

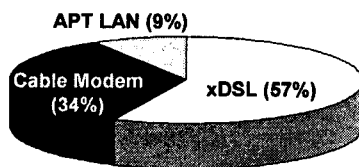
xDSL Technology Review (Draft)

Nov. 2003

DASAN Networks
Ilchan Jung

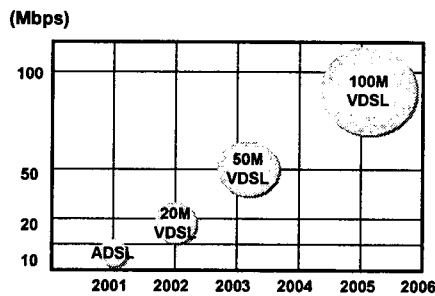
Broadband Internet Access

Broadband Internet service Subscribers (Total: 21M)



* MIC, Korea, Sept, '03

- xDSL: ADSL → VDSL
- Cable Modem: DOCSIS1.0/1.1 → 2.0
- APT LAN: 10/100Tx → 100Fx
- Others: Satellite



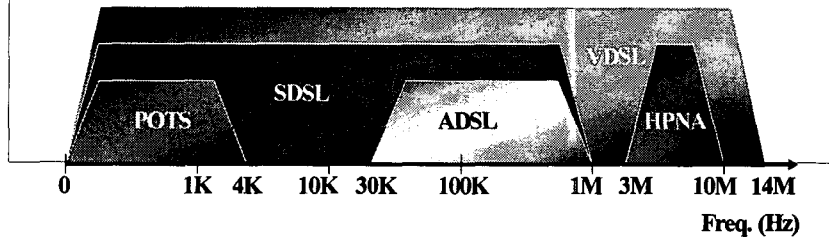
VDSL speed migration

- up to 100Mbps/subscriber



Definition of xDSL

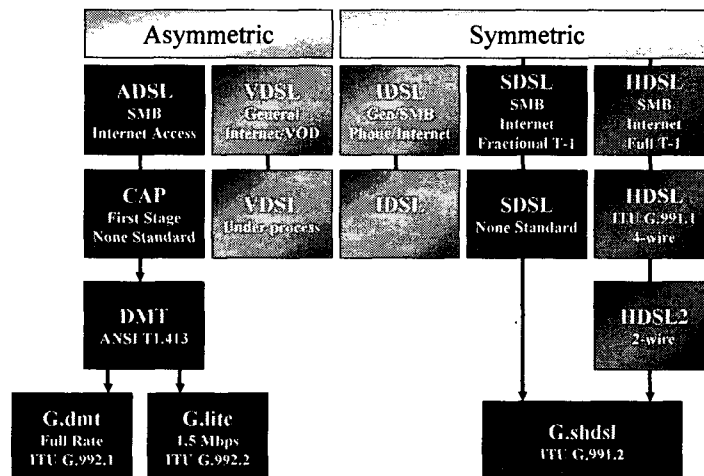
xDSL is a generic abbreviation for the many flavors of DSL or Digital Subscriber Line technology. DSL refers to the technology used between a customer's premises and the telephone company, enabling more bandwidth over the already installed copper cabling than users have traditionally had.



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xDSL Family Tree



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Copper Solution

○ ADSL

- Up to 8Mbps Downstream
- Maximum Speed depends on the distance

○ VDSL

- Up to 52Mbps Downstream
- Up to 26Mbps for Symmetric Transmission
- Up to 16Mbps symmetric
- Maximum Speed depend on the distance and band plan



