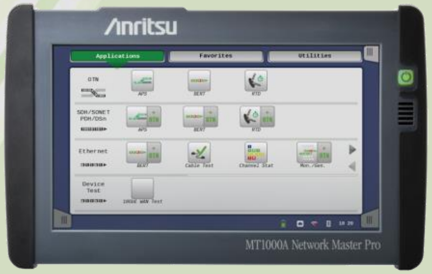
Application Note

Advancing beyond

Evaluating 5G/Local 5G Networks
- Differences Between PC (iPerf/Ping) and MT1000A Evaluations -

Network Master Pro

MT1000A



Introduction

5G/Local 5G features high reliability and low latency in comparison to conventional LTE (4G), and different applications using these features are being considered.

Evaluation of 5G/Local 5G network performance uses the PC iPerf and Ping applications for simple evaluation cases.

The following diagram compares evaluation results using iPerf and Ping with results from the Network Master Pro MT1000A to clarify the differences.

Network Master Pro MT1000A

■ All-in-one support for 10M~100G Ethernet

■ Supports required on-site measurements, including throughput, packet loss, BER, latency, packet jitter, TCP throughput, Ping, trace route, etc.

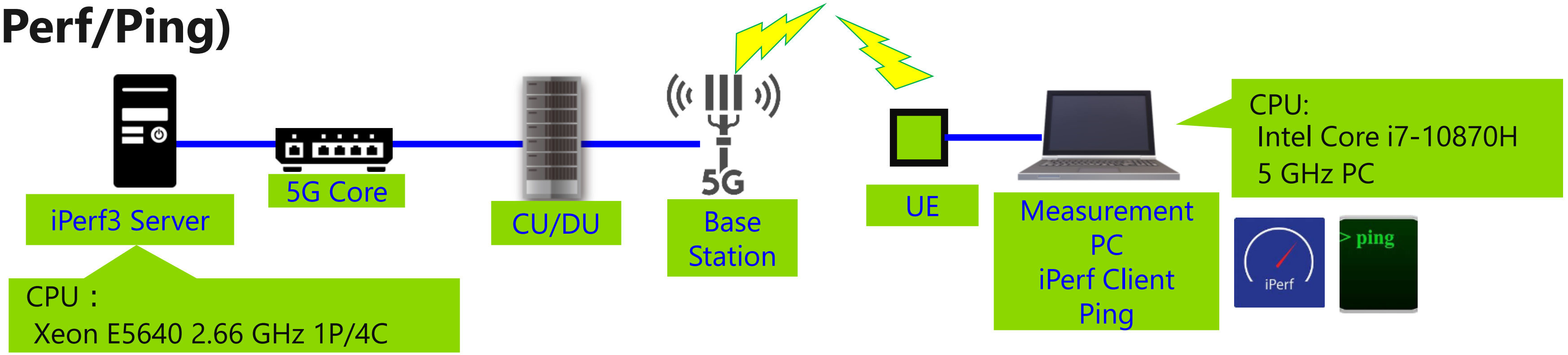
■ Evaluates low-latency 5G/Local 5G

■ Measures PTP time synchronization accuracy

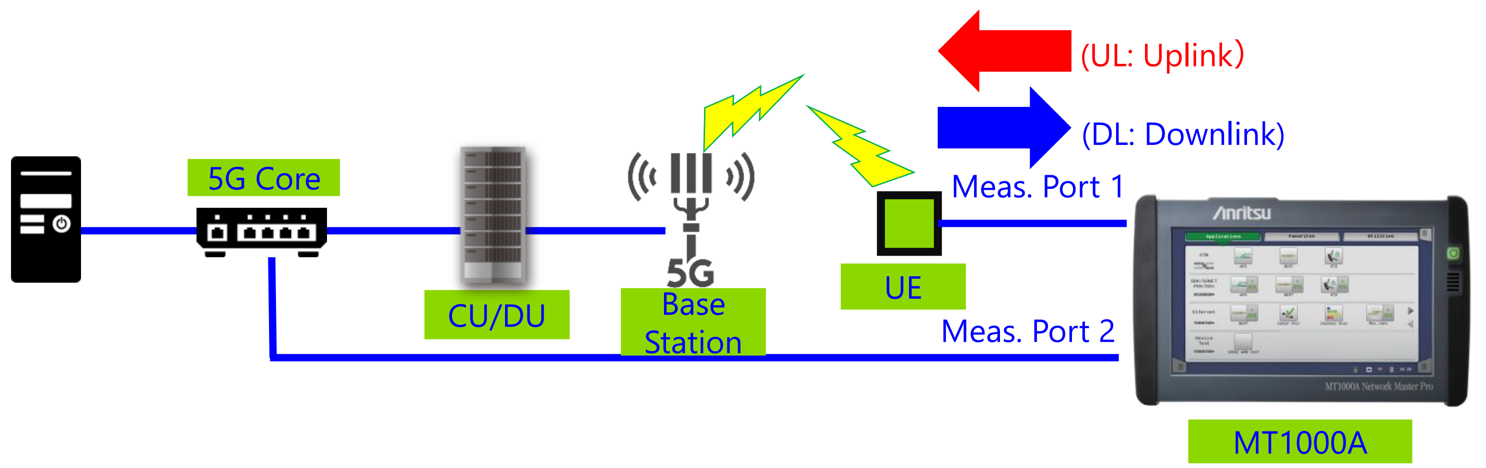
- Evaluation Configuration/Items
- UDP Throughput/Packet Loss/Packet Jitter Measurement
- Latency Measurement
- Summary
- Measurement Precautions
- Appendix
  - Differences between MT1000A and iPerf Technologies

Evaluation Configuration

■ 5G/Local 5G Network Laboratory Setup using PC (iPerf/Ping)



■ 5G/Local 5G Network Laboratory Setup using MT1000A



Evaluation Items

This table lists the measurement items for each method. The next pages compare the evaluation results using a PC (iPerf/Ping) with results from the MT1000A to identify differences.
(*These materials do not include comparison of TCP throughput.)

Measurement		PC		MT1000A
		iPerf	Ping	
UDP Throughput	UL: UE → 5G/L5G core network	v	No support	v
	DL: 5G/L5G core network → UE	v	No support	v
UDP Packet Jitter (Both UL/DL)	AVE	v	No support	v
	MAX/MIN	No support	No support	v
UDP Latency	UL: UE → 5G/L5G core network (MAX/MIN/AVE)	No support	No support	v
	DL: 5G/L5G core network → UE (MAX/MIN/AVE)	No support	No support	v
Ping RTT (two way)		No support	v	v
TCP Throughput	UL: UE → 5G/L5G core network	v	No support	v
	DL: 5G/L5G core network → UE	v	No support	v

Note: This table shows whether the measurement function is supported or not but does not compare measurement accuracy.

