Trends in ISDN and DSL testers

Information from Powertel Telecom

The increasing diversity in telephony requires testers which are both smarter and more complex. An important issue for the next generation of testers is the measurement of voice quality.

Telecommunications is one of the technology sectors which exhibits exceptionally rapid development – and every advance in telecommunications technology constitutes a new challenge for measurement technology. The sector seems to sprout new types of accesses, services and protocols on a daily basis. Nonetheless, this does not necessarily mean that the existing ones are completely replaced. As an example of this expansion, one need to only consider the many analogue plain old telephone systems (POTS) and ISDN accesses which are still used alongside the current high-speed accesses. In view of this mixed environment, the best tester for onsite measurements is naturally a combi-tester, which includes all of the necessary functionality in a single compact tester and presents the test/measurement results directly on its display. All of this without swapping out modules or connecting a PC.

Germany is currently facing a massive change in its telecommunication interfaces: the planned unbundling of the broadband internet accesses from the traditional telephone access will place even greater demands on the test equipment. As a consequence of this unbundling, accesses will be tailored even more closely to the requirements of the individual customer in the future. In this connection and to name just a few, the following topics spring to mind: ISDN, DSL or circuit-switched or packet-switched telephony, Triple Play and VoIP. Another increasingly important aspect, in particular in the area of voice quality, is quality of service (Qos). Considering the current telecommunications environment in all its diversity and complexity, one might well ask: how did it come to this?

The evolution of telecommunication services and measurement technology

ISDN was introduced on a nationwide basis in Germany at the end of the 1980s. However, this is not to say that all telecommunications in Germany were in digital form from then on. On the contrary, analogue telephones continued to be popular, in particular in the private sector, as the new, convenient ISDN telephones began to gain a portion of the market. Suddenly, test handsets had to support not only the testing of POTS accesses but also ISDN service checks, determining which supplementary services are supported by the access under test as well as the performance of bit error rate tests. By the end of the 1990s, analogue modems and ISDN channel bundling could no longer satisfy the increased demand for bandwidth so DSL became a product for the mass market. The demand for bandwidth continued to grow and ADSL2 and ADSL2+ were developed to satisfy it. At this point a service technician needed a tester that could not only be used to run acceptance tests on POTS and ISDN accesses but could also be used to replace a NTBA, splitter or modem. In addition to these basic functions, high-quality testers were also able to replace the customer's PC as well as to set up a point-to-point protocol (PPP) connection to analyse the quality of the internet connection using upload and download tests.

DSL also became an important factor in telephony since its greater bandwidth allowed it to support innovative new services. In the beginning, the advantages of packet-switched telephony were only exploited by a few individuals, but it did not take long for the network operators to recognise the advantages of the internet protocol (IP) for packet-oriented telephone service. Voice over IP (VoIP) had moved to centre stage. The session initiation protocol (SIP) developed into an elegant solution for joining telephony and DSL; in the process, however, it created new challenges for measurement technology.

In the meantime, it was no longer sufficient to synchronise with the DSL line and display its bitrate. Even a connection with the internet service provider (ISP) is now no more than an intermediate step in the process of setting up a packet-oriented telephone connection. A DSL tester must not only be able to call up data from the internet but also to serve as a complete POTS or ISDN telephone. Furthermore, it must be able to act as a SIP telephone on any of the various DSL standards and must be useable on Ethernet as well. There is currently no reason to believe that the traditional POTS twisted-pair and the ISDN S0-bus will both be quickly replaced by Ethernet as the sole telephone interface so any complete tester must continue to support tests of the traditional interfaces.

ISDN and POTS - even with IP-based telephony, they are still an issue

Even after the arrival of IP telephony, ISDN und POTS accesses still remain important. After all, some customers will not be persuaded to purchase a new telephone just because his or her subscriber line is no longer circuit-switched – assuming that they are even aware of the fact or its significance. Such customers will, therefore, also not necessarily replace their existing in-house telephone wiring or have a new telephone system (PBX) installed. Modern modems and routers will handle this task. They are connected via the traditional and, in Germany, still quite

common TAE connector to the DSL line (two-wire line) and offer the flexibility of connecting terminals such as POTS, ISDN or SIP telephones as well as one or more PCs. Consequently, there are a multitude of combinations which are possible and may be found at the customer's site and which cannot be checked using stationary measuring heads in the exchange or in a street cabinet. After all, the possibly relatively "short piece" of twisted pair and the peripherals used by the customer (i.e., modem, router and internal bus) are all important components of the complete connection. The ISDN and DSL tester must, therefore, also be able to replace the modem, router and SIP telephone both together (as a unit) and individually.

The measurement of voice quality

There are, however, even more demands which must be met by the tester. The measurement of voice quality is important in determining the QoS, in particular in the case of packet-oriented telephony. If, for example, data packets for a telephone connection are lost (packet loss) or if they arrive later (jitter), the voice quality will definitely suffer. Since customers in Europe are accustomed to the excellent voice quality of ISDN, it is to be expected that they will be unforgiving of such deterioration. VoIP customers will certainly appreciate the associated new services and flexibility, but they won't accept a loss of quality. One might ask whether a compact and economical handheld tester can reliably measure this decisive criterion.