Trend of xDSL Standard

□ International Standard – ITU-T SG15

Rel- DOC	Description	Remark
G.991.1(G.hdsl)	High bit Digital Subscriber Line (HDSL) Transceivers	1998.10 Approval
G.991.2(G.shdsl)	Single pair High bit Digital Subscriber Line (SHDSL) Transceivers	2001.2 Approval
G.992.1(G.dmt)	Asymmetrical Digital Subscriber Line (ADSL) Transceivers 10/1998 06/1999	1999. 6 Approval
G.992.2(G.lite)	Splitterless Asymmetrical Digital Subscriber Line (ADSL) Transceivers	1999. 6 Approval
G.994.1(G.hs)	Handshake procedures for Digital Subscriber Line (DSL) Transceivers	1999. 6 Approval
G.995.1(G.ref)	Overview of Digital Subscriber Line (DSL) Recommendations	1999. 6 Approval
G.996.1(G.test)	Test procedures for Digital Subscriber Line (DSL) Transceivers	1999. 6 Approval
G.997.1(G.ploam)	Physical layer management for Digital Subscriber Line (DSL) Transceivers	1999. 6 Approval
G.vdsl (G.993 series)	Very high bit rate Digital Subscriber Line (VDSL) Transceivers	G.993.1 2001.10 Approval

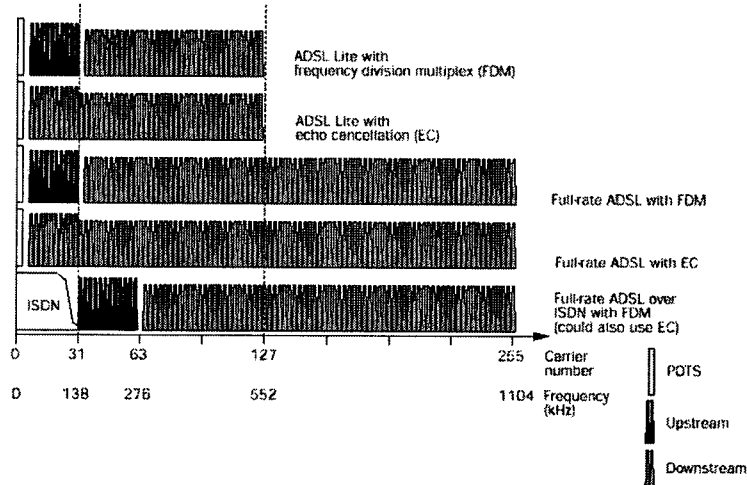


ADSL overview



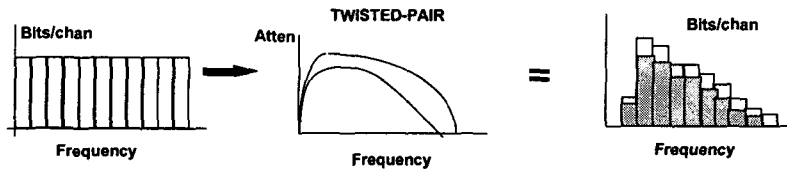
ADSL Technical Review

○ Full-rate ADSL & UADSL Bandwidth

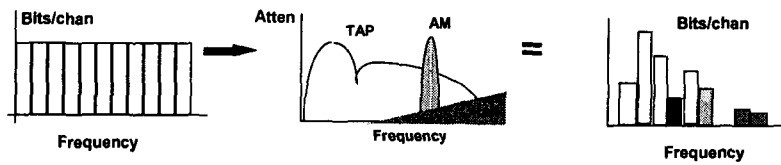


ADSL Technical Review(DMT)

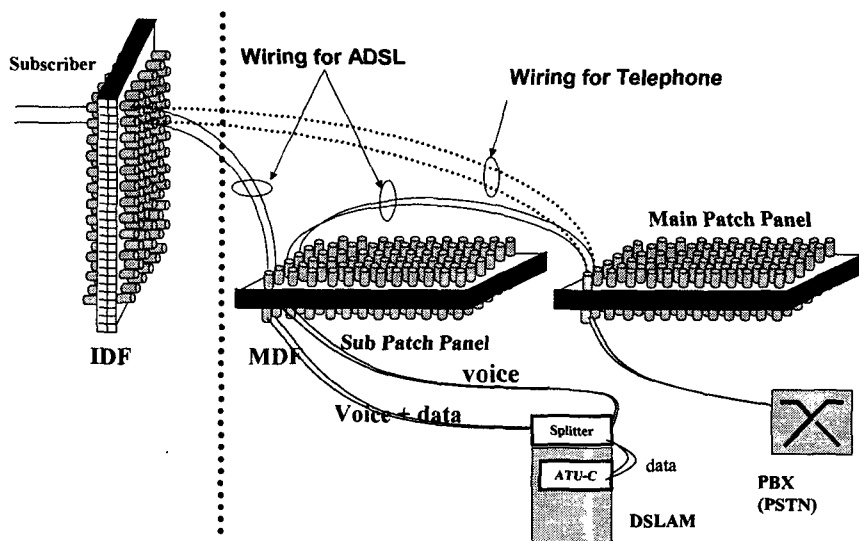
○ Discrete Multi-Tone : Allocate proper number of bits to each tone

