MPCP with Multi-Cycle Grants

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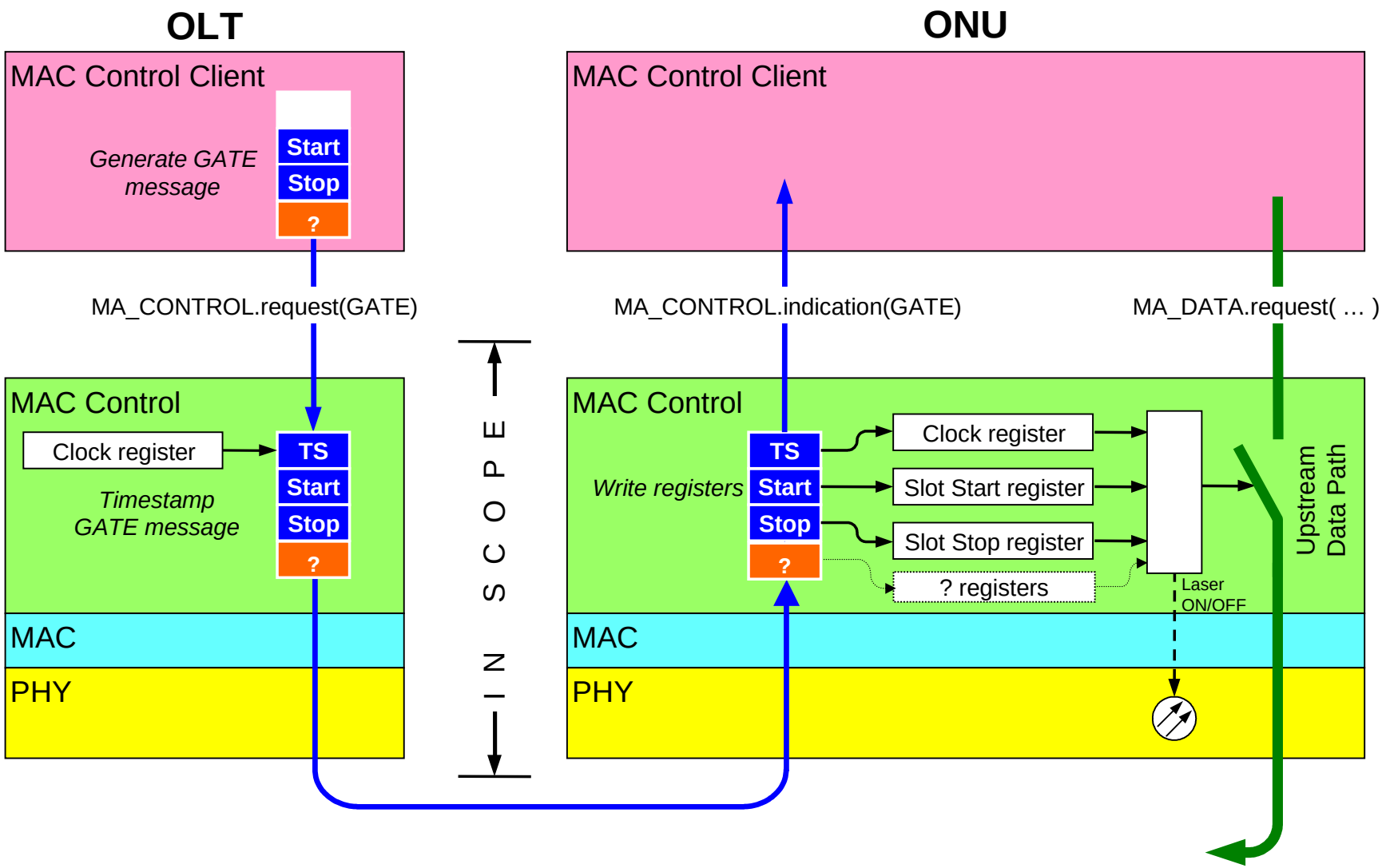
Current direction of MPCP

- MAC-Control frames
- REGISTER / REGISTER_REQUEST for Auto-discovery
- GATE / REPORT for ONU timeslot arbitration
  - GATE (OLT→ONU) --- Laser ON/OFF
  - REPORT (ONU→OLT) --- TBD
- Multi-Grant Packing (~5/GATE)
- 44 available bytes

