

New WAN-PHY Approach Proposals

– Feed Forward Rate Control (**FFRC**) & 10Gigabit Ethernet Network Interface Extension (**10GENIE**) –

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Goal of Today's Presentation

- Propose 802.3ae-native capability of WAN by defining two features on XAUI (10 Gigabit Attachment Unit Interface)
 - Feed-Forward Rate Control (**FFRC**) through auto-negotiation that enables LAN-PHY access to WAN without 802.3x flow control.
 - 10 Gigabit Ethernet Network Interface Extension (**10GENIE**), that supports WAN signaling on LAN-Compatible PHY by using InterPacket Gap (IPG).



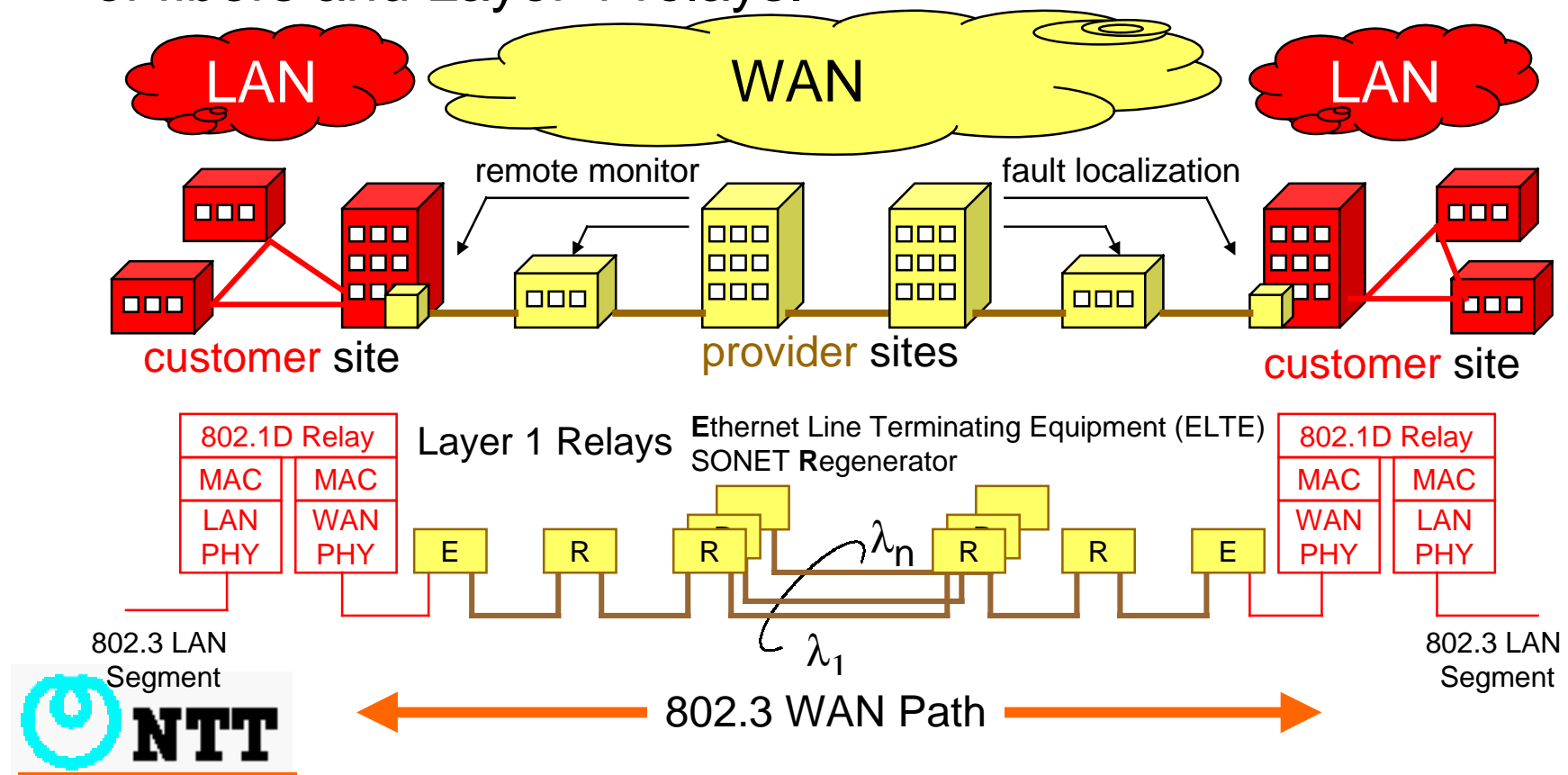
Outline of Today's Presentation

- Why WAN-PHY?
 - What is main capability of WAN?
 - Two alternatives for WAN providers, and their problems.
- WAN-Compatible PHY Issues:
 - Limited WAN-access design flexibility.
 - Suffers Duplicated frame-encapsulation.
 - No path to LAN-Native PHY in WAN.
- Propose two new features on XAUI;
 - Equip Feed-Forward Rate Control (**FFRC**).
 - Define 10GbE Network Interface Extension (**10GENIE**).



What is Capability of WAN? (1/2)

- Providing *reliable* PHY connection over multiple spans of fibers and Layer 1 relays.



What is Capability of WAN? (2/2)

- Providing *reliable* and *maintainable* connection over multiple spans of fibers and L1 relays; this requires
 - PHY bandwidth dedicated to WAN-specific signaling for remote monitoring and fault localization.
- SONET provides this capability by its domain-nested overhead bytes in its specific frame.
- SONET is *NOT* the only solution: Digital Wrapper, Ethernet-native

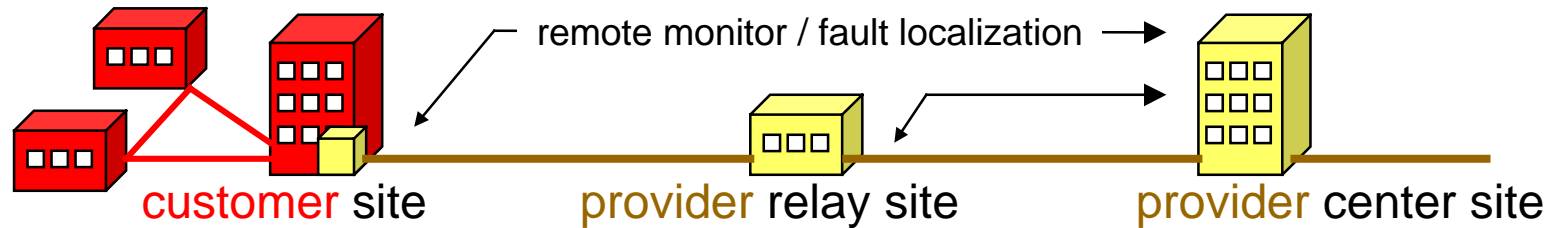


WAN Providers Face Two Opportunities (1/2)

