TELECOM ITALIA GROUP

GogoNET

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Migration to IPv6 in Telecom Italia

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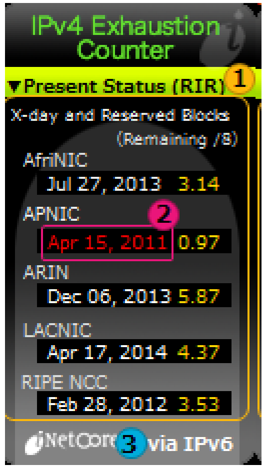
Agenda

- *Main Drivers*
- Methodology
- TI's IPv6 Architecture
- Lessons learned and Conclusions

Main Drivers

- We are facing the IPv4 depletion:
  - In February 2011 IANA assigned all the remaining /8 blocks
  - In April 2011 APNIC announced its IPv4 Address Pool reached Final /8
  - RIPE is going to reach its final /8 soon



- How can we continue offering internet services?
  - New customers need *connectivity* to the internet
  - How long can we survive with remaing IPv4 addresses?
  - What's next? What are the possible options?

Possible options

Optimizing IPv4 public space utilization

- How many IPv4 addresses can we really save? At what cost?
- How long do we want to extend the IPv4 life?
- It is not a target solution

Introducing NAT techniques

- It is a trivial task
- It requires a lot work in order to engineer a deployable solution
- Again it is not a target solution: it is just a way to extend IPv4 life

Moving to IPv6

- IPv6 solves IPv4 addresses depletion problem
- It requires a lot of activities on the entire network not only for the IPv6 introduction but also to deal with the IPv4/IPv6 co-existence phase

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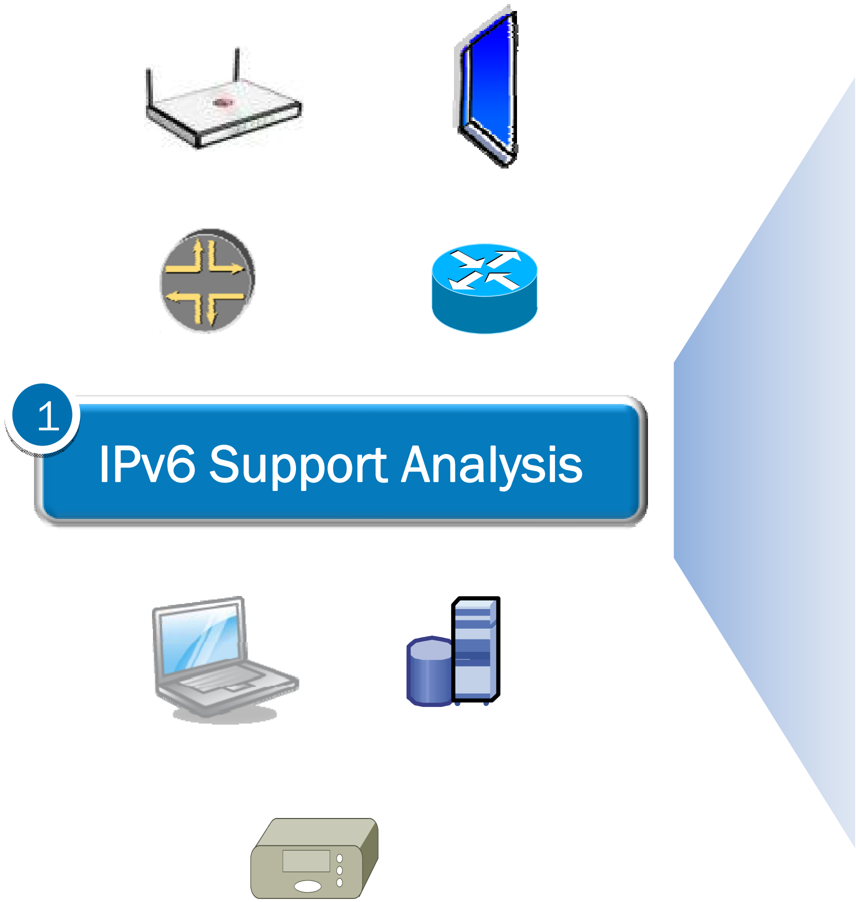
Methodology