UDP Throughput, Packet Loss Rate, Packet Jitter Measurements

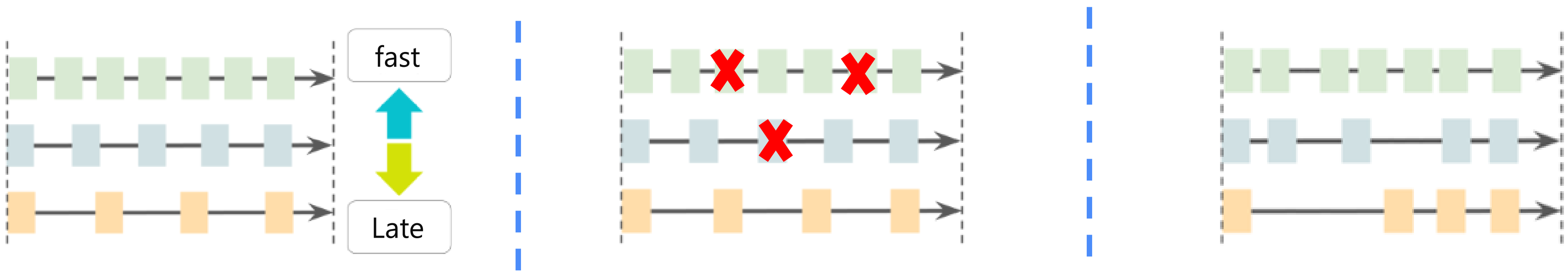
Throughput and packet loss are network evaluation indices.

Throughput expresses the data transfer per unit time in bits per second (bps) as a measure of high-speed communications.

As the name suggests, packet loss means the number of packets that are lost during transfer and is expressed as the percentage (%) of packets lost per second. Evaluation of both throughput and packet loss is used to confirm network quality.

Additionally, measurement of packet jitter is recommended when configuring high-quality networks. Since Ethernet achieves its best effort specification by not using a constant packet interval, a short packet interval can easily inflict heavy loads on communications equipment, which can cause lost packets.

The following diagram expresses these concepts.



Throughput Packet Loss Packet Jitter

The next pages introduce the MT1000A and iPerf evaluation differences.

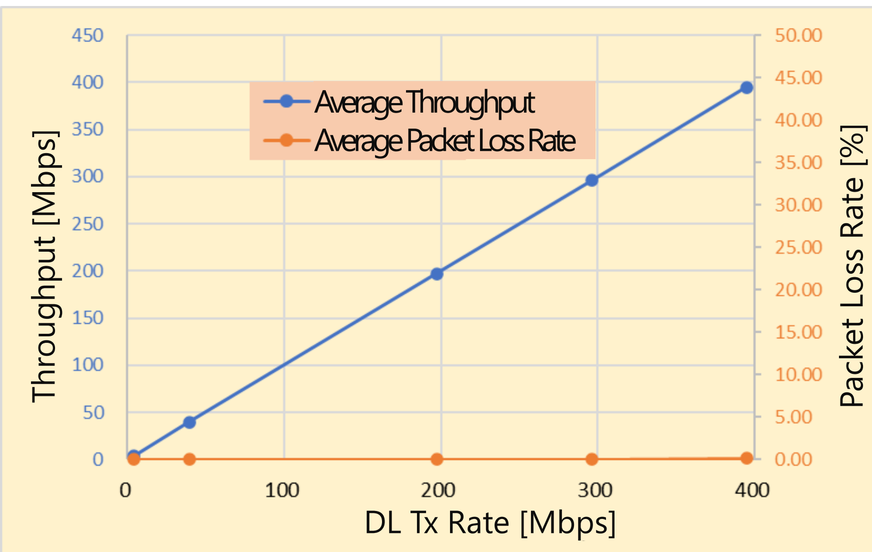
Comparison of MT1000A and PC (iPerf)

■ UDP Throughput and Packet Loss Rate Measurement

In both measurements, test packets were sent at a specified rate and the throughput and packet loss rate were measured at the Rx side.

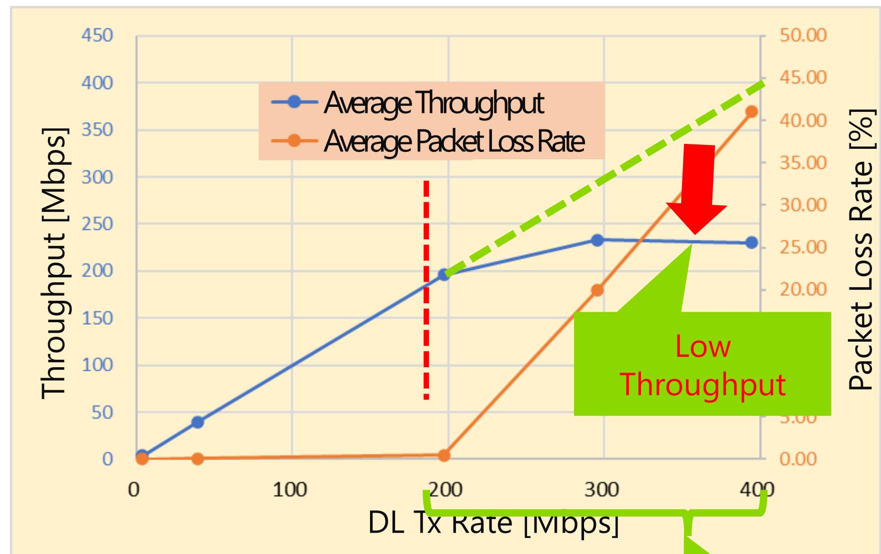
(1) Sending 1482 bytes of Ethernet packets in DL direction

MT1000A Measurement



Measures throughput and packet loss rate accurately even at full wire rate (100% load)

PC (iPerf) Measurement



Cannot measure throughput accurately at speeds above 200 Mbps due to start of packet loss

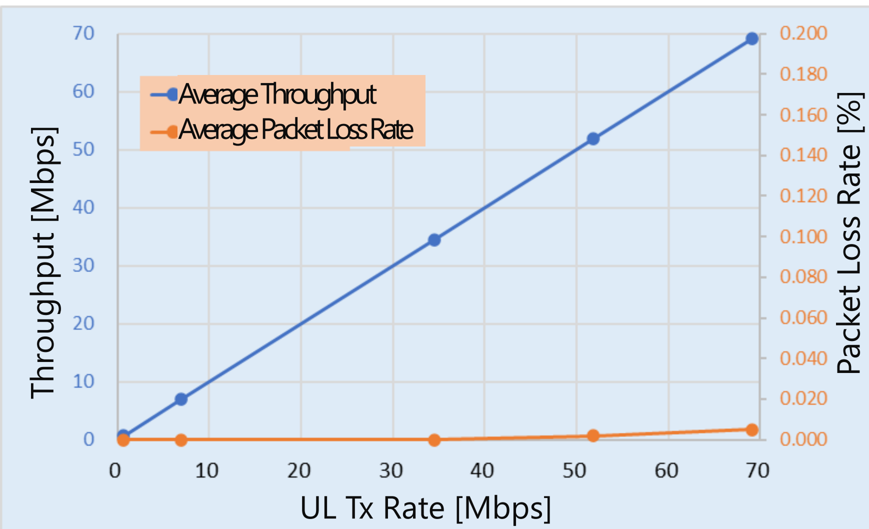
Comparison of MT1000A and PC (iPerf)

