A Comparison of Bluetooth and ANT for Mesh Networking Applications

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ANT Wireless

What is “ULP” and why is it important in IoT?

- Ultra Low Power
  - mA to nA
  - AA’s to coin cell batteries
  - Weeks to years of battery life

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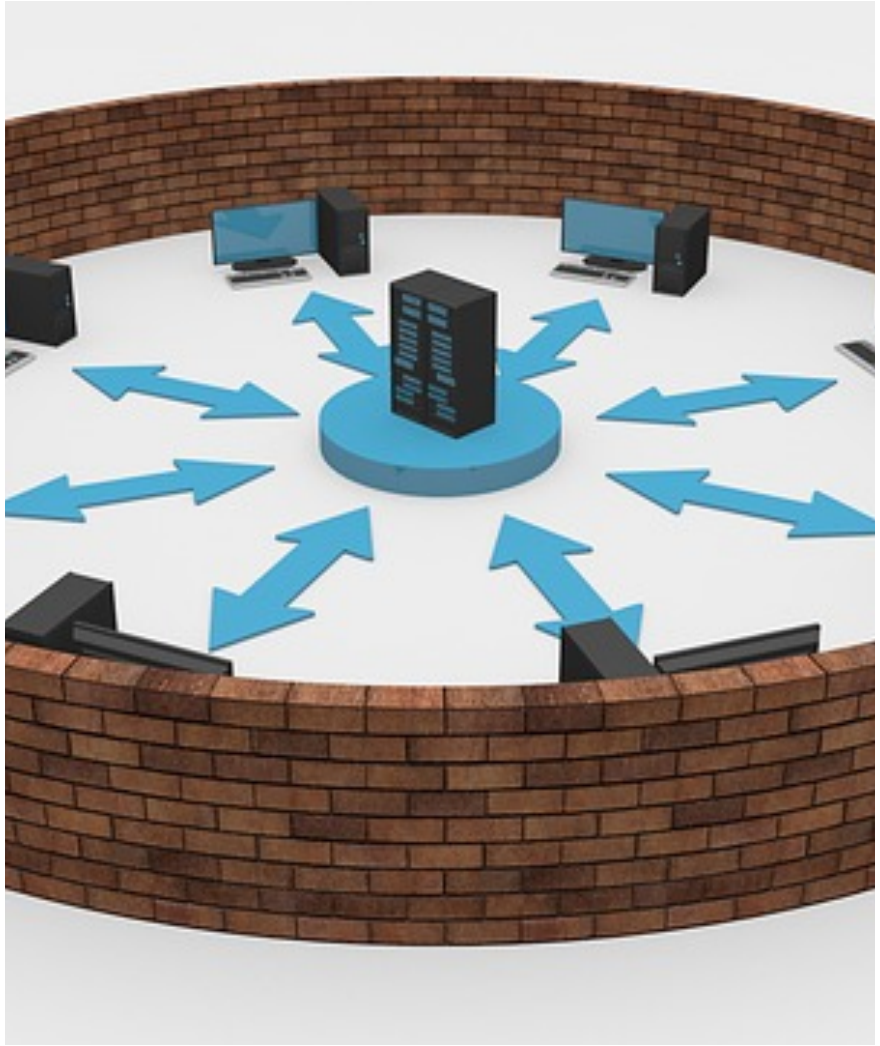
  - Weeks to years of battery life
- First battery costs pennies…
- Second battery can cost hundreds…

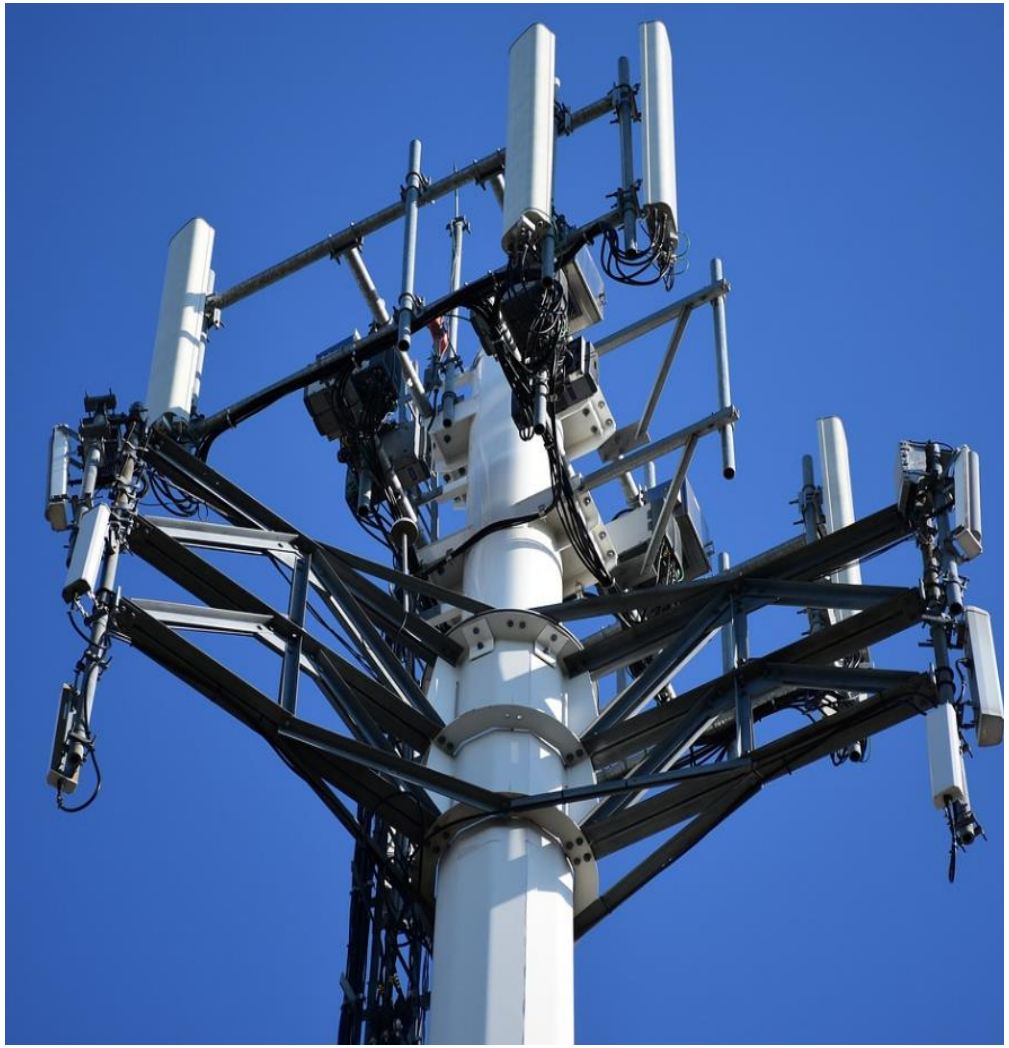
What did ULP wireless networks look like before?

- Local area networks
- Several sensors connecting to a phone
- A couple dozen devices to a Wi-Fi gateway/router



What do ULP wireless networks look like now and why?

- Big Star Networks
  - More information points
  - Adding more sensor types
- Ad-hoc Networks
  - Sensors moving in and out of spatial areas
- Deep Learning
  - Neural networks require big data to be effective

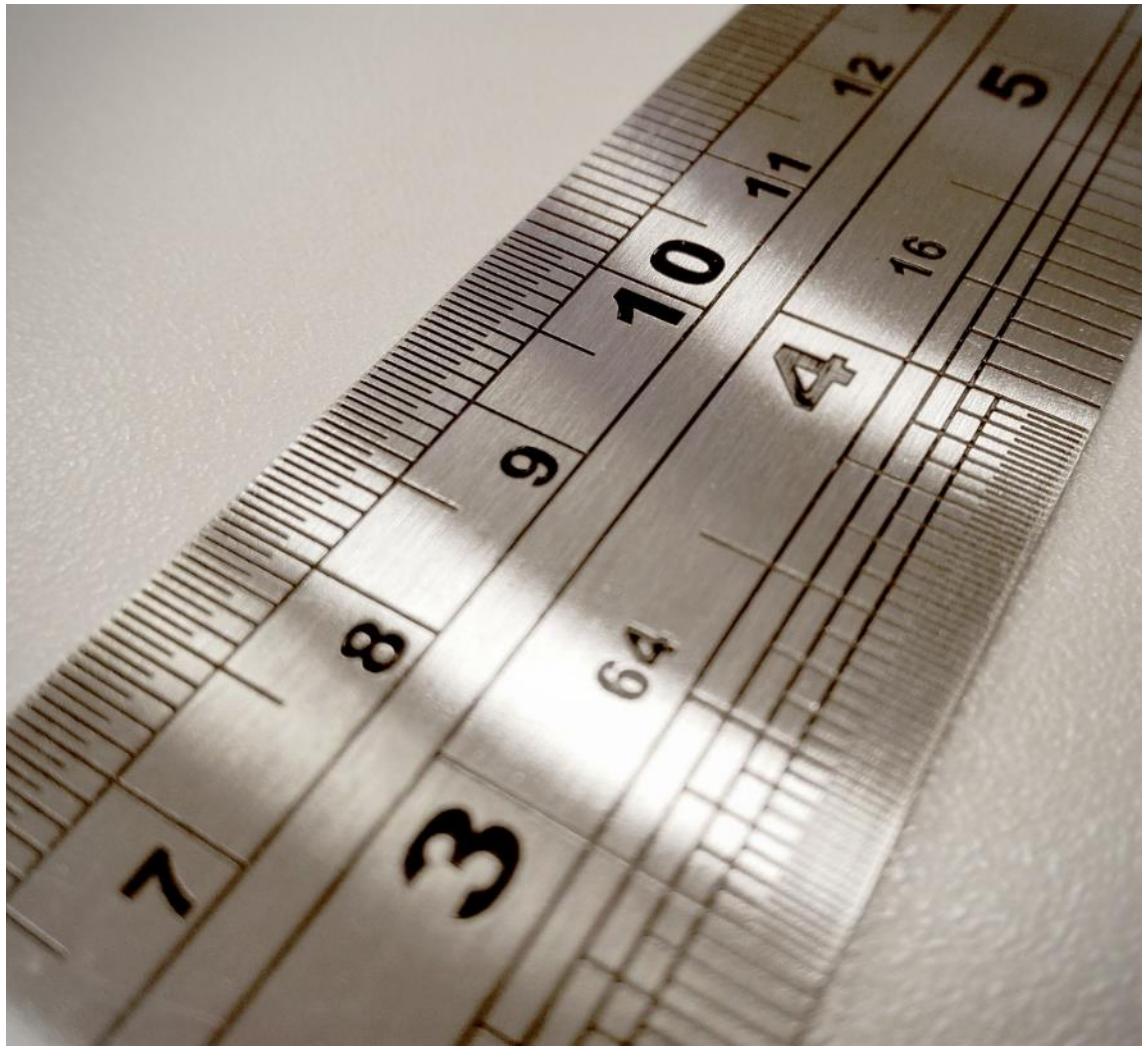


What challenges are we seeing with new applications?

