CERI-Choctaw Short-term Plan

CERI has been working, as resources permit, to replace legacy analog stations with digital hardware. Converting a station to digital includes installing a digitizer with microsecond or better timing accuracy at each station and converting the telemetry to digital. We are licensed in the 216-220Mhz band for analog telemetry but must move to license-free 900 MHz or 2.5GHz spread spectrum band for digital telemetry. The increased attenuation of the higher frequency telemetry, in addition to the cost of standard seismograph digitizers, is a significant impediment to upgrade.

For historic reasons, CERI operates two networks. The NM network covers the New Madrid Seismic Zone and the ET network covers the East Tennessee Seismic Zone. We will focus our initial efforts on a complete conversion, as resources permit, of the ET network. This focus will include both a short-term plan for prototype development and testing and a long-term plan for upgrading the rest of the ET network.

Traditional digitizers used by the seismological community (e.g. Kinemetrics Q330 or Nanometrics Centaur) are cost prohibitive (on the order of $10,000). We are investigating using a new, crowd-funded system initially developed as part of the RaspberryShake Project (https://raspberryshake.org/) that are an order of magnitude less costly (~$1,000). While these digitizers are unsuitable for ANSS Class A broadband stations it may be suitable for converting the remaining shortperiod analog ET stations to digital. This short-term plan includes two phases. Phase I will convert an existing digital station to Choctaw spectrum. Phase II will convert an analog station using Choctaw Spectrum and a Raspberry Jam digitizer.

Phase I

Phase I will be a test and prototype installation of GE MDS-ECR radios using Choctaw spectrum. Station DYTN (Figure 1, large red arrow) near Dayton, TN currently uses 900 MHz spread spectrum telemetry. Trees and foliage in the vicinity of the station reduce available bandwidth that prevents transmission of data from all 6 components. We're currently sending only 3 channels. A successful test will allow real-time transmission of all 6 components.

The current infrastructure at DYTN should be sufficient to provide a nearly 1-to-1 swap of the radios. In particular, power and telemetry systems capable of supporting the existing spread spectrum radios and Class A digitizer should be sufficient to support the GE MDS-ECR radios compatible with Choctaw spectrum.

Bench testing and familiarization with new radios will require two days of technician time over the course of approximately a week. Installation will require a two-person crew and overnight travel for two days. Staff time and travel support will be provided by the CERI seismic networks. Choctaw will supply the radios.

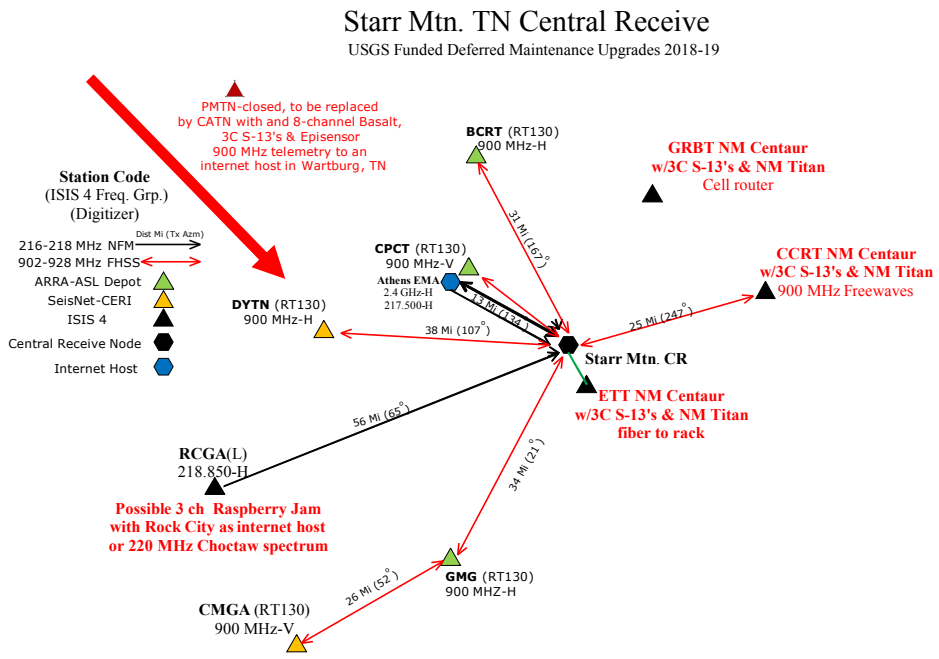

Figure 1. Star Mountain Node. Stations telemetered to the central receive at Star Mountain. Phase I upgrade station, DYTN, is indicated by the large red arrow. Azimuth and distance are shown at each telemetry path.

