Document Number: 802.16mp-99/01

Title: Proposal for a MAC Layer Approach Agnostic to Higher Level Protocols

Date Submitted: 1999-11-11

Source:

Ray W. Sanders
CircuitPath Network Systems Corporation
P O Box 24950
Los Angeles, CA 90024

Voice: (310) 476-5063
Fax: (310) 471-7854
E-mail: rws@CircuitPath.com

Venue: Montreal, Quebec, Canada

Base Document:

802.16mc-99/01 URL <http://grouper.ieee.org/groups/802/16/mac/contrib/80216mc-99_01.pdf>

Purpose:

To propose that the 802.16 standard be based on defining a sub-layer MAC layer protocol that separates bandwidth-on-demand connectivity from higher layer MAC and other user and network protocols.

Notice:

Release:

IEEE Patent Policy:

Presentation Outline

- How can 802.16 be protocol agnostic to higher level protocols?
- Common threads in today's networks
- A proposed MAC layer extension
- Simulation example
- Conclusion

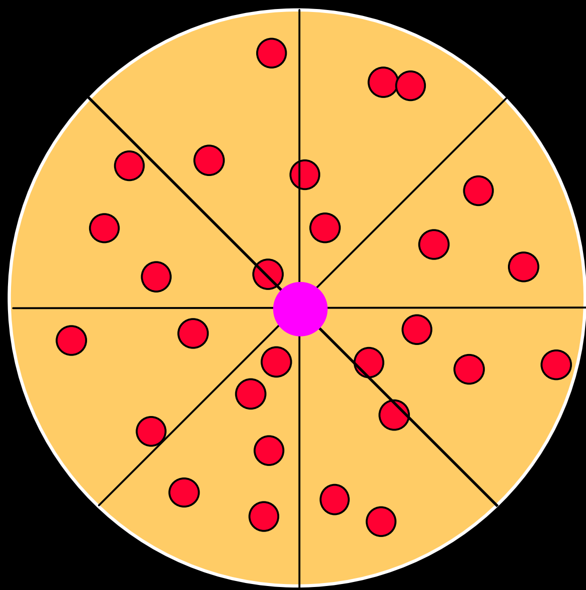
Reference Model

- A single Base Station and one or more Subscriber Station(s)
- FDD or TDD
- Symmetrical or asymmetrical
- Bandwidth allocations controlled by Base Station

The 802.16 Challenge

How do we produce a broadband wireless access system standard that is agnostic to current and future user and network protocols?

What Base Functionality Do Service Providers Need?



"My world is like Pepperoni Pizza. All I want is bandwidth-on-demand connectivity from a base station to all the pepperoni."

Sherman Ackley, Orlando 802.16 January meeting

One Common Thread

Network architects are using

“mini-slots”

to efficiently manage bandwidth

in shared-media-network

system designs

Other Common Threads

- **Network architects are concluding that the best approach to providing robust QoS is to develop "admission control" and "flow control" strategies**

And …

- **Effective edge-node to edge-node bandwidth scheduling is the essential design requirement**

A Growing Consensus

But …

No universal mechanism has yet been deployed that solves the QoS problem —

It all seems too complicated

using <u>only</u> level 3 & 4 protocols

A New Approach

- **Find *simple* methods of *dynamically* allocating network bandwidth**
- **Devise strategies that require traffic buffering only at network edges**

Analogous Scheduling Methods That Work

- **How is traffic handled within a single node of a network?**
  - **Isochronous traffic is passed across backplanes in small scheduled intervals**
  - **Non-isochronous traffic is passed across backplanes using various (weighted or unweighted) queuing algorithms plus backplane scheduling**

