Time-based virtualization of an 802.11-based wireless facility

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The goal of this project is to demonstrate a key capability that will be needed to realize GENI's wireless facility — virtualization of a wireless network. The objective of virtualization is to allow multiple experiments (slices) on a wireless facility to co-exist in an efficient manner. While the potential scope of this work can be fairly broad, in this one year effort, we limit our activities to one 802.11 based testbed platform and study *time-based* approaches to virtualization. This work will be done in close collaboration with our colleagues at Rutgers University and the team managing the ORBIT wireless testbed (orbit-lab.org). In particular, we will use the 802.11 component of the ORBIT platform to demonstrate the virtualization capabilities. All of our developed functions will be integrated in the ORBIT testbed software platform by the end of the project.

Challenges

Virtualization on wireless platforms is quite challenging owing to the need for neighboring wireless nodes to parameters corresponding to a single slice. For example, physical nodes that serve as transmitter and receivers for a specific slice need to be configured with the same notion of a wireless channel in order for the communication to be successful and allow the experiment to evaluate the consequences of the transmission. The goal of our work will be to develop and demonstrate techniques of Time-Division Multiplexing of slices on the ORBIT facility or its equivalent. In particular, we will demonstrate how different experiments can co-exist in the same wireless facility and explore specific requirements for such co-existence.

The specific questions we will need to study include:

- What granularity of control would be feasible in the TDMA approach?
- How does the system scale with increase in the number of simultaneous experiments running on the wireless facility?
- How does scalability depend on the complexity of experiment topologies being used?
- What experiment throughputs are sustainable?
- How does proposed ideas work with nodes using multiple radio interfaces?

- How does this approach scale with the size of the facility, number of experiments, and the complexity of experiment topology?
- What degree of isolation between experiments is necessary and what can be achieved using the proposed TDMA techniques?

Objectives

- Implementation: Prototype the TDM approach for wireless network virtualization under practical hardware and software constraints.
- Integration: Upgrade ORBIT software components to implement the TDM methods.
- Evaluation: Quantify performance of TDM virtualization methods, considering factors such as number of slices supported and degree of isolation between slices.
- Demonstration: Provide demonstration of TDM based wireless virtualization technology through an operational system.

Milestones and demonstration schedule

- Dec 2006: Initial prototype of TDM based virtualization using a two node ORBIT sandbox.
- Feb 2007: Demonstration of TDM virtualization on the two node sandbox.
- July 2007: Integration of the prototype in the 400 node ORBIT facility.
- August 2007: Full demonstration and operation of the system.

GENI Risk Reduction Impact

This project is expected to lead to validation of the TDM-based wireless virtualization approach which are considered to be a critical path technology in the development of GENI. The effort should also result in prototype Linux code for virtualization that can later be ported to various GENI wireless implementations. Quantitative studies will also help guide the selection of virtualization methods for different types of experimental scenarios.

Current status

We have currently designed and developed the first prototype of a TDM system which is functional for stateless protocols, such as UDP. Our implementation extends the two main software components of ORBIT — NodeHandler and NodeAgent. We have implemented a simple round-robin scheduling mechanism for experiments. Through our early experiments of this system, we illustrate its scalability with increasing number of experiments.

Our next steps will be to study extensions needed for stateful protocols, such as TCP. In particular, we are investigating different approaches for handling such applications using the virtual machine abstraction through open source software systems such as Xen.