MOMA Python Time Synchronization

This applies to r1920.

The code responsible for packet timestamp resolution is the BufferedMomaPacketList class inside of momapacketlist.py.

- Terminology:
  - **FSW timestamp**: the 4 byte integer at the end of every packet header. This integer represents the number of 100us ticks since the last reset near the time when the packet was created. (This article is going to pretend that the FSW has no other kinds of timestamps.)
  - **time packet**: a FSW time sync packet (type 2) or a digital status packet with non-zero time fields (type 7) which can be used to convert FSW timestamps to UTC. Time packets contain a FSW timestamp along with an equivalent J2000 timestamp, so time packets can be used to go from FSW timestamp -> J2000 -> UTC.
    - The "equivalent J2000 timestamp" I mentioned is actually Rover Elapsed Time (RET), which does not have a final definition (meaning, the UTC time equivalent to RET = 0 has not been defined). When MOMA is integrated with the rover, RET may no longer be J2000.
    - Marker packets should be considered time packets, too, however when I wrote momapacketlist.py, I thought that packet types 2 and 7 were the only packets that could be used to resolve time fields. I need to fix this after I'm finished working on more important stuff.
  - **earliest packet timestamp**: the packet timestamp with the smallest UTC value. Packets in a tmfile are not in timestamped order, so this is not always the first packet's timestamp. (By "first", I'm referring to the first packet inside of a tm.mom file.)
    - Note that the timestamps of lines in a message log are not used when determining the earliest timestamp in a tm.mom file. Because of this, and because message log line timestamps can be earlier than the timestamp of the message log packet that contains the message log, lines in a message log can have negative relative times. This is normal and expected behavior.
  - **first packet timestamp**: the timestamp of the first non-GSE packet in a tm.mom file.
- Converting a FSW timestamp to UTC requires pairing that packet with a **time packet**.
  - For **packets that occur before the first time packet**, that first time packet is used to convert the FSW timestamps of those packets.
  - For **packets that occur after the last time packet**, that last time packet is used to convert FSW timestamps of those packets.
  - **All other packets** are either themselves time packets (so they can just use themselves to convert their FSW timestamps), or non-time packets that have both a preceding time packet and a following time packet. (Digital status packets are a type of time packet that come out every few seconds, so there's almost always a time packet close to any given packet).
    - If the two time packets that precede and follow a packet have identical time synchronization fields (remember that "time synchronization fields" refers to a FSW timestamp paired with an equivalent J2000 value), then either one may be selected to convert the packet's FSW timestamps to UTC.
    - However, if the preceeding and following time packets are different, a reset probably occurred, and each middle packet needs to be paired with either the preceeding time packet or the following time packet:
      - If a packet's FSW timestamp is smaller than the FSW timestamp seen for the same packet type, then that packet, and subsequent packets of the same type, are considered post-reset packets and are paired with the time packet that follows them.

        - If a packet's FSW timestamp is larger than the last FSW timestamp seen for the same packet type, then that packet is considered a pre-reset packet, and is paired with the preceding time packet.
        - If a packet is the first of its type in the tm.mom file, then that packet is paired with a time packet based on the following logic:
            - If the packet is a message log packet containing "MOMA CDH Boot Loader", then that packet (and subsequent message log packets) are paired with the following time packet.
            - If the packet's FSW timestamp is smaller than the following time packet's FSW timestamp, then that packet is paired with the following time packet.
            - If the packet's FSW timestamp is larger than the preceding time packet's FSW timestamp, then that packet is paired with the preceding time packet.
            - Otherwise, the "closer" time packet is selected. For example:
                - time packet t1 has a header with an FSW timestamp of 1,000,000, and
                - time packet t2 has a header with an FSW timestamp 14,000,
                - and packet p has a header with an FSW timestamp of 20,000, then p will be paired with t2, because ABS(20,000 - 14,000) < ABS(20,000 - 1,000,000)
                - Note that the FSW timestamps in the **packet headers** are the only things considered when making the decision in this edge case; time synchronization fields outside of the packet headers are not used to make this decision.
- Rover Simulation (RSIM) timestamp correction
    - **The problem**: Before MOMA is turned on, a tm.mom file may be accumulating RSIM packets, which could have large arbitrary headers. A common situation is to have RSIM packet FSW timestamps of 0, 10000, 20000, ..., 1040000, 1050000, etc. Then, when MOMA is turned on, the first time packet might have a FSW timestamp of, say, 20000. When that time packet is applied to the previous RSIM packet that had a FSW timestamp of 1050000, that RSIM packet will appear to have occurred much later than the time packet, even though the RSIM packet was created **before** the time packet.
    - When the first digital status packet with non-zero time synchronization fields is seen, the RSIM will alter the FSW timestamps in subsequent packets to have FSW timestamps that are close to the packets that MOMA is outputting. These new FSW timestamps are considered accurate by the Python tools.
    - **The solution**: If the FSW timestamps of "bad" RSIM packets are all 1 second apart, then the Python tools will change the interpretation of their FSW timestamps. The last "bad" RSIM packet will be set to 1 second before the first "good" RSIM packet, the second-to-last "bad" RSIM packet will be set to 2 seconds before the first "good" RSIM packet, etc.
    - If the FSW timestamps of "bad" RSIM packets are not all 1 second apart from each other, the Python tools will not correct the timestamps, and will output a warning.
- Relative time
    - After FSW timestamps are converted to UTC and RSIM timestamp correction is applied, the MOMA Python tools will examine all packets and select the timestamp of the **~~earliest~~ first** packet as t0. Before February 2016, the earliest packet was used. However, this was changed to the first packet to be consistent with momadataview, among other reasons.
- GSE packets
    - The first two packets in a tm.mom file are "fake", GSE generated message log packets. The timestamps of these two packets are set to match the timestamp of the earliest packet.

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