Application Note

ITU Y.1564 Ethernet Testing

MT9090 / CMA 3000
Network Master / Communications Analyzer

By Stuart Whitehead

Background

Has Ethernet testing come of age? Ethernet – the technology has been around for many years with most of us considering it as a LAN (Local Area Networks) technology and often not seen as an End to End communication medium. With Ethernet now firmly in the access and core of Telecom networks testing standards needed to be developed.
Anritsu was actively involved in creating a new standard designed to allow service providers to assess customer end to end network performance. This application note is an overview of the ITU-T Y.1564 standard and how it will benefit all, the standardization is currently being finalized within the ITU-T (International Telecommunication Union – Telecommunication Standardization Sector) and appears it could release as early as first half of 2011.

History of Ethernet testing

Ethernet heritage came from LAN connected computers within an office environment over copper cable, with the move to higher speed and optical cable Ethernet started to move into the WAN (Wide Area Networks). Ethernet service suppliers required a repeatable testing methodology which would allow them to supply results to their end users, RFC 2544 is often used for this. RFC 2544 wasn't originally designed for testing end to end customer networks (across several network elements) but rather a methodology to test network devices, offering network equipment suppliers a way to report on the performance of their products.
The testing methodology used in RFC 2544 is designed to find the limits of a single element in different testing situations such as throughput, latency, frame loss, back to back, system recovery and reset.

Note: System recovery and system reset tests are normally not recommend when testing is completed on a network.

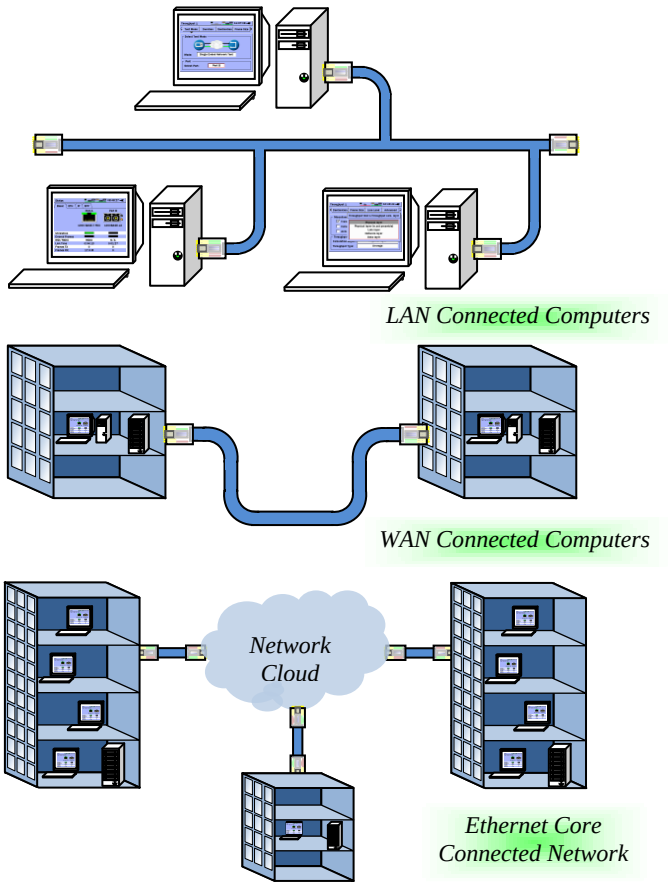

Figure 1: Ethernet Network Evolution

While RFC 2544 has been widely accepted as the standard to use for testing customer end to end networks, with the advancement of networks and network policing becoming more common a new methodology was required. When completing all RFC 2544 tests at all frame sizes the time required is quite long. Due to this often service providers complete only a subset of the tests, Anritsu also allows several of the tests to be completed simultaneously. The combination of these elements and not completing system recovery or system reset testing allows the service provider drastically reduce required test time.

