PNC Implementation Issues on Software Radio Platform

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Outline

1 Background

2 Proposed Schemes for PNC

3 PNC Implementation on USRP

4 Conclusions

Outline

1 **Background**

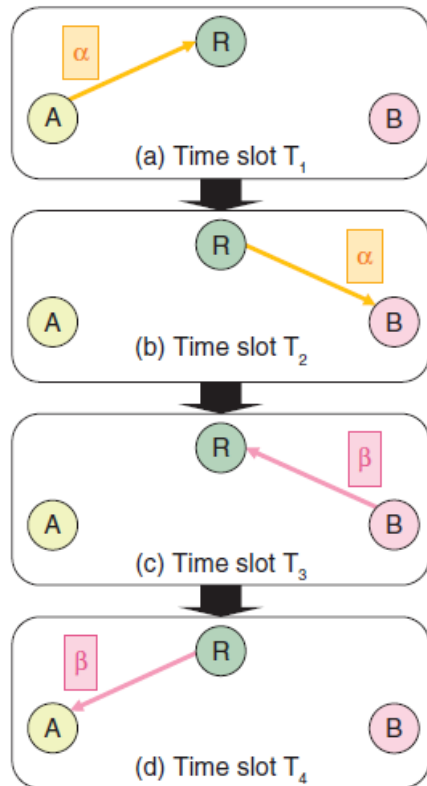**2** Proposed Schemes for PNC
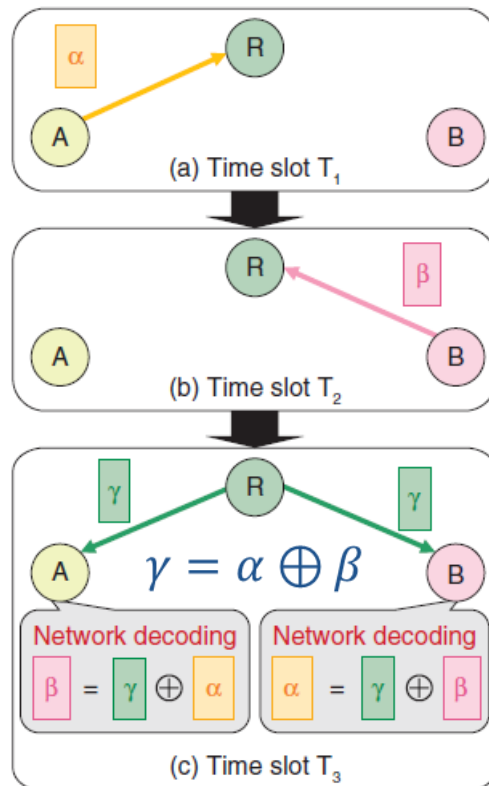
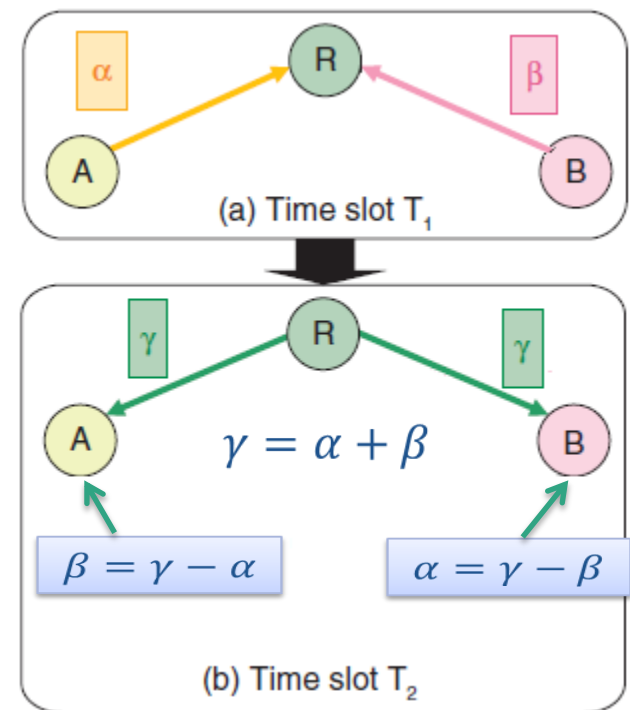**3** PNC Implementation on USRP

4 Conclusions

Background

Trans. time：$4T$

Conventional relaying

Trans. time ：$3T$

Conventional Network Coding (CNC)

Trans. time ：$2T$

Physical-layer Network Coding (PNC)

