ECS614U/ECS749P: Sound Recording and Production

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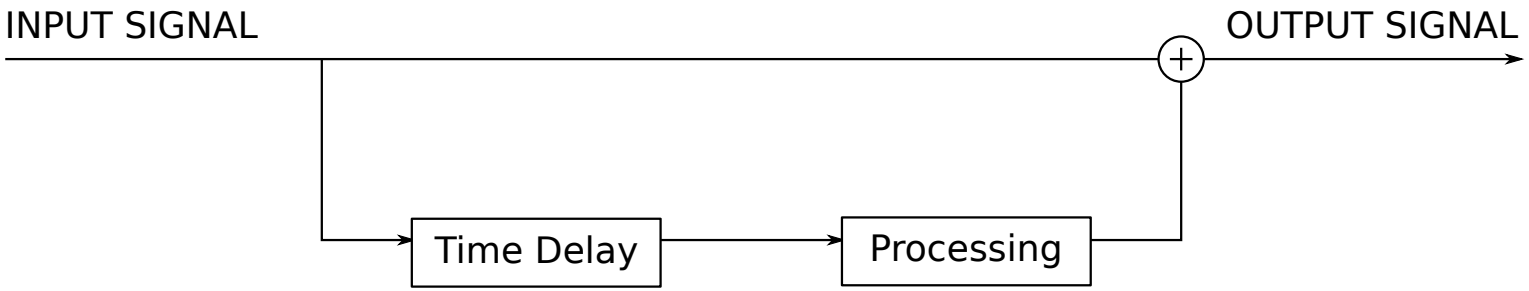
Mixing: Delay

Introduction

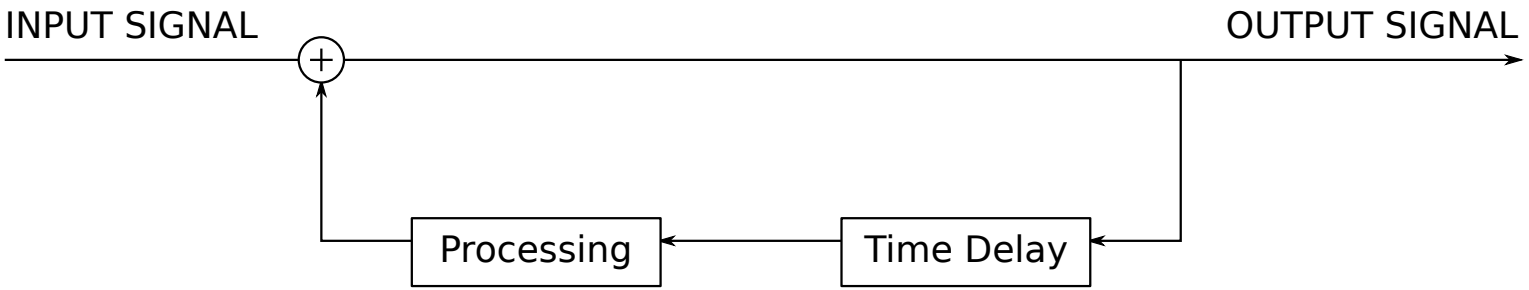
- Delay based effects send copies of the original signal to which a time delay and various other processing has been applied.
- Delay based effects have a number of uses.
  - As equalisation filters.
  - As tools to add interest to a song, e.g. echo, chorus, flanger.
  - To simulate room acoustic effects, e.g. reverberation.

