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**Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)**

**Submission Title:** [Interference Mitigation Issues for LECIM]

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**Re:** []

**Abstract:** [A PHY Proposal for Low Energy Critical Infrastructure Networks Applications]

**Purpose:** [To be considered in IEEE 802.15.4k]

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# Interference Mitigation Issues for LECIM

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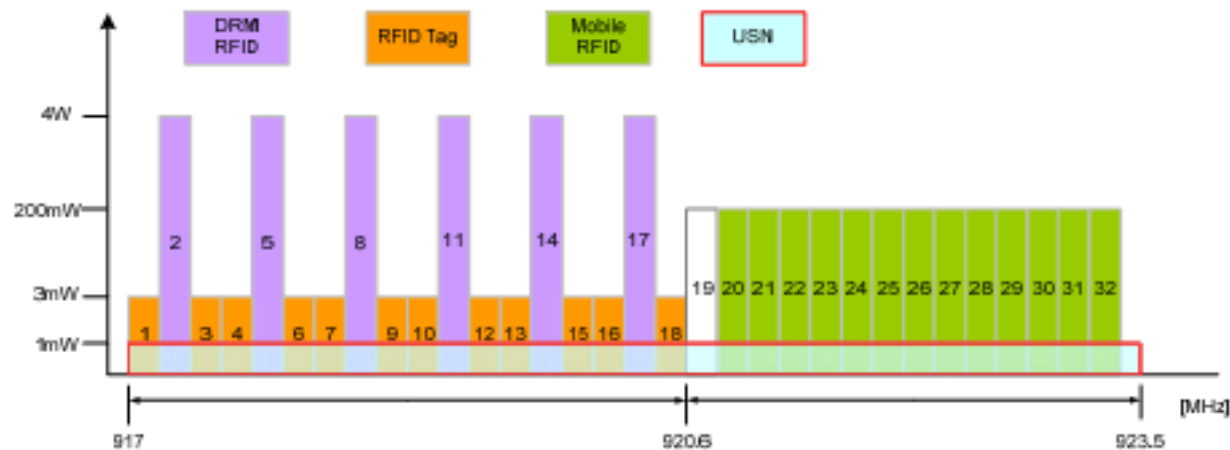
## 2. Interference Mitigation Issues

## Frequency Bands

<b>Frequency Band(MHz)</b>	<b>Channel Spacing(kHz)</b>	<b>Total Number of Channels</b>	<b>Remarks</b>
<b>400 ~ 470</b>	<b>12.5(NB)</b>	<b>57</b>	<b>Unlicensed Band for Safety &amp; Light control</b>
<b>917 ~ 923.5</b>	<b>200</b>	<b>32</b>	<b>ISM</b>
<b>2400 ~ 2483.5</b>	<b>200</b>	<b>416</b>	<b>ISM</b>

# Frequency Bands in 900MHz

## RFID/USN Frequency Regulation in Korea



- 900MHz New Band RFID/USN Technical Regulation
  - 917~920.6 MHz for the Channelization of the fixed RFID systems
    - DRM(Dense Reader Mode) RFID & Tag Band
    - 18 Channels (CH#1 ~ CH#18)
  - 920.6~923.5 MHz for the Channelization of the mobile RFID systems
    - Low transmission power RFID Channelization
    - 13 Channels (CH#20 ~ CH#32)
  - 917~923.5 MHz USN Channelization
  - Guard Channel : CH#19

# Interference Mitigation

## 1) Challenging propagation environments

=> Spreading Gain(Gold code)

## 2) Simultaneous operation for 8 co-located orthogonal networks (PANs)

=>FDM or CDM with orthogonality

## 3) Coexistence with other systems in the same band

=> FDM or CDM w/ Good Cross-correlation Property

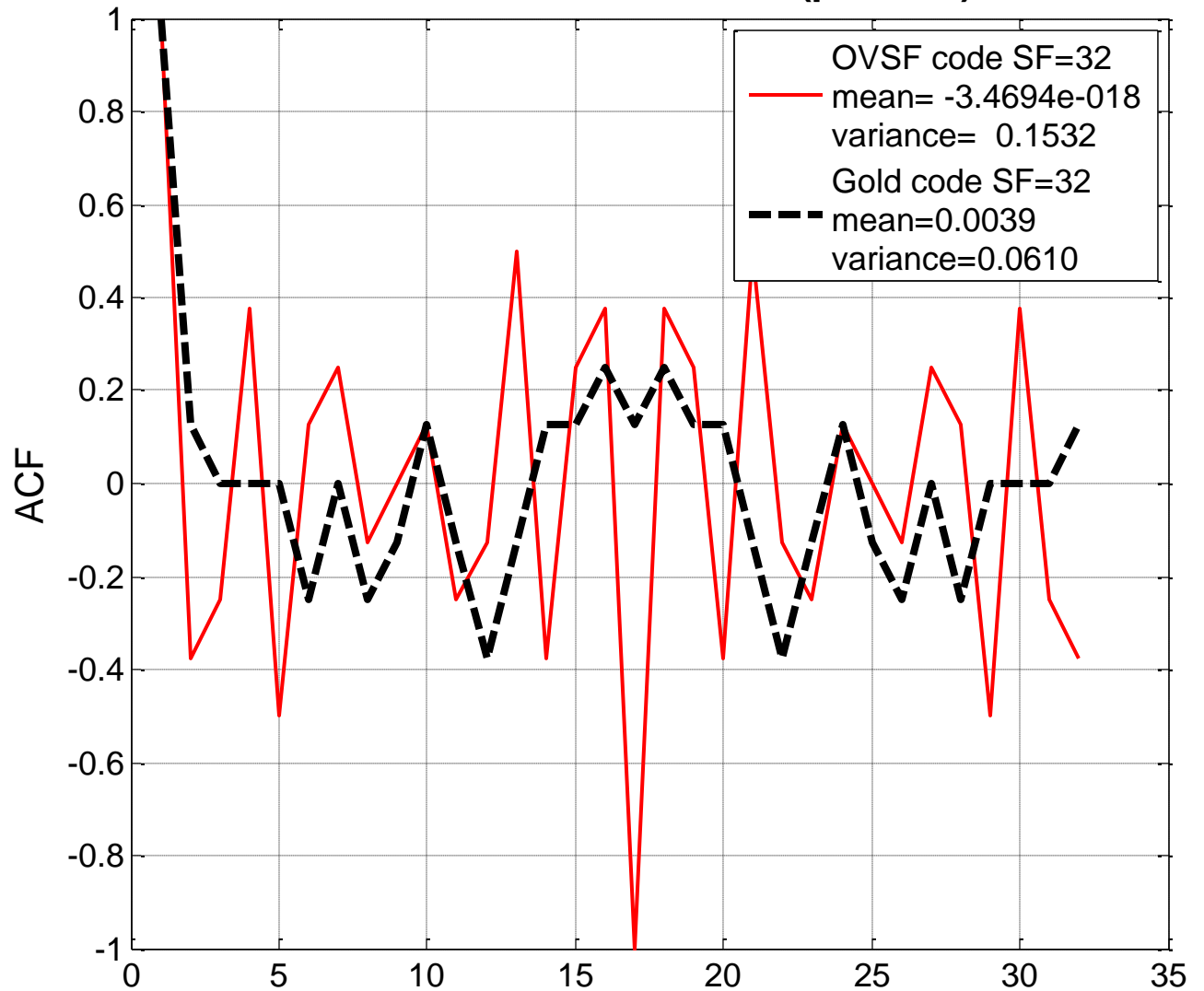
# ACF and CCF Properties

1. **The autocorrelation function (ACF) of Gold code and OVSF code.**
  - **Mean value**
  - **Variance value**
  
