Contention Resolution

(random delay, exponential back-off, or both?)

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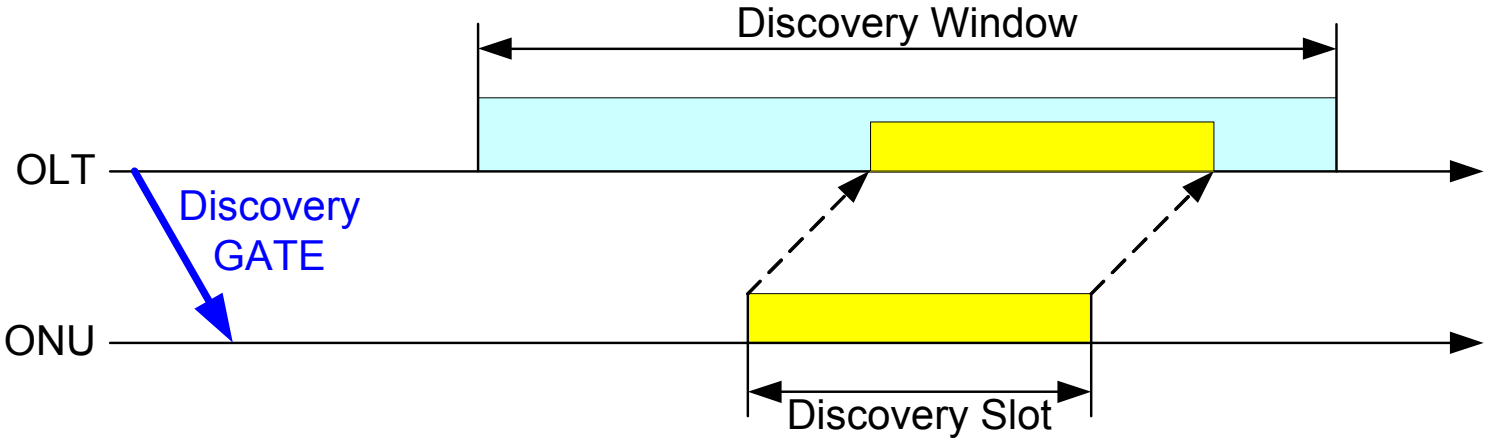
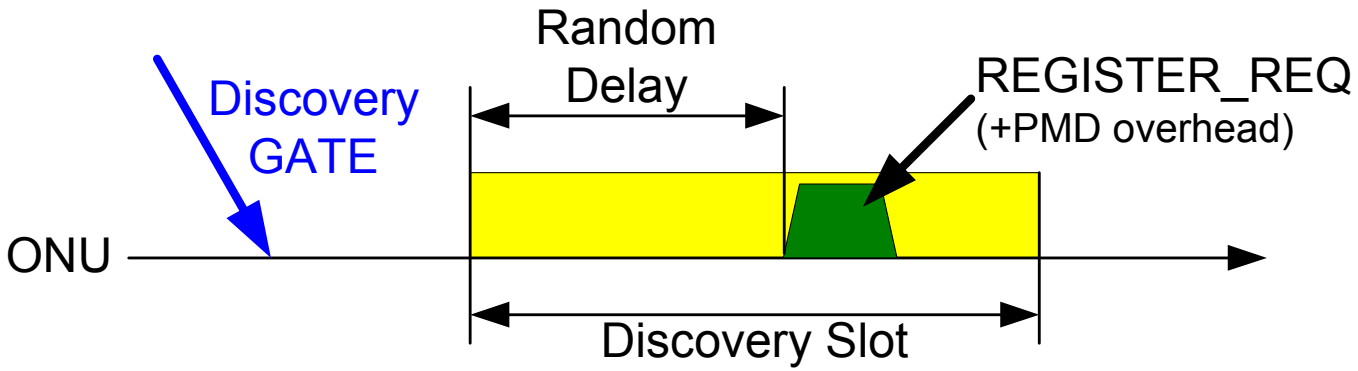
Definitions

