POTENTIAL OF USING CHAOTIC SIGNAL IN 6G COMMUNICATIONS

FIRST IEEE NEXT G SUMMIT

JOHNS HOPKINS UNIVERSITY

APPLIED PHYSICS LAB

LAUREL, MARYLAND, USA

Nizar N. Albassam

Middle East College

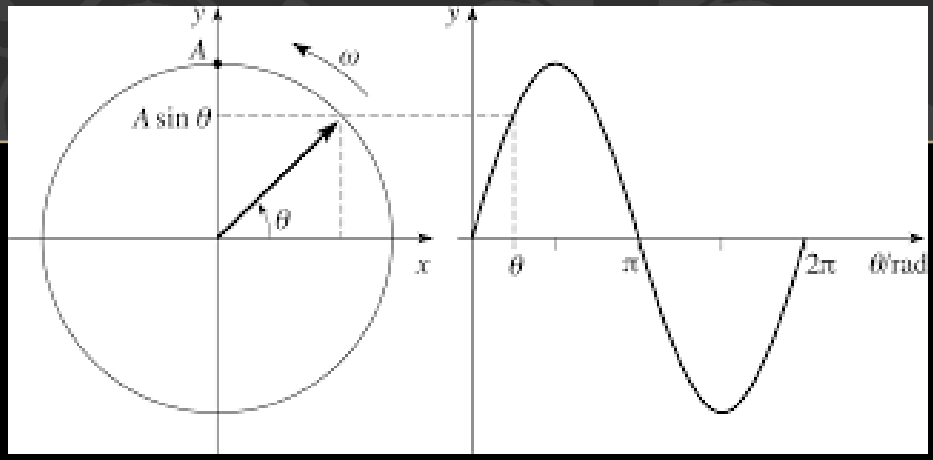
Muscat/Oman

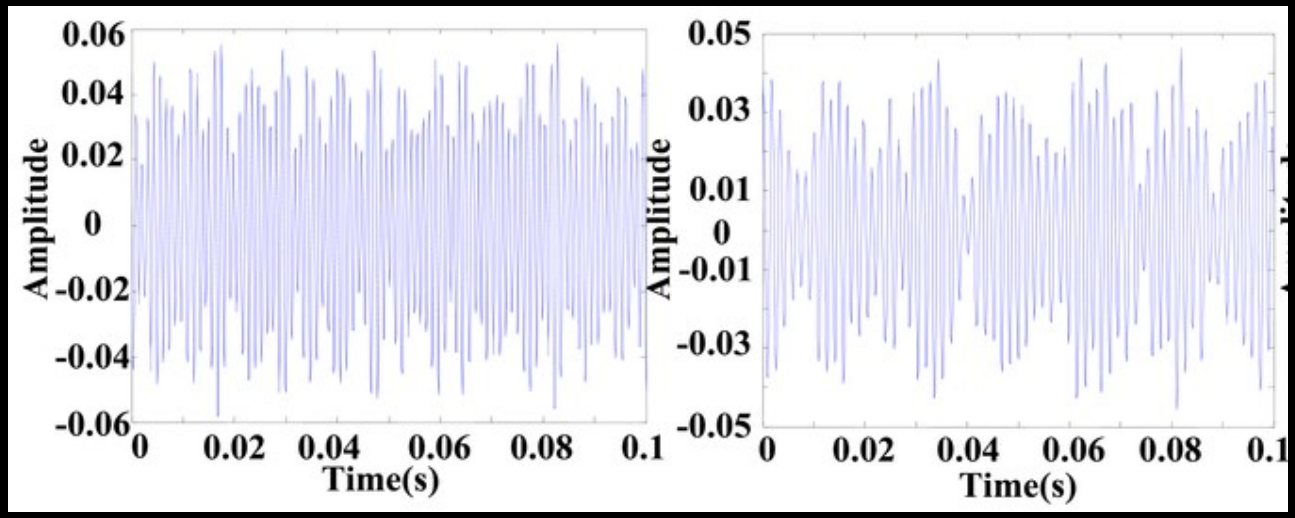
AGENDA:

- Introduction
- Why ***Chaos*** signal?
- Properties of Chaotic Signals
- Detection schemes
- Differentially Coherent schemes and Permutation Index schemes
- Proposed transmitted signal format for multiple users
- Proposed transmitter and Receiver

INTRODUCTION

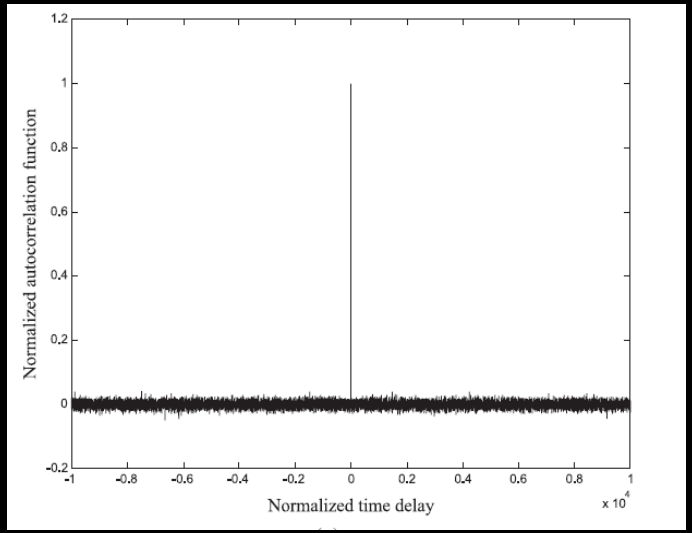
"Chaotic signals are non-periodic, random-like and bounded signals that are generated in a deterministic manner"

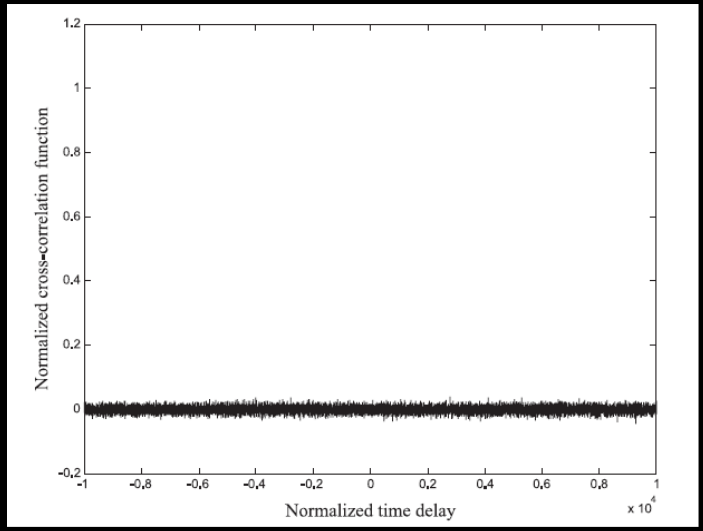




CHAOTIC SIGNAL PROPERTIES

1. Sensitive dependence on initial conditions.
2. Impulse-like autocorrelation
3. Very low cross-correlation properties(flipped , delayed version)
4. Power spectrum of the chaotic signal exhibits a wideband feature
5. Simple hardware requirement for generation





