGCF
MGCF
MRFP
MGW
MGW
Node B
RNC
BTS
BSC
WLAN
RAN
SGSN
GGSN
PSTN PLMN
Intranet/ Internet
TRANSPORT PLANE

ETSI TISPAN Vision



Ovum's prediction for an IP Multiservice Network

(Source: Ovum Next Generation Internet: Strategies for the Multiservice Network)



How EuQoS is addressing the topic

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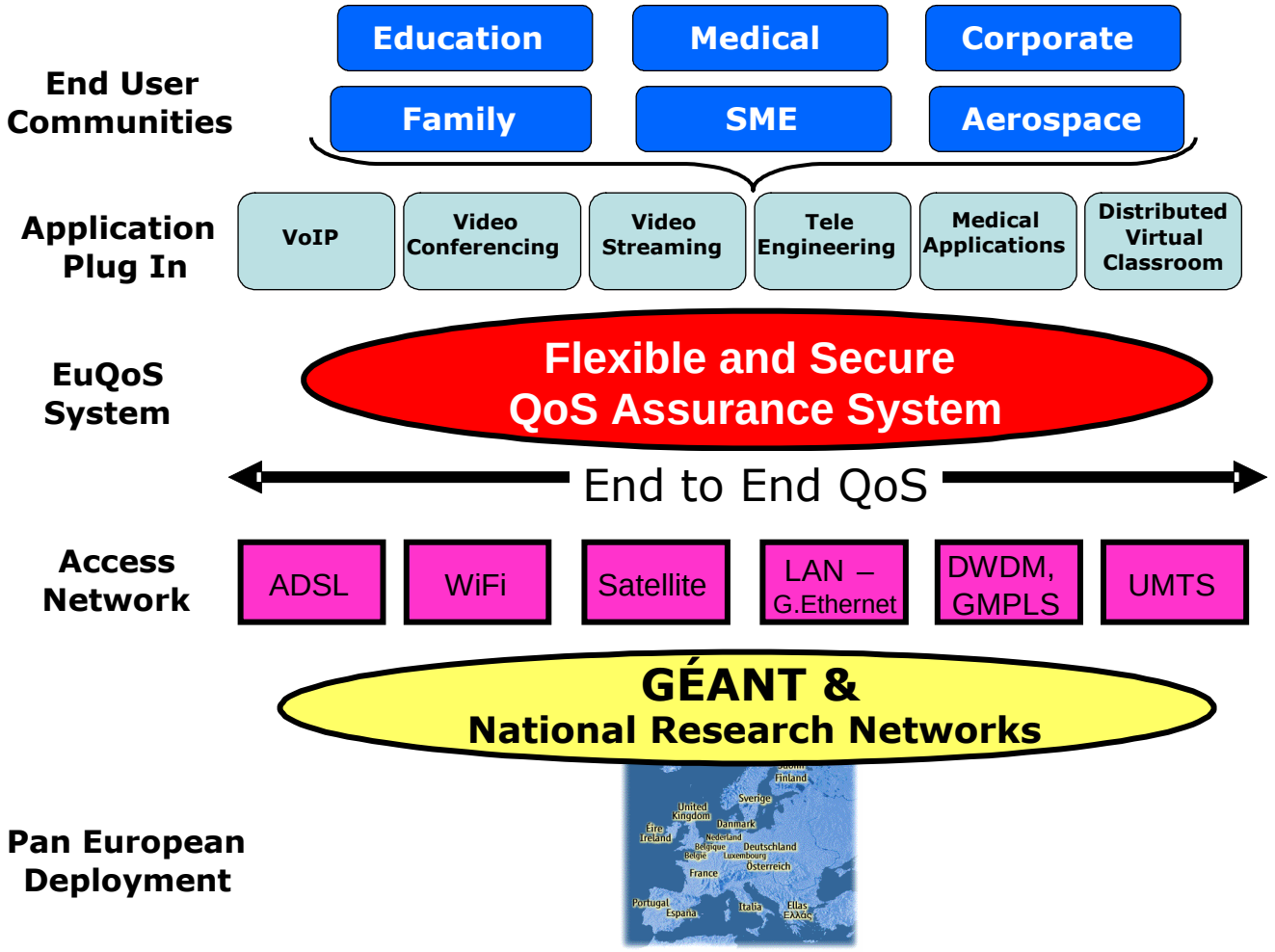
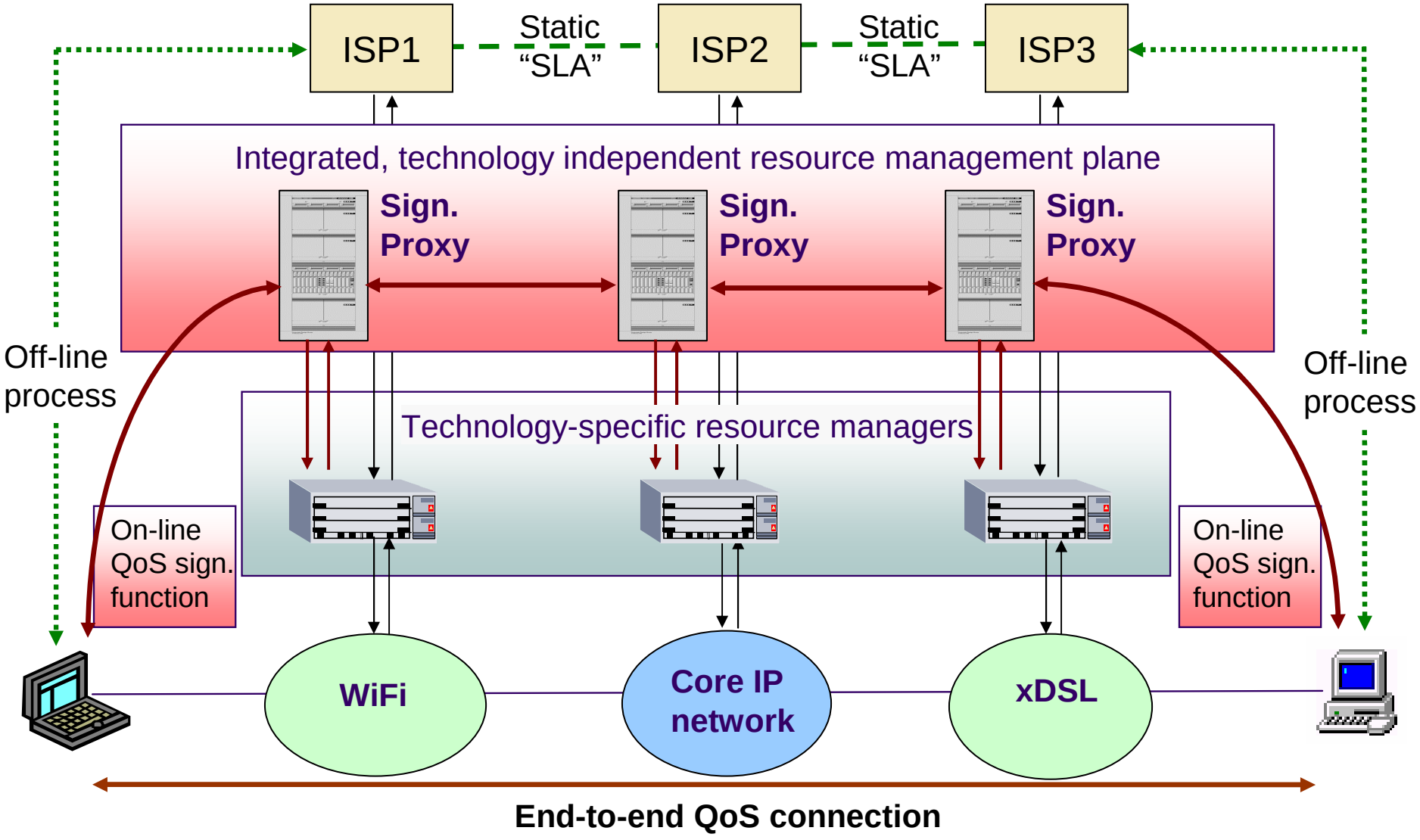
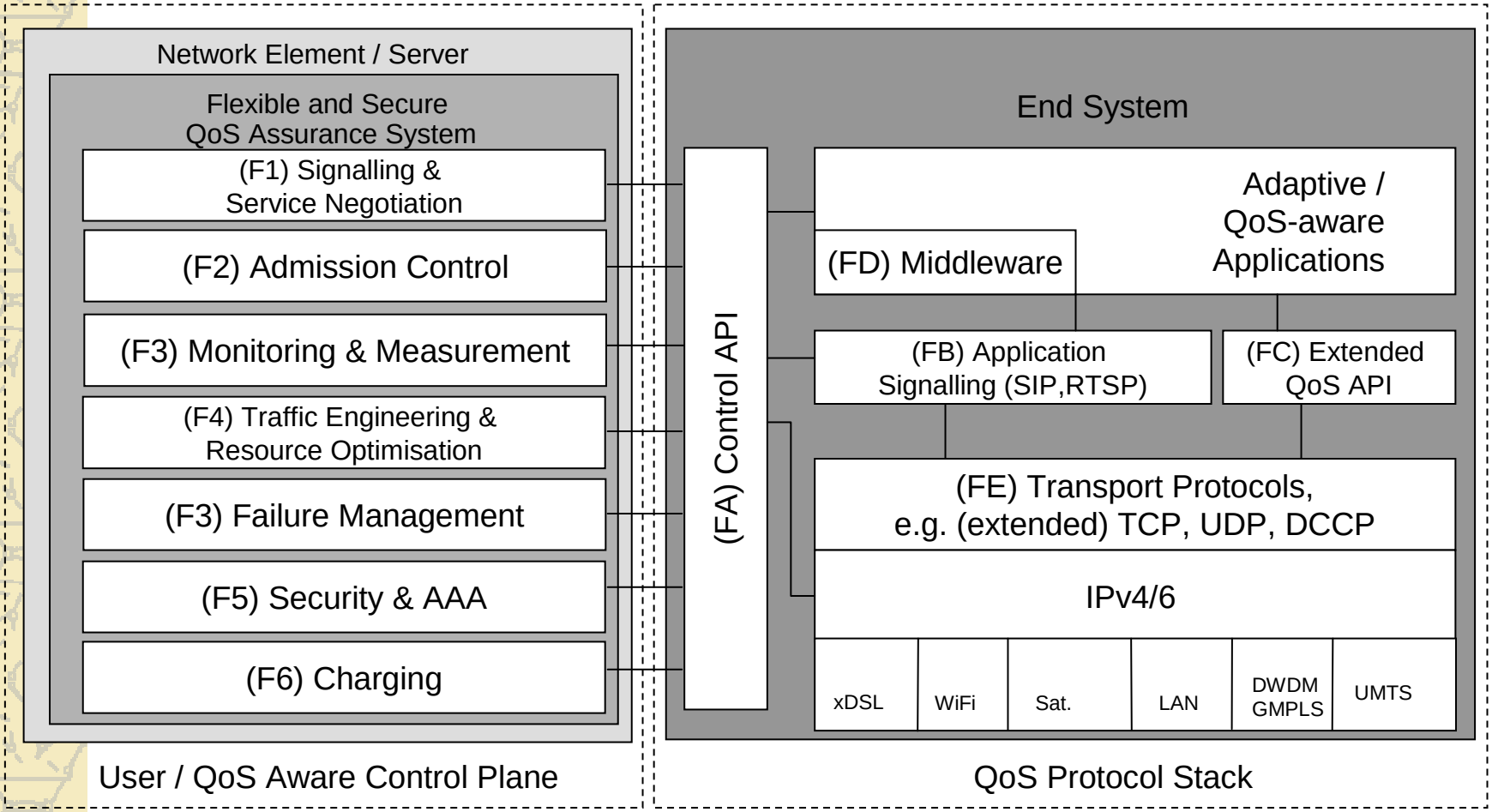


EuQoS solution:

