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| Emergency Services |



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# Introduction

This document consolidates some ideas which could lead to a possible Emergency Support Service. It describes what is current concept of an emergency support in response to a declared spacecraft emergency, captures the activities that are necessary to be conducted today to provide the support and follows on with potential future extensions.

## Emergency support today.

Currently, when a spacecraft emergency is declared to cooperating space agencies. The spacecraft is given immediately the highest priority in the ground station scheduling and usage. The agencies will then provide as quickly as support from any requested ground station to the agency requesting emergency support.

This emergency support is therefore just the provision of ground stations, which therefore provides more connectivity to the spacecraft in trouble. It is not currently the provision of emergency support from another agencies mission control centre.

# Activities to be Performed

To provide emergency support the ground station must be configured correctly to support the satellite in trouble, and all the data links and hand-shakes from the requesting agencies mission control centre to the ground station must be configured.

Generally all this configuration is conducted and validated a long time in advance of the emergency support request, such that provision of additional support is just a scheduling issue. Where this is not configured in advance, this requires engineering work to configure all the systems prior to providing the support, this engineering activities may require higher level authorisation to proceed.

## Request Emergency Support to the Agency Ground Station Scheduling Office.

This is typically done via direct telephone contact, so confirm the status of the emergency and query available ground station resources that could be made available at short notice, either because they are inactive or low priority activities can be dumped off.

To enable this productive discussion the spacecraft orbit and general pass visibility information over the other agencies ground stations needs to be available. Initially course information is sufficient, however as the actual ground stations are assigned this needs to be improved.

## Configure Ground Station for Uplink and Downlink

All the necessary tables that are required to define the uplink and downlink characteristics need to be set in the ground station. This is frequencies, modulations, data rates, sweep ranges, emitted power, etc to match the on-board configurations. Each satellite is likely to have multiple RF configurations, and in case of emergencies one of several could be used.

These tables are generally preconfigured in advance for all spacecraft that are likely to use station. Where they are not preconfigured in the station systems, they need to be fully provided by the requesting agency and defined in the station configuration before it can be used.

Between ESA and NASA for inter-agency use of the DSN, the full RF configuration of all the spacecraft that could potentially require cross-support is documented. So that quick configuration of a station by engineering support can occur, once emergency support is requested.

## Configure SLE Connection via SICF

Once the ground station is configured and assigned to a satellite, the requesting agency can connect to the ground station via the CCSDS Satellite Link Extension (SLE) service, but matching the Service Instance Configuration File (SICF) during the session initiation hand-shake.

This CCSDS standard allows the transfer of CLTUs or Packets between a mission control centre and the support ground station in the forward session and return of TM Frames and CLCWs in the return session.

## Provide Antenna Pointing

The satellite state vector, Two Line Element or equivalent antenna pointing file need to be provided to enable the ground station to be correctly pointed to track the requested satellite. The CCSDS compliant Orbit Ephemeris Messages (OEM) tend to be the most supported format by ground station providers, even if internally the agencies use other means. OEM is the cross support format shared between ESA and NASA/DSN, from ESA to NASA/DSN this is provided on the Service Preparation Subsystem Portal (SPS), which is the pre-agreed interface portal for all cross-support.

## Configure Data connection to SLE provider

To allow connection from the requesting mission control centre to the requested ground station, the necessary data connectivity through the various security layers needs to be provided. If not set up in advance this is the activity that can take the longest time, and the necessary security authorisations are often required before access can be provided.

## Commanding Spacecraft directly from the Ground Station

Most ground stations provide the capability to transmit predefined telecommands to a spacecraft from the ground station systems themselves. These are a final fall back option in emergency situations, and initiated by the mission control team over voice-loops or via emergency communication means when connectivity to the ground station by normal means is not possible.

## Provide TM & TC of Spacecraft from another control-system / agency.

Currently backup Mission Control Systems are installed at alternative agency sites at most space agencies. For ESA these are typically at the primary ground station sites, for NASA at alternative operations centres. These backup Mission Control Systems can be remotely or locally used via the ground station network in case of major failures at the primary site.

Mission control systems could be also be guest hosted at supporting agency sites and remotely / locally used in case of emergencies.

MO SM&C could be used to route forward and return messages via guest hosted Mission Control System, or another agencies mission control system that supported MO services through its own ground station network and too/from the satellite rather than going directly to the ground station

### SLE Gateway

Typically agencies provide an SLE gateway to allow external access to the ground stations, this provides basic forward and backward sessions for TM and TC. In effect this very similar to a TM & TC service provided by another agencies mission control centre via MO services.

# How Services Can be used.

## Emergency Request to the Scheduling Office

This is a request between the two agency scheduling offices to provide quick emergency support to a satellite in trouble.

### Forward service

The forward service should be able to request what ground stations can be provided as extra support, and also to provide the security/data connection and RF connection information such that the connectivity from the Mission Control System to the To-Be-Provided ground station can be initiated and the RF connection from the Ground Station to the spacecraft in trouble can be initiated.

#### Basic information for ground station scheduling

In this request the basic information required by the agency scheduling office to determine available ground station resources that can be provided against the “emergency high priority request” is provided. This will be basic orbital information, as well as basic RF frequency, power and modulation information. This should be sufficient for the scheduling office to determine which ground stations have the necessary capabilities and which ground stations have actual visibility of the spacecraft in trouble.

#### Complete RF, Data Link, Spacecraft information for complete system configuration.

This service would provide the necessary information to make to allow the connection from the Mission Control System to the ground station network, so the information needed by the ground station provider to allow the data and SLE connection. As well as all the RF information required to configure the ground station to receive the downlink signal and provide a successful uplink signal.

With this information the ground station provider should be able to temporarily configure their ground network and ground stations to provide the emergency services.

### Return Service

The return session should provide the answers to the request, which are the ground stations that are available to support and the times that they may be used, and the information required to connect the mission control system to the ground station network.

#### Antenna assignment schedule

The ground station antenna of the type suitable to provide support and their availability times over the requested period shall be returned to the requester, to allow them to be included into the recovery plan.

#### Ground Station Configuration Status

The configuration of the ground stations to be provided, including full RF uplink and downlink configuration shall be provided by to the requester, to allow confirmation that the configuration is sufficient and suitable to provide the support.

#### SICF for connection.

All the Data link, Security and SLE Service Instance Configuration File required to allow the mission control system to connect to the ground station network in a secure manner are provided back. To allow these to be used for the ground stations assigned to the support, over the expected time period.

# Recommendations

If a ground station scheduling standard exists to define information exchange between cooperating agencies, it would be recommended to extend this to include an emergency service support request and response. The service would provide all the necessary hand-shaking to provide emergency ground station support to any cooperating agency and to configure the network to allow temporary access to the requesting Mission Control System.

Any exchange between cooperating agencies needs to be prepared in advance and validated. In the current case this is done on a mission by mission basis, however if a standardised service was provided this would only be required to be validated once at agency level, and potentially re-validated once per year in each direction to demonstrate continued compliance.

Data link security is one area which could benefit from the service, but is also one area of most sensitivity.