SAND2021-6783C

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Clipping for More Efficient Large-Scale Simulations in ns-3

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WNS3 2021 – Lightning Talk – June 24, 2021

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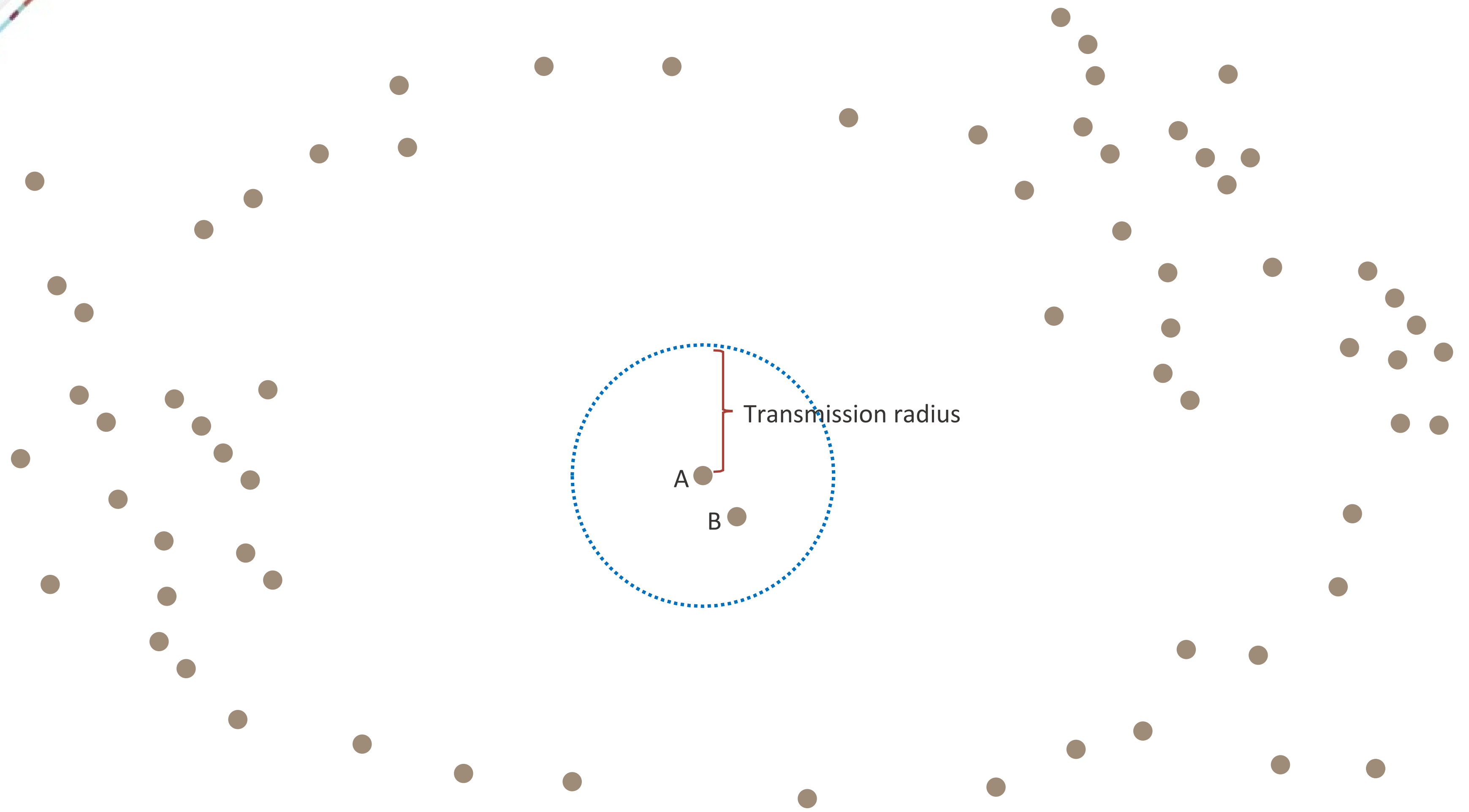
Events Scheduled on Every Node