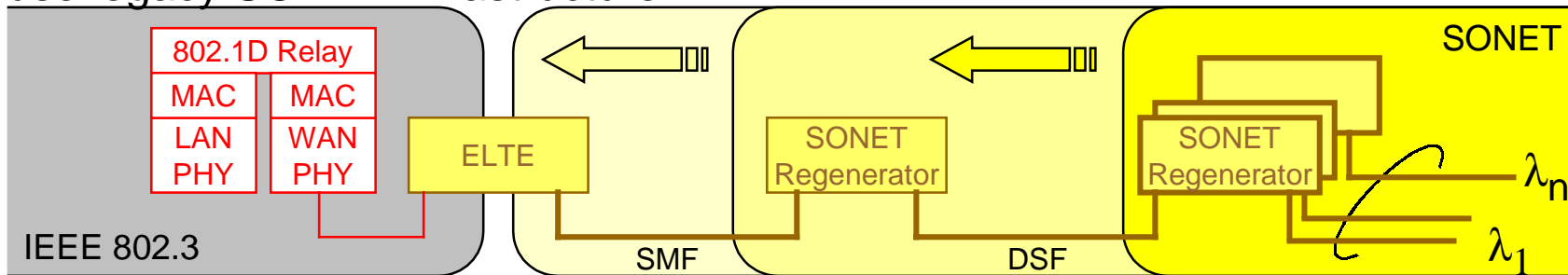
- Reuse legacy SONET infrastructure.
 - Pack native Ethernet packets in SONET frame.
 - Administer fibers and regenerators with SONET network operation system. Fine! But
 - *How far we should invest in expensive SONET gear?*
- Forget SONET.
 - Reuse installed fibers or rent dark fibers.
 - Construct WAN with LAN-native PHY. Great! But
 - *How to administer fibers & PHYs remotely?*



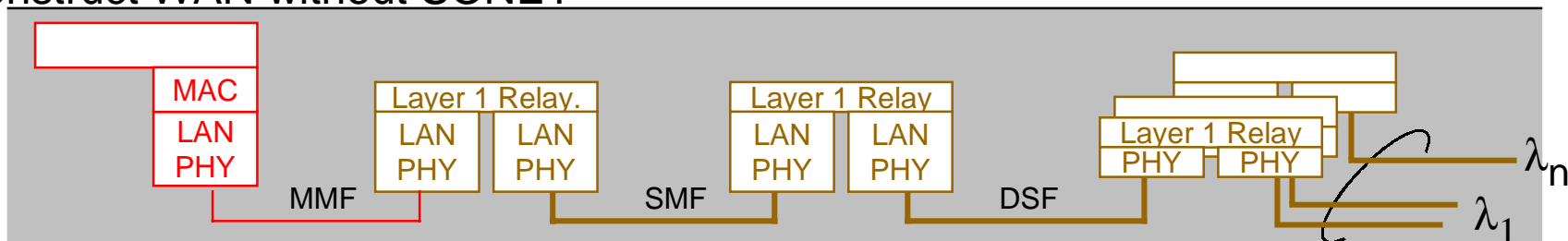
WAN Providers Face Two Opportunities (2/2)



Reuse legacy SONET infrastructure *How far we should invest in expensive SONET gear?*



Construct WAN without SONET *How to administrate fibers & PHYs remotely?*



Layer 1 Relay connects PHYs at Attachment Unit Interface (AUI) for maintainability.

ELTE: Ethernet Line Terminating Equipment

What do WAN providers want?

- Reusing installed SONET infrastructure;
 - compatibility with SONET regenerators, that requires
 - SONET framing at 9.95 Gb/s, and that requires
 - MAC/PLS rate-control to 9.58 Gb/s.
- More essentially, low-cost solution with capability of WAN operation;
 - compatibility with Network OpS, that requires
 - dedicated bandwidth at AUI for OAM&P, that supports
 - domain-nested fiber/PHY administration.



Our Vision of 802.3ae

- Support both WAN providers' opportunities:
 - Reuse SONET infrastructure *with minimal access cost*.
 - Reuse fiber infrastructure *with LAN-native PHY*.
- WAN-Compatible PHY approach is halfway.
 - It has *limitation on WAN-access design flexibility*.
 - It will suffer *duplicated frame encapsulation*.
 - It provides *no solution for LAN-native PHY* in WAN.
- Our proposals on XAUI are new WAN-PHY approach to support both opportunities;
 - **FFRC** allows LAN-PHY access to WAN.
 - **10GENIE** enables WAN signaling on LAN-Compatible PHY.



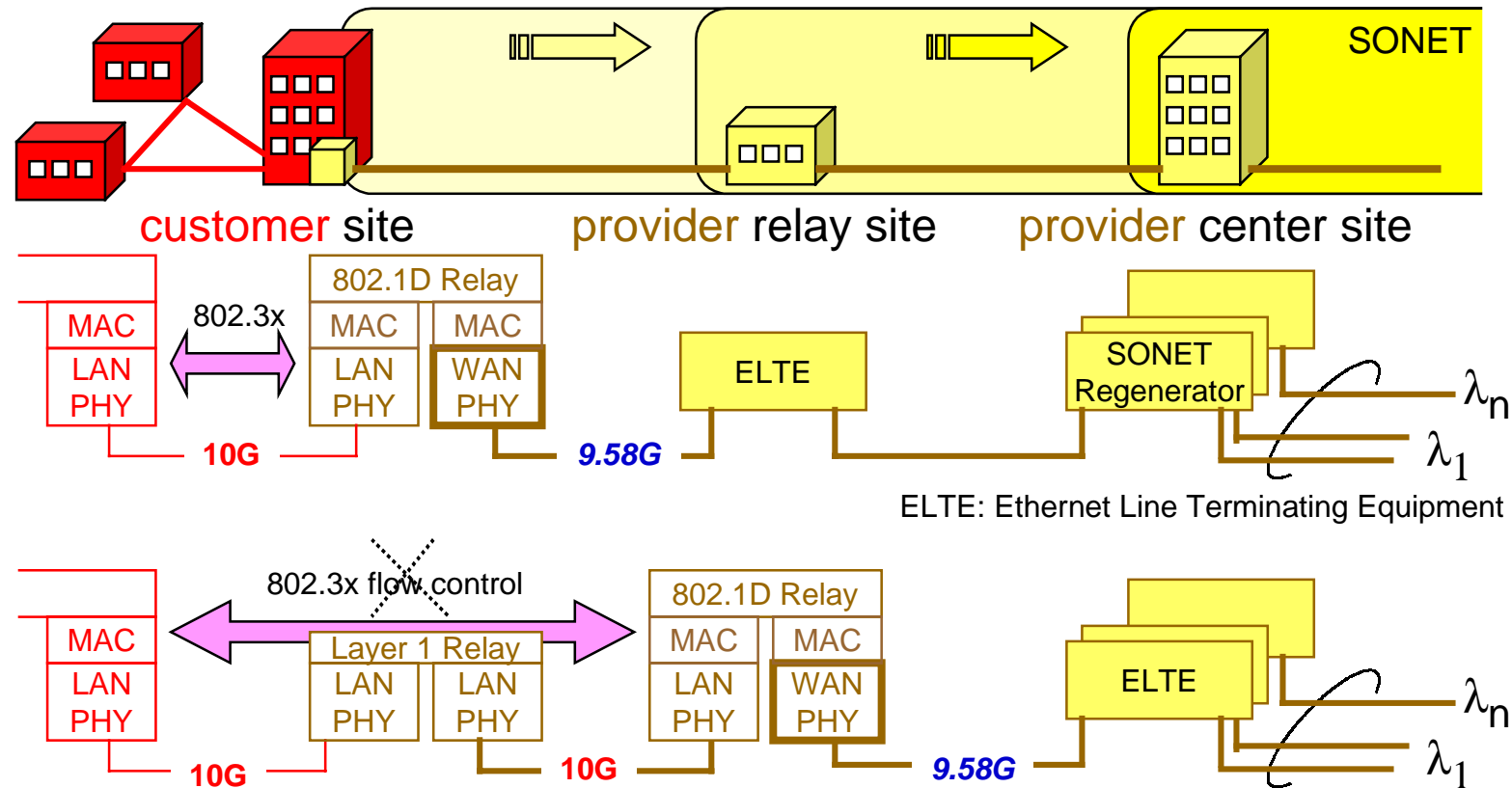
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 - What is main capability of WAN?
 - Two alternatives for WAN providers, and their problems.
- **WAN-Compatible PHY Issues:**
 - Limited WAN-access design flexibility.
 - Suffers duplicated frame-encapsulation.
 - No path to LAN-Native PHY in WAN.
- **Propose two new features on HARI;**
 - Equip Feed-Forward Rate Control (**FFRC**).
 - Define 10GbE Network Interface Extension (**10GENIE**).



