



Echo Cancellation and Voice Quality in Today's Circuit Switched, Digital Wireless, and Voice over Packet Networks

OCT6100 Series Glossary of Terms

Acoustic echo: Acoustic echoes consist of reflected signals caused by the qualities of an enclosed space when sound is transmitted.

Acoustic echo is caused by acoustic coupling problems between a telephone's speaker and its microphone and can occur in wireless or wireline telephones, or in the hands-free set of a speakerphone. These may be caused by poor quality handsets, the environment surrounding the caller, or from handset cross talk, which occurs when there is electrical pickup between the analog circuits of the microphone and the speaker.

Also includes signal pickup in the handset from the speaker to the microphone because of bad isolation.

BER (Bit Error Rate): The average number of bits transmitted in error per units of time (typically seconds).

Buffering delay: In streaming audio or video, buffering refers to bringing in an initial amount of data before actually playing, displaying or transmitting the material. Sometimes momentary delays in transmission can occur causing blips in the sound or video. Having more data in the buffer than is necessary for real-time delivery compensates for this delay.

Circuit switched network: A networking technology that provides a temporary, but dedicated connection between two stations no matter how many switching devices the data is routed through. Circuit switching was originally developed for the analog-based telephone system in order to guarantee steady, consistent service for two people engaged in a phone conversation.

Comfort noise: The low level noise that is heard on a phone conversation and that makes the connection sound live. This noise must be continuous in order to avoid the annoyance of intervals of speech with background noise followed by intervals of silence.

Compression (Voice): Encoding digital speech to take up less storage space or transmission bandwidth. Compression typically trades quality of the voice signal with bandwidth of transmission.

Convergence: The process of developing a model of the echo path, which will be used in the echo estimator to produce the estimate of the electric echo.



Convergence Time: For a defined echo path, the interval between the instant a defined test signal is applied to the receive-in port of an echo canceller with the estimated echo path impulse response initially set to zero, and the instant the returned echo level at the send-out port reaches a defined level.

In short, how much time it takes an echo canceller to estimate and remove the echo to a defined level.

Digital wireless network: A network that transmits any combination of voice, video and/or data between users via the radiowaves through air. Various communications techniques are used to provide wireless transmission including infrared line of sight, cellular, microwave, satellite packet radio.

DSP (Digital Signal Processor): A special-purpose CPU used for digital signal processing. It provides ultra-fast instruction sequences, such as shift and add, and multiply and add, which are commonly used in math-intensive signal processing applications. DSP chips are widely used in a myriad of devices, including sound cards, fax machines, modems, cellular phones, high-capacity hard disks and digital TVs. DSP chips are used in sound cards for recording and playback, compressing and decompressing and speech synthesis.

Dispersion time: The duration of a signal when a signal such as voice is distorted through a process like echo. In these cases, the resulting signal/distortion is often longer than the original.

Echo path: The transmission path between R_{out} and S_{in} of an echo canceller. This term is intended to describe the signal path of the echo.

Echo path delay: The delay from the R_{out} port to the S_{in} port due to the delays in the echo path transmission facilities including dispersion time due to the network elements. In case of multiple echo paths, all delays and dispersions of any individual echo path are included. The dispersion time, which varies with different networks, is required to accommodate the band-limiting, and hybrid transit effects.

ERL (Echo Return Loss): How much smaller in level, the echo is compared to the original signal in relation to the echo path. In technical terms, the decrease in power of a signal from the receive-out port (R_{out}) to the send-in port (S_{in}) of an echo canceller, due to transmission and hybrid loss, i.e. the loss in the (cancelled-end) echo path.

ERLE (Echo Return Loss Enhancement): How much echo is removed by the echo canceller. In technical terms, the decrease in power of the echo signal as it passes through the send path of an echo canceller. This definition specifically excludes any nonlinear processing on the output of the canceller to provide for further attenuation.

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Electric echo: Electric echoes consist of reflected signals caused by the near end impedance mismatch, e.g. at a 2-wire/4-wire conversion unit (hybrid).

