IPv6 in the public sector – Country Profiles

A report for the European Commission

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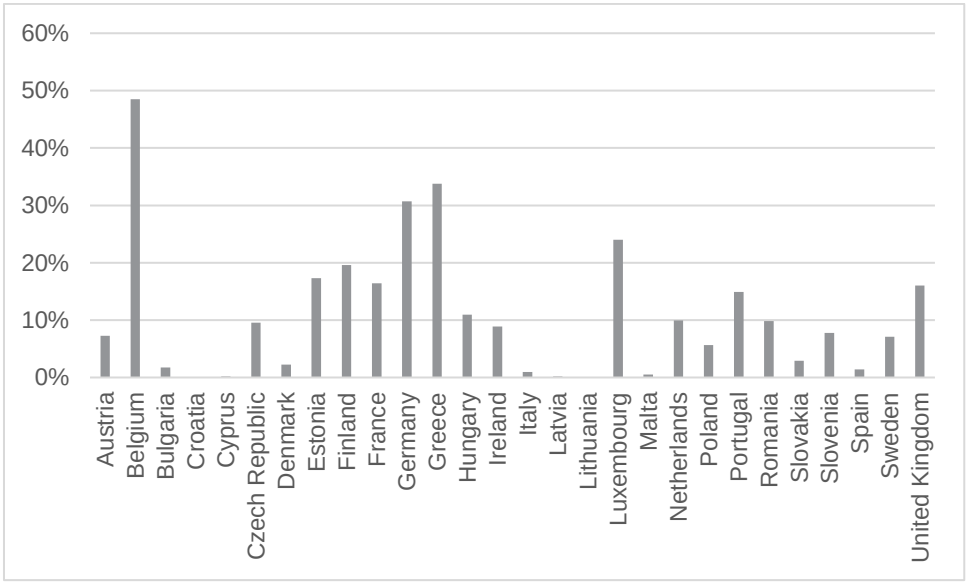
1 Synthesis

1.1 Global adoption of IPv6

The adoption of IPv6 in general is very different across MS in Europe, with Belgium, Germany and Greece (plus to a lesser extent Luxemburg) at the forefront, while many MS are still below 2% of total penetration. More than half of MS are below 10% of penetration overall (and at least 10MS below 5%).

Figure 1: Overall development of IPv6



Source: IDATE, combining Google and Akamai data

With this in mind, it is no surprise to see very low adoption in the public sector, as seen in the next section.

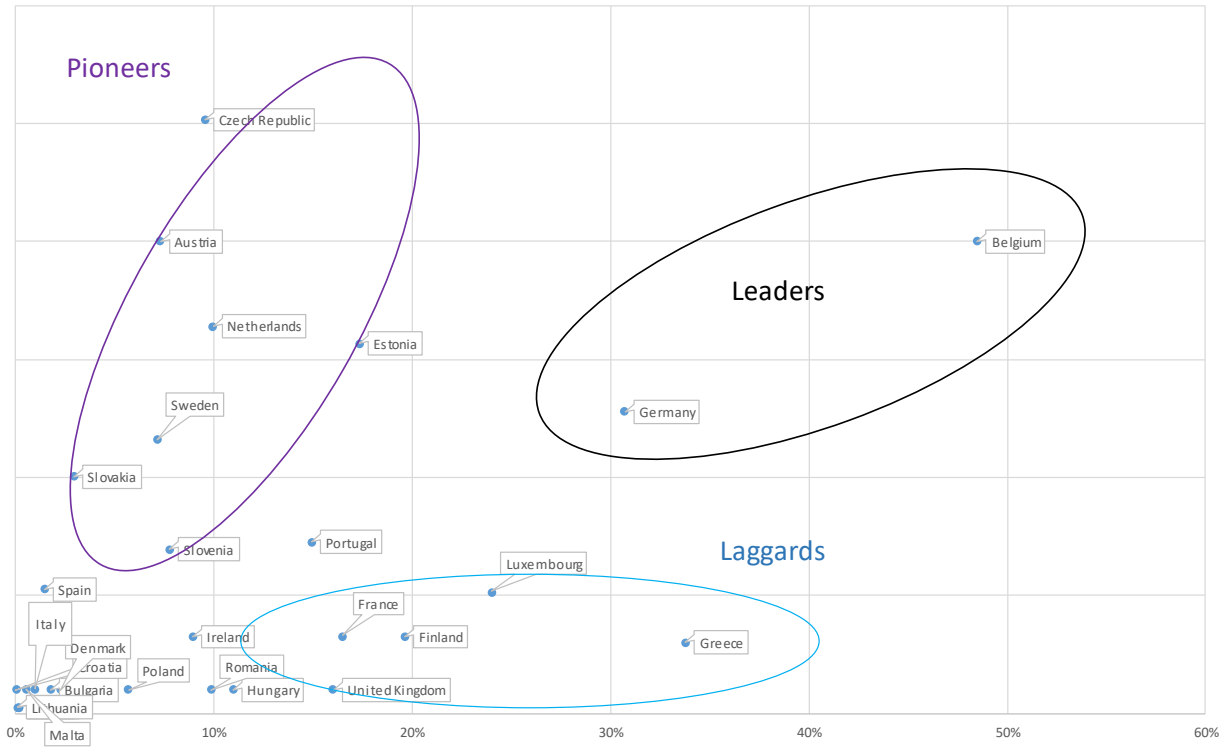
1.2 Overall adoption in the public sector

There are no numbers to really compare IPv6 adoption in the public sector for all MS, so we have used various metrics (including CZ.NIC tool but mostly for Gen6 countries) that are not fully equivalent country by country. The graph below should therefore be taken as a good proxy, rather than the exact reality.

A few countries stand out, including countries that have not developed really well yet on IPv6 like Netherlands, Czech Republic, Austria, Sweden or Estonia. On the contrary, MS like Luxemburg or Greece (plus to a lesser extent France or UK) benefit from a good penetration of IPv6 but have not really made any significant developments for the public sector.

With no surprise, all MS with very low global IPv6 penetration are obviously also lagging behind for the public sector.

Figure 2: Adoption of IPv6 (global and public sector)



X-axis = penetration of IPv6 (global)

Y-axis = penetration of IPv6 (public sector)

There are no major clusters of MS that appear from the analysis. Indeed, for most MS, there is a strong correlation between the level of adoption of IPv6 in the public sector and the adoption of IPv6 in the country as a whole, with many MS not developed on both (more than 10MS really close to no development at all). Only around 10 MS have a very different adoption rate for the public sector than for the whole country. This implies a progressive roll out by some organisations as IPv6 is being offered by ISPs and equipment being renewed.

Indeed, as already mentioned, two groups stand out in the analysis, with some common patterns :

- A first group of advanced users in the public sector, despite low adoption overall in the country. These MS can be referred as “Public pioneers”.
- A second group of laggards for adoption in the public sector, despite quite good adoption in the country. These MS can be referred as “Public laggards”.
- Two MS also stand out (Belgium and Germany) and appear as the leaders. But they are very specific and can not been analysed as a coherent group, but more as specific cases.
- Finally, Gen6 MS are more advanced than other MS on average, but the results are still very different between from one MS to another even among Gen6 main players. Gen6 MS have been analysed in more details in a separate deliverable.

1.3 Overall analysis regarding IPv6 in the public sector

1.3.1 Key stakeholders

Government

Most advanced MS for adoption of IPv6 in the public sector are without surprise the MS that have some direct involvement of the government (Ministry level or equivalent). This is the case of all MS with adoption of more than 20% of the public sector and also a of few laggards MS.

List of MS with direct government involvement
Austria, Belgium, Estonia, Germany, Ireland, Italy (recent), Netherlands, Portugal, Spain (plus to a lesser extent Luxemburg, Malta

Task Forces

The involvement of other stakeholders is not a guaranteed sign of success. Some MS have been successful without leveraging a task force or the national R&D centre. Most task forces (whose action was generally both public and private sector) are anyway today inactive (only Belgium, Sweden, Netherlands and Estonia seem really still partly active as of early 2018, compared to more than 10 back in 2011-2012).

List of MS with IPv6 Task Force or equivalent
Still active : Belgium, Sweden, Netherlands and Estonia Now inactive : Croatia, Finland, France, Greece, Ireland, Italy, Poland, Portugal, Spain, the UK, Luxemburg, Romania

R&D research centre

In most of the cases, the R&D research centre has been involved on its own, not impacting any global plans (and often being as a very specific testbed). In addition, there are many examples of MS without any success that have involved this type of stakeholder (Romania, Poland, Hungary, Greece, etc…). Leading MS for IPv6 adoption in the public sector are rarely using this type of stakeholder (somehow Netherlands are the exception, but not their main focus).

List of MS with R&D research center
Romania, Poland, Hungary, Greece, Bulgaria, France, Ireland, Luxemburg, Spain, Lithuania, Slovenia, Portugal + to a lesser extent Netherlands and the UK

National Regulation Authority

Finally, the MS in which activities are mostly driven by telecom regulators have also not shown any signs of being a good practice for further developments (Finland, Croatia, Denmark, Malta, etc…). While Sweden has had good results (until 2013-2014), it looks as an exception as other MS relying on the NRA are trailing behind in adoption.

List of MS with NRA
Finland, Croatia, Denmark, Malta, Sweden, Cyprus, Poland + to a lesser extent France

Third party organization

It should also be noted that some third parties have been used quite efficiently in leading MS like Czech Republic, Slovenia and Ireland, but have led to various results in general, with Czech Republic at the forefront, but Ireland still lagging behind.

Central organization

Only a few MS are relying on a central organization/approach managed by a Ministry (Germany, Spain, Belgium, Netherlands) or by a third party (Czech Republic), with even a central LIR (Germany, Czech Republic) or a central network (Spain). One MS (Belgium) even considered to develop an IPv6 public service datacentre but gave up as it considered this too ambitious. The results of such an approach are generally good, but the adoption may remain still low (Spain).

1.3.2 Plans

As mentioned in details below (see section 6), many MS do not have a plan for IPv6 (public sector or more globally). It is obviously the case of MS with no government involvement.

Specific plans for the public sector

For those with real plans (beyond just an analysis of the situation), specific plans addressing the public sector are quite rare (Netherlands, Belgium, Germany, Czech Republic, plus to a lesser extent Austria and Spain) and can be found logically in the most successful MS for IPv6 adoption in the public sector. The commitment of the government is showing improved performances than for other MS. Most other MS have tried to adopt a more global IPv6 plan addressing both public and private sector (Sweden, France, Spain, plus to a lesser extent Luxemburg or Slovakia), with results that are generally not as good.

Targets

It should be noted that most plans, when they do exist, are still mainly recommendations with no clear targets, deadlines and/or enforcement. Clear targets are mainly within plans of Belgium, Luxemburg, Denmark and Sweden, with quite various types of results. All these MS did not reach their targets and have gone for an updated but less ambitious plan.

1.3.3 Key initiatives to develop IPv6

Apart from very specific initiatives mentioned earlier, main actions taken by MS can be classified into 4 categories:

- The most important one is without a doubt **procurement** that is often mandatory for new equipments and/or new websites. This is especially the case of Belgium, Czech Republic, Spain Italy, Latvia and Portugal, plus with less enforcement for Denmark, Austria and Slovakia (but also MS like Croatia, France, Germany). This measure is quite positive, but has had so far limited impacts, as it only concerns new equipments. Many MS have now such rules (or equivalent) and are still trailing behind for adoption, as the measure takes time to have some effect.
- The other major action is **training**, even though it is a little bit more developed than procurement. Key MS that developed such an approach are Belgium, Estonia, Slovenia, Luxemburg, France, Spain. Like for procurement, this measure is positive, but not fully efficient (this is also done by laggards MS without real reduction of the gap).
- **General information** on IPv6 is provided by many MS, but generally by MS are the most motivated ones by IPv6 in the public sector.
- **Definition of IPv6 profiles** is rare (Slovenia, reused by Germany) and used by tech-savvy MS.

1.3.4 Barriers

There are three main barriers identified, almost independently of the situation regarding the current (or even future) adoption of IPv6 in the public sector:

- **The lack of interest and involvement of most MS**, not identifying benefits of moving to IPv6 and often ready to leave it to ISPs. There are some MS not feeling any urgency. This is mostly the case of MS not well advanced yet on IPv6 in the public sector.
- **The cost and budget necessary to operate the transition to IPv6**. This has been identified by both leading MS during the deployment of their plans (there is no scale effect yet and also no clear budget allocated to this) like Belgium, Austria or Germany and by MS that have reduced their ambitions, often due to budget cuts like Sweden or Slovenia. MS see IPv6 as essentially costs, especially as support is required for both IPv4 and IPv6.
- Finally, **there are also technical issues**. IPv6 maturity (around hardware) is still considered as being low, especially in terms of performance and security, even by MS that have advanced adoption of IPv6 (Germany). Many MS mention they would need some technical support.

A few MS have also mentioned that ISPs are often not enough involved to develop IPv6, which is an additional roadblock (Italy, Latvia, but also Netherlands).

Organizational issues are sometimes mentioned (especially in terms of coordination), but are not as important as expected. It seems to be more an issue of commitment (political and budget), then organization will often follow.

1.4 Cluster of public pioneers

This cluster (Austria, the Czech Republic, Estonia Netherlands, Portugal, Slovakia and Sweden) represents the countries where global IPv6 deployment is not particularly high when compared to overall Member States, yet does score high when focusing on IPv6 deployment in the public sector. In other words, this is the cluster where one could reasonably argue: “these Member States have promoted IPv6 deployment in the public sector”. This does not include leading MS like Belgium and Germany, performing well on both public and private sector, with their own specific approach.

1.4.1 Key stakeholders

There are two main axes one can look for regarding the key stakeholders; the existence of an IPv6 Task Force, and whether the key stakeholder is a part of the government (typically a Ministry).

Concerning the existence of an IPv6 Task Force, there is no real pattern since its existence is roughly half-and-half. The Netherlands, Portugal, Austria and Estonia all had an IPv6 Task Force in place, although with the exception of Estonia, it must be noted that these Task Forces have been defunct since around 2003/2004 (the Netherlands, according to our interview, claims that the Task Force still holds yearly meetings but nevertheless there have been no public activities since 2004).

Estonia’s IPv6 Council was set up in 2014, which is comparatively very recent; however, this council apart from the launch of the Council itself has mentioned no activities. Slovakia, the Czech Republic and Sweden have no such Task Forces (Sweden can appear to have had one, but in reality it was and still is the PTS, see below).

Figure 3 : Cluster analysis: Task forces in select countries

	IPv6 Task Force	Currently active
Austria	Yes	No
Czech Republic	No	No
Estonia	Yes	Yes
Netherlands	Yes	Yes (but no publications)
Portugal	Yes	No
Slovakia	No	No
Sweden	Yes (PTS acts a Task Force)	Yes

Source: IDATE Digiworld, based on desk research and interviews

Concerning the involvement of the government, it is noteworthy that for five of the seven Member States the key stakeholder is indeed the government. The exceptions are the Czech Republic, where the key stakeholder is the CZ.NIC Association (which runs and maintains the Czech national domain and is the main body for IPv6 related issues), and in Sweden where the key stakeholder is the PTS (Swedish Post and Telecom Agency) together with the IIS (Internet Foundation in Sweden).

1.4.2 Government Plans and Strategies

It can be noted that all of the governments of the Member States included in this cluster have some sort of national plan in place. Of particular interest in the Czech Republic and Sweden, as both had an IPv6 policy plan mapped out by the government, running up to 2013 (and not much more being done since). Austria could also potentially be grouped here, since although there was no given governmental policy per se, the government did carry out a survey in 2011 in which the majority of ministries replied that they intend to complete IPv6 deployment by 2013. One could assume this survey (recorded as a white paper) put pressure on the ministries to proceed with the IPv6 deployment.

The Netherlands and Estonia, on the other hand, have recent governmental plans in place, which run until 2019 and 2020 respectively. In the case of Estonia, the policy was put in place in 2003, while for the Netherlands it has been running since 2016.

1.4.3 Deployments

Regarding this cluster of countries, IPv6 is more broadly adopted in the public sector, at national and regional levels, as well as in research networks. These research networks were often used as "test beds" for IPv6 deployment and were generally the first compatible networks in the country.

Some initiatives related to the improvement of the overall quality of websites/services, while not directly related to IPv6, take nonetheless this parameter into account. These initiatives directly promote IPv6 adoption (among other internet standards) by offering "rewards" for higher-ranking websites. This is notably the case in the Netherlands and in the Czech Republic.

1.4.4 Operations & Organisation

Procurement requirements generally apply, which compel public administrations to choose IPv6-compatible equipment when facing a purchase equipment. In some countries, public administrations must explicitly explain their decision is they choose to buy a non-compatible equipment (comply or explain)

In order to help overcome technical difficulties, training sessions were offered in many of these countries, generally led by public entities responsible for the management of government networks.

1.4.5 Barriers and Future developments

Barriers are roughly the same as in other countries, but several governments from this group aim to implement plans to overcome them, notably by formulating procurement requirements (if none yet), setting clear deadlines for migration and working more closely with ISPs.

1.5 Cluster of laggards

There is no obvious common elements between those countries (France, UK, Luxemburg, Greece and Finland) displaying a relatively high level IPv6 adoption in global and a very low implementation of IPv6 in public administrations.

Though few elements can be highlighted like:

- The current inactivity, dismantlement or inexistence of national IPv6 Task Force, often used to get more information
- The involvement of ISPs as stakeholders (members of the IPv6 dedicated group) and also being pushed forward as key references of IPv6 implementation, leading to less focus on the public sector
- The lack of focus on public sector from the responsible organization (except for France)
- Somewhat a relative involvement of the government by being a stakeholder or by being interested in having a national review of IPv6 (except for Greece and Finland)

Also, the main barriers identified for the IPv6 implementation in the public sector are mainly related to the lack of coordination (coherent move) and also the lack of reasons to move.

Therefore, the development in these MS is indeed driven by ISPs and not the public sector, that has no or minimal plans. IPv6 adoption is therefore slow and with no direct impacts for the public sector.

	France	UK	Luxembourg	Greece	Finland
Dedicated Task Force created initially	Inactive since 2007	Inactive since 2002 (except in Scotland)	No	Dismantled in 2015	Inactive since 2008
Responsible organization	Government	IPv6 council	IPv6 council	GRNOG	Regulatory body (FICORA)
Focused on public sector	*Yes*	*No*	*No*	*No*	*No*
Government involvement	IPv6 responsible organization	Member of UK TF but not in IPV6 council	Member of IPv6 council	No	Initially member of Finnish TF
Existing government plan	*Yes (without target)*	*No (IPv6 not mention in eGov plan)*	*Yes with target*	*No*	*No*
Procurement rules	*Yes (but not enforced)*	*Recommended*	*In the roadmap*	*n/a*	*n/a*
Review asked	*Regulator body (ARCEP) assigned by the government for a review in 2016*	*Secretary of State for Culture and Digital Economy commissioned for a review of IPv6 in 2015*	*Review asked by the Ministry of Communications in 2011*	*No*	*No*
ISPs involvement	None	Members of UK IPv6 council	None	Key members of GRNOG	Initially members of Finnish TF
ISPs as references being IPv6-enabled	*ISPs IPv6 implementation provided in the ARCEP observatory*	*ISPs IPv6 implementation provided in the OFCOM annual "Connected Nations"*	*Post Luxembourg case cited as pioneer in IPv6 since 2009*	*No*	*Participants to the national IPv6 day*

	France	UK	Luxembourg	Greece	Finland
Barriers identified	• Lack of interest from public institutions • No coordination deployments within the public sector • No coherent moves/initiatives	• Lack of commercial opportunity in short term • Lack of coordination “wait and see” • Lack of maturity (control) • Lack of centralized information system within government entities	• Lack of technical knowledge in admin and need for training • No motivation to move into innovation and digitalization	N/A	• Lack of motivations • Lack of organization • Lack of education to move

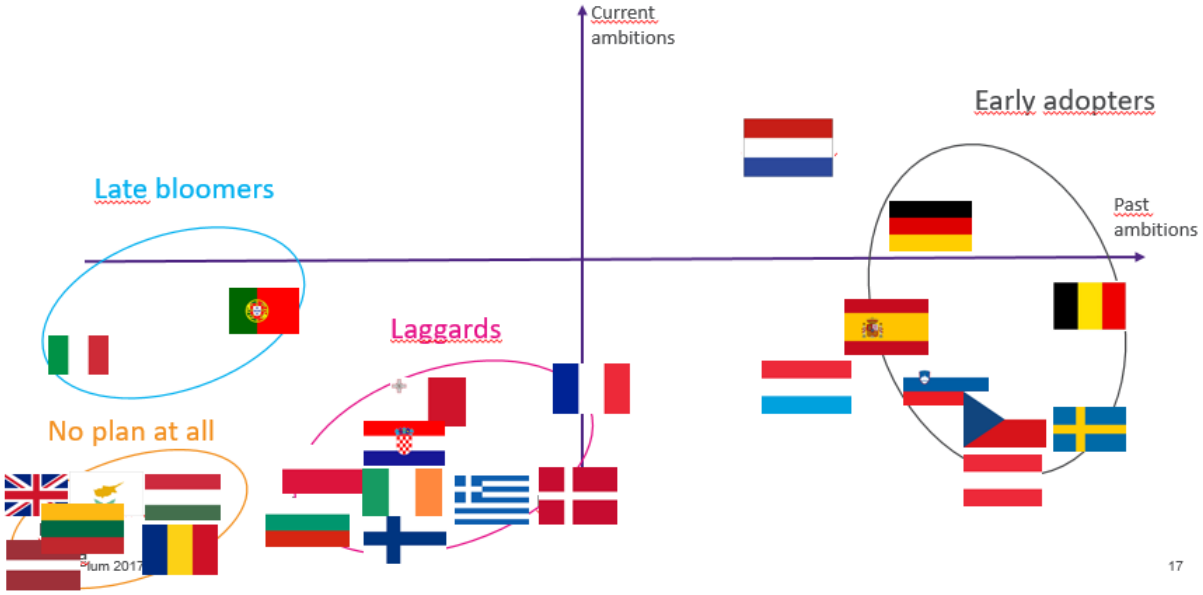
1.6 Classification of MS around past and current ambitions

Finally, we conclude with a dynamic vision of the IPv6 in the public sector. The different European countries have shown different attitudes and level of ambitions toward the adoption of IPv6 in their public administrations.

Overall, the main outcome of this analysis is that, globally and with only a few exception, the ambitions towards the adoption of IPv6 have significantly decreased in recent years. For the most forward-looking countries, the ambitions of IPv6 transition started to develop in the early 2000s, they probably peaked overall in Europe around the 2010-2013 time frame and are clearly decreasing since. This decrease in ambition is noticeable by the diminution of the number of national plans (regardless of current adoption metrics) as well as the diminution of the number of studies and report related to IPv6. The trend is often confirmed in interviews with responses pointing toward a shift in priority, a lack of budget, or a general discouragement toward the status quo.

We can group several countries showing similarities in their attitude, the measure they concretely took and the timing at which they decided to act. Estonia is not covered into a group due to limited information.

Groups of players according the ambitions of the plans



Group 1: early adopters with reduced ambitions over time

- This first group gathers countries that identified early on within their national government the necessity and implications of switching toward IPv6. This group includes Belgium, Germany, the Czech Republic, Spain, Slovenia, the Netherlands, Sweden and Austria.
- They often had an active IPv6 taskforce, well identified structures in the government responsible for the digital transformation of public administrations, defined public procurement rules, set up training programs and often had a clearly identified national plan. Some, such as Sweden or

Belgium even defined clear deadlines for adoption. For this group, most of these activities were done before 2014.

Country	Past Ambitions	Current Ambitions
Belgium	Plan for full adoption in public services by 2014 Very active taskforce Plans at regional levels as well	Resource limitation has delayed plan Plan downscaled to mandatory adoption on new public procurement or significant website update
Germany	Identified responsibility in gov Plan for public procurement Support to local / regional gov for adoption No deadline set	Still supporting adoption
Czech Republic	National association providing training Plan for adoption in public administration Public procurement rules	Mostly inactive since 2013 not mentioned anymore in eGov plans
Spain	IPv6 Task Force National Plan for IPv6 (non gov) Identified responsibilities in gov Public Procurement rules	Task Force now inactive Plan still there but low efforts
Slovenia	Responsibilities well identified National association with gov support Plan and action toward public procurement	Economic downturn reduced budget for training Seem to have reduced efforts
Sweden	Plan to deploy by 2013 Main stakeholder: regulator	Minimal support to some IPv6 activities
Netherlands	Existing Task force and supporting organizations Plan for adoption in public administrations	Still active Plan in 2016 to help municipalities migrate to IPv6 (target 2019)
Austria	Task force set up Gov agency responsible Training provided Public procurement rules	Transition considered as complete (no plans for regional / local government)
Luxembourg	Government plan for adoption Plan for public procurement rules Plans for promotion	Plan still in place without update

After these initial ambitions, most of them seem to have now significantly reduced their ambitions, mostly by lack of budget, political support or because (such as Austria) they consider the task as complete (although the adoption is clearly not reaching 100% yet). The level of adoption of IPv6 in public administrations in these countries can be expected to still rise but quite slowly mainly due to the public procurement rules in place, except maybe for Netherlands and Germany still quite active.

All these MS are classified as IPv6 pioneers or leaders for the public sector. Without a surprise, early adopters can be found only within MS that have a public plan.

Group 2: limited interest and potentially dropping out

This second group gather countries that started to move toward IPv6 usually around the same time as the first group (2002-2010) but with much more limited ambitions. These initial ambitions have now

decreased and in many cases they have entirely dropped their meagre ambitions. This group includes: France, Luxembourg, Slovakia, Malta, Croatia, Denmark, Finland, Poland, Bulgaria, Ireland and Greece.

The countries in that group have at some point set up some policies for IPv6 adoption such as dedicated research groups and pilots, taskforces, national plans, training or public procurement rules. Some of these activities are still active or policies still in place but a large part of the initial ambitions have been given up.

Country	Past Ambitions	Current Ambitions
France	IPv6 Task Force IPv6 national transition plan not dedicated to public administration Mixed and changing responsibilities in gov Public procurement rules	Task Force now inactive Gov plan objectives not met Reduced interest Procurement rules not really enforced.
Slovakia	No Taskforce or well identified government agency IPv6 mandatory in public services (public procurement?)	No recent activity or visible plan
Malta	IPv6 included in the national digital agenda Lack of concrete plan or organization driving things forward	Recent events and annual plan suggest IPv6 still on the agenda but low priority
Croatia	Limited awareness, mostly in R&D and Education	Limited awareness, mostly in R&D and Education
Denmark	Past plans for IPv6 adoption at national level Past plans for public procurement	No plan or support from gov
Finland	Main stakeholder: regulator No plans or strategy specific to gov Past task force	No plan or support from gov
Poland	Past task force and limited plans	No plan or support from gov
Bulgaria	No Taskforce or gov initiative R&D Lab set up	No plan or support from gov
Ireland	IPv6 TaskForce with participation of gov No visible government plan	No plan or support from gov
Greece	Taskforce from 2010 to 2015 (disbanded) Ambition to have a national plan	No plan or support from gov

The overall ambition in this group started lower than in group 1, it diminished over time, but is still somewhat active. The level of adoption of IPv6 in public administrations in these countries can be expected to stagnate or rise very slowly mainly when public procurement rules are in place.

Group 3: potential late bloomers?

This third group gather the countries in which the necessary transition of public services to IPv6 was only considered relatively recently and that show some limited ambitions of adoption. This group gathers Portugal and Italy.

The effort of adoption seem to be relatively recent in these countries, and they have set up a plan to switching to IPv6 (considered for 2019 in Portugal) and public procurement rules (since 2016 in Italy).

Country	Past Ambitions	Current Ambitions
Portugal	Limited plans and public procurement in research and education	Entity responsible for management of government network has plans for switching in 2019
Italy	No plan or support from gov	Recently included requirement in public procurements

The countries in this group appear to have rising ambitions of IPv6 transition, but this should be taken with caution as the plans announced are not very ambitious (compared to Belgium, Netherlands or Germany). In addition, the overall limited adoption of IPv6 in these countries does not prefigure a rapid switch of their public services to IPv6. It is thus mostly by a figure of contrast with the other group that these countries appear to have ambitions.

Group 4: No interest past or present

This group gather countries, which seem to have never had any ambitions of transitioning their public services toward IPv6. This group includes the United Kingdom, Lithuania, Cyprus, Hungary, Latvia, and Romania.

At most, they had at one point a taskforce in place, but the public administration never showed much interest or support for a transition to IPv6.

Country	Past Ambitions	Current Ambitions
United Kingdom	No plan or support from gov Some form of task force in the past (defunct now)	No plan or support from gov
Lithuania	No plan or support from gov	No plan or support from gov
Cyprus	No plan or support from gov	No plan or support from gov
Hungary	Identified responsibility in gov but no plans or specific support to IPv6 in gov	No plan or support from gov
Latvia	No plan or support from gov	No plan or support from gov
Romania	Taskforce established, no activity since 2014 No government plan	No plan or support from gov

The adoption of IPv6 by public administration in this group can be expected to stagnate with very limited activities for the future.

2 Focus on development in public administrations

2.1 Spain

2.1.1 Key stakeholders

IPv6 Task Force

Like the European Task Force IPv6, the IPv6 Task Force Español is a working group in charge of implementing IPv6 according to the needs of the local market for both private and public sectors. The group is responsible of studying the perspectives of IPv6 technology and the actions to be taken accordingly.

The group is composed of:

- RedIRIS;
- Consulintel (also part of Gen6);
- IPv6 Task Force.

The last (and unique?) work done by the group was the production of a report1 from 2003. The report covered the analysis and recommendations for the migration to IPv6 in which the co-existence of IPv4 and IPv6 has been identified as a slow and gradual process.

For the current study, the IPv6 Task Force Español has been contacted unsuccessfully with undelivered email.

The Spanish government

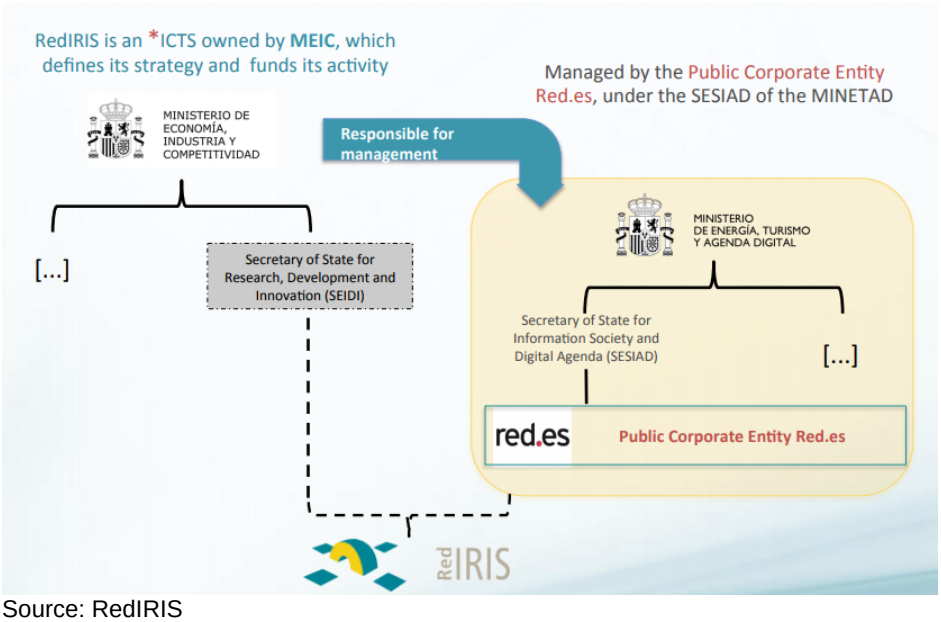
Regarding IPv6, two different ministries are involved:

- the Ministry of Energy, Tourism and the Digital Agenda that has developed a Plan to foster the deployment of IPv6;
- the Ministry of Finance and Public Function within the scope of the general integration of the IPv6 protocol in public administrations. Specifically, the General Secretariat of Digital Administration is in charge of requesting the address space for RIPE and the update of the Address Plan in the Administration.

[1] http://www.spain.ipv6tf.org/public/IPv6TF_Spain_v10.pdf

As part of the Ministry of Energy, Tourism and the Digital Agenda, **RedIRIS - one of Red.es missions** - is the Spanish academic and research network that provides advanced communication services to the scientific community and national universities. RedIRIS counts over 500 institutions, mainly universities and public research centres. The organization's objectives are to launch different initiatives towards improving the academic network and thus introducing new technologies and services.

Figure 4: Link between Red.es and RedIRIS



Source: RedIRIS

As part of their activities, RedIRIS worked to encourage affiliated institutions to draw up their strategic plans to include migration to IPv6 in all their networks. Though, most of related-activities date to 2011-2012 such as the participation to the IPv6 World Day pushed by Internet Society. It seems that RedIRIS is currently more focused on the deployment of fiber networks.

At that time, RedIRIS had provided:

- a schedule for IPv6 migration (*worth to be noticed that the link on their website is broken*);
- a guide for deploying of IPv6;
- an observatory for the status of IPv6 implementation (dating from 2010[2]).

A dedicated group was constituted for the IPv6 observatory as shown in the figure below in order to analyze the state and main initiatives related to IPv6 in Spain and to provide information on the migration. This page has not been modified since 2011[3].

[2] Spanish IPv6 observatory: http://slideplayer.com/slide/3835383/

[3] http://wiki.rediris.es/observatorio_ipv6/IPv6_Spain

Figure 5: IPv6 Observatory working group

Source: RedIRIS

2.1.2 Government plans and strategies

A national plan of transition to IPv6 under the umbrella of the Ministry of Energy, Tourism and the Digital Agenda has been signed by the Council of Ministers in April 2011 resulting in the launch of initiatives including:

- An official IPv6 website has been developed through a **dictatic portal** http://www.ipv6.es/es-es/Paginas/Index.aspx provides explanatory and information regarding IPv6 and the development of the National Plan at the destination of individual users, companies, ISPs and public administrations.
- The responsibility to the Ministry of Finance and Public Function (MINHAP) for the integration of IPv6 in Public Administration;
- The launch of **10 measures[4] regarding IPv6 but not necessarily IPv6 centric**, of which:
  - **The creation of information portal**: Electronic Administration Portal (PAe)[5];
  - **The creation of working groups**;
  - **Projects funding**;
  - Free 20 theoretical and hands-on **IPv6 training sessions** launched across the country were co-organized by 6DEPLOY[6] and the Spanish Government;
  - The studies for **transition of administrative network: Red SARA** (Spanish governmental network allowing the interconnection among the 3[7] levels of Spanish Public Administrations) which include.

That plan did not integrate goals, neither timeline.

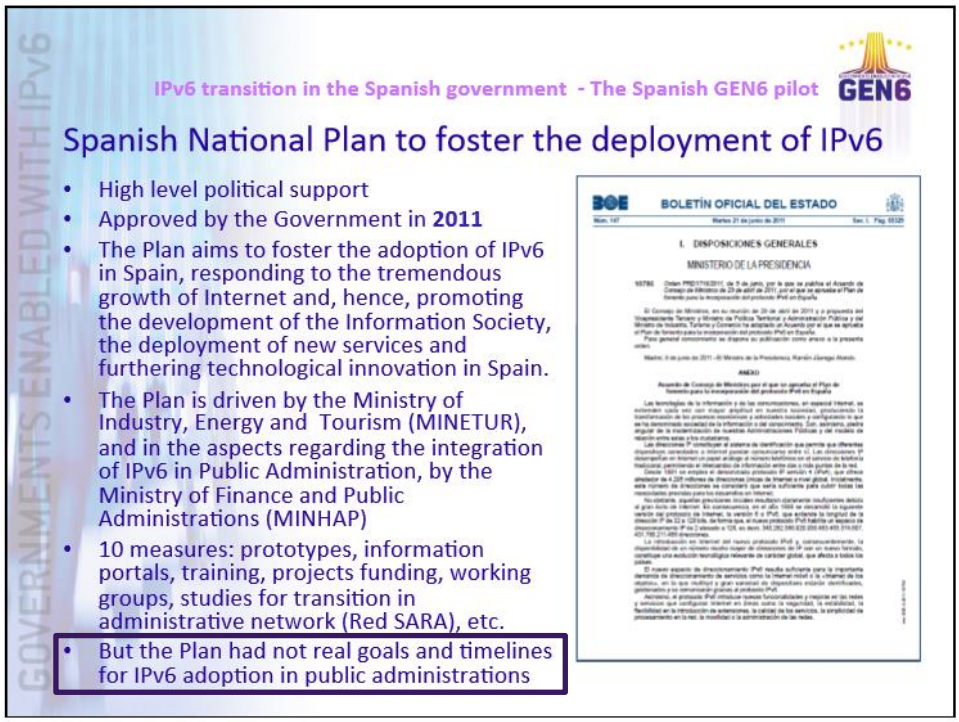
[4] http://www.ipv6.es/es-ES/transicion/Documents/Spanish%20IPv6%20Deployment%20Plan.pdf

[5] https://administracionelectronica.gob.es/pae_Home.html?idioma=en

[6] Project part of FP7 EU program in support of the deployment of IPv6, in Europe and developing regions (http://www.6deploy.eu/)

[7] National (13 ministries), regional (17 autonomous communities) and local (over 8000 municipalities)

Figure 6: Spanish national plan for the deployment of IPv6



Source: IPv6 transition in the Spanish government, Gen6 Lisbon 2015

The MINHAP also engages in the IPv6 promotion through:

- the update of current addressing and networking interconnection plan of the administration (dating from 2010);
- the incorporation of IPv6 in Red SARA;
- the training for the people responsible for the Internet services of the administration.

2.1.3 Technical aspects/issues

Addressing and network interconnection

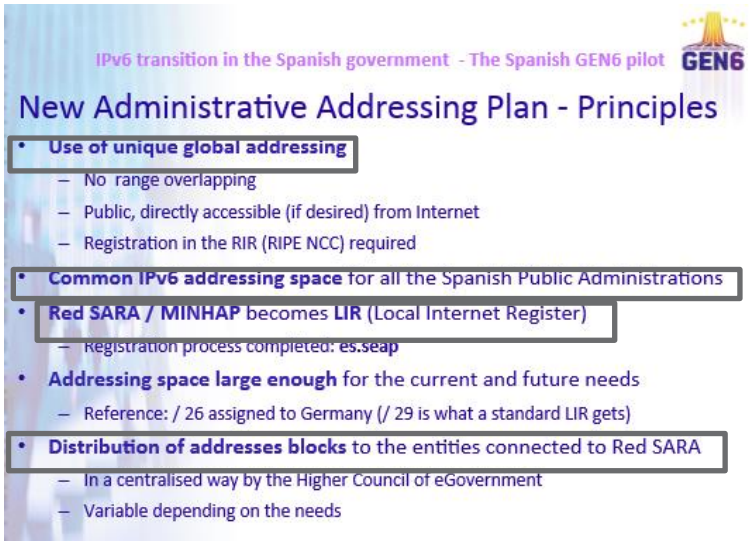
According to the art. 14 in the Royal Decree in 2010, public administrations are requested to apply the addressing and networking interconnection plan of the administration approved by the Higher Council of eGovernment. Currently, distribution of addresses are made by the Higher Council of eGovernment in a centralized way and recommendations were made for the development of an own addressing plan inside the public sector.

Among the measures taken by the MINHAP, there is a new addressing plan for administration as developed in the figure below with main principles:

- Unique global addressing;
- A common IPv6 addressing space dedicated to public administrations;
- Red SARA/MINHAP to become a LIR;

- Addresses blocks distributed for entities connected to Red SARA.

Figure 7: New Administrative Addressing Plan



Source: IPv6 transition in the Spanish government, Gen6 Lisbon 2015

Concretely today, the General Secretariat for Digital Administration, a MINHAP unit, has the centralized role of managing the allocation of IPv6 space from RIPE for the public sector. The unit act as RIPE LIR and they have a /24 IPv6 allocation for their LIR. Actually, the request is centralized but a distributed management by each management by each region is expected.

From organisation point of view, the Plan of addressing and interconnection of networks is based on the establishment of a directory of IP network addresses. The Plan allows each entity to independently establish their IP numbering plans, depending on their network infrastructure, or organizational or departmental distribution. The risk here is to use duplicate addresses.

2.1.4 Current deployments

In line with the adoption at the country level, the use of IPv6 in public sector is unsurprisingly low.

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[8] as November 2016.

According to **CZ.NIC statistical portal**, Web server (WWW), name servers (NS) and mail exchange (MX) readiness to IPv6 remain low with **3 web servers, 15 name servers and 10 mail exchanges totally supports IPv6.**

[8] https://www.vyncke.org/ipv6status/detailed.php?country=es&type=Gov

The 3 web servers are:

- Congreso de los Diputados (congress of deputies);
- Ministerio de Industria, Energía y Turismo (Ministry of Industry, Energy and Tourism) which is responsible of Red.es;
- Ayuntamiento de Aranjuez (city council of Aranjuez).

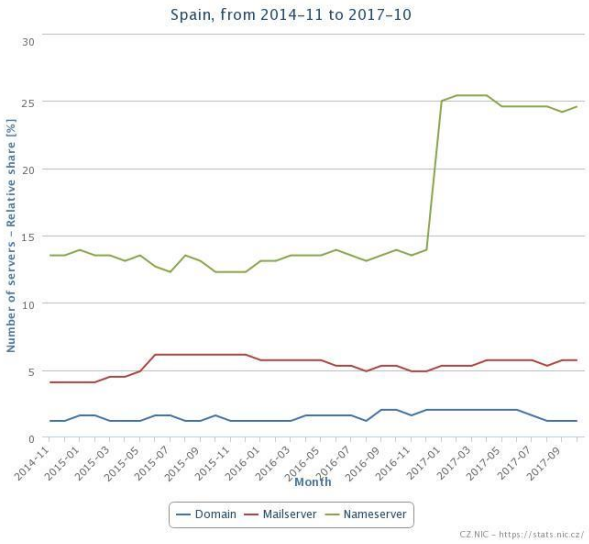
Also, there has been a rising trend in early 2017.

Figure 8: Implementation of IPv6 government servers

Data for 01-12-2017				
Name	Domain	WWW	NS	MX
Total: 244		238	184	230
		3	45	4
		3	15	10

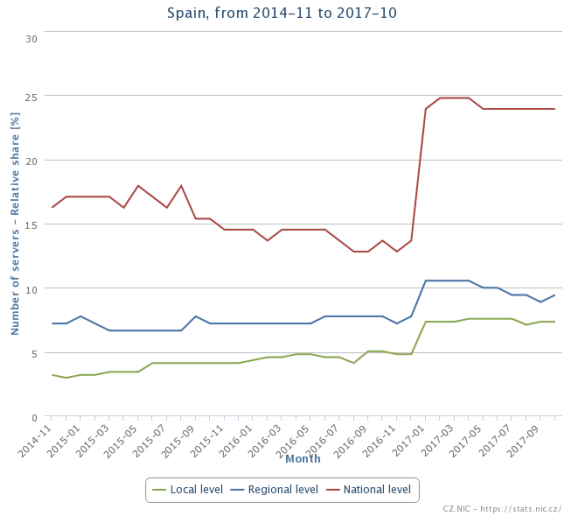
Source: https://devpub.labs.nic.cz/ipv6-smt-new/country/es/

Figure 9: Implementation of IPv6 by governments – countries



Source: CZ.NIC

Figure 10: Implementation of IPv6 by governments - administrative units



Source: CZ.NIC

According to the interview with MINHAP, they are in an early phase of IPv6 deployment, recognizing that the level of adoption is low. Some services are provided over IPv6, like the https://administracionelectronica.gob.es/ and http://administracion.gob.es/, but the internal services are not using IPv6 yet.

Also, there are some IPv6 traffic over their network but she were not able to provide any estimation.

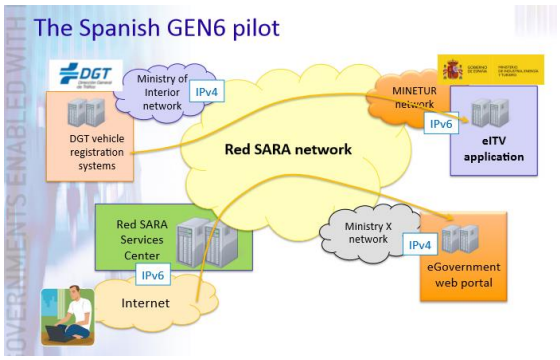
2.1.5 Deployments and pilots

Spanish Gen6 pilot

As part of Gen6, the Spanish government conducts a pilot for the Ipv6 transition. The major goals include:

- The creation of a platform for general IPv6 accessibility for eGovernment services;
- The test interoperability between IPv6-ready and IPv4-only administrative units.

Figure 11: Spanish Gen6 pilot



Source: IPv6 transition in the Spanish government, Gen6 Lisbon 2015

To reach the goals, 3 different action lines have been taken by the Spanish government:

i. The upgrade of Red SARA:
   - Implementation of IPv6 in most of backbone of Red SARA with the aim to transport native IPv6 communications between administrative units;
   - Update to support dual stacks (IPv4/IPv6) connection between ministries;

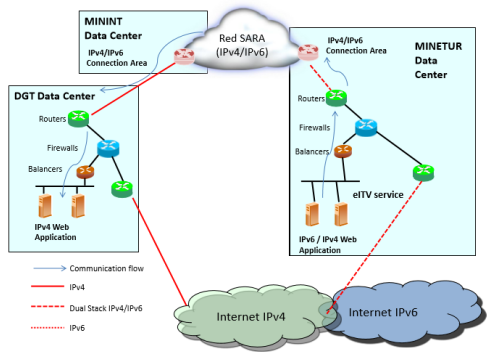
ii. IPv6 enablement of public administration web portals:
   - Implementation of a transition mechanism allowing public administrations to offer services accessible by means of IPv6 (based on a shared service approach): creation of an IPv6 Gateway Solution for Public Administration (IPv6 to the outside and IPv4 to the inside);

iii. Evolution of MINETUR (Ministry of Industry, Energy and Tourism) to provide native IPv6 services to be consumed by administrative units from other ministries.

Red SARA and IPv6 gateway

As of 2015 and according to Gen6 pilot, the Spanish national project is about preparing the government core Network for IPv6[9]: implementation of IPv6 in Red SARA.

Figure 12: Implementation of IPv6 in Red SARA backbone



Source: IPv6 transition in the Spanish government, Gen6 Lisbon 2015

First IPv6-enabled web portals using IPv6 gateway solution:

- Several MINHAP web portals made IPv6 enabled;
- Update of some of major Ministry of Justice web portals to be accessible in IPv6 using common services of Red SARA. The Ministry of Justice integrates its main e-Government services to IPv6 Gateway solution, thus increasing the availability of public services online with IPv6;
- Ministry of Defense web portals in test;
- Health, Social Policy and Equality web portals in discussion.

[9] http://www.gen6-project.eu/fileadmin/GEN6/Gen6-EU-IPv6Observatory.pdf

In support of IPv6 implementation, the MINHAP is updating an IPv6 routing guide aiming to facilitate the connection of other entities to Red SARA in order to minimize/eliminate potential routing problems that may occur.

2.1.6 Operations & Organisation

Procurement

The MINHAP has taken measures to foster IPv6 deployment including the procurement aspect: IPv6 to be incorporated as a requirement in the public procurement of ICT products and services. The MINHAP has provided a suggestion for the general clause to be added in public procurement like the following sentence: “Every system must be able to work fully according to the commercial standards for IPv6, keeping or improving the service, quality and confidence levels, with technical support for both protocols”.

As regards to procurement of devices for administration (desktops, laptops, mobile devices), the interviewee from MINHAP confirms the presence of the clause ensuring the compatibility of the devices with IPv6. Thus, they assume the readiness of the hardware.

Training

According to MINHAP, IPv6 knowledge is a prerequisite for an ICT civil servant in Spain. In addition, IPv6 courses are offered.

2.1.7 Barriers and Future developments

According to the Spanish representative in Gen6, the main issues in Spain in the transition to IPv6 are:

- The complex and decentralized administrative services and associated difficulties involved;
- The lack of commitment from Ministries in the past (though, regaining interest);
- The difficulties to obtain IPv6 permanent address space because of delay in the administrative addressing plan (temporary IPv6 address provided by the ISP).

Indeed, Spain is one of the most highly decentralized countries in Europe:

- All Autonomous Communities have their own elected parliaments, governments, public administrations, budgets and resources;
- Health and education systems among others are managed regionally.

The three levels of Public Administration as described below are expected to work together to implement policies and provide services.

Figure 13: Organization of Spanish public administration with decentralized services

Source: IPv6 transition in the Spanish government, Gen6 Lisbon 2015

Main lessons learned from Gen6 pilot:

i. Technical issues are not a problem
   - More incompatibility expected with IPv6 in hardware and software
   - No costly investments were required

ii. The main barriers are organizational
   - Lack of receptiveness in other administrative units to the need of transition
   - Make things easy for them (simple solutions: IPv6 gateway)

iii. Addressing may be a headache
   - Cumbersome process not expected in defining the IPv6 National Addressing Plan
     - RIPE demands justification if size is larger than /29
     - Agreement required among national, regional and local administrations (but this may be subject to the particularities of Spanish territorial organization)

Also according to MINHAP interviewee, regarding addressing, since there is a common address space reserved for all public administration, the coordination is very critical.

2.2 France

2.2.1 Key stakeholders

The government

The entity in charge of the migration to IPv6 in the public sector in France **is not well defined**. The government gave the **responsibility to an inter-ministerial entity but without any power of decision** on each ministry to implement concretely the protocol (according to our interviewee from AFNIC organisation).

In 2011, in order to foster the adoption of IPv6 protocol and as part of the government plan presented that year, the French government gave the responsibility of the deployment of an inter-ministerial IPv6 enabled core network to the inter-ministerial direction of the information system and communication (Direction interministérielle des systèmes d'information et de communication (DISIC)).

In 2012, the service with national competence of inter-ministerial network of the State (Service à Compétence Nationale "Réseau Interministériel de l'Etat" (RIE)) was in charge of the management, the operation and the security of the inter-ministerial network of the State. The service was attached to the General Secretariat for the modernization of public action (Secrétariat Général pour la Modernisation de l'Action Publique (SGMAP)), a Prime Ministry service. Actually, the agents affected to this service in charge of deploying and managing came from nine different ministries.

Since then, in 2015, DISIC merged with Etalab (a mission dedicated to Open data) and with the innovation activity of SGMAP (Secrétariat Général pour la Modernisation de l'Action Publique) and it became DINSIC (Direction Interministérielle du Numérique et des Systèmes d'Information et Communication) for inter-ministerial direction of the digital and information system and communication.

Recently, in November 2017, since the dissolution of the SGMAP, the DINSIC is now under the authority of the Minister in charge of the digital.

According to the AFNIC interviewee, the role of this entity is not to be the information system department of the government but much more a role of coordinator between the different ministries as so far each ministry has its own information system department.

Other stakeholders

Among other stakeholders in the adoption of IPv6 in France is **RENATER**. It is notably a lead partner of 6Deploy2, a European project providing IPv6 training and support for deployments to network operators, service providers and industry throughout the world. RENATER is also in charge of the working group about the globalisation of IPv6 training labs.

The **AFNIC has no direct responsibility** in the transition to IPv6. Their role is to encourage the adoption of the protocol and to be exemplary. Also in partnership with ANSSI, they produce an observatory of the resilience of the Internet infrastructure since 2011 (not focusing on public sector).

Historically, there has been a **Task Force IPv6 France (TFF)** which was created in 2002 and was in charge of the development of IPv6 in France. It had published recommendations in 2003[10]. Since 2006-2007, TFF has joined the Association G6 in charge of the promotion and development of IPv6. Since then, according to the information on their current website[11], it seems that the group has no current activity. The interviewee from AFNIC confirms the inactivity of this organism.

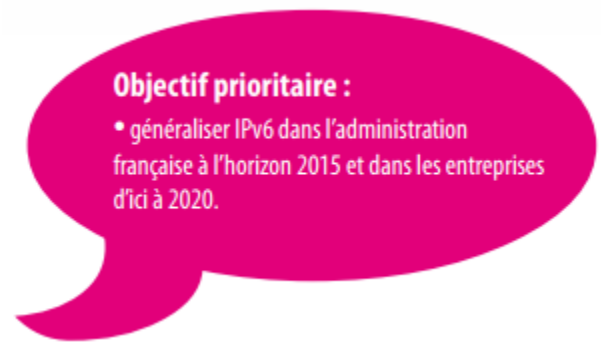
2.2.2 Government plans and strategies

The introduction of IPv6 in the public sector has been integrated in the digital plan presented by the government in 2008 as part of 2012 targets. Indeed, the French digital plan was composed of 150 measures articulated in 4 axis:

- Access to digital networks;
- Development of the production and the supply of digital content;
- Diversification of digital usages and services;
- Renovation and ecosystem of the digital economy.

The measure number **149 of this plan referred to IPv6 protocol indicating the importance of introducing progressively from 2009 the compatibility with IPv6 in the public procurements.**

Also, one of the major goals of the government plan included the utilisation **of IPv6 by the whole public services by 2015 and by companies by 2020**.



Source: http://fr.unesco.org/creativity/sites/creativity/files/periodic_reports/files/2011_plan_france_numerique2020.pdf

In line with the measure 149, in 2011, a **circular letter[12] addressed to the state administrations, relayed to local authorities, encouraged the inclusion of IPv6 compatibility in the technical specifications of public procurement for goods or services using the IP protocol.** It also included that the public services gradually but as quickly as possible ensure the compatibility and availability of their sites and online services to IPv6.

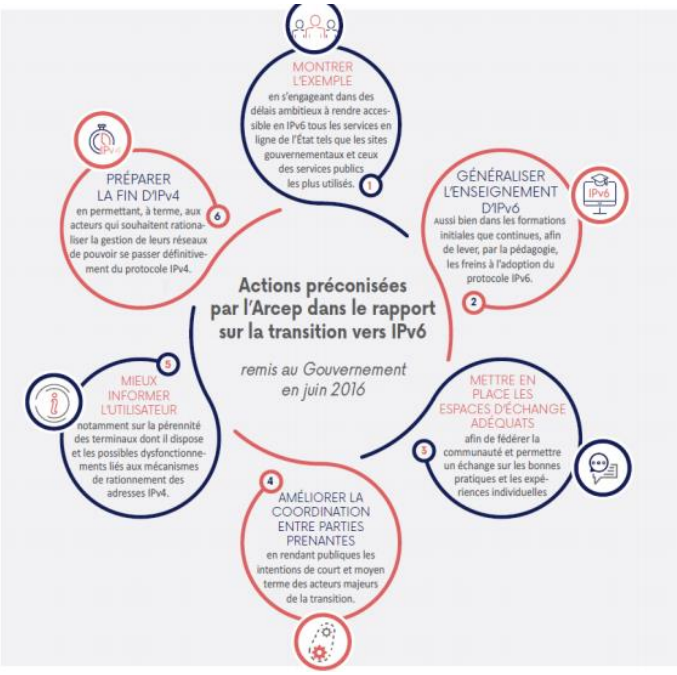
[10] https://www.afnic.fr/data/actu/public/2003/interop-recommandations-task-force-ipv6.pdf

[11] http://g6.asso.fr/apropos/

[12] http://circulaires.legifrance.gouv.fr/pdf/2011/12/cir_34250.pdf

Then, in 2016, the government **has referred the ARCEP (the French telecom regulator) to provide a statement in the transition to IPv6 in France (not specific to the public sector but globally)**. The report produced by ARCEP notably include an analysis of IPv6 deployment in France, the identification of the barriers to the migration, the risk of delays and 6 key actions to take to encourage the adoption.

Figure 14: Key actions of the plan



Source: ARCEP

Actually only the first action highlighted by the ARCEP is related to the public sector pointing **that the government has to be the example**. Precisely, the recommendation is about setting up ambitious goals in order to make the whole public services accessible on IPv6 including government websites and the most used public services.

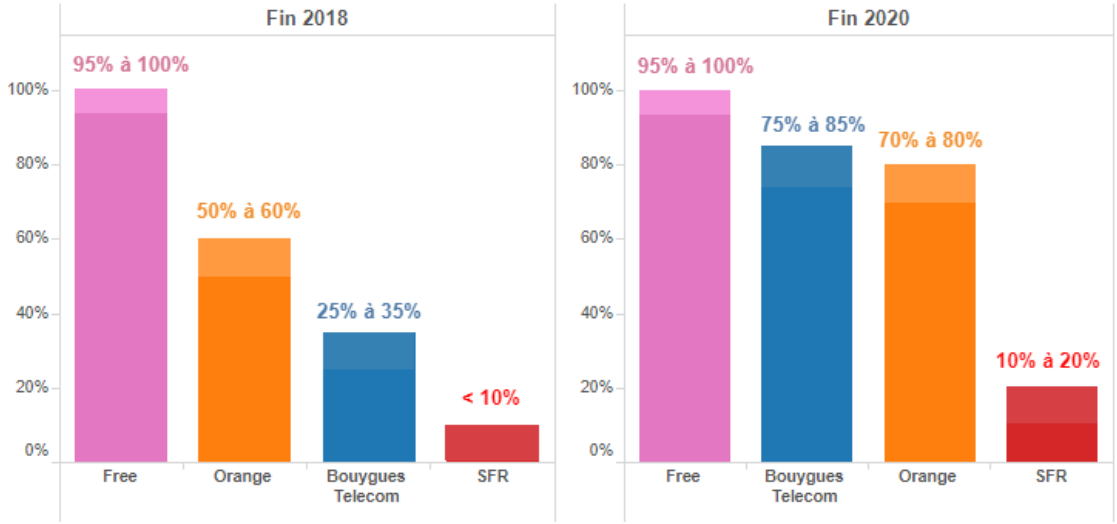
The other actions include:

- Generalization of IPv6 courses;
- Implementation of adequate exchange areas (to share good practices);
- Coordination improvement between stakeholders;
- Better informed the user (device sustainability, IPv4 resource scarcity);
- Preparation of the end of IPv4 period.

However, there is **no precision about timeline neither on any quantitative goals**.

Following this referral, the ARCEP has created an observatory[13] of the transition to IPv6 in France (not distinguishing public and private sector). The observatory takes the form of a report which the latest version has been published in December 2017[14]. Actually, ARCEP relies on external sources like Cisco, Google, AFNIC to provide the status of the art of IPv6 implementation. Also, in this latest report, IPv6 implementation from ISP are provided.

Figure 15: Forecasts of rates of fixed customer IPv6 enabled at end of 2018 and end of 2020



Source: ARCEP (from operators)

2.2.3 Technical aspects/issues

According to the AFNIC, there is **no specification for the allocation of IPv6 addresses for the public sector:**

- No specific process: each organisation needs to ask their required addresses;
- No specific LIR allocated to public sector (public sector can use different LIR);
- No transition plan designed.

It is worth noting that some service providers, which are also LIRs in France allocate automatically IPv6 addresses along with their services by default. Typically, that is the case with Cloudfare, which provides IPv6 when provisioning its content delivery network, Internet security services and domain name server services.

[13] https://www.arcep.fr/index.php?id=13169

[14] https://www.arcep.fr/uploads/tx_gspublication/rapport-gvt-transition-IPv6-sept2016.pdf

2.2.4 Current deployments

According to Vyncke blog, only one organization in the government[15] (the regional council of Haute Normandie) has a website, mail server and DNS in IPv6 (though, not successful for Mail server). This website has participated to the World IPv6 Day in 2011.

Figure 16: Number of hosts supporting IPv6 in the French government

Name	Alexa (Nov 2016) country/global	Web	Mail	DNS
Gov Conseil Régional de Haute-Normandie More whois	258/172884	www.crihan.fr 2001:660:7401:211::62 2010-07-30	orion.utc.fr 2017-11-27	orion.utc.fr ns.crihan.fr 2001:660:7401:201::10 2/3 2010-12-11
In total 1 hosts		1 (100%)	1 (100%)	1 (100%)

Source: Extract from Vyncke blog

Figure 17: Number of IPv6 prefixes assigned in France

IPv6 Prefixes

Here are the **2592** (2592 with a prefix length <= 48) IPv6 prefixes assigned to the country color coded:

Description	Side chart	Table below	Prefix count
Not announced on BGP	RED	RED	761 (29.4 %)
Announced on BGP but under an aggregated prefix (such as the ISP rather than the customer)	N/A	ORANGE	1115 (43 %)
Announced on BGP individually (i.e. using a routing entry)	GREEN	GREEN	716 (27.6 %)
Traffic from this prefix has been seen	BLUE		383 (14.8 %)

Source: Extract from Vyncke blog

According to the AFNIC, 6 websites over the 878 domain names with "gouv.fr" are IPv6 enabled. In addition, they point out that AFNIC as a public service providing ".fr" domain names are 100% IPv6 since 2003.

According the ARCEP report, government websites at high audience like impots.gouv.fr, education.gouv.fr, legifrance.gouv.fr, interieur.gouv.fr, finances.gouv.fr, defense.gouv.fr and telecom.gouv.fr are not available in IPv6. Other public service websites like insurance health and family allowance fund are not also available.

2.2.5 Deployments and pilots

As regards to IPv6 deployment, a network between different French ministries (Réseau Interministériel de l'Etat (RIE))[16] was inaugurated in 2015. This **network supports natively both IPv4 and IPv6.** Though, there is no information of breakdown between v4 and v6 IP protocol version.

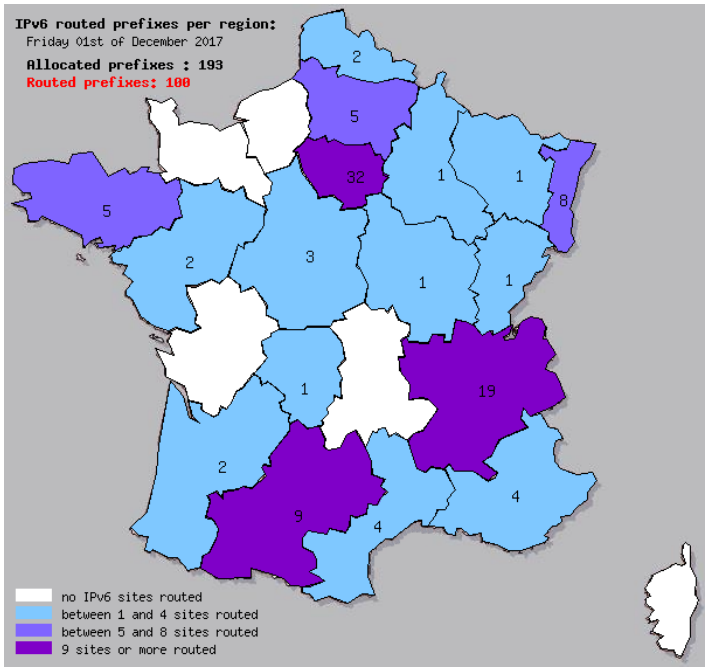
Concerning assessment readiness, still according to the AFNIC, **devices and networking equipment are already IPv6-enabled** (no assessment was specifically made).

[15] Over a total of 414 hosts identified with website and/or mail server and/or DNS server in IPv6.

[16] http://www.modernisation.gouv.fr/en/node/89058

In France, the **major player having largely deployed IPv6 is RENATER**, which is also a pioneer in the promotion of the protocol. Over hundreds of teaching and research institutions currently use IPv6 which is in production since 2003.

Figure 18: Mapping of RENATER IPv6 prefixes



Source: RENATER[17]

2.2.6 Operations & Organisation

As regards to procurement, **according to the ARCEP report**, the stakeholders met during the preparation of the report mostly confirm **the presence of the IPv6 requirement in public calls for tenders for connectivity services.**

The version of AFNIC on this point is that IPv6 is not necessarily mentioned and thus not automatically included in call for tenders as for the search of hosting for instance. Also, AFNIC indicates that IPv6 adoption also depends on the renewal of contracts.

Still according to AFNIC, they are not aware about information about specific training offered on IPv6 and neither about allocated budget (but not the real issue).

[17] http://supervision2.renater.fr/Stats_sites/index.php

2.2.7 Barriers and Future developments

The ARCEP highlights 4 categories of barriers in the transition to IPv6 but not specifically for government sector:

1. **Lack of appetite for IPv6**, related among other things to the lack of immediate commercial benefits (from ISPs);
2. The **lack of coordination between stakeholders**: each player is encouraged to begin the transition only if the other actors with whom it interacts engage themselves in turn. A national coordination could facilitate a better visibility on the intentions of the players;
3. A **psychological barrier with the lack of maturity** around the implementation of the protocol IPv6 remains a novelty (even not a new technology) to be apprehended from players and a **lack of control** may lead to errors in its use or implementation. The low level of adoption does not encourage the share of information and best practices in France;
4. The **necessary support of both IPv4 and IPv6 protocols in parallel**: the growing complexity incurred by the exploitation of networks using 2 protocols for an indefinite period.

According to the AFNIC, the main issue is **organizational with the lack of centralized information system within government entities**: each information system department makes its own choice (sort of procrastination from players).

2.3 The Czech Republic

2.3.1 Key stakeholders

The CZ.NIC Association, which runs and maintains the Czech national domain is the main body for IPv6 related issues. It was the CZ.NIC who was also involved the GEN6 project.

While it is the decision of the government / ministries to deploy (or not) IPv6, CZ.NIC provides technical advice and training (to all parties interested, not only the public sector).

2.3.2 Government plans and strategies

According to the "eGovernment in the Czech Republic[18]" report, part of the eGovernment factsheets updated annually, the Czech Republic administration authorities are the best prepared in Europe for the implementation of IPv6. This was the result of a survey carries out by the CZ.NIC as part of the GEN6 project. It must be mentioned, however, that this was back in 2013, and the latest eGovernment report (April 2017) has no newer mentions regarding IPv6, suggesting that there has been no specific activities of note since 2013. That said, CZ.NIC provides monthly statistics of IPv6 deployment by governments, and according to this the Czech Republic remains far ahead of other European Nations.

According to Pavla Moravcová of the Czech Ministry of Interior, IPv4 technology is used in the Ministry of Interior and there are no Ipv6 deployment plans in the near future.

2.3.3 Technical aspects/issues

CZ.NIC is the LIR. They are also the go-to association for any technical advice on IPv6 (and DNS).

2.3.4 Current deployments

The Czech Republic is one of the, if not the leading European nation in terms of IPv6 development by governments. The figure below shows that the Czech Republic is far ahead of the other nations covered in the sample.

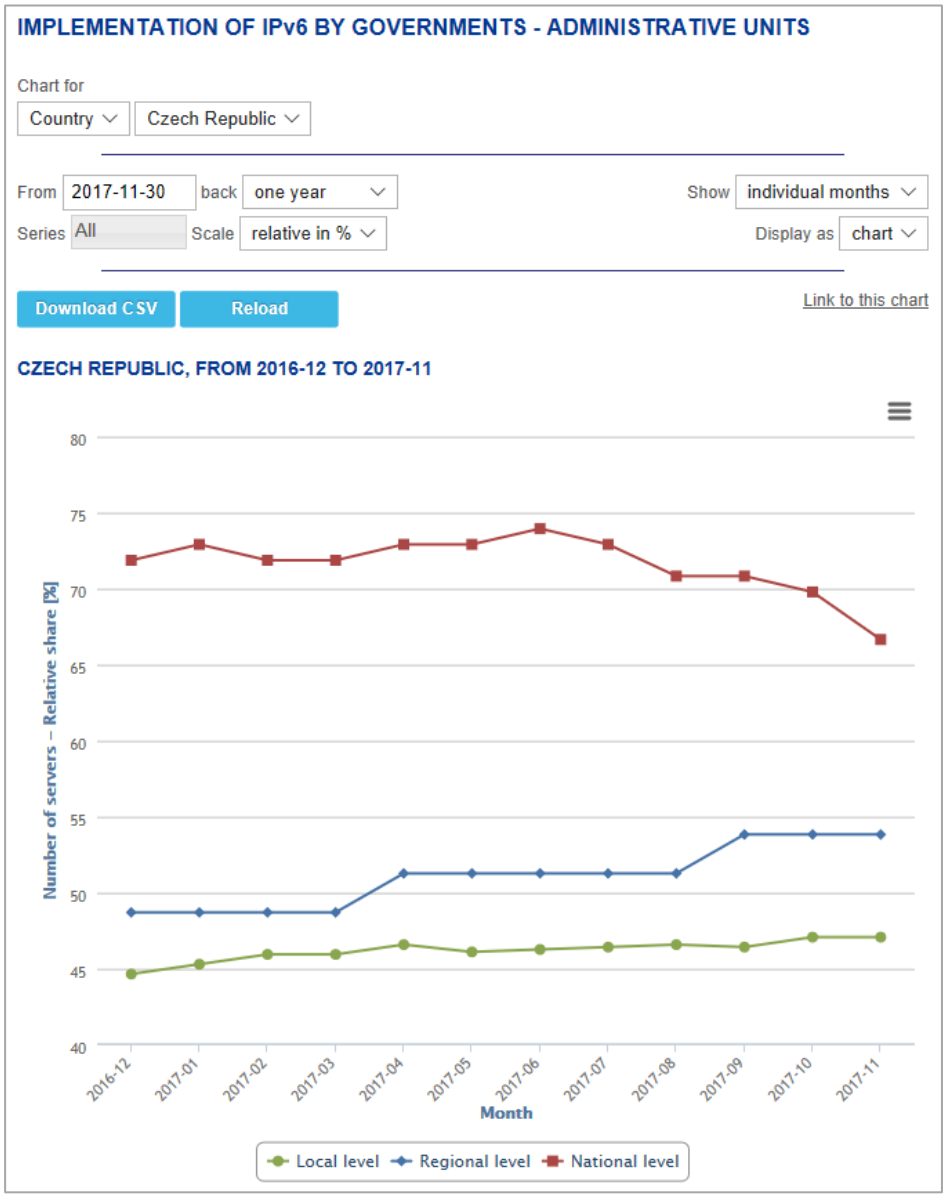
[18] https://joinup.ec.europa.eu/sites/default/files/inline-files/eGovernment_in_Czech_Republic_March%202017_v3_00.pdf

Source: https://stats.nic.cz/stats/gen6/

Focusing on the Czech Republic, 80% of government nameservers are IPv6, while mailservers are low at 25%.