Today's networks

Network traffic requirements have diversified over the more recent years from data centric to very mixed with much more importance by end users now being placed on real time applications such as video and voice. With network elements buffering traffic concern is often raised as to the possible effects on real time applications across the full network especially if poorly implemented.
In most cases the data pipe provided to end customers can be increased in line rate with future customer requirements, with the service provider normally rate limiting or policing the link based on the SLA (Service Level Agreement) or contract between the two parties. Most service provider's rate limit customer's traffic at the network ingress and egress point, the point where the customer traffic enters or departs the service provider's equipment. It's also possible for service providers to offer different Ethernet classes of service to customers this is commonly achieved with the use of VLAN's (Virtual Local Area Network) or DSCP (Differentiated Services Code Point). Some service providers are starting to look into allowing their customer to burst traffic for different durations, this type of implementation isn't common in today's Ethernet networks.

Requirement for a new standard

With the combination of changing end user traffic profiles including multiple frame sizes and streams which require different traffic priorities through the network, service providers have quickly discovered some shortcomings in RFC 2544. Many service providers also understand their future requirements will most likely require the network to offer a per stream traffic policed system, not a less complicated rate limited model. The area's most important for service providers includes, testing multiple traffic streams simultaneously, confirming the policing per stream, confirming the transfer time and jitter across the network and confirming the network could manage bursts of traffic for short durations.

Dividing traffic priorities from the end user perspective

End users are dividing their traffic into different classes each with different priorities of service, service providers are able to package this data into different service offerings. This allows the service provider to offer end users more flexible ways to design their networks and offer different cost models.
Traffic is commonly divided into 3 key groups each with different network requirements. With areas such as Video on Demand, Video conferencing and telephony systems switching to Voice over IP, network requirements have quickly changed to low latency and jitter becoming key factors. Customers are now looking into not only their current network loads but also the requirement of each service type and purchase packages which allow them the flexibility they require.

	Priority	Latency	Frame size	Bandwidth Requirement
Data	Low	n/a	Varying	Varying
Voice	High	Low	Small	Small
Video	Very High	Very low	Varying	Medium

Table 1: Traffic Types

Setting different traffic types

The Metro Ethernet Forum (MEF) released the standard MEF 10.2 Phase 2 which offers great detail on how to classify traffic on a network into different bandwidth profiles, color-blind or color-aware.

Note: The ITU-T Y.1564 standard uses the same methodology to ensure consistency and wherever possible the same terminology but in the first instance whenever available follows the terminology defined in ITU-T Y.1563.

Traffic can be divided into 3 bandwidth profiles each assigned a different color, traffic up to the CIR (Committed Information Rate) is classified as green, traffic from the CIR up to EIR (Excess Information Rate) is classified as yellow while traffic above the EIR is classified as red.

Note: Interestingly today terms such as CIR and EIR are often not referenced in Ethernet but they date back to much earlier data standards such as Frame Relay FRF.13 and ISDN ITU-T I.370.

Color-blind traffic is when the service provider does not take into account any CoS (Class of Service) marked within the frame and normally offers a simple rate limited type of service. Color-aware traffic takes into account the CoS of the frames by defining them as CIR and EIR then implementing the network policing settings.

CIR: Traffic rate the service provider commits will be obtainable, large bursts of frames might be dropped.

EIR: Traffic rate the service providers commits is possible to deliver but may not always be available, not normally obtainable during times of network congestion.

Up to CIR	Always obtainable
CIR to EIR	Able to be discarded by the network
Above EIR	Discarded by the network

Table 2: Color States

Ethernet traffic throughput profile varies continuously due to the large variation in traffic types and multiple users making it very important to test the worst case situation. The most extreme case being a high throughput burst's over a short period of time which is policed by the CBS (Committed Burst Size) and EBS (Excess Burst Size) configurations of a network element.

CBS: Maximum limit of frames able to be sent (in bytes) with a minimum IFG (Inter Frame Gap) at the interface line rate above the CIR.

EBS: Maximum limit of frames able to be sent (in bytes) with a minimum IFG at the interface line rate above the EIR.

