CCSDS Service Management + DDOR Standards

Proposed Approach re Coordination for Standards Development re SEA DOR and CSS CSSM WGs

22 August 2022

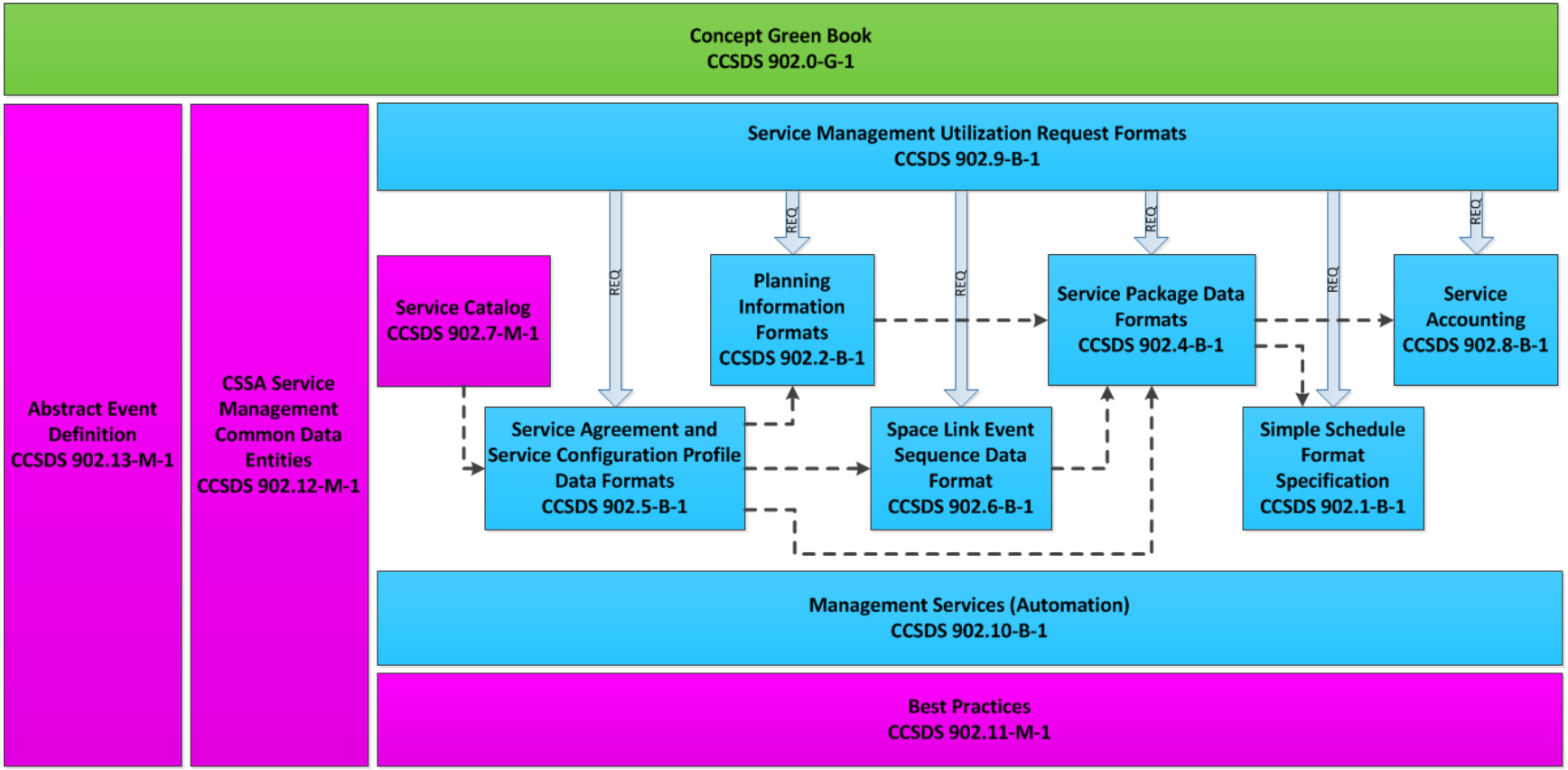
Background/Intro (1/1)

