

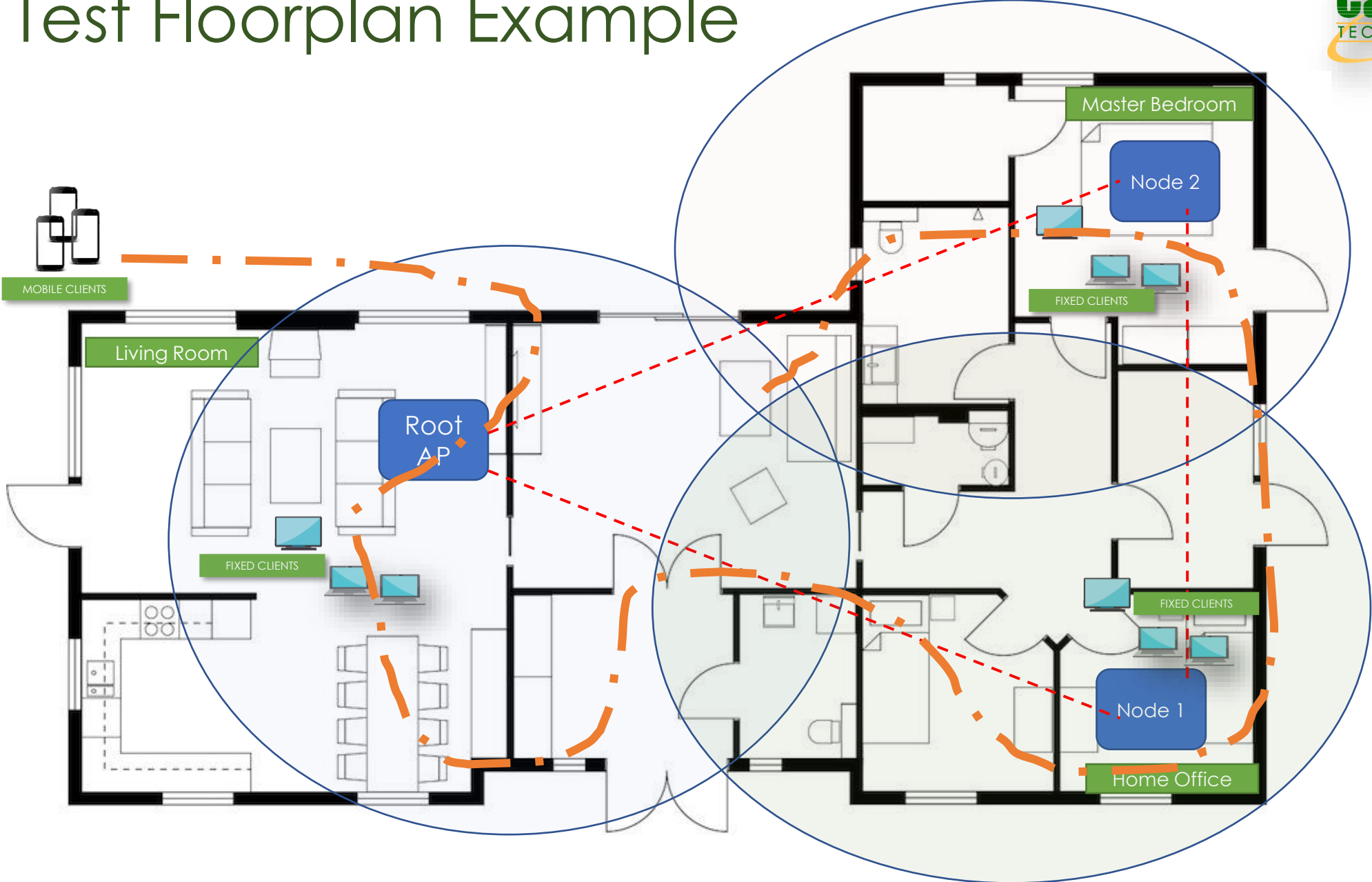
Network
Testing &
Emulation
Solutions

- Founded in 2000
- Focus on Network testing and Emulation Solutions
- WiFi test solutions since 2006
- Small team of Networking Technologies and Firmware Experts
- Helping over 200 customers, design, develop and deploy high quality networking products

