The Pan-European IPv6 IX Backbone
Towards deployment of IPv6
in Telcos / ISPs

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Caracas, May 2005

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Euro6IX: The Concept

- How to pronounce it: forget IX and read 6 ("SIX")

- Build a large, scalable and native IPv6 Backbone of Traffic Exchanges, with connectivity across Europe and other IPv4/v6 Exchangers
- In order to promote and allow other players to trial v6 and port/develop key applications and services
- In order to break the chicken and egg issue !
- Gain REAL IPv6 experience, in a real world with not just research users, involving Telcos/ISPs/ASPs, among others: Allow new players into our trials
- Bring IPv6 into a production transit service

Euro6IX Goal

- Support the fast introduction of IPv6 in Europe.
- Main Steps:
  - Network design & deployment
  - Research on network advanced services
  - Development of applications validated by user groups & international trials
  - Active dissemination:
    - participation in events/conferences/papers
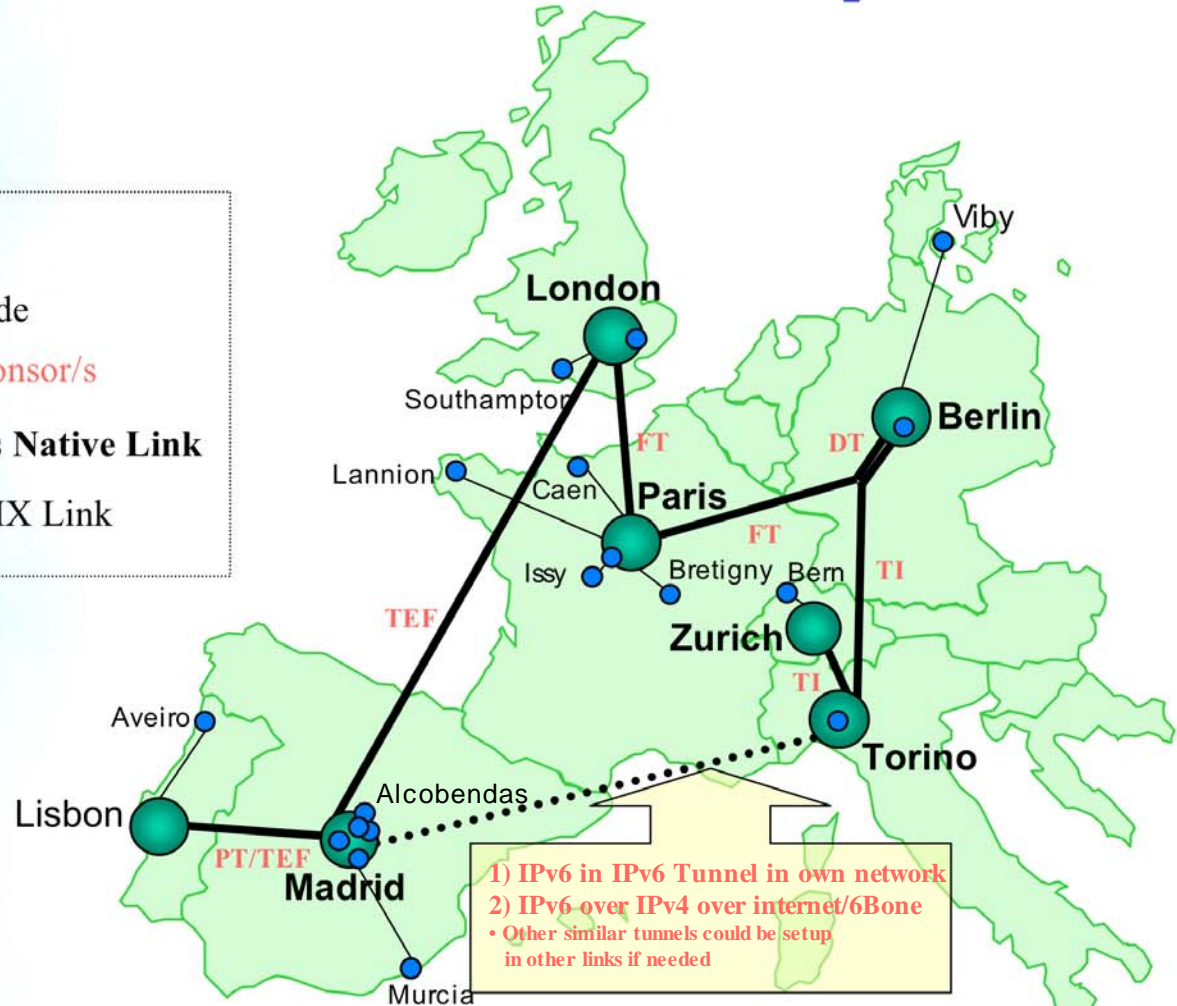   - contributions to standards
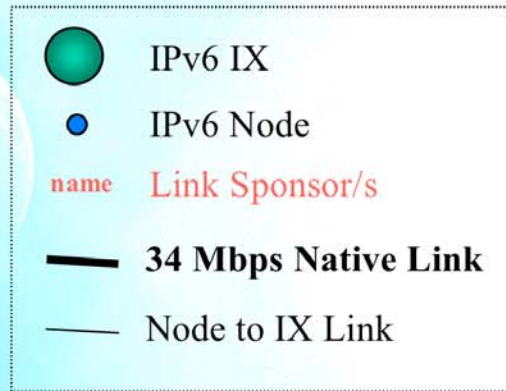   - project web site

Objectives

1. Research an appropriate architecture, to design and deploy the first Pan-European non-commercial IPv6 Internet Exchange Network.

2. Use this infrastructure to research, test and validate IPv6-based applications & services.

3. Open the network to specific User Groups for its validation in trials.

4. Dissemination, liaison and coordination with clusters, fora, standards organizations (e.g. IETF, RIPE) and third parties.

Consortium Members (17)

- Telcos/ISPs (7):
  - Telecom Italia LAB (WP2 leader), Telefónica I+D (WP3 leader and project coordinator), Airtel-Vodafone, British Telecom Exact, T-Nova (Deutsche Telecom), France Telecom RD, Portugal Telecom Inovação

- Industrial (2):
  - 6WIND, Ericsson Telebit

- Universities (3):
  - Technical University of Madrid (WP4 leader), University of Southampton, University of Murcia

- Research, System Integrators and Consultancy (3):
  - Consulintel (WP1 leader and project coordinator), Telscom (WP5 leader), novaGnet systems

- Others (2):
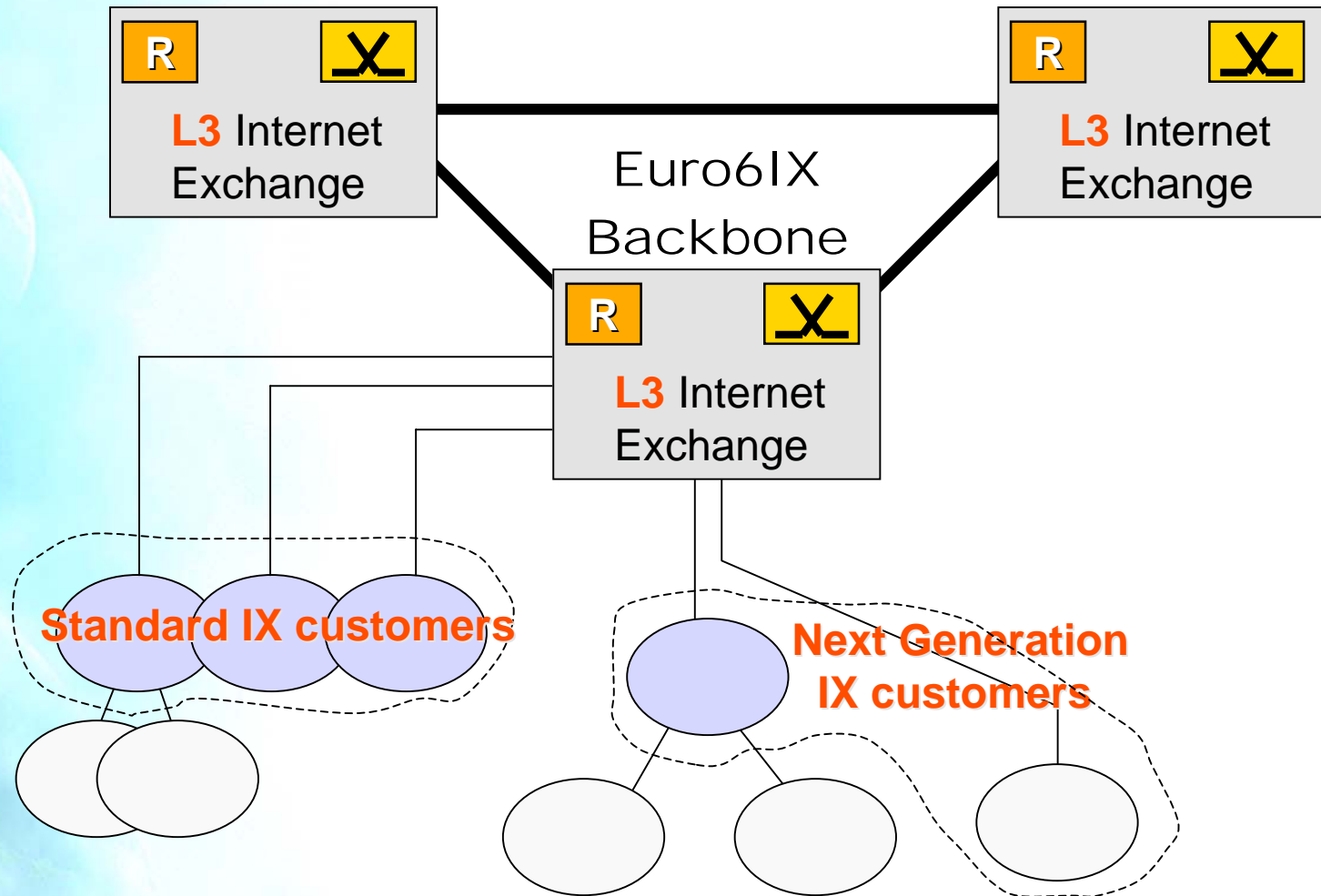 - Écija & Asociados Abogados, Eurocontrol

Updated Network Map

IPv6 IX

IPv6 Node

name   Link Sponsor/s

34 Mbps Native Link

Node to IX Link

Viby

London

Southampton

Lannion

Caen   **Paris**   FT

Issy   Bretigny Bern

Berlin

FT   DT

FT   TI

Zurich

TI

TEF

Aveiro

Alcobendas

Lisbon

Torino

PT/TEF

Madrid

1) IPv6 in IPv6 Tunnel in own network
2) IPv6 over IPv4 over internet/6Bone
• Other similar tunnels could be setup
  in other links if needed

Murcia

Euro6IX
IPv6: The New Internet

Information Society
Technologies

- 6

Layer 3 IX

- Infrastructure providing both layer 2 and layer 3 interconnection service.

- Several IXs can make direct peering offering also Wide Area Layer 3 transport as an Internet Service Provider. Every IXs will use an assigned xTLA prefix (x=p or s) to assign NLA prefixes to ISPs or customers connecting to the IX.