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Implementation Issues

❖ **MAC layer protocols**

  ✓ Coordinating simultaneous transmissions

  ✓ Checking for PNC opportunity

  ✓ Compatibility with other relaying schemes

Implementation Issues

❖ **Synchronization**

  ✓ Packet alignment

  ✓ Symbol alignment

  ✓ Frequency synchronization

  ✓ Phase synchronization

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Proposed Schemes for PNC

1. **MAC protocol supporting PNC (PNC-MAC)**

2. **Synchronization for PNC with QPSK modulation**

Distributed MAC Protocol Supporting PNC

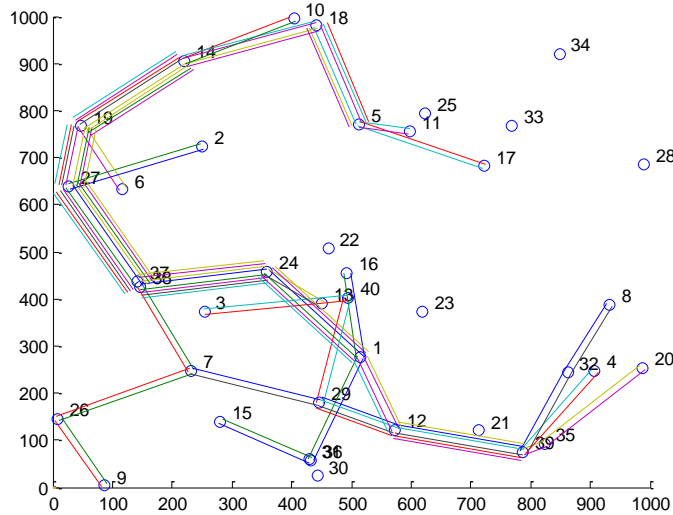❖ **Supporting PNC, CNC and conventional relaying.**

- When using conventional relaying: IEEE 802.11

- When using CNC: MAC with reliable broadcasting [1] (CNC-MAC)

- When using PNC: (see next page)

