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IEEE

P1752 Sleep Schema Subgroup Meeting

Sponsored by IEEE Engineering in Medicine & Biology (EMB) Standards Committee

- 7 Jan 2020
- Teleconference

Attendance

- **Put your name and affiliation in the chat window for attendance today.**
- If you are joining only via phone, please email charlotte.chen@philips.com with "P1752 Sleep Schema Subgroup call" as subject
- The document shows attendance is under https://ieee-sa.imeetcentral.com/omh/folder/WzIwLDEwMjY4MDg1XQ/ .
  --If you attended the call, please verify that your name is listed
  --If you name is not listed, either edit the document above or email charlotte.chen@philips.com

Agenda

1. Attendance
2. Modified timelines
3. Status updates
4. Discuss major WG review comments
5. Summary of other WG review comments
6. Review comments on the 2nd batch of quantitative schemas
7. Action Items
8. Q&A

Timeline for Stage2 Remaining Work

-**Complete addressing subgroup comments** for Quantitative Sleep Schemas by **May 12, 2019**
-**Complete subgroup reviewing** Qualitative Measure Schemas by **May 31, 2019**

-**Validate** Quantitative Schemas by **Oct 28, 2019**
-**Draft** Qualitative Measure Schemas by **Nov 19,**

-**Review/Discuss/Address** WG comments on 1st batch Quantitative Schemas by **Jan 20, 2020**
-**Review/Discuss/Address** WG comments on 2nd batch quantitative schemas by **Jan 31**
-**Distribute** Survey Schemas by **(TBD by WG)**

Status Update (1)

- Completed addressing WG comments on the following 1st batch schemas
  --ambient-light
  --ambient-temperature
  --sleep-onset-latency

Status Update (2)

- Addressing WG comments on the following 1st batch schemas
  --ambient-sound
  --deep-sleep-percentage
  --light-sleep-percentage
  --time-in-bed
  --total-sleep-time

Status Update (3)

- Presented/Discussed quantitative schemas with the main WG members on Dec 10 and Dec 13 of 2019
- Summarized WG major review comments (details below)

Discuss Major Review Comments/Proposals (1)

1. Proposal for describing the cases where the schema models both a simple measure and summary measures (Simona)

case #1: quantitative measure where individual measurements are associated with timestamps (e.g., ambient temperature)

top-level schema description
"description": "This schema represents the ambient temperature."
[...]

description of the property:
"descriptive_statistic": {
"description": "The descriptive statistic of a set of measurements (e.g., average, maximum) within the specified time frame."
[...]

case #2: quantitative measure where individual measurements are associated with time intervals (e.g., total sleep time)

top-level schema description
"description": "This schema represents total sleep time, i.e. The total sleep time is the interval between initial sleep onset time and final awakening time minus the duration of all awakenings."
[...]

description of the properties:
"description": "The descriptive statistic of a set of measurements (e.g., average, maximum) within the specified time frame."
[...]

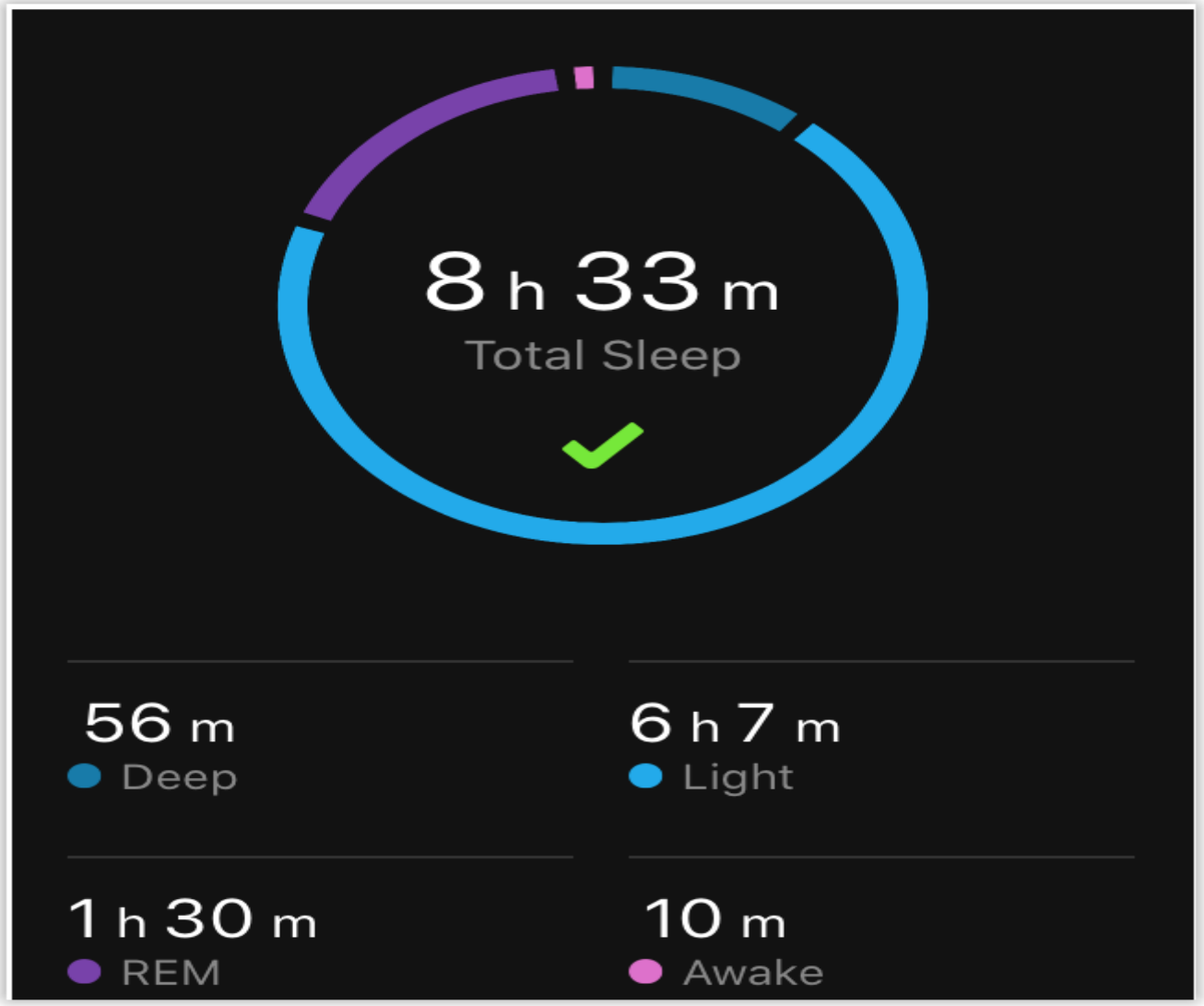
"descriptive_statistic_denominator": {
"description": "The denominator of the descriptive statistic when the measure has an implicit duration (e.g., if the descriptive statistic is 'average' and the statistic denominator is 'd' the measure describes the average daily total sleep time during the period delimited by the effective time frame)."
[...]

