/ULTRAZED™

1000Mbps Ethernet Performance
Test Report

2017.4

<u>Test Setup:</u>

<u>Test Equipment Used:</u>
- Lenovo ThinkPad T420 Laptop
    - Intel® Core i5-2540M CPU - 2.60 GHz
    - 4GB DDR3 Memory
    - Intel® 82579LM Gigabit Ethernet Adapter
    - CentOS 7.0 64-bit Desktop
- UltraZed-7EV SOM and UltraZed-EV Carrier Card
- Category 5e Ethernet patch cable

<u>Test Details:</u>
- The network adapter of the test PC is set to 1Gbps Full Duplex setting

<u>Disclaimer:</u>
- The results of this experiment are provided for reference/educational purposes only and may not reflect results observed with other test equipment
- There are a number of factors which can impact network performance and throughput in addition to transmission overheads, including latency, receive window size, and system limitations such that the calculated throughput typically does not reflect the maximum achievable throughput
- If several systems are communicating simultaneously, the throughput between any pair of nodes can be substantially lower than nominal network bandwidth

Test Case 1: Roundtrip Ping Latency

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to ping a host PC for 100 iterations
- Ethernet linked at 1000Mbps

Test Details:
- The following command was used to test each UltraZed module:

```
# ping 192.168.1.100 -q -c 100
```

Test Case 1: Roundtrip Ping Latency

<u>Test Results:</u>
- No amount of packet loss observed
- Average package round-trip 0.556ms to 0.643ms delay

Test Case 2: Normal TCP Throughput Test

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
  https://github.com/esnet/iperf.git
- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
  ```
  $ ./iperf3 --server
  ```
- The following command was used for each UltraZed module TCP throughput test:
  ```
  # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
  --format m --time 60
  ```

Test Case 2: Normal TCP Throughput Test

Test Results:
- Sustained throughput rates of 856-942 Mbits/sec to server

Test Case 3: Normal TCP Throughput Parallel Stream Test

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
   https://github.com/esnet/iperf.git
- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
   ```
   $ ./iperf3 --server
   ```
- The following command was used on each test UltraZed module to launch 2 parallel TCP throughput test streams:
   ```
   # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
   --format m --parallel 2 --time 60
   ```

Test Case 3: Normal TCP Throughput Parallel Stream Test

<u>Test Results:</u>
- Sustained throughput rates of 857-934 Mbits/sec to server

Test Case 4: Normal UDP Throughput Test

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
  https://github.com/esnet/iperf.git
- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
  ```
  $ ./iperf3 --server
  ```
- The following command was used on each test UltraZed module to launch UDP bandwidth 1000mbps tests:
  ```
  # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
  --format m --time 60 --udp
  ```

Test Case 4: Normal UDP Throughput Test

<u>Test Results:</u>
- Sustained throughput rates aroung 958 Mbits/sec to server.

Test Case 5: Zerocopy TCP Throughput Test

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
   https://github.com/esnet/iperf.git
- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
   ```
   $ ./iperf3 --server
   ```
- The following command was used for each UltraZed module TCP throughput test:
   ```
   # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
   --format m --time 60 --zerocopy
   ```

Test Case 5: Zerocopy TCP Throughput Test

Test Results:
- Sustained throughput rates of 856-942 Mbits/sec to server

Test Case 6: Zerocopy UDP Throughput Test

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
  https://github.com/esnet/iperf.git
- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:

```
$ ./iperf3 --server
```

- The following command was used on each test UltraZed module to launch UDP bandwidth 1000mbps tests:

```
# ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
--format m --time 60 --udp --zerocopy
```

Test Case 6: Zerocopy UDP Throughput Test

<u>Test Results:</u>
- Sustained throughput rates around 863-958 Mbits/sec to server.

