

The Events Defining Bhutan's Internet



Philip Smith
btNOG 8
21st October 2021

Where it all started: 1998

- Internet to be made available to coincide with the 25th anniversary of the 4th King's coronation (2nd June 1999)
- November 1998 Cisco ISP Workshop hosted by UNDP's APDIP programme in Kuala Lumpur
 - Two participants from Department of Telecom (Bhutan Telecom)
- March 1999 request from UNDP office in Thimphu asking for help to provide training & configuration assistance for the Government's new ISP (DrukNet)
- Frantic activity in April before my trip in May

From Henrik Holde <henrik.holde@undp.org>☆

Reply

Subject Bhutan: ISP setup

To Philip Smith <pfs@cisco.com>☆

User agent Mozilla 4.04 [en] (Win95; I)

Philip – it was nice meeting you (although briefly) again at APRICOT in Singapore.

As you may be aware, Bhutan is about to make its way to the Internet and the first ISP in Bhutan will be funded jointly by UNDP Bhutan and APDIP. I am currently trying to identify means of providing training in various aspects of ISP management, routing, local access etc.

When we first spoke in November in Kuala Lumpur, you mentioned that you would be interested in visiting Bhutan. I was wondering if you would be able to combine a visit with providing some hands-on training in configuring and setting up the routing and local access equipment together with the Telecom/ISP staff here. We would obviously pay for your travel etc – unless Cisco would be interested in sponsoring your visit :-~

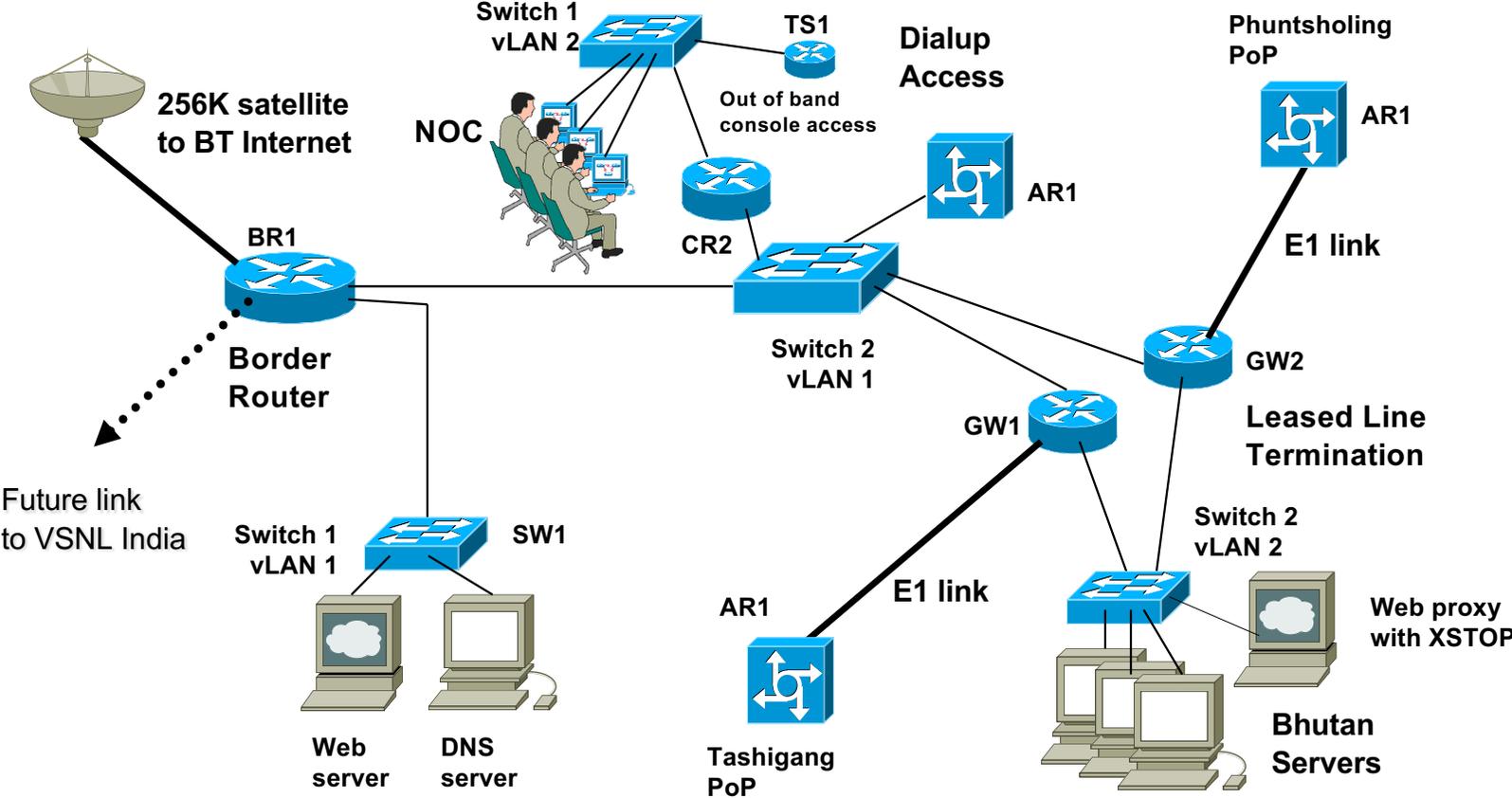
I look forward to hearing from you – if you are interested in the above, the most likely time for the installation of the internet would be sometimes late April/early May.

