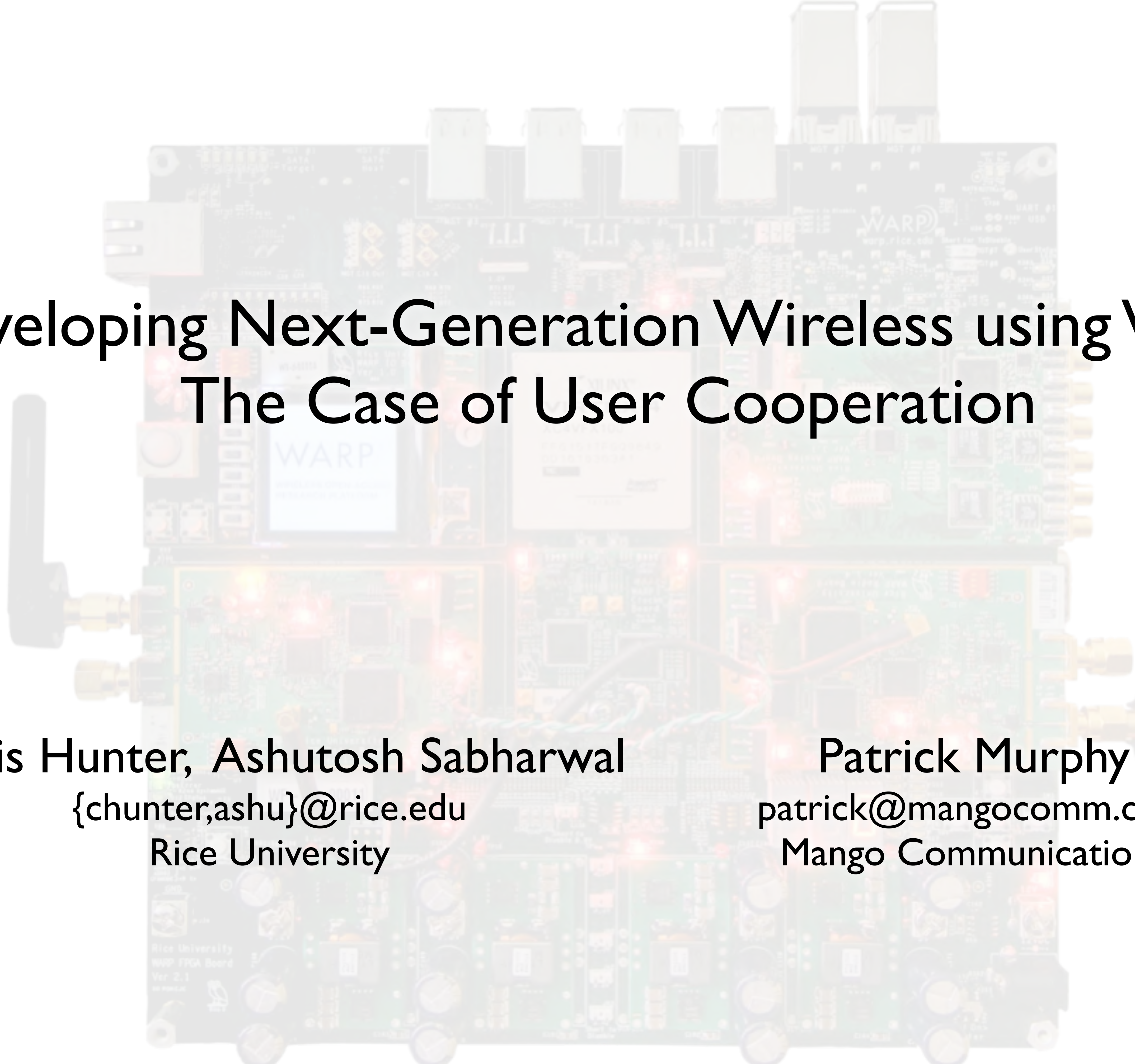

Developing Next-Generation Wireless using WARP: The Case of User Cooperation

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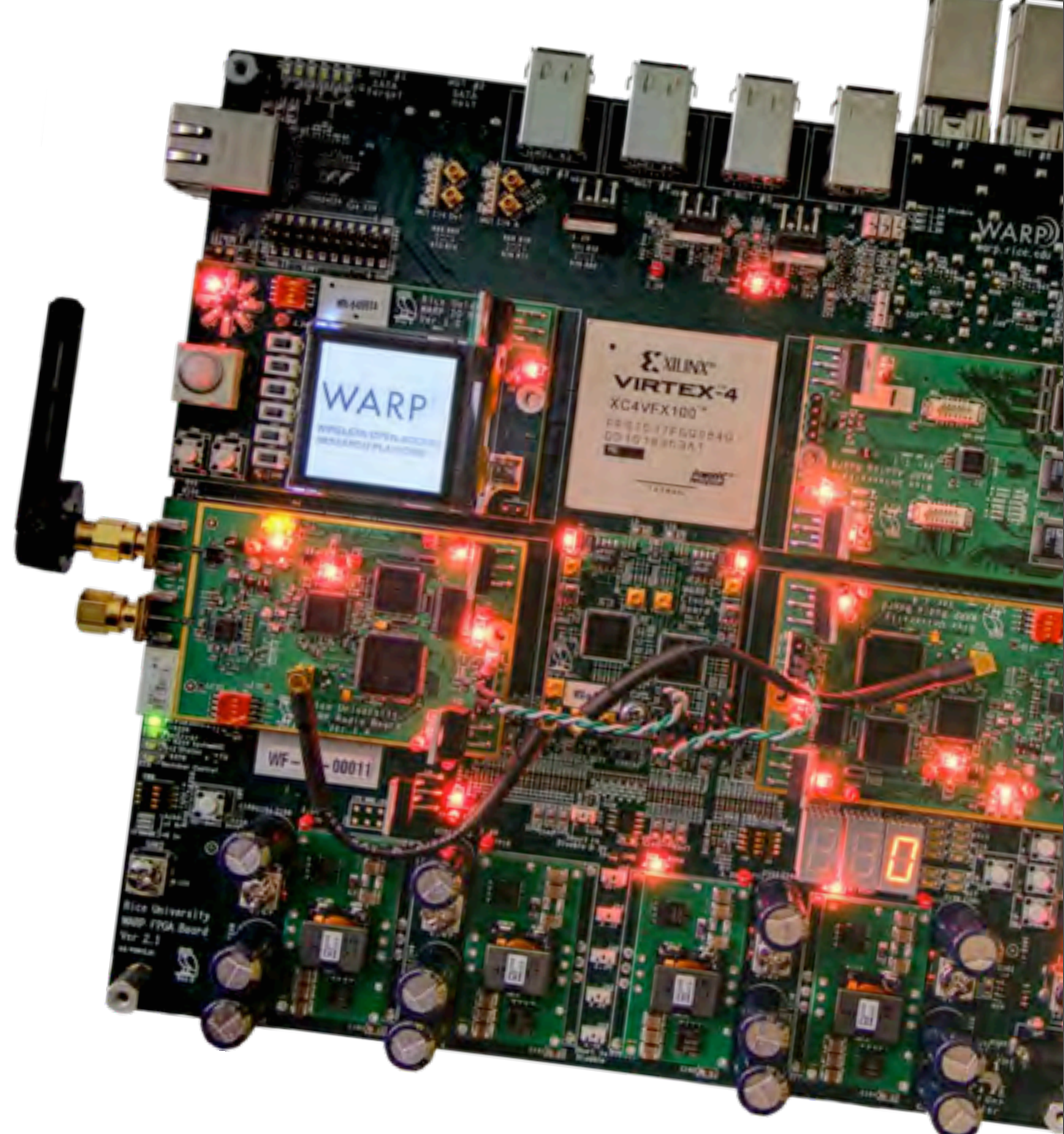
Mango Communications

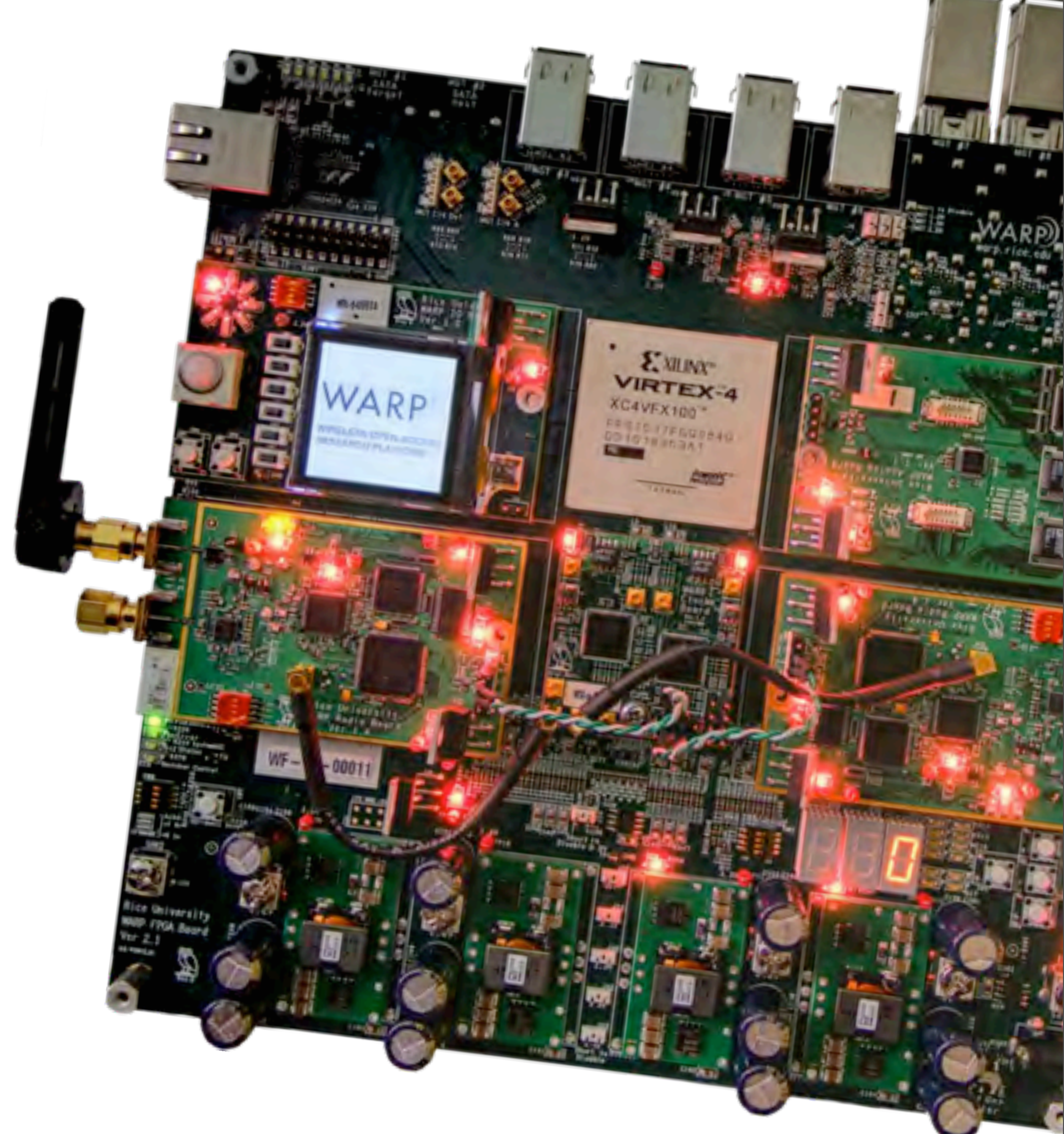
Outline

- WARP Overview
- Research Examples
- Case Study: User Cooperation
- Demonstration



