Ethernet Phys for Copper Subscriber Loop

Daun Langston

Metanoia, Technologies Inc.

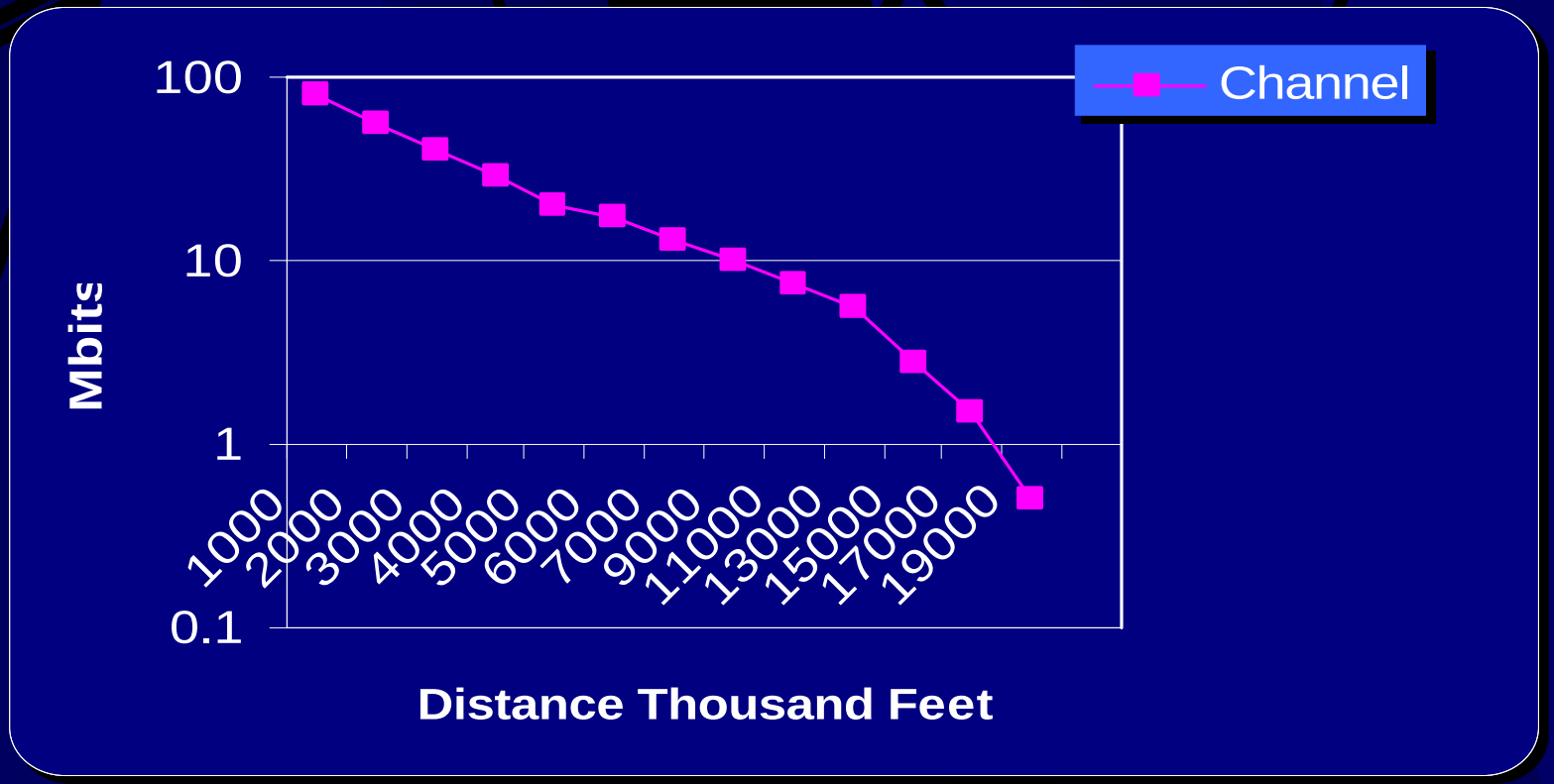
daun@nccn.net

Strategy for Selection

- Select the simplest modulation strategy which solves the most problems
- The channel characteristics should drive the modulation selection
- Go for the most bang!
- Select a versatile method so we never have to meet again

Daun Langston Metanoia, Inc
Daun@nccn.net

Meet the Channel



Issues with the Channel

- High Bandwidth close in
  - 70 Mbits at 1000 feet
  - Less than 20 Mbits at 5000 feet
  - 10 Mbits at 12,000 feet
  - 0.5 Mbits at 21,000 feet
- Some bands subject to AM ingress
- Stationary channel!! No frequency offsets, distance of the link is not changing, timing easy to recover

