HUawei Dslam Technology and Product Pre-Sales Specialist Training
Content

1. Overview of DSLAM Technology
2. Basic xDSL concepts
3. Huawei DSLAM Solution
4. Huawei Product Introduction
What is DSLAM?

**DSLAM**: Digital Subscriber Line Access Multiplexer

A network device, which connects multiple customer digital subscriber line (DSL) interfaces to a high-speed digital communications channel using multiplexing techniques.
Digital subscriber line (DSL, originally digital subscriber loop) is a family of technologies that provide Internet access by transmitting digital data over the wires of a local telephone network.

**Mainstream xDSL technologies:** ADSL2+, VDSL2, SHDSL.

**Currently xDSL technologies:**
- **ADSL2+** (including ADSL) is the most mainstream broad band access DSL technology due to large scale used and well compatible.
- **VDSL2** is the newest and most advanced standard of digital subscriber line (DSL) broadband wire line communications. Vectoring improves the performance that downstream/upstream rate can theoretically reaches 100 Mbps.
- **G.SHDSL** has less latency, mainly used for E1/T1/V35 distance extension and enterprise leased line.
New copper technologies: VDSL2, Vectoring, G.fast and so on.

- VDSL2 is mature and scale used in commercial environment, the subscriber can be provided 50M@300m bandwidth.
- Vectoring will mature on 2013, and actually provides downstream rate at 100M@300m, 80M@500m bandwidth.
- G.Fast is expected to be used in commercial environment after 2012, and it can provide 1G@100m bandwidth each subscriber.
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ADSL Standard and Model

ADSL: Asymmetrical Digital Subscriber Line

- Standards:
  - ADSL G.992.1/ T1.413  G.dmt
  - ADSL G.992.2 G.lite
  - ADSL2 G.992.3 G.dmt.bis
  - ADSL2 G.992.4 G.lite.bis
  - ADSL2+ G.992.5 ADSL2 PLUS
- Transmit voice, data and video on a twisted pair simultaneously.
- ADSL2+ is an extension of ADSL. The upstream rate of ADSL2+ reaches 2.5 Mbit/s, and the downstream rate reaches 24 Mbit/s.
- The maximum transmission distance of ADSL2+ is 6.5 km.
ADSL Modulation-DMT

DMT: Discrete Multi-Tone

- It modulates data to multi-carrier, and the data on each carrier is modulated by QAM. DMT is by far the mainstream modulation technology.
- DMT uses 4.3125 kHz bandwidth as its unit. It divides a 1 MHz band into 256 subchannels. The POTS service occupies the band ranging from 300 Hz to 4 kHz on the telephone wire. By taking the isolation into consideration, DMT assigns the band from 0 kHz to 25 kHz (namely, the first six channels) to the POTS service. Therefore, only 250 subchannels are actually assigned for transmitting digital services.
- ADSL2 assigns the band as ADSL does, their downstream band is 1104 kHz. Since ADSL2 uses the enhanced modulation mode, its downstream rate can theoretically reaches 12 Mbps and its upstream rate 1.2 Mbps or so.
- ADSL2+ extends the bandwidth of ADSL to 2.208 MHz and uses DMT to split the bandwidth into 512 tones.
ADSL Annex

- ADSL Annex A: ADSL Over POTS
- ADSL Annex B: ADSL Over ISDN
- G.992.2: G.lite
- Annex I, Annex J: All digital mode ADSL
- Annex L: Reach Extended ADSL2
- ADSL2+ Annex M: Extending the capability of commonly deployed Annex A by more than doubling the number of upstream bits.

Note:
1. non-overlapped downstream PSD is same like annex B
2. For detail of f1 and inband PSD, see G.992.3
## ADSL Features Comparison

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<th>Enhanced coding function</th>
<th>Lower power consumption</th>
<th>Modularization structure</th>
<th>High rate &amp; Long distance</th>
<th>Enhanced coding function</th>
<th>Rate binding function</th>
<th>Lower power consumption</th>
<th>More stable running &amp; Good spectrum compatibility</th>
<th>Modularization structure</th>
<th>Seamless rate adaptation technology</th>
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<td><strong>ADSL2</strong></td>
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<td>Enhanced coding function</td>
<td>Rate binding function</td>
<td>Lower power consumption</td>
<td>More stable running &amp; Good spectrum compatibility</td>
<td>Modularization structure</td>
<td>Seamless rate adaptation technology</td>
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<td>INP(impulse noise protection)</td>
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<td>SELT, MELT</td>
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<td></td>
<td>SELT: Automatic test method for testing the DSL loop from one end of the line</td>
</tr>
</tbody>
</table>
VDSL2 Main Features

