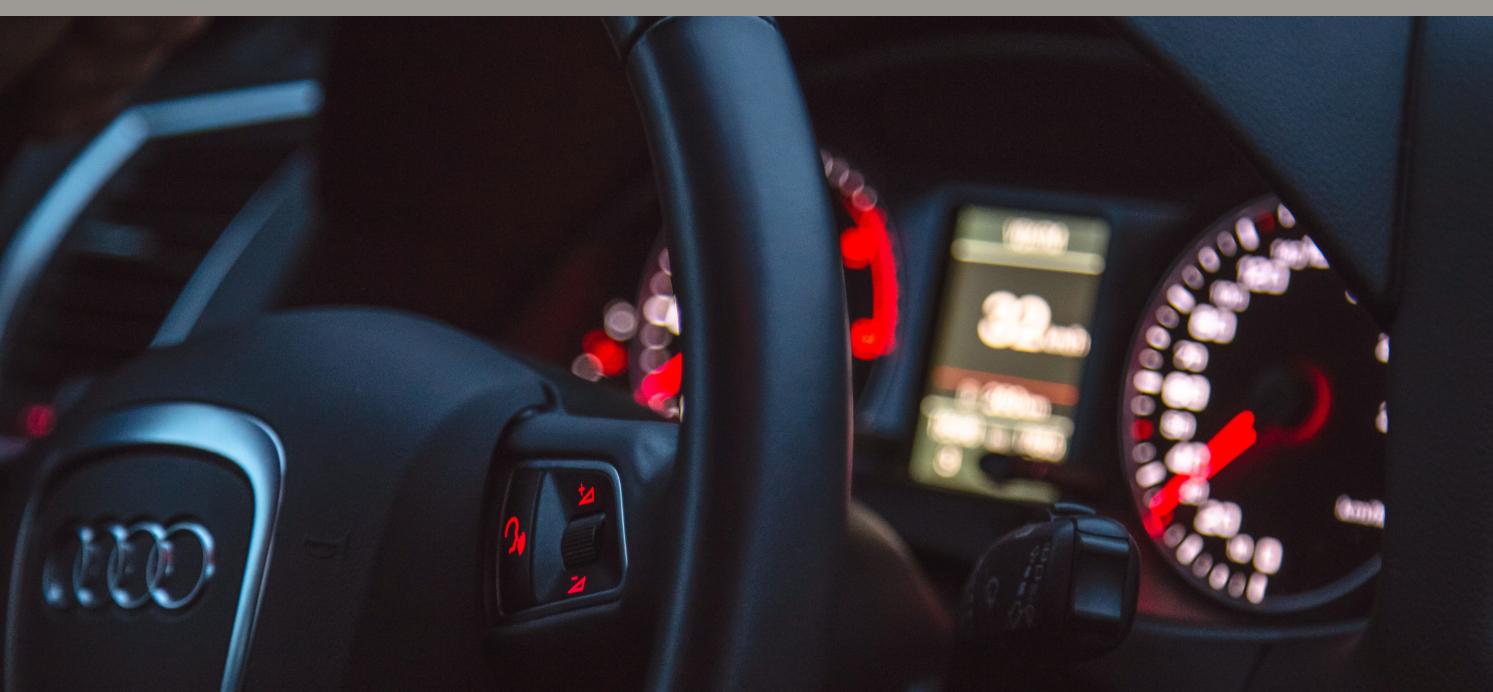
