

TCP Throughput Tests

Practical throughput testing based on RFC 6349

Network Master Pro	MT1000A
10G Multirate Module	MU100010A1
100G Multirate Module	MU100011A

Introduction

Optimizing communication performance and quality is essential to both wired and wireless Ethernet network environments. Typically, network operators and service providers perform lower layer testing based on the IETF*¹ RFC 2544 Benchmarking Methodology for Network Interconnect Devices and the ITU-T*² Y.1564 Ethernet Service Activation Methodology. However, even if these test results are acceptable, there are cases where end-user satisfaction is not attained due to reduced throughput. One example of this is the case where the Transmission Control Protocol (TCP) connection, the upper layer of terminal-to-terminal communication in the network, is not optimized.

TCP guarantees reliable communication by ensuring that data packets are received correctly. However, if the window size or buffer capacity settings on the network device are not optimized for the TCP connection, the TCP throughput may be lower than the throughput achieved by Ethernet/Internet Protocol (IP). For this reason, operators and service providers must test according to the RFC 6349 Framework for TCP Throughput Testing, a standard for measuring network performance.

With the TCP Throughput option installed, the Network Master Pro MT1000A can perform TCP throughput tests based on RFC 6349 in addition to regular Ethernet/IP tests (RFC 2544 /ITU-T Y.1564) that support speeds up to 10 Gbps.

*1: The Internet Engineering Task Force (IETF) is one of the organizations that develop standards for the Internet.

*2: ITU-T is the Telecommunication Standardization Sector of the International Telecommunication Union (ITU), responsible for ITU-T Recommendations.

Product Features

- A single unit can support up to two ports.
- Supports 10-gigabit Ethernet (10GbE)
- Bidirectional simultaneous testing
- Simultaneous emulation and analysis using up to 16 TCP sessions
- Testing of connectivity to iPerf server by emulating iPerf client

Multiple ports allow for the simultaneous testing of multiple lines and for opposing testing in the lab prior to the start of service. The test port supports up to 10GbE, allowing the verification of services using high-speed lines.

Simultaneous Multiple Connection Testing



Laboratory Testing before Commissioning

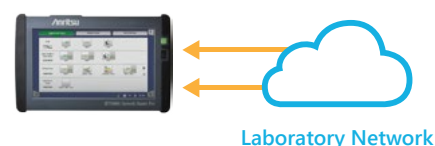


Figure 1 TCP Throughput Test Using Multi-Ports (Up to 10GbE)

Overview of TCP Throughput Test and RFC 6349

The most important test parameter when measuring Ethernet performance is throughput. In general, throughput refers to the maximum bandwidth that can be achieved without incurring packet loss. However, the actual use of Ethernet services often involves communication over the TCP protocol, such that there is an increasing demand for throughput testing using TCP, including flow control and retransmission control. The TCP throughput testing method is defined in RFC 6349.

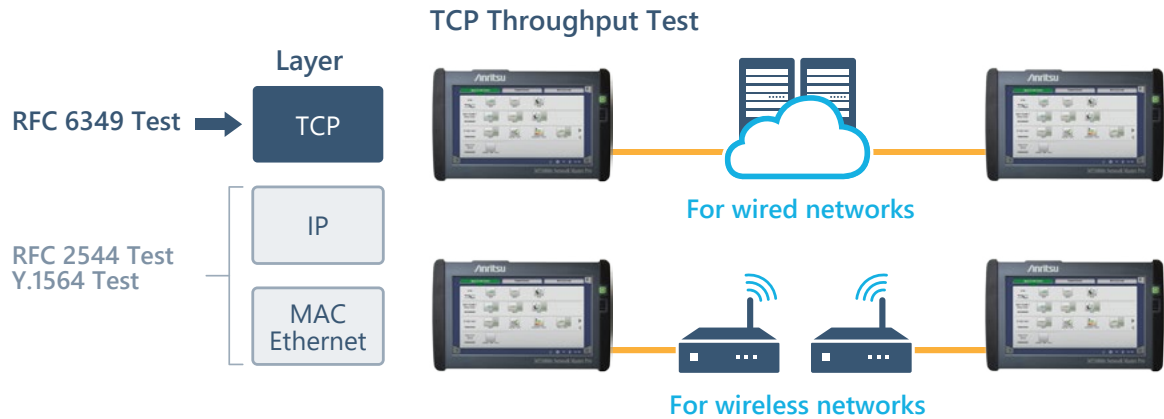


Figure 2 RFC 6349 TCP Throughput Test

According to RFC 6349, the following items are measured:

- Path MTU
- Baseline round trip time and bottleneck bandwidth
- TCP throughput

Path MTU (Maximum Transmission Unit)

The path MTU means the largest IP packet that can pass through a network without being fragmented along the communication path. For Ethernet, it is 1500 bytes. In this case, the data size (Maximum Segment Size) that can be sent over TCP is 1460 bytes, excluding the IP and TCP headers from the path MTU. Some network devices may be configured with less than this. If the data size of a packet to be sent exceeds the path MTU, the packet is split (fragmented) during transmission and the throughput reduces. Therefore, the upper limit on the packet size for the throughput test is determined from the path MTU. In the example shown in Figure 3, 1350 is the smallest MTU for each device, so this becomes the path MTU.