WAN-Compatible PHY *Issues* (1/2)

– Limitation on WAN-Access Design Flexibility –

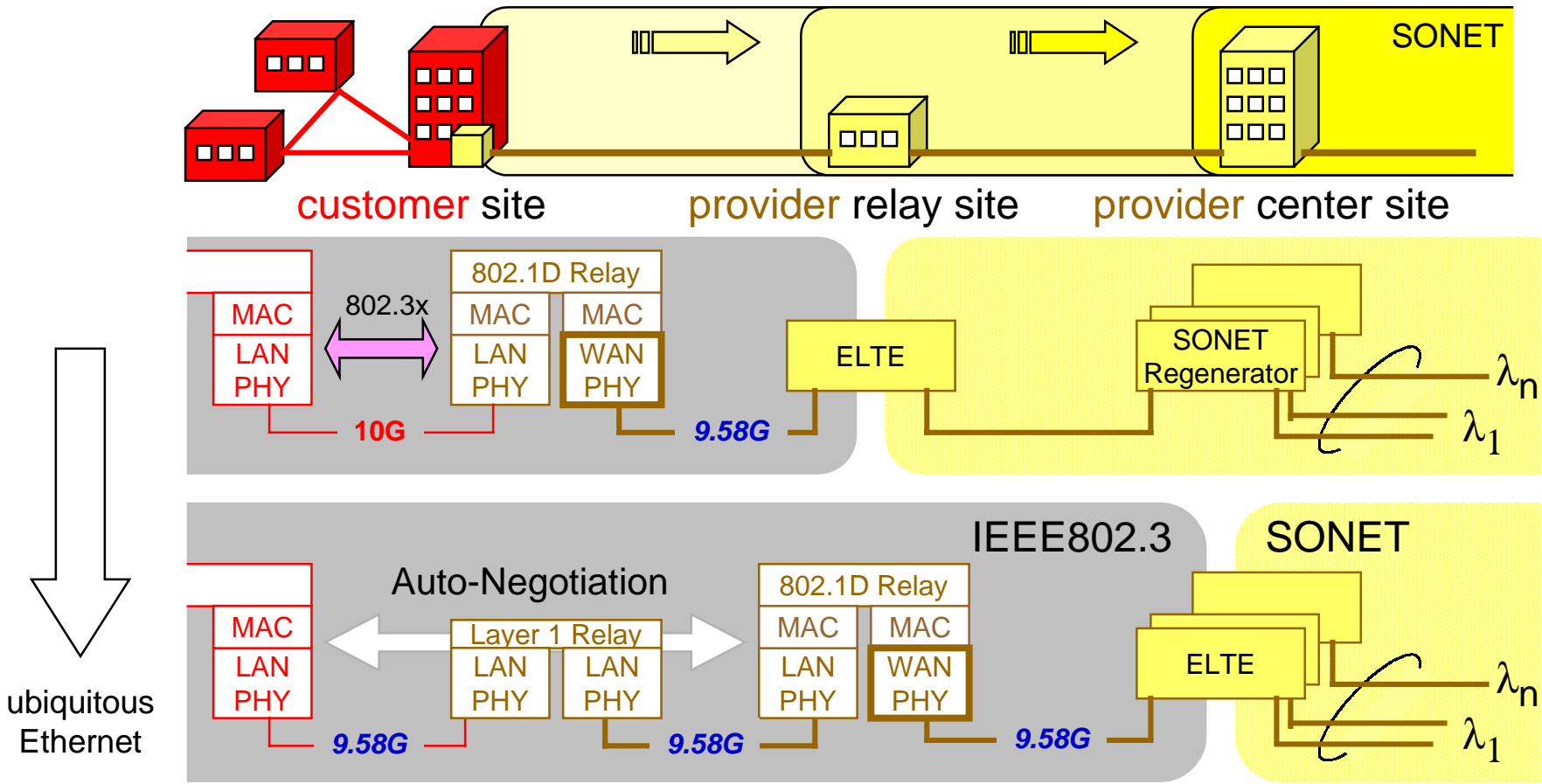


- WAN-C PHY requires L2 Relay buffer and backward flow control.
- Flow control over longer distances is *not* welcome.



Proposal 1 : FFRC (1/3)

– How FFRC Increases WAN-Access Design Flexibility –



ubiquitous Ethernet

ELTE: Ethernet Line Terminating Equipment

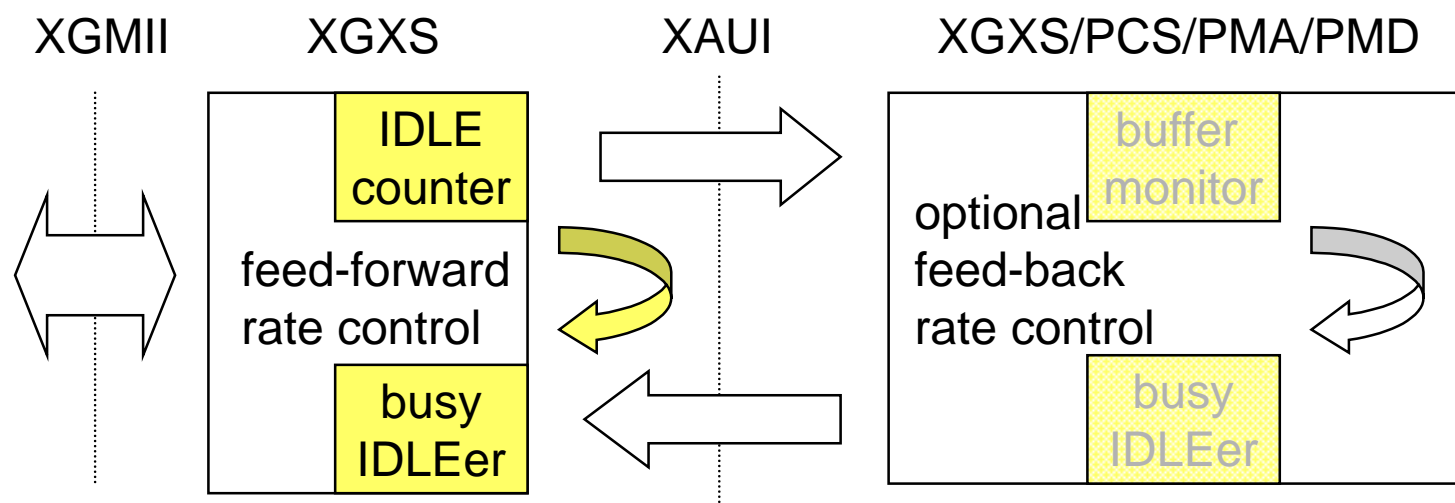


Proposal 1 : FFRC (2/3)

– Equip Feed-Forward Rate Control at XAUI –

Implementation example

Busy IDLEer: Unified LAN/WAN PHY Proposal - H. Frazier - January, 2000
http://grouper.ieee.org/groups/802/3/10G_study/public/jan00/frazier_1_0100.pdf



- MAC rate is monitored and regulated at XAUI.
- All PHY support both **10Gb/s** and **9.58 Gb/s** MAC rates, and is set through auto-negotiation process.
- Feed-back rate control by serial PCS may co-exist.