<u>Test Case 7: Type of Service TCP and UDP Throughput Tests</u>

<u>Test Overview:</u>
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

<u>Test Details:</u>
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
    https://github.com/esnet/iperf.git
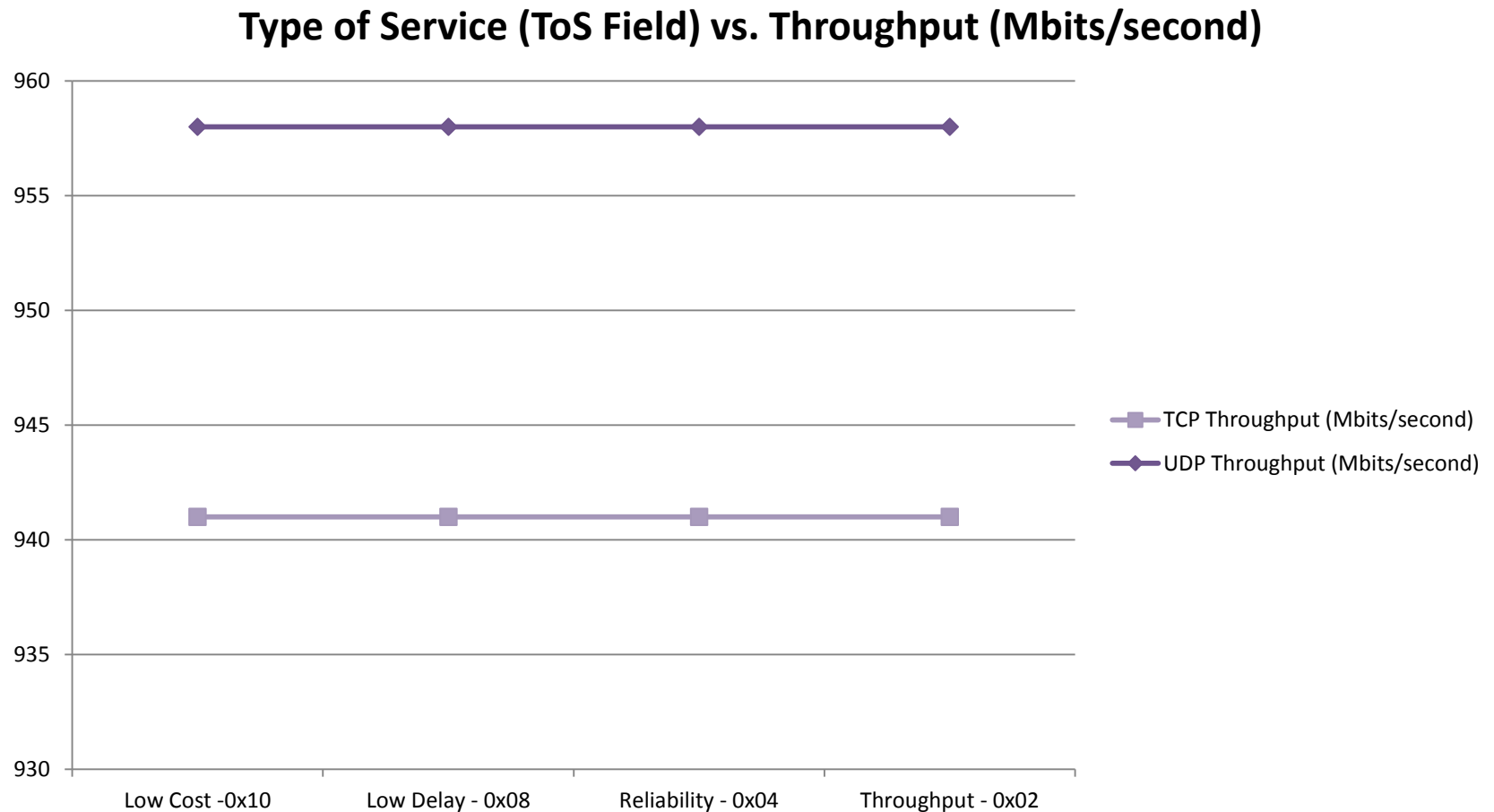- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
    ```
    $ ./iperf3 --server
    ```
- Several iperf3 commands were used on a UltraZed module in order to determine how the Type of Service field can affect throughput, here is one example:
    ```
    # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
    --format m --time 60 --tos 0x02
    ```

Test Case 7: Type of Service TCP and UDP Throughput Tests

<u>Test Results:</u>
- Little to no performance differences noted for various Type of Service types used during tests.

Type of Service (ToS Field) vs. Throughput (Mbits/second)

