

Exploring the Security Capabilities of Physical Layer Network Coding (PNC) in Wireless Networks

PI: Weichao Wang (UNC-Charlotte) <http://coitweb.uncc.edu/~wwang22/Research/Projects/PhyNetCod/PhyNetCode.html>

1. Objectives

- Deeply understand the security capabilities of the physical layer network coding (PNC) technique in wireless networks;
- Build attack detection mechanisms to defend against malicious attacks on network topology and node identities;
- Evaluate the approaches through simulation and implementation over cognitive radios.

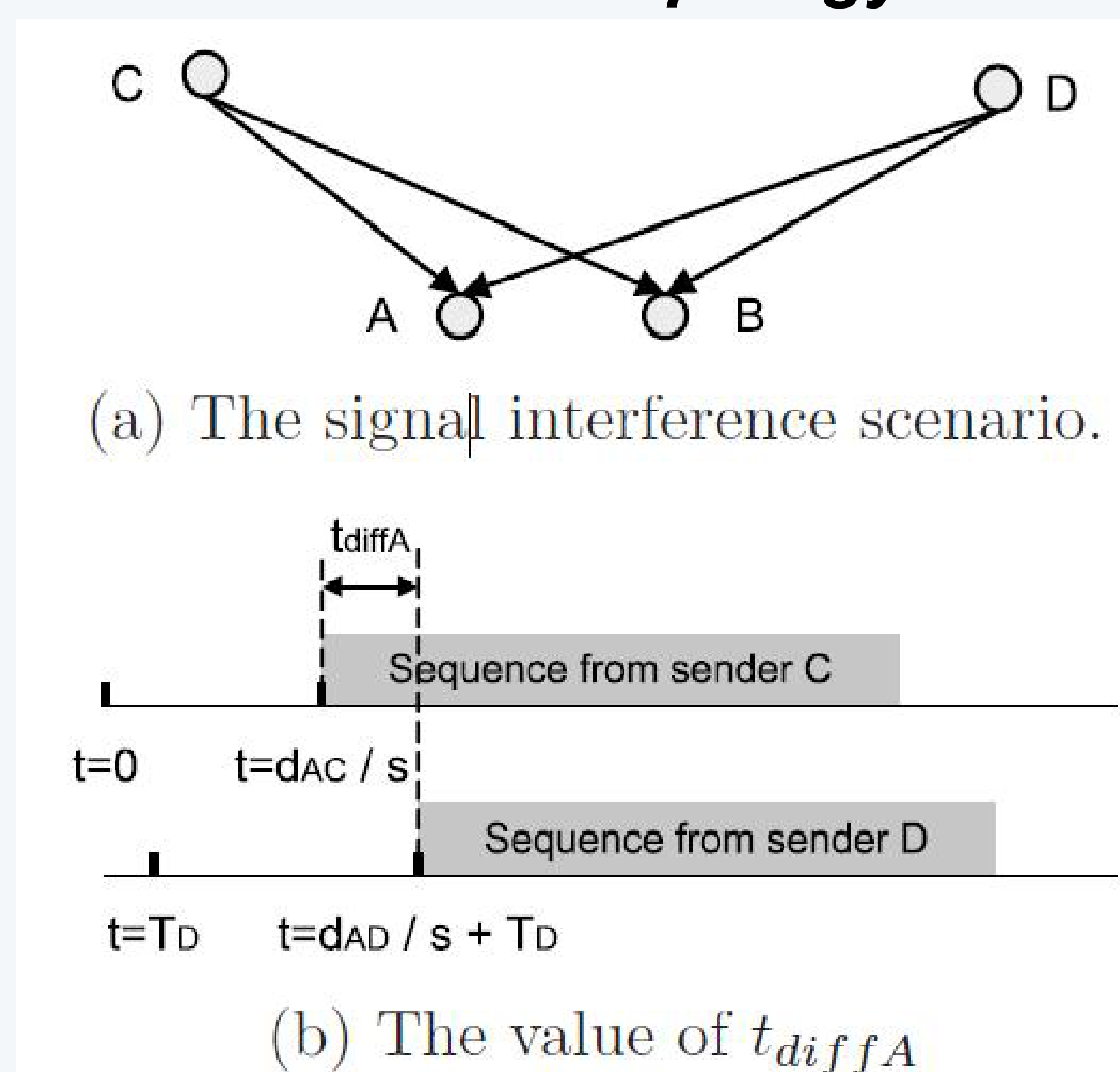
2. Motivations