- Discovery Slot
  - slot length value sent in Discovery GATE
- Extended Guard Band
  - additional guard band allocated by the scheduler to absorb unknown RTT (200 μs for 20 km max distance)
- Discovery Window
  - transmission window used for discovery (i.e., not available to normal traffic)
    Discovery Window = Discovery Slot + Extended Guard Band



Contention Resolution Mechanisms

- Random Delay
  - ONU applies random delay before transmitting REGISTER_REQ



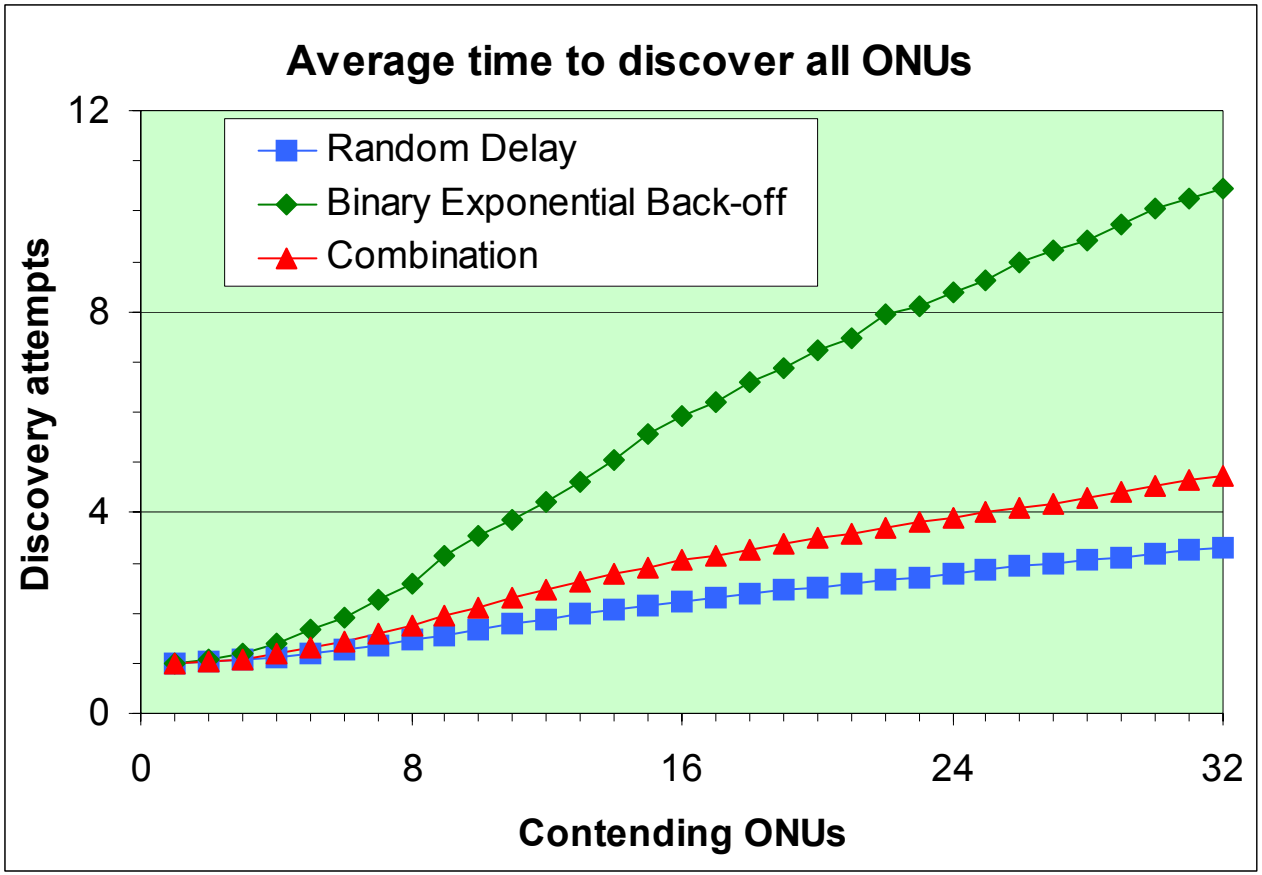
- Binary Exponential Back-off
  - Skip random number of Discovery GATEs

