Cognitive Wireless Networking With WARP

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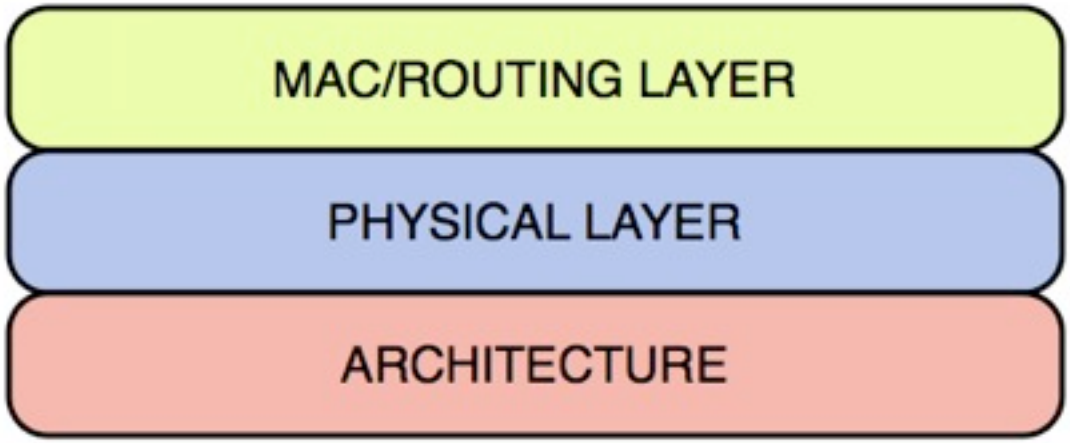
Welcome !

Round of Introductions

- Name
- Affiliation (University, Company etc)
- Research interests


Wireless Open-Access Research Platform
1
2
3

1 Wireless

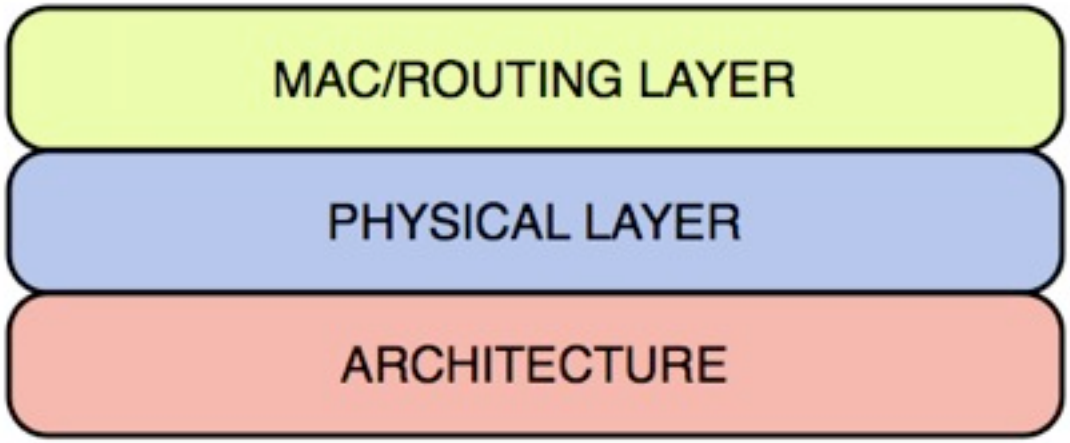


Network Stack

Devices

- Well-understood
- Many successful networks
  - 3G, WiFi, Bluetooth, ….

1 Wireless



- Isolated optimization at each layer has "maxed" out
- Only road forward is cross-layer
- Tons of *theoretical* cross-layer recommending *clean-slate*

1 Wireless

- Clean-slate hard to do
  - Fully operational
  - Real-time
  - At-speed (10-100 Mb/s)

