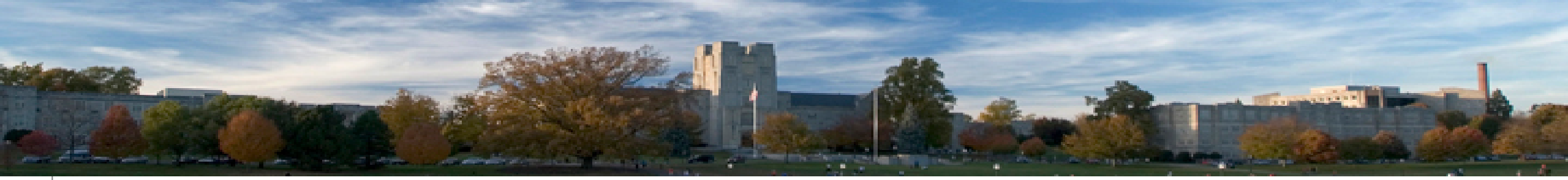
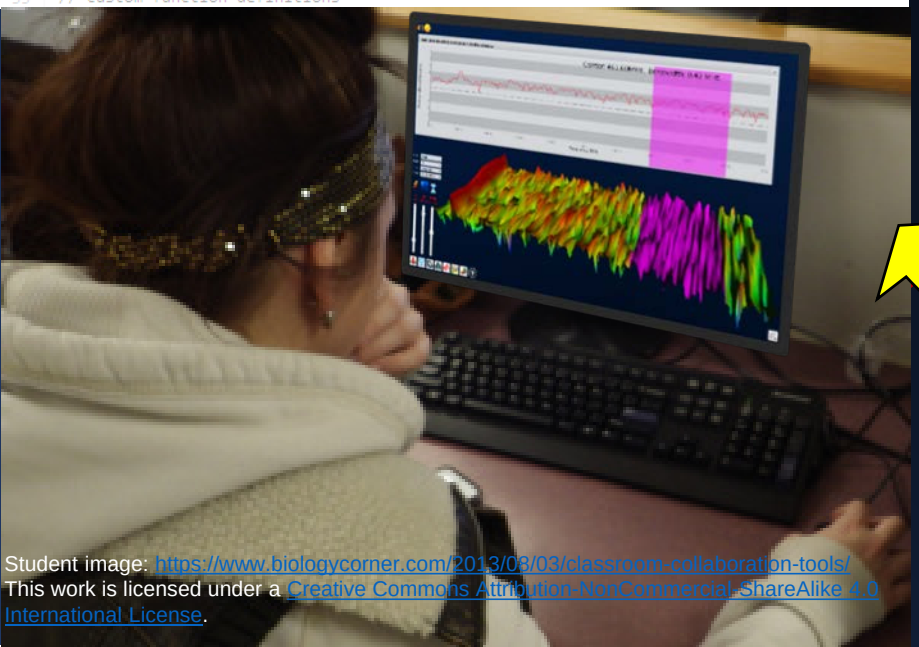


Hands-on Learning for Novel Solutions to Radio Spectrum Problems Using Remote Laboratory Exercises and Tutorials for Spectrum-agile Radio Frequency Systems

