

Loop Aggregation

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Supporters:

Howard Frazier, Dominet Systems

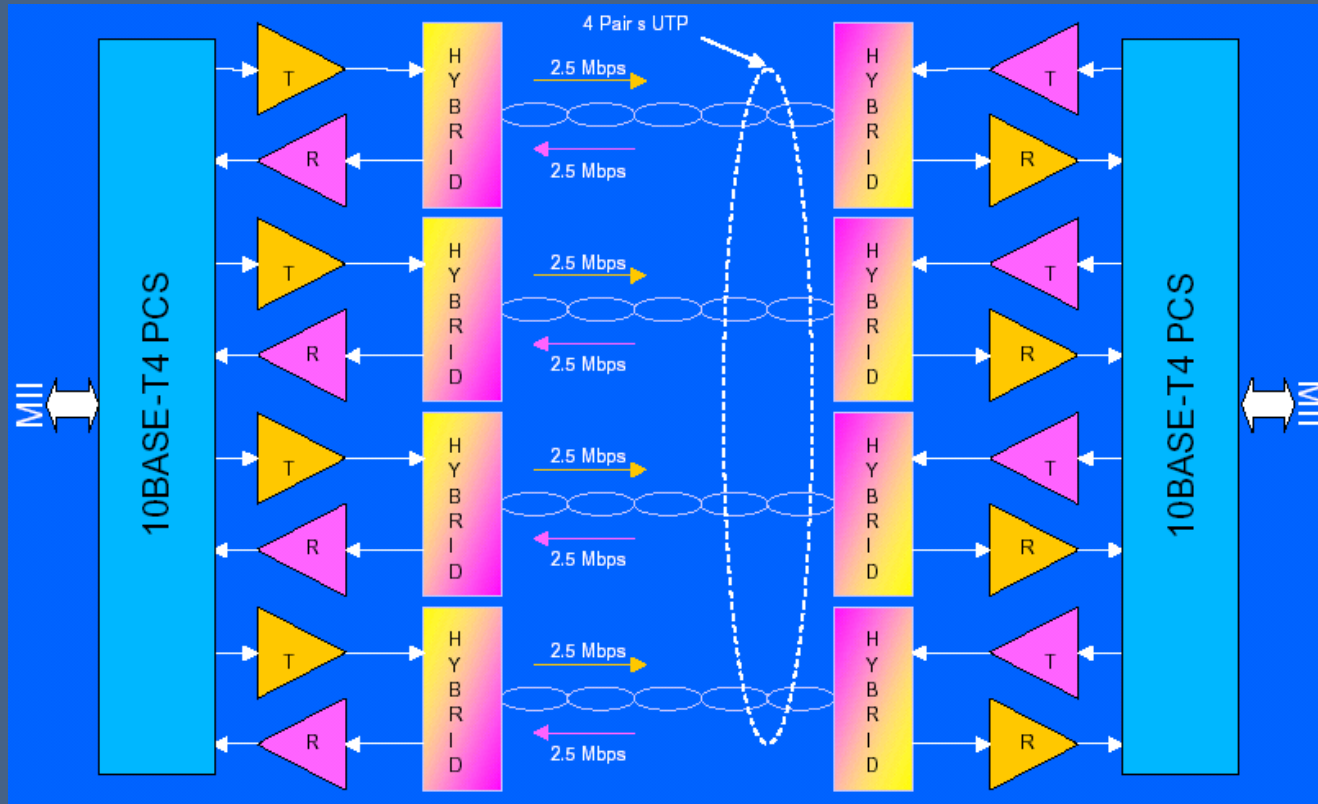
[Other Supporters Here]

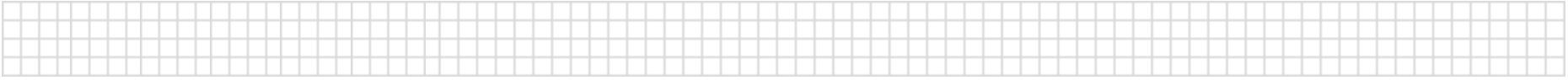
November, 2001

What is Loop Aggregation?

