Eworks Development Status Report

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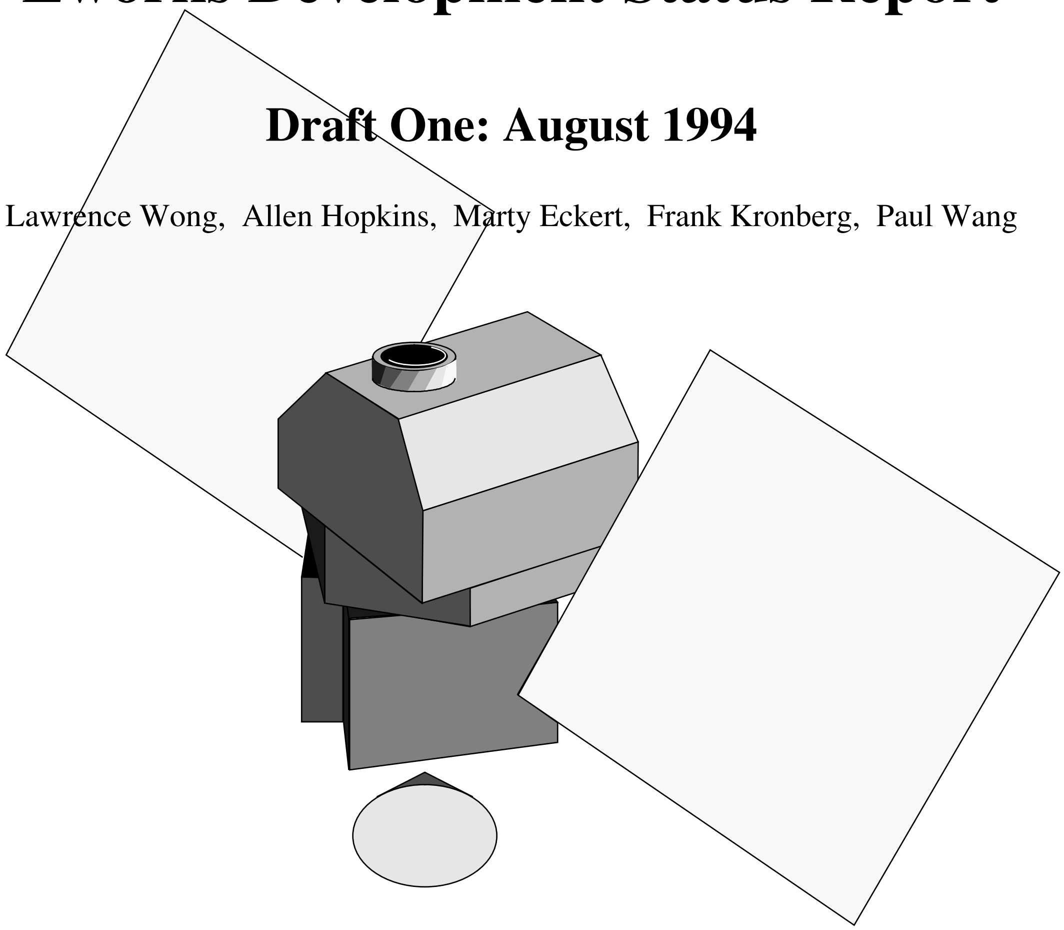

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I. Overview

Eworks is a rule-based expert system telemetry monitoring application using the RTworks software package from Talarian. It is being developed by the EUVE software development team at the CEA (Center for the Extreme Ultraviolet Astrophysics) at UC Berkeley. RTworks can be used to develop and run distributed applications for real-time monitoring, analysis and display of complex systems.

The goal is to have this expert software monitor the EUVE payload autonomously 24 hours a day, 7 days a week. It will also page the Anomaly Coordinator for the ESOC (ACE) for corrective actions when anomalies are detected. A by-product of Eworks development and evaluation process is a test-bedding baseline that applied to future software packages which could be incorporated into the ESOC's operational software.

II. Development

1. Flow Chart Development

A series of the EUVE payload subsystems flowcharts was developed by the EUVE operations team and approved by the EUVE scientists. These approved flow charts were coded into rules that Eworks uses in monitoring the payload. The first series of flowcharts consists of the following payload subsystems which are considered essential to monitor for the health and safety of the payload. Following each subsystem is the listing of associated system status that Eworks checks for the payload's health.

