Fax / Data Modem Test Applications

Using GoldenVoice™ impairment measurements and Bit Error Rate measurements as a method of characterizing throughput in a digital network

A white paper describing a practical method of relating bit/block error rates, GoldenVoice technology and fax/modem spoofing tones to characterize modem transfer rates

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I. Introduction

Since 1998 Ameritec has been a provider of Voice Over Packet test solutions for companies whose business focus is the development of voice over packet networks and network components. The solution Ameritec has adopted for testing packet-switched networks is unique in the market segment and one that has become a standard for most companies. The great challenge for a developer has been to determine how to improve the performance of their product without metrics that highlight the potential sources of the problem. This is why Ameritec's focus for a VoP test product has been based on stimulating the network with stimuli of a known characteristic, GoldenVoice and Bit Error Rate, and then reporting results based on objective measurements. The results of these tests provide developers a broad range of measurements that allow them to evaluate the product's performance based on "*real*" numbers. In a white paper authored and published by Ameritec in August 2000, "*Filling the VoID in VoIP Testing"*, we provided developers with insight into the correlation of impairments with specific elements of a packet-switched network.

The content of this document will focus on Ameritec's implementation of specific E-Model metrics into a Conductor™ software tool named MQoS™ and bit and block error rate testing as a means of

characterizing fax/data throughput. Conductor is the Graphical User Interface (GUI) used to manage and control Ameritec's analog and digital models of Allegro and Fortissimo Call Generators. Conductor supports test environments built from Ameritec products for testing from single line IADs (Integrated Access Device) to multiple DS3 and OC3 configurations from a single control tool – where scalability and functionality are the criteria: Ameritec is the solution.

II. Parameters Affecting Modem Traffic

Data transmission in the digital network is typically affected by the following parameters:

- Packet loss rate
- Error rate
- Delay

Error rates can be measured and displayed in many ways with the most common being bit and block error counts. Utilizing both bit and block counters it is possible to determine whether errors are occurring in a random or burst fashion. This determination is especially critical in fax and modem scenarios since these devices use symbols to represent many bits and varying window sizes of data transfer. Delay is a characteristic of the packet-switched network, and the wide ranges of delays are generally a result of the load conditions of access nodes, or gateways, which make variable delays in *real-life* a network characteristic.

III. What is MQoS?

Modem Quality of Service (MQoS) is a set of metrics resulting from the data collection ability of an Ameritec Call Generator and the power of Conductor to process data to produce channelized modem quality scores and related impairment data. The MQoS application resident in Conductor is Ameritec's implementation of the G.107 recommendation and the characterization of error rates on different modem types. Figure 1 is a sample of the report generated by the MQoS application.

