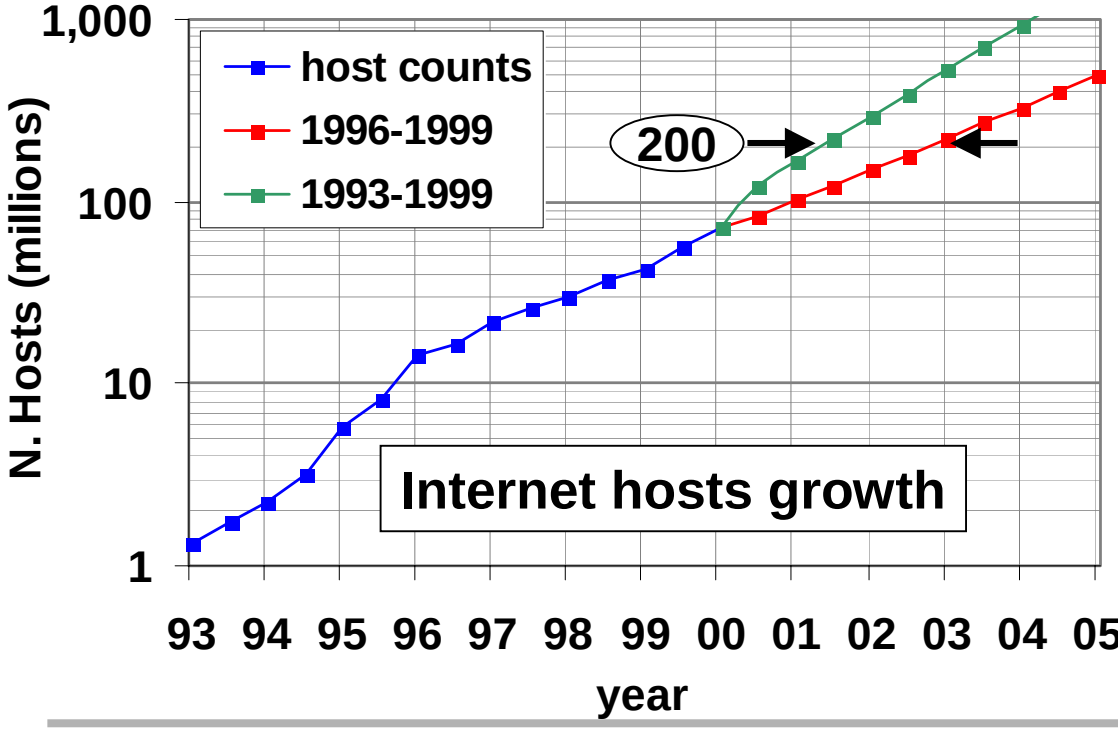
Migrating from IPv4 to IPv6: transition tools and scenarios

Ivano Guardini - CSELT S.p.A.
e-mail: **ivano.guardini@cselt.it**
WWW: **http://carmen.ipv6.cselt.it/ipv6**

Why IPv6?

- **The real reason for IPv6 is that the IPv4 addresses are rapidly running out**
  - assigned IPv4 addresses: **~93 millions** (Jul 00)
  - practical upper bound: **200 millions**



Exaustion expected in the timefame **2001-2003**

Source: Internet Software Consortium (http://www.isc.org)

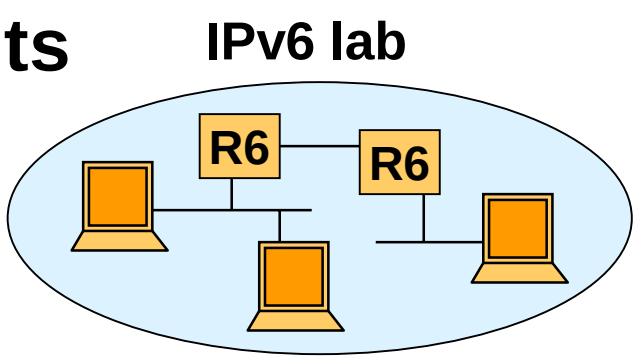
But...

- **IPv4 and IPv6 do not interoperate**
  - IPv4 applications do not work with IPv6
  - IPv4 nodes can not communicate with IPv6 nodes

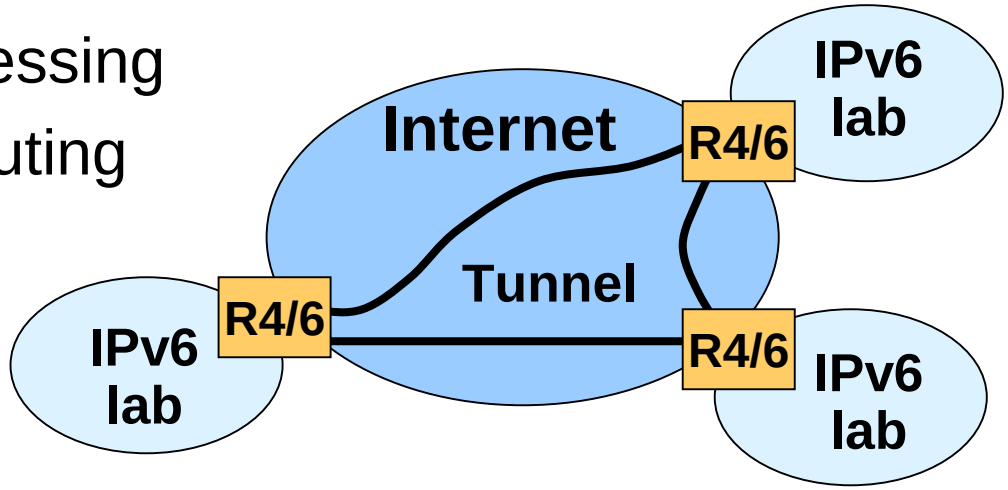
- **It is likely that IPv4 and IPv6 will coexist for a long period of time**
  - how to enable communications among IPv6 islands isolated in the IPv4 world?
  - how to enable communications between the existing IPv4 world and the new IPv6 world?