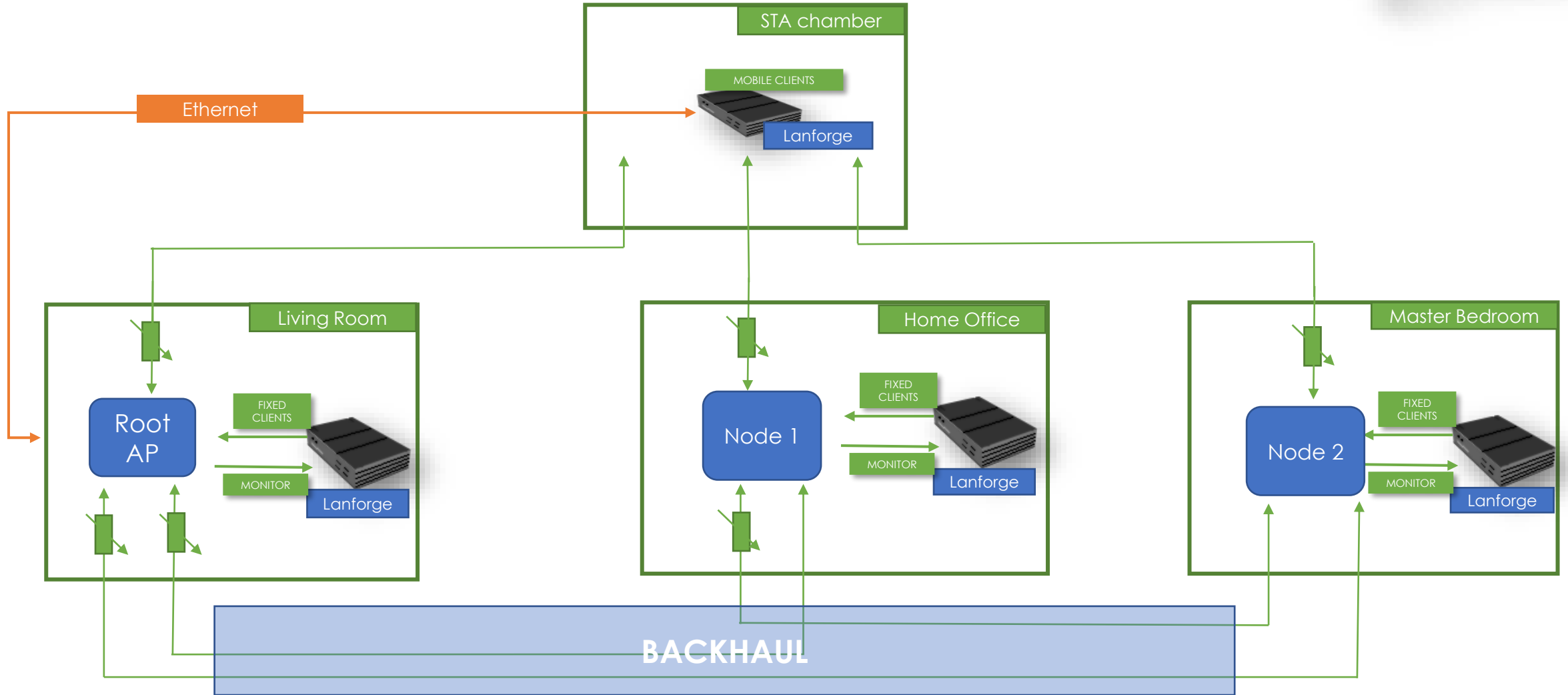
 sales@candelatech.com
 1-360-380-1618

Candela WiFi Mesh Testing

Mesh Test Floorplan Example

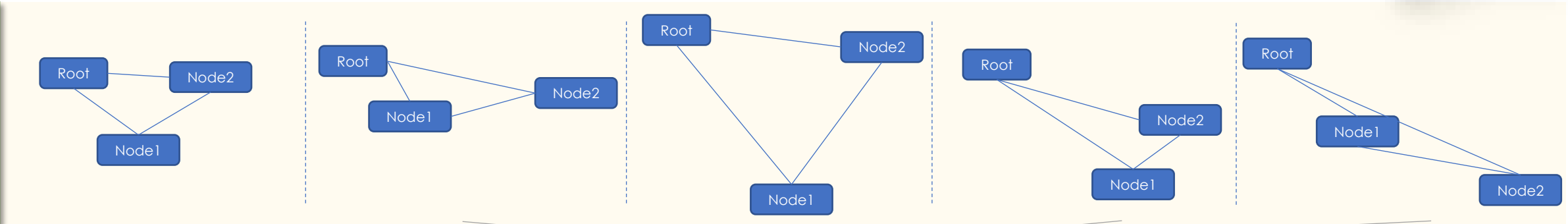


3 Node Testbed Example

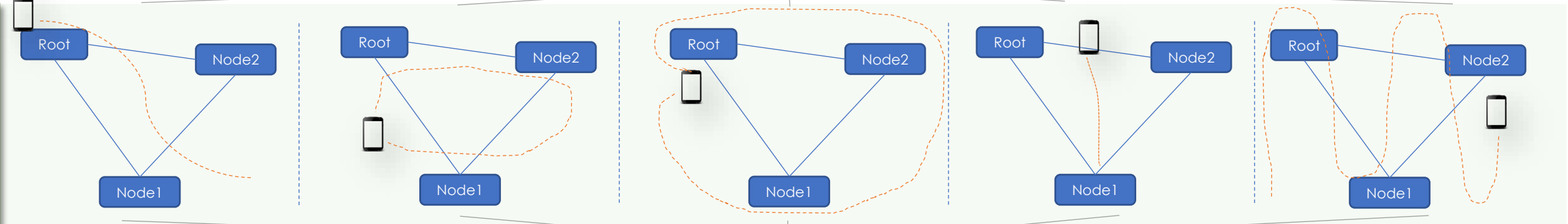


Test Automation Variables

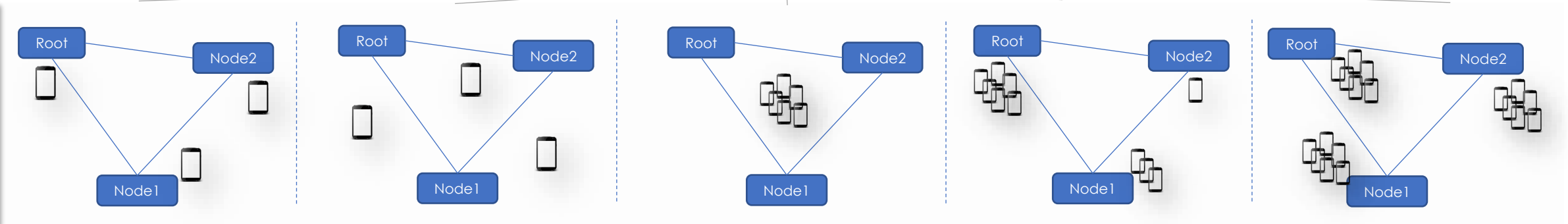
Mesh Node Placements



Station Moving Patterns