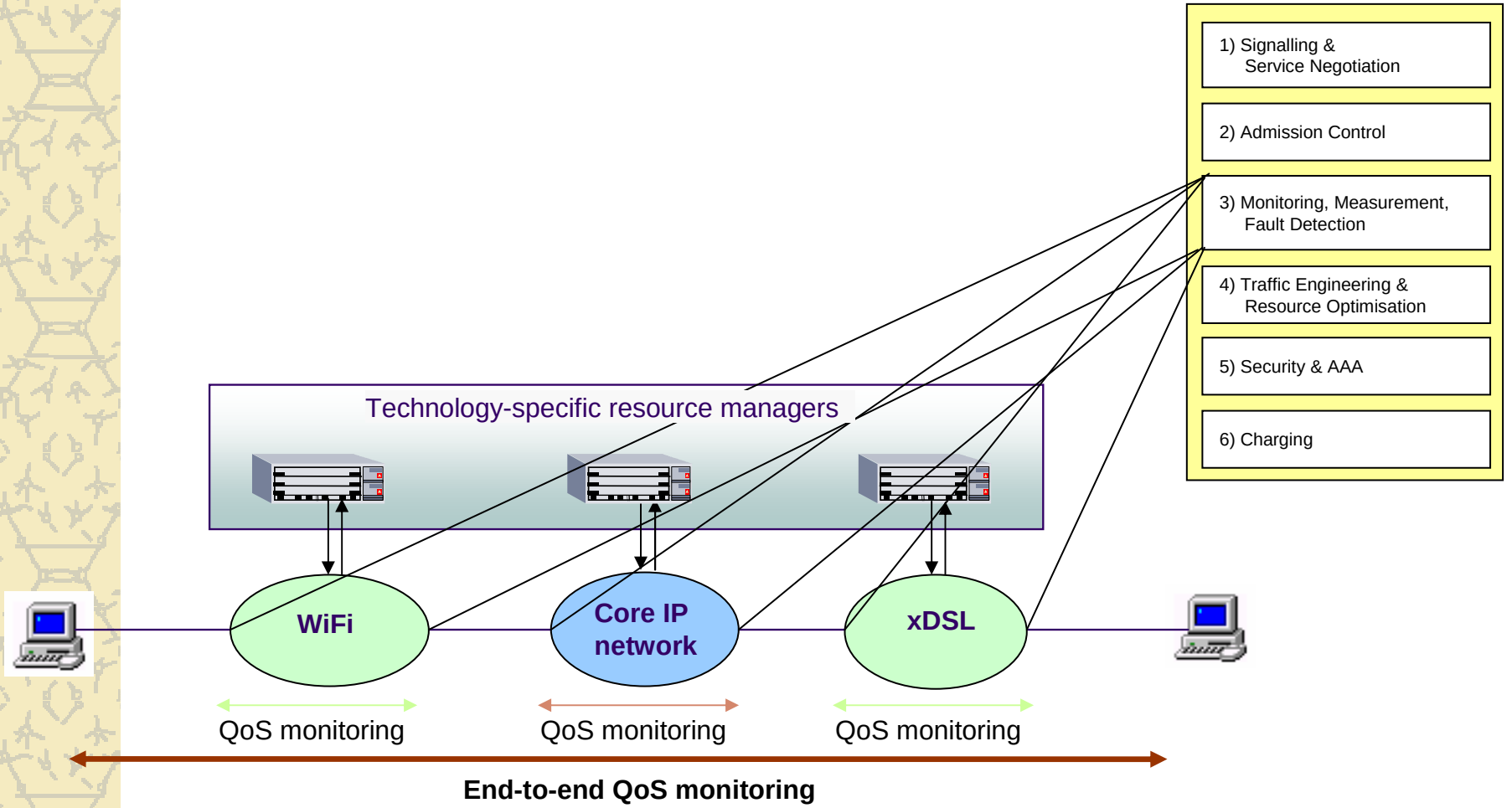
- technology-independent layer added
- QoS signalling capabilities added to the applications (terminals)



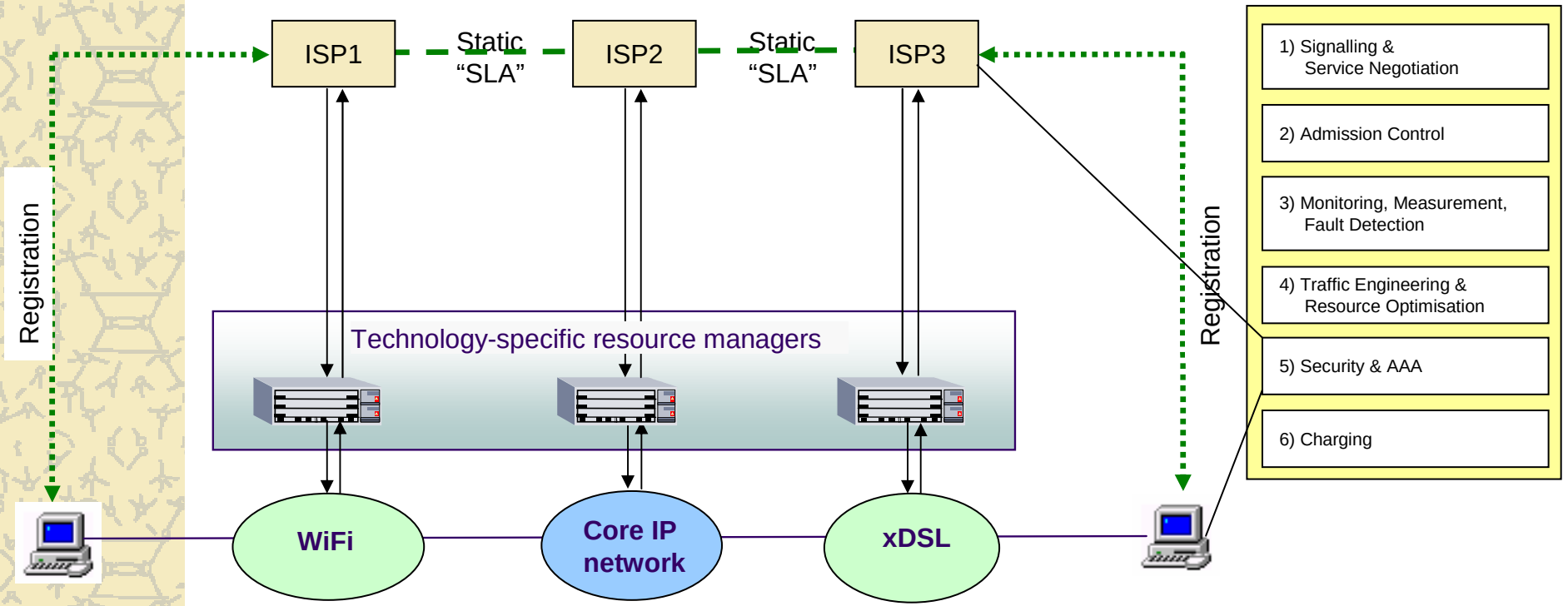
Functional Blocks of the EuQoS Architecture



General View of the Monitoring and Fault Management Function

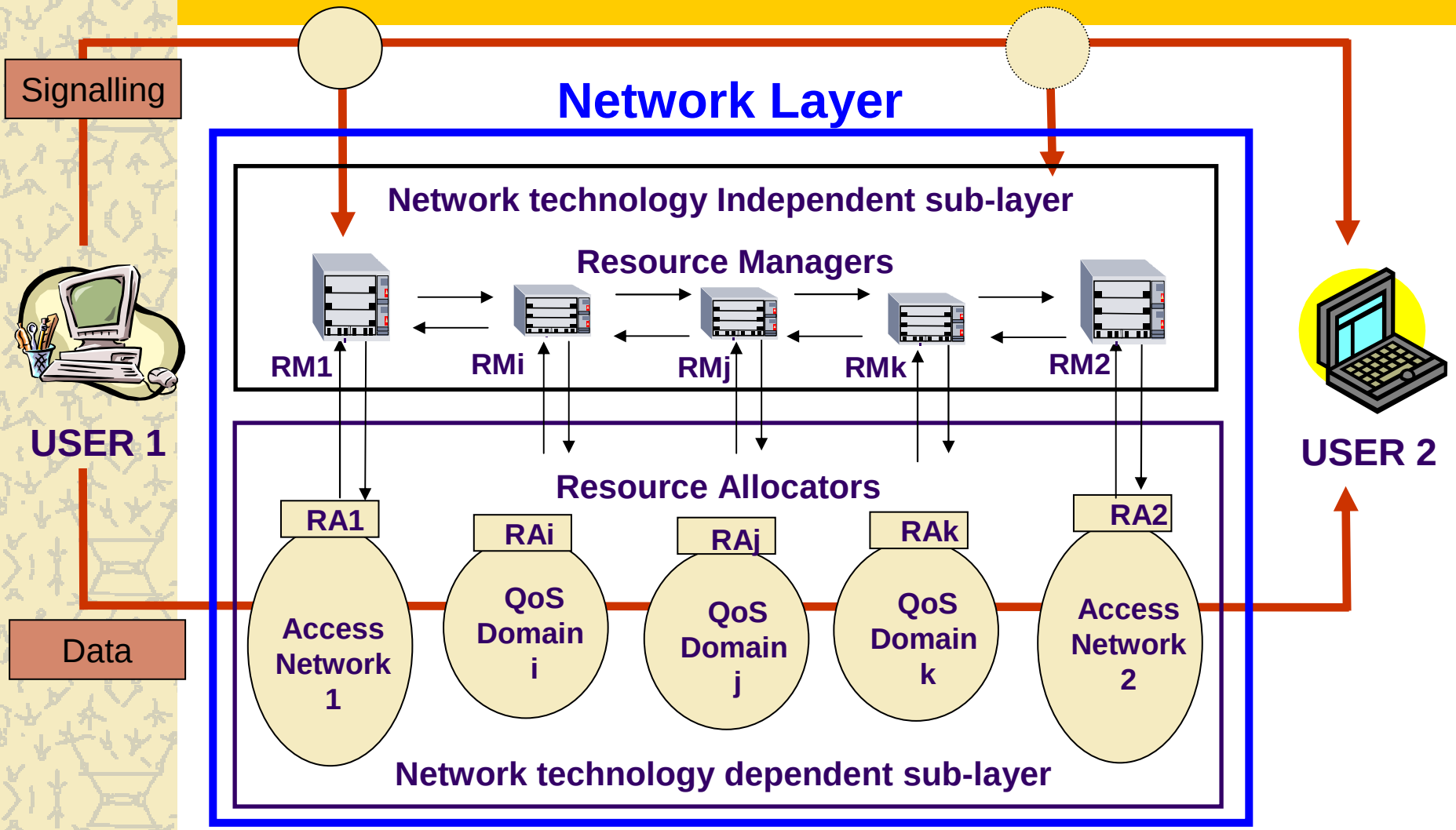


The Registration Process



For AAA purposes, a user has to register to the EuQoS service.
Registration is an off-line process between the user and the SP, which is performed over the Internet, by phone, or by filling in a paper form.
The details provided are used for coarse network dimensioning purposes, but are primarily for the subsequent authorisation of a user, and for billing.

Reaching the Resource Managers (1)



Reaching the Resource Managers (1)

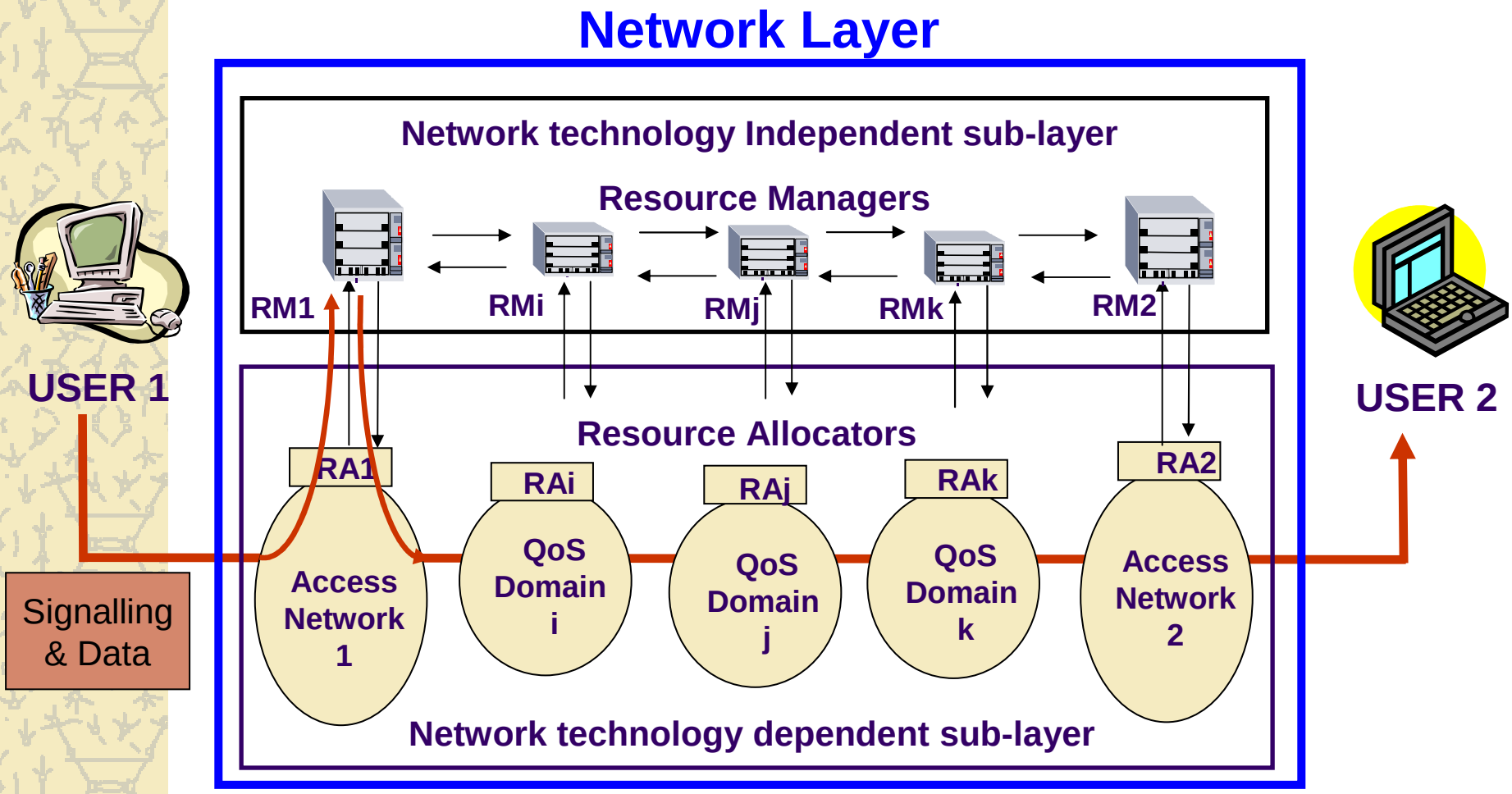
SIP is used to:

