

144.3.3 Discovery processing

Discovery is the process whereby newly connected or off-line ONUs are provided access to the PON. The process is driven by the OLT, which periodically makes available Discovery Windows during which off-line ONUs are given the opportunity to make themselves known to the OLT. The periodicity of these windows is unspecified and left up to the implementer. The OLT signifies that a discovery period is occurring by broadcasting a DISCOVERY GATE MPCPDU, which includes the starting time and length of the discovery window, along with the *Discovery Information* field, as defined in 77.3.6.1. With the appropriate settings of individual flags contained in this 16 bit wide field, the OLT notifies all the ONUs about its upstream and downstream channel transmission capabilities. Note that the OLT may simultaneously support more than one data rate in the given transmission direction.

Off-line ONUs, upon receiving a DISCOVERY GATE MPCPDU, wait for the period to begin and then transmit a REGISTER_REQ MPCPDU to the OLT. Discovery windows are unique in that they are the only times when multiple ONUs can access the PON simultaneously, and transmission overlap can occur. In order to reduce transmission overlaps, a contention algorithm is used by all ONUs. Measures are taken to reduce the probability for overlaps by artificially simulating a random distribution of distances from the OLT. Each ONU waits a random amount of time before transmitting the REGISTER_REQ MPCPDU that is shorter than the length of the discovery window. Note that multiple valid REGISTER_REQ MPCPDUs can be received by the OLT during a single discovery window. Included in the REGISTER_REQ MPCPDU is the ONU's MAC address and number of maximum pending grants. Additionally, a registering ONU notifies the OLT of its transmission capabilities in the upstream and downstream channels by setting appropriately the flags in the Discovery Information field, as specified in 77.3.6.3.

Note that even though a compliant ONU is not prohibited from supporting more than one data rate in any transmission channel, it is expected that a single supported data rate for upstream and downstream channel is indicated in the Discovery Information field. Moreover, in order to assure maximum utilization of the upstream channel and to decrease the required size of the guard band between individual data bursts, the registering ONU notifies the OLT of the laser on/off times, by setting appropriate values in the Laser On Time and Laser Off Time fields, where both values are expressed in the units of 1 EQ.

Upon receipt of a valid REGISTER_REQ MPCPDU, the OLT registers the ONU, allocating and assigning a new port identity (LLID), and bonding a corresponding MAC to the LLID.

The next step in the process is for the OLT to transmit a REGISTER MPCPDU to the newly discovered ONU, which contains the ONU's LLID, and the OLT's required synchronization time. Moreover, the OLT echoes the maximum number of pending grants. The OLT also sends the target value of laser on time and laser off time, which may be different than laser on time and laser off time delivered by the ONU in the REGISTER_REQ MPCPDU.

The OLT at that time has enough information to schedule the ONU for access to the PON and transmits a standard GATE MPCPDU allowing the ONU to transmit a REGISTER_ACK MPCPDU. Upon receipt of the REGISTER_ACK MPCPDU, the discovery process for that ONU is complete, the ONU is registered and normal message traffic can begin. It is the responsibility of Layer Management to perform the MAC bonding, and start transmission from/to the newly registered ONU. The discovery message exchange is illustrated in Figure 144–11.

There may exist situations when the OLT requires that an ONU go through the discovery sequence again and reregister. Similarly, there may be situations where an ONU needs to inform the OLT of its desire to deregister. The ONU can then reregister by going through the discovery sequence. For the OLT, the REGISTER MPCPDU may indicate a value, Reregister or Deregister, that if either is specified forces the receiving ONU into reregistering. For the ONU, the REGISTER_REQ MPCPDU contains the Deregister bit that signifies to the OLT that this ONU needs to be deregistered.