Load Patterns



Testbed Picture - Front



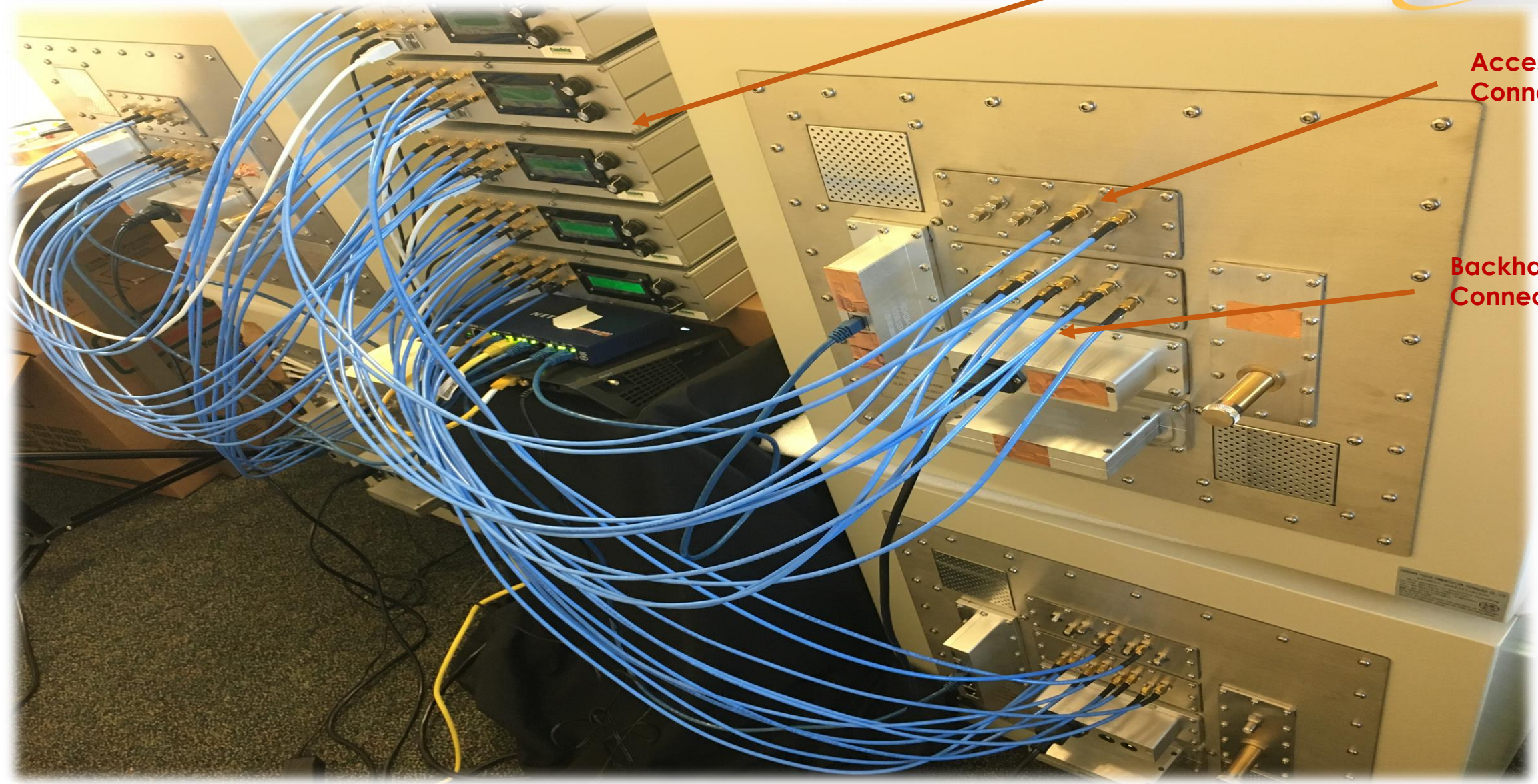
Testbed Picture - Back

Programmable
Attenuators



Access
Connections

Backhaul
Connections



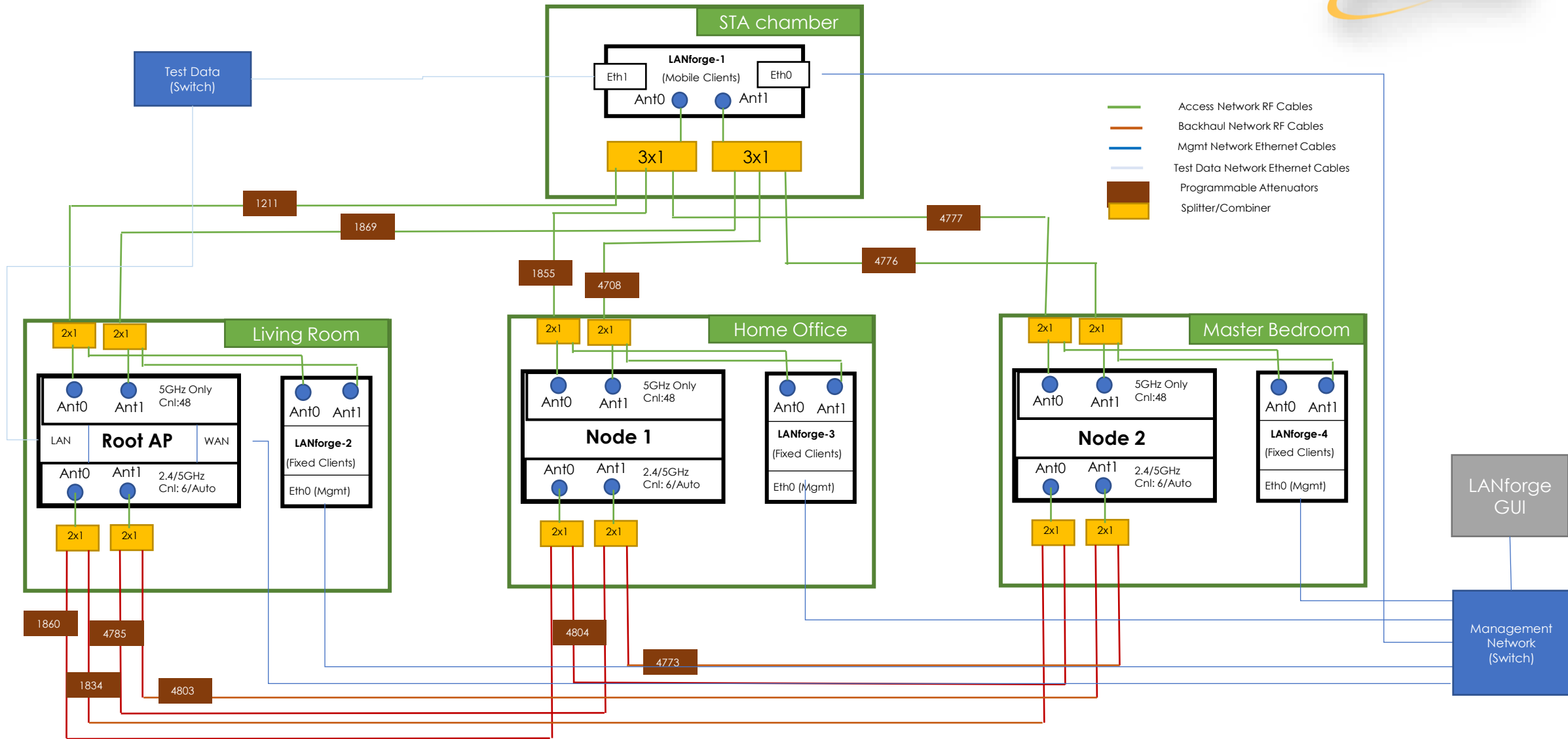
Testbed - Inside

LANforge systems doing Fixed clients, Mobile clients,
Background traffic, interference, monitoring, roaming etc...

