Ethernet based Broadband Access Networks

Abhay Karandikar
Department of Electrical Engineering
IIT Bombay
Mumbai 400076
karandi@ee.iitb.ac.in

ICBN 2003, Bangalore,
Invited Talk

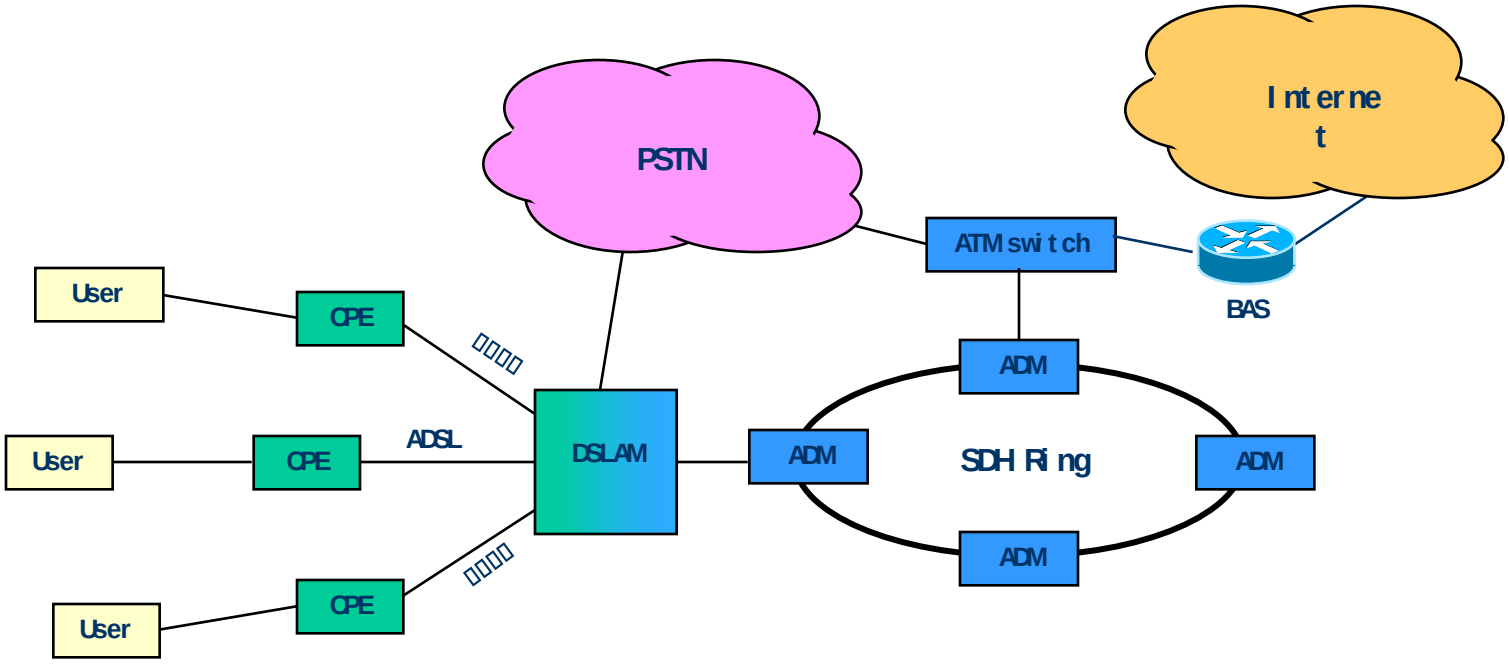
Agenda of Talk

- Current Broadband Access Architecture
- Ethernet in Next Generation Access
  - Ethernet in First Mile
  - Ethernet in Metro Access
- Transport Mechanism
  - Ethernet in Metro Access
    - Role of MPLS
  - Ethernet in First Mile
    - Eiso Architecture

Current Broadband Access Architecture

- First Mile
  - xDSL
  - DOCSIS Cable Network
  - Broadband Wireless
- Metro Access
  - Physical Layer
    - SONET/SDH
  - Transport
    - ATM

DSL Access Architecture



Limitations of Current Access Architecture

- Low bandwidth
- High cost per port
- Inflexible provisioning
- For converged data, cell based/TDM based technology is inefficient

Requirements of Next Gen Broadband Access Architecture

- Scalable aggregation
- High bandwidth
- Efficient transport of voice, data and video
- Quality of Service (QoS) guarantees and usage based billing
- Rapid deployment and provisioning
- Protection and restoration capability

