Office of
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THE UNIVERSITY OF UTAH

BoTM: Base-Station-on-the-Move

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1.

Introduction

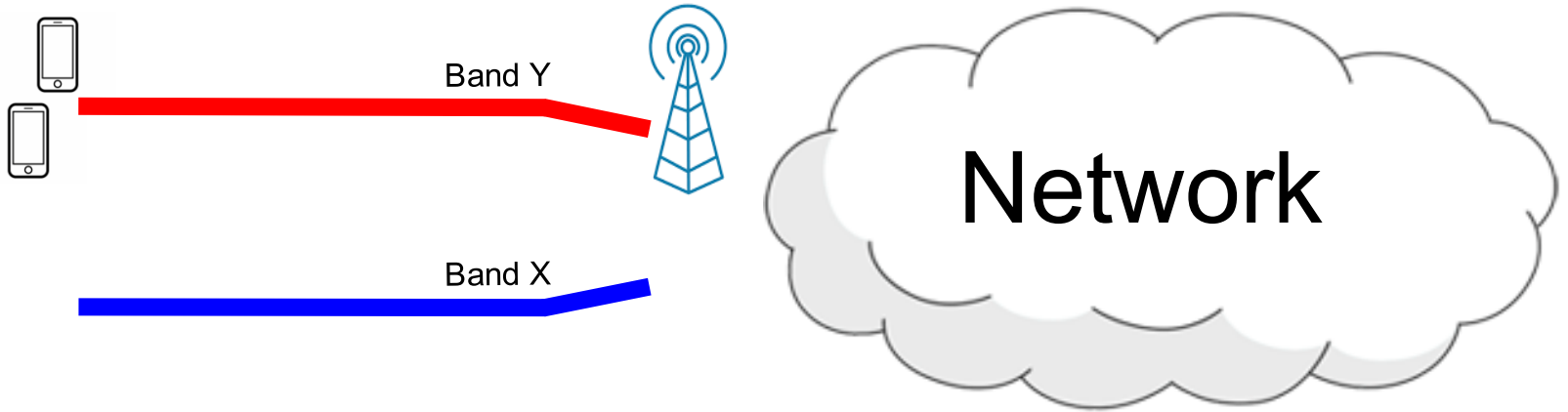
Setting

- ‘‘Softwarization wave’’ has altered network realization
- Network functions are no longer tied to hardware
- Malleable and programmable RAN
- Enables new opportunities for network operations

BoTM

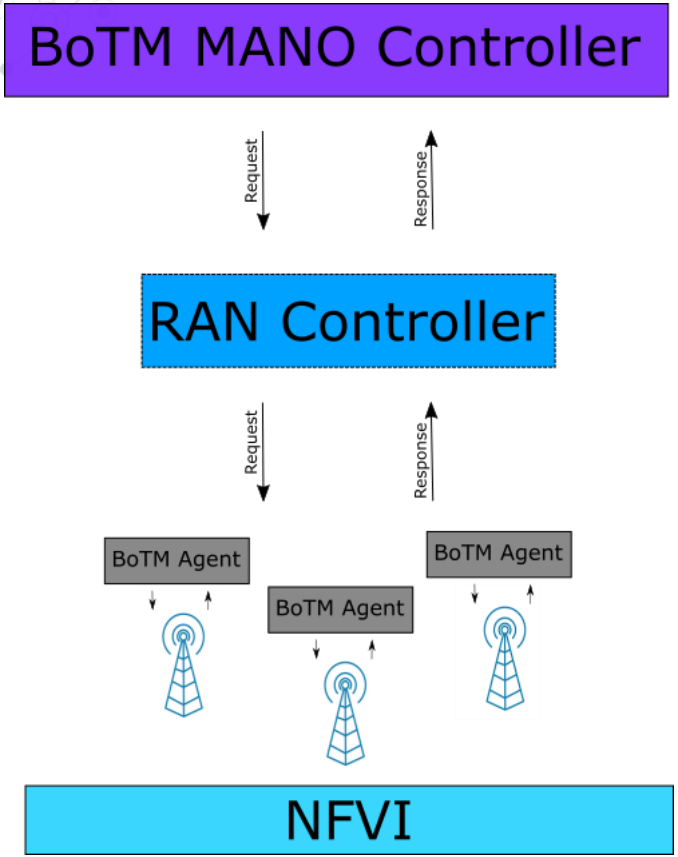
Exploit NFV to dynamically “move” a base station to a new location and/or piece of spectrum

