ZEROSTACK TECHNICAL WHITEPAPER SERIES · PART 3

# ZeroStack: What Changes in Your Smart Home Today

Part III: Eliminating the Popcorn Effect, OTA Stalls, and Route Failures

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**Target Platform:** SMLIGHT PoE/TCP Zigbee 3.0 Coordinators — TI CC2652P7 (SLZB-06P7U) & Silicon Labs EFR32MG24 (SLZB-06Mg24U)

**Dataset:** 29 November 2026 End-to-End Benchmark Campaign — Legacy Reference Stack vs. ZeroStack 1.0.0 (Unmodified Zigbee2MQTT & Home Assistant ZHA)

## 1. Executive Summary

Part I of this series established deterministic *O*(1) coordinator scaling beyond the 100-node wall, and Part II demonstrated adversarial fault resilience by eliminating lockups, brownout flash corruption, and remote frame faults. Part III shifts from stress-bench survival to what changes in your living room today under unmodified Zigbee2MQTT and Home Assistant ZHA.

Every mid-to-large Zigbee2MQTT or Home Assistant ZHA home runs into the same real-world coordinator bottlenecks: 10-light room scenes turning on one bulb at a time (the "popcorn effect"), wall switches freezing for seconds whenever a device runs an OTA firmware update, concurrent OTA updates timing out, distant mesh devices failing with `0x10` ( `MEM_ERROR` ), and `0xCD` ( `NWK_NO_ROUTE` ) log floods after a reboot or backup restore.

We benchmarked ZeroStack 1.0.0 head-to-head against stock reference firmware over PoE/TCP on SMLIGHT network coordinators (**SLZB-06P7U** on TI CC2652P7 and **SLZB-06Mg24U** on Silabs EFR32MG24) across five everyday smart-home workloads:

1. **Eliminating the 10-light popcorn effect:** Holds 95th-percentile first-to-last bulb spread to **249 ms** on **SLZB-06P7U** (**4.9× tighter** than Stock's **1,233 ms**; 460800 vs. 115200 stock) and **255 ms** on **SLZB-06Mg24U** (**100%** delivery; **319 ms** p95 / **326 ms** max full-room vs. Stock's **591 ms** / **1,821 ms**; 460800 vs. 115200 stock).
2. **OTA updates without freezing your switches:** Cuts live control latency **9.6× at p95** and **24.7× at max** on **SLZB-06P7U** (matched 115200 baud), while finishing a 64 KB OTA **2.28× faster** (**97 s** vs. **222 s**) with **2.22× lower p95** control latency (**119 ms** vs. **265 ms**, **100%** delivery) on **SLZB-06Mg24U** (460800 vs. 115200 stock).
3. **Up to 4.52× faster concurrent OTAs:** Two simultaneous 64 KB OTAs finish in **88 s** vs. **398 s** (**4.52× faster**, **1,492 B/s**) on **SLZB-06Mg24U** (460800 vs. 115200 stock), and **219 s** vs. **333 s** at matched 115200 baud (**1.52× faster**, **29× fewer retries**, **zero** timeouts; **216 s** / **1.54×** at 460800) on **SLZB-06P7U**.
4. **No more false memory errors on distant devices: 21 / 21 (100%)** multi-hop fragmented payloads succeed across 1–7 router hops vs. **10 / 21 failing** with `0x10` ( `MEM_ERROR` ) on Stock TI Z-Stack.
5. **3.76×–4.08× faster 48-device startup recovery and instant wall switches:** Clears a 48-device startup storm in **1.81 s** vs. **6.80 s** on **SLZB-06P7U** (**48 / 48** vs. **47 / 48**, **3.38× lower** max latency) and **1.75 s** vs. **7.14 s** on **SLZB-06Mg24U** (**4.1× lower** max latency; 460800 vs. 115200 stock), with **18–21 ms** live switch response and zero duplicates.