- Locate the called party
- Check that the capabilities of the calling and called parties are consistent (codecs)

SIP is *extended* to:

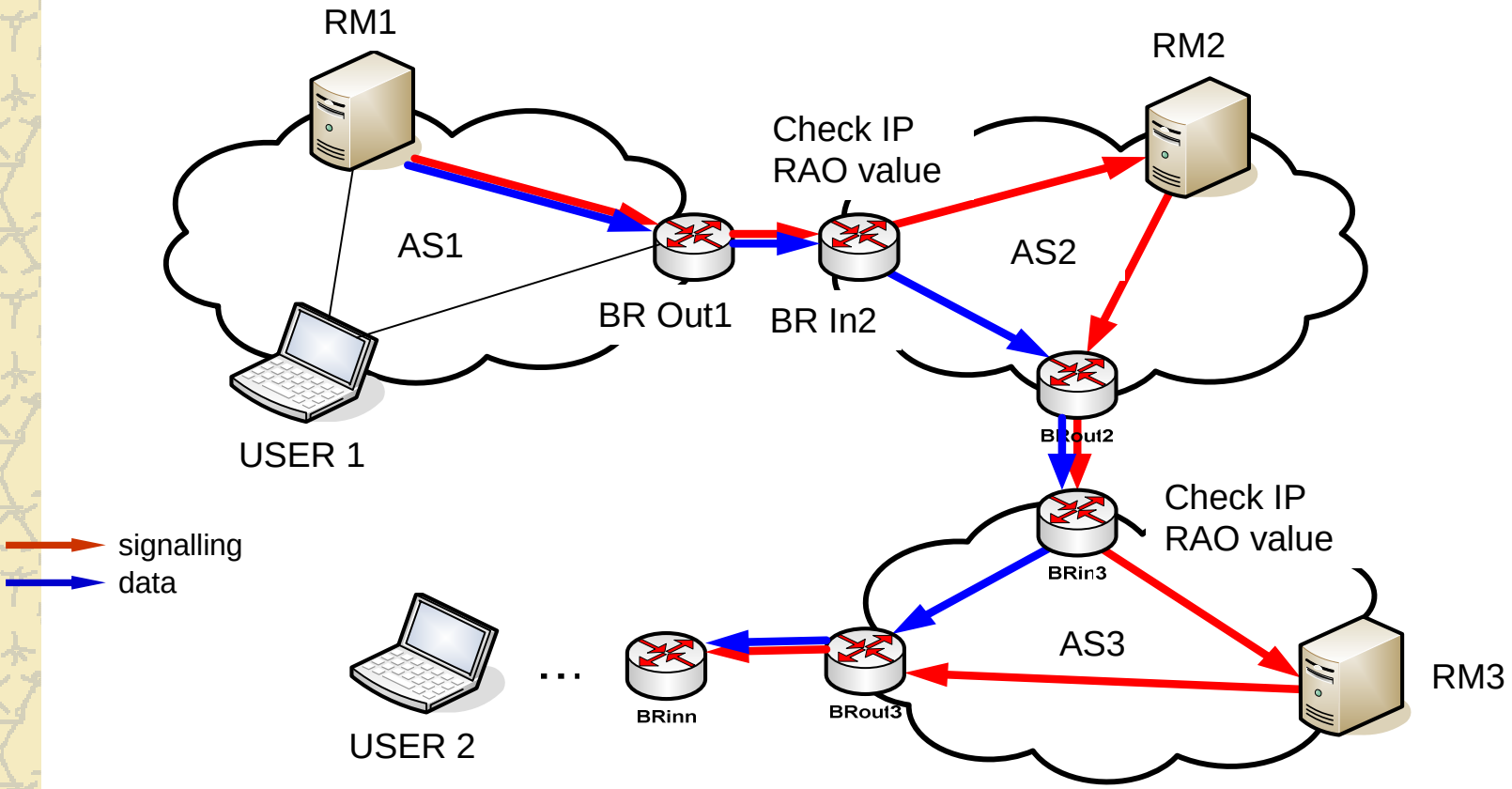
- Include pre-conditions (rfc 3312)
  ie. don't start the session until QoS is assured)
- Add QoS parameters in the SDP or use QSIP
  (the Internet Draft: veltri-sip-qsip-01 defines a solution based on an enhancement of the SIP protocol to convey QoS related information)

Reaching the Resource Managers (2)



Reaching the Resource Managers (2)

NSIS in EuQoS:
Border Router IP Router Alert Option (RAO) check



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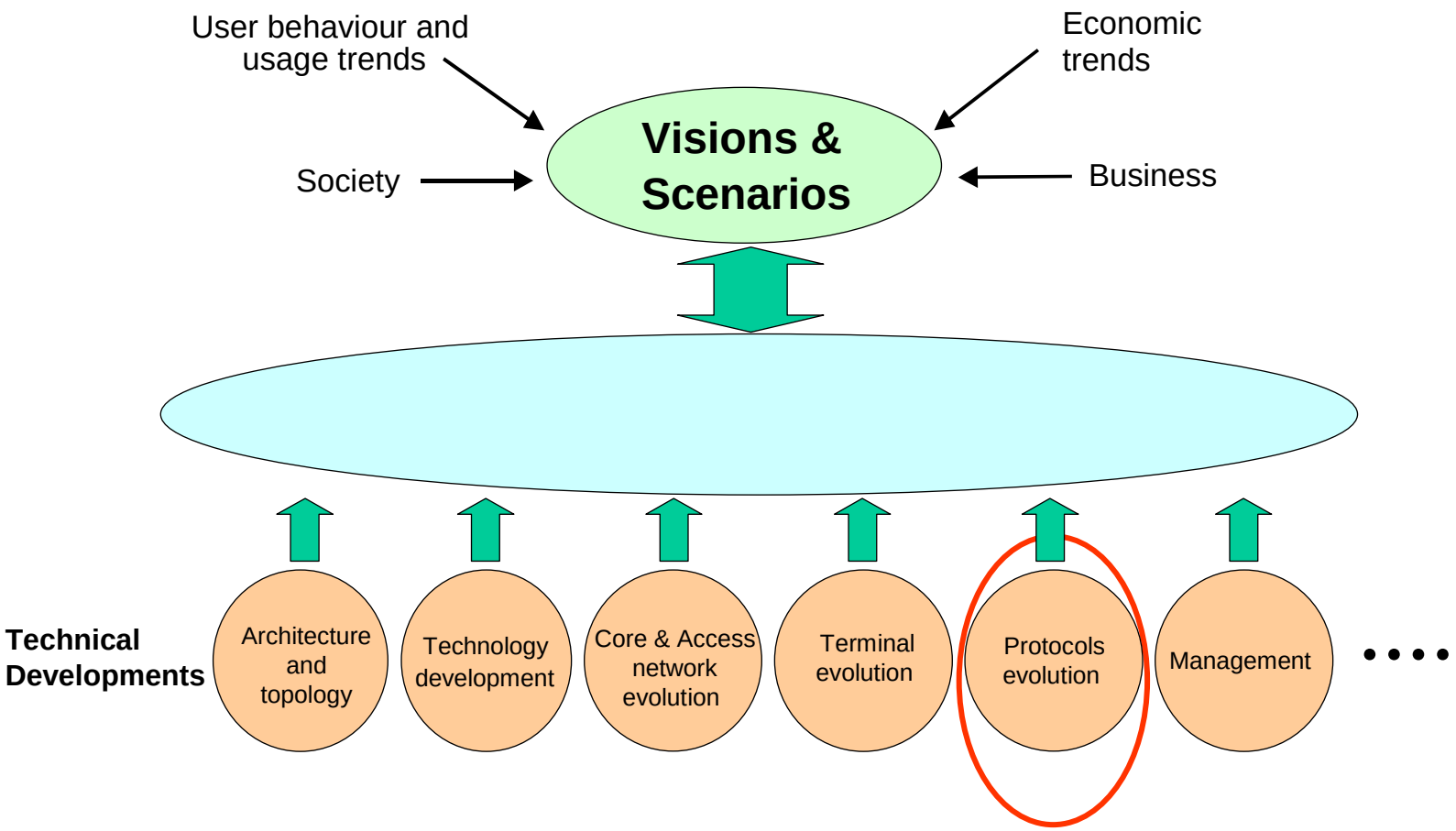

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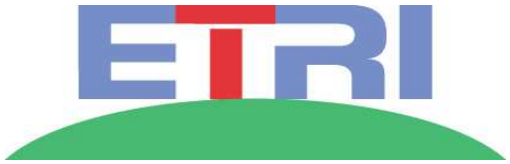
- **IPv6 deployments and information sources** (the EU project 6NET)

6NET Objectives

- To build and operate a dedicated international IPv6 network, and use this network to validate that the demands for the continuous growth of the global Internet can be met with the new IPv6 technology
- To support high-impact demonstrators and deployment scenarios
- To help European research and industry to play a major role in defining the next generation of networking and application technologies that go beyond the current state of the art

Industry Partners



NREN Partners

POZMAN

CESNET

GRNET
ΕΔΕΤ

SURFnet

DANTE

fcc

TERENA
TRANS-EUROPEAN RESEARCH AND EDUCATION NETWORKING ASSOCIATION

UKERNA

HUNGARNET

NORDUnet

SWITCH
The Swiss Education & Research Network

Renater

UNINETT

Forskningsnettet
The Danish Research Network

DTU

DFN
Deutsches Forschungsnetz

Academic Partners

University of Oulu

Universität Wien

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ULB

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Westfälische Wilhelms-Universität Münster

UCL

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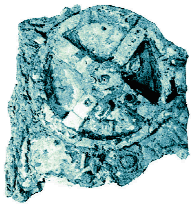
ulp Université Louis Pasteur Strasbourg



Research Academic Computer Technology Institute

University of Southampton

FOKUS

Fraunhofer Institute for Open Communication Systems

The Beginning ....

