
The Role of Traffic Management in Broadband Access Systems

DSL Market Trends

- Operators seeking enablers to make DSL the broadband access method of choice by:
 - Growing their networks
 - Economically increasing coverage
 - Increasing the value, provided by those networks
 - Expands the market they can address
 - Video alone can double the TAM
 - Sometimes called the Triple Play
 - But why stop at three?

What “Enablers” Are Required?

- Growing networks/increased coverage
 - Distributed architecture capability
 - Network-scale
 - Large DSLAMs in CO to efficiently serve high-density, short loop customers
 - Small DSLAMs in the plant/curb/basement to expand coverage while maintaining high BW capability
 - Equipment (DSLAM) scale
 - Cost-effectively scales from low-end pizza box to high-end rack using same basic architecture
 - Pay-as-you-grow incremental approach
 - Ethernet/IP capability as part of a multiservice offering
 - Allows low-cost alternatives to ATM in the access network
 - Allows use of widely deployed IP services
 - Controlling the access to IP based services
 - Still must support ATM over the DSL link
 - Multiservice support is critical to address all markets

What “Enablers” Are Required? (Cont’d)

- Increasing value/expanding market
 - Higher BW
 - QoS and traffic management capabilities
 - Flexible wire-speed classification and filtering
 - The combination of the above three capabilities provides next-gen network capabilities
 - BW guarantees gold/silver/bronze service grades
 - Bounded latency for delay-sensitive applications
 - Provisioning flexibility (business users vs. residential)
 - Security features necessary for Ethernet transport and MS-protocol handling, etc.

Creating a Wealth of New Revenue-Generating Opportunities for Operators

Move Applications from Trendy to Everyday Use

- Online gaming
- Video/audio conferencing
- Video/audio streaming and downloads
- Real-time video
- Virtual private networks
- Virtual shopping
- Video on demand
- Remote security surveillance
- And so much more!



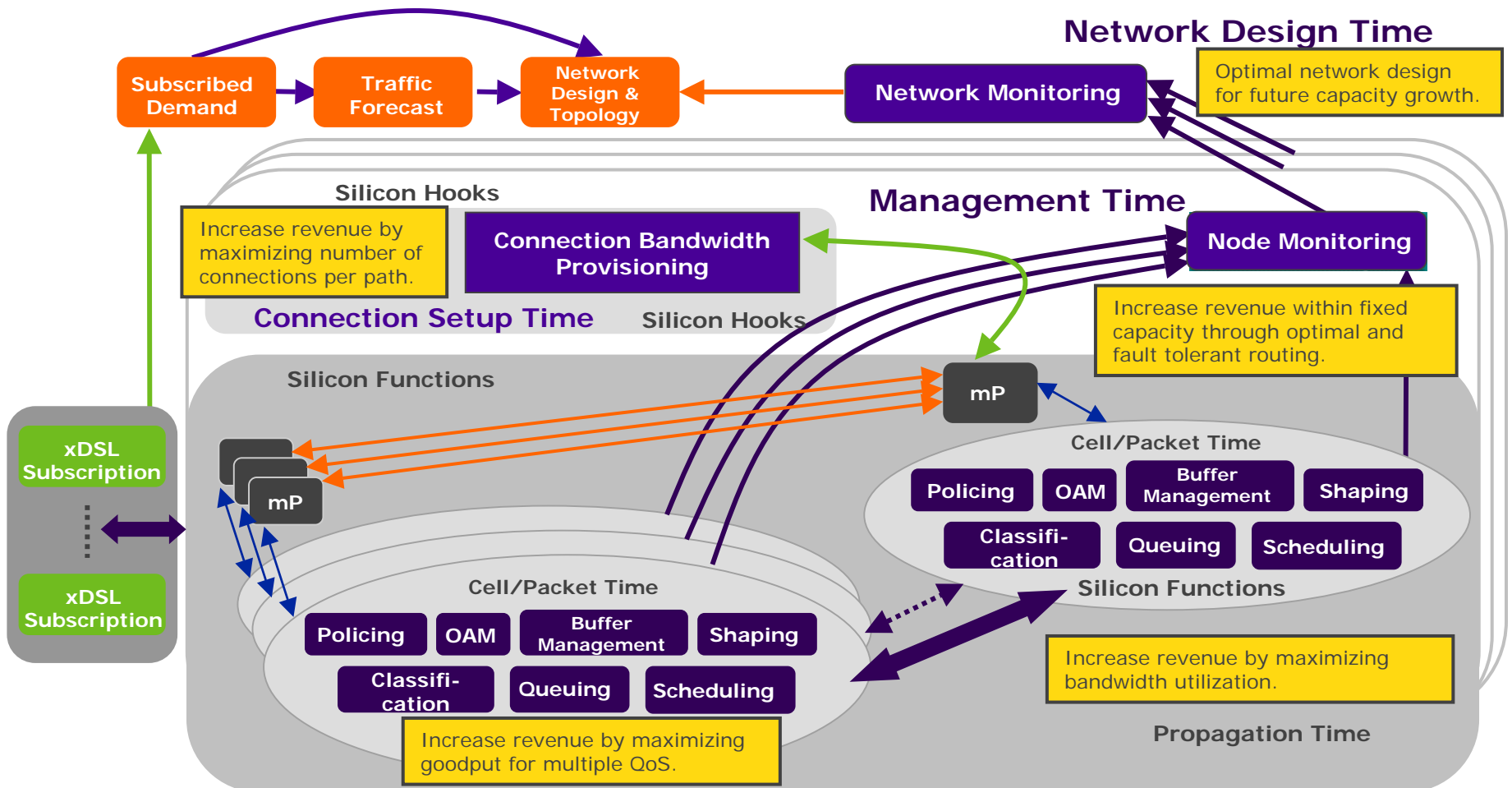
Personal Broadband to Everyone in Household Anytime

