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COURSE: **NETWORK DESIGN AND IMPLEMENTATION**

PROJECT 2

REPORT

This is the report for the project and it is divided into 2 parts; the design evaluation (proposed network design, performance, scalability and security) and details about the project.

PROPOSED NETWORK DESIGN

The design used is a Collapsed Core Campus design (Tier-2) which makes use of access layer switches and distribution layer switches in each building with the necessary number of routers per building and per campus.

PERFORMANCE

This design is meant to bring forth a highly powerful network that is always performing the expected way.

SCALABILITY

Thanks to the use of access and distribution layer switches, together with VLANs and VLAN Trunking, any increase in the size of the university will not be a problem as the design takes into consideration a possible large increase of devices in the future with negatively impacting the current state.

SECURITY

Thanks to VLANs and the port-security feature of switches, the network is quite secure.

A. PLANNING

ENTITIES

- 2 campuses (main and small)
- 4 buildings (3 in main and 1 in small)
- Departments (4)

- Faculties (4)
- Administrative staff PCs (in departments)
- Staff PCs (in faculties)
- Students' lab PCs (in faculties and some buildings)

DEPARTMENTS

- Management (mgt)
- Human Resource (hr)
- Finance (fin)
- IT (it)

FACULTIES

- Arts and Design (fad)
- Business (fb)
- Engineering and Computing (fec)
- Health and Sciences (fhs)

MAIN CAMPUS

1. Building A
- 1 access switch per floor
- 1 distribution switch
- 1 router
- N administration staff PCs (mgt, hr, fin)
- N fb staff PCs
- N fb student PCs
- N network resources (e.g printer)
2. Building B
- 1 access switch per floor
- 1 distribution switch
- 1 router
- N fec staff PCs
- N fec student PCs
- N fad staff PCs
- N fad student PCs
3. Building C
- 1 access switch per floor
- 1 distribution switch
- 1 router
- N administration staff PCs (it)
- N student lab PCs
- N web servers

SMALL CAMPUS

1. Building D

- 1 access switch per floor
- 1 distribution switch
- 1 router
- N fhs staff PCs
- N fhs student PCs
- N student lab PCs

B. DESIGN (HIGH-LEVEL)

LAYER 1

- Tier-2 design (access and distribution switches)
- Ethernet standard (802.3)

LAYER 2

- VLANs
- Vlan 1 for network resources (nr e.g printers)
- Vlan 2 for mgt
- Vlan 3 for hr
- Vlan 4 for fin
- Vlan 5 for it
- Vlan 6x for fb
- Vlan 7x for fec
- Vlan 8x for fad
- Vlan 9x for fhs

Note: "x" can be any positive integer with zero included e.g. 0, 1, 2 etc.

LAYER 3

- Classful IP network: 10.0.0.0/8
- Assuming number of devices for each campus to be > 65000
- N=8, S=8, H=16 (2^16 >= 65000)
i. SUBNETS
- 10.1.0.0/16 for network resource like printers, servers etc. (vlan 1)
- 10.2.0.0/16 for mgt (vlan 2)
- 10.3.0.0/16 for hr (vlan 3)
- 10.4.0.0/16 for fin (vlan 4)
- 10.5.0.0/16 for it (vlan 5)
- 10.6.0.0/16 for fb (vlan 6x)
- 10.7.0.0/16 for fec (vlan 7x)
- 10.8.0.0/16 for fad (vlan 8x)
- 10.9.0.0/16 for fhs (vlan 9x)
- 10.10.0.0/16 for WAN links (router-to-router segments)
- 10.11.0.0/16 for student labs not found in faculties

Note 1:

The "x" in "vlan 6x" and others represents a number (0 or 1) for staff PCs or student PCs respectively.

The first "y" below is 10 while the "z" could be anything from 6 to 9 inclusive.

   a. y.z.0.0/24 is reserved for staff PCs
   b. y.z.1.0/24 to y.y.10.0/24 is reserved for student PCs
   c. Any other ip subnet not used is reserved for future use (staff or student)

Note 2:

   a. Network resources in Building A will use ip subnet 10.1.1.0/24
   b. Network resources in Building B will use ip subnet 10.1.2.0/24
   c. Network resources in Building C will use ip subnet 10.1.3.0/24
   d. Network resources in Building D will use ip subnet 10.1.4.0/24
   e. 10.1.5.0/24 is used for the cloud service having the email server (added as a static route to routers which are not MCROUTER)

Note 3:

Routers will use ROAS (router-on-a-stick) to enable inter-vlan communication.

C. DESIGN (LOW-LEVEL)

Main Campus

Building A

The hosts in this building get their ip addresses from the building's router which is DHCP-based.