- Physical layer network coding (PNC) technique greatly improves bandwidth usage efficiency in wireless networks;
- We must have a thorough understanding and evaluation of its safety;
- Previous research on PNC focuses on improving the decoding accuracy;
- This knowledge deficiency has affected further development and wide adoption of this technique.

3. Proposed Efforts

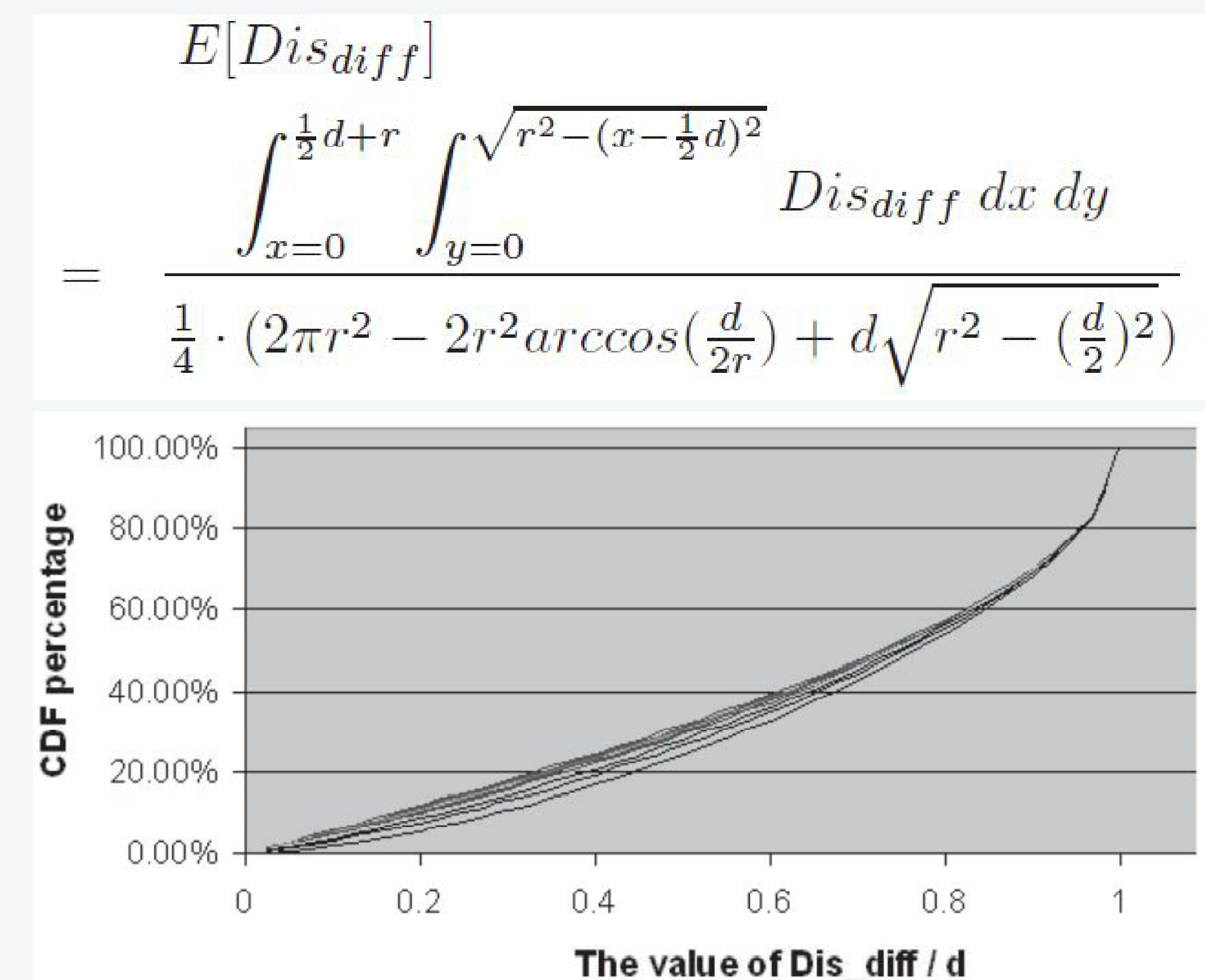
- Identify properties of PNC that can be used for attack detection;
- Design the detection mechanisms under different network structures and attacker models;
- Identify and overcome the difficulties of turning the designs into practical solutions in real networks;
- Evaluate the approaches.