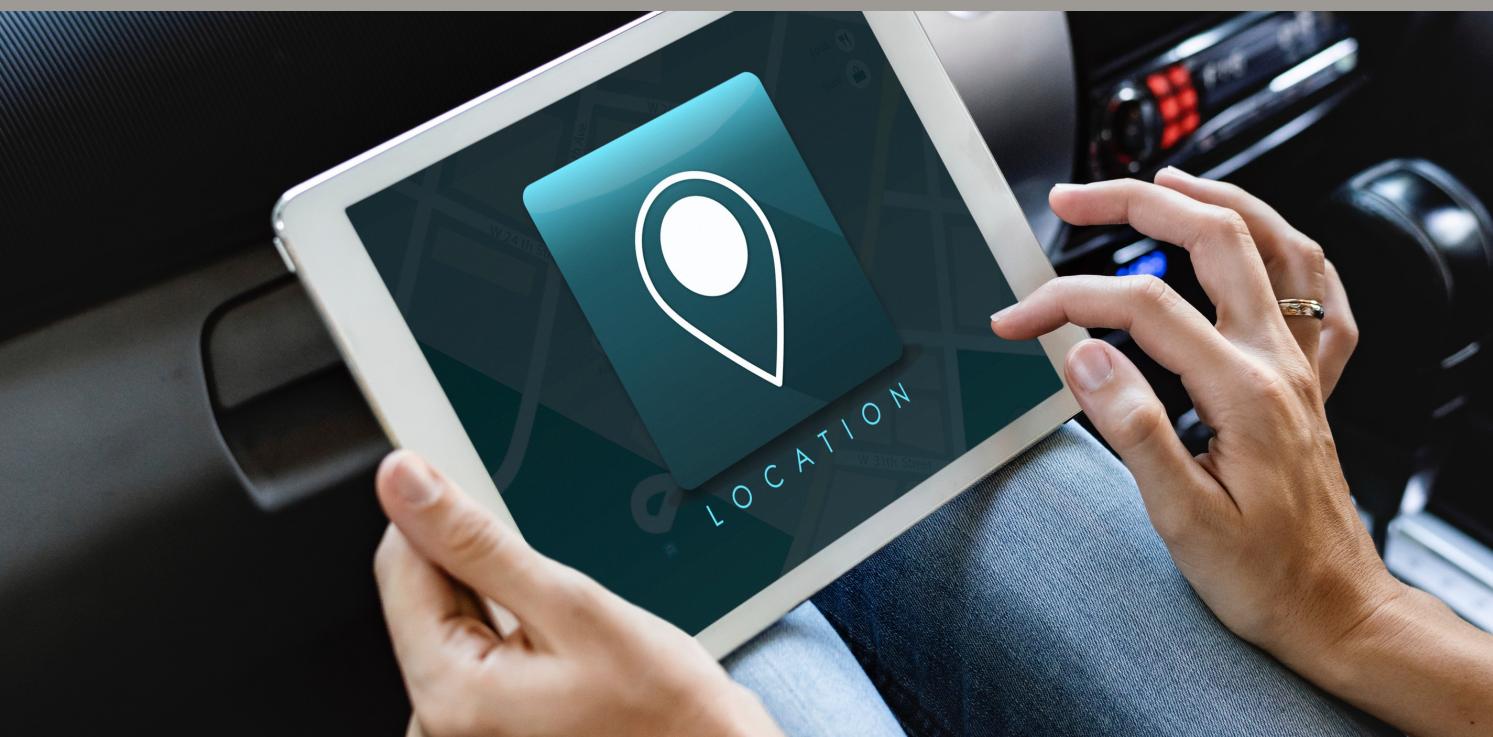


