



Digital Seminar on Competitive Edge of NREN and Financial Sustainability



Ministry of Electronics and
Information Technology
Government of India



Competitive Edge of NKN

National Knowledge Network



NKN is a state-of-the-art multi-gigabit pan-India network for providing a unified high speed network backbone for all knowledge related institutions in the country



1st Indian unified high speed backbone network that carries the traffic of e-Governance, Research and Internet on a single platform

Multi gigabit Pan- India network connecting all the State capitals and Districts with n*10 Gbps & n*1 Gbps

NKN has been designed to be a dynamic and scalable network, and is planned for an up-gradation to 100G

Encourage, Enable, Enrich & Empower

NKN is the primary backbone for the implementation of Digital India

Secure and reliable connectivity to education facilities, R&D institutions, Indian mission critical agencies and government deployments

Quality of Services in a Network

measures accounts for importance of specific metric to one type of application eg: Packet Loss, Latency, Jitter etc.

Metrics

Latency: implies the minimum possible delay and assumes no queuing & no contention encountered along the path

Packet Delay: The transmission delay between the times that the first and last bits of the packet are transmitted

Jitter: The variation in the latency on a packet flow between two systems, when some packets take longer to travel from one system to the other

Committed Information Rate (CIR): is the bandwidth that is allocated to a logical connection and is guaranteed by the provider

NKN Quality of Services

All the vendors providing services to NKN, maintain strict Quality of Services through SLAs

- ➔ IP prefixes in IPV4 & IPV6
- ➔ Packet Loss is always less than 1% (measured by pkt. loss of 1000 pings of 64 bytes each)
- ➔ Port Availability - 99.5%
- ➔ Committed Information Rate (CIR)- 100%
- ➔ Jitter below 30 ms.
- ➔ Latency is dependent on the distance Round trip latency to various locations across globe are:

➔ Europe Link

Eur. (max ms.)	Sing. (max ms.)	NY (max ms.)	LA (max ms.)
220	120	280	300

➔ SAARC Link

Af-De/Af-Mu (max ms.)	Ba-Ko (max ms.)	Bh-Ko (max ms.)	Ne-De (max ms.)	SI-Ch/SI-Mu (max ms.)
80	60	60	50	50

Competitive advantage of NKN over ISPs

NKN-Connectivity Spread



1703

Institutes Connected to
NKN as of May 2019



506

District Links



31

Point of Presence in
State Capital



30

State Data Centre

33

SWANs
Connected to NKN



3

International
Point of Presence
Singapore, Amsterdam
& Geneva



More than
5 Petabytes
of data flows
across NKN
daily



24*7

Network Monitoring
Centre



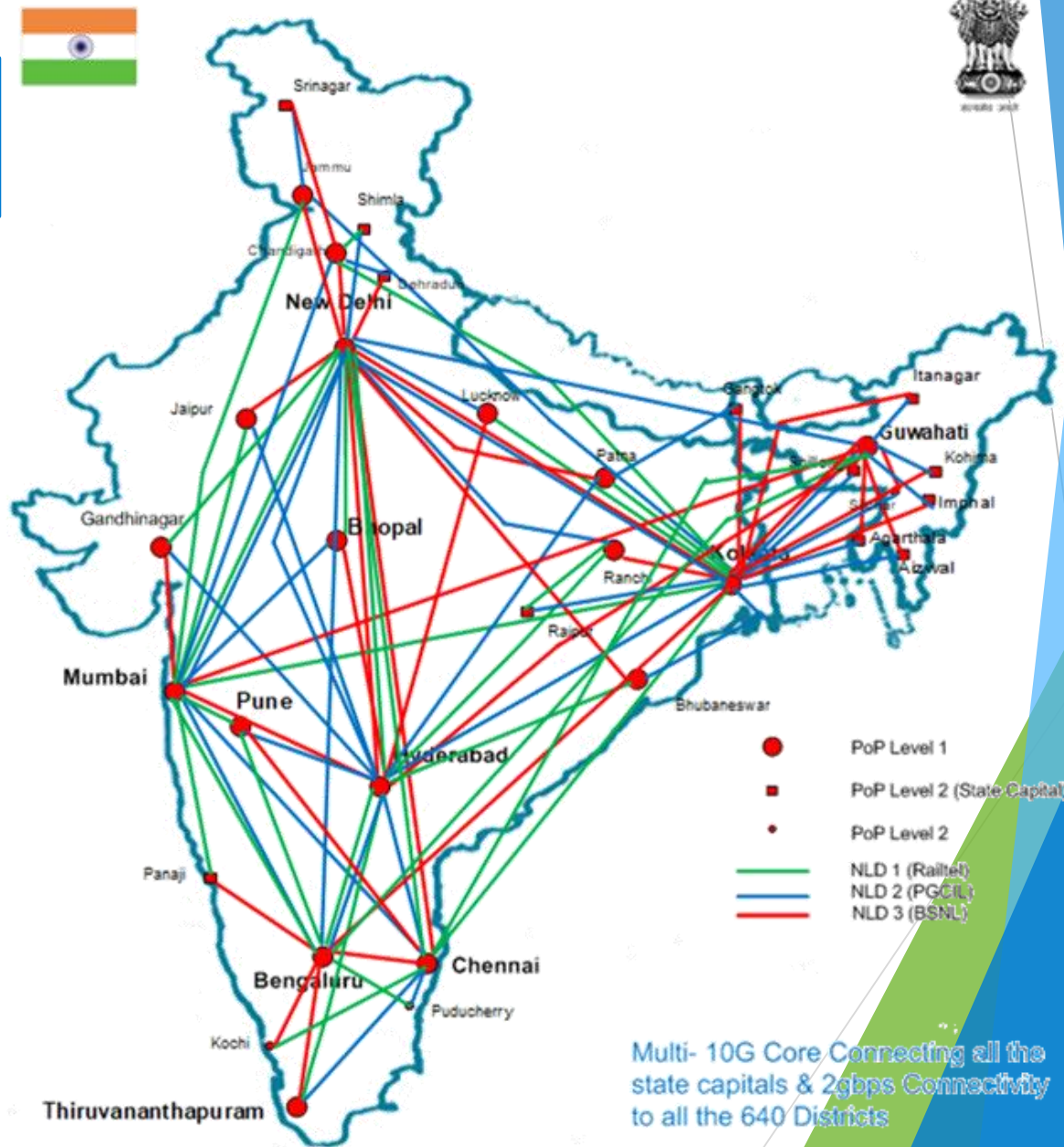
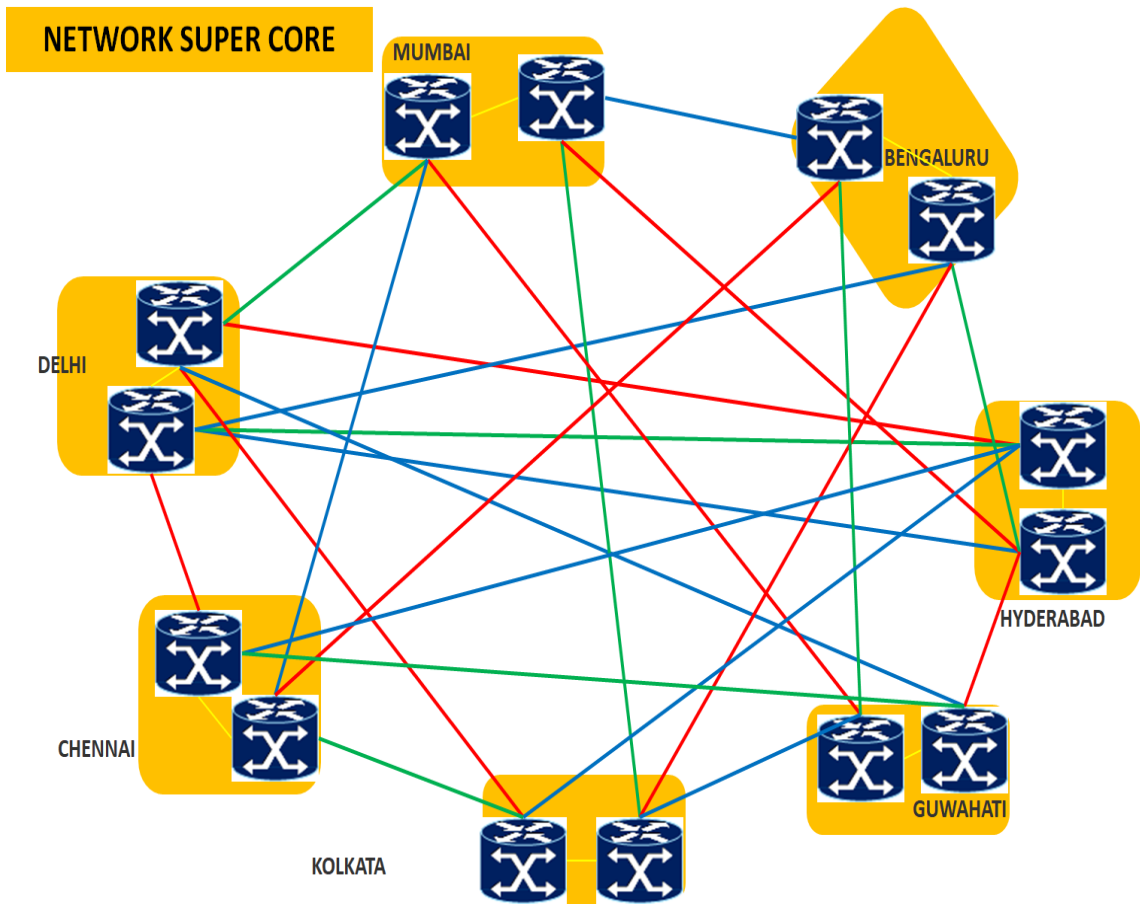
Peering With **9**
International Education
and Research Network