The proposal above would replace the current wording of the top-level schema description (e.g.:
"description": "This schema represents measurement of ambient light. It could be either a single measurement or the result of aggregated measurements over the time."

Discuss Major Review Comments/Proposals (2)

2. In reference to the discussion on light/deep sleep percentage, an example of sleep data on a tracker shows base values for the various types of sleep plus total. Although we don't know if the API exposes the light/deep sleep percentages, those values can be calculated using the given base values. (see picture below)

Discuss Major Review Comments/Proposals (3)



Discuss Major Review Comments/Proposals (4)

3. standardizing nomenclature: with an eye to existing conventions in the sleep research community, we should ensure that we use consistent names to indicate the same thing.
One example is individual segments of sleep vs non-sleep or different types of sleep. Right now we are using bouts, events, episodes partly as a result of different people drafting different schemas.
Another example is time vs duration to describe a length of time
4. referencing other schemas: when you reference schema A in schema B, keep in mind that the requirements for schema A must be met by schema B instances for them to be valid. Here's an example (next slide):

Discuss Major Review Comments/Proposals (5)

In the schema **sleep-episode** the property total_sleep_time is defined based on duration_unit_value

```
      "duration_unit_value": {
         "$ref": "duration-unit-value-1.x.json"
      }
[...]
      "total_sleep_time": {
         "description": "The total amount of time spent asleep within the effective time frame.",
         "$ref": "#/definitions/duration_unit_value"
      }
```

The duration_unit_value schema has two required properties: a numeric value and a unit of measure to be chosen among a value set that includes units of time. So this sample data complies with it

```
   "total_sleep_time": {
      "value": 487,
      "unit": "min"
   }
```

There is also a schema called total-sleep-time but using it to define the property below is not equivalent, because an instance of total sleep time must include not only a numerical value and unit of time,

but also an effective time frame, with possible clashes with the **sleep-episode** effective time frame

```
   "total_sleep_time": {
     "$ref": "total-sleep-time-1.x.json"
   }
[...]
      "total_sleep_time": {
         "description": "The total amount of time spent asleep within the effective time frame.",
         "$ref": "#/definitions/total_sleep_time"
      }
```

This sample data does not comply with the above (and validation would generate an error about it)

```
   "total_sleep_time": {
      "value": 487,
      "unit": "min"
   }
```

Summary of Other Review Comments

1. The inclusion of time interval of individual event were proposed in some of the schemas (e.g. total-sleep-time)
2. Suggest to reevaluate inclusion/exclusion of statistical measures for some schemas (e.g. sleep-body-movement, on-going discussion)
3. Fix missing keyword (e.g. “item” for array) for some schema
4. Make sure to use the valid units of duration in sample data (e.g. h, wk)
5. Editorial comments (e.g. description, etc.)
6. Sample data (one file with delimiters between instances for review, one file/instance for validation), here is an example:

==========

ambient temperature: instance #1

==========

Review Comments on 2nd Batch Quantitative Schemas

Review Comments on apnea-hypopnea-index (1)

1	Schema Line or Line Range	Comments	Date (comment)	Email Address of the person who made comments	Resolution
2	7	Should this include a time_frame definition?	1-Dec-19	paul.t.harris@ieee.org	
3	13	Should the schema support other measures such as obstructive and hypopnea indices, clear airway index, leak rates (average, above threshold, avg/min/max pressures, respiratory rate, session times, time in apnea, tidal volumes, etc?	1-Dec-19	paul.t.harris@ieee.org	
4	4	why cannot the schema model statistics? (N/A or some other reason?)	5-Dec-19	simona.carini@ucsf.edu	
5	4	the sleep session is not defined in the schema: without a time reference any instance of the schema would have no value	5-Dec-19	simona.carini@ucsf.edu	
6	14	usage of what?	5-Dec-19	simona.carini@ucsf.edu	
7	14	Can the unit of time be only hours?	5-Dec-19	simona.carini@ucsf.edu	
8	22	if so, then please use standard unit (h)	5-Dec-19	simona.carini@ucsf.edu	
9	28	it is not clear what this property represents and what the unit of measure should be	5-Dec-19	simona.carini@ucsf.edu	

Review Comments on apnea-hypopnea-index (2)

10	31	it is not clear what this property represents and what the unit of measure should be	5-Dec-19	simona.carini@ucsf.edu	
11	34	an index usually is a number. If this index has a unit of measure it should be specified in the schema	5-Dec-19	simona.carini@ucsf.edu	
12	N/A	Most of my comments above were made on the first version of the schema and I don't see them addressed so I am wondering if there is a different version of the schema we should review	5-Dec-19	simona.carini@ucsf.edu	
13	sample data: 19 and 39	remove hanging comma	5-Dec-19	simona.carini@ucsf.edu	

```
{
    "$schema": "http://json-schema.org/draft-07/schema#",

    "description": "This schema represents a person's apnea-hypopnea index (AHI), a measure of sleep apnea severity, as events per hour during a sleep session",
    "type": "object",

    "definitions": {
        "unit_value": {
            "$ref": "#/definitions/unit_value"
        }
    },

    "properties": {
        "usage_hours": {
            "allOf": [
                {
                "$ref": "#/definitions/unit_value"
                },
                {
                "properties": {
                    "unit": {
                    "enum": ["hh" ]
                        }
                    }
                }
            ]
        },
        "mask_seal": {
            "$ref": "#/definitions/unit_value"
        },
        "mask_on_off": {
            "$ref": "#/definitions/unit_value"
        },
        "apnea_hypopnea_index": {
             "$ref": "#/definitions/unit_value"
        }
    },

    "required": [
        "usage_hours",
        "apnea_hypopnea_index"
    ]
}
```

```
================================================================================
apnea hypopnea index sample data: instance #1
================================================================================
{
    "usage_hours": {
                "value": "5.8",
                "unit": "hh"
        },
        "mask_seal": {
                "value": 85,
                "unit": "%"
        },
        "mask_on_off": {
                "value": 2,
        },
        "ahi": {
                "value": "0.6",
                "unit": "e/h"
        },
}
================================================================================
apnea hypopnea index sample data: instance #2
================================================================================
{
    "usage_hours": {
                "value": "7.5",
                "unit": "hh"
        },
        "mask_seal": {
                "value": 100,
                "unit": "%"
        },
        "mask_on_off": {
                "value": 1,
        },
        "ahi": {
                "value": "1.5",
                "unit": "e/h"
        },
}
```