[1] A. Argyriou. Wireless Network Coding with Improved Opportunistic Listening [J]. IEEE Transactions on Wireless Communications, 2009, 8(4): 2014–2023.
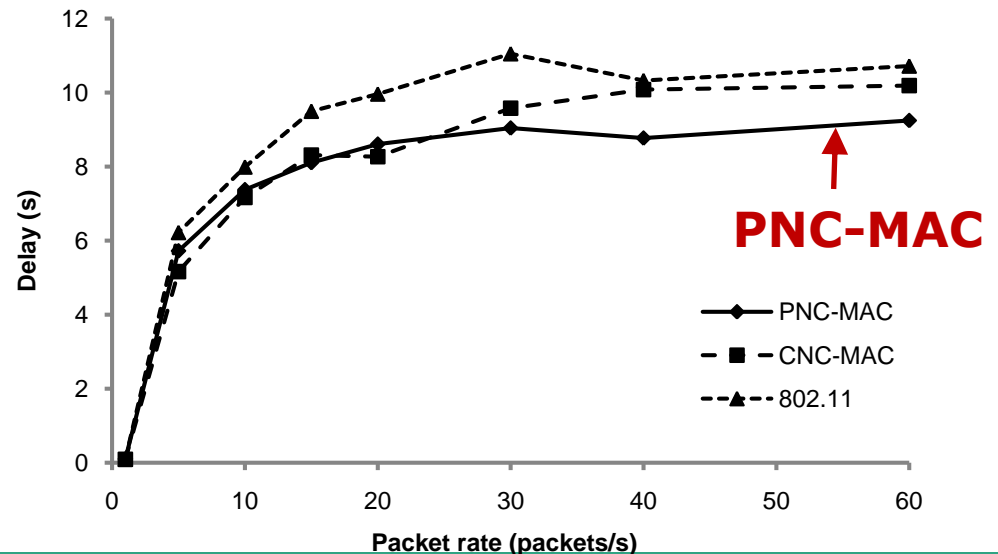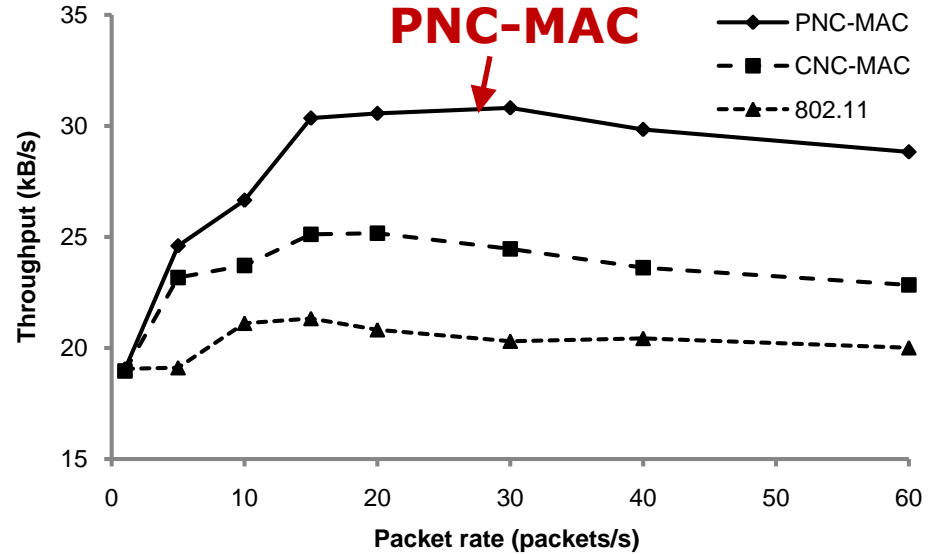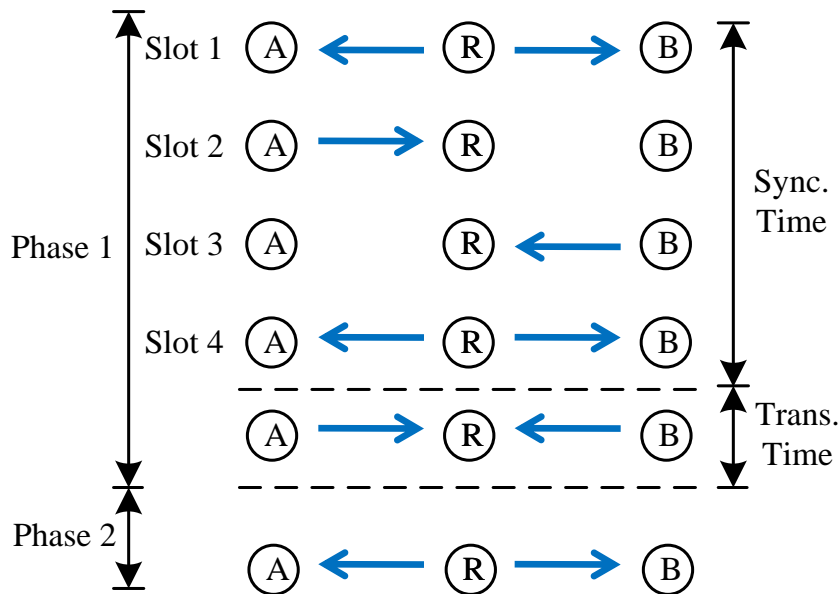
Timing Diagram of PNC-MAC
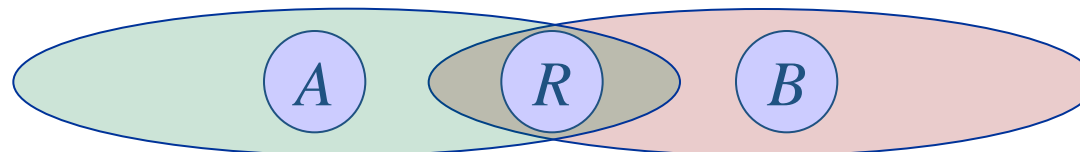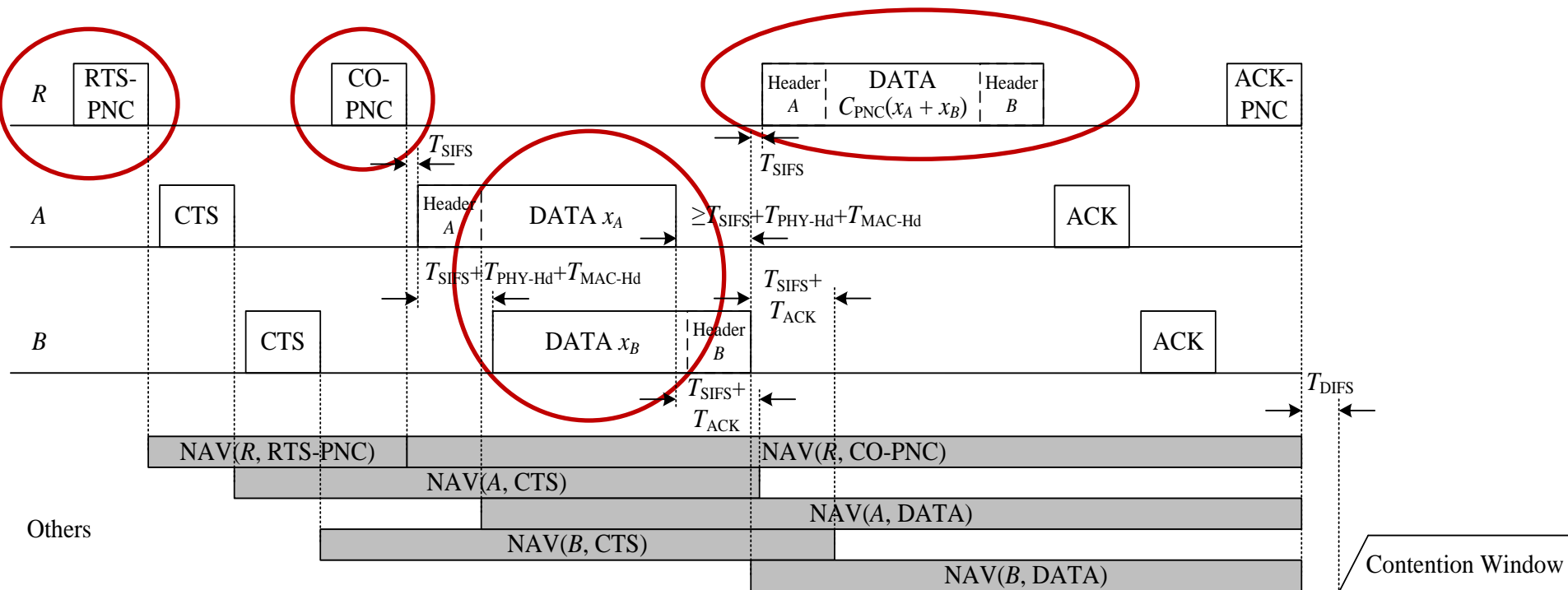
- **1000 × 1000 m² area**
- **40 randomly distributed nodes**
- **20 nodes exchange packets in pairs**