- SE Area DOR WG (SEA-D-DOR) has produced and is producing standards for coordinating and processing inter-agency Differenced Doppler One-Way Ranging (DDOR) measurements
- CSS Area CSSM WG (CSS-SM) has produced and is producing standards for inter-agency cross support service management including, but not limited to service package request, service package definition, event sequence, and configuration profile
- Common to both these efforts is the need for specifying a scan pattern for performing a DDOR measurement
- For the CSS-SM standards, for the service management messages involved, there is a commonly defined service management header
- The CSS-SM service management header as well as the service package request, configuration profile, and event sequence overlaps some of the information found in the SEA-D-DOR definition for the scan pattern
- The overlapping set of concerns have to do with
  - Spacecraft DDOR Tones in SEA-D-DOR, Configuration Profile in CSS-SM
  - Spacecraft DOR Tones on/off time in SEA-D-DOR, Event Sequence in CSS-SM
  - Ground Observation definition/scan pattern in SEA-D-DOR, Service Request and Service Package in CSS-SM
- This is not surprising as SEA-D-DOR standards need to operate in an environment (such as we currently have) where standardized CSS-SM service management is only partially adopted and still in development
- At the same time, it would be good for agencies that do adopt the CSS-SM standards to be able to incorporate SEA-D-DOR such that there are a consistent set of standards that address both service management and DDOR

Background/Intro (2/2)

- J. Border, when he was chair of the SEA-D-DOR , did some work with the CSS-SM and jointly we developed a scan pattern definition that more-or-less works
  - At least from the CSS-SM perspective
- Following is
  - Reference information re CSSM program of work
  - Current 506.0-M-2 DDOR Ground Observation Sequence definition
  - XML DDOR Scan Pattern definition developed jointly with Jim Border
  - Proposed approach for development and coordinate with regard to expressing a standardized DDOR scan pattern that can be used both within and outside the context of standardized service management

CSSM Program of Work Overivew



506.0-M-2 DDOR Grnd Obs Seq w CSSM Cmts (1/4)

Item Name	Item Description	Format	Units/Precision/Range
	The first four items are the header		
RequestId	Issue date (ID) of the event sequence	YYYY-DDD **T**HH:MM:SS	UTC year, day of the year, hour/minute/second, precision=1 s, Time format as per reference [6], ASCII time code B
FormatVersion	File format version	Integer	Positive integer Current version is 1
orginatingOrganization	Originating Organization	ASCII	From 'Name' field in the CCSDS Organizations registry (reference [11])
MissionId	Name of spacecraft requesting the service	ASCII	From 'Spacecraft Abbreviation' field of the CCSDS Spacecraft Identifiers registry (reference [9])

- ***In CSSM context, this is all addressed via a common service management header***
- ***SMURF (Service Management Utilization Request Format) 902.9 is where service request is defined***
  - ***Including DDOR scan pattern***

506.0-M-2 DDOR Grnd Obs Seq w CSSM Cmts (2/4)

Item Name	Item Description	Format	Units/Precision/Range
This is the start of the event sequence for a session. All items below repeat as a group for each session.			
ddorConfigPro fileId	DDOR Configuration Profile (ID) to be used	ASCII	ID of an existing DDOR Configuration Profile
The following four items are referred to as the Spacecraft Table. They repeat for each spacecraft to be observed.			
ScIndex	Internal index to this spacecraft	4 ASCII characters	SC01, SC02, …
ScId	Spacecraft name	ASCII	From 'Spacecraft Abbreviation' field of the CCSDS Spacecraft Identifiers registry (reference [9])
DorOn	Start time for reception of spacecraft DOR tones	YYYY-DDD THH:MM:SS	UTC year, day of the year, hour/minute/second, precision=1 s; Time format as per reference [6], ASCII time code B
DorOff	End time for reception of spacecraft DOR tones	YYYY-DDD THH:MM:SS	UTC year, day of the year, hour/minute/second, precision=1 s Time format as per reference [6], ASCII time code B

- ***Spacecraft DOR Tones (ddorConfigProfileId) will be part of the configuration profile definition***
  - ***But quasar flux, etc. will not be part of the CSSM configuration profile definition***
- ***DorOn/DorOff times addressed by Event Sequence – 902.6***
- ***Multi-spacecraft scan patterns do not currently fit will within CSSM – more work required***

506.0-M-2 DDOR Grnd Obs Seq w CSSM Cmts (3/4)