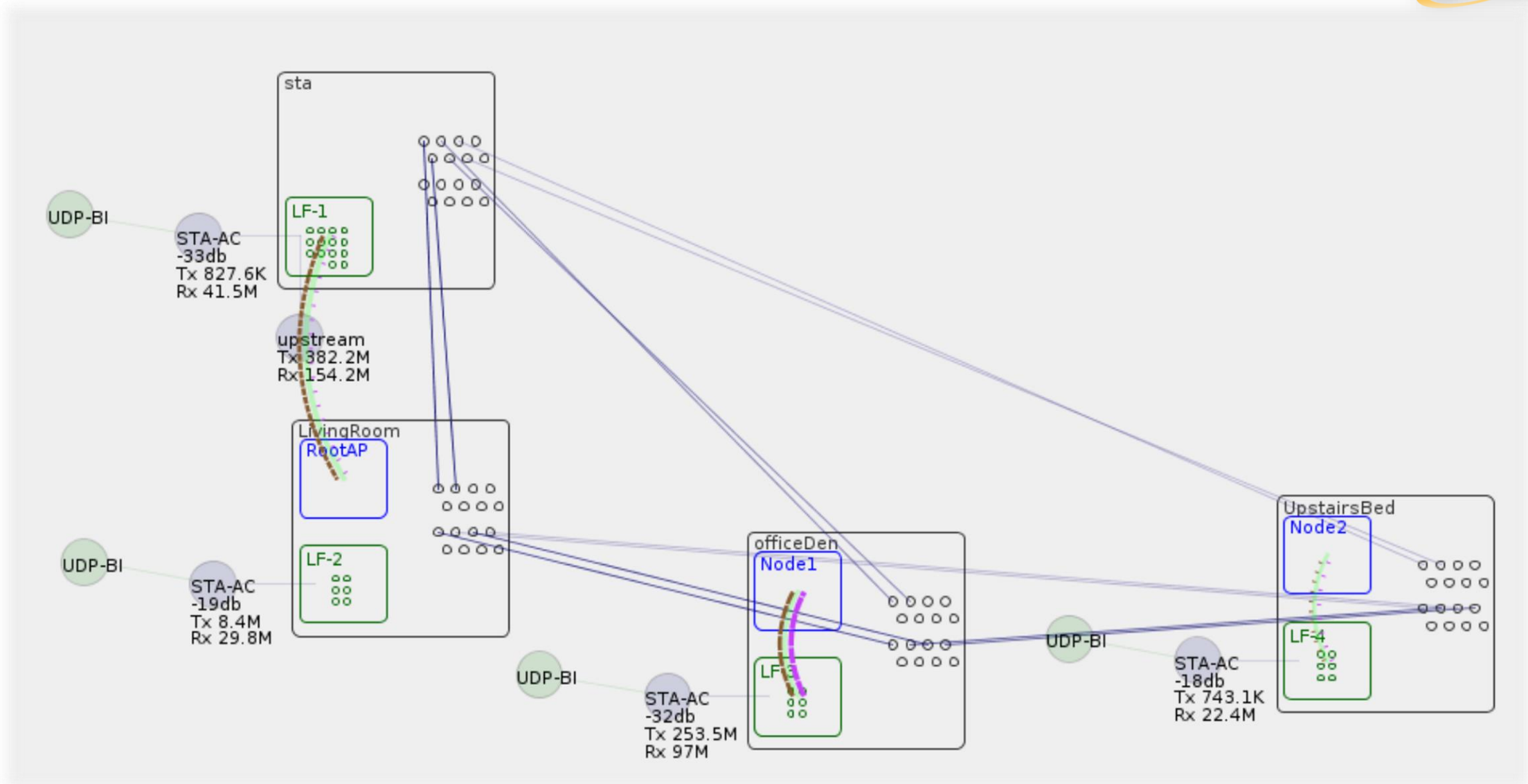
Mesh AP Nodes
under Test



More Detailed Testbed Diagram Example (2x2 MIMO/ Triband/ Root + 2 Node Config)



LANforge Chamber View



Mesh Automated Test GUI Settings



Mesh Automated Test

Settings | Advanced Configuration | Report Configuration

Upstream Port: 1.1.1 eth1

Selected DUT 2G: TR398-DUT NETGEAR68 Selected DUT 5G: TR398-DUT NETGEAR68

AP Root Chamber: TR-398 Node 1 Chamber: <Custom> Node 2 Chamber: <Custom> STA Chamber: <Custom>

STA Count: 1 STA Count: 1 STA Count: 1 STA Count: 1

2.4Ghz Radios: [] [] [] []

5Ghz Radios: [] [] [] []

AP Chamber Position: Current Position
ABC
A-BC
AB-C
A-B-C
A--B-C
A-B--C
A--B--C
BAC
B-AC
BA-C
B-A-C
B--A-C
B-A--C
B--A--C
Random

STA Chamber Position: Current Position
Random
Close Root AP
Close Node 1
Close Node 2
Medium Root AP
Medium Node 1
Medium Node 2
Far Root AP
Far Node 1
Far Node 2

Roam Path: Orbit Near
Orbit Middle
Orbit Far
Random Near
Random Middle
Random Far
South-East

Traffic Type: UDP
TCP

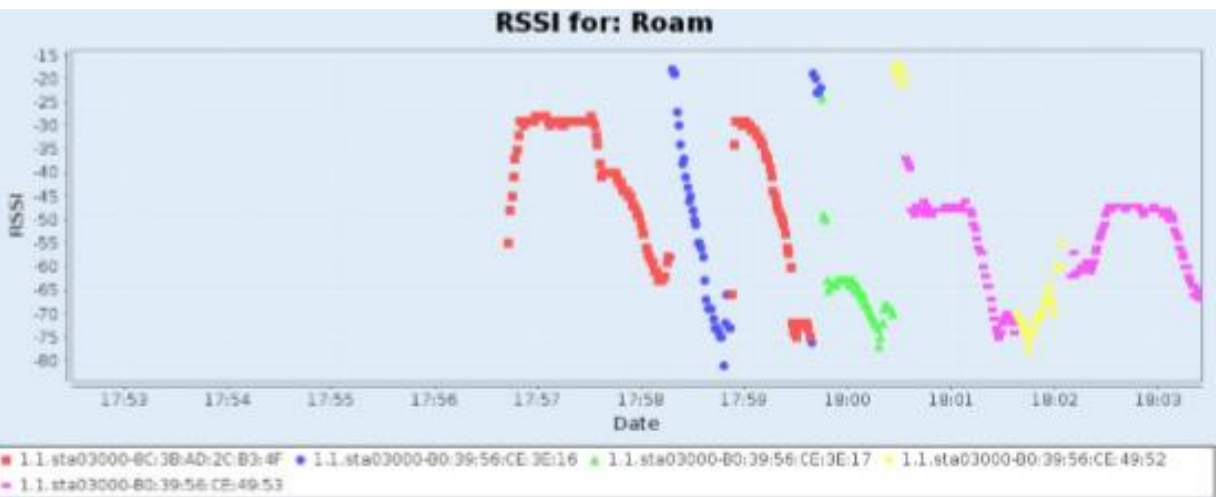
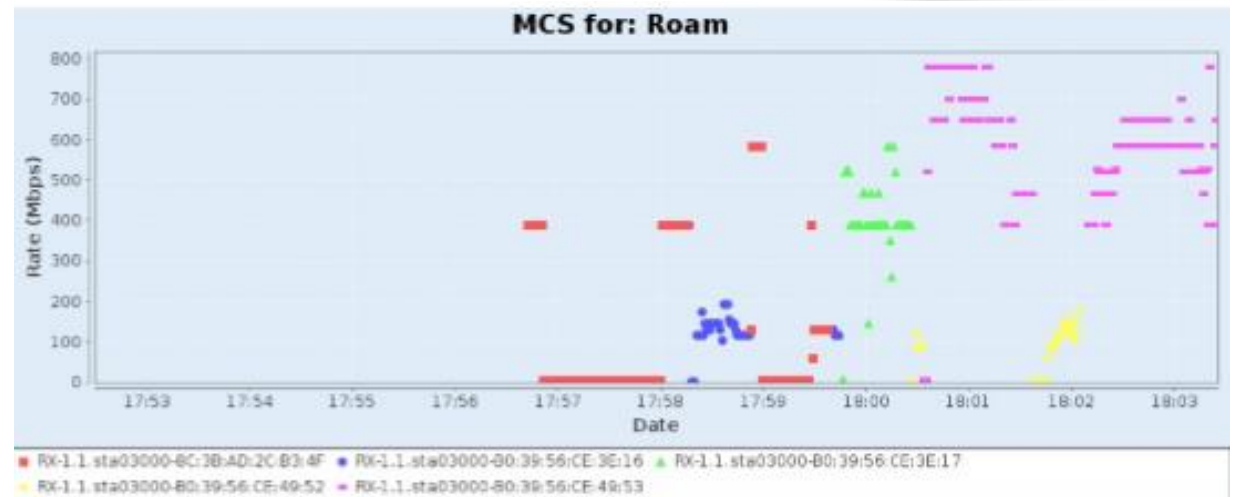
Traffic Direction: Download
Upload
Both

