Consultation paper No. 13/2006

# TELECOM REGULATORY AUTHORITY OF INDIA

## Consultation paper

## On

## Improvement in the Effectiveness of National Internet Exchange of India (NIXI)

October 2006

TRAI House
A2/14, Safdarjung Enclave
New Delhi-110029.

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# Preface

National Internet Exchange of India (NIXI) was set up for peering of ISPs among themselves for the purpose of routing the domestic traffic within the country. This was expected to reduce International bandwidth requirement, reduce latency for domestic traffic and cost savings resulting in better Quality of Service and reduced charges to customers.

It has been observed that a limited number of ISP's have joined NIXI resulting in sub optimal utilisation of NIXI's infrastructure. A lot of domestic traffic is still not routed through NIXI negating the very purpose of NIXI.

With an objective to make NIXI more efficient and effective, TRAI has come up with the consultation paper on **"Improvement in the effectiveness of NIXI".** The consultation paper is placed on TRAI's website (www.trai.gov.in).

The stakeholders are requested to send their comments on the various issues mentioned in the consultation paper by 15th November 2006. In case of any clarification/information please contact Sh. S. K. Gupta, Advisor (Converged Network), Tel.No.+91 11 26167914, Fax: 26191998 or email at skgupta@trai.gov.in .

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## CHAPTER 1 INTRODUCTION

1.1 A Task Force was set up in 2002 by Telecom Regulatory Authority of India (TRAI) having experts from Department of Information and Technology (DIT), IIT Delhi, IIM Ahmedabad, C-DOT, Telecom Engineering Center (TEC) and Internet Service Providers Association of India (ISPAI) to examine the slow growth of Internet services in the country. The task force was to prepare an Action Plan to achieve a faster growth of Internet in the Country and recommending an implementable methodology to facilitate the establishment of Internet Exchange Points (IXP) for peering within the country.

1.2 One of the main recommendations of the Task Force was that Internet Exchange Points named NIXI (National Internet Exchange of India) should be set up in the country under the aegis of Industry as a non-profit, neutral body. MOC&IT should facilitate this by one time grant for capital requirement and also the provision of space at their associate offices at nominal rent in four metros. The Task force emphasized that this will result in the cost saving as well as decongestion on the International Connectivity by retaining the domestic Internet traffic within the country and hence resulting into better Quality of Service and reduced Internet access charges for customers.

1.3 Govt. (DIT) agreed upon the recommendations of the Authority for setting up of NIXI for peering of ISPs among themselves for exchange of domestic Internet traffic within the country, instead of taking it all the way to other countries and back and provided the financial support of the order of Rs 4 crores. There after NIXI was setup in year 2003.

1.4 The Task force had further recommended that NIXI should have a distributed and redundant architecture with deployment at four metro locations i.e. New Delhi, Mumbai, Chennai and Kolkata. These locations to be interconnected for enabling the routing of inter-ISP traffic only and without carrying any intra-ISP traffic.

## CHAPTER 2 BACKGROUND

2.1 President ISPAI made a presentation to the Authority regarding present status of NIXI in December 2005, wherein it was highlighted that a limited number of ISP's have joined NIXI due to the following Strategic problems:

2.1.1 The 4 NIXI nodes are not interconnected, which is causing ***sub-optimal*** utilization of NIXI.

2.1.2 VSNL has not announced all its routes on NIXI, which is resulting in a lot of domestic Internet traffic not being routed through NIXI.

2.2 He also suggested that following steps for the proper utilisation of infrastructure of NIXI:

2.2.1 All The Exchanges should be immediately interlinked using upgradeable backbone links provided by the NLDOs/IP-II.

2.2.2 Establishment of NIXI in all state capitals of India, (possibly leveraging STPI's infrastructure after suitable upgradation of the same).

2.2.3 DOT should mandate that ALL ISPs to interconnect to NIXI through a licence condition.

2.2.4 NIXI, DOT/DIT/IB could facilitate to set up the security monitoring of ISPs at each NIXI node in addition to the International Gateways. Costs and management of this security infrastructure, to be borne by the Home ministry.