Hands-on Tutorials

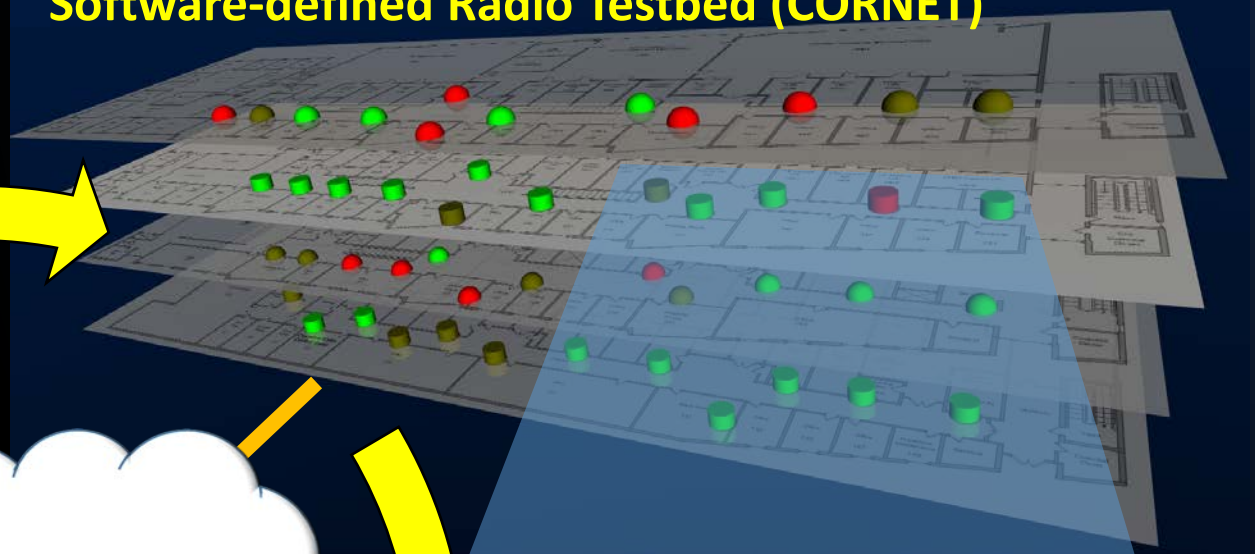
```
#include "CE.hpp"
#include "CE_Example_1.hpp"

// declare custom members struct
struct CE_Example_1_members{
        float example_ce_metric;
};

// custom function declarations

// constructor
CE_Example_1::CE_Example_1(){
        //printf("Entered CE example 1's construction fn");
        struct CE_Example_1_members cm;
        cm.example_ce_metric = 15.0;
        custom_members = malloc(sizeof(struct CE_Example_1_members));
        memcpy(custom_members, (void *)&cm, sizeof(struct CE_Example_1_members));
}

// destructor
CE_Example_1::~CE_Example_1(){
        //printf("Entered CE example 1's destruction fn");
}

// execute function
void CE_Example_1::execute(void * _args){
        struct CE_Example_1_members * cm = (struct CE_Example_1_members*) custom_members;
        //printf("Entered CE example 1's execute function\n");
        //printf("The example metric is now %f\n", cm->example_ce_metric);
        cm->example_ce_metric += 1.0;
}

// custom function definitions
```

Radio Controller Code and Configuration

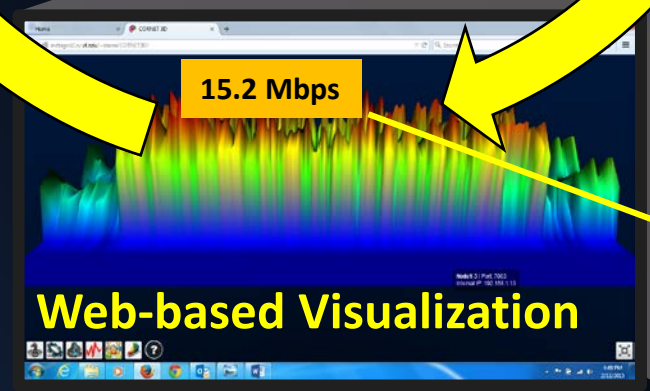


Student image: https://www.biologycorner.com/2013/08/03/classroom-collaboration-tools/

