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LB4-Section 6 Revised Structure

1. Sensor Manager Operational System Requirements

The SM is primarily responsible for forming the sensor network consisting of one or more associated SDs, for exchanging information about the capabilities and status of the sensor network to the SCOS Client, and for sensing task management.

The Sensing Manager’s Control Service shall operate database services for:

* + Sensor Devices database: store data as to each associated SD’s state, authentication data and capabilities
  + SCOS Resources database: store data describing aggregated capabilities across all associated SDs, and the state and nature of scheduled tasks that have been requested of SDs and their status (accepted, pending, rejected)
  + SCOS Users database: data store of user credentials, user role, SCOS role profiles and the relevant CRUD permissions

The following services interact with these databases to provide application interfaces:

* **SCOS Client Control Service:** Provides access for SCOS Clients to access a set of sensing functions provided by the SCOS System.
  + SCOS Client Authentication Service: Provides for the authentication of SCOS Clients to allow them to send resource queries, task requests and task status requests, stored in SCOS Users database.
  + SCOS Resources Management: SM maintains the sensing resource information from sensors obtained during the SD/SM association message exchange and stored in its Sensor Devices database. The sensor information is identified in Annex B.
  + Sensing Task Management: Task management function maintains information in the SCOS Resources database itemizing available SCOS resources across the SCOS System, and the to-be-scheduled, scheduled, and on-going tasks. The information about task scheduling requests is is synchronized with the SDs.
* **SD Control Service:** the service that manages instructions from the SM to SDs, including the transfer of scheduling requests and acceptance status by the SD.
  + SD Authentication and Registration API: Manages the association of devices, querying of capabilities
  + Task Status API: The SM communicates with the SDs using the Task Status API to query the status of the SDs and any tasks they have scheduled, and provides for the SD to send notification to the SM upon task completion or task error events.
  + SD Tasking API: The SM communicates with SDs using the SD Tasking API, receives the sensor capabilities, and provides a spectrum scan schedule to the sensors along with necessary information for sending sensing data to the DM.
* **SM Data Distribution Service:**
  + This service transmits data to the appropriate end point specified by the SCOS Client. It receives completed scan data packages (sensor data and metadata) from the SDs on a listener service, and retransmits to the appropriate SCOS Client(s) as defined in the Client task request.
* **SM Administration Service:** system management functions to ensure security and management of the SCOS System. These are not defined in this standard as they are considered implementation specific.
  + Policy enforcement: A key part of SCOS administration is enforcing policies for spectrum sensing. The SM ensures that the SCOS Client issuing a scan request is authorized to perform the requested scan, the scanning parameters comply with the regulatory policy for the location, frequency, time, and resolution.
  + User authentication and user profile management: allows for permissions to be assigned to users defined by their Role to access Control and Administrative functions.
  + System administration functions such as software changes. These are out of scope for this standard as they are implementation specific.
  1. Sensor Manager System Requirements: SCOS Control Service
     1. SCOS Client Authentication Service
        1. SCOS Client Authentication Service: Function

The SCOS Client authenticates with an SM through a username password and/or certificate exchange, where the SCOS Owner pre-configures the SM with authorized users. The authorization is valid for a particular session, the length of which is determined by the SCOS Owner according to their policies. Authentication must take place over a secure mechanism such as TLS with no credientials exchanged in plaintext.

* + - 1. SCOS Client Authentication Service: Interfaces

Table 11 describes the SCOSClientAuthenticateRequest JSON object.

Table 11 – SCOS Client Authenticate Request Object Definition

|  |  |  |
| --- | --- | --- |
| Parameter | R/O/C | Description |
| NAME: SCOSClientName DATA TYPE: String | Required | The name of the SCOS User registered with SCOS operator.  The maximum length is 64 octets. |
| NAME: SCOSClientPassword DATA TYPE: String | Required | The hashed password of the SCOS User registered with SCOS operator.  The maximum length is 64 octets. |
| NAME: SCOSOperator DATA TYPE: String | Required | The name of the SCOS operator.  The maximum length is 64 octets. |
| NAME: SDCertFile  DATA TYPE: String | Conditional | The path of the SD certificate file.  The maximum length of the ID string is 256 octets. |
| NAME: SDKeyFile  DATA TYPE: String | Conditional | The name of the SD certificate file.  The maximum length of the ID string is 256 octets. |
| NAME: SDCAFile  DATA TYPE: String | Conditional | The name of the trusted certificate authority.  The maximum length of the ID string is 256 octets. |

Table 12 describes the SCOSClientAuthenticateResponse JSON object.

