NM-Net Gigabit-based Implementation on Core Network Facilities and Network Design Hierarchy.

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Nuclear Malaysia computing network or NM-net has been gradually developed since 1990's. Since then it has been the main backbone of internetworking on the agency's IT infrastructure, serving users ranging from researchers to operational staffs. Main network operating center or NOC is situated in Block 15 and linkup via fiber cablings to adjacent main network blocks (18, 29, 11, 42 and 44-Dengkil) and later to other blocks enabling network connections. Pre 2009 infrastructure; the main core network has been built up form several switches uplinked together to form the core networking switch. Although this setup gives maintenance flexibility, the total performance of the core network infrastructure were limited by the uplink between core switches that is the Unshielded Twisted Pair (UTP) Category 6 Cable. Furthermore, majority of the networking infrastructure throughout the agency were mainly built with Fast Ethernet Based or 100Mbps based networking switch with inferior performance specifications to date. With current research and operational tasks highly dependent on IT infrastructure that is being enabled through NM-Net, the performance of the infrastructure are most critical. This paper will discuss NM-Net implementing gigabit-based networking system and performance network design hierarchy in order to achieve optimal performance of internetworking services in the agency thus catalyzing Nuclear Malaysia TSO initiative.

Keywords: Network Hierarchy, Gigabit, 10GbE, NM-NET

Introduction: NM-Net Infrastructure hierarchy and design

Nuclear Malaysia Network or NM-Net is a Local Area Network infrastructure comprising of the main Bangi and Dengkil Mint-Tech Park complex. It encompass of over 272 acre [1] of perimeter and consist of over 40 actively computer network connected blocks. NM-net are currently run on 115 network switches. It is currently connected to the internet through a 4Mbps dedicated line. In June 2011 additional internet line of 34Mbps to JARING were successfully deployed. It is currently being managed through 10 distinct VLAN, where network switches are manage through dedicated management VLAN. It is basically organized into three level of switches or distribution hierarchy; the Core, Distribution and the End User switch level. The Core level is the main network infrastructure built up by the main core switch facility. The Distribution switch level is divided into two types, which are the Main Distribution level and the Block Distribution level switch. The Main Distribution switches are the first level or the adjacent distribution switch connected directly to the core switch to enable networking within their respective zone. The Block Distribution level is the first main switch to enable computer networking within a particular block that is connected from the Main Distribution switch. While the End User level switch is the switches within a block connecting users to the network facility.

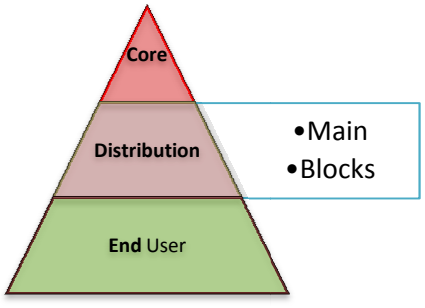

Figure 1. NM-net Switch Hierarchy

VLAN	Buildings/Block/Segments
1	Default VLAN
10	Dengkil Mint Tech
12	27,28,29(T),30,32,34
14	18,19,20,21,23,25, 26
16	10, 11, 12, 24
18	13, 15
150	Server Farm
160	Switches Management
170	Wireless
200	Security

Table 1. NM-net VLAN

Core networking facility is located in Block 15, Data Center Bangi complex. From Block 15, the network will be distributed to Main Distribution blocks that is Block 11, Block 18, Block 29 for Bangi Complex and Block 42 and 44 for Dengkil Complex. All connections to the Main Distributions are via fiber optic connections. These Main Distributions switch then form their respective distribution zone. Blocks distributions within their zone are connected to the Main Distribution switch and later to user distribution switches. Blocks and User Distribution level switches are connected either through fiber or UTP backbone cabling. UTP cables used for backbone cabling are primarily based on Category 5e or Cat5e cables. Basic topology or the network distribution in NM-net is star topology.

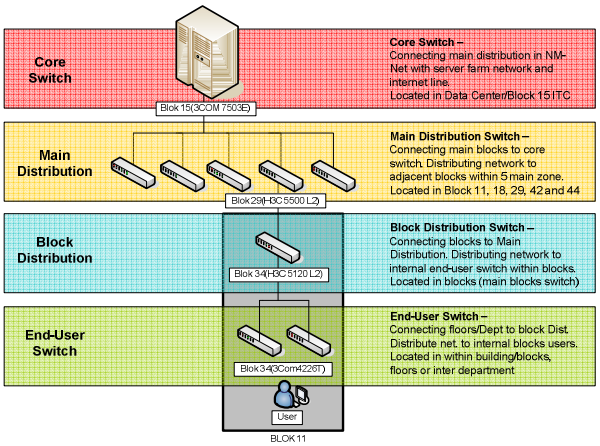

Figure 2 NM-net hierarchy explained.

