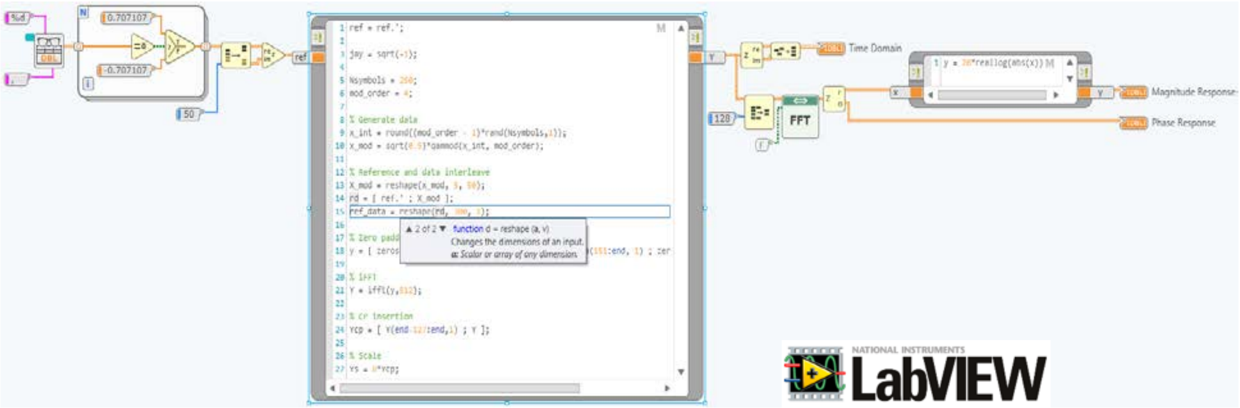
Prototyping Next Generation Wireless Systems with Software Defined Radio



Erik Luther
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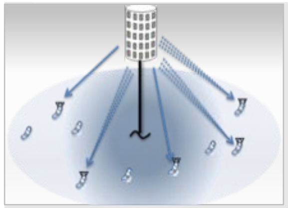
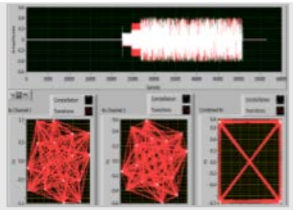
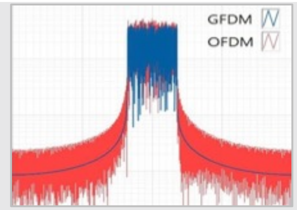
Product Marketing
Software Defined Radio

