DASAN Networks

GPON Standard G.984.4 OMCI

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Overview about OMCI

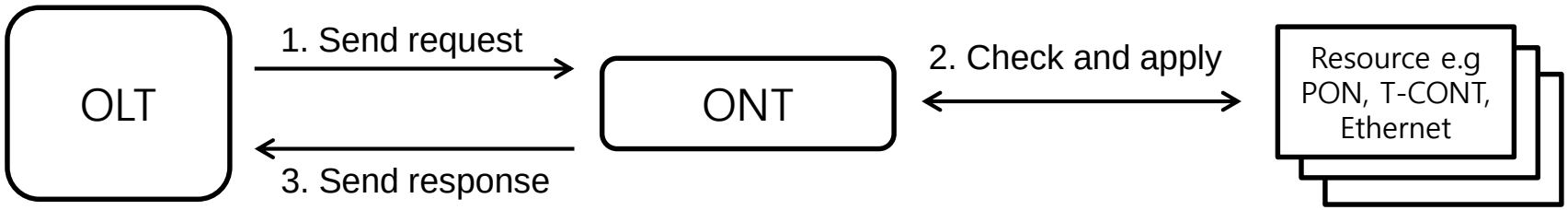
Overview about OMCI

- Different vendors exist in market place
- Existing deployment of ONTs: Customers currently have ONTs deployed. Swapping ONTs is not a practical task.
- Different customer preferences: Customers have changing requirements, making the need to be flexible to add newer services and ONT models to supported portfolio
- Managing ONTs should be seamless when adding new services

→ All vendors must use a standard to manage ONTs

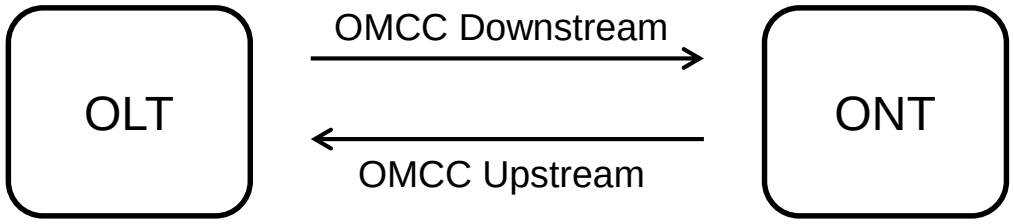
ONT management and control interface

- ONT management and control interface for G-PON system
  - Defined in ITU-T G.984.4 and G.983.3 to enable multi-vendor interoperability between the OLT and the ONT
- Purpose:
  - Configuration management
  - Fault management
  - Performance management
  - Security management

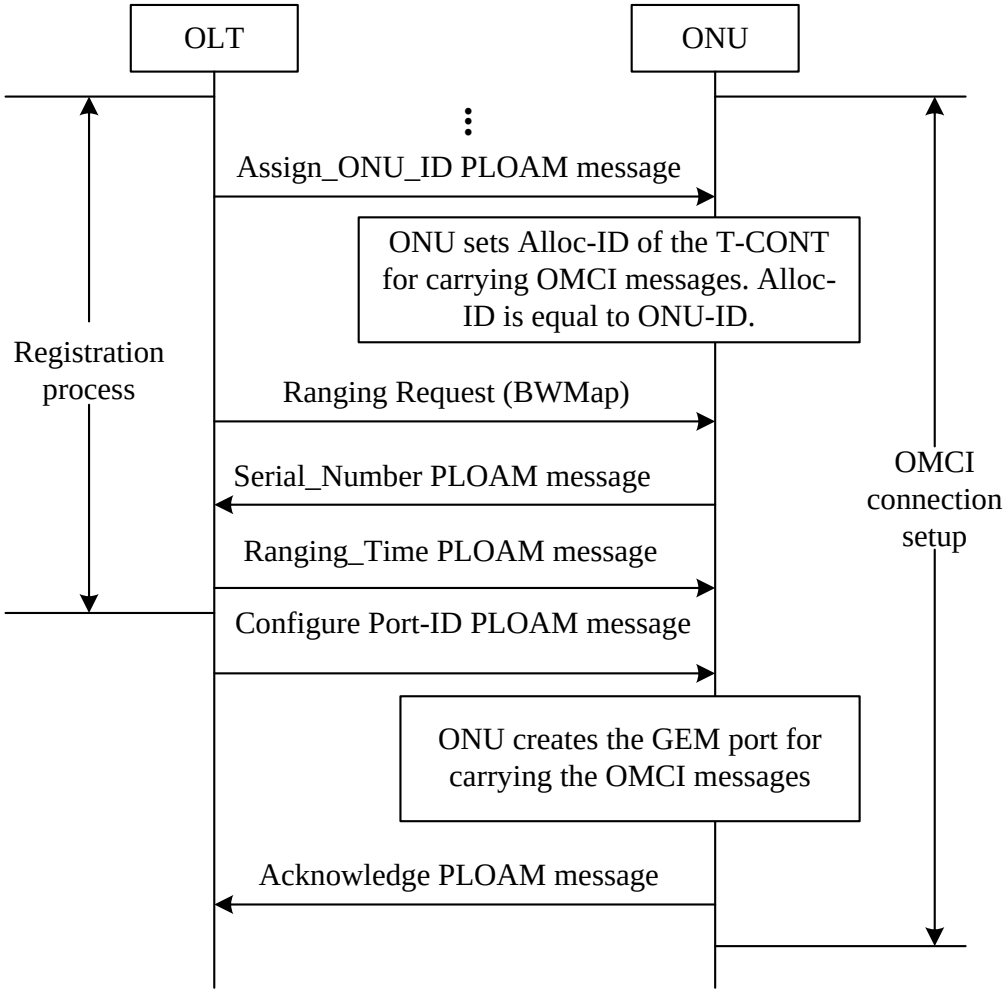


ONT Management and Control Channel (OMCC)

- OMCC provides the communication channel for OMCI
- The OMCC is set up as part of the ONU discovery process
- A GEM connection shall be provisioned for the OMCC via a PLOAM message that activates a dedicated GEM PortID between the OLT and ONT
- The OMCC performance requirements :
  - The upstream traffic on each OMCC should not exceed x bandwidth, where x is based on the operator's requirement.
  - An upstream OMCC packet should always be put in the high priority queue
  - Response time
    - High priority protocol < 1 s
    - Low priority protocol < 3 s



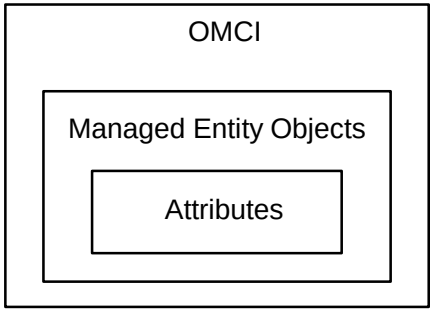
OMCC Establishment



Management Information Base (MIB)

Why we need MIB?