Phase Synchronization Scheme

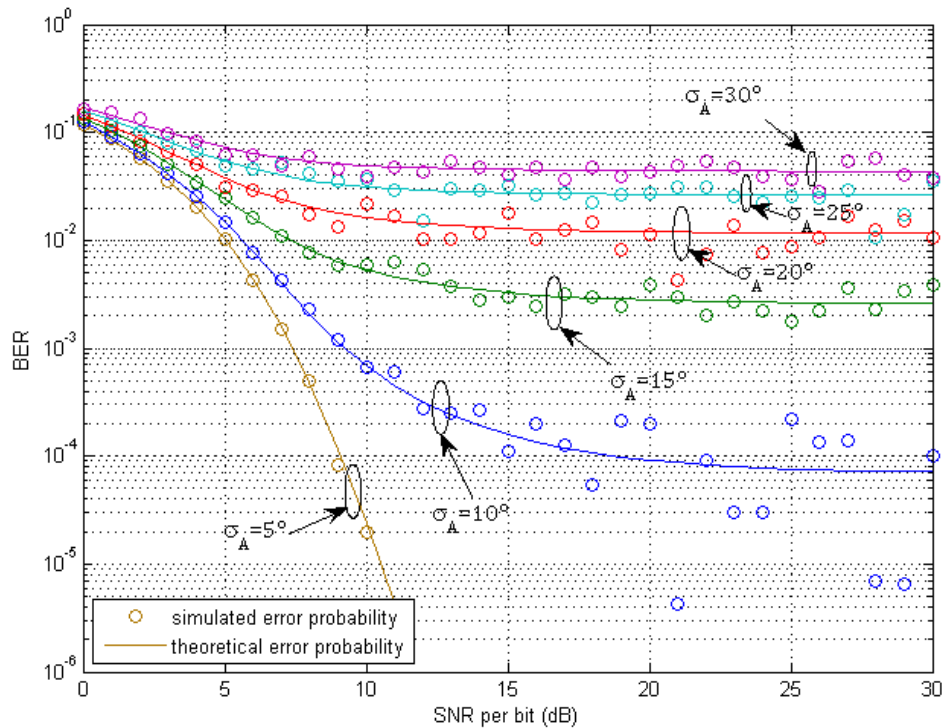- **Time Slot Arrangement for Phase Synchronization**

Timeslots allocation in sync. time.