Procedures such as the mean opinion score (MOS) were developed to evaluate the quality of voice service and are utilised for testing purposes. What are known as MOS values are derived from the statistical analysis of subjective evaluations of sound samples by test subjects. Such MOS values provide an assessment of the quality of a voice connection as a value on a scale from 1 to 5 and thus allow the evaluation of VoIP-to-VoIP connection. However, it is questionable whether such a connection is all that common in IP telephony, and, thus, whether this procedure can be used to achieve consistently good voice quality.

In the day-to-day world, it is far more likely that a call will be placed as a POTS-to-VoIP, an ISDN-to-VoIP or a POTS via Ethernet to ISDN connection (or any other combination of these). Under these real-world circumstances, it is obvious that one needs an end-to-end measurement to evaluate the connection without regard for how many or which legs are involved, whether it is packet-oriented or circuit-switched or even whether it uses two, four or eight wires. In connection with the latter, the transition from a two-wire line to a four-wire line can cause echoes, which

degrade the quality of the connection at least as much as interference caused by bit errors or the deterioration in voice quality caused by packet delays. In the case of packet delays, the voice quality may actually be quite good, but the customer is unlikely to accept the fact that he or she has to continually wait for the response from the other party. Unfortunately, this is a factor that is not always considered in the assessment of a sound sample.

PESQ – measuring voice quality objectively

Naturally, a subjective evaluation is not enough, an objective measurement is also necessary – one that can be performed directly at the customer's site regardless of whether the line in question is an ISDN or POTS interface or even Ethernet. The method of choice, in this case, is a perceptual evaluation of speech quality (PESQ) analysis in accordance with ITU-T P.862. A PESQ analysis is mathematically very involved, but therefore also a very precise, objective procedure for determining the voice quality of a connection. This algorithm is a mathematical procedure that models a voice connection optimised for the human ear and measures the degree to which a specific connection deviates from this optimum. Obviously, this is an ideal approach for dealing with the application mentioned above. Furthermore, a MOS value can also be derived from the PESQ value.

Thanks to a project developed jointly by ITD (Informationstechnologie) in Flensburg and Intec Gesellschaft für Informationstechnik

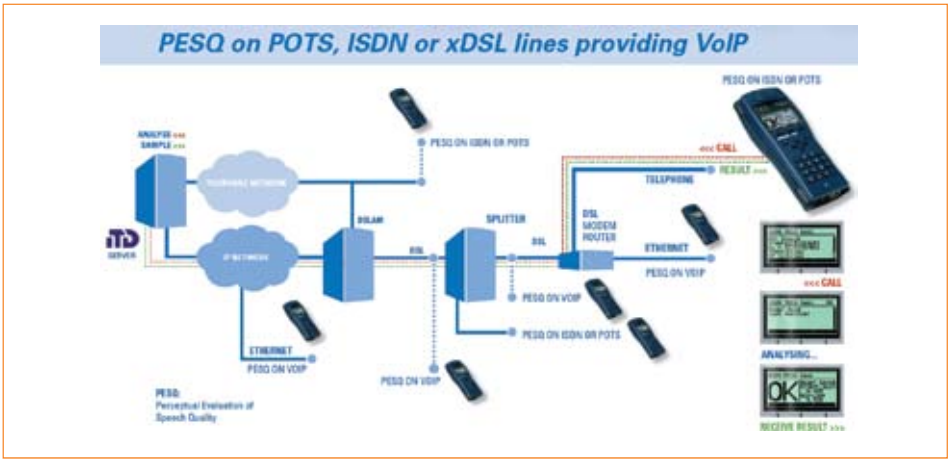
in Lüdenscheid, it is now even possible to display the PESQ value for a connection on a compact tester. ITD developed the Trafficlyser measurement system which runs on a server. This software makes it possible to compare the currently measured recorded voice sample with a reference master sample so that the PESQ value and other quality values can be calculated for a specific connection. This procedure is quite compute-intensive and can, therefore, not be run on the tester itself. This problem is solved by installing and running the software on a server located on a backbone. This server has its own telephone number and is thus theoretically reachable from anywhere. The recorded voice samples are now exchanged between the server and the other end – e.g. an analogue (POTS) or digital terminal on a packet or circuit switched subscriber access – through the connecting network, and the resulting impact on the quality is determined when the server compares the voice sample, which it receives, with a reference master sample.