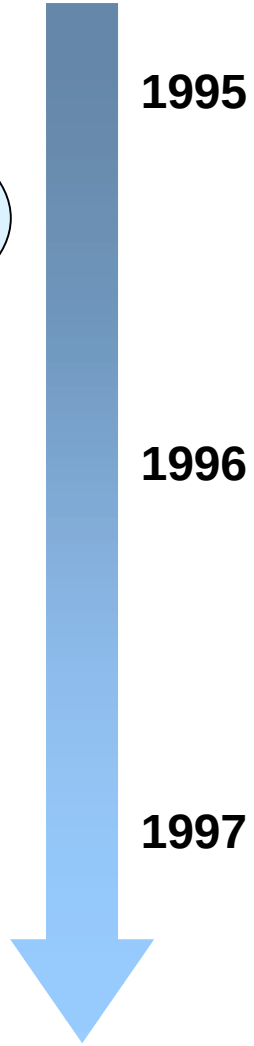
Transition steps

- **Laboratory experiments**
  - network services
  - applications

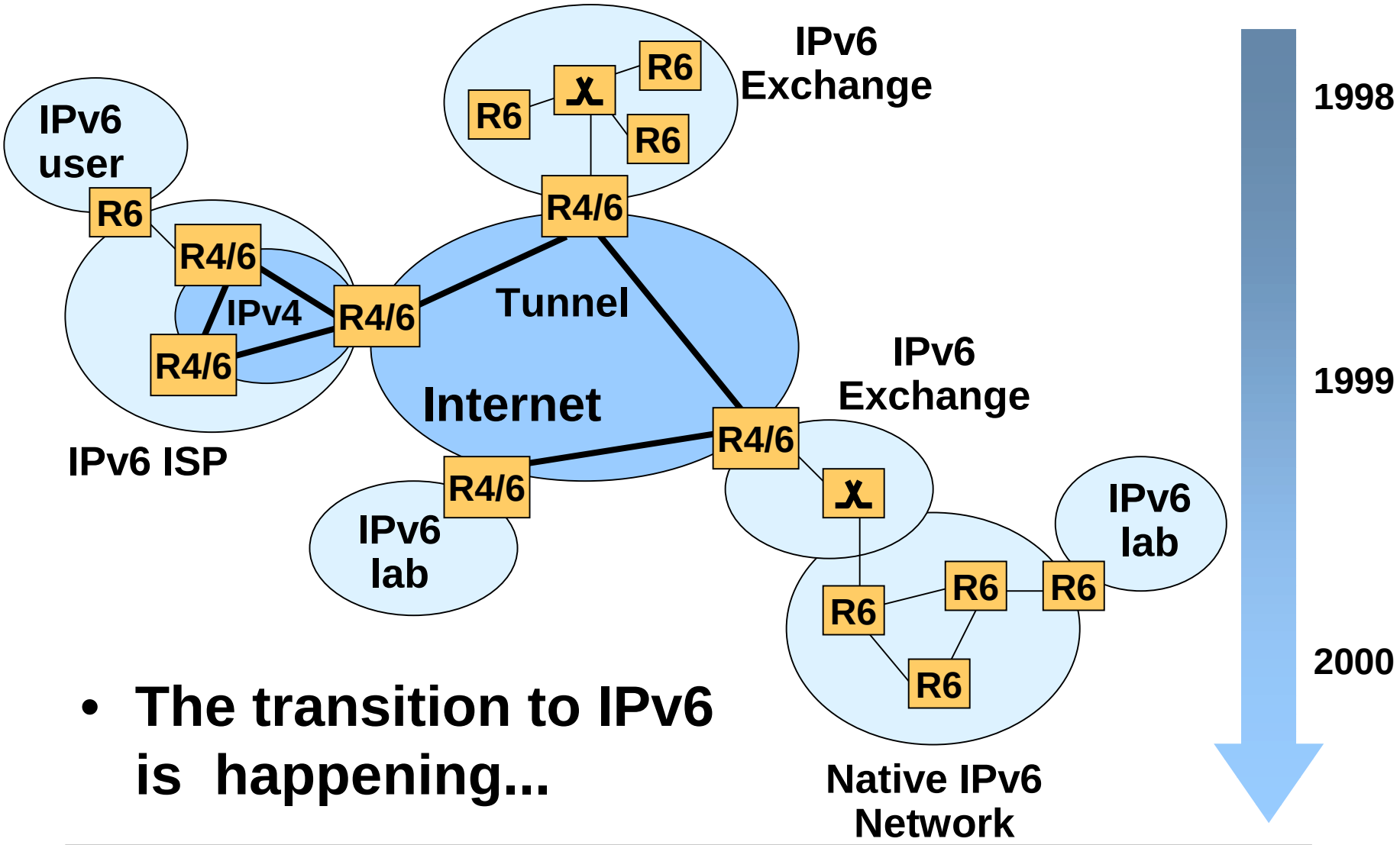


- **Geographical experiments (6bone)**
  - DNS
  - IPv6 addressing
  - BGP4+ routing





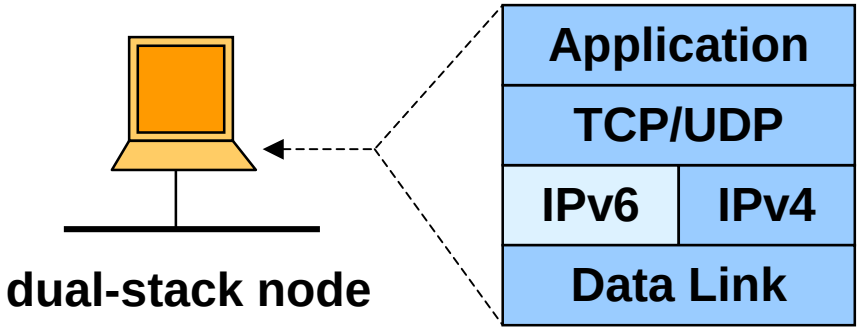
Transition steps (cont.)



- The transition to IPv6 is happening...

Enabling 6-4 co-existence

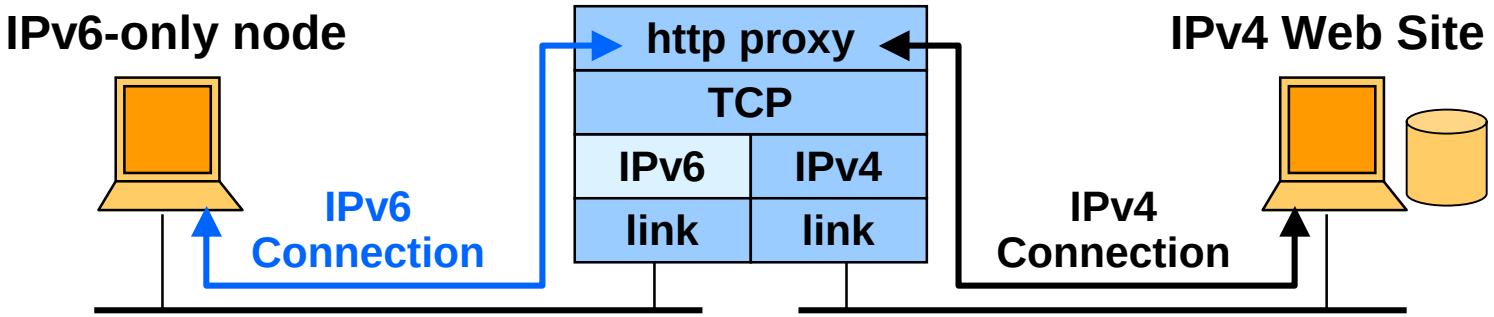
- **Dual IP Stack**
  - provision of complete support for both IPv4 and IPv6 in hosts and routers



- **Issues**
  - it does not reduce the demand for globally routable IPv4 addresses
  - it increases network complexity due to the need for a double (IPv4/IPv6) routing infrastructure

