Spectrum Collaboration Challenge (SC2)

www.SpectrumCollaborationChallenge.com

System Specification Document

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Document Change Summary

Section	Description	Date
3.3.1	Updated SRN USRP HW Specification	1/31/17

Contents

1 Introduction

The Spectrum Collaboration Challenge (SC2) asks teams to develop software and firmware which will run on multiple instances of government provided hardware, called the Standard Radio Node (SRN). This combination of hardware, firmware and software will fully define and instantiate a Collaborative Intelligent Radio (CIR). Multiple instances of these CIR's communicating will define a Collaborative Intelligent Radio Network (CIRN). This CIRN will compete against other teams CIRN's during the SC2 Preliminary Event #1 (PE1), SC2 Preliminary Event #2 (PE2), and SC2 Championship Event (SCE).

This document serves to capture the specification of the equipment, both hardware and software, that comprise the overall SC2 Colosseum Testbed. It does not address *how* these systems will be used for the purposes of testing, scrimmages, and competitive events. Due to the living nature of SC2, this kind of information will be posted on the SC2 Wiki Page which is intended to go-live in January 2017.

Beyond the Colosseum hardware and software, Colosseum has many programming interfaces. These interfaces are not captured in this document. When published, they will be contained in the Protocol Specifications document.

1.1 Standard Radio Nodes

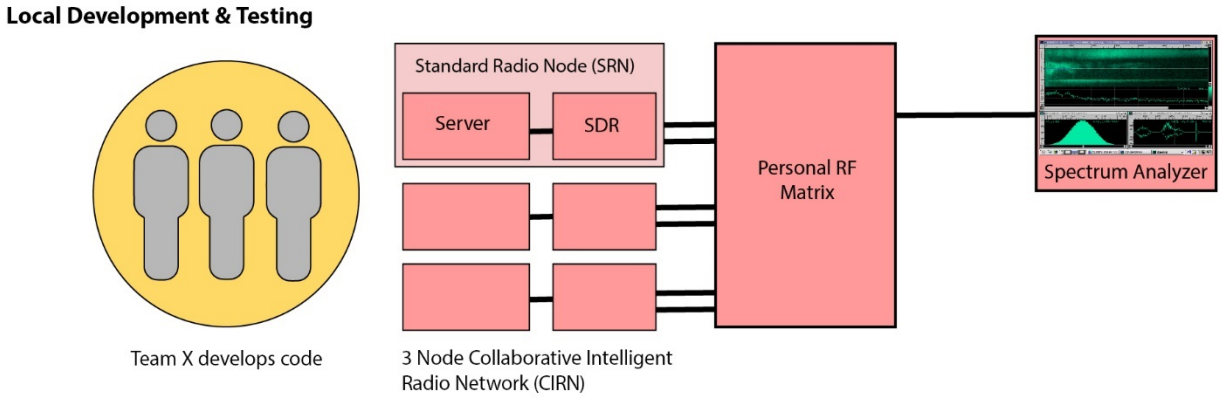
The Colosseum Testbed hosts 128 Standard Radio Nodes which will be available for team use by scheduling them as resources through the Resource Manager. More information about how to schedule resources can be found in the SC2 Wiki. The specifics of the SRN's are detailed in Section 2 of this document.