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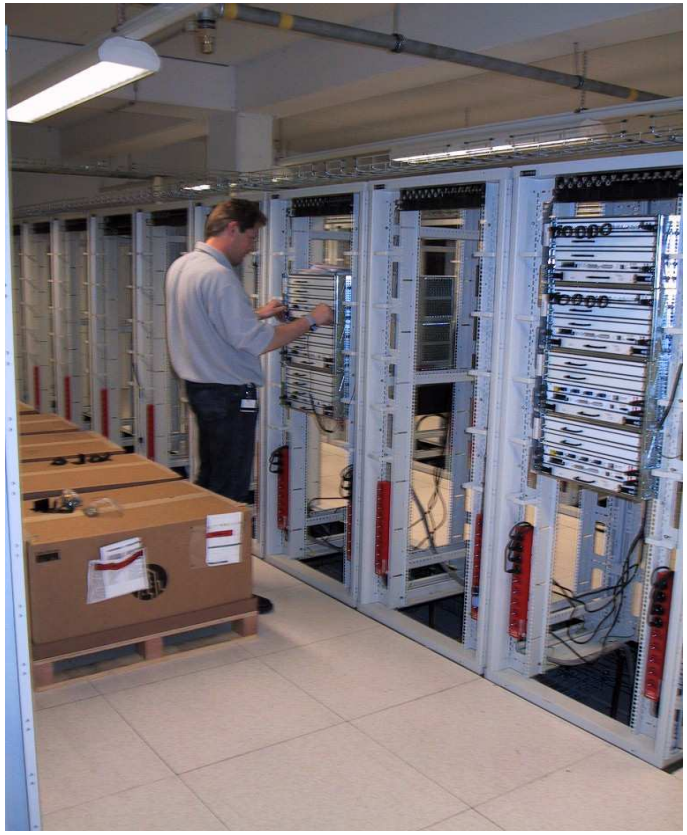
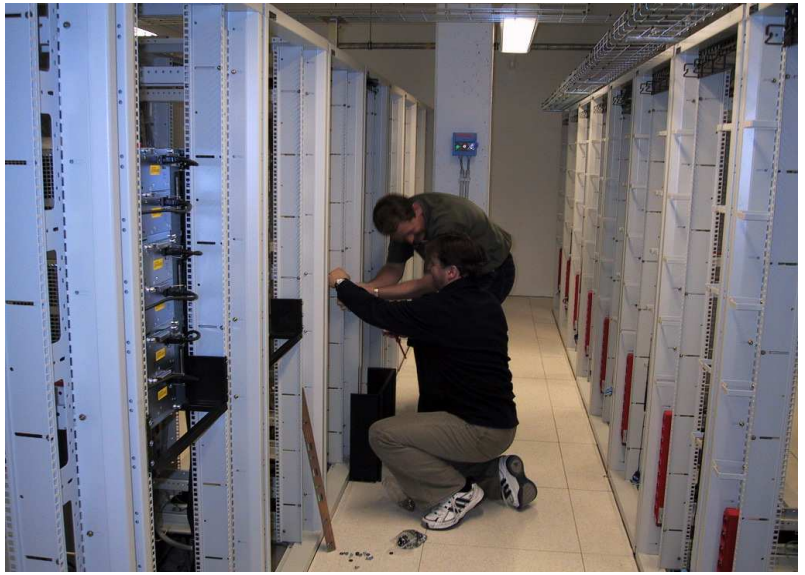
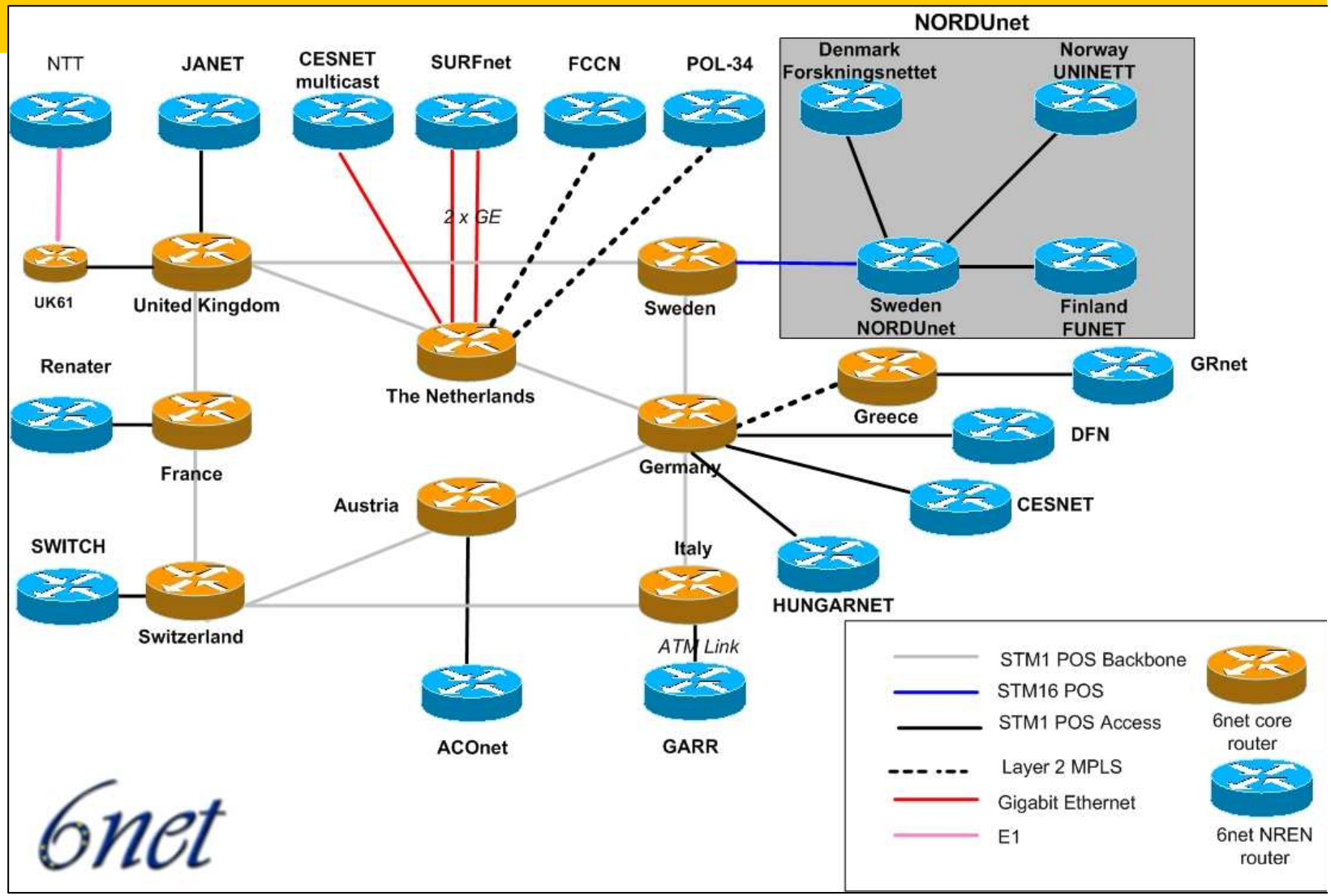




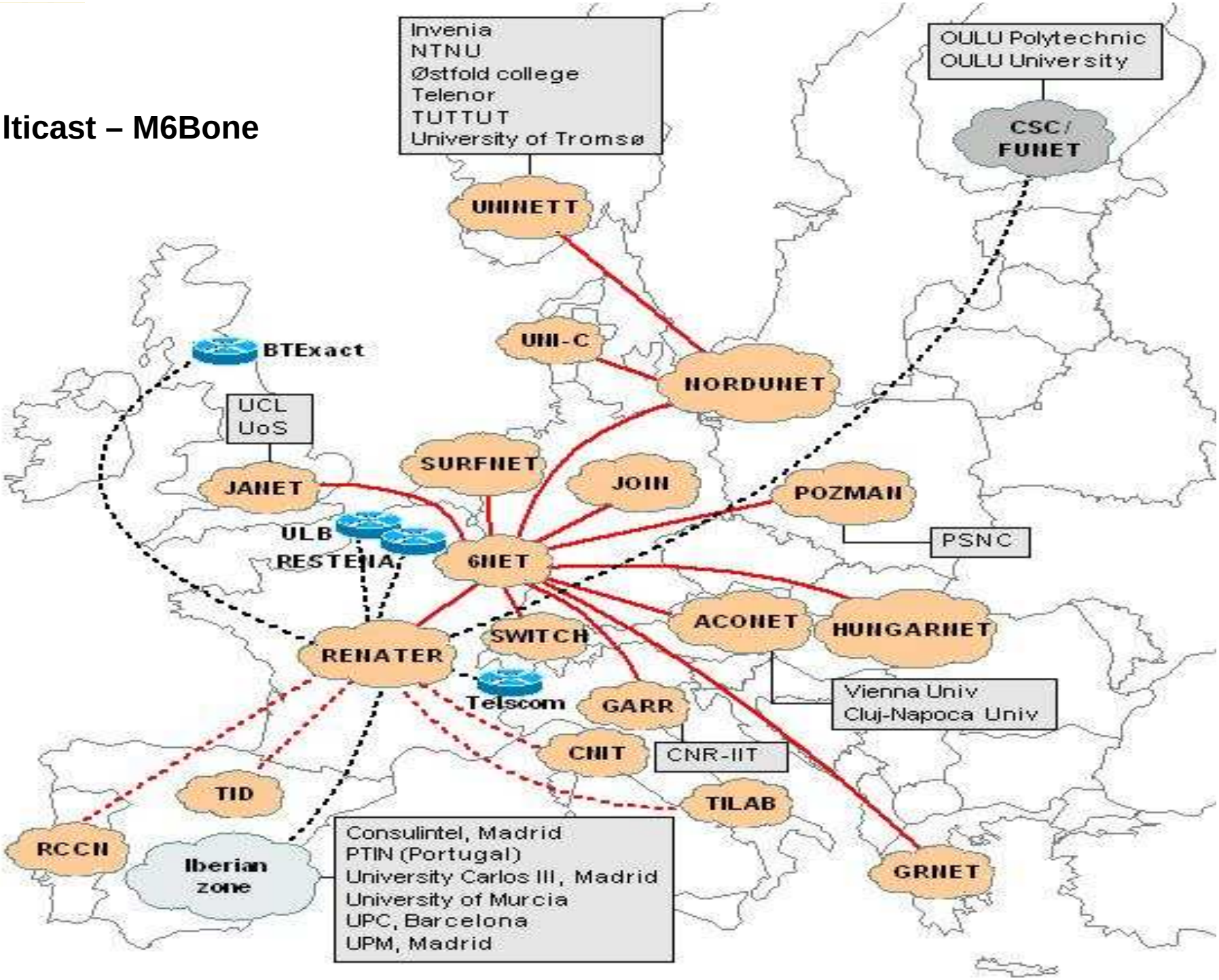
The End ....

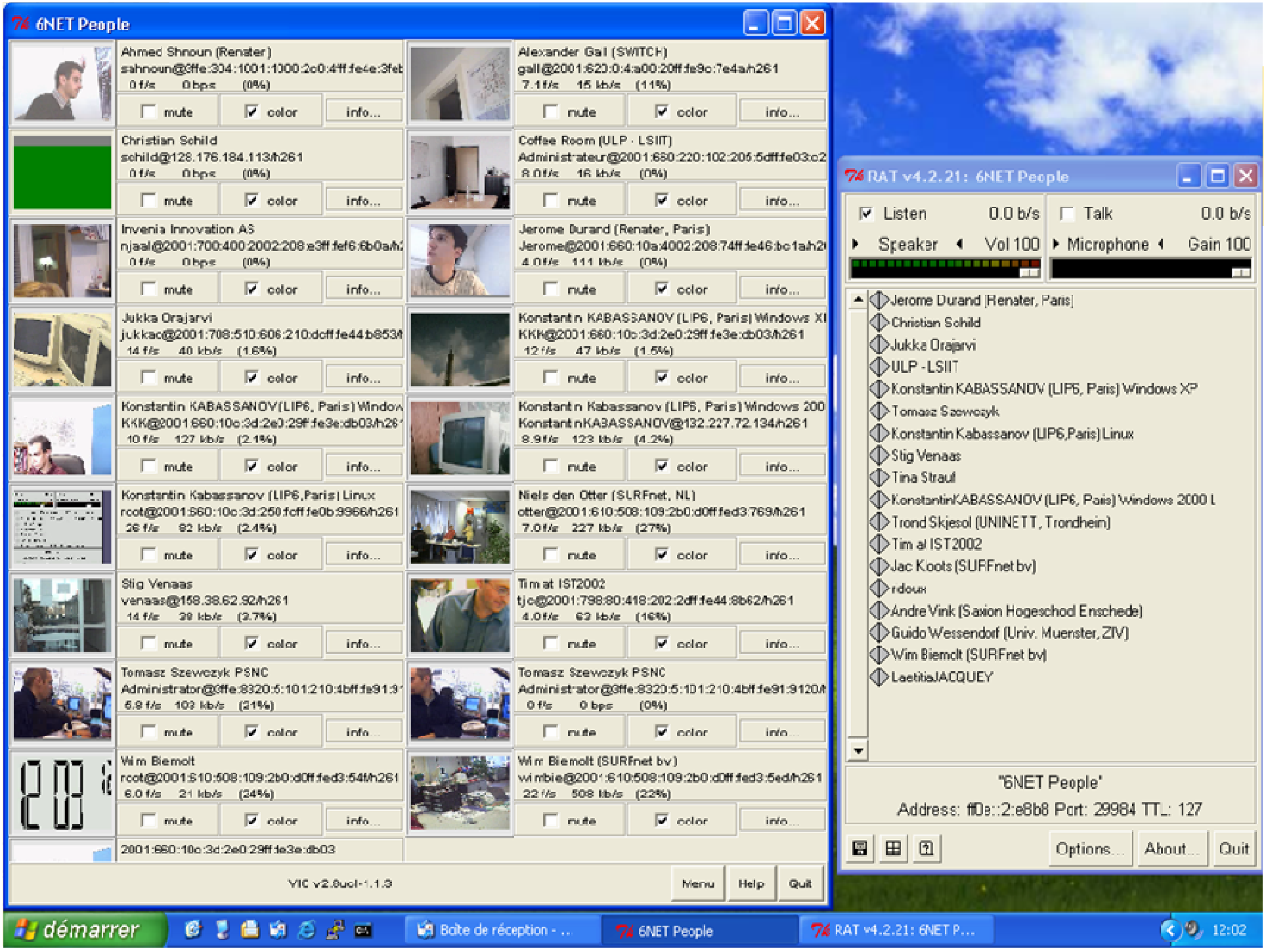

NORDUnet
NTT
JANET
CESNET multicast
SURFnet
FCCN
POL-34
Denmark Forskningsnettet
Norway UNINETT
2 x GE
UK61
United Kingdom
Sweden
Sweden NORDUnet
Finland FUNET
Renater
The Netherlands
GRnet
Greece
DFN
France
Germany
CESNET
Austria
SWITCH
Italy
HUNGARNET
Switzerland
ATM Link
ACOnet
GARR
6net
STM1 POS Backbone
STM16 POS
STM1 POS Access
Layer 2 MPLS
Gigabit Ethernet
E1
6net core router
6net NREN router

