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| **The South Asian Telecommunication Regulator’s Council Meeting (SATRC)** |  |
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**SATRC report on**

**strategies for migration to ipv6**

**Prepared by**

**SATRC Working Group on Policy, Regulation and Services**

Adopted by

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1. **INTRODUCTION**

Internet is one of the greatest inventions of our present time which transformed our way of life and provided convenience in doing our daily tasks in offices, homes, and even in retrieving numerous information, processing and using other services in many fields.

Internet Protocol (IP) is one of the communications protocols that lie at the heart of the Internet, which enables data and other traffic to traverse the Internet and to arrive at the desired destination. IP not only provides a standardized “envelope” for the information sent, but it also contains “headers” that provide addressing, routing, and message-handling information that enables a message to be directed to its final destination over the various media on Internet. The current and most widely used version of IP version 4 (IPv4) uses a 32 bit addressing and allows for approximately 4.3 billion unique IP addresses.

The Internet was originally designed as an experimental research network, not a general purpose, world-wide network. IPv4 is insufficient to accommodate present and future needs for address space. This shortage has been accelerated by mobile devices, always-on broadband connections and virtual hosts that increase the need for IP addresses.

Since the depletion of IP addresses has long been anticipated, several industry-supported workarounds used to extend the address pool. Mechanisms like Network Address Translation (NAT) are currently being used in order to solve the problem of address scarcity, but these add complexity in the implementation of peer-to-peer applications and are pointed out as a mechanism used by network operators to retain control over end users.

Reclaiming addresses can be another alternative; however its identification is difficult. Regional Internet Registries (RIRs) are working to prevent the waste of IP addresses. There is also some interest in opening up “E class” space in IPv4, which was set aside for future use when the IPv4 protocol was first developed. In addition, discussions have also started for developing modalities for commercial transfer of IP addresses, which is not permitted as of now. However, Interim measures will help extend the life of IPv4, but eventually it must be replaced in order to provide enough IP addresses for the world’s needs.

IPv6, the newer version of IP, provides virtually unlimited address space. Its deployment is considered to be the only readily available long-term solution to the upcoming shortage of IPv4 Internet address space needed to support the proliferation of broadband, Internet-connected mobile phones and sensor networks, as well as the development of new types of services. Implementation of IPv6 has experienced significant growth. However, adequate adoption of IPv6 to satisfy foreseeable demand for Internet deployment still requires a significant increase in its relative use and significant mobilisation across all parts of the Internet.

The migration from IPv4 to IPv6 is ultimately essential to pave the way for the maturation of the Internet around the world. Without this transition, the Internet will be stuck in second gear, unable to cope with the demands and needs of an interconnected world.

1. **STATUS OF IPV4 ADDRESSES**

Internet protocol version 4 (IPv4) addresses held by the Internet Assigned Numbers Authority (IANA) ran out in February 2011. This meant that the IANA had distributed its last IPv4 blocks to the Regional Internet Registries (RIRs). While the RIRs can continue to allocate these addresses for the few months following the depletion, there are now no more previously unallocated IPv4 addresses for distribution to growing networks with address space needs. Table 1 illustrates the exhaustion of IPv4 addresses with IANA and RIRs.

**Table 1: Status of IPv4 Address Exhaustion**

|  |  |  |
| --- | --- | --- |
| **Organisation** | **Date of Exhaustion** | **Remarks** |
| IANA | 03/02/2011 | Exhausted |
| APNIC | 19/04/2011 | Exhausted |
| RIPE NCC | 14/09/2012 | Exhausted |
| LACNIC | 10/06/2014 | Exhausted |
| ARIN | 21/02/2015 | Projected |
| AFRINIC | 24/07/2019 | Projected |

Source: IPv4 Address report available at potaroo.net (as on 29/07/2014)

Table 2 illustrates the internet penetration and allocation of IPv4 addresses in SATRC countries. It indicates that internet penetration in the region is very low and per user IPv4 address is not even 1. Looking at the large population of the SATRC countries and plans undertaken by the Governments of the region, internet & broadband penetration in the region is likely to grow at a rapid pace. In this scenario a large number of IP addresses will be required. Only IPv6 can fulfil this demand.

