

# NetSimulyzer

## A 3D Network Simulation Analyzer for ns-3

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WNS3 2021

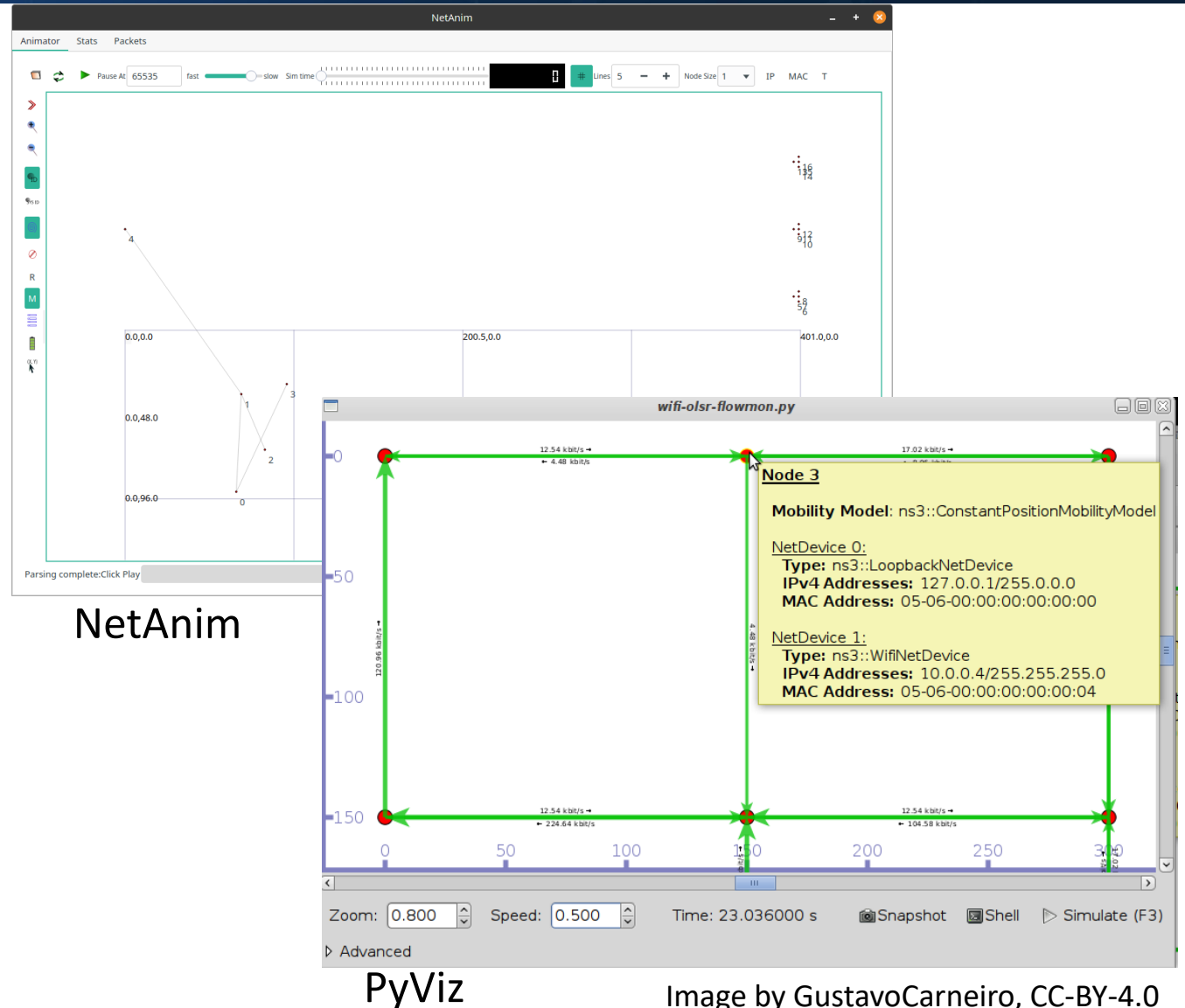
# Disclaimer

Certain commercial software is identified in this presentation to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the software identified is necessarily the best available for the purpose.

- Interpreting network performance has become more complex
  - Increasing number of devices
  - Integration of different technologies
  - Protocol complexity
- Analyzing raw data takes significant effort
- Post processing tools are often employed
  - Often technology specific
  - Challenging to develop and scale
- Visualization tools sometimes employed to ease this burden
- Visualizers allow for analysis of scenario details
  - Topology
  - Simulation environment
  - Event timeline
  - Performance metrics

# The Problem – Visualizers

- Two supported visualizers for ns-3: NetAnim & PyViz
- 2D topology
- Mobility and network information
- Fixed metrics
- Other community developed visualizers exist, but are often specific to research needs



