

V.34 Fax Verification

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Overview

Voice over the Internet Protocol (VoIP) has enjoyed a great deal of recent industry press coverage and considerable commercial acceptance as well. A recent analysis of North American Residential VoIP Markets from Frost & Sullivan, indicated that market revenue totaled \$295.1 million in 2004 and expects to reach \$4,076.7 million in 2010. With some justification, its supporters market VoIP as the future of telecommunications; supplanting switched circuit network connections as quickly as the hardware is built and deployed. Since VoIP solutions are being marketed as replacements for switched circuit connections, they must replicate all switched circuit capabilities and that requires compatibility with fax transmissions.

The presence of millions of fax machines installed around the world, combined with their ease of use and acclimated user base, has made fax resistant to the encroachments of email and other newer technologies. Facsimile transmission, or fax, has existed in one form or another for over a century. In its early incarnations, fax messages were sent over telegraph lines, then migrated to the switched circuit telephone network in the early 1900's. Fax transmission's next half-century was marked by a steady acceleration of technological development:

1935 – fax transmission becomes sufficiently robust to be sent over regular phone lines.

1963 – faxing over the Public Switched Telephone Network (PSTN) authorized by the FCC

1968 – the Carterphone Decision authorizes connection of third party (not Bell Telephone) equipment directly to the PSTN

1978 – the FCC issues its Part 68 regulations

1980 – CCITT issues a series of fax protocol definitions culminating in the Group 3 fax recommendation (T.30)

With the opening of the regulatory gates, and the creation of fax transceivers on single integrated circuit chips in the mid '80s, the stage was set for the mass use of fax machines.

The push to wider acceptance and use of fax lead to the introduction of Error Correction Mode (ECM) in 1988. This made possible the introduction of color fax, high speed V.34 modulation and Internet fax. However, it did not address the most basic facsimile problem, interoperability. The lack of manufacturer-to-manufacturer interoperability delayed the widespread acceptance of these technologies for years. In fact, color and Internet fax

are still slimly represented and only a basic implementation of V.34 is widely available.

With the near simultaneous appearance of VoIP and V.34 fax in the market, VoIP designers were faced with a design conundrum. How were they to verify a VoIP system's basic interoperation and its interoperation with a V.34 fax device without the ability to verify the proper operation of the V.34 fax system?

Most manufacturers were able to avoid this problem because V.34 fax operation was itself untried, untested and unused. The average V.34 fax machine would quickly drop back to the older, slower and much more simplistic modulations that have been used since the 1980's if it encountered any difficulty at all in using V.34. However, 2003 began seeing considerable improvements that allowed V.34 to become a used standard rather than an avoided one and this is just now beginning to concern VoIP manufacturers.

The Challenge

The V.34 modulation was introduced to fax in the same year (1996) that VoIP made the leap from an interesting experiment to actual delivered products. While VoIP applications and devices struggled to overcome technical hurdles and interoperability problems, V.34 did the same with the result that VoIP manufacturers are just beginning to seriously entertain support of this fax capability.

As VoIP matured, it began reaching to fulfill its promise of replacing the switched circuit PSTN system. This has continued such that, according to Steve Jurvetson of Draper Fisher Jurvetson, "Ten thousand landlines are cancelled every day in the USA," And, while email and web conferencing were becoming entrenched business realities, there was still an installed base of well over 100 million easy-to-use fax machines. If VoIP was to replace the existing PSTN system, it would have to handle those fax machines at least as well as the switched circuits. Fax capability quickly became a "required" feature for VoIP systems.

When the T.30 document that describes Group 3 fax was approved in 1980, it contained a considerable list of compromises that were necessary to get the then current group of fax device manufacturers to sign on. Each of them had been making systems with proprietary protocols for years if not decades, and each wanted their proprietary version made into the 'universal' protocol.

This resulted in a document with wide latitude for interpretation, and the devices built to it reflected an extreme divergence of design decisions. Add to this the fact that a number of highly successful fax manufacturers have directly violated even the loose constraints of T.30 and you have a telecom

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technology whose chaotic nature is exceeded only by its success of implementation.

With millions of fax machines installed by 1995 and dozens of manufacturers, this was onerous enough. With the introduction of color page encoding, V.34 (which changed the basic operation of a fax device) and fax data shipped across the Internet in packets, interoperability problems got several orders of magnitude worse. V.34 fax machines in particular suffered through a years-long period when they would communicate using the V.34 modulation only with other devices of the same make and model. In many instances, V.34 fax machines will still negotiate down to V.17 upon encountering any difficulty in completing a V.34 fax call.

Typically, conformance to a telephony protocol is the key to interoperability - the ability to accurately interchange data with other devices that conform to the same protocol. In this respect, fax has suffered from a long, painful history. The result of this is the necessity to test fax devices for proper operation with other fax devices - to test their interoperability.

