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TECHNICAL REPORT

**Network Technologies (NTECH);
Description of the DNS protocol usage
in IP based operators networks**

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Network Technologies (NTECH).

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1 Scope

The present document describes different use cases for the usage of the DNS protocol (e.g. Service Location, NP/ENUM, address resolution) in IP based operators networks. The DNS base protocol itself is defined in RFC 1035 [i.16].

The present document describes the behaviour and details for DNS protocol usage in IP based operators networks, transport options for DNS messages, DNS protocol behaviour and configuration as well as options to make the usage of the DNS protocol more reliable (e.g. timer characteristics etc.).

The use cases described here and options to make the usage of the DNS protocol more reliable are principal ones for network operators and not intended to be exhaustive.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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2.2 Informative references

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ICANN: "Internet Consensus Policy 2: Criteria for Establishment of New Regional Internet Registries".

[i.2] ETSI TS 182 028: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN integrated IPTV subsystem Architecture".

[i.3] IETF RFC 5966: "DNS Transport over TCP - Implementation Requirements".

[i.4] ETSI TS 124 229: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3 (3GPP TS 24.229)".

[i.5] IETF RFC 3263: "Session Initiation Protocol (SIP): Locating SIP Servers".

[i.6] ETSI TR 184 003: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Portability of telephone numbers between operators for Next Generation Networks (NGNs)".

[i.7] IETF RFC 3761: "The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM)".

[i.8] ETSI TS 184 009: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Rules covering the use of TV URIs for the Identification of Television Channels".

[i.9] IETF RFC 2838: "Uniform Resource Identifiers for Television Broadcasts".

[i.10] IETF RFC 2396: "Uniform Resource Identifiers (URI): Generic Syntax".

[i.11] IETF RFC 2782: "A DNS RR for specifying the location of services (DNS SRV)".

[i.12] IETF RFC 3403: "Dynamic Delegation Discovery System (DDDS) Part Three: The Domain Name System (DNS) Database".

[i.13] IETF RFC 1034: "Domain names - concepts and facilities".

[i.14] IETF RFC 2317: "Classless IN-ADDR.ARPA delegation".

[i.15] IETF RFC 3596: "DNS Extensions to Support IP Version 6".

[i.16] IETF RFC 1035: "Domain names - implementation and specification".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

access network provider: service provider that provides physical and IP connectivity to a user equipment (UE) via a fixed or mobile access

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AfriNIC	African Network Information Centre
APNIC	Asia Pacific Network Information Centre
ARIN	American Registry for Internet Numbers
IANA	Internet Assigned Numbers Authority
DDDS	Dynamic Delegation Discovery System
DNS	Domain Name System
ENUM	tElephone NUMber mapping
FQDN	Fully Qualified Domain Name
ICANN	Internet Corporation for Assigned Names and Numbers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPTV	Internet Protocol TeleVision
LACNIC	Latin America & Caribbean Network Information Centre
LIR	Local Internet Registry
NAPTR	Naming Authority Pointer
NGN	Next Generation Network
NP	Number Portability
OSI	Open System Interconnection
P-CSCF	Proxy-Call Session Control Function
PTR	Pointer
RIPE NCC	Réseaux IP Européens Network Coordination Centre
RIR	Regional Internet Registry
RR	Resource Record
S-CSCF	Serving-Call Session Control Function
SDP	Session Description Protocol

SIP	Session Initiation Protocol
SRV	Service
TCP	Transport Control Protocol
TV	Tele Vision
UDP	User Datagram Protocol
UE	User Equipment
URI	Uniform Resource Identifier

4 DNS use cases in IP based operators networks

4.1 Service discovery

4.1.1 Service access point discovery

Service discovery can be defined as a mechanism which provides to a client, given a type of service that the client is looking for, and a domain in which the service is located and the IP protocol version the client is using, one or several IP addresses of systems which offer the requested services.