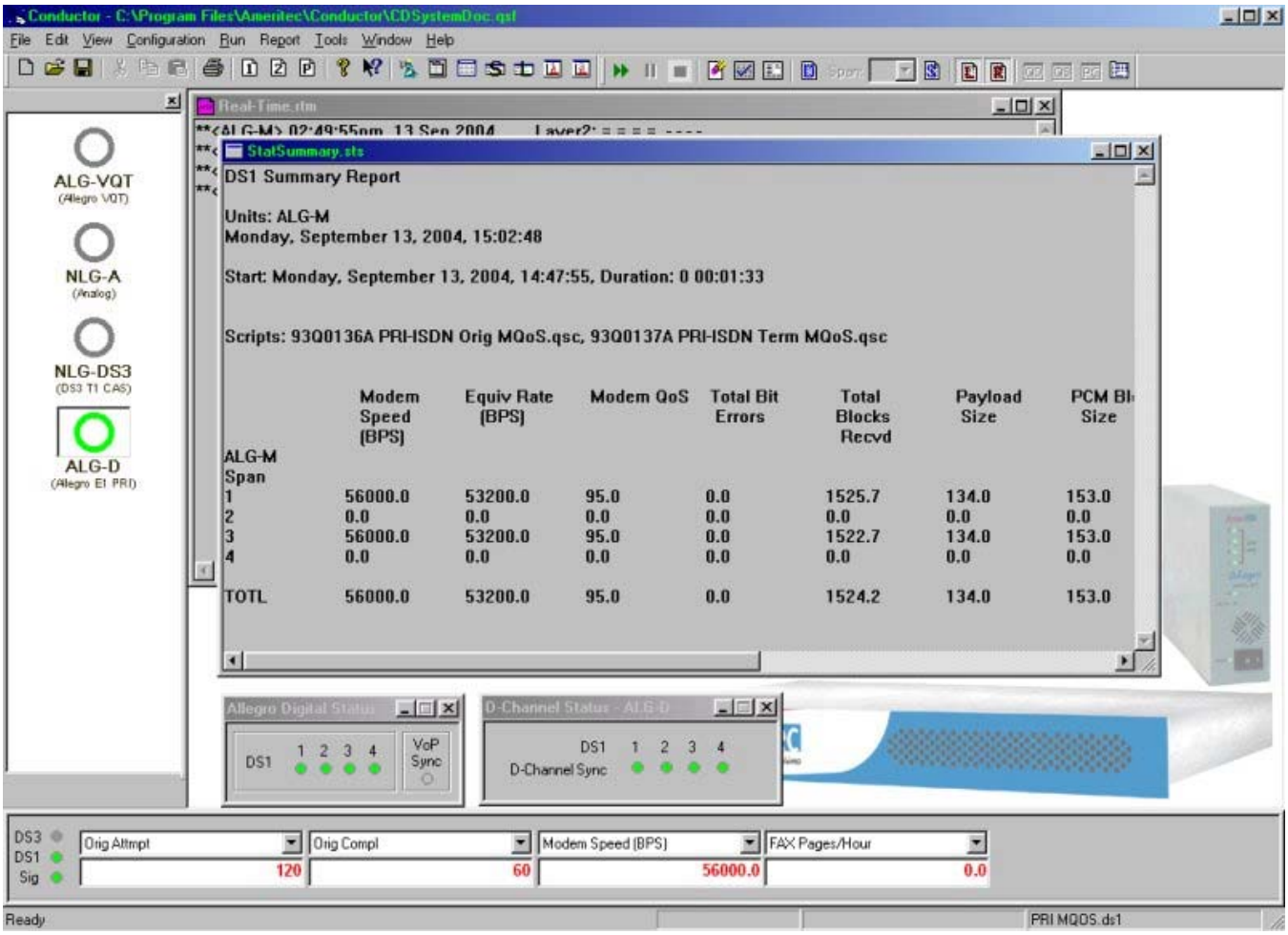

Figure1
MQoS Report

IV. Generating Data for the MQos Application

A. Modem Spoofing

For developers desiring to test their products under high volumes of fax and data modem traffic, the economics of purchasing and implementing products with this functionality quickly becomes cost prohibitive. Realizing the developer is primarily concerned with ensuring his product can consistently and properly recognize the presence of a fax or data modem call and then pass this call through his device under test (DUT) with maximum efficiency, Ameritec implemented a more cost-effective method of performing fax/modem testing.

"Modem Spoofing" is a technique Ameritec employs to generate the fax and modem tones needed to force the device under test to recognize the presence of an incoming fax/modem call and implement the appropriate software/hardware routines to accommodate this call. Common examples of such a routine include operating a DUT with G.729, G.723, G.726, etc, vocoders implemented and placing a fax/modem call to determine whether the DUT recognized the fax/modem signals and efficiently switched to G.711 encoding so that the call could originate and complete as expected.

B. Bit Error Rate Testing

The usual method for determining the "goodness" or robustness of a signal converter in a modem is to pass blocks of random (or pseudo-random) bits through a modem connection over a telephone channel with well-known characteristics, and measure the number of blocks that were received correctly versus the number of blocks transmitted. The result is called the *error ratio* measurement; a number of these measurements can be made to estimate the *error rate* of the particular connection.

Some number of errors are normal. The typical design goal is to have at most one block error in one thousand blocks. In order to accurately measure the error ratio, and thus accurately characterize the error rate for the modem, there needs to be enough data transferred during each test such that at least ten (10) error events occur during each test. This means that to verify that the modem meets the design specification of one error in one thousand, the tester runs ten times that number of blocks, or ten thousand (10,000) blocks of data, so that if the number of blocks lost or corrupted is less than eleven (11) then the modem meets the criteria.

