DEUTSCHLAND-ONLINE INFRASTRUKTUR

IPv6 Reference Manual

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1 SUMMARY

The "Internet Protocol" (IP) is vital to the operation of networks in general and the Internet in particular. Not only does it facilitate the transport of data packages, but it also enables the addressing of components connected to the Internet. IP addresses are at the heart of every modern network infrastructure and ensure the operational effectiveness of the Internet activity.

Internet address space has become a scarce resource, and the on-going expansion of the Internet makes it evident that internet addresses will run out sooner or later. In practical terms this means that - in the long run – we will no longer be able to depend on a trouble-free use of the Internet because the number of internet addresses permitted by the current Internet Protocol version 4 (IPv4) will suffice no more. This situation can only be avoided by the introduction of a new Internet Protocol version (IPv6) which will provide a significantly greater addressing potential. In addition to solving the address space problem the transition to IPv6 will also address major policy goals such as maintaining the effectiveness of the Internet and promoting the use of new technologies.

Therefore the Cooperation Committee on Automated Data Processing for the Federation, the Länder and the municipalities KoopA (Decision Nr. 04 - 09/2007[1]) and the State Secretary Committee "Deutschland-Online" (November 2007) decided that, as central authority, the Federal Government should request IPv6 address space for the entire public administration sector in Germany. This decision was accompanied by the information and communications technologies strategy "Deutschland Digital 2015" for Germany adopted by the Federal Cabinet on 10 November 2010 [http://www.bmwi.de]. The strategy makes clear that, for Federation, Länder and municipalities, the introduction of IPv6 (Internet protocol version 6) represents an essential element in the implementation of new Internet technologies within the context of modern and secure communication infrastructures. The German public administration sector's request for Internet address space was granted by the European address allocation authority (RIPE NCC, Réseaux IP Européens Network Coordination Centre) in December 2009. In consequence the Federal government, represented by the Federal Ministry of the Interior (BMI), received a ::/26 IPv6 address block that equates to 2^{102} addresses and is there-

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[1] The KoopA considers the reservation of sufficient IPv6 address space for administrative use as advisable. The KoopA, therefore, asks the Federal Government as central authority to request such provider-independent IPv6 address space for the German federal public services from the RIPE. The "Deutschland-Online" project team of the KoopA, in coordination with the "Deutschland-Online"project, has the task of coming up with proposals on the organisation and implementation of future IPv6 address allocations and presenting those proposals to the KoopA.

fore considered sufficient for the entire German public administration sector. A contract establishing this allocation has been signed by the BMI and the RIPE NCC. In this process the BMI assumes the function of a Local Internet Registry (LIR) (referred to as "de.government") which is comparable to that of an Internet Service Provider. An IPv6 working group consisting of members from different administration levels ("IPv6 AG"), the Deutschland-Online Netz e.V. association and the BMI has established plans for structuring the address space as well as for organising and implementing the address assignment. Technical recommendations concerning the introduction of IPv6 have also been prepared.

Addresses will be made available on the basis of an address framework which describes the allocation of address space to the public administration. The address space has been divided into 64 equally sized blocks. It has been established for the long term and is believed to hold sufficient reserves for the foreseeable future. In a first step, address blocks were reserved for the Länder, the Federation and the indirectly subordinate administration.

The assignment and usage of addresses is based on a description of roles and processes. The de.government LIR has the overall responsibility for the address management at the highest level. End users will be assigned address blocks by means of so-called Sub-LIRs. At the present time, it is intended that the Länder, the DOI, the NdB and the Federal Ministry of Defence should act as Sub-LIRs. Additional Sub-LIRs may be established according to a clearly defined process. The Sub-LIRs are generally also responsible for administering the address space of the respective municipalities.

Other organs of public administration may be permitted to assume the role of a Sub-LIR where the address requirement can be adequately justified.

Matters of IPv6 technology in public administration infrastructures will be dealt with at a later time and will take into consideration the results of the current pilot projects.

To date there is little or no practical experience with the introduction and operation of IPv6 in Europe. In fact, we are entering uncharted waters here with the public administration sector taking on a pioneering role in the deployment of IPv6 in Europe. It is in this context that the present reference manual has been developed for the use of users, administrators and IT managers. It describes organisational frameworks and address structures and provides support for the migration. The contents of this reference manual may be revised and expanded as additional experience is gathered.

2   CHAPTER DESCRIPTION

Chapter 3 – "ORGANISING IPV6 IN PUBLIC ADMINISTRATION" describes the introduction of IPv6 addresses to the public administration sector of the Federal Republic of Germany.

This chapter addresses administration directors, IT managers in public administration, administrators, IT service providers, Internet service providers and IT employees performing related tasks.

The **Appendices II, Roles, and III, Processes,** describe the essential processes and roles that need to be followed for the assigning of IPv6 addresses in public administration. These processes and roles serve as templates for the processes and roles to be implemented in individual organisations and are meant to be included in internal manuals or workflow posters for the daily routines of employees.

They are aimed IT network administrators in public administration, directors and employees of de.government and their operative and strategic SUB-LIRs, and Internet service providers in public administration.

The remaining appendices provide help with the implementation of the structures and procedures described therein.

They are aimed at IT network administrators in public administration, directors and employees of de.government and operative and strategic SUB-LIRs.

3 ORGANISING IPv6 IN PUBLIC ADMINISTRATION

3.1 Introduction

In November 2009, the Local Internet Registry (LIR) **de.government**, represented by BMI IT5, was allocated the IPv6 address space **2a02:1000::/26** on behalf of the entire public administration sector of the Federal Republic of Germany by the RIPE NCC, the contracting authority responsible for Europe, for the purpose of sub-allocating and sub-assigning it.

The allocation of address space to de.government is accompanied by the step-by-step implementation of IPv6-enabled components and services to the major Federal IT infrastructures "Netze des Bundes" (NdB) and the "Deutschland-Online Infrastruktur" (DOI) core network that spans different levels of administration.

After paving the way for the use of IPv6 from the technical point of view, the first IPv6 pilot projects were introduced in 2010. Their aim was to test the new features, and, at the same time, lay the foundation for the broader productive rollout of IPv6 in public administration in the future.

At the same time as the pilot projects were being carried out, the fundamental organisational and technical elements were also being agreed upon by an IPv6 working group composed of representatives of the Federation, the Länder and the municipalities, public IT service providers, the BSI and the future operator. The forthcoming use of the IPv6 address space and the LIR operations will be based on the ideas and proposals of this working group.

The experiences and results from the aforementioned activities have been incorporated into this organisational framework, which is described in greater detail in the following sections.

3.2 Organisations involved

The IPv6 activities in the public sector of the Federal Republic of Germany involve different organisational units with different functions and responsibilities. The individual organisational units are described in greater detail in the following sections.

3.2.1 IT Planning Council

The IT Planning Council rules on the fundamental issues involved in the setting up, organising and assignment of IPv6 addresses affecting the Federation, the Länder and the municipalities.

The legal basis for the collaboration between the Federation and the Länder in matters of information technology was established by the Act on Connecting the IT Networks of the Federation and the Länder (implementing Article 91c of the Basic Law) [IT-NetzG] and the State Treaty on IT which took effect on 1 April 2010.

- The IT Planning Council is responsible for coordinating the work of the Federation and the Länder in matters of information technology.

- It establishes subject-independent and interdisciplinary standards on IT interoperability and security and is responsible for coordinating the core network.

- In accordance with the IT-NetzG the IT Planning Council makes the following specifications and monitors their implementation:

    – Requirements to be met by the core network
    – User classes of service to be offered
    – Minimum extent of services to be offered
    – Conditions for using the classes of service
    – Costs of using the classes including the procedure to establish their extent
    – Procedure for urgent decisions

The IT Planning Council consists of the Federal Government Commissioner for Information Technology and one IT representative from each Land. Three municipal representatives have an advisory function in the body.

3.2.2 CIO Council

The cabinet decision of 5 December 2007 "IT Management at Federal Level" established two new bodies: the CIO Council, made up of the chief information officers from each federal ministry, and the Federal IT Management Group. The CIO Council is the central body for interministerial control at Federal level. It is made

up of the chief information officers from each federal ministry. The CIO Council decides on the IT strategies, architectures and standards in the federal administration. In addition, it acts as a central contract point for the interministerial IT demand of the individual ministries and coordinates the portfolio of the Federal IT service providers.