XGXS = XGMII Extender Sublayer
PCS = Physical Coding Sublayer



XGMII = 10 Gigabit Media Independent Interface
XAUI = 10 Gigabit Attachment Unit Interface

PMA = Physical Medium Attachment
PMD = Physical Medium Dependent

Proposal 1 : FFRC (3/3)

– Pros and *Cons* –

- Increase WAN-Access design flexibility.
- Expand LAN-PHY market, which will
- Enhance economies of scale.

- *Some cost burden to LAN-PHY*
 - Add rate provisioner and BUSY IDLEer at XGXS.
 - simple IDLE counter will be enough for rate provisioning.
 - Add an auto-negotiation process.



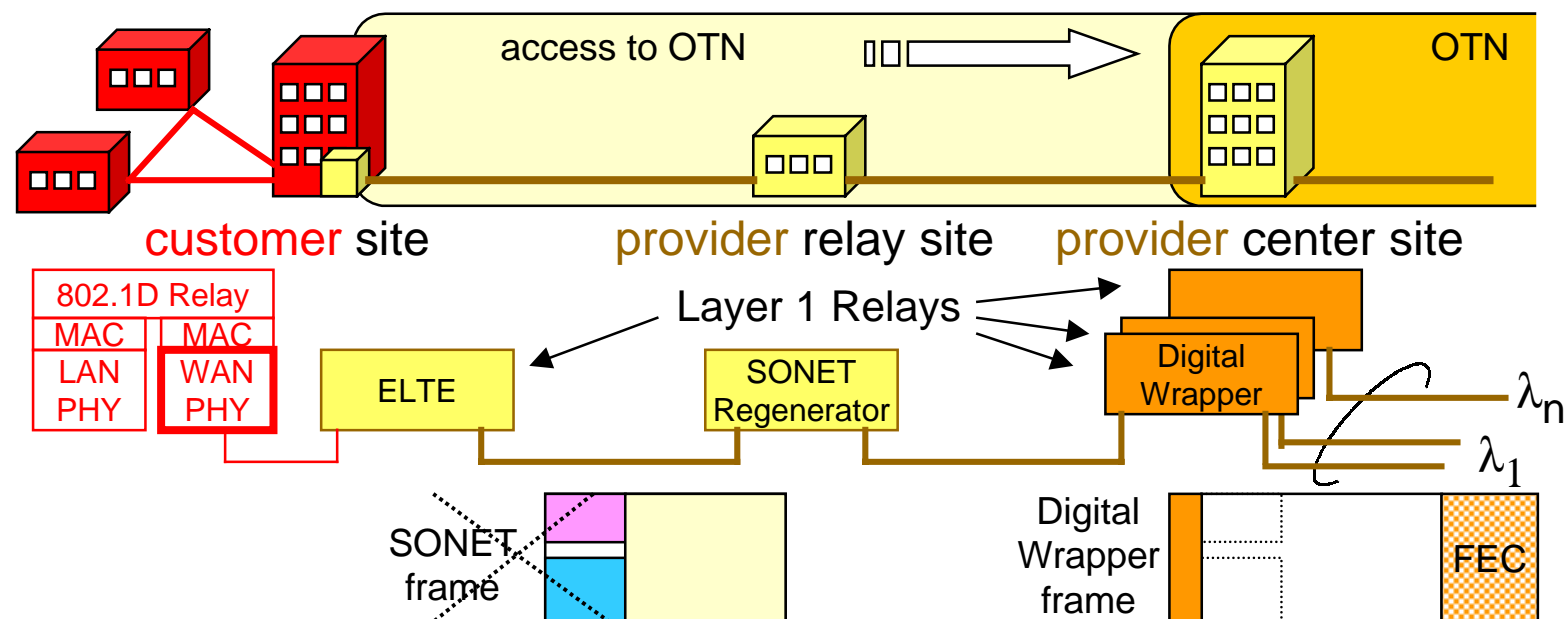
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WAN-Compatible PHY *Issues* (2/3)

– Duplicated Frame Encapsulation –

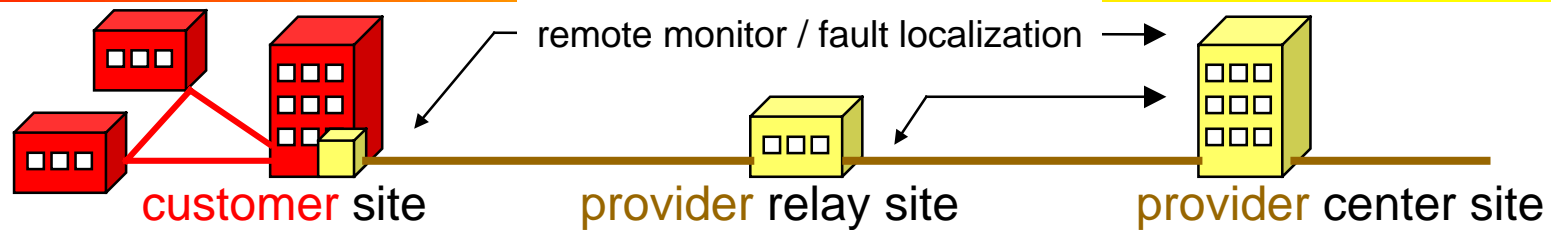


- ITU-T may recommend G.709 'Network Node Interface for the Optical Transport Network (OTN)' in 02/2001, where another frame 'Digital Wrapper' will provide up-to-date domain-nestable overhead bytes for WAN signaling.
- SONET framing will be excessive just for OTN access, while WAN providers may still require remote fiber/PHY administration in access.

