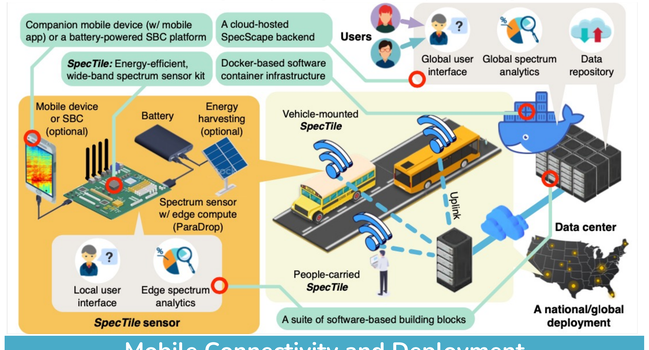
Enabling a Global Spectrum Observatory through Mobile, Wide-band Spectrum Sensing Kits and a Software Ecosystem

Suman Banerjee, Younghyun Kim, Bhuvana Krishnaswamy (UW-Madison)
Dinesh Bharadia, Aaron Schulman (UC San Diego)

Project supported in part through the US National Science Foundation award # 2213688 & 2213689

Introduction

SpecScape is creating an ecosystem of global, wide-band spectrum sensing

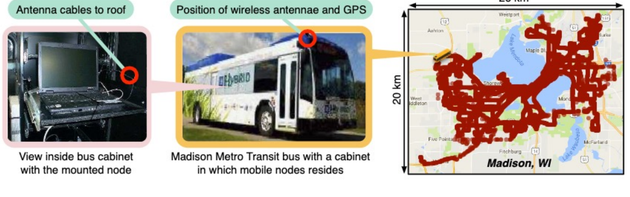


Mobile Connectivity and Deployment

SpecTile hardware connected to the Tablet.

Deployment on the vehicle.

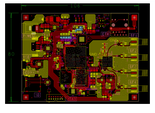
Prior preliminary trial of deploying a stand-alone high-end spectrum analyzer on a Madison bus



View inside bus cabinet with the mounted node

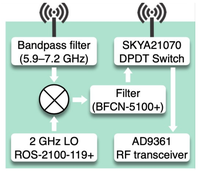
Madison Metro Transit bus with a cabinet in which mobile nodes resides

SpecTile Sensor Design



Frequency: 40MHz – 8Ghz
Bandwidth: 56MHz
1Gbps Ethernet PHY
USE 3.2
USB OTA interface
ZYNQ 7020

Front-end Design for 6GHz-8GHz

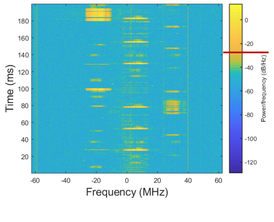


SpecTile Features
Wideband Front End
More program logic (FPGA)
Heterogeneous Computing Processor
Built-in Edge Computing Support

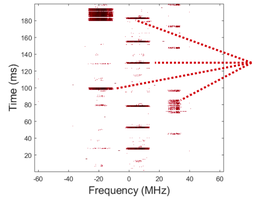
	RTL-SDR	LimeSDR	BladeRF	SpecTile
Frequency range	22 MHz –2.2 GHz	10 MHz –3.5 GHz	300 MHz –3.8 GHz	**70 MHZ –8 GHz**
RF Bandwidth	3.2 MHz	30.72 MHz	40 MHz	**56 MHz**
Sample depth	8-bit	12-bit	12-bit	12-bit
Sample rate	3.2 MSPS	61.44 MSPS	40 MSPS	61.44 MSPS
Duplex	No	Yes	Yes	**Yes**
Interface	USB 2.0	USB 3.0	USB 3.0	**USB 3.0 OTG**
On-board edge compute	No	No	No	**Yes**

