| **Page** | **Section** | **Line** | **Type** | **Comment/ Rationale** | **Source of Comment (Name/Agency)** | **Suggested Disposition** | **Disposition**  **(Completed by Principal Editor)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| N/A | N/A | N/A | ed/te | You have a question as to what should be in the Glossary. I have a few comments scattered herein that offer some thoughts. I've also tentatively scheduled some time at the Fall Meetings to discuss this question. | David Berry / NASA/JPL | Ponder. Discuss at The Hague. |  |
| Cover | N/A | N/A | ed/te | The document went out with a cover showing it was version 3.3, even though it was version 3.4. | David Berry / NASA/JPL | Double check version numbers before sending out to avoid confusion. |  |
| 1-1 | 1.2 | 2-5 | te | The terms here (flight-to-ground, etc.) are used without definition (though they are in the Glossary). | David Berry / NASA/JPL | Either (a) point the reader to the Glossary for definitions, or (b) define the terms here. |  |
| 1-4 | 1.4 | [31] thru [33], [35] to end | ed/te | These references don't appear to be used in the document (thought I do recall a Comment from you indicating a place where ref 33 could be used). | David Berry / NASA/JPL | Consider (a) deleting references that are not used from this list or (b) referring relevant topics in text to these sources. |  |
| 1-4 | 1.4 | [33] | ed | Typo | David Berry / NASA/JPL | From: "Delta-/DOR"  To: "Delta-DOR" |  |
| 1-4 | 1.4 | last 2 | ed | The last 2 listings in the References have no reference number. | David Berry / NASA/JPL | Assign a reference number. |  |
| 2-1 | 2.2.2 | para 4, line 1 | ed | The paragraph starts with "Of course, ". The fact cited may not be known by the reader, so "of course" could be construed as being a bit condescending. | David Berry / NASA/JPL | Remove the "Of course, " from the sentence. It's not necessary to convey the technical fact. |  |
| 2-2 | 2.2.2 | Fig 2-1 | te | Text preceding the Figure implies that attitude will be discussed in the figure, but it is not discussed. | David Berry / NASA/JPL | Discuss at The Hague. |  |
| 2-3 | 2.2.2 | Fig 2-1 | ed | The spacecraft in the diagram looks like it is disintegrating. | David Berry / NASA/JPL | See if we can find an older version of the picture in which the entire spacecraft is depicted. |  |
| 3-1 | 3 | Title | te | The title referring to "Exchange Framework" is leftover from an earlier version of the document. Material related to this topic has been removed. A title more applicable to the information presented is in order. | David Berry / NASA/JPL | From: "Navigation Message Exchange Framework"  To: "Navigation Message Data Types and Units" |  |
| 3-1 | 3.2 | 4 | te | At end of second full sentence, there is a good opportunity to refer to the SI units documentation. | David Berry / NASA/JPL | Add reference to [31] at end of second sentence. Note that this reference is currently not cited in the document. |  |
| 3-1 | Table 3-1 |  | te | For the "Range" entry, only "km" is listed as typical units. However, in 6.2.2.6, kilometers, seconds, and range units are cited. | David Berry / NASA/JPL | Add "s" and "RU" to the "Typical Units" column for this data type. |  |
| 3-1 | Table 3-1 |  | te | For "Variable Transmitter Doppler", there are no units provided. | David Berry / NASA/JPL | Suggest that "Hz" be the unit. |  |
| 3-1 | Table 3-1 |  | te | For "Integrated Doppler count", there are no units provided. | David Berry / NASA/JPL | Suggest that "counts" be the unit. |  |
| 3-1 | Table 3-1 |  | te | The "Type" called "Quality of measurements" seems like it's not a unique data type. Since there are no typical units provided, there is no risk in removing it from the table. | David Berry / NASA/JPL | Remove "Quality of measurements" from the table. |  |