- Overall Health

    Realtime telemetry arrival
        (Has realtime telemetry arrived within a specified time frame?)

    Top level status check
        (Clock updating? RIFs and TIFs power on? CDP patched?)

    Detectors functioning?

    Rate shutdown functioning correctly?

- High Voltage

    Programmed high voltage limit checks

    Special observation configuration

Detector high voltage read-back limit check

High voltage status appropriate for Day/Night?

- Power limit checks

CDP current

Detectors voltages and currents

RIF voltages and currents

TIF voltages and currents

- Command Echoes

Command counts
(Is increase in command counter accompanied by command echoes?)

Command echoes
(Any instrument error messages received requiring attention?)

- Thermal limit checks

CDP temperature

Detectors temperatures

RIF temperatures

TIF temperatures

Mirror and focal plane differential temperatures

The first version of Eworks was released on July 5, 1994 with limited payload monitoring functionality. Eworks is currently being run in parallel with the existing payload monitoring software which requires operator intervention during the realtime passes on a 24-hour-a-day basis.

2. Eworks architecture

Eworks is configured and being developed on a network of Unix workstations and servers in a distributed environment. Eworks is a collection of programs built upon Talarian Corporation's RTworks realtime data monitoring tools. The programs include the following modules:

- euvertdaq Data Acquisition module

- euvertie Inference Engine module

- euverthci Graphical Human-computer Interface module

- euverttr Telemetry Reception module

- rtserver RTworks Data Server module

The Eworks architecture is shown in figure 1. The data acquisition module reads telemetry as it is received at the ESOC, extracts the engineering health information from it and passes that on to the data server which makes it available to the inference engine, human-computer interface and telemetry reception watchdog modules.

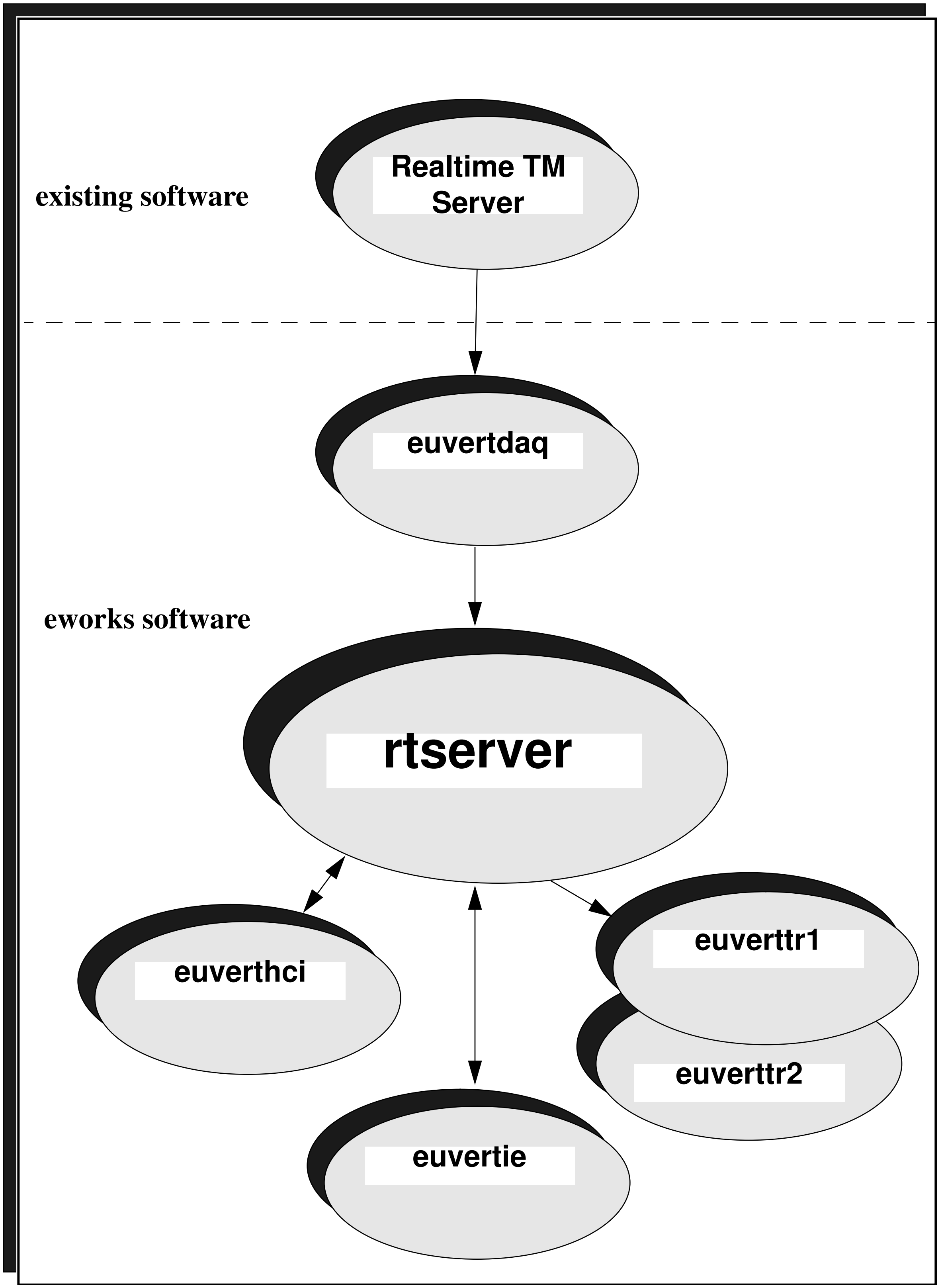
The inference engine module monitors the health information using rules written here at the CEA and pages an ACE if any problem conditions are found.