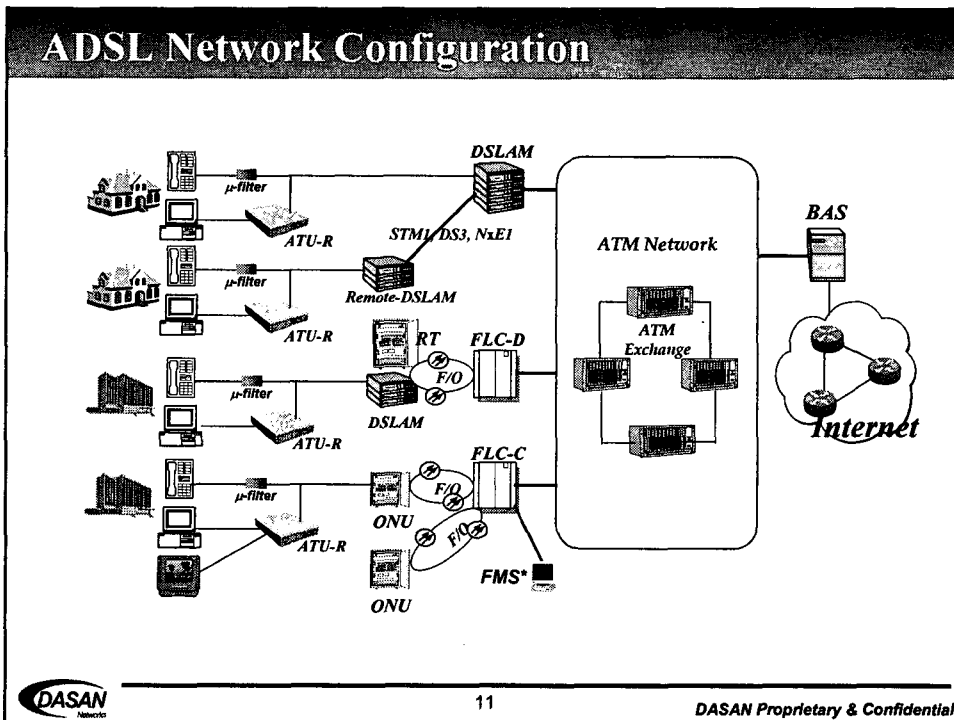
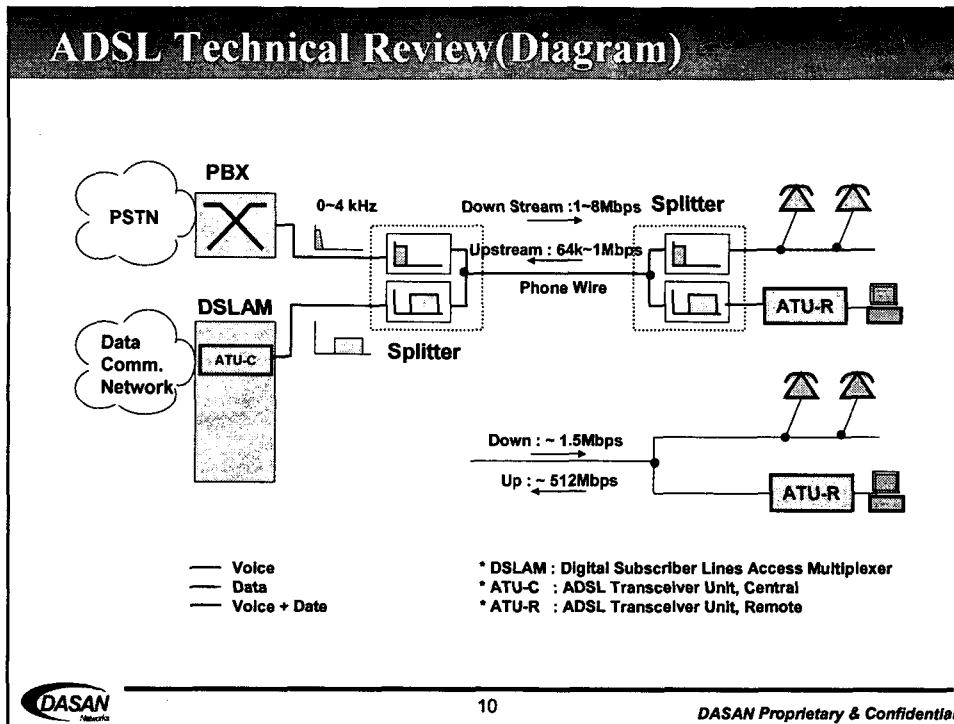