Best regards,
Henrik

PS. There are literally no airconditioners in Bhutan!!



Network Diagram



| ip unnumbered | | customer |
|-------------------------------|----------------|----------|
| 202.144.129.0/25 | backbone pt | |
| 129.128/25 | public serv | |
| 129.0/27 | core eth | |
| 129.32/27 | DNS etc | |
| 129.64/26 | NOC | |
| 129.128/25 | Dialups | |
| 202.146.128.0 → 202.146.129.0 | Thimphu | |
| 202.146.130.0/24 | P/ling | |
| 202.146.131.0/24 | Jakart | |
| 202.146.132.0/24 | T/gang | |
| | infrastructure | |
| | customers | |
| 202.146.158.0/24 | loops | |
| 202.146.159.152/26 | | |

| IP | Subnet | Location |
|-----|--------|----------|
| 128 | infr | 128 |
| 129 | | 129 |
| 130 | | 130 |
| 135 | cust | 135 |
| 136 | | 136 |
| 137 | in | 137 |
| 138 | | 138 |
| 139 | cust | 139 |
| 140 | | 140 |
| 158 | cust | 158 |
| 159 | | 159 |

P/ling:

| | | | |
|------------|-------|--------------------|----------|
| ARI.p/ling | eth 0 | 202.144.130.1/27 | (159.20) |
| ser 0 | | 202.144.128.2/30 | |
| dial pool | | 202.144.130.129/25 | |

T/gang:

| | | | |
|-----------|-------|--------------------|----------|
| ARI.tgang | eth 0 | 202.146.132.1/27 | (159.21) |
| | | 202.146.128.6/30 | |
| | | 202.144.128.128/25 | |

202.146.129.128

- .200 NS. DRUKNET.NET.BT
- .210 REGAY. DRUKNET.NET.BT
- .220 WWW. DRUKNET.NET.BT
- .254 eth0-1.br1.druknet.net.bt

202.146.129.0

- .1 eth0-0.br1.druknet.net.bt
- .2 eth0-cr1.thimphu.druknet.net.bt
- .3 eth0-cr2
- .4 eth0-gul
- .5 eth0-guo2
- .6 eth0-ar1
- .30 eth0-sw1



| IP addresses | loops | ip unnumbered | customer (line pt loops) |
|------------------------------------|---------|-------------------------------|--------------------------|
| BR1: eth0/0 202.146.129.1/27 | (m.n) | 202.144.129.0/25 | backbone pt to pt links |
| eth0/1 202.146.129.254/25 | | 129.128/25 | public server network |
| ser0/0 from BT Internet | | 129.0/27 | core ethernet Thimphu |
| CR1: eth0 202.146.129.2/27 (m.n) | | 129.32/27 | DNS etc Server network |
| ser0 202.146.128.1/30 | | 129.64/26 | NOC |
| ser1 202.146.128.5/30 | | 129.128/25 | Dialups |
| CR2: eth0/0 202.146.129.2/27 (m.n) | | 202.146.128.0 → 202.146.129.0 | (/23) |
| eth0/1 202.146.129.126/26 | | 202.146.130.0/24 | P/ling |
| GW1: eth0/0 202.146.129.4/27 (m.n) | Thimphu | 202.146.131.0/24 | Jakart |
| eth0/1 202.146.129.60/27 | | 202.146.132.0/24 | T/gang |
| GW2: eth0/0 202.146.129.5/27 (m.n) | | | infrastructure |
| eth0/1 202.146.129.61/27 | | | customers |
| HSRP 202.146.129.62/27 | | 202.146.158.0/24 | loops |
| SW1: eth0 202.146.129.125/26 (m.n) | | 202.146.159.152/26 | |
| SW2: eth0 202.146.129.30/27 (m.n) | | | |
| ARI: eth0/0 202.146.129.6/27 (m.n) | | | |
| TS1: eth0 202.146.129.124/26 (m.n) | | | |