All this makes the verification of conformance to T.30 just the barest beginning of fax product assurance testing. The real metric of fax device quality of operation, and this includes VoIP gateways, is its performance when sending and receiving faxes with other devices. And, until the release of QualityLogic's FaxLab product, that meant stacking as many fax machines from as many manufacturers as time and money permitted into a lab and gauging a product's interoperability by its ability to send and receive pages with this plethora of devices.

Solutions

Product design verification covers three categories of test work: conformance, interoperability, and troubleshooting. Thorough coverage of this troika is necessary to ensure that a communications system fully addresses its feature complement. It must do this to earn the user community's confidence that it will perform reliably and be updated accurately and quickly when the inevitable post-production bugs are discovered.

Conformance tests ensure the product's suitability for its operational intention. This process verifies operation within the strictures of the protocols covered and that the product's feature list has been implemented in accordance with its market position.

Interoperability verification is concerned with how the product fairs in the 'real world' of existing devices that it must communicate with. This typically requires research of the market in which the product will compete and testing of its full feature set under actual use conditions and in conjunction with the predominant devices in that market.

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Troubleshooting is the identification of problems that escaped the initial product verification process and are discovered after its release. This requires the ability to isolate the element or subsystem at fault and to determine the cause of that fault accurately enough to direct the design staff to the point at which it can be corrected.

Conformance is necessary to establish the ground level operational characteristics of the system, and interoperability testing will go far to eliminate or reduce the number of field surprises that must be dealt with. However, the troubleshooting element is extremely important, as the impact on a VoIP system of problematic fax implementations can easily become a customer sore spot if it is not diagnosed accurately and treated quickly. The VoIP system's tech support must be able to quickly isolate a fax transmission problem to either the operation of the fax devices involved or the carrier system and make solid corrective recommendations.

Since fax capability has become a check-list item for VoIP systems, it has become necessary for manufacturers to be able to confidently claim the ability to carry fax traffic. A quick, reliable test of conformance and a thorough, configurable interoperability test are key to meet the time to market window for a VoIP product. An effective fax transmission troubleshooting capability is a necessity for maintaining customer confidence.

While T.30 conformance may be only the start of verifying a fax implementation, be it terminal, gateway or transmission system, it is still a very necessary aspect of testing to ensure the ability to exchange data with other devices. A part of the wide variation of T.30 interpretations is that some regional telecom standards groups have attempted to standardize their locality by issuing test suites that attempt to verify interoperation through conformance to their test specification.

The DTC specification was an effort on the part of several European countries to create such a standard. In the US, the Electronics Industry Association (EIA) created the TSB-85 standard for the same purpose. Its execution covers all the standard T.30 flowchart branches and a considerable number of its error recovery schemes.

QualityLogic has implemented a TSB-85 test suite and made it available with its FaxExpert test product. FaxExpert is focused on scripting fax test calls for troubleshooting odd T.30 behaviors but its use of suites to manage test scripts lends it to test specification support as well.

Once the initial T.30 conformance hurdle has been cleared, it is time to consider interoperability with the realm of installed fax devices. Interoperability testing raises the twin problems of gathering the requisite array of fax devices and prompting them through the transmission/reception

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process. This leaves open the question of what happens when connection conditions change. How do you prompt a fax machine through the various T.30 error recovery branches?

The answer is through fax device emulation. QualityLogic's FaxLab test tool emulates some 1600 T.30 behaviors of over 139 different fax machines and has precise test call scripting that allows exploration of the interoperability limits of each device.

The goal of the conformance and interoperability test programs is to release a product. However, the testing process doesn't stop there. Supporting released systems will always involve encounters with the unexpected and understanding which part of a complex system is causing problems when it tries to communicate.

Troubleshooting fax transmission when it doesn't work is the province of QualityLogic's DataProbe/FaxSend duo. DataProbe is designed to monitor fax calls at data rates from the slowest V.17 machine to the fastest V.34 device and report each T.30 message and V.34 control exchange in detail. If a known good fax device is required to stimulate either another device or even both ends of a transmission system, FaxSend offers the ability to design and execute specific test call suites for that purpose.

Summary

Contrary to press and opinion, facsimile isn't going to disappear because of email, web conferencing or express mail. While its predominance may eventually erode over time, fax is a "must have" aspect of any telephony carrier system, and VoIP is no exception. The simplicity of use and decades of user familiarity guarantee that fax will be in wide use for the foreseeable future and the growing interoperation of V.34 devices will begin to impact VoIP designs.

Fax testing is neither simple nor straight forward, but it is manageable. With an understanding of what's involved and the necessary tools to do the job, verifying a fax implementation is an achievable goal. It will require substantial research to set market and feature parameters and a carefully thought out approach to cover all the testing bases. However, the pay-off is a product release that, rather than being plagued by customer complaints, is greeted with complements for the company that went the extra mile to ensure its customers a low-impact, trouble-free installation experience.

Like every other product test process, the sooner a system's fax capability is proven, the larger the impact it can make on market share.