MPCP Auto Discovery Baseline Proposal

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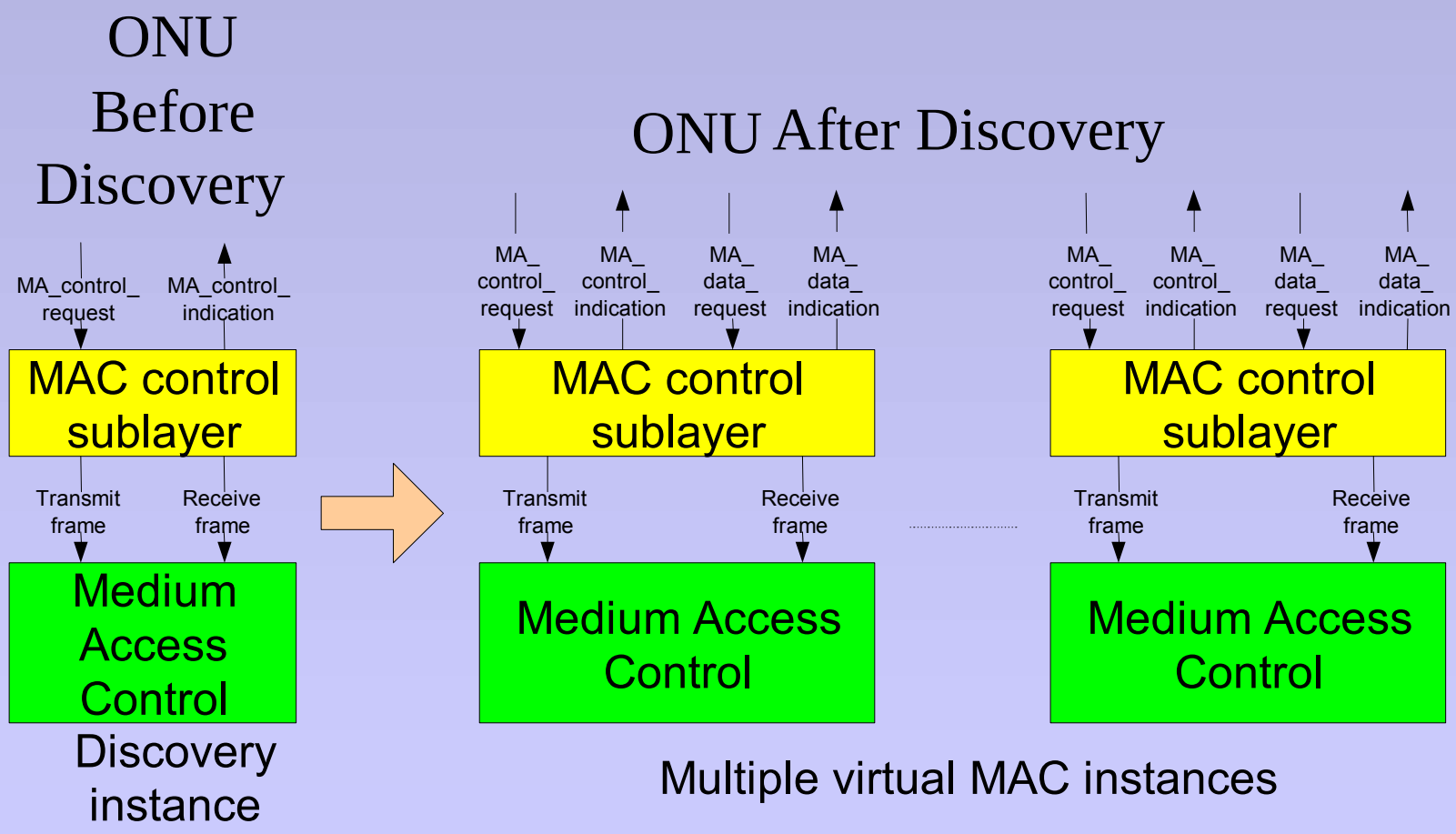
Problem Description

- **Harmonizing a new ONU into a PON**
  - Knowing it's there
  - Knowing who it is
  - Compensating for RTD
  - Negotiating System parameters
  - Assigning Logical PHY ID's for Virtual MACs: P2PE, SE, Single copy Broadcast (SCB)