Node R broadcasts reference carrier .

Source nodes bounce the beacon from relay node R in timeslot 2 and 3.

Node R estimates the channel phase offset and then broadcasts them to sources for phase compensation.
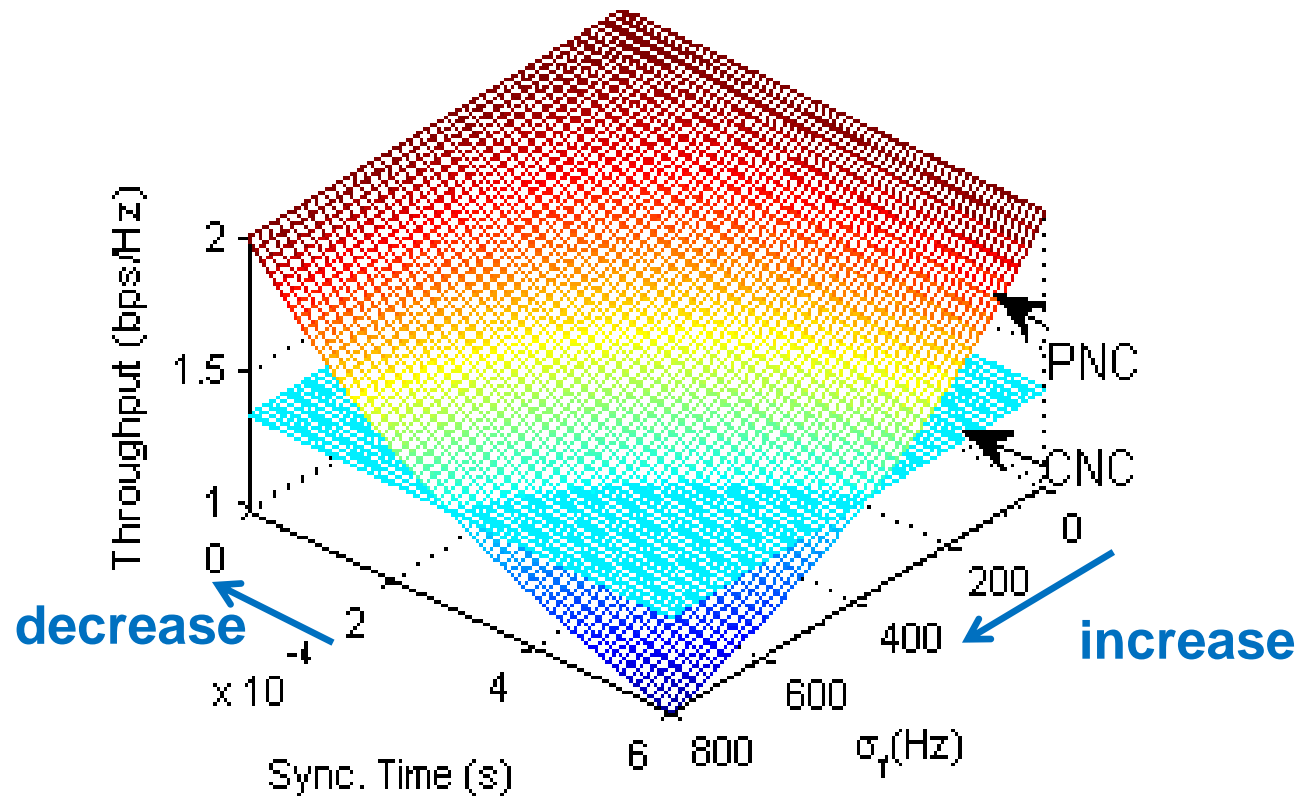
We construct the relation between average BER and phase error based on analysis. With the system BER requirement , we can find the system tolerance to phase error.

Simulation Results

When required BER = 10^{-3}, then $\sigma_A \approx 13°$

The standard deviation of the maximum frequency offset is σ_f

decrease

increase

Outline

PNC Implementation on USRP

- Linux system cannot support real-time tasks effectively

- Latency in processing and bus transfers

- Must be connected to PC

- Not portable

Outline

Conclusions

❖ **PNC is a promising technique for next-generation wireless multi-hop networks.**

❖ **A distributed MAC protocol supporting PNC (PNC-MAC) has been proposed.**

❖ **A phase synchronization scheme has been proposed.**

❖ **PNC implementation issues on USRP have been briefly analyzed.**

Thank You!