# Performance Analysis of IEEE 802.11ad in Large Scale Deployments Through Experiments and Simulations

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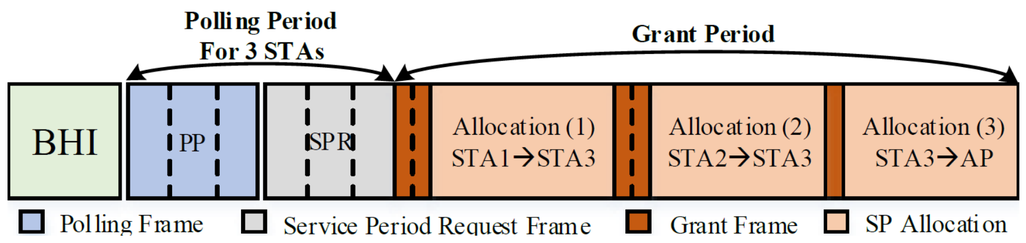
## Motivation

- Extend the WLAN IEEE 802.11ad Model in ns3 to support scheduled access, spatial reuse, clustering, and relaying.
- Performance analysis of first COTS 802.11ad devices in large scale deployments.

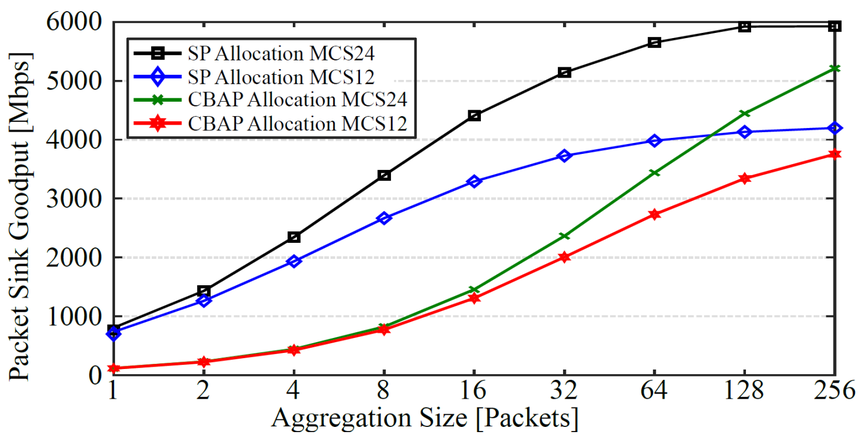
## 802.11ad Model and Capabilities in ns-3

### Channel Access:

- Supports CSMA/CA Channel Access, Service Period Channel Access, and Dynamic Allocation of Service Period as defined in IEEE 802.11ad amendment.
- Allocation of service periods for either isochronous or asynchronous traffic type.
- Customized admission control and resource allocation for traffic stream allocation.