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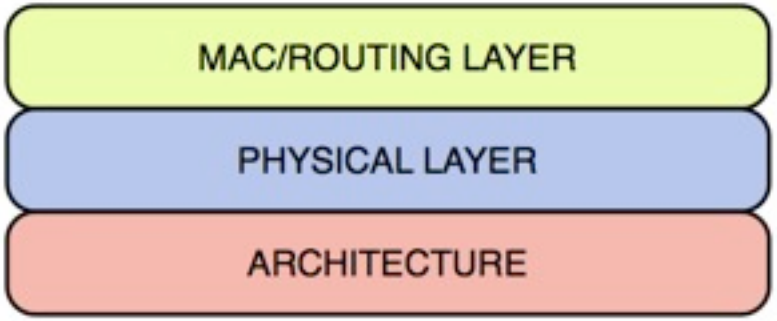
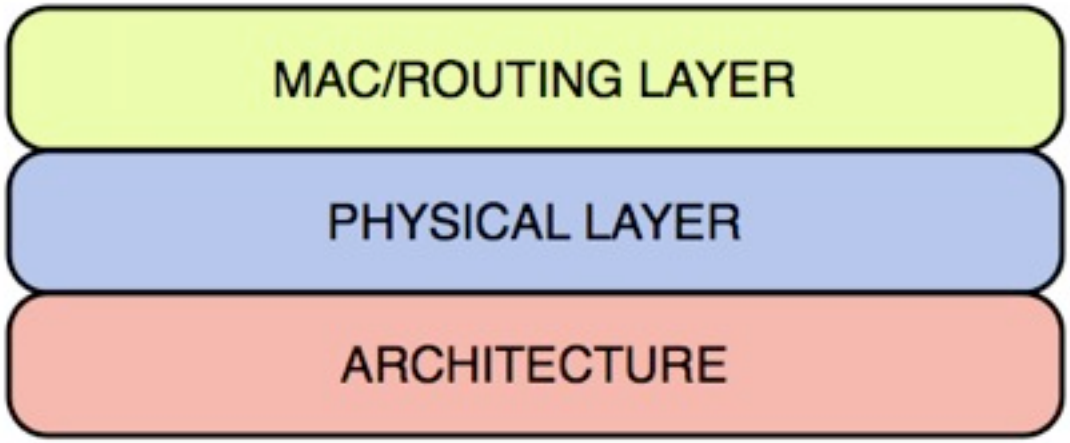


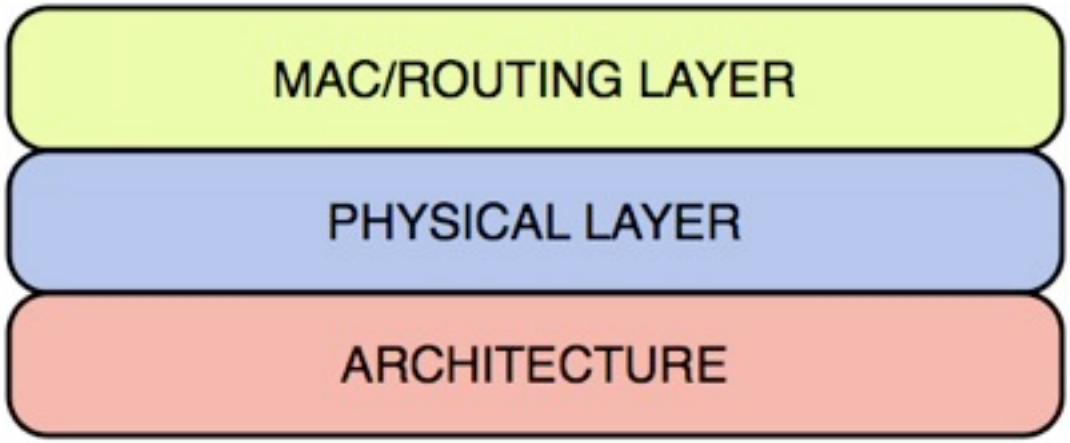
- Designers speak different "languages"
  - Layers use different tools (ns-2, matlab, VHDL,…)
- Full design impossible for a single group