1.2 Colosseum

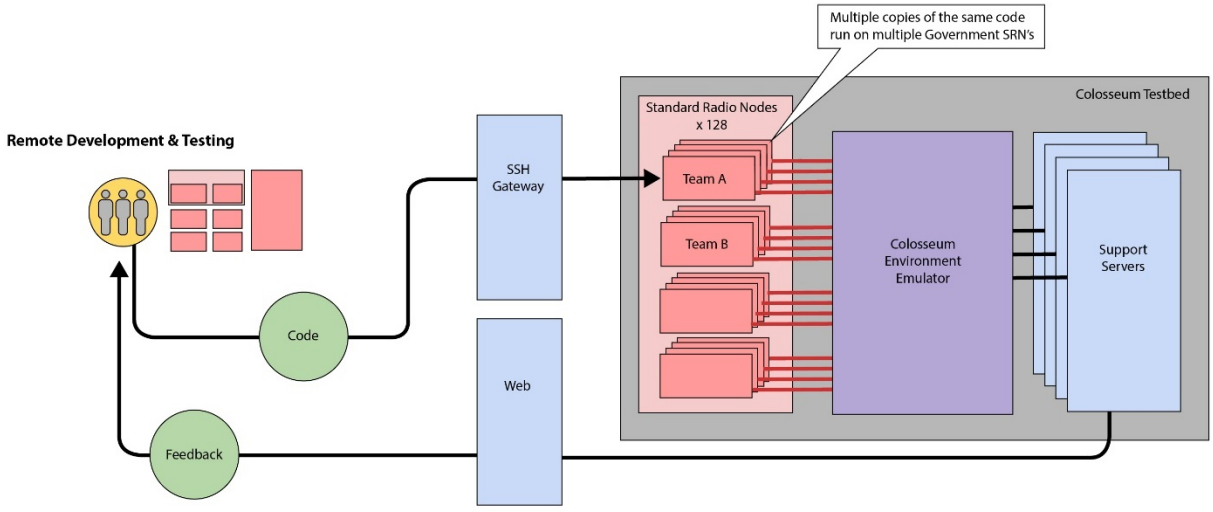
All teams CIRN solutions will be connected to the Colosseum Environment Emulator (CEE) for the purposes of testing, scrimmages and competitive events. The Colosseum is comprised of the worlds largest channel emulator, network traffic generators, an internet-like collaboration network, scoring and visualization servers, a command and control network, networked storage, and a security infrastructure. Resources of the Colosseum are available to the teams and may be scheduled during testing windows. More information describing how to schedule resources will be located on the SC2 Wiki. During scrimmage, competitive events and maintenance windows, Colosseum will be under the control of the event coordinators and will be unavailable for testing. The specifics of the team facing components of Colosseum are detailed in Section 3 of this document.

2 System Overview

The systems described in this System Specification Document are used in two different environments. Teams may choose to stand up a local development and testing environment. In this environment, a number of team owned SRN's are used to represent the radios in their CIRN. To fully take advantage of their nodes, teams will need to provide their own physical networks to control their SRN's. Teams will also need to provide a personal RF matrix which will likely use a set of discrete RF components like circulators, attenuators, splitters and combiners to simulate real world channels. They will also need some capability to generate traffic to push across their CIRN solutions. The advantage of operating in this environment is that teams have complete control and direct access to their own resources.



The second environment is used when participating in scrimmages, large scale testing, or competing in a competitive event. In these scenarios teams will be using the government provided Colosseum Testbed. In this environment, teams will submit software and firmware code to the Colosseum which will leverage its large number of nodes, network infrastructure, highly configurable digital channel emulator, and multiple traffic generators to execute tests. This environment provides more SRN resources, and more capable channel modeling.