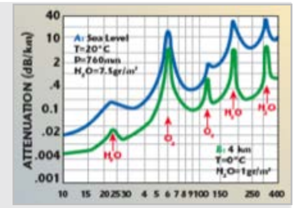
Platform-Based Design for 5G


Massive MIMO


Wireless Networks



Cognitive Radio



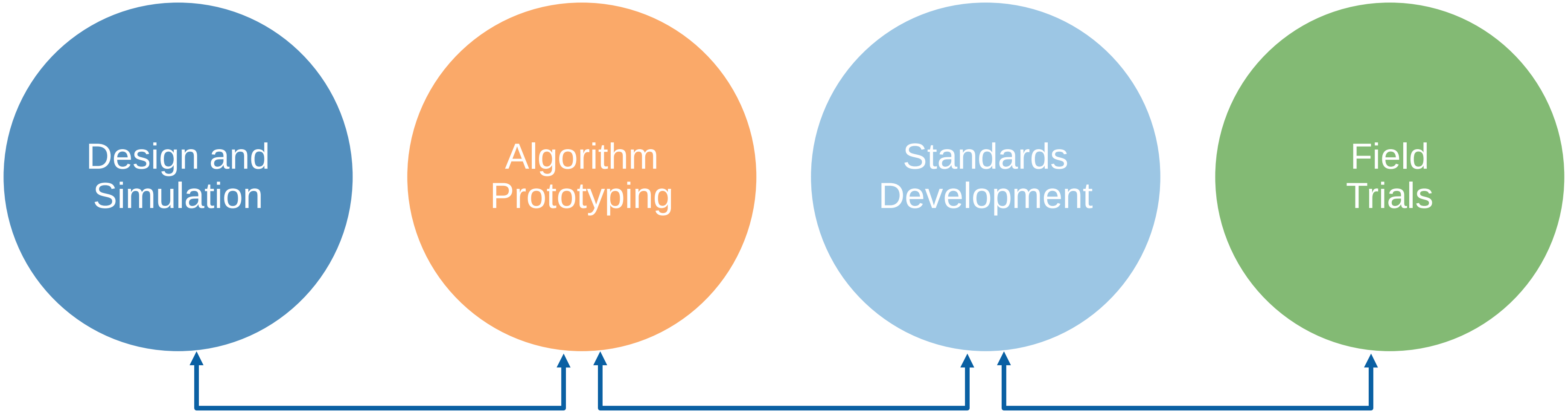
mmWave

Unified Design Software

Hardware Implementations

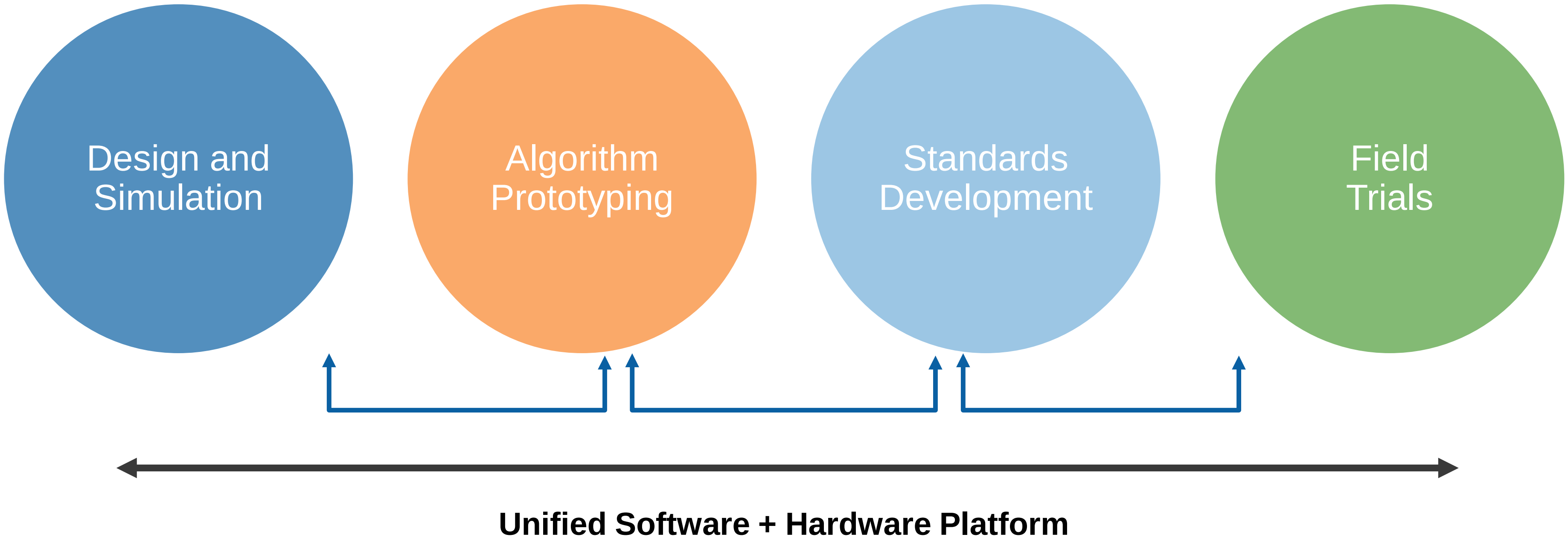
Technology Development Lifecycle

Common tools for rapid iteration of real-time prototypes

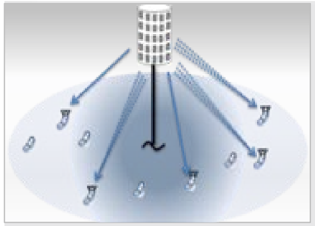


Technology Development Lifecycle

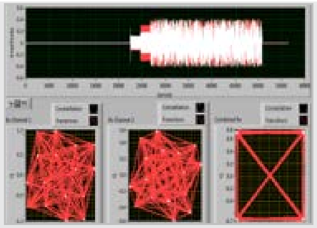
Common tools for rapid iteration of real-time prototypes