2 Open-Access Research



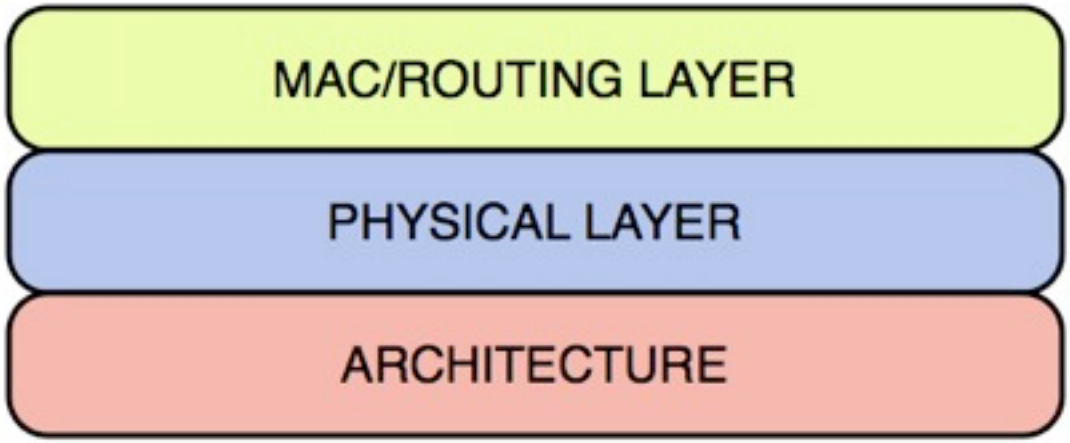
- We are used to open-access at every layer
  - Publish papers (instead of patents)

2 Open-Access Research



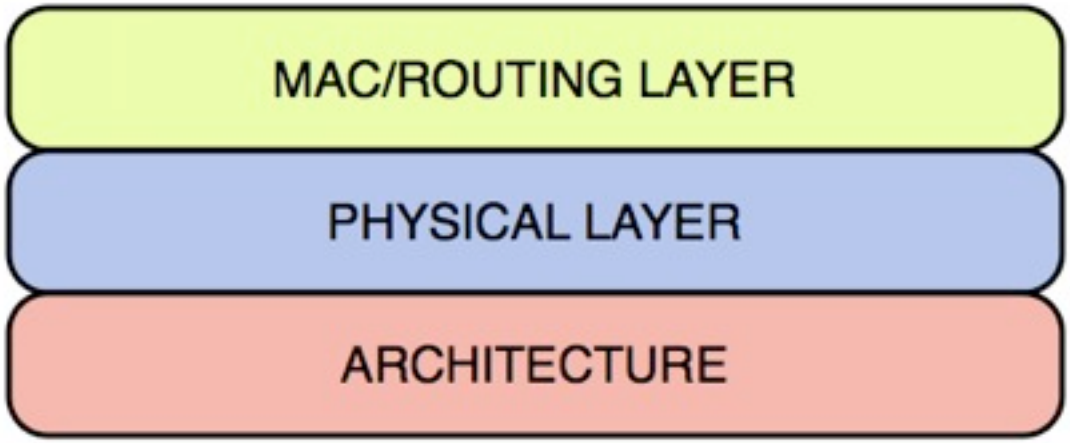
- We are used to open-access at every layer
  - Publish papers (instead of patents)
- We don't do experimental cross-layer
  - Why ?

2 Open-Access Research



- Because we speak different languages

2 Open-Access Research



- Because we speak different languages
- No platforms for *clean-slate* designs

3 Platform

3 Platform

+

3 Platform

+ Linux  + C/C++/Java

3 Platform

+ Linux  + C/C++/Java

= Powerful Applications

3 Platform

Where is the wireless research "computer" ?