The two telemetry reception modules monitor the absent of telemetry for prolong periods of time. Presently, one module pages the ACE if the ESOC's telemetry reception has been absenced for longer than six consecutive hours and the other module pages the ACE to prepare to shut down the payload if absence of telemetry exceeds sixteen hours.

The human-computer interface module can be used to display graphical representations of the state of the payload.

These modules use network protocols to communicate with each other and so can be run on separate machines if desired.

Figure A: **Eworks Architecture**



III. Stress Test Environment

Testing and evaluation of the released Eworks is in progress in both the development and operational environments. The test data is compiled primarily from the ESOC logbooks and the data discrepancy logs (DDLs) and classified as follows:

Type of Anomalies	Descriptions
seu	Single Event Upset (cosmic ray hits to payload electronics)
ool	Out of Limit of Payload Monitors
eng	Engineering Test Data (i.e., high voltage power supply or detector test)
obs	Special Target Observations (i.e., moon, bright targets)
others	Other Anomalies (i.e., power shed, clamup, etc...)

Each test data set is compiled with a complete description of the anomaly including the time the anomaly occurred and the related errors seen in the telemetry data. This is accomplished through analyzing the anomaly with the corresponding flowcharts.

In order to determine the number of errors expected, we used a combination of the anomaly or test descriptions, logbooks, and data products obtained by decommutating the data with the End-to-End System software (EES). We use that information in conjunction with the flow charts to determine the number of expected errors.

In some cases our knowledge and experience were enough to determine the number of expected errors from the description of the anomaly. Reading the logbooks enabled us, in some cases, to determine exactly what happened, and, again, we could use experience to determine the expected errors. For the more complex problems, there simply was not enough specific information in the logs and we had to resort to looking at data products, i.e., limit transitions and the command echoes to make the determination. The number of errors expected is a function of the software that we were testing and could increase as the software becomes more sophisticated.

Eworks is tested with the realtime anomaly test data and cross checked with the production data covering the same time period when the anomalies occurred. The important things that we looked for in this first phase of stress testing were the following:

- whether a particular anomaly that occurred at a specific major frame was detected by Eworks and Eworks accurately displayed the corresponding error and alert messages

- whether a glitch in the realtime telemetry caused Eworks to stop functioning

- and whether telemetry glitches triggered erroneous warnings

IV. Tasks in Progress

Testing of Eworks is in progress using the normal telemetry and the anomaly data set compiled since EUVE launch. A new flowchart developed for the payload configuration during special observations has been submitted to the EUVE scientists for approval. We are resolving the outstanding issues of the Eworks flowcharts for future implemention.

