The IOAG Recommendations On Spacecraft Emergency Cross Support

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The IOAG Recommendations On Spacecraft Emergency Cross Support

- Purpose of the paper
  - The paper presents the results, i.e., findings and recommendations, of the Interagency Operations Advisory Group (IOAG) study on Spacecraft Emergency Cross Support (SECS).
- Objective of this IOAG activity
  - To establish a common, standard process, agreed upon by the IOAG member agencies, for providing spacecraft emergency cross support.
- Background
  - The top management of the various space agencies at the Inter Operability Plenary-3 (IOP-3) endorsed the recommendation to investigate the issues and solutions concerning the SECS.
  - The Spacecraft Emergency Cross Support Working Groups (SECSWG) was chartered and formed by the IOAG in February 2014.
  - The working group was comprised of members representing the following space agencies:
    - ASI, CSA, CNES, DLR, ESA, JAXA, and NASA

The IOAG Recommendations On Spacecraft Emergency Cross Support
-- What Are The Problems In The Current State? --

Current approach to the inter-agency emergency cross support works well, but falls short because of two inherent problems:

- The difficulty in achieving timely availability of uplink and downlink frequency authorizations for SECS:
  - Particular for cases where the SECS is provided to missions without existing bi-lateral agreements between the two agencies.
- The difficulty in ensuring the SECS be conducted in an expedited, timely, and orderly manner:
  - Spacecraft emergency is an unplanned event. It is a rare event. And the need for potential SECS by communication assets of other agencies very often is under-estimated and not predicted.
  - It sometimes tends to take an intense, frantic, and heroic effort at both provider and user sides to conduct the SECS operations.
  - The situation is worse in those instances where there is no existing bi-lateral agreement between the two agencies.

IOAG Spacecraft Emergency Cross Support (SECS) Key Issues and Recommended IOAG Positions

Issue	Recommended IOAG Position
1. Context of emergency support	Spacecraft emergency mode is the anomalous state of the spacecraft that its persistence will result in the loss of the spacecraft entirely or the loss of any of the spacecraft's essential faculties.
2. Providing emergency support under a cross-support agreement	IOAG Services Catalog will include explicit definition of emergency mode (as opposed to nominal mode) of the services. IOAG will define certain standard functional and performance attributes governing the SECS, so that SECS requirements can be explicitly specified in the service agreement.
3. Providing emergency support with no cross-support agreement	IOAG will establish some multi-lateral guidelines for its member agencies to support each other in time of spacecraft emergency.
4. Legal and liability issues	IOAG member agencies will agree that, for the SECS, the supporting agency shall not be held liable for any consequential damages resulting from its actions. IOAG member agencies will apply for relevant RF uplink license, through their local licensing authorities, for the declared spacecraft over the declared ground stations.

IOAG Spacecraft Emergency Cross Support (SECS) Recommended IOAG Positions

Issue	Recommended IOAG Position
5. Response time	For reducing the response time, i.e. from the time of a request for SECS to the readiness to support, a "cross-support emergency system" will be established by IOAG member agencies. At a minimum, each agency shall define an Emergency Contact Point to facilitate the request of the SECS.
6. Support priority	IOAG member agencies will adopt similar priority scheme for providing SECS: Priority 1: Emergency with astronauts affected Priority 2: Emergency during the launch and early orbit phase (LEOP) after the separation of spacecraft from the launcher Priority 3: Spacecraft emergency for missions with bi-lateral agreements Priority 4: Spacecraft emergency for missions with no bi-lateral agreements
7. Services provided	In addition to the IOAG core services, IOAG will define a simple way to quickly establish or acquire ground-to-ground communication lines so that in time of emergency need this pre-requisite condition will not become a bottleneck. IOAG will define standard operational interfaces at process-level and/or procedural level for its member agencies to abide by in time of SECS. This will include some comprehensive common data bases, e.g., assets and missions data bases, deployed according to the templates defined by the IOAG.

IOAG Spacecraft Emergency Cross Support (SECS) Recommended IOAG Positions

Issue	Recommended IOAG Position
8. Sustaining emergency support capabilities	Chief among the capabilities are the SECS-specific, mission-unique configuration set-up, the operational proficiency in SECS, and the information databases established by the IOAG for assisting the SECS operations.
9. Charge for the support	Payment for SECS services is the general ground rule. IOAG will explore a multi-lateral guideline by which all agencies agree to provide and receive services under certain global and reciprocal arrangements where the actual SECS are accounted in a ledger for exchanges of services.