Source: https://stats.nic.cz/stats/gen6/

Finally, looking at the government administrative bodies, it is the national level units that are the most IPv6 adapted, followed by regional level, then local.



Source: https://stats.nic.cz/stats/gen6/

It is worth noting that the data (statistics) above from CZ.NIC was initially a pilot project within the GEN6, to benchmark government institutions.

Currently the CZ.NIC are in the process of analysing IPv6 compatibility of all public websites; they have collected about 7,000 data. It is on a mission for the Ministry of Interior and they cannot publish results yet; but the roughly 200 large cities of Czech Republic are showing positive results.

2.3.5 Deployments and pilots

According to Jiri Prusa of the CZ.NIC, as of today the vast majority of national level ministry services are IPv6 enabled (web servers, mail servers and name servers). Municipality level is less clear, as there is no obligation. That said, the country holds a competition called “Golden Crest”, awarded to the best municipality website, and IPv6 support is one of the criteria considered (essentially cannot win if not IPv6 enabled). There are roughly 500 municipality sites, and they know that IPv6 is required to win this competition.

2.3.6 Operations & Organisation

According to a presentation made by Jiri Prusa of CZ.NIC and confirmed through an interview with IDATE, the Czech government policies are as below.

Policy overview

- **Implemented 8 June 2009: Government Resolution on IPv6**
  - IPv6 in public tenders on network infrastructure components (*implemented 30/6/2009*)
  - Ensure availability of government websites via IPv4 and **IPv6** (*implemented 1/1/2011*)
- **Implemented 20 March 2012: Digital Czech 2.0 Strategy**
  - Wider government support for IPv6 deployment
  - Government policy for DNSSEC support
  - Internet Governance rules: preferring self-regulation and Internet freedom
- **Implemented 18 December 2013: Government Resolution on DNSSEC and IPv6**
  - DNSSEC and IPv6 in all relevant public tenders (*implemented 1/1/2014*)
  - Availability of mail servers via IPv6 (*implemented 1/3/2015*)
  - Secure all governments websites by DNSSEC (*implemented 1/7/2015*)
- **Implemented 19 December 2013: Guidelines for data traffic management**
  - National telecom regulator declared IPv6 as a part of net-neutrality

Initially, Czech Republic had a less clear “IPv6 support obligatory for all eGovernment services”, but this had two major downfalls: a) there were no sanctions and monitoring was difficult, and b) there was no clear definition of what an eGov service is. The above policies put into consideration these early lessons.

2.3.7 Barriers and Future developments

According to the eGovernment report of 2013, although government adoption of IPv6 was high (in comparison to other European Nations) support is however lacking on the side of Czech internet service providers.

As of today support is much broader. However, not all hardware is supported yet, and even if officially supported, performance (speed, power etc) may be lower compared to IPv4.

2.4 The United Kingdom

2.4.1 Key stakeholders

There is no specific organisation and/or stakeholder directly in charge of the transition to Ipv6 for the public sector. The closest, although not specific to the public domain, is the **UK IPv6 Council** which is "a non-profit technology user group focused on promoting and sharing best practices on IPv6 deployment and adoption in the United Kingdom".

Its members are comprised of various players, as follows:

Organisation
Core Team members
Veronika McKillop, Microsoft, President / Chair
Tim Chown, Jisc, Co-chair
Nick Chettle, Facebook
Ian Dickinson, TFM Networks Ltd
Nick Heatley, BT
Marcus Keane, Microsoft
Ahmed Kotb, The Institution of Engineering and Technology
Phil Mayers
Loba Olopade, Virgin Media
Richard Patterson, Sky UK
Craig Taylor, BBC
Stephen Youell, JP Morgan

Source: UK IPv6 Council

2.4.2 Government plans and strategies

Back in 2002, the e-Government Interoperability Framework had recommended the purchase of IPv6 capable devices for government and public organizations, and at the time Government organizations for e.g. Defence Science and Technology Laboratory (DSTL) were showing interest on expertise for the transition to IPv6. IPv6 was also being introduced into research programmes, for e.g. Department of Trade and Industry (DTI's) Pervasive Computing in the Environment, and the UbiComp (Ubiquitous Computing) programme being proposed for Higher Education Funding Council for England (HEFCE) funding. The UK also had an IPv6 Task Force, although not directly funded by the government; it was an independent locally self sufficient activity associated with leading IPv6 experts and organizations globally including the EU IPv6 Task Force.

However, this UK IPv6 Task Force has long been defunct, and it seems that governmental support for IPv6 is generally lacking in the UK.

In April 2010, 6UK, a non-profit membership organisation was found to help the UK transition to IPv6. However, it shut down in late 2012 "having determined that the organisation cannot fulfil its purpose".

The reason cited by 6UK was the lack of government support. According to the BBC[19]:

"The biggest organisation we needed to join 6UK was the government," said Philip Sheldrake, former director of the non-profit body. Although the UK government handed over £20,000 ($32,000) to get 6UK going in 2010, said Mr Sheldrake, support had been scant ever since. For instance, he said, nothing had been done to change official procurement rules to mandate the new protocol which would have had a significant effect on adoption. Official indifference was revealed, said Mr Sheldrake, by the fact that no government website sat on an IPv6 address.

The fact that there is no mention of IPv6 at all in the annual "eGovernmnt in the United Kingdom" reports, handed to the EC, also suggests a lack of plan / strategy in IPv6.

2.4.3 Technical aspects/issues

While overall user traffic is 20% IPv6, there is an evident lack of interest in IPv6 from governmental / public institutions. Despite the best efforts of the UK IPv6 Council, they remain largely uninterested in migrating to IPv6, with no coherent moves taken. The Scottish government is 3% IPv6 enabled, while UK schools are also roughly 3% (11,500) IPv6 enabled, according to Veronika McKillop, chair of the IPv6 Council.

2.4.4 Current deployments

According to a post by dxw in November 2016[20], of the 3,528 registered .gov.uk domains, 2,774 were found to have DNS records. Of these 2,774 domains, only 33 sites supported IPv6; **only 1.19% of government sites support IPv6**.

[19] http://www.bbc.com/news/technology-20646710

[20] https://www.dxw.com/2016/11/ipv6-on-gov-uk-1-year-on/

The post also provides the list of the 33 sites, as follows:

The 2016 hall of fame for IPv6 in UK government

- aberystwyth.gov.uk
- antrimandnewtownabbey.gov.uk
- carlisle.gov.uk (carlisle.gov.uk is IPv4-only but www.carlisle.gov.uk supports IPv6)
- clayton-pc.gov.uk
- clitheroetowncouncil.gov.uk
- cowfold-pc.gov.uk
- dormingtonmordifordgroup-pc.gov.uk
- downtonparishcouncil.gov.uk
- dungannon.gov.uk
- hagleyparishcouncil.gov.uk
- ivybridge.gov.uk
- kent-pcc.gov.uk
- londoncouncils.gov.uk
- london.gov.uk
- maghull-tc.gov.uk
- ~~mhtscot.gov.uk~~ (redirect to an IPv4-only site)
- nw-ifca.gov.uk
- octf.gov.uk
- pensionwise.gov.uk
- peterborough.gov.uk
- princeofwales.gov.uk
- scilly.gov.uk
- southribble.gov.uk
- steep-pc.gov.uk
- st-ive-parishcouncil.gov.uk
- stroud-pc.gov.uk
- ststephenparishcouncil.gov.uk
- tewkesburytowncouncil.gov.uk
- uphollandpc.gov.uk
- verwood.gov.uk
- waddesdonparishcouncil.gov.uk
- wilsdenparishcouncil.gov.uk
- woodchurch-pc.gov.uk

Source: dxw

Fast forward to 2015, and the situation is that more than 80% of the UK's 24 ministerial departments don't hold any IPv6 addresses, according to a series of freedom of information (FoI) requests filed by Infoblox (a tech firm specializing in aspects such as DNS and IP addresses)[21]. The Ministry of Defence and the Department of Health were the only two government departments to state that they currently hold any IPv6 allocation as of October 2015, while the Department for Environment Food & Rural Affairs and the Department for Transport were the only ones that said they are currently considering adopting IPv6 in the next 12 months.

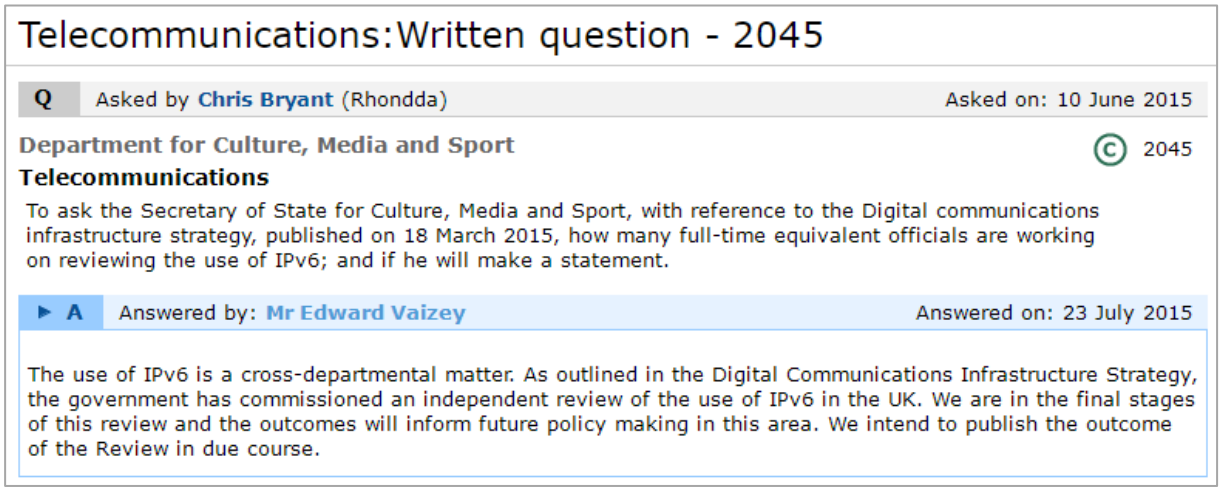
2.4.5 Deployments and pilots

There are no coordinated deployments or pilots of IPv6 of note within the public sector, although some trusts, such as the NHS, are moving towards IPv6 by their own accord. The current Brexit issues have also pushed back any potential IPv6 debate.

2.4.6 Operations & Organisation

In the summer of 2015, the then Secretary of State for Culture and Digital Economy Edward Vaizey mentioned that an independent review of the use of IPv6 in the UK had been commissioned. However despite mentioning that "we intend to publish the outcome of the Review in due course", there does not appear to have been such publication made public.

[21] http://www.businessinsider.fr/uk/government-slow-to-embrace-ipv6-2015-10/



Telecommunications:Written question - 2045

Q Asked by **Chris Bryant** (Rhondda) Asked on: 10 June 2015

Department for Culture, Media and Sport © 2045

Telecommunications

To ask the Secretary of State for Culture, Media and Sport, with reference to the Digital communications infrastructure strategy, published on 18 March 2015, how many full-time equivalent officials are working on reviewing the use of IPv6; and if he will make a statement.

▶ A Answered by: **Mr Edward Vaizey** Answered on: 23 July 2015

The use of IPv6 is a cross-departmental matter. As outlined in the Digital Communications Infrastructure Strategy, the government has commissioned an independent review of the use of IPv6 in the UK. We are in the final stages of this review and the outcomes will inform future policy making in this area. We intend to publish the outcome of the Review in due course.

Source: http://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2015-06-10/2045/

In September 2016, Ofcom answerd to a FoI requesting for any government paper regarding the deployment of IPv6 in the UK, or any other paper that Ofcom published regarding this issue[22]. To this, Ofcom replied by referencing three documents, dated 2015, 2014 and 2013. The 2015 report is the "Connected Nations 2015" report[23], which does not touch upon IPv6 for the public sector, but mentions briefly that the major ISPs are progressively becoming more IPv6 capable. The 2016 version[24], for reference, is a similar story outlining that the large ISPs are becoming more IPv6 compatible. It also references Akamai's statistics, also provided in this report in the first section.

2.4.7 Barriers and Future developments

As of end 2017 there is no governmental mandate for IPv6 deployment. Since there is little financial motivation to move to IPv6, without such a mandate it seems difficult to persuade the public administrations to move to IPv6.

Should large, famous companies declare a move to IPv6 then this may get the ball rolling; but as of today, out of the FTSE100 companies, only 3% are IPv6 enabled, meaning there are no leaders / big players using their voices on the matter.

As already mentioned, 20% of UK households are IPv6 enabled with ISPs such as BT, Sky and Virgin all working on the issue. However the government is not picking this movement up, made complicated by the fact the IPv6 issue spans across the entire government; there are no coherent initiatives nor any unit within the government to take the lead.

[22] https://www.ofcom.org.uk/__data/assets/pdf_file/0024/88260/IPv6-information.pdf

[23] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/69634/connected_nations2015.pdf

[24] https://www.ofcom.org.uk/__data/assets/pdf_file/0035/95876/CN-Report-2016.pdf

2.5 Germany

2.5.1 Key stakeholders

The government

The process of migration to IPv6 is driven by the Federal Ministry of the Interior (BMI) and the Federal Office of Administration (BVA). The BMI and the BVA coordinate the IPv6 working group that brings together experts from federation, states and municipalities, public IT service providers as well as representatives from the Federal Office for Information security.

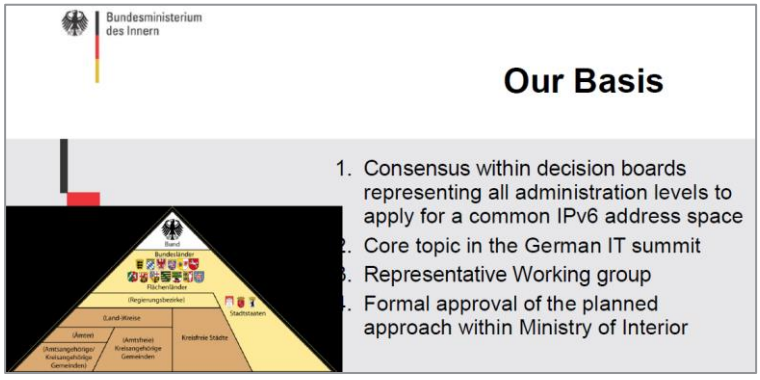
2.5.2 Government plans and strategies

The government's push for IPv6 is primarily driven by the fact that Internet addresses are rapidly becoming a scarce resource. This development is fuelled by the growing number of Internet users and an even more rapidly growing number of connected devices.

At the same time, the migration to IPv6 was perceived as an opportunity to shed legacy communications networks and create an integrated, efficient and highly secure communications infrastructures for government needs at all layers in Germany.

The decision to adopt IPv6 in the public sector was taken in 2007 by the responsible under-secretaries of state as well as the coordinating council for automated data processing of the different layers of government.

Figure 19: IPv6 consensus



Source: BMI

2.5.3 Technical aspects/issues

No details on technical issues are available (to be discussed in technical interviews in next steps)

2.5.4 Current deployments

Of the organisations monitored by Vynke.org, only Munich has an IPv6 enabled web site. None of the 8 hosts observed has an IPv6-capable mail exchange, whereas 4 out of this sample have their DNS in IPv6.

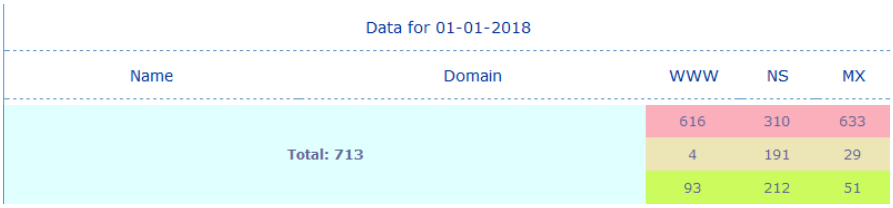
Name	Alexa (Nov 2016) country/global	Web	Mail	DNS
Gov German Rail whois	29/1395	FAILED ***CDN***	FAILED	ns-371.awsdns-46.com ns-604.awsdns-11.net ns-1253.awsdns-28.org ns-1641.awsdns-13.co.uk 2600:9000:5306:6900::1 4/4 2016-05-13
Gov muenchen.de whois	258/24517	muenchen.de 2a00:1830:a001:f001:80::a158 2015-09-11	FAILED	ns01e.muenchen.de 2a00:1830:a001:f003:53::a001 1/3 2012-11-12
Gov bundestag.de whois	275/29645	FAILED	FAILED	anycast2.irondns.net b.ns14.net anycast1.irondns.net 2a01:5b0:4::5 3/3 2013-09-20
Gov bundespraesident.de whois	492/308333	FAILED	FAILED	ns4-eu.123ns.de 2a01:238:4334:4000:fdad:399d:617d:3983 1/4 2016-03-07
Gov polizei-bw.de whois	505/345241	FAILED	FAILED	FAILED
Gov abdsb.bayern.de whois	/	FAILED	FAILED	FAILED
Gov finanzamt.bayern.de whois	/	FAILED	FAILED	FAILED
Gov immobilien.bayern.de whois	/	FAILED	FAILED	FAILED
In total 8 hosts		1 (13%)	0 (0%)	4 (50%)

Tests are:

Source: vynke.org[25]

Data from cz.nic show the level of IPv6 adoption among a total of 713 public sector domains tracked. Of these, 13% have an IPv6-enabled web server and as much as 30% a web server complying with IPv6. However, only 7% of mail exchanges are compatible with the technology yet.

Figure 20: Current IPv6 deployments in public sector



Source: cz.nic[26]

2.5.5 Deployments and pilots

Several deployments have taken place at different levels. The state of Hamburg has switched its telephony services to VoIP the German Bundeswehr was among the early adopters as well in order to avoid using network address translation and ensure seamless, secure end-to-end communications services. Federal communications networks and IT infrastructures are migrating, too. The German administration has generally adopted a dual stack approach, running IPv4 and IPv6 in parallel for a transition period, rather than a vastly more complicated and expensive big bang approach. Replacements are taking place at rhythm of equipment's lifecycle.

[25] https://www.vyncke.org/ipv6status/detailed.php?country=de&type=Gov

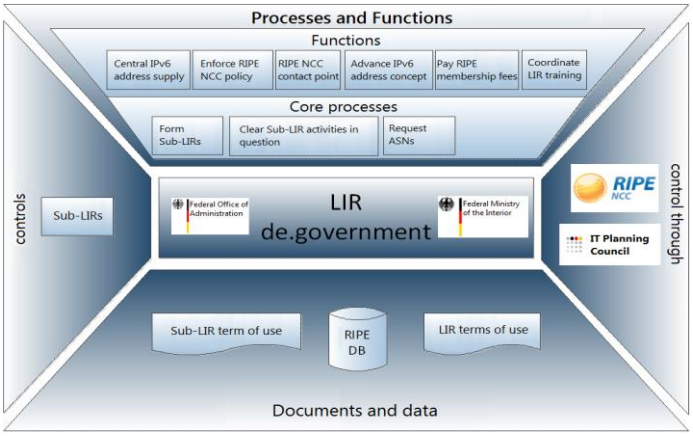
[26] https://devpub.labs.nic.cz/ipv6-smt-new/country/de/

2.5.6 Operations & Organisation

After the application for blocks of IPv6 addresses was made by the German administration, RIPE NCC granted this range in 2009. It was assigned to the BMI on behalf of the German government. The range allocated to them is considered as being large and sufficient for a reasonable amount of time by German authorities.

The BMI manages the de.government LIR. This LIR is responsible for the entire IPv6 address space of the public administration sector of Germany. It oversees day-to-day operations and point of reference in technical matters for the public sector and manages the allocation of address space to the Sub-LIR at lower administrative levels, e.g. Länder, municipalities, data centers or the like.

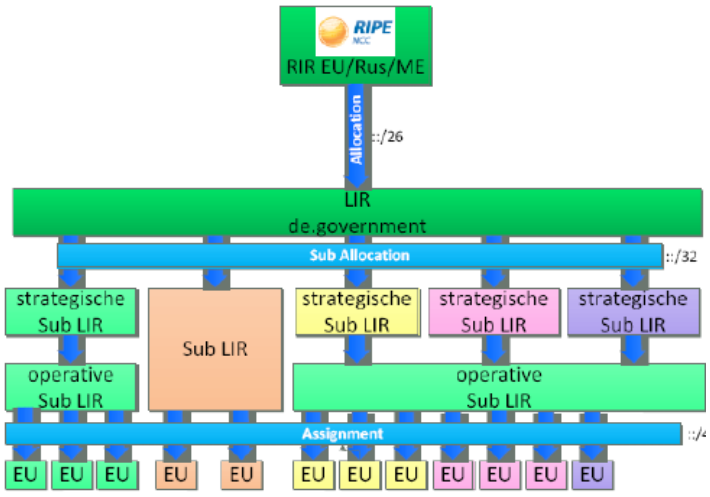
Figure 21: role of de.government LIR



Source: BMI IPv6 reference manual

The first allocations have been made in 2010 to Federal IT resources, Länder as well as the ministry of defence.

Figure 22: Management structure of IPv6 addresses in the German public sector



Source: BMI

The BMI is not forcing other public administrations to adopt IPv6 immediately, but seeks to create traction for the transition through evangelization and facilitating the move. The BMI and the BVA have developed a series of documents designed to lower the hurdle for public administrations to migrate towards IPv6. For instance, based on the Slovenian example, a number IPv6 profiles for the purpose of facilitating procurement has been developed in cooperation with external experts from Fraunhofer Institut and other organizations.

Figure 23: IPv6 profile example

Profile example 1 - RFC and feature/function with requirement level

Sheet Node:

Cate-gory	Cate-gory	Cate-gory	RFC	Title	Feature, function	Project recommendation	Comment
Communication of the IPv6 node							
	Basic requirements						
		Basic					
			RFC 2460	Internet Protocol, Version 6 (IPv6) Specification		mandatory	
					Flow Label Field not used and ignored (unless RFC 6437 is implemented)	mandatory	

Source: BVA

Furthermore, the BMI and the BVA developed a number of reference documents such as an IPv6 reference manual and best practices, which are available online[27].

2.5.7 Barriers and Future developments

The migration process has encountered several obstacles. Initially, being an early mover, there were virtually no references in terms of IPv6 specifications for procurement (an issue that has been addressed by means of above-mentioned profile specs). Furhermore, there was some reluctance among the persons in charge of IT services to make the move as they feared it would cause complications (again, the reference documents are meant to address this issue)

There is also an aspect of scale. The German government would like to see more momentum across the member states in order to create the critical mass with respect to OEMs. Single member states may lack the bargaining power in negotiations with global OEMs to impose their required specifications, for instance in terms of security. Germany is therefore keen to support the EC in its IPv6 initiatives.

[27] Cf http://www.bva.bund.de/DE/Organisation/Abteilungen/Abteilung_BIT/Leistungen/IT_Beratungsleistungen/IPv6/best_practice/bestpractice_node.html

2.6 Slovenia

2.6.1 Key stakeholders

The main platform for the migration to IPv6 in Slovenia is the non-profit Go6 Institute. The institute's mission is *raising awareness, education, consulting and assistance in the deployment of IPv6 Internet protocol on the territory of Slovenia, EU and wider*.

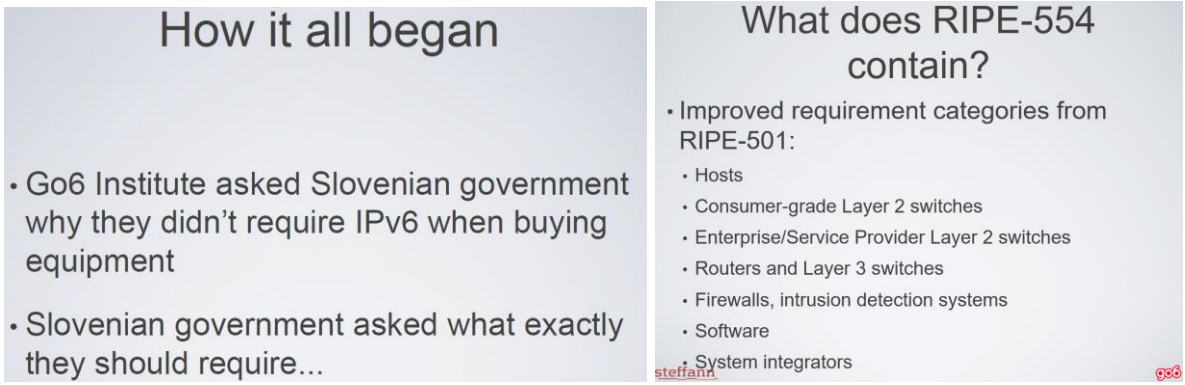
The Slovenian government cooperates with Go6. The main players from the public sector include through the Ministry for Higher Education (MVZT), the Ministry for Public Administration, the national regulating authority APEK as well as the University of Ljubljana's laboratory for telecommunications (LTFE) as well the academic and research network ARNES.

2.6.2 Government plans and strategies

As mentioned above, the government is actively involved in the dissemination of IPv6 in Slovenia.

One of the major contributions was the involvement in the development of IPv6 profiles together with the Go6 Institute. This document fed into discussions at RIPE level and ultimately led to the adoption of RIPE 55428, which defines requirements for IPv6 in a number of ICT equipments. The Slovenian approach and RIPE 554 have served as blueprint for public administration in numerous other countries, including Germany.

Figure 24: Slovenian contribution to RIPE 554



Source: Go6 Institute[29]

In 2010, the MVZT commissioned a study to Go6 Institute on *Guidelines for Deliberation in the IPv6 Strategy.* This document has received an update in 2012 and has been made available in English language[30]. The study notes that *the Slovenian government, in contrast to comparable countries, has yet to make an important step towards deploying IPv6 that would encourage all relevant stakeholders*

[28] Available at: https://www.ripe.net/publications/docs/ripe-554

[29] Available at: http://www.ipv6conference.ch/wp-content/uploads/Slide/Business_Track/B10%20-%20Zorz_RIPE-554-generic.pdf

[30] Available at: http://go6.si/docs/Study_MVZT_IPv6_en.pdf

to deploy IPv6[31] The document is therefore aimed at functioning as a guide to help the government and the public sector at large to define an IPv6 strategy.

The government is also involved in financing training sessions on IPv6 across the country to create awareness of the issue and spread best practices. However, these budgets were apparently cut back eventually.

The Slovenian NRA APEK also contributed to the IPv6 push. Around the year 2010, APEK ran public consultation on the issue and launched an IPv6 monitoring effort. It is not clear today if the effort is continued ort when and why it might have been halted.

With ARNES and LTFE, two publicly funded bodies are involved in of the Sinog4.0 summit, which is organized by Sinog a Slovenian industry association. Since 2017 Sinog 4.0 has absorbed the Slovenian IPv6 Summit.

2.6.3 Current deployment

Of the 266 hosts observed by cz.nic, only 2% have an IPv6 web server. 8% of the hosts sampled operated IPv6 enabled name servers, while no more than 5% of mail exchanges sported IPv6-capability.

Figure 25: Current IPv6 deployments in public sector

Data for 01-01-2018

Name	Domain	WWW	NS	MX
Total: 266		260	173	252
		1	72	1
		5	21	13

Source: cz.nic[32]

Go6 Institute used to track IPv6 implementationby major stakeholders, too. However, the most recent publicly available figures date back to 2013

[31] Ibid. p.11

[32] Available at: https://devpub.labs.nic.cz/ipv6-smt-new/country/si/

Table 1: IPv6 implementation by main stakeholders

Organisation	IPv6 implemented	IPv6 is being implemented	IPv6 is planned	No data or not planned
Arnes	X			
zavod go6	X			
LTFE	X			
Domenca hosting	X	X		
Astec	X			
Mobitel	X	X		
IskraTel		X		
CHS		X		
Iskra Sistemi d.d.	X			
APEK		X		
AMIS	X	X		
RTVSLO	X	X		
Moj Mikro (Delo revije)			X	
Telekom Slovenije		X		
gov.si			X	
T-2	X	X		
Telemach	X	X		
TušTelekom	X	X		
NLB				X
POPtv				X
najdi.si		X		
SiMobil			X	
ZDRZZ			X	
dnevnik.si				X
NIL	X	X		
SmartCom	X	X		
Univerza v Mariboru		X		
Arne d.o.o.		X		
delo.si			X	

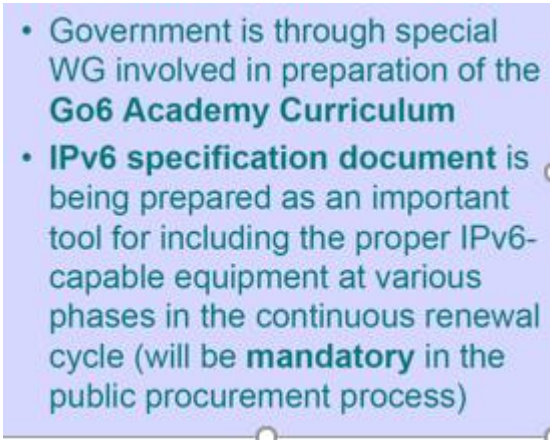
Organisation	IPv6 implemented	IPv6 is being implemented	IPv6 is planned	No data or not planned
IZUM	X	X		
Stelkom	X	X		
Bass.si	X			

Source: Go6 Institute[33]

2.6.4 Deployments and pilots

Several pilots were supported by the Slovenian government. For instance, together with Spain and Luxembourg, Slovenia participated in a cross-border pilot for public safety networks[34]. Other initiatives include the above mentioned roadshow to spread knowledge about IPv6 out the capital region as well as the participation in GO 6's initiatives.

Figure 26: Government IPv6 action examples



Source: Davor Sostaric ; Ministry of Higer Education, Science and Technology Information Society Directorate

2.6.5 Operations & Organisation

The key stakeholders have been presented above. In an older (2010) presentation, the roles of some of these stakeholders were defined as follows:

[33] Available at https://go6.si/stanje-ipv6-v-slo-devel/ (in Slovenian)

[34] http://www.gen6.eu/x-border-pilots

Figure 27: Slovenian public sector stakeholders' roles

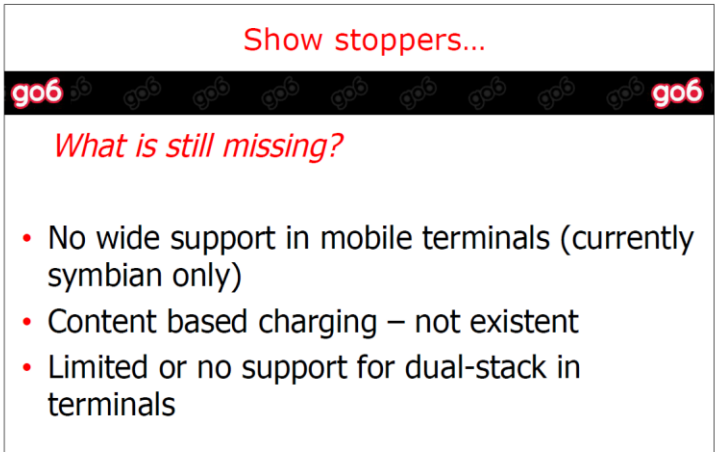
Source: Urban Kunc, *Status of IPv6 in Slovenia*, 2010[35]

[35] Available at: http://ipv6-ghent.fi-week.eu/files/2010/12/1330-3-Urban-Kunc.pdf

2.6.6 Barriers and Future developments

Recent information on barriers is rather scarce. As mentioned above, the economic downturn led to cuts in the budget for training sessions funded by the public sector.

Go 6 Institutes also hints at the lack of IPv6 capability in devices.



Source: Go6 Institute

The 2012 version of the government's study cites other reasons for the failure of Ipv6 gain more momentum, among them a lack of awareness by stakeholders (p. 10):

> *The factors hindering the deployment of IPv6 are ignorance of the issue and of the consequences of IPv4 address space exhaustion, unfamiliarity with its operation, additional operational costs related to design, deployment and maintenance of IPv6 equipment and costs for educating staff.*

2.7 Italy

2.7.1 Key stakeholders

Agenzia per l'Italia Digitale (digital Italia agency)

Created in 2012, the digital Italia agency is responsible for ensuring that the objectives of the Italian Digital Agenda are achieved in line with the European Digital Agenda. The agency is responsible for the IT coordination of central, regional and local administration and for the issuing of guidelines and technical rules. It is thus the main body responsible for the adoption of IPv6 by Italian public administrations.

The adoption of IPv6 has been integrated in the triennal plan for information technology in public administration (pianno triennal per l'informatica nella pubblica amministrazione36) for 2017 – 2019.

IPv6 Italia

Similarly to other countries an IPv6 task force was set up in Italia, and it evolved into the IPv6 Italia website (http://www.ipv6italia.it/).

This initiative gathered mainly:

- ISOC Italia (italian chapter of the Internet Society)
- L'Istituto di Informatica e Telematica (Institute of Informatics and Telematics) of the CNR (national research counsel).

The last activities of the group date from 2012 and it has not been active since.

Ministero dello sviluppo economico (Ministry of Economic Development)

The transition from IPv4 to IPv6 at a national level (not limited to public administration) is under the responsibility of the ministry of economic development37 and the Higher Institute of Communications and Information Technologies (Istituto superiore delle comunicazioni e delle tecnologie dell'informazione).

According to the website, this Institute has launched a technical meeting with the Associations of Operators, Internet Providers and Bodies working in the "Governance" of the Internet. The goal of this consultation is to tackle the problem from a technical point of view and with a long-term perspective, by starting the definition of a "road map" with a view to a transition to IPv6 protocol.

The dates and eventual results of the meeting are not visible.

[36] http://www.publicpolicy.it/wp-content/uploads/2017/05/2_5267203160006459413.pdf

[37] http://www.sviluppoeconomico.gov.it/index.php/it/comunicazioni/istituto-superiore-comunicazioni/internet-governance/esuarimento-indirizzi-ip-e-protocolli-ipv4-e-ipv6

2.7.2 Government plans and strategies

The adoption of IPv6 has been integrated in the triennal plan for information technology in public administration (pianno triennal per l'informatica nella pubblica amministrazione38) for 2017 – 2019. This plan (set up by the Digital Italia Agency) is the first national plan integrating IPv6 in its objectives.

The plan states that:

In principle, public administrations must initiate processes of adjustment of its own connectivity in order to be able to provide all services related to both internal administrative processes and public services for citizens. They shall have a network connection infrastructure capable of comply at least with the following general principles.

Public administrations should set up their services to support IPv6 protocol.

In addition when contracting for network services, the plan states that starting from 2017:

Public administrations should give preference to those supplies where the transport service is based on dual-stack (IPv4 and IPv6).

2.7.3 Technical aspects/issues

The national plan setup by the Digital Italia Agency provide no detailed technical specification of how public administration should set up their IPv6 connectivity except for the requirement on dual stack support.

2.7.4 Current deployments

In line with the adoption at the country level, the use of IPv6 in public sector is unsurprisingly low. The only plan set up at national level dates from 2017 (triennial national plan) and it remained to be seen how it will be followed and enforced.

Vyncke blog

According to **Vyncke blog, there are two identified host** using IPv6 in the government sector[39], but both are now listed as "Failed" for Web, Mail and DNS.

Name	Alexa (Nov 2016) country/global	Web	Mail	DNS
Gov italia.it whois	182/31662	FAILED	FAILED	FAILED
Gov posteitaliane.post whois	285/990638	FAILED	FAILED	FAILED
In total 2 hosts		0 (0%)	0 (0%)	0 (0%)

Two independent Italian bloggers have set-up monitoring initiatives to follow IPv6 adoption in public administration website. The initiative are not fully up to date but still present a complementing view of the current adoption (which is very low).

[38] http://www.publicpolicy.it/wp-content/uploads/2017/05/2_5267203160006459413.pdf

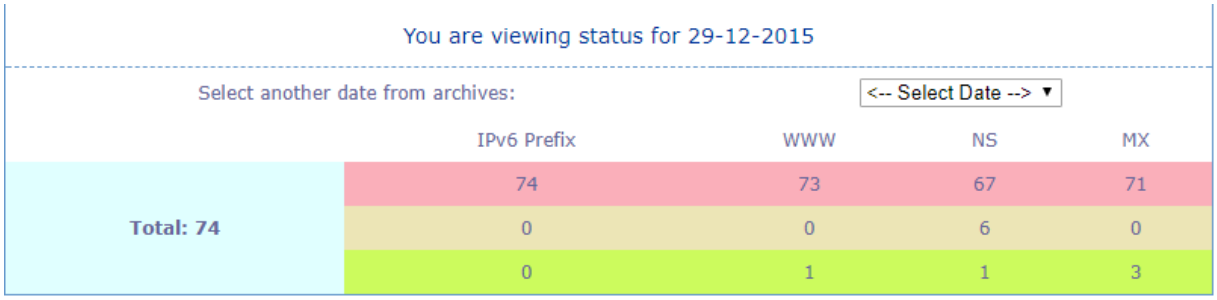
[39] https://www.vyncke.org/ipv6status/detailed.php?country=it&type=Gov

Pierky's blog

Set up in 2013, the initiative builds up independently on the result of the Gen6 project40. The initiative evaluated 74 website and domain names taken from the Italian Government official website. The last update of the result date from December 2015.

According to this evaluation 2 website have support for IPv6 Mail DNS and 6 have partial support for IPv6 DNS.

Figure 28: Pierky's blog evaluation of Italian IPv6 adoption by public administration



	IPv6 Prefix	WWW	NS	MX
Total: 74	74	73	67	71
	0	0	6	0
	0	1	1	3

Source: https://www.pierky.com/ipv6-smt/it/

Siamogeek

Set up in 2014 Siamogeek launched its own initiative to follow up adoption of IPv6 in Italian public administration. The website of public administrations are queried to monitor if they host an AAAA type of DNS record. The initiative monitors government sites, sites of regions, provinces, and municipalities. The last update of data trace back to December 2016.

The initiative counted:

- 3 out of 217 government sites with AAAA IPv6 records (1.38%)
- 0 out of 20 region sites with AAAA IPv6 records (0 %)
- 0 province sites with AAAA IPv6 records (0 %)
- 58 out of 8001 municipalities sites with AAAA IPv6 records (0.7%)

Giving a total of 61 out of 8238 (0.7%) government website.

2.7.5 Deployments and pilots

The few public administrations that have adopted IPv6 for now in Italy result from local initiatives that haven't been coordinated by national government services. These different initiatives have exchanged information between themselves but without a formal organisation.

One of the most noticeable and significant pilot has been set up in the San Benedetto di Tronto city. The public services of the city have been made available in IPv6 and the city digital services are following closely the development of IPv6 compatible services.

[40] https://blog.pierky.com/ipv6-adoption-in-italy/

Since October 2013, the municipality services are ranked as 5 star IPv6 RIPEness by the RIPE.

2.7.6 Operations & Organisation

As mentioned above, the national triennial plan set-up by the digital italia agency requires that from 2017 onward, public administrations give preference to network offering integrating dual stack connectivity in public contracting.

This seems to be the only requirement and organization of IPv6 adoption by public administrations.

2.7.7 Barriers and Future developments

According to our interviews, the main barriers for the adoption of IPv6 by Italian public services have been:

- The low level of adoption of IPv6 at the national level (attributed to a lack of interest and external motivation of ISPs).
- The low level of knowledge of the IPv4 issues and a strong reliance on ISP services by local government services
- The lack of knowledge and interest of the general public for the issue (which is therefore not a political topic / incentive).

Regarding future developments, it remains to be seen how the triennial plan set up by the Digital Italia agency is adopted and enforced. IPv6 seem to remain a minor issue for the digitalisation of Italian public administrations.

2.8 Sweden

2.8.1 Key stakeholders

It appears that the national telecom regulator PTS (Swedish Post and Telecom Agency) is the key stakeholder in driving IPv6 adoption, although not specifically in the public domain. The IIS (Internet Foundation in Sweden), responsible for the Internet's Swedish top-level domain, .se, and the operation of the .nu top-level domain is also involved, but again not specific to the public administration. In fact, upon request for an interview, the IIS referred IDATE to the PTS and Torbjörn Eklöv, who is a consultant who has been a driving spirit of IPv6 in Sweden for over 15 years. The IIS partially funds his activities for the promotion of IPv6.

2.8.2 Government plans and strategies

In October 2011, the PTS published "Deploying IPv6 – Internet Protocol version 6 - Practical guidance"[41]. Within this document, it states:

"The Government has stated that public authorities should deploy IPv6 no later than 2013. To make this possible, PTS should be assigned to promote and follow up the deployment of IPv6 at government authorities"

Also in Appendix 1 of this report is PTS's mandate for IPv6, and a description of the Government decision (N2010/7521/ITP).

Indeed, upon speaking to the PTS it was confirmed that there was active involvement by the PTS and authorities during 2012 and 2013. For example interviews were carried out with whose who adopted IPv6 to understand best practices, and surveys were carried out to understand the main challenges.

However, after 2013 such efforts have stopped and there has been no active involvement in the public sector to deploy IPv6. With the mandate deadline over, the priority of IPv6 became significantly lower.

2.8.3 Technical aspects/issues

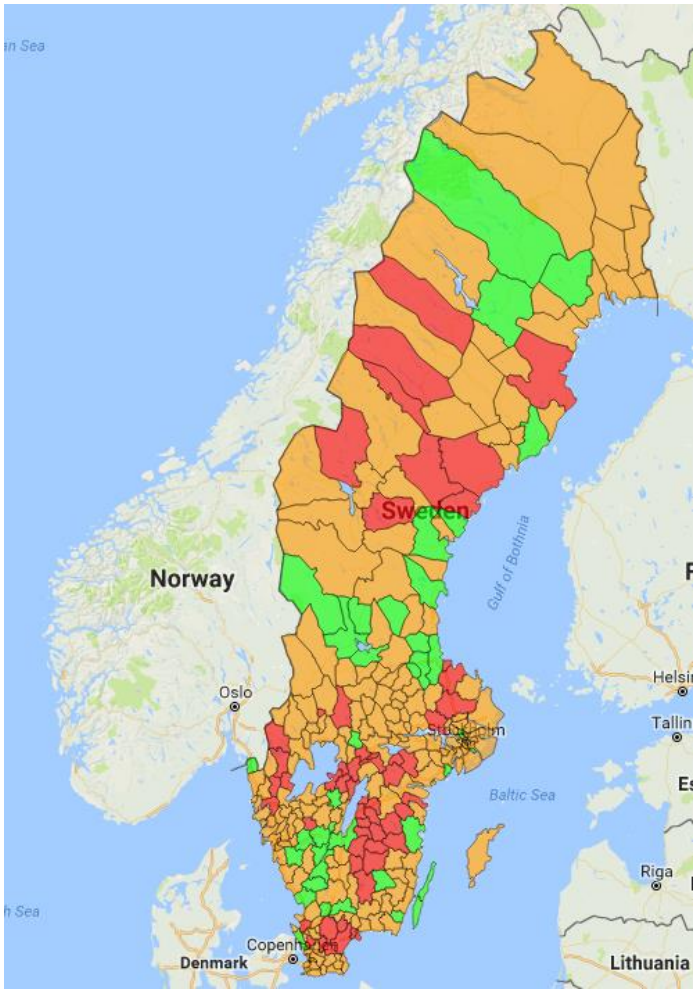
The issues seem to centre more on motivational / policy issues rather than technical aspects. According to both the PTS and Torbjörn Eklöv, leading ISPs such as Tele2 and Telia are willing and prepared to deploy IPv6, but the board of municipalities are not interested in the move, mainly due to a lack of business case (only costs, no added revenues).

2.8.4 Current deployments

Despite the Swedish government's statement that all public authorities should deploy IPv6 by 2013, the reality is that this is not the case.

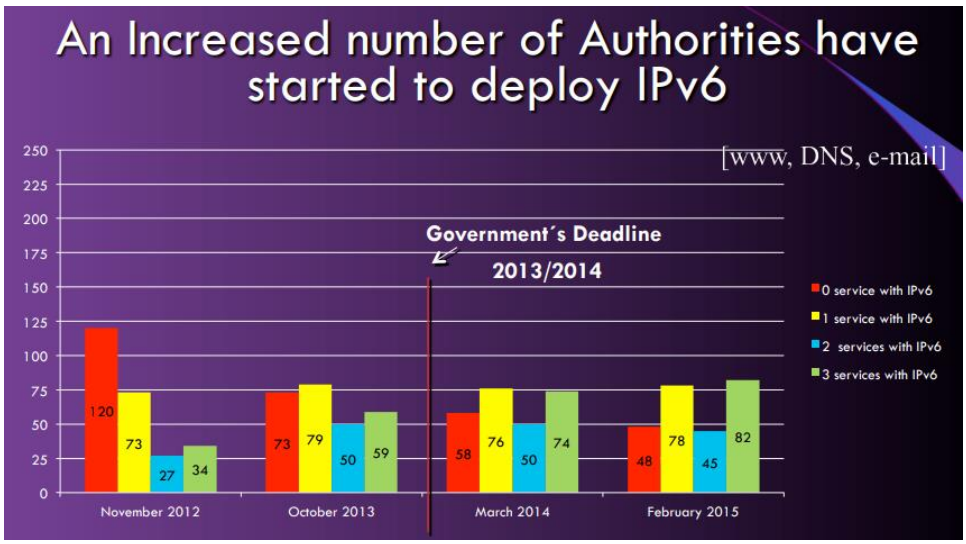
According to the site created by Interlan, co-founded and owned by Torbjörn Eklöv, only 41 of 290 municipalities have IPv6 on www, mail and dns (in green below).

[41] https://www.pts.se/upload/Rapporter/Internet/2012/2012-02-21%20Deployment%20of%20IPv6%20-%20practical%20guidance.pdf



Source: https://www.kommunermedipv6.se/

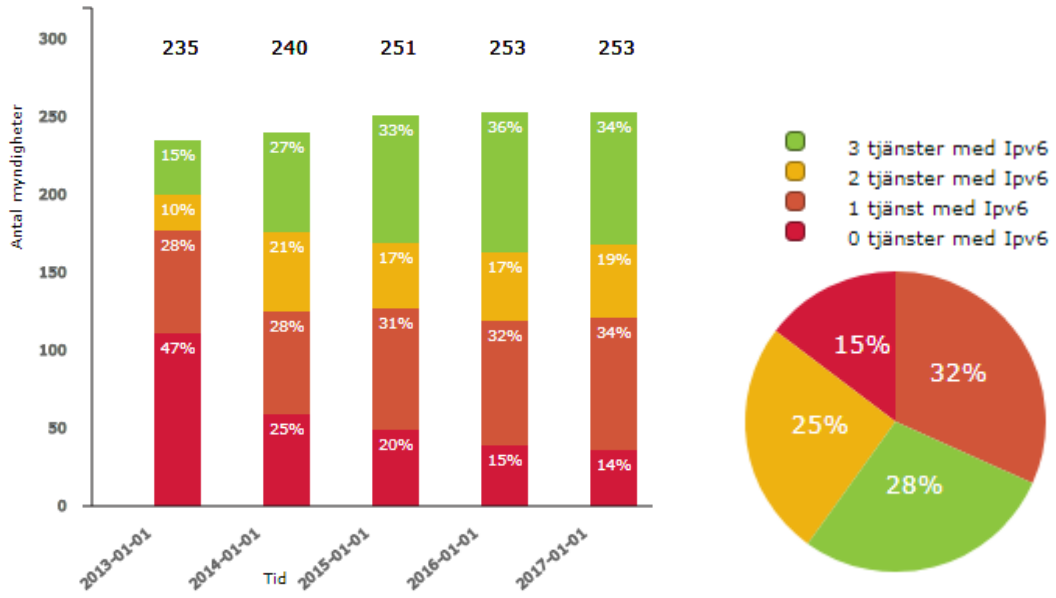
PTS provides a slightly more positive outlook concerning authorities, with 82 out of 253 authorities (32%) being IPv6 enabled on www, DNS and e-mail as of February 2015.



Source: PTS

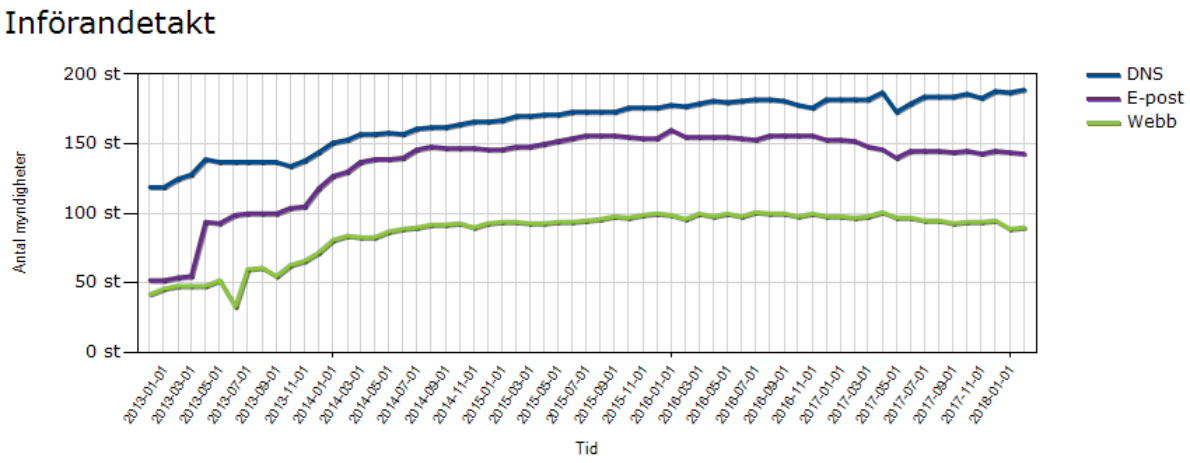
Finally, the PTS has an e-services page (Swedish only) which has statistics relating to the number of authorities that are IPv6 enabled. According to the PTS, there are roughly 250 “main” public authorities covered in this service.

In the figures from the PTS e-service page below, green indicates all three of the web, DNS and email services are IPv6 enabled. Yellow represents two out of three, orange one out of three, and red none. While the bar graph (left) shows yearly evolution, the pie chart on the right is updated daily.



Source: http://etjanster.pts.se/internet/ipv6

There is also a breakdown per service (web, DNS, email), as below.



Source: http://etjanster.pts.se/internet/ipv6

Looking at the graphs above, it actually appears that IPv6 compatibility has gown down over the last few years. This is likely due to tests temporarily being done but then being abandoned.

2.8.5 Deployments and pilots

Despite the government mandate requiring public authorities to deploy IPv6 by 2013, there appears to have been no coordinated effort in the public sector after 2013. The recent decline even suggests that maybe pilots have been done but have then been abandoned (leading to decline in IPv6 capable municipalities).

2.8.6 Operations & Organisation

There appears to be little operations and/or organisation around IPv6 in Sweden as of January 2018.

That said, with the experience up to 2013, PTS remains the main go-to organization as regards IPv6 in the public sector, and the fact that they do follow IPv6 deployment statistically on their website.

It is perhaps worth noting that there is a working group for innovation set up in Sweden by the PTS, which involves various stakeholders including telecom operators, manufacturers etc., and that the topic of IPv6 has at least been raised in this working group.

2.8.7 Barriers and Future developments

The main barrier seems to be lack of understanding of the need to move to IPv6, and thus education on the topic would be important for future development.

According to Torbjörn Eklöv, there are close to no requirements nor demands for IPv6, with neither authorities nor external enterprises expressing any urgency on the matter.

PTS share a similar view, stating for example that there is no requirement for IPv6 in the procurement stage that may help drive IPv6. Ultimately there is a limit to the resources available in the public authorities, and there is no real motivation (particularly a business case) to move to IPv6, and thus its priority naturally lowers.

2.9 Finland

2.9.1 Key stakeholders

It appears that the national telecom regulator FICORA (Finnish Communication Regulatory Authority) is the key stakeholder in driving IPv6 adoption, although not specifically in the public domain. It is certainly worth noting that in Finland a "National IPv6 launch" day was organised by FICORA on the 9th June 2015, in conjunction with the companies below.

The event is organised in cooperation by:

Ministry of Transport and Communications	Finnish Federation for Telecommunications and Teleinformatics (FiCom)	Finnish Communication and Internet Exchange (FICIX)
TREX Tampere Region Exchange Oy	Internet Users Forever (IKI)	Working group for IPv6 (information in Finnish)
Kapsi Internet-users association	FNE-Finland Oy (information in Finnish)	Internet Society
Suomen Internet-yhdistys - the Finnish Internet Association		

However, not much appears to have happened since. No information can be found leading to further action in the public domain (nor in any sector) concerning IPv6.

2.9.2 Government plans and strategies

FICORA also produced a document entitled "Recommendation on the introduction of IPv6 for consumer broadband (in Finnish only)42" in 2014, although not specifically for the public domain. Within, there appears to be no plans or strategies defined, only recommendations as indicated by the title of the document.

It is also worth noting that back in 2002, the Finnish IPv6 Task Force was established supported by FICORA (although not specific to the public domain). However, the Task Force appears to have long been defunct, with the webpage's last update 2008. In fact, FICORA appears to have taken the Task Force and renewed it in 2013, resulting in the National IPv6 launch" day as described above.

2.9.3 Technical aspects/issues

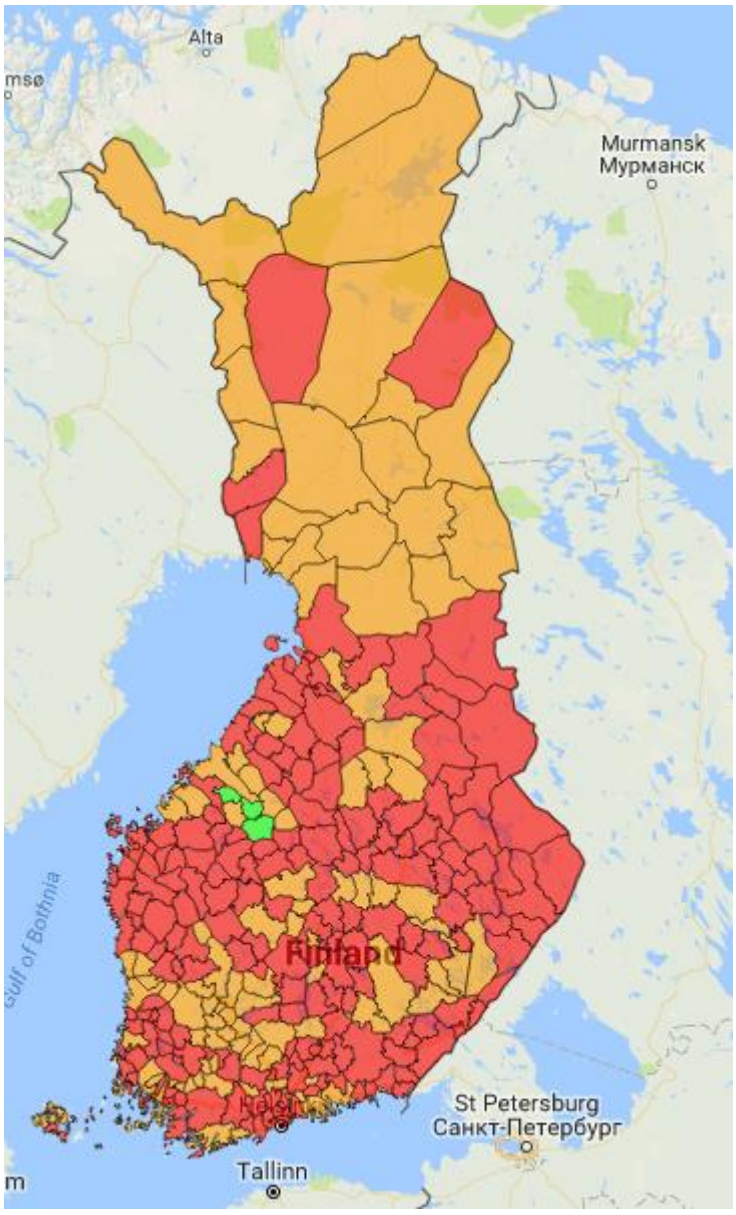
Considering that the general deployment of IPv6 on Finland is high, the issues are likely related not to technical aspects but more motivational within the public sector.

[42] https://www.viestintavirasto.fi/attachments/suositukset/200_2014_S_Suositus_IPv6_n_kayttoonotosta_kuluttajaliittymissa.pdf

2.9.4 Current deployments

Despite the comparatively high IPv6 adoption in Finland, adoption in municipalities is low.

According to the site created by Interlan, co-founded and owned by Torbjörn Eklöv, only 3 of 319 municipalities have IPv6 on www, mail and dns (in green below).

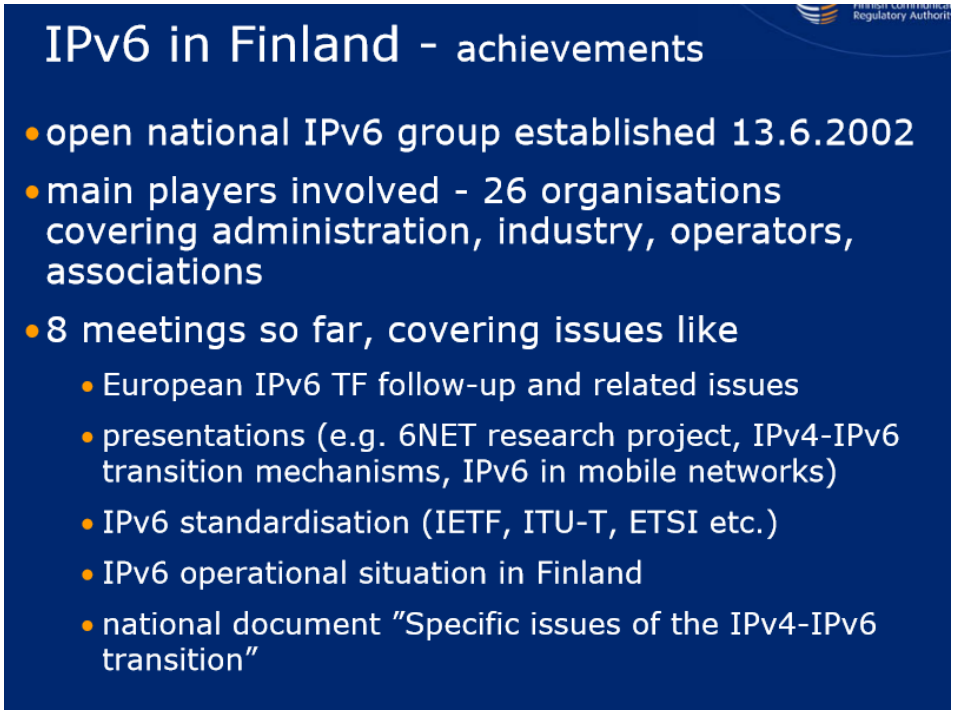


Source: https://www.kommunermedipv6.se/

2.9.5 Deployments and pilots

In January 2014, FICORA provided a few slides on an update to their situation in Finland[43], at which stage the achievements given were the following:

[43] http://www.ec.ipv6tf.org/PublicDocuments/IPv6_Finland-Bryssel.pdf



According to this slide, 26 organisations, including administration had been involved. However, no deployments nor pilots can be identified, and as described above, since the IPv6 day in 2015 not much seems to have evolved.

2.9.6 Operations & Organisation

It is noticeable that the links which can be found relating to IPv6, both on the FICORA site and also the slides above, lead to either only old articles or dead ends. This suggests that there is a lack of organisation and operations regarding IPv6 as of today.

2.9.7 Barriers and Future developments

The main barrier, as is common with most other countries, seems to be lack of understanding of the need to move to IPv6, and thus education on the topic would be important for future development. Finland itself is one of the forerunners for IPv6 deployment so the operators and other businesses seem to already have the knowledge; by contrast, it is the administrations that have a very low adoption rate and thus need educating.

2.10 Denmark

2.10.1 Key stakeholders

There appears to be no key stakeholder responsible for IPv6 development in the public domain (or in general for that matter), which explains the current Danish situation of very low IPv6 adoption.

Back before 2011, the Danish NRA (National IT and Telecom Industry) was taking the lead for overall IPv6 deployment, but this body was abolished in 2011. Its duties were passed to the Danish Business Authority (DBA) and Danish Agency for digitalization, with the DBA resuming the role of national regulator. However, it appears that neither body has continued with plans on IPv6 deployment.

2.10.2 Government plans and strategies

Back in 2010, the National IT and Telecom Agency had developed a strategy as well as an action plan for the deployment of IPv6 in Denmark, approved by the Minister of Science, Technology and Innovation after public hearings. The strategy had four pillars, as follows:

- Creating awareness of IPv6 and the exhaustion of IPv4 addresses, through the establishment of a private/public partnership that represents relevant Danish stakeholders (e.g. content providers and telecom operators)
- Public procurement IPv6-compliant mandate
- Creating an IPv6 test-bed in the future
- Potentially making IPv6 support mandatory for Danish State institutions and agencies (as opposed to the current "recommended standard" at that time).

However, as mentioned above, these strategies appear not to have been taken up after the National IT and Telecom Industry was abolished in 2011.

It is also perhaps worth noting that both the eGovernment strategy 2011-201544 and digital strategy 2016-2020[45] do not contain any mention of IPv6.

2.10.3 Technical aspects/issues

The situation in Denmark seems to be more a lack of interest and motivation, with no particular body positioned to drive IPv6 adoption.

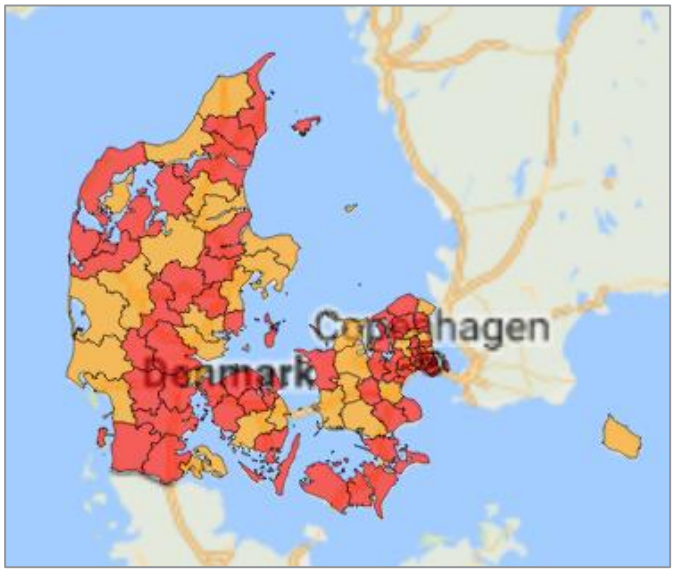
2.10.4 Current deployments

IPv6 adoption in Danish municipalities is at a very nascent stage.

According to the site created by Interlan, co-founded and owned by Torbjörn Eklöv, none of the 97 municipalities have IPv6 on www, mail and dns (as indicated by the lack of green areas in the figure below).

[44] https://www.digst.dk/Servicemenu/English/Policy-and-Strategy/eGOV-strategy

[45] https://www.digst.dk/Servicemenu/English/Policy-and-Strategy/Digital-Strategy-2016to2020



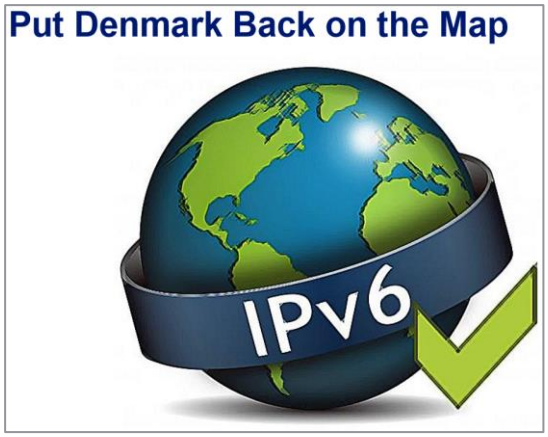
Source: https://www.kommunermedipv6.se/

2.10.5 Deployments and pilots

No pilots/deployments within the Danish public sector has been identified.

2.10.6 Operations & Organisation

It is worth noting that the RIPE NCC organised "IPv6 Day Denmark" in December 2017[46]. But despite the event being advertised as *"featuring keynote speakers from industry, **government** and the international Internet community"*, the agenda does not include such a government representative. This would suggest a lack of interest and/or a designated party on behalf of the Danish government. Perhaps the final slide from the presentation of Nathalie Trenaman of RIPE NCC[47] sums up best the current situation in Denmark:



There would be no need for such a statement should Denmark actively be involved in IPv6.

[46] https://www.ripe.net/participate/meetings/regional-meetings/ipv6-day-denmark

[47] https://www.ripe.net/participate/meetings/regional-meetings/ipv6-day-denmark/presentations/10-natha-dk.pdf

2.10.7 Barriers and Future developments

The main barrier would seem to be that there is no body or organisation within Denmark concerned with IPv6. The last reference by the government and regulator on the topic dates back to 2010. In order to see any future development, one could reasonably assume that some sort of body needs to be set up with the responsibility of driving IPv6, but for this to happen the public sector first needs to be educated on the topic, and even if this happens then there is the motivational issue to be solved.

2.11 Poland

2.11.1 Key stakeholders

There is only a very limited amount of information available on IPv6 migration in Poland. Also, most of the available information is fairly old, dating back to the beginning of the decade.

Figure 29: @Poland.ipv6 twitter account

Source: Twitter

The Polish regulatory authority UKE has shown some interest in the topic. In March 2009, it published a press release on the importance of the migration towards IPv648. The press release states that the regulator was planning to hold a debate on the subject and was already receiving support from the Polish IPv6 task force. No further action from UKE regarding the debate has been identified in the current research.

The abovementioned IPv6 task force does not seem to be operational anymore. The web site has been replaced by an IPv6-Wiki in Polish language without references to recent actions. Attempts to reach out to the members of the Wiki via the site's contact form have remained unanswered.

Other players involved in the topic include universities and research facilities. The Poznan Supercomputing and Networking Centre49 has played an active role and employs experts in the field, who have contributed to Task Force (Bartosz Gajda50). The country's main Universities of Technology in Warsaw, Poznan and Wroclaw were also involved in activities related to IPv6 migration.

2.11.2 Government plans and strategies

No comprehensive IPv6 migration strategy could be identified at this point. In 2003, the Polish government presented its "ePoland" information society strategy for the years 2004 to 2006, which mentions, amongst others, an IPv6 objective:

[48] http://en.archiwum.uke.gov.pl/internet-addressing-ipv6-241

[49] http://www.man.poznan.pl/

[50] Also mentioned in the UKE press release. Interview requests have not been answered by Mr Gajda

Figure 30: ePoland 2004 – 2006

A3 Access Infrastructure	Implementation of the IPv6 Internet Protocol	2nd half of 2006[6]
	10% of households with the broadband Internet access	2nd half of 2005
	Penetration of computers at 30% level	2nd half of 2005
	Costs of the Internet access not more than 10% higher than in the Czech Republic and Hungary (taking into consideration purchasing power differences)	2nd half of 2004
	Each town and commune office makes the Gateway to Poland publicly available	1st half of 2005

Source: ePoland strategy 2003[51]

Furthermore, documents published by organisations such as the EU and the OECD hint at the Polish government's awareness of the topic. For instance, in the 2011 edition of the OECD Communications Outlook, it says that

> "There is political debate on IPv6 in Poland. Poland wishes to take into account commitments made at the OECD level by further promoting the development of IPv6 in the country"[52]

Likewise, in a 2017 profile of the status of digitization of industries in Poland, the European Commission confirms that the government in Poland is ready to support the migration towards IPv6:

> "The Polish Government also supports […] all efforts to modernize both communications networks and end-devices to migrate to IPv6 addresses"[53]

There is, however, no information available on concrete measures and objectives beyond these general statements.

2.11.3 Current deployment

There are no data on the current status of IPv6 deployment in the public sector available.

2.11.4 Deployments and pilots

Several Polish universities and research centres participated in IPv6 pilots such as the international 6bone project. In the early 2000s,with support from the European GEANT iniative[54], the Polish "Pionier" network was connected to the global IPv6 infrastructure.

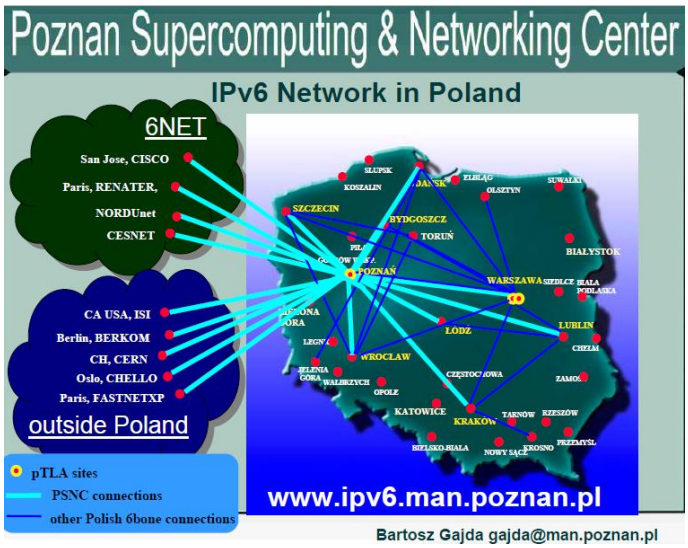
[51] Available at: http://workspace.unpan.org/sites/internet/Documents/Poland%20eGov6.pdf

[52] Available at: http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-communications-outlook-2011_comms_outlook-2011-en#page211

[53] Available at: https://ec.europa.eu/futurium/en/system/files/ged/pl_country_analysis.pdf

[54] Cf. *Why is IPv6 Deployment Important for the Internet Evolution?* Available at: https://www.researchgate.net/publication/228733500_Why_is_IPv6_Deployment_Important_for_the_Internet_Evolution

Figure 31: "Pionier" IPv6 network



Source: PSNC[55]

A more recent initiative, the *Future Internet Engineering project* ran from 2010 to 2013, involving again Poland's major technical universities. The project had a fourfold objective, among which the acceleration of the *transformation process from IPv4 into IPv6 in Poland*[56].