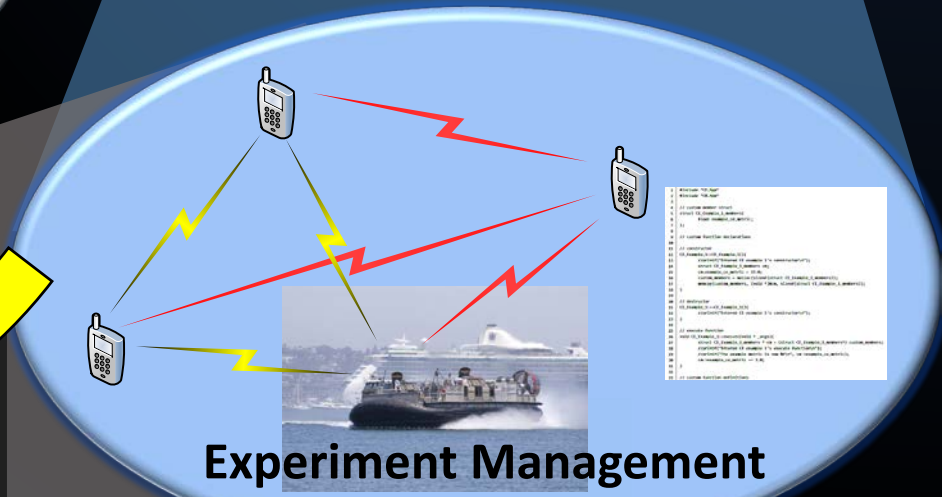
Software-defined Radio Testbed (CORNET)



Internet



Web-based Visualization



Experiment Management (CRTS)

Performance Reporting

Goals

- The intended use of the tutorials is to teach / review and demonstrate radio adaptation techniques using cognitive radio (CR) systems that can be controlled by logging into a remote software-defined radio (SDR) - based testbed

- This will be useful for anyone interested in learning, reviewing, teaching, demonstrating, or researching technical concepts related to spectrum sharing and cognitive radio.

Specific Goals

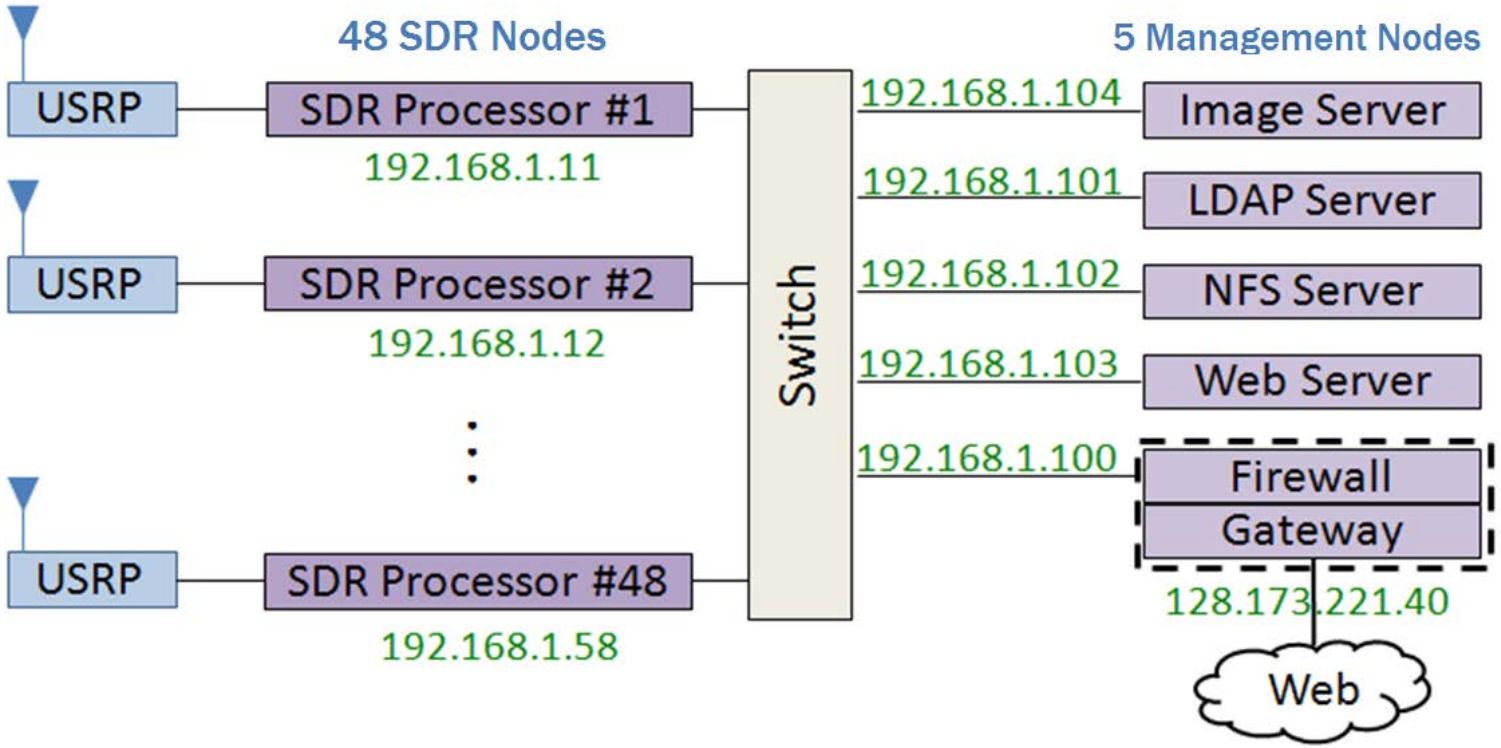
- Encourage those interested in spectrum sharing and CR to utilize our free available resources.
- Allow the users to familiarize themselves with the software while applying changes in radio parameters
  - such as frequency, transmitted power, modulation type, error correction coding type, and packet length.
- Encourage user to feel comfortable enough to conduct their own experiments.
- Gather feedback from tutorial participants to help improve the lessons and expand features (hardware and software) in the testbed to accommodate participants' educational and research requirements.