2. **The cross-correlation function (CCF) of Gold code and OVSF code.**
  - **Mean value**
  - **Variance value**
  - **Maximum value**

# ACF (periodic)

Gold	OVSF
1.0000	1.0000
0.1250	-0.3750
0	-0.2500
0	0.3750
0	-0.5000
-0.2500	0.1250
0	0.2500
-0.2500	-0.1250
-0.1250	0
0.1250	0.1250
-0.1250	-0.2500
-0.3750	-0.1250
-0.1250	0.5000
0.1250	-0.3750
0.1250	0.2500
0.2500	0.3750
0.1250	-1.0000
0.2500	0.3750
0.1250	0.2500
0.1250	-0.3750
-0.1250	0.5000
-0.3750	-0.1250
-0.1250	-0.2500
0.1250	0.1250
-0.1250	0
-0.2500	-0.1250
0	0.2500
-0.2500	0.1250
0	-0.5000
0	0.3750
0	-0.2500
0.1250	-0.3750

## Autocorrelation Function (periodic)

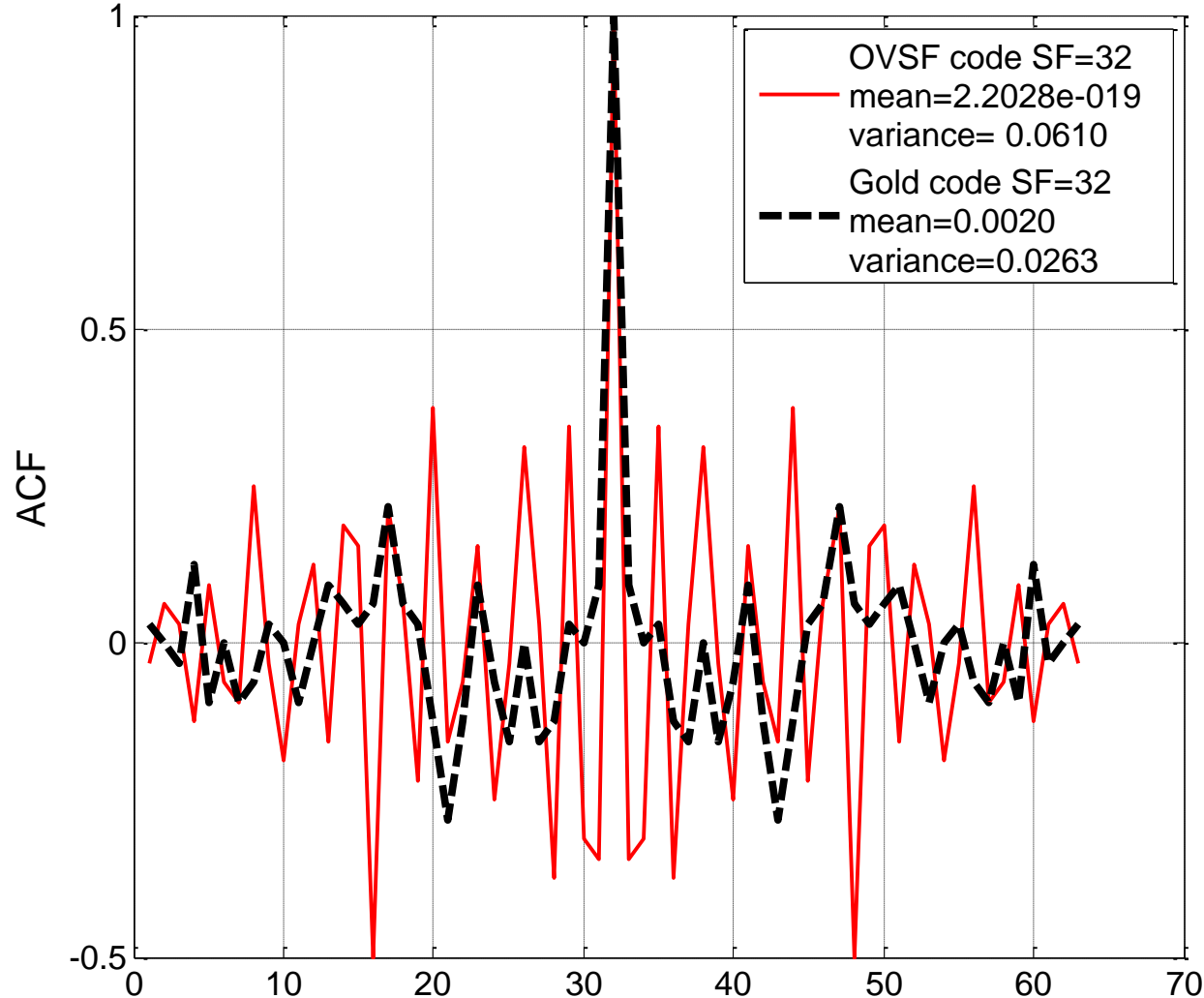




# ACF (aperiodic)

## Autocorrelation Function (aperiodic)

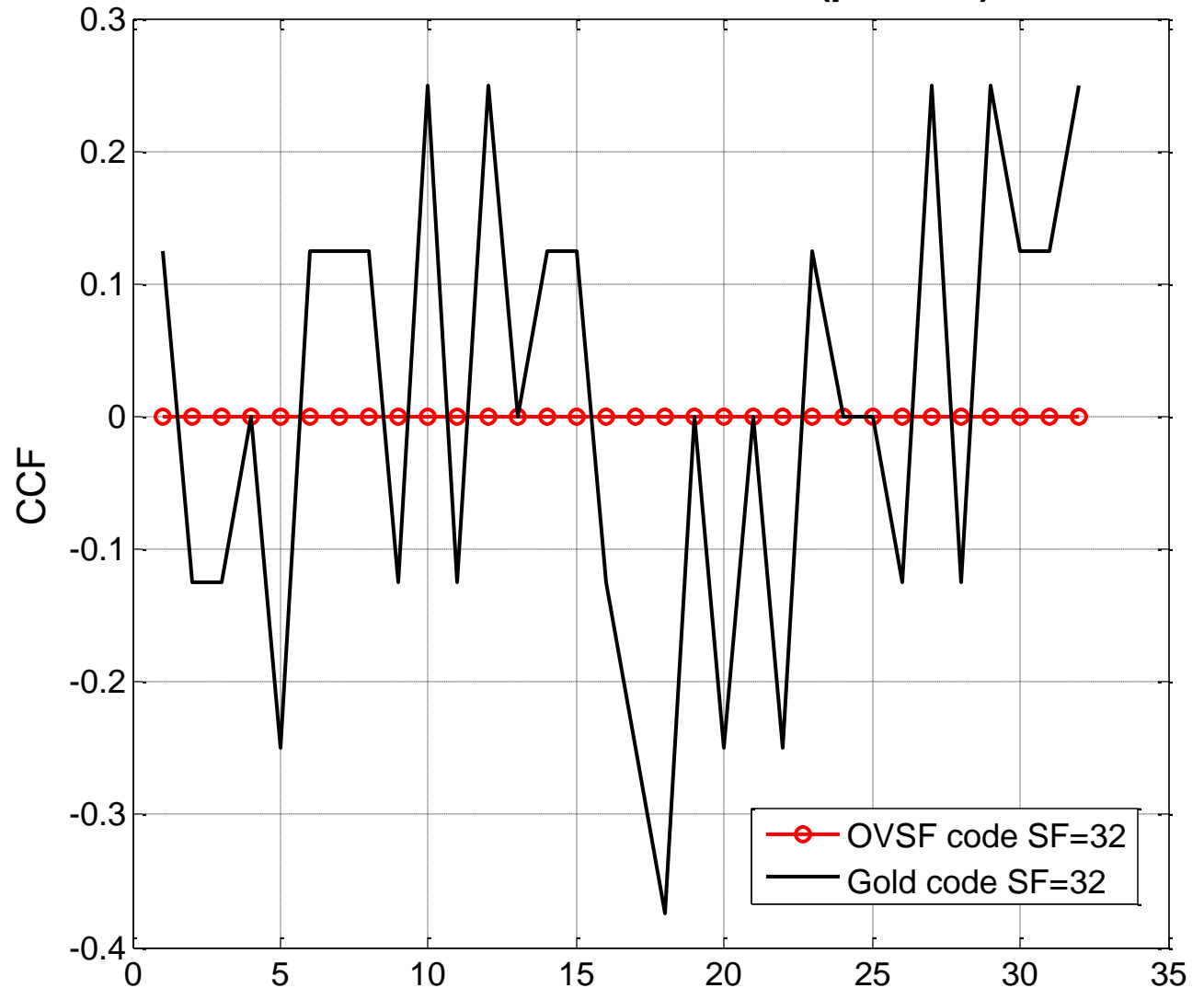
Gold		OVSF	
0.0312	-0.1563	-0.0313	1.0000
0.0000	0.0000	0.0625	-0.3437
-0.0312	-0.1562	0.0312	-0.3125
0.1250	-0.0625	-0.1250	0.3437
-0.0937	0.0938	0.0938	-0.3750
-0.0000	-0.1250	-0.0625	0.0313
-0.0938	-0.2812	-0.0625	0.3125
-0.0625	-0.1250	-0.0937	-0.0312