EXAMPLE: As described in clause 9 of ETSI TS 124 229 [i.4] the User Equipment (UE) can employ the DNS to obtain the P-CSCF IP address(es). This can be done when the UE is using IPv6 or IPv4 as a DNS or SIP/RTP message transport protocol and is valid for different IP-Connectivity Access Network (IP-CAN) types. Usually the UE will use RFC 3263 [i.5] to locate the P-CSCF IP address as a Session Initiation Protocol (SIP) server.

4.1.2 Locating service capabilities

The DNS protocol and infrastructure can be used to locate service capabilities in a DNS domain. In general there are 2 possibilities applicable:

- querying a FQDN which indicates service capabilities; or
- querying a distinct RR type and obtain the service capabilities from the answer.

In the first case the DNS client forms a FQDN which labels associate distinct service capabilities (e.g. SRV RFC 2782 [i.11]). On a try and fail basis the DNS is queried with this FQDN in the query section. When there is a RR delivered this service (DNS response code 0 - no error) is available in the DNS domain. When there is a negative answer (DNS response code 3 - NX Domain) this service does not exist in that domain. The application which triggers the DNS client can try to form a new FQDN which labels associate a similar service and sends a new DNS query with another FQDN in the query section. When there is no positive answer the application can try another FQDN or can stop using the DNS for service location for this current process.

In the second case the queried DNS Resource Records contain in their data section information regarding the available services for the domain. Therefore the DNS delivers typically several DNS RRs. So the DNS client can analyse this answer and select the best matching RR for the further processing of the communication service. A typical example for such a kind of service location is ENUM. The services field within the NAPTR RR [i.12] contains a character-string that specifies the service parameters applicable to the queried FQDN.

4.2 IP Address resolution

The impetus for the development of the domain system in the 1980's was the growth in the Internet. In the early days of the Internet the mapping of hostnames to IP addresses was provided in a single file (HOSTS.TXT) which was distributed via File Transfer Protocol by all hosts. This has now been replaced by the DNS. Whereas today the DNS provides possibilities for managing more than 100 different Resource Record types (http://www.iana.org/assignments/dns-parameters), the mapping of hostnames to IPv4 (DNS Resource Record Type 1) and IPv6 addresses (DNS Resource Record Type 28) is still a key functionality of the DNS. It should be mentioned that the queried resource record type is independent of DNS transport protocol.

A DNS client can:

- query an IPv4 address of a given FQDN by using IPv4 or IPv6 transport; and

- query an IPv6 address of a given FQDN by using IPv6 or IPv4 transport.

Resolving an IPv4/IPv6 address for a given/configured FQDN instead of configuring static IP addresses reduces the necessity of configuration on DNS client side.

4.3 Load sharing and load balancing

The basic idea of DNS load sharing is to associate several resource records with a single domain name. When the DNS responds to a request, it returns the whole list of resource records to the client. The resource records are then used in a round-robin or load-sharing fashion, thus providing some form of load balancing.

Four types of DNS load sharing techniques are possible:

- Load Sharing with round-robin DNS
- DNS views a.k.a. Split DNS
- Parsing and analyzing fields of the DNS query and calculating an answer
- DNS resource records with fields for priority indication

Load sharing with round-robin DNS

In its simplest implementation round-robin DNS works by responding to DNS requests not only with a single IP address, but a list of IP addresses of several servers that host identical services. The order in which IP addresses from the list are returned is the basis for the term round-robin. With each DNS response, the IP address sequence in the list is permuted. Usually, basic IP clients attempt connections with the first address returned from a DNS query so that on different connection attempts clients would receive service from different servers, thus distributing the overall load among servers.

DNS views

Setting up different views, or visibility, of the DNS space to internal and external resolvers is usually referred to as a Split DNS setup. This mechanism can also be used in order to distribute load on servers.
Due to the configuration of different views for different IP source address ranges on an authoritative DNS server, the authoritative DNS server will provide to each DNS client dependent on the IP address of the DNS client a preconfigured response. The figure 1 provides an overview on how an authoritative DNS server can process and answer a DNS query based on the source address of the query packet of the DNS client.

