WAN Interface Sublayer (WIS) Update

IEEE P802.3ae
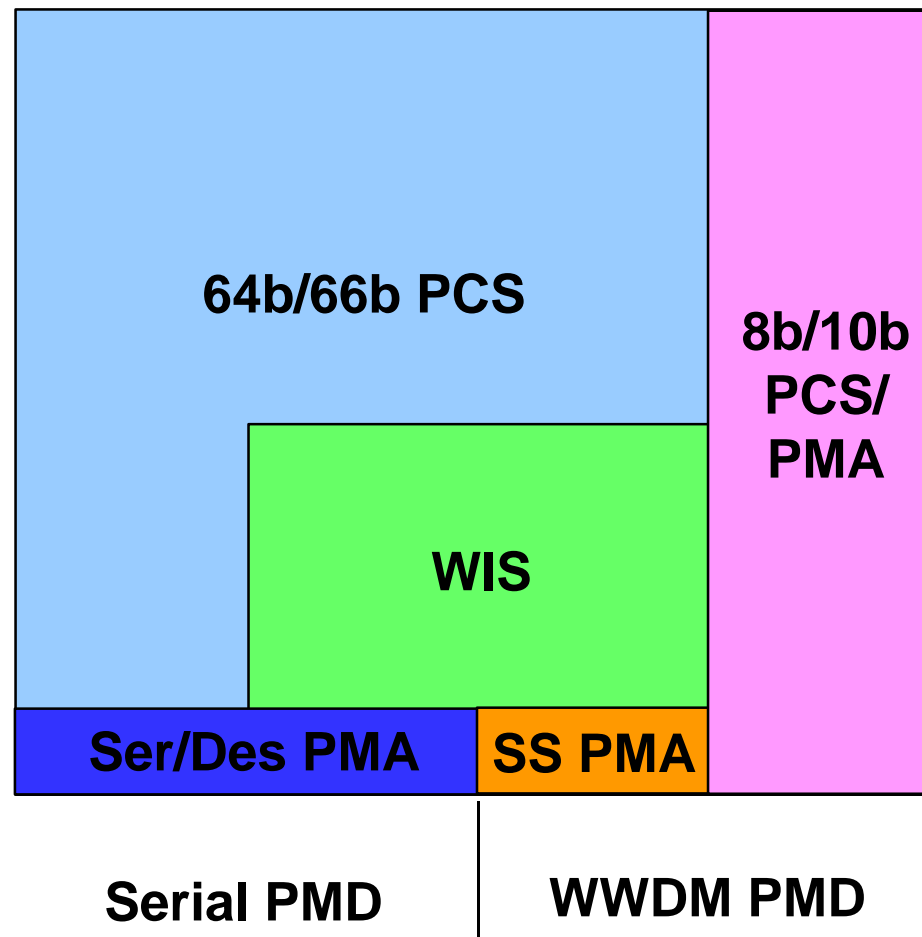## La Jolla
July 2000

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Bijan Raahemi:………………………………………………………… Nortel Networks
Richard Dugan:………………………………………………………... Agilent
Tom Palkert:…………………………………………………………. AMCC
Juan Pineda, Bill Rivard:……………………………………………….. Bravida Corporation
Howard Frazier:………………………………………………………. Cisco Systems
Steve Haddock:……………………………………………………….. Extreme Networks
Nan Chen:…………………………………………………………….. Force10 Networks
Michael McDonald:…………………………………………………… Galileo Technology
Kevin On:……………………………………………………………... Infineon Technologies
Pankaj Kumar, Bradley Booth, Bob Grow:……………………………... Intel
Bjørn Liencres:……………………………………………………….... Juniper Networks
Nader Vijeh:…………………………………………………………... Lantern Communications
Enrique Hernandez (Bell Labs), Nevin Jones (Microelectronics):……….. Lucent
Iain Verigin, Stuart Robinson, Tom Alexander, Farzin Firoozmand:…… PMC Sierra
Lee Yong-Hee, Won Jonghwa:……………………………………….... Samsung Electronics
Shimon Muller:………………………………………………………. Sun Microsystems
Frederick Weniger:…………………………………………………... Vitesse
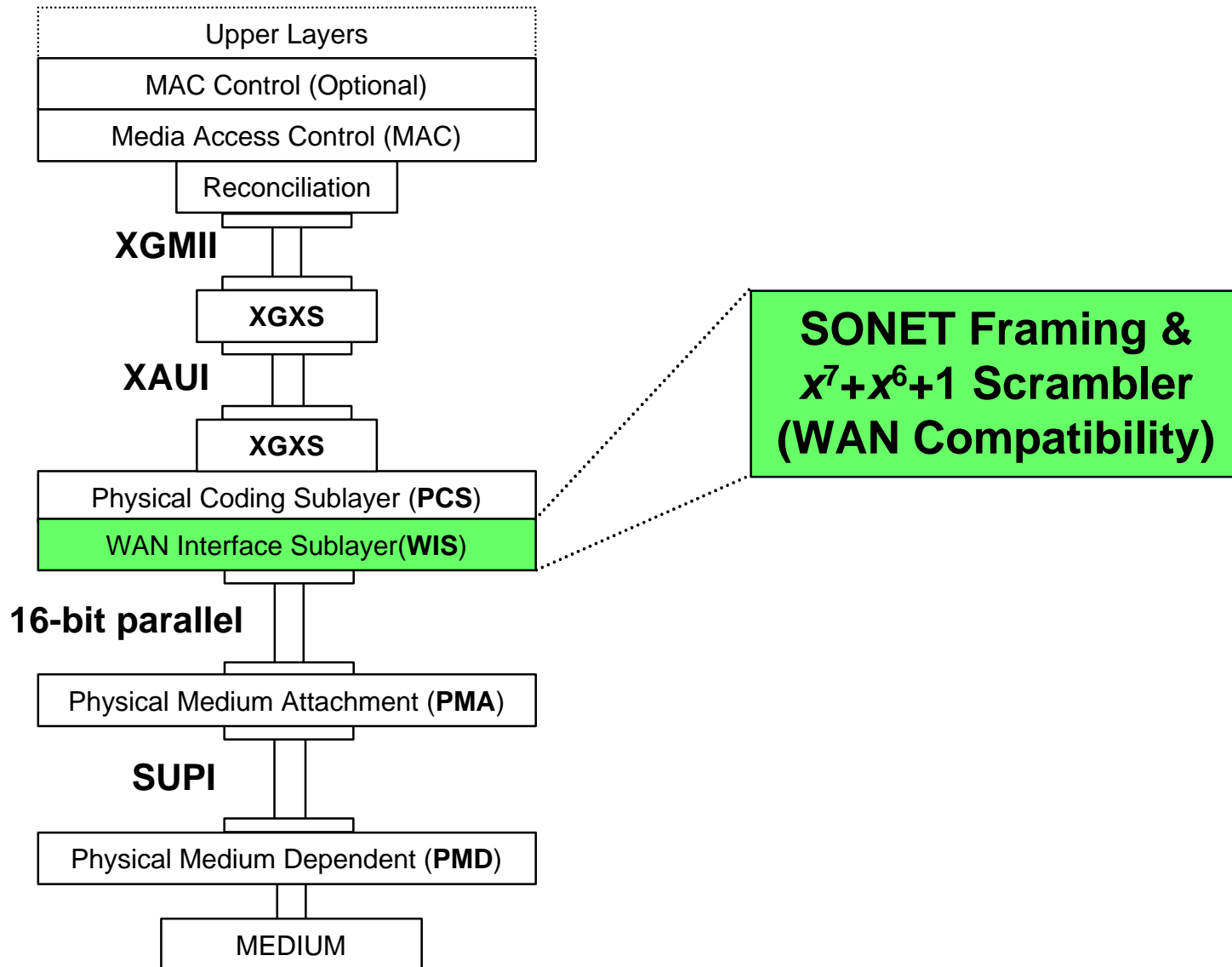
V1.1

Agenda

- **WIS**
    - $x^7 + x^6 + 1$ scrambler
    - SONET framing
    - overheads
    - frame synchronization

