



New Jersey Institute of Technology

**CENTER FOR WIRELESS COMMUNICATIONS  
AND SIGNAL PROCESSING RESEARCH**

# Software Defined Radio - Communication Lab



*N. P. M. H. Salem, Prof. O. Simeone, and Prof. A. M. Haimovich*  
(Email: [npy3@njit.edu](mailto:npy3@njit.edu))

April 18, 2013

# Software Defined Radio Team

**Advisors:** Alexander M. Haimovich, *Prof.*  
Oswaldo Simeone, *Prof.*  
Ali Abdi, *Prof.*

**Current Participants:** N. Pelin M. H. Salem, *PhD student*  
Si Yang, *MSc student*  
Mohammad Akhtar, *MSc student*

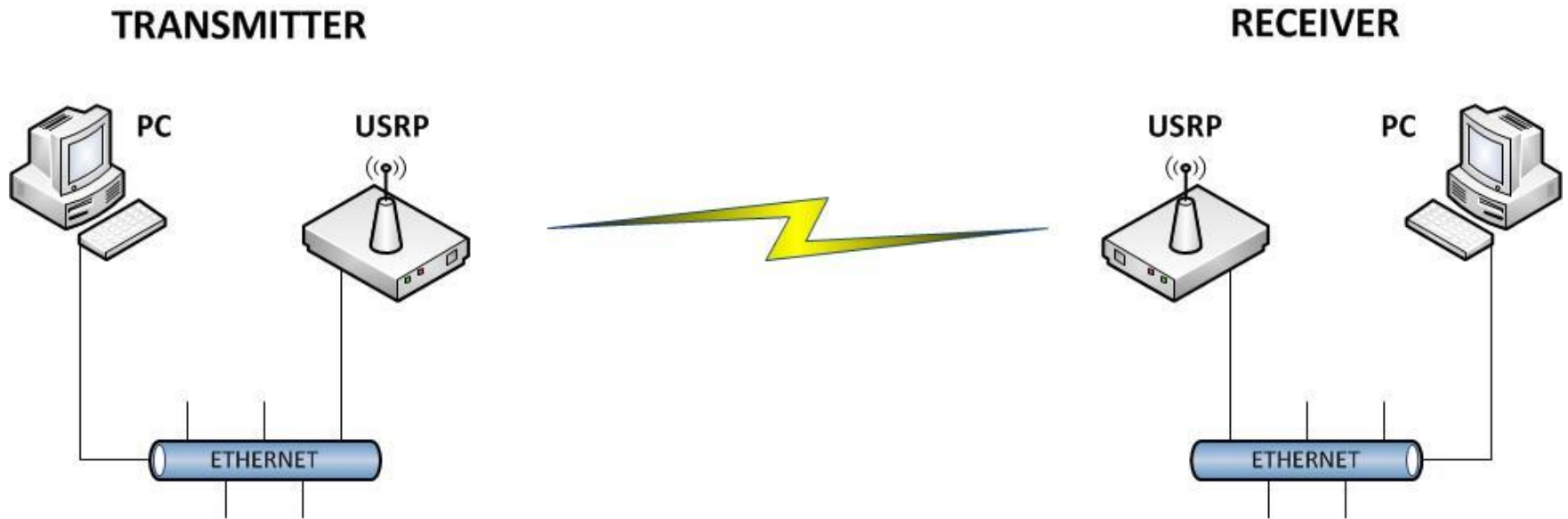
**Technical Support:** Gil Hernandez, *ECE Labs*

**Past Participants:** Charles Beltran, *BSc student*  
Westmore Bowman, *BSc student*  
Nafiseh Farzamfar, *MSc student*  
Reza Golestani, *MSc student*