2.11.5 Operations & Organisation

No further information

2.11.6 Barriers and Future developments

No further information

[55] Available at: https://www.6net.org/publications/presentations/gajda-psnc.pdf

[56] https://www.iip.net.pl/objectives/

2.12 Lithuania

2.12.1 Key stakeholders

The LITNET, the academic and research network in Lithuania, launched a website[57] as early as 2001 to “promote the development of IPv6 in Lithuania”.

2.12.2 Government plans and strategies

No information on government plans or strategies

2.12.3 Technical aspects/issues

According[58] to the ECC[59], transmission in LITNET was limited to unicast only in 2010. No information on technical aspects/issues

2.12.4 Current deployments

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[60].

2.12.5 Deployments and pilots

No information available on active policies or IPv6 deployment in the “National Policy Initiatives for the Deployment of IPv6” report published by the CESifo Group[61].

2.12.6 Operations & Organisation

No information on measures to foster IPv6 deployment.

2.12.7 Barriers and Future developments

According[62] to the ECC[63], the lack of strong business cases for IPv6 hinders wider deployment in Lithuania. No other information on barriers and future developments

[57] http://ipv6.lt/kontaktai.php

[58] Preparing For Ipv6, 2010

[59] Electronic Communications Committee

[60] https://www.vyncke.org/ipv6status/detailed.php?country=lt&type=Gov

[61] Consisting of the Center for Economic Studies (CES), the ifo Institute and the CESifo GmbH (Munich Society for the Promotion of Economic Research), 2010

[62] Preparing For Ipv6, 2010

[63] Electronic Communications Committee

2.13 Bulgaria

2.13.1 Key stakeholders

The Bulgarian State Agency for Information Technologies and Communications – DAITS is responsible for all initiatives and projects in the area of ICT, including IPv6. It launched a laboratory in 2008.

There is no IPv6 task force or council in Bulgaria as of early 2017.

2.13.2 Government plans and strategies

No information on government plans or strategies

2.13.3 Technical aspects/issues

No information on technical aspects/issues

2.13.4 Current deployments

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[64].

2.13.5 Deployments and pilots

In 2008, Europe's second lab (after the first launched by RENATER) for IPv6 training and research was established in Bulgaria. It is managed by the Bulgarian State Agency for Information Technologies and Communications (DAITS), in cooperation with EU projects (such as 6Deploy)

2.13.6 Operations & Organisation

No information on measures to foster IPv6 deployment.

2.13.7 Barriers and Future developments

No information on barriers and future developments

[64] https://www.vyncke.org/ipv6status/detailed.php?type=Gov&country=bg

2.14 Belgium

2.14.1 Key stakeholders

SPF Economie (federal economy ministry)

The SPF Economie is responsible for the policies regarding the adoption of IPv6 in Belgium. It launched several initiatives and studies related to the adoption of IPv6, including some targeting specifically the adoption of IPv6 in public administrations.

SPF BOSA (policy and support ministry)

The policy and support ministry is responsible for public procurement services and the organization of federal administrations. As such, it supported the SPF Economie plans for the adoption of IPv6 by providing interoperability training and by editing public procurement rules promoting IPv6.

IPv6 Council - Belgium

The IPv6 Council is the local chapter of the IPv6 Task Force, with a mission to promote the adoption of IPv6 in the country. It is still very active in Belgium with several events organized every month. But it does not have any specific role for the public sector.

Regional governments

Given the federal nature of Belgium, regional government have an important level of freedom and thus local ICT agencies can also have a significant role in the adoption of IPv6 in public administrations.

2.14.2 Government plans and strategies

A first report on IPv6 was edited by the SPF Economy in 2011 presenting the general challenges of IPv6 transitions.

A plan for the adoption of IPv6 in Belgium (and more specifically Belgian public administrations) was validated by the Belgian government in June 201265. The plan66 gives the SPF Economy and the SPC policy and support the role of ensuring the adoption of IPv6 by public services before the end of 2014. The plan relied on a first preparatory phase from May to December 2012, followed by an implementation phase up to December 201467.

In 2014, the SPF BOSA (policy and support) edited a public procurement rule68 requiring IPv6 compatible equipment in future public procurement contracts.

[65] https://m.datanews.levif.be/ict/actualite/le-conseil-ministeriel-approuve-le-plan-ipv6/article-normal-284527.html

[66] https://dt.bosa.be/sites/default/files/downloads/IPv6News-fr-20121129.pdf

[67] http://www.presscenter.org/fr/pressrelease/20120623/plan-de-d%C3%A9ploiement-de-lipv6-en-belgique

[68] http://www.publicprocurement.be/sites/default/files/documents/2014_06_16_circ_omzend_ipv6.pdf

In 2015, the SPF Economy published a report[69] on the adoption of IPv6 in Belgium, including a section focusing on public administrations. The report noted a significant delay from the plans of 2014 as, contrary to the plan, not all public administrations had transitioned to IPv6.

According to our interviews, the current status is that the 2012 plan is now considered as too ambitious. The transition requires equipment changes and no dedicated budget is allocated. IPv6 adoption is thus now dealt with when public administration need new equipment or when a significant update of public website is released.

2.14.3 Technical aspects/issues

Apart from the general public procurement rules presented above (and requiring IPv6 connectivity and compatibility) the Belgian public administrations have not issued specific technical specification regarding IPv6.

In several cases the by default configuration of new software and hardware is set by the manufacturer as IPv6. This leads sometimes to by default transition in several services, including intranet services.

2.14.4 Current deployments

In line with the adoption at the country level, the use of IPv6 in public sector is high.

According to **Vyncke blog, there are 26 identified host** using IPv6 in the government sector[70], but only a fraction of them offer full IPv6 services: 31% provide Web, 12% provide Mail et 50% provide DNS. 3 of these hosts participated to the IPv6 day in 2011.

According to our interviews, most of the major public administration websites including e-government services (such as tax declaration services, or open data services) have migrated to IPv6. However given the large number (250+ at federal level) of websites, including small ones, to migrate, the transition is not complete yet. The current process is to migrate website whenever there is an equipment change or a significant update, with a priority for website serving a large number of citizens.

Mailbox services and web services are considered as less of a priority, as well as intranet services.

The situation in regional public administration is considered as globally similar to the federal services and sometimes a bit more advanced.

2.14.5 Deployments and pilots

Given the adoption level of the country and of public services, they are past the pilot phase.

2.14.6 Operations & Organisation

The IPv6 Council is organizing regular meetings and workshops on IPv6, with several meetings every year. Government representatives from BOSA (policy and support ministry) participate to these meetings.

[69] https://economie.fgov.be/fr/publications/etude-sur-le-deploiement-de

[70] https://www.vyncke.org/ipv6status/detailed.php?country=be&type=Gov

The Policy and Support Ministry is also providing help and guidance to the different system administrators of public services in their transition to IPv6 through an interoperability expert that is mobilized to support transition processes and provide training.

2.14.7 Barriers and Future developments

The main barriers to the 2012 plan for the adoption of IPv6 in public administration appear to have been the cost of transition.

No specific budget was dedicated to the transition. Additionally despite the 2015 report on adoption (that recommended it) no new plan for the adoption of IPv6 in public administrations was adopted.

The adoption of IPv6 is thus done in an opportunistic way (transition on hardware or software changes), privileging websites with a high traffic. Internal services as well as webservices or mailbox are considered as less of a priority since they often don't face directly end users but rather other administrations.

A plan for an IPv6 public service data center was considered for a time but the idea was abandoned, being considered as too ambitious in the current situation.

2.15 Ireland

2.15.1 Key stakeholders

Department of Communications

The department of Communications, Climate Action and Environment is responsible for communication policies in Ireland.

It participated to the Irish IPv6 Task Force as main representation of government and is considered as the main branch of government responsible for IPv6 adoption in Ireland.

Office of the government chief information officer (OGCIO)

The OGCIO is responsible for communication technology adoption in public administrations and services (including eGovernment).

It is thus the main body responsible for IPv6 adoption in Ireland public administrations.

Commission for Communications Regulation

The Commission for Communication Regulation is the Irish telecommunication regulator.

It participated to the Irish IPv6 Task Force.

Irish IPv6 Task Force

The local task force was co-founded in 2004 by the TSSG research center, the HEAnet (Ireland's national research and education network) and the Department of Communications, Energy and Natural Resources (DCENR).

The Task Force was active until 2014, but with most activity happening before 2012. It gathered a large group of stakeholders: research centers, government and regulator representatives, as well as ISPs and ICT industrials.

Irish National IPv6 Centre

The Irish National IPv6 Centre is an initiative of the Irish IPv6 Task Force, established in 2005. The Centre objective was to support the task force and act as a R&D centre on IPv6, focusing on implementation and research questions while the task force concentrated on promotion and discussions between the stakeholders.

The Centre consortium consisted of:

- Waterford Institute of Technology (TSSG)
- NUI Maynooth (Hamilton Institute)
- HEAnet
- BT Ireland

The Centre was active up to 2011.

IPv6Ready.ie

IPv6Ready.ie was an initiative set up by INEX (a neutral, industry-owned Association, providing IP peering) to promote the adoption of IPv6.

It's a website that tracked IPv6 adoption and awarded badges to website adopting IPv6.

2.15.2 Government plans and strategies

The Irish regulator (Commission for Communications Regulation) issued a briefing note on IPv6 in 2002: INTERNET PROTOCOL VERSION 6 (IPV6)- BRIEFING NOTE. The note presented the main challenges of the transition from IPv4 to IPv6 and the transition approaches and current state (without a focus on government).

The CCR and the Department of Communication then participated to the IPv6 Taskforce from 2004 to 2011.

However, no overall plan or strategy for IPv6 adoption in public administration has been released up to now.

Some activities linked with the IPv6 Taskforce and the National Centre were launched in research centers and universities to ensure their transition to IPv6 but without central coordination.

2.15.3 Technical aspects/issues

The Irish National IPv6 Centre was created by the Irish Task Force to address technical issues related with IPv6 adoption. However no specific guidelines for public administrations have been issued.

2.15.4 Current deployments

In line with the adoption at the country level, the use of IPv6 in public sector is unsurprisingly low.

According to **Vyncke blog, there are only one identified host** using IPv6 in the government sector[71], but it is now listed as "Failed" for Web, Mail and DNS.

Name	Alexa (Nov 2016) country/global	Web	Mail	DNS
Gov Irish Meteorological Service whois	49/38737	FAILED ***hosted***	FAILED	FAILED
In total 1 hosts		0 (0%)	0 (0%)	0 (0%)

According to our interviews, other public administrations, especially universities and public research centres have deployed IPv6 in Ireland. It is also likely that some local public administration have at least partially switched to IPv6 by following their ISP decisions.

[71] https://www.vyncke.org/ipv6status/detailed.php?country=ie&type=Gov

2.15.5 Deployments and pilots

The main pilot is the Irish National IPv6 Centre gathering TSSG (Telecommunications Software & Systems Group – a research center), HEAnet (Ireland's national research and education network) and British Telecom Ireland.

The testbed provides IPv4 and IPv6 connectivity to the European research network GÉANT and also to other NRENs peering at its PoP in New York, such as Internet 2, Ca*net, SINET and TWAREN. It also exchanges IPv6 traffic with ISPs at INEX. BT Ireland has offered access to the BT Exact testbed laboratories in UK that can provide more fully featured tests and trials.

2.15.6 Operations & Organisation

No operation or organization of the transition to IPv6 in public administration appear to be present in Ireland.

2.15.7 Barriers and Future developments

According to our interviews the main barrier to IPv6 adoption is a lack of priority of the issue in national government services.

IPv6 is seen as mostly an issue for ISPs on which neither government nor regulator are willing to intervene.

The transition of public services to IPv6 is seen as an issue with a real cost and no visibility (or demand) from end users (citizens) and therefore little value.

Only universities and research centres focusing on ICT are experiencing with the transition to IPv6.

The only significant force that seem currently able to push Irish public services to adopt IPv6 would be a transition of Irish ISPs to IPv6 with a significant rise of the number of citizens using IPv6.

2.16 Luxembourg

2.16.1 Key stakeholders

Internet Society (ISOC)/ Luxembourg Task Force IPv6

In 2002, ISOC has been tasked with setting up a Task Force dedicated to the deployment of IPv6 in Luxembourg, not focusing on the public sector but globally.

As of today, there is no activities and no news as regards to IPv6 from ISOC Luxembourg neither from the existence of the Task Force[72].

IPv6 Council

The Luxembourg IPv6 Council has been established in 2007 to support a smooth transition to IPv6 by consulting and advising all stakeholders with recommendations and roadmaps. Made up of experts from industry, research, politics and administrations in the IPv6 field this council has the mission to advocate IPv6 by improving technology, market, and deployment user and industry awareness of IPv6.

2.16.2 Government plans and strategies

The Luxembourg IPv6 Council has presented an action plan in 2009 with a roadmap set up including 4 actions for a wide deployment in Luxembourg – involving both public and private sectors[73] :

i. Actions to stimulate IPv6 accessibility to content, services, and applications. As part of this action, the council called upon the Luxembourg Government to enable IPv6 on public sector websites;
ii. Actions to generate demand for IPv6 connectivity and products through public procurement. In this action, the council recommended the Luxembourg Government to specify IPv6 capabilities as a core requirement for the continuous renewal cycle of its own network equipment and services;
iii. Actions to ensure timely preparation for IPv6 deployment including the inclusion of IPv6 technology knowledge in relevant training and courses in computer and network engineering of universities;
iv. Actions to tackle security and privacy issues. The council undertook in the consultation of key stakeholders such as data protection authorities or law enforcement to monitor the privacy and security implications of IPv6.

The first target through the roadmap was to get immediate milestone by beginning of 2009 in order to reach a 25% penetration in using IPv6 by 2010.

In 2011, the Ministry of the communications and media has been asked to provide an overview of the IPv6 implementation in the country (not focus on public administrations) following the action plan presented above. Since then, there was no update on this roadmap.

[72] The site dedicated to the IPv6 Task Force(http://www.isoc.lu/ipv6) is currently unreachable

[73] http://www.ipv6council.lu/docs/IPv6+Council+Luxembourg+roadmap.pdf

2.16.3 Technical aspects/issues

The State Technology Center or Centre des Technologies de l'Information de l'Etat (CTIE) is the central player in the establishment and development of eGovernment and supports the digital transition of the Luxembourg administrations. As regards to IPv6, the CTIE has acquired the status of being a LIR since 2009. It has asked for IPv6 addresses (no information about it today).

2.16.4 Current deployments

According to **Vyncke blog,** there is no identified host using IPv6 in the government sector[74] as November 2016.

According to **CZ.NIC statistical portal**, 1 web server, 14 names servers and 1 mail exchanges support IPv6 in the government sector.

- In early 2018, the web server of Chambre des Députés du Grand-Duché de Luxembourg fully supports IPv6.

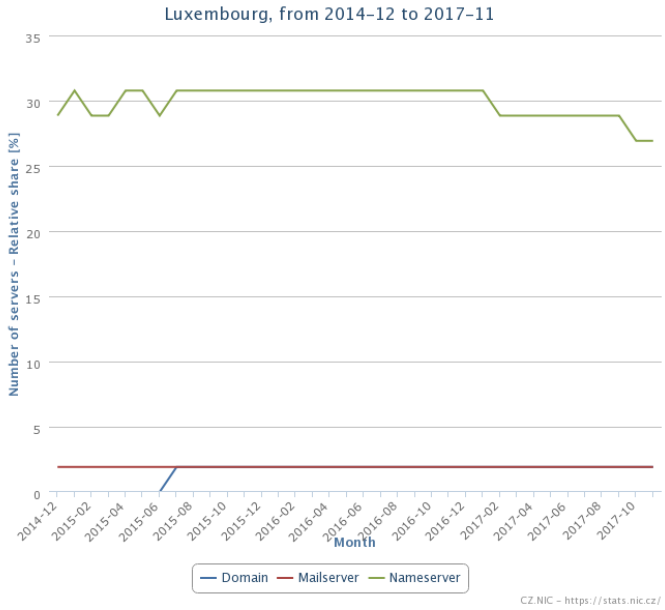
Figure 32: Implementation of IPv6 government servers

Data for 01-03-2018				
Name	Domain	WWW	NS	MX
Total: 52		51	38	51
		0	0	0
		1	14	1

Source: https://devpub.labs.nic.cz/ipv6-smt-new/country/lu/

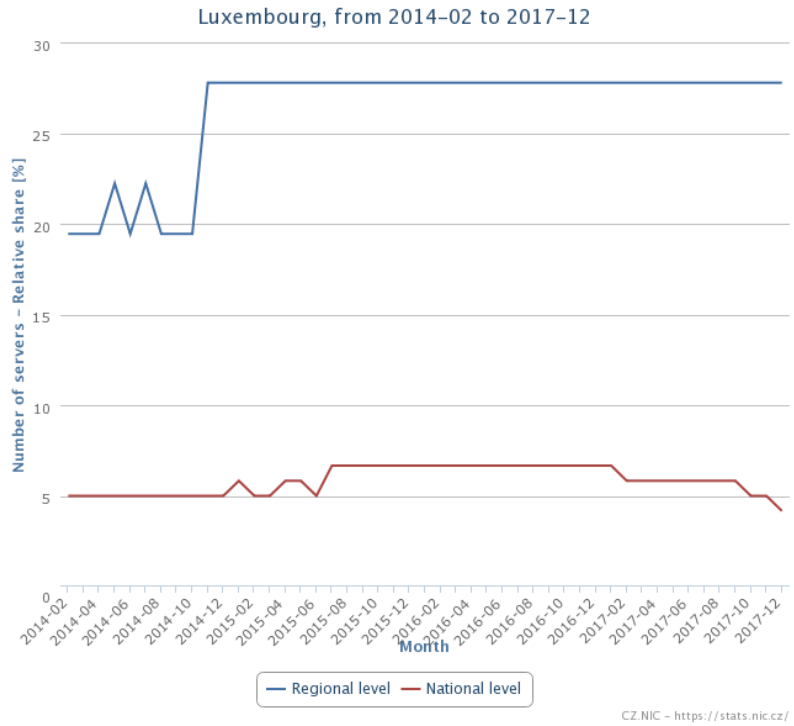
[74] https://www.vyncke.org/ipv6status/detailed.php?country=lu&type=Gov

Figure 33: Implementation of IPv6 by governments – countries



Source: CZ.NIC

Figure 34: Implementation of IPv6 by governments - administrative units



Source: CZ.NIC

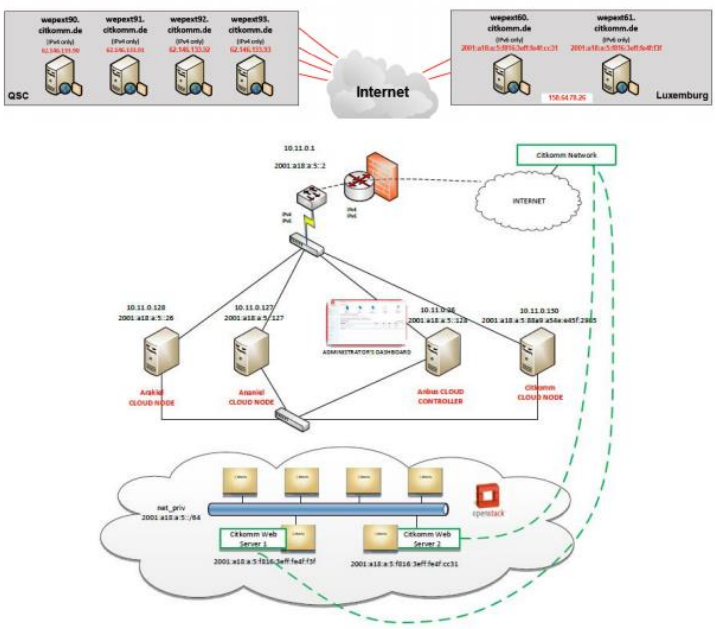
2.16.5 Deployments and pilots

Cloud on 6

Luxembourg is part of Gen6 national pilot on IPv6 upgrade of Secure Cloud Services75. The pilot focuses on the transition to IPv6 of a private cloud that can be used internally by governments or for public services. The output of the pilot is a set of guidelines for governments to be used to the global community helping about how to perform the transition, as well as tools for checking security and configurability properties of cloud services at network level.

A use-case of the Luxembourg pilot was the support of elections in Germany in May 2014 in cooperation with Citkomm and Nephos6. At this event, the University of Luxembourg hosted an IPv6-only cloud in a production environment where the system has successfully served 5% of the requests of all the citizens accessing the election results presented there.

Figure 35: Secure election infrastructures based on IPv6 Clouds



Source: Nephos6[76]

Post Luxembourg (previously P&T)

Post Luxembourg, a public company, was the first network running an end-to-end connectivity over IPv6 in 2009[77] and is an important showcase for the country.

This subsection will be detailed in the final document.

[75] http://www.gen6-project.eu/fileadmin/GEN6/Flyer_GEN6/BrochureULpilot_-_Luxembourg_pilot.pdf

[76] https://www.nephos6.com/wp-content/uploads/2015/07/Secure-Election-Infrastructures-Based-on-IPv6-Clouds.pdf

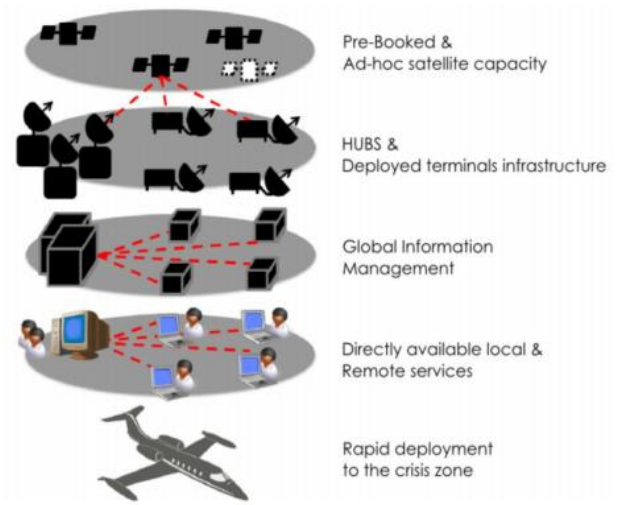
[77] www.ipv6council.lu/docs/J-M_Spaus.pdf

u2010 (public safety)

u2010 (Ubiquitous IP Centric Government & Enterprise Next Generation Networks, Vision 2010) is a 3-year project led by the University of Luxembourg funded by the European Commission launched in 2006 and is seen as a showcase for Luxembourg.

The idea of u2010 was to rely on new technologies and especially IPv6 to link the different systems within the ubiquitous network to provide the most capable means of communication and the most effective access to information to everybody required to act in case of accident, incident, catastrophe or crisis. The u2010 project had a very beneficial impact in terms of introduction of IPv6 in Luxembourg, especially in starting a network on the fly and using any technology that survived a major disaster or where mobility and redundancy are the essence with satellite as the prime candidate.

Figure 36: u-2010 infrastructure



Source: Secricom[78]

2.16.6 Operations & Organisation

As part of the four actions undertaken by the IPv6 council, training has been identified as important and the inclusion of IPv6 technology knowledge in relevant retraining curricula in computer and network engineering courses of universities has been foreseen.

2.16.7 Barriers and Future developments

According to Mr Latif Ladid interview, the main barriers for the implementation of IPv6 in public administration are:

- The lack of technical knowledge and the need for training;
- The willingness to move into innovation and digitalization.

[78] http://www.secricom.eu/images/news/Moving_Towards_IPv6.pdf

2.17 Greece

2.17.1 Key stakeholders

Hellenic IPv6 Task Force (HTF)

The Hellenic IPv6 Task Force (HTF) was created in 2010 dedicated to the promotion of IPv6 in Greece [79]. HTF was not a governmental organisation with members from the market, large companies, universities and also from some governmental bodies. It was designed to be an open forum giving the opportunity to Greek ICT players to present best practices and exchange information for the provision of new advanced services based on IPv6 technology.

The conclusions of HTF as of 2012 are as follows:

i. the major local ISPs aim to introduce IPv6-enabled services to their broadband subscribers by the World IPv6 Launch
ii. the national public sector infrastructure is planned to support a wide IPv6 service portfolio in the forthcoming major upgrade
iii. successful IPv6 over 3G tests have been demonstrated by the local mobile operator
iv. the research community explores the provision of IPv6-only cloud services,
v. IPv6 is considered as enabling technology for advanced services in the Smart Grid sector

GRNOG

Following the HTF dismantlement in April 2015[80], the GRNOG (Greek Network Operators Group) has been created. This community of professionals are involved in the design, implementation, and operation of networking infrastructures and services for the Greek internet including IPv6.

2.17.2 Government plans and strategies

No government plan identified so far.

Interpretation: the creation of GRNOG seems to favour the focus of IPv6 implementation in telecom operators.

This subsection needs to be clarified for final report.

2.17.3 Technical aspects/issues

No information yet

2.17.4 Current deployments

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[81] as November 2016.

[79] https://www.ipv6forum.com/dl/presentations/Greece.pdf

[80] https://www.enog.org/presentations/enog-10/102-Odessa-2015.pdf

According to **CZ.NIC statistical portal**, 2 web servers, 8 names servers and 2 mail exchanges support IPv6 in the government sector.

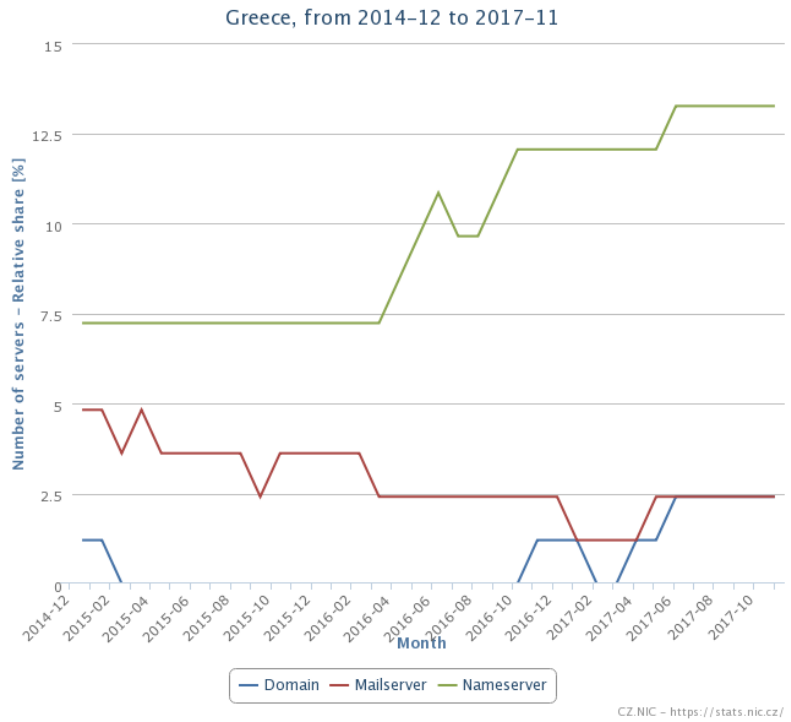
- Ministry of Foreign Affairs www.mfa.gr;
- Polygros city hall website www.polygyros.gr.

Figure 37: Implementation of IPv6 government servers

Data for 01-12-2017				
Name	Domain	WWW	NS	MX
Total: 83		81	72	81
		0	3	0
		2	8	2

Source: https://devpub.labs.nic.cz/ipv6-smt-new/country/

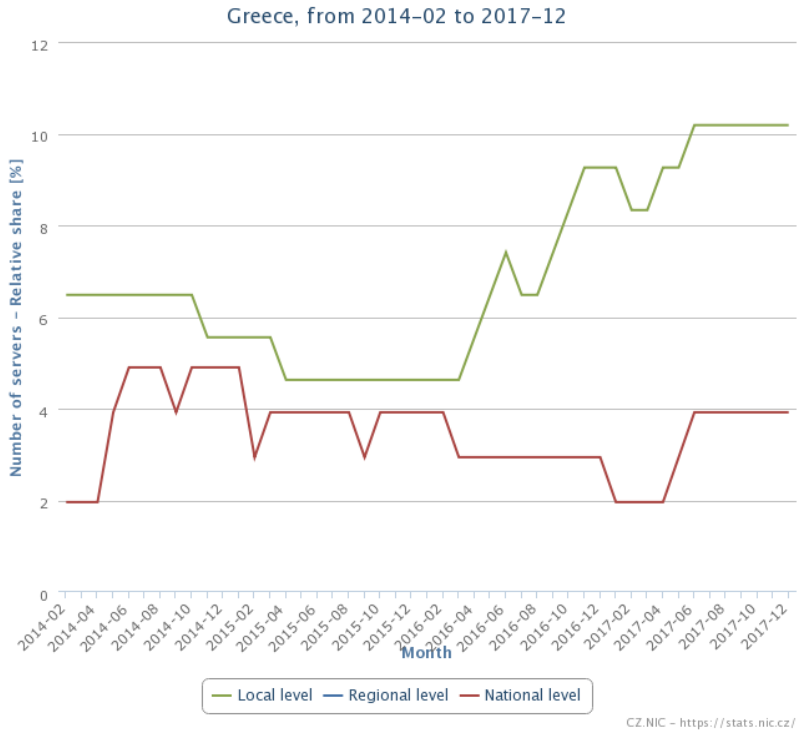
Figure 38: Implementation of IPv6 by governments – countries



Source: CZ.NIC

[81] https://www.vyncke.org/ipv6status/detailed.php?country=gr&type=Gov

Figure 39: Implementation of IPv6 by governments - administrative units



Source: CZ.NIC

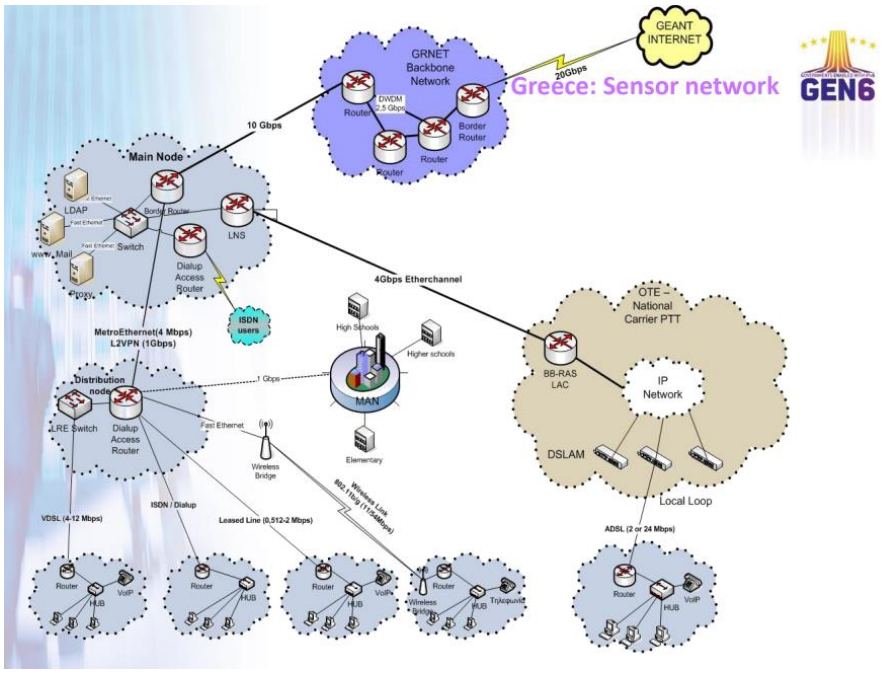
2.17.5 Deployments and pilots

Energy Efficiency in school networks with IPv6

Gen6 pilot[82]

[82] http://www.ipv6observatory.eu/wp-content/uploads/2012/11/02-06-Varvarigos-IPv6-Greek-school-Network-GEN6-pilot_v51.pdf

Figure 40: IPv6-based sensor network for energy efficiency in school communities



Source: Gen6[83]

GR-Net

The Greek Research and Technology Network (GR-Net) is the Greek National Academic and Research Network (NRN). It is an initiative of the General Secretariat for Research and Technology (GSRT) of the Ministry of Development, initially as part of the EPET II sub programme of the 2nd Framework Programme of the European Union (EU). The goal of GR-Net is to provide advanced and high quality inter-networking and Internet connectivity services to both Greek Universities and Technological Educational Institutes.

The backbone network of this infrastructure runs on IPv6.

2.17.6 Operations & Organisation

No information yet

2.17.7 Barriers and Future developments

No information yet (due to no interviews yet)

[83] http://www.gen6.eu/docs/presentations/Gen6-EU-IPv6Observatory.pdf

2.18 Austria

2.18.1 Key stakeholders

The key stakeholder for the Austrian IPv6 public domain development in the Federal Chancellery. According to IDATE's interview, the Austrian Federal Chancellery deems the transition to IPv6 for the federal ministries as complete.

An Austria-wide IPv6 Task Force expert group was also set up to promote IPv6 activities.

2.18.2 Government plans and strategies

According to Peter Kustor of the Federal Chancellery, the issue of IPv6 in the public sector has already been evaluated and discussed quite a long time ago. Already in 2011, a white paper on this containing an assessment and measures has been released84.

According to this white paper, significant national initiatives to promote IPv6 activities were set already back in 2004 (not limited to the public sector).

Already in 2004, significant national initiatives to promote IPv6 activities were set. With the establishment of the IPv6 Task Force, an Austria-wide expert group was set up, which promoted the national IPv6 activities. The result of this initiative was the introduction of IPv6 in the networks both on the consumer side and as peering between individual Internet Service Providers.

This is supported by the OECD Communication Outlook 2011 report85, which contains a table of policy initiatives for the deployment of IPv6 as of 2010 (the table has unfortunately been discontinued from 2013 onwards). According to this table, an industry platform (IPV6 Task Force Austria) dealing with various IPv6 issues was founded in 2004 with the support of the government and telecommunications regulatory authority. It appears that Austria was successful in having an influential IPv6 Task Force, supported sufficiently by both the government and NRA, to drive the Ministries into action to deploy IPv6.

2.18.3 Technical aspects/issues

Nothing specifically relating to technical issues has been found; some mention of need for care to not create a digital divide.

Some mention in the aforementioned 2011 white paper of the need for care to not create a digital divide between IPv4 and IPv6 users, irrespective of consumer or business use cases.

2.18.4 Current deployments

A survey was conducted in May 2011 on the topic of IPv6, providing an overview of the state of implementation of IPv6 at the federal ministries.

Around half of the federal ministries at that time already had IPv6-capable hardware and software in place. The websites and e-mail services of BMG and BMeiA were already accessible via IPv6, and six

[84] https://www.ref.gv.at/fileadmin/_migrated/content_uploads/IPv6_1-0-0_20111011.pdf (German only)

[85] https://dwmw.files.wordpress.com/2011/06/oecd-commoutlook-2011.pdf

federal ministries were then working on an internal strategy for implementation. A minority of 4 posts were not yet involved in the implementation of IPv6. The BMG was offering IPv6 access to its eGovernment services.

Further, according to the survey, the majority (6) of the federal ministries were pushing for a switch to IPv6 from 2013 (with three ministries already having implemented IPv6 before 2013).

Upon questioning how these implementations and pushes played out, Peter Kustor of the Federal Chancellery replied as follows:

“We did not explicitly gather recent data, but we also did not receive any requests for support or for further discussion; we assume that the completion to IPv6 has been done. Thus we can regard this as concluded and posing no major difficulties in Austria.“

According to Eric Vyncke’s blog86, the Federal Ministry of Labour, Social Affairs, Health and Consumer Protection is indeed already IPv6 ready. No other Federal Ministry information was available on the blog.

2.18.5 Deployments and pilots

Aside from the information already given above, perhaps it is interesting to note that in the “Broadband in Austria Evaluation report 2015”, provided by the Federal Ministry of Transport, Innovation and Technology, mentions within its strategic measures to “Ensure the full interoperability of eGovernment services through IPv6”.

2.18.6 Operations & Organisation

As already mentioned, the Federal Chancellery oversees the IPv6 transition. The IPv6 task force, set up in 2004 was the main driver of IPv6. As of today, there appears to be no such organisation in place, but at least for the ministries makes sense in that the transition has already been completed.

2.18.7 Barriers and Future developments

Referring back to the aforementioned survey back in 2011, the cost factor (network planning and network infrastructure) was mentioned as a potential concern.

Moving forwards, the Federal Ministries mentioned the following as key points for a successful transition to IPv6:

- A need for coordination in the exchange of experience
- Clear definition of strategic objectives
- Setting the timeline for the migration scenarios
- Formulation of the procurement requirements
- Determination of common liabilities
- The need to offer training

[86] https://www.vyncke.org/ipv6status/detailed.php?country=at&type=Gov

2.19 Malta

2.19.1 Key stakeholders

The regulator MCA (Malta Communications Authority) is the key stakeholder for IPv6 deployment in the public domain, but also globally. MITA (Malta Information Technology Agency) is also involved.

It is also worth noting that The Internet Society has a "Malta Chapter", which organised an IPv6 related workshop in September 2017. That said, any noticeable action before this goes back to 2014, suggesting it has been largely inactive since then.

2.19.2 Government plans and strategies

In March 2014, the MCA announced the Government's presentation of Digital Malta – the National Digital Strategy for 2014-202087. Within this document, there is a mention of IPv6, albeit very small. Under the actions to be taken for a nationwide NGA network, there is a mention of IPv6. Specifically, it states the following:

"Government will promote deployment of the IPv6 protocol, for identifying and locating computers on networks and traffic routes across the Internet. This acknowledges the need to prepare for an 'Internet of Everything,' where all objects connected to the web must be uniquely identified"

There is a dedicated webpage "Digital Malta"88 implementing this concept, and the above initiative is included as one of the infrastructure initiatives. According to the programme of initiatives89 that can be found on this site, there have been two IPv6 related initiatives as of 2016 (the most recent document available).

[87] https://digitalmalta.org.mt/en/Documents/Digital%20Malta%202014%20-%202020.pdf

[88] https://digitalmalta.org.mt/en/Pages/Home.aspx

[89] https://digitalmalta.org.mt/en/Documents/DM-POI-2016.pdf

Theme		Action Title	Initiatives 2014	2015	2016	TOTAL	
Regulation and Legislation	38	Digital Single Market	2	0	1	**3**	
	39	Radio spectrum for mobile data communications	2	1	1	**4**	
	40	Digital legislation and contracts	0	0	0	**0**	•
	41	Infrastructure based competition	0	4	3	**7**	
	42	Standards and Good Practice	3	3	5	**11**	
	43	Cyber Crime Legislation	0	0	0	**0**	•
	44	Digital legislation and regulation	1	0	3	**4**	
Infrastructure	45	Supporting NGA Networks	4	4	3	**11**	
	46	Broadband Supply and Demand	2	5	3	**10**	
	47	IPv6	0	1	1	**2**	
	48	Network Infrastructure Sharing Opportunities	3	2	2	**7**	
	49	Safeguarding Networks	0	2	1	**3**	
	50	Quality of Service	4	2	1	**7**	
	51	International Connectivity	1	1	0	**2**	
	52	Connectivity between Malta and Gozo	1	1	1	**3**	
	53	National Cyber Security Strategy	0	1	1	**2**	
	54	Authentication Services	2	1	4	**7**	
	55	Trust Services	0	0	0	**0**	•
	56	Modernisation and Re-Use	6	11	14	**31**	
	57	Foresight	0	0	0	**0**	•
	58	Incubation of novel ICT driven solutions	0	2	1	**3**	

One of these initiatives was the deployment of IPV6 at the Malta Resources Authority, described in both the 2015 and 2016 reports, while the other remains unclear.

According to the ECC Report 144 “Preparing for IPv6” released in 2010:

“The MCA is currently drafting an IPv6 strategy for Malta - setting out a number of IPv6-related objectives that need to be achieved within a stipulated timeframe. The MCA has, and continues, to deliver lectures on IPv6 thus helping to raise IPv6 awareness and disseminate IPv6 information. The MCA will, in the near future, be evaluating incentives (either offered by itself or by other stakeholders) which could serve to encourage the deployment of IPv6 in Malta”

It is unclear as to what level the MCA have delivered on the above.

2.19.3 Technical aspects/issues

No particular documentation can be found discussing the technical aspects of IPv6.

In fact, Malta advertises itself as “A Unique Test and Trial Opportunity”90 for IPv6 technology (highlight by IDATE):

*“Malta’s size, geographic location and population density mean that it is **an ideal location to act as a test-bed for new services**. It is a microcosm that offers the potential for testing applications, such as city management and intelligent transport systems, or technologies, **such as IPv6, on a nationwide basis with limited investment**”*

[90] https://www.mca.org.mt/sites/default/files/pageattachments/MCA%20-%20Malta%20Fact%20Sheets%20Document.pdf

2.19.4 Current deployments

There appears to be no specific data available to assess the current deployment status of IPv6 in the Maltese public sector. However, given the national rollout status in the previous section, combined with the perceived lack of any dedicated organisation or movements concerning IPv6, one can assume that the current deployment status is not high.

2.19.5 Deployments and pilots

That said, as mentioned in the government and strategies section, there do appear to be at least two IPv6 initiatives that have been deployed.

2.19.6 Operations & Organisation

The Maltese IPv6 Task Force (http://www.mt.ipv6tf.org) originally set up in 2005 appears to be defunct, and while IPv6 is included in the national Digital Malta 2014-2020 Program, there appears to be no real operations / organisations driving IPv6 in the public sector forward.

The ISOC (Internet Society) did organise an event in September 2017 at the MITA Data Center, called ION Malta, covering topics such as IPv6, DNSSEC, Securing BGP, and TLS for Applications91. However, this seems to be more of a one off, and the presentation materials do not show any particular signs of what the Maltese public sector (or as a country as a whole) is doing regards IPv6.

2.19.7 Barriers and Future developments

According to MCA's 2018 Annual Plan[92], released January 2018, there is a section titled "Review of IPv6 and other numbering limitations". This suggests that the topic of IPv6 is on Malta's agenda; but the planned output is a report on the current scheme, and thus any actual drive towards IPv6 is likely still some distance away in the future.

[91] https://www.internetsociety.org/events/ion/malta2017/agenda/

[92] https://mca.org.mt/sites/default/files/pageattachments/MCA%20Annual%20Plan%202018.pdf

Priority Programme of Works 2018 - Strategic Objective IN1 (Business Innovation)	
Project / Activity	**Planned Output**
Supporting wireless research and development	
Test and Trial Licences	– Promoting the uptake of test and trial licences *(specifically in respect of new innovative services)*
Updating the National Broadband Plan - 5G and Gigabit Society	
Broadband policy towards a gigabit society	– Stakeholder workshops – Draft and consult on the strategy document – Review feedback from Consultation – Publish final version of the Broadband Policy
Review IPv6 and other numbering limitations	
Review of IPv6 and other numbering limitations	– Report outlining any addressing/numbering schemes which might impair the deployment of new service

2.20 Cyprus

2.20.1 Key stakeholders

The OCECPR (Office of the Commissioner of Electronic Communications and Postal Regulation) would seem the most likely key stakeholder.

2.20.2 Government plans and strategies

No particular governmental plans could be found.

2.20.3 Technical aspects/issues

Before approaching the technical issues, there needs to be a plan to adopt IPv6 put in place.

2.20.4 Current deployments

Current deployment of IPv6 remains unknown.

2.20.5 Deployments and pilots

In line with the above, deployment or pilots of IPv6 remains unknown.

2.20.6 Operations & Organisation

The ICT 2017 Conference (24th International Conference on Telecommunications)[93] was held in Cyprus in May 2017, hosted by the University of Cyprus. While not dedicated to IPv6, it is worth noting that one of the three keynote speakers, Latif Ladid from the University of Luxembourg, presented "Future Internet (IPv6-Based IoT, CC, SDN-NFV and 5G)", and that one of the other keynote speakers was from the OCECPR, although his topic was a more general presentation of the electronic communications market in Cyprus.

There appears to be no real dedicated operations and/or organisation for the implementation of IPv6 in the public sector.

2.20.7 Barriers and Future developments

The first step would be to have a governmental and/or regulatory stance in place to drive the adoption of IPv6 in the public sector. It appears there is no real urgency to adopt IPv6 at this stage.

[93] http://ict-2017.org/

2.21 Hungary

2.21.1 Key stakeholders

The NISZ (National Infocommunications Service Company), is responsible for the operation and development of the public sector's ICT and e-governmental services, including the digital telecommunications networks of public institutions and the National Telecommunications Backbone Network. Therefore, they are the most relevant institution regarding the IPv6 adoption of the Hungarian public sector.

The KIFÜ is providing Services (IP-based services, networking or applications) for Education, Research and Collections (Libraries, Museums, Public Collections). It is a publicly financed institution which operates independently nationwide.

2.21.2 Government plans and strategies

There is no specific, official timeline/action plan on IPv6 adoption yet. According to the NISZ there are no official requirement to purchase IPv6-compatible infrastructure, software and services.

2.21.3 Technical aspects/issues

According to the NISZ, equipment usually support the IPv6 technology, but they use IPv4 anyway for all internal communication.

2.21.4 Current deployments

According to the NISZ, there are no public-facing services provided over IPv6. In addition, there are no internal services provided over IPv6 either.

According to the KIFÜ, the adoption of IPv6 in the R&E sector is “moderate”

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[94].

2.21.5 Deployments and pilots

No information available on deployments or pilots.

2.21.6 Operations & Organisation

No information on measures to foster IPv6 deployment.

[94] https://www.vyncke.org/ipv6status/detailed.php?country=hu&type=Gov

2.21.7 Barriers and Future developments

There are devices in the network that do not support IPv6. The elements of the core network are typically suitable for introducing the technology, but the suitability of system monitoring and support tools is required, according to the NISZ.

There are no organizational barriers according to the NISZ.

2.22 Portugal

2.22.1 Key stakeholders

IPv6 Task force

The Portugal IPv6 Task Force is a working group in charge of following the recommendations of the European Commission on the migration to IPv6, identify the barriers to the migration to IPv6 and to suggest actions to define a roadmap.

According to the FCT95 (previously called FCCN), the IPv6 task force did some videos and workshops to promote IPv6. The task force also received some money from the government in order to help the education sector migrate successfully

However, the last update on the IPv6 Task Force website was made on May 2004. The last work done by the group was the production of a report96 in 2004. The report covered the analysis of different IPv6 Mobility Scenarios.

Government

The CEGER is the entity responsible for the management of the government network (RInG) and is the co-responsible, with FCCN, for the attribution of the .gov.pt addresses. As a result, CEGER is one of the stakeholders for the IPv6 migration in the public sector.

However, according to the CEGER, it still hasn't implemented IPv6, as of March 2018. CEGER is planning to implement it in 2019.

[95] Fundação para a Ciência e a Tecnologia

[96] http://www.ipv6-tf.com.pt/grupostrabalho/grupo/publico/grupo_5/mip6_M1_1504.pdf

Figure 41: CEGER role

Source: Evolução para IPv6 na Rede Informática do Governo – RinG

FCT/FCCN provides Internet connectivity to all major universities, polytechnics, primary and secondary schools and research centers in Portugal. It also manages the Portuguese Internet Exchange Point. It is in charge of the "Portuguese Research and Education Network" and is an active promoter of IPv6, in particular in higher education and R&D institutions networks.

According to the FCT/FCCN, it was one of the first network to support IPv6 in Europe.

Figure 42:"The public sector, the missing lever for IPv6 deployment"

Source: GEN6

eSPap manages networks for the public sector and is pushing for IPv6. The FCT/FCCN has been collaborating with ESPap for the last 2 years, on what steps should be followed.

2.22.2 Government plans and strategies

eSPap has a timeline for IPv6 deployment (no more information yet).

2.22.3 Technical aspects/issues

All equipment being bought by the FCT/FCCN must support IPv6. The FCT/FCCN network was part of the 6bone project. These were IPv6 islands connected by IPv6 over IPv4 tunnels. Its current network is dual stack (IPv4 and IPv6)

2.22.4 Current deployments

The FCT/FCCN has already deployed IPv6 in all its network for more than a decade. Almost all services are already being provided using IPv6 (email, web page, internet, DNS, etc.). There are only a few ones that are not still totally IPv6 like some internal web sites/pages. It started deploying IPv6 in a "testbed" in early 1998.

The FCT/FCCN is connected to Géant (European Research Network that connects all NRENs from all European countries. Géant provides full IPv6 connectivity and routing table. According to the FCT/FCCN, it also manages the "Portuguese IX" and use IPv6 widely on this platform.

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[97].

According to CZ.NIC statistical portal, Web server (WWW), name servers (NS) and mail exchange (MX) readiness to IPv6 remain low with 4 web servers, 47 name servers and 20 mail exchanges totally supports IPv6.

The 3 web servers are:

- City Council of Lagoa (Algarve)
- City Council of Montalegre
- City Council of Oliveira De Azeméis
- City Council of Oliveira De Frades

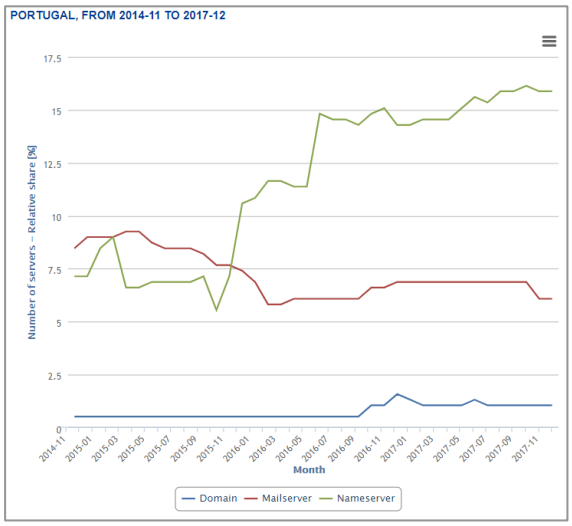
Figure 43: Implementation of IPv6 government servers

Data for 01-01-2018				
Name	Domain	WWW	NS	MX
Total: 378		374	318	355
		0	13	3
		4	47	20

Source: https://devpub.labs.nic.cz/ipv6-smt-new/country/pt/

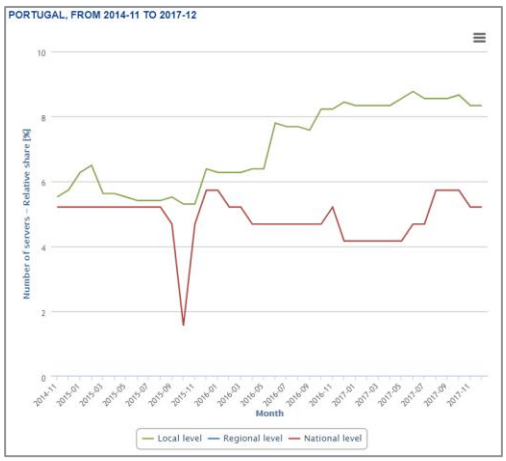
[97] https://www.vyncke.org/ipv6status/detailed.php?country=pt&type=Gov

Figure 44: Implementation of IPv6 by governments – countries



Source: CZ.NIC

Figure 45: Implementation of IPv6 by governments - administrative units



Source: CZ.NIC

2.22.5 Deployments and pilots

There was a feasibility study done in support of the implementation for the FCT/FCCN network.

According to the FCT/FCCN, when the RFI documentation was done for buying new equipment, having IPv6 and support for several IPv6 protocols and features was a mandatory question. Despite all that, the transmission equipment does not support IPv6 management, but it uses a special O&M system that is not IPv6 or IPv6 – so no need for supporting the protocol.

2.22.6 Operations & Organisation

IPv6 is not anymore a part of FFCN's current or future training requirements

2.22.7 Barriers and Future developments

According to the CESifo Group[98], "Portugal considers that the main problem with the low degree of IPv6 deployment is its low priority status in each network/environment, despite its efforts close to national entities in particular electronic communications providers."[99]

[98] Consisting of the Center for Economic Studies (CES), the ifo Institute and the CESifo GmbH (Munich Society for the Promotion of Economic Research)

[99] [99]

2.23 Croatia

2.23.1 Key stakeholders

Croatia only joined the EU in 2013, which can explain its delay in launching dedicating structures for IPv6, and for its deployment in general.

The HAKOM is the national regulatory agency, responsible for the principles and policy objectives for the development of electronic communications in Croatia; It is responsible for assessing the situation regarding IPv6 and to promote and raise awareness. It initiated the establishment of the "IPv6 Croatia Forum", which is open for all interested parties (operators, equipment manufacturers, application developers, academic community, government, public authorities, etc.).

The association "Ipv6 Task Force Croatia" appears to have been established in 2010, but no publication or website currently exists.

According to CARNet (Croatian Academic and Research Network), every organization must make its own strategy for implementing IPv6.

2.23.2 Government plans and strategies

According to a report100, the "Broadband Development Strategy in Republic of Croatia 2011–2015" the importance of the readiness for IPv6 adoption has been noted.

No other information on government plans or strategies

2.23.3 Technical aspects/issues

All of CARNet internal services are on dual-stack.

IPv6 is a requirement in purchasing decisions related to networking services, hardware and application software for CARNet

2.23.4 Current deployments

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[101].

In June 2010 the NREN CARNet implemented IPv6 in its core network and started to offer IPv6 Internet access as a service to its members.

2.23.5 Deployments and pilots

A study[102] on IPv6 deployment and transition plans covers 14 Croatian PAB (public administration bodies), among which different government ministries and state administrative organizations. In this study, 13 out of the 14 PAB surveyed rated their own knowledge on the IPv6 transition to "good", "very

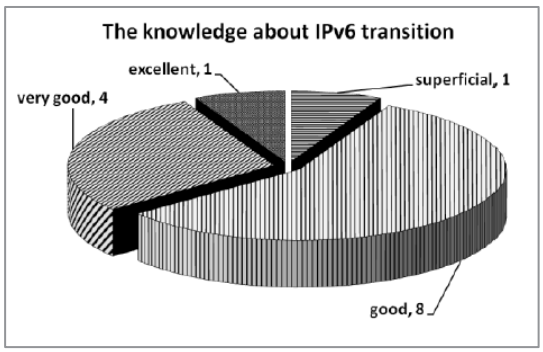
[100] Towards Assessment of IPv6 Readiness, Deployment and Transition Plans in Croatia, 2011

[101] https://www.vyncke.org/ipv6status/detailed.php?country=hr&type=Gov

[102] IPv6 Deployment and Transition Plans in Croatia: Evaluation Results and Analysis, 2012

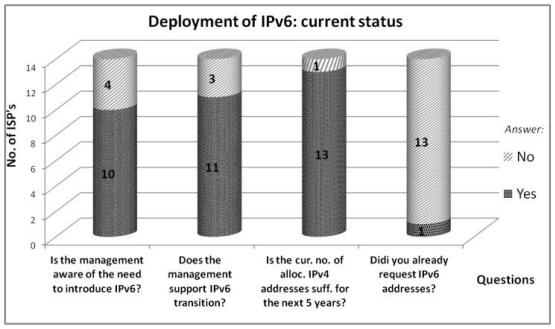
good" or "excellent" while only one rated its knowledge as "superficial". However, most of the PABs had not started the transition at the moment of the study.

Figure 46: Knowledge about IPv6 transition in 14 Public Administration Bodies



Source: IPv6 Deployment and Transition Plans in Croatia: Evaluation Results and Analysis, 2012

Figure 47: Deployment of IPv6: current status in 14 Public Administration Bodies



Source: IPv6 Deployment and Transition Plans in Croatia: Evaluation Results and Analysis, 2012

2.23.6 Operations & Organisation

No information on measures to foster IPv6 deployment.

2.23.7 Barriers and Future developments

According to the results of a study103 on IPv6, 6 out of 14 surveyed PABs stated that they lacked "enough knowledge (and experience)". In addition, the second most influential drawback was the low "availability of (knowledgeable) staff".

According to CARNet, hardware is not a barrier for its organization, but it can be for some of its customers (ancient hardware in LAN – over 10 years old). There are no organizational barriers, according to CARNet.

No information on future developments

[103] IPv6 Deployment and Transition Plans in Croatia: Evaluation Results and Analysis, 2012

2.24 Romania

2.24.1 Key stakeholders

In July 2014, the Romanian IPv6 Forum was launched under the leadership of IPv6 experts from RCS-RDS, a Romanian ISP. The last update on the Romanian IPv6 Forum is dated September 2014.

The “agency ARNIEC” is in charge of the RoEduNet (Romanian National Research and Education Network). It mainly deals with interconnection of institutions that fall under the Ministry of Education umbrella, to other similar networks, through GEANT and to the Internet. RoEduNet is also a RIPE LIR that can assign IPv4 and IPv6 addresses to members.

The agency ARNIEC is not aware of any organization in charge of IPv6 deployment in the public sector.

2.24.2 Government plans and strategies

No other information on government plans or strategies. No mention of IPv6 in the document “National Strategy on Digital Agenda for Romania”, dated 2014.

2.24.3 Technical aspects/issues

Services provided by some institutions connected to RoEduNet are using a dual-stack approach, with websites, mail services, file transfer available on IPv4 and IPv6.

For the agency ARNIEC, it is crucial that network-related hardware have IPv6 capabilities. Regarding software, the agency use open-source operating systems, with IPv6 support well implemented.

2.24.4 Current deployments

Regarding public sector, the Agency ARNIEC estimate that adoption level is low for public-facing services. According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[104].

2.24.5 Deployments and pilots

Email, web, file transfer and other services in some of the institutions connected to RoEduNet use IPv6.

[104] https://www.vyncke.org/ipv6status/detailed.php?country=ro&type=Gov

2.24.6 Operations & Organisation

No information on measures to foster IPv6 deployment.

2.24.7 Barriers and Future developments

According to the agency ARNIEC, there are several possible barriers to IPv6 deployment:

- Lack of interest
- Insufficient knowledge and unwillingness to learn/modify processes which are currently working
- Lack of understanding and support from upper management to replace old equipment

At this moment, RoEduNet has no solution for IPv6 only islands connectivity to IPv4-only networks, but is considering solving this issue.

2.25 Estonia

2.25.1 Key stakeholders

RIA

The Information System Authority[105] (RIA) coordinates the development and administration of the national information system (which helps the state provide services to citizens). It can also provide data communication and internet services to state agencies and local governments.

IPv6 Council

The Estonian IPv6 Council was established in 2014 and is a chapter of the IPv6 forum. Its stated goal is to "engage key stakeholders from government, industry and academia to design the IPv6 roadmap and vision together for Estonia to embrace the New Internet world based on IPv6"

The chairman of the IPv6 council is a lecturer at the Estonian IT College, which is an IT institution of applied higher education, in Estonia.

2.25.2 Government plans and strategies

In November 2013, the Estonian Government approved the Digital Agenda 2020 for Estonia, with the stated goal to establish a "well-working state information and communication technology environment". Inside this document, IPv6 is mentioned once, in the "Action lines" chapter: "Transition to IPv6 will be promoted. Move to IPv6 will be launched in the public sector and private sector service providers will be encouraged to follow suit."106

2.25.3 Technical aspects/issues

State agencies and local governments using the RIA's internet services can use both IPv4 and IPv6 address space.

2.25.4 Current deployments

According to Vyncke blog, there is no identified host using IPv6 in the government sector107.

[105] Riigi Infosusteemi Amet

[106] Digital Agenda 2020 For Estonia, 2013

[107] https://www.vyncke.org/ipv6status/detailed.php?country=ee&type=Gov

According to CZ.NIC statistical portal, Web server (WWW), name servers (NS) and mail exchange (MX) readiness to IPv6 remain low with 3 web servers, 9 name servers and no mail exchanges totally supports IPv6.

The 3 web servers are:

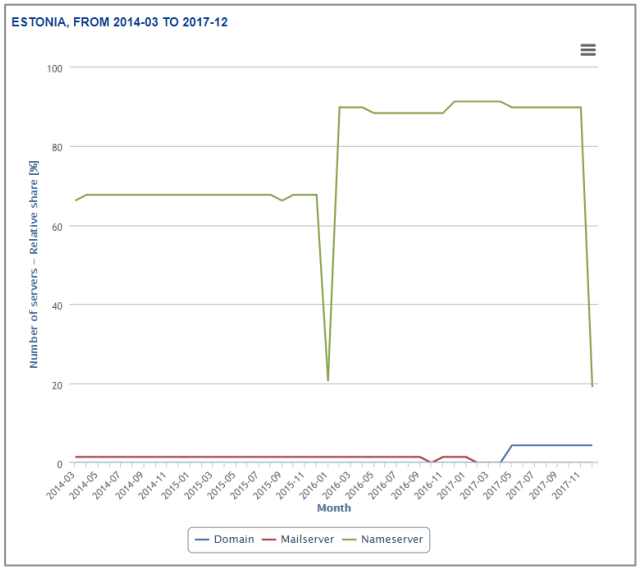
- Ministry of Economic Affairs and Communications
- Estonia Civil Aviation Administration
- Consumer Protection Board

Figure 48: Implementation of IPv6 government servers

Data for 01-01-2018				
Name	Domain	WWW	NS	MX
Total: 68		65	55	68
		0	4	0
		3	9	0

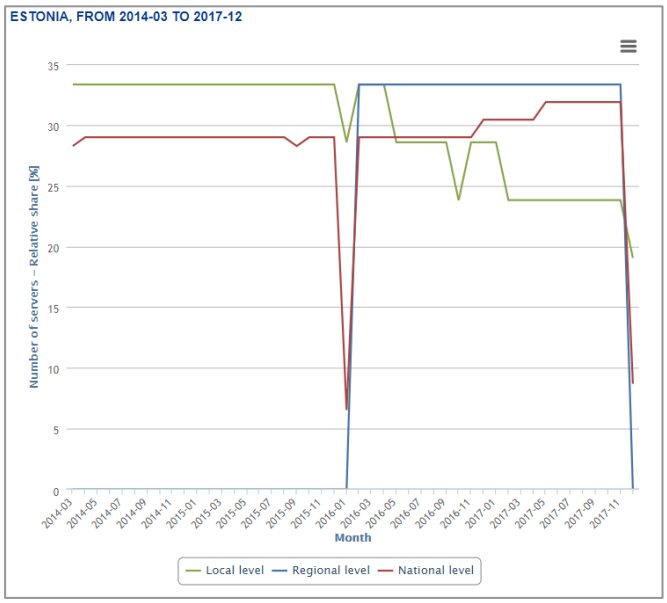
Source: https://devpub.labs.nic.cz/ipv6-smt-new/country/ee/

Figure 49: Implementation of IPv6 by governments – countries



Source: CZ.NIC

Figure 50: Implementation of IPv6 by governments - administrative units



Source: CZ.NIC

2.25.5 Deployments and pilots

According to the CESifo Group108, there were no active policies for IPv6 deployment but some trials as of 2010.

2.25.6 Operations & Organisation

In early 2014, the Information System Authority (Riigi Infosusteemi Amet) held a training session targeting system administrators of state and local government networks and critical information infrastructure companies. It lasted two days, and was held at the University of Tartu.

2.25.7 Barriers and Future developments

No information on barriers and future developments.

[108] Consisting of the Center for Economic Studies (CES), the ifo Institute and the CESifo GmbH (Munich Society for the Promotion of Economic Research)

2.26 Latvia

2.26.1 Key stakeholders

There is no IPv6 task force or council in Latvia as of early 2017.

Ministry of Transport

The Ministry of Transport performs general State administration in the electronic communications sector within the scope of policy maker. According to the ministry, there is no organization in charge of IPv6 in the public sector.

2.26.2 Government plans and strategies

According to the ECC[109], Latvia's regulator was not leading any working groups or drafting any IPv6 strategies as of early 2010.

According to the ministry of transport "there is intention to have a discussion with stakeholders and involved parties to raise awareness of the necessity to use IPv6 instead of IPv4".

2.26.3 Technical aspects/issues

Client devices already support IPv6, according to the ministry of transport.

2.26.4 Current deployments

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[110].

There are no internal services provided using IPv6 in the public sector, according to the ministry of transport.

2.26.5 Deployments and pilots

No information available on active policies or IPv6 deployment in the "National Policy Initiatives for the Deployment of IPv6" report published by the CESifo Group[111].

According to the ECC[112], the Institute of Mathematics and Computer Science, at the University of Latvia (IMCS UL), was the first[113] to deploy IPv6 on its network. It was done in 2008, in cooperation with GEANT.

[109] Electronic Communications Committee

[110] https://www.vyncke.org/ipv6status/detailed.php?country=lv&type=Gov

[111] Consisting of the Center for Economic Studies (CES), the ifo Institute and the CESifo GmbH (Munich Society for the Promotion of Economic Research), 2010

[112] Electronic Communications Committee

[113] Preparing For Ipv6, 2010

2.26.6 Operations & Organisation

IPv6 is already a requirement in purchasing decisions related to networking services, hardware and software, according to the Ministry of Transport.

2.26.7 Barriers and Future developments

There are no hardware nor organizational barriers. The biggest concern for the Ministry of Transport is IPv6 security: “IPv6 based services must be tested well enough before go live and are offered to the customers”.

In addition, “any new system implementation takes time and effort”.

None of biggest ISP in Latvia has rolled out big IPv6 projects as ISP still have lot of IPv4 addresses available. That is the main reason for slow IPv6 adoption in Latvia, according to the Ministry of Transport.

2.27 Slovakia

2.27.1 Key stakeholders

The topic of IPv6 awareness and migration is mainly promoted by the Ministry of Finance. There is no IPv6 task force or council in Slovakia as of early 2018.

2.27.2 Government plans and strategies

The Ministry of Finance of the Slovak Republic released a 19-pages report[114], intended primarily for architects and network administrators, to move from the IPv4 to the IPv6.

2.27.3 Technical aspects/issues

UPC, a major operator in Slovakia, turned on IPv6 support in early 2017. No other information on technical aspects/issues

2.27.4 Current deployments

According to **Vyncke blog, there is no identified host** using IPv6 in the government sector[115].

According to CZ.NIC statistical portal, Web server (WWW), name servers (NS) and mail exchange (MX) readiness to IPv6 is high with 26 web servers, 27 name servers and 24 mail exchanges totally supports IPv6.

Figure 51: Implementation of IPv6 government servers

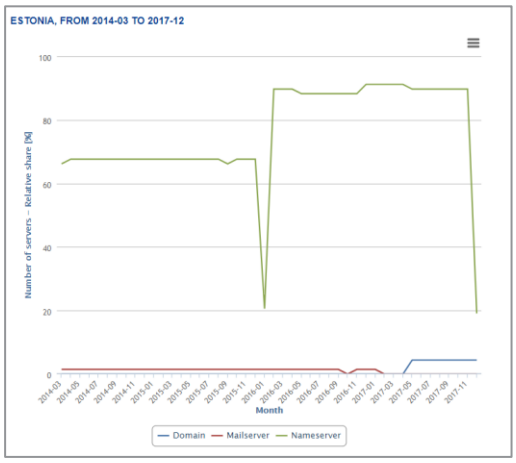
Data for 01-01-2018				
Name	Domain	WWW	NS	MX
Total: 118		91	78	93
		1	13	1
		26	27	24

Source: https://devpub.labs.nic.cz/ipv6-smt-new/country/sk/

[114] Manuál pre prípravu adresného plánu IPv6

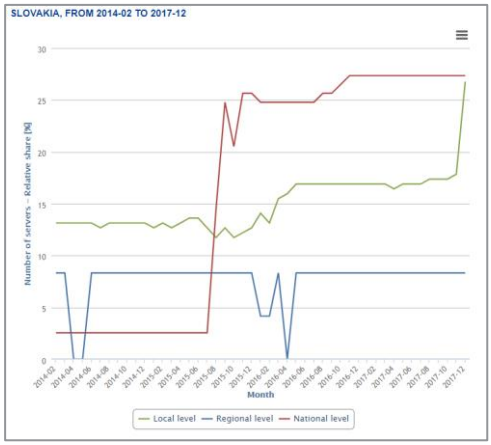
[115] https://www.vyncke.org/ipv6status/detailed.php?country=sk&type=Gov

Figure 52: Implementation of IPv6 by governments – countries



Source: CZ.NIC

Figure 53: Implementation of IPv6 by governments - administrative units



Source: CZ.NIC

2.27.5 Deployments and pilots

According to the CESifo Group[116], support of IPv6 is mandatory in public services since 2008.

In 2011, the Technical University of Kosice (Tuke) and Cisco announced the opening of a laboratory for training and research in IPv6. Cisco donated compatible networking and communications equipment.

2.27.6 Operations & Organisation

No information on measures to foster IPv6 deployment.

[116] Consisting of the Center for Economic Studies (CES), the ifo Institute and the CESifo GmbH (Munich Society for the Promotion of Economic Research), 2010

2.27.7 Barriers and Future developments

The ministry of finance of the Slovak republic conducted a survey[117] in 2011, showing that awareness of the importance of IPv6 is high, while readiness and activity in this area is “very low”.

