



# Final Report - PC Rate Degradation Analysis of the Longview LoRaWAN System

## Executive Summary

- The Longview system in Starkville, MS includes 7 Browan LoRaWAN sensors and a single RAK7268C gateway.
- Before the gateway outage (Aug 2–11, 2025), **all devices maintained ~94% packet completion rate (PC Rate)**.
- After gateway recovery, **2 devices returned to ~94% PC Rate** but **5 devices dropped to ~34%**.
- The poor PC Rate of the 5 devices is caused by a combination of an RX timing mismatch and expanded channel masks.
- The straightforward way to fix the problem is to pull each device's battery, short-circuit the battery terminals, then re-insert the battery to force each device to perform a rejoin, but this approach is not readily available because of how and where the devices are deployed in the Longview system
- Trying downlinks on 1 of the devices to first fix the Rx Timing and then to address the channel mask problem was unsuccessful because I was unable to get the device accept any downlinks.
- Due to how and where the devices are deployed, I decided to leave the 5 poor performing devices in their current state because, while it is not ideal, there is enough data from the devices to enable the system dashboards to meet the client's needs.

## Root Cause Analysis

- **Observation:** Devices continued transmitting at the expected cadence; frame counters incremented normally.
- **Finding:** The network server only received ~1/3 of the expected uplinks from affected devices.
- **Analysis:**
  - This pattern is consistent with a **channel mask desynchronization** rather than a total sub-band mismatch.
  - Likely scenario: affected devices began transmitting across **24 channels (3 sub-bands)** instead of the gateway's **8-channel block**.
  - The gateway hears only 8 of those 24 → **8/24 ≈ 33%**, matching the observed ~34% PC Rate.
  - Downlink testing confirmed another issue: the gateway transmits downlinks with **RX1 Delay = 5s**, but devices likely still expect **RX1 = 1s**. Result: devices miss downlinks, never ACK, and cannot receive corrective MAC commands.

## Root Cause Statement

**The poor PC Rate is caused by a combination of RX timing mismatch and expanded channel masks.**

- RX1 Delay desynchronization prevents devices from acknowledging confirmed downlinks and applying corrective MAC commands. - Devices remain stuck transmitting across more channels than the gateway monitors, resulting in only ~1/3 of uplinks being received.



## Solution Approach

### 1. Re-establish Downlink Reliability (RX Fix)

- Set **RX1 Delay = 1s**.
- Verify **RX2 = 923.3 MHz / DR8 (SF12, 500 kHz)**.
- Set **RX1 Data Rate Offset = 0**.
- Send a small confirmed downlink (e.g., 0x01 payload) and verify ACK.

### 2. Re-align Channel Mask

- Once downlinks are working, issue **LinkADRReq** to restrict devices to the **8-channel block used by the RAK7268C**.
- Confirm **LinkADRAns (success)** in MAC events.

### 3. Monitor Recovery

- PC Rate should return to ~90–95% within 24 hours.
- Repeat the procedure for each of the 5 affected devices.

## Preventive Measures

- Document and lock the intended **gateway sub-band** and **device MAC parameters**.
- Apply MAC updates in sequence: **fix RX timing first, then channel masks**.
- Temporarily disable ADR during recovery to prevent unwanted LinkADRReqs.

