IPv6 Transition Mechanisms

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***Abstract – The next-generation Internet Protocol, initially known as IP Next Generation (Ipng), and then later as IPv6, has been developed by the Internet Engineering Task Force (IETF) to replace the current Internet Protocol (also known as IPv4). To enable the integration of IPv6 into current networks, several transition mechanisms have been proposed by the IETF IPng Transition Working Group*[1].**

Many transition mechanisms have been developed by IETF to provide coexistence between networks and applications. The main goal of this paper is to develop a scenarios for IPv6 transition will be useful for ISPs, enterprises and customers to carry out a smooth transition to IPv6 within a wide variety of network configurations and scenarios. We have identified three scenarios:

- ***ISP networks.***
- ***Enterprise networks.***
- ***Unmanaged networks (users).***

The goal is to provide guidelines to ISPs, network operators and users for IPv6 deployment within existing IPv4 networks.

***Index Terms*—IPv6, IPv4, IPv6 Transition Mechanisms, Proposed Scenarios.**

I. INTRODUCTION

The migration of Internet Protocol version 4 (IPv4) to Internet Protocol version 6 (IPv6) will not happen overnight. There will be a period of transition when both protocols are in use over the same infrastructure. To address this transition period, the designers of IPv6 have created technologies and address types so that IPv6 nodes can communicate with each other in a mixed environment, even if they are separated by an IPv4-only infrastructure.[2]. The designers of ipv6 recognize that the transition from ipv4 to ipv6 will take years and that there might be organization or hosts within organization that will continue to use ipv4 indefinitely. Therefore , while migration is the long-term goal , equal consideration must be given to the interim co-existence of Ipv4 and Ipv6 hosts [2].

II- PAPER OBJECTIVES

Since updating network infrastructure and applications simultaneously to support only IPv6 protocol is not feasible and is not possible , we must provide coexistence between heterogeneous networks (IPv4 and IPv6) and heterogeneous applications (IPv4 and IPv6).

To enable a seamless transition from IPv4 to IPv6, several scenarios have been proposed by the IETF. Existing IPv6 transition mechanisms can be classified into four categories based on the techniques they use. They are hybrid IPv4/IPv6 network, translation at IP or transport layer, and tunneling.

In this research we will examine existing transition mechanisms from the point of view of ISPs, enterprises , users networks. Different scenarios will be investigated with particular focus on the backbone structure and traffic conditions in the networks, and what should a migration scenario look like, which part of the infrastructure must be replaced, and which equipment can be updated?

Finally, we have proposed a number of scenario algorithms of Ipv6 transition for ISP, enterprise, and users.

III- TRANSITION MECHANISMS

Network transition is very complex task, as there exist several application of each transition mechanism, each with its peculiar pros and cons. The IETF IPv6 working group has designed several transition Mechanisms for the deployment of IPv6.

The mechanisms can be divided into three groups:

- Dual-stack techniques, allowing IPv4 and IPv6 to coexist in the same devices and networks.
- Tunneling techniques, used when IPv6 packets traverse the IPv4 infrastructure.
- Translation techniques, making IPv6-only nodes able to communicate with IPv4-only nodes.

Even though the techniques are presented separately, they can and likely will be used in combination with one another.

IV- PROPOSED SCENARIOS FOR IPV6 TRANSITION

A combination of the tools described in the previous chapters will be useful for ISPs, enterprises and customers to carry out a smooth transition to IPv6 within a wide variety of network configurations and scenarios. We have identified three scenarios:

- ISP networks.
- Enterprise networks.
- Unmanaged networks (users).

The goal is to provide guidelines to ISPs, network operators and users for IPv6 deployment within existing IPv4 networks.

A. Algorithms of Ipv4 to Ipv6 Transition for ISPs

In the first, an ISP is already offering IPv4 services as usual and now intends to offer new services based on the new IPv6 protocol. So, some kind of transition mechanism is needed in order to make the transition from its existing network smoothly or, at least, to make both protocols coexist.