# NetSimulyzer Overview

- Open source
- 3D topology
- General purpose
- Visualize
- Aid understanding

The screenshot displays the NetSimulyzer application window. At the top, there is a menu bar with 'File', 'Camera', 'Window', and 'Playback'. Below the menu is a playback control bar with a play button, a progress slider, and a time display showing '10ms' and '01:29.400 / 02:45.800'. The main 3D view shows a simulated environment with a road, a fire truck, and several responders. Two areas are highlighted with colored boxes: a green box around a responder and a blue box around a group of responders. On the left, a 'Nodes' panel lists the following items:

| ID | Name               |
|----|--------------------|
| 4  | Cell tower         |
| 5  | Responder 0-team 1 |
| 6  | Responder 1-team 1 |
| 7  | Responder 2-team 1 |
| 8  | Responder 3-team 1 |
| 9  | Responder 4-team 2 |
| 10 | Responder 5-team 2 |

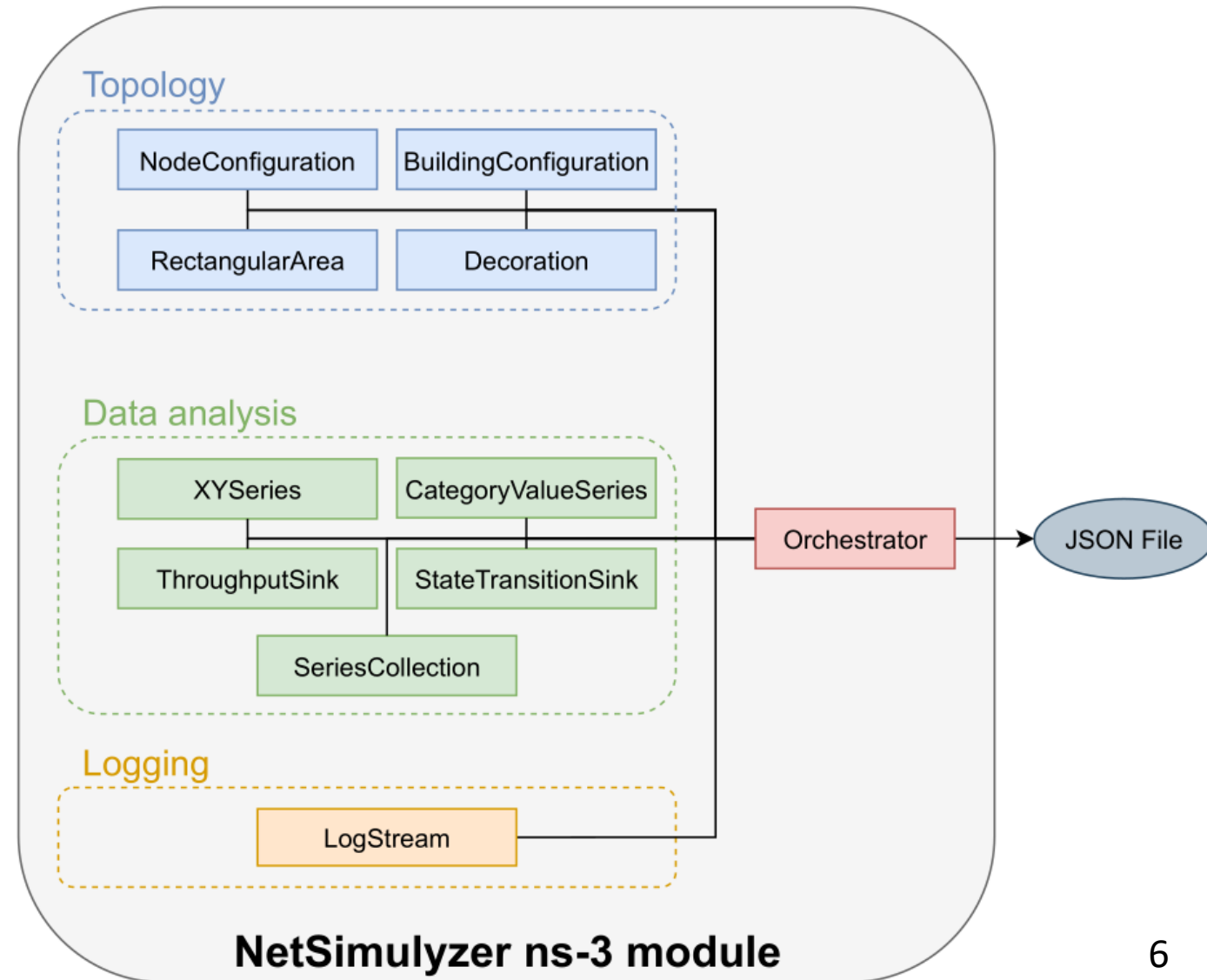
Below the nodes panel is a 'Log' window showing a 'Unified Log' with the following entries:

```
[Application log]: 15 s: Team 1 starts group call  
[Application log]: 15 s: Team 2 starts group call  
[Application log]: 15 s: Team 3 starts group call  
[Mobility log]: 30 s: Team 1 starts moving  
[Mobility log]: 45 s: Team 1 enters building  
[Application log]: 75 s: Team 1 stops group call  
[Mobility log]: 75 s: Team 1 stops moving  
[Mobility log]: 75 s: Team 2 starts moving
```

On the right side, there are two charts. The top chart is titled 'RSRP' and shows 'RSRP (dbm)' on the y-axis (ranging from -130.0 to -110.0) versus 'Time (s)' on the x-axis (ranging from 0.0 to 109.6). The chart shows three data series: UE 2 R... (red), UE 6 R... (green), and UE 11... (blue). The RSRP values are relatively stable around -120.0 dbm until approximately 45 seconds, where they drop significantly to around -125.0 dbm. The bottom chart is titled 'Mouth-to-Ear latency' and shows 'Latency (ms)' on the y-axis (ranging from 0.0 to 89.3) versus 'Time (s)' on the x-axis (ranging from 0.0 to 106.8). The chart shows three data series: UE 2... (red), UE 6... (green), and UE 11... (blue). The latency values are relatively stable around 70-80 ms throughout the simulation.