TWISTED-PAIR with TAP, AM/RF, and XTALK



xDSL Wiring





SHDSL overview



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SHDSL Technical Review

- SHDSL technology**
 - Symmetric Bandwidth Service
 - One-pair : 192 Kbps ~ 2.312 Mbps
 - Two-pair : 384 Kbps ~ 4.624 Mbps
 - ITU-T Recommendation
 - Guarantees interoperability
 - Greater reach
 - Longer than 30% compare with 2B1Q SDSL
- Asymmetric PSDs**
 - North America : 1.544Mbps, 768kbps
 - Europe : 2.048Mbps, 2.304Mbps
- TC-PAM Line Coding**
- Optional repeater for extended range**




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SHDSL Service


Target Service

- **Business Subscribers**
 - Com bined multi-channel voice plus data service
 - Video conference
 - Rem ote LAN access
 - Leased lines with customer specific data rates
- **Residential Users**
 - Long r each for remote customer
 - Intern et access with one more telephone line
 - Intern et game
 - Hom e network


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Symmetric DSL Technologies

	HDSL	SDSL	HDSL2	G.shdsl
Organization	ITU-T SG 15	ETSI TM6	ANSI T1E1.4	ITU-T SG 15
Data Rate	T1	192K - 2.3M	T1	192K - 2.360M 384K - 4.720M
Pairs	2	1	1	2
Line Code	2B1Q	2B1Q	TC PAM	TC PAM
Rate Adaptation	No	Yes	No	Yes
Repeaters	Yes	No	Yes	Yes
Reach (2.304M)	NA	5.5 kft	NA	6.5 kft
Reach (1.544M)	CSA	7 kft	CSA	CSA


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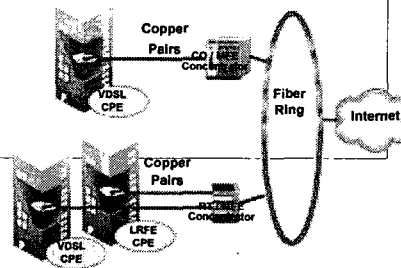
VDSL overview

VDSL Technology Review

VDSL (Very high data rate Digital Subscriber Line)

The most promising technology capable of Delivering full-service access is very-high-data-rate digital subscriber line (VDSL). VDSL is both symmetric and asymmetric and provides up to 52 Mbps of bandwidth over voice on a single twisted-pair copper loop

