

Exploring the Security Capabilities of Physical Layer Network Coding

Weichao Wang

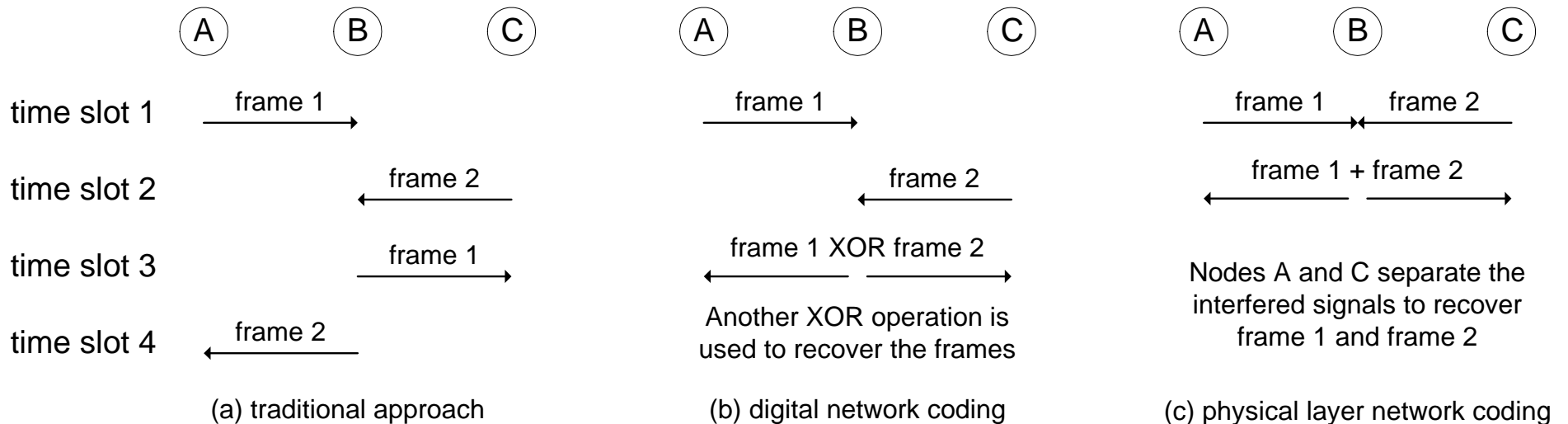
SIS Dept & CyberDNA Security Center

UNC Charlotte



Background

- Network coding can effectively improve data robustness and bandwidth efficiency
- PNC uses signal interference to achieve coding [MobiCom'06, SigComm'07]



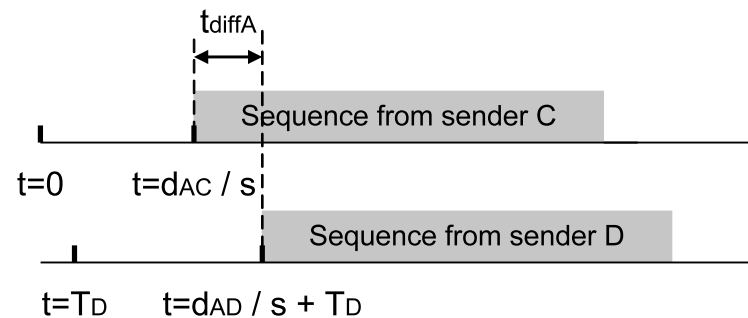
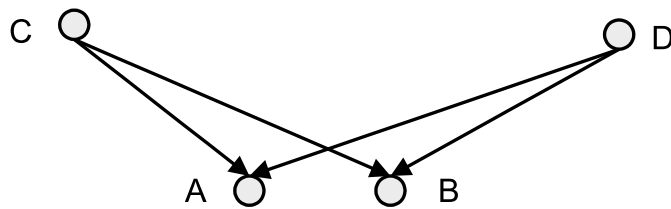
Background

- Previous research on security of network coding focuses on detection of pollution attacks
- Our research investigates this problem from a different aspect: Can we use network coding to detect some attacks on wireless networks?
- The following parts
 - Basic idea
 - A concrete example: Sybil attack detection using PNC