**Table 2: Status of Internet penetration and IPv4 Addresses in SATRC countries**

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **Percentage of individuals using Internet\*** | **Allocated**  **IPv4 Address**  **/32s #** | **IPv4 Address Allocated**  **/32s per user#** |
| Afghanistan | 5.90 | 125504 | 0.08 |
| Bangladesh | 6.50 | 1018368 | 0.128 |
| Bhutan | 29.50 | 26880 | 0.167 |
| India | 15.10 | 35899136 | 0.281 |
| Iran | 31.40 | 9938944 | 0.139 |
| Maldives | 44.10 | 54784 | 0.139 |
| Nepal | 13.30 | 487680 | 0.016 |
| Pakistan | 10.90 | 5212672 | 0.028 |
| Sri Lanka | 21.90 | 537600 | 0.167 |

Source: \* ITU

# potaroo.net (report generated on 29/07/2014)

1. **INTERNET PROTOCOL VERSION 6 (IPV6)**

The issue of shortage of IP addresses has been recognized since early 1990s, and both short and long-term remediation measures were worked out. For the long term, a new 128-bit IP standard has been defined by the Internet Engineering Task Force (IETF) in 2000, , called IPv6, or, as it’s sometimes known, IPng for “next generation” and has been in a process of phased adoption since then. It uses 128-bit addresses, which are conventionally expressed using hexadecimal notation (e.g. 2001:db8:85a3::8a2e:370:7334), and thus provides virtually unlimited address space (2128 or 3.40281367 x 1038 IP addresses). That means it will be able to absorb considerable future growth and support the proliferation of IP-addressable devices that is expected in years ahead. Various PCs, mobile Internet endpoints, mobile phones, automobiles, VoIP gateways, gaming stations and home appliances will need their own IP addresses.

**Advantages of IPv6**

Besides opening up more room for IP address space, IPv6 offers several additional advantages such as improved quality of service (QoS) for new Internet applications (e.g. IP telephony), authentication and privacy capabilities, and better support for mobile Internet, among others.

* Larger address space
* Built-in security, IPSec is a part of the IPv6 protocol
* Simplification of Header format allows faster and efficient processing at intermediate routers enabling efficient routing
* Better QoS support
* Mobility support across the networks
* Auto-configuration mechanism makes the life of network managers easier and save substantial cost in maintaining IP networks
* Scalability
* Multi-homing

IPv6 incorporates some additional enhancements. Additional layers of security in IPv6 may make spoofing more difficult, which could help reduce the amount of spam and block certain kinds of network attacks. In addition, IPv6 header also includes extensions to specify a mechanism for authenticating its origin, to help ensure data integrity and protect data privacy.

Many of the benefits of IPv6 are due to its IP header, where the source and destination addresses are defined. In the design of IPv6, the size of the IP header is significantly increased from 32 bits to 128 bits for source and for destination addresses. IPv6 also provide for enhanced addressing options, by extending the header of each packet to support unicast, anycast or multicast transmission. Unicast traffic travels from one host to another specific host, the way IPv4 traffic travels today, while multicast traffic travels simultaneously to multiple hosts. Anycast traffic travels to the nearest of multiple hosts, with the idea that any host can respond appropriately.

Under IPv4, mobile applications use triangular routing. Triangular routing refers to the use of a home agent that forwards all traffic to the mobile device. The IP endpoint might move to a new address but it checks back with its home agent for connectivity. So traffic destined for a mobile endpoint first goes to the home agent and gets forwarded to the new address. With IPv6, each mobile device will have its own IP address, and mobile communications will be direct, possibly improving routing times.

IPv6 enables new & innovative applications

* Centralized Building Management System
* Smart Grid System
* Intelligent Traffic Management System
* Intelligent Healthcare
* Environmental control applications

1. **STATUS OF IPV6 ALLOCATION AND DEPLOYMENT**

Figure 3 illustrates the status of IPv6 address allocation in other parts of the world and figure 4 gives the status of IPv6 address allocation in SATRC Countries.

**Table 3: International status on IPv6 address allocation**

|  |  |  |
| --- | --- | --- |
| **Country** | **Allocated**  **/64s** | **/64s**  **per capita** |
| **US** | **1.38E+14** | **426868** |
| **China** | **7.18E+13** | **51483** |
| **Germany** | **5.32E+13** | **644333** |
| **Japan** | **4.02E+13** | **316644** |
| **France** | **4.10E+13** | **633785** |
| **Australia** | **3.73E+13** | **1576303** |
| **Korea** | **2.25E+13** | **454786** |
| **Italy** | **2.39E+13** | **390452** |
| **UK** | **1.49E+13** | **275277** |
| **Bahrain** | **2.49E+11** | **183712** |
| **Malaysia** | **3.26E+11** | **17699** |

Source: potaroo.net (report generated on 29/07/2014)