To simplify testing several new terms have been defined in this standard, the key ones listed below,

Information Rate: IR is the average bit rate of Frames measured from the start of the first MAC address bit to the end of the last FCS (Frame Check Sequence) bit.

Utilization Line Rate: ULR is the average bit rate of Frames measured from the start of the first IFG (at minimum IFG size) bit until the end of the last FCS bit.

Test Flow: An individual stream of traffic which can be identified by its Ethernet header information. Within the traffic stream the header information may vary to allow for different CM (Color Mode) and traffic types (CIR, EIR) within the stream.

Policing

Most modern switches and NID (Network Interface Devices) have the ability to set different traffic policing parameters. When a policer is activated it will monitor the incoming frames and determine their CM. If CM is set to Color-Aware it will then monitor incoming frames and assign them the relative color of Green or Yellow based on the frame header matching the policer setting and current IR. Refer to Figure 2 and the text below for more details,

1. As frames enter the network device they will be defined as Color-Aware or not.
2. Once confirmed to be Color-Aware the frames are then passed to the first of two token buckets,
    a. Frame headers are then check to confirm what color they are tagged, commonly via the DSCP or PCP (Priority Code Point ({within the 802.1Q header}) bits within the header.
3. The incoming green frames IR is compared to the CBS tokens in the bucket, if tokens remain in the bucket the frame will consume a token and be passed to the egress of the network element. When the IR is lower than the CBS token replenishment rate the bucket will be fill.

Note: The CBS bucket is replenished at a rate of CIR/8/sec.

    a. If the IR is higher than the CBS replenishment rate the tokens within the bucket will reduce to 0, at this point the incoming frame will be passed to the EBS bucket for processing.

4. Frames tagged as yellow and frames passed from the CBS bucket will be checked against the EBS buckets tokens, if the IR is lower than the number of tokens they will be allowed to pass any frames above this rate will be tagged as red and discarded.

Note: The EBS bucket is replenished at a rate of EIR/8/sec.

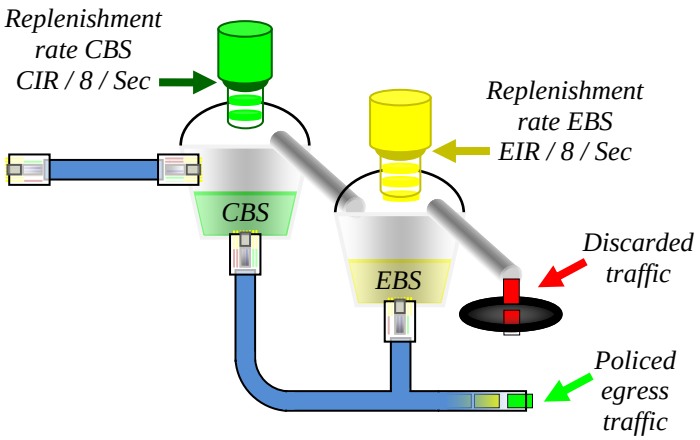

Figure 2: Internal workings of Policer

The Y.1564 standard

With networks evolving the standard needed to address these different types of network configurations and ensure quality is maintained across networks with multiple streams with different policing parameters. This new standard also allows the engineer to input the SAC (Service Acceptance Criteria) information which is normally based on a subset of the users SLA (Service Level Agreement). By inputting the SAC information before the test is started it's possible to set simple pass fail criteria simplifying the results and possible points of concern for the engineer. In order to simply the test and address all areas the standard has been written around two core components the Service Configuration Test and the Service Performance Test.

Service Configuration Test

During this stage each of the individual Test Flows are completed in a sequentially manner, confirming there are no network configuration issues. The service provider has the ability to configure each Test Flow individually to different frame size or mixture of frame sizes called an EMIX as well as adjusting the throughput and other header information such as MAC addresses, VLAN settings, IP addresses, DSCP etc. The standard also allows engineers to configure the different types of Service Configuration Tests to perform such as,

CIR: Color Aware and Non Color Aware, simple or stepped.
EIR: Color Aware and Non Color Aware,
Traffic Policing: Color Aware and Non Color Aware,
CBS: Color Aware and Non Color Aware,
EBS: Color Aware and Non Color Aware with CIR=0, Color Aware and Non Color Aware with CIR>0.

