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# Asymmetric Flow Control (AFC) and Gigabit Ethernet

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# Adding Asymmetric Ability

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- **802.3x defines extensions to Clause 28 that allows configuration of PAUSE function**
- **The single bit definition only supports symmetric PAUSE ability**
  - PAUSE=1 means “I can transmit & receive PAUSE frames
  - PAUSE=0 means “Not only can’t I transmit PAUSE frames, but I won’t understand them”
  - Turn on PAUSE functionality only if PAUSE=1 on both ends
- **Asymmetric PAUSE requires an additional bit**
- **Solution: Add ASM\_DIR bit**
  - PAUSE=0, ASM\_DIR=1 -> Advertises transmitter but no receiver
  - PAUSE=1, ASM\_DIR=1 -> Advertises receiver but no transmitter

# Resolution & Compatibility

- Resolution is identical to 802.3x except:
  - Asymmetric cases (#4 & #9)
  - No Receiver case (part of #2)
- In Cases 4 & 9 both devices are aware of new asymmetric flow control

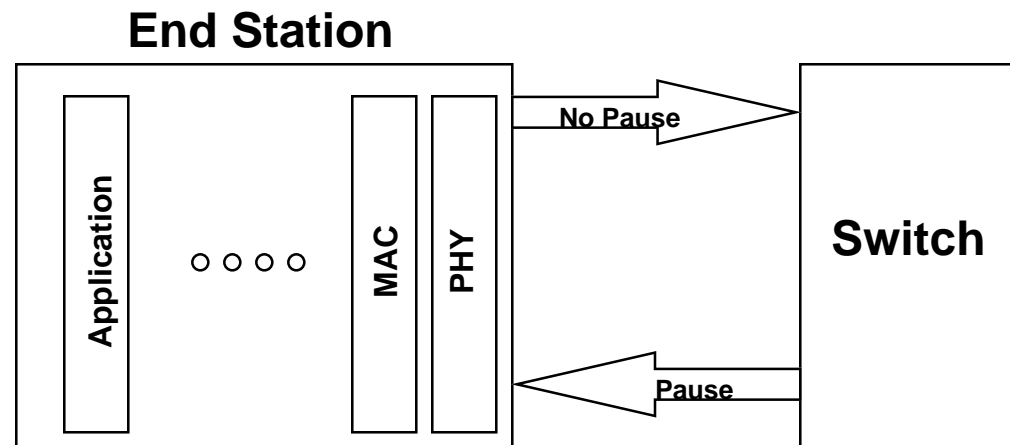
	Local Device		Link Partner	
	PAUSE	ASM_DIR	PAUSE	ASM_DIR
Case #1	0	0	Don't Care	Don't Care
	←-----X-----→			
Case #2	0	1	0	Don't Care
	←-----X-----→			
Case #3	0	1	1	0
	←-----X-----→			
Case #4	0	1	1	1
	-----→			
Case #5	1	0	0	Don't Care
	←-----X-----→			

	Local Device		Link Partner	
	PAUSE	ASM_DIR	PAUSE	ASM_DIR
Case #6	1	0	1	0
	←-----→			
Case #7	1	0	1	1
	←-----→			
Case #8	1	1	0	0
	←-----X-----→			
Case #9	1	1	0	1
	←-----→			
Case #10	1	1	1	Don't Care
	←-----→			

# AFC to End Stations

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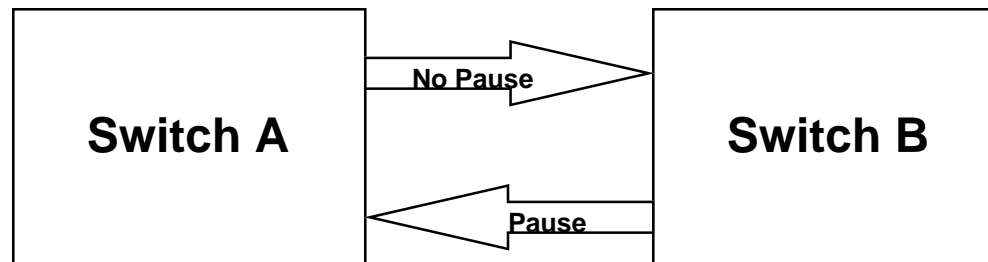
- **Stop traffic at its source**
  - Eliminates potential for network congestion (a good thing)
  - Flow Control below the application causes potential for congestion within the end station
    - Generally more buffers inherent in End Stations
    - Switches will not need to replicate these buffers
  - Abuse of upstream PAUSE will lead to network congestion
  - AFC allows enforcement that End Stations not apply backpressure to the network



# AFC Between Switches

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- **Effects are dependent on traffic flows and topology**
- **1Asymmetry causes a burden on switch design**
  - **Switch B “saves” the cost of a PAUSE receiver**
  - **Switch A can be shut down by Switch B**
    - **Congestion in Switch A more likely**
    - **Switch A designer must account for additional probability of congestion**
- **Asymmetry causes a burden on the user**
  - **Requires awareness of individual switch resource limitations**
  - **Cannot assume a given topology will work**
  - **Too many options**
  - **At least one of the switches must support PAUSE**



# AFC and “Gigabuffer”

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- **Gigabuffer performs much like a traditional repeater**
  - Both cause congestion in switches below them in the network hierarchy
- **Requires the attached device to implement the PAUSE receiver**
  - Otherwise, it cannot function correctly
  - Implies that all switches must implement PAUSE receiver or not be compatible with Gigabuffer
- **Who saves?**
  - “No receiver” benefactors are switch ports dedicated to end station connections and Gigabuffer Repeaters
  - Switches must implement PAUSE receiver to allow Gigabuffer interoperation
  - Switch to Switch AFC will cause more user pain than switch savings

# The Bottom Line

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- **Gigabuffer Repeaters require AFC to function**
  - Cannot act on PAUSE receive (without stopping the network)
  - Requires switches to implement PAUSE receiver
- **Switch to Switch links**
  - AFC is bad for the (l)user and switch designer
  - Symmetric Flow Control puts design burden on all switches equally
- **AFC from switch to end stations**
  - Denies end stations the ability to apply backpressure
  - Reduces probability of network congestion
  - This is really a means to enforce a PAUSE transmit policy
  - Cost savings not present if all switch ports are designed to connect to either an end station or switch port

# Recommendations

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- **If Gigabuffer Repeaters are to be supported, then PAUSE receive needs to be mandated for all uplink switch ports**
- **Allow switch ports connected to end stations to ignore and discard PAUSE frames**
  - Through ASM\_DIR bit and special defaults for end stations and switch ports, or
  - Through policy definitions (may need a “standard” distinction between end station and switch port)
- **Disallow asymmetric Flow Control on switch to switch links**
- **Require PAUSE receiver in Gigabit end stations???**
  - **We have the opportunity to reduce optionality and provide services that can be relied on**