2.3 In its recommendations on Accelerating growth of Internet and Broadband Penetration during April 2004, the Authority observed that the response from the ISP's to join NIXI has not been very encouraging due to issues regarding insufficient infrastructure, equal flow of traffic to prevent certain operators from having a free ride on others' infrastructure, separation of international, national and regional traffic and governance. Authority was of the view that for ISP's to have incentive to join NIXI and thereby allow the country to realize its benefits, the appropriate infrastructure and processes must first be established to address the issues mentioned above. Therefore, it was recommended

" 4.2.16 The current working group of NIXI's Board of Directors should complete the process for arriving at commercial agreements and processes and make their plans and price list for services publicly available within two months.

4.2,17 Providers of backbone services, including NLDOs, BSOs and IP-II operators, should be mandated for the next two years to provide links to NIXI for ISP's, if it is technically feasible.

4.2.18 The Government should consider for the first two years subsidizing the cost of leased lines from a Class B or C ISPs point of presence to a NIXI node for purposes of promoting inter-connection. The order of magnitude of this support could be 30 – 50%.

4.2.19 The structure of the Board of Directors of NIXI should be altered to account for appropriate weight and participation from the applicable constituencies. This should include a total of 12 members, with the greatest weighting given to the largest ISP operators in the country. These large operators should be assigned five seats amongst them, while smaller ISP's should have representation via two seats. Two seats should also be reserved for independent individuals who do not have managerial stake in ISP operators, while the remaining three seats should be reserved for Government representatives, one each from DIT, DOT and TRAI. "

2.4 Recently in its recommendations on Transition from IPv4 to IPv6 in India, (Jan 2006) the Authority has also recommended that

2.4.1 Setup of NIXI should be upgraded to IPv6 and its various nodes interconnected so that it can be utilised as a test bed by the ISP's by providing access to all the ISPs.

2.4.2 National Internet Registry (NIR) should be established in the country within the framework of APNIC, the Regional Internet Registry, utilizing the existing setup of NIXI.

2.5 Based on above observations the Authority felt that urgent steps are required by Govt. (DIT) as well as NIXI board to make NIXI fully effective. With an objective to make NIXI more efficient and effective, the Authority recommended on dated 29th May 2006 that urgent steps are required by Govt. (DIT) in respect of the following:

2.5.1 All the four nodes of NIXI should be interconnected with each other.

2.5.2 All ISPs connected to NIXI to be mandated to announce all of their routes on NIXI.

2.5.3 Consideration of establishment of NIXI nodes in all state capitals of the country.

2.5.4 Subsidizing the cost of leased lines for category B and category C ISP's node to a NIXI node for purposes of promoting their connectivity with NIXI.

2.5.5 Restructuring of the Board of Directors of NIXI to account for appropriate weight and participation from the applicable constituencies

# CHAPTER 3 PRESENT STATUS

## 3.1 Structure of NIXI

3.1.1 NIXI is managed by a limited liability company under the name National Internet Exchange of India, registered as a Section 25 company of the Companies Act and other applicable laws of India. It is managed by a Board of Directors. The Directors are drawn from the Department of Information Technology, eminent academicians such as from IIT, ISPAI, and from among the peering ISPs.

3.1.2 NIXI is physically hosted at the premises of Software Technology Parks of India at all its present locations, ie. Noida, Mumbai, Chennai and Calcutta. Presently 27 ISPs have 54 connections to these four nodes (Annex I).

3.1.3 The initial cost of the project was provided for by a Grant of the order of Rs 4 crores from the Deptt. Of Information Technology, Ministry of Communications and Information Technology, Government of India. It was envisaged that from the Second year of operations, the venture would become financially self-sustaining and all surplus income would be used to meet the objectives of NIXI.

## 3.2 Existing Routing Policy of NIXI

3.2.1 An ISP at any NIXI node must at a minimum announce all its regional routes to the NIXI router at that NIXI location. All ISPs connecting to that NIXI node are entitled to receive these routes using a single BGP session with the NIXI router. This will guarantee the exchange of regional traffic within NIXI. This is referred to as forced regional multi-lateral peering under the policy.

3.2.2 In the event, one NIXI member is already providing transit to another NIXI member, the exchange of regional routes mentioned in 3.2.1 above, may also happen using a separate private connection between the ISPs.