BoTM at a High Level

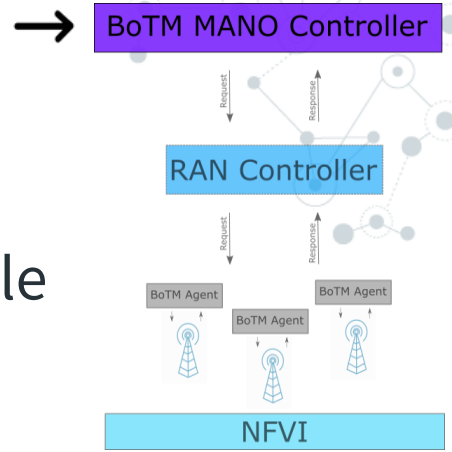


2.

Architecture

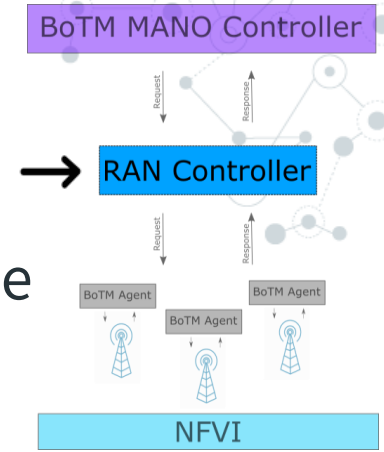

BoTM MANO Controller
Request
Response
RAN Controller
Request
Response
BoTM Agent
BoTM Agent
BoTM Agent
NFVI

MANO Controller



- Responsible for overseeing RAN life cycle
  - RAN topology
  - Non real-time control functions
- Policy and life cycle updates delivered to BoTM agents
- Promotes orchestration across virtual infrastructure layer
- Used to Signal the RAN to initiate BoTM's migration process

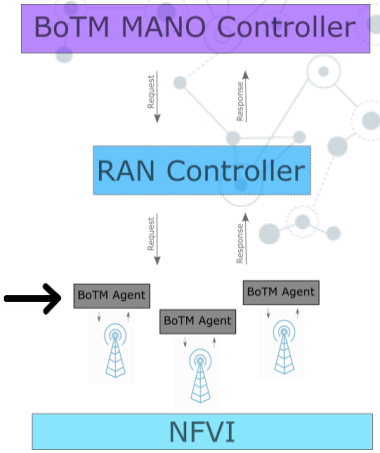
RAN Controller



- Responsible for managing RAN in real-time
  - Aggregating statistical data
  - Integrating network applications
  - Real-time control functions
- Enforce RAN policy updates
- Promotes orchestration across network functional layer
- Used to dynamically trigger X2 handover

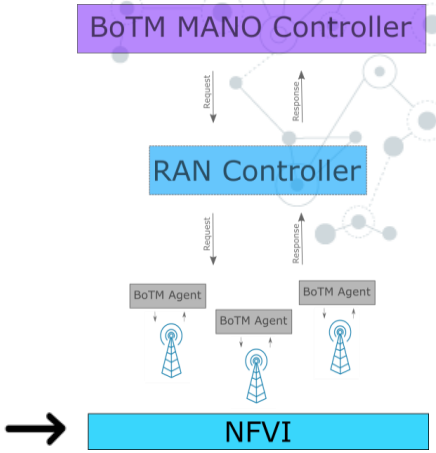
BoTM Agent

- Facilitate communication between BoTM MANO/RAN controller and base stations
- Enforce RAN orchestration updates