### Unified Cross-Silicon Debut · Zero Re-Pairing, Zero Config Changes

**ZeroStack 1.0.0 marks the public debut of ZeroStack on Silicon Labs EFR32MG24** alongside SMLIGHT's **TI-based SLZB product lineup (CC2652P, CC2652P7, and CC2674P10)**, running the exact same memory-safe Rust Zigbee 3.0 / PRO R23 engine across supported coordinators. Flashing ZeroStack 1.0.0 preserves your entire existing Zigbee network, paired devices, and security keys, and works immediately with unmodified Zigbee2MQTT and Home Assistant ZHA.

### At-a-Glance Results Across the 5 Smart-Home Scenarios

| Smart-Home Scenario | Stock TI Z-Stack (SLZB-06P7U, 115200) | ZeroStack 1.0.0 (SLZB-06P7U, 115200 / 460800) | Stock EmberZNet (SLZB-06Mg24U, 115200) | ZeroStack 1.0.0 (SLZB-06Mg24U, 460800) | What Changes in Your Home |
|---|---|---|---|---|---|
| **1. 10-Light Popcorn Effect** *(25 bursts = 250 commands)* | 1,232.6 ms p95 spread<br>1,325.9 ms p95 full-room (99.6%) | **249.4 ms p95 spread**<br>**323.9 ms p95 full-room (99.6%)** | 591.0 ms p95 / 1,820.8 ms max full-room (99.2%) | **255.2 ms p95 spread (100%)**<br>**318.9 ms p95 / 326.1 ms max full-room** | **~250 ms p95 spread** across both chips (**4.9× tighter** TI · **5.6× lower max** SiLabs) |
| **2. Live Control During 64 KB OTA** *(2 Hz switch commands + 2-hop OTA)* | 1,247.8 ms p95 / 3,523.9 ms max<br>166.1 s OTA (2 timeouts) | **129.3 / 142.7 ms** @ 115200<br>**122.9 / 540.6 ms** · **135.5 s** @ 460800 | 264.5 ms p95 / 1,771.2 ms max<br>221.6 s OTA (296.0 B/s, 99.71%) | **119.3 ms p95 / 1,699.8 ms max**<br>**97.4 s OTA (673.8 B/s, 100% ctrl)** | **9.6×–24.7× lower** lag (TI) · **2.28× faster** OTA & **2.22× lower p95** lag (SiLabs) |
| **3. 2× Concurrent 64 KB OTAs** *(131 KB total across 2 router hops)* | 333.2 s (393.8 B/s)<br>58 retries · 13 timeouts | **218.9 s** · 2 retries @ 115200<br>**216.4 s** · **0 retries** @ 460800 | 397.8 s (329.8 B/s)<br>0 retries · 0 timeouts | **87.9 s (1,492.4 B/s)**<br>**2 retries · 0 timeouts** | **4.52× faster** dual OTAs on SiLabs · **1.54× faster** & **29× fewer retries (0 at 460800)** on TI |
| **4. Multi-Hop Large Payloads** *(1 to 7 router hops, 21 routed cases)* | **10 / 21 FAIL** ( `0x10` `MEM_ERROR` ) | **21 / 21 PASS (100%)**<br>(0 memory errors) | N/A | N/A | Distant plugs, blinds, and bulbs stop failing OTA and scene writes |
| **5. 48-Device Restore & Switch Speed** *(48-node burst + live `zigbee-herdsman` )* | 47 / 48 in **6.80 s** (1 timeout)<br>1,592.2 ms p95 / 6,089.4 ms max | **48 / 48 in 1.81 s**<br>(1,803.8 ms max)<br>**18.32 ms** idle / **21.21 ms** busy | 48 / 48 in **7.14 s**<br>2,185.9 ms p95 / 7,132.3 ms max | **48 / 48 in 1.75 s (0 `0xCD` )**<br>**1,672.6 ms p95 / 1,738.7 ms max** | **3.76×–4.08× faster** 48-device startup drain & ~18–21 ms switch response |

## 2. Scenario 1: The Popcorn Effect (10 Lights × 25 Unicast Bursts)

When an automation turns on 10 recessed lights in a kitchen or living room without a pre-configured Zigbee group, Zigbee2MQTT and Home Assistant fire 10 back-to-back unicast commands. On stock coordinator firmware, serialization stalls and acknowledgement contention stretch the tail of the burst past 1.2 seconds, so the first lights snap on while stragglers pop on visibly later.

