

Mini-RFC draft

Introduction

Telemetry protocol is a lightweight telemetry protocol that we designed to let small IoT sensors send data to a central collector using UDP.

It's meant for simple, real-time applications such as temperature or humidity reporting, where packets are small, sent frequently, and occasional packet loss is acceptable.

Most existing IoT protocols, like MQTT or HTTP, rely on TCP, which guarantees delivery but adds a lot of overhead — extra headers, connection setup, and retransmissions that waste time and energy.

In contrast, it focuses on speed, simplicity, and low power use.

Instead of trying to guarantee delivery, it lets the collector detect if a packet was lost or duplicated.

This trade-off keeps the system light and perfect for low-power or resource-limited sensors.

Protocol Architecture

It follows a simple client–server design.

- The Sensor (Client) simulates a small IoT device that measures something (like temperature).
It sends messages at regular intervals and uses a unique device ID so the collector can tell which device sent which packet.
- The Collector (Server) listens for UDP packets, checks if they belong to the protocol, and records them in a CSV log file.
It keeps a small internal “memory” for each device so it can detect if a packet arrived twice (a duplicate) or if one went missing (a gap).

The protocol doesn't require an open connection. Every message stands alone and includes everything the collector needs to understand it.

Operation Flow

1. Initialization:

When a sensor starts, it sends an INIT message to announce itself.

The collector replies with an INIT_ACK to confirm that it's ready.

2. Data Transmission:

After that, the sensor sends regular DATA messages that carry readings (like temperature values).

These packets are sent every few seconds, depending on the configuration.

3. Heartbeat:

If the sensor has no new data to send, it sends a HEARTBEAT message just to say "I'm still here."

4. Logging and Monitoring:

The collector logs every packet it receives into a CSV file that includes:

5. device_id, seq, timestamp, arrival_time, duplicate_flag, gap_flag

This makes it easy to later analyze how reliable the communication was.

Key Design Choices

- Transport Layer: UDP
- Reliability: Detection only
- Header Size: 12 bytes fixed
- Payload Limit: 200 bytes maximum per message
- Reordering: The collector can buffer out-of-order packets for about one second before writing them to the log
- Supported Format: Float32 readings

This simple structure allows efficient communication while still making it possible to measure performance and packet behavior accurately.

Message Formats

Header Structure

Every packet begins with a **12-byte header** that identifies the sender, the message type, and basic timing information.

| Field | Size | Description |
|------------------|---------|---|
| MAGIC | 1 byte | A constant value (0x54) used to confirm the packet belongs to Telemetry protocol. |
| VER_TYPE | 1 byte | Combines the protocol version (upper 4 bits) and message type (lower 4 bits). |
| DEVICE_ID | 2 bytes | Unique ID for the sending device. |
| SEQ | 4 bytes | Sequence number that increases with each new message. |
| TIMESTAMP | 4 bytes | Time (in seconds) since the device started running. |

Message Types

| Code | Type | Direction | Purpose |
|------|------------------|--------------------|--|
| 0x0 | INIT | Sensor → Collector | Announces the sensor and starts the session. |
| 0x1 | INIT_ACK | Collector → Sensor | Confirms initialization. |
| 0x2 | DATA | Sensor → Collector | Sends one or more sensor readings. |
| 0x3 | HEARTBEAT | Sensor → Collector | Indicates the sensor is still alive when no new data exists. |

DATA Payload Format

After the 12-byte header, a DATA message carries one or more small “reading blocks.”

Each block contains:

| Field | Size | Description |
|-----------|---------|--|
| Sensor ID | 1 byte | Identifies which sensor the reading came from (e.g., 1 = temperature). |
| Format | 1 byte | Data type (0x01 = float32). |
| Value | 4 bytes | The measurement value in IEEE 754 float format. |

Multiple readings can be batched in one packet, as long as the total size does not exceed **200 bytes** (header + payload).

Example Message

Below is an example of a single **DATA** packet from a temperature sensor:

| Field | Example Value | Explanation |
|-----------|--|-------------------------------------|
| MAGIC | 0x54 | Identifies this as a packet. |
| VER_TYPE | 0x12 | Version 1, Message Type = DATA (2). |
| DEVICE_ID | 100 | Sensor ID = 100. |
| SEQ | 5 | Fifth packet sent by this sensor. |
| TIMESTAMP | 60 s | Sent 60 seconds after startup. |
| PAYLOAD | Sensor 1, Format = float32, Value = 20.45 °C | The actual reading. |

Interpretation

After running for one minute, sensor #100 sends its fifth packet containing a single temperature reading of 20.45 °C.

The collector logs this packet and can later tell, from the sequence numbers, if any packets were lost or repeated.