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10 SEP 1970

MEMO TO: Col Sweeney, SS-1
Mr. Harry Davis

SUBJECT: HEXAGON Software Capabilities: IOC versus FOC.

1. Per your request on your visit to SAFSP on 26 Aug 70 the following information is provided:

a. The 'TUNITY (HEXAGON) software package is being developed in two phases. The Initial Operating Capability (IOC) provides all of the capabilities required to support a first flight on 17 Dec 70. The Full Operating Capability (FOC) phase includes those items which are (a) required to support hardware on later flights, or (b) highly desirable from an operational viewpoint.

b. For a description of the IOC capabilities, I have selectively incorporated a few paragraphs from the MS 4 engineering design document. This functional description should relate the scope and method of the IOC development.

2. IOC 'TUNITY:

a. Purpose of 'TUNITY

The purpose of the 'TUNITY Software System is to assist in the satisfaction of the photographic intelligence requirements specified in Para 2.1 by supporting the HEXAGON System operational data processing requirements. Specifically, 'TUNITY fulfills this purpose by performing the following tasks in a sequence that permits the timely satisfaction of the mission requirements.

(1) Mission Planning. The purpose of 'TUNITY in Mission Planning is to determine the maximum possible satisfaction of mission area targeting requirements, taking into account predicted cloud cover weather information as well as the vehicle/sensor/operational constraints and capabilities. 'TUNITY determines the specific optimum sequence of vehicle and sensor operations intended to maximize the intelligence value of the selected photography and maintains information pertaining to the degree of satisfaction of mission requirements.

(2) Command and Control. The purpose of 'TUNITY in Command and Control is to translate the sequence of required vehicle and sensor

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events into command messages to be transmitted to the orbiting vehicle. 'TUNITY also maintains a current status of the vehicle including the command memory image and predicted state of the vehicle subsystems.

(3) Mission Reporting. The purpose of 'TUNITY in Mission Reporting is to provide information to the intelligence community pertaining to the relative satisfaction of mission requirements. 'TUNITY also reports on the actual photography accomplished during the mission.

b. Functional Requirements

(1) Mission Planning

(a) Store and maintain descriptive information pertaining to the areas of interest to the intelligence community.

(b) Allow the intelligence community to select from all the areas the specific areas of interest for each mission.

(c) Allow the areas of interest to be changed dynamically, i.e., pre-mission, during the mission, post-mission.

(d) Allow the areas of interest to have easily modified relative intelligence values.

(e) Identify all the areas of interest within view of the sensor for specified time periods.

(f) Select the actual areas to be photographed subject to the maximization of intelligence value per unit of film expended.

(g) Determine and maintain the relative satisfaction of mission photographic requirements.

(h) Provide sufficient intermediate information to allow effective manual control over the above tasks.

(2) Command and Control

(a) Generate the commands required to allow the sensor and vehicle to accomplish the selected photography.

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(b) Translate the above commands into a conflict free command message or identify any conflicts that exist.

(c) Make the command message available to be transmitted to the vehicle.

(d) Maintain a ground based up-to-date image of the commands stored in the vehicle command memory.

(e) Provide sufficient intermediate information to allow effective manual control over the above tasks.

(3) Mission Reporting and Assessment

(a) Provide information pertaining to the photography accomplished in a manner that an assessment of the relative satisfaction of mission requirements may be made.

(b) Provide access for reporting of all of the information pertaining to the areas of interest and mission requirements satisfaction.

(c) Retain information for later use in the performance of the tasks of Para (1) and (2) above.

(d) Provide sufficient intermediate information to allow effective manual control over the above tasks.

c. 'TUNITY Functional Description

The 'TUNITY System performs the following major tasks as required:

(1) 'TUNITY performs mission objectives data management by generating and maintaining a central file of coverage requirements and the state of satisfaction of these requirements. This file is updated by manual modifications and by data generated internal to the software to reflect the latest status of the requirements.

(2) 'TUNITY performs sensor area visibility determination, predicting as a function of time the areas that will be visible to the sensor subsystem. This function not only filters out areas that will not be visible but prepares area acquisition data for operations selection processing.

(3) 'TUNITY performs mission performance reporting by generating display data for both the photography thought to have been accomplished and the current status of the intelligence objectives. In the mission coverage reporting, each reporting target that has been calculated as being in a camera operation is identified and located on the film for use by the intelligence community. The current status of the intelligence objectives is determined by retrieving data from the central file of intelligence requirements and achievements, utilizing parameter search techniques.

3. The FOC capabilities are best described using IOC for comparison. As I mentioned before, some of the FOC requirements are dictated by new hardware which will not be flown on the first few vehicles, the prime example of which is the mapping and stellar camera system. To support this system the following additional software is required:

a. Mission Planning. Identification of all areas of interest within the mapping camera's field of view. Selection of areas to be photographed based on mapping and intelligence requirements and subject to the amount of film available.

b. Command and Control. Generate commands required to allow the mapping camera to accomplish the selected photography and include these commands in a conflict-free message.

c. Mission Reporting and Assessment. Provide mission history so that an assessment may be made of satisfaction of mapping requirements. Report on all areas of interest and point targets photographed by the mapping camera.

The remaining FOC capabilities are provided to support the operation in a manner which reflects the intent of the original Statement of Work as amended by approved ECPs. The major areas include automatic generation of vehicle maneuver events, monitoring of the status of various vehicle systems, use of climatology data in the selection preprocessor and automatic vehicle attitude error and frame reference time feedback. Three of these capabilities are performed manually in IOC. Vehicle maneuvers are performed by the system software (not 'TUNITY) with a great deal of manual operator intervention. The FOC design allows 'TUNITY to automatically call out the proper system routine. Monitoring of the vehicle is done strictly

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by hand calculations in IOC. The FOC design models the vehicle's power, propellant and film handling systems. Frame reference times are required to correlate the vehicle position with the actual optical bar position. This data comes from telemetry, and the cards are hand punched in IOC. The FOC design provides a direct interface, via the data base, between the telemetry data and the mission performance reporting software. The other two capabilities are new in FOC. The weighting function will include a new parameter which accounts for the historical (climatological) probability of a target's cloud cover. The final capability is the inclusion of vehicle attitude errors in the mission performance report. This data comes from telemetry and is automatically added to the commanded pointing information to determine exactly which areas were photographed.

4. There are, of course, documents available which describe the software to a much greater detail. The Milestone 2 which is the design baseline, and the Milestone 4 which is the engineering design and software description are available if you would like to examine any portion of the software in greater detail.

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