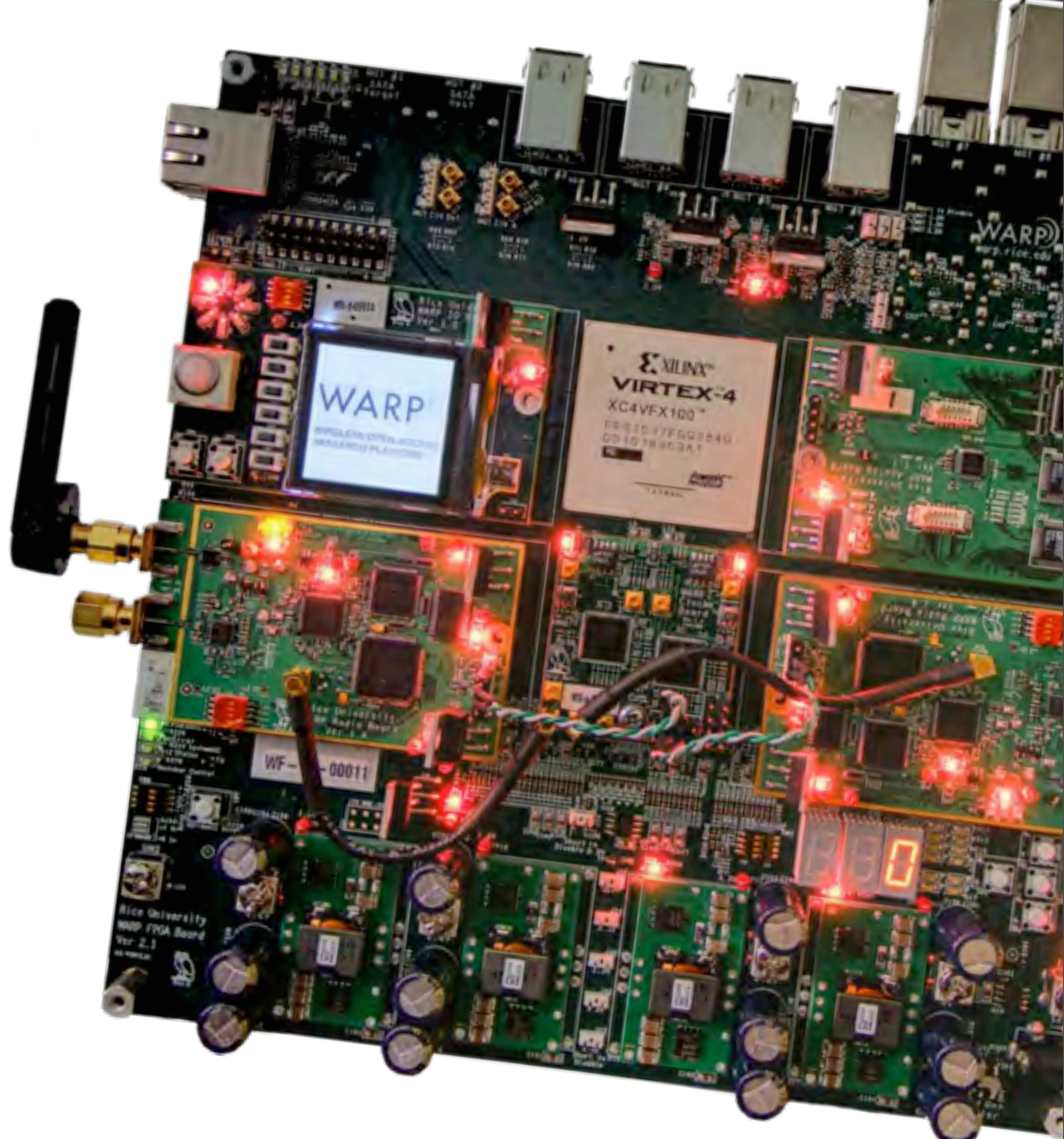
Wireless Open-Access Research Platform

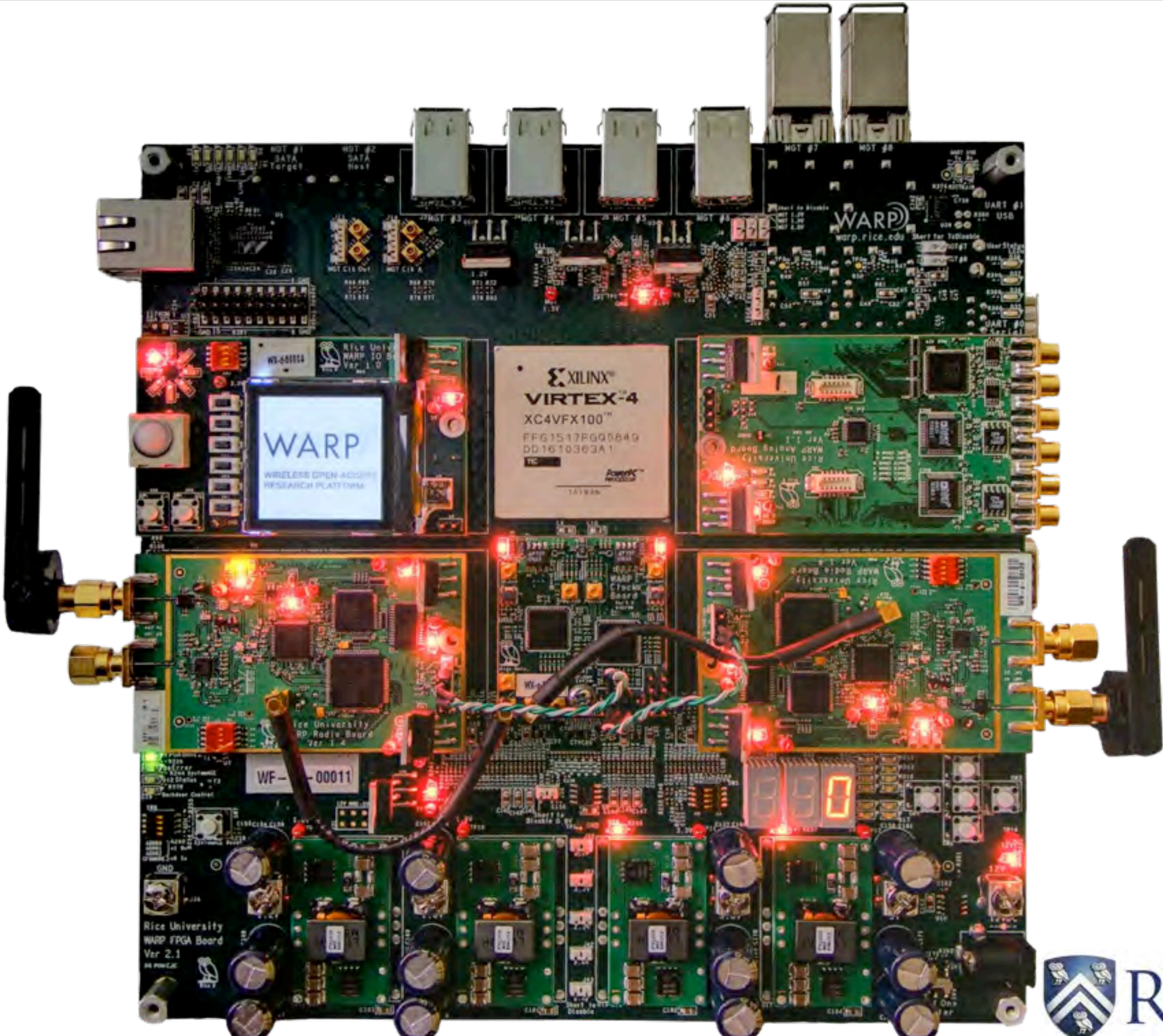
- Cross-layer design
  - Completely programmable, from PHY through networking
- Fast timescales and wide bandwidths
  - 40MHz bandwidth per radio
  - Turn-around-Times in ~20μsec



Wireless Open-Access Research Platform

- WARP refers to two things
  - The Hardware
  - The Support Packages

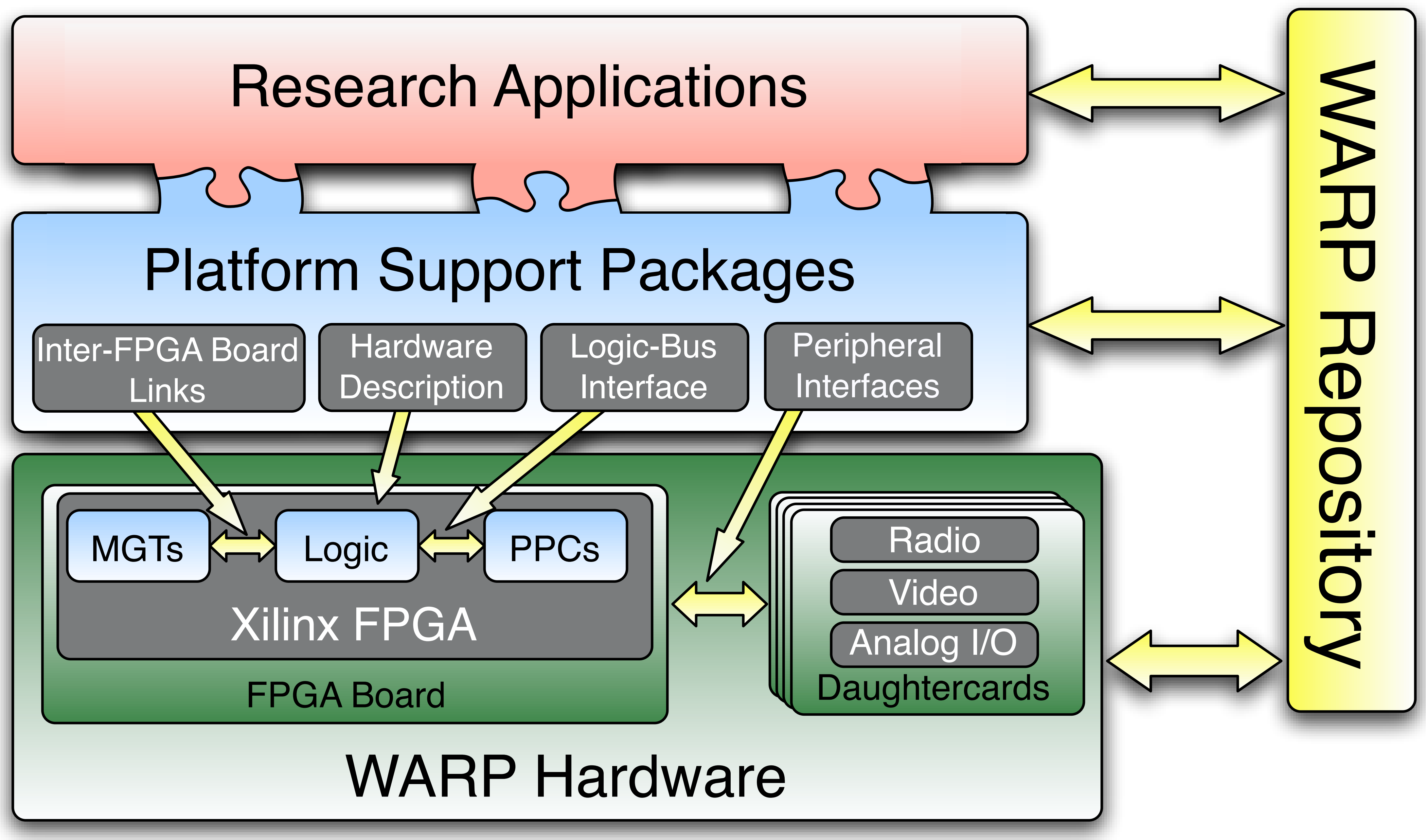



WARP
warp.rice.edu
XILINX
VIRTEX-4
XC4VFX100
WARP
WIRELESS OPEN-ACCESS
RESEARCH PLATFORM
Rice University
WARP FPGA Board
Ver 2.1

RICE

- Xilinx Virtex-4 FX100 FPGA (XC4VFX100-11FFG1517C)
  - All processing is local to the board (no host PC required)
  - FPGA fabric to handle PHY processing
  - PPC (inside FPGA) to handle MAC processing

- Up to 4 radio interfaces
  - MAX2829-based RF front-end (2.4/5GHz, 40MHz BW)
  - All frequency locked for MIMO applications
  - Slots can be used for other daughterboards

