
Glossary of Terms and Acronyms

Page 1

1. Glossary of Terms

Action Time

The point in time at which the controller starts frame transmission (in its own sending slot) or expects frame transmission from another controller. Several interrupts are raised only at the Action Time. See also Transmission Phase.

Active State

Protocol State in which the TTP controller sends frames on both channels. Normal state of operation.

Agreed Slots Counter

A counter that counts in each TDMA round the number of SRUs that have sent at least one correct frame. It is reset in its own slot.

Application Identification

The name of the application (MEDL file) that is loaded into the controller, as defined by the cluster designer. Has no influence on protocol execution.

Await State

If the host processor decides that the SRU needs a software update, the controller does not perform TTP communication and instead waits for download in the await state.

Babbling Idiot

A faulty-node that monopolizes the bus by sending permanently. This is a worst-case scenario for a bus system since one faulty component can disturb the function of the complete system.

Blackout

Temporary interference of the TTP system's operation by some powerful external disturbance, causing correlated failure of a set of SRUs. Not the same as Communication Blackout.

Built-in Self-Test Error

An error indicating that the controller hardware has a transient or permanent fault. Built-in self-test results in an interrupt. This interrupt is raised whenever the controller finishes a self-test requested by the host or when it detects an internal hardware fault. It subsequently transits into the freeze state.

Bus

In TTP the bus consists of two replicated communication channels and interconnects all SRUs of a TTP cluster. The term 'bus' here denotes all possible physical topologies – including bus, star, and ring architectures – unless explicitly noted otherwise.

Bus Guardian

An independent unit that protects the bus from timing failures of the controller. Can be part of the controller silicon or an external unit. It ensures fail-silence in the temporal domain.

Byzantine Failure

In a multiple receiver scenario, the different receivers see differing, possibly incorrect, results.

Glossary of Terms and Acronyms

Page 2

C-State (Controller State)

The internal state of the controller, consisting of the current time, current position in the MEDL, the current mode of operation, a pending deferred mode change (DMC) and the current membership.

C-State MEDL Field

This field contains the current mode, the current position in the MEDL and a pending deferred mode change.

C-State Membership Field

This field contains the current membership vector of the cluster.

C-State Time Field

The C-state time field contains the synchronized global time in SRU slot granularity.

C-State Valid

This CNI field informs the host that the C-state field in the CNI holds valid data. This indicates that the controller is now synchronized with the cluster (or rather the active SRUs in the cluster) and from now on performs communication as defined in the MEDL according to the current mode.

Channel

The physical communication channel. In TTP there are always two replicated communication channels in a cluster. The channels are called channel 0 (Ch0) and channel 1 (Ch1).

Class C

Control applications that are safety critical (e.g., anti lock brakes). Used by the SAE (deprecated).

Clock State Correction Term

The current value of the correction term computed by the clock synchronization algorithm, in units of microticks.

Cluster

The set of SRUs sharing a bus in a TTP system.

Cluster Cycle

The sequence of different TDMA rounds. Each mode has a cluster cycle; different modes may have cluster cycles of different lengths. The least common multiple of the lengths of all cluster cycles in a cluster design is called transmission cycle.

Cluster Time Field

This field contains the synchronized global time with a granularity of one macrotick.

Cold Start

When the cluster is powered up, the first transmission of an I-frame in the cold start state is asynchronous because no global timebase has yet been established. Cold start is controlled by several well-defined timeouts in order to prevent multiple collisions between cold-starting SRUs and to guarantee a worst-case startup time of a cluster.

Glossary of Terms and Acronyms

Page 3

Communication Blackout

Protocol error raised by the controller if no traffic was observed on any channel during one TDMA round.

Communication Network Interface (CNI)

The interface between a TTP controller and the host computer within a node of a distributed system.

Composability (also called "Interoperability")

An architecture is composable regarding a specified property if the system integration will not invalidate this property, provided it has been established at the subsystem level.

Concurrency Control Field (CCF)

The concurrency control field allows the reader in the non-blocking write protocol to check whether the writer has updated the value while the reader was reading.