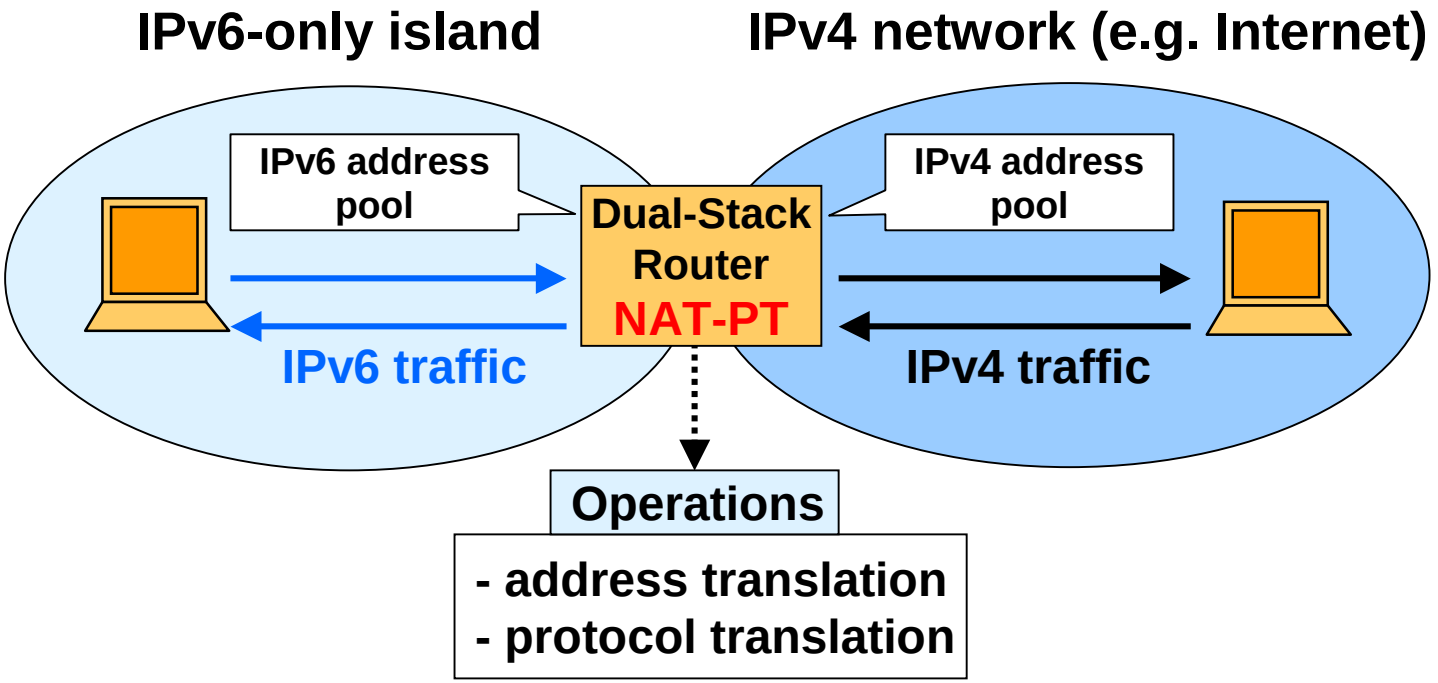
Other dual-stack approaches

- **DSTM (Dual Stack Transition Mechanism)**
  - deployment of dual-stack nodes with dynamically assigned IPv4 addresses
  - IPv4 over IPv6 tunneling to avoid the need for a dual-stack routing infrastructure
- **Application Level Gateways (ALG)**
  - the client is IPv6-only and the communication with the IPv4 world goes through a dual-stack proxy



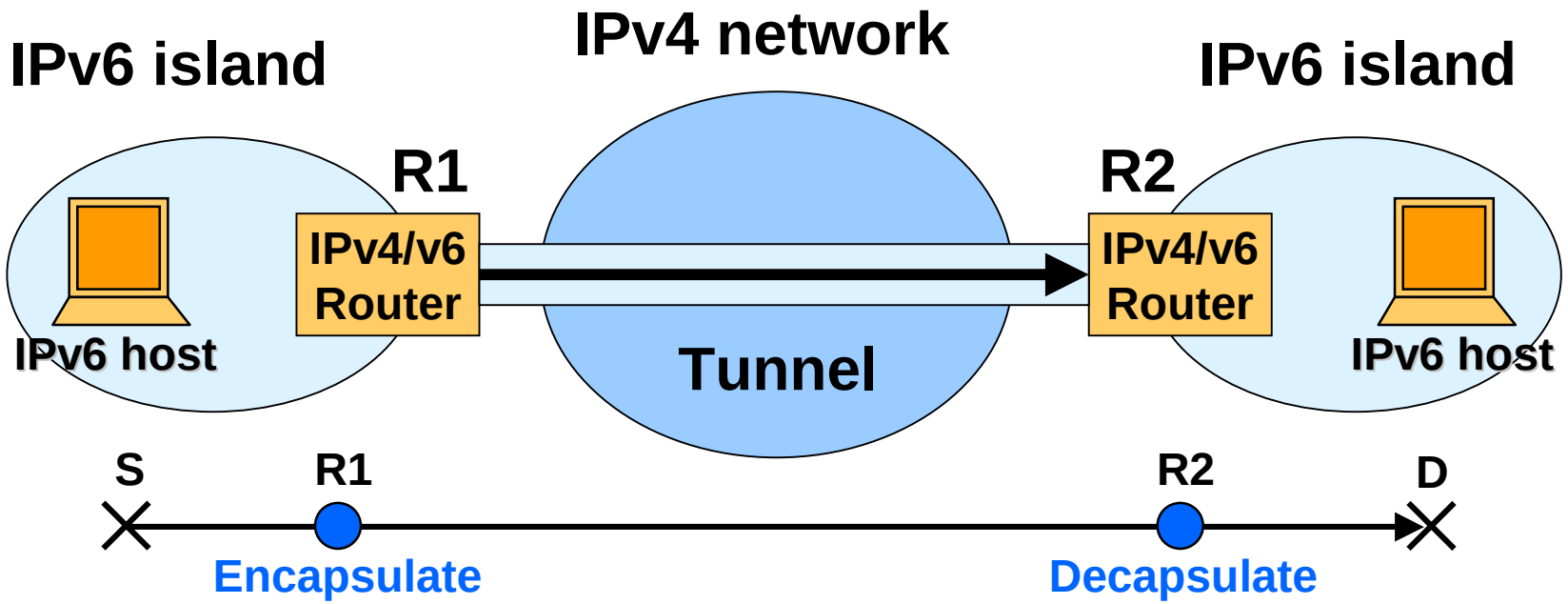
A dual-stack alternative

- **NAT-PT (NAT - Protocol Translator)**
  - the customer site is an IPv6-only network
  - the communication with the IPv4 world relays on a NAT box that translates between IPv4 and IPv6