- Hundreds of wireless nodes in a single room
- Latency, bandwidth and cost
- Commissioning complexity

What’s commonly used so far?

- Wi-Fi
- Zigbee
- Thread
- Bluetooth Mesh

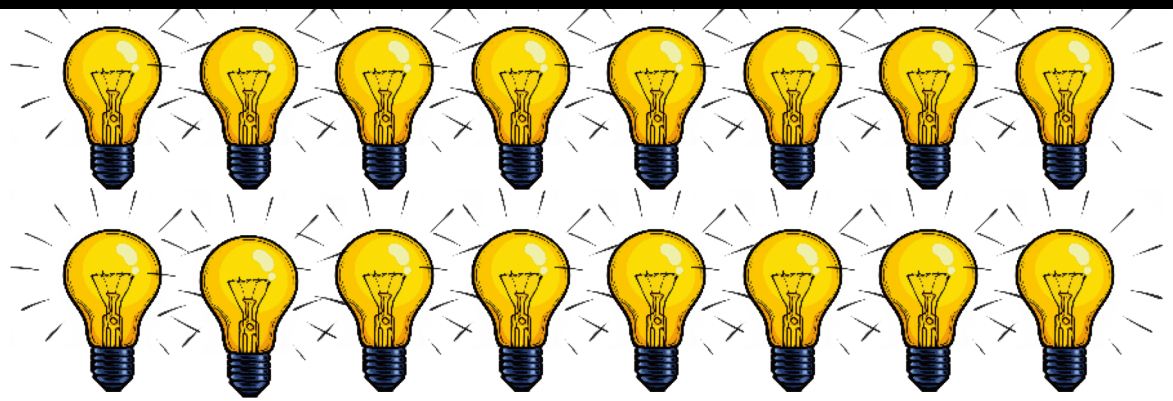


What is Bluetooth Mesh optimized for?

- Optimized for latency
  - Small payload packets
    - Control focused lighting mesh model
  - Multi-cast flood routing
    - Rapid re-transmission of new messages
- Low-cost hardware
  - Re-use BLE Physical and Transport Layers
  - Ubiquitous consumer support
- Multiple application re-use
  - Multiple mesh models and elements over the same network