Controller Await Field (CA Field)

This field is used to force the controller into the await state.

Controller Lifesign Field

The controller updates this field once every TDMA round. The host can use the contents of this field to check whether the controller is still alive, but also to update its own lifesign field, as required by the controller.

Controller On Field (CO Field)

This field is used by the host to switch the controller on or off. Additionally, it informs the host whether the controller is operational or whether it has turned itself off.

Controller State (C-State)

See C-State.

Controller Version Number

The version number of the controller implementation.

Correct Frame

A valid frame, which passed the CRC check and all additional semantic checks at the receiver.

CRC

Cyclic redundancy check.

Deferred Mode Change

A mode change that is deferred until the beginning of the next cluster cycle.

Deferred Mode Change Field (DMC)

A field in the C-state of the controller that stores the request for a deferred mode change.

Delay Correction

Term A time interval contained in the MEDL that denotes the expected delay of signal propagation between two SRUs.

Glossary of Terms and Acronyms

Page 4

Download

TTP download is a dedicated communication protocol apart from normal TTP communication; it serves the purpose of updating MEDLs and/or application data in an SRU from a central maintenance node (the download master node). Download is a safety-critical functionality because it can change MEDLs in the controllers. The download protocol is a point-to-point protocol that does not utilize the TDMA strategy and cannot be executed simultaneously with normal TTP communication.

End Of Cluster Cycle (EOC)

This flag in the CNI indicates that the current slot of the MEDL is the last slot of the cluster cycle. After execution of this slot, the controllers restart the cluster cycle.

Electronic Module

An electronic module is an electronic control unit in a vehicle. (An electronic module that is connected to a TTP bus and has the structure of Figure 1 is called an SRU – smallest replaceable unit).

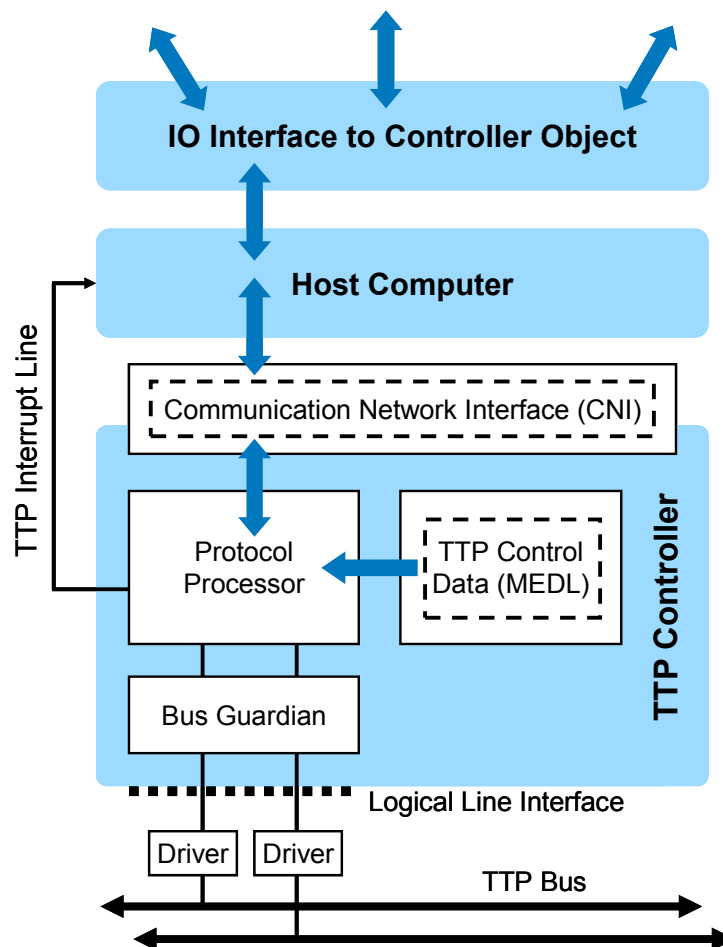


Figure 1

Glossary of Terms and Acronyms

Page 5

Event

An event is a happening at a cut of the time-line. Every change of state is an event.