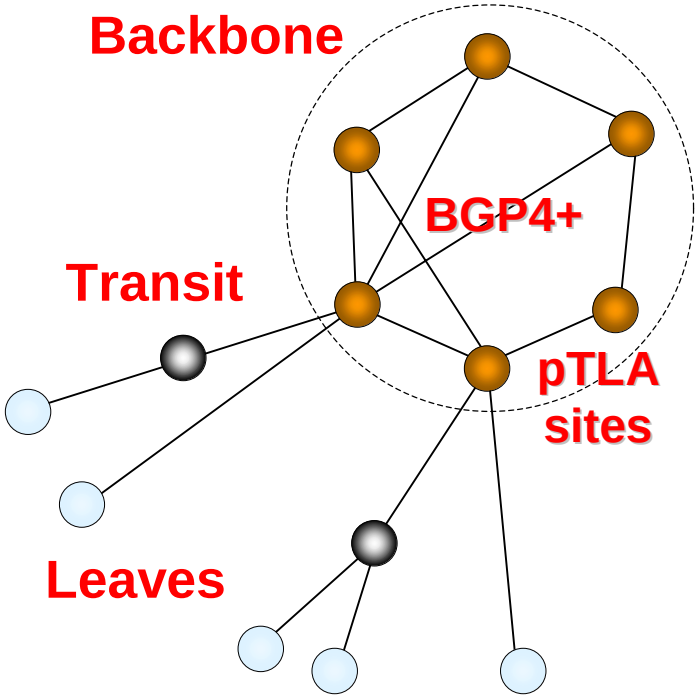
Carrying 6 over 4

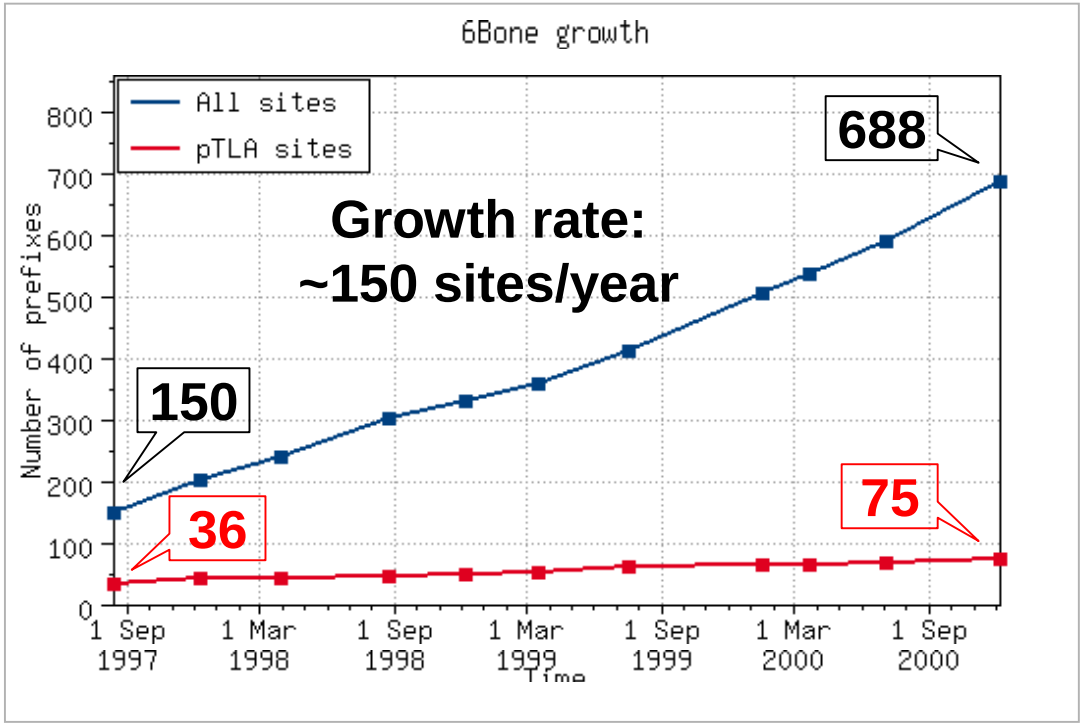
- **IPv6 over IPv4 tunneling**
  - encapsulation of IPv6 packets within IPv4 headers to carry them over an IPv4 network (e.g. Internet)
  - manual end-point configuration



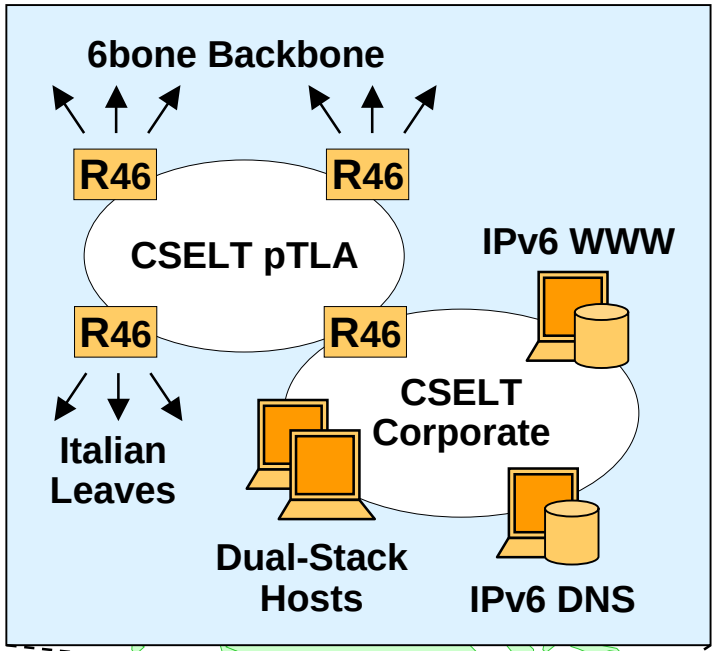
The 6bone network

- **6bone is a worldwide experimental IPv6 network**
  - mainly built on top of the Internet (**tunneling**)
  - to provide feedback to the IETF and IPv6 product developers based on testbed experience

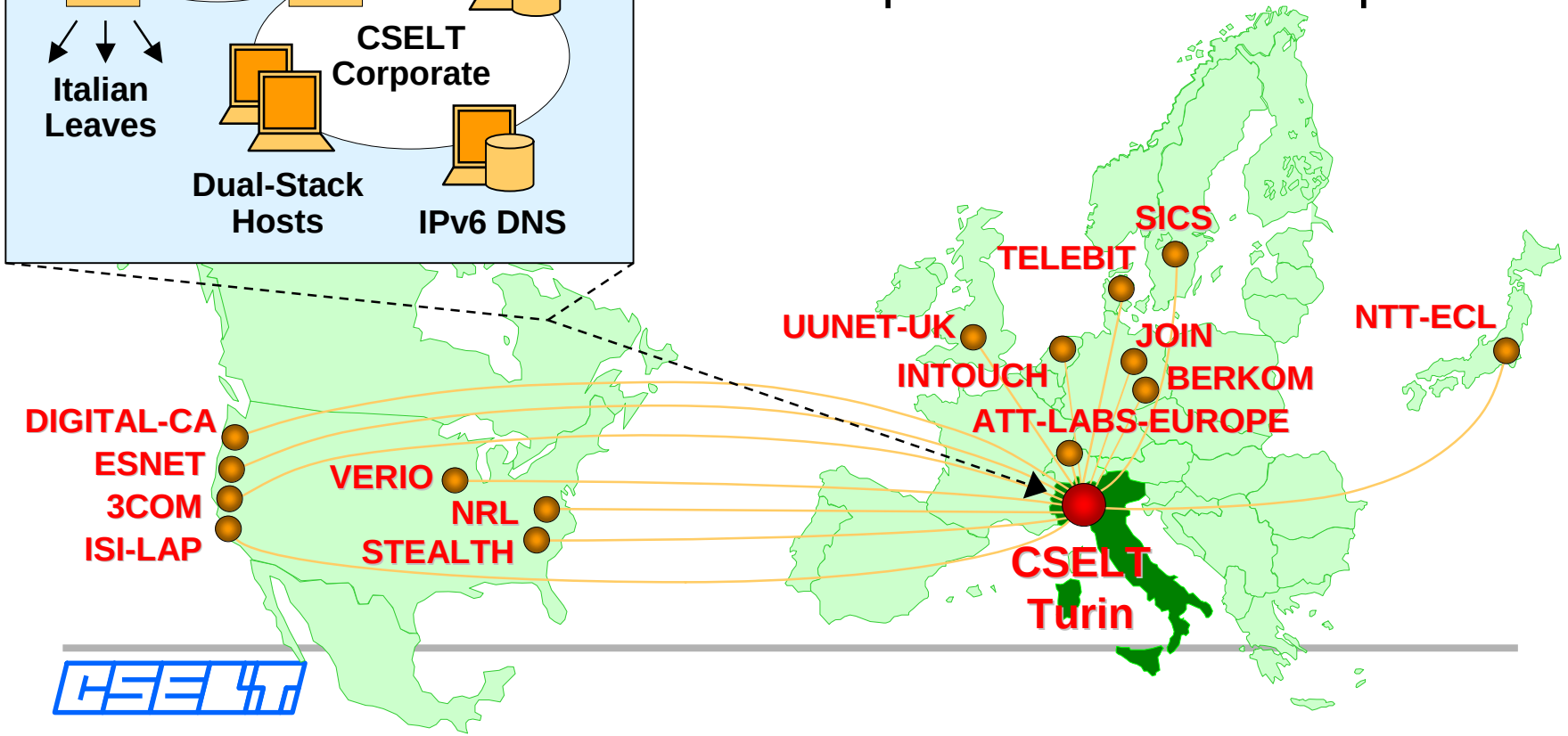




The CSELT's IPv6 site



- **Connected to the 6bone as a backbone node since 1997**
  - http://carmen.cselt.it/ipv6