Review Comments on arousal-index Schema

1	Schema Line or Line Range	Comments	Date (comment)	Email Address of the person who made comments	Resolution	Date (resolution)
2	noise schema	merge with sound schema in ambient sound (not sure why this schema appears here)	5-Dec-19	simona.carini@ucsf.edu		
3	arousal schema	separate words with hyphen in file name	5-Dec-19	simona.carini@ucsf.edu		
4	4	I suggest to keep the description focused on what the schema models	5-Dec-19	simona.carini@ucsf.edu		
5	5	delete line	5-Dec-19	simona.carini@ucsf.edu		
6	14 and 17	if the schema models the measure for only one sleep session (see description), what are descriptive statistics used for?	5-Dec-19	simona.carini@ucsf.edu		
7	sample data: 32	please use standard units of duration (wk)	5-Dec-19	simona.carini@ucsf.edu		
8	sample data: instance 2	the use of average weekly in this instance seems a bit strange; in any case, if weekly is really what is meant here, it is helpful to define a time frame > 1 week	5-Dec-19	simona.carini@ucsf.edu		

arousal_index.json

Schema: http://json-schema.org/draft-07/schema#

```
{
  "$schema": "http://json-schema.org/draft-07/schema#",
  "type": "object",
  "description": "This schema represents the arousals index during a sleep session (main or nap), i.e., the number of awakenings between 3-15 secs per hour during a sleep session. It may be used to measure the degree of sleep fragment.",
  "references": [],

  "definitions": {
    "unit_value": {
      "$ref": "unit-value-1.x.json"
    },
    "time_frame": {
      "$ref": "time-frame-1.x.json"
    },
    "descriptive_statistic": {
      "$ref": "descriptive-statistic-1.x.json"
    },
    "descriptive_statistic_denominator": {
      "$ref": "descriptive-statistic-denominator-1.x.json"
    }
  },
  "properties": {
    "arousal_index": {
      "allOf": [
        {
          "$ref": "#/definitions/unit_value"
        },
        {
            "properties": {
                "unit": {
                    "enum": [
                        "awakenings/h"
                    ]
                }
            }
        }
      ]
    },
```

```
    "effective_time_frame": {
      "description": "Effective time frame is restricted to be a time interval. For an individual measurement, this is the interval of time between when the person began a sleep session and when it ended. For a summary measurement, this is the interval of time between the beginning of the first measurement and the end of the last measurement.",
      "allOf": [
        {
          "$ref": "#/definitions/time_frame"
        },
        {
          "required": [ "time_interval" ]
        }
      ]
    },
    "is_main_sleep": {
      "type": "boolean"
    },
    "descriptive_statistic": {
      "$ref": "#/definitions/descriptive_statistic"
    },
    "descriptive_statistic_denominator": {
      "anyOf": [
        {
          "$ref": "#/definitions/descriptive_statistic_denominator"
        },
        {
          "description": "If the value needed is a standard unit of duration, select from the duration-unit-value value set.",
          "type": "string"
        }
      ]
    }
  },

  "required": [
    "arousal_index",
    "effective_time_frame"
  ]
}
```

noise_unit_value.json | arousal-index-sample-data.json | arousal_index.json

Schema: http://json-schema.org/draft-07/schema#

```
1  {
2    "$schema": "http://json-schema.org/draft-07/schema#",
3
4    "description": "This schema represents the noise unit value in decibel.",
5    "type": "object",
6
7    "allOf": [
8      {
9        "$ref": "unit-value-1.x.json"
10     },
11     {
12       "properties": {
13         "unit": {
14           "enum": [
15             "dB"
16           ]
17         }
18       }
19     }
20   ]
21 }
```

arousal-index-sample-data.json | arousal_index.json

Schema: <No Schema Selected>

```
================================================================================
arousal index sample data: instance #1
================================================================================
{
  "arousal_index": {
        "value": 0.6,
        "unit": "awakenings/h"
  },
  "effective_time_frame": {
    "time_interval": {
        "start_date_time": "2019-02-05T22:00:00Z",
        "end_date_time": "2019-02-06T06:00:00Z"
    }
  },
  "is_main_sleep": true
}
================================================================================
arousal index sample data: instance #2
================================================================================
{
  "arousal_index": {
        "value": 1.2,
        "unit": "awakenings/h"
  },
  "effective_time_frame": {
    "time_interval": {
        "start_date_time": "2019-02-05T22:00:00Z",
        "end_date_time": "2019-02-11T06:00:00Z"
    }
  },
  "descriptive_statistic": "average",
  "descriptive_statistic_denominator": "w"
}
```

Review Comments on sleep-body-movement Schema

1	Schema Line or Line Range	Comments	Date (comment)	Email Address of the person who made comments	Resolution
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					

sleep-body-movement.json | noise_unit_value.json | arousal-index-sample-data.json | arousal_index.json

Schema: http://json-schema.org/draft-07/schema#

```
{
    "$schema": "http://json-schema.org/draft-07/schema#",
    "type": "object",
    "description": "This schema represents body movement during sleep, a simple count of the number of times movement was detected during a sleep session.

    "definitions": {
        "time_frame": {
            "$ref": "time-frame-1.x.json"
        },
        "descriptive_statistic": {
            "$ref": "descriptive-statistic-1.x.json"
        }
    },
    "properties": {
        "movement_count": {
            "type": "number"
        },
        "effective_time_frame": {
            "description": "Effective time frame is restricted to be a time interval. For an individual measurement, this is the interval of time between
            "allOf": [
                {
                    "$ref": "#/definitions/time_frame"
                },
                {
                    "required": ["time_interval"]
                }
            ]
        },
        "is_main_sleep": {
            "type": "boolean"
        },
        "descriptive_statistic": {
            "$ref": "#/definitions/descriptive_statistic"
        }
    },

    "required": [
        "movement_count",
        "effective_time_frame",
        "descriptive_statistic"
    ]
}
```

sleep-body-movem...-sample-data.json | sleep-body-movement.json | noise_unit_value.json | arousal-index-sample-data.json | arousal_index.json

Schema: <No Schema Selected>

```
{
    "body_movement_count": {
        "value": 30
    },
    "effective_time_frame": {
        "time_interval": {
            "start_date_time": "2019-02-05T06:00:00Z",
            "end_date_time": "2019-02-06T06:00:00Z"
        }
    },
    "descriptive_statistic": "count"
}
```