3 Platform

\+ WARP +

C/MATLAB/HDL

WARPLab
WARP Real-time
WARPnet

= Clean-slate Designs

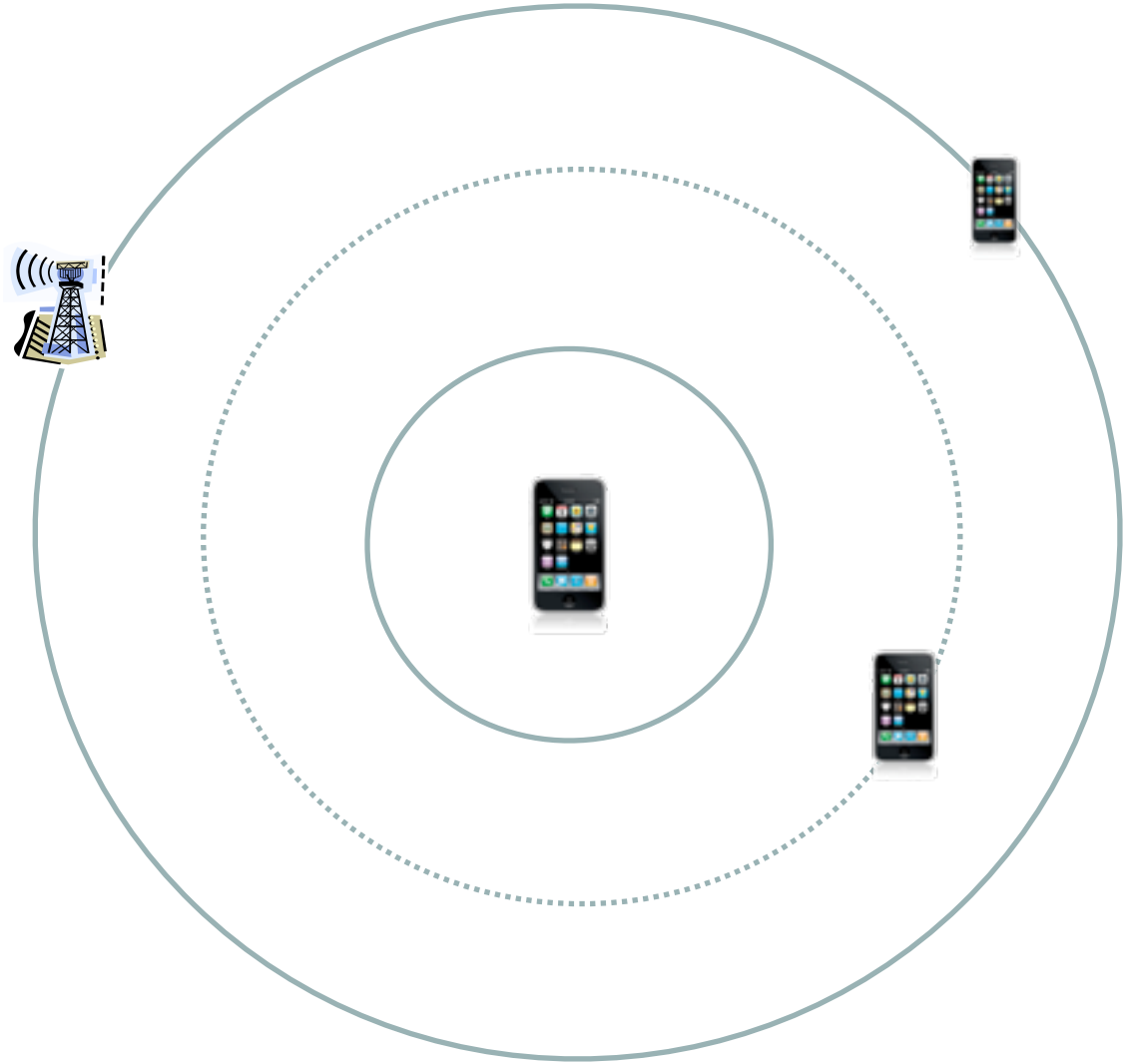
Clean-slate Design Examples

1. Directional on Mobile