Features of the Channel

- Frequency response slow to change
- Has length of echo of no longer than 120 microseconds for ADSL at 1 Mhz
- Bridge TAPs – cause irregularities in attenuation curves
- Stationary Channel – does not change length
- Passband modulation allows an easy implementation of an asymmetric channel
- Passband modulation allows multiple gauge wire and bridge taps, no conditioned lines

QAM is the Solution

- QAM been used on subscriber loops since the early 1980s (V.22bis)
- What kind of QAM?
  - Half-duplex QAM (example Etherloop)
    - Easy, efficient for low densities cable bundles
  - QAM - simple to implement
    - Great for high density cable bundles
  - Multi-Carrier QAM (example DMT)
    - Most adaptable to unusual line conditions: Radio interferers, bridge taps, rock solid timing recovery

QAM – the FACTS

- Any QAM features can be implemented in other QAM technologies, some do it better
- All can be designed to probe the line for interferers and impairments and adapt
- All can be designed to be polite in small company, that is not to blow away adjacent pairs in the same cable bundle
- All modems can be implemented without POTs splitters
- All can be installed with bridge taps in place

Are these habits bad?

- Power can be throttled down to avoid splitters but splitters improve reach with all strategies
- Transmit-only-when-required has advantage but some may find their link no longer works after complete system build-out
- Some QAM strategies are better at avoiding interferers than others

Advantages of a Single Carrier System

- Single Carrier
  - Lower peak-to-average power ratio
  - Possibly a simpler implementation
    - However more difficult timing recovery
  - Lower A/D precision converters required
  - Easier modulation technology
    - Less gates to implement

Advantages of a Multiple Carrier System

- Less Fragile Equalizer
  - Receiver is a very robust structure with only one vector degree of freedom per frequency domain equalizer bin
- Very low excess bandwidth, about 92.3% data payload or higher
  - Provides more data with given bandwidth
- Simple, stable timing recovery

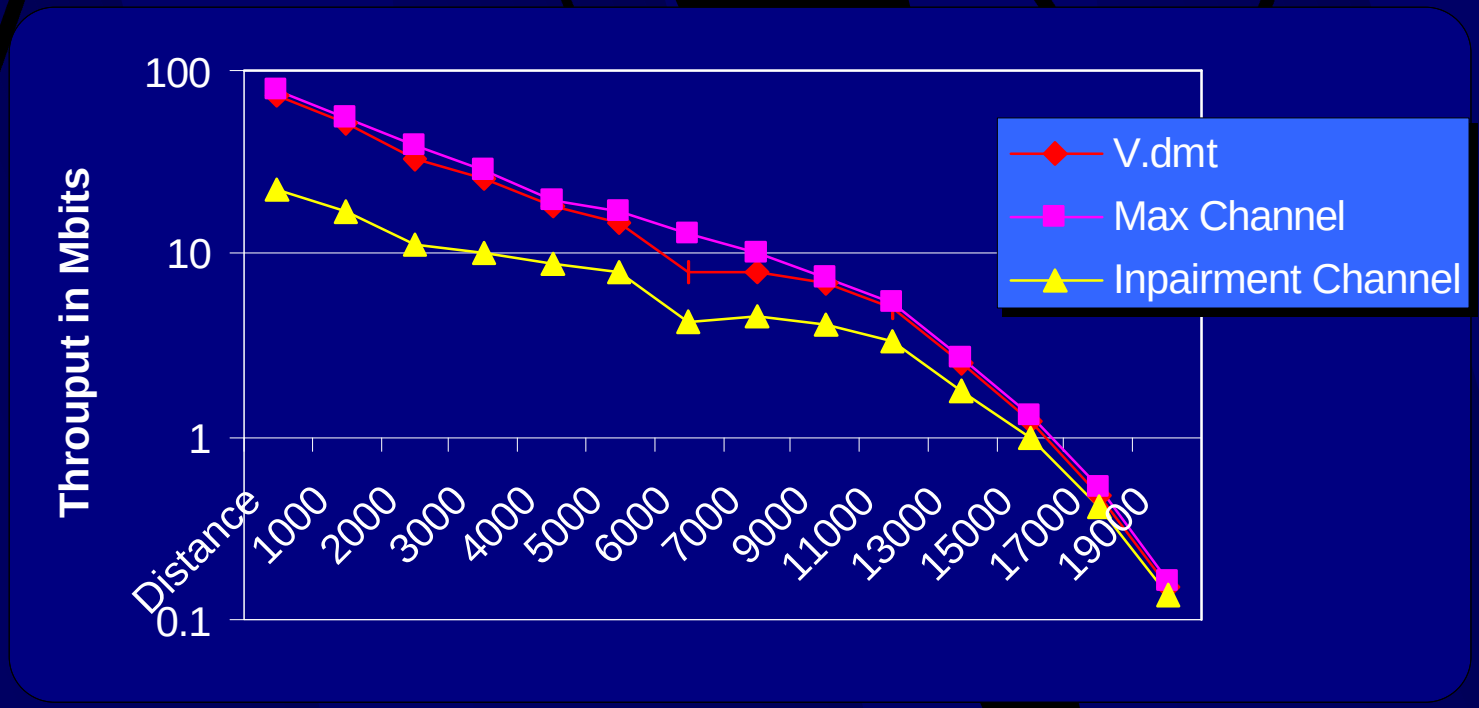
Do we consider a dual standard Multi-carrier?