- **How to write the WIS Clause by cross-referencing ANSI T1.416-1999**

    — Defining required changes and additions

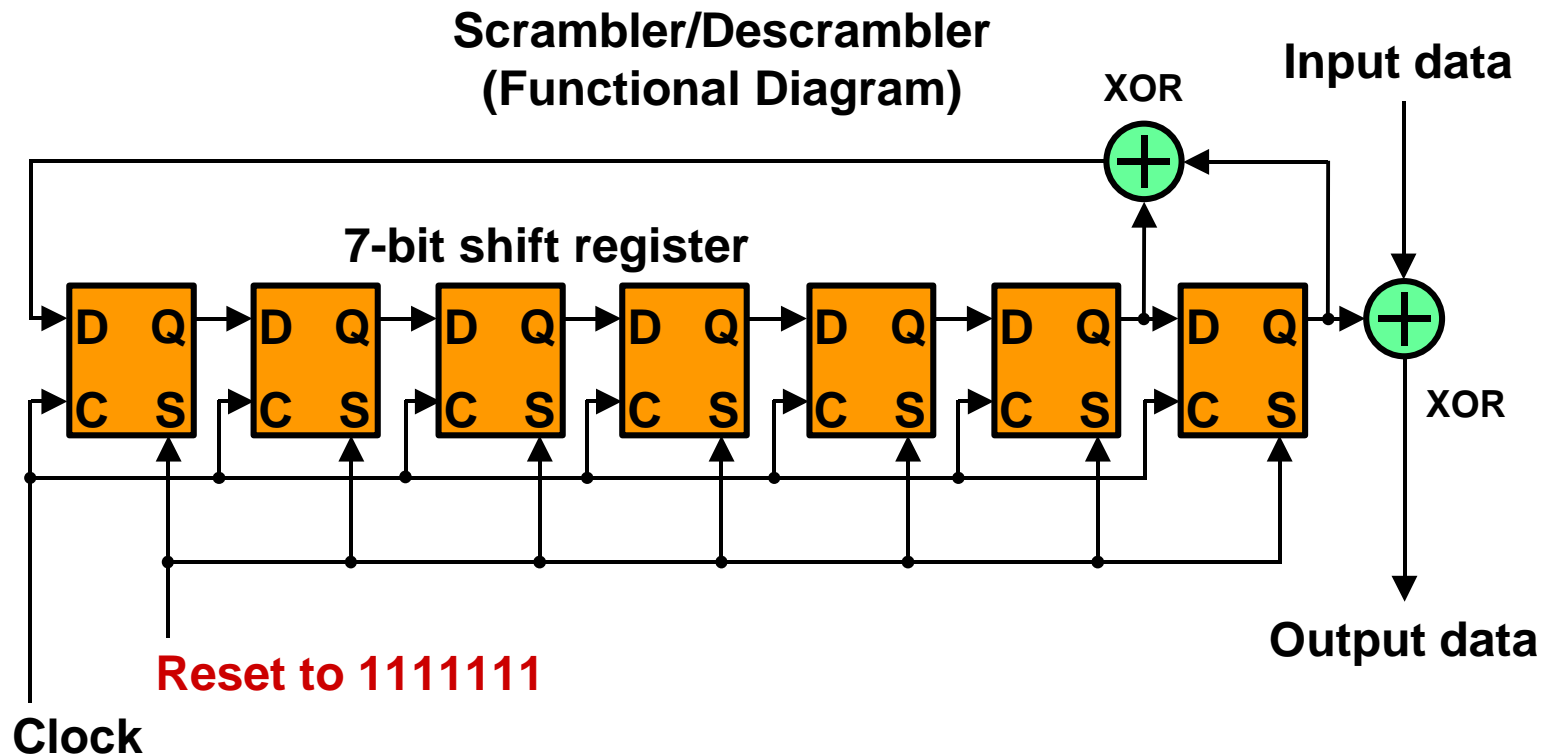   — Keeping SDH compatibility

UniPHY Components
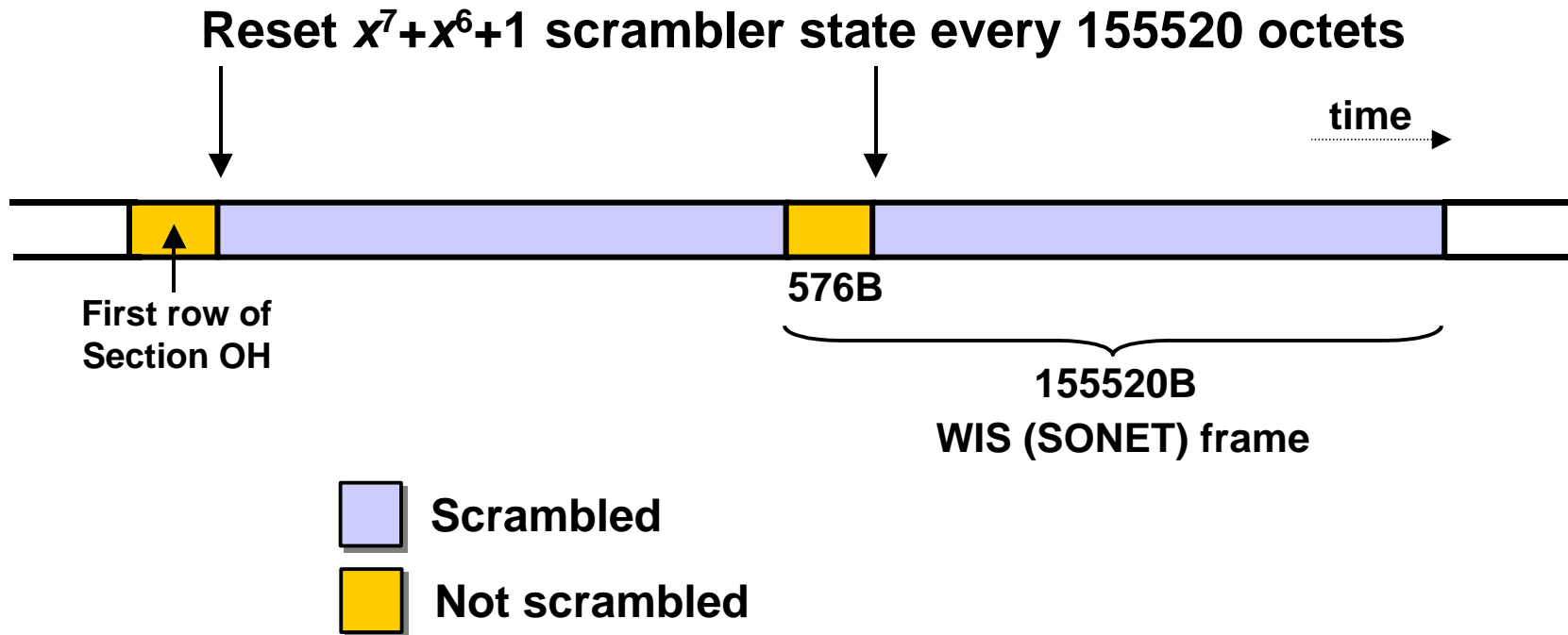
WAN-PHY and UniPHY Layer Model

Upper Layers

MAC Control (Optional)

Media Access Control (MAC)

Reconciliation

XGMII

XGXS

XAUI

XGXS

Physical Coding Sublayer (**PCS**)

WAN Interface Sublayer(**WIS**)

16-bit parallel

Physical Medium Attachment (**PMA**)

SUPI

Physical Medium Dependent (**PMD**)

MEDIUM

SONET Framing & x^7+x^6+1 Scrambler (WAN Compatibility)

WIS x^7+x^6+1 Scrambler

- **Provides high randomization**
 - Assures adequate number of transitions for line rate clock recovery at the receiver

Scrambler/Descrambler (Functional Diagram)