GEANT, Internet2,
SingAREN, Asi@Connect,
CERN, NORDUnet, LEARN,
DrukREN & BdREN

Strength of NKN Network




NKN Network- having strength of multiple National Long Distance Link Providers



Presence of NKN in India

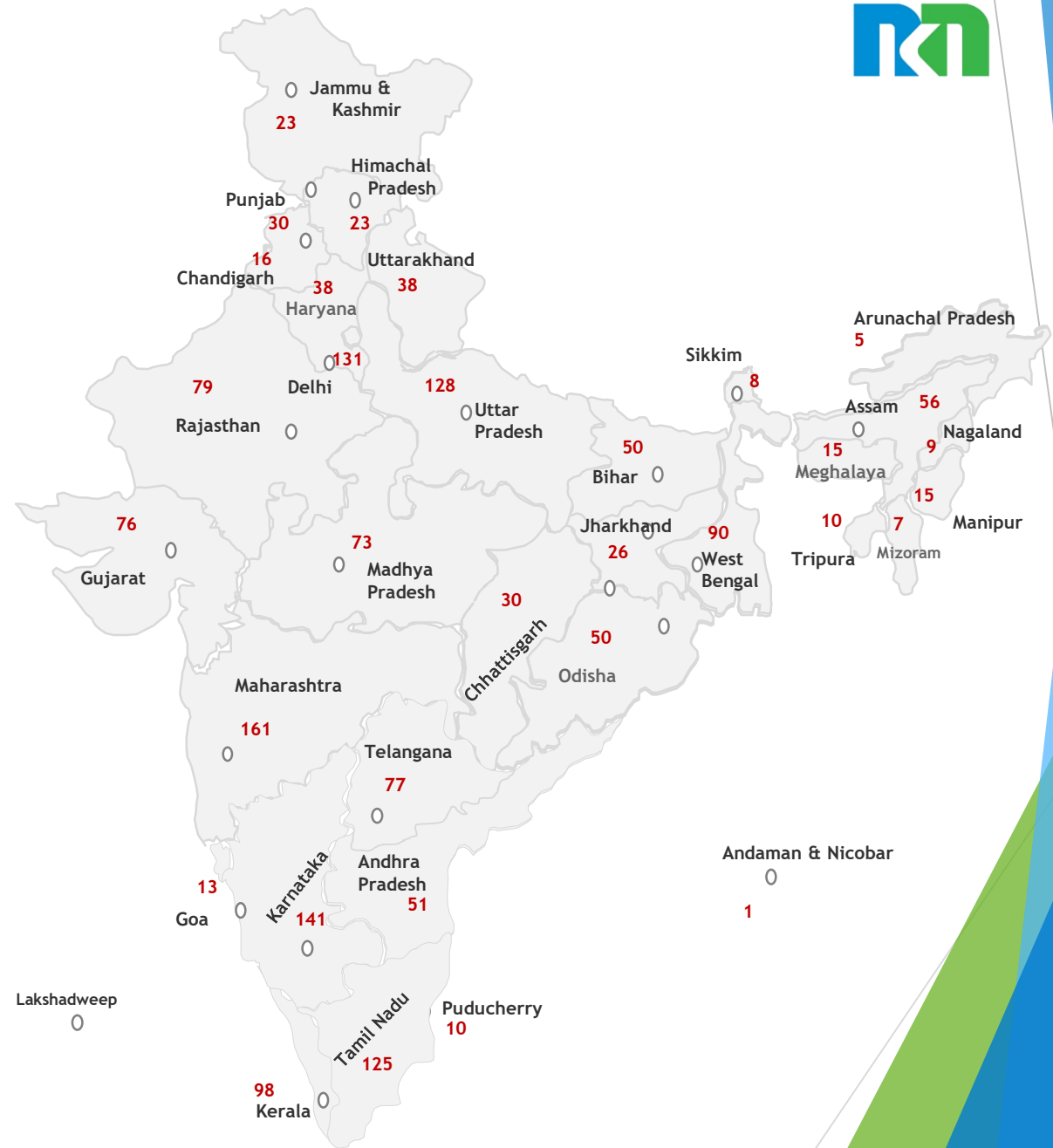


 1703 institutes in India connected to NKN thereby touching and empowering over 5 cr. students and faculty

 33 NKN links in India are 10 Gbps

 15 NKN institutes are of 10X2 Gbps

 66 Virtual Classrooms



Competitiveness of NKN over ISPs for the users



Aggregation of network has provided cost effectiveness as compared to individual network spending to the connected users