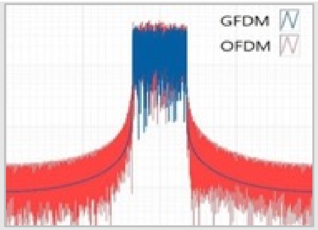
Platform-Based Design



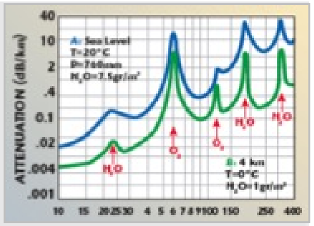
Massive MIMO



Wireless Networks



Cognitive Radio



mmWave

NATIONAL INSTRUMENTS LabVIEW™

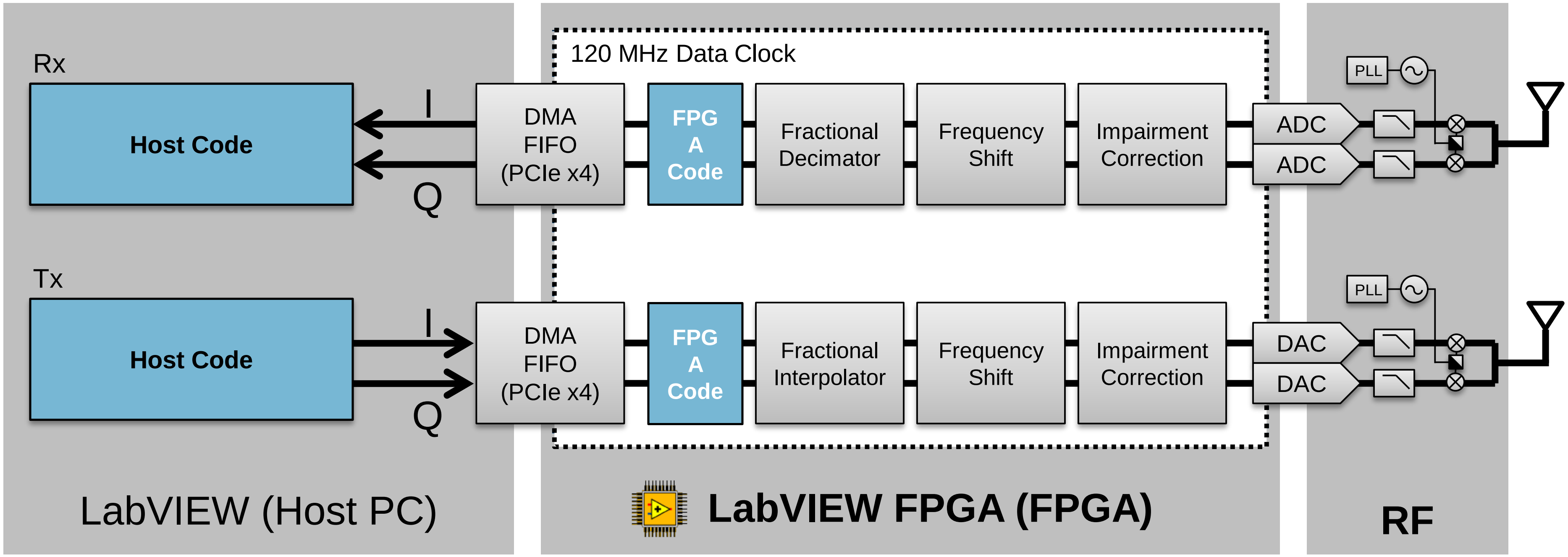
Reconfigurable Instruments

High Performance IO

Software Defined Radio

mmWave Prototyping

NI USRP RIO Driver Software (Host + FPGA)