Single Nodes *versus* Point-to-point Links

Scheduling

input/output traffic

<u>over</u> a backplane and

scheduling traffic <u>between</u>

interconnected backplanes are

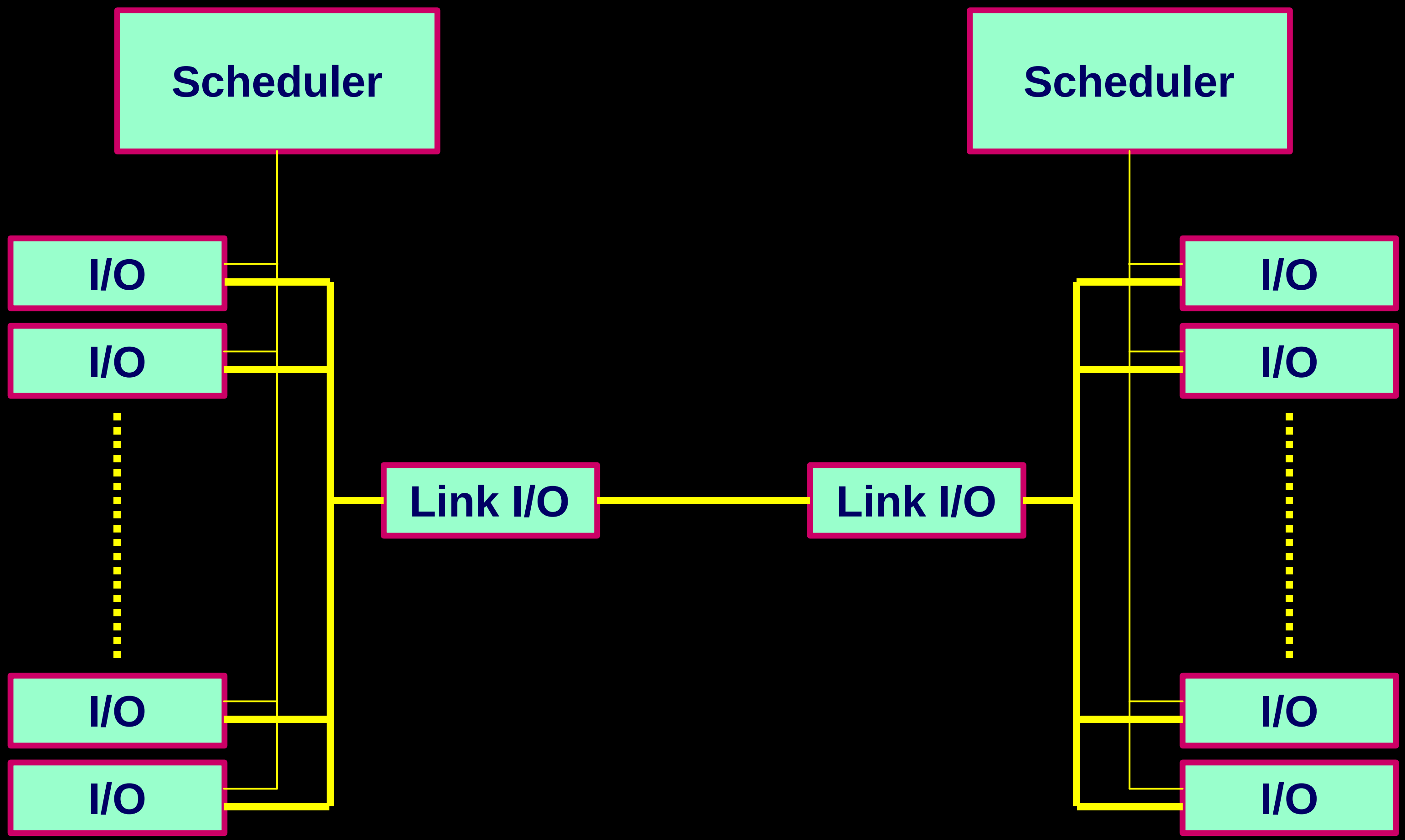
both examples of

two-point scheduling processes

Backplane Scheduling For One and Two Units

- **Within a single unit, one scheduler can handle both input and connected output traffic**
- **Between two units, it is necessary to synchronize schedulers at two ends of a link**

The Two-Unit Case With Synchronized Schedulers



Synchronizing Schedulers at a Distance

- **Linking backplanes locally and**

  linking backplanes at a distance:

what are the differences??

