# India - LHCONE

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# India's e-infrastructure

Two main collaborative computing grids exist in India
- **GARUDA**, the Indian National Grid Initiative.
- The Regional component of the **Worldwide LHC Computing Grid** (WLCG )

**GARUDA**, the National Grid Initiative of India is a collaboration of scientific and technological researchers on a nationwide grid comprising of computational nodes, storage devices and scientific instruments

The Department of Information Technology (DIT) has funded the Center for Development of Advanced Computing (C-DAC[22]) to deploy the nation-wide computational grid 'GARUDA' which today connects 45 institutions cross 17 cities in its Proof of Concept (PoC) phase with an aim to bring "Grid" networked computing to research labs And industry.

In pursuit of scientific and technological excellence, GARUDA PoC has also brought together the critical mass of well-established researchers.

The Regional component of the **Worldwide LHC Computing Grid** (WLCG )

1. IN--INDIACMS--TIFR – (T2_IN_TIFFR)
2. IN--DAE--KOLKATA--TIER2 – (IN--DAE--VECC--02)



Source.. http://www.euindiagrid.eu

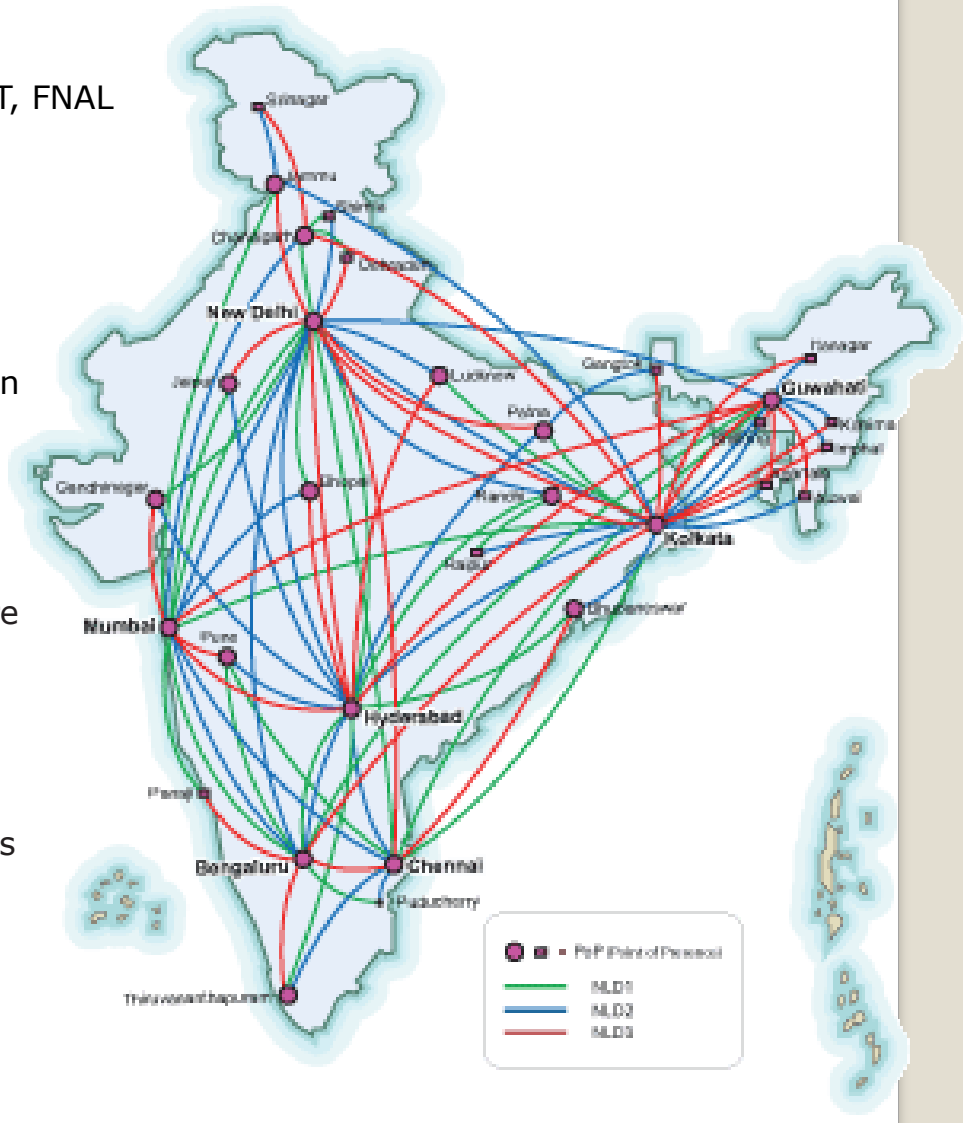
Both above initiatives strongly rely on the development of national and international connectivity.