NKN - Beyond Internet Services of ISPs

- Centralised resilience and cyber security capability has enabled quick recovery from breakdowns and other cyber-attacks, thereby saving in individual expenditure
- The cyber incident response team of NKN has ensured security and resilience of network. In case all these services were to be deployed at individual institutes it would not be cost effective and lead to higher budgetary expenditure
- Other Services like: Virtual SOC, NOC, DNS, Mail Messenger services, managed by NKN is being given to connected institutions as shared service, thereby resulting in huge cost savings

NKN Cost Savings to Users

- Peering with TSPs and Content Cash providers such as: Google, Akamai, Facebook& Microsoft has resulted in great saving for connected institutions
- The link aggregation by NKN platform has resulted in huge saving for the connected institutions in terms of of individual spending , which the users would have spent for their varied individual bandwidth need
- The video conferencing solution of NKN has resulted in tremendous saving in time and travel cost for Govt. of India

NKN International Collaborations for Connected Users



NKN PoPs at Amsterdam, Singapore and Geneva

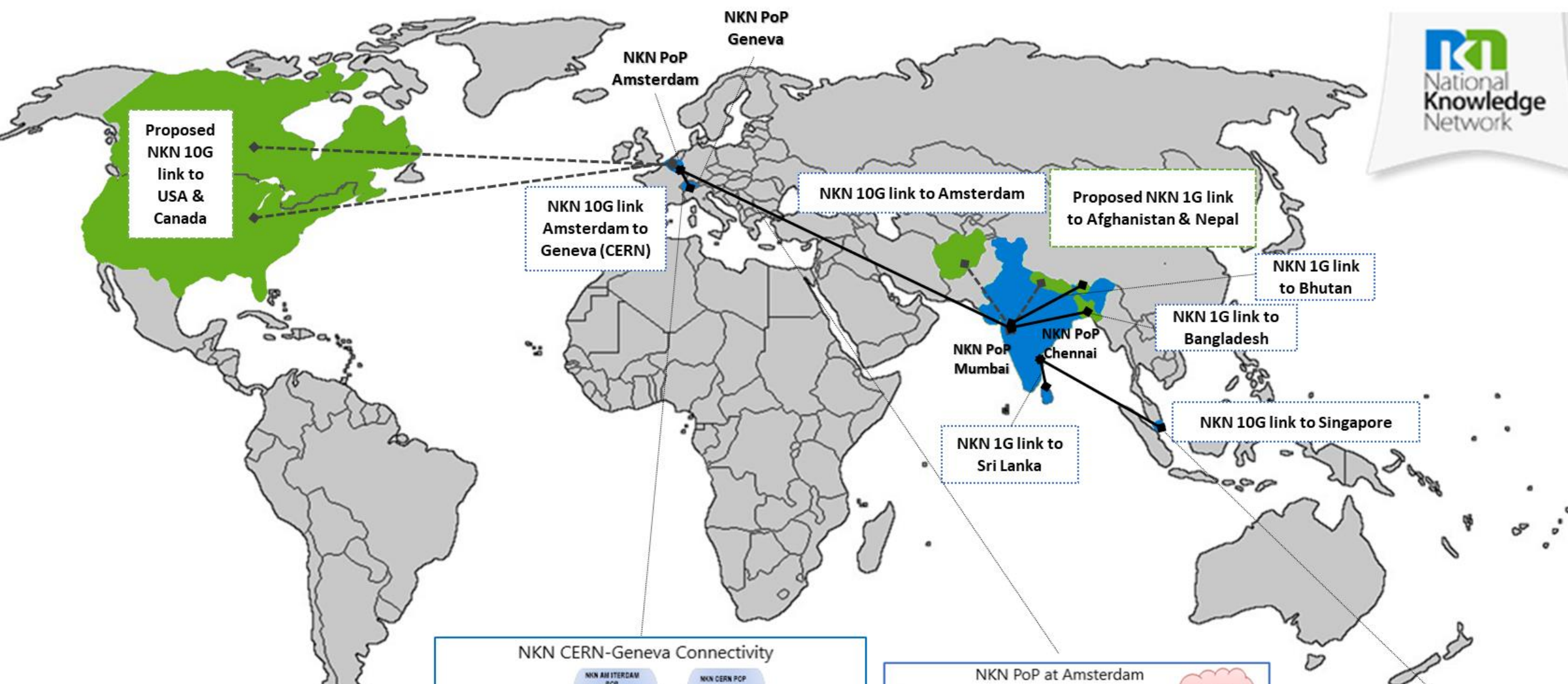
NKN has enhanced Global Collaboration by peering with RENS such as Internet2, GEANT, SingAREN, CERN, NORDUnet, Asi@connect, LEARN, DrukREN and BdREN

Peering/Cache with Content Providers: Google, Akamai, Microsoft & Facebook

NKN connectivity will soon be extended to Afghanistan, Maldives, and Nepal. Peering with Sri Lanka, Bhutan and Bangladesh has been completed

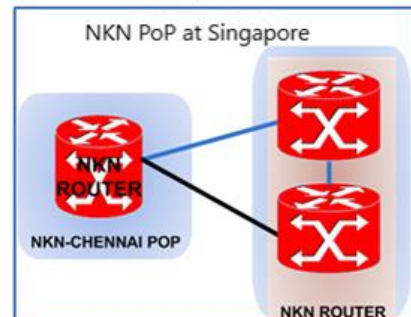
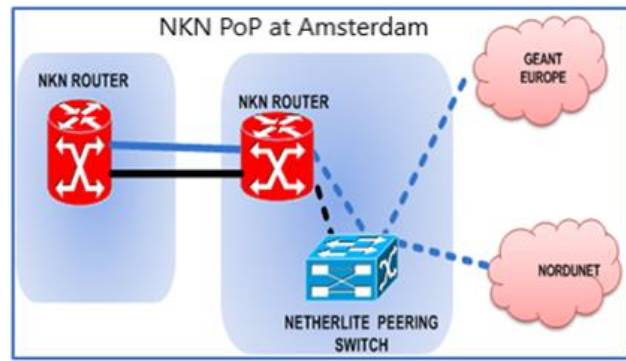
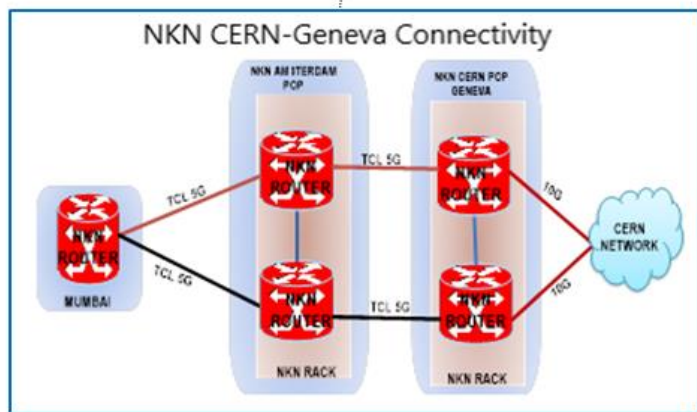
Provided redundant path to Asi@connect for TEIN-EU traffic from Singapore to Europe via NKN international backbone