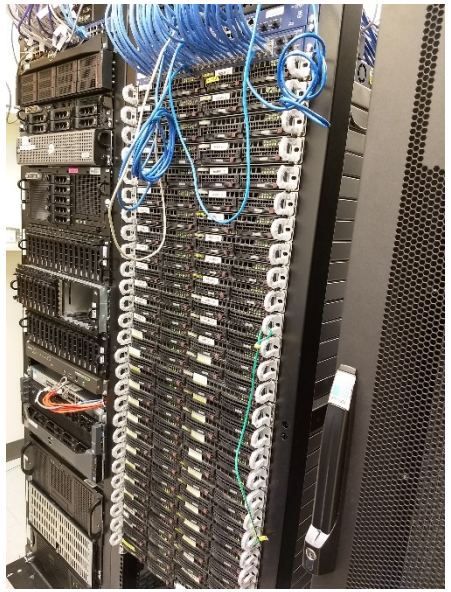
Available Resources

- Available resources:
  - The Cognitive Radio Network Testbed (CORNET)
  - The Cognitive Radio Test System (CRTS)
  - CORNET 3D
- CORNET is a network of software-defined radios which can be remotely accessed from most Internet-connected computers
- CRTS provides a flexible framework for over the air test and evaluation of (CR) networks
- CORNET 3D is a web-based spectrum visualization software where the users can monitor the statuses of nodes

CORNET

- CORNET testbed consists of 48 software-defined radio nodes, all remotely accessible