0.0312	0.0312	0.2500	-0.2500
0.0000	0.0625	-0.0313	0.1562
-0.0937	0.2187	-0.1875	-0.0625
0.0000	0.0625	0.0312	-0.1563
0.0938	0.0313	0.1250	0.3750
0.0625	0.0625	-0.1562	-0.2187
0.0313	0.0938	0.1875	0.0625
0.0625	0.0000	0.1562	0.2188
0.2187	-0.0937	-0.5000	-0.5000
0.0625	0.0000	0.2188	0.1562
0.0312	0.0312	0.0625	0.1875
-0.1250	-0.0625	-0.2187	-0.1562
-0.2812	-0.0938	0.3750	0.1250
-0.1250	-0.0000	-0.1563	0.0312
0.0938	-0.0937	-0.0625	-0.1875
-0.0625	0.1250	0.1562	-0.0313
-0.1562	-0.0312	-0.2500	0.2500
0.0000	0.0000	-0.0312	-0.0937
-0.1563	0.0312	0.3125	-0.0625
-0.1250		0.0313	0.0938
0.0313		0.3437	-0.1250
-0.0000		-0.3125	0.0312
0.0937		-0.3437	0.0625
1.0000			-0.0313
0.0937			
-0.0000			
0.0313			
-0.1250			



# CCF (periodic)

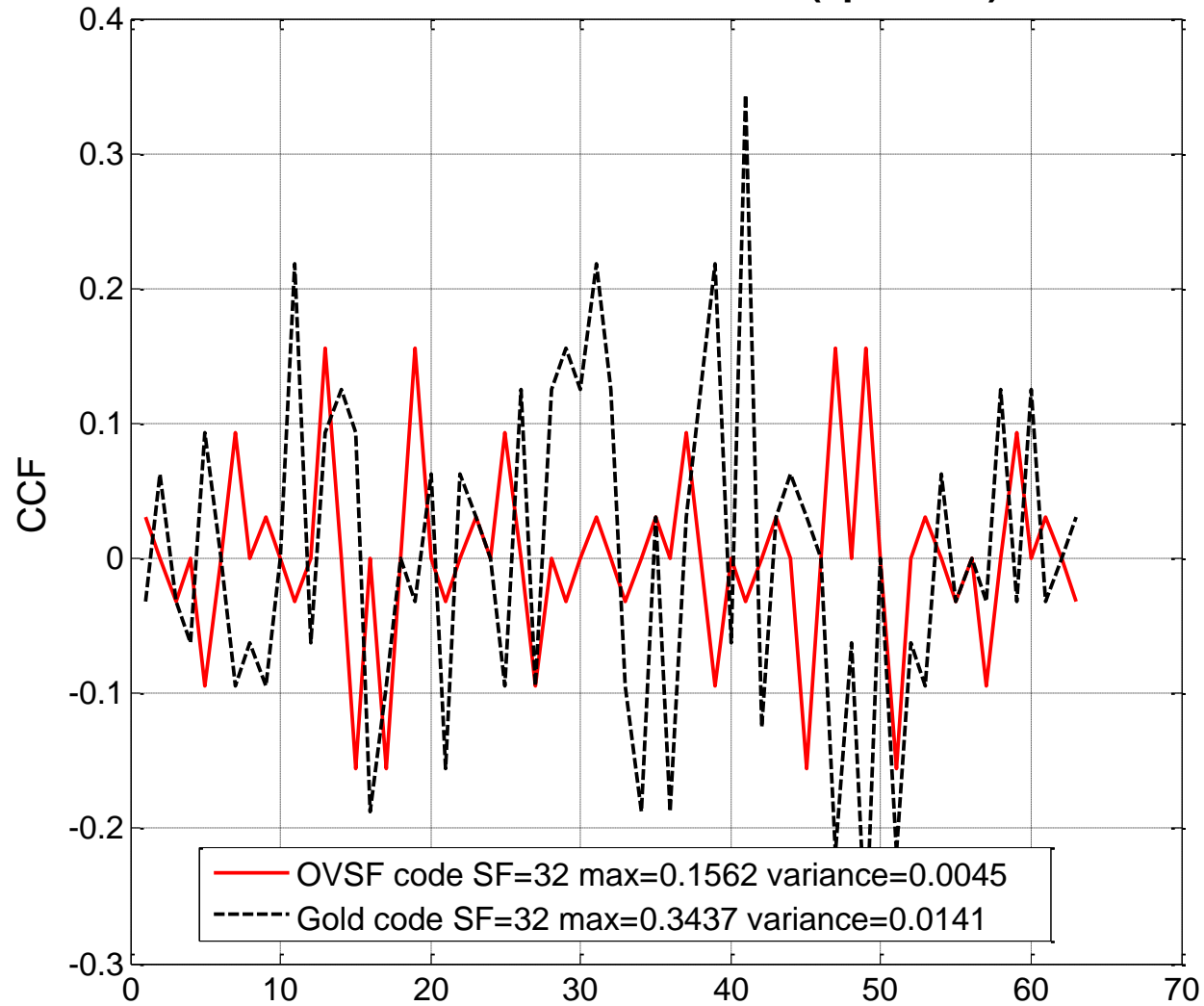
Gold	OVSF
0.1250	0
-0.1250	0
-0.1250	0
0	0
-0.2500	0
0.1250	0
0.1250	0
0.1250	0
-0.1250	0
0.2500	0
-0.1250	0
0.2500	0
0	0
0.1250	0
0.1250	0
-0.1250	0
-0.2500	0
-0.3750	0
0	0
-0.2500	0
0	0
-0.2500	0
0.1250	0
0	0
0	0
-0.1250	0
0.2500	0
-0.1250	0
0.2500	0
0.1250	0
0.1250	0
0.2500	0

