Temasek Defence Systems Institute

TDSI

Temasek Defence Systems Institute

Contact: tdsbox2@nus.edu.sg

Performance Analysis of ROS 2 Networks using Variable Quality Of Sensor and Security Constraints for Autonomous Systems

ME5 Chen Zhaolin , Republic of Singapore Airforce
Thesis advisor: Dr Preetha Thulasiraman
Second Reader: Dr Brian S. Bingham

PR2 Robot

What is ROS

ROS : Robotic Operating System
ROS 1 designed for use with the Willow Garage PR2 robot
ROS 2 – redesign of ROS 1 to overcome short comings

- Use of DDS for networking
- Use of Security plugins

Motivation

Importance of Swarming Autonomous System
Development of ROS-M

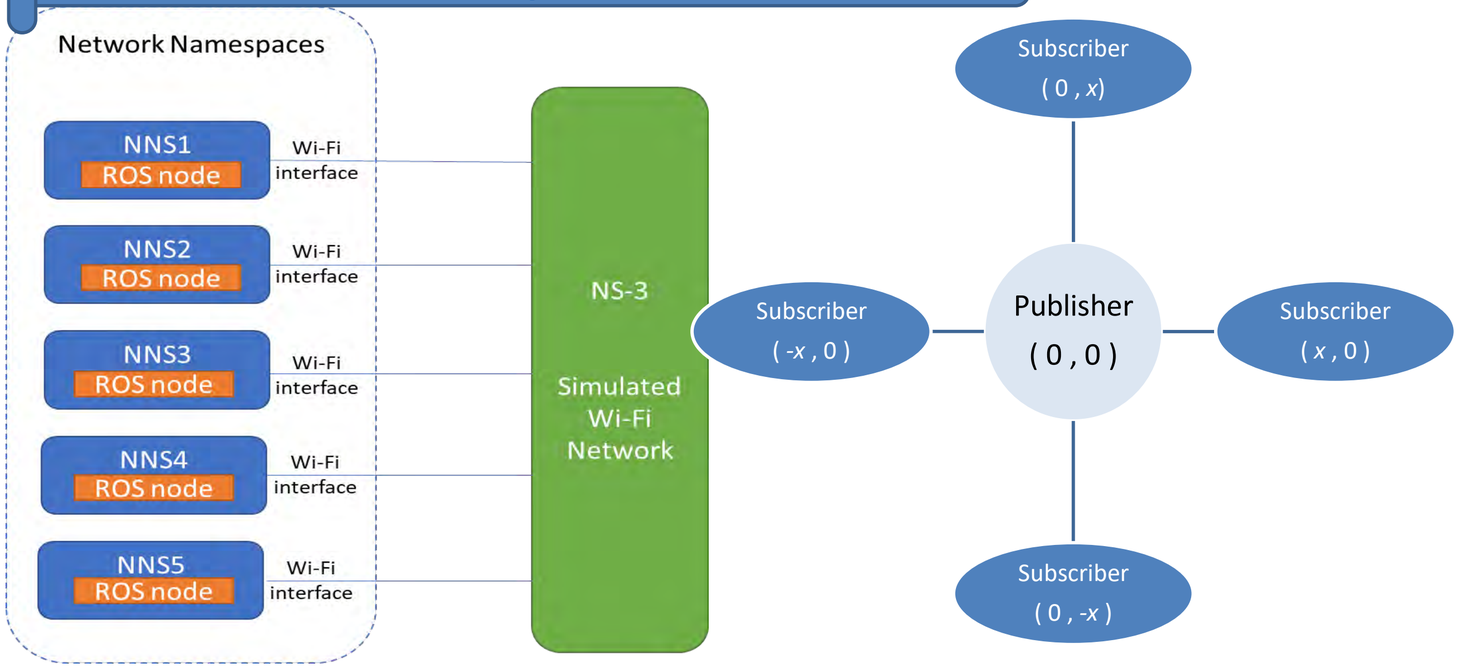
- Cost savings in program development cycles
- Increase in reliability and operability