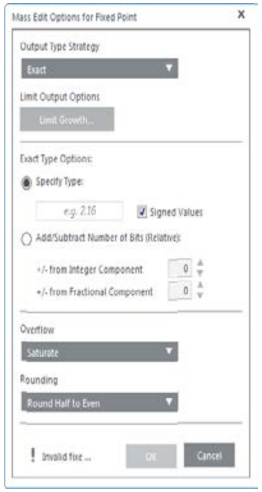
PC or Laptop

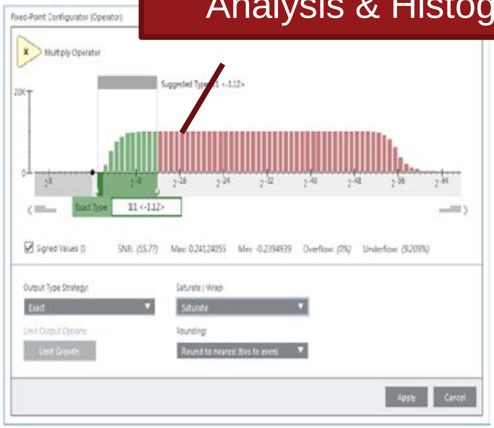
Cabled PCIe

USRP RIO

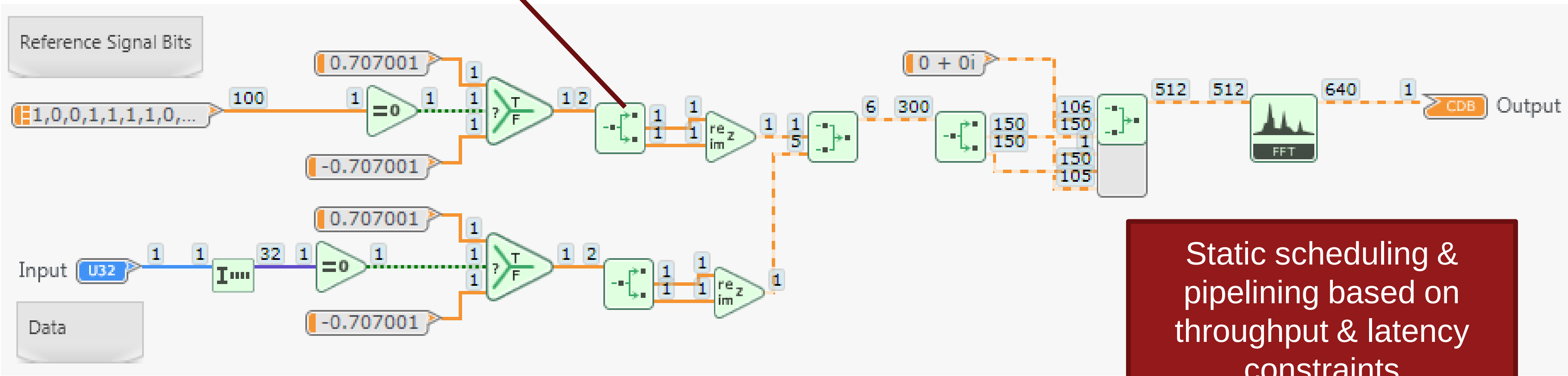
Design Exploration

Float to Fixed Analysis & Histogram

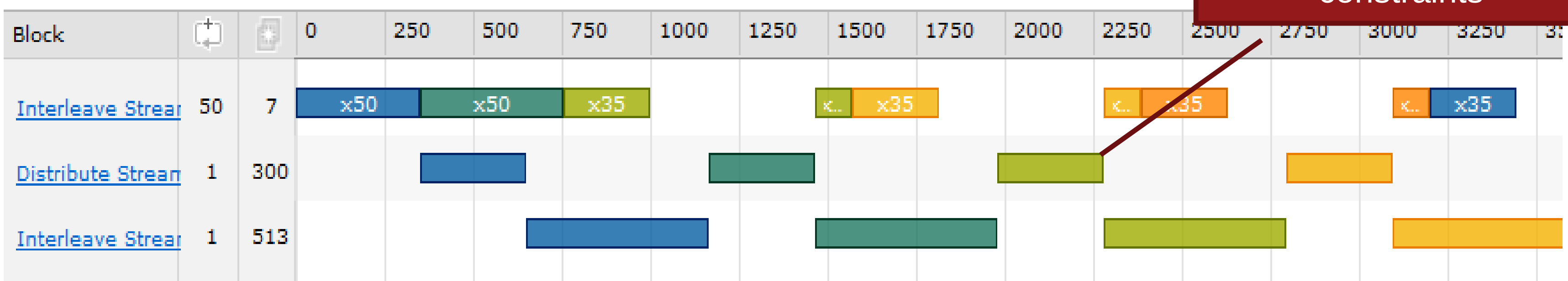




Intuitive multi-rate DSP Design



Static scheduling & pipelining based on throughput & latency constraints



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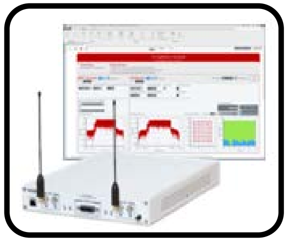
LTE and 802.11 Application Frameworks



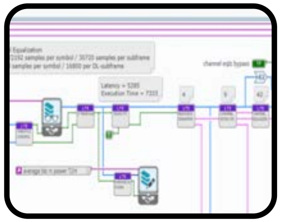
Real-time wireless system implementation

Ready to run PHY and basic MAC

Communicate between devices or in loop-back mode

Applications

- Customize LTE and 802.11
- LTE/802.11 coexistence
- New 5G waveforms



Open and Modular Source Code

~50% of FPGA resources available for customization

Replace existing blocks with your own waveform designs

WIFI meets
16µS SIFS timing!

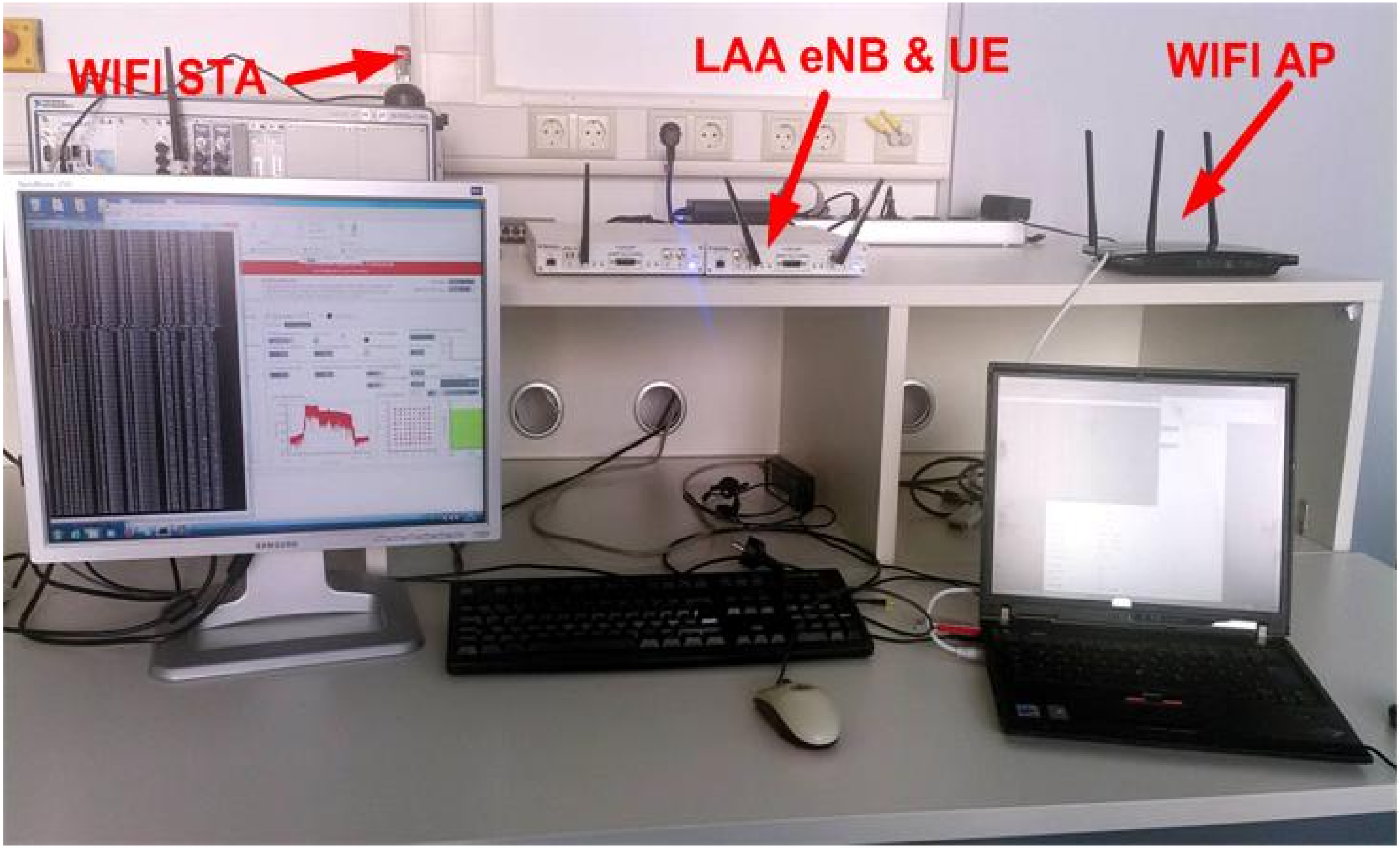
Fastest path from algorithm to prototype