Item Name	Item Description	Format	Units/Precision/Range
The following three items are referred to as the Quasar Table. They repeat for each quasar to be observed.			
QuIndex	Internal index to this quasar	4 ASCII characters	QU01, QU02, …
QuId	Quasar name	ASCII	From 'Name' field of the CCSDS quasar registry [5]
QuFlux	Received flux density of quasar	Decimal notation	Jy
The following three items are referred to as the Station Table. They repeat for each tracking station.			
TrkStnId	Station ID, given as <site name>-<aperture name>	ASCII	From 'Site Name Abbreviation' field and 'Aperture Name Abbreviation' field of the CCSDS Service Sites and Apertures registry (reference [8])
TrackStart	DDOR Session start time	YYYY-DDD **T**HH:MM:SS	UTC year, day of the year, hour/minute/second, precision=1 s Time format as per reference [6], ASCII time code B
TrackEnd	DDOR Session end time	YYYY-DDD **T**HH:MM:SS	UTC year, day of the year, hour/minute/second, precision=1 s Time format as per reference [6], ASCII time code B
DdorEpoch	Begin time for DDOR recording activity	YYYY-DDD **T**HH:MM:SS	UTC year, day of the year, hour/minute/second, precision=1 s Time format as per reference [6], ASCII time code B

Don't anticipate CSSM to ever address Quasar Table

CSSM addresses this either in SPDF (Service Package Data Format) - 902.5 or Event Sequence – 902.6

506.0-M-2 DDOR Grnd Obs Seq w CSSM Cmts (4/4)

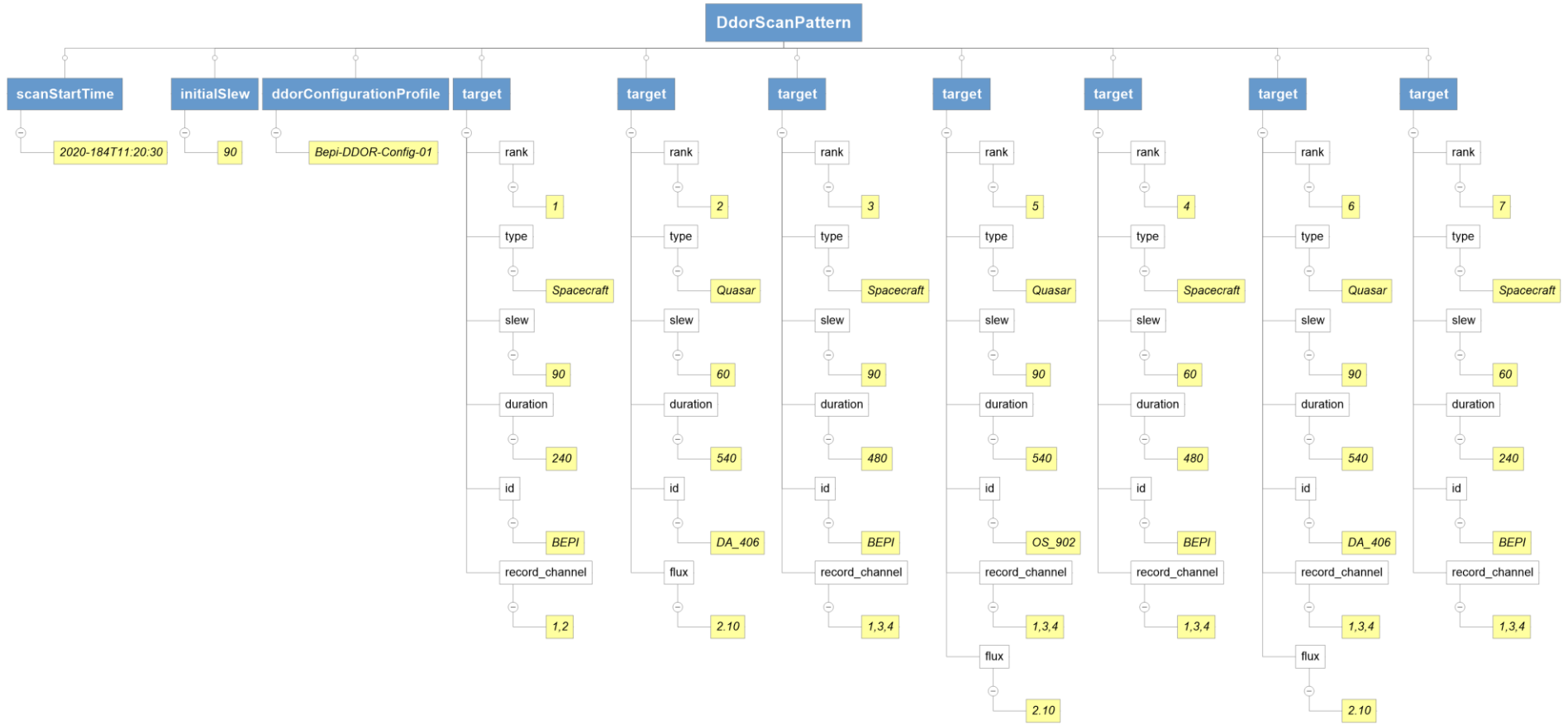
Item Name	Item Description	Format	Units/Precision/Range
The following four items are referred to as the Scan Table. They repeat for each source to be observed.			
ScanNum	Scan number	Integer	Positive integer, consecutive starting with 1
ScanSource	Internal index to this source	4 ASCII characters	From either QuIndex list in the Quasar Table or ScIndex list in the Spacecraft Table
ScanStart	Scan start time	HH:MM:SS	hour/minute/second, time past DDOR Epoch
Duration	Scan duration	HH:MM:SS	hour/minute/second