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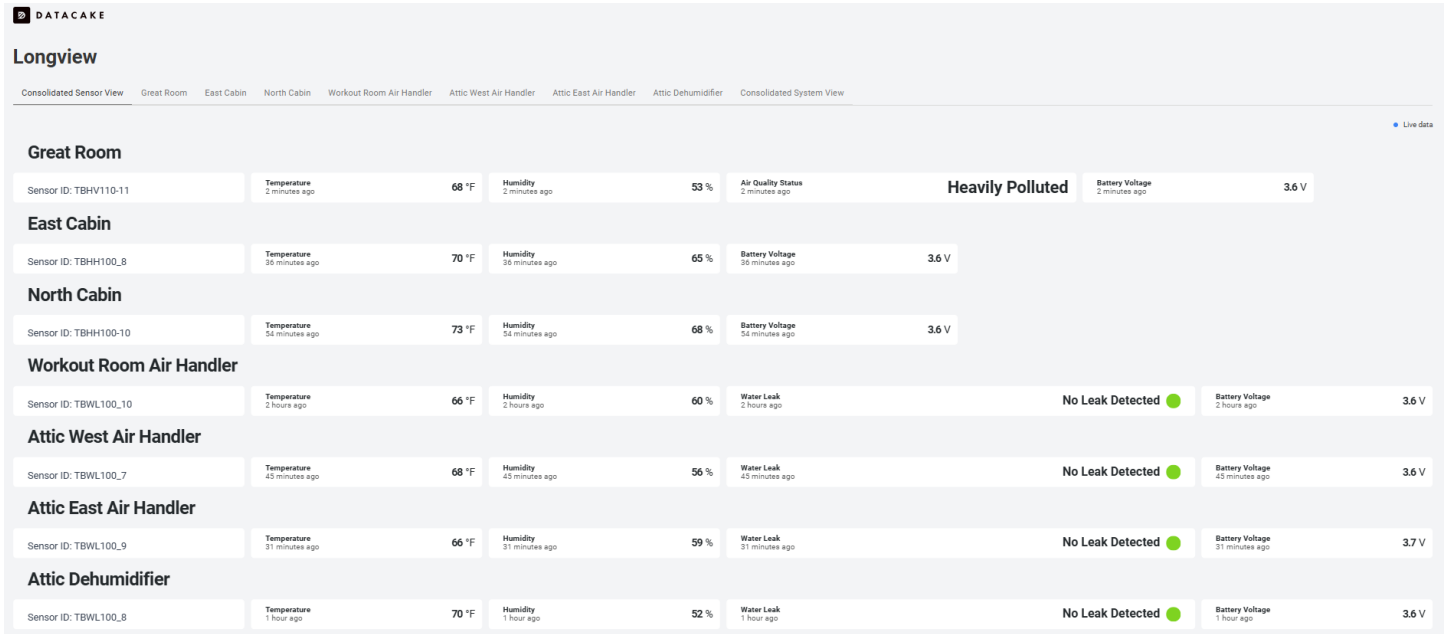
**In summary:** The degraded PC Rate is the result of **channel mask expansion combined with RX timing mismatch**. The corrective action is to **fix RX timing, confirm downlink ACKs, then reapply the proper 8-channel mask** to realign devices with the gateway.

## Solution Results

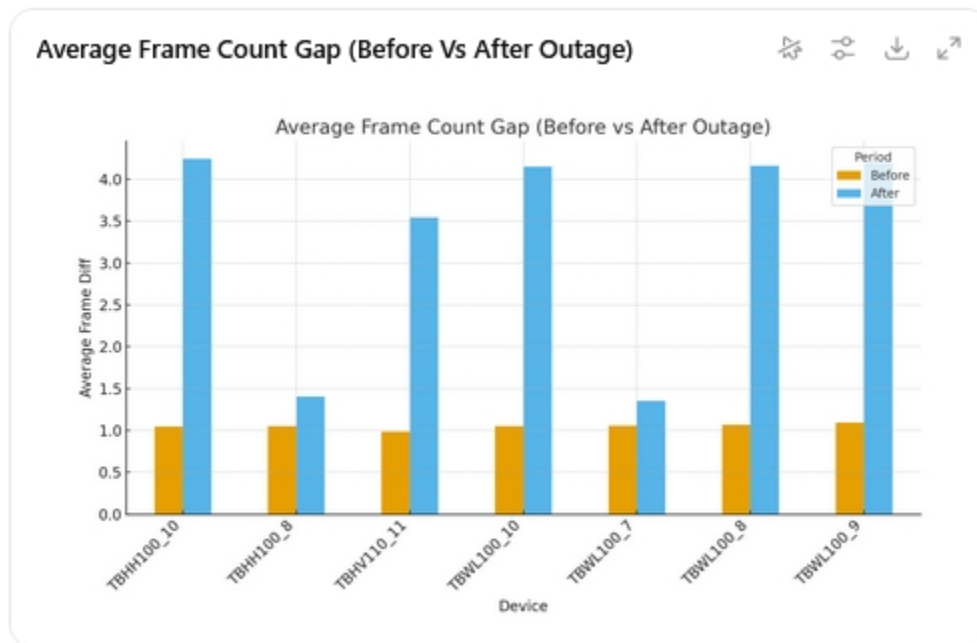
Despite repeated attempts to re-establish downlink reliability on one of the IoT devices, I was unable to complete a downlink to the device, thus was unable to re-align the channel mask for that device.

