

# DVB-T Signal Analysis on Passive Coherent Location system in Single Frequency Network

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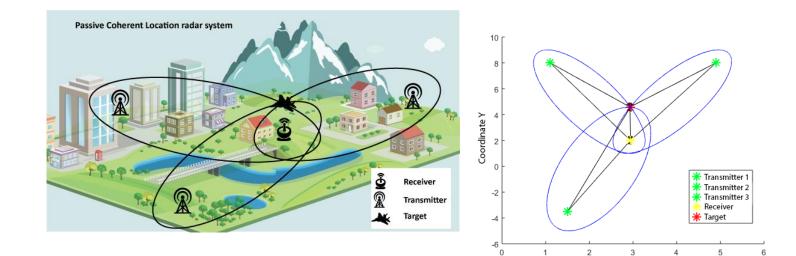
# INTRODUCTION



- The development of passive radar systems has long history in Czech Republic
- The DVB-T analysis in terms of guard interval, symbols quantity, scattered pilot carries

### **Passive Coherent Location**

- The PCL system is based on the **bistatic radars**
- Type of the bistatic radars
  - Bistatic radars I. consist of own transmitter and receiver
  - Bistatic radars II. consist of receiver and transmitters in environment



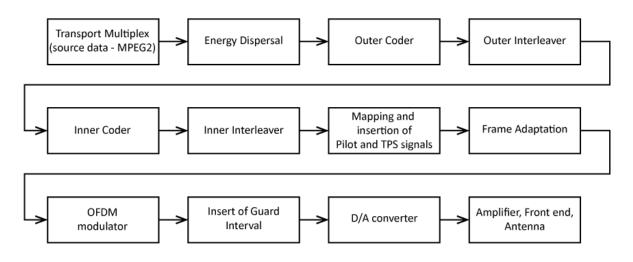


Coordinate X

### The DVB-T Signal Analysis

- The digitization of the terrestrial broadcasting services (radio, television broadcasting) brings new possibilities for the PCL systems
- The DVB-T, DVB-T2, and DAB standards will require new signal processing techniques, algorithms, etc. for future PCL systems
- The analysis of DVB-T signal based on CA function is required for new generation of PCL systems
- The analysis focuses on parameter description from the point of view the CA function
- The description of DVB-T standard is in norm ETSI EN 300 744

#### The block scheme of the DVB-T generator

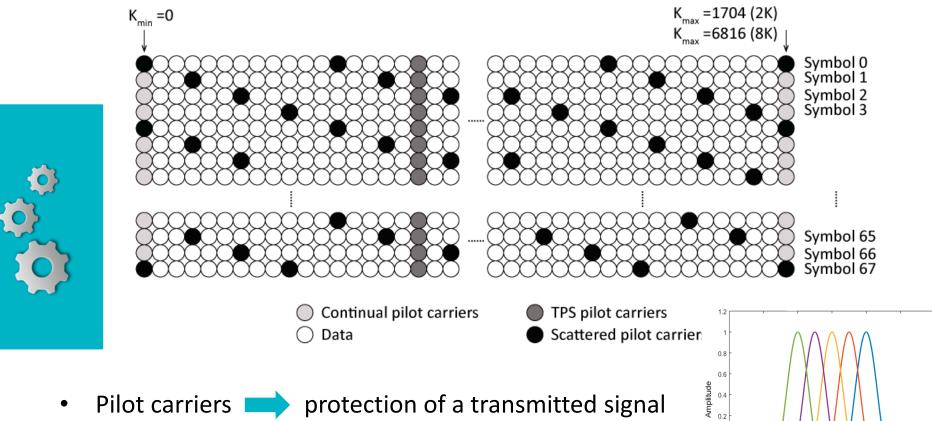


### **OFDM frame structure**

	<ul> <li>Transmission mode</li> <li>2K, 4K, 8K</li> <li>Frame include 68 symbols</li> </ul>	Parameters	Transmission modes		
Ö			2K	8K	
		The number of data carrier frequencies	1705	6817	
	$k' = k - \left(K_{\min} + K_{\max}\right)/2$	Useful time interval (without guard interval)	224 <i>µ</i> s	896 µs	
		Distance between neighboring carrier frequencies	4464 Hz	1116 Hz	
		Distance between first and last carrier frequency	7,61 MHz	7,61 MHz	
$s(t) = \operatorname{Re}\left\{e^{j2\pi f_{c}t} \sum_{m=0}^{\infty} \sum_{l=0}^{67} \sum_{k=K_{\min}}^{K_{\max}} c_{m,l,k} \times \psi_{m,l,k}(t)\right\}$					
$\psi_{m,l,k}(t) = \begin{cases} e^{j2\pi \frac{k'}{T_U}(t-\Delta - lT_s - 68mT_s)}, (l+68m)T_s \le t \le (l+68m+1)T_s \\ 0, & other \end{cases}$					

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### OFDM carrier frequencies in DVB-T system



- Main function synchronization and equalization
- Scattered & Continual Pilot carriers

$$k = K_{\min} + 3 * \mod(l, 4) + 12 * p$$

2000

4000

6000

-6000

-4000

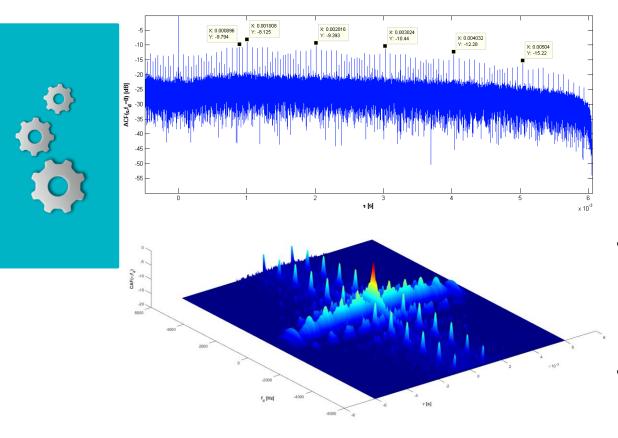
-2000

Frequency

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# Analysis of the symbols quantity