[117] Prieskum stavu používania protokolu IPv6

2.28 Netherlands

2.28.1 Key stakeholders

Ministry of the Interior and Kingdom Relations

The Dutch Ministry of the Interior and Kingdom Relations (BZK) has launched initiatives related to IPv6, based on recommendations by TNO (Netherlands Organisation for applied scientific research).

Logius is the digital government service of the BZK. It maintains government-wide ICT solutions and common standards, with the goal to simplify the communication between authorities, citizens and businesses. Logius supplies products relating to access, data exchange, standardization and information security.

Dutch Standardisation Forum

The Dutch Standardisation Forum's role is to advise the government on open standards and interoperability. It monitors the adoption of the compulsory open standards, including IPv6. It publishes frequent "monitors" regarding the situation for the country.

VNG Realisatie (part of the Association of Netherlands Municipalities)

VNG Realisatie supports municipalities with their information provision and services, and is pushing for IPv6 adoption.

IPv6 task force

An "Ipv6 Task Force" for the Netherlands was established in 2005 by order of the Ministry of Economic Affairs. Its goal is to raise awareness about the usefulness and especially the necessity of IPv6, to exchange knowledge about the application of IPv6 and to achieve coordination regarding the introduction of IPv6.

It notably organized a seminar dedicated to IPv6 in public administration in 2013.

The Netherlands IPv6 task for was subsumed, in 2018, under the Platform Internetstandaarden[118].

Stipv6

[118] http://ecp.nl/activiteiten/platform-internetstandaarden/

Stipv6 is another organization aiming at promoting IPv6 development and awareness. It is still active as of March 2018.

2.28.2 Government plans and strategies

The BZK has launched an effort to create a Dutch government-wide IPv6 numbering plan. The purpose of this IPv6 numbering plan is to provide all Dutch governmental organizations (with the exception of the Ministry of Defense) with IPv6 address space.

Governmental organizations such as ministries, agencies, provinces and municipalities typically both provide public functions that require globally reachable address space as well as sensitive functions for which communication must be limited within the scope of the government, which are best served by address space that is not routed to the public internet.

There is no set deadline for IPv6 adoption for governmental organizations, except for municipalities.

Beginning in June 2016, VNG Realisatie started a campaign[119], in partnership with Logius, to push municipalities to adopt IPv6, with documents and publications to raise awareness, development and elaboration of a step-by-step plan and its execution. Completion of the project is aimed for end-2019.

2.28.3 Technical aspects/issues

The Ministry of Defense has the prefix 2a04:8f80::/29. They will continue to use this prefix and not participate in the government-wide IPv6 numbering plan.

Currently, Logius, a division of the Ministry of the Interior and Kingdom Relations, is LIR and holds the prefix 2a04:9a00::/29 for the purpose of distributing IPv6 addresses to organizations within the Dutch national government (rijksoverheid).

Logius is seeking to extend this prefix with another /29 to add room to provide IPv6 address space to regional and local governmental organizations in the Netherlands. Preferably, the new /29 would be 2a04:9a08::/29, so the address space used for Dutch governmental organizations comes from the single prefix 2a04:8f80::/28.

[119] Planning belangrijkste activiteiten invoering IPv6-adressen VNG(King)

2.28.4 Current deployments

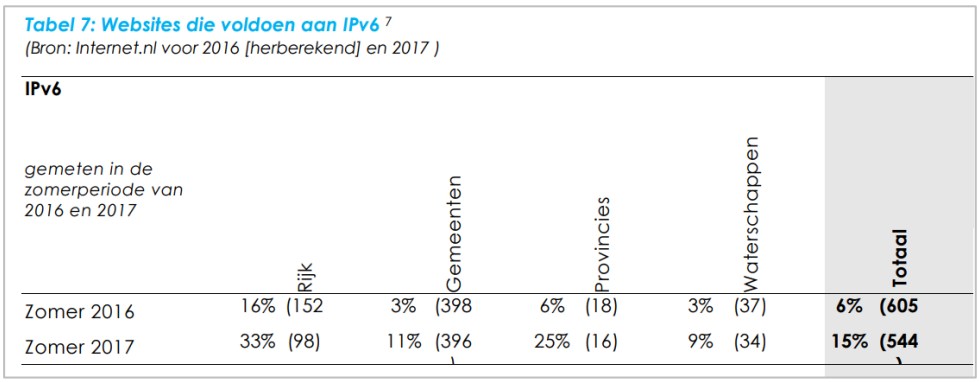
The Netherlands is one of the leading European nations in terms of IPv6 development by governments, according to the figure below.

Source: https://stats.nic.cz/stats/gen6/

According to a report[120] by the Dutch Standardisation Forum, based on a sample of 544 public administration websites, 15% of websites were IPv6-compatible in 2017, compared to 6% the year before. The report concludes that adoption is still low, but the growth trend is positive.

[120] Rapport ICTU met detail-informatie per open standaard

Figure 54: Public-administration websites that comply with IPv6



Tabel 7: Websites die voldoen aan IPv6 [7]
(Bron: Internet.nl voor 2016 [herberekend] en 2017)

IPv6 gemeten in de zomerperiode van 2016 en 2017	Rijk	Gemeenten	Provincies	Waterschappen	Totaal
Zomer 2016	16% (152	3% (398	6% (18)	3% (37)	**6% (605**
Zomer 2017	33% (98)	11% (396	25% (16)	9% (34)	**15% (544**

Source: Rapport ICTU met detail-informatie per open standaard

According to Logius, most of its 29 services are IPv6 compatible.

2.28.5 Deployments and pilots

According to a study carried by out Pb7 Research and CloudWorks on behalf of Stipv6[121], public administrations are “more concerned” with IPv6 than the business community. It is higher in the agenda and more steps are being taken.

In this study, 36% of public administrations surveyed think they will be ready on time, while only 31% of companies think so.

2.28.6 Operations & Organisation

The “Dutch Internet Standards Platform” launched Internet.nl, a website which check whether a website, email and Internet connection use modern and reliable Internet Standards (including IPv6), in collaboration with partners from the internet community and the Dutch government[122] .

According to a report from TNO[123], IPv6 was signed up for inclusion in the 'Comply or Explain' list of Open Standards for Government[124]. This means that public administrations must ask for IPv6 when purchasing IT equipment and explicitly need to explain when choosing a product or service, if IPv6 is not supported.

SIDN, the registry in charge of the “.nl” extension, is monitoring registrars’ portfolios of website for several “quality determinants” in order to calculate a “Registrar Scorecard” (which gives access to rewards). Since mid-2017, it also uses the number of IPv6-enabled domain names into this ranking. According to SIDN, this policy is working, as “the number of domain names that can be reached using IPv6 has more than doubled since the rewards came in”.

[121] November 2016

[122] DHPA, ECP, Forum Standaardisatie, Internet Society international, Internet Society Nederland, ISPConnect, Ministerie van Economische Zaken, NCSC, NLnet, NLnet Labs, RIPE NCC, SIDN, SURFnet

[123] IPv6 Monitoring in Nederland: De tweede meting, November 2010

[124] May 2010

2.28.7 Barriers and Future developments

Obstacles are the same for government and private organizations. For users, the advantages of IPv6 are not clear. As a result, it is not seen as a priority and there are hardly any deadlines.

Making a clear plan with a deadline, monitoring and transparency is what could help the situation.

In addition, not many ISP support IPv6 currently. It would help if access providers would be “frontrunners”, which is not happening in the Netherlands.

3 Appendix - General development / Background development of IPv6 (not public sector)

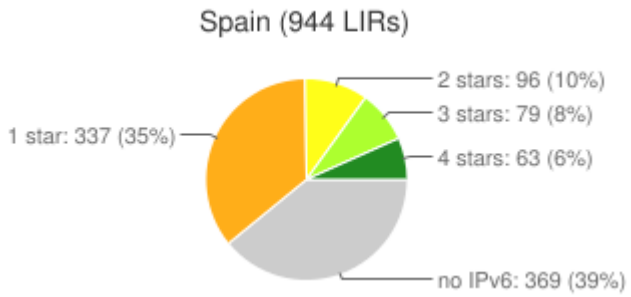
3.1 Spain

Overall, Spain is lagging behind for IPv6 adoption as a whole.

3.1.1 RIPElabs RIPEness assessment

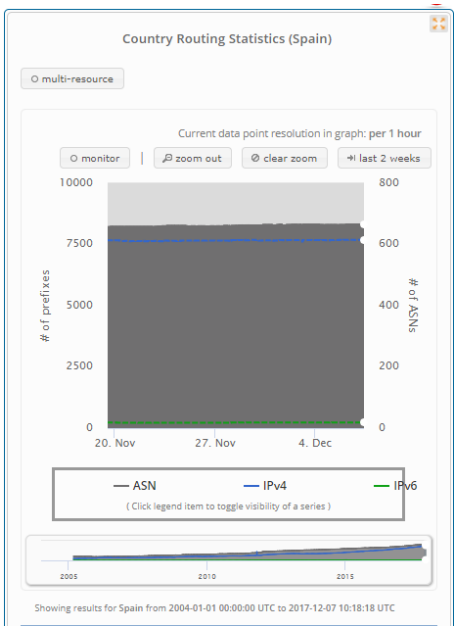
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Spain is low compared to other countries. Out of the 944 LIRs, only one quarter of them have been awarded of 2, 3 or 4 stars.

Figure 55: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 56: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Spain

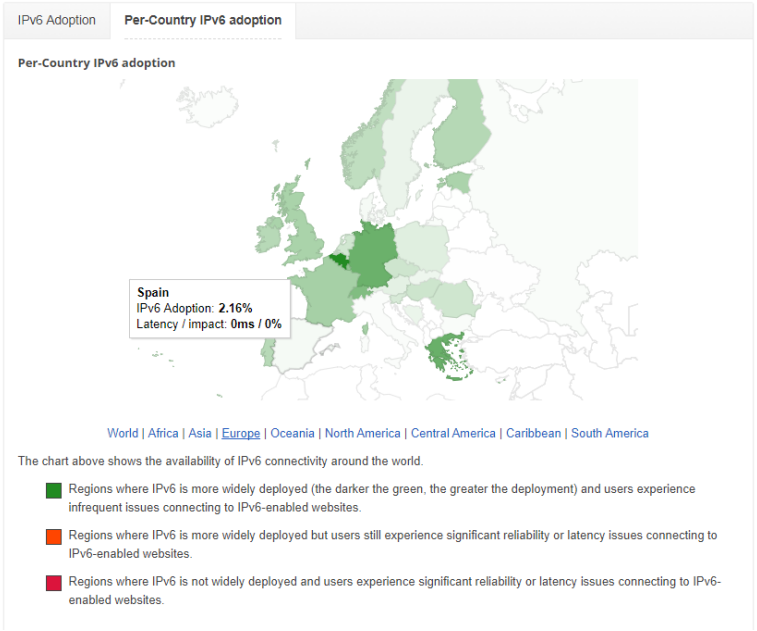


Source: https://stat.ripe.net/specials/country-comparison

3.1.2 Google IPv6 statistics

According to Google[125], the adoption rate barely exceeds 2% in Spain, which is low, when compared to global adoption (around 20%) and to European countries in advance in the topic like Belgium, Germany or Greece.

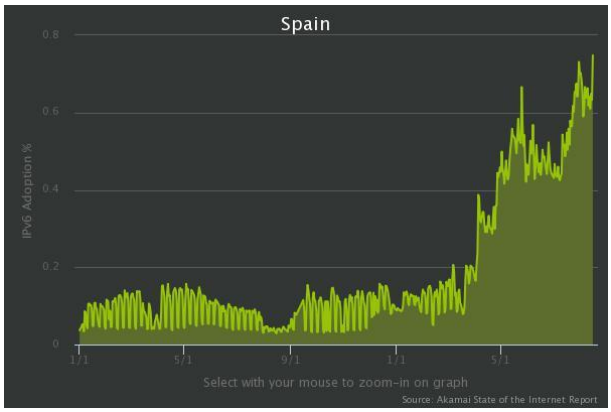
Figure 57: IPv6 adoption



Source: Google IPV6 statistics

3.1.3 Akamai IPv6 Adoption Visualization

For Akamai, Spain ranks at the 47th place with 0.7% adoption rate of IPv6[126]. However, it seems that there is a growing trend since 2017 spring.



Source: Akamai, state of the Internet IPv6 adoption visualization

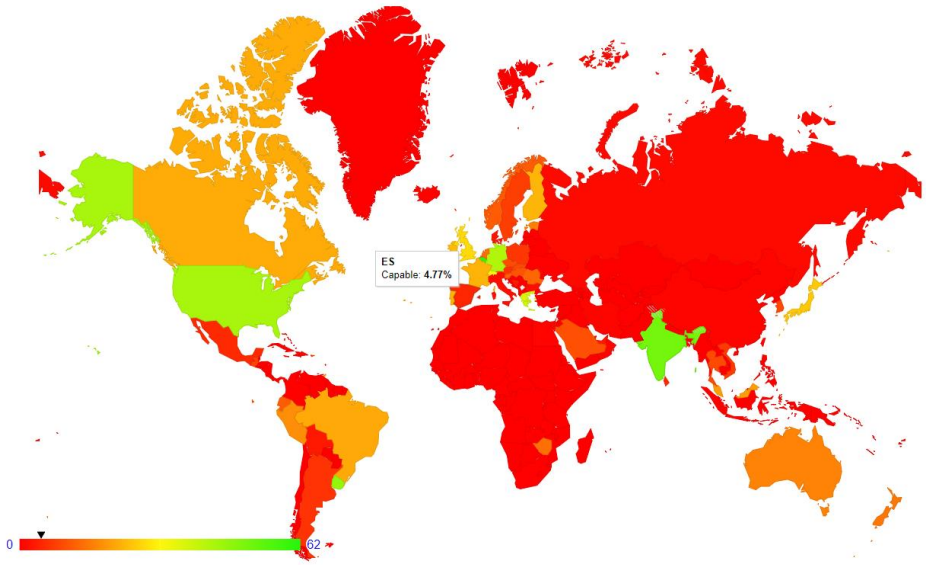
[125] Volume of users that access Google over IPv6

[126] Volume of IPv6 requests to Akamai

3.1.4 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Spain displays in red revealing a low adoption.

Figure 58: IPV6 capable rate by country (%)



Source: APNIC, https://stats.labs.apnic.net/ipv6

3.2 France

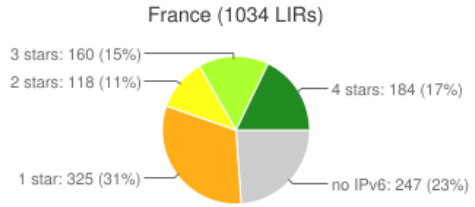
France is average overall in terms of IPv6 adoption as a whole, not trailing behind but not a leader.

3.2.1 RIPElabs RIPEness assessment

According to RIPE NCC, France counts 1034 LIRs[127]. The readiness to move to IPv6 for those RIPE NCC members in France is relatively in line with all LIRs RIPEness globally as shown in the figure below:

- 17% of French LIRs have been awarded with 4 stars for different IPv6 support (IPv6 allocation, visibility in the Routing Information Service (RIS), route object in the RIPE Database, reverse DNS);
- 23% of LIRs indicate no sign of IPv6 deployment (no star).

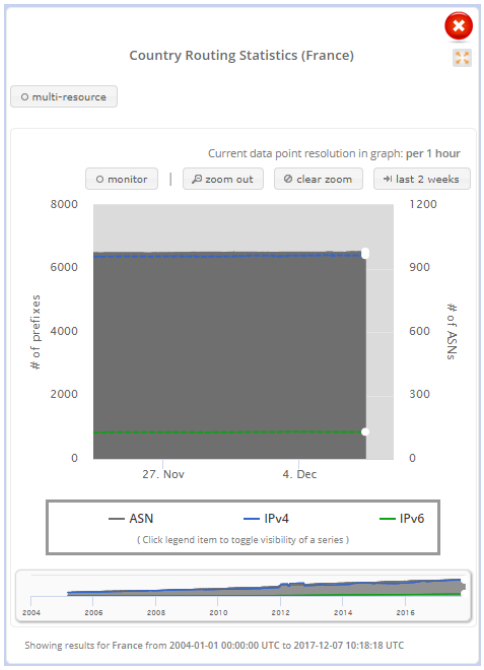
Figure 59: IPv6 RIPEness in France



Source: http://ripeness.ripe.net/pies.html

[127] https://www.ripe.net/membership/indices/FR.html

Figure 60: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in France

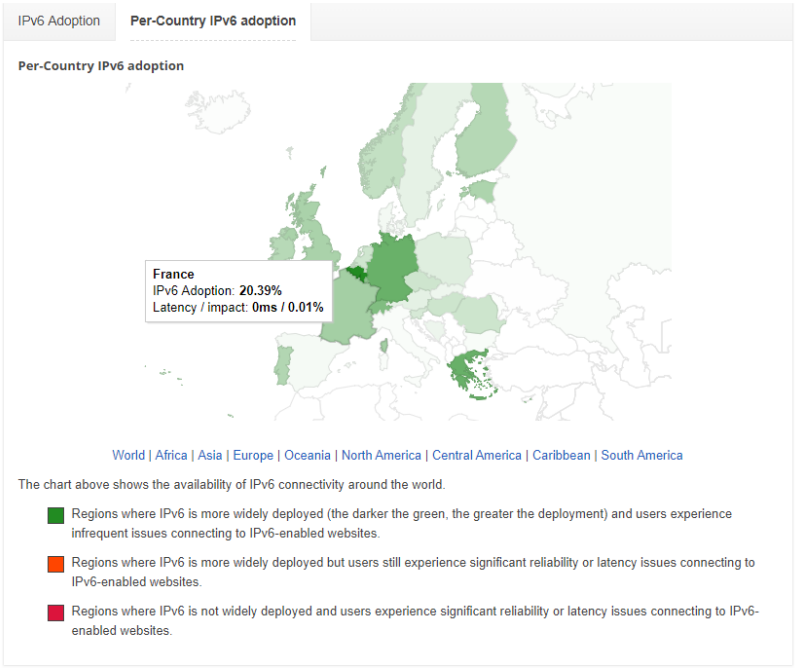


Source: https://stat.ripe.net/specials/country-comparison

3.2.2 Google IPv6 statistics

According to Google statistics, France is in line with global IPv6 adoption, estimated around 20%. However, the figures are low when comparing with advanced European countries in the topic like Belgium, Germany or Greece.

Figure 61: IPv6 adoption by Google

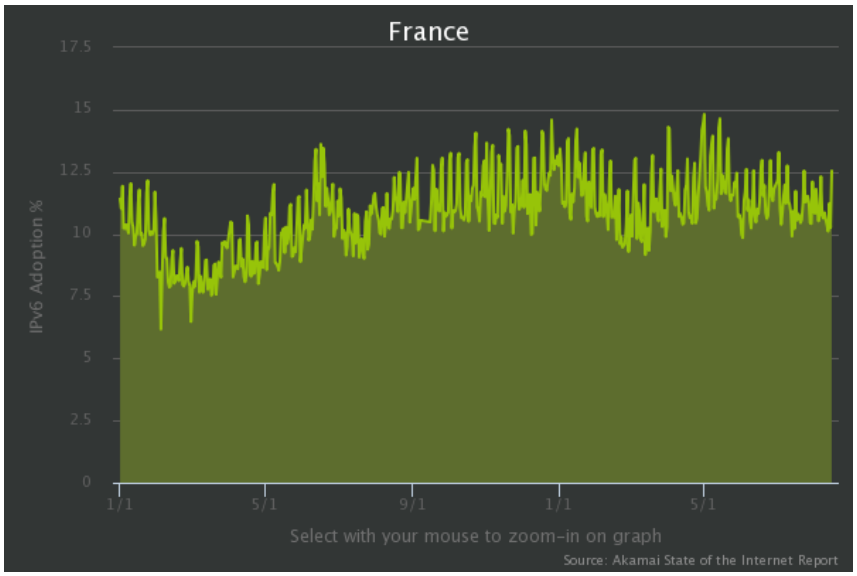


Source: Google IPv6 stats

3.2.3 Akamai IPv6 Adoption Visualization

For Akamai, France ranks at the 18th place with 12.5% adoption rate of IPv6 . It seems that the trends is constant since the beginning of 2017.

Figure 62: IPv6 adoption by Akamai



Source: Akamai, state of the Internet IPv6 adoption visualization

3.2.4 Other - AFNIC

According to the AFNIC organization[128] (which has been interviewed), the way to assess IPv6 adoption is not that obvious. A unique indicator is not representative enough to measure how the protocol is really used and it could also introduce biases. Typically, when detecting IPv6 through traffic, if a video website support IPv6, it will naturally increase IPv6 adoption. On the other side, strictly counting the number of websites supporting IPv6 does not indicating if they are concretely used.

So far there is a clear consensus about the fact that IPv4 addressing is not going to be switched off in short term and in another hand that IPv6 is adopted (though progressively).

That being said, the AFNIC suggests to follow different indicators from IPV6 adoption of players along the technical value chain from the users to the content websites, including transit providers and ISPs.

Figure 63: IPv6 adoption along the technical value chain

Players in the value chain	2014[129]	2016/2017
Equipment vendors	100%	100%
Websites	47% pf which 11% in ".fr"	50%
Intermediaries (transit providers)	73%	70%
ISP	10-12%	15% for fixed operators 0% for mobile operators
DNS providers	63%[130]	60%

Sources: AFNIC, Cisco, Google, Vyncke

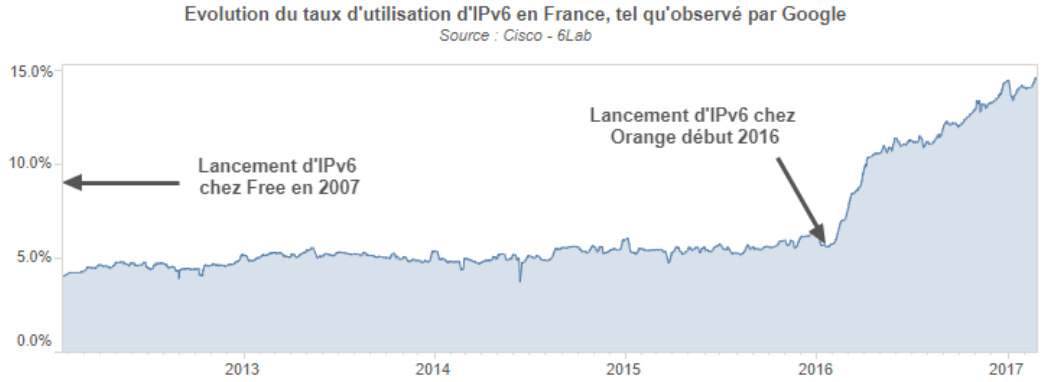
In addition, the AFNIC highlights the impact of Internet players' concentration that can affect the IPv6 utilisation. As regards to telcos, the introduction of IPv6 by Free in 2007 (operating only on IPv6) and then by Orange in 2016 clearly boost the figures of IPv6 adoption as shown in the figure below.

[128] AFNIC stands for "Association Française pour le Nommage Internet en Coopération" which is the French Network Information Centre. The organisation is in charge of providing the « .fr » domain names.

[129] Source: https://www.nextinpact.com/news/101585-larcep-veut-accelerer-deploiement-dipv6-en-france-avec-aide-etat.htm

[130] https://www.afnic.fr/fr/l-afnic-en-bref/actualites/actualites-generales/9337/show/l-observatoire-de-la-resilience-de-linternet-francais-publie-son-rapport-2014.html.

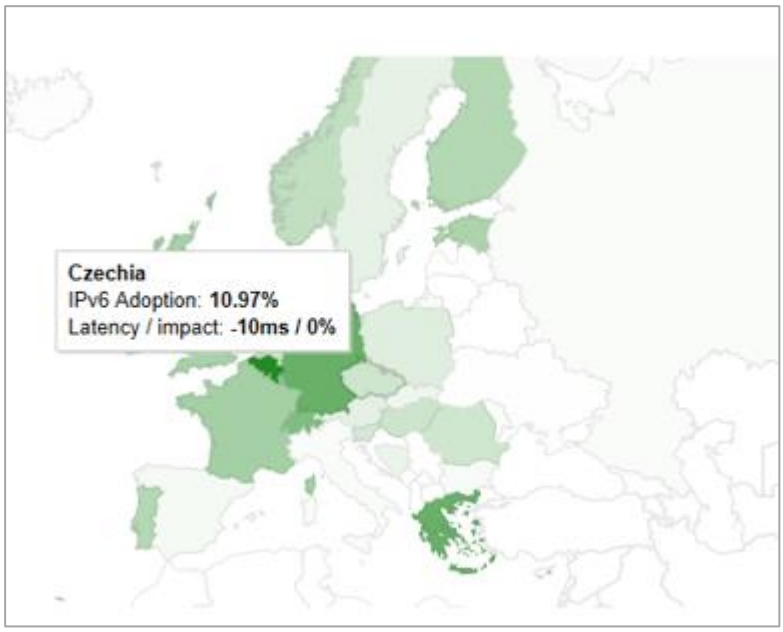
Figure 64: Impact of few players on IPv6 utilisation



Source: ARCEP

3.3 Czech Republic

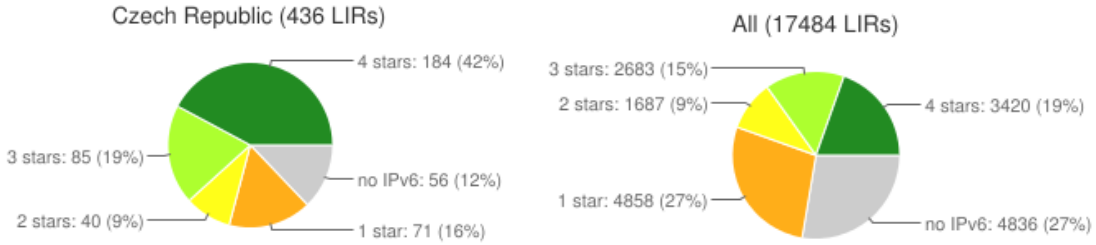
According to Google, the IPv6 adoption rate in the Czech Republic is roughly 11% (as of December 2017). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[131], the Czech Republic has an 8.1% IPv6 adoption rate, which ranks 28th in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[132]. Compared to the overall pie chart, one can see that the Czech Republic is quite ahead.



Source: http://ripeness.ripe.net/pies.html

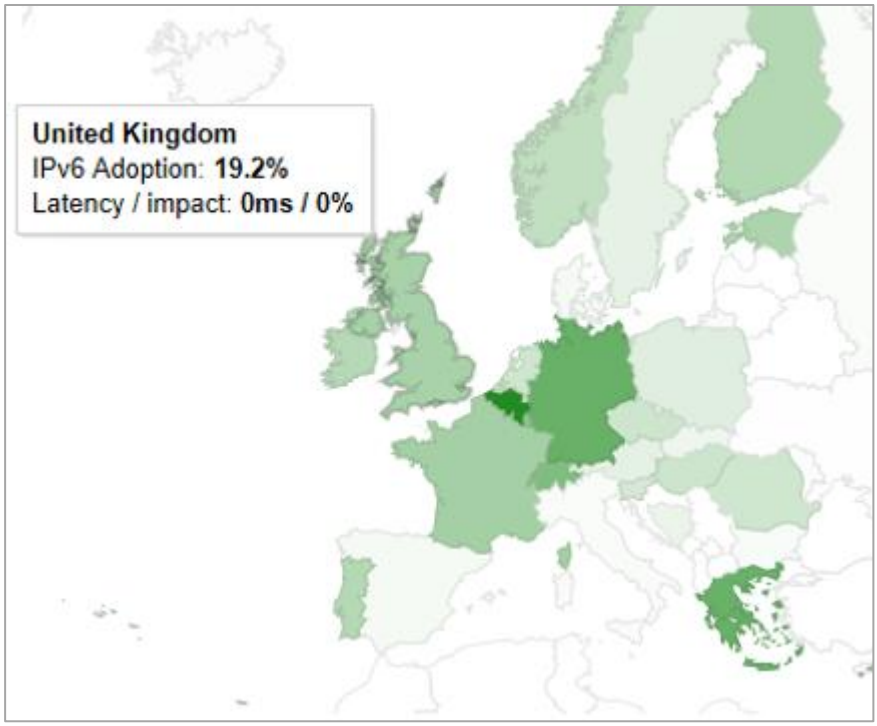
[131] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

[132] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

3.4 The United Kingdom

Like France, UK is overall average within Europe for IPv6 adoption as a whole.

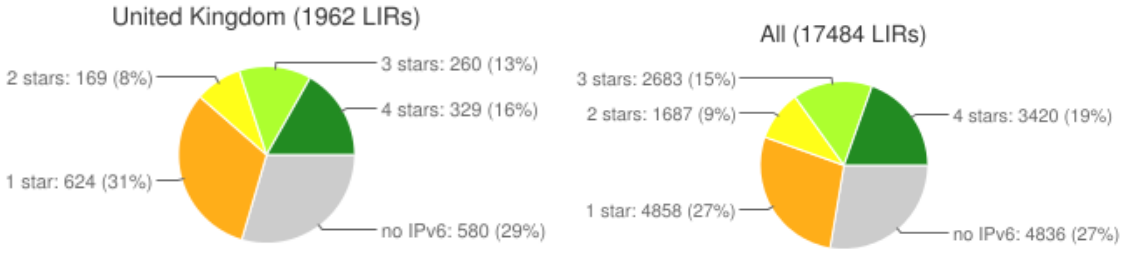
According to Google, the IPv6 adoption rate in the UK is roughly 19% (as of December 2017). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[133], the UK has a 12.8% IPv6 adoption rate, which ranks 17th in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[134]. Compared to the overall pie chart, one can see that the UK is marginally behind.



Source: http://ripeness.ripe.net/pies.html

[133] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

[134] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

In terms of ISPs, all four of the major UK ISPs are moving towards IPv6 support. The largest, BT, has 7 to 10 million subscribers, although various home gateways mean some cannot be moved to IPv6; 2 million subscribers are being tracked on their latest home gateway (BT Hub). Sky, with 6 million households, says 97% are IPv6 enabled. Virgin has done internal trials and it is expected that 2018 may see some moves; there is pressure from the parent company, Liberty Global, to move to IPv6. Finally TalkTalk has not made any move yet but attended the annual IPv6 Council meeting for the first time in late 2017 showing their interest. It may however take 12 to 24 months for any significant move to be made.

3.5 Germany

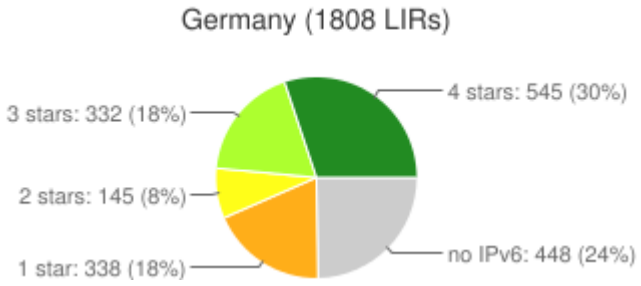
Germany is one of the leading country worldwide for IPv6 adoption.

3.5.1 RIPElabs RIPEness assessment

RIPE NCC counts 1808 LIRs[135] in Germany. The readiness to move to IPv6 for those RIPE NCC members in Germany is slightly better than the figures for all LIRs taken together (cf: **Error! R eference source not found.**)

- 30% of German LIRs have been awarded with 4 stars for different IPv6 support (compared to 19% overall)
- 24% of LIRs indicate no sign of IPv6 deployment (compared to 27% overall).

Figure 65: IPv6 RIPEness in Germany



Source: http://ripeness.ripe.net/pies.html

[135] https://www.ripe.net/membership/indices/DE.html

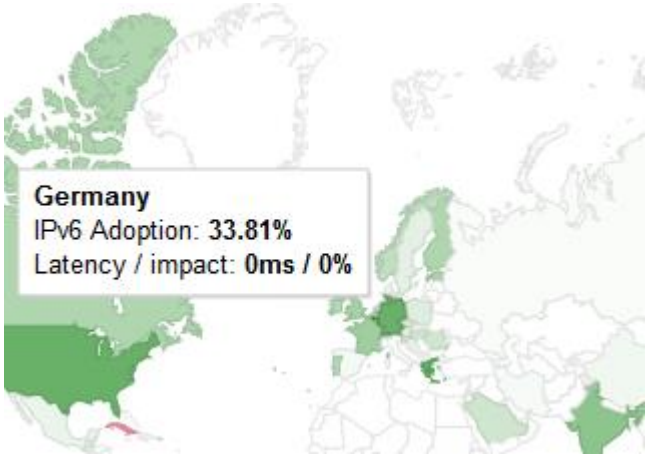
Figure 66: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Germany

Source: https://stat.ripe.net/specials/country-comparison

3.5.2 Google IPv6 statistics

Data from Google show a similar picture to that of RIPE data, with Germany doing better than the global average with an IPv6 adoption rate of 34%, compared to about 20% on global scale.

Figure 67: IPv6 adoption by Google

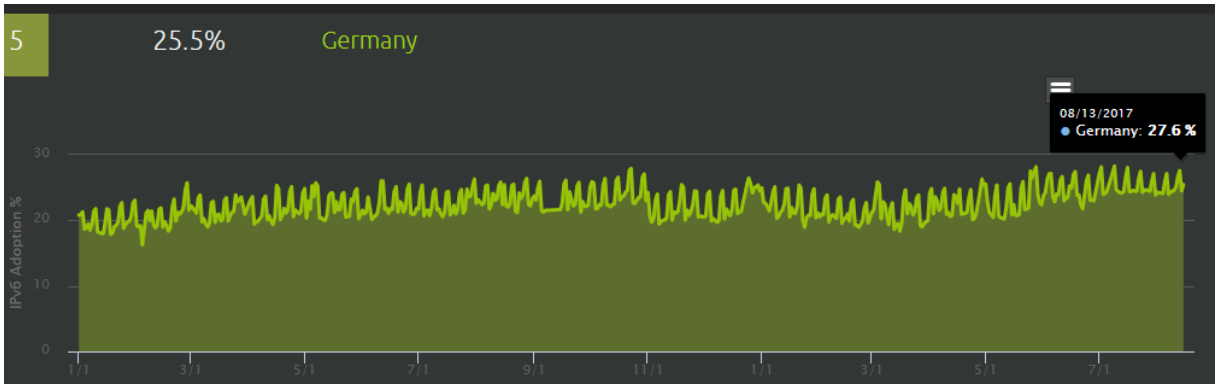


Source: Google IPv6 stats

3.5.3 Akamai IPv6 Adoption Visualization

In Akamai's IPv6 adoption ranking, Germany holds the 5th rank, behind Greece and ahead of Luxembourg.

Figure 68: IPv6 adoption by Akamai



Source: Akamai, state of the Internet IPv6 adoption visualization

3.5.4 Other

There is no coordinated tracking of IPv6 adoption data at public level. In response to an online-query in mid-2017, German regulator BNetzA referred to above-mentioned sources like Cisco and Google for statistics on IPv6 adoption in the German market.

3.6 Slovenia

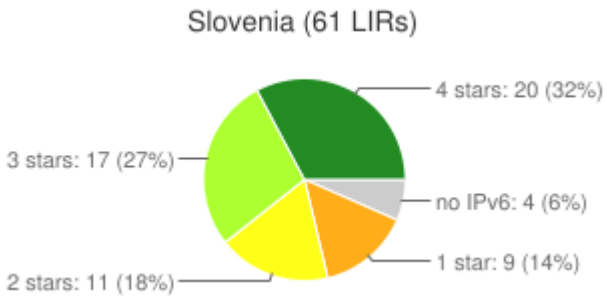
Slovenia is average to low regarding IPv6 development.

3.6.1 RIPElabs RIPEness assessment

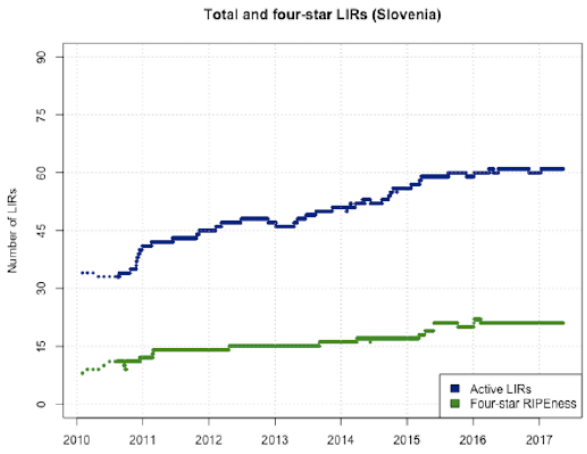
RIPE NCC's RIPEness assessment for Slovenia clearly shows the country's advance in IPv6. 32% of LIRs qualify for 4 starts, compared to 19% on global average. The number of LIRs that are not IPv6-enabled is significantly lower than the overall RIPEness reference, with 14% in Slovenia compared to 27% overall.

Regarding a potential fifth that RIPE NCC would allocate for actual IPV6 deployment, 13% of the Slovenian LIRs would qualify for this star in terms of content and 3% in terms of access.

Figure 69: IPv6 RIPEness in Slovenia

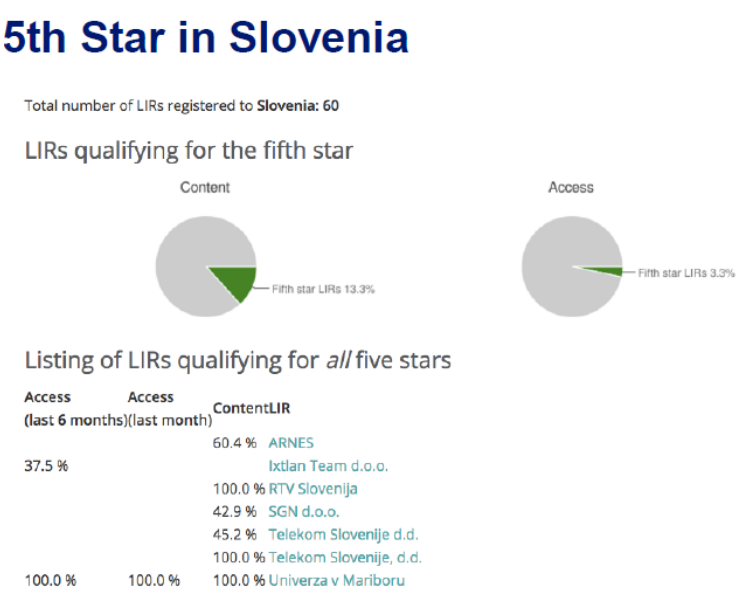


Source: http://ripeness.ripe.net/pies.html



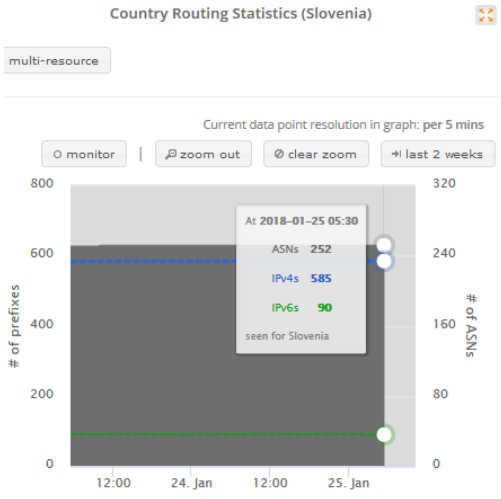
Source: RIPE NCC presentation « IPv6 Routing in Slovenia », [136] , May 2017

[136] Available https://www.sinog.si/wp-content/uploads/2017/05/IPv6_routing_in_Slovenia.pdf



Source: RIPE NCC presentation « IPv6 Routing in Slovenia », [137] , May 2017

Figure 70: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Slovenia



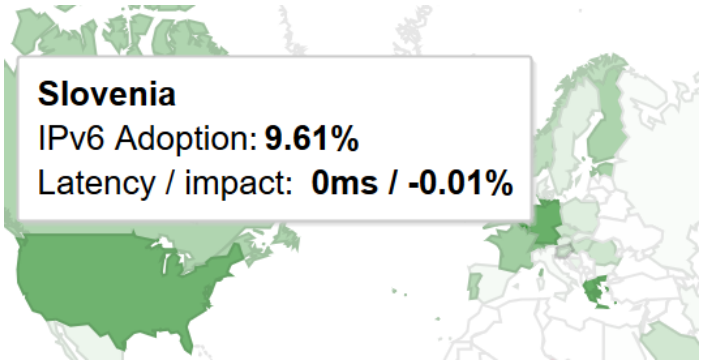
Source: https://stat.ripe.net/specials/country-comparison

3.6.2 Google IPv6 statistics

Google data are somewhat less bullish, showing that IPv6 rate in Slovenia stands at just below 10%, which is relatively low by international standards.

[137] Available https://www.sinog.si/wp-content/uploads/2017/05/IPv6_routing_in_Slovenia.pdf

Figure 71: IPv6 adoption by Google

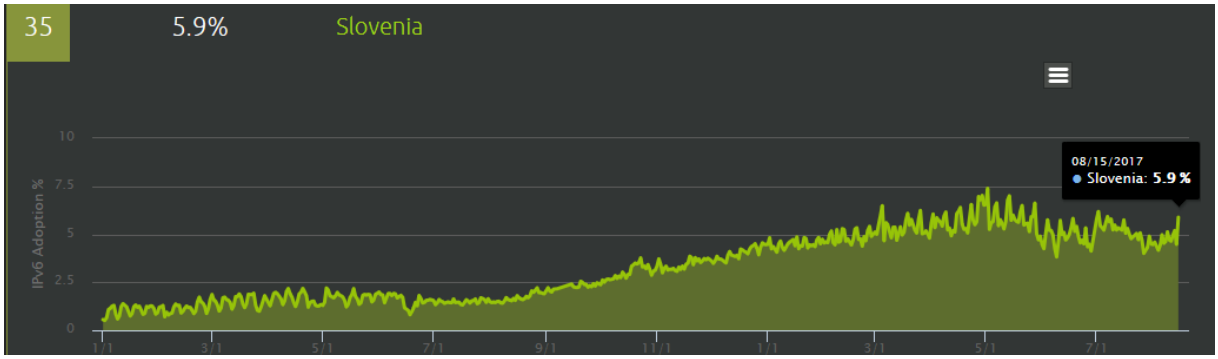


Source: Google IPv6 stats

3.6.3 Akamai IPv6 Adoption Visualization

In Akamai's ranking, Slovenia does not occupy a top-spot either. The country ranks 35th in Akamai's IPv6 adoption measurement, with an adoption rate of 5.9% in mid-August 2017, which is somewhat lower than the peak of 7% reached in April of the same year.

Figure 72: IPv6 adoption by Akamai



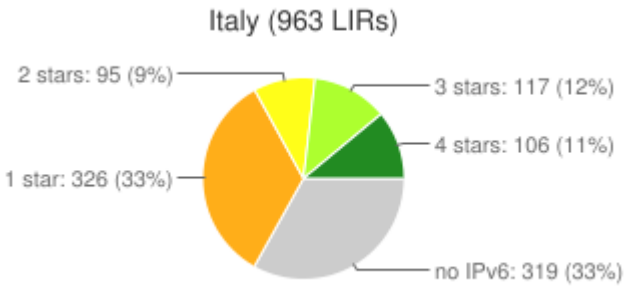
Source: Akamai, state of the Internet IPv6 adoption visualization

3.7 Italy

3.7.1 RIPElabs RIPEness assessment

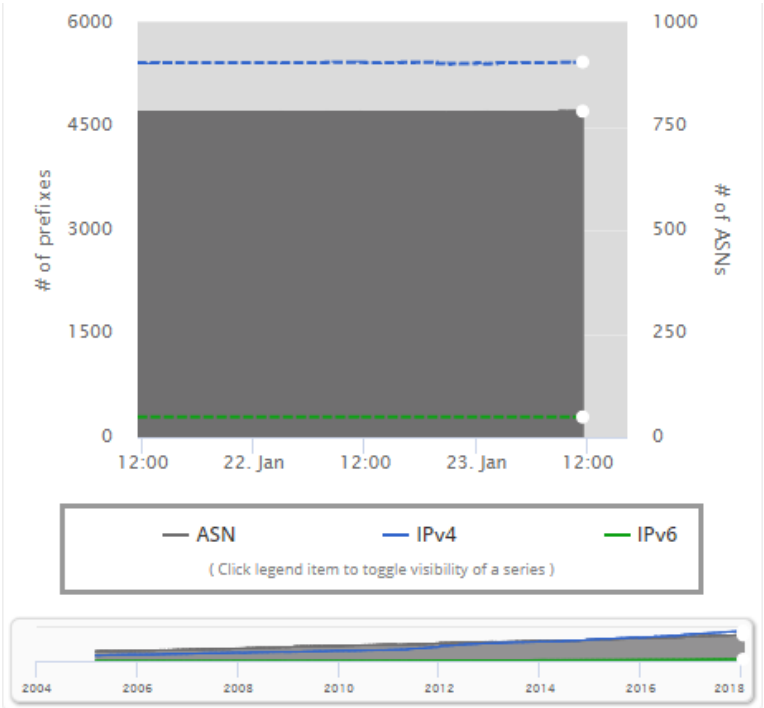
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Italy is relatively low compared to other countries. Out of the 963 LIRs, a little less than a third are ranked 2 star or more and a third remain still providing no IPv6 at all (0 star).

Figure 73: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 74: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Italy

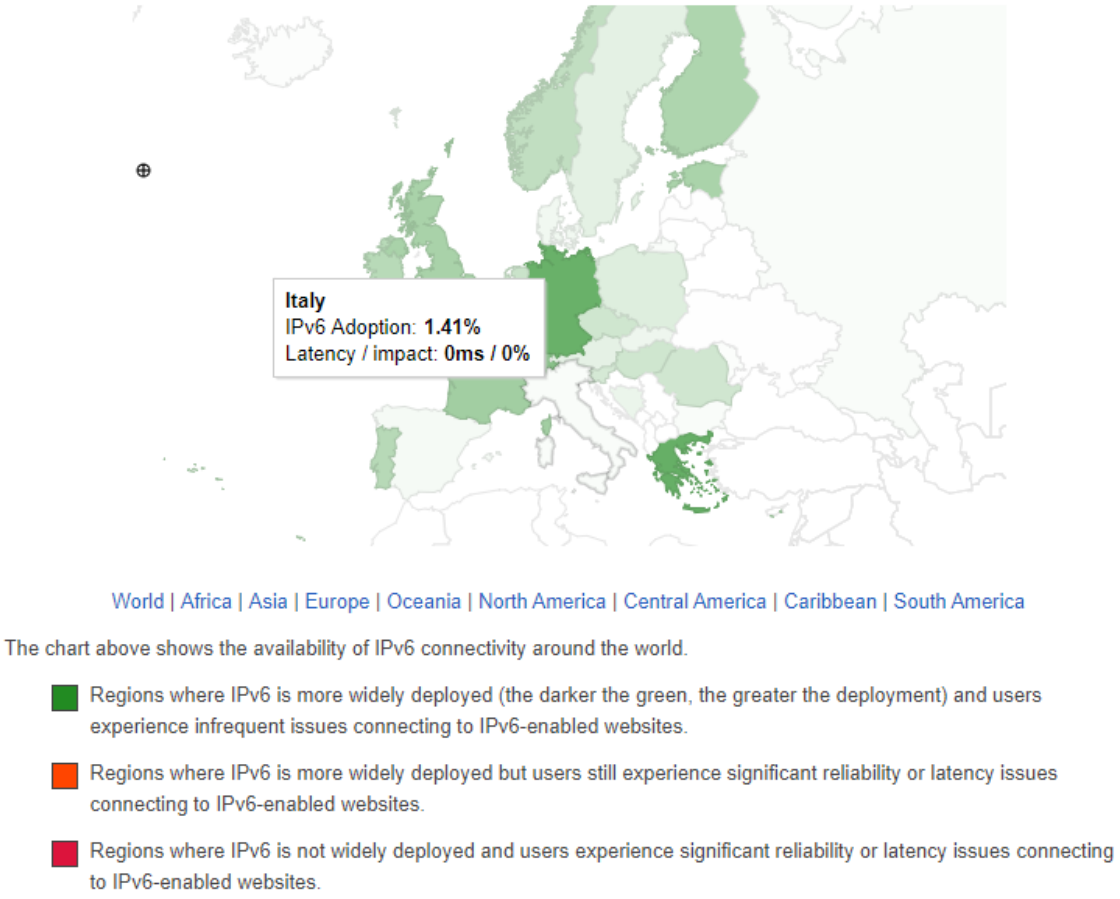


Source: https://stat.ripe.net/specials/country-comparison

3.7.2 Google IPv6 statistics

According to Google[138], the adoption rate is around 1.41% in Italy, which is very low, when compared to global adoption (around 20%) and one of the lowest adoption of European countries.

Figure 75: IPv6 adoption



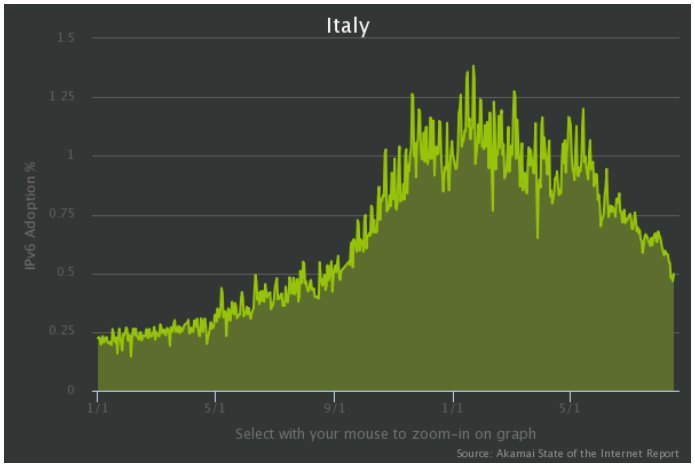
Source: Google IPV6 statistics

3.7.3 Akamai IPv6 Adoption Visualization

For Akamai, Italy ranks at the 60th place with 0.5% adoption rate of IPv6[139]. Past data show that adoption rate varied with maximum value up to 1.25%.

[138] Volume of users that access Google over IPv6

[139] Volume of IPv6 requests to Akamai

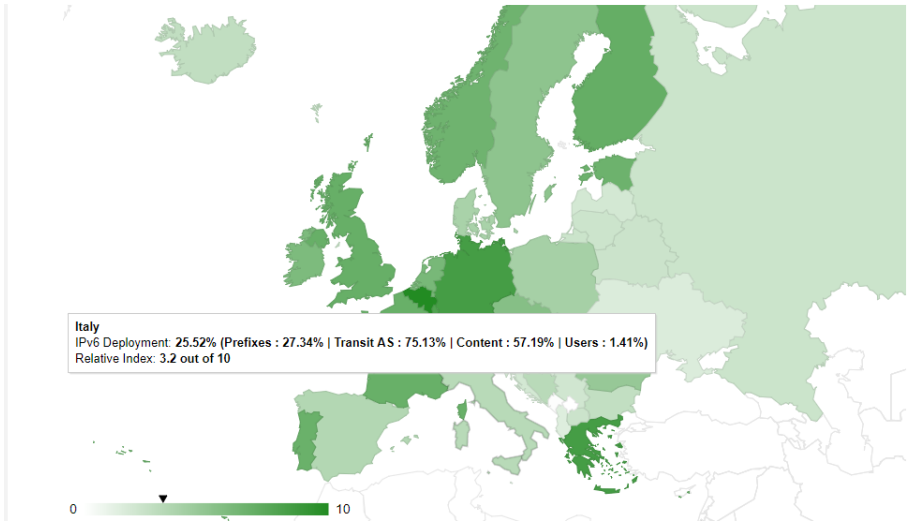


Source: Akamai, state of the Internet IPv6 adoption visualization

3.7.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…Italy is ranked at 25.52% and 3.2 out of 10 (relative index).

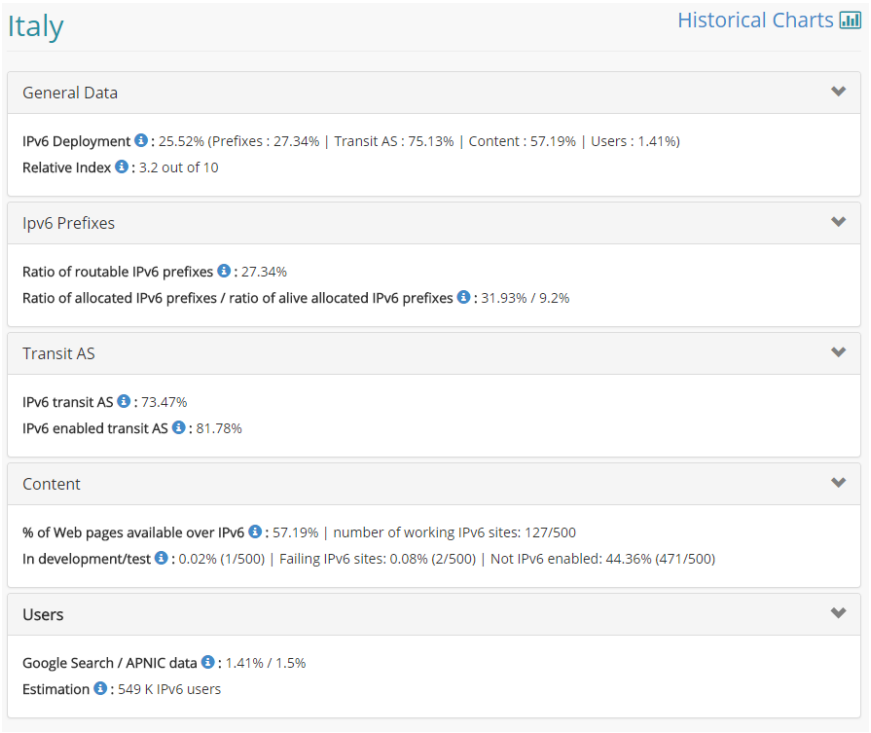
Figure 76: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

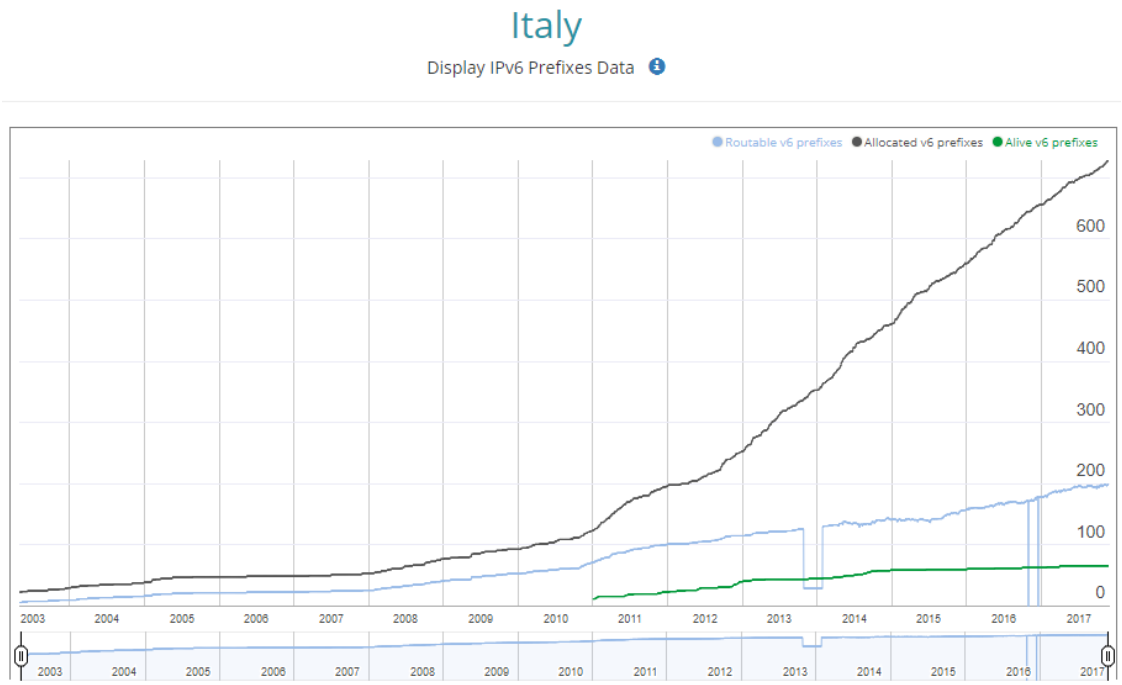
Other figures from Cisco indicates that in Italy, 127/500 sites run on IPv6 and there are 549 K IPv6 users.

Figure 77: IPv6 adoption at different layers



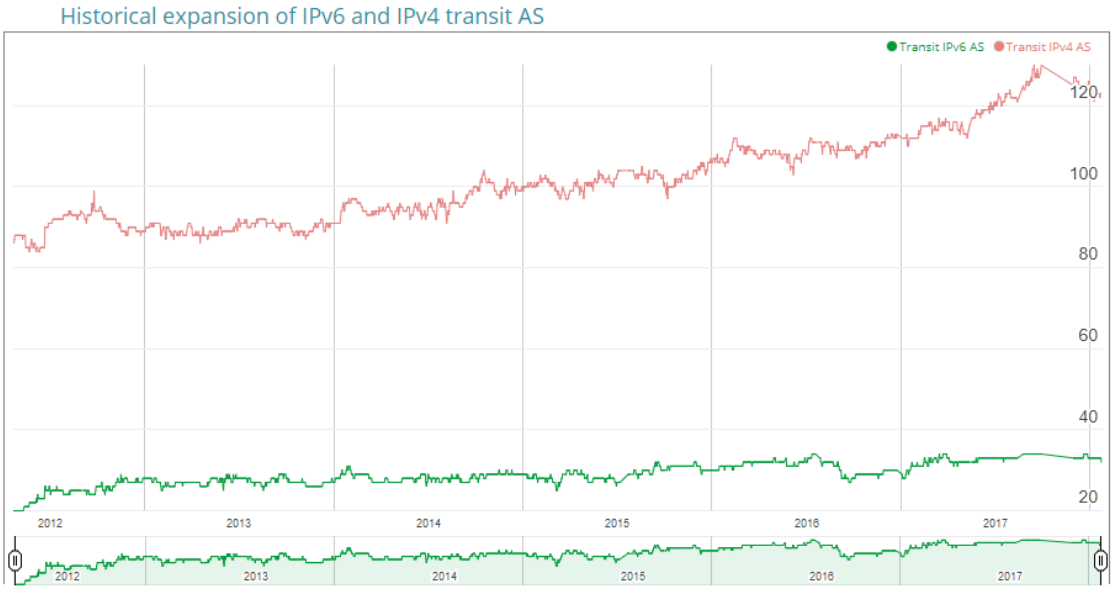
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 78: The evolution of IPv6 adoption in terms of "prefixes"



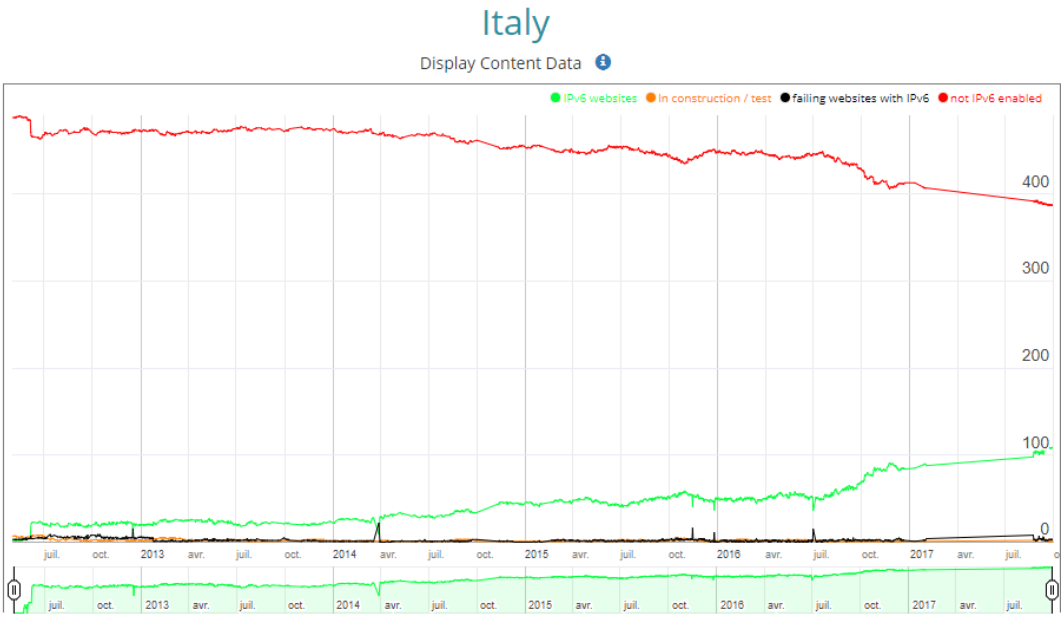
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 79: The evolution of IPv6 adoption in terms of “transit AS”



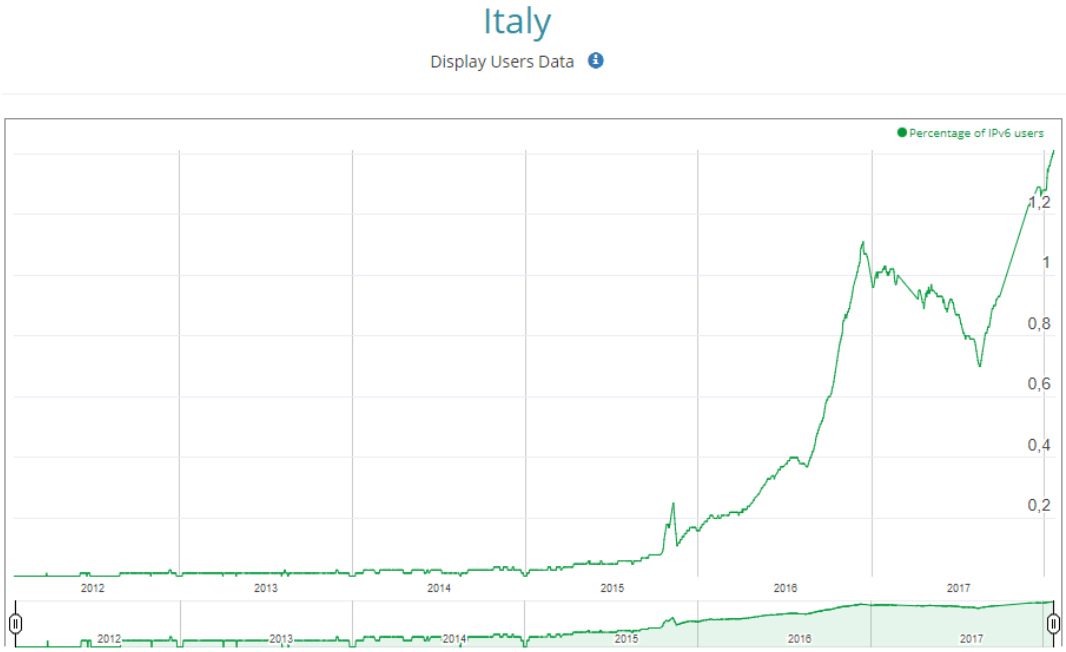
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 80: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 81: The evolution of IPv6 adoption in terms of “display users data”

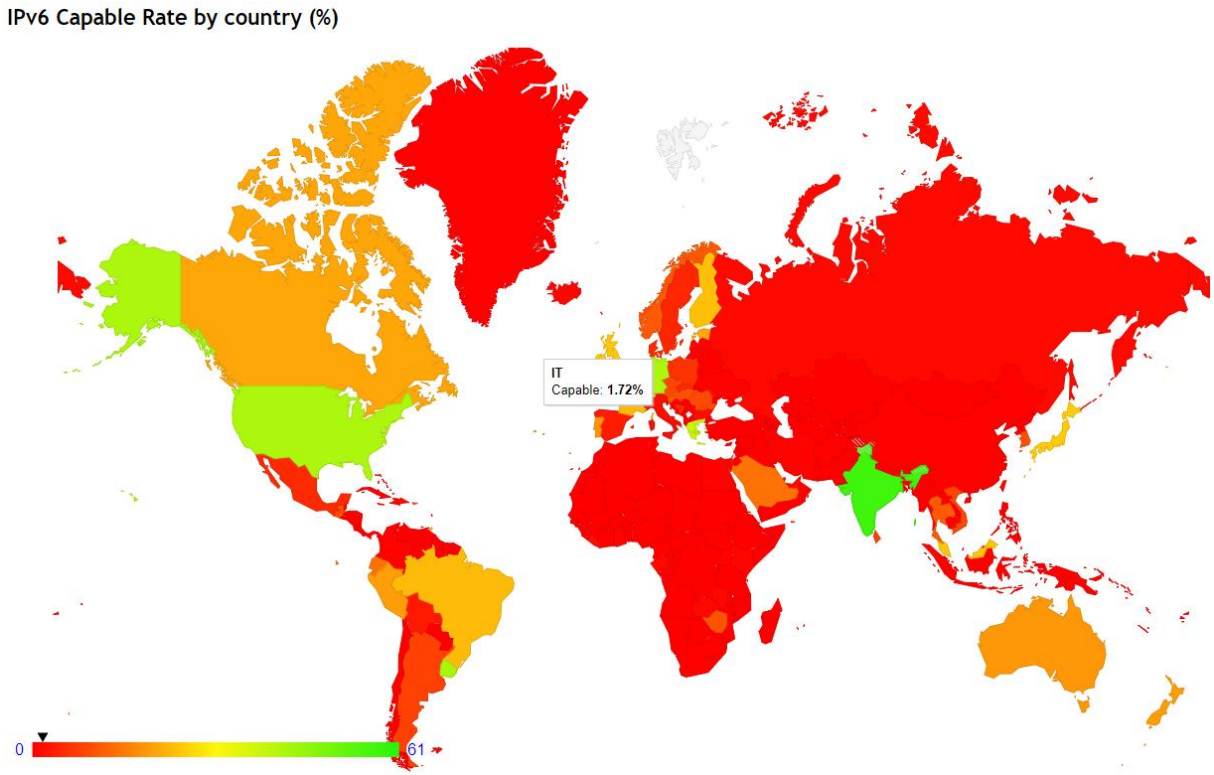


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.7.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Italy displays in red revealing a low adoption (ranked at 1.72%).

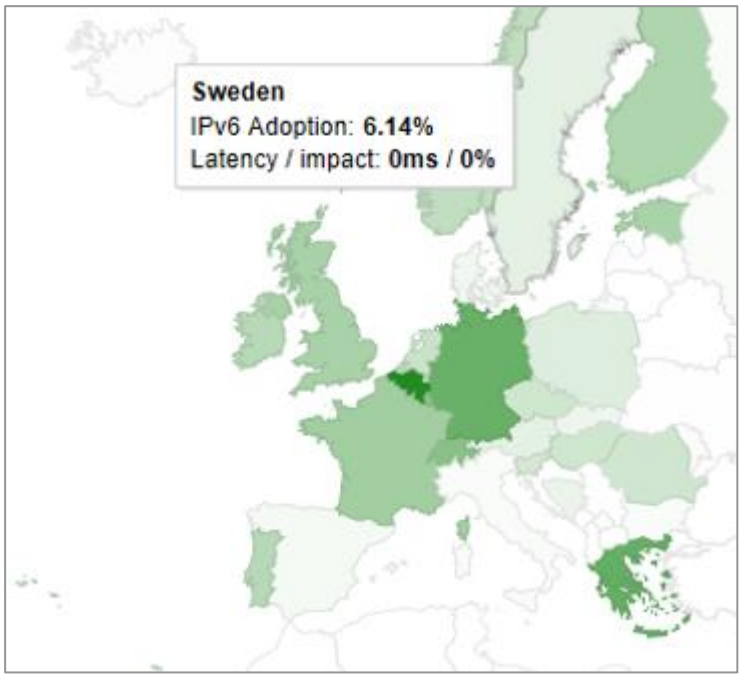
Figure 82: IPV6 capable rate by country (%)



Source: APNIC, https://stats.labs.apnic.net/ipv6

3.8 Sweden

According to Google, the IPv6 adoption rate in Sweden is roughly 6% (as of December 2017). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[140], Sweden has a 8.1% IPv6 adoption rate, which ranks 27th in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[141]. Compared to the overall pie chart, one can see that Sweden is ahead of the world average.

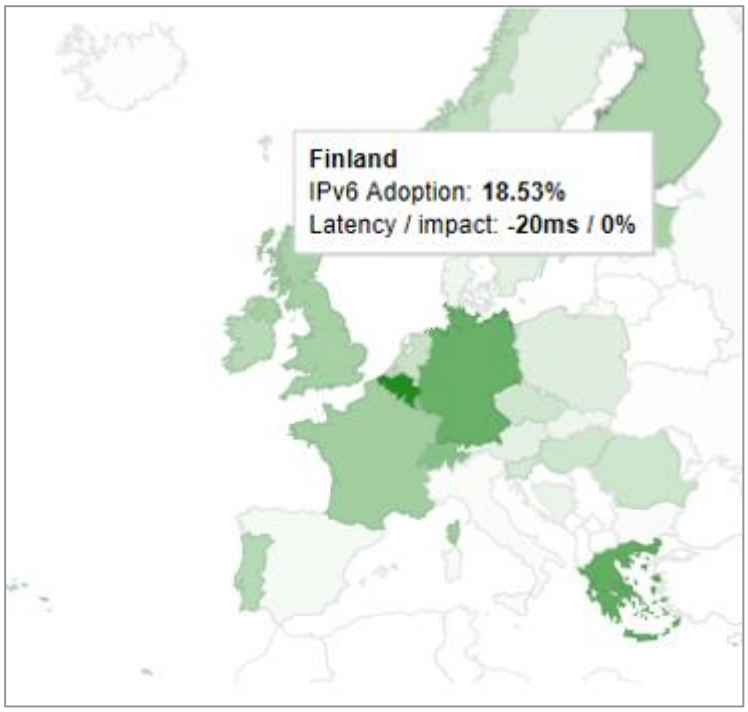
Source: http://ripeness.ripe.net/pies.html

[140] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

[141] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

3.9 Finland

According to Google, the IPv6 adoption rate in Finland is roughly 18.5% (as of January 2018). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[142], Finland has a 20.7% IPv6 adoption rate, which ranks 8th in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[143]. Compared to the overall pie chart, one can see that Finland is some distance ahead of the world average.