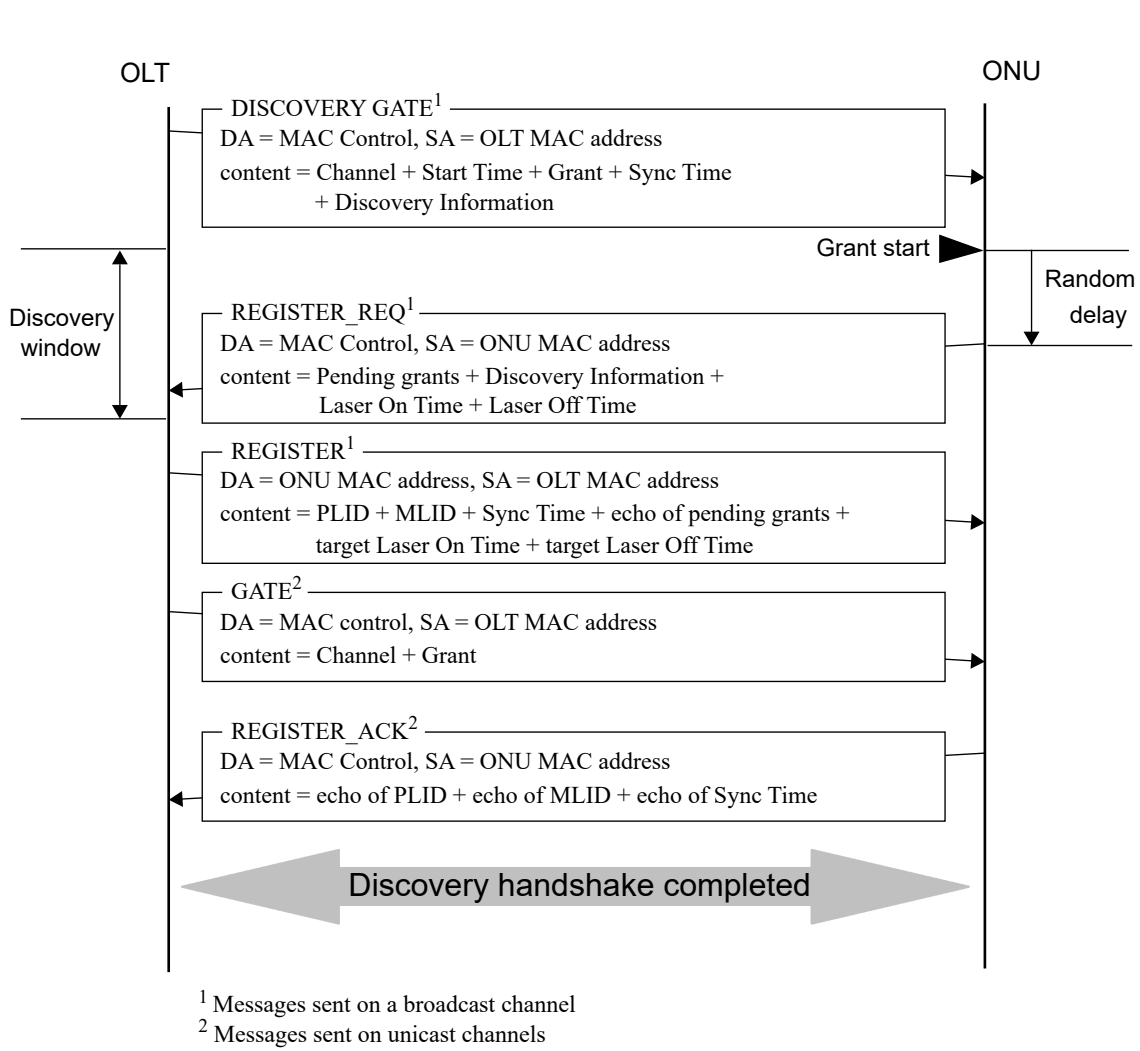


Figure 144-11—Discovery handshake message exchange

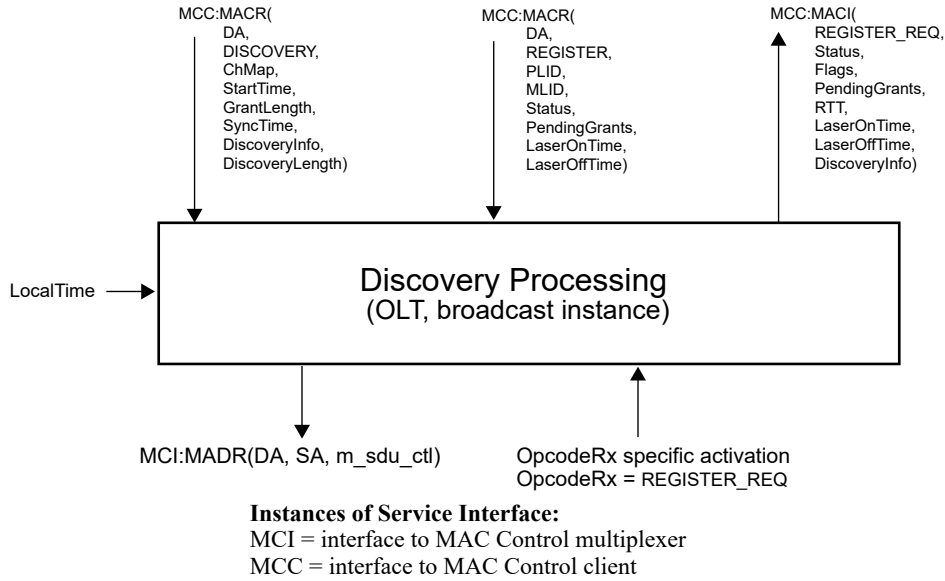


Figure 144-12—Discovery Processing service interfaces (OLT, broadcast instance)