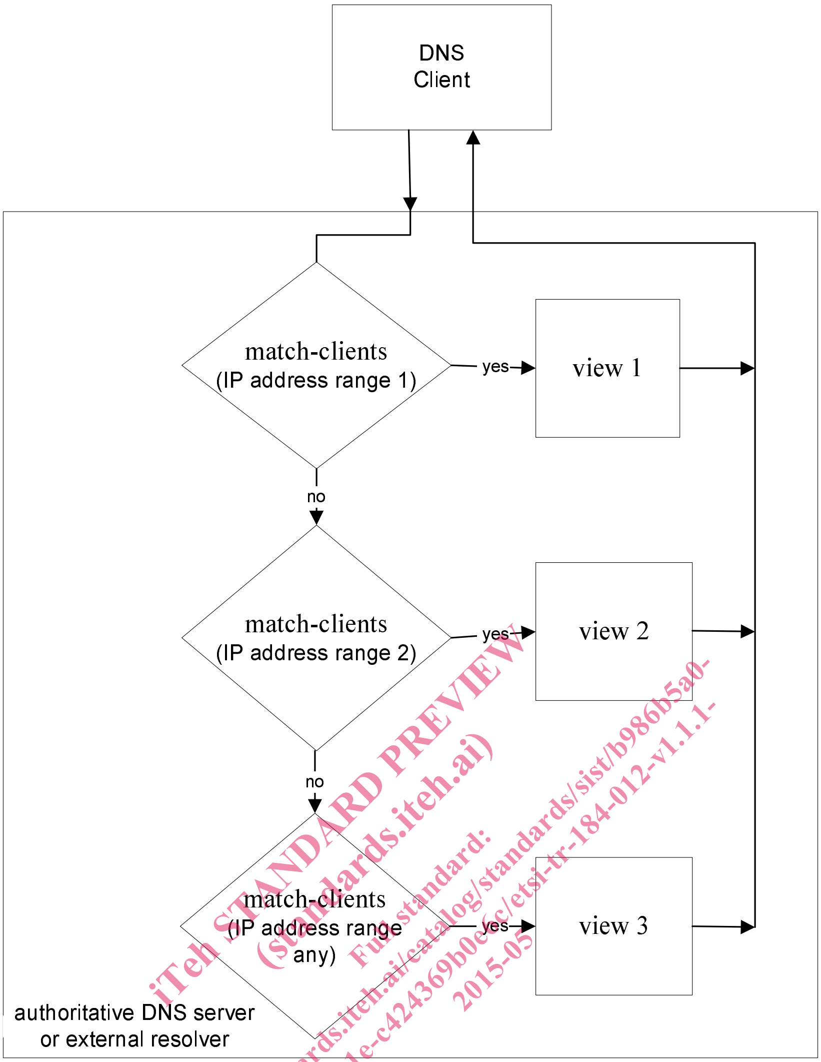

Figure 1: Processing of a DNS answer based on the IP address of the DNS client

Parsing and analyzing fields of the DNS query and calculating an answer

Similar to the split DNS approach where different DNS clients will be served with different answers based on a more or less static configuration it is possible to parse all or selected fields of a DNS query and calculate a DNS answer on demand based on distinct characteristics of the content of these fields. A typical use case here is the realization of DNS reverse mapping.

DNS resource records with fields for priority indication

Some resource record types contain in their data format fields which mandate the client to prioritize these RRs. Examples are the fields priority and weight within the SRV RR [i.11] or the fields order and preference within the NAPTR RR [i.12].

4.4 Number portability real time operational database

As described in ETSI TR 184 003 [i.6] DNS/ENUM is an option to provide Telephone Number Portability functionalities in NGN. Number Portability (NP) refers here only to the E.164 number part of the user's public identifier that, in NGN, can be represented with either a tel URI or a SIP URI (the user part of SIP URI) with the parameter "user=phone". ENUM itself is standardized in [i.7] and uses DNS protocol functionalities and mechanism.

4.5 Indicating security association

The DNS reverse mapping provides a capability to map an IP address to a hostname, whereas the authoritative rights for managing the DNS zone for the IP address will be delegated to the Local Internet Registry that assigns and allocates address space to its customers, telecom and enterprise organisations, as well as academic institutions.