# Communication Coding of Pulsed Radar Systems

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The idea of coding Radar signals in time, frequency and phase domains has been followed up since many years, especially for military systems for Electronic Warfare purposes. During the past few years the research in coding of Radar signals has been extended to communication-type codings, such as Direct Sequence Spread Spectrum (DSSS), orthogonal frequency division multiplexing (OFDM) and others. The results are surprising and encouraging. These systems would be particularly suitable for applications with multiple targets, such as UAVs for Radar observation or in intelligent transportation systems, which require the capability of vehicle-to-vehicle communication as well as the need for reliable environment sensing. While first approaches toward a joint implementation of Radar sensing and communications have been based on DSSS, presently OFDM waveforms seem to be the more promising candidates for these applications.

The basic idea of the DSSS approach is to use a pseudo random signal to which only a small amount of user data is added so that it will still preserve its pseudo random characteristics. The Radar processing will then be carried out, similar to any standard pseudo-random Radar.
OFDM signals are advantageous regarding Doppler shift. Besides providing high tolerance against Doppler shift they also do not experience range-Doppler coupling, which allows for independent and unambiguous range and Doppler processing. For single targets each line of the OFDM carriers can be separately processed, enabling a high accuracy by averaging over all carriers. Due to their origin in digital communications, OFDM signals are designed to carry information, which allows for simultaneous information transmission in parallel to Radar sensing. This is an interesting feature in particular concerning security applications. However, there are also some drawbacks related to OFDM Radar. Since the auto-correlation properties of OFDM signals are not ideal, as in the case of classical, correlation-based processing, higher side-lobes may occur in the Radar image. This requires proper code selection.

For Radar applications with multiple targets, not only range but also direction of arrival estimation is required in order to separate objects. This can be performed by multiple antenna processing techniques (Digital Beamforming (DBF)), which exploit the phase differences between the signals received at different spatial positions. For this purpose numerous algorithms exist, based on different mathematical approaches; also super resolution algorithms work very well for OFDM coding.

For the future it can be foreseen that the present “stupid” Radar will become intelligent through communication coding.