Delay loops

FORWARD LOOP

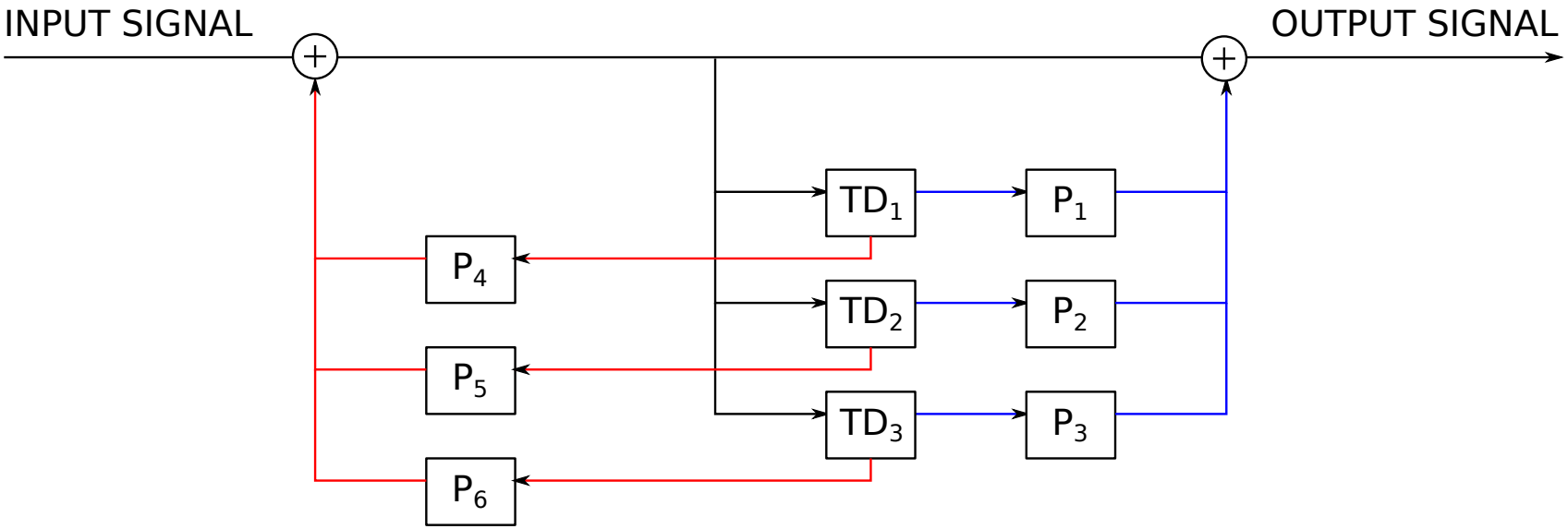


FEEDBACK LOOP



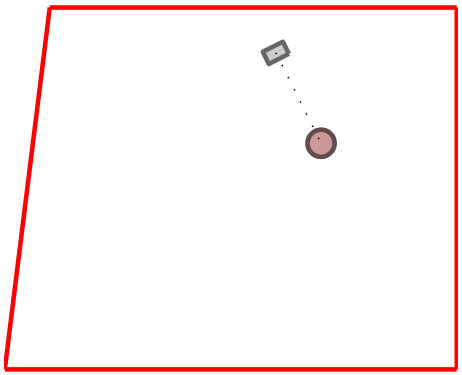
Delay cascade

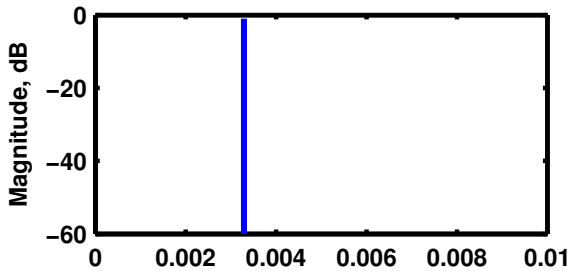
- A typical delay effect will contain a cascade of delay paths, and both forward and feedback sections.



Room Reflections

How can we model the signal path from loudspeakers to the listener, including the effect of reflections?