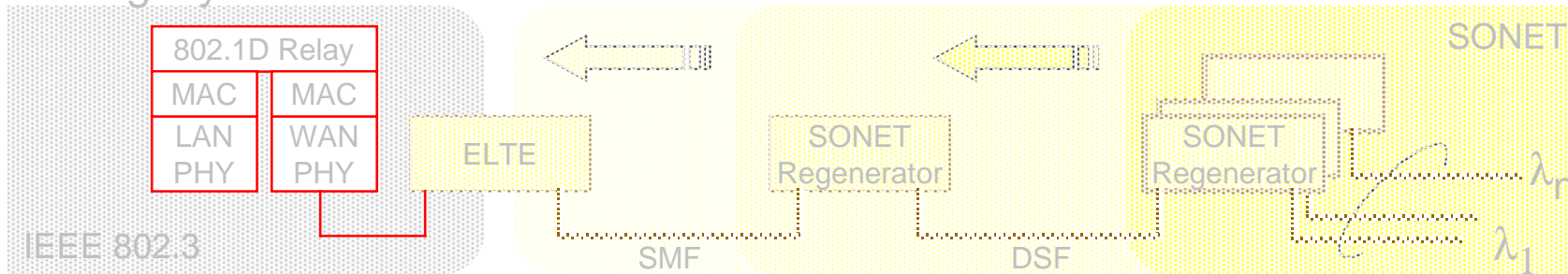


WAN-Compatible PHY *Issues* (3/3)

– No solution for LAN-native PHY in WAN –

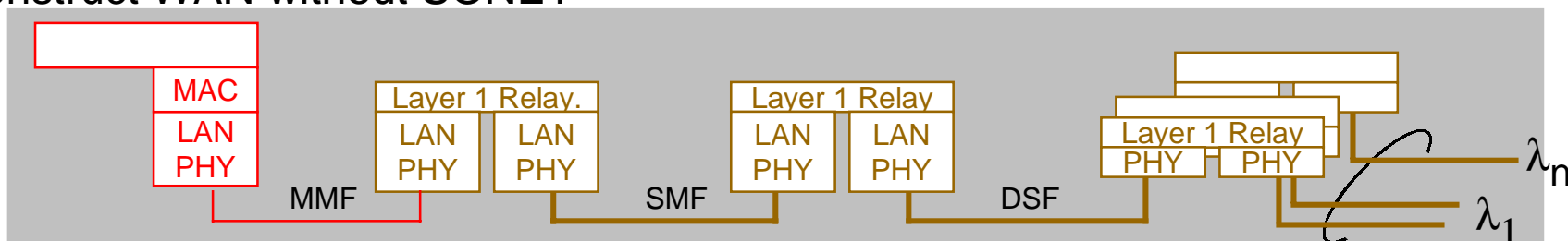


Reuse legacy SONET infrastructure *How far we should invest in expensive SONET gear?*



Construct WAN without SONET

How to administrate fibers & PHYs remotely?



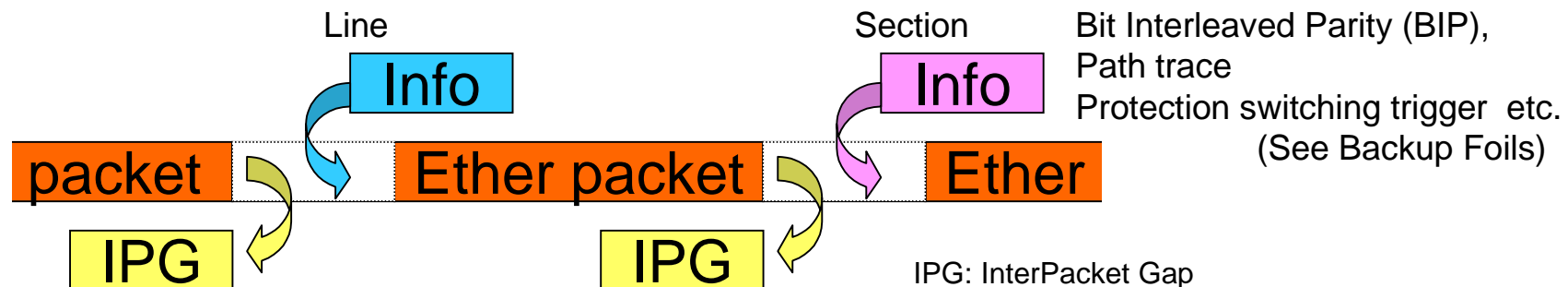
Layer 1 Relay connects PHYs at Attachment Unit Interface (AUI) for maintainability.

ELTE: Ethernet Line Terminating Equipment

Proposal 2 : 10GENIE (1/6)

–10 Gigabit Ethernet Network Interface Extension –

- New WAN-PHY approach:
 - LAN-Compatible PHY in WAN
- Implement ‘nestable OAM&P bytes’ into IPG

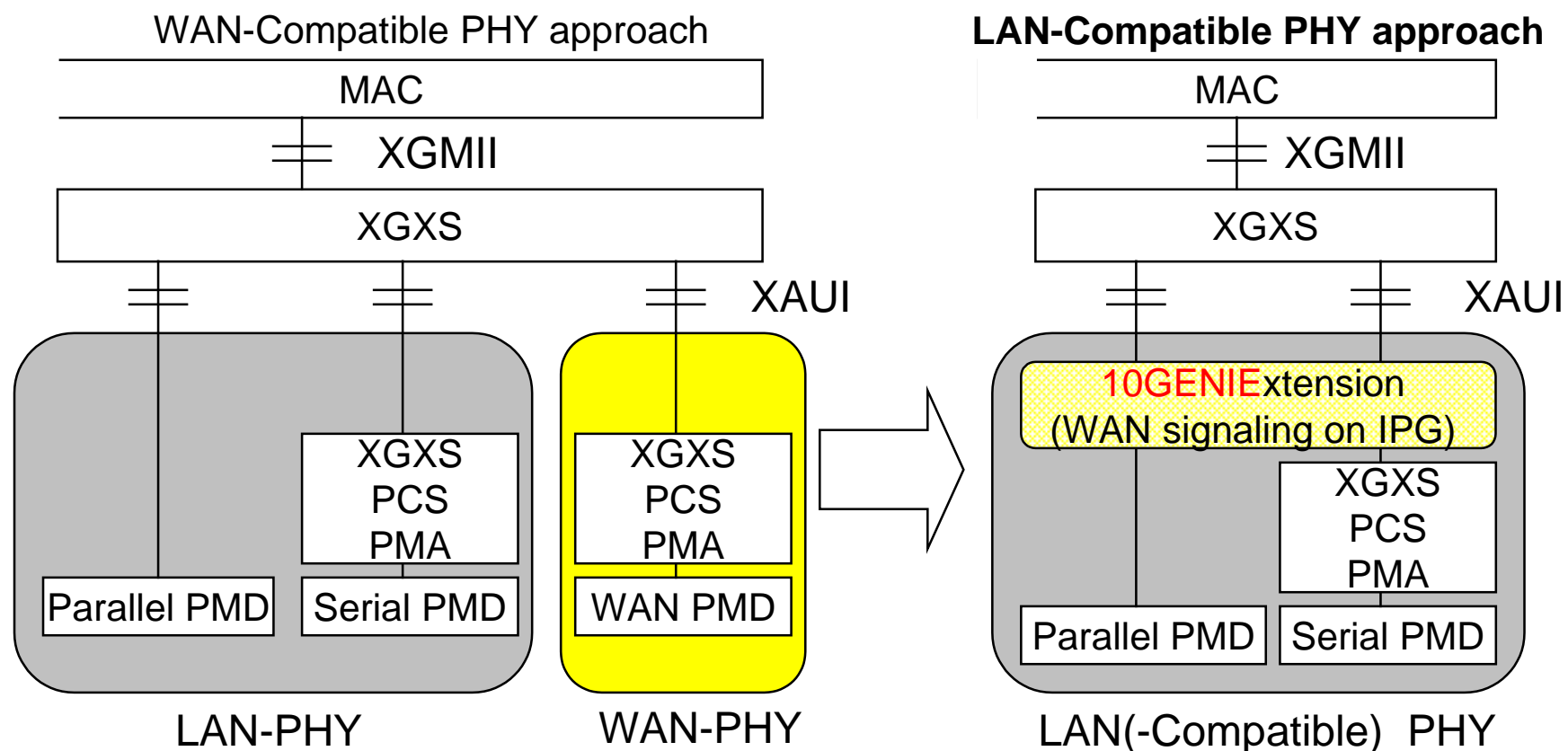


- It's an extension: no influence on LAN-PHY
 - LAN-PHY ignores Info bytes, treats them as just IPG.



