Transition & Coexistence IPv4-IPv6

Case studies & Conclusions

Francisco Fontes

PT Inovação

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Classification of Transition Mechanisms

- *Several techniques have been defined to support the transition towards an all-IPv6 Internet:*
  - *Dual Stack techniques, allowing IPv4 and IPv6 to coexist in devices and networks;*
  - *Layer 2 supporting infra-structure, allowing native IPv6 communication to co-exist with IPv4 communication (ATM, FR, MPLS, ...)*
  - *Translation*
    - *allows IPv4 and IPv6 devices and networks to establish communication*
    - *Network layer*
      - *SIIT, NAT-PT*
    - *Upper layers*
      - *ALG, TRT, SOCKS64, BIS, BIA*
  - *Tunnelling/Encapsulation*
    - *allows end-to-end communication between IPv6 devices and networks*
      - *Configured tunnels*
      - *Automatic tunnels*
      - *Tunnel broker*
      - *6to4*
      - *6over4*
      - *Teredo*

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LONG Main Objectives

- *Define and deploy an IPv6 test-bed network, which includes the combination and exploitation between the following technologies:*
  - *IPv6 Protocol*
  - *Advanced Network Services: DNS, Mobility, Multicast, Anycast Security, QoS, Auto-configuration*
  - *IPv6-IPv4 Transition Mechanisms*
  - *Access and Transport Technologies*
  - *Applications and services based on IPv6 protocol and on IPv6/IPv4 mixed scenarios*

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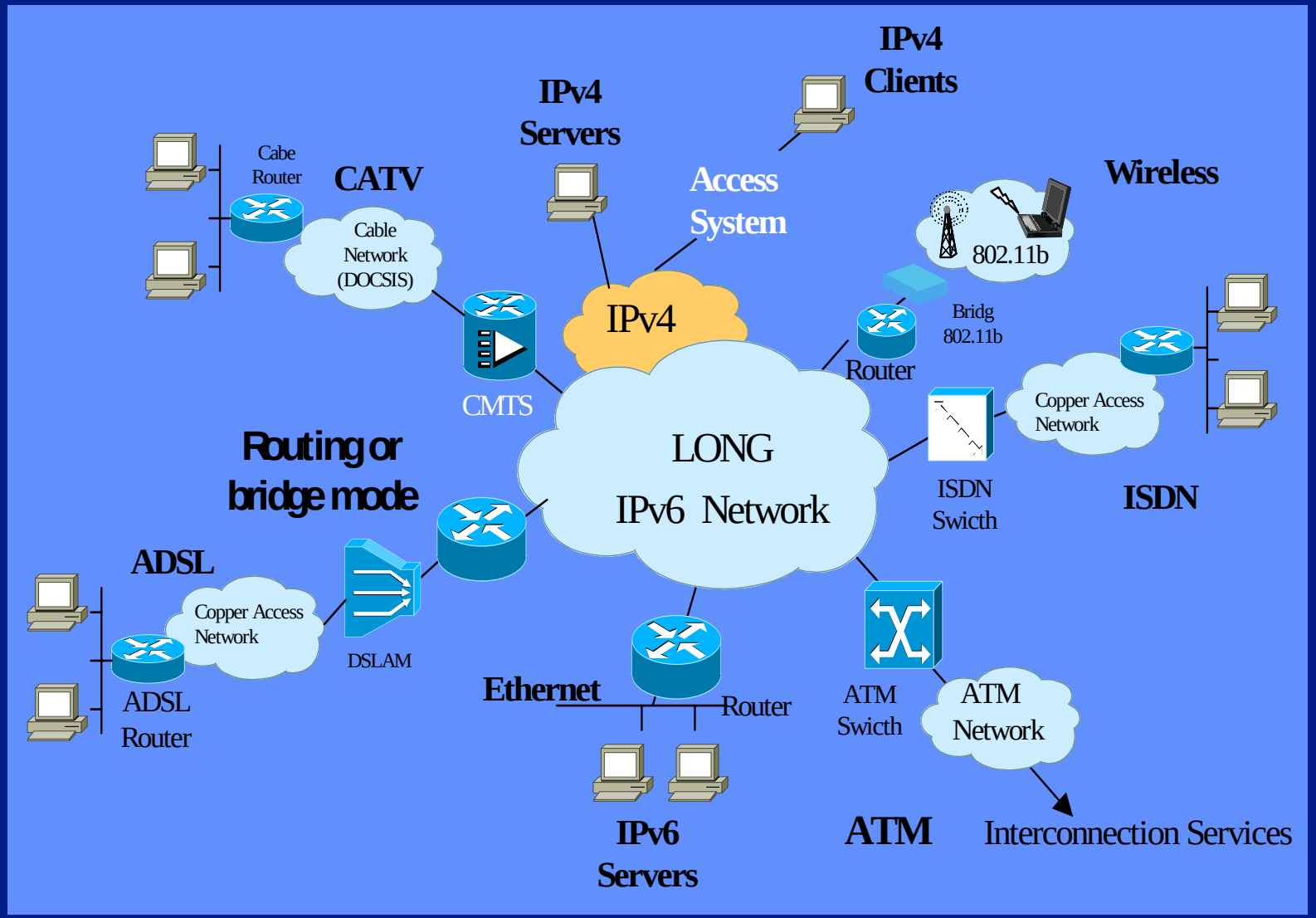
LONG Test-bed



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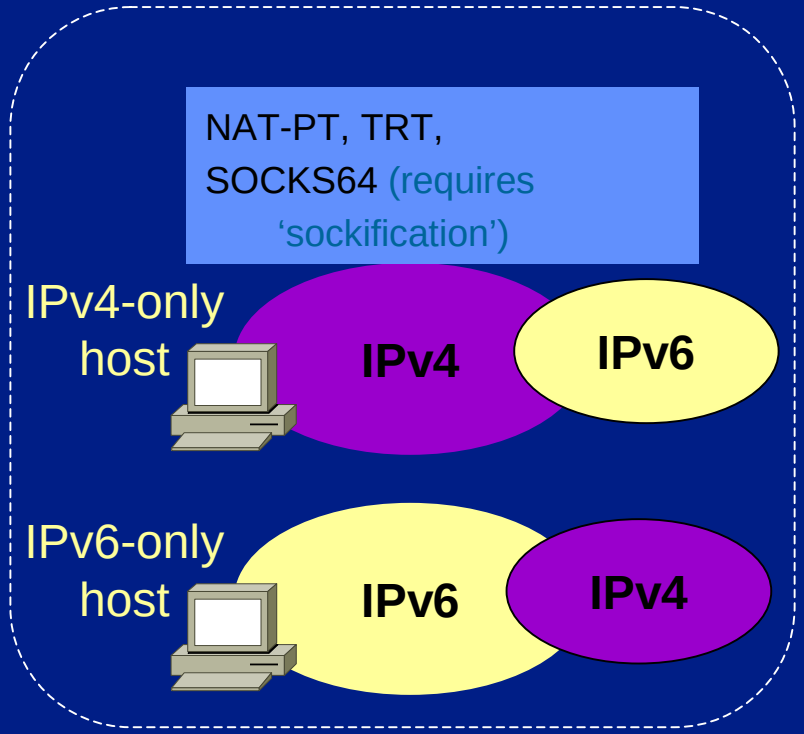
Isolated host-to-net communication