Algorithm of ISP Network Transition

In this algorithm we will show how can ISP transition from Ipv4 only network to dual Ipv4/Ipv6 stack network as shown in figure 1.

In ISP we should look at the deployment of IPv6 in three key phases:

Starting the deployment of IPv6 at the customer access level permits an IPv6 service to be offered now without a major upgrade to the core infrastructure and without an impact on current IPv4 services. This approach allows an evaluation of IPv6 products and services before full implementation in the network, and an assessment of the future demand for IPv6 without substantial investment at this early stage.

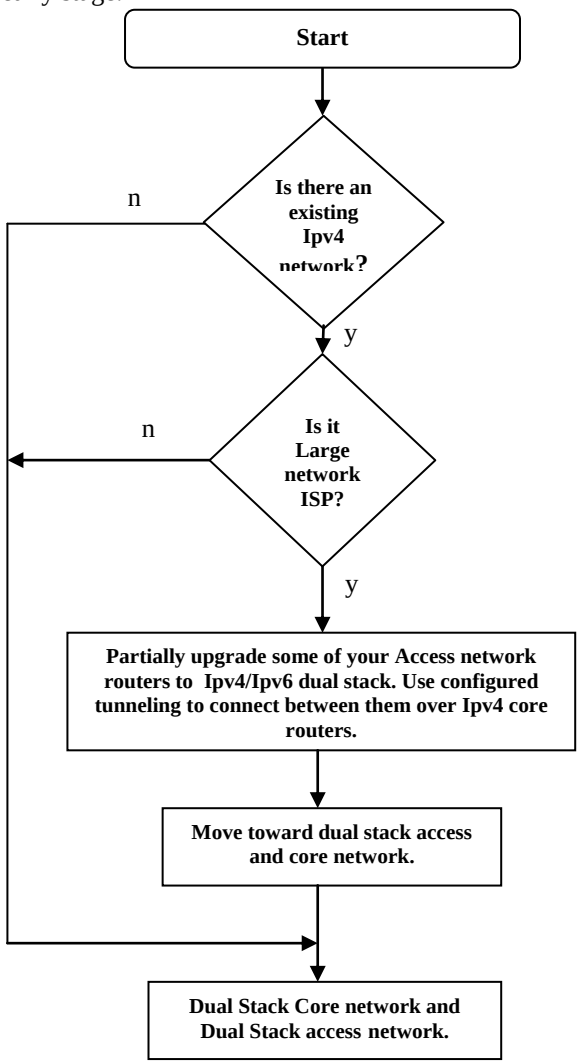

Figure 1: Ipv4 to Ipv4/Ipv6 dual stack ISP network Transition algorithm

To provide an IPv6 service at the customer level, as a network administrator for a service provider, you should begin by deciding which areas and customers are most likely want IPv6 services, and then identify the access routers that can be upgraded to be dual-stack (a technique for running both IPv4 and IPv6 protocols in the same router) so as to provide both an IPv4 and IPv6 service to these customer sites.

Initially, these access routers should be interconnected over the existing IPv4 core routers or infrastructure using one of the available deployment strategies to carry IPv6 over IPv4: carrying IPv6 packets inside IPv4 packets (tunneling) .

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Algorithm of Ipv6 Connection for ISP

The ISP will also need to establish Ipv6 connectivity to its upstream providers and peers, it is of utmost importance to require Ipv6 transit when negotiating IP transit deals with the upstream ISPs. If the upstream is not providing Ipv6 connectivity at the moment, it may be possible to obtain temporary connectivity from a nearby ISP, possibly using a short configured tunnel, tunnel broker, or 6to4 mechanisms as shown in Figure 2. However, the longer-term goal must be to require and to obtain Ipv6 connectivity from the transit ISPs, because otherwise the quality of Ipv6 connectivity will likely be poor.