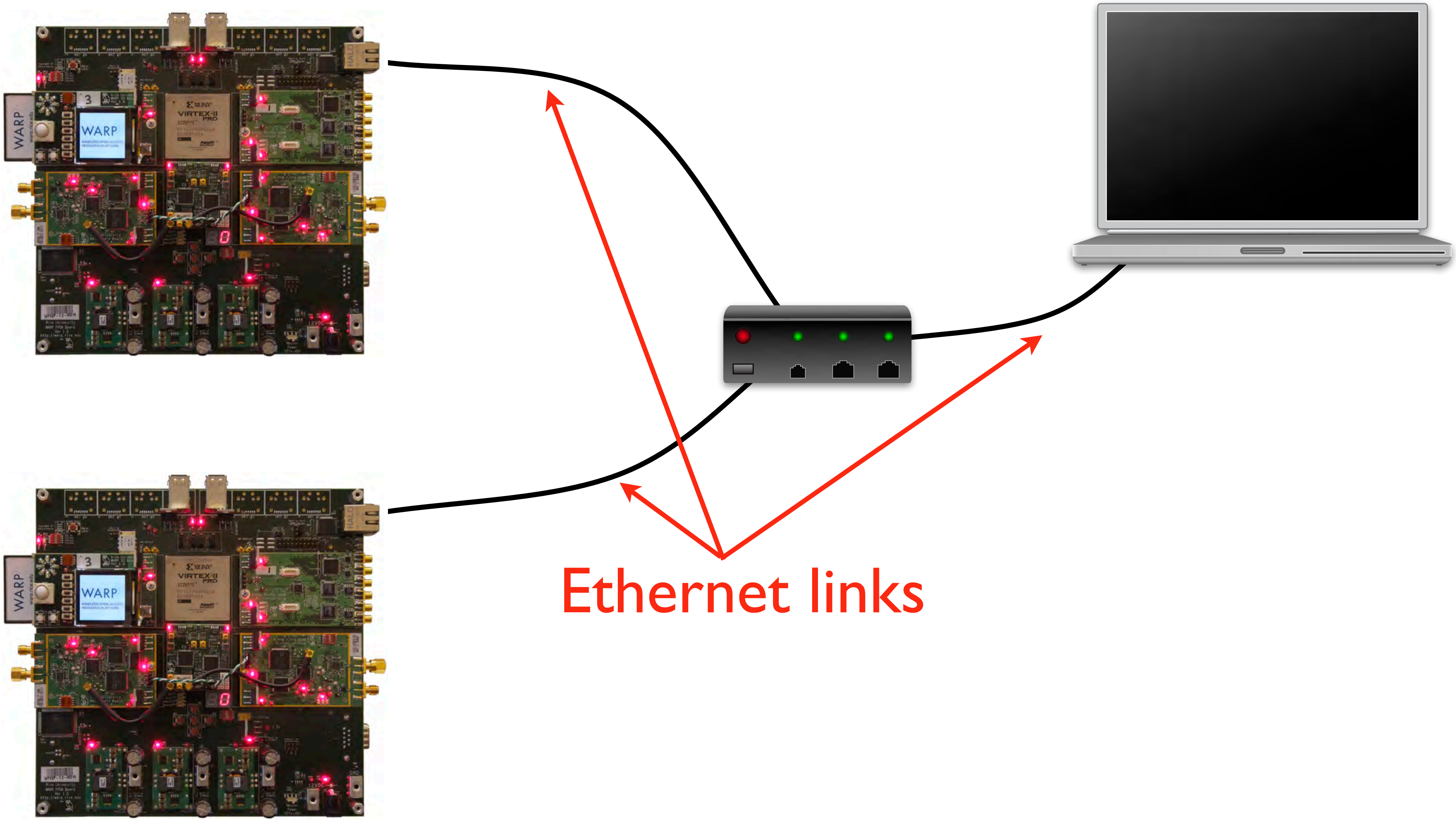


warp.rice.edu

WARPLab

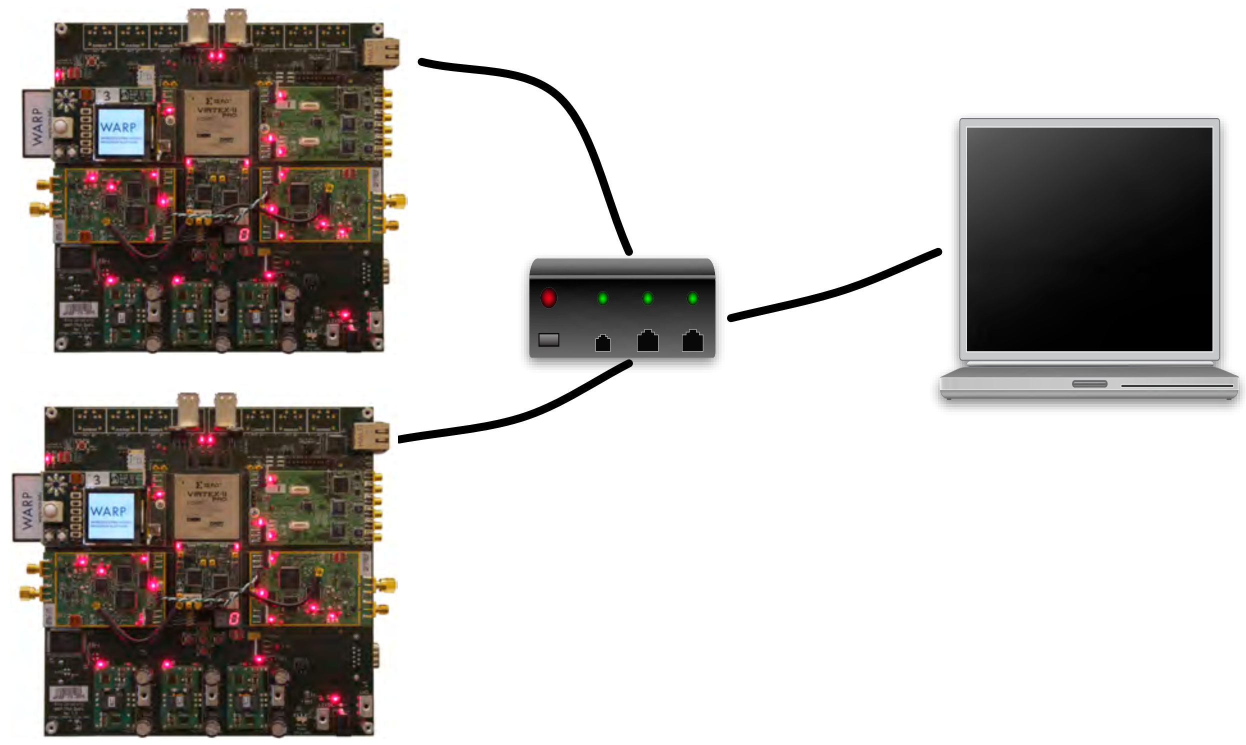
rapid PHY prototyping

WARPLab



WARPLab

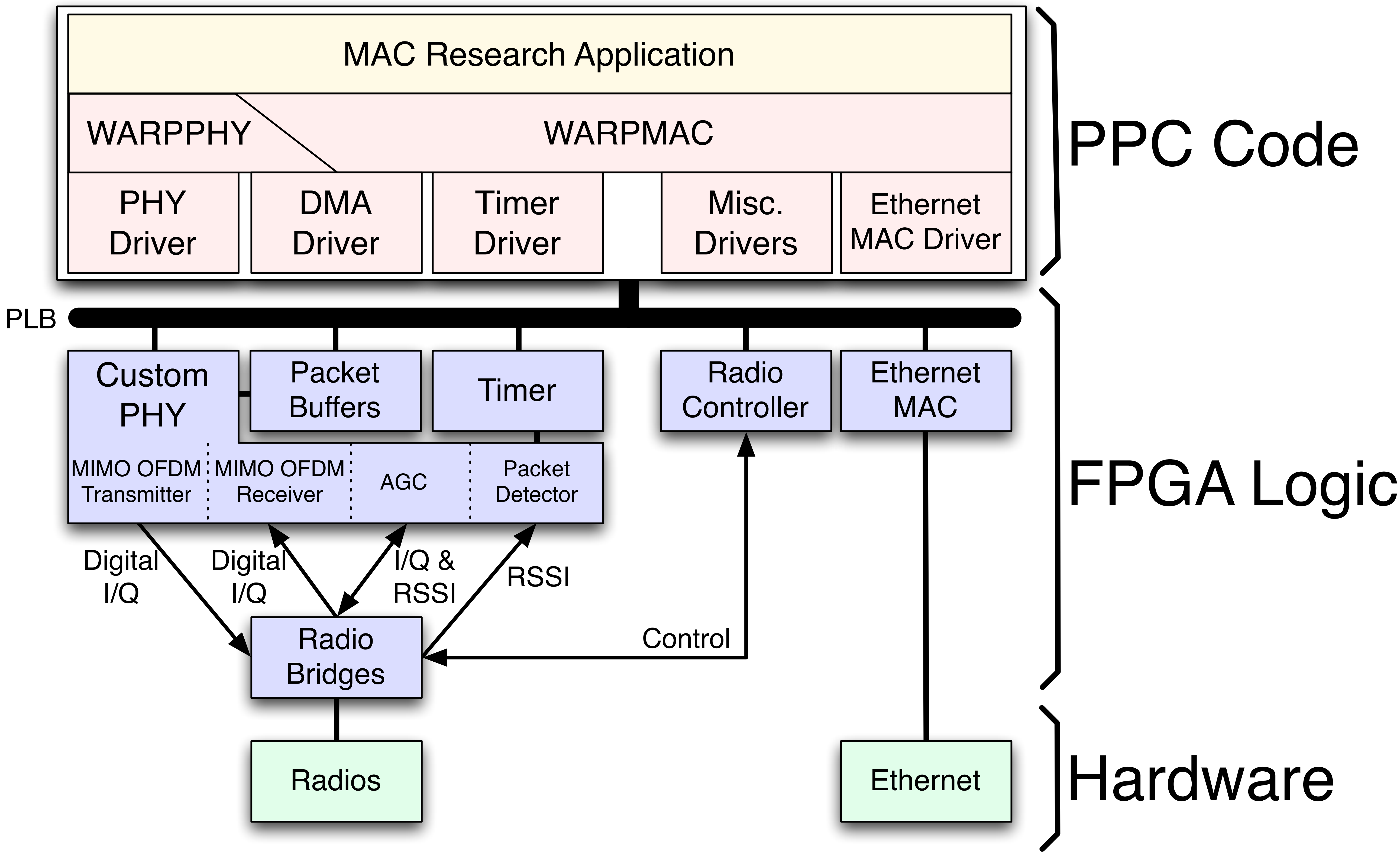
- One PC controls many WARP nodes
- MATLAB for signal processing
- Non-real-time processing
- WARP for wireless interfaces
- Real-time channel use



WARP real-time

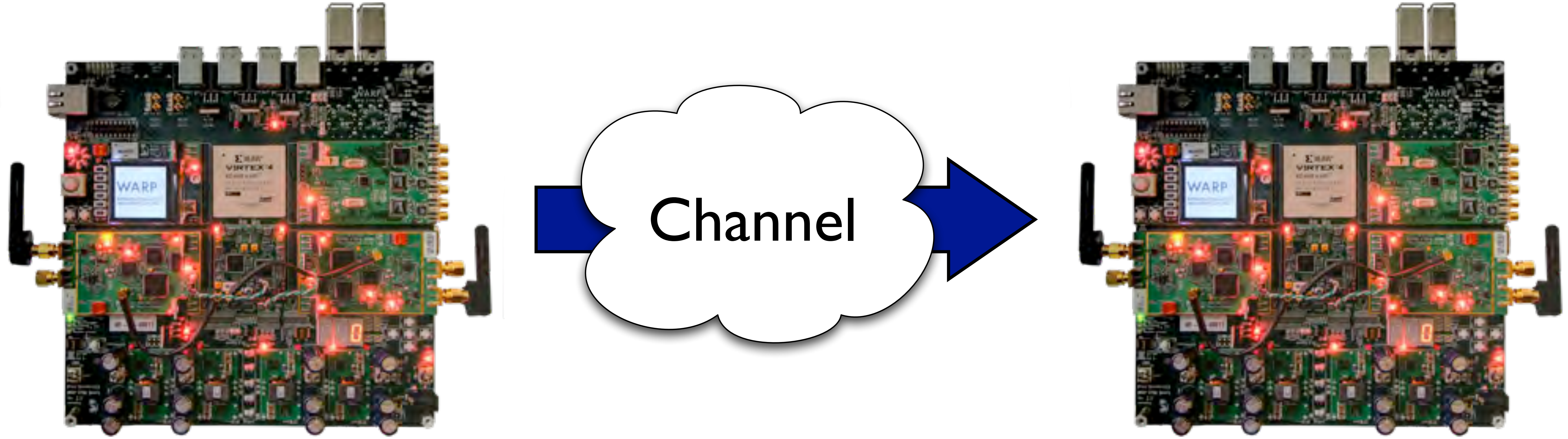
host-free processing

OFDM Reference Design

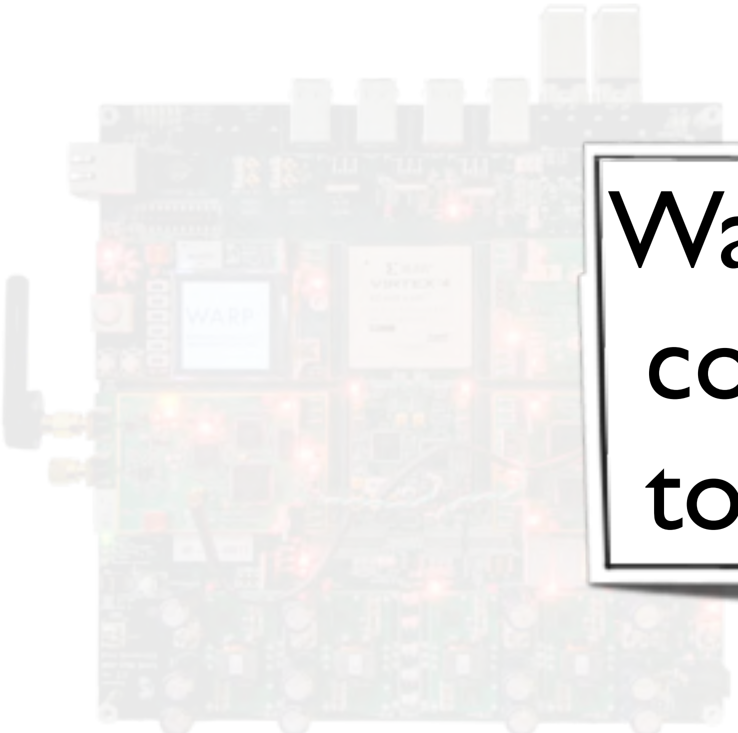


WARPnet

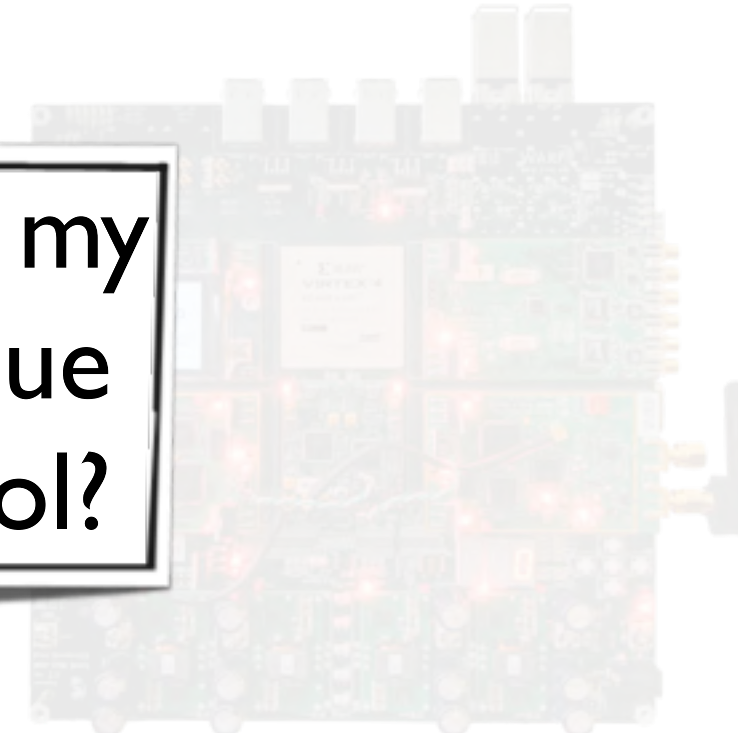
enables experiments with networks



Controlled: Node position, Tx Power, etc.
Uncontrolled: Multipath fading, interference, etc.