- Project partners will use their xTLA prefix to assign NAL to customers and regional ISP connecting to IX.
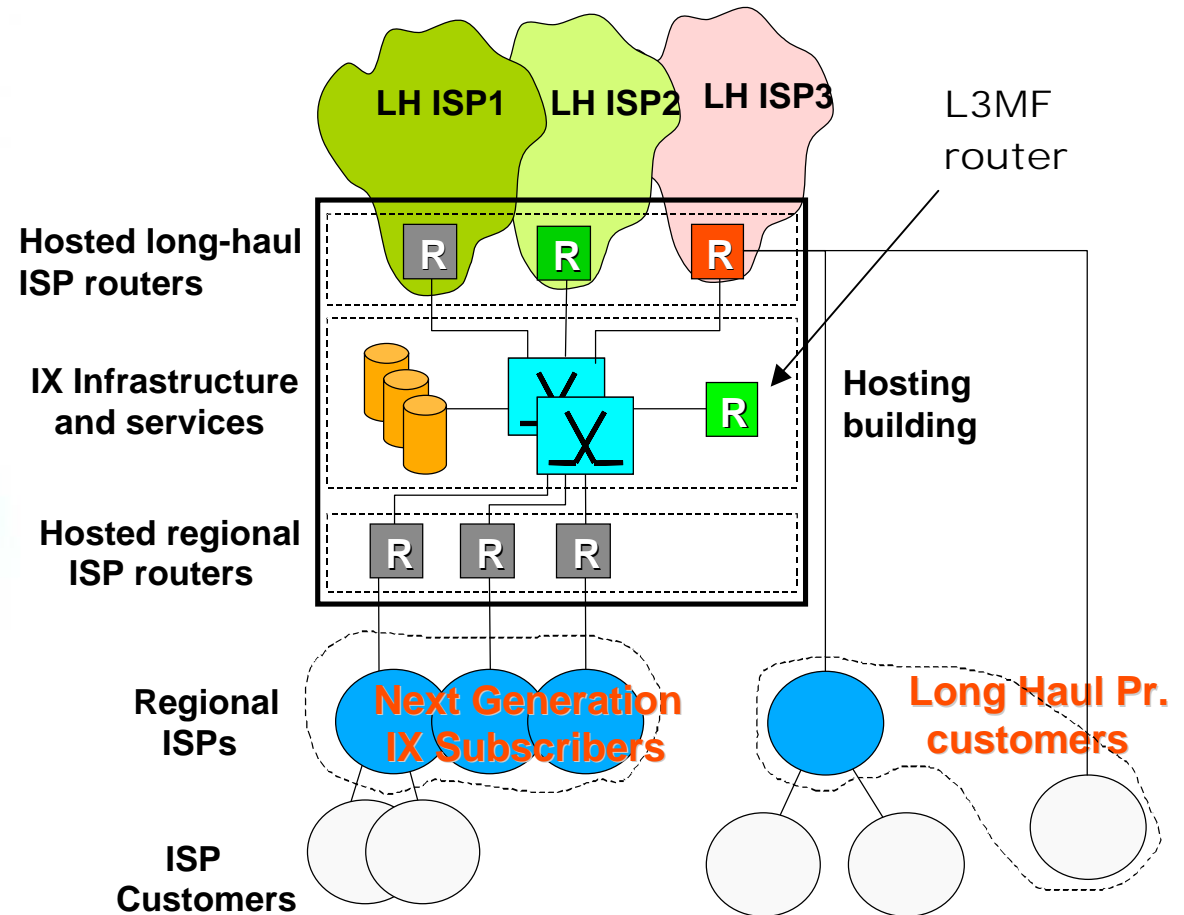
Layer 3 IXs Network Architecture

R **X**
L3 Internet Exchange

R **X**
L3 Internet Exchange

Euro6IX
Backbone

R **X**
L3 Internet Exchange

Standard IX customers

Next Generation IX customers

IX Model C

- L2 infrastructure (fully redundant) where the IX services are placed

- Routers infrastructure (long-haul providers and customers)

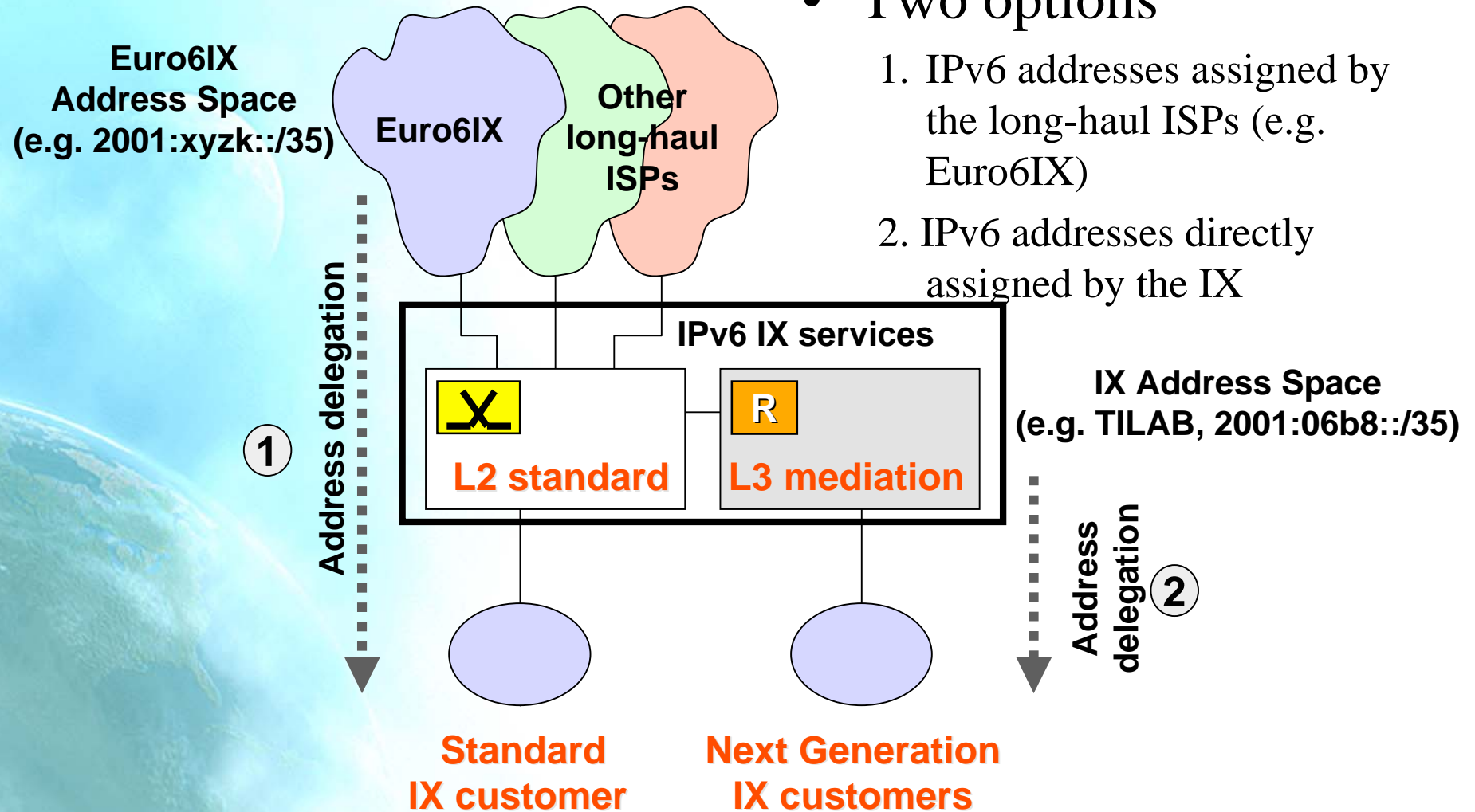- Layer 3 mediation function router (L3MF) is the real new element of this model

LH ISP1 LH ISP2 LH ISP3

L3MF router

Hosted long-haul ISP routers

R R R

IX Infrastructure and services

R

Hosting building

Hosted regional ISP routers

R R R

Regional ISPs

Next Generation IX Subscribers

Long Haul Pr. customers

ISP Customers

RFC2374 Benefits

- This model is based on the RFC 2374 to verify that:
  - a customer could change its service provider without changing its addressing space
  - the renumbering functionality could be realized more easily (no renumbering in the better case)
  - the multihoming functionality could be realized more easily

- IX plays an intermediation role between the ISP and the customers (Layer 3 mediation function router)

- Routing:
  - iBGP+IGP: inside the Long Haul Provider
  - Euro6IX is the collection of the routers inside the IX emulating the LHP (single AS)
  - eBGP4+: between the customers and the IX
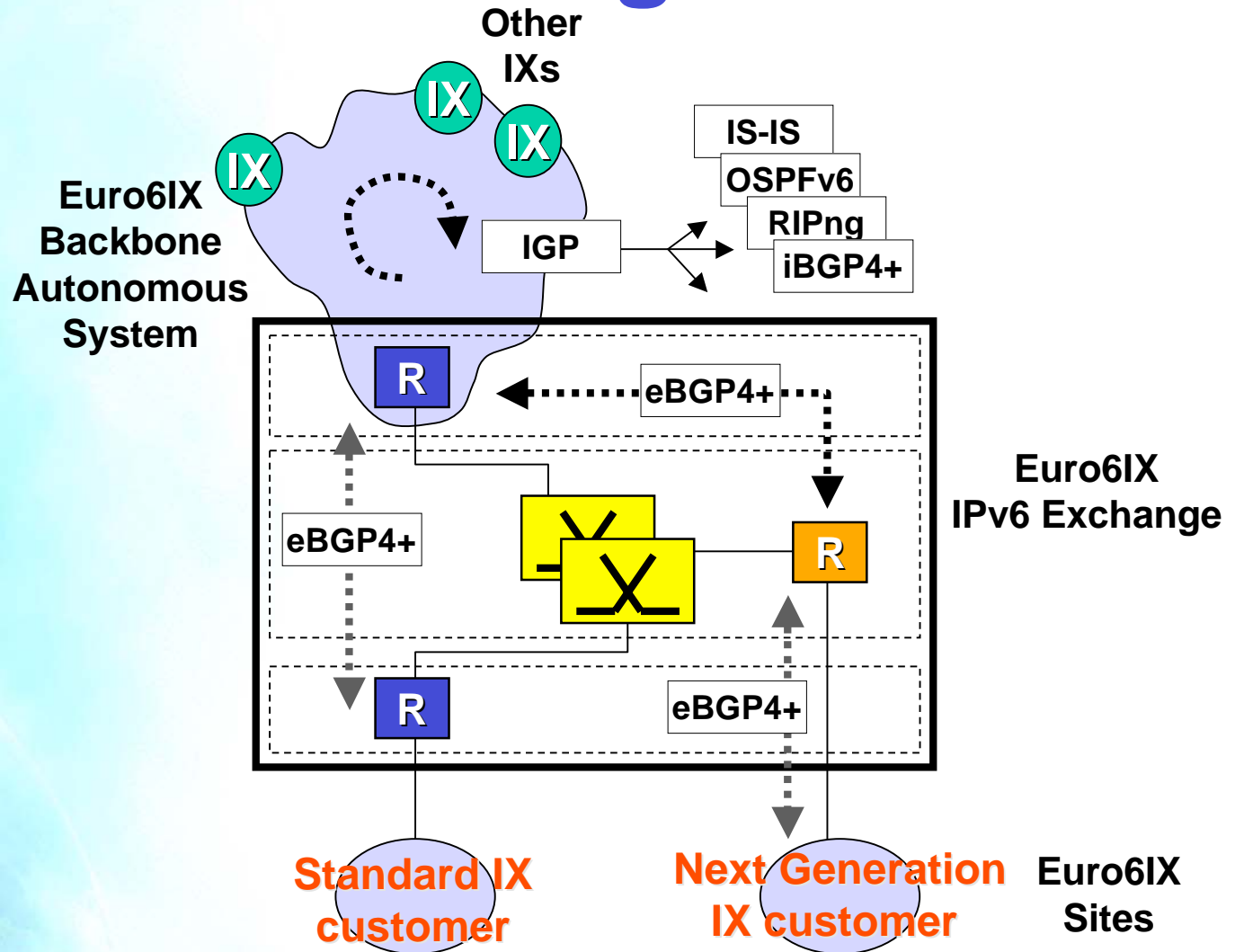 - eBGP4+: between the IX and the LHPs