- The OMCI should be defined to allow vendors to offer modular, incremental capabilities to meet different levels of customer needs
- A protocol-independent MIB is used to describe the exchange of information across the OMCI
- The protocol-independent MIB is defined in terms of *managed entities* (MEs)
  - The MEs are abstract representations of resources and services in an ONT such as serial number, parameters of its resident software images…



Managed Entities Levels

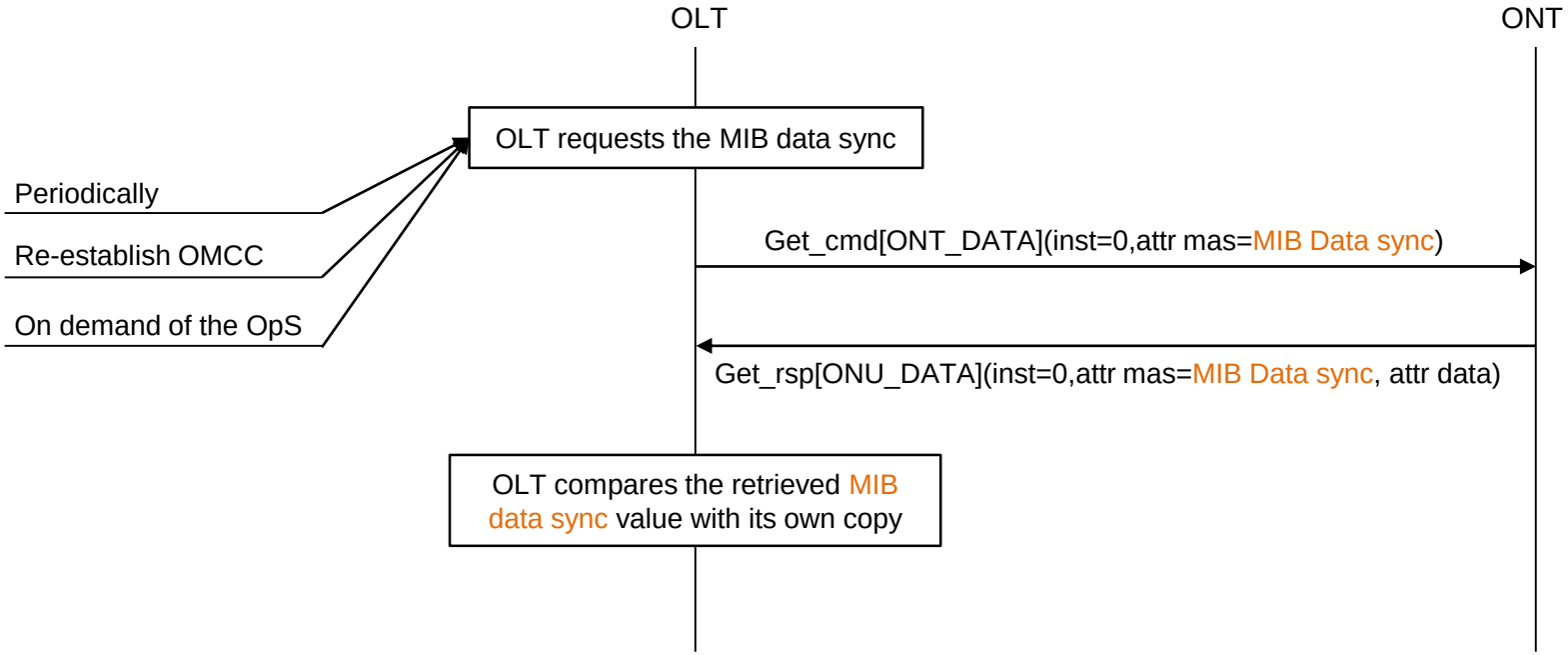
- There are three levels for indicating the degree of compliance necessary for specific functions and managed entities associated with the OMCI specification
  - **Requirement (R)**: Entities necessary for operational compatibility
  - **Conditional requirements (CR)**: Entities necessary when the specified optional function is implemented
  - **Option (O)**: Entities that may be useful and required by an operator but that are not necessary for operational compatibility

Managed Entity of the OMCI

Managed entity	Required/ optional	Description
T-CONT	R	T-CONT
VoIP line status	O	Used for VoIP line status that relates to a POTS port. Member of VoIData group
ONT data	R	Used for OMCI MIB management
Network address	CR	Used to bind a network address (URI, IP address) to its associated security method. Member of IPHostData group
GEM port performance monitoring history data	O	Used for GEM port performance monitoring
Cardholder	CR	Used for a circuit pack plug-in slot
IP route table	CR	Used for IP router supported by the ONT
ANI-G	R	Used for ANI management
…	…	…