Traffic Management as an Enabler for DSL QoS

Traffic Management

- Classical view includes policing, scheduling/shaping, buffer management, backpressure, CAC, etc.
 - Maintains network efficiency
 - Important in SP networks—BW is not free.
 - Key to keeping services affordable
 - Delivers QoS guarantees (BW, delay, etc.)
 - For individual customers and services
 - Despite oversubscription and congestion
- Broader view includes classification and modification
 - Important for distinguishing, manipulating, isolating (i.e. security) and aggregating user flows

Traffic Management: Occurs at Different Timescales



- Silicon capabilities are most influential at shorter timescales, control/management software at longer timescales.

Importance of Flexible Classification and Modification

- DSL requires highly flexible filtering and packet modification options due to the variety of protocol options and security needs, e.g.,
 - User isolation is critical for WAN services
 - VLAN tag insertion/modification/stacking
 - Spoofing protection
 - Source MAC address and/or IP address checking
 - MAC bound to IP address via DHCP snooping
 - Only traffic from validated addresses allowed
 - Protocol type checking (i.e. discard all except PPPoE)
 - Forced forwarding (subscriber only allowed to communicate with default gateway)
 - All subscriber ARP requests are returned with the MAC address of the gateway
 - Service mapping: VC type to VLAN
 - PPPoA to PPPoE conversion
 - PPP termination

Traffic Management Efficiency and Effectiveness

- Can be huge disparity in effectiveness of approaches to achieve a given objective
 - Simple example: policing vs. shaping to enforce 128 Kbits/s maximum bandwidth limit
 - Application throughput of 84 Kbits/s with policing, 121 Kbits/s with shaping
 - Another example: maximizing goodput with bursty traffic
 - Static buffer management requires six times more buffer space than dynamic buffer management
- Supporting even 10% more subscribers with the same level of service can enable a DSLAM to generate thousands of dollars of additional revenue per month
- Often must simulate alternatives with expected traffic workloads to rigorously compare approaches. Higher workload = higher revenue

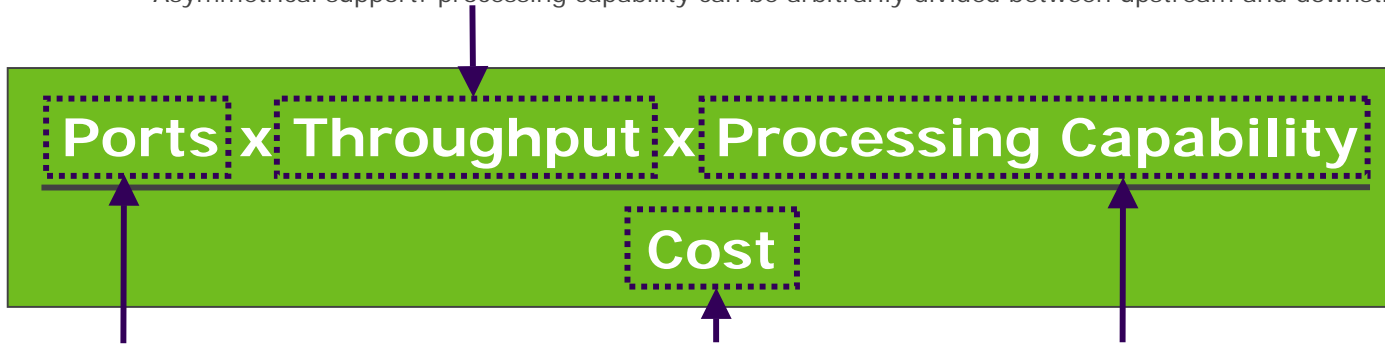
TM Summary

- Traffic management and flexible classification and modification functions are essential for maintaining network efficiency and delivering QoS guarantees
- The need to effectively deliver these features is very apparent in DSLAMs and other oversubscribed systems
 - Oversubscription keeps network costs low and services affordable
- There is a wide disparity in efficiency and effectiveness of traffic management approaches
- It is critical to understand both efficiency and effectiveness economics and associated implementation costs