Proposal 2 : 10GENIE (2/6)

– Implementing WAN extension on XAUI –



XGMII = 10 Gigabit Media Independent Interface
 XAUI = 10 Gigabit Attachment Unit Interface
 PCS = Physical Coding Sublayer

XGXS = XGMII Extender Sublayer
 PMA = Physical Medium Attachment
 PMD = Physical Medium Dependent

Proposal 2 : 10GENIE (3/6)

– Implementation Example Similar to FC-AL –

- IDLE ordered set in IPG is occasionally replaced by Extended IDLE ordered set.
 - This concept is used in Fibre Channel for arbitration.
 - E-IDLE example : (-) / K28.5 / ID1 / ID2 / DATA /
 - / ID1 /, / ID2 /, and / DATA / are valid 8B/10B data characters, and have some restriction on their disparity.
 - / ID1 / indicates 10GENIE. (probably reserved for further extensions.)
 - / ID2 / indicates what kind of signaling in what domain.
 - / DATA / carries signaling, such as Bit-Interleaved Parity.
 - LAN-PHY should *not* distinguish E-IDLE from IDLE.



Proposal 2 : 10GENIE (4/6)

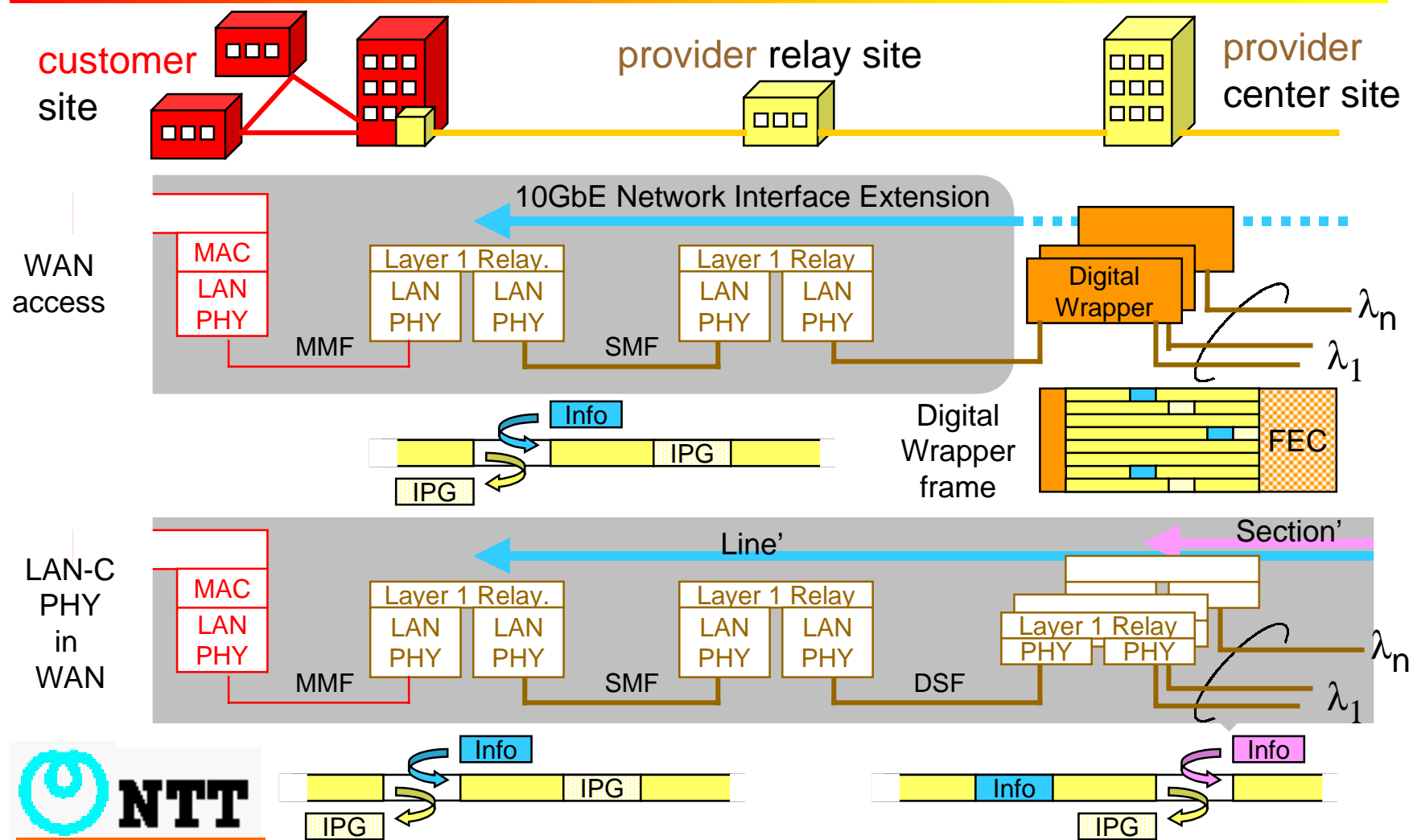
– What Should Be Defined by Std.? –

- All E-IDLE should be just IDLE for MAC/XGXS.
 - MAC/XGXS transmits normal IDLE alone.
 - IDLE and E-IDLE are removable without disparity control.
 - Serial PCS is transparent to E-IDLE.
- Define minimal interoperable Extended-IDLE for
 - nested BER monitoring, alarm forwarding, path tracing,
 - Data Communication Channel (DCC)
- Define rules for vender-specific extention.
 - Valid definition must be established by Std.
 - Unassigned SONET overhead bytes are a bad example.



Proposal 2 : 10GENIE (5/6)

– Applications: WAN Access and LAN-Compatible PHY–



Proposal 2 : 10GENIE (6/6)

– Pros and *Cons* –

- LAN-PHY unification at customer site
 - enjoy economies of scale
 - enjoy unified PHY maintenance
- 802.3ae-native capability of WAN signaling
 - enhance economies of scale on PHY hardware
 - enjoy compatibility with WAN operation system (OpS)
 - pave the way to replace SONET with OTN infrastructure.
- *Some constraint on*
 - XGXS coding to allow IDLE extension, and
 - Serial PCS for extended IDLE transparency.



XGXS = XGMII Extender Sublayer
PCS = Physical Coding Sublayer

OTN = Optical Transport Network

Summary

- Propose 802.3ae-native capability of WAN by defining two features on XAUI. XAUI = 10 Gigabit Attachment Unit Interface
 - **FFRC** (Feed-Forward Rate Control) enables LAN-PHY access to WAN without 802.3x flow control.
 - **10GENIE** (10 Gigabit Ethernet Network Interface Extension) supports WAN signaling without SONET.
- 10GENIE and FFRC accelerate true ubiquitous Ethernet and its economies of scale.