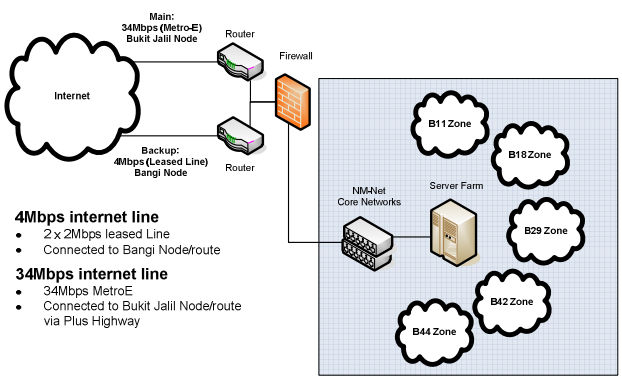

Figure 3 NM-net Distribution Zone

Core Switch facility

Prior to 2009, the setup was based on multiple switches built up to run the core network. It was built on 4 different switches uplinked together through fiber and UTP patch cords. The main switch in the core facility was the 3Com 5500G (performance rated with 240Gbps and 170Mpps)[2] and the other switches connected to it to form the core NM-net switch system. All the other switches have the performance rate between 56Gbps to 170Gbps for forward rate and 41Mpps to 130Mpps for switching rate[3][4]. The respective switches and their function are as follows:

Switch	Description	Uplink type
3Com 4950	Fiber interconnect switch, connection main distribution switch through Fiber module (GBIC)	Fiber
3Com 3300	Fiber interconnect switch, connection main distribution switch through Fiber module (GBIC)	Fiber
3Com 5500G	Fiber interconnect switch, connection main distribution switch through fiber with SFP module, UTP interconnect for main server farm connection	Fiber
HP Procurve 1800G	UTP interconnect for server farm connection	UTP

Table 2. Switch component prior to 2009 Network Core Switch System

- GBIC module = Gigabit Interface Converter [5]
- Mini GBIC or SFP module = Single Form-Factor Pluggable module [6]

The switches individually were not very obsolete in term of performance rate but the major fallback of this setup was at the inter-switch performance side. Although it has fiber and UTP Cat6 uplinks, the performance rate will be up to only 1Gbps. This means that users in NM-net, for an example from Dengkil complex connected through 3Com 4950 wanted to access the storage server in the server farm, that is through the 3Com 5500G were limited to 1Gbps performance channeled by the uplink limitation. This performance fallback will escalate when number of

users multiplied or application used, demand for network connection throughput performance ie. real-time streaming applications such video conferencing or performance based such as grid applications.

At the end of 2009 the core switch system has been upgraded to a chassis system, 3Com S7903E Core switch system. The functions of the previous multiple switches were replaced by modules within a chassis system. The modules include 24 Port for fiber connection using the latest fiber module connecter type; the SFP modules while for the server farm UTP connections were ported to 48 port gigabit UTP module. The modules are now connected through backplanes rather than UTP/Fiber uplinks, giving out performance up to 1Tbps. While for switching and forwarding rate has been nearly doubled; 240Gbps (single CPU) and 276Mpps [7]

Model	Status	Performance Rate			Function
		Max Forward rate	Max Swicthing rate	Interlink rate	
3Com Superstack III 4950	Discontinued	41.6Mpps	56Gbps	1Gbps (fiber patch cord)	Fiber interconnect switch, connection main distribution switch through GBIC interface and module
3 Com Superstack III 3300FX	Discontinued	1.3Mpps	2Gbps	1Gbps (fiber patch cord)	Fiber interconnect switch, connection main distribution switch through Fiber module
3Com 5500G (Loan Unit)	Discontinued	170Mpps	240Gbps	1Gbps (fiber patch cord)	Fiber interconnect switch, connection main distribution switch through SFP interface and module, UTP interconnect for main server farm connection
HP Procurve 1800G	Discontinued	35Mpps	48Gbps	1Gbps (UTP patch cord)	UTP interconnect for server farm connection
3Com 7903E	**New**	**274Mpps**	**240Gbps**	**1Tbps (Backplane)**	**All of the above**

Table 3. Comparison of previous core network switch system and the current system

Main Distributions and zone

NM-net main distribution switch are located at Block 11, Block 18, Block 29, Block 42 and 44. Within every main distribution zone, comprises of other network connected building blocks. Prior to 2010 switches for the main distribution switches was mainly Fast Ethernet or 100Mbps based. They are connected from the core network facility using fiber connections with 1Gbps for uplink but utilizing 100Mbps ports for user usage. The network switches deployed were the 3Com 4200 series. Performance for forward rate was 8 to 12Gbps and 6 to 9Mpps for switching rate.[8]

In 2010, the first phase project on enhancing NM-net distribution level networking facility was done. The project was to upgrade the previous network switches infrastructure for all main distribution level from 100Mbps based to Gigabit Ethernet (GbE) based. Several block distribution switch were also chosen to be upgraded in the first phase. Chosen criteria were based on load or number of user connecting to the switch and the obsolete state of the switch system. It was also mainly targeted to replace the existing GBIC based fiber connecting switches to the more up-to-date mini-GBIC or SFP supporting switches. Performance rating for the new main distribution switches is 176Gbps for forward and 130Mpps for switching rate while for block distribution switches ranging 128 to 170Gbps for forward rate and 95 to 130Mpps for switching rate.

