Next Generation PON: Lessons Learned from G-PON and GE-PON

Frank J. Effenberger
ECOC - Sep. 2009

- **www.h**

uawei.

com

HUAWEI TECHNOLOGIES CO., LTD.

Introduction

- **The current PON generation consists of two systems**

  – IEEE EPON

  – ITU G-PON

- **They are essentially the same technology**

  – WDM diplexing, TDM downstream, TDMA upstream, packet-based

- **Their differences stem mainly from the style of the SDO that created them**

  – IEEE is a "grass roots" organization – Vendors drive the process

  – ITU is a "top down" organization – Operators direct the process

IEEE Positive: Readily implementable standard

- **EPON reused a lot of existing designs**

  - 8b10b line coding from GbE point to point

  - MAC control signaling mechanism from Pause function

- **EPON was designed to tolerate nearly any optics**

  - Very loose transmitter timing meant even CM optics could work

  - Very loose receiver timing allowed a wide range of designs

- **The time from initial inception to first field deployment was quite impressive (4 years)**

IEEE Negative: Vendor-dominated standards may lack operator interest

- **The flip side of easy implementation is that you often sacrifice capability**

    - 8b10b and loose timing really do use up a lot of bandwidth

- **The optical budgeting process was all wrong**

    - The optical budget belongs to the operators, not the vendors

    - The vendors had a poor idea of what real access networks look like

    - The resulting budgets were quite a bit off

IEEE Negative: Narrow scope results in a standard that is incomplete

- **The 802.3 project's scope is limited to the "PHY"**

  - Optics, line coding, and whatever logical shims are needed

- **This prevents work on many issues needed for PON**

  - Dynamic bandwidth allocation

  - Security

  - ONU management

- **The result is a standard that describes just the "engine", and not the automobile**

  - Each operator around the world has had to define their own proprietary standard to fill in the blanks

  - There is no interoperability between Japan, Korea, and Chinese EPON

HUAWEI

ITU Positive: A complete system of standards that covers it all

- **The ITU (and its feeder organizations) have a wide mandate to work on whatever subjects are required**

- **The result is a complete standard, describing nearly every requirements and aspect of design of the PON system**

  - Physical layer

  - Protocols

  - Signaling

  - Management

- **A well established scheme to modify and augment the standard means that it can follow the trend of the market and technology**

ITU Negative: Operator-dominated standards can be gold-plated

- **Operators will naturally ask for more capability**

    - It takes discipline not to ask for everything that you've seen in an ECOC paper or in a marketing slide

    - There is a tendency to ask for the perfect system, when in fact "good enough" is much cheaper

- **Examples of this in G-PON include**

    - Support of every legacy service under the sun

    - Tight OLT timing parameters

    - Extended loss budgets

    - Power leveling

ITU Negative: Consensus often creates the "all of the above" standard

- **In ITU, consensus must be achieved**

  - Consensus is defined as the lack of sustained opposition

- **When there is opposition, the most common way to resolve it is to allow options**

  - Everybody gets what they want

- **But, the problem is that the standard then allows more than one solution to a problem**