■ UDP Throughput and Packet Loss Rate Measurement

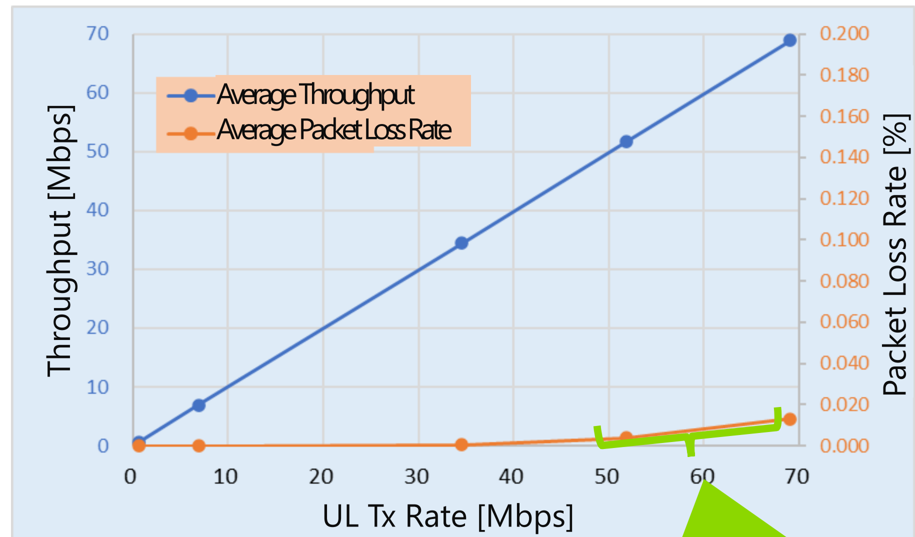
In both measurements, test packets were sent at a specified rate and the throughput and packet loss rate were measured at the Rx side.

(2) Sending 1482 bytes of Ethernet packets in UL direction

MT1000A Measurement



PC (iPerf) Measurement



Packet loss increases as the Tx rate exceeds 50 Mbps

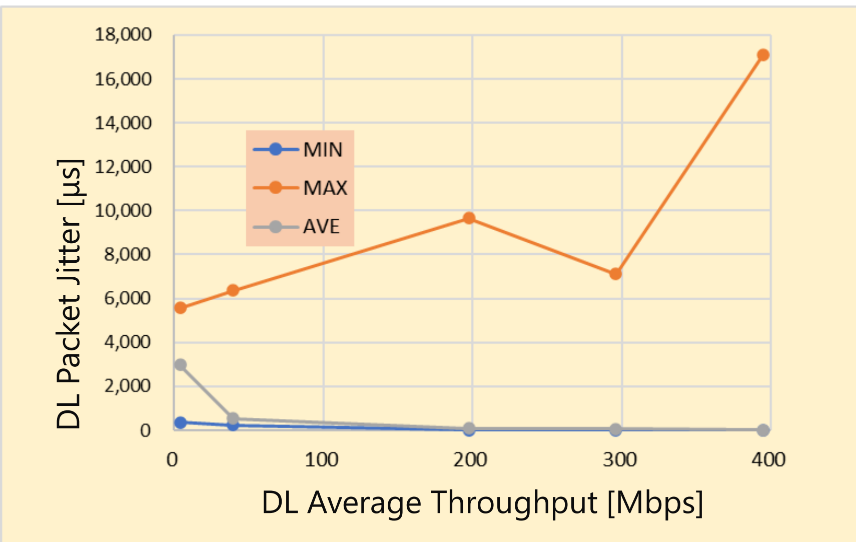
Comparison of MT1000A and PC (iPerf)

■ UDP Packet Jitter Measurement

In both measurements, test packets were sent at a specified rate and the throughput and packet loss rate were measured at the Rx side.

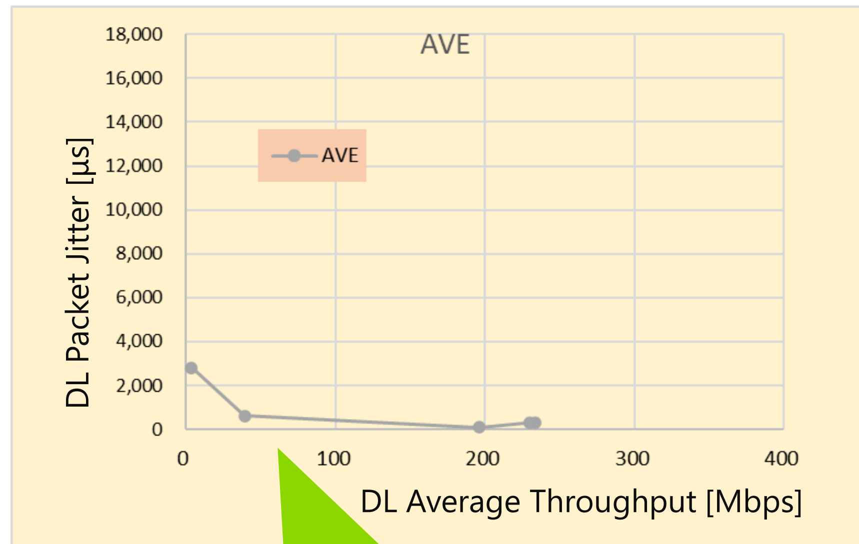
(1) Sending 1482 bytes of Ethernet packets in DL direction

MT1000A Measurement



Measures packet jitter MAX, MIN, and AVE rates

PC (iPerf) Measurement



In comparison with MT1000A, iPerf measured jitter values are averages and jitter MAX and MIN cannot be measured.

Comparison of MT1000A and PC (iPerf)

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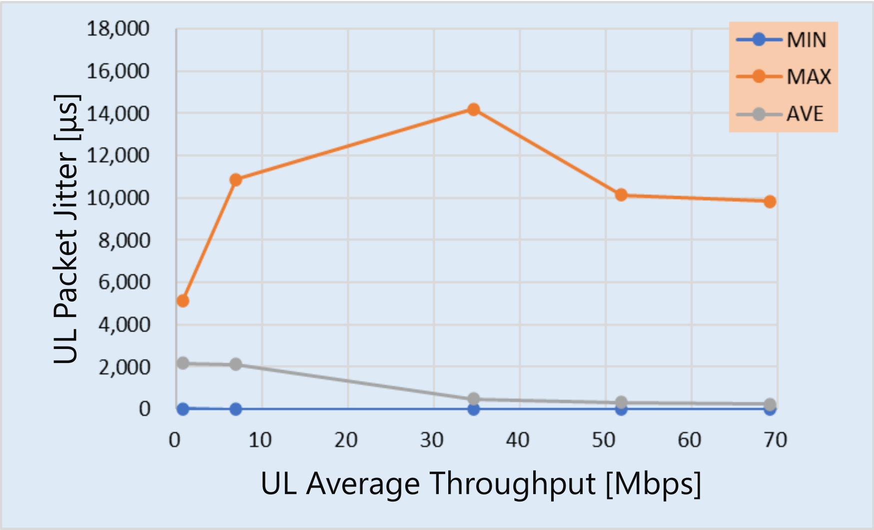
■ UDP Packet Jitter Measurement

In both measurements, test packets were sent at a specified rate and the throughput and packet loss rate were measured at the Rx side.