2. Single-channel Full-duplex
3. Physical-layer Cooperation

TRUMP: Cognitive Networking - RWTH

- Challenge basic assumptions
- Have to build to show the viability

1. Directional on Mobile



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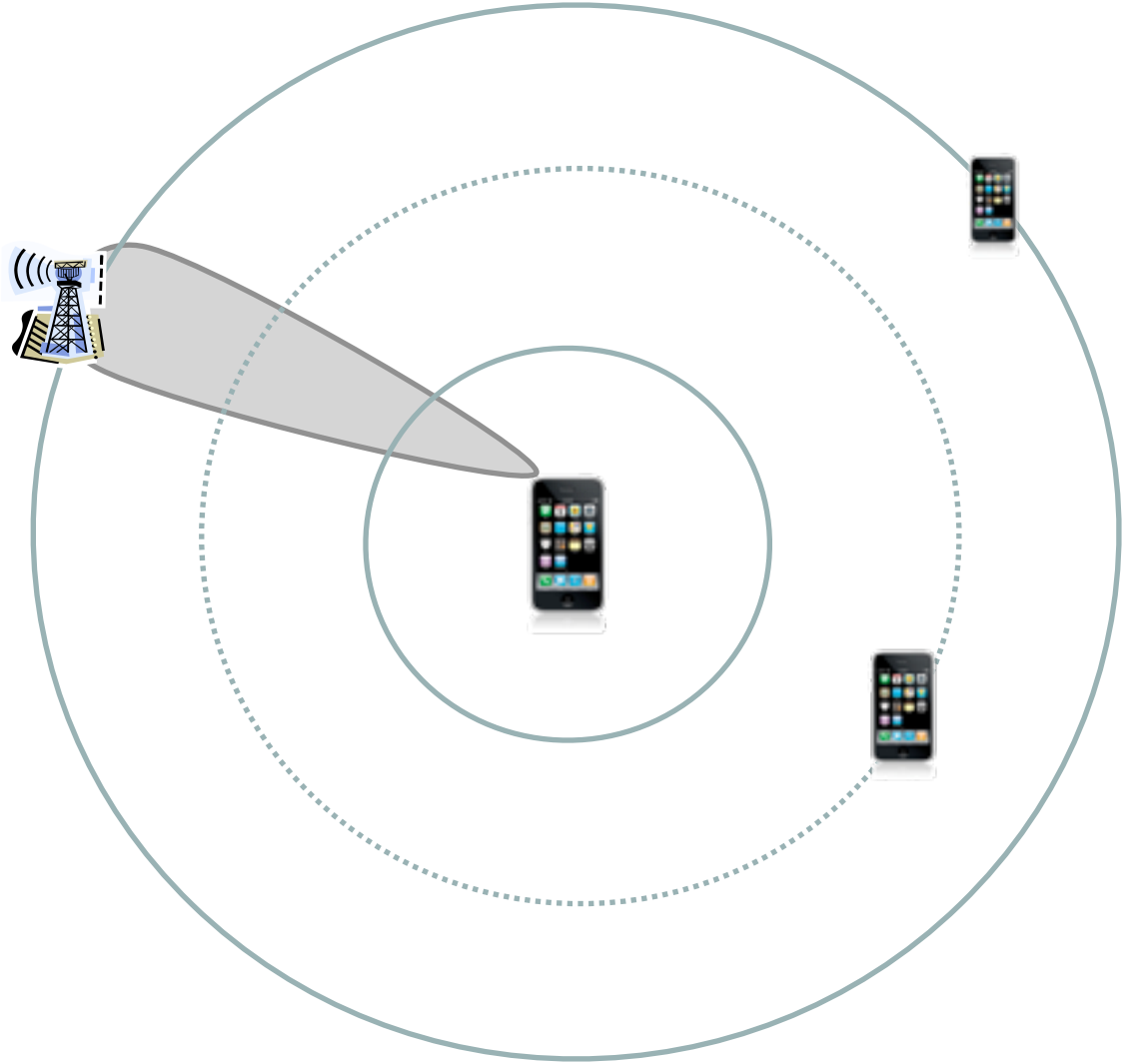
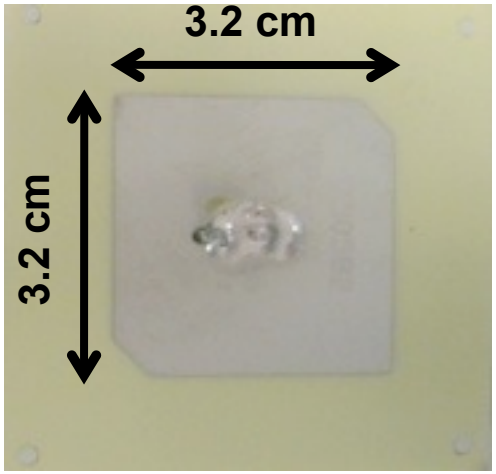
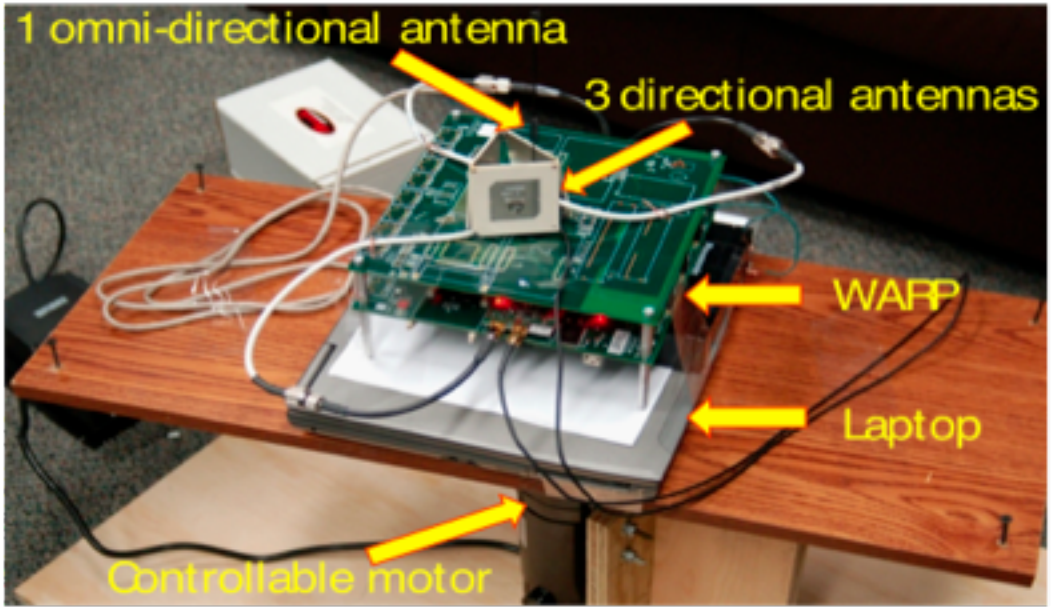


