Forging Meaningful Synergies between NRENs & CSPs
(The Case of Uganda's NREN (RENU))

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Presentation Overview

I. Introduction
II. Laying a Foundation – From BPC to PNO
III. Maximizing the Metropolitan Last-mile Opportunity
IV. Connecting the Upcountry Campuses
V. The Effect of the Rapid Growth Phase
VI. Enhancing NREN Competitiveness
VII. The Change in Topology that was made
VIII. Network Availability Metrics for Selected Months
IX. Assessing the Overall Impact of the NREN Debut
X. Lessons Learnt
XI. Concluding Thoughts

Introduction

1. Jan 2006: 7 VCs & 2 Heads of Research institutions met & Resolved to Establish an NREN.
2. In 1st 5 years, RENU was not ready to establish & operate its own network but it established a transitional bandwidth purchase consortium (BPC) that did not work well.
3. In September 2013, with partial Contribution from a few Members, RENU was assisted by the Telecom. Regulator to complete the subscription to AfricaConnect.
4. In November 2009, RENU received MoES Endorsement as Uganda's NREN & in July 2010 also received a PNO from the Regulator (UCC).
5. Institutions that contributed to ACAPA hoped to have their need for more affordable *connectivity & Internet, access to research and education online resources*, and for better *support to collaboration*, in order to more effectively empower their researchers & Educators.
6. The above cocktail of events enabled the commencement & development of a dedicated national research and education network (NREN).

Laying the Foundation - From BPC to PNO

- The BPC was wreaked with challenges such as: *very low internal revenue*, very low aggregate BW, very high unit price of BW (at US$ 630), many institutions delaying to settle RENU bills, institutions disinterested in consortium (: no compelling incentive to join since price differential was negligible), partner CSP had very low QoS at the time. The aggregate effect of those challenges lead to BPC opportunity wilting.
- Dec. 2013 saw the arrival of UA PoP in Kampala, which presented a new opportunity that needed to be grabbed.
- Still missing pieces of puzzle: providing last-mile links between institutions and the envisaged RENU PoP was still too costly for most institutions.
- Several options for last-mile were explored between Aug. 2013 & Feb. 2014, but were found not feasible (for varying reasons).
- It was pre-decided that the NREN was to operate as a community-owned & also a community-driven network. It was also pre-decided to follow a true cost recovery not-for-profit business model. (it would even capture monthly amortisation to ensure network equipment replenishment in future.
- End Feb. 2014, 1st campus, & by end of March 3 sites were on & by July 2014 5 were on.

Maximizing the Metropolitan Last-Mile Opportunity (a)

- The greater Kampala metropolitan area (GKMA) connectivity agreement with Project Link's (C Squared) took >6 months to conclude but when it was, it had arguably one of the most pivotal impact on initial RENU's growth.
- The agreement provided dark fibre on a distance-neutral & uniform price basis so the last-mile link throughput depended on the throughput & the client premises equipment RENU was able to arrange for.
- The dark fibre agreement was a key enabler of RENU's future ability to provide uncapped local connectivity to member institutions.
- Initially the maximum bandwidth was set at 1 Gbps through the choice of Small Factor Pluggable (SFP) modules to be used.
- The above & other core considerations were the basis for determining that the least break-even international link capacity for connected institutions would need to be 10Mbps.

Maximizing the Metropolitan Last-Mile Opportunity (b)

- It was eventually decided that institutions who could only afford 5 Mbps, (though not economically viable), would also be connected and that those buying more bandwidth would offset the loss. The rationale for allowing sub- optimal connections (5 Mbps) was to attain more inclusive local collaboration through wider sharing of resources over a very fast national network. This sacrifice later yielded a bonus by speeding up membership & aggregate bandwidth growth.
- Another way that the GKMA was maximised, was thru initially focusing on institutions in the GKMA where the non-recurrent costs (NCR) had become substantially lower than other parts of the country at this time. It also resulted in other CSPs improving terms for providing RENU last-mile and back-haul links.
- It was resolved that at the point in time when local backbone traffic would exceed the initial 1Gbps (which happened in July 2017), it would be economical to upgrade the backbone (say to 10 Gbps) by simply changing SFPs from 1Gbps to 10 Gbps, since the RENU core back-borne equipment were by then capable of multiple 10 Gbps channels.
- Keep in mind that the dark fibre links were vital for RENU to deliver on the promise of uncapped in-country traffic between member institutions.