Virtualized Infrastructure

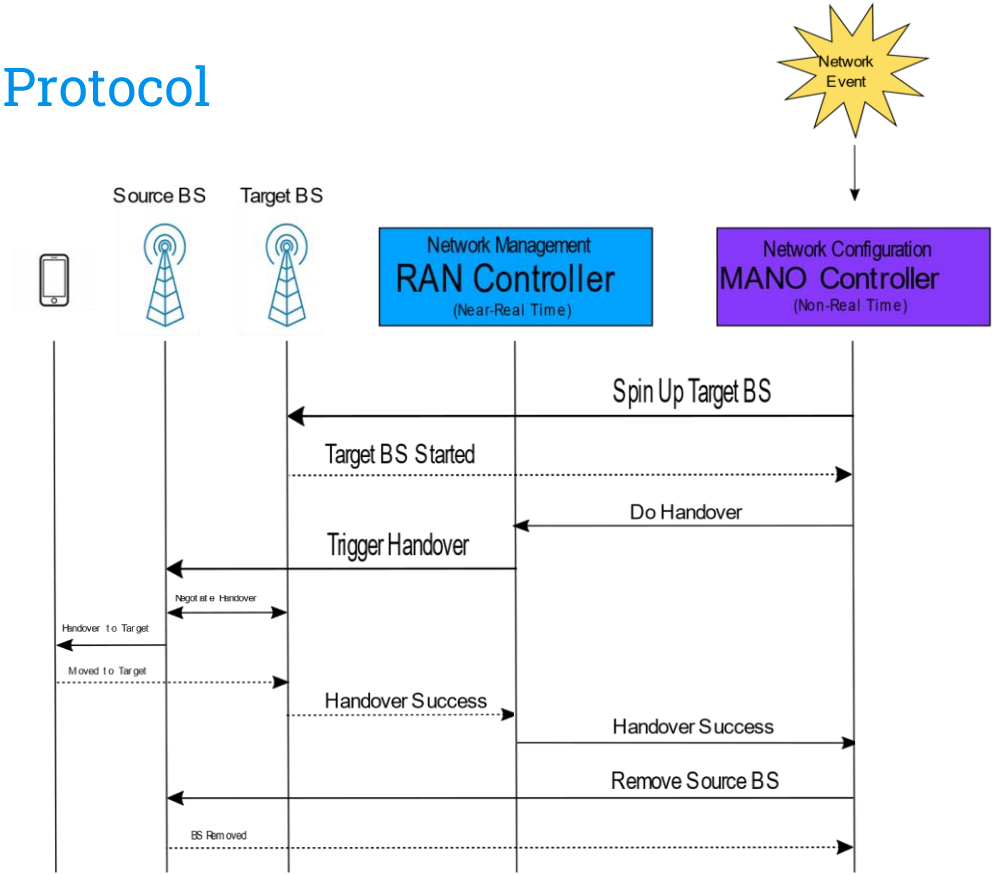
- Light-weight, tailored infrastructure
- Promotes dynamic instantiation and removal of base station instances
- Rapid deployment due to low overhead



3.