The need for automatic tunneling

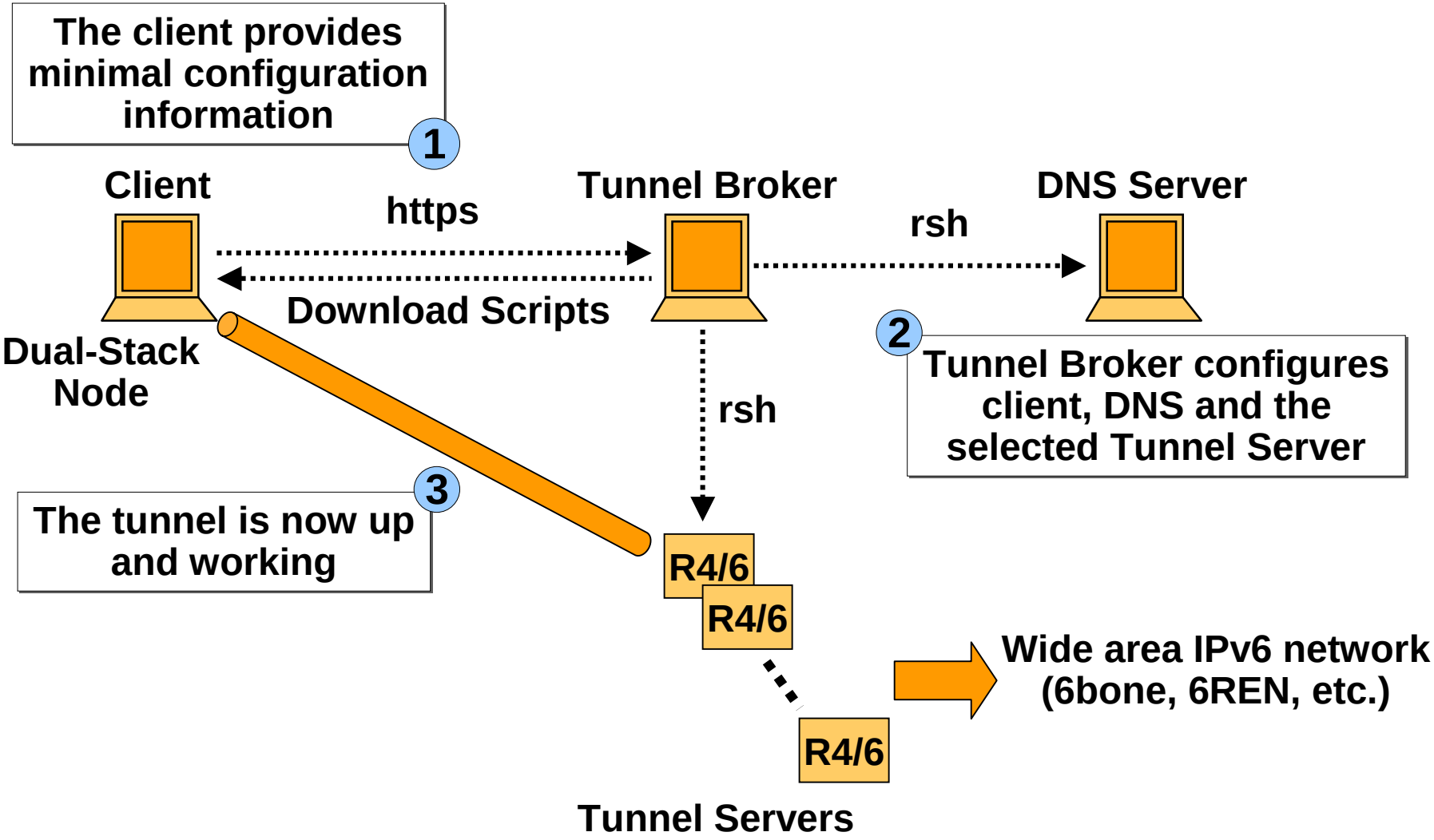
- **The CSELT case**
  - **~ 30** client enterprises and ISPs
  - **> 1000** single users (e.g. dial-up customers of various IPv4 ISPs)

- **Issues**
  - configured tunneling requires heavy manual configuration and therefore does not scale well
  - the originally defined automatic tunneling is not the solution because it can be used only between individual hosts

Tunneling enhancements

- **Tunnel Broker**
  - automatic tunnel and DNS setup assisted by a tunnel broker server operated by the IPv6 ISP
- **6over4**
  - IPv6 hosts in an IPv4 site communicate through automatic IPv6 over IPv4 encapsulation
  - a virtual link is created relaying on IPv4 multicast to enable IPv6 Neighbor Discovery over IPv4
- **6to4**
  - interconnection of isolated IPv6 domains in an IPv4 world (e.g. Internet)
  - the egress router of the IPv6 domain automatically creates a tunnel to the other domain

The tunnel broker service at CSELT



Service available at: https://carmen.cselt.it/ipv6tb

Transition scenarios

- **Enterprise**
  - new organization
  - existing organization with lots of IPv4 addresses
  - existing organization with private IPv4 addresses and NATs