- National Knowledge Network
- NKN- TEIN connection
- Direct P2P connection with CERN -LHCONE, GEANT, FNAL

## National knowledge Network ( NKN)

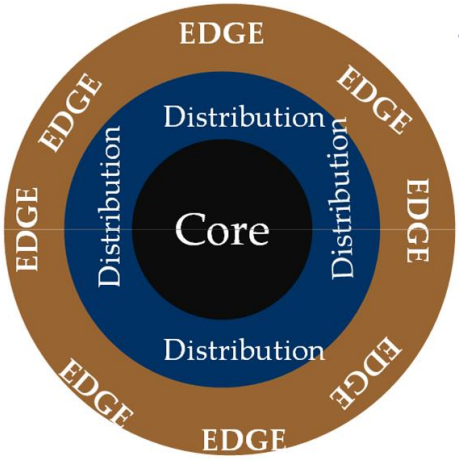
The NKN is a state-of-the-art multi-gigabit pan-India network for providing a unified high speed network backbone for all knowledge and research institutions in the country

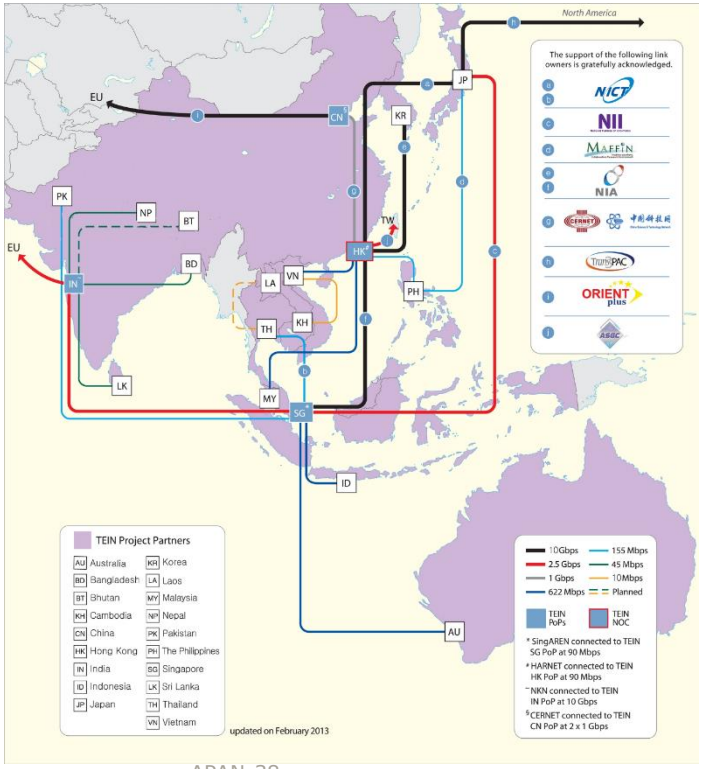
- Connectivity to **1500+** institutions. in the country using high bandwidth / low latency network
- The network architecture and governance structure allows users with options to connect to the distribution layer as well. NKN enables creation of Virtual Private Networks (VPN) as well for special interest groups.
- NKN provides international connectivity to its users for global collaborative research via APAN. Presently, NKN is connected to Trans Eurasia Information Network TEIN4. Similar connectivity to Internet#2 network is in the pipeline




Multiple 10G Connecting all the State Capitals
Gigabit Connectivity to all the 640 Districts

- The network consists of an ultra-high speed core, starting with multiple 2.5/10 G and progressively moving towards 40/100 Gigabits per Second (Gbps).. between 7 Supercore (fully meshed) locations pan India.
- The network is further spread out through 26 Core locations with multiple of 2.5/10 Gbps partially meshed connectivity with Supercore locations.
- The distribution layer connects entire country to the core of the network using multiple links at speeds of 2.5/10 Gbps.
- The participating institutions at the edge seamlessly connect to NKN at gigabit speed




- **Two 2.5 Gigabit links – one to Europe and other to Singapore through TEIN4**
- **T2-IN-TIFR has been in the pilot project of LHCONE from 2008-9**

**EUIndiaGrid** played an very important role in enhancing, increasing and consolidating Euro-India cooperation on e-Infrastructures through collaboration with key policy players both from the **Government of India** and the E**uropean Commission**.

EU-IndiaGrid2 focused on four application areas strategic for Euro-India research cooperation:
- **Climate change**
- **High Energy Physics**
- **Biology**
- **Material Science**

Over the course of the project, further areas of interest were identified
-**seismic hazard assessment** produced interesting results
- **neuroscience** applications

## EU-IndiaGrid2 Consortium

### EUROPE

- INFN - The Italian National Institute of Nuclear Physics (project coordinator)
- TRUST-IT — Communicating ICT to Markets
- Consortium GARR — Italian Academic and Research Network (GARR)
- University of Cambridge — Cambridge University
- CEA - Commissariat à l'Énergie Atomique - France