Test Case 8: TCP Packet Length Throughput Tests

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
  https://github.com/esnet/iperf.git
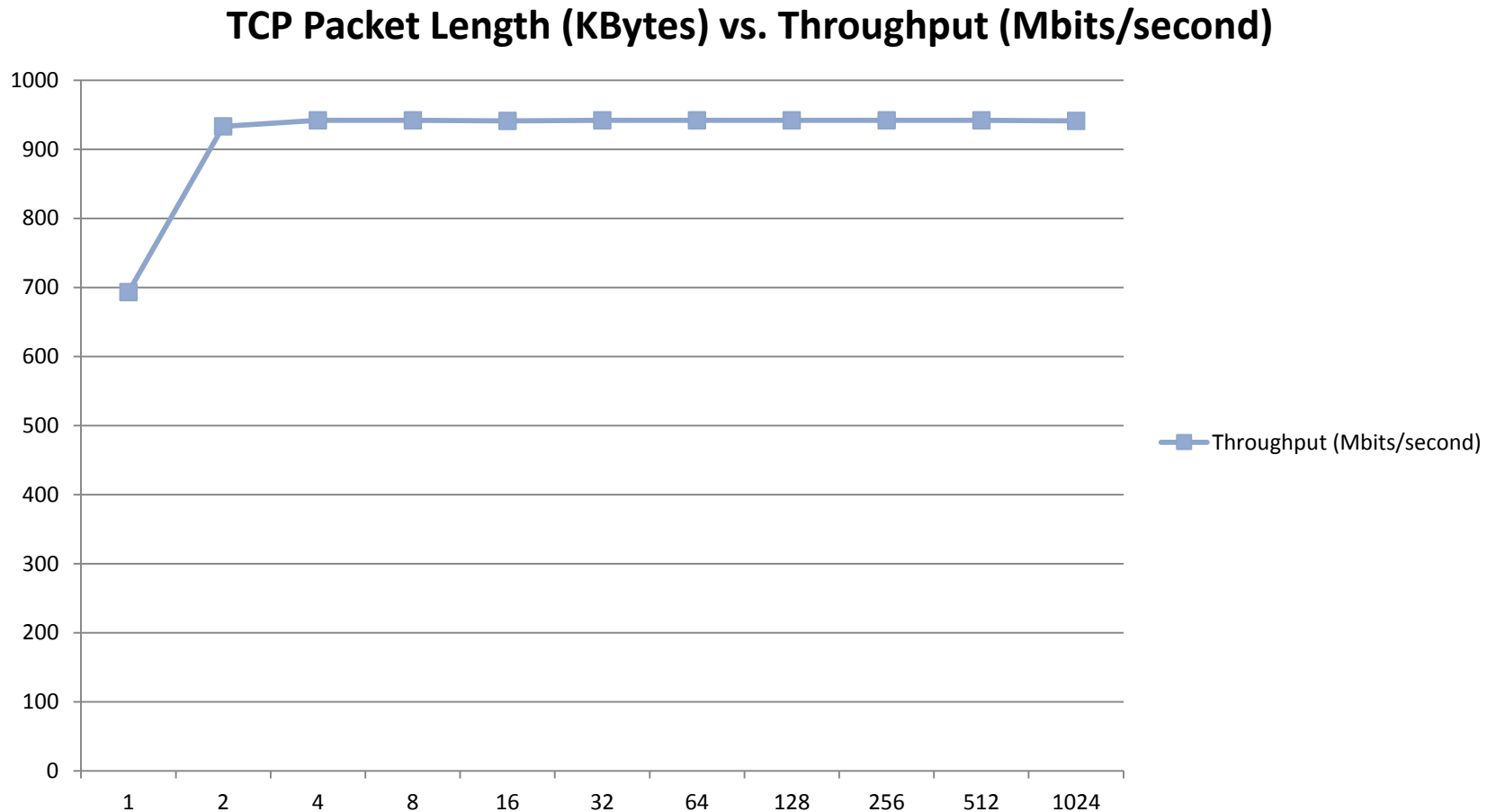- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
  ```
  $ ./iperf3 --server
  ```
- Several iperf3 commands were used on a UltraZed module in order to determine how the TCP packet length field can affect throughput, here is one example:
  ```
  # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
  --format m --length 1K --time 60
  ```

Test Case 8: TCP Packet Length Throughput Tests

Test Results:

- Performance differences noted for various TCP packet lengths used during tests.

TCP Packet Length (KBytes) vs. Throughput (Mbits/second)