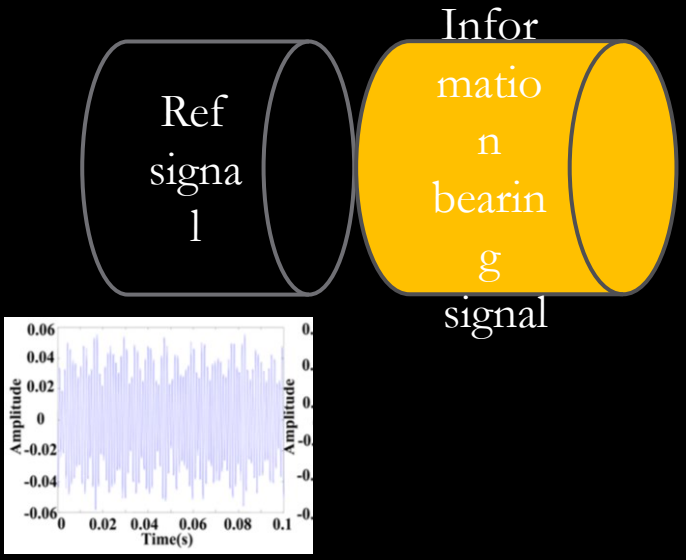
DETECTION SCHEMES

1. Coherent : There is a need to reproduce a replicated copy of the chaos signal at the receiver during the demodulation process (CSK)

2. Non-coherent scheme: Based on extracting one of the signal parameters to distinguish between the transmitted information(e.g. COOK, Map regression, …etc.)

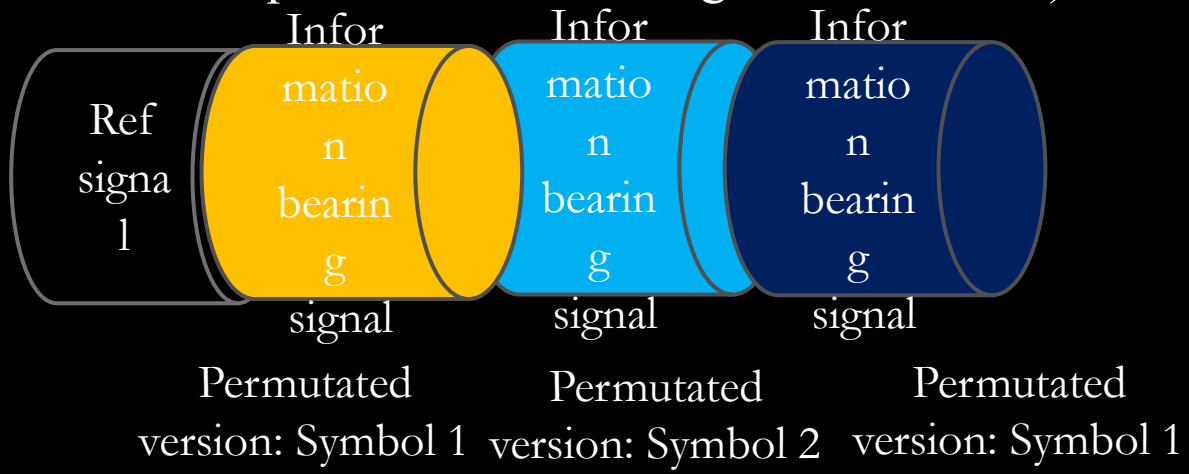
3-DIFFERENTIALLY COHERENT:

Two chaotic segments within successive time slot presents each symbol. The first segment serves as a reference signal, while the other segment serves as an information bearing signal (DCSK, CDSK,HE-DCSK).