Event Message

A message is an event message if every new version of the message is queued at the receiver and consumed on reading. See also State Message.

Extended I-Frame

This type of frame carries both the sender's C-State and application data; each part is secured with a CRC. Clusters which utilize this type of frame have a higher transmission overhead due to the inclusion of the C-state in each frame but allow for schedules where all SRUs can transmit data in every slot in every round.

External Rate Correction Field

A field in the CNI that contains the external rate correction term used for external clock synchronization, e.g. to a GPS receiver. The contents of this field are application defined; the controller adds the contents of this field to the current clock state correction term. Many applications do not need the service of external clock correction and will not use this field.

Fail-Silent

An SRU is called fail-silent, if it either

- Operates correctly by sending correct (both in value and time domain) frames or
- Sends frames which all receivers can reliably detect as incorrect (e.g., by means of a checksum)
- Sends no frames at all.

This means that it is quiet in case it cannot deliver the correct service. Thus a fault in a fail-silent SRU is detectable by all receivers without additional effort.

Failed Slots Counter

A counter that counts in each TDMA round the number of SRUs sending at least one failed frame but no correct frame. This counter is reset in the own SRU slot.

Failed Frame

A valid frame for which all CRC checks have failed at the receiver.

Fault-Tolerant Unit (FTU)

A unit of two or more SRUs that performs the specified function despite a specified failure of one of its constituent SRUs.

Frame

A frame is one complete transmission of information on a communication channel. A frame is delimited by two interframe gaps.

Frame Diagnosis Field

This status field of the CNI contains diagnosis information on the frames received in the last SRU slot.

Glossary of Terms and Acronyms

Free-Running Macroticks Count

Number of unchanged macroticks between two macroticks that are modified for the purpose of clock adjustment.

FTU Membership

This membership depends on the chosen FTU layer. – If, for example, an FTU consists of two fail-silent SRUs, the FTU is considered to be a member if at least one of the SRUs is in the SRU membership.

H-State

The h-state is the dynamic data structure of a task or node that is changed as the computation progresses. The h-state must reside in read/write memory. It encompasses all information that is required to start an "empty" SRU (or task) at a given point in time.

Host

The computer within an SRU that executes the application software.

Host Error

An error in the host.

Host Error Flag

Flag in the interrupt status field of the CNI that is set by the controller if it detects a host error (e.g., the host has violated the CNI access timing). The controller generates a host error interrupt and transits into the passive state.

Host Error Interrupt

An interrupt generated by the controller whenever it judges the host to be in error.

Host Lifesign Field

A control field in the CNI that must be periodically updated by the host computer with the inverted value of the controller lifesign field.

I-Frame Counter

Holds the number of cold start I-frames already sent by this SRU; this number is limited by the Cold Start Entry.

Idle Phase

The MEDL may contain slot durations that specify an inter-frame gap longer than required by the protocol (the sum of post-receive phase and pre-send phase). In this case, the controller will idle between the post-receive phase and the pre-send phase. This decreases data throughput, which can be desirable in order to set up application related round durations.

Immediate Mode Change

A mode change that is executed immediately after it has been requested. This kind of mode change is an optional TTP controller feature, i.e., controllers may or may not support it. Immediate mode changes may only be used in a cluster design if all controllers support them.

Glossary of Terms and Acronyms

Page 7

Implicit Acknowledgment

Acknowledgment of the receipt of a frame by the successor of the sender is implicit by the SRU membership.

Initialization Frame (I-Frame)

A special TTP frame used for initialization. It consists of three fields, the header, the C-state of the sender, and the CRC field. I-frames need to be sent in all modes to allow re-integration of controllers.

Inter-frame Gap (IFG)

The time interval required by the controller to execute the protocol tasks following a transmission phase and preceding a frame transmission. See also Post-Receive Phase, Idle Phase, Pre-Send Phase.