**Table 4: Status on IPv6 address allocation in SATRC Countries**

|  |  |  |
| --- | --- | --- |
| **Country** | **Allocated**  **/64s** | **/64s**  **per capita** |
| **Afghanistan** | **4.30E+10** | **1370** |
| **Bangladesh** | **2.88E+11** | **1814** |
| **Bhutan** | **1.29E+10** | **16801** |
| **India** | **1.21E+12** | **951** |
| **Iran** | **1.68E+12** | **21383** |
| **Maldives** | **8.59E+09** | **24400** |
| **Nepal** | **9.09E+10** | **3204** |
| **Pakistan** | **1.42E+11** | **764** |
| **Sri Lanka** | **6.44E+10** | **3002** |

Source: potaroo.net (report generated on 29/07/2014)

Table 5 illustrates the status of implementation of IPv6 in other parts of the world and figure 6 provides the status of IPv6 implementation in SATRC Countries.

**Table 5: International status on IPv6 deployment**

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | | **Number of IPv6 prefixes Allocated** | **Number of IPv6 prefixes Visible** |
| USA | | 3937 | | 1483 |
| Germany | | 1154 | | 594 |
| UK | | 1081 | | 404 |
| Australia | | 732 | | 204 |
| Russia | | 927 | | 337 |
| Netherlands | | 751 | | 360 |
| France | | 622 | | 252 |
| Sweden | | 486 | | 276 |
| Japan | | 420 | | 220 |
| Indonesia | | 301 | | 91 |
| Malaysia | | 117 | | 44 |

Source: <https://www.sixxs.net/tools/grh/dfp/all/?sort=country>

**Table 6: Status on IPv6 deployment in SATRC Countries**

|  |  |  |
| --- | --- | --- |
| **Country** | **Number of IPv6 prefixes Allocated** | **Number of IPv6 prefixes Visible** |
| Afghanistan | 12 | 2 |
| Bangladesh | 81 | 30 |
| Bhutan | 3 | 1 |
| India | 320 | 66 |
| Iran | 119 | 5 |
| Maldives | 2 | 1 |
| Nepal | 27 | 8 |
| Pakistan | 40 | 13 |
| Sri Lanka | 17 | 11 |

Source: <https://www.sixxs.net/tools/grh/dfp/all/?sort=country>

Above statistics indicate that the deployment of IPv6 in STARC is sluggish. Efforts from all stakeholders- Government policy makers, regulators, international organizations, standards bodies, service providers, equipment vendors and end users- are required to boost the transition to IPv6. Here it is important to understand that transition to IPv6 is not an option but necessity. We must not look towards “West” as this may not be so important to the countries, which already have high Internet penetration and huge chunk of IPv4 addresses.

Chaotic changeover to IPv6 may require cost multiple times compared to planned migration and may degrade performance of network. Whereas, progressive changeover to IPv6 is cost effective and can be better planned. Planned upgrade of software to IPv6 can be done with minimal expenditure and in some cases without any expenditure. If not acted now the migration of IPv6 may be equally critical as the Y2K scenario threatening IT networks to breakdown if not acted in time.

1. **MIGRATION TO IPV6**

There are number of technical solutions available for transition to IPv6, depending on the network owners’ long-term strategy. Establishing a method of communicating between IPv4 and IPv6 is key to a successful migration. IPv4 and IPv6 traffic can share a network, traveling from all edges to the core, or be accepted by isolated gateway IPv6 devices. The latter technique will let IPv6 domains communicate with each other before a full IPv6 backbone is in place. Traffic can be translated between IPv4 and IPv6 protocols, so that hosts communicating in one format can communicate with hosts running the other format. IPv6-based services can also be delivered over an MPLS core network.

The major hurdle for Ipv6 deployment is the unavailability of IPv6 content and applications leading to lack of consumer push. In addition, migration from IPv4 to IPv6 may require hardware and software upgrades, in the operator’s network as well as in the applications and programs used at the user’s end. This will require some cost to be incurred by the operator as well as the users.

The reasons for modest deployment of IPv6 include the associated costs, lack of backwards compatibility with IPv4, and the weak business cases for migration to IPv6. There is, nonetheless, increasing interest in promoting policy initiatives to raise awareness of IPv6 and to encourage IPv6 research.