- New name for “10BASE-T4” concept?
- Scheme for using multiple loops to achieve higher bandwidth

Loop Aggregation





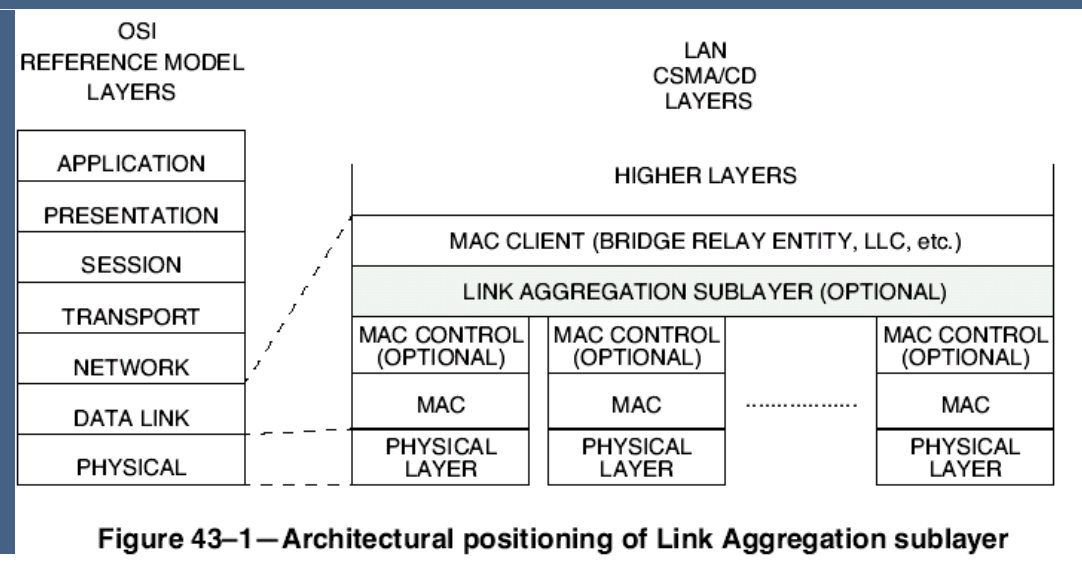
Loop Aggregation Characteristics

Loop Aggregation

- Based on 802.3ad Link Aggregation standard
- Ensures low packet latency and preserves sequence
- Resilient to loop failures
- Supports individual loops having different bit rates
- Supports an “unlimited” number of aggregated loops (8)
- Independent of any specific xDSL flavor
 - Works over existing ITU defined DSL specs
 - Works over asymmetric as well as symmetric versions of DSL

Link Aggregation

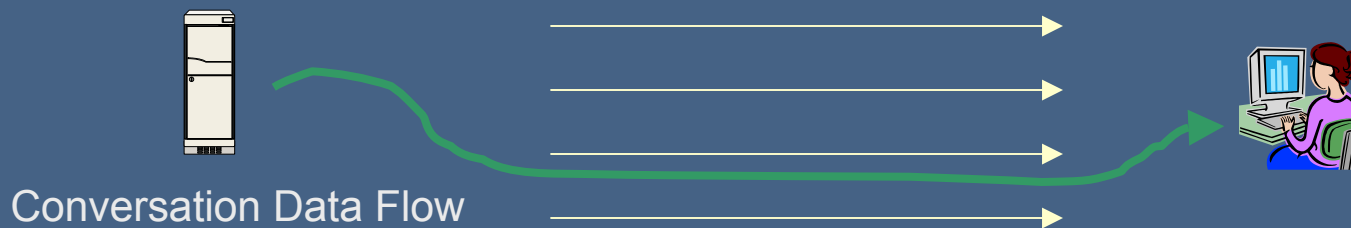
- 802.3ad, now clause 43 of IEEE 802.3 standard
- Plug and play, automatically detects connected links
- Resilient, detects link failures
- Proven protocol, “Link Aggregation Control Protocol” (LACP)
- Widely understood technology
- Sublayer in Data Link Layer

