

The background features a complex geometric design with overlapping gray and black triangles and lines. A prominent yellow line curves across the upper half, while several white lines intersect at various angles. A small globe icon is positioned to the left of the main text.

Broadband-Wireline Technologies

**Faculty of Network Planning
ALTTC, Ghaziabad.**



Existing Internet Service

Categorized as Narrowband Service:

- Dial up Internet Service (PSTN + ISDN)
- Direct Internet Access Service (DIAS)
- CLI based Accountless Internet Service
- Internet Leased Line Service



What is Broadband?

As per TRAI:

Broadband is an “An always-on data connection that is able to support interactive services, and has the capability of minimum download speed of 256 kbps”

Note: This definition for throughput may undergo upward changes in the future.



Advantages of Broadband

- **Always on (Not on shared media)**
- **Fast (speed ranging from 256 kbps to 2 Mbps)**
- **No disconnection**
- **No additional access charge**
- **Telephone and Data simultaneously**
- **Fat pipe has to be continuously supplemented with value added applications to enjoy the advantage.**



Digital Subscriber Line (DSL)



xDSL Family Tree

- xDSL
 - Symmetric DSL
 - Provide identical data rates upstream & downstream
 - Asymmetric DSL
 - Provide relatively lower rates upstream but higher rates downstream
- Four main variations of xDSL exist:
 - ADSL-Asymmetrical Digital Sub's Line
 - HDSL-High bit/data rate Digital Sub's Line
 - SDSL-- Symmetric Digital Sub's Line
 - VDSL-Very-high-data-rate Digital Sub's Line



DSL Technology

- DSL may offer more than 100 times the network performance of a traditional analog modem
- Precise speed of a connection depends upon the type of DSL employed
- DSL uses the same telephone line as traditional modem
- Provides simultaneous access to Web & Telephone removing the need for a second telephone line.



DSL Technology

- DSL remains **always-on** all the time
 - Customer no longer need to physically dial up to the ISP to “log in to the internet”
- On power failure, telephone line is still available like a standard telephone line.
- DSL can also be implemented with PPOE (Point to Point Protocol over Ethernet) that does not support always-on. This is required when authentication is necessary. PPPoE can be configured in PC or it can be configured in ADSL modem itself.



ADSL

- Asymmetric Digital Subscriber Line
 - G.DMT / G.992.1 standard
 - Used for applications which require greater download bandwidth but require relatively little in opposite direction like Web browsing; File downloads etc.
 - An ADSL circuit connects an ADSL modem on each end of a twisted pair telephone line creating three information channels
 - A high speed downstream channel
 - A medium speed duplex channel for both upstream & downstream applications
 - A basic telephone service channel



ADSL

- The basic telephone service channel is split off from the digital modem by splitter at client site
- Allows simultaneous access of the line by the telephone and the computer
- In case of power/ADSL failure, data transmission is lost but basic telephone service will be operational
- Provides
 - 16-640 kbps upstream
 - 1.5-9 mbps downstream
- Can work up to a distance of 3.7 to 5.5 kms



ADSL

- Data Rate - Wire Size – Distance

Data Rate	Wire Size	Distance	
1.5-2.0 Mbps	0.5 mm	18000 Feet	5.5 Kms
1.5-2.0 Mbps	0.4 mm	15000 Feet	4.6 Kms
6.1 Mbps	0.5 mm	12000 Feet	3.7 Kms
6.1 Mbps	0.4 mm	9000 Feet	2.7 Kms



ADSL 2

- Second generation of ADSL
- G.DMT.bis or G.992.3 standard
- Offers a greater data rates of 15 Mb/s downstream and upto 1.5 Mb/s upstream with a range of 6.4 Kms
- Has two power management modes (L2 mode for power saving at ATU-C by rapidly entering and exiting low power mode based on internet traffic over the connection)and L3 mode for overall power saving at both ATU-C and ATU-R by entering into sleep mode) that help reduce power consumption



ADSL 2...contd.

- Supports seamless adaptation of data rate in real time to meet the changing line conditions
- Fast start up i.e.Reduced initialization time from 10 secs to 3 secs.
- Data rates can be increased by bonding multiple phone lines (2 or more copper pairs) together.



ADSL 2 +

Second generation of ADSL

- G.992.5 standard
- Doubles the max. frequency used for downstream data transmission from 1.1 Mhz to 2.2 Mhz.
- Offers a greater data rates of 25 Mb/s downstream and upto 1.5 Mb/s upstream. Can work upto 6.3 Kms with reduced data rates
- Has all the other benefits of ADSL 2 like improved power management , seamless adaptation of data rate in real time to meet the changing line conditions, bonding of copper pairs for higher data rates etc.



ADSL

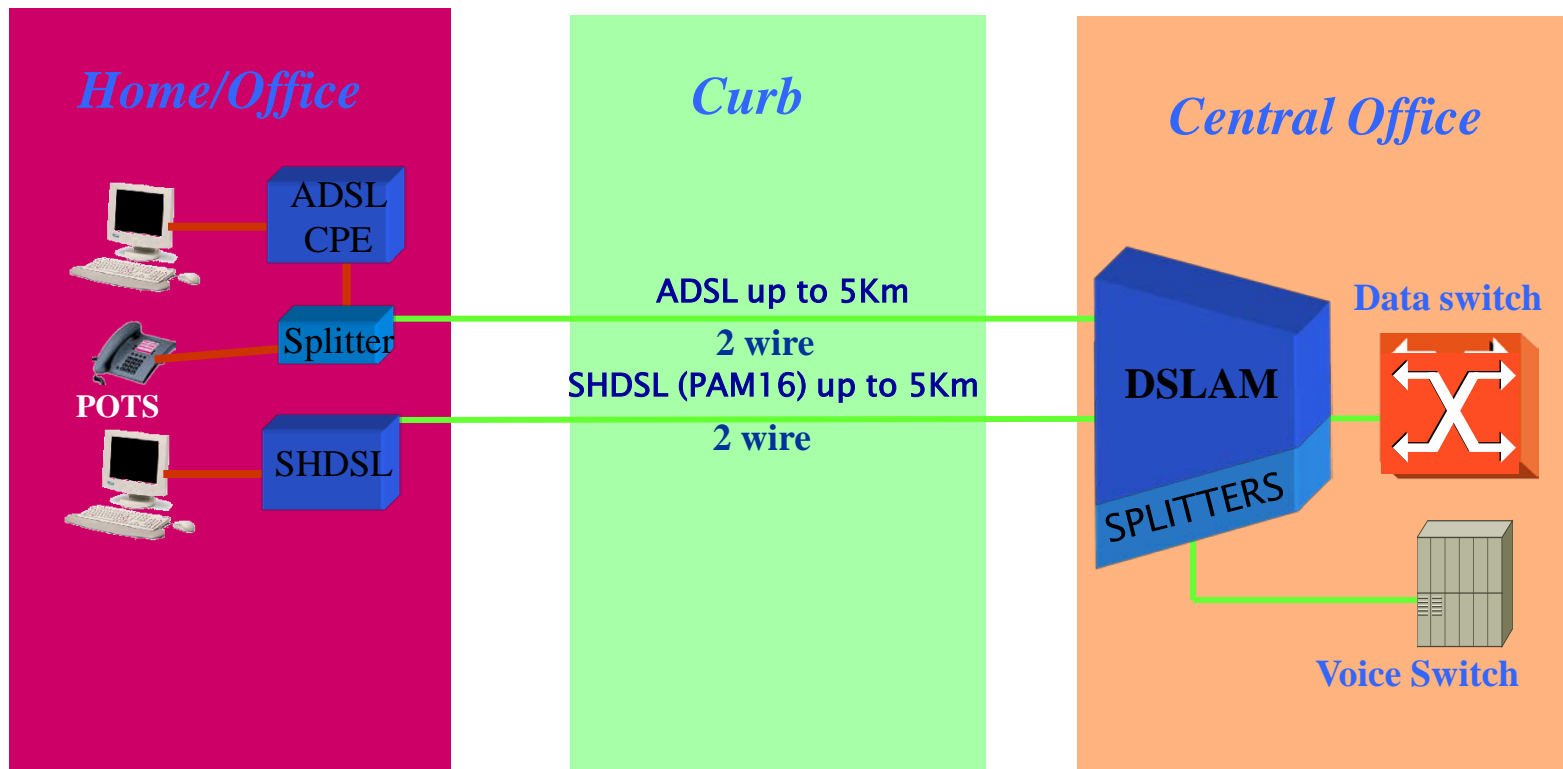
Family	Description	Upstream Rate	Down stream Rate	Max. range	
ADSL	G.992.1 / G.DMT	640 KBps	8 MBps	5.5 Km	June 1999
ADSL Lite	G.992.2 / G.Lite	384 KBps	2 MBps	6Km	
ADSL2	G.992.3 / G.dmt.bis	1-1.5 MBps	12-16 MBps	5.7 Km	July 2002
ADSL2 Lite	G.992.4 / G.lite.bis				
ADSL2 +	G.992.5 / ADSL 2 plus	1 MBps	26 MBps	5.7 Km	May 2003
ADSL2 RE	G.992.3 Reach Extended	1MBps	12 MBps	7Km	



ADSL APPLICATIONS

- Internet access (SOHO)
- LAN Access (Telecommuting)
- Distance Learning
- Tele-medicine
- Broadcast TV
- Home shopping
- Interactive Games
- Movies

ADSL Deployment Today





DMT Modulation

- Discrete Multi-Tone modulation
 - Evolved from the concept of operating an array of N relatively low-rate transceivers in parallel to achieve an overall high rate on one line
 - The N low-rate information streams are kept separated from one another by sending them over N separate frequency sub-bands or sub-channels, also called sub-carriers.
 - DMT achieves this sub-channel arraying by utilising the IFFT (Inverse Fast Fourier Transform) and its counterpart, the FFT (Fast Fourier Transform)