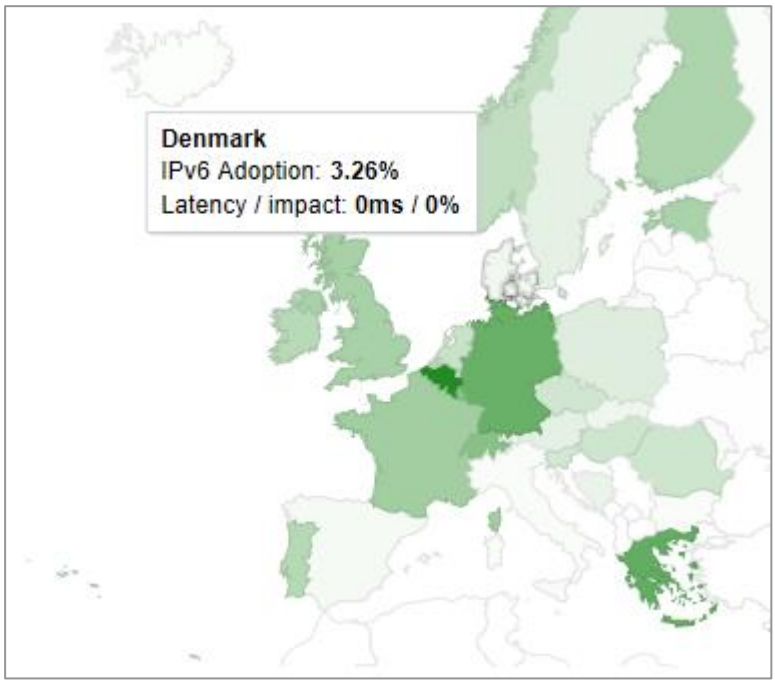
Source: http://ripeness.ripe.net/pies.html

[142] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

[143] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

3.10 Denmark

According to Google, the IPv6 adoption rate in Denmark is roughly 3% (as of January 2018). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[144], Denmark has a 1.2% IPv6 adoption rate, which ranks 54th in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[145]. Compared to the overall pie chart, one can see that Denmark is roughly the same (slightly above) the world average.

Source: http://ripeness.ripe.net/pies.html

[144] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

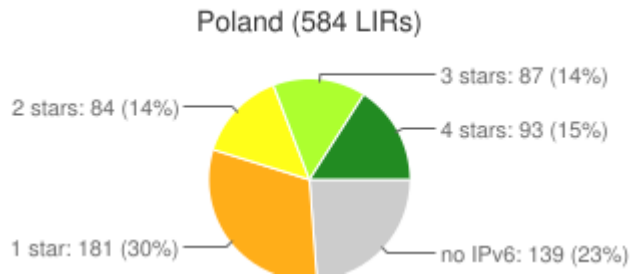
[145] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

3.11 Poland

3.11.1 RIPElabs RIPEness assessment

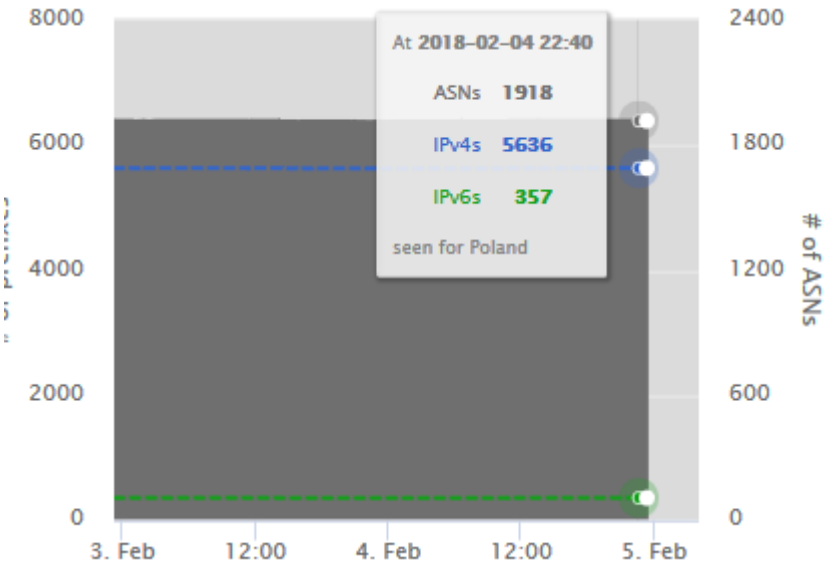
RIPE NCC's RIPEness assessment for Poland shows the country is not a leader in terms of IPv6 on a global scale. The data show that only 15% percent of Polish LIRs are rated 4 stars, compared to 19% on average. At the 3-star level, Poland is slightly below average, too, with 14% of LIRs compared to 15% overall. 23% of LIRs are not IPv6-ready in Poland, which is somewhat better than the 27% for the entirety of LIRs.

Figure 83: IPv6 RIPEness in Poland



Source: http://ripeness.ripe.net/pies.html

Figure 84: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Poland

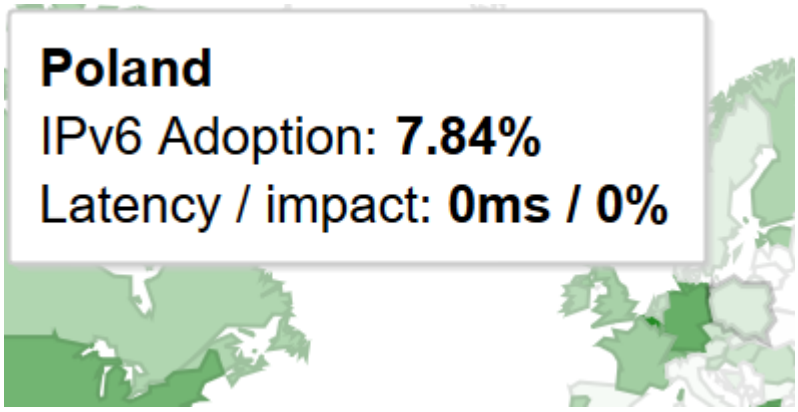


Source: https://stat.ripe.net/specials/country-comparison

3.11.2 Google IPv6 statistics

Similarly, Google data show a rather low level of IPv6 adoption, with the latter standing at 7.8% according to the data published.

Figure 85: IPv6 adoption by Google

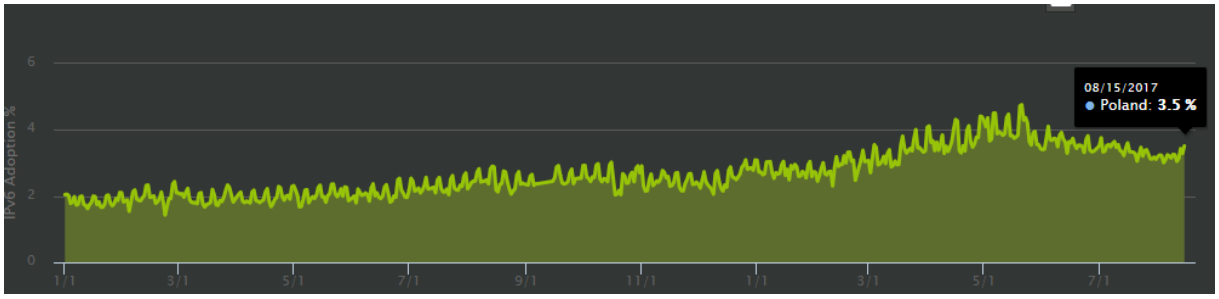


Source: Google IPv6 stats

3.11.3 Akamai IPv6 Adoption Visualization

Akamai data confirm the tendency shown by RIPE and Google data. In the CDN provider's ranking, Poland takes up the 41st spot, behind Bolivia, but ahead of Singapore.

Figure 86: IPv6 adoption by Akamai

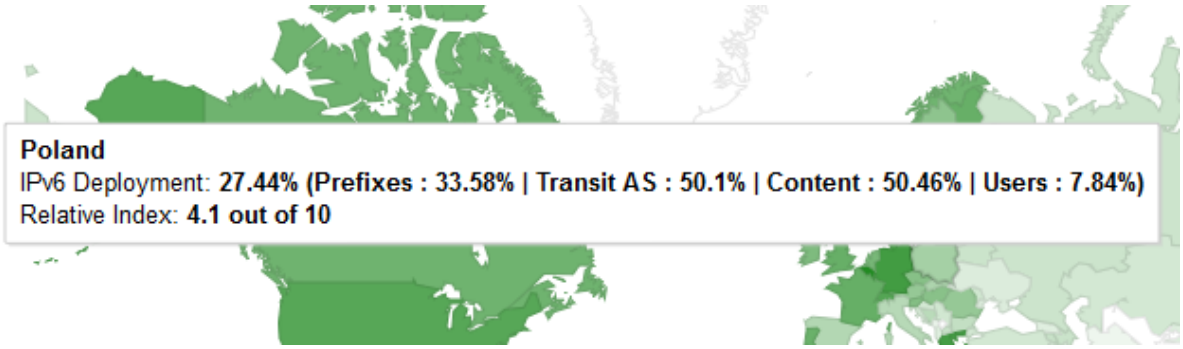


Source: Akamai, state of the Internet IPv6 adoption visualization

3.11.4 Cisco 6lab

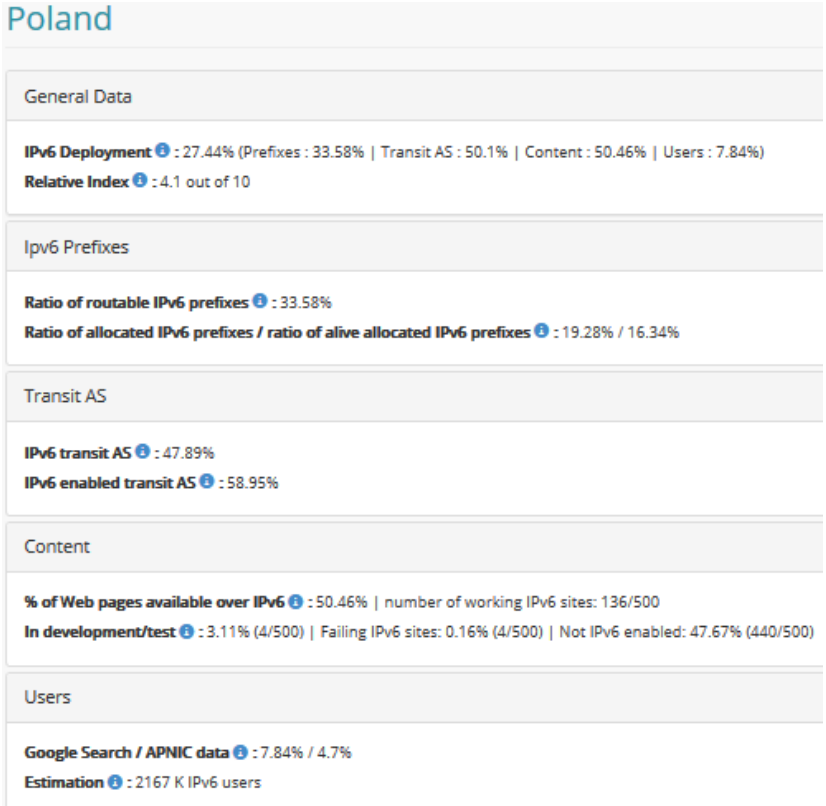
With a value of 4.1/10 Poland's relative IPv6 index attributed by Cisco is low.

Figure 87: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

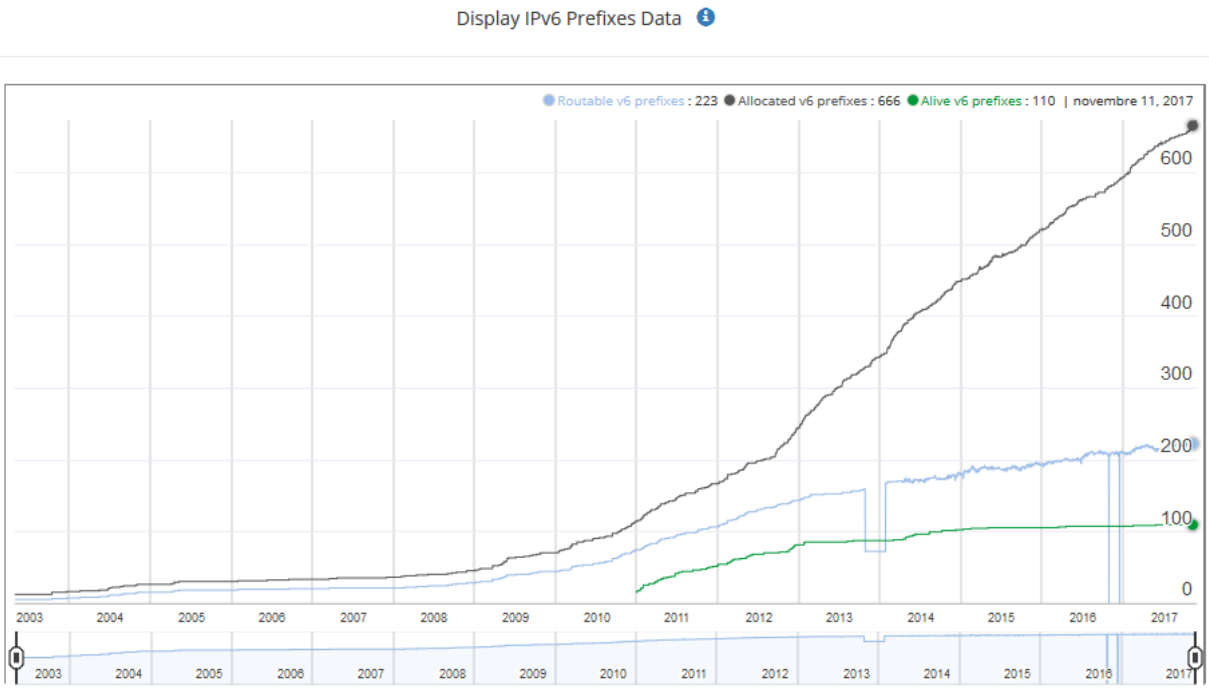
Figure 88: IPv6 adoption at different layers



Source: Cisco - 6lab - The place to monitor IPv6 adoption

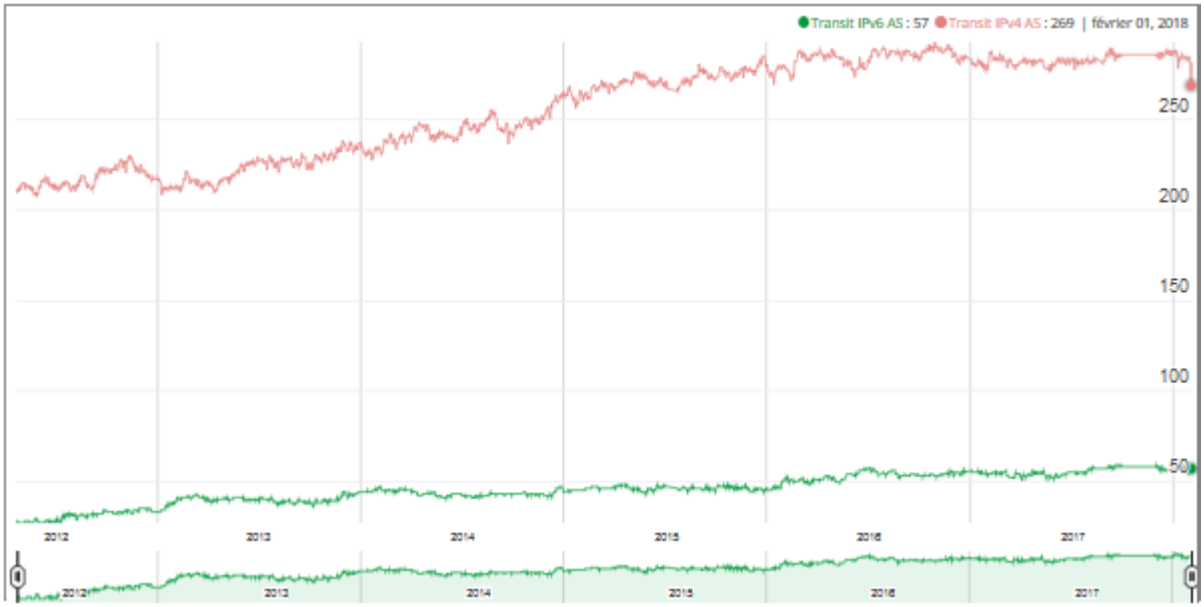
As in other countries, the allocation of IPv6 prefixes is progressing at considerable speed, however, the actual implementation keeps lagging as the gap widens.

Figure 89: The evolution of IPv6 adoption in terms of “prefixes”



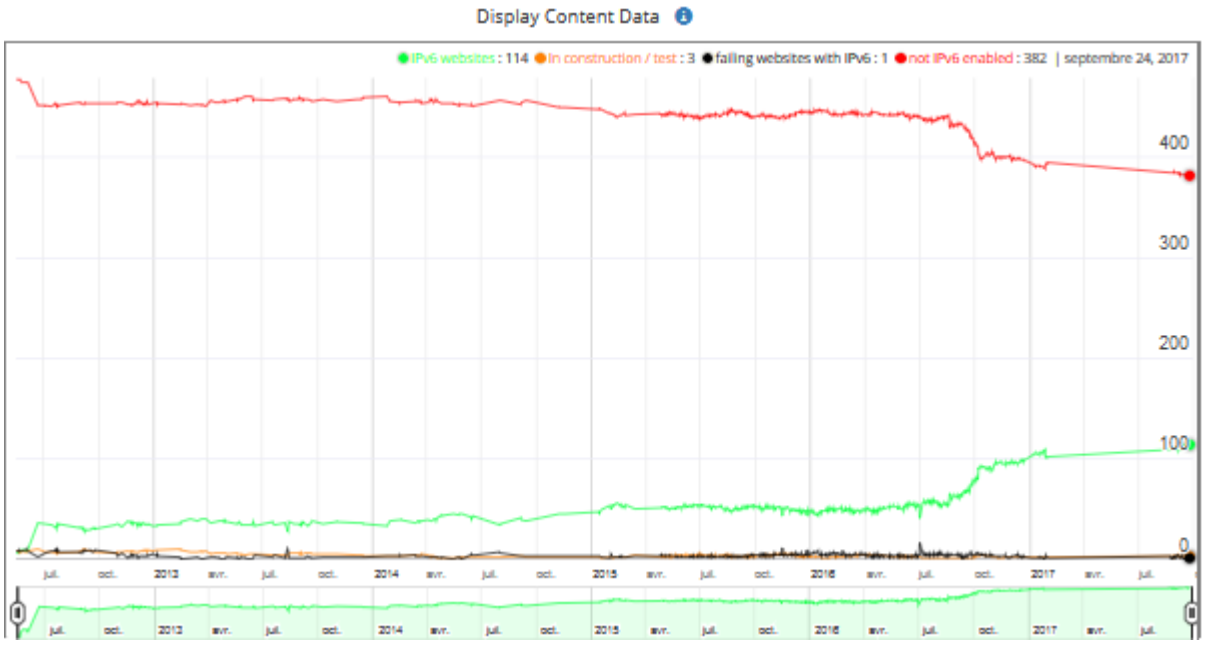
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 90: The evolution of IPv6 adoption in terms of “transit AS”



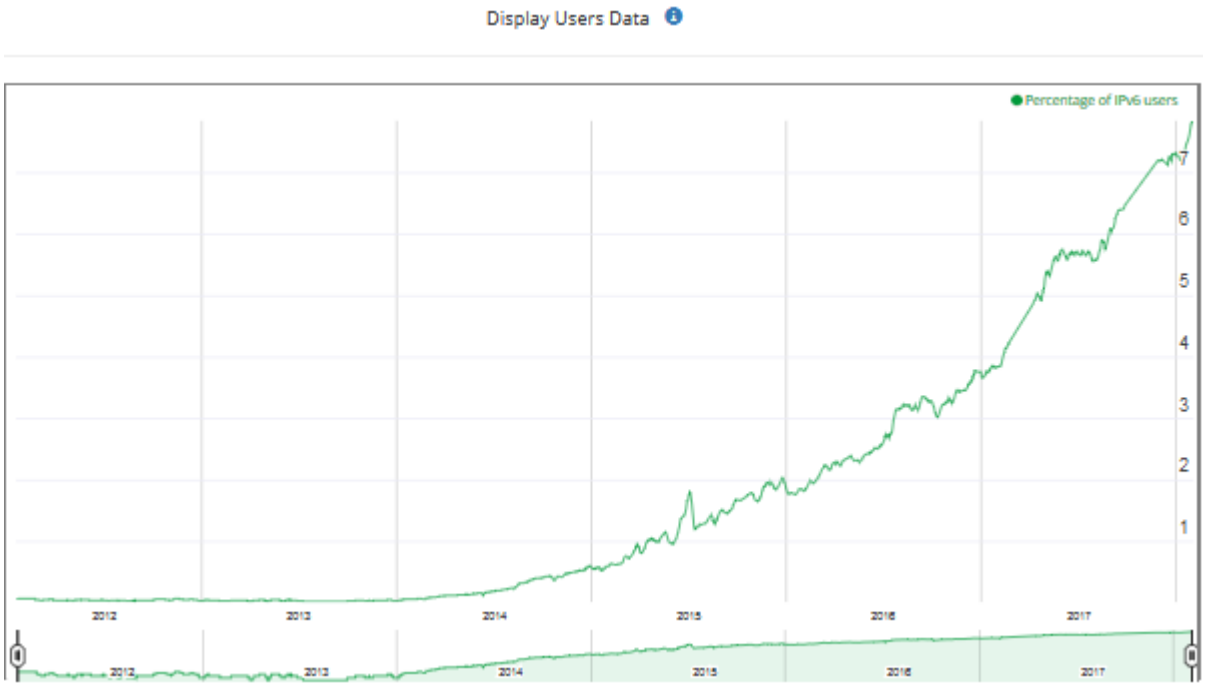
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 91: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 92: The evolution of IPv6 adoption in terms of “display users data”



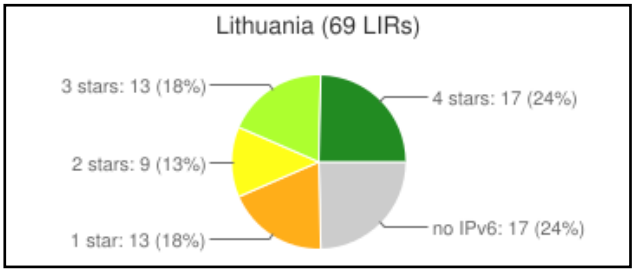
Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.12 Lithuania

3.12.1 RIPElabs RIPEness assessment

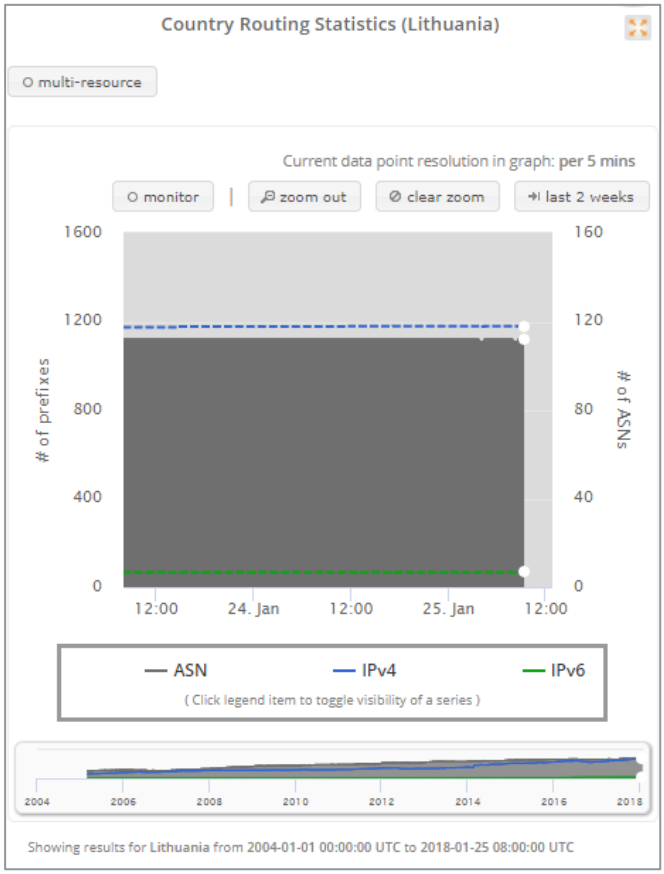
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Lithuania is relatively in line with all LIRs RIPEness globally. Out of the 69 LIRs, around one quarter of has been awarded 4 stars.

Figure 93: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 94: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Lithuania

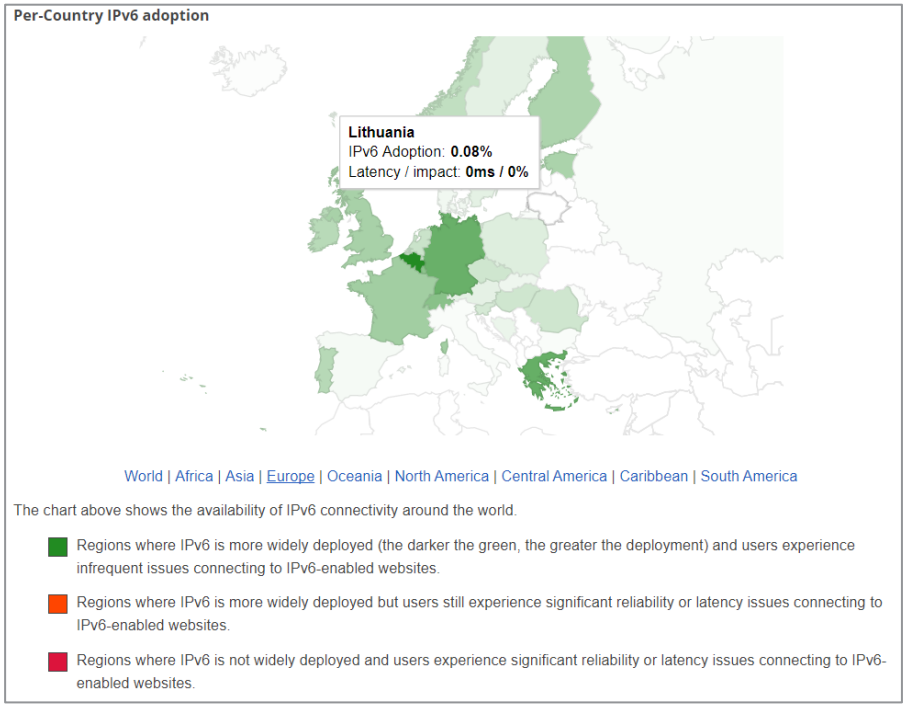


Source: https://stat.ripe.net/specials/country-comparison

3.12.2 Google IPv6 statistics

According to Google[146], the adoption rate barely is close to 0.1% in Lithuania, which is extremely low, when compared to global adoption (around 20%) and to virtually all European countries.

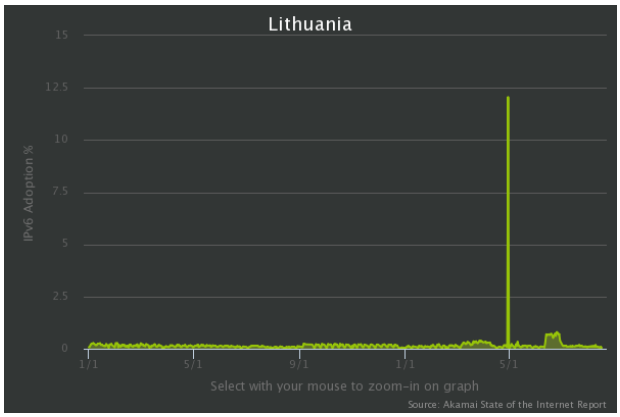
Figure 95: IPv6 adoption



Source: Google IPV6 statistics

3.12.3 Akamai IPv6 Adoption Visualization

According to Akamai, Lithuania ranks at the 83th place with a 0.1% adoption rate of IPv6[147].



Source: Akamai, state of the Internet IPv6 adoption visualization

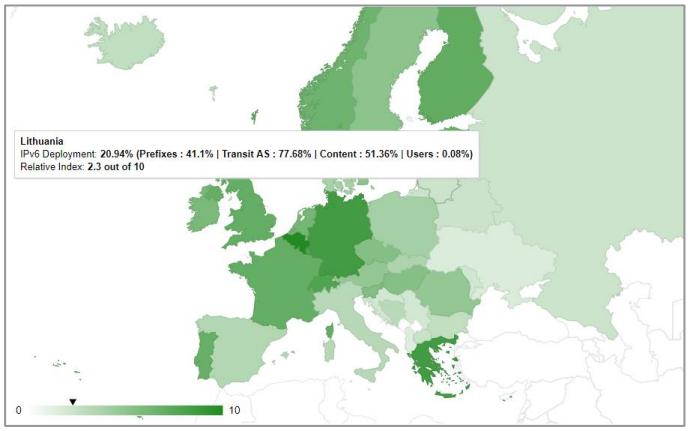
[146] Volume of users that access Google over IPv6

[147] Volume of IPv6 requests to Akamai

3.12.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Lithuania is one of the least advanced country regarding IPv6 in Europe, displaying an IPv6 adoption rate a little below 21%.

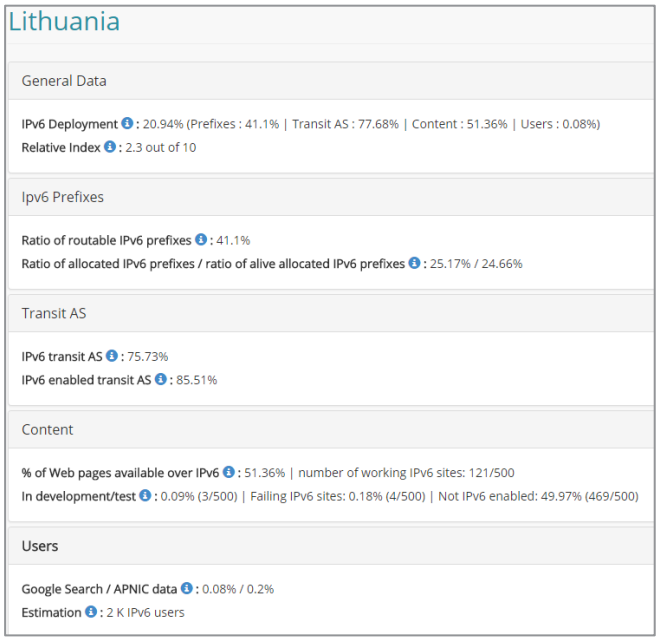
Figure 96: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

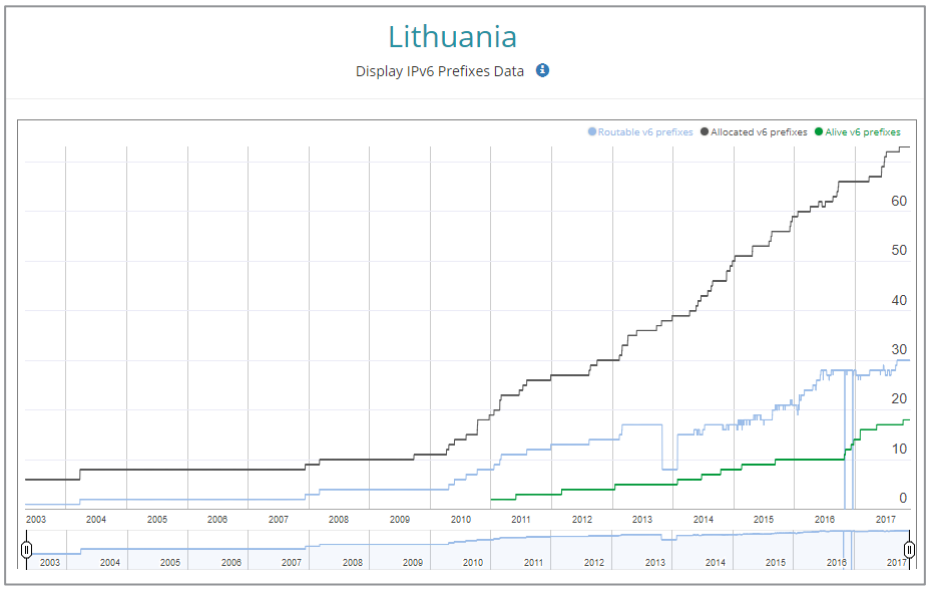
Other figures from Cisco indicates that in Lithuania, 121/500 sites run on IPv6 and there are 2 000 IPv6 users.

Figure 97: IPv6 adoption at different layers



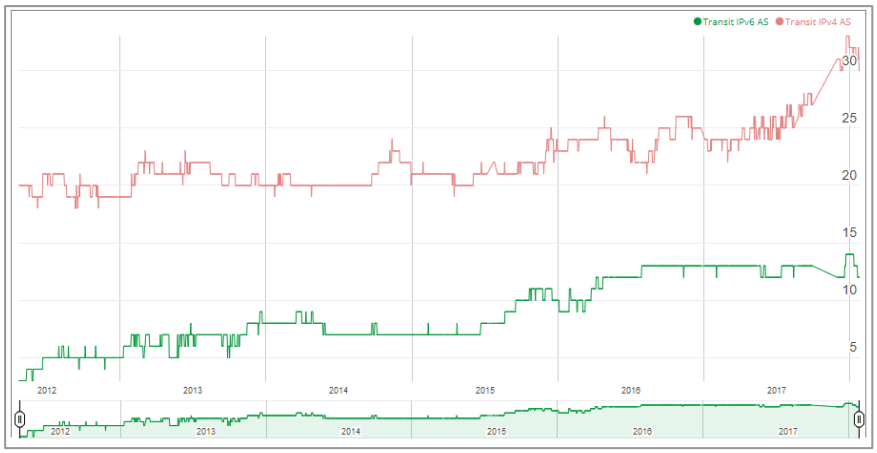
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 98: The evolution of IPv6 adoption in terms of “prefixes”



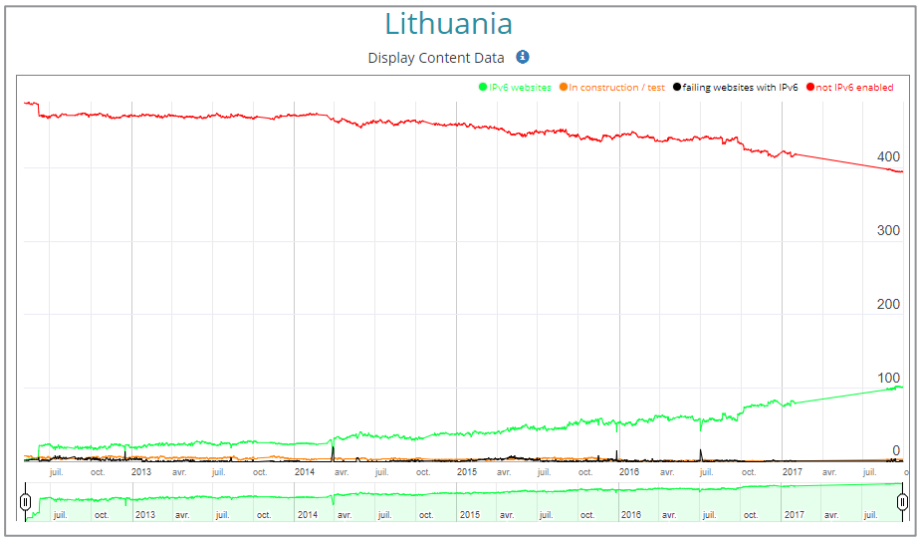
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 99: The evolution of IPv6 adoption in terms of “transit AS”



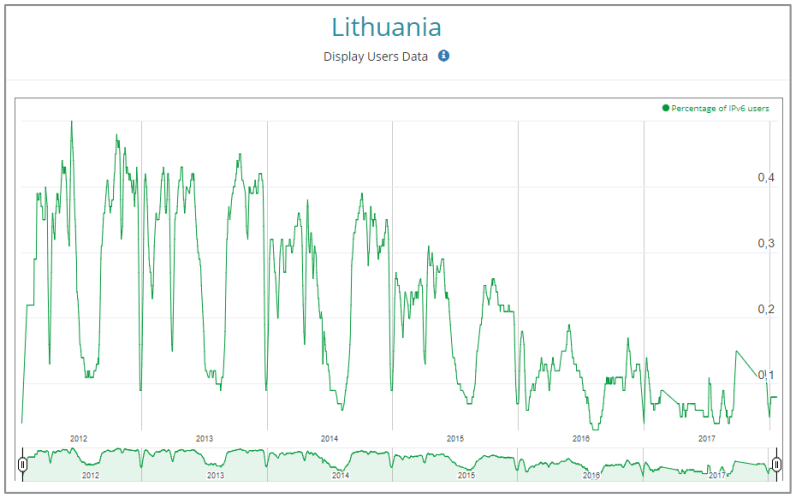
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 100: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 101: The evolution of IPv6 adoption in terms of “display users data”

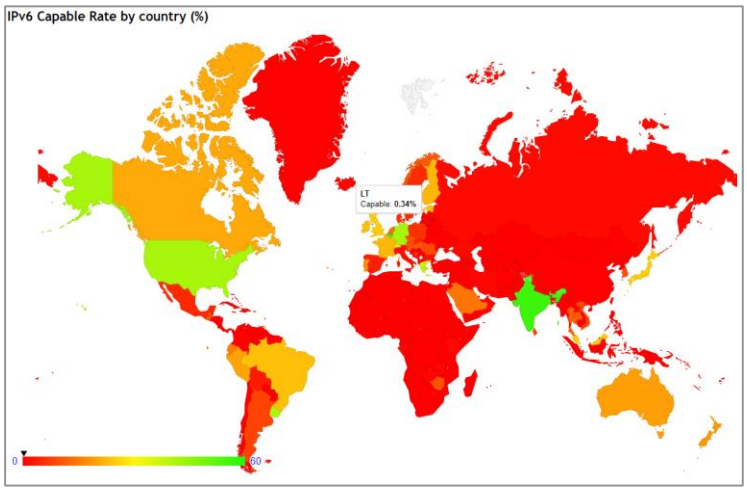


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.12.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Lithuania is displayed in red, revealing a low adoption.

Figure 102: IPV6 capable rate by country (%)



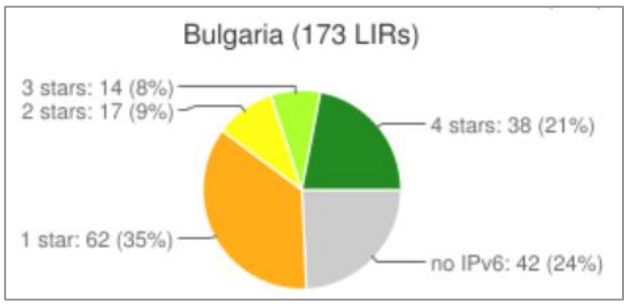
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.13 Bulgaria

3.13.1 RIPElabs RIPEness assessment

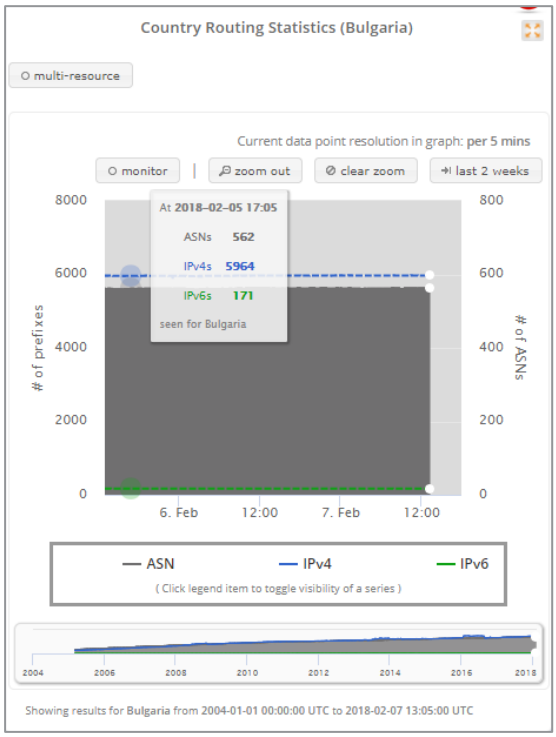
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Bulgaria is relatively in line with all LIRs RIPEness globally. Out of the 173 LIRs, 21% has been awarded 4 stars.

Figure 103: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 104: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Bulgaria

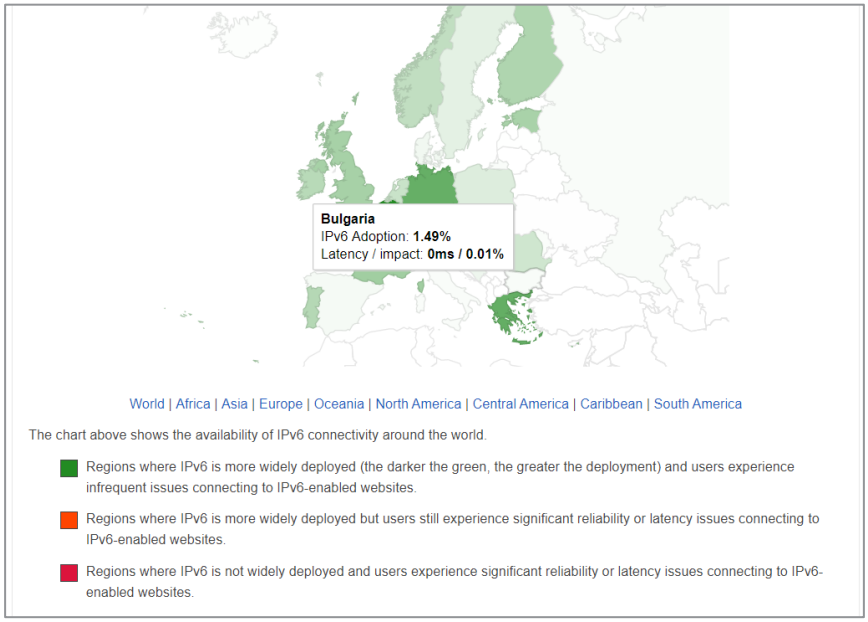


Source: https://stat.ripe.net/specials/country-comparison

3.13.2 Google IPv6 statistics

According to Google[148], the adoption rate is close to 1.5% in Slovakia, which remains very low, when compared to global adoption (around 20%) and to many European countries.

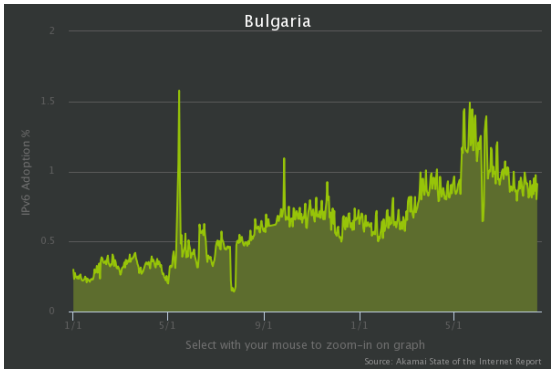
Figure 105: IPv6 adoption



Source: Google IPV6 statistics

3.13.3 Akamai IPv6 Adoption Visualization

According to Akamai, Bulgaria ranks at the 56th place with a 2% adoption rate of IPv6[149]. It is growing, slowly, since at least the beginning of 2016.



Source: Akamai, state of the Internet IPv6 adoption visualization

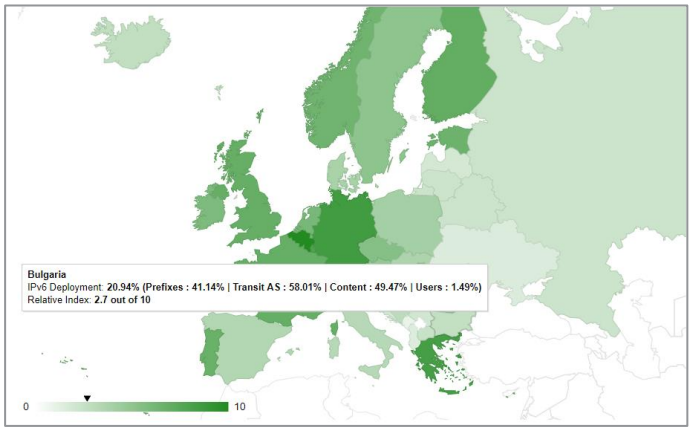
[148] Volume of users that access Google over IPv6

[149] Volume of IPv6 requests to Akamai

3.13.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Bulgaria is one of the least advanced country regarding IPv6 in Europe, displaying an IPv6 adoption rate a little below 21%.

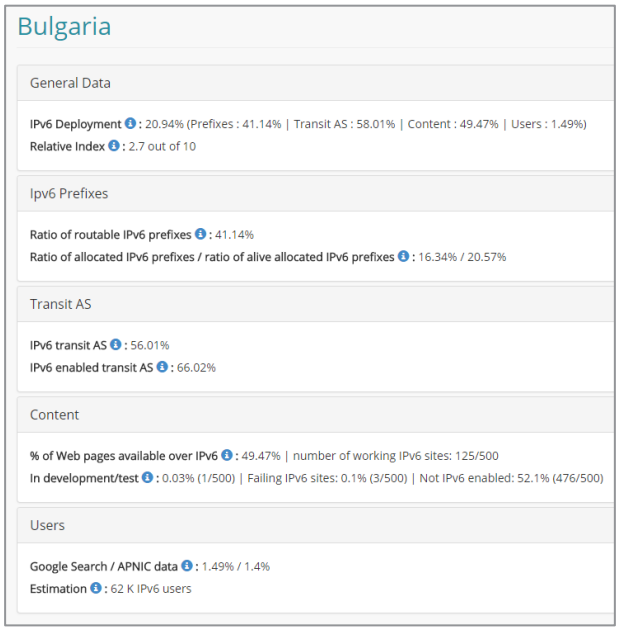
Figure 106: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

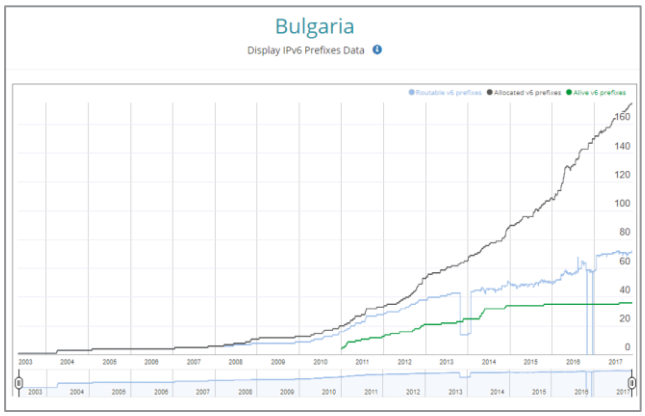
Other figures from Cisco indicates that in Bulgaria, 125/500 sites run on IPv6 and there are 62 000 IPv6 users.

Figure 107: IPv6 adoption at different layers



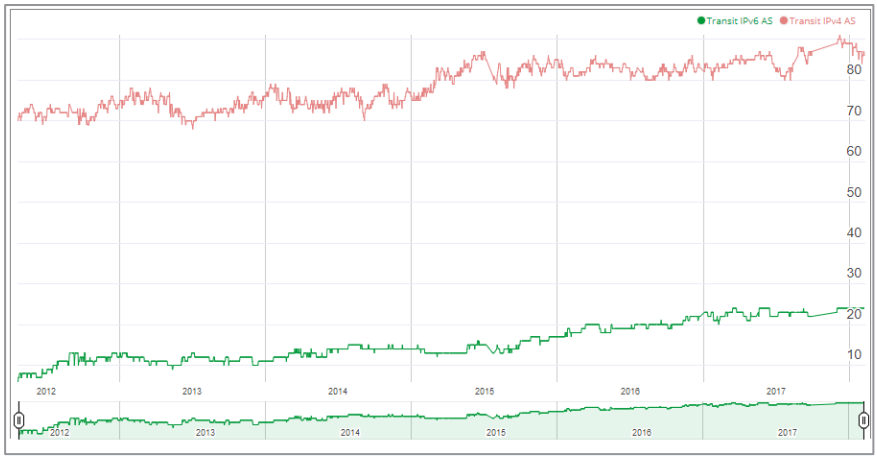
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 108: The evolution of IPv6 adoption in terms of “prefixes”



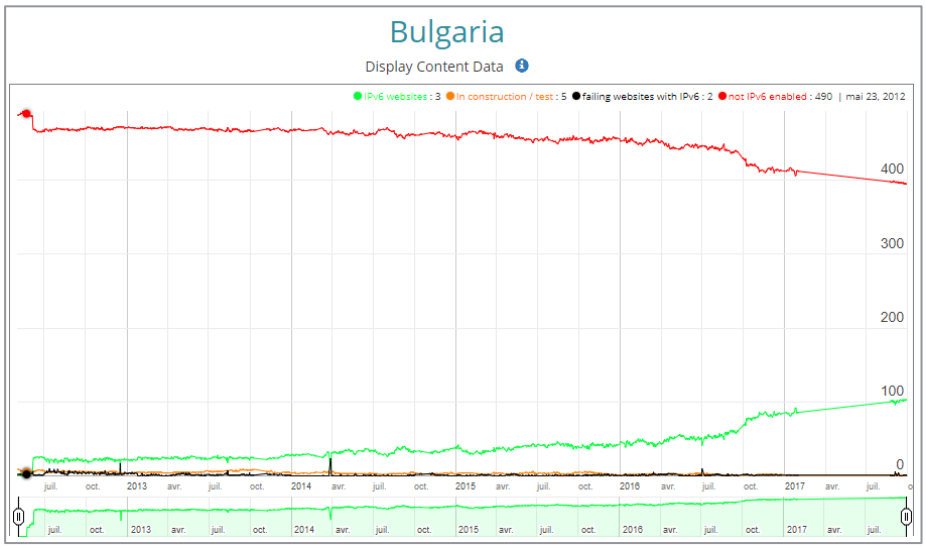
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 109: The evolution of IPv6 adoption in terms of “transit AS”



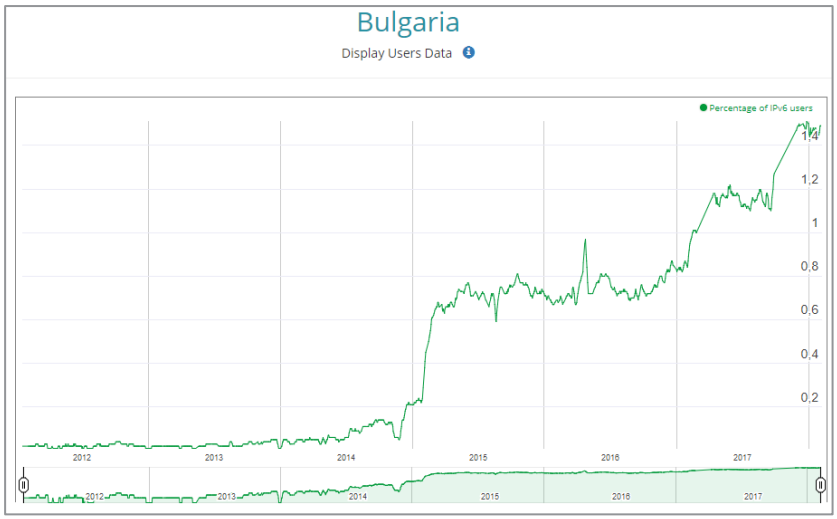
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 110: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 111: The evolution of IPv6 adoption in terms of “display users data”

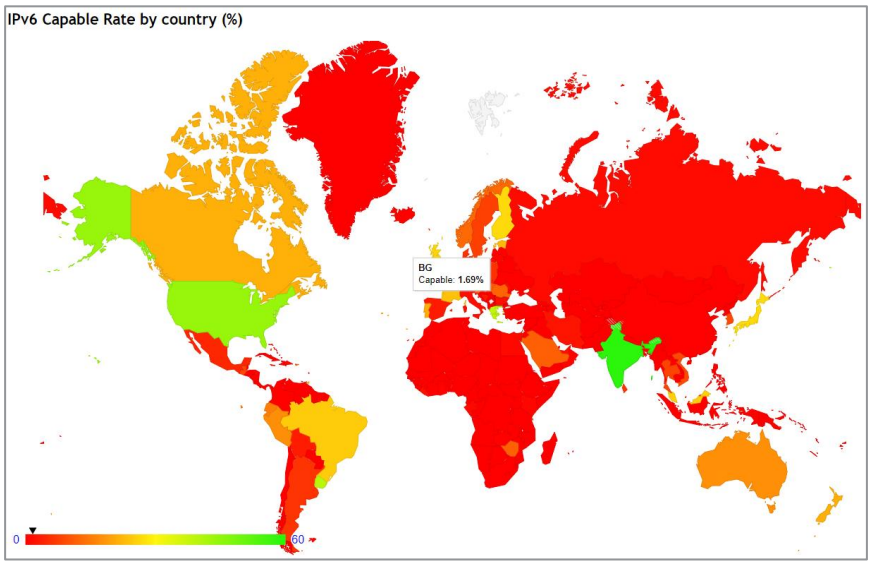


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.13.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Bulgaria is displayed in red, revealing a low adoption.

Figure 112: IPV6 capable rate by country (%)



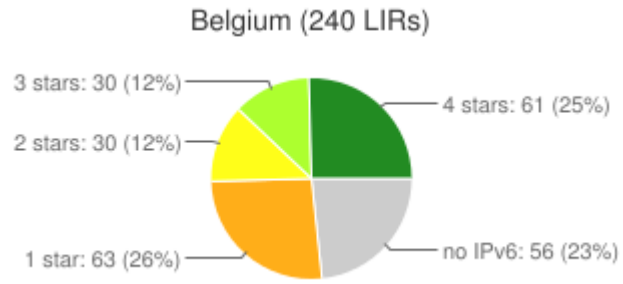
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.14 Belgium

3.14.1 RIPElabs RIPEness assessment

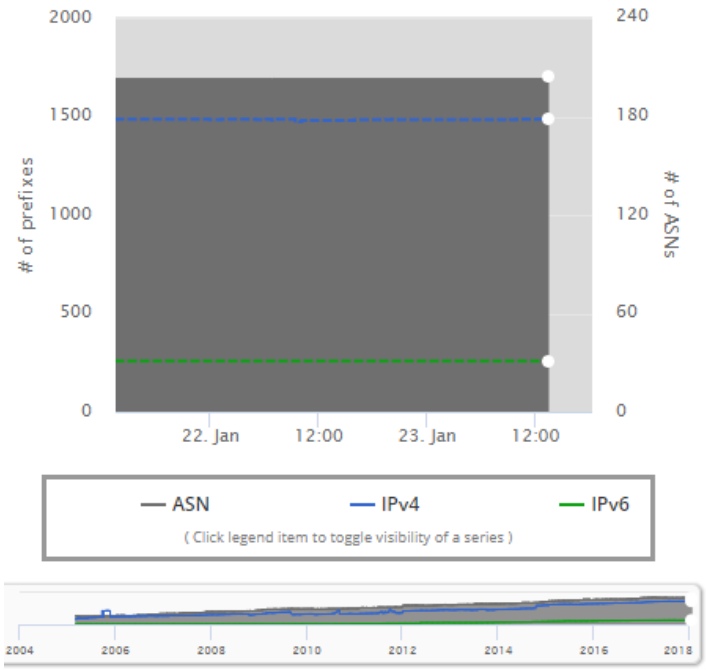
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Belgium is high compared to other countries. Out of the 240 LIRs, a quarter are 4 stars, half rank at least at 2 stars and only less than a quarter don't provide any kind of IPv6 support.

Figure 113: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 114: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Belgium

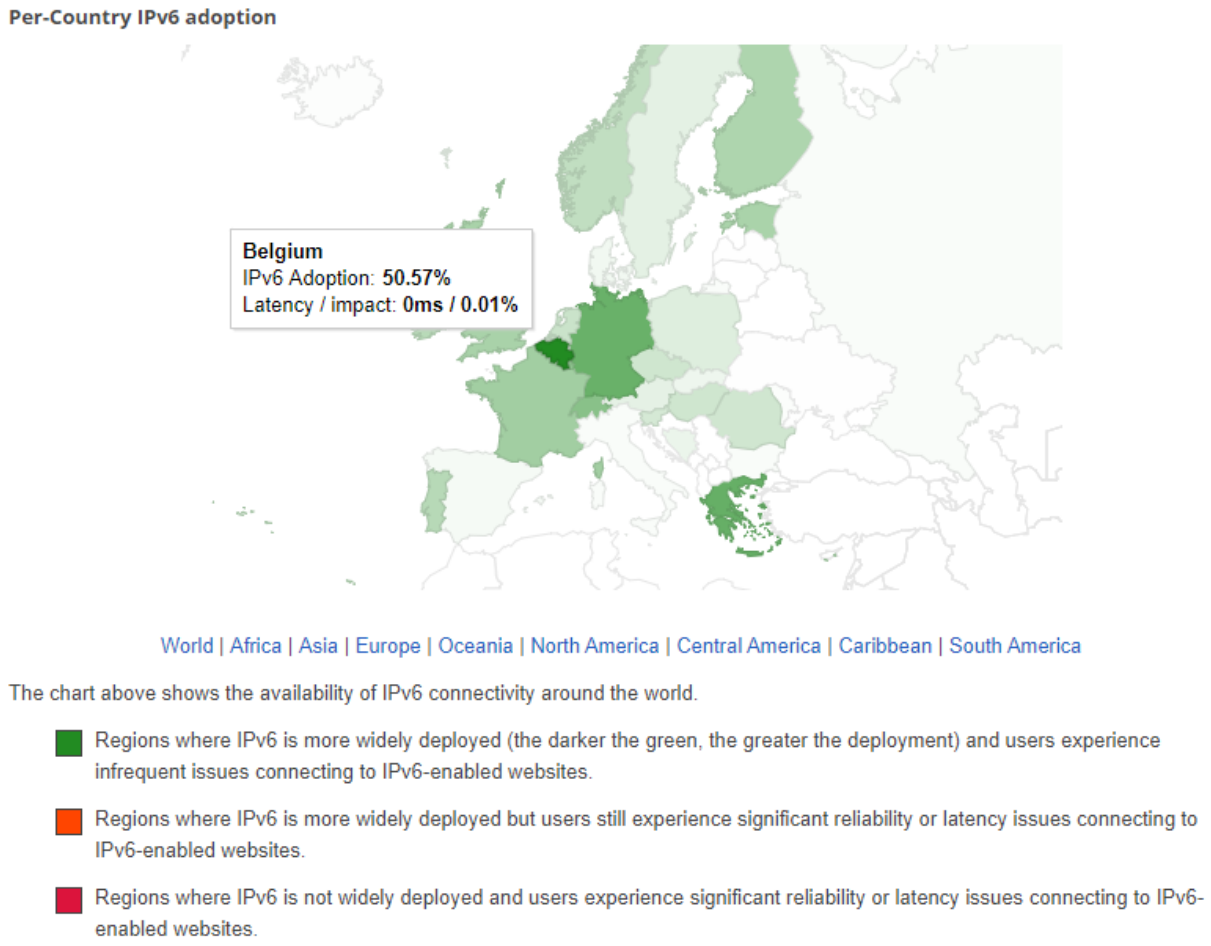


Source: https://stat.ripe.net/specials/country-comparison

3.14.2 Google IPv6 statistics

According to Google[150], the adoption rate is around 50.57% in Belgium, well above global adoption (around 20%) and the highest-ranking adoption of European countries.

Figure 115: IPv6 adoption



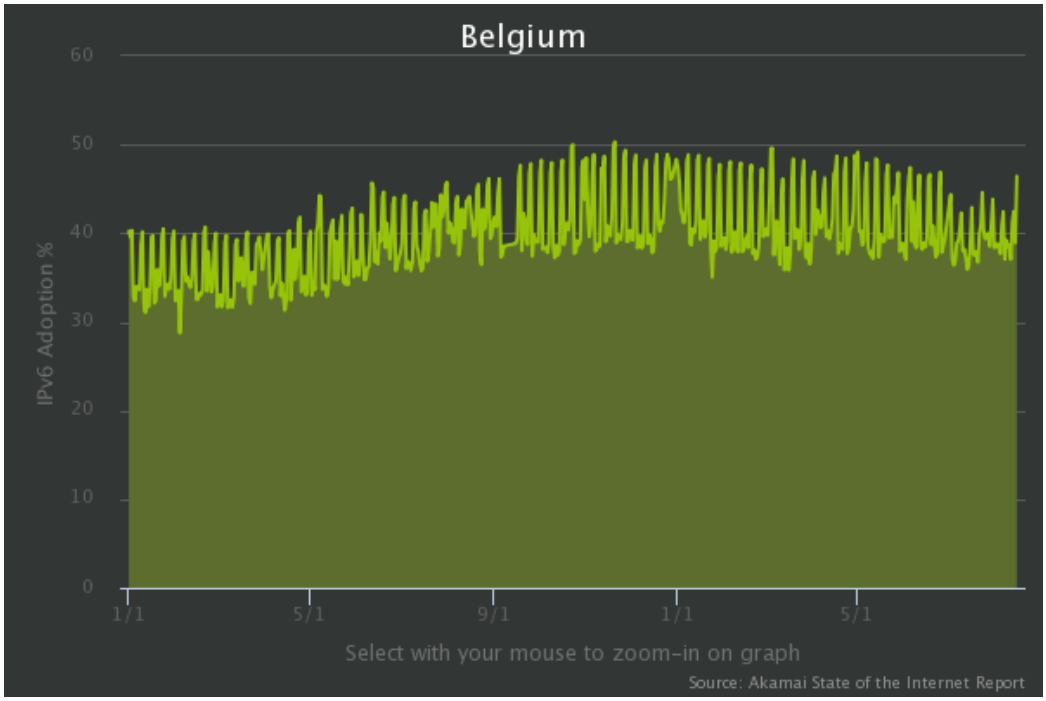
Source: Google IPV6 statistics

3.14.3 Akamai IPv6 Adoption Visualization

For Akamai, Belgium ranks at the 1st place with 46.4% adoption rate of IPv6[151]. Past data show a very moderate growth in recent years (data 2016-2017).

[150] Volume of users that access Google over IPv6

[151] Volume of IPv6 requests to Akamai

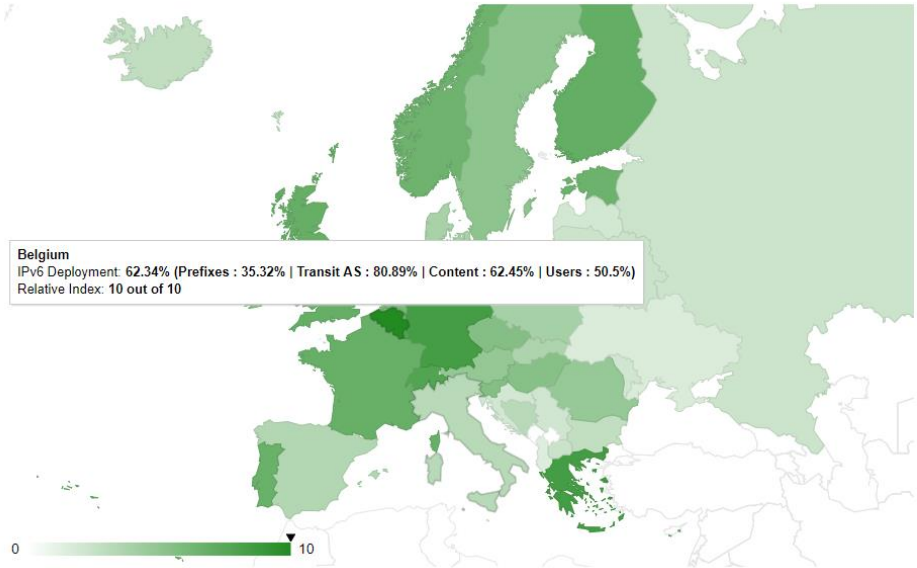


Source: Akamai, state of the Internet IPv6 adoption visualization

3.14.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages. Belgium is ranked at 62.34% and 10 out of 10 (relative index).

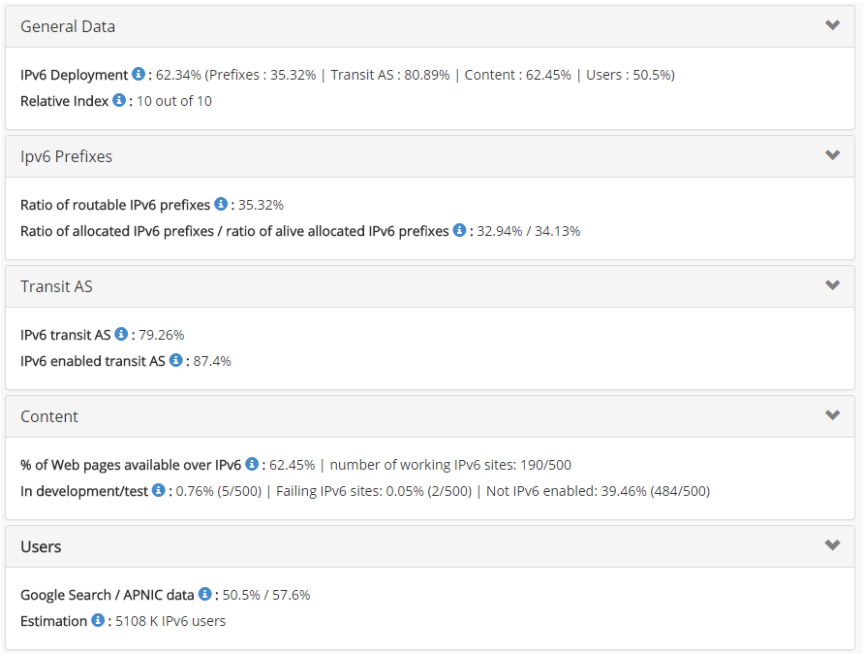
Figure 116: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

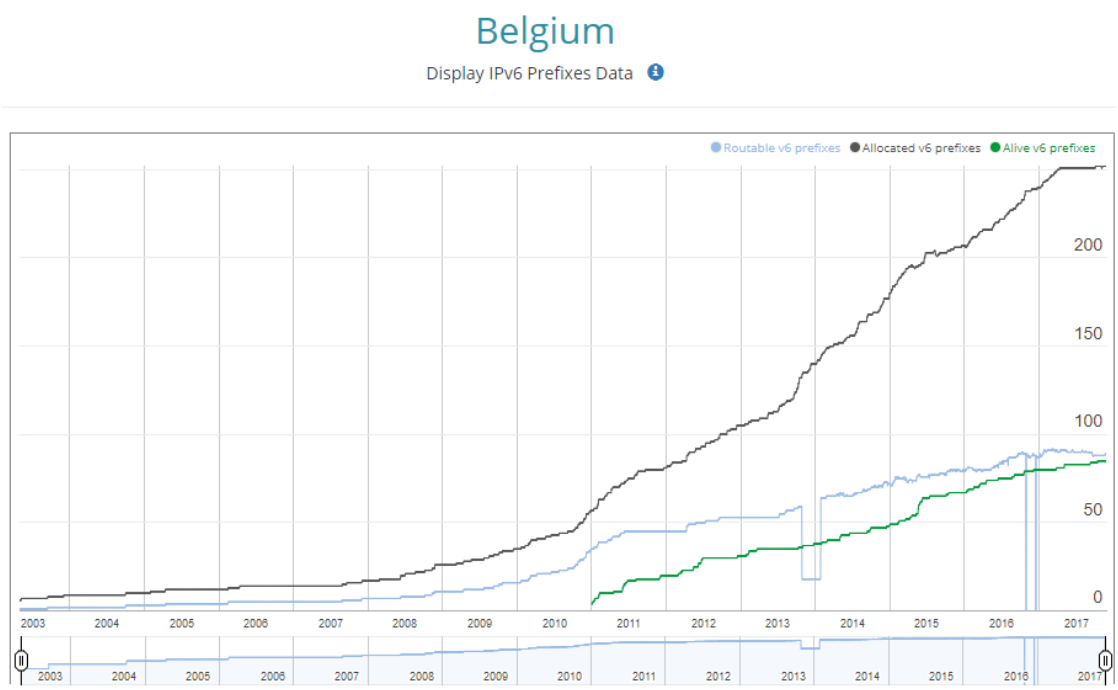
Other figures from Cisco indicates that in Belgium, 190/500 sites run on IPv6 and there are 5108 K IPv6 users.