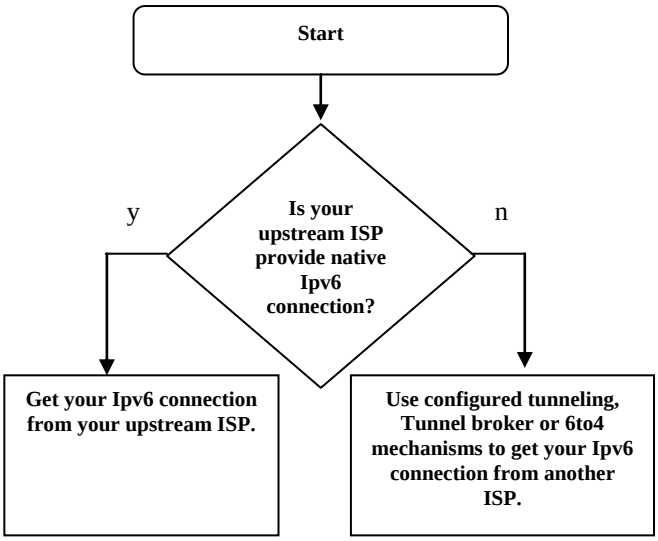

FIGURE 2: AN ALGORITHM FOR HOW CAN ISP GET IPV6 CONNECTION

Algorithm for ISP to offer Ipv6 connection to his customers

In this algorithm we will overview an algorithm that show how can an ISP offer Ipv6 connection to his customers as shown in figure 3.

The ISP mechanism selection depend on the type of customer network. There are the following customer network type:

- Ipv4 only stack network (this is normal existing state).
- Ipv4/Ipv6 dual stack network.
- Ipv6 only stack network.

If the customer network is Ipv4 only network then the ISP continue to offer Ipv4 connection to the customer as before, but if the customer network is Ipv4/Ipv6 dual stack network then the ISP will offer Ipv6 connection to the customer by using some tunneling mechanisms like tunnel broker and 6to4, and if the customer network is only Ipv6 dual stack network then the ISP will offer Ipv6 connection to the customer by using some tunneling mechanisms like tunnel broker and 6to4 and use translation mechanisms like NAT-PT or TRT to offer Ipv4 connection to the customer.

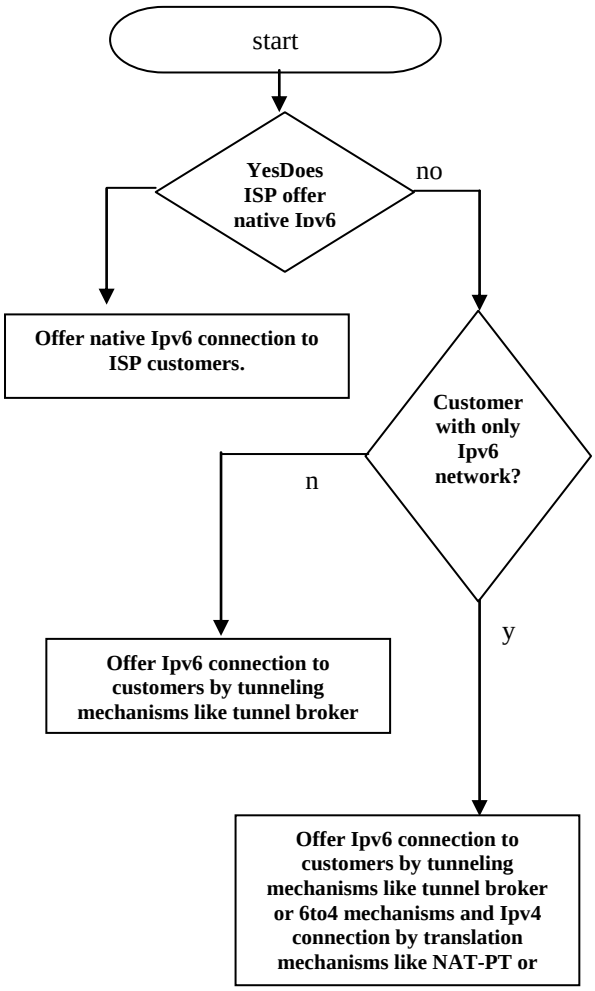

Figure 3: An algorithm how can ISP offer Ipv6 connection to his Customers

To transition to IPv6 ISP have many choices include:

- Dual stack.
- Manually configured tunnel .
- Tunnel broker
- 6to4
- ISATAP.