**Challenges for IPv6 Deployment**

1. Large Investments in current IPv4 Infrastructure
2. IPv4 still work, NAT reduces IPv4 address requirement
3. Uncertainty of Market Demand
4. No clear IPv6 business model
5. IPv4 and IPv6 will co-exist for long time
6. Non compatible end user equipment
7. Interoperability with IPv4 as IPv6 is not back compatible with IPv4
8. IPv6 deployment lack motivation
9. Lack of consumer push as IPv6 does not give users new experiences.
10. Non availability of real IPv6 content and application
11. Lack of IPv6 Skills
12. Non availability of IPv6 Test Beds for end to end testing
13. Lack of Government initiatives

**The Role of National Governments and Regulators**

Government policy-makers and regulators have not been passive in promoting efforts to build capacity, deploy infrastructure and urge the adoption of IPv6. Regulators have had a foundational role in ensuring that regulations governing licensing, interconnection and numbering resources are aligned with efforts to promote the transition to IPv6. Regulatory agencies have at times cited a need to maintain a “light-handed” or “light-touch” regulatory stance towards Internet addressing, emphasizing the development of regulations for a competitive and affordable Internet access market that would promote demand. Governments have, however, taken some specific steps to promote awareness of the need to utilize IPv6 to expand Internet resources. Key elements of governmental action include:

* Establishing or supporting national IPv6 transition task forces (often in conjunction with multi-stakeholder groups or RIRs);
* Establishing national “roadmaps” with benchmarks and timetables for IPv6 deployment;
* Encouraging/mandating government agencies adopt IPv6 technology for their networks, websites or services;
* Promoting the use of IPv6 in government-funded educational, science and research networks; and
* Promoting overall awareness of the transition through setting up websites, hosting workshops or forums, and setting up training programmes.
* Capacity building for developing technical competency
* Development of Standards,
* Establishing IPv6 test beds
* Conducting Pilot tests, Interoperability etc
* Measuring IPv6 Deployments and Tracking Progress

1. **INITIATIVES FOR MIGRATION TO IPV6**
2. **International**

IPv6 is being adopted progressively around the world. The biggest push for IPv6 comes from the Asia Pacific region, which faces the most serious shortage of allocated IPv4 addresses. In a number of Asian countries there are incentives and government mandates adoption of IPv6 on an accelerated schedule. China is testing IPv6 networks in some large cities, and Japan has already implemented an IPv6 production network that is used by every Internet Service Provider (ISP) in the country. South Korea is working with the European Union to develop IPv6 applications and services, in the hope that leadership in IPv6 will provide a competitive advantage.

A number of international governments have issued IPv6 adoption mandates in response to the imminent depletion of IPv4 resources and the increased demand for IP addresses. Many of these orders include deadlines for full migration to IPv6.

**Australia:**

In 2008, the Australian Government Information Management Office (AGIMO) initiated a three-stage plan for the country’s migration from IPv4. The AGMIO established a December 31, 2012 deadline requiring every Commonwealth agency to have IPv6 compliance for all Internet gateways, applications and customer-facing systems. The AGMIO serves as Australia’s nominated agency for IPv6-related guidance and governance.

**China:**

China launched its five-year plan for early IPv6 adoption in 2006. The program, known as the China Next Generation Internet (CNGI) project, has been instrumental in helping the country build the world’s largest IPv6 network. China showcased its CNGI project at the 2008 Olympic Games in Beijing. Its expansive next-generation network connects millions of devices, users, and security and transportation systems throughout the country.

**Japan:**

Regarded as one of the first countries to adopt IPv6, Japan began deploying the next-generation Internet protocol in the late 1990s through its Widely Integrated Distributed Environment (WIDE) Project. In March 2000, Japanese telecommunications company NTT became the world’s first ISP to offer IPv6 services to the public. Millions of smartphones, tablets and other devices in homes, offices and public spaces throughout Japan rely on the country’s long-standing IPv6 network.

**South Korea**:

In 2004, South Korea initiated widespread migration from IPv4 via IT839, making it one of Asia Pacific’s earliest adopters of the next-generation Internet protocol. The policy, established by the Ministry of Information and Communication, required the mandatory upgrade to IPv6 in the public sector by 2010.

**Indonesia:**

Indonesia developed a comprehensive, phased national plan and roadmap, beginning in 2006. The first phase involved generating awareness of IPv6, establishing an implementation model that included a first-stage native IPv6 network, and developing a broad-based national policy. Meanwhile, Indonesia made a commitment to participate in global efforts to shape the development of IPv6, as well as policies on Internet governance and standards activities. Additional phases called for development of further infrastructure and training to accelerate the transition process to IPv6.