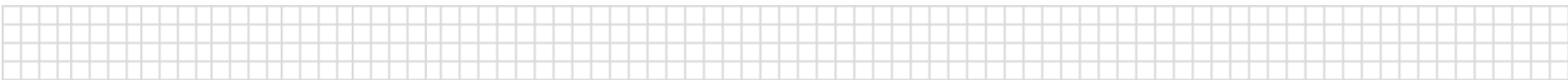


Link Aggregation Shortcomings

Almost solves the problem, however:

- Packets are not bonded, each packet is sent over one loop
- Packet latency determined by (slow) loop latency
- All loops have to have same speed
- Each “conversation” is not bonded, e.g. an ftp session is as slow as the speed of one of the loops





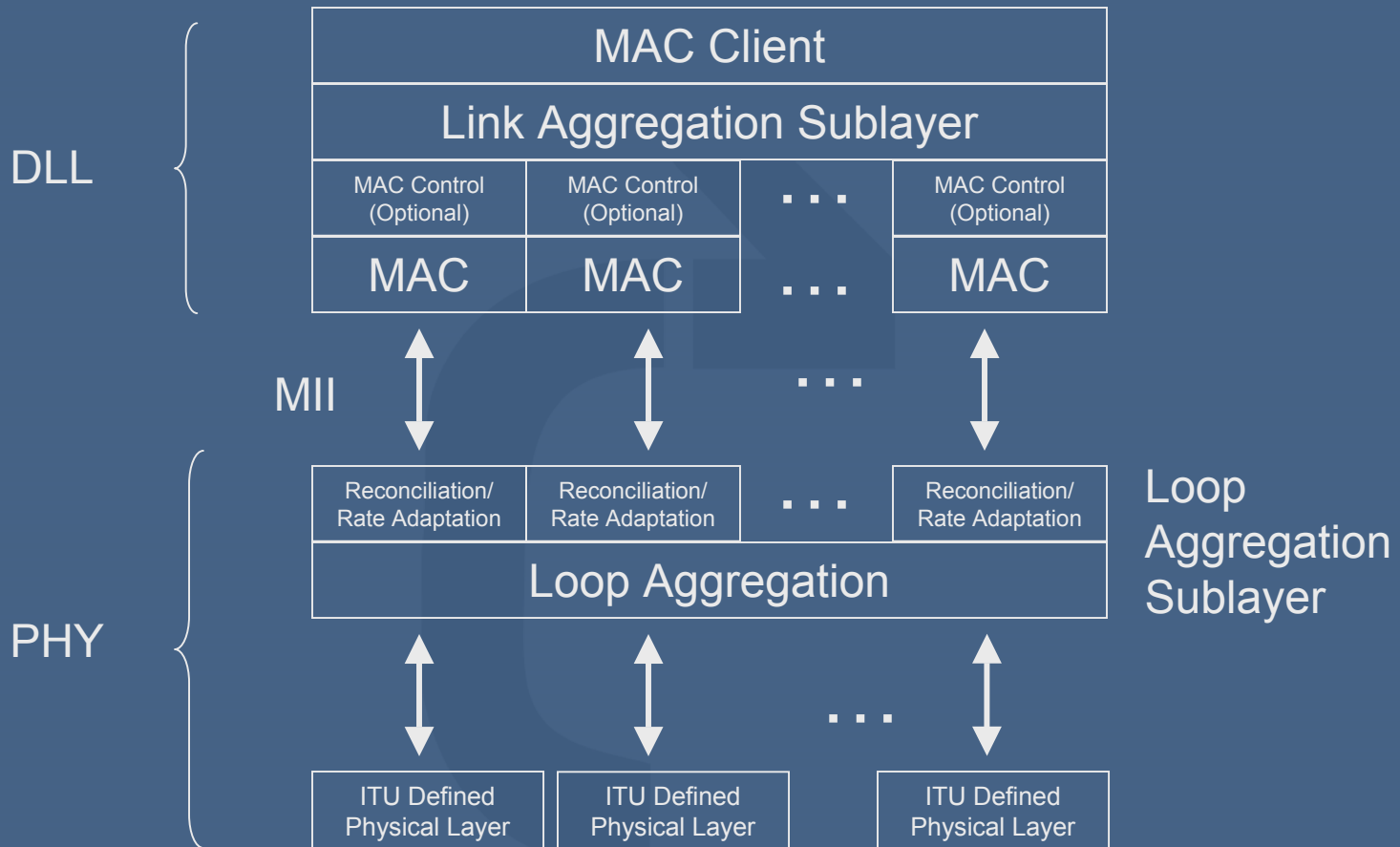
Loop Aggregation

Loop Aggregation

- Uses control scheme from Link Aggregation
 - Link Aggregation sublayer still there
 - Re-use of “Link Aggregation Control Protocol (LACP)” - let’s call it the “Loop Aggregation Control Protocol (LoACP)”
 - Re-use of unique multicast address for control – “Slow_Protocols_Multicast address”
- New Sublayer in PHY between MII and an xDSL interface
- Does segmentation and reassembly of each packet across all loops
- Max speed available to all traffic across the link