Address Assignment

Euro6IX Address Space (e.g. 2001:xyzk::/35)

Euro6IX

Other long-haul ISPs

Address delegation

①

IPv6 IX services

X

L2 standard

R

L3 mediation

IX Address Space (e.g. TILAB, 2001:06b8::/35)

Address delegation

②

Standard IX customer

Next Generation IX customers

- Two options
  1. IPv6 addresses assigned by the long-haul ISPs (e.g. Euro6IX)
  2. IPv6 addresses directly assigned by the IX

Routing

Other IXs

Euro6IX Backbone Autonomous System

IX IX IX

IGP

IS-IS
OSPFv6
RIPng
iBGP4+

R ←········ eBGP4+ ·······

Euro6IX IPv6 Exchange

eBGP4+

R

R eBGP4+

Standard IX customer

Next Generation IX customer

Euro6IX Sites

Mobility

- Definition of mobility scenarios for IPv6
- Identification of macro-mobility technologies to be used in the test-beds
- First Identification and evaluation of available implementations for macro-mobility for a common platform
- Selection of access technologies to be used in the test-beds
- Every participant will design their own access network based on the available implementations identified before.

Static and Dynamic VPNs with IPv6

- To evaluate the current status of the main open source IPsec/IKE implementations and some commercial IPsec/IKE solutions

- To deploy of a static VPN service in the Euro6IX test-bed

- Configuration and installations guides for IPsec/IKE

- Test reports of interoperability and conformance

UMU – PKIv6 Description

- Main Objective: Establish a high security infrastructure for distributed systems

- Main Features:
    - PKI supporting IPv6
    - Developed in Java ➔ Multiplatform
    - Issue, renew and revoke certificates
    - Final users can use either RAS or Web
    - LDAPv6 directory support
    - Use of smart cards (file system, RSA or Java Cards) ... allowing user mobility and increasing security
    - PKI Certification Policy support
    - VPN devices certification support (using the SCEP protocol)
    - Support for the OCSP protocol and Time Stamp
    - Web administration

UMU – PKIv6 Architecture

LDAP Server

End User

VPN Device

Administrator

Certification Authority

WWW Secure Request Server

Registration Authority

IPv6 Plain connection
IPv6 SSL connection
SCEP over IPv6

Data Base

https://pki.ipv6.um.es
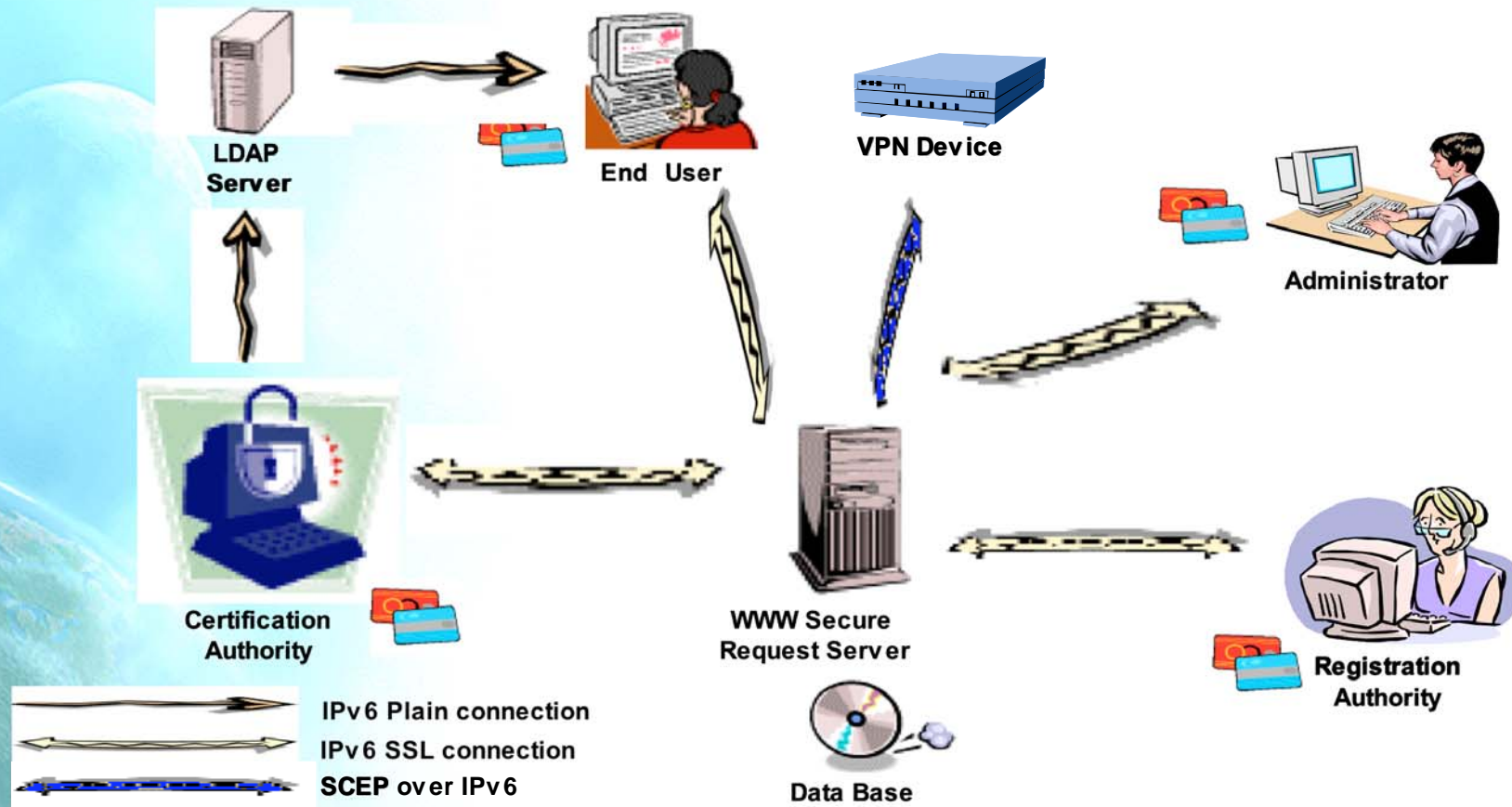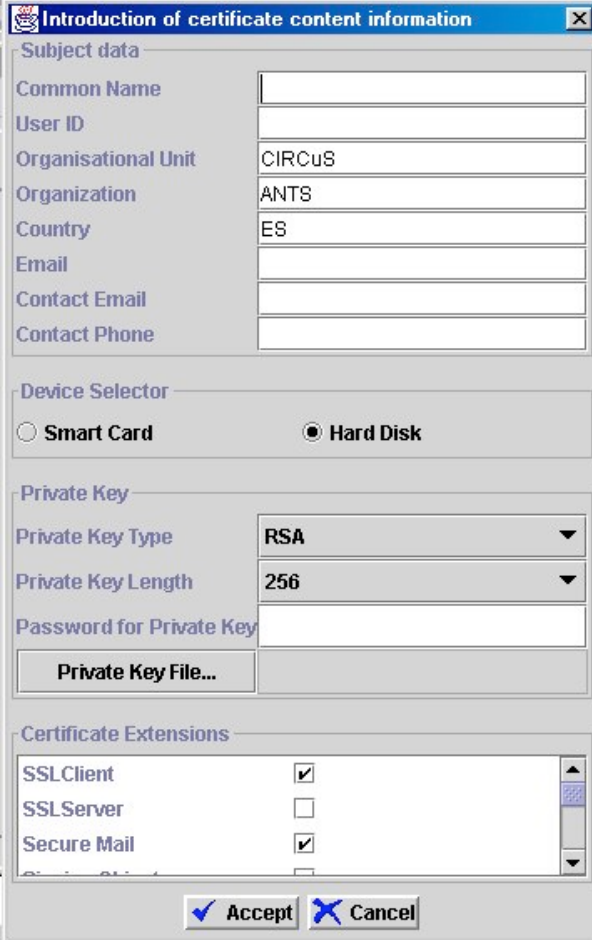
UMU – PKIv6 Advanced Services
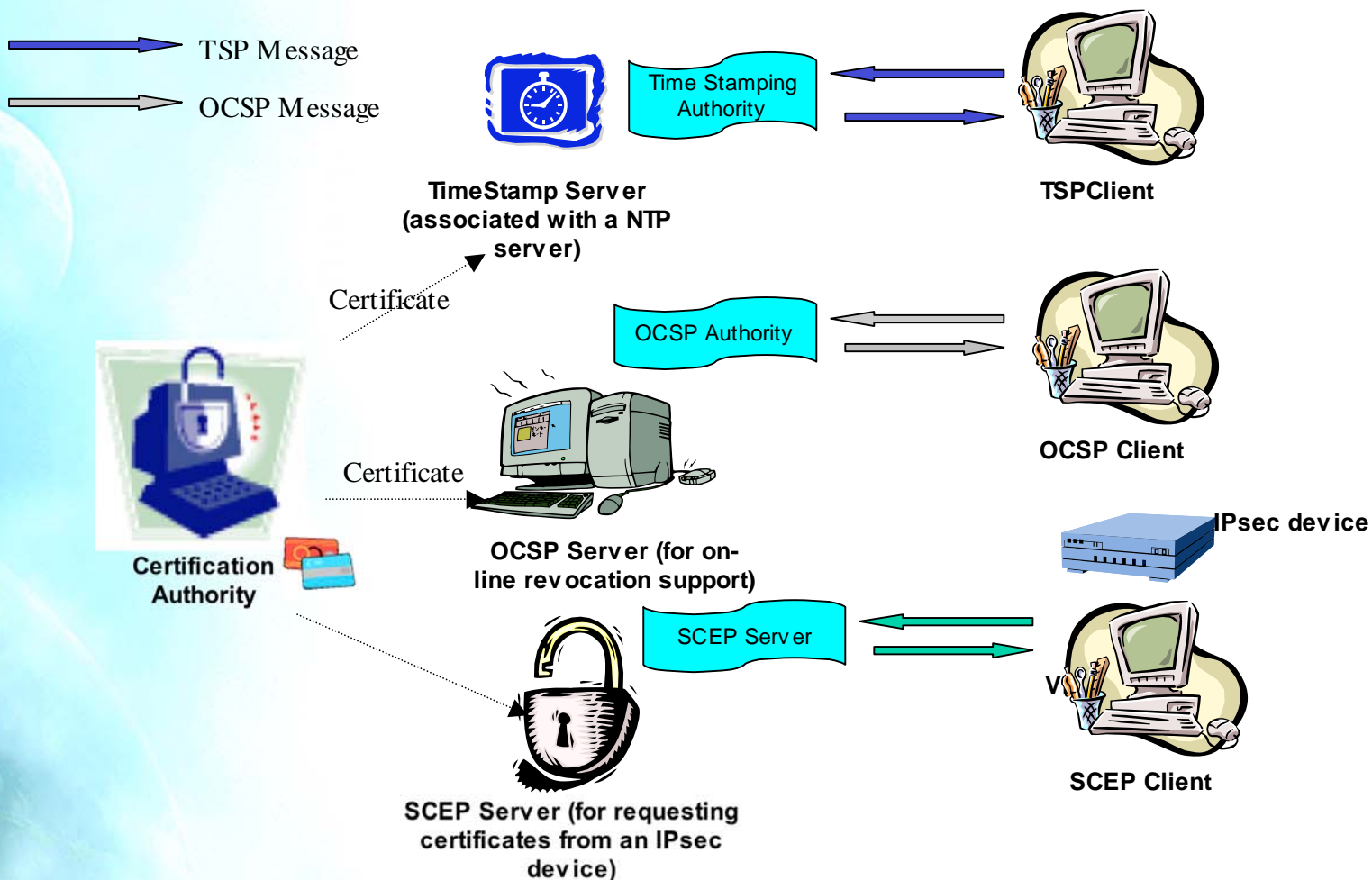
→ TSP Message