The IOAG Recommendations On Spacecraft Emergency Cross Support
-- Key Solutions To The Current SECS Problems --

- Apply the *a priori licensing* scheme for achieving timely availability of RF licenses in time of SECS.
- Enlist and organize suitable, global communications assets to participate in the provision of SECS.
- Execute the Standard Operations Process/Procedures (SOP) for operational interfaces between SECS providers and users.

Two guiding principles:

- Proactive planning for spacecraft emergency event is analogous to purchasing life insurance.
- Spacecraft emergency support can be provided to missions of other space agencies even without a prior bi-lateral agreement.

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-- Key Solutions: The *a priori RF Licensing* Scheme --

RF License: Recommended the *a priori licensing* scheme to achieve the need for timely availability of RF licenses at the supporting agencies for the SECS. The scheme features:

- All agreed communications assets potentially needed by a mission for the SECS are licensed in advance to use the frequencies to support that subject mission.
- The subject mission is pre-approved by the provider agency, in terms of its support by these communications assets in time of spacecraft emergency.
- A possible scenario exemplifying this scheme is as follows:
- During the mission formulation phase, when a mission, say Mission X, of Agency A submits advance publication and notification filings to the ITU, it includes in the ITU filings the communications assets (say Station Y of another IOAG agency, Agency B) that are potentially needed for the SECS. [Note: For missions already in flight, the same process applies, although limited to the notification filing.]
- Agency A informs Agency B of such a potential need for SECS by Station Y for Mission X.
- Agency B grants the approval based on the IOAG multi-agency SECS guidelines.
- Agency B spectrum management submits a Radio Frequency Authorization (RFA) to its national and/or local RF licensing agency for approving Station Y to use the frequencies to support Mission X.

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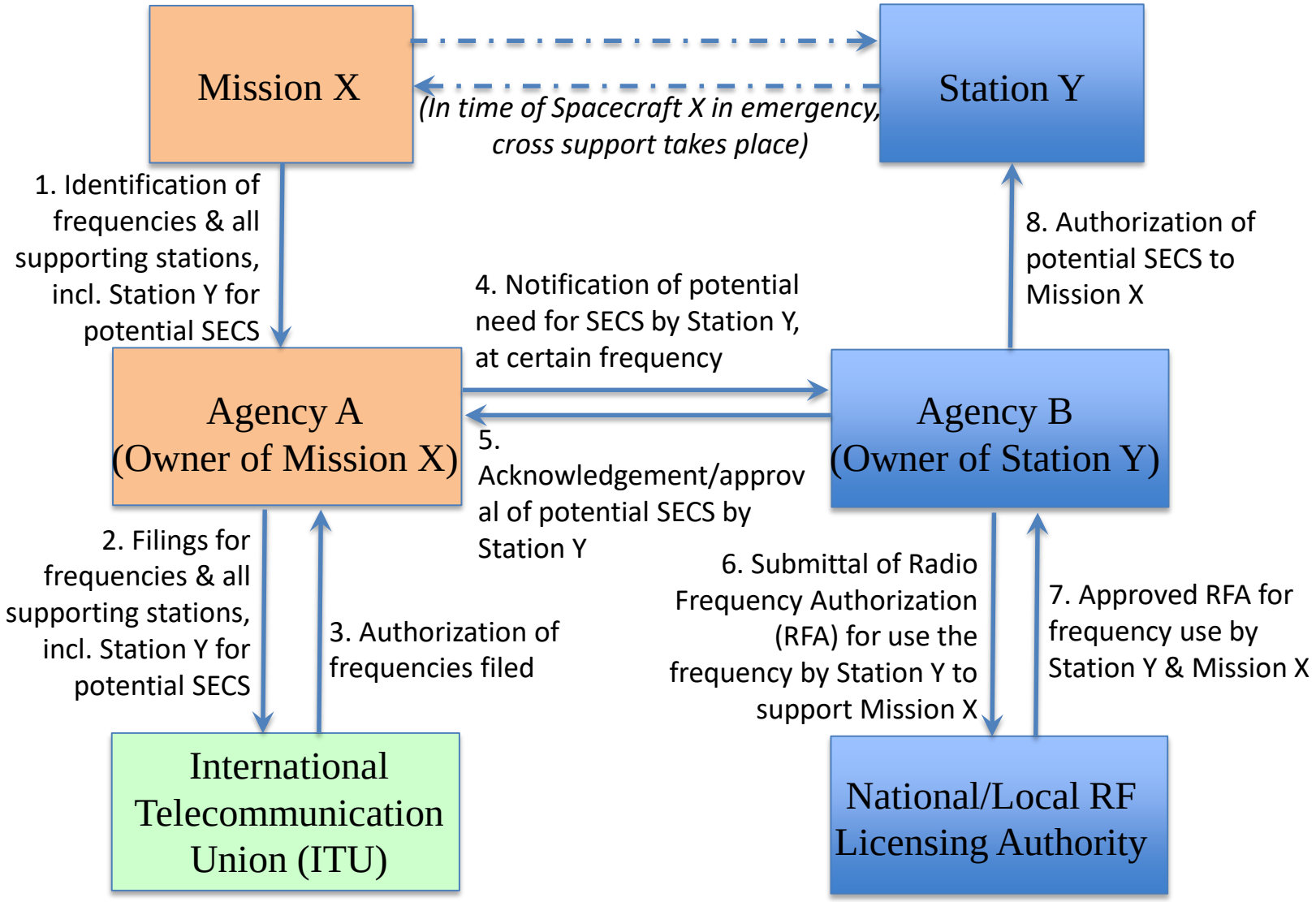
-- Key Solutions: The *a priori RF Licensing* Scheme -- 2 of 2