- A step by step process to drive the IPv4/IPv6 migration

1. IPv6 Support Analysis
2. Model definition
3. Implementation Analysis
4. Early Deployment

Step 1: IPv6 Support Analysis

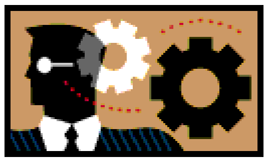


- Deep analysis of all the network segments to understand both the status of the IPv6 support the roadmap for new IPv6 features
- The vendors were fully involved in this phase

- Network segments analyzed:
  - Home network: CPE
  - Access and Aggregation: DSLAM (IP and ATM), Multilayer Switches
  - IP Edge: BNG, AAA RADIUS Server
  - Backbone: Core Routers
  - Service Platforms: Management Systems, IPTV Platforms ,...

Step 2: Model definition

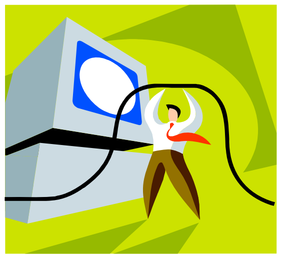
2 Model definition



- Challenging questions raised based on the previous analysis:
  - How many network devices are the IPv6 ready ? (*Few in the Edge)*
  - Which services could we move to IPv6? (*HIS* only in the first phase)
  - Do we need additional functions? (*IPv4/IPv6 transition mechanism*) How do we choose one?
  - What could be a reasonable timeframe for a lab trial as Proof of Concept?
  - What is still missing? Bringing new requirements and proposals in the standardization bodies (IETF, BBF)

Step 3: Implementation Analysis

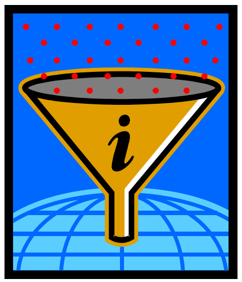
3 Implementation Analysis



- Goal: building a solid Proof of Concept to evaluate the readiness of IPv6 features and their interoperability in TI's network
- Main Challenges:
  - A multi-vendor network implies differences in features roadmaps and raises interoperability issues
  - Not all network elements are not fully IPv6 ready (prototype CPE)
  - Narrowing down the IPv6 features list without loosing required functions
  - Testing to ensure that IPv6 introduction does not impact existing services

Step 4: Early Deployment

4 Early Deployment



- Goal: early pilot deployments are meant to assess functional design in the field:
  - verifying the IPv6 service behavior
  - collecting feedback about the customers satisfaction
  - monitoring performance
  - detecting unexpected behaviors and impacts on existing services
- Additional challenge:
  - Training people to IPv6: not only engineers, but call centers, field techs, customer facing personnel

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From Requirements to ...

Summary of the Requirements

- We are running out of IPv4 public addresses
- Routing private IPv4 addresses introduces operational complexity
- Two levels of NAT (at the CPE and at the network level) could negatively affect the behaviour of some applications
- Simple Dual-Stack model does not solve the IPv4 addresses depletion problem
- IPv4 service continuity is required for legacy IPv4 host
- Deploying IPv6 must not impact existing services

TI's IPv6 Architecture

IPv6 on the Edge

- IPv6 only over PPP for Residential customers

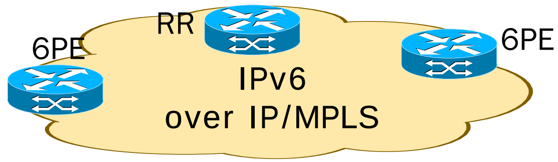
IPv6 only

- Dual Stack IPv4 and IPv6 for Business customers

IPv4 + IPv6

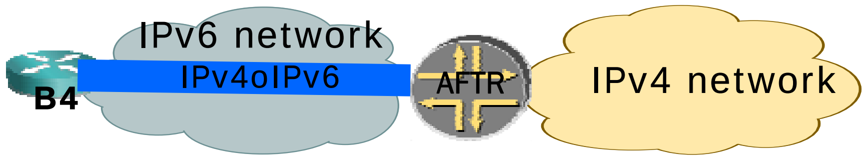
IPv6 over IP/MPLS in the Backbone

- 6PE on Backbone edge devices
- IP/MPLS forwarding in Backbone routers
- IPv6 dedicated Route Reflector Servers