- Combination

Test 1: Simulation Parameters

- Number of contending ONUs varies from 1 to 32
- RTTs are uniformly random between 100 μs and 200 μs (distance between 10 km and 20 km)
- PMD Overhead (Laser_ON + CDR + AGC + Laser_OFF) = 200 ns
- Discovery Slot = 1200 bytes (9.6 μs)
- Extended Guard Band = 200 μs
- Max Deferral = 2^{10}

Average time (attempts) to discover ***N*** ONUs

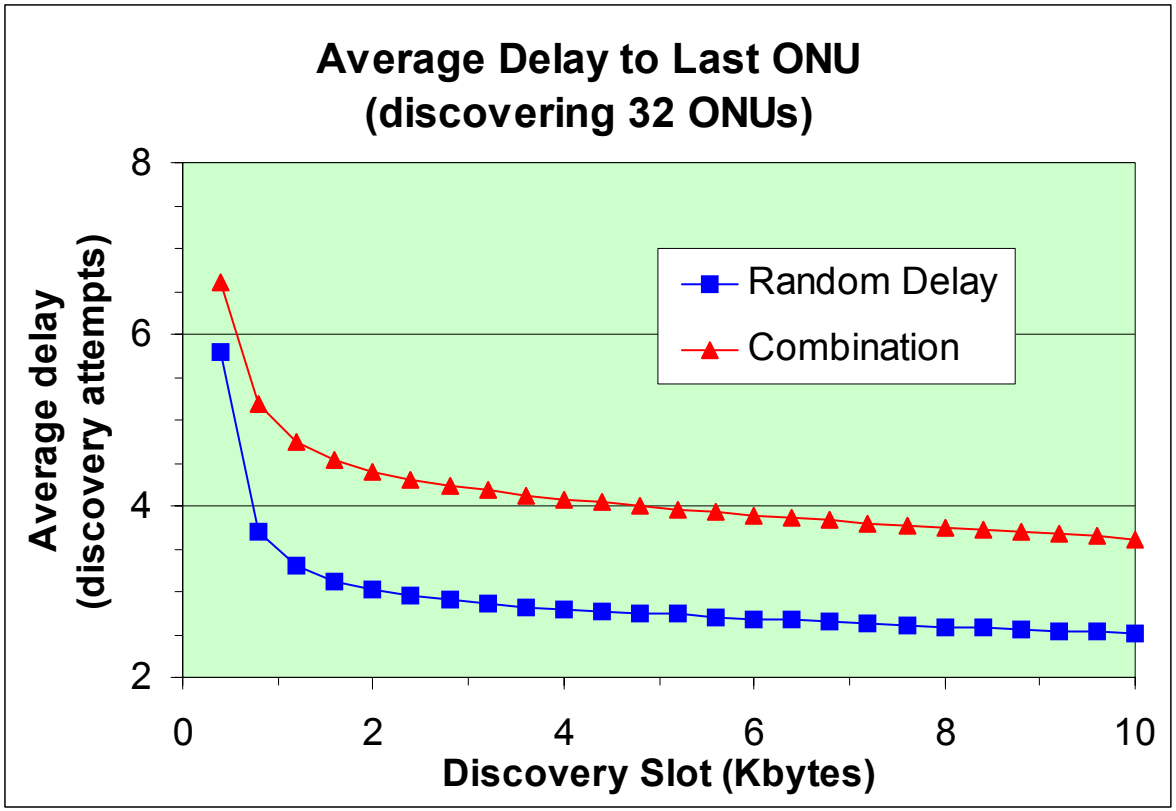


Random Delay performs better than either Binary Exponential Back-off or Combination