The IOAG Recommendations On Spacecraft Emergency Cross Support

Key Solutions: Participating Communications Assets in SECS

- The communication assets, owned by the IOAG member agencies, available for SECS must be explicitly identified and known to the potential user missions in their planning for spacecraft emergency event:
  - They are subject to the *a priori* licensing scheme, if chosen
  - They have to make upfront engineering set-up for asset configuration, if chosen
- We have identified a set of potential communication assets available for providing SECS. The asset information is categorized into the following three operational domains.
  - Assets for near-earth missions below GEO
  - Assets for near-earth missions on or beyond GEO within 2M Km
  - Assets for missions beyond 2M Km or deep space missions
- Selection of the assets by a given mission may be dependent on the following factors:
  - Site location: how does the asset, relative to other assets, fit in to ensure the needed geometric coverage?
  - Spectral bands: S-/X-band for near-earth missions or deep space X-band
  - Capabilities: G/T, EIRP, etc.

Potential IOAG Ground Communication Assets Available for SECS

Agency	Size (M)	Asset Type	Location	band	S-UL	S-DL	X-UL	X-DL
ASI	10	NE	Malindi, KEN	S,X	O	O		O
	10	NE	Malindi, KEN	S	O	O		
CSA	10	NE	St-Hubert, CAN	S	O	O		
	10	NE	Saskatoon, CAN	S	O	O		
	13	NE	Gatineau, CAN	S,X	O	O		O
	13	NE	Prince-Albert, CAN	S,X	O	O		O
	13	NE	Prince-Albert, CAN	X				O
	13	NE	Inuvik, CAN	S,X	O	O		O
CNES	11	NE	Kourou, GUF	S	O	O		
	10	NE	Kerguelen Islands, FRA	S	O	O		
	11	NE	Aussaguel, FRA	S	O	O		
	6.4	NE	Aussaguel, FRA	S	O	O		
	12	NE	Hartebeesthoek, ZAF	S	O	O		
	13	NE	Kiruna, SWE	S,X	O	O		O
	13	NE	Inuvik, NT, CAN	S,X	O	O		O
DLR	15	NE	Weilheim, DEU	S	O	O		
	15	NE	Weilheim, DEU	S,X	O	O		O
	30	NE/DS	Weilheim, DEU	L,X				O
	7.3	NE	Neustrelitz, DEU	S,X	O	O		O
	7.3	NE	Neustrelitz, DEU	S,X	O	O		O
	7.3	NE	Neustrelitz, DEU	S,X		O		O
	9	NE	O'Higgins, CHL	S,X	O	O		O
	13	NE	Inuvik, NT, CAN	S,X	O	O		O

Agency	Size (M)	Asset Type	Location	band	S-UL	S-DL	X-UL	X-DL
ESA	15	NE	Kiruna, SWE	S,X	O	O		O
	13	NE	Kiruna, SWE	S,X	O	O		O
	15	NE	Kourou, GUF	S,X	O	O	O	O
	35	DS	Cebreros, ESP	X			O	O
	35	DS	New Norcia, AUS	S,X	O	O	O	O
	35	DS	Malargue, ARG	X			O	O
JAXA	10	NE	Katsuura, JPN	S	O	O		
	13	NE	Katsuura, JPN	S	O	O		
	20	NE	Katsuura, JPN	S,X	O	O		O
	10	NE	Masuda, JPN	S	O	O		
	10	NE	Okinawa, JPN	S	O	O		
	18	NE	Okinawa, JPN	S	O	O		
	10	NE	Mingenue, AUS	S	O	O		
	10	NE	Santiago, CHL	S	O	O		
	10	NE	Kiruna, SWE	S	O	O		
	10	NE	Maspalomas, ES	S	O	O		
	20	NE	Uchinoura, JPN	S,X	O	O		O
	34	NE/DS	Uchinoura, JPN	S,X	O	O	O	O
	11	NE	Uchinoura, JPN	S	O	O		
	64	DS	Usuda, JPN	S,X	O	O	O	O