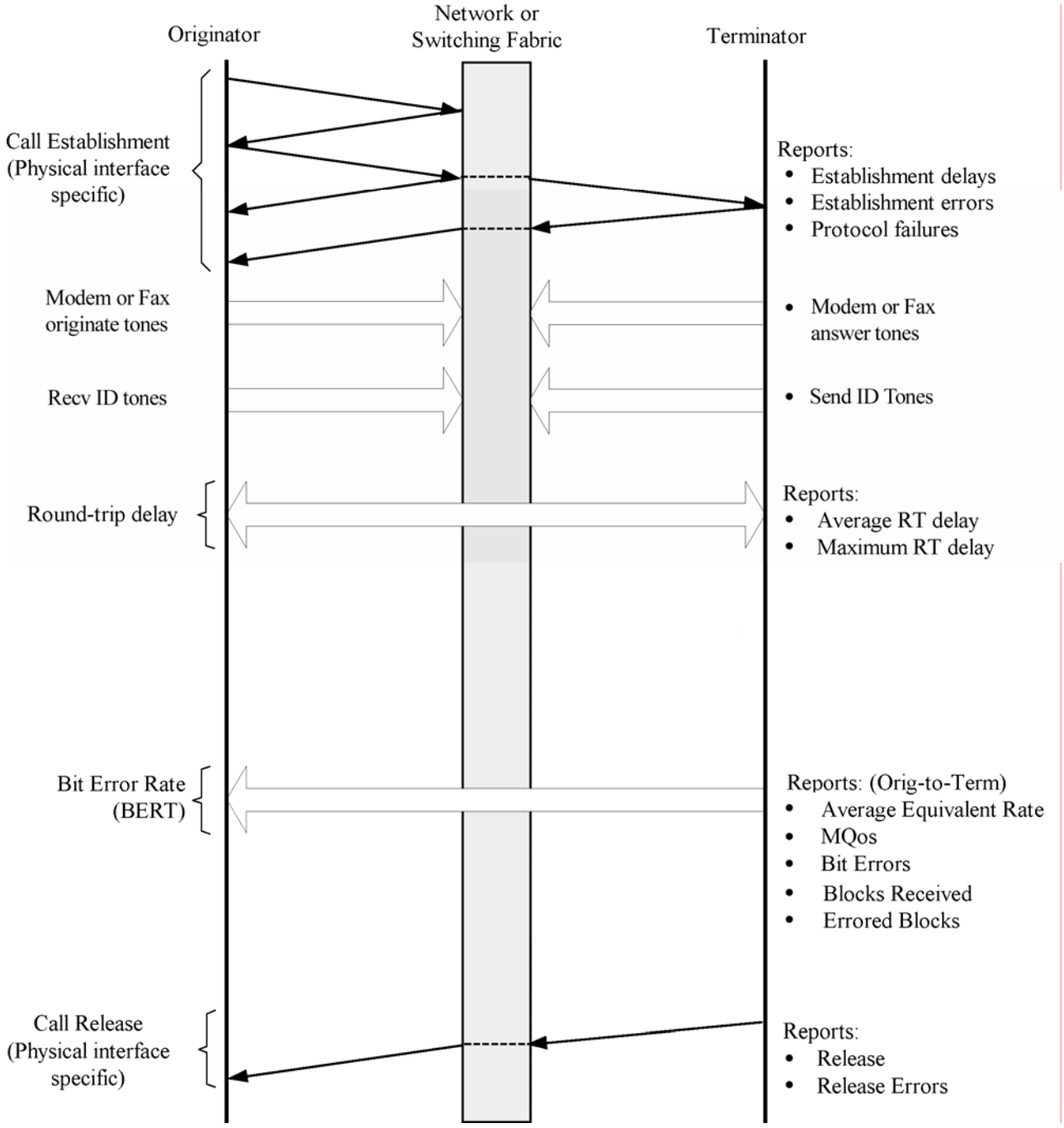

Figure 2
MQoS Call Flow Diagram

C. Directional Delays

The E-Model requires both directional delay and round trip delay measurements. Using a synchronized timing mark distributed between different call generators, or different physical interfaces, measurements are made on a local connection or connections spread across a wide area. Synchronization is provided locally or globally by an internal clock or Ameritec's AMSG (available GPS timing option). The 1-way delay measurement is made by launching a 100-millisecond wide GoldenVoice packet on the timing mark, receiving it on the far end and measuring the deviation between the receipt of the packet and the timing mark (see Figure 3).