Currently, the Federal Government Commissioner for Information Technology chairs the CIO Council. The members of the CIO Council meet every two months.

3.2.3 RIPE

The Réseaux IP Européens (RIPE) represents the Internet community in the RIPE countries (Europe, Countries of the former Soviet Union and Middle East) and, through the RIPE Community, defines the guiding principles for RIPE NCC (see below).

3.2.4 RIPE NCC

The Réseaux IP Européens Network Coordination Centre (RIPE NCC) is the Regional Internet Registry (RIR) responsible for Europe. It allocates IP address spaces and unique Autonomous System Numbers (ASN).

The organisation is based in Amsterdam. It was founded in 1992 as a non-profit organisation and is financed from the contributions of its members, mainly Internet service providers, universities and major IT companies. Its superordinate organisation, the Internet Assigned Numbers Authority (IANA), is responsible for all questions relating to IP address spaces and ASNs.

The RIPE NCC allocates blocks from the IP address space made available to it by the IANA to the Local Internet Registries (LIR) which in turn assign these to end users. In addition to the allocation of address blocks, the RIPE NCC also takes care of the database with the IP address spaces allocated by the RIPE NCC. The identity of users who have been allocated specific address blocks can be verified through the publically available Whois service.

A list of all LIRs broken down by country is available on the organisation's website. Individuals, companies or other organisations that require IP addresses must contact a LIR or become a member of the RIPE themselves.
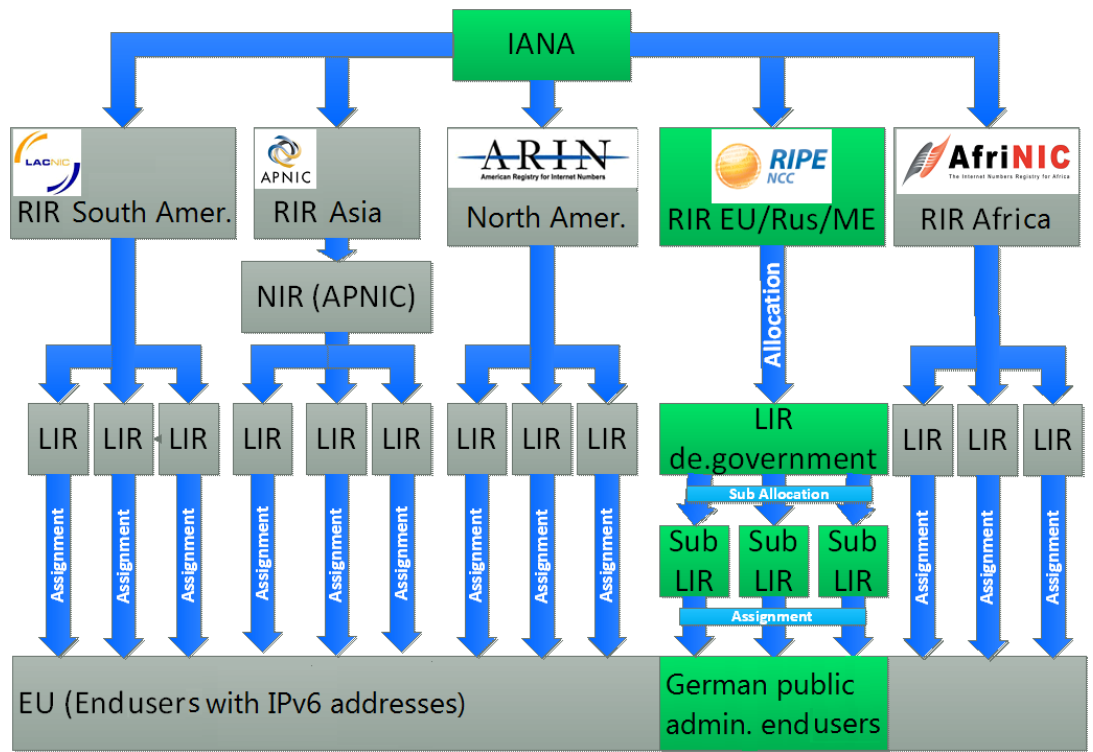
Figure 1: Global IP Address Registry

3.2.5 Local Internet Registry (LIR) "de.government"

In 2008, the BMI IT5 for and on behalf of the public administration in Germany, became a member of the RIPE NCC und hence assumed the role of a Local Internet Registry (LIR). The Registry ID (Reg. ID), i. e. the name of this LIR responsible for the managing of the entire IPv6 address space for the public administration in Germany, is "de.government". Hence BMI IT5 in this role is referred to as "LIR de.government" or "de.government" in the following sections.

The LIR "de.government" is the contractual partner of the RIPE NCC. This means that de.government is responsible for the entire IPv6 address space of the public administration sector in the Federal Republic of Germany.

De.government has been allocated a very large IPv6 address space by the RIPE NCC, one that can be considered sufficient for an extensive time period. The de.government address space is also provider-independent which gives it long-term stability. Therefore potential users within the de.government address space do not need to apply for a separate (provider-independent) IPv6 address space with the RIPE NCC, and the latter can refer such applicants to the de.government address space as covering their needs.

From 2011 on, the Federal Office for Information Technology (BIT) in the Federal Office of Administration (BVA) will be responsible for operational IPv6 functions. The contractual and strategic responsibility for the de.government LIR rests with

the BMI IT5.

3.2.6 Sub-LIR

Within the IPv6 address framework (see chapter 3.6), /32 IPv6 address blocks are allocated from the de.government address space 2a02:1000::/26 to different users who provide their own address space management. By so doing, these users become Sub-LIRs. A typical Sub-LIR would, for example, be a Land. The rights to the IPv6 addresses always remain with the Sub-LIR so that even if the service provider changes, readdressing will not become an issue. Past allocations remain in place and are now being managed by the new operational Sub-LIR.

As IT services for public administration are often provided by public IT service providers this enables Sub-LIRs to split their responsibilities into those carried out by strategic and by operational Sub-LIRs, which may be an IT service provider. However, Sub-LIR responsibilities can also be assumed by one organisational unit and need not be split up.

3.2.6.1 Strategic Sub-LIR

Strategic Sub-LIRs are entitled to an independent administration and/or usage of the allocated address block within their own area of responsibility. De.government coordinates the awarding of usage rights to the strategic Sub-LIRs.

3.2.6.2 Operational Sub-LIRs

Sub-LIRs (such as Länder) can transfer the operational management of their address spaces to operational Sub-LIRs (for example Hamburg to the service provider Dataport). This can be agreed upon between a strategic and an operational Sub-LIR without involving de.government. Of course, the operational Sub-LIR must be able to perform its duties from a technical and organisational point of view. Despite the transfer the strategic Sub-LIR still has the authority and control over the address space. It is recommended that all rights and obligations between strategic and operational Sub LIRs be documented.

3.2.7 End users

Organisations and divisions that use address space are referred to as end users in the following sections. An end user of the de.government address space can basically be any organisation belonging to the public administration sector in the Federal Republic of Germany.

At the present time, the de.government LIR does not assign IPv6 addresses to end users. End users are currently assigned IPv6 addresses through Sub-LIRs only.

End users who require IPv6 address blocks from the de.government address space will generally receive those from the address space of the relevant Sub-

LIR. In most cases, they should be able to find out about the appropriate Sub-LIR with the help of section 3.6.

3.2.8 IPv6 working group

The IPv6 working group (IPv6 AG) was established at the beginning of 2010 in order to concentrate the IPv6 know-how in public administration in one place and to develop basic proposals for the organisational and technical implementation of the IPv6 address space. The members of this working group drawn from the Federation, the Länder and the municipalities, DOI, NdB, BIS and BIT as well as from public service providers who are actively involved in IPv6 matters. The group is open to additional active members.

The IPv6 working group forms the foundation, now and in the future, upon which the advancement of IPv6 matters in public administration in general and de.government in particular, will be built. Sub-LIRs are to be integrated into the working group, and it is planned that group workshops will become a regular forum for the further development of the de.government address space.

On the invitation of de.government the working group meets at least twice a year and more often during the initial phase of the address space management.