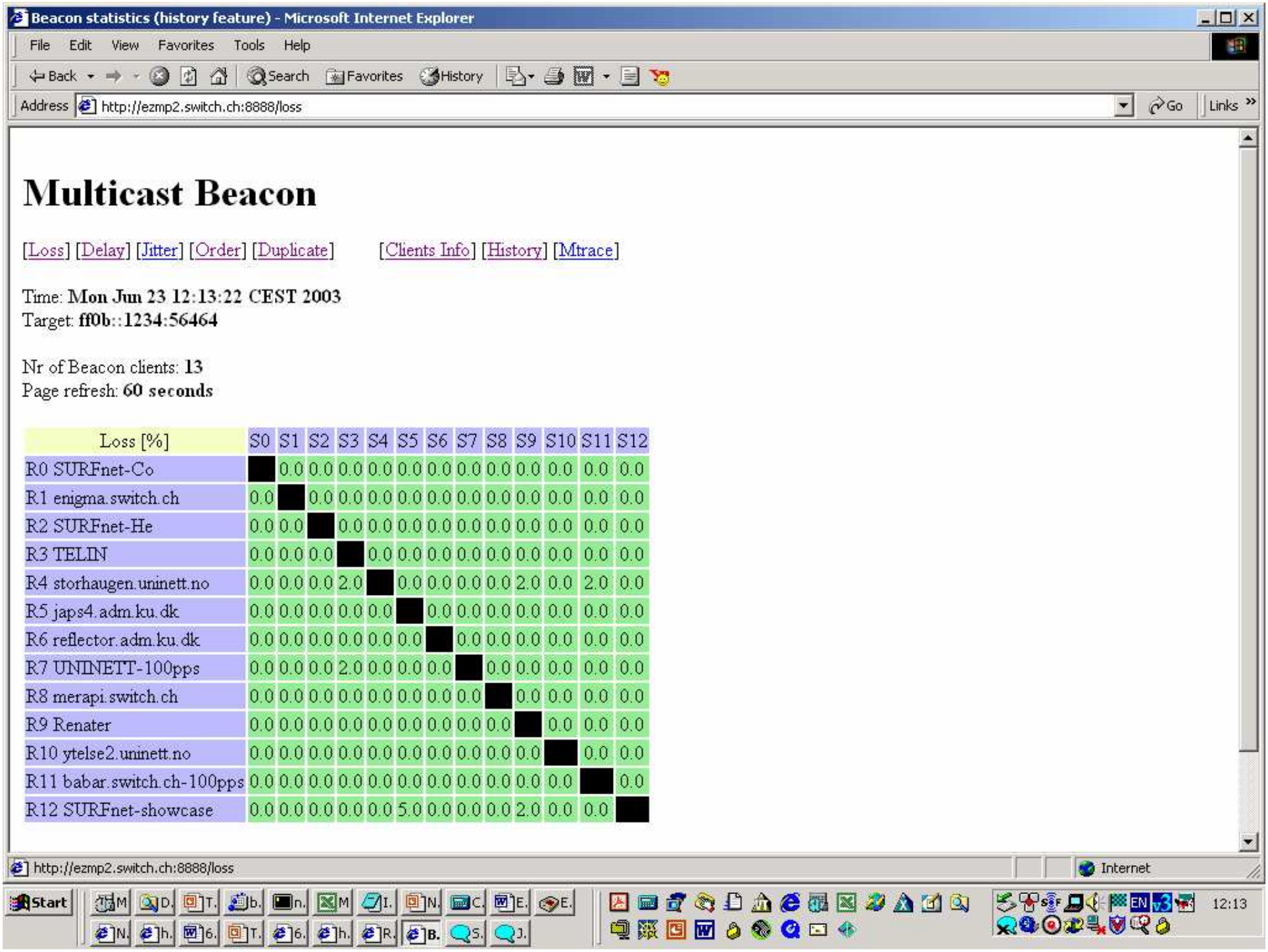
Network Services and Applications

- **Multicast**
- **QoS**
- **Mobility**
- **… and subsequent deployment support**

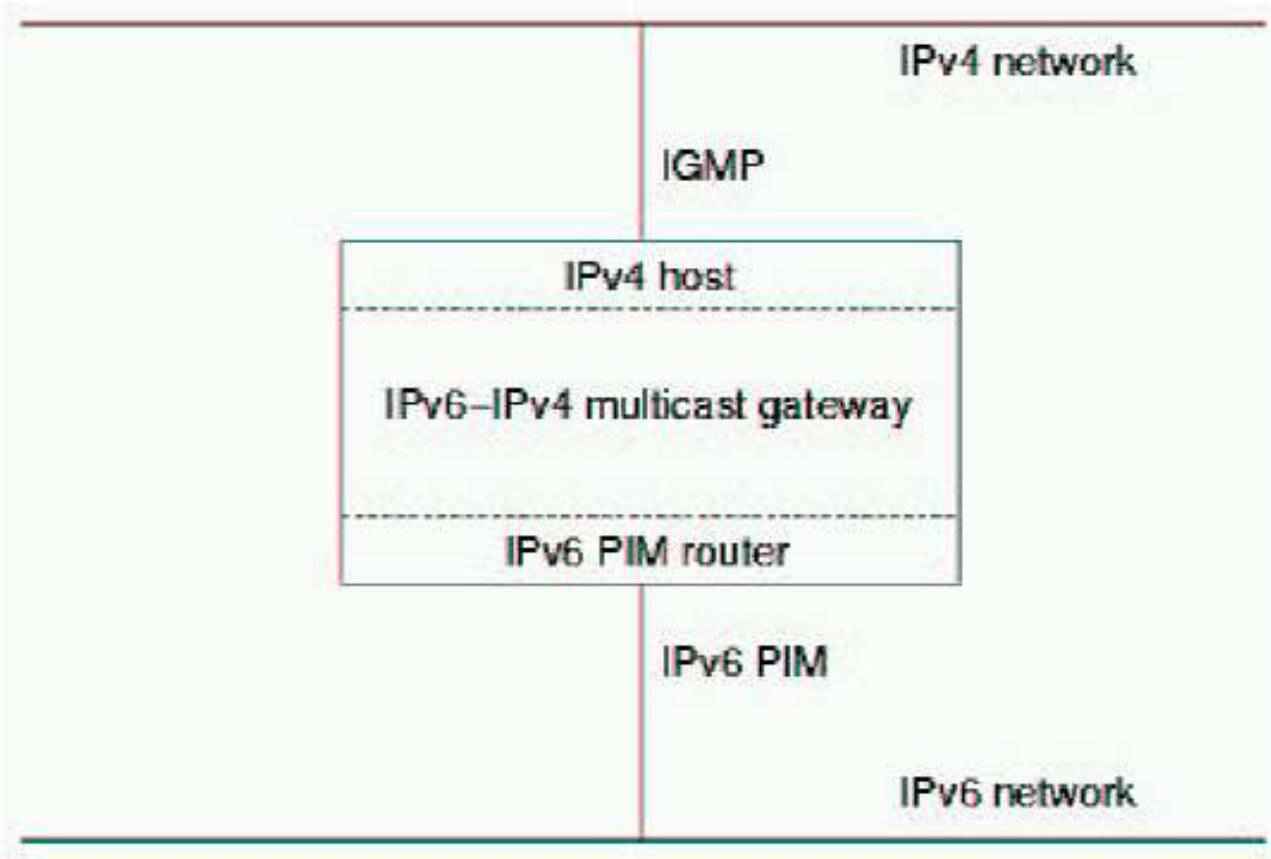
Multicast – M6Bone




6NET People
Ahmed Shnoun (Renater)
sahnoun@3ffe:304:1001:1300:2c0:4fff:fe4e:3feb
0 f/s 0 bps (0%)
mute
color
info...
Alexander Gall (SWITCH)
gall@2001:620:0:4:a00:20fff:fe9c:7e4a/h261
7.1 f/s 15 kb/s (11%)
mute
color
info...
Christian Schild
schild@128.176.184.113/h261
0 f/s 0 bps (0%)
mute
color
info...
Coffee Room (ULP - LSIIT)
Administrateur@2001:660:220:102:205:5dfff:fe03:c2
8.0 f/s 16 kb/s (0%)
mute
color
info...
Invenia Innovation AS
njaal@2001:700:400:2002:208:e3ff:fef6:6b0a/h2
0 f/s 0 bps (0%)
mute
color
info...
Jerome Durand (Renater, Paris)
Jerome@2001:660:10a:4002:208:74fff:fe46:bc1a/h2
4.0 f/s 111 kb/s (0%)
mute
color
info...
Jukka Orajarvi
jukkac@2001:708:510:606:210:dcff:fe44:b853/h
14 f/s 40 kb/s (1.6%)
mute
color
info...
Konstantin KABASSANOV (LIP6, Paris) Windows XI
KKK@2001:660:10c:3d:2e0:29ff:fe3e:db03/h261
12 f/s 47 kb/s (1.5%)
mute
color
info...
Konstantin KABASSANOV(LIP6, Paris) Windov
KKK@2001:660:10c:3d:2e0:29f:fe3e:db03/h26
10 f/s 127 kb/s (2.1%)
mute
color
info...
Konstantin Kabassanov (LIP6, Paris) Windows 200
KonstantinKABASSANOV@132.227.72.134/h261
8.9 f/s 123 kb/s (4.2%)
mute
color
info...
Konstantin Kabassanov (LIP6,Paris) Linux
rcot@2001:660:10c:3d:250:fcff:fe0b:9966/h261
26 f/s 92 kb/s (2.4%)
mute
color
info...
Niels den Otter (SURFnet, NL)
otter@2001:610:508:109:2b0:d0ff:fed3:769/h261
7.0 f/s 227 kb/s (27%)
mute
color
info...
Stig Venaas
venaas@158.38.62.92/h261
14 f/s 39 kb/s (2.7%)
mute
color
info...
Tim at IST2002
tjc@2001:798:80:418:202:2dff:fe44:8b62/h261
4.0 f/s 63 kb/s (16%)
mute
color
info...
Tomasz Szewczyk PSNC
Administrator@3ffe:8320:5:101:210:4bff:fe91:3
6.9 f/s 103 kb/s (21%)
mute
color
info...
Tomasz Szewczyk PSNC
Administrator@3ffe:8320:5:101:210:4bff:fe91:9120/h
0 f/s 0 bps (0%)
mute
color
info...
Wim Biemolt
rcot@2001:610:508:109:2b0:d0ff:fed3:54f/h261
6.0 f/s 21 kb/s (24%)
mute
color
info...
Wim Biemolt (SURFnet bv)
wimbie@200:610:508:109:2b0:d0ff:fed3:5ed/h261
22 f/s 508 kb/s (22%)
mute
color
info...
2001:660:10c:3d:2e0:29ff:fe3e:db03
VIC v2.8ucl-1.1.3
Menu
Help
Quit
RAT v4.2.21: 6NET People
Listen 0.0 b/s
Talk 0.0 b/s
Speaker Vol 100
Microphone Gain 100
Jerome Durand (Renater, Paris)
Christian Schild
Jukka Orajarvi
ULP - LSIIT
Konstantin KABASSANOV (LIP6, Paris) Windows XP
Tomasz Szewczyk
Konstantin Kabassanov (LIP6,Paris) Linux
Stig Venaas
Tina Strauf
KonstantinKABASSANOV (LIP6, Paris) Windows 2000 L
Trond Skjesol (UNINETT, Trondheim)
Tim at IST2002
Jac Kools (SURFnet bv)
rdoux
Andre Vink (Saxion Hogeschool Enschede)
Guido Wessendorf (Univ. Muenster, ZIV)
Wim Biemolt (SURFnet bv)
LaetitiaJACQUEY
"6NET People"
Address: ffDa::2:e8b8 Port: 29984 TTL: 127
Options...
About...
Quit
démarrer
Boîte de réception - ...
6NET People
RAT v4.2.21: 6NET P...
12:02


Beacon statistics (history feature) - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://ezmp2.switch.ch:8888/loss
Go Links
Multicast Beacon
[Loss] [Delay] [Jitter] [Order] [Duplicate] [Clients Info] [History] [Mtrace]
Time: Mon Jun 23 12:13:22 CEST 2003
Target: ff0b::1234:56464
Nr of Beacon clients: 13
Page refresh: 60 seconds
Loss [%] S0 S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12
R0 SURFnet-Co 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R1 enigma.switch.ch 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R2 SURFnet-He 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R3 TELIN 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R4 storhaugen.uninett.no 0.0 0.0 0.0 2.0 0.0 0.0 0.0 0.0 2.0 0.0 2.0 0.0
R5 japs4.adm.ku.dk 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R6 reflector.adm.ku.dk 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R7 UNINETT-100pps 0.0 0.0 0.0 2.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R8 merapi.switch.ch 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R9 Renater 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R10 ytelse2.uninett.no 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R11 babar.switch.ch-100pps 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
R12 SURFnet-showcase 0.0 0.0 0.0 0.0 0.0 5.0 0.0 0.0 0.0 2.0 0.0 0.0
http://ezmp2.switch.ch:8888/loss
Internet
Start
12:13