BeamSwitch: Multiple Antennas with Single RF





- 3-5 dB link gain, higher with more antenna patches (*Amiri, Zhong @ Mobicom 2010*)
- Reduced interference → capacity gains with decentralized protocols

Testing Rotational Mobility

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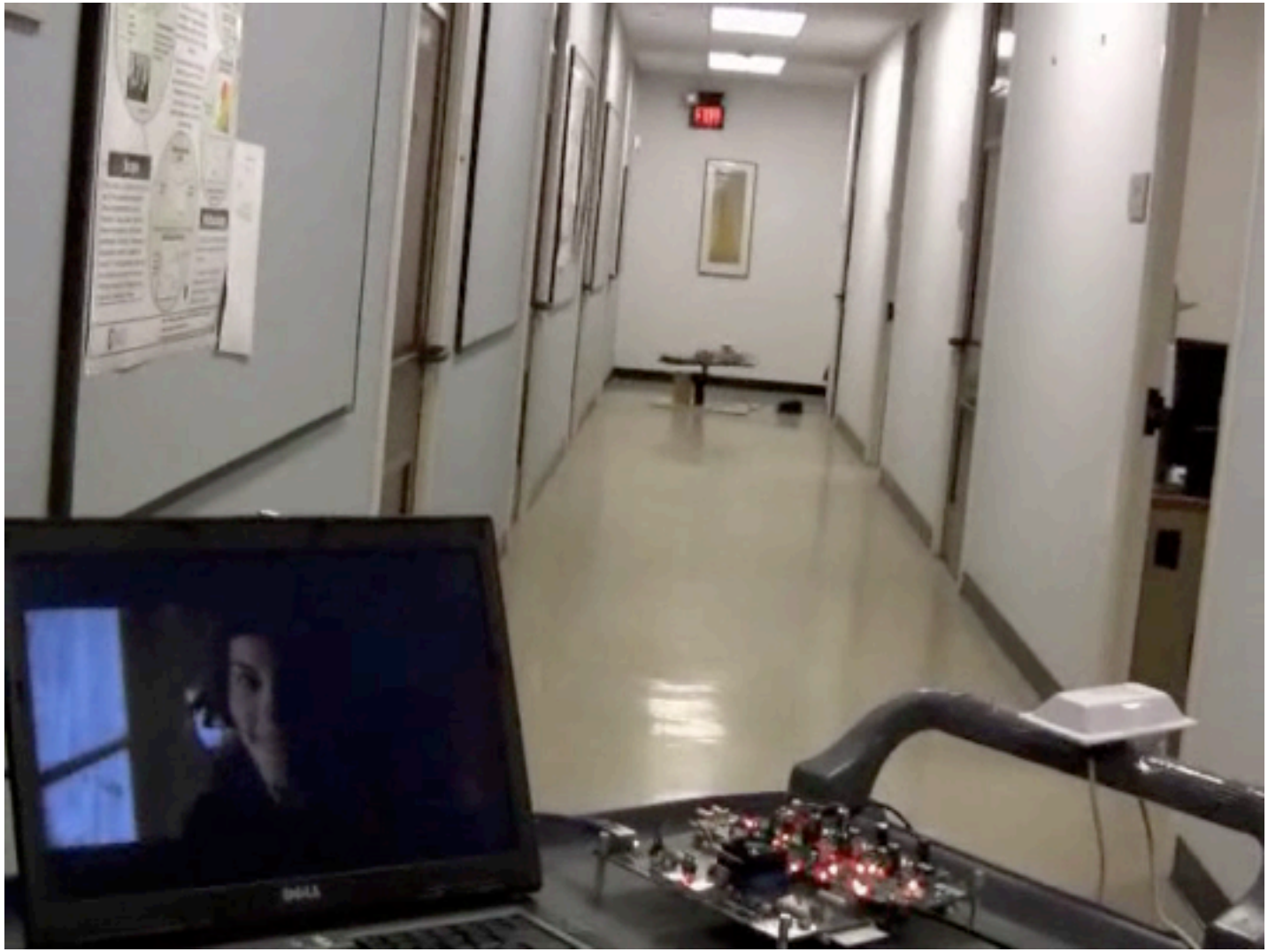
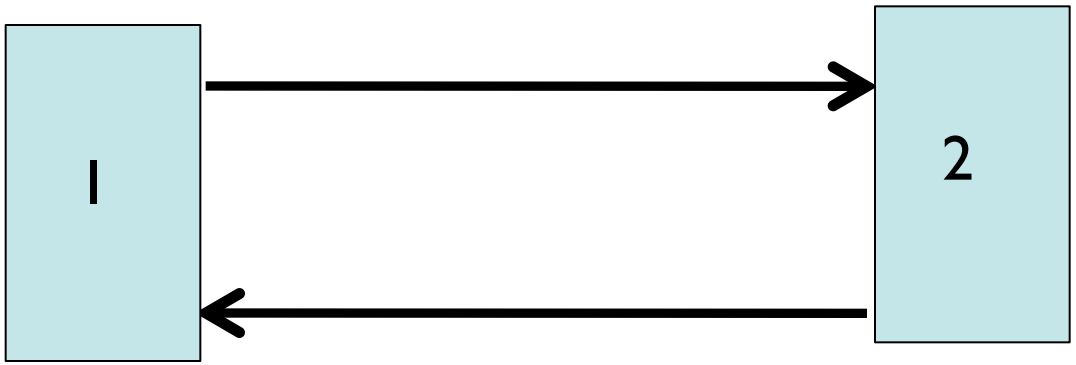


