GENI CRKit
Spiral 2 Year-end Project Review

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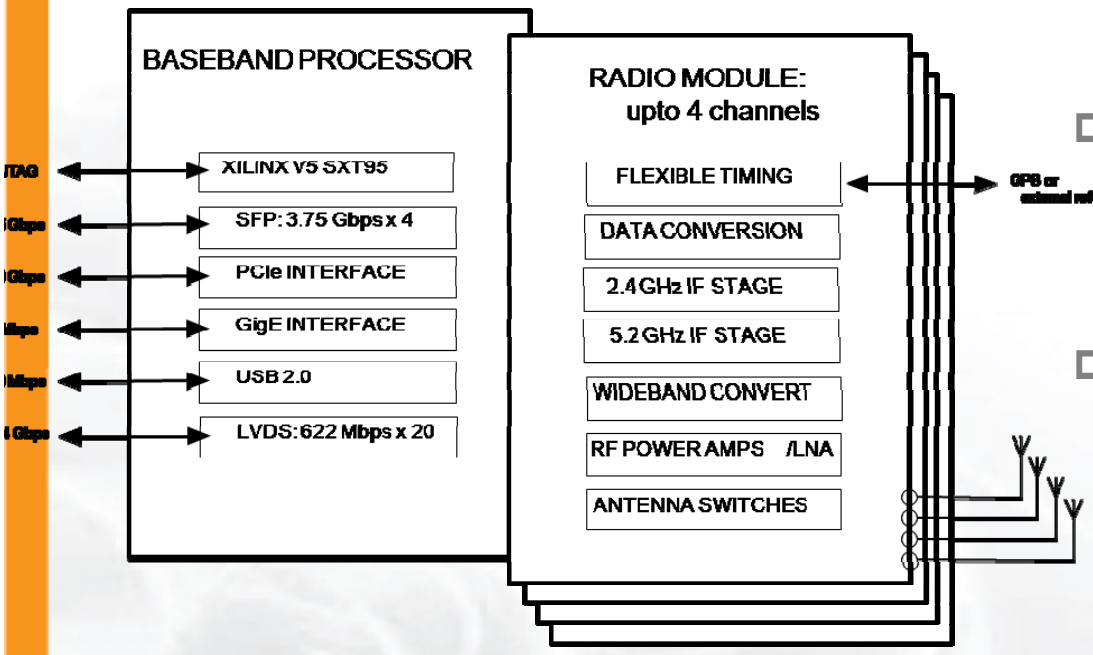
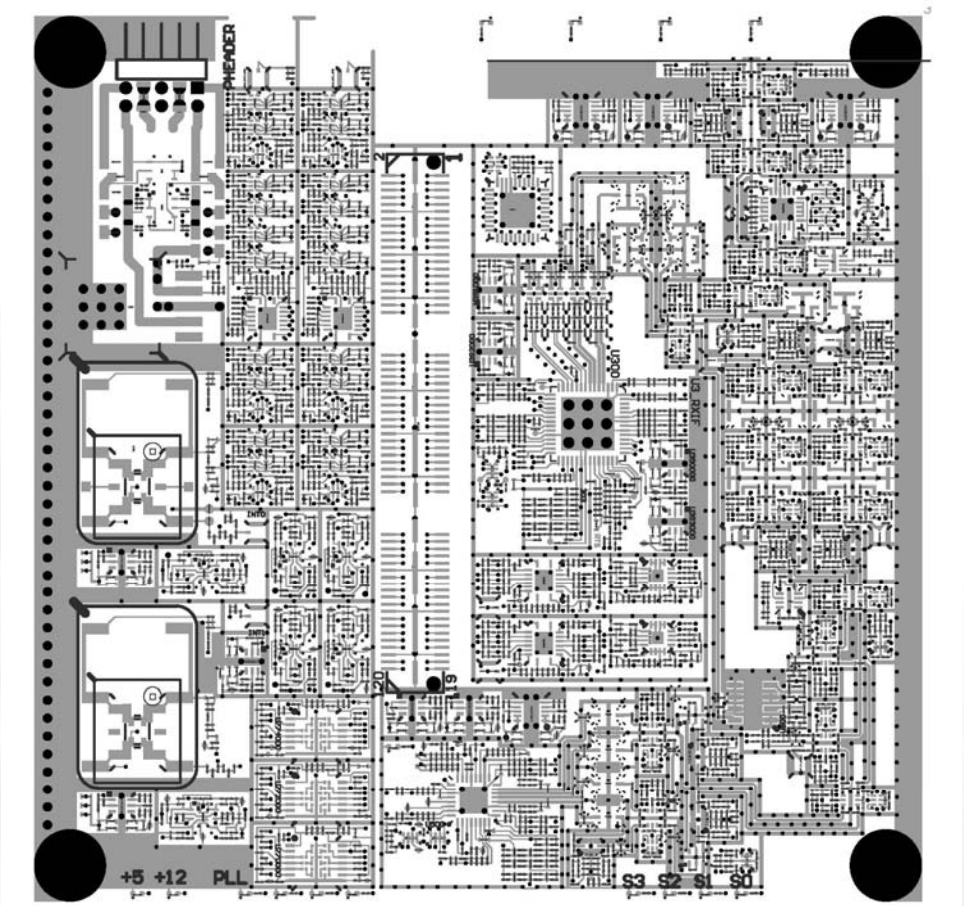
CRKit