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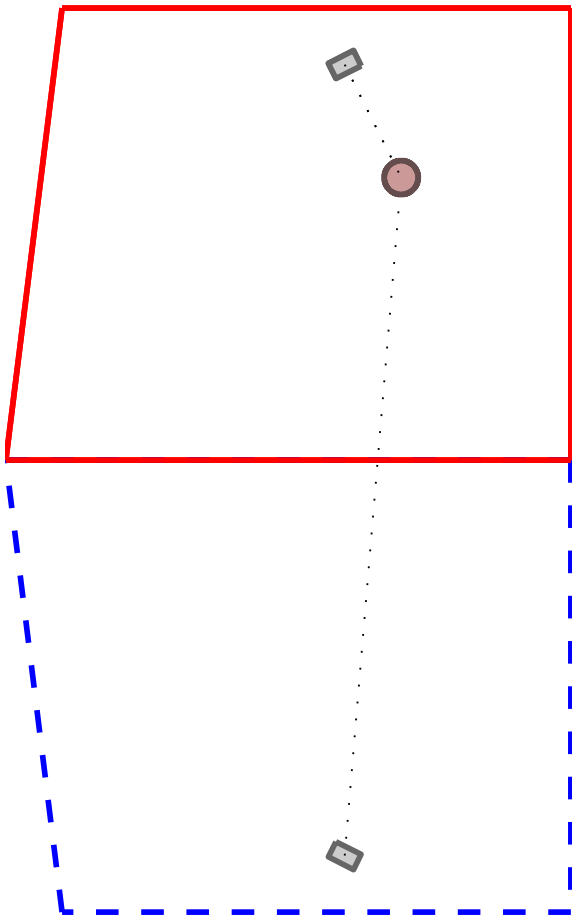

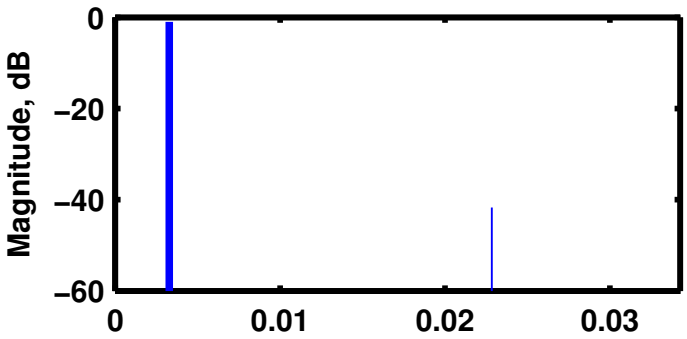

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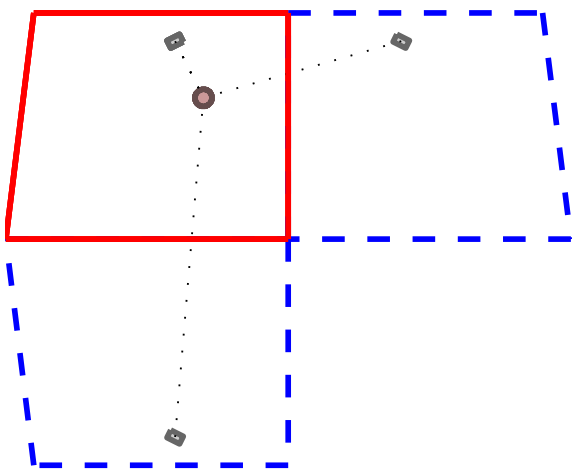

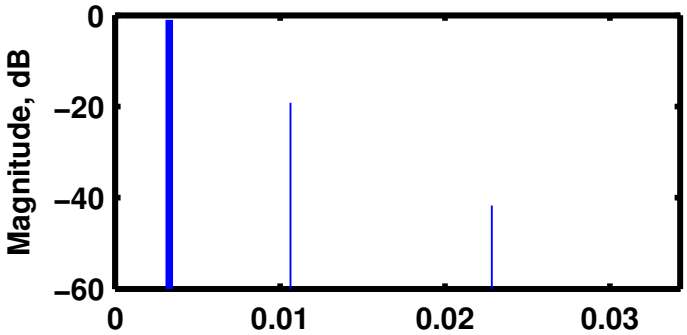

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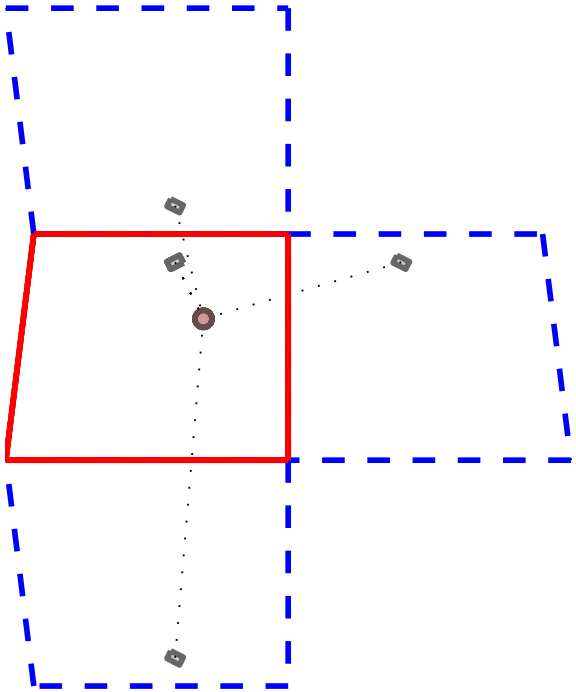