Receive event for every node

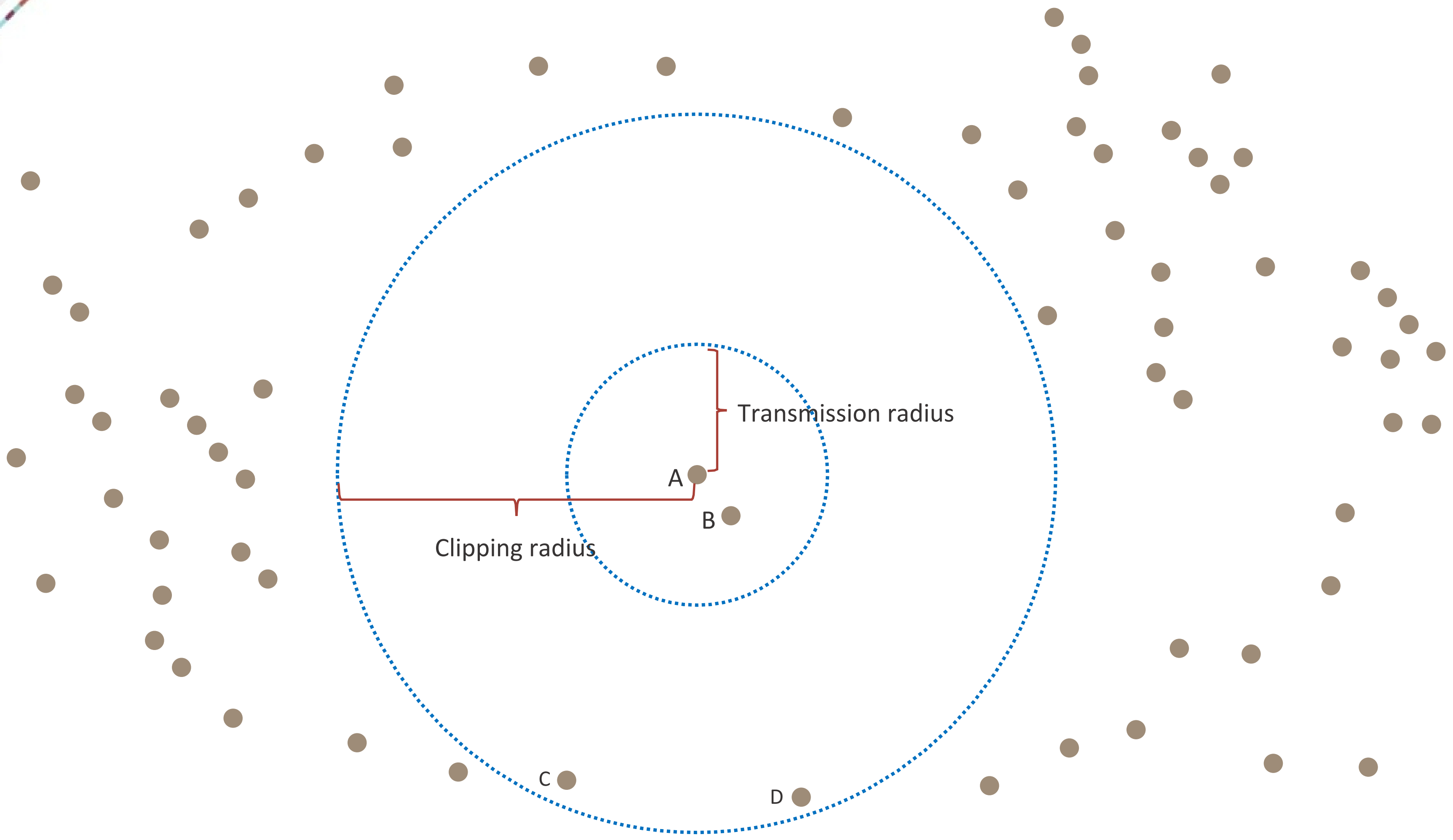
Event Priority Queue

Receive N	10.008
Receive M	10.0078
Receive L	10.0075
Receive K	10.007
Receive J	10.0068
Receive I	10.0067
Receive H	10.0066
Receive G	10.0065
Receive F	10.0064
Receive E	10.0062
Receive D	10.006
Receive C	10.005
Receive B	10.001

ns-3 sends every packet to every wireless receiver in the same channel in a simulation