**Canada:**

The Government of Canada (GC) IPv6 adoption strategy consists of a phased approach to progressively enable IPv6, while continuing to support IPv4. The strategy begins at the perimeter of the GC network and moves progressively toward the centre of the network. It is a business-focused approach designed to minimize cost and risk. The strategy leverages SSC's enterprise network renewal initiative and the regular equipment and software refresh cycles.

Business partners and entrepreneurs from emerging economies who, in the future, may only have IPv6 Internet service will be able to access GC websites to do business and research. Canadian citizens travelling or living abroad and non-Canadians who may have access to IPv6 networks only will be able to access G2C web services ― for example, to access their personal income tax information through the Canada Revenue Agency or to apply for a student or work visa through Citizenship and Immigration Canada.

1. **SATRC countries**

**India**

* The Indian Department of Telecommunications (DoT) released the government’s National IPv6 Deployment Roadmap in July 2010, updating it in 2013. The result is a set of “recommendations” (many of them are mandatory) for government entities, equipment manufacturers, content/applications providers and service providers. Government organizations are required to prepare a detailed plan for transition to dual stack IPv6 infrastructure by December 2017. All new IP-based services, including cloud computing or data centre services, should immediately support dual stack IPv6. Public interfaces of all government services should be able to support IPv6 by no later the 1 January 2015. Government procurements should shift to IPv6-ready equipment and networks with IPv6- supporting applications. Finally, government agencies will have to develop human resource (i.e., training) programmes to integrate IPv6 knowledge over a period of one to three years, and IPv6 skills will be included in technical course curricula at schools and technical institutes around India.
* Service providers will have a role to play in the country’s IPv6 transition, as well. After 1 January 2014, all new enterprise customer connections (wireless and wireline) will have to be capable of carrying IPv6 traffic, either on dual-stack or native IPv6 network infrastructure. Service providers will be urged to advise and promote the switch-over to existing customers, as well. Meanwhile, the roadmap sets aggressive timelines for retail custom-ers. All new wireline retail connections will have to be IPv6-capable after 30 June 2014. All new GSM or CDMA wireless connections will have to meet the same deadline, and all new wireless LTE connections will have to comply a year earlier. There will also be goals for transitioning existing wireline customers, culminating in the upgrade of all customer premises equipment by the end of 2017.
* The target for new website content and applications to adopt IPv6 (at least dual stack) will be 30 June 2014, with even pre-existing content and apps converted by the following January. India’s financial services industry (including banks and insurance companies) was to transition to IPv6 by no later the 30 June of this year (2013). All new registrations of the “.in” national domain would be IPv6 (dual stack) by the beginning of 2014, with full migration of the domain being completed by the middle of that year.
* On the equipment side, all mobile phones, data card dongles and other mobile terminals sold for 2.5 G (GSM/CDMA) or higher technology will have to be sold with IPv6 capability (either dual stack or native) after 30 June 2014. And all wireline customer premises equipment sold after 1 January 2014 will have to meet the same criteria. Finally, all public cloud computing/data centre services should target adoption of IPv6 capabilities by the middle of 2014.

**Bangladesh:**

* So far 52 organizations in Bangladesh have received /32 IPv6 allocations from APNIC including ISPs, IIGs and Mobile operators. Still half of the service providers have not obtained IPv6 addresses.
* At this moment 11 organizations (3 IIGs and 8 ISPs) using IPv6 in their core network. One ISP has a partial deployment of IPv6 in its access network. So far only one Mobile operationally deployed IPv6 in their core network among the 5 Telecom Operators. No one implemented IPv6 in their transport and access network.
* ISPAB, ISOC Dhaka Chapter and BDIX are providing training on IPv6 deployment and creating awareness among the stakeholders and helping if there are any issues related to IPv6 deployment.
* Ministry of Post and Telecommunication formed a committee for monitoring and providing support to migrate to IPv6. The committee comprises of Ministry, Telecom Regulatory Commission, Industry and stakeholders.
* There are test beds for different organizations and they are connected through BDIX.

