Multi-Service ISP infrastructure documentation

BIT is an Internet service provider located in The UK. It has branches in London and Sheffield with its main office in Manchester. BIT offers infrastructures that allow its customers to route Data and Voice from one end to the other and also deal with Cable TV and 3G/2g mobile service.

BIT Core service network made up of routers and switches running different routing protocols, is separated from its operational network which connect to the core from its three (3) offices.

Each office is design as fallow:

Manchester (Head Office)

Manchester runs a local area network segmented in multiple smaller network (7 of which are represented in the simulation). The infrastructure is made up of:

- A Router also used as a CUCM (Cisco Unified Communicator Manager) to manage the company internal telephony service.
- Two (2) Layer 3 and three (3) layer 2 switches to manage the company's department
- A few servers to
- Several end point devices (Computers, phones and printers)

The internal network uses the private IP range 172.17.0.0/16 and 100.3.77.0/29 to the public and devices configuration are detailed in table 1 below

Table 1 BITHQ IP Address table

BIT Headquarter devices configuration

Device	Interface	IP Address	Mask	Default Gateway	F-R DLCI
BITHQ	S0/0/0	100.3.50.1	255.255.255.252		102
	S0/0/1	100.3.50.5	255.255.255.252		103
	FA0/0.300	172.17.3.254	255.255.255.0		
	FA0/0.400	172.17.4.254	255.255.255.0		
	FA0/1.50	172.17.50.254	255.255.255.0		
	FA0/1.150	172.17.150.254	255.255.255.0		
	FA0/1.200	172.17.2.254	255.255.255.0		
	FA0/1.500	172.17.5.254	255.255.255.0		
	FA0/1.999	172.17.9.254	255.255.255.0		
BITDLS1	VLAN 999	172.17.9.1	255.255.255.0	172.17.9.254	
BITDLS2	VLAN 999	172.17.9.2	255.255.255.0	172.17.9.254	
BITFL2	VLAN 999	172.17.9.3	255.255.255.0	172.17.9.254	
BITFL1	VLAN 999	172.17.9.4	255.255.255.0	172.17.9.254	
BITFL0	VLAN 999	172.17.9.5	255.255.255.0	172.17.9.254	

All data communication, except the servers use the exit interface of BITHQ facing the ISP for external communication. This is done by implementing NAT (Network address translation). The Servers offering services like Http, DNS have their private IP translated using Static NAT

The distribution switch BITDLS1 is set has the VTP server and is manually configured with the below VLAN

Table 2 VLANS

VLAN	Name	Network
VLAN 99	Unused	
VLAN 999	Management	172.17.9.0 /24
VLAN 150	Voice	172.17.150.0 /24
VLAN 50	Servers	172.17.50.0 /24
VLAN 100	IT/Support	172.17.1.0 /24
VLAN 200	Sales/Support	172.17.2.0/24
VLAN 300	Accounting	172.17.3.0 /24
VLAN 400	HR	172.17.4.0 /24
VLAN 500	Logistic	172.17.5.0 /24

All other Switches in the network act as client to the BITDLS1 with the domain ***bithq*** and password ***bitpass***.

Telephony

BIT is assigned the telephone number with prefix ***20211xxx***. The 3 xs represent the extension are set to match BIT employees with their department VLAN number. For example someone working in accounting which is assign the VLAN 200 will have a number that looks like ***20211201.***
Each IP Phone is assigned an IP address to allow call routing. In order to route call outside the network, the telephony LAN uses the public **IP 100.3.77.3.**

The design and implementation is straight forward using the logic and information above.

London (South Office)

Less complex than the head office, the London office is connected to the backbone via DSL (Digital Subscriber Line). Similar to The head office it uses a Router to manage interconnection between its office VLANs and is assign the public **IP 100.3.77.12/30** which will be used for its servers and External voice network routing. Any other service uses the exit interface IP address which is assigned through DHCP from the ISP side.