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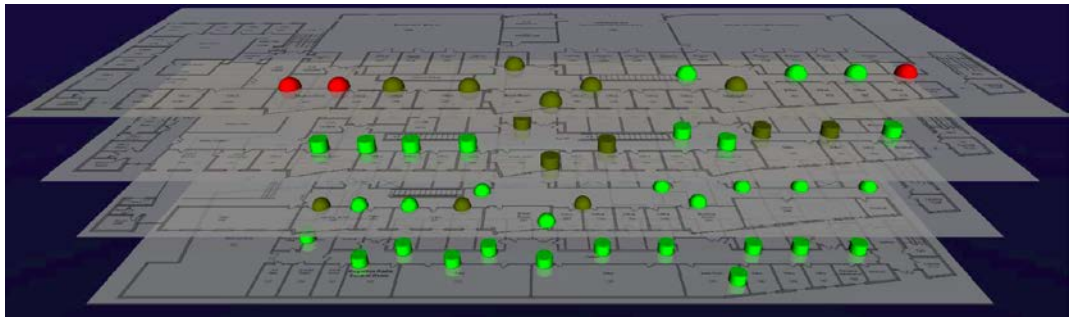
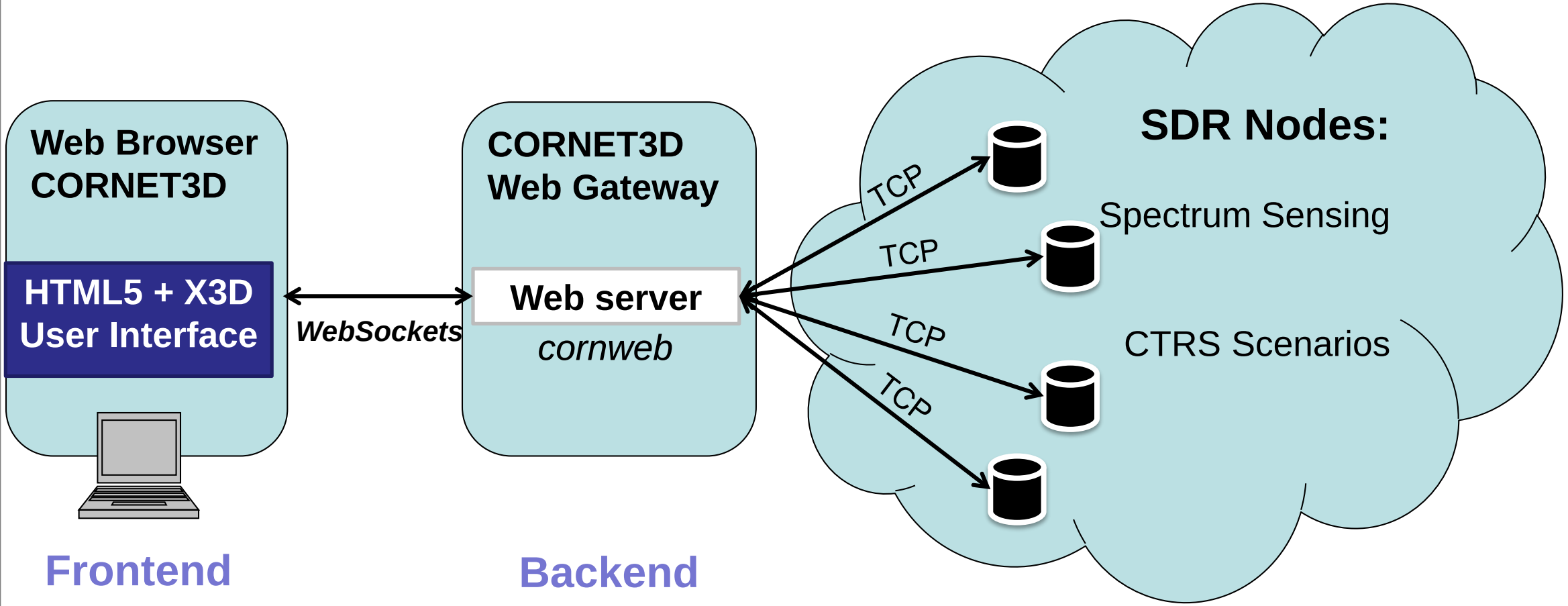
CORNET

- CORNET nodes are located in Kelly Hall of the main campus of Virginia tech in Blacksburg, VA

