Ethernet PON Protocol Suggestion

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Scope

- Device registration
  - Device discovery
  - Ranging
- Access control (request / grant)

Control Channel – Side Note

- Use of MAC control frames is preferred
- Addition of new opcodes to MAC control is required

- Other mechanisms are not excluded

PASSAVE NETWORKS

Device Registration

- Discovery of new devices in the network:
  - MAC address
  - Distance from ONU
  - Device capabilities
  - Power levels
- The process requires opening a receive window (200µsec for a 20km span)

Device Discovery

- Device discovery is a periodic process:
  - Long periods → high delays when adding ONUs
  - Short periods → high bandwidth loss
- The period is implementation specific
  - Boundaries should be specified

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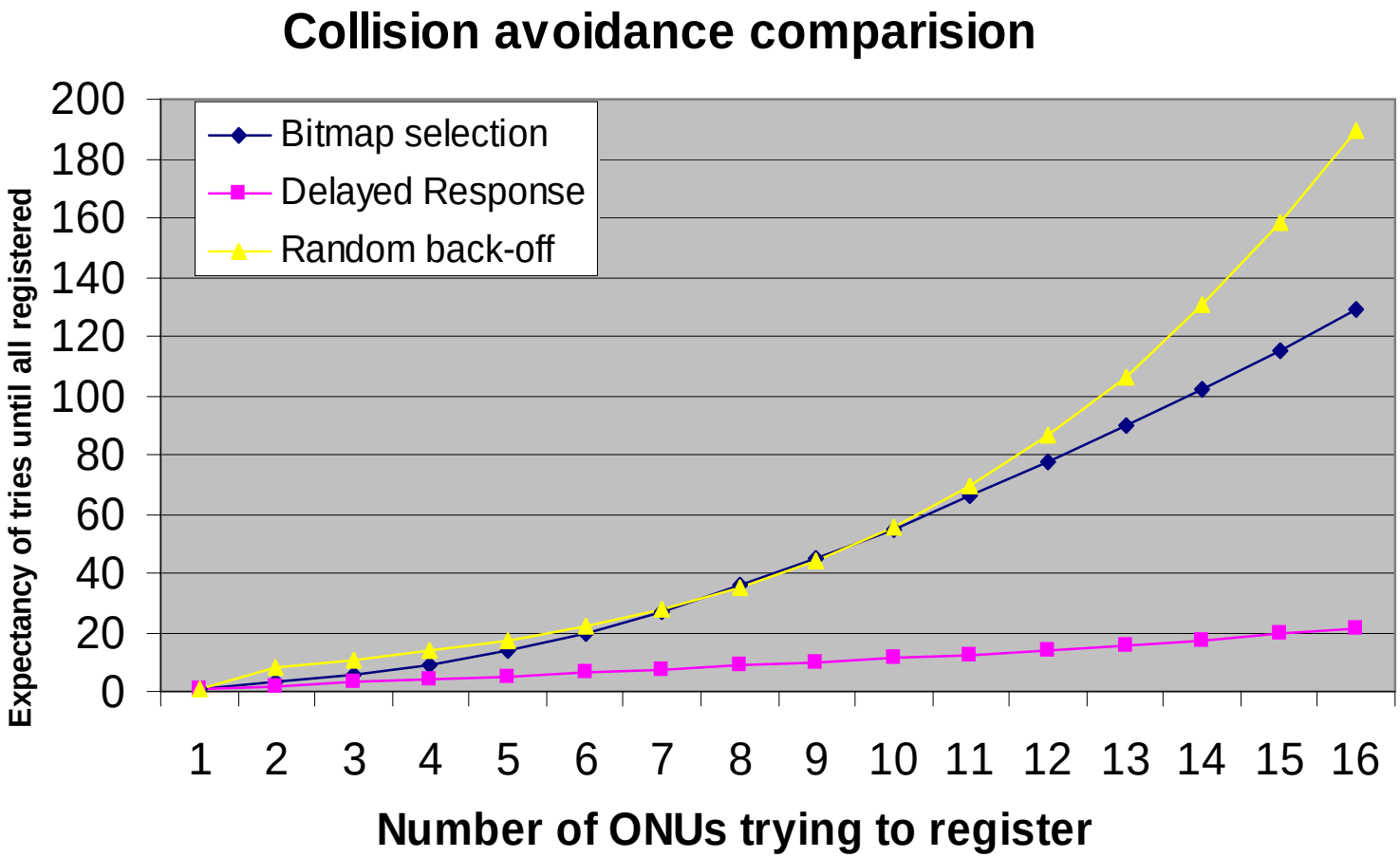
Collision Domain