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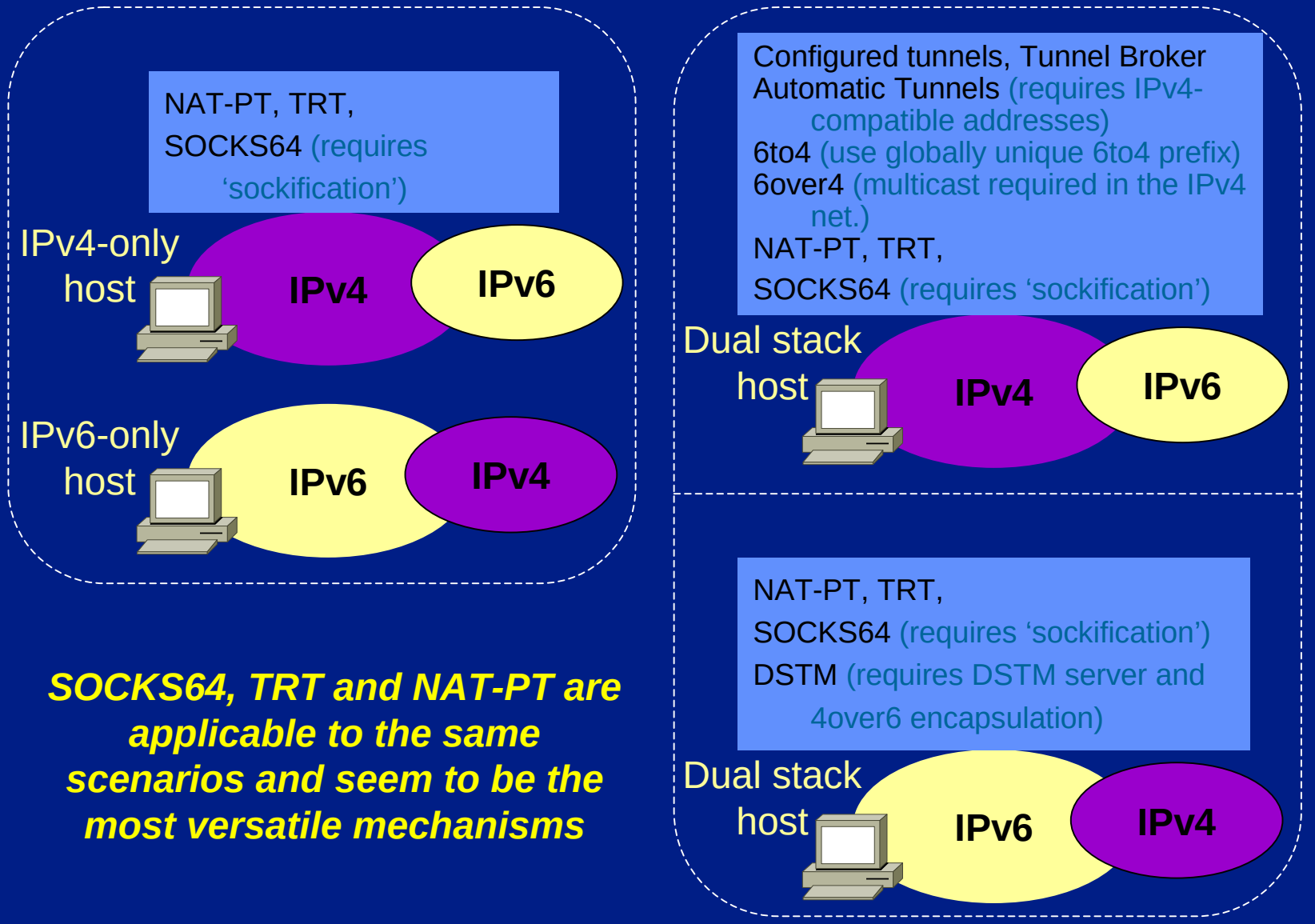
Isolated host-to-net communication



SOCKS64, TRT and NAT-PT are applicable to the same scenarios and seem to be the most versatile mechanisms

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Network-to-Network communication

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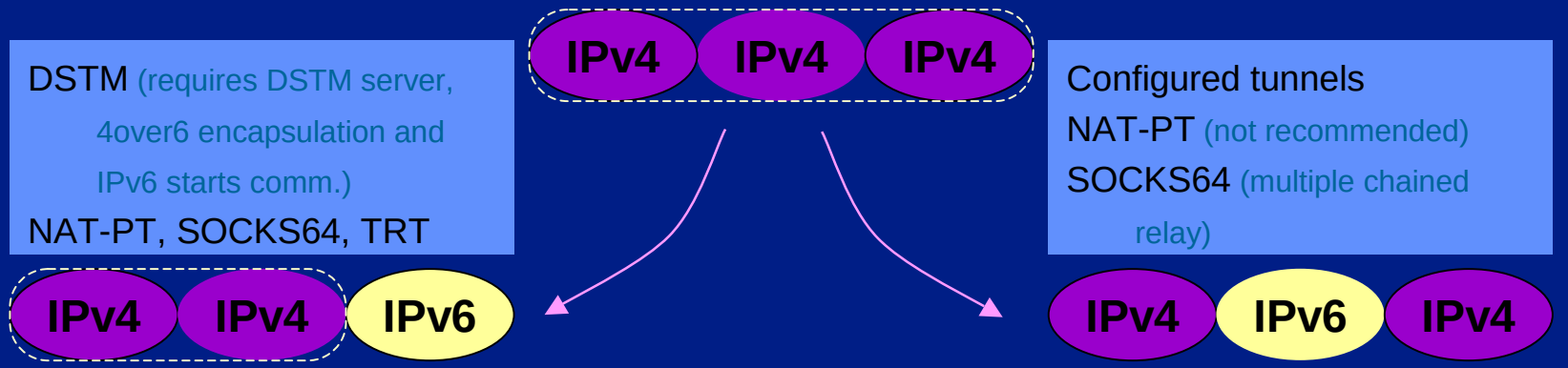
Network-to-Network communication