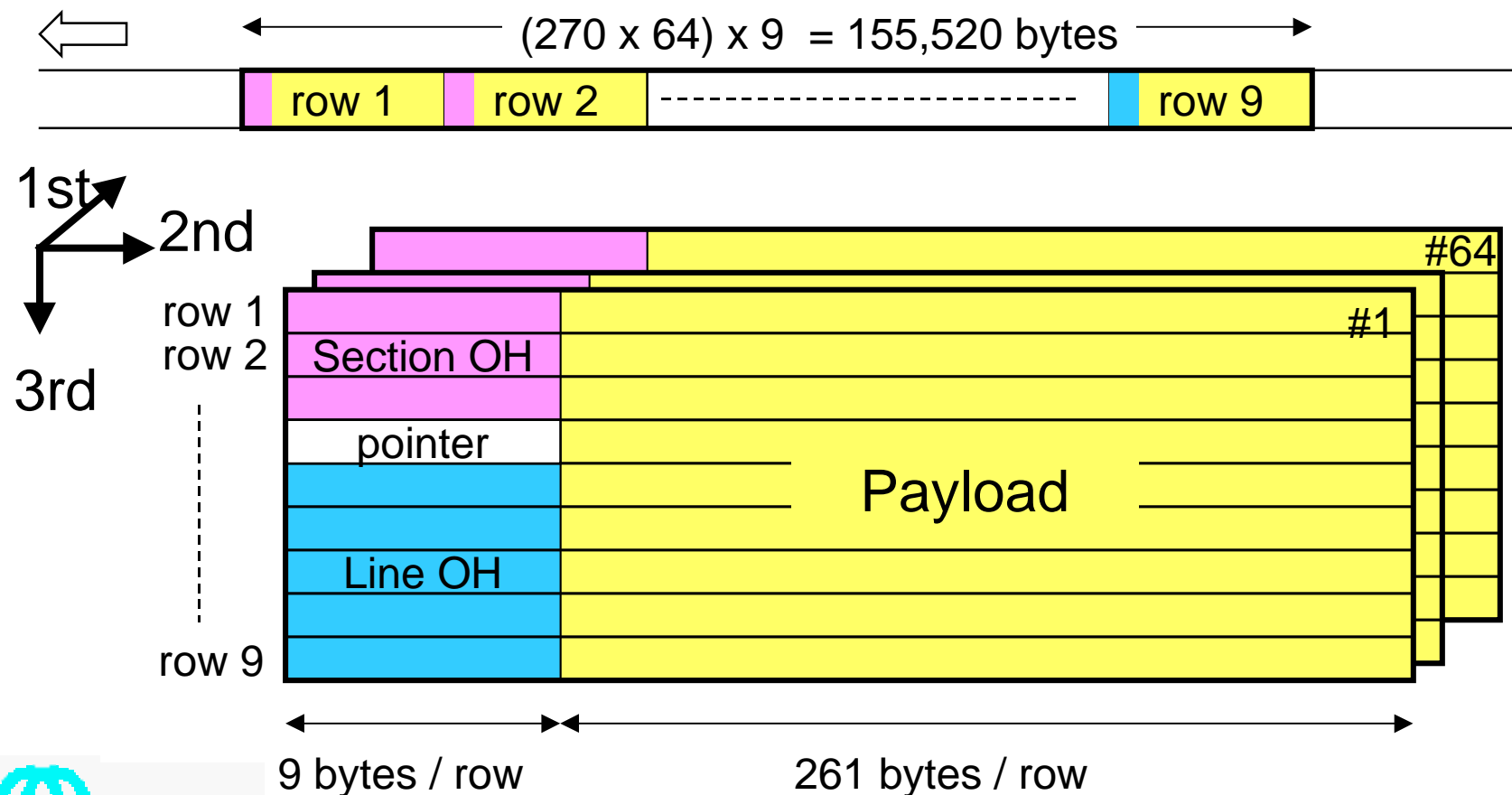


Backup Foils



What is SONET? (1/5)

– SONET OC192 Framing (9.96 Gb/s) –



What is SONET? (2/5)

– SONET function –

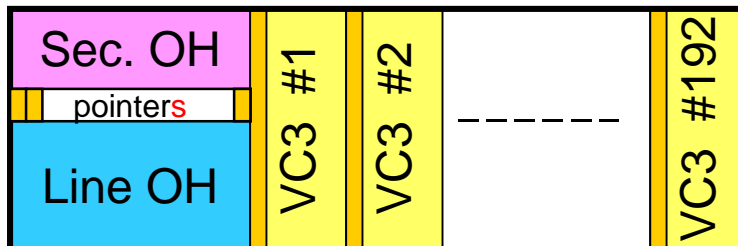
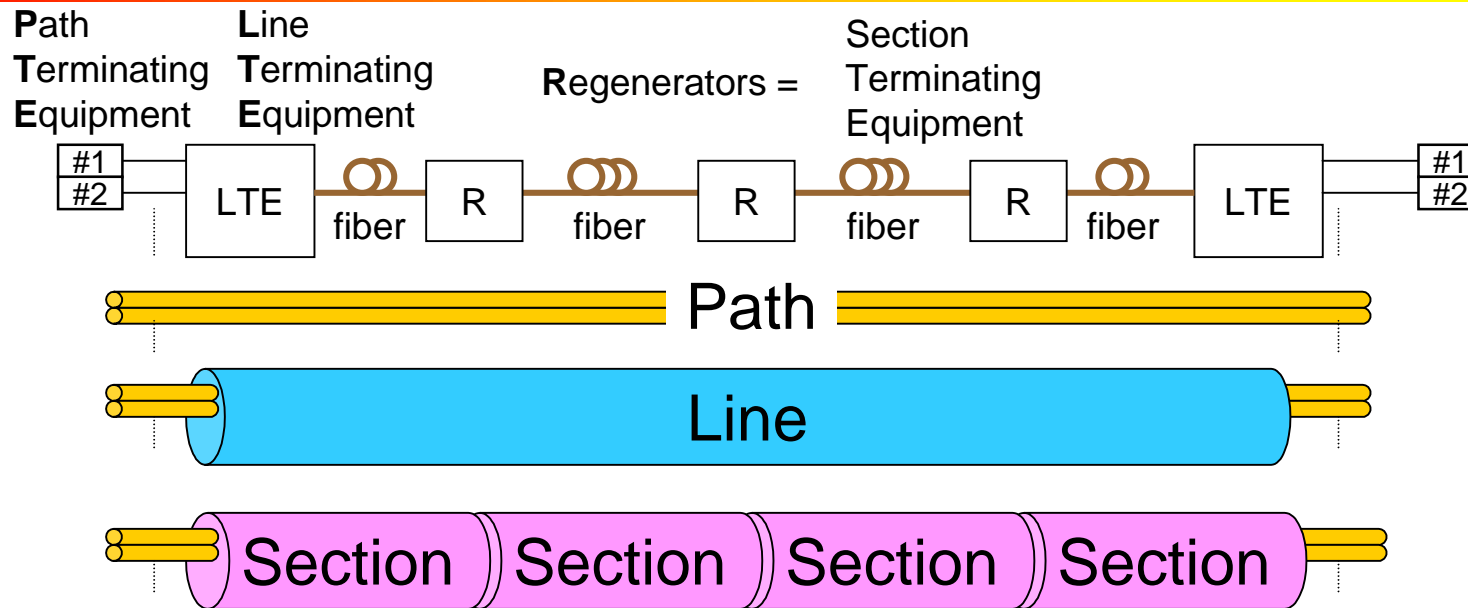
- SONET is virtual **wiring** in **fiber cascades**, where
 - **wire** is called 'Path',
 - **fiber cascades** are called 'Line', and
 - each **fiber** is called 'Section'.
- SONET realizes three functions:
 - bundling hundreds of Paths into Line by TDM
 - Path-by-Path byte-stuffing (Sync.) by pointers
 - hierarchical OAM&P* by using overhead bytes