Review Comments on sleep-episode Schema

1	Schema Line or Line Range	Comments	Date (comment)	Email Address of the person who made comments	Resolution	Date (resolution)
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

sleep-episode.json | sleep-body-movem...-sample-data.json | noise_unit_value.json

Schema: http://json-schema.org/draft-07/schema#

```
{
    "$schema": "http://json-schema.org/draft-07/schema#",
    "type": "object",
    "description": "This schema represents one sleep episode, which can be the main sleep event (i.e., a night sleep for most people) or a nap.",

    "definitions": {
        "unit_value": {
            "$ref": "unit-value-1.x.json"
        },
        "duration_unit_value": {
            "$ref": "duration-unit-value-1.x.json"
        },
        "time_frame": {
            "$ref": "time-frame-1.x.json"
        },
        "date_time": {
            "$ref": "date-time-1.x.json"
        }
    },

    "properties": {
        "latency_to_sleep_onset": {
            "description": "Amount of time between when person starts to want to go to sleep and sleep onset.",
            "$ref": "#/definitions/duration_unit_value"
        },
        "latency_to_arising": {
            "description": "Amount of time between final awakening and when person stops wanting to go to sleep.",
            "$ref": "#/definitions/duration_unit_value"
        },
        "total_sleep_time": {
            "description": "The total amount of time spent asleep within the effective time frame.",
            "$ref": "#/definitions/duration_unit_value"
        },
        "light_sleep_time": {
            "description": "The amount of total sleep time spent in light sleep.",
            "$ref": "#/definitions/duration_unit_value"
        },
        "deep_sleep_time": {
            "description": "The amount of total sleep time spent in deep sleep.",
            "$ref": "#/definitions/duration_unit_value"
        },
```

```
        "rem_sleep_time": {
            "description": "The amount of total sleep time spent in REM sleep.",
            "$ref": "#/definitions/duration_unit_value"
        },
    "number_of_awakenings": {
            "type": "integer"
        },
        "is_main_sleep": {
            "type": "boolean"
        },
        "effective_time_frame": {
            "description": "The initial sleep onset time maps to start_date_time, the final awakening time maps to end_date_time and total sleep episode
            "allOf": [
                {
                    "$ref": "#/definitions/time_frame"
                },
                {
                    "required": ["time_interval"]
                }
            ]
        },
        "sleep_maintenance_efficiency_percentage": {
            "description": "The amount of time spent asleep as a percentage of the sleep episode bounded by the effective time frame.",
            "allOf": [
                {
                    "$ref": "#/definitions/unit_value"
                },
                {
                    "properties": {
                        "unit": {
                            "enum": ["%"]
                        }
                    }
                }
            ]
        }
    },
    "required": [
        "effective_time_frame"
    ]
}
```

```
{
    "effective_time_frame": {
        "time_interval": {
            "start_date_time": "2016-02-05T21:35:00Z",
            "duration": {
                "value": 520,
                "unit": "min"
            }
        }
    },
    "latency_to_sleep_onset": {
        "value": 17.5,
        "unit": "min"
    },
    "latency_to_arising": {
        "value": 5.2,
        "unit": "min"
    },
    "total_sleep_time": {
        "value": 487,
        "unit": "min"
    },
    "light_sleep_time": {
        "value": 312,
        "unit": "min"
    },
    "deep_sleep_time": {
        "value": 37,
        "unit": "min"
    },
    "rem_sleep_time": {
        "value": 138,
        "unit": "min"
    },
    "number_of_awakenings": 1,
    "is_main_sleep": true,
    "sleep_maintenance_efficiency_percentage": {
        "value": 93.7,
        "unit": "%"
    }
}
```

Review Comments on sleep-stages Schema (1)

1	Schema Line or Line Range	Comments	Date (comment)	Email Address of the person who made comments	Resolution
2	3	the description does not capture accurately what the schema models	9-Dec-19	simona.carini@ucsf.edu	
3	5	remove references section	9-Dec-19	simona.carini@ucsf.edu	
4	27, 30, 33	when referencing another schema one must ensure that when that is used at least all of the required properties are present (see email I wrote on 12/9 with an example)	9-Dec-19	simona.carini@ucsf.edu	
5	105, 128	in their current form, these schemas model a % associated to an effective_time_frame: the way the schemas are referenced here does not match what the sample data shows; even without the time frame, this would not be correct as the value already has % as unit	9-Dec-19	simona.carini@ucsf.edu	
6	38	I am not sure I understand why this property is defined as an array vs a set of properties. I looked at the sample data but don't see an example of a case where this array has more than one element	9-Dec-19	simona.carini@ucsf.edu	

Review Comments on sleep-stages Schema (2)

7	38	An instance with just total sleep time would comply with this schema and yet it does not show sleep stages (see my other comment below, asking for sample data with only required properties)	9-Dec-19	simona.carini@ucsf.edu	
8	49	Is "total" in the name necessary?	9-Dec-19	simona.carini@ucsf.edu	
9	76	I made a similar comment in another schema:I think we should agree on a standard name for episodes/events/bouts of sleep and use the chosen name across all schemas	9-Dec-19	simona.carini@ucsf.edu	
10	76, 99, 122, 145, 182	the name "events" is used to refer to a count 4 times than the last time it refers to an array, which is actually what I expect from the plural name. I suggest to clarify in the property name when it refers to a count	9-Dec-19	simona.carini@ucsf.edu	
11	190	I suggest to add "sleep" to all the values where it applies	9-Dec-19	simona.carini@ucsf.edu	
12	141	should this be "awake_duration"?	9-Dec-19	simona.carini@ucsf.edu	
13	148	should this be "awake_percentage"?	9-Dec-19	simona.carini@ucsf.edu	

Review Comments on sleep-stages Schema (3)

