

INTERNATIONAL STANDARD



**Industrial communication networks – Fieldbus specifications –
Part 6-10: Application layer protocol specification – Type 10 elements**

IEC 61158-6-10:2023

<https://standards.iteh.ai/catalog/standards/sist/bfeeca70-4bcf-4aa1-b38e-a9c1b6fc8b3a/iec-61158-6-10-2023>



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2023 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

[IEC 61158-6-10:2023](https://standards.iteh.ai/catalog/standards/sist/b1eccc70-4b6f-4aa1-b38e-a9c1b61c8b3a/iec-61158-6-10-2023)

<https://standards.iteh.ai/catalog/standards/sist/b1eccc70-4b6f-4aa1-b38e-a9c1b61c8b3a/iec-61158-6-10-2023>



IEC 61158-6-10

Edition 5.0 2023-03

INTERNATIONAL STANDARD



**Industrial communication networks – Fieldbus specifications –
Part 6-10: Application layer protocol specification – Type 10 elements**

IEC 61158-6-10:2023

<https://standards.iteh.ai/catalog/standards/sist/bfeeca70-4bcf-4aa1-b38e-a9c1b6fc8b3a/iec-61158-6-10-2023>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 35.100.70; 35.110

ISBN 978-2-8322-6633-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	46
INTRODUCTION.....	48
1 Scope.....	49
1.1 General.....	49
1.2 Specifications	49
1.3 Conformance	50
2 Normative references	50
3 Terms, definitions, abbreviated terms, symbols, and conventions	54
3.1 Referenced terms and definitions.....	54
3.1.1 ISO/IEC 7498-1 terms.....	54
3.1.2 ISO/IEC 8822 terms.....	55
3.1.3 ISO/IEC 8824-1 terms.....	55
3.1.4 ISO/IEC 9545 terms.....	55
3.2 Terms and definitions.....	55
3.3 Abbreviated terms and symbols	64
3.3.1 Abbreviated terms and symbols for services	64
3.3.2 Abbreviated terms and symbols for distributed I/O	64
3.3.3 Abbreviated terms and symbols for IEC 62439-2	68
3.3.4 Abbreviated terms and symbols for IEC/IEEE 60802.....	68
3.3.5 Abbreviated terms and symbols for IEEE Std 802.1CB	68
3.3.6 Abbreviated terms and symbols for IEEE Std 802.1Q	68
3.3.7 Abbreviated terms and symbols for IEEE Std 802.3	69
3.3.8 Abbreviated terms and symbols for IETF RFC 2474.....	69
3.3.9 Abbreviated terms and symbols for IETF RFC 4291.....	69
3.4 Conventions.....	69
3.4.1 General concept	69
3.4.2 Conventions for distributed I/O	70
3.4.3 Conventions used in state machines.....	78
4 Application layer protocol specification for common protocols.....	83
4.1 FAL syntax description.....	83
4.1.1 DLPDU abstract syntax reference	83
4.1.2 Data types	85
4.2 Transfer syntax.....	87
4.2.1 Coding of basic data types	87
4.2.2 Coding section related to common basic fields	95
4.3 Discovery and basic configuration.....	109
4.3.1 DCP syntax description	109
4.3.2 DCP protocol state machines.....	143
4.3.3 DLL Mapping Protocol Machines.....	162
4.4 Precision transparent clock protocol	162
4.4.1 FAL syntax description	162
4.4.2 AP-Context state machine	173
4.4.3 FAL Service Protocol Machines	173
4.4.4 Application Relationship Protocol Machines.....	173
4.4.5 DLL Mapping Protocol Machines.....	238
4.5 Time synchronization	238
4.5.1 General	238