This can be inefficient for certain large-scale simulations

Clipping Avoids Extra Overhead

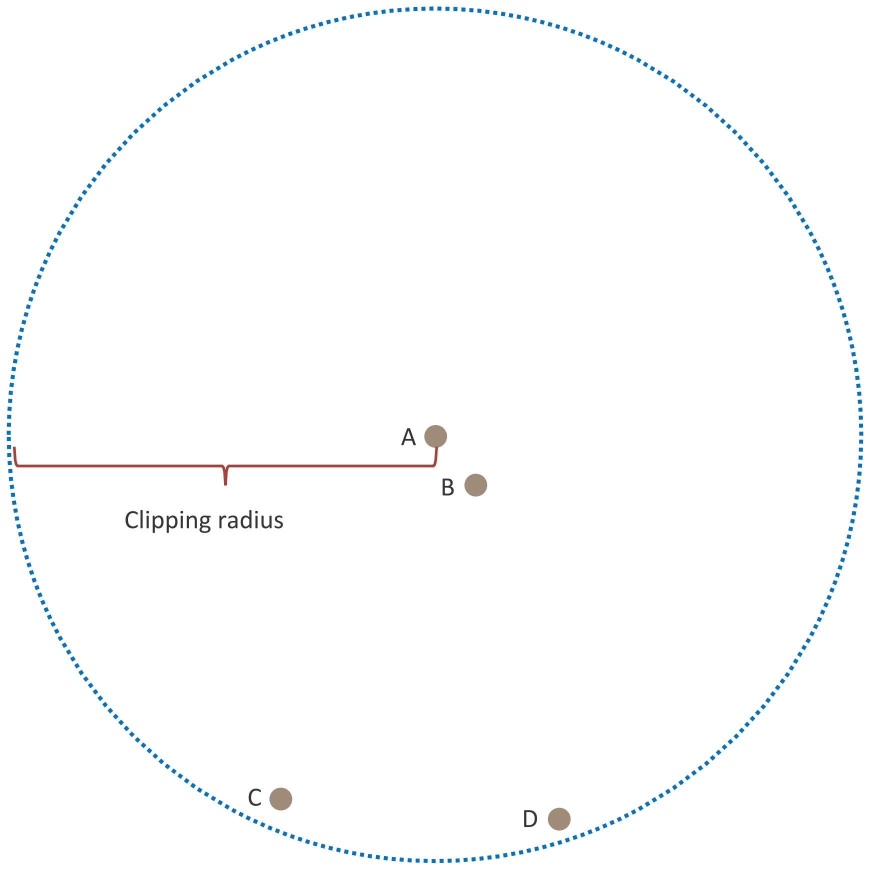


Clipping: Only schedule receive events on nodes within some clipping radius

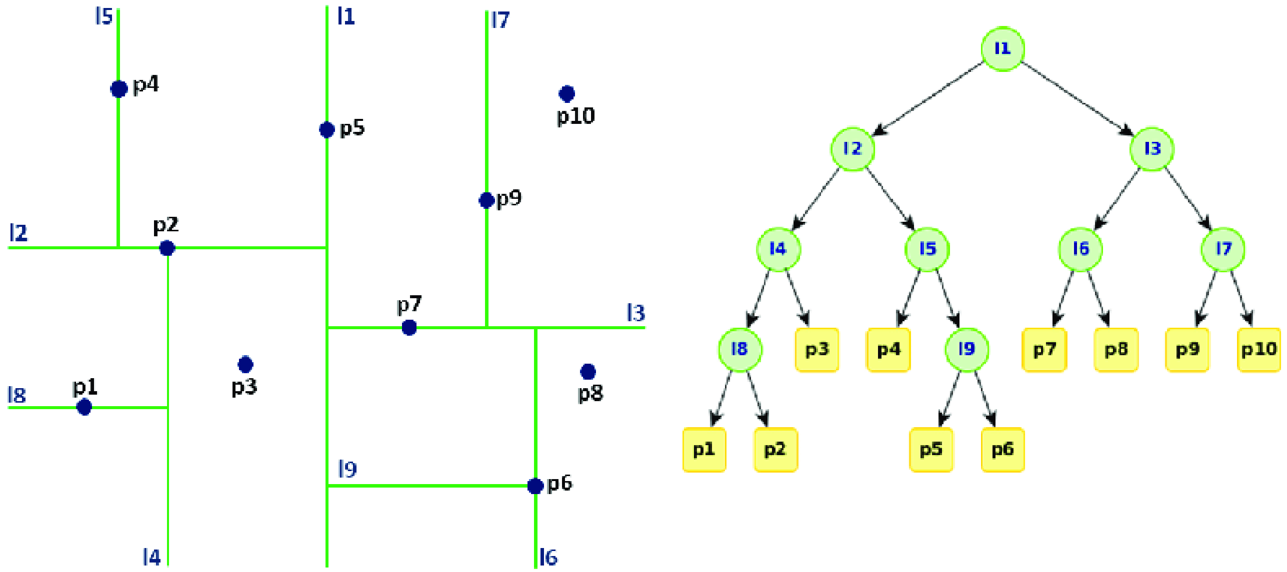
Determining Nodes Within the Clipping Radius

Need to be able to list all the nodes within A's clipping radius. {B,C,D}

Bad idea: compute distance from A to every other node.