- **Good work has been done on this, working with previous DDOR WG Chair (Jim Border)**
- **Following Slides show this work**

SEA-D-DOR WG Scan Pattern Definition (Taken from 506X0P3_18nov2020 – XML Text)

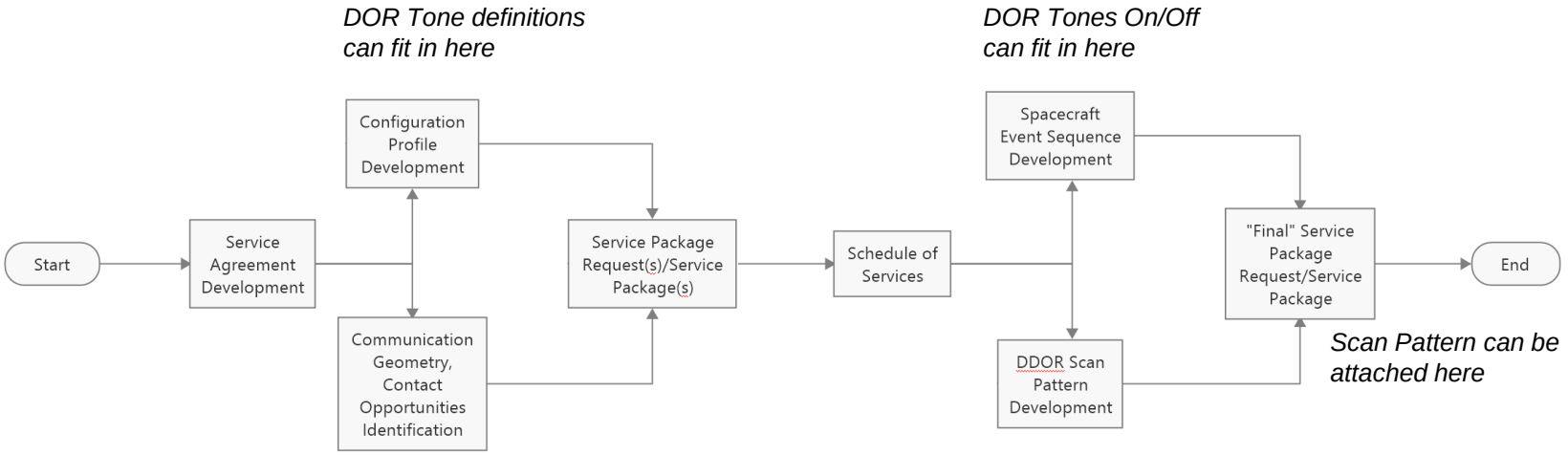
```xml
<?xml version="1.0" encoding="UTF-8"?>
<ddorScanPattern>
   <!-- service indication, configuration name, etc are removed from this version of the proposal as these will be addressed by higher layers of the SMURF -->
   <!-- Also, it's not quite clear yet that there would be fixed scan patterns called out by identification; this would imply that we would have to start tracking and managing these various configuration profiles in their own right -->
   <!-- The spacecraft_configuration can be used to convey information relevant for the station configuration on a per DL basis (if needed)-->
   <!-- Note that there is an assumption here that the configuration profile will have named carrier profiles, such that they can be called out as part of the SMURF in general; -->
      <!-- this will identify the exact carrier (and therefore band);  I am including the reference  in here to make sure we track consideration -->
   <!-- Number of DDOR scans to be executed does not need to be stated as the rank sttributes in the target elements already provide this  -->
   <!-- Note:  the receiver configuration for multi-spacecraft DDOR needs to be coordinated.  Signal components for all spacecraft must be defined in one ddorConfigurationProfile. -->

   <!-- Scan pattern for DDOR recording activity -->
   <!-- "scanStartTime" is the absolute start time of the DDOR activity within a scheduled tracking pass -->
   <!-- "initialSlew" is the slew time (sec) allocated to slew to the first target beginning at scanStartTime -->
   <!-- "ddorConfigurationProfile" is the name of the DDOR Configuration Profile to be used, defining downlink signal components and receiver configuation for all spacecraft -->
   <!-- each "target" has the following attributes: a rank defining the execution order of the scan, type, slew, duration, id, carrierRef (spacecraft only), flux (quasar only, optional)-->
   <!--   "rank" defining the execution order of the scan -->
   <!--   "type" indicates whether the target is a spacecraft or a quasar -->
   <!--   "duration" duration of the scan in seconds -->
   <!--   "id" Identifer of the target (note we would perhaps have to have some reference to a Sana quasar catalog to get the IDs for quasars) -->
   <!--   "flux" quasar flux [Jy, optional, but can be stated only for targets of type Quasar] -->
   <!--   "slew" amount of slew time following the scan in seconds -->
   <!--   "record_channel" list of channels defined in ddorConfigurationProfile to record for this scan [optional, default is all channels] -->

   <!-- Note: The Network Schedule must indicate pass start/stop times, tracking stations to be used, and the DDOR Scan Pattern to be used. -->

   <scanStartTime>2020-184T11:20:30</scanStartTime>
   <initialSlew>90</initialSlew>
   <ddorConfigurationProfile>Bepi-DDOR-Config-01</ddorConfigurationProfile>
   <target rank="1" type="Spacecraft" slew="90" duration="240" id="BEPI"   record_channel="1,2" />
   <target rank="2" type="Quasar"     slew="60" duration="540" id="DA_406" flux="2.10"/>
   <target rank="3" type="Spacecraft" slew="90" duration="480" id="BEPI"   record_channel="1,3,4" />
   <target rank="5" type="Quasar"     slew="90" duration="540" id="OS_902" record_channel="1,3,4" flux="2.10"/>
   <target rank="4" type="Spacecraft" slew="60" duration="480" id="BEPI"   record_channel="1,3,4" />
   <target rank="6" type="Quasar"     slew="90" duration="540" id="DA_406" record_channel="1,3,4" flux="2.10"/>
   <target rank="7" type="Spacecraft" slew="60" duration="240" id="BEPI"   record_channel="1,3,4" />

</ddorScanPattern>
```