3.2.3 ISPs should announce only those routes that belong to their AS, i.e their own network, and their customer routes at the NIXI. An ISP in any region can aggregate traffic from other ISPs in the region and connect to the NIXI through a single connection.

3.2.4 The NIXI router will only exchange information but not carry any transit traffic.

3.2.5 All NIXI members must ensure that they suitably and proactively upgrade capacity from time-to-time so that they do not end up dropping traffic that other peers are exchanging with them.

3.2.6 The routing policy here also applies to "large" content providers to directly peer at any of the NIXI nodes. They will be treated like stand-alone Data Centers. For this they need to adhere to the following criteria:

3.2.6.1 They must have their own AS number

3.2.6.2 They must bring at least 20+ Mbps of traffic to the NIXI Node(s)

3.2.6.3 The content hosted by them should be in accordance with Indian laws (i.e they should not be hosting obscene content or promoting gambling or anti-national content, or any other content that violates either the ISP license condition or any other Indian Law)

### 3.3 Existing Tariff Policy of NIXI

3.3.1 For traffic exchange at a NIXI node between ISP A and ISP B, B will pay to A (through NIXI) an amount equal to Rs. 50 per Gbyte multiplied by the difference in traffic from A to B and traffic from B to A. Here, the concept of "Requester Pays" to promote domestic content. Thus the "requested" traffic from ISP A to ISP B is measured and subtracts the "requested" traffic from ISP B to ISP A. The settlement of this is done by paying this money to the NIXI and the NIXI paying the net of all such settlements to the respective ISP. The tariff of Rs. 50 per GB can be reviewed from time to time as bandwidth prices drop.

3.3.2 In the case of a NIXI member providing transit to another NIXI member, where they agree to adhere to the NIXI routing policy using a separate link between them, the above "X-Y" calculation will be done by both the members as above settlement will be done amongst themselves. However, in the event of a dispute, the NIXI will have the right to intervene and NIXI's decision in the matter will be binding on both parties.

3.3.3 To prevent unfair advantage to stand alone Data Centers, there will be an additional factor (P) introduced in the calculation of payment for interconnect between the ISPs. The factor will have a value of 0 if it is determined that the ISP is primarily a Data Center (outgoing traffic is 5 times incoming traffic). It will be 1 otherwise.

3.3.4 In order to simplify measurement, the NIXI will do the settlement between the ISPs accordingly. Thus, the ISPs will pay to NIXI/

receive from NIXI the traffic settlement charges based on the formula given below:

C x P x (X - Y)

Where C is currently Rs. 50 per G Bytes, P has a value of 0 if the ISP is a Standalone Data Center (i.e his outgoing traffic is 5 times his incoming traffic), or 1 if ISP is not data center as per above definition. X is the traffic in GB sent to NIXI and Y is the traffic in GB received from NIXI.

This formula has been worked out by NIXI after discussion with its members to ensure uniform treatment to all ASPs connected and proportionate payment for imbalanced traffic (Unequal out going and incoming traffic).

### 3.4 Other existing Charges at NIXI:-

3.4.1 **Joining Charges** (per NIXI PoP) one time: Rs 50,000

3.4.2 **Membership fee:** Rs. 1000 per annum all India basis. The same is to be paid at the time of joining.

3.4.3 **Connectivity Charges**

| **Port Capacity** | **Charges in Rs. per annum** |
|---|---|
| 64kbps | 50,000 |
| 128Kbps | 75,000 |
| 512Kbps | 100,000 |
| 1Mbps | 125,000 |
| 2Mbps | 150,000 |
| 4Mbps | 200,000 |
| 8Mbps and above | 300,000 |

3.4.4 **Rack space including electricity:** Rs 2500 per U per year

3.4.5 **Accompanied Access:** Rs 500 per accompanied access.
Rs 5000 maximum per month