3.3 Basic terms

The following terms are used in this document:

Allocation: Allocation in general refers to the allocation of IPv6 address space from a Regional Internet Registry (RIR) to a Local Internet Registry (LIR). The allocation of address space does necessarily imply that this address space has already been assigned to an end user. For example, in the context of de.government, the RIR RIPE NCC has allocated a /26 IPv6 address space to the de.government LIR.

Sub-allocation: The applicable RIPE policies permit a sub-allocation to secondary LIRs (see also appendix VII, "IPv6 RIPE Policy", section 5.1.1). As previously described, recipients of sub-allocations become so-called **Sub-LIRs**. Sub-LIRs manage the allocated address spaces on their own account.

Assignment: Assignment refers to the assignment of IPv6 addresses by a Sub-LIR to its end users. For this purpose Sub-LIRs develop a specific address framework. This framework serves to coordinate the address assignments made by the Sub-LIR.

Announcement: Announcements signify the disclosure of new routing information on the internet through the Border Gateway Protocol (BGP); registrations of system addresses with a public DNS server are also referred to as announcements.

3.4 Range of use of de.government IPv6 addresses

De.government has requested so-called global unicast addresses (GUA) from the RIPE NCC which means that they can be globally routed. Globally routable addresses from the de.government address space must be used for any comprehensive communication. In cases where the IP traffic remains within one organisational unit and does not need to be routed between different organisations, unique local addresses (ULA) may also be used. ULAs are generally not routed by a provider.

3.5 IPv6 address allocation/assignment hierarchy

The following figure shows the organisational structure with respect to the allocation and assignment of IPv6 addresses in public administration. In addition, the different variants of a Sub-LIR in the form of a complete unit, the separation into a strategic and an operational Sub-LIR and the operational grouping of various Sub-LIRs with one service provider are illustrated.
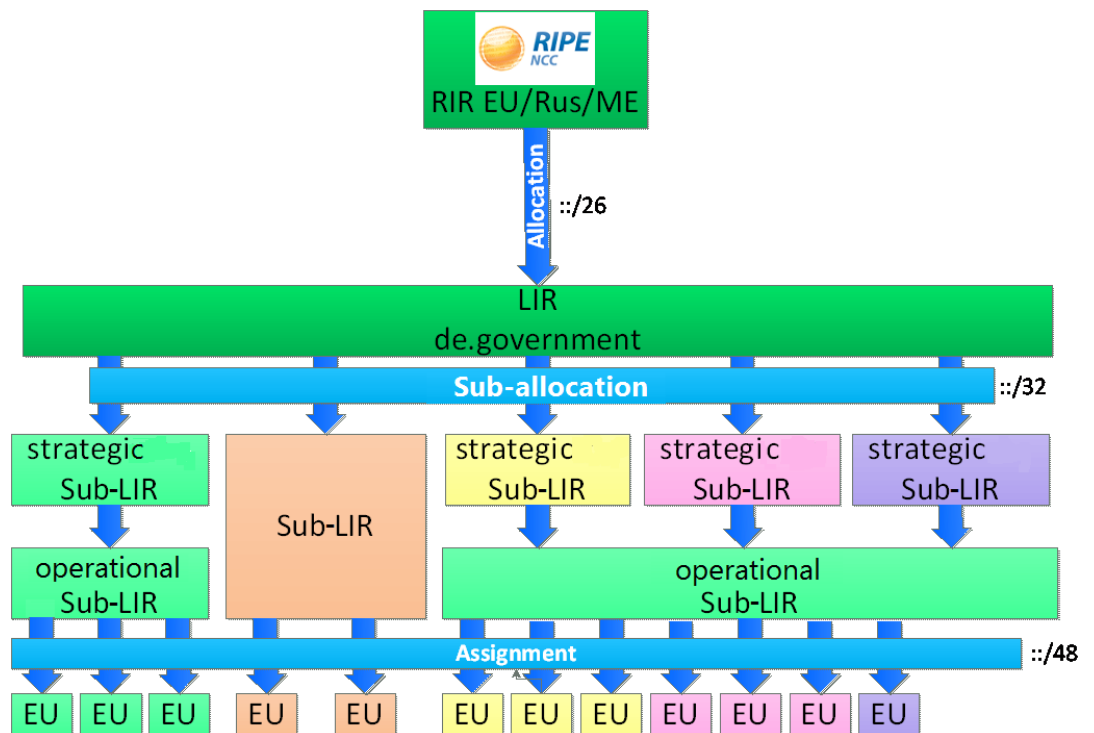

Figure 2: Organisational structure

3.6   IPv6 address framework

The IPv6 address framework governs the overall distribution of the IPv6 address space within the public administration sector of the Federal Republic of Germany.

De.government holds the allocation 2a02:1000 /26. The proposal for an IPv6 address framework, prepared by the IPv6 working group in February 2010, is set out below. The prefixes for the individual sub-allocations are shown in the table.

Block	No.	Dual	Prefix	Block	No.	Dual	Prefix
00: Hamburg	0	000000	2a02:1000 /32	08: Lower Saxony	8	001000	2a02:1008 /32
01: Reserve	1	000001	2a02:1001 /32	09: Reserve	9	001001	2a02:1009 /32
02: Schleswig Holstein	2	000010	2a02:1002 /32	10: Reserve	10	001010	2a02:100a /32
03: Reserve	3	000011	2a02:1003 /32	11: Reserve	11	001011	2a02:100b /32
04: Bremen	4	000100	2a02:1004 /32	12: NRW	12	001100	2a02:100c /32
05: Reserve	5	000101	2a02:1005 /32	13: Reserve	13	001101	2a02:100d /32
06: Mecklenburg-Western Pomerania	6	000110	2a02:1006 /32	14: Reserve	14	001110	2a02:100e /32
07: Reserve	7	000111	2a02:1007 /32	15: Reserve	15	001111	2a02:100f /32
Block	No.	Dual	Prefix	Block	No.	Dual	Prefix
16: Hesse	16	010000	2a02:1010 /32	24: Saarland	24	011000	2a02:1018 /32
17: Reserve	17	010001	2a02:1011 /32	25: Reserve	25	011001	2a02:1019 /32
18: Reserve	18	010010	2a02:1012 /32	26: DOI+ Public SP	26	011010	2a02:101a /32
19: Reserve	19	010011	2a02:1013 /32	27: Reserve	27	011011	2a02:101b /32
20: Rhineland-Palatin.	20	010100	2a02:1014 /32	28: Saxony	28	011100	2a02:101c /32
21: Reserve	21	010101	2a02:1015 /32	29: Reserve	29	011101	2a02:101d /32
22: Reserve	22	010110	2a02:1016 /32	30: Reserve	30	011110	2a02:101e /32
23: Reserve	23	010111	2a02:1017 /32	31: Reserve	31	011111	2a02:101f /32
Block	No.	Dual	Prefix	Block	No.	Dual	Prefix
32: Brandenburg	32	100000	2a02:1020 /32	40: Baden-Württemberg	40	101000	2a02:1028 /32
33: Reserve	33	100001	2a02:1021 /32	41: Reserve	41	101001	2a02:1029 /32
34: Berlin	34	100010	2a02:1022 /32	42: Reserve	42	101010	2a02:102a /32
35: Reserve	35	100011	2a02:1023 /32	43: Reserve	43	101011	2a02:102b /32
36: Saxony-Anhalt	36	100100	2a02:1024 /32	44: Bavaria	44	101100	2a02:102c /32
37: Reserve	37	100101	2a02:1025 /32	45: Reserve	45	101101	2a02:102d /32
38: Thuringia	38	100110	2a02:1026 /32	46: Reserve	46	101110	2a02:102e /32
39: Reserve	39	100111	2a02:1027 /32	47: Reserve	47	101111	2a02:102f /32
Block	No.	Dual	Prefix	Block	No.	Dual	Prefix
48: Netze des Bundes	48	110000	2a02:1030 /32	56: BMVg res.	56	111000	2a02:1038 /32
49: Reserve	49	110001	2a02:1031 /32	57: BMVg res.	57	111001	2a02:1039 /32
50: Reserve	50	110010	2a02:1032 /32	58: BMVg res.	58	111010	2a02:103a /32
51: Reserve	51	110011	2a02:1033 /32	59: BMVg res.	59	111011	2a02:103b /32
52: Reserve	52	110100	2a02:1034 /32	60: BMVg	60	111100	2a02:103c /32
53: Reserve	53	110101	2a02:1035 /32	61: BMVg	61	111101	2a02:103d /32
54: Reserve	54	110110	2a02:1036 /32	62: BMVg	62	111110	2a02:103e /32
55: Reserve	55	110111	2a02:1037 /32	63: BMVg	63	111111	2a02:103f /32

Table 1: Prefix overview

The individual block holders of an IPv6 sub-allocation in the table correspond to the Sub-LIRs described in chapter 3.2.6. The complete address framework including recommendations for using and assigning addresses is part of the address request from BMI IT5 to RIPE NCC.