Next Gen Broadband Access

- First Mile
  - Ethernet in the First Mile (EFM)
- Metro Access
  - Next Generation SONET/SDH
    - Ethernet over SONET/SDH
  - Gigabit Ethernet
    - 1/10 Gbps Fully meshed architecture
  - Resilient Packet Ring/Dynamic Packet Transport

Standardization

- Ethernet in First Mile
  - IEEE 802.3ah
- Ethernet in Metro Access
  - Metro Ethernet Forum (MEF)
  - MPLS Forum
  - IETF MPLS Working Group
  - IETF PWE3 Working Group

Ethernet in First Mile

- Efficient transport of broadband data
- Rapid provisioning
  - Ethernet based solution can scale in granularity of 64 Kbps
- Optimized solution for multi-tenant/multi-unit residential/office building
- With Ethernet in Metro and Ethernet in Enterprise, EFM provides end to end Ethernet solution

EFM (IEEE 802.3ah) Approaches

- EFM Copper (EFMC)
  - 10 Mbps over Copper up to at least 750 meters
- EFM Fiber (EFMF)
  - 100 Mbps and 1 Gbps up to at least 10 Kms
- EFM PON
  - 1 Gbps and beyond upto 20 Kms.

Ethernet in Metro Access

- Reduces the cost of per user provisioning
- Efficient and Flexible transport
- Ease of Interworking
- Ubiquitous adoption

Metro Ethernet Forum (MEF) Services

- Ethernet Line Service
  - Point to Point Service
- Ethernet LAN Service
  - Multipoint to multipoint

(Source: Metro Ethernet Forum white paper)

Carrier Class Ethernet-Requirements

- Notion of Ethernet Virtual Circuit
  - Connects two or more UNI
  - Like ATM Virtual Circuit
- Guaranteed SLA and QoS Attributes
  - Committed Information Rate (CIR)
  - Committed Burst Size (CBS)
  - Peak Information Rate (PIR)
  - Maximum Burst Size (MBS)

Carrier Class Ethernet

- 50ms Resiliency and Protection
- Support of TDM voice through Circuit Emulation
- Provisioning and Service Management

Transport for Ethernet Services

- Native Ethernet
  - IEEE 802.3, 802.3ad, 802.1p, 802.1Q, 802.1s, 802.1x
- MPLS
  - RSVP-TE
  - DiffServ for QoS

Ethernet as Transport - Limitations

- Carrier class features
  - No admission control
  - No buffer management/scheduling
  - No concept of Ethernet circuit with QoS features and end to end context
  - Inefficient multi-service transport
- Scalability
  - Limited VLAN Tag space
  - Large number of MAC addresses

Ethernet Limitations

- Protection and Restoration
  - Limited protection and restoration
    - Available only through Rapid Spanning Tree protocol
- Performance Management
  - No OAM capability in Ethernet

MPLS as Transport Mechanism

- Scalability in terms of aggregation
- End to End QoS
  - Guaranteed Bandwidth LSP
- Offers circuit setup and traffic engineering capabilities
- Protection and Restoration
  - MPLS-TE (Backup LSP/LSP Preemption, Fast Reroute Option)

MPLS Bridges the gap

- Ethernet Encapsulation over MPLS
  - Bridging the gap for providing Ethernet Line and Ethernet LAN services
    - Martini Draft
      - Layer 2 Ethernet VPN (point to point)
    - Kompella Draft
      - Layer 2 Ethernet VPN (point to multipoint)

Challenges…..

- Effective multi-service transport
  - Circuit Emulation
    - TDM circuit emulation over Packet Switched Network (CSEoPSN) (Sasha Draft)
- MPLS performance monitoring and service provisioning