## Cross-correlation Function (periodic)



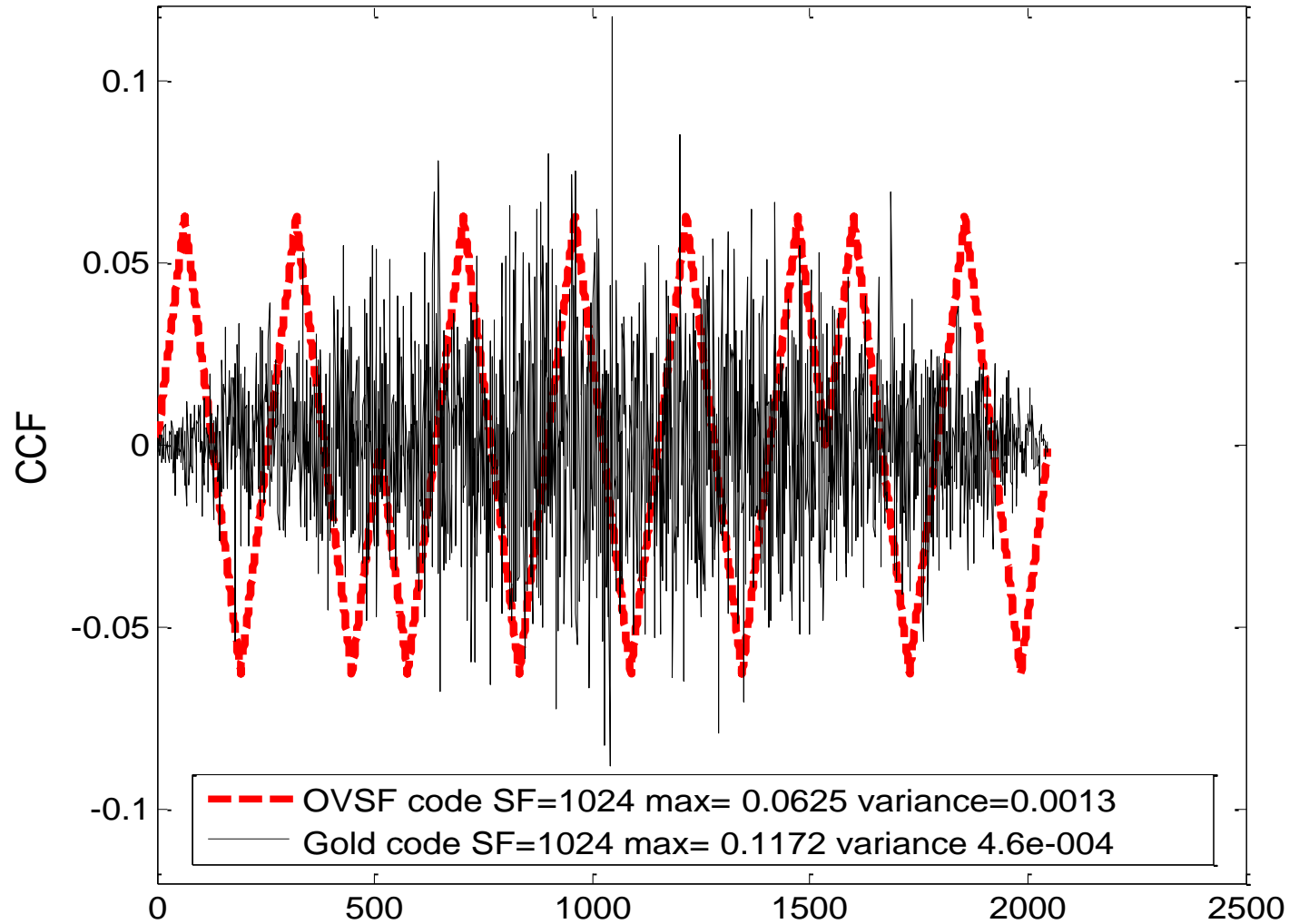
# CCF (aperiodic)