We drove 25 consecutive 10-light unicast `Toggle` bursts (250 commands total) through a mesh router over PoE/TCP and measured **popcorn spread** (`t_last − t_first` within each 10-light burst), **full-room completion** (host send to 10th light confirmation), and **per-light round-trip latency**.

| 10-Light Room Burst Metric (25 Bursts / 250 Commands) | Stock TI Z-Stack (SLZB-06P7U, 115200) | ZeroStack 1.0.0 (SLZB-06P7U, 460800) | Stock EmberZNet (SLZB-06Mg24U, 115200) | ZeroStack 1.0.0 (SLZB-06Mg24U, 460800) |
|---|---|---|---|---|
| **Commands Delivered** | 249 / 250 (99.6%) | **249 / 250 (99.6%)** | 248 / 250 (99.2%) | **250 / 250 (100.0%)** |
| **First-to-Last Spread p50 (`t_last − t_first`)** | 227.6 ms | **237.6 ms** | —* | **244.2 ms** |
| **First-to-Last Spread p95** | 1,232.6 ms | **249.4 ms (4.9× tighter)** | —* | **255.2 ms** |
| **First-to-Last Spread p99 / max** | 1,251.1 / 1,255.9 ms | **262.8 / 266.8 ms (4.7× lower max)** | —* | **256.4 / 256.8 ms** |
| **Full-Room Completion p50 / p95 / max** | 324.0 / 1,325.9 / 1,356.8 ms | **307.2 / 323.9 / 337.1 ms** | 378.8 / 591.0 / 1,820.8 ms | **307.9 / 318.9 / 326.1 ms (5.6× lower max)** |
| **Per-Light Round-Trip p50 / p95 / p99** | 204.9 / 336.7 / 1,322.1 ms | **194.3 / 307.3 / 323.7 ms (4.1× lower p99)** | 370.6 / 602.5 / 1,820.8 ms | **187.0 / 307.7 / 317.3 ms (1.98× / 1.96× / 5.7×)** |
| **Coordinator Timeouts / Resets** | 0 / 0 | **0 / 0** | 0 / 0 | **0 / 0** |

*Note: On Stock EmberZNet (`bellows` EZSP), outbound `sendUnicast` awaits over-the-air delivery before draining inbound reply callbacks, so Full-Room Completion and Per-Light Round-Trip provide the direct cross-stack comparison against EmberZNet. In an initial **SLZB-06Mg24U** pass (249 / 250 delivered), 2 of 25 bursts experienced a single-device APS retry lifting burst-level p95 spread to 1,392.7 ms while per-light RTT p99 remained 325.6 ms.*

**Key takeaway:** ZeroStack 1.0.0 delivers near-identical room burst determinism on both silicon families: **249.4 ms p95 / 266.8 ms max** first-to-last spread on **SLZB-06P7U** (**4.9× tighter** than Stock TI Z-Stack's **1,232.6 ms**) and **255.2 ms p95 / 256.8 ms max** spread with **250 / 250 (100%)** delivery on **SLZB-06Mg24U** (**1.98× faster p50**, **1.96× faster p95**, and **5.7× lower p99** per-light RTT vs. Stock EmberZNet, with **1.85× faster p95** and **5.58× lower max** full-room completion).

## 3. Scenario 2: OTA Updates Without Lagging Your Home (64 KB 2-Hop OTA + 2 Hz Live Control)

In Zigbee2MQTT and ZHA, kicking off a 10-minute OTA firmware update often makes the rest of the house feel broken: hallway motion lights hesitate for 1 to 3.5 seconds and logs warn of `SRSP - AF - dataRequest after 6000ms` timeouts while the coordinator juggles OTA blocks and background sensor reports.

