

Cell-Lab: A Femtocell-based Testbed for Evaluating Future Cellular Networks

International Conference on Future Internet Technologies (CFIoT8), Korea

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Outline

- Motivation
- Cell-Lab testbed
 - Design Goals
 - Architectural Plan
 - Virtualization
 - Usage Scenarios
- Conclusion

Motivation (1/2)

- Many network testbeds have designed
 - Wired: PlanetLab, VINI, Emulab
 - Wireless: ORBIT, APE, MIT Roofnet, ..
 - Based on IEEE 802.11 series protocols
- Wireless testbeds have a limited spectrum of radio technologies
 - Currently, no testbed for cellular networks (e.g. 3G) in spite of its worldwide popularity

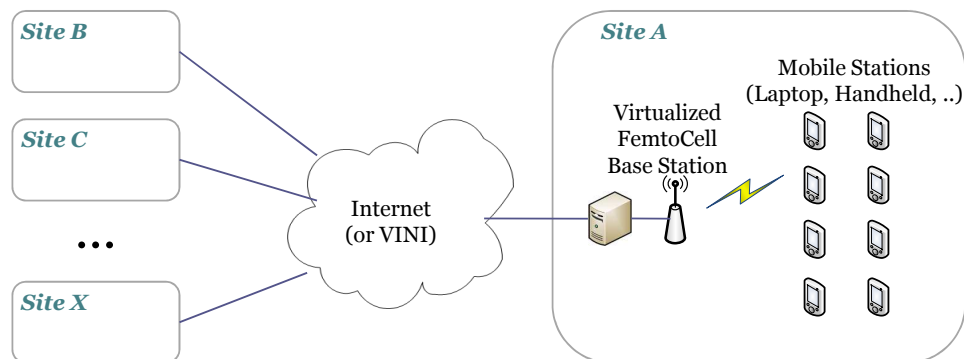
Motivation (2/2)

- Emerging femtocell can be used to build a cellular-based testbed
 - Originally designed as a small base station to extend the service coverage indoors in a residential setting
 - Incorporates the functionality of a typical base station but extends it to allow a simpler, self-contained deployment

Project Outline

- **Goal**

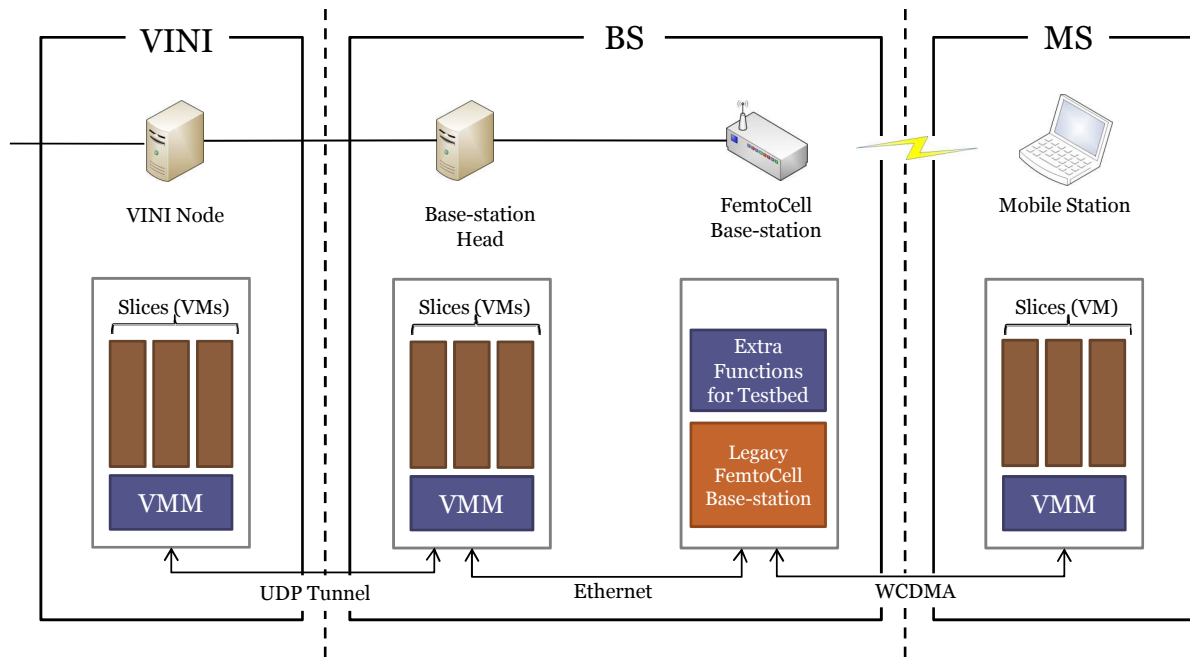
- To build a *cellular-based* wireless experimental facility, called *Cell-Lab*, which is similar concept with “*Wireless Subnet*” in GENI