4.5.2	GlobalTime	241
4.5.3	WorkingClock	242
4.6	Media redundancy	246
4.6.1	Media redundancy and loop prevention.....	246
4.6.2	Seamless media redundancy	249
4.7	Real time cyclic.....	249
4.7.1	FAL syntax description	249
4.7.2	FAL transfer syntax	250
4.7.3	FAL Service Protocol Machines	260
4.7.4	Application Relationship Protocol Machines.....	260
4.7.5	DLL Mapping Protocol Machines.....	282
4.8	Real time acyclic.....	282
4.8.1	RTA syntax description.....	282
4.8.2	RTA transfer syntax.....	284
4.8.3	FAL Service Protocol Machines	294
4.8.4	Application Relationship Protocol Machines.....	294
4.8.5	DLL Mapping Protocol Machines.....	339
4.9	Fragmentation.....	340
4.9.1	General	340
4.9.2	FRAG syntax description	343
4.9.3	FRAG transfer syntax	344
4.9.4	FAL Service Protocol Machines	346
4.9.5	Application Relationship Protocol Machines.....	346
4.9.6	DLL Mapping Protocol Machines.....	346
4.10	Remote procedure call	356
4.10.1	General	356
4.10.2	RPC syntax description	356
4.10.3	RPC Transfer syntax	358
4.10.4	FAL Service Protocol Machines	374
4.10.5	Application Relationship Protocol Machines.....	374
4.10.6	DLL Mapping Protocol Machines.....	375
4.11	Link layer discovery	375
4.11.1	General	375
4.11.2	FAL common syntax description	376
4.11.3	LLDP transfer syntax	378
4.11.4	FAL Service Protocol Machines	388
4.11.5	Application Relation Protocol Machines	388
4.11.6	DLL Mapping Protocol Machines.....	388
4.12	End stations and bridges.....	388
4.12.1	General	388
4.12.2	Traffic classes	390
4.12.3	End station	393
4.12.4	Bridge.....	416
4.12.5	Bridged end station.....	461
4.12.6	Q port state machine	470
4.12.7	Pruning port state machine	476
4.12.8	Bridge extensions	478
4.12.9	FAL Service Protocol Machines	479
4.12.10	Application Relation Protocol Machines	479

4.12.11	DLL Mapping Protocol Machines.....	479
4.13	IP suite	516
4.13.1	Overview	516
4.13.2	IP/UDP syntax description	516
4.13.3	IP/UDP transfer syntax	517
4.13.4	ARP.....	520
4.14	Domain name system.....	522
4.14.1	General	522
4.14.2	Primitive definitions	523
4.14.3	DNS state transition diagram	523
4.14.4	State machine description	523
4.14.5	DNS state table	523
4.14.6	Functions, Macros, Timers and Variables	523
4.15	Dynamic host configuration	524
4.15.1	General	524
4.15.2	Primitive definitions	524
4.15.3	DHCP state transition diagram.....	524
4.15.4	State machine description	525
4.15.5	DHCP state table.....	525
4.15.6	Functions, Macros, Timers and Variables	526
4.16	Simple network management	526
4.16.1	General	526
4.16.2	MIB overview.....	527
4.16.3	MIB access.....	527
4.16.4	IETF RFC 1213-MIB	527
4.16.5	Enterprise number for PNIO MIB	528
4.16.6	MIB cross reference	528
4.16.7	Behavior in case of modular built bridges	529
4.16.8	LLDP EXT MIB	529
4.17	Network configuration	529
4.17.1	Overview	529
4.17.2	NETCONF	530
4.17.3	YANG	531
4.18	Common DLL Mapping Protocol Machines	532
4.18.1	Overview	532
4.18.2	Data Link Layer Mapping Protocol Machine	533
4.19	Void.....	540
4.20	Additional information	540
5	Application layer protocol specification for distributed I/O	540
5.1	FAL syntax description.....	540
5.1.1	DLPDU abstract syntax reference	540
5.1.2	APDU abstract syntax.....	540
5.2	Transfer syntax.....	567
5.2.1	Coding section related to BlockHeader specific fields	567
5.2.2	Coding section related to RTA-SDU specific fields	586
5.2.3	Coding section related to common address fields	591
5.2.4	Coding section related to AL services	613
5.2.5	Coding section related to ARVendorBlock.....	652
5.2.6	Coding section related to PNIOStatus.....	653