Agency	Size (M)	Asset Type	Location	band	S-UL	S-DL	X-UL	X-DL
NASA	5	NE	Wallops Island, VA, USA	S	O	O		
	11.3	NE	Wallops Island, VA, USA	S,X	O	O		O
	10	NE	Fairbanks, AK, USA	S,X		O		O
	11.3	NE	Fairbanks, AK, USA	S,X	O	O		O
	18.3	NE	White Sands, NM, USA	S	O	O		
	70	DS	Canberra, AUS	S,X	O	O	O	O
	70	DS	Goldstone, CA, USA	S,X	O	O	O	O
	70	DS	Madrid, ESP	S,X	O	O	O	O
	34	NE/DS	Canberra, AUS	S,X	O	O	O	O
	34	NE/DS	Canberra, AUS	S,X	O	O	O	O
	34	NE/DS	Canberra, AUS	X			O	O
	34	NE/DS	Canberra, AUS	X			O	O
	34	NE/DS	Canberra, AUS	X			O	O
	34	NE/DS	Goldstone, CA, USA	S,X	O	O	O	O
	34	NE/DS	Goldstone, CA, USA	X			O	O
	34	NE/DS	Goldstone, CA, USA	X			O	O
	34	NE/DS	Goldstone, CA, USA	X			O	O
	34	NE/DS	Goldstone, CA, USA	S,X	O	O	O	O
	34	NE/DS	Madrid, ESP	S,X	O	O	O	O
	34	NE/DS	Madrid, ESP	X			O	O
	34	NE/DS	Madrid, ESP	X			O	O
	34	NE/DS	Madrid, ESP	X			O	O
	34	NE/DS	Madrid, ESP	S,X	O	O	O	O

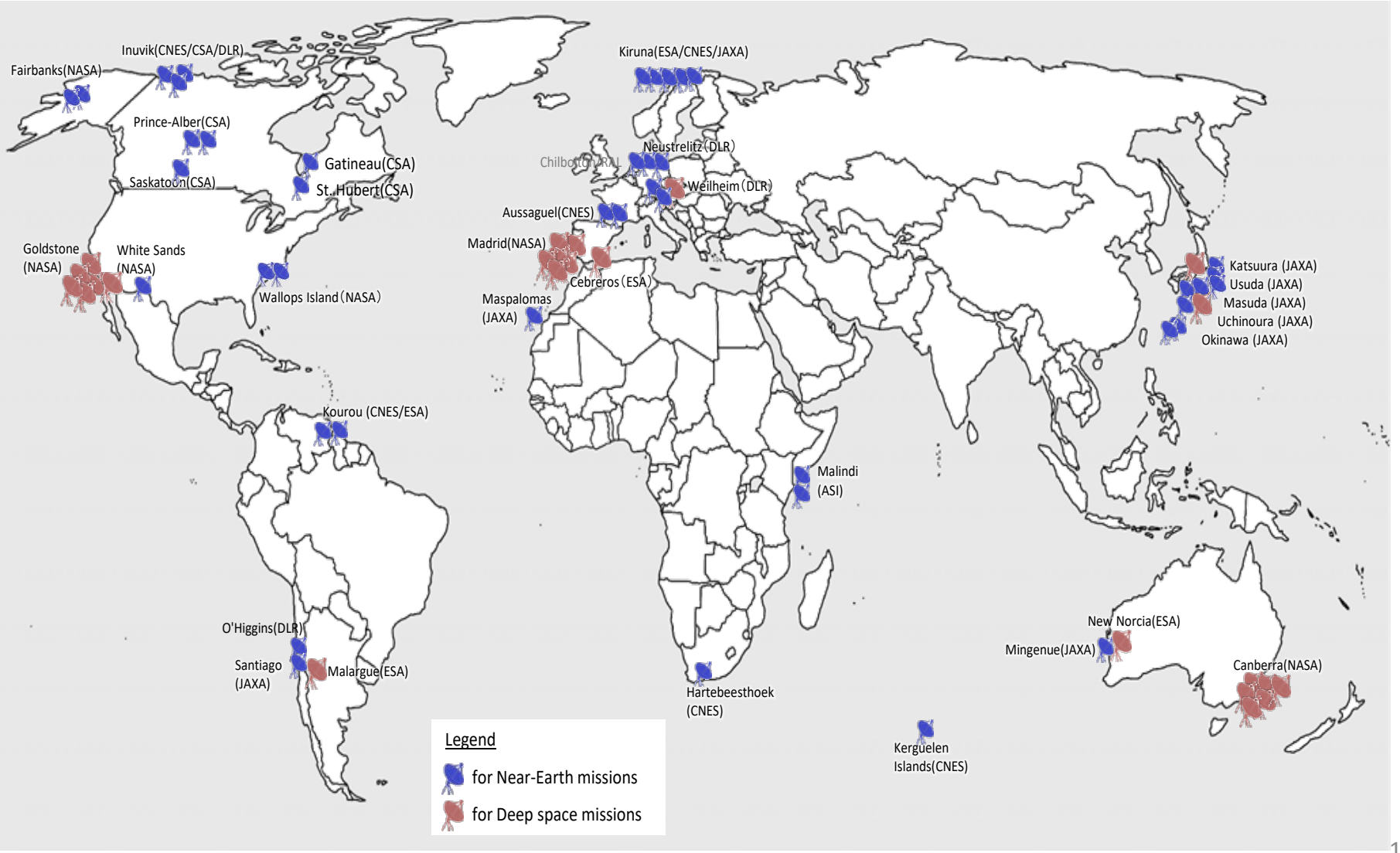
Remarks:

NE for Near Earth mission

DS for Deep Space mission

with Restrictions (e.g. operation not around 24H, Highest priority to certain agency's missions)

Potential IOAG Ground Communication Assets Available for SECS - A Global Sites Map



The IOAG Recommendations On Spacecraft Emergency Cross Support

Key Solutions: Standard Operations Process/Procedures (SOP)

The Scope of SOP:

- The SOP is focused on the operational interfaces between the SECS service User and service Provider.
- It applies to the SECS provided to CCSDS-fully compliant missions only; otherwise limitations on services are quite likely.
- The services to be provided are those of the IOAG Service Catalog #1, mainly for telemetry, telecommanding, and radiometric tracking.
- The SOP will be used by the IOAG member agencies for SECS purpose, although the use cases can potentially be extendible to non-IOAG agencies in the future.
- In addition, the SOP may apply to the SECS provided to a mission regardless whether a bi-lateral service agreement exists or not.

Standard Operations Process/Procedures (SOP) for SECS
-- Key Characteristics --

For the purpose of achieving common, standard operational interfaces for the SECS, five key processes have been defined, so far, at a conceptual level:

- Process 1. Selection of a Provider
- Process 2. Assessment on Ability to Support
- Process 3. Support Preparation
- Process 4. Pass Support
- Process 5. Support Termination

Of the above, Processes 1 and 2 are unique to the SECS. They possess certain key characteristics:

- Formalized Point-Of-Contact (POC) positions at service providers
- Pre-defined, populated information base facilitates expedited support.
  - Mission profiles with spacecraft trajectory for all registered IOAG missions
  - Configuration profiles for all registered IOAG missions
  - POCs for all registered IOAG SECS providers
- Make use of available CCSDS SANA registries: RF assets registry, SCID registry, Service providers registry
- IOAG-blessed SECS App's are available to assist.

The IOAG Recommendations On Spacecraft Emergency Cross Support
Conclusion: Some Programmatic Guidelines

The following programmatic guidelines for each member agency have been identified for SECS services provision:

- Enlist its communication assets (e.g. ground stations) as potential SECS providers to missions of other member agencies.
- Enlist missions requiring SECS and obtain acknowledgement from agencies that could provide potential SECS for enlisted missions.
- Obtain RF license for use by a given station (per "*a priori licensing*" scheme) for potential provision of SECS to other member agencies, such that, in time of service invocation, the timely use of certain frequencies is legal, ITU-compliant, and fully permitted by the national/local licensing authority.
- For promoting the common goals of international space exploration, endorse the principle of providing the requested emergency support at highest priority allowable.
- For achieving expedited emergency support, as either the SECS user or provider agency, agree to execute the standard operations processes/procedures, as defined by the IOAG, for the SECS interfaces.
- With full-faith understanding, the SECS user agency accepts the condition that the provider agency will not be held liable for any negative consequences that may occur to the spacecraft during the service provision.