

# EFM Copper

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## The pitfalls of rate adaptation

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# Rate adaptation in Ethernet

- **Ethernet is simple and reliable**  
That's why higher layers work so well above it
- **Rate adaptation is not the same as auto-negotiation**  
Auto-negotiation is based on PHY capabilities – not environment
- **Rate adaptation allows a link to operate at the maximum possible rate in the circumstances**  
... but circumstances change

# Rate adaption / Auto negotiation

- **Auto negotiation adapts the link behavior according to the capabilities of the communicating systems**

**The media is not assessed**

- **Rate adaptation adapts the link behavior according to the capabilities of the media and environment used for communication**

**Requires assessment of media and environment**

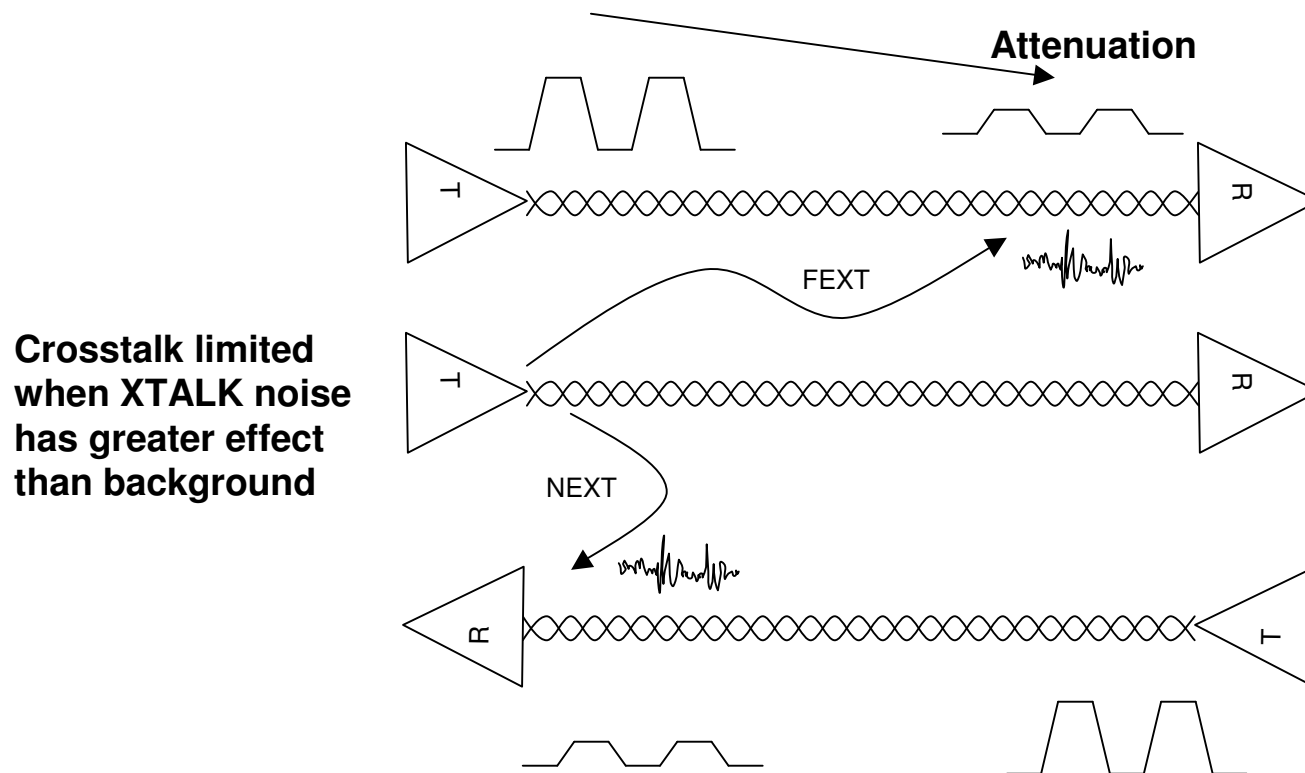
- **Rate adaptation  $\neq$  Auto negotiation**

**Ethernet includes auto negotiation but not rate adaption**

# Rate adaption basics

- **Rate adaptation works well for dial-up modems**
  - The most basic connectivity
  - Low/no expectation of service – no SLA
  - Medium relatively stable (once link is established)
- **Rate adaptation is more problematic for crosstalk or noise limited environments**
  - Increasing number of variables
- **Rate adaptation has never been used for high rate services**
  - ... premium, high revenue

# Crosstalk limited environments



Crosstalk limited  
when XTALK noise  
has greater effect  
than background

- Coupling higher with frequency – riser cable NEXT, -35dB @1MHz, -25dB @4MHz
- High rate, premium services most effected
- E.g. Shannon capacity = >80Mb/s no xtalk; 40Mb/s FEXT; 6Mb/s NEXT

# The “N+1” problem

- **Whatever rate you train to with N disturbers, it will likely be reduced with N+1 disturbers**
  - Although statistics and quantization sometimes help
- **Dis-incentive to tell your neighbor about the service**
  - ... remember the cable modem ads?
- **Even non-static services suffer**
  - Service deterioration hits when it matters most!

# Service Level Agreements

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- **The more reliable and predicable a service is, the easier it is to charge for it**
  - This has always been the case**
- **Premium data service needs an SLA**
  - SP's prefer to use higher layer to provide Committed Access Rate (not physical layer)**
- **“Next generation” services absolutely must have minimum guaranteed data rates**
  - Most attractive revenues in EFM come from voice and video**

# Who pays?

- **User generally pays according to the minimum guaranteed rate**
  - Offering occasional extra bandwidth doesn't justify higher charges
- **SP must tailor the traffic engineering to match peak demand**
  - This requires more expensive core or...
  - Throttling the user b/w – defeating the purpose of rate adaptation
- **Rate adaptation may be intellectually satisfying**
  - ... but it doesn't improve profitability



# Degradation and link failure

- **Sometimes the link may degrade**
  - Due to outside causes ...
  - ... or due to deterioration of the medium
- **How should the link react?**
  - Re-adapt to a lower speed
  - Continue to operate with lower margin and raise alarm
- **Which is better...**
  - Slower speed link with the same noise margin or...
  - Consistent speed with reduced margin?
  - Assume that alarm is raised in both cases

# Re-adaption

- **A link re-adapts due to change...**
  - ... in most cases going down in rate
- **Link must notify higher layers that speed is reduced**
  - Higher layer protocols are not expecting change
  - Needs new mechanism for lower layer pre-emptively signaling to higher layer
- **Guaranteed b/w services must stop**
  - Video or voice application hangs up

# No re-adaption

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- **Link does not re-adapt due to change...**
  - ... change in noise margin increases error rate
- **Higher layers do not see a step change**
  - Higher error rate may cause some re-adaptation (e.g. TCP windows)
- **Committed services continue**
  - More noise may cause loss of quality

# In conclusion

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- **Rate adaptation and Ethernet do not mix**  
Simplicity and stability will be lost
- **Increased PHY complexity**  
Longer time to develop  
Increased PHY cost
- **No revenue justification...**  
...for delay or cost increase