Current MPCP



Simplicity is key

- It's Ethernet, after all…
- Some useful objectives for MPCP:
  - Minimize GATE/Request traffic load
  - Minimize GATE/Request message size
  - Flexibility & Scalability
  - "Grantable Entity" = 1 ONU
  - Request Message: no mandatory 'queue priorities' or other higher layer parameters

Suggested strategy

- MPCP is a flexible & scalable protocol
- A single model allows a number of modes of operation..
- ...from:
  - simple DSL replacement
  - Low complexity / low cost
  - Fixed BW, e.g., 10-20 Mbps per subscriber
  - BW changes are VERY RARE (like DSL)

  → opportunity to drastically minimize GATE traffic load
- ...to:
  - highly sophisticated DOCSIS cable modem replacement
  - Higher complexity / higher cost
  - Dynamic Bandwidth Allocation

  → GATE/Request traffic galore (e.g., 1 grant/GATE)

Potential Benefits...

- Simple, low cost baseline model
- Provides evolution path to Service Providers
- Scales to support integrated transmission of voice, video and data traffic
- Appropriate for Isochronous services (e.g., voice, T1):
  - cyclic nature
  - capable of support Jitter-sensitive and delay-sensitive traffic

Proposed additions to MPCP

1. Minimize GATE message traffic load
   - Benefits:
     - Minimizes GATE processing tax
     - Minimizes control traffic overhead

2. Add cyclic property
   - Benefits:
     - Enables transport of isochronous traffic over a deterministic, low-jitter / low delay scheme

Multi-cycle Grants

- Allow the OLT to use a single GATE message to provide grants to an ONU for multiple, equidistant, same-length, timeslots
- A special case of 'Multi-grant packing' feature of MPCP, which allows the OLT to use a single GATE message to provide grants to an ONU for multiple, variable-distant, variable-length, timeslots
- Note: No 'perpetual' Grants

Operation

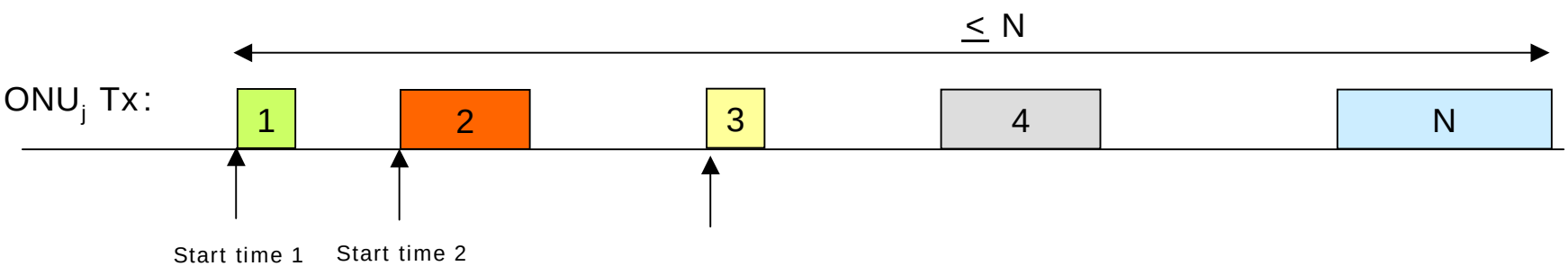
- OLT can support mixture of ONUs in the same network; GATEs are generated appropriately
- Multi-cycle Grant includes 2 additional fields:
  - **Time To Live** (TTL) – # cycles this grant is good for
  - **Cycle** – specifies interval between transmissions
- At ONU:
  - If **Multi-cycle Grant**
    - Read single **Slot Start, Slot length** pair
    - Interpret **TTL** and **Cycle** for multi-cycle grant operation
    - Laser ON/OFF with Cycle, for TTL
  - Else:
    - Read **Slot Start, Slot length list** for DBA operation
    - Laser ON/OFF per Start/Length values

Current GATE Message

- 6 octets: Destination address
- 6 octets: Source address
- 2 octets: Type
- 2 octets: Opcode
- 4 octets: Timestamp
- 1 octet: Number of Grants
- 4 octets: Slot start time (laser ON)
- 2 octets: Slot length (laser OFF)

} Repeat * N

- Optional Fields
- 4 octets: CRC



Multi-cycle Grant GATE

- GATE identification:
  - Separate ***opcode*** = "Multi-cycle Grant"

  or,
  - ***Number of Grants*** field specifies mode of operation:
    - 1-N: variable-distant, variable-length timeslots (N~5)
    - 0xFF: "Multi-cycle Grant"