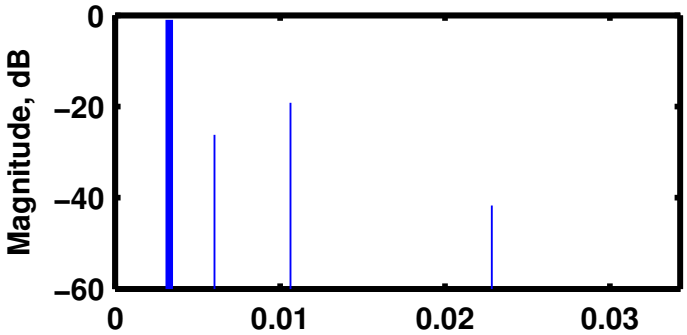

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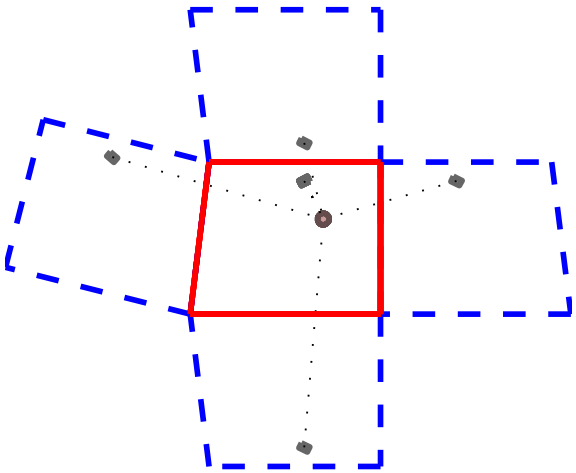

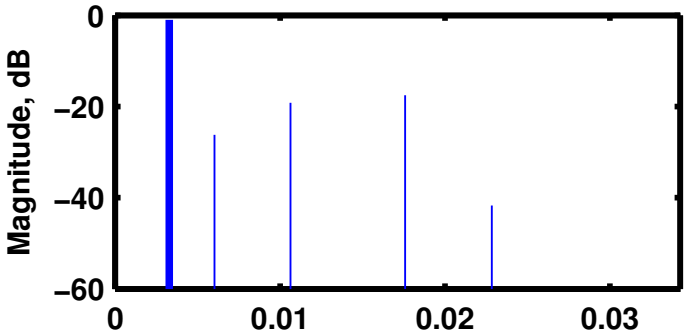

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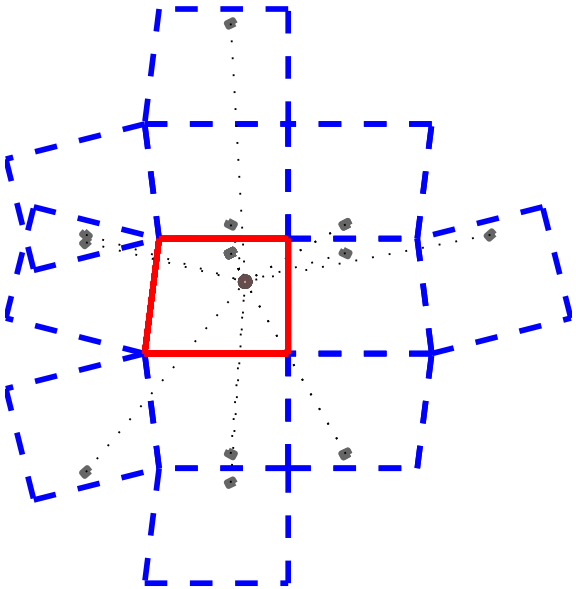