• The analysis of the CA function for higher quantity of received symbols



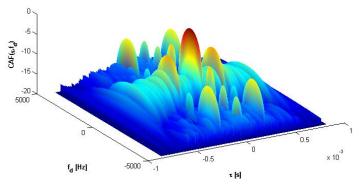
Time delay Description The cursor 896 The time duration of one 1 symbol without GI 2 1008 The time duration of one symbol with GI 2016 The copy of the symbol with 3 GI (2x1008) 4 3024 The copy of symbol with GI (3x1008) 5 4032 The copy of the symbol with GI (4x1008) 6 5040 The copy of symbol with GI (5x1008)

- Every peaks that presents a replica of time length of one symbol, with GI, have several local maxima around this copy
- This periodicity occurs during receiving of more symbols in the CA function

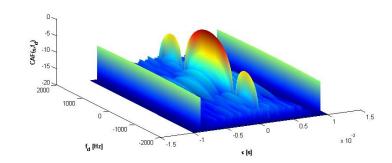
Parameters 8K mode: GI 1/8, No of symbols: 6, 16QAM, CR 5/6

# Analysis of the guard interval

- Shape of CA function  $\implies \operatorname{sinc}(x)$
- Significant minima in both modes
- The length of guard interval influence length of symbol influence of minima position



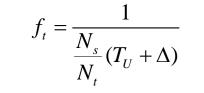
Parameters 2K mode: GI 1/4, No of symbols: 3, 16QAM, CR 1/2 (red)

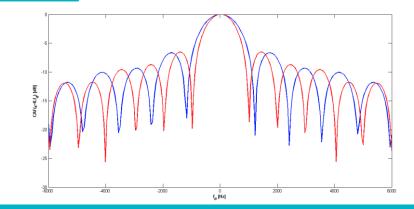


Parameters 8K mode: GI 1/8, No of symbols: 1, 64QAM, CR 7/8 (blue)

Cut in 
$$au = 0$$







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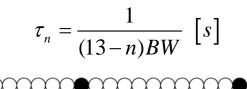
# Analysis of the scattered pilot carriers

• The output from the CA function in  $f_d = 0$  (equal to autocorrelation function)

8K mode – BW=1116 Hz Length of symbol x: 0.000896 Y: -7.033  $\tau = 896 \ \mu s$ ACF(7;f<sub>d</sub>=0) [dB] X: 7.471e-05 X: 0.0002987 Y: -13.22 V: -13.43 X: 0.000597 2K mode – BW=4464 Hz Length of symbol ACF(7,f<sub>d</sub>=0) [dB]  $\tau = 224 \ \mu s$ X: 0.000224 Y: -6.97 X: 1.871e-05 X: 7.473e-0 Y: -12.61 -12 X: 5.602e-05 Y -13.05 V: 13.47 X: 0.000168 X: 0.0001308 X: 9.333e-05 X: 3.731e-05 Y: -13.85 Y: -14.09 X-0.0001868

#### Between the "length of symbol" is eleven peaks placed with constant distance

- Distance is equal for any values of guard interval, code rate or type of modulation
- Influence of scattered pilot carriers
- The derived general formula for computation of maxima of the scattered pilot carriers





Parameters 2K/8K mode: GI 1/4, No of symbols: 1, 16QAM, CR 1/2

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# Conclusion I.

- Analysis of the DVB-T signal from the point of view of detection possibilities of the PCL system that exploit DVB-T emitters in a Single Frequency Network
- The detailed description of DVB-T signal is presented and DVB-T generator developed (ETSI EN 300 744 v1.6.1)
- The individual parameters of the DVB-T signal are shown in the behavior of the CA function

Influence parameters of DVB-T signal	Not-influence parameters of DVB-T signal	
quantity of the symbols	code rate	
length of the guard interval	type of modulation	
position of the scattered carriers	TPS and continual pilot carriers	

• Elimination of the mentioned influence parameters will be the next step in future research



# Conclusion II.

- The principle of SFN was described from the point of view of principle target detection of the PCL radar in SFN
- Preliminary analysis of the target detection in the SFN network
- The simulated situation is presented for one/multiple target with a multipath effect
- The multipath effect clearly and significantly influences the determination of the precise accuracy of the maximum of the CA function

### Future work

- Upgrading DVB-T generator for DVB-T2 standard
- The analysis of the DVB-T 2 signal from the point of view of the CA function
- The elimination of the DVB-T/DVB-T2 signal parameters that negatively influence the behavior of the CA function
- The detection of the multiple targets in the PCL system exploiting DVB-T/DVB-T2 emitters on the SFN
- The elimination of the multipath effect and influence of the SFN for the PCL system for real data
- The detection of the multiple targets in the PCL system exploiting DVB-T/DVB-T2 emitters on the SFN



### ACKNOWLEDGEMENT & CONTACT

Knajstrikolev, a stodowy flight into the dangenus world of emanning does not exist. Michael Knajstr, a young base nooctastile to champion the cases of the intescent, the helpfest is a world of chinesis who spends above the law.

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