Phase I Schedule

Task	Start Date	Completion Date	Staff Involved
GE MDS-ECR acquisition	9/18/18	10/30/18	Choctaw, Bollwerk
GE MDS-ECR familiarization and testing.	10/30/18	11/13/18	Bollwerk, Steiner, Parker
GE MDS-ECR installation	11/13/18	11/16/18	Parker, Steiner

Phase II

Phase II will be a complete upgrade of analog station TVNC2 (Figure 2, large red arrow) to digital using GE MDS-ECR radios and a Raspberry Jam digitizer. Neither CERI nor any other ANSS network has a Raspberry Jam in production and it is not field ready. Development and testing will be required. We anticipate about two weeks of staff time over two months will be required for familiarization, testing, and development. This will be the prototype for future

upgrades and will show us whether or not this low-cost digitizer is a viable alternative to the traditional ANSS Class A system.

Most of the station infrastructure will need upgrades to accommodate the new equipment and increased power demand. We will also need to repackage the Raspberry Jam digitizer to provide conditioned power and environmental protection. This includes:

$350 2@ 85 watt panels
$500 Solar panel/battery enclosure mounts
$680 Group 27 AGM batteries (4@$170 ea.)
$600 Solar regulator, TSP's and misc. cabling
$900 Enclosures for batteries and electronics
$650 Fiber with media converters, necessary to isolate and protect electronics at tower from remote DAS and sensors
$1200 Raspberry Jam digitizer with environmental isolation and power conditioning

Total station cost excluding staff time and travel (time and travel will be supported by the CERI Seismic Networks): $4,880. Choctaw Telecomm has agreed to supply the four necessary radios and, pending successful tests with the Raspberry Jam digitizer, the CERI seismic networks will pay for the remainder of the costs listed in this plan.

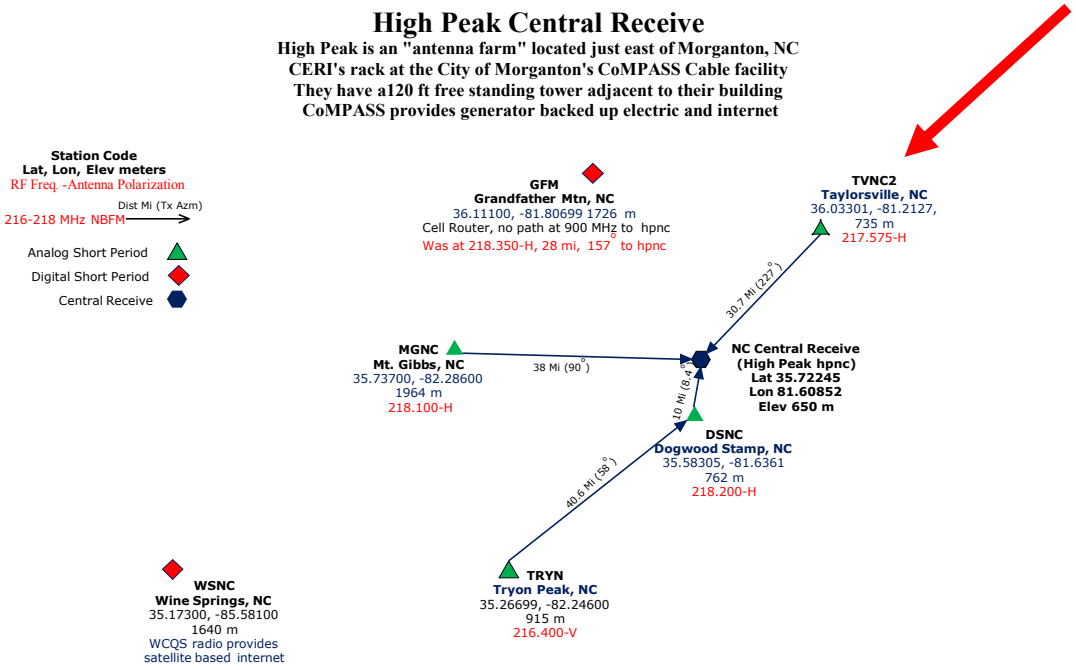

Figure 2. High Peak node. Stations telemetered to the central receive at High Peak, North Carolina. Phase II upgrade station, TVNC2, is indicated by the large red arrow. Azimuth and distance are shown at each telemetry path.

Phase II Schedule

Task	Start Date	Completion Date	Staff Involved
RS testing and tuning (timing and data handling)	9/15/18	9/30/18	Davis
Acquire RJ	9/30/18	10/8/18	Brewer
RJ prototype construction	10/8/18	10/31/18	Bollwerk, Steiner, VLF
RJ prototype testing	10/31/18	11/16/18	Davis, Bollwerk, Steiner
Infrastructure hardware acquisition	10/31/18	11/16/18	Bollwerk, Steiner
Station build and burn in.	11/16/18	11/30/18	Steiner, Davis

Station Installation	12/3/18	12/7/18	Parker, McGoldrick, Bollwerk, Steiner
Node installation	12/3/18	12/7/18	Parker, McGoldrick
Node reconfig	12/3/18	12/7/18	Davis, Brewer
Metadata update	12/3/18	12/7/18	Davis
Station certification	12/10/18	12/14/18	Withers, Davis