Template for suggesting changes to miniseed specification		
Commenting on document version #	M=modification, N= add new section, D=Delete existing section	Delete
Topic		Eliminate Time Quality Field
Type of Action (M=modification, N= add		Delete
Current Wording from document	Applies to M or D	Suggestion: Remove the 32-bit timing quality field.
New wording	Applies to M or N	Retain a one-byte "Time Quality" value in the fixed data record header. Document snad standardize the definition, since time quality defined in some way and recorded synchronously with waveform data is an essential requirement for valid interpretation of the data. A
Rationale		The credibility of the time stamp in the waveform header is a key metric contributing to the ability to interpret the time series correctly. A data logger has only a rendition of time, estimated to the best of its ability based on a number of factors. The data logger's notion of "time" is, or should be, a vector valued function consisting of not only the time label, but a measure of the validity – or if known, the error – of the label. This concept is discussed in a recent publication, http://dx.doi.org/10.1016/B978-0-444-53802-4.00023-3

Various implementations of data loggers may apply more or fewer qualifications to their estimate of time. We introduced the concept over 25 years ago of a time quality on a percent scale that attempts to assign a measure of the likely accuracy, and the representation of "time quality" was incorporated in the Timing Blockette (to flag significant changes in timing system state) and the Data Extension Blockette in order to attach the time quality estimate to the time tag in each fixed data record header. This scale is documented, and though arbitrary in its definition, concisely summarizes an essential description of the quality of the associated time label. The time quality attains a maximum when multiple qualifying metrics are met, diminishing at a defined rate (1%/10min) when one or more of these criteria are not met.

A suggestion in the MS3 straw man to perhaps retain time quality in the header if time quality can be defined in terms of a time error cannot be in general realized, since if the time error is known, the time label can be improved and the error reduced. We do the next best thing, which is to incorporate in the time quality value a representation of the time since the last known quality state was achieved.

The proposed change in the MS3 straw man retains only two bits pertaining to an estimate of time quality: "questionable" and "locked". Yet without definition of how these should be applied, they are ambiguous. For example, a digitizer's GPS receiver may be "locked" to a satellite while the digitizer's clock free runs, or a digitizer's phase-locked-loop can be "locked" to a spurious time source. The time of an instantaneous sample "locked" to an external time reference point may not yield any information about the uniformity of the digitizer's sampling. So what does "locked" mean? Similarly, what does "questionable" mean? The "locked" and "questionable" bits may be redundant if time quality is included. |
| Rationale | | In the case of a Quanterra system, the "locked" bit is set when quality is ≥ 80%, although 81% to 100% encompasses a great range in terms of physical state of the timing system. For example, the values 0-10% correspond to no valid time since reboot; 11-59% means that time was acquired at least once since reboot, but the timebase has been running for some time between 10-500 minutes since the last external time reference; 60-79% means that the time is accurate, but the timebase frequency is not tracking; 80-89%means the timebase frequency was tracking but is currently in a hold state; 90-99% means the timebase is tracking; 100% means that the timebase is accurate and frequency is locked. Time is guaranteed correct for any value 60% or higher. In a system where the GPS is power-cycled, after acquisition of time and stabilization of the time base's PLL, the GPS is switched off, and the quality decreases at the rate of 1% per 10min. Typically no more than a few hundred microsec error can accumulate in the standard 3-hr off cycle. So effectively, quality is acceptable in the range 11% or higher. If GPS time has been missing longer than 500 minutes, the quality decreases to 10%. Time quality 10% or less should be considered not meaningful. In particular, time quality <10% means there was never any GPS time acquired. The time is meaningless in this case.

If the problem is that the definition of "locked" or "time quality" is not in station metadata, the solution is not to eliminate this vital information, but to define the meaning in the metadata. Certainly a definition of what "time quality" means in the context of different acquisition systems is as important as the various vendor-specific sensor responses. Time is fundamentally important to the valid interpretation of recorded data. Ignoring time quality in the MSEED format definition is not a good direction. The use of time quality by writers and readers should be encouraged. While the recording of SOH parameters (including time quality, and other metrics of the timing system) as time series (a concept we introduced in miniSEED) is extremely valuable (and should be strongly encouraged) for overall data quality assurance, these SOH time series are typically not considered simultaneously in seismological data analyses, if the information is available at all to users. Information regarding the integrity of the time label is so fundamental that it belongs synchronously attached to the time label in each data record, and its meaning documented in the format. Users should be encouraged to take the value into account if present. |
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Date of Comment		5/18/16