VoIP meets DECT

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Introduction

The telecommunication market currently changes rapidly initiated by the migration of traditional telephone networks to IP based (Internet Protocol) infrastructure (NGN, Next Generation Network). The advantage is obvious: one network transports all kind of data including voice for telephone communications, customers will benefit from new features. End users can still use their telephones like DECT at home. However, the interconnection to the NGN network differs. Interface IAD's (Integrated Access Devices) are currently promoted and sold by manufacturers for private use. As side effect this migration to NGN network infrastructure introduces longer propagation delay.

This contribution discusses a typical interconnection problem between DECT terminals commonly in use at private customer's and NGN networks. Quality impairments arise which were completely underestimated by network providers and equipment manufacturers.

Migration to NGN

Figure 1 shows a typical connection between an ISDN handheld phone and an analog DECT terminal [1] via the traditional ISDN network. DECT phones are very common in use especially in Europe and also in Germany..

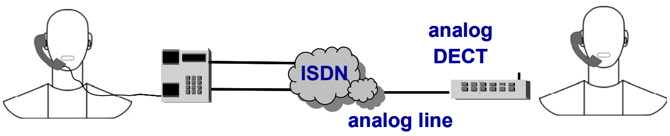

Figure 1: Example of traditional network connection

A similar connection via a NGN network infrastructure is exemplarily shown in figure 2.

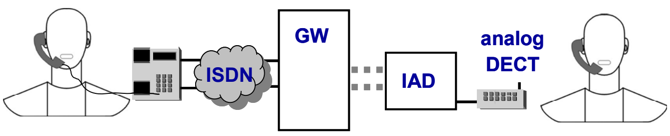

Figure 2: NGN connection

Gateways (GW) interconnect traditional networks to NGN VoIP backbones. IADs can be installed in private homes to connect the commonly used DECT phone (analog or digital). These two example demonstrate that the migration from traditional telephone networks to NGN happens without the need to exchange the telephones at the user side, except the installation of an IAD. However, the NGN network between the gateway and the IAD introduces a significantly higher delay compared to the traditional ISDN network. Consequently echoes which are produced by many DECT phones currently on the market appear now as disturbing, even they were imperceptible and did not lead to any problems in the traditional ISDN network. The driving factor is the network delay.

Principal of DECT Echoes

In order to objectively assess this quality aspect and provide appropriate measurement technique for laboratory tests it is necessary to analyze the typical structure of residual acoustic echoes from DECT phones. The principal is shown in figure 3. The terminal can be mounted to an artificial head measurements system (ITU-T P.58 [2]), exposed to free field or can be laid on a hard surface. Such conditions represent typical use cases and need to be considered. DECT echoes can typically be characterized by three main aspects:

- a low echo attenuation violating a recommended terminal coupling loss (TCL_w) of 46 dB [1],
- a time delay (designated as t_d in figure 3) of approximately 30 ms [1] caused by DECT technology and,
- linear and non-linear echo components. Non-linearities are typically introduced by loudspeaker distortions or mechanical vibrations.

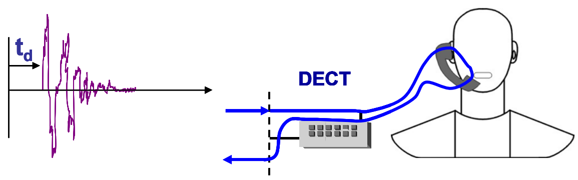

Figure 3: Principle of DECT echoes (4-wire digital)

Table 1 shows exemplarily three results of commercially available digital DECT phones under different test conditions. None of this configuration provides a TCL_w of > 46 dB. This recommendation is significantly violated in critical situations, e.g. when the DECT phone is laid on a hard surface with transducers down.

	DECT No.1	DECT No.2	DECT No.1 (hard surface)
TCL_w	31.0 dB	36.3 dB	17.8 dB

Table 1: TCL_w of DECT scenarios

The power density spectrum of a test signal and a residual DECT echo is shown in the two examples in figure 4. Significant signal energy can be analyzed especially in the high frequency range for these two examples introduced by non-linearities.

These results demonstrate that DECT echoes do not always meet the recommended requirements for the echo attenuation. This did not lead to significant quality impairments when these phones were connected to the traditional ISDN network introducing a low propagation delay.

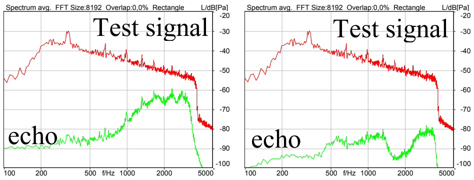

Figure 4: PDS of test signal and DECT echoes

The subscriber on the other end of the connection does not judge this echo as disturbing because the round trip delay is low. Using the same phones in a VoIP scenario (see figure 2) now introduces a significant echo disturbance caused by the increased round trip delay.