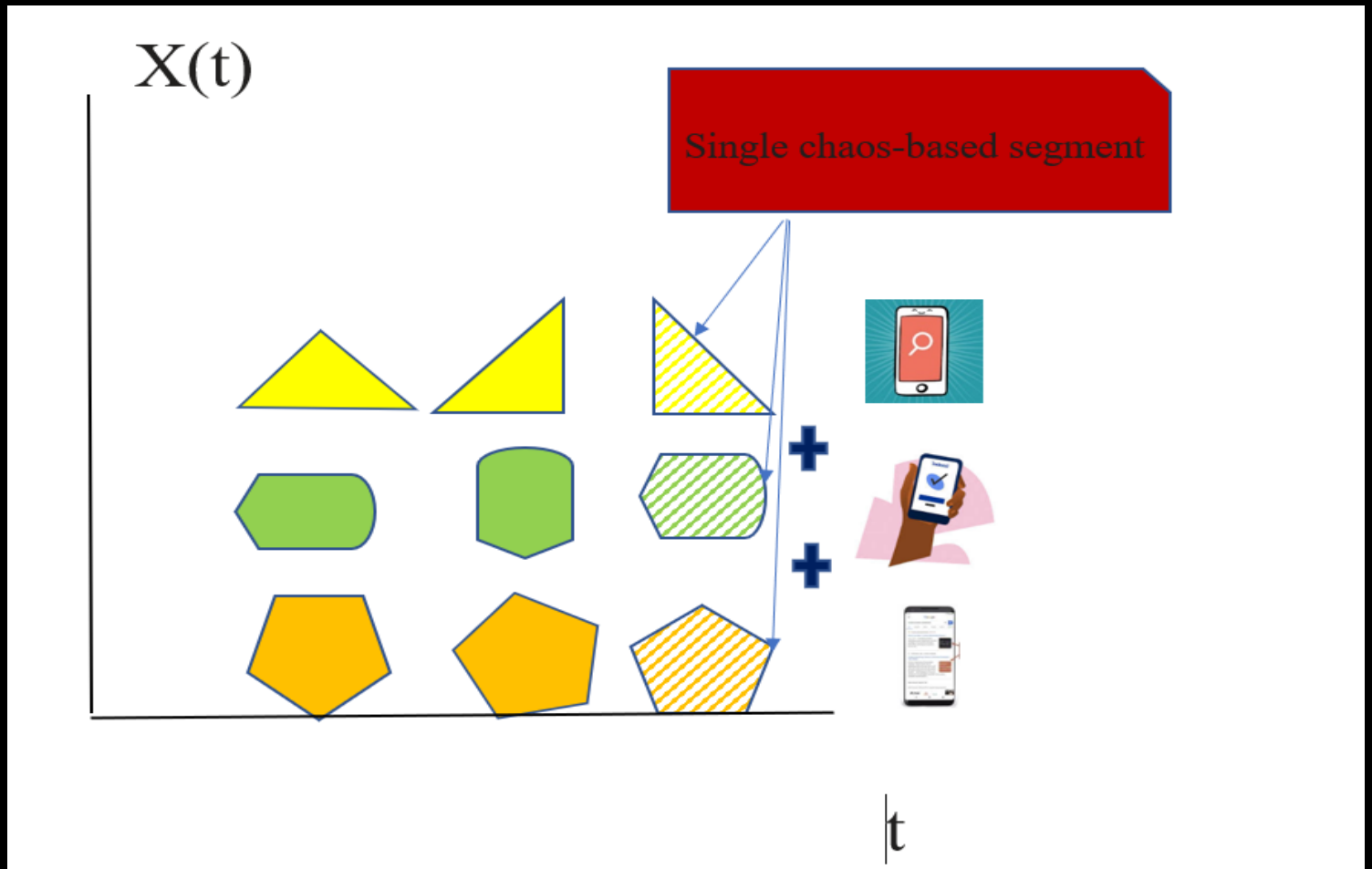


PERMUTATION INDEX DIFFERENTIALLY COHERENT

Two chaotic segments within successive time slots are used to present each symbol. The first segment serves as a reference signal, while the other segment is served as an information bearing signal (Permutation is performed according to the data set)



PROPOSED TRANSMITTED SIGNAL FORMAT FOR MULTIPLE USERS



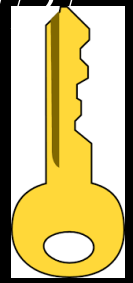
CHALLENGES OF PREVIOUS Gs

G1 G2 G3 G4 G5

DATA TRAFFIC

(IOT, Virtual reality,….etc)-> increase the bandwidth ..> suggestion to use millimetre waves

No matter how many devices are available, each initial condition can lead to new signal generation at almost the same bandwidth and orthogonal with others from the same map[1][2][3]



ANTENNA DESIGN

Ultra small scale coverage to efficiently use the bandwidth and overcome the challenges of obstacles