3.7   IPv6 address supply for municipalities

Municipal users have a number of options with regard to their participation in the de.government address space and the assignment of IPv6 addresses.

3.7.1   Assignment of addresses through the Land

The standard procedure for municipalities to request IPv6 addresses from the Land prefix is through the corresponding Sub-LIR of the Land. Where Sub-LIR structures have not yet been established throughout the Land, de.government may be able to help identify appropriate contacts.

3.7.2   Assignment of addresses through service providers

Some Länder (such as North Rhine-Westphalia) do not have one central service provider, but rather a number of local service providers who offer IT services to the municipalities.

Municipalities must, therefore, assess their situation and find out whether IPv6 addresses are available from the Sub-LIR of the Land in question (see 3.7.1). Where this is not the case, a common Sub-LIR can be initiated for an association of multiple IT service providers. Associations with sufficient address requirements may use a /32 address block from the overall address framework. Addresses from this block can then be assigned by the Sub-LIR of this association. It is recommended that the establishment of such an association be initiated and coordinated by an appropriate organisation such as the central associations of municipalities. De.government will gladly consider any proposals made on this issue.

APPENDICES

I. GLOSSARY

Admin-c	RIPE database role.
Allocation	Address space allocated to a LIR for the purpose of assignments to end users.
Announcement	Disclosure of routes or DNS names.
AS	An Autonomous System (AS) is a collection of IP networks which are managed as a unit and which are connected through at least one internal Routing-Protocol (IGP). This definition is especially important with regard to the use of the internet routing protocol BGP.
Assignment	Assignment of address spaces to end users.
ASN	Every Autonomous System (AS) is assigned a unique so-called Autonomous System Number (ASN). The ASNs are used to publish routes to these networks (AS) on the internet.
BGP	Border Gateway Protocol, a routing protocol used on the internet.
De.government	German public administration LIR.
End users	Organisation which uses the assigned addresses within its infrastructure.
ISPs of public administration	Internet service providers connecting the German public administration sector to the Internet.
LIR	Local Internet Registry
Operational Sub-LIRs	Sub-organisation of a Sub-LIR for the execution of operational Sub-LIR responsibilities.
PI addresses	PI addresses are provider-independent addresses.
PA addresses	Provider-aggregatable *address space* is an address space which can be aggregated in a manner that facilitates its disclosure as a route through an ASN.
RPKI	PKI for the issuance of certificates to sign route objects.
Sub-Allocation	Part of an allocation to be assigned to end users by a Sub-LIR.
Sub-LIR	LIR which has been assigned the management of part of a superordinate LIR allocation.
Tech-c	RIPE database role.

II. ROLES

In the following the major organisational roles with regard to IPv6 address management in public administration are described.

A.   LOCAL INTERNET REGISTRY (LIR) "DE.GOVERNMENT"

1. PURPOSE AND OBJECTIVE

The LIR de.government is the sole contractual partner of the RIPE NCC for the management of the comprehensive IPv6 address space in public administration. This means that de.government is accountable for the overall public administration sector IPv6 address space in the Federal Republic of Germany.

De.government connects the RIPE NCC with the IPv6 address space users in public administration.

Internally, de.government aims to satisfy the demand for IPv6 address space and IPv6 resources in the public administration sector in the long term as well as to provide the address space with a secure structure. De.government is responsible for the daily operation and the management of IPv6 addresses and acts as a contact point for technical and operational matters.

Externally, de.government wants to provide a focus for the interests and demands of all address space users, to assume representative functions and thereby exert active influence on Internet policy.
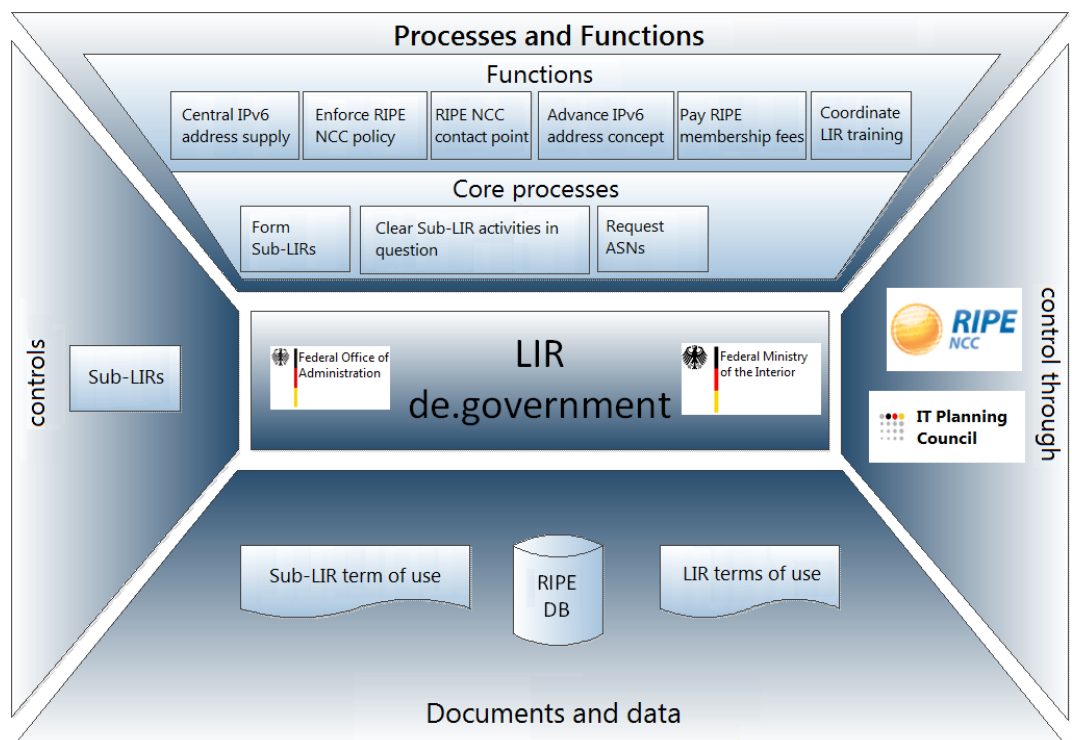
2. ROLES DIAGRAM

Figure 3: De.government roles diagram

3. RESPONSIBILITIES

The responsibilities of a Local Internet Registry that are directly connected to the management of the address space are described in the RIPE LIR training manual (http://www.ripe.net/training/material.html#LIR).

De.government assumes the following responsibilities:

Payment of RIPE NCC membership fees: The membership fees are centrally funded.

Coordination of the advancement of the IPv6 framework: The advancement of the address framework is coordinated by de.government in in collaboration with end users. Amendment requests are dealt with by the IPv6 working group on a consensus basis.

Central supply of IP resources: De.government has been allocated a /26 address space for its needs by the RIPE NCC. Following the request for address space in 2008, a plan for its use in the short and medium term was presented to the RIPE NCC. The supply of further IP resources (such as AS numbers) is centrally organised through de.government, which requests them from the RIPE NCC.

Responsibility and advancement of the overall IPv6 strategy: The IPv6 strategy is continuously advanced on the basis of end users' needs and feedback by de.government.

Responsibility for the implementation of policies in accordance with RIPE: Owing to its RIPE NCC membership de.government must comply with RIPE's policies, as amended from time to time. In case of discrepancies with those policies de.government will consult the respective Sub-LIRs.

RIPE NCC contact point: De.government is the contact point for RIPE NCC. De.government arranges RIPE NCC training measures for Sub-LIR staff and, where applicable, other persons involved. De.government coordinates the effectuation of such training measures together with RIPE NCC.

RIPE contact point: De.government participates in the central exchange of information (such as RIPE Meetings or eGovernment roundtables) and represents the positions of Sub-LIRs and end users in discussions with RIPE (e.g. in working groups or policy proposals).

