

ISO/IEC 14908-1:2012-11 (E)

Information technology - Control network protocol - Part 1: Protocol stack

Contents		Page
Foreword		7
Introduction.....		8
1 Scope.....		9
2 Normative references.....		9
3 Terms and definitions		9
4 Symbols and abbreviations.....		11
4.1 Symbols and graphical representations		11
4.2 Abbreviations.....		12
5 Overview of protocol layering.....		13
6 MAC sublayer.....		15
6.1 Service provided.....		15
6.2 Interface to the link layer		15
6.3 Interface to the physical layer.....		16
6.4 MPDU format.....		17
6.5 Predictive <i>p</i> -persistent CSMA — overview description		17
6.6 Idle channel detection.....		18
6.7 Randomising.....		19
6.8 Backlog estimation.....		19
6.9 Optional priority.....		20
6.10 Optional collision detection		21
6.11 Beta1, Beta2 and Preamble Timings		21
7 Link layer.....		23
7.1 Assumptions.....		23
7.2 Service provided.....		24
7.3 CRC.....		24
7.4 Transmit algorithm.....		25
8 Network layer		26
8.1 Assumptions.....		26
8.2 Service provided.....		27
8.3 Service interface.....		27
8.4 Internal structuring of the network layer		28
8.5 NPDU format		28
8.6 Address recognition.....		29
8.7 Routers		29
8.8 Routing algorithm.....		30
8.9 Learning algorithm — subnets		30
9 Transaction control sublayer		30
9.1 Assumptions.....		30
9.2 Service provided.....		31
9.3 Service interface.....		31
9.4 State variables		31
9.5 Transaction control algorithm		32
10 Transport layer		32
10.1 Assumptions.....		32
10.2 Service provided.....		32
10.3 Service interface.....		33
10.4 TPDU types and formats.....		33

10.5	Protocol diagram	35
10.6	Transport protocol state variables	35
10.7	Send algorithm	35
10.8	Receive algorithm.....	36
10.9	Receive transaction record pool size and configuration engineering.....	36
10.9.1	General	36
10.9.2	Number of retries.....	36
10.9.3	Transport layer timers.....	37
11	Session layer	38
11.1	Assumptions.....	38
11.2	Service Provided	38
11.3	Service interface.....	39
11.4	Internal structure of the session layer	40
11.5	SPDU types and formats	41
11.6	Protocol timing diagrams	42
11.7	Request-response state variables	44
11.8	Request-response protocol — client part.....	45
11.9	Request-response protocol — server part	45
11.10	Request-response protocol timers.....	45
11.11	Authentication protocol.....	46
11.12	Encryption algorithm	46
11.13	Retries and the role of the checksum function	46
11.14	Random Number Generation	47
11.15	Using Authentication	47
12	Presentation/application layer	47
12.1	Assumptions.....	47
12.2	Service provided.....	47
12.3	Service interface.....	48
12.4	APDU types and formats	49
12.5	Protocol diagrams	50
12.6	Application protocol state variables	51
12.7	Request - response messaging in offline state.....	51
12.8	Network variables.....	52
12.8.1	General	52
12.8.2	Network variable processing	52
12.9	Error notification to the application program.....	53
12.9.1	General	53
12.9.2	Error notification for messages	53
12.9.3	Error notification for network variables	53
13	Network management & diagnostics	53
13.1	Assumptions.....	53
13.2	Services provided.....	54
13.3	Network management and diagnostics application structure.....	54
13.4	Node states	54
13.5	Using the network management services.....	55
13.5.1	General	55
13.5.2	Addressing considerations	55
13.5.3	Making network configuration changes.....	56
13.5.4	Downloading an Application Program	56
13.5.5	Error handling conditions (informative).....	56
13.6	Using router network management commands	59
13.7	NMPDU formats and types	60
13.7.1	General	60
13.7.2	Query ID.....	60
13.7.3	Respond to query	61
13.7.4	Update domain.....	61
13.7.5	Leave domain.....	61
13.7.6	Update key	61

