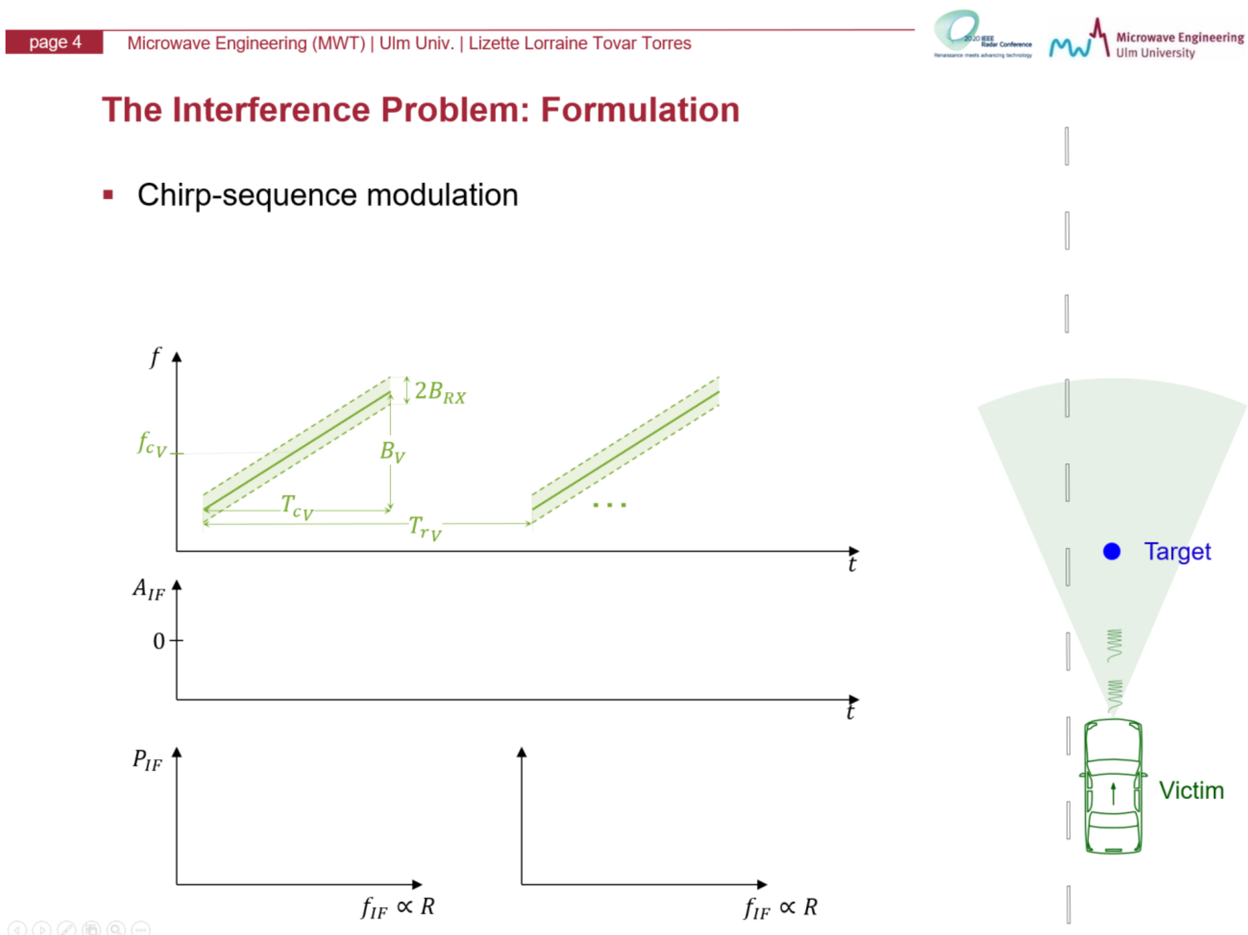