Spatial Indexing



[John Anzola, et. al.]

Instead, use a k-d tree space partitioning data structure to organize node locations for fast ”look up” of nodes within range.

Clipping Feature is Being Merged into ns-3


SAND2017-7695C

A Novel Approach to Exponential Speedup of Simulation Events in Wireless Networks

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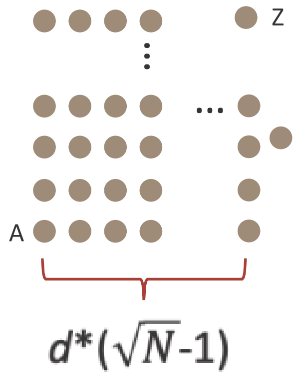
Abstract—We demonstrate a new approach that yields exponential speedup of communication events in discrete event simulations (DES) of mobile wireless networks. With the trending explosive growth of wireless devices including internet-of-things devices, it is important to have the capability to simulate wireless networks at large scale accurately. Unfortunately, current simulation techniques are inadequate for large-scale network simulation especially at high rate of total transmission events due to poor performance scaling. This has limited many studies to much smaller sizes than desired. We propose a method for attaining high fidelity DES of mobile wireless networks that leverages (i) path loss of transmissions and (ii) the relatively slower topology changes in a high transmission rate environment. Our approach guarantees a runtime of $k(r)O(\log N)$ per event, where N is the number of simulated wireless nodes, r is a factor of maximum transmission range, and $k(r)$ is typically constant obeying $k(r) \ll N$.

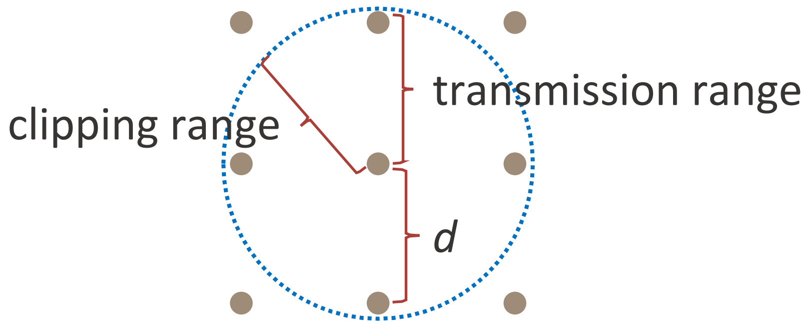
I. Introduction

Published simulation improvements have now been integrated into the ns-3 simulator and are under review for inclusion

AODV Example

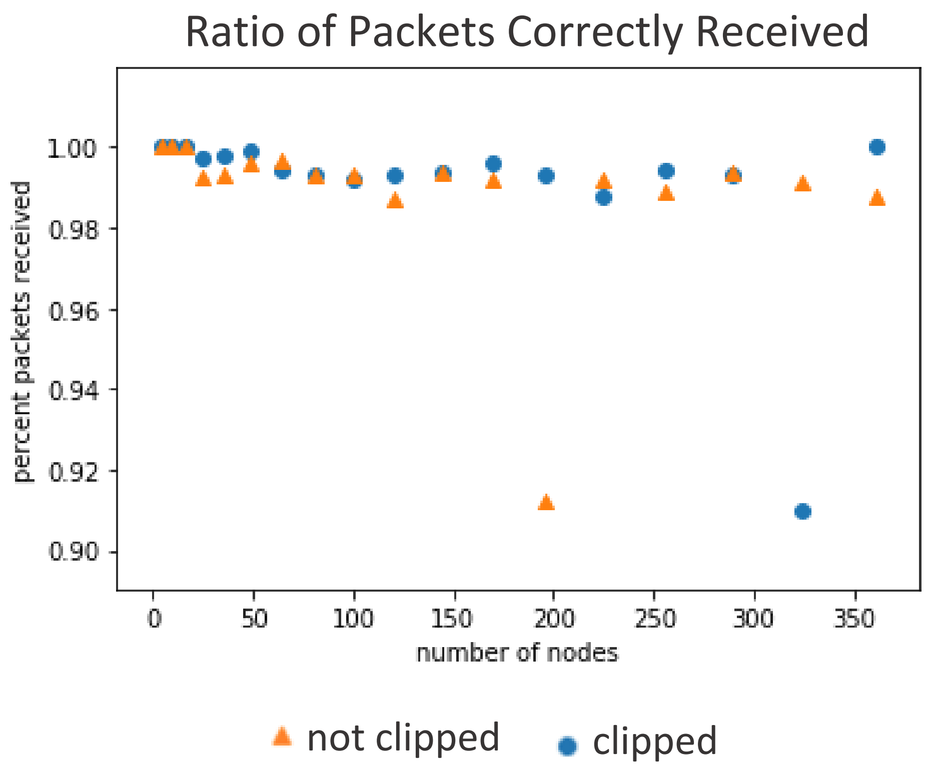
Grid of *N* nodes spaced *d* units apart