| 3-2 | Table 3-2 |  | te/ed | The unit for "Power" is incorrect. | David Berry / NASA/JPL | From: kgm/s3  To: kgm2/s3 |  |
| 3-2 | Table 3-2 |  | te | For "Antenna Angles", the Alternate Units could be "rad" | David Berry / NASA/JPL | Add "rad" under "Alternate Units" |  |
| 3-2 | Table 3-2 |  | te | For "Oscillator frequency", the Units should also list "GHz" | David Berry / NASA/JPL | Add "GHz" under "Units" |  |
| 3-2 | Table 3-3 |  | ed/te | The table lists no units. I think it can be removed. | David Berry / NASA/JPL | Remove Table 3-3 |  |
| 3-4 | 4.3.3.1 | 6 | ed | Incomplete phrase. | David Berry / NASA/JPL | From: "... time for local frame"  To: "... time for a local frame"  OR  To: "... time for local frames". |  |
| 3-6 | 4.3.5 | Title | ed/te | I think the title should be expanded to include Mean of Date | David Berry / NASA/JPL | From: existing title  To: "True of Date (TOD) and Mean of Date (MOD) Coordinate Systems"  OR  To: "'Of Date' Coordinate Systems" |  |
| 3-6 | 4.3.5.1 | last | ed | Missing closing quote | David Berry / NASA/JPL | From: 'Greenwich Rotating Coordinate Frame  To: 'Greenwich Rotating Coordinate Frame' |  |
| 3-6 | 4.3.5.2 | 3 | ed/te | Equation mangled. (Here and in several other places in the document.) | David Berry / NASA/JPL | See email I sent to Alexandru... maybe it will help to work in ".docx" and let the CCSDS editor take care of converting it back to ".doc" (?) |  |
| 3-8 | 4.3.5.3 |  | te | Might be good to cite a reference for this TEME material. | David Berry / NASA/JPL | Ask Dan Oltrogge or Dave Vallado for a reference... do we already have one in Sec 1.4? |  |
| 3-11 | 4.4.1 | 7 | ed | Too many "or's" | David Berry / NASA/JPL | From: "... or (2) monotonically..."  To: "... (2) monotonically..." |  |
| 3-11 | 4.4.1 | last | ed | Not enough "or's", consistency with other list items. | David Berry / NASA/JPL | From: ", (4) constant"  To: ", or (4) constants" |  |
| 3-12 | 4.4.2.2.2 |  | te | A reference should be provided. | David Berry / NASA/JPL | Add a reference. Probably we already have one in Sec 1.4. |  |
| 3-12 | 4.4.2.2.3 |  | te | A reference should be provided. | David Berry / NASA/JPL | Add a reference. Probably we already have one in Sec 1.4. |  |
| 4-2 | 4.4.2.2.4 |  | te | A reference should be provided. | David Berry / NASA/JPL | Add a reference. Probably we already have one in Sec 1.4. |  |
| 4-2 | 4.4.2.2.5 |  | te | A reference should be provided. | David Berry / NASA/JPL | Add a reference. Probably we already have one in Sec 1.4. |  |
| 4-2 | 4.4.2.2.6 |  | te | A reference should be provided. | David Berry / NASA/JPL | Add a reference. Probably we already have one in Sec 1.4. |  |
| 4-2 | 4.4.2.2.7 |  | te | Allow for the possibility that a leap second could be added at end of March or September. The definition of UTC states that the last day of December and June are preferred, with the last day of March or September as second preference. | David Berry / NASA/JPL | From: "... which is done only at the end"  To: "... which is generally done only at the end..." |  |
| 4-3 | 4.4.2.2.7 |  | ed/te | For the "no leap second" example and "positive leap second example, the time 23:59:59 is specifically listed. It is not immediately obvious that this is what is missing for the negative leap second. | David Berry / NASA/JPL | For the negative leap second, specifically cite the absence of the time entry 23:59:59.  From: "UTC negative leap second"  To: "UTC negative leap second (23:59:59 missing)" |  |
