IPv6 Integration at The French Registry

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Introduction

❑ AFNIC:

- DNS Registry for *.fr* (France)*, .re* (Réunion island)*, .tf, .wf, .pm* and *.yt*

❑ IPv6 is deployed at AFNIC:

- In the Enterprise managed network (routing equipment, firewalls, servers, workstations…)

- In the AFNIC's Registration System
    - The Database, as the unique source of DNS and Whois Data
    - Network tools and scripts used at AFNIC support IPv6

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Reminder: Two approaches to the DNS

❏ The DNS seen as a database

- Stores different types of resource records (RR), including those related to IPv4 and IPv6 addersses: SOA, NS, A, AAAA, MX, PTR, TXT, …

- *DNS database is IP transport version agnostic!*

❏ The DNS seen as a TCP/IP application

- The service is accessible in either transport modes (UDP/TCP) and over either IP versions (v4/v6)

- *Information given over either IP version MUST BE CONSISTENT!*

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DNS Extensions for IPv6 Support
RFC 3596 (DS)

❑ *Forward lookup* ('Name à IPv6 Address'):

- A **new** Resource Record (RR) : **'AAAA'**

- The **'AAAA'** RR is for IPv6 what the **'A'** RR 'is for IPv4

- Example:
  www.afnic.fr.   IN   **A**   192.134.4.20
                 IN   **AAAA**   2001:660:3003:2::4:20

❑ *Reverse lookup* ('IPv6 Address à Name'):

- **A new and dedicated** reverse tree: **ip6.arpa**

- The IPv6 equivalent to the IPv4 dedicated in-addr.arpa tree

- Populated with **PTR** and NS RRs with *nibble* (4 bits) *boundaries*

- Example:
0.2.0.0.4.0.0.0.0.0.0.0.0.0.0.0. 2.0.0.0.6.0.0.3.0.6.6.0.1.0.0.2.ip6.arpa.   PTR www.afnic.fr.

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IPv6 at AFNIC: Main reasons

❑ **Technical reasons for AFNIC's Network**

- As an IT actor, AFNIC must master IPv6 technology and progressively integrate it in its network infrastructure and services

❑ **Technical and political reasons for the "French Internet"**

- The DNS is among the most critical IP applications

  ➔ Support of IPv6 in the DNS is a pre-requisite for the Internet-v6 deployment

- Support IPv6 in .fr TLD zone ➔ Get out of the critical path of IPv6 deployment in France

- Since its creation, AFNIC has embraced IPv6 technology in order to facilitate its deployment in France

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IPv6 at AFNIC:
Implementation & Early Deployment

❑ **1996-2000: Participation in G6 activities**

- G6: French Group for IPv6 experimentation and deployment (http://www.g6.asso.fr/)

- INRIA among the early G6 members in 1996. The French NIC (formerly "NIC-France"), part of INRIA at that time, offered its DNS expertise to the G6 community

- The French NIC became AFNIC, a French association founded in 1998. Support for IPv6 and its related activities have been increasing since then

❑ **2000: Started an IPv6 testbed**

- A test platform made and interconnected with the G6bone

- Experimentation of IPv6-enabled network services: DNS (BIND 9.0), Web, …

❑ **2001: Started basic IPv6 deployment**

- Interconnected with the Renater2 pre-production network ("IPv6 pilot")

- *Native* IPv6 support made for a *.fr* official secondary DNS server (ns3)

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IPv6 at AFNIC:
Evaluation, Validation & Full Deployment

❑ **2002-2003: Evaluation and integration in production**

- **For AFNIC's network infrastructure and services**
  - Native interconnection with Renater3 production network
  - Progressive support of IPv6 in production (dual-stack) for basic network services: DNS, FTP, SSH, …
  - Active participation in the IETF interoperability activities ➔ standardization of DNS extensions to support IPv6 (RFC 3596: AAAA, ip6.arpa)

- **For AFNIC's Registration System**
  - First stage: IPv6 adresses IPv6 (AAAA glue records) registered manually in fr zone
  - IPv6 support in the new version (2002) of ZoneCheck, the AFNIC's zone checker: http://www.zonecheck.fr/
  - October 2003: IPv6 full automation in the daily .fr et .re Registries operations http://www.afnic.fr/data/actu/public/2003/CP20030915-english.pdf

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IPv6 at AFNIC: Keep improving, stay active!

❑ **2004 ➔ today: Increasing involvement, more results**

- July 2004: The *.fr* was among the first 3 TLD (with *.jp* and *.kr*) whose DNS IPv6 addresses were registered in the root zone:
  http://www.afnic.fr/actu/nouvelles/international/CP20040722

- Assisted IANA in writing procedures for TLD delegation with IPv6 support:
  http://www.iana.org/procedures/delegation-data.html

- IPv6 expertise, documentation and training support for the French and other TLDs communities (e.g. AFNIC's "Collège international")

- Active participation in IPv6 and DNS related topics within IETF, RIPE and G6 communities

For DNS Registries not supporting IPv6 yet

❑ Not yet IPv6-ready?! It's high time you went for it ;-)

❑ Yet, go for it step by step!