De.government marketing and public relations: De.government represents the address space at political level and serves as a contact point for national and international institutions. In addition, de.government promotes participation in informative meetings, congresses, manufacturer's meetings etc. De.government also maintains contacts with the media, product manufacturers, academic institutions and the Internet economy.

Maintenance of the LIR information in the RIPE database: The RIPE database is a public database that contains information about the IP address space,

IP sub-allocations, AS numbers, routing policies and reverse DNS lookups. Furthermore, contact information for all database objects is saved in the database. Information on the comprehensive address space (address framework) is prepared and maintained by the LIR.

Coordination of the Initialisation of Sub-LIRs: The LIR is responsible for the operational execution of all duties with respect to

- initialisation of the address space for Sub-LIRs (see also appendix A)
    - provision of information and address templates for Sub-LIR applicants
    - examination of Sub-LIR address frameworks
    - evaluation of quantity structures and address requirements of new Sub-LIR applicants and other assignments to existing Sub-LIRs according to RIPE's policies
    - approval of address space for Sub-LIRs (sub-allocations)
- application for additional resources (such as ASNs)

To support the address space planning the following instructions and templates are currently available:

- Template address blocks
- Template address spaces
- Ripe-538.pdf (valid RIPE policy)
- IPv6_Einführung_InfoHighway_v2 2.doc (upon request, available in German only)

Advancement of address framework planning: The LIR is in charge of the advancement of IPv6 address framework planning.

Support of developments to further the implementation of IPv6: De.government together with the network operators promotes and supports IPv6 capability and the advancement of IPv6 in network platforms. Important issues in this regard are:

- Use of IPv6-enabled components in the backbone and the connection area
- Identification of IPv6-enabled value-added services and applications
- Tests and IPv6 pilot projects

Maintenance and updating of the IPv6 reference manual for public administration: The LIR amends the IPv6 documentation (such as the reference manual) and updates the toolset as needed.

Organisation and preparation of IPv6 working group meetings: The IPv6 working group currently represents all participants in the IPv6 address space. In the future it will be supplemented by representatives of the SUB LIRs. The IPv6

working group makes technical, organisational and implementational recommendations with respect to the IPv6 address space.

Implementation of RIPE policies: The LIR monitors the activities of the RIPE working groups and, if required, plays an active role in contributing to the recommendations and guidelines of the RIPE Community. The LIR communicates policy changes to the Sub-LIRs and implements them where required.

4. INPUT

De.government works with the following essential input:

- RIPE NCC contract data
- RIPE policies
- RIPE working group recommendations
- IETF requests for comments (RfCs)
- End user feedback
- IT-related draft laws and orders
- IT architecture and safety requirements

5. OUTPUT

De.government generates the following essential output:

- Lead role in advancement of the address framework
- Allocated IPv6 address spaces
- Approved Sub-LIR address space frameworks
- Lead role in advancement of the address space documentation
- General information on the address space for end users
- Strategic guidelines

B.   SUB-LIRs

1. PURPOSE AND OBJECTIVE

Sub-LIRs are formed in order to enable the autonomous administration of address spaces allocated within the de.government address framework. To begin with, these Sub-LIRs must go through an initialisation process by which the planned use and management as well as, where appropriate, requirements of the individual sections are established in an address framework. A typical Sub-LIR would for example be a Land.

After its successful formation the Sub-LIR will responsibly perform all LIR tasks as defined by the RIPE for the address space in question as well as document the relevant duties, including those vis-à-vis de.government.

2. ROLES DIAGRAM

Figure 4: Sub-LIR roles diagram

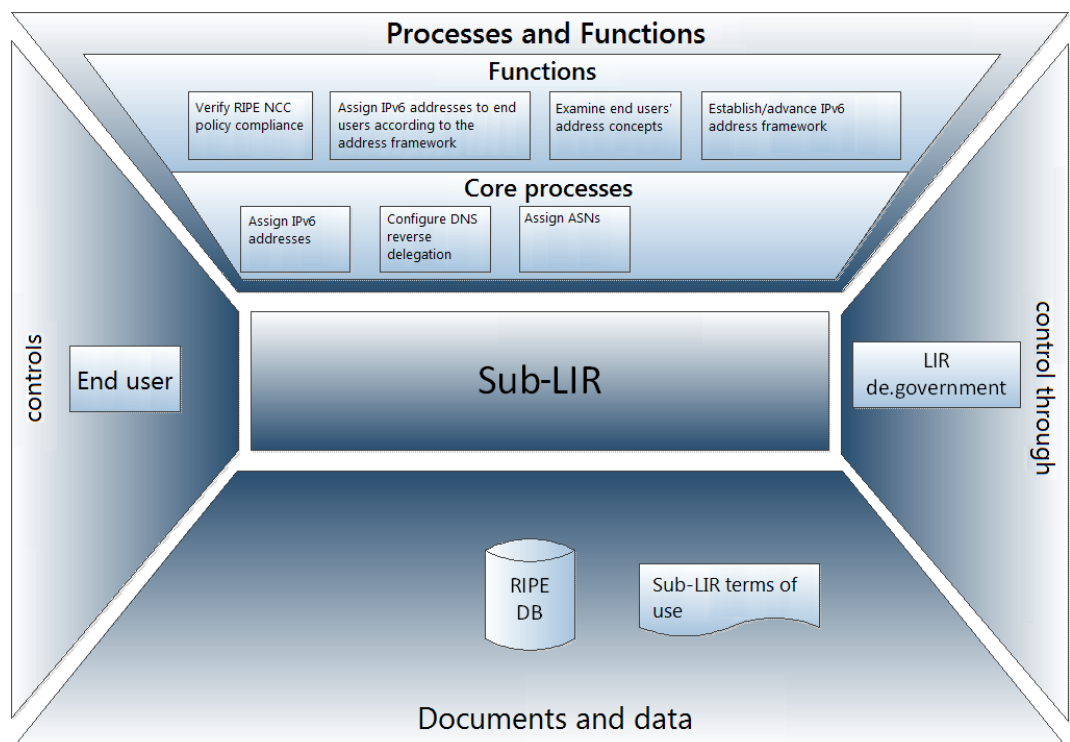### 3. RESPONSIBILITIES

The responsibilities of a Sub-LIR are similar to those of a LIR but with the difference that they relate only to the sub-allocation.

Sub-LIR Initialisation: Sub-LIRs are defined as part of the IPv6 address framework planning. The initialisation of a Sub-LIR as described below, therefore, follows the description under "Formation of a Sub-LIR" in Appendix III, section A.

Optionally, the responsibilities can be handed over to an operational Sub-LIR.

Present address planning: Sub-LIRs establish an address framework for their allocation based on their own needs or the needs of the users they serve and taking into consideration the general recommendations as well as the templates provided. To this end, the Sub-LIR evaluates the address requests and planning of its customers and users. Following evaluation of the address planning and amendment of the data in the RIPE database by de.government the Sub-LIR is allocated the address space.

Assign address space: After it has been allocated address space the Sub-LIR can begin assigning addresses to its end users. In doing so, however, the RIPE policies, as amended from time to time, must not be violated. The following rules are currently valid:

Assignments to end users

End users receive assignments from their associated Sub-LIR. The size of the assignment is determined by the local Sub-LIR. Without the need of further justification to the RIPE NCC, the maximum size of an assignment to a so-called "site", generally an organisation in public administration, is /48. Smaller assignments cannot be made without deviating from the RfC standard recommendations.

Assignments for the Sub-LIR infrastructure

Sub-LIRs can assign network prefixes for their own service infrastructure. Per point of presence (PoP) and independent of the number of PoP users the RIPE allows a maximum /48 assignment. An additional /48 assignment can be used by the Sub-LIR for in-house operations (such as switches or LANs).

Documenting assignments: The assignments made by a Sub-LIR must be properly documented. The documentation must be prepared in such a way as to allow the RIPE NCC to review it upon request for troubleshooting purposes. Assignments from the de.government address space are documented with an entry in the RIPE DB. According to the RIPE NCC's provisions, a Sub-LIR is required to create one so-called "inet6num" object in the RIPE database per assignment. Following a current proposal made to the RIPE on documentation of assignments, only a statistical value which reflects the percentage of addresses assigned from an allocation is to be included in the RIPE DB.