| 4-5 | 4.6 |  | te | The section specifically cites "... for the Earth environment". What about non-Earth environments? | David Berry / NASA/JPL | Consider whether this qualification can be removed, or whether additional information needs to be provided for non-Earth environments. |  |
| 4-5 | 4.7.2 | para5, line 2 | te | Cites that a keyhole results from angular rates being too high, but keyholes can also exist due to portions of the sky being unviewable as a consequence of antenna architecture (e.g., at zenith or at horizon). | David Berry / NASA/JPL | Add a phrase similar to "... or portions of the sky being unviewable as a consequence of antenna architecture" at end of sentence. |  |
| 4-7 | 4.8.2 |  | te | Should we cite a reference? Cheryl Gramling can probably provide one. | David Berry / NASA/JPL | Check with Cheryl regarding a generally available TDRSS document. |  |
| 5-1 | 5.1 | Table 5-1 | te | Virtually all of the Properties listed in Table 5-1 are spacecraft related; rovers, equipment, and tracking stations seem to be excluded | David Berry / NASA/JPL | Adding a bunch of data types for rovers, equipment, and tracking stations might be a big job. Consider changing title of Table 5-1 to "Example Spacecraft Property Data Types". Maybe add a line in Sec 5.1 that examples are provided for spacecraft, but similar properties apply to rovers, equipment, and tracking stations. |  |
| 5-1 | 5.1 | Table 5-1 | ed | On the row labelled "Three-Dimensional Object", the "(e.g., attitude)" seems superfluous. No other row has examples. | David Berry / NASA/JPL | Remove "(e.g., attitude)". |  |
| 5-1 | 5.1 | Table 5-1 | ed | On the row labelled "Physical", there are some abbreviations in the "Example Data Types" column that should probably be expanded. | David Berry / NASA/JPL | From: "Rad. Press."  To: "Radiation Pressure"  Also, make the "Definition" column narrower so that the Example Data Type doesn't wrap. |  |
| 5-2 | 5.2.2.1 | 1-2 | te | The term "orbital elements" is in the Glossary, but it is not used in the document. There is an opportunity here. | David Berry / NASA/JPL | From: "... various sets of parameters."  To: "... various sets of parameters called 'orbital elements'." |  |
| 5-3 | Table 5-2 |  | ed | The term "Semi-major Axis" has a dash in the table entry, but no dash in the Glossary entry. | David Berry / NASA/JPL | Make the table and the Glossary consistent for this entry. |  |
| 5-4 | 5.2.2.5 |  | te | A reference should be provided. | David Berry / NASA/JPL | Add a reference. Probably we already have one in Sec 1.4. |  |
| 5-5 | 5.2.3.2 |  | te | The section describes 3 methods to propagate the orbit. They are listed in order of most accurate, least accurate, second most accurate (i.e., integration, analytical, semi-analytical). | David Berry / NASA/JPL | Re-order the 3 paragraphs in order from most accurate to least accurate. You could also consider listing them in this order in the first paragraph lead-in. |  |
| 5-5 | 5.2.3.2 | para3, line 6 | ed/te | I think the phrase "simple enough" is excessively vague. | David Berry / NASA/JPL | From: "simple enough"  To: "relatively simple" (which is also vague, but I think better expresses the intended concept). |  |
| 5-7 | 5.2.5 | 3 | ed/te | Incorrect term with respect to interpolation. | David Berry / NASA/JPL | From: "allows for"  To: "requires" |  |
| 5-7 | 5.2.5 | last | ed | The term "definitive" may require some explanation. | David Berry / NASA/JPL | Explain briefly what is meant by "definitive" in the context of the ephemeris. |  |
| 5-7 | 5.3.1, 5.3.2 |  | ed/te | The definition of "attitude" is repetitively provided in 5.3.1 lines 2-4; 5.3.2 paragraph 1 lines 1-2; and 5.3.2 paragraph 2 line 1 (i.e., one frame with respect to another). | David Berry / NASA/JPL | Reduce the level of repetition. |  |