Test Case 9: UDP Packet Length Throughput Tests

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
  https://github.com/esnet/iperf.git
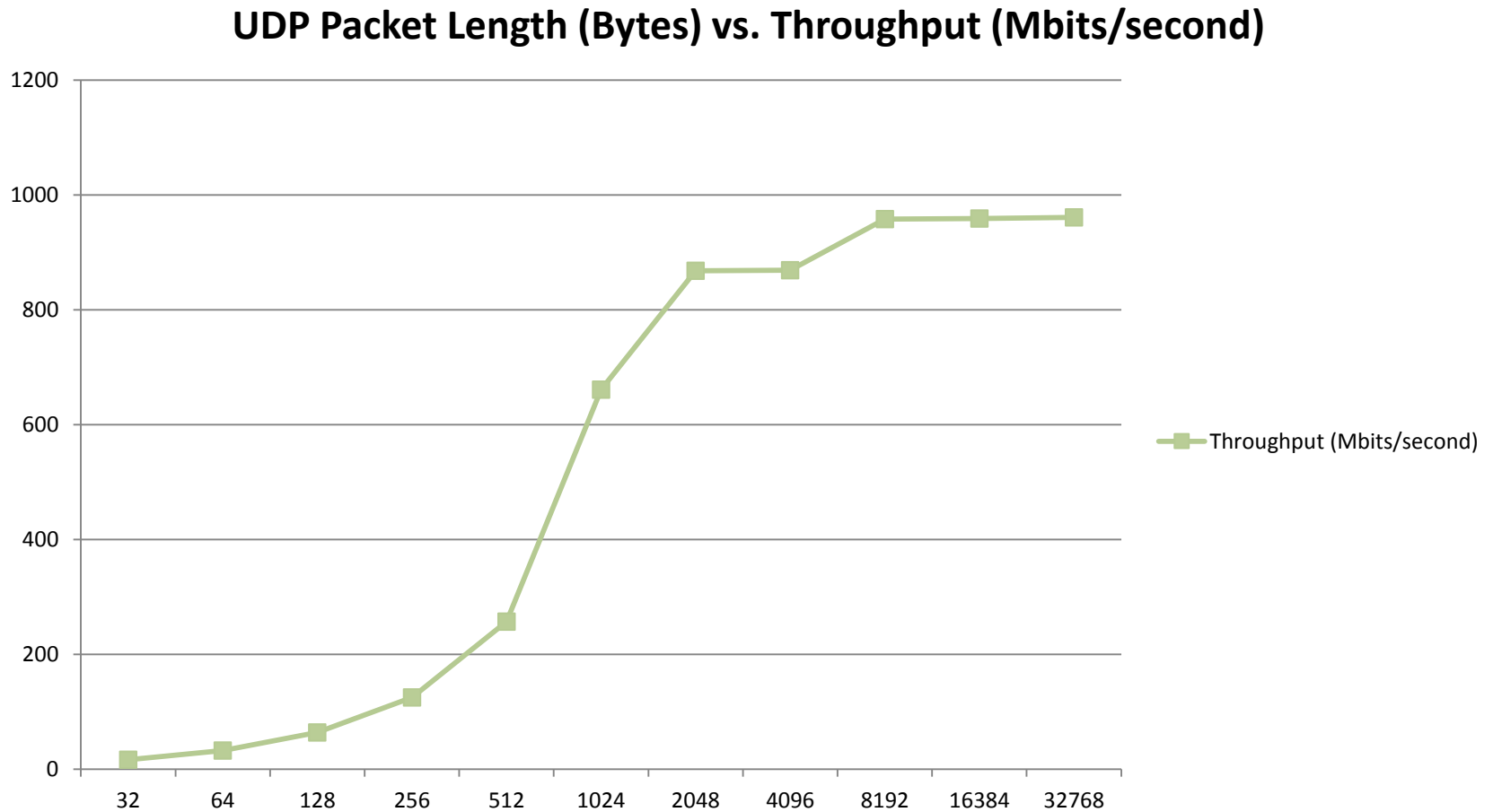- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
  ```
  $ ./iperf3 --server
  ```
- Several iperf3 commands were used on a UltraZed module in order to determine how the UDP packet length field can affect throughput, here is one example:
  ```
  # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
  --format m --length 32 --time 60 --udp
  ```

Test Case 9: UDP Packet Length Throughput Tests

Test Results:

- Performance differences noted for various UDP packet lengths used during tests.

UDP Packet Length (Bytes) vs. Throughput (Mbits/second)