Connecting Upcountry Campuses (a)

- Despite its great contribution to the take-off of the RENU network, Google's Project Link coverage remained within the confines of the GKMA.
- Therefore RENU sought additional connectivity options for institutions outside the GKMA.
- The 1st upcountry provider RENU engaged was NITA-U, a government agency charged with providing IT services to MDAs. NITA-U hosts some of RENU's upcountry network equipment and it backhauls some of the upcountry traffic back to the main PoP.
- After the second half of 2014, RENU engaged other CSPs (BCS & Liquid) to link institutions in the West and South-west to its main gateway. However, an affordable last-mile solution in upcountry regions remained elusive until RENU established Metropolis fibre networks in a number of towns at monthly tariffs close to those offered in Kampala.
- Next, Faro Technical Service was contracted to implement a RENU owned dark fibre sub-ring in the metropolis of Mbale, in Eastern Uganda. This was implemented at a competitive rate of $3,000 per km.

Connecting Upcountry campuses (b)

- By January 2017, MTN Uganda & ATC Uganda joined the list of commercial service providers working with RENU. MTN is providing backhaul capacity between the boarder town of Arua and the central-Northern town of Gulu while ATC is hosting the RENU aggregation site in Arua.
- Currently a total of 7 CSPs provide various Services to RENU.
- Thus the RENU model of subcontracting various service providers worked well to enable the procurement of in-country bandwidth at tariffs ranging between $2 and $19 per Mbps per month. It has also created a competitive supply environment resulting in the best possible rates and quality of service to RENU. This has helped to build a solid, burstable yet affordable local network.
- This model has also helped RENU to maintain a lean team while delivering quality connectivity and NREN services to member institutions. It has greatly helped to keep the RENU operating expenses as low as possible.

The Effects of the Rapid-Growth Phase

The steep bandwidth price reduction and the confidence building for network engineers (generated by the RENU technical capacity building program) combined to generate a growth pace faster than RENU had dared to hope which was pleasant but resulted in challenges such as:

- A number of institutions struggled to meet their bandwidth budgets & accumulated debts.
- After campus networks registered performance improvement, the systems and content utilization capability of many institutions continued to lag.
- Institutions in hard to reach upcountry locations started to express interest to be connected but this need could not be readily met, which temporarily exacerbated the urban-rural connectivity divide.
- The need to upgrade the network backbone equipment came sooner than had been anticipated, resulting in budgetary pressure that somewhat rattled financial stability in 2016.
- The private sector responded to RENU's not-for-profit pricing with faster than expected price drops & in some cases forming alliances to improve their packages. Activities of intercontinental carriers also increased & resulted in steep change of volume- pricing in the market. This combination put pressure on RENU to be more intentional about finding a way around the pricing asymptote it had experienced after the second year of (own-network) operation.

Enhancing NREN Competitiveness (a)

- RENU's response to the pricing pressure was to be more intentional in identifying sources of inefficiency, and culminating into a strategy to improve its competitiveness.
- The first step taken was to develop a network topology that would ensure all-round resilience for all stages of the network, including the first borders (between the RENU network and the campus networks).
- Delivering a primary and secondary fibre at each campus was adopted as the standard for access links. In the GKMA where competition was very stiff, the primary fibre link connected to one RENU PoP and the secondary connected to a different RENU PoP. Internationally and regionally, it was resolved that RENU would seek to peer with the UbuntuNet Alliance at 2 points. The first peering point was at the Alliance's international gateway in Kampala. The second peering point was done at a UA PoP in Europe. These measures were augmented by the enhancement of the RENU NOC.
- The second intervention was to explore international PIP unit-price ranges with-in the Ugandan telecom market. This process established that several international PIP providers could offer unit prices that were several times lower than what RENU was hitherto capable of.