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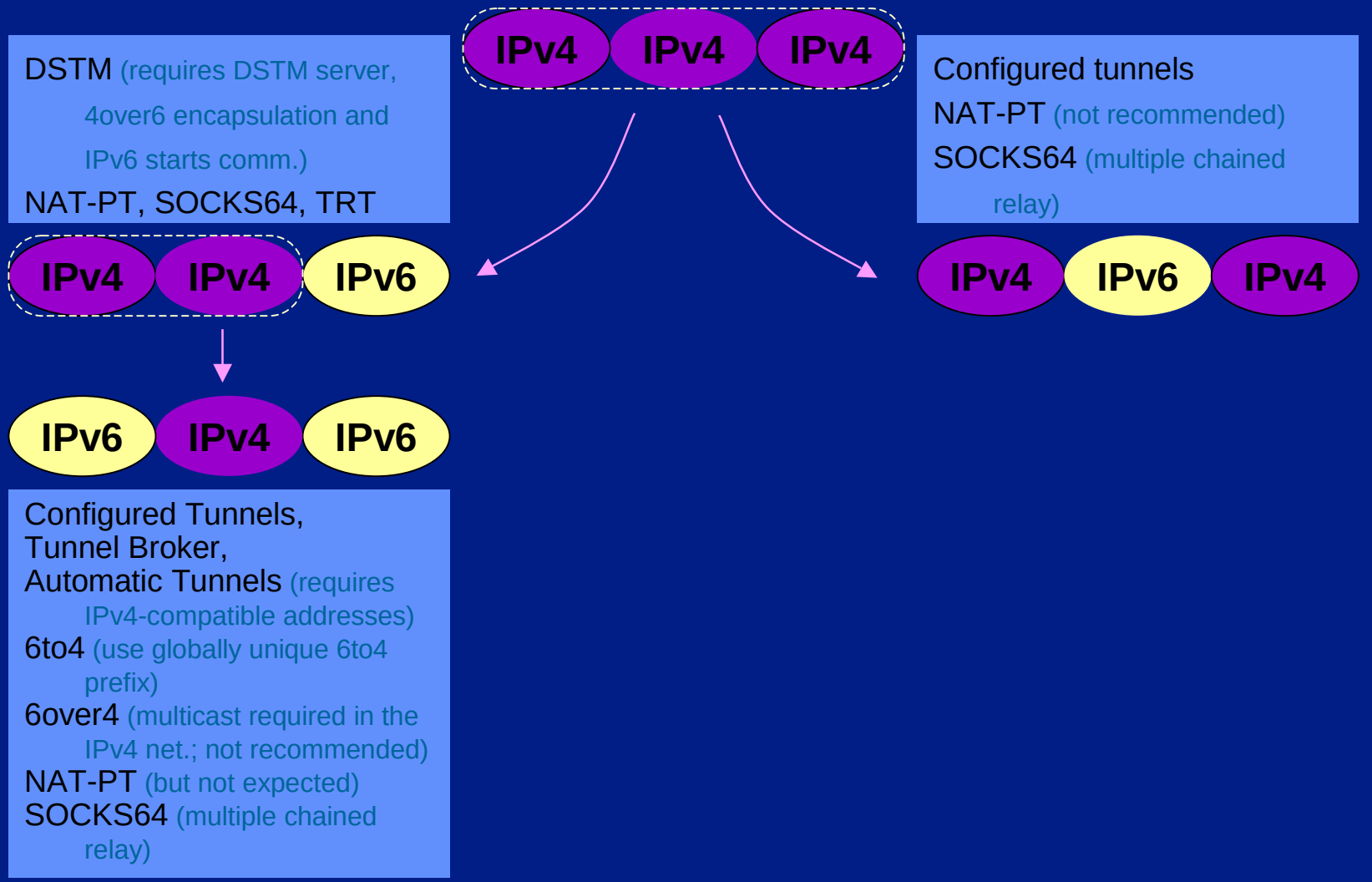
Network-to-Network communication



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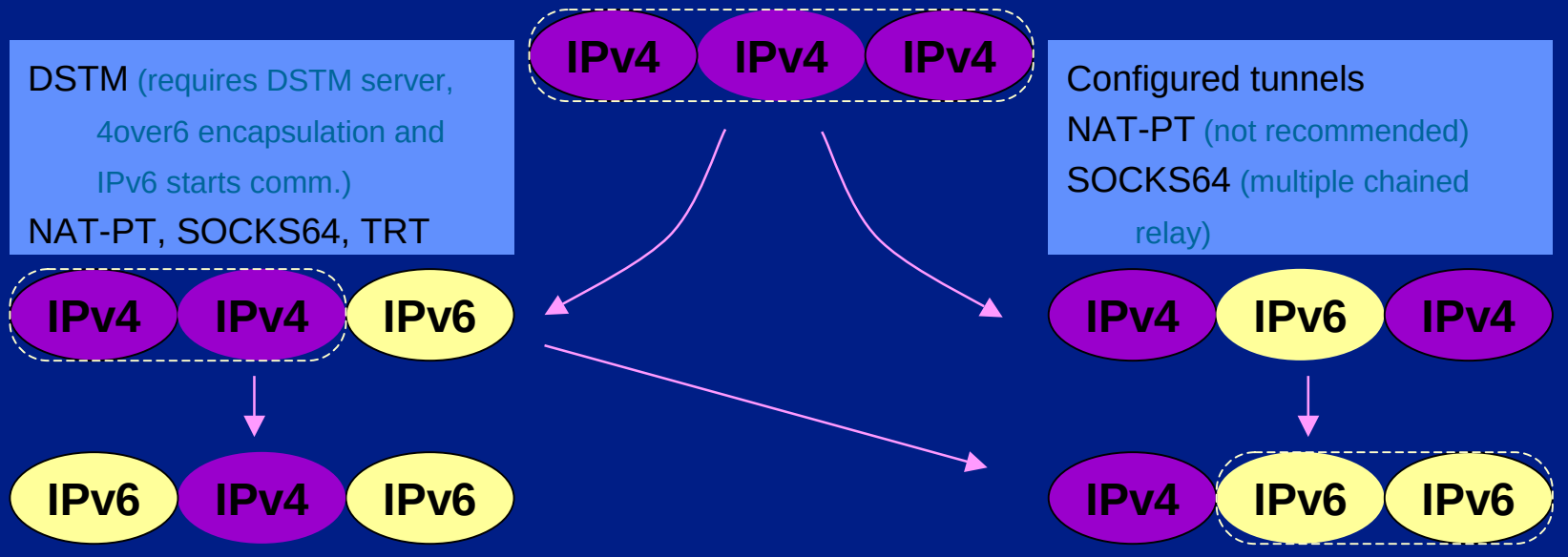
Network-to-Network communication



DSTM (requires DSTM server, 4over6 encapsulation and IPv6 starts comm.)
NAT-PT, SOCKS64, TRT

Configured tunnels
NAT-PT (not recommended)
SOCKS64 (multiple chained relay)

Configured Tunnels,
Tunnel Broker,
Automatic Tunnels (requires IPv4-compatible addresses)
6to4 (use globally unique 6to4 prefix)
6over4 (multicast required in the IPv4 net.; not recommended)
NAT-PT (but not expected)
SOCKS64 (multiple chained relay)

DSTM (requires DSTM server, 4over6 encapsulation and IPv6 starts comm.)
NAT-PT
SOCKS64
TRT (but not expected)