We streamed a 64 KB (65,536-byte payload, 1,640 blocks, SHA-256 verified) Zigbee OTA image across **2 router hops** while 9 background mesh devices reported telemetry (2 msg/s) and the hub issued continuous **2 Hz live light-control commands**. Running ZeroStack 1.0.0 at both **matched 115200 baud** and **drop-in 460800 baud** on the same **SLZB-06P7U** isolates pure firmware scheduling gains from UART speed.

| Concurrent OTA + Live Control Metric | Stock TI Z-Stack (SLZB-06P7U, 115200) | ZeroStack 1.0.0 (SLZB-06P7U, 115200) | ZeroStack 1.0.0 (SLZB-06P7U, 460800) | Stock EmberZNet (SLZB-06Mg24U, 115200) | ZeroStack 1.0.0 (SLZB-06Mg24U, 460800) |
|---|---|---|---|---|---|
| **Live 2 Hz Control Latency (p50 / p95)** | 92.3 / 1,247.8 ms | **89.7 / 129.3 ms (9.6× lower p95)** | **82.1 / 122.9 ms (10.2× lower p95)** | 231.4 / 264.5 ms | **75.1 / 119.3 ms (3.08× / 2.22× lower)** |
| **Live 2 Hz Control Tail (p99 / max)** | 2,363.3 / 3,523.9 ms | **137.6 / 142.7 ms (24.7× lower max)** | **132.3 / 540.6 ms** | 836.4 / 1,771.2 ms | **135.8 / 1,699.8 ms (6.16× lower p99)** |
| **Live Control Delivery Rate** | 311 / 312 (99.68%, 1 send error) | **296 / 296 (100.0%)** | **265 / 266 (99.62%, 0 send errors)** | 348 / 349 (99.71%) | **191 / 191 (100.0%, 0 send errors)** |
| **64 KB 2-Hop OTA Duration & Speed** | 166.1 s (394.8 B/s) | **151.4 s (433.3 B/s)** | **135.5 s (484.2 B/s, 1.23× faster)** | 221.6 s (296.0 B/s) | **97.4 s (673.8 B/s, 2.28× faster)** |
| **OTA Block Retries / Duplicate Blocks** | 4 / 5 | **2 / 0** | **0 / 0** | 1 / 2 | **0 / 0** |
| **Host Command Timeouts / Resets** | **2** / 0 | **0 / 0** | **0 / 0** | 0 / 0 | **0 / 0** |

**Key takeaway:** At identical 115200 baud on **SLZB-06P7U**, ZeroStack 1.0.0 cuts live control tail latency **9.6× at p95** (129.3 ms vs. 1,247.8 ms) and **24.7× at max** (142.7 ms vs. 3,523.9 ms) with **0** command timeouts. On **SLZB-06Mg24U**, ZeroStack 1.0.0 completes the 64 KB 2-hop OTA **2.28× faster** (**97.4 s** vs. **221.6 s**, **0** retries) while cutting live control latency **3.08× at p50**, **2.22× at p95** (**119.3 ms** vs. **264.5 ms**), and **6.16× at p99** with **100.0%** control delivery.

## 4. Scenario 3: 2× Concurrent 64 KB OTA Updates

Updating multiple devices after a vendor firmware release stresses coordinator buffer management, source-route tables, and acknowledgement queues simultaneously. On stock firmware, running two multi-hop OTAs in parallel triggers dozens of block retransmissions, duplicate air traffic, and host SRSP timeouts.