Control Focused

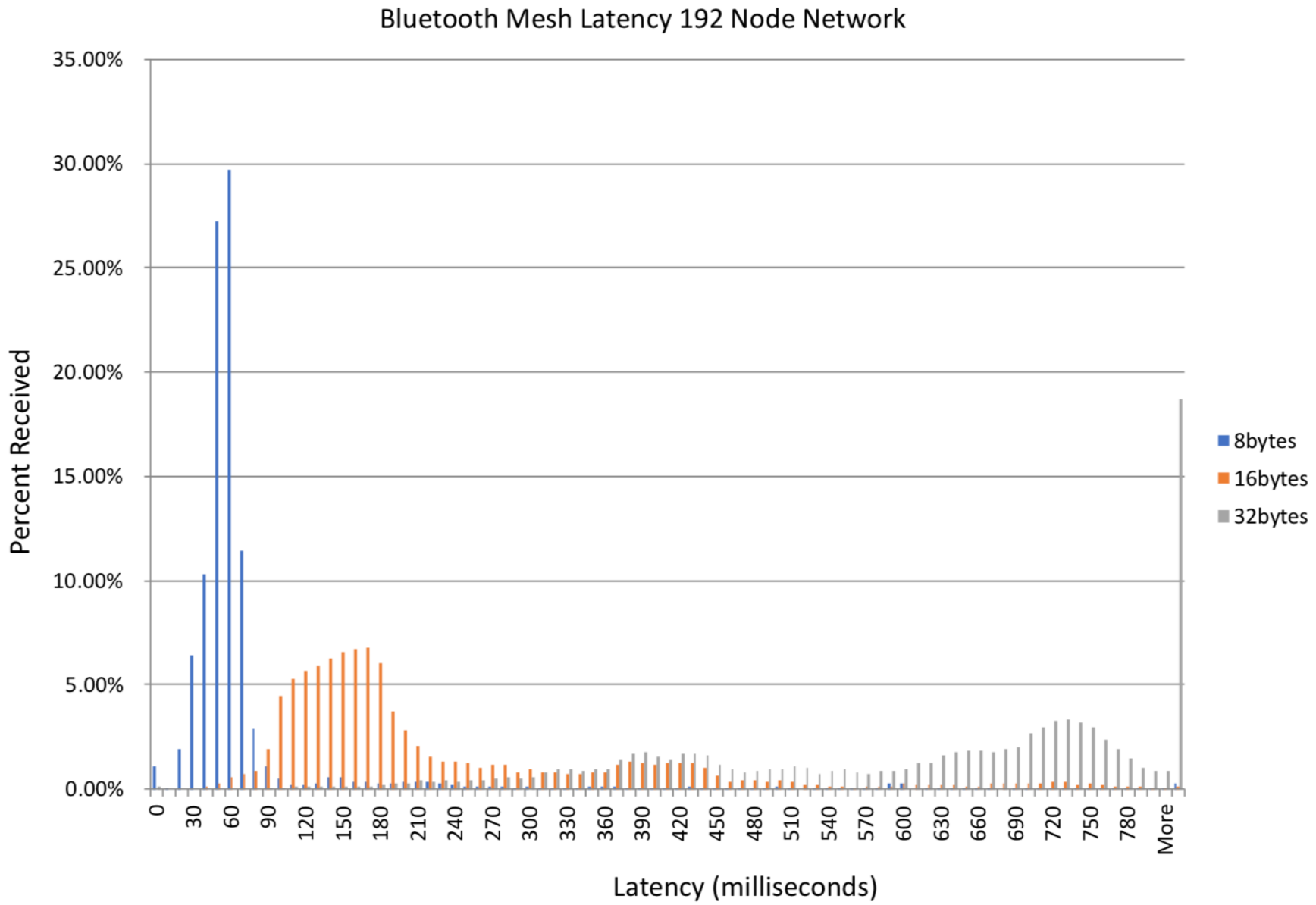
Control Focused



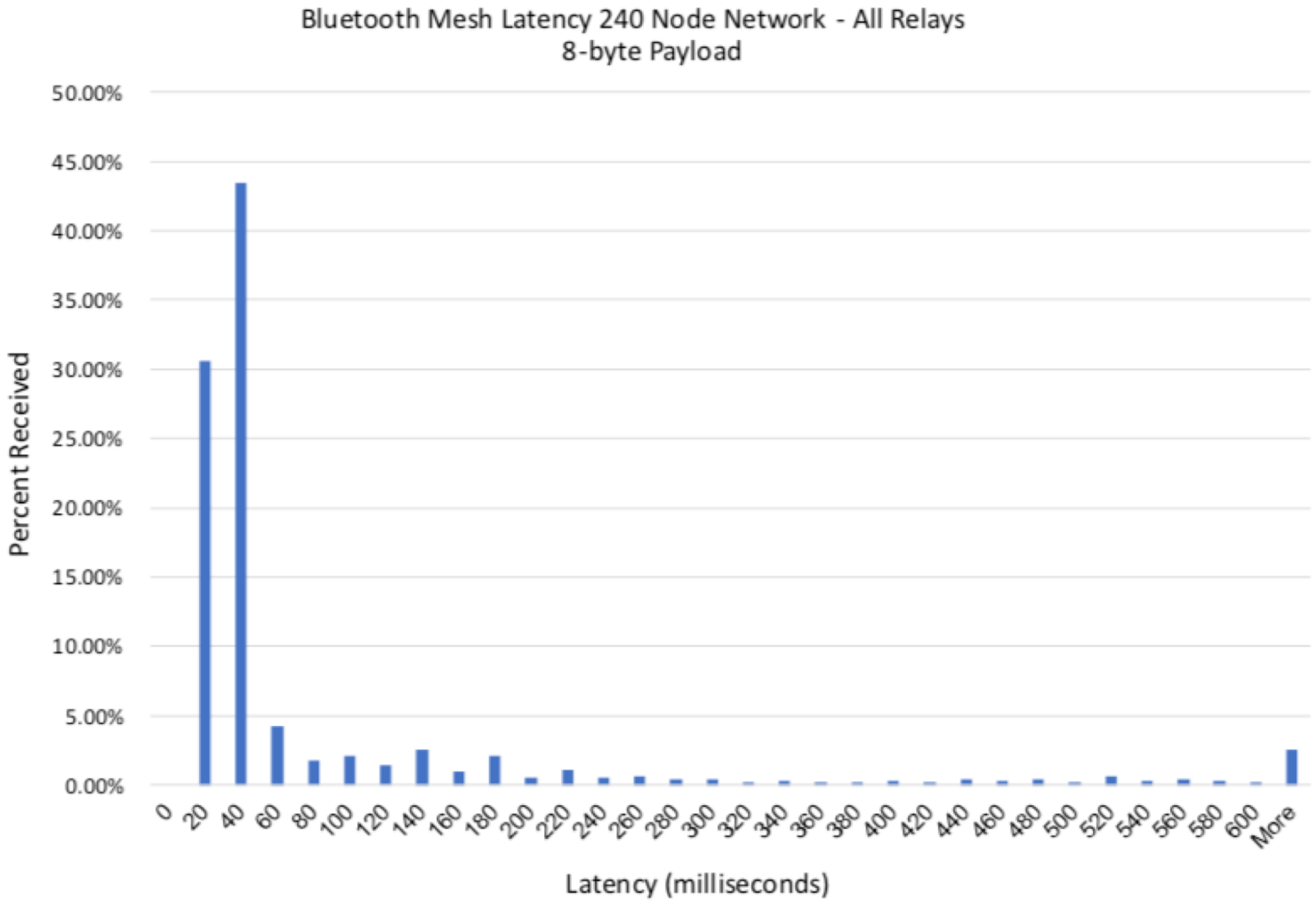
Bluetooth® MESH

3rd Party Testing (SiLabs) - ~60x35m

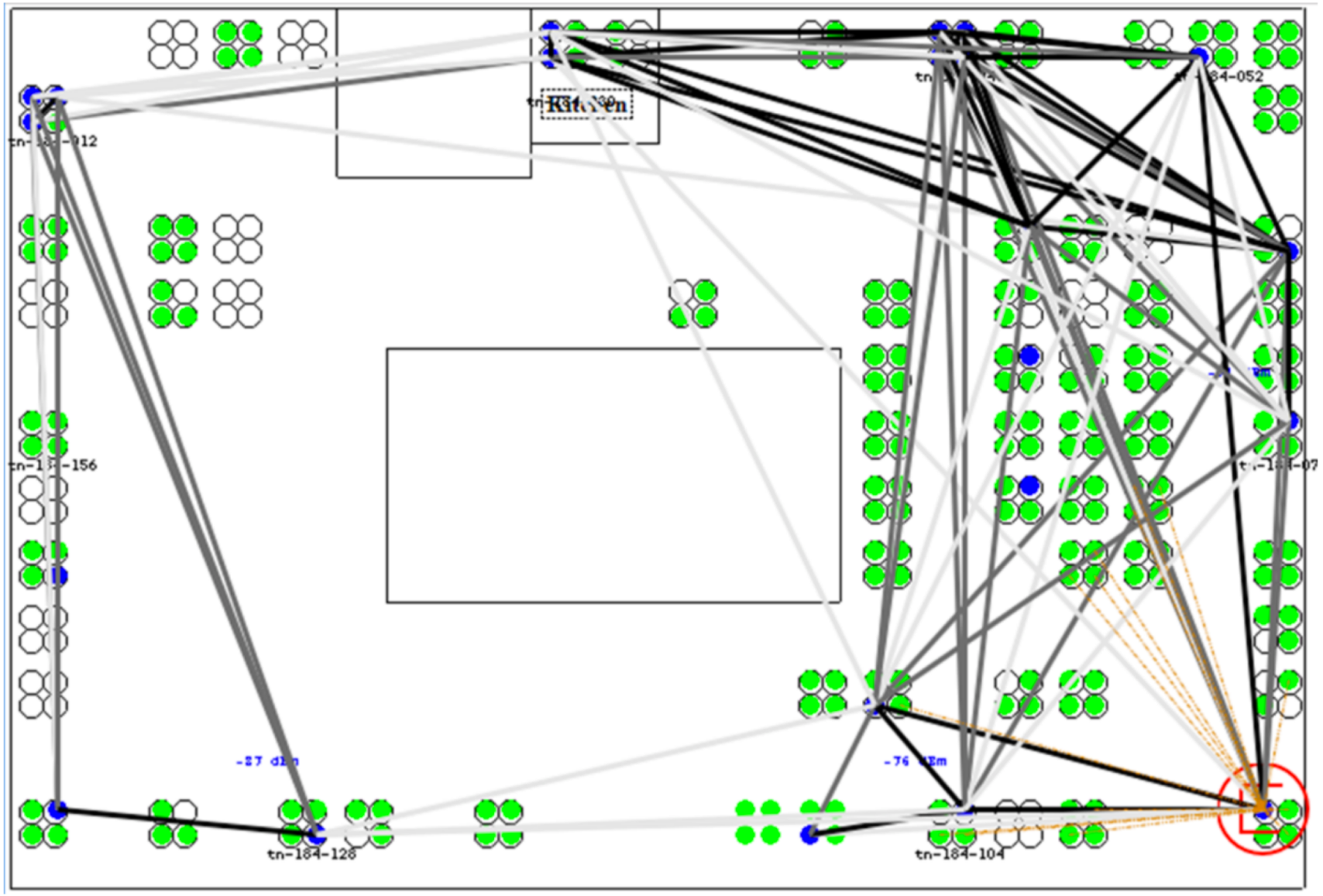
Round-trip Latency Testing – 192 Node Network



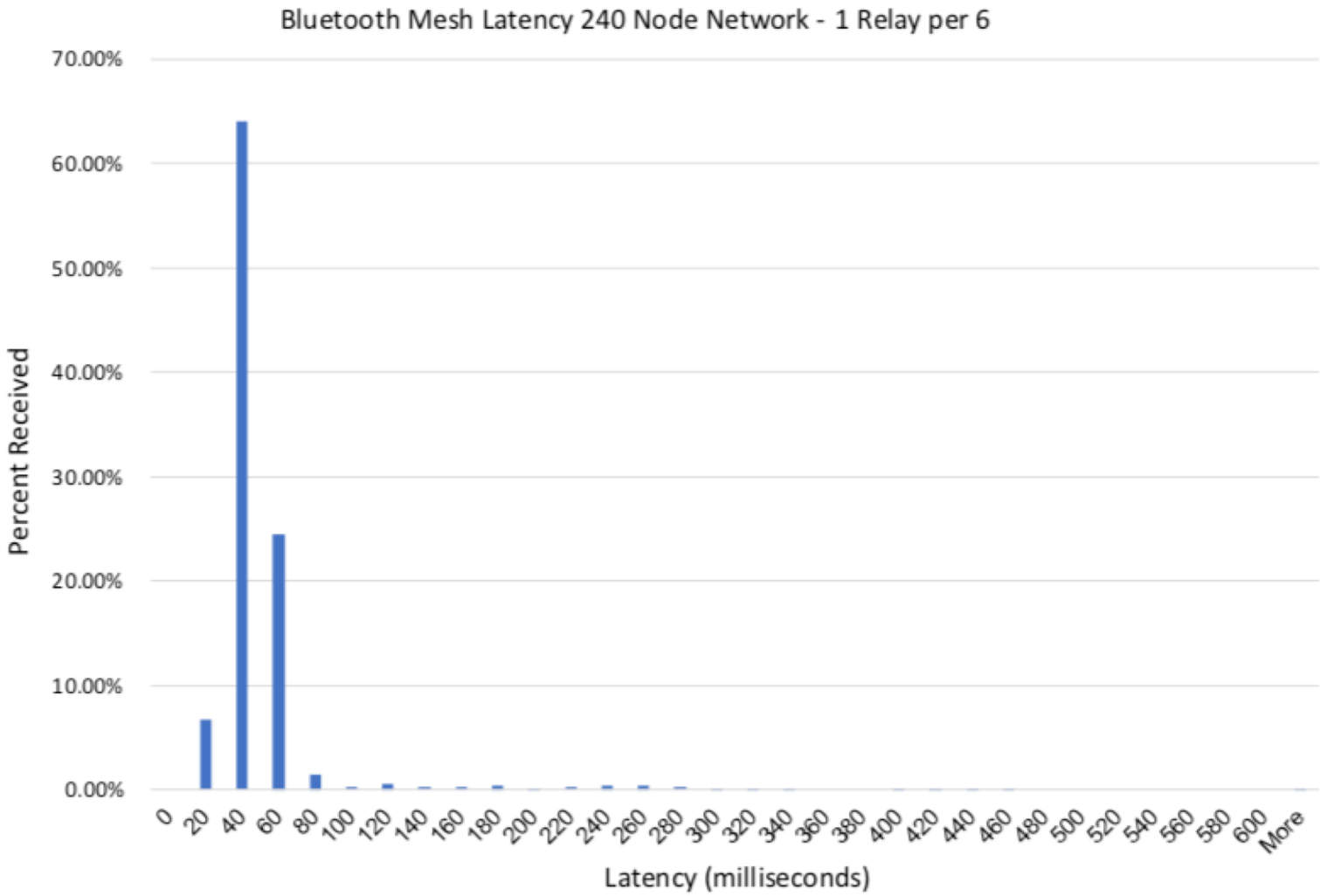
Round-trip Latency Testing – All Relay Role



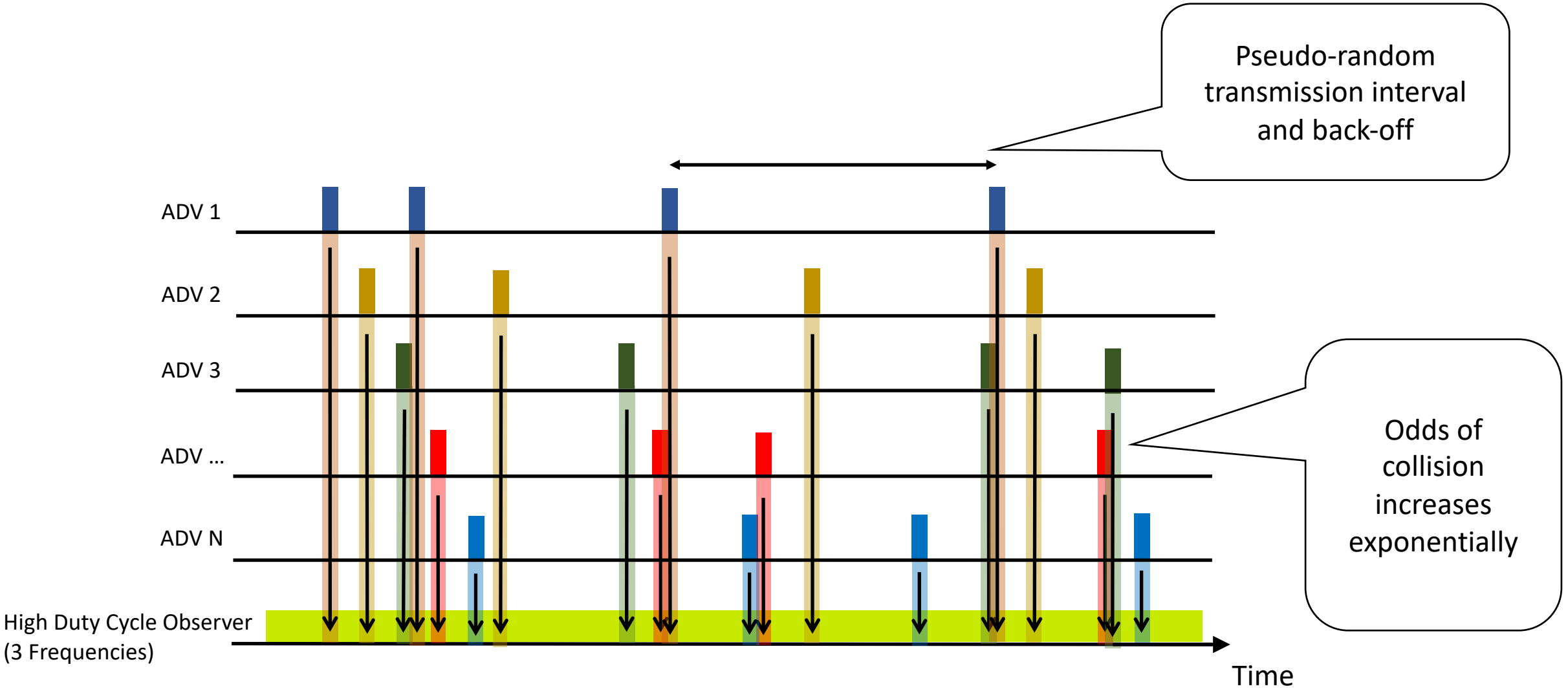
What about strategically placed relays?