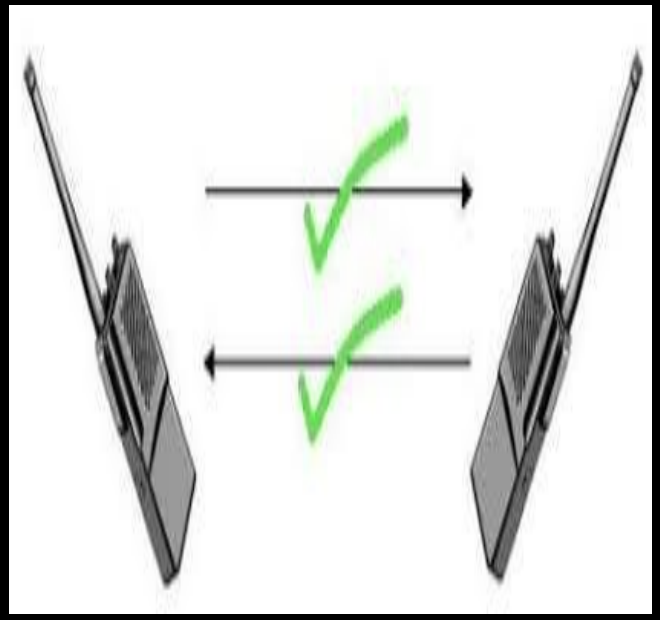
This is used to overcome the challenges of using the millimetre waves; however, the antenna design of chaos based systems are under-researched. Several studies have been conducted to design antenna in Utra-Wideband [4][5] [6],…etc

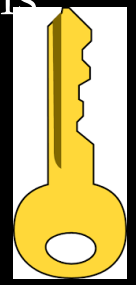
MASSIVE MIMO:

Identical to that used in standard communication systems; results show that the Massive MIMO-based communication system is competing with the one used in communications systems[ ][ ][ ]