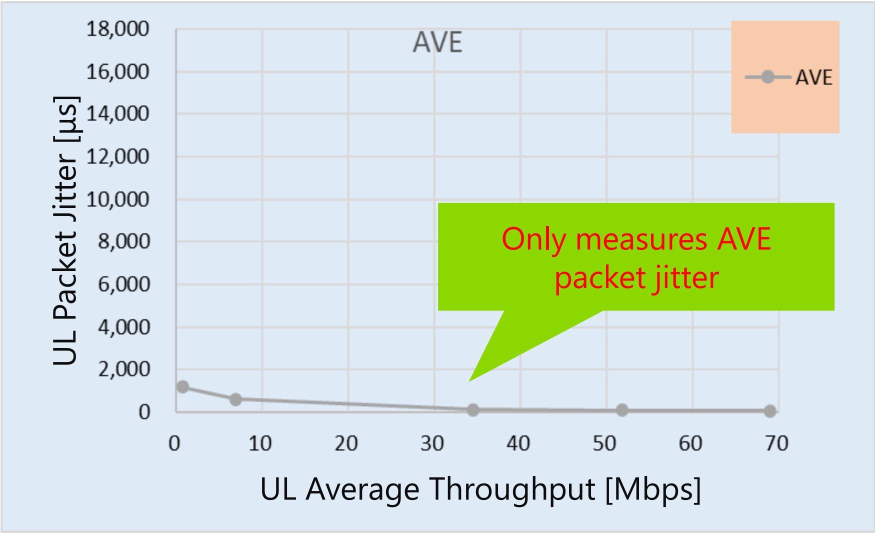
(2) Sending 1482 bytes of Ethernet packets in UL direction

MT1000A Measurement



Measures packet jitter MAX, MIN, and AVE rates

PC (iPerf) Measurement

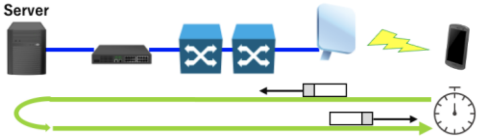


Latency Measurement

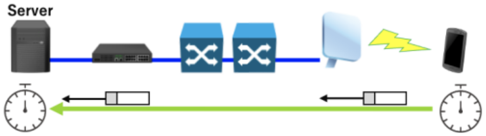
Low latency is a feature of 5G/Local 5G networks that will support many new services.

Network latency is measured using the following two methods:

- Round Trip Time (RTT)
  Measures time required for data sent from the UE to return to the server and requires one clock for measurement



- One Way Delay
  Measure time required for data sent from UE to reach server and requires two clocks for measurement



Delay is usually measured using the Ping tool. Although Ping can measure the RTT, it is inadequate for measuring network quality.

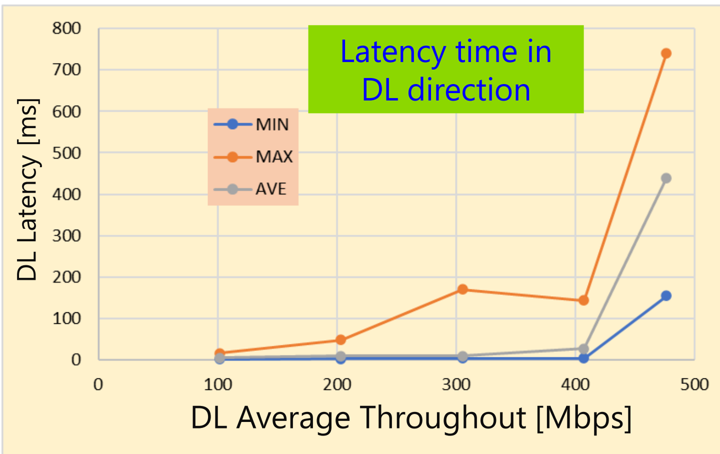
The next pages introduce MT1000A and Ping measurement differences and results.

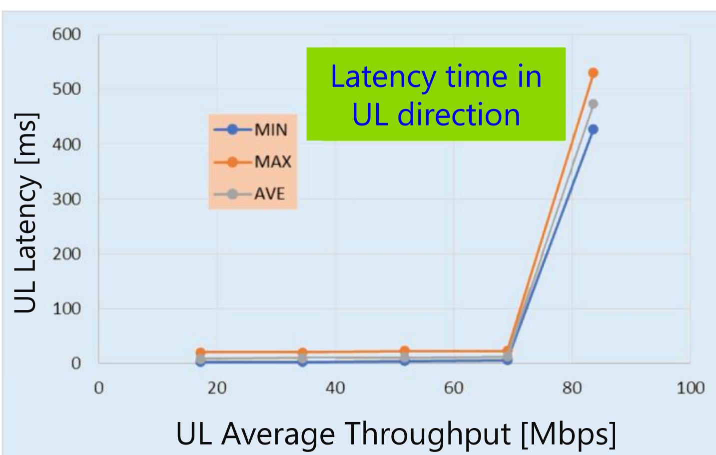
Comparison of MT1000A and PC (Ping)

Latency time changes with the UL and DL transfer direction and load rate.

The PC Ping tool cannot measure latency in each direction.
In addition, it cannot evaluate changes with time because it measures only one sample per second.

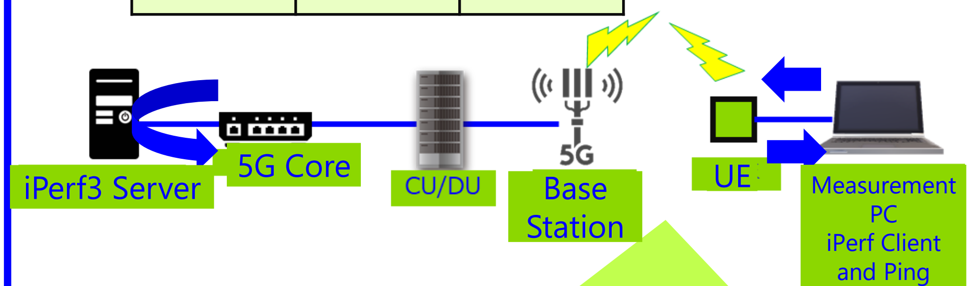
MT1000A Measurement





PC (Ping) Measurement

Ping RTT [ms]		
MIN	MAX	AVE
10	38	25



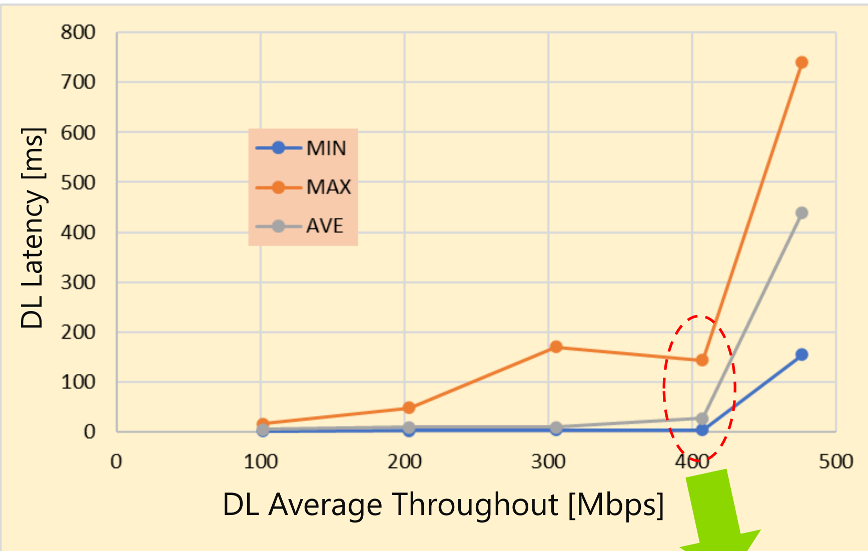
1. Ping unable to measure RTT accurately because measurement includes replying PC server processing time
2. Unknown error degree included in each Ping measurement because measurement accuracy unclear
3. Ping ms-order measurement resolution prevents measurement at accuracies better than ms
4. Sample measurement of one Ping test per second
5. Latency changes with load but Ping test does not support load setting