13.7.7	Update address.....	62
13.7.8	Query address	62
13.7.9	Query network variable configuration.....	62
13.7.10	Update group address	62
13.7.11	Query domain	62
13.7.12	Update network variable configuration.....	62
13.7.13	Set node mode.....	63
13.7.14	Read memory.....	63
13.7.15	Write memory.....	63
13.7.16	Checksum recalculate.....	63
13.7.17	Install	64
13.7.18	Memory refresh.....	78
13.7.19	Query SI.....	78
13.7.20	Network variable value fetch	79
13.7.21	Manual service request message	79
13.7.22	Network management escape code	79
13.7.23	Router mode	80
13.7.24	Router clear group or subnet table	80
13.7.25	Router group or subnet table download	80
13.7.26	Router group forward.....	80
13.7.27	Router subnet forward.....	80
13.7.28	Router Do Not forward group.....	80
13.7.29	Router Do Not forward subnet.....	80
13.7.30	Router group or subnet table report	80
13.7.31	Router status	81
13.7.32	Router half escape code.....	81
13.8	DPDU types and formats	81
13.8.1	General	81
13.8.2	Query status.....	81
13.8.3	Proxy status	85
13.8.4	Clear status	85
13.8.5	Query transceiver status	85
Annex A	(normative) Reference implementation	86
A.1	General	86
A.2	Predictive CSMA algorithm	86
A.3	LPDU transmit algorithm	141
A.4	LPDU receive algorithm.....	143
A.5	Routing algorithm.....	144
A.6	Learning algorithm.....	145
A.7	Transaction control algorithm	145
A.8	Network layer algorithm.....	152
A.9	TPDU and SPDU send algorithm with authentication	168
A.10	Application Layer	223
A.11	Network Management Commands.....	278
A.12	Configuration data structures	315
A.13	Include files for the reference implementation	334
A.14	Application protocol state variables and address recognition Structures	363
A.15	Query-id data structures.....	366
A.16	Respond to query data structure.....	366
A.17	Update somain data structures.....	367
A.18	Leave domain data structures	367
A.19	Update key data structures	367
A.20	Update address data structures	367
A.21	Query address data structures	368
A.22	Query NV Cnfg data structures.....	369
A.23	Update group address data structures	369
A.24	Query domain data structures	369
A.25	Update network variable configuration data structures.....	370
A.26	Set node mode data structures.....	370

A.27	Read memory data structures.....	370
A.28	Write memory data structures	371
A.29	Checksum recalculate data structures	371
A.30	Install command data structures	371
A.31	Memory refresh data structures	380
A.32	Query SI data structures.....	380
A.33	NV fetch data structures.....	380
A.34	Manual service request message ddata structures.....	380
A.35	Product query data structures	381
A.36	Router mode data structures	381
A.37	Router table clear group or subnet table data structures.....	381
A.38	Router group or subnet download data structures	381
A.39	Router group forward data structures	382
A.40	Router subnet forward data structures.....	382
A.41	Router group No-Forward data structures	382
A.42	Router subnet No-Forward data structures.....	382
A.43	Group / subnet table report data structures.....	383
A.44	Router status data structures	383
A.45	Query status data structures	383
A.46	Proxy status data structures.....	384
A.47	Clear status data structures	384
A.48	Query transceiver status data structures	384
Annex B (normative) Additional Data Structures.....		385
B.1	General	385
B.1.1	System image	385
B.1.2	Application image.....	385
B.1.3	Network image.....	386
B.2	Read-only structures.....	386
B.2.1	Fixed read-only data structures.....	386
B.2.2	Read-only structure field descriptions.....	387
B.3	Domain table	390
B.3.1	Domain table field descriptions	391
B.4	Address table.....	391
B.4.1	Declaration of group address format	392
B.4.2	Group address field descriptions	392
B.4.3	Declaration of subnet/node address format.....	392
B.4.4	Subnet/node address field descriptions	393
B.4.5	Declaration of broadcast address format	393
B.4.6	Broadcast address field descriptions	393
B.4.7	Declaration of turnaround address format	393
B.4.8	Turnaround address field descriptions.....	394
B.4.9	Declaration of protocol processor's address format	394
B.4.10	Protocol processor address field descriptions.....	394
B.4.11	Timer field descriptions	394
B.5	Network variable tables - informative.....	395
B.5.1	Network variable configuration table field descriptions - informative	396
B.5.2	Network variable alias table field descriptions - informative.....	397
B.5.3	Network variable fixed table field descriptions - informative	397
B.6	Self-Identification structures.....	397
B.6.1	SI Structure field descriptions	398
B.6.2	NV descriptor table field descriptions.....	398
B.6.3	SNVT table extension records	399
B.6.4	SNVT alias field descriptions	400
B.6.5	Version 2 SI data.....	400
B.7	Configuration structure	403
B.7.1	General	403
B.7.2	Configuration structure field descriptions	404
B.8	Statistics relative structure	405
Annex C (informative) Behavioral characteristics		407