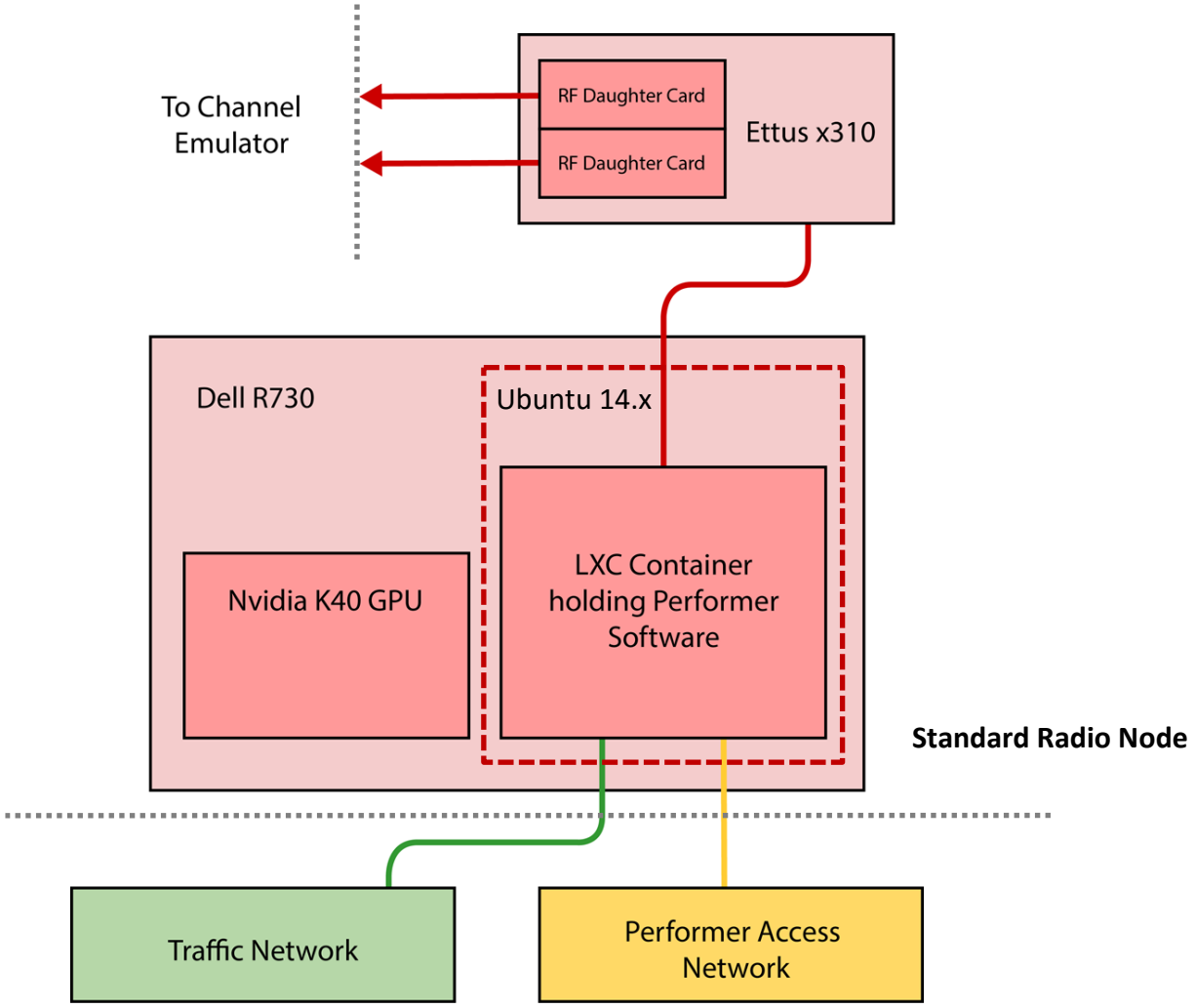
3 Standard Radio Node

For the purposes of testing, scrimmages and competitive events, the Standard Radio Nodes are an integral part of the Colosseum Testbed. However, since teams will need to be developing their CIRN solutions independent of Colosseum, the specifications of the SRN's are being broken out into their own section to highlight the independent nature of the resource. Teams may want to acquire SRN hardware resources of their own for local development and testing, prior to deploying their radio software/firmware images to Colosseum for large scale testing.

NOTE: Purchasing details will be forthcoming from both Dell and Ettus Research in a future version of this document.

NOTE: Information about development toolchain resources will be forthcoming in a future version of this document.