- A multicast address is used to address unregistered devices
- Collisions probable with multiple devices

Collision Avoidance Solutions

- Some or all of these solutions:
  - Specifying bit masks for devices that are allowed to response at each occasion – managed back off
  - Back off for random time when not acknowledged
  - Random delay in the response time inside response window
  - Multiple responses for every request with random spacing



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Preferred Scheme

- Usually not many devices will be discovered simultaneously
- The main criteria for selection is simplicity of implementation
- Randomizing response time is easy and has the fastest convergence time

Ranging

- Significantly improves bandwidth utilization
- Can be added to registration process with minimal changes:
  - The registration request will state the current clock and time to answer ➔ Device loads current clock
  - The response will state the time it was sent at
  - The acknowledge will include the trip delay ➔ Device adjusts clock difference
  - The trip delay is:

$$\frac{\textit{Response reception time (@OLT) - Response sending time (@ONU)}}{2}$$

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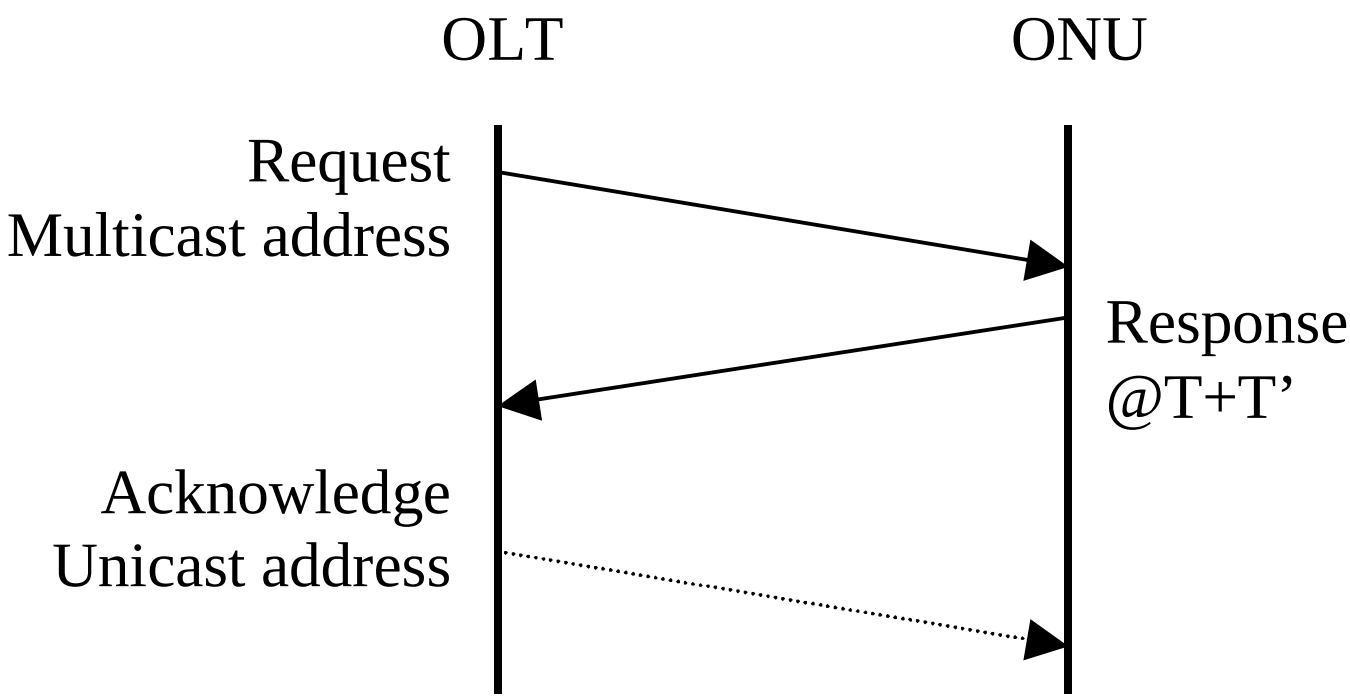
Ranging Drifts