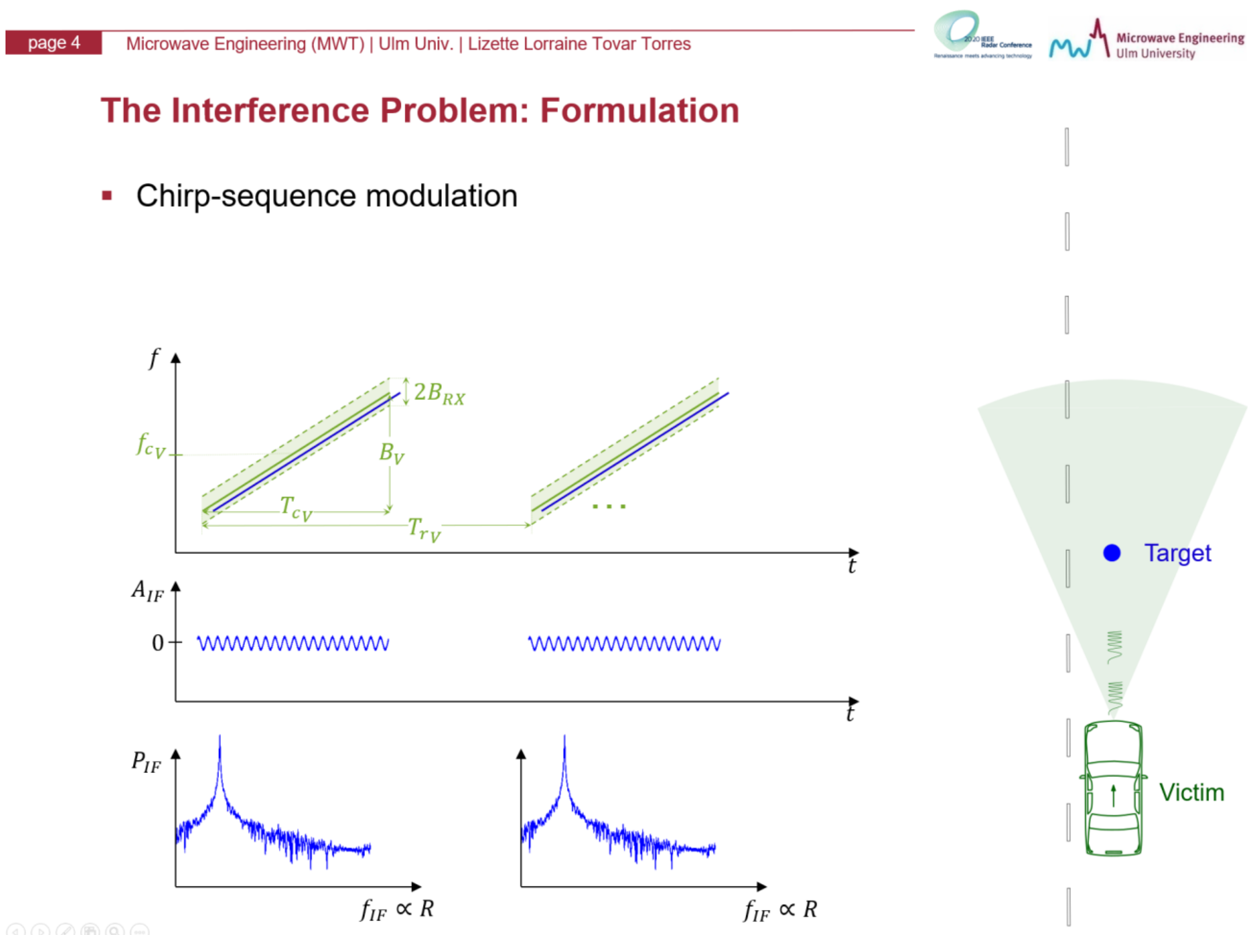