Discovery and Virtual MACs

- **Various Virtual MACs (P2PE, SE, SCB) are being defined**
  - A discovery/default Logical PHY ID (=0?) is used following ONU power-up/reset
  - SCB mode can use the same default PHY_ID value
  - Additional PHY_IDs are assigned during registration
  - Only during discovery can Virtual MACs be registered (Logical PHY ID assigned)
    - Support for dynamically registering individual Virtual MACs after discovery is under consideration

Discovery Process Conceptual View



ONU Behavior During Discovery

- **At Power-up / Reset, an ONU enters Discovery State:**
  - Undiscovered ONU's Await Reception of "Discovery Gate" message from OLT
- **ONU responds only:**
  - If received message's Logical PHY ID matches discovery/default PHY ID and the grant type is discovery

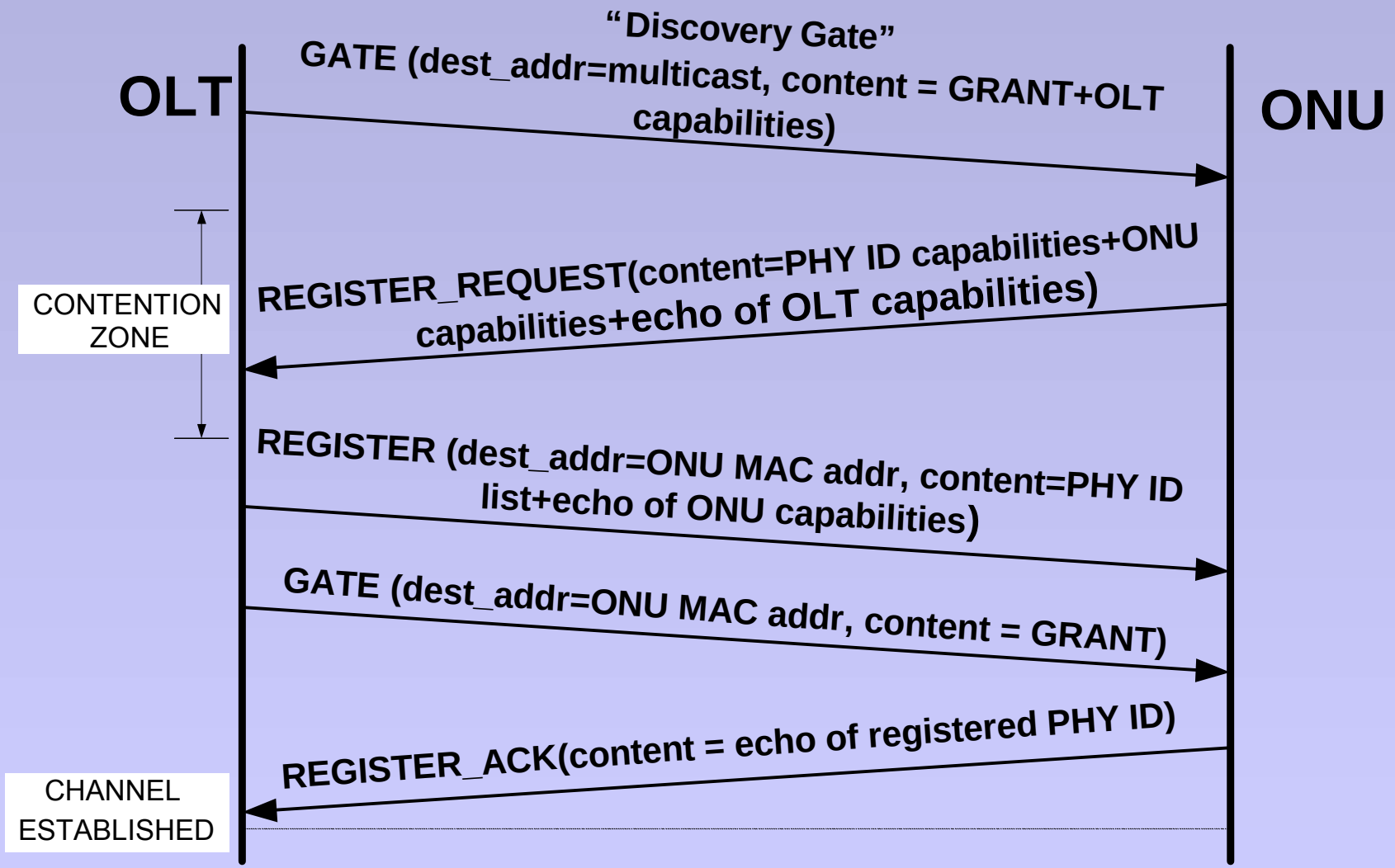
OLT Behavior During Discovery

- **OLT Must Periodically Reserve Time Periods for Discovery**
  - This Discovery Window must be large enough to handle maximum reach of 20 Km (200 usecs RTD)
    - The Frequency of discovery windows can be chosen for desired overhead
- **Since Undiscovered ONU Addresses are Unknown**
  - "Discovery Gates" are broadcast to all ONU's
  - A globally assigned, link constrained, multicast MAC address should be defined (Request one from 802.xx)
- **If MAC addresses are known through a Provisioning interface, then "Unicast MAC" addresses can be used for "Discovery Gates"**

Discovery Protocol

- **Four MAC control messages implement the protocol**
  - **"Discovery GATE": Creates transmission opportunity for undiscovered devices**
  - **Register_Request: ONU response to "Discovery Gate"**
  - **Register: OLT response to Register_Request**
  - **Register_Ack: ONU response to Register**
- **ONU's can wake-up Simultaneously**
  - **Protocol must deal with contention in Register_Requests**
- **Multiple ONU's can potentially be registered within single Discovery time period**