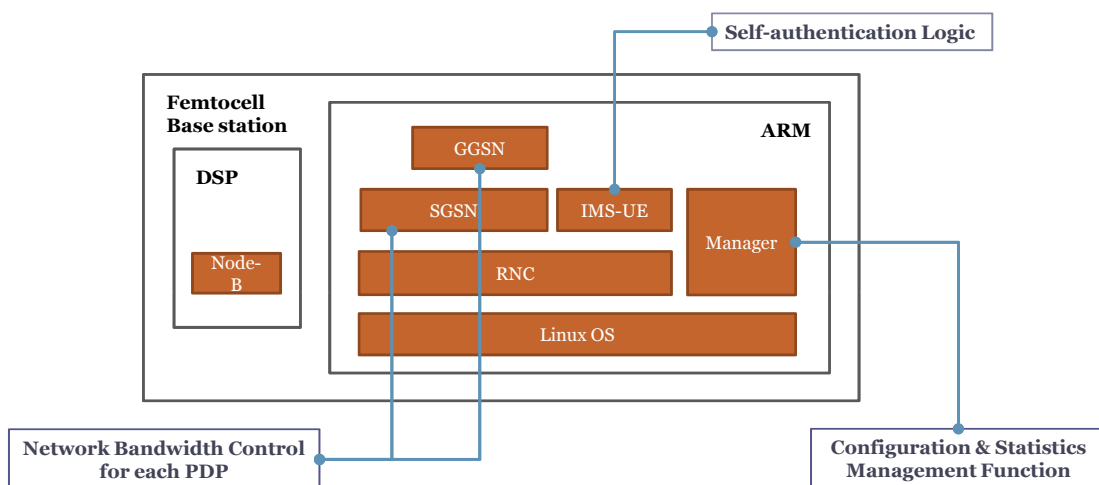
Design Goals

- Providing open-access to remote users
- Supporting simultaneous experiments
 - achieved by virtualization of BSs and MSs
 - reduces the cost of installing and running
 - supplements the maximum simultaneous MSs
- Interworking with existing wired testbeds
 - provides global-scale experiments with customized topologies

Implementation Scenario



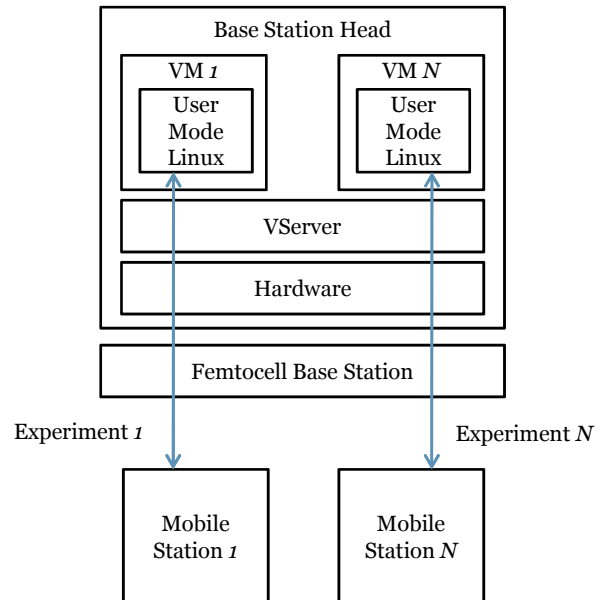
Femtocell BS Implementation



- For self-authentication, a part of IMS core logic is included
- Throughput control functions for each PDP context are included
- Web server is used for configuration & statistics temporarily
 - will be replaced by new protocol like SNMP