Agere as an Enabler for Traffic Management

Agere NPs Economically Deliver World-Class, Next-Gen Enablers

- Purpose-built NP architecture provides high-throughput solutions:
 - Highly predictable performance: complete data and control plane separation (**not** a communications processor)
 - Asymmetrical support: processing capability can be arbitrarily divided between upstream and downstream

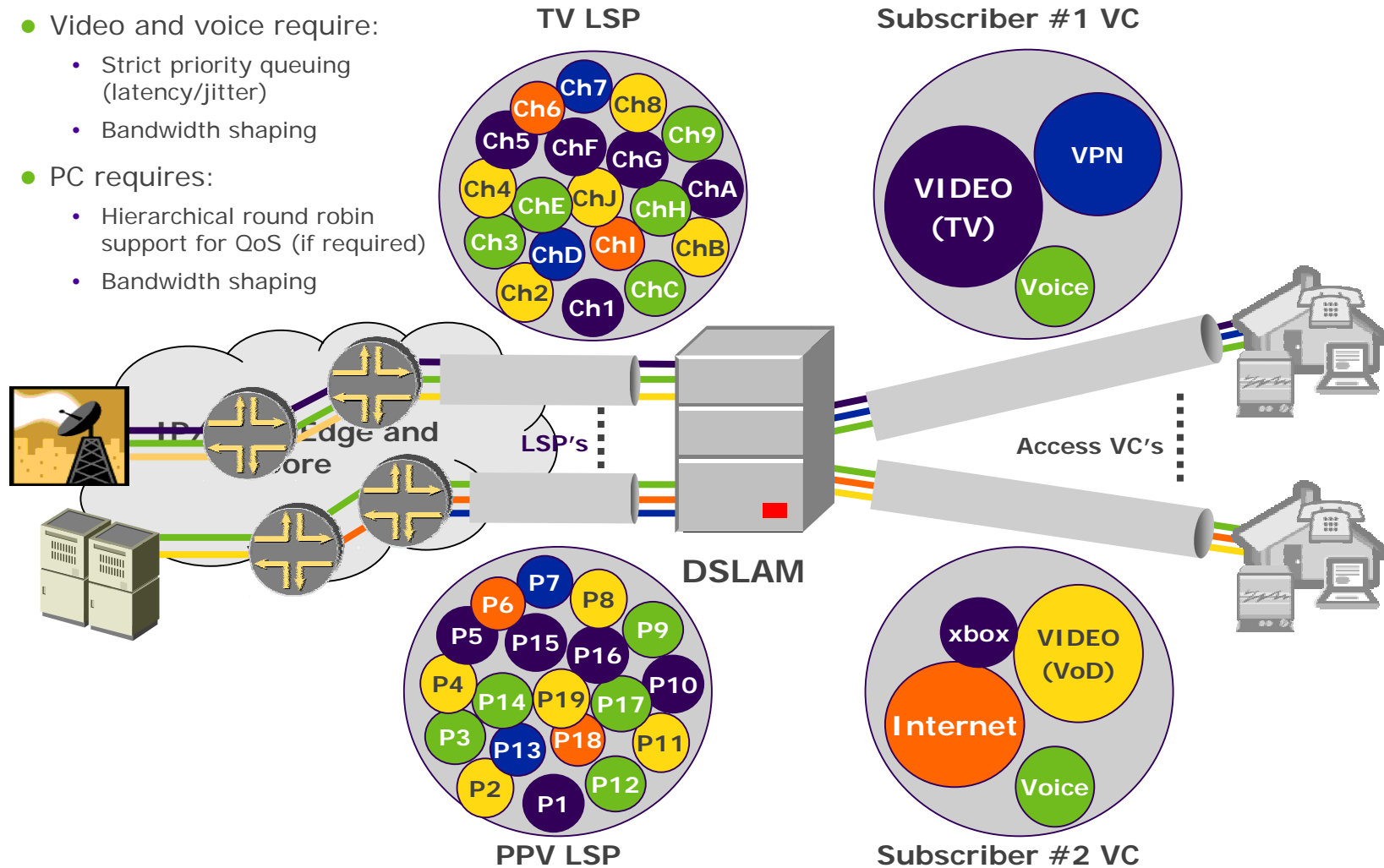


- Interface options are independent of throughput and processing capability, allowing the same base architecture to be leveraged on all product variations (pizza box, CO DSLAM, etc.)
- Multiple interface options allows support of a range of protocol and physical layer options (FE/GE, UTOPIA-2, POS-2)
- Economically delivers features
 - Low cost memory
 - Embedded host processor
 - Low cost PCB
- QoS and traffic management; classification; filtering; policing, etc.
 - All at wire rate, while supporting multiple protocol options
 - Key enablers for advanced services

- . . . at lowest cost of ownership
 - Short, simple programs with predictable performance
 - Rapid code development
 - Reusable across entire product family
 - Low maintenance and high reliability

Example—MPLS LSPs Per Service

- Video and voice require:
 - Strict priority queuing (latency/jitter)
 - Bandwidth shaping
- PC requires:
 - Hierarchical round robin support for QoS (if required)
 - Bandwidth shaping



DSL Hierarchical Scheduling