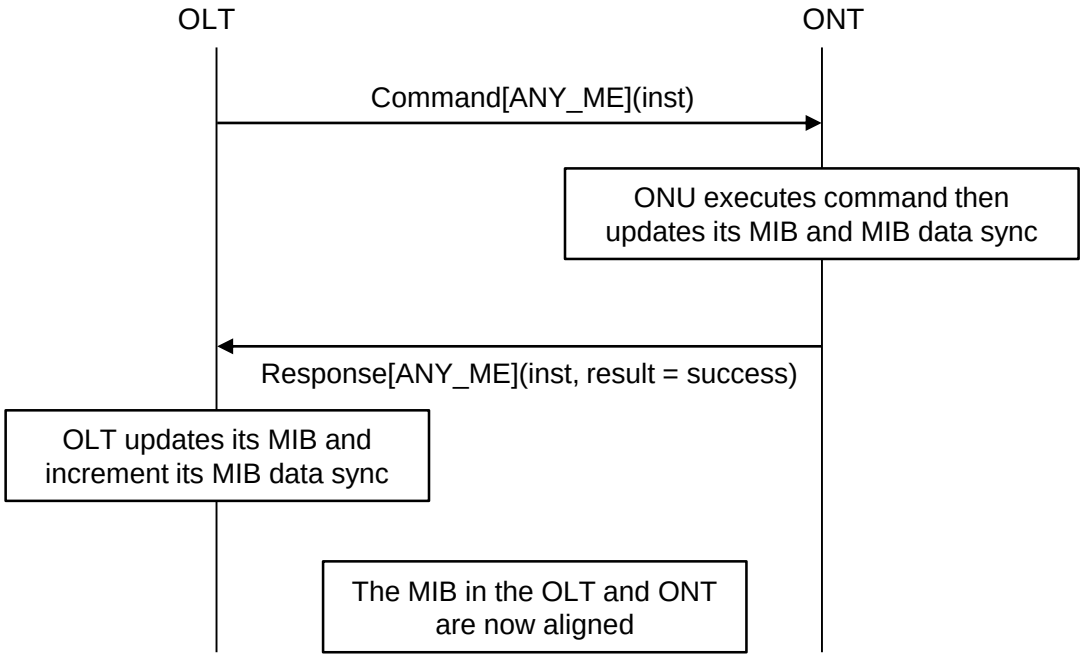
MIB Synchronization

- The MIB at OLT and the instances of the MEs in ONT have to be synchronized at all times
- The MIB data sync number in OLT and ONT does provide the way to examine MIB sync condition
  1. OLT retrieves the MIB data sync number of ONT Data in ONT
  2. Compares the number against its own for ONT
  3. OLT may start MIB resynchronization process if there is a difference. Otherwise, no further action is needed

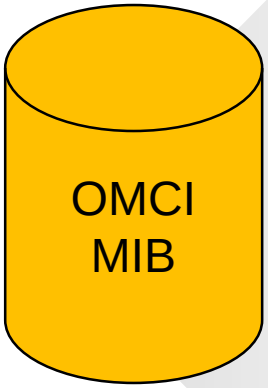


MIB Data Sync

- The MIB data sync attribute is a global *eight-bit* sequence number
- Both the OLT and the ONT must locally update the MIB and increment the MIB data sync as one atomic action
- When incremented, the sequence number that follows 255 is 1
- MIB Data Sync number 0x00 is used for:
  - Default MIB with which the ONT left the factory
  - An ONT which after (re-)initialization cannot restore its MIB



Example of ONT MIB



ONT DATA

Attribute	*Value*	*Description*	*Bytes*
Managed Entity ID	0x0	One instance	2
MIB Data Sync	0		1

Software Image

Attribute	*Value*	*Description*	*Bytes*
Managed Entity ID	0x000{0/1}	Two instance	2
Version	Obtained	-	14
Is committed	Obtained	Not allow both software Images to be committed at the same time	1
Is active	Obtained		1
Is valid	Obtained	-	1

T-CONT

Attribute	*Value*	*Description*	*Bytes*
Managed Entity ID	Format of 0xSSBB: SS = PON slot BB = T-CONT ID	OAL_T-CONT_MAX_COUNT instances	2
Alloc-ID	Assigned by OLT	Must match the value in D/S Assign Alloc-ID	2
Mode Indicator	1:GEM mode	-	1
Policy	HOL or WRR	-	1

ONT Management and Control Protocol

OMCI PDU Format

- ONT management and control protocol packet format

GEM/ATM header (5 bytes)	Transaction correlation identifier (2 bytes)	Message type (1 byte)	Device identifier (1 byte)	Message Identifier (4 bytes)	Message contents (32 bytes)	OMCI trailer (8 bytes)

- 53 bytes for ATM/GEM modes

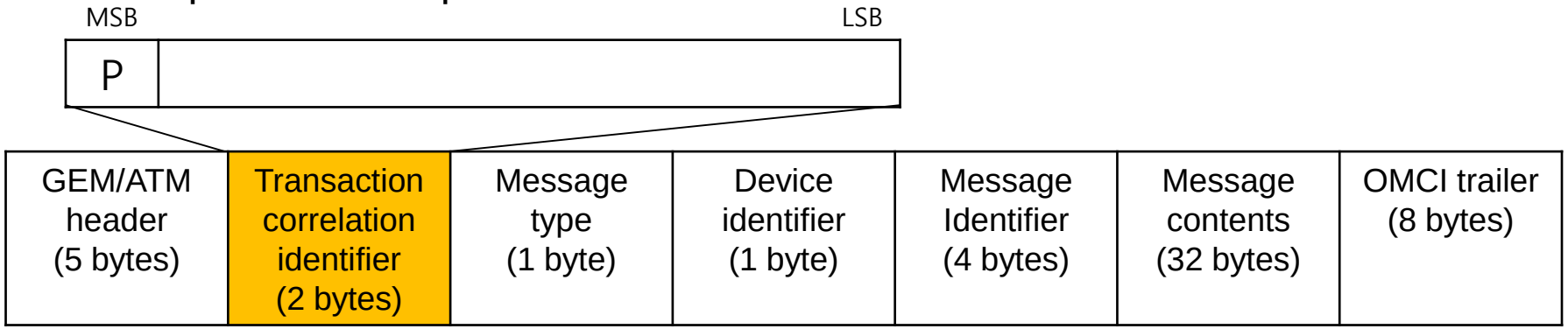
ATM/GEM Header

- The ATM/GEM header contains the VPI/VCI or the PortID value of OMCC for ONT

GEM/ATM header (5 bytes)	Transaction correlation identifier (2 bytes)	Message type (1 byte)	Device identifier (1 byte)	Message Identifier (4 bytes)	Message contents (32 bytes)	OMCI trailer (8 bytes)