As a result, the 5 poor performing devices continue to have a PC Rate of ~34%.

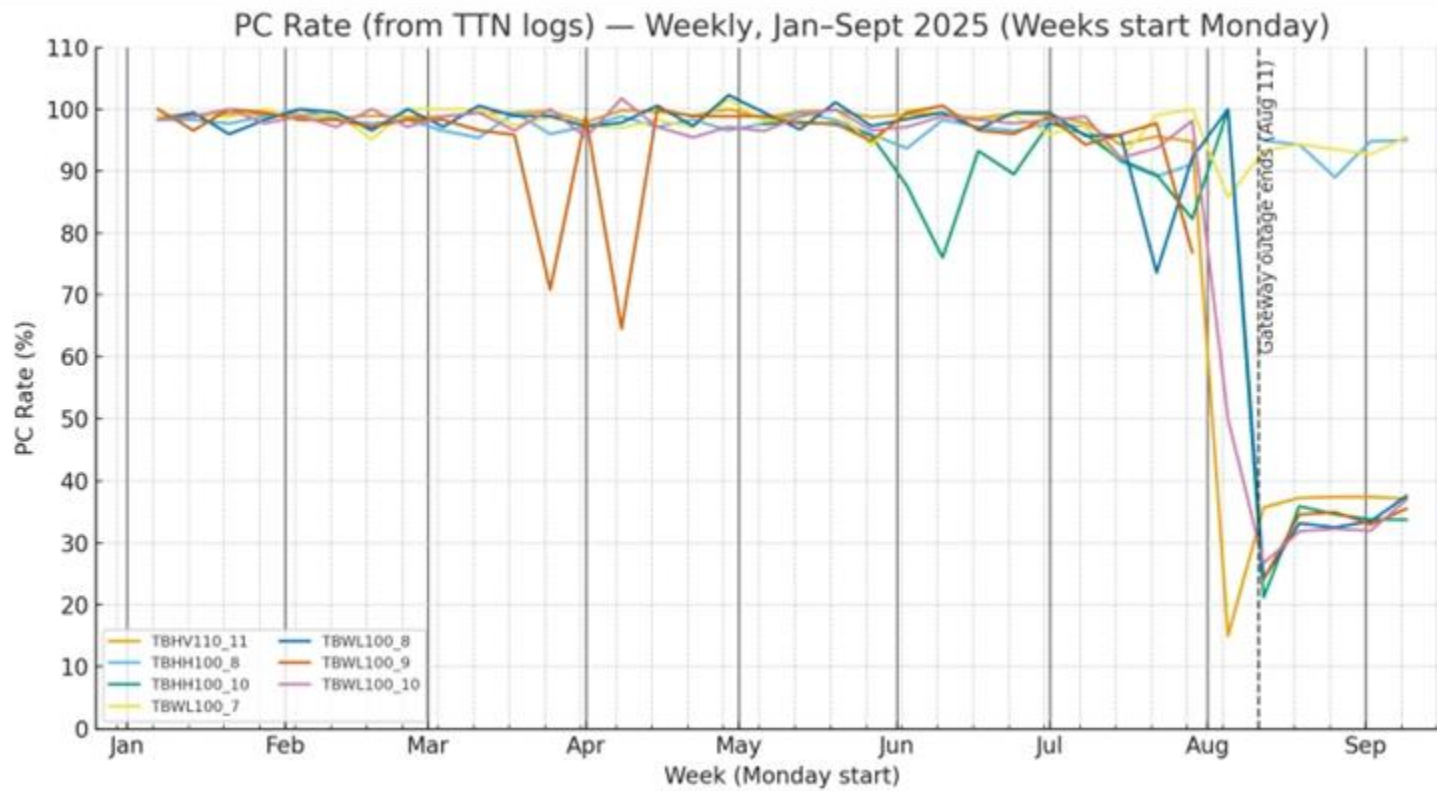
Because I am several hundred miles from the Longview site **and** because users at the Longview site have limited technical capability **and** because some of the devices are in hard-to-reach places, for the immediate future I plan to leave the devices in their current state and not attempt battery-pull resets on the devices. The screenshot below shows the main Longview dashboard.



Above - Longview System Dashboard



Above – Using Gaps in Framecount to Illustrate Performance Degradation in the Longview System



Above – Using Gaps in PC Rate to Illustrate Performance Degradation in the Longview System