# NetSimulyzer ns-3 Module

- Designed to collect and export information to a JSON file
- Modular components
- Each component requires few lines of code to integrate



# NetSimulyzer Application

- Reads the exported JSON file
- Displays the topology in the central widget
- Tracked Nodes are displayed in the “Nodes” widget
- Charts and logs are displayed in optional, detachable widgets
- Playback speed and current time can be adjusted with the “Playback” widget

The screenshot displays the NetSimulyzer application interface. The central window shows a 3D simulation of a scene with a road, a fire truck, and several people. The interface includes several panels:

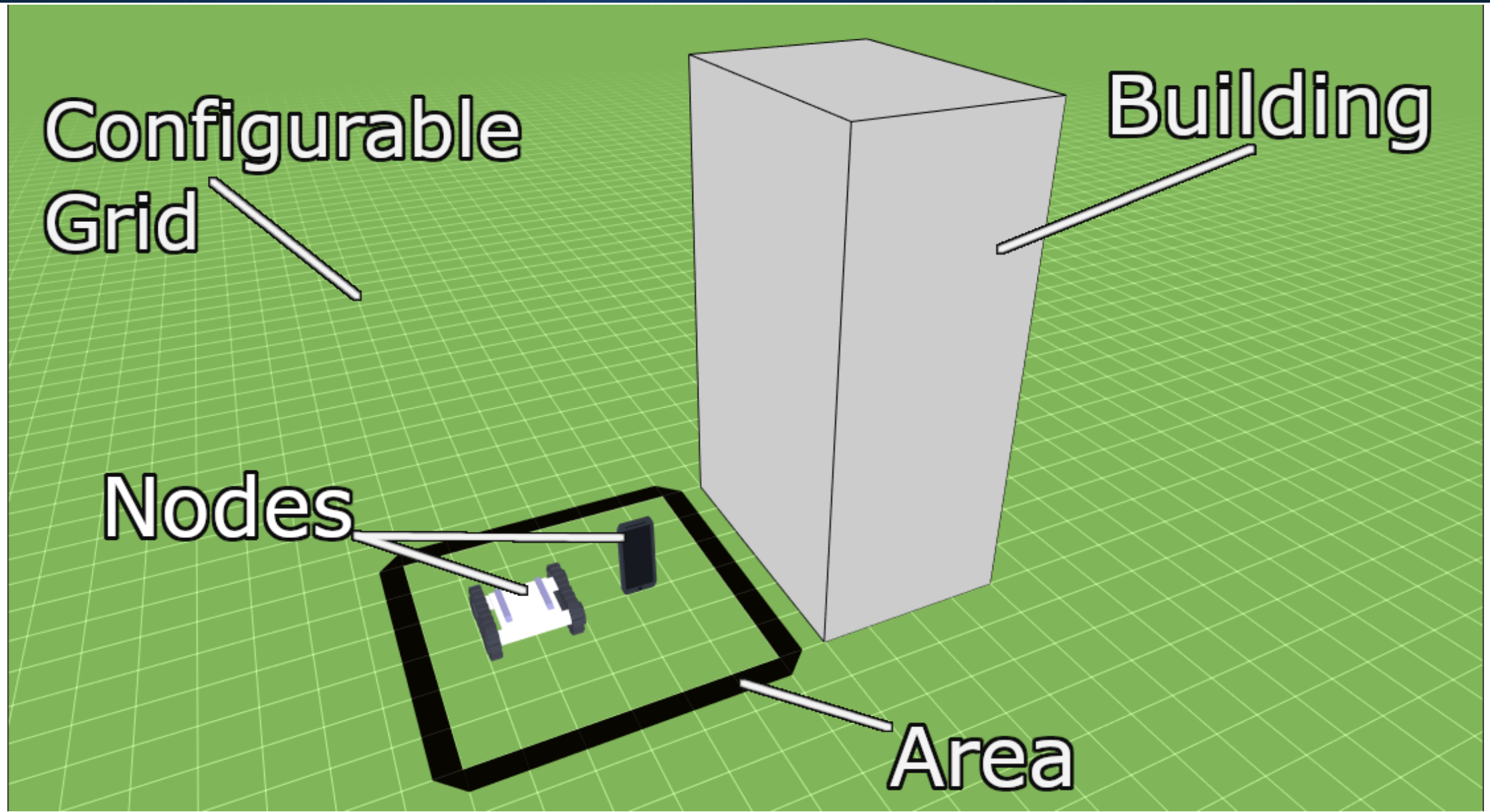
- Playback:** A control bar at the top with a play button, a progress slider, and a time display showing 01:29.400 / 02:45.800.
- Nodes:** A table listing tracked nodes:

| ID | Name               |
|----|--------------------|
| 4  | Cell tower         |
| 5  | Responder 0-team 1 |
| 6  | Responder 1-team 1 |
| 7  | Responder 2-team 1 |
| 8  | Responder 3-team 1 |
| 9  | Responder 4-team 2 |
| 10 | Responder 5-team 2 |