Answer:

- **Propagation delay is a function of distance between backplanes, and**
- **The likelihood of link transmission errors increases with distance – *but* –**
  - ***Neither factor substantially alters the scheduling requirements***
  - ***Distance-sensitive parameters are tractable***

Some Things Bandwidth Schedulers Can Do

- Support class of service offerings
- Provide agnostic support for all network protocols
- Eliminate the need for traffic shaping and user parameter control
- Eliminate end-to-end packet and/or cell delay variation

A Unique Opportunity

- **Broadband Wireless Access systems present a unique opportunity to apply these simple principles**
- **Properly applied within 802.16, the standard can become a paradigm as a next-generation approach to MAC-PHY protocols**

CBR Channel Models

- Full period service
  - Permanent link bandwidth allocated
- Contention service
  - High connect probability with guaranteed after-connect bandwidth
- TASI-like service
  - Release connection during periods of silence
- Best available CIR
  - Initial bandwidth close to CIR as possible and guaranteed after connection

VBR Channel Models

- **Guaranteed minimum bandwidth**
  - **Priority additional bandwidth as needed**
- **Guaranteed minimum bandwidth**
  - **Priority but limited additional bandwidth**
- **Guaranteed bandwidth with delay**
  - **Bandwidth required averaged over several seconds to reduce volatility**
  - **Once established, delay remains constant**

ABR Channel models

- **Guaranteed Minimum Bandwidth**
  - **Maximum bandwidth determined by the application, not the network, except for traffic load from other high priority traffic**
- **Guaranteed Minimum with Defined Maximum**
- **No Guaranteed Minimum Bandwidth**
  - **Priority given over lower service classes**

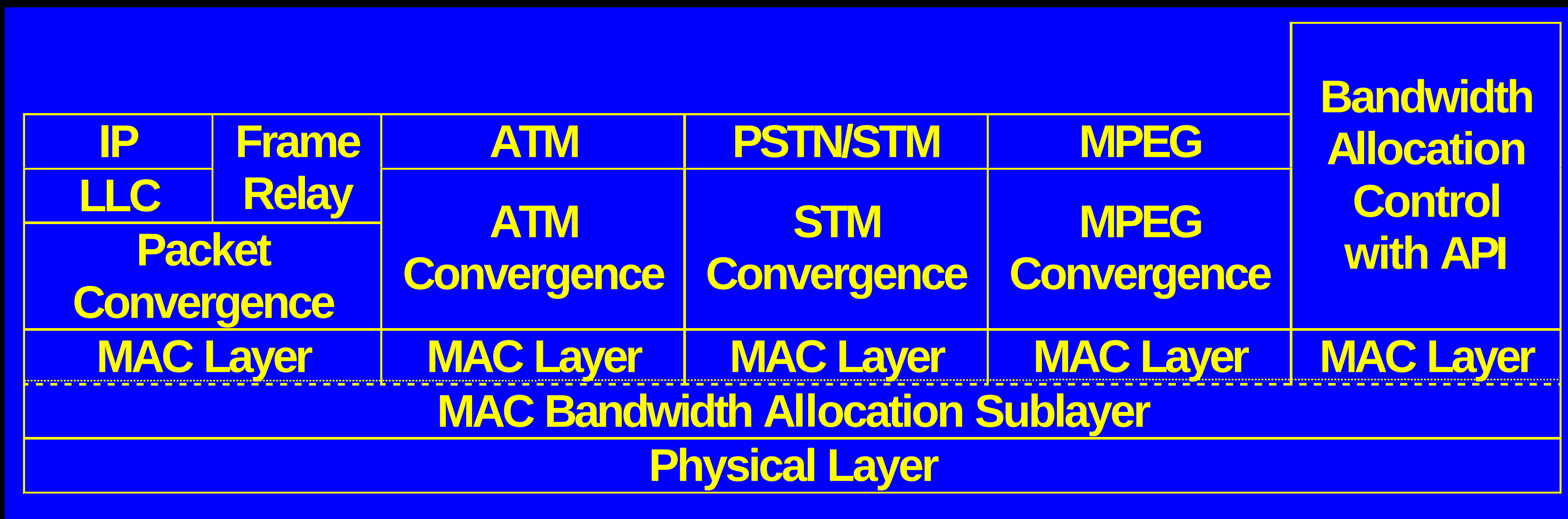
UBR Channel Models

- **Traffic Limited to Percentage of Total Non-CBR Traffic**
- **Traffic Limited to Bandwidth Unused by Other Channels**