Test 2: Vary Discovery Slot size

- Number of contending ONUs = 32
- RTTs are uniformly random between 100 μs and 200 μs (distance between 10 km and 20 km)
- PMD Overhead (Laser_ON + CDR + AGC + Laser_OFF) = 200 ns
- Discovery Slot varies from 400 bytes to 10000 bytes (3.2 μs to 80 μs)
- Extended Guard Band = 200 μs
- Max Deferral = 2^{10}

Average time (attempts) to discover ***32*** ONUs

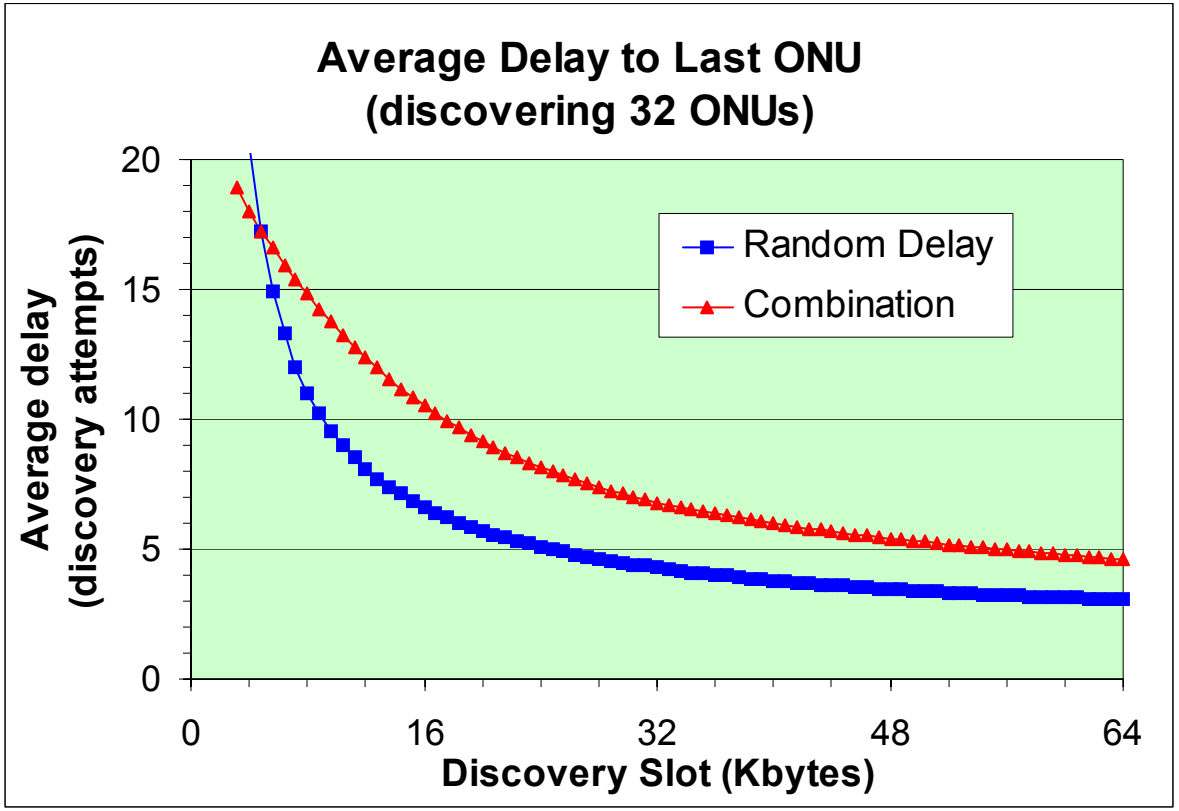


Random Delay performs better than Combination

Test 3: Increase PMD Overhead

- Number of contending ONUs = 32
- RTTs are uniformly random between 100 μs and 200 μs (distance between 10 km and 20 km)
- PMD Overhead (Laser_ON + CDR + AGC + Laser_OFF) = 5 μs
- Discovery Slot varies from 3200 bytes to 64000 bytes (25.6 μs to 512 μs)
- Extended Guard Band = 200 μs
- Max Deferral = 2^{10}