Existing Link

Proposed Link

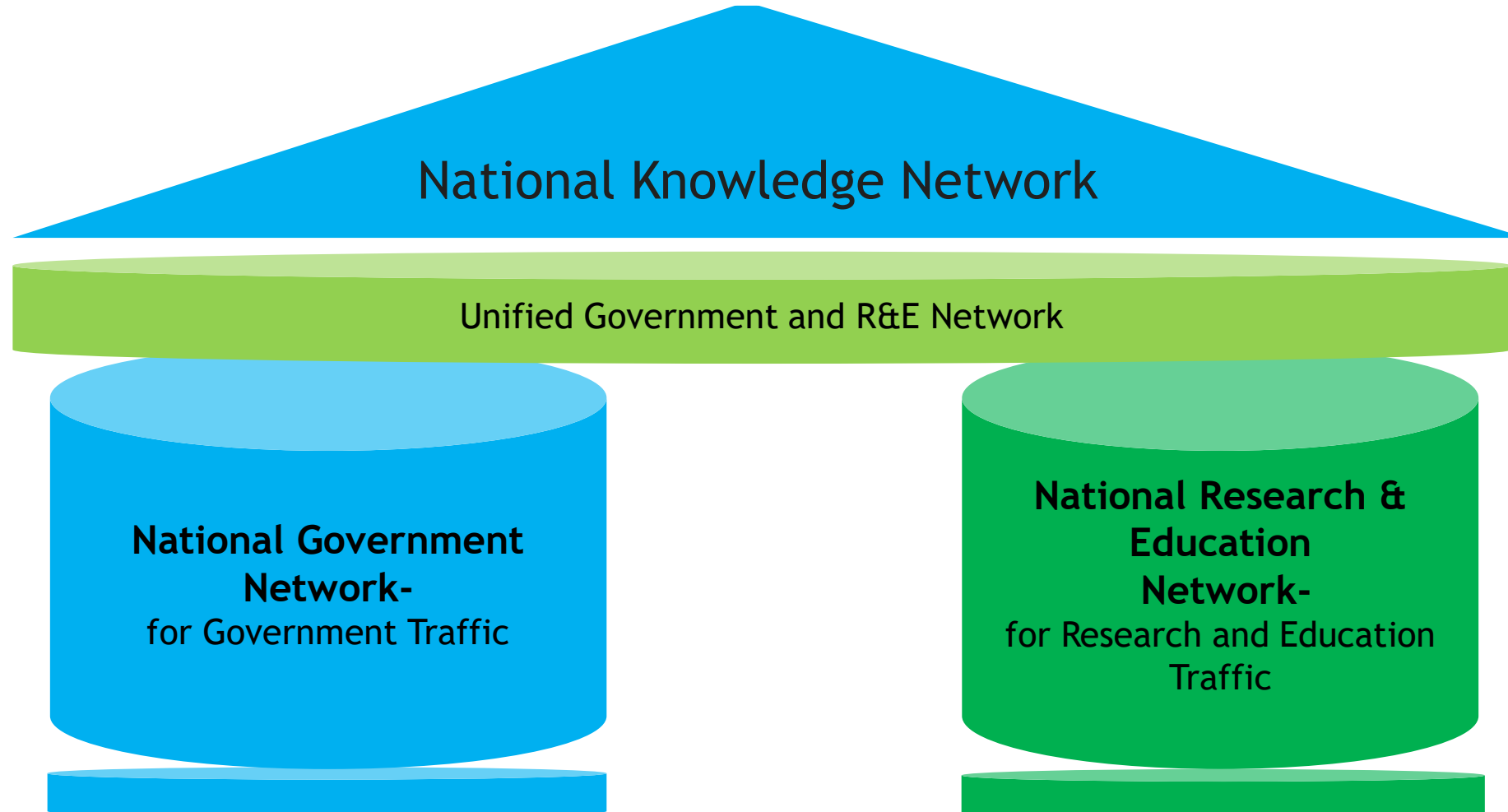


Services of NKN- vis-à-vis other NRENs

NKN- The Unified Network- Govt. and R&E



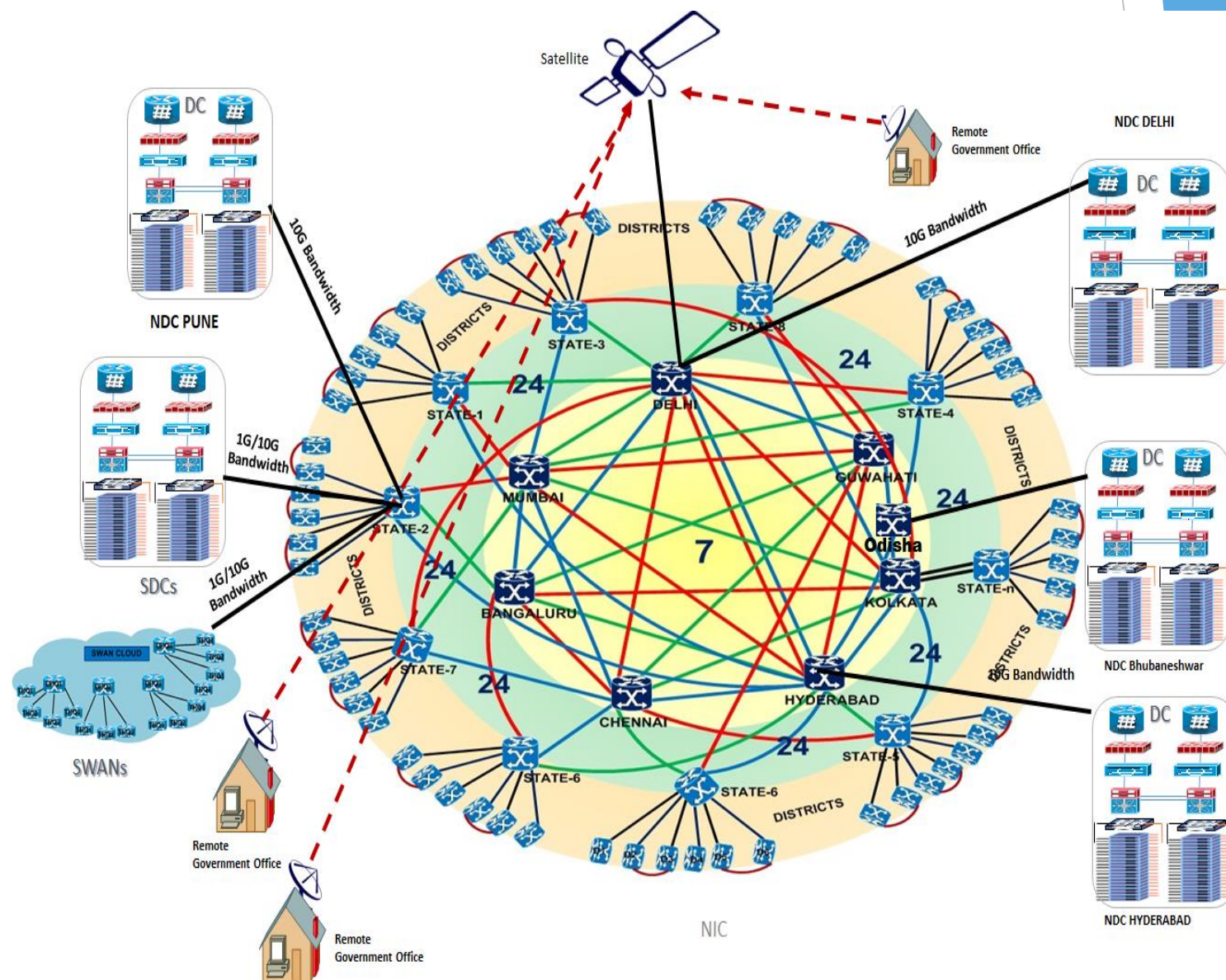
State of Art unified high speed backbone network that carries the traffic of e-Governance, Research and Internet on a single platform