14	sample data	please separate each instance as agreed upon	9-Dec-19	simona.carini@ucsf.edu	
15	sample data: 264	this instance says the person sleeps an average 6 hours per week, which seems unlikely	9-Dec-19	simona.carini@ucsf.edu	
16	sample data	please create an instance that shows only the required properties. I don't see any required properties within the sleep_stage_summary array, so it is possible that an instance contains an empty array.	9-Dec-19	simona.carini@ucsf.edu	

```
{
  "$schema": "http://json-schema.org/draft-07/schema#",
  "description": "This schema represents durations for varying sleep stages and wakefulness during a sleep episode, i.e. The total duration of REM, Light, and Deep sleep as a summation of equatable stages between initial sleep onset time and final awakening time minus the duration of all other stages including wakefulness.",
  "type": "object",
  "references": [
        {
            "description": "The SNOMED code represents Sleep, function (observable entity)",
            "url": "http://purl.bioontology.org/ontology/SNOMEDCT/258158006"
        }
  ],
  "definitions": {
    "duration_unit_value": {
      "$ref": "duration-unit-value-1.x.json"
    },
    "unit_value": {
      "$ref": "unit-value-1.x.json"
    },
    "time_frame": {
      "$ref": "time-frame-1.x.json"
    },
    "descriptive_statistic": {
      "$ref": "descriptive-statistic-1.x.json"
    },
    "descriptive_statistic_denominator": {
      "$ref": "descriptive-statistic-denominator-1.x.json"
    },
    "light_sleep_percentage": {
      "$ref": "light-sleep-percentage-1.x.json"
    },
    "deep_sleep_percentage": {
      "$ref": "deep-sleep-percentage-1.x.json"
    },
    "total_sleep_time": {
      "$ref": "total-sleep-time-1.x.json"
    }
  },
```

```
  "properties": {
    "sleep_stage_summary": {
    "description": "A summary of durations, percentages, event counts related to sleep stages and wakefulness during a sleep episode.",
     "type": "array",
      "items": [
        {
         "type": "object",
         "properties": {
            "total_sleep_time": {
              "description": "The total amount of time spent asleep within the effective time frame.",
              "$ref": "#/definitions/total_sleep_time"
            },
            "total_sleep_efficiency_percentage": {
              "description": "The amount of time spent asleep as a percentage of the sleep episode bounded by the effective time frame.",
              "allOf": [
              {
                "$ref": "#/definitions/unit_value"
              },
              {
                "properties": {
                    "unit": {
                        "enum": ["%"]
                    }
                }
              }
            ]
            },
            "latency_to_sleep_onset": {
              "description": "Amount of time between when person starts to want to go to sleep and sleep onset.",
              "$ref": "#/definitions/duration_unit_value"
            },
            "latency_to_arising": {
              "description": "Amount of time between final awakening and when person stops wanting to go to sleep.",
              "$ref": "#/definitions/duration_unit_value"
            },
            "rem_sleep_duration": {
              "description": "Total time in REM Sleep Stage from bedtime until final awakening time or across the 24-h period. This excludes any time that a person
              "$ref": "#/definitions/duration_unit_value"
            },
           "rem_sleep_events": {
              "type": "integer"
            },
            "rem_sleep_percentage": {
              "allOf": [
                {
                  "$ref": "#/definitions/unit_value"
                },
```

```
            {
              "properties": {
                "unit": {
                  "enum": [
                    "%"
                  ]
                }
              }
            }
          ]
        },
        "light_sleep_duration": {
          "description": "Total time in Light Sleep Stage from bedtime until final awakening time or across the 24-h period. This excludes any time that a perso
          "$ref": "#/definitions/duration_unit_value"
        },
        "light_sleep_events": {
          "type": "integer"
        },
        "light_sleep_percentage": {
          "allOf": [
            {
              "$ref": "#/definitions/light_sleep_percentage"
            },
            {
              "properties": {
                "unit": {
                  "enum": [
                    "%"
                  ]
                }
              }
            }
          ]
        },
        "deep_sleep_duration": {
          "description": "Total time in Deep Sleep Stage from bedtime until final awakening time or across the 24-h period. This excludes any time that a person
          "$ref": "#/definitions/duration_unit_value"
        },
        "deep_sleep_events": {
          "type": "integer"
        },
        "deep_sleep_percentage": {
          "allOf": [
            {
              "$ref": "#/definitions/deep_sleep_percentage"
            },
```

```
                {
                  "properties": {
                    "unit": {
                      "enum": [
                        "%"
                      ]
                    }
                  }
                }
              ]
            },
            "awake_sleep_duration": {
              "description": "Total time in Awake Stage from bedtime until final awakening time or across the 24-h period. This excludes any time that a person is a
              "$ref": "#/definitions/duration_unit_value"
            },
            "awakening_events": {
              "type": "integer"
            },
            "awake_sleep_percentage": {
              "allOf": [
                {
                  "$ref": "#/definitions/unit_value"
                },
                {
                  "properties": {
                    "unit": {
                      "enum": [
                        "%"
                      ]
                    }
                  }
                }
              ]
            },
        "descriptive_statistic": {
          "$ref": "#/definitions/descriptive_statistic"
        },
        "descriptive_statistic_denominator": {
          "anyOf": [
            {
              "$ref": "#/definitions/descriptive_statistic_denominator"
            },
            {
              "description": "If the value needed is a standard unit of duration, select from the duration-unit-value value set.",
              "type": "string"
            }
```

```
            ]
          }
          }
          }
        ]
        },
        "sleep_stage_events": {
          "description": "Individual sleep events and their durations to describe at what points throughout the sleep episode is the individual is asleep, and when summ
          "type": "array",
          "items": [
            {
              "type": "object",
              "properties": {
                "sleep_stage_state": {
                "enum": [
                  "REM",
                  "Light",
                  "Deep",
                  "Awake"
                ]
                },
                "sleep_stage_time_frame": {