The telephone prefix used in London is ***202122xx***

Table 3 London VLANs

VLAN 100	IT/SUPPORT	192.168.100.0	255.255.255.0
VLAN 150	VOICE	192.168.150.0	255.255.255.0

Table 4 London Address Table

BIT South devices configuration				
Device	**Interface**	**IP Address**	**Mask**	**Default Gateway**
BITSouth	Fa0/0	DHCP		12.112.212.1
	FA0/1.100	192.168.100.254	255.255.255.0	
	FA0/0.150	192.168.150.254	255.255.255.0	

Sheffield (East Office)

Exact replica of the London office except for the IP Address:

- Public 100.3.77.8/30
- Private 192.168.0.0/16
- Telephone prefix ***202122xx***

Table 5 East VLANS

VLAN 100	IT/SUPPORT	172.17.100.0	255.255.255.0
VLAN 150	VOICE	172.17.150.0	255.255.255.0

Table 6 BIT South Addressing Table

BIT East devices configuration				
Device	**Interface**	**IP Address**	**Mask**	**Default Gateway**
BITEast	Fa0/0	DHCP		12.112.212.1
	FA0/1.100	172.17.150.254	255.255.255.0	
	FA0/0.150	172.17.100.254	255.255.255.0	

BIT Service Provision configuration

The internet is made up of several devices (mostly switches and routers) which are configured to route information from one end to the other. Each device is owned and managed by entities such as internet service providers. In this simulation we will be dealing with BIT devices.

In a typical environment, the infrastructure will be more complex than BIT's network with some companies managing thousands of devices across large areas. More modest providers will not owe a device but will rather lease ports and managed users connecting to these ports. ISPR2 has its Fast Ethernet port 0/0 dedicated to the FoneGroup and will be used to serve FoneGroup customers (See FoneGroup session).

The BIT infrastructure is made up of:

- 2 Routers (ISPR1 & ISPR2) and
- 5 Frame-Relay Switches (ISP1, 2, 3, 4 AND 5)

The devices are configured with switching and routing protocols allowing for the transfer of Data and voice to and from each end of the network

Table 7BIT ISP devices configuration

BIT ISP devices configuration

Device	Interface	IP Address	Mask	Default Gateway	F-R DLCI
ISPR1	S0/0/0	100.3.50.2	255.255.255.252		201
	S0/0/1	100.3.50.10	255.255.255.252		204
	S0/1/0	100.3.50.18	255.255.255.252		205
	S0/1/1	100.1.50.1	255.255.255.252		
	FA0/0	12.112.212.1	255.255.255.240		
	FA0/1	12.112.212.17	255.255.255.248		
	FA1/0	200.100.50.1	255.255.255.0		
	FA1/1	80.18.28.1	255.255.255.0		
ISPR2	S0/0/0	100.3.50.6	255.255.255.252		301
	S0/0/1	100.3.50.14	255.255.255.252		304
	S0/1/0	100.3.50.22	255.255.255.252		305
	S0/1/1	100.1.50.2	255.255.255.252		
	FA0/0.10	50.30.10.1	255.255.255.192		
	FA0/0.20	50.30.10.65	255.255.255.192		
	FA0/0.99	50.30.20.1	255.255.255.252		

Table 8 ISP1 Switch

BIT ISP1 Frame relay configuration

From	Sublink	To	Sublink	Description
Serial0	BITHQ-ISPR1	Serial2	ISPR1-BITHQ	Links BIT to its ISP First Router
Serial1	BITHQ-ISPR2	Serial3	ISPR2-BITHQ	Links BIT to its ISP Second Router

Table 9 ISP2 Switch

BIT ISP2 Frame relay configuration

From	Sublink	To	Sublink	Description
Serial0	ABCHQ-ISPR1	Serial2	ISPR1-ABCHQ	Link BIT ISP1 to ABC
Serial1	ABCHQ-ISPR2	Serial3	ISPR2-ABCHQ	Link BIT ISP2 to ABC