B. Algorithms of Ipv4 to Ipv6 Transition for Enterprise

In this section we will show how can an enterprise migration from Ipv4 network to Ipv4/Ipv6 dual stack network or only Ipv6 stack network, and how can get it's Ipv6 connection.

Algorithm of Network Transition for Enterprise

In this algorithm we will show how can enterprise transition from Ipv4 only network to dual Ipv4/Ipv6 stack network or only Ipv6 stack network.

The Base Scenarios Defined are:

Scenario 1: Wide-scale/total dual-stack deployment of IPv4 and IPv6 capable hosts and network infrastructure. Enterprise with an existing IPv4 network wants to deploy IPv6 in conjunction with their IPv4 network.

Scenario 2: Sparse IPv6 dual-stack deployment in IPv4 network infrastructure. Enterprise with an existing IPv4 network wants to deploy a set of particular IPv6 applications" (application is voluntarily loosely defined here, e.g., peer to peer). The IPv6 deployment is limited to the minimum required to operate this set of applications.

Scenario 3: IPv6-only network infrastructure with some IPv4-capable nodes/applications needing to communicate over the IPv6 infrastructure. Enterprise deploying a new network or restructuring an existing network, decides IPv6 is the basis for most network communication. Some IPv4 capable nodes/applications will need to communicate over that infrastructure.[4]

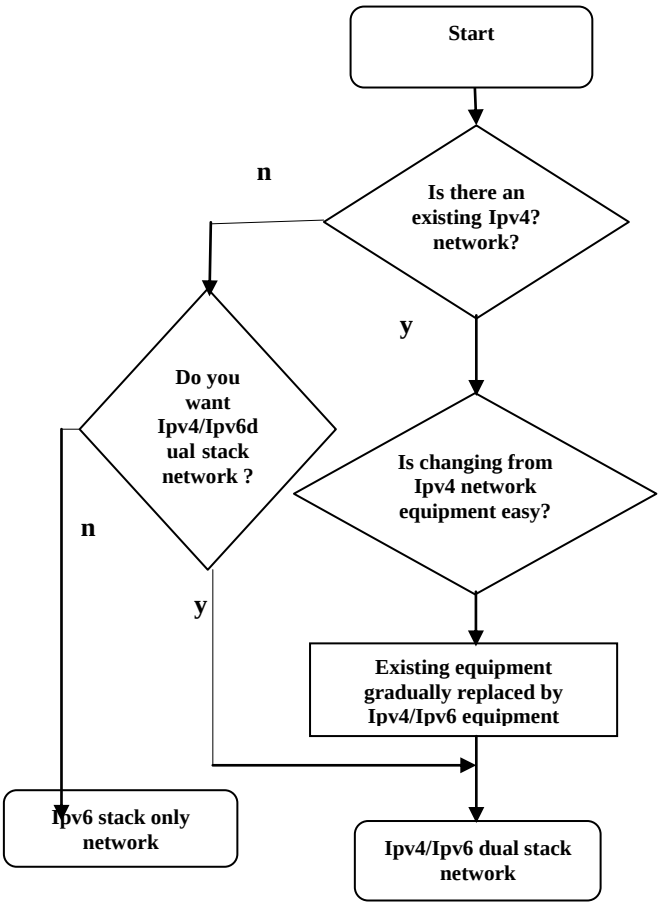

Figure 4: An algorithm of Enterprise network for Ipv6 Transition

Algorithm of Ipv6 Connectivity for Enterprise:

Several tools have been developed or are being developed to help network administrators during the migration from IPv4 to IPv6. Some of the tools provide the means to tunnel IPv6 traffic through an IPv4 network and some provide the ability for IPv6 to interoperate with IPv4. Some are implemented in network equipment and some are implemented in individual workstations. There are several factors that impact which tools an enterprise will use during a transition. The number of registered IPv4 addresses, application support, service provider offerings, and the desired transition time frame are important considerations[5].