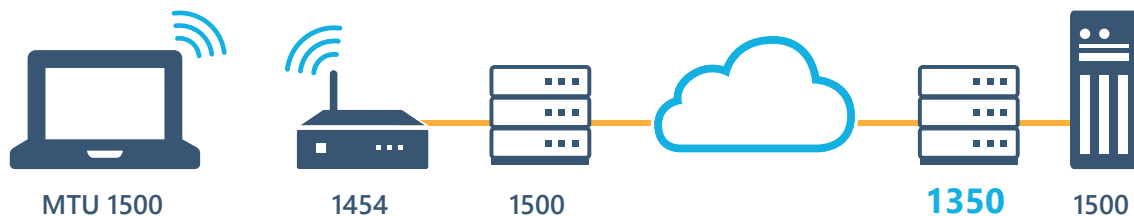


Figure 3 Determining the Path MTU

Baseline Round Trip Time

In TCP processing, after sending data, the next data is sent after receiving an Acknowledgement (ACK) message from the receiver PC. The time between the sending of the data and the receiving of an ACK message is the round trip time (RTT). The RTT is determined by the length of the communication path and the total processing time required by the router. The RTT varies depending on the degree of congestion of the packets being processed by the router. The minimum RTT value when assuming no network congestion is called the baseline RTT.

Bottleneck Bandwidth

RFC 6349 also requires the measurement of the bandwidth of the network under test (Bottleneck Bandwidth, BB) using Ethernet frames and UDP packets. The measuring of RTT and BB allows us to predict the maximum number of packets that can be transferred at one time.

For example, if $RTT = 10\text{ ms}$ and $BB = 100\text{ Mbps}$, the amount of data that can be transferred before receiving an ACK is $0.01 \times 100 = 1\text{ Mbit} = 1250\text{ kbytes}$, and if the path MTU is 1500 bytes, this amounts to approximately 830 packets.

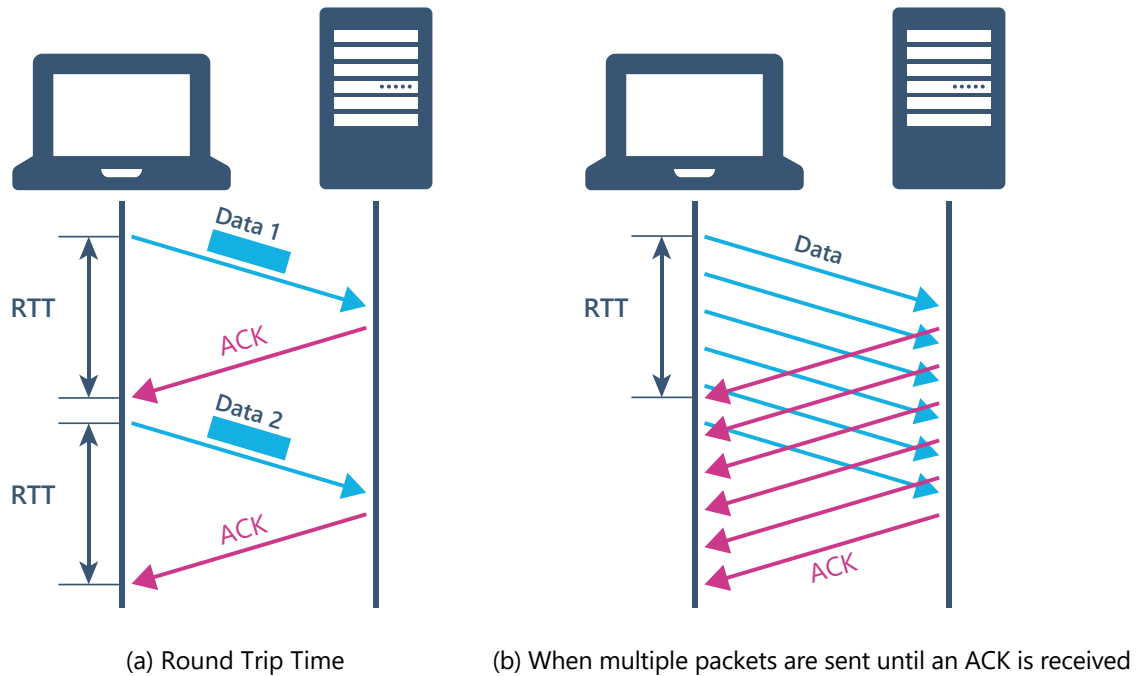


Figure 4 TCP Acknowledgments and RTT

The TCP protocol provides full-duplex communication, whereby data can be transferred simultaneously in both directions.