Set-up reverse delegation: Reverse delegation refers to the resolution of IP addresses in domain names. Addresses from the de.government address space that are used on the Internet and that are routed must allow for reverse DNS lookups. In order to set-up reverse DNS lookups, reverse zones must be configured on the respective name servers and a corresponding domain object created in the RIPE database.

Sub-LIR roles in relation to de.government: Two roles must be mentioned with respect to the relationship between Sub-LIRs and de.government. One role concerns the interests of the strategic Sub-LIR (legal role such as Land representative) with respect to de.government. The other role concerns the operational

business of a Sub-LIR, which acts as a contact point in such matters.

4. INPUT

The essential input of a Sub-LIR includes:

- Control information from de.government
- Address frameworks from organisations which are not yet part of the address framework
- Assignment applications from organisations which are not yet part of the address framework
- ASN applications
- RIPE Policies

5. OUTPUT

The essential output of a Sub-LIR includes:

- Setup applications
- Sub-LIR address framework
- Assignments
- Objects in the RIPE database

6. SUB-LIR ROLES

- Responsible Sub-LIR person
- Strategic and operational Sub-LIR contact persons (contact points)

C. END USERS

1. PURPOSE AND OBJECTIVE

End users are organisations in German public administration who depend on IT systems to complete their tasks.

2. RESPONSIBILITIES

- Assignment applications from organisations which are not yet part of the address framework
- Making use of the assigned IPv6 addresses
- Complying with RIPE policies

3. INPUT

- Assignments
- RIPE Policies

4. OUTPUT

- Assignment applications (optional)
- IPv6 address framework (optional)

5. END USER ROLES

- Responsible for IPv6 address management

III. PROCESSES

In the following, the core processes with regard to the IPv6 address management in public administration are described.

A. Formation of a Sub-LIR

1. PURPOSE AND OBJECTIVE

This process aims to initialise a new Sub-LIR in accordance with the requirements of the address framework. Additional users may apply to become Sub-LIRs if they can prove sufficient address needs.

2. INPUT

- Sub-LIR initialisation application
- Sub-LIR address framework

3. OUTPUT

- New Sub-LIR

4. ROLES INVOLVED

- Already named Sub-LIRs or new users with necessary requirements
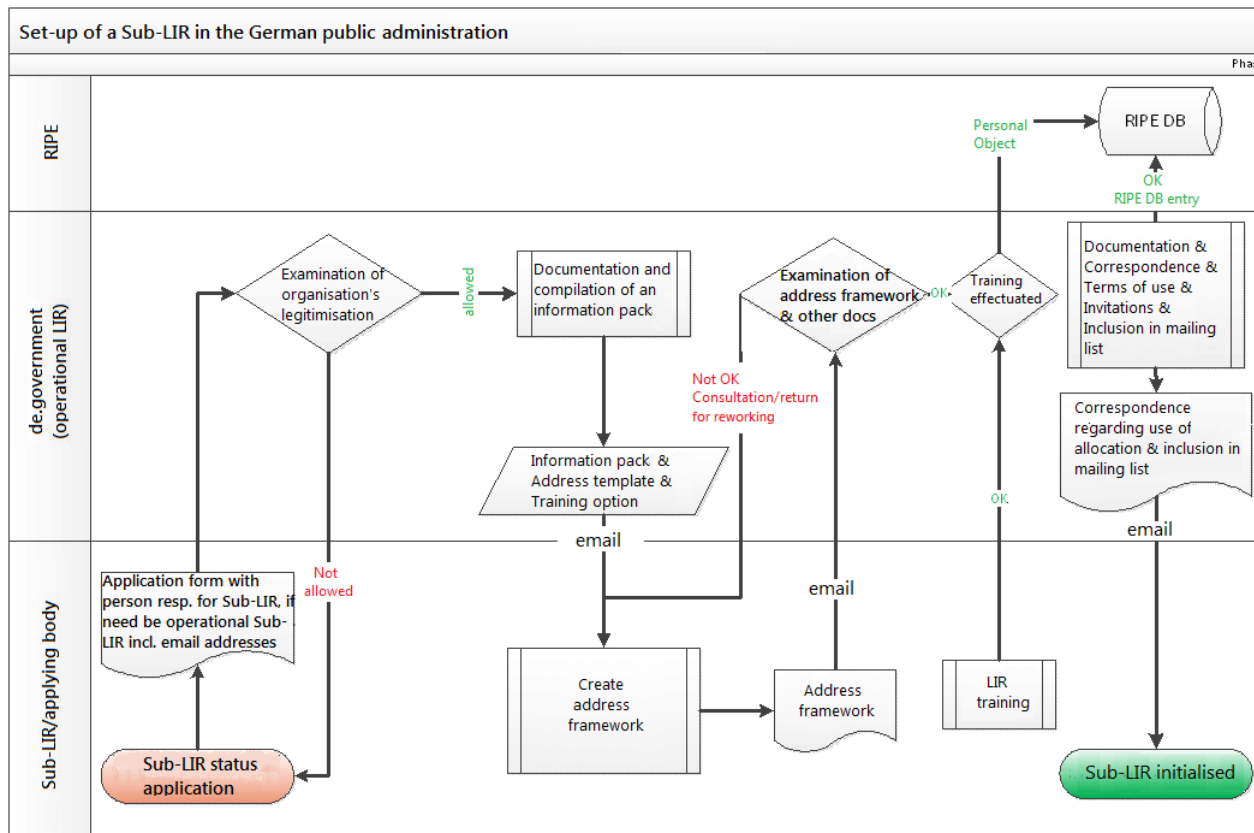- de.government

5. PROCESS DIAGRAM

Figure 5: Sub-LIR setup process diagram

6. PROCESS NOTES AND REMARKS

The exact form of the RIPE DB entries has not yet been defined. A proposal to the RIPE is currently being discussed.

The address framework envisions /32 sub-allocations. One or more /32 blocks are managed by a Sub-LIR. The potential Sub-LIRs can be directly created from the de.government address framework. Generally, every address space user can become a Sub-LIR if they can prove a /32 address requirement to de.government. Sub-LIRs can also be formed by multiple single users with evident address requirements who agree on a common Sub-LIR and whose address requirements are not yet covered by another Sub-LIR.

In order to be allocated a proper address space from the address framework by de.government the applicant must be recognised as a Sub-LIR.

At present, the address framework shows the 16 Länder, the NdB, the DOI and the BMVg as strategic Sub-LIRs. Strategic Sub-LIRs can transfer the operational administration of their address space to an operational Sub-LIR. For example, the Land Hamburg can perform a transfer to Dataport or the Land Hesse to HZD. However, the (strategic) Sub-LIR designated in the address framework remains holder of the address block at all times.

Rejection of a Sub-LIR application

If the quantity structures presented to de.government do not justify the allocation of a /32 address space, Sub-LIR applications may be rejected. The evaluation of quantity structures by de.government is based on standard RIPE principles and procedures. This ensures that applicants are not put in a worse position than those who obtain their address space directly from the RIPE NCC. A rejection does not, under any circumstances, mean that applicants will not receive the address space required for their operations. In cases of rejections the applicant has three options:

a) To adjust quantity structure by cooperating with other users to establish a joint Sub-LIR.

b) To request addresses from an existing Sub-LIR.

c) To obtain addresses from the "service provider block" of the address framework, if no corresponding Sub-LIR can be identified.

Users who have already been identified as block holders in the address framework (such as the Länder) do not need to prove quantity requirements to de.government as their quantity structures have already been approved by the RIPE NCC in the course of the application for address space. In this case a Sub-LIR can be formed on the basis of an address framework and notification from the appropriate role holder.

B.   Address assignment by a Sub-LIR

1. PURPOSE AND OBJECTIVE

Sub-LIRs assign IPv6 addresses to end users. This makes parts of the de.government address space available for actual use by end users.