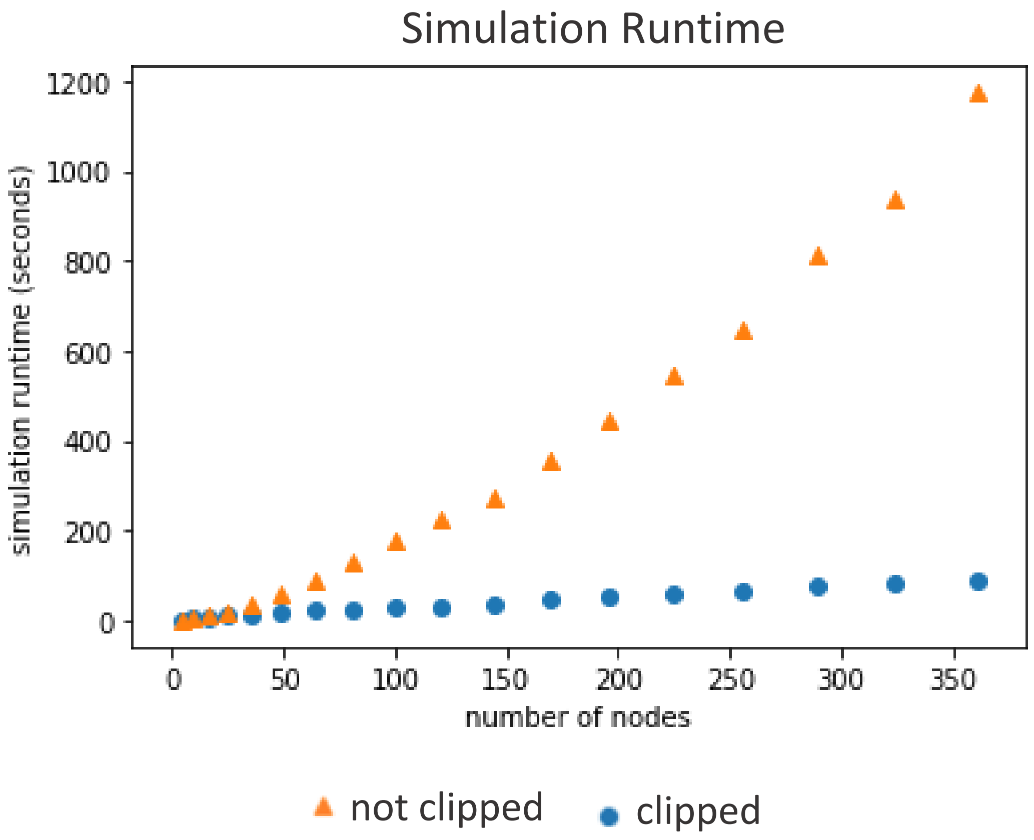
Use AODV Adhoc Routing protocol to route 1 packet/second from node A to node Z.

AODV Results: Similar packets received



Comparison of number of packets received with and without “clipping”
AODV drops a few packets (in both cases) while initially establishing routes.

