Remote Operations of ESTRACK During Critical Mission Phases

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The ESA tracking network (ESTRACK) is supporting the full range of ESA missions by providing highly reliable telecommand, telemetry and radiometric services across all mission phases. The introduction of centralised, remote monitoring and control of ESTRACK stations about 10 years ago and the subsequent automation of ESTRACK routine operations marked a major change in the ground segment operations concept. Today ESTRACK is in the process of introducing central, remote operations also for the support to critical mission phases across the full range of the supported ESA missions.

The paper starts by presenting the motivation and expected benefits driving this evolution. It then describes the major elements of the novel operations concept including the definition of new or modified operations roles with a new task and responsibilities split across the ground segment operations team. A key point is the reduced operations role of the local station staff and the introduction of a remote station operator role at ESOC. The corresponding impact on central and local staffing in terms of team size, skills and know-how is addressed as well as the introduction of a systematic training programme for the central operations staff.

Along with the new operations roles the paper presents the additional or enhanced technical means that were put in place to safely conduct such operations from remote. Specific tools required to handle the peculiarities of critical mission phases, for instance first acquisition after separation or spacecraft recovery from a non-nominal state are presented and assessed.

As ESA have applied this new concept for a number of launch supports a summary of the lessons learnt to date is presented together with an intermediate assessment. The paper concludes with an outlook on the envisaged next steps in this ESTRACK evolution.

I. Introduction

THE European Space Agency operates and maintains a global network of ground stations (ESTRACK), which comprises several Telemetry, Tracking and Command (TT&C) ground stations. Today the ESTRACK core network encompasses 10 antennas on 9 different sites, as follows:

- Six 15m and one 13m TT&C station (Kiruna - Sweden, Redu - Belgium, Maspalomas & Villafranca - Spain, Kourou - French Guiana, Perth - West Australia;
- Two 35m Deep Space Ground Stations in New Norcia - Western Australia and in Cebreros - Spain - a 3rd Deep Space ground station is being built in Malargue - Argentina;
- One 5.5m station on the island of Santa Maria, Azores - Portugal for tracking of Ariane/ ATV launches.

This core network is augmented through long term contractual arrangements with commercial tracking service providers e.g. SSC/USN, and KSAT. Furthermore, additional non-ESA stations are occasionally provided under cooperative agreements with Partner Space Agencies (ASI, CNES, DLR, JAXA, NASA).

The ESTRACK comprising ground stations from the core network, the augmented network, and the cooperative network is depicted in Figure 1.

Figure 1. ESTRACK Stations Network

II. Drivers for change and expected benefits

While architecture and design of ESTRACK stations and network have undergone significant changes over the last decades this is only partly true for the operations methods of ESTRACK. For the conduct of routine operations the new technical capabilities of the network have been used to implement - as of the year 2000 - a highly automated, remote operations scheme for ESTRACK. Today about 55000 routine tracking hours are provided per annum ranging from short duration passes (several minutes) for earth observation missions to very long passes (up to 60 hrs) for astronomical observatory missions. The service quality is ~~in a service quality that is at least~~ equivalent to

the previous manual and local operations. Two round-the clock positions (12 staff) in the ESTRACK Control Centre at ESOC supervise the largely automated operations ~~which~~ thus yielding~~results in~~ a very cost effective delivery of TT&C services.

For conducting ESTRACK operations in support of critical missions phases the center has used until recently the traditional scheme i.e. local manual operations by the respective station staff under voice control from ESOC. However, the confidence built up with the remote ops concept employed for routine operations triggered the ~~transition~~ application of a~~of critical ops to a~~ remote scheme also for critical operations. Critical operations are defined as activities whose failure would have a severely degrading impact on the space mission objectives.

~~This~~ The reasons for moving towards remote operations also for critical phases are as follows:

- ~~The~~ Ce~~e~~ntral and remote operations by a small team (running ESTRACK operations in typically multi-shift mode) is expected to be more cost effective. A single central team has to be trained and put on duty rather than multiple teams, one for each station.
- The colocation and physical proximity of station builders (ESTRACK engineering group at ESOC) and actual station operators makes a vast engineering know-how immediately accessible to operations and helps to mitigate risks in critical phases.
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- Due to the introduction of remote ops for routine operations much of the ops know-how has gradually moved to the central operations engineers at ESOC. A training of experienced central staff at ESOC is more effective than a redeployment of ops knowledge and skills from ESOC to the respective ground stations.
- A centrally available set of ops skills and know-how can be maintained and developed more effectively across mission ~~and stations~~ types than a widely distributed one. Flexibility and versatility of the central ops personnel pool is expected to increase.
- The resulting shift of local station staff from doing 'Maintenance & Operations' towards 'Maintenance only' supports in the long run a cost effective running of the ground stations.
- The technical means in place for routine operations have proven~~d~~ to be reliable and mature. ~~and are judged to be safe also for use during critical phases.~~ The systems for remotely monitoring and controlling the ground stations provide an extensive set of parameters that permit safe and effective conduct of critical ground station operations e.g. first acquisition after launch or investigation into space link anomalies.
- Reliable and wideband data link connectivity is nowadays in place for all stations.
- ~~The specific technical means for the support of critical operations e.g. spectrum analysers, front end controllers, search functions for first acquisition are equally accessible from local and remote.~~

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III. New ops concept

~~Some~~ Key elements of the new ops concept ~~being~~ introduced are:

1. ESTRACK support to critical mission phases is operated remotely from ESOC.
2. Local station staff is on site during critical phases to act as local support to remote operations. Typical tasks performed locally are hardware resets or equipment exchanges.
3. During the very critical phases of the missions the set of ground stations is operated by experienced engineers from the console at ESOC. ~~–~~During less critical moments ~~STARCH~~operations may be temporarily transferred to the ESTRACK Control Centre e.g. the pure track phase of a GTO pass following initial acquisition.

4. A systematic training program (Operations Manager curriculum) is created to develop and maintain skills and know-how of staff who qualify for critical ESTRACK operations . The training programme is managed by the Training and Simulations Manager at ESOC.

5. For simplicity and safety reasons all ESTRACK operations ~~should~~ use as far as possible ~~use~~ standard ESTRACK capabilities and tools. ~~This is particularly recommended for third-party missions.~~

6. ESTRACK support to some types of critical mission operations can be safely run by only slightly modifying the actual routine ops scheme of ESTRACK. Examples of this are planetary flyby operations or tracking to long duration LEOP passes, for instance into GTO or Galileo type orbits. A pragmatic and phase dependent split of tasks across an OM Team and standard ECC personnel should be applied for such cases.

~~7. For supports for which an OM learner is assigned, Prime OM and Training Manager shall agree the set of tasks to be carried out by the trainee. Typically this shall include on-console time during MRTs as well as during less critical actual operations phases with over the shoulder supervision by senior OM Team members. The prime OM shall ensure that in the OM Team a suitable staff is assigned to provide the training/supervision and that the training takes place.~~

IV. Lessons learnt from supports so far

The new approach is being partly implemented for supports to missions in 2011 and for the year 2012 all ESTRACK (Metop-B, MSG-3, Swarm) will follow the new scheme.

The major advantage seen so far is the concentration of operations and engineering know-how in smaller groups that provides within a physically collocated team an unprecedented ability to react fast and safely to unforeseen events. A further advantage is a higher effectiveness of the missions specific training programme (Mission Readiness Tests, GSOV). For the time being the training effort per ground station is kept on the same level as with the old scheme but as it is spread over fewer people thus the resulting team fluency is greatly increased.

The main disadvantage of the remote ops approach is the demotivation experienced with the teams at the respective stations. Seeing their local role reduced to a mainly maintenance team by taking away the high profile operations tasks is often perceived as a demotion. Various measures, among other a higher level of autonomy in the execution of maintenance tasks, are implemented to mitigate this.

A further obvious disadvantage is the stronger dependency on a reliable wideband connectivity between ESOC and the ground stations. However, as such connectivity is now available at very affordable cost an appropriate fault-tolerant communications topology can be built easily. In combination with multiple ground station assignment for critical phases this is considered an adequate mitigation measures.

~~What worked and did not work for Phobos-Grunt?~~
~~What are new risks discovered?~~
~~What were positive and negative surprises?~~

V. ~~Outlook~~Conclusion

Remote operations of ESTRACK stations during critical mission phases is being gradually introduced. The experience so far has been predominantly positive and ESA will continue to implement this methodology. ESTARCK operations for all major LEOP supports in 2012 (Swarm, MSG-3, METOP-B) will follow this novel approach.

~~Next steps to be done?~~

~~VI. Conclusion~~