VDSL2: Very High Speed Subscriber Line Transceivers 2


- High-speed Transmission
- Compatibility with ADSL/ADSL2+
- Flexible Profile Configuration Solutions
- Long-distance Transmission
- Stronger Support for Video Service

Band plan covers frequencies as high as 30 MHz.
Bidirectional high-speed data transmission at 200 Mbit/s within short distances. The 30a spectrum profile supports a total minimum upstream and downstream rates of 200 Mbit/s, and 17a supports a total of 100 Mbit/s.

Dynamically adjust the interleaving depth according to the condition of error bits.

VDSL2 enhanced downstream transmit power (20.5 dBm). And achieves a maximum transmission reach of over 2.5 km.
VDSL2 Band Plan

High speed

Band plan covers frequencies as high as 30 MHz
VDSL2 profile introduction

- **17a and 30a profile**: Applicable to short distances, usually within 300 m. In fact, 30a is not widely applied and 17a is in more use. 17a provides a 100 Mbit/s downstream bandwidth and a 50 Mbit/s upstream bandwidth and applies to the FTTB+VDSL2 scenario.

- **12a/12b and 8c/8d profile**: 12a/12b and 8c/8d are applicable to medium distances, ranging from 300 m to 1000 m, and apply to the FTTC+VDSL2 scenario.

- **8a/8b profile**: Strong transmit power and are applicable to long distances. 8a and 8b are compatible with ADSL2/ADSL2+, provide a 30 Mbit/s/10 Mbit/s bandwidth, and apply to COs. 8b can provide a 20.5 dBm output power, which is equal to ADSL2+.

In terms of rate, VDSL2 is superior to ADSL2+ mainly within the distance of 1.2 km.
Various VDSL2 Line Profiles for the Bandwidth Needs on Different Scenarios

- If the rate curve of VDSL2 exceeds 1.5 km, the performance of VDSL2 is the same as that of ADSL2+. It is recommended to use VDSL2 within 1 km.
- 17a (compatible with 8a/8b/8c/8d/12a/12b) technology is mature. The majority of commercial operations use this technology; it is recommended to use 17a and 30a for different scenarios. 30a is used within 300 m, providing a maximum of 100 M downstream bandwidth; 17a is used between 300 m and 1 km, providing a maximum of 50 M downstream bandwidth.
Introduction of Vectoring technology

**Crosstalk cancellation**
*always call Vectoring*

- Define in ITU-T G.993.5, base on VDSL2
- Crosstalk is removed in vectored DSL system
- Rate, stability are improved greatly

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**Without Vectoring**

- Original Signal + Crosstalk → Received Signal

**With Vectoring**

- Precoded Signal + Crosstalk → Received Signal

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**17a Downstream data rates v.s. loop length (24 users)**

- Without Vectoring:
  - 200m: 76%
  - 300m: 69%
  - 400m: 63%
  - 500m: 65%
  - 600m: 56%
  - 700m: 45%
  - 800m: 39%

- With Vectoring:
  - 200m: 76%
  - 300m: 69%
  - 400m: 63%
  - 500m: 65%
  - 600m: 56%
  - 700m: 45%
  - 800m: 39%

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Differences between Vectoring DSL and traditional DSL

Main differences:
- Updates crosstalk matrix parameters in real time to ensure stability of the vectored group
- Backchannel implements matrix calculations
- Vectored group
What’s new introduced:
- Vector Control Unit, SLV need new VP card.

