The COSMOS Testbed – a Platform for Advanced Wireless, Smart Cities, Edge-cloud, and Optical Experimentation

MERIF Tutorial – Intro to COSMOS
May 23, 2023

The COSMOS testbed design and deployment is joint work with the COSMOS team (www.cosmos-lab.org)
Presenter Intro + Outline

- List of presenters
  - Abhishek Adhikari
  - Jennifer Shane
  - Manav Kohli

- How do you benefit from this tutorial?
  - Go to the wiki
  - Understand high level motivation
  - Try the SDRs
    - Outdoor/indoor at sub-6 and mmWave

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<td><strong>Brief COSMOS Testbed Recap (Abhi)</strong></td>
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<td><strong>Hello World SDR Experiment (Abhi, Jenny, Manav)</strong></td>
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<td><strong>28 GHz mmWave w/ IBM PAAMs in SB2 (Abhi)</strong></td>
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<td><strong>General Q/A (Abhi, Jenny, Manav)</strong></td>
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Signup Instructions

• How many people did not go through the signup instructions?
  • If so, no worries! While we proceed with brief recap of COSMOS, Jenny and Manav will go around and help get you set up

https://wiki.cosmos-lab.org/wiki/Workshops/MERIF2023/SignupInstructions
Developing Future Wireless Networks

Researchers’ objective: design, prototype, and evaluate technologies for the wireless edge to enable novel modes of interaction between city residents and the urban environment.

- Millimeter-wave
- Multi-antenna
- Edge cloud

Networking & communications

Transportation systems

Environmental monitoring

Internet-of-Things (IoT)

NSF PAWR COSMOS wireless testbed in West Harlem, NYC

Full-duplex

Optical x-haul

NSF Platforms for Advanced Wireless Research

Courtesy of Columbia Engineering
Columbia Large Node (lg1)

Large antenna

RF front ends and fiber to large sector

Large sectors

s1

s2

s3

Software-defined radios (SDRs)
Columbia Medium Nodes (md1 and md2)

200-level (Amsterdam Ave.)

100-level (West 120th St.)

Medium antenna with GPS

Medium node coverages

Live camera view
CCNY Large and Medium Nodes (md3 and md4)
Key Technology: Software-Defined Radios

- Sub-6GHz RF Front End
- Power Supply & Management
- USRP N310 (Krypton)
- RF Cables Passthrough (to Tx/Rx Antennas)
- USRP-2974 + USRP N310
- Fiber & Power Passthroughs
- Medium-light node (lightpole-mounted)

- Eth Switch & Chassis Manager
- Optical MUX/DEMUX
- A large node sector or a medium node

- TX/RX Antennas
- RF Front End, RoF
- Small portable
- Hand-held
- Small mobile node
Key Technology: mmWave

• Programmable mmWave front ends with different baseband options:
  - IBM 28 GHz 64-element PAAMs
    - Integrated in Sandbox 1 and 2
    - Up to ~500 MHz bandwidth using the Xilinx UltraScale+ RFSoC platform
    - Experiment with adaptive beamforming and mmWave MIMO communications
  - Sivers IMA 60 GHz WiGig transceiver

• End-to-end mmWave systems:
  - Facebook Terragraph 60 GHz radios
  - InterDigital 28 GHz 5G NR platform
  - InterDigital 60 GHz EdgeLink nodes

Key Technology: Optical Networking

Data Center @ Columbia

- Patch panel
- Fiber spools
- Top of rack switches
- Space switch and ROADMs
- Compute servers
- Fiber spools

Add/Drop ROADMs
Calient S320 optical space switch
Edgecore Cassini Switch & Lumentum 200G Transceivers
Lumentum Transmission ROADMs & Line Amplifiers plus fiber
Telemetry Instruments

Plumaers for Advanced Wireless Research

- Mininet-optical simulator

Platforms for Advanced Wireless Research

- SDN Controller (ONOS)
- NETCONF
- OpenFlow

32 Avenue of the Americas (32 AoA)

- Deployed
- Ongoing
- Planned

Silicon Harlem
City College
Columbia