7-bit shift register

Reset to 1111111

Clock

Input data

XOR

XOR

Output data

State is Periodically Resynchronized

Reset x^7+x^6+1 scrambler state every 155520 octets

time

First row of
Section OH

576B

155520B
WIS (SONET) frame

Scrambled

Not scrambled

Bit Order of Scrambling/Descrambling

- **Most significant bit (MSB) first**

Octets

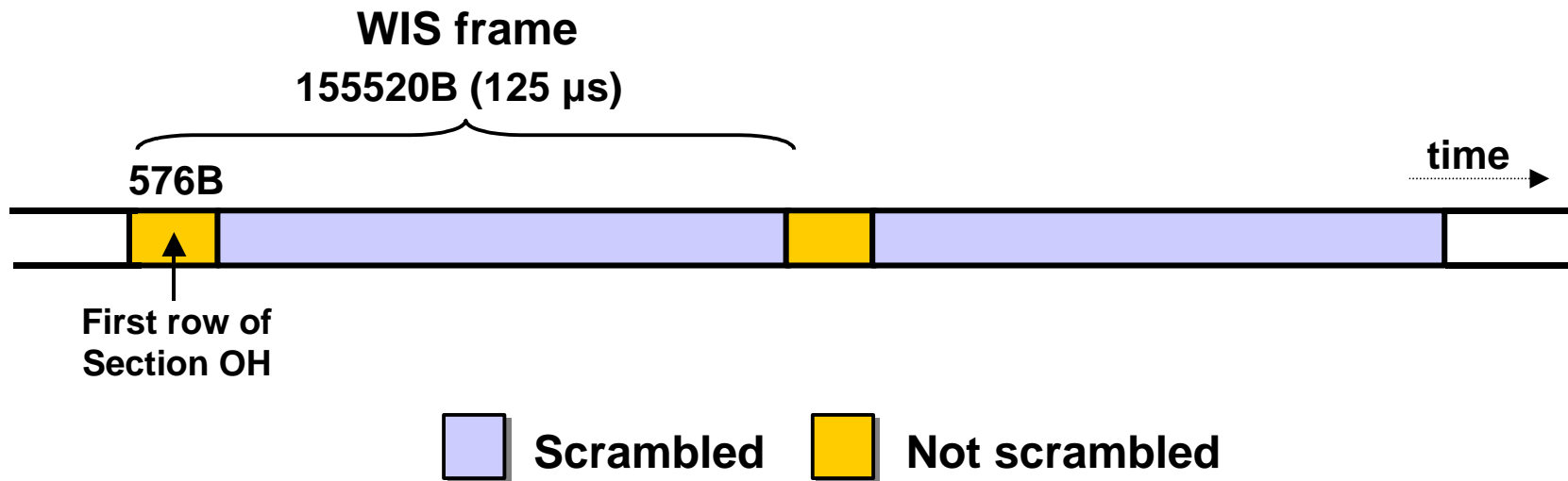7 6 5 4 3 2 1 0

1

$$x^7 + x^6 + 1$$
Scrambler/Descrambler

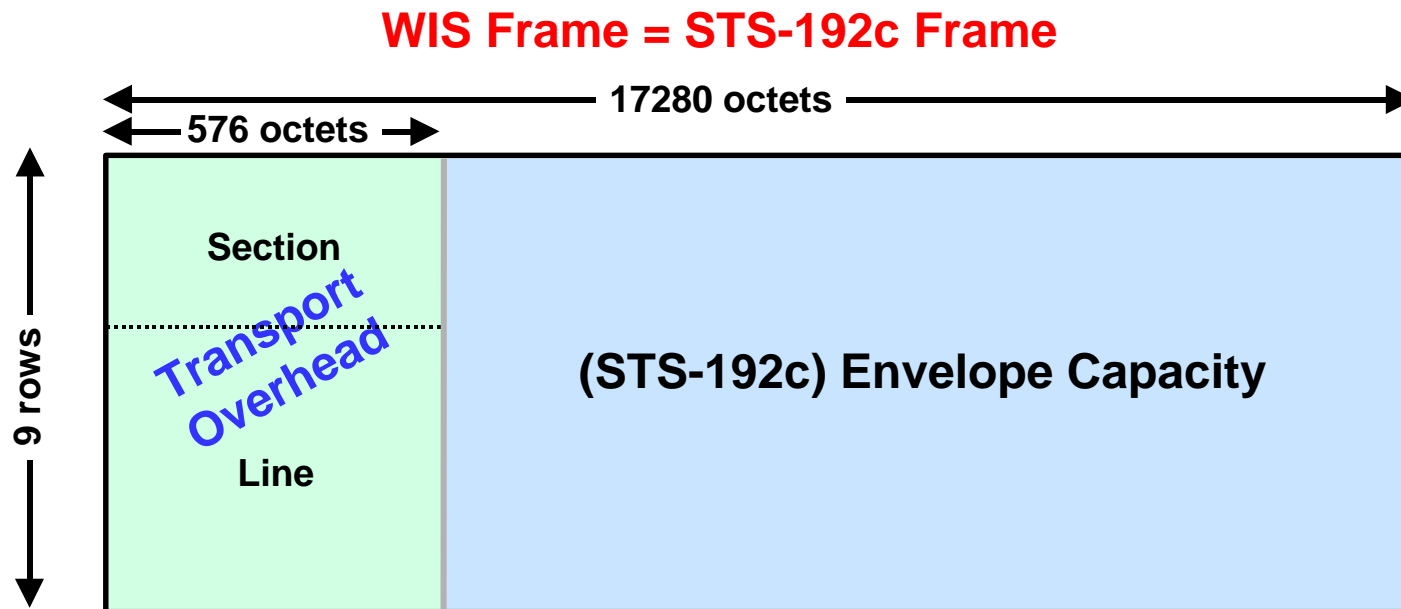7 6 5 4 3 2 1 0

1

Octets
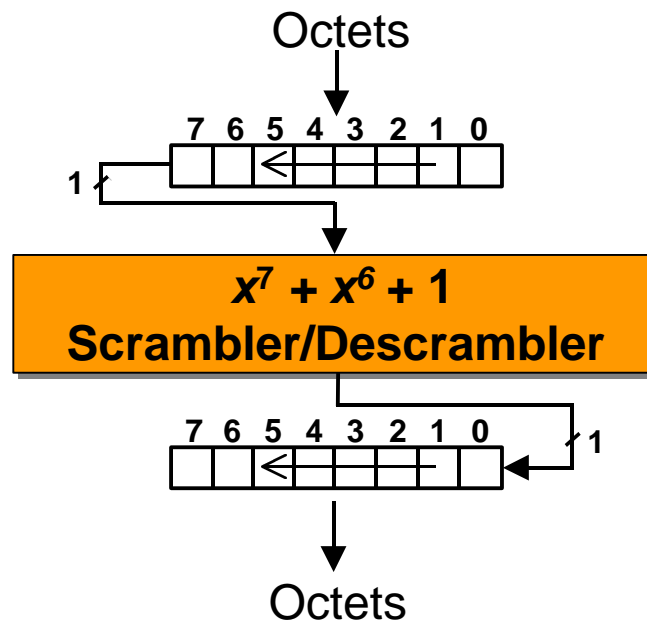
(Functional diagram)

WIS SONET Framing

- ## SONET frame with minimum overhead support

  - Overheads are out of band management used to control SONET networks

  - While the WIS frame is compatible with SONET, it does not provide full SONET management

- ## Sequence of 155520 octets (125 µs)

WIS frame

155520B (125 µs)

time

576B

First row of Section OH

Scrambled   Not scrambled

WIS Frame: Viewed as 9×17280 Octets

WIS Frame = STS-192c Frame

17280 octets

576 octets

9 rows

Section

Transport Overhead

Line

(STS-192c) Envelope Capacity

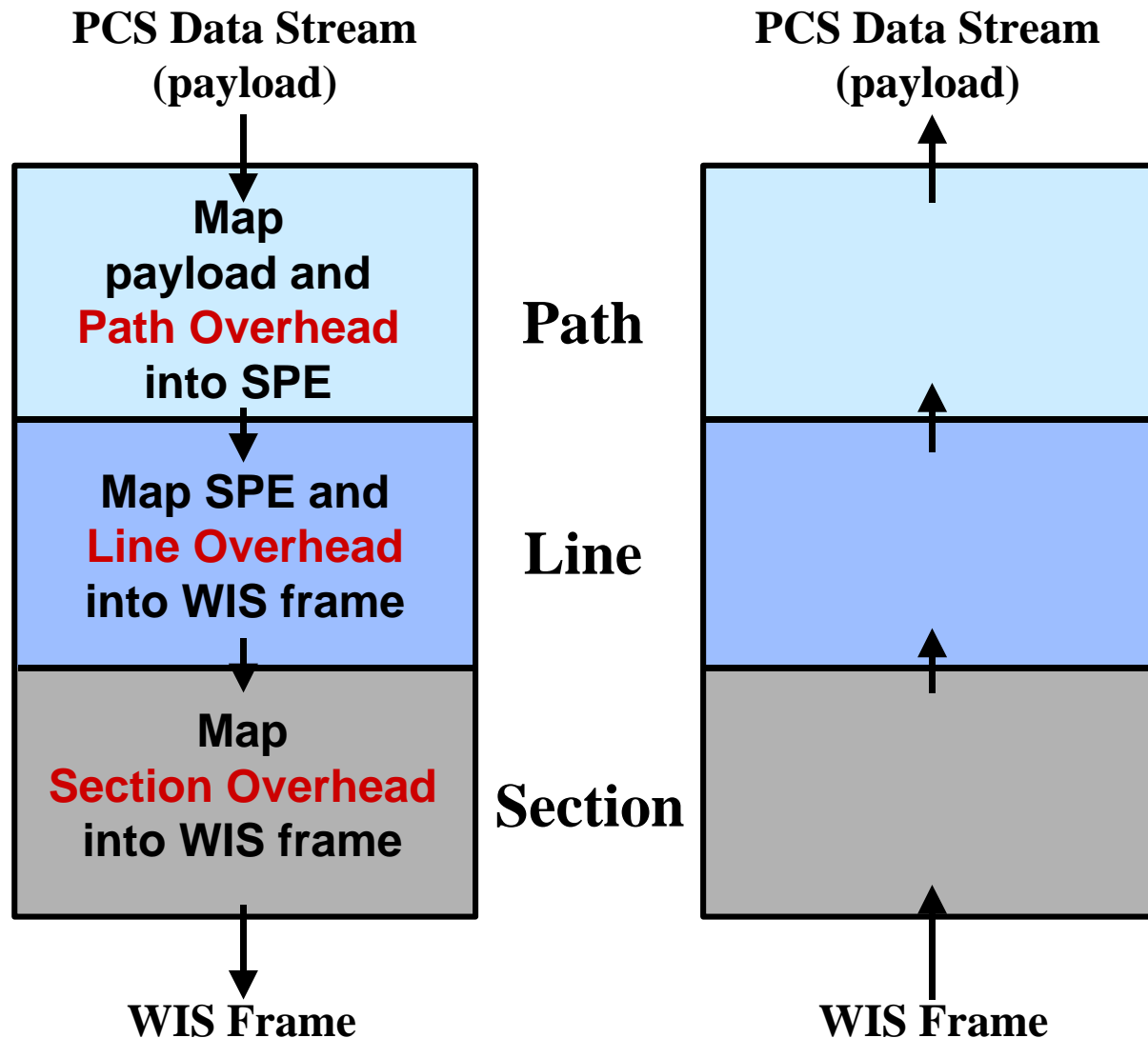STS-192c = Synchronous Transport Signal – level 192, c = concatenated.

Transmission order: top to bottom, row-by-row, left to right.