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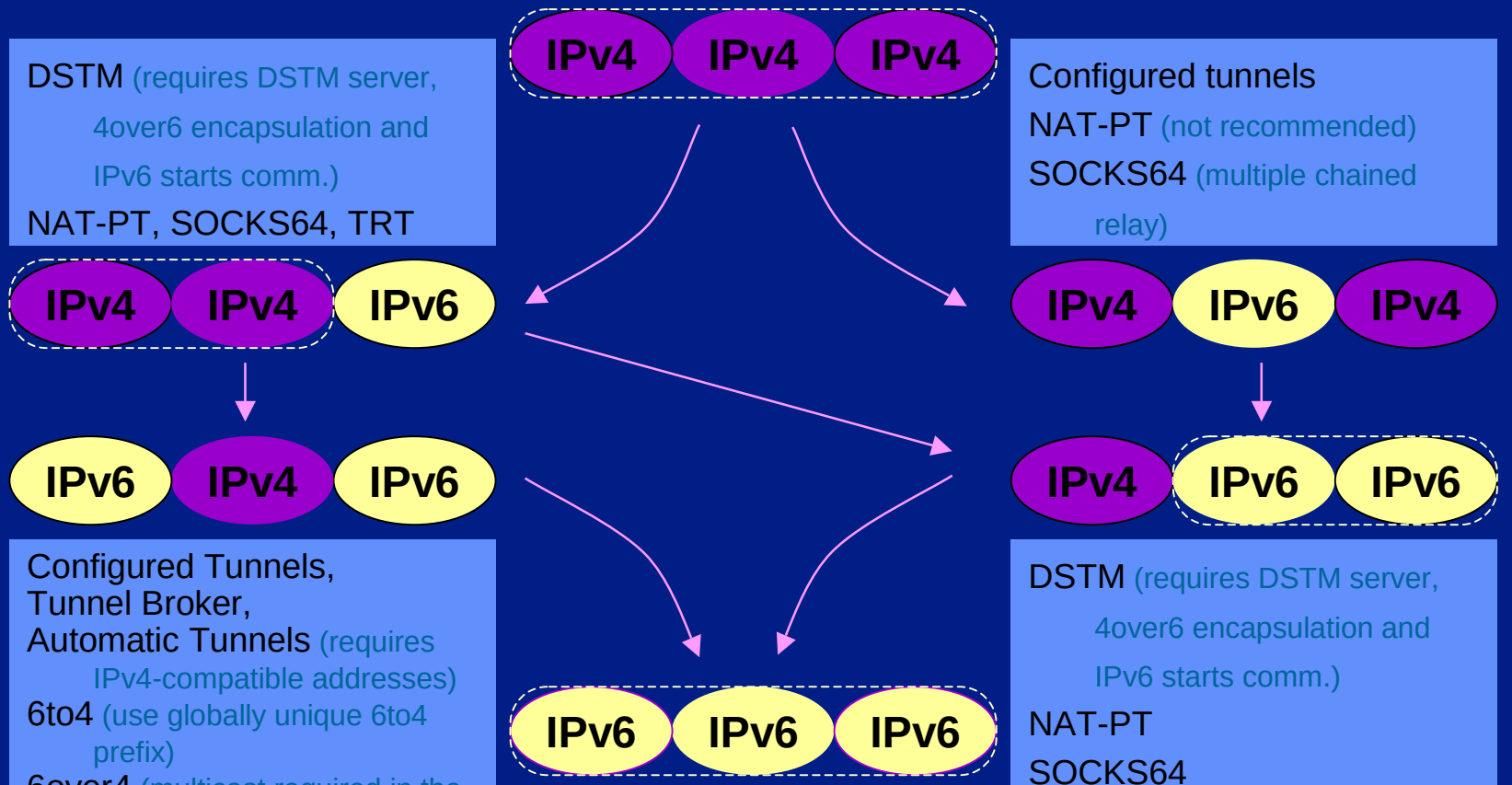
Network-to-Network communication



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QoS (I)

- *DiffServ [RFC2475] adopted as the basis for e2e QoS comparison*
  - *DiffServ concepts are applicable to both protocol versions: classification, shaping, metering, marking, dropping & scheduling (see [RFC2474])*
  - *Routers in both v4 and v6 must implement the technology, making usage of TOS in IPv4 and Traffic Class in IPv6*

- *Two possible scenarios for QoS in IPv4-IPv6 transition:*
  - *In association to a Translation Mechanism (A)*
  - *In association to a Tunnelling Mechanism (B)*

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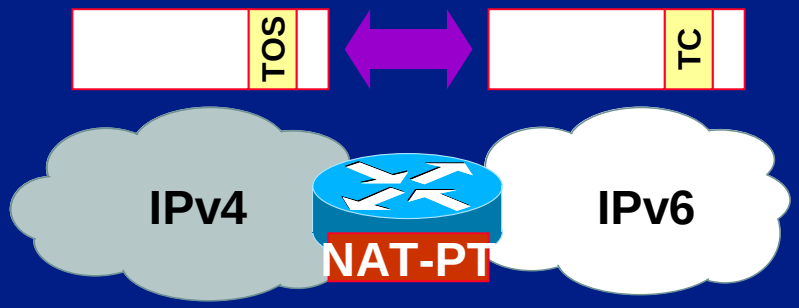
QoS (II)

- *Translation mechanisms & QoS (A)*
  - *IPv4 → IPv6*
    - *Translate TOS field to Traffic Class field*
  - *IPv6 → IPv4*
    - *Translate Traffic Class field to TOS field*
  - *In both situations*
    - *If different networks correspond to different domains, the translator must also implement DS border functions*

    → ***Issue a**ddressed in Translation Mechanisms*
    (NAT-PT/SIIT)



+Classification
+Shaping
+Metering
+Marking
+Dropping
+scheduling

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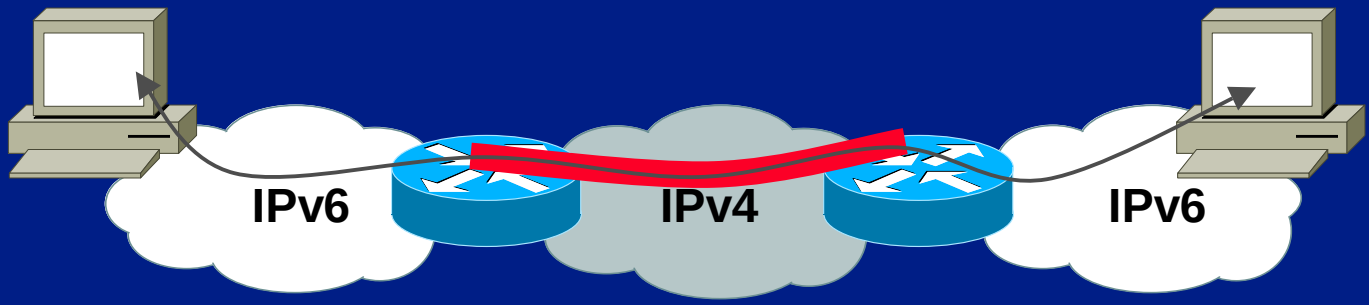
QoS (III)

- *Tunnelling mechanisms & QoS (B)*
  - *How will the outer packet (IPv4) have a correct treatment with the DSCP field in the inner packet (IPv6)? → The TC field in the inner packet must be copied to the TOS field at IPv4 network ingress*



  - *It makes possible to use IPv4 DiffServ implementations while IPv6 ones are not available*
  - *DSCP field may change inside the IPv4 domain*

  → ***Issue not addressed by Tunnelling Mechanisms***

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IP Mobility

- *Mobile IP has implementations for both IPv4 and IPv6*
- *Concepts and required entities are similar but MIPv6 presents some improvements relatively to the v4 standard (for example regarding triangle-routing)*
- *IP Mobility adoption in real scenarios is growing BUT all transition mechanisms assume devices are static inside some IPv4 or IPv6 network*
  - *Is there any solution for IP Mobility in transition scenarios?*
  - *Discovery, Registration & Tunnelling operations are supported?*
  - *MN, HA, HN, FA, FN, COA, CN will interoperate and be valid?*
- *Recent drafts RFC appeared addressing this topic*
  - *Almost all require Dual-stack MN*
  - *Proposals for new entities are introduced*
  - *MIPv6 operates similar to IPv4, in several situations (no BC in IPv4-only hosts)*