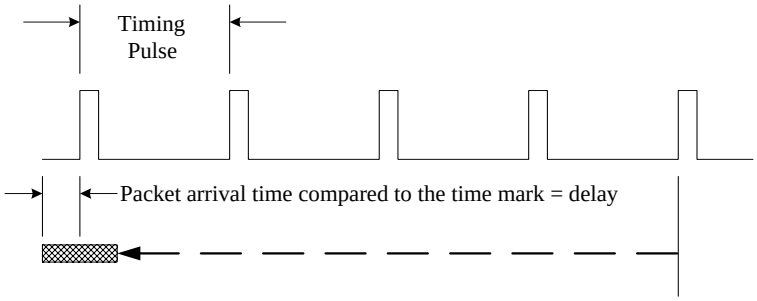

Figure 3
1-way delay measurement

Round trip delay is measured by launching a 100-millisecond GoldenVoice pulse from the terminator (listener) towards the originator (speaker). The pulse is recognized by the originator, held for a period of time and sent back to the terminator. The delay is calculated by measuring the total trip time, less the hold time at the originator, which is a constant in the script.

V. Generating MQoS Values

There are several key parameters that the user selects in Conductor to calculate MQoS values for each Allegro or Fortissimo call generator unit. These values include:

A. SeqNum

1. This parameter selects which modem calling signal or answer signal will be sent at the start of the call to place the DUT into pass-through mode. The following values can be selected:
   1 – CI Signal (V.8 Chan 1)
   2 – CT Signal (V.25)
   3 – CNG (T.30)
   4 – ANS (V.25, T.30)
   5 - /ANS (V.25)
   6 – ANSam (V.8)
   7 - /ANSam (V.8)
   8 – SigA (V.21 Chan 2)
   9 – SigA (V.22 Chan 2)
   10 – SigA (V.17 Chan 2)
   11 – Fax Start CNG Tone Continuous
   12 – Fax Answer CED Tone, SigA V.21
   13 – Fax Answer ANSam followed by quiet followed by SigA V.21
   14 – Fax Call CNG followed by SigA V.21

   Each of these signals represents an origination or answer tone or tone set. While a true modem will not send just one signal as it negotiates the connection, in reality, the device under test should recognize the tone "subset" and react as if a modem/fax call is present.

   Typically, V.34 and V.90/V.92 modems will normally use V.8 signals at connection regardless of the final connection speed. The user can safely assume that if the speed is above 14,400 bps, then V.8 signals are appropriate selections. Ameritec has defaulted these selections for that reason. The remaining selections allow the user to test to see how the DUT responds to other modem types that generally operate at lower speeds.

   It is important to note that Ameritec has provided numerous fax/modem tone set selections because developers of switching products execute different algorithms for the detection of these tones. Regardless of the tones selected it is critical that the DUT properly recognize the tone sets and place the DUT in a true pass through mode. For example, the presence of specific tones may result in the detection of a fax or modem call and switch the DUT to G.711 codecs, but phase reversal may be used to disable echo cancellation. Therefore, a tone set that includes phase reversal must be used, otherwise the voicepath and thus the ability to accurately perform BERT tests will be compromised.

SeqNum Value	Frequencies Sent	Type of Signal	Cadence
1	980 Hz / 1180 Hz FSK	Origination	2 sec off, repeating (0.5 sec on, 0.5 sec off)
2	1300 Hz	Origination	Repeating 0.5 sec on , 2 sec off
3	1100 Hz	Origination	Repeating 0.5 sec on, 3 sec off
4	2100 Hz	Answer	2 sec off, 2.6 – 4.0 sec on
5	2100 Hz 2 phase	Answer	2.6 sec – 4.0 sec on
6	2100 Hz / 15 Hz	Answer	Up to 10 sec on
7	2100 Hz / 15 Hz 2 phase	Answer	Up to 10 sec on
8	1650 Hz / 1850 Hz FSK	Terminating Modem at 300 bps	Continuous
9	2400 Hz	Terminating Modem at 1200 bps	Continuous
10	1800 Hz QAM	Terminating Modem at 14400 bps	Continuous
11	1100 Hz CNG Tone	Fax Origination	Continuous
12	2100 Hz, SigA V.21	Fax Answer	4 sec of CED tone, up to 15 sec SigA
13	2100 Hz/15 Hz, SigA	Fax Answer	3 sec of ANSam, quiet, SigA V.21 tone
14	1100 Hz, SigA V.21	Fax Origination	7 sec of CNG tone repeating at (0.5 sec on, 3 sec off), SigA V.21 on