- 2 additional fields:
  - ***Time To Live*** (TTL) – # cycles this grant is good for
  - ***Cycle*** – specifies interval between transmissions

- Cycle:
  - The actual value of the inter-transmission time T is 2^{Cycle} ticks

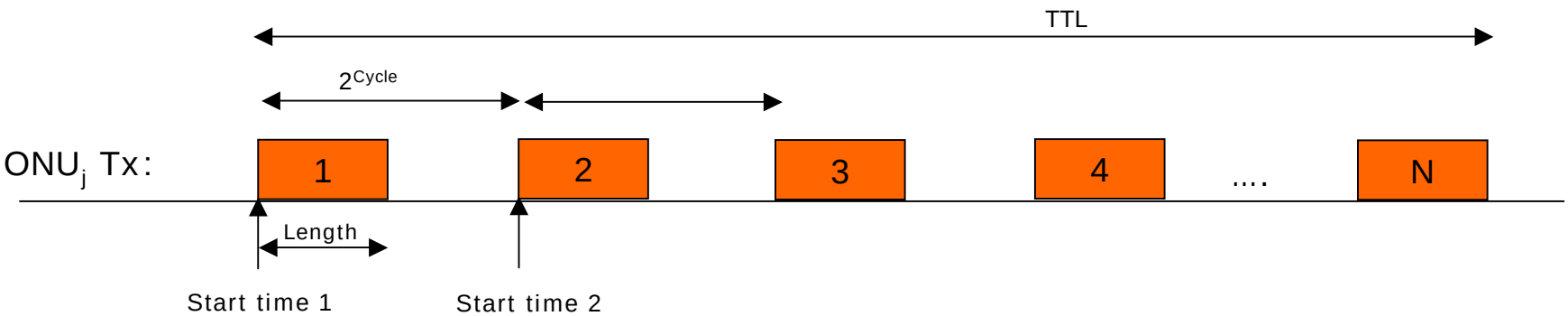
    E.g., one tick = 8ns, and Cycle = 18
  - $T = 2^{18} * 8ns \sim 2ms$
    - ➔ Upper limit is for further study

Multi-cycle Grant GATE / seperate opcode

- 6 octets: Destination address
- 6 octets: Source address
- 2 octets: Type
- 2 octets: **Opcode** = "Multi-cycle Grant"
- 4 octets: Timestamp
- 4 octets: Slot start time (laser ON)
- 2 octets: Slot length (laser OFF)

} One pair only

- **1 octet: TTL** – specifies how many cycles a grant is worth (up to 255)
- **1 octet: Cycle** - specifies the (single) interval between transmissions
- Optional Fields
- 4 octets: CRC



Multi-cycle Grant GATE / same opcode

- 6 octets: Destination address
- 6 octets: Source address
- 2 octets: Type
- 2 octets: Opcode
- 4 octets: Timestamp
- 1 octet: **Number of Grants =** "Multi-cycle Grant" (e.g., 0xFF)
- 4 octets: Slot start time (laser ON)
- 2 octets: Slot length (laser OFF)

  } One pair only

- **1 octet: TTL** – specifies how many cycles a grant is worth (up to 255)
- **1 octet: Cycle** - specifies the (single) interval between transmissions
- Optional Fields
- 4 octets: CRC

Impacts

- GATE Message:
  - “Opcode” vs. “Number of Grants” Field?
  - Additional “TTL” and “Cycle” Fields
- ONU:
  - 2 more registers
  - Transmits with derived period (while TTL != 0)
  - Decrements TTL with each transmission
- OLT:
  - Up to N Cycle values (N = # ONUs)
  - Up to N TTL values
  - Sends new GATE periodically, renewing TTL

Modifying/Revoking a Grant

- Multi-cycle grants can be modified and revoked based on higher layer decisions
- Modifying a Grant
  - OLT sends GATE with new Cycle & TTL to ONU
- Revoking a Grant
  - OLT sends GATE with e.g., Number of Grants = 0 or TTL = 0 to ONU

Summary

- **Proposal: Extend MPCP to allow Multi-cycle Grant operation**

- Multi-cycle Grant schema is a special case of MPCP
- GATE message w/ additional TTL & Cycle fields
- Separate opcode?

- Provides simple mechanism to handle isochronous traffic
- Results in simple cyclic, low-jitter protocol
- Appropriate for simplest, static bandwidth, service model
- Reduces GATE processing and traffic load overhead up to 255 times