Figure 117: IPv6 adoption at different layers



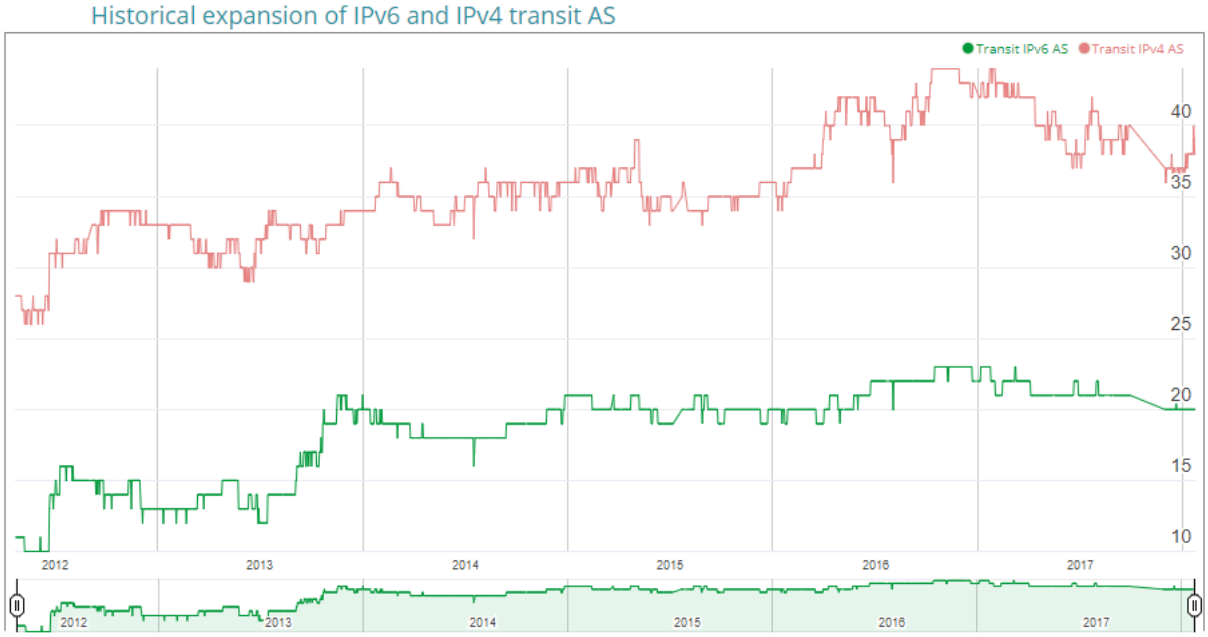
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 118: The evolution of IPv6 adoption in terms of "prefixes"



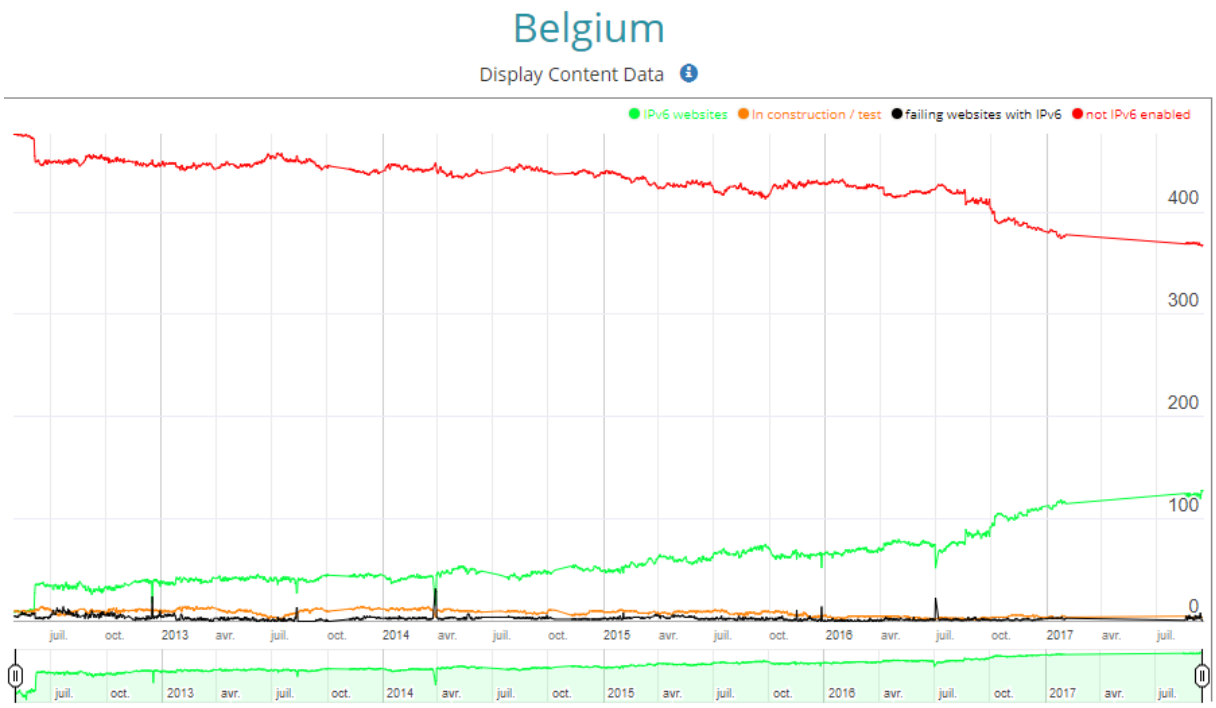
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 119: The evolution of IPv6 adoption in terms of “transit AS”



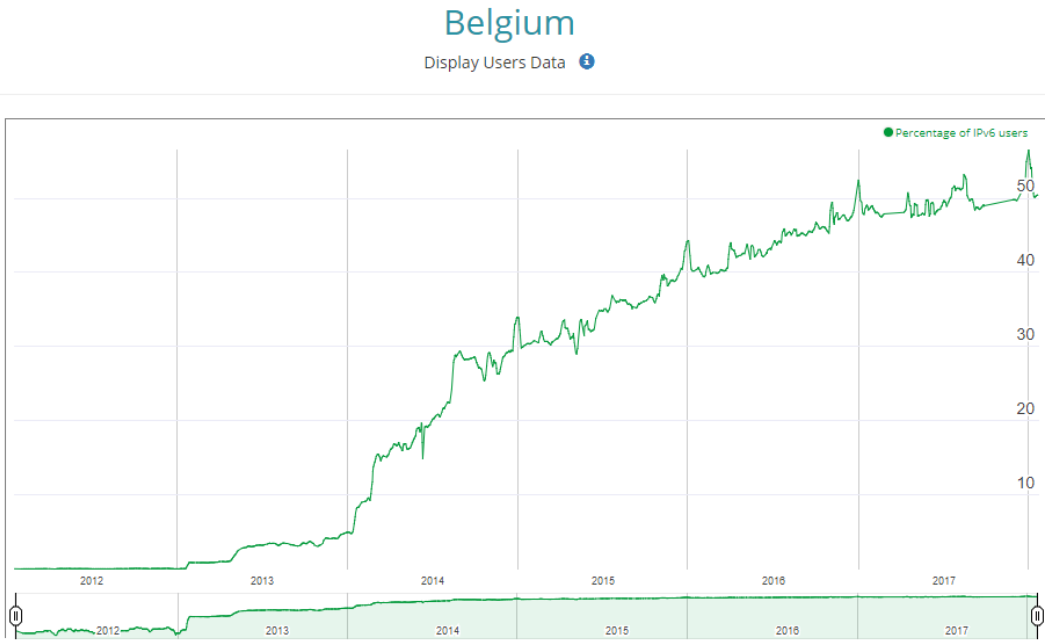
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 120: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 121: The evolution of IPv6 adoption in terms of “display users data”

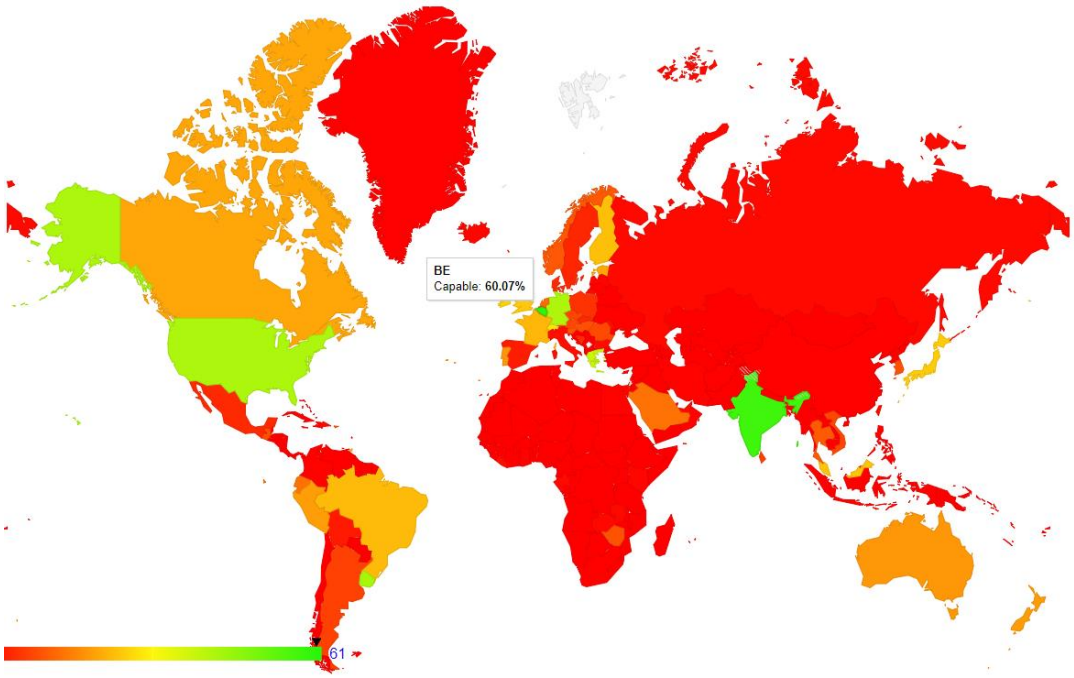


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.14.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Belgium displays in green revealing a very high adoption (ranked at 60.07%).

Figure 122: IPV6 capable rate by country (%)



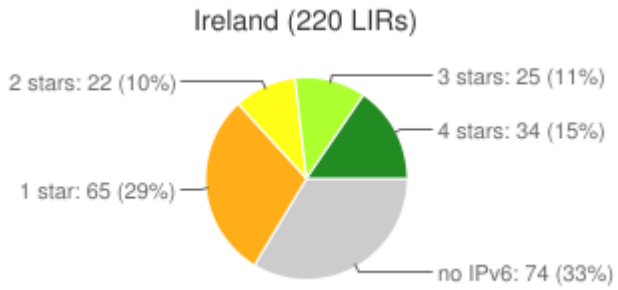
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.15 Ireland

3.15.1 RIPElabs RIPEness assessment

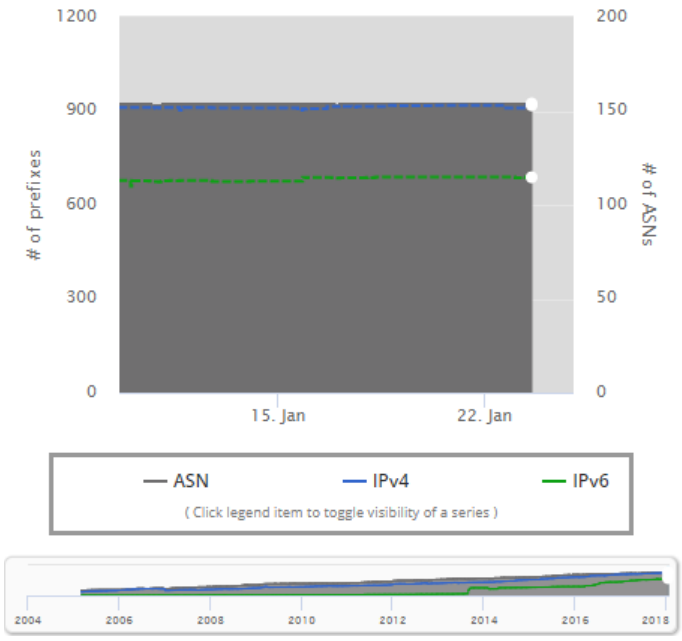
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Ireland is just below the average. Out of the 220 LIRs, a third still offer no IPv6 solution, and only 36% are ranked 2 star or more.

Figure 123: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 124: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Ireland

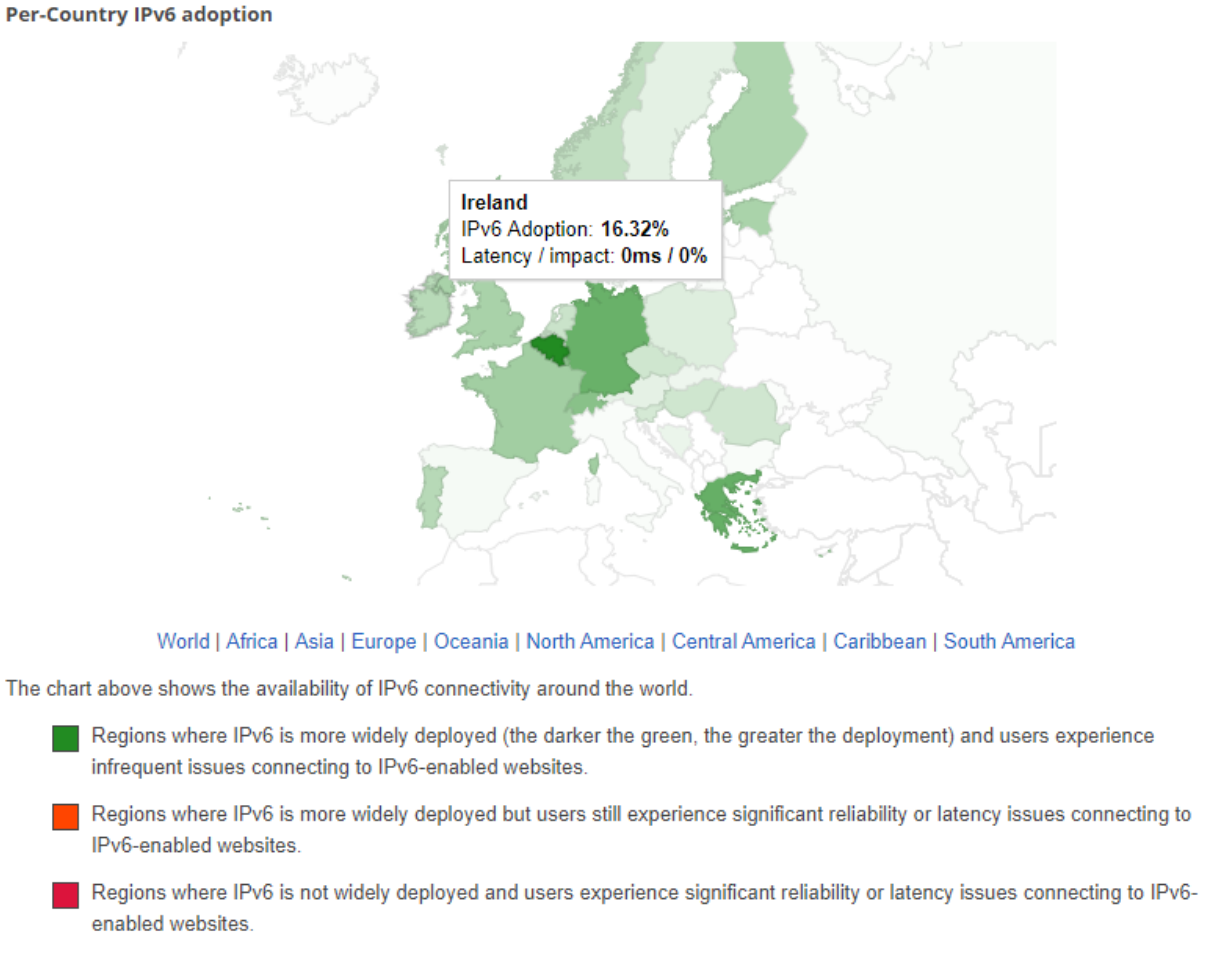


Source: https://stat.ripe.net/specials/country-comparison

3.15.2 Google IPv6 statistics

According to Google[152], the adoption rate is around 16.32% in Ireland, which is a bit below the global adoption (around 20%) and around the average adoption of European countries.

Figure 125: IPv6 adoption



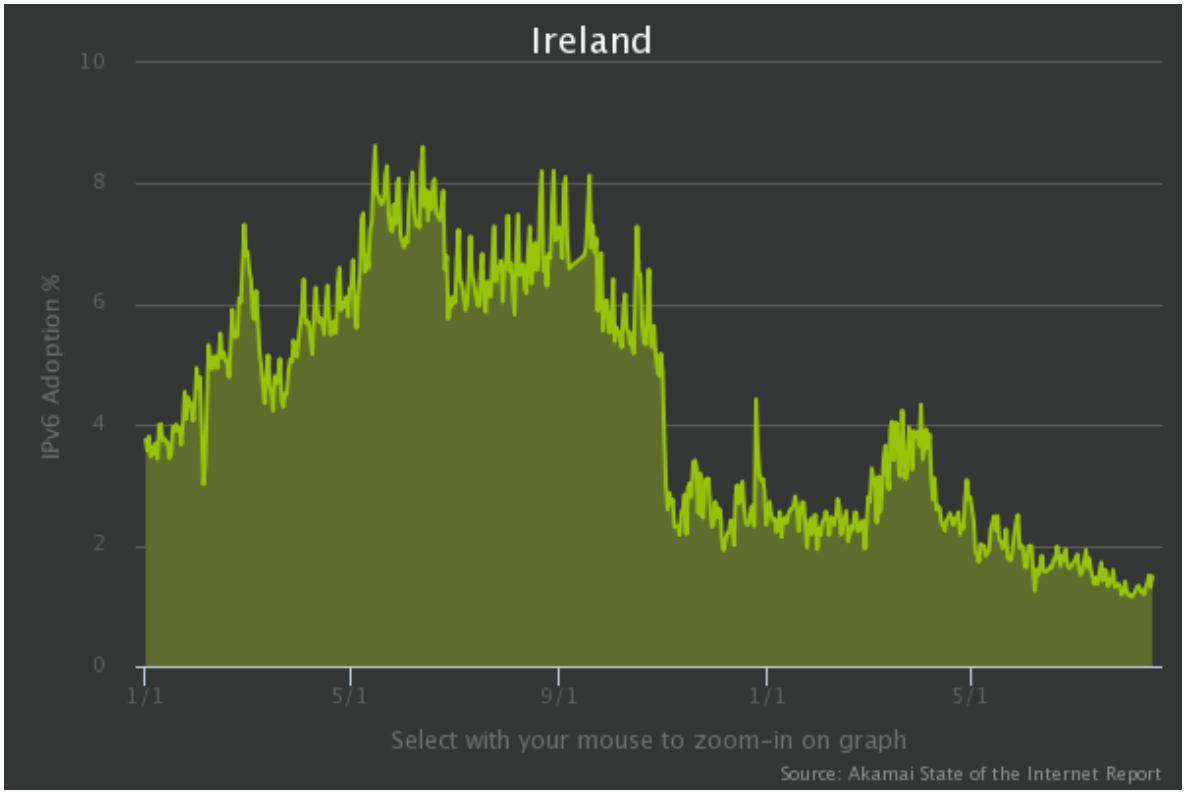
Source: Google IPV6 statistics

3.15.3 Akamai IPv6 Adoption Visualization

For Akamai, Ireland ranks at the 53rd place with 1.5% adoption rate of IPv6[153]. Past data show a significant drop, with previous maximum reaching 8.1% in June 2016.

[152] Volume of users that access Google over IPv6

[153] Volume of IPv6 requests to Akamai

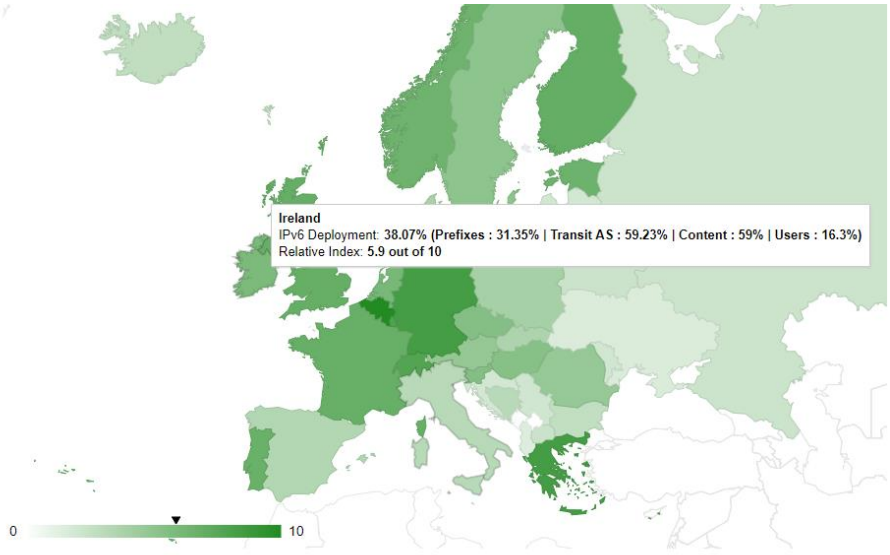


Source: Akamai, state of the Internet IPv6 adoption visualization

3.15.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…Ireland is ranked at 38.07% and 5.9 out of 10.

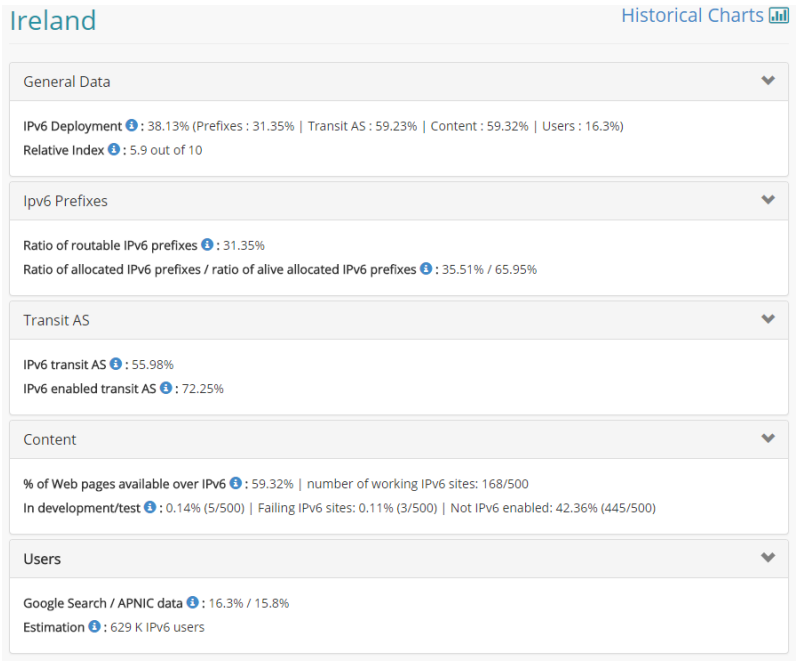
Figure 126: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

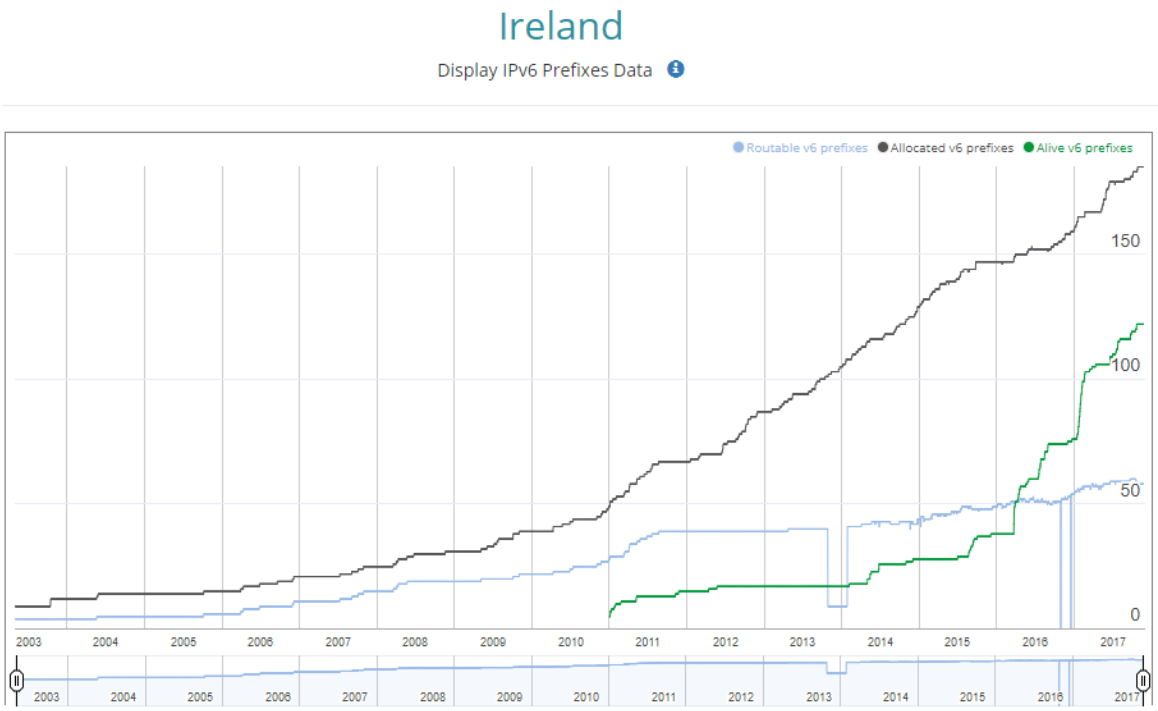
Other figures from Cisco indicates that in Ireland, 168/500 sites run on IPv6 and there are 629 K IPv6 users.

Figure 127: IPv6 adoption at different layers



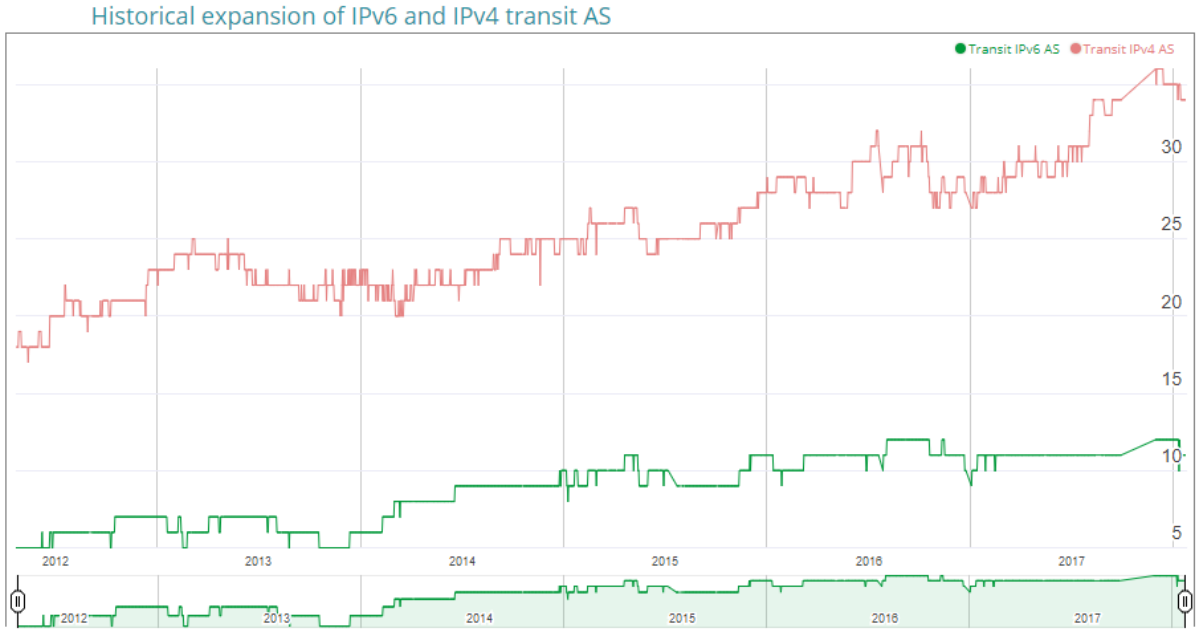
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 128: The evolution of IPv6 adoption in terms of "prefixes"



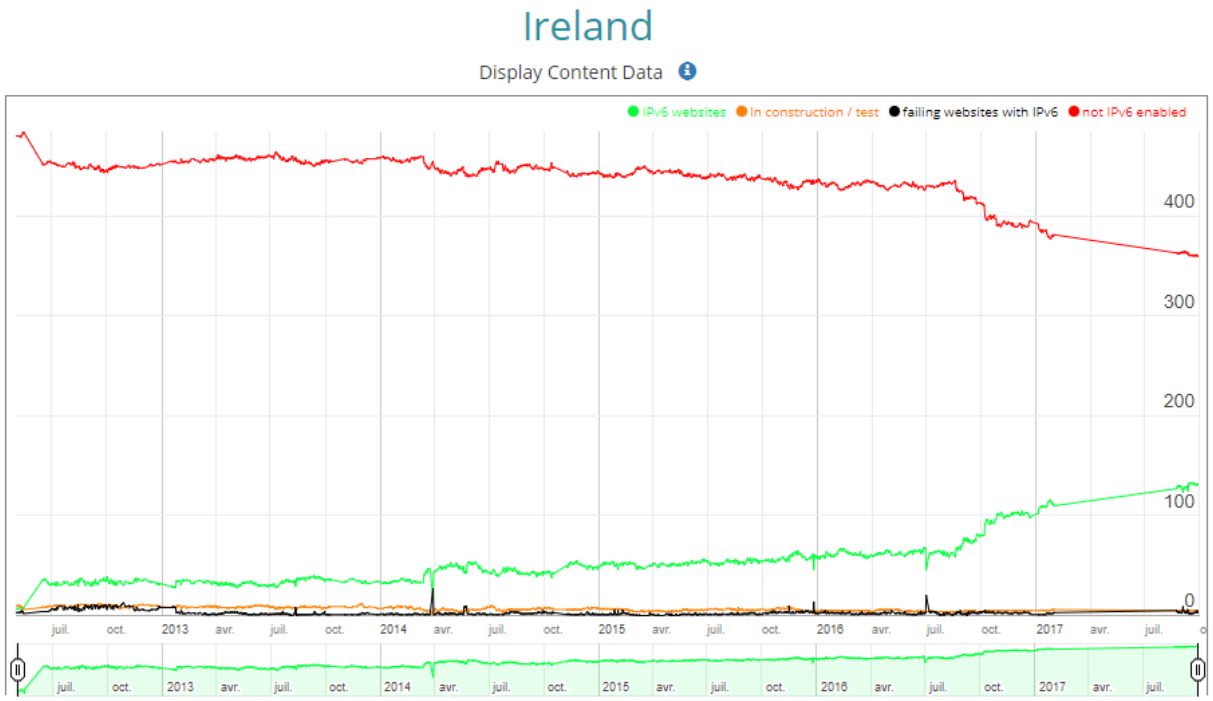
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 129: The evolution of IPv6 adoption in terms of “transit AS”



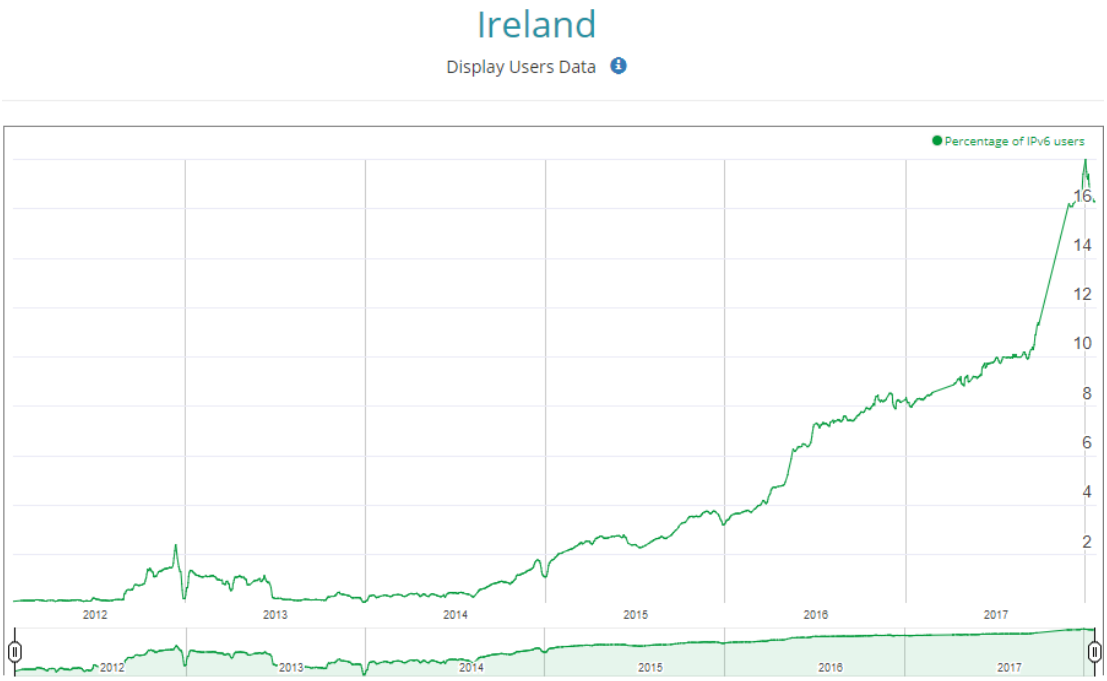
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 130: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 131: The evolution of IPv6 adoption in terms of “display users data”

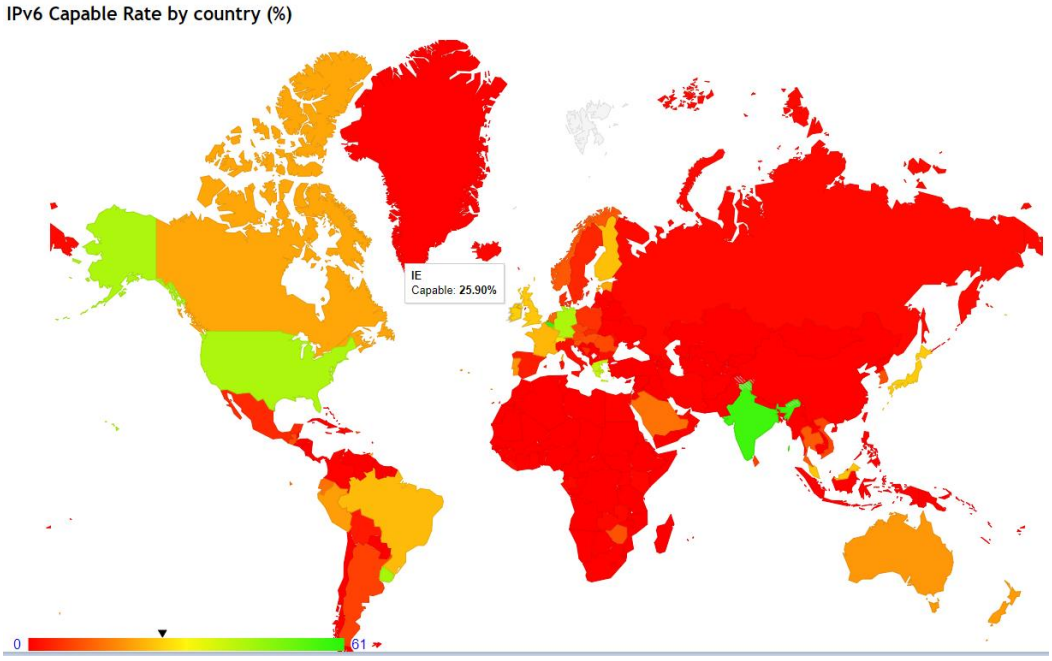


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.15.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Ireland displays in orange revealing a moderate adoption (ranked at 25.9%).

Figure 132: IPV6 capable rate by country (%)



Source: APNIC, https://stats.labs.apnic.net/ipv6

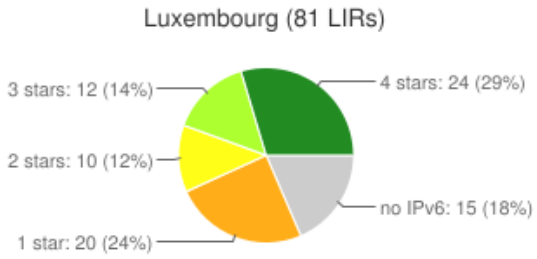
3.16 Luxembourg

3.16.1 RIPElabs RIPEness assessment

According to RIPE NCC, Luxembourg counts 81LIRs. The readiness to move to IPv6 for those RIPE NCC members in Luxembourg is higher than all LIRs RIPEness at global level in proportion.

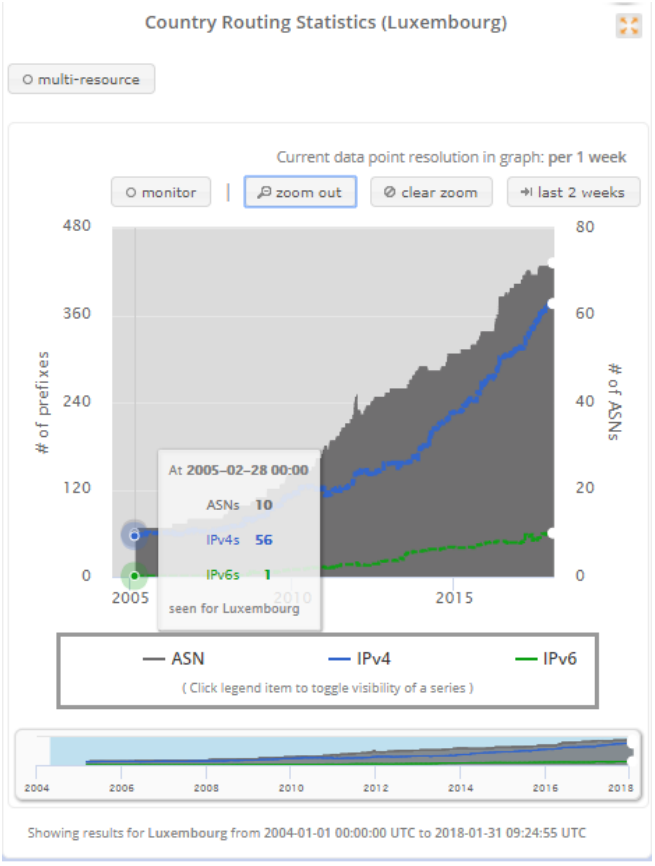
- 29% of LIRs have been awarded with 4 stars for different IPv6 support (IPv6 allocation, visibility in the Routing Information Service (RIS), route object in the RIPE Database, reverse DNS), compared to 19% globally;
- Only 18% of LIRs indicate no sign of IPv6 deployment (no star), compared to 27% globally.

Figure 133: IPv6 RIPEness in Luxembourg



Source: http://ripeness.ripe.net/pies.html

Figure 134: Evolution of number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Luxembourg, 2005-2018

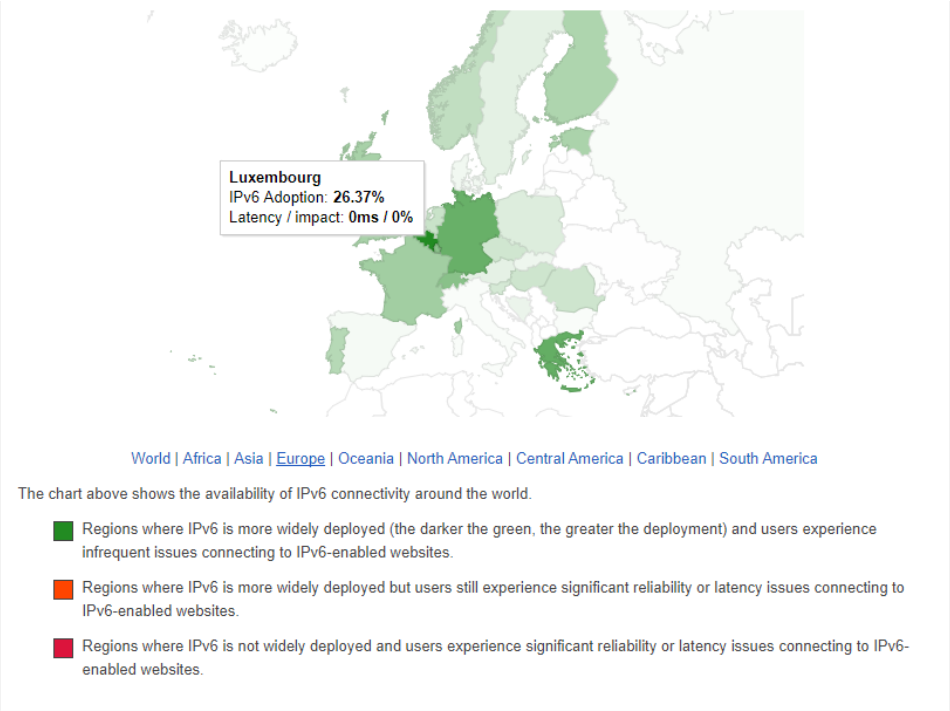


Source: https://stat.ripe.net/specials/country-comparison

3.16.2 Google IPv6 statistics

According to Google statistics, Luxembourg is among the countries the most advanced with 26.37% displayed in the figure below.

Figure 135: IPv6 adoption by Google

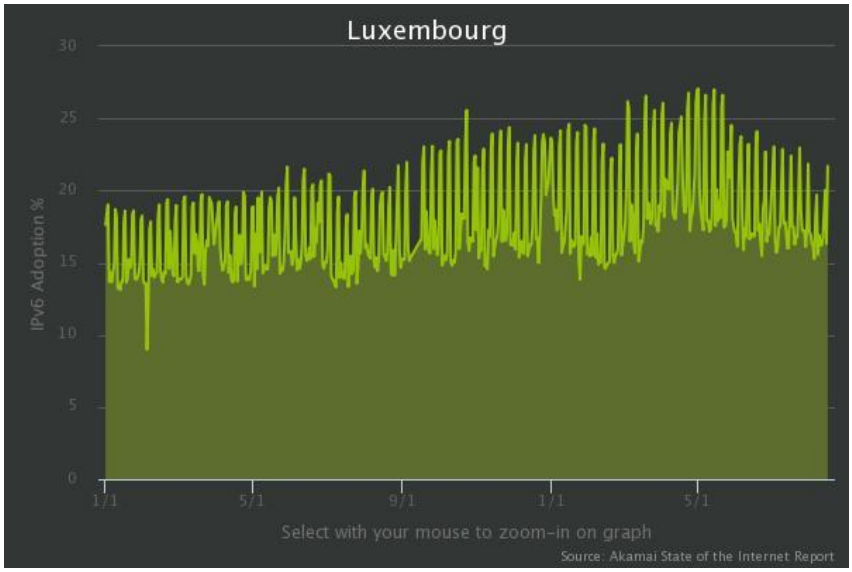


Source: Google IPv6 stats

3.16.3 Akamai IPv6 Adoption Visualization

Akamai ranks Luxembourg at the 6th position (out of 246 countries) with 21.7% adoption rate.

Figure 136: IPv6 adoption by Akamai

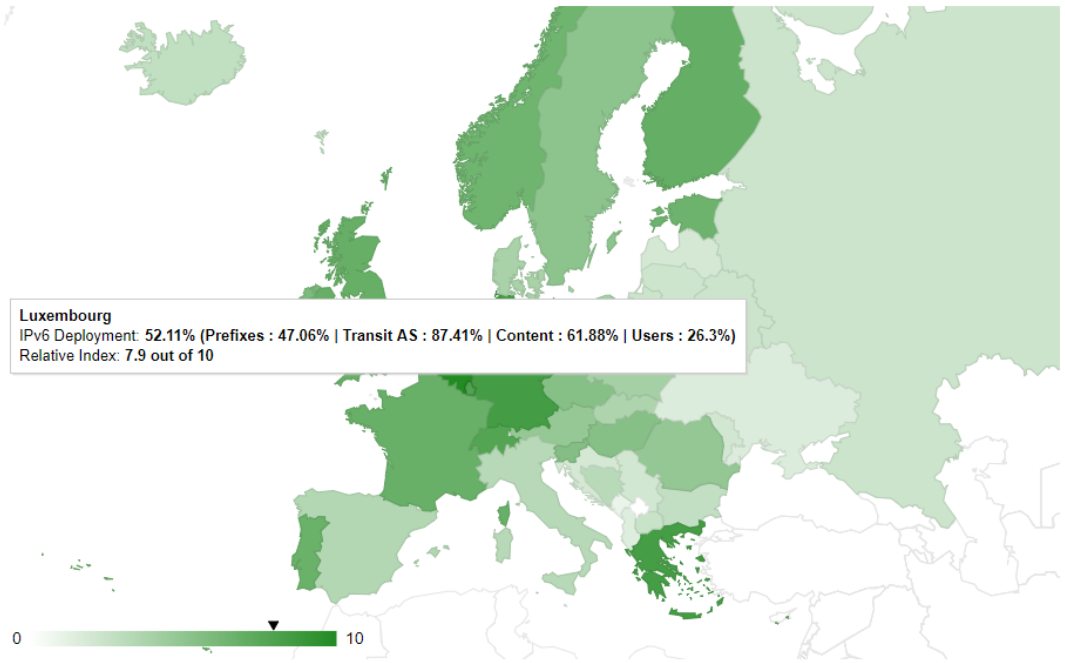


Source: Akamai, state of the Internet IPv6 adoption visualization

3.16.4 Cisco 6lab

According to Cisco, Luxembourg displays a relatively high IPv6 implementation (index at 7.9 out of 10).

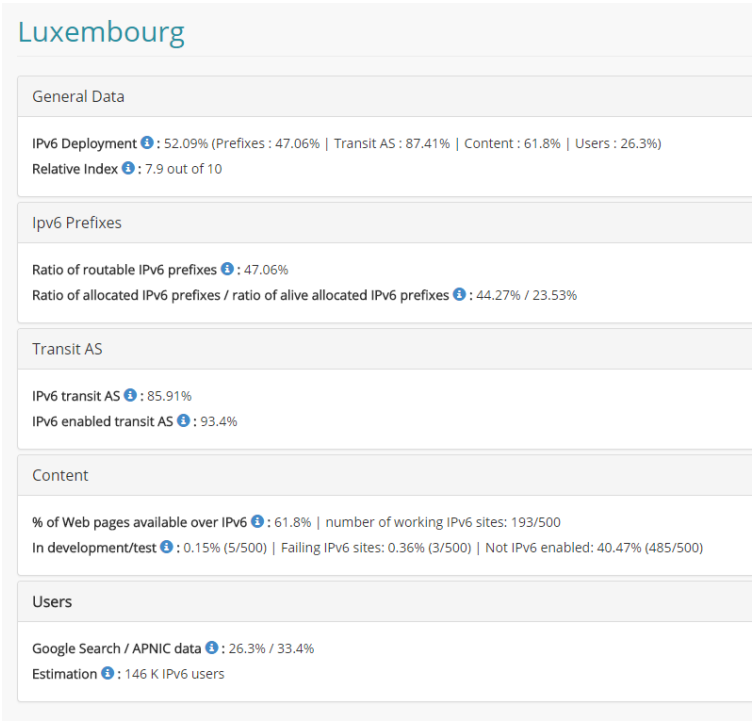
Figure 137: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Other figures from Cisco indicates that in Luxembourg, 193/500 sites run on IPv6 and there are 146 K IPv6 users.

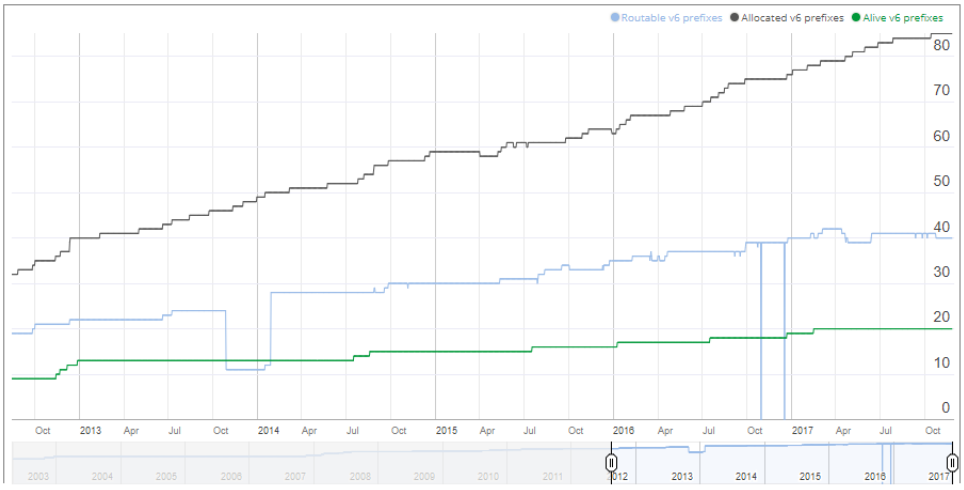
Figure 138: IPv6 adoption at different layers



Source: Cisco - 6lab - The place to monitor IPv6 adoption

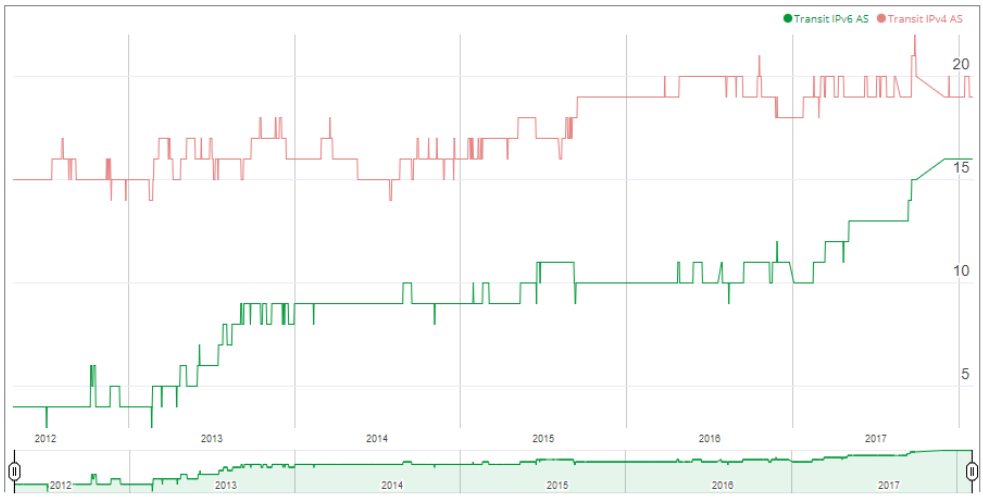
In addition, Cisco provides an evolution of IPv6 adoption in different aspects (prefixes, transit, content users) indicating a growing trends of use of the protocol.

Figure 139: The evolution of IPv6 adoption in terms of “prefixes”



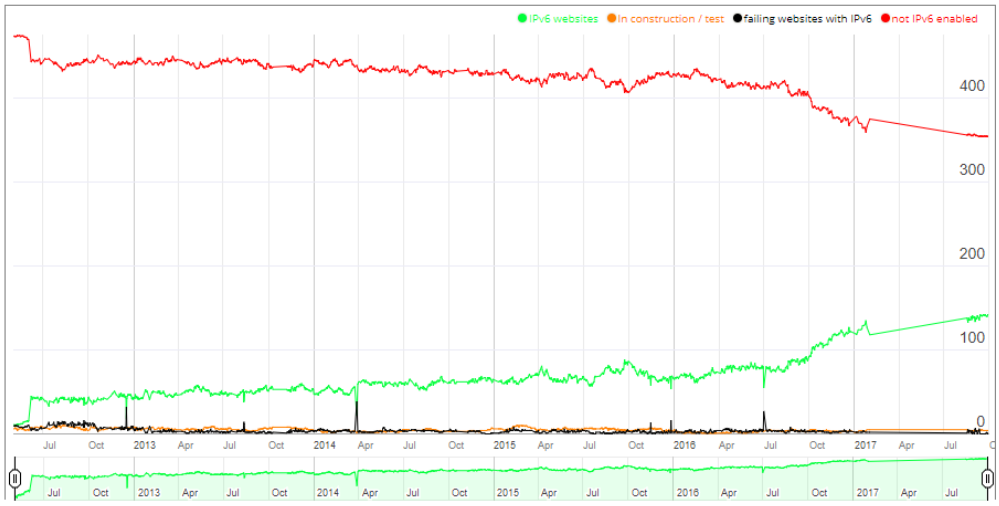
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 140: The evolution of IPv6 adoption in terms of “transit AS”



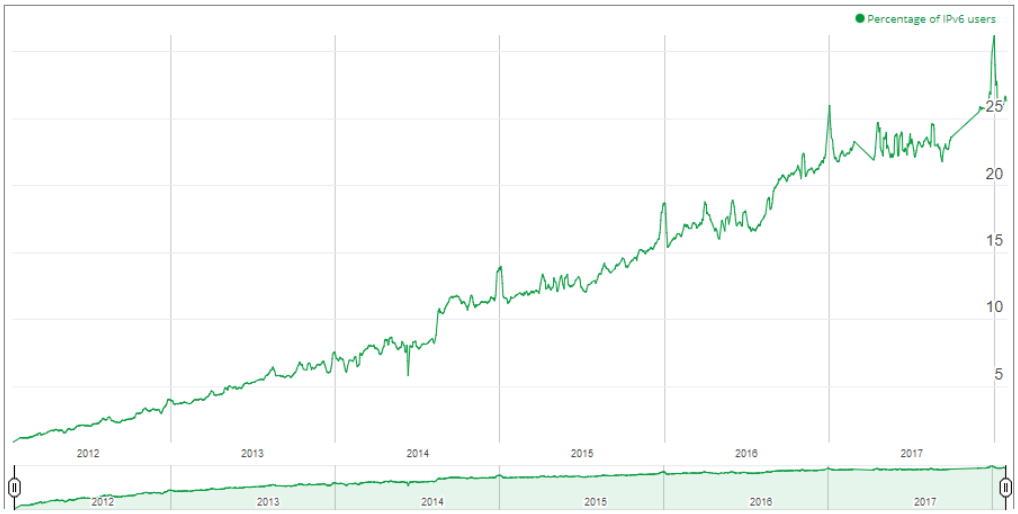
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 141: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 142: The evolution of IPv6 adoption in terms of "display users data"



Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.16.5 Ministry of the communications and media

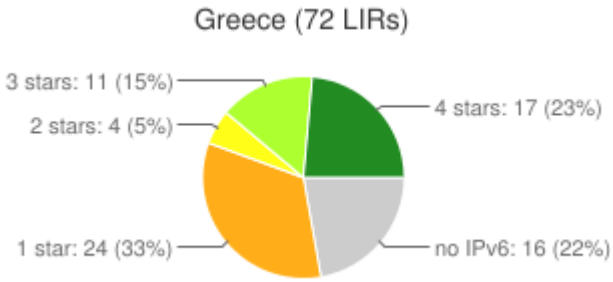
As of 2011, in a letter[154] addressed by the ministry of the communications and media to the government of Grand Duchy of Luxembourg, the percentage of active domain names under .lu displaying an IPv6 address was roughly 1.5% (875 domains out of 58500).

[154] http://www.greng.lu/sites/greng/files/20110609-1509-AD-IPv6-QR.pdf

3.17 Greece

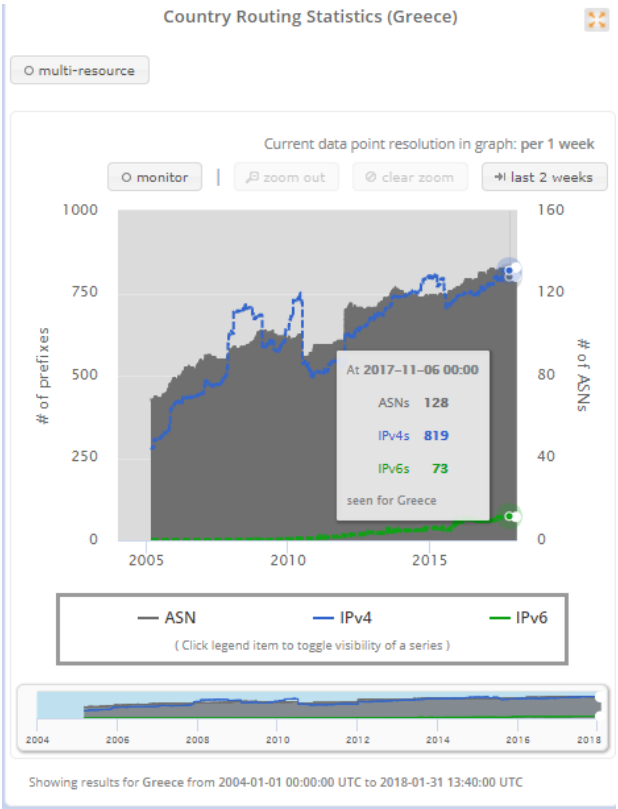
3.17.1 RIPElabs RIPEness assessment

Figure 143: IPv6 RIPEness in Greece



Source: http://ripeness.ripe.net/pies.html

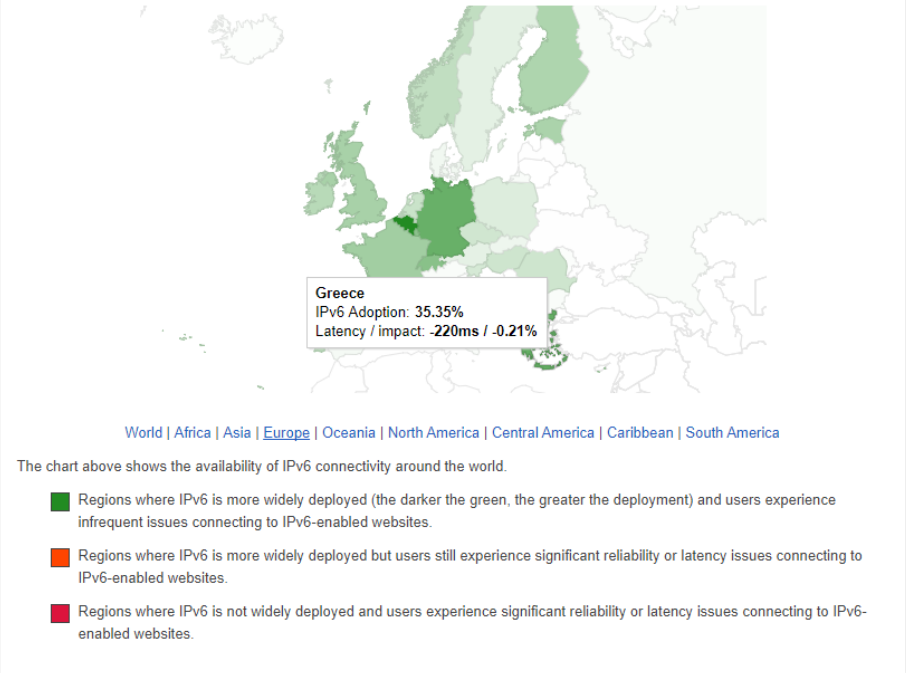
Figure 144: Evolution of number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Greece, 2005-2018



Source: https://stat.ripe.net/specials/country-comparison

3.17.2 Google IPv6 statistics

Figure 145: IPv6 adoption by Google

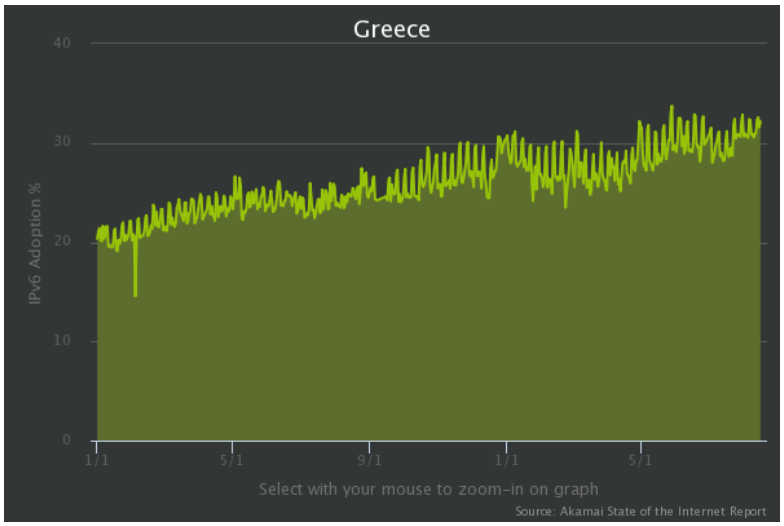


Source: Google IPv6 stats

3.17.3 Akamai IPv6 Adoption Visualization

Akamai ranks Greece at the 4th position (out of 246 countries) with 32.2% adoption rate.

Figure 146: IPv6 adoption by Akamai

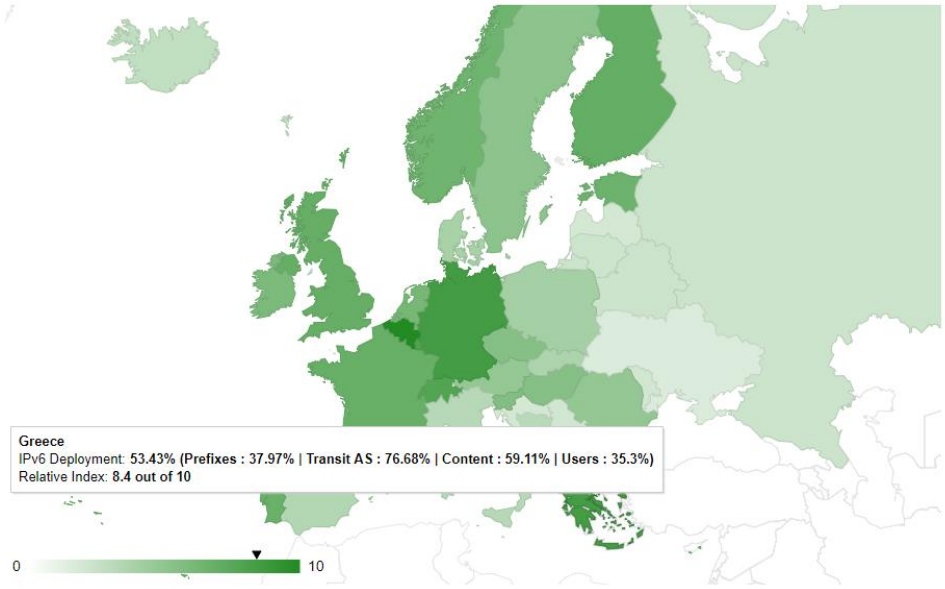


Source: Akamai, state of the Internet IPv6 adoption visualization

3.17.4 Cisco 6lab

According to Cisco, Greece displays a high IPv6 implementation (index at 8.4 out of 10).

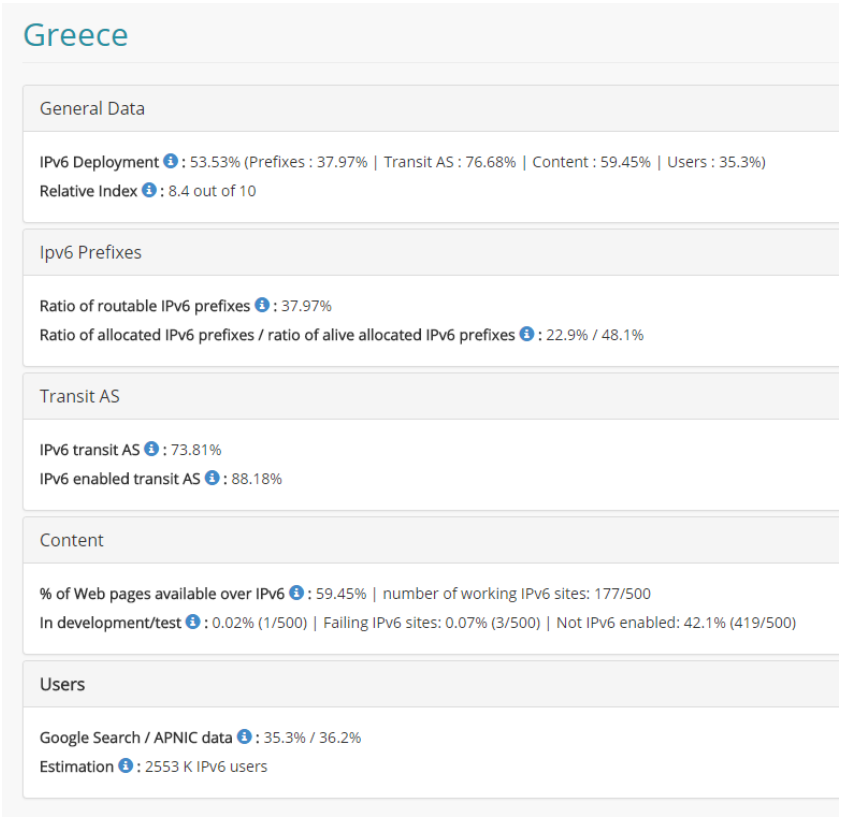
Figure 147: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Other figures from Cisco indicates that in Greece, 177/500 sites run on IPv6 and there are 2553 K IPv6 users.

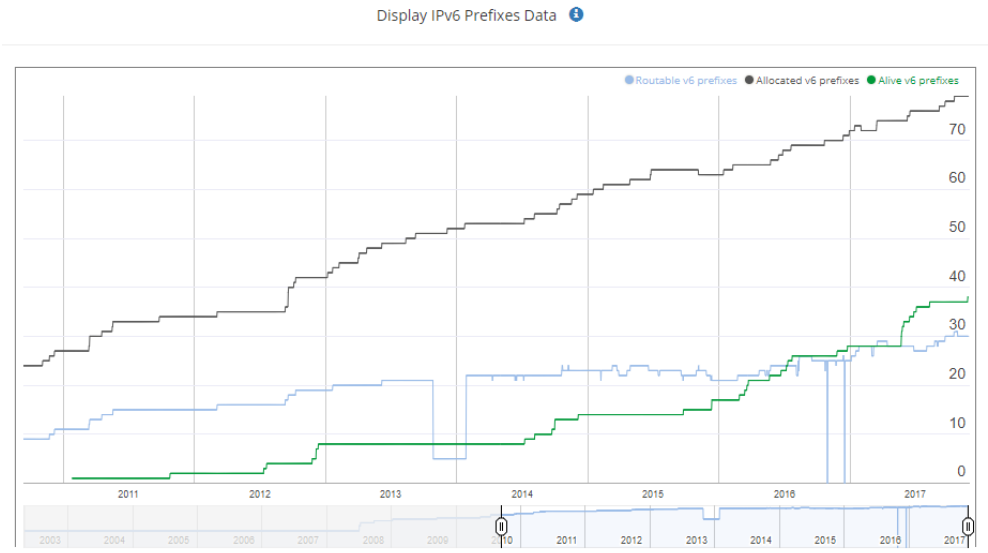
Figure 148: IPv6 adoption at different layers



Source: Cisco - 6lab - The place to monitor IPv6 adoption

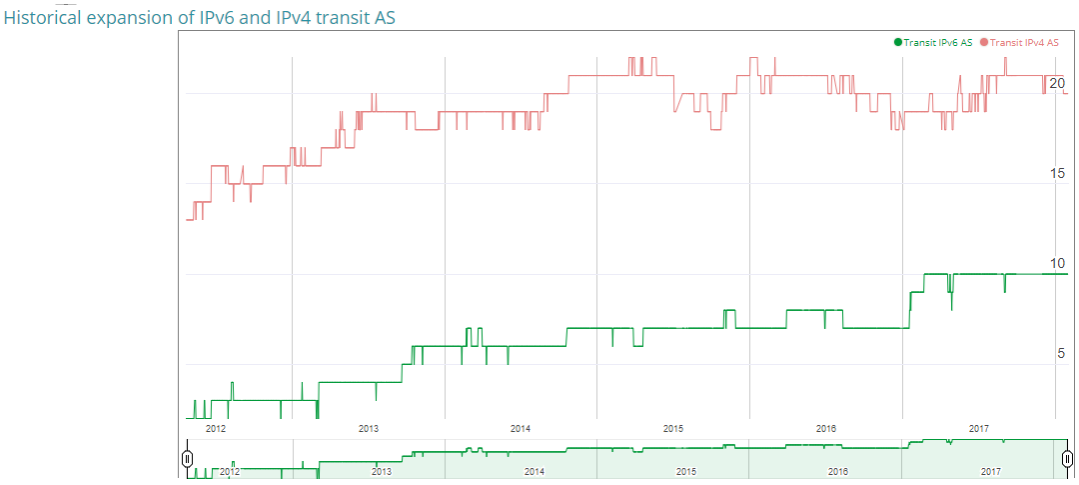
In addition, Cisco provides an evolution of IPv6 adoption in different aspects (prefixes, transit, content users) indicating a growing trends of use of the protocol.