Latency Measurement using MT1000A

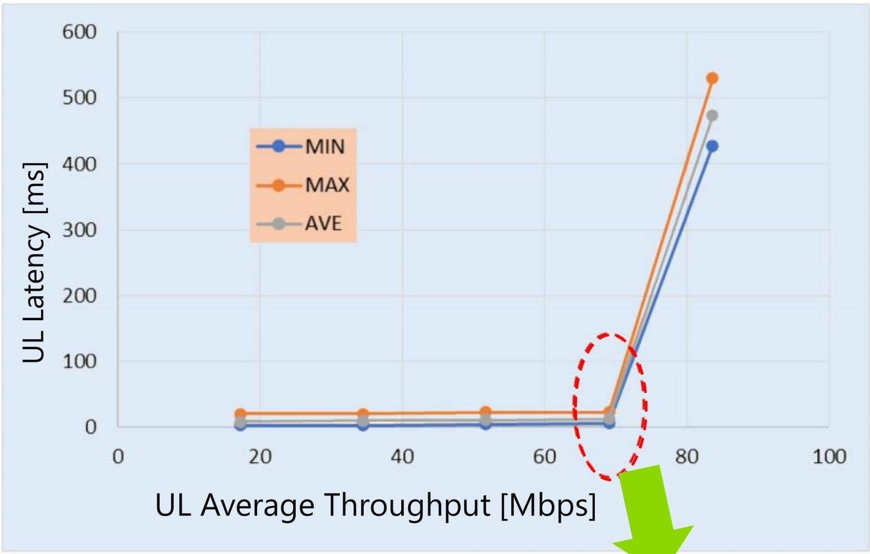
The latency time in the UL and DL directions can be measured using the MT1000A.

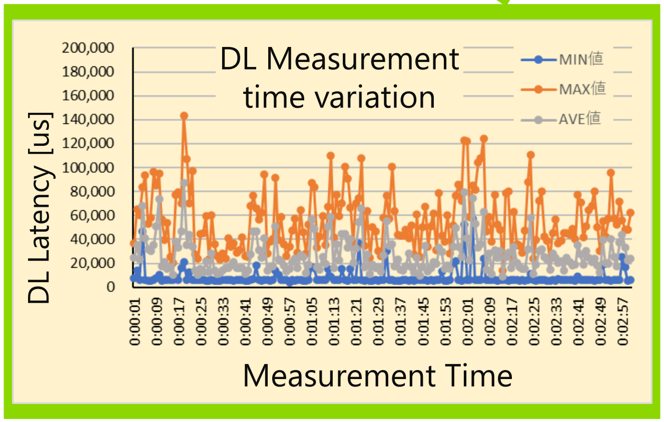
■ UDP One-Way Latency (1482 Test Packets)

DL Latency Time

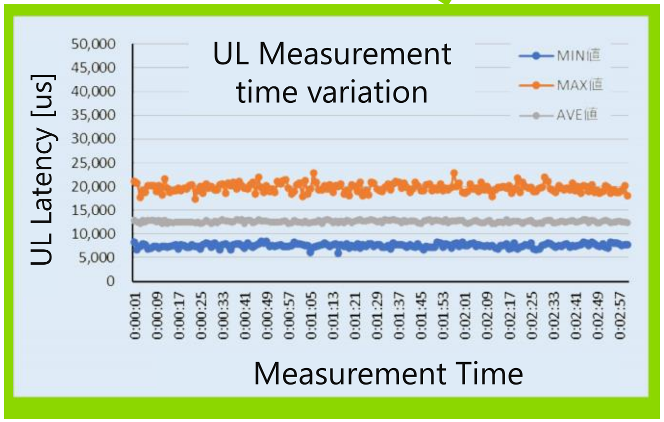


UL Latency Time





Latency Change During 3 Minutes



Summary

	MT1000A	PC (Ping)	PC (iPerf)
Latency	One-way	Roundtrip	Roundtrip
Traffic Load	Real IP traffic	ICMP, sparse load Windows: 1 s interval MAC: 100 ms interval	Real IP traffic
Load Accuracy	Accurately stable	N/A	Unstable depending on CPU load

Using the MT1000A has the following advantages.

① The MT1000A measures MIN/MAX/AVE latency times for both UL and DL.
It also accurately measures time-series changes in latency.

- Ping measures RTT latency but cannot measure one-way latency for each direction.
- Ping RTT includes the processing time for the PC receiving the ICMP packets. Since it cannot measure this separately, the measured latency time is inaccurate.
- Ping measures one sample per second and the RTT cannot be measured while applications run because the load cannot be specified.
- Ping measurement accuracy cannot be clarified because it uses software processing.

② MT1000A measures packet jitter MAX and MIN values as well as AVE.

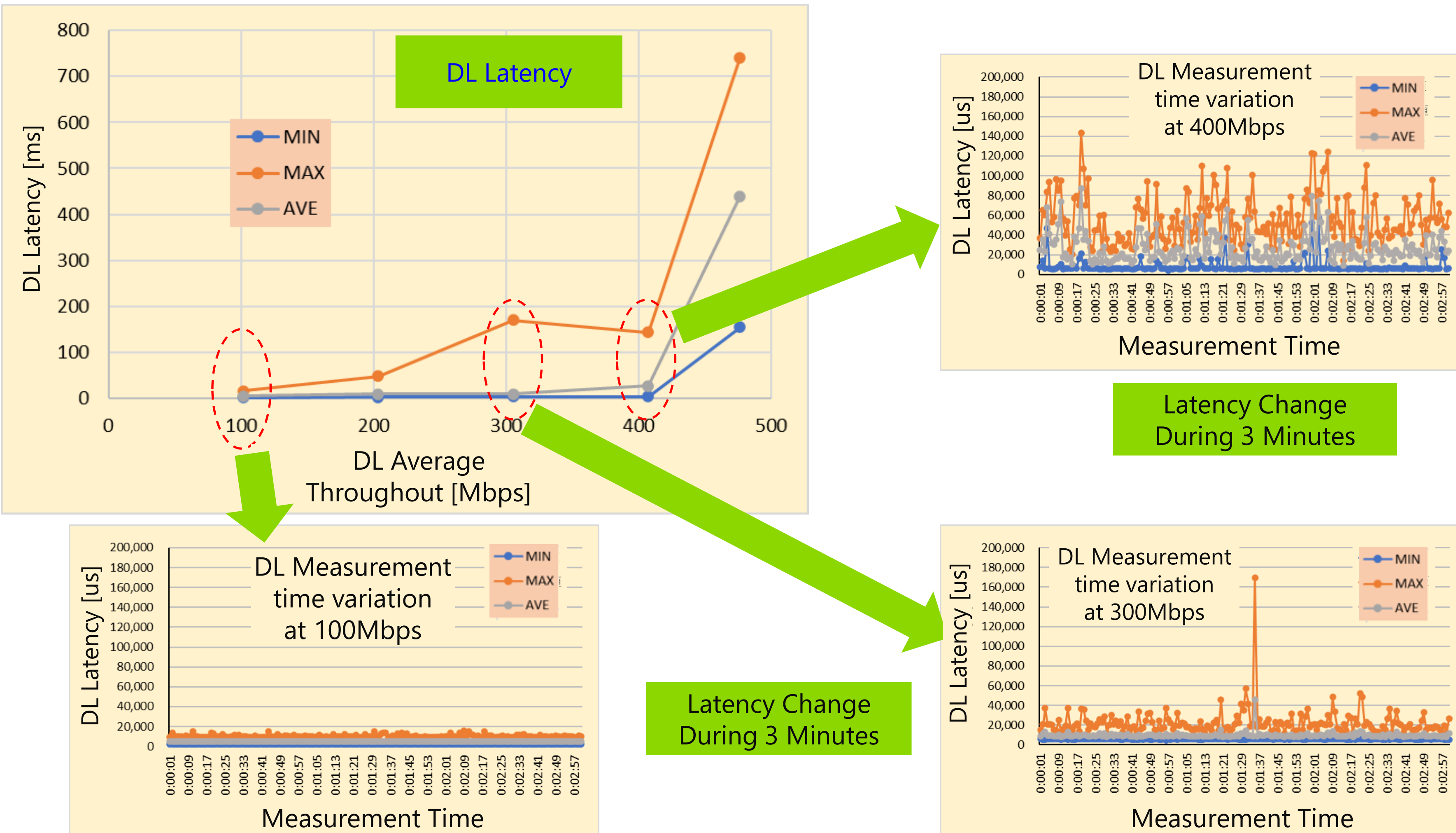
③ Since iPerf sends test packets in bursts (software processing), system performance cannot be evaluated accurately. The MT1000A measures accurately because it uses hardware processing to always send packets at a fixed rate.