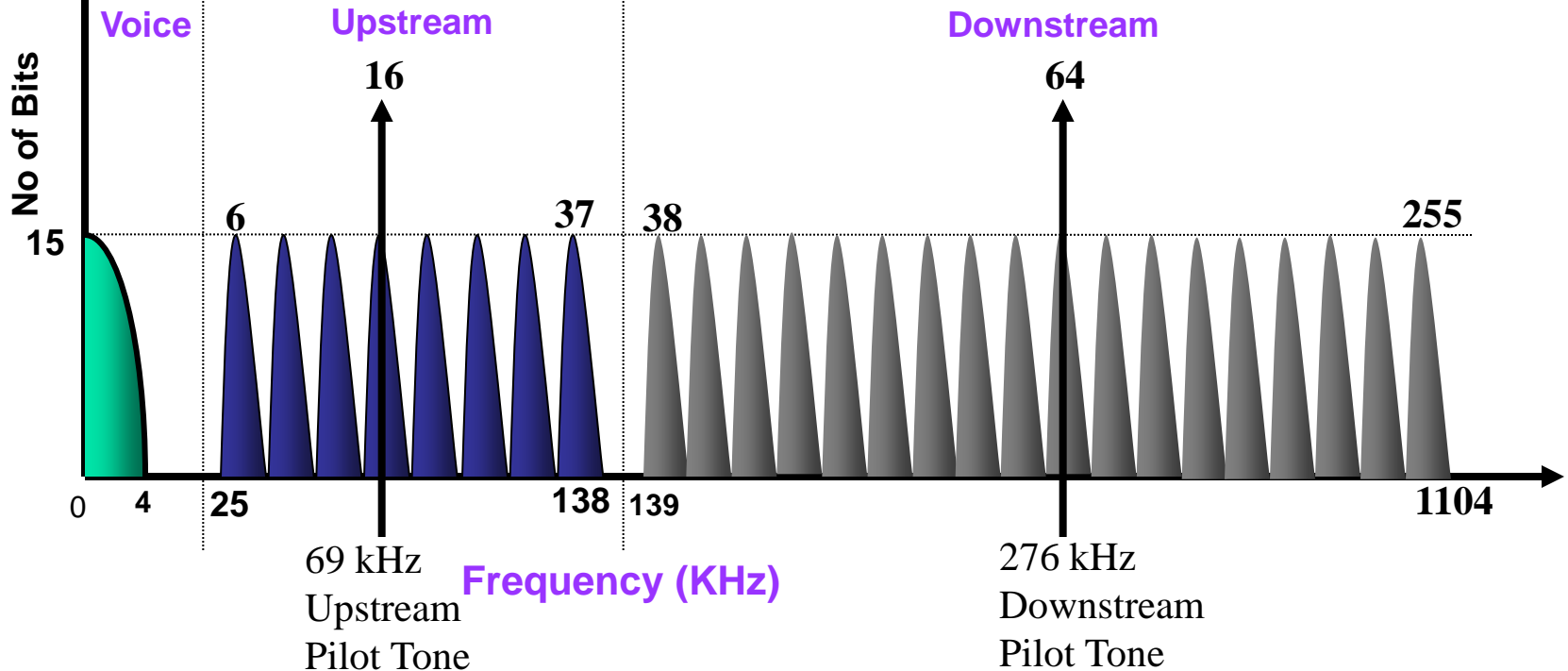


DMT modulation

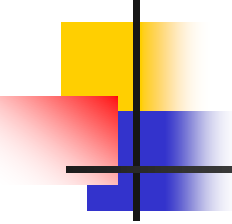
- Bandwidth from 0 to 1.1 Mhz is divided into 256 sub carriers with each occupying 4 Khz. Lower 1 to 6 sub-carriers are reserved to pass the 4khz analog voice.
- There are 32 upstream channels and 218 downstream channels.

ADSL DMT

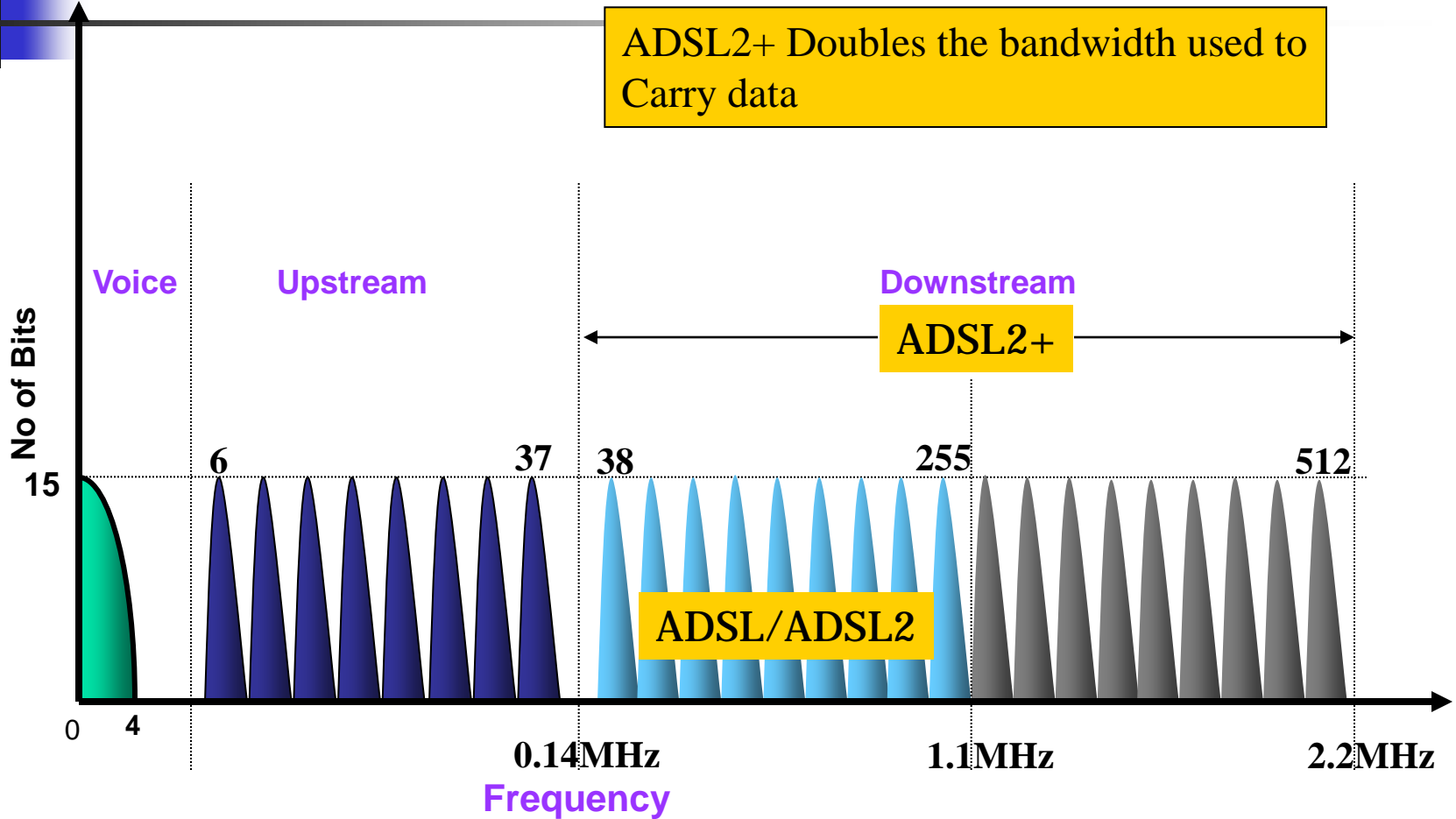
256 frequency bands of sub-carriers of 4 KHz bandwidth and spacing of 4.3 KHz. Each sub carrier can support maximum 15 bits/Hz. Depending on signal to noise Ratio for that sub carrier a decision is taken How many bits that particular sub carrier can Support. Each carrier can carry 0-15 bits/sec/Hz Carriers 1-6 for voice and guardband



Frequency Spectrum of ADSL

- 
- ❑ The ADSL transmit signal consist of a large number (up to 256) of sub-carrier located at spacing of 4.3125 Khz.
 - ❑ The channel 0 is for POTS , Channel 1-5 are not used to avoid interference between voice and data.
 - ❑ POTS Channel - Separated by a POTS splitter
 - ❑ Upstream/Downstream channels separated by either FDM using LPF/HPF or a combination of FDM and echo cancellation . Echo cancellation improves the BW through put in the downstream direction