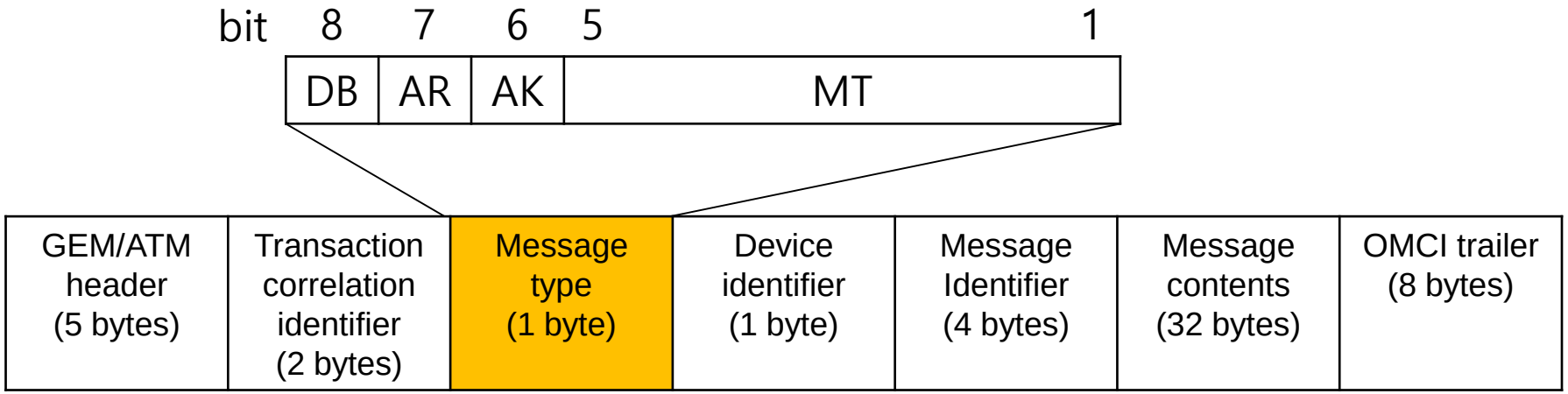
Transaction Correlation Identifier

- Purpose: Associate a request message with its response message
- Request message
  - OLT selects a transaction ID
- Response message
  - Carries transaction ID of the request
- The transaction identifier of event messages is 0x0000
- MSB of Transaction correlation ID indicates the priority of the message
  - 0: low priority (in range of 0x000 ~ 0x7FFF)
  - 1: high priority (in range of 0x8000 ~ 0xFFFF)
- Rest of bits are not standardized, left to the implementers
- Response match problem



Message Type

- MSB bit is **Destination Bit (DB)**, in OMCI this bit is always 0
- **Acknowledge request (AR)**, indicates whether or not the message requires an acknowledgement
- **Acknowledgement (AK)**, indicates whether or not this message is an acknowledgement to an action request
- **Message type (MT)**, indicate the message type



OMCI Message Type Table

MT	Type	Purpose	AK	Inc MIB data sync.
4	Create	Create a managed entity instance with its attributes	yes	yes
5	Create complete connection	Deprecated	–	–
6	Delete	Delete a managed entity instance	yes	yes
7	Delete complete connection	Deprecated	–	–
8	Set	Set one or more attributes of a managed entity	yes	yes
9	Get	Get one or more attributes of a managed entity	yes	no
10	Get complete connection	Deprecated	–	–
11	Get all alarms	Latch the alarm statuses of all managed entities and reset the alarm message counter	yes	no
12	Get all alarms next	Get the active alarm status of the next managed entity	yes	no
13	MIB upload	Latch the MIB	yes	no
14	MIB upload next	Get latched attributes of a managed entity instance	yes	no
15	MIB reset	Clear the MIB and re-initialize it to its default and reset the MIB data sync counter to 0	yes	no
16	Alarm	Notification of an alarm	no	no

OMCI Message Type Table (cont'd)

MT	Type	Purpose	AK	Inc MIB data sync.
17	Attribute value change	Notification of an autonomous attribute value change	no	no
18	Test	Request a test on a specific managed entity	yes	no
19	Start software download	Start a software download action	yes	yes
20	Download section	Download a section of a software image	yes/no	no
21	End software download	End of a software download action	yes	yes
22	Activate software	Activate the downloaded software image	yes	yes
23	Commit software	Commit the downloaded software image	yes	yes
24	Synchronize Time	Synchronize the time between OLT and ONT	yes	no
25	Reboot	Reboot ONT or circuit pack	yes	no
26	Get next	Get the latched attribute values of the managed entity within the current snapshot	yes	no
27	Test result	Notification of test result that is initiated by "Test"	no	no
28	Get current data	Get current counter value associated with one or more attributes of a managed entity	yes	no

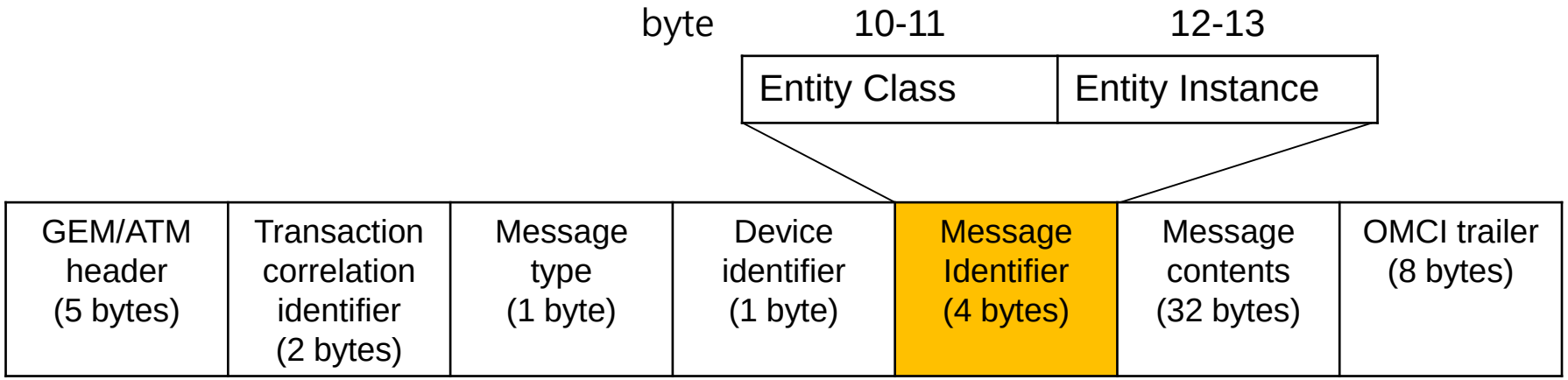
Device Identifier

- For system defined in G.984.3, this field is defined as 0x0A

GEM/ATM header (5 bytes)	Transaction correlation identifier (2 bytes)	Message type (1 byte)	Device identifier (1 byte)	Message Identifier (4 bytes)	Message contents (32 bytes)	OMCI trailer (8 bytes)

Message Identifier

- Two bytes MSB indicate which managed entity (ME) is target
  - Profile, history data, T-CONT, 802.11, ATM, Ethernet, ADL …
  - 280 kinds of ME listed, 65535 maximum
- Two bytes LSB identify managed entity instance
  - Depending on the ME, there will be only one or several instance in an ONT



Managed Entity Identifiers

- This table contains all the managed entities ever standardized for OMCI, including G.983 series and ATM features

