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A POSSIBLE MISSION FOR THE SUB-SET OF COSMOS SATELLITES WHICH PRODUCE ADDITIONAL OBJECTS DURING THEIR ACTIVE PHASE

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ABSTRACT

A sub-set of COSMOS satellites produces additional objects, a few at a time, irregularly throughout the active phase of their missions. Analysis of orbital element sets for these objects, generated soon after their detection, can, in some cases, determine the time of deployment with sufficient accuracy to permit consideration of their subsequent ground-tracks. It can be shown that such ground-tracks are suitable for the calibration of ground-based missile detection radars. Results of typical analyses are presented.

It is suggested that with the recent changes in the international situation there is no longer a need for such missions which contribute in small measure to the orbital debris population.

1. INTRODUCTION

In March 1962, the Soviet Union began to use COSMOS for the name of the majority of its satellites. This served to conceal the mission identities and to disguise failures which did not reach the intended orbits. The repetitive patterns of many launches for which no scientific results were openly published enabled the identification of the major military programmes for surveillance, communications, early warning and navigation. The term 'minor military' was used to embrace those missions which did not correspond to any particular classification (Ref.1).

The C-1 (or SL-8) was initially used to launch these payloads but, recently, the more powerful F-2 (or SL-14) has also been used. Various missions have been proposed but the majority are considered to be calibration flights (Ref. 2). Missions with presumed calibration rôles may be further sub-divided into those which do not produce additional objects, those which produce additional objects in clusters on only a few occasions and those which produce additional objects, a few at a time, irregularly throughout the active phase of their missions. The sporadic emergence and the small number of objects deployed with each event for this latter class led to the postulation that the additional objects, designated 'debris' by US Space Command and 'fragments' in *The RAE Table of Earth Satellites*, were shed deliberately to simulate MIRV attacks, providing targets for training the crews of radar units on the alert for a possible attack by multiple independently targeted re-entry vehicles and whose duty is to detect and/or engage such threats (Ref. 3).

Typical averaged UHF radar cross-sections for these objects lie in the range 0.1 to 0.2 m^2 (Ref. 4). They decay much more rapidly than their host spacecraft. They tend to be deployed in pairs in opposite directions. The history of this sub-set of satellites is well documented (Ref. 5) and need not be repeated.

2. METHODOLOGY

To test the MIRV-related postulation it is necessary to determine the ground-track following deployment of additional objects. The major difficulty arises in establishing the time at which the objects are deployed from the host spacecraft. The separation velocities relative to the host spacecraft are, in general, quite small and extrapolations from two-line element sets (elsets) are often inconclusive.

In a number of cases, use of special software (Ref. 6) permits identification of the orbit on which deployment has occurred. State vectors for the host spacecraft and recently deployed objects are generated at one-minute intervals from the earliest elsets of the deployed objects and the elset of the host spacecraft immediately preceding the appearance of those objects. These are used to generate ground-track files for the host spacecraft and each deployed object. A routine, which places the host spacecraft at the origin of co-ordinates, is used to derive in-plane and out-of-plane plots for the motion of a selected object relative to the host spacecraft.

3. RESULTS

Two events in June 1992 provide typical examples. The initial elsets for two objects, 1990-104AB and 104AC (21994 and 21995), had an epoch 92167.256. The available elset for COSMOS 2106, 1990-104A (20966), immediately preceding this had an epoch 92166.666. The motion of 1990-104AB, in-plane and out-of-plane, relative to COSMOS 2106 from 1600 UT, 14 June to 0600 UT, 15 June, in which time marks are shown at five-minute intervals, indicates coincidence some five orbits into the period (Fig.1).

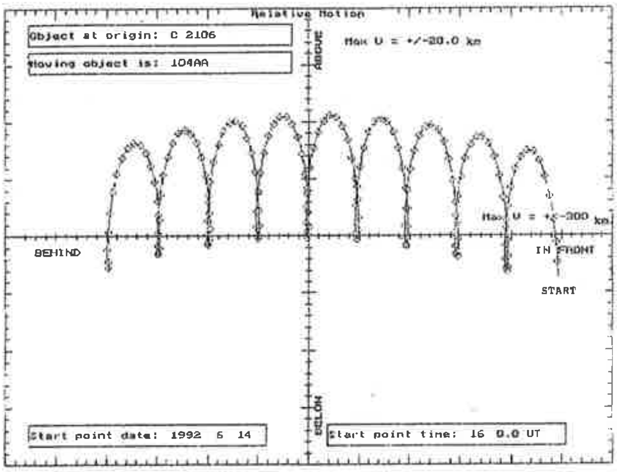

Figure 1. In-plane motion of 1990-104AA relative to COSMOS 2106, 14 June 1992.

A more precise determination of 2345 UT, 14 June, is possible by selection of a briefer period straddling the approximate time (Fig.2).

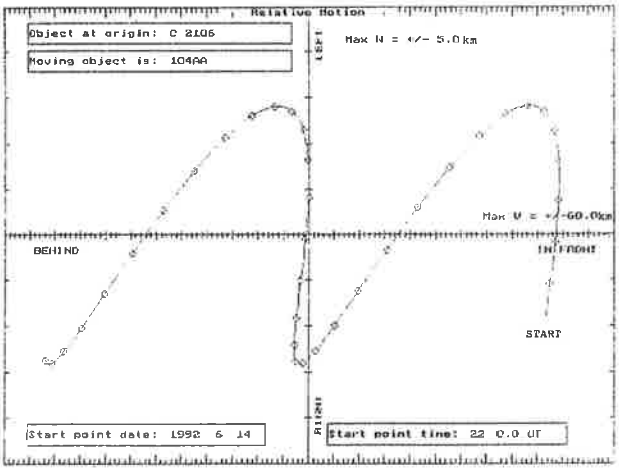

Figure 2. Out-of-plane motion of 1990-104AA relative to COSMOS 2106, 14 June 1992.

