Campus Area Network in Ramakrishna Mission Vivekananda University

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Ramakrishna Mission Vivekananda University, Belur Math, has campus wide network which caters to IT needs of two schools, School of Mathematical Sciences and School of Indian Heritage and the administrative building. There are plans to extend the network to students' hostels restrictively and to guest house. There are eight departments in Belur Campus, computer science, data science, physics, mathematics, sanskrit, indian spiritual heritage, bengali, classical music, and yoga studies. Currently the number of computers that are using campus wide services is around hundred and growing.

The university runs its own web server (apache, drupal, wordpress), mail transport server (exim), mail exchange server (dovecot), web-mail application (sogo), our own domain name server (bind), both external and internal, dhcp server for dynamic configuration of clients (isc-dhcp-server), masquerading firewall (shorewall), transparent web proxy (squid), web-site blocking (squidguard), web content filtering (dansguardian), light directory service (openldap), time server (ntpd), debian software archive (apt-cacher-ng), instant messaging (ejabber). All these are open source software based on linux.

The university shares its pool of sixteen IP addresses with the departments so that the departments can have their own fully function Internet server accessible from Internet to the world. The deparments which have Internet servers are computer science, mathematics, physics, sanskrit, Indian heritage. Library and computer centre also have servers accessible from Internet. These computers have the minimum basic services — their own web servers (apache) and mail servers (exim4) — installed by us, and then the departments are free to add their own user and other services. Along with this we also host websites for Narendrapur campus, Ranchi campus (incomplete), and a few sister institutions, Ramakrishna Mission Shilpayatana and Ramakrishna Mission Shilpavidyalaya. This is because it does not cost us much when the infrastructure is already in place.

The campus wide network is fully designed and created by the department of computer science locally. Right from the beginning it was meant to provide fail safe operation for 24x7. We also have fault tolerant design at a few choke points. We do not have fault tolerance every where because of the cost involved. Even then it is an astonishing fact that our availability is in high 99% for the past several years, at least since last five years.

The campus wide network was designed in 2005 with the design progressively modified till the current year without major structural changes. This was because we kept the future requirements in the mind. The network has scaled well to the requirements a decade later and we hope will continue to do so. The only think that is still not upgraded in the 100mbps distribution network in the main administrative building which we did not go to 1gbps initially was again because of funds crunch. Yet the backbone in administrative

Figure 1: Core and distribution switches in Medhabhavan. The red cables on the top left are fibre optic cables.
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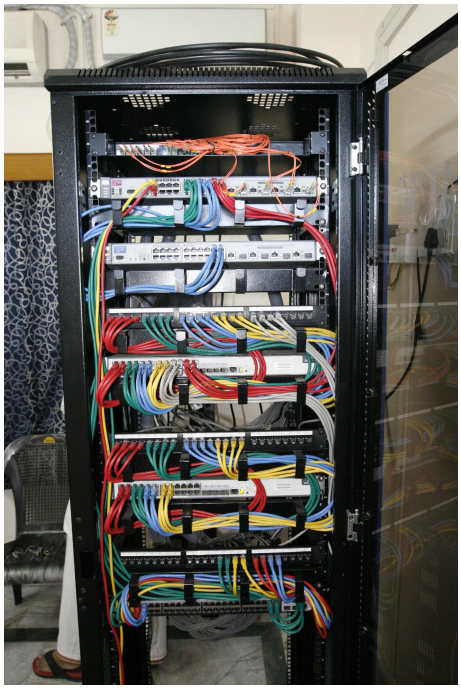

Figure 2: Distribution switches in Prajnabhavan. The red cables on top are fibre optic cables.
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building was conceived to be a 1gbps link and we were able to install a 1gbps backbone link between the access switches, distribution switches and the core switches.

1 Layer 2 Networking

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Since we wanted to host our own web server in the same IP segment as was given for our shared Internet, we needed to create a DMZ (demilitarized network zone). This zone needed to be protected from both outside Internet and the unsecured lab networks used by students. To actualize this we used vlans (virtual lan standard 802.1q) to segregate networks. Also we came up with the design of dual firewalls. The DMZ will have to be sandwiched between the two firewalls.

Layer 2 of network concerns itself with the physical connections. To have virtual lans having managed switches is a must. Though Cisco is the leading manufacturer of managed switches, we went by HP Procurve switches, again, because of the costs. We also understood that once we develop skills in Procurve switches we would get equivalent performance and functionality of Cisco switches. It helped that we completely wanted to segregate the virtual lans and routed all the traffic using software linux routers. So we did not need to have extra features that Cisco switches provided. So we structures our network around HP Procurve switches, thus saving cost to one third of Cisco's costs. The core procurve switches are 3400CL series gigabit switches. See figure 1 above the dedicated Juniper router (blue, second from the top). We also have two 3Com 5500G gigabit switches used as distribution switches. See figure 2 at the top. All the distribution