Managed entity class	Managed entity
1	ONTB-PON
2	ONT data
3	PON IF line cardholder
4	PON IF line card
5	Cardholder
6	Circuit pack
7	Software image
8	UNIB-PON
9	TC Adapter B-PON
10	Physical path termination point ATM UNI
…	…
172..239	Reserved for future B-PON managed entities
240-255	Reserved for vendor-specific managed entities
256	ONT-G
…	…
312	FEC performance monitoring history data
313-65279	Reserved for future standardization
65280-65535	Reserved for vendor-specific use

DASAN Private OMCI List

Managed entity class	Managed entity
240	ONT System Management
241	IGMP PM Data
243	ONT Switch Control
244	ONT Self-loop Detection
245	ONT System Condition
246	Optic Module Info
247	UNI Link Info
248	Optic Module DDM
249	ONT RF Data
250	Software Real Image
…	…
65300	ONU Extended Multicast Config
65302	ONU Boot config
65303	ONU Traffic Management Policy
65304	ONU File Auto Provisioning
65305	PPPoE Status
65306	RF Band Info

More details: http://wiki.dasannetworks.com/display/GPON/DASAN+Private+OMCI+List

Message Contents

- The layout of the message contents field is message-specific, including 4 types:
  - Get, get response, create response and set messages
  - Alarm notifications
  - Test, test response and test result
  - Result and reason

GEM/ATM header (5 bytes)	Transaction correlation identifier (2 bytes)	Message type (1 byte)	Device identifier (1 byte)	Message Identifier (4 bytes)	Message contents (32 bytes)	OMCI trailer (8 bytes)

Get, get response, create response and set messages

- Attribute mask coding
- This bit map indicates which attributes are requested (get) or provided (get response and set)

Byte	Bit							
	8	7	6	5	4	3	2	1
1	Attr. 1	Attr. 2	Attr. 3	Attr. 4	Attr. 5	Attr. 6	Attr. 7	Attr. 8
2	Attr. 9	Attr. 10	Attr. 11	Attr. 12	Attr. 13	Attr. 14	Attr. 15	Attr. 16

Attribute mask coding

Software Image

Attribute	***Value***	***Description***	***Bytes***	***Attr. num***
Managed Entity ID	0x000{0/1}	Two instance	2	
Version	Obtained	-	14	1
Is committed	Obtained	Not allow both software Images to be committed at the same time	1	2
Is active	Obtained		1	3
Is valid	Obtained	-	1	4
				5~16 as N/A

Get, get response, create response and set messages

Byte	Bit							
	8	7	6	5	4	3	2	1
1	Attr. 1	Attr. 2	Attr. 3	Attr. 4	Attr. 5	Attr. 6	Attr. 7	Attr. 8
2	Attr. 9	Attr. 10	Attr. 11	Attr. 12	Attr. 13	Attr. 14	Attr. 15	Attr. 16

Message contents										
	14									MS byte attribute mask
	15									LS byte attribute mask
	16									Attribute value of first attribute to set (size depending on the type of attribute)
										…
										Attribute value of last attribute to set (size depending on the type of attribute)
	xx-45	0	0	0	0	0	0	0	0	Padding

byte 14 45

GEM/ATM header (5 bytes)	Transaction correlation identifier (2 bytes)	Message type (1 byte)	Device identifier (1 byte)	Message Identifier (4 bytes)	Message contents (32 bytes)	OMCI trailer (8 bytes)

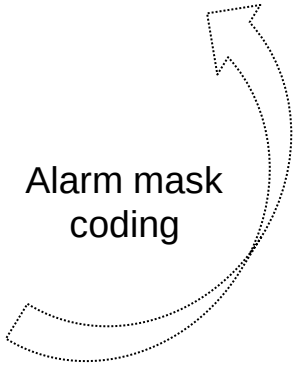
Alarm notifications

- Alarm mask coding
- Support up to 224 kinds of alarms.

Byte	Bit							
	8	7	6	5	4	3	2	1
1	Alarm 1	Alarm 2	Alarm 3	Alarm 4	Alarm 5	Alarm 6	Alarm 7	Alarm 8
2	Alarm 9	Alarm 10	Alarm 11	Alarm 12	Alarm 13	Alarm 14	Alarm 15	Alarm 16
…								
28	Alarm 216	Alarm 217	Alarm 218	Alarm 219	Alarm 220	Alarm 221	Alarm 222	Alarm 223

Example of Cardholder

Number	Alarm	Description
0	Plug-in LIM missing alarm	Configured circuit pack is not present. If the plug-in LIM missing alarm is active, none of the mismatch alarms are declared.
1	Plug-in type mismatch alarm	Inserted circuit pack is wrong type
2	Improper card removal	Circuit pack has been removed without being de-provisioned. This is a redundant alarm that helps the OLT distinguish between transitions from state S2 to state S1 (Figure 9.1.5-1) and transitions from state S4 to state S1. This alarm is sent only when a transition occurs from state S2 to state S1.
3	Plug in equipment id mismatch alarm	Inserted circuit pack has wrong equipment ID
4	Protection switch	An autonomous equipment protection switch has occurred. This notification is reported by the protected cardholder.
5..207	Reserved	
208..223	Vendor-specific	Not to be standardized



Result and Reason

- Responses to commands can indicate the result of the command
  - NULL: command was processed successfully
  - Non-NULL: the reason of the failure
- The definition of each result and reason is as follows
  - command processed successfully
  - command processing error
  - command not supported
  - parameter error
  - unknown managed entity
  - unknown managed entity instance
  - device busy
  - attributes failed or unknown

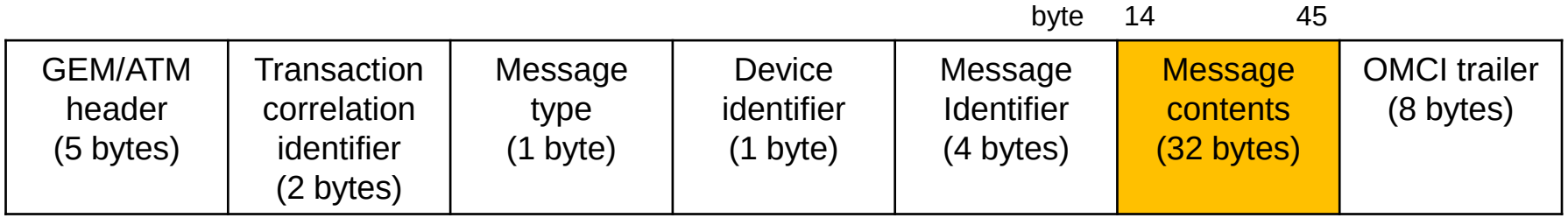
Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	14	0	0	0	0	X	X	X	x	Result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy 1001 = attribute(s) failed or unknown
	…									…

byte 14 45

GEM/ATM header (5 bytes)	Transaction correlation identifier (2 bytes)	Message type (1 byte)	Device identifier (1 byte)	Message Identifier (4 bytes)	Message contents (32 bytes)	OMCI trailer (8 bytes)