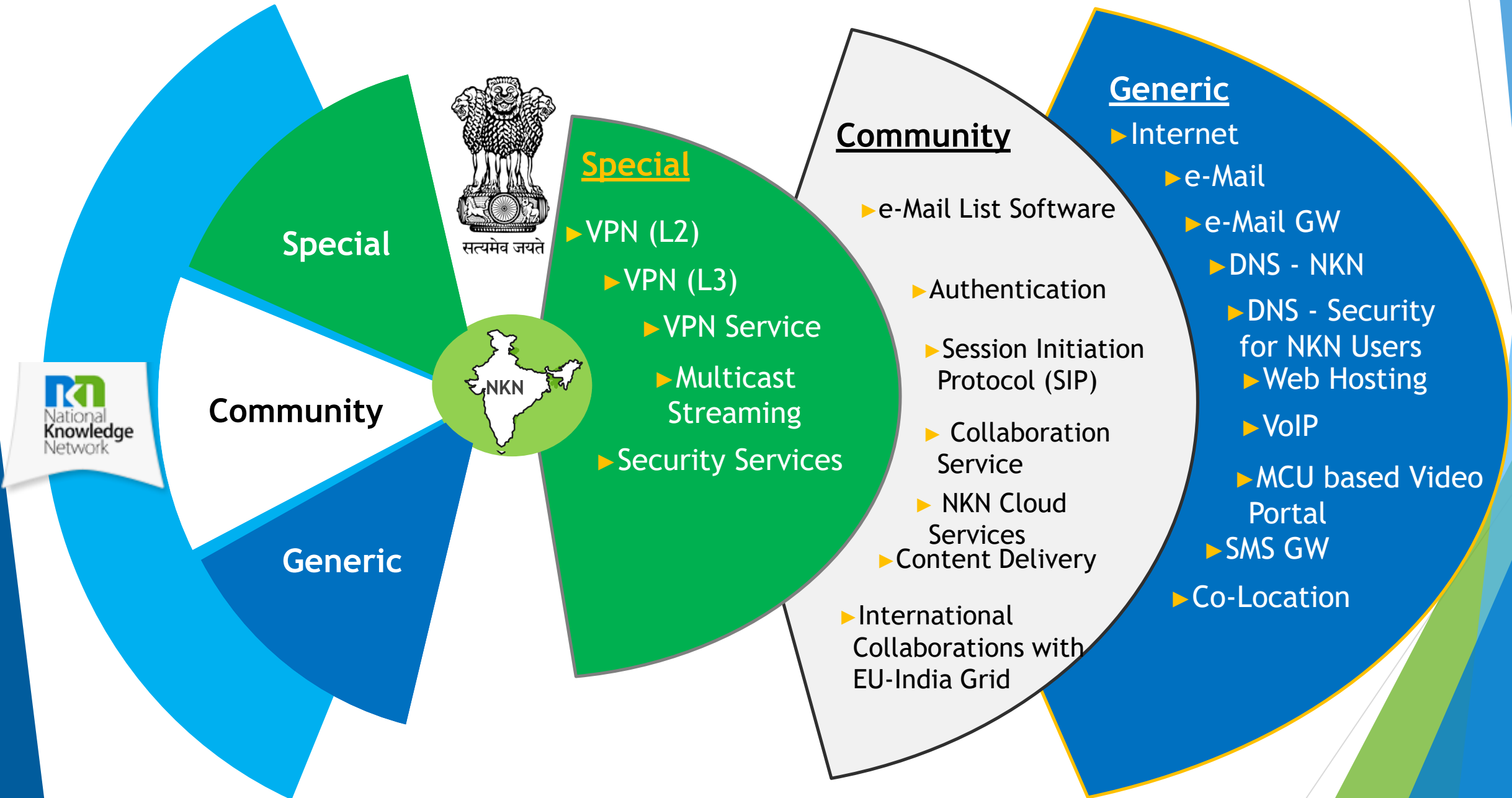
NKN- As State-of-Art Network- Design



- NKN National long distance high speed (multiple 10 Gbps) leased data circuits to state capitals
- NKN Connectivity from State Capitals to Districts using 34/100 Mbps/ 1Gbps leased circuits
- NKN Connectivity through VSAT, Lease Line, RF, MPLS, WiFi etc.
- NKN Connects 4 National Data Centers and all State Data Centres on high speed network
- NKN Secured access through VPN
- NKN Connects State Wide Area Networks (SWANs) and State Data Centre's (SDCs)
- NKN VSAT services at 100+ locations
- NKN Video Conferencing Services, eMail, VPN, Web Hosting, DNS, etc



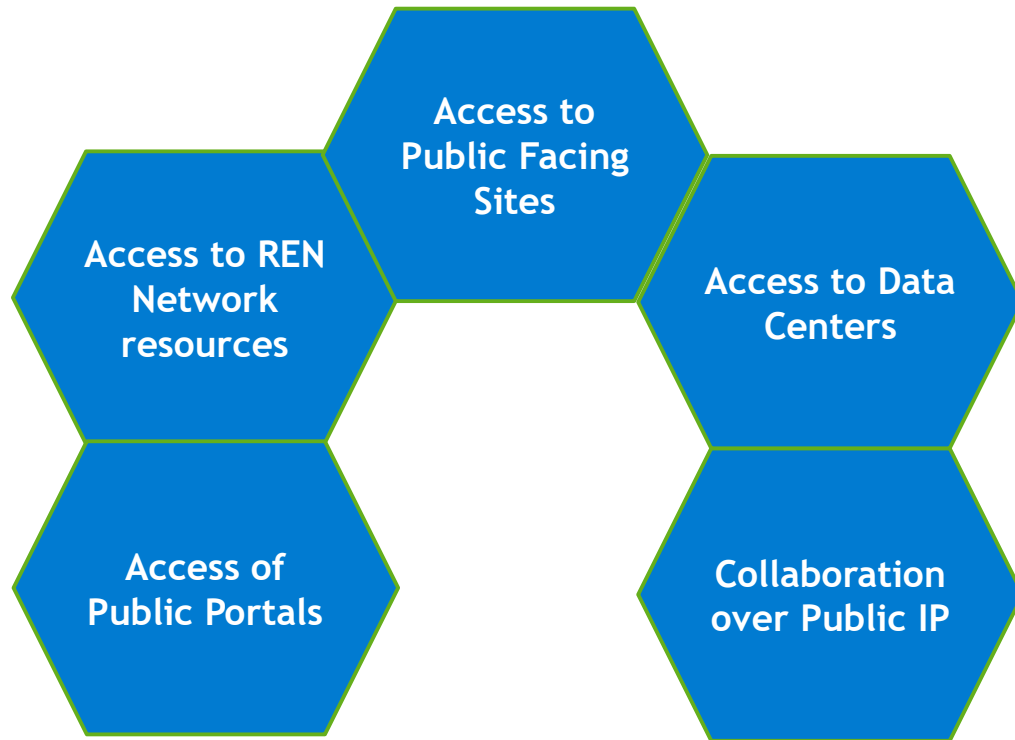
NKN- Services for Users-vis-à-vis other NRENs