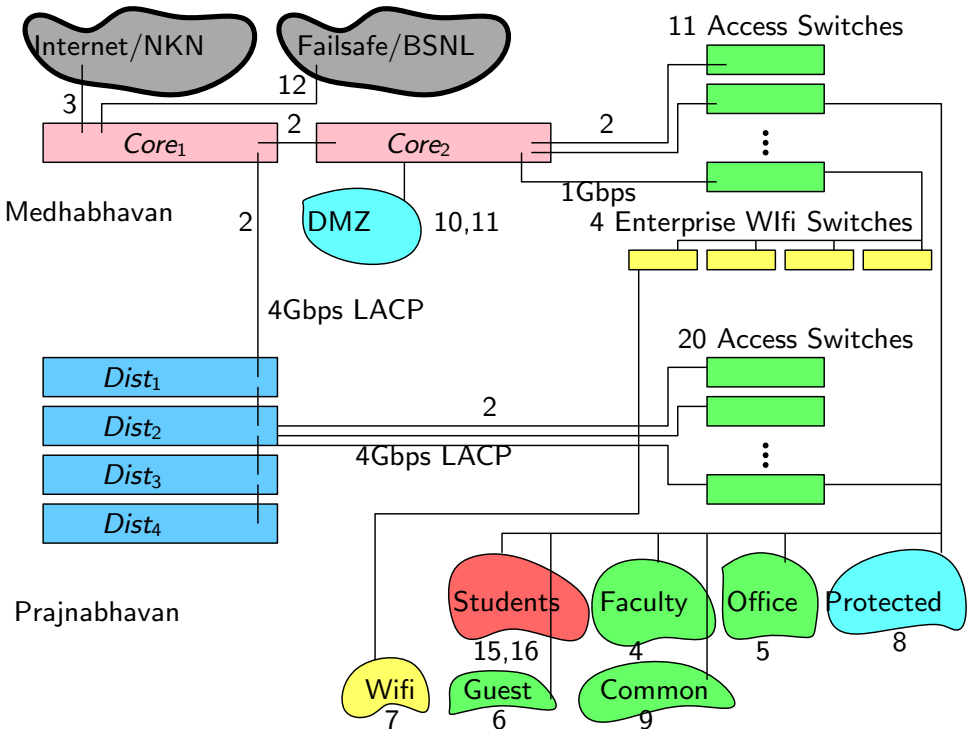

Figure 3: Simplified Layer 2 networking schematic diagram with associated VLAN numbers

switches are gigabit switches as well as the access switches used in the computer laboratory. The computer laboratory is given gigabit switched to enable high speed transfer for intra computer transfers and for transfers to and from laboratory main servers situated in the computer center LAN segment. The schematic diagram for layer 2 networking is given in figure 3.

It is to be noted that the interswitches links in Prajnabhavan in massive throughput 4Gbps link by using LACP and trunking with four parallel links. In Medhabhavan, due to some unavoidable civil engineering mistakes, we could only provide 1Gbps links (we went for under the floor cables, and though we used fireproof and waterproof cables, during the layout of cables, several cables were damaged, and we could not have a functioning LACP).

We have a fible optic 4Gbps link between Prajnabhavan and Medhabhavan. We have also laid fible optic cable to hostels and guest house for future links.

2 Layer 3 Networking

Layer 3 of network conserns win IP addressing. To have plug and play Internet, we used DHCP server in our network which is hosted on internal firewall in figure 4.

NKN gave us 16 IP addresses. Initially they gave us a link. We installed our network without a hitch. Later on NKN came to know that we have installed our own software routers and servers in the network. Then NKN thought that we need a dedicated router. We told them that we already have a software router but they insisted on putting a dedicated Juniper router (a waste of money, if you take my opinion). NKN instructed BSNL to install dedicated router in our premises. Anyway, surprise of surprises, BSNL put dedicated router and programmed it as a bridge. They refused to give the control