# EVALUATION OF SPATIAL SHARING IN IEEE 802.11AD/AY

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# OBJECTIVES

## 802.11AD NS-3 SIMULATOR VALIDATION

- Literary Study and Familiarisation with 802.11ad module
- Investigation into Performance of different MAC Protocols
- Evaluation of Spatial Sharing Functionality
- Extension of Spatial Sharing Implementation

# IEEE 802.11AD STANDARD

- First Multi-Gigabit Wifi Protocol
- Operates at the 60 GHz Band Frequency
- Extremely High Attenuation partially countered by Directional Transmission and Beamform Training Processes
- Does not Specify a Spatial Sharing Mechanism, rather just provides Infrastructure support



## INTRODUCTION

# 802.11AD MODULE FOR NS-3

Currently, there is no support for the 802.11ad Protocol in the base NS-3 Simulator. For the duration of the Internship, a module developed by H. Assasa of IMDEA Networks Institute was used. [1]

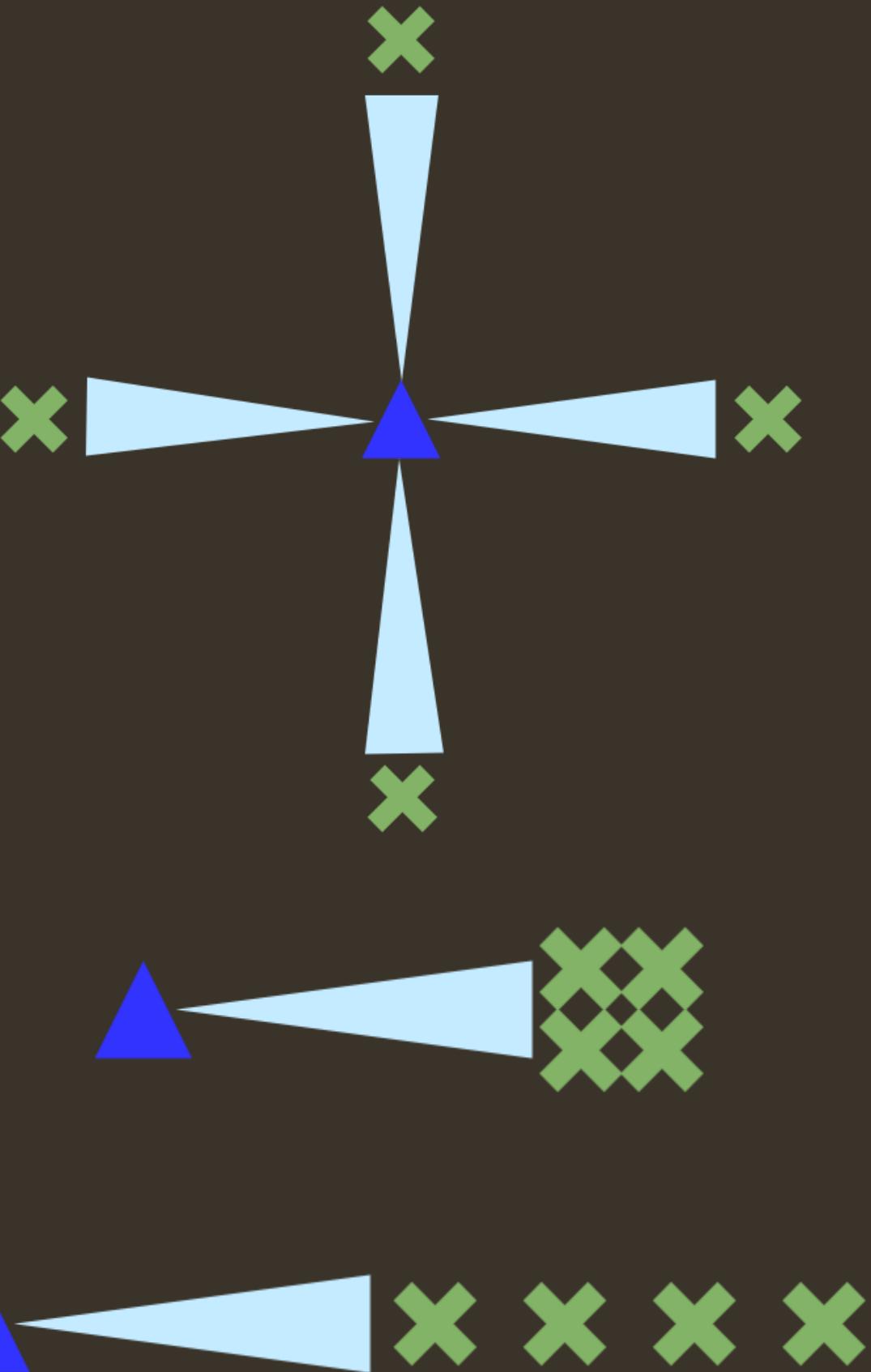
**This module built for Ns-3 was used in all investigations and extensions.**