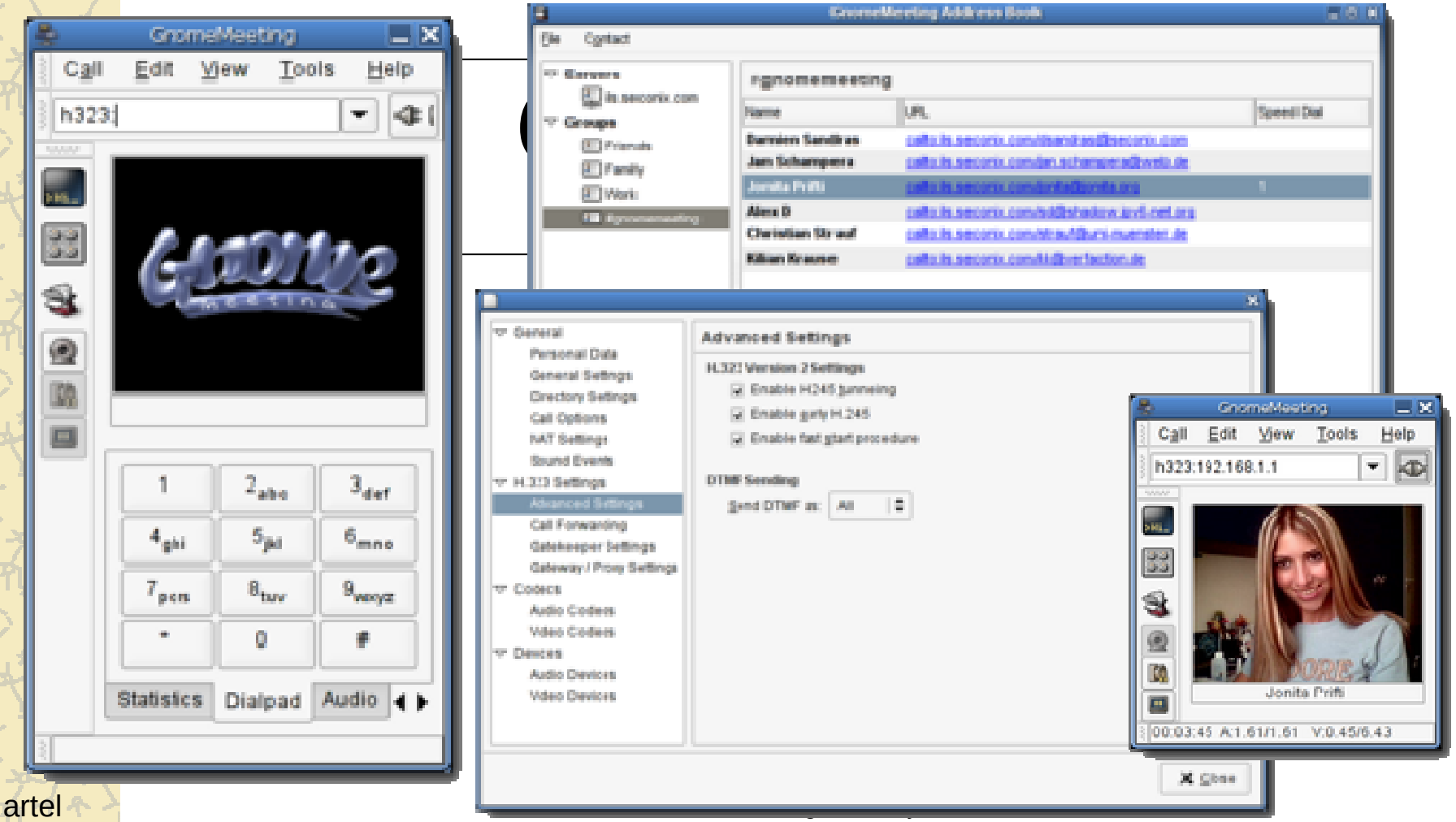
Multicast Gateway



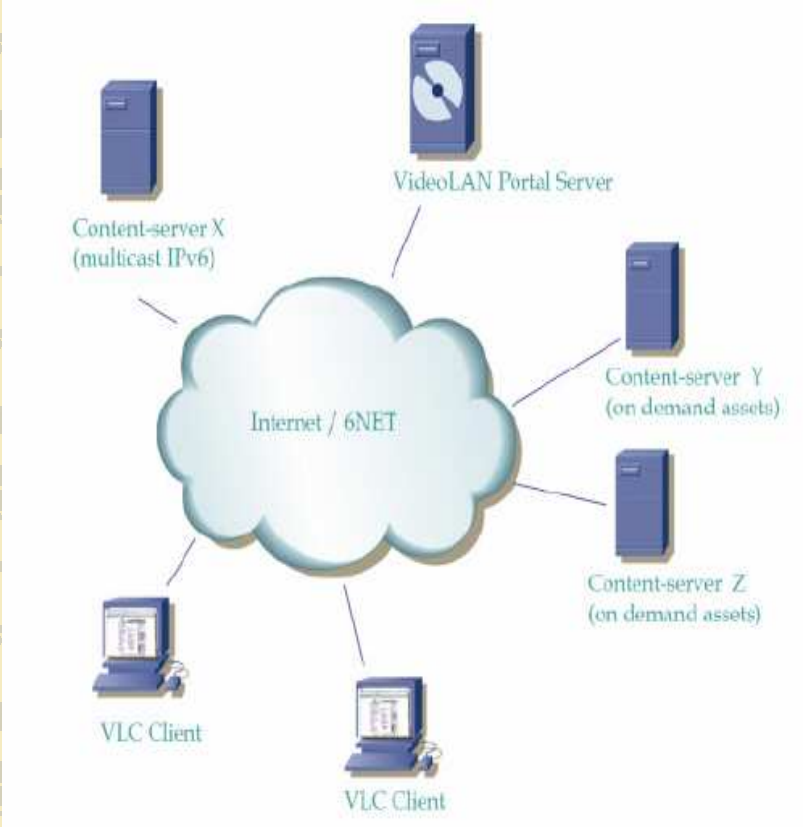
- In IPv4 the gateway is a multicast host using IGMP
- In IPv6 the gateway is a PIM router and RP for the /96 prefix

GnomeMeeting

http://www.gnomemeeting.org/



VideoLAN



1. User uses a web browser to connect to the VideoLAN Portal Server (over IPv6);
2. The portal shows a set of video-assets on servers connected to the 6NET network;
3. User selects a video-assets from the portal;
4. VideoLAN Portal Server starts the stream on Content-server Y or Z and gives as result of the choice, a mine-type that triggers VideoLAN Client to start and connect to the server or to join on the IPv6 Multicast group

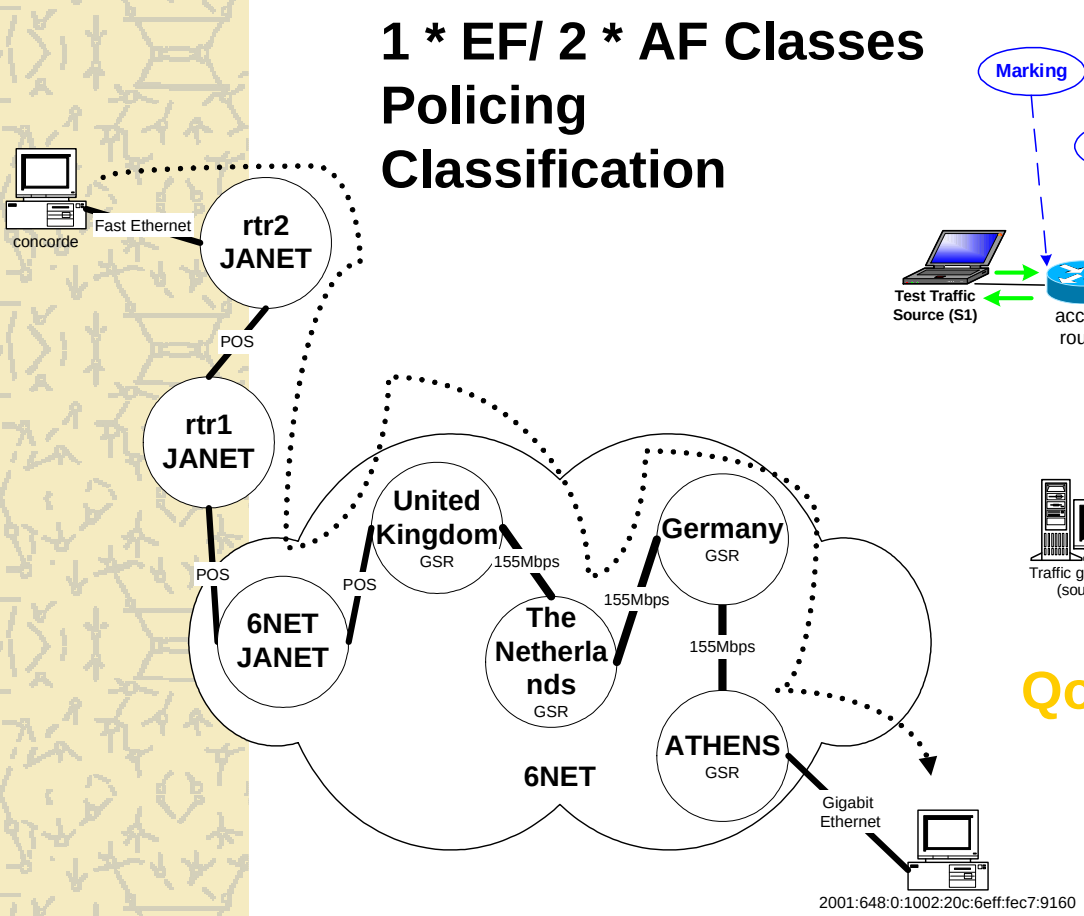
6NET QoS

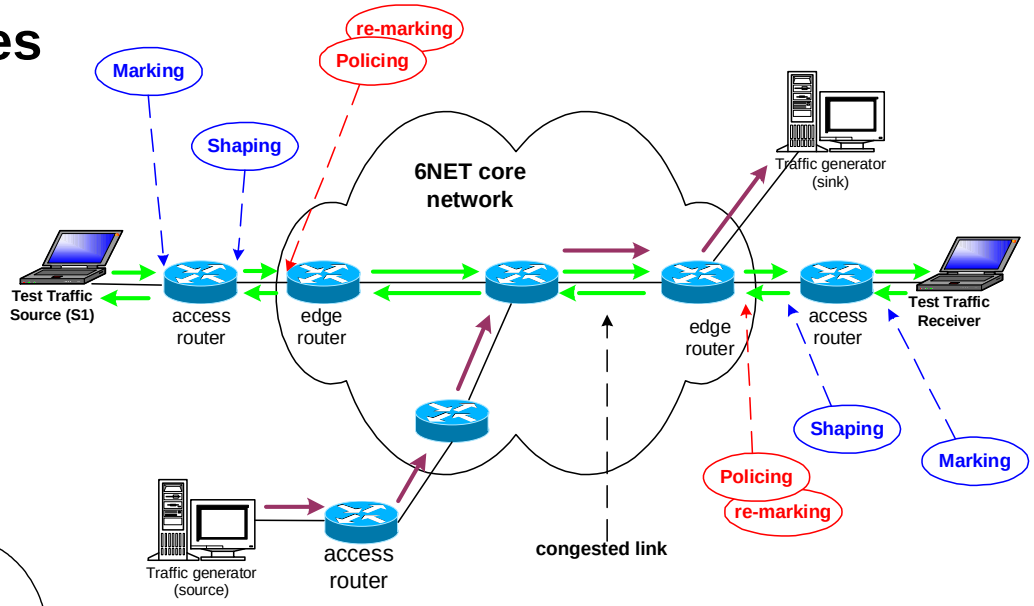
Test included:

1 * EF/ 2 * AF Classes

Policing

Classification





QoS was enabled for >8 months !!