- **Examples of this in G-PON include**

  - PIN vs. APD

  - Single vs. multiple T-Conts

  - OMCI vs. TR-69
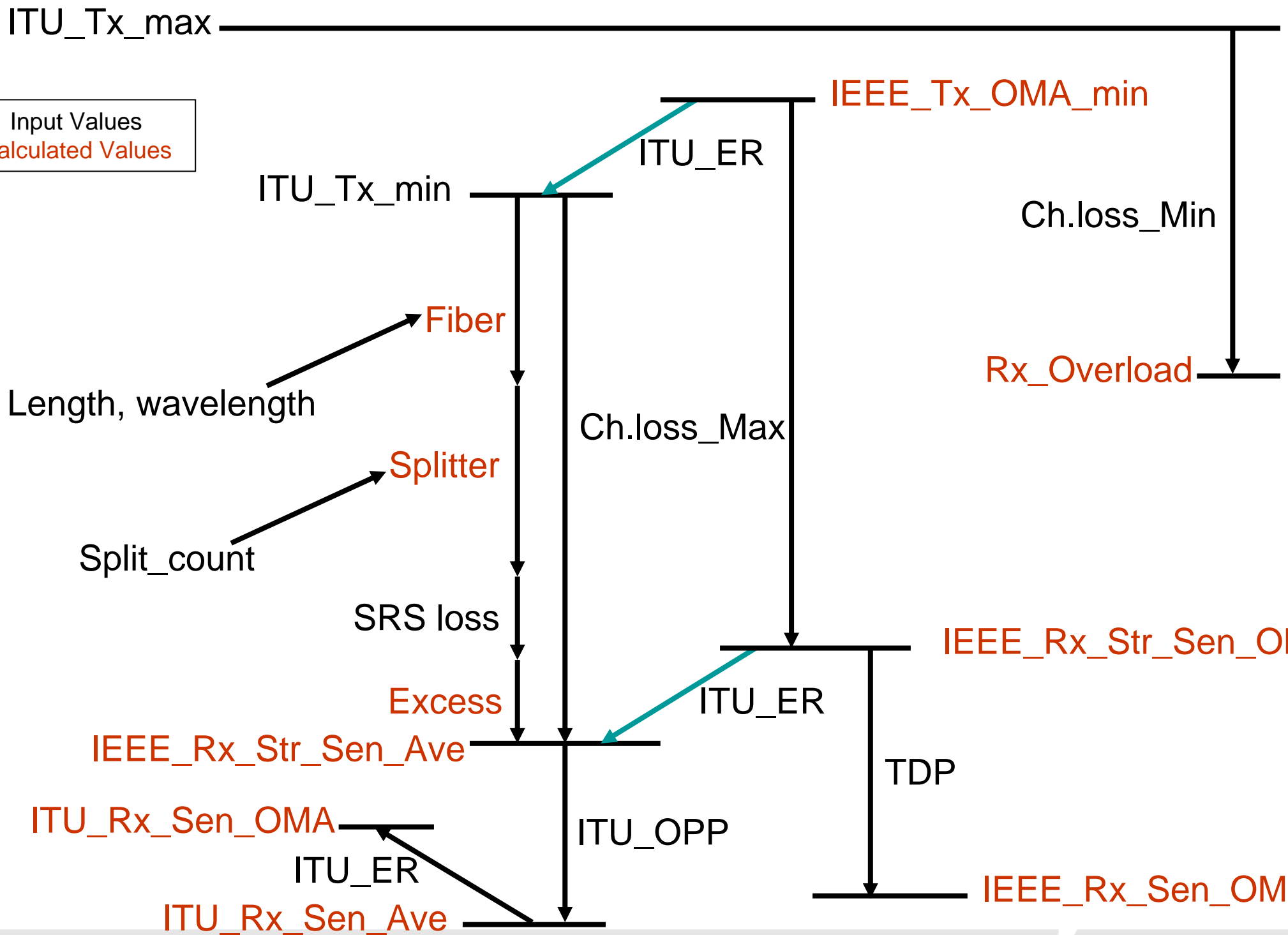
General observation: Market effects

- **In both standards groups, you get "horse races" of technology developing**
  - PIN vs. APD detectors
  - FP vs. DFB lasers
- **The predictions on cost are usually not accurate**
- **They depend on many unstable factors**
  - Will the market take off, or be stuck in neutral
  - Will the vendors be aggressive, or find greener pastures
- **The best approach is probably to allow both options, and let the market truly decide the issue in the future**

HUAWEI

Applying the lessons: NG PONs

- **IEEE 10GE-PON: Optics specifications include a high-budget option**

- **ITU XG-PON: Recognition that specifications must be relaxed reasonably**

- **Cooperative approach: The two groups have worked together to complement their efforts**

IEEE 10GE-PON

- **Optics specifications have been completely reworked**

  - Different specification method that relates to the ITU method more directly

  - Different approach where the optical link budget is given (by the operator), not calculated from first principles

  - Different results, including a high budget option of 29 dB that is more in keeping with real deployment

- **This promises to make these specifications much more relevant in the marketplace**

HUAWEI

ITU_Tx_max

IEEE_Tx_OMA_min

Input Values
Calculated Values

ITU_ER

ITU_Tx_min

Ch.loss_Min

Fiber

Length, wavelength

Ch.loss_Max

Rx_Overload

Splitter

Split_count

SRS loss

IEEE_Rx_Str_Sen_OMA

Excess

ITU_ER

IEEE_Rx_Str_Sen_Ave

TDP

ITU_Rx_Sen_OMA

ITU_OPP

ITU_ER

IEEE_Rx_Sen_OMA

ITU_Rx_Sen_Ave

HUAWEI

ITU XG-PON

- **The design philosophy is more balanced towards achieving economical performance**

  - Relaxed optical timing is allowed (but doing better is possible)

  - Not every last bit of efficiency must be obtained

  - Usable line rates below their "nominal" values

  - Protocol modified to make implementation easier

- **Taken together, all of these work to make XG-PON simpler to implement and cheaper to manufacture**

Cooperative approach

- **The two groups have worked together to complement their efforts**

- **A long stream of liaison communications**

- **Sharing the same wavelength plan**

- **Perhaps sharing the same loss budgets**

- **IEEE providing interfaces to allow ITU functions to tie into the 10GE-PON system**

- **ITU moving to extend its higher-layer functions (e.g., OMCI)**

Cooperation in 10Gb/s PON systems

XG-PON1   10G EPON

In-Band FCAPS: BB-F WT-155 (TR-69 for PON)
Service Model: BB-F WT-156 (TR-101 for PON)

Out-of-band FCAPS: OMCI

X-PON Common functions: DBA, SEC, PLOAM

XG-PON1 TC TDMA, Act. GEM, FEC	MAC-C: MPCP
	MAC: Ethernet
	RS: LLID

XG-PON1 PHY 10G/2.5G	PCS: 64b66b, FEC
	PMA: Burst mode
	PMD: Maximal

HUAWEI

Thank you!