Open Source Platform



- Range of COTS baseband FPGA platforms
  - Medium size (LX50)
  - Large size (SX95)
- Standard interfaces:
  - 1000 BaseT, (SFP)
  - USB
  - (8x PCIExpress)
- 4 (2) configurable radio modules for phased or smart antenna applications:
  - SDR/F – 25 MHz, 100 M -2.4/5GHz
  - WDR – 25 MHz, 100MHz -7.5GHz
  - XDR – 500 MHz, 100MHz-7.5GHz
- Application framework with support for both RTL and Matlab (Simulink)

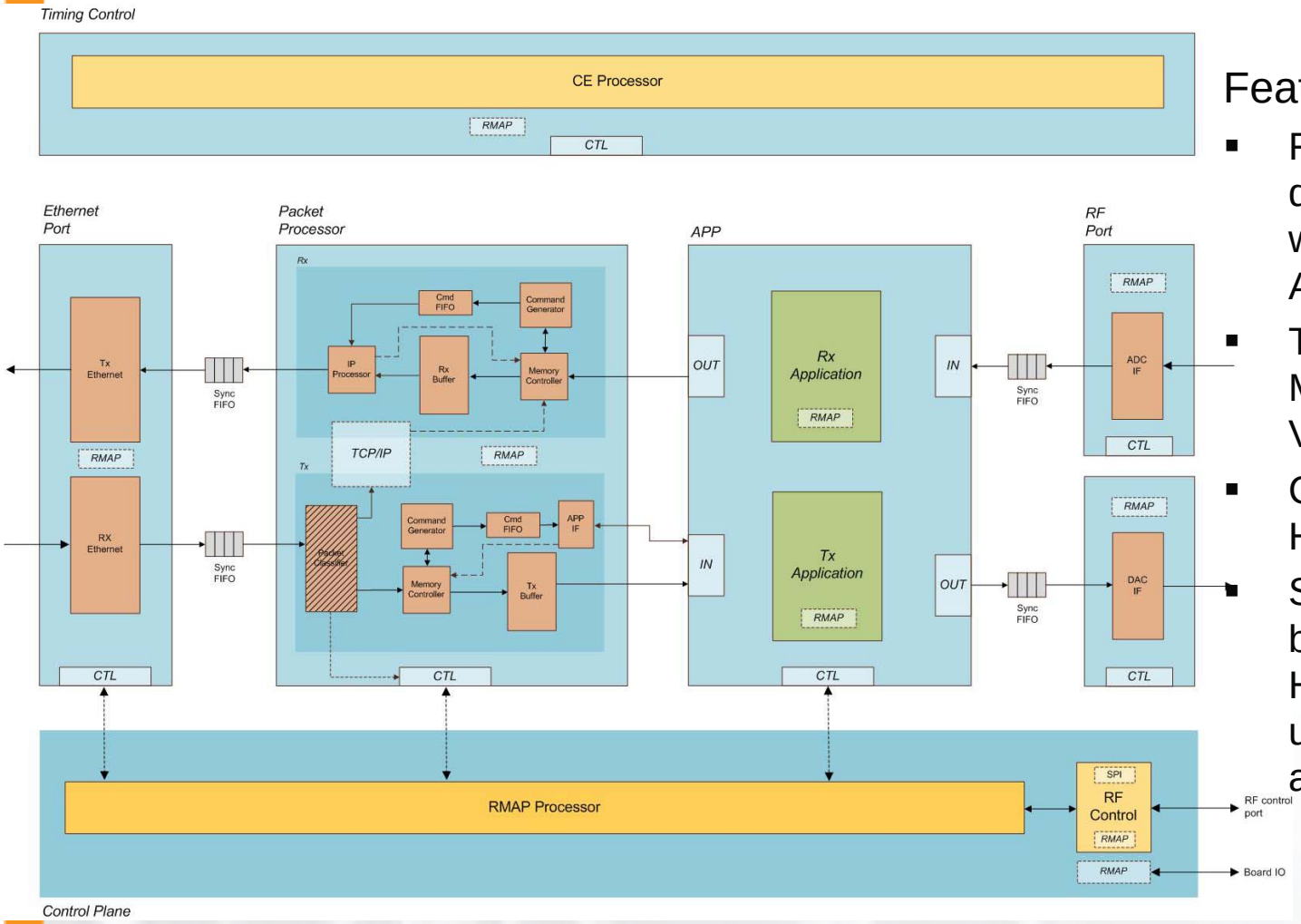
WDR RF Front-end (Curr: WDR v2.02)