ADSL2+ DMT Modulation

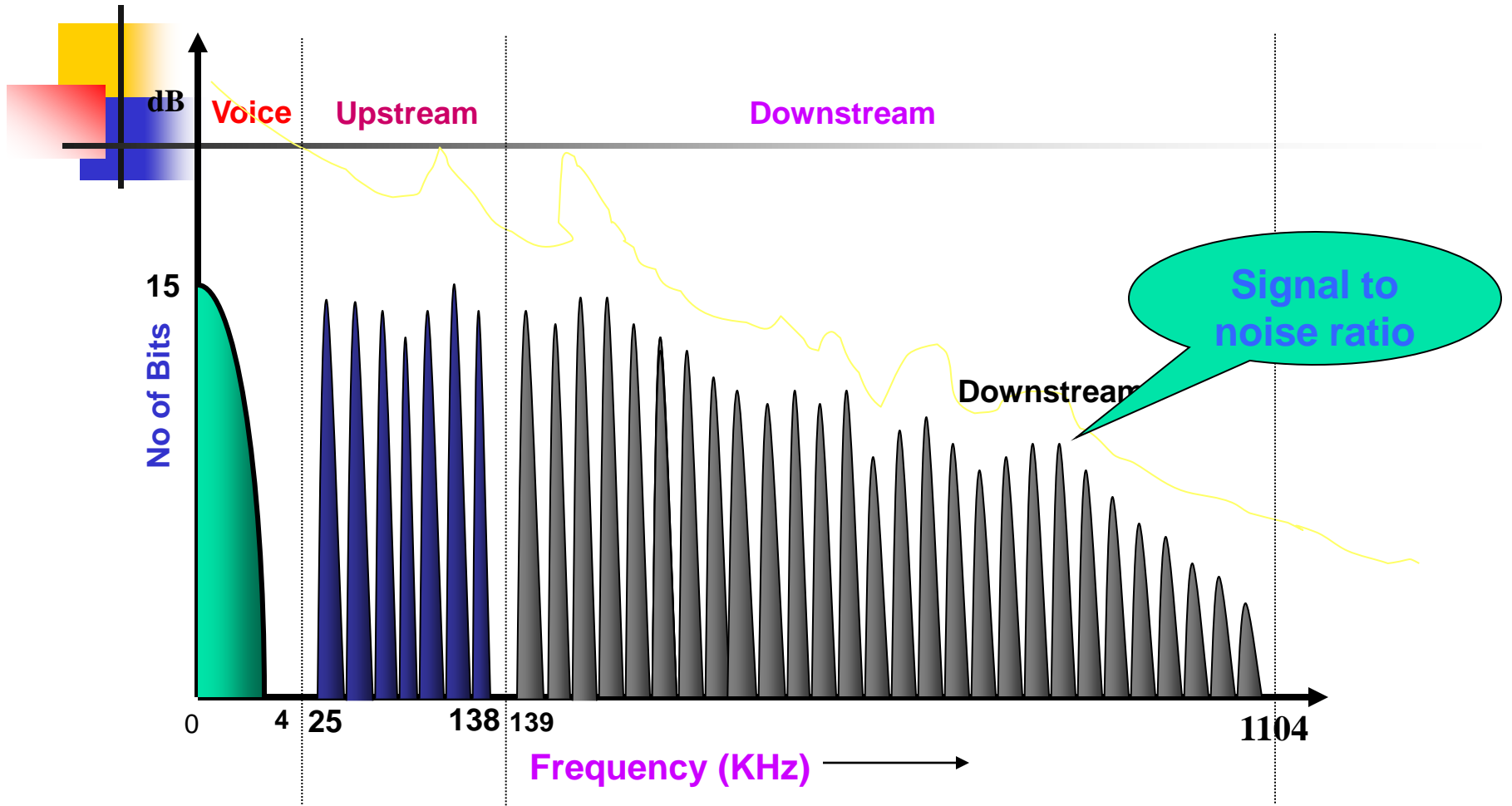




ADSL 2/2+

- ADSL 2/2+ are further improvement over ADSL and provide greater download speed and better range.
- Due to better modulation efficiency, more download speed is possible.
- ADSL 2/2+ can re-synchronize on line at different speed without interrupting the communication if SNR changes due to external interference. This is not possible with ADSL.
- When no communication is taking place ADSL2/2+ can go in sleep/power saving mode and come back to live mode automatically when data transmission starts.

ADSL DMT Modulation





Broadband Target

- **1 Million by December 2005**
- **Another 2 millions by December 2006**
- **Another 3 millions by December 2007**

Thus a Total of Six Millions by December 2007

To be Achieved Through NIB-II, Broadband Loop

Carrier, Wi-Fi & Wi-Max, New Tender for five million

Broadband Lines titled “Broadband – Multi Play**”**



Requirement at Customer End

- **BSNL's BFone**
- **Computer of minimum configuration, with 10/100 Mbps Ethernet Card**
- **DSL Modem + Splitter**
- **PPPoE software to be loaded in the Client**
- **Broadband Account (Username and Password)**



Broadband Drivers in BSNL

- 1. Prevent Churn of 35 million Wireline base**
 - To Competitors, who are churning creamy customers**
 - To Mobile Technologies**
- 2. Additional Source of Revenues**
 - High Speed Internet Access**
 - Triple Play services**

ITU Report 2003:

For telecommunication companies, broadband offers a route to offset the current slowdown in the industry. In the Republic of Korea, the average revenue per user (ARPU) for a broadband user is up to seven times higher than for a narrowband user.



Broadband Components

- **Customer Premises Equipment(CPE)**
- **Digital Subscriber Line Access Multiplexer (DSLAM)**
- **LAN Switches: for aggregating DSLAM**
- **Broadband Remote Access Server (BRAS)**
- **RADIUS and LDAP (SSSC)**
- **Provisioning System**

Brief Functions of DSL Components

- **DSL CPEs**: At customer premises. On one end it connects telephone cable coming from exchange via splitter. At the other end, it connects to PC through Ethernet / USB Port.
- **DSLAM**: called as DSL Access Multiplexer. It has a built in splitter which splits voice and data. While voice follows the normal conventional path through exchange, data is aggregated and up linked through Ethernet Port (Gigabit Ethernet for 480 port and Fast Ethernet for lower DSLAM)
- **LAN Switch**: For aggregating multiple DSLAM and providing a common uplink to the core



Brief Functions of DSL Components....contd.

- **BRAS**: called as Broadband Remote Access Server. First intelligent device in the whole chain. It terminates the customer session, authenticates, allott IP addresses and keeps track of user session for billing along with RADIUS
- **SSSS**: Called as Subscriber Service Selection System. When customer logs in he will be welcomed with this customized screen from where he can select various range of service. This provides on demand service without manual intervention



Brief Functions of DSL Components...contd.

- **RADIUS**: This in conjunction with BRAS authenticates customer, upload customer profile in the SSSS and keeps track of billing
- **LDAP**: It stores customer database viz username, password and the default services that it can subscribe to.
- **Provisioning**: This is the most critical components for ensuring quick delivery of service. It ensures end-to-end provisioning of service right from DSL CPEs to DSLAM to Switch to BRAS to LDAP



DSLAM

- **DSLAMs shall in general be collocated with existing PSTN exchanges which provide last mile access to customers over copper wire up to average span lengths of 3 kms**
- **Size of DSLAM vary considerably from 480 Ports , 240 ports, 120 Ports, 64 ports, 48 Ports and 24 ports.**
- **Uplink of DSLAM is on a Ethernet interface, converting ATM traffic to Ethernet.**
- **2 Wire analog for PSTN interface**



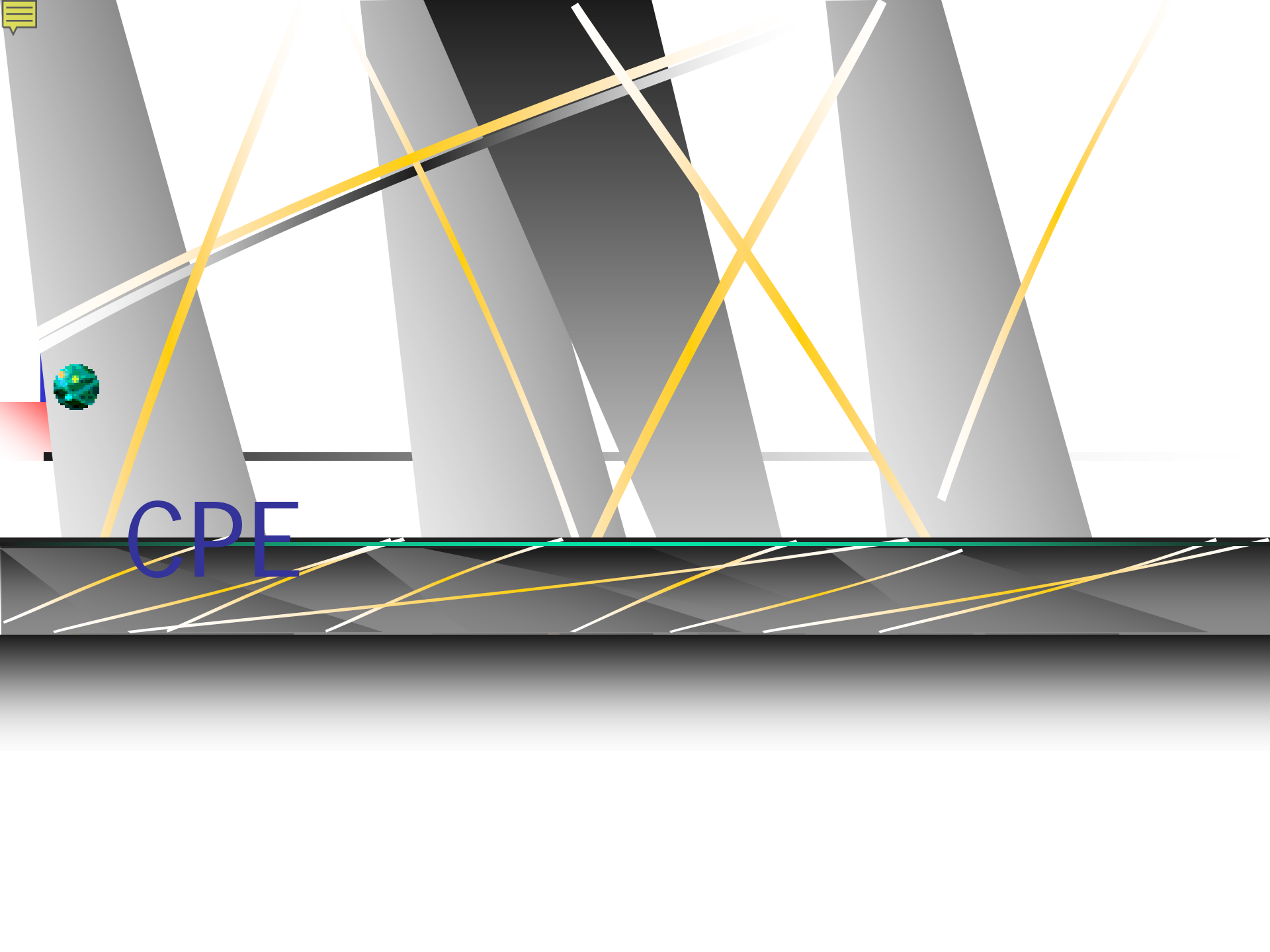
BRAS

- **Supports termination of DSL customers.**
- **Allotment of IP address to customer**
- **Bandwidth control using rate limiting**
- **Act as an edge router for terminating VPN traffic.**
- **Protocols: OSPF, BGP, MP-BGP and LDP**
- **Supports Lawful interception and monitoring**



BRAS Architecture

- **Deployed at the edge of the NIB-II network**
- **Installed in all the A sites (except Mumbai). Total 23**
- **Capacity of 8 Gbps (in A1 sites) and 4 Gbps (in other A sites)**
- **Can handle 480000 concurrent sessions (A1 sites)**