Test Case 10: TCP Window Size Throughput Tests

Test Overview:
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

Test Details:
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
    https://github.com/esnet/iperf.git
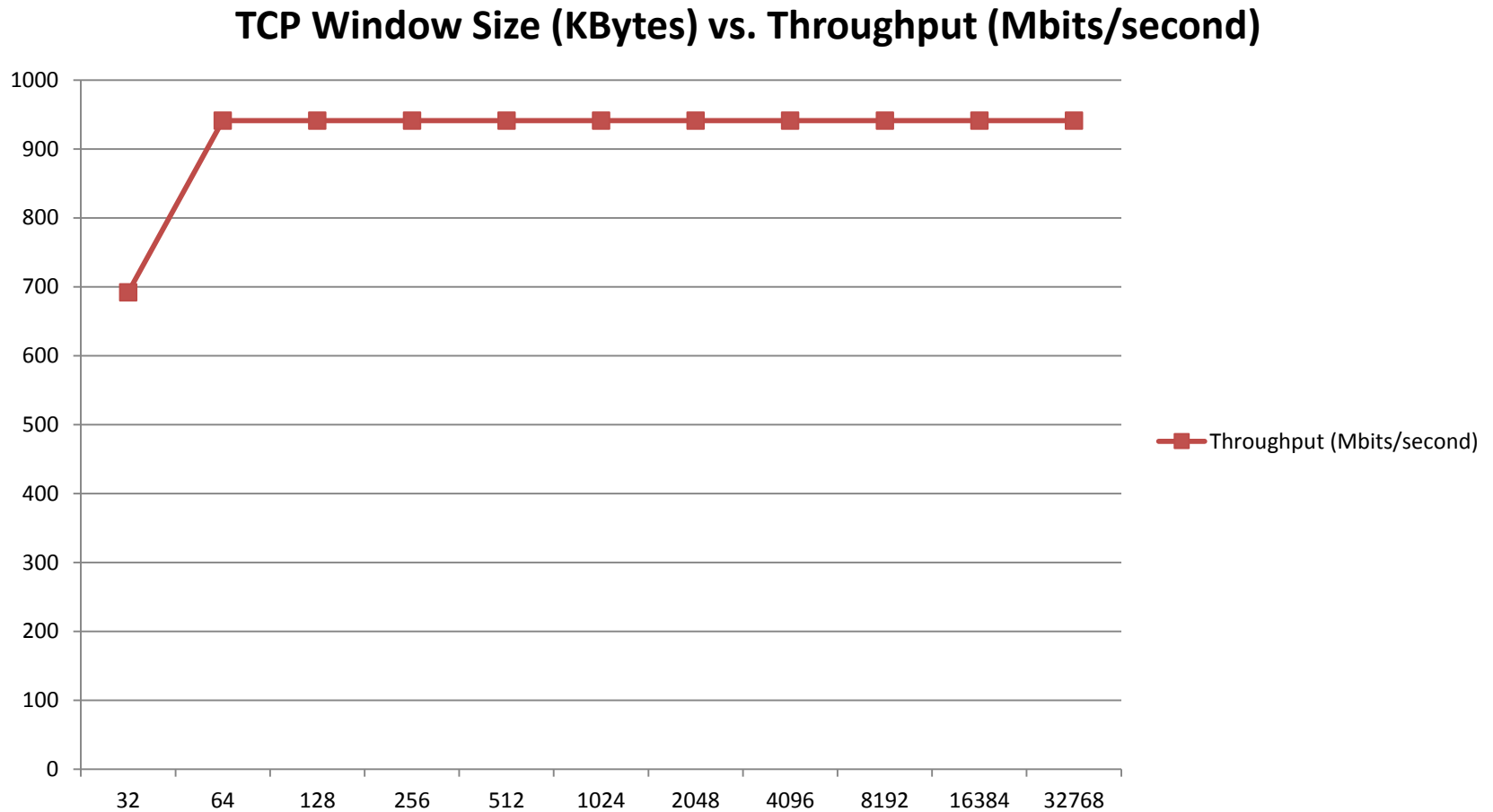- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
    ```
    $ ./iperf3 --server
    ```
- Several iperf3 commands were used on a UltraZed module in order to determine how the TCP window size field can affect throughput, here is one example:
    ```
    # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
    --format m --time 60 --window 32K
    ```

Test Case 10: TCP Window Size Throughput Tests

Test Results:

- Performance differences noted for various TCP window sizes used during tests.

TCP Window Size (KBytes) vs. Throughput (Mbits/second)

<u>Test Case 11: UDP Window Size Throughput Tests</u>

<u>Test Overview:</u>
- 2017.4 PetaLinux BSP is used on UltraZed targets to throughput performance test the network connection to a host PC for 60 seconds
- The application iperf3 v3.1.7 compiled for Zynq to perform network throughput performance testing
- Ethernet linked at 1000Mbps

<u>Test Details:</u>
- The iperf3 v3.1.7 compiled for x86 target using gcc compiler from github source repository
    https://github.com/esnet/iperf.git
- Used for iperf3 v3.1.7 server on CentOS 7.0 host PC:
    ```
    $ ./iperf3 --server
    ```
- Several iperf3 commands were used on a UltraZed module in order to determine how the UDP window size field can affect throughput, here is one example:
    ```
    # ./iperf3 --bandwidth 1000M --client 192.168.1.100 \
    --format m --time 60 --udp --window 32K
    ```

Test Case 10: UDP Window Size Throughput Tests

Test Results:

- Little to no performance differences noted for various UDP window sizes used during tests.

UDP Window Size (KBytes) vs. Throughput (Mbits/second)