## Cross-correlation Function (aperiodic)

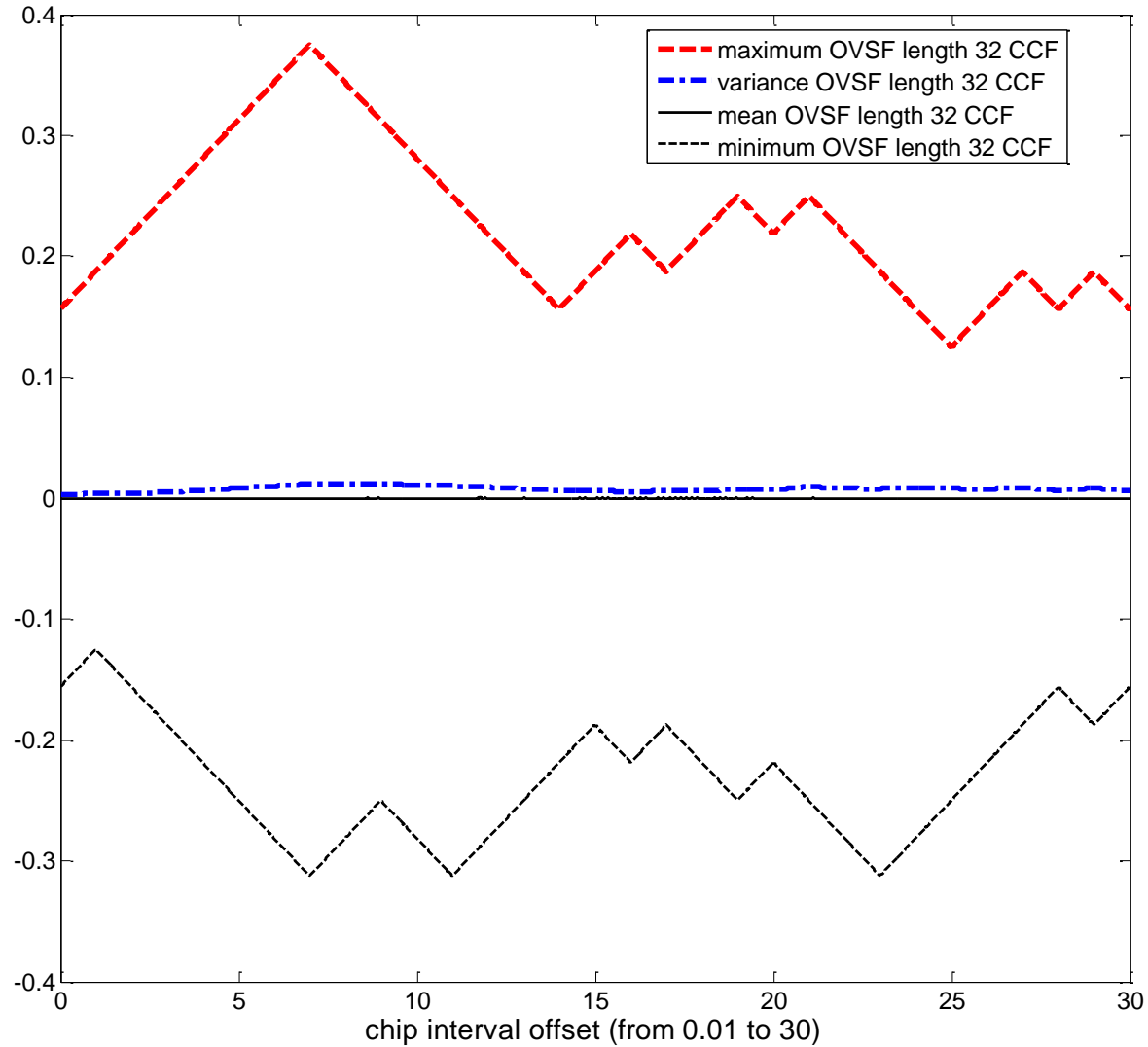


# CCF (aperiodic)

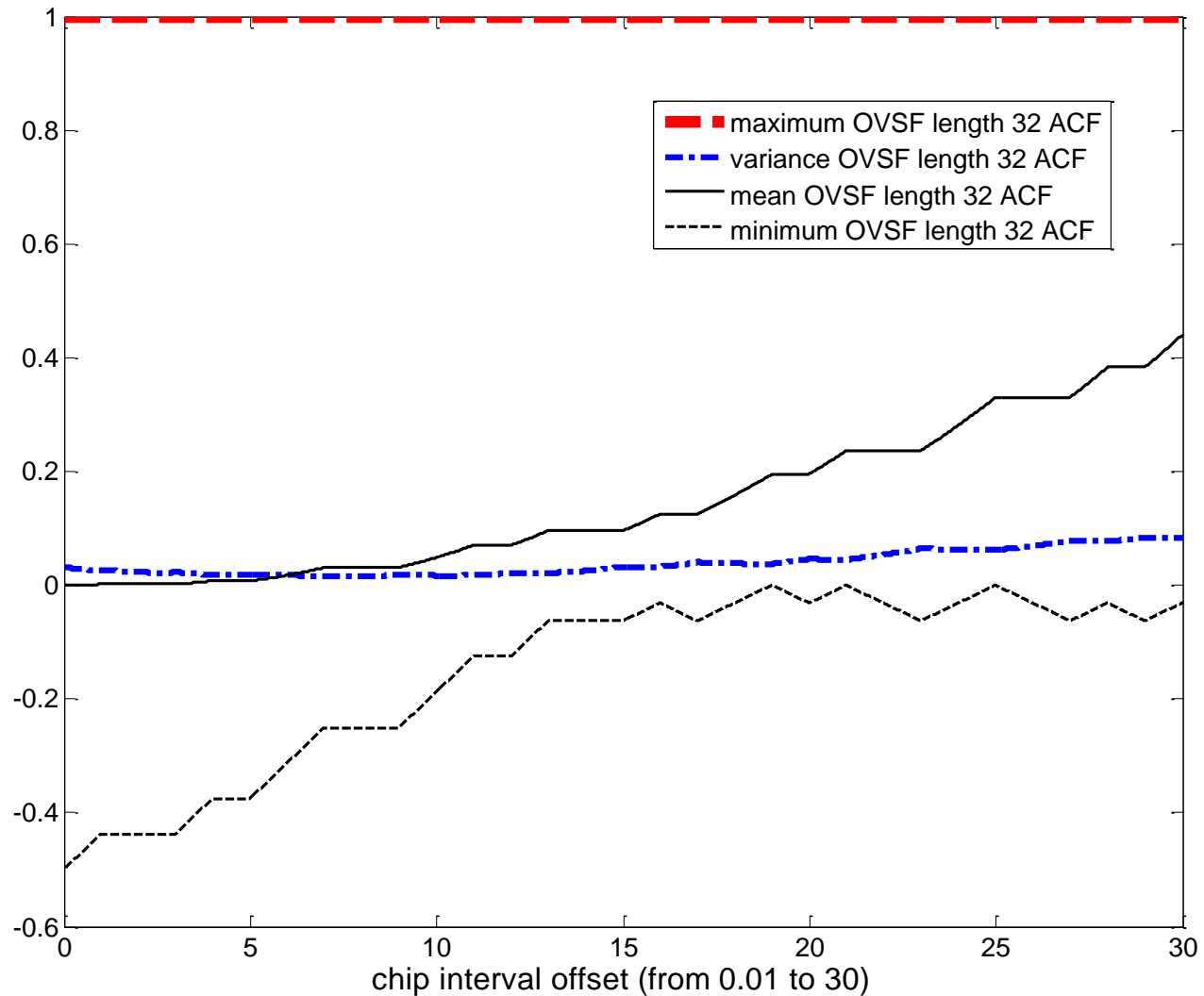
## Cross-correlation Function (aperiodic)



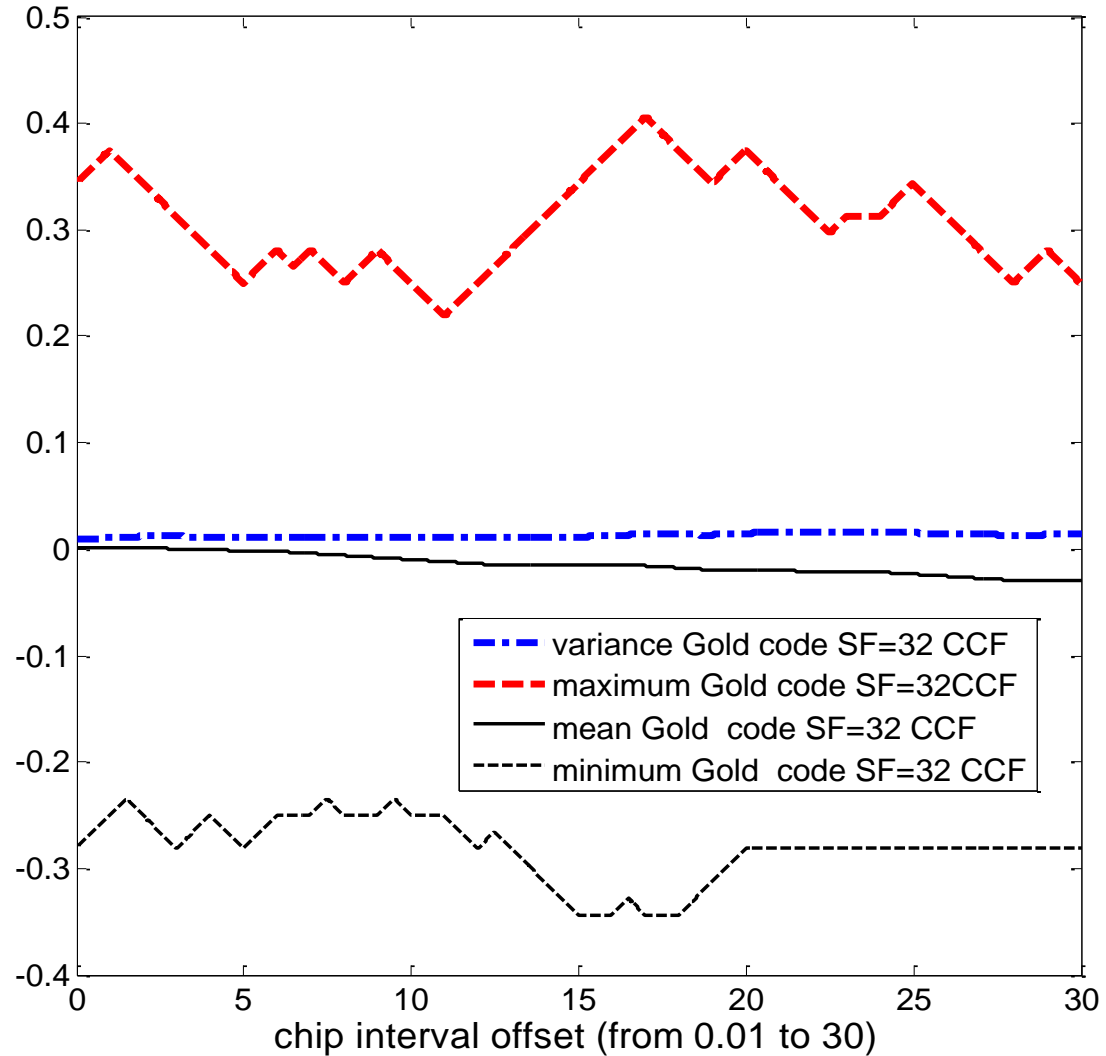
# CCF of OVSF : imperfect synch(aperiodic)