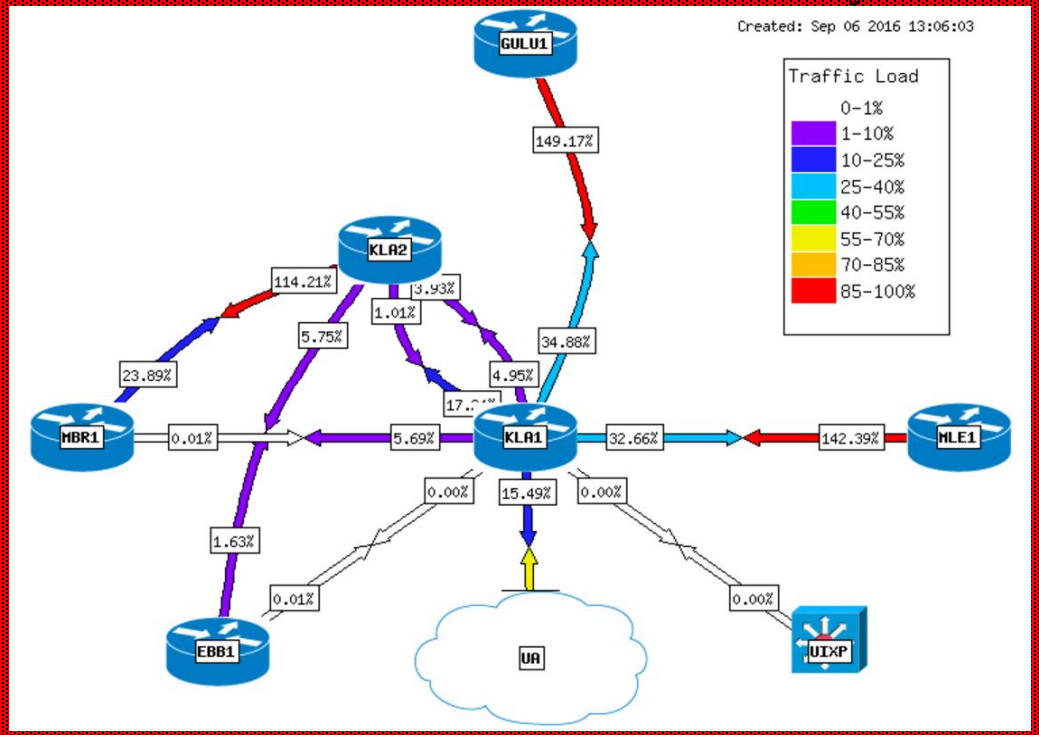
Enhancing NREN Competitiveness (b)

The above interventions resulted in substantially improved quality of service, reliability, & recovery of NREN bandwidth unit-price improvement & the introduction of a price tier system (a scheme that suited the operational needs of both small & large institutions, while securing room for shared price improvements).

The other positive impacts were on resilience, quality of service (QoS) and enhancement of capacity to measure performance metrics (and hence enable RENU to make decisions based on reliable data).

Enhancing NREN Competitiveness (c)

Before international redundancy



After international redundancy

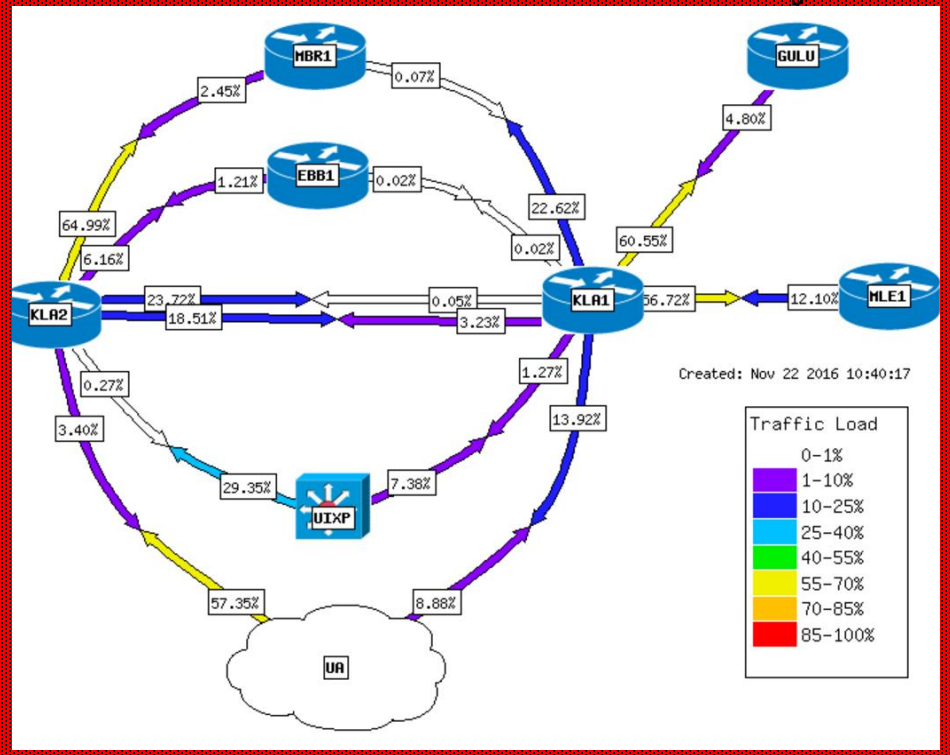
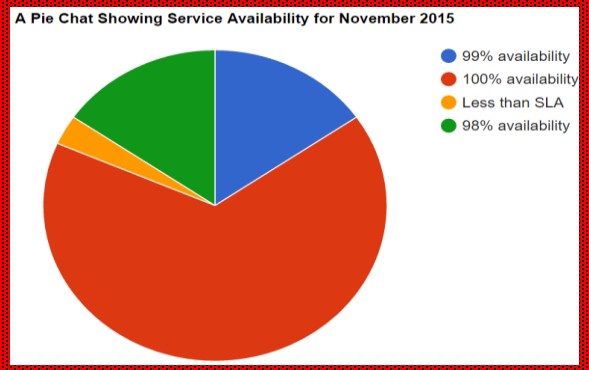