- Log:** A text area showing a unified log of events, including application and mobility logs.
- Chart (RSRP):** A line graph showing Received Signal Strength (RSRP) in dBm over time (s) for three user equipment (UE) instances: UE 2 R..., UE 6 R..., and UE 11 ... The y-axis ranges from -110.0 to -130.0 dBm, and the x-axis ranges from 0.0 to 109.6 s.
- Chart (Mouth-to-Ear latency):** A line graph showing Mouth-to-Ear latency in milliseconds over time (s) for the same three UE instances. The y-axis ranges from 0.0 to 89.3 ms, and the x-axis ranges from 0.0 to 106.8 s.

The bottom left corner of the application window shows the current time: 01:29.400.

# NetSimulyzer Topology Features

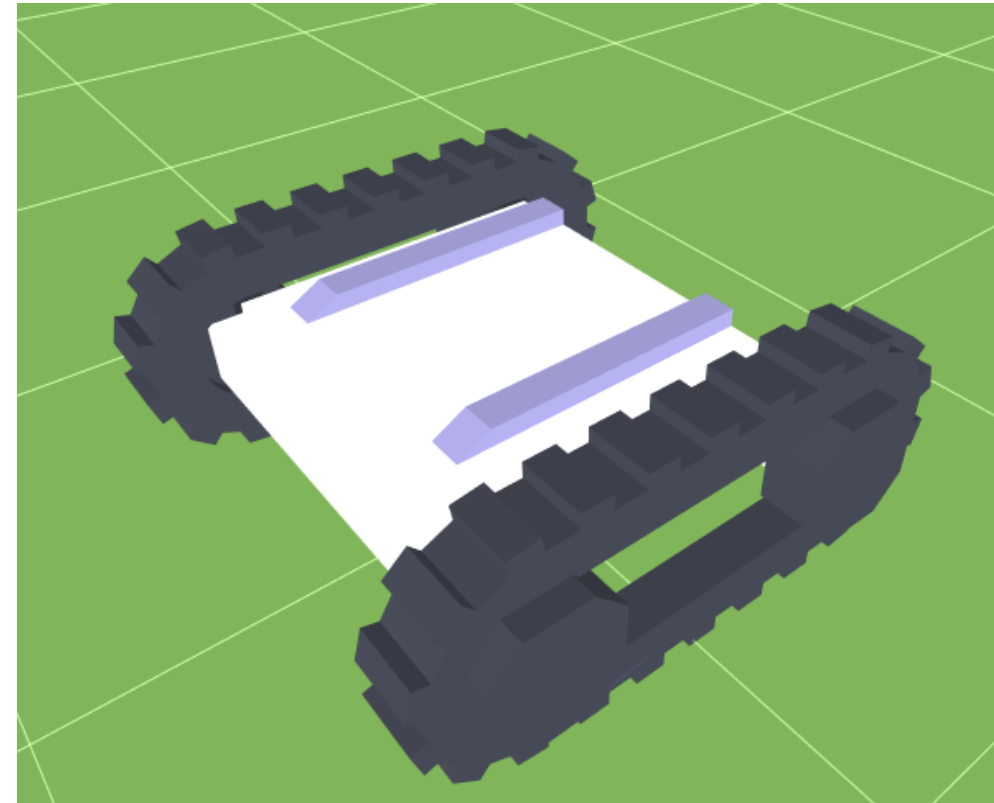




# NetSimulyzer Topology – Node

- Represented by selected model
- Models provided, but users may provide their own
- Position from mobility model
- Configurable colors