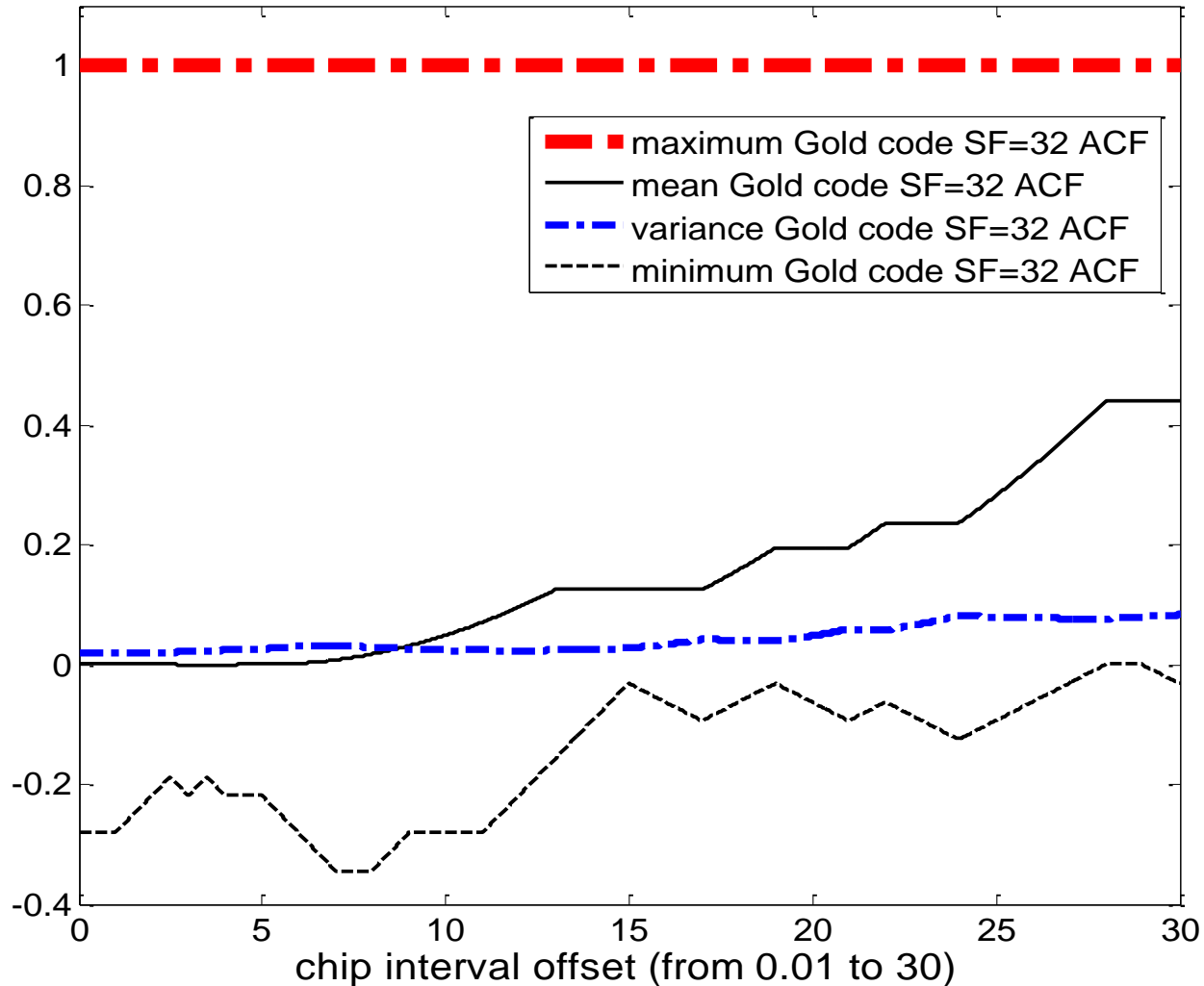
## ACF of OVSF : imperfect synch(aperiodic)