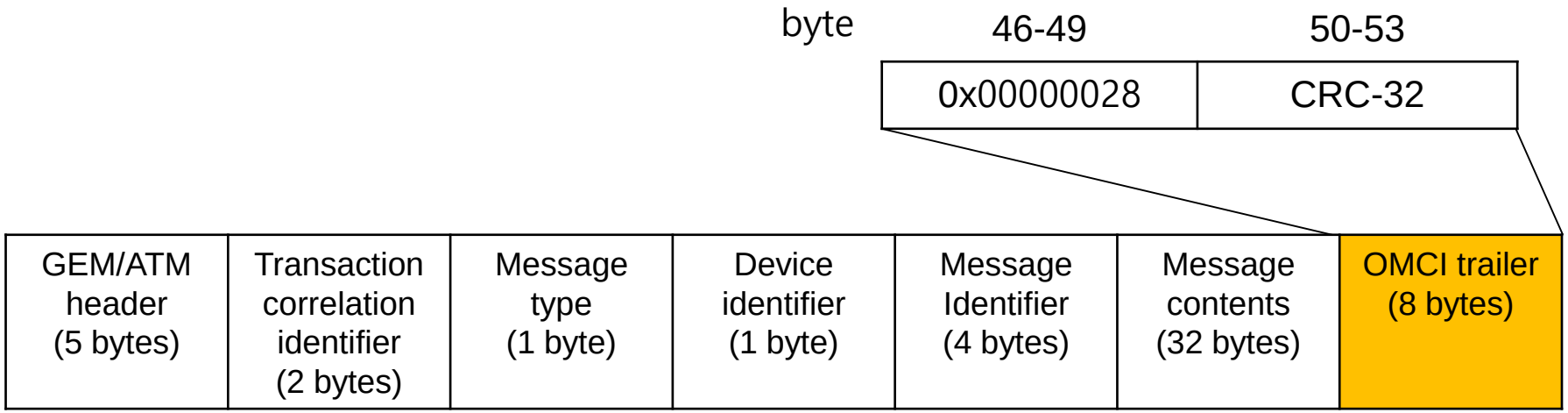
Test, test response and test result

- Each ME that supports tests needs to have an action test defined for it
- The test response message is an indication to the OLT that the test request is received and is being processed
- The results of a requested test are sent to the OLT via a specific test result message (only pass-fail results)
  - Notification is sent to the OLT via an alarm in case of failure



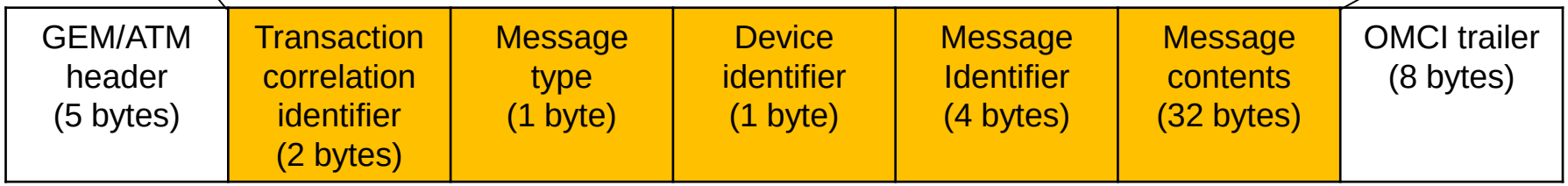
OMCI Trailer

- 4 bytes MSB is fixed: 32’h 00000028
- 4 bytes LSB is 32-bit CRC
  - Specified in ITU-T I.363.5



Message Layout Example – Delete Response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = delete
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10-11									Entity class
	12									MS byte entity instance
	13									LS byte entity instance
Message contents	14									Result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	15-45	0	0	0	0	0	0	0	0	Padding



OMCI Size Limitation

- The OMCI imposes limits on the size of the message payloads (32 bytes)
- It is important that all MEs are defined such that they fit into the G-PON limits

Item	Limited by	G-PON limit
Total size of Set-by-create attributes (including ME ID)	Create	34
Size of (R) or (R,W) simple attribute	Get response	25
Size of (R) or (R,W) table entry	Set	30
Total size of a get	Get response	25
Total size of a get current data	Get current data response	25

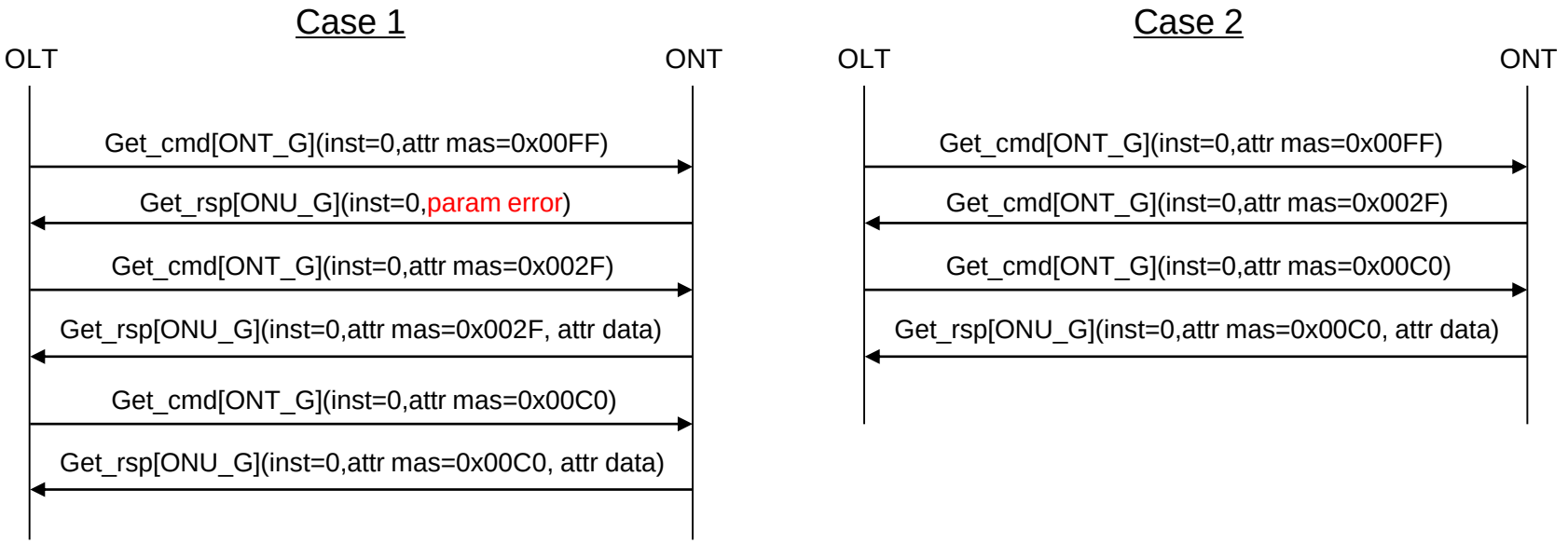
OMCI Size Limitation (cont'd)