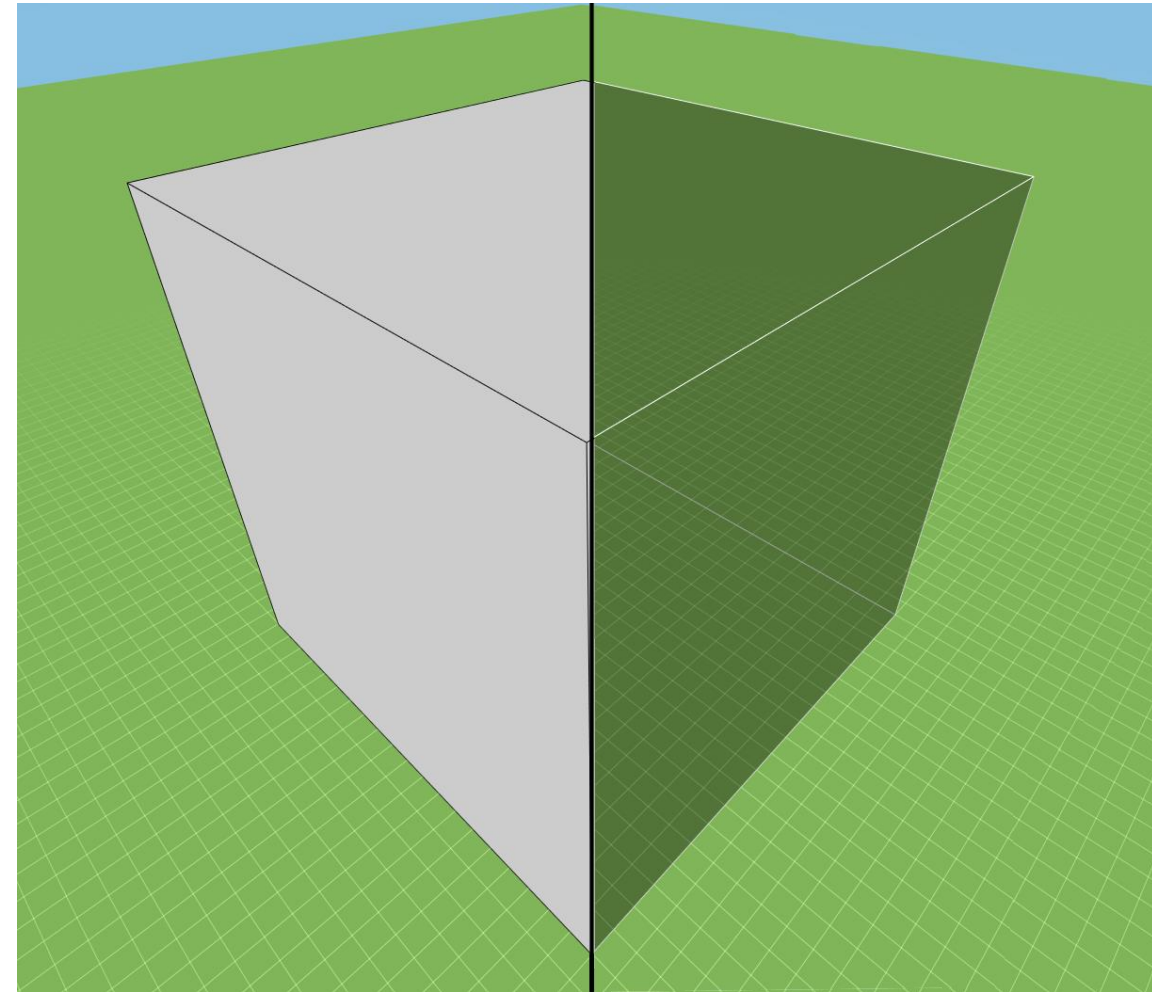
| Attribute                | Description                           |
|--------------------------|---------------------------------------|
| Name                     | Display name                          |
| Model                    | 3D model to display                   |
| Orientation              | Orientation on each axis              |
| Offset                   | Positional offset                     |
| Height/Scale             | Adjust the size of the rendered model |
| BaseColor/HighlightColor | Primary color to use for the model    |



# NetSimulyzer Topology – Building

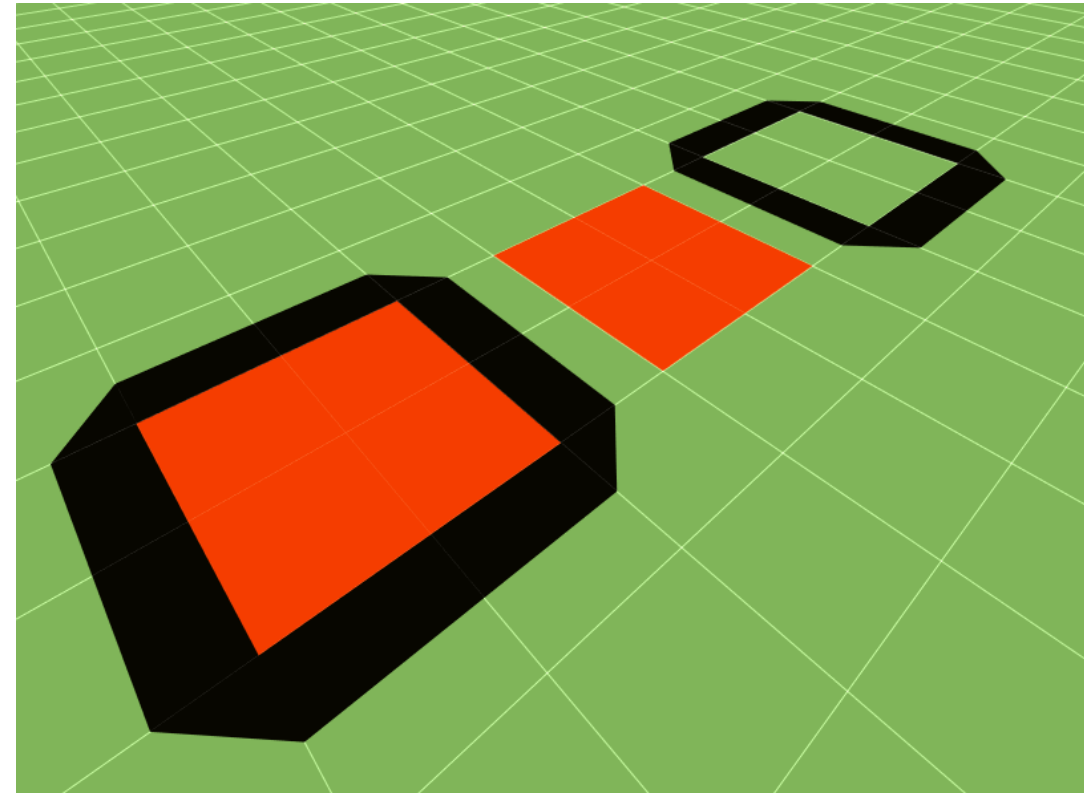
- Dimensions, room, & floor count from ns-3
- Can be transparent or opaque

| Attribute | Description  |
|-----------|--|
| Color     | The color/tint to use for the walls                    |
| Visible   | Flag to render this building in the application or not |