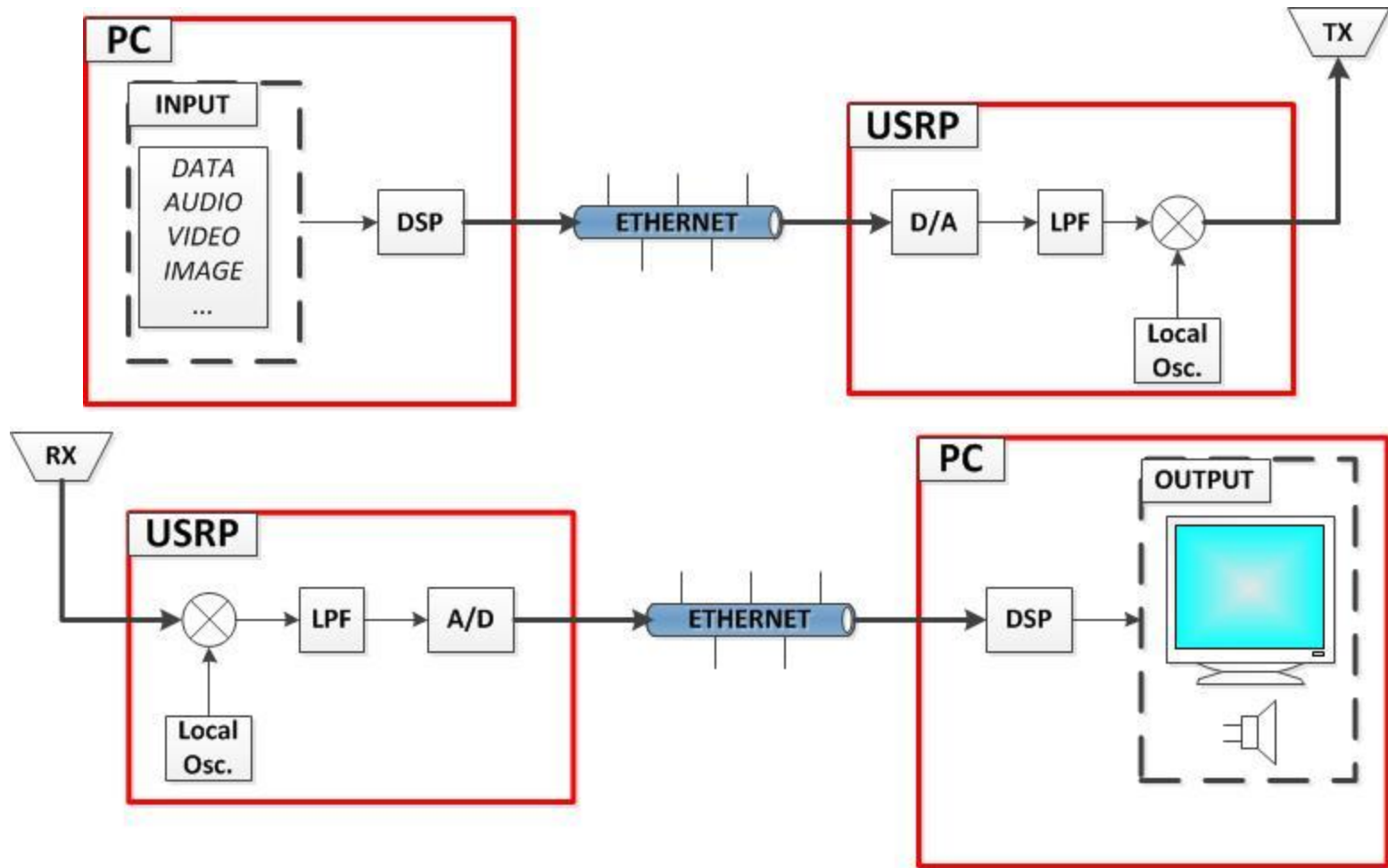
# Overview

- ❑ Software Defined Radio (SDR)
- ❑ Universal Software Radio Peripheral (USRP)
- ❑ Features
- ❑ Prerequisite Knowledge
- ❑ Skills to be Acquired
- ❑ Demonstrations
- ❑ Conclusions

# Software Defined Radio (SDR)



# Software Defined Radio



# Software Defined Radio

## Applications

- ❑ Education (ECE – Communications)
- ❑ Research (Implementing new concepts)
- ❑ Amateur radio (WebSDR, GNURadio, etc)
- ❑ Military (SpeakEasy, JTRS)