Bhutan Internet in 1999

- Network looks a bit messy in retrospect:
 - But this was a rescue job
 - Used whatever equipment had already been delivered
 - (Cisco 2511 access servers, IBM AIX Servers)
 - Plus Cisco routers/switches specially purchased for this job
 - No time for refinements!
- Designed and built as an ISP
 - 256kbps satellite link to UK
 - Dialup via Cisco 2511 and modems
 - Leased line access via Cisco 3640
 - Border router was Cisco 2611
 - Replaced previous “Internet Café” design proposal



Following 5 years

- Bhutan Telecom moved out of Department of Telecom
 - DrukNet division well established, running the national Internet backbone
- 2005 snapshot:
 - 1Mbps to London (British Telecom)
 - 640kbps to Germany (Intelsat)
 - 1Mbps to Japan (KDDI)
 - 3Mbps to Hawai'i (Loral Skynet)
 - Growing domestic Internet backbone with points of presence in Thimphu, Paro, Phuentsholing, and Tashigang



The arrival of fibre at the border

- First external terrestrial IP link was E1 (2Mbps) to BSNL in Kolkatta
 - Very unreliable 😬

- Fibre from India arrived at Phuentsholing in 2007
 - Opened huge possibilities/opportunities

- DrukNet deployed the first international terrestrial IP link:
 - Planning started in mid-2006, live in February 2008
 - 45Mbps to LINX in London
 - PoP built in Telehouse London
 - Peering on both LINX LANs
 - Transit from AboveNet
 - Reduced satellite capacity for backup (approx. 20Mbps only)

The start of competition

- Drukcom operational as domestic provider

- First appeared in global BGP table on 6th June 2006 via PCCW

```
*> 202.89.24.0      202.249.2.110      0 2516 3491 9237 38004 i
```

- Tashi Infocomm established

- Became Bhutan's second mobile operator
- First appeared in global BGP table on 12th April 2008 via DrukNet

```
*> 118.103.136.0/21 202.249.2.169      0 2497 6461 17660 38740 i
```

The arrival of mobile data

- Initial mobile services started in 2003 by Bhutan Telecom
 - Just telephony

- 3G started being offered in mid-2008
 - Data rates of around 2-3Mbps (realistically)

- 2013 saw the introduction of 4G
 - Bhutan Telecom (B-mobile)
 - Tashi Infocomm (TashiCell)
 - Eventual data rates of around 15-20Mbps to the handset
 - Coverage starting in Thimphu

Expansion of mobile

- 4G started rolling out across the country
 - Adopter hesitancy due to faster data rates consuming data allowance more quickly!
 - Customers asking to be downgraded to 3G !
 - 2017 saw both operators deploying dual stack (IPv4/6) network
 - Fun and games getting Apple and Google Android to support

- And now 5G is starting to become available

Root nameserver

- I-root nameserver operational in April 2011
 - Operated by Netnod
 - Hosted by Bhutan Telecom
 - Part of the global effort to distribute DNS Root nameserver instances to as many locations as possible
 - Local root nameserver greatly speeded up initial DNS lookups
 - Instance also included the ccTLDs hosted by Netnod

- Today: 4 Root nameservers (D, F, I, K)

Caches!

- Google Global Cache operational by December 2011
 - Hosted by Bhutan Telecom
 - Available for all customers/connected networks
 - Greatly enhanced access to cacheable content provided by Google (including YouTube)
 - Initial cache had 4Gbps capability (traffic less than 1Gbps)

- Today: Akamai, Facebook,...

National Fibre

- Fibre network in Bhutan uses two technologies
 - ADSS – All Dielectric Self Supporting
 - Fibre strung along local distribution power poles
 - OPGW – OPTical Ground Wire
 - Fibre strung with the earth cable on overhead power distribution network

- Nationalisation of the fibre network resulted in:
 - Fibre pair reserved for each national network operator
 - Dark fibre – unlit
 - Options included CWDM and DWDM (coarse and dense wave division multiplexing), supporting up to 18 and 80 channels respectively
 - Opportunities for operators to deploy larger domestic backbone bandwidths

The R&E network

- Almost every country in the world has a dedicated Research and Education network
 - For connecting education institutions
 - Universities, Colleges, higher education (sometimes schools)
 - For connecting research establishments
 - Institutes involved in research, including libraries, museums etc

- Usually operated by:
 - The country's largest University -or-
 - A non-profit entity funded by all the members -or-
 - Government funding agency/department