Protocol stack

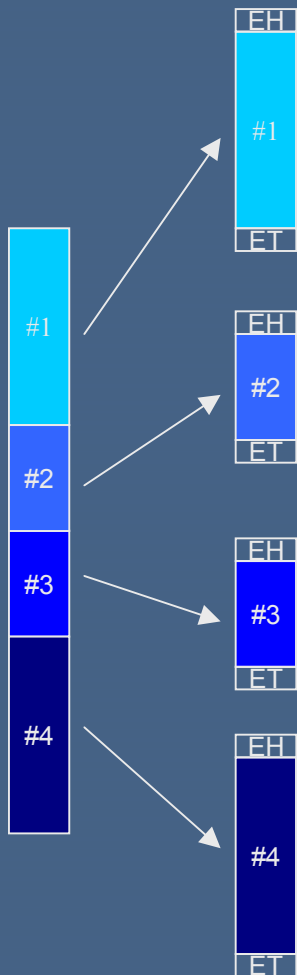
Loop Aggregation



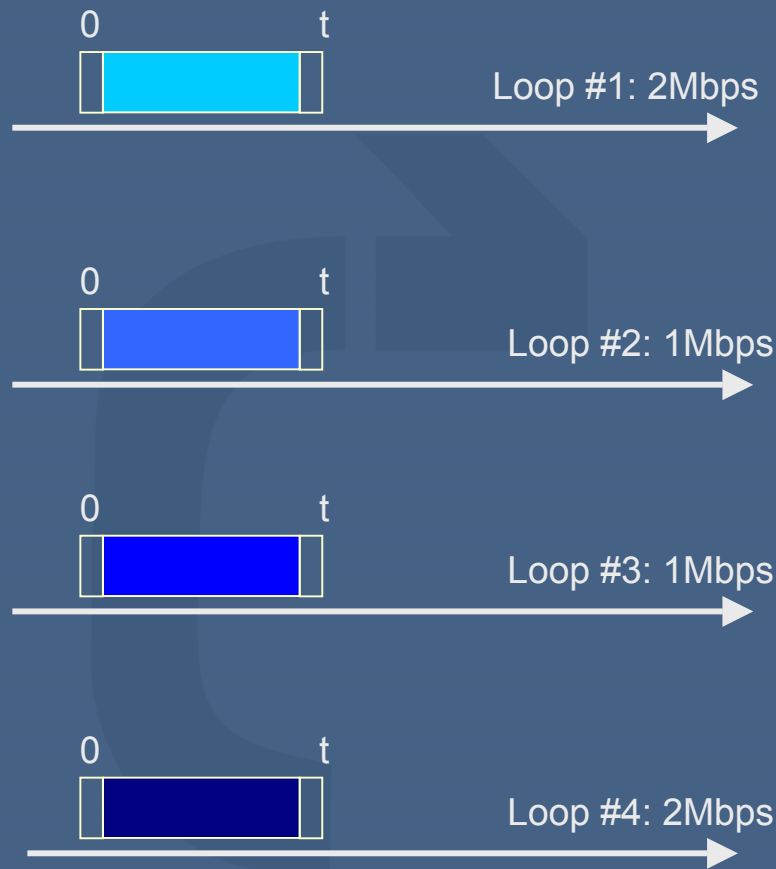
Segmentation & Reassembly

Loop Aggregation

SEGMENTATION



LOOP PLANT

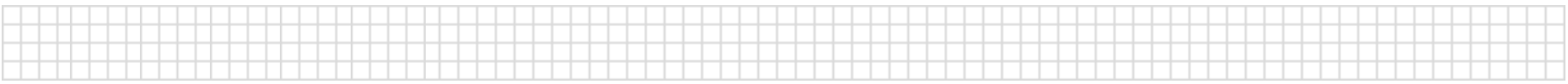


