**Predictable, Reliable, Real-Time, High-Throughput (PRRT) Wireless Communication and Networking**

**Predictable Wireless Interference Control as Fundamental Challenge**
- Co-channel interference as a major obstacle for predictable reliability, real-time, and throughput in wireless networking
- Reliability as low as ~30% in current wireless scheduling/MAC protocols, thus not suitable for real-time, safety-critical networking control
- Decades of research and practice: high-fidelity interference models that are suitable for distributed, field-deployable protocol design are still missing
- Ratio-K model (i.e., protocol model) is local but not of high-fidelity
- SINR model (i.e., physical model) is of high-fidelity but non-local

**Physical-Ratio-K (PRK) Interference Model**
- Key idea: use link reliability requirement as the basis of instantiating the ratio-K model
- Model: given a transmission from node S to node R, a concurrent transmitter C does not interfere with the reception at R iff:

  \[ P(C) \leq P(S, R) \frac{S, R, t_s}{S, t_s} \]

**Optimality of PRK-based Scheduling**
- Throughput loss is small, and it tends to decrease as PRK requirement increases

**PRKS: PRK-based Scheduling**
- **TOA Slab-Based, protcol signaling**
  - Link reliability feedback
  - Link/relay link measurement
- **Prior signaling**
  - Joint reliability distribution
- **state of environment transmission link**
- **Reliability estimation**
  - Data packet 
  - Control plane

**Predictable Link Reliability and High Throughput in PRKS**

**Transformative Impact on State of Art/Practice**
- **From Predictable Interference Control to PRRT Wireless Communication & Networking**
  - Addressing dynamics & uncertainties of different spatiotemporal scales
  - Multi-scale network structures: joint scheduling, channel hopping, power control, rate control, routing
  - Advanced communication techniques & architectures
    - Interference cancellation, multi-jamming, mmWave
    - Blurred boundary between cellular and ad hoc networks (e.g., D2D mode)
    - Integrated wireless & wired networks and edge computing
  - **New perspectives**
    - From fiber/copper to wireless
      - Wireless backhaul networks
    - From rural communities for smart agriculture farms
    - Enabling technologies & innovation paradigms
      - 5G & beyond
      - Massive & critical machine-type communications
      - CBRS, TWS, dynamic spectrum, innovation zone etc
    - Open-innovation/open-source platforms for distributed innovation
      - OpenAirInterface, SDR, SDN etc
  - Call to action
    - Public-private partnership: academia, industry, government, communities
    - Federal seed programs for innovation & capacity building in rural regions & communities

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**CyNet: Software-Defined Wireless Living Lab for Cross-Discipline, Cross-Domain Collaboration**

**Deployment & Partners**

**CyNet for Smart Agriculture**

**Software-Defined CyNet**

**Virtualized Infrastructure (VI)**

**CyNet for AR/VR-based Multi-Mode CAT Emulation**

**Open 5G/Wireless Innovation**

**Cyber Living Lab for Smart Agriculture**

**ISU IT Partnerships in Agriculture**

**ISU IT**