- Go for short and long reach capability
- A VDSL, ADSL combined Phy is
  - One consistent modulation standard
  - Widest scaleable reach -1K to 20K #26 ga
    - Highest data rate per given channel
    - Flexible assignment of symmetry
  - Fills the channel closer to Shannon capacity limit, moves more data on a given channel than competitive modulations

Combined ADSL/VDSL best matches the channel

Impairment: 26 AWG, 20 self-next, 5 db coding, 6db noise margin, 1 AM Radio Station at 830 Khz @ 25 Kw

Impairment: 26 AWG, 0 self-next, 5 db coding, 6db noise margin



Daun Langston Metanoia, Inc
Daun@nccn.net

What else is required other than a Phy?

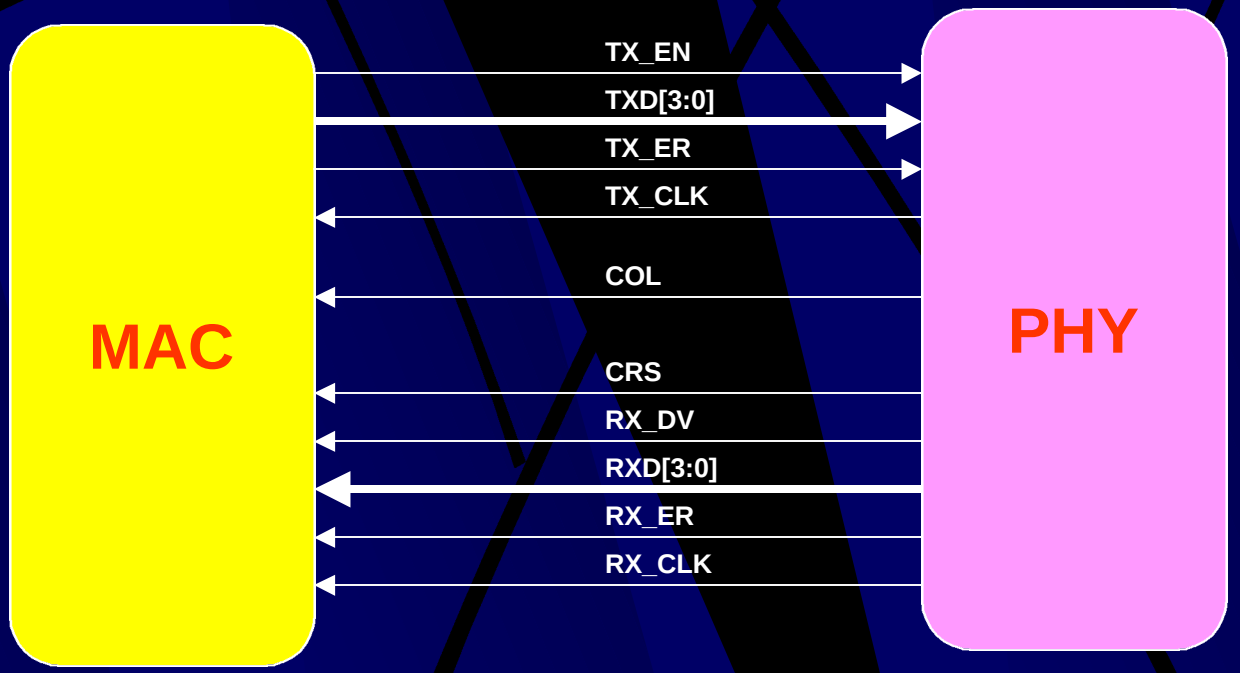
- We need a Physical Standards Oriented interface between the Phy and the MAC
- Should consider adopting an existing interface between any proposed Phy and MAC

Daun Langston Metanoia, Inc
Daun@nccn.net

Summary of Tasks

- Choose between continuous modulation or intermittent modulation
- Select between single carrier or multiple carrier (DMT)
- Are we supporting users on long lines, how much additional cost is justified?
  - A ADSL Phy for long reach on a VDSL Phy for short haul is almost a freebee.

MII Interface



- The interface operates at 25MHz
- The data is transferred on rising clock edges

Proposal

- Adopt and modify the ITU-T G.992 specification for ADSL and VDSL using G.hs to specify one Phy for Ethernet
  - Speeds should be negotiated during the connect
- Specify an interface between the MAC and the Phy
  - MII