2. Single-Channel Full-duplex Wireless

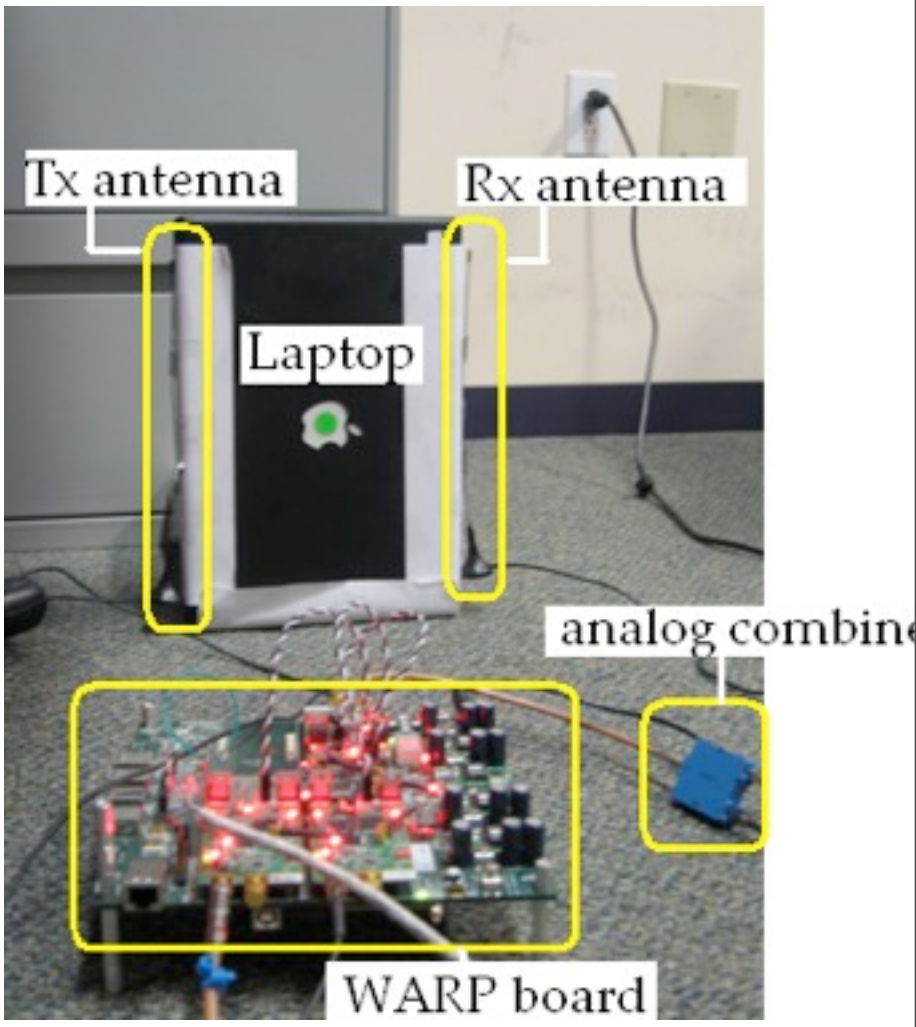


- Same time and same frequency band
- Assumed to be impossible
- Revisit this assumption

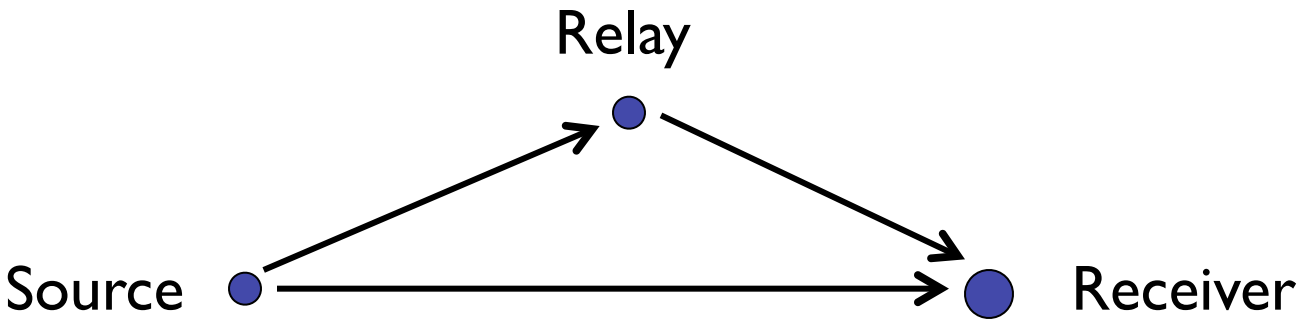
Real-time WARP Implementation

- 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*



3. Cooperative Communication



- Use all channels (all routes)
- Interference is carefully "created," not avoided
- Symbol level cooperation – synchronization huge bottleneck
- Hunter, Murphy, Sabharwal – *CISS 2010, IEEE-VT 2011*

See Live Demo on May 5, DySpan Demo Session

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Platform to a Program

Education

Real "wireless" in wireless curricula

Research

- System-level thinking
- "what if" questions

Collaboration

70+ papers with
> 2 faculty co-authors

Adoption Beyond Rice

- All code-base is open-sourced at http://warp.rice.edu
- In-use at 100+ research groups worldwide
- Facilitated 65+ publications, and quickly growing

Educational Outreach

- 10 workshops (5@Rice, 2@India, Taiwan, Finland, Egypt)
- 11th @ DySpan on May 3, 2011, Aachen, Germany
- 350+ participants

Workshop Goals

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- Expose to important issues, not all
  - Expertise requires experience
- Ask a lot of questions
  - Instructors are creators of WARP and Cognitive-on-WARP
- Do all labs (even if not in your area)
  - Great programmers know hardware
  - Great computer architects know their applications

Post-Workshop

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- More questions ?
  - WARP Repository Documentation
  - WARP Forums

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- Contribute, this is an open-source effort
  - Participate in discussions online, help with knowledge base
  - Contribute code to increase codebase
  - Post data from experiments
  - Share methodology to conduct experiments more efficiently

Agenda

- Presentation: Introduction to WARPLab (Melissa)
- Lab 1: WARPLab
- Presentation: Networking on WARP (Chris)
- Lab 2: MAC Exercise
- Lunch
- Lab 3: (Prelim cognitive) MAC Exercises
- Presentation: Cognitive Network Framework (Junaid)
- Lab 4: TRUMP Exercise

Questions ?

WARP Project - http://warp.rice.edu