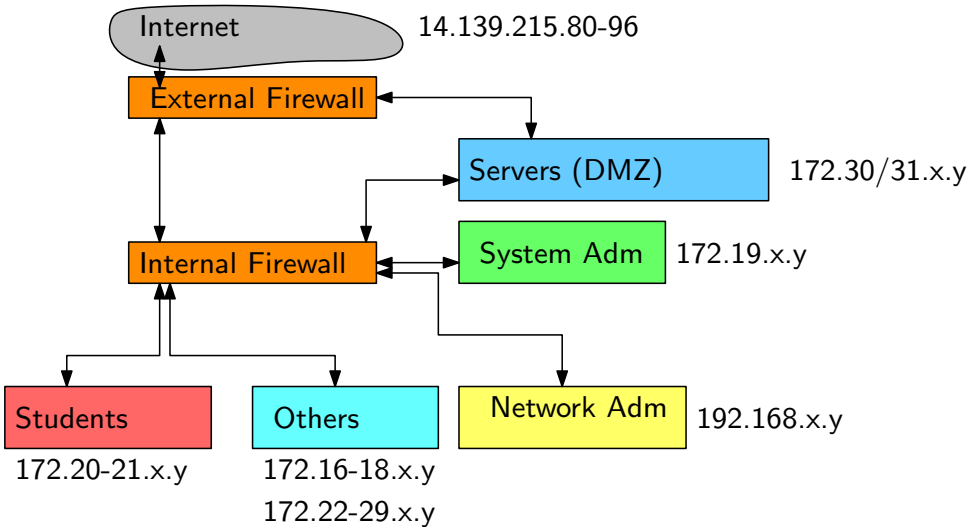

Figure 4: Simplified Layer 3 Networking Schematic Diagram

of the dedicated router, which we would have programmed better in our VLAN setup and also used it as a proper router. Also they did not know how to hook up their dedicated router in our VLAN based network. They did not know how to get a linux computer talk to a dedicated Juniper router. We had to reverse engineer their windows computer configuration to get the whole thing working. It turned out that even though the dedicated Juniper was using 10.x.y.x address, we need to overwrite the packets with 14.139.215.80-96 addresses. We had to do SNAT with every packet in our software router to get the job done. So, in short, with all the hoopla, the software one armed router was still needed and was still there. And the Rs 8 lakh beauty, was doing nothing but bridging packets across the network, a glorified repeater.

Anyway, we use IP addresses 192.168.x.y as a class B subnet for our switches. This is to enable new switches which usually have IP address 192.168.1.1 when they are purchased. We plug the new switches to our network and we are immediately able to connect to them, we change their IP address to something other than 192.168.1.1 and bingo! we can use them and also are ready for another switch. All the managed switches and wifi switches in our campus wide network have static IP addresses.

For rest of our network we use classles 172.16-31.x.y addresses. These and the 192.168.x.y ones are fixed by IANA for local area network explicitly and there is no chance of conflict with any external IP addresses. Also there are firewall rules per VLAN using shorewall. Also we have some amount of traffic control and sharing, but we are yet to come up with optimal strategy to allow fair use of network bandwidth. As of now, the faculty uses the maximum chunk of bandwidth.

3 Layer 4 Networking

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Layer 4 concerns itself with the actual services. Since we decided to put our servers on linuxes, we also decided to only use open source software for all our needs.

For Internet sharing, we needed firewall, proxy caching server, dns service and a dhcp service. After carefully studying and testing (we tried quite a few alternatives), we went for shorewall as firewall for its versality, squid as proxy caching server because of its proven

Figure 5: Main Internet and Intranet Servers
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Figure 6: Servers for Clustering and GPU Processing
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robustness, bind as a dns service because we wanted to serve our internal computers as well as resolve our addresses for external computers and internet-dhcp-server because it did the job.

We registered the domain rkmvu.ac.in and gave the dns servers as our own servers, even though Ernet complained that we need to have functional dns servers before they gave us the domain. Anyway they registered the domain and put the IP addresses in the database as we told, our dns servers worked and everyone was happy. However having our own dns servers had one big advantage. We could use as many subsites we wanted, would resolve them using our dns servers to whatever IP we wanted and have valid redirections and routings. Thus with zero additional cost, we had domains cs.rkmvu.ac.in, cc.rkmvu.ac.in, phy.rkmvu.ac.in, maths.rkmvu.ac.in, sanskrit.rkmvu.ac.in, and even domains for offcampus websites, such as ranchi.rkmvu.ac.in and coimbatore.rkmvu.ac.in.

Thus we not only could have webserver at www.rkmvu.ac.in but we could also have webservers for several of our departments. The servers can be clearly seen in figures 5 and 6.

So, with some effort, we could have web service (apache), mail service (exim) and other services installed in the servers. The only major troubles that we faced where with mail services and the mailing list services. In the mail services, there were several servers that treated the NKN IP addresses as spam sources and therefore rejected our valid servers. Also google wanted a separate treatment, and also needed password authentication before mail transfer. We also needed to integrate exim with our light directory server. We also needed aliases, forwarding addresses, organizational roles and local delivery. This meant and still means that we had to highly customize our mail server. Of course we needed to customize each and every server according to need (does any server software ever work out of box in linux?), but customizing exim was a major challenge. This took double work because we first implemented everything in the mammoth and unmaintainable sendmail before trying exim (we also explored procmail).

We later on removed mailing list server because no one uses it. Well even with our major effort in mail server, very few people use official email addresses. Even the official university emails are given as both gmail and an rkmvu.ac.in one, of which people continue to prefer using the gmail address. In fact we have many services which took a lot of effort to install but few people use (instant messaging, time server, sogo, etc.), and quite a few services that people say they urgently need but we are lethargic to implement (backup

service). We have not yet implemented backup, possibly because people will still forgot to backup, and if we do automatic backup centrally, it will be huge data, because we will have to backup everything, both necessary and unnecessary data.