Single language for host and FPGA design in LabVIEW

Documented for ease of use and understanding

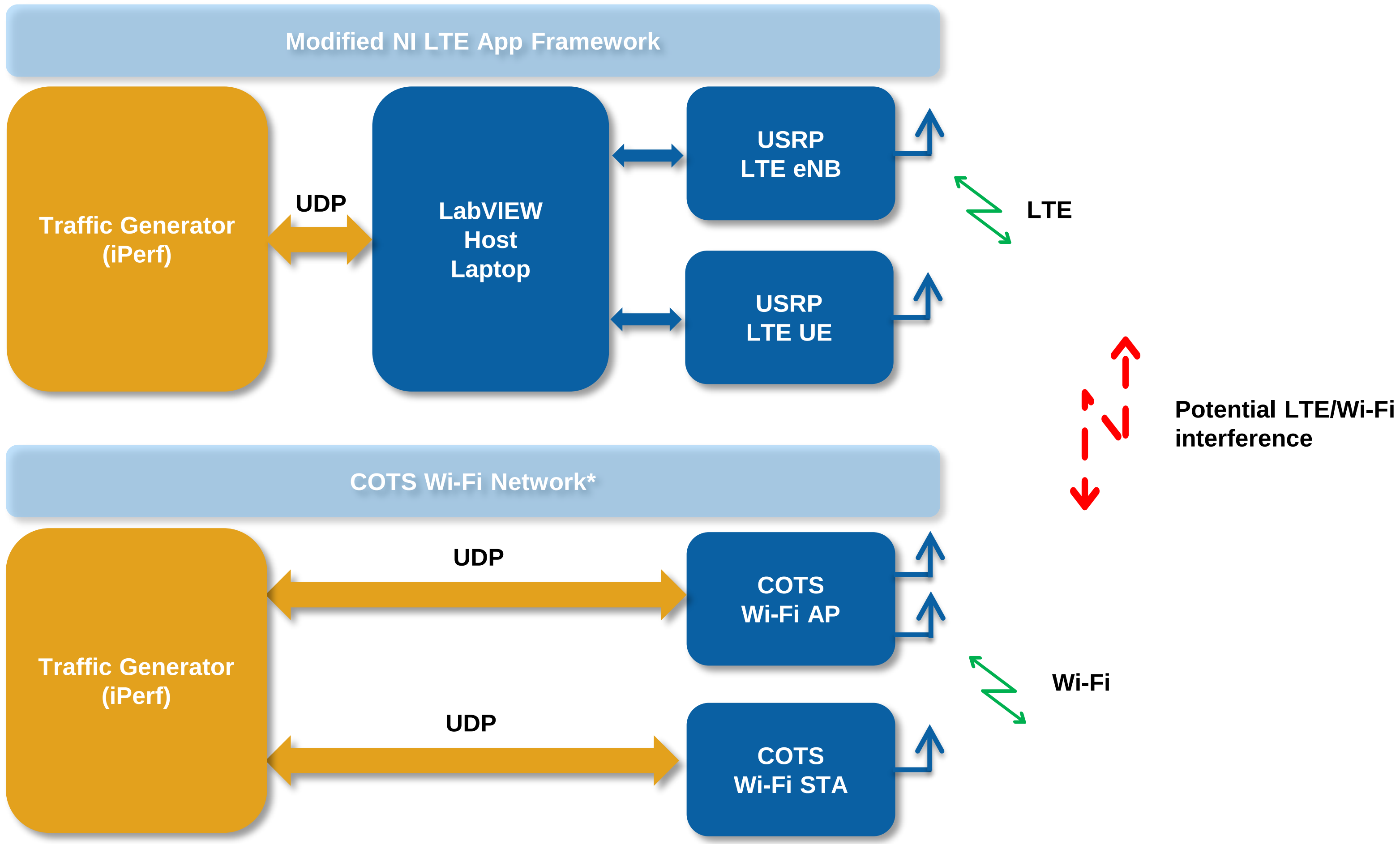
LTE/Wi-Fi Coexistence Study

LTE/Wi-Fi Coexistence Setup



∗ Can also use NI 802.11 Application Framework with USRP RIO for emulating Wi-Fi network.