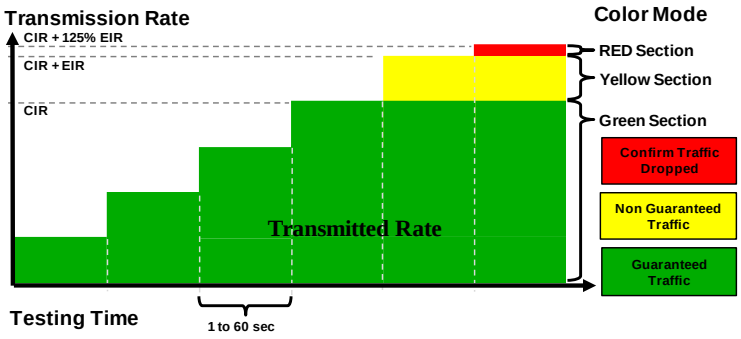

Figure 3: Service configuration

Note: CBS and EBS are placed in review status and **not** implemented in the first release. Current status is **preliminary / experimental**.

The configured tests are then completed within a few seconds allowing the following information to be monitored and recorded;
IR (Information Rate), FLR (Frame Loss Ratio), FTD (Frame Transfer Delay), FDV (Frame Delay Variation), FLR_{SAC} (Frame Loss Ratio with reference to the Service Acceptance Criteria).
Figure 4 below is a pictorial view of frames traveling at the CIR then bursting to the CBS, while completing this the test and measurement equipment must also comply to specific Pre Burst and Post Burst gaps ensuring the token buckets are in the correct status.

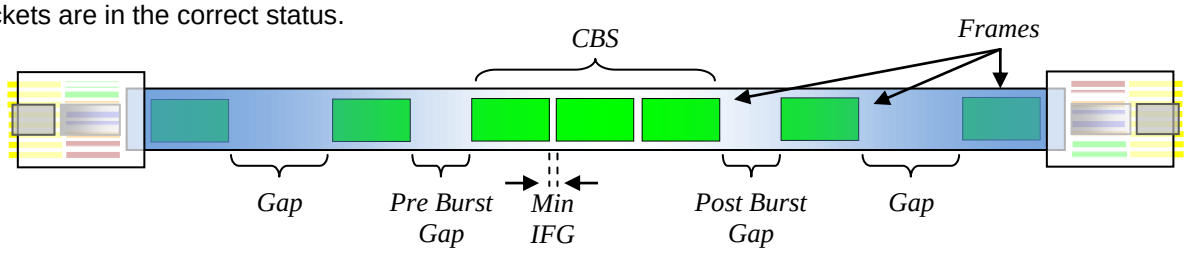

Figure 4: CIR and CBS frames

The Service Configuration Test is required to pass before moving to the Service Performance test,

Service Performance Test

Once the network configuration test has completed, confirming the network is able to work under load over a configured duration of time is required. The Service Performance Test completes this phase by generation all Test Flows simultaneously at the CIR for a period of time of 15min, 2h or 24h (based on ITU-T M.2110) or user selectable. Placing the network under load with multiple Test Flows for this duration allows the engineer to see if other services are affecting the service under test but also allows for statistics such as AVAIL (Availability) and Un-AVAIL to be measured. Full details on how AVAIL is characterized can be found in ITU-T Y.1563.