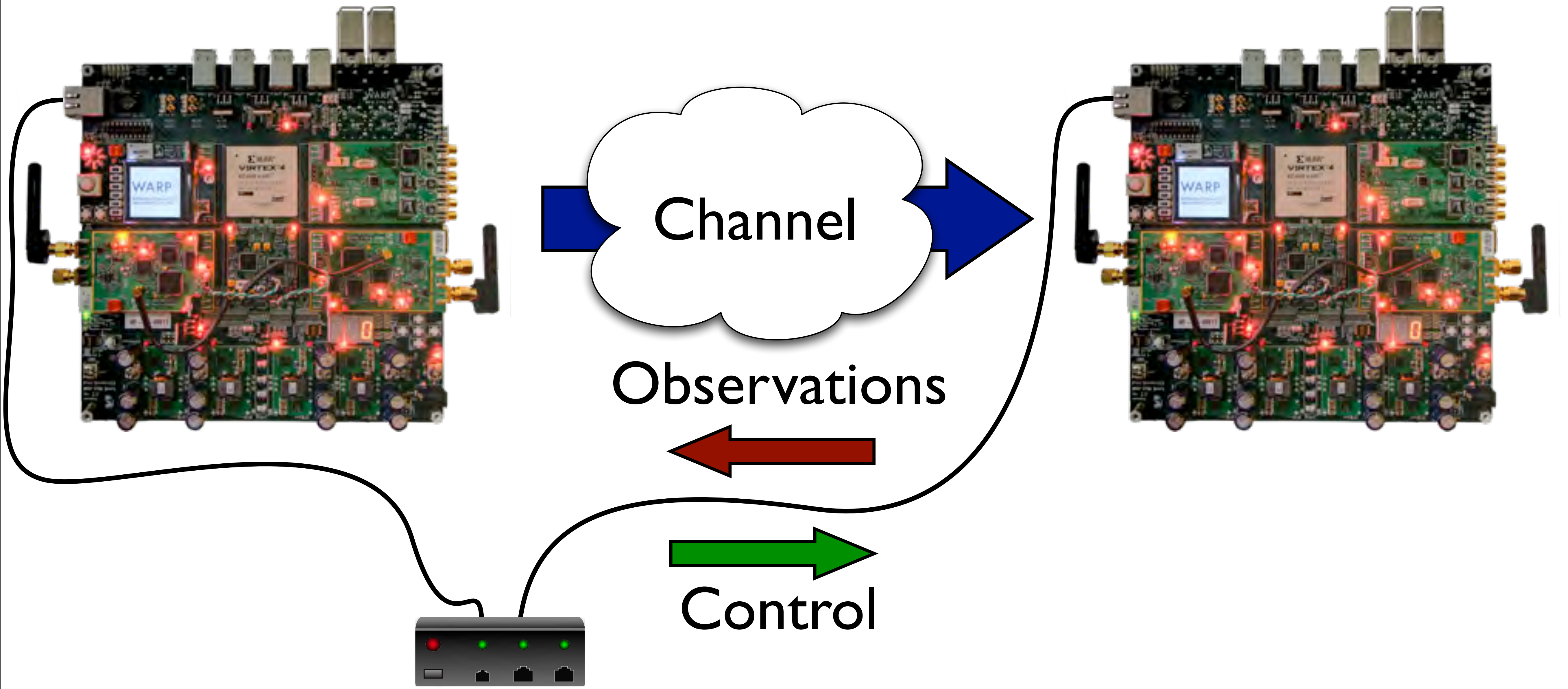


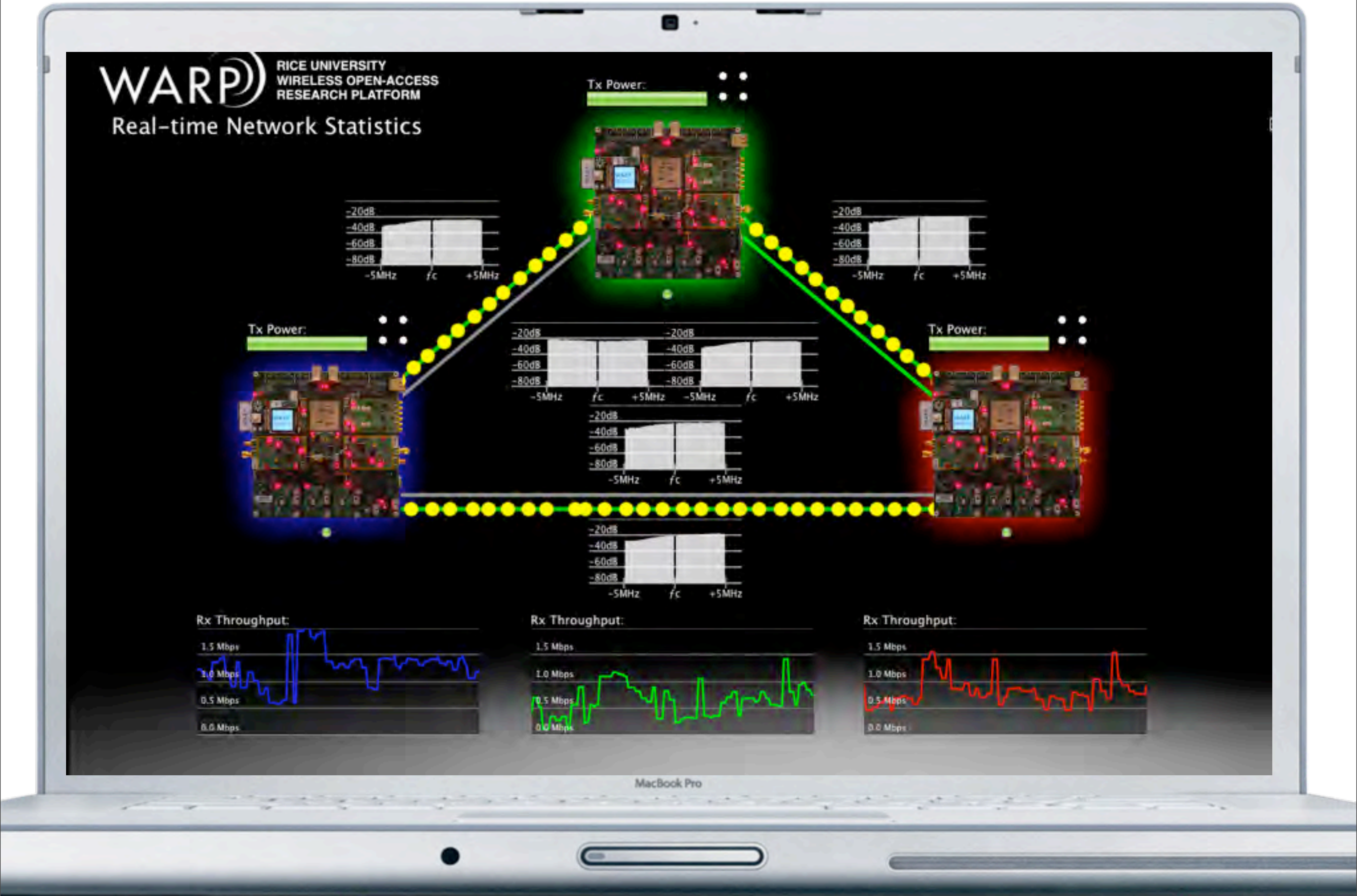
Was observed effect due to my controlled parameters or due to causes beyond my control?



Controlled: Node position, Tx Power, etc.

Uncontrolled: Multipath fading, interference, etc.

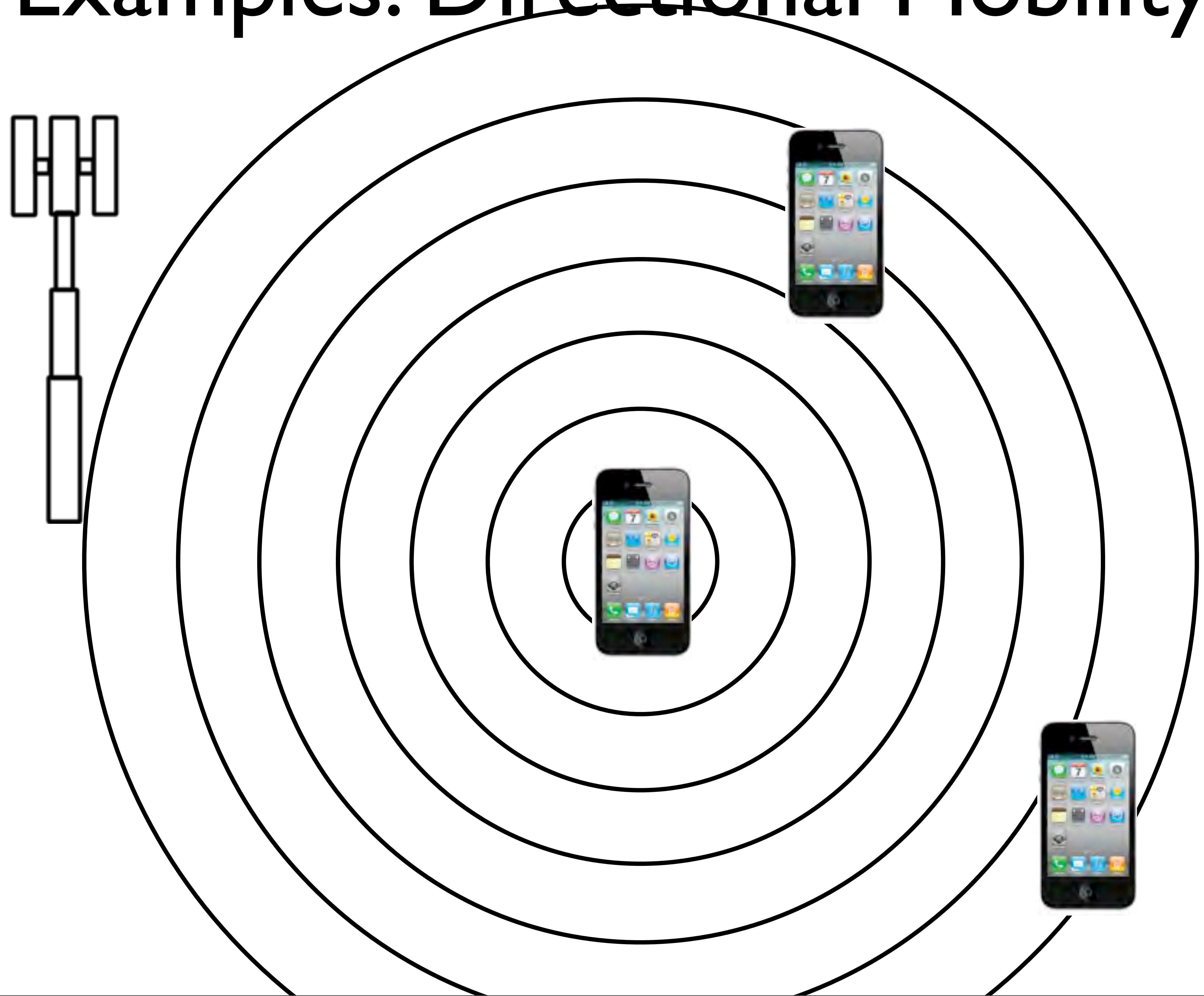

Channel
Observations
Control



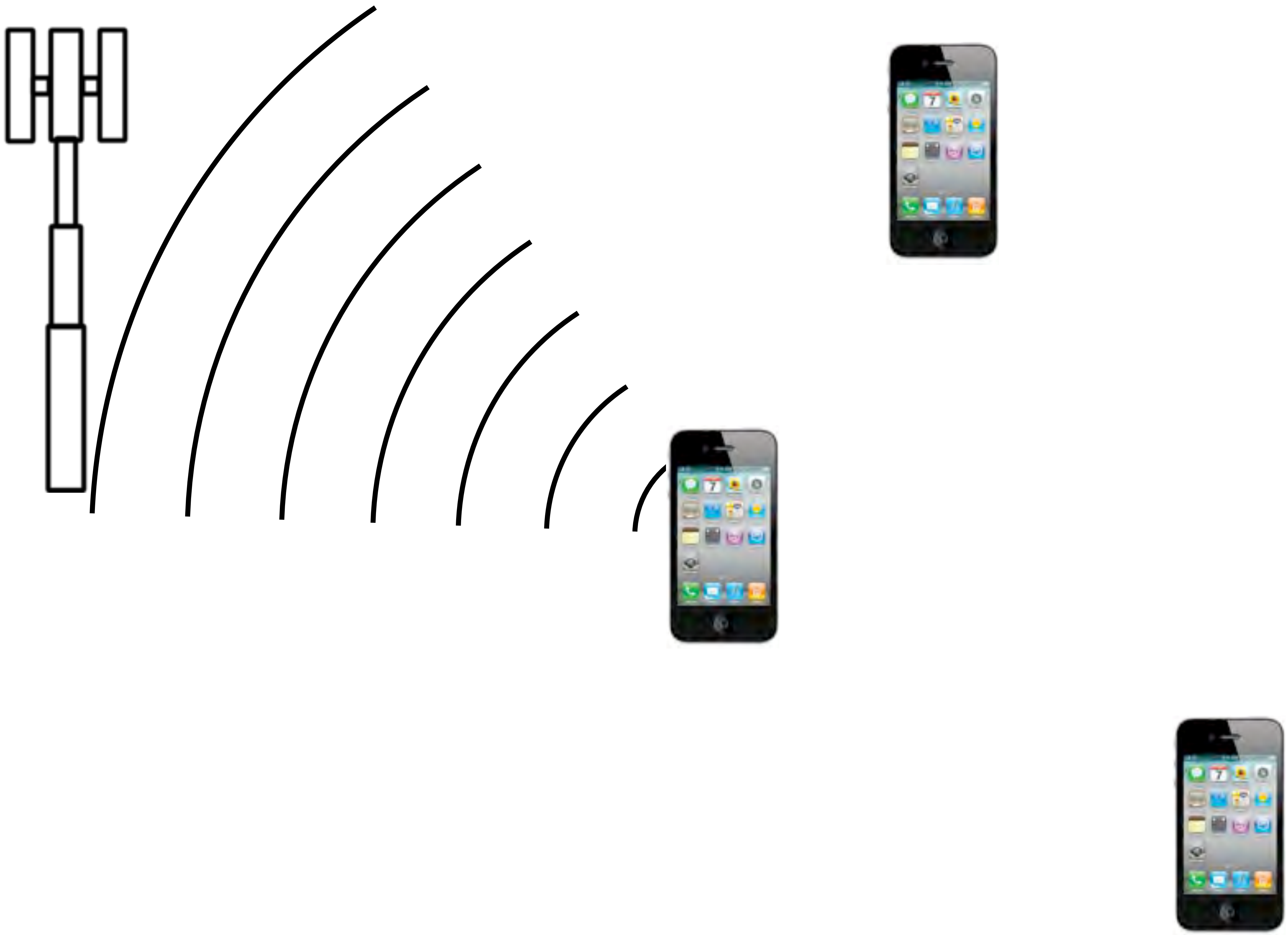
Real-time Network Monitoring with WARPnet