Average time (attempts) to discover ***32*** ONUs

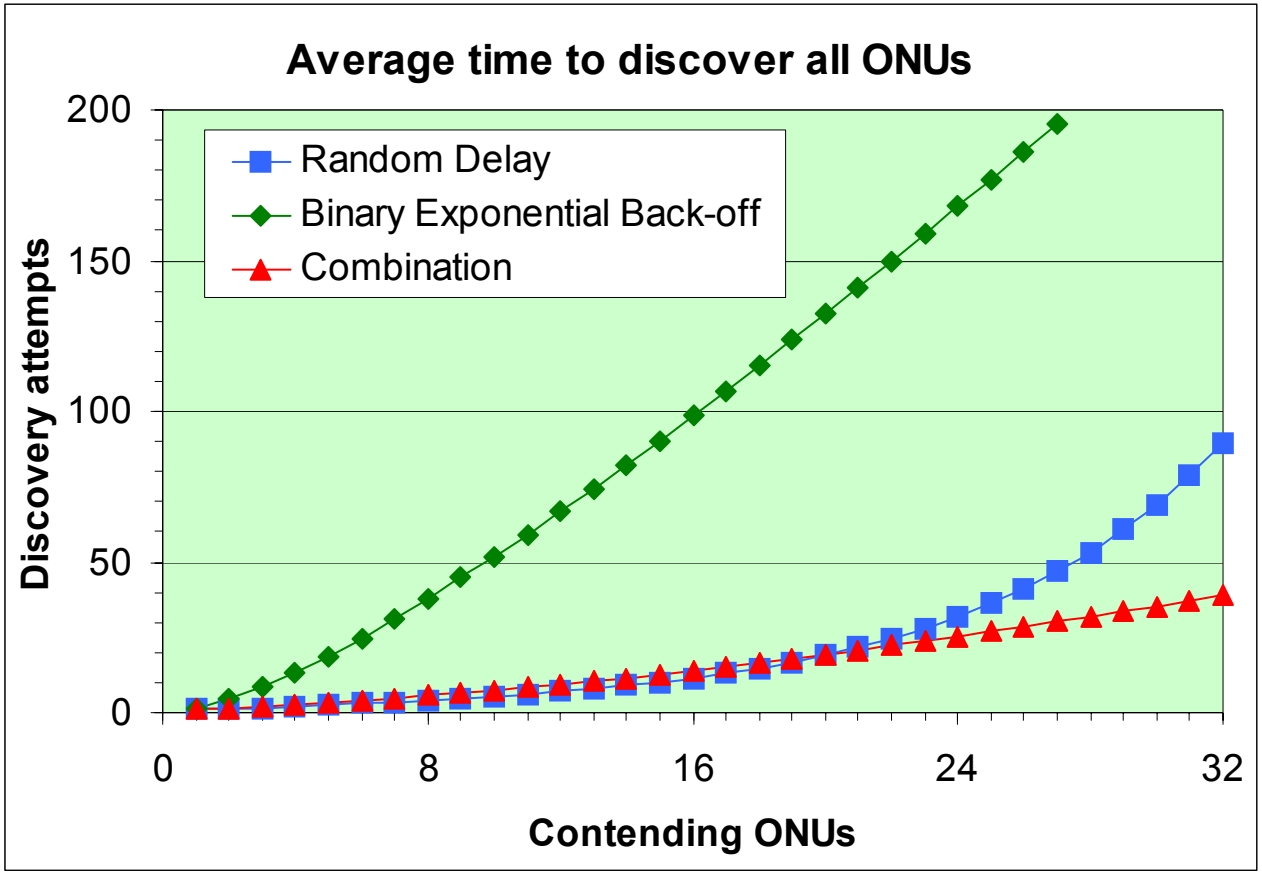


Random Delay performs better than Combination except when Discovery Slot is very small.