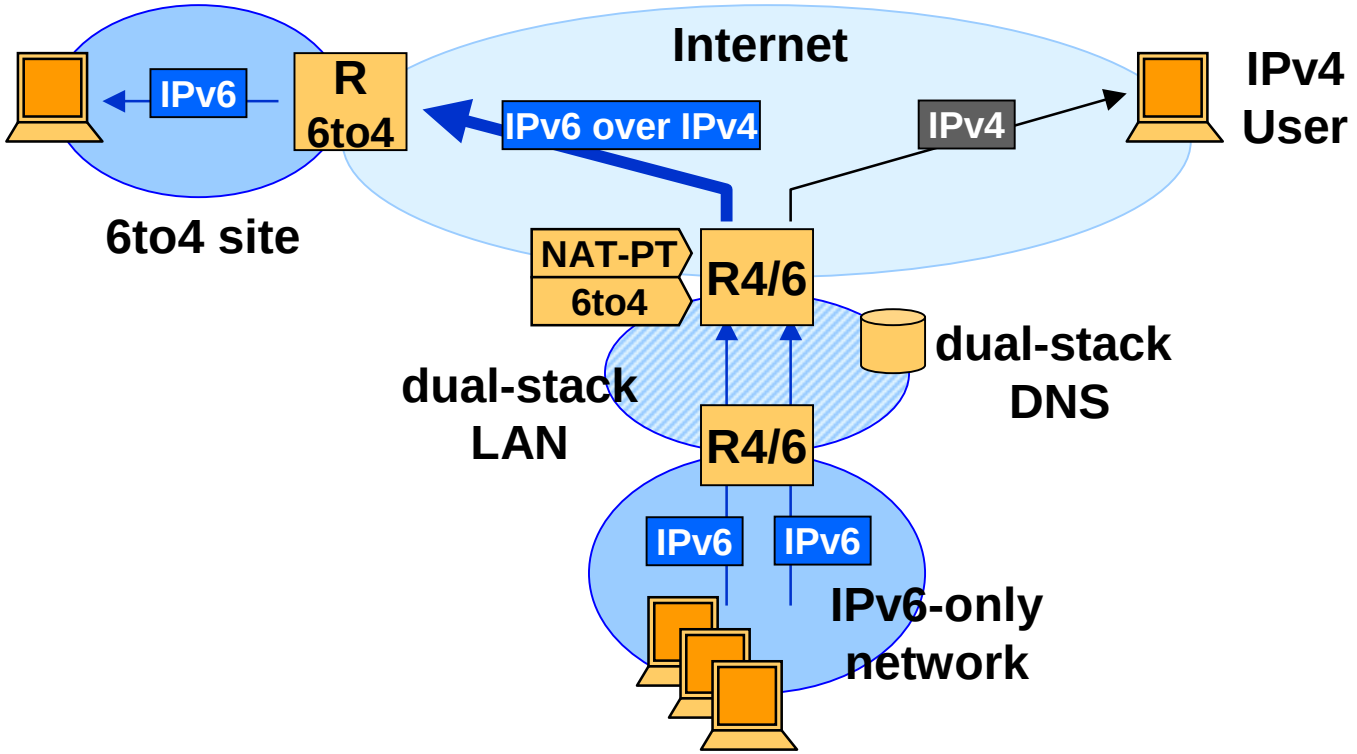
- **ISP**
  - backbone ISP
  - small/medium ISP

New organization

- **Network technology**
  - deploying an IPv6-only network is future proof
- **Communication with the IPv4 world**
  - at least one global IPv4 address
  - NAT-PT or dual-stack ALG (e.g. WWW proxy)
- **Communication with other IPv6 domains**
  - IPv4-only ISP: configured tunneling or 6to4
  - dual-stack ISP: relay on the upstream IPv6 service

New organization (cont.)

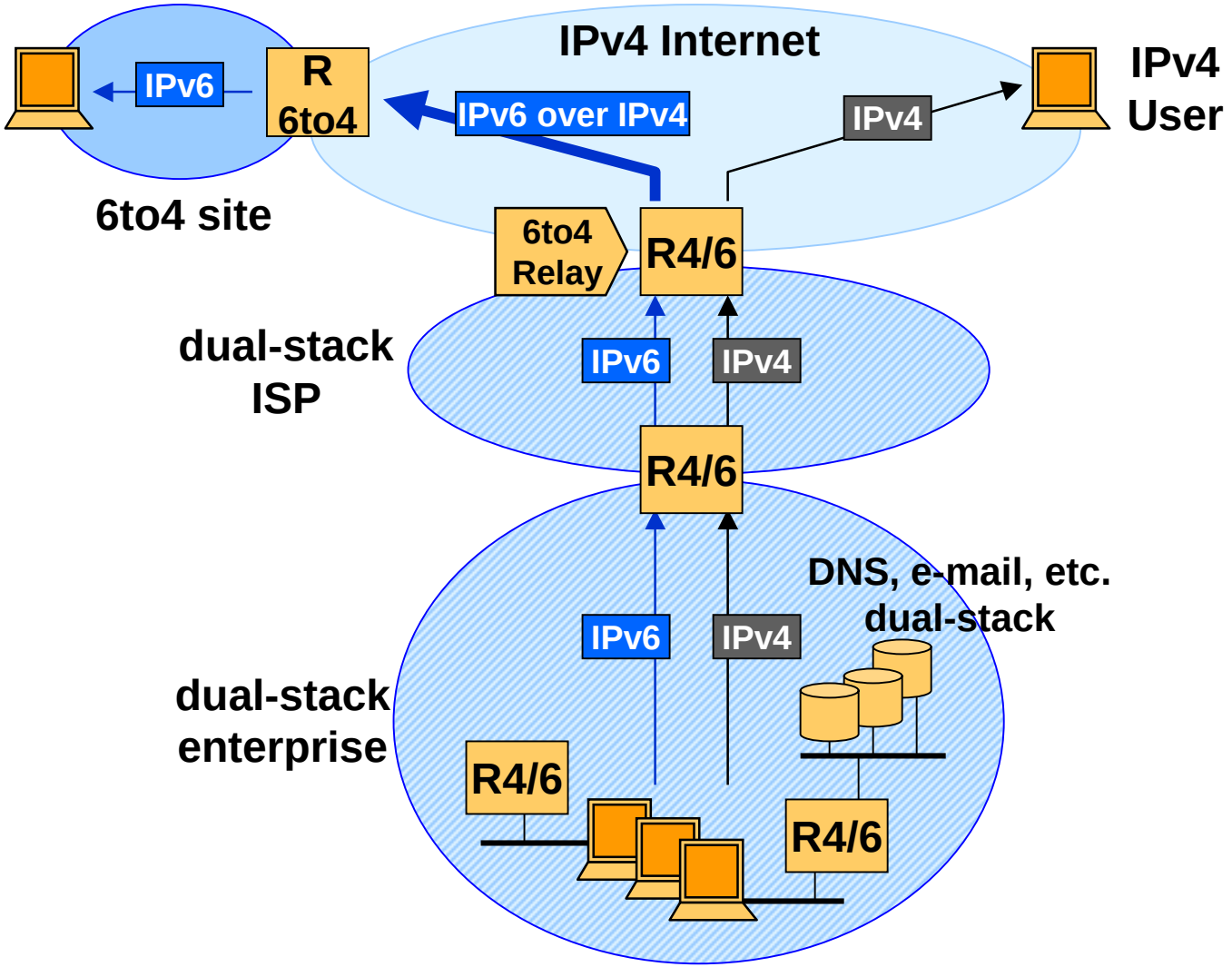
- **Provided that the basic application services are available...**



Existing organization

- **Network technology**
  - migration to dual-stack anywhere with configured or automatic tunneling during the transition
- **Communication with the IPv4 world**
  - IPv4 end-to-end (if lots of addresses are available)
  - or use the existing proxy or NAT box
- **Communication with other IPv6 domains**
  - IPv4-only ISP: configured or automatic tunneling
  - dual-stack ISP: relay on the upstream IPv6 service

Existing organization (cont.)