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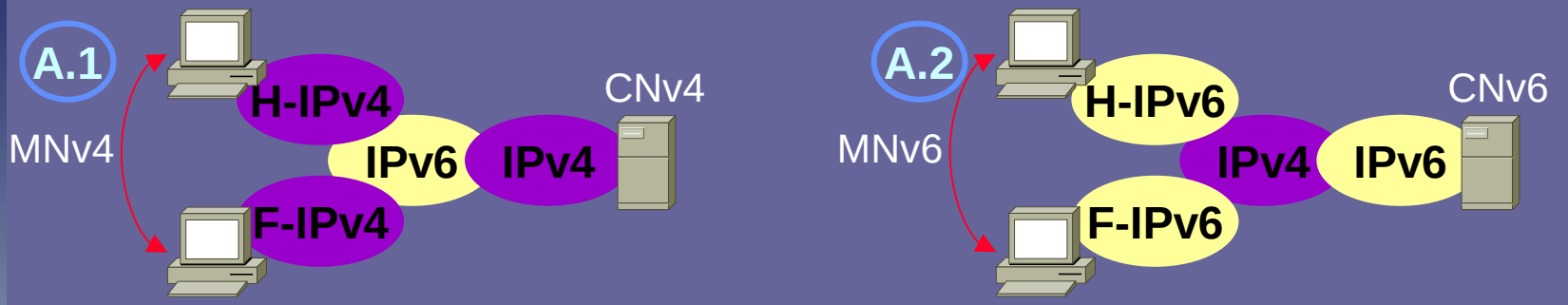
IP Mobility between same IP version



- *No problem for mobility! Just use an appropriate tunnelling mechanism*

- *If MN is single stack (IPv4 or IPv6) mobility is only possible between networks having the same IP version!*
  - *Use TM mechanisms like SIIT or NAT-PT*
  - *MN sends MIPv4 or MIPv6 registration messages to the HA*
- *If MN is double-stack, DSTM can also be used with Binding restrictions*

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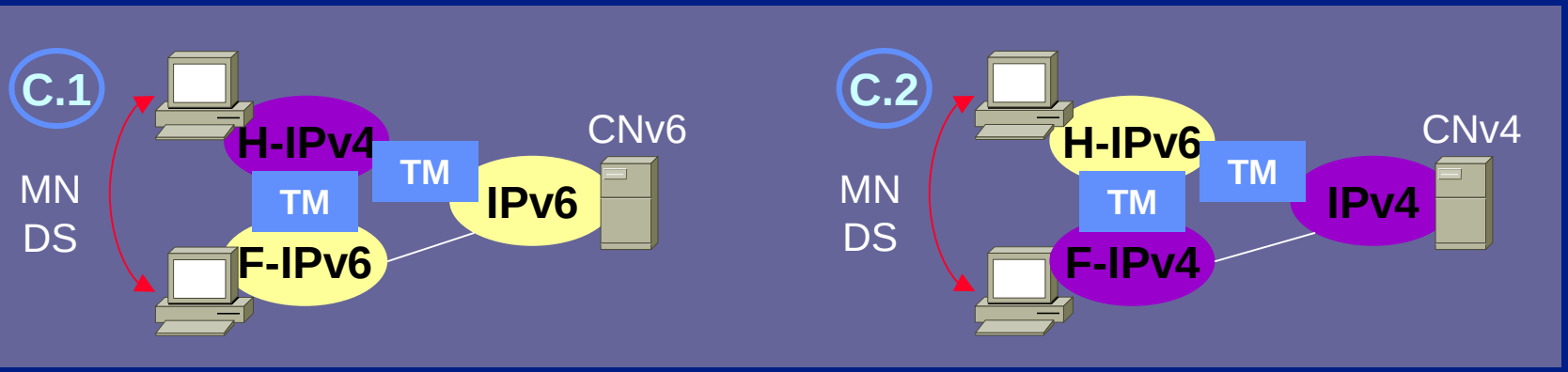
IP Mobility between IPv4 and IPv6



- *Dual-stack MN is required*
- *C.1: New entity introduced (draft-engelstad-ngtrans-mipv4-over-mipv6-01.txt): Dual Stack Mobility Agent (DSMA)*
  - *Mobility reduced to MIPv4 functionality (IPv4 connectivity)*
  - *May operate in the HN as (DS)HA or (DS)FA or in the FN as a (DS)FA*
  - *Requires that MIPv4 registration requests include "IPv6 Address Extension"*
- *DSMA may also be used with 6to4 (as well as Automatic Tunnelling)*

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Case studies: Application Level Services

- *Requests for new End–user Applications & Services represent a major driver for IPv6 deployment (taking benefit from always-on facility, for instance)*
- *Besides network level services (QoS, Mobility, ...), application level services operation (FTP, Web, Mail, LDAP, ...) must be guaranteed (while implementations should be migrated to IPv6)*
  - *IPv6 is supported by all major terminal Operating Systems (Windows, Solaris, FreeBSD, Linux)*
- *Services transition phases:*
  - *Use upper layer translation mechanisms (like BIS and BIA)*
  - *Port server applications to IPv6*
  - *Run server applications in dual-stack hosts*
  - *Other TM will be required to give access to the server, depending in the network IP version the server and the clients are placed*

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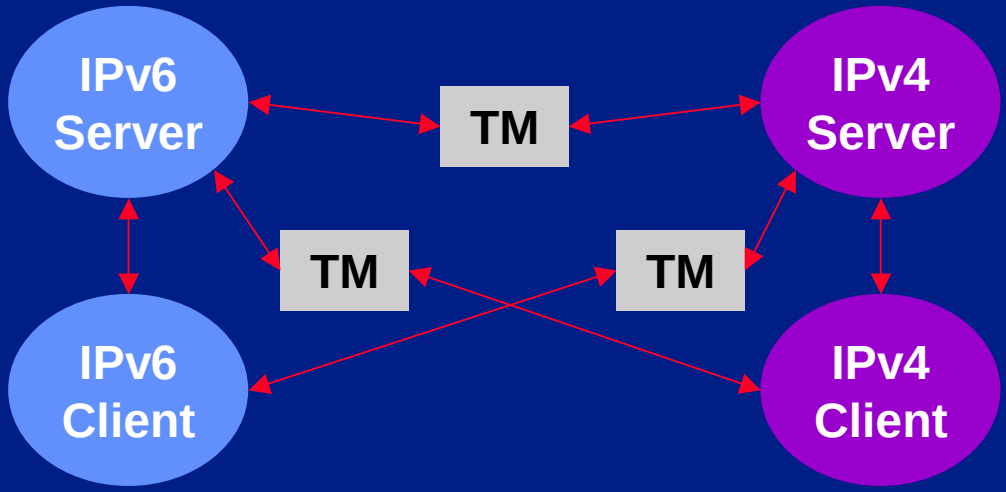
Client – Server service architectures

- *Scenario:*
  - *Client-server services used in full IPv4/v6 communication configurations*
- *There is at least one IPv6 implementation for the following service servers and clients:*
  - *FTP, Mail, News, IRC, LDAP, DNS, DHCP*
- *Some of these services require Application Level Gateways (e.g DNS and FTP)*



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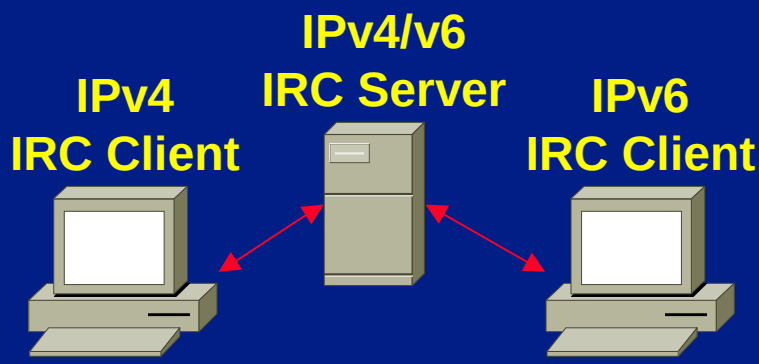
IRC scenario (I)