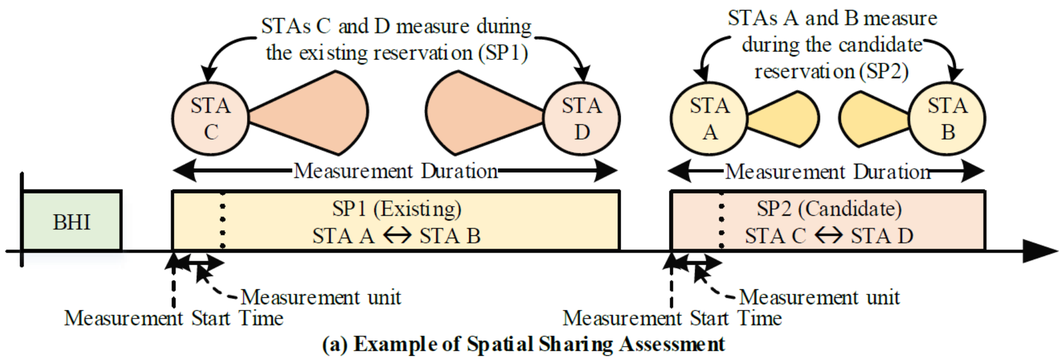



**Comparing Channel Access Schemes:**



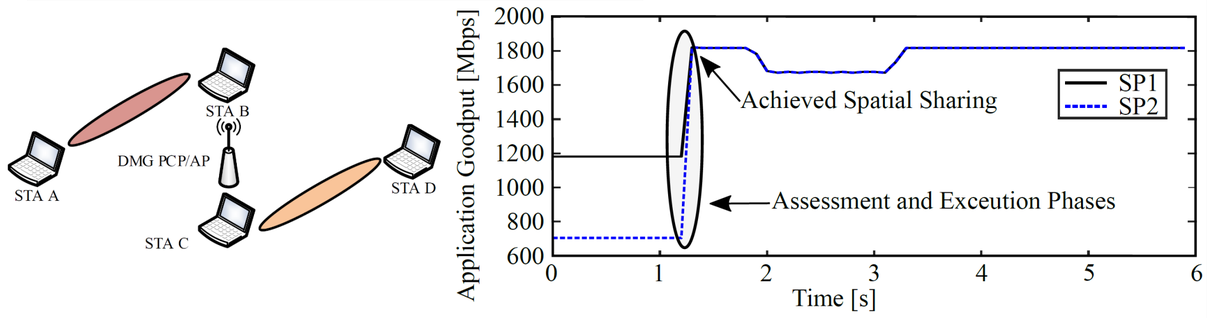

### Spatial Sharing:

- Supports interference and channel assessment procedure to allow concurrent transmissions.



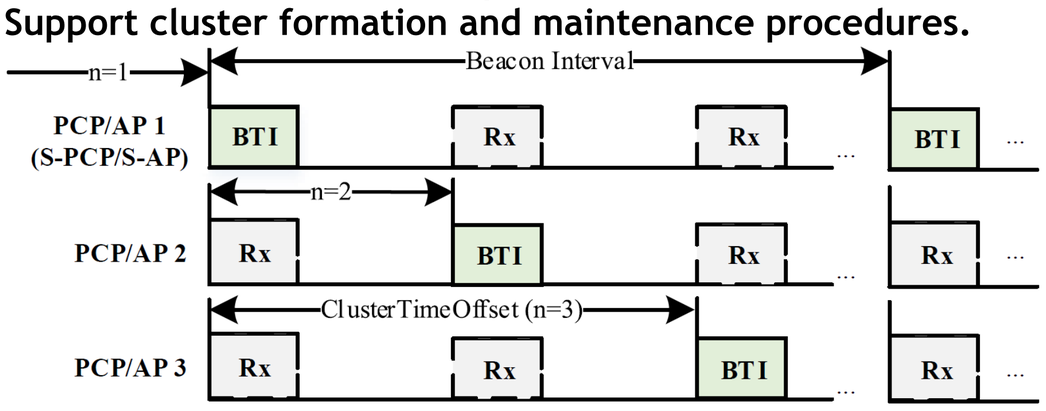

(a) Example of Spatial Sharing Assessment

**Spatial Sharing Example and Results**




### Decentralized Clustering:

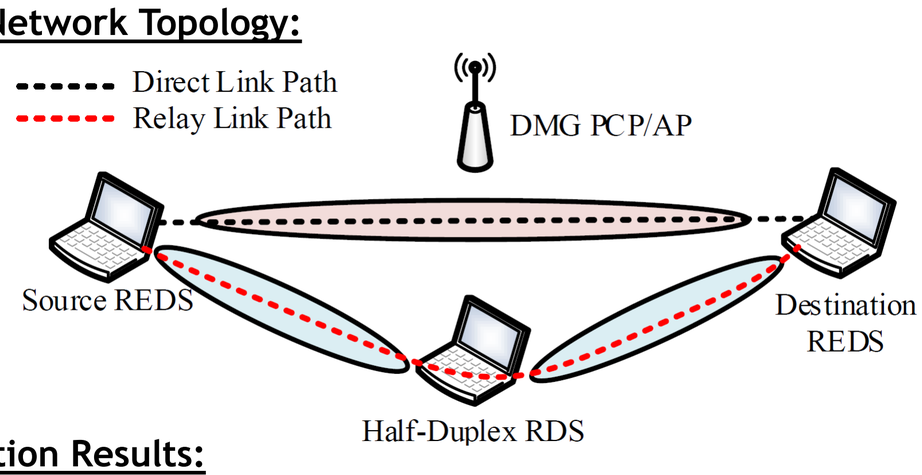
- Allows co-channel APs to coordinate beaconing to avoid interference and enhance operation in dense environments.
- Support cluster formation and maintenance procedures.