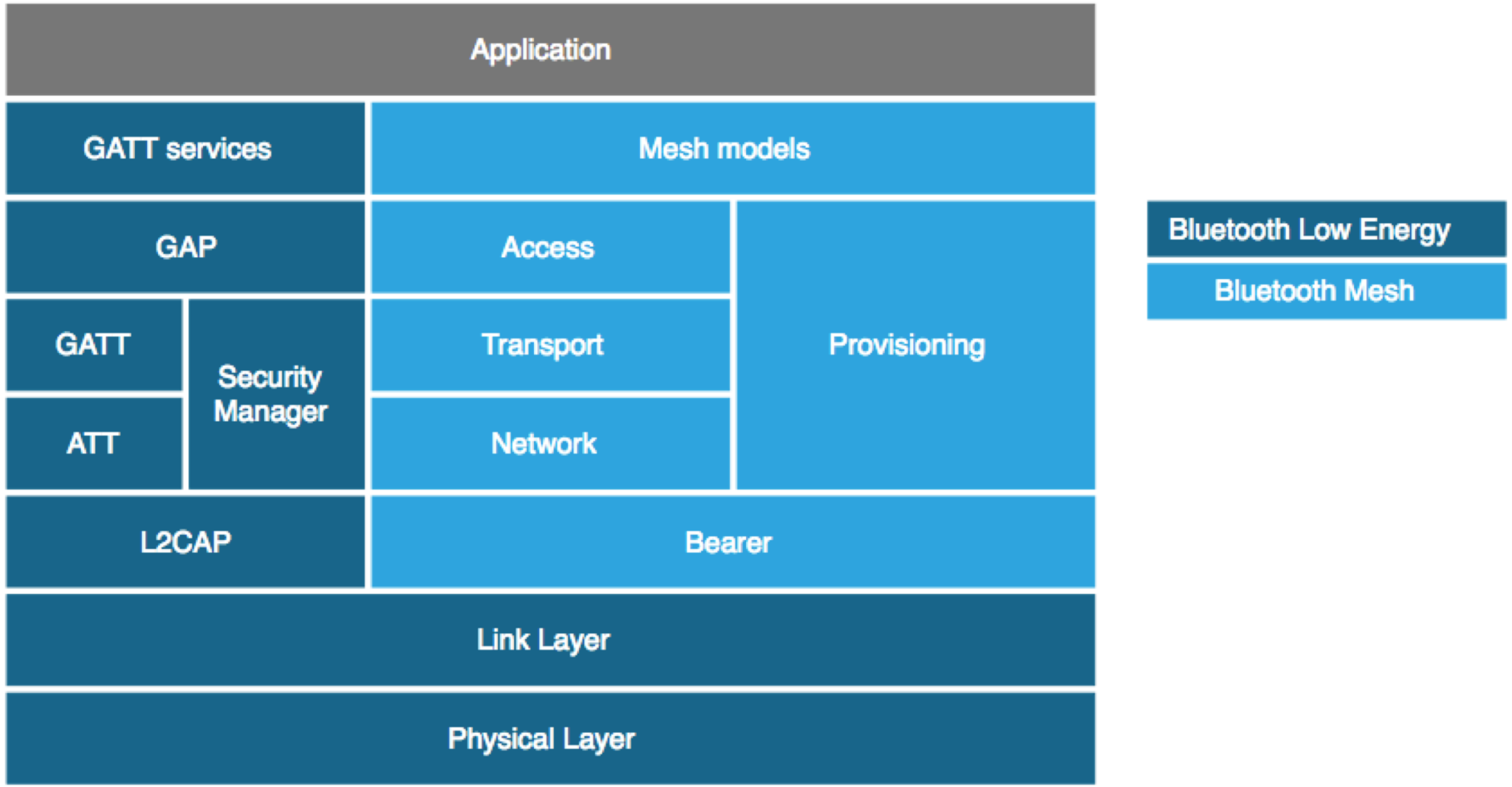
Round-trip Latency Testing – 1/6 Relay Role