Payload Capacity (9.58464 Gb/s)
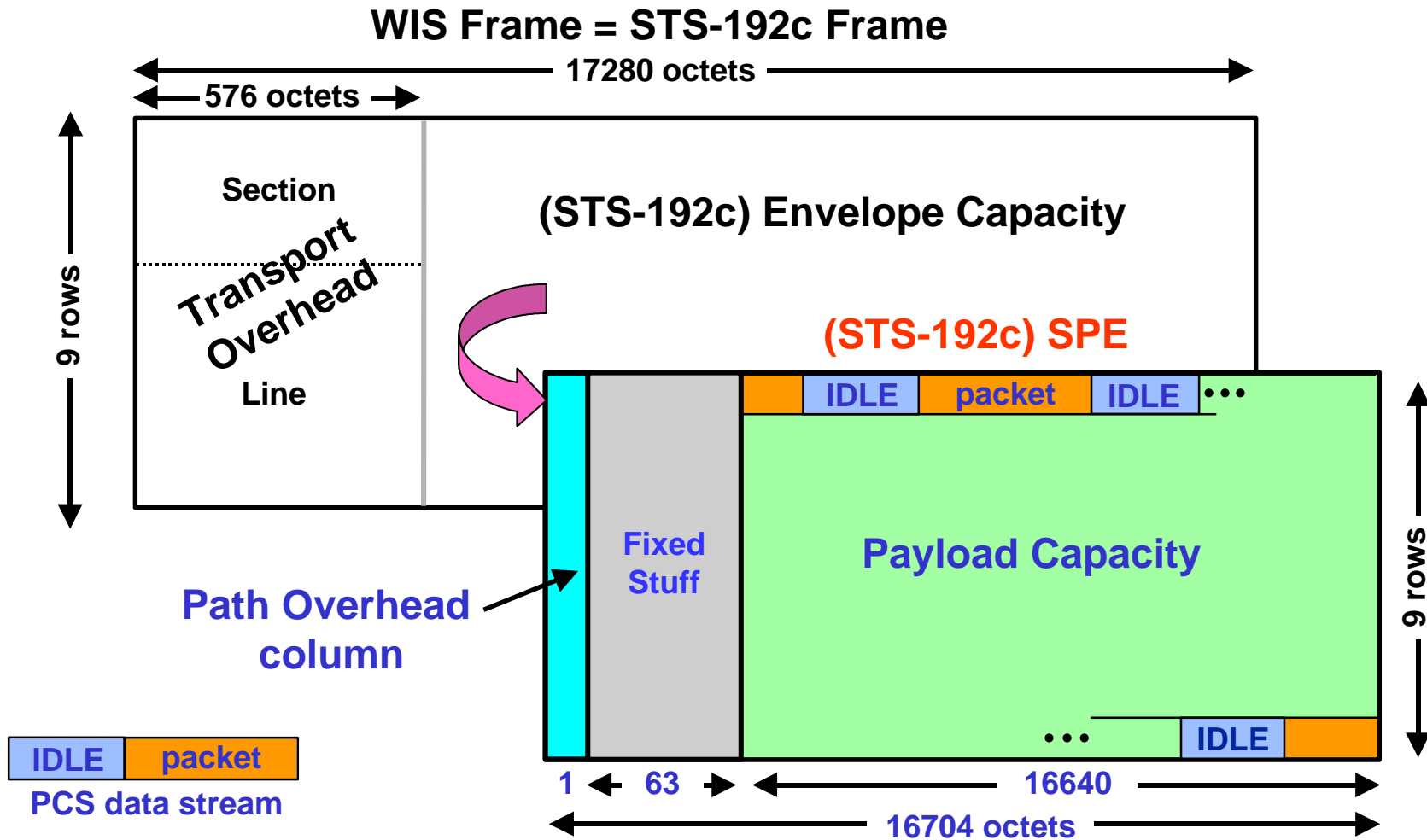
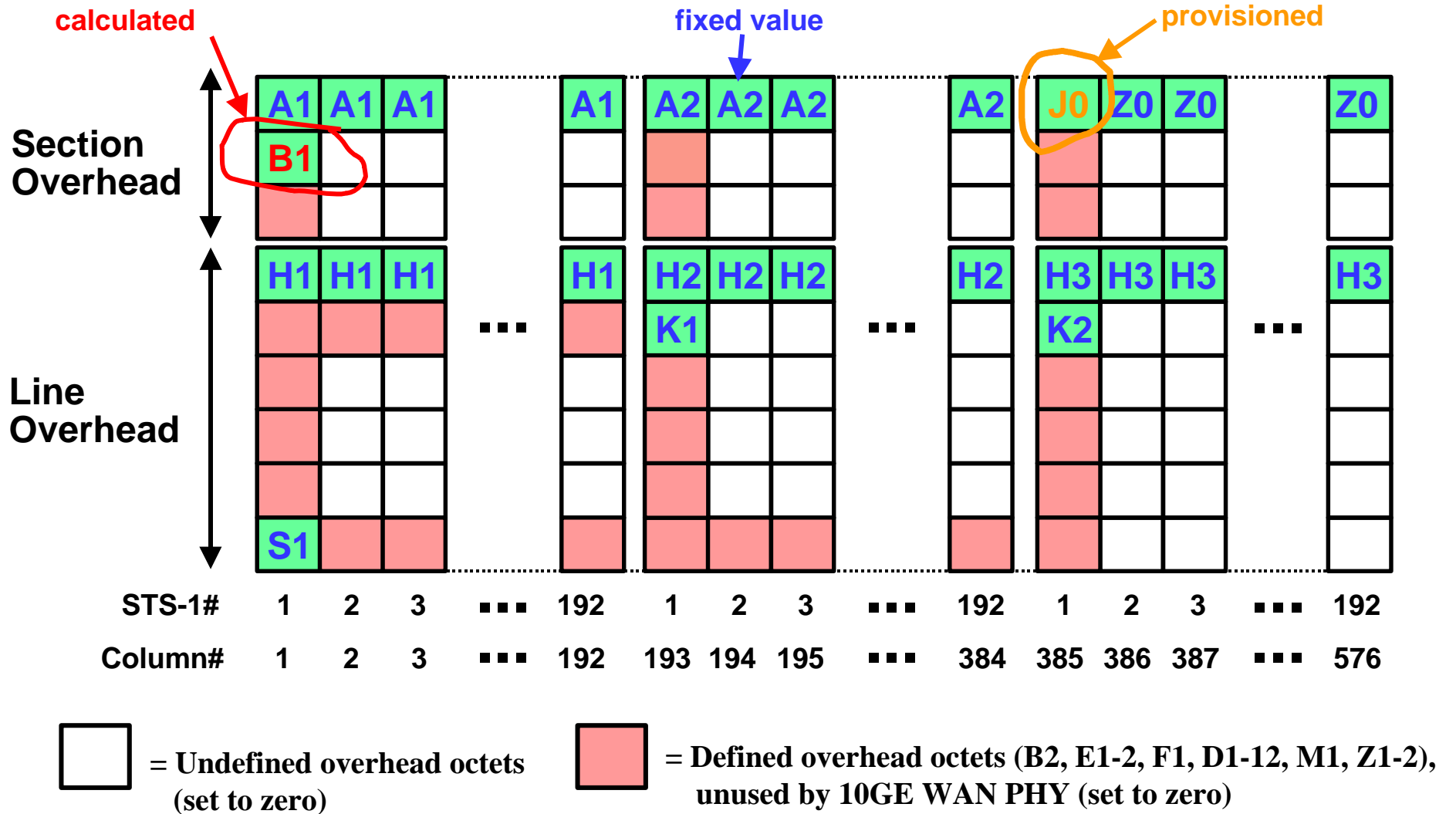STS-192c = Synchronous Transport Signal – level 192, c = concatenated
SPE = Synchronous Payload Envelope

WIS Overhead Layers

PCS Data Stream
(payload)

PCS Data Stream
(payload)

**Map
payload and
Path Overhead
into SPE**

Path

**Map SPE and
Line Overhead
into WIS frame**

Line

**Map
Section Overhead
into WIS frame**

Section

WIS Frame

WIS Frame

Transport Overhead


WIS Update, July 2000- 11

Section Overheads

- **A1 and A2 ("Framing octets")**
  - Fixed value: A1 = 11110110, A2 = 00101000
  - A1/A2 transition is used for WIS frame synchronization

- **J0 ("Section Trace")**
  - Allows a receiver to verify its continued connection to the intended transmitter
  - Provisioned Value
    - when no value is provisioned, J0 shall be set to 00000001)

- **Z0 ('Section Growth")**
  - Fixed value: 11001100

Section Overheads (cont.)

- **B1 ("Section BIP-8")**
  - — Used as a Section error monitoring function
  - — Calculated value:
    - – BIP-8 code (using even parity) over all the bits of the last transmitted WIS frame <u>after</u> scrambling
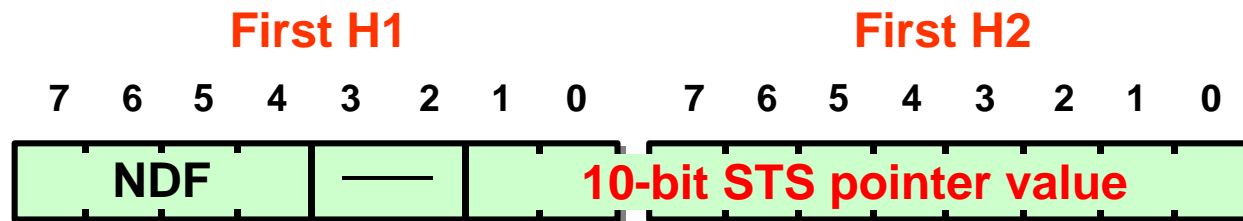
B1

7	6	5	4	3	2	1	0

Even parity over the bit 7 of all the octets of the WIS frame

---
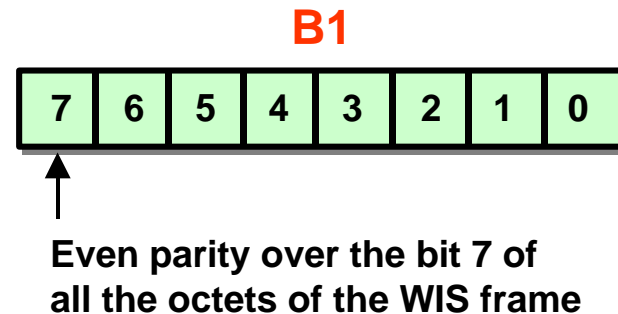
BIP-8 (Bit-Interleaved Parity-8) with even parity: The ith bit of the code provides even parity over the ith bit of all the covered octets.