Appendix

Notes on Measuring Packet Loss, Latency and Jitter

Packet loss, latency, and packet jitter change with traffic loads. These measurements require predetermined traffic load rates for test packets.

The following graphs show the DL latency differences with traffic loads.



Differences in Throughput and Latency with Packet Size

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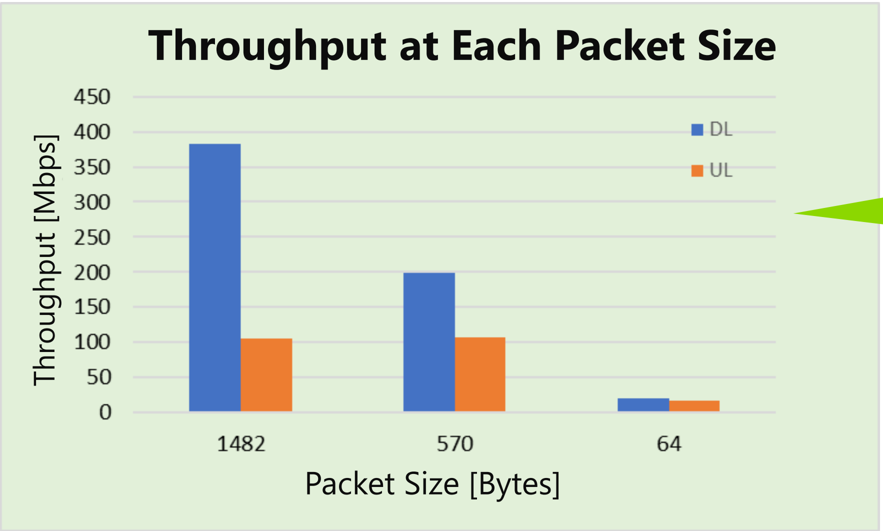
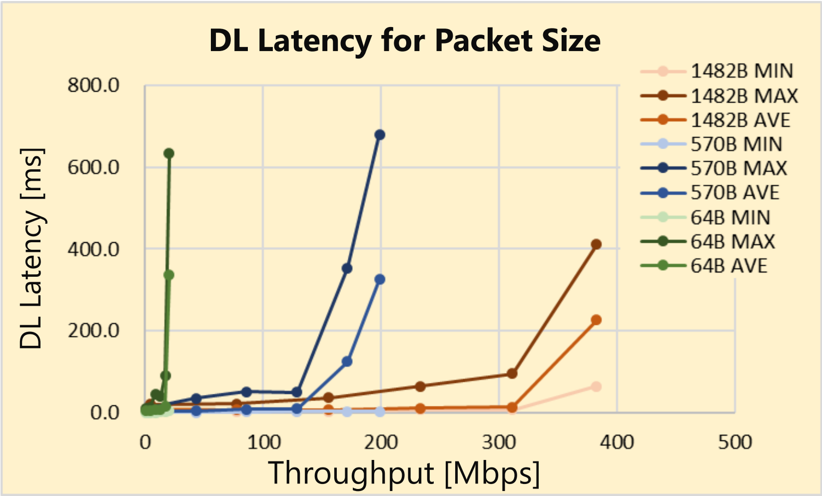
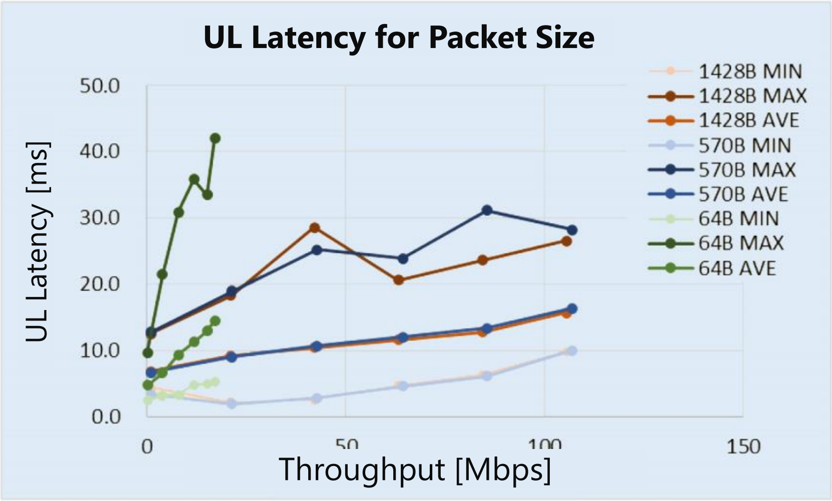
System load changes with packet size even at the same traffic load, and the system load is bigger with smaller packets. Since latency increases with higher system load, the test packet size must be predetermined.