| 5-7 | 5.3.1 | 4 | ed/te | The sentence that begins with "The motion of a rigid body ..." seems out of place. | David Berry / NASA/JPL | Since it refers to position, velocity, attitude, and angular velocity, it may be better to move it to section 5.1. |  |
| 5-7 | 5.3.2 | last | te | It is stated that "active and passive rotations differ in sign". | David Berry / NASA/JPL | Consider providing an example. |  |
| 5-7 | 5.3.3 | 1-2 | ed | Potentially missing word. | David Berry / NASA/JPL | From: "... that describe orientation using..."  To: "... that describe spacecraft orientation using..." |  |
| 5-8 | 5.3.4 | para 2, line 4 | te | Can we really call a quaternion "non-ambiguous" given the two very different interpretations of the 4 numbers? | David Berry / NASA/JPL | Consider if "non-ambiguous" is the proper description. |  |
| 5-8 | 5.3.4 | para 3, line 2 | te | Cites "time of application" as one of the attitude elements. It made me wonder "application of what?". | David Berry / NASA/JPL | Consider if there is a better term, e.g., "applicable epoch" or "timetag" or something like that. |  |
| 5-9 | 5.3.4 |  | te/ed | Given that you are using a unit vector **u**, should the components still be labelled e1, e2, e3? | David Berry / NASA/JPL | Consider using u1, u2, u3 for consistency. |  |
| 5-10 | 5.3.4 | para 3, line 2 | te | Is there in fact an identity X=1=roll, Y=2=pitch, Z=3=yaw? Some of the changes Alain is proposing for the ADM make me wonder. | David Berry / NASA/JPL | Check with Alain and Julie. I'm ignorant. |  |
| 5-11 | 5.3.5 | 5 | ed/te | Incorrect term with respect to interpolation. | David Berry / NASA/JPL | From: "allows for"  To: "requires" |  |
| 5-13 | 5.3.7 | para 1, last line | te | Question: Is the choice of torques to include in a model only dependent upon the location of the spacecraft in inertial space? Seems like there could well be other factors. | David Berry / NASA/JPL | If there are other factors, list a few for example. |  |
| 5-14 | 5.5.1 | 2 | te | Refers to the OPM. This is the only Nav WG message referred to explicitly in this document, so it should probably be removed. | David Berry / NASA/JPL | Consider removing the parenthetical remark after AD |  |
| 5-15 | 5.6 |  | te | This section lists some more detailed properties than are discussed previously. | David Berry / NASA/JPL | You may want to consider adding a line at the end something like: "Use of these properties enables more complex models of solar radiation pressure and atmospheric drag to be formulated." |  |
| 6-1 | 6.1 |  | ed | Last sentence in this section is awkwardly constructed. | David Berry / NASA/JPL | Review sentence and revise so that it makes sense. |  |
| 6-1 | 6.2.2.1 | 7-10 | ed | The sentences beginning "Spacecraft tracking is the process..." and ending with "... from one participant to another." seem like they could be the first sentences of this section. | David Berry / NASA/JPL | Consider moving. |  |
| 6-2 | 6.2.2.3 | 1-3 | ed/te | The terms "satellite-to-ground" and "ground-to-satellite" are used here, but we have terms "flight-to-ground" and "ground-to-flight" in Section 1-1 and in the Glossary and in our other Green Book. | David Berry / NASA/JPL | Change "satellite" to "flight" in "\*-to-ground" and "ground-to-\*" |  |
| 6-3 | 6.2.2.3 | para 2, lines 1-2 | ed/te | The terms "satellite-to-ground" and "ground-to-satellite" are used here, but we have terms "flight-to-ground" and "ground-to-flight" in Section 1-1 and in the Glossary and in our other Green Book. | David Berry / NASA/JPL | Change "satellite" to "flight" in "\*-to-ground" and "ground-to-\*" |  |
