Contribution To IEEE 802.22.3

From

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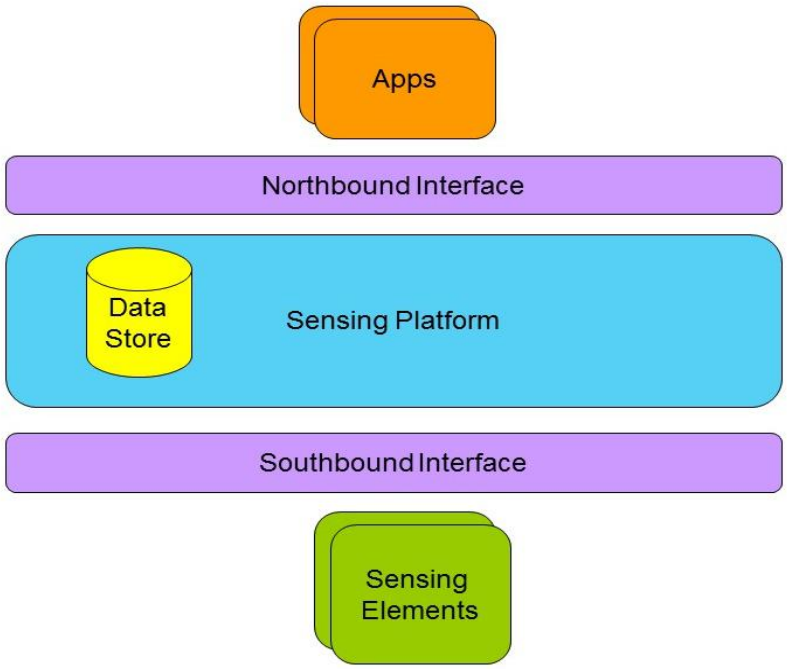
Spectrum Sensing Platform

A.1 Block Diagram



The above block diagram shows spectrum sensing platform that provides spectrum sensing service for various potential applications. . The sensing platform defines two interfaces: (A) South-bound interface to the sensing elements or spectrum sensing device (SSD) (B) North-bound interface to the 'Apps' using the services provided by the sensing platform.
Multiple Spectrum Sensing Apps (SSA) can potentially use the Spectrum Sensing Platform (SSP) for multiple different purposes.

A.2 Spectrum sensing API

The spectrum sensing platform provides spectrum sensing as a service using Spectrum sensing API. This is the northbound interface from the block diagram.
We identify following four types of API

1. Registration
2. Configuration
3. Query
4. Coordination

With the Registration API, an SSA can enable/disable usage of the API. Configuration API enables an SSA to configure the SSP for desired purpose. Using Query API, an SSA can request real-time data or past data. (*Inference regarding secondary spectrum-access is purposefully excluded from the SSP API. For example, Is it safe to transmit? This spectrum-access inference logic is considered to be in the apps that are using the spectrum-sensing platform*.)

The coordination API is optional. It can be used in circumstances wherein the Apps wants to provide information about secondary spectrum-access. For example, an SSA may use the real-time sensing data and infer feasibility of secondary spectrum-access. This SSA would grant spectrum-access parameters to secondary user radios and use the coordination API to notify the secondary spectrum access to SSP.