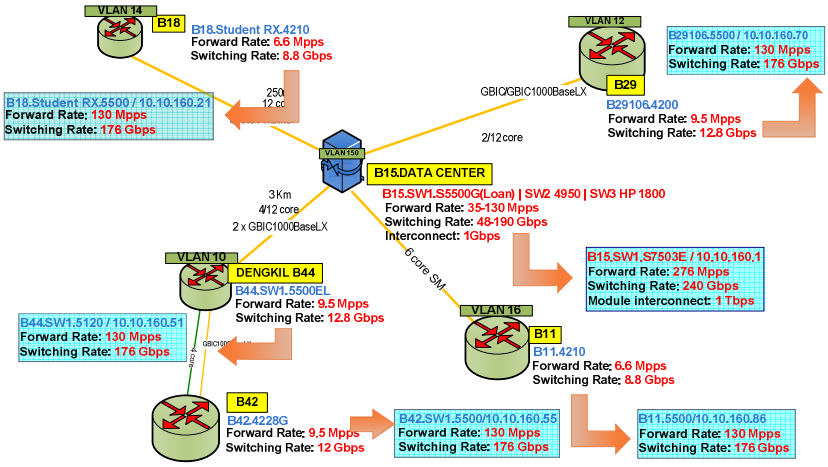

Figure 4. Core Switch and Main Distribution Switch Performance upgrade.

Future roadmap

In 2009, the first phase of facility upgrade was done on the core switch level, while in 2010; expansion of the gigabit network facility has been expanded to main distribution and critical block distribution level. The next upgrade will be further expansion of gigabit infrastructure throughout the agency computer network facility; it is planned within RMK10 period. The Core Switch is also planned to be enhanced with 10GbE modules and redundant system for high availability (two core switch system). CPU also will be upgraded from single CPU mode to Dual-CPU mode. This will provide twice the performance enhancement compared to the single CPU mode and redundant CPU properties for failure tolerant per core switch.

While for the Distribution switch level, upgrade will be on completing the Block Distribution level switches and End User level switches to adopt total gigabit based switches. The original plan was to rollout on 2011, but due to budget restriction the project is in KIV status. Other than that, the next level of network infrastructure upgrade targeted on 2012-2013 is on upgrading main distribution level facility to adopt 10 GbE network performances. The current switches via the latest upgrade on Main and major Block Distribution switches support 10GbE. The upgrade will include the modules for 10GbE mode enabling and probably some of the older or non compliant fiber cables connection on supporting the 10GbE mode to be upgraded also. But due budget allocation unpredictability lately, the status of the project was also been put in KIV status.

Quarter/year	NM-Net GbE facility initiative activity/planning	Status
Q3, 2009	Acquire Chasis based core switch - performance rating 274Mpps/240Gbps (Single CPU) with 1Tbps module interconnect	Done
Q1, 2010	Dedicated network switch VLAN	Done
Q3, 2010	Main and Block distribution switch upgrade to fully support GbE network and 10GbE ready	Done
Q4, 2010	Dedicated wireless network VLAN (Experimental)	Done
Q2, 2011	34Mbps Internet Line	Done
Q3, 2011	Firewall with GbE support, Bandwidth Managment	Planned
Q4, 2012	10GbE Core Switch, Dual CPU Mode,	Planned
Q3, 2012	End User distribution switch upgrade to fully support GbE network	Planned
Q3, 2013	10GbE Main Distribution Network	Planned
Q4, 2013	Dual Core Switch Facility Setup	Planned
Q2, 2014	2nd Internet Line proposed minimum of 50Mbps and MyREN 50Mbps	Planned

Table 4. NM-Net GbE network initiative

Conclusion

As user data multiplied to the fraction of gigabit and application have been increasingly complex relating workgroups or multiple users, they are becoming more dependent to run through computer networking system. The issue of network performance has been an issue that cannot be taken lightly anymore. Performance bottlenecks will be the main Achilles heel of a research facility such as Nuclear Malaysia on dealing massive data managed with IT system through a networking system infrastructure. In order to meet future demand and requirement for IT services that mainly run through the networking system for example GRID applications and massive centralized storage system, the current networking facility must develop through properly planned and structured with adequate either administrative or financial support. This will then leads to better infrastructure upgrade or development process giving the best performance and support for researcher and daily operational purposes for the agency initiative towards TSO.

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