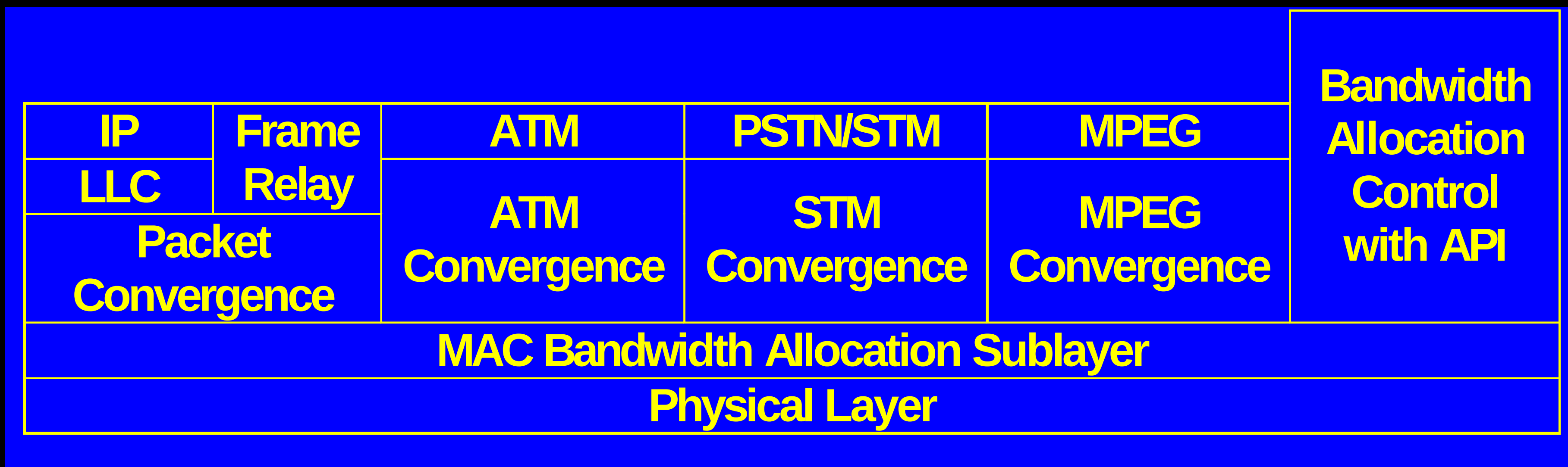
Working Hypothesis for Coherent Networks

- CBR and VBR traffic assigned bandwidth priority
- All non-isochronous traffic buffering occurs only at network edges - no buffering needed within intranetwork links