The changes made to the flowcharts have been submitted to the Hardware Scientist John Vallega for his approval. These changes involve

- the identification of day, night, dawn and dusk crossing in the telemetry stream

- rate shutdown algorithm

- detector high voltages and differential temperature tolerances for the mirror and the focal plane

The following outstanding issues are being resolved

- the ability to implement external parameters for Eworks to reference for expected events (i.e., special observations and engineering tests) and anomalies within a specified time frame

- define and refine the ESOC's activities involved in the simulation run over the September and October 1994 period

V. Tasks Planned for the Upcoming Months

The telemetry team will be continuing with the regression testing of Eworks. The test environment and testing procedures will be updated based on lessons learned through the first phase of Eworks testing. The TBD (To be determined) sections of the existing flowcharts will be updated as we become more knowledgeable in dealing with difficult cases. Additional flowcharts for the remaining payload subsystems will be developed in the upcoming months.

VI. Test Results

1. Stress Testing in the Development Environment

The results from stress testing Eworks with anomaly data is compiled, analyzed and presented in table 1. The first column indicates the date (year, month, day) that the event occurred followed by a key word referring to the type of anomaly data used in testing Eworks (see Type of Anomalies descriptions in the table above).

The third column indicates the total number of errors Eworks is expected to detect which are the numbers compiled by analyzing the events with the EES software and the flowcharts. The fourth column indicates the number of errors detected by the current version of Eworks. In some of the tests the number of errors detected is greater than the number of errors expected. This is due to the tight tolerances in some of the limit constraints.

We found two cases in which Eworks did not catch instrument settings that changed for the testing of different configurations for special observations. This error has been corrected by introducing a new "Special Observation" flowchart to deal with special configurations.

(Notes on Table 1 which follows on next page)

If any monitor went out of limits and the EES software reported a violation of both yellow and red limits, only one error was counted.

* We decommutated the file associated with the archiveID number in which the event occurred. This number is a lower limit.

\# For the SEU's detected by the dumpallram that are listed here, the ISW that would implement the check for whether the CDP was patched had not been installed, so no errors are expected.

@ Hopr should be out of limits when detectors are at half voltage during orbital night.

IP Indicates testing in progress

Table 1: Stress Testing Anomalies

Dates	Description	# of Errors Expected	# of Errors Detected
920814.eng	daytime data; detectors on in day	0	0
930324.eng	WSZ Test	0	0
930601.eng	WSZ Test	0	0
930711.eng	WSZ Test	0	0
930731.eng	WSZ Test	0	0
940312.eng	WSZ Test	0	0
940327.eng	WSZ Test	0	0
940330.eng	WSZ Test	0	0
940429.eng	WSZ Test	0	0
940507.eng	HV Test	10	IP
931112.ool	Tif6IonC red for a few frames	0	0
931215.ool	Tif4+Rf under red for a few secs	1	IP
931116.others	Power shed clamup	15	IP
920820.seu	Cdp reset, Tifs, Rifs were off	10*	25
920927.seu	Detector 5 at 50% voltage.	1	IP
921218.seu	Tif7 Reset.	3	7
930322.seu	CDP reset, TIFs, RIFs, off, Sunsensors disabled	9*	50
931107.seu	Clam-up during EOR uplink in R/T	14*	IP
931124.seu	CDP reset, Payload in TO mode, occurred in R/T	3*	IP
940110.seu	SEU detected by dumpallram	0#	IP
940218.seu	SEU detected by dumpallram	0#	IP
940411.seu	CDP reset, TIFs, RIFs, off, Sunsensors disabled	16*	IP
931103.obs	Reconfigured for moon (1-3+7 off)	6@	5
931115.obs	Det1,2,3off	3@	3
931125.obs	Det 1,2,3 off for Feige 24	6@	IP
931129.obs	det 1-6 off, allwsz, det7 on and blanked	12@	IP
931203.obs	Moon (1-3+7 off)	8@	IP
931205.obs	lower voltage for H 1504 (U Gem?) obs (1-3 off)	6@	IP
931219.obs	det 3 off for Beta CMa obs	2@	IP
931221.obs	det 1,2,and 7 off	6@	IP
931224.obs	det1,2,3,7 off for moon, shutdown rates chg	8@	IP
931229.obs	two rt passes/det 3,7 off at end	4@	IP
931230.obs	det 3,7 off	4@	IP
940129.obs	Detector 1,2,3,7 off, rate shutdown changed	8@	IP

2. Testing in the Operational Environment

In addition to the Eworks stress testing in the development environment, testing is also done in the operational environment where we run Eworks in parallel with the existing payload monitoring software called SOCTOOLS.