### INTERNATIONAL

- Abdus Salam International Centre for Theoretical Physics

### INDIA

- Bhabha Atomic Research Centre, Mumbai
- C-DAC — Centre for Development of Advanced Computing (C-DAC)
- ERNET — Indian Education and Research Network (ERNET)
- Indian Institute of Science, Banglore
- Indian Institute of Technology, Delhi
- University of Pune
- SAHA Institute of Nuclear Physics
- TIFR, ncbs — TATA Institute for Fundamental Research, and National Centre for Biological Sciences
- Variable Energy Cyclotron Centre (VECC)

www.euindiagrid.eu

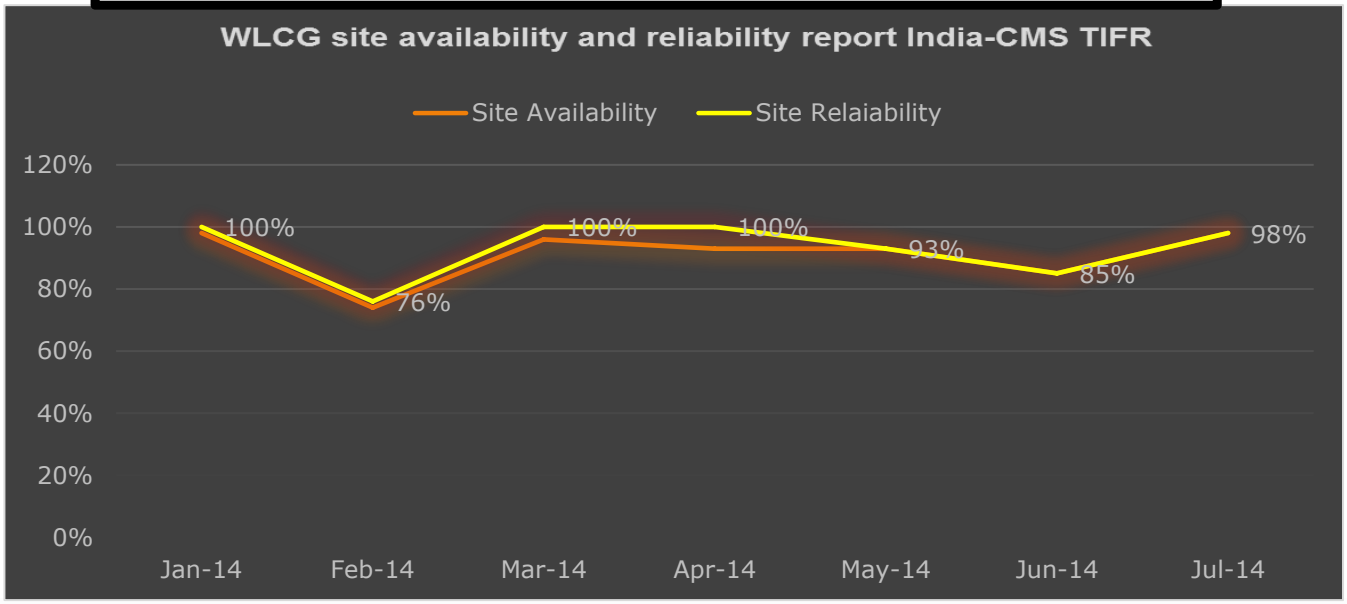
# T2_IN_TIFR Resources

Computing
- Existing computational nodes = 48 with total of 384 cores and 864 GB of memory
- New computational nodes = 40 with total of 640 cores and 960 GB of memory

Total no of physical cores is 1024. Total Average of Runs executed on a machine (Special Performance Evaluation) i.e. (HEP-SPEC06) is 7218.12

Storage
- Existing storage capacity of 23 DPM Disk Nodes is aggregated to 570 TB of existing storage.
- Five new DPM Disk Nodes with each node having 80 TB are installed adding 400 TB to the total storage capacity
- Total Capacity of 970 TB

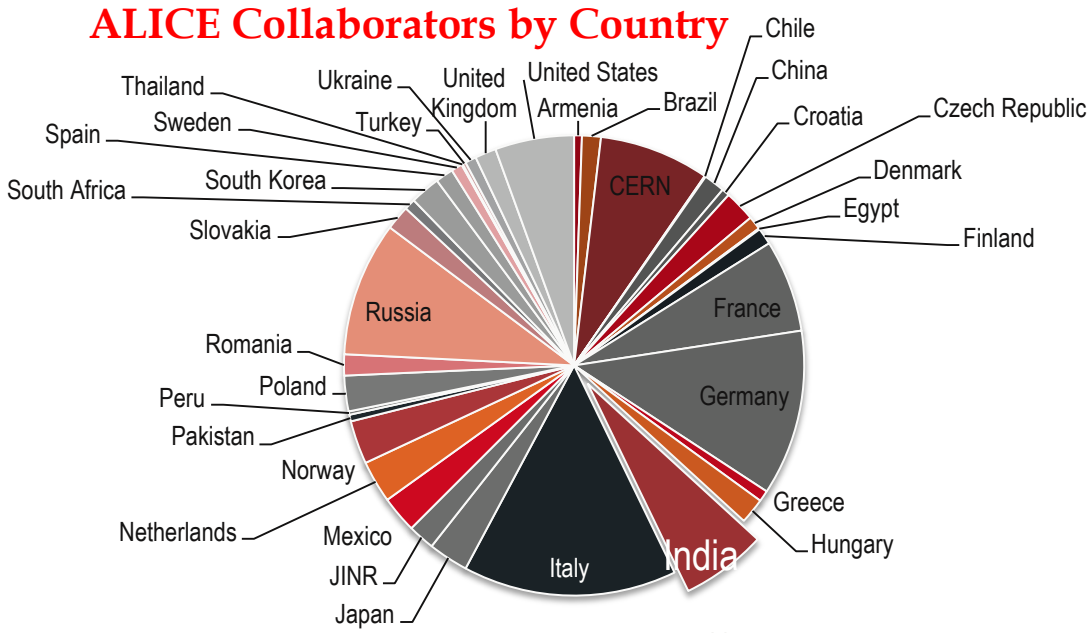
**WLCG site availability and reliability report India-CMS TIFR In 2014 (Jan-14 to Jul-14)**