- Example: The OLT forms a "get" command that asks the ONT to return all attributes data of ONT_G (total is: 31 bytes) that is rather the space in the response message (max: 25 bytes)

Byte	Bit							
	8	7	6	5	4	3	2	1
1	Attr. 1	Attr. 2	Attr. 3	Attr. 4	Attr. 5	Attr. 6	Attr. 7	Attr. 8
2								

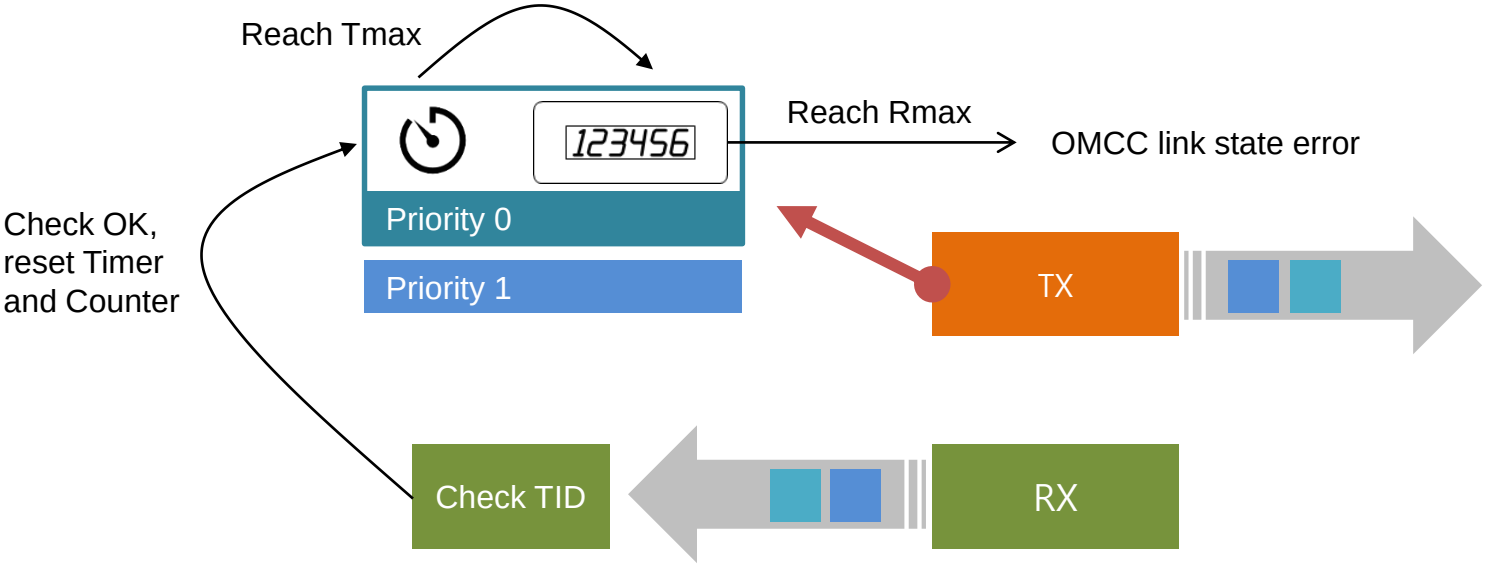
ONT-G

Attribute	*Bytes*	*Attr. Num*
Managed Entity ID	2	
Vendor ID	4	1
Version	14	2
Serial number	8	3
Traffic Management Option	1	4
VP/VC cross-connection function	1	5
Battery Backup	1	6
Administrator State	1	7
Operational State	1	8