Interrupt Line

A signal from the controller to the host computer that is used to inform the host computer about interrupt conditions within the controller and about host errors detected by the controller, and to provide a globally synchronized time signal. The TTP controller offers several interrupt conditions to be selectively enabled or disabled by the host.

Interrupt Status Field

This field contains information on the condition(s) that triggered an interrupt from the controller to the host computer.

Invalid Frame

A frame that is syntactically invalid, i.e., coding rules (e.g., MFM coding or expected length) were violated.

Jitter

The jitter is the difference between the maximum and the minimum duration of an action (processing action, communication action).

Lifesign Fields

Used by the controller to check whether the host is still operating and vice versa. See Host Lifesign Field, Controller Lifesign Field.

Logical Name

The name that determines the role of an SRU in a cluster. The logical name can be changed by reconfiguration if a controller supports this feature.

Macrotick

A periodic signal that delimits a granule of the global time.

Maximum Membership Failure Count (MMFC)

A field that denotes the maximum number of successive membership failures before an SRU has to terminate its operation. Contained in the MEDL. Required for checking of the membership failure counter.

Measured Time Difference

The time difference between the expected arrival time and the actual arrival time of a frame on a channel.

Glossary of Terms and Acronyms

Page 8

MEDL

See Message Descriptor List.

Member SRU

A member SRU is a real member SRU (a non-multiplexed SRU) or a virtual member SRU (a set of multiplexed SRUs). Each member SRU is assigned to one unique SRU slot of a TDMA round.

Membership

The information about which SRUs in the cluster are currently operational, based on correct transmission activity.

Membership Service

A membership service is a service in a distributed system that generates consistent information about the operational state (operating or failed) of all nodes at agreed points in time (membership points). The length and the jitter of the interval between a membership point and the moment when the consistent membership information is available at the other nodes are quality-of-service parameters of the membership service.

Membership Failure

The event when an operational SRU fails, as judged by a majority of SRUs in a cluster.

Membership Failure Counter (MFC)

A counter used to count the number of successive membership failures. A controller will assume that it is faulty if the MFC reaches the value of the maximum membership failure count.

Membership Point

Moment when the membership is established. This is in the PRP after an SRU was supposed to send a frame.

Membership Recognition Point

The membership recognition point is the moment when an observing SRU makes a final decision about the membership of a sending SRU. In a failure scenario, the membership recognition points at different observing SRUs can be different.

Membership Vector

A bit vector that has a unique bit assigned to each member SRU. If this bit is set the member SRU was operational at its last membership recognition point, otherwise it was not operational.

Message

The (application) data contained in N-frames is called message. The frames sent on the two channels in one slot by one sender may or may not contain identical messages. In fault-tolerant systems, the channels are typically used for fully redundant transmission.

Message Descriptor List (MEDL)

In an abstract form, the complete communication design of the TTP cluster. In a personalized form, the data structure in the controller that contains the control data for the controller. The contents of the MEDL

Glossary of Terms and Acronyms

Page 9

determine when a particular frame has to be sent or received or what mode change is permitted at any given point in time.

Microtick

A periodic signal that is generated by the oscillator of the controller. Each macrotick is made up of a number of microticks.

Mode

The term 'mode' (also known as 'operational mode' and 'cluster mode') denotes application-defined functional behavior of the distributed system; for the communication system, a specific mode is associated with a specific set of data that needs to be transmitted between the SRUs, and different modes (if a system design has them) may require quite different sets of data, for example 'application mode', 'diagnosis and maintenance mode', and 'emergency mode'. The TTP protocol requires one dedicated mode – the startup mode – to establish synchronized communication among the SRUs. Each MEDL contains at least two modes, the startup mode and one application mode; a large number of modes can be defined in a single cluster design. The current mode and pending mode changes are part of the C-state and therefore subjected to the continuous state agreement performed by all controllers.

Mode Address Section

The mode address section is part of the MEDL. Its entries contain addresses of memory locations in the CNI where the N-frame data are exchanged between host processor and communication controller.