Table 12 – SCOS Client Authenticate Response Object Definition

|  |  |  |
| --- | --- | --- |
| Parameter | R/O/C | Description |
| NAME: SMID DATA TYPE: string | Required | The unique ID assigned to the sensor manager. The maximum length is 64 octets. |
| NAME: SCOSClientID DATA TYPE: string | Required | The unique ID assigned to the SCOS Cient, permanent and unique (or as per SCOS Operator policy). The maximum length is 64 octets. |
| NAME: authenticateResponseCode DATA TYPE: string | Required | Association request response  - OK (association granted)  - Refused\_unknownuser (SM does not recognize username/password)  - Refused\_invalidcert (SM does not accept certificate)  - Refused\_unknown (unknown error) |
| NAME: authenticateTTL DATA TYPE: Integer | Optional | The time to live of the session in seconds |

* + 1. SCOS Resource Management
       1. SCOS Resource Discovery: Function

Allows capabilities of associated SDs to be queried and exposed to SCOS Clients (depending on any role-based permission policy) via the SMs SCOS Resources database. Capabilities advertised by SDs include what types of measurements they can do, what bands can be measured and associated measurement facilities (such calibration, antenna control, mobility, storage, processing) that can be specified and controlled and over what locations. This discovery function is per-session, and the data sent to the SCOS Client is only valid at the time of transmission. The SCOS Client must resend discovery requests as often as needed to ensure it has current information.

* + - 1. SCOS Resource Discovery: Interfaces

The SCOS Client transmits an SMCapabilityRequest message, to which the SM replies with the smCapabilityResponse message containing all the sdCapability objects that it holds for all associated SMs detailing their available resources at time of most recent association.

Table 13 describes the SCOSDiscoveryRequest object.

Table 13 – SCOS Discovery Query Message Object

|  |  |  |
| --- | --- | --- |
| Parameter | R/O/C | Description |
| NAME: SCOSClientID DATA TYPE: string | Required | The unique ID assigned to the SCOS Client during authorization. The maximum length is 64 octets. |
| NAME: SMID  DATA TYPE: String | Required | Unique ID for the Sensing Manager.  The maximum length of the ID string is 64 octets. |
| NAME: resourceQuery DATA TYPE: String | Required | Type of Resource Query  - All (SM to return all known SD resources)  - Range [comma-separated list and/or dash-separated range of SDIDs] (to query resources on range of SDs |

The SM returns an sdCapabilityResponse for each specified SDID as per Table 5 - SD Capability Response Object Definition.

* + 1. Sensing Task Management
       1. Sensing Task State Request: Function

Allows the SCOS Client to query the state of any associated SD or the state of tasks currently being performed for that SCOS Client (a SCOS Client may only query status of tasks it did not task if it is a User/Role permitted to do so in the SCOS Owner policy defined on the SM).

* + - 1. Sensing Task Management: Interfaces

The objects used for a task status query is the sxScanTaskQuery (Table 8) from the SCOSClient to the SM, which in turn transmits to the relevant SD if the permissions policy allows). The object returned by the SD to the SM and back to the SCOS Client is the sxScanTaskCompletionStatus object (Table 9).

Note that the sxScanTaskQuery only identifies a TaskID, a unique identifier of a task. A SCOS Client would need to know the TaskID to query the status of a particular scan. The SM holds the database of current scan tasks, and would map the TaskID to the relevant SDID performing that task, and direct the sxScanTaskQuery to the relevant SD.

* 1. Sensor Manager System Requirements: SD Control Service
     1. SD Authentication and Registration
        1. SD Authentication and Registration: Functions

Allow SDs to attach to the SM, be authenticated and made an active node in the SCOS system. These procedures define the association and authentication process for an SD and SM entity to connect and communicate. They include facilities to prevent spoofing based on shared key exchange. Once an SD is authenticated and registered to a SM, the SM can then discover the capabilities of the SD. A SM will have associated with it at least one SD. The SM may then assign appropriate sensing tasks to the appropriate set of SDs in order to fulfil the sensing request of the SCOS Client.