Figure 149: The evolution of IPv6 adoption in terms of “prefixes”



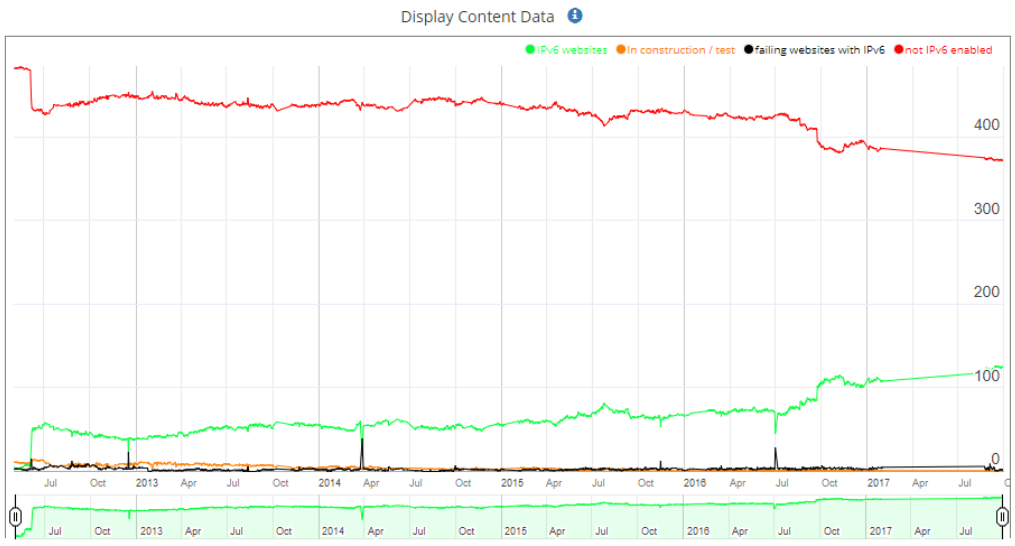
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 150: The evolution of IPv6 adoption in terms of “transit AS”



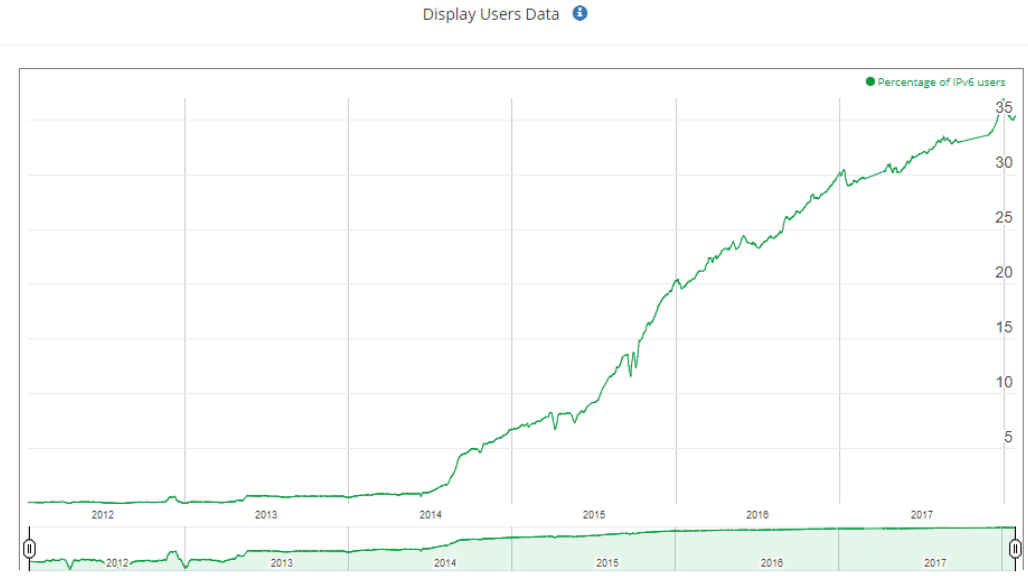
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 151: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

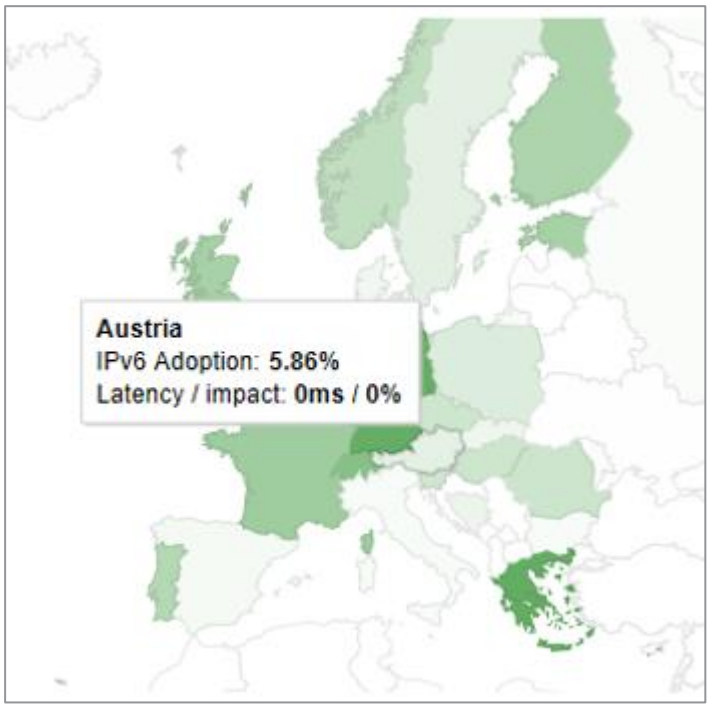
Figure 152: The evolution of IPv6 adoption in terms of “display users data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.18 Austria

According to Google, the IPv6 adoption rate in Austria is roughly 6% (as of February 2018). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[155], Austria has a 8.7% IPv6 adoption rate, which ranks 25th in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[156]. Compared to the overall pie chart, one can see that Austria is higher than the world average.

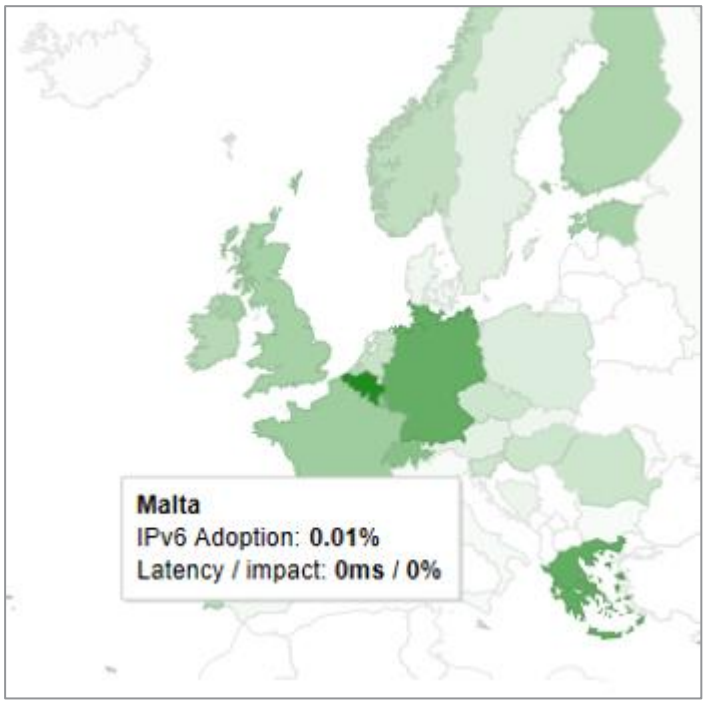
Source: http://ripeness.ripe.net/pies.html

[155] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

[156] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

3.19 Malta

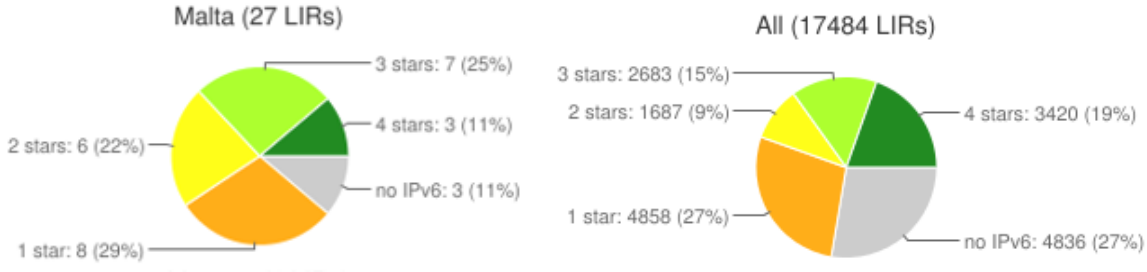
According to Google, the IPv6 adoption rate in Malta is 0.01% (as of February 2018). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[157], Malta has a 0.0% IPv6 adoption rate, which ranks 111th in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[158]. Compared to the overall pie chart, Malta actually comes across as having a good IPv6 readiness compared to the world average. Those numbers will be checked again, as this is not relevant with data mentioned above.



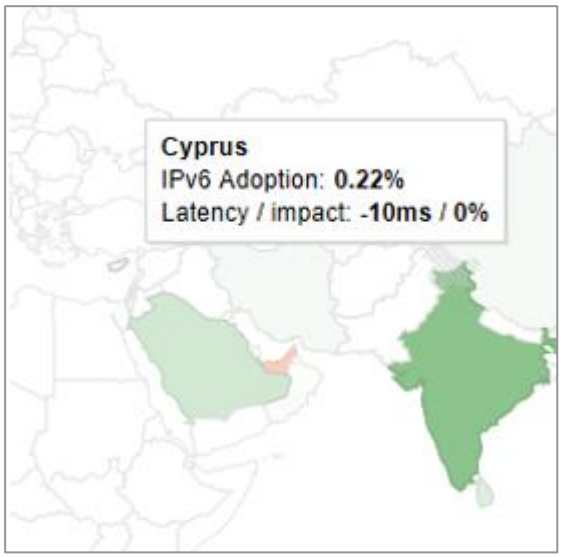
Source: http://ripeness.ripe.net/pies.html

[157] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

[158] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

3.20 Cyprus

According to Google, the IPv6 adoption rate in Cyprus is 0.22% (as of February 2018). This is based on the percentage of access to google sites using IPv6.



Source: https://www.google.fr/ipv6/statistics.html#tab=per-country-ipv6-adoption&tab=per-country-ipv6-adoption

According to Akamai[159], Cyprus has a 0.1% IPv6 adoption rate, which ranks 72nd in the world.

Finally, below is a pie chart from RIPE NCC, which measures countries' IPv6 preparedness[160]. Compared to the overall pie chart, one can see that Cyprus is not ready for IPv6 compared to the world average.

Source: http://ripeness.ripe.net/pies.html

[159] https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp

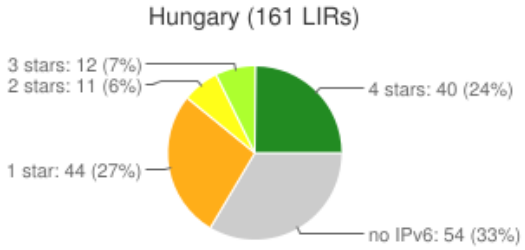
[160] Details on how to achieve 4 star status can be found at https://labs.ripe.net/Members/becha/ipv6-ripeness-how-to-reach-the-stars

3.21 Hungary

3.21.1 RIPElabs RIPEness assessment

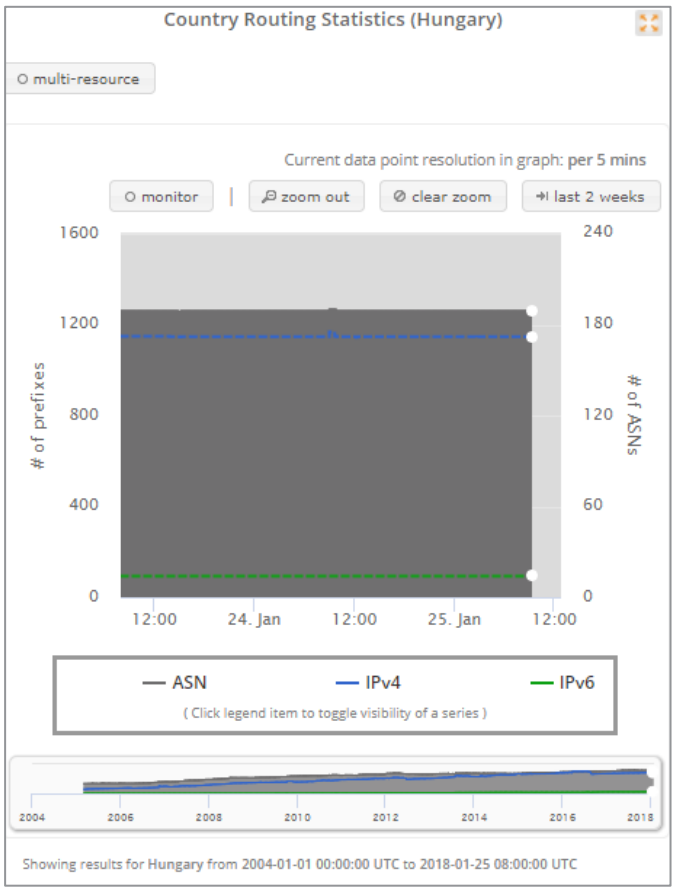
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Hungary is relatively in line with all LIRs RIPEness globally. Out of the 161 LIRs, around one quarter of has been awarded 4 stars.

Figure 153: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 154: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Hungary

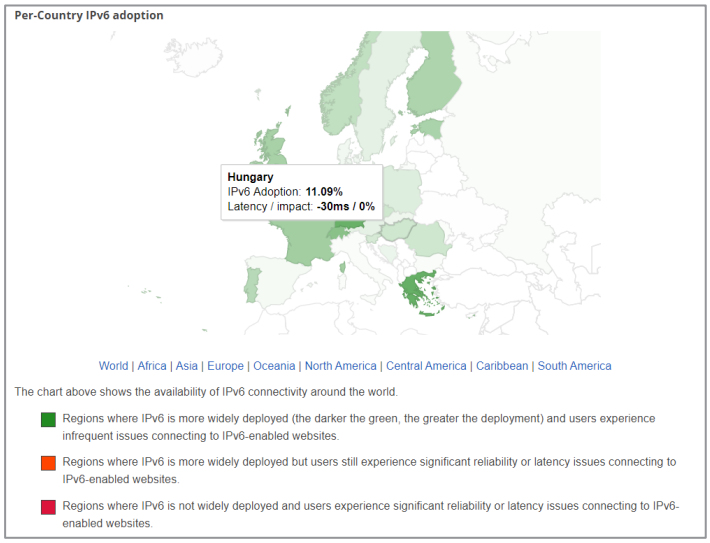


Source: https://stat.ripe.net/specials/country-comparison

3.21.2 Google IPv6 statistics

According to Google[161], the adoption rate is above 11% in Hungary, which remains low, when compared to global adoption (around 20%) and to European countries that are ahead like Belgium, Germany or Greece.

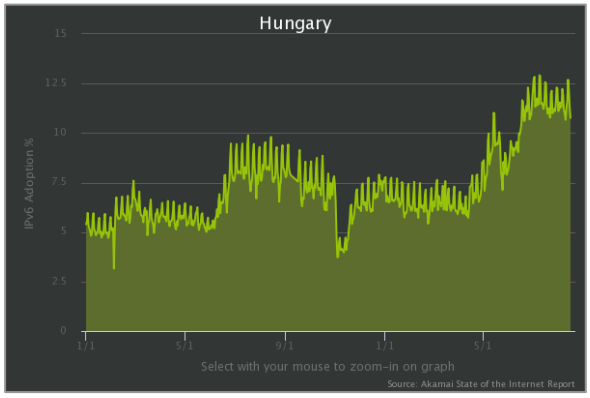
Figure 155: IPv6 adoption



Source: Google IPV6 statistics

3.21.3 Akamai IPv6 Adoption Visualization

According to Akamai, Hungary ranks at the 21th place with a 10.8% adoption rate of IPv6[162]. However, it seems that there is a growing trend since the beginning of 2017.



Source: Akamai, state of the Internet IPv6 adoption visualization

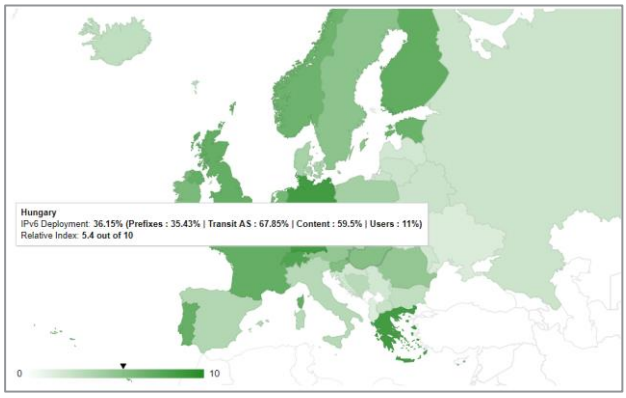
[161] Volume of users that access Google over IPv6

[162] Volume of IPv6 requests to Akamai

3.21.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages… In this configuration, Hungary is in the middle of the pack, displaying an IPv6 adoption rate a little above 36%.

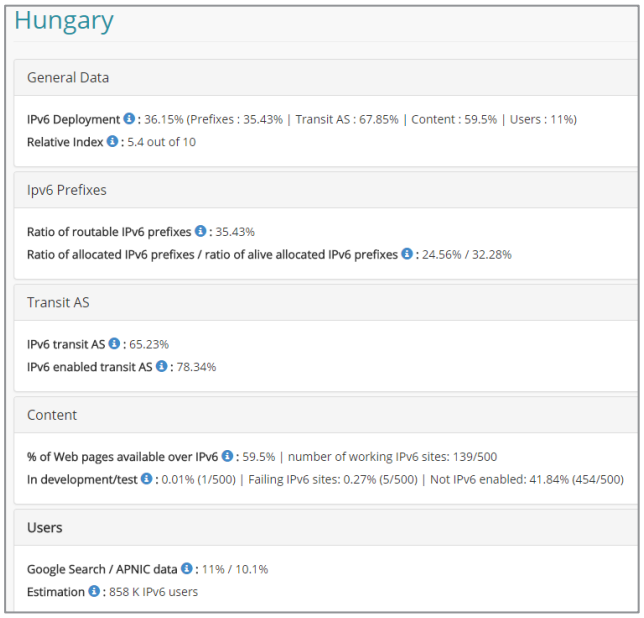
Figure 156: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

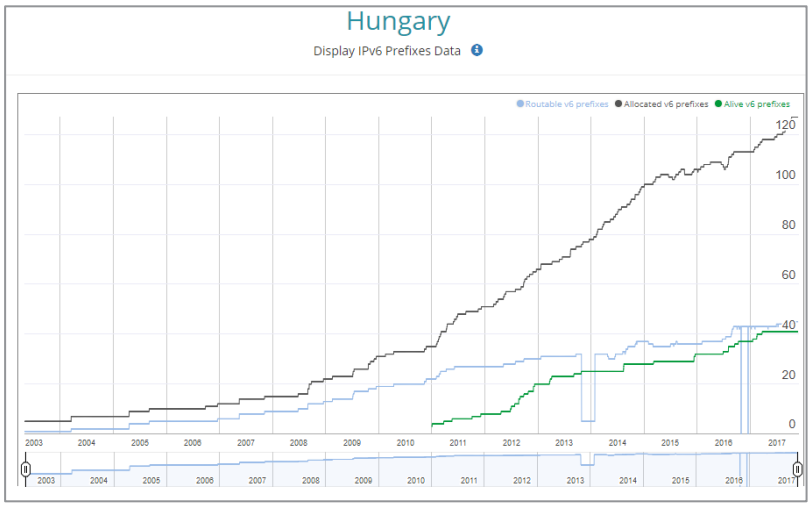
Other figures from Cisco indicates that in Hungary, 139/500 sites run on IPv6 and there are 858 000 IPv6 users.

Figure 157: IPv6 adoption at different layers



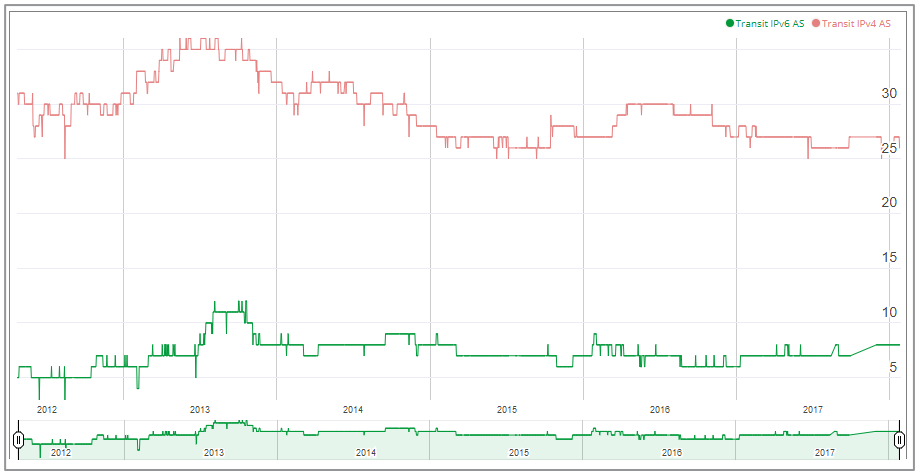
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 158: The evolution of IPv6 adoption in terms of “prefixes”



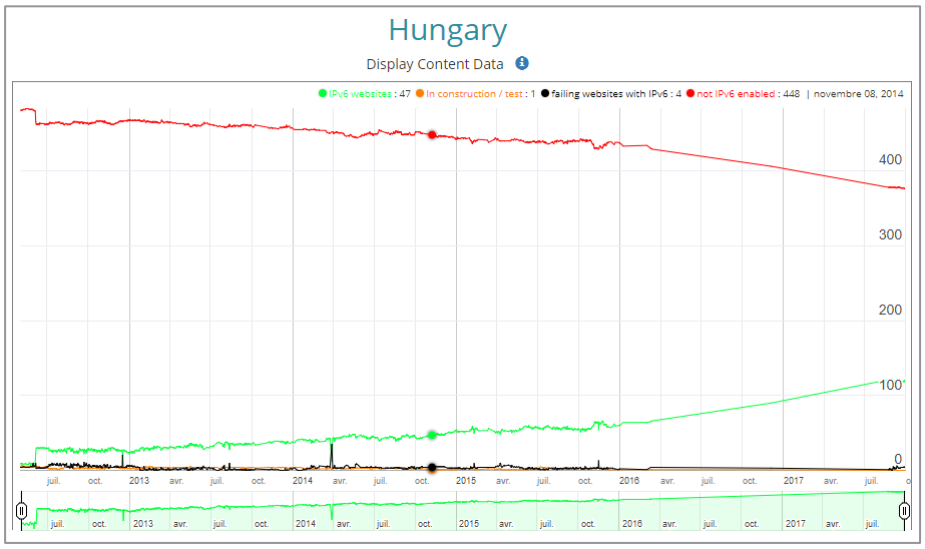
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 159: The evolution of IPv6 adoption in terms of “transit AS”



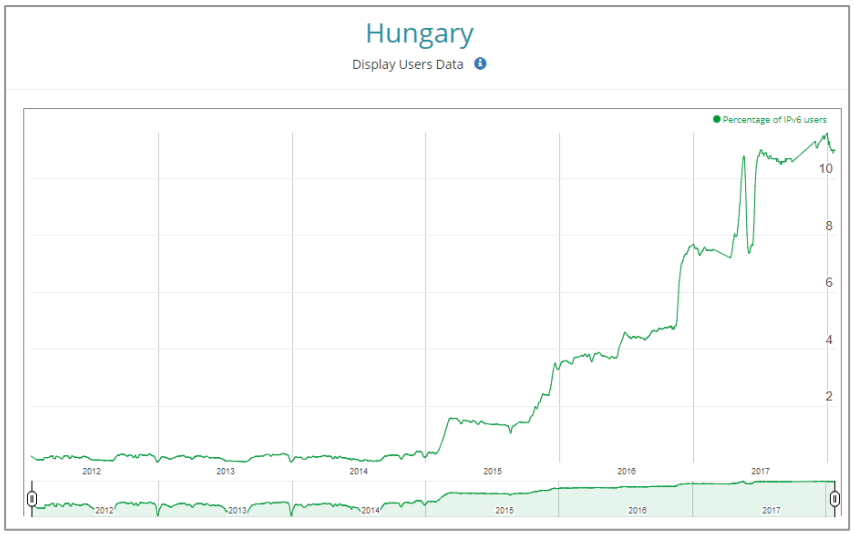
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 160: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 161: The evolution of IPv6 adoption in terms of “display users data”

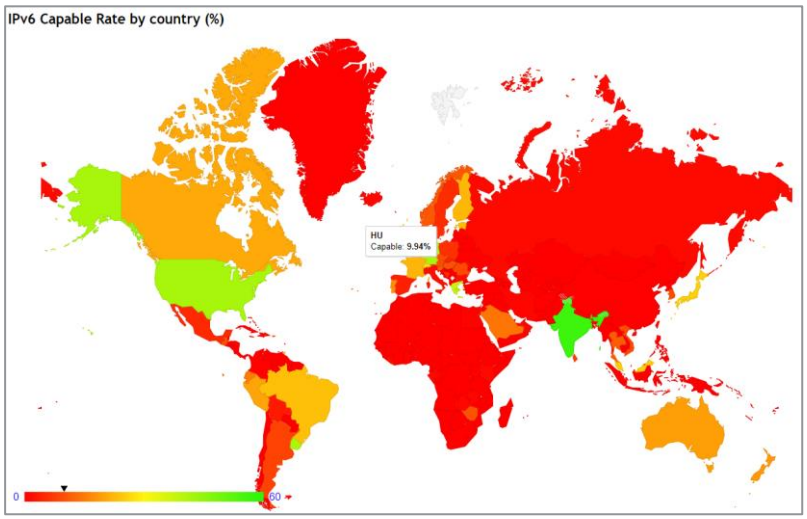


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.21.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Hungary is displayed in dark-orange, revealing a low-medium adoption.

Figure 162: IPV6 capable rate by country (%)



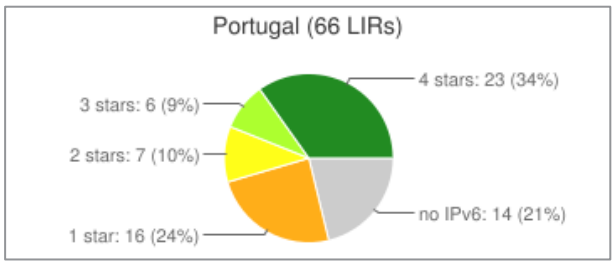
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.22 Portugal

3.22.1 RIPElabs RIPEness assessment

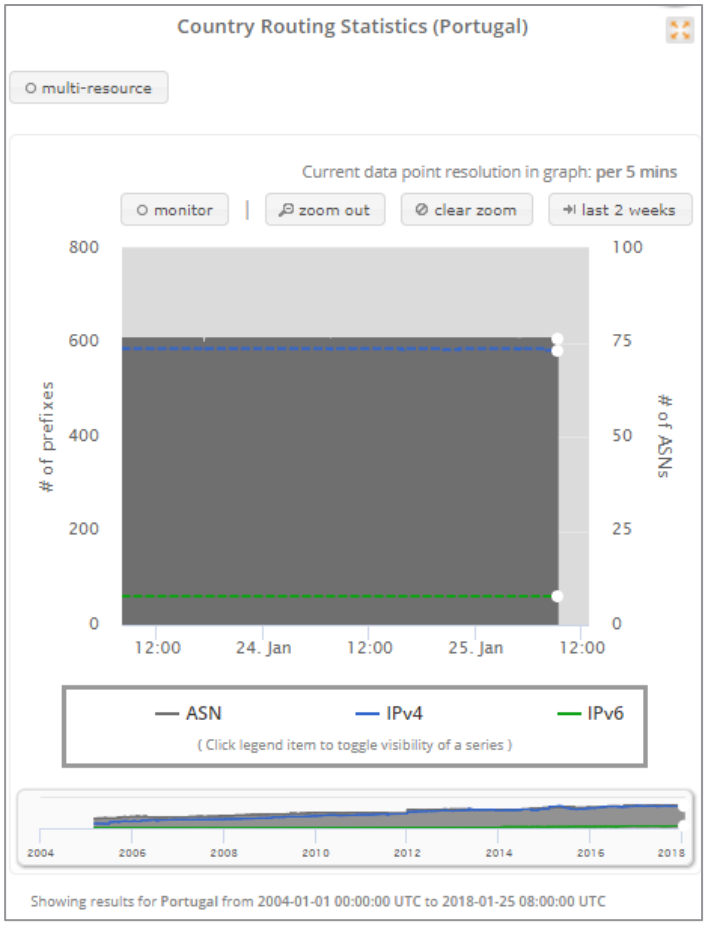
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Portugal is somewhat high compared to other countries. Out of the 66 LIRs, 34% has been awarded 4 stars.

Figure 163: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 164: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Portugal

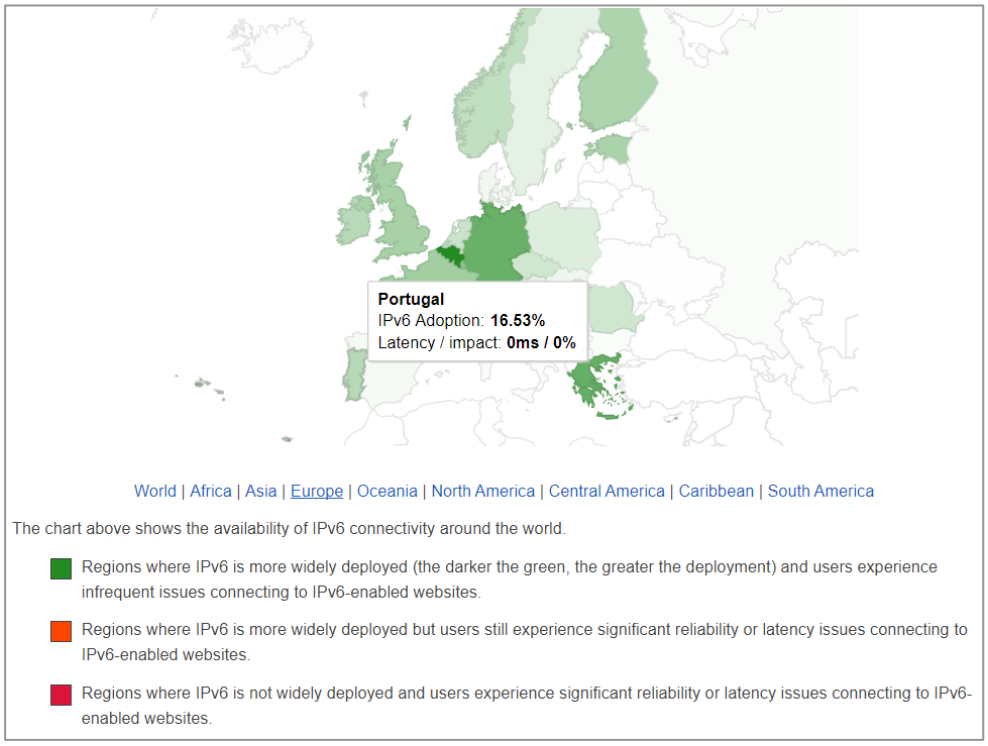


Source: https://stat.ripe.net/specials/country-comparison

3.22.2 Google IPv6 statistics

According to Google[163], the adoption rate is close to 17% in Portugal, which is almost in line with global adoption (20%). It remains behind several European countries, such as Belgium, Germany or Greece.

Figure 165: IPv6 adoption



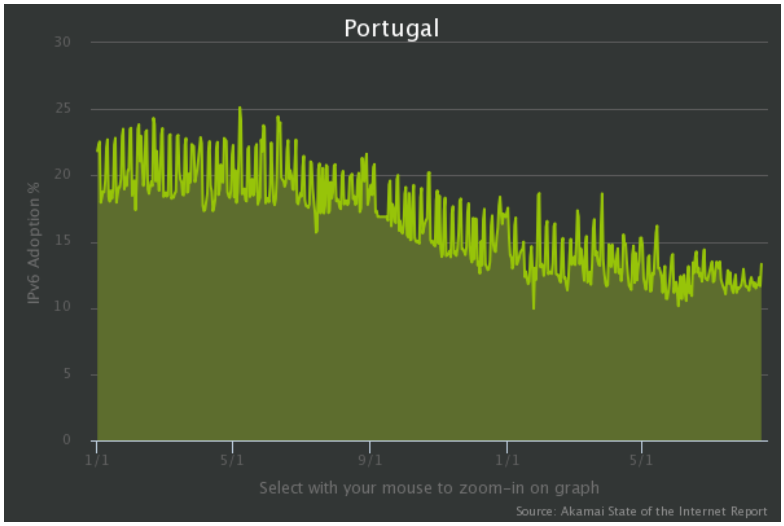
Source: Google IPV6 statistics

3.22.3 Akamai IPv6 Adoption Visualization

According to Akamai, Portugal ranks at the 15th place with a 13.3% adoption rate of IPv6[164]. However, it seems that there is a growing trend since the beginning of 2017.

[163] Volume of users that access Google over IPv6

[164] Volume of IPv6 requests to Akamai

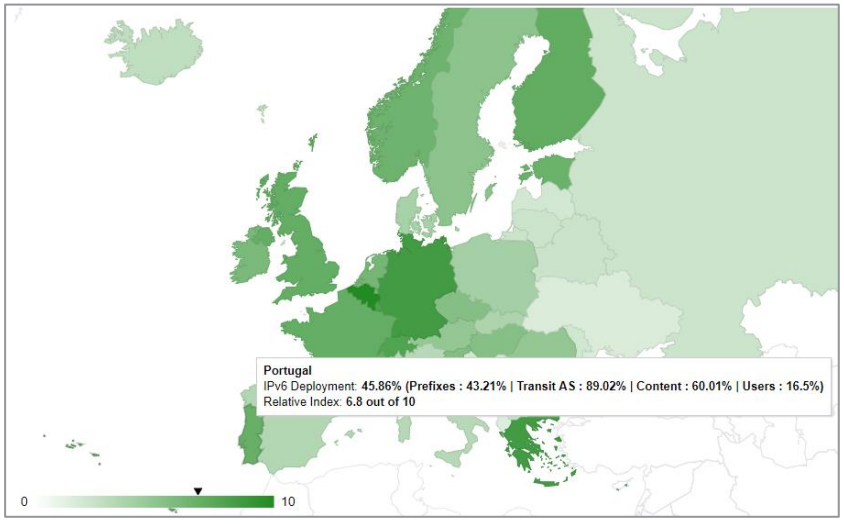


Source: Akamai, state of the Internet IPv6 adoption visualization

3.22.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Portugal is one of the most advanced country regarding IPv6 in Europe, displaying an IPv6 adoption rate a little below 46%.

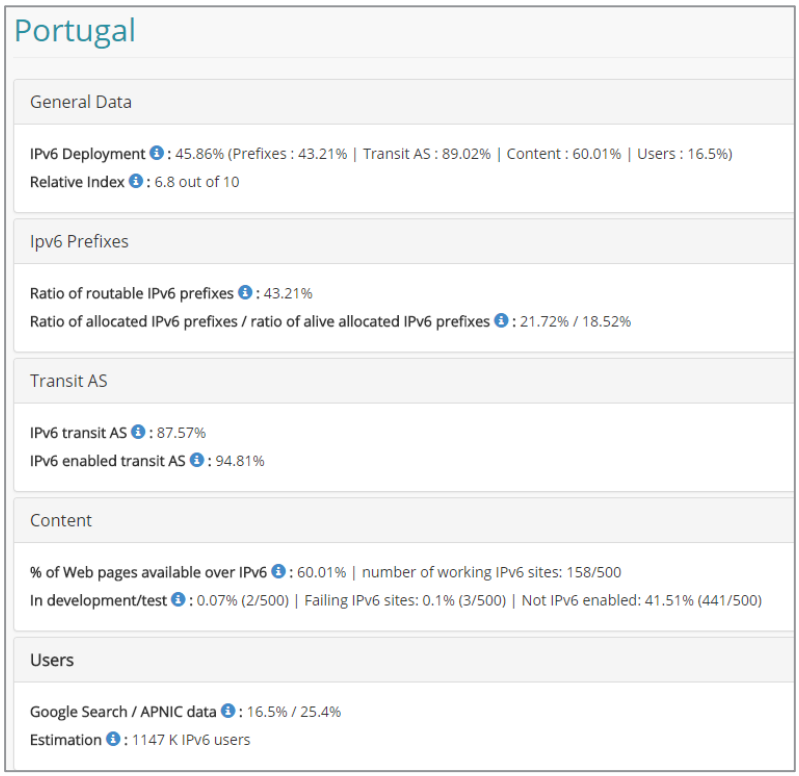
Figure 166: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

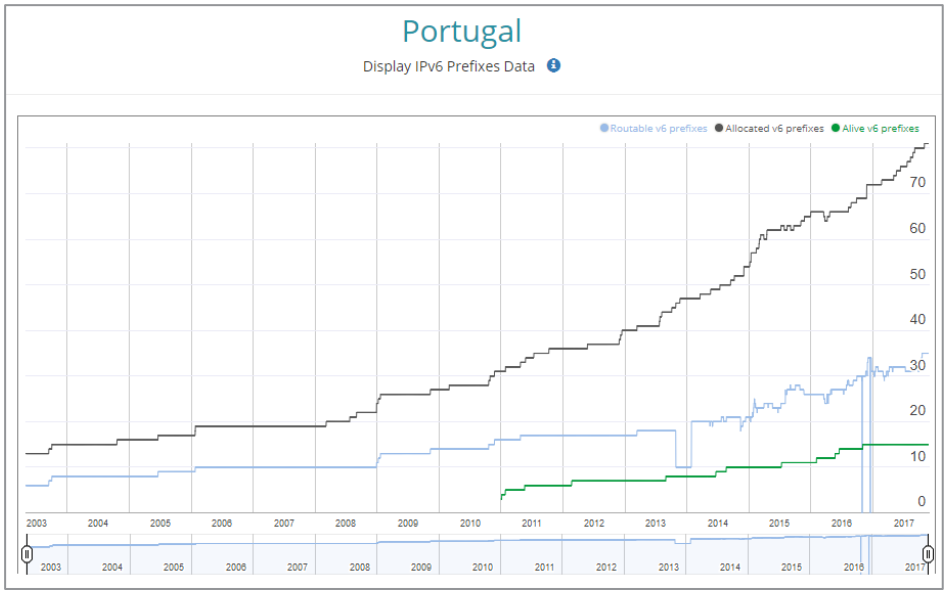
Other figures from Cisco indicates that in Portugal, 158/500 sites run onIPv6 and there are 1 147 000 IPv6 users.

Figure 167: IPv6 adoption at different layers



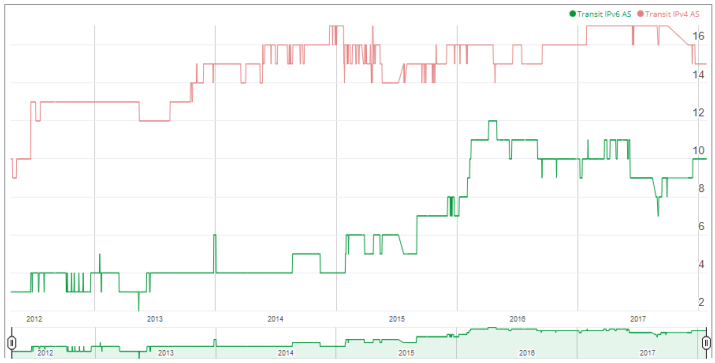
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 168: The evolution of IPv6 adoption in terms of "prefixes"



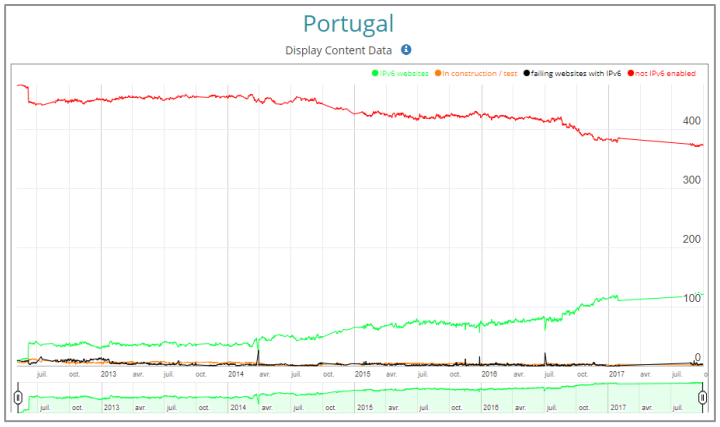
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 169: The evolution of IPv6 adoption in terms of “transit AS”



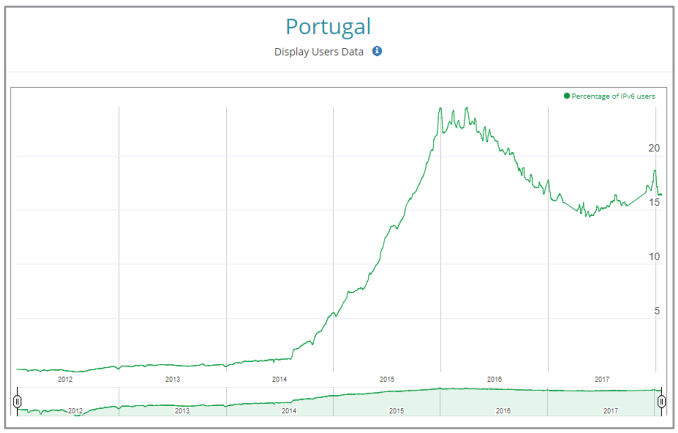
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 170: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 171: The evolution of IPv6 adoption in terms of “display users data”

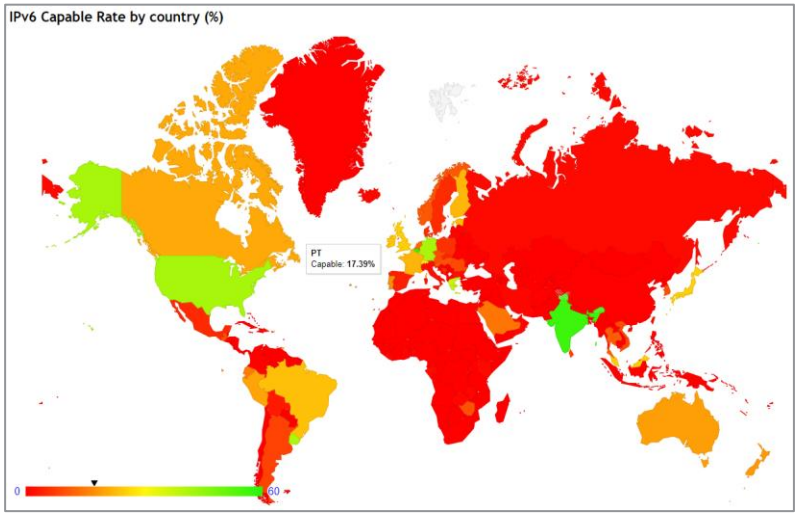


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.22.5 Other - APNIC

APNIC also provides IPv6 measurement, which is baed on testing users web browsing with IPv6 capability. In the range, Portugal is displayed in orange, revealing a medium adoption.

Figure 172: IPV6 capable rate by country (%)



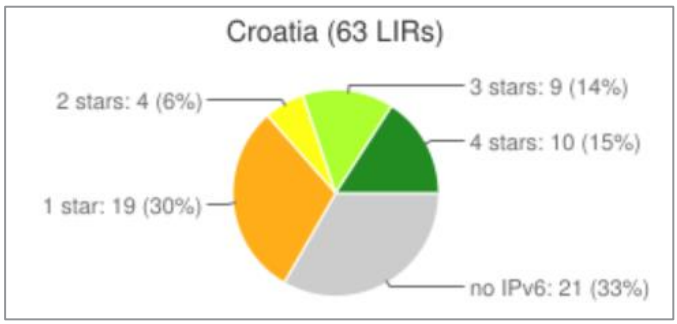
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.23 Croatia

3.23.1 RIPElabs RIPEness assessment

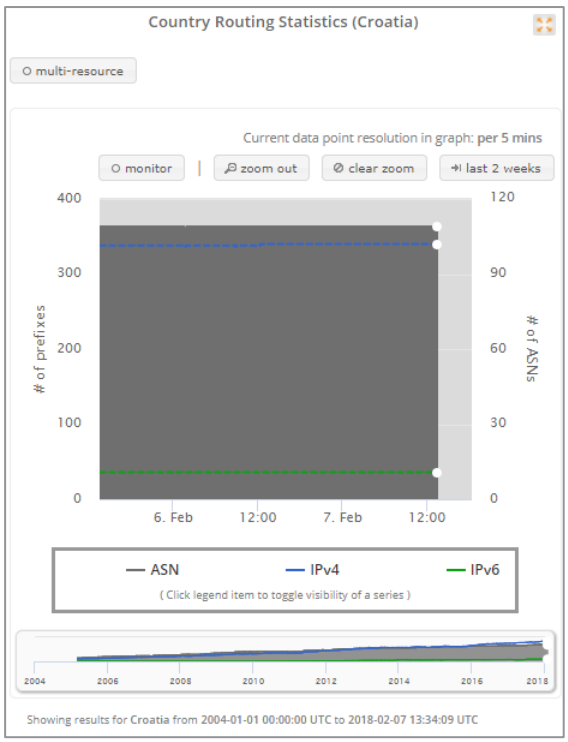
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Croatia is relatively in line with all LIRs RIPEness globally. Out of the 63 LIRs, 15% has been awarded 4 stars.

Figure 173: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 174: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Croatia

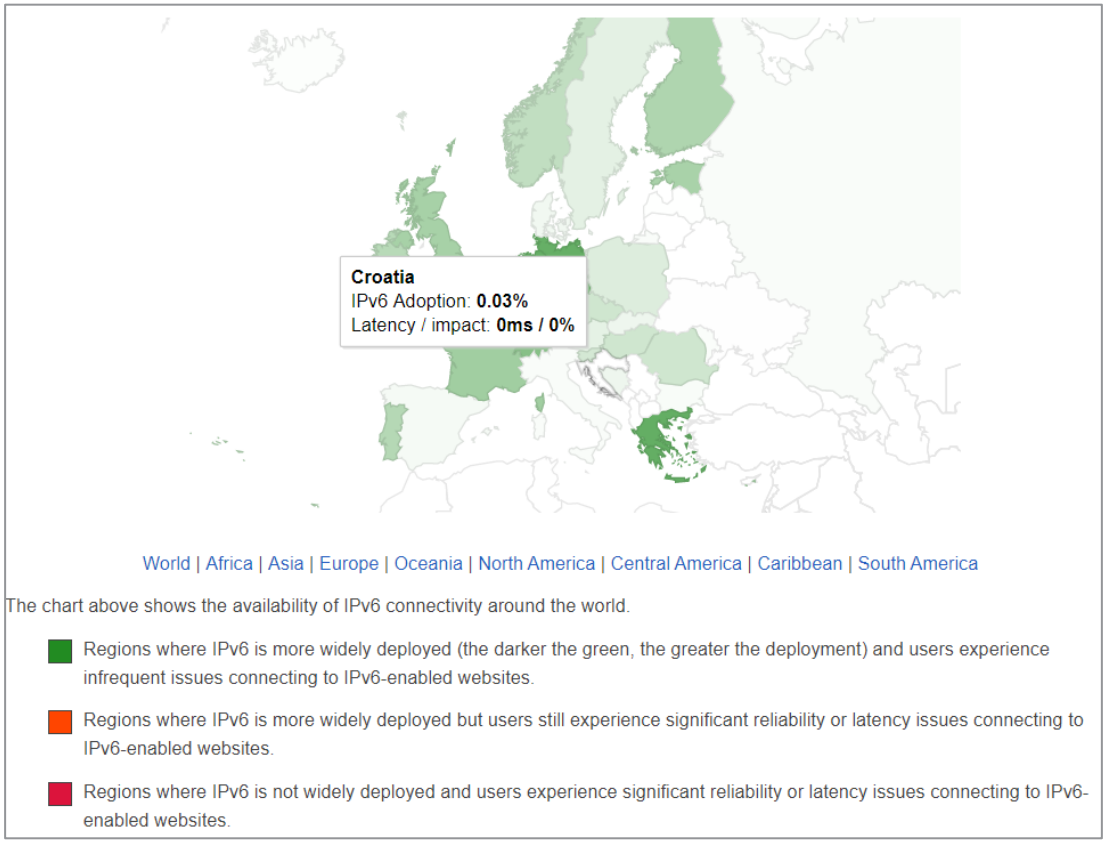


Source: https://stat.ripe.net/specials/country-comparison

3.23.2 Google IPv6 statistics

According to Google[165], the adoption rate is close to 0% in Croatia, which ranks among the least advanced countries.

Figure 175: IPv6 adoption



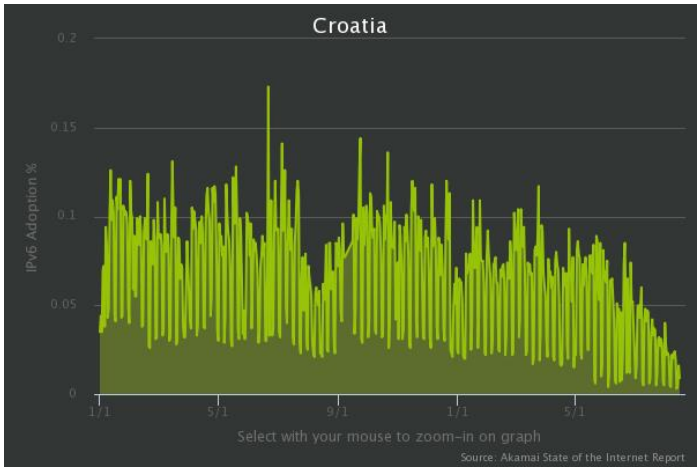
Source: Google IPV6 statistics

3.23.3 Akamai IPv6 Adoption Visualization

According to Akamai, Croatia ranks at the 110th place with a "0%" adoption rate of IPv6[166].

[165] Volume of users that access Google over IPv6

[166] Volume of IPv6 requests to Akamai

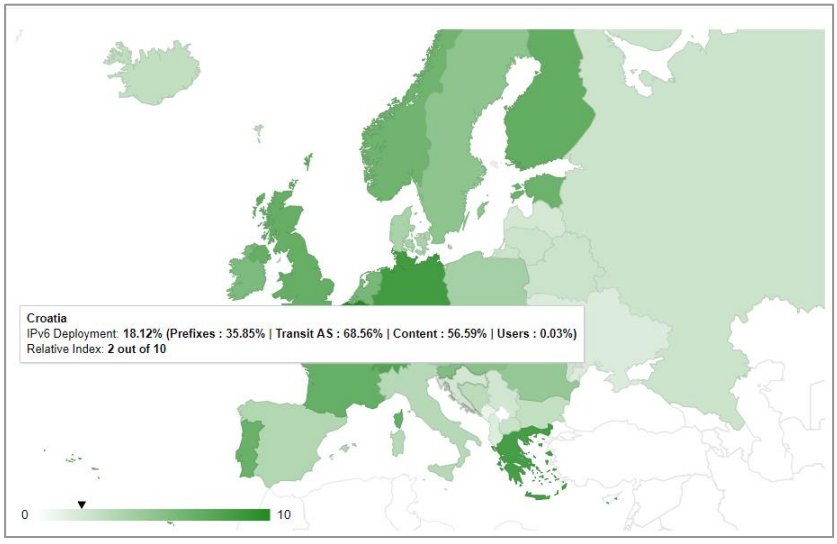


Source: Akamai, state of the Internet IPv6 adoption visualization

3.23.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Croatia is one of the least advanced country regarding IPv6 in Europe, displaying an IPv6 adoption rate a little above 18%.

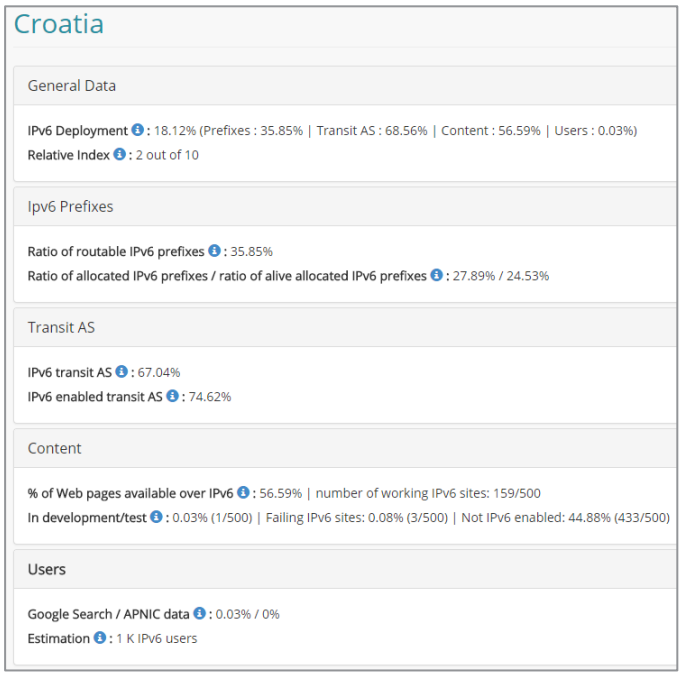
Figure 176: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

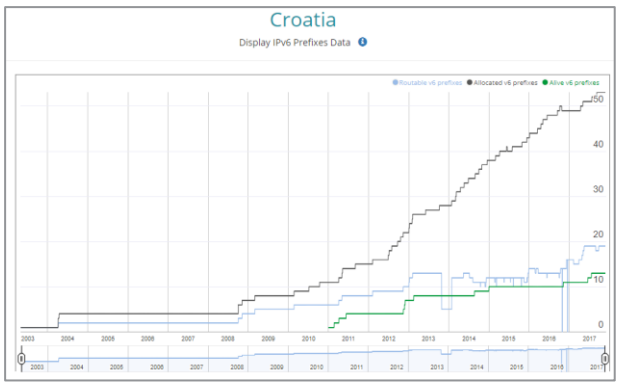
Other figures from Cisco indicates that in Croatia, 159/500 sites run on IPv6 and there are only 1 000 IPv6 users.

Figure 177: IPv6 adoption at different layers



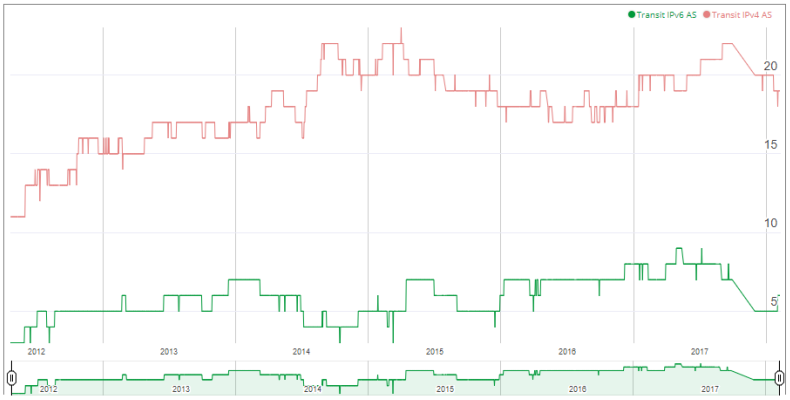
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 178: The evolution of IPv6 adoption in terms of “prefixes”



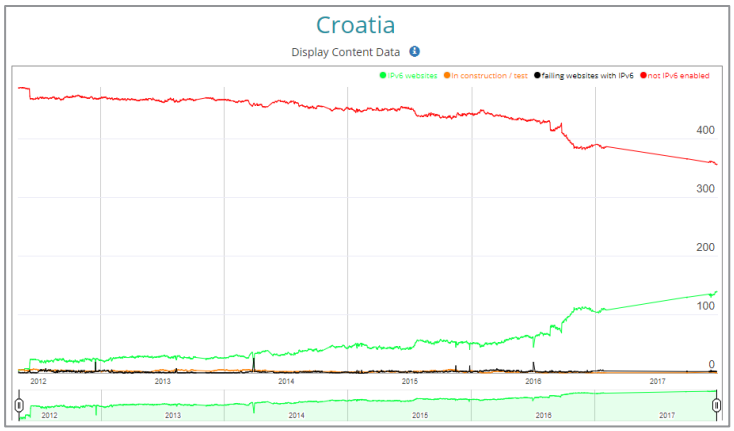
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 179: The evolution of IPv6 adoption in terms of “transit AS”



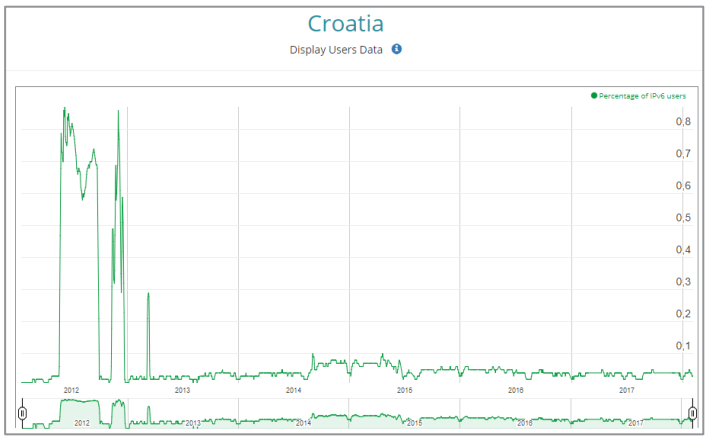
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 180: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 181: The evolution of IPv6 adoption in terms of “display users data”

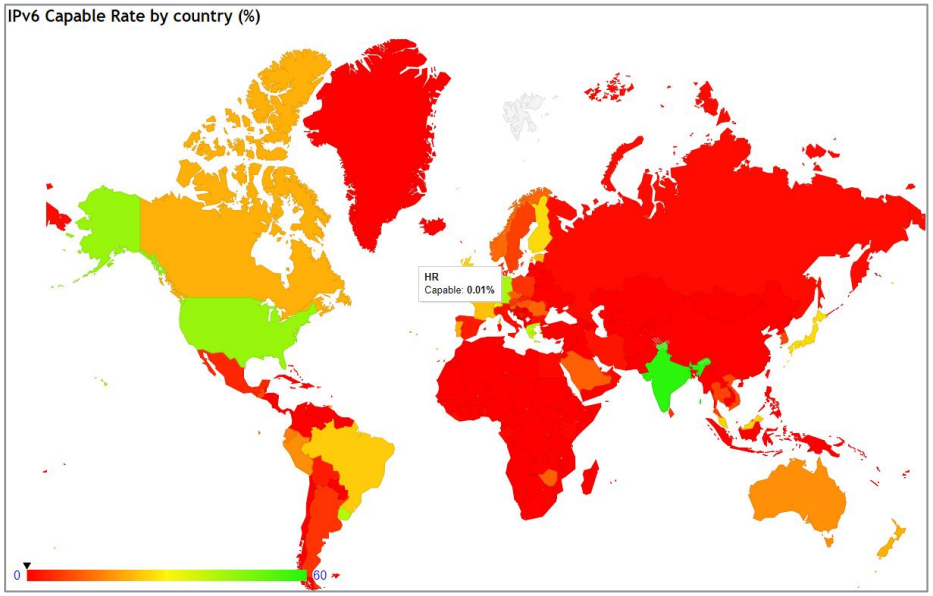


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.23.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Croatia is displayed in red, revealing a low adoption.

Figure 182: IPV6 capable rate by country (%)



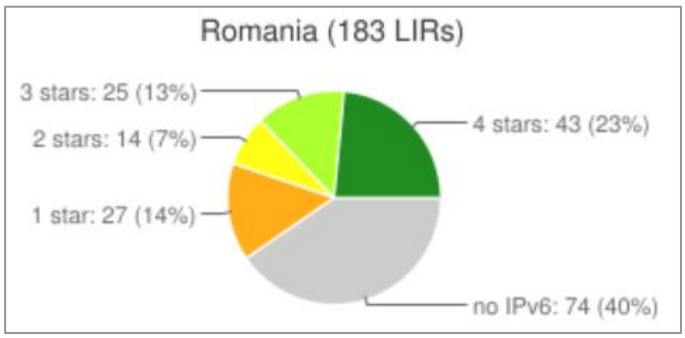
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.24 Romania

3.24.1 RIPElabs RIPEness assessment

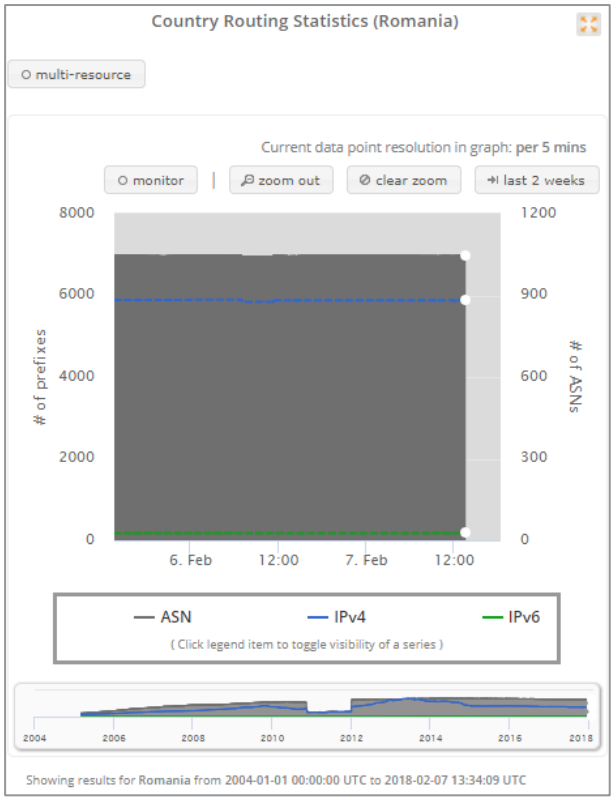
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Romania is relatively in line with all LIRs RIPEness globally. Out of the 183 LIRs, 23% has been awarded 4 stars.

Figure 183: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 184: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Romania

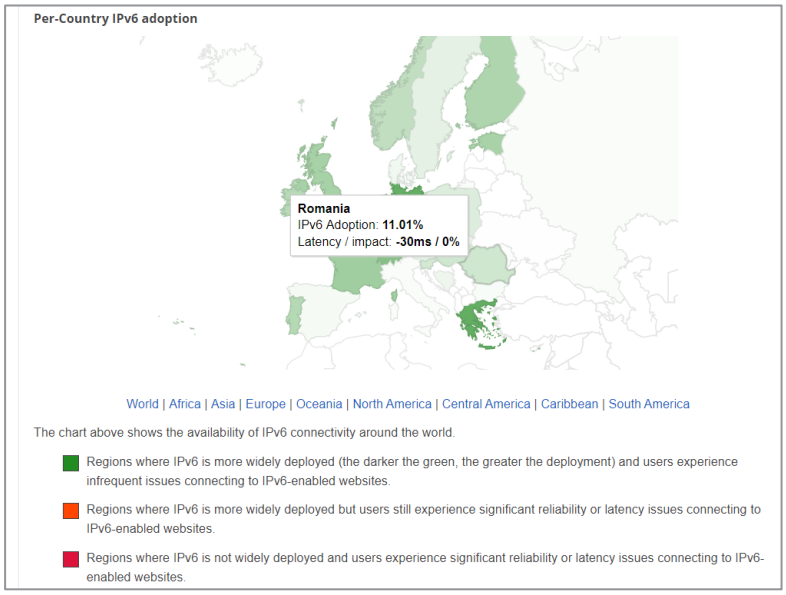


Source: https://stat.ripe.net/specials/country-comparison

3.24.2 Google IPv6 statistics

According to Google167, the adoption rate is a little above 11% in Romania, which remains low, when compared to global adoption (around 20%) and to European countries that are ahead like Belgium, Germany or Greece.

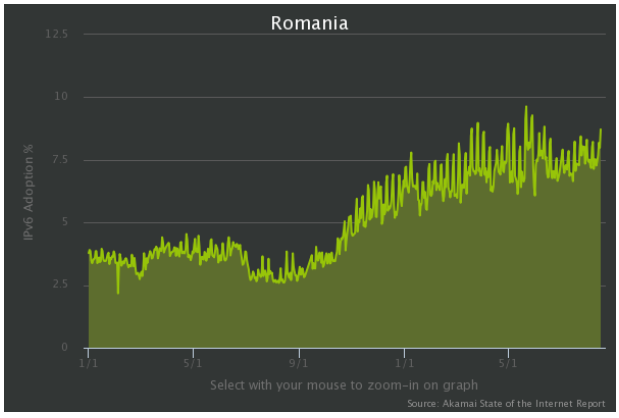
Figure 185: IPv6 adoption



Source: Google IPV6 statistics

3.24.3 Akamai IPv6 Adoption Visualization

According to Akamai, Romania ranks at the 24th place with a 8.7% adoption rate of IPv6[168]. It seems that there is a growing trend since the beginning of 2017.



Source: Akamai, state of the Internet IPv6 adoption visualization

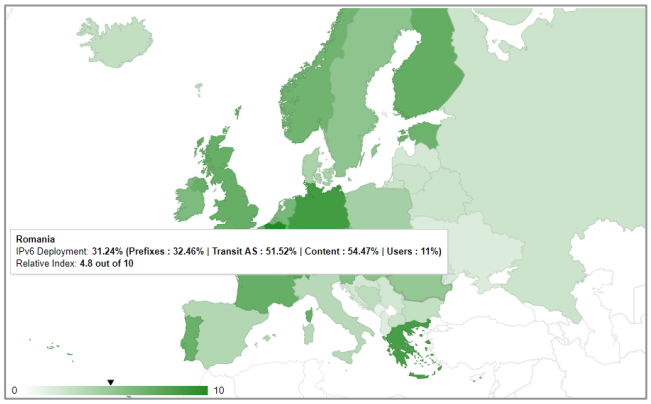
[167] Volume of users that access Google over IPv6

[168] Volume of IPv6 requests to Akamai

3.24.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Romania is in the middle of the pack, displaying an IPv6 adoption rate a little above 32%.

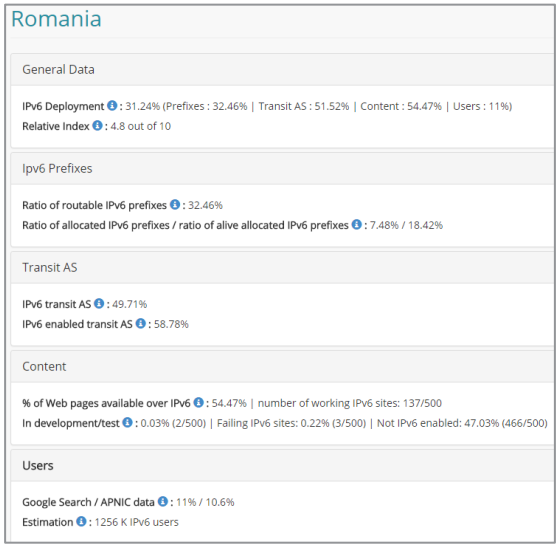
Figure 186: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

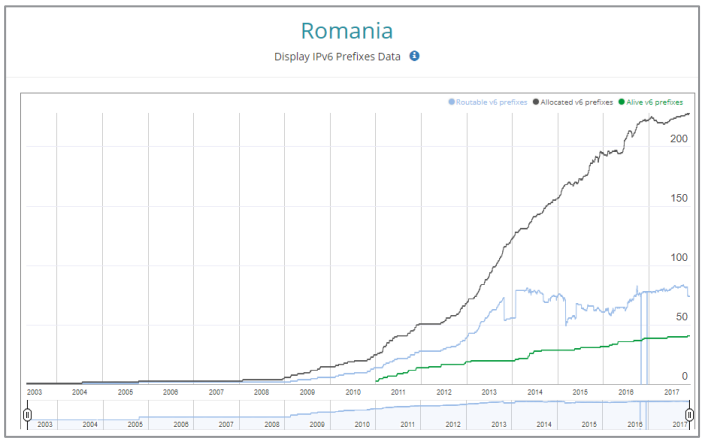
Other figures from Cisco indicates that in Romania, 137/500 sites run on IPv6 and there are 1 256 000 IPv6 users.

Figure 187: IPv6 adoption at different layers



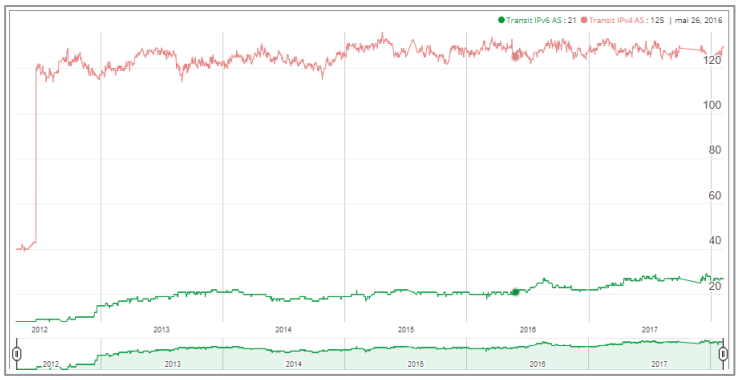
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 188: The evolution of IPv6 adoption in terms of “prefixes”



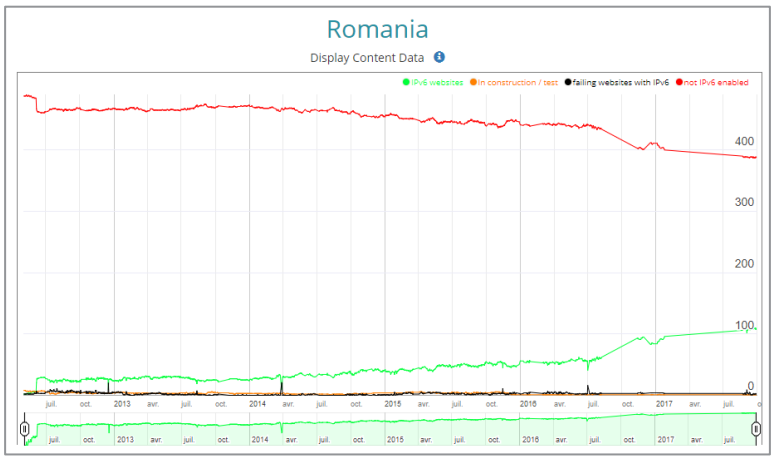
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 189: The evolution of IPv6 adoption in terms of “transit AS”



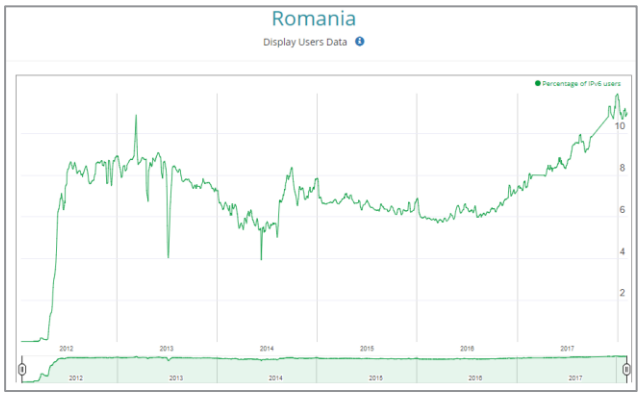
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 190: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 191: The evolution of IPv6 adoption in terms of “display users data”

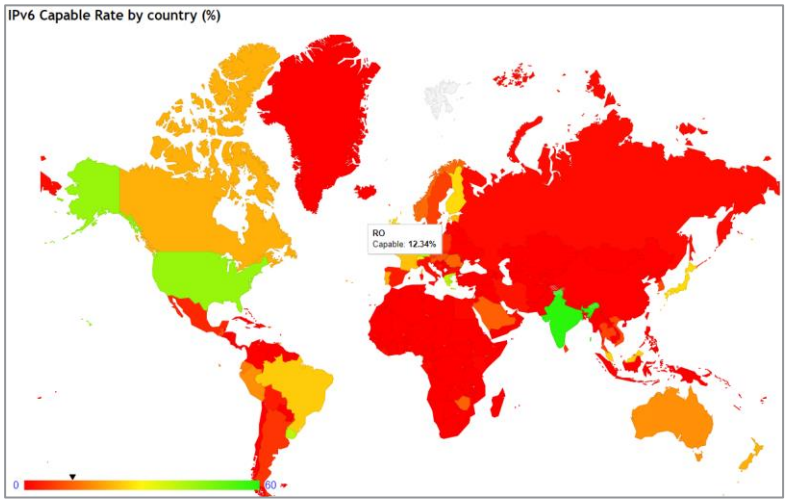


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.24.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Romania is displayed in dark-orange, revealing a low-medium adoption.