CPE

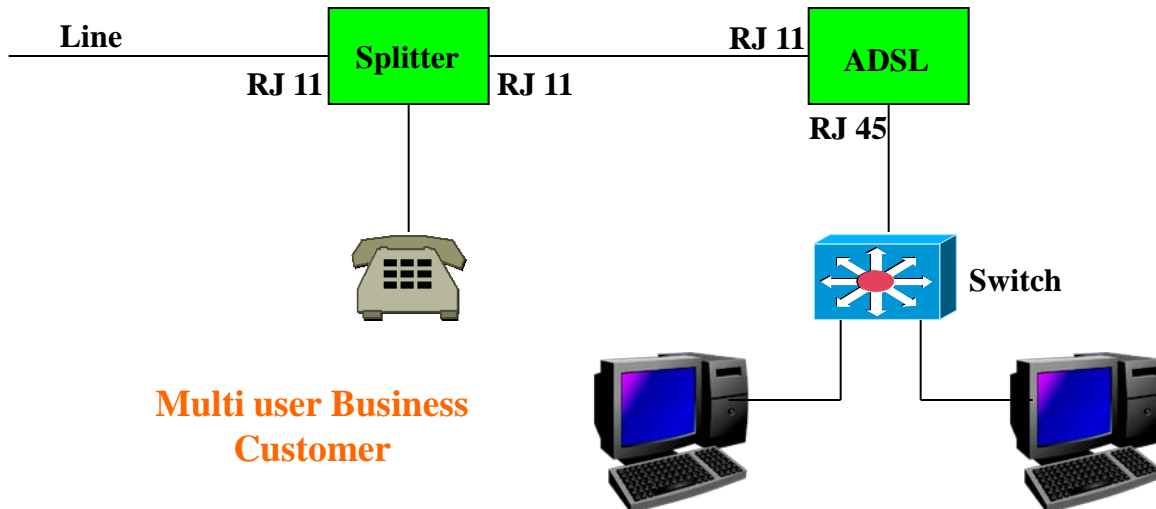
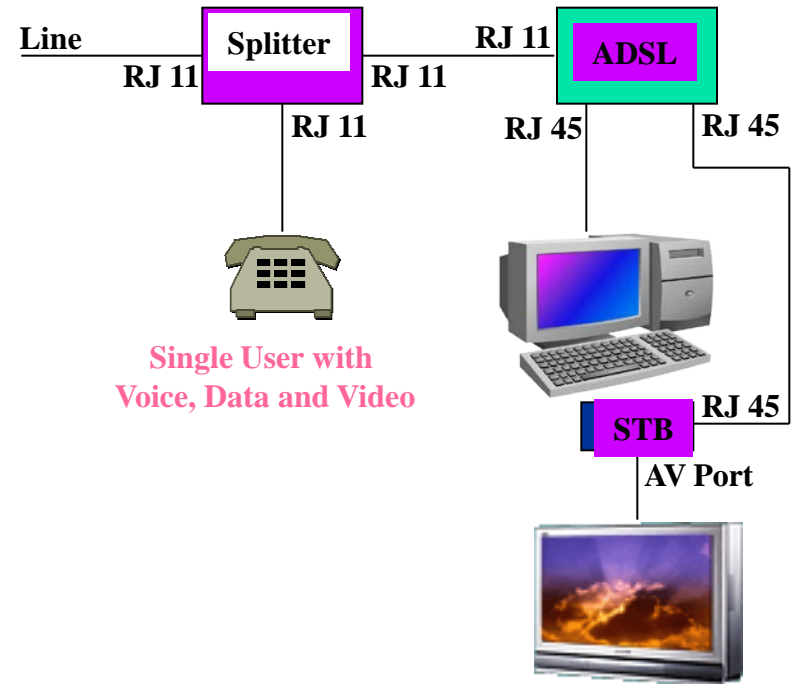
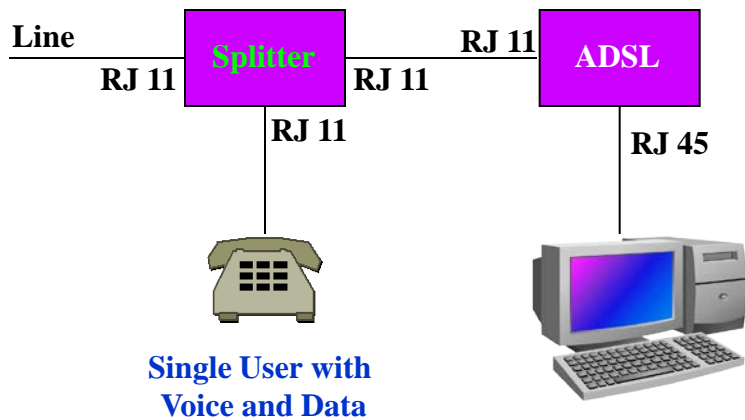
UT- 300R ADSL CPE

Product Features

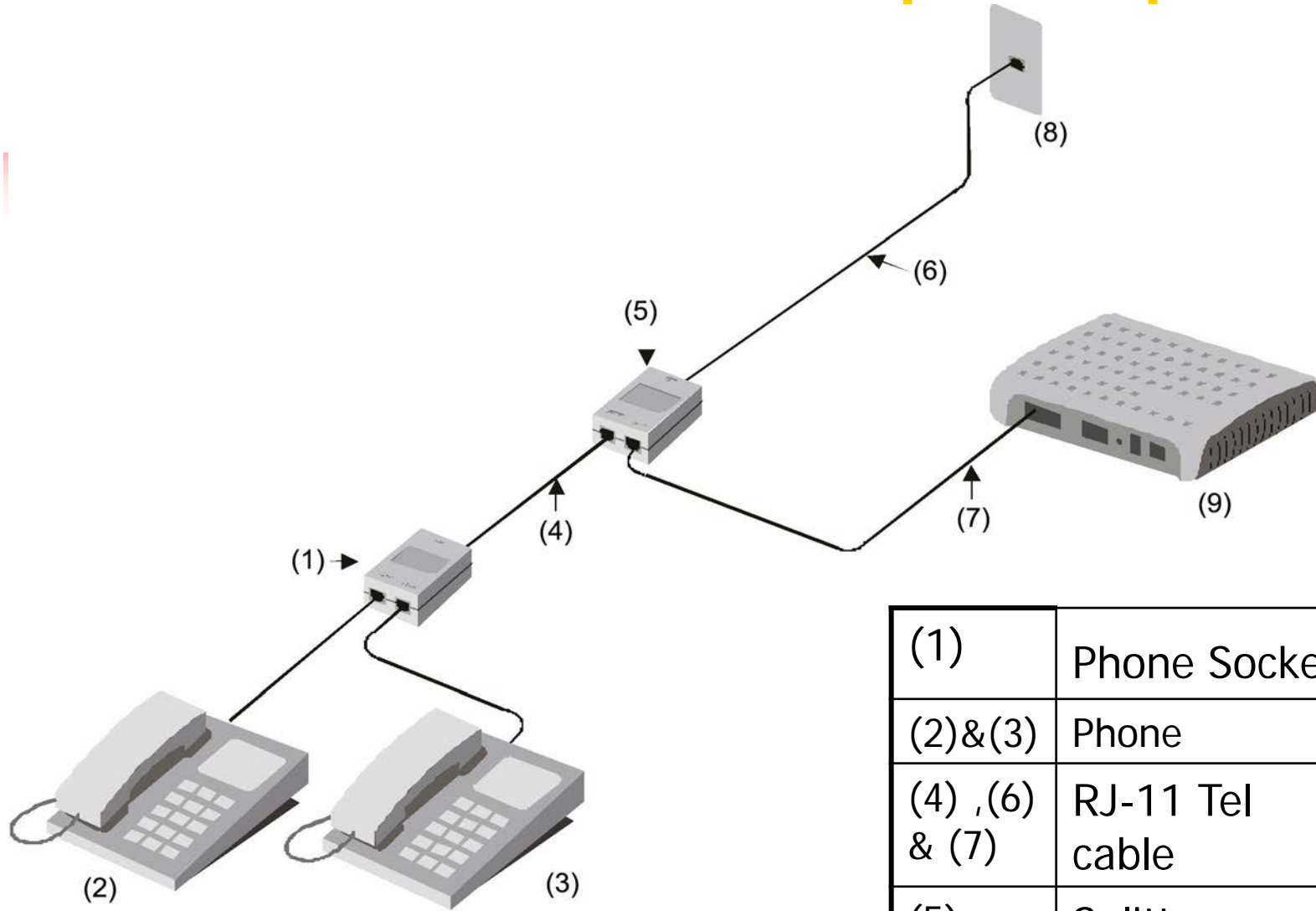
- One RJ 45 and One RJ-11 ports available
- Supports ANSI T1.413, G.DMT and G.LITE
- Supports swappable Bridge and Router mode
- Supports IP routing and NAT/NAPT function
- Supports DHCP server and dynamic allocation of IP address
- Built-in IP filter and access logs
- High reliability, easy operation and low power consumption
- Web based configuration and monitoring
- Interoperable with other DSLAM