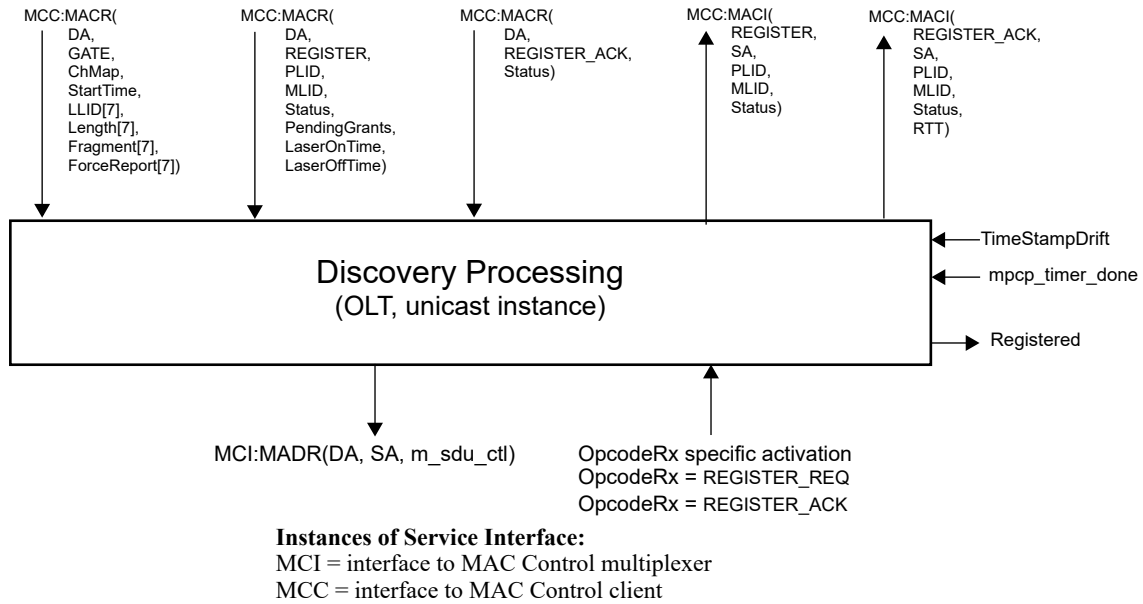
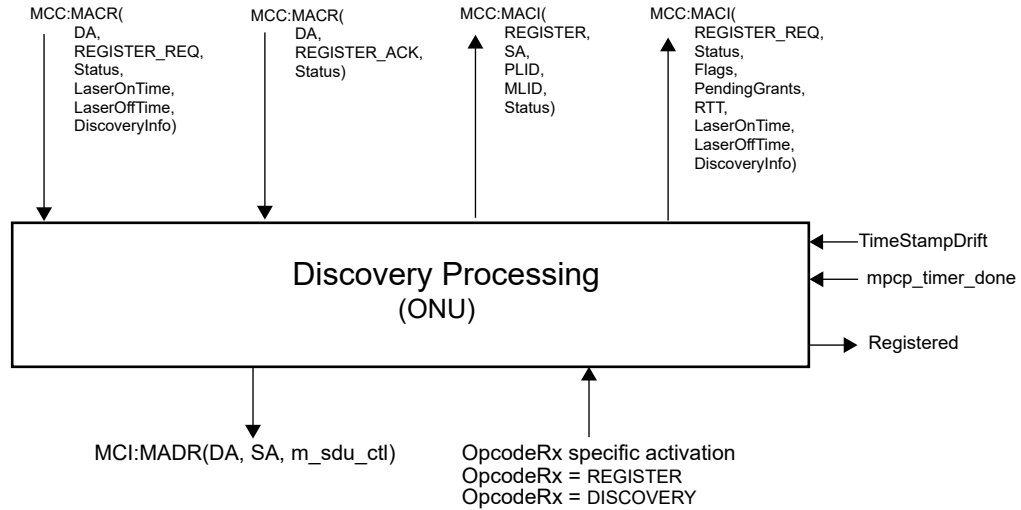


Figure 144-13—Discovery Processing service interfaces (OLT, unicast instance)

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Instances of Service Interface:
 MCI = interface to MAC Control multiplexer
 MCC = interface to MAC Control client

Figure 144–14—Discovery Processing service interfaces (ONU)

144.3.3.1 Constants

LaserOffTimeCapability

TYPE: 8-bit unsigned

This constant represents the time required to terminate the laser, in the units of 1 EQ. While the default value corresponds to a maximum allowed T_{off} (as specified in Table 75–8 and Table 75–9), implementations may set it to the actual value time period required for turning off the PMD, as specified in 75.7.14.

VALUE: 0xC8 (512 ns, default value)

LaserOnTimeCapability

TYPE: 8-bit unsigned

This constant represents the time required to initialize the laser, in the units of 1 EQ. While the default value corresponds to a maximum allowed T_{on} (as specified in Table 75–8 and Table 75–9), implementations may set it to the actual value time period required for turning on the PMD, as specified in 75.7.14.

VALUE: 0xC8 (512 ns, default value)

144.3.3.2 Variables

BEGIN

This variable is defined in 144.2.2.3.

DataRx

This variable is defined in 144.2.2.3.

DataTx

This variable is defined in 144.2.2.3.

GrantEndTime

TYPE: 32-bit unsigned

This variable holds the time at which the OLT expects the ONU grant to complete. Failure of a REGISTER_ACK message from an ONU to arrive at the OLT before <i>GrantEndTime</i> is a fatal error in the discovery process, and causes registration to fail for the specified ONU, who may then retry to register. The value of <i>GrantEndTime</i> is expressed in the units of 1 EQ.	1
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InsideDiscoveryWindow	6
TYPE: Boolean	7
This variable holds the current status of the discovery window. It is set to true when the discovery window opens, and is set to false when the discovery window closes.	8
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LaserOffTime	11
TYPE: 8-bit unsigned	12
This variable holds the time required to terminate the laser and counts the time period required for turning off the PMD, as specified by the value of T_{off} in 75.7.14, expressed in the units of 1 EQ.	13
VALUE: LaserOffTimeCapability (default value)	14
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LaserOnTime	17
TYPE: 8-bit unsigned	18
This variable holds the time required to initiate the PMD and counts the time period required for turning on the PMD, as specified by the value of T_{on} in 75.7.14, expressed in the units of 1 EQ.	19
VALUE: LaserOnTimeCapability (default value)	20
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LocalTime	23
This variable is defined in 144.2.2.2.	24
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m_sdu_ctl	26
This variable is defined in 144.2.2.3.	27
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OpcodeRx	29
This variable is defined in 144.2.2.3.	30
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PendingGrants	32
TYPE: 16-bit unsigned	33
This variable holds the maximum number of pending grants that an ONU is able to queue.	34
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Registered	36
TYPE: Boolean	37
This variable holds the current result of the Discovery Process. It is set to true once the discovery process is complete and registration is acknowledged.	38
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SyncTime	41
TYPE: 16-bit unsigned	42
This variable holds the time required to stabilize the receiver at the OLT. It counts 1 EQ units from the point where transmission output is stable to the point where synchronization has been achieved. The value of SyncTime includes gain adjustment interval ($T_{\text{receiver_settling}}$), clock synchronization interval (T_{CDR}), and code-group alignment interval ($T_{\text{code_group_align}}$), as specified in 75.7.14. The OLT conveys the value of SyncTime to ONUs in DISCOVERY GATE and REGISTER messages. During the synchronization time a 100G-EPON ONU transmits Synchronization Pattern (SP, see 76.3.2.5.2) followed by Burst Start (BS) delimiter pattern (BURST_DELIMITER, see 76.3.2.5.2).	43
Editor's Note (to be removed prior to publication): need to settle on terminology and names for delimiters_ start burst, burst StartTime, or something else. Also, should keep the end of burst delimiter named aptly and consistently, i.e., Burst End and not End of Burst as referred to right now in Clause	44
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76. Sync Time definition will need to be updated once the decision on the pattern distribution mechanism is reached.