**The module introduces new features to NS-3 such as Directional Transmission, Beamform Training along with Support for Spatial Sharing.**

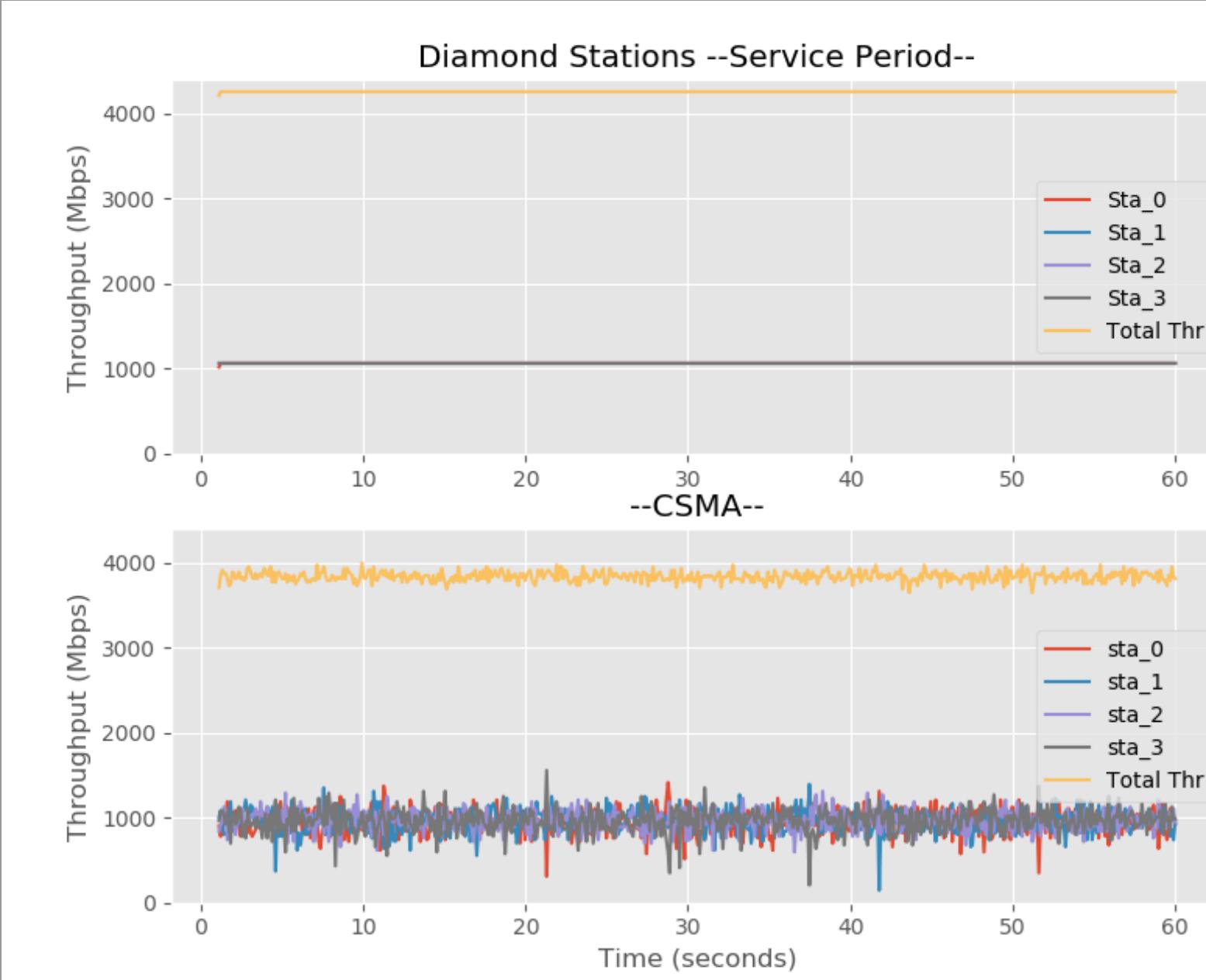
[1] H. ASSASA, J. WIDMER. "EXTENDING THE IEEE 802.11AD MODEL: SCHEDULED ACCESS, SPATIAL REUSE, CLUSTERING, AND RELAYING". WORKSHOP ON NS-3 (WNS3), 2017.