5.2.7	Coding section related to I&M Records	670
5.2.8	Coding section related to Alarm and Diagnosis Data	677
5.2.9	Coding section related to upload and retrieval	701
5.2.10	Coding section related to iParameter	701
5.2.11	Coding section related to NME	702
5.2.12	Coding section related to CIM	711
5.2.13	Coding section related to Physical Sync Data	776
5.2.14	Coding section related to Physical Time Data	781
5.2.15	Coding section related to Isochrone Mode Data	786
5.2.16	Coding section related to fast startup	788
5.2.17	Coding section related to DFP	791
5.2.18	Coding section related to MRPD	795
5.2.19	Coding section related to controller to controller communication	796
5.2.20	Coding section related to system redundancy	797
5.2.21	Coding section related to energy saving	800
5.2.22	Coding section related to asset management	800
5.2.23	Coding section related to reporting system	805
5.2.24	Coding section related to logbook	811
5.2.25	Coding section related to Time	812
5.2.26	Coding section related to Channel Related Process Alarm Reason	812
5.2.27	Void	815
5.3	FAL protocol state machines	816
5.3.1	Overall structure	816
5.4	AP-Context state machine	817
5.5	FAL Service Protocol Machines	817
5.5.1	Overview	817
5.5.2	FAL Service Protocol Machine Power-On	817
5.5.3	FAL Service Protocol Machine Device	818
5.5.4	FAL Service Protocol Machine Controller	828
5.5.5	FAL Service Protocol Machine Network Management Entity	839
5.6	Application Relationship Protocol Machines	840
5.6.1	Alarm Protocol Machine Initiator	840
5.6.2	Alarm Protocol Machine Responder	844
5.6.3	Device	848
5.6.4	Controller	934
5.6.5	Network Management Entity	1013
5.7	DLL Mapping Protocol Machines	1047
5.8	Checking rules	1048
5.8.1	General	1048
5.8.2	IODConnectReq	1048
5.8.3	IODConnectRes	1061
5.8.4	IODControlReq	1066
5.8.5	IODControlRes	1068
5.8.6	IOXControlReq	1072
5.8.7	IOXControlRes	1073
5.8.8	IODReleaseReq	1075
5.8.9	IODReleaseRes	1076
5.8.10	IODWriteReq	1077
5.8.11	IODWriteRes	1079

5.8.12	IODWriteMultipleReq	1081
5.8.13	IODWriteMultipleRes	1082
5.8.14	IODReadReq	1084
5.8.15	IODReadRes	1086
Annex A (normative)	Unified establishing of an AR for all RT classes	1089
A.1	General.....	1089
A.2	AR establishing.....	1090
A.3	Startup of Alarm transmitter and receiver	1097
A.4	Time-aware systems path establishment.....	1099
A.5	Void.....	1100
A.6	Void.....	1100
Annex B (normative)	Compatible establishing of an AR.....	1101
Annex C (informative)	Establishing of a device access AR.....	1104
Annex D (informative)	Establishing of an AR (accelerated procedure).....	1106
Annex E (informative)	Establishing of an AR (fast startup procedure).....	1109
Annex F (informative)	Example of the upload, storage and retrieval procedure	1111
Annex G (informative)	Implementation of send list control.....	1113
G.1	General.....	1113
G.2	Implementation model.....	1114
G.3	Constraints	1116
Annex H (informative)	Overview of the IO controller and the IO device state machines	1117
Annex I (informative)	Overview of the PTCP synchronization master hierarchy	1119
Annex J (informative)	Optimization of bandwidth usage for Time Aware Shaping	1121
Annex K (informative)	Time constraints for RT_CLASS_3 bandwidth allocation	1123
Annex L (informative)	Time constraints for the forwarding of a frame	1125
L.1	Principle	1125
L.2	Forwarding.....	1125
Annex M (informative)	Principle of dynamic frame packing.....	1127
Annex N (informative)	Principle of Fragmentation	1131
Annex O (informative)	MRPD – Principle of seamless media redundancy.....	1133
Annex P (normative)	Principle of a RED_RELAY without forwarding information in PDIRFrameData	1135
Annex Q (informative)	Constraints for Auto-negotiation.....	1138
Q.1	Optimization for fast startup without auto-negotiation	1138
Q.2	Gigabit PHYs, 2 pair Ethernet cables, and auto-negotiation	1140
Annex R (informative)	Example of a PrmBegin, PrmEnd and ApplRdy sequence.....	1141
Annex S (informative)	List of supported MIBs.....	1142
Annex T (informative)	Structure and content of BLOB	1143
Annex U (normative)	Management information bases	1144
U.1	Void.....	1144
U.2	LLDP EXT MIB.....	1144
Annex V (normative)	Cross reference to IEC 62439-2	1167
V.1	Cross reference to IEC 62439-2.....	1167
V.1.1	General	1167
V.1.2	Ring	1167
V.1.3	Interconnection.....	1168