- One to four independent radio modules on one (FPGA) processor.
- Each module allows two up to 40 MHz bands from 100 to 7500 MHz
  - 12 bit ADC sampling up to 80MSps on both I and Q rails.
  - NF = 6dB, optional external LNA for customized applications.
  - 70dB of RX gain control.
  - 14 bit DAC sampling upto 200MSps on both I and Q rails.
  - +20dBm TX output power with fast gain control.
  - 60 dB of TX gain control
- Supports full duplex operation.
- 1 usec RF frequency switching time
- Switched antenna diversity for both TX and RX channels
- Comprehensive reference clock selection or generation with internal, external or digitally derived sample clocks.
- Extensive built-in-test for monitoring system status and health (including loopback).

- 14 layer PCB with high-frequency 5.5 mil thick NELCO N4000-13 material
- 6000 part footprints with more than 4800 parts

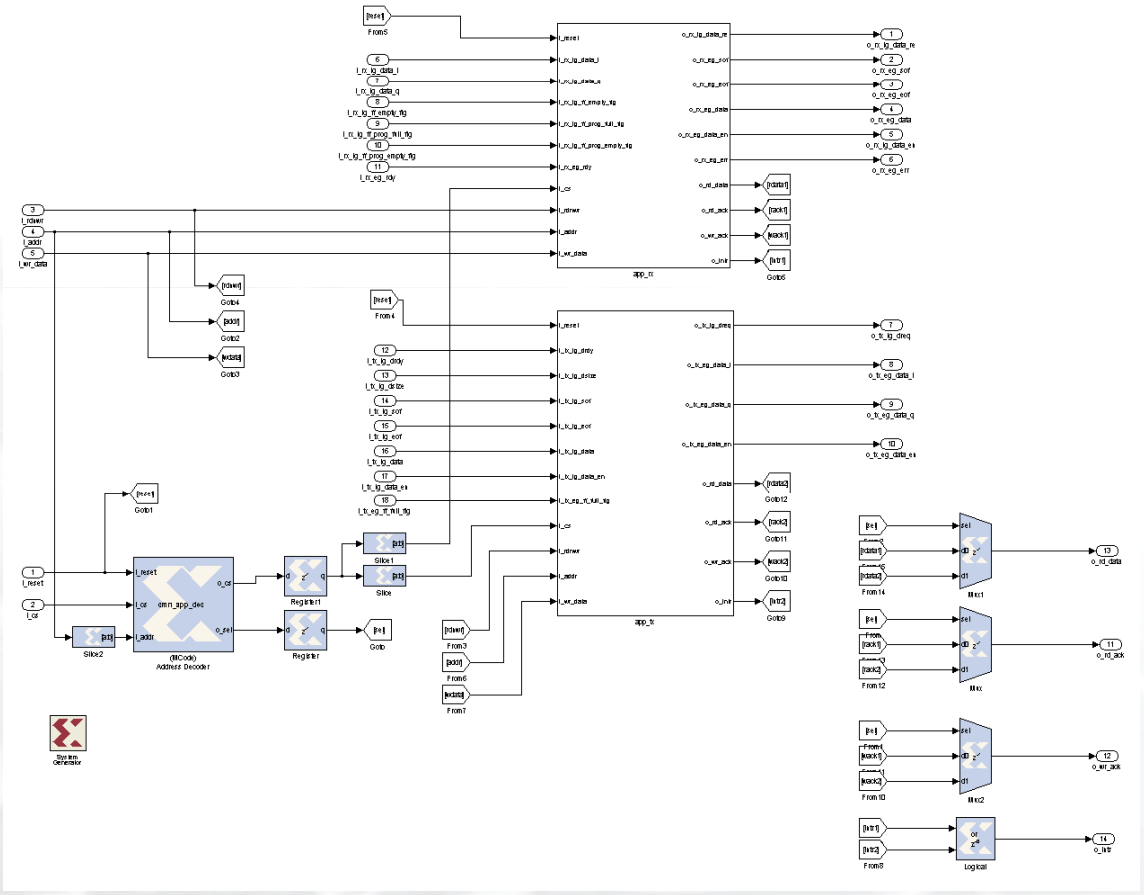
CRKit Framework



Feature :

- Fully functional FPGA development platform with Pluggable User Apps .
- Two environments: MATLAB/Simulink or VHDL/Verilog/BlueSpec
- Communication with Host using GbE links
- Streamlined FPGA building process e.g. HW design made-easy using MATLAB/Simulink and build scripts.