WARPLab
WARP real-time
WARPnet

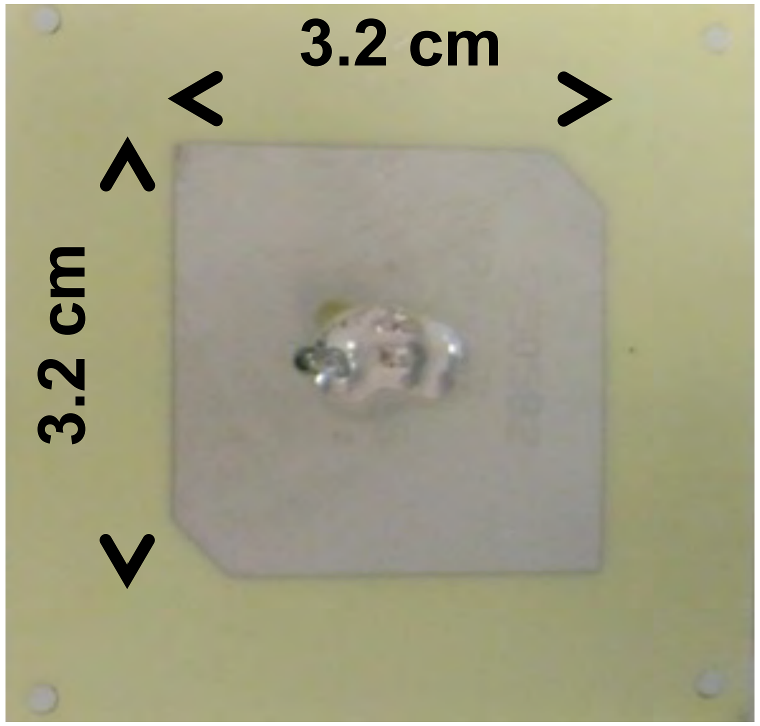
Examples: Directional Mobility

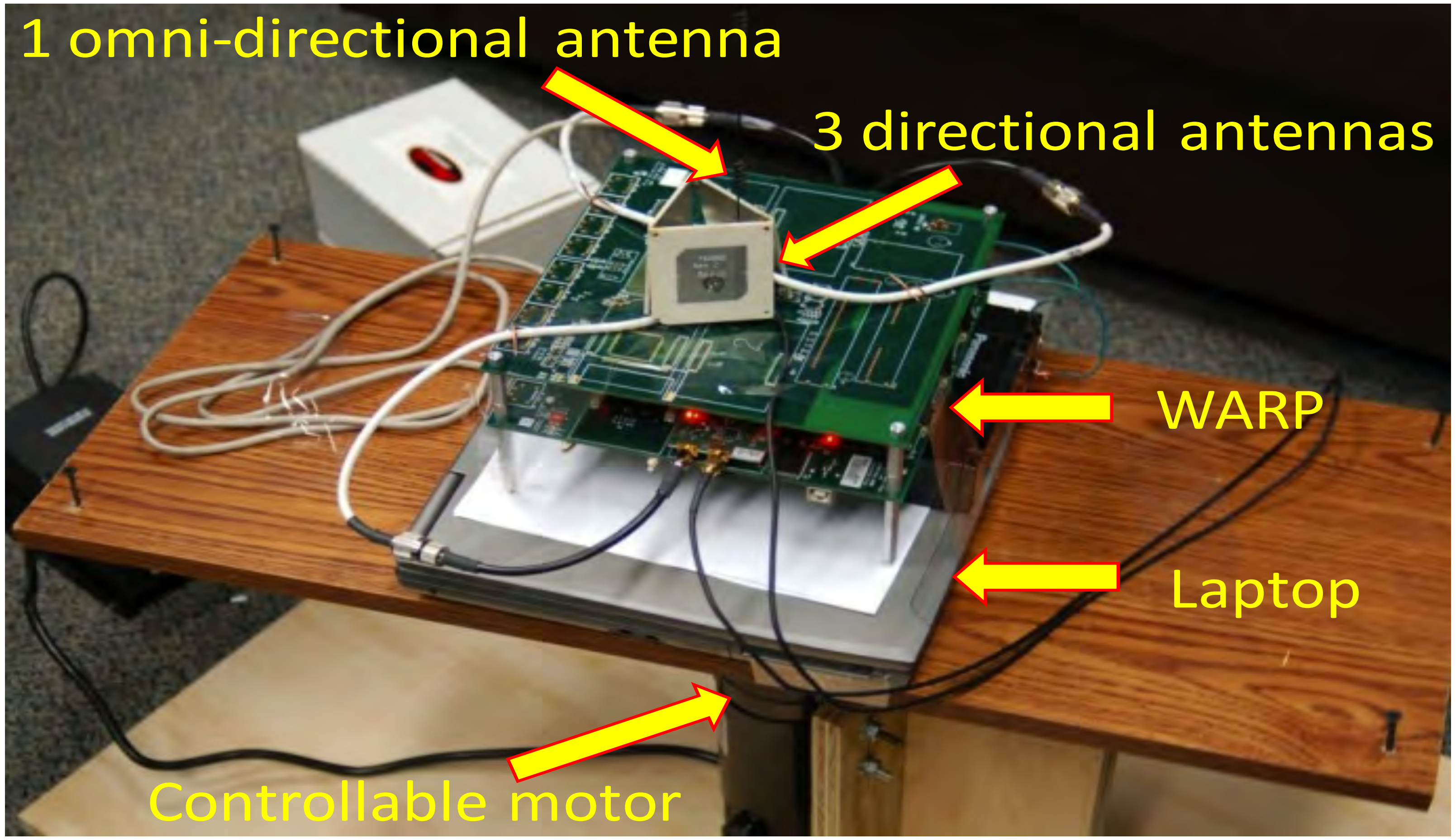


Examples: Directional Mobility



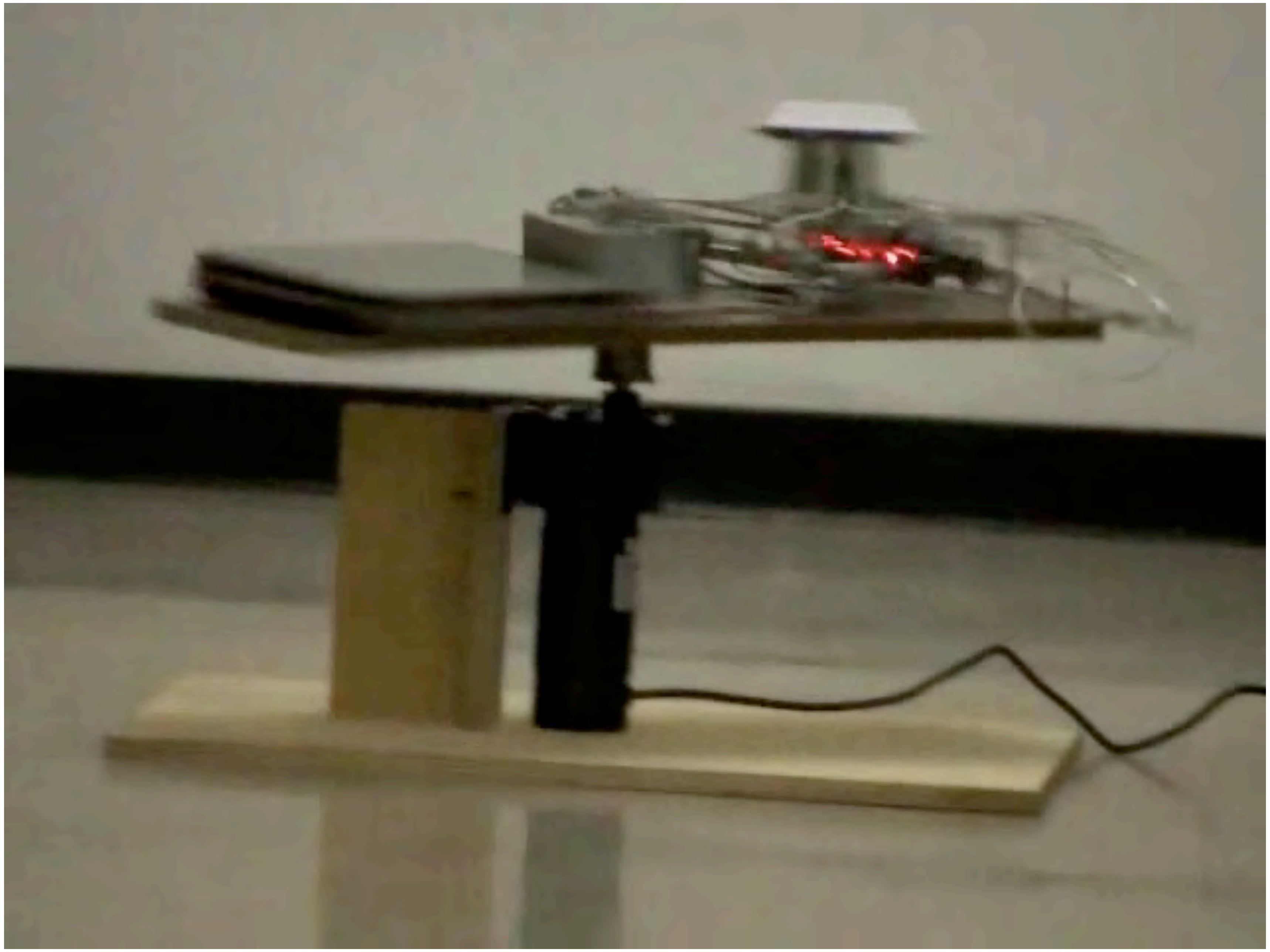
Examples: Directional Mobility





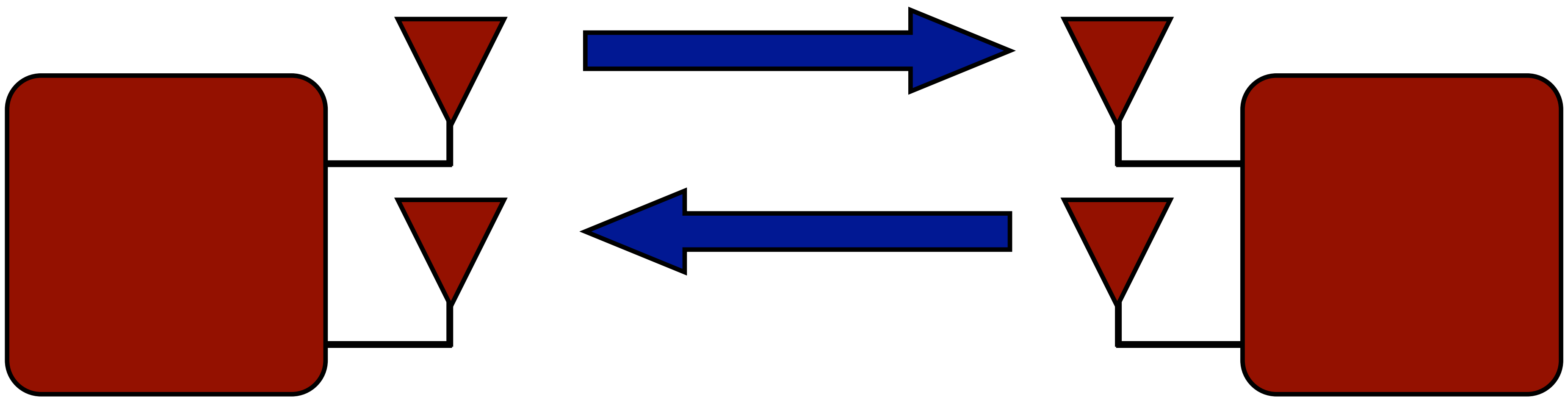
3-5 dB link gain, higher with more antenna patches
(Amiri, Zhong @ Mobicom 2010)