- Drop line with FTTC application
- CAP-16, DMT, QAM



VDSL Technology Review

- ❑ **Highest Bandwidth Support among xDSL Family**
 - ❑ ~ 52 Mbps
- ❑ **Line Coding Hot Competition**
 - VDSL Coalition Group : ADI, Broadcom, GSI, Infineon (QAM)
 - VDSL Alliance Group : IKANOS, Alcatel, TI, Aware, GSI (DMT)
 - ANSI,ETSI select both Line Coding
- ❑ **ITU-T Standard**
 - Spectrum Allocation Negotiation (2000.4, ITU-T Annual Meeting)
 - Bandwidth : 138 kHz ~ 12 MHz
 - Number of Band : 4
 - 3 Frequency Band Plan

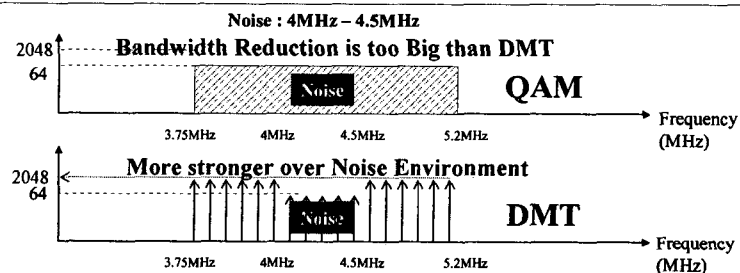


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VDSL: Line code battle

- ❑ **VDSL Alliance: (DMT-based VDSL)**
 - Alcatel , Aware, Ericsson, ETRI, Globespan, IBM Research, Marvell Semiconductor, Mitel Corporation, Mitsubishi Electric Corporation, NEC, Nortel, Samsung, ST Microelectronics, Stanford University, Telia Research AB, Texas Instruments, Toshiba.
- ❑ **VDSL Coalition: (QAM/CAP-based VDSL)**
 - ADI, Broadcom, Globespan, Infineon(Siemens), Lucent, Metallink, Orckit, Rockwell,



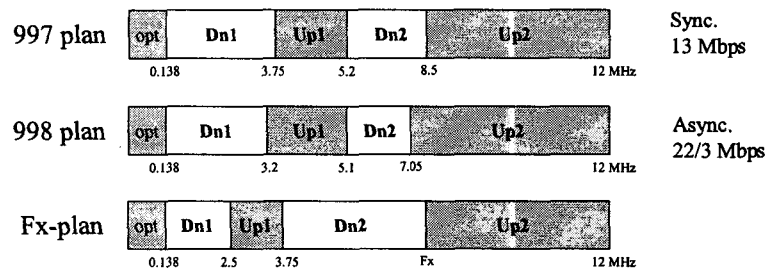
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Bandwidth Plan of VDSL

○ Draft G.vdsl.f(G.993.1) make standard(Oct, 2001) after G.vdsl devide to G.vdsl Foundation (G.vdsl.f) and G.vdsl Line Coding (G.vdsl.l)

○ Frequency Band Plan



VDSL vs. ADSL




VDSL vs. ADSL

VDSL (Very-high-data-rate Digital Subscriber Line)

- Internet Broad casting, VoD · online Education · HDTV, High Quality Multimedia Service
- profit model of Contents Service Provider
- Symmetric Service , Overcome ADSL Bandwidth Limitation
- New High Speed Internet Access Technology