→ OCSP Message

TimeStamp Server (associated with a NTP server)

Time Stamping Authority

TSPClient

Certificate

Certification Authority

OCSP Authority

OCSP Client

Certificate

OCSP Server (for on-line revocation support)

IPsec device

SCEP Server

V

SCEP Client

SCEP Server (for requesting certificates from an IPsec device)

UMU – PKIv6 RA Snapshot
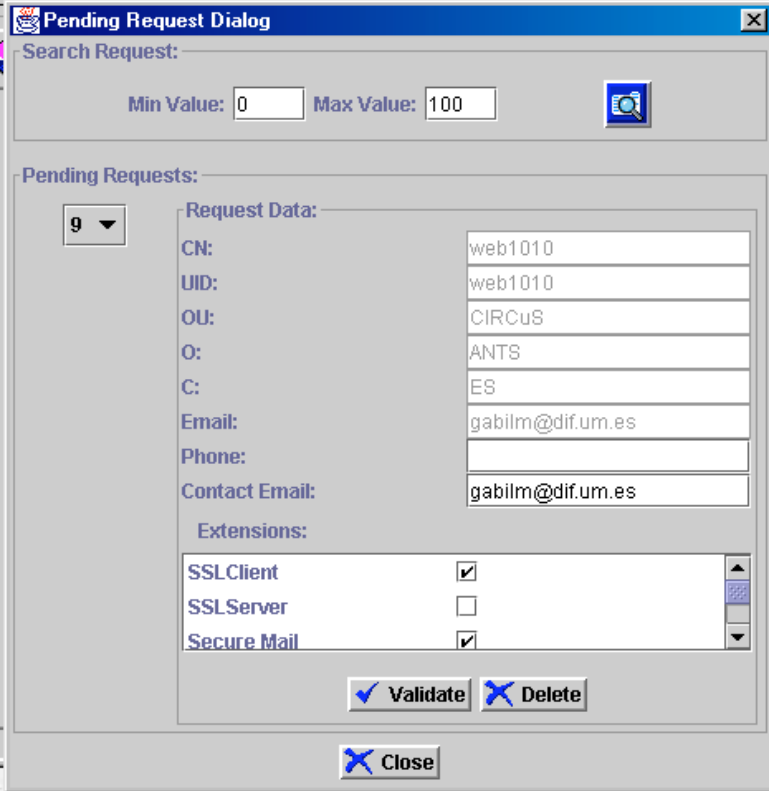
Requesting a certificate

Validating a certificate

UMU – PKIv6 CA Snapshot
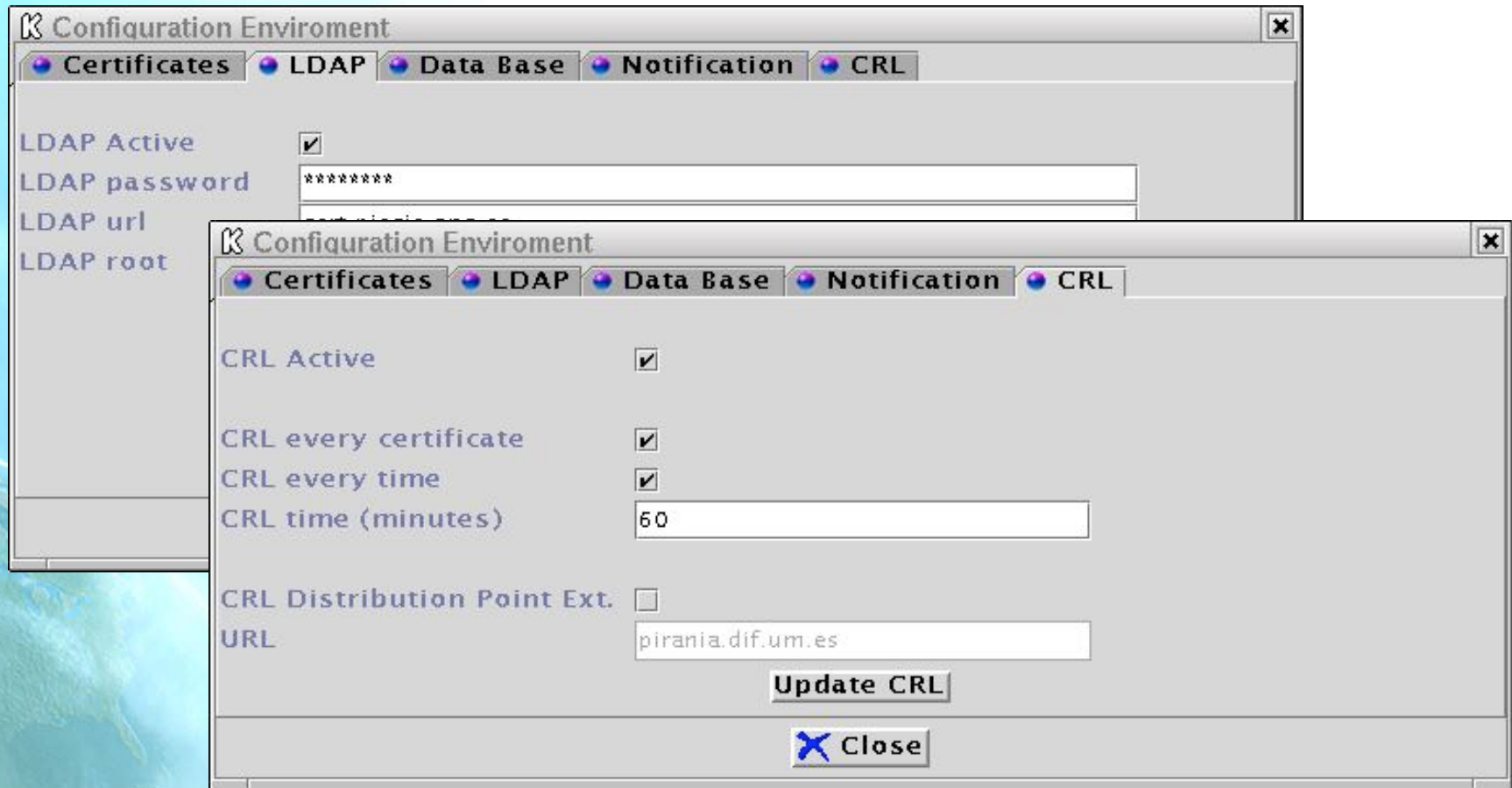
CA Internal Management Process

Other Applications

- Messaging Systems:
  – Peer-to-peer

- Audio and video-conferencing:
  – Include multi-conference and collaboration

- Web mail tools

- VNC over IPv6

- Network Management, Analysis, test & diag:
  – IPv6 Network Management Tool (Magalia)
  – Intrusion Detection System
  – Route Server

IX Based Services

- IX becomes a place where new services are offered to the users.

- IX is an aggregation point, so it can provide those services who can benefit by this "user aggregation" (e.g. in a based multicast network, the RP could be located inside the IX, because a lot of users connect to it).

  - Network Services
    - Multicast, AAA, QoS, DNSSec
    - Transition Mechanisms: NAT-PT, Tunnel Broker, 6to4
    - Route Server mechanism
  - Application Services
    - HTTP, FTP, SMTP
    - VideoConference/e-learning services
    - P2P applications
  - Monitoring Services
    - Routing/Traffic/Reachability Monitoring (Magalia, AS-Path tree, Looking Glass)
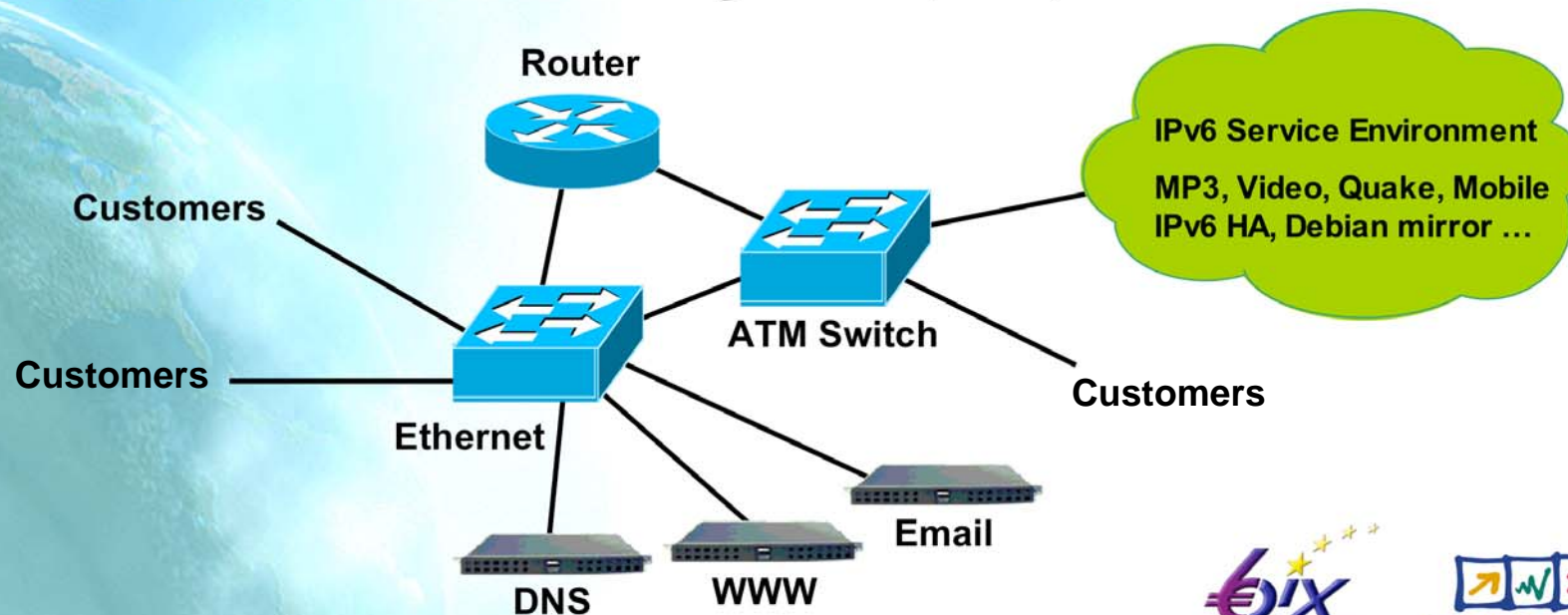
The UK6x (LON6IX)