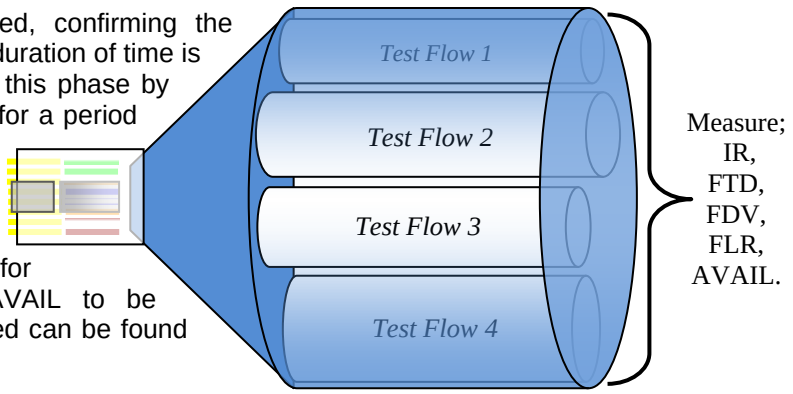

Figure 5: Service Performance

With the tester generating each Test Flow and recording the IR, FTD, FDV, FLR and AVAIL results for each frame simultaneously dramatically reduces the testing time when compared to RFC 2544.

Overview of measurements

IR: The Information Rate is the average rate of the frames starting from the first MAC address bit and ending with the last FCS bit at a measurement point. It is normally expressed as CIR or EIR.

FTD: The time a frame takes to transfer between two measurement points of a network is considered the FTD. Due to complexities of timing across Ethernet networks FTD is normally measured in a round trip manner.

FDV: The variation of the arrival of frames at the measurement point.

FLR: The ratio of the total lost frames with comparison to the total frames transmitted.

FLR_{SAC}: The FLR stated in the Service Acceptance Criteria, allowing the measurement equipment to offer a simple pass or fail indication based on user inputted data.

AVAIL: A test flow is considered to be in one of two states either Available or Unavailable, switching to the Unavailable happens from the commencement of a block of 10 consecutive SES_{ETH} (Severe Errored Second Ethernet). A SES_{ETH} is considered when the FLR for that second excess a rate of 0.5. Once the SES_{ETH} rate is exceeded the test flow will remain in the Unavailable state until the commencement of a block of 10 consecutive non-SES_{ETH}.

Note: The rate of 0.5 is a proposed value in ITU-T Y.1563 and can be adjusted depending on the CoS requirements.

Conclusion

The new standard ITU-T Y.1564 offers a very large advancement on the current testing methods of RFC 2544 used by service providers or manually configuring multiple streams. One of many key points being the ability to confirm each Test Flow at rates which will exceed the network configuration, then complete a timed test with all test flows concurrently. As network services advance to include policing by color and Burst Rates this standard will become essential for commissioning a circuit and completing testing after repair or during fault verification. Due to this Anritsu believe service providers will quickly make use of the many benefits of Y.1564 and our products will be your ideal companion in the field to ensure you get the job quickly first time and on time.

References

If you require further information don't hesitate to contact your local Anritsu office or refer to the standards listed below;

ITU-T Y.1564 (Ethernet Service Activation Test Methodology),
- http://www.itu.int/rec/T-REC-Y.1564/en

ITU-T Y.1563 (Ethernet frame transfer and availability performance),
- http://www.itu.int/rec/T-REC-Y.1563/en

ITU-T I.370 (Congestion Management for the ISDN Frame Relaying Bearer Service),
- http://www.itu.int/rec/T-REC-I.370/en

ITU-T M.2110 (Bringing into service international multi-operator paths, sections and transmission systems),
- http://www.itu.int/rec/T-REC-M.2110/en

MEF 10.2 (Ethernet Service Attributes Phase 2),
- http://metroethernetforum.org/page_loader.php?p_id=29

IETF RFC 2544 (Benchmarking Methodology for Network Interconnect Devices),
- http://datatracker.ietf.org/doc/rfc2544/