Select Tests: Calibrate
Throughput
Roam

Traffic Combination: Add STA Traffic
STA
Root
N1
N2
Root+N1
Root+N2
N1+N2
Root+N1+N2

Start Another Iteration Pause Cancel

Mesh Roam Test Results



Testbed Building Blocks

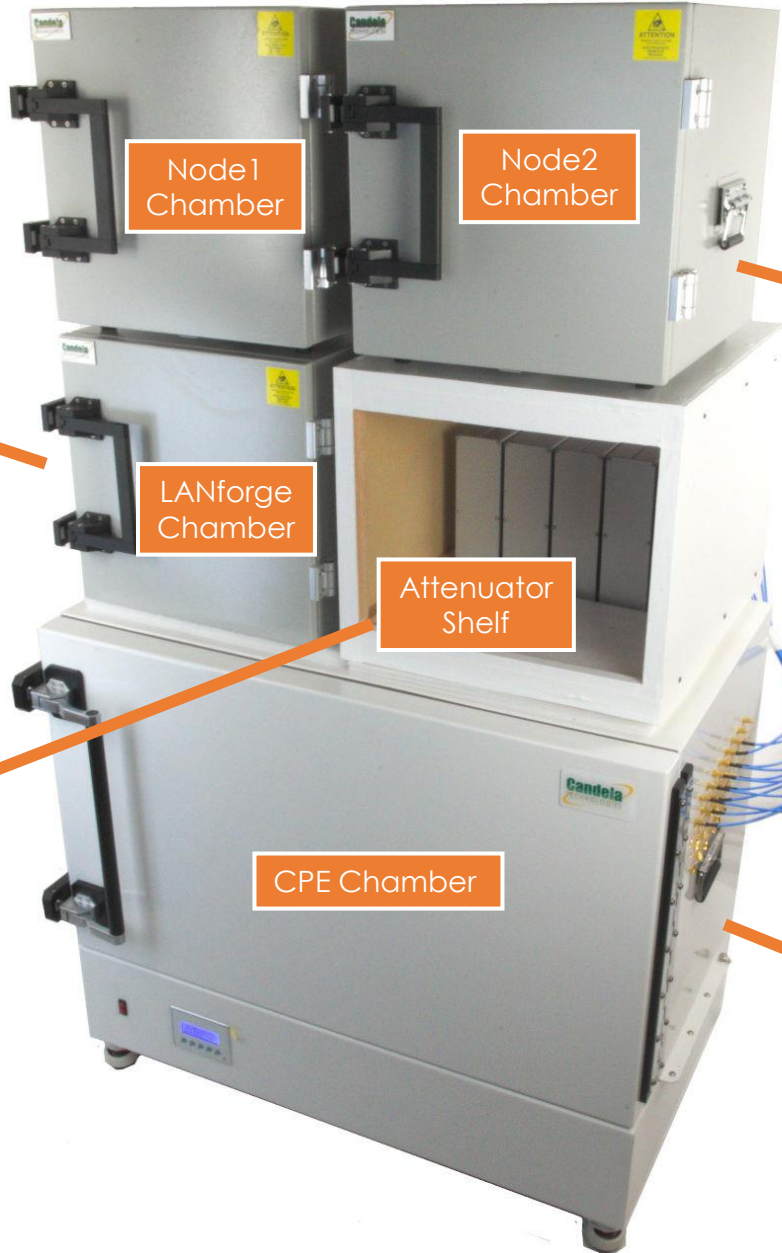
- ✓ RF enclosures
- ✓ Programmable Attenuators
- ✓ RF & Ethernet Cables
- ✓ Splitters/Combiners
- ✓ LANforge Hardware for Station Emulation
- ✓ LANforge-MESH Test Application Software