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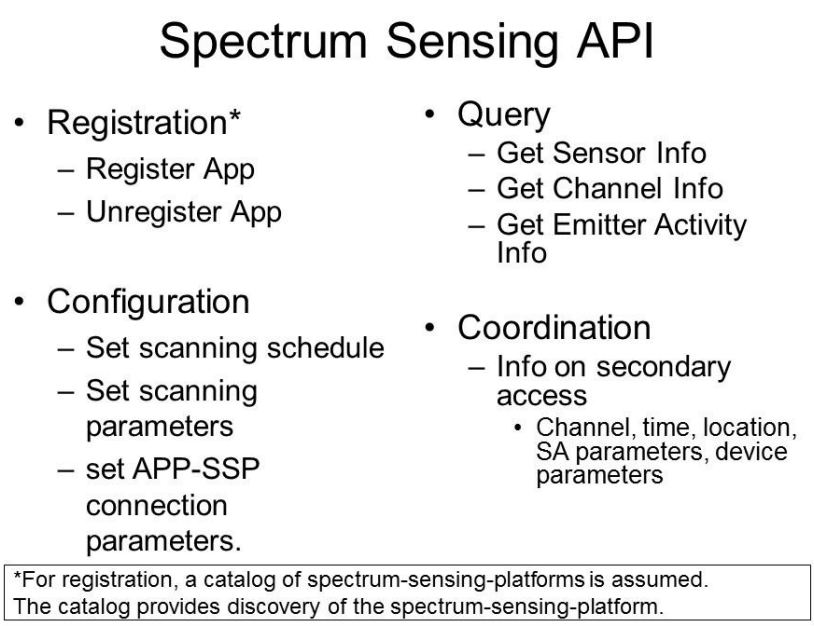
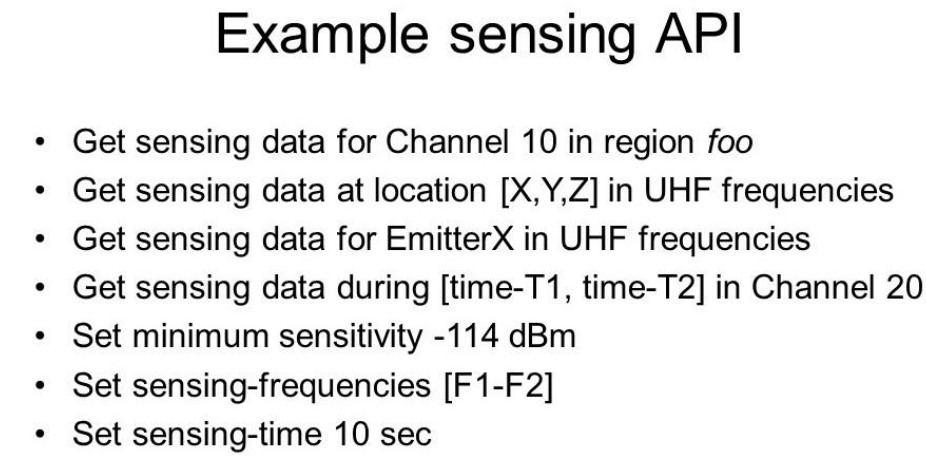
Following diagram captures the high-level summary of the SSP API.



A.2.1 Example spectrum sensing API design

The spectrum sensing requirements vary significantly in terms of geographies (different countries have different regulations) and they have been evolving over time. The requirements also vary depending on frequency-bands. Thus, there is a need for configurability and extensibility for SSP API. In this regard, policy-based interface is very much appealing. Furthermore, we may consider developing semantics for sensing-data and ontology-driven sensing policy (OWL). Following diagram shows some examples of possible SSP API.



A.2.2 Message Exchange

SSA API requests and SSP API response are encapsulated in messages. Each message has a message-ID, message-Type, and the message body. Following diagram identifies various message types.

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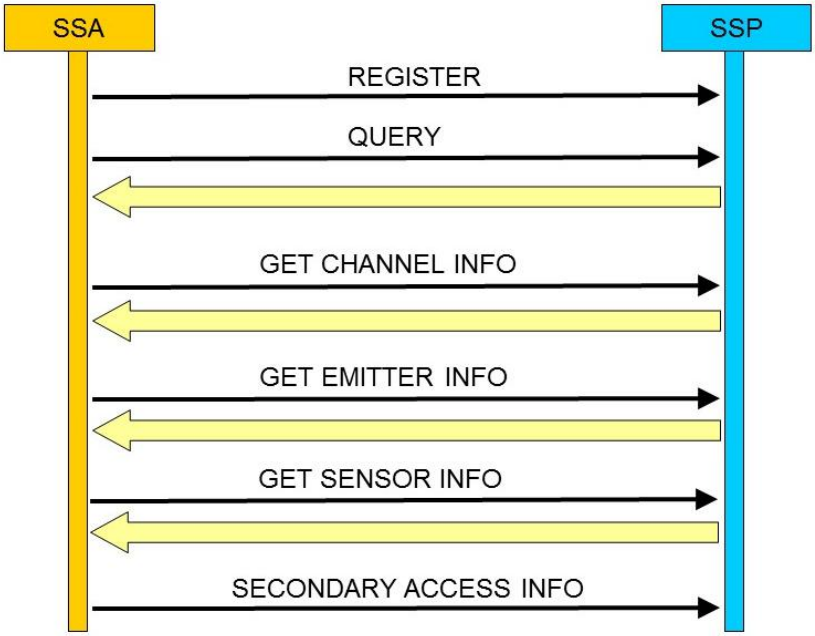
SSA2SSP MSG
GetSensorInfo GetSensorData GetEmitterSensingData GetChannelSensingData SenseChannel MonitorChannel DetectEmitter ScanFrequencies

SSP2SSA MSG
ReplySensorInfo ReplySensorData ReplyEmitterSensingData ReplyChannelSensingData ReplySenseChannel ReplyMonitorChannel ReplyDetectEmitter ReplyScanFrequencies

Following sequence diagram illustrates message exchange between SSA and SSP.