# IN-DAE-VECC-02 Resources

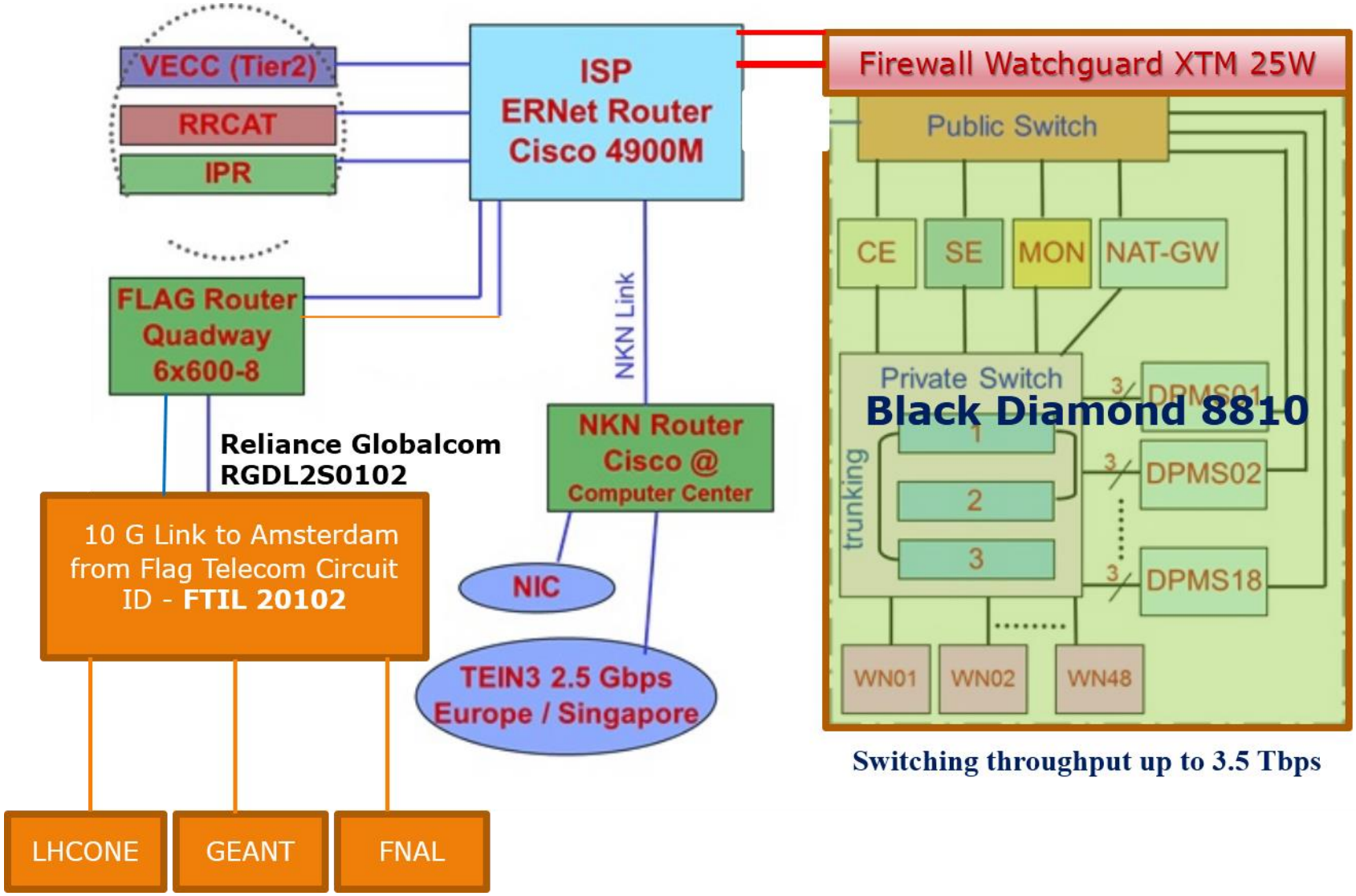
| Month | Pledged CPU | Pledged Efficiency (HS06-Hrs) | Used Hours | Used as % of Pledge | Availability | Reliability |
|---|---|---|---|---|---|---|
| July 2014 | 6,000 | 3,124,800 | 5,904,876 | 189% | 86% | 86% |
| June 2014 | 6,000 | 3,024,000 | 3,890,104 | 129% | 99% | 99% |
| May 2014 | 6,000 | 3,124,800 | 5,205,432 | 167% | 100% | 100% |
| April 2014 | 6,000 | 3,024,000 | 3,847,468 | 127% | 92% | 92% |
| March 2014 | 6,000 | 3,124,800 | 4,503,244 | 144% | 98% | 98% |
| February 2014 | 6,000 | 2,822,400 | 2,357,172 | 84% | 89% | 89% |
| January 2014 | 6,000 | 3,124,800 | 775,156 | 25% | 96% | 96% |