NKN Peering Services



NKN peering Services for NREN Community users



NKN Services



Benefits for other NRENs

Other Leading NRENs- Services



- **Connectivity Services:** Flexible IP and P2P Connectivity Options, L3VPN, Point to Point, Open Exchange, Bandwidth on demand, Testbed Service etc.
- **Network Performance Services:** perfSONAR for network performance, eduPERT- Performance enhancement consulting, network security
- **User Access and Applications:** End user applications like: eduroam (Mobility Application), eduGAIN (Simplification of People and Data), eduPKI (Adoption of Digital Certificate), eduCONF (Video Conferencing)
- **Cloud Services:** Cloud Platform and cloud applications
- **Name Space Registry:** Uniform Resource Name (URN) namespace, supporting the assignment of unique, global, persistent names to various kinds of resources by the GÉANT community and its delegates
- **Trainings:** For empowering NRENs and Professional Development

Source: www.geant3plus.archive.geant.net/Services/Pages/home.aspx



- **Advanced Networking:** Advanced Layer 3, Layer 2 and Layer 1 services, DDoS Mitigation Service, Global Services (Global Open LightPath Exchange), DC Facilities, Networking for Cloud etc.
- **Cloud Services and Applications:** Acquia, AWS Direct Connect, Google Cloud Platform, Microsoft Azure Express Route, Oracle Cloud Services by Mythics, SkypeSync, Zoom etc.
- **Trust & Identity:** InCommon Federation (secure and privacy-preserving trust fabric to enable the sharing of protected resources), InCommon Trusted Access Platform (single sign-on access to local, distributed, and cloud services), eduroam, InCommon Certificate Service (unlimited certificates for one fixed annual fee), eduPerson and eduOrg (LDAP schema), URN Registries
- **Performance & Analytics:** Deepfield Analytics (loud intelligence solution), Performance Assurance Service (network service performance), Performance Tools (performance monitoring software)
- **Support Service for users**

Source: www.internet2.edu/products-services

GEANT Compendium Survey: NRENs- Services



End User Network Services	% of NRENs offering
Ipv4	94%
WiFi	94%
IP Connectivity	91%
DDos Mitigation	88%
Lambdas	85%
IPv6	82%
Network Monitoring	79%
Multicast	64%
LAN Extension/Virtual Network	58%
L2VPN	48%
Software Mirroring/FTP	48%
End User Monitoring/Troubleshooting Tool	45%
NetFlow	42%
Optical Wavelength	42%
Software as a Service	36%
L3VPN	33%
Managed Router Service	33%
PERT	33%
QoS	33%
Other Network Service (not named)	33%
Anti-virus Software	30%
VPN Client Access	30%
Network as a Service	21%
Disaster Recovery	18%
SDN Testbed	12%

NREN Sustainability

NREN Funding Models



FUNDING

PRINCIPLES

- The models for ownership, management, and funding of NRENs can vary depending on geography and national policies however there is a remarkable similarity in models around the world. Type of NRENs:
 - Government Owned
 - Trust Owned
 - Private Company
- NRENs governance model is generally a not-for-profit, which is owned by the member institutions, and with a certain decided financial aid from government
- It is a general practice for operational expenses of NRENs to be covered by fees and service charges from their members, while the government covers major capital expenses for initial setup and later upgrades (with possible donor support)

FUNDING

SOURCES

- **EXTERNAL SOURCES:** Funding from outside of the firms' stakeholders such World Bank, UN Development Programs, and EU etc.
- **GOVERNMENT FUNDING:** 100% funding from the respective government to run the NREN. Under this model, connectivity & services are provided to the users free of cost.
- **USER BASED:** NREN charges it's operational and other expenses from its users through membership fees, service fees, subscription etc.
- **COMBINATION:** Combination of all the above models wherein to start the NREN, seed money may be funded by external sources, while government provides support for capital expenses. The operational expenses are charged with the members / Users.

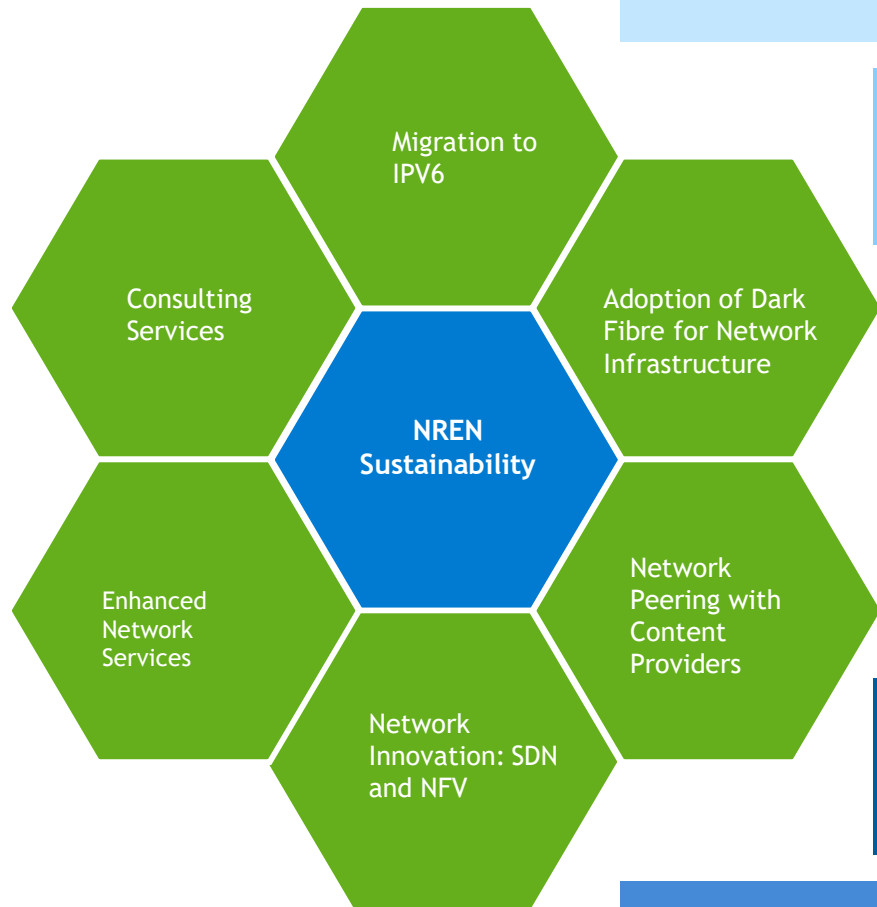
Illustrations of NREN Funding Models

Country	NREN	Funding Source / Model
Algeria	CERIST	Members fees, services
Togo	TogoRER	Government Funding
Ghana	GARNET	Government Funding
Gabon	GabonREN	Government Department
Uganda	RENU	Majority from members, rest from Government and donations from USAID.
Tanzania	TERNET	Government Funding
Somalia	SomaliREN	World Bank (for counterpart funding of Africa Connect participation and for some internal connectivity of universities)
Mozambique	MoRENet	Government, World Bank (MEGCIP)
Kenya	KENET	Majority from Members and other funding from Government, Google sponsorship, World,Bank (KTCIP)
Ethiopia	EthERNET	Government Funding
Congo	Eb@le	Government Funding
Burundi	BERNET	Members, Government (World Bank RECIP2)
Canada	CANARIE	Government of Canada, Membership fees
Canada	ORION	Government, CANARIE
Australia	AARnet	Members
Singapore	SingaREN	Members
Malaysia	MYREN	Membership fees/ Network Services
US	Internet2	Membership fees, service fees and Government grant
Europe	GEANT	European Union, Service fees and Membership fees
Korea	Asi@connect	European Union, Korean Government, Membership fees
Nordic Countries	NorduNet	Nordic Council of Ministers, Membership fees /Network Services

