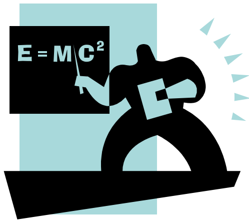
Breakout Group 3

"The Boffins"



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Summary Report

The complexity increases in space missions necessitates a requirement for OOS. There comes a stage when longer life can no longer be guaranteed through reliability - indeed, we felt that 20y lifetimes without OOS were unrealistic. Space assets are the only engineered vehicles of any complexity and long operational lifetimes that are not designed to be serviced – the only comparable vehicles in terms of complexity, lifetime and cost are military aircraft and naval ships. Both military aircraft and naval vessels undergo regular servicing and full refits every 10 years. The lack of maintainability of space assets represents a serious limitation affecting spacecraft performance, flexibility of deployment and cost of high reliability components.

Given that space missions are governed by political, economic, legislative or scientific patronage, these are the primary drivers that must be fostered. A big push for OOS would be for legislation on satellite disposal - the space debris issue is one, which requires priority from the top level (agencies, etc). Economic drives must be based around two issues – the application of commercial services (such as OOS business) and the development of new economic markets (such as the development of space-based manufacturing). However, our main concern here is technological which itself has a strong effect on perceptions both within the space industry and outside it. The chief problem within the industry is the perception that either robotic OOS is not technologically available, or that such a facility would not serve any useful function. Both are of course incorrect, but must be tackled as a major barrier to the advent of OOS.

The first and most difficult problem highlighted was that to ease the robotics requirements for OOS, cooperative satellite design was essential. The focus was to attempt to ensure convergence that as robotics evolved greater capabilities, so co-operative design would become more standard and more part of the design process. This must begin simply by the inclusion of beacons and grapple pins as first step in co-op design which have only a small impact on satellite mass, etc. Accessibility is already a part of design process to allow integration and test - this must be exploited by OOS, e.g. access through the EGS test ports. This facility in conjunction with an emphasis on skin/frame structures rather than dual shear plate approach to structures offers accessibility for spacecraft servicing. Wholesale redesign of interfaces, subsystems, connectors, etc was not plausible currently. One big problem is dealing with thermal blankets. As co-op design gets better, so robotics requirements diminish – this is unfortunate as the opposite situation would be more amenable. Currently, we need to deal with uncooperative targets - RVD, proximity ops, and grappling needs to be robust from the robotics end. The need for acquiring servicing targets is a critical issue. The only co-op design spacecraft are LEO-based observatories designed for astronaut servicing – astronaut OOS has already been demonstrated with the Solar Maximum Repair Mission (1984) which has become a textbook OOS operation, and with the Hubble Space Telescope Servicing Missions. Indeed, the first HST Repair Mission enabled the recovery of the subsequently most successful astronomical telescope ever built. Astronaut-OOS operations may represent a robotic OOS opportunity – currently, the STS RMS (Remote Manipulator Arm) supports astronaut EVA, primarily in a “fly-swatting” mode but it was based on 1970s technology and lacks any force feedback capability. More advanced technologies currently available would enable a significant widening of its capabilities – the ISS Canadarm incorporates much of this more modern technology for deployment on ISS. The proposed permanent X-ray facility observatory, XEUS, is to be refurbished and upgraded with new optics using the ISS ERA (European Robotic Arm). This may be extended to other astronomy satellites. If so, astronomical spacecraft represents a natural target for OOS. There is however a limited window of opportunity for this as many observatories planned are to deployed at Langrangian points or further such as beyond asteroid belt.

Co-operative design requires a sea-change in attitudes in satellite design philosophy to incorporate maintainability as well as reliability through redundancy. Although previous technology demonstrations by DLR and others have been a great success (e.g. ROTEX/ETS VII), they have not filtered down to the design/user level. Part of the reason for this is because these have not been end-to-end demonstrations. Although aspects of OOS were demonstrated very successfully on a specifically designed target including chase and capture maneuvers, these were not “in-the-field” demonstrations with all or most of the characteristics of a full OOS mission. This was highlighted as the absolutely necessary next step - a full end-to-end demonstration of OOS. This is essential to prove to the user market that this service can be supplied – this highlights one of the barriers to OOS: if the facility is available, it will be used, but there is little incentive or interest in developing it. The launcher market suffered a similar perception in the UK – the lack of a perceived market for launchers led to the termination of the UK Black Arrow launcher. Launchers, like OOS, are part of space infrastructure. An end-to-end demonstration requires funding by agencies, as part of their responsibility is the development of infrastructure. The end-to-end demonstration may be of two varieties. We recommend that both end-to-end technology demonstration programmes should be followed in dual track configuration. First, the Orbital/Express Recovery program should be executed to demonstrate limited operations, which should be followed by a more ambitious Orbital Recovery Mark II for science missions. Second, a full robotic end-to-end demonstrator should be developed for more complex operations, which involve robotic manipulation. TECSAS may be adapted to such an end-to-end demonstration mission deployed to service a dysfunctional operational satellite - it must demonstrate useful observation, automated RVD, flexible manipulation such as thermal blanket handling, ORU exchange. The purpose of the two tracks is to twofold. The Orbital Express track will demonstrate the feasibility of the OOS concept in a commercial application. The TECSAS track will essentially technologically leapfrog this track to demonstrate that the technology is in place for further, more sophisticated OOS activities beyond Orbital Express.

These demonstrators should persuade the agencies, manufacturers and users of the reality and capabilities of OOS. The agencies will be convinced that OOS can be achieved as part of a more general space infrastructure capability. Furthermore, the agencies may begin to take greater interest in the development of a space-based industry – after all, OOS is the first step in this direction. Only then will the space environment be opened up for commercial development in a robust fashion. The manufacturers will be encouraged to alter their current “reliability-first” focus on spacecraft design and development towards including maintainability as part of their focus towards design-for-servicing, and indeed, to take a more proactive part in the development of OOS. The users, and the insurance community, may become more amenable to recovery of space assets rather than discarding them wholesale due to lack of accessibility. The primary result of OOS is to open up options for all aspects of the space business from the user, manufacturer and agency interest.

In conclusion, to address the many-factored issue of OOS and its future development, we agree that a dual track approach involving end-to-end technology demonstrators must be pursued. This development program must also be pursued with vigour and tenacity as soon as possible as a matter of urgency. The space environment is becoming increasingly populated with space assets, which are being driven to larger sizes, costs and lifetimes. The effect of this will be to slow down the reactivity of the space segment to advances in commercial services. OOS is the only enabling technology, which can overcome the limitations imposed by the space segment.