2. INPUT

- End user application (optional)
- End user address framework

3. OUTPUT

- Officially allocated global unicast IPv6 addresses
- Inet6num object in the RIPE DB

4. ROLES INVOLVED

- Sub-LIR
- End user (optional)

7. PROCESS DIAGRAM

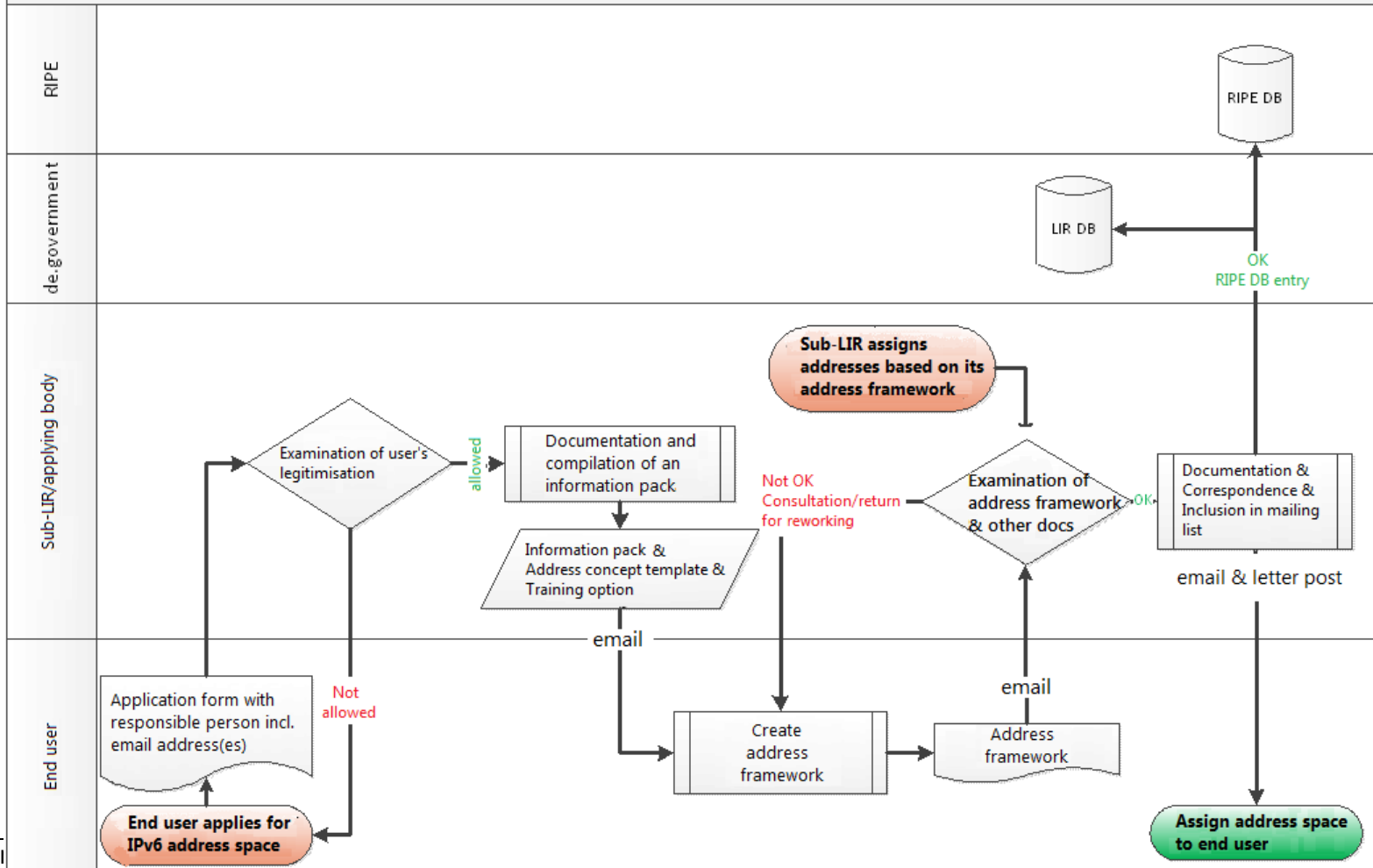Assignment of IPv6 address spaces to an end user in the German public administration by a Sub-LIR

Figure 6: Assignment process diagram

8. PROCESS NOTES AND REMARKS

A proposal for the documentation of IPv6 assignments is currently being discussed at the RIPE. For data protection reasons, it is planned that only statistical values from the individual assignments are to be registered in the public RIPE DB.

C. Set-up and administration of DNS reverse delegation

1. PURPOSE AND OBJECTIVE

Reverse delegation refers to the resolution of IP addresses in domain names. Addresses from the de.government address space that are used on the Internet and that are routed must allow for reverse DNS lookups. If no reverse DNS lookups are provided, problems with the use of certain services (such as FTP or email) can arise. Troubleshooting can prove difficult, too. In order to set-up reverse DNS lookups, reverse zones must be configured on the respective name servers and a corresponding domain object created in the RIPE database.

2. INPUT

- Addresses or address space
- Corresponding DNS names

3. OUTPUT

- Functioning name resolution of IPv6 addresses on the Internet to the DNS names of systems

4. ROLES INVOLVED

- RIPE
- Sub-LIR
- End users

D. Assignment and administration of ASNs

1. PURPOSE AND OBJECTIVE

In addition to the assignment of the actual IPv6 addresses, the assignment of ASNs for the BGP Internet routing protocol to address space users is another, albeit rare, responsibility of LIRs and hence also of Sub-LIRs. Under certain circumstances, ASNs are required to disclose routing rules for a specific address space to additional routers on the Internet. RIPE normally assigns ASNs only for IPv6 address space allocations greater than or equal to a /32, as a global routing on the Internet cannot be guaranteed for smaller address spaces. In order to apply for an ASN

- the corresponding network must be addressed by two independent Internet service providers/network nodes on the Internet

- the applicant must handle Internet traffic for third party networks (so-called transit) with additional Internet connections or

- other specific routing-related reasons must exist

The assessment criteria are very complex and the RIPE requires that the applying end user be assisted by a "sponsoring" LIR which controls the communication with the RIPE. This process will not occur very often but will require direct cooperation between end user, Sub-LIR and de.government.

It must also be noted that the RIPE considers the assignment of an ASN equal to an allocation of address space and therefore charges additional fees. In each case the assumption of such costs must be given clearance.

Applications made to the RIPE for an ASN in the de.government address space are made by the end user together with the de.government LIR.

2. INPUT

- ASN application

3. OUTPUT

- ASN

4. ROLES INVOLVED

- RIPE

- LIR de.government

- Sub-LIR

- End users

E. Signing of route objects

1. PURPOSE AND OBJECTIVE

IANA and RIPE are introducing a so-called *Resource Public Key Infrastructure (*RPKI) with the aim of raising the level of security on the Internet. The intention is to provide a certificate infrastructure for the signing of route objects. The signing of route objects – Route Origin Authorisation (ROA) – prevents the announcement of unauthorised routes on the Internet via BGP which could lead to address spaces redirecting to wrong systems.

The introduction of signatures started at the beginning of 2011. However, currently no software versions for routers are available that would allow for an automatic verification of those signatures for announced routes.

De.government supports this development and therefore requires all route objects of the de.government address space to be signed.

As soon as this process has been implemented by the RIPE a corresponding process description will be created.

2. INPUT

- Existing route object

3. OUTPUT

- Signed route object

4. ROLES INVOLVED

- RIPE
- LIR de.government
- Sub-LIR

F. Approval of Sub-LIR activities requiring permission

1. PURPOSE AND OBJECTIVE

Address space users' activities which require intervention by or communication with the RIPE are coordinated by the operating LIR in cooperation with the corresponding Sub-LIR.

Activities that require permission can be derived from the applicable RIPE policies.

2. INPUT

- Application with framework and justification

3. OUTPUT

- Approval by the RIPE

4. ROLES INVOLVED

- RIPE
- LIR de.government
- Sub-LIR

5. PROCESS DIAGRAM

This process is described in greater detail as part of the LIR pilot phase.

The following steps describe the general procedure:

1. The responsible Sub-LIR communicates the matter in question to de.government.

2. De.government makes the required documents/links available.

3. The Sub-LIR responsible coordinates the completion of the documents for its end users and, if need be, the procurement of additional documents (justifications, illustrations etc.) and sends them to de.government.

4. De.government preexamines the documents. Optional further enquiries are directed to the responsible Sub-LIR.

5. De.government sends the documents to the RIPE NCC.

6. De.government passes the RIPE NCC's questions on to the corresponding Sub-LIR.

7. De.government informs the Sub-LIR about the RIPE NCC's decision.

8. RIPE NCC or de.government create the modified database objects.

9. The documentation and the databases of the Sub-LIR are maintained and adapted.

G.   Withdrawal of IPv6 addresses

1. PURPOSE AND OBJECTIVE

In rare cases Sub-LIRs may be forced to withdraw IPv6 addresses already assigned to end users, or Sub-LIR allocations may need to be returned to de.government.