Annex W (normative) Maintaining statistic counters for Ethernet.....	1170
W.1 General.....	1170
W.2 Counting model.....	1170
W.3 Explanation of the IETF RFC defined statistic counters.....	1172
W.4 Value range of the IETF RFC defined statistic counters.....	1173
W.5 VLAN specific statistic counters.....	1173
Annex X (informative) Example of RSI fragmentation.....	1175
Annex Y (informative) Delayed cut through.....	1177
Bibliography.....	1179
Figure 1 – Common structure of specific fields for octet 1.....	71
Figure 2 – Common structure of specific fields for octet 2.....	71
Figure 3 – Common structure of specific fields for octet 3.....	71
Figure 4 – Common structure of specific fields for octet 4.....	72
Figure 5 – Common structure of specific fields for octet 5.....	72
Figure 6 – Common structure of specific fields for octet 6.....	72
Figure 7 – Common structure of specific fields for octet 7.....	73
Figure 8 – Common structure of specific fields for octet 8.....	73
Figure 9 – Common structure of specific fields for octet 9.....	73
Figure 10 – Common structure of specific fields for octet 10.....	74
Figure 11 – Common structure of specific fields for octet 11.....	74
Figure 12 – Common structure of specific fields for octet 12.....	74
Figure 13 – Common structure of specific fields for octet 13.....	75
Figure 14 – Common structure of specific fields for octet 14.....	75
Figure 15 – Common structure of specific fields for octet 15.....	75
Figure 16 – Common structure of specific fields for octet 16.....	76
Figure 17 – Coding of the data type BinaryDate.....	88
Figure 18 – Encoding of TimeofDay with date indication value.....	88
Figure 19 – Encoding of TimeofDay without date indication value.....	89
Figure 20 – Encoding of TimeDifference with date indication value.....	89
Figure 21 – Encoding of TimeDifference without date indication value.....	90
Figure 22 – Encoding of a NetworkTime value.....	90
Figure 23 – Encoding of NetworkTimeDifference value.....	91
Figure 24 – Encoding of TimeStamp value.....	92
Figure 25 – Encoding of TimeStampDifference value.....	93
Figure 26 – Encoding of TimeStampDifferenceShort value.....	94
Figure 27 – FastForwardingMulticastMACAdd.....	100
Figure 28 – Stream Destination MAC Address – StreamDA.....	102
Figure 29 – State transition diagram of DCPUCS.....	145
Figure 30 – State transition diagram of DCPUCR.....	149
Figure 31 – State transition diagram of DCPMCS.....	154
Figure 32 – Basic structure of a DCP Multicast Receiver.....	156
Figure 33 – State transition diagram of DCPMCR.....	157
Figure 34 – State transition diagram of DCPHMCS.....	160