- Layer 2 & 3 IPv6 Internet exchange
- First in the UK
- Uses commercial IPv6 addresses
- Located at the heart of the UK Internet – Telehouse
- Open to all
- Primary aims are:
  - to stimulate the IPv6 environment in the UK, Europe and the World
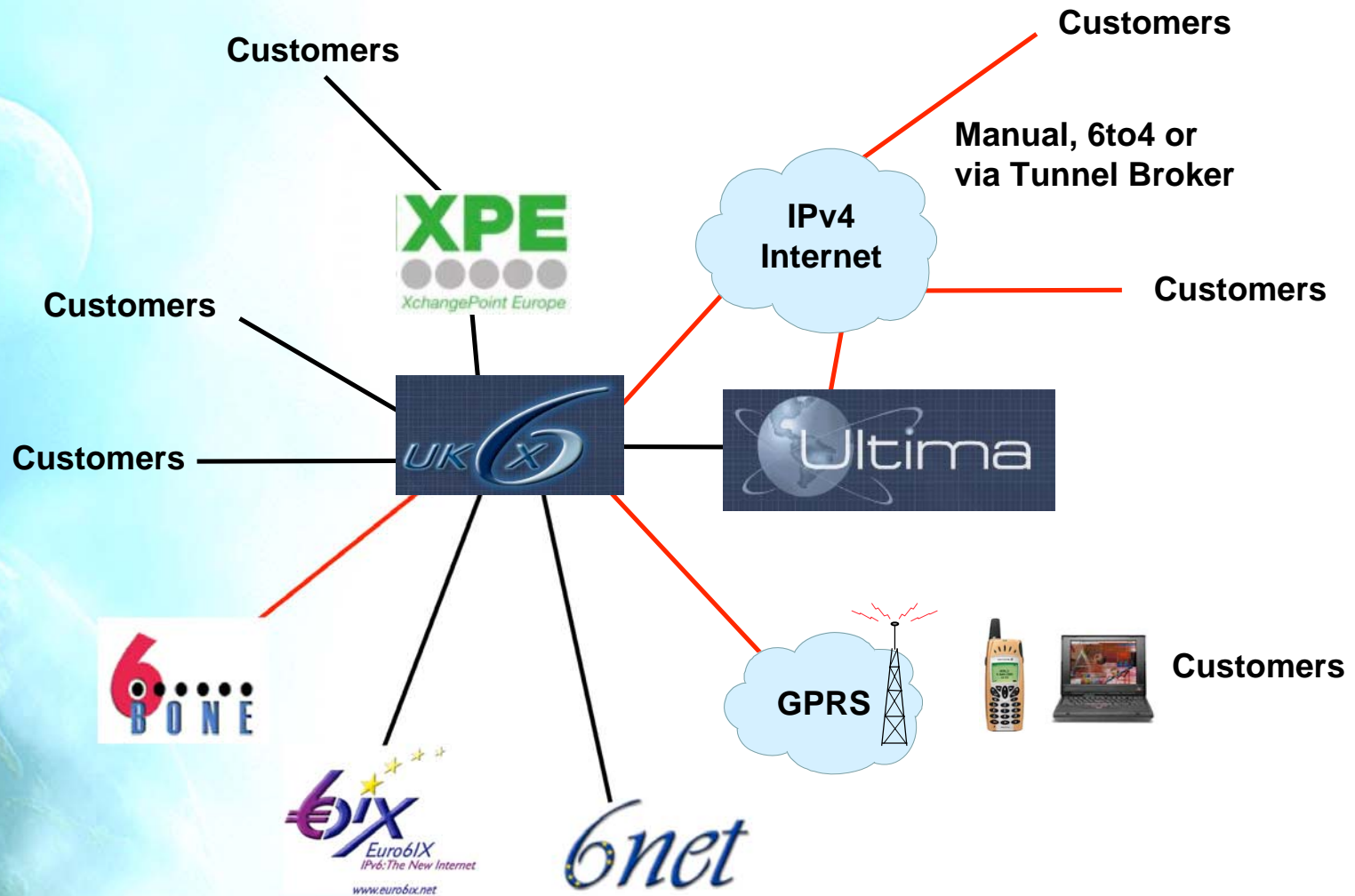 - to further the understanding of IPv6

UK6x Core Architecture

- Ethernet switch for Layer 2 peering
- ATM switch for additional customer access mechanisms
- Router for Layer 3 functionality
- 2001:618::/32 used for address allocation
- 2001:7F8:2::/48 used for infrastructure
- Maintenance via Looking Glass, ASpath-tree etc.

Router

Customers

Customers

Ethernet

ATM Switch

IPv6 Service Environment

MP3, Video, Quake, Mobile IPv6 HA, Debian mirror ...
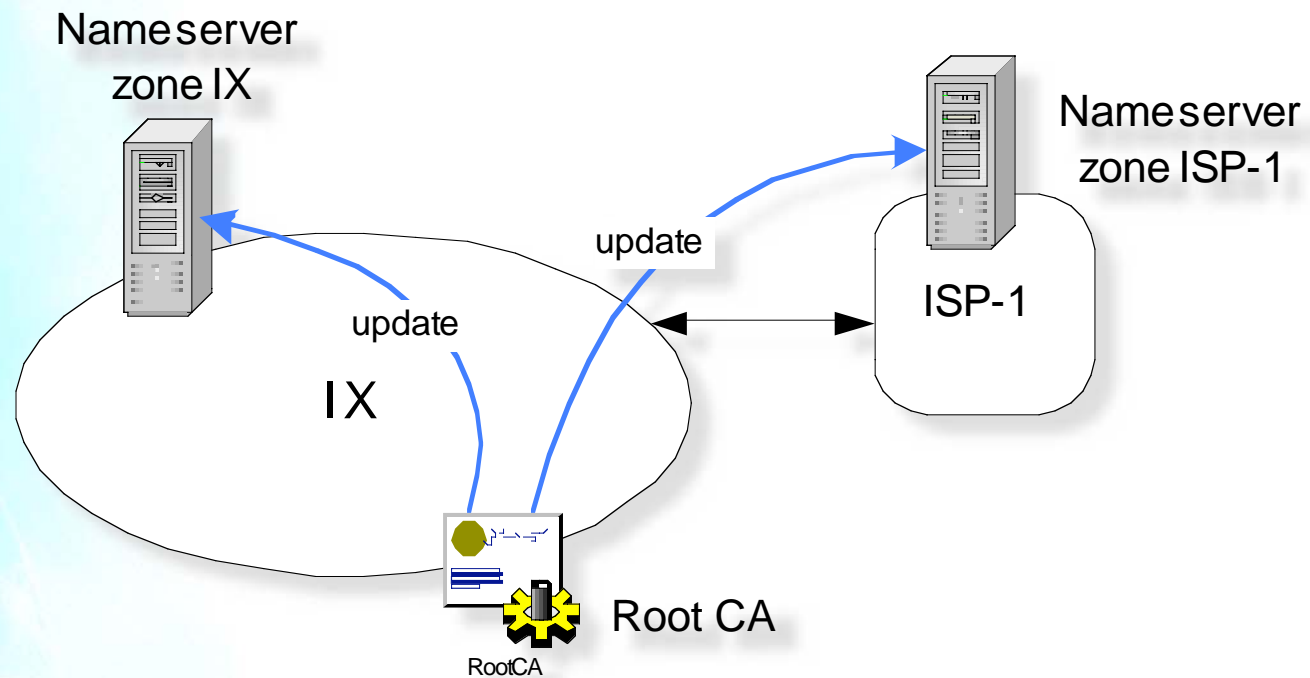
Customers

DNS

WWW

Email

DNSsec Services

- UPM is completing the DNS emulation environment
- Developing a complete set of DNSSEC example configurations using the emulation environment
- DNSSEC pilot work on setting-up and maintaining experiment between UMU, Consulintel and UPM
- Publishing certificates using DNSsec
  - Models analyzed to publish certificates:
    - TSIG Model: symmetric keys.
    - SIG Model: asymmetric keys.
  - Support in PKIv6:
    - PKIv6 supports TSIG Model
      - BIND 9.2.0 or newer for TSIG
    - PKIv6 will support SIG Model
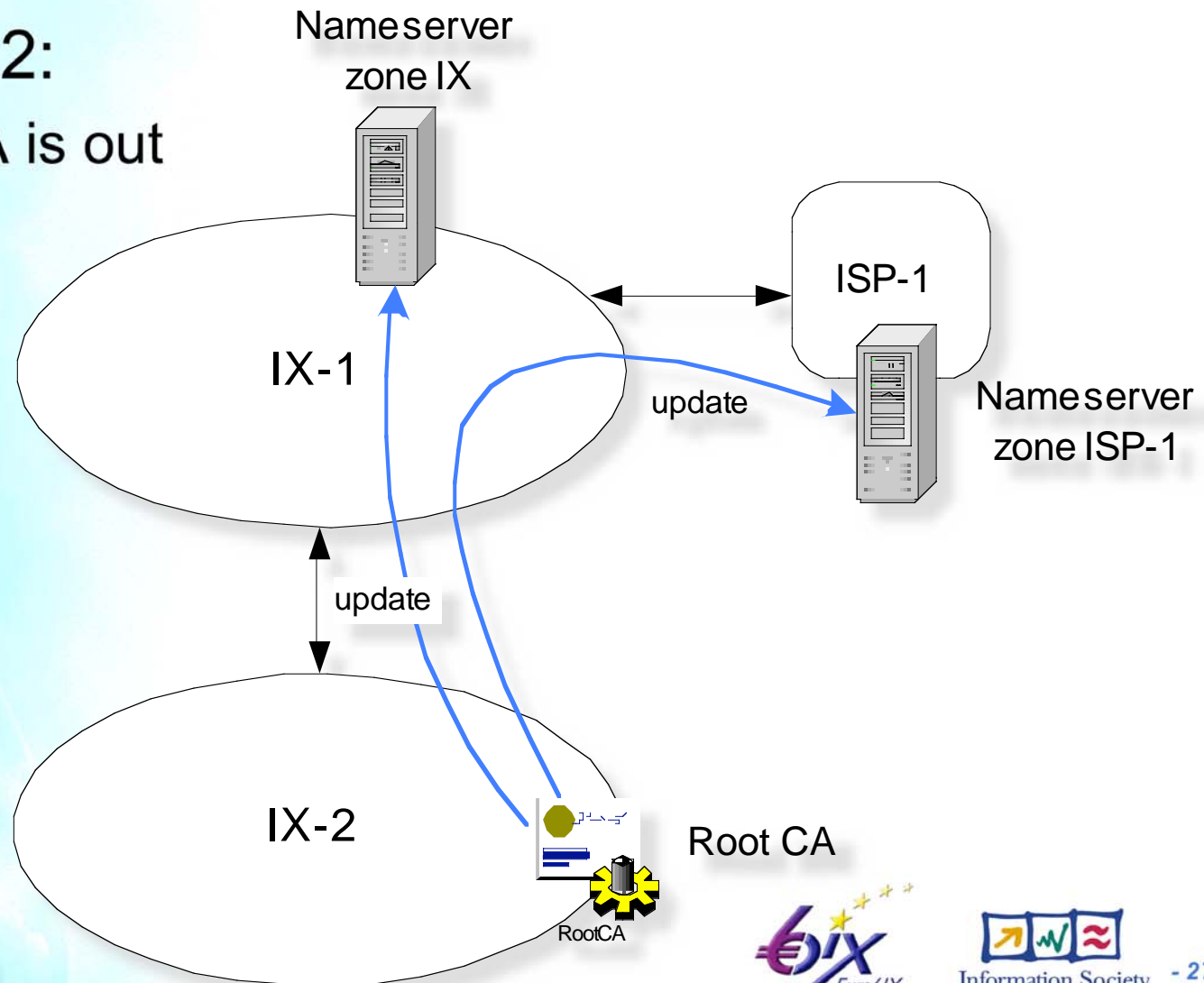   - BIND 9.3.0 (snapshot) for SIG(0)