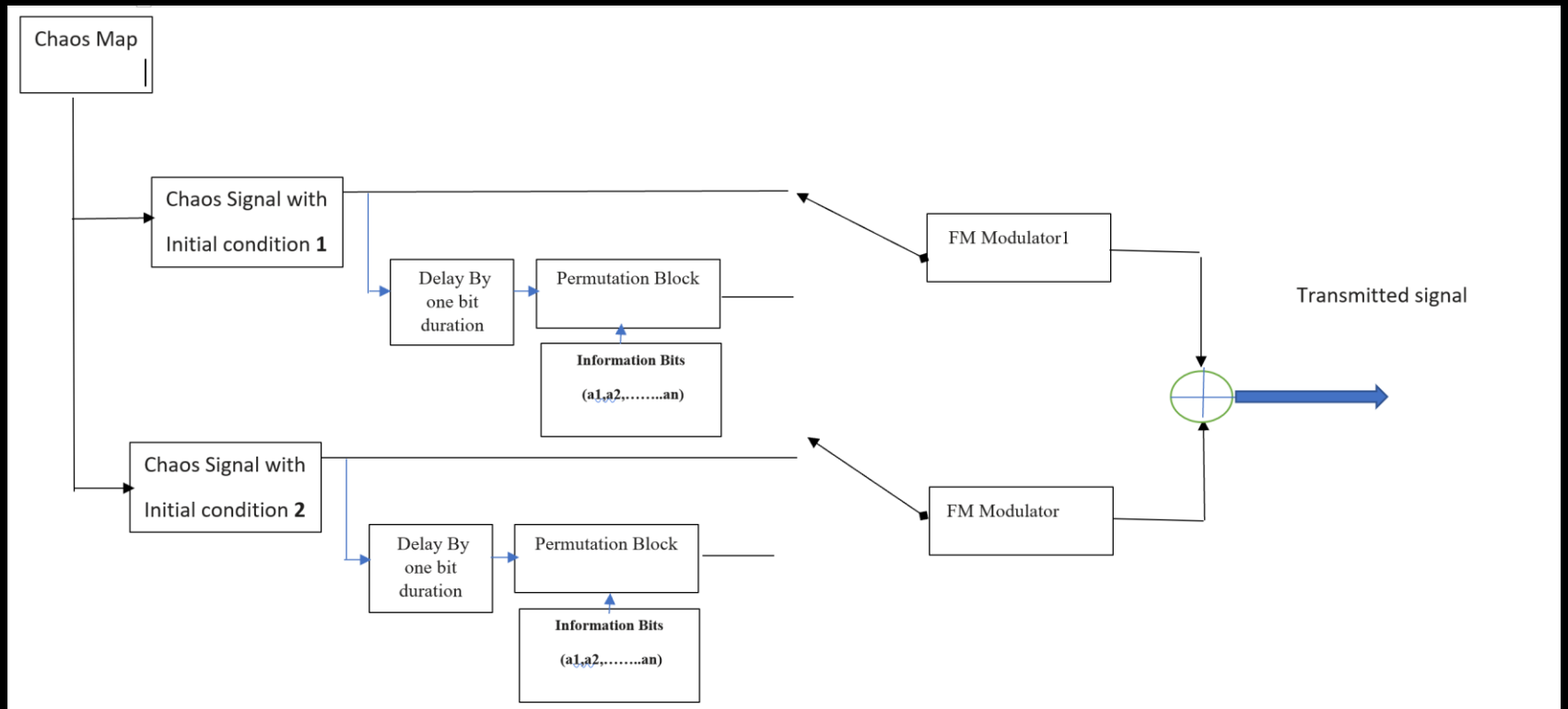
FULL DUPLEX

Easy to accomplish due to orthogonality and low cross-corelation between chaotic signal and its shifted, manipulated versions