The MT1000A can perform simultaneous bidirectional testing, enabling the verification of services with high uplink and downlink loads, such as videoconferencing systems.



Figure 5 Bidirectional Testing

RFC 6349 TCP Throughput Testing for Network Operators

Network operators must test their networks using RFC 2544 or Y.1564 to confirm compliance with customers' Service Level Agreements (SLA). However, the methods defined in these standards do not test TCP networks, despite this being the most used protocol among customers. Consequently, end users often feel that their network performance is very different from the speeds promised in the SLA contract with their operator. Operators can help end users configure their network parameters by testing their TCP throughput based on RFC 6349 in addition to SLA verification with RFC 2544 or Y.1564. This is beneficial for both the operator and end user because it reduces the costs associated with managing customers' complaints and reduces churn.

The MT1000A can perform TCP throughput tests based on the RFC 6349 standard by emulating end users' network elements. It also supports more advanced testing abilities over TCP.

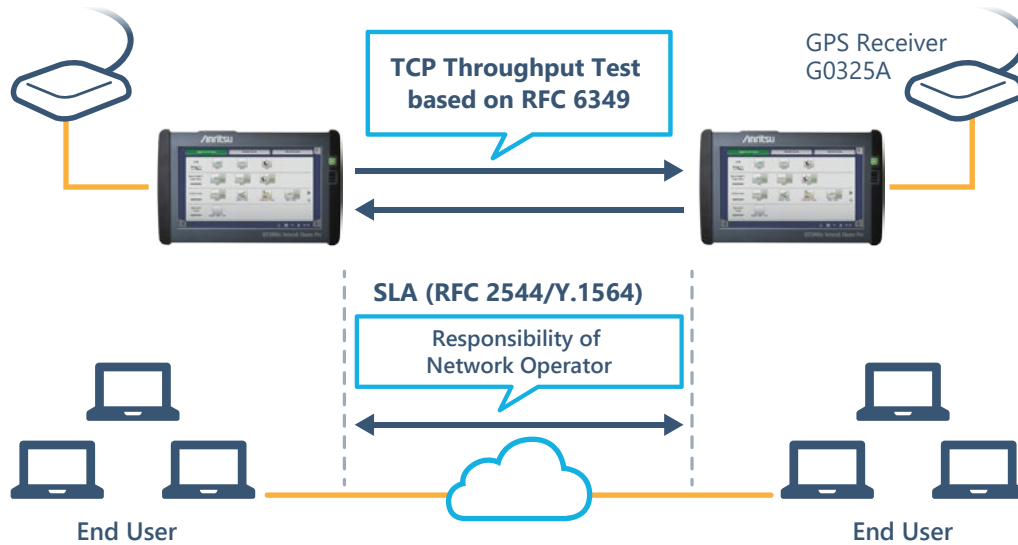


Figure 6 TCP Throughput Test for IP Network Operator

TCP Throughput Testing Using iPerf for Service Providers

Service providers use servers and networks to provide their customers with a range of services. Because critical services are based mainly on TCP connections, TCP throughput is checked using iPerf, a software-based TCP throughput test tool. However, because the iPerf software tool depends on the end user's terminal performance, it has low repeatability.

The MT1000A uses hardware-based TCP throughput tests and a connected iPerf server for high reliability and high accuracy.