IX service PKIv6 to publish certificates using DNSSEC

- Scenario 1:
  - Root CA and Name Server are together in the IX

Nameserver
zone IX

Nameserver
zone ISP-1

update

update

IX

ISP-1

Root CA

RootCA

IX service PKIv6 to publish certificates using DNSSEC

- Scenario 2:
  - Root CA is out

Nameserver zone IX

IX-1

ISP-1

update

Nameserver zone ISP-1

update

IX-2

Root CA

RootCA

Security Framework

- General VPN Policy Definition. Tools VPNEtool
- Tested with UCL in 6NET-Euro6IX collaboration
- 6WIND VPN Enforcement element working, and being tested by 6WIND
- CISCO: Waiting CISCO IOS version that could be accessible with support for IPsec for IPv6. Actually working with IPv4

Instant Messaging v1

- Jabber based
- Developed using Java
- Up to now, we have
  - Deployed and debug the Jabber IM server
  - Developed the GUI based IM client
  - Debugged the interaction of IM client and IM server
  - Migrated to IPv6 Internet
- IM Services include:
  - User management:
    - register/unregister; login/out;
  - Roster management:
    - add/delete friends
  - Messaging
  - Presence management
  - Group management:
    - join/leave group
  - Group chat

Instant Messaging v2

- Client relayed multicast messaging
  - based on the Jabber address scheme
  - some clients can be configured to relay the chat messages
  - balance the store-forward load on the IM server
  - easily integrated to IM version 1
  - prototype implemented

VOCAL

- Porting was undertaken within the Euro6IX project (www.euro6ix.org)
  - But also in conjunction with 6NET (www.6net.org)
  - Work done by a researcher between degree and PhD
  - Being used in 6NET, 6WINIT and Euro6IX
  - Quality of VoIP depends largely on latencies in hardware
- Now moving to VOCAL+ENUM integration
  - A lot of issues to be sorted out

Certification Publish and Request with DNSsec


```
[root@shire root]# dig CERT manuel.umu.euro6ix.org

; <<>> DiG 9.2.1 <<>> CERT manuel.umu.euro6ix.org
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 55523
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 0

;; QUESTION SECTION:
;manuel.umu.euro6ix.org.                IN      CERT

;; AUTHORITY SECTION:
umu.euro6ix.org.        3600    IN      SOA     dns.umu.euro6ix.org. gabilm.dif.um.es. 200210300 3600 600 8640

;; Query time: 10 msec
;; SERVER: 155.54.95.19#53(155.54.95.19)
;; WHEN: Mon Oct 13 18:29:14 2003
;; MSG SIZE  rcvd: 96

[root@shire root]# dig CERT manuel.sigz.umu.euro6ix.org
;; Truncated, retrying in TCP mode.

; <<>> DiG 9.2.1 <<>> CERT manuel.sigz.umu.euro6ix.org
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 43522
;; flags: qr rd ra; QUERY: 1, ANSWER: 6, AUTHORITY: 1, ADDITIONAL: 1

;; QUESTION SECTION:
;manuel.sigz.umu.euro6ix.org.    IN      CERT

;; ANSWER SECTION:
manuel.sigz.umu.euro6ix.org. 3600 IN    CERT    PKIX 16 0 TU1JREhEQONBb1dnQXdJQkFnSUJFREFOQmdrcWhraUc5dzBCCQVFR
d0pGVXpFUQOKTUEOROExVUVDaE1IW1hWeWJ6 WnBlREVWTUJNROExVUVDeE1NW1hWeWJ6WnBlQOIwW1hOME1SVXdFd11E V1FRRAOKRXd4RFFT
URNdO9URXhhNVEkx TXpJNFdoYO5NRFF3T1RFdO1USTFNekkOV2pCVQQKTVFzdONRWURWUVFH RXdKR1V6RVFNQTRHQTFVRURNoTUhaWFZ5Ynpac
FZ5YnpacAOKZUNCMFpYTjjBNUnd3R2dZRFZRUURFeE5RRY25WbFlt RWdUbVYwYzJOaGNHVWdMUOF4TUZ3dORRWUpLb1pJaHZjTgOKQVFFQkJR Q
FIQ1g3RVBhWDFxUzBqWXNobEx3MExB ROpNekJlVmozSmZpdXh4VQOKWVFxcko0a2puMkc3cU8rMnQ4U3hOaERP bVJmT2pjFN3ZWM5YOpjQO
HQTFVZAOK SUFSSO1FZ3dSZ11JS3dZQkJRVUhBZOV3T2pBNEJnZ3JCZOVGQ1F jQOFS WXNhSF1wYORvdkwyZHZjbWR2Y2O5MAOKYUM1MWJYVXV
selkybHpMMk53Y3k4d2dhd0dDQ3NHQVFVFVRkJ3RUJCSUdm TU1HWwOKTURnRONDcOdBUVVGQnpBQ2hpeG9kSFJ3T2k4d1loyOX1aMjl5 YjNSbOx
Wnk5dwOKYVhOamFYTXZZZV2xo THpCZOJnZ3JCZOVGQ1F jdOFZW1VhSFIwYORvdkwyZHZjbWR2Y2O5MGFD NTFiWFV1W1hWeQOKYnpacGVDNXZ.j
1pY UXZjR2x6WTJsekxuQnJhUzVqWVM1elpYSjjiR1YwY3k1UAOKUTFOUVVt Vnp.jRz11WkdWeU1CRUdDVONHUOFHRytFSUJBUVFFQXdJRThEQ
TFVZAOKRVFRYU1CaUNbTFoYm5WbGJJRU9iV2R3 TWtCaGGJJVXVkVzB1W1hNdORRWUpLb1pJaHZjTkFRRUVCUUFEZ11FFQQOK cnVWWG14UE4zb
VDL1RzbnlPMOFpTE1I Mnd.jblpLS1NZMngyY1doMTcOb3R4MAOKRU9VQ1hQcDhsTU5XYWd1MkRo OFR4ZF1UMXRLVXdrTFM5MG9.jWE9neE5WV1
hiTwOKVHddDR.jJuK1NLYm5ORXkzckZCaGpSNVRuSkJBd3BKUEU2OTRr aEp4eGpxNDO=
```
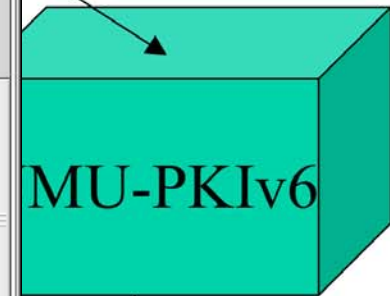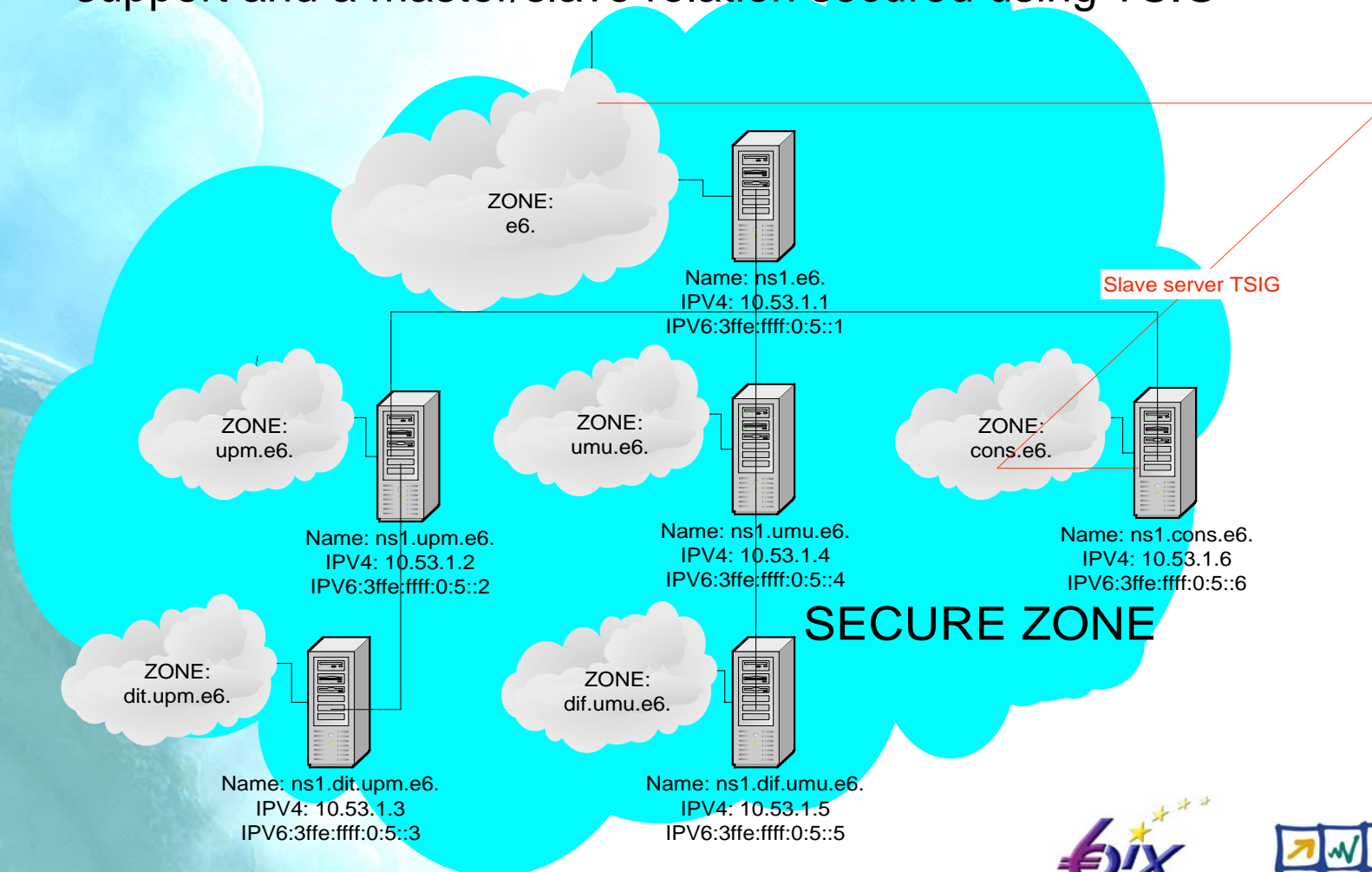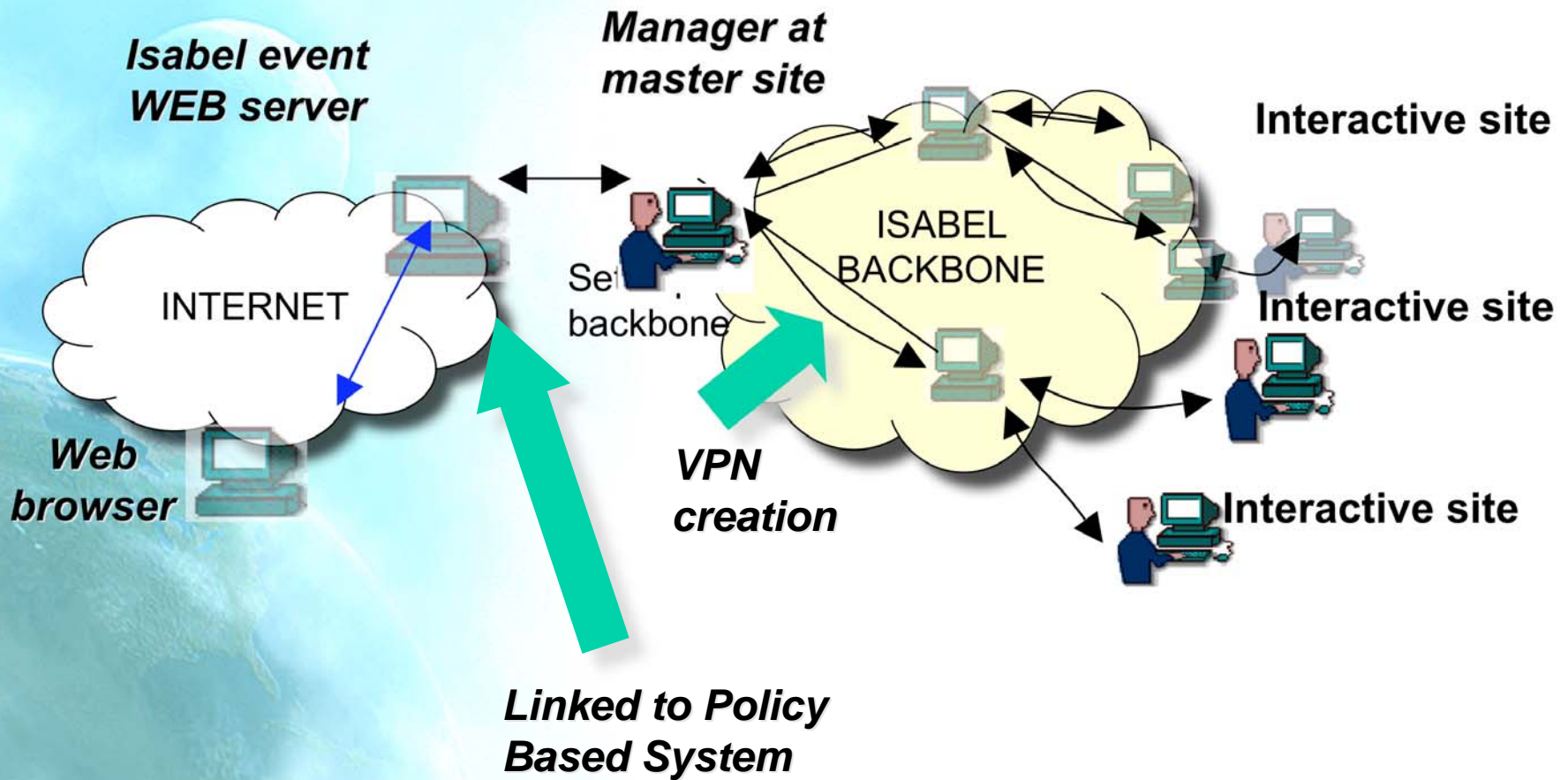
MU-PKIv6