Need to validate if ROS 2 meets requirements

- Security needs
- Tradeoffs in network performance

Very little existing research in ROS 2 performance

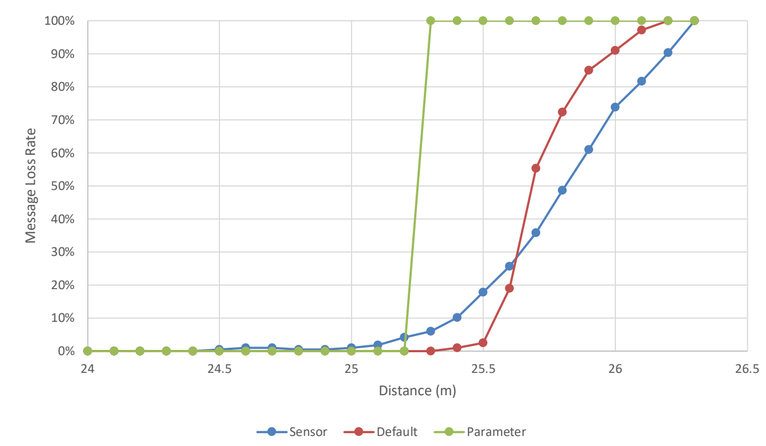
First application of NS-3 to simulate multiple ROS nodes



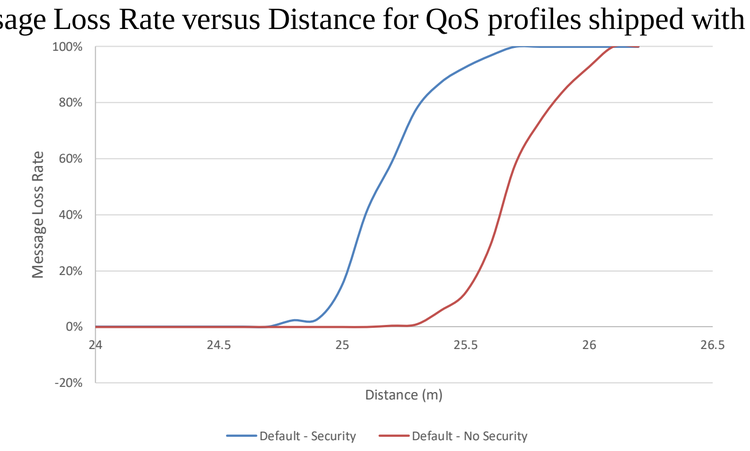
Use of NS-3 to simulate WIFI network

Multiple ROS nodes simulating a swarm of Autonomous Systems

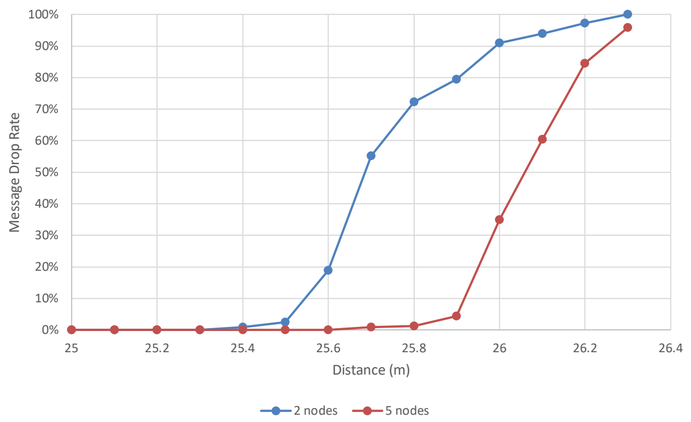
Sample Results



Message Loss Rate versus Distance for QoS profiles shipped with ROS 2.



Message loss rate with security turned on and off using the Default profile.



Message drop rates comparing two nodes and five nodes with the Default profile.

Conclusion

The simulation architecture of NS-3 + ROS 2 is effective for rapidly studying ROS 2 network performance.
On top of studying the tradeoffs between various QOS and Security settings, it was found that the latency of ROS 2 messages scaled poorly. Not viable for use in a swarm network without addressing the impact on latency.
Future work : Tuning additional QoS and security settings, formulate use case of swarm UxS network, Performance testing through actual hardware.

NUS National University of Singapore