Far end: The side of an echo canceller which does not contain the echo path on which this echo canceller is intended to operate. Also called non-cancelled end, it is the end where the voice that will echo is generated.

Heterogeneous networks: A network that includes computers and other devices from different manufacturers i.e. a network that is not built of one type of device, non-homogenous.

H register: The register within the echo canceller which stores the impulse response model of the echo path.

Interoperability: The capability of two or more hardware devices or two or more software routines to work together. For example, routers and switches in a network require interoperability.

Leak time: The interval between the instant a test signal is removed from the receive-in port of a fully-converged echo canceller and the instant the echo path model in the echo canceller changes such that, when a test signal is reapplied to R_{in} with the convergence circuitry inhibited, the returned echo is at a defined level. This definition refers to echo cancellers employing, for example, leaky integrators in the convergence circuitry.

Local loop: The lines between a customer and the telephone company's central office, often called the "last mile." Local loops use copper-based telephone wire.

Loading coils: Inductors, coils of wire, placed in telephone lines to smooth out the frequency characteristic, in order to extend the reach of the voice signal or to improve the quality of the communication.

Near end: The side of an echo canceller which contains the echo path on which this echo canceller is intended to operate. This includes all transmission facilities and equipment (including the hybrid and terminating telephone set) which is included in the echo path. Also called cancelled-end.

NLP (Non Linear Processor): Part of an echo canceller which has a defined suppression threshold level and in which:

a) signals having a level detected as being below the threshold are suppressed, and

b) signals having a level detected as being above the threshold are passed although the signal may be distorted

Packetization: In the transmission of real-time voice in a packet switching network, the operation of transporting a digital voice signal into packets. A



network technology that breaks up a message into smaller packets for transmission.

Packet switched network: A networking technology that transmits messages broken into smaller packets and switches them to their required destination. Unlike circuit switching, which requires a constant point-to-point circuit to be established, each packet in a packet switched network contains a destination address. Thus all packets in a single message do not have to travel the same path. They can be dynamically routed over the network as lines become available or unavailable.

PSTN (Public Switched Telephone Network): the worldwide voice telephone network. Once only an analog system, the heart of most telephone networks today is all digital. In the U.S., most of the remaining analog lines are the ones from your house or office to the telephone company's central office (CO).

Pure delay: The delay from the R_{out} port to the S_{in} port due to the delays inherent in the near-end echo path transmission facilities, not including dispersion time due to the network elements. In this case, the transit time directly across the hybrid is assumed to be zero

Receive path: The voice path coming from the far end and is sent to the near end. It is used by the echo canceller to correlate with the returning echo.

Residual echo level: The level of the echo signal which remains at the send-out port of an operating adaptive filter of an echo canceller after imperfect cancellation of the circuit echo. It is related to the receive-in signal L_{Rin} by

$$L_{RES} = L_{Rin} - A_{ECHO} - A_{CANC}$$

Returned echo level: The level of the signal at the send-out port of an operating echo canceller which will be returned to the talker. The attenuation of a NLP is included, if one is normally present. L_{RET} is related to L_{Rin} by

$$L_{RET} = L_{Rin} - (A_{ECHO} + A_{CANC} + A_{NLP})$$

If nonlinear processing is not present, note that $L_{RES} = L_{RET}$.

Scalability: Refers to how much a system can be expanded. The term by itself implies a positive capability. For example, "the device is known for its scalability" means that it can be made to serve a larger number of users without breaking down or requiring major changes in procedure or investments.

Send path: With regards to an echo canceller, the voice path on which it operates to remove echo.

Switching/Routing delay: The delay endured by packets in a router or switch while a decision is taken for forwarding according to header. It also includes the

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delay while packets are queued for exit with other packets, this delay may be variable for each packet.

Unused taps: An unused electrical connection that permits signals to be transmitted onto or off a wire. This situation changes the impedance of the line and may cause reflection or distortion in the signal.

VoP (Voice over Packet) networks: Combines legacy voice networks and packet networks by allowing both voice and signaling information to be transported over the packet network

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