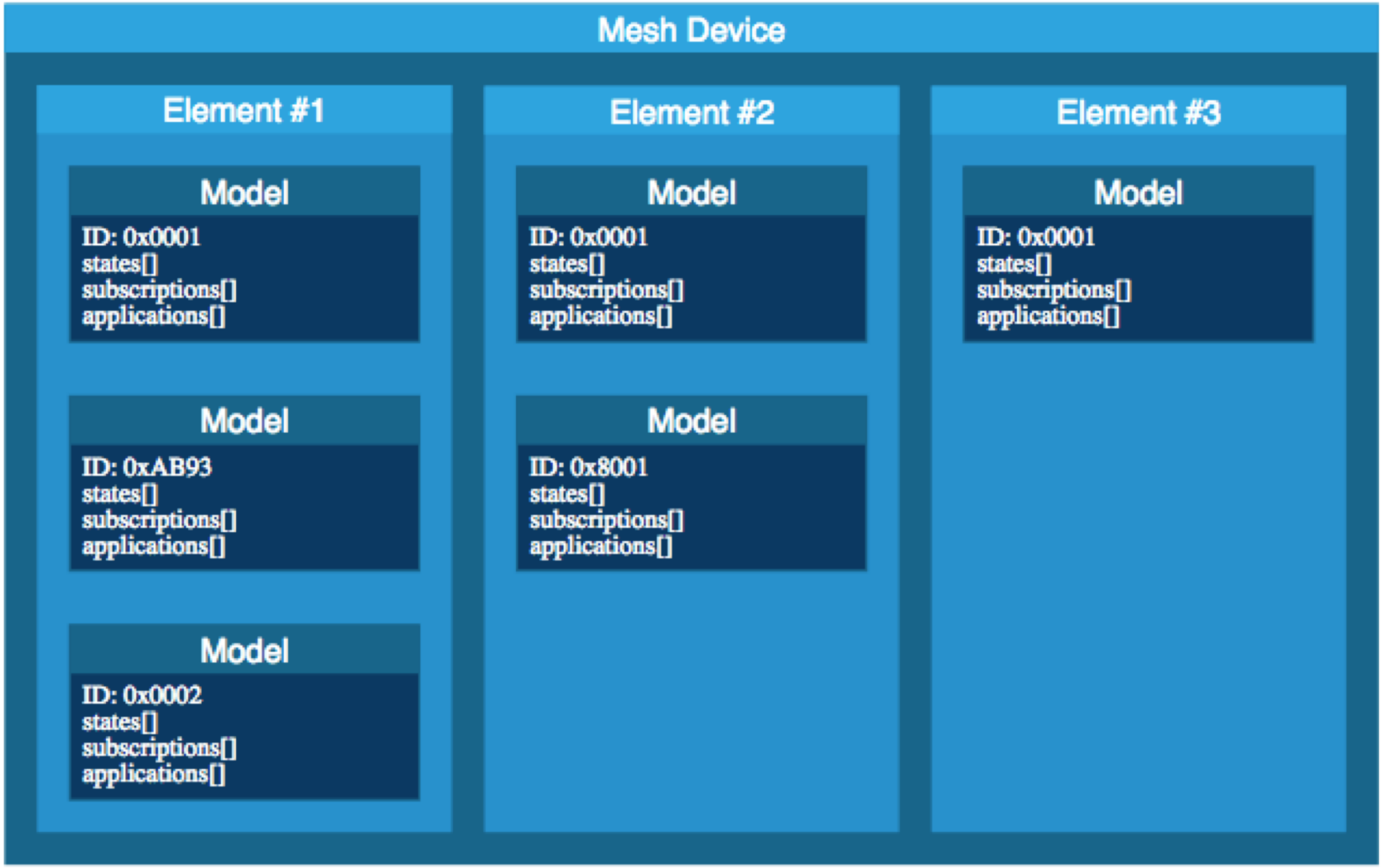
Bluetooth Mesh Advertising Time Domain



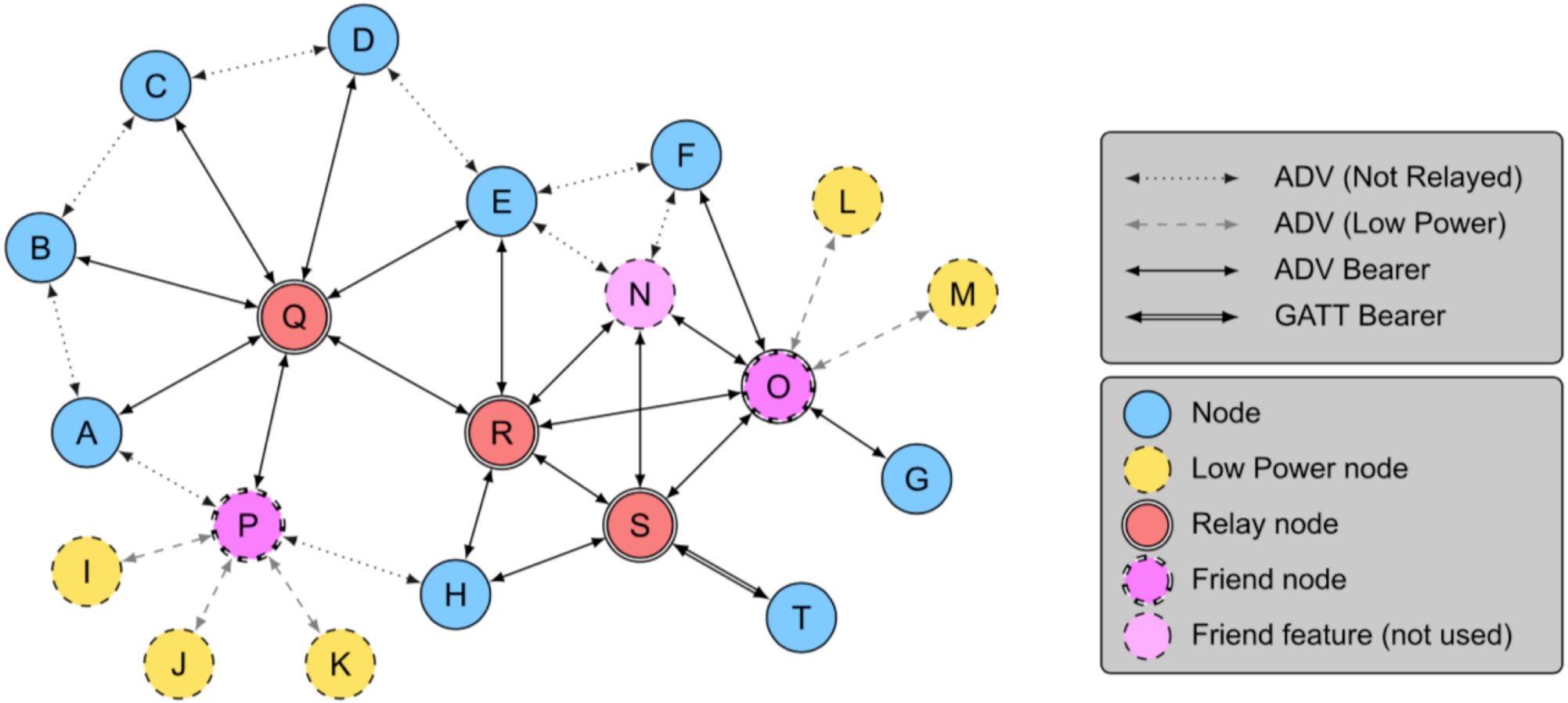
Bluetooth Mesh Layers



Bluetooth Mesh Elements and Models

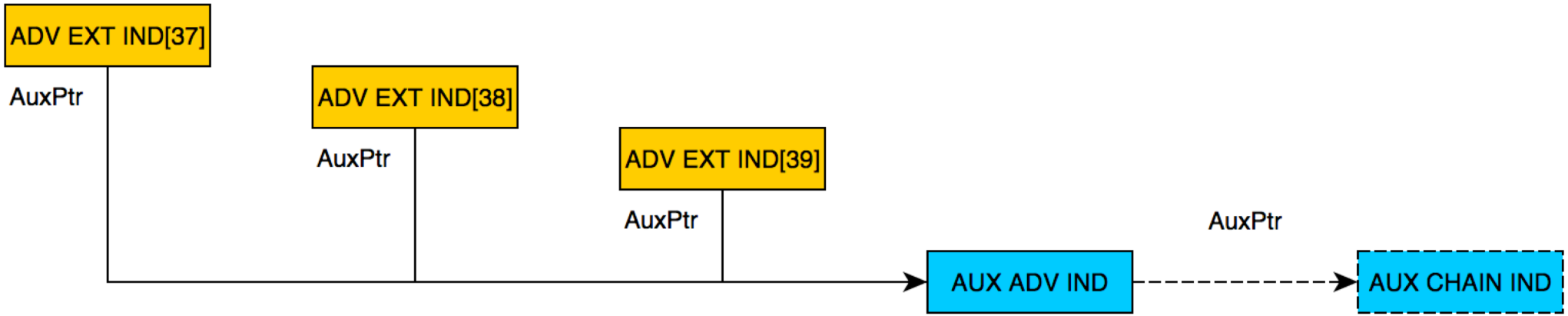


Bluetooth Mesh Asymmetric Topology



Will it benefit from Bluetooth 5.0?

- Advertising Extensions
  - Lowered mesh format overhead
  - Increased node-to-node bandwidth for large data packets
  - Increased latency for small data packets



Will it benefit from Bluetooth 5.0?

- Long Range Coded PHY
  - Reduced number of hops
  - Decreased latency for small data packets
  - Decreased node-to-node bandwidth

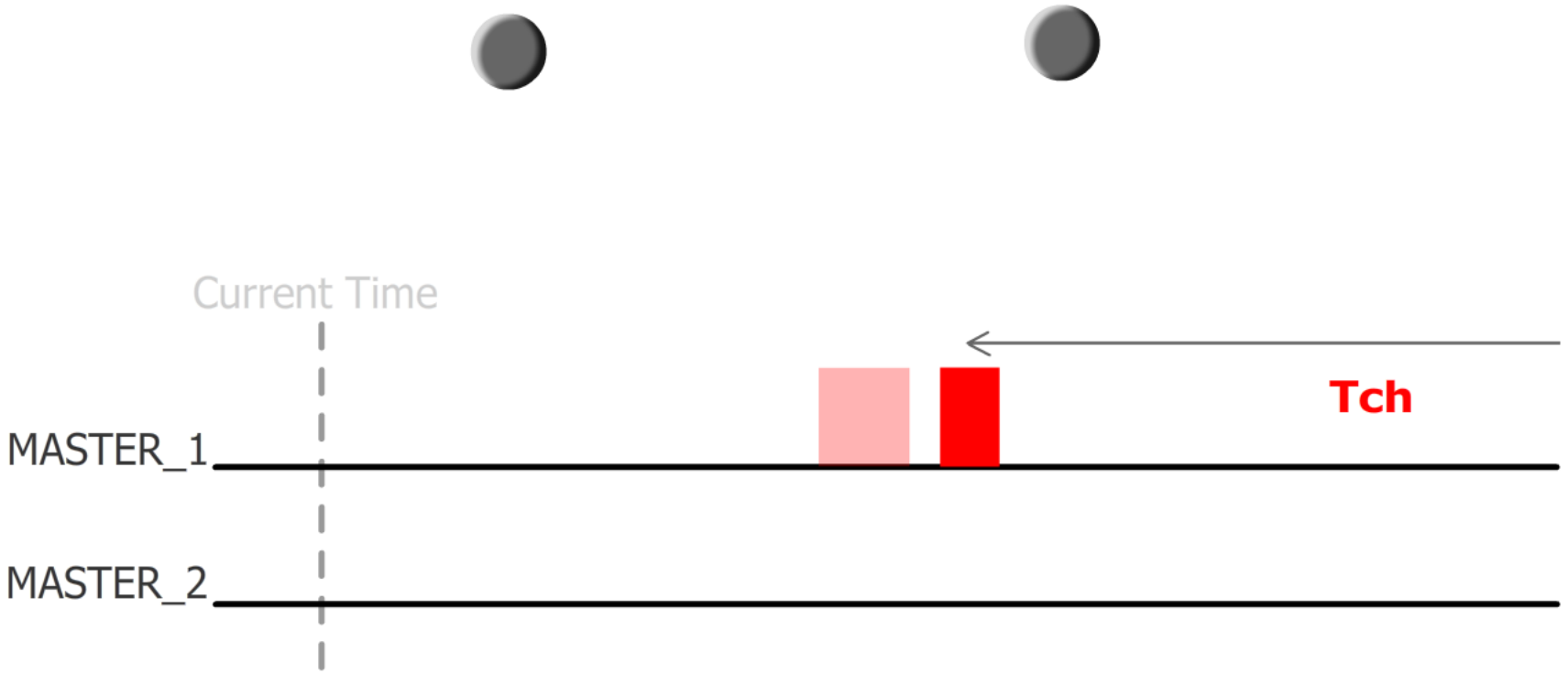
Bluetooth Mesh

- Low-latency for infrequent, small packets
- Mesh models defined for on/off, luminance, etc
- Supports mutually distrusted applications operating over a single transport
  - Layered architecture
  - Multiple levels of encryption
  - Required provisioning for key allocation and distribution

What is ANT BLAZE optimized for?

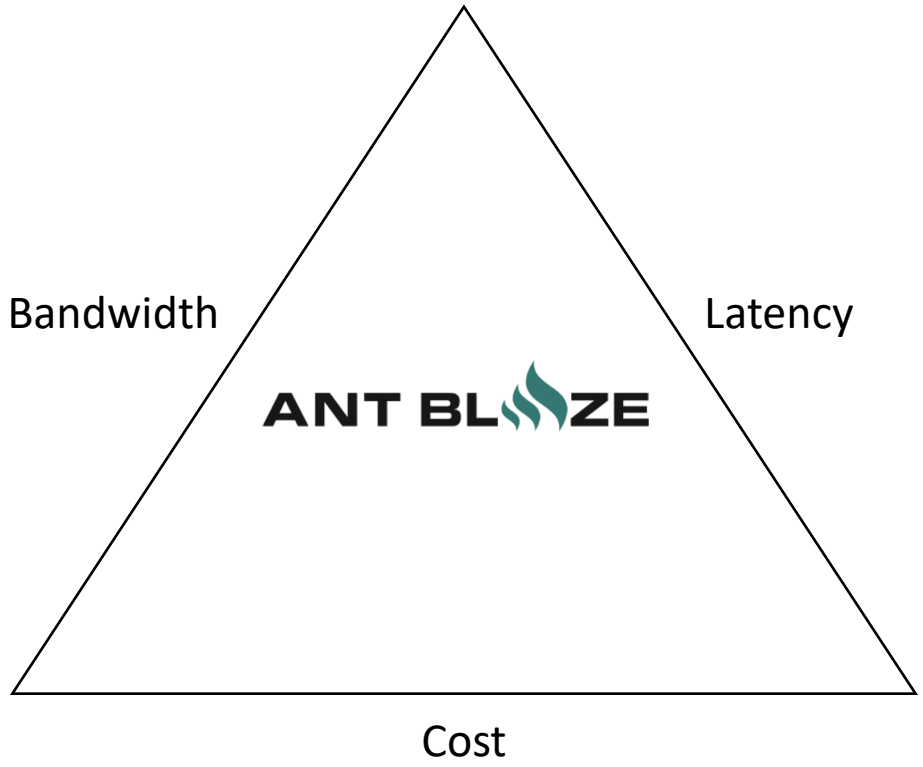
- Optimized for throughput
  - Time-synchronized transmission intervals
    - Group polling
    - Parallel data generation
  - Multi-broadcast flood routing
    - “C10K” Problem for Wireless
- Low-cost hardware
  - Supported by similar Bluetooth physical layer
  - Hundreds of millions of devices worldwide including cellphones
- Low-cost deployment
  - All nodes are routers
  - Application-controlled static addressing