▶ **Premium traffic**

Demonstrators

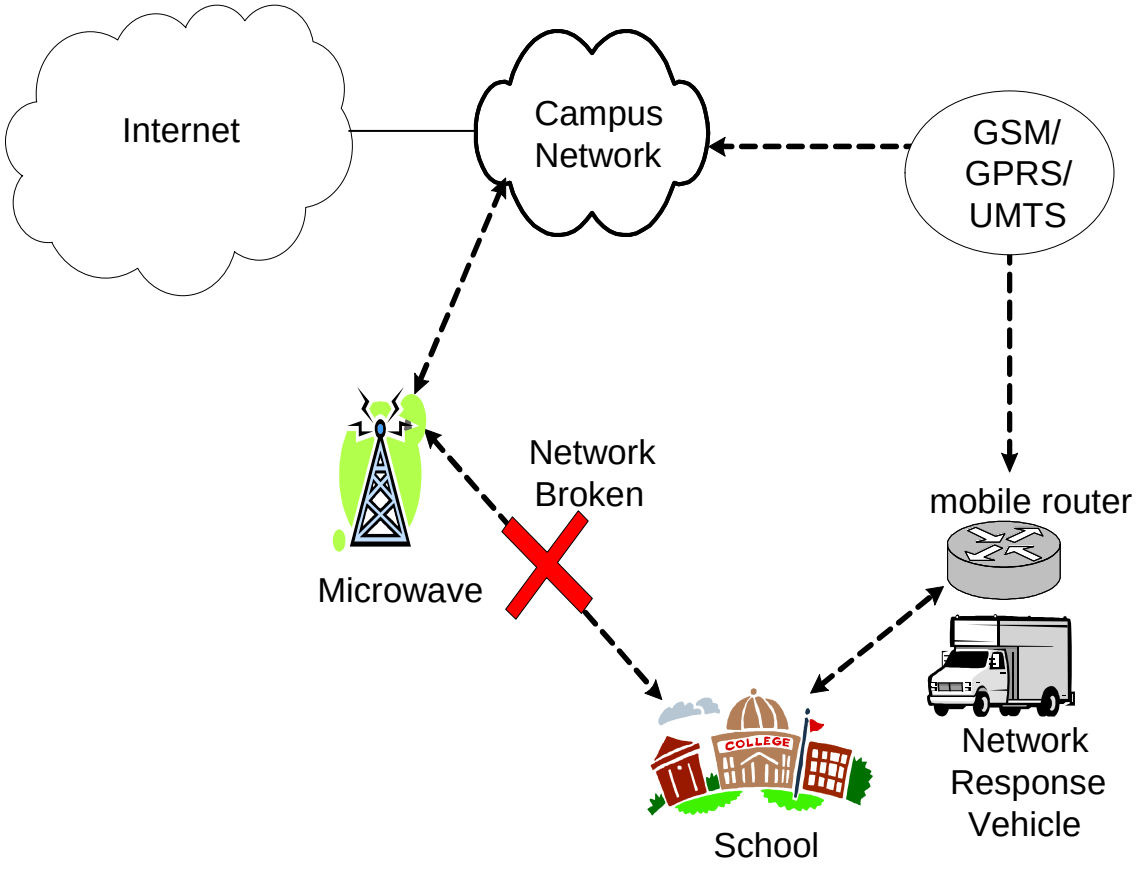
- VoIP with SIP (SIP Express Router) + voice user agent (eg. Kphone IPv6) + PSTN gateway + MCU + VPN functionality
- Flute (Multicast)
- Streaming between mobile hosts, including Mobile IP functionality
- AccessGrid
- Globus (GT3)
- Open H323 + Open VPN
- Home Networking
- Greek School Network
- Mobility demonstrators

Mobility Demonstrators

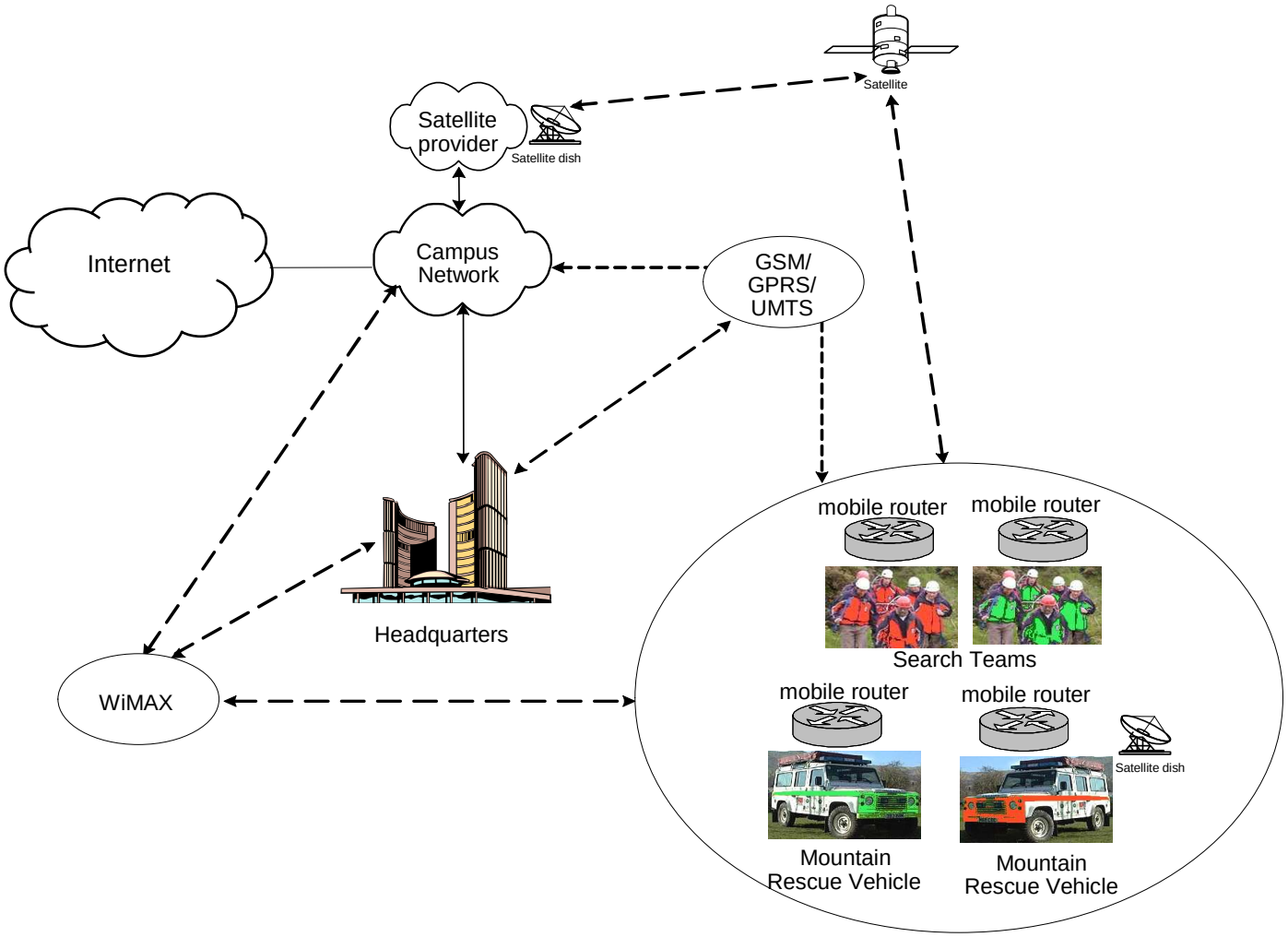
- 3 Mobility demonstrators:
  - Remote Schools Network Support
  - Mountain Rescue
  - Mobile Library
- UCL worked on integrating VoIP into the above

Remote School Network Support

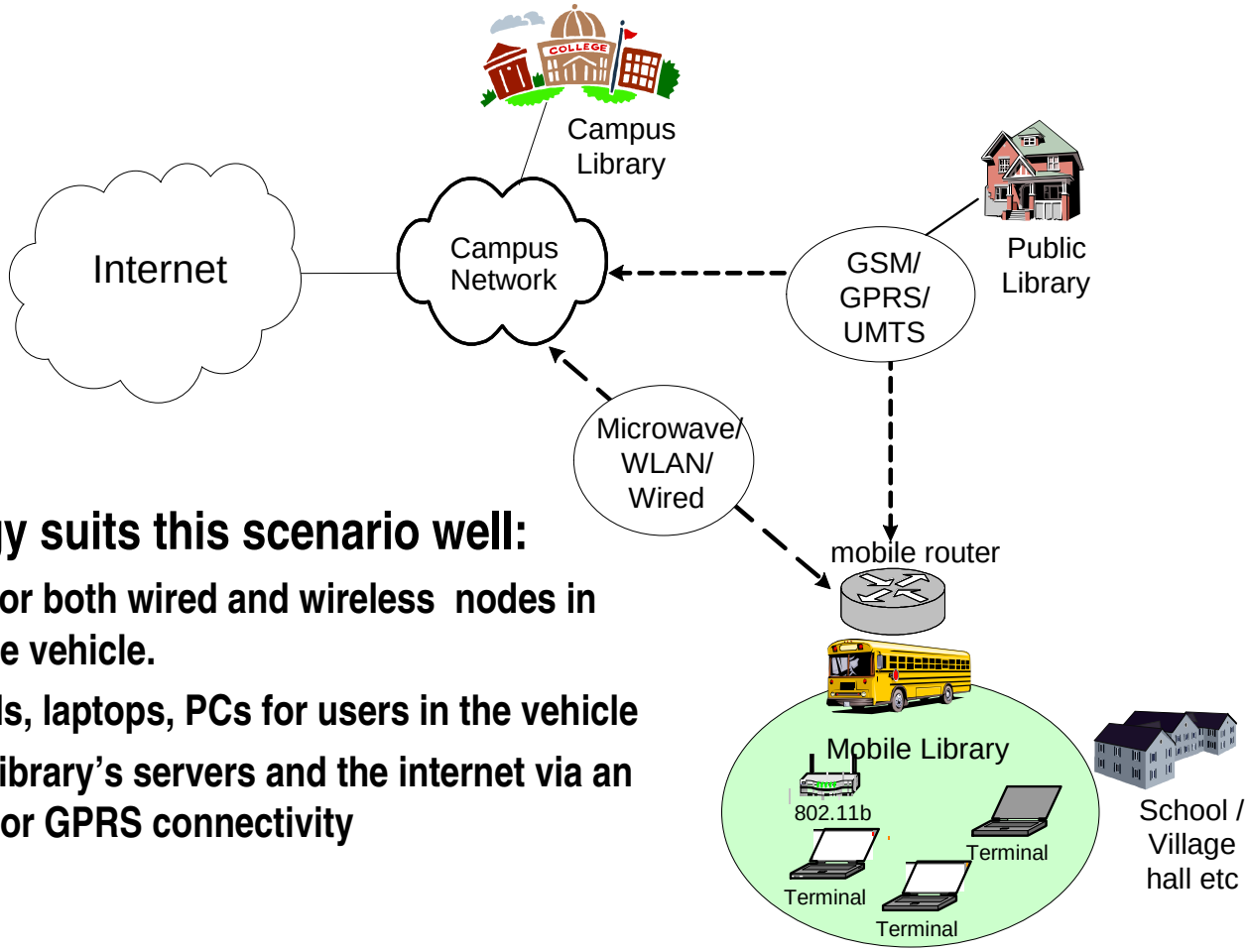
- Each network support vehicle will be fitted with a 3200 series MAR
- Each MAR will support numerous interface types to connect back to campus network
  - Also provide a temporary 802.11g hotspot around the vehicle