AODV Results: Faster runtime



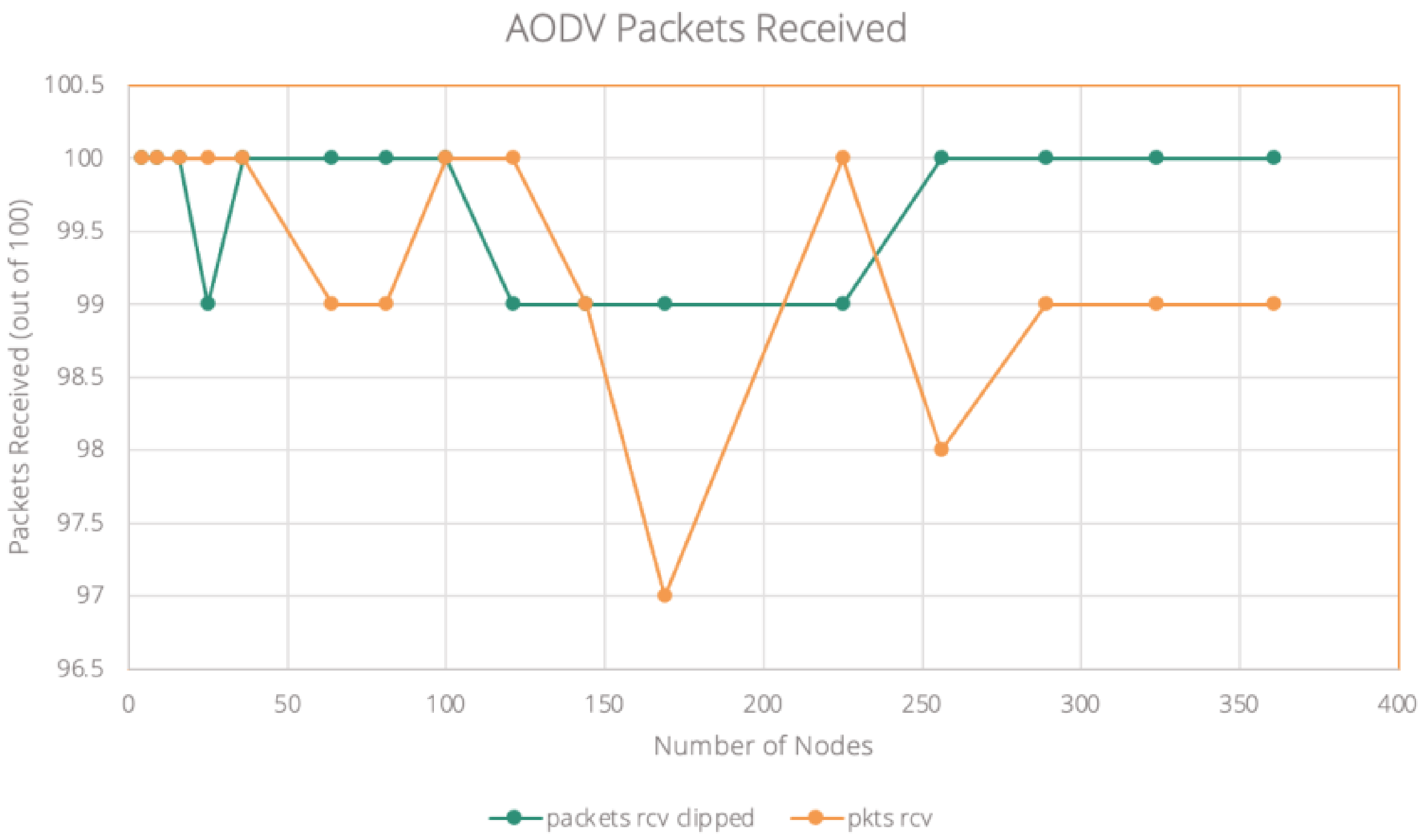
~14x speedup for 361 nodes

Questions?