- Used to mark an important region
- Optional border for areas
- Optional fill for areas
- Configurable colors

| Attribute                 | Description                                |
|---------------------------|--|
| Bounds                    | The coordinates to highlight               |
| Height                    | How far from the ground to render the area |
| Border/Fill               | Display a fill/border                      |
| BorderColor/<br>FillColor | The color of the border/fill               |

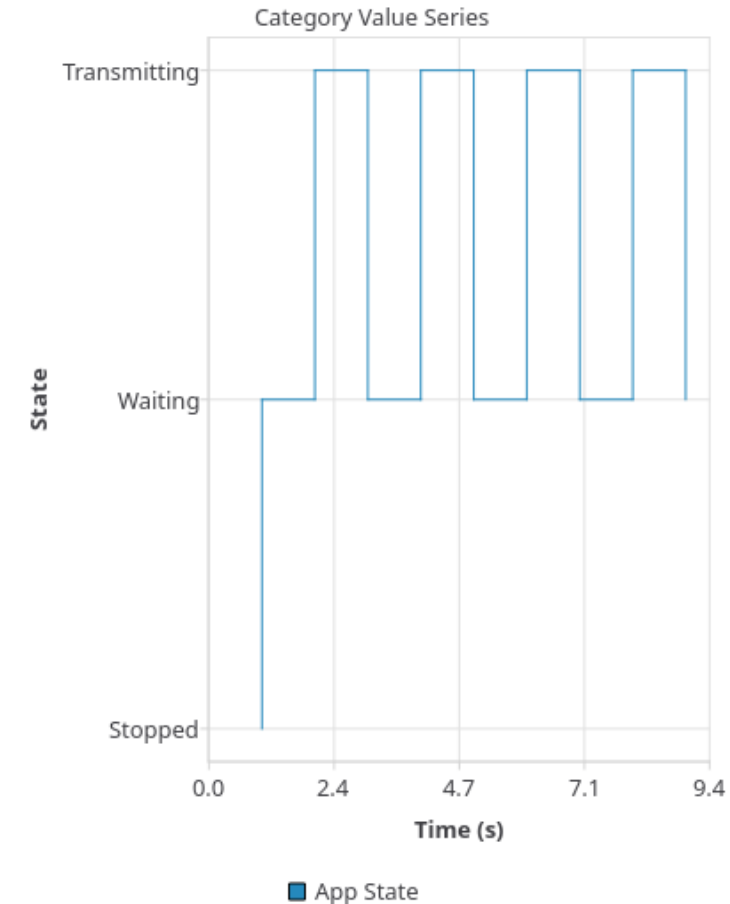
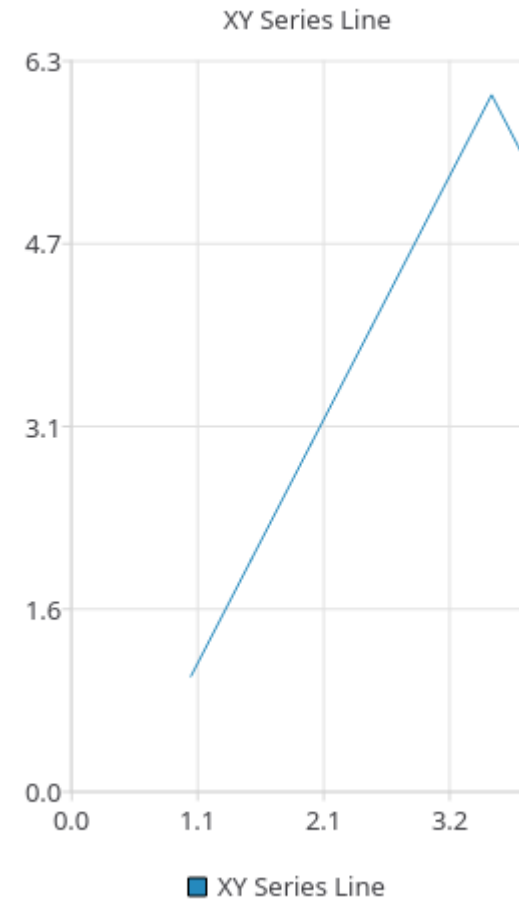


## Generic Sinks

- Accept points as two numbers, or a number and a string
- Allow for plotting arbitrary metrics from ns-3