Figure 192: IPV6 capable rate by country (%)



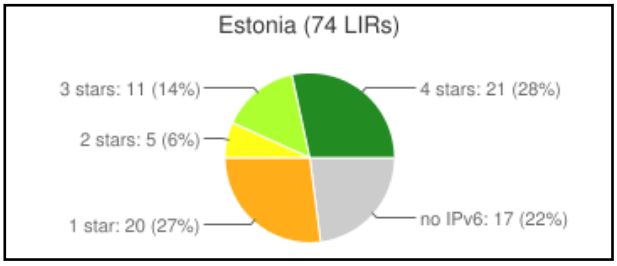
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.25 Estonia

3.25.1 RIPElabs RIPEness assessment

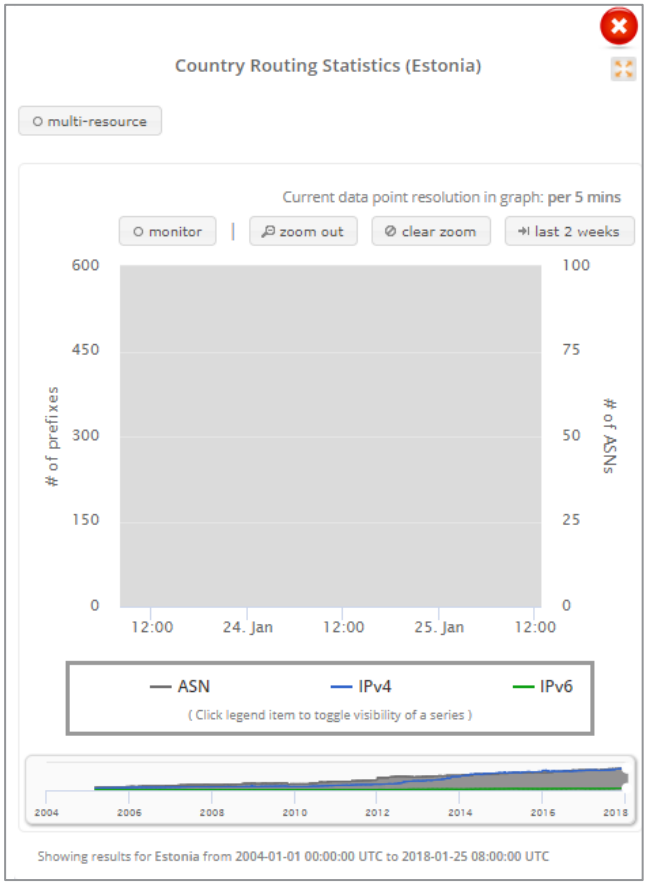
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Estonia is relatively in line with all LIRs RIPEness globally. Out of the 74 LIRs, more than one quarter of has been awarded 4 stars.

Figure 193: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 194: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Estonia

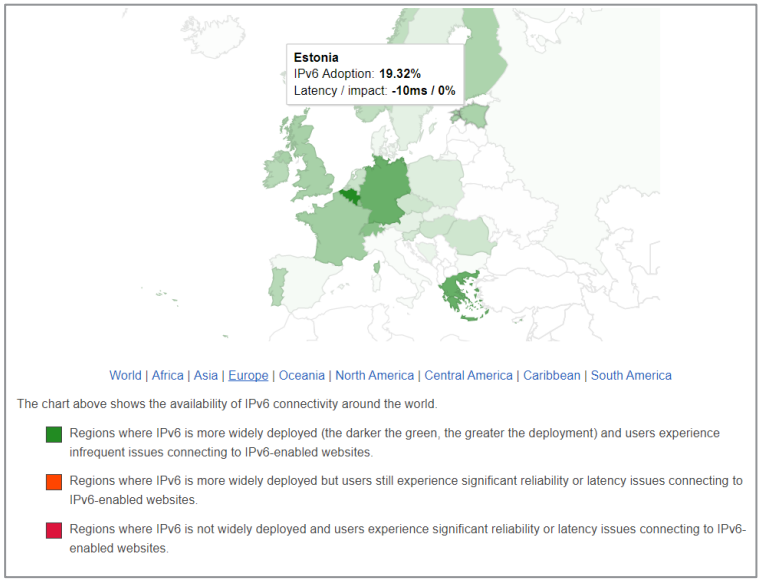


Source: https://stat.ripe.net/specials/country-comparison

3.25.2 Google IPv6 statistics

According to Google[169], the adoption rate is close to 20% in Estonia, which is in line with global adoption. It remains behind a few European countries that are ahead (Belgium, Germany or Greece).

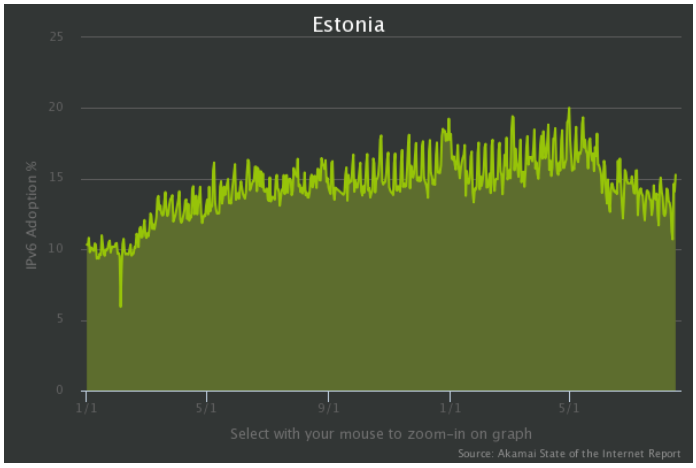
Figure 195: IPv6 adoption



Source: Google IPV6 statistics

3.25.3 Akamai IPv6 Adoption Visualization

According to Akamai, Estonia ranks at the 12th place with a 15.3% adoption rate of IPv6[170].



Source: Akamai, state of the Internet IPv6 adoption visualization

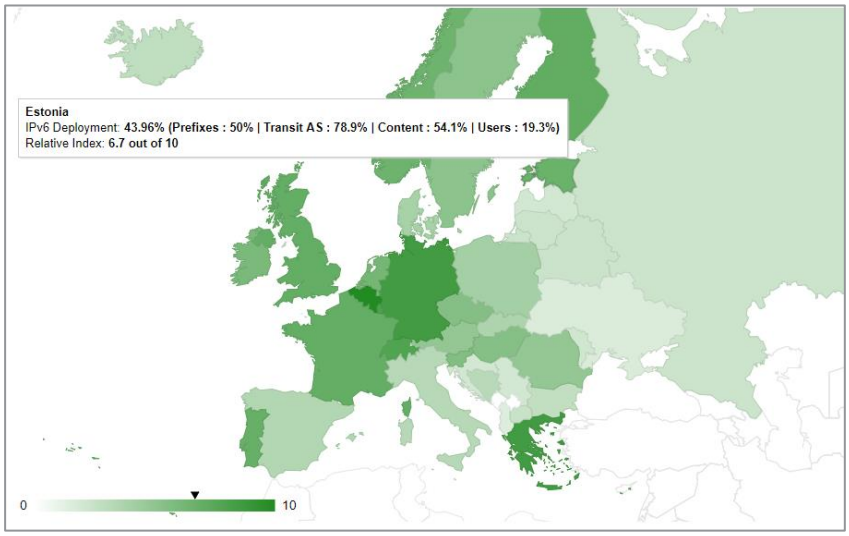
[169] Volume of users that access Google over IPv6

[170] Volume of IPv6 requests to Akamai

3.25.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Estonia is rather well positioned among other European countries, displaying an IPv6 adoption rate a little below 44%.

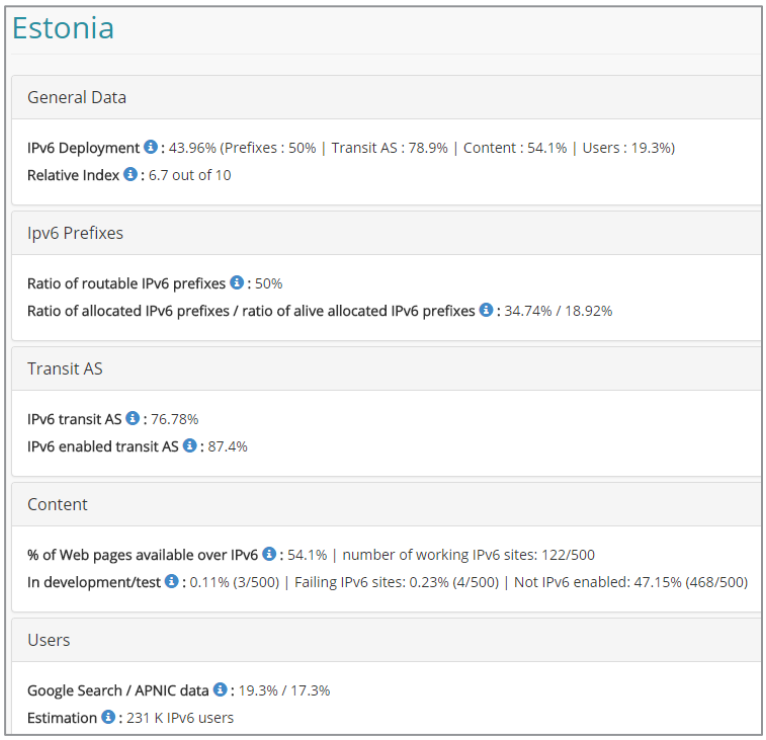
Figure 196: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

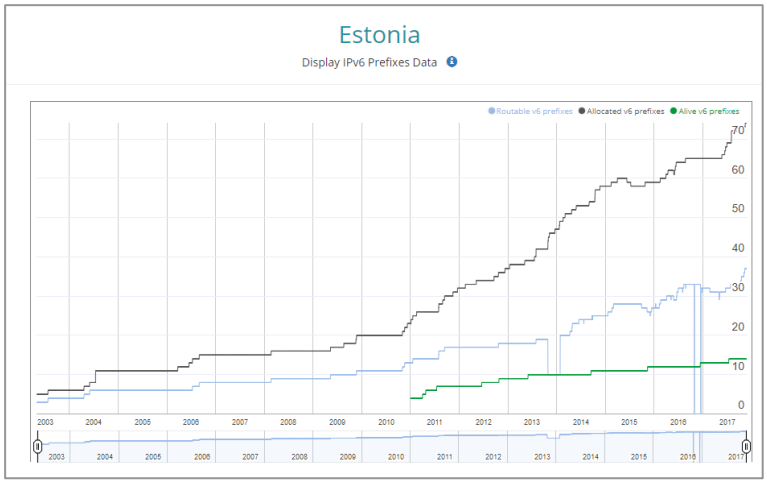
Other figures from Cisco indicates that in Estonia, 122/500 sites run on IPv6 and there are 231 000 IPv6 users.

Figure 197: IPv6 adoption at different layers



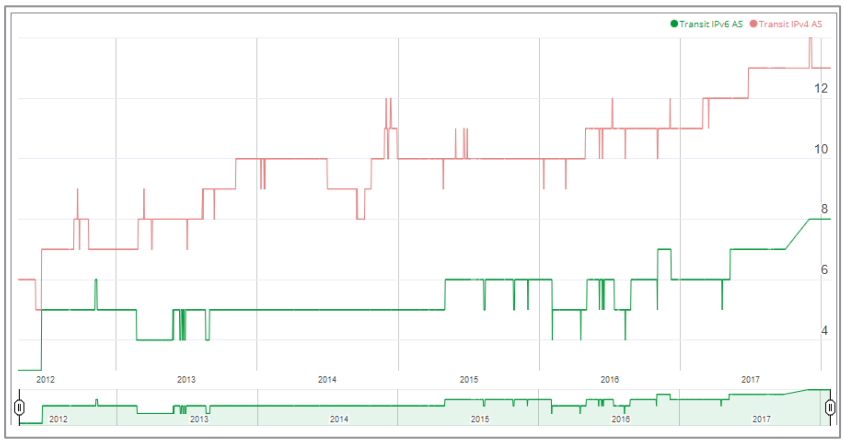
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 198: The evolution of IPv6 adoption in terms of "prefixes"



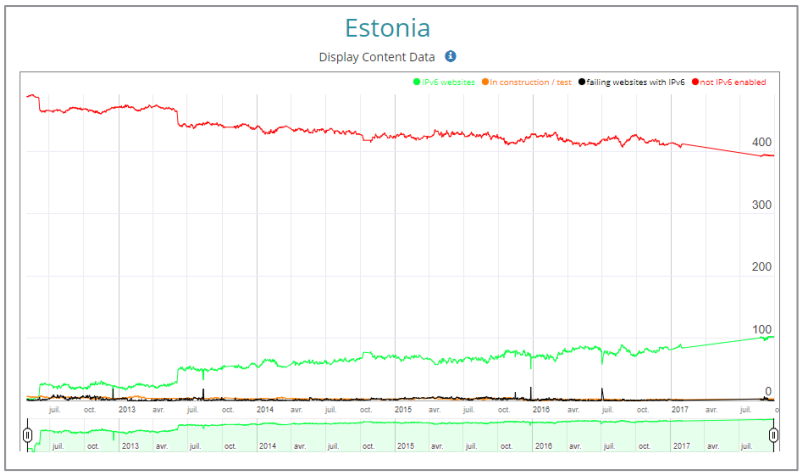
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 199: The evolution of IPv6 adoption in terms of “transit AS”



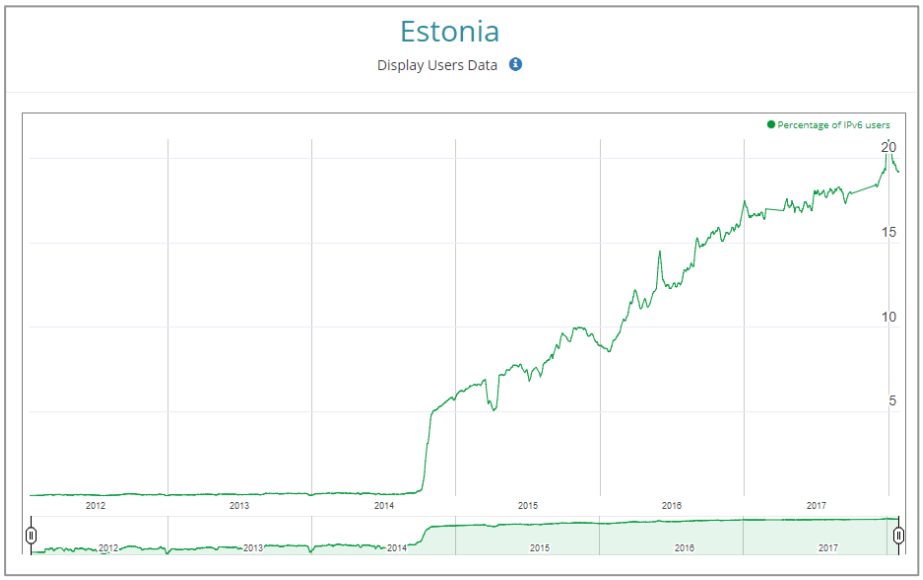
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 200: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 201: The evolution of IPv6 adoption in terms of “display users data”

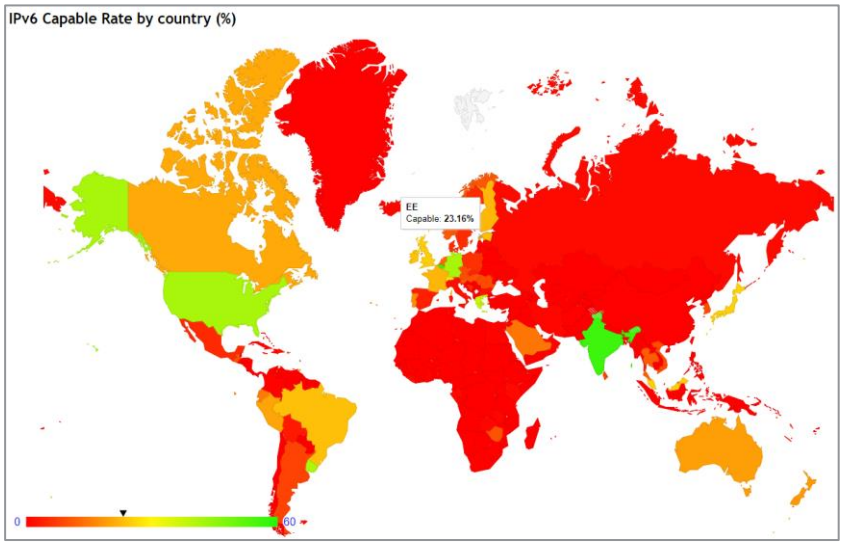


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.25.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Estonia is displayed in orange, revealing a medium adoption.

Figure 202: IPV6 capable rate by country (%)



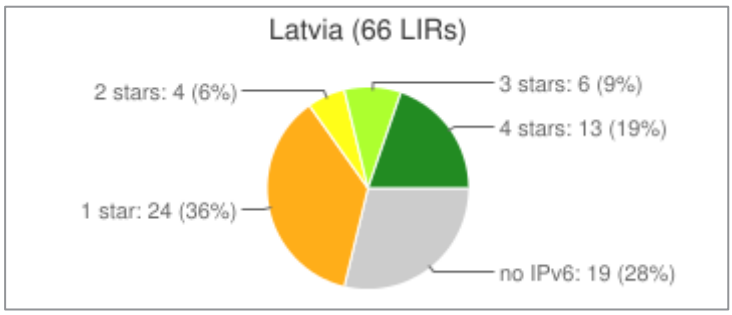
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.26 Latvia

3.26.1 RIPElabs RIPEness assessment

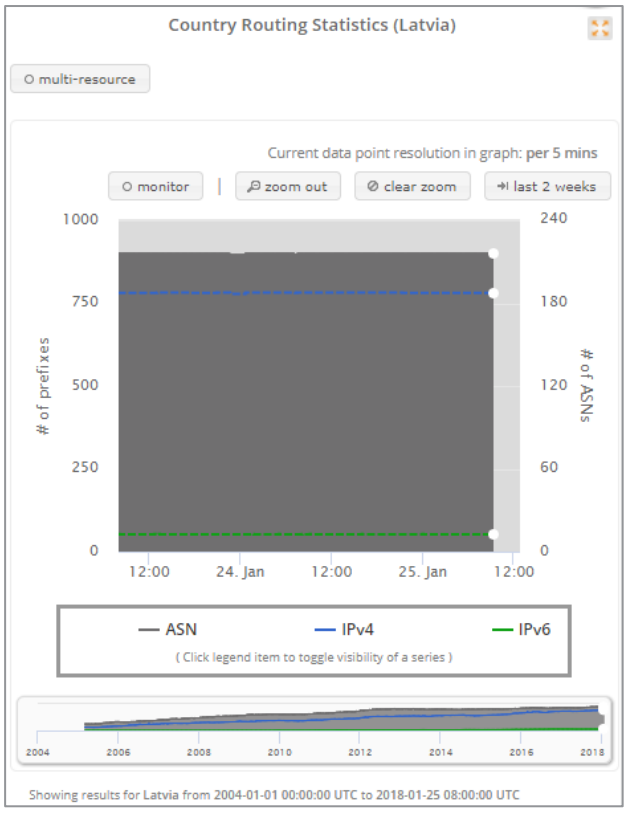
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Latvia is very similar with all LIRs RIPEness globally. Out of the 66 LIRs, around 20% of has been awarded 4 stars.

Figure 203: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 204: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Latvia

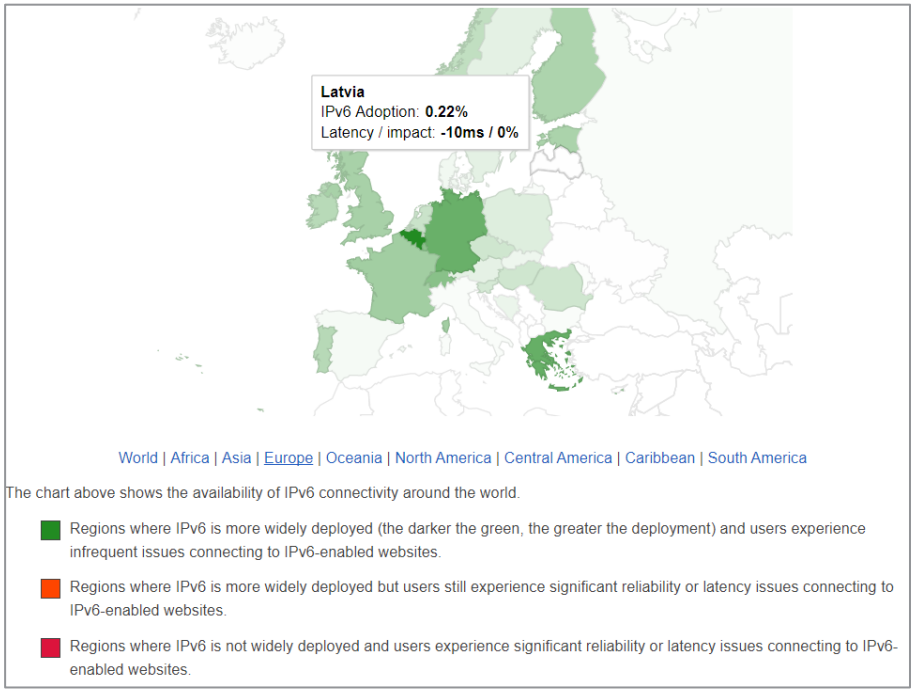


Source: https://stat.ripe.net/specials/country-comparison

3.26.2 Google IPv6 statistics

According to Google[171], the adoption rate barely is close to 0.2% in Latvia, which is extremely low, when compared to global adoption (around 20%) and to virtually all European countries.

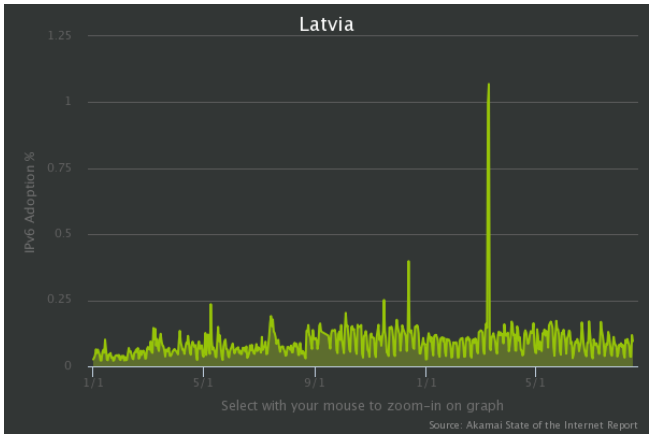
Figure 205: IPv6 adoption



Source: Google IPV6 statistics

3.26.3 Akamai IPv6 Adoption Visualization

According to Akamai, Latvia ranks at the 76th place with a 0.1% adoption rate of IPv6[172].



Source: Akamai, state of the Internet IPv6 adoption visualization

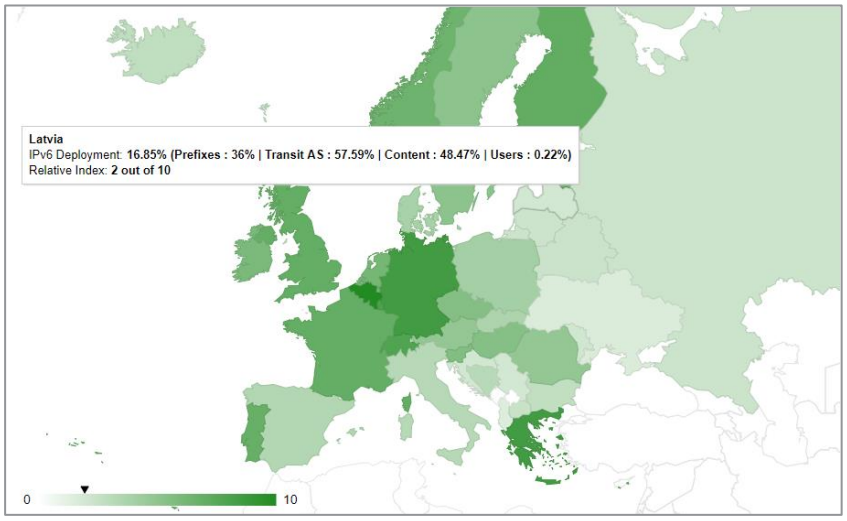
[171] Volume of users that access Google over IPv6

[172] Volume of IPv6 requests to Akamai

3.26.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Latvia is one of the least advanced country regarding IPv6 in Europe, displaying an IPv6 adoption rate a little below 17%.

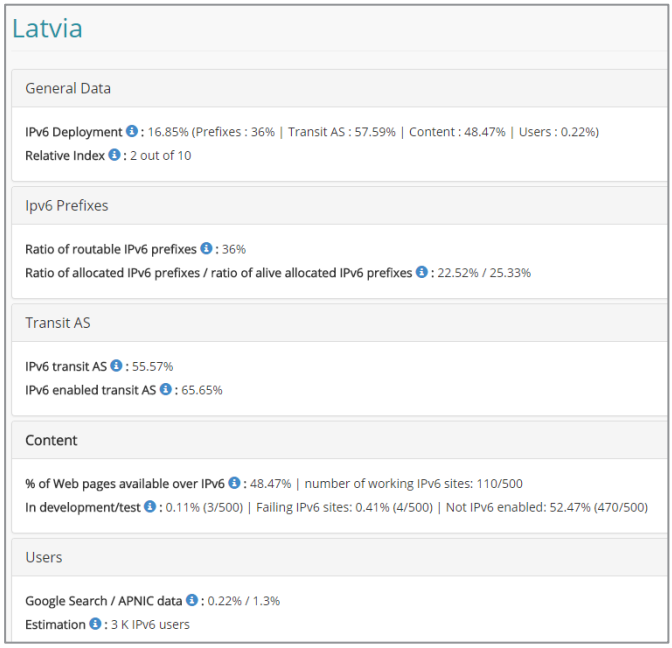
Figure 206: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

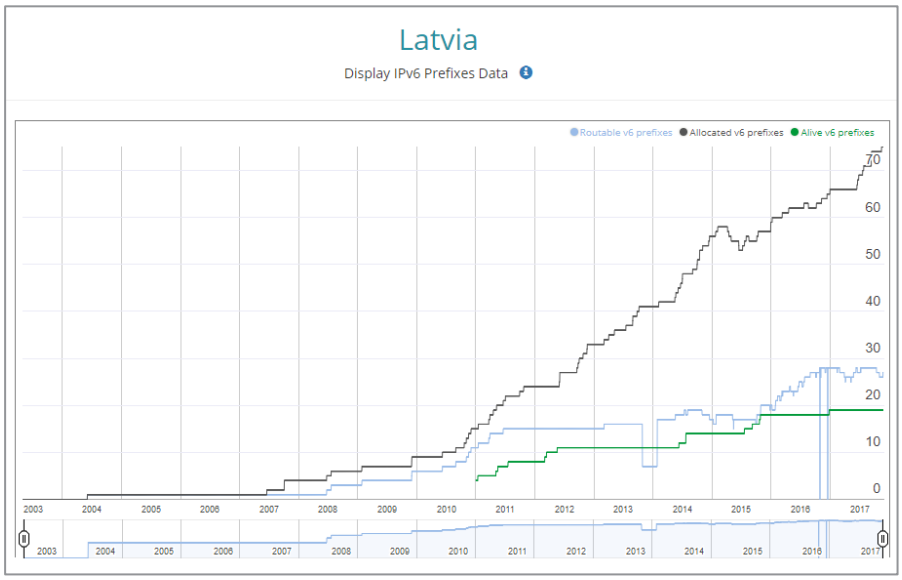
Other figures from Cisco indicates that in Latvia, 110/500 sites run on IPv6 and there are 3 000 IPv6 users.

Figure 207: IPv6 adoption at different layers



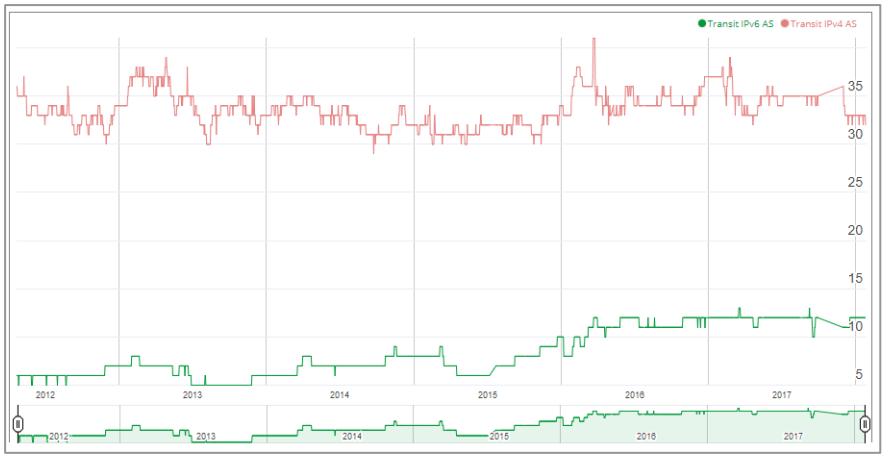
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 208: The evolution of IPv6 adoption in terms of “prefixes”



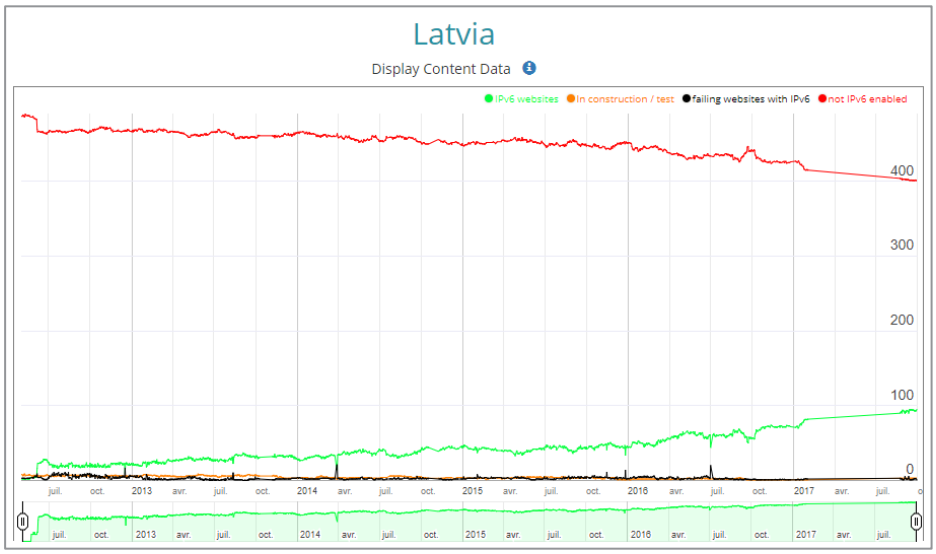
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 209: The evolution of IPv6 adoption in terms of “transit AS”



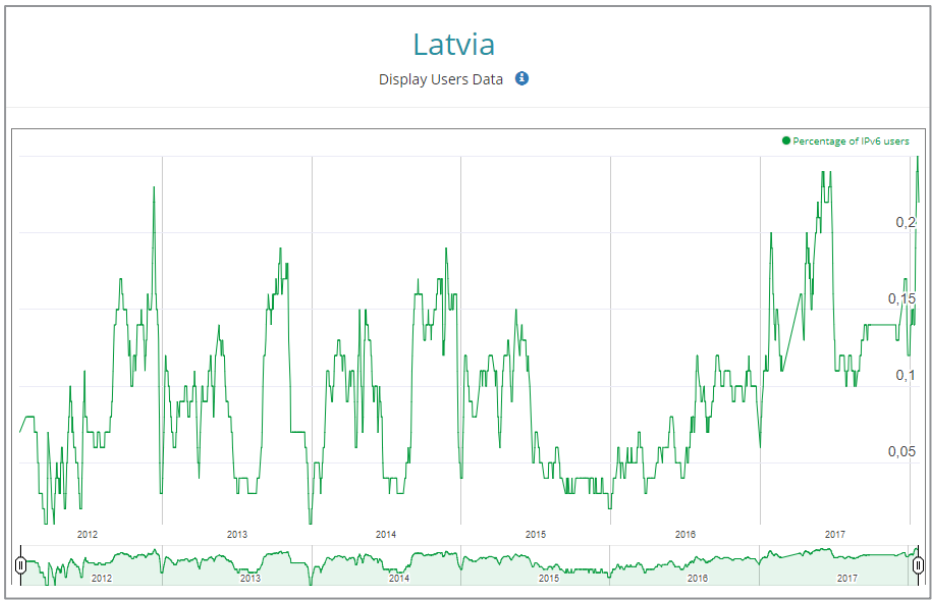
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 210: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 211: The evolution of IPv6 adoption in terms of “display users data”

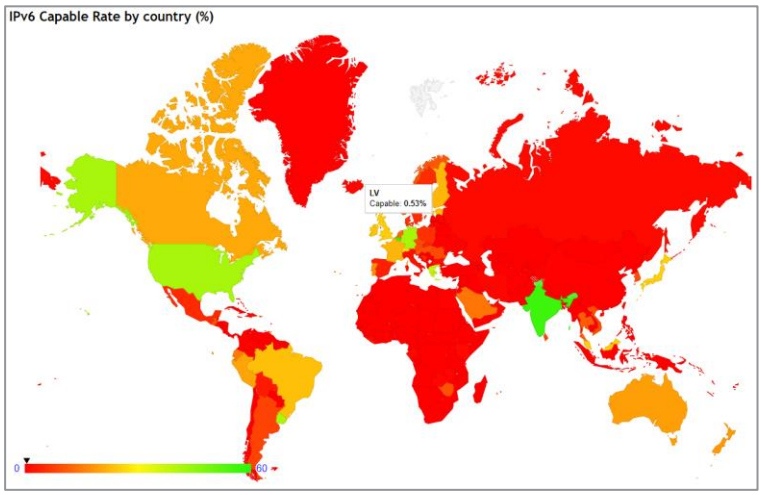


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.26.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Latvia is displayed in red, revealing a low adoption.

Figure 212: IPV6 capable rate by country (%)



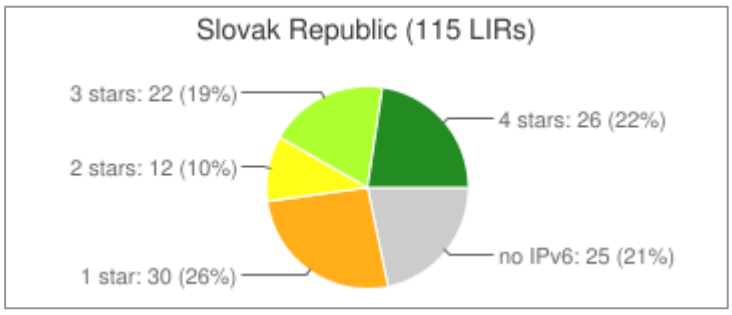
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.27 Slovakia

3.27.1 RIPElabs RIPEness assessment

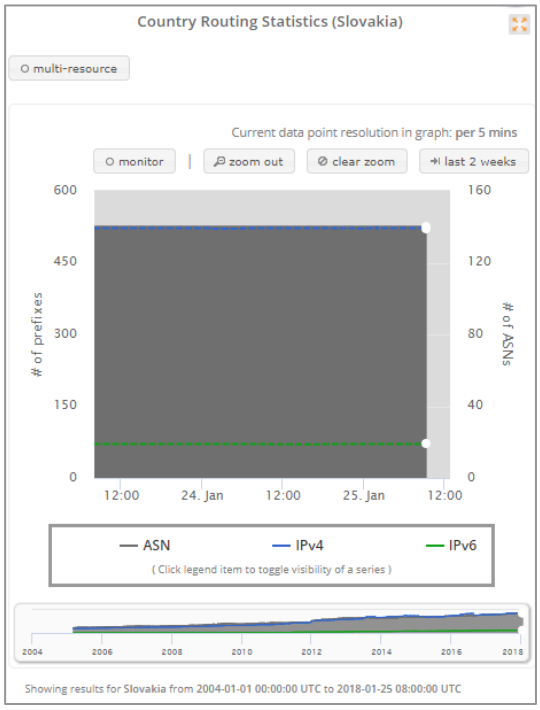
According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in Slovakia is relatively in line with all LIRs RIPEness globally. Out of the 115 LIRs, 22% has been awarded 4 stars.

Figure 213: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

Figure 214: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Slovakia

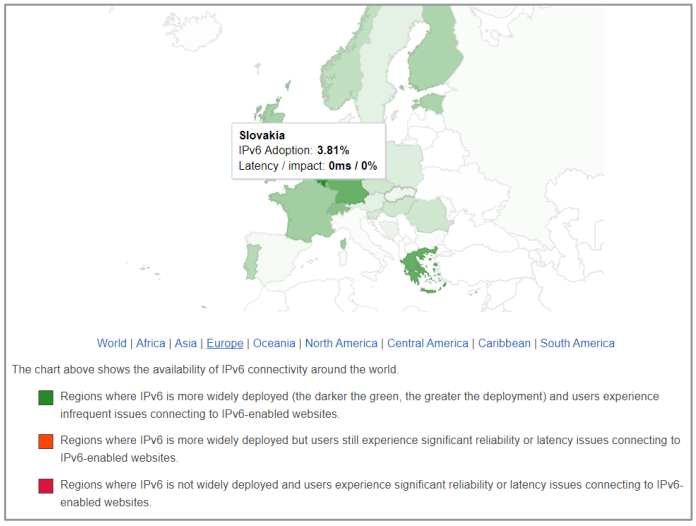


Source: https://stat.ripe.net/specials/country-comparison

3.27.2 Google IPv6 statistics

According to Google[173], the adoption rate is close to 4% in Slovakia, which remains quite low, when compared to global adoption (around 20%) and to many European countries.

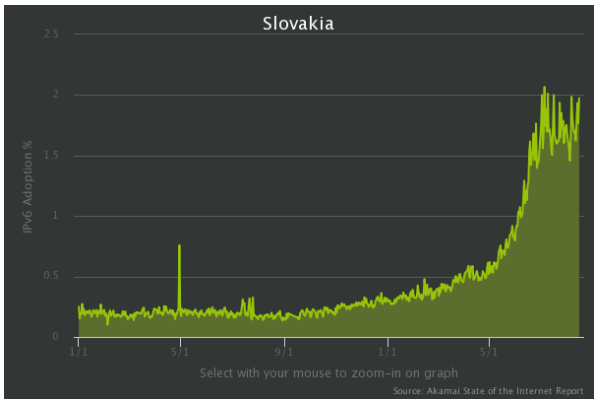
Figure 215: IPv6 adoption



Source: Google IPV6 statistics

3.27.3 Akamai IPv6 Adoption Visualization

According to Akamai, Slovakia ranks at the 49th place with a 2% adoption rate of IPv6[174]. However, it seems that there is a growing trend since the beginning of 2017.



Source: Akamai, state of the Internet IPv6 adoption visualization

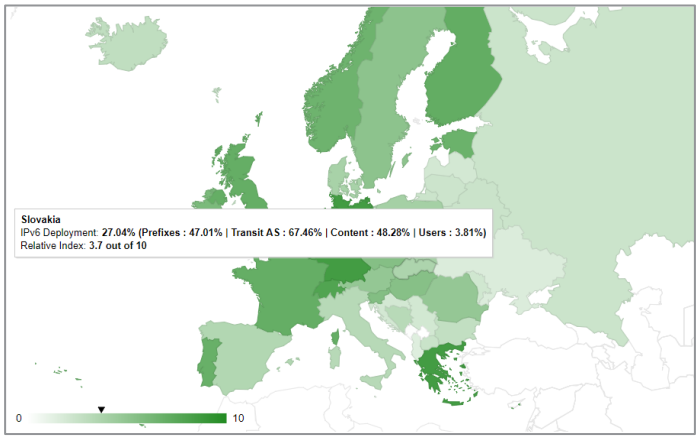
[173] Volume of users that access Google over IPv6

[174] Volume of IPv6 requests to Akamai

3.27.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Slovakia is almost in the middle of the pack, displaying an IPv6 adoption rate a little above 27%.

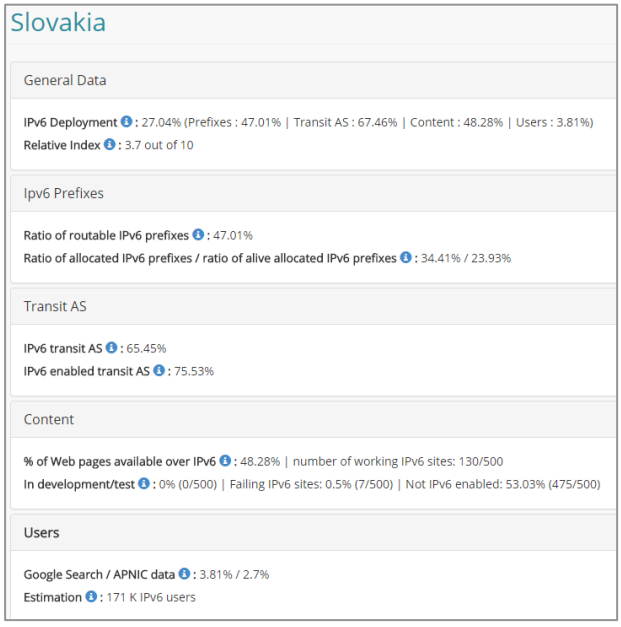
Figure 216: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

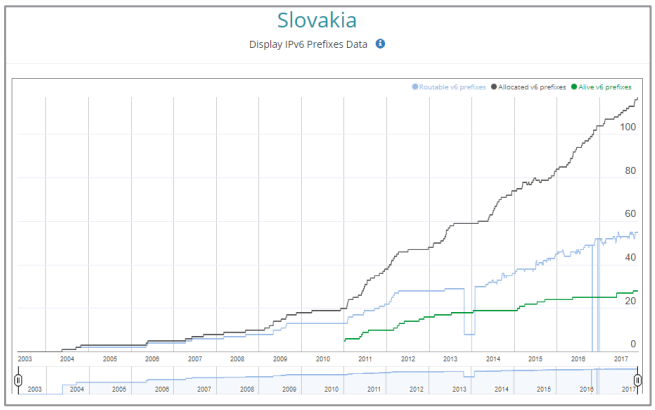
Other figures from Cisco indicates that in Slovakia, 130/500 sites run on IPv6 and there are 171 000 IPv6 users.

Figure 217: IPv6 adoption at different layers



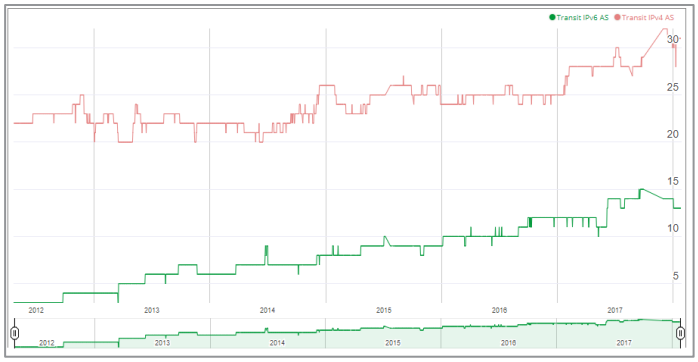
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 218: The evolution of IPv6 adoption in terms of “prefixes”



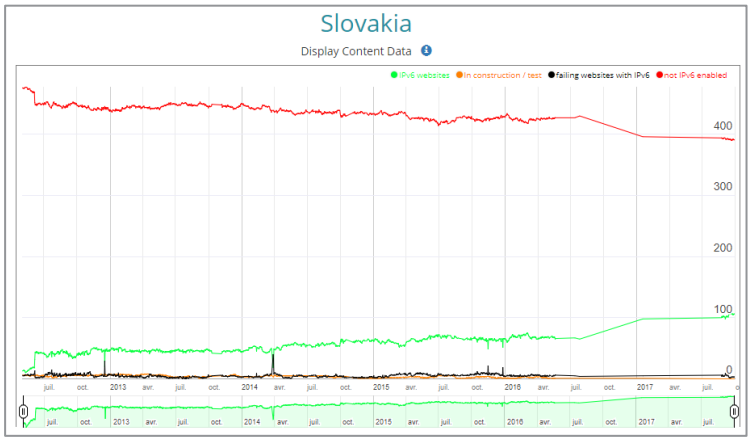
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 219: The evolution of IPv6 adoption in terms of “transit AS”



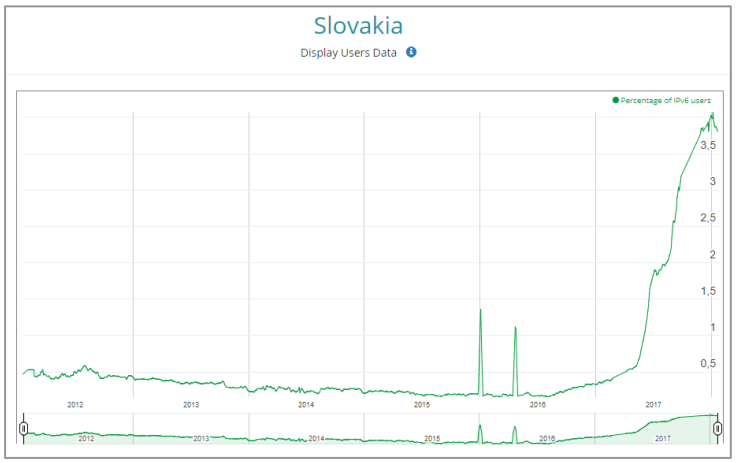
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 220: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 221: The evolution of IPv6 adoption in terms of “display users data”

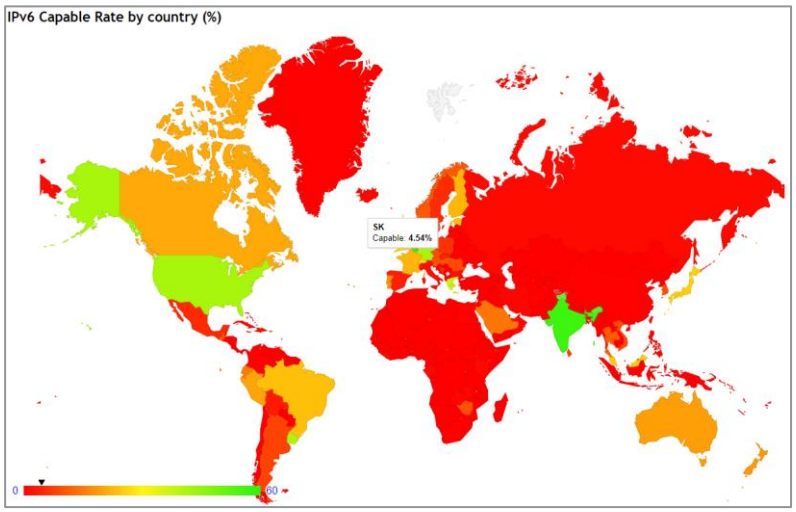


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.27.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, Slovakia is displayed in red, revealing a low adoption.

Figure 222: IPV6 capable rate by country (%)



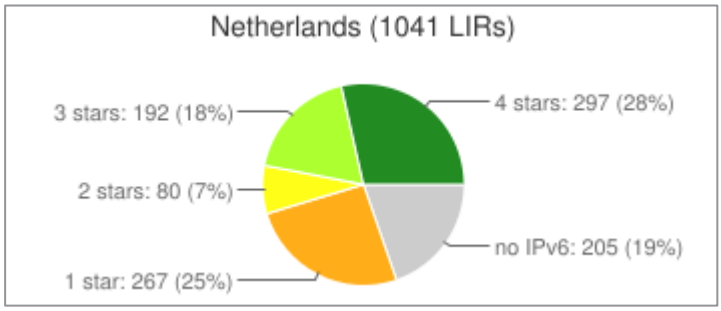
Source: APNIC, https://stats.labs.apnic.net/ipv6

3.28 Netherlands

3.28.1 RIPElabs RIPEness assessment

According to RIPE NCC, the readiness to move to IPv6 for those RIPE NCC members in The Netherlands is relatively in line with all LIRs RIPEness globally. Out of the 183 LIRs, 23% has been awarded 4 stars.

Figure 223: IPv6 RIPEness



Source: http://ripeness.ripe.net/pies.html

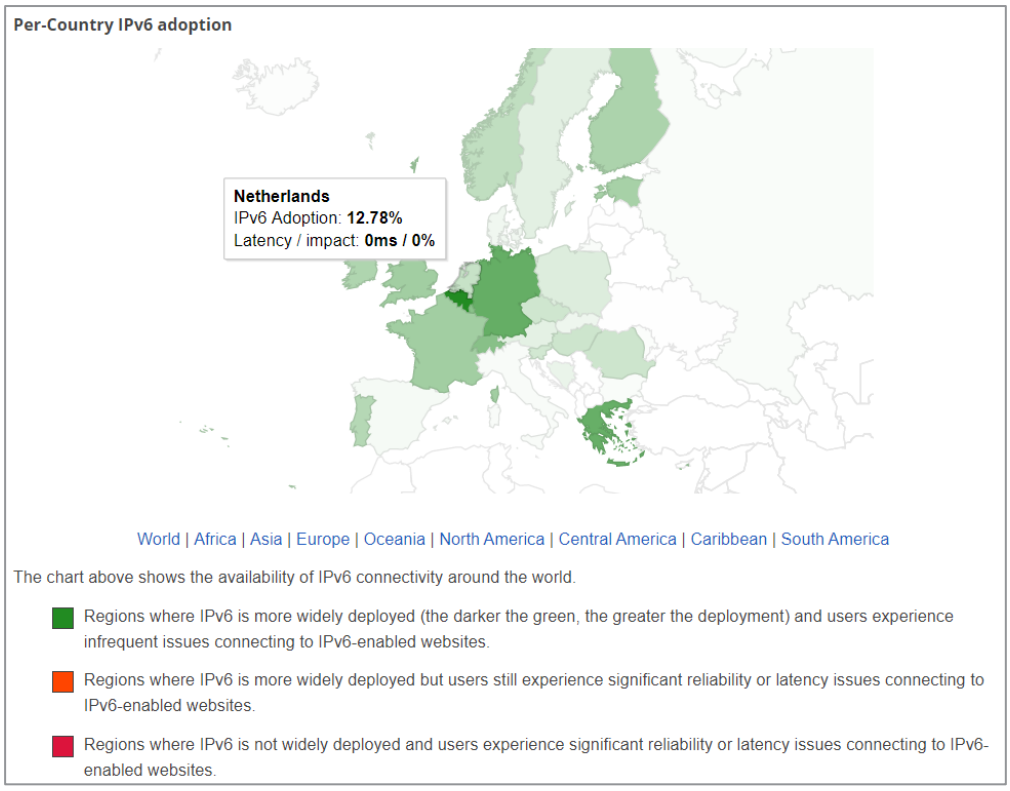
Figure 224: Number of IP prefixes (IPv4 and IPv6) and Autonomous System Numbers (ASNs) in Netherlands

Source: https://stat.ripe.net/specials/country-comparison

3.28.2 Google IPv6 statistics

According to Google[175], the adoption rate is a little above 11% in The Netherlands, which remains low, when compared to global adoption (around 20%) and to European countries that are ahead like Belgium, Germany or Greece.

Figure 225: IPv6 adoption



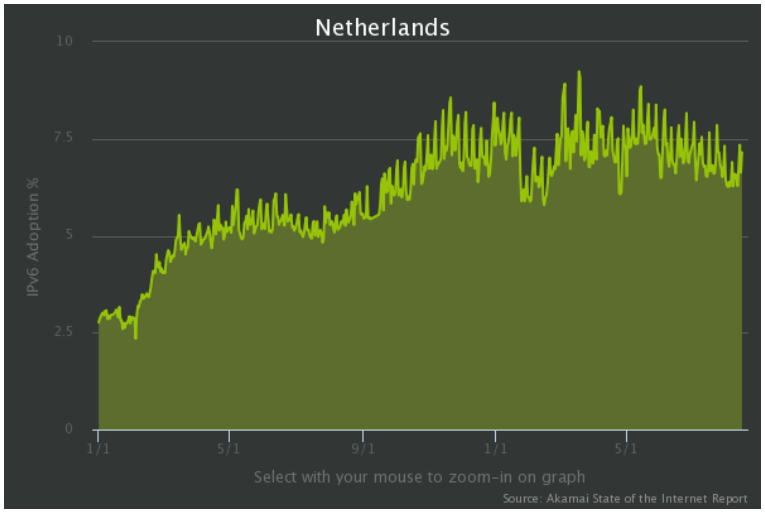
Source: Google IPV6 statistics

3.28.3 Akamai IPv6 Adoption Visualization

According to Akamai, The Netherlands ranks at the 29th place with a 7.1% adoption rate of IPv6[176]. It seems that the growth in IPv6 is flat since the beginning of 2017.

[175] Volume of users that access Google over IPv6

[176] Volume of IPv6 requests to Akamai

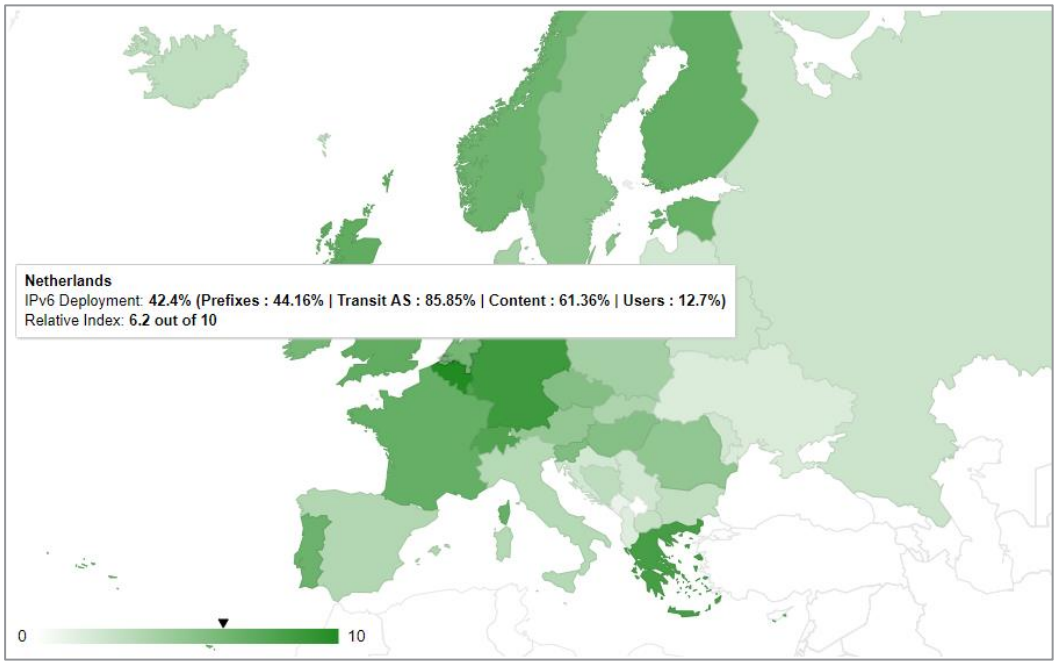


Source: Akamai, state of the Internet IPv6 adoption visualization

3.28.4 Cisco 6lab

On Cisco side, IPv6 adoption statistics are measured from several parameters: IPv6 prefixes, routing, IPv6 webpages…In this configuration, Netherlands is ahead of the pack, displaying an IPv6 adoption rate a little above 42.4%.

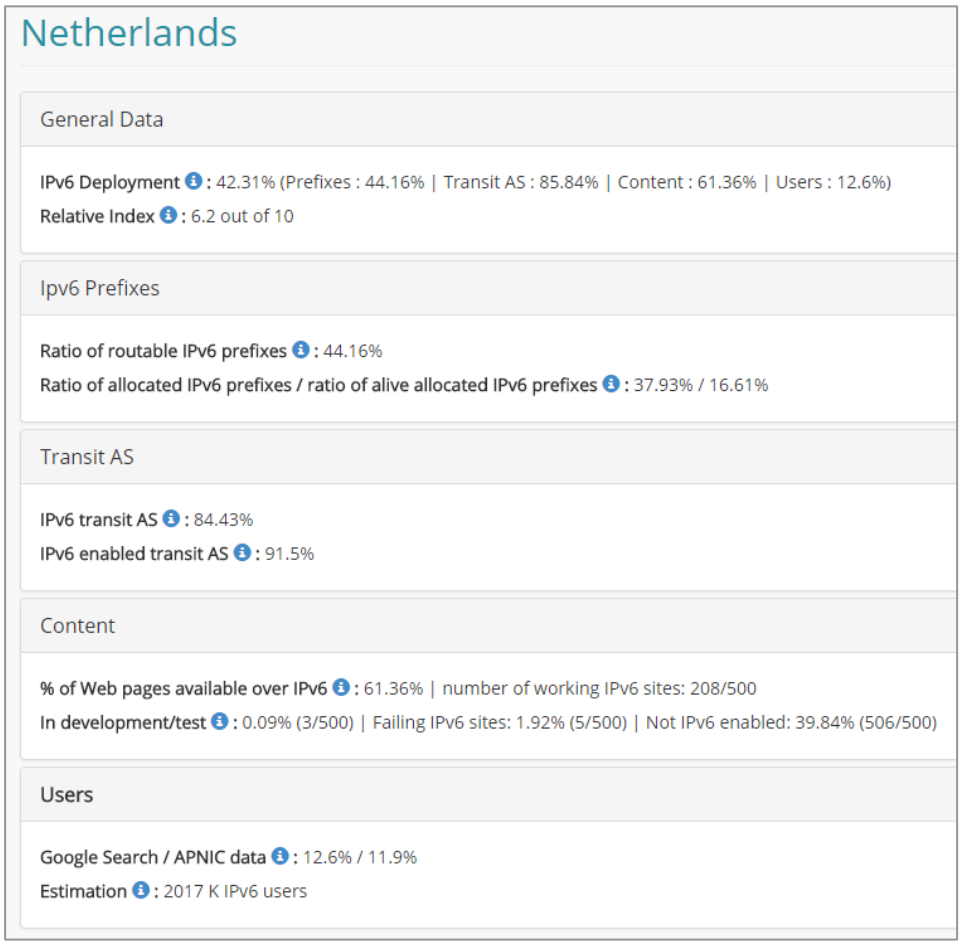
Figure 226: IPv6 adoption by Cisco



Source: Cisco - 6lab - The place to monitor IPv6 adoption

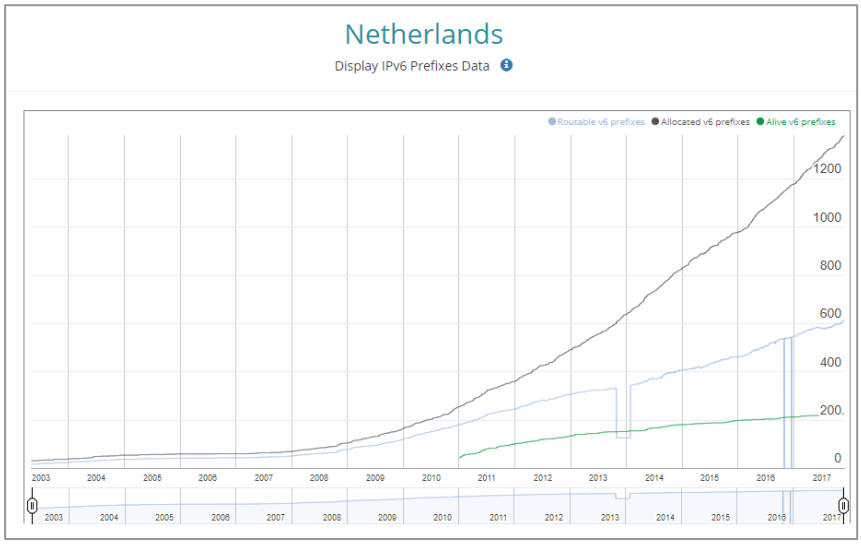
Other figures from Cisco indicates that in the Netherlands, 208/500 sites run on IPv6 and there are 2 017 000 IPv6 users.

Figure 227: IPv6 adoption at different layers



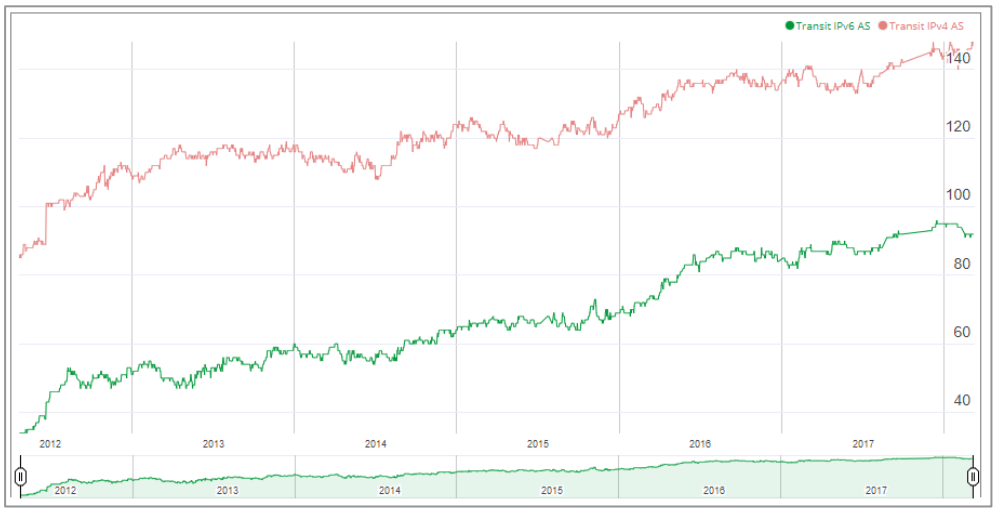
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 228: The evolution of IPv6 adoption in terms of "prefixes"



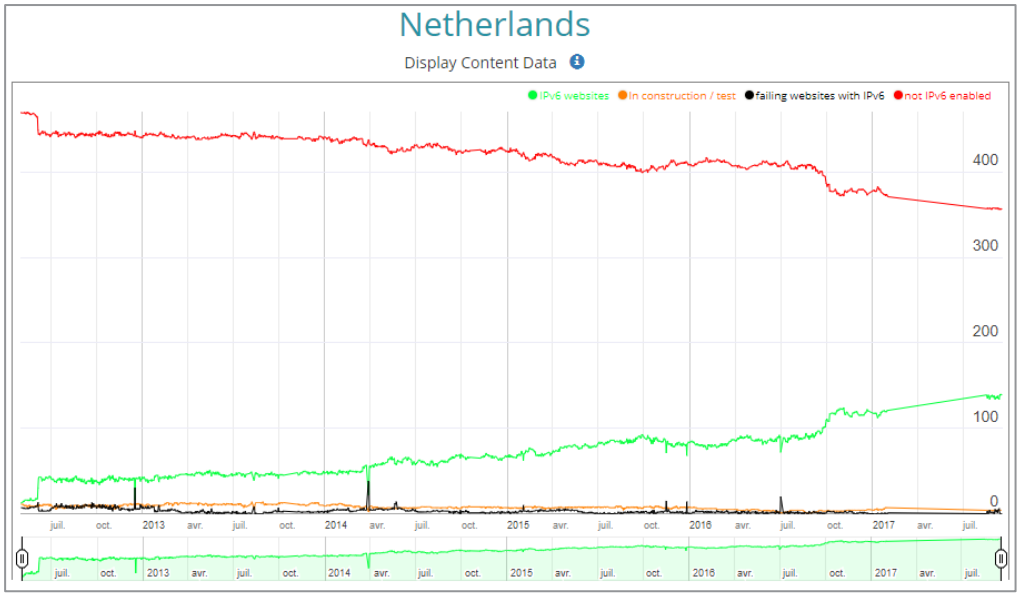
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 229: The evolution of IPv6 adoption in terms of “transit AS”



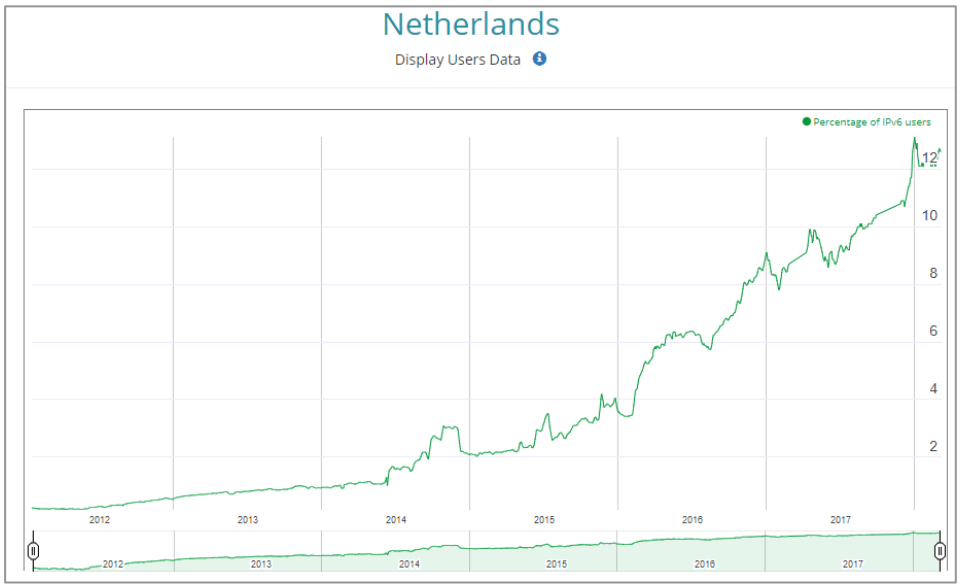
Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 230: The evolution of IPv6 adoption in terms of “display content data”



Source: Cisco - 6lab - The place to monitor IPv6 adoption

Figure 231: The evolution of IPv6 adoption in terms of “display users data”

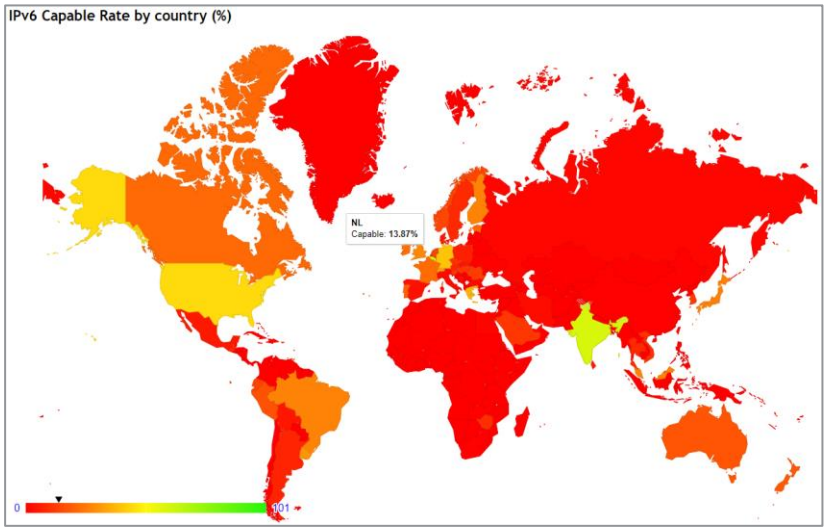


Source: Cisco - 6lab - The place to monitor IPv6 adoption

3.28.5 Other - APNIC

APNIC also provides IPv6 measurement, which is based on testing users web browsing with IPv6 capability. In the range, the Netherlands is displayed in dark-red, revealing a low adoption.

Figure 232: IPV6 capable rate by country (%)



Source: APNIC, https://stats.labs.apnic.net/ipv6