Customer Premises Installation

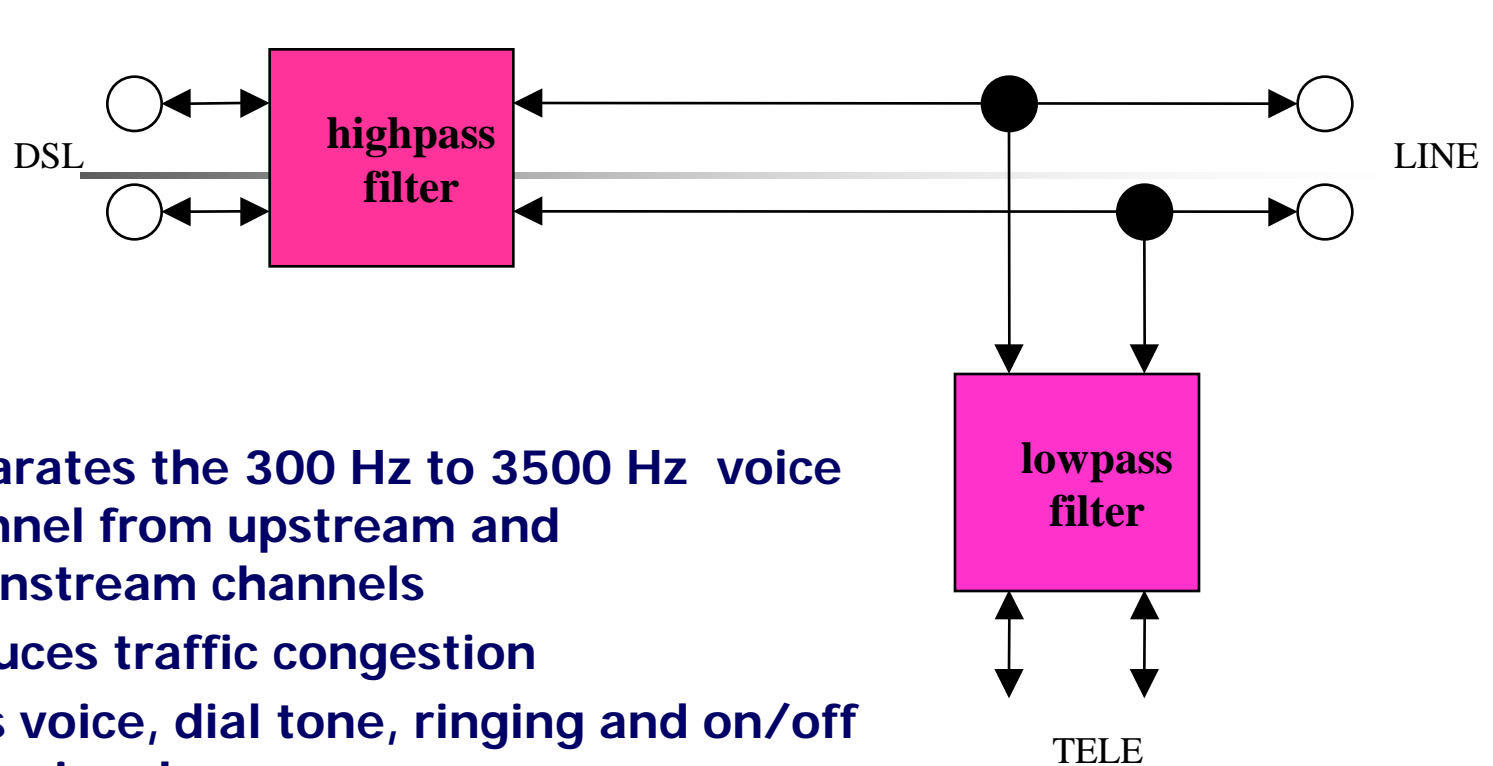


How to connect Multiple Telephones



(1)	Phone Socket
(2)&(3)	Phone
(4) ,(6) & (7)	RJ-11 Tel cable
(5)	Splitter
(8)	Phone Jack

Circuit Diagram of A POTS Splitter



□ Splitter

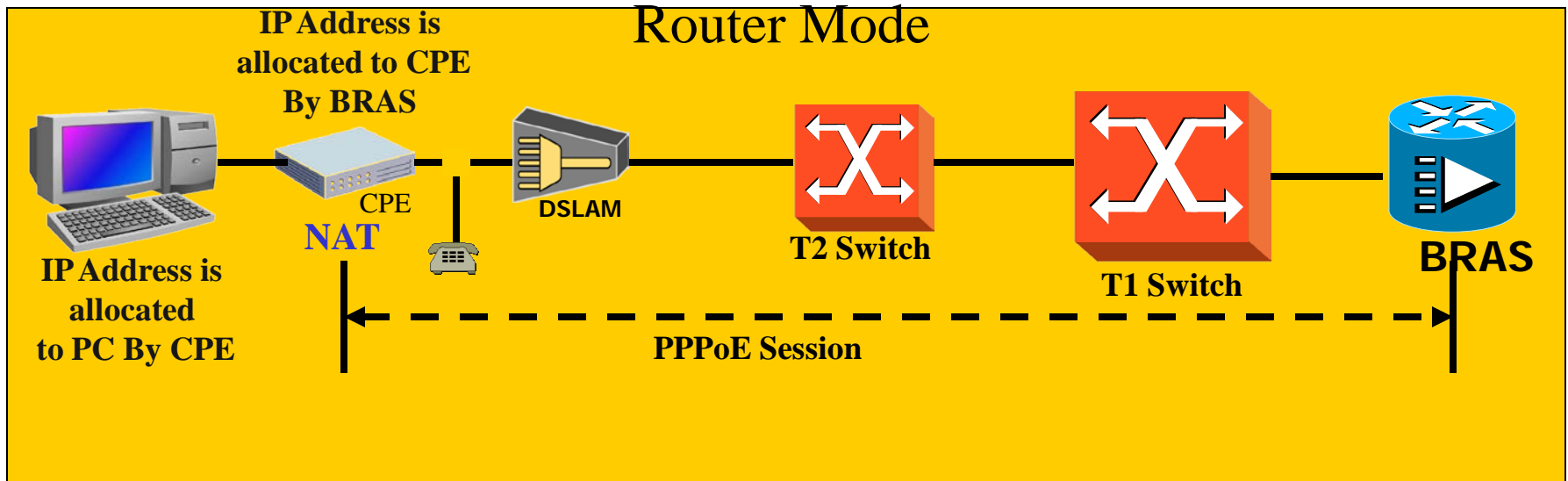
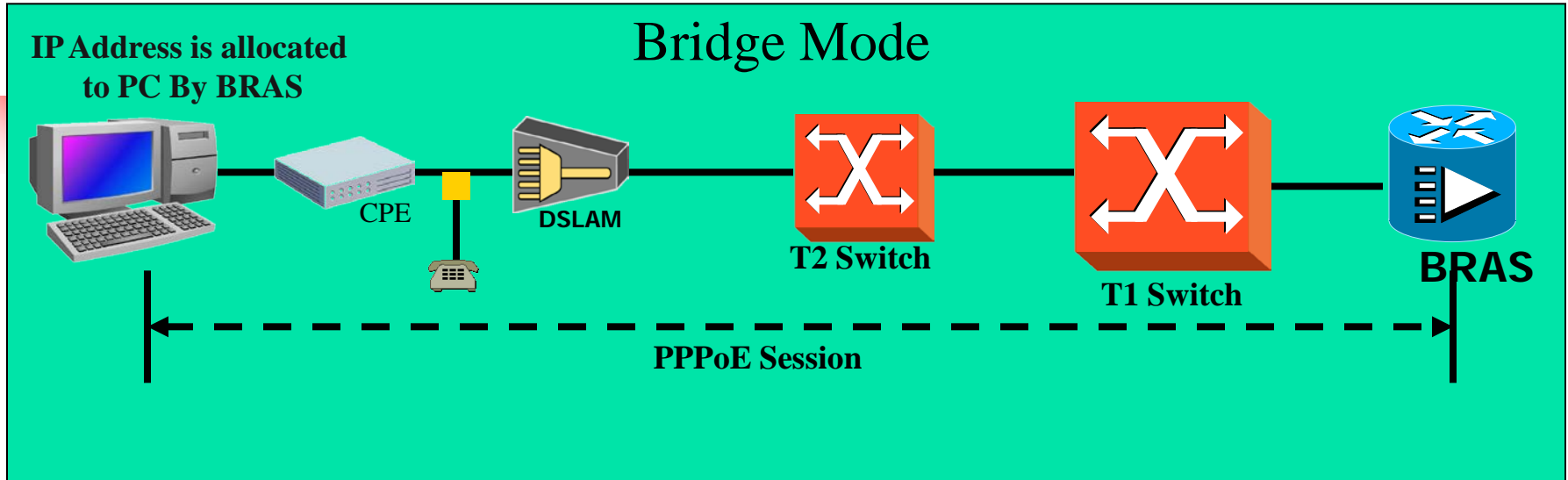
- Separates the 300 Hz to 3500 Hz voice channel from upstream and downstream channels
- Reduces traffic congestion
- Pass voice, dial tone, ringing and on/off hook signals
- Consists of a lowpass filter (LPF) for POTS and a highpass filter (HPF) for upstream/downstream channels
- Passive device
- Contains lightning protection circuitry



CPE Installation

- CPE(ADSL MODEM) can be utilized in two different ways
 - 1. Transparent Bridge – In this mode we need to configure PPPoE in the customer's PC and modem simply passes ethernet frames from one side to other side in transparent fashion. Customer's PC authenticates itself with BRAS
 - 2. Router Mode- In this mode PPPoE is configured in modem. Modem authenticates itself to BRAS and gets IP address. Modem provides different address from its DHCP server to PC. Modem also performs the NAT function in this mode.