TimeStampDrift

This variable is defined in 144.2.2.3.

144.3.3.3 Functions

None.

144.3.3.4 Timers

discovery_window_size_timer

This timer is used to wait for the event signaling the end of the discovery window.

VALUE: The timer value is set dynamically based on the parameters received in a DISCOVERY GATE message.

mcp_timer

This timer is used to measure the arrival rate of MPCP frames in the link. Failure to receive frames is considered a fatal fault and leads to deregistration.

144.3.3.5 Messages

MAC:MADI(DA, SA, m_sdu, receiveStatus)

The service primitive is defined in 2.3.2.

MAC:MADR (DA, SA, m_sdu)

The service primitive is defined in 2.3.2.

MCC:MACR(DA, DISCOVERY, ChMap, StartTime, GrantLength, SyncTime, DiscoveryInfo, DiscoveryLength)

The service primitive is used by the MAC Control client at the OLT to initiate the Discovery Process. This primitive accepts the following parameters:

- DA: Multicast or unicast MAC address.
- DISCOVERY: Opcode for DISCOVERY GATE MPCPDU as defined in Table 31A-1.
- ChMap: A bitmap representing the wavelength channel(s) on which to transmit on during the assigned transmission slot. See Table 144-1 for details.
- StartTime: Start time of the discovery window.
- GrantLength: Length of the grant given for discovery.
- SyncTime: The time interval required to stabilize the receiver at the OLT.
- DiscoveryInfo: This parameter represents the Discovery Information field in GATE MPCPDU as specified in 77.3.6.1, defining the speed(s) the OLT is capable of receiving and speed(s) at which the discovery window is opened for.
- DiscoveryLength: Length of the discovery window process.

MCC:MACR(DA, GATE, ChMap, StartTime, LLID[7], Length[7], Fragment[7], ForceReport[7])

This service primitive is used by the MAC Control client at the OLT to issue the GATE message to an ONU. This primitive accepts the following parameters:

- DA: Multicast MAC Control address as defined in Annex 31B.

GATE:	Opcode for GATE MPCPDU as defined in Table 31A–1.	1
ChMap:	A bitmap representing the wavelength channel(s) on which to transmit on during the assigned transmission slot. See Table 144–1 for details.	2 3 4
StartTime:	Represents the start time of the transmission grant. The start time is compared to the local clock, to correlate the start of the grant.	5 6 7
LLID[7]:	Represents the logical link that is being granted a transmission slot. Only elements <i>j</i> with non-zero value in associated <i>Length[j]</i> field of the array are used.	8 9 10
Length[7]:	Lengths of the individual grants. Only elements <i>j</i> with non-zero value in <i>Length[j]</i> field of the array are used.	11 12
Fragment[7]:	Flags indicating whether fragmentation is allowed within the given grant. Only elements <i>j</i> with non-zero value in associated <i>Length[j]</i> field of the array are used.	13 14 15
ForceReport[7]:	Flags indicating whether a REPORT message should be generated in the corresponding grant. Only elements <i>j</i> with non-zero value in associated <i>Length[j]</i> field of the array are used.	16 17 18 19
MCC:MACR(DA, REGISTER_REQ, Status, LaserOnTime, LaserOffTime, DiscoveryInfo)		20
	The service primitive is used by a client at the ONU to request the Discovery Process to perform a registration. This primitive accepts the following parameters:	21 22
DA:	Multicast MAC Control address as defined in Annex 31B.	23
REGISTER_REQ:	opcode for REGISTER_REQ MPCPDU as defined in Table 31A–1.	24 25
Status:	This parameter takes on the indication supplied by the flags field in the REGISTER_REQ MPCPDU as defined in Table 144–2.	26 27 28
LaserOnTime:	This parameter holds the LaserOnTime value, expressed in the units of 1 EQ, as reported by MAC client and specified in 77.3.6.3.	29 30 31
LaserOffTime:	This parameter holds the LaserOffTime value, expressed in the units of 1 EQ, as reported by MAC client and specified in 77.3.6.3.	32 33 34
DiscoveryInfo:	This parameter represents the Discovery Information field, as specified in 77.3.6.3, defining the speed(s) the ONU is capable of transmitting and speed(s) at which the registration attempt is made.	35 36 37 38 39
MCC:MACI(REGISTER_REQ, Status, Flags, PendingGrants, RTT, LaserOnTime, LaserOffTime, DiscoveryInfo)		40
	The service primitive is issued by the Discovery Process to notify the client and Layer Management that the registration process is in progress. This primitive accepts the following parameters:	41 42 43 44
REGISTER_REQ:	Opcode for REGISTER_REQ MPCPDU as defined in Table 31A–1.	45 46
Status:	This parameter holds one of the following values: <i>incoming</i> or <i>retry</i> . Value <i>incoming</i> is used at the OLT to signal that a REGISTER_REQ message was received successfully. The value <i>retry</i> is used at the ONU to signal to the client that a registration attempt failed and needs to be repeated.	47 48 49 50 51
Flags:	This parameter holds the contents of the <i>Flags</i> field in the REGISTER_REQ message. This parameter holds a valid value	52 53 54