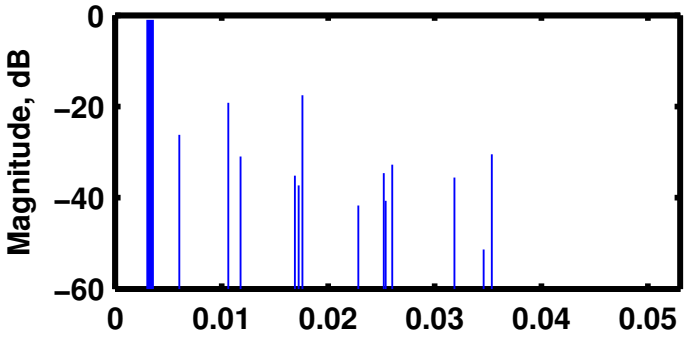

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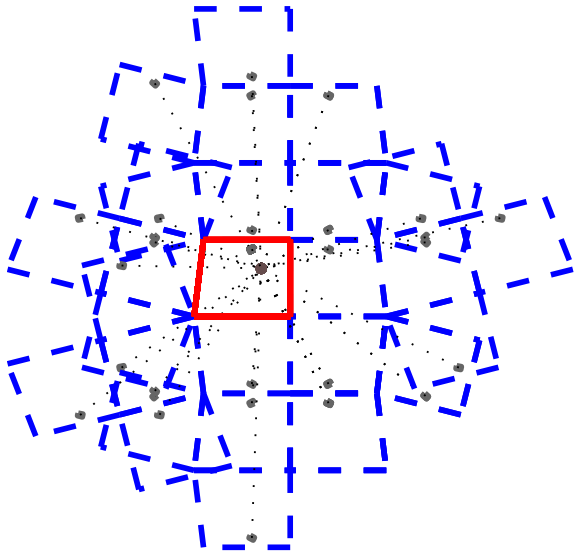

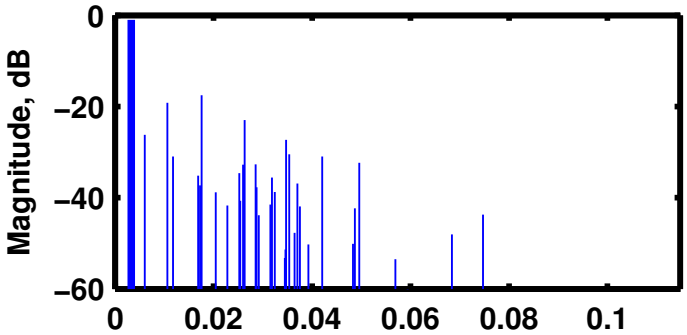

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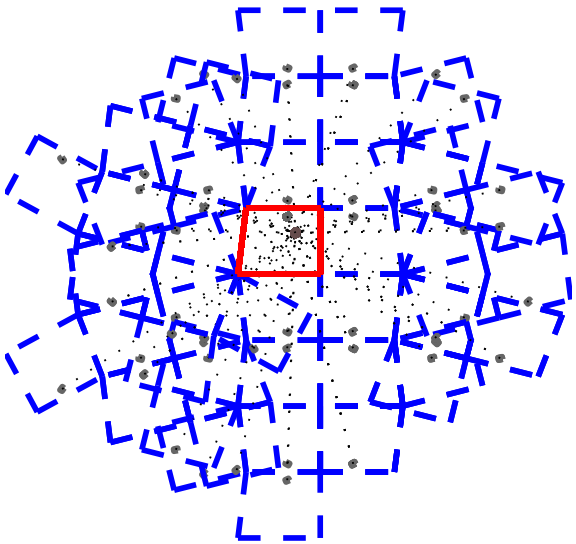