Figure 35 – State transition diagram of DCPHMCR	161
Figure 36 – PTCP_SequenceID value range	167
Figure 37 – Message timestamp point.....	173
Figure 38 – Timer model	174
Figure 39 – Four message timestamps	174
Figure 40 – Line delay protocol with follow up.....	175
Figure 41 – Line delay protocol without follow up	176
Figure 42 – Line delay measurement	178
Figure 43 – Model parameter for GSDML usage	180
Figure 44 – Bridge delay measurement.....	181
Figure 45 – Delay accumulation for PTCP.....	182
Figure 46 – Delay accumulation for PTP	183
Figure 47 – Worst case accumulated time deviation of synchronization	183
Figure 48 – Signal generation for measurement of deviation	184
Figure 49 – Measurement of deviation	184
Figure 50 – PTCP master sending Sync-Frame without Follow Up-Frame	185
Figure 51 – PTCP master sending Sync-Frame with FollowUp-Frame.....	186
Figure 52 – !FU Sync Slave Forwarding Sync-Frame	187
Figure 53 – FU Sync Slave Forwarding Sync- and FollowUp-Frame.....	188
Figure 54 – FU Sync Slave Forwarding Sync- and Generating FollowUp-Frame.....	189
Figure 55 – Principle of the monitoring of the line delay measurement.....	190
Figure 56 – State transition diagram of DELAY_REQ.....	192
Figure 57 – State transition diagram of DELAY_RSP	200
Figure 58 – Overview of PTCP.....	204
Figure 59 – State transition diagram of SYN_BMA	207
Figure 60 – State transition diagram of SYN_MPSM	216
Figure 61 – State transition diagram of SYN_SPSM.....	222
Figure 62 – State transition diagram of SYNC_RELAY	229
Figure 63 – State transition diagram of SCHEDULER	235
Figure 64 – Station clock model.....	240
Figure 65 – End station model with time synchronization	241
Figure 66 – GlobalTime timer model	242
Figure 67 – WorkingClock timer model.....	243
Figure 68 – Non-time-aware system – WorkingClock and CycleCounter.....	243
Figure 69 – Time-aware system – Queue masking – WorkingClock and CycleCounter	244
Figure 70 – Time-aware system – WorkingClock and CycleCounter	245
Figure 71 – Media redundancy – Ring.....	246
Figure 72 – Media redundancy – Interconnection	248
Figure 73 – CycleCounter value range	251
Figure 74 – Structure of the CycleCounter	252
Figure 75 – Optimized CycleCounter setting	253
Figure 76 – SFCRC16 generation rule	257
Figure 77 – SFCycleCounter value range.....	258

Figure 78 – Overview Buffer Lifetime Model.....	261
Figure 79 – PPM Flow Model	262
Figure 80 – CPM Flow Model	262
Figure 81 – Basic structure of a PPM with frame structure	264
Figure 82 – Basic structure of a PPM with subframe structure.....	265
Figure 83 – State transition diagram of PPM.....	267
Figure 84 – Basic structure of a CPM.....	271
Figure 85 – State transition diagram of CPM.....	273
Figure 86 – Addressing scheme of RTA	285
Figure 87 – Structure of the APM	295
Figure 88 – Structure of the RSI	296
Figure 89 – Structure of the APMS.....	297
Figure 90 – State transition diagram of APMS.....	299
Figure 91 – Structure of the APMR	304
Figure 92 – State transition diagram of APMR	306
Figure 93 – State transition diagram of RSII	310
Figure 94 – State transition diagram of RSIIN	322
Figure 95 – State transition diagram of RSIR	325
Figure 96 – State transition diagram of RSIRN.....	337
Figure 97 – State transition diagram of FRAG_D	347
Figure 98 – State transition diagram of FRAG_S.....	350
Figure 99 – State transition diagram of DEFRAG	353
Figure 100 – DLL Mapping Protocol Machines (DMPM)	389
Figure 101 – Schematic diagram of data flow of control loop.....	390
Figure 102 – End station model with IEEE Std 802.1Q alignment.....	394
Figure 103 – Ethernet interface model with IEEE alignment – transmit direction	395
Figure 104 – SendListControl alignment with Ethernet interface model	396
Figure 105 – Algorithm for end station ETS model	397
Figure 106 – Credit-based shaper algorithm	399
Figure 107 – Send List Feed.....	401
Figure 108 – Bandwidth vs. SendClock @ 10 Mbit/s	403
Figure 109 – 10 Mbps SendClock adaption	403
Figure 110 – Bandwidth vs. SendClock @ 100 Mbit/s	403
Figure 111 – Bandwidth vs. SendClock @ 1 Gbit/s	404
Figure 112 – Queue masking – time-aware end stations – without time-aware streams.....	408
Figure 113 – Queue masking – time-aware end station – with time-aware streams	410
Figure 114 – Queue masking – non-time-aware – without RT_CLASS_3.....	412
Figure 115 – Queue masking – non-time-aware end station – with RT_CLASS_3	414
Figure 116 – End station.....	415
Figure 117 – End station System – with multiple end station components	416
Figure 118 – System incorporating a bridge.....	417
Figure 119 – Domain Boundary.....	418
Figure 120 – Domain Boundary – RT_CLASS_STREAM, class RT.....	419