- *Objective:*
  - *To allow seamless communication between IPv4 and IPv6 IRC clients*
- *No ALG required for IRC*
- *Simplest scenario:*
  - *Dual-stack server accepting connections from both IPv4 and IPv6 clients*
    - *IPv6 socket opened to accept connection in all interfaces can also accept IPv4 packets*



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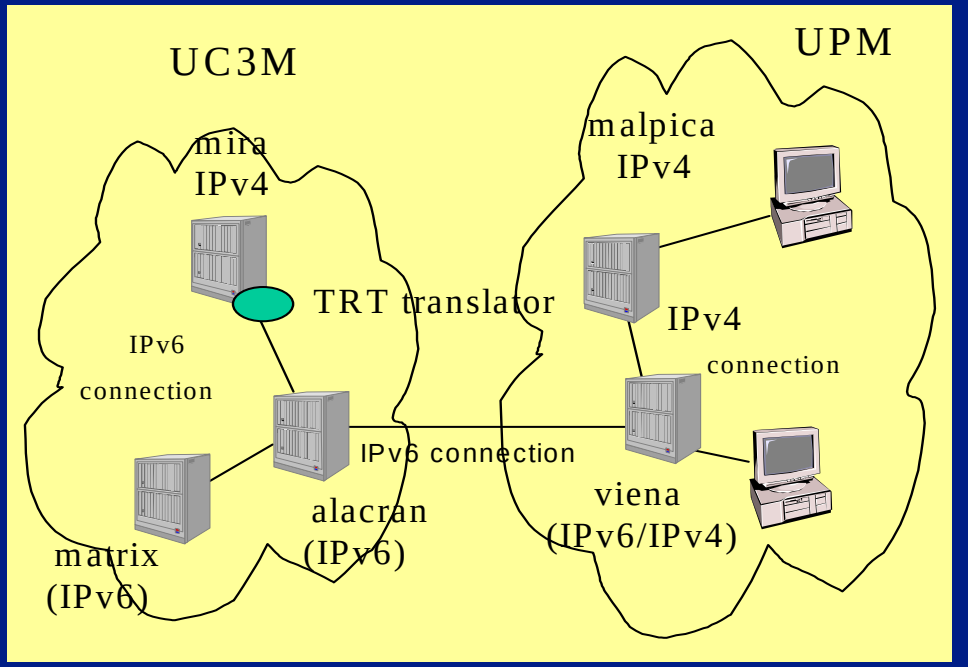
IRC scenario: Servers

- *At UC3M site:*
  - ***alarcan** & **matrix**, IPv6-only, and **mira**, IPv4-only, servers*
  - *TRT 'connects' mira to alarcan; NAT-PT was a possibility but TRT (FreeBSD faithd) was used instead, only for the required communication port (TCP 7000)*
  - *It must be the IPv6 IRC server establishing the connection to the IPv4 IRC server (faithd limitation)*



- *At UPM site:*
  - ***viena**, Dual-stack, accepts connections from IPv4 and IPv6 clients; **malpica**, IPv4-only, connects to viena and accepts connections from IPv4-only clients*

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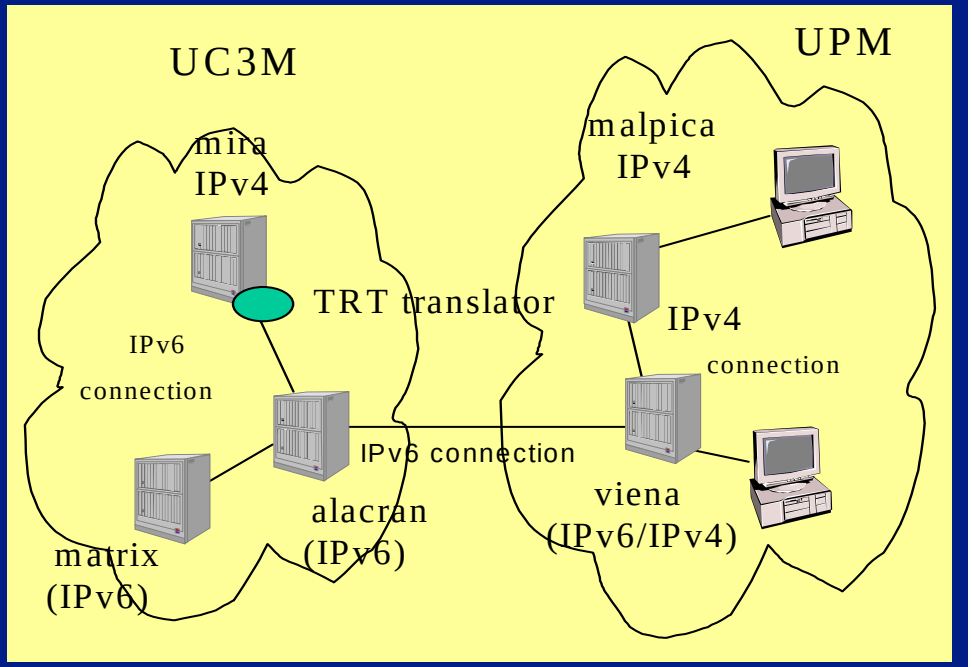
IRC scenario: Clients

- *UC3M will access to alacran using an IPv6 client (for example, xchat 1.8.6 – IPv6 is supported form version 1.8)*
- *UPM will access to viena using an IPv6 client*
- *TID will access mira using an IPv4 client*
- *PTIN will access viena using an IPv6 client*
- *The rest of the partners can choose what protocol and server they can use*



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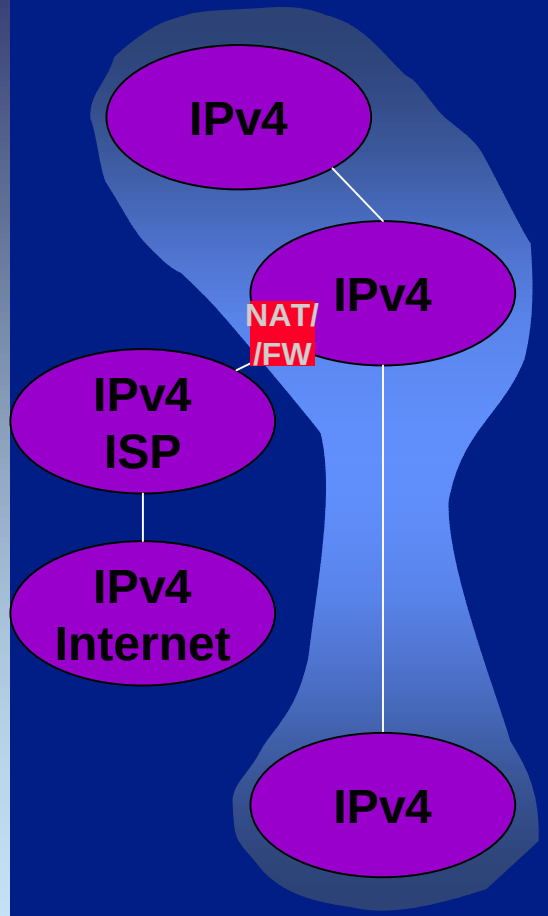
Example: Company network evolution towards IPv6



