Replace Subclause 56.1.3 with the following text

56.1.3 Physical Layer signaling systems

EFM extends the family of 100BASE–X Physical Layer signaling systems to include 100BASE–LX10 (long wavelength), plus the combination of the 100BASE–BX10–D (Bidirectional long wavelength Downstream) and the 100BASE–BX10–U (Bidirectional long wavelength Upstream), as defined in Clause 58. All of these systems employ the 100BASE–X PCS and PMA as defined in Clause 66.

EFM also extends the family of 1000BASE–X Physical Layer signaling systems to include 1000BASE–LX10 (long wavelength), plus the combination of the 1000BASE–BX10–D (Bidirectional long wavelength Downstream) and the 1000BASE–BX10–U (Bidirectional long wavelength Upstream), as defined in Clause 59. All of these systems employ the 1000BASE–X PCS and PMA as defined in Clause 66. 1000BASE–LX10 is interoperable with 1000BASE–LX on single–mode and multimode fiber, and offers greater reach than 1000BASE–LX on single–mode fiber.

For P2MP topologies, EFM introduces a family of Physical Layer signaling systems which are derived from 1000BASE–X, but which include extensions to the RS, PCS and PMA, along with an optional FEC capability, as defined in Clause 65. The family of P2MP Physical Layer signaling systems includes the combination of 1000BASE–PX10–D (Passive Optical Network Downstream 10 km), plus 1000BASE–PX10–U (PON Upstream 10 km), and the combination of 1000BASE–PX20–D (PON Downstream 20 km) plus 1000BASE–PX20–U (PON Upstream 20 km), as defined in Clause 60.

Additionally, EFM introduces a family of Physical Layer signaling systems which are derived from 10GBASE–R, but which include extensions to the RS, PCS and PMA, along with a mandatory FEC capability, as defined in @@Clause 92@@. The family of P2MP Physical Layer signaling systems includes the following series of PMD combinations:

a) 10GBASE–PR–D1 and 10GBASE–PR–U1, creating a PR10 power budget, with symmetric 10 Gb/s downstream and 10 Gb/s upstream data rates, supporting the reach of at least 10 km and the split ratio of at least 1:16;
b) 10GBASE–PR–D2 and 10GBASE–PR–U1, creating a PR20 power budget, with symmetric 10 Gb/s downstream and 10 Gb/s upstream data rates, supporting the reach of at least 20 km and the split ratio of at least 1:16 or the reach of at least 10 km and the split ratio of at least 1:32;
c) 10GBASE–PR–D3 and 10GBASE–PR–U3, creating a PR10 power budget, with symmetric 10 Gb/s downstream and 10 Gb/s upstream data rates, supporting the reach of at least 20 km and the split ratio of at least 1:32;
d) 10/1GBASE–PRX–D1 and 10/1GBASE–PR–U1, creating a PRX10 power budget, with asymmetric 10 Gb/s downstream and 1 Gb/s upstream data rates, supporting the reach of at least 10 km and the split ratio of at least 1:16;
e) 10/1GBASE–PRX–D2 and 10/1GBASE–PRX–U1, creating a PRX20 power budget, with asymmetric 10 Gb/s downstream and 1 Gb/s upstream data rates, supporting the reach of at least 20 km and the split ratio of at least 1:16;
f) 10/1GBASE–PRX–D3 and 10/1GBASE–PRX–U3, creating a PRX10 power budget, with asymmetric 10 Gb/s downstream and 1 Gb/s upstream data rates, supporting the reach of at least 20 km and the split ratio of at least 1:32;

All 10G–EPON PMDs are defined in @@Clause 91@@.

For copper cabling, EFM introduces a family of Physical Layer signaling systems. There are two distinct signaling systems specified for copper cabling. Both of them share a set of common functions and interfaces as described in Clause 61. Clause 61 also includes an optional specification that supports combined operation on multiple copper pairs, affording greater data rate capability for a given link span. Underlying these functions, two Physical Layer signaling system specific PMAs and PMDs are described in Clause 62 and Clause 63. Non–loaded cable is a requirement of the signaling methods employed.

For high–speed applications, the 10PASS–TS signaling system is defined in Clause 62. 10PASS–TS relies on a technique referred to as Frequency Division Duplexing (FDD) to accomplish full duplex

communication on a single wire pair. 10PASS–TS is a passband signaling system derived from the Very high–speed Digital Subscriber Line (VDSL) standard defined in American National Standard T1.424, using Multiple Carrier Modulation (MCM, also referred to as Discrete Multi–Tone or DMT). This PHY supports a nominal full duplex data rate of 10 Mb/s, hence the identifier 10PASS–TS. For the 10PASS–TS PHY, two subtypes are defined: 10PASS–TS–O and 10PASS–TS–R. A connection can be established only between a 10PASS–TS–O PHY on one end of the voice–grade copper line, and a 10PASS–TS–R PHY on the other end. In public networks, a 10PASS–TS–O PHY is used at a central office (CO), a cabinet, or other centralized distribution point; a 10PASS–TS–R PHY is used at the subscriber premises. In private networks, the network administrator will designate one end of each link as the network end. A PHY implementation may be equipped to support both subtypes and provide means to be configured as a 10PASS–TS–O or a 10PASS–TS–R.

For long distance applications, the 2BASE–TL signaling system is defined in Clause 63. 2BASE–TL is a baseband signaling system derived from the Single–Pair High–Speed Digital Subscriber Line (SHDSL) standards defined by ITU–T. The 2BASE–TL PMD supports a nominal full duplex data rate of approximately 2 Mb/s. As is the case with the 10PASS–TS PHY, the 2BASE–TL PHY consists of two subtypes: 2BASE–TL–O (network end) and 2BASE–TL–R (subscriber end).