	only when the primitive is generated by the Discovery Process in the OLT.	1
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PendingGrants:	This parameter holds the contents of the <i>Pending Grants</i> field in the REGISTER_REQ message. This parameter holds a valid value only when the primitive is generated by the Discovery Process in the OLT.	3
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RTT:	The measured round trip time to/from the ONU is returned in this parameter. RTT is expressed in the units of 1 EQ. This parameter holds a valid value only when the primitive is generated by the Discovery Process in the OLT.	7
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LaserOnTime:	This parameter holds the contents of the <i>Laser On Time</i> field in the REGISTER_REQ message. This parameter holds a valid value only when the primitive is generated by the Discovery Process in the OLT.	11
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LaserOffTime:	This parameter holds the contents of the <i>Laser Off Time</i> field in the REGISTER_REQ message. This parameter holds a valid value only when the primitive is generated by the Discovery Process in the OLT.	15
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DiscoveryInfo:	This parameter holds the contents of the <i>Discovery Information</i> field in the REGISTER_REQ MPCPDU. This parameter holds a valid value only when the primitive is generated by the Discovery process in the OLT.	19
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MCC:MACR(DA, REGISTER, PLID, MLID, Status, PendingGrants, LaserOnTime, LaserOffTime)		24
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	The service primitive is used by the MAC Control client at the OLT to initiate acceptance of an ONU. This primitive accepts the following parameters:	26
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DA:	Unicast MAC address or multicast MAC Control address as defined in Annex 31B.	28
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REGISTER:	Opcode for REGISTER MPCPDU as defined in Table 31A-1.	30
PLID:	This parameter holds the logical link identification number assigned by the MAC Control client to the PLID.	31
		32
MLID:	This parameter holds the logical link identification number assigned by the MAC Control client to the MLID.	33
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Status:	This parameter takes on the indication supplied by the <i>Flags</i> field in the REGISTER MPCPDU as defined in Table 144-4.	35
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PendingGrants:	This parameters echoes back the <i>Echoed Pending Grants</i> field that was previously received in the REGISTER_REQ message.	37
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LaserOnTime:	This parameter carries the target value of Laser On Time for the given ONU transmitter. This value may be different than the LaserOnTime value carried in the REGISTER_REQ MPCPDU received from the corresponding ONU MAC during Discovery stage.	40
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LaserOffTime:	This parameter carries the target value of Laser Off Time for the given ONU transmitter. This value may be different than the LaserOffTime value carried in the REGISTER_REQ MPCPDU received from the corresponding ONU MAC during Discovery stage.	45
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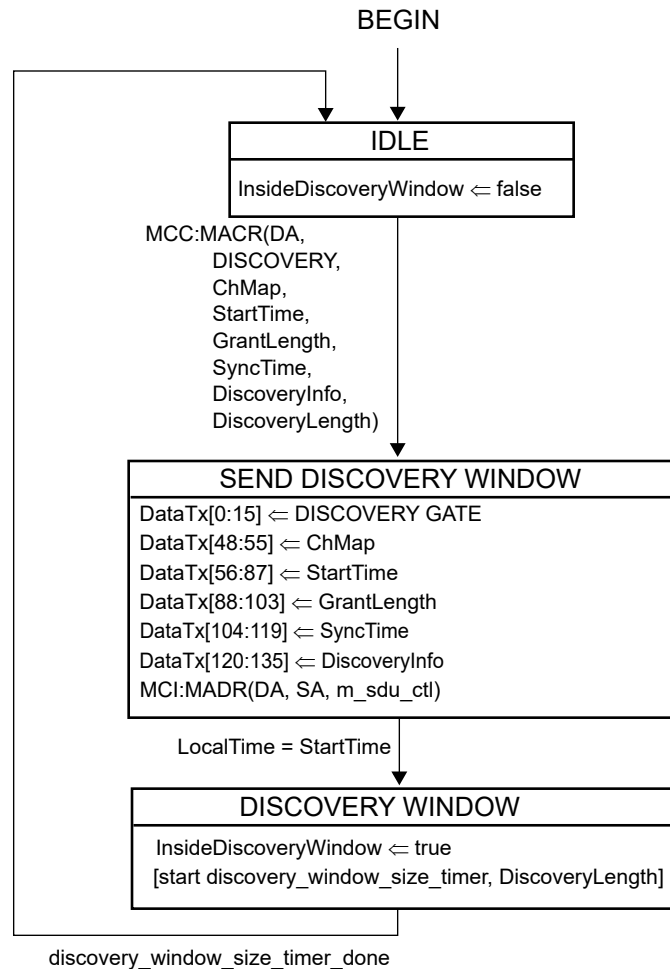
MCC:MACI(REGISTER, SA, PLID, MLID, Status)	1
This service primitive is issued by the Discovery Process at the OLT or an ONU to notify the MAC Control client and Layer Management of the result of the change in registration status. This primitive accepts the following parameters:	2
REGISTER:	3
SA:	4
PLID:	5
MLID:	6
Status:	7
REGISTER: Opcode for REGISTER MPCPDU as defined in Table 31A-1.	8
SA: This parameter represents the MAC address of the OLT.	9
PLID: This parameter holds the logical link identification number assigned by the MAC Control client to the PLID.	10
MLID: This parameter holds the logical link identification number assigned by the MAC Control client to the MLID.	11
Status: This parameter holds one of the following values: <i>accepted / denied / deregistered / reregistered</i> .	12
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MCC:MACR(DA, REGISTER_ACK, Status)	14
This service primitive is issued by the MAC Control clients at the ONU and the OLT to acknowledge the registration. This primitive accepts the following parameters:	15
DA:	16
REGISTER_ACK:	17
Status:	18
DA: Multicast MAC Control address as defined in Annex 31B.	19
REGISTER_ACK: Opcode for REGISTER_ACK MPCPDU as defined in Table 31A-1.	20
Status: This parameter takes on the indication supplied by the <i>Flags</i> field in the REGISTER_ACK MPCPDU as defined in Table 144-5.	21
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MCC:MACI(REGISTER_ACK, SA, PLID, MLID, Status, RTT)	24
This service primitive is issued by the Discovery Process at the OLT to notify the client and Layer Management that the registration process has completed. This primitive accepts the following parameters:	25
REGISTER_ACK:	26
SA:	27
PLID:	28
MLID:	29
Status:	30
RTT:	31
REGISTER_ACK: Opcode for REGISTER_ACK MPCPDU as defined in Table 31A-1.	32
SA: This parameter represents the MAC address of the reciprocating device (ONU address at the OLT, and OLT address at the ONU).	33
PLID: This parameter holds the logical link identification number assigned by the MAC Control client to the PLID.	34
MLID: This parameter holds the logical link identification number assigned by the MAC Control client to the MLID.	35
Status: This parameter holds one of the following values: <i>accepted / denied / reset / deregistered</i> .	36
RTT: The measured round trip time to/from the ONU is returned in this parameter. RTT is expressed in the units of 1 EQ. This parameter holds a valid value only when the invoking Discovery Process in the OLT.	37
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OpcodeSpecificFunction(Opcode)	45
Functions exported from opcode specific blocks that are invoked on the arrival of a MAC Control message of the appropriate opcode.	46
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144.3.3.6 State Diagrams