What’s updated:
- Backplane, 20+ Gbps vector I/F to each line card
- Vector Line card

What’s kept:
- Cabinet, cables
- Engineering experience

- MA5603T+H802MABO+H80BVCMM+H801VPE
- MA5616 + CCUE +VCMM
G.SHDSL developing

Before 2000

- SDSL
  - Symmetric DSL
  - 2B1Q, 144 to 768Kbps
  - Some claim 2.3Mbps
  - 1 pair HDSL

- ISDN DSL
  - 2B1Q, 144Kbps
  - Looks like ISDN to telco eqt

- HDSL
  - High-speed Symmetric DSL
  - 2B1Q, to 1.5Mbps
  - 2 pair
  - T1 only

After 2000

- G.shdsl
  - Multi rate symmetric DSL
  - TCPAM to 4.6Mbps
  - T1, E1, Frame, Cell

- HDSL2
  - High-speed Symmetric DSL 2
  - TCPAM to 1.5Mbps
  - T1 only

= non-standard
= standardized
G.SHDSL introduction

**G.SHDSL.BIS basic features**

- **Symmetrical** data rates in both the upstream and downstream directions, range from 192kbps to 5696kbps;
  - Transmission distance reach up to 4.3km (2312kbps) -- 8.2km (192kbps)
  - G.SHDSL.BIS uses TC-PAM32 modulation (G.SHDSL uses TC-PAM16 modulation)
  - Support of symmetric data rates made SHDSL a popular choice by businesses for private branch exchange (PBX), virtual private network (VPN), web hosting and other data services.

**SHDSL service**

- Flexibility
- Flexible bit rate to meet user's requirement
- Support **ATM, TDM, PTM**
- Easy to be developed
- Standard: **G.991.2**、G.994.1、RFC 3276 (for mib)
- Supported by many chips
- Frequency Compatibility
- Lower Cost
SHDSL employs TC-PAM modulation and frequencies that include those used by analog plain old telephone service (POTS) to provide equal transmit and receive (i.e. symmetric) data rates. As such, a frequency splitter, or DSL filter, cannot be used to allow a telephone line to be shared by both an SHDSL service and a POTS service at the same time.
G.SHDSL Application

- Single-pair high-speed digital subscriber line (SHDSL), defined by ITU-T (such as ITU-T G.991.2), is a data transmission technology over twisted pairs to transmit voice, data, and video signals.
- SHDSL provides the symmetric upstream and downstream rates.
- SHDSL includes ATM SHDSL, EFM SHDSL, TDM SHDSL:
  - **ATM SHDSL**: ATM SHDSL provides symmetric broadband access services for subscribers to meet the requirement for high downstream rate from SOHO subscribers.
  - **EFM SHDSL**: EFM SHDSL can provide traditional voice service and high rate Internet access service over common twisted pairs to meet the requirements for high definition TV service and VoD service from subscribers, which suit the last mile access for broadband to the campus.
  - **TDM SHDSL**: TDM SHDSL is a mode to transmit TDM signals through SHDSL.
## Comparison between SHDSL and ADSL2+, VDSL2

<table>
<thead>
<tr>
<th></th>
<th>G.SHDSL.BIS</th>
<th>G.SHDSL</th>
<th>ADSL2+</th>
<th>VDSL2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modulation</strong></td>
<td>TC-PAM32</td>
<td>TC-PAM16</td>
<td>DMT</td>
<td>DMT or QAM</td>
</tr>
<tr>
<td><strong>Date rates</strong></td>
<td>192kbit/s~5696kbit/s</td>
<td>192kbit/s~2312kbit/s</td>
<td>Upstream: 2.5Mbit/s</td>
<td>Upstream: 100Mbit/s</td>
</tr>
<tr>
<td></td>
<td>(single pair)</td>
<td>384kbit/s~4624kbit/s</td>
<td>Downstream: 24Mbit/s</td>
<td>Downstream: 100Mbit/s</td>
</tr>
<tr>
<td></td>
<td>(double pairs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Symmetric</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>selected</td>
</tr>
<tr>
<td><strong>Maximum distance</strong></td>
<td>6.5km</td>
<td>6.5km</td>
<td>6.5km</td>
<td>1.2km</td>
</tr>
<tr>
<td><strong>Used with POTS</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Transmission method</strong></td>
<td>TDM/ATM/PTM</td>
<td>TDM/ATM</td>
<td>ATM/PTM</td>
<td>PTM</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>Enterprise</td>
<td>Enterprise</td>
<td>Resident</td>
<td>Enterprise/resident</td>
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Over view of DSLAM Solution

