Packet Bursting

Mart Molle, Jayant Kadambi, Mohan Kalkunte, and Howard Frazier
• The following people have indicated support for this proposal
  – Moti Weizman
  – Dave Fifield
  – Steve Haddock
Overview

- Carrier Extension & Packet Packing
- Packet Bursting Overview
- Simulation Results
- Summary and Observations
Objective

- Improve shared 1000 Mbps performance to make it an attractive option to enable inexpensive gigabit networks
- Minimize transmitter and receiver complexity to enable this
- Requires only a minimal change to original Carrier Extension proposal
Current Situation

- Carrier Extension "wastes" up to 448 bytes for small packets resulting in low throughput performance
  - Only marginally better than shared 100Mbps for small packet sizes
- Packet Packing improves performance significantly for 64 byte packets at all offered loads and at high offered loads for the workgroup distribution
  - Requires receiver to discard multiple packets after a collision
  - Increases complexity of statistics collection since both transmitter and receiver must delay updates until end of slot time
Solution: Packet Bursting

- Packet Bursting is carrier extension plus a burst of packets
- Station transmissions are padded to slot time if necessary using carrier extension
- Subsequent to slot time, stations transmit packets with minimum IPG spacing until burst timer (1500 bytes) expires
  - Collision window has passed, so stations are guaranteed there are no collisions
Packet Burst Timing

Burst Timer (1500 bytes)

CARRIER SENSE (512 bytes)

TRANSMIT DATA

PACKET #1 RRRRRRRRRR PACKET #2 RRR PACKET #3 RRR PACKET #4

RXDV
Packet Bursting

- As with baseline carrier extension, receiver is guaranteed to see only one packet during collision window.
- Subsequently, RXDV will delimit further packets
  - All these packets are guaranteed not to collide
- The de-assertion of CRS ends reception
- Maximum duration of carrier event is two 1500 byte packets
Simulation Environment

- 1000 Mbps network
- 15 stations
- 512 byte slot times
- 200 m network diameter
- Packet size distributions
  - All 64 bytes
  - All 1500 bytes
  - Workgroup Average
Performance Measures

- Performance characterized in terms of
  - Network Throughput
    » Amount of traffic the network can carry under the given offered load
  - Collision Likelihood
    » Probability that a packet experiences one or more collisions
  - Deference Likelihood
    » Probability that a packet waits upon arrival at the MAC
  - Number of consecutive packets
    » The number of consecutive packets a station transmits on the network until there is a receive on the wire
  - Access Latency
    » Waiting time of a frame when it is the head of the MAC queue until successful transmission or discard
Simulation Results

15 Stations, 100% offered load, Total Network Throughput (Data Utilization)

<table>
<thead>
<tr>
<th>Packet Size</th>
<th>Reference</th>
<th>Packet Packing</th>
<th>Packet Bursting</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 bytes</td>
<td>90.68 Mbps</td>
<td>339.84 Mbps</td>
<td>286.75 Mbps</td>
</tr>
<tr>
<td>1500 bytes</td>
<td>853.20 Mbps</td>
<td>853.20 Mbps</td>
<td>853.20 Mbps</td>
</tr>
<tr>
<td>Workgroup Distribution&lt;sup&gt;1&lt;/sup&gt;</td>
<td>562.19 Mbps</td>
<td>740.80 Mbps</td>
<td>700.32 Mbps</td>
</tr>
</tbody>
</table>

1. Distribution data collected by Howard Frazier that averaged workgroup traffic across 10Mbps and 100Mbps networks
Simulation Results

Network Throughput Vs. Offered Load
(15 stations, Packet Size Distributions - Work group Average)

Note: The network throughput indicated here is data throughput.
Simulation Results

Collision Likelihood Vs. Network Offered Load
(15 stations, Packet Size Distributions - Work group Average)

Percentage Offered Load:
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Collision Likelihood:
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7

Baseline (1000 Mbps)
Packet Bursting (1000 Mbps)
100 Mbps Network
Simulation Results

Deference Likelihood Vs. Network Offered Load
(15 stations, Packet Size Distributions - Work group Average)

- Baseline (1000 Mbps)
- Packet Bursting (1000 Mbps)
- 100 Mbps Network
Simulation Results

Average End-End Packet Delay Vs. Network Offered Load
(15 stations, Packet Size Distributions - Work group Average)

- Baseline (microsec)
- Packet Bursting (microsec)
- 100 Mbps (microsec)
Simulation Results

Percentage of Packets > AttemptLimit Vs. Network Offered Load
(15 stations, Packet Size Distributions - Work group Average)
Simulation Results

Mean Access Latency at 30% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

- Baseline (30% Load)
- Packet Bursting (30% Load)
- 100 Mbps Network (30% Load)
Simulation Results

Mean Access Latency at 40% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

Station Number

Microseconds

Baseline (40% Load)
Packet Bursting (40% Load)
100 Mbps Network (40% Load)
Simulation Results

Mean Access Latency at 50% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

![Graph showing mean access latency at 50% offered load for 15 stations with different packet size distributions and network configurations. The graph includes baseline (50% load), packet bursting (50% load), and 100 Mbps network (50% load) scenarios.]
Simulation Results

95th Percentile Access Latency Comparison at 30% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

- Baseline (30% Load)
- Packet Bursting (30% Load)
- 100 Mbps Network (30% Load)
Simulation Results

95th Percentile Access Latency Comparison at 40% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

Microseconds

Station Number

Baseline (40% Load)
Packet Bursting (40% Load)
100 Mbps Network (40% Load)
Simulation Results

95th Percentile Access Latency Comparison at 50% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

- Baseline (50% Load)
- Packet Bursting (50% Load)
- 100 Mbps Network (50% Load)
Simulation Results

95th Percentile Station Consecutive Transmits at 30% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

No. of Packets

Station Number

Station 1  Station 3  Station 5  Station 7  Station 9  Station 11  Station 13  Station 15

Baseline (30% Load)
Packet Bursting (30% Load)
100 Mbps Network
Simulation Results

95th Percentile Station Consecutive Transmits at 40% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

No. of Packets

Station Number

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Simulation Results

95th Percentile Station Consecutive Transmits at 50% Offered Load
(15 stations, Packet Size Distributions - Work group Average)

No. of Packets

Station Number

Baseline (50% Load)
Packet Bursting) (50% Load)
100 Mbps Network (50% Load)
Results Summary

• PB provides three times more throughput for small packets than baseline
• PB improves throughput by 25% for workgroup packet size distribution
• PB delays the capture effect to happen at higher offered loads than baseline
• PB improves all measures of performance for workgroup
Summary & Observations

• Packet Bursting provides a performance improvement similar to that of packet packing
  – makes shared gigabit Ethernet an attractive option
• Packet Bursting does not require receivers and transmitters to hold multiple packets or statistics till end of collision window
• Packet Bursting requires minimal changes in MAC Pascal with Carrier Extension
  – addition of burst length timer, a receiver flag and a transmit state variable
Summary & Observations

• No change to repeaters
  – Repeats everything after CRS assertion until CRS de-assertion
  – Oblivious to packet bursting