C.1	Channel capacity and throughput	407
C.2	Network metrics	408
C.3	Transaction metrics	409
C.4	Boundary conditions — power-up	410
C.5	Boundary conditions — high load	410
	Annex D (normative) PDU summary	411
	Annex E (normative) Naming and addressing	413
E.1	Address types and formats	413
E.2	Domains	413
E.3	Subnets and nodes	414
E.4	Groups	414
E.5	Unique_Node_ID and node address assignment.....	415
E.6	NPDU addressing	416
	Annex F (normative) List of patents that pertain to this International Standard	418
	Bibliography.....	420

Figures

Figure 1	— Network topology & symbols	12
Figure 2	— Protocol terminology	12
Figure 3	— Protocol layering	14
Figure 4	— Interface between the MAC and the link layers	16
Figure 5	— MPDU/LPDU format	17
Figure 6	— Predictive p -persistent CSMA concepts and parameters.....	18
Figure 7	— Allocation of priority slots within the Busy Channel Packet Cycle.....	20
Figure 8	— CRC register state behaviour example	25
Figure 9	— Single channel topologies.....	26
Figure 10	— Typical tree-like domain topology	27
Figure 11	— Network service interface	28
Figure 12	— Network layer—internal structure	28
Figure 13	— NPDU format	28
Figure 14	— Transaction control service interface.....	31
Figure 15	— Transport interface to upper layers.....	33
Figure 16	— TPDU types and formats	34
Figure 17	— Transport protocol diagram for multicast message with a loss of both the message and the ACK TPDU.....	35
Figure 18	— Transport protocol—Send FSM.....	36
Figure 19	— Transport protocol—Receive FSM	36
Figure 20	— Probability of transaction completion in k Retries.....	37

Figure 21 — Methodology for calculating timer values	38
Figure 22 — Session layer interface to application layer	39
Figure 23 — Session layer—internal structuring.....	40
Figure 24 — SPDU types and formats	41
Figure 25 — Non-Idempotent request with multiple SPDU losses.....	43
Figure 26 — Secure idempotent request with multiple SPDU losses	44
Figure 27 — Request-response protocol—client FSM.....	45
Figure 28 — Request-response protocol—simplified server FSM	45
Figure 29 — Application layer interface	48
Figure 30 — APDU format.....	49
Figure 31 — Application protocol diagram for multicast acknowledged transaction.....	50
Figure 32 — Application protocol diagram for multicast request/response transaction	51
Figure B.1 — SI data	400
Figure C.1 — Probability of successful delivery over k hops	409
Figure D.1 — Protocol PDU summary	412
Figure E.1 — Physical topology and logical addressing (single domain)	415
Figure E.2 — NPDU/TPDU/SPDU addressing—physical address formats.....	416

Tables

Table 1 — Application layer primitives	48
Table 2 — Resource codes	65
Table 3 — Space of the property ID	65
Table B.1 — Buffer size encodings	389
Table B.2 — Buffer Count Encodings	390
Table B.3 — Encoding of timer field values	395
Table B.4 — Buffer timeout encoding	405
Table C.1 — Key throughput parameters.....	408
Table E.1 — NPDU/TPDU/SPDU addressing - logical address formats	416
Table F.1 — Patents in the US.....	418
Table F.2 — Patents in Europe and other countries	419