REASSEMBLY



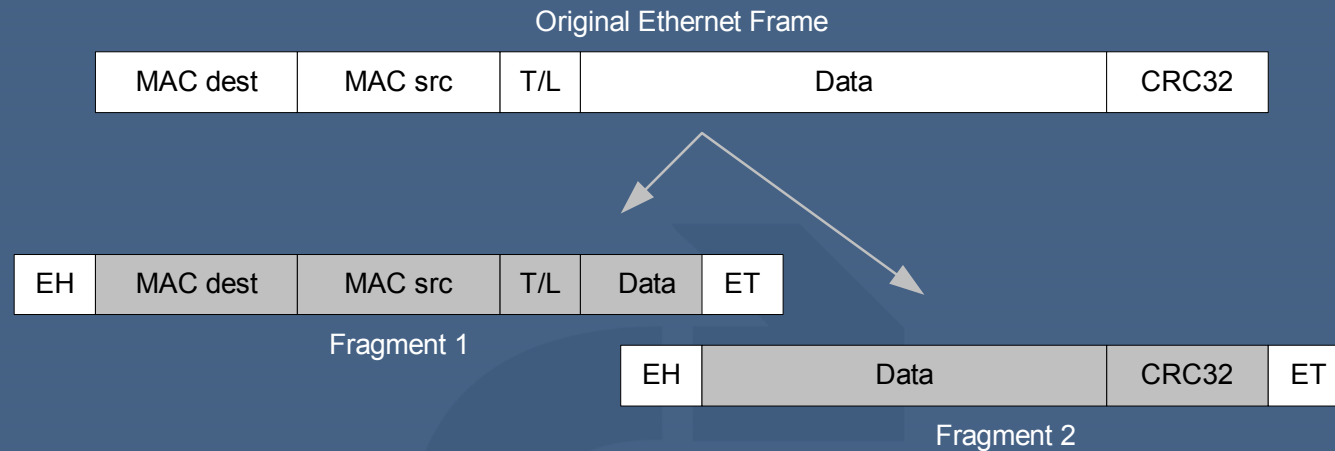
DATA FRAME RECEIVE





EFM Protocol Encapsulation

Loop Aggregation



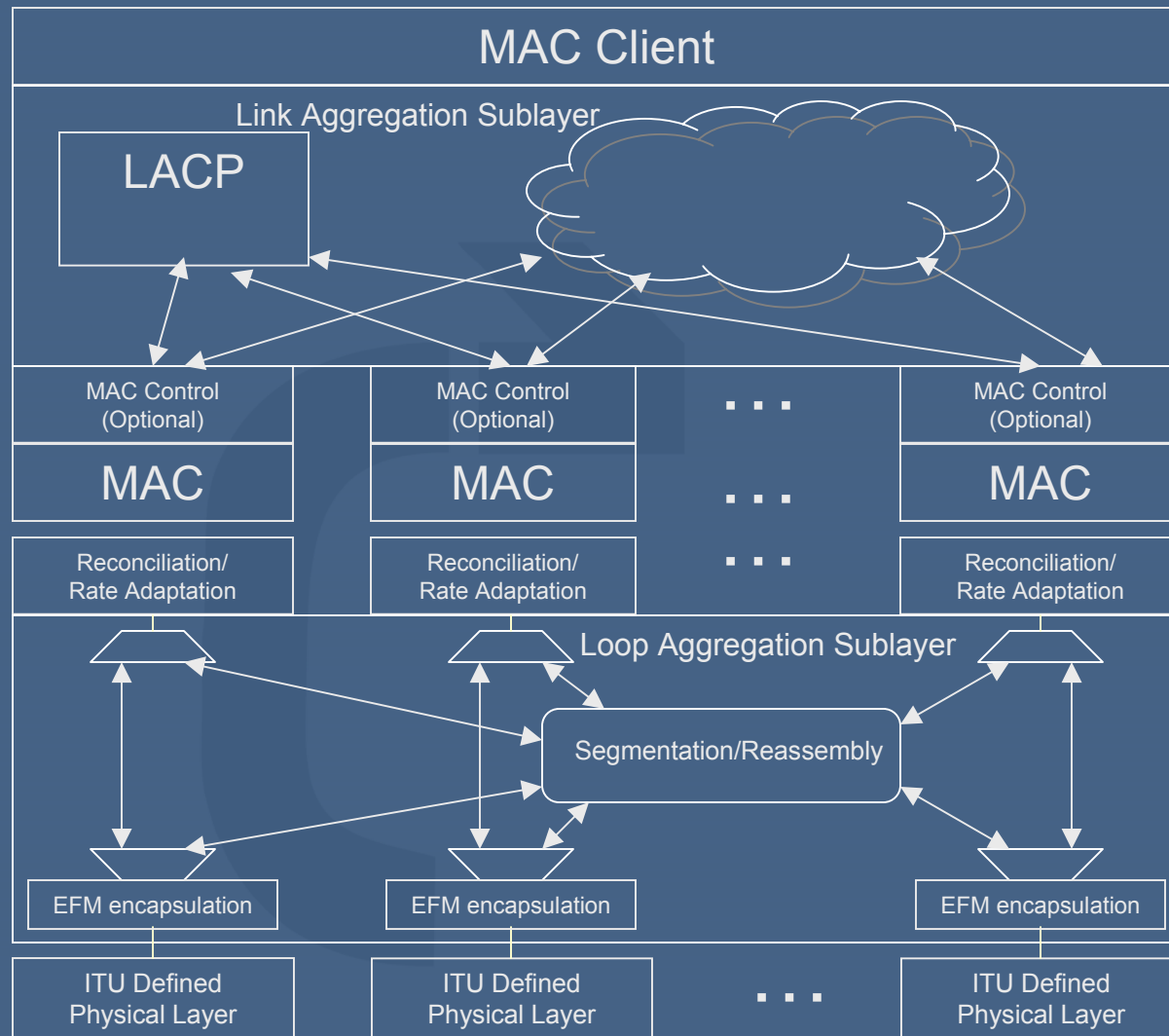
- EFM Header (EH)
 - SeqNum - frame sequence number (3bit)
 - TotalFrag - # of fragments that belongs to this Ethernet frame (3bit)
 - FragOffset - offset of this fragment in the Ethernet Frame (10bit)
- EFM Trailer (ET)
 - CheckSum - CRC checksum (16bit)

Loop Aggregation “Block Diagram”