3.1 Standard Radio Node Block Diagram



3.2 Server

3.2.1 Hardware

Hardware	Dell PowerEdge R730 Server (210-ACXU) PE R730/xd Motherboard MLK (329-BCZK)
Processors	Intel Xeon E5-2650 v4 2.2GHz,30M Cache,9.60GT/s QPI,Turbo,HT,12C/24T (105W) Max Mem 2400MHz (338-BJDV) Intel Xeon E5-2650 v4 2.2GHz,30M Cache,9.60GT/s QPI,Turbo,HT,12C/24T (105W) Max Mem 2400MHz (338-BJDW)
Graphics Processing Unit	NVIDIA Tesla K40M GPU (490-BBSQ) R730 GPU Installation Kit (490-BCDP)
Memory	128GB [16GB RDIMM, 2400MT/s, Dual Rank, x8 Data Width (370-ACNX) x8 2400MT/s RDIMMs (370-ACPH)] Performance Optimized (370-AAIP)
Hard Drives	Chassis with up to 8, 3.5" Hard Drives, Software RAID (350-BBEM) Bezel (350-BBEJ) 1TB 7.2K RPM SATA 6Gbps 3.5in Hot-plug Hard Drive,13G (400-AEEZ) 2x
Networking Adapters	R730/xd PCIe Riser 2, Center (330-BBCO) R730 PCIe Riser 3, Left (330-BBCQ) R730 PCIe Rise 1 Filler Blank, Right (374-BBHS) Qlogic 57810 Dual Port 10Gb Base-T Network Adapter (540-BBBD) Qlogic 57800 2x10Gb BT + 2x1Gb BT Network Daughter Card (540-BBBZ) iDRAC8 Enterprise, integrated Dell Remote Access Controller, Enterprise (385-BBHO)

3.2.2 Operating System

Operating System	Ubuntu 14.04.5 with Linux kernel 4.4.0-36-generic due to the current limitations of CUDA 7.5. The version of Ubuntu may move forward when CUDA 8.0 comes out for general availability
Container Environment	LXC Linux Container
Container Image Packages	***To be released at a later date***

3.3 Software Defined Radio

3.3.1 Hardware

Base Unit	Ettus X310 https://www.ettus.com/product/details/X310-KIT
Bandwidth	100Mhz Total / 80Mhz usable
FPGA Resources	XILINX Kintex 7 – 410T Logic Cells: 406K Memory: 28,620 Kb Multipliers: 1540 Clock Rate: 200Mhz Streaming Bandwidth per Channel (16-bit): 200MS/s
Daughter Card	Modified Ettus UBX 160 for reduced power output and increased RX/TX isolation https://www.ettus.com/product/details/UBX160
Networking	10G will be provided ~~*PCI-express may also be provided to be determined in a later version of this document*~~ *PCI-express will not be available in Phase 1*
Reference Clock	~~GPSDO~~ ~~https://www.ettus.com/product/details/GPSDO-MINI~~ Internal Reference https://www.ettus.com/content/files/X300_X310_Spec_Sheet.pdf