DNSSec

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Scenario

- Complete DNSSEC hierarchy under .e6 with IPv6 and IPv4 support and a master/slave relation secured using TSIG

ZONE:
e6.

Name: ns1.e6.
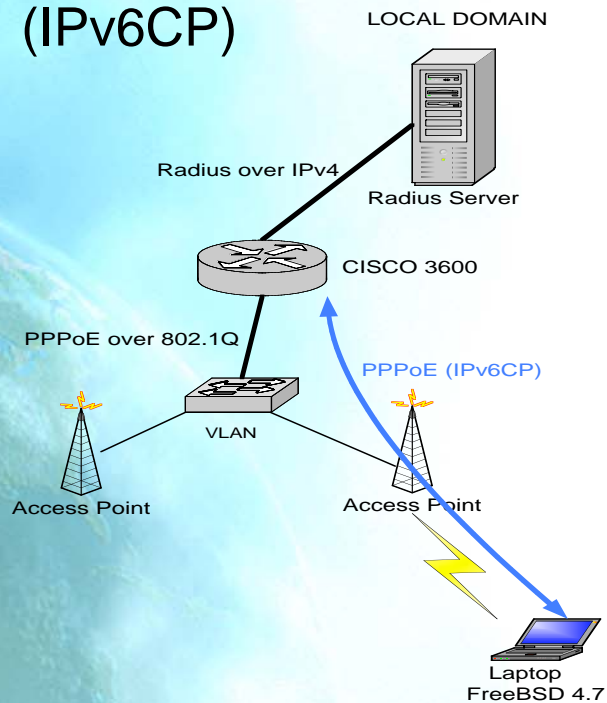IPV4: 10.53.1.1
IPV6:3ffe:ffff:0:5::1

Slave server TSIG

ZONE:
upm.e6.

Name: ns1.upm.e6.
IPV4: 10.53.1.2
IPV6:3ffe:ffff:0:5::2

ZONE:
umu.e6.

Name: ns1.umu.e6.
IPV4: 10.53.1.4
IPV6:3ffe:ffff:0:5::4

ZONE:
cons.e6.

Name: ns1.cons.e6.
IPV4: 10.53.1.6
IPV6:3ffe:ffff:0:5::6

ZONE:
dit.upm.e6.

Name: ns1.dit.upm.e6.
IPV4: 10.53.1.3
IPV6:3ffe:ffff:0:5::3

ZONE:
dif.umu.e6.

Name: ns1.dif.umu.e6.
IPV4: 10.53.1.5
IPV6:3ffe:ffff:0:5::5

SECURE ZONE

XEDL: Session Management Tool

Isabel event
WEB server

Manager at
master site

Interactive site

INTERNET

Se...
backbone

ISABEL
BACKBONE

Interactive site

Web
browser

VPN
creation

Interactive site
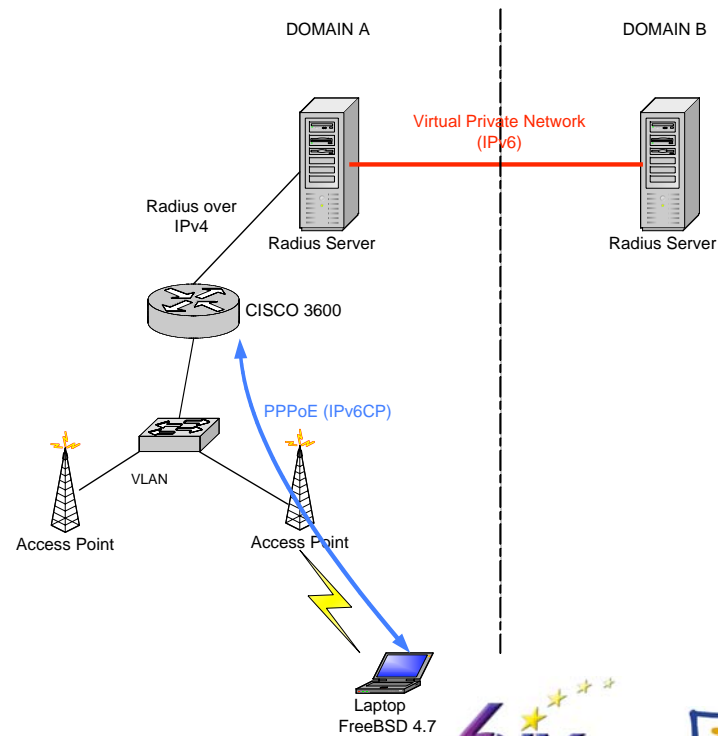
Linked to Policy
Based System

User Auth. DSL, PPP connections based on IPv6
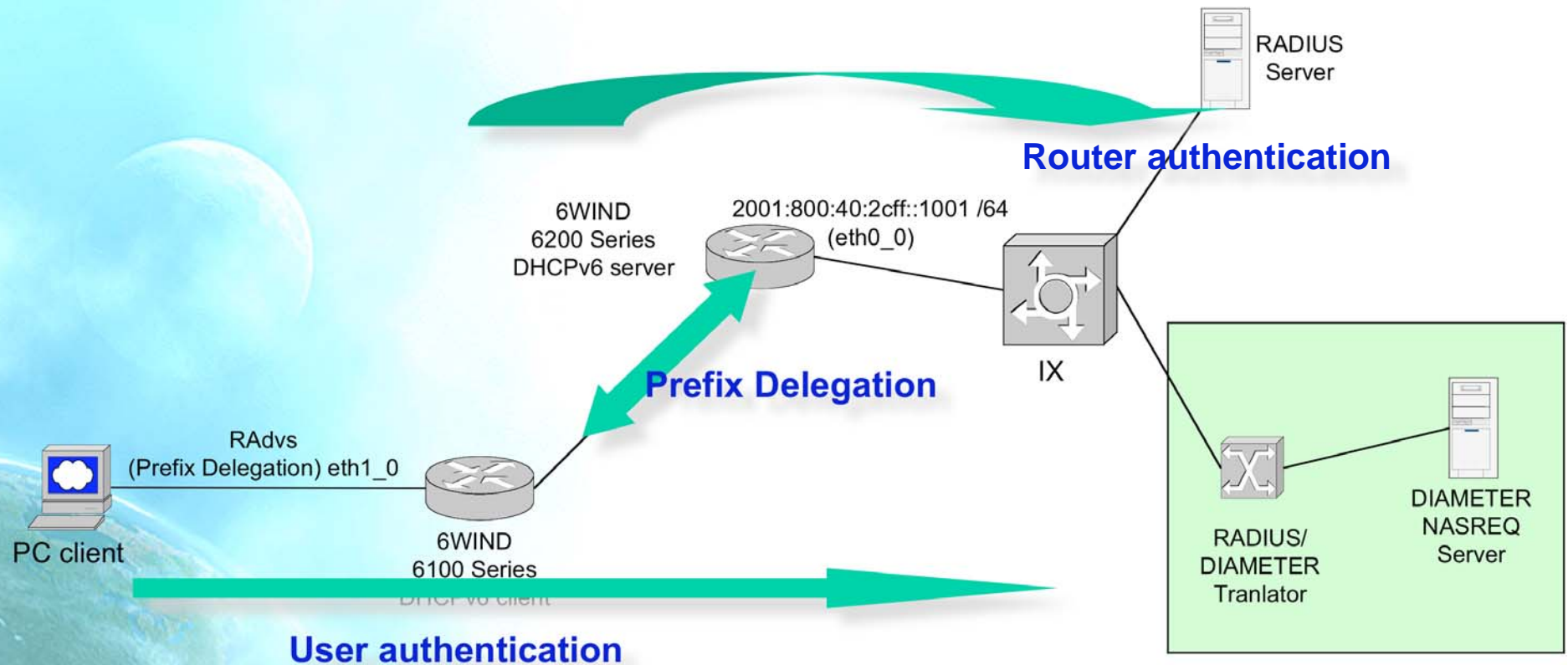
- First scenario:
  - Unique domain
  - End-user is authenticated
  - End-user obtains a prefix (IPv6CP)