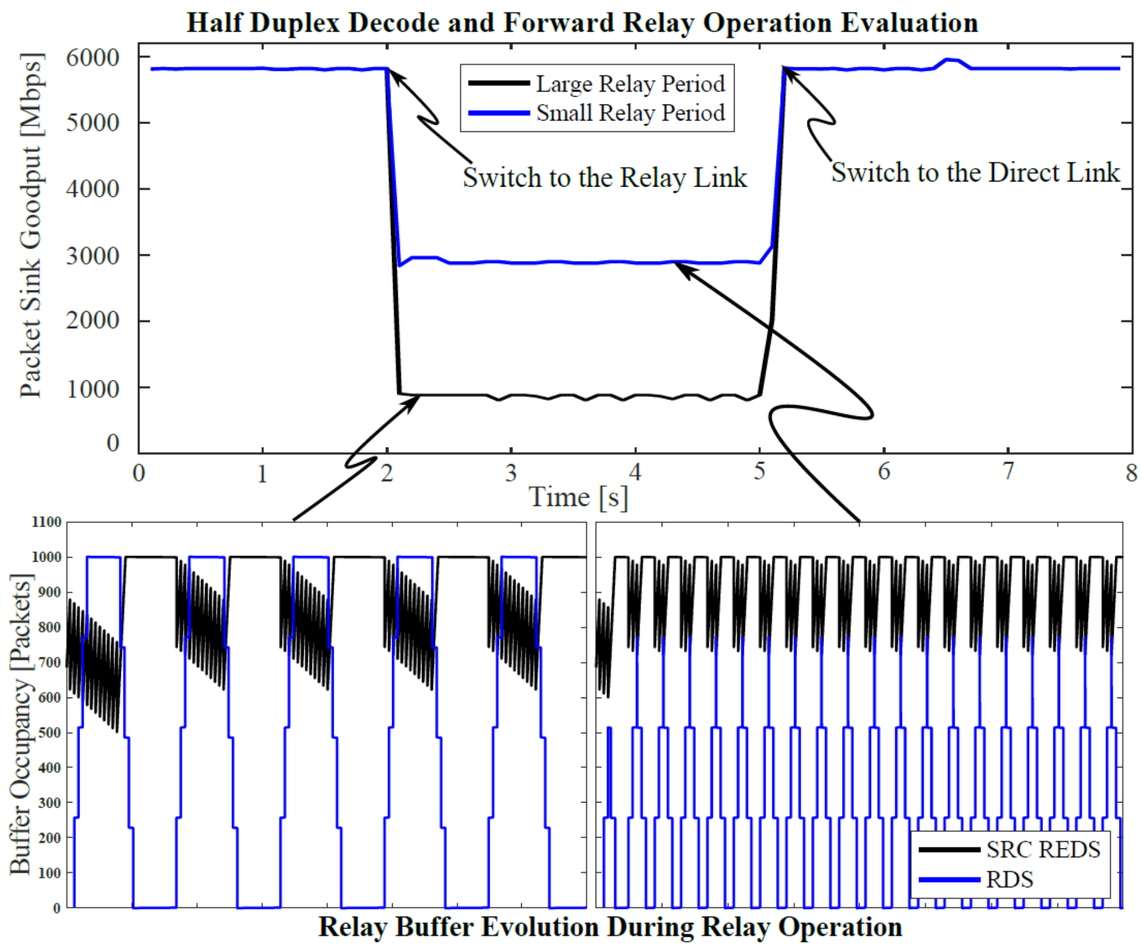

### DMG Relay Operation:

- Supports Half Duplex Decode and Forward (HD-DF) and Full Duplex Amplify and Forward (FD-AF) Relay operation modes for coverage area extension, improved link resilience against interruptions, and persistent multi-gigabit throughput.
- Incorporate frame exchange rules during a service period allocation as defined in the amendment for both FD-AF and HD-DF relay modes.

**Relay Network Topology:**



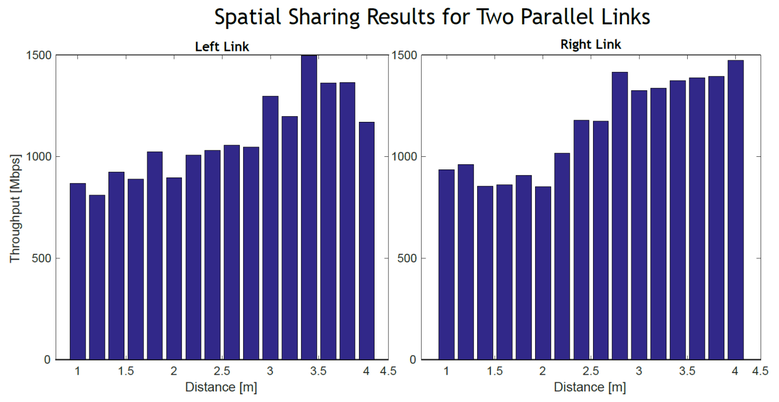

**Evaluation Results:**




Relay Buffer Evolution During Relay Operation

## Large Deployment Testbed

- A test bed of large number of TP-Link TALON 7200AD routers with custom LEDE OS.
- The custom LEDE OS allows TALON routers to work in monitor mode, station mode, or access point mode.
- Study MAC layer efficiency, interference, spectrum sharing, spatial sharing, and multi-AP deployment issues.




## References

[1] Implementation and Evaluation of a WLAN IEEE 802.11ad Model in ns-3. Hany Assasa, Joerg Widmer
[2] Extending the IEEE 802.11 ad Model: Scheduled Access, Spatial Reuse, Clustering, and Relaying. Hany Assasa, Joerg Widmer