# PERFORMANCE OF MAC PROTOCOLS IN DIRECTIONAL TRANSMISSION

- Experiment to Test Performance of Service Periods (SP) and CSMA
- Three Main Scenarios:
- Diamond Formation
- Clustered Formation
- Inline Formation

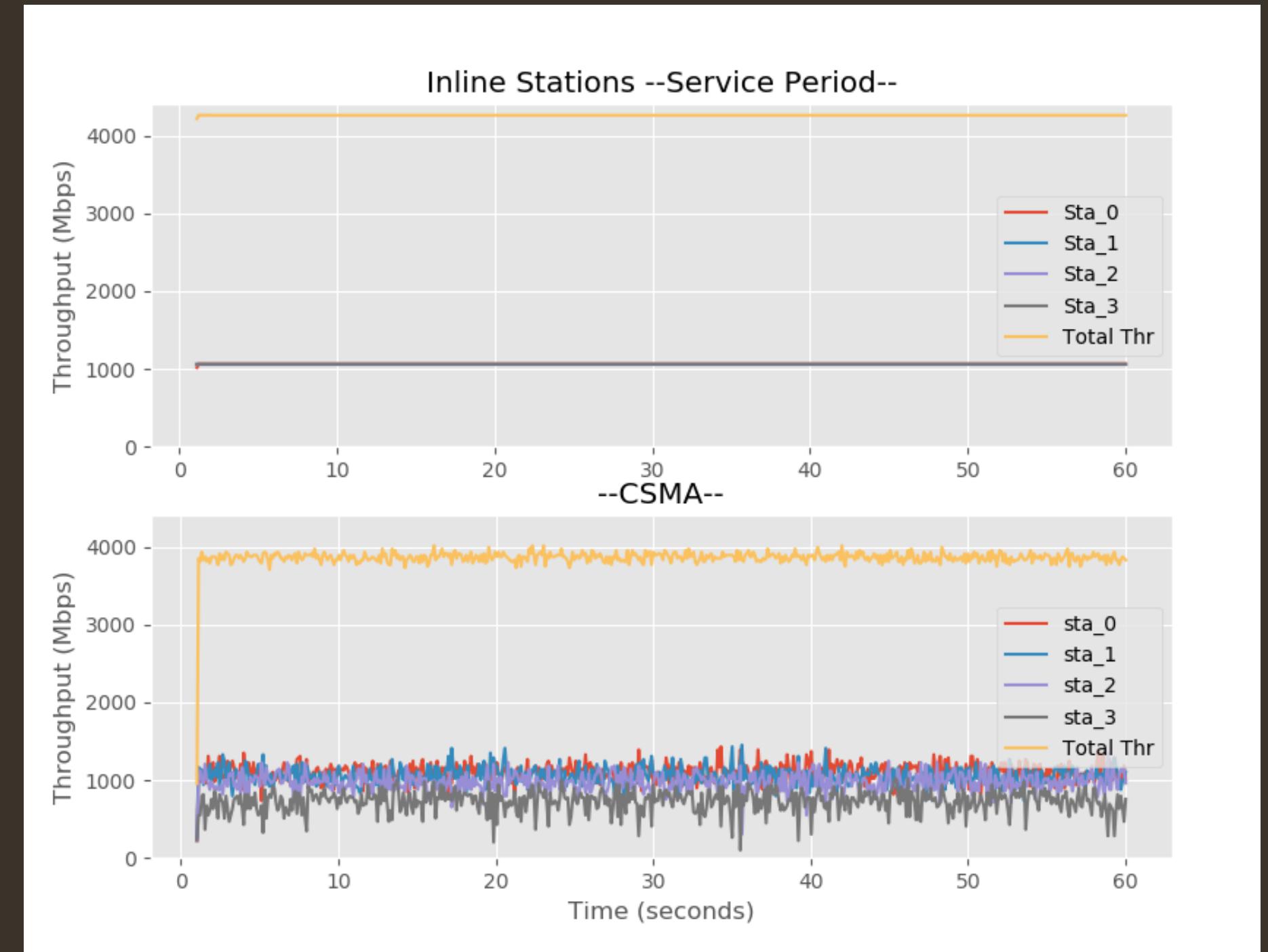