System considerations for Ethernet subscriber access networks are described in Clause 67.

Specifications unique to the operation of each physical layer device are shown in Table 56–1.

Table 56–1—Summary of EFM physical layer signalling systems

Name	Location	Rate[a]	Nominal Reach (km)	Medium	Clause
100BASE–LX10	ONU/OLT[b]	100	10	Two SMFs	58
100BASE–BX10–D	OLT	100	10	One SMF	58
100BASE–BX10–U	ONU				
1000BASE–LX10	ONU/OLT[a]	1000	10 0.55	Two SMFs Two MMFs	59
1000BASE–BX10–D	OLT	1000	10	One SMF	59
1000BASE–BX10–U	ONU				
1000BASE–PX10–D	OLT	1000	10	One SMF PON	60
1000BASE–PX10–U	ONU				
1000BASE–PX20–D	OLT	1000	20	One SMF PON	60
1000BASE–PX20–U	ONU				
10GBASE–PR–D1	OLT	10 Gb/s	10	One SMF PON	91
10GBASE–PR–U1	ONU				
10GBASE–PR–D2	OLT	10 Gb/s	20	One SMF PON	91
10GBASE–PR–U1	ONU				
10GBASE–PR–D3	OLT	10 Gb/s	20	One SMF PON	91
10GBASE–PR–U3	ONU				
10/1GBASE–PRX–D1	OLT	10 Gb/s	10	One SMF PON	91
10/1GBASE–PRX–U1	ONU	1000			
10/1GBASE–PRX–D2	OLT	10 Gb/s	20	One SMF PON	91
10/1GBASE–PRX–U2	ONU	1000			
10/1GBASE–PRX–D3	OLT	10 Gb/s	20	One SMF PON	91
10/1GBASE–PRX–U3	ONU	1000			
10PASS–TS–O	CO[c]	10[d]	0.75[e]	One or more pairs of voice grade copper cable	62
10PASS–TS–R	Subscriber[b]				
2BASE–TL–O	CO[b]	2[f]	2.7[g]	One or more pairs of voice grade copper cable	63
2BASE–TL–R	Subscriber[b]				

[a]The data rate is expressed in Mb/s unless specifically stated otherwise in the given cell.
[b]Symmetric
[c]In private networks, the network administrator will designate one end of each link as the network end.
[d]Nominal rate stated at the nominal reach. Rate may vary depending on plant. Refer to Annex 62B for more information.
[e]Reach may vary depending on plant. Refer to Annex 62B for further information.
[f]Nominal rate stated at the nominal reach. Rate may vary depending on plant. Refer to Annex 63B for more information.
[g]Reach may vary depending on plant. Refer to Annex 63B for further information.

Table 56–2 specifies the correlation between nomenclature and clauses for P2P systems, while Table 56–3 specifies the correlation between nomenclature and clauses for P2MP systems. A complete implementation conforming to one or more nomenclatures meets the requirements of the corresponding clauses.

Table 56–2—Nomenclature and clause correlation for P2P systems[a]

Nomenclature	Clause									
	57	58		59		61	62	63	66	
	OAM	100BASE–LX10 PMD	100BASE–BX10 PMD	1000BASE–LX10 PMD	1000BASE–BX10 PMD	Cu PCS	10PASS–TS PMA, PMD	2BASE–TL PMA, PMD	100BASE–X PCS, PMA	1000BASE–X PCS, PMA
2BASE–TL	O					M		M		
10PASS–TS	O					M	M			
100BASE–LX10	O	M							M	
100BASE–BX10	O		M						M	
1000BASE–LX10	O			M						M
1000BASE–BX10	O				M					M

[a]O = Optional, M = Mandatory

Table 56–3—Nomenclature and clause correlation for P2MP systems[a]

Nomenclature	Clause																						
	57	60		64	65		66		91												92		93
	OAM	1000BASE–PX10 PMD	1000BASE–PX20 PMD	P2MP MPCP	P2MP RS, PCS, PMA	FEC	100BASE–X PCS, PMA	1000BASE–X PCS, PMA	10GBASE–PR–D1	10GBASE–PR–U1	10GBASE–PR–D2	10GBASE–PR–D3	10GBASE–PR–U3	10/1GBASE–PRX–D1	10/1GBASE–PRX–U1	10/1GBASE–PRX–D2	10/1GBASE–PRX–U2	10/1GBASE–PRX–D3	10/1GBASE–PRX–U3	P2MP RS, PCS, PMA	FEC	P2MP MPCP for 10G–EPON
1000BASE–PX10–D	O	M		M	M	O		M															
1000BASE–PX10–U	O	M		M	M	O																	
1000BASE–PX20–D	O		M	M	M	O		M															
1000BASE–PX20–U	O		M	M	M	O																	
10GBASE–PR–D1	O			M					M												M	M	M
10GBASE–PR–U1	O			M						M											M	M	M
10GBASE–PR–D2	O			M							M										M	M	M
10GBASE–PR–D3	O			M								M									M	M	M
10GBASE–PR–U3	O			M									M								M	M	M
10/1GBASE–PRX–D1	O			M										M							M	M	M
10/1GBASE–PRX–U1	O			M											M						M	M	M
10/1GBASE–PRX–D2	O			M												M					M	M	M
10/1GBASE–PRX–U2	O			M													M				M	M	M
10/1GBASE–PRX–D3	O			M														M			M	M	M
10/1GBASE–PRX–U3	O			M															M		M	M	M

[a]O = Optional, M = Mandatory