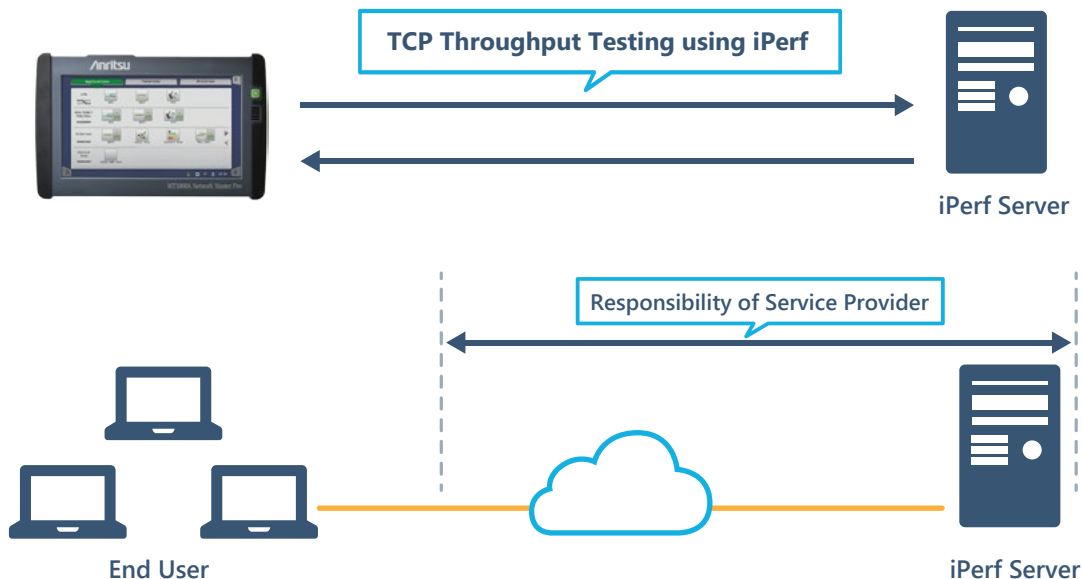


Figure 7 TCP Throughput Test for Service Provider

The MT1000A can connect to an iPerf2 server.
By installing iPerf on a server in a network, the MT1000A can test the TCP throughput of the network including the server.

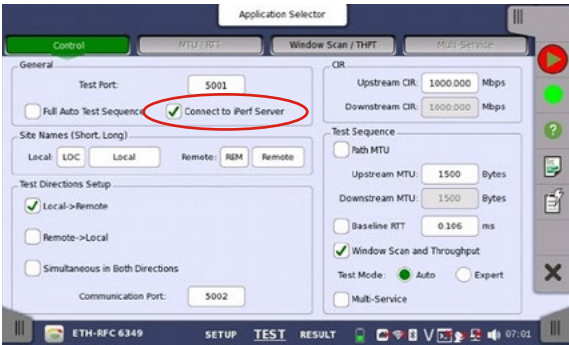


Figure 8 Connecting to iPerf Server

Testing Result Examples

The MT1000A measures the throughput while automatically changing the TCP window size and displays the optimal window size.



Figure 9 Window Scan

The calculated ideal and tested TCP throughput, as well as details like the number of retransmitted bytes, round-trip delay, are also displayed.

Graphs of TCP throughput/time and other parameters are also displayed, helping users identify possible issues quickly.



Figure 10 TCP Throughput

Configuration of simultaneous tests for 16 TCP sessions supports realistic multi-service network emulation and analysis. This test can also be performed with different DSCP/TOS priorities per session.

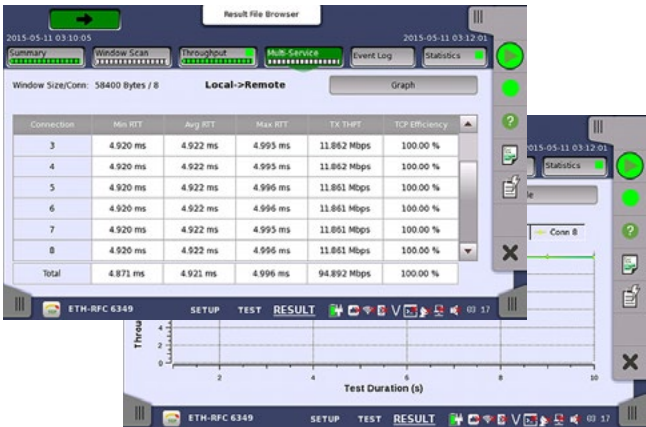


Figure 11 Up to 16 TCP Sessions

Summary

The MT1000A supports TCP throughput tests in addition to RFC 2544 and Y.1564 to provide a true analysis of network performance. These tests help improve the quality of continuously expanding advanced networks.

Ordering Information

Please specify the model/order number, name and quantity when ordering.

The names listed in the chart below are Order Names. The actual name of the item may differ from the Order Name.

MT1000A

Model/Order No.	Name
Mainframe	
MT1000A	Network Master Pro
Module	
MU100010A1	10G Multirate Module
MU100011A	100G Multirate Module
Option	
MU100010A-001	Up to 2.7G Dual Channel
MU100010A-011	Ethernet 10G Single Channel
MU100010A-012	Ethernet 10G Dual Channel
MU100010A-020*1	TCP Throughput
MU100011A-001	Up to 10G Single Channel
MU100011A-003	Up to 10G Single Channel
MU100011A-020*2	TCP Throughput
Optional Accessory	
G0325A	GPS Receiver



For details of products

*1: Requires that at least one of the following options is installed:
MU100010A-001, MU100010A-011, MU100010A-012

*2: Requires that at least one of the following options is installed:
MU100011A-001, MU100011A-003