4. Signal Interference Results and Network Topology



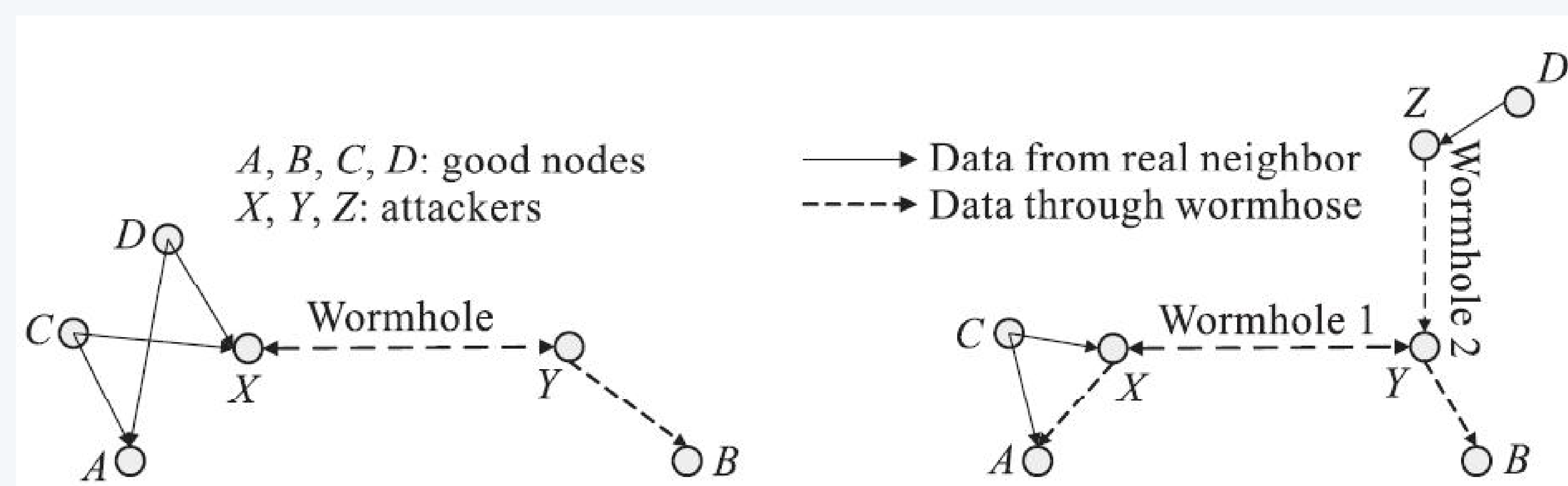
5. Detection of Sybil Attacks in Wireless Networks

- Distance bounding b/w wireless nodes
- $$t_{diffB} - t_{diffA} = \frac{(d_{BD} - d_{AD}) + (d_{AC} - d_{BC})}{s}$$
- Using the differences in signal interference results, two nodes can recover the original sequences. The Sybil nodes cannot conduct the operation.
 - The approach does not need clock synchronization or special hardware. It works in a distributed manner.
 - Distances b/w nodes may cause false alarms. Their impacts must be studied.