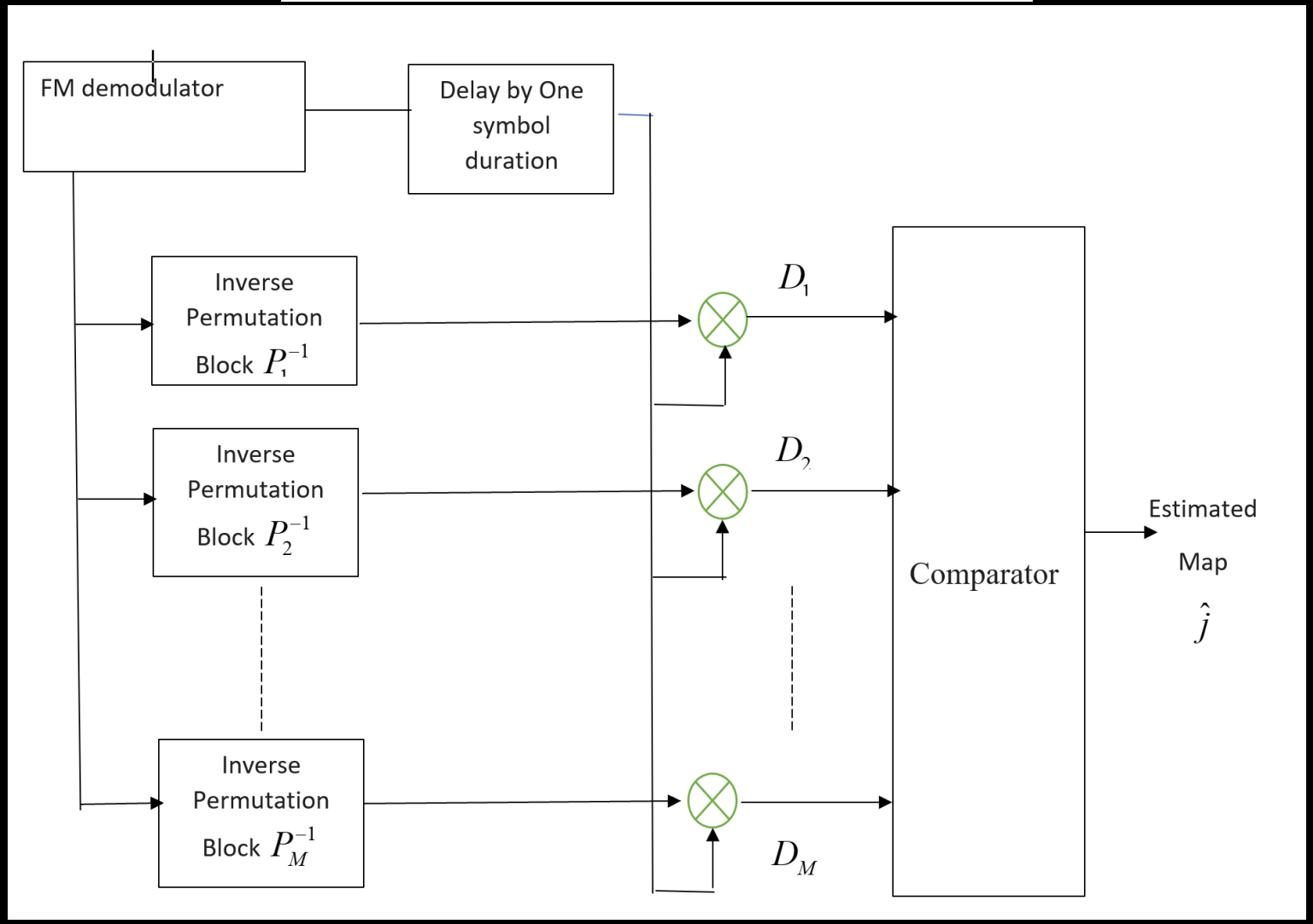


LOOKING TO THE FUTURE PERMUTATION BASED FM_DCSK TRANSMITTER



A simplified Block Diagram for FM based SR-MI-DCSK system

LOOKING TO THE FUTURE PERMUTATION BASED FM_DCSK RECEIVER



REFERENCES

[1] Somayeh Hashemi, Mohammad Ali Pourmina, Saleh Mobayen & Mahdi R. Alagheband (2020) Design of a secure communication system between base transmitter station and mobile equipment based on finite-time chaos synchronisation, International Journal of Systems Science, 51:11, 1969-1986,

[2] Herceg, Marijan, et al. "Chaos-Based transmitted-reference ultra-wideband communications." International Journal of Electronics 106.1 (2019): 160-172.

[3]Soujeri, E., Kaddoum, G., & Herceg, M. (2018, February). Design of an initial condition-index chaos shift keying modulation. Electronics Letters, 2. doi:10.1049/el.2018.0119 [

[4] Dmitriev, A.S., Kletsov, A.V., Laktyushkin, A.M. et al. Ultrawideband wireless communications based on dynamic chaos. J. Commun. Technol. Electron. 51, 1126–1140 (2006). https://doi.org/10.1134/S1064226906100020

[[4]Chia-Chin Chong, Su Khiong Yong and Seong Soo Lee, "UWB direct chaotic communication technology," in IEEE Antennas and Wireless Propagation Letters, vol. 4, pp. 316-319, 2005, doi: 10.1109/LAWP.2005.855632.

[5] Fellah, R., Azzaz, M.S., Tanougast, C. et al. Design of a simple and low cost chaotic signal generation circuit for UWB applications. Eur. Phys. J. Spec. Top. 230, 3439–3447 (2021). https://doi.org/10.1140/epjs/s11734-021-00251-5

[6] Sangeetha, M., Bhaskar, V. NR-DCSK Based Chaotic Communications in MIMO Multipath Channels. Wireless Pers Commun 103, 1819–1834 (2018). https://doi.org/10.1007/s11277-018-5882-3

[7] E. Salahat, "On the performance of DCSK MIMO relay cooperative diversity in Nakagami-m and generalized Gaussian noise scenarios," IECON 2016 - 42nd Annual Conference of the IEEE Industrial Electronics Society, 2016, pp. 7203-7207, doi: 10.1109/IECON.2016.7794109.