# Time Management Working Group Minutes

2021 Fall Meetings (virtual)  
Meeting dates:

* 2021-10-27 14:00 – 16:00 UTC
* 2021-11-01 14:00 – 16:00 UTC

## Attending

2021-10-27:

* Jon Hamkins
* Beau Blanding
* Christian Stangl
* Eric Pitts
* Yukio Yamamoto
* Carlyn Lee
* Sinda Mejri
* Peter Shames
* Victor Sank

2021-11-01:

* Jon Hamkins
* Beau Blanding
* Daphna Enzer
* Eric Pitts
* Ivan Agullo
* James Troupe
* Marina Ohara
* Nan Pei
* Stav Haldar
* Yukio Yamamoto
* Iu Ian
* Paul Kwiat
* Stan Cooper
* Victor Sank
* Iu Ian

## Agenda:

2021-10-27:

* Introduction and review of the agenda
* Review of actions list
* Finalization of mission survey
* Review of the draft Green book
* Any Other Business
* Conclusion/wrap up

2021-11-01:

* Quantum clock synchronization – presentation by James Troupe (Xairos)
* Mission survey discussion (continued)
* Review of the draft Green Book
* Schedule for next meeting
* Conclusion/wrap up
* Open action items are listed in the table below.

The working group met virtually 2021-10-27 and 2021-11-01 14:00 – 16:00 UTC. Documents related to the meeting are stored in CWE, in the “Meet Materials/2021/2021-10-27 and 2021-11-01 Fall Meetings 2021” folder.

## Minutes

Eric Pitts noted that Lee Pitts has fully retired.

## Day 1 – 2021-10-27

## Review of action items

AI\_20\_01. NASA and ESA has no input yet on this action item. ESA may get material for 2021-11-01 meeting. NASA will work on this in November.

AI\_20\_02. JAXA is waiting for response for atmospheric satellite.

AI\_20\_03. ESA has completed its mission survey input and it has been placed in the spring 2021 CWE folder.

AI\_21\_01. Jon and others have made a large number of edits, but this is not yet complete. Among the changes, a full list of acronyms has been produced, editing and formatting throughout has been done, references have been de-duplicated and verified, tables reformatted, a number of terms added to definitions list, uniform math formatting applied in many places.

Jon suggests that the majority of the material supplied for Section 6 on time synchronization relates to general concepts that could be placed in Section 2 instead. A smaller amount of material could remain in Section 6.

AI\_21\_02. Sinda received feedback from Mr. Nan Pei and Ms. Lan Lu. Sinda forwarded draft version 9 and asked them to draft the BEIDOU section, which has now been supplied. They may reply to survey, but if they don’t the WG will proceed with publication without this material.

AI\_21\_05. Beau states that the release process has been completed. It has not been incorporated. The text is available.

AI\_21\_06. Carlyn has completed this. The WG agreed that several table columns could be merged and the tables reformatted, which Carlyn will do. We will keep the Action Item open until the tables are in their final form.

AI\_21\_07. Jon completed this. The WG went over the list and filled in a few additional blanks. Jon moved the acronyms list to Annex B, which is where the CCSDS publications manual indicates it should be.

AI\_21\_08. GPS future evolutions. Beau Blanding plans to complete this section by late November or early December.

## Mission survey

### Mission contacts table

Carlyn will rewrite the introductory paragraph before Monday 2021-11-01.

### Mission precision classification table.

What does UTC column mean? Victor states that all of the near-Earth satellites are tracking UTC. After discussion, the working group “UTC” column should be merged with “Most stringent time” column.

Ability to track time on a spacecraft to a given level of accuracy may be different from its ability to execute activities to a given level of time accuracy.

Victor states that many satellites track UTC value.

We could Add a table to list satellites that track UTC (as opposed to a spacecraft clock)

### Time and Navigation Accuracy

Will pick up this topic on Monday, 2021-11-01.

## Day 2 – 2021-11-01

### Quantum clock synchronization

James Troupe from Xairos Systems presented about quantum clock synchronization.  
James described quantum entanglement and synchronization or syntonization, including entangled photon generation, quantum entanglement and timing with coincidence detection, a two-way quantum entanglement and timing protocol using direct direction with an APD.