Discovery Sequence Summary



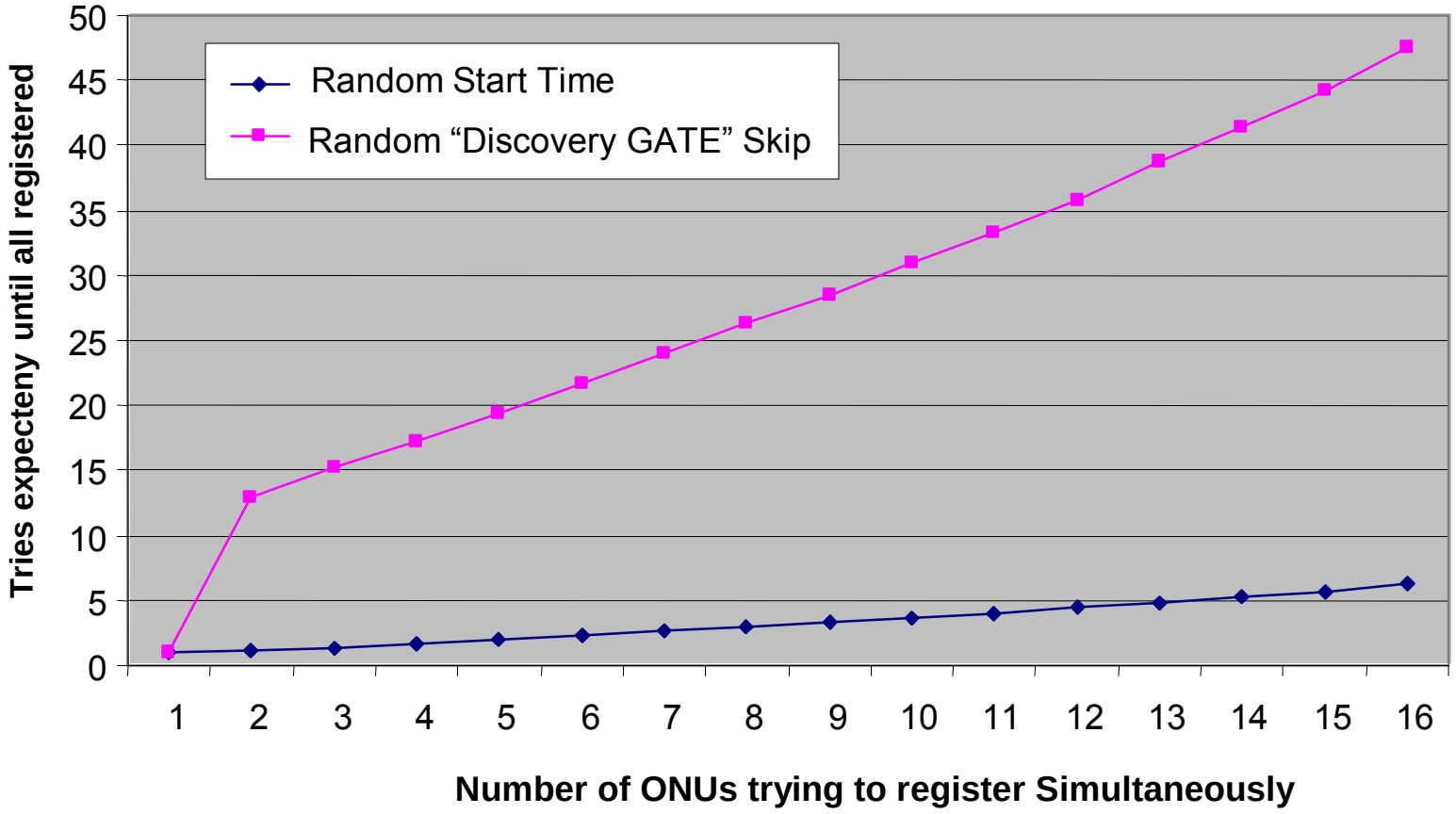
Sequence – Failure Modes

- **OLT assumes ONU is unregistered if:**
  - REGISTER_ACK message wasn't received at the first grant opportunity
  - ONU responds to "Discovery GATE" messages
- **ONU assumes it is unregistered if:**
  - After sending a REGISTER_REQUEST message, it receives a "Discovery GATE" before receiving a REGISTER message
  - After sending a REGISTER_ACK message, it receives a "Discovery GATE" before receiving a "Normal GATE" message

Resolving Discovery Contention

- **Some sort of randomization must be applied to ONU Register messages to minimize collisions**
- **Two options are being investigated:**
  - ONU skips (ignores) random number of discovery windows if previous ONU response wasn't acknowledged
    - Graph represents exponentially growing backoff scenario
  - ONU responds to every discovery opportunity using a random delay within the discovery window
    - Graph represents the scenario in which the window size allows up to 8 ONUs to be registered within a single discovery window
    - Discovery window size is fixed for entire graph

Contention Resolution Comparison



Comparison of two schemes

- **Compare case where 8 ONU's are registering simultaneously**
  - For Random Discovery Gate Time Case:
    - It takes 3 discovery windows to register all 8 ONU's
      - For 0.1 sec discovery window rate ==> 0.3 seconds
      - For 1 sec discovery window rate ==> 3 seconds
  - For Random Discovery Gate Skip Case:
    - It takes 26 discovery windows to register all 8 ONU's
      - For 0.1 sec discovery window rate ==> 2.6 seconds
      - For 1 sec discovery window rate ==> 26 seconds

Protocol Implications on Link Efficiency

- **Link efficiency is impacted by:**
  - **Frequency of discovery windows**
    - Link efficiency goes down with more frequent discovery windows
      - Frequency also impacts length of time-out for error recovery