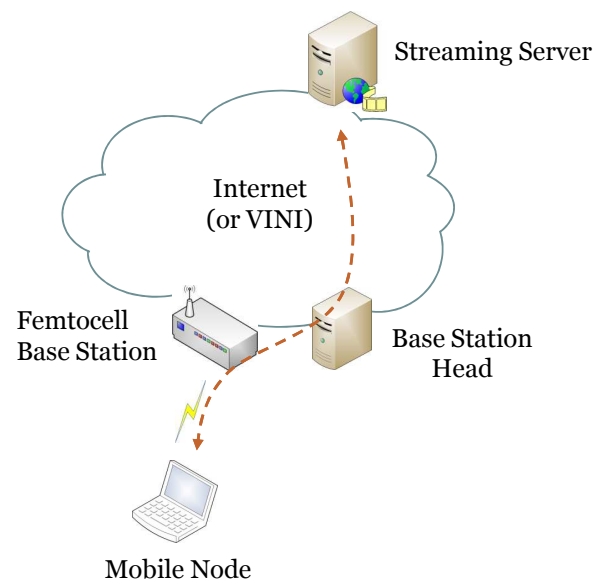
Virtualization

- BS head is virtualized instead of Femtocell BS
- VServer
 - provides root access to Cell-Lab users while isolating users from each other
- User Mode Linux (UML)
 - is a full-featured Linux Kernel running as a user process
 - makes a development process faster



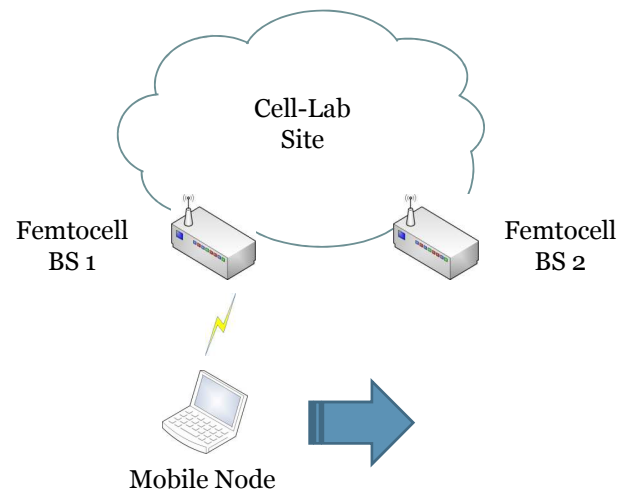
Usage Scenarios (1/2)

- Transport-layer protocols for cellular network
 - Split-connection approach
 - Base station head can be a splitting point, instead of femtocell base station



Usage Scenarios (2/2)

- Handover mechanisms
 - Horizontal handover can be experimented by using multiple base stations or deploying multiple Cell-Lab sites or and vertical handover mechanisms
 - Vertical handover can be experimented by interworking with WLAN testbeds



(Known) Limitations

- Limited capacity of femtocell base station
 - High mobility experiment is impossible
 - Small cell coverage and mobility (<30m, <10km/h)
 - Maximum simultaneous (WCDMA)UEs: 4
- Frequency License
 - Use of UMTS license band may be illegal
 - Interference with macrocell signals

Conclusion

- This paper introduces a femtocell-based testbed which is currently being developed for evaluating future wireless network protocols
- Virtualization, open and remote access to the testbed, and integration with wired testbeds will be considered as basic features