Happy to answer any questions now or later via email: bdnewto@sandia.gov

Backup Content

AODV Results: Similar packets received



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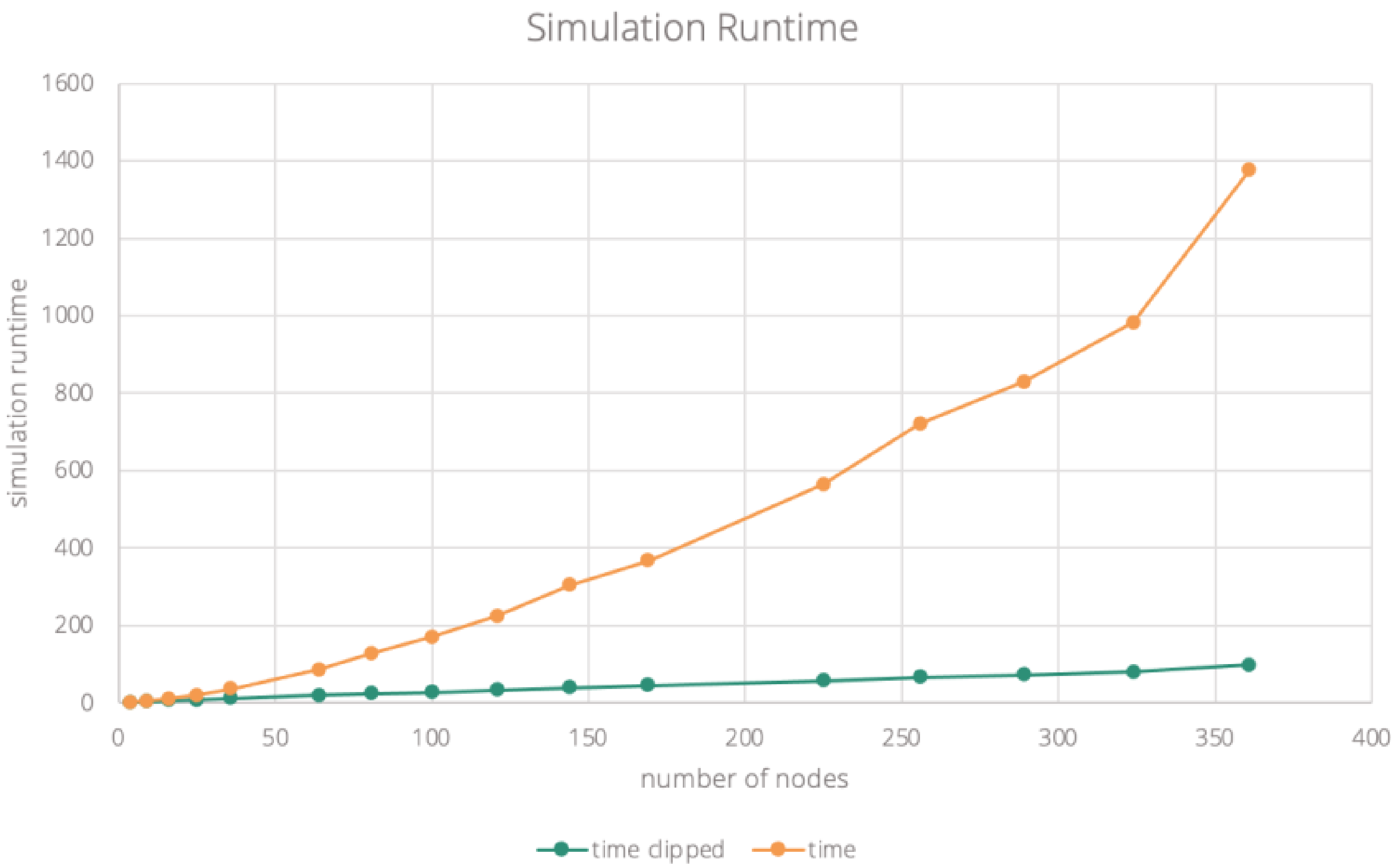
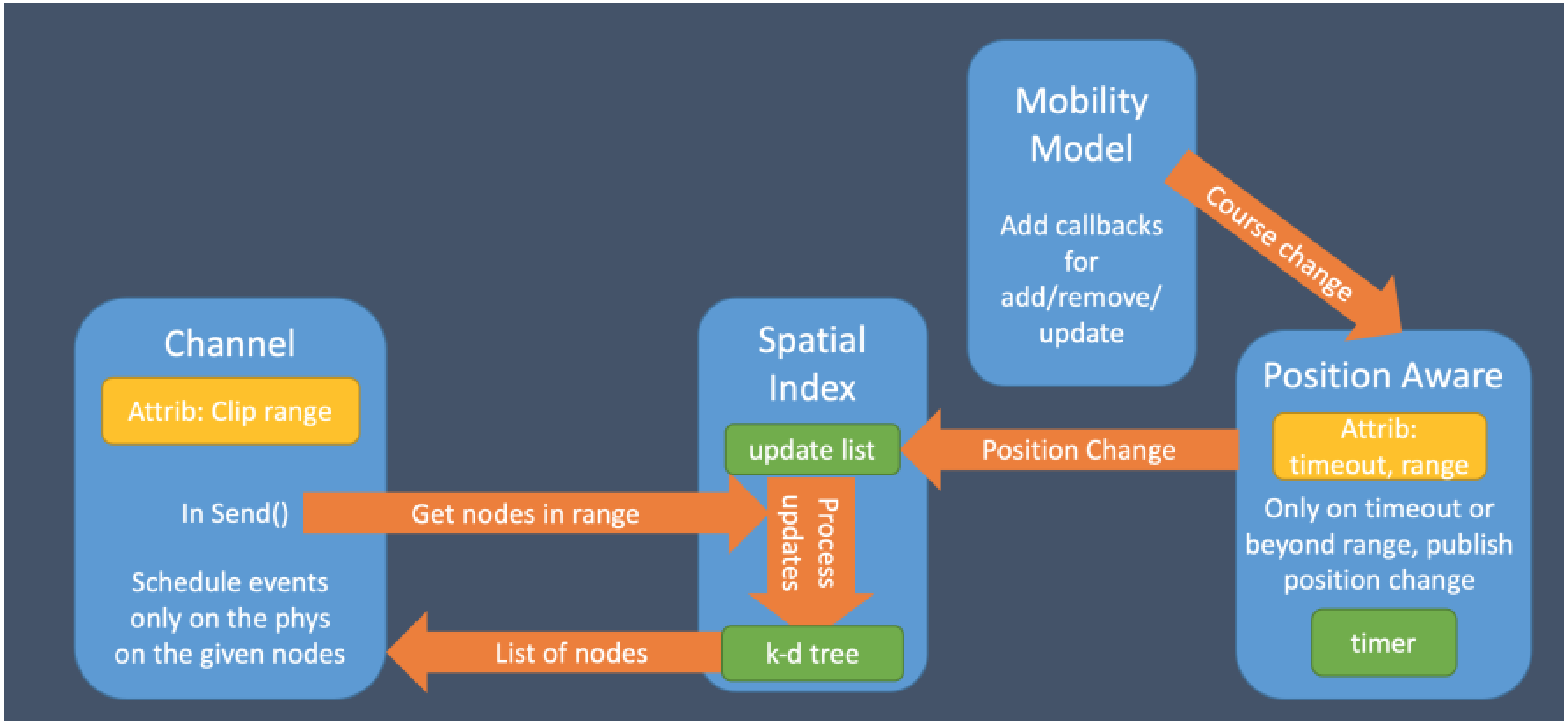