Examples: Directional Mobility



Video of Real-Time Directional Mobility Testbed

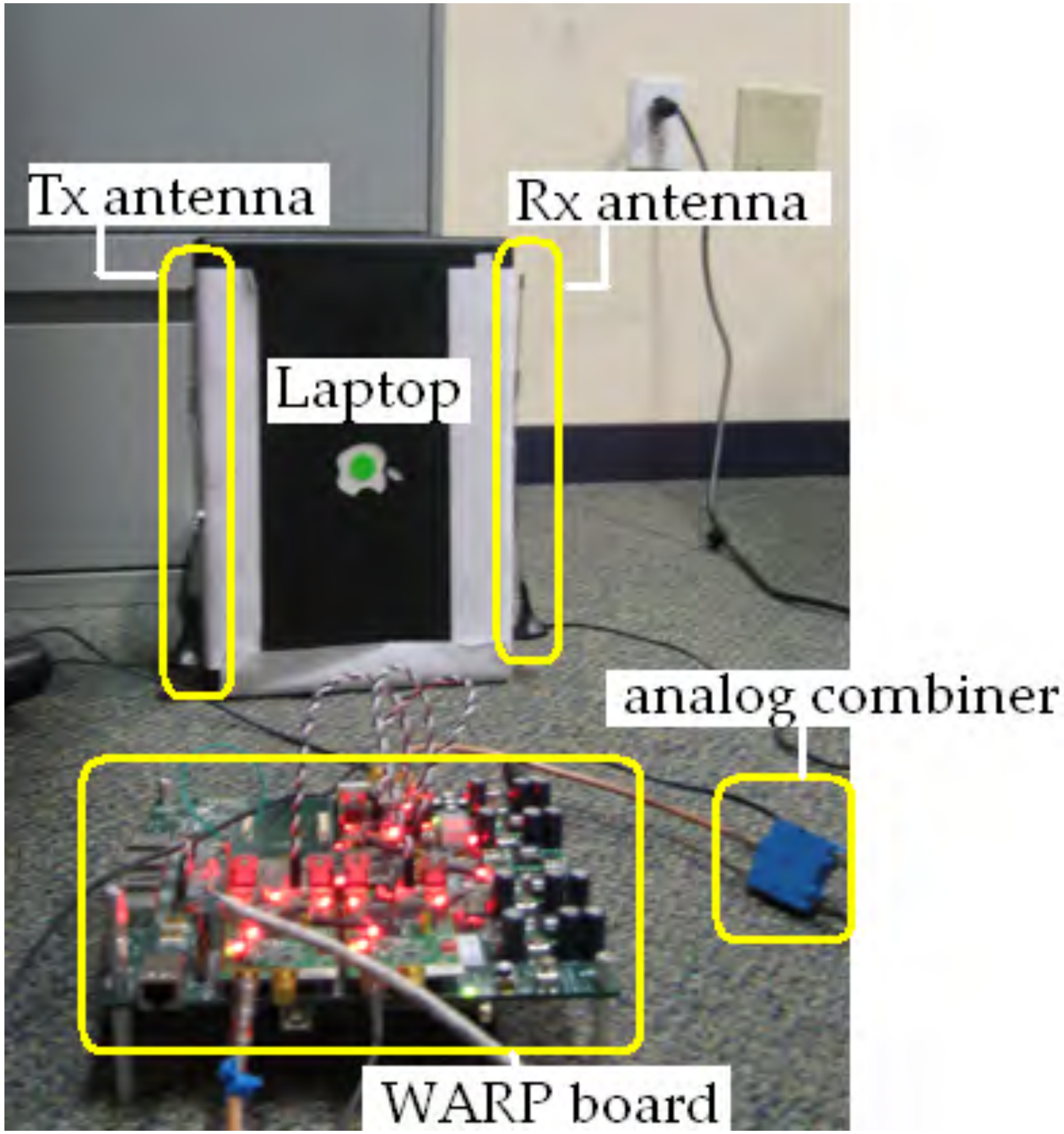
Examples: Full Duplex

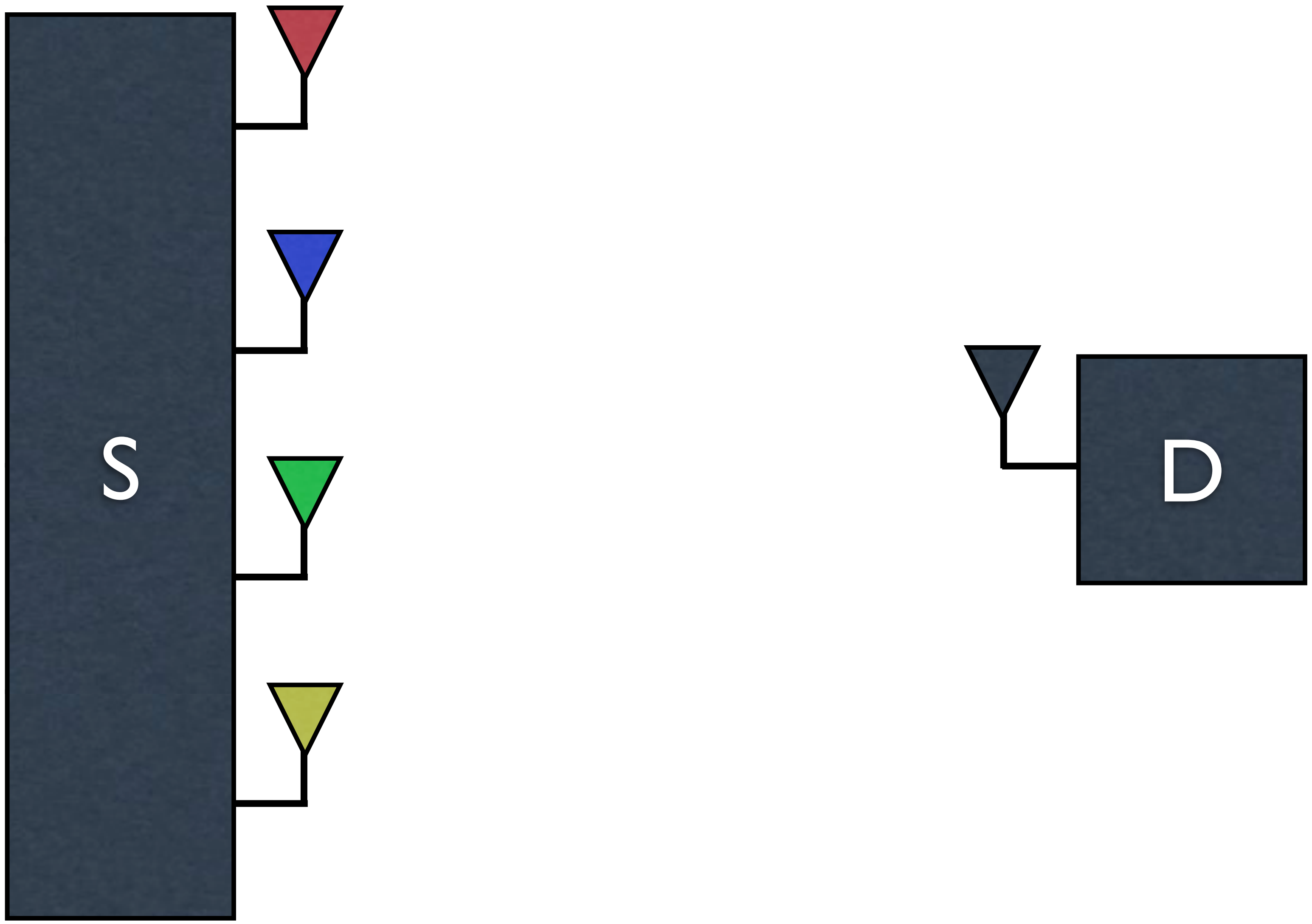


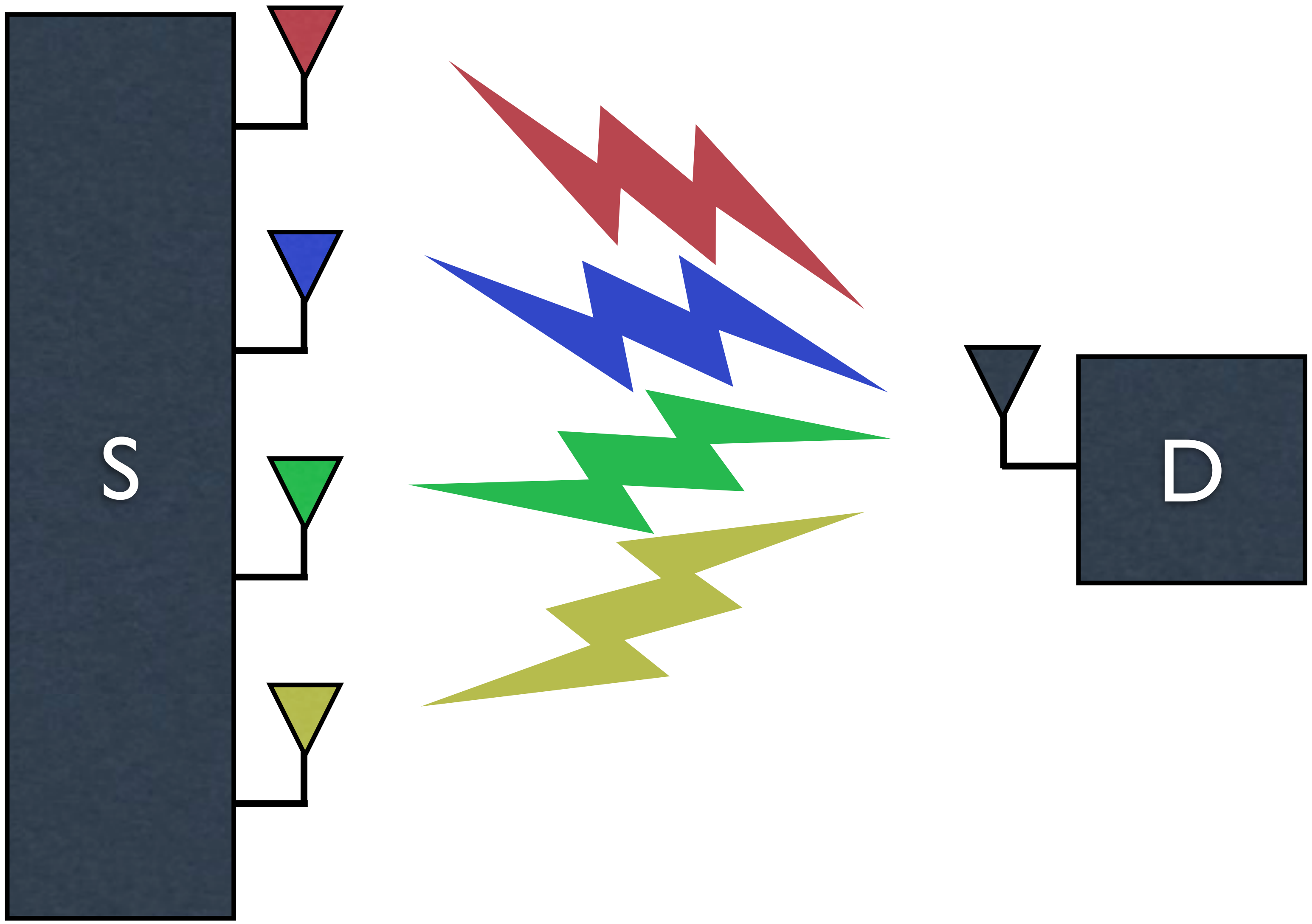
Examples: Full Duplex

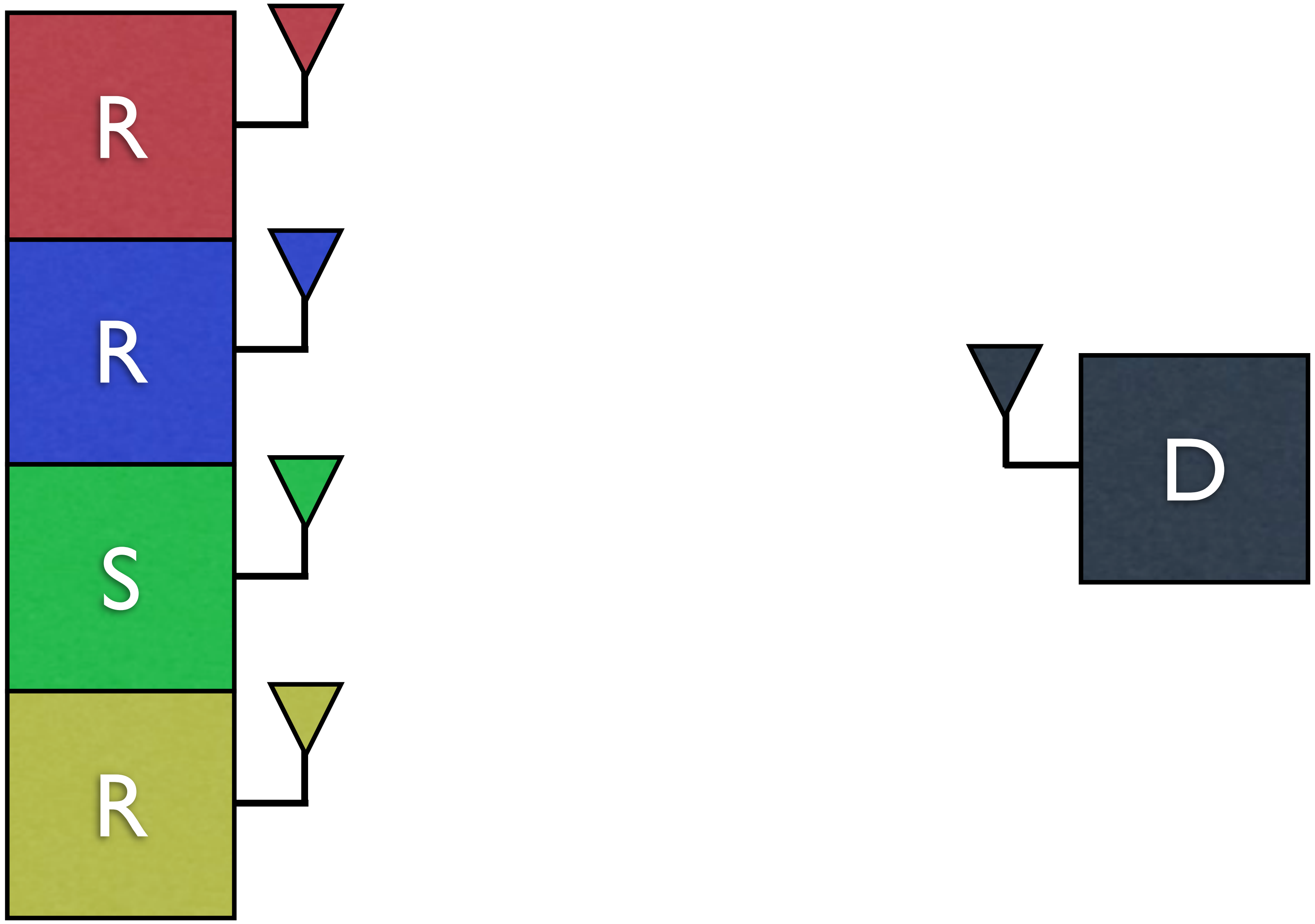
- 2 WARP nodes, each with 3 Radios (2 Tx + 1 Rx)
- 10 MHz OFDM
- Inter-node distance 10m.