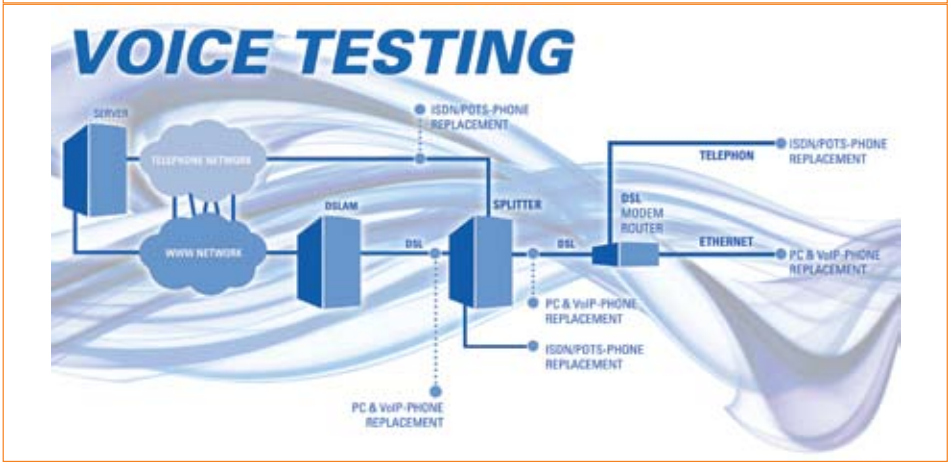
In such a test configuration, one of the Intec Argus ISDN and/or DSL handheld testers can serve as the remote end on the customer's subscriber access and exchange the standard voice recordings with the server on the backbone. This standard recorded sample can be sent from the Argus tester to the server to test the transmit direction. To test the connection in both directions, the server can send a sample to the tester which will then loop it back to the server. The result calculated by the ITD software on the server is then sent back to the tester for it to display. In this manner, one can receive an informative PESQ value directly onsite – without delay. This value can be evaluated easily on a scale ranging from - 0,5 to 4,5 (1 = bad, 2 = poor, 3 = OK, 4 = good, and 4,5 = excellent). An ideal ISDN connection using the G.711 codec would offer - with a PESQ value of 4,4 - a maximum of voice quality and could well serve as a quality reference for all other means of communication.

Information regarding the PESQ analyse package, which consists of the server software and a handheld tester, is available upon request from ITD Informationstechnologie or Intec Gesellschaft für Informationstechnik.

Comprehensive analysis using a handheld tester

The Argus testers from Intec are positive proof that the currently diverse requirements connected with ISDN / DSL testing can be handled using a compact, battery-operated tester. Thanks to their all-in-one design – that trades off modularity in favour of completeness – these compact combi-testers can be quickly used on any of the





various telephone interfaces. A variety of testers are available which all support POTS and ISDN accesses as well as VoIP via Ethernet or xDSL.

At CeBIT 2008, intec introduced not only the Argus 145 platform, which is conceived as a premium tester that can be expanded to a comprehensive Triple Play test set, but also the economical entry level combi-tester, the Argus 42, as a special voice tester. The latter test includes support for not only BRI, U-interface, POTS, DSL and Ethernet lines, but can also be equipped with support for VoIP as an option. This option enables it to simulate a VoIP terminal and, with its integrated handset, to serve as a "normal" SIP telephone. Beyond that, it can also determine key data regarding the connection, such as the degree of jitter.

Further trends: VDSL2, VoD, IPTV and SHDSL 4-wire

In addition to the arrival of a new generation of voice communications, there are currently also significant developments on the physical layer. As an example, today a DSL tester must not only support ADSL and ADSL 2/2+ accesses, but must also include measurement and test routines for broadband VDSL2 accesses. These new high-speed accesses, which in part offer symmetrical bitrates of 25 Mbps to 50 Mbps, support not only the traditional data communications and internet telephony but also IP-based, high-resolution television (HDTV). It is precisely this simultaneous use of the various time-sensitive services and those that are more tolerant, which makes the use of modern, portable and flexible measurement technology so critically important. In answer to this need, two VDSL testers were introduced in 2007, an entry level tester and a high-end tester with a colour display. Both of these testers support the various VDSL2 profiles and bandplans and each also have an independent ADSL chipset.

For its xDSL tester, also available are optional measurement routines for assessing the quality of IPTV or video on demand (VoD). These options can be easily added at any time – also later in the field – by simply entering the appropriate key. This analyse function is not limited to determining key physical characteristics, such as packet loss, jitter, latency and continuity errors. It also includes support for set-top-box emulation, evaluation of the media delivery index and an IPTV-Online-Trace, which records the connection's physical parameters, (mentioned above) over a longer period of time and then presents the results graphically.

SHDSL 4-wire lines are another interesting topic. Here high symmetrical bitrates can be achieved over great distances by connecting wire pairs together and using them in SHDSL-4 or multiwire mode. The Argus 145 xDSL and ISDN combi-tester can be upgraded to handle such configurations as well, for example with the optional SHDSL.bis (enhanced SHDSL) support.

Conclusion

The technology available for packet-switched and circuit-switched telephony is constantly changing. The physical limits are continually being redefined as higher frequency ranges and innovative modulation procedures find application and this confronts ISDN and DSL measurement technology with a constant supply of new challenges. The ideal testers for use onsite are, naturally, ones which pack all the necessary functionality into a single compact case. Another particularly important topic today is seen in the assessment voice quality, which can be accomplished quite accurately using the PESQ method.

Contact Michael Braun, Powertel Telecom, Tel 011 251-6460, michaelb@powertel.co.za