ANT Time Domain Adaptation

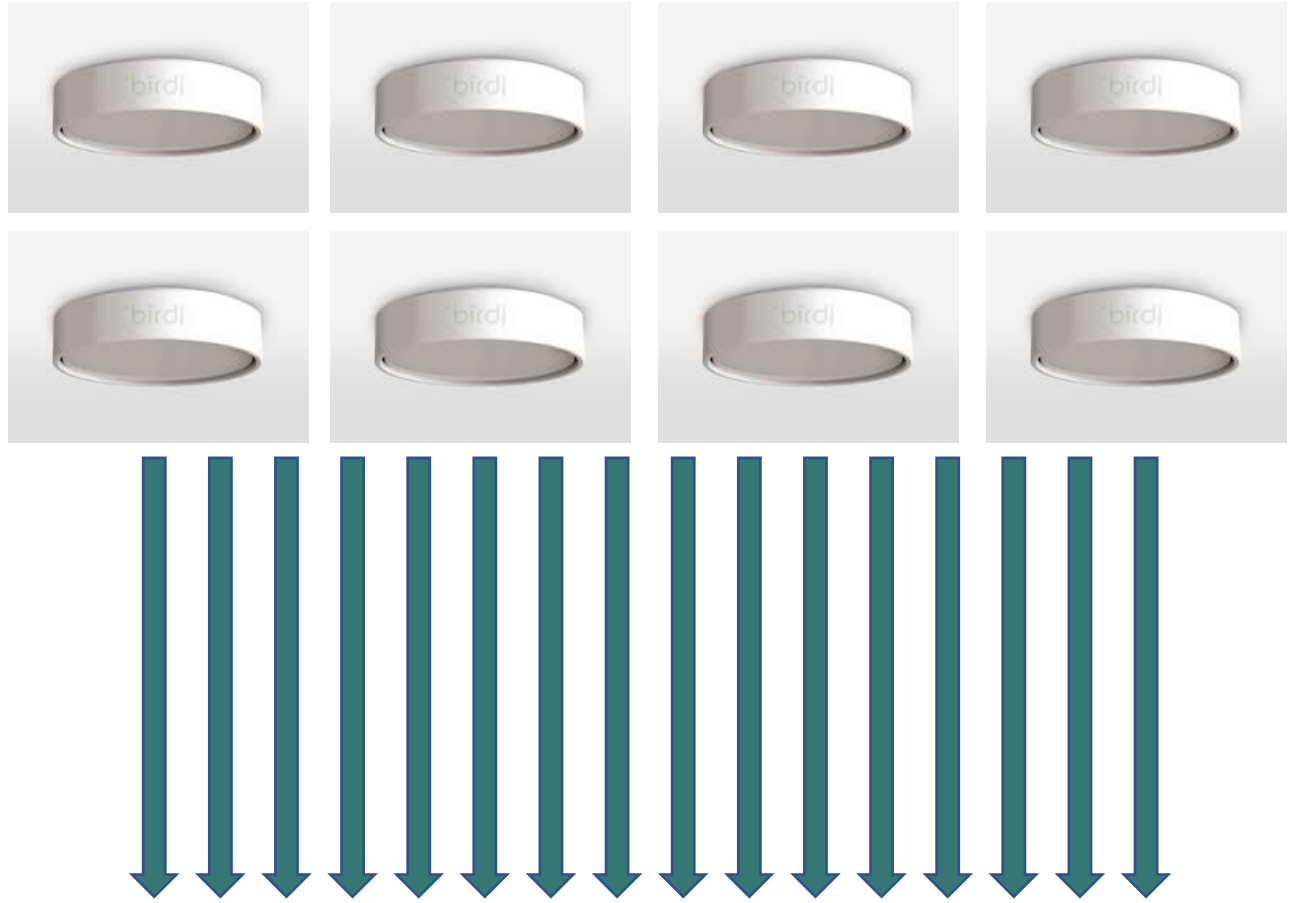


What is BLAZE targeting?

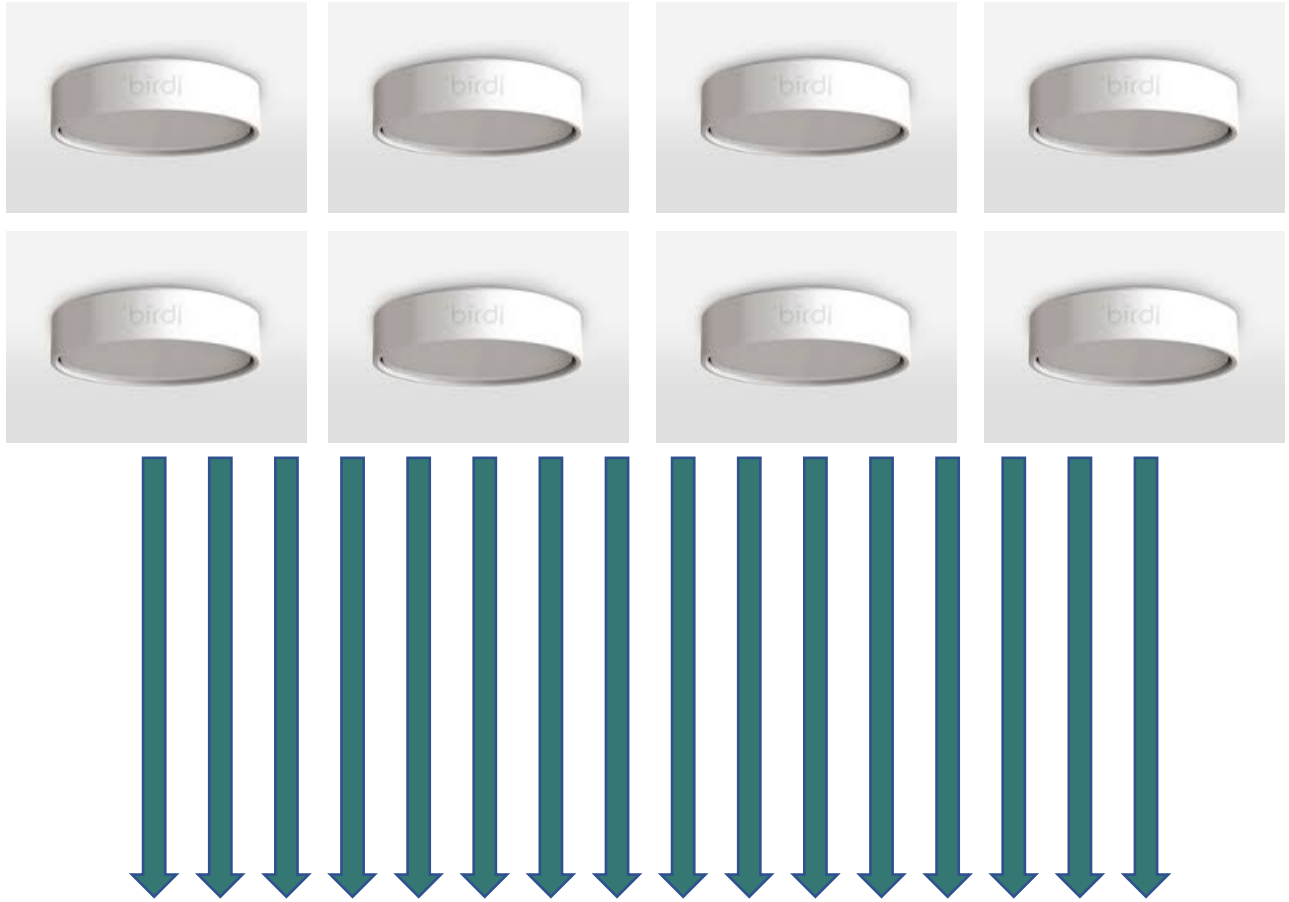
- Aggregate Network Bandwidth
- Consistent Network Latency
- Total Costs
  - Flash and RAM Size
  - Development and Deployment Time
  - Radio Hardware



Data Focused



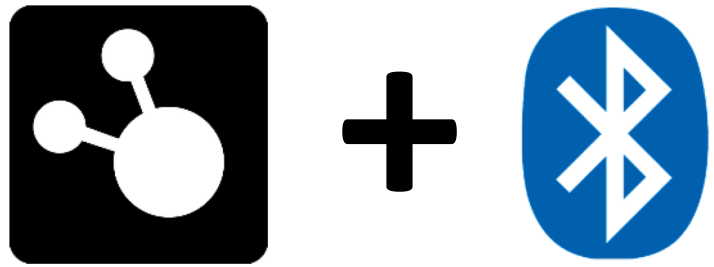
Data Focused



ANT BLAZE

Either/or? Why not more than one!