# Universal Software Radio Peripheral (USRP)





# Universal Software Radio Peripheral

- ❑ Computer controlled software radios
- ❑ High speed connection (i.e., Gigabit Ethernet or USB)
- ❑ Control software:
  - ❑ LabVIEW (by National Instruments)
  - ❑ MATLAB (by MathWorks)
  - ❑ Third party software (mostly open-source)
- ❑ Inexpensive compared to traditional communication hardware with similar abilities

# Features

- ❑ Hands-on, state of the art approach to undergraduate/graduate communication systems laboratory
- ❑ Currently practiced at only a handful of institutions: Stanford, U of T (Austin), Rutgers, WPI, and ÉPFL
- ❑ Interactively experiment with different digital communication schemes
- ❑ Experiment with different algorithms
- ❑ Acquire the essential knowledge on Software Defined Radio systems

# Prerequisite Knowledge

- Basic knowledge of wireless and digital communications
- Basic knowledge of using block diagrams to represent systems
- Familiarity with flowcharts and block diagrams

# Skills to be Acquired

- ❑ Learn how to use a software which is widely used in industry (LabVIEW )
- ❑ Learn how to form algorithms using block diagrams
- ❑ Gain hands on experience with USRP units
- ❑ Gain hands on experience with a real wireless communication system

# List of Topics

## Under Development

Lab 1 – Introduction to LabVIEW

Lab 2 – Introduction to NI RF Hardware (USRP)

Lab 3 – Modulation and Detection

Lab 4 – Pulse Shaping and Matched Filtering

Lab 5 – Synchronization: Maximum Energy Alignment  
Method

Lab 6 – Synchronization: Early-Late Gate Method

# Demonstration: Lab Preparation

The screenshot shows the NJIT website with the following content:

- Header:** NJIT logo with tagline "THE EDGE IN KNOWLEDGE". Navigation menu includes Popular Links, Calendar, Directory, Offices & Services, Visit NJIT, and Search.
- Sub-header:** Information for: Current Students
- Main Menu:** Home, About, Admissions, Academics, Research, Campus Life, Athletics, Continuing Ed, Career Center, News, Giving.
- Hero Banner:** "MASTER WHAT'S NEXT GRADUATE STUDIES AT NJIT". Text: "GRADUATE OPEN HOUSE THURSDAY, APRIL 11, 2013 5:00PM TO 7:30PM CAMPUS CENTER ATRIUM". Image of a woman.
- News Article 1:** "NJIT's 'Master What's Next' Campaign Awarded Gold". Text: "CN Foundry and NJIT's 'Master What's Next' campaign running on the PATH system received a gold award in the 'Outdoor Transit/Billboard' category at the 28th Annual Educational Advertising Awards sponsored by the Higher Education Marketing Report." Image of a man.
- News Article 2:** "Sandy Recovery: Alternative Spring Break NJIT news from Jersey shore".
- News Article 3:** "He's the Voice of Civil Engineering: Patrick Natale Named Outstanding NCE Alum". Text: "Patrick Natale is one of the nation's leading advocates of civil engineering. As executive director of the American..." Image of Patrick Natale.
- Video Player:** "NJIT Alternate Spring Break - Restore the Shore".

# Demonstration: Image Transmission



CENTER FOR WIRELESS COMMUNICATIONS AND  
SIGNAL PROCESSING RESEARCH

SOFTWARE DEFINED RADIO

# Conclusion

<b>Proposed SDR Lab</b>	<b>Traditional Labs</b>
Reconfigurable, limited by software	Fixed, limited by hardware
Easy to control (graphical development environment)	Requires knowledge specific to the equipment
Simulation before experiment	No simulation
Students have more control	Students have less control
Inexpensive to expand abilities	Expensive to expand abilities



# Conclusion

- ❑ SDR allows to explore different digital communication schemes while using the same hardware.
- ❑ SDR is reconfigurable which allows students to experiment with their own algorithms.
- ❑ User-friendly LabVIEW, a flexible graphical development environment, is used with SDR.

THANK YOU

NJIT

*THE EDGE IN KNOWLEDGE*

QUESTIONS?