EFM Copper PHY

Rate Adaptation

Rate Control Options

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Co-Sponsors of This Presentation

Why Rate Adaptation?

Copper Subscriber Access Network marketplace covers a wide range of loop lengths

Picking a few fixed rates wastes potential bandwidth on shorter loops, and prevents service on longer loops

Rate Adaptation Options

FIFO in PHY, discard packets that exceed line rate

802.3ae style MAC self-pacing

Busy Idle

Frame Based

Other options: clock stretching, and word hold,

Half Duplex MII, with simulated collision

Packets exceeding line rate are dropped

Simplest to implement

Bridging Function violates 802.3 hierarchy

Not considered any further in this presentation

802.3ae style MAC self-pacing

IPG stretching, proportional to length of transmitted frame and rate

Would require PHY to communicate variable rate to MAC

Optionally provisioned by service provider to limit to a rate <= line rate

Would not be compatible with existing 100BASE-X MACs

PHY sends normal Idle to MAC when it can accept data

PHY sends Busy Idle to MAC when it wants MAC to slow down

 ◆ MAC inhibits further transmission at packet boundary

Would not be compatible with existing 100BASE-X MACs

Frame Based

Similar to 802.3x Pause Flow Control

PHY generates Pause frames with a timer value of either FF (XOFF) or 00 (XON)

Clock Stretching, Word Hold

Offer sub-frame granularity

Interrupt flow of data through pipeline stages

Not considered any further in this presentation

Half-Duplex MII

Simulated Collision could hold off transmission of next frame

Disadvantage is that it requires half-duplex MII operation

Not considered any further in this presentation

MAC Self-Pacing

PROS

Familiar – 802.3ae

CONS

MAC must know a priori the rate

PHY must provide feedback to MAC for variable rate

Busy Idle

PROS

- **Precise**

- **PHY Controls the rate**

- **Adapts to a wide range of rates and variable rates**

CONS

- **Requires change to 100BASE-X MAC**

Frame Based

PROS

Familiar Mechanism

Already implemented in most Gig MACs

PHY controls rate

CONS

Confusion between PHY to MAC rate control and end-to-end flow control

Range of Supported Rates

Range from 100Mbps to 125kbps

- ◆ Supports both high bandwidth services and long reach data services

- ◆ Using PAUSE Frame means that the rate can be nearly continuously variable, with actual rates determined by architecture of copper PHY

- ◆ Recommend bandwidth step become finer as bandwidth decreases

Example Rates:100BASE-Cu

Supported rates, in ascending order, in Mbps

0.125	1.5	7.5
0.1786	1.666	8
0.25	2	10
0.358	2.142	13.33333
0.375	2.5	15
0.5	2.856	20
0.5358	3	26.66667
0.714	4	30
0.75	4.284	40
1	5	53.33333
1.074	5.712	60
1.428	6	80
1.432	6.666667	106.6667

Recommendations

Suggest PAUSE frame approach

- Supports wide range of rates

- PHY controls the rate directly

- Uses Existing MAC mechanism

Alternative would be 802.3ae style self-Pacing

- PHY would control rate, indirectly, by writing parameter to MAC

Recommend that PHY control rate based on loop conditions, with optional provisioning of a rate <= maximum loop rate

Will require that the PHY be able to FIFO at least 1 maximum size frame