Figure 121 – Domain Boundary – Boundary Port..... 420

Figure 122 – Domain Boundary – Inter NME domain streams..... 421

Figure 123 – LLC protocol flow 425

Figure 124 – Ingress rate limiter – Domain boundary 434

Figure 125 – Ingress rate limiter – Link speed transition 438

Figure 126 – Schematic traffic flow model of a bridge 441

Figure 127 – Time-aware system – Egress port resource model of a bridge..... 445

Figure 128 – Non-time-aware system – Egress port resource model of a bridge 446

Figure 129 – Bridge queue masking usage model 452

Figure 130 – RED_RELAY – Bridge queue masking usage model..... 453

Figure 131 – TAS setup – Bridge queue masking model 454

Figure 132 – RED_RELAY setup – Queue masking model 455

Figure 133 – Bridge with end station 458

Figure 134 – Transmit – one port of a bridge 458

Figure 135 – Forwarding process – bridge 459

Figure 136 – Receive – one port of a bridge 459

Figure 137 – Transmit – Management port..... 460

Figure 138 – Receive – Management port..... 461

Figure 139 – Bridged end station 462

Figure 140 – Bridged end station interface model with IEEE alignment 463

Figure 141 – Bridged end station system reference planes 464

Figure 142 – Send List principle..... 465

Figure 143 – Fallback in case of sync loss / resync for WorkingClock 466

Figure 144 – Bridged end station with proprietary interfaces 467

Figure 145 – Internal vs. external reference plane 468

Figure 146 – Forwarding bridge resources vs. dedicated bridge resources 469

Figure 147 – Bridged end station with multiple entities – one end station per bridge component..... 470

Figure 148 – Bridged end station with multiple entities – multiple end station per bridge component..... 470