CMA 3000 All-in-one-field tester CMA 3000 is Anritsu's next-generation portable, compact and user-friendly field tester, it's designed specifically for field technicians who install and maintain mobile-access and fixed-access networks, transmission networks and switching. Powerful testing of framed/unframed 2 Mbps and easy-to-install options: Ethernet interface (10/100/1,000/10,000 Mbps) with add-on options for Stacked VLAN, MPLS, IP channel statistics, VoIP and Y.1564 for (Ethernet) Service Activation Test: SDH interface including STM-1 to STM-64, E3, E4 interface: ATM layer measurements: V-Series interfaces: FR testing: SS7, Abis and ISDN protocol analysis and ISDN PRI call emulation.	
MT909060A Network Master Gigabit Ethernet Analyzer The MU909060A is purpose build for Ethernet testing with the field engineer in mind. A simple to use interface ensures any engineer is able to complete all testing requirements with ease. While very compact in size it's high resolution screen and Test Automator system ensures complicated testing scenarios can be completed quickly by anyone in the field. Any Ethernet networks can be tested with options including MPLS, VLAN Stacking, Multi-Stream, RFC2544, Channel Statistics and Y.1564.	

Anritsu

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Anritsu Corporation
5-1-1 Onna, Atsugi-shi, Kanagawa, 243-8555 Japan
Phone: +81-46-223-1111
Fax: +81-46-296-1238

• **U.S.A.**
Anritsu Company
1155 East Collins Blvd., Suite 100, Richardson,
TX 75081, U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

• **Canada**
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

• **Brazil**
Anritsu Eletrônica Ltda.
Praca Amadeu Amaral, 27 - 1 Andar
01327-010-Paraiso-São Paulo-Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

• **Mexico**
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

• **U.K.**
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire, LU1 3LU, U.K.
Phone: +44-1582-433200
Fax: +44-1582-731303

• **France**
Anritsu S.A.
16/18 avenue du Québec-SILIC 720
91961 COURTABOEUF CEDEX, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

• **Germany**
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

• **Italy**
Anritsu S.p.A.
Via Elio Vittorini 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

• **Sweden**
Anritsu AB
Borgafjordsgatan 13, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

• **Finland**
Anritsu AB
Teknobulevardi 3-5, FI-01530 VANTAA, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

• **Denmark**
Anritsu A/S
Kirkebjerg Allé 90, DK-2605 Brøndby, Denmark
Phone: +45-72112200
Fax: +45-72112210

• **Spain**
Anritsu EMEA Ltd.
Oficina de Representación en España
Edificio Veganova
Avda de la Vega, n° 1 (edf 8, pl 1, of 8)
28108 ALCOBENDAS - Madrid, Spain
Phone: +34-914905761
Fax: +34-914905762

• **Russia**
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor.
Russia, 125009, Moscow
Phone: +7-495-363-1694
Fax: +7-495-935-8962

• **United Arab Emirates**
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suit 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

• **Singapore**
Anritsu Pte. Ltd.
60 Alexandra Terrace, #02-08, The Comtech (Lobby A)
Singapore 118502
Phone: +65-6282-2400
Fax: +65-6282-2533

• **India**
Anritsu Pte. Ltd.
India Branch Office
3rd Floor, Shri Lakshminarayan Niwas, #2726, 80 ft Road,
HAL 3rd Stage, Bangalore - 560 075, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

• **P.R. China (Hong Kong)**
Anritsu Company Ltd.
Units 4 & 5, 28th Floor, Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong
Phone: +852-2301-4980
Fax: +852-2301-3545

• **P.R. China (Beijing)**
Anritsu Company Ltd.
Beijing Representative Office
Room 2008, Beijing Fortune Building,
No. 5, Dong-San-Huan Bei Road,
Chao-Yang District, Beijing 100004, P.R. China
Phone: +86-10-6590-9230
Fax: +86-10-6590-9235

• **Korea**
Anritsu Corporation, Ltd.
8F Hyunjuk Building, 832-41, Yeoksam Dong,
Kangnam-ku, Seoul, 135-080, Korea
Phone: +82-2-553-6603
Fax: +82-2-553-6604

• **Australia**
Anritsu Pty. Ltd.
Unit 21/270 Ferntree Gully Road, Notting Hill,
Victoria 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

• **Taiwan**
Anritsu Company Inc.
7F, No. 316, Sec. 1, Neihu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

No. MT9090/CMA 3000-Ethernet_Testing-E-F-1-(1.00) 公知 Printed in Japan 2011-7 MG