Signal Detection

Spatial Sparsity



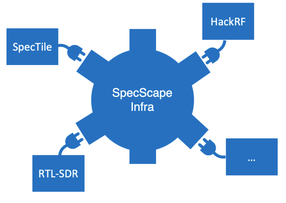
SparSDR



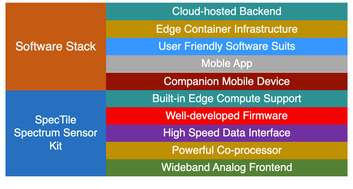
Only backhaul and compute **active signals**

Infrastructure and ToolKits

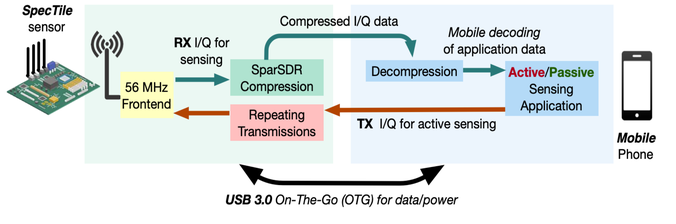
SpecSpace Infra is open to a variety of spectrum sensors



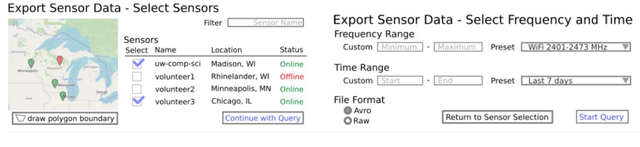
Hardware and software stack of SpecScape ToolKits



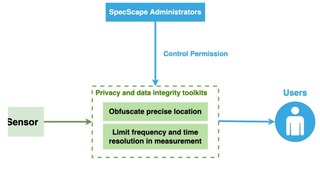
SpecScape Data Collection Infra



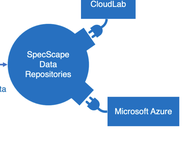
Access interface to generate spectrum data from various SpecTile



Privacy and Data Integrity

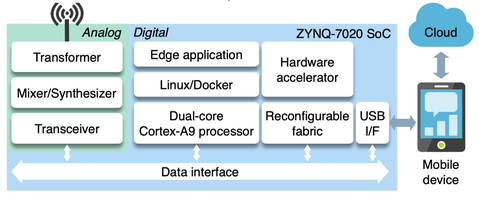


Data Repositories

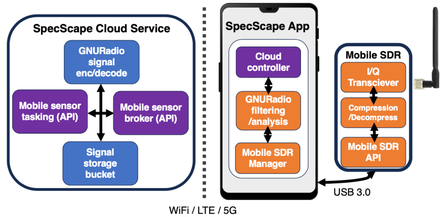


Implementation Overview

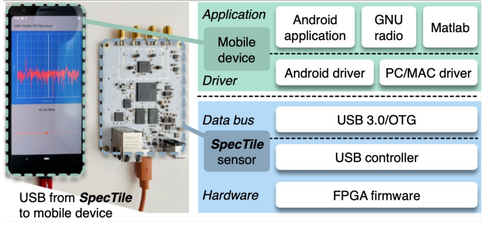
Hardware Implementation



Software Implementation



Software-Hardware Co-Design



USB from **SpecTile** to mobile device

Publication

1. Yilong Li, Yijing Zeng, and Suman Banerjee. 2021. Enabling Wideband, Mobile Spectrum Sensing through Onboard Heterogeneous Computing. In Proceedings of the 22nd International Workshop on Mobile Computing Systems and Applications (HotMobile '21). Association for Computing Machinery, New York, NY, USA, 85–91.

2. Yijing Zeng, Varun Chandrasekaran, Suman Banerjee, and Domenico Giustiniano. 2019. A Framework for Analyzing Spectrum Characteristics in Large Spatio-temporal Scales. In The 25th Annual International Conference on Mobile Computing and Networking (MobiCom '19). Association for Computing Machinery, New York, NY, USA, Article 49, 1–16.