The following factors are important in the IPv6 transition for an enterprise:

1.Amount of IPv4 address space : This is one of the most important factors. Organizations that have a large number public IPv4 addresses have the opportunity to take a dual-stack approach. Organizations with fewer addresses will need to use a mechanism that uses an IPv6-only internal infrastructure such as NAT-PT or ISATAP. It is also possible to run parallel networks that run IPv6 and IPv4+NAT.

2.Speed of deployment: For organizations looking to perform testing and gradually migrate to IPv6, ISATAP or an internal tunnel broker may be the most appropriate mechanism. In this scenario, an ISP would provide a /48 IPv6 prefix for division across various internal groups.

3.ISP service offering: Organizations that have access to an ISP that can offer native-IPv6 connectivity have the ability to use a number of tools. Those organizations that do not have access to a native-IPv6 connection will need to use a 6to4 tunnel or build IPv6-to-IPv4 tunnels to other IPv6 locations.

The gateway of an enterprise network may have the following cases:

- a gateway with no IPv6 support.
- a dual-stack gateway connected to a dual-stack ISP.
- a dual-stack gateway connected to an IPv4 ISP.
- a gateway connected to an IPv6 ISP.

Case 4 is not relevant for ISP, given that the goal of the transition is not a native IPv6 ISP, but rather a dual-stack ISP. In Case 2, both gateway and ISP network are dual-stack enabled, allowing hosts to be IPv4, dual-stack, or even IPv6 only. For Case 1 and Case 3, a tunneling mechanism is necessary, and the choice for the enterprise is which tunnel mechanism to use. These choices include:

- Native IPv6.
- Manually configured tunnel.
- Tunnel broker.
- 6to4.
- ISATAP.
- Teredo.
- NAT-PT, TRT.

While 6to4 is convenient and automatic, it can lack reliability (depending on the 6to4 relays being used). It also means the site does not use production address space, or its own allocated address space. A manual tunnel or tunnel broker would generally be preferred. If the site is using IPv4 NAT, a tunnel can still be established, but may need specific forwarding of (for example) Protocol 41 on the NAT device, or use of a protocol such as TSP to establish a NAT friendly tunnel method such as UDP tunneling.

Ipv6 Connectivity algorithm for dual stack enterprise network:

Figure 5 shows an algorithm that indicates how can an enterprise with Ipv4/Ipv6 dual stack network gets Ipv6 connection.