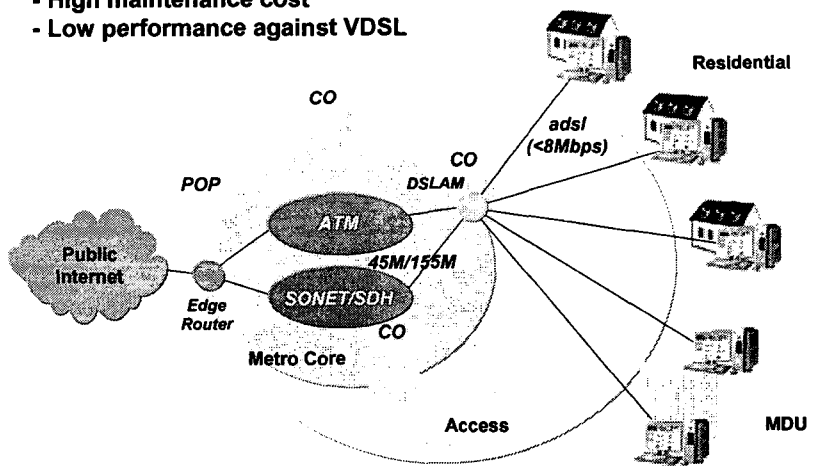
Item	VDSL		ADSL
	Asymmetric	Symmetric	
Bandwidth	52 ~6 Mbps (Down)	26 ~ 13Mbps (Down/up)	8 Mbps (Down)
	26 ~ 3 Mbps (Up)		800 Kbps (Up)
Distance	0.3 ~ 1.6 Km		5.4 Km
Value Added Service	High Resolution Image + High Speed Internet		High Speed Internet
Service	Image + Data + Image		Data + Voice
Application	Pay TV, Remote diagnosis online Education, VoD, HDTV, Home Shopping		High Speed Data Communication
Terminal	TV, PC, Phone		PC, Phone



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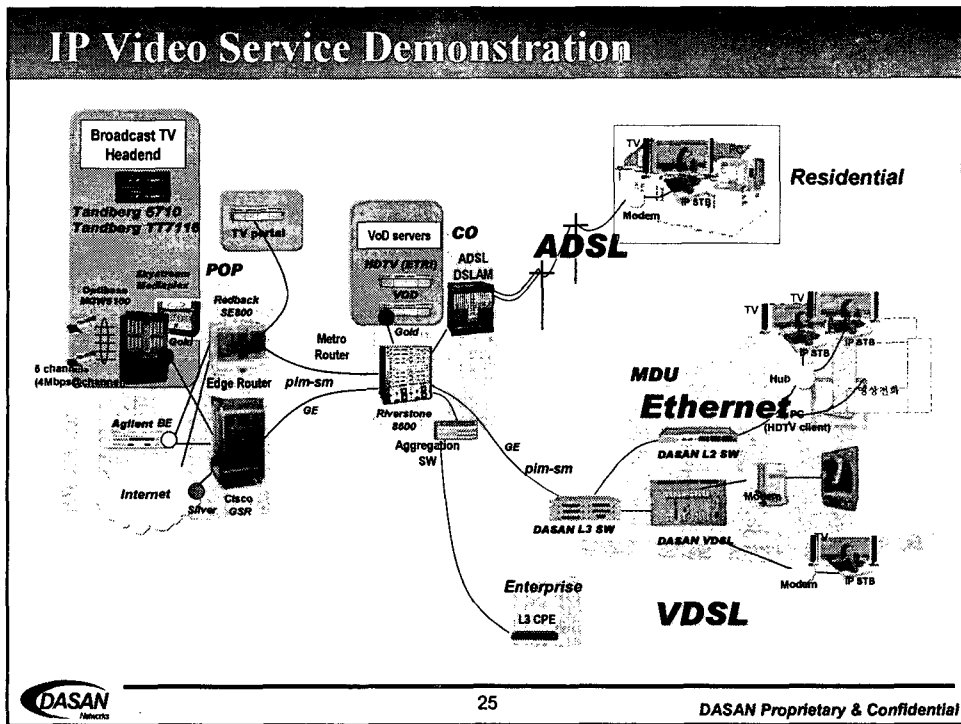
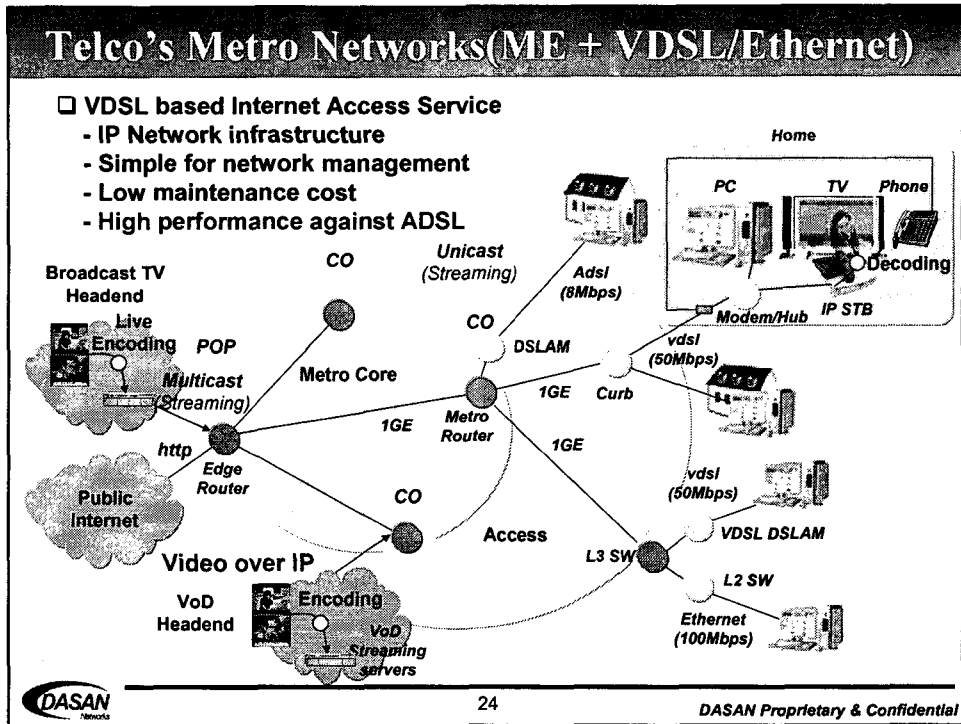
Telco's Metro Networks(ADSL)