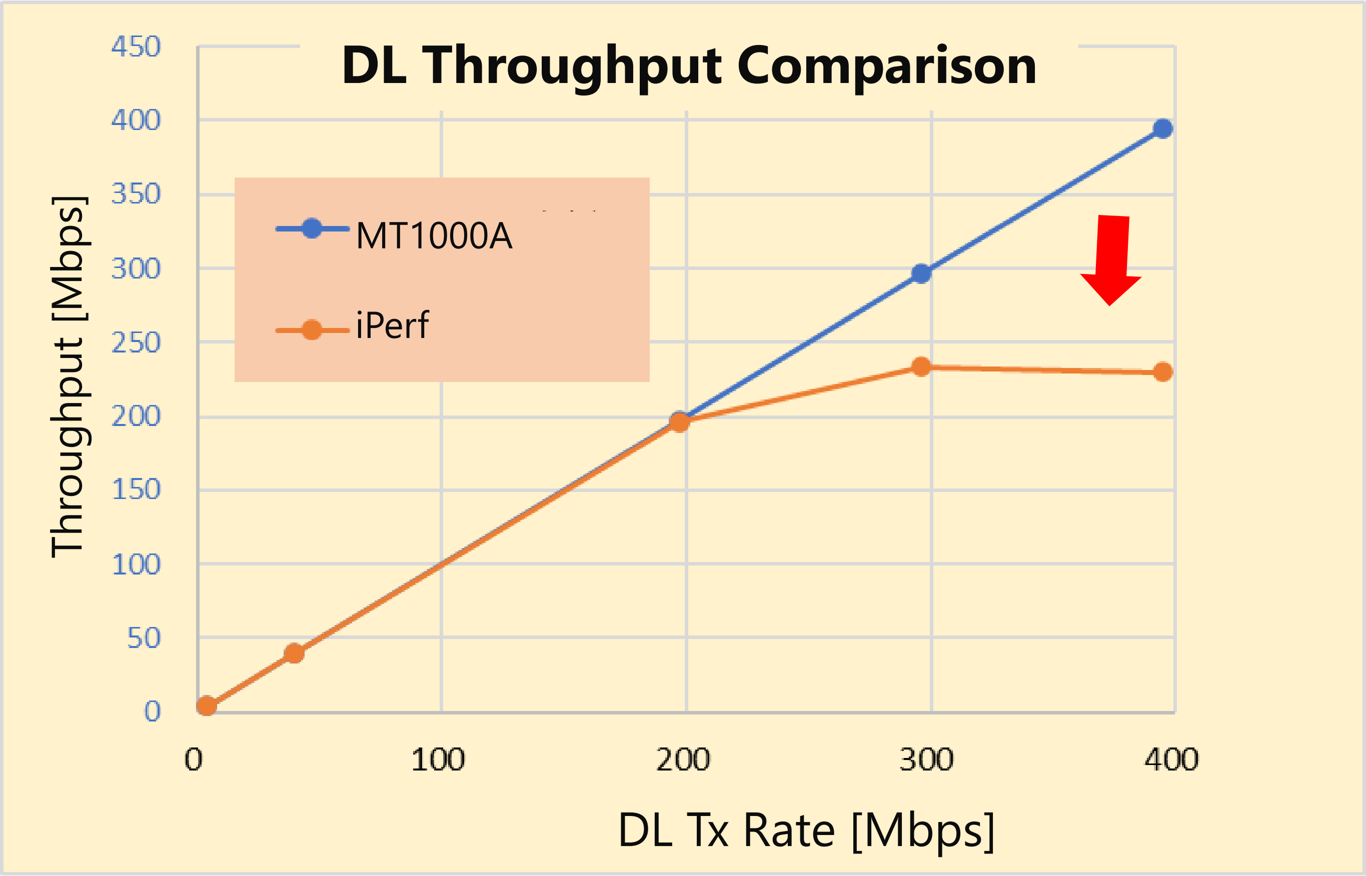
Packet size is known to greatly affect system load in DL direction.





Lower Throughput at iPerf Measurement

The throughput measured using iPerf appears to decrease when the Tx rate exceeds 200 Mbps. The cause of this phenomenon has been analyzed.



This is confirmed by measuring how test packets are output from the PC iPerf application.

Differences in Measured Throughput (1/3)

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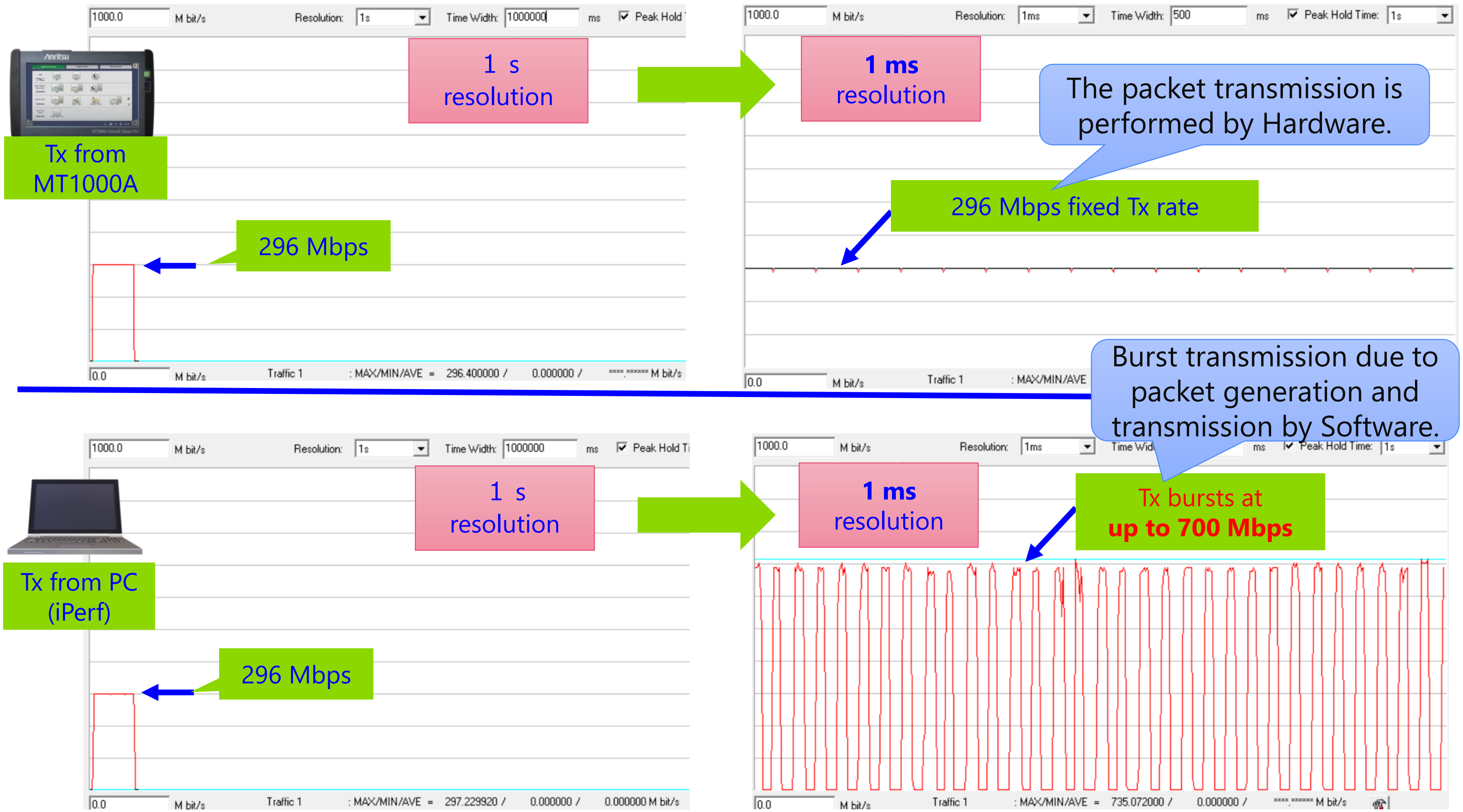
Both the MT1000A and PC (iPerf) were used to send UDP test packets at 300 Mbps and the original equipment was used to measure any differences.