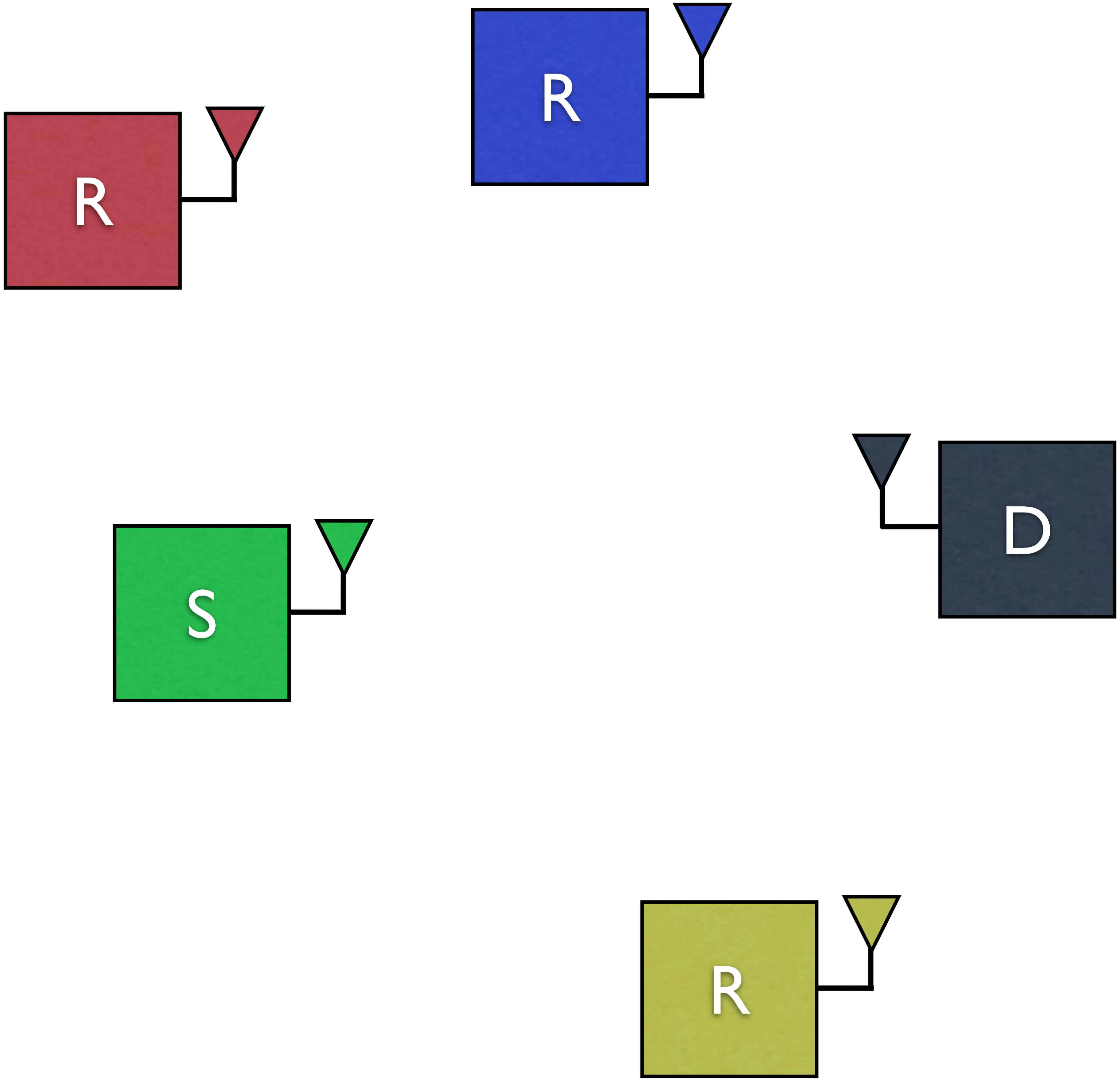
- 80dB self-interference suppression
- 50-70% throughput gain
- *Duarte & Sabharwal, 2010*