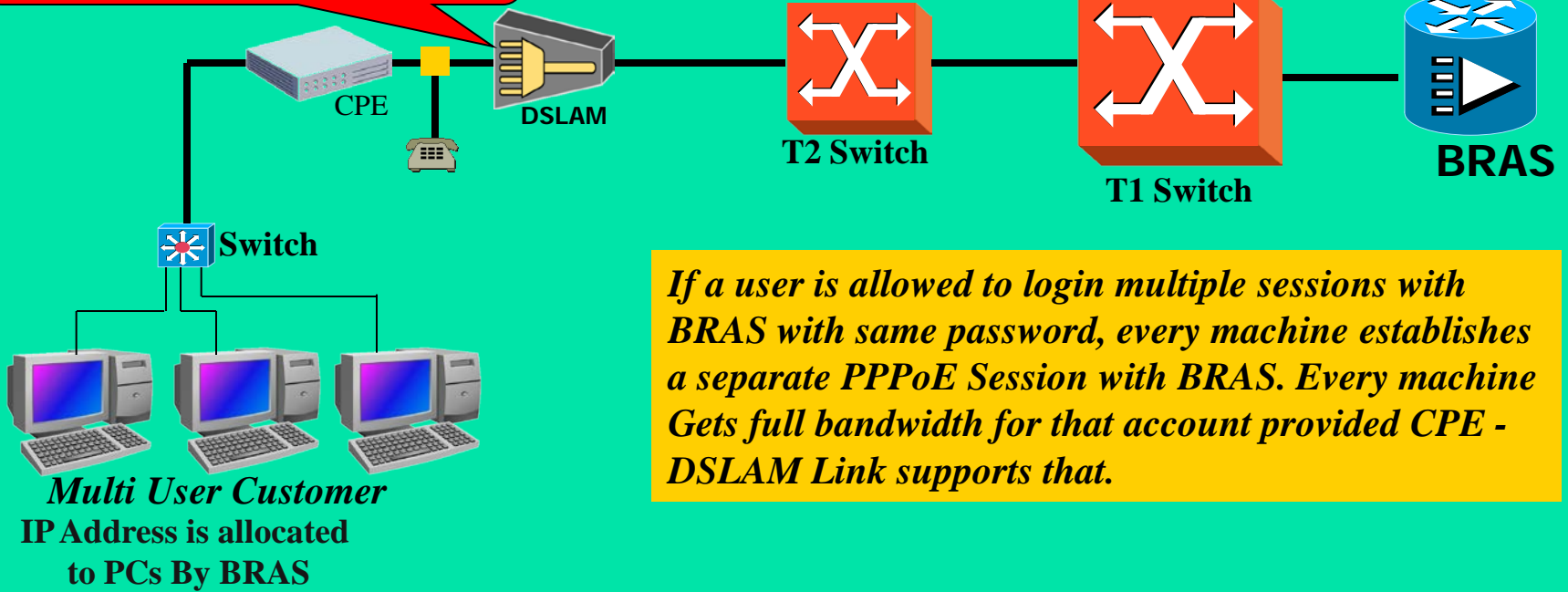
CPE Installation



Multi User Customer

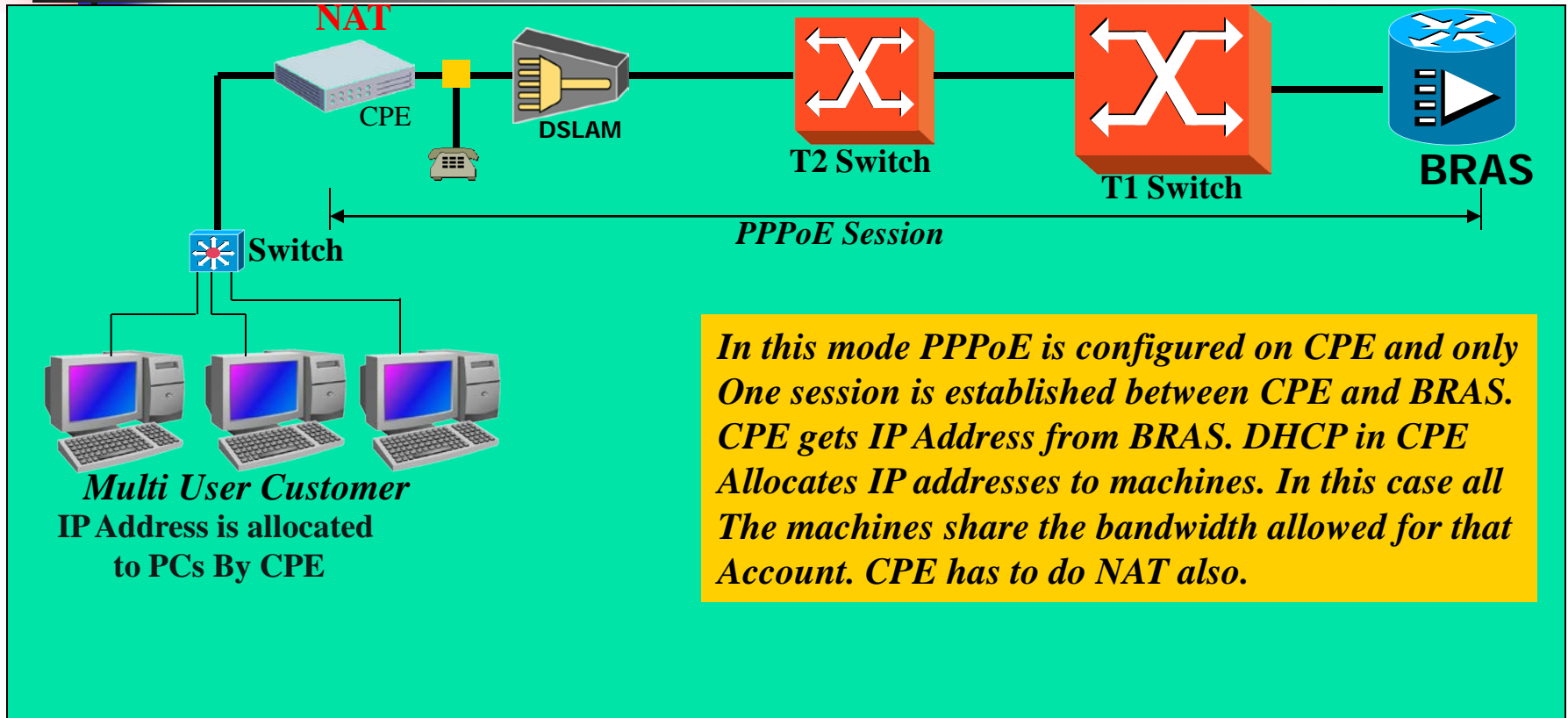
Bridge Mode

ADSL Port on DSLAM Should allow that many MAC addresses



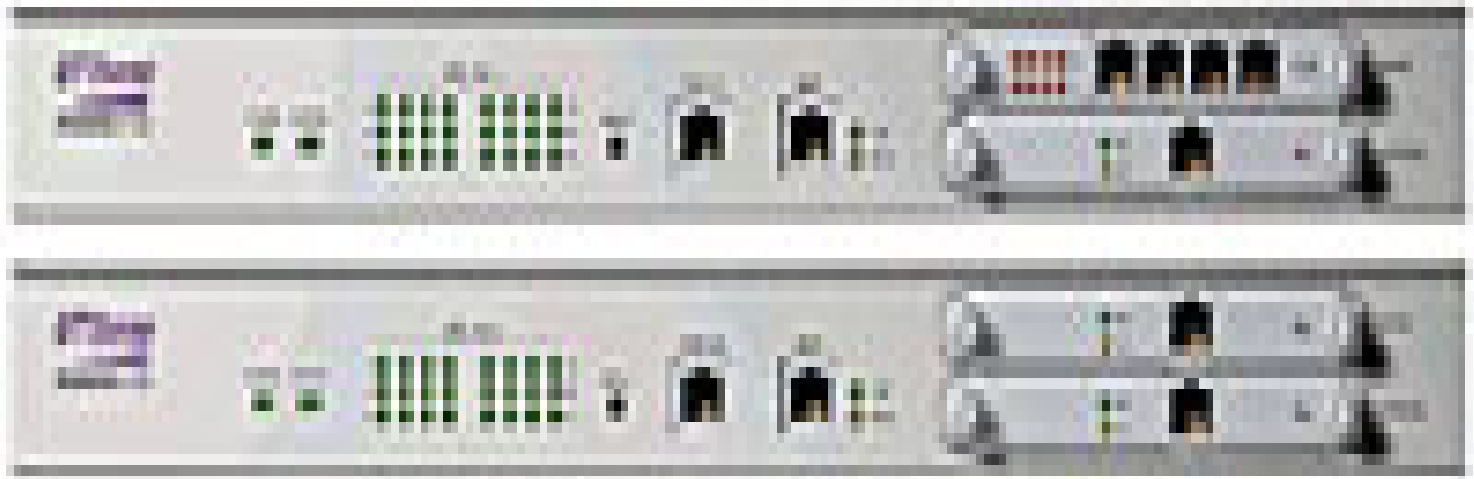
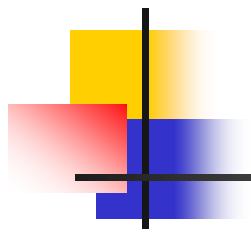
Multi User Customer