Key Tests



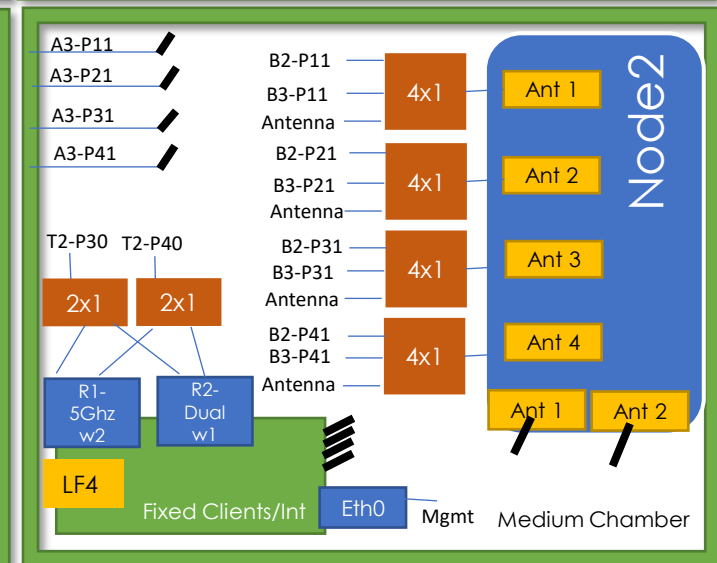
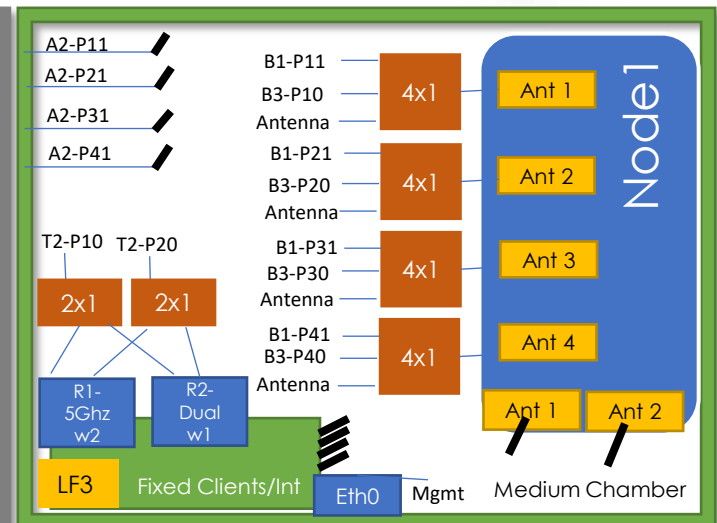
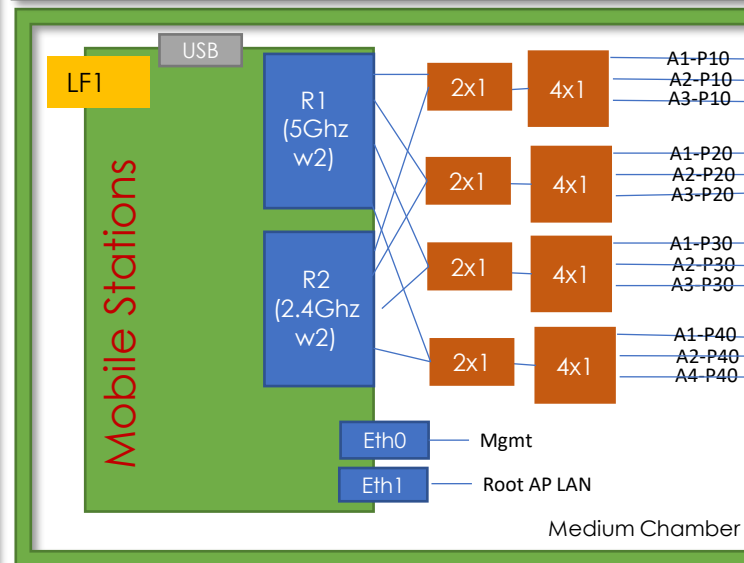
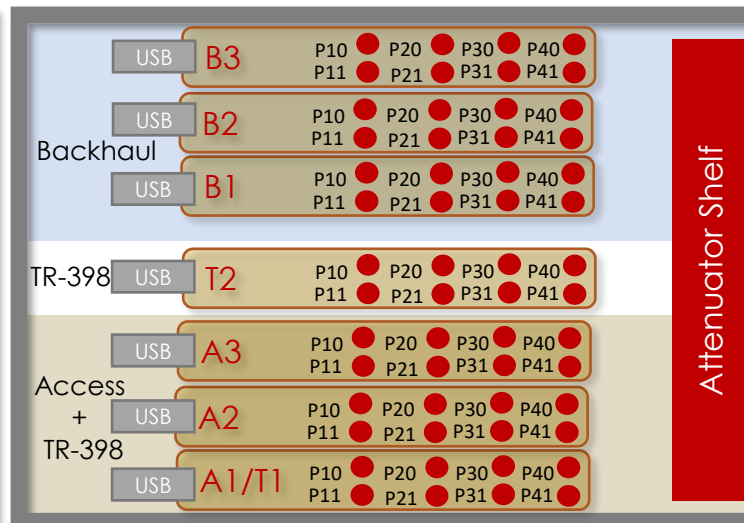
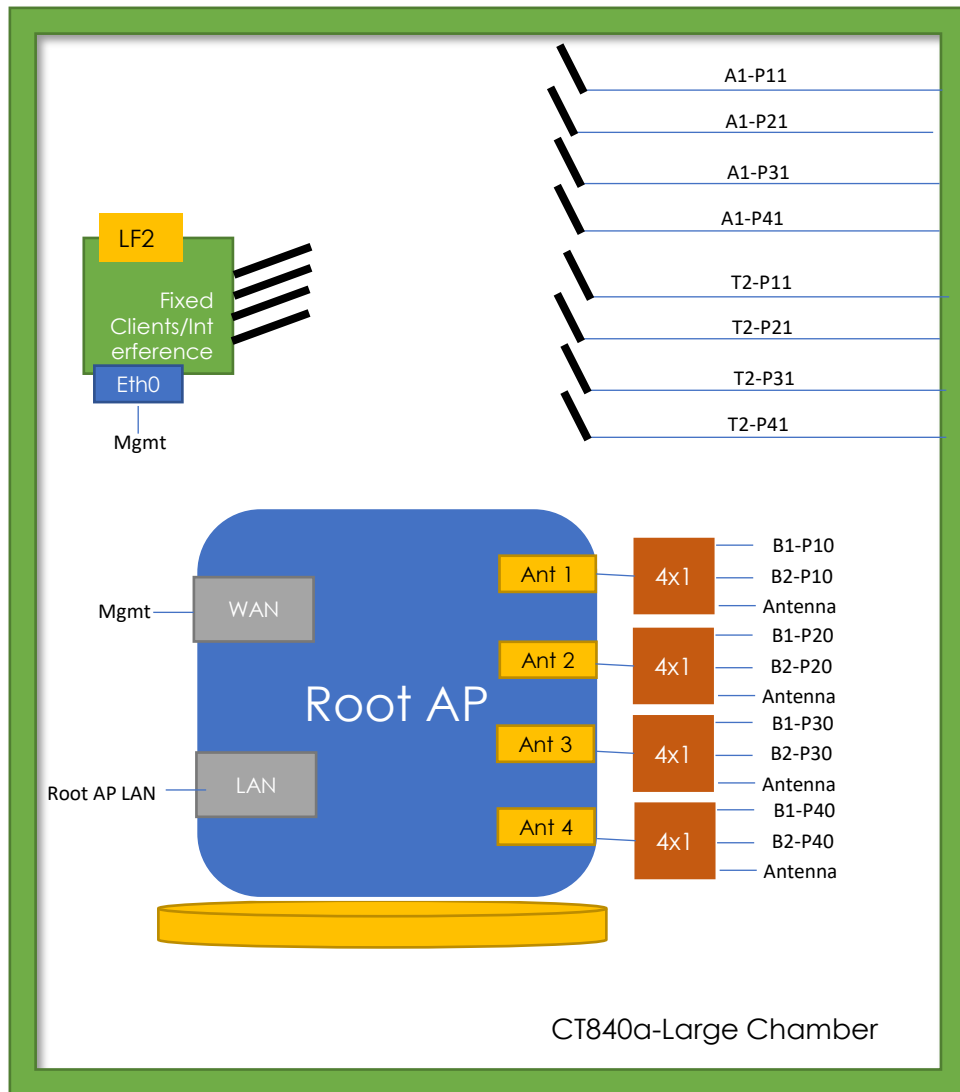
- ✓ Measure maximum upstream and downstream throughput that can be achieved per each hop in the mesh.
- ✓ Repeat test 1 on different channels, Channel Bandwidths, MIMO types.
- ✓ Measure the maximum number of stations each node in the mesh can handle.
- ✓ Measure the connection times and number of connection drops for the stations for each node in the mesh over time.
- ✓ Repeat 1,2,3 and 4 with different distance settings between the nodes in the mesh.
- ✓ Measure the maximum possible distance between the nodes in the mesh where they can all still maintain connectivity.
- ✓ Test how the mesh backhaul can rate adapt and find the best possible channel in a noisy environment.
- ✓ Force a disconnect on a specific link on the mesh and measure time taken to find the next best path in the mesh.
- ✓ Create different levels of co-channel and adjacent channel interference and measure overall performance.
- ✓ Run performance test with different mixes of voice, video and data traffic and measure quality of experience.
- ✓ Repeat tests 1 through 10 with different security types (Open, WPA-PSK, WPA-Enterprise)
- ✓ Test load balancing and band steering capabilities of the nodes in the mesh by creating different amounts of stations and traffic loads on different nodes in the mesh.
- ✓ Test handoff delays for stations handing off between various nodes in the mesh.
- ✓ Measure roaming performance with different security methods and fast roaming methods and 802.11k/v/r
- ✓ Measure performance over distance for stations connecting to each mesh node.