## CCF of GOLD : imperfect synch(aperiodic)

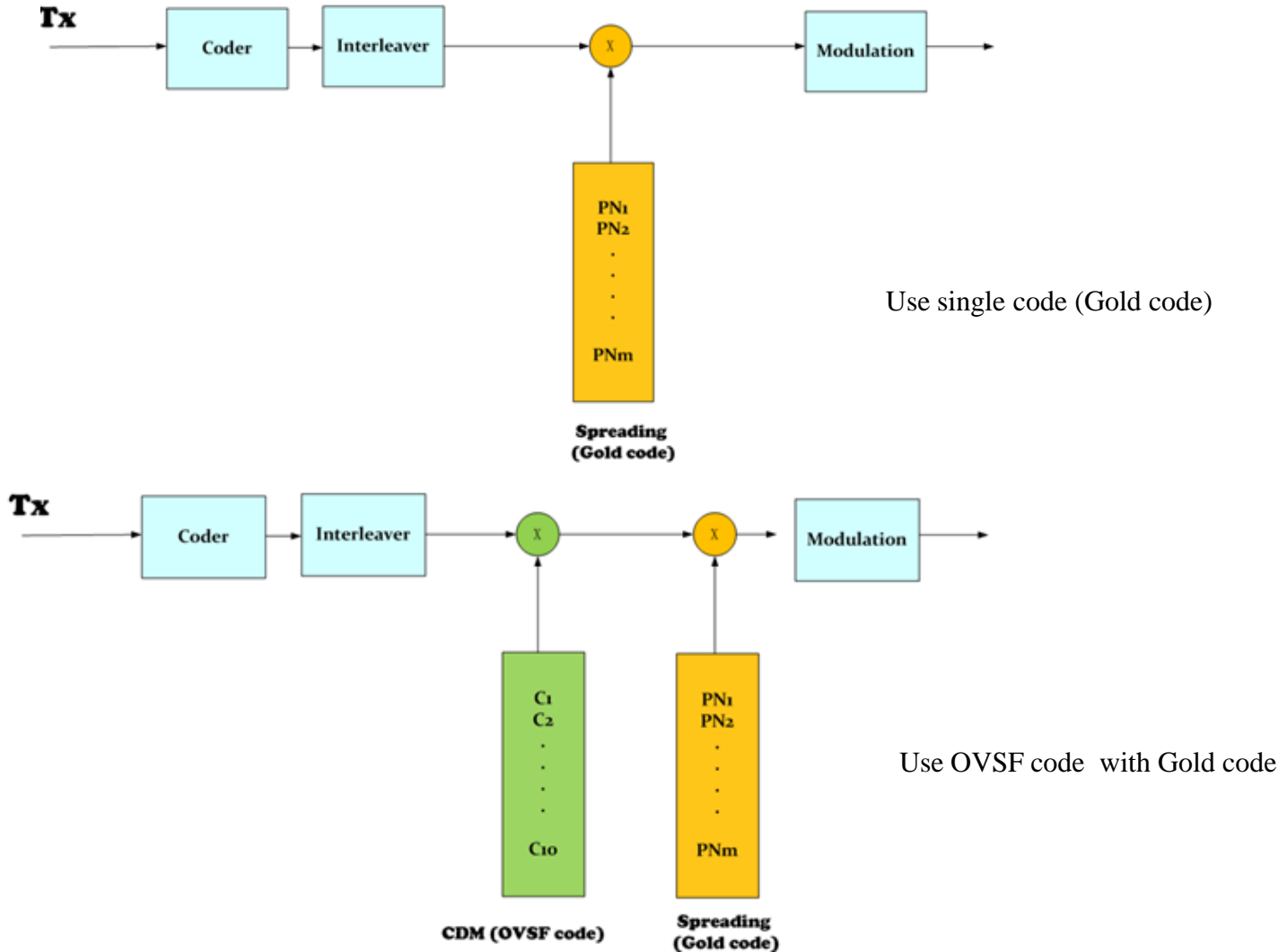


## ACF of Gold : imperfect synch(aperiodic)

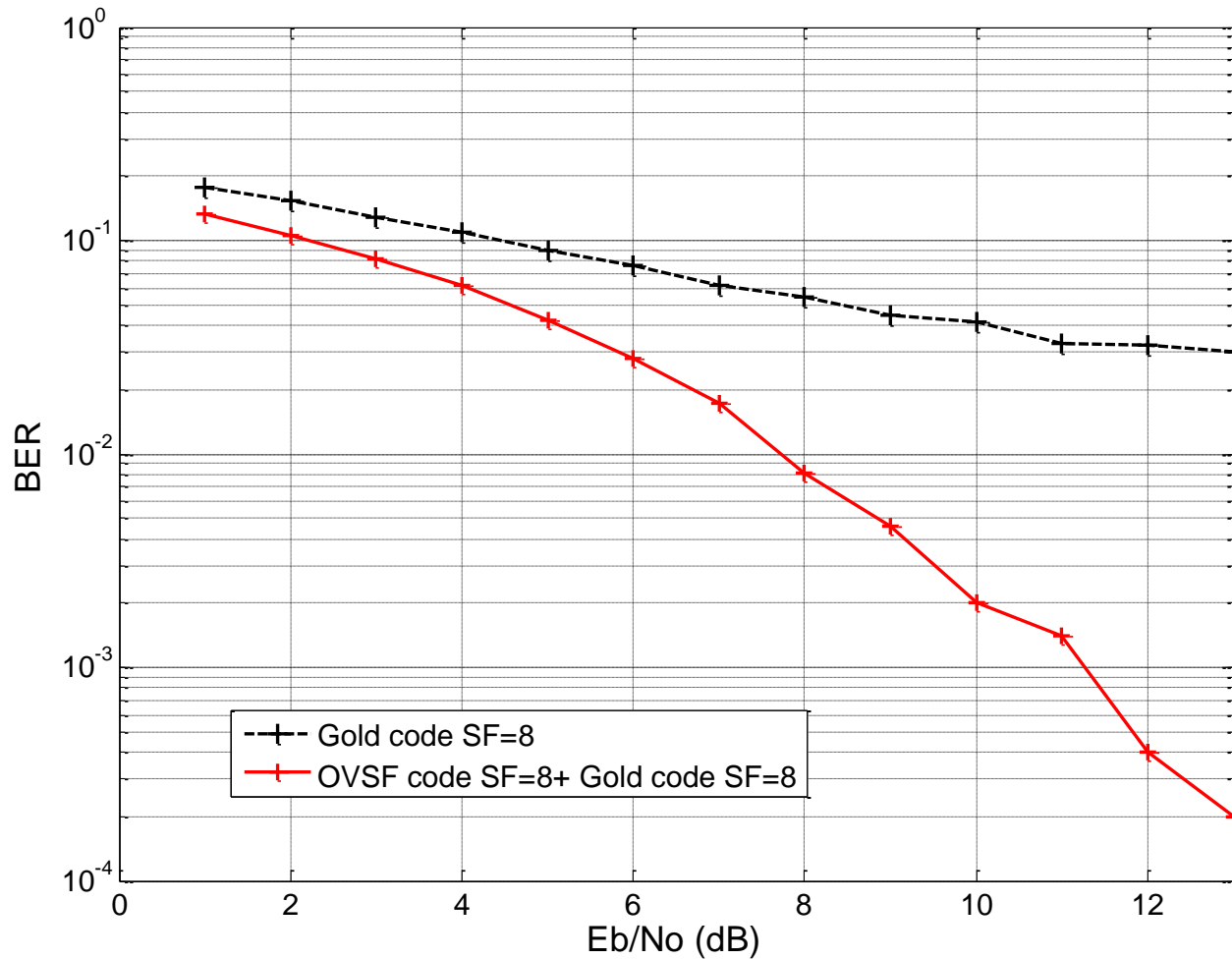




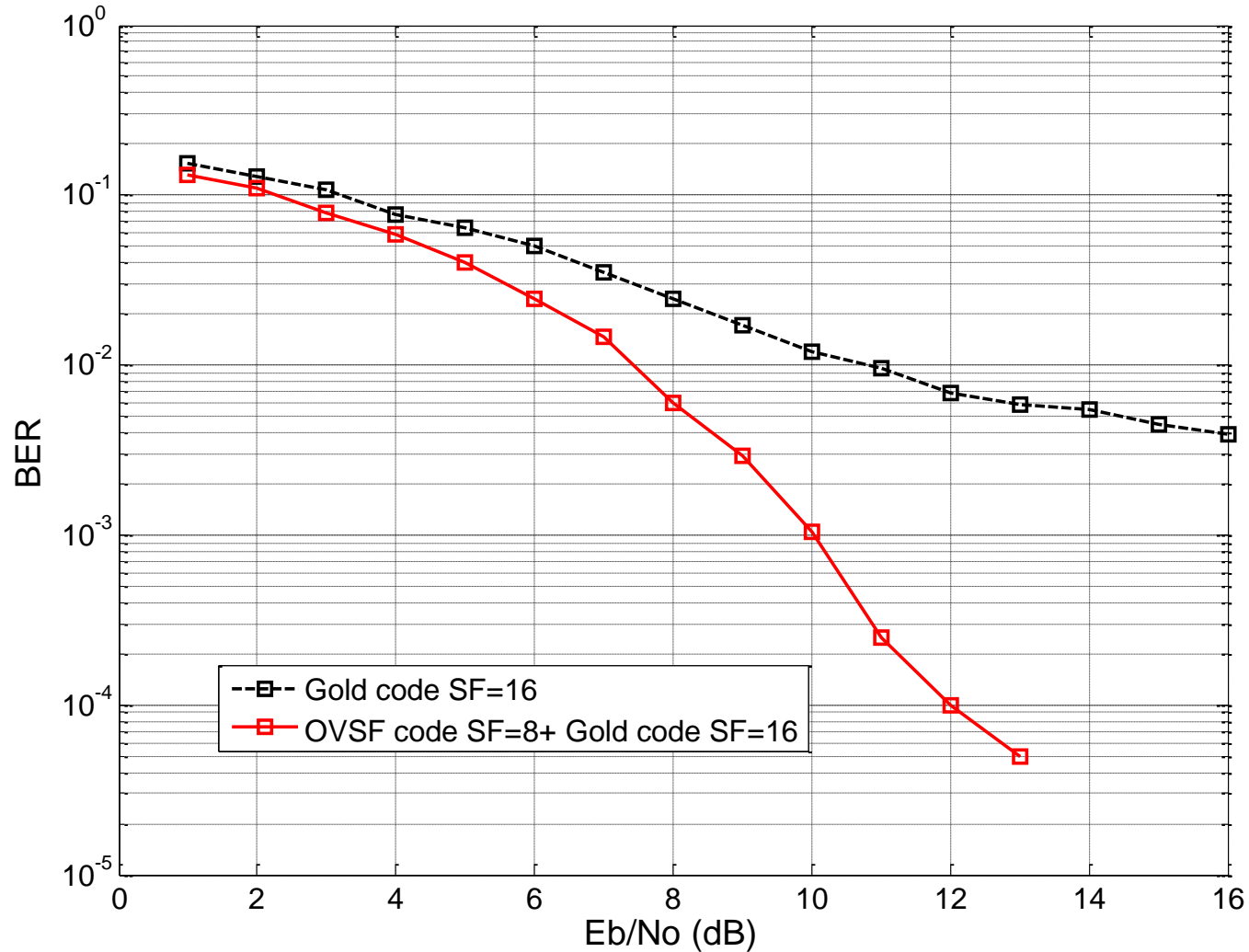
# OVSF code to realize CDM scheme with Gold code



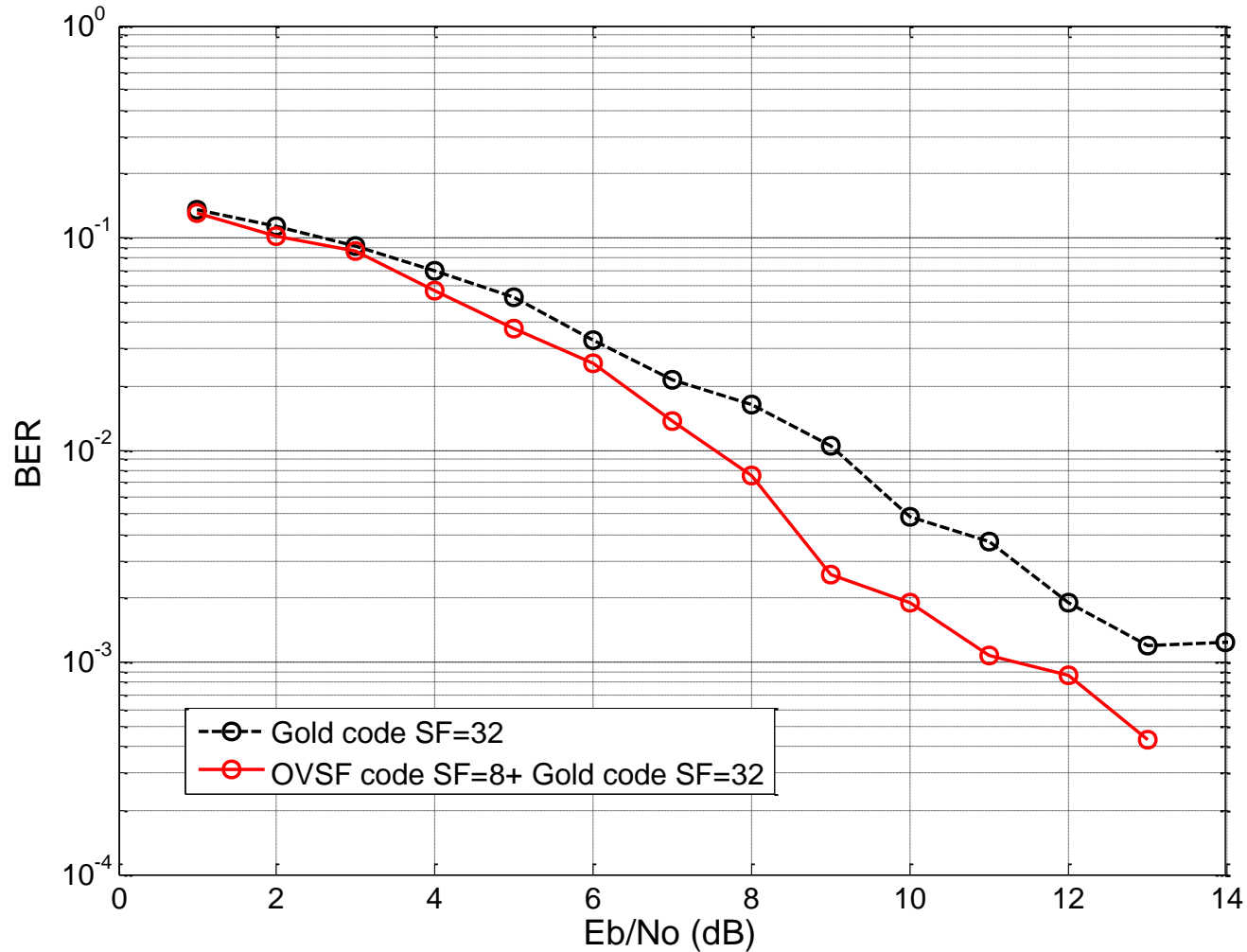
# BER under 7 MAI(3a-CM1)



# BER under 7 MAI(3a-CM1)



# BER under 7 MAI(3a-CM1)



# Conclusion

- 1. In a CLON, Time-Division multiple access is used to share a Resource (Channel). In order to cover the high path loss or user interference, Spreading Code (Gold) is used**
- 2. Among PANs, FDM and CDM are used to mitigate the interference. According to the code performance comparison above, OVSF code has better orthogonality even under imperfect synchronization conditions.**
- 3. Therefore the OVSF code can be used to realize the CDM scheme as well as to have orthogonality among PANs and Clusters.**