Figure 149 – State transition diagram of QPSM 471

Figure 150 – State transition diagram of PPSM..... 477

Figure 151 – State transition diagram of RTC3PSM 481

Figure 152 – State transition diagram for generating events 485

Figure 153 – State transition diagram of RED_RELAY 487

Figure 154 – Scheme of the DFP_RELAY 491

Figure 155 – Scheme of the DFP_RELAY_INBOUND and DFP_RELAY_IN_STORAGE 491

Figure 156 – Scheme of the DFP_RELAY_OUTBOUND..... 492

Figure 157 – State transition diagram of DFP_RELAY 493

Figure 158 – State transition diagram of DFP_RELAY_INBOUND 496

Figure 159 – State transition diagram of DFP_RELAY_IN_STORAGE..... 500

Figure 160 – State transition diagram of DFP_RELAY_OUTBOUND 504

Figure 161 – State transition diagram of MUX..... 508

Figure 162 – State transition diagram of DEMUX 513

Figure 163 – State transition diagram of ACCM	521
Figure 164 – State transition diagram of DHCP.....	524
Figure 165 – Network Management Entity.....	530
Figure 166 – NMDA model for network management.....	531
Figure 167 – YANG models of a bridge component.....	532
Figure 168 – YANG models of an end station component.....	532
Figure 169 – Structuring of the protocol machines within the DMPM (bridge).....	533
Figure 170 – State transition diagram of LMPM.....	536
Figure 171 – AlarmSpecifier.SequenceNumber value range.....	589
Figure 172 – FrameSendOffset vs. duration of a cycle	644
Figure 173 – Severity classification of fault, maintenance and normal operation	700
Figure 174 – UpdateInterval measurement.....	706
Figure 175 – Deadline measurement.....	707
Figure 176 – MaxCalculatedLatency	709
Figure 177 – Timing model with RR = 1	710
Figure 178 – Timing model with RR = 4	710
Figure 179 – Calculation principle for a cycle.....	718
Figure 180 – Calculation principle for the minimum YellowTime.....	719
Figure 181 – Example IPG behavior of an ideal end station component in case of bursts	751
Figure 182 – Example IPG behavior of an end station component in case of bursts	752
Figure 183 – Detection of dropped frames – appear.....	761
Figure 184 – Detection of dropped frames – disappear.....	761
Figure 185 – Definition of the reserved interval.....	778
Figure 186 – Toplevel view of the PLL window.....	781
Figure 187 – Definition of PLL window	781
Figure 188 – Toplevel view of the time PLL window	783
Figure 189 – Definition of time PLL window	784
Figure 190 – Detection of DFP late error – appear and disappear	794
Figure 191 – MediaRedundancyWatchDog expired – appear and disappear	795
Figure 192 – EndPoint1 and Endpoint2 scheme – above and below.....	798
Figure 193 – EndPoint1 and Endpoint2 scheme – left and right.....	798
Figure 194 – Relationship among Protocol Machines	816
Figure 195 – State transition diagram of ALPMI	841
Figure 196 – State transition diagram of ALPMR.....	845
Figure 197 – Scheme of the IO device CM.....	849
Figure 198 – State transition diagram of the IO device CM.....	851
Figure 199 – State transition diagram of CMDEV	855
Figure 200 – Scheme of the IO device CM – device access	860
Figure 201 – State transition diagram of CMDEV_DA.....	863
Figure 202 – State transition diagram of CMSU	867
Figure 203 – State transition diagram of CMIO	872
Figure 204 – State transition diagram of CMRS	875

Figure 205 – State transition diagram of CMWRR	878
Figure 206 – State transition diagram of CMRDR	883
Figure 207 – State transition diagram of CMSM	886
Figure 208 – State transition diagram of CMPBE	890
Figure 209 – State transition diagram of CMDMC	895
Figure 210 – State transition diagram of CMINA	899
Figure 211 – State transition diagram of CMRPC	904
Figure 212 – Intersection and residual amount using different ARUUID.ConfigIDs	912
Figure 213 – Intersection and removed amount using different ARUUID.ConfigIDs	912
Figure 214 – State transition diagram of CMSRL	914
Figure 215 – Single Input and single Output buffer of CMSRL.....	920
Figure 216 – Dynamic reconfiguration with CMSRL.....	921
Figure 217 – Alarm queue management of CMSRL.....	922
Figure 218 – Reporting System management of CMSRL.....	923
Figure 219 – Primary: Switchover time between two ARs of an ARset.....	923
Figure 220 – Backup: Switchover time between two ARs of an ARset	924
Figure 221 – State transition diagram of CMSRL_AL	926
Figure 222 – State transition diagram of CMRSI	931
Figure 223 – Scheme of the IO controller CM	935
Figure 224 – State transition diagram of the IO controller CM	937
Figure 225 – State transition diagram of CMCTL.....	941
Figure 226 – State transition diagram of CTLSM.....	949
Figure 227 – State transition diagram of CTLIO	951
Figure 228 – State transition diagram of CTRLDI	955
Figure 229 – State transition diagram of CTRLRDR.....	958
Figure 230 – State transition diagram of CTRLRPC.....	962
Figure 231 – State transition diagram of CTLSU	967
Figure 232 – State transition diagram of CTLWRI	973
Figure 233 – State transition diagram of CTLWRR.....	978
Figure 234 – State transition diagram of CTLPBE	981
Figure 235 – State transition diagram of CTLDINA.....	986
Figure 236 – Automatic NameOfStation assignment.....	992
Figure 237 – State transition diagram of CTLSRL	994
Figure 238 – Input and Output buffer of CTLSRL	998
Figure 239 – Input and Output buffer with dynamic reconfiguration	998
Figure 240 – Alarm queue management of CTLSRL.....	999
Figure 241 – Alarm queue management with dynamic reconfiguration	999
Figure 242 – State transition diagram of CTLSC	1001
Figure 243 – State transition diagram of CTRLRSI	1006
Figure 244 – State transition diagram of CTLINA	1010
Figure 245 – Scheme of a station hosting CIM and NME.....	1014
Figure 246 – Scheme of the station hosting CIM and Query Stream.....	1014
Figure 247 – Scheme of a station hosting CIM only.....	1015