Mode Change

A transition from one operational mode to another operational mode. A TTP mode change always affects the cluster as a whole, even if some SRUs may not have to change their internal mode of operation.

Mode Change Interrupt

An interrupt generated by the controller whenever it performs a mode change.

Mode Change Permission Field (MCP)

A field in the MEDL that contains the information about the permitted mode change requests in each slot.

Mode Change Request Field

The control field in the CNI that informs the controller about the mode change request from the host.

Mode Control Block (MCB)

A section of the MEDL containing a table for translating a mode change request stored in the deferred mode change field to a mode address section.

Modified Frequency Modulation (MFM)

A bit encoding/decoding technique that results in a synchronizing code with a feature size of one bit cell.

Multiplexed SRU

An SRU that shares an SRU slot with one or more SRUs. A multiplexed SRU role is statically assigned to a specified SRU slot in a specified TDMA round for reintegration. With multiplexing, the number of physical nodes in a cluster can exceed the number of TDMA slots in a round.

Glossary of Terms and Acronyms

Page 10

Never Give Up (NGU)

A strategy that aims at providing the highest possible system availability. The design of the TTP protocol is guided by several principles, including the NGU strategy. For critical errors, the host CPU must agree to continue operation.

Non-Blocking Write Protocol (NBW)

A non-locking reader-writer protocol. See also Concurrency Control Field.

Null-Frame

No activity is observed on any of the channels during an SRU slot.

Oversampling Rate

The ratio of the controller's clock rate to the transmission speed on the physical channel.

Permanence of a Message

A particular message becomes permanent at a receiver when all messages that have been sent to this receiver before the send time of the particular message have arrived at the receiver or will never arrive.

Personality Field

The personality field contains several identification values for the controller as it is currently configured: the version of the controller implementation, a schedule identification and an application identification of the MEDL currently loaded, the physical address and the current role of the controller.

Post-Receive Phase (PRP)

The time interval that the controller requires to process the frames received in the previous transmission phase, and to perform the appropriate updates in the CNI. The duration of the PRP is an implementation-specific parameter of a controller design.

Pre-Send Phase (PSP)

The time interval that the controller requires to prepare for sending in the next transmission phase. The duration of the PSP is an implementation specific parameter of a controller design.

Precision (P)

Maximum interval between any two corresponding ticks of the synchronized clocks of a global timebase. The precision is defined by the cluster design and continuously checked by the controllers; if a controller detects that its clock cannot achieve this level of synchronization anymore, it raises a synchronization protocol error and terminates operation.

Protocol Error

An error detected by the checking mechanisms of the protocol that makes further execution of the protocol impossible. The occurrence of a protocol error forces the controller into a halt – it enters the freeze state.

Protocol Error Interrupt

This interrupt is raised whenever a protocol error occurs.

Glossary of Terms and Acronyms

Protocol State

The TTP protocol controller is always in a defined state of operation. The protocol specification describes the state machine for the execution of the protocol. This field contains the number of the state the controller currently is in.

Protocol Status Field

The protocol status field in the CNI is used to display internal information about the current execution of the communication protocol.

Reconfiguration

Advanced protocol feature, which does not have to be supported by all controllers. Allows the host to specify and change the SRU role during protocol operation.

Reconfiguration Role List

This list contains the controller logical name and timing information for the bus guardian for each defined SRU role.

Reconfiguration Scope

The set of SRU slots statically (off-line) assigned to an SRU. In the reconfigure state the reconfiguration scope is checked.

Real Member SRU

An operational SRU that does not share an SRU slot with another SRU.

Real-Time (RT) Entity

A real-time (RT) entity is a state variable, either in the environment of the computational cluster, or in the computational cluster itself, that is relevant for the given purpose. Examples of RT entities are: the temperature of a vessel, the position of a switch, the setpoint selected by an operator, or the intended valve position calculated by the computer.

Real-time (RT) Image

This is a current picture of a real-time entity.

Real-Time (RT) Object

A real-time (RT) object is a container inside a computer for an RT entity or an RT image. A clock with a granularity that is in agreement with the dynamics of the RT object is associated with every RT object.