3.4.6 **Charges for reconnection:** Rs 50,000 per port per location per instance

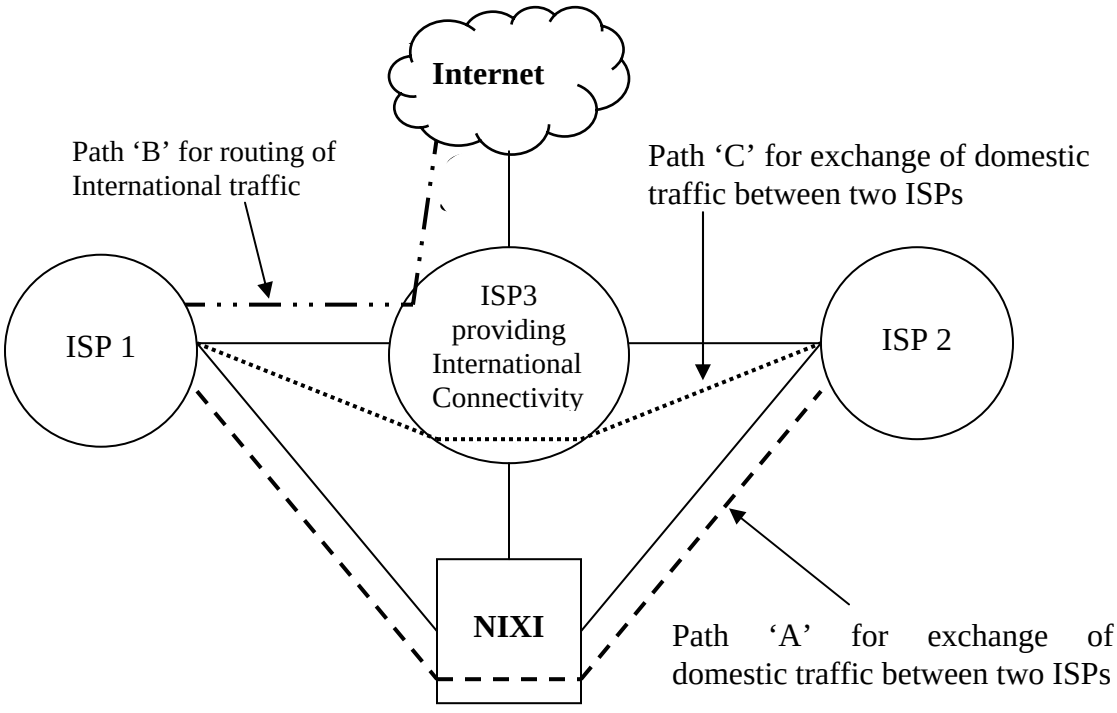
3.4.7 **Charges for modification in capacity/ port :** Rs 5000 for each modification instruction.

## CHAPTER 4 CAUSE OF THE PROBLEMS AND ANALYSIS

4.1 Most of the ISPs do not have International Long Distance (ILD) operations and they depend on ILDOs for International Internet bandwidth. The International Internet bandwidth can be taken in two forms:

(i) IP Port in India
(ii) IPLC to designated country

If ISPs take IP port in India and the ILD operator is also an ISP (Majority of International Internet bandwidth providers are ISP also) having its presence at NIXI, then two paths are available between the ISP and the ILD for exchange of traffic (One at NIXI and other at International Internet bandwidth provider ISPs network) as shown in the diagram:




For exchange of domestic traffic between ISP1 and ISP 2 through NIXI, path 'A' should be followed and for routing of International traffic through ISP3, path 'B' should be followed. In some cases, since all routes of ISP1 are declared at ISP3 also for routing of the international traffic, the domestic traffic of ISP 2 meant for ISP 1 can

pass through ISP 3 through path 'C' if it is shorter path as compared to path 'A'. In such a situation the ISP 3 starts functioning as national exchange point also. Such exchange of traffic is unwarranted and reduces effectiveness of NIXI.

This type of traffic routing is likely to results in one of the following:

- No traffic exchange through NIXI even if ISPs are connected to NIXI resulting in suboptimal utilisation of NIXI.
- Domestic traffic from ISP 1 or ISP 2 follows the same path as that of international traffic to ISP3
- ISP 1 and ISP 2 pay international traffic charges for their domestic traffic going through ISP 3, resulting in loss to ISPs and gain to ISPs.

4.2 There is another possibility also. ISPs can manipulate the Border Gateway Protocol (BGP) at NIXI interconnect point so that International traffic coming through ISP 3 passes to ISP 1 following the NIXI interconnect point. In this manner International traffic passes through the NIXI path from ILD providing the international internet band width to ISP resulting in loss to International Internet bandwidth providers.