Figure 248 – State transition diagram of NME	1019
Figure 249 – State transition diagram of TDE.....	1025
Figure 250 – State transition diagram of PCE	1028
Figure 251 – State transition diagram of NCE	1032
Figure 252 – State transition diagram of NUE	1036
Figure 253 – State transition diagram of BNME.....	1042
Figure 254 – State transition diagram of NMEINA	1045
Figure A.1 – Establishing of an AR using RT_CLASS_1, RT_CLASS_2 or RT_CLASS_3 (Initial connection monitoring w/o RT).....	1090
Figure A.2 – Establishing of an AR using RT_CLASS_1, RT_CLASS_2 or RT_CLASS_3 (Connection monitoring with RT)	1091
Figure A.3 – Principle of the data evaluation during startup (RED channel establishment delayed)	1092
Figure A.4 – Principle of the data evaluation during startup (RED channel establishment immediately).....	1093
Figure A.5 – Principle of the data evaluation during startup (Special case: Isochronous mode application)	1094
Figure A.6 – Establishing of an AR using RSI	1095
Figure A.7 – Establishing of an AR using Streams and isochronous mode application.....	1096
Figure A.8 – Startup of Alarm transmitter and receiver without System Redundancy	1097
Figure A.9 – Startup of Alarm transmitter and receiver with System Redundancy	1098
Figure A.10 – Startup of Alarm transmitter and receiver during a PrmBegin / PrmEnd / ApplRdy sequence	1099
Figure A.11 – Time-aware systems path establishment.....	1100
Figure B.1 – Establishing of an AR using RT_CLASS_3 AR with startup mode “Legacy”	1102
Figure B.2 – Establishing of an AR using RT_CLASS_1, 2 or UDP AR with startup mode “Legacy”	1103
Figure C.1 – Establishing of a device access AR	1104
Figure C.2 – Establishing of a device access AR using RSI	1105
Figure D.1 – Accelerated establishing of an IOAR without error	1107
Figure D.2 – Accelerated establishing of an IOAR with “late error”	1108
Figure E.1 – Establishing of an IOAR using fast startup	1110
Figure F.1 – Example of upload from storage.....	1111
Figure F.2 – Example of retrieval from storage.....	1112
Figure G.1 – Application queues to implement reduction ratio	1114
Figure G.2 – Application queue to implement phases.....	1115
Figure H.1 – Overview of the IO controller state machines	1117
Figure H.2 – Overview of the IO device state machines	1117
Figure H.3 – Overview of the Network Management Entity state machines.....	1118
Figure H.4 – Overview of the common state machines	1118
Figure I.1 – Level model for synchronization master hierarchy	1119
Figure I.2 – Two level variant of the synchronization master hierarchy.....	1120
Figure J.1 – Devices built up in a linear structure.....	1121
Figure J.2 – Propagation of frames in linear transmit direction	1121
Figure J.3 – Propagation of a frames in receive direction	1122