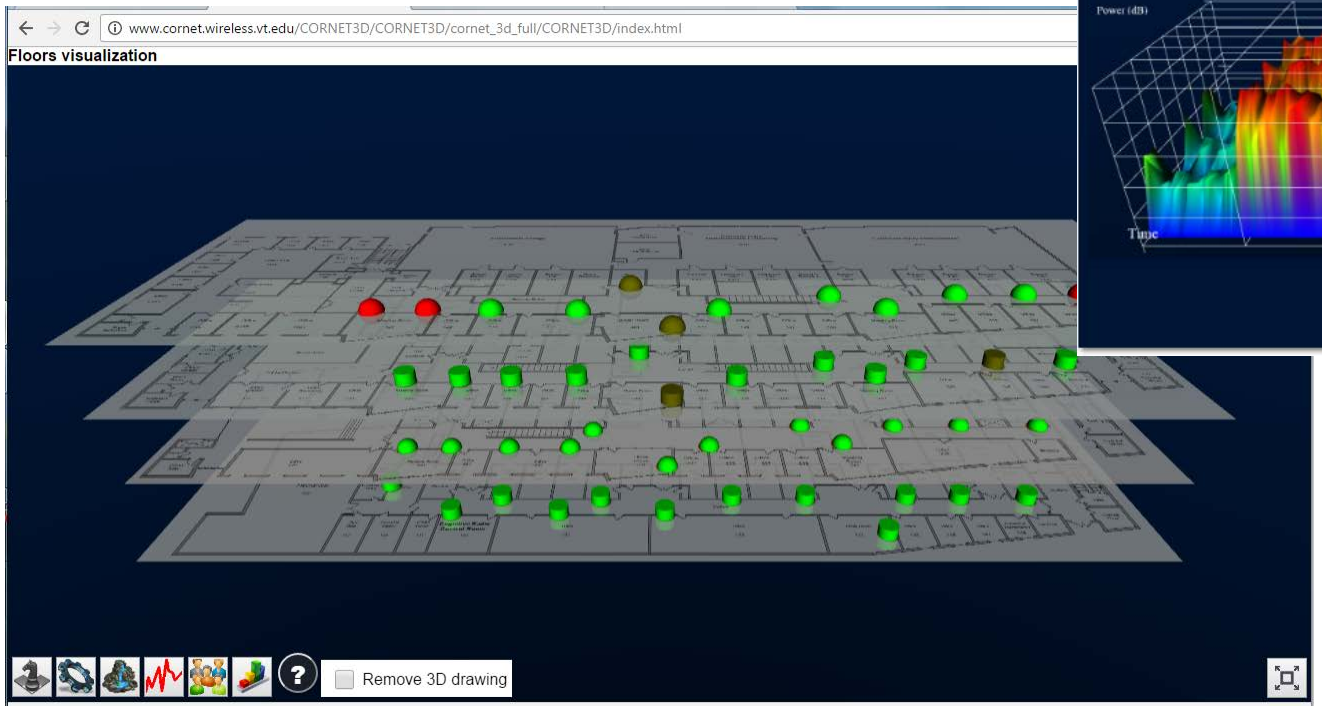


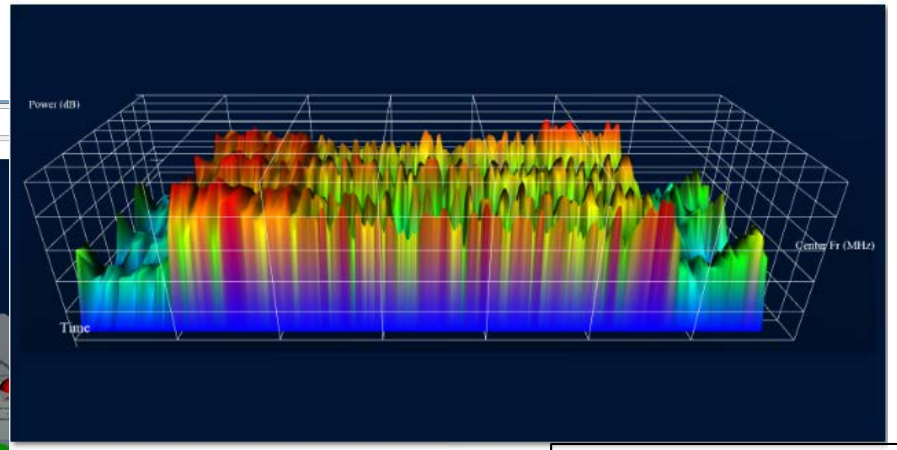
CORNET-3D



CORNET-3D

- CORNET-3D can be used to visualize tests as they happen and allows for human control of the radios which can be useful for tutorials





