MAKING G.FAST REAL

Cost-Power-Robustness tradeoffs in G.fast
May 21th, 2014
Agenda

- Short G.fast introduction
- The cost-power-robustness tradeoff
  - Performance
  - Robustness
  - Power
  - Cost
Next Generation xDSL...

100 Mbps × 10 → 1000 Mbps

xDSL
OLD ITU STANDARD

G.fast
NEW ITU STANDARD, G.9700/1
G.fast is not only about speed…

- **Network side**
  - No trenching in the last 100m, significantly lower cost versus FTTH

- **Customer side**
  - self-install, faster roll-out, no customer visit coordination

- Flexible asymmetry ratio (up:down ratio)

- And many more important features…

- Much more robust

- Better power management:
  - Power scales with traffic
Cost-Power-Robustness Triangle

- We’ll now look at these elements one by one…

The DPU PHY rate is a shared resource
Binder Model – 100m, 10 lines
Flat line based on BT’s actual measurements contributed to the ITU

- BT’s binder - signal and cross-talk levels (Tx PSD=-76dBm/Hz)
Vectoring Performance and Single Line Bound
Adding an In-Home Network Model

- Simulating the self-install scenario
- Wire model
  - Combination of BT’s measured binder and in-home model
  - In-home model based on ITU’s H2-USA

Diagram:
- DP
- FTU-O: BT 100m/0.5mm binder
- NID
- FTU-R
- H2-USA in-home model
  - 30 m
  - 22.5 m
  - 15 m
  - 7.5 m
  - 3.8 m

Self install performance
BT’s binder + in-home wire model, rates for the 10 lines in the binder

- With in-home wires, 2-88MHz
  - Bit-rate = 605-680Mbps

- With in-home wires, 17-88MHz
  - Bit-rate = 455-520Mbps
Frequency Range 17-88MHz

Rate vs Length

Bit-Rate > 500Mbps @ 200m
Robustness
Rate adaptation in G.fast

- G.fast capacity is mostly allocated for best effort services
  - Using the extra capacity to protect the high QoS streams
  - Much room for rate adaptation
    - In the 15-25dB range
Rate Adaptation In G.fast

- Adaptation is quicker in G.fast
  - Via RMC, up to per TDD-frame (750 µsec)
  - Faster also via EOC management channel
    - Holds much higher capacity in G.fast, up to ~10Mbps

- More robust adaptation
  - Each frame holds all the information needed to decode it, no error propagation
Power Control Tools

Scaling power with the data traffic, staying within the thermal limits

- Dynamic transmission time
  - ETT – estimated transmission time
  - DRRus – dynamic resource reports, queues status

- Discontinuous operation
  - The ability to switch off lines while other lines are still active
  - Impacts the precoder, bit-loading and gains

- L2.0
  - Transmission time control based on actual DP temperature and traffic needs
  - TBUDGET, TTR, TA
Assuming we have all the power management tools implemented, how much power can we really save???
Power Consumption

1G Ethernet i/f Example

- The overall G.fast DP capacity is much above the backhauling capacity!
GPON i/f Example, Split Ratio=32

- Only one forth of the DP (total) capacity can be utilized
G.fast Transceiver Operation States

Power modes along the TDD-frame

G.fast Summit, Paris, May 20-22\textsuperscript{nd}, 2014
Power Consumption Analysis - Assumptions

- Optical backhauling
  - 1Gbps Ethernet, one i/f per DP
  - GPON with different split ratios
    - Two cases:
      - One OLT per DP
      - OLT divided to “N” (fixed) customers

- Average G.fast link capacity – 500Mbps
- Average BB service rate – 500Mbps
- Power consumption (example)
  - Active state, Tx or Rx: 2.0 W/port
  - Stby state (fast wake up): 500 mW/port
Power vs. DP port-count

Power consumption for GbE i/f

![Graph showing power consumption vs. DP port count.](image)
Power vs. DP port-count
Power consumption for a GPON i/f

Activity Duty-Cycle (per port)

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Sensitivity analysis
GPON i/f, active power=3.0W, STBY=0.5W/port
Cost vs. Power Consumption
Impact of power consumption on the equipment housing cost

- Reference: Adtran ITU-T contribution 2012-02-4A-058R1, a case study done in 2012
Observations

- Average power consumption of ~1W/port seems at reach under real deployment scenarios

- Some tools are needed:
  - DRA
    - Ability to monitor the traffic flows and allocate transmission time accordingly
  - VCE
    - Support for discontinuous operation
    - Ability to update the loading table per operation interval
  - PME, L2.0
    - Power management entity, monitoring the actual power consumption to assure that the upper limit is never exceeded
Thank You!
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