| 6-4 | 6.2.2.4 |  | te | I almost think the example text should be removed (though the relay diagram is useful). I think Cheryl Gramling might consider this an example of 2-way communication via the relay. | David Berry / NASA/JPL | Confirm with Cheryl. |  |
| 6-5 | 6.2.2.5 | para 1, line 6 | ed | The acronym "GNSS" is used without spelling it out the first time. | David Berry / NASA/JPL | Spell out first instance of the term. |  |
| 6-5 | 6.2.2.5 | para 2, line 5 | ed | Double period after "forward link". | David Berry / NASA/JPL | Remove one period. |  |
| 6-9 | 6.2.3 |  | te | The single sentence on non-gravs is probably not sufficient. | David Berry / NASA/JPL | Provide a few examples of the types of non grav acceleration. |  |
| 6-9 | 6.2.4 |  | te | A reference should be provided. | David Berry / NASA/JPL | Add a reference. Probably we already have one in Sec 1.4. |  |
| 6-10 | 6.3.2 | last | ed | Typo. | David Berry / NASA/JPL | From: "start sensor"  To: "star sensor" |  |
| 6-10 | 6.3.4 | para 3, line 2 | ed | Typo. | David Berry / NASA/JPL | From: "FOV 9and"  To: "FOV (and" |  |
| A-1 | Annex A |  | ed/te | The following terms are listed in the Glossary, but they do not appear in the document:  Agency Center  Apocenter  Attitude Equipment  Clock Bias | David Berry / NASA/JPL | Delete the terms from the Glossary. You could consider changing "Attitude Equipment" to "Attitude Sensor", which does appear in the doc. The term "clock bias" does not appear in the document, but the term "clock drift" which describes changes in clock bias DOES; so this one is more complicated. |  |
| A-2 | Annex A |  | ed/te | The following terms are listed in the Glossary, but they do not appear in the document:  In situ assets  Mean anomaly | David Berry / NASA/JPL | Delete the terms from the Glossary. |  |
| A-2 | Annex A |  | ed/te | The definition in the Glossary should probably also appear in Section 2.2.1 since that is the main theme of the entire document. | David Berry / NASA/JPL | Consider working in the Glossary definition into Sec 2.2.1 |  |
| A-3 | Annex A |  | ed/te | The following terms are listed in the Glossary, but they do not appear in the document:   * Receiver Independent Exchange Format * RINEX | David Berry / NASA/JPL | Delete the terms from the Glossary. |  |
| A-3 | Annex A |  | ed/te | The definition of "Participant" is a bit clinical. | David Berry / NASA/JPL | Provide a couple of examples ("e.g., spacecraft, ground station, etc.") |  |
| A-4 | Annex A |  | ed | Typo. In definition of "Stability" | David Berry / NASA/JPL | From: mesurand  To: measurand |  |
| A-4 | Annex A |  | te | Omission. In definition of "Tracking Station", consider adding "space-based" | David Berry / NASA/JPL | From: "Ground-based facility..."  To: "Ground-based facility or space-based asset..." |  |
| B-1 | Annex B |  | ed | The following abbreviations and acronyms do not appear in the document:  ALT  CDMA  DE  DSN  EFG  ESA  FDMA  Galileo  GCRF  GNS | David Berry / NASA/JPL | Remove from Annex B |  |
| B-1 | Annex B |  | te | Erroneous definition for "GM" | David Berry / NASA/JPL | From: Greenwich Mean  To: gravitational parameter |  |
| B-2 | Annex B |  | ed | The following abbreviations and acronyms do not appear in the document:  GRC  HEO  ICD  IMU  JPL  LEO  MCI  MEME  MET  MOON\_ME  MOON\_MEIAUE  MOON\_PA | David Berry / NASA/JPL | Remove from Annex B |  |
| B-3 | Annex B |  | ed | The following abbreviations and acronyms do not appear in the document:  NASA  NAVSTAR  OPM  PET  RIC  RINEX  SC  SCLK | David Berry / NASA/JPL | Remove from Annex B |  |
| B-4 | Annex B |  | ed | The following abbreviations and acronyms do not appear in the document:  TVN  USAF  UVW  VNC | David Berry / NASA/JPL | Remove from Annex B |  |