# MAC PROTOCOL RESULTS

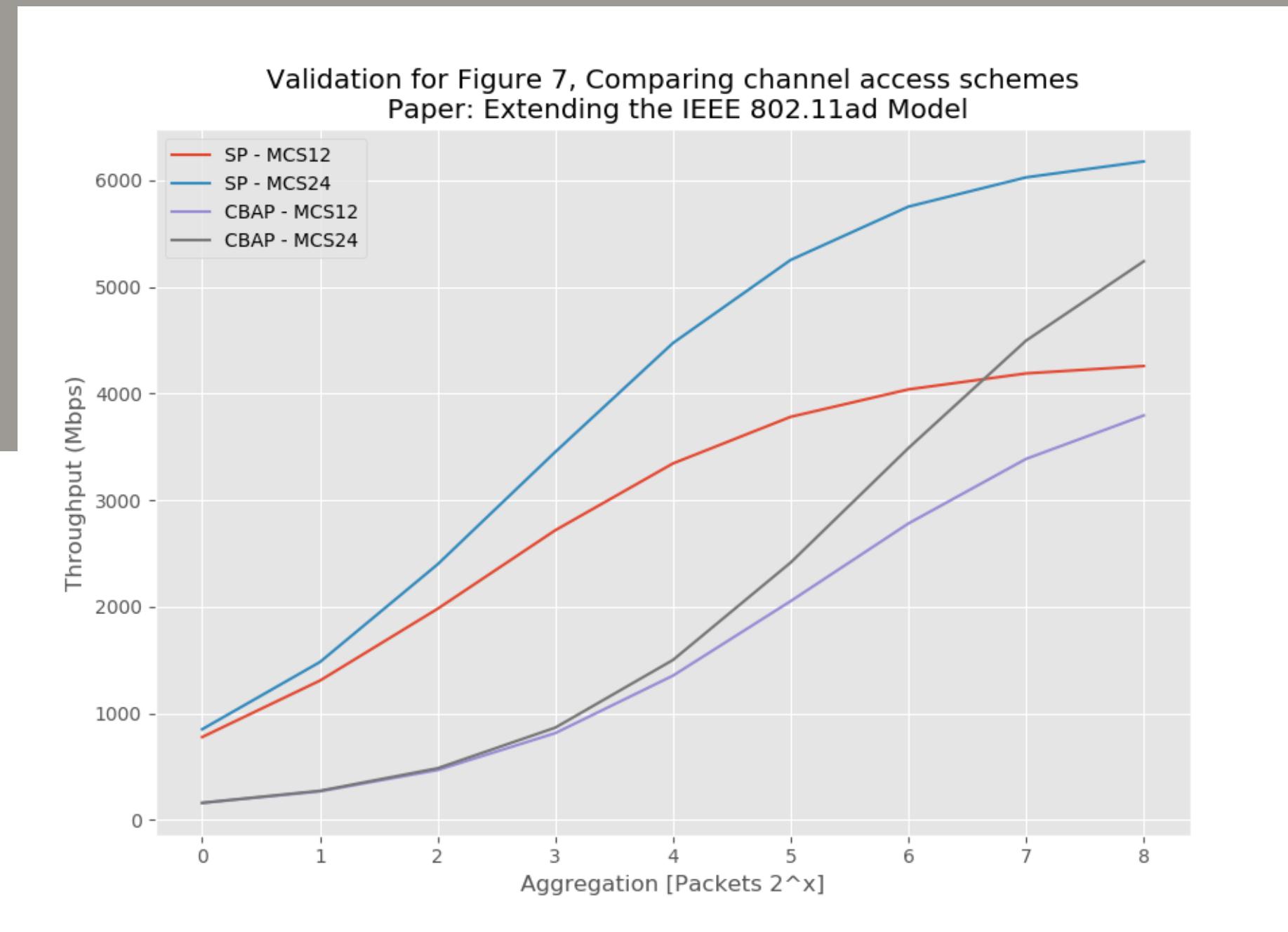
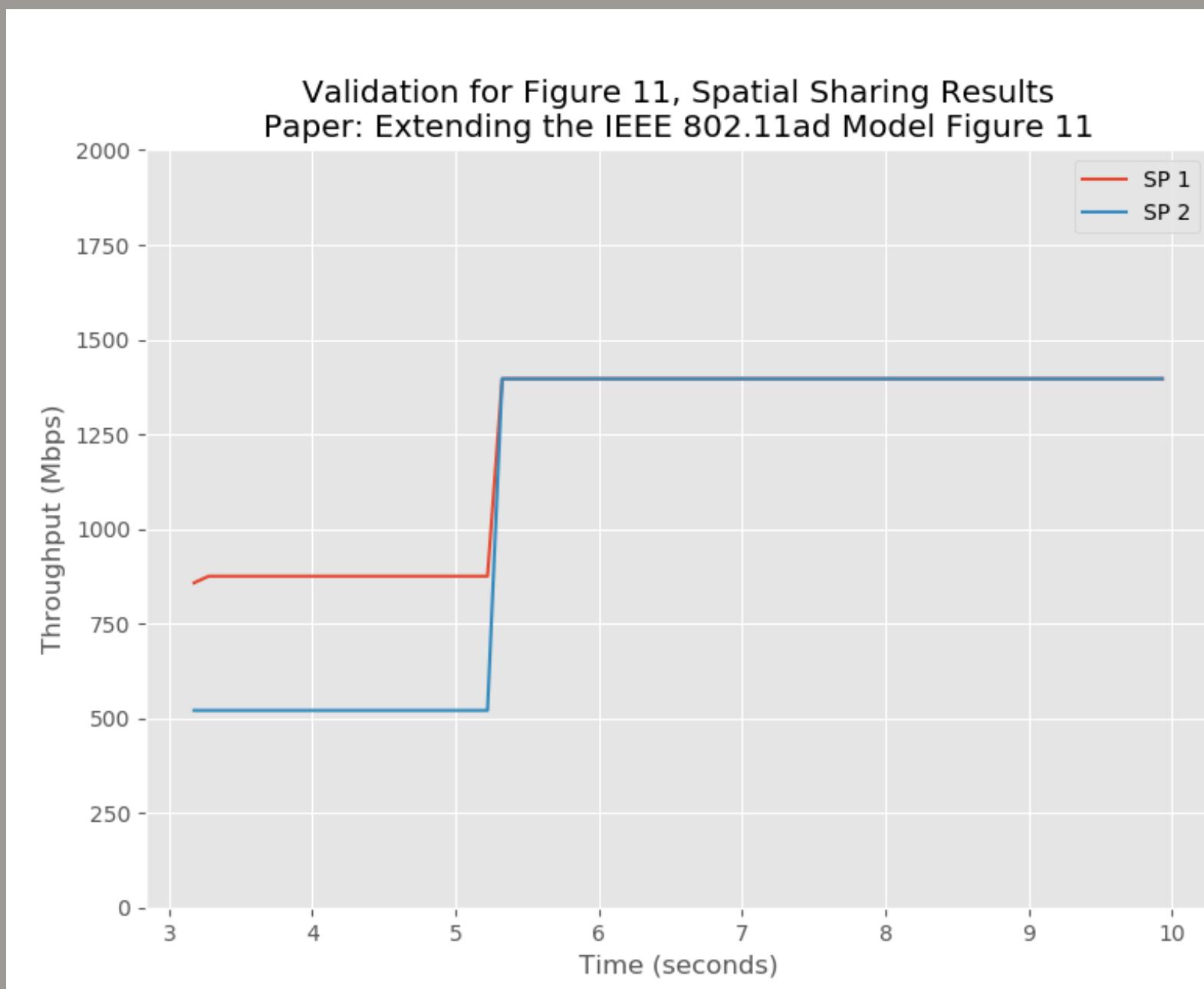