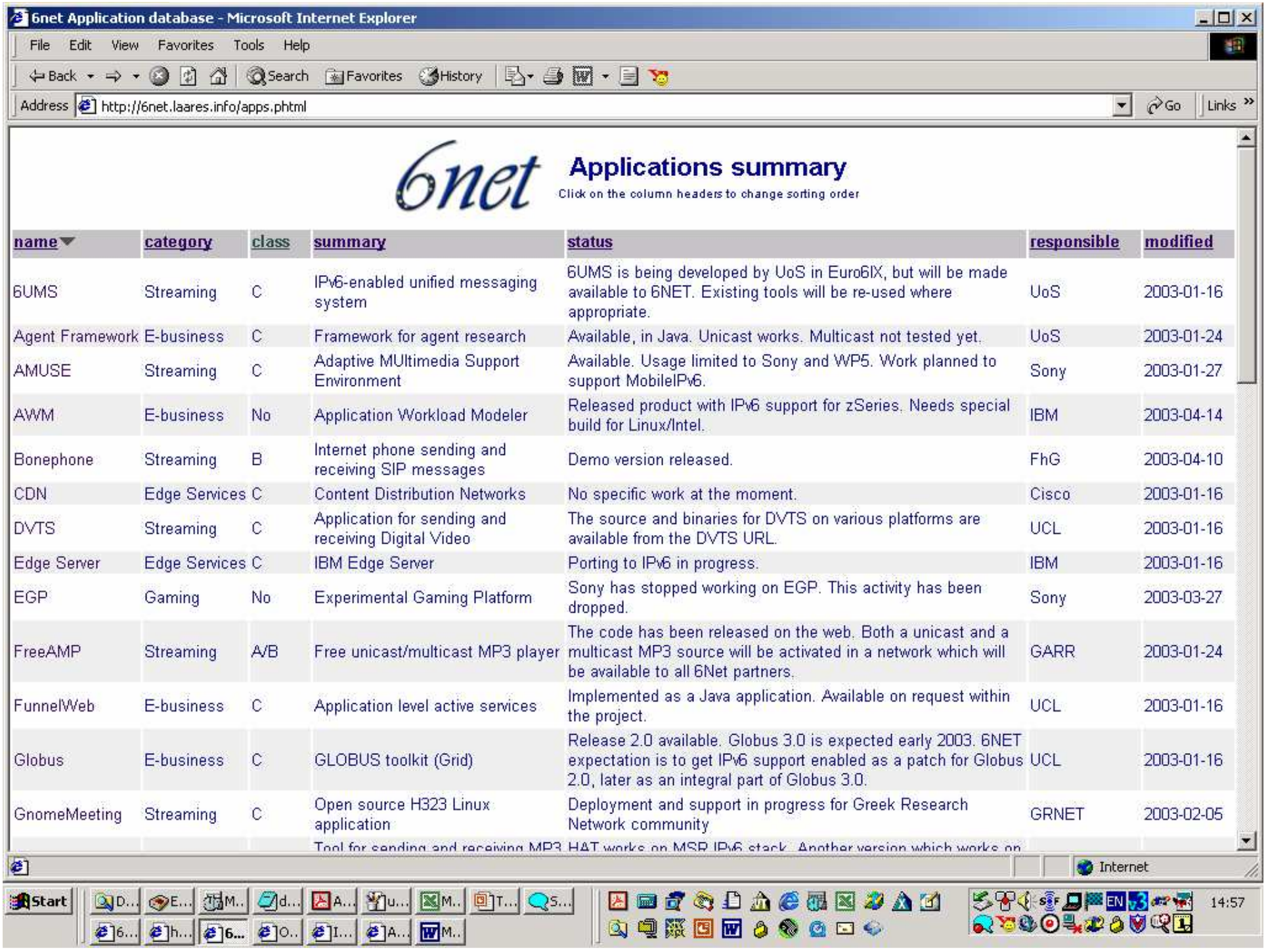
Mountain Rescue



Mobile Library



- **MAR technology suits this scenario well:**
  - **Provide LAN for both wired and wireless nodes in and around the vehicle.**
  - **Fixed terminals, laptops, PCs for users in the vehicle**
  - **Uplink to the library's servers and the internet via an 802.11 bridge or GPRS connectivity**


6net Application database - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://6net.laares.info/apps.phtml
Go Links
6net
Applications summary
Click on the column headers to change sorting order
name category class summary status responsible modified
6UMS Streaming C IPv6-enabled unified messaging system 6UMS is being developed by UoS in Euro6IX, but will be made available to 6NET. Existing tools will be re-used where appropriate. UoS 2003-01-16
Agent Framework E-business C Framework for agent research Available, in Java. Unicast works. Multicast not tested yet. UoS 2003-01-24
AMUSE Streaming C Adaptive MUltimedia Support Environment Available. Usage limited to Sony and WP5. Work planned to support MobileIPv6. Sony 2003-01-27
AWM E-business No Application Workload Modeler Released product with IPv6 support for zSeries. Needs special build for Linux/Intel. IBM 2003-04-14
Bonephone Streaming B Internet phone sending and receiving SIP messages Demo version released. FhG 2003-04-10
CDN Edge Services C Content Distribution Networks No specific work at the moment. Cisco 2003-01-16
DVTS Streaming C Application for sending and receiving Digital Video The source and binaries for DVTS on various platforms are available from the DVTS URL. UCL 2003-01-16
Edge Server Edge Services C IBM Edge Server Porting to IPv6 in progress. IBM 2003-01-16
EGP Gaming No Experimental Gaming Platform Sony has stopped working on EGP. This activity has been dropped. Sony 2003-03-27
FreeAMP Streaming A/B Free unicast/multicast MP3 player The code has been released on the web. Both a unicast and a multicast MP3 source will be activated in a network which will be available to all 6Net partners. GARR 2003-01-24
FunnelWeb E-business C Application level active services Implemented as a Java application. Available on request within the project. UCL 2003-01-16
Globus E-business C GLOBUS toolkit (Grid) Release 2.0 available. Globus 3.0 is expected early 2003. 6NET expectation is to get IPv6 support enabled as a patch for Globus 2.0, later as an integral part of Globus 3.0. UCL 2003-01-16
GnomeMeeting Streaming C Open source H323 Linux application Deployment and support in progress for Greek Research Network community GRNET 2003-02-05
Internet
Start
14:57

What did 6NET Prove?

- IPv6 is ready for usage
- IPv6 is stable
- IPv6 makes life easy
- IPv6 advanced network services are available (QoS, Mobile IPv6, etc…)

6NET Follow-on Work

- Research on ‘IPv6 Closed User Group’
- Getting IPv6 Services to end-points (i.e. Greek School Network)
- Collaboration Projects:
  - SILK
  - SEEREN
  - EGEE
  - IPv6 Renumbering

- Transfer of Information:
  - IPv6 Book
  - IPv6 tutorials (Belgrade, …)
  - IPv6 Tiger Team
  - 6DISS (workshops, e-learning)
  - Hardware kit for TOI usage

Greek School Network

Backbone: Based on 7 PoPs of GRNET

Distribution Network : 51 nodes

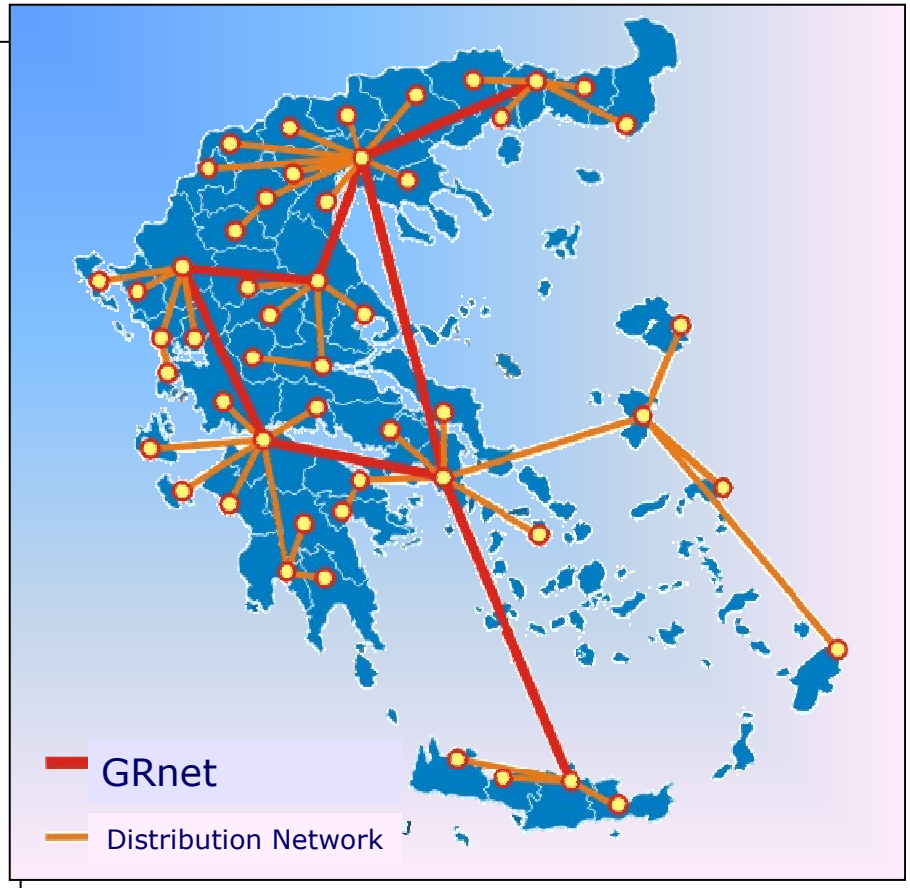
- 9 main
- 42 secondaries

75 routers, 71 servers,

Current Access Network technology:

PSTN, ISDN, Leased Lines, Wireless nodes, VDSL, ADSL - Links

6K Primary and 3.7k Secondary schools already connected !

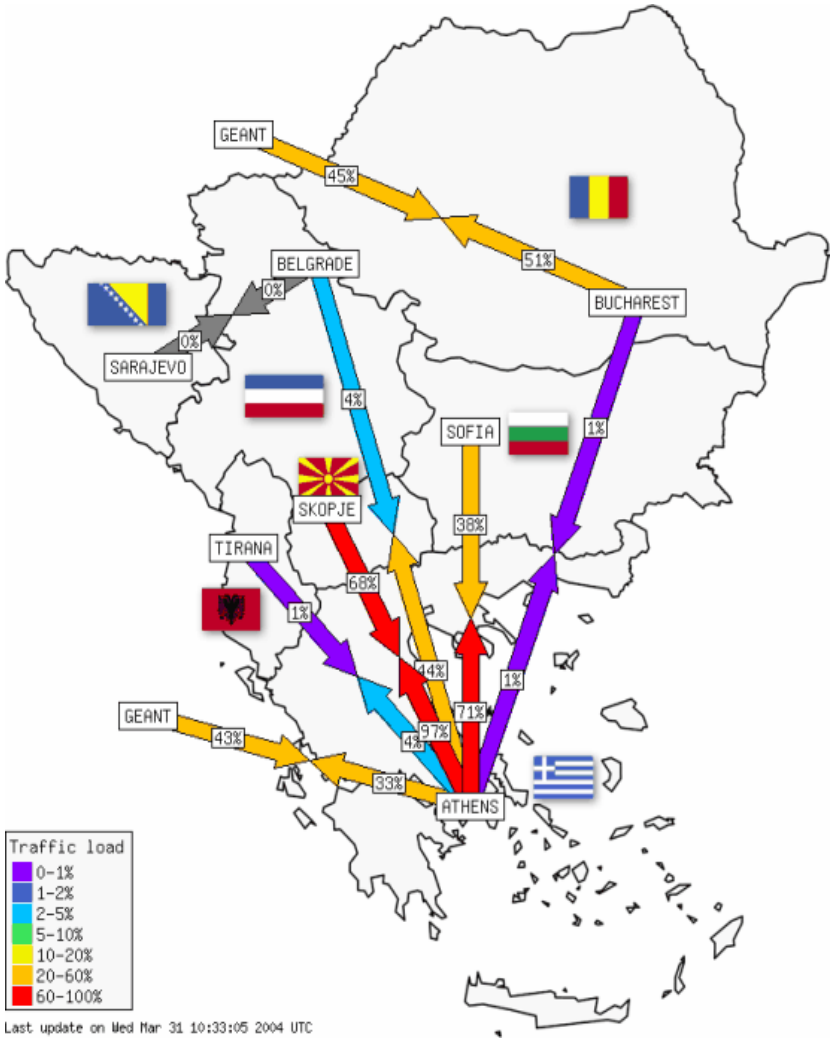


www.sch.gr

Balkans

SEEREN
SOUTH EASTERN EUROPEAN RESEARCH & EDUCATION NETWORKING

- SEEREN → South-Eastern European Research and Education Networking Initiative
- Interconnects the Research and Education Networks of Albania, Bosnia-Herzegovina, Bulgaria, FYROM, Hungary, Serbia-Montenegro, Romania and Greece among them and to GEANT.
- Built in 2003, launched and entered its stable operation on Jan. 2004
- Constitutes today the South Eastern European segment of the multi-gigabit pan-European Research and Education network GÉANT
- Initial seed funding by the EC/IST programme (1.3 m€). Additionally around 4 m€ pulled together in various complementary (sub)-projects (FP6, NATO, National funds, etc.).



Conclusions

Conclusions

- What do we want networks to do ?
- What are the factors that influence how networks evolve ?
- QoS and the EU project EuQoS
- IPv6 deployments and information sources (the EU project 6NET)

Conclusions

Several key messages have been identified relating to NGNs:

1. How networks evolve
2. User behaviour and usage trends
3. Ambient Intelligence
4. Where convergence makes sense
5. Broadband and mobility
6. IPv6
7. External influences

Conclusions

A summary of some of the key technologies for NGNs would have to include:

- middleware and distributed systems (to enable Service Provider - Network Provider separation)
- IP: IPv6, broadband, QoS, security, mobile and wireless
- multi-domain network management (for seamless roaming and QoS support)
- seamless interworking between core and access networks
- micro and opto-electronics
- cross-media content
- multi-modal and adaptive interfaces
- multi-lingual dialogue mode
- embedded intelligence

Conclusions

- facilities for (mobile) transitioning between networks owned by different providers mid-session (and the corresponding charging issue)
- QoS may be demanded from the network or, alternatively, accounted for by (adaptive) applications
- QoS parameters have to be agreed between Network Providers
- the same service used on a different terminal, or transmitted over a different access network, will require different QoS values
- QoS on IP has been a research topic for several years. However, practical deployments are starting now

Last Word …….

"If the automobile had followed the same development cycle as the computer, a Rolls-Royce would today cost $100 and get a million miles per gallon"

X. Cringely, InfoWorld magazine

"…… and crash once a week"

Martin Potts

Thank you for your attention