Below are the configurations for the router, access switches, distribution switches, PCs and network resources in this building:

Router A

Interfaces

Interface Gi0/0/0

   - No ip address configured here as sub-interfaces will be used

Sub-interfaces (ip address *sub-address netmask)*

Interface Gi0/0/0.1

   - 10.1.1.1/24
   - Encapsulation dot1q
   - Vlan 1 (nr)

Interface Gi0/0/0.2

- 10.2.0.1/16
- Encapsulation dot1q
- Vlan 2 (mgt)

Interface Gi0/0/0.3

- 10.3.0.1/16
- Encapsulation dot1q
- Vlan 3 (hr)

Interface Gi0/0/0.4

- 10.4.0.1/16
- Encapsulation dot1q
- Vlan 4 (fin)

Interface Gi0/0/0.60

- 10.6.0.1/24
- Encapsulation dot1q
- Vlan 60 (fb-staff)

Interface Gi0/0/0.61

- 10.6.1.1/24
- Encapsulation dot1q
- Vlan 61 (fb-student)

Interface S0/1/0

- 10.10.0.2/24
- IP subnet between Router A and main campus router (MCROUTER)

RIPv2

- Global: **router rip**
- RIP sub: **version 2**
- **RIPv2**
- Global: **router rip**
- RIP sub: **version 2**
- RIP sub: **network** *subnet-id (e.g 10.1.1.0)*
- RIP sub: no auto-summary (to disable RIPv2 automatic route summarization)
- Global: ip routing

DHCP CONFIGURATION (For each subnet in Building A)

- Global: **ip dhcp excluded-address** *first last (e.g 10.1.1.1 10.1.1.49)*

- Global: **ip dhcp pool** *name*
- DHCP POOL: **network** *subnet-id netmask*
- DHCP POOL: **default-router** *address1 address2...*
- DHCP POOL: **dns-server** *address1 address2...*
- DHCP POOL: **lease** *days hours minutes*

Note: The first 50 addresses will be excluded by default e.g 10.1.1.1 to 10.1.1.50

DSwitch A (Distribution Switch)

Interfaces

Interface Fa0/1

- Vlan trunking enabled

Interface Fa0/2

- Vlan trunking enabled

Interface gi0/1

- Vlan trunking enabled

Note: Always create the VLANs and allow them to be forwarded on the trunk segments using the interface subcommand (switchport trunk allowed vlan add x) for the distribution switches.

ASwitch A1 (Access Switch)

Interface Fa0/1

- Port security, Vlan 2, switchport mode access

Interface Fa0/2

- Port security, Vlan 3, switchport mode access

Interface Fa0/3

- Port security, Vlan 4, switchport mode access

Interface Fa0/4

- Port security, Vlan 60, switchport mode access

Interface Fa0/5

- Port security, Vlan 61, switchport mode access

Interface Fa0/6

- Port security, Vlan 1, switchport mode access

Interface Fa0/24

- switchport mode trunk

ASwitch A2 (Access Switch)

Interface Fa0/1

- Port security, Vlan 2, switchport mode access

Interface Fa0/2

- Port security, Vlan 3, switchport mode access

Interface Fa0/3

- Port security, Vlan 4, switchport mode access

Interface Fa0/4

- Port security, Vlan 60, switchport mode access

Interface Fa0/5

- Port security, Vlan 61, switchport mode access

Interface Fa0/6

- Port security, Vlan 1, switchport mode access

Interface Fa0/24

- switchport mode trunk

CLOUD SERVICE FOR EMAIL SERVER

- DSL used
- Server used (10.1.5.2)
- Cloud-PT model

Building B

Router B

Interface Gi0/0/0

- No ip address configured here as sub-interfaces will be used

Sub-interfaces (ip address *sub-address netmask)*

Interface Gi0/0/0.1

- 10.1.2.1/24
- Encapsulation dot1q
- Vlan 1 (nr)

Interface Gi0/0/0.70

- 10.7.0.1/24
- Encapsulation dot1q
- Vlan 70 (fec-staff)

Interface Gi0/0/0.71

- 10.7.1.1/24
- Encapsulation dot1q
- Vlan 71 (fec-student)

Interface Gi0/0/0.80

- 10.8.0.1/24
- Encapsulation dot1q
- Vlan 80 (fad-staff)

Interface Gi0/0/0.81

- 10.8.1.1/24
- Encapsulation dot1q
- Vlan 81 (fad-student)

Interface S0/1/0

- 10.10.1.2/24
- IP subnet between Router B and main campus router (MCROUTER)

RIPv2

- Global: **router rip**
- RIP sub: **version 2**
- RIP sub: **network** *subnet-id (e.g 10.1.1.0)*
- RIP sub: no auto-summary (to disable RIPv2 automatic route summarization)
- Global: ip routing

DSwitch B (Distribution Switch)

Interfaces

Interface Fa0/1

- Vlan trunking enabled

Interface Fa0/2

- Vlan trunking enabled

Interface gi0/1

- Vlan trunking enabled

Note: Always create the VLANs and allow them to be forwarded on the trunk segments using the interface subcommand (switchport trunk allowed vlan add x) for the distribution switches.