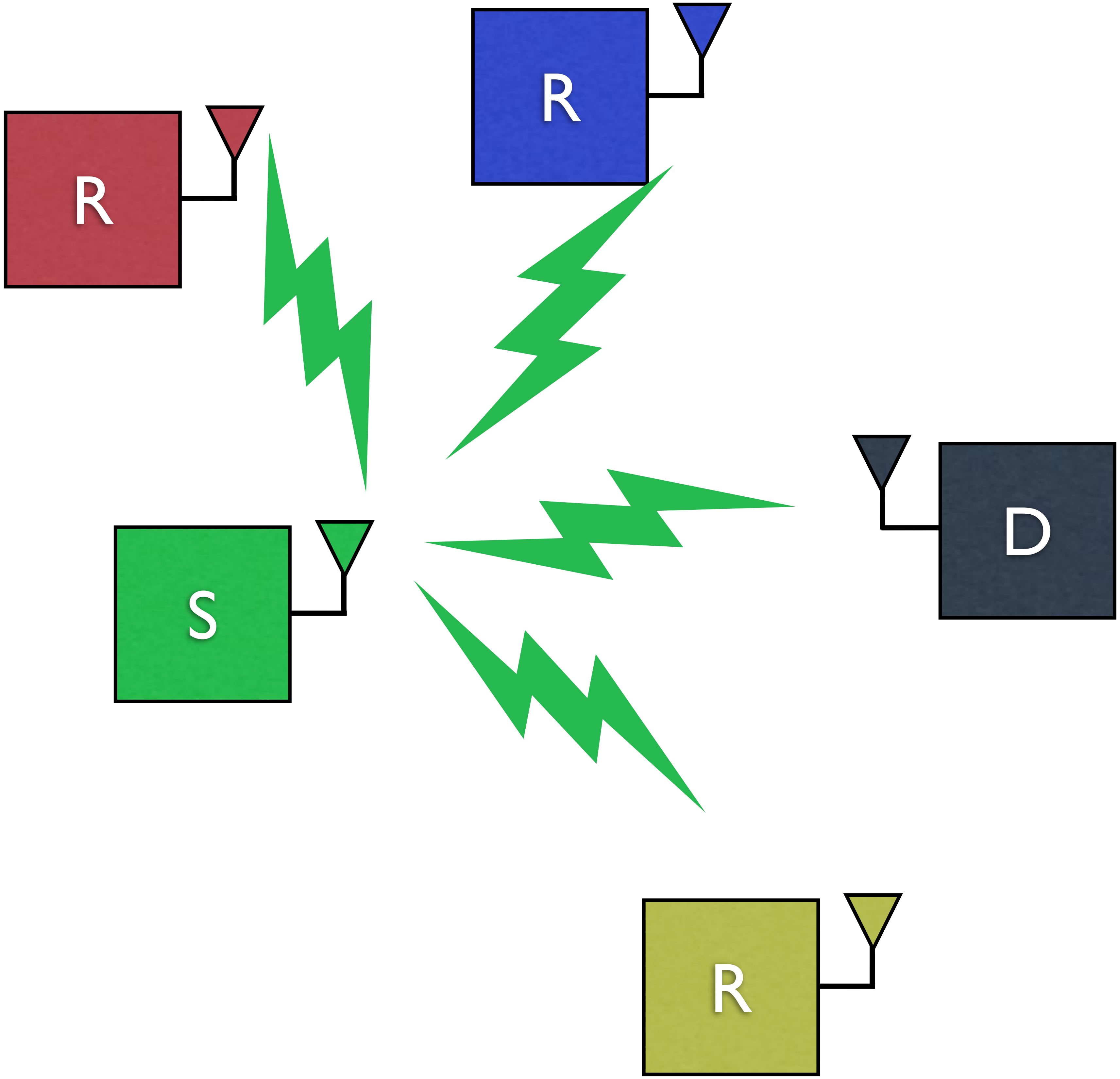


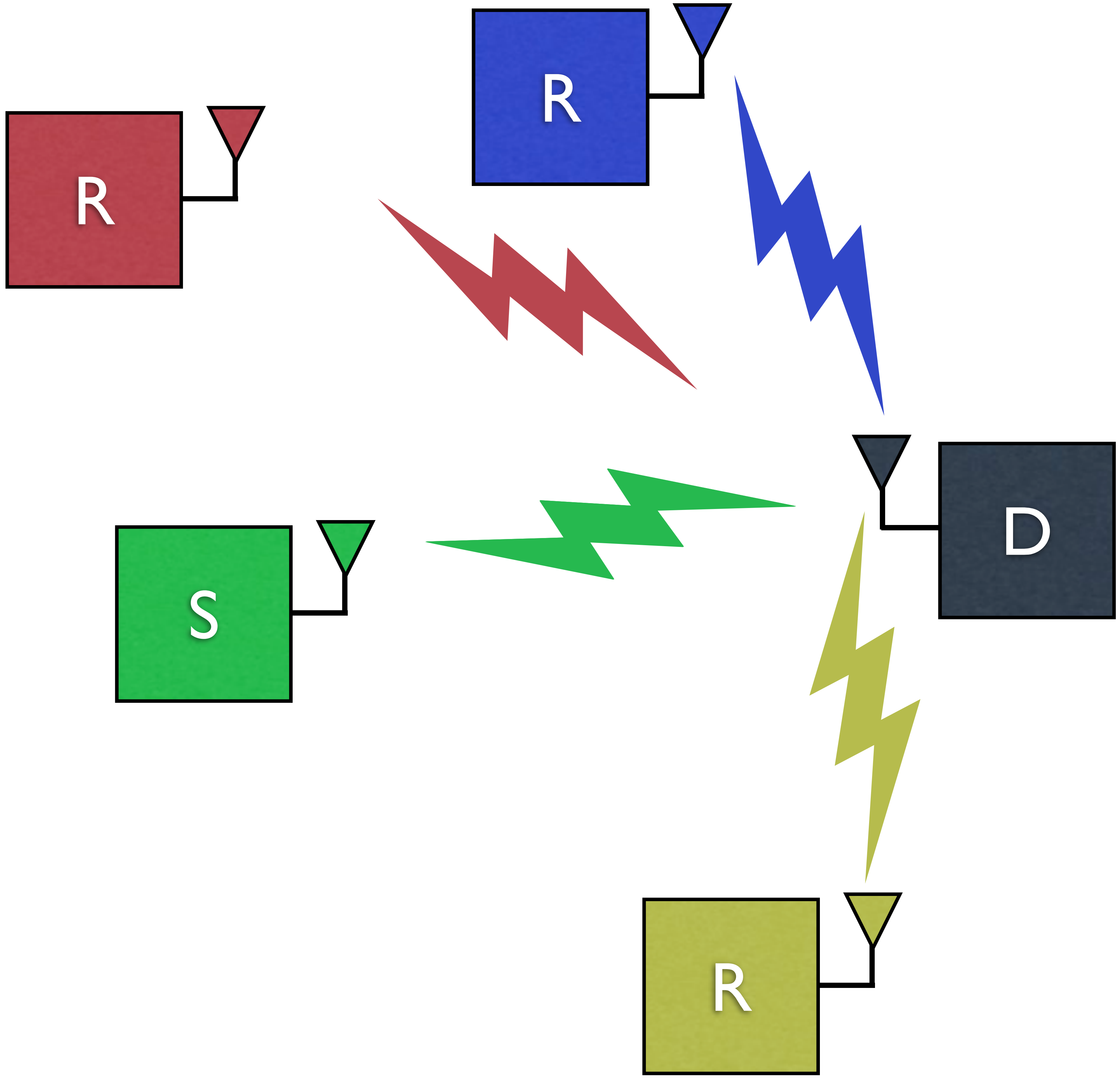

S
D


S
D


R
R
S
R
D

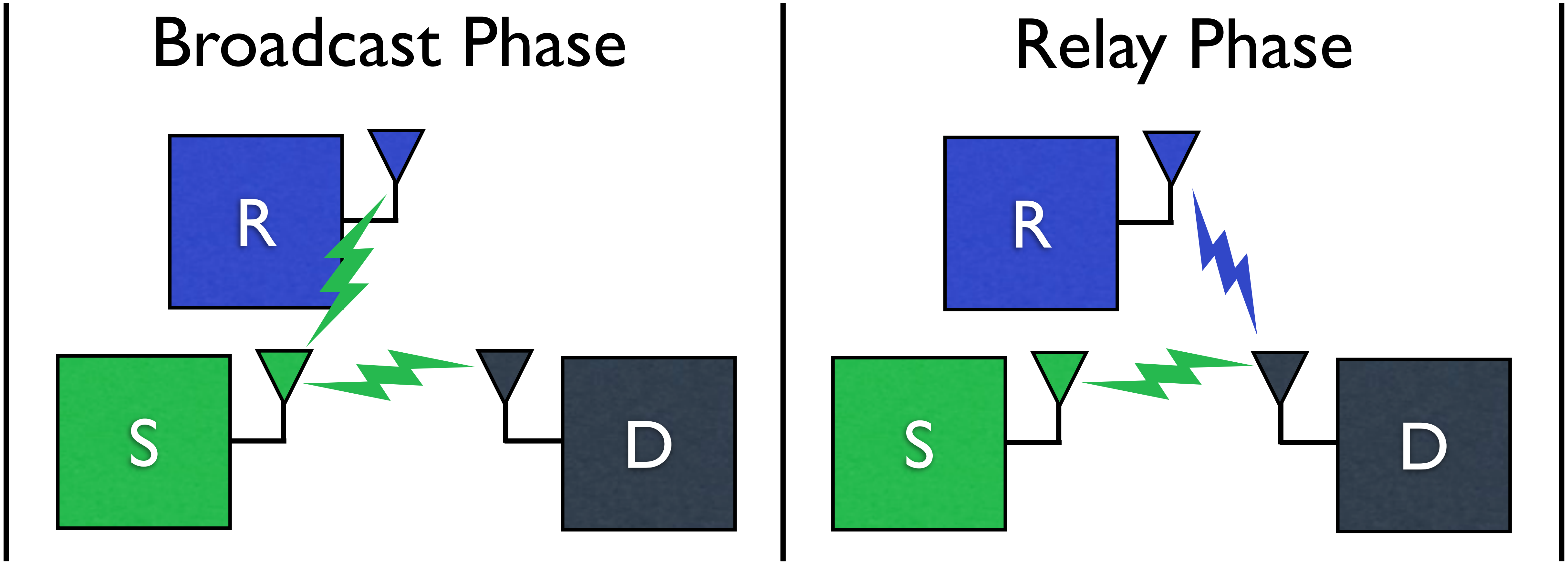

R
R
D
S
R


R
R
D
S
R

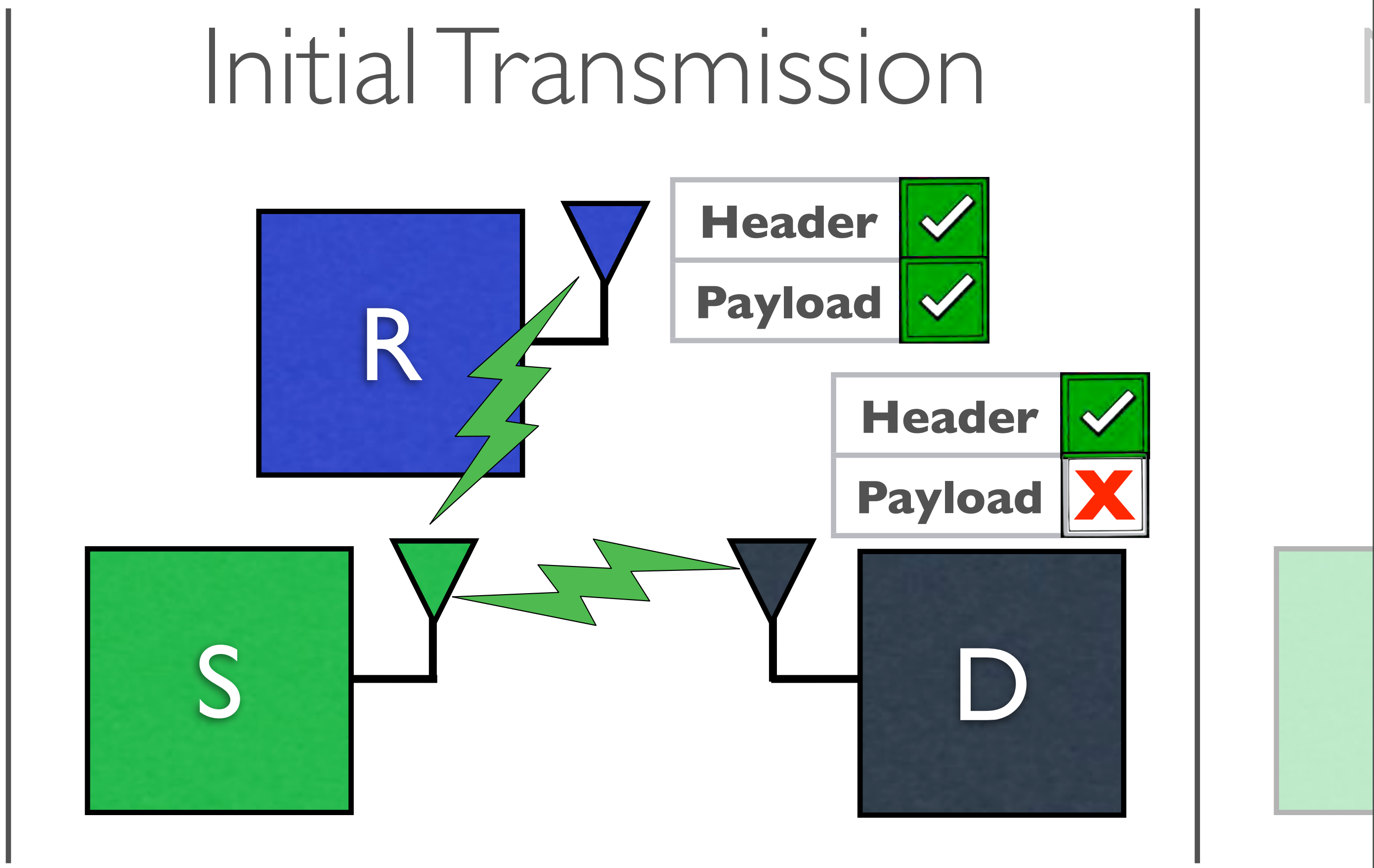


R
R
D
S
R

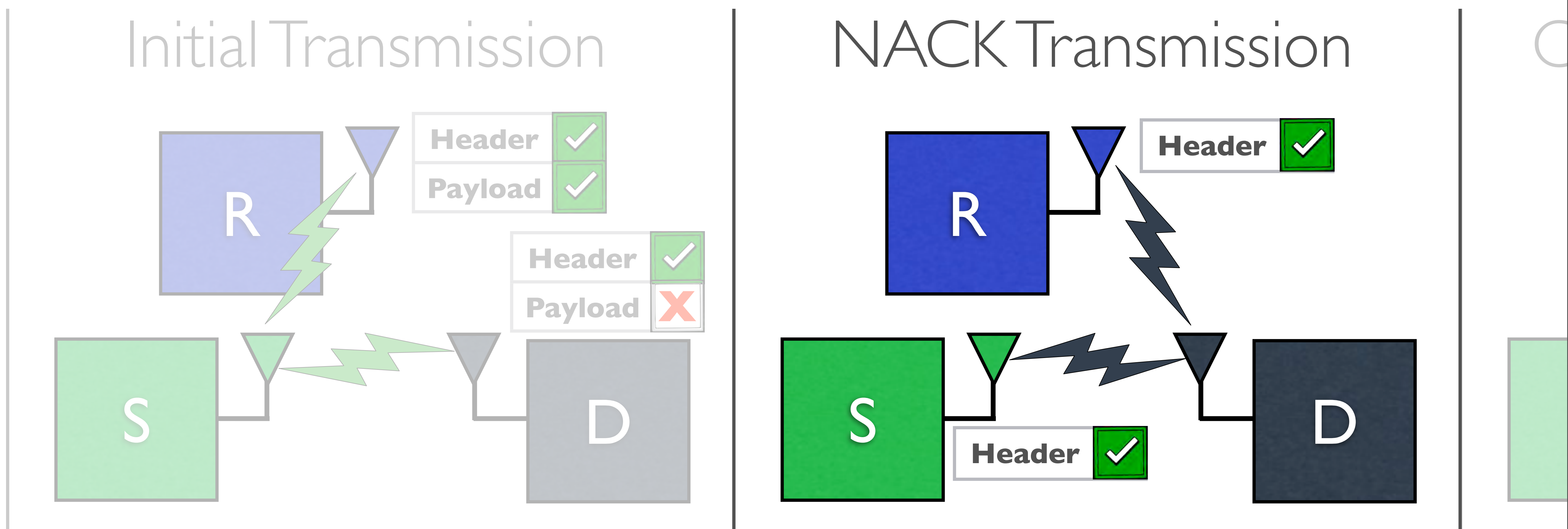
Examples: User Cooperation



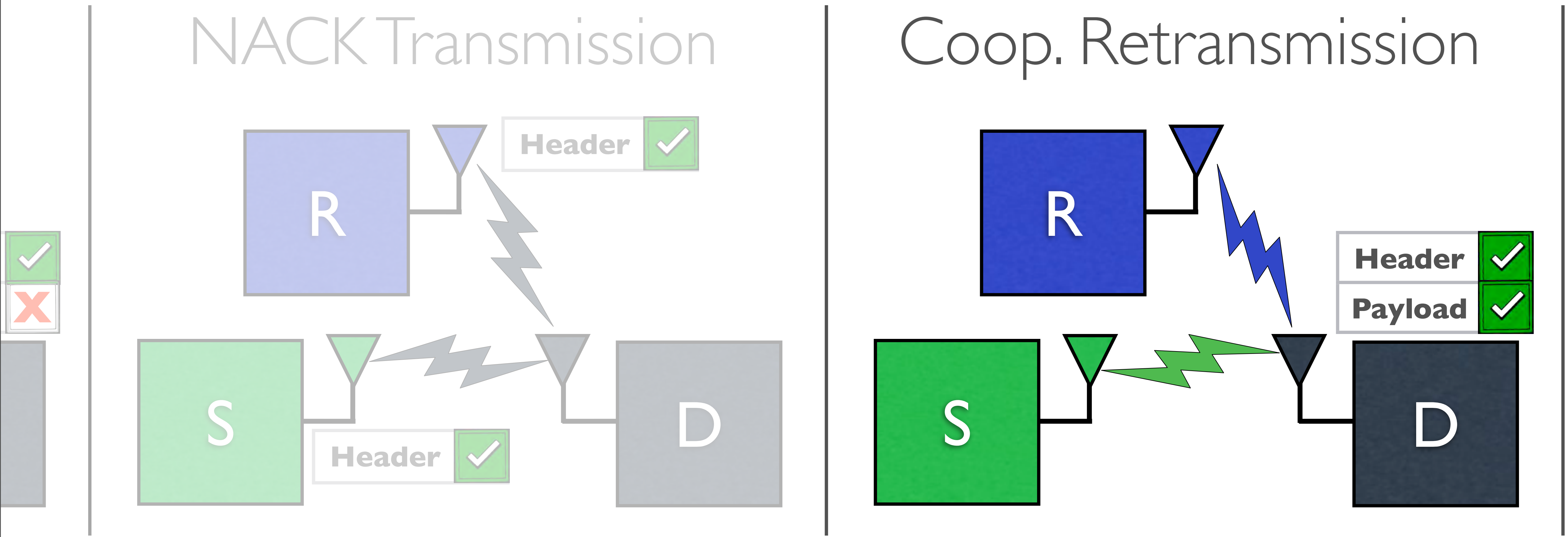
Examples: User Cooperation



Examples: User Cooperation

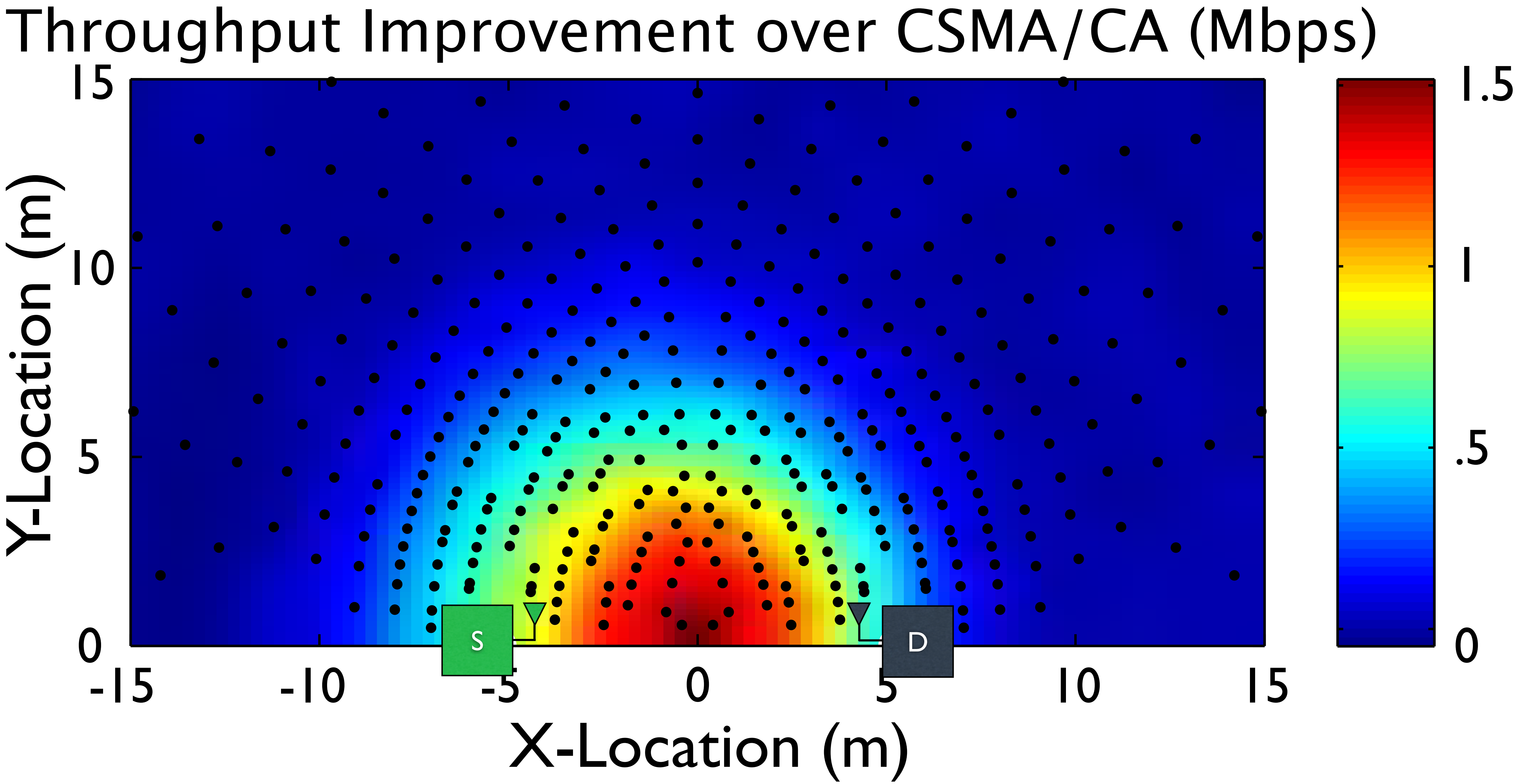


Examples: User Cooperation



On-demand: only cooperates when retransmission would happen anyway

Examples: User Cooperation



warp.rice.edu/papers

- WARP hardware provides resources for next-generation wireless
- WARP platform support provides high-level access to resources
  - WARPLab for PHY prototyping
  - Real-time implementation for real-world timescales
  - WARPnet for network testing

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