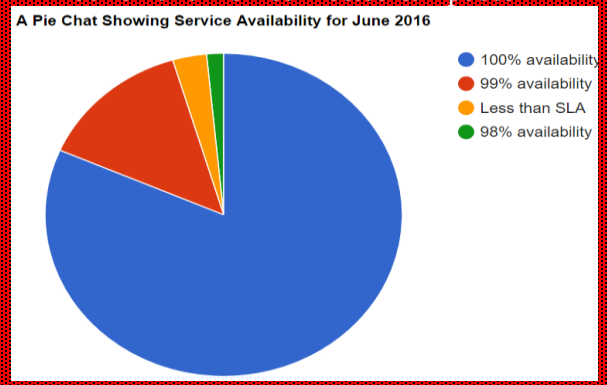
Figure 6.1: High-level network topology of the RENU backbone

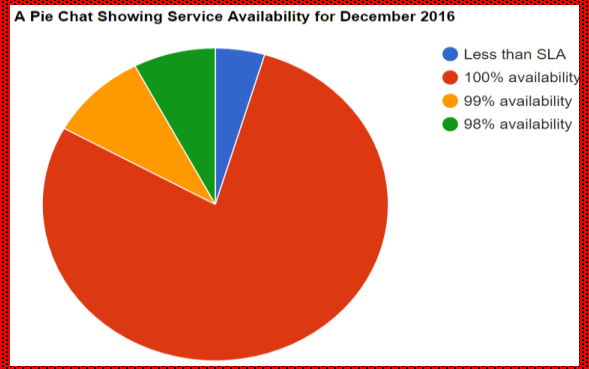
Enhancing NREN Competitiveness (d)



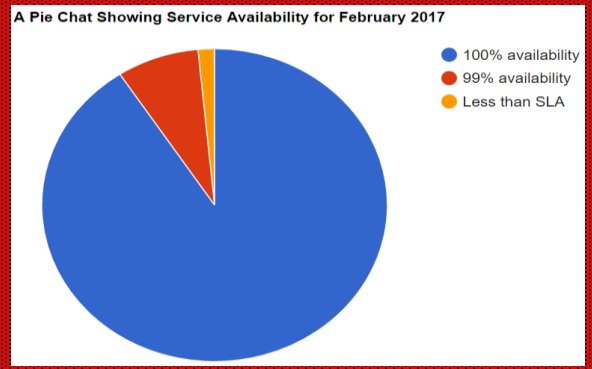
November 2015 – **43** connected campuses

June 2016 – **51** connected campuses





December 2016 – **63** connected campuses



February 2017 – **65** connected campuses

Figure 6.2: Service availability for campuses connected to the RENU network for selected months.

Assessing the Overall Impact of the NREN

The above interventions resulted in substantially improved quality of service, availability, & the resuscitation of NREN bandwidth unit-price reduction & a pricing scheme that suites the operational needs of both small & large institutions, while at the same time it secures room for future price improvements.