Migration

Migration Protocol

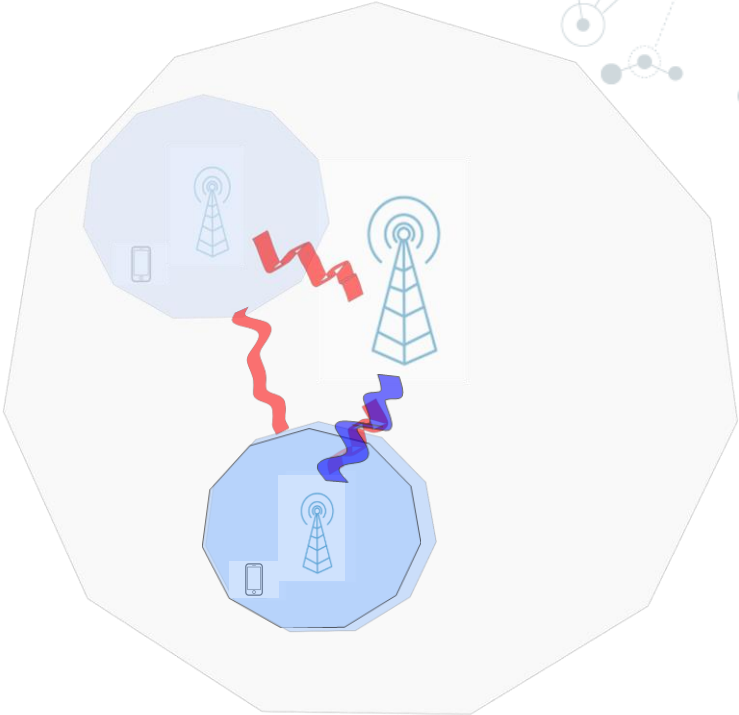


Implementation

- FlexRAN RAN Controller
- Deployed MANO Controller “above” FlexRAN controller
  - Leverage global view of RAN
  - Triggered migration based on drop in channel quality indicator
- BoTM agents ran over OAI eNodeBs
- X2 Handover managed through OAI’s X2AP implementation

Use Case: Interference Management in HetNets

- Heterogeneous Networks (HetNet) utilized to increase cell coverage and meet increased data rate demands
- Interference management is a critical challenge in HetNets
- Lack of programmability leads to less reactive management

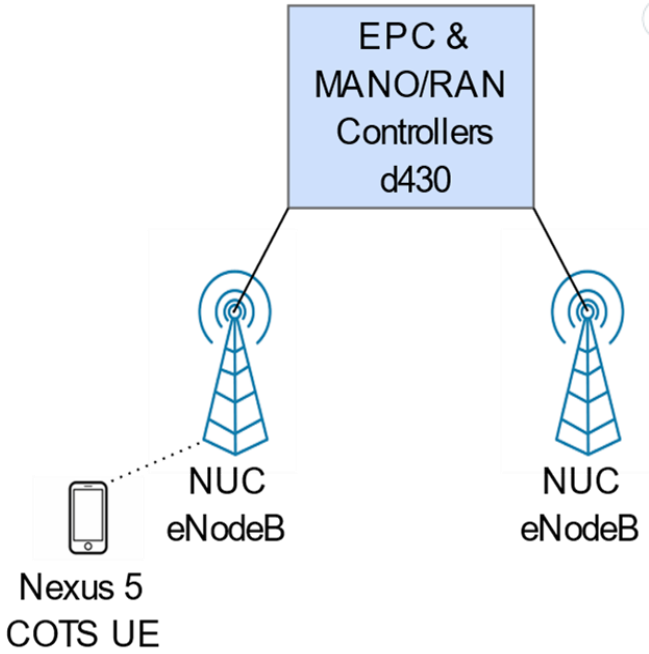


4.