Test 4: Fix all RTTs

- Number of contending ONUs varies from 1 to 32
- RTT = 200 μs (identical for all ONUs)
- PMD Overhead (Laser_ON + CDR + AGC + Laser_OFF) = 200 ns
- Discovery Slot = 1200 bytes (9.6 μs)
- Discovery Window = 200 μs
- Max Deferral = 2^{10}

Average time (attempts) to discover ***N*** ONUs

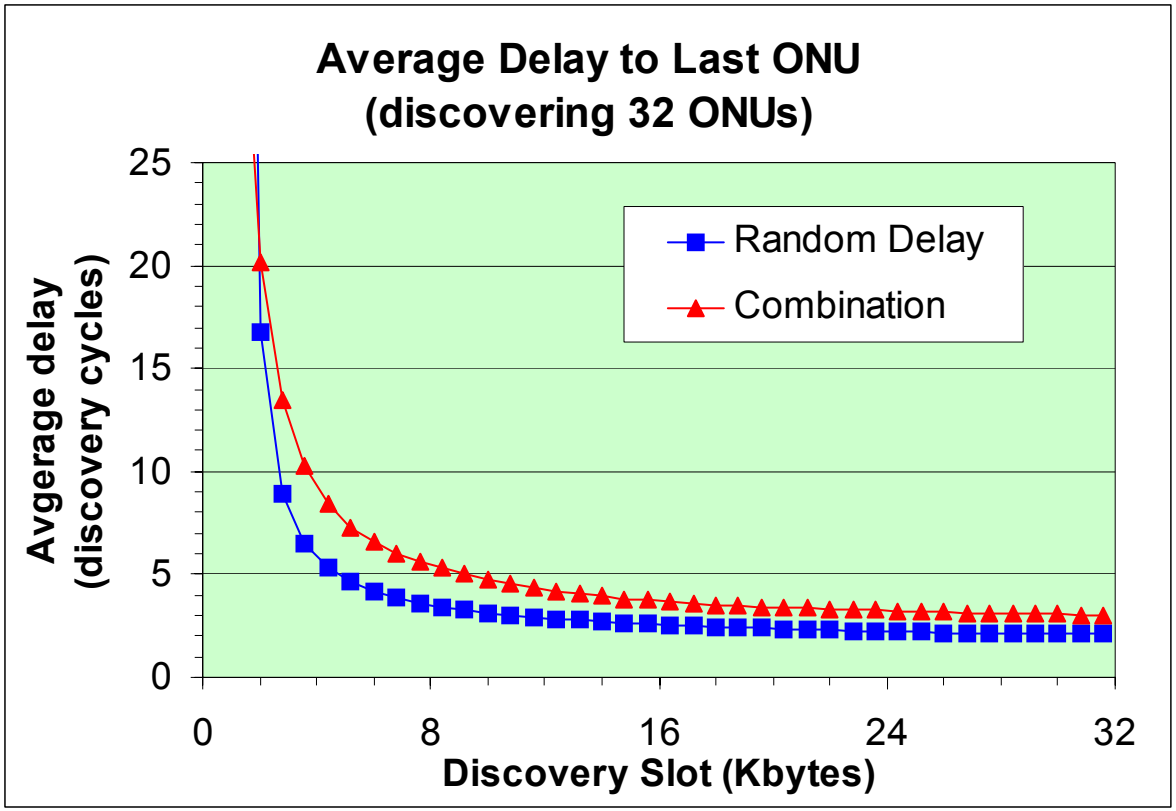


Random Delay performs worse than Combination when Discovery Slot is small and number of contending ONUs is large.