The other impact was on resilience, quality of service (QoS) and enhancement of capacity to measure performance metrics (and hence enable RENU to make decisions based on reliable data).

Assessing the Overall Impact of the NREN

- Assessment of overall Impact is presented in two renderings namely:

I. An outcome to purpose review (OPR) report in table form .

II. A graph portraying both the variation of aggregate international bandwidth and the associated unit price, over a 3-year period.

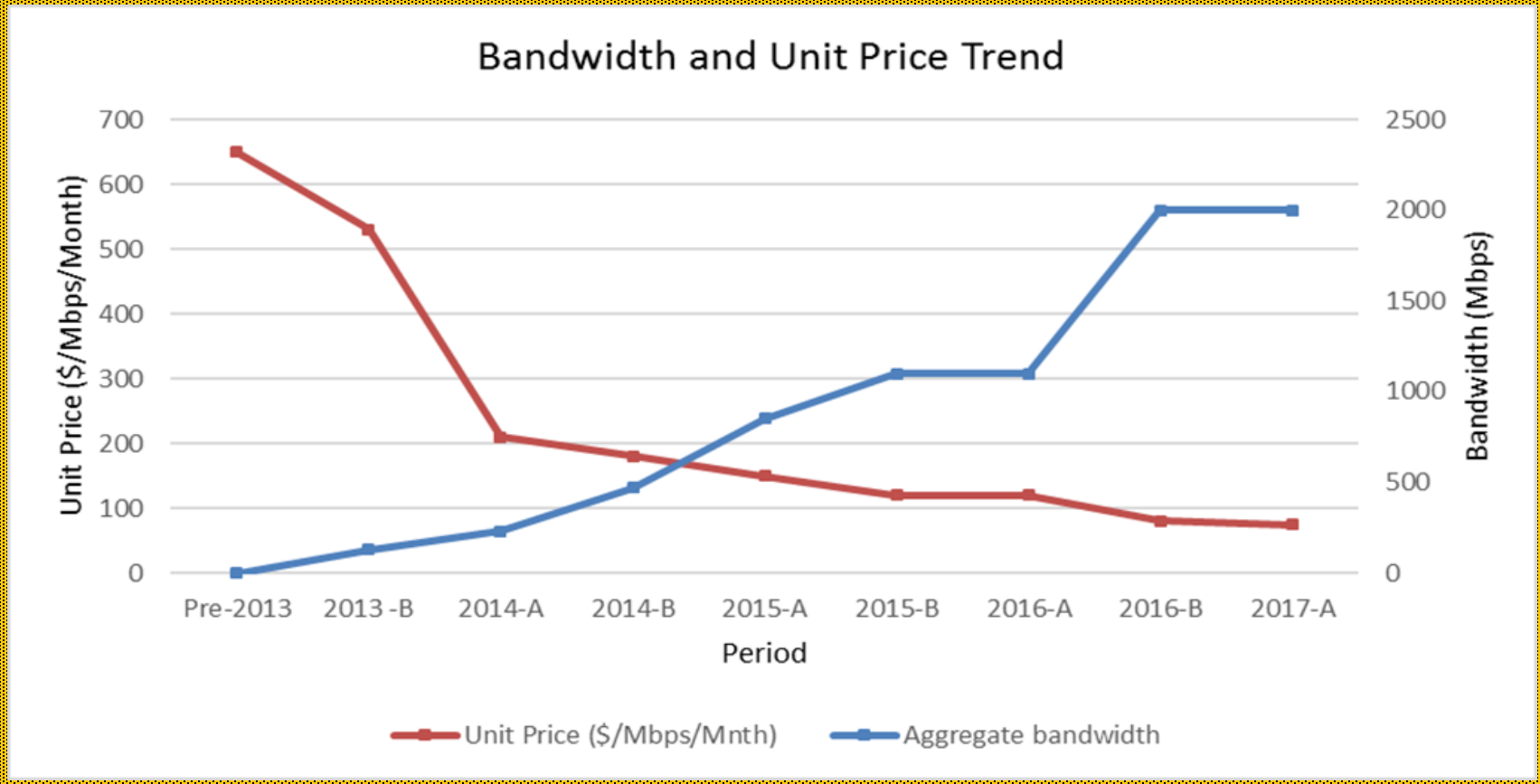
The OPR is based on a 7-Fold Purpose:

Provide a *resilient high-speed connectivity* to *connect R&E institutions* in Uganda (public & private) in order to facilitate *local collaboration*, provide quality *access to the global R&E* network and to the commodity Internet augmented by *services* and applications that *support research collaboration*. Provide *technical capacity building* and attain NREN *sustainability*.