Replica Determinism

Replica Determinism is a desired relation between replicated RT objects. A set of replicated RT objects is replica determinate if all objects of this set have the same visible external h-state and produce the same output messages at points in time that are at most an interval of d time units apart.

Requested Logical Name Field

Field in the CNI control area that contains the logical name that the host requests the controller to take. Only used if the controller supports reconfiguration.

Glossary of Terms and Acronyms

Page 12

Resynchronization Interval

The time interval after which the clocks of a cluster are resynchronized. The Clock Synchronization Slot (ClkSyn) flags in the MEDL determine this time interval.

Role

The function assumed by an SRU at a particular point in time. During reconfiguration, this function can change.

Role Change

See Reconfiguration

Shadow SRU

Shadow SRUs are provided to avoid spare exhaustion after permanent failures.

Shared Slot

A slot that is shared by more than one SRU in a cluster cycle; the SRUs sharing the slot are 'multiplexed SRUs', the group of SRUs sharing the slot are called 'virtual member SRU'.

Slot

A slot is the smallest time-interval of a TDMA schedule.

Slot Control Section

This section is part of the transmission block and contains all parameters for the SRU slots which are common for all cluster modes.

Slot Name

The position of a slot in the basic TDMA round.

Smallest Replaceable Unit (SRU)

An electronic module that is connected to a TTP network and that has the structure of Figure 1.

SRU Membership

The SRU membership service informs all SRUs of a cluster about the operational state of each SRU within a latency of about one TDMA round.

SRU Name

The static physical name of an SRU, which must be unique within the cluster and can be used for addressing this SRU during download. The SRU name is not related to the sending slot; at different times an SRU with the same SRU name can play different roles in a cluster according to its logical name (when using reconfiguration).

SRU Slot

The total bus capacity is statically subdivided into several 'time windows' called SRU slots, which are exclusively assigned to SRUs for transmission. The relation between the length of the SRU slot and the length of the TDMA round represents the share of the total available bandwidth that is assigned to this SRU and can be utilized by it exclusively.

Glossary of Terms and Acronyms

Successor Mode Identifier

The successor mode identifier denotes the mode address section that contains the entries for the successor mode.

Startup Timeout

The startup timeout is an SRU specific, unique timeout value (relevant only for nodes that have cold start permission).

State Message

A message is a state message if a new version of the message replaces the previous version and the message is not consumed on reading. See also Event Message.

Synchronization Flag (SYF)

A flag in the MEDL denoting that the SRU sending in this slot is part of the ensemble of SRUs that provide the basis for the global clock synchronization.

Temporal Firewall

A Temporal Firewall is an interface concept supported by TTP that guarantees temporal composability. A temporal firewall is defined as an

- unidirectional data-sharing interface with
- state-data semantics where
- at least one of the interfacing subsystems accesses the temporal firewall according to an a priori known schedule and where
- at all points in time the information contained in the temporal firewall is temporally accurate for at least dacc time units into the future.

TDMA (Time Division Multiple Access)

Media access scheme used by the time-triggered protocol family – bus access is divided into non-intersecting time slots. Each slot is statically assigned to the communicating nodes in a cluster. A node is only allowed to send a message during its slot.

TDMA Round

The sequence of SRU slots in a cluster.

Time Field (also called “Alarm Timer”)

A CNI control area field that can be used as a time interrupt source by the host computer. TTP controllers must support at least one such timer to allow efficient access to the global time for the host CPU, e.g., for embedded operating systems.

Time Gateway

The time gateway is a special SRU that has access to an external reference time (e.g., a GPS receiver or another cluster). The time gateway provides the drift rate correction term for the cluster to allow for external rate correction.

Glossary of Terms and Acronyms

Page 14

Time Interrupt

A programmable interrupt generated by the controller whenever the time field in the CNI is equal to the current global time. See also Time Field.

Transmission Block

The section of the MEDL that contains the slot control section and the mode address sections.