- BLAZE, a Bluetooth-enabled ANT Mesh
- nRF52-based
  - BLE Peripheral Edge Connections
  - ANT-Powered Backbone
  - Concurrent ANT/BLE Examples in Nordic SDK



Case Study

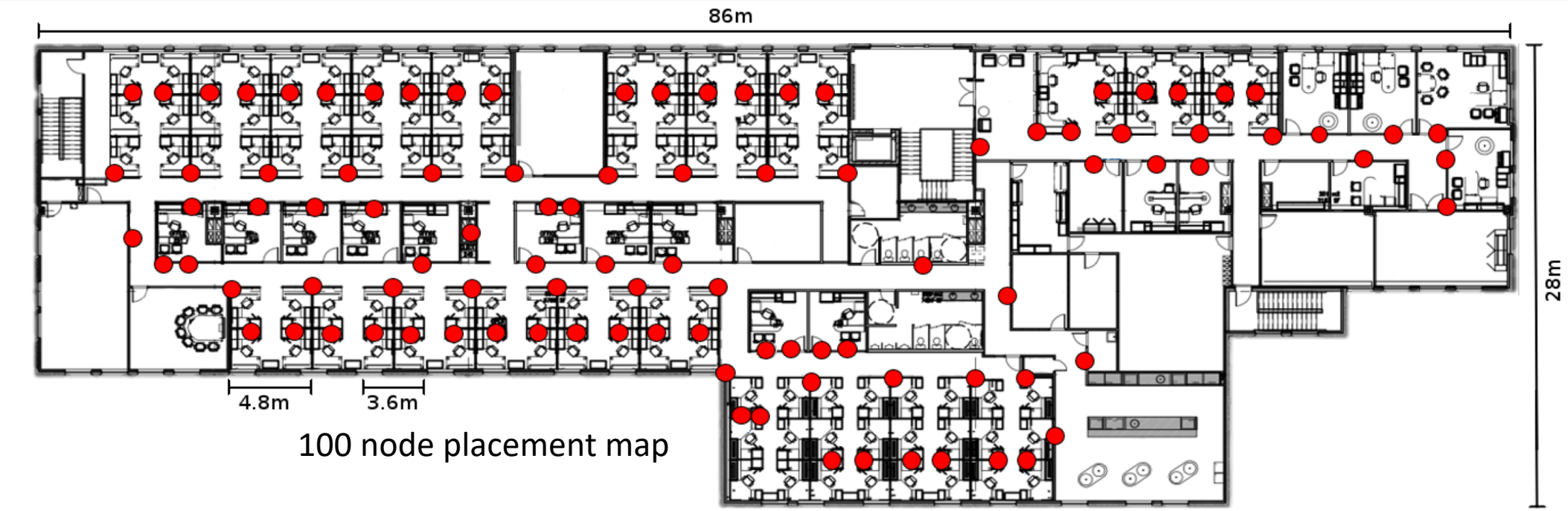
- 300+ Nodes in a Building
- Receive Data Within 2 Minutes
- Coexist With Other Wireless

ANT BLAZE – Sample Use Cases and Test Results

- For the following examples, an ANT BLAZE network was established in an office environment with cubicles and enclosed offices.
- Different network sizes and application payloads were tested to measure throughput, success rate and the average time to poll all nodes.
- A group polling approach was used to query 20 nodes at a time.
- Performance is dependent on parameters such as # of nodes in a network, node density, message size and whether frequency diversity enabled.

- Definitions:
- $\text{throughput} = \frac{\text{number of bytes received from all ping responses}}{\text{total time for all responses}}$
- $\text{success rate} = \frac{\text{number of ping responses received}}{\text{total number of ping requests}}$

Test Results – Low Density

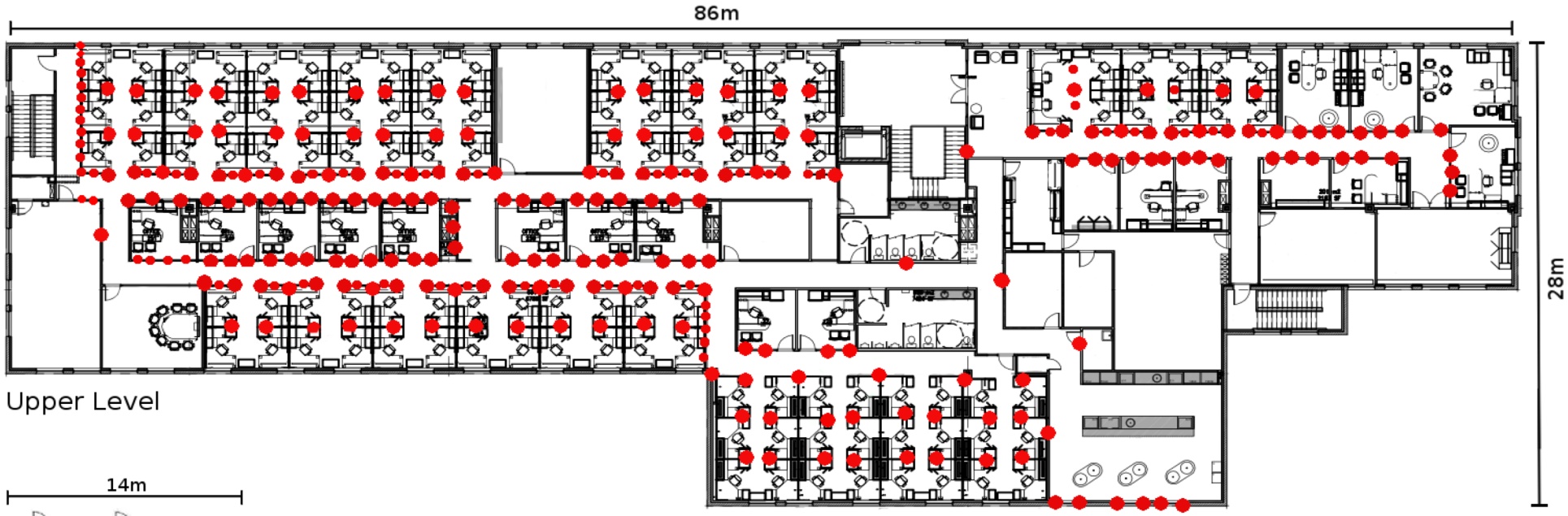


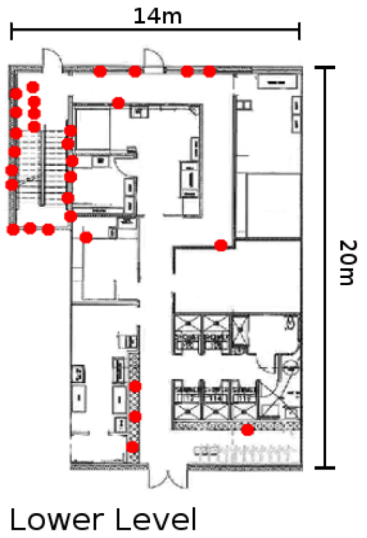
100 node placement map

*Dimensions Approximate

Scenario 300 nodes	Success rate (%)	Average throughput (bytes/sec)	Average time to poll all nodes (sec)
Single frequency	99.50	147.01	26.1
Frequency Diversity	99.679	60.75	41.5