* + - 1. SD Authentication and Registration: Interfaces

The SD will initiate the association via the sdAssociateRequest object, whereupon the SM Control Service will perform authentication and registration in its Sensor Devices database of SD resources. The SM will signal to the SD that it is successfully associated via the sdAssociateResponse, whereupon the SD will publish its capabilities back to the SM via the sdCapabilityResponse message. The SM will then insert these capabilities in its Sensor Devices database as per the SCOS Discovery service below.

The SM will store the sdAssociation Object(s) returned by the SDs as part of the association process for security and audit purposes, as required by any SCOS Operator policy in force.

If the SM is required to disconnect its associated SDs, it will transmit a disassociation message sxDissasociationRequest (e.g. if it is rebooting or about to go into an offline mode).

* + 1. SD Status Query
       1. SD Status Query: Functions

Allows SD current tasks and state to be queried and exposed to SCOS Clients (depending on any role-based permission policy), and maintains association with the SM. A Status Query can be transmitted as a heartbeat periodically to indicate an SD is still associated with the SM (depending on Mode).

* + - 1. SD Status Query: Interfaces

The objects used for a task status query is the sxScanTaskQuery (Table 8) from the SM to the SD. The trigger for the query can be when there is a scheduled task refresh procedure by the SM, or it can be triggered by a task status query from the SCOS Client, which sends the SM a sxScanTaskStatusQuery obect, which in turn transmits to the relevant SD if the permissions policy allows). The object returned by the SD to the SM (potentially for on-transmission to a requesting SCOS Client) is the sxScanTaskCompletionStatus object (Table 9).

The SM would map the TaskID specified in the sxScanTaskQuery to the appropriate SDID that is performing that task in its SCOS Resources database, to send the query to the correct SD.

* + 1. SD Tasking Service
       1. SD Tasking Service: Functions

The Task Request message originating from the SM is sent to the appropriate SDs for execution as a scan schedule. It includes the parameters of the desired spectrum measurement to be made based on knowledge of the SD’s capabilities. This request will include the time to make the measurement, the repetition rate (if applicable), the locations, etc. and the format of the measured data. In the case of a single, once-off scan, the schedule will indicate no repetition.

* + - 1. SD Tasking Service: Interfaces

The SM sends a scan task to the SD in the form of a Sensing Task Object (Table 17), enclosed in a Sensing Task Insert message sxScanTaskInsert (Table 6). The SD shall respond with a Sensing Task Insert Message Response sxScanTaskInsertResponse (Table 6) which indicates if the task is accepted or not. If accepted, the SM will update its internal task scheduler (Sensor Devices database) of current tasks per assocatied SD. If not accepted, the SM will return the appropriate error code to the SCOS Client in the smScanTaskInsertResponse (Table 7).

* 1. Sensor Manager System Requirements: SM Data Distribution Service
     1. Sensing Manager Data Distribution Service: Functions

SCOS Data Distribution Service: manages the transfer of sensor data northbound to the eventual SCOS Client consuming the data.

* Sensing Data Management: The SDs send spectrum measurements as requested by the scheduled scan with Annex B.3.27.2 describing the sensing data, environmental data including location, humidity and temperature, and operating data of the sensing system, all enclosed within the sensingDataObject (Table 21). The sensing data is identified by ScanTaskId, SDID, SCOSClientID (of the client requesting the task) and timestamp.
* Policy enforcement: A key part of SCOS administration is enforcing policies on the sensing data. The Data Distribution Service ensures that the destination Data Consumer(s) specified are authorized to receive the data. The length of time the SM may store the data locally is determined by any policy of the SCOS Operator in force.
* Data validation and consolidation (informative): The Data Distribution Service can validate the data received from the SDs against the specified details from the task such as location, frequency, time, and measured data format. It can also consolidates data based on scanning task requirements.
  + 1. Sensing Manager Data Distribution Service: Interfaces

The following are the key communication interfaces for the Data Dsitribution Service:

* SD Data Distribution Service listener: receives northbound data transfers coming from each associated SD’s Data Distribution Service into the SM.
* SM Data Distribution Service sender interface: The interface between the Data Distribution Service of an SM and the Data Consumer endpoint is asynchronous, using any accepted standard transport mechanisms, as specified in Annex D.9: Transport Mechanism Requirements.

The Data Distribution services sends the data as per the sxPublishSensingData JSON object described in Table 10 from the SM to the Data Consumer.