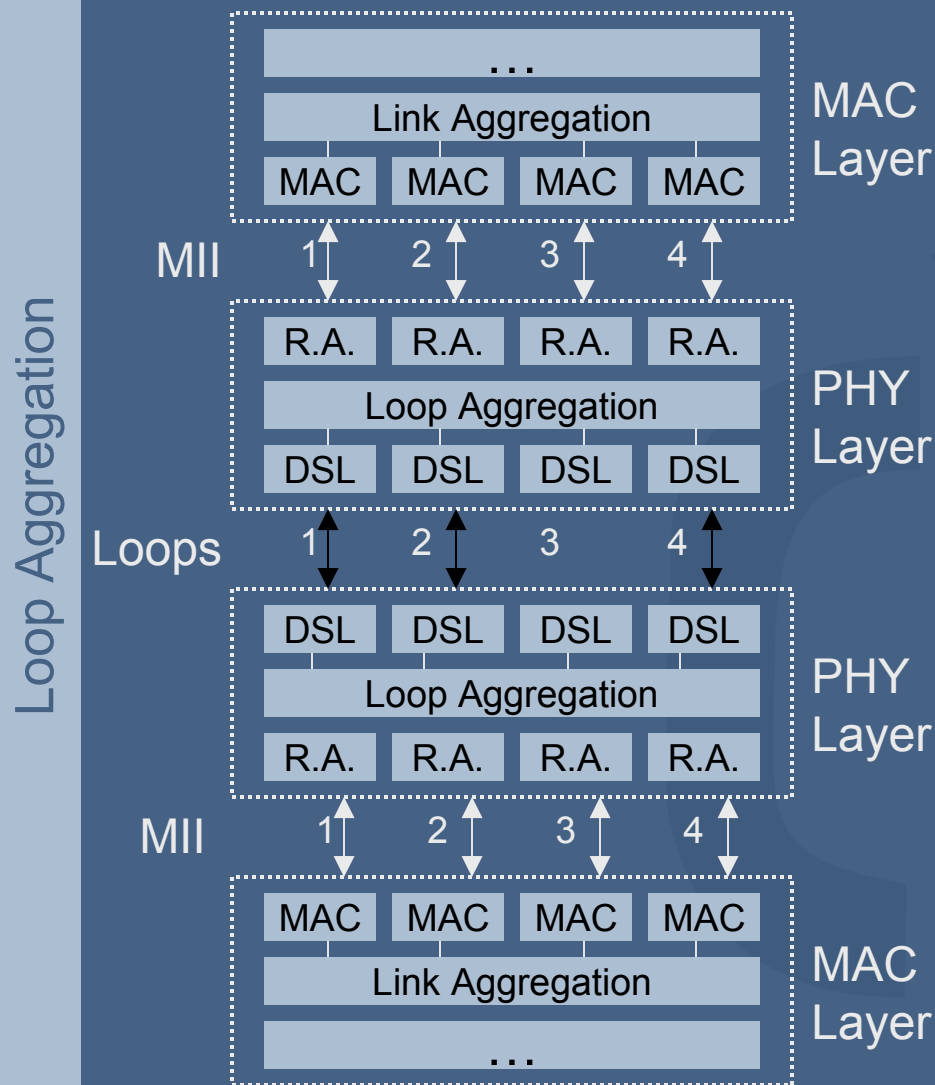
Loop Aggregation

DLL

PHY



Loop Aggregation Example



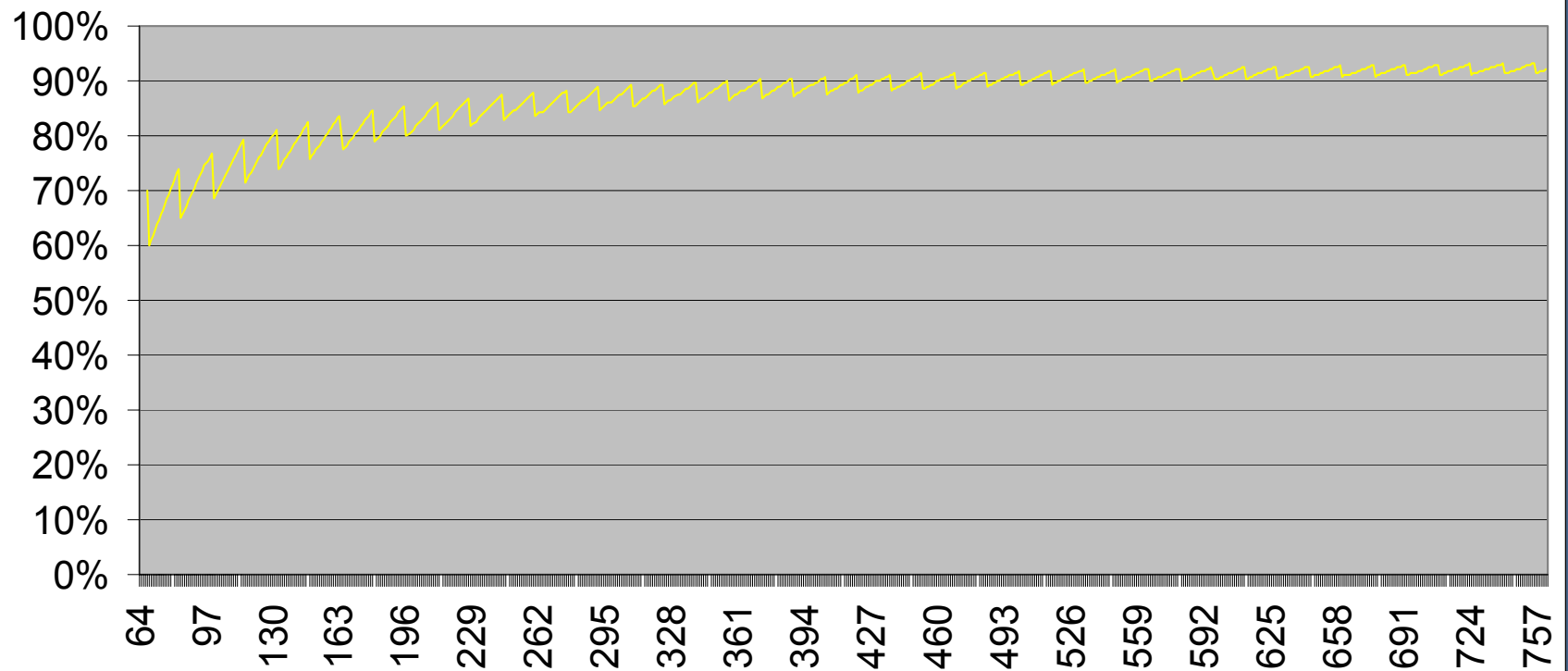
- LACP detects 1,2 and 4 can be link aggregated
- MAC layer may start to do Link Aggregation
- A “Data” Ethernet frame transmitted on MII 1, 2 or 4 is transmitted in fragments on the loops and is received in the remote end on the corresponding MII
- A “Control” Ethernet frame transmitted on MII 1,2 or 4 is transmitted on the corresponding loop and is received in the remote end on the corresponding MII

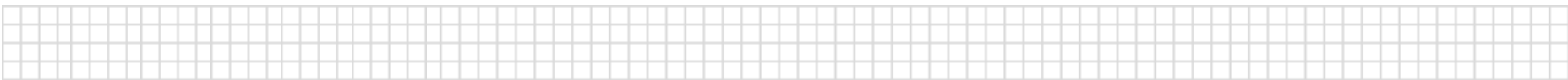
R.A. = Rate Adaptation/
Reconciliation

Protocol efficiency

Loop Aggregation

Loop Aggregation Link Utilization





Rate Adaptation

Some possible solutions:

- Control MII transmit clock
- 802.3x flow control
- Use fifos
- 802.3ae Interframe Spacing scheme
- Backpressure, fake collisions

Open Issues

- What OAM mechanism are needed on each loop?
- What framing method should be used? HDLC?
- Limitations to be put on transmitter to allow simple receiver
- Exact method for rate adaptation

Summary

- Method for Loop Aggregation in a DSL independent way
- Works over DSL loops with different bit rates
- Scalable, supports any number of bonded loops
- Based on proven technology
- All the complicated work is already done