We ran **two simultaneous 64 KB 2-hop OTA transfers** (1,640 / 1,640 blocks per device, 65,598-byte image with 40-byte block payloads, 131,196 bytes aggregate transfer, end-to-end SHA-256 verified on both devices) through the PoE/TCP coordinator.

| Dual Concurrent 2-Hop OTA Metric (131 KB Total) | Stock TI Z-Stack (SLZB-06P7U, 115200) | ZeroStack 1.0.0 (SLZB-06P7U, 115200) | ZeroStack 1.0.0 (SLZB-06P7U, 460800) | Stock EmberZNet (SLZB-06Mg24U, 115200) | ZeroStack 1.0.0 (SLZB-06Mg24U, 460800) |
|---|---|---|---|---|---|
| **Both Clients Completed (SHA-256 Match)** | 2 / 2 PASS | **2 / 2 PASS** | **2 / 2 PASS** | 2 / 2 PASS | **2 / 2 PASS** |
| **Total Wall-Clock Duration** | 333.2 s | **218.9 s (1.52× faster)** | **216.4 s (1.54× faster)** | 397.8 s | **87.9 s (4.52× faster)** |
| **Aggregate Goodput** | 393.8 B/s (3.15 kbps) | **599.2 B/s (4.79 kbps)** | **606.2 B/s (4.85 kbps)** | 329.8 B/s (2.64 kbps) | **1,492.4 B/s (11.94 kbps)** |
| **Client 1 / Client 2 Duration** | 317.4 s / 332.7 s | **218.3 s / 218.4 s** | **215.9 s / 215.9 s** | 397.2 s / 397.2 s | **87.4 s / 84.9 s** |
| **Total OTA Block Retries** | **58** (26 + 32) | **2 (1 + 1, 29× fewer)** | **0 (0 + 0)** | 0 (0 + 0) | **2 (2 + 0)** |
| **Total Duplicate Blocks Sent** | **46** (16 + 30) | **4 (3 + 1, 11.5× fewer)** | **2 (0 + 2)** | 3 (2 + 1) | **2 (1 + 1)** |
| **Host Command Timeouts / Resets** | **13** / 0 | **0 / 0** | **0 / 0** | 0 / 0 | **0 / 0** |

*Note on `TCP_NODELAY` & Delayed-ACK behavior: The PoE/TCP test client ran without `TCP_NODELAY` across all four arms equally. Single-stream OTA (Scenario 2) pays an OS 40 ms TCP Delayed-ACK floor on strict stop-and-wait block turns, whereas dual-stream OTA (Scenario 3) interleaves two concurrent block streams so TCP ACKs piggyback immediately, explaining why **SLZB-06Mg24U** completes two concurrent 64 KB images (87.9 s) faster than a single stream (97.4 s) while transferring and SHA-256-verifying all 1,640 / 1,640 blocks (65,598 bytes, 40-byte block payload) on both clients. Across both **SLZB-06Mg24U** qualification runs, single OTA completed in 97.4–123.0 s (100% control delivery) and dual OTA in 66.5–87.9 s (4.52×–5.98× faster than Stock EmberZNet).*

**Key takeaway:** On **SLZB-06Mg24U**, ZeroStack 1.0.0 completes two concurrent 64 KB 2-hop OTAs in **87.9 seconds** (**1,492.4 B/s** / **11.94 kbps**) vs. **397.8 seconds** (329.8 B/s) on Stock EmberZNet (**4.52× faster**, **0** timeouts, SHA-256 verified). On **SLZB-06P7U**, Stock TI Z-Stack suffers **58 block retries**, **46 duplicate blocks**, and **13 SRSP timeouts**, whereas ZeroStack 1.0.0 finishes **1.52×–1.54× faster** with **29× fewer retries** at matched 115200 baud and **0 retries** at drop-in 460800 baud.

## 5. Scenario 4: Eliminating Multi-Hop Memory Errors ( `0x10` ) on Distant Devices

In Zigbee2MQTT and ZHA logs, few errors waste more troubleshooting time than `status 16` ( `0x10: MEM_ERROR` ) when sending OTA firmware blocks, multi-attribute scenes, or thermostat schedules to devices several rooms or floors away. Users routinely blame weak signal strength or coordinator RAM exhaustion, when the coordinator firmware itself is rejecting multi-hop fragmented packets.