Country	Govt./ Public Sources	Users/ Clients	EU	Other Sources
Bulgaria	NIL	NIL	50%	50%
Greece	90%	NIL	10%	NIL
Romania	100%	NIL	NIL	NIL
Lithuania	80%	NIL	NIL	20%
Montenegro	70%	NIL	30%	NIL
Slovenia	99%	NIL	1%	NIL
Spain	98%	NIL	2%	NIL
Luxembourg	68%	10%	20%	2%
Finland	45%	50%	2%	3%
Iceland	NIL	90%	NIL	10%
Hungary	50%	30%	20%	NIL
Belgium	80%	20%	NIL	NIL

(Source: GÉANT Compendium Report)

Factors- Leading to Sustainability of NRENs



1. The recent version of Internet Protocol (IP), simplifies routing and supports further growth of the number of connected hosts and transmitted data traffic. Other benefits include: Directed data flows, support for new services (VoIP, QoS etc.), enhanced security, efficient packet processing etc.

2. Dark fibre refers to fibre leased or purchased from another supplier in an unlit state, hence the name 'dark' fibre. The R&E community moving towards ownership of dark fibre over recent years. The use of Dark Fibre gives flexibility to lit the fibre through DWDM technology according to the need and it can achieve massive increment of bandwidth with very less capital investment

3. Network peering refers to direct peering with commercial networks or content providers such as: Google, Akamai, Amazon, Facebook etc. This settlement free peering offers savings of bandwidth consumption by saving fee for upstream traffic

4. Adoption of SDN and NFV has led to next level of network transport defined on software rather than traditional infrastructure depend transport. This has enabled network management—dynamic, cost-effective and adaptable. NRENs are using SDN and NFV for many purposes other than network management like: Test Bed facility for researchers, production services, pilot projects etc.

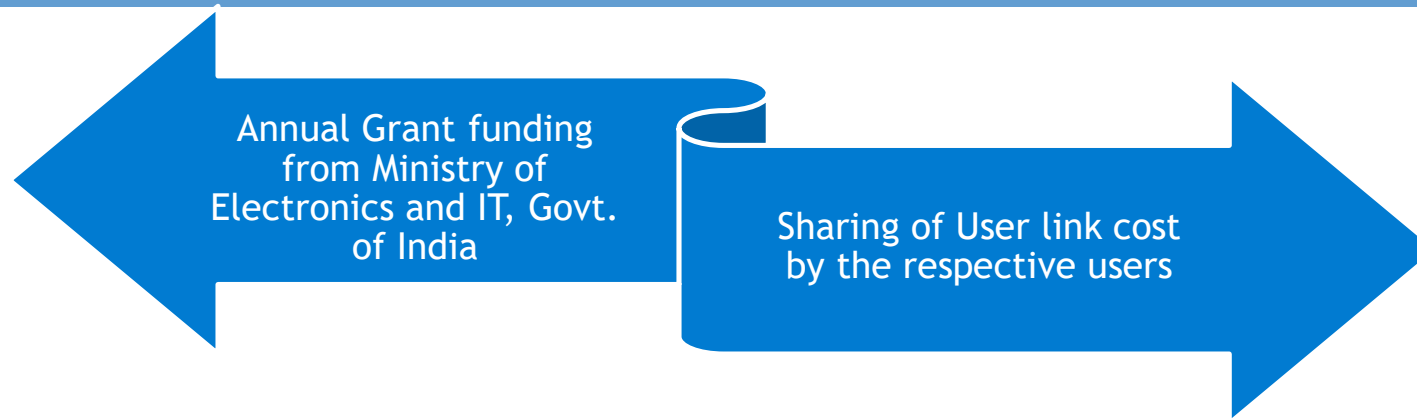
5. Other than IP service, NRENs are now offering plethora of services like: DDoS Mitigation, Network Monitoring, Multicast, L3VPN, SaaS services, Cloud Services, Managed Router Services, Virtual SOC, NOC services etc. These services have led to increase in revenue of NRENs and enhanced service offerings for the users

6. Big NRENs now have developed expertise over various network functions and have team of certified experts in the field of network technology, campus network design, information security and other aspects necessary for efficient functioning of the NREN network. These consultancy services lead to enhanced service portfolio of NRENs and efficient network design for the connected users

NKN Sustainability Model



Sustainability Model for NKN- Future Course



Currently NKN is completely funded by Ministry of Electronics and IT, Govt. of India

NKN- Cost Sharing Model for achieving Sustainability

Cost for the Core Infrastructure, Admin, FMS, Research, International Peering, Manpower etc.

User link cost according to the link capacity (bandwidth and distance from nearest NKN PoP)

Establishment of NKN fund in the user Ministry or Dept. for additional usage and fund flow

Ministry of Electronics & IT

Connected Users

The new model ensures:

- Funding from respective stakeholders
- Increased ownership of stakeholders in the NREN
- Enhanced governance and decision making
- Less dependency on single source for funds
- Sustainability of operations

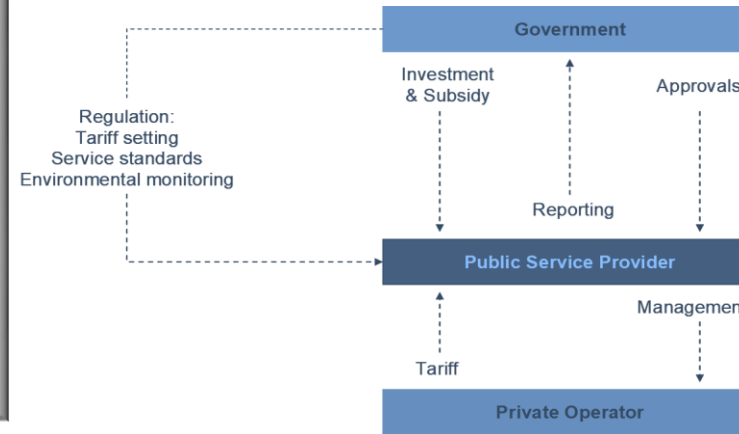
Public Private Partnership Model for NRENs