Test 5: Vary Discovery Slot size

- Number of contending ONUs = 32
- RTT = 200 μs (identical for all ONUs)
- PMD Overhead (Laser_ON + CDR + AGC + Laser_OFF) = 200 ns
- Discovery Slot varies from 1200 bytes to 32000 bytes (9.6 μs to 256 μs)
- Discovery Window = 200 μs
- Max Deferral = 2^{10}

Average time (attempts) to discover ***32*** ONUs

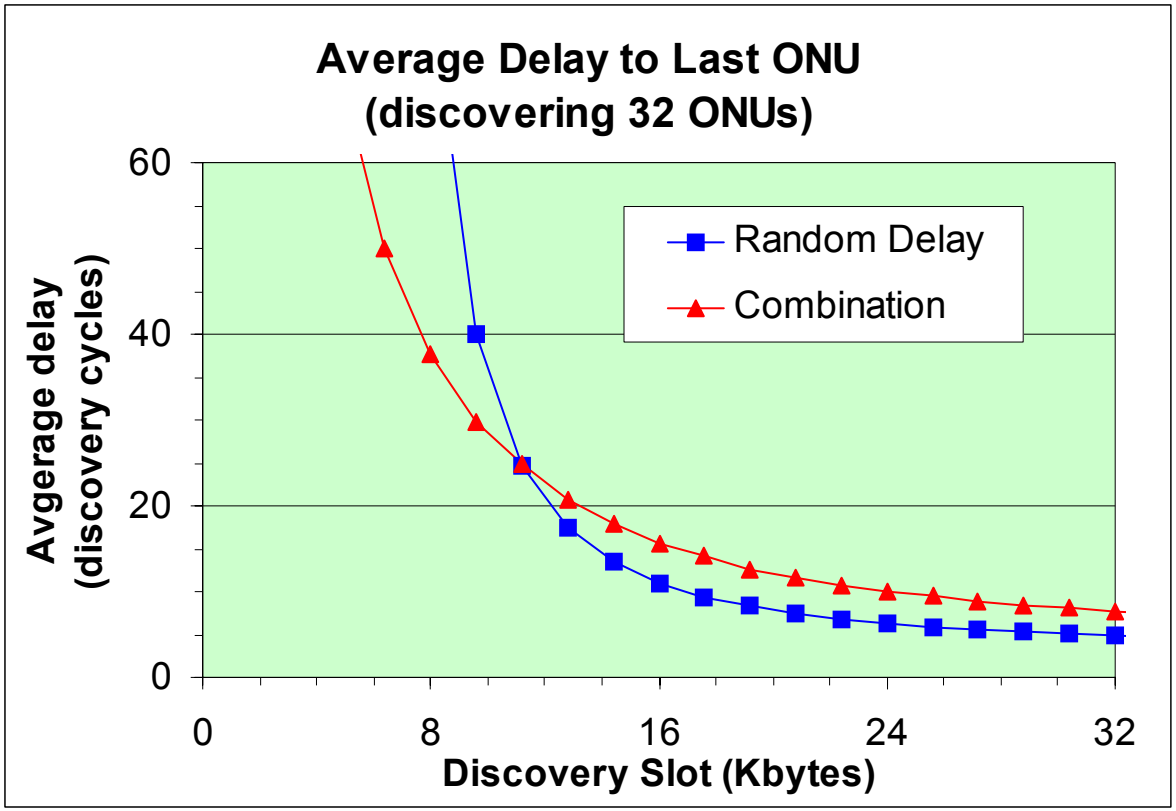


Random Delay performs better than Combination except when Discovery Slot is very small.

Test 6: Increase PMD Overhead

- Number of contending ONUs = 32
- RTT = 200 μs (identical for all ONUs)
- PMD Overhead (Laser_ON + CDR + AGC + Laser_OFF) = 5 μs
- Discovery Slot varies from 1200 bytes to 32000 bytes (9.6 μs to 256 μs)
- Discovery Window = 200 μs
- Max Deferral = 2^{10}

Average time (attempts) to discover ***32*** ONUs



Random Delay performs better than Combination except when Discovery Slot is small.

Conclusion

- Random Delay performs better than Combination most of the time
  - Combination is better only when the Discovery Slot is small and number of contending ONUs is large.
- It is advantageous to give larger Discovery Slot for large number of contending ONUs
  - If Discovery Slot is small, both Random Delay and Combination require several tens to hundreds discovery attempts before the success.
  - If number of contending ONUs is large, bandwidth is not scarce resource, since contending ONUs do not transmit user's data. Assigning larger Discovery Slot is not a problem.