4.3 Both the above situations are unwarranted and need to be curbed.

4.4 It is understood that due to these factors, ILD operator cum ISP does not declare full routes at NIXI or learns route of other ISP having IP port in India from them for International connectivity. Non acceptance of ISPs route by the international Internet band width providers (IP port providers) at NIXI forces such ISPs to route all its domestic traffic through IP Port. This type of exchange of the traffic is disadvantageous to the ISP taking IP port in India as they have to pay charges for exchange of domestic traffic between them and Internet Bandwidth providers at the rate of International Internet band width for routing their domestic traffic.

4.5 This is one of the problems, which is badly affecting the effectiveness of NIXI. The technical separation of the domestic and International traffic is the only solution, which is possible with advanced tools and availability of Multi Protocol Label Switching (MPLS) networks. However, ILD operators having ISP operation need to incorporate good amount of changes in their routing policies.

4.6 The other issue is regarding interconnectivity with NIXI.There are approximately 130 active ISPs operating in India however only 27 of them are connected to NIXI say 20%. It is important to note that there are 43 Category 'A' ISPs and 61 Category 'B' ISPs. This indicates very poor connectivity with NIXI nodes. The issue comes that should we mandate that all ISPs must be connected at NIXI?

4.7 Presently, NIXI nodes are available only at 4 metros. Many ISPs may not have their operations in these stations. Hence, these ISP have to obtain dedicated leased line to connect to NIXI. It may have too much burden on these ISPs considering their small operations and likely leased line cost to connect to NIXI.

4.8 It can be argued that these ISPs may be provided subsidized leased lines for connecting to NIXI, but this may hamper the level playing field. More over the resource of the funding has to be worked out as NIXI is an organization not for profit and depends on members for fund generation.

4.9 Then issue comes whether India need to setup NIXI nodes at all the state capitals to support such small ISPs.

4.10 **Setting up of NIXI nodes at state capitals**

4.10.1 Setting up of NIXI nodes at state capitals will lead to huge investment without any commensurate value addition as the content hosted in the country is limited to 9-10 major cities. Before taking this decision cost benefit analysis, its management traffic growth etc is required.

4.10.2 Most of the states do not have sufficient traffic; setting of such nodes will only complicate the issue of maintenance of NIXI nodes, its manning without serving any fruitful purpose.

4.10.3 The total traffic at four NIXI node is not even 1GB. As such creation of NIXI at all states may not serve any fruitful purpose. The issues of staffing, maintenance, QoS, technical obsolesce and up gradation will be more complex.

4.10.4 At this point one need to keep in mind that top 20 ISPs accounts for 98.2% of the total Internet customers. These are the ISPs which are providing International bandwidth to smaller ISPs and work as their upstream providers. For all practical purpose they carry the traffic of small ISPs.

4.10.5 NIXI policy permits bigger ISPs to carry traffic in the region and carry to NIXI (Refer 3.2.2). The purpose of the exchange of the domestic traffic at NIXI can be fulfilled even if all routes are declared by up stream providers at NIXI.

4.10.6 One may have to consider at this point the issues related with small ISPs having multi-homing. Who should carry the traffic of such ISPs and how their routes shall be declared at NIXI.

4.10.7 Now, let us move to other issue. How traffic between four NIXI nodes shall be exchanged especially when ISPs connected to NIXI node have regional presence. There are divergent views.

### 4.11 **Interconnection of NIXI nodes**

4.11.1 The basic philosophy of NIXI was to retain the domestic traffic within the country. However, during design & implantation only peering of ISPs was kept in mind and emphasis was not on the transit of domestic traffic through NIXI nodes. As a result four standalone nodes were established.

4.11.2 One can say that NIXI nodes are interconnected than the bigger ISPs might connect only at one or two locations just for peering and would ride on NIXI' s backbone for the transit of their traffic. Thus NIXI would become domestic transit provider and compete with all other ISPs and may change the basic philosophy of NIXI to be a neutral body.

4.11.3 NIXI will have to obtain the appropriate licence from DoT for carrying ISPs traffic over such backbone, which may lead to several other complications.

4.11.4 Since NIXI is a non-profit organization, the cost of such interconnection is to be bourn by NIXI members. Non-equal utilization of backbone may raise disputes in financial settlement.