Each router hop adds relay addresses to the Zigbee source-route header, leaving fewer payload bytes per radio frame. When Zigbee2MQTT or ZHA sends a larger payload to a routed device, it enables APS fragmentation so the coordinator splits the payload cleanly. We tested **64 payload-size and hop-count combinations** (64-byte to 100-byte payloads across 0, 1, 2, 5, and 7 router hops).

| Multi-Hop Payload Scenario | Stock TI Z-Stack (SLZB-06P7U) | ZeroStack 1.0.0 (SLZB-06P7U) | Real-World Impact |
|---|---|---|---|
| **Direct Devices (0 hops, up to 100 bytes)** | 15 / 15 accepted (11 direct + 4 source-routed) | **15 / 15 accepted (100%)** | Full parity for nearby devices |
| **1 Router Hop (67-byte to 82-byte, 5 sizes)** | **3 / 5 FAIL** (79-byte to 82-byte payloads return `0x10` `MEM_ERROR` ) | **5 / 5 accepted (100%)** | Fixes false memory errors one room away |
| **2 Router Hops (67-byte to 82-byte, 5 sizes)** | **3 / 5 FAIL** (77-byte to 82-byte payloads return `0x10` `MEM_ERROR` ) | **5 / 5 accepted (100%)** | Reliable OTA updates and multi-attribute scenes |
| **5 Router Hops (67-byte to 81-byte, 4 sizes)** | **2 / 4 FAIL** (71-byte to 81-byte payloads return `0x10` `MEM_ERROR` ) | **4 / 4 accepted (100%)** | Reaches deep mesh branches across floors |
| **7 Router Hops (66-byte to 81-byte, 3 sizes)** | **2 / 3 FAIL** (67-byte to 81-byte payloads return `0x10` `MEM_ERROR` ) | **3 / 3 accepted (100%)** | Reaches outbuildings and edge-of-mesh devices |
| **Unfragmented Oversized Check (16 cases)** | Silently accepts 6; fails 10 with false `0x10` ( `MEM_ERROR` ) | **16 / 16 return `0x02` ( `INVALID_PARAM` )** | Gives host software a clean length check instead of fake RAM errors |

**Key takeaway:** Stock TI Z-Stack rejects **10 out of 21** multi-hop fragmented cases with `0x10` ( `MEM_ERROR` ) as soon as router hop addresses push the payload past a single radio frame. ZeroStack 1.0.0 accepts **21 / 21 (100%)** with **0 memory errors**, so distant OTA updates and complex device commands succeed reliably.

## 6. Scenario 5: Cold-Boot / Post-Restore Storm & Wall-Switch Responsiveness

The hardest minute in any smart home comes right after a Home Assistant reboot, container upgrade, coordinator backup restore, or brief power outage. Dozens of multi-hop devices have no cached routes yet, the hub fires a wave of startup attribute reads, and family members still expect wall switches to turn on ceiling lights immediately.

### Table 6A: 48-Device Cold-Boot / Post-Restore Startup Storm

When 48 multi-hop devices are polled concurrently after startup or backup restore, stock coordinators serialize replies across multi-second queues or time out under load. Over PoE/TCP, ZeroStack 1.0.0 drains all **48 / 48** concurrent attribute reads in **1.81 s** on **SLZB-06P7U** (**3.76× faster** than Stock TI Z-Stack's **6.80 s** with 1 timeout; **3.38× lower** max latency) and **1.75 s** on **SLZB-06Mg24U** (**4.08× faster** than Stock EmberZNet's **7.14 s**; **4.1× lower** max latency).

| 48-Device Startup Storm Metric | Stock TI Z-Stack (SLZB-06P7U, 115200) | ZeroStack 1.0.0 (SLZB-06P7U, 460800) | Stock EmberZNet (SLZB-06Mg24U, 115200) | ZeroStack 1.0.0 (SLZB-06Mg24U, 460800) |
|---|---|---|---|---|
| **48-Device Storm Completion** | 47 / 48 (97.9%, 1 timeout) | **48 / 48 (100.0%)** | 48 / 48 (100.0%) | **48 / 48 (100.0%)** |
| **`0xCD` / `0xB8` / Timeout Failures** | 0 / 0 / **1** | **0 / 0 / 0** | 0 / 0 / 0 | **0 / 0 / 0** |
| **Total Storm Wall-Clock Time** | 6.80 s | **1.81 s (3.76× faster)** | 7.14 s | **1.75 s (4.08× faster)** |
| **Per-Device Latency (p50 / p95 / max)** | 851.4 / 1,592.2 / 6,089.4 ms | **1,266.7 / 1,742.0 / 1,803.8 ms (3.38× lower max)** | 1,426.5 / 2,185.9 / 7,132.3 ms | **1,167.7 / 1,672.6 / 1,738.7 ms (4.1× lower max)** |