Basic idea

- The start point of signal interference is determined by the distances b/w the receivers and senders, and the sending time



- The difference b/w two t_{diff} can cancel out the impacts of the sending time

$$\| t_{diffB} - t_{diffA} \| = \| (d_{BD} - d_{AD}) + (d_{AC} - d_{BC}) \| / s$$

$$\leq (\| (d_{BD} - d_{AD}) \| + \| (d_{AC} - d_{BC}) \|) / s \leq 2 \times d_{AB} / s$$

Basic idea

- We can link the distance b/w the receivers to the signal interference results
- Potential applications:
 - Detecting stealth attacks on wireless network topology
 - A concrete example: Sybil attack detection using PNC [by Wang et al. DSN 2010]

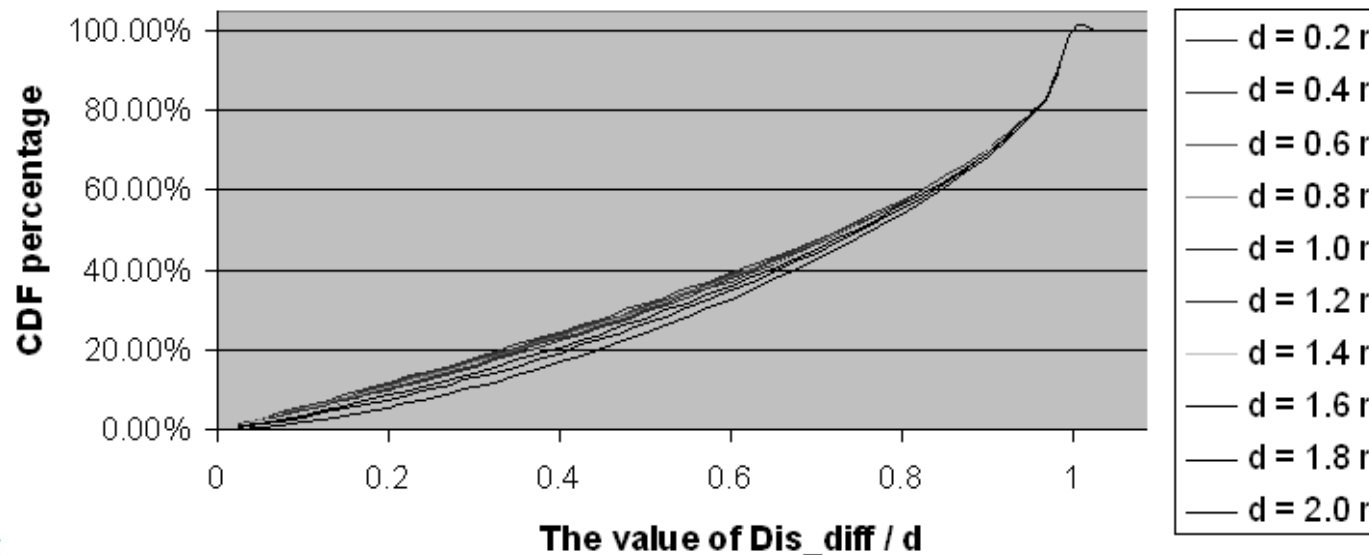
Sybil attack detection using PNC

- Two distinct receivers can combine their received signals to reconstruct the sequences
- For multiple Sybil identities that attach to the same physical device
 - They will receive the same interference results
 - Cannot separate the signals
- Therefore, we can challenge the two receivers to determine whether or not they are attached to the same physical device



Sybil attack detection using PNC

- Operations at the senders
 - Randomly choose senders and signal sequences
- Operations at the receivers
 - Signal recovery algorithm
- Reducing false alarms



Conclusion

- Exploring the security capabilities of Physical Layer Network Coding
- Using Sybil attack detection as a concrete example
- Advantages:
 - Avoid the dependence on special hardware
 - Take advantage of bandwidth efficiency improvement mechanisms
- Other potential applications

Thanks. Questions?