*INDIA is the 6th Largest group under ALICE Collaboration.*



# Network at T2_IN_TIFR

**T2-IN-TIFR has been included in the pilot project of LHCONE during 2008-9**




**Switching throughput up to 3.5 Tbps**

## TIFR - ASGC

```
[brij@ui2 ~]$ traceroute 117.103.109.130
traceroute to 117.103.109.130 (117.103.109.130), 30 hops max, 40 byte packets
 1  144.16.111.1 (144.16.111.1)  0.546 ms  0.550 ms  0.558 ms
 2  202.141.153.30 (202.141.153.30)  0.170 ms  0.178 ms  0.187 ms
 3  10.152.12.5 (10.152.12.5)  2.774 ms  2.738 ms  2.819 ms
 4  mb-xe-01-v4.bb.tein3.net (202.179.249.41)  1.221 ms  1.125 ms  1.179 ms
 5  sg-so-04-v4.bb.tein3.net (202.179.249.53)  59.434 ms  59.401 ms  59.419 ms
 6  hk-xe-03-v4.bb.tein3.net (202.179.241.101)  91.568 ms  91.567 ms  91.530 ms
 7  asgc-pr-v4.bb.tein3.net (202.179.241.98)  91.646 ms  91.727 ms  91.643 ms
 8  so-4-1-0.r1.tpe.asgc.net (117.103.111.222)  174.172 ms  174.335 ms  174.232 ms
 9  117.103.111.226 (117.103.111.226)  175.008 ms  174.862 ms  174.993 ms
10  coresw.tpe.asgc.net (117.103.111.233)  175.081 ms  175.093 ms  175.101 ms
11  rocnagios.grid.sinica.edu.tw (117.103.109.130)  174.479 ms !X  174.570 ms !X  174.491 ms !X
```

Via **Singapore**

## VECC to CERN

```
[vsinghal@gpu ~]$ traceroute alien.cern.ch
traceroute to alien.cern.ch (137.138.99.142), 30 hops max, 60 byte packets
 1  vecc-direct.tier2-kol.res.in (144.16.112.28)  0.194 ms  0.190 ms  0.183 ms
 2  10.173.35.237 (10.173.35.237)  44.383 ms  44.386 ms  44.494 ms
 3  10.255.237.205 (10.255.237.205)  127.543 ms  127.670 ms *
 4  10.255.232.21 (10.255.232.21)  42.718 ms  42.767 ms  42.764 ms
 5  mb-xe-01-v4.bb.tein3.net (202.179.249.41)  37.256 ms  37.263 ms  37.258 ms
 6  eu-mad-pr-v4.bb.tein3.net (202.179.249.118)  154.480 ms  154.398 ms  154.396 ms
 7  ae3.mx1.par.fr.geant.net (62.40.98.65)  175.897 ms  175.885 ms  175.855 ms
 8  switch-bckp-gw.mx1.par.fr.geant.net (62.40.124.82)  178.095 ms 178.119 ms  178.087 ms
 9  e513-e-rbrxl-2-te20.cern.ch (192.65.184.70)  178.075 ms  178.234 ms  178.336 ms
```

**Mumbai**

Via **EU**

## TIFR – LHCONE Route

```
[root@localhost ~]# nmap -sn --traceroute lxplus.cern.ch
Starting Nmap 5.51 ( http://nmap.org ) at 2014-08-10 21:56 IST
Nmap scan report for lxplus.cern.ch (188.184.28.151)
Host is up (0.17s latency).

TRACEROUTE (using proto 1/icmp)
HOP RTT       ADDRESS
1   0.99 ms   144.16.111.1
2   171.30 ms e513-e-rbrrt-3-ee5.cern.ch (192.16.155.17)
3   170.26 ms e513-e-rbrxl-2-ne2.cern.ch (192.65.184.57)
4   ... 6
7   166.23 ms r513-b-rbrml-2-sc2.cern.ch (194.12.149.6)
8   ...
9   166.56 ms lxplus0062.cern.ch (188.184.28.151)
Nmap done: 1 IP address (1 host up) scanned in 4.51 seconds
```

## TIFR to voms.cern.ch

```
[root@localhost ~]# nmap -sn --traceroute voms.cern.ch
Starting Nmap 5.51 ( http://nmap.org ) at 2014-08-10 21:59 IST
Nmap scan report for voms.cern.ch (128.142.153.115)
Host is up (0.17s latency).

TRACEROUTE (using proto 1/icmp)
HOP RTT       ADDRESS
1   0.97 ms   144.16.111.1
2   167.46 ms tifr.mx1.gen.ch.geant.net (62.40.125.49)
3   334.13 ms swiCE2-10GE-1-1.switch.ch (62.40.124.22)
4   182.46 ms e513-e-rbrxl-1-te1.cern.ch (192.65.184.222)
5   ... 7
8   163.76 ms l513-b-rbrmx-3-ml3.cern.ch (194.12.148.18)
9   ...
10  169.49 ms voms3.cern.ch (128.142.153.115)

Nmap done: 1 IP address (1 host up) scanned in 4.54 seconds
```

Why different routes ?