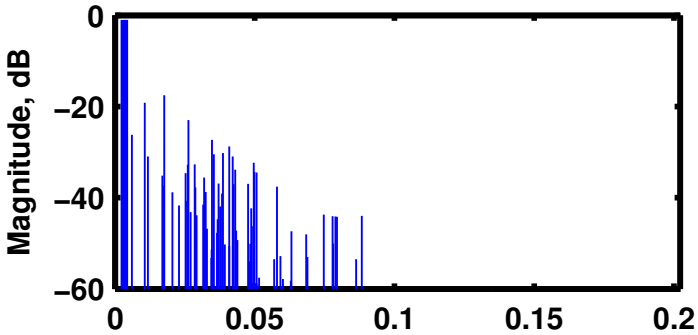

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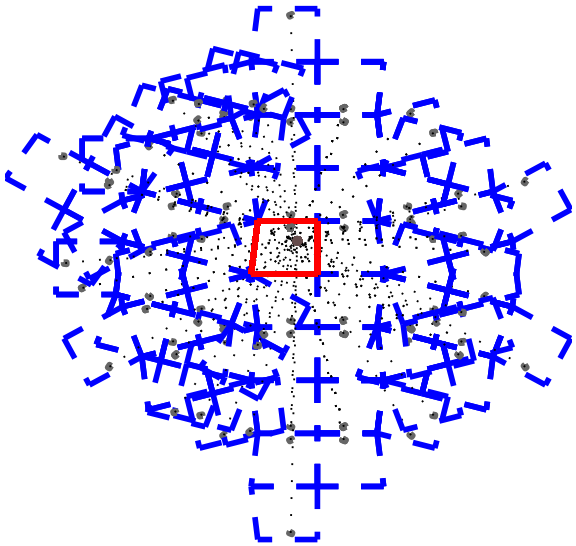
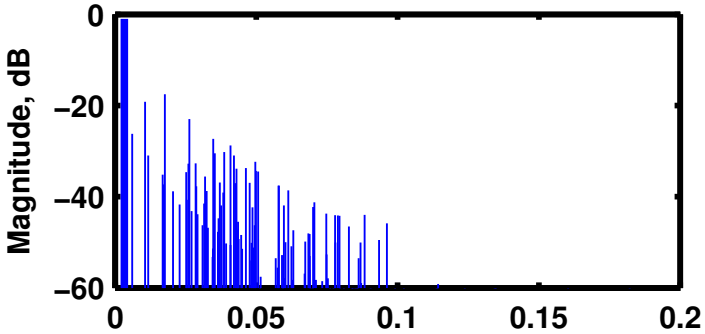
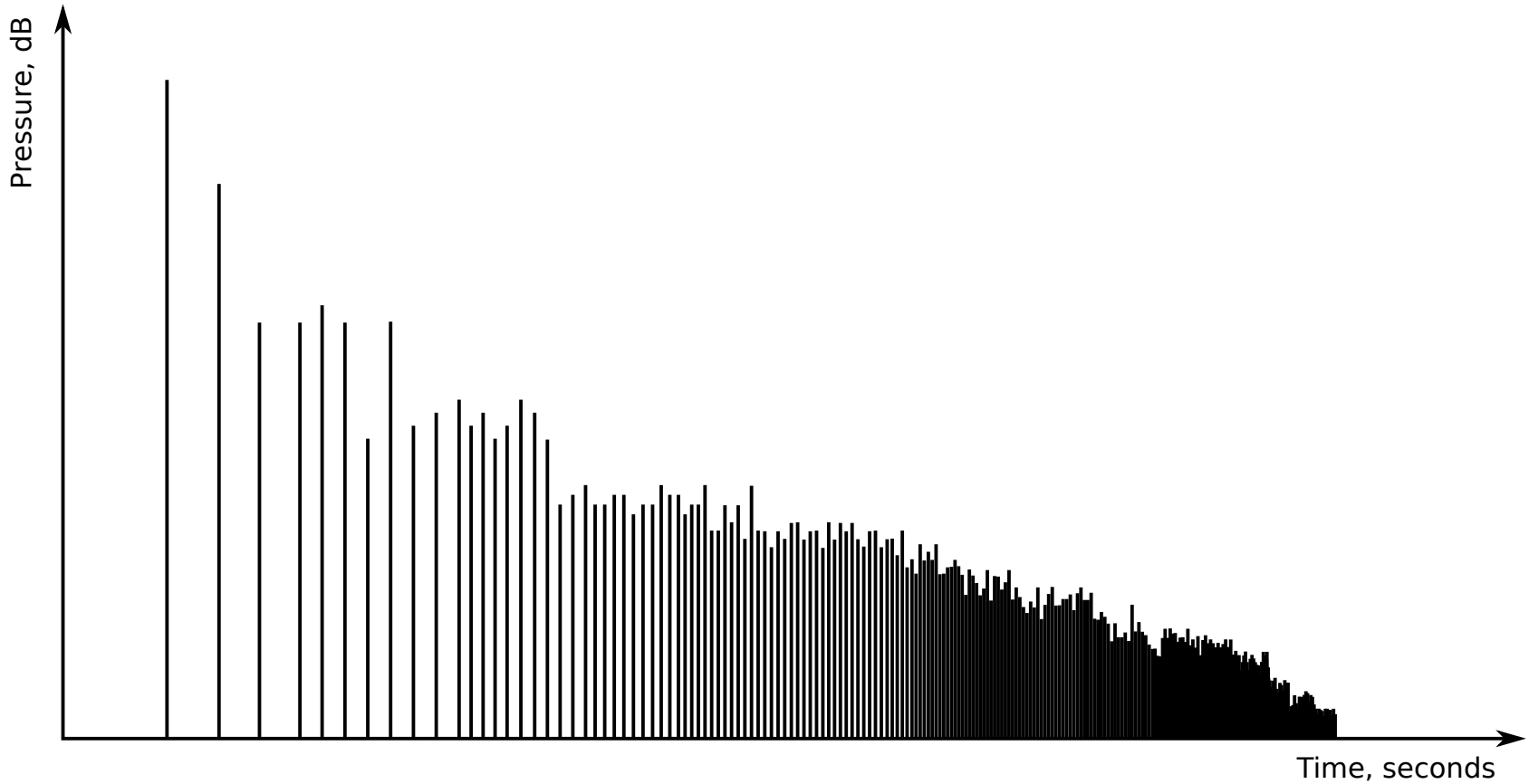