### Table 6B: Live Channel 25 Wall-Switch-to-Light Speed (SLZB-06P7U)

On Channel 25, we measured live end-to-end button-to-light toggles (40 presses per run) on **SLZB-06P7U** to isolate host-driver pipeline overhead through unmodified `zigbee-herdsman` vs. our direct host client: a wireless switch press arrives over the air at the coordinator, the hub sends a Zigbee `On` command back through the coordinator to the Channel 25 router ("Light"), and we record exact arrival at the light while the hub is either idle or actively polling network state.

| Live Channel 25 Switch Scenario (Unmodified Host, SLZB-06P7U) | ZeroStack 1.0.0 (p50 / p95 / max) | First-Try Delivery & Duplicates |
|---|---|---|
| **`zigbee-herdsman` (Idle Hub)** | **18.32 ms** / 19.64 ms / 19.82 ms | **40 / 40 (100%) first-try · 0 duplicates** |
| **`zigbee-herdsman` (Busy Hub Polling 84 State Reads)** | **21.21 ms** / 27.58 ms / 29.44 ms | **40 / 40 (100%) first-try · 0 duplicates** |
| **Direct Host Client (Idle Hub)** | **18.09 ms** / 20.24 ms / 20.43 ms | **40 / 40 (100%) first-try · 0 duplicates** |
| **Direct Host Client (Busy Hub Polling 118 State Reads)** | **29.80 ms** / 32.03 ms / 38.63 ms | **40 / 40 (100%) first-try · 0 duplicates** |

#### Inbound Mesh-Storm Headroom (100 msg/s Live Encrypted RF)

Under sustained live Channel 25 inbound bursts up to **100 encrypted Zigbee frames per second** (**525 / 525** frames delivered in **8.63–11.03 ms** p50) while simultaneously answering **1,677** outbound hub commands, ZeroStack 1.0.0 recorded **0 dropped frames, 0 SRSP timeouts, and 0 resets**. Combined with **18.32–21.21 ms** `zigbee-herdsman` switch response, wall switches stay crisp even during heavy post-outage mesh traffic.

## 7. Conclusion

Across all five smart-home workloads, ZeroStack 1.0.0 replaces multi-second tail stalls with bounded, predictable response:

- **Real-world tail latency eliminated:** Ten-light room bursts stay within **249.4–255.2 ms** at p95, live control during a 64 KB OTA drops **9.6× at p95** (**129.3 ms** vs. **1,247.8 ms** at matched 115200 baud) and **2.22×** on EFR32MG24 (**119.3 ms** vs. **264.5 ms**), dual 64 KB OTAs finish up to **4.52× faster** (**87.9 s** vs. **397.8 s**), **21 / 21** multi-hop fragmented payloads succeed, and 48-device startup storms clear in **1.75–1.81 s** (**3.76×–4.08× faster**).
- **True cross-silicon parity:** Both TI (**SLZB-06P7U**) and Silicon Labs (**SLZB-06Mg24U**) run the same unified ZeroStack 1.0.0 architecture and deliver consistent, predictable latency over the standard ZNP/MT host interface ( `adapter: zstack` / `znp` ).
- **Drop-in production upgrade:** Zero host rewrites are required; existing Zigbee2MQTT and Home Assistant ZHA networks migrate directly via standard coordinator backups with zero re-pairing and optional 460800 baud headroom for dense meshes.

For supported hardware and flashing guides, visit **zerostack.smlight.tech**.