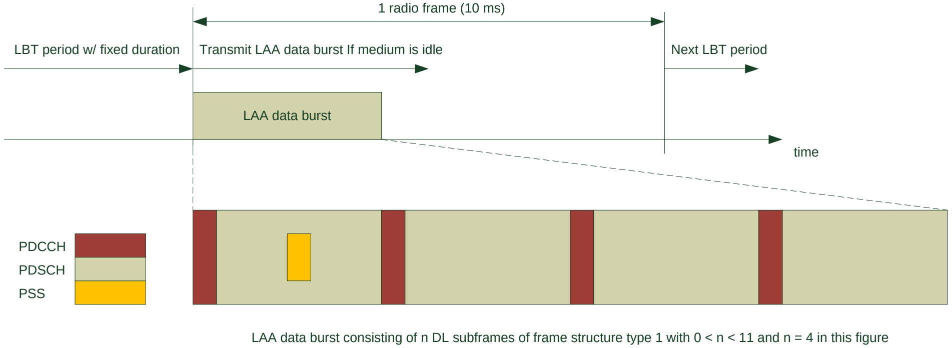
Current LTE/Wi-Fi Coexistence Setup

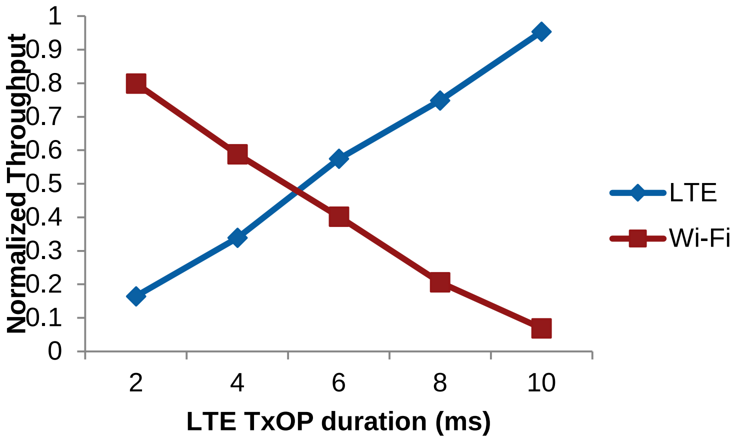


∗ Can also use NI 802.11 Application Framework with USRP RIO for emulating Wi-Fi network.

3GPP RAN1 Contribution R1-154740 (Aug 2015)

- Listen before talk:
  - Configurable CCA-ED threshold
  - Cat 2: Configurable duration
- Discontinuous transmission (DTX)
  - FBE (LTE-U): configurable duty cycle
- SISO
- Coexistence metrics
  - Throughput measurements
- Traffic generation
  - iPerf





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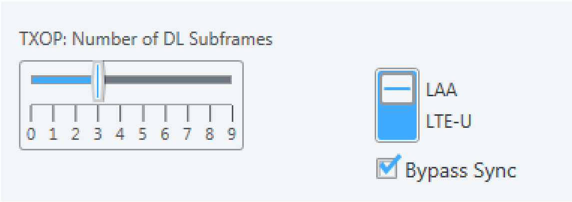
Current Features Available

- LAA
  - Listen before talk:
    - Configurable CCA-ED threshold
    - Cat 2: Configurable duration
    - **NEW:** Cat 4: Configurable contention window size (CWS)
  - SISO
  - Discontinuous transmission (DTX)
    - **NEW:** LBE (LAA): Configurable TXOP



- LTE-U
  - FBE (LTE-U): configurable duty cycle
- Coexistence metrics
  - Throughput measurements
- Traffic generation
  - iPerf