Stav Haldar, graduate student at LSU, discussed synchronizing clocks which are far apart and moving, as part of a global QCS network. Pairs are generated at 10^7 pairs/s. The model does not yet account for the atmosphere. Singapore showed about 7 ps accuracy using standard APDs with ~100 ps of jitter, 20 s integration time, and 4,000 pairs detected. Goal is around 1 ps level. Some scenarios of orbits were discussed. Currently the TRL of QCS is not high, and

### Updated tables

Carlyn updated the mission survey tables as we had discussed on Day 1.

There was some discussion about the meaning of the headers and the multiple tables with timing requirements/performance. Jon took an action item to combine the tables into one.

The meaning of “High” in the tables was discussed.

### Green Book discussion

Jon noted that the bulk of the material in Section 6, Time Synchronization, is not actually about time synchronization. A lot of it is general concepts, definitions of other terms, and so forth, which would be better placed in section 2. Lee Pitts authored this section and unfortunately is not expected to be available to contribute further to this.

The Working Group agreed that it would be best to substantially edit section 6, removing material that is not about time synchronization, and either deleting it or incorporating it as appropriate into Section 2 or other sections. Jon took the action to do this.

### Other business

### Next meeting

The Working Group tentatively agreed to meet for two days in early December. Jon will make a poll to see availability.

## Action items

Open action items are listed in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **AI#** | **Action** | **Assignee** | **Due Date** | **Status** |
| AI\_20\_01 | Each space agency to detail format of time calibration packets used in missions | NASA: Jon; ESA: Sinda; ~~JAXA: Yukio~~  ~~DLR: Christian~~ | ~~Dec 2020: determine what can be released.~~  Est. Nov 2021 | Open. Agencies may be limited in what can be released. JAXA: closed  DLR: closed 8/17/2021 |
| ~~AI\_20\_02~~ | ~~Determine what/whether mission survey data can be publicly released~~ | ~~NASA: Carlyn~~  ~~ESA: Sinda~~  ~~DLR: Christian~~  ~~JAXA: Yukio~~ | ~~Dec. 2020 Sep. 2021 Dec. 2021~~ | ~~Open~~  ~~NASA: closed DLR: closed ESA: closed~~  Closed 10/27/2021 |
| AI\_20\_03 | Complete mission survey | NA~~SA: Carlyn~~  ~~ESA: Sinda (in spring meeting folder)~~ JAXA: Yukio (1 more coming) | ~~May 2021~~ ~~Sep 2021~~ Dec 2021 | Open NASA: closed DLR: closed |
| AI\_21\_01 | Prepare Green Book draft for initial WG review | Jon Hamkins | ~~March 2021~~  ~~Oct 2021~~  Dec 2021 | Open. Section 5-6 left to do. |
| AI\_21\_02 | Draft section on BEIDOU (section 4.4) | Sinda Mejri | ~~March 2021~~  ~~June 2021~~  Dec 2021 | Open.  Nan Pei and Lan Lu will provide this section. |
| ~~AI\_21\_05~~ | ~~Write section 7.1 science activities~~ | ~~Beau Blanding~~ | ~~June 2021~~  ~~Sep. 2021~~ | Closed, 10/27/2021 |
| ~~AI\_21\_06~~ | ~~Merge mission survey tables and add “early operations” column~~ | ~~Carlyn-Ann Lee~~ | ~~June 2021~~  ~~Sep. 2021~~ | Closed, 10/27/2021 |
| ~~AI\_21\_07~~ | ~~Create acronyms list~~ | ~~Jon Hamkins~~ | ~~Oct 2021~~ | Closed, 10/27/2021 |
| AI\_21\_08 | Write new section 4.1.2, “GPS Evolution” | Beau Blanding | ~~Sep 2021~~  Dec 2021 | Open |
| AI\_21\_09 | Edit Section 6, removing or moving material to other sections. | Jon Hamkins | Dec. 2021 | Open |