Table 10 ISP3 Switch

BIT ISP3 Frame relay configuration

Interface	Service Type	Description
FastEhernet5	Cable Modem	Internet service to London (South) customers
FastEthernet6	Cable Modem	Internet service to Sheffield (East) customers

Table 11 ISP4 Switch

BIT ISP4 Frame relay configuration

From	Sublink	To	Sublink	Description
Serial0	CityBank-ISPR1	Serial2	ISPR1-CityBank	Link BIT ISP1 to CityBank
Serial1	CityBank-ISPR2	Serial3	ISPR2-CityBank	Link BIT ISP2 to CityBank
FastEhernet8	Cable Modem	TV Line		

Table 12 ISP5 Switch

BIT ISP Frame relay configuration

Interface	Service Type	Description
FastEhernet0	DSL	Internet service to London (South) customers
FastEthernet1	DSL	Internet service to Sheffield (East) customers

Customers side links

ISP exists to offer connectivity to the customers wishing to use the internet. As such, they services stop at the customer premise. In the topology, each customer premise equipment has its FastEthernet0/0 port facing the ISP. The ISP routers are configured with DHCP (Dynamic Host Configuration Protocol) to serve its customer with a Public IP address to access the internet.

Whatever happens beyond that point is usually dealt with by the customer. Some ISP offer service beyond this point however these will not be discussed here.

ISP Franchise (FoneGroup)

FoneGroup represents a service provider who uses BIT infrastructure to deliver services to its customers. To achieve that, FoneGroup leases one (1) or several ports from a Layer 3 device in BIT ISP network to which it connect its own Switch.

- BIT ISPR2 FastEthernet 0/0 port is leased to the FoneGroup and, in this topology is sub-interfaced with enable IEEE 802.1Q encapsulation to multiple networks.
  FoneGroup in this part of the network is leasing 3 IP network:
  1. 50.30.10.0/26
  2. 50.30.10.64/26
  3. 50.30.20.0/30
- At FoneGroup site, the Switch is configured to serve these multiple network using VLAN and in turn connect to a frame relay switch to which its customers connect. Each customers is assigned a public IP Address depending on which port its equipment is connected to

Customer device IP Addressing

Table 13 Customer devices IP Addresses

Customer	IP Address	Mask

ABCHQ	100.3.50.9	255.255.255.252
	100.3.50.13	255.255.255.252
CITYBANK	100.3.50.17	255.255.255.252
	100.3.50.21	255.255.255.252
ABC Enterprise	DHCP	
FoneGroup Corporate	DHCP	
FoneGroup Franchise	DHCP	
Elms&Co	DHCP	
P&T Boutique	DHCP	

Protocols used

Each protocol and technology used in the topology can be further researched for educational purpose through the intent. Each technologies come pack with capabilities, most of which are not supported with packet tracer.

- **BGP**
  The ISP connects to every edge routers using Border Gateway Protocol. It is the standard protocol for routing information from different autonomous systems. Our topology is made up of different Autonomous Systems (AS) representing the different corporate organisation connected to each other using the BIT infrastructure. In most cases, BGP will be used between ISPs.
- **EIGRP**
  Extended Gateway Routing Protocol is used at BITHQ. Although it is not entirely needed, it was configured to be used for the BIT network extension
- **FRAME-RELAY**
  Frame-relay is used to govern the physical connection between BIT ISP and corporate client's routers
- **DHCP**
  Help in the assignment of IP Addresses dynamically in most parts of the network
- **NAT**
  Network Address Translation helped independent networks with private non routable IP addresses to be translated to public address for internet connectivity
- **VLAN**
  Help break large networks in smaller one and separate them. The BIT network was VLAN to represent the different departments in the organisation.
- **VTP**
  VLAN Trunking Protocol is used to propagate VLANs from one switch to the other
- **ETHERCHANNEL**
  Used to aggregate the distribution switches port into a single layer 2 port channel
- **TELEPHONY SERVICE**
  Due to the limitation in VoIP commands in Packet Tracer, a basic telephony service was used to demonstrate telephony service between sites through the internet.