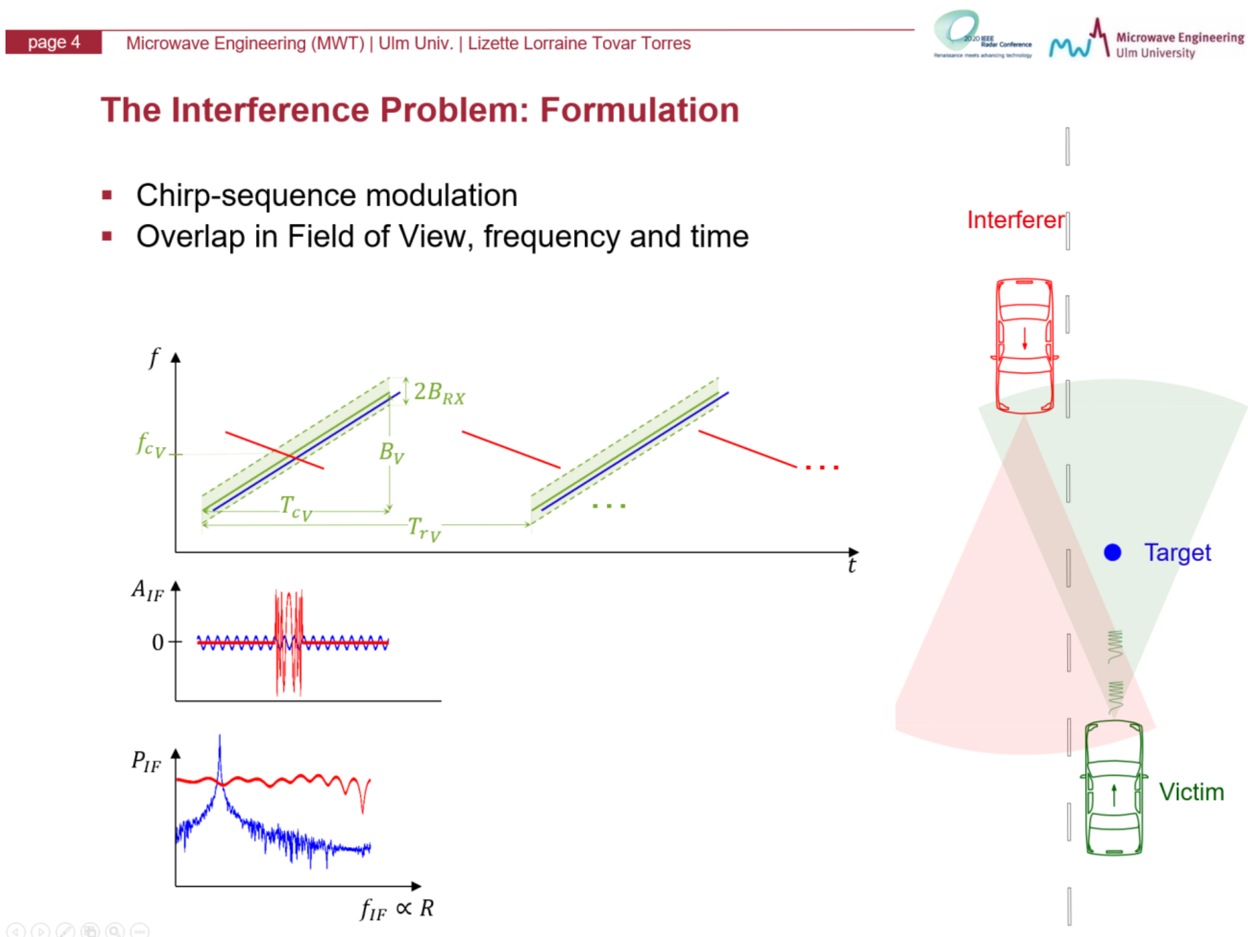