Router Mode

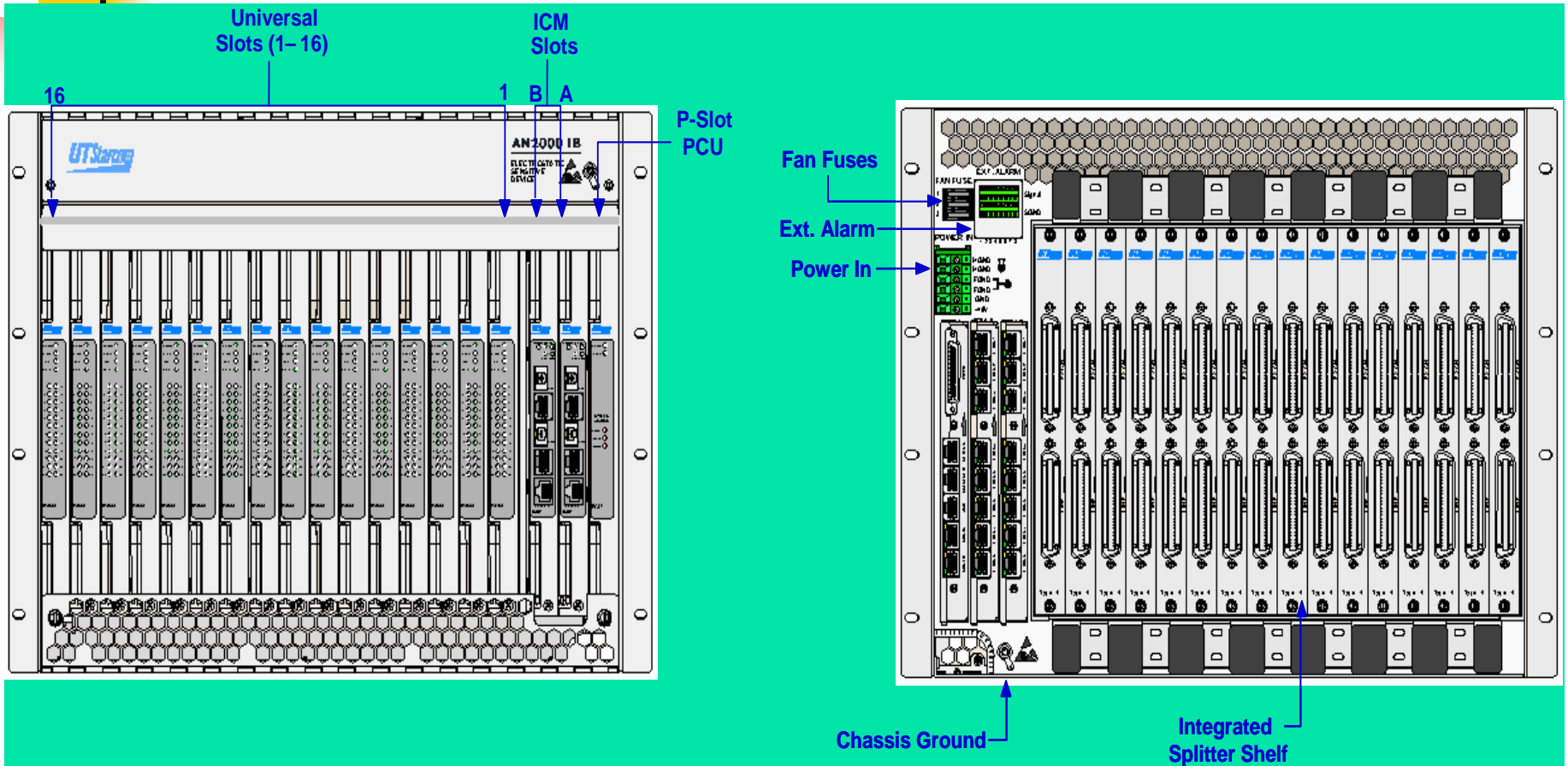




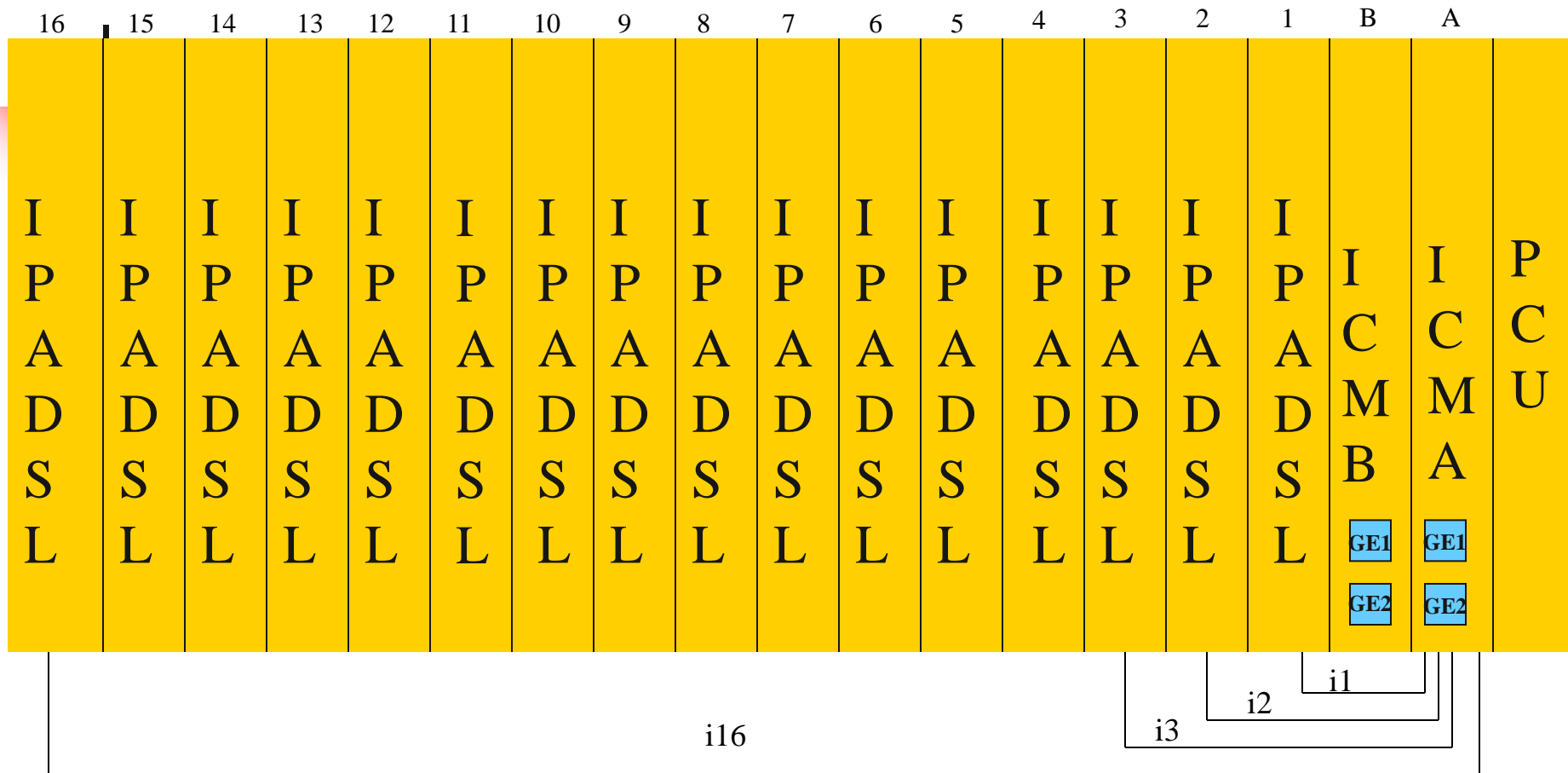
DSLAM



IP DSLAM

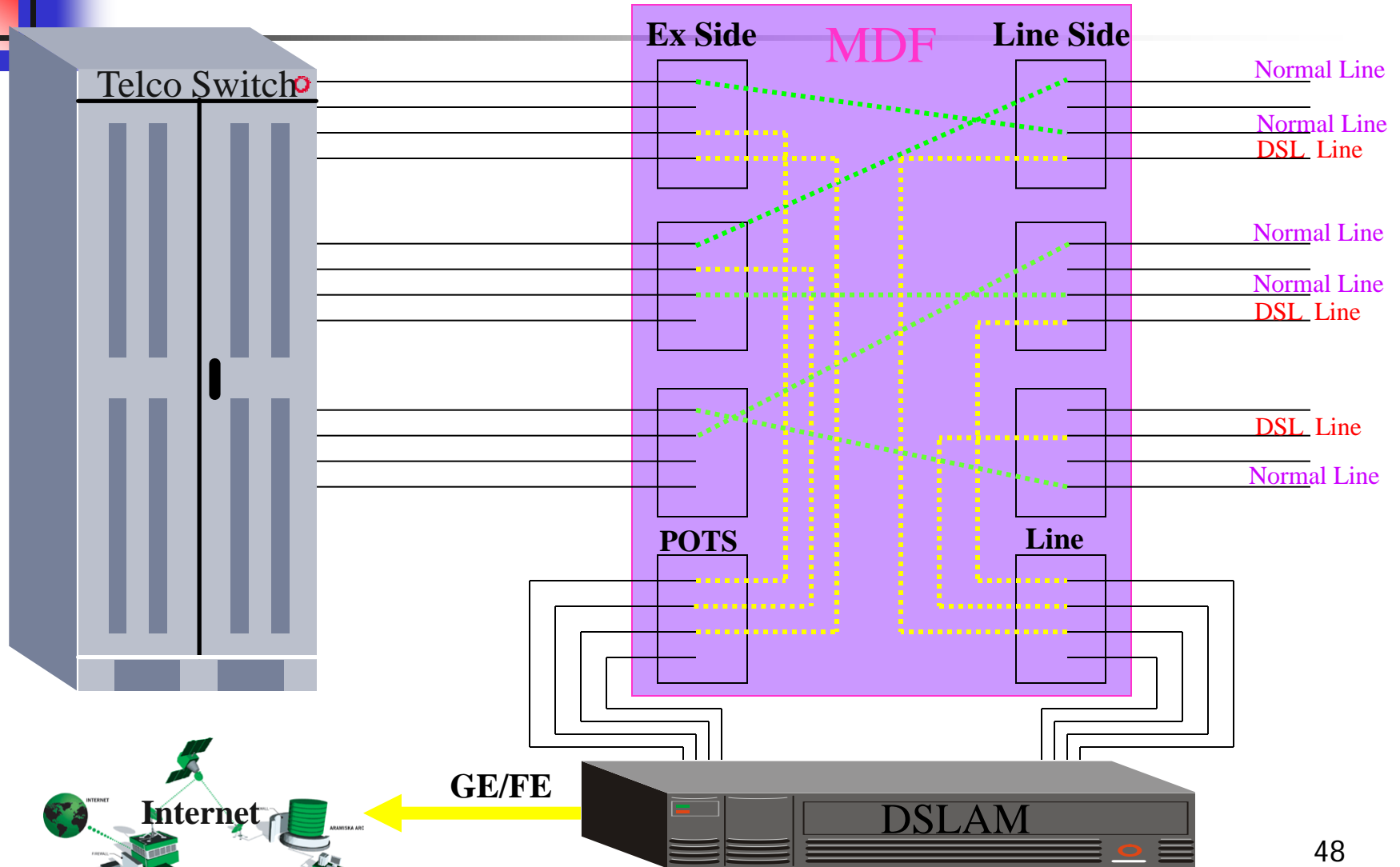


IP DSLAM - UTStarcom




i1-i16 links are internal links between IPADSL card and ICM card. Each link has got a capacity of 200 Mbps. GE1 and GE2 links are uplink ports to connect Tier 2 switch. In case of 480 port DSLAM we use these GE Ports. For 240 port and 120 port DSLAM one FE port out of 4 FE ports available at the back of ICM cards Are used for Tier 2 connectivity. At a time only one ICM card remains active and other remains standby.