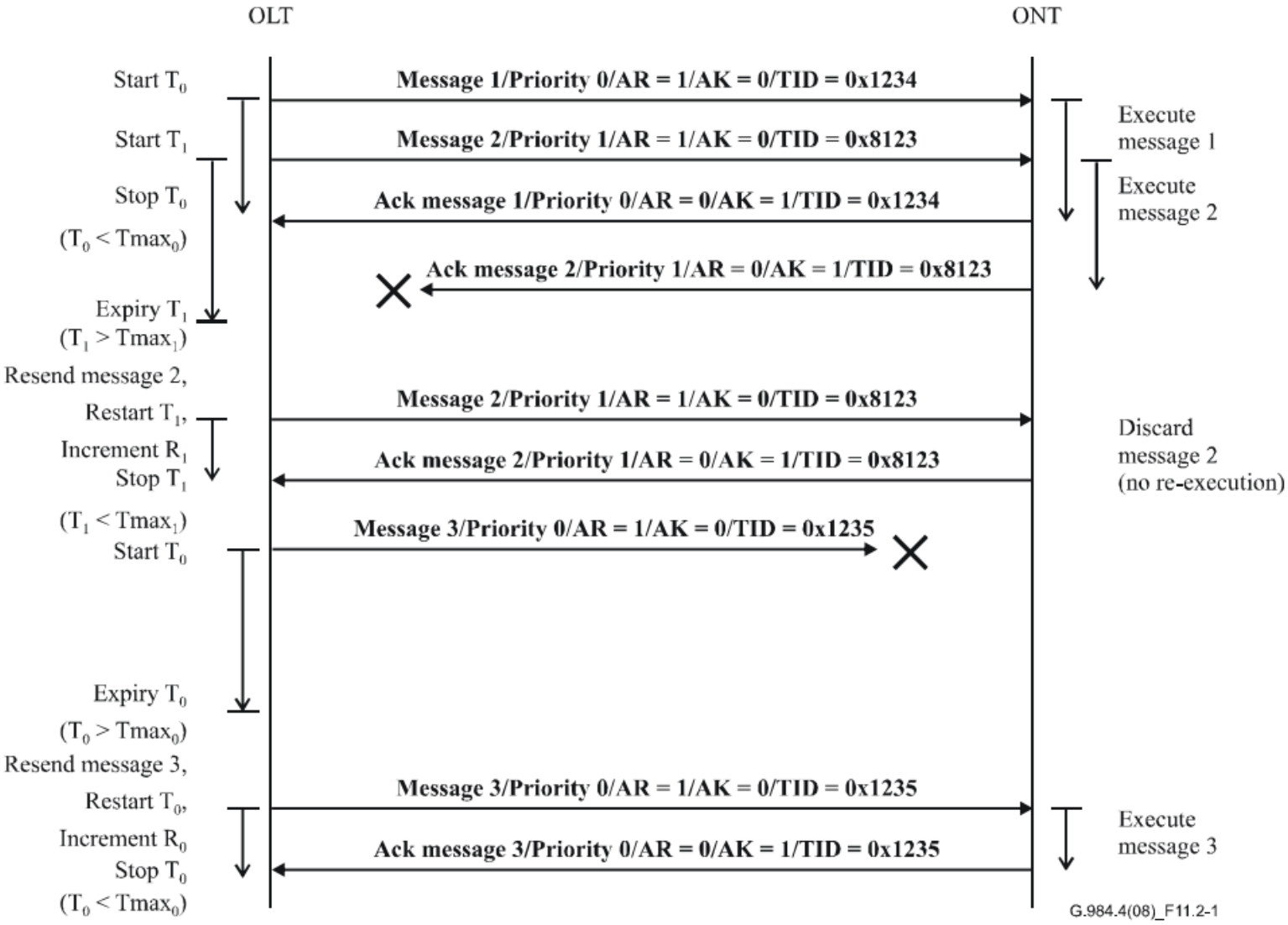


Message flow control and error recovery

- Using a simplex acknowledged transaction stop-and-wait mechanism
- Ensure that a low level acknowledged transaction request transmitted from the OLT has been properly received and processed to completion by the ONT before the next message of the same priority level is sent by the OLT
- The stop-and-wait protocol uses
  - Transaction correlation identifier - TID
  - Transaction request timers - T_i with expiration time $Tmax_i$
  - Retry counters - R_i with maximum retry value $Rmax_i$

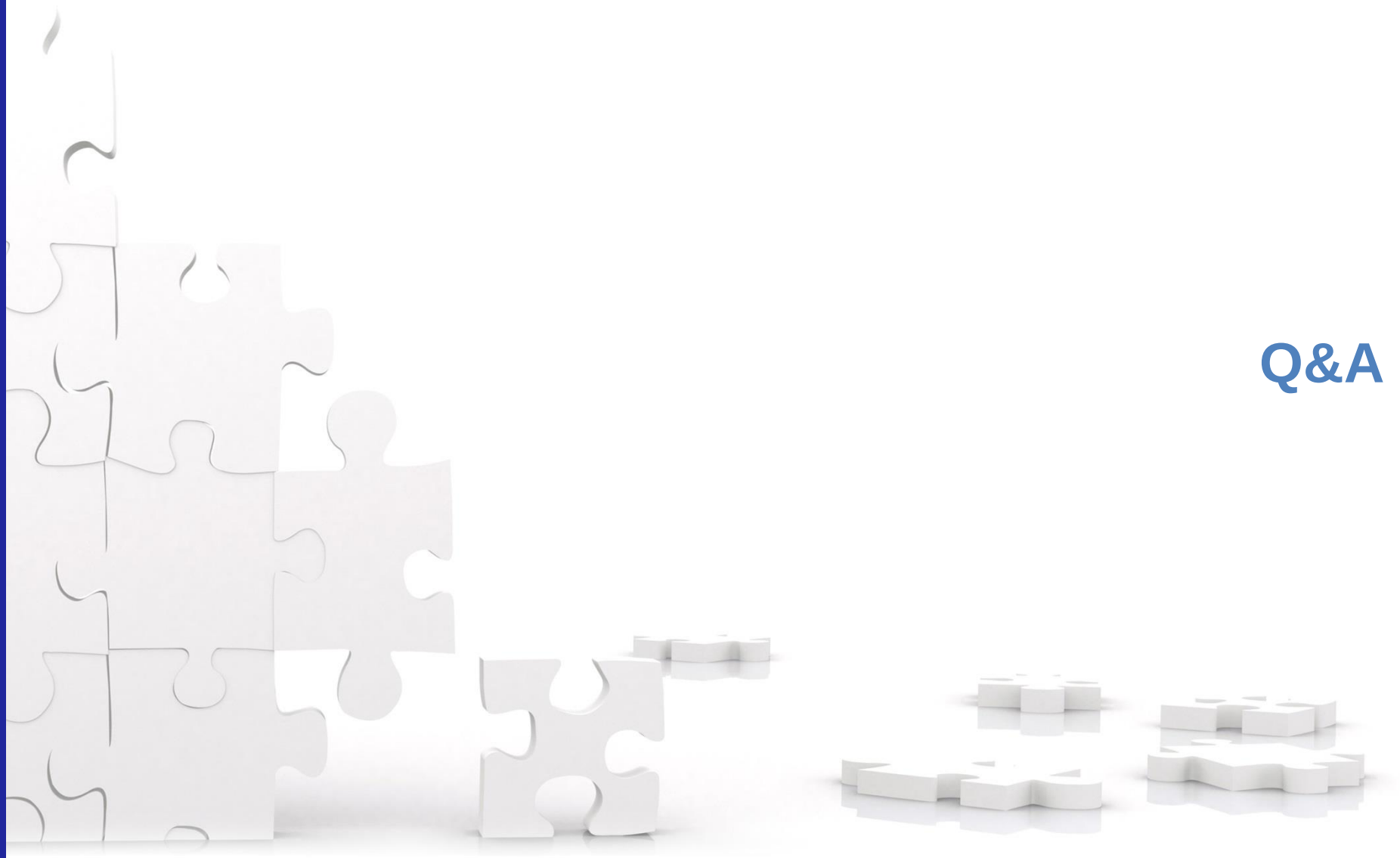


Message flow control and error recovery



Reference

- T-REC-G.Imp984.4-200910 - G.984.4 Implementer's Guide document
- Optical network terminal management and control interface (OMCI) containing a description of the OMCI Patent, US8121479 B2
- Gigabit-Capable Passive Optical Networks, 448 pages, D. Hood
- ITU-T Recommendation G.984.4 slides: http://www.cs.nthu.edu.tw/~ctchiu/meeting/gpon/9844-2.pdf



Q&A

Thank You