4.11.5 The exchange of regional traffic is still a problem. Since most of the top 20 ISPs have all India presence this problem can be mitigated only if we assume that these ISPs shall announce all the routes at all the NIXI exchanges and carry traffic of their customers on their backbone.

4.11.6 Solution to this situation is necessary to improve effectiveness of NIXI.

4.11.7 Non declaration of all routes at NIXI is also a point of concern. Let us discuss the issue in detail.

### 4.12 ISPs connected to NIXI to announce all of their routes on NIXI

4.12.1 If ISPs or their upstream providers are mandated to connect to NIXI and announce all the routes, then it will enhance the effectiveness of NIXI to a great extent. However it may require amendment of ISP license condition.

4.12.2 Ensuring proper connectivity is also important. It may be possible that ISPs may announce all their routes, but do not have adequate bandwidth connectivity to NIXI resulting in congestion. ISPs must take suitable connectivity to NIXI based on the traffic and upgrade the connection to higher level as

soon as the average tariff on the link exceeds 80% of the capacity

4.12.3 Declaring all routes may be seen as using 'A' Category ISPs backbone to carry traffic of class B/C ISPs without any transit service revenue to category 'A' ISPs.

4.12.4 One can argue that all ISPs connected to NIXI could be mandated to announce all of their domestic regional routes to NIXI instead of all of their routes; as exchange of all the routes at all the NIXI locations may lead to Class A ISPs' domestic backbone being used by other.

4.12.5 Effectiveness of NIXI can be increased once these issues are discussed to find solution.

## CHAPTER 5 ISSUES FOR CONSULTATION

5.1 What is the basic reason holding back effective utilization of the NIXI? In your view what actions are required to ensure all domestic traffic passes through NIXI?

5.2 Should all ISPs or their Up stream providers be mandated to connect at NIXI? If So,

5.2.1 Should minimum connection size, space requirement, power requirements etc be also defined based on the slab of customer base of the ISP?
5.2.2 Will it increase interconnect cost with upstream provider?
5.2.3 Will there be any limitations when an ISP has multi-homing?

5.3 Should ISPs connected to NIXI be mandated to announce all of their routes on NIXI? If so
5.3.1 Should only regional traffic be announced on NIXI regional node?
5.3.2 How to handle situations where connecting ISPs have regional presence?
5.3.3 Whether announcing all routes at NIXI node can result in misuse of national backbone of class A ISPs?
5.3.4 What are the alternatives and solutions?

5.4 Do you feel Interconnection of 4 nodes of NIXI is necessary? If so
5.4.1 Whether NIXI will become a transit service provider thereby competing with its members, contrary to the role assigned to it?
5.4.2 Whether NIXI will require any licence from DoT as it will start carrying of traffic between two stations and distributing between the ISPs?
5.4.3 Can links interconnecting NIXI nodes be misused by connecting ISPs to carry their traffic between two stations on NIXI backbone? If so, can it be prevented technically?
5.4.4 Since NIXI is an organization not for profit, how cost towards interconnecting lease line etc will be collected from the members?
5.4.5 Whether interconnection of NIXI nodes will increase NIXI popularity and effectiveness.

5.5 Is there a need to establish NIXI nodes at all state capitals?
5.5.1 Whether there will be adequate traffic?
5.5.2 What purpose will it serve if traffic is less?
5.5.3 What should be the basis to take such decisions?

5.6 How segregation of domestic and international traffic can be done when a ISPs is peering as well as transiting the traffic of other ISP?

5.6.1 Can NIXI platform be misused for routing international traffic?

5.7 Is there a need to upgrade NIXI nodes to facilitate implementation of IP V6?

5.8 Is there a need to define QoS for NIXI nodes? If so

5.8.1 What parameters need to define and how should it be monitored?

5.9 Should NIXI settlement formula be considered for modification to encourage Data center and WEB hosting in India? If so, give your suggestions.

5.10 Any other suggestion, which you feel will increase the effectiveness of NIXI?

## CHAPTER 6 INTERNATIONAL EXPERIENCE:

In most of the countries there are multiple Internet exchanges, which are independent and are not interconnected. Here are some of the examples:

### 6.1 UK

#### 6.1.1 London Internet Exchange (LINX)

LINX is a mutual not-for-profit organisation, owned by the ISPs and content service delivery providers, which have connections there. The LINX Network consists of two separate high-performance Ethernet switching platforms installed across seven interconnected locations in London. It has more than 200 members – both ISPs and content delivery service providers – from the UK, mainland Europe, the USA, Africa and the Far East. It handles up to 95 per cent of all UK Internet traffic.