ASwitch B1 (Access Switch)

Interface Fa0/1

- Port security, Vlan 70, switchport mode access

Interface Fa0/2

- Port security, Vlan 80, switchport mode access

Interface Fa0/3

- Port security, Vlan 71, switchport mode access

Interface Fa0/4

- Port security, Vlan 81, switchport mode access

Interface Fa0/24

- switchport mode trunk

ASwitch B2 (Access Switch)

Interface Fa0/1

- Port security, Vlan 70, switchport mode access

Interface Fa0/2

- Port security, Vlan 80, switchport mode access

Interface Fa0/3

- Port security, Vlan 71, switchport mode access

Interface Fa0/4

- Port security, Vlan 81, switchport mode access

Interface Fa0/24

- switchport mode trunk

Building C

Router C

Interface Gi0/0/0

- No ip address configured here as sub-interfaces will be used

Sub-interfaces (ip address *sub-address netmask)*

Interface Gi0/0/0.1

- 10.1.3.1/24
- Encapsulation dot1q
- Vlan 1 (nr)

Interface Gi0/0/0.5

- 10.5.0.1/16
- Encapsulation dot1q
- Vlan 5 (it)

Interface Gi0/0/0.11

- 10.11.1.1/24
- Encapsulation dot1q
- Vlan 11 (student-lab)

Interface S0/1/0

- 10.10.2.2/24
- IP subnet between Router C and main campus router (MCROUTER)

RIPv2

- Global: **router rip**
- RIP sub: **version 2**
- RIP sub: **network** *subnet-id (e.g 10.1.1.0)*
- RIP sub: no auto-summary (to disable RIPv2 automatic route summarization)
- Global: ip routing

DSwitch C (Distribution Switch)

Interfaces

Interface Fa0/1

- Vlan trunking enabled

Interface Fa0/2

- Vlan trunking enabled

Interface gi0/1

- Vlan trunking enabled

Note: Always create the VLANs and allow them to be forwarded on the trunk segments using the interface subcommand (switchport trunk allowed vlan add x) for the distribution switches.

ASwitch C1 (Access Switch)

Interface Fa0/1

- Port security, Vlan 5, switchport mode access

Interface Fa0/2

- Port security, Vlan 5, switchport mode access

Interface Fa0/3

- Port security, Vlan 11, switchport mode access

Interface Fa0/4

- Port security, Vlan 11, switchport mode access

Interface Fa0/24

- switchport mode trunk

ASwitch C2 (Access Switch)

Interface Fa0/1

- Port security, Vlan 1, switchport mode access

Interface Fa0/2

- Port security, Vlan 1, switchport mode access

Interface Fa0/24

- switchport mode trunk

Main Campus Router (MCROUTER)

Interfaces

Gi0/0/0

- 10.1.5.1/24 (connected to the DSL for accessing the cloud-based email server)

S0/1/0

- 10.10.0.1/24 (connected to Building A's router)

S0/1/1

- 10.10.1.1/24 (connected to Building B's router)

S0/2/0

- 10.10.2.1/24 (connected to Building C's router)

S0/2/1

- 10.10.3.1/24 (connected to small campus)

RIPv2

- Global: **router rip**
- RIP sub: **version 2**
- RIP sub: **network** *subnet-id (e.g 10.1.1.0)*
- RIP sub: no auto-summary (to disable RIPv2 automatic route summarization)
- Global: ip routing

Small Campus

Building D

Router D

Interface Gi0/0/0

- No ip address

Interface Gi0/0/0.90

- 10.9.0.1/24
- Encapsulation dot1q
- Vlan 90 (fhs-staff)

Interface Gi0/0/0.91

- 10.9.1.1/24
- Encapsulation dot1q

- Vlan 91 (fhs-student)

Interface Gi0/0/1

- 10.10.4.2/24
- IP subnet between Router D and main campus router (MCROUTER)

RIPv2

- Global: **router rip**
- RIP sub: **version 2**
- RIP sub: **network** *subnet-id (e.g 10.1.1.0)*
- RIP sub: no auto-summary (to disable RIPv2 automatic route summarization)
- Global: ip routing

DSwitch D (Distribution Switch)

Interfaces

Interface Fa0/1

- Vlan trunking enabled

Interface Fa0/2

- Vlan trunking enabled

Interface gi0/1

- Vlan trunking enabled

Note: Always create the VLANs and allow them to be forwarded on the trunk segments using the interface subcommand (switchport trunk allowed vlan add x) for the distribution switches.

ASwitch D1 (Access Switch)

Interface Fa0/1

- Port security, Vlan 91, switchport mode access

Interface Fa0/2

- Port security, Vlan 91, switchport mode access

Interface Fa0/24

- switchport mode trunk

ASwitch D2 (Access Switch)

Interface Fa0/1

- Port security, Vlan 90, switchport mode access

Interface Fa0/2

- Port security, Vlan 90, switchport mode access

Interface Fa0/24

- switchport mode trunk

Small Campus Router (SCROUTER)

Interfaces

S0/1/0

- 10.10.3.2/24 (connected to MCROUTER)

Gi0/0/0

- 10.10.4.1/24 (connected to small campus)

RIPv2

- Global: **router rip**
- RIP sub: **version 2**
- RIP sub: **network** *subnet-id (e.g 10.1.1.0)*
- RIP sub: no auto-summary (to disable RIPv2 automatic route summarization)
- Global: ip routing