Room Impulse Response

If my source produces and impulse, what does my receiver measure?



Delay networks for reverberation

- There are two classes of reverberation effect.
  - Artificial reverb.
  - Convolution reverb.
- In both types, each delayed copy of the input signal represents a reflection.

Artificial reverb

- Artificial reverberators use delay networks to **simulate** room reverberation.
- Artificial reverberators do not attempt to replicate the sound of a specific space.
- The delay networks can be tuned using multiple parameters to get the desired sound.
- High end artificial reverberator plugins are **very** expensive.

Convolution reverb

- Convolution reverberators use measured (or modelled) impulse responses.
- The impulse response is a representation of the sound in a real or virtual space.
- Each point on the impulse response represents a particular reflected path.
- Each point has a delay, gain and polarity. A very large cascade of delay loops is needed to represent this!
- The calculation process (convolution) has been optimised. It is performed in the frequency domain to improve efficiency but they are still processor intensive.

Spatialisation using reverberation

- Our sense of space and position of sources is highly dependent on reverberation.
- The amount of reverb used can convey distance, and using stereo impulse responses alongside panning can give convincing impressions of source position.
- The only way fool the brain completely is to incorporate a full 3D sound field.
- This can be done fairly easily for playback on headphones if you have some HRTFs handy.

HRTFs

- HRTF stands for **H**ead **R**elated **T**ransfer **F**unction.
- It is analogous to an impulse response:
  - An impulse response describes how the sound waves travel from a source to a microphone within a space.
  - An HRTF describes how the sound travels from the space around you, and into your ears.
- You can get exceptionally good impressions of space using this approach.

Impulse response measurement

- How do we measure a room impulse response?
  - Play a test tone through a loudspeaker, e.g. noise or sine-sweep, that contains all frequencies of interest.
  - Record the signal at a location within the room.
  - Compare the original signal with the recorded signal.
- You can do this in any space and them super-impose the measured response onto any future recording.

Educational multi-track resource

- Practice audio files are included in the resources folder for this week.
- Many more projects can be downloaded from: *http://www.cambridge-mt.com/ms-mtk.htm*