- *The company has three sites communicating through dedicated lines (L2)*
- *Actually, the company only runs IPv4 hosts and applications*
- *Access to Internet, mail and other company services is made at the central site*
- *The company wants to deploy a strategy towards a full IPv6 operation and seeks for an IPv6 ISP*
  - *Addressing: Internal private addressing*
  - *Servers: all IPv4 native*
  - *Clients: all IPv4 native*
  - *Internet: Access: through NAT and FW*

  (routing and DNS are not addressed)

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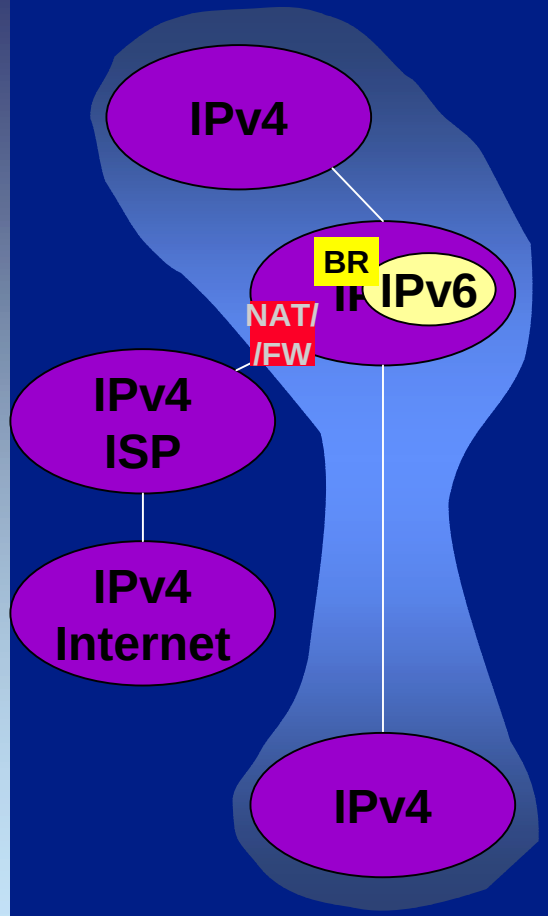
Step I: First local tests



- *Perform first tests selecting or deploying a new network section to deploy Dual-stack and IPv6-only hosts; this section is likely to be connected by a Dual-stack router (Border Router)*
- *Dual-stack servers should also be deployed, serving as IPv6 servers for Dual-stack hosts and also as relay for IPv4 servers ('official' company servers); IPv4 hosts may also experiment to connect to IPv6 servers*
  - *Use NAT-PT to connect this IPv6 network section*
  - *Servers can also use TRT to connect to other IPv4 company servers*

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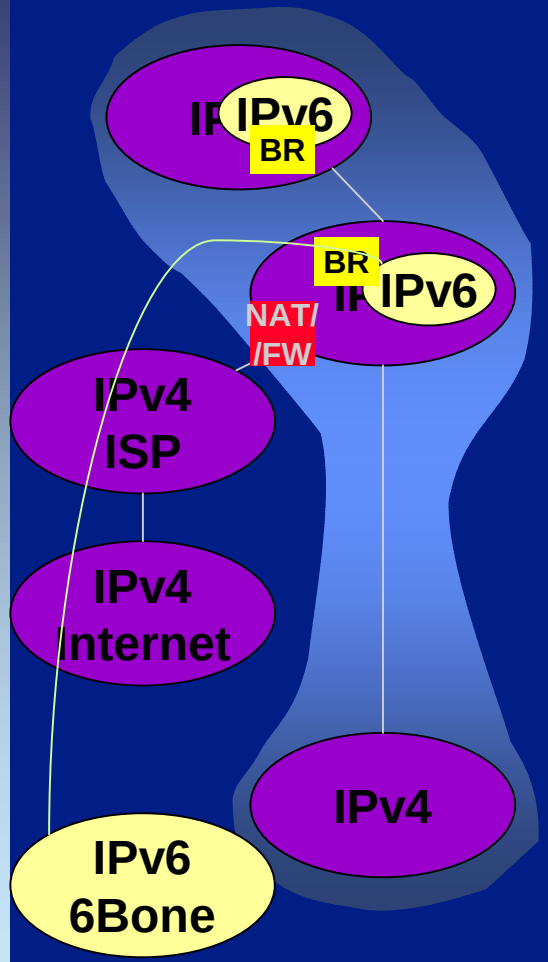
Step II: Start internal and external remote IPv6 connections



- *Start deploying remote IPv6 connectivity over the internal IPv4 infra-structure*
  - *Keep previous translation mechanisms and start using appropriate tunnelling mechanisms*
- *The company intends to start connections to external IPv6 networks, like 6Bone; the actual ISP still does not provide IPv6 connectivity*
  - *Use a configured tunnel or 6to4 (may require current firewall conf. or install a new IPv6 firewall)*

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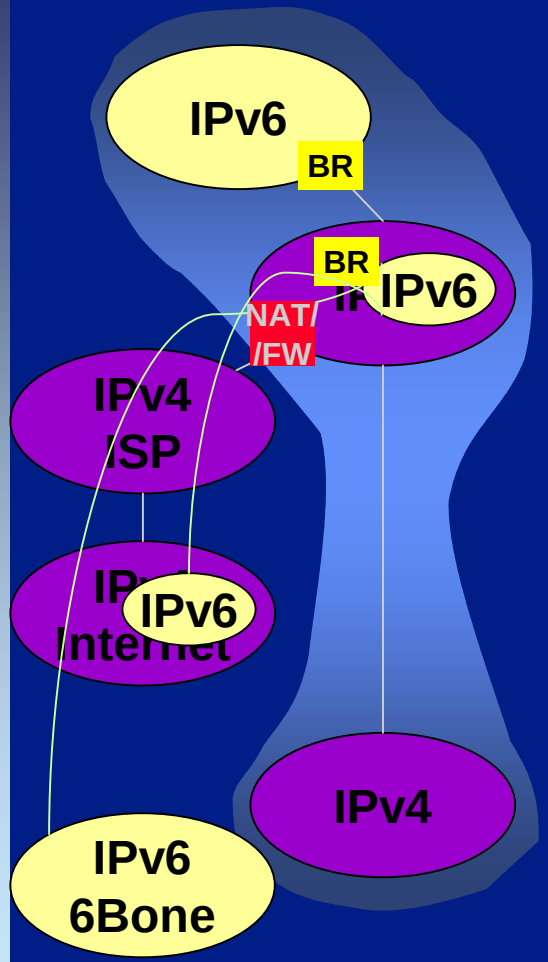
Step III: Create extranets with partners



- *One of the sites is completely moved to IPv6 (using both Dual-stack and IPv6-only hosts)*
- *DSTM can de used at that site, as well as any other TM to connect to other IPv6 islands; translation is required to reach IPv4 hosts and servers (if those are not isolated Dual-stack nodes)*
- *IPv6 islands of interest start to appear in the Internet, maybe belonging to external partners; IPv6 extranets may/must now be established;*
  - *6to4 is the adopted mechanism*