# MAC PROTOCOL RESULTS CONT.

- Results would Indicate SP are more predictable
- On further tests SP appeared to be more prone to Errors where association fails, especially with larger number of STAs
- SP has further disadvantage of being a Centralised MAC where CSMA is Decentralised



# PAPER VALIDATION [1]



[1] H. ASSASA, J. WIDMER. "EXTENDING THE IEEE 802.11AD MODEL: SCHEDULED ACCESS, SPATIAL REUSE, CLUSTERING, AND RELAYING". WORKSHOP ON NS-3 (WNS3), 2017.

# IMPLEMENTATION OF SPATIAL SHARING INFRASTRUCTURE

- Started Implementation of Helper Functions
- Creation of Scheduler Function which takes Interference measurements of the Channel at a given Frequency
- New Encoding Function, which Encodes Interference Information into 8 bit Values
- Fixed Multitude of Bugs in Existing Software

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<i class="fa fa-happy-clients">
<h3>Happy Clients</h3>
</div>
</div>
<!-- end first count item -->
<!-- second count item -->
<div class="col-md-3 col-sm-6 col-xs-12 text-center wow fadeInDown"
data-wow-duration="500ms" data-wow-delay="200ms">
<div class="counters-item">
<div>
<span data-speed="3000" data-to="565">565</span>
</div>
<i class="fa fa-check-square fa-3x"></i>
<h3>Projects completed</h3>
</div>
</div>
<!-- end second count item -->
<!-- third count item -->
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data-wow-duration="500ms" data-wow-delay="400ms">
<div class="counters-item">
<div>
<span data-speed="3000" data-to="95">95</span>
<span>%</span>
</div>
<i class="fa fa-thumbs-up fa-3x"></i>
<h3>Positive feedback</h3>
</div>
</div>
<!-- end third count item -->
<!-- fourth count item -->
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<div class="counters-item kill-margin-bottom">
<div>
<span data-speed="3000" data-to="2500">2500</span>
</div>
```

INTERFERENCE MITIGATION IN MULTI-OPERATOR MMWAVE NETWORKS

# FOURTH YEAR PROJECT

CSMA/CA is a troublesome MAC when used with Directional Transmissions due to the hidden terminal problem. Utilisation of SPs is a suitable alternative Mechanism. Unfortunately SPs pose the problem of mutual Interference when two separate, uncooperative operators are working in overlapping regions.

**Research will initially be conducted into existing relevant literature on interference mitigation in directional transmission systems. Based on this review an algorithm will be investigated and implemented that will take into account the coexistence issues.**



Q&A

# THANK YOU

27TH OF AUGUST 2018

PROF. DA SILVA'S 5TH ANNUAL RESEARCH WORKSHOP WATERFORD