Possible reasons are

- the liquidation of an organisation
- the merger of large IT organisations or
- the long-term non-use of addresses

The addresses must then be systematically returned to the pool of addresses available for assignments.

As this procedure is unlikely to occur very frequently the steps to be taken will depend on the particular case.

2. INPUT

- Decision to withdraw the addresses

3. OUTPUT

- IPv6 address resources available for reassignment

4. ROLES INVOLVED

- End users
- Sub-LIR
- LIR de.government

IV. CONTACTS

The LIR is the central contact point for Sub-LIRs, address space users and other interested parties as regards information and advice on the IPv6 address space.

From 2011 on, the Federal Office for Information Technology (BIT) will assume this operational responsibility. Contact information will be published soon.

Constanze Bürger	+49 (0)30-18681-4357	**Con-stanze.Buerger@bmi.bund.de**	**LIR de.government**
Randi Korff	+49 (0)22899 358 3557	**Randi.Korff@bva.bund.de**	**BIT**

V. CHECKLIST FOR ASSUMING SUB-LIR RESPONSIBILITIES

The following checklist aims to facilitate a realistic self-assessment of the current degree of maturity with regard to the exercise of Sub-LIR duties. It is does not constitute a preselection of potential Sub-LIRs.

Issue	Yes	No
Is a contact person, who will be responsible for dealing with de.government, available?		
Do employees have experience with IPv6?		
Does the organisation have sufficient personnel resources in order to handle the Sub-LIR duties?		
Do I (or the organisation) have the resources to set up an IPv6 address framework for the potential user group?		
Can the management of the IPv6 address space start within one year?		
Are the current and future IP address requirements of my users known to me?		
Do the IT services cover a high percentage of municipalities' IT requirements as well as those of the Land?		
Do I understand the responsibilities of a Local Internet Registry, and have the capability to administer objects in the RIPE database?		
Is my user network already IPv6-enabled?		
Can the RIPE requirements with respect to IPv6 documentation be fulfilled?		
Is my current ISP IPv6-enabled / will my future ISP be IPv6-enabled?		
Is the upstream provider ready to announce the /32 IPv6 address block to the external network if need be?		
Are my network management systems and the applicable tools capable of administrating IPv6 addresses?		

VI. ADDRESS TEMPLATES

The address templates as example for Sub-LIRs can be requested from the LIR "de.government"

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(1) Exemplary address framework for Schleswig-Holstein

(2) Exemplary address framework for Schleswig-Holstein (after address prefix)

VII.   RIPE IPV6 POLICY

The current RIPE IPv6 policy is available on the following website:
http://www.ripe.net/ripe/docs/ripe-538

VIII. FAQs

The following FAQs provide short answers to basic questions about the initialisation and implementation of the address space.

(1) How can I become a Sub-LIR?

Sub-LIRs are established during definition of the address framework. Generally, every address space user can become a Sub-LIR if it can prove a /32 address need.

Sub-LIRs can also be formed by multiple single users with evident address requirements who agree on the setting up of a joint Sub-LIR.

A prerequisite for the formation of a Sub-LIR is that the technical and organisational conditions for rendering LIR services to the users can be met.

If you are interested in establishing a Sub-LIR you should get in touch with the IPv6 contact point.

(2) The address framework shows that I am a Sub-LIR. What's next?

Get in touch with the responsible IPv6 contact point where your contact data will be registered.

De.government will then send you an information pack [source reference]. Amongst other things, this information pack contains the address templates required for the creation of address frameworks as well as the intended address prefix.

Create an address framework for your address space which reflects the intended address assignment and quantity structure and send it to the IPv6 contact point.

The framework will be evaluated and, if necessary, consultations carried out.

After the address framework has been evaluated, you will be informed in a letter by de.government about the assignment of the address space.

(3) I would like to use my /32 address block exclusively in the internal network (no internet). What do I have to do?

Basically: nothing. You can start to assign addresses to users on the basis of your address framework. However, as de.government addresses are global addresses you must make sure that your routers are configured in such a way as to ensure that your addresses cannot be accidentally routed to the Internet.

(4) I would like to use my /32 address block on the Internet also.

In these cases de.government must first create an "inet6num" object in the RIPE database and mark the address space with a specific status. In addition, the Sub-LIR requires certain permissions in order to be able to perform specific actions on the RIPE database. If you intend to use the address space on the Internet you should get in touch with the IPv6 contact point.

(5) What do I do if I require only a few IPv6 addresses?

IPv6 addresses and IPv6 address spaces cannot be directly obtained from de.government. Only Sub-LIRs may assign IPv6 addresses and IPv6 address spaces. Therefore, in a first step, a suitable Sub-LIR must be identified. An adequate first contact point would be the Sub-LIR of the relevant Land. The IPv6 contact point can help where clarification is needed, or with finding of relevant contact points. As a growing number of Sub-LIRs become established central lists with contact points and persons will be made available by de.government.

(6) Does the participation in the de.government address space involve any costs?

Basically the participation in the de.government address space does not involve any costs. As a result of its RIPE membership BMI IT5 pays a fee of between 1500 and 5000 Euro a year, depending on the overall address volume. Users of the address space do not have to pay for using IPv6 addresses.

(7) Who can I contact if I have any questions?

The operational LIR can be contacted through the IPv6 contact point: This service is free of charge.

Phone number:

+49 (0)800 - 3646389 (DOINETZ)

Monday to Friday 9 am to 5 pm.

(8) Can I request my own addresses from the RIPE NCC in addition to the de.government address space?

In applying for IPv6 address space with the RIPE NCC, the current and future potential needs of the entire public administration sector in the Federal Republic of Germany were taken into account. Hence, separate applications for IPv6 address space with the RIPE NCC that relate to quantity structures already allowed for will be rejected. Exceptions to this rule are universities and research institutions as they were not included in the application for address space.

(9) I already have IPv6 addresses. Can I receive de.government addresses nonetheless?

In this case there are several options. If you want, you can exchange your IPv6 address block for a de.government address block. This requires that your provider be willing to route de.government address space instead of its own address space.

Basically the address space that is already being used (i. e. not the de.government addresses) can continue to be used without changes.

However, IPv6 communication with other users via the switched DOI network makes the use of de.government addresses obligatory.

(10) I have outsourced my IP operations to a service provider. How do I proceed?

This case is identical to (9). The willingness of the service provider to take over an IPv6 address block from the de.government address space must be clarified.

(11)   Where can I acquire the necessary LIR and IPv6 knowledge?

De.government will offer training in various regions on selected topics in cooperation with RIPE NCC (LIR operations, IPv6, Routing Registry, RIPE Database use etc.). Additional information can be found in the IPv6 reference manual.

IX. LINK LIST

The list below contains links to additional information on IPv6. This list will be amended from time to time.

LIR training manual:

http://www.ripe.net/lir-services/training/material/LIR-Training-Course/LIR-Handbook.pdf

Contents of planned LIR trainings:

http://www.ripe.net/lir-services/training/courses/lir/outline

RIPE working groups:

http://www.ripe.net/ripe/mail/mailing-lists

RIPE policy process:

http://www.ripe.net/ripe/docs/ripe-500

IPv6ready logo:

http://www.ipv6ready.org/

IPv6 Act Now:

http://www.ipv6actnow.org/

Internet Assigned Numbers Authority (IANA):

http://www.iana.org

CIO Council:

http://www.cio.bund.de/DE/Politische-Aufgaben/Rat-der-IT-Beauftragten/rat_d_it_beauftragten_node.html

IT Planning Council:

http://www.cio.bund.de/DE/Politische-Aufgaben/IT-Planungsrat/it_planungsrat_node.html

IPv6 on Wikipedia:

http://en.wikipedia.org/wiki/IPv6

IPv6.net community:

http://ipv6.net/

Internet Protocol, Version 6 (IPv6) Standard:

http://www.ietf.org/rfc/rfc2460.txt

Requirements for IPv6 in ICT equipment:

http://www.ripe.net/ripe/docs/ripe-501