                  "allOf": [
                  {
                    "$ref": "#/definitions/time_frame"
                  },
                  {
                    "required": [
                      "time_interval"
                    ]
                  }
                  ]
                  }
              },
              "required": [
                "sleep_stage_state",
                "sleep_stage_time_frame"
              ]
            }
            ]
        },
```

```
    "effective_time_frame": {
      "description": "As a measure of a duration, time asleep should not be associated to a date time time frame. Hence, effective time frame is restricted to be a
      "allOf": [
        {
          "$ref": "#/definitions/time_frame"
        },
        {
          "required": [
            "time_interval"
          ]
        }
      ]
    },
    "is_main_sleep": {
      "type": "boolean"
    }
  },
  "required": [
    "sleep_stage_summary"
  ]
}
```

```
{
  "sleep_stage_summary": [
    "deep_sleep_duration": {
          "value": 2,
          "unit": "h"
    }
  ],
  "sleep_stage_events": [
    {
    "sleep_stage_state" : {
      "value": "Deep"
    },
    "sleep_event_time_frame": {
        "start_date_time": "2019-02-20T00:30:00Z",
        "end_date_time": "2019-02-20T02:00:00Z"
    }
    },
    {
    "sleep_stage_state" : {
      "value": "Deep"
    },
    "sleep_event_time_frame": {
        "start_date_time": "2019-02-20T03:00:00Z",
        "end_date_time": "2019-02-20T03:30:00Z"
    }
    }
  ],
  "effective_time_frame": {
    "time_interval": {
      "start_date_time": "2019-02-19T22:30:00Z",
      "end_date_time": "2019-02-20T04:50:00Z"
    }
  }
}
```

```
{
  "sleep_stage_summary": [
      "total_sleep_time": {
            "value": 380,
            "unit": "min"
      },
      "total_sleep_efficiency_percentage": {
          "value": 86.8,
          "unit": "%"
      },
      "latency_to_sleep_onset": {
            "value": 17.5,
            "unit": "min"
      },
      "latency_to_arising": {
            "value": 5.2,
            "unit": "min"
      },
     "rem_sleep_duration": {
            "value": 70,
            "unit": "min"
     },
    "rem_sleep_events": 4,
     "light_sleep_duration ": {
            "value": 140,
            "unit": "min"
     },
      "light_sleep_events": 6,
     "deep_sleep_duration": {
            "value": 120,
            "unit": "min"
     },
      "deep_sleep_events": 2,
     "awake_sleep_duration": {
            "value": 50,
            "unit": "min"
     }
     "number_of_awakenings": 3,
  ],
```

```
  "sleep_stage_events": [
    {
      "sleep_stage_state" : {
        "value": "REM"
      }
      "sleep_event_time_frame": {
          "start_date_time": "2019-02-19T22:30:00Z",
          "end_date_time": "2019-02-19T22:50:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "Light"
      }
      "sleep_event_time_frame": {
          "start_date_time": "2019-02-19T22:50:00Z",
          "end_date_time": "2019-02-19T23:50:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "Awake"
      }
      "sleep_event_time_frame": {
          "start_date_time": "2019-02-19T23:50:00Z",
          "end_date_time": "2019-02-20T00:15:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "Light"
      }
      "sleep_event_time_frame": {
          "start_date_time": "2019-02-20T00:15:00Z",
          "end_date_time": "2019-02-20T00:30:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "Deep"
      }
```

```
    "sleep_event_time_frame": {
          "start_date_time": "2019-02-20T00:30:00Z",
          "end_date_time": "2019-02-20T02:00:00Z"
      }
    },
    {
    "sleep_stage_state" : {
      "value": "Light"
    },
    "sleep_event_time_frame": {
          "start_date_time": "2019-02-20T02:00:00Z",
          "end_date_time": "2019-02-20T02:15:00Z"
      }
    },
    {
    "sleep_stage_state" : {
      "value": "Awake"
    },
    "sleep_event_time_frame": {
          "start_date_time": "2019-02-20T02:15:00Z",
          "end_date_time": "2019-02-20T02:30:00Z"
      }
    },
    {
    "sleep_stage_state" : {
      "value": "REM"
    },
    "sleep_event_time_frame": {
          "start_date_time": "2019-02-20T02:30:00Z",
          "end_date_time": "2019-02-20T02:45:00Z"
      }
    },
    {
    "sleep_stage_state" : {
      "value": "Light"
    },
    "sleep_event_time_frame": {
          "start_date_time": "2019-02-20T02:45:00Z",
          "end_date_time": "2019-02-20T03:00:00Z"
      }
    },
```

```
    {
      "sleep_stage_state" : {
        "value": "Deep"
      },
      "sleep_event_time_frame": {
        "start_date_time": "2019-02-20T03:00:00Z",
        "end_date_time": "2019-02-20T03:30:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "Light"
      },
      "sleep_event_time_frame": {
        "start_date_time": "2019-02-20T03:30:00Z",
        "end_date_time": "2019-02-20T03:45:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "REM"
      },
      "sleep_event_time_frame": {
        "start_date_time": "2019-02-20T03:45:00Z",
        "end_date_time": "2019-02-20T04:00:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "Awake"
      },
      "sleep_event_time_frame": {
        "start_date_time": "2019-02-20T04:00:00Z",
        "end_date_time": "2019-02-20T04:10:00Z"
      }
    },
    {
      "sleep_stage_state" : {
        "value": "Light"
      },
```

```
      "sleep_event_time_frame": {
            "start_date_time": "2019-02-20T04:10:00Z",
            "end_date_time": "2019-02-20T04:30:00Z"
      }
    },
    {
      "sleep_stage_state" : {
            "value": "REM"
      }
      "sleep_event_time_frame": {
            "start_date_time": "2019-02-20T04:30:00Z",
            "end_date_time": "2019-02-20T04:50:00Z"
      }
    }
  ],
  "is_main_sleep": true,
  "effective_time_frame": {
    "time_interval": {
          "start_date_time": "2019-02-19T22:30:00Z",
          "end_date_time": "2019-02-20T04:50:00Z"
    }
  }
}
{
  "sleep_stage_summary": [
      "total_sleep_time" {
            "value": 360,
            "unit": "min"
      },
      "total_sleep_efficiency_percentage": {
            "value": 86.8,
            "unit": "%"
      }
    "rem_sleep_duration": {
            "value": 60,
            "unit": "min"
    },
    "rem_sleep_percentage": {
            "value": 16.7,
            "unit": "%"
    },
```

```
    "light_sleep_duration": {
            "value": 180,
            "unit": "min"
        },
    "light_sleep_percentage": {
            "value": 50,
            "unit": "%"
        },
    "deep_sleep_duration": {
            "value": 90,
            "unit": "min"
        },
    "deep_sleep_percentage": {
            "value": 25,
            "unit": "%"
        },
    "awake_sleep_duration": {
            "value": 30,
            "unit": "min"
        },
    "awake_sleep_percentage": {
            "value": 8.3,
            "unit": "%"
        }
        "number_of_awakenings": 4,
    "descriptive_statistic": "average",
    "descriptive_statistic_denominator": "w"
  ],
  "effective_time_frame": {
    "time_interval": {
        "start_date_time": "2019-02-19T22:30:00Z",
        "end_date_time": "2019-02-26T22:30:00Z"
    }
  },
}
```