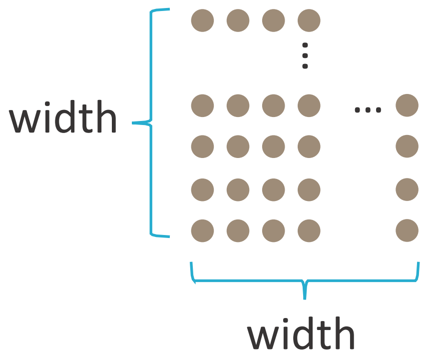
14x speedup for 361 nodes

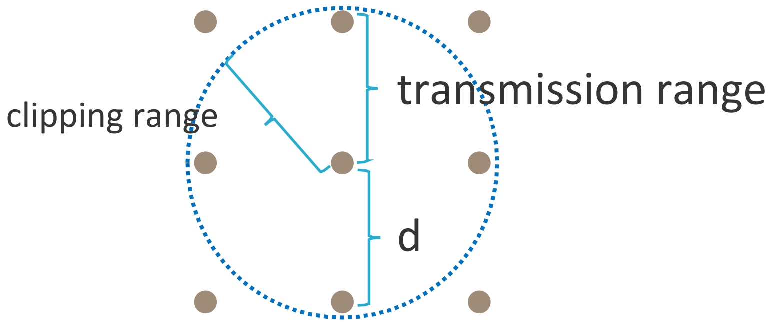
System Diagram



Position Aware “buffers” position updates. Spatial Index maintains a k-d tree of node positions. Channel now gets “nodes in range” before scheduling receive events.

Static Grid Simulation





Node separation distance (d) is set to be just under maximum transmission range. Data can only flow vertical and horizontal (not diagonal).

Clipping range is set such that receive events are scheduled only for nodes that can actually receive the transmission

Every node sends a packet to the broadcast IP address. Received by every node "in range". (in this case only vertical and horizontal neighbors).

Static Grid Results