B. SeqTimeout

This parameter selects the amount of time to send the Modem Signal and has a range of 0 to 6553 seconds.

C. SpeedNum

1. This parameter selects the modem speed for the Rate Estimate equation. Values include:
   0 – 56000 bps
   1 – 33600 bps
   2 – 28800 bps
   3 – 14400 bps
   4 – 9600 bps
   5 – 2400 bps
   6 – 1200 bps
   7 – 300 bps
   8 – 14400 (FAX)
   9 – 9600 (FAX)

D. SendTripTone and RecvTripTone

These parameters define the tone to be sent for the round trip delay test.

E. TestNum

This parameter selects the pseudorandom bit pattern used for the measurement.

1 – 2047 pattern 64K
2 – 2047 pattern 56K
3 – 511 pattern 64K
4 – 511 pattern 56K

F. TestTimeout

This parameter selects the amount of time to perform the measurement. Values range from 0 to 6553 seconds.

VI. Calculating MQoS Values for Fax

Ameritec has defined the Quality of Service metric for fax traffic to be Fax Pages per Hour. This value is calculated when the SpeedNum parameter is set for one of the fax values. Although ERATES and MQoS scores are reported for the fax calls, they are not appropriate metrics for rating a fax transfer. A better metric for fax is pages per hour. To make this calculation, the following criteria are used:

1. Each scan line has the same compression ratio.
2. Error Correction Mode (ECM) is used.
3. Standard resolution is implemented which equates to 1024 scan lines per page.
4. Text is sent with an average of 65 characters per line
5. There is 15% vertical white space.

VII. Calculating MQoS Values for Data Modem

The Quality of Service metric for data modem is MQoS. The Modem QoS value reports the MQoS score which is equal to percent ratio of Equivalent Rate divided by the Modem Speed. The Equivalent Rate value is measured in bits per second and represents the estimated rate based on the channel delay and bit error count.

VIII. Performing MQoS Testing on an Analog Circuit

For analog circuits, it is not possible to generate a digital bit error rate pattern to calculate bit and block errors. Therefore, on these circuits Ameritec performs an MQoS test that verifies the Device Under Test (DUT) recognizes the generated fax and data modem tone sequences and appropriately switches into a G.711 mode of operation as a result.

This switch-over verification to G.711 is performed by sending a gated GoldenVoice tone set for approximately 1.5 seconds followed by a 0.5 second period of quiet that repeats for a predetermined period of time. This tone sequence creates a very predictable set of events for non-G.711 vocoders and therefore allows Ameritec to reliably verify when G.711 encoding is being utilized (switched into place).

At the conclusion of the G.711 switch-over test, the Fortissimo and Allegro units perform a traditional set of QoS tests to verify overall quality of the line.

IX. Summary

What Ameritec Call Generators offer are performance, accuracy, capability and scalability. Ameritec Call Generators are designed to make precise impairment measurements, and now with fax and data modem simulation, the developer has a complete testing suite to fit his or her call generation needs. All the functions are done simultaneously on every channel in the call generator without impacting the performance of the test equipment – a single tool that is capable of satisfying the needs of every department in your organization.

Ameritec Call Generators are available in a wide range of physical interfaces -- Analog, T1/E1 CAS, ISDN-PRI, SS7, DS3, SIP, OC3 and STM-1 – and provide interworking between the different interfaces. No longer is your testing confined to one piece of equipment in one location but with a GPS clocking source testing can also be done over a wide area duplicating the characteristics that are representative of actual deployed products.

You can count on Ameritec to provide the tools, the resources and the support to make you a success. If you have questions on testing your application: askzeke@ameritec.com