Implemented LAA LBT Cat4 Flowchart

- Followed TR 36.889v1.0

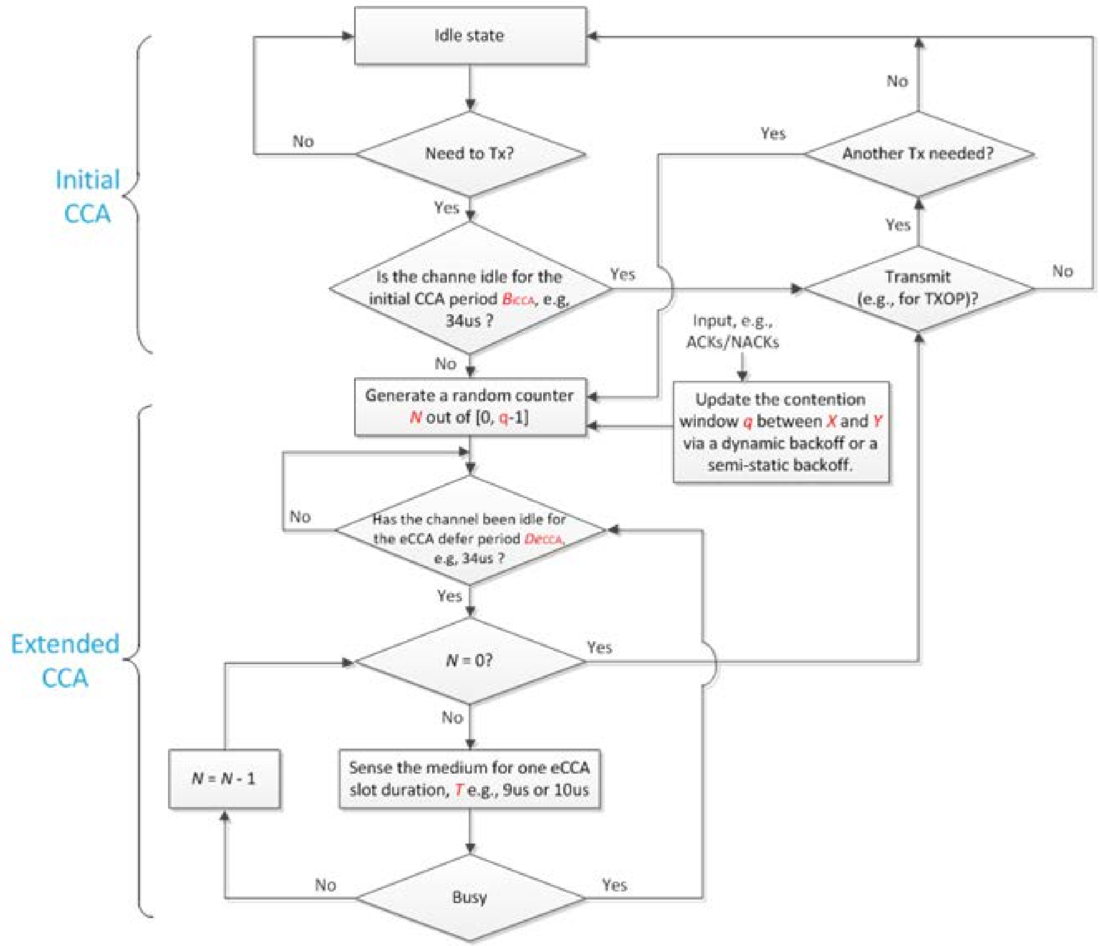
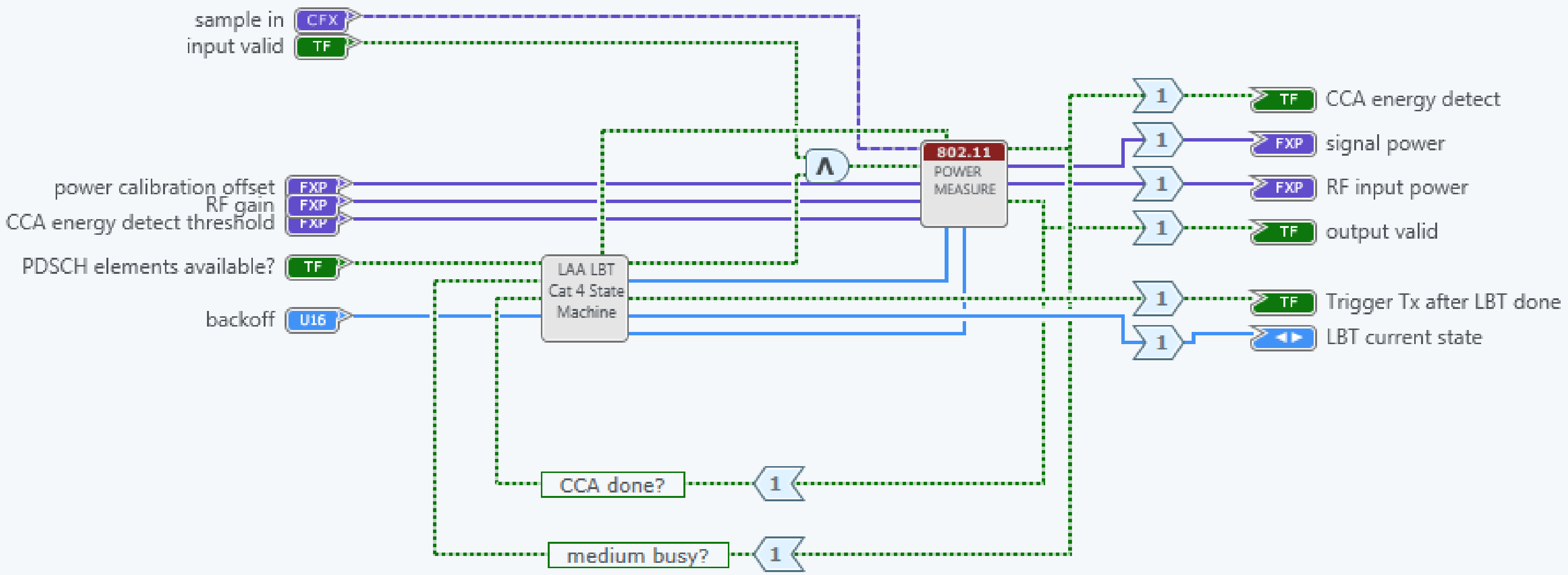