Stacked Chamber Configuration Example (Mesh + TR-398)

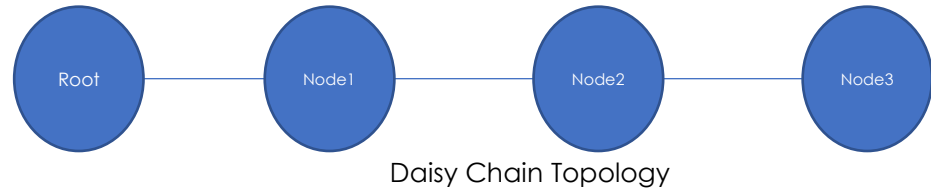


TR-398 + 3-Node Mesh Tested (Cabled)

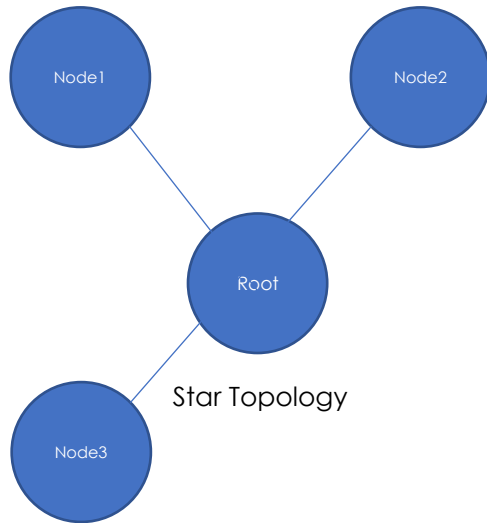
Every Mesh system is different. In this example the APs are dual-band with 4 antennas on Root AP and 6 Antennas on Extenders