Review Comments on snore-index Schema (1)

1	Schema Line or Line Range	Comments	Date (comment)	Email Address of the person who made comments	Resolution	Date (resolution)
2	4 and 39	what is the definition of "a snore"? Does it mean a snoring sequence of a min duration or something else?	5-Dec-19	simona.carini@ucsf.edu		
3	13	see comment elsewhere about this schema	5-Dec-19	simona.carini@ucsf.edu		
4	47	the description does not match what the array is modeling	5-Dec-19	simona.carini@ucsf.edu		
5	69	please reference existing OmH value set body-posture	5-Dec-19	simona.carini@ucsf.edu		
6	56	this should be effective-time-frame	5-Dec-19	simona.carini@ucsf.edu		
7	66	not sure why this matters; also a snoring bout has a duration so what is the definition of the intensinty of it?	5-Dec-19	simona.carini@ucsf.edu		
8	53	if the array includes bouts of snoring, what it is the definition of this property and its reason for being defined?	5-Dec-19	simona.carini@ucsf.edu		
9	69	it is unclear how this property refers to the measure: body position changes during sleep and possibly during a snoring event	5-Dec-19	simona.carini@ucsf.edu		

Review Comments on snore-index Schema (2)

10	sample data: instance 2	It is not clear what this instance describes: there is an array of events which refer to one night but the index is a statistic defined as average weekly.	5-Dec-19	simona.carini@ucsf.edu		
11	sample data: instance 3	same comment as for instance 2 and also reference to questions above: this mean that the snoring intensity was exactly 90 dB for the full duration of the snoring event and the body position was supine	5-Dec-19	simona.carini@ucsf.edu		
12						

```
{
  "$schema": "http://json-schema.org/draft-07/schema#",
  "type": "object",
  "description": "This schema represents the snore index in a sleep session (main sleep or nap), i.e., the number of snores per hour. It can be used for a

  "definitions": {                single measurement, or for the result of aggregating measurements over time. However, the result of aggregating measurements
    "unit_value": {
      "$ref": "unit-value-1.x.json"                                                    would only be meaningful if they have the same type of sleep",
    },
    "duration_unit_value": {
      "$ref": "duration-unit-value-1.x.json"
    },
    "noise_unit_value": {
      "$ref": "noise-unit-value-1.x.json"
    },
    "time_frame": {
      "$ref": "time-frame-1.x.json"
    },
    "body_posture": {
      "$ref": "body-posture-1.x.json"
    },
    "descriptive_statistic": {
      "$ref": "descriptive-statistic-1.x.json"
    },
    "descriptive_statistic_denominator": {
      "$ref": "descriptive-statistic-denominator-1.x.json"
    }
  },
  "properties": {
    "snore_index": {
      "allOf": [
        {
          "$ref": "#/definitions/unit_value"
        },
```

```
35          {
36            "properties": {
37              "unit": {
38                "enum": [
39                  "snores/h"
40                ]
41              }
42            }
43          }
44        ]
45      },
46      "snore_events": {
47        "description": "An array of snore events to describe each snore bouts with its time interval, its intensity and corresponding majority body posture
48        "type": "array",
49        "items": [        during an entire sleep session (main or nap). The duration for each snore bout is the time interval between the snoring start time and the stop time.",
50          {
51            "type": "object",
52            "properties": {
53              "snored": {
54                "type": "boolean"
55              },
56              "snore_time_frame": {
57                "allOf": [
58                  {
59                    "$ref": "#/definitions/time_frame"
60                  },
61                  {
62                    "required": [ "time_interval" ]
63                  }
64                ]
65              },
66              "snore_intensity": {
67                "$ref": "#/definitions/noise_unit_value"
68              },
69              "body_posture": {
70                "description": "body position during sleep",
71                "allOf": [
72                  {
73                    "$ref": "#/definitions/body_posture"
74                  },
```

```
                {
                  "enum": [
                    "lying supine",
                    "lying prone",
                    "side lying"
                  ]
                }
              ]
            }
          },
          "required": [
            "snored",
            "snore_time_frame"
          ]
        }
      ]
    },
      "effective_time_frame": {
        "description": "Effective time frame is restricted to be a time interval. For an individual measurement, this is the interval of time between when
        "allOf": [
          {
            "$ref": "#/definitions/time_frame"
          },
          {
            "required": [ "time_interval" ]
          }
        ]
      },
      "is_main_sleep": {
        "type": "boolean"
      },
      "descriptive_statistic": {
        "$ref": "#/definitions/descriptive_statistic"
      },
      "descriptive_statistic_denominator": {
        "anyOf": [
          {
            "$ref": "#/definitions/descriptive_statistic_denominator"
          },
```

```
                {
                  "description": "If the value needed is a standard unit of duration, select from the duration-unit-value value set.",
                  "type": "string"
                }
              ]
            }
        },
        "required": [
          "snore_index",
          "effective_time_frame"
        ]
    }

```

```
=====================================================================
snore index sample data: instance #1
=====================================================================
{
  "snore_index": {
        "value": 7,
        "unit": "snores/h"
    },
  "effective_time_frame": {
     "time_interval": {
        "start_date_time": "2019-02-05T22:00:00Z",
        "end_date_time": "2019-02-06T06:00:00Z"
     }
  },
  "is_main_sleep": true
}
=====================================================================
snore index sample data: instance #2
=====================================================================
{
  "snore_index": {
        "value": 0.17,
        "unit": "snores/h"
    },
  "snore_events": [
     {
        "snored": {
           "value": false
        },
        "snore_time_frame": {
           "start_date_time": "2019-02-05T22:00:00Z",
           "end_date_time": "2019-02-05T022:15:00Z"
        }
     },
     {
        "snored": {
           "value": true
        },
        "snore_time_frame": {
           "start_date_time": "2019-02-05T22:16:00Z",
           "end_date_time": "2019-02-05T022:26:00Z"
        }
     },
```

```
    {
        "snored": {
            "value": false
        },
        "snore_time_frame": {
            "start_date_time": "2019-02-05T22:27:00Z",
            "end_date_time": "2019-02-06T006:00:00Z"
        }
    }
  ],
  "effective_time_frame": {
    "time_interval": {
        "start_date_time": "2019-02-05T22:00:00Z",
        "end_date_time": "2019-02-06T06:00:00Z"
    }
  },
  "is_main_sleep": true,
  "descriptive_statistic": "average",
  "descriptive_statistic_denominator": "w"
}
=====================================================================
snore index sample data: instance #3
=====================================================================
{
  "snore_index": {
        "value": 0.17,
        "unit": "snores/h"
  },
  "snore_events": [
    {
        "snored": {
            "value": false
        },
        "snore_time_frame": {
            "start_date_time": "2019-02-05T22:00:00Z",
            "end_date_time": "2019-02-05T022:15:00Z"
        }
    },
```

```
    {
      "snored": {
        "value": true
      },
      "snore_time_frame": {
        "start_date_time": "2019-02-05T22:16:00Z",
        "end_date_time": "2019-02-05T022:26:00Z"
      },
    },
    {
      "snore_intensity": {
        "value": 90,
        "unit": "dB"
      }
    },
    {
      "body_posture": {
        "value": "lying supine"
      }
    }
  },
  {
    "snored": {
      "value": false
    },
    "snore_time_frame": {
      "start_date_time": "2019-02-05T22:27:00Z",
      "end_date_time": "2019-02-06T006:00:00Z"
    }
  }
 ],
 "effective_time_frame": {
   "time_interval": {
     "start_date_time": "2019-02-05T22:00:00Z",
     "end_date_time": "2019-02-06T06:00:00Z"
   }
 },
 "is_main_sleep": true,
 "descriptive_statistic": "average",
 "descriptive_statistic_denominator": "w"
}
```