Ethernet in First Mile--Issues

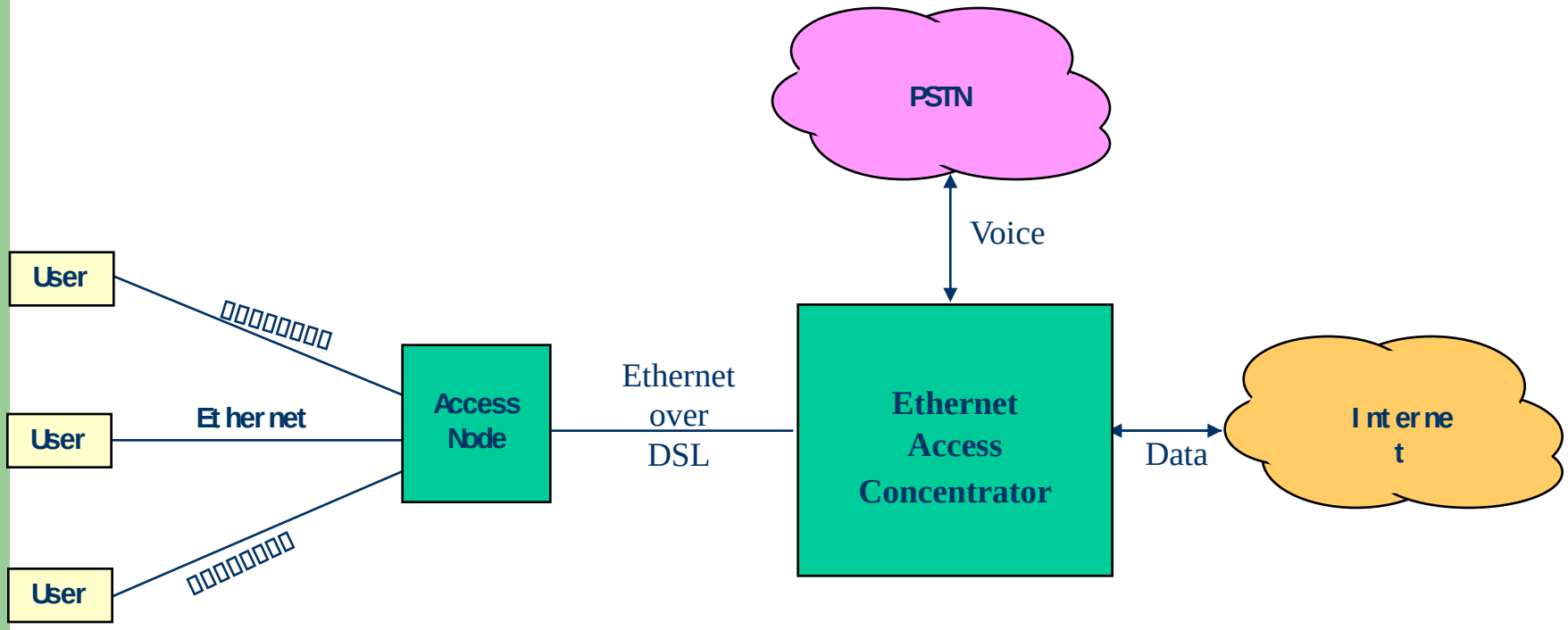
- IEEE 802.3ah working on MAC and PHY layer and OAM issues
- Issues not attempted
  - Bandwidth Reservations and QoS in EFM
  - Broadband Loop Emulation for multi-service transport

Eiso Access for EFM

- Eisodus Networks, a company incubated in IIT Bombay developing architecture for QoS management in EFM
- EFM Topology
  - Hub and Spoke
  - Tree and Branch

(Eiso Access is patent pending concept of Eisodus Networks)

Ethernet Access Architecture



Eiso Access Architecture

- Ethernet transport in First Mile is on Ethernet Circuit
- Ethernet Circuit has QoS attributes
- Ethernet Switches in First Mile support QoS at Layer 2 (Priority Scheduling and Packet Dropping)
- Ethernet circuits can be aggregated into MPLS LSP at Ethernet Access Concentrator (which acts as LER)

Eiso QoS Management

- Ethernet Circuit
  - Statically provisioned through NMS
  - Dynamic provisioning through proprietary protocol
- TDM Voice over Ethernet Circuit
  - Broadband Loop Emulation
- Service Level Specification
  - CIR
  - CBS
  - Enforced through Ingress Rate Limiting

Conclusions

- Ethernet evolving as Next Generation Access Technology
  - Cost Effective
  - Flexible
  - Simple
- MPLS with TE capabilities is key to provision Ethernet Services in Metro Access
- Proposed Eiso Architectures provides the bridge between Metro and Customer in First Mile

Acknowledgements

- Eisodus Networks Pvt Ltd
  - Sunil Mehta
  - Abhijit Gadgil
  - Zainul Charbiwala
  - Praveen Kumar