NIB-II Broadband DSL Deployment



Creation of VLANs

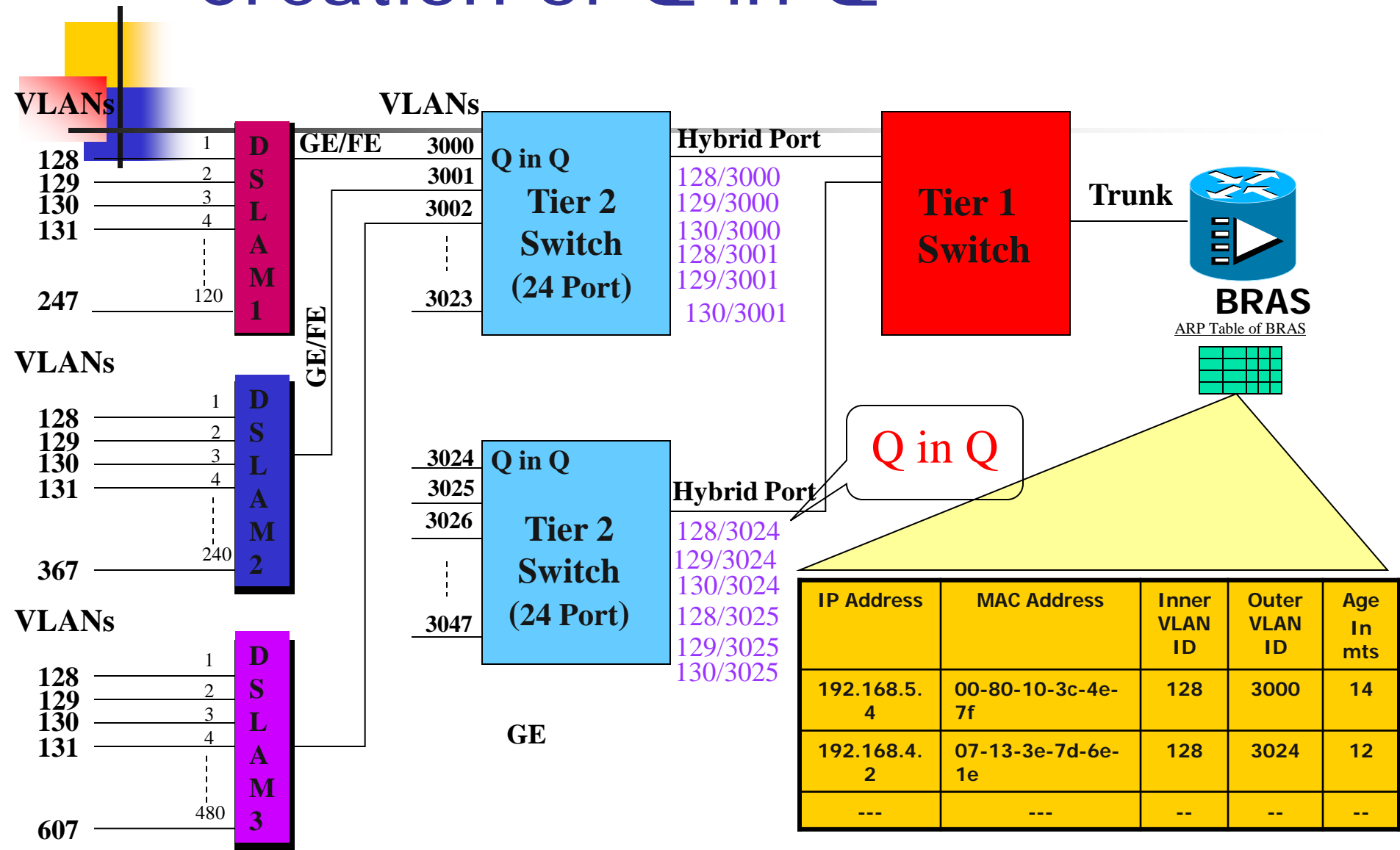
- 
- VLAN 126 & 127 are reserved for Management
 - ADSL ports are put in different VLANs in the following manner
 - VLAN 128-151 ADSL ports 1-24 card slot 1 mapped to i1
 - VLAN 152-175 ADSL ports 1-24 card slot 2 mapped to i2
 - VLAN 176-199 ADSL ports 1-24 card slot 3 mapped to i3
 - VLAN 200-223 ADSL ports 1-24 card slot 4 mapped to i4
 - VLAN 224-247 ADSL ports 1-24 card slot 5 mapped to i5
 - VLAN 248-271 ADSL ports 1-24 card slot 6 mapped to i6
 - VLAN 272-295 ADSL ports 1-24 card slot 7 mapped to i7
 - VLAN 296-319 ADSL ports 1-24 card slot 8 mapped to i8
 - VLAN 320-343 ADSL ports 1-24 card slot 9 mapped to i9
 - VLAN 344-367 ADSL ports 1-24 card slot 10 mapped to i10
 - VLAN 368-391 ADSL ports 1-24 card slot 11 mapped to i11



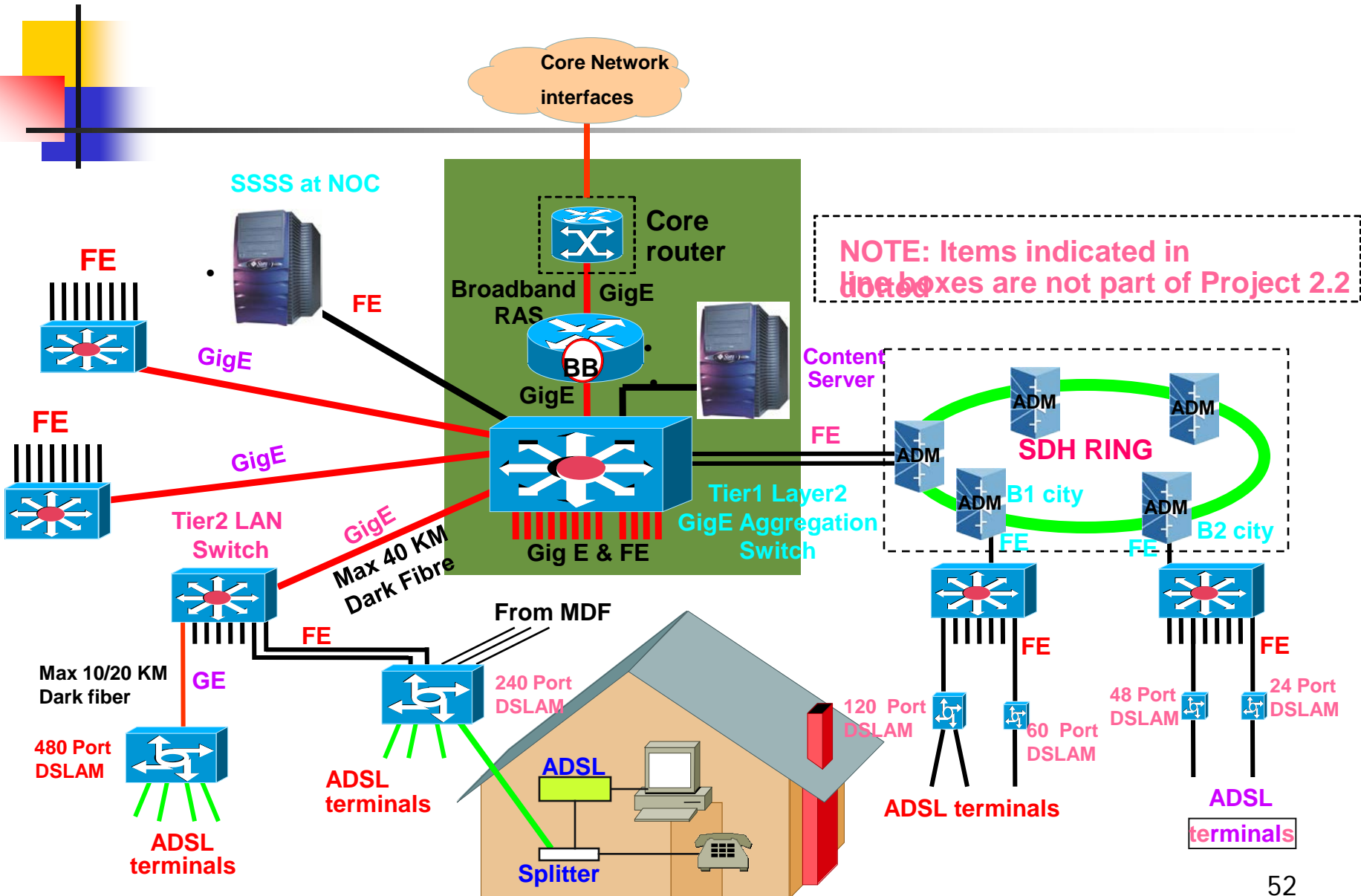
Creation of VLANs

- VLAN 392-415 ADSL ports 1-24 card slot 12 mapped to i12
- VLAN 416-439 ADSL ports 1-24 card slot 13 mapped to i13
- VLAN 440-463 ADSL ports 1-24 card slot 14 mapped to i14
- VLAN 464-487 ADSL ports 1-24 card slot 15 mapped to i15
- VLAN 488-511 ADSL ports 1-24 card slot 15 mapped to i16
- All the VLANs from 128 to 511 should also be mapped to G1 or G2 port whichever is used for uplink to tier 2 switch.

Creation of Q in Q



NIB-II Broadband DSL Deployment





Broadband Services - Basket

■ DATA BASED

- *High Speed Internet access – Killer App.*
- *VPNs*

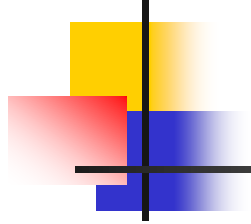
■ VIDEO BASED

- *IP TV – BROADCAST*
- *VIDEO ON DEMAND- (Most Expensive to provide)*
- *Conferencing*

■ VOICE BASED

- *VOIP & NGN based*

Internet access is the killer app. today, but equipment has to be future proof



Thanks !