SEA-D-DOR WG Scan Pattern Definition (Taken from 506X0P3_18nov2020 – Graphical Version)



CSS-SM Envisioned Process and DDOR Fit

- **General process envisioned and mapping from DDOR considerations in a standardized service management context (process is notional, not exact)**



Proposed approach, from CSS-SM WG perspective

- Spacecraft DOR Tone Definitions:
  - The CSS Area in general has developed the Functional Resource Model (FRM) – a standardized model of all the functions, in the abstract, that a ground station needs to provide along with configuration, monitoring and control parameters (for each function)
    - This leads to standardized monitor data item definitions as well as standardized configuration parameter definitions
  - Proposed approach is to
    - include the DOR Tone definitions in the FRM, which means it will, in turn, be part of the CSS-SM defined configuration profile (i.e., CCSDS 902.5, in development)
    - Request the SEA-D-DOR WG to review the DOR Tone definitions in the FRM
- Spacecraft DOR Tone On/Off Times:
  - The CSS Area has a draft of recommendation for sequencing of space link services in progress (CCSDS 902.6)
    - As this addresses the entire set of space link service sequencing (e.g., command (uplink) telemetry modulation (downlink), ranging tone modulation (uplink and downlink), DDOR tones (downlink)), it is proposed that information in the event sequence would ultimately take precedence over DOR tone on/off times defined in information conveyed outside the context of service management, where service management is implemented
- Ground observation, Scan Pattern:
  - In general, CSSM WG prefers that DDOR WG develop the definitions needed for DDOR
    - But can this be done in XML ?
      - Seem to have a good start with work done with Jim Border
- In general: understood that DDOR standards have to be useable where standardized service management does not exists or its implementation is not sufficiently complete
- But also foresee that CSSM WG standards will be adopted and therefore CSSM WG proposes to take the approach of indicating what parts of DDOR standards might be ignored or “overridden” in a CSSM context
    - E.g., if the CSSM event sequence indicates indicates DDOR tones on at time A, propose to indicate that a scan pattern definition indicating time other than time A will be ignored
    - This would be done via adding NOTEs in the CSSM recommendations as appropriate
    - The NOTEs will be collected and distributed to the DDOR WG for consideration/review as needed