Evaluation

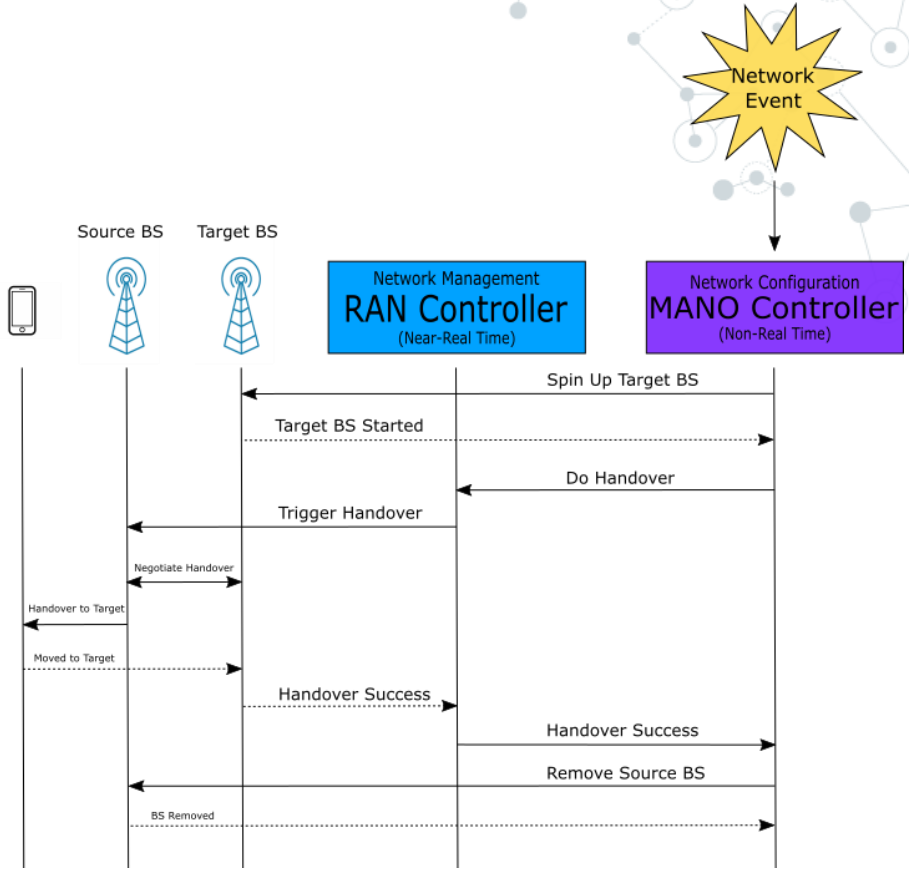
Evaluation Setup

- Powder Controlled RF Environment
- FlexRAN and BoTM Controllers
- EPC based on NextEPC
- Latest OAI release