Transmission Cycle

The least common multiple of all cluster cycles in a cluster design. If all cluster cycles have lengths of $2 \cdot n$ rounds, $n \geq 1$, the transmission cycle is determined by the length of the longest cluster cycle.

Transmission Phase (TP)

The period of time which is reserved for sending or receiving frames in a slot. The start of the TP is called Action Time.

Transmitter-Invalidated Frame

A frame which was transmitted by an SRU that considers itself not in the membership due to a clique scenario. Therefore the C-state contained in the frame (explicitly for I-frames, implicitly for N-frames) has the sender not set in the membership and the receivers mark the frame in the CNI accordingly.

Triple Modular Redundancy (TMR)

A TMR system will tolerate any single failure of any of its three components. TMR is needed to provide 'single fault' tolerance for fail-consistent components.

Valid Frame

A frame is valid if it has a syntactically correct frame format, i.e., it starts during the time window contained in the MEDL and does not violate any coding rules. A valid frame can still be incorrect if it was corrupted during transmission or if sender and receiver are in disagreement.

Virtual Member SRU

A virtual member SRU consists of a set of multiplexed SRUs that share a single SRU slot.

Glossary of Terms and Acronyms

Page 15

2. Abbreviations and Acronyms

AR	Allow external rate correction
BA	Bus Guardian Arm
BG	Bus Guardian
BIST	Built-In Self-Test
BL	Bus Guardian Lifesign
BR	BIST Result interrupt
C-State	Controller State
CA	Controller Await
CB	Communication Blackout
CCF	Concurrency Control Field
CE	Clique Error
CF	Cold Start Allowed Flag
Ch0	Channel 0
Ch1	Channel 1
CIA	Cold-start Integration Allowed flag
ClkSyn	Clock Synchronization Slot (formerly known as CS)
CNI	Basic Communication Network Interface
CO	Controller On
CR	Controller Ready interrupt
CRC	Cyclic Redundancy Check
CTS	Clear To Send
DAFL	Data Field Length
DC	Download Completed
DMC	Deferred Mode Change
DPRAM	Dual-Ported Random Access Memory
EOC	End of Cluster Cycle
EOR	End of Round
EOT	End of Transmission Cycle
FTU	Fault-Tolerant Unit
FTU CNI	FTU Communication Network Interface
HE	Host Error interrupt
I-Frame	Initialization Frame
ID	Identifier
IF	I-Frame Flag
IFG	Inter-Frame Gap
IMC	Immediate Mode Change
LSB	Least Significant Bit
MC	MEDL Check Error
MCB	Mode Control Block

Glossary of Terms and Acronyms

Page 16

MCP	Mode Change Permissions
ME	Membership Error
MEDL	Message Descriptor List
MEMB(A)	Value of the Membership Flag of A
MFC	Membership Failure Counter
MFM	Modified Frequency Modulation
ML	Membership Loss interrupt
MM	Multiplexed slot with Mixed membership
MMFC	Maximum Membership Failure Count
MO	Multiplexed slot with Own membership
MOC	Mode Change interrupt
MSB	Most Significant Bit
MSC	Membership Changed interrupt
Mux	Multiplex Flag
MV	Mode Violation
NBW	Non-Blocking Write Protocol
NE	Non-Blocking Write Error
NR	Frame Not Ready Error
N-Frame	Normal Frame
OS	Operating System
PE	Protocol Error interrupt
PRP	Post-Receive Phase
PS	Passive role
PSP	Pre-Send Phase
RA	Reintegration Allowed
RC Layer	Reconfiguration Layer
RE	Reconfiguration Error
RS	Reception Status, Ready Status
SAE	Society for Automotive Engineers
SE	Synchronization Error
SO	Slot Occupied
SRU	Smallest Replaceable Unit
SYF	Synchronization Frame
TI	Time Interrupt
TDMA	Time Division Multiple Access
TMR	Triple Modular Redundancy
TP	Transmission Phase
TTA	Time-Triggered Architecture
TTP	Time-Triggered Protocol
U1	User defined interrupt 1
U2	User defined interrupt 2