Assessing the Overall Impact of the NREN

No.	Key Results Areas (KRA)	Key Performance Indicators (KPI)	36 Months Outcome	Comments
1	I. NREN Coverage + Expansion + Grow membership	Percentage of country reached by R&E network & No of connected Sites.	[75%] 3 upcountry PoPs & 3 aggregation points + 3 GKMA PoPs + 2 aggregation points; >65 sites of which 15 are upcountry.	Funded by internal Rev. streams 2 new towns to be added in 2017
2	Facilitate Local R&E Collaboration.	Traffic Exchange between local sites	RENU does not bill for on-net traffic.	In GKMA network supports up to 1Gbps & upcountry it varies between 70Mbps and 400 Mbps
3	Access to Global REN & Internet.	Aggregate International bandwidth	Peaked at 1,900 Mbps. Core backbone currently @ 2Gbps	Google quasi-static content got by local peering.
4	Resilience of local & international routes.	International availability. National availability.	Implemented Full redundancy in August 2016, & international uptime in last 6 months = 100%. Exceeded level specified in SLA.	Implemented fully redundant topology with 2 exit points at 2 different PoPs.
5	Services and Applications to support R&E collaboration	Number of Supported tools.	SNS; R&E content hosting	New Internal Revenue Streams have started
6	NE capacity building	Number of NE trained + DEA done	About 8 NE workshops @ 25 trainees + 12 DEAs	RENU expects to attain CB autonomy by end of 2017.
7	NREN Sustainability.	Diversification of Rev. stream + Partnerships + sourcing from local PIP	Started Rev. stream from SNS. 2 new partnerships.	Network expansion funded by internal revenue streams. Presence at UIXP.

Assessing the Overall Impact of the NREN



Lessons Learnt - Category 1: Principles & Methods

- For efficient and all-inclusive NREN development, it is important to embark on autonomous operation as early as possible, as opposed to a symbiotic one with a CSP or one where the NREN is run as a government agency.
- In spite of the challenges faced, the path of self-reliance imparts early lessons that strengthen competitive operation, which is a benefit in the long run that yields sustainability.
- In negotiations with PIP and service providers NRENs should be alert to effectively manage costs, risks and expectations, as well as steering clear of being locked in uncompetitive agreements. This situation was encountered on the bandwidth consortium, the dark fibre indefeasible rights of use (IRU) and with the international bandwidth purchase.

Lessons Learnt - Category 2: Relationships & HR

- NREN success invariably requires passion and substantial time commitment from team members.
- Close coordination between among management teams is important for NREN progress. Building of teams should follow a meritocratic process, because having the right people (with passion and discipline) at the earliest opportunity is valuable for progress and for maximising opportunities.
- It became quite valuable to get services from in-country PIPs & CSPs and reduced the animosity previously felt by some CSPs towards the NREN and it resulted in enhanced symbiotic co-existence between CSPs & the NREN.

Concluding Remarks

- Forging mutually beneficial business relationships with commercial service providers is helpful for attaining long-term sustainability of NRENs, as well as improving stability and competitiveness. Identifying and exploiting opportunities for relationships that make business sense to CSPs is essential for unlocking opportunities for synergy.
- Despite being a not-for-profit organisation, RENU aims at private sector-like efficiency. RENU adopted a subcontracting model that mostly evaluates and chooses to work with the best commercial service providers for a given service. The service providers are counted on to offer competitive pricing and maximum quality of service. It has helped RENU maintain a lean team while providing best possible services. This has greatly helped RENU to minimise operating expenses and meet the stringent QoS required by many research teams.
- In the medium term, RENU aims to focus on growing services that best support end-user (researchers, academics, students and administrators) needs and will endeavour to cooperatively address the exponential growth of R&E ICT growth required for 21st Century higher education and research.

Forging Meaningful Synergies between NRENs & CSPs,

We thank You for Your Attention