Corresponding plots for the motion of 1990-104AC relative to COSMOS 2106, though less precise, show the "approach" occurring from the opposite direction to that of 1990-104AA confirming opposite directions of deployment from the host spacecraft.

Great precision in the determination of the time of deployment is not essential for establishing the particular ground-track encompassing the deployment. Two preferred ground-tracks are noted. In one, deployment occurs on an ascending pass over the South Pacific Ocean. The ensuing ground-track passes over the western USA, Canada, to the north of Greenland, entering Russia from the direction of the White Sea (Fig.3). The other, used in the event of

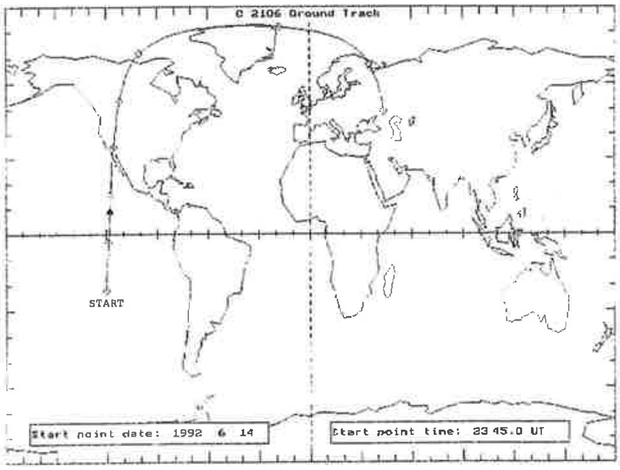

Figure 3. Ground-track of COSMOS 2106 immediately following the deployment of 1990-104AA and 104AB, 14 June 1992.

10 June, with deployment over Antarctica, passes northbound across Africa and enters Russia from the direction of the Black Sea (Fig.4).

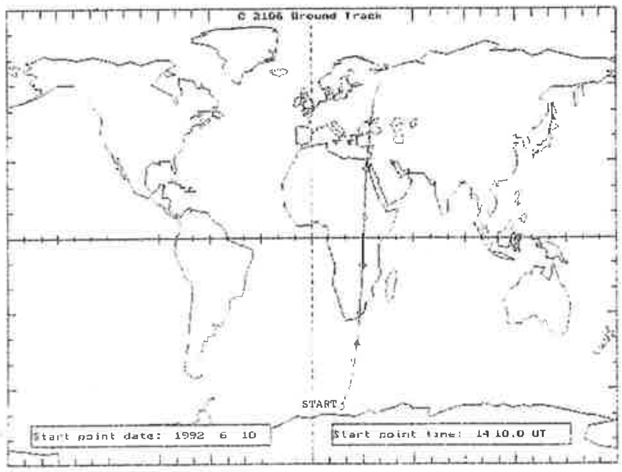

Figure 4. Ground-track of COSMOS 2106 immediately following the deployment of 1990-104X, 104Y and 104Z, 10 June 1992.

The preference for these particular ground-tracks suggests some purpose other than routine calibration. The MIRV simulation scenario is strengthened by noting that these trajectories are aimed very close to Moscow, the site of the only Antiballistic Missile (ABM) Defence system permitted for the USSR by the 1972 ABM Treaty (Ref. 7).
There have been no further launches in this sub-set

following the dissolution of the USSR but deployment of objects from COSMOS 2053, 1989-100A (20389) and COSMOS 2106 continued during 1991 and 1992. The last three objects from COSMOS 2053 were deployed on 5 November, 1991. By the end of 1992, 28 additional objects had been catalogued from COSMOS 2106. Although these objects contribute minimally to the orbital debris population it is suggested that, with the easing of international tensions, the requirement for such missions is no longer paramount.

4. REFERENCES

1. *Soviet Space Programs, 1971-75* (Overview, Facilities and Hardware, Manned and Unmanned Flight Programs, Bioastronautics, Civil and Military Applications, Projections of Future Plans), vol.1, Committee on Aeronautical and Space Sciences, U.S.Senate, 1976, 14, 408.

2. *Soviet Space Programs: 1976-80* (With Supplementary Data through 1983), part 3, Committee on Commerce, Science, and Transportation, U.S.Senate, 1985, 1109-1110.

3. *ibid,* 1109

4. *Satellite Catalog*, United States Space Command, 1993.

5. Johnson, N.L., *Soviet Space Programs 1980-1985*, vol 66, Science and Technology Series, American Astronautical Society, 1987, 133-137; *The Soviet Year in Space 1986*, Teledyne Brown Engineering, 1987, 48-49; *The Soviet Year in Space 1987*, Teledyne Brown Engineering, 1988, 76-77; *The Soviet Year in Space 1988*, Teledyne Brown Engineering, 1989, 81-83; *The Soviet Year in Space 1989*, Teledyne Brown Engineering, 1990, 86-88; *The Soviet Year in Space 1990*, Teledyne Brown Engineering, 1991, 92-94.

6. *Space Mission Expert*, Evergreen Engineering, 1990.

7. *World Armaments and Disarmament SIPRI Yearbook 1973*, Almqvist & Wiksell, Stockholm, 1973, 20-24.