  - **Length of discovery windows**
    - Larger windows allow more ONUs to be registered per window
    - Link efficiency goes down with larger discovery windows
  - **Values for these parameters are left up to system implementers/designers**

Protocol Implications on Link Efficiency: An Example

- For Max Reach, 200 usecs RTD, window must be 200 usecs plus enough time for:
  - single register_request message (random “discovery gate” skip case)
  - several register_request messages (random start time case)
- For 64 byte messages: approximately 2 usecs link occupancy
  - 1 usec for message, 1 usec for (guard band + Laser turn-on/off).
- For
  - random “discovery gate” skip case: use 2 usecs
  - random start time case: use (16 * 2 usecs) = 32 usecs
- This totals:
  - For random “discovery gate” skip case: 202 usecs
  - For random start time case: 232 usecs

Example Continued

The Overhead for Discovery for various Window Rates:

Rate	Random "Discovery Gate" skip	Random start time
0.1 second:	0.202%	0.232%
1 second:	0.0202 %	0.0232 %
5 seconds:	0.00404%	0.00464%
10 seconds:	0.00202%	0.00232%

- For rates 1 second and above, these overheads appear negligible
- Both schemes overhead is dominated by RTD for Maximum reach

Unresolved Issues

- Assignment of Logical PHY ID's or use existing ONU MAC addresses
- Support for Dynamic registration of individual Virtual MACs
- Assignment of BW to virtual MACs
- Discovery Contention Resolution Scheme.
- Defining SE Virtual MACs
- Number of virtual MACs allowed of each type (P2PE, SCB, SE)
- Static provisioning of MAC addresses versus Discovery protocol

P2MP Motion: MPCP Auto Discovery

P2MP Track Motion:

Use proposal <gaglianello_1_0302.pdf> as a basis for the first P2MP draft, with the exception of:

- removal of slide # 16
- replace slide #11 with revised graph presented by Gaglianello

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