## Specific Sinks

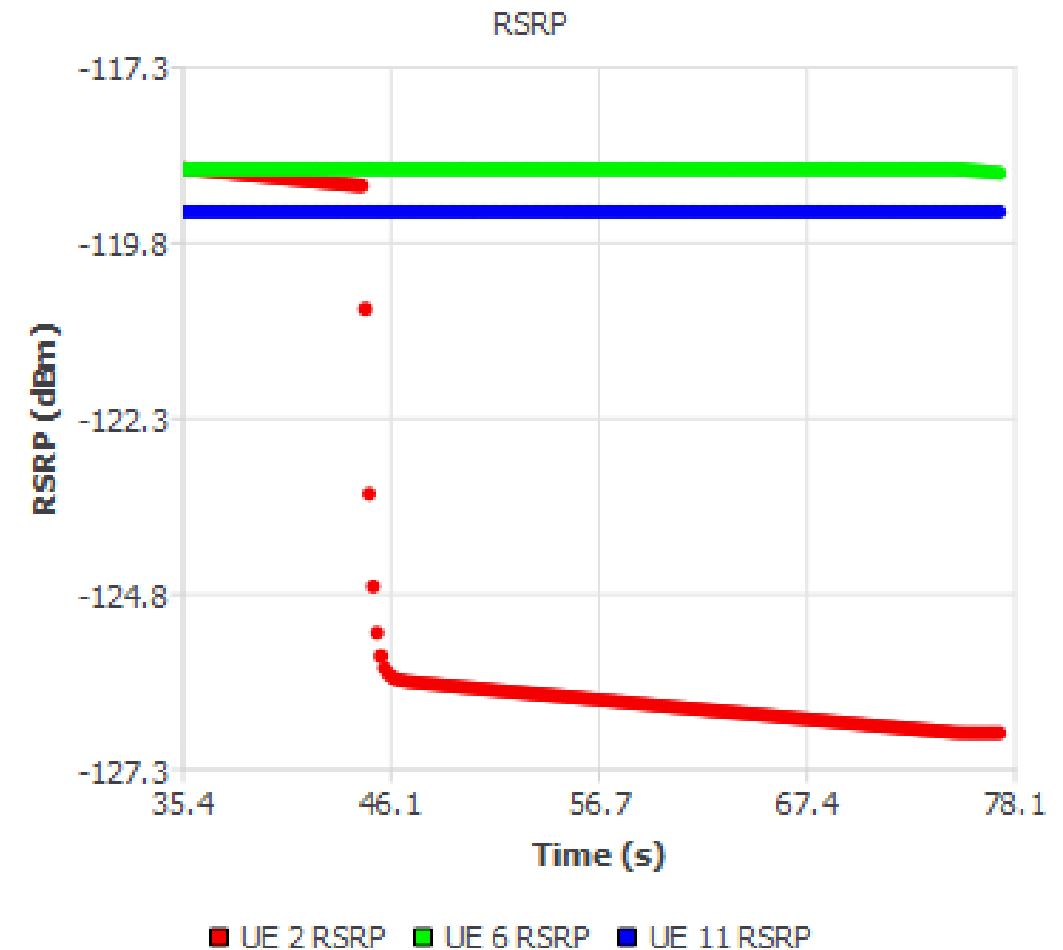
- (Usually) Connect directly to traces from ns-3
- Produce specific plots (e.g., Throughput vs Time)



# Data Analysis Features

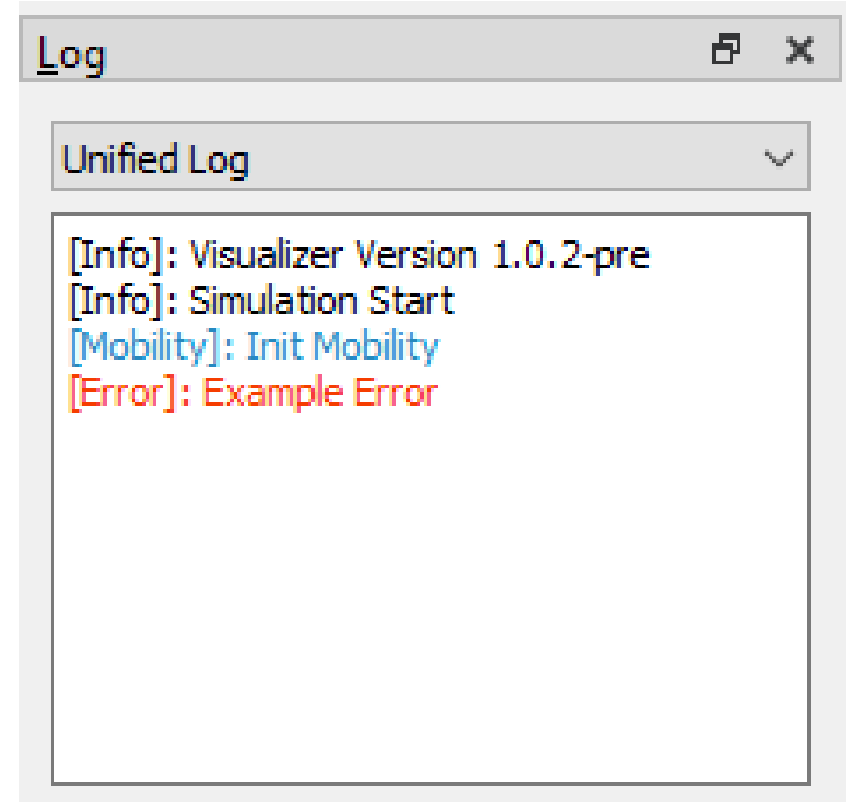
- Axes can be fixed or grow to data
- XYSeries can be placed in collections for display together
- Charts can be directly exported as an image file or to the clipboard

| Attribute   | Description  |
|-------------|--|
| Name        | Name of the plot in the application  |
| XAxis/YAxis | Access options for each axis   |
| Connection  | Set how the points on the plot are connected (Scatter, Line, Spline) (XYSeries Only) |
| Color       | The color to use for points & connections  |