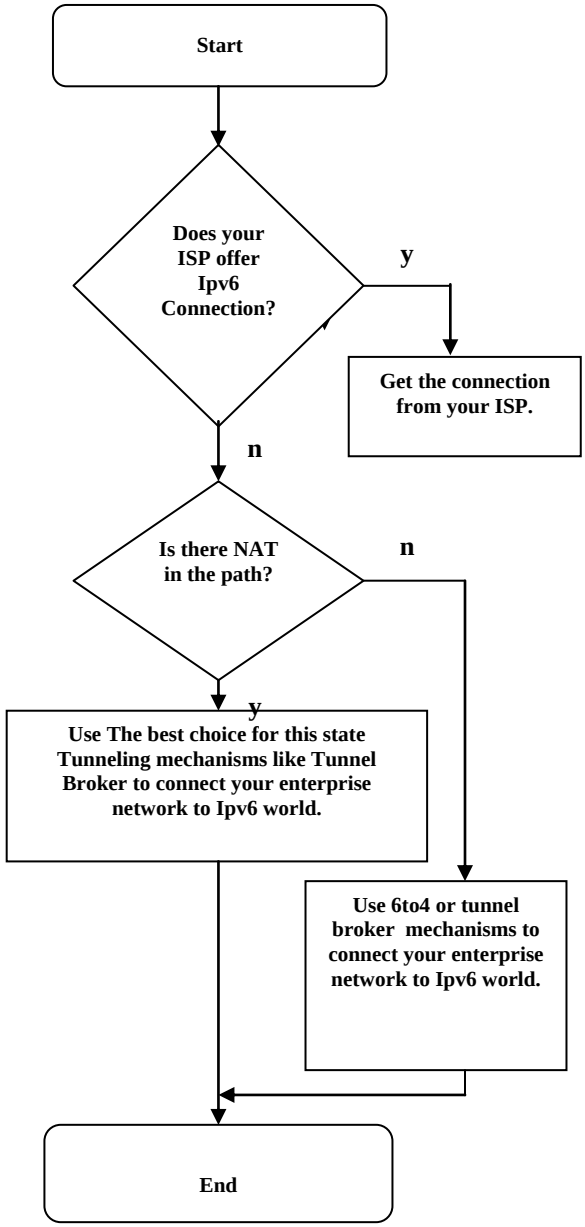

Figure 5: An algorithm for how can an enterprise with dual stack network get Ipv6 connection

Ipv6 Connectivity algorithm for enterprise with only Ipv6 network:

Figure 18 show an algorithm that indicates how can an enterprise with only Ipv6 stack network get Ipv6 connection.

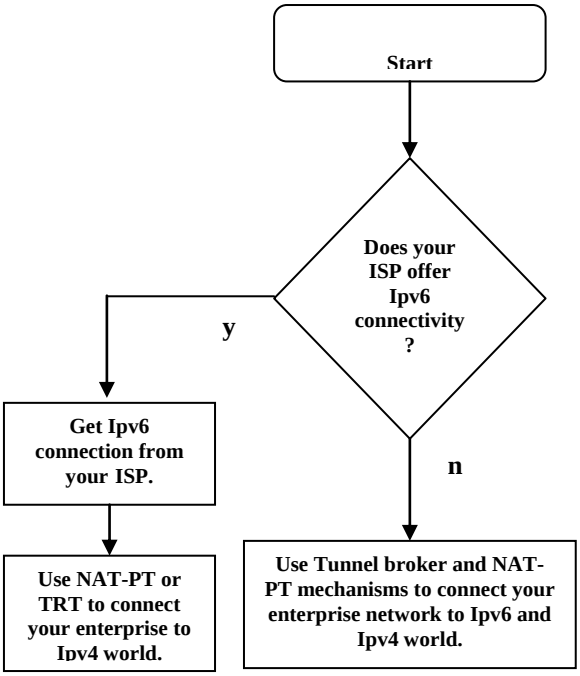

Figure 6: An algorithm for how can an enterprise with only Ipv6 stack network get Ipv6 connection

C. Ipv6 Transition for User:

In this section we will show how a customer can migrate to IPv6. Figure 7 shows A single user connecting to an ISP

Most of ISPs have not any support to IPv6, and ISPs that have their own business focused on IPv4 are tempted to wait for a significant user demand before offering IPv6 services. Other providers aiming at innovative service offerings targeted to build their own market-share might instead be interested in pushing IPv6 as an enabling technology. Therefore, Customers have the chance to plan their IPv6 strategy independently of their providers, and their enterprise by using transition mechanisms like 6to4, tunnel broker, Teredo, as shown in Figure 8.