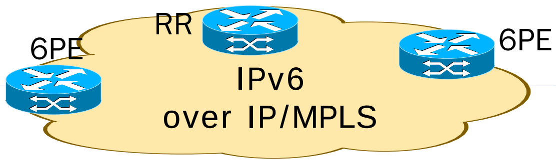


DS-Lite as Migration Strategy

- IPv4 over IPv6 tunnel initiated by CPE
- IPv4 NAT in the network



IPv6 over IP/MPLS in the Backbone

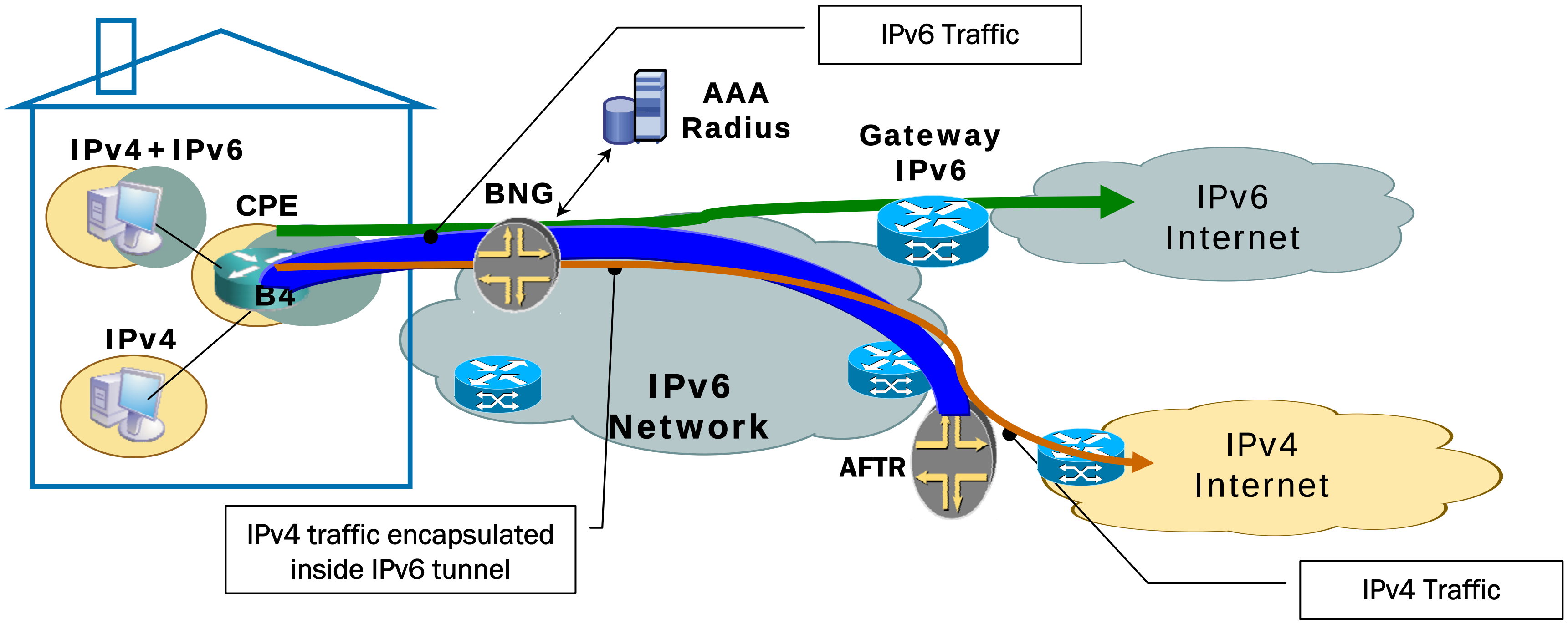


- Why using 6PE mechanism?
  - it provides IPv6 connectivity by leveraging the IP/MPLS architecture: it does not require upgrading to IPv6 the backbone routers
  - It is a standard already available on different routers
- Network Architecture:
  - 6PE functionalities enabled on all PoPs
  - Two dedicated IPv6 Route Reflectors introduced for advertising IPv6 customers routes
  - OSPFv3 on 6PE devices and on Route Reflectors
  - IPv6 peering gateway introduced for the interconnection with the IPv6 Global Internet
  - No impact on backbone P routers