# NetSimulyzer Logging Features

- Allows for writing messages during the simulation
- Provides an API similar to `std::cout``
- Allows for several different named logs with optional colors
- Logs may be selected individually, and all show up in the “Unified Log”



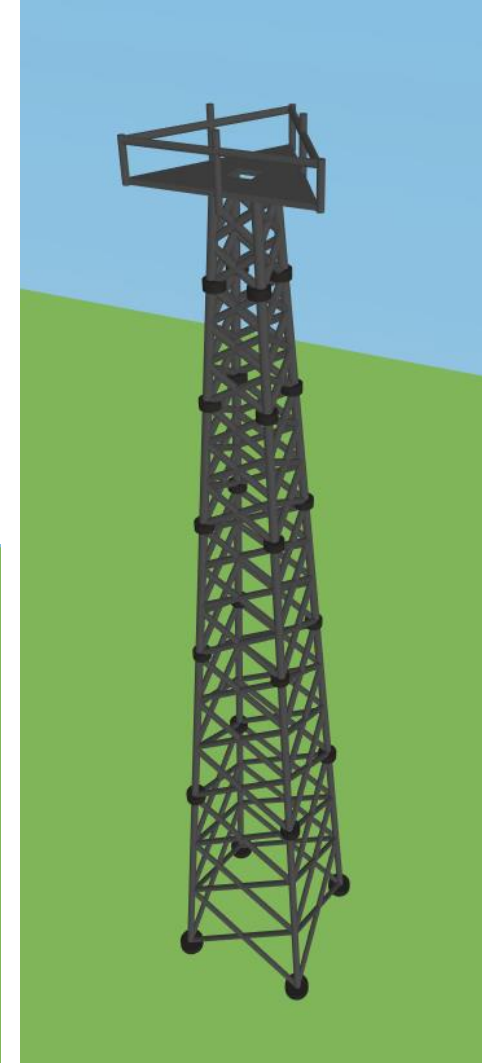
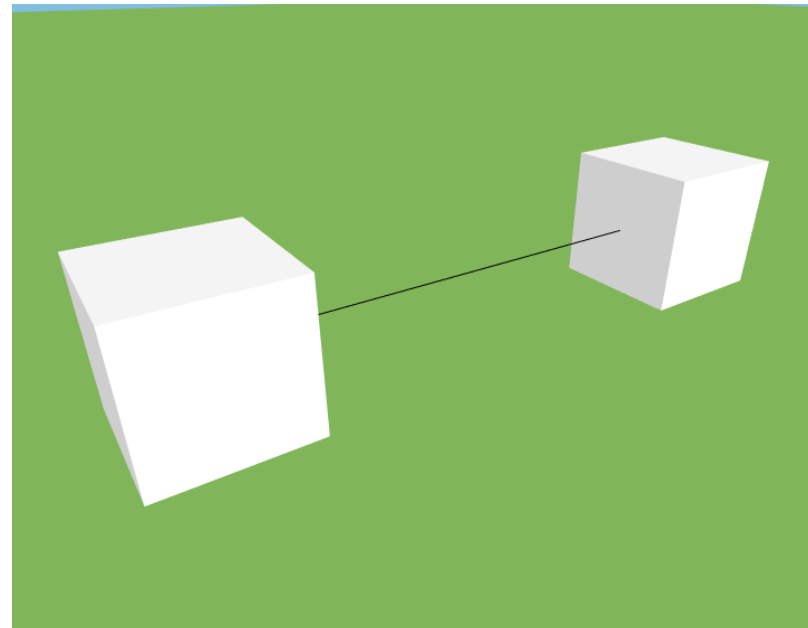
| Attribute | Description                                      |
|-----------|--|
| Name      | The name to list the log stream under            |
| Color     | The text color in the application                |
| Visible   | Show this log in the dropdown in the application |

## New Features

- Display of wired (Point to Point) links
- Direct copying/exporting of charts

## Future Work

- Antenna radiation patterns
- Additional trace sinks
- Node widget
- More models
- “Live” mode



# Demo



Application: <https://github.com/usnistgov/NetSimulyzer>  
Module: <https://github.com/usnistgov/NetSimulyzer-ns3-module>  
ns-3 App Store: <https://apps.nsnam.org/app/netsimulyzer/>  
Email: [evan.black@nist.gov](mailto:evan.black@nist.gov)

Live Tutorial: Friday June 25<sup>th</sup>, 1300 UTC

# Questions?