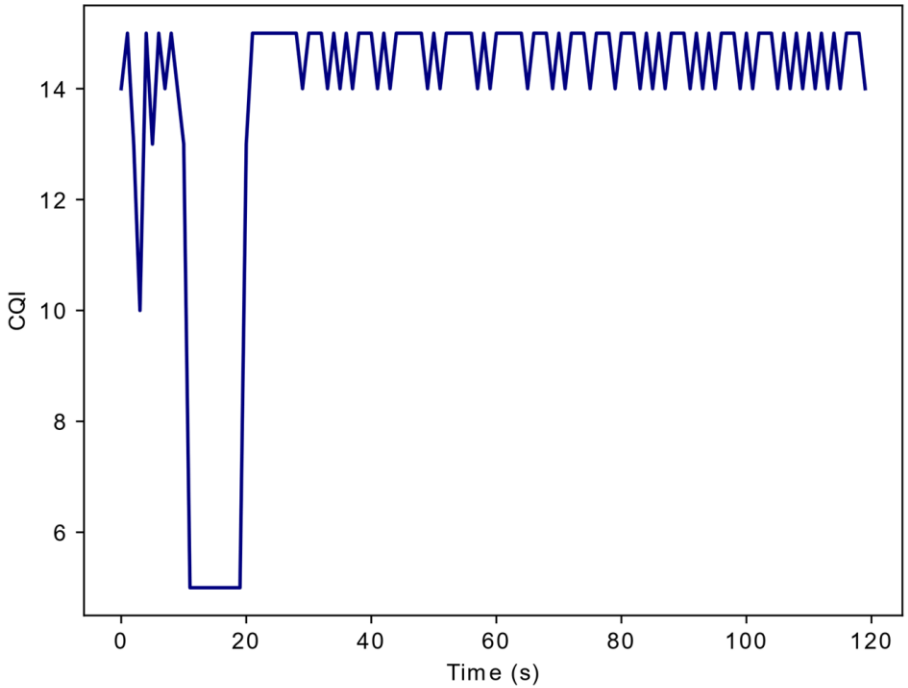


Evaluation Procedure

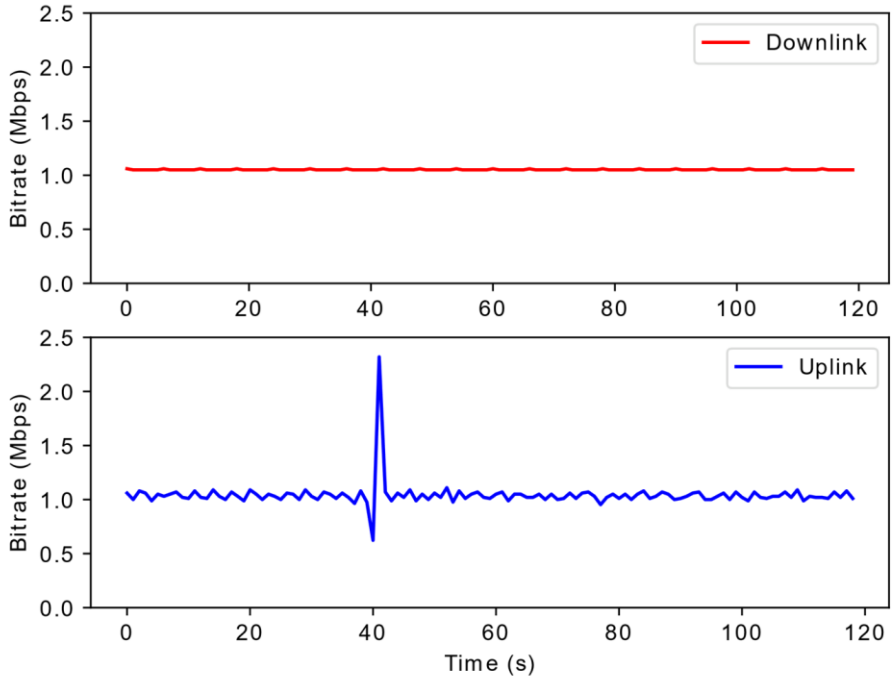
- Generated uplink and downlink traffic with iperf2
- Introduce interference with attenuator
- MANO detected drop in CQI and triggered migration procedure
- Monitored CQI, bitrates, and packet loss



Channel Quality Indicator vs. Time



Uplink and Downlink Bitrates vs. Time



Packet Loss Comparison Against Standalone X2 Handover

	Average Bitrate	Average Packet Loss	Total Dropped Packets	Total Packets Sent
BoTM Downlink	**1.03 Mbps**	**1.9%**	**206**	**10701**
Standalone Downlink	**1.03 Mbps**	**2.1%**	**223**	**10701**
BoTM Uplink	**1.03 Mbps**	**0.19%**	**20**	**10564**
Standalone Uplink	**1.03 Mbps**	**0.16%**	**17**	**10565**

5.
Concluding Remarks

Future Work

Spectrum Migration

Dynamically move base stations between frequencies with little to no added impact on end points

Dynamic Carrier Aggregation

Utilize adjacent resources by instantiate target base station on optimal band

Load Balancing

“Split” a base station instance by instantiating multiple target base station instances and distributing endpoints among targets

Intelligence

Integrate statistical model into decision process to react in real-time based on current network state

Summary

- Presented a novel RAN management primitive
- Enables orchestration across infrastructure layer and mobile network function layer
- Provided and validated proof of concept prototype
- Improve RAN resource management in the context of future generation networks

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