**Bhutan**:

* Both the telecom operators; Bhutan Telecom Ltd and Tashi InfoComm Ltd have obtained IPV6 address
* Till date, Bhutan Telecom Ltd has tested ADSL broadband on v6 without any problems and has also implemented v6 at institutions for free as a proof of concept to our customers that v6 will not bring down their network. However, Tashi InfoComm Ltd are conducting trail run of IPV6 on their network and will soon implement with its clients.
* Both the telecom operators have already prepared their own migration and implementation plan for IP v6
* There is no specific organization dealing with IPV6, the respective telecom operators with support from the regulator is working on this transition.
* The initiatives to migrate to IPv6 is purely by telecom operators . They, especially Bhutan Telecom Ltd offers free technical support in implementing and maintaining a v6 network, and conduct trainings for customers at their premises. They do not charge any fees for each /48 blocks that we allocate to each customer.
* The Bhutan Telecom Ltd have been conducting adhoc v6 routing and management trainings for all IT personnel within the country to encourage them to migrate to v6 and also to indicate how easy it is to do so and most importantly, why do it.
* Both the operators did it without a test bed though they did test it on a segment of their network before deploying it throughout the network.
* Customer/user awareness and their assumptions is a major challenge: most are not confident with v6 management and routing as they were with v4, and most assume that only v4 contents exist on the internet.

**Maldives:**

* All three operators have deployed IPv6 in their core network
* There is no specific technical body to deal with IPv6 issues. Presently Communications Autjority of Maldives deal with IPv6 related regulatory issues.
* Some private agencies conduct public awareness program on IPv6.
* No specific IPv6 roadmap has been prepared.
* Operators currently use IPv4 addresses on their network; there may be issues on software deployed on some old equipment being used for providing service.

**Nepal**:

* One Operator (Nepal Telecom) has obtained IPv6, rest five operators are yet to obtain.
* Specially there is no any technical organization/body dealing with issues however Tribhuvan University, institute of engineering has its IPv6 only research network carrying research of migration and implementation of newer technologies in IPv6 platform. This network is the research network under WIDE university of AI3 (www.wide.ad.jp, www.ai3.net, [www.soi.asia](http://www.soi.asia))
* NTA is initiating to prepare national roadmap of IPv6 migration.
* Some telecom operator(s) and ISP(s) are preparing for network readiness and CPE readiness for IPv6
* Challenges for migration to IPv6
* Lack of trust due to the unavailability of stable applications like these are available in IPv4
* Cost of Migration. (hardware and software cost), cost of human resource development
* Risk of deployment
* Lack of awareness.

**Sri Lanka:**

* All the ISPs have obtained IPv6 addresses.
* TRCSL along with the support of ISOC Sri Lanka chapter are dealing with technical issues related to IPv6.
* There is a plan to have national registry for IP address block allocation/registration
* IPv6 test bed has been established and few drill of IPv6 have also been carried out.
* Initiatives by the Government : preparing roadmap and policy with regards to migration of IPv6
* Initiatives by the Industry: Capacity building, public awareness, promote the use of IPv6
* Major challenges for migration to IPv6:
* Capital Expenditure for infrastructure upgrade
* End User Device Compatibility
* Capacity building

1. **RECOMMENDATIONS:**

Some of the potential solutions in improving the IPv6 deployment and encouraging IPv6 research are:

1. Establish national taskforce for developing roadmap for migration to IPv6 tasking it with:

* The assessment of current status of IPv6 deployment, as well as with the formulation of guidelines and dissemination of best practises relating to the efficient transition towards IPv6.
* Developing measures to align IPv6 integration schedules, favouring cohesive IPv6 deployment and ensuring that the nation can gain a competitive advantage in rolling out next-generation Internet networks and services.
* Ensuring the active participation of national experts in the work of developing international standards and specifications on IPv6-related matters, working with groups such as ETSI, 3GPP, IETF, and ITU-T.
* Conduct pilot projects
* Keeping up-to-date IPv6 activities around the world

2) Facilitate establishment of IPv6 test bed.

3) Development of standards by National Technical Standardisation Body.

4) Create more awareness program

* Local universities should conduct lecture series on IPv6 technology. Promote the adoption of IPv6 through awareness-raising campaigns and co-operative research activities, focusing on small and medium-size enterprises, ISPs and wireless service providers and operators. Local media should publish more IPv6 related materials.

5) Develop technical competency

* Local universities should open up more courses on IPv6 technology
* Establish and launch IPv6 competence centres and educational programmes on IPv6 techniques, tools and applications, to significantly improve the quality of training on IPv6 at the professional level and create the required base of skills and knowledge.

6) Encouragement development of IPv6 application

* Encourage application developments through competitions, grants and loans.

7) Government support

* Governments to take lead in IPv6 deployment by encouraging/mandating government agencies to adopt IPv6 technology for their networks, websites or services;
* Strengthen financial support for national and regional research networks, with a view to enhancing their integration into worldwide networks and increasing the operational experience with services and applications based on the use of IPv6.

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