Backbone ISP

- **Addressing**
  - a backbone ISP must request a global IPv6 prefix (TLA prefix) to a Regional Internet Registry (RIPE, ARIN o APNIC)
  - a smaller ISP can obtain its IPv6 address space from a backbone ISP

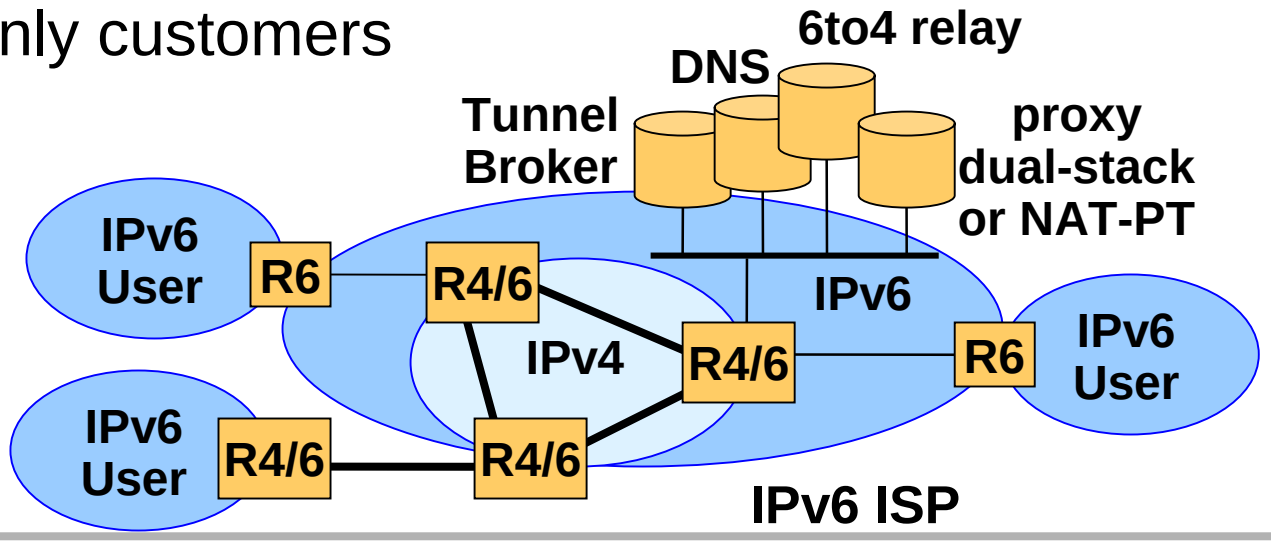
- **IPv6 equipment**
  - deployment of dedicated IPv6 routers and servers
  - incremental upgrade of the existing IPv4 routers and servers as the IPv6 traffic grows

Backbone ISP (cont.)

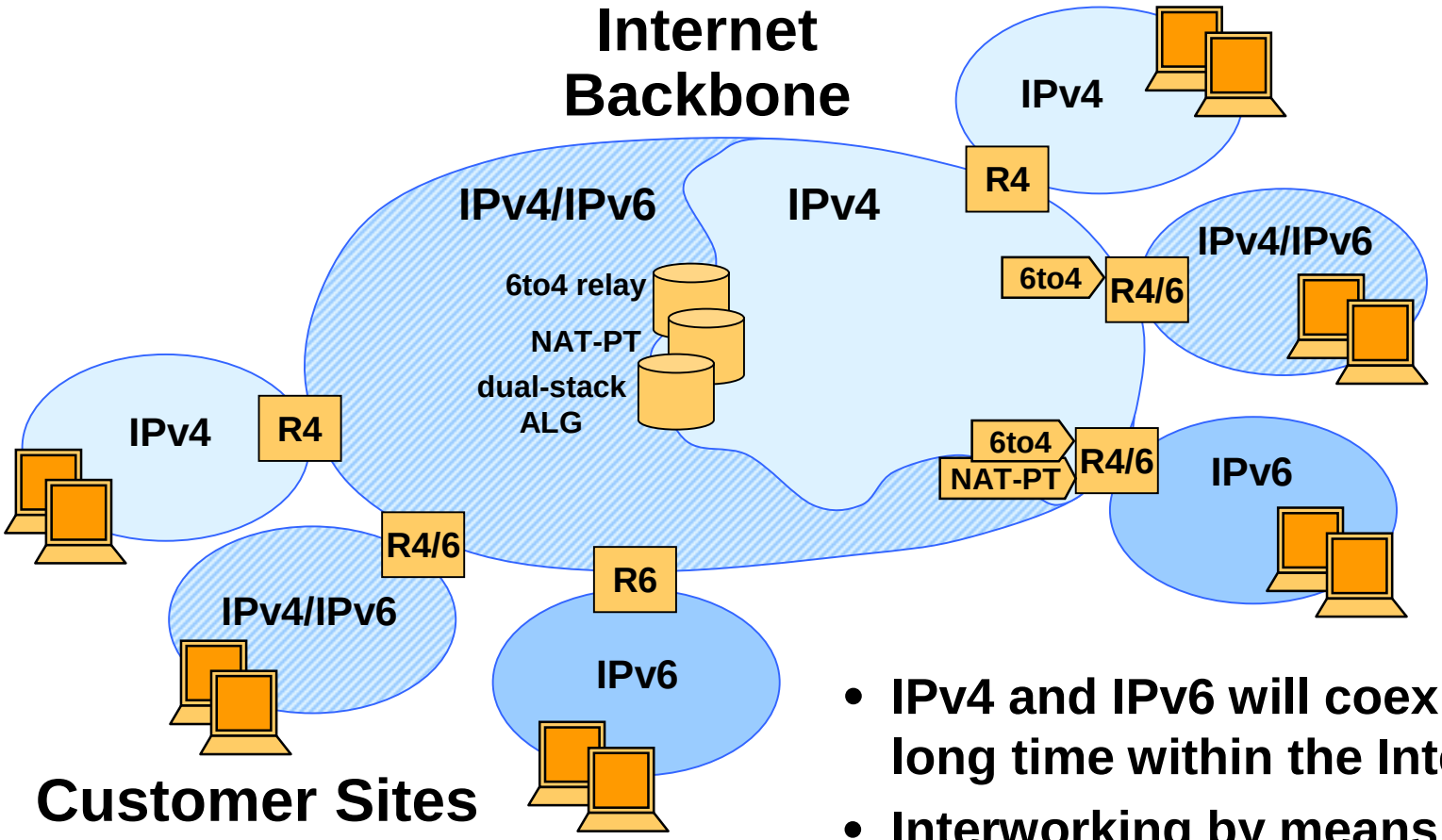
- **IPv6 connectivity in the backbone**
  - initially configured tunneling over the existing IPv4 infrastructure should be enough
  - migration to native links as the IPv6 traffic grows
- **IPv6 connectivity with other ISPs**
  - setup of IPv6 peerings with other big ISPs
  - the IPv6 peering policies should be similar to those in place for IPv4

Backbone ISP (cont.)

- **IPv6 connectivity to customers**
  - configured tunneling or native connections
  - Tunnel Broker for residential customers
  - provision of communication services with isolated IPv6 networks (e.g. 6to4 relay)
  - provision of IPv4/v6 interworking services for IPv6 only customers