- Large drifts caused by clock asynchrony
  - Compensated by lock on Rx Clock
- Small drifts caused by temperature changes
  - A sufficient guard time compensates this phenomenon
  - Tracking of grant start at OLT compensates as well
  - OLT performs periodic non-destructive re-ranging

Scheme Summary



Response Packet Content

- ONU MAC identity
- Time tag
- Power measurement
- Device capabilities (TBD …)

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Access Control Logic

- Access granting is safer than access denial
  - Better say “talk” than “shut-up”
- Easier to say “talk at time T_1” than to say “talk T_1 from now”
  - Time packet received is unpredictable
- Pause is “shut-up until T_1”
  - Pause can’t be used!

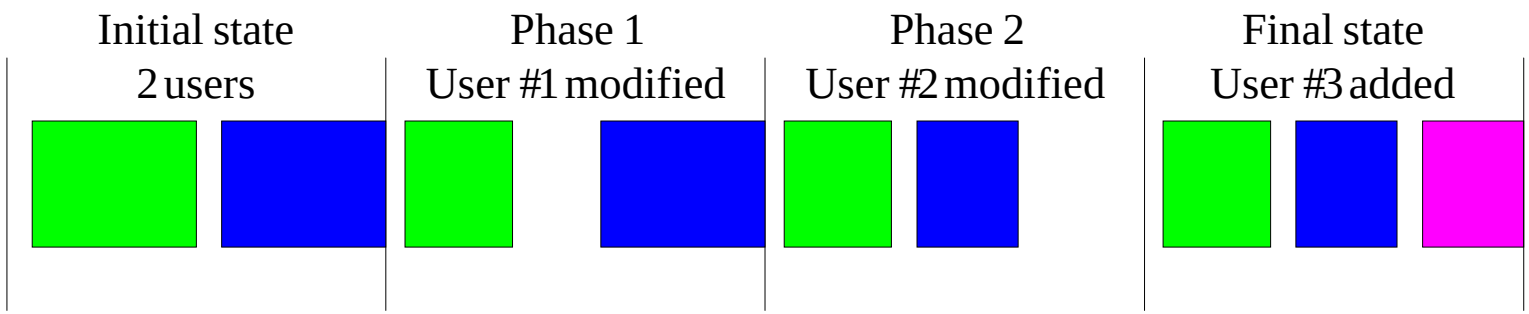
Fixed Access Control

- Fixed allocation to users denies dynamic bandwidth distribution
  - Limit customer differentiation
  - Limit possible applications
- Prevents over subscription
- Not robust against failure scenarios – similar to problems rising from access denial

PASSAVE NETWORKS

Endless Granting

- Changing bandwidth partition initiates serial process of communication to all ONUs
  - Example: addition of new devices to network



Suggested Access Control

- One-time grant
- Concatenation of several grants allowed:
  - "talk between T1 to T2 and between T3 to T4…"
- ONU can request more bandwidth
  - Request packets sent with growth of bandwidth demand
  - OLT not required to respond in real-time for those requests

Recommendations

- Add a device registration process based on scheme showed
- Access control should be based on one-time grants
- Enable dynamic bandwidth changes in response to ONU requests