1 Theory, assumed state of knowledge

Lecture (CE I/Script): Chapters 1, 2; especially section 2.4: M-ary transmission, transmission with orthogonal waveforms

2 What is shown?

This demonstration shows a three-dimensional vector space belonging to a three-dimensional signal space. Three orthogonal signals span this room. The result are three unit vectors for the vector space.

If the three signals are used for a transmission with orthogonal basic waveforms (of course, better would be to take four basic waveforms), then received signal vectors will not be the same if transmitted over an AWGR channel. Because of the scattering of the vector end points around the wanted signal vector points so called *noise spheres* result. If a large number of orthogonal waveforms used insted of three – i.e. the dimension of the signal space is increased accordingly – the end points of the noise vectors tend to lie within a thin shell of a sphere. We say that the noise spheres tend to become "harder" with an increasing number of signal space dimensions. This is the *Sphere Hardening* effect.

To get an accoustic impression of the SNR, there is a demonstration with a music-signal having the same SNR as the signal shown in the signal vector space.

3 What is demonstrated?

The aim of this demo is to create a geometrical understanding of the signal space and its corresponding signal vector space. Related to that is the sphere hardening effect, which says that with an increasing number of dimensions the noise spheres are getting harder and harder. This again is the basis to understand that there is a theoretical possibility to transmit error-free on arbitrary interfered transmission channels. The demo with acustical signals shall connect the acustical impression with the geometrical one and the value of the SNR.