#### 6.1.2 London Internet Providers Exchange (LIPEX)

Started in October of 2001, Lipex is one of the fastest growing Internet Exchange Points (IXP) or Peering Points in Europe. It has 56 members and has 6 PoPs in London.

#### 6.1.3 London Network Access point (LoNAP)

A neutral not-for-profit, independent peering point, LoNAP has been providing the infrastructure for its members to establish peering and exchange traffic since 1997. It has 43 members and 3 PoPs in London.

#### 6.1.4 Manchester Network Access point (MaNAP)

MaNAP is a neutral, not-for-profit Internet Exchange committed to the provision of continuous and resilient layer two ethernet connectivity to operators of Autonomous Systems. It has 29 members and 4 PoPs.

It has created the first National peering LAN in the UK by extending its network to London and allow providers in London to peer at MaNAP without the need to buy expensive circuits to the North of England. Continuing to support the MaNAP membership, it will provide special pricing on Point to Point circuits to London from Manchester for MaNAP members only, with an almost 50% reduction on 1Gbps connections. This will benefit members wanting to source their transit in London, which is typically cheaper, and also for members who wish to co-locate a router in Manchester to expand their own network.

### 6.1.5 **Redbus Interhouse Internet Exchange (RBIEX)**

RBIEX is a neutral Internet Exchange with 15 members and 3 PoPs in London.

### 6.1.6 **Scottish Internet Exchange (SCOTIX)**

ScotiX" - Scotland's first Internet Exchange opened for business on 14th September 1999. ScotIX is a not for profit company, limited by guarantee, and registered in Scotland. The Stakeholders are ISPs or Telcos who have their own permanent connection to the Internet and their own paths from an IP address within the Autonomous System.

## 6.2 **Australia**

### 6.2.1 **PIPE Internet Exchange**

PIPE Networks is Australia's largest peering provider with 16 IX locations across 6 metro-IX networks. PIPE Networks is a Metro Area Internet Exchange that has distributed its switching capacity in areas of high customer density in Brisbane, Sydney, Melbourne, Adelaide, Hobart and Canberra. As such the PIPE network can connect to customers in buildings other than its main point of presence. It has 59 members at present. PIPE Networks operates a vendor and carrier neutral environment for its peers and provides fully redundant, state of the art layer 2/3 Ethernet switches and routers operating up to gigabit speed.

### 6.2.2 **West Australia Internet Exchange (WAIX)**

WAIX commenced in early 1997 to allow members of the WA Internet Association (WAIA) the ability to inter-connect using an independent facility. The facility allows members to multi-laterally peer their networks at a considerably reduced rate. WAIA charges each of the four ISPs a quarterly fixed fee (plus setup charge) for connection and this allows them access to all shared information.

### 6.2.3 **Equnix Sydney**

Equinix Exchange is a solution for Internet Service Providers (ISP), Content Service Providers (CSP), and large enterprises seeking to expand geographically without incurring the cost of building new data centers.Equinix Exchange provides new

peering flexibility and intra-data center LAN connectivity to ISPs, CSPs and large enterprise customers at multiple Asian and U.S. locations.

### 6.2.4 **Globalcenter Internet Exchange (AUSIX)**

As the first successful neutral commercial Internet Exchange in Australia, AUSIX's Melbourne facility is recognized as one of the top ISP interconnection points in the world.

### 6.2.5 **Victorian Internet Exchange (VIX)**

The **Victorian Internet Exchange** is an Internet Exchange Point in Australia. Formed from the Australian Internet Exchange (AUIX) project, VIX is located in the Australian Associated Press Telecommunication (AAPT) Exchange at Melbourne and offers multi-lateral peering.