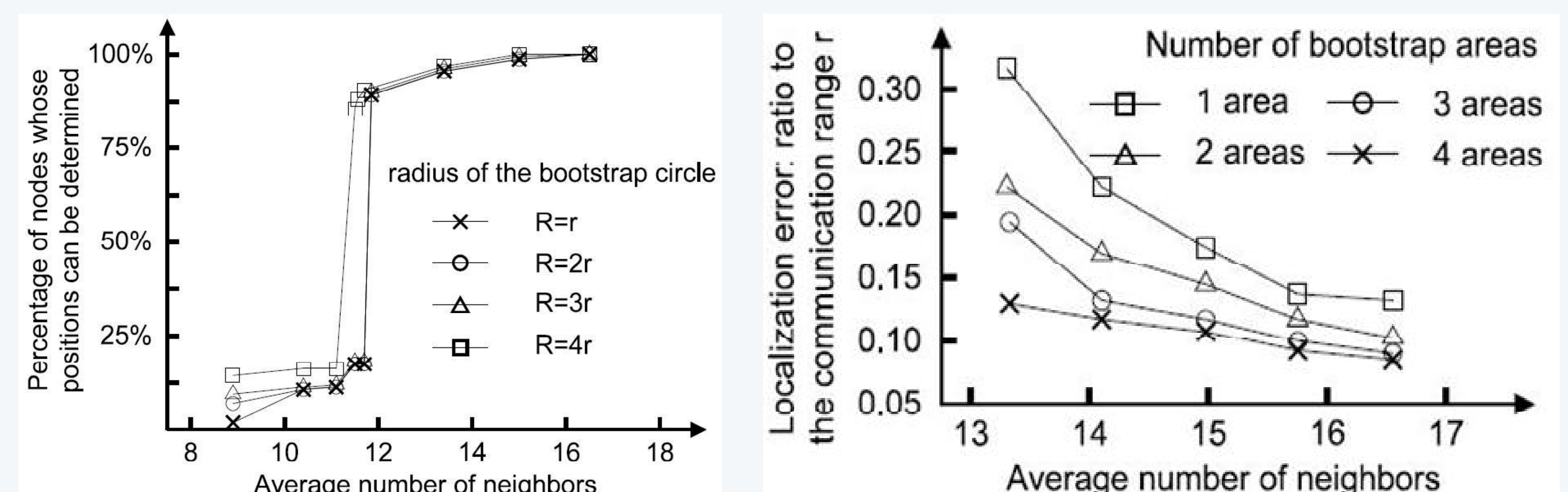
6. Detection of Wormhole Attacks

- The extra transmission delay through wormholes will impact the signal interference results.
- The impacts of power amplitude of the signals, phase shift, and frequency jitter are investigated.



7. Localization with PNC

- Determine the position of a wireless node by comparing the starting points of collisions and calculating a hyperbola for the node.
- The bootstrap requirements and localization accuracy are studied.



8. Publications

- Node Localization through Physical Layer Network Coding: Bootstrap, Security, and Accuracy, Ad Hoc Networks, vol.10, no. 7, p. 1267--1277, 2012. Z. Li and W. Wang.
- Forced Collision: Detecting Wormhole Attacks with Physical Layer Network Coding, in Elsevier Tsinghua Science and Technology, special issue on Wireless Mobile Computing and Networking, volume 16, number 5, pages 505--519, 2011. Z. Li, D. Pu, W. Wang, and A. Wyglinski.
- Node Localization in Wireless Networks Through Physical Layer Network Coding, in IEEE GLOBECOM 2010. Z. Li, D. Pu, W. Wang, and A. Wyglinski.
- Detecting Sybil Nodes in Wireless Networks with Physical Layer Network Coding, in Proceedings of IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), pp. 21--30, 2010. W. Wang, D. Pu, and A. Wyglinski.