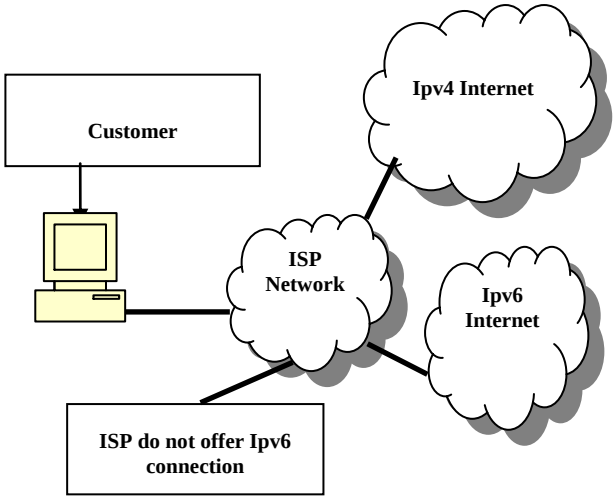

Figure 7: A single user connecting to an ISP

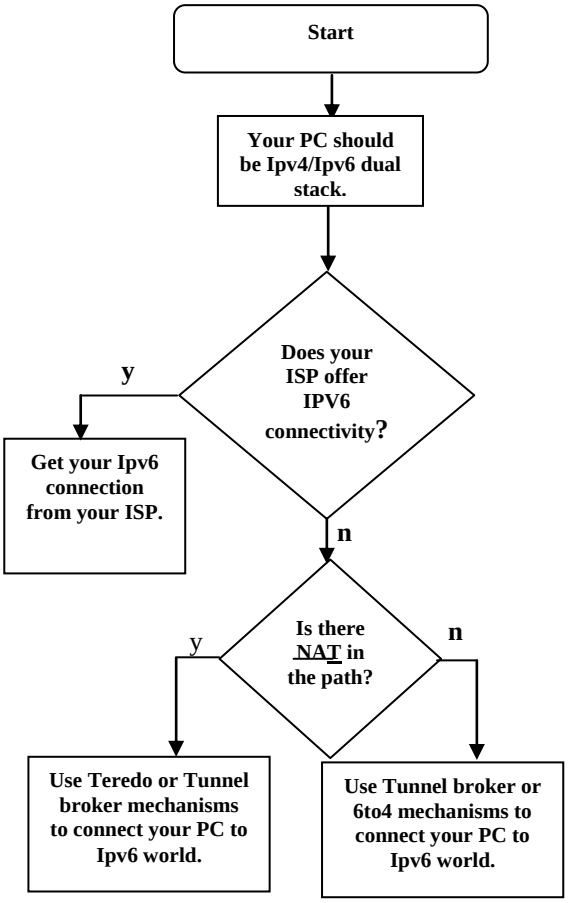

Figure 8: An algorithm for how can users get Ipv6 connection

V- CONCLUSION

This paper has addressed the general characteristics, of the three transition mechanisms. Therefore in this work we have proposed many transition algorithms for ISPs , enterprises, and users to help them to chose the convenient transition mechanisms for their networks and to aid the network migratory to analyze and simplify the migration process.

It is very clear that there are many transition tools available to assist in the process of migration towards and integration of IPv6 network services. There are many ways to evaluate and compare transition mechanisms. From our research the following points could be concluded:

There are many transition mechanisms and there are differences between them in the technical and performance characteristics, and each one of them is optimized specific services and applications, some of them are useful for ISPs and the others are useful for Enterprises and users.

The Ipv6 and Ipv4 are going to be co-exists for a long time on Internet.
Deploying transition mechanisms at a large scale can lead to scalability issues that could heavily limit the IPv6 performance compared to a native solution.
Transition from Ipv4 to IPv6 from the point of view of large internet service providers(ISPs) is a complex task. There is no perfect strategy since the transition depends on the size of existing infrastructure and it is driven mainly by customer growth.
With the algorithms described in this paper there can be a smooth evolving towards IPv6-only services instead of using both IPv4 and IPv6 protocols independently. In other words, IPv4 access connectivity can be phased out by using a translation mechanisms, such as NAT-PT, were is implemented in the service provider's backbone, enabling v6-only terminals to communicate with the v4-only resources on the Internet.
Since there are no Internet service providers (ISPs) are IPv6-ready yet in Libya, therefore, to get going deploying IPv6 we need the transition mechanisms for both enterprises and users .

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