- Internet
- Softswitch
- BTV/VoD
- Game
- MCU
- BSC/RNC
- iManager U2000
- IP/MPLS
- Core network
- SmartAX DSLAM
- GE
- ADSL/ADSL2+
- Small Enterprise
- Large/Medium Enterprise
- Resident
- Phone
- HSI
- IPTV
- Game
- Video phone
- HSI
- VPN
- IP Centrex
- HSI
- VPN
- Video Conference
- Mobile
- BTS
- NODE B
- G.SHDSL
- GE
- ADSL2+/VDSL2
- GE

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**DSL Bonding Provide High Bandwidth**

- **Application Scenarios:**
  - High bandwidth access
  - Long distance broadband coverage
  - Mobile backhaul

- **Provide almost N times bandwidth with N pairs bonding**
- **Distance increases compare to one DSL pair with the same bandwidth**
- **Reuse the abundant copper line resource and provide FTTH like bandwidth**
Various VDSL2 scenarios

- Various profiles supported:
  30a, 17a, 12a, 12b, 8a, 8b, 8c are all supported
- Flexible PSD Control
  DPBO, UPBO, PSD Notching, MIB Controlled PSD
- Enhanced INP
  INP UP TO 16
- Backward compatibility to ADSL2+
- Auto-sense VDSL2 PTM/ATM mode

- Fulfills various requirement scenarios
- Overcomes noise & minimizes interference
- Improved Video Quality
G.SHDSL.bis for Business Services

- Data rates of single pair ranges from 192kbps-5696kbps symmetrically
- G.SHDSL service boards support two-pair ATM bonding, 2/3/4 EFM bonding and IMA bonding. The IMA bonding supports a maximum of 16 groups.

- Symmetric services
- Higher bandwidth or Long distance
- Higher reliability
Entirely Speed Up: System Level vectoring

- Bandwidth gain of vectoring is from 62% to 76%
- Vectoring rates are very close to single line performance

The vectoring VD card supports 48 ports.

- Cables come from more than one card
- Crosstalk happens in whole bundle copper cable
- System level Vectoring cancels the crosstalk of the entire bundle of cables
- MA5603T supports 6 cards vectoring, which has the highest density in the industry.
Point to Point Fiber Access for Enterprise

- Easy launch: convenient enterprise access service with DSLAM!
- Higher bandwidth: dedicated FE/GE Ethernet access for high level user!
- Higher availability: carrier-class reliability and OAM for Ethernet access!
- Easy management: with QinQ feature, operator and enterprise can manage service independently!
- High density (MA5600T): 48 ports per card, one frame support 768 P2P interfaces!
- MA5603T/MA5608T/MA5616 support GPON uplink port
Smooth Migration from ATM to IP

Customized Migration Solution
- **ATM Aggregation**
  - Other vendor ATM DSLAM
  - STM-1
  - IP DSLAM MA5600T
- **Subscriber Cutover**
  - Other vendor ATM DSLAM
  - IP DSLAM MA5600T

Abundant Migration Experience
- 10+ global successful cases
- Local migration experience

Quick Migration Implementation
- **Engineering Implementation**
- **Service Seamless Inherit**
  - ATM DSLAM cascading: 4*STM-1 interface
  - HSI service: 4k PPPOA to PPPOE
  - ATM leased line service: MPLS ATM PWE3
  - IPTV service: provide by IP DSLAM
- **Data Migration Tools**
  - OSS rapid integration
  - Data migration tools for batch operation

- Reduce OPEX by reusing ATM DSLAM and wipe out ATM aggregation network
- Increase revenue by satisfy customers' requirement for new services
MPLS PWE3 for Reliable TDM Leased Line Inheritance

- First E2E MPLS network in-the-industry
- TDM E1 access over IP DSLAM reduce 30% OPEX

Benefits of TDM Inheritance On DSLAM

- **Simplified Network With ALL-IP**
  - Unify the network for broadband and traditional DDN/FR/ATM with low TCO

- **SDH-like Availability**
  - Uplink switch over protection < 50ms
  - Access switch over protection <200ms(LACP+), <100ms(BFD)