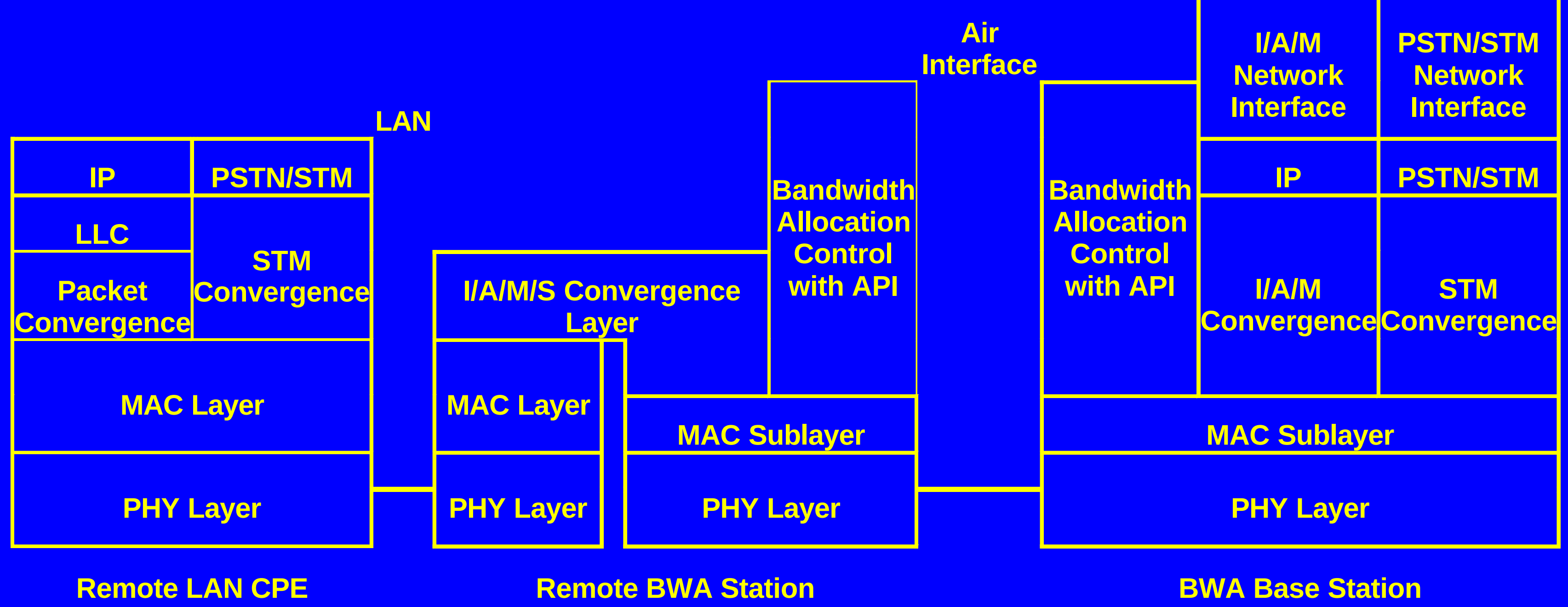
Proposed MAC Sublayer



Alternative Architecture



LAN Extension Example



I/A/M/S = Internet ATM MPEG STM

MAC Sublayer = MAC Bandwidth Allocation Sublayer

Example of Proposed Architecture with LAN Extension

Simulation Parameters and Results for Non-Isochronous Applications

A Way of Handling Asynchronous Data

- All data are treated as “flows”
- One-packet flows are allowed
- Channel bandwidth is first assigned based on an expected or application-defined QoS value
- Channels without QoS values share common bandwidth using network-defined principles

Non-Isochronous Data Input Buffer Strategy I

- **Segregate traffic into "flows" by:**
  - Type (ATM, IP, IPX, frame relay, etc)
  - Quality of service type (VBR, ABR, UBR)
  - Defined latency
  - Defined error rate
  - Quality of service subtype
- **Result: class based queuing (CBQ) and/or weighted fair queuing (WFQ)**