Test Results – High Density

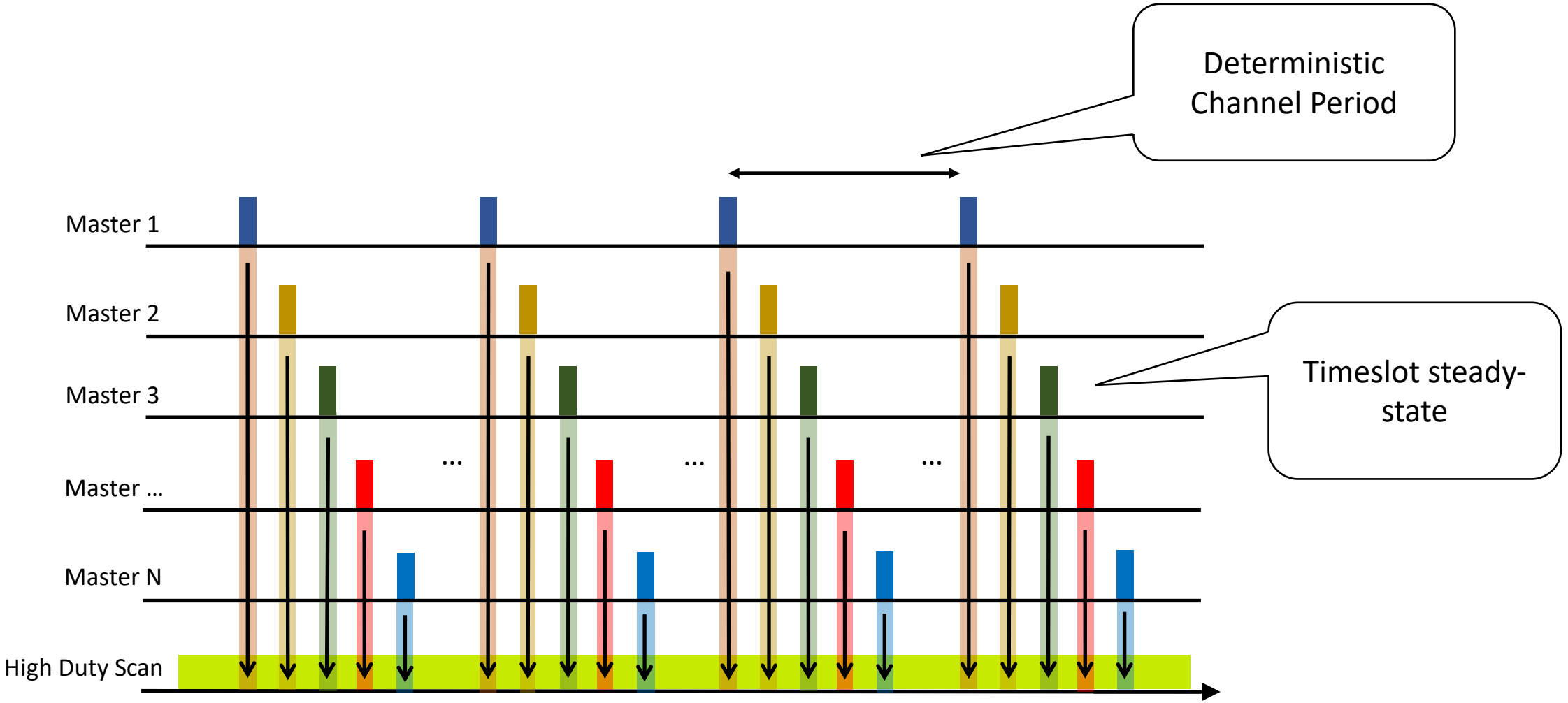




300 node placement map

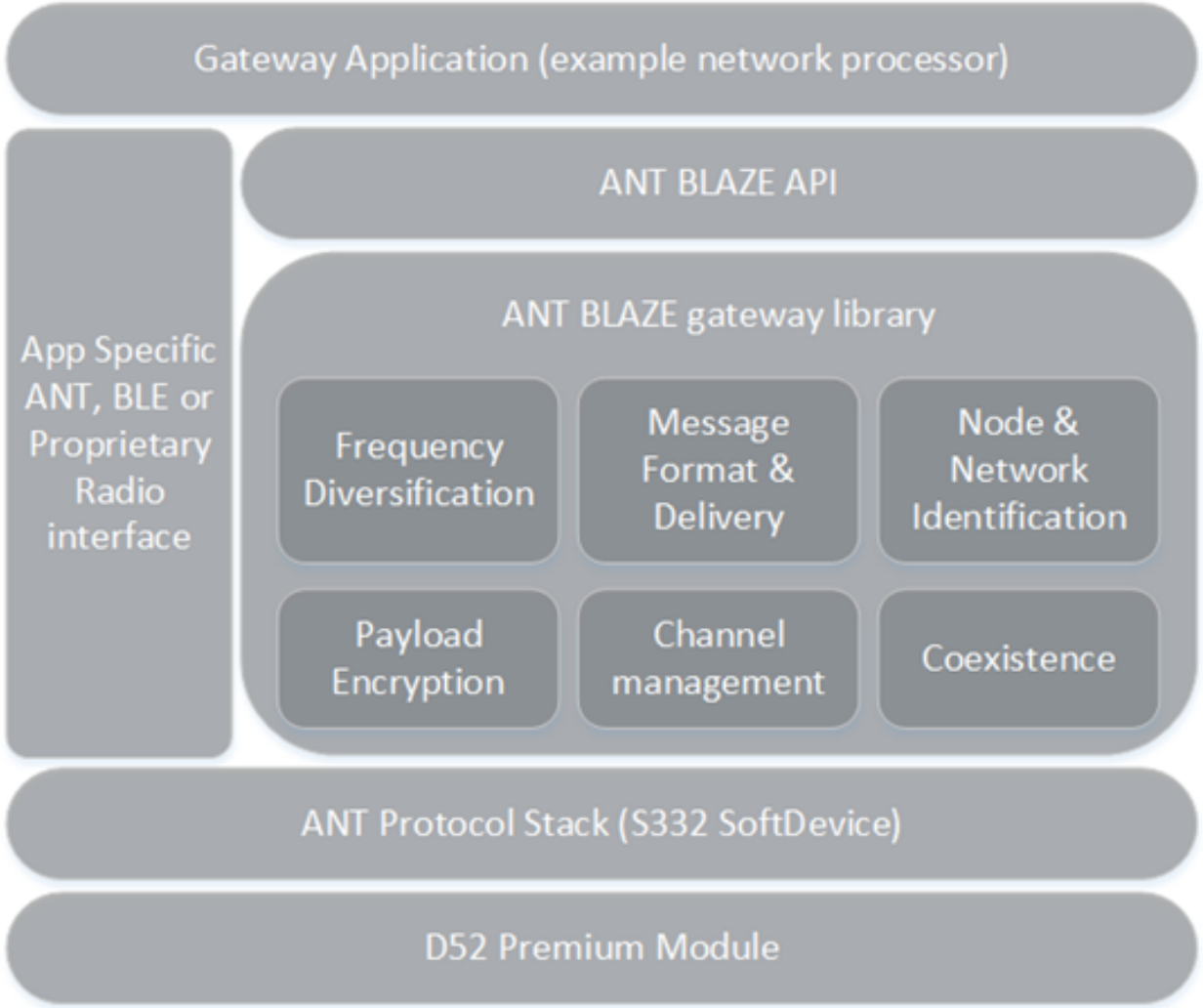
Scenario 300 nodes, with Frequency diversity	Success rate (%)	Average throughput (bytes/sec)	Average time to poll all nodes (sec)
Large payload (20 bytes)	98.52	39.43	152.2
Small payload (10 bytes)	99.67	47.56	63.0

BLAZE Broadcast Time Domain



Focused on Developer Productivity

- Lightweight BLAZE Mesh API
  - 14 Function Calls
- Direct Support
- Library-based Solution



Focused on Developer Productivity – BLAZE API

- ant_blaze_node_init(…);
- ant_blaze_node_config(…);
- ant_blaze_node_start(void);
- ant_blaze_node_stop(void);
- ant_blaze_node_process_channel_event(…);
- ant_blaze_node_process_timeout(void);
- ant_blaze_node_send_message(…);
- ant_blaze_node_get_version_string(…);
- ant_blaze_node_get_current_scan_frequency(…);
- ant_blaze_node_get_number_of_nodes_in_range(…);
- ant_blaze_node_get_current_channel_period(…);
- ant_blaze_node_add_to_group(…);
- ant_blaze_node_remove_from_group(…);
- ant_blaze_node_remove_from_all_groups(void);

Focused on Developer Productivity - MVP

- **ant_blaze_node_init(…);**
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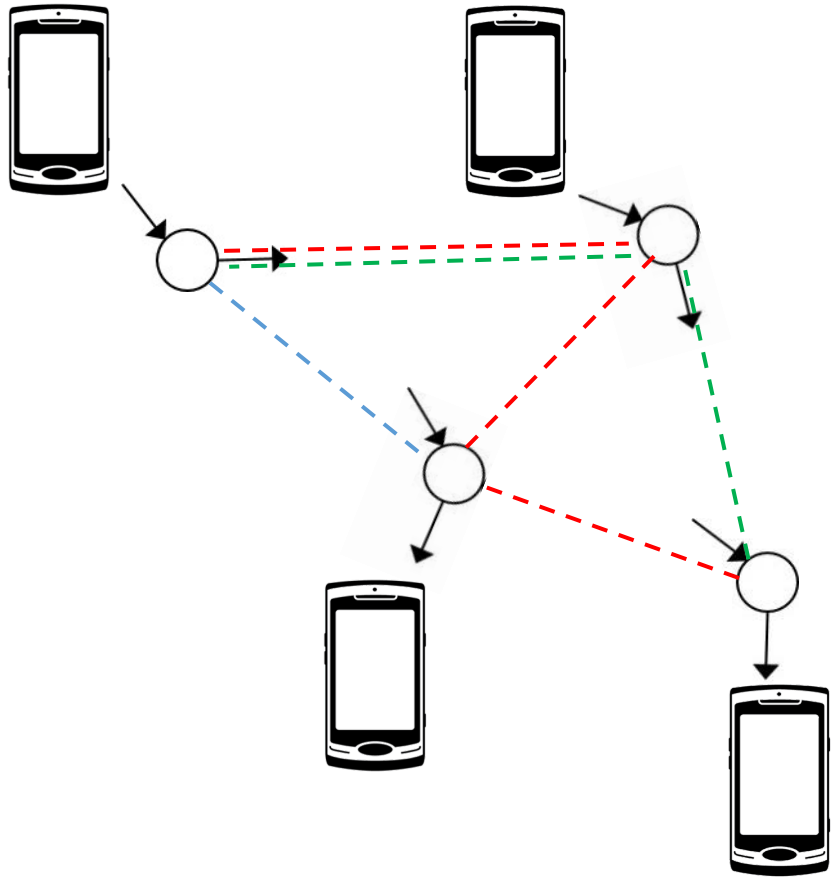
All Nodes are Relays

- Easy deployment for installers
- All nodes improve wireless coverage area
- All nodes improve the user endpoint access



Continuous Innovation – Current and Future Updates

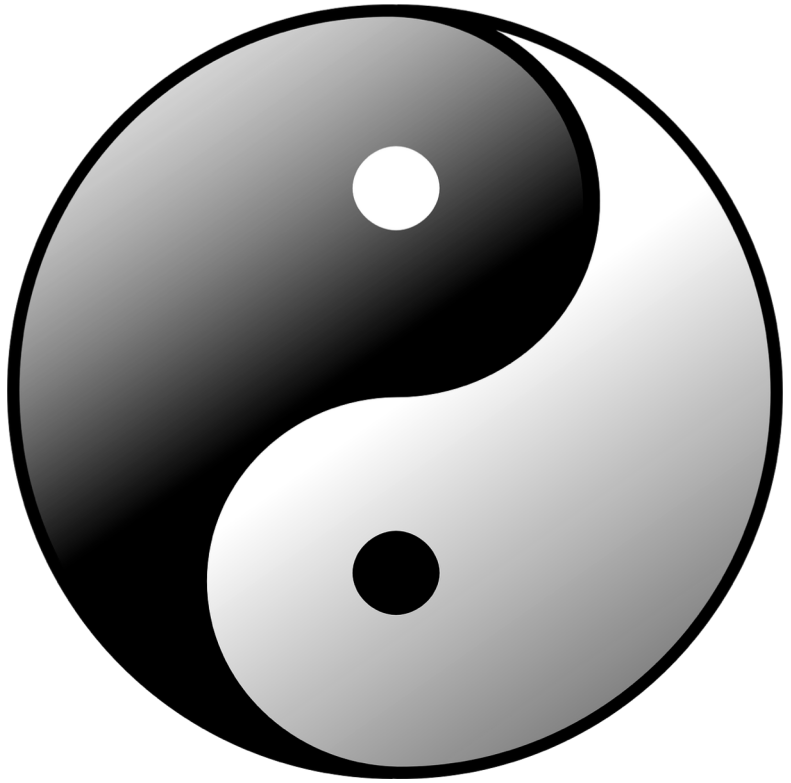
- Device Firmware Updates
  - SoftDevice 4.0.5 – On-chip coexistence
  - Smarter polling+async data generation
- 2 Mbps PHY
  - BLAZE benefits from increased node density
- Extended Broadcast Packets
  - Reduced mesh overhead

ANT BLAZE

- High throughput for large numbers of parallel nodes
- Role-less, stateless architecture for simple deployment
  - Increased node numbers improve wireless coverage area
  - Increased node numbers improve user access points
  - Flexible node addressing for bespoke solutions
- Minimal API surface area
  - Easier to grok
  - Faster development effort
  - Reduced refactoring for future product updates

Bend the Curve – Choose the Right Tool for the Job

- Different technologies make different trade-offs
- You don’t have to choose only one
  - Multi-protocol chipsets
  - Nordic SDK support
- Better products in a competitive market



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