- **Smooth Evolution for DDN/PBX**
  - E1/V35 accessed with GSHDSL
  - Clock synchronization with BITS/E1/Ethernet Syn/1588v2/NTR
  - TDM/ATM emulation with MPLS PWE3

- **Service Quality Assurance:**
  - H-QoS
  - MPLS VPN/E-LAN

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Unified Network Management System Solution

- Centralized and unified management for all the Network Elements: OLT, DSLAM, MSAN, MDU, ONT.
- Minimal on-site software work. Profile-based batch operation, off-line pre-configuration.
- Flexible Northbound Interfaces to integrate with OSS.
- High Performance, Scalability, Reliability.
Intelligent Line Assurance System - iManager N2510

- ATCA architecture
- Maximum management capacity of 5 million ports.
- WEB Client
- TL/XML NBI

OSS

N2510

WEB Client

FTP

NMS for DSLAM/MSAN

OSS

ADSL2/ADSL2+/VDSL2

Home gateway

MDF

Local Office

IP Network

DSLAM

ADSL2+/VDSL2

Home gateway

Remote Site

OLT

GPON

Local Office

IP Network

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Huawei DSLAM Series

IP DSLAM

MA5600 Series

MA5600T Series

NG IP DSLAM

Out door cabinet:
D500, S300, S100

MA5600
MA5603
MA5600T
MA5603T
MA5608T
MA5616
### MA5600T Series DSLAM Detail Description

#### MA5600T

**High-Capacity DSLAM**
- 10U height DSLAM
- GE/10GE uplink/cascading
- 21 inch frame, 300mm slim design
- 2 *main control slots, 16*service slots,2*uplink slots

**Features**
- 64*16 ADSL2+
- 64*16 VDSL2
- 16*16 G.SHDSL
- 64*16 POTS
- (16*E1+16*TDM G.SHDSL)*16
- 48*16 P2P GE

#### MA5603T

**Medium-size DSLAM**
- 6U height DSLAM
- GE uplink/cascading
- 19 inch frame, 300mm slim design
- 2 *main control slot, 6*Service slots,2*uplink slots
- Boards are same as MA5600T

**Features**
- 64*6 ADSL2+
- 64*6 VDSL2
- 16*6 G.SHDSL
- 64*6 POTS
- (16*E1+16*TDM G.SHDSL)*6
- 48*6 P2P GE
MA5600T Series DSLAM Detail Description

**MA5608T**
- Small-size DSLAM
  - 2U height DSLAM
  - GE uplink/cascading
  - 19 inch frame, 300mm slim design
  - 2*main control slot, 2*Service slots
  - Boards are same as MA5600T
- 64*2 ADSL2+
- 64*2 VDSL2
- 16*2 G.SHDSL
- 64*2 POTS
- (16*E1+16*TDM G.SHDSL)*2
- 48*2 P2P GE

**MA5616**
- Mini DSLAM
  - 2U height MDU, 300depth
  - 1*main control slot, 4*Service slots
  - GPON/GE uplink
- 32*4 ADSL2+
- 24*4 VDSL2
- 64*4 POTS
MA5600 Series DSLAM

Central Office

MA5600

Remote Sites

MA5603

MA5616

HOME

Outdoor Cabinet

F01D500

GE

GE

ADSL2+/VDSL2/GSHDSL

Ethernet P2P

ADSL2+/VDSL2

Ethernet P2P

F01S300

F01S100

Outdoor Cabinet

Outdoor Cabinet

Outdoor Cabinet
MA5600 Series DSLAM Detail Description

### Large-size DSLAM
- 19-inch frame, 10U height
- 2 main control slots
- 14 service slots
- 6GE/FE for uplink/cascading
- ATM interfaces: 4*STM-1
- 8 GE/FE for VIP access
- 64*14 ADSL2+
- 32*14 VDSL2
- 32*2 G.SHDSL

### Medium-size DSLAM
- 19-inch, 5U height
- 1 main control slot
- 6 service slots
- 6GE/FE for uplink/cascading
- ATM interfaces: 4*STM-1
- 8 GE/FE for VIP access
- 64*6 ADSL2+
- 32*6 VDSL2
- 32*6 G.SHDSL