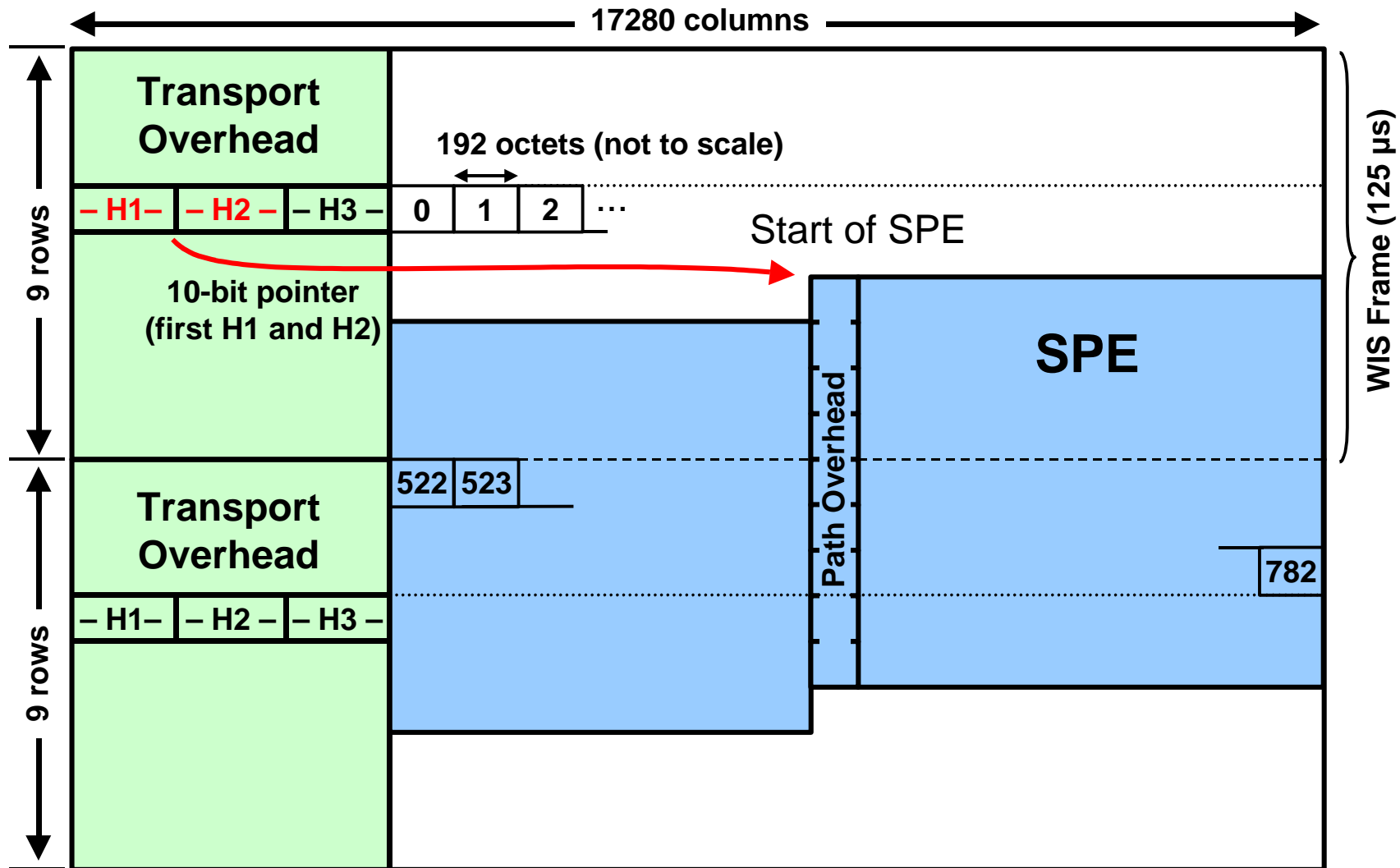**BIP-8of the bit sequence 11110000 00001111 is 11111111.**

Line Overheads

- **First H1 and H2 ("Payload Pointer")**
  - 16-bit word containing 10-bit pointer in the range of 0 to 782
  - Transmits fixed values: H1 = 01100010 and H2 = 00001010 (i.e., pointer = 522)
  - Receiver 10GE WAN PHY shall be able to process arbitrary pointer values (which may be changed by a transport network)

- **Second to last H1 and H2**
  - Fixed Values: H1 = 10010011 and H2 = 11111111

First H1   **First H2**

7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
NDF				—				10-bit STS pointer value							

NDF (new data flag) field

H1/H2 Pointer and SPE Position

17280 columns

Transport Overhead

192 octets (not to scale)

– H1– – H2 – – H3 –   0 1 2 ...

Start of SPE

10-bit pointer (first H1 and H2)

9 rows

SPE

Path Overhead

522 523

Transport Overhead

782

– H1– – H2 – – H3 –
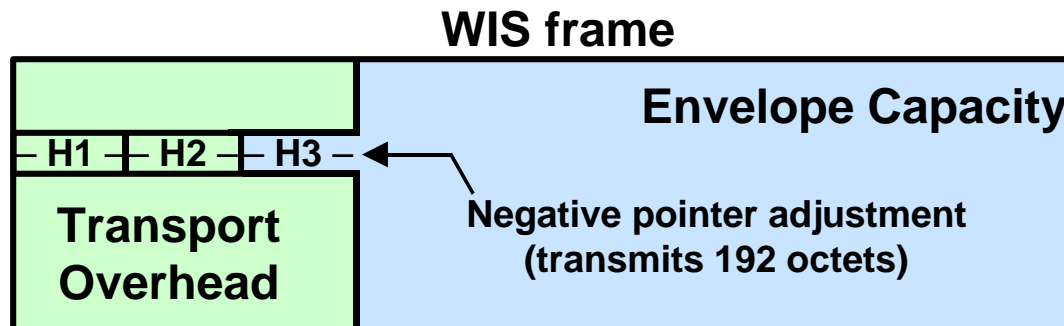
9 rows

WIS Frame (125 μs)

Line Overheads (cont.)

- **H3 ("Pointer Action Bytes")**

  — Allows an LTE to have slightly different clocks at the receiver and transmitter paths

  — Carries 192 extra SPE (payload) octets in the event of a "negative pointer adjustment," which may be required when the receiver clock is faster than the transmitter clock

  — Set to zero when not used

WIS frame

Line Overheads (cont.)

- **K1 and K2**

  — Fixed values: K1 = 00000001, K2 = 00010000

  — K1 and K2 are used on the protection line for automatic protection switching signaling. Above settings indicate a working channel rather than the protection channel.

- **S1**

  — Fixed value: 00001111

  — Indicates quality clock information to receiver. Above setting indicates "don't use for synchronization"

Path Overhead and "Fixed Stuff"
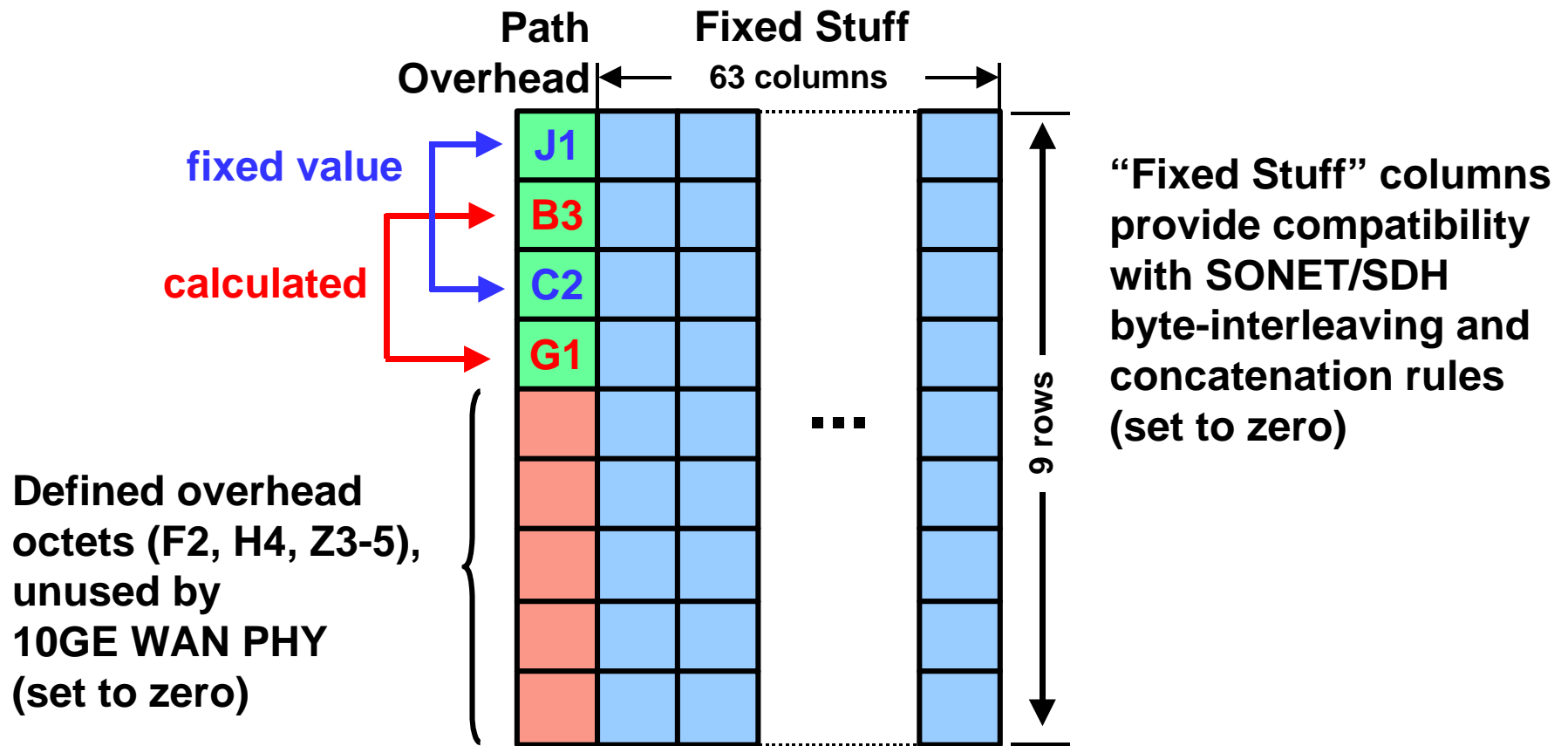
Path Overheads