Review Comments on wake-after-sleep-onset Schema (1)

1	Schema Line or Line Range	Comments	Date (comment)	Email Address of the person who made comments	Resolution	Date (resolution)
2	4	suggested wording: "This schema represents the summary duration of all awakenings after sleep onset in a main sleep session."	9-Dec-19	simona.carini@ucsf.edu		
3	4	suggest to add also the definition of awakening (i.e., minimum duration)	9-Dec-19	simona.carini@ucsf.edu		
4	24	recommend choosing a standard way of referring to episodes and using it throughout (right now we have: bout, episode, event in various schemas)	9-Dec-19	simona.carini@ucsf.edu		
5	31	there is no need to name the individual elements of the array	9-Dec-19	simona.carini@ucsf.edu		
6	41	this is not accurate: For an individual measurement, this is the accumulated interval of awaken time after a person's sleep onset.	9-Dec-19	simona.carini@ucsf.edu		
7	41	Thisn seems to me to apply to the schema description: This WASO time accumulation ends when the person stops trying to fall asleep again (i.e. some time after final awakening may be part of WASO if the person continues to try to go sleep).	9-Dec-19	simona.carini@ucsf.edu		

Review Comments on wake-after-sleep-onset Schema (2)

8	38 and others	this may be an artifact of my text editor but I see several properties where the : and then the opening { are each on a different line: both should follow the property name on the same line, e.g., "effective_time_frame": {	9-Dec-19	simona.carini@ucsf.edu		
9	51 and 56	add description as per recent discussion	9-Dec-19	simona.carini@ucsf.edu		
10	sample data: instance #1	update array as per comment above	9-Dec-19	simona.carini@ucsf.edu		
11	sample data	add one instance showing only the required properties	9-Dec-19	simona.carini@ucsf.edu		
12	sample data: instance #2 line 5	see comment in other schemas: I believe you mean average daily	9-Dec-19	simona.carini@ucsf.edu		
13						
14						

```
{
  "$schema": "http://json-schema.org/draft-07/schema#",
  "type": "object",
  "description": "This schema represents the measurement of accumulated wake up duration after sleep onset in a main sleep session.",

  "definitions": {
    "duration_unit_value": {
      "$ref": "duration-unit-value-1.x.json"
    },
    "time_frame": {
      "$ref": "time-frame-1.x.json"
    },
    "descriptive_statistic": {
      "$ref": "descriptive-statistic-1.x.json"
    },
    "descriptive_statistic_denominator": {
      "$ref": "descriptive-statistic-denominator-1.x.json"
    }
  },
  "properties": {
    "wake_after_sleep_onset": {
      "$ref": "#/definitions/duration_unit_value"
    },
    "wake_bout_durations": {
      "description": "An array of awakening bout durations contains the duration of each awakening bout after sleep onset in an entire sleep session.",
      "type": "array",
      "items": [
        {
          "type": "object",
          "properties": {
            "wake_bout_duration": {
              "$ref": "#/definitions/duration_unit_value"
            }
          }
        }
      ]
    },
```

```
    "effective_time_frame"
    :
    {
      "description": "As a measure of a duration, wake after sleep onset should not be associated to a date time time frame. Hence, effective time frame is
      "allOf": [
        {                                    restricted to be a time interval. For an individual measurement, this is the accumulated interval of
          "$ref": "#/definitions/time_frame"
        },                                   awaken time after a person's sleep onset. This WASO time accumation ends when the person stops trying
        {
          "required": [ "time_interval" ]    to fall asleep again (i.e. some time after final awakeining may be part of WASO if the person continues to try to sleep).
        }
      ]                                  For a summary measurement, this is the interval of time between the beginning of the first measurement and the end of the last measurement.'
    },
    "descriptive_statistic"
    :
    {
      "$ref": "#/definitions/descriptive_statistic"
    },
    "descriptive_statistic_denominator"
    :
    {
      "anyOf": [
        {
          "$ref": "#/definitions/descriptive_statistic_denominator"
        },
        {
          "description": "If the value needed is a standard unit of duration, select from the duration-unit-value value set.",
          "type": "string"
        }
      ]
    }
  },

  "required": [
    "wake_after_sleep_onset",
    "effective_time_frame"
  ]
}
```

```
=====================================================================
wake after sleep onset sample data: instance #1
=====================================================================
{
  "wake_after_sleep_onset": {
      "value": 35,
      "unit": "min"
  },
  "wake_bout_durations": [
      {
          "wake_bout_duration": {
              "value": 15,
              "unit": "min"
          }
      },
      {
          "wake_bout_duration": {
              "value": 12,
              "unit": "min"
          }
      },
      {
          "wake_bout_duration" {
              "value": 8,
              "unit": "min"
          }
      }
  ],
  "effective_time_frame": {
      "time_interval": {
          "start_date_time": "2019-02-05T22:00:00Z",
          "end_date_time": "2019-02-06T06:00:00Z"
      }
  }
}
```

```
=====================================================================
wake after sleep onset sample data: instance #2
=====================================================================
{
  "wake_after_sleep_onset": {
      "value": 31,
      "unit": "min"
    },
  "effective_time_frame": {
      "time_interval": {
          "start_date_time": "2019-02-05T22:00:00Z",
          "end_date_time": "2019-02-11T06:00:00Z"
      }
    },
  "descriptive_statistic": "average",
  "descriptive_statistic_denominator": "w"
}
```

Next Steps

- Prepare the revised version of 1st batch schemas for WG to review
- Prepare the revised version of 2nd batch schemas for WG to review
- Get ready to distribute generic survey documents and schemas by TBD

Action Items

- Address the WG comments on 1st batch schemas by Jan 20 (Distribute on TBD)
- Address the main WG comments on 2nd batch schemas by Feb 21 (Distribute on TBD)

Future Meetings

- Continue with Tuesdays at 8:00 AM Pacific / 11:00 AM Eastern
- Upcoming meetings
  - Feb 4, 2020

Adjournment