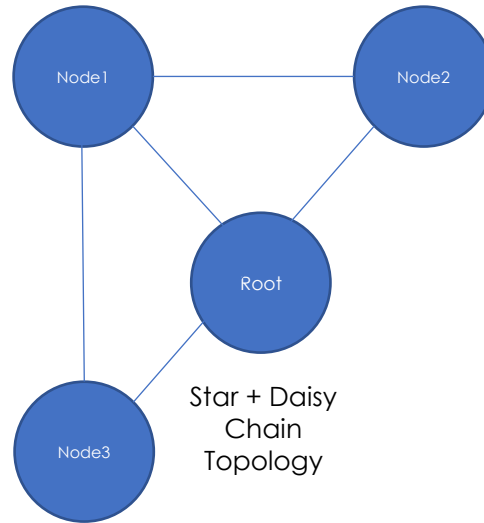
Root + 3 Satellites Topology Examples



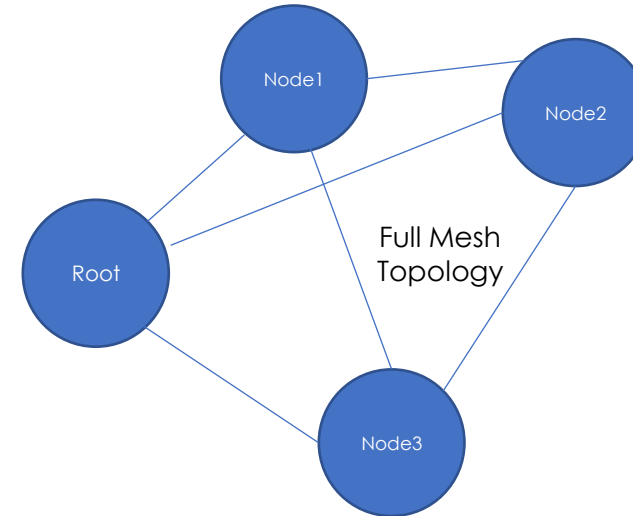
Daisy Chain Topology



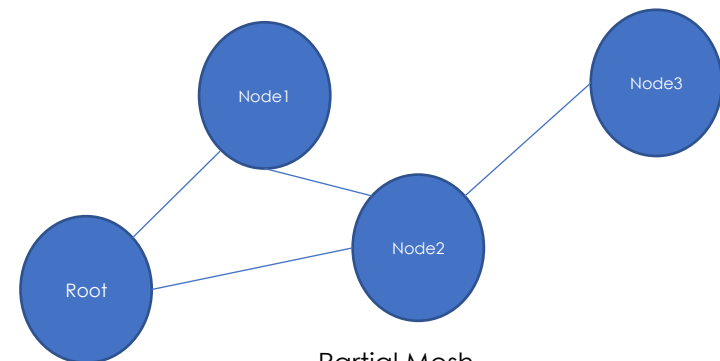
Star Topology



Star + Daisy Chain Topology



Full Mesh Topology



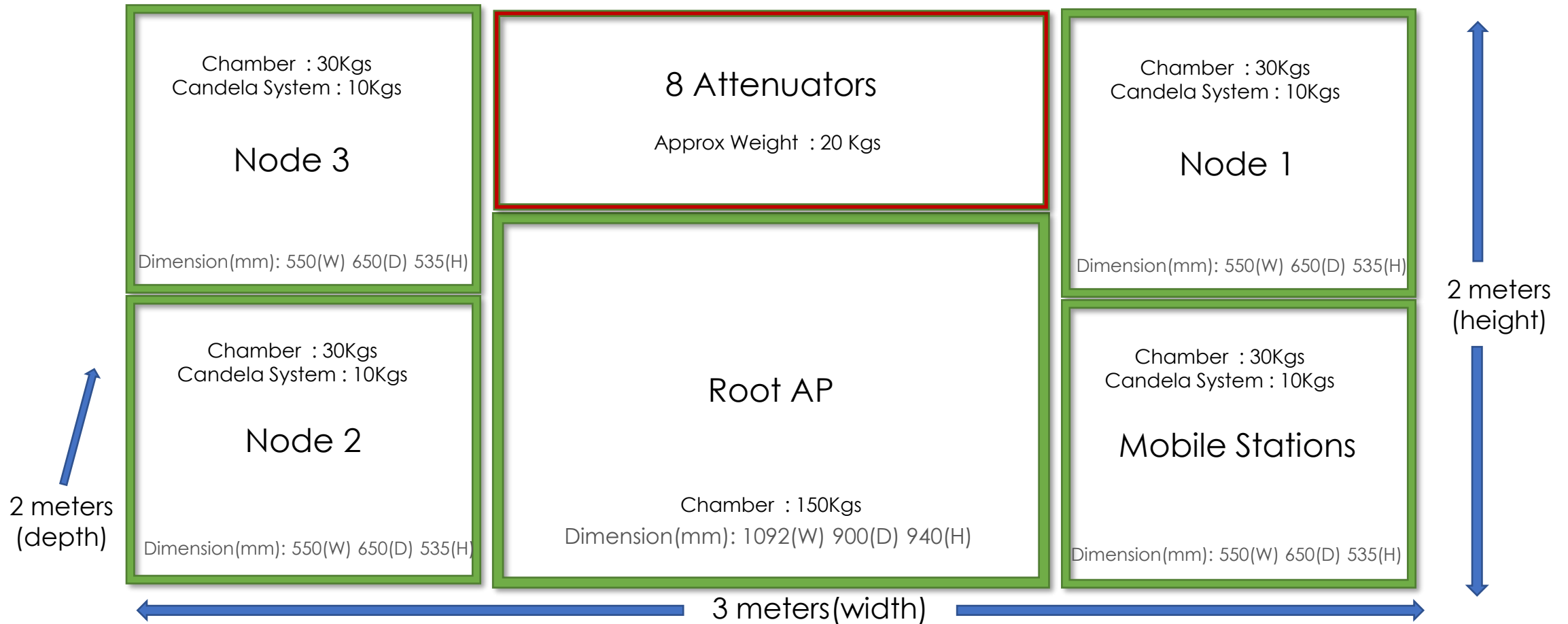
Partial Mesh Topology

TR-398 + Star Topology Tested (Root AP + 3-Nodes)

Total Testbed Approximate Weight : 400 Kgs

Approx space required : 3 meters (width) x 2 meters (depth) x 2 meters (height)

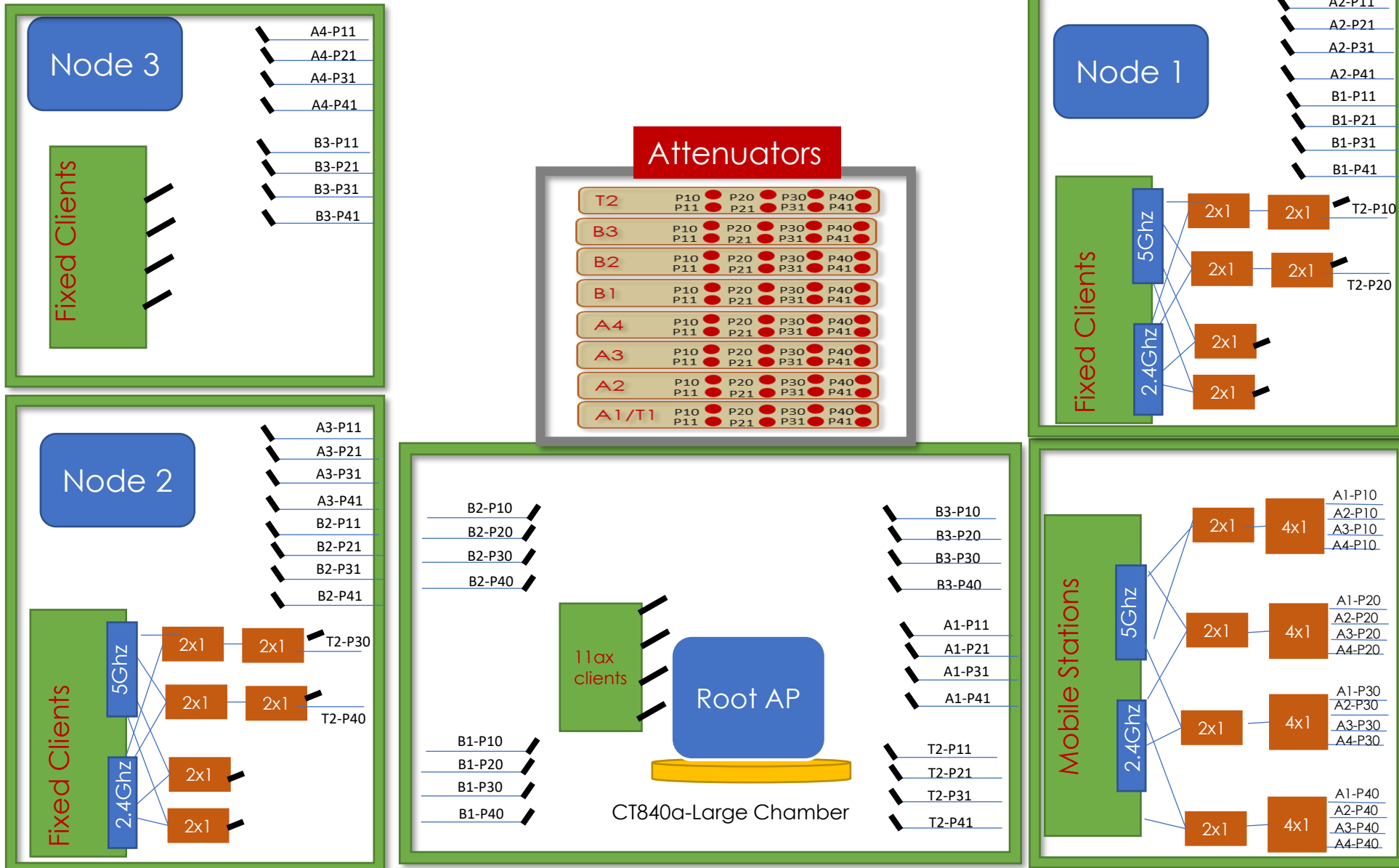
No special power requirements. Candela units draw power similar to Desktop PCs and chambers draw power for small fans



TR-398 + Star Topology Tested (Root AP + 3-Nodes)



TR-398 + Star Topology Tested (Root AP + 3-Nodes) - OTA





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