Service Model for Residential customers

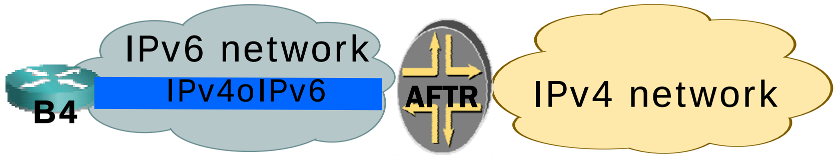
- IPv6 only over a PPP session:
  - thanks to PPP no change is required in the Access network
- DHCPv6 Prefix Delegation used to delegate a prefix for the home network
- SLAAC used to number the WAN interface of the CPE
- IPv6 prefixes for the subscribers can be:
  - assigned from AAA RADIUS server (IPv6 specific RADIUS attributes)
  - extracted from an IPv6 local pool configured on the BNG
- RADIUS Accounting records with IPv6 info are generated by the BNG
- CPE configured as Dual-Stack (IPv4/IPv6) device for the home network
- Hosts connected to CPE obtain their addresses by means of SLAAC

Dual-Stack Lite as IPv4/IPv6 migration strategy



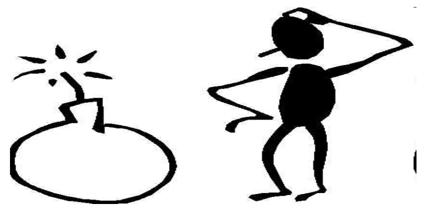
- **B4** (**B**asic **B**ridging **B**road**B**and)
  - Dual-Stack IPv4/IPv6 (IPv4 private and IPv6 prefix)
- **AFTR** (**A**ddress **F**amily **T**ransition **R**outer)
  - IPv4-over-IPv6 tunnel terminator
  - IPv4 NAT (Carrier Grade NAT)

DS-Lite: Motivations and Requirements



- Why DS-Lite?
  - it avoids using two levels of IPv4 NAT and routing IPv4 private addresses
  - It allows provisioning the CPE with an IPv6 only prefix while providing both IPv6 and IPv4 connectivity:
    - rationalized usage of remaining IPv4 addresses during the transition period to guarantee IPv4 service continuity for legacy IPv4 hosts
- Any additional requirements?
  - new provisioning tools for CPE: DHCPv6 option and RADIUS attribute
  - standard specifications are available: now we need implementations

DS-Lite deployment challenges



- DS-Lite support on CPE:
  - only prototypes are currently available
- AFTR inherits some CGN issues:
  - logging needed for users traceability
  - A huge amount of data are produced by AFTR for loggging
  - A lot of work is required for logging post processing
  - Optimizations are needed: port block allocation
  - Users/Application control of the port allocation: Port Control Protocol
- Subscribers Manager functions split between BNG and AFTR:
  - The BNG interacts with AAA RADIUS Server while the AFTR
  - However: the BNG sees IPv6 traffic only
  - Policies on IPv4 traffic must be applied on the AFTR

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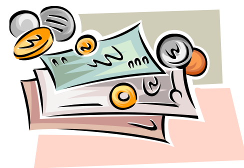
Lessons learned and Conclusions



- Costs for IPv6 migration are high:
  - upgrading network devices but also training people
- A transition mechanism is required to deal with the IPv4/IPv6 migration and co-existence phase
- Standardization is key for a multi-vendor environment
- Testing and interoperability are critical for a successful deployment
- Not all network segments are fully IPv6 ready yet
- More applications and more contents over IPv6 are needed

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Questions?

Thank you!