3D visualization of spectrum

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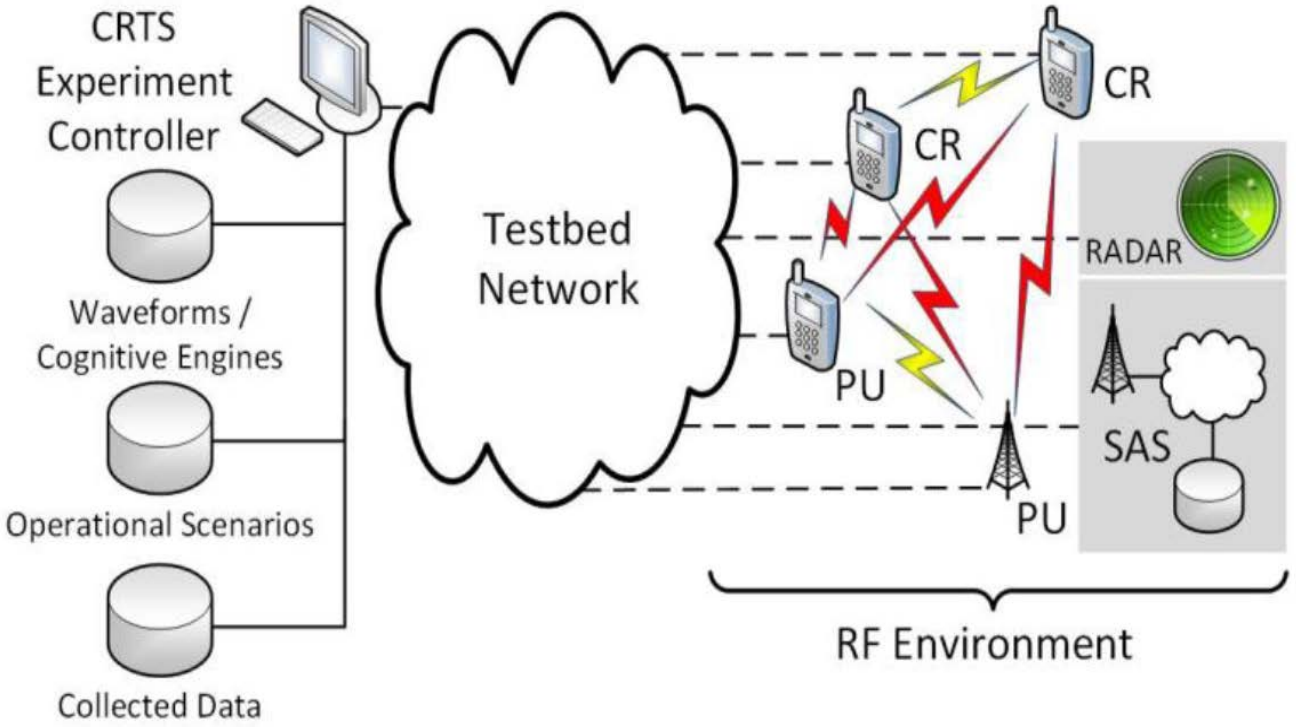
CRTS

- CRTS is an open source software that enables development and testing of CR networks
- Users can define testing scenarios involving a number of CR's as well as interferers
- Results and metrics can be visualized using octave/MATLAB logs automatically generated during experiment



Thank You

- Comments?
- Questions?