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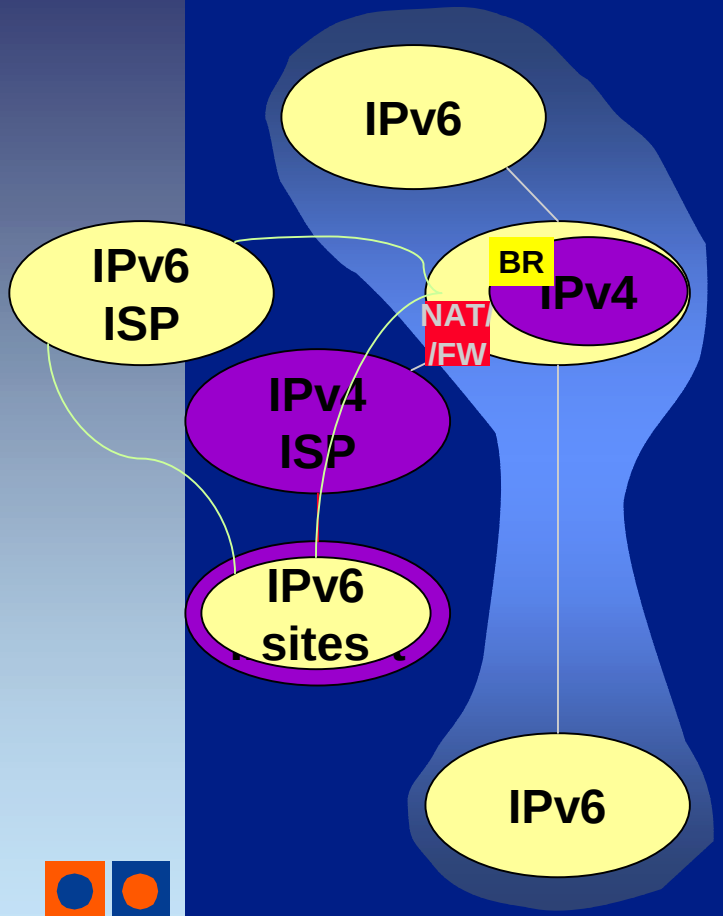
Step IV: IPv6 becomes the main protocol



- *Company servers are migrated to Dual-stack or IPv6-only; now IPv4-only devices (hosts and servers) represent an island inside the company network or are isolated hosts;*
  - *BIS may be required; BIA may also be used*
- *At this time it may be expected that a native IPv6 ISP may appear and, besides native IPv6 access to Internet IPv6 sites, Multi-homing can also be tested*

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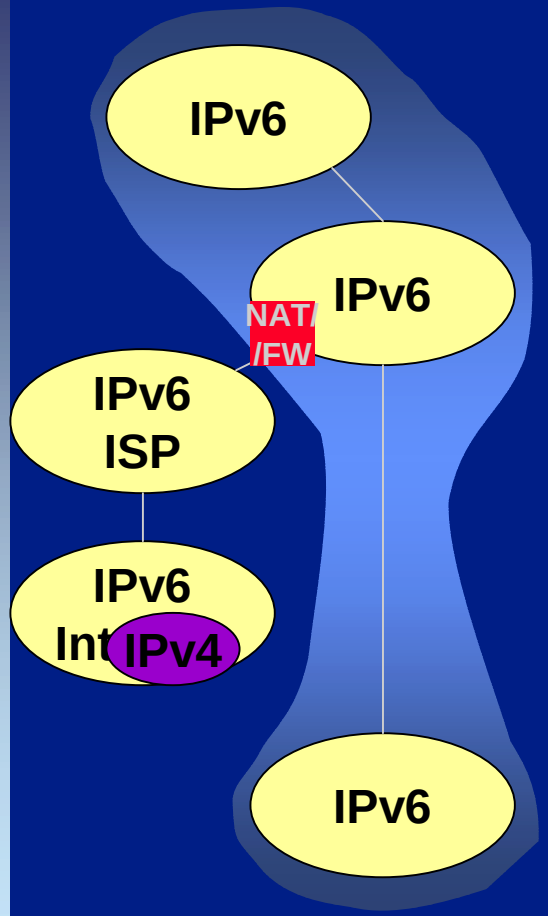
Final situation



- *At this phase the company has moved completely to IPv6, even if it may exist some IPv4 islands in the Internet*
  - *NAT-PT at these networks entry-points should be used*

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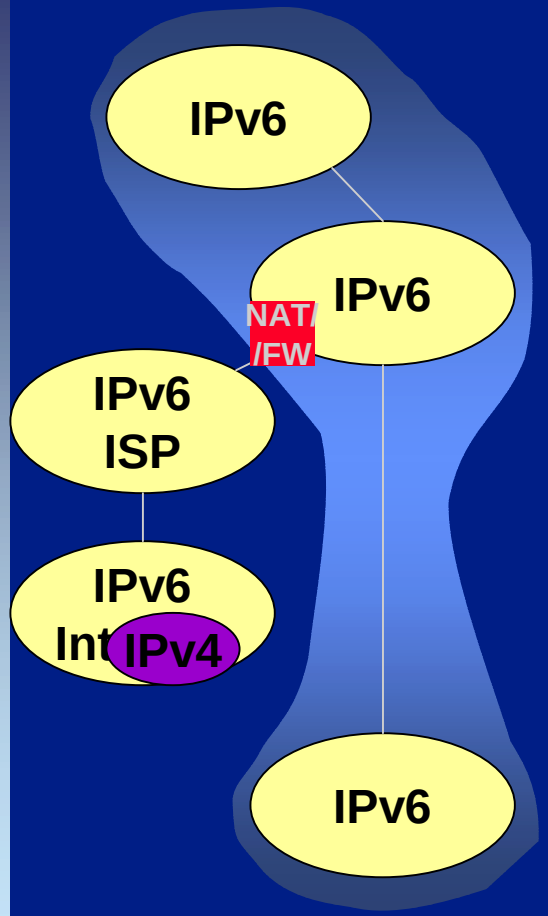
Additional aspects



- *But, what about required native ...*
  - *... IPv6 network management?*
  - *... IPv6-VPN services at L2 and L3?*
  - *... Applications and services or IP version independent ones?*
  - *... Hardware acceleration for IPv6?*

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Conclusions

- *Most of the existing Transition Mechanisms are devoted to the end-to-end transmission of IPv6 packets in an IPv4 routing environment*
- *All transition mechanisms require at least one dual-stack device in communication path (end-points or terminals)*
- *Even if IPv6 covers almost all basic IPv4 aspects (even improving most of them), actual Transition Mechanisms do not fully support all of the advanced network services:*
  - *Connectivity and application operation is well supported*
  - *Advanced network aspects, like QoS, Mobility and Security are not fully supported or are impossible to be deployed*

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Conclusions

- *Today's experience, do not fully guarantee that Translation do not have unknown effects on aplics & servs running between end-points with different IP versions; in the same way, Tunelling may take to unexpected network effects on aplics & servs usage even if transparent to IP versions from end-points point-of-view*
  - *Where protocol translation is necessary, translators operating at upper layer should be used; IP-layer protocol translators should be used when there is no alternative*
  - *6to4 encapsulating mechanism is one of the most flexible*
- *Anyway, today we have good conditions to start migrating to IPv6, running real services*

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THANK YOU!!

Francisco Fontes

fontes@ptinovacao.pt

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