A.3 Spectrum Sensing Control

The spectrum sensing platform provides spectrum sensing service by controlling the spectrum sensing devices (SSD) with southbound interface. There are following 3 types of API

1. Registration: Allows to add/remove an SSD to SSP
2. Control: Controlling the sensing function and schedule of an SSD
3. Query: Requesting sensing data from an SSD

A.3.1 Sensing Functions

There exist multiple sensing techniques/algorithms from energy detection to exploiting cyclostationarity and signal statistics. Some sensors may be able to report occupancy in terms of aggregate RF-power received at the sensor location while higher end sensors may be able to estimate location and received power (RP) in the presence of cochannel interface and noise.

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A.3.2 Sensing Schedule

The SSP may need to scan a wide range of frequencies at a specific periodicity. Thus, SSP may in tur define a sensing schedule for each of SSDs. The schedule may be adapted in response to certain events or policies from the SSAs.

A.3.3 Examples

Following are a few examples of the interface between the SSP and SSD.

Example commands for sensing control

- Sense UHF frequencies every 10 second
- Sense frequency-range 540MHz-580MHz
- Sense with sensitivity -114 dBm
- Sense with sampling-frequency 25 MHz and sample-length 32768
- Detect EmitterX
- EstimateRP EmitterX
- EstimateTDOA EmitterX

A.3.4 Message Exchange

The message from SSP to SSD is formatted in the similar way (has message-ID, message-type, and actual message). Following diagram shows some of the message types.

SSP2SSD MSG
Start-scan Stop-scan Modify-scan Schedule-scan Query-scan Detect EstimateRP EstimateTDOA

SSD2SSP MSG
Start-scan-Ack Stop-scan-Ack Modify-scan-Ack Schedule-scan-Ack Query-scan-Response Detect-Response EstimateRP-Response EstimateTDOA-Response

Following sequence diagram illustrates the message exchange between SSP and SSD.

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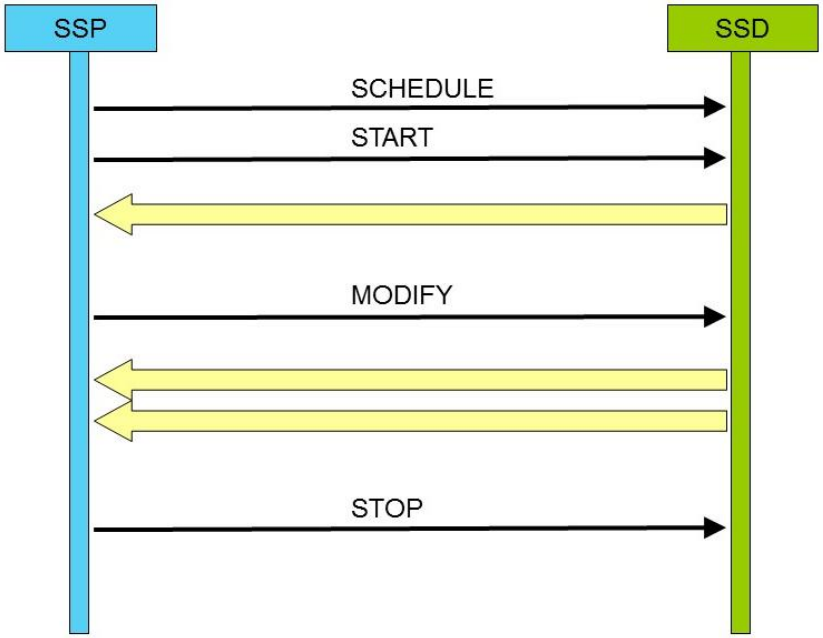

A.4 Data Store

SSP collects and stores the sensing data to provide the services defined under the SSP APi. One of the popular approaches is to use relational database. Following diagram illustrates records for (a) sensing measurement, (b) SSD (c) SSA.

Sensing measurement Record

	SensorID	ChannelID	Timestamp	Occupancy	PUDetection	EstRp	MODE

Sensor Record

	Sensor ID	Locn	Region ID	RF/Antenna Specs	Sensing Params	Det Params	Pkg Params	Transmission	Mgmt Params

Spectrum-sensing App Record

	AppID	AppName	App-Privilege	App-Stats

Alternate approach could be to develop spectrum sensing semantics based data-store.

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