## 6.3 **Hongkong**

### 6.3.1 **Hong Kong Internet eXchange (HKIX)**

HKIX is initiated and coordinated by Information Technology Services Centre (ITSC) of the Chinese University of Hong Kong (CUHK). **HKIX is not a transit service provider**; instead, it is a layer-2 settlement-free multi-lateral exchange point mainly for routing of intra-HongKong Internet traffic. However, HKIX can also be used for routing of Internet traffic between the networks in Hong Kong and the peer or downstream networks of HKIX participants in other countries. The peering model of HKIX is a SKA (Sender Keep All) peering model.

### 6.3.2 **The Equinix Internet Business Exchange**

Equinix Exchange is a solution for Internet Service Providers (ISP), Content Service Providers (CSP), and large enterprises seeking to expand geographically without incurring the cost of building new data centers.

## 6.4 **Singapore**

### 6.4.1 **Singapore Open Exchange**

Singapore Open Exchange (SOX) is a public/neutral Internet exchange Point (IXP) hosted by National University of Singapore. SOX differs from existing IXPs in Singapore as it

operates at OSI layer 2 and does not provide any transit traffic. It has 13 members.

### 6.4.2 **StarHub IP Exchange (SiX)**

StarHub IP Exchange or SiX is a comprehensive IP Transit Service designed to help Service Based Operators (SBOs) such as Domestic and Regional ISPs and content providers.

### 6.4.3 **Equinix Internet Business Exchange**

Equinix Exchange is a solution for Internet Service Providers (ISP), Content Service Providers (CSP), and large enterprises seeking to expand geographically without incurring the cost of building new data centers.

## 6.5 **Indonesia Internet Exchange (IIX)**

All active ISPs in Indonesia including Govt. owned TelkomNet and IndosatNet are connected to IIX, which is administered by the Association of Internet Service Providers of Indonesia (APJII). IIX has two nodes; one Telkom building and other is at Internet Data Center Indonesia.

**Annex I**

**ISPs connected at NIXI Noida:**

1. Bharat Sanchar Nigam Ltd
2. Bharti Infotel Ltd.
3. Dishnet Wireless Ltd
4. ERNET India
5. Estel Communication Pvt. Ltd
6. HCL-Infinet Ltd.
7. Hughes Escorts Communications Ltd
8. Hathway Cable& Datacom Pvt. Ltd
9. Mahanagar Telephone Nigam Ltd.
10. National Informatic Centre (NIC)
11. Primus Telecommuncations India Ltd.
12. Reach India Private Ltd
13. Reliance Communications Infrastructure Ltd
14. Sify Ltd
15. Software Technology Park of India
16. Spectra Net Ltd.
17. Trak Online Net India(P) Ltd.(Net4India )
18. Videsh Sanchar Nigam Ltd.

**ISPs connected at NIXI Mumbai:**

1. Bharat Sanchar Nigam Ltd.
2. Bharti Infotel Ltd.
3. Broadband Pacenet (India) Pvt. Ltd
4. Cyquator technology Ltd.
5. ERNET India
6. Exatt Technologies Pvt.Ltd.
7. Five Networks Solutions India Ltd.
8. Hathway Cable& Datacom Pvt. Ltd.
9. Indian Quotation Systems (P) Ltd.
10. Iqara Telecom India Pvt. Ltd.
11. Mahanagar Telephone Nigam Ltd
12. Netmagic
13. Primenet Global Ltd.
14. Railtel Corporation of India Ltd
15. Reliance Communications Infrastructure Ltd
16. Reach India Private Ltd.
17. Sify Ltd.
18. Software Technology Park of India
19. Spectra Net Ltd.
20. Trak Online Net India(P) Ltd.(Net4India )
21. Videsh Sanchar Nigam Ltd.

**ISPs connected at NIXI – Chennai**

1. Bharat Sanchar Nigam Ltd
2. Bharti Infotel Ltd.
3. Dishnet Wireless Ltd
4. ERNET India
5. Hathway Cable& Datacom Pvt. Ltd.
6. Railtel Corporation of India Ltd
7. Reliance Communications Infrastructure Ltd
8. Sify Ltd.
9. Software Technology Park of India
10. Trak Online Net India(P) Ltd.(Net4India )
11. Videsh Sanchar Nigam Ltd.

**ISPs connected at NIXI- Kolkata**

1. ERNET India
2. Sify Ltd
3. Software Technology Park of India
4. Videsh Sanchar Nigam Ltd.