ADSL based Internet Access Service

- Need ATM Network infrastructure
- Very difficult for network management
- High maintenance cost
- Low performance against VDSL




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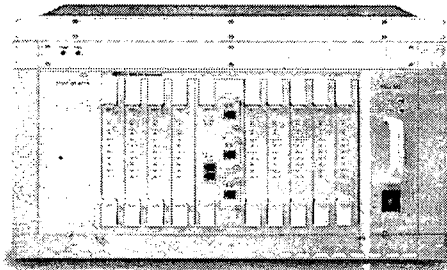
DASAN Networks VDSL Solutions



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V5972 VDSL DSLAM



□ Key Features & Benefits

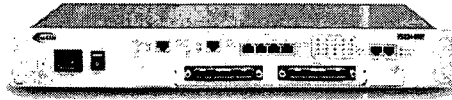
- Performing 52.0/13.0 Mbps Asym. VDSL service.
- Deploying standard DMT technology.
- Chassis type architecture.
- Max. 72 VDSL subscriber serviceable.
- 8-Subscriber/Module architecture.
- 3-Port Ethernet Interface(TX, FX, or GBIC) supported Fabric Board.
- Full support Layer 2 performance.
- Advanced network security functions.



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V5924-DMT50 VDSL DSLAM



□ Key Features & Benefits

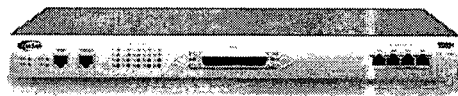
- Performing 52.0/13.0 Mbps Asym. VDSL service.
- Deploying standard DMT technology.
- Max. 24 VDSL subscriber serviceable.
- Support fixed 4-Port 10/100 Base-TX Ethernet Interface.
- Present pluggable 2-Port Ethernet Interface. (TX, FX, or GBIC)
- Full support Layer 2 performance.
- Advanced network security functions.



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V5924 VDSL DSLAM



□ Key Features & Benefits

- Performing 24.0/8.0 Mbps Asym. VDSL service.
- Performing 16.0/16.0 Mbps Sym. VDSL service.
- Deploying standard QAM technology.
- Max. 24 VDSL subscriber serviceable.
- Support fixed 4-Port 10/100 Base-TX Ethernet Interface.
- Present pluggable 2-Port 100 Base-FX Ethernet Interface.
- Full support Layer 2 performance.



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The End of Presentation
Thank you very much!