- **J1 ("Path Trace")**
  - Fixed value: 00000000

- **B3 ("Path BIP-8")**
  - Used as a Path error monitoring function
  - Calculated value: BIP-8 code (using even parity) over all the octets of the last transmitted SPE before (x^7+x^6+1) scrambling

- **C2 ("Path Signal Label")**
  - Identifies the contents of the STS SPE (i.e., 10GE WAN PHY)
  - Fixed value: 00011010 (provisional value assigned to 10 GE)

Path Overheads (cont.)

- **G1 ("Path Status")**
  - — Conveys the <u>Path</u> terminating status and performance back to the transmitter (i.e., a PTE)
  - — Calculated value:
    - – REI-P field = number of bit errors detected with the B3 octet of the last received SPE
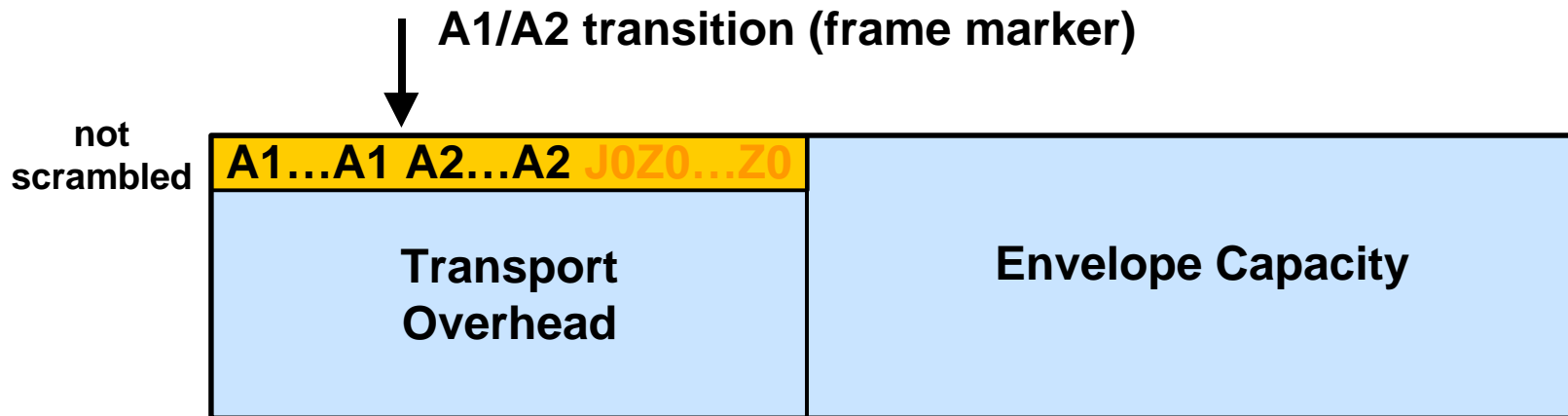   - – RDI-P field = Detected defects on the received signal

G1

7	6	5	4	3	2	1	0
	REI-P			RDI-P			0
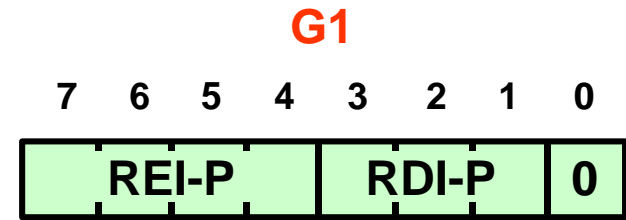
REI-P = Path Remote Error Indication
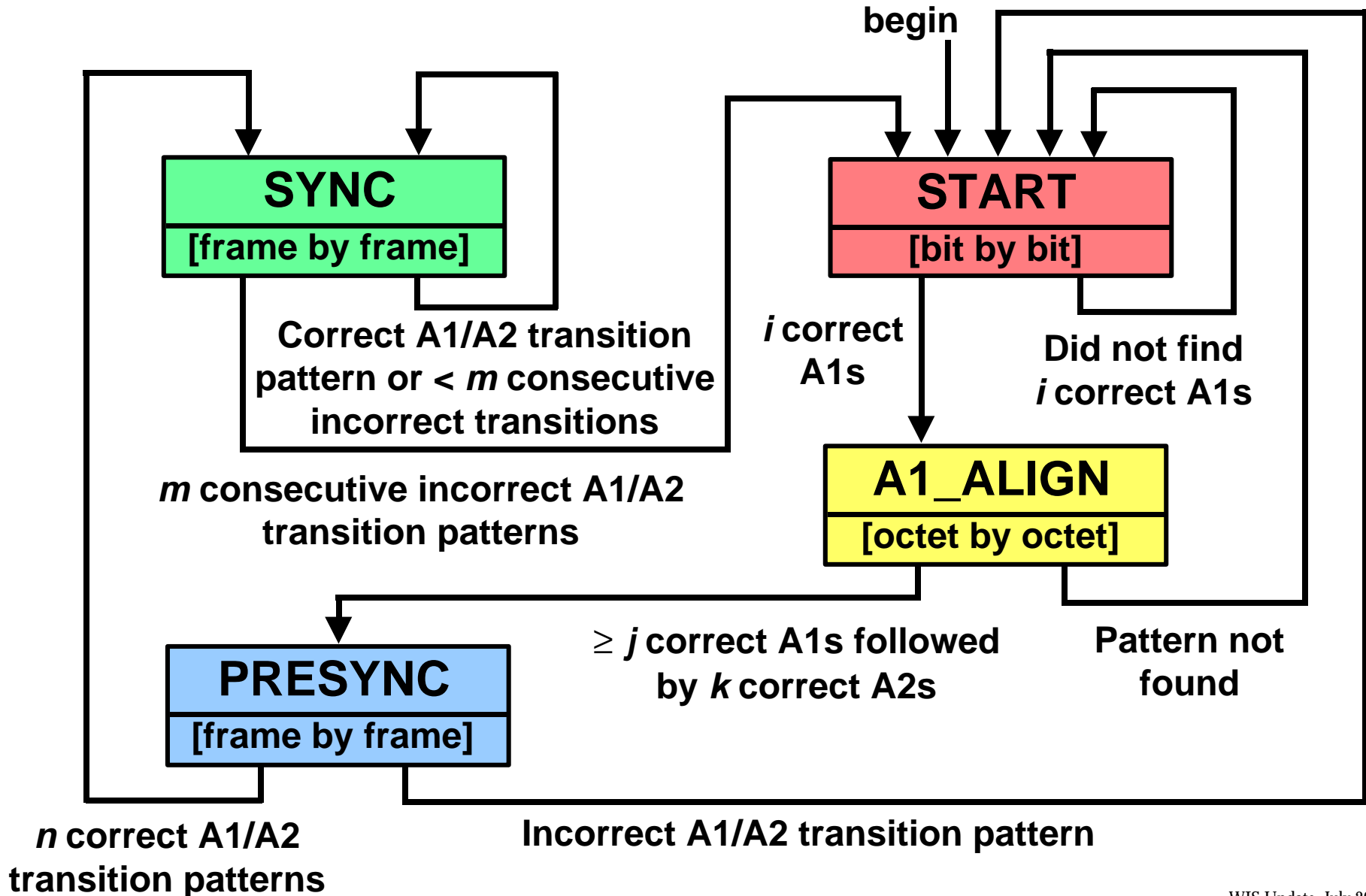**RDI-P = Path Remote Defect Indication**