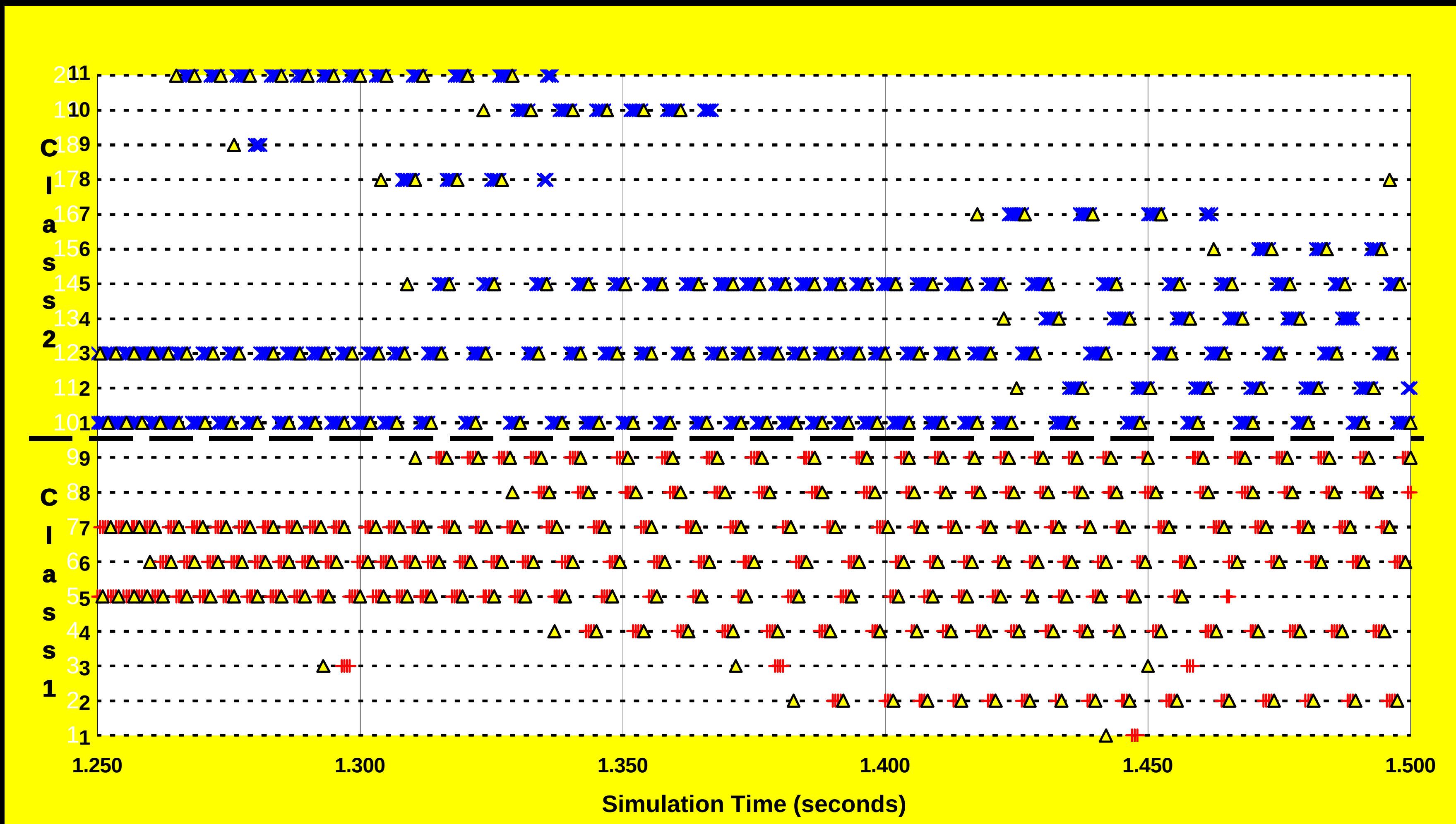
Non-Isochronous Data Input Buffer Strategy II

- **Establish a "flow" for each virtual channel such as:**
  - IP address pair or address/port pair
  - ATM virtual channel (VC/VP)
  - Frame relay permanent virtual circuit (PVC) or data link connection identifier (DLCI)
- **Use criteria of strategy I for weighting**
- **Result: fine-grained CBQ/WFQ**

Relative Advantages of Input Buffer Strategies I & II

- **Main advantage of Strategy I**
  - Smaller number of virtual channel connections
- **Main advantage of Strategy II**
  - All packet traffic interleaved so that one packet need not wait for transmission until another is finished
- **Advantages also exist for in-between strategies**

Simulation Example



Conclusions

- There is a simple approach to providing MAC-PHY protocols that are agnostic to higher level protocols
- Bandwidth scheduling at MAC-PHY layers can lead to networks that are simpler to implement, understand and manage
- The proposed approach can be the basis for a vibrant Broadband Wireless Access industry