❑ **Bare minimum IPv6 support**

- Support for IPv6 AAAA glue records in your registration system
    - You may start with processing manually requests with IPv6 glue input
    - Push IPv6 AAAA records into the DNS zone to publish

- All authoritative name servers must support AAAA records
    - You're lucky: Today, it's the case for all new and/or up-to-date DNS server software
    - Remember: DNS zone seen as a database, does not need IPv6 transport

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For DNS Registries not supporting IPv6 yet (2)

❑ **Advanced support: Keep going!**

- Have at least one of your authoritative name servers support IPv6 transport
    - You're lucky: almost all DNS server software support IPv6 transport today
    - If you have IPv6 good connectivity, then you're done

- Integrate IPv6 support throughout your Information System
    - In Whois (database and service transport)
    - Think at your internal tools and scripts

- Integrate IPv6 support in all your other network services
    - Examples: web, ssh, smtp…
    - Once again: step by step with prior testing and validation

❑ **Further involvement: A nice-to-have :-)**

- You've set the example: Now, you should raise awareness within your local community

- Promote IPv6 deployment everywhere

- Put pressure on other actors not doing their work (well)

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Operational Requirements & Recommendations

❑ During the long IPv4-IPv6 co-existence period:

- Some systems will remain IPv4-only
- Some systems will be dual-stacked
- Some systems will start/be IPv6-only

❑ Progressive and smooth integration of IPv6 on a service basis

- Example: How to publish in the DNS the IPv6 address of a new service running on equipment foo?
  - Add a AAAA record for foo?
  - Or add a new entry dedicated to the v6-only service?
  - That depends on how many services are running on foo…

❑ For DNSv6 Deployment

- Any DNS zone SHOULD be served by at least one IPv4 name server
- All DNS zones SHOULD be reachable over IPv4 and IPv6
- Read: RFC 3901: "DNS IPv6 Transport Operational Guidelines"
  - RFC4472 "Operational Considerations and Issues with IPv6"

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Operational Requirements & Recommendations (2)

❑ Typical recommended steps for IPv6 support in service deployment:

- Evaluate the interest and the priority, and study the feasibility

- Test and validate the/a solution in a near-production environment

- Enable IPv6 in production
    - Schedule the service activation (provisioning, communication, …)
    - Provide for a **"rollback"** mechanism (if things go wrong…)
    - DO NOT disturb the IPv4 service access (if any)
    - Be careful of potential side effects!
    - Keep an eye on the service operation on a reasonably long period
    - Make sure the whole service performance (with "IPv6 on") is at least as good as before
    - Add the new IPv6 service to the set of your documented & monitored ones

❑ Share your experience with other people

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And… There ain't no perfect world ;-)

❑ **Being an early adopter of IPv6 makes of you an IPv6 tester and an IPv6 guinea pig at a time!**

- Tunnels with MTU issues ➔ Service global degradation
- Hard (especially at early stages) to find hardware and software handling IPv6 and IPv4 at the same level in terms of:
  - Functional completeness
  - Robustness and efficiency
    – Examples: bugs discovered in some combinations of IPv6-related factors with Linux kernels
- When/where needed, accept some short-term tradeoffs and workarounds for long-term better solutions
- Persevere in getting people as reactive at IPv6 incidents as they are at IPv4 ones
- Keep raising awareness in your community: nobody can deploy IPv6 alone!

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Conclusion

❑ **IPv6 is quite mature today**

- Core Specifications (IETF) are stable (RFCs in « DS » state)
- The main needed hardware and software elements are available
- Integration of IPv6 in a production environment is feasible
- Even if there are still many things to do/improve…

❑ **As ccTLD operators:**

- DO NOT stay in the « critical path » of IPv6 deployment
- IPv4-IPv6 co-existence period will be much longer than expected if Network actors keep postponing IPv6 adoption
- Staff training is a key factor of IPv6 adoption and deployment

DNS IPv6-capable software

- BIND distribution (recursive server and authoritative server + utilities)
  - http://www.isc.org/products/BIND/

- NSD (authoritative server only)
  - http://www.nlnetlabs.nl/nsd/

- Unbound (validating recursive caching resolver)
  - http://www.nlnetlabs.nl/unbound/

- Microsoft Windows (Resolver & Server)

- Others: PowerDNS, Atlas…

- On Unix distributions
  - Resolver Library (+ (adapted) BIND)

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