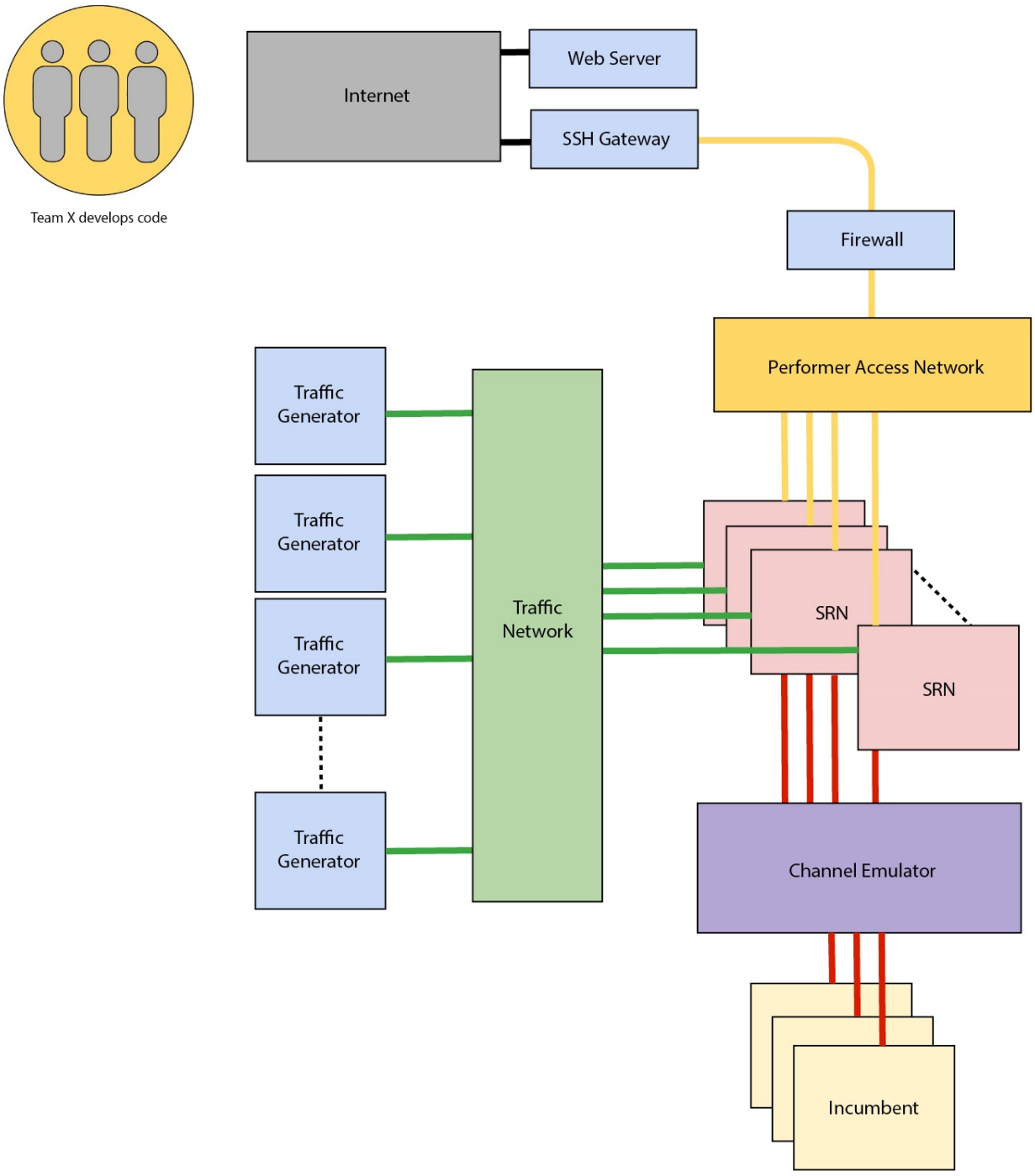
3.3.2 As Configured

Antenna Configuration	2x2 MIMO
USRP Hardware Driver	USRP Hardware Driver (UHD)
Development Frameworks Supported	GNU Radio Xilinx Vivado 2015.2 Design Suite RedHawk

4 Colosseum (performer facing)

The Colosseum Testbed provides a number of capabilities that are not exposed to the participating teams. For simplification purposes, only those elements pertinent to the performers are being show here.

4.1 Colosseum Block Diagram



4.2 Colosseum Environment Emulator*

Number of channels	256 x 256 Full Mesh
Channel Front End	Ettus X310
Phase alignment	Coherent across all 256 channels
Channel Frequency Range	0.01 GHz to 6.0 GHz, resolution 0.1 Hz
Channel Bandwidth	80 MHz
Channel Gain	Nominal Gain, 0 to 31.5 dB, resolution = 0.5 dB
Channel reproduction	The power delay profile for each channel uses a sparse FIR filter: a) 4 non-zero complex taps b) 10 ns of tap resolution c) 5.12 microseconds of max tap delay (delay line length) d) Tap delay, 0 to 512
Channel Update Rate	750 Hz
Latency	15 uSec port-to-port max

* More detailed specifications will be supplied in later releases

4.3 Network Traffic Generators

Traffic generation within the Colosseum may be provided by several different software-based traffic generation tools. The variation in tools will allow the Colosseum to generate a wider variety of traffic types to meet practice, scrimmage, and test event needs.

Currently, the Colosseum will deploy versions of the Distributed Internet Traffic Generator (D-ITG, http://traffic.comics.unina.it/software/ITG/) and the Multi-Generator (MGEN, http://www.nrl.navy.mil/itd/ncs/products/mgen). Future iterations may include additional traffic generation tools.

4.4 Collaboration Channel

The Colosseum's collaboration channel exists as a part of the Performer Access Network. One gateway node per performer team will have access to the collaboration channel.

The collaboration channel will be provided by a PacketStorm Hurricane III IP network emulator.