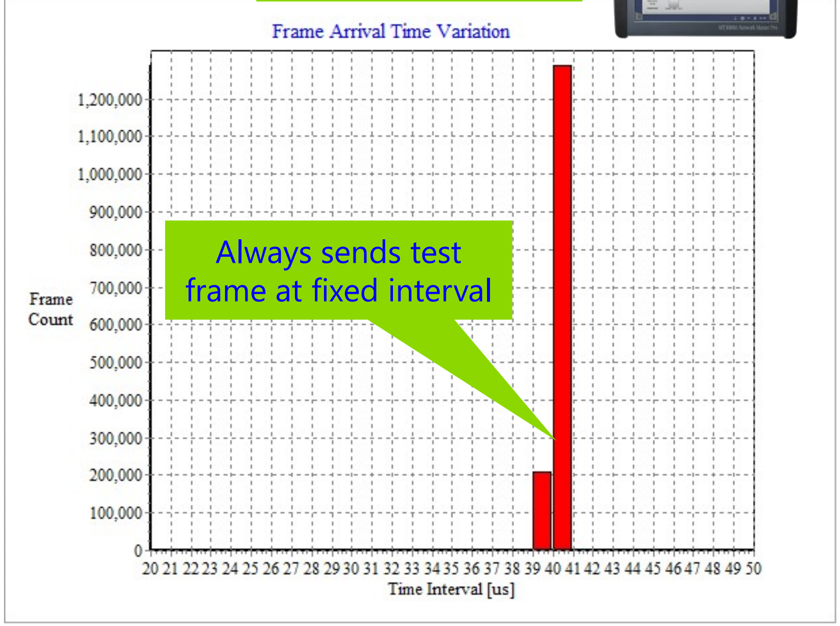
At the 1 s measurement resolution, iPerf appeared to be sending at a fixed rate, but at the 1 ms measurement resolution, iPerf was clearly sending in bursts of up to 700 Mbps.



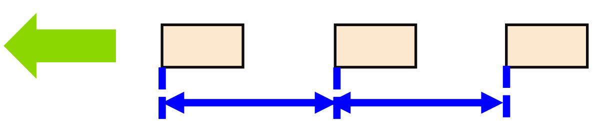
Differences in Measured Throughput (2/3)

Both the MT1000A and PC (iPerf) were used to send UDP test packets at 300 Mbps and the original equipment was used to measure differences in the Tx test packet interval.

Tx from MT1000A

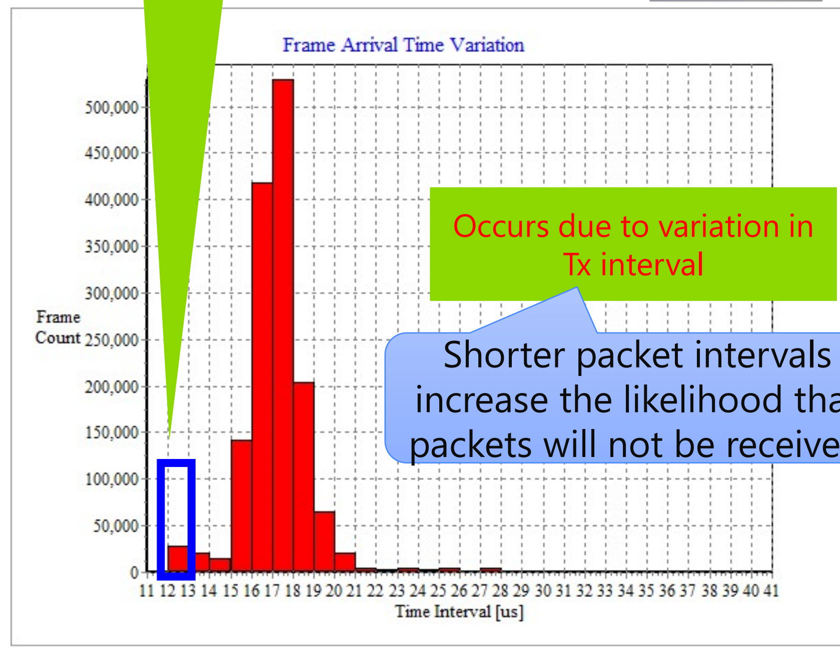


Always sends test frame at fixed interval



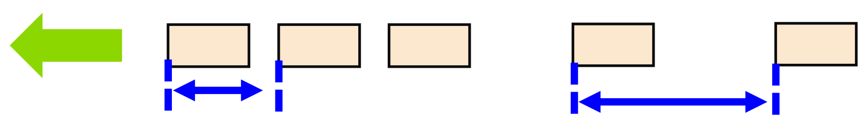
Occurs even at full wire rate Tx interval

Tx from PC (iPerf)



Occurs due to variation in Tx interval

Shorter packet intervals increase the likelihood that packets will not be received.

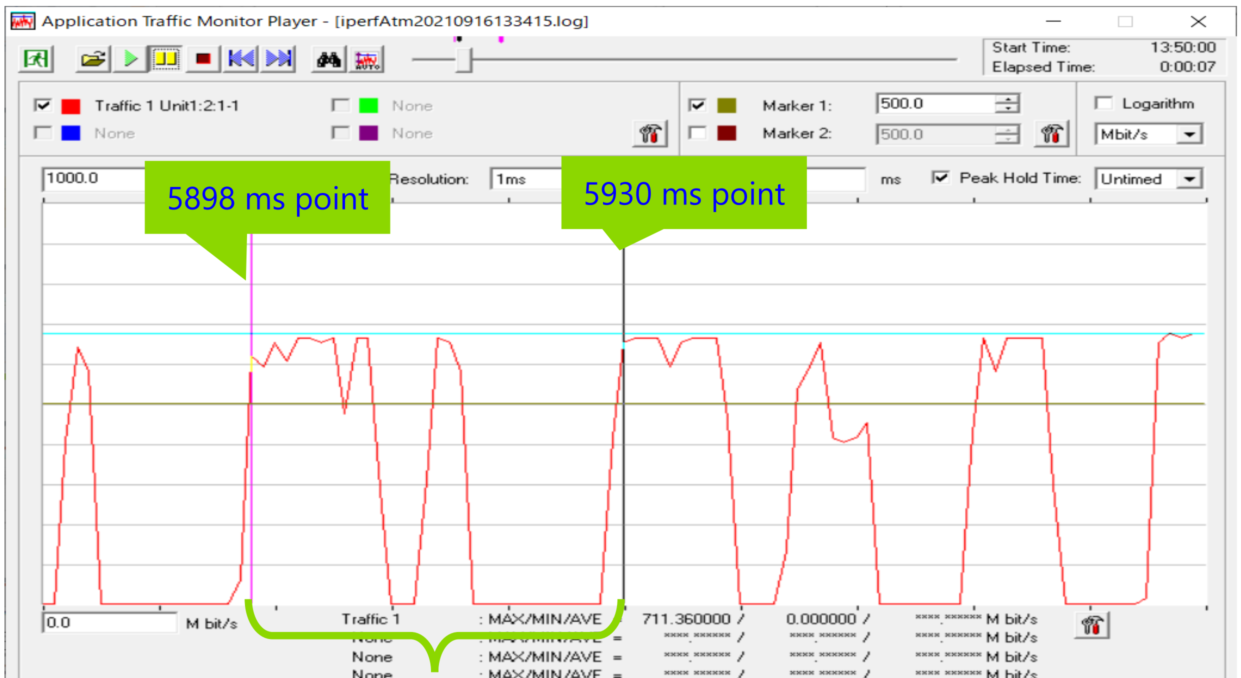


Tx packets sent in bursts as shown on previous page

Differences in Measured Throughput (3/3)

The instantaneous Tx burst rate of 711 Mbps seen when measuring test packets sent from the PC (iPerf) at 1 ms resolution results in high loads that are thought to cause issues with system packet loss and reduced throughput.

Tx from PC (iPerf)



Tx bursts at up to 711 Mbps in cycle of about 40 ms.
Packet loss occurs when system load exceeds 700 Mbps

Probable differences in burst shape due to PC performance and Tx rate

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