PPP Models

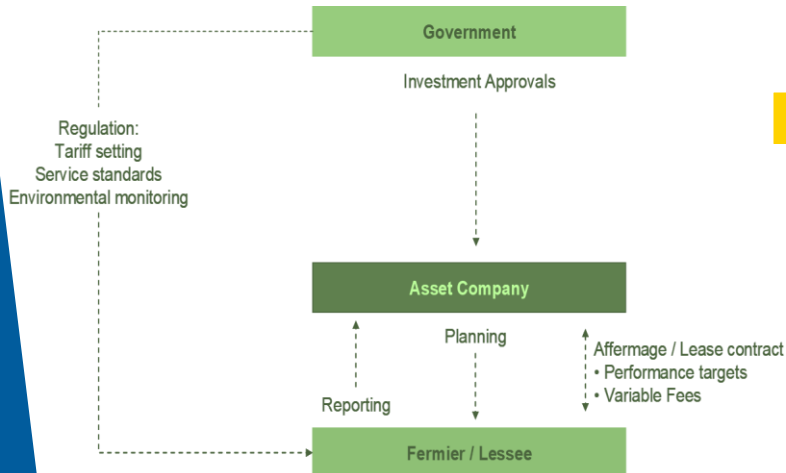
- ➔ Service contracts
- ➔ Management contracts
- ➔ Lease contracts
- ➔ Build-operate-transfer (BOT) and similar arrangements
- ➔ Others like: Concessions, Joint Ventures

Management/Service Contracts



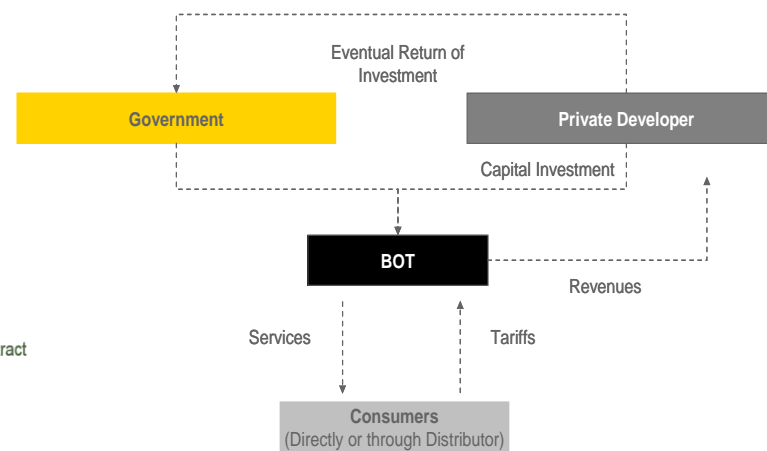
Ultimate obligation for service provision remains in the public sector, daily management control and authority is assigned to the private partner or contractor. In most cases, the private partner provides working capital but no financing for investment

Affermage or Lease contracts



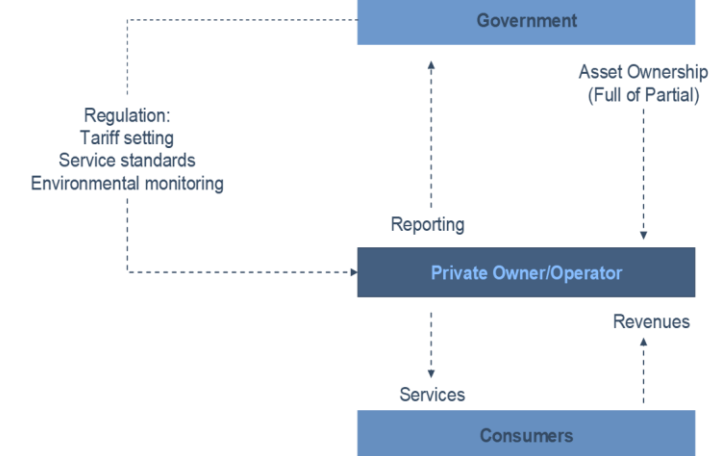
The private partner is responsible for the service in its entirety and undertakes obligations relating to quality and service standards. Except for new and replacement investments, which remain the responsibility of the public authority, the operator provides the service at his expense and risk. The duration of the leasing contract is typically for 10 years to 20 years

Build-Operate-Transfer



Private firm or consortium finances and develops a new infrastructure project or a major component according to performance standards set by the government. Beneficial for project-specific application so they are potentially a good vehicle for a specific investment, but with less impact on overall system performance.

Joint Ventures



Under this the infrastructure is co-owned and operated by the public sector and private operators. The public and private sector partners can either form a new company or assume joint ownership of an existing company through a sale of shares to one or several private investors

Exploring the PPP Models



	SERVICE CONTRACTS	MANAGEMENT CONTRACTS	LEASE CONTRACTS	CONCESSIONS	BOT
Scope	Multiple contracts for a variety of support services such as meter reading, billing, etc	Management of entire operation or a major component	Responsibility for management, operations, and specific Renewals	Responsibility for all operations and for financing and execution of specific investments	Investment in and operation of a specific major component, such as a treatment plant
Asset Ownership	Public	Public	Public	Public/Private	Public/Private
Duration	1–3 years	2–5 years	10–15 years	25–30 years	Varies
O&M Responsibility	Public	Private	Private	Private	Private
Capital Investment	Public	Public	Public	Private	Private
Commercial Risk	Public	Public	Shared	Private	Private
Overall Level of Risk Assumed by Private Sector	Minimal	Minimal/moderate	Moderate	High	High
Compensation Terms	Unit prices	Fixed fee, preferably with performance incentives	Portion of tariff revenues	All or part of tariff revenues	Mostly fixed, part variable related to production parameters
Competition	Intense and ongoing	One time only; contracts not usually renewed	Initial contract only; subsequent contracts usually Negotiated	Initial contract only; subsequent contracts usually Negotiated	One time only; often negotiated without direct Competition
Special Features	Useful as part of strategy for improving efficiency of public company; Promotes local private sector Development	Interim solution during preparation for more intense private Participation	Improves operational and commercial efficiency; Develops local staff	Improves operational and commercial efficiency; Mobilizes investment finance; Develops local staff	Mobilizes investment finance; Develops local staff
Problems and Challenges	Requires ability to administer multiple contracts and strong enforcement of contract laws	Management may not have adequate control over key elements, such as budgetary resources, staff policy, etc.	Potential conflicts between public body which is responsible for investments and the private operator	How to compensate investments and ensure good maintenance during last 5–10 years of contract	Does not necessarily improve efficiency of ongoing operations; May require guarantees

Source: <https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/Cross-Border-Infrastructure-Toolkit>

Strategy for Developing PPP Models



Payment Model

- Pay per use: The member institution pays as it uses the technology based on pre-defined scales and levels
- Project based charging: The private sector company provides end to end solution including the application, hardware, skilled personnel and final computing/processing and charges the member institution for the entire project.
- Charges based on building a dedicated technology along with the desired application for a member institution

Areas where PPP can be explored

- Network / Infrastructure related - Network operations, management, research
- Application Development - Medical apps group, Education publishing groups, Supercomputing, Emerging Technologies etc.
- Capacity Building for the connected institutions

Guidelines for leveraging PPP model for NRENs

- Investment in the leadership development of NREN Members, where there is evidence of leadership, support and commitment.
- Creating a region wise presence of NREN with the targeted outcomes of the components being:
 - Public investment in content
 - Private investment in infrastructure
 - Adoption of Emerging Technologies
 - The flexibility to remain responsive to future technological innovations
- The partnerships can be with the entire network or in part with various areas including the following - Network research or management or operations, application / projects, infrastructure management, etc.
- Apart from the above, collaborative strategies can be developed for the following areas:
 - Charging policy for the services to be delivered using the Network, that would differ based on whether the service being provided is for a social cause, commercial purpose or a socio-commercial purpose
 - Understanding (in form of agreement/contract) between Private Partner and NREN for setting service levels, service monitoring procedures as well as payment terms



Thank You



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