Figure 7.2.1.6-1: Flowchart of DL LAA SCell Cat 4 LBT procedure

- http://www.3gpp.org/ftp/Specs/archive/36_series/36.889/36889-101.zip

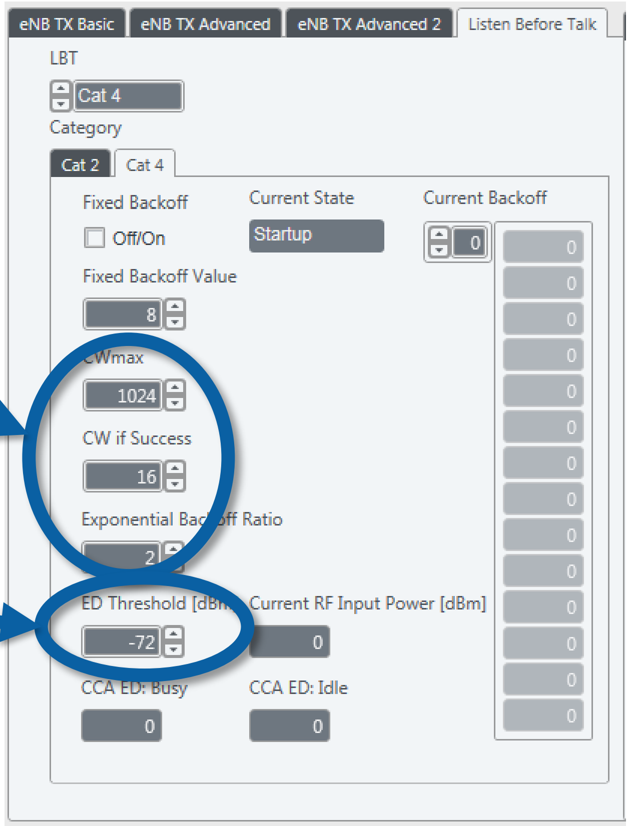
LBT Cat4: Top Level



LBT Cat4: Configuration Capabilities

Configurable contention window parameters

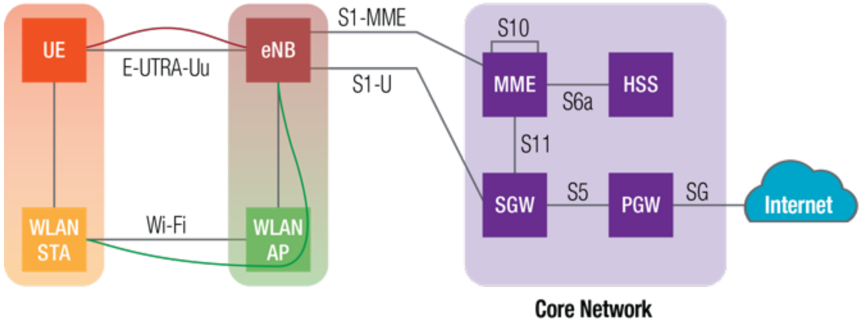
Configurable energy detection threshold



LWA: LTE/Wi-Fi link aggregation on higher layer

- We discussed so far LTE/Wi-Fi coexistence on PHY layer: LAA/LTE-U

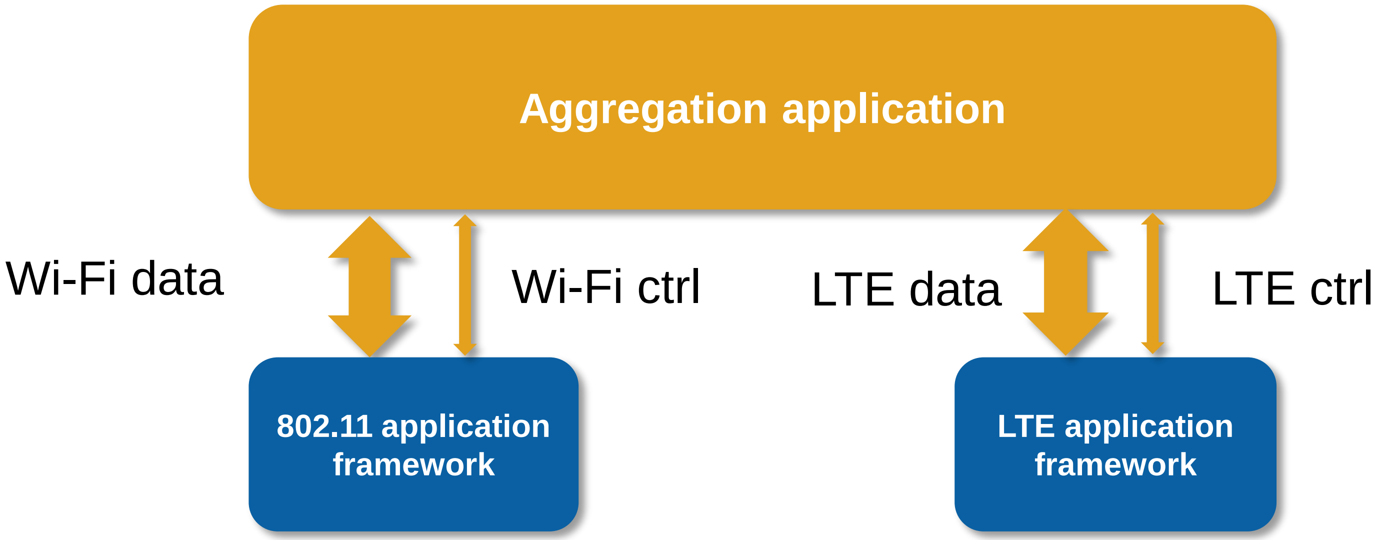
- LWA: **L**TE + **W**i-Fi Link **A**ggregation
  - Aggregation happens on higher layers
  - Also part of 3GPP Rel. 13
  - Pushed by Ruckus
  - Preferred flavor of Wi-Fi community
  - Pro from the Wi-Fi standpoint:
    - No need to share physical medium between Wi-Fi and LTE
    - No need to change LTE PHY
  - Con from the cellular standpoint:
    - Slow migration path as protocol stack changes on Wi-Fi access points are needed



Source: http://www.theruckusroom.net/2015/04/getting-engaged-lte-and-wi-fi-falling-in-love.html

Next Steps to LWA

- Take the existing 802.11 and LTE application framework
- Build on top scheduler application for aggregation



- Data: PDCP packets
- Ctrl: Info about link quality such as RSSI, SNR, BLER

Summary

- LabVIEW provides higher layer of abstractions supporting multiple models of computation

- Ready-to-run application IP includes real-time LTE and 802.11 reference designs

- Open and modifiable real-time soutions for cognitive radio, coexistence, and monitoring applications

Questions