* Operations, Administration, Management, and Provisioning



What is SONET? (3/5)

– SONET Architecture –



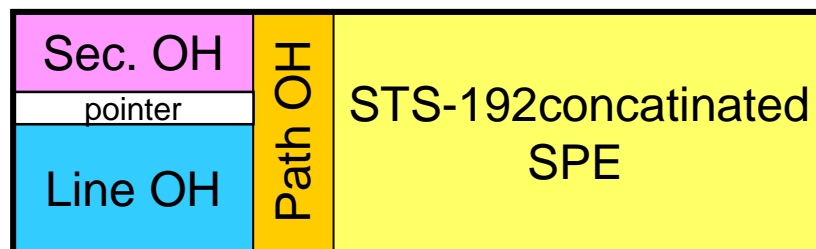
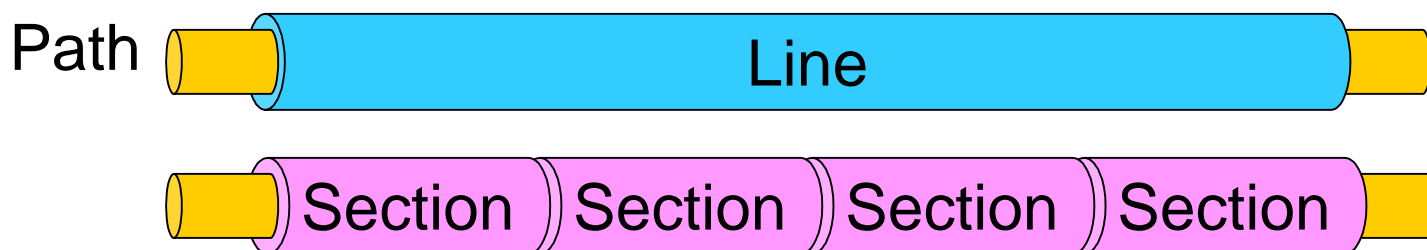
- LTE synchronizes Path by Path with each pointer offset & stuffing.
- Regenerator is jitter-sensitive since transmit clock is the recovered received clock of the previous Section.



What is SONET? (4/5)

– What Will Happen in 10 GbE WAN-Compatible PHY? –

- SONET provides just one function:
 - *(bundling hundreds of Paths into Line by TDM)*
 - *(Path-by-Path byte-stuffing (Sync.) by pointers)*
 - **3 nested domain** OAM&P by using OH bytes



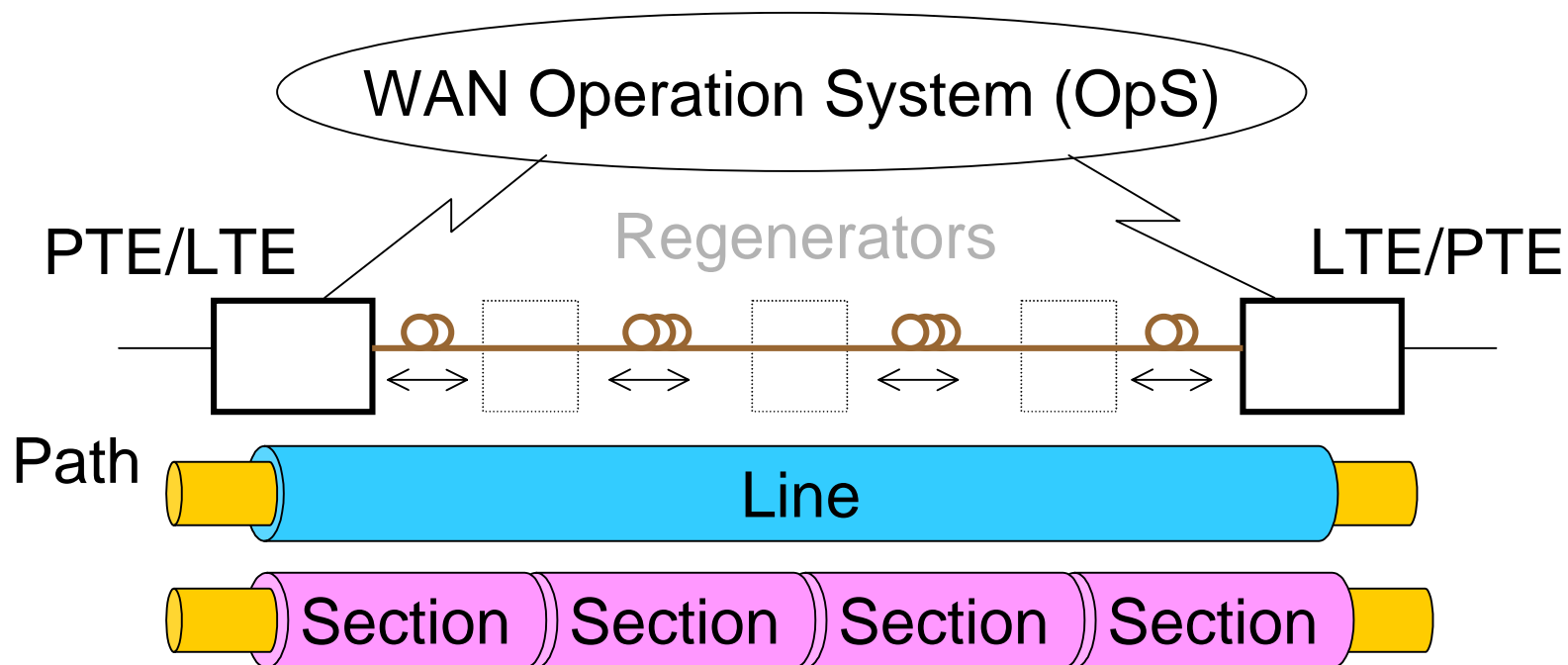
OAM&P = Operations, Administration, Maintenance, and Provisioning



What is SONET/SDH? (5/5)

– *Nested-domain* OAM&P with Over-Head (OH) bytes –

- WAN providers administer fibers & regenerators remotely and hierarchically.



- Path/Line OH is for end-end signal trace, error-rate monitor, protection switching, ...
- Section OH is for remote monitor, alarm forwarding, fault localization, ...



WAN-Compatible PHY *Issues*

- WAN-Compatible PHY approach was proposed:
 - Ether on SONET (EOS) LITE, and 64B/66B on SONET.
- Their SONET framing provides best compatibility with installed SONET regenerators and network OpS.
- It has *limited WAN-access design flexibility*.
- It will suffer *duplicated frame encapsulation*.
- It provides *no solution for LAN-native PHY* in WAN.



Proposal 2 : 10GENIE

– What Function Should Be Implemented? –

- Support minimal WAN signaling, such as
 - Bit-Interleaved Parity (BIP) for fiber/PHY administration
 - protection switching trigger (K1/K2) for premier restoration
 - path trace identifier (J0) for assure correct cross-connection
 - Data Communication Channel (DCC) for extra signaling
 -
- Support flexible domain OAM&P, similar to
 - Path, Tandem Connection, Line, Section (SDH) [G.707]
 - Protected domain (ATM) [I.610]
 - Nested administrative domain (OTN) [to be G.709]



OAM&P = Operations, Administration, Maintenance, and Provisioning
OTN = Optical Transport Network