Route from TIFR to US ( U.Chicago)

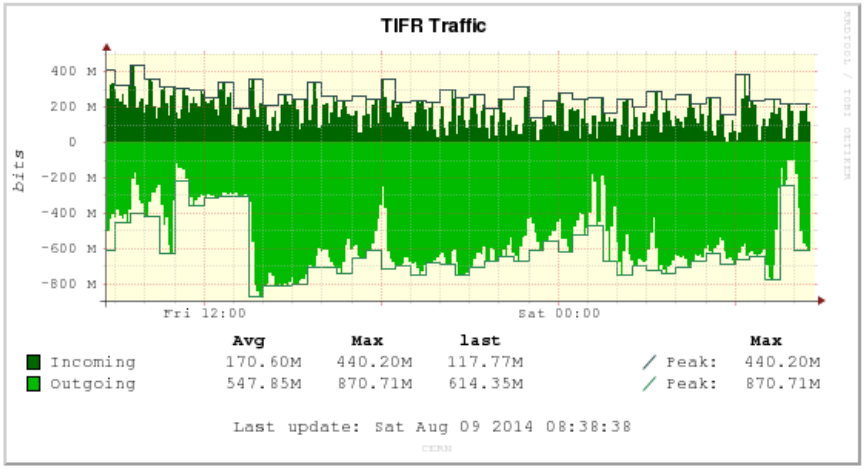
Traceroute to 144.16.111.1

| Hop | %L | IP Address | Node Name | Location | Tzone | ms | Graph | Network |
|---|---|---|---|---|---|---|---|---|
| 0 | | 172.16.34.132 | brij-lp.uchicago.edu | | | 0 | 0 295 | [Local Network] |
| 1 | | 172.16.32.2 | i04-b12-200-v2721. | | | 7 | | [Local Network] |
| 2 | 14 | 128.135.100.98 | - | Chicago, IL, USA | -06:00 | 49 | | University of Chicago |
| 3 | | 10.4.247.133 | i04-b12-200-v930.u | | | 34 | | [Local Network] |
| 4 | | 10.4.247.65 | south-to-edelstone. | | | 19 | | [Local Network] |
| 5 | | 10.4.247.224 | - | | | 28 | | [Local Network] |
| 6 | | 128.135.247.12 | internet2-router.uch | Chicago, IL, USA | -06:00 | 6 | | University of Chicago |
| 7 | | 198.71.45.57 | et-9-0-0.115.rtr.was | Ann Arbor, usa | | 26 | | Internet2 |
| 8 | | 62.40.125.17 | abilene-wash.mx1.f | *(United Kingdom)?* | | 134 | | IP allocation for GEANT |
| 9 | | 62.40.98.108 | ae1.mx1.gen.ch.ge | *(United Kingdom)?* | | 139 | | IP allocation for GEANT |
| 10 | | **144.16.111.1** | - | *(India)?* | | 289 | | ERNET India |

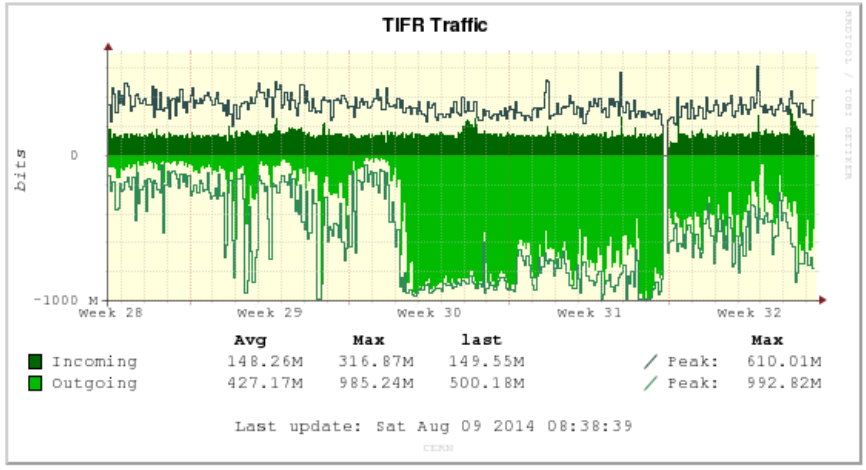
Using Globus online and PhEDEX transfers, peak data transfer rates between TIFR and FNAL, U. Chicago of up to 1.2 Gbps .