APP Development



APP subsystem:

- Build App as separate entity in MATLAB/Simulink, then integrate into Framework.
- Integration of Tx and Rx subsystems
- Well-defined IO interfaces between APP and Framework.
- Either develop own Tx/Rx Apps, or select from libraries

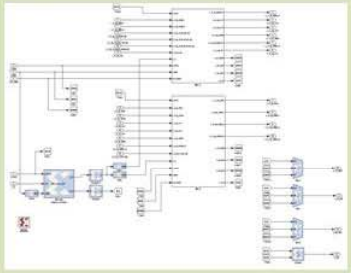
Framework Design Flow

MATLAB/Simulink Environment

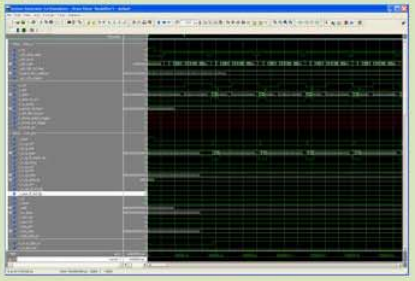
CRKit

Firmware Library

APP



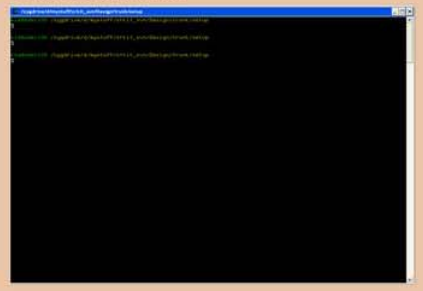
Simulation



Build APP

External Build Environment

Integrate APP & Build Framework



Bit file

Your radio!

Milestone & QSR Status

ID	Milestone	Status	On Time?	On Wiki?	GPO signoff?
S2a	Roadmap for stand-alone and infrastructure-class platform	Roadmap was released at GEC7	Late	Yes	Yes
S2b	Phase 1 radio card for stand-alone system	The first prototype with extended RF range was demonstrated at GEC7. Full version of WDR RF stage will be delivered in time for GEC9	Late	Yes	Yes
S2c	Integrate stand-alone platform	Stand-alone platform was demonstrated at both GEC7 and GEC8	Late (?)	Yes	No
S2d	Initial integration stand-alone system and with OMF	Initial integration with OMF was demonstrated at GEC8	Yes	No	No
S2e	Stand-alone system available to GENI users	Two nodes are available for remote access as part of ORBIT*. The platform is also available for purchase from Radio Technology Systems.	Early	No	No
S2f	Release design information for stand-alone system kit	Framework as well as all of the technical information is continuously released at http://crkit.orbit-lab.org	Early	No	No
S2g	Contribution to GENI outreach	Two undergraduate students were involved in framework testing and verifications as part of the WINLAB Summer Internship		No	No

Note: issues with Xilinx and Matlab licenses for general public use

Accomplishments 1: Advancing GENI Spiral 2 Goals

Deep Programmability:

- CR-GENI kit (both platform and framework) are designed with focus on versatility (in both RF flexibility and baseband capabilities of the FPGA platform).

Slicing:

- The demo @ GEC8 illustrated simultaneous and independent scanning and communication. Slicing capabilities are limited by FPGA resources

Rapid experimentation:

- The platform can be readily used for quick development of various wireless experiments and demos.

Accomplishments 2: Other Project Accomplishments

- On parallel funding at Colorado, transmitter chain as been improved
  - Support for NC-OFDM waveform
  - Support for “blind synchronization” across NC-OFDM waveform
  - Support for Hierarchical Coding
  - Support for enhanced modulation rates
  - Papers at ANCS, CoroNet WinHEC
- Started development of Bluespec conversion of pipeline
  - Stalled because undergrad (supported by NSF) at LLNL for summer

Issues

- Main issue to date is the use of licensed software (namely Xilinx and Matlab) that is required for FPGA code development. This is especially troublesome for deployments in remotely accessible testbeds not only because it requires that each user have a valid license, but because most academic licenses require that the actual development be done on the machines that belong to the licensee (rather than on the infrastructure machines that the testbed provides). Same issue exists for other FPGA based solutions (like NetFPGA)

- Specification tools like BlueSpec reduce some of these issues (matlab/simulink), but don't get around basic Xilinx license issue

- Outreach to Xilinx Research at Colorado to explore options

Plans

- What are you plans for the remainder of Spiral 2?
  - Conversion of waveform to more modular form (BlueSpec)
  - Validation of waveform control across wide-band front-end
  - Further development of basic communication blocks (GENI Radio Library)
  - Phase 2 radio development (wider baseband)
  - Multi-FPGA support and design partitioning
- The GPO is starting to formulate goals for Spiral 3. What are your thoughts regarding potential Spiral 3 work?
  - Wider GENI deployment