The Discovery Process in the OLT shall implement the Discovery Window Setup state diagram shown in Figure 144-15, Discovery Request Processing state diagram as shown in Figure 144-16, Register Processing state diagram as shown in Figure 144-17, and Final Registration state diagram as shown in

Figure 144–18. The discovery process in the ONU shall implement the registration state diagram as shown in Figure 144–19.

Instantiation of state diagrams as described in Figure 144–15, Figure 144–16, and Figure 144–17 is performed only at the Multipoint MAC Control instances attached to the broadcast LLID (0x7FFE). Instantiation of state diagrams as described in Figure 144–18 and Figure 144–19 is performed for every Multipoint MAC Control instance attached to a MAC associated with PLID, except the instance attached to the broadcast channel.

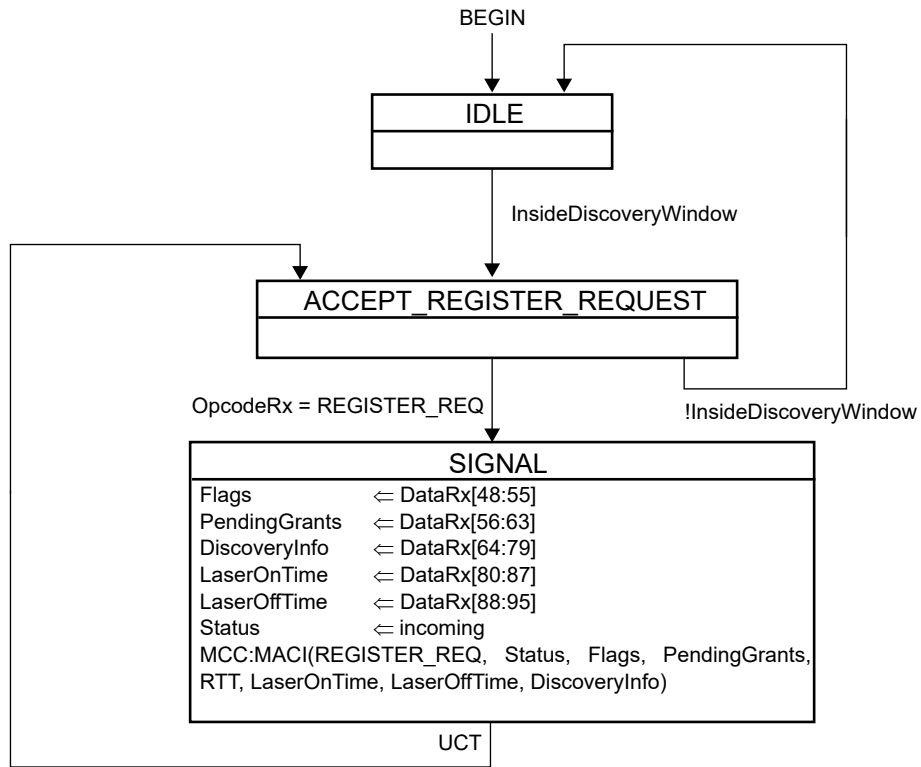


Instances of Service Interface:

MCI = interface to MAC Control multiplexer

MCC = interface to MAC Control client

Figure 144–15—Discovery Processing OLT Window Setup state diagram



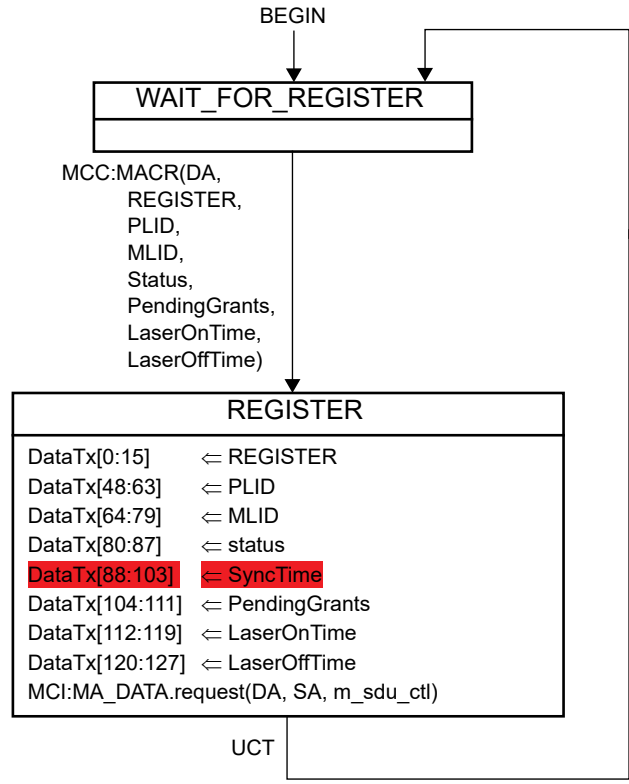
Instances of Service Interface:

MCI = interface to MAC Control multiplexer

MCC = interface to MAC Control client

Figure 144–16—Discovery Processing OLT Process Requests state diagram

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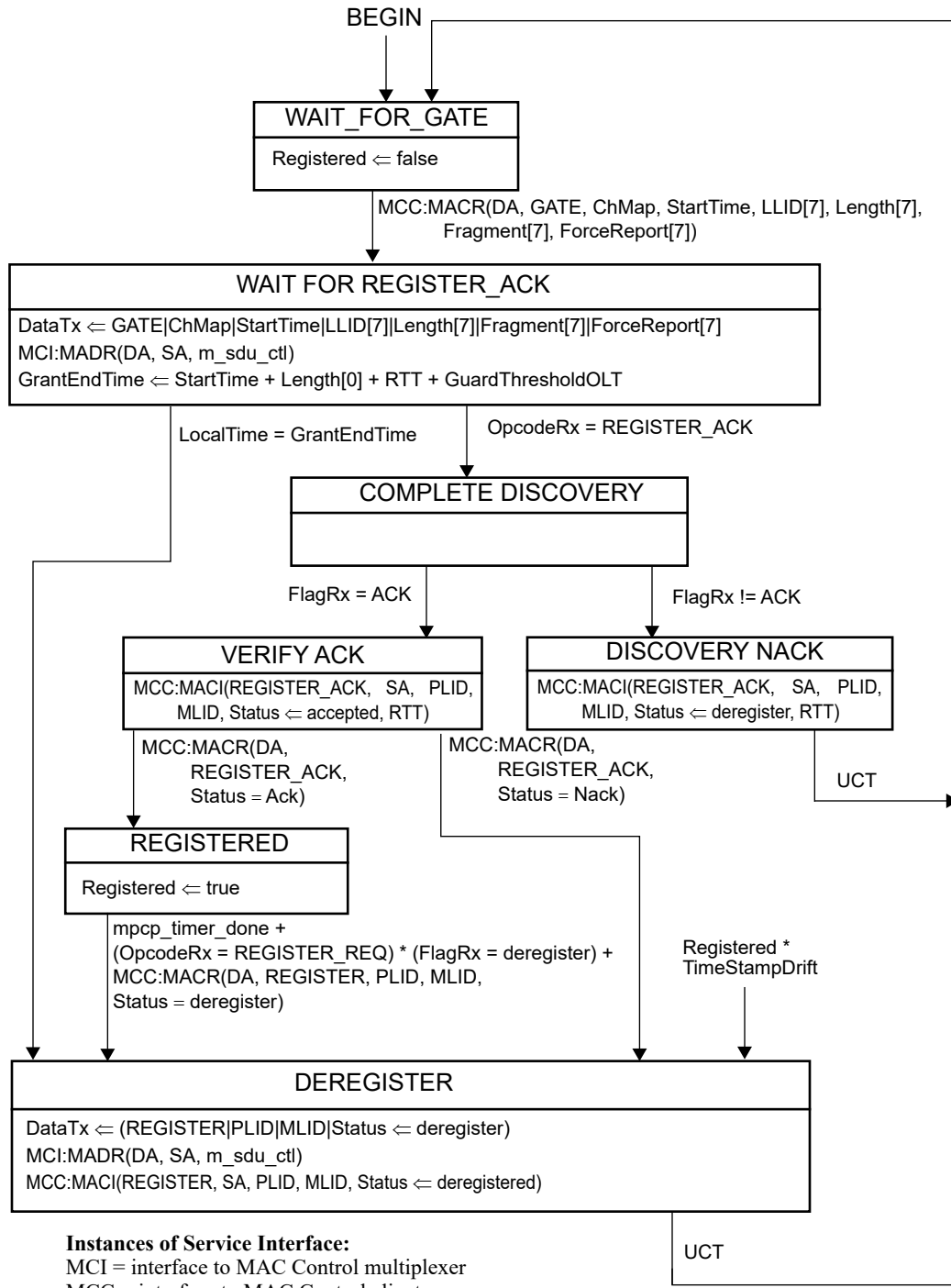
Instances of Service Interface:

MCI = interface to MAC Control multiplexer

MCC = interface to MAC Control client

Figure 144–17—Discovery Processing OLT Register state diagram

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NOTE—The MAC Control Client issues the grant following the REGISTER MPCPDU, taking the ONU processing delay of REGISTER MPCPDU into consideration.

Figure 144–18—Discovery Processing OLT Final Registration state diagram

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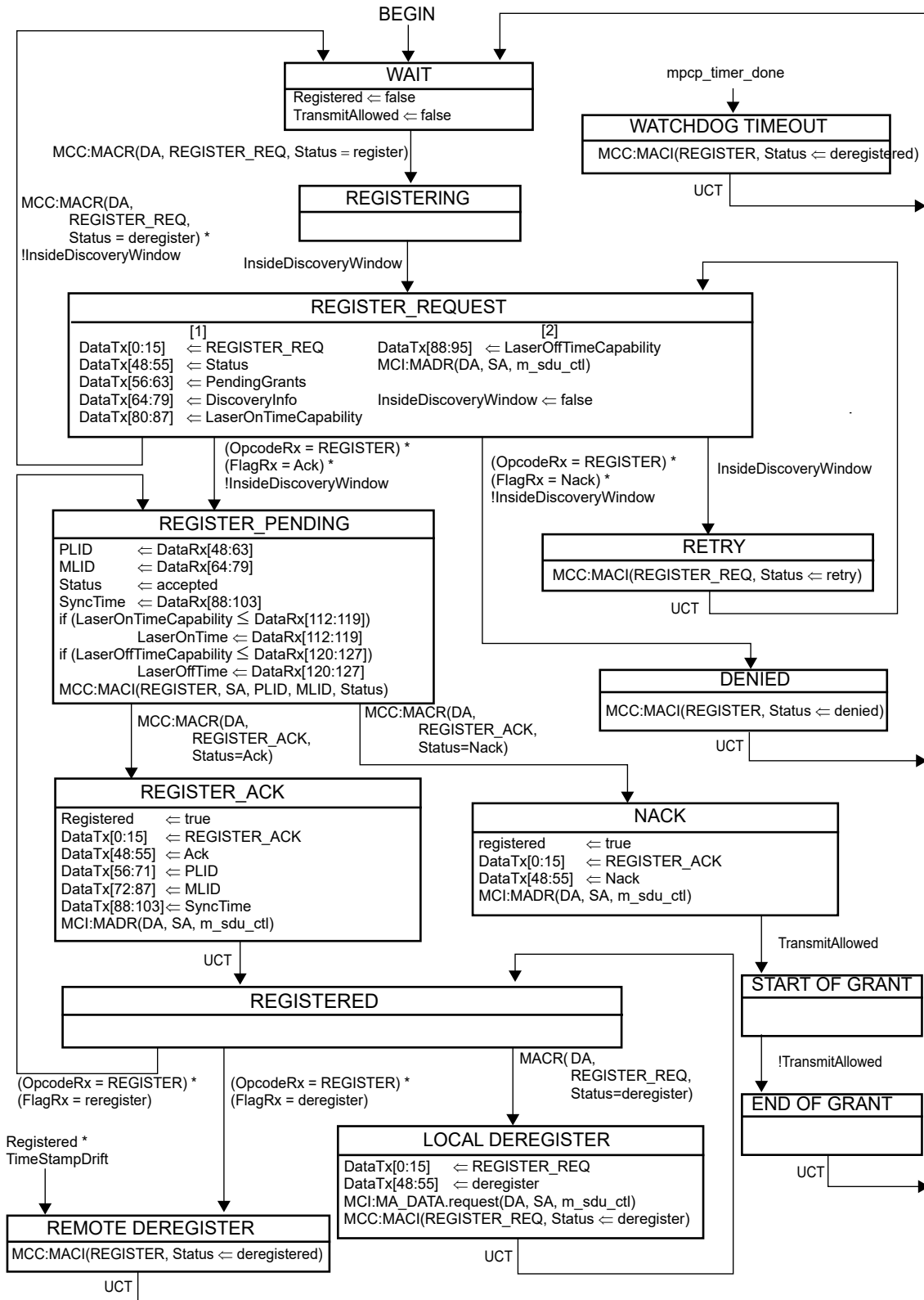


Figure 144-19—Discovery Processing ONU Registration state diagram