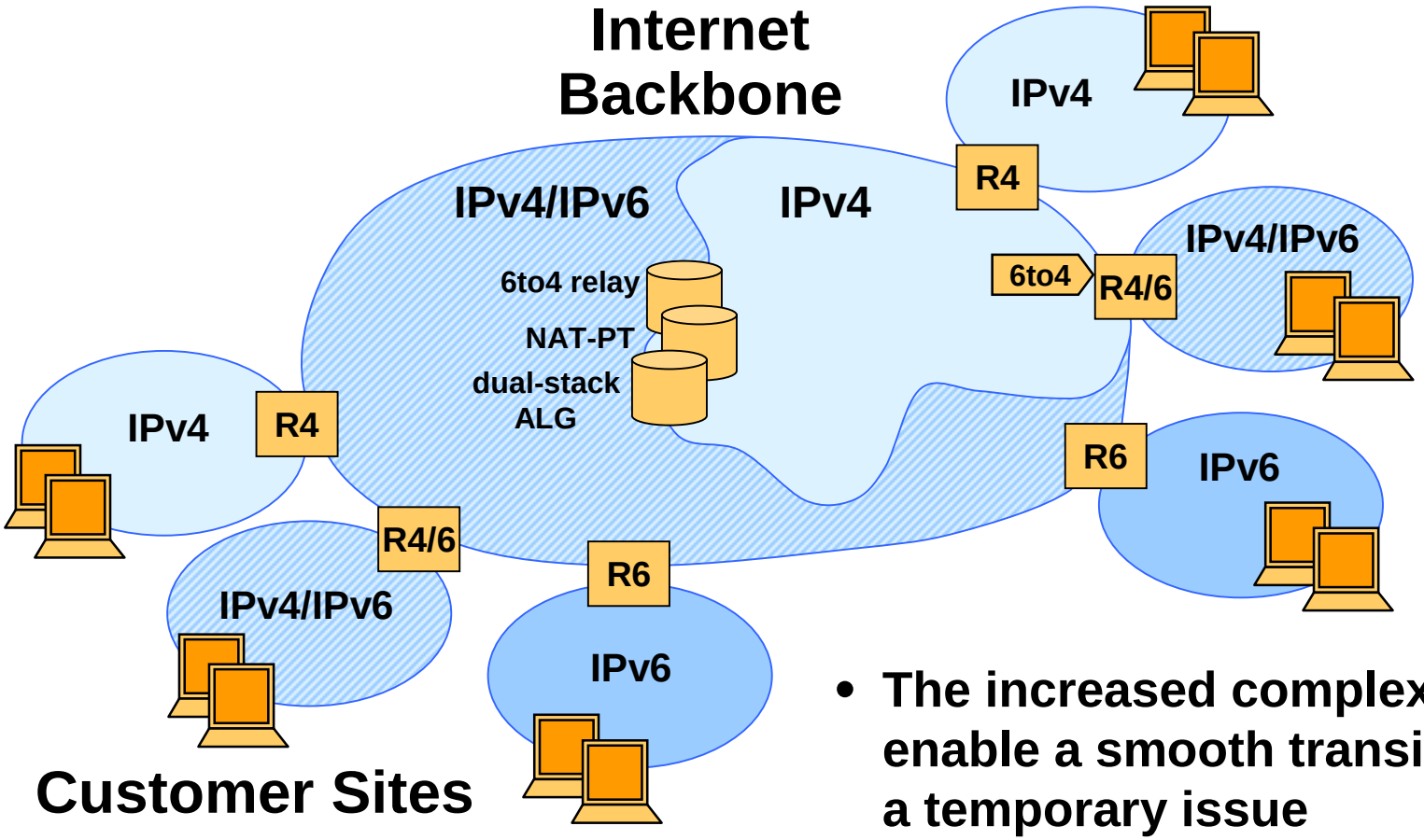


Towards a smooth transition



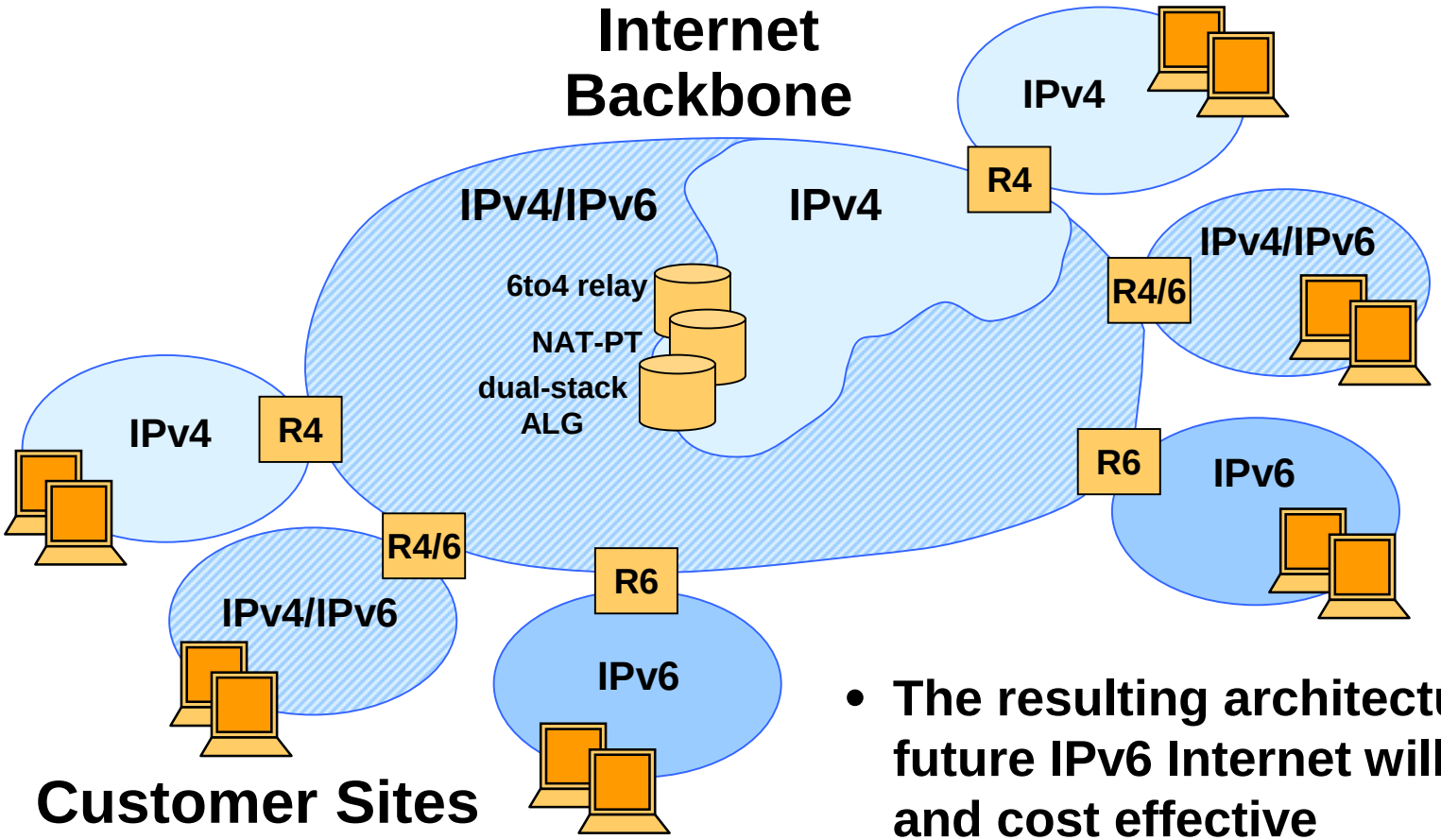
- **IPv4 and IPv6 will coexist for a long time within the Internet**
- **Interworking by means of**
  - tunnelling (static/dynamic)
  - protocol translators and dual-stack ALGs

Towards a smooth transition (Cont.)



- **The increased complexity to enable a smooth transition will be a temporary issue**
  - the interworking boxes can be removed as the transition goes on

Towards a smooth transition (Cont.)



- **The resulting architecture for the future IPv6 Internet will be simple and cost effective**
  - e2e transparency
  - no need for complex NATs or application specific gateways

For further information....

- **IETF ngtrans working group**
  - http://www.ietf.org/html.charters/ngtrans-charter.html
- **6bone**
  - http://www.6bone.net
- **IPv6 Forum**
  - http://www.ipv6forum.com
- **CSELT Official IPv6 Site**
  - http://carmen.cselt.it/ipv6 (IPv4)
  - http://carmen.ipv6.cselt.it/ipv6 (IPv4 & IPv6)