Echo Canceller Implementations in IAD's

IAD's provide the interface between analog or digital DECT phones and NGN. In order to suppress echoes reflected from the telephone side or from the internal hybrid (in case of analog 2-wire interfaces) echo cancellers in combination with non-linear processors are implemented in these IAD's. The principal is shown in figure 5.

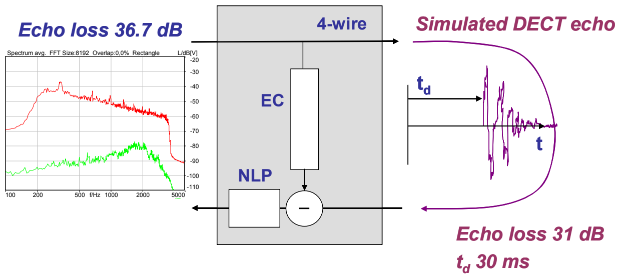

Figure 5: EC implementation in IAD (example)

Connecting a DECT phone to an IAD may still lead to an insufficient echo attenuation even echo canceller and NLP are active. The example shown in figure 5 introduces a simulated DECT echo from an existing, commercially available phone providing an echo loss (TCL_w) of 31 dB and an echo path delay t_d of 30 ms. The measured echo loss for the combination of IAD with integrated echo canceller and NLP and this DECT simulation is only 36.7 dB in this example. This is only slightly higher than the DECT echo itself, but represents a typical measurement result in this scenario. Both, the implemented echo canceller and NLP are not capable to suppress the DECT echo efficiently. In principal there are two reasons for this: the echo path delay t_d exceeding the processing window of the echo canceller and the non-linear characteristic of the DECT echo.

Further tests can be carried out by eliminating the echo delay (t_d = 0 ms) using the appropriate measurement technique. This example is shown in figure 6. The echo loss measurement now leads to a result of 70 dB indicating that the combination of echo canceller and NLP completely suppress the DECT echo. However, it should be carefully considered that the DECT echo still consists of a linear and a non-linear part. Echo cancellers can only reduce linear echo components, the non-linear part can not be reduced by an echo canceller implementation. The high echo loss result under this condition indicates that the NLP definitely suppresses the residual echo.

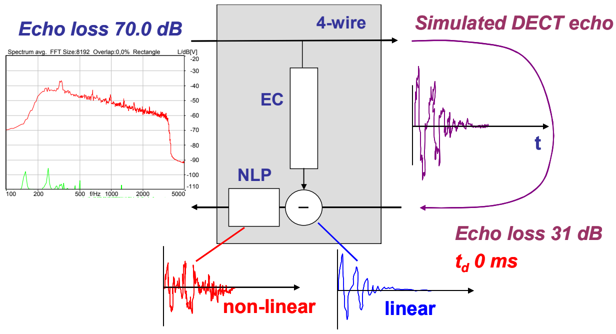

Figure 6: Simulated DECT echo, t_d = 0 ms

However, under double talk conditions, when the NLP needs to be deactivated, the non-linear echo component appears in sending direction and may again be disturbing for the conversational partner on the other end of the connection.

The single talk echo disturbance can significantly be improved if echo cancellers are implemented with "sliding window" technique, i. e. working with at least two processing windows which can be time shifted in order to cover hybrid echoes (in case of 2-wire interfaces) and the linear part of a delayed DECT echo. A typical NLP implementation relaying on a pure attenuation of the residual echo can only be regarded as a "work around" because non-linearities are not suppressed. A new implementation design needs to be considered, IAD's are more confrontrated with acoustic echoes than expected. Consequently the implementations need to be more designed like acoustic echo cancellers than electrical line echo cancellers as they used to be before.

Another aspect that needs to be addressed is the artificial echo in a 4-wire DECT fix part (FP) introducing a 24 dB echo [3]. This shall ensure proper operation of network echo cancellers. In case network echo cancellers are disabled in a NGN network in this connection, this echo will appear as very disturbing for the subscribers on the other end of the connection.

Conclusion

The migration to NGN introduces underestimated quality degradations using DECT phones. This is especially important because 90 % of market share of new subscribers use wireless DECT phones. Echo cancellers in IAD's are typically not designed to cover these DECT echoes and need to be adapted. This is of special relevance because quality degradations risk the acceptance of the new technologies in NGN.

References

[1] ETSI TBR 10, Digital Enhanced Cordless Telecommunications (DECT); General terminal attachment requirements; Telephony applications

[2] ITU-T Recommendation P.58, Head and Torso Simulator

[3] Draft ETSI TR STQ 117 29 V0.0.1 (2007-08)