REI-P field
0000 to 1000 = 0 to 8 errors
when received, 1xx1 = 0 errors

WIS Frame Synchronization

- **Uses A1/A2 transition (i.e., frame marker) for frame and octet delineation**

- **Looks for the A1/A2 framing pattern consistently**
  - Expects it to appear once every 155520 octets (length of the frame)
  - When the framing pattern appears in the right place enough times, correct frame synchronization is assumed

A1/A2 transition (frame marker)

not scrambled

A1…A1 A2…A2 J0Z0…Z0	
Transport Overhead	**Envelope Capacity**

Frame Sync Example: State Diagram

begin

SYNC

[frame by frame]

START

[bit by bit]

Correct A1/A2 transition pattern or < *m* consecutive incorrect transitions

i correct A1s

Did not find *i* correct A1s

m consecutive incorrect A1/A2 transition patterns

A1_ALIGN

[octet by octet]

PRESYNC

[frame by frame]

≥ *j* correct A1s followed by *k* correct A2s

Pattern not found

n correct A1/A2 transition patterns

Incorrect A1/A2 transition pattern

WIS Frame Sync. Performance

- **Example for $m = 4$, A1/A2 transition pattern = 2 A1/A2s**

  — Probability of frame loss $\approx 1.049 \times 10^6 \times BER^4$
  $= 1.049 \times 10^{-42}$ (@ BER $= 10^{-12}$)

  — Average interval to frame loss
  – $\approx 3.7 \times 10^{30}$ years (@ BER $= 10^{-12}$)
  (> estimated age of observable universe, i.e., $\sim 10^{10}$ years)

- **More robust implementations are possible, e.g., see**

  — **"10GE WAN PHY Delineation Performance"**

  — **http://grouper.ieee.org/groups/802/3/10G_study/public/
 email_attach/delineation_perf.doc**

Reference Diagram: Transmit WIS Frame
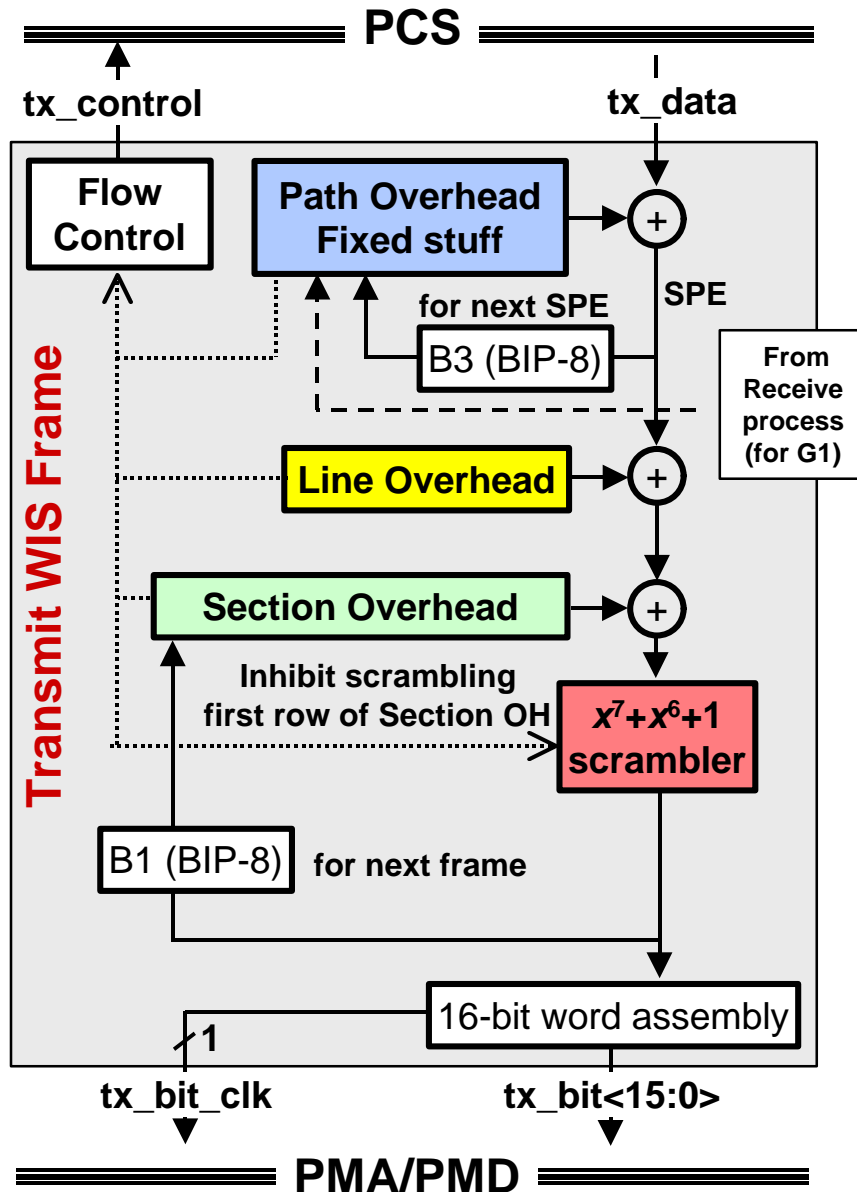

- **Functional View**

- **WIS frame formation (stages)**
  - (1) Path Overhead and fixed stuff columns
  - (2) Line Overhead
  - (3) Section Overhead
  - (4) Scramble with x^7+x^6+1 (first row of Section Overhead, i.e., A1/A2, J0, and Z0, is <u>not scrambled</u>)
  - (5) 16-bit words are transmitted to PMA/PMD (for 16-bit Parallel I/F)