# Tiers2-LHCONE: TIFR

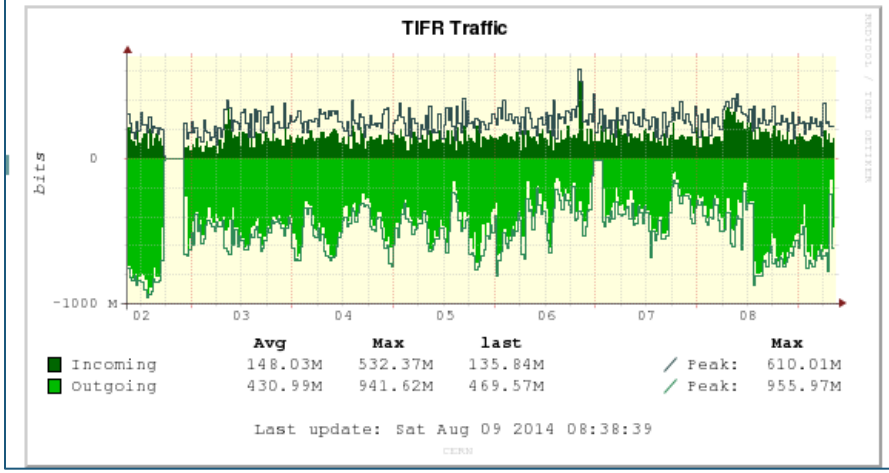
## Daily



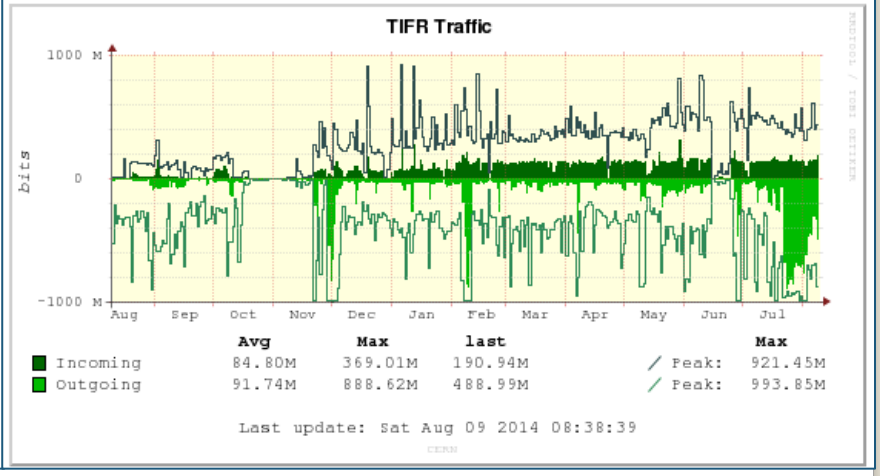

## Monthly

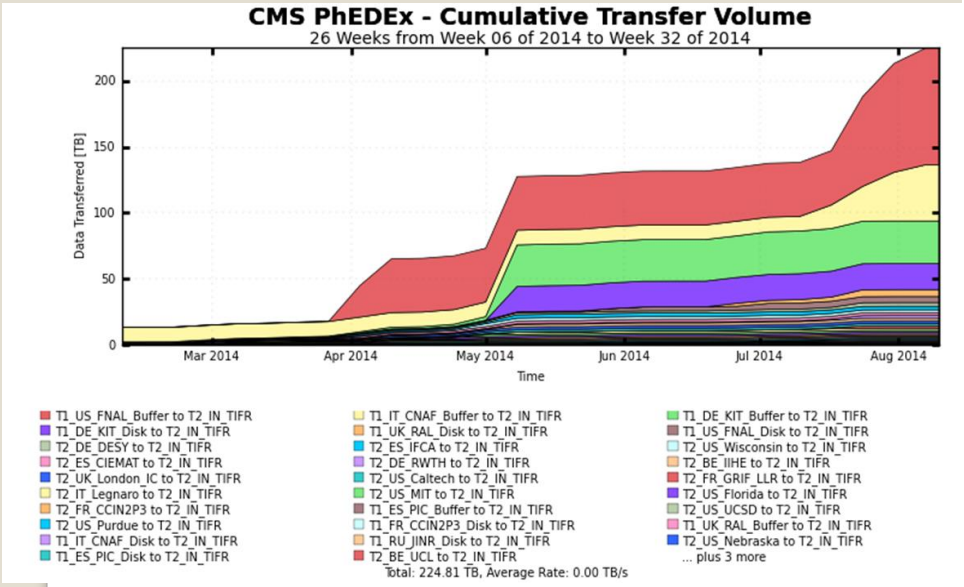


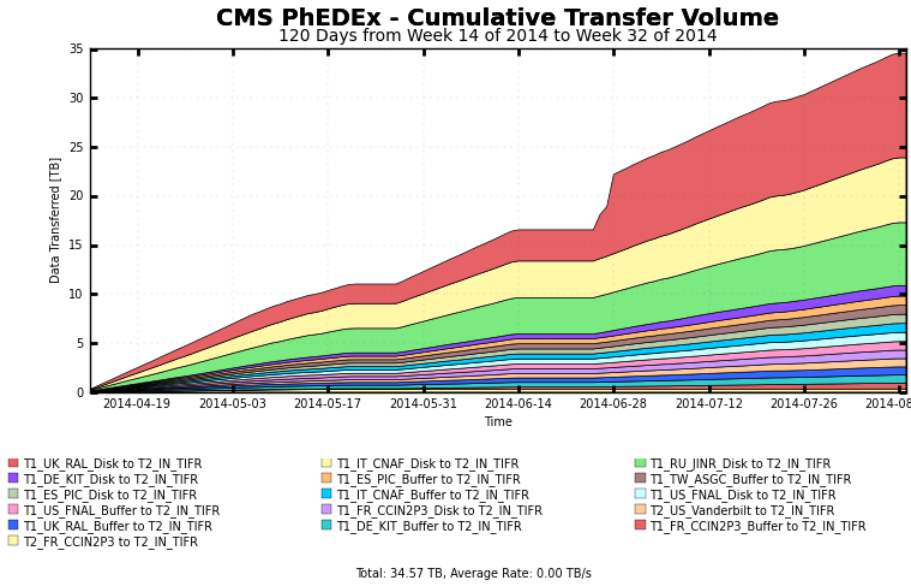

## Weekly



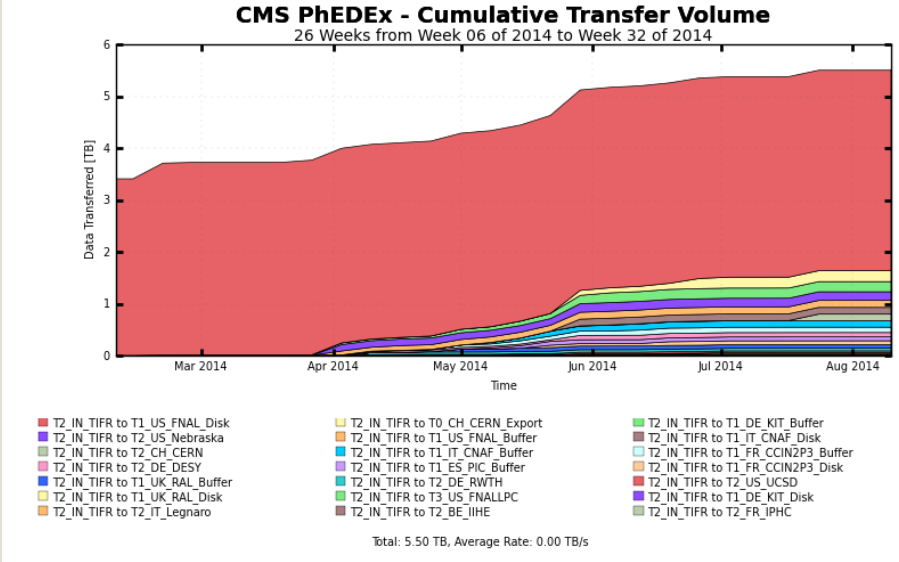

## Yearly

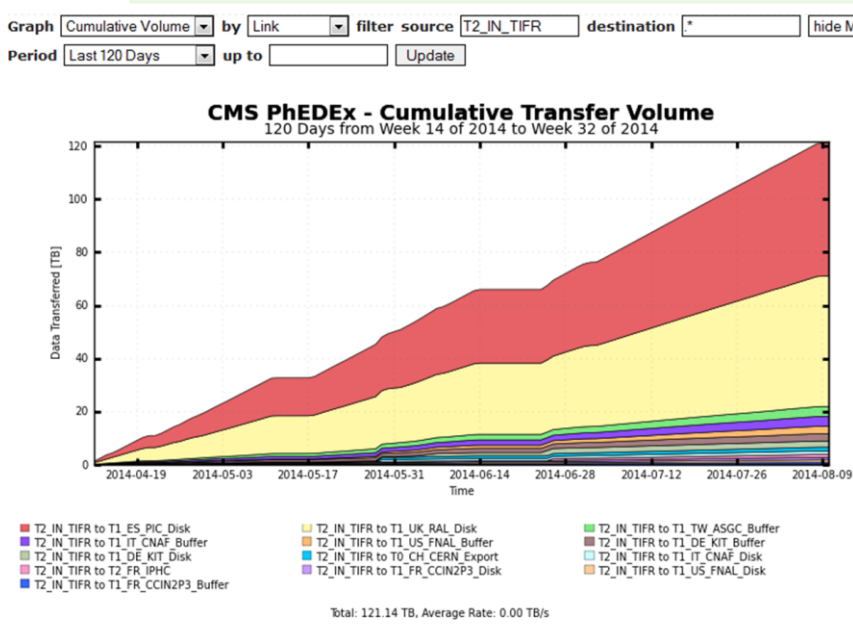





# Total cumulative data transfers for last four months is 450 TB



# Future developments

- NKN is planning to locate International PoP of NKN at CERN. CERN has agreed to provide necessary space, power etc for NKN
- Direct NKN connectivity to Internet#2 in pipeline
- Yes, the operations of existing dedicated P2P link from TIFR, Mumbai to Europe will continue.
- P2P Virtual Circuit for Alice T2 at VECC with LHCONE ?

Your Suggestion or Questions ?

**Thank you**