Modern automotive radar sensors use the well-known chirp sequence modulation scheme.

The victim radar transmits a sequence of chirps which are defined by a carrier frequency, bandwidth, chirp duration, chirp repetition time, and the receiver's bandwidth, which is depicted in the shaded green area of the figure. All the received signals falling within this area are downconverted and taken into account in the analysis.



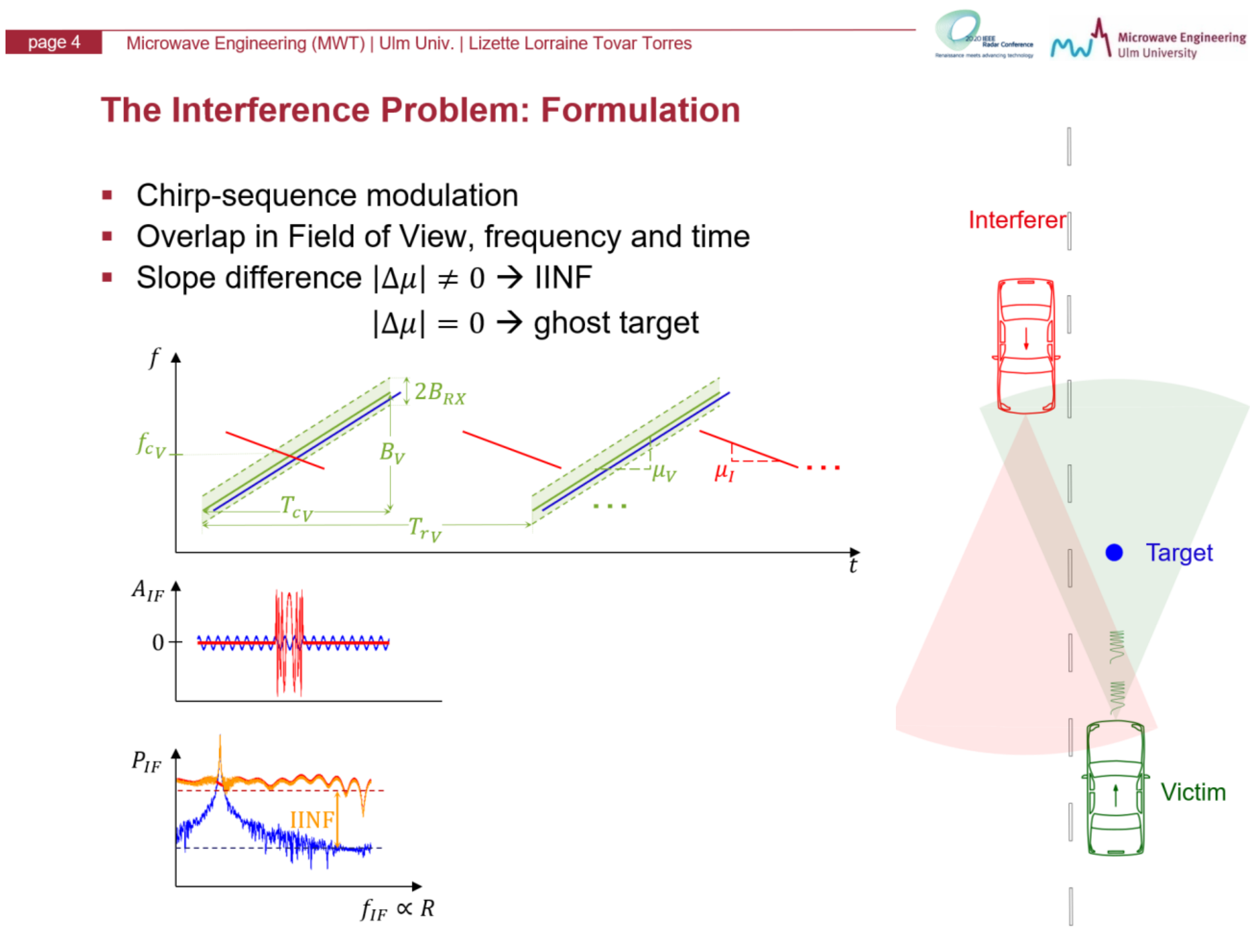
In blue, the normal target response is presented. The received signal is a delayed version of the transmitted one. After down conversion the signal approaches to a sinusoidal, whose frequency is proportional to the targets range. The spectrum is this signal exhibits a peak with certain SNR, and the frequency at which the peak occurs gives the target's range information.



Now, consider that the interfering signals are depicted in red. Interference can take place when a signal generated by another sensor impinges inside the field of view (FoV) of the victim, and this signal overlaps in frequency and time with the victim's signal. Despite the fact that those three conditions are accomplished in the given example, just the first victim chirp is being affected by the interference, since no interfering chirp is falling in the receiver's bandwidth of the second one.