- Second scenario:
  - several domains
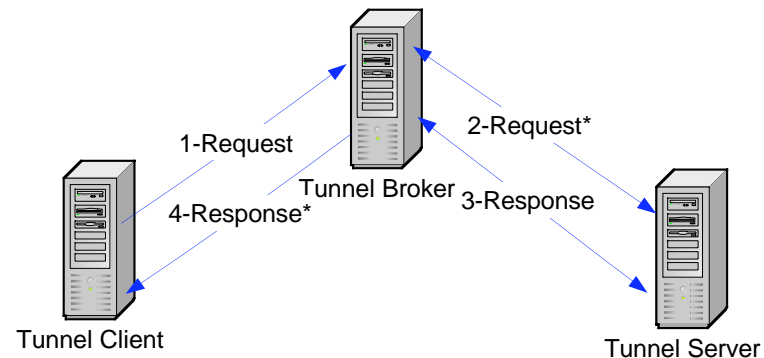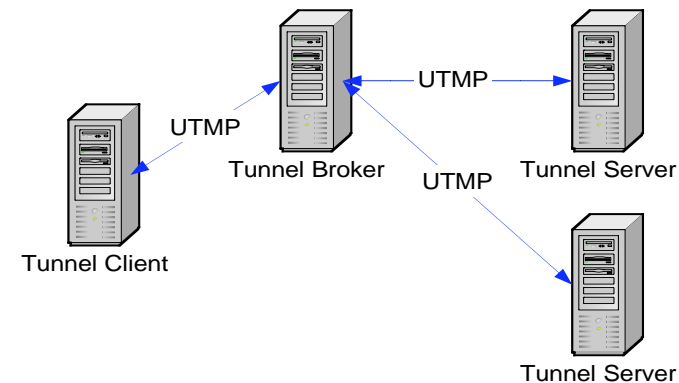 - Security between Radius servers is a concern => VPN

LOCAL DOMAIN

Radius over IPv4

Radius Server

CISCO 3600

PPPoE over 802.1Q

PPPoE (IPv6CP)

VLAN

Access Point

Access Point

Laptop FreeBSD 4.7

DOMAIN A

DOMAIN B

Virtual Private Network (IPv6)

Radius over IPv4

Radius Server

Radius Server

CISCO 3600

PPPoE (IPv6CP)

VLAN

Access Point

Access Point

Laptop FreeBSD 4.7

RADIUS/DIAMETER Translator

RADIUS Server

Router authentication

6WIND
6200 Series
DHCPv6 server

2001:800:40:2cff::1001 /64
(eth0_0)

IX

Prefix Delegation

RAdvs
(Prefix Delegation) eth1_0

PC client

6WIND
6100 Series
DHCPv6 client

RADIUS/
DIAMETER
Tranlator

DIAMETER
NASREQ
Server

User authentication

- **Future**: PANA Protocol for carrying Authentication for Network Access (PANA) and DIAMETER Protocol that allows clients to authenticate themselves to the access network using IP protocols
- *Collaboration with PANA-developers for integration with DIAMETER pure scenario.*
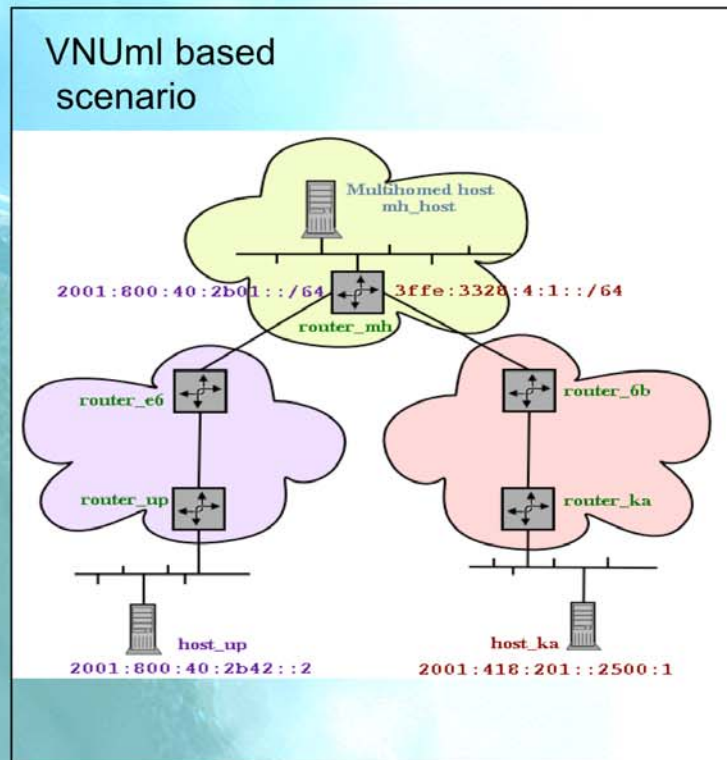
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Extended TB architecture

- Integrate new functionality over TB RFC
- Supports entities authentication (Integration with PKIv6)
- UMTP Universal Tunnel Management Protocol
  - used between all devices
  - messages can be "secured" using signs
  - supports several tunnel types (IPv6 in IPv4, IPv6 over UDP, IPSECv6 tunnels)
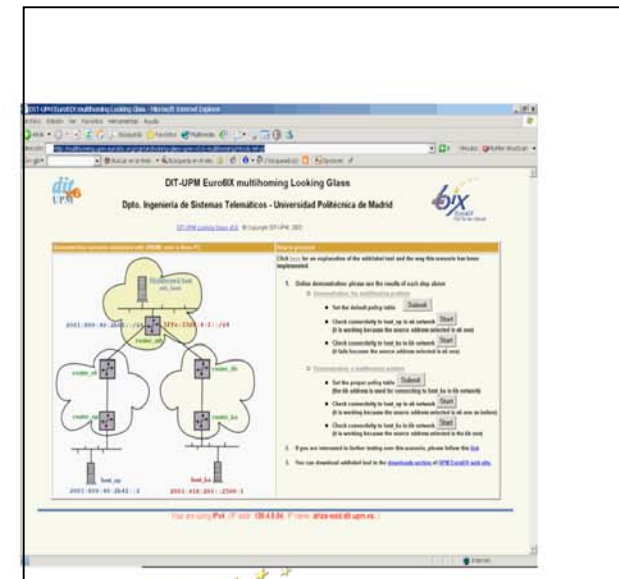
Tunnel Client

UTMP

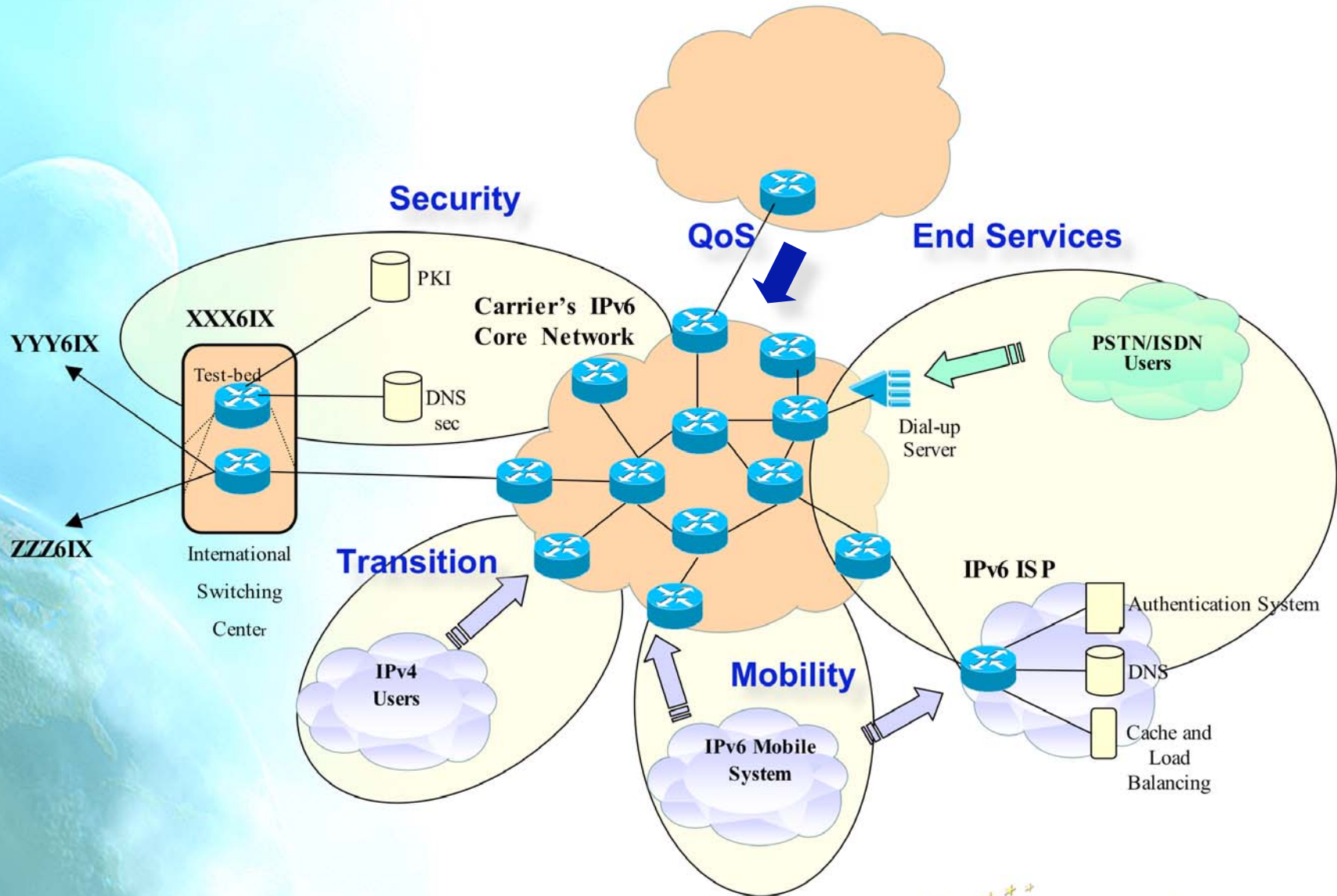Tunnel Broker

UTMP

UTMP

Tunnel Server

Tunnel Server

1-Request

2-Request*

Tunnel Broker

4-Response*

3-Response

Tunnel Client

Tunnel Server

Multihoming demonstration

Linux web server with an adapted version of Looking Glass

Euro6IX network

IPv6 enabled web browser

Advanced Services Vision

Thanks !

Contact:

- **Jordi Palet (Consulintel): jordi.palet@consulintel.es**

- **Madrid 2005 IPv6 Summit, soon more info at:**
  http://www.ipv6-es.com

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