Reference Diagram: Receive WIS Frame

- **Functional View**

- **WIS frame processing (stages)**
  - (1) "Serialize" received signal (figure shows 16-bit Parallel I/F)
  - (2) WIS frame synchronization and octet delineation
  - (3) Descramble with x^7+x^6+1 (first row of Section Overhead is <u>not descrambled</u>)
  - (4) Extract Section Overhead, Line Overhead, Path Overhead, Fixed Stuff columns
  - (5) Remaining octets = payload
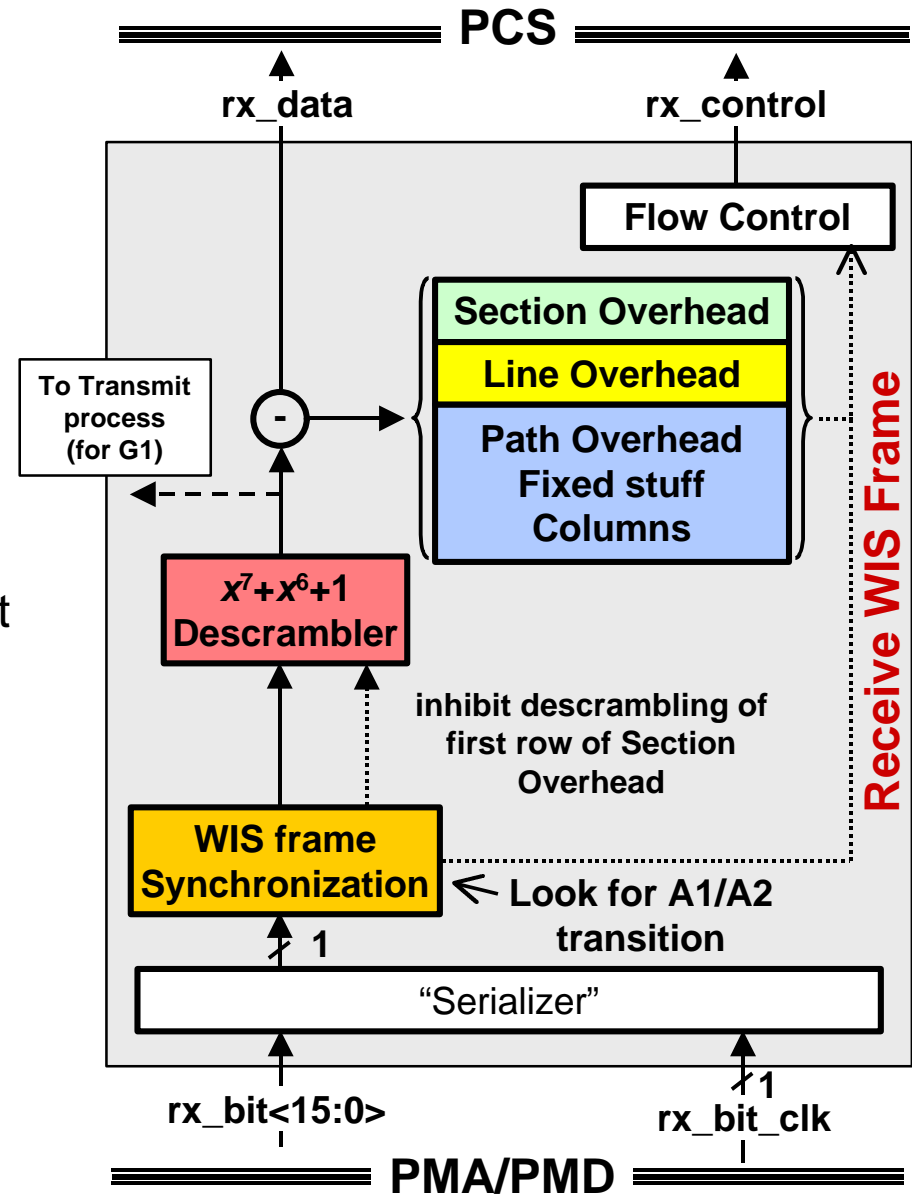
WIS Reference Diagram
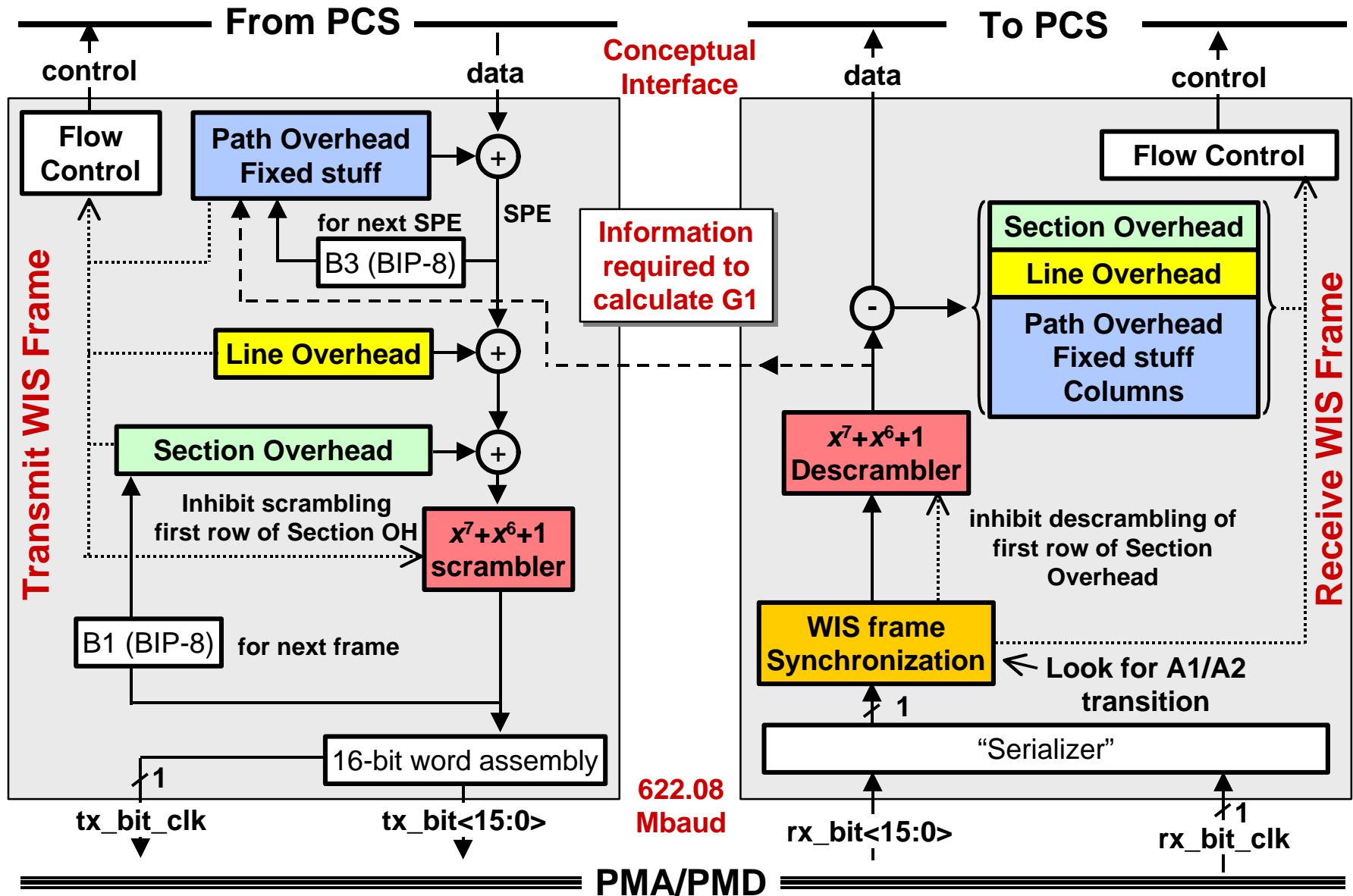
Writing the WIS Clause by Cross-Reference

- **How to write the WIS Clause by cross-referencing ANSI T1.416-1999**

  — WIS Clause proposed in "IEEE P802.3ae Document Structure Update" http://grouper.ieee.org/groups/802/3/ae/public/may00/booth_1_0500.pdf

  — ANSI T1.416-1999 can be obtained at the following URL: http://www.atis.org/atis/docstore/index.asp

- **WIS as described here**

  — With optional text to add support to B2/M1 and J1 (provisionable) and ±20 ppm reference clocks (if desired)

ANSI T1.416-1999

- **Title: "Network to Customer Installation Interfaces --
  Synchronous Optical NETwork (SONET)
  Physical Layer Specification: Common Criteria"**
  - Contains definitions and references to other documents providing a complete specification of network and customer installation interfaces compatibility

- **Presentation provides definitions that allow for SDH compatibility**

Cross-References to ANSI T1.416-1999

- **Section 1 "Scope"**
  - Applicable as is

- **Section 2 "Normative References"**
  - Applicable as is

- **Section 3 "Definitions, Abbreviations, and Acronyms"**
  - Applicable as is

Cross-References (cont.)

- **Section 4 "Common Criteria"**
  - Applicable with changes to Table 1 (SONET Overheads at NIs), as indicated below

  - Following "optional" overheads are not supported
    - Section: D1-D3, E1, F1 (all set to 00000000)
    - Line: D4-D12, E2, Z1, Z2 (all set to 00000000)
    - Path: Z3-Z4, J1 (all set to 00000000)
      If J1-provisionable support is added, remove J1 from the above list and define a default value, say 00000000, or a default Path Trace message

  - Add that Z0 (Section Growth) is set to 11001100

  Note: H1 "ss" bits do not compromise SDH compatibility, since the ITU now specifies that the receiver ignores them

Cross-References (cont.)

- **Section 4 "Common Criteria" (cont.)**
  - Following "required" overheads are not supported
    - Section: B2 (set to 00000000), M0-M1 (set to 00000000)
      If B2/M1 support is added, remove B2 and M1 from the above list
    - Line: S1 (set to 00001111, i.e., "don't use for synchronization")

  - Following "application specific function" overheads are not supported
    - Line: K1 (set to 00000001), K2 (set to 00010000) -- These settings indicate a working channel rather than the protection channel
    - Path: F2 (set to 00000000), H4 (set to 00000000), N1 (set to 00000000)

  - Add that C2 (STS Path Label) is set to 00011010
    (This is the provisional value assigned to 10GE)

  - VT Path Overheads are not applicable (not supported)

Cross-References (cont.)

- **Section 5 "Jitter"**
  - — Not applicable. IEEE P802.3ae defines jitter specification

- **Section 6 "Synchronization"**
  - — Not applicable
  - — Add (not necessarily to Clause 48) that 10 Gigabit Ethernet signal is defined to be within ±100 ppm of the nominal rate (if required, replace ±100 ppm with ±20 ppm)

- **Section 7 "Maintenance"**
  - — Sections that are not applicable
    - – Section 7.2.2 "VT1.5 rate - Electrical Interface"
    - – If B2/M1 support is added: Section 7.4.2 "VT1.5 rate"
      otherwise: Section 7.4 "Line"
    - – Section 7.6 "Performance and Failure Alarm Monitoring"
    - – Section 7.7 "Performance Monitoring Functions"

Cross-References (cont.)

- **Section 7 "Maintenance" (cont.)**
  - Section 7.1, Table 2 "Near-end events and far-end reports", <u>only</u> the following is supported
    - Defects: LOS (as defined in Section 7.2.1)

      SEF/LOF (as defined in Section 7.3)

      LOP-P (as defined in Section 7.5)

      AIS-P (as defined in Section 7.5)

      ERDI-P (as defined in Section 7.5)

      In addition, PLM-P (which is not listed in Table 2) is supported (as defined in Section 7.5)

    - Anomalies: BIP-N(S) (as defined in Section 7.3)

      If B2/M1 support is added:

         BIP-N(L) (as defined in Section 7.4.1)

         REI-L (as defined in Section 7.4.1)

      BIP-N(P) (as defined in Section 7.5)

      REI-P (as defined in Section 7.5)

Cross-References (cont.)

- **Section 7 "Maintenance" (cont.)**

  — Sections 7.2.1, 7.3, 7.4.1 (only if B2/M1 support is added), and 7.5 are applicable with the exclusion of defects and anomalies not listed in the previous slide

  — Section 7.2.1

    – Make T = T' = 125 / 3 µs (i.e., three row periods)

      – Comment: Ambiguity in this value has long been an annoyance in SONET/SDH. Proposed value falls in the middle of the suggested range and gives vendors a single convenient value to implement. Removal of LOS would then take 125 µs.

Cross-References (cont.)

- **Annex A**
  "Normative -- SONET VT1.5 Line Interface Common Criteria"
    - Not applicable

- **Annex B**
  "Informative -- SONET maintenance signals for the NI"
    - Not applicable

- **Annex C**
  "Informative -- Receiver Jitter Tolerance and Transfer"
    - Not applicable

- **Annex D**
  "Informative -- Bibliography"
    - Applicable as is

Summary

- **WIS**
  - *$x^7 + x^6 + 1$ scrambler*
  - SONET framing, overheads, and frame synchronization

- **How to write the WIS Clause by cross-referencing ANSI T1.416-1999**

  — All required changes and additions are indicated

  — Provides SDH compatibility