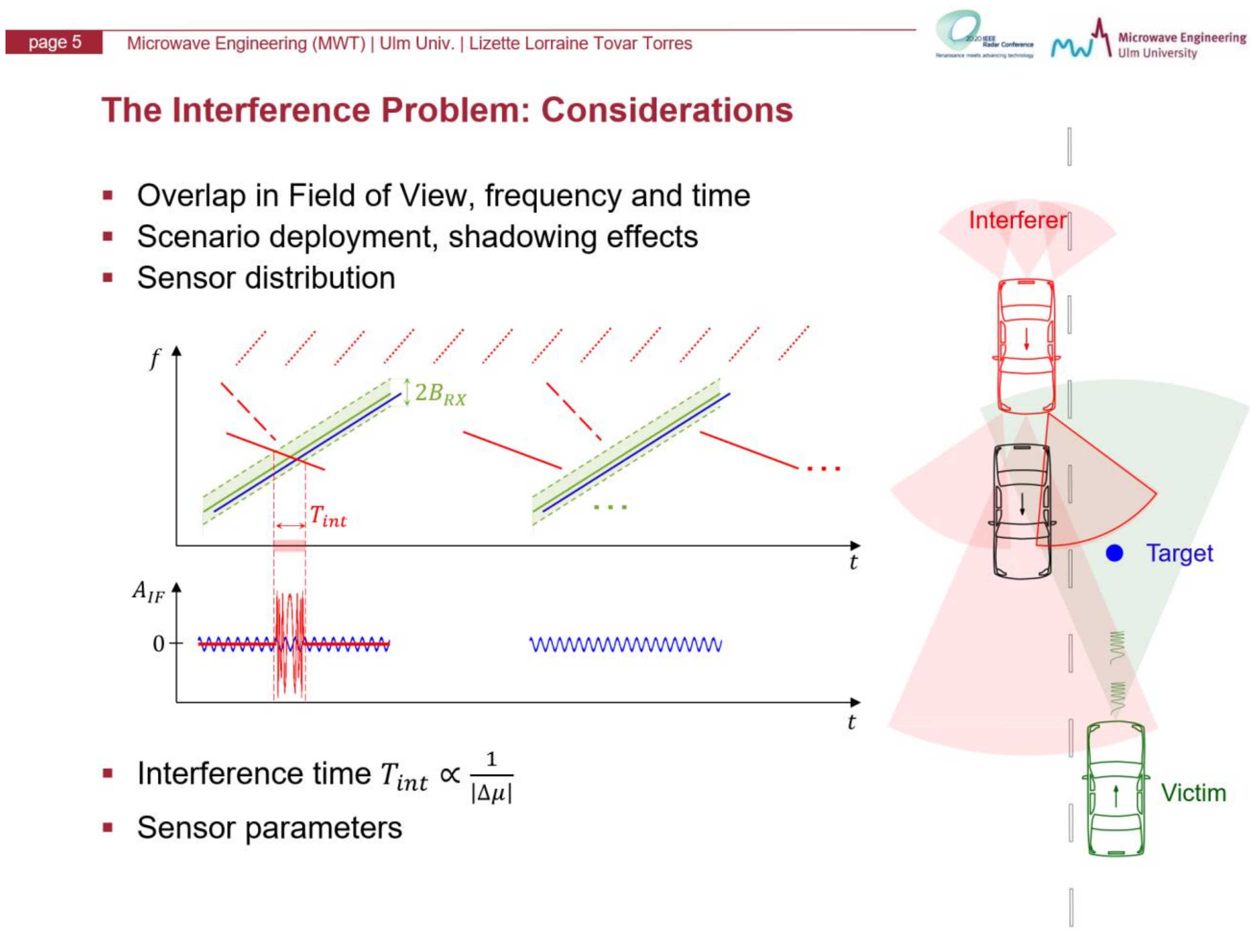
The second figure depicts the interferer signal after downconversion. This signal is determined by the parameters of the involved sensors, the range, velocity and angle of the interferer respect to the victim.

The effect of interference when detecting a target can be seen in the third picture. The red line represents the spectrum of the intermediate frequency corresponding to the interferer.