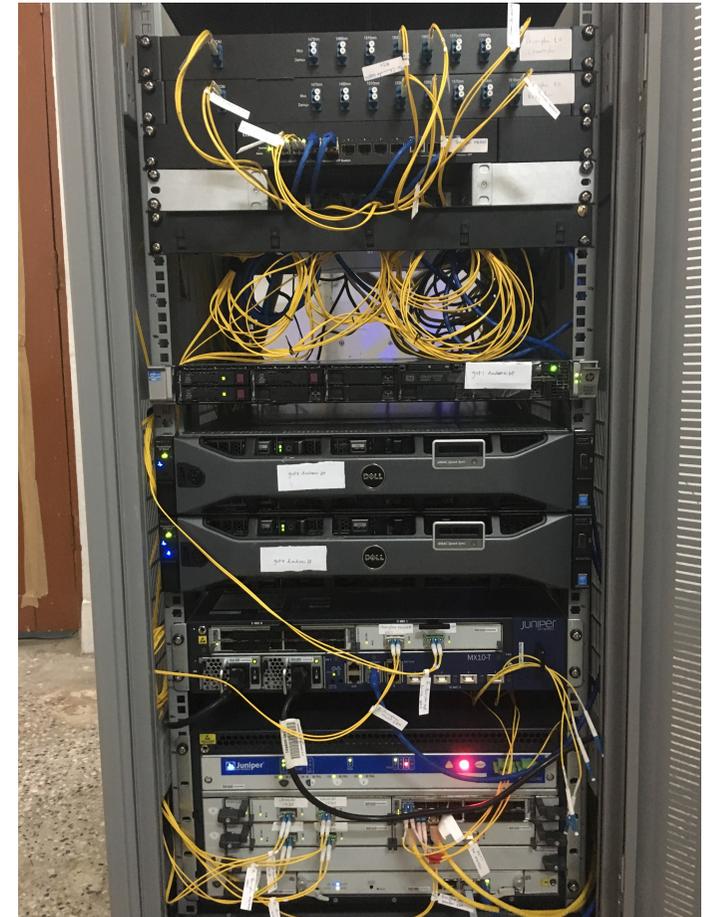
The R&E network

- August 2014 saw the first serious discussions about establishing an R&E network in Bhutan
 - TEIN*CC and NSRC combined to assist/advise on the establishment of “DrukREN”
- *Campus Network Design and Linux Sysadmin* workshops by NSRC in September 2015
 - For technical staff of prospective members of DrukREN



The R&E network

- DrukREN live by February 2018
 - Old SASEC¹ infrastructure taken over
 - Network equipment updated & enhanced
 - National fibre network fibre-pair used, CWDM deployed
 - 10Gbps backbone, 1Gbps access for members (RUB colleges initially)
 - Transit agreement with Bhutan Telecom
- Connection to NKN and onwards to Global R&E Internet live in February 2019



¹ South Asia Subregional Economic Cooperation had planned to build a network connecting all SASEC member countries, from 2005. Only Bhutan had put its infrastructure in place, basically unused.

The IXP: take 1

- The Internet Exchange Point for Bhutan took longer to be established than I expected
 - My hope: that with Tashi Infocomm and DrukCom operational by 2010, an IX would come soon after that
 - But where? And how?
 - Conversation about a “ThimphuIX” kicked off in August 2014!

- First attempt at interconnect hosted by DrukREN/MOIC and called BIX
 - TashiCell, BT, and DrukREN interconnected their networks
 - The other operators did/could not due to logistical challenges
 - Some traffic flowing by late January 2017

The IXP: take 2

- ❑ After much discussion, tireless persuasion, hard work behind the scenes, agreement was reached in October 2018

- ❑ Located at Thimphu Technology Park
 - Own facility in the building
 - Easier access for all operators
 - Management Board consists of members
 - ❑ IXP is operated by members for members
 - Official launch 8th January 2019
 - <https://www.btix.bt>
 - Today there are 8 full members



The NOG

- Last and definitely not least!
 - Bhutan's Network Operators Group
 - 🤗👏

- South Asia Network Operators Group (SANOG) held meetings in Bhutan:
 - July 2005 (SANOG6 – Thimphu)
 - July 2010 (SANOG16 – Paro)
 - January 2014 (SANOG23 – Thimphu)
 - January 2019 (SANOG33 – Thimphu)

The NOG

- ❑ SANOG 23 in Thimphu saw the big push that established the Bhutan's NOG
 - For everyone running IP network infrastructure in Bhutan
- ❑ First meeting was in Phuentsholing in 2014
 - Coordination Team formed from interested parties in Bhutan's domestic industry
 - One day conference (17th November)
 - Four days of 3 parallel training workshops (18th – 21st November)
- ❑ And the rest is history!
 - <https://nog.bt/>
- ❑ **Congratulations to the btNOG team!**



Today!

- While the road may have been long, twisty, rough, with roadblocks, landslides, steep uphill/downhill tracks...
- ...I hope that Bhutan can see its Internet success story
- All the components are in place and functioning
 - Well, there is always room for improvement...
 - (redundant fibre paths, independent local data centres, local content hosting,...)
- **Congratulations and Tashi Delek!**