The orange line is the superposition of the signals. As it can be observed, there is an interference-induced noise floor increase (IINF) which makes problematic to identify weak targets.

This increase is related to the difference between victim's and the interferer's slopes Delta µ. When Delta µ = cero, the received ramp behaves as a ghost target. However, this case is very unlikely to happened due to the uncorrelated phase noise of the victim and interferer chirps.



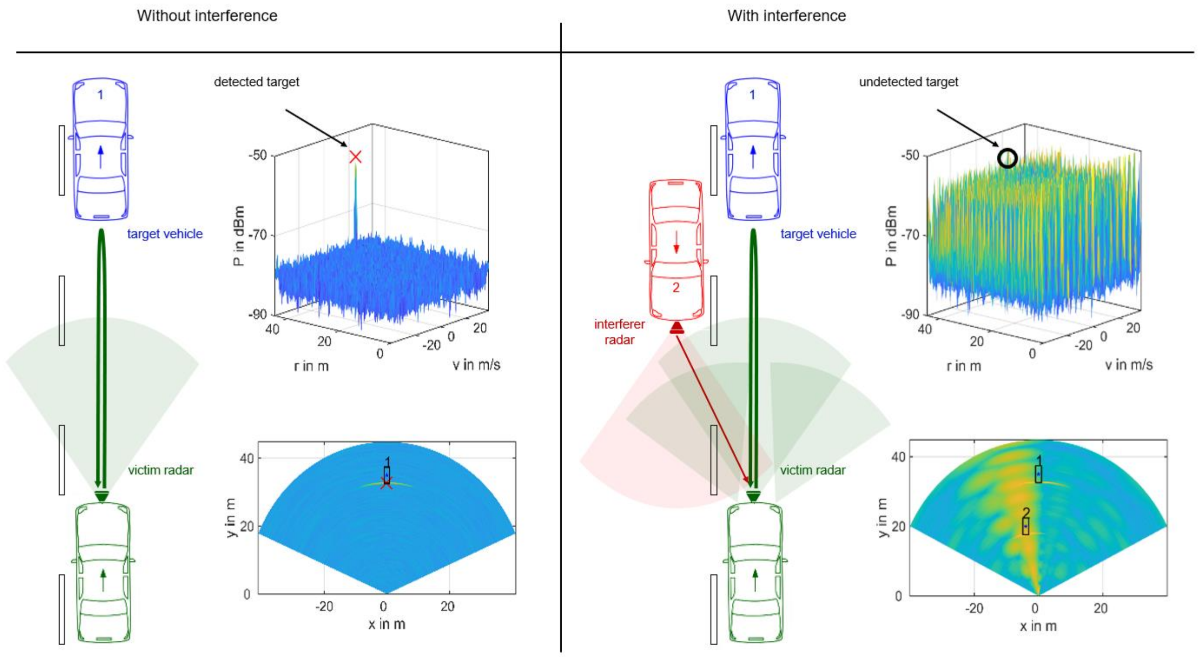
The simulator must be able to recognize interfering situations in complex traffic scenarios where, not one but, multiple potential interferes are present.

The example shows that from the 6 potential interferer sensors, some of them are looking towards other direction or are out of the victims FoV. Now, if another vehicle is included in the scenario, one of the interfering sensors is covered and probably will not interfere, leaving just 1 of the 6 potential interferers to be considered.

It must me mention that the effect of the interference is seen just during the time interval where the interferer crosses the victim's revivers bandwidth. This short time interval is proportional to Delta μ.

Using a different sensor with other parameters, like the one depicted in dotted lines, no frequency overlapping takes place, and therefore no interference occurs. As a final example, the dashed lines represent a sensor, which overlaps in in FoV, frequency and time. Nevertheless, no interference occur since the interferer signal does not fall in the victim's receiver.

The interference simulator is developed in Matlab. It includes a catalog with different traffic scenarios and a catalog with several radar sensors.


Without interference
With interference
detected target
target vehicle
victim radar
P in dBm
r in m
v in m/s
x in m
y in m
undetected target
interferer radar