When anomalies are detected by Eworks, the SOCTOOLS displays are used to verify that Eworks is detecting the anomalies correctly. Eworks problems encountered in this environment are logged as an ESOC data discrepancy log (DDL).

Table 2. shows the listing of ESOC DDLs relating to Eworks problems. The descriptions of the problems and the status of the resolution to the problems are also shown in the table.

The DDL# indicates the data discrepancy log number assigned to the problem and the EPR number is the EUVE Problem Report number assigned to problem which needs further analysis. The status "Open" indicates problem under investigation and "Closed" indicates problem solved and the resolution implemented in the next version.

Table 2: DDL Report

DDL #	Date	Status	EPR #	Description
1119	7/07	Closed	 1382 1383	Received errors in EWorks at beginning of pass. CDPclock did not update as expected ccnt changed 48>64 but there were no command echoes
1120	7/07	Closed	 1384 1385 1386 1387	Ework's errors during Frank's shift RTdaq: "Unable to keep up" RThci: "Type mismatch..." RTie: no license rttr.out: undefined symbol
1123	7/08	Closed		Eworks errors relating to DDL #1120
1124	7/08	Closed		Eworks errors relating to DDL #1119 and #11120
1126	7/09	 Oped Closed	 1388 1389	Eworks errors during Paul's shift "Det6HVlt wandering" "Failure to achieve Rate Shutdown"
1127	7/09	Closed		Eworks errors relating to DDL #1126
1128	7/10	Closed	1390	ADct 2 zero for 3 frames
1129	7/09	Closed		Eworks shows Det1 ADct 0 for 3 frames Error relating to DDL #1128
1133	7/16	Closed	1398	Eworks script not creating working directory
1134	7/17	EPR	1397	Eworks shows "Det3HVlt wander" warning when Det 3 HV command sent
1135	7/17	Closed EPR	1395 1396	Det3Hopr violating LOWER YELLOW limit Rate shutdown change
1138	7/20	Closed	1403	Tel3 violating thermal control
1139	7/24	Closed		Rif1Cur and CDPPwrV showed a sad face state but the status flag showed green
1141	7/27	Closed	1407	RTworks did not process data for R/T pass euvertdaq exited during a telemetry glitch
1143	8/03	Closed	1410	Could not bring up eworks on the SOC net
1144	8/04	Closed		Unable to kill Eworks in a directory not writable by me Action: this has been fixed in a new version
1151	8/09	Open		Eworks did not notice that Det5RSrt or Det7Blnk are out of limits
1152	8/10	Closed		RTworks failed to process R/T data error relating to DDL #1141

3. User Interface Evaluation

In addition to systematic testing of Eworks, functionality of the Eworks' user interface implementation is also evaluated by the ESOC personnel. The following feedback has been compiled:

1. It would be very useful to display all the monitors with the last 10 or 15 frames of data so that one can look at how a monitor reading has been progressing for the past 15 seconds. Currently, only the power system has this feature.

2. Color shade the limits in the plots to give an idea of the monitor's readings relative to the limit boundaries.

3. As a diagnostic tool, it would be useful to be able to bring up the flowchart associated with the monitor in trouble and have the path to the troubled node in the flowchart highlighted. This would allow us to quickly obtain useful information for speedy corrective action.

4. It would be useful to have the ability to bring up a graphical representation of the subsystem in trouble and highlight the component associated with the anomaly.

VII. Summary

Based on the Eworks test results compiled, Eworks is found to be able to detect most of the anomalies in the test data at the correct time. A few of the constraints were missed due to special cases not considered in our first flowchart development. We will continue optimizing the flowcharts as testing and use of Eworks progress.

Glossary

ACE	Anomaly Coordinator for the ESOC
CDP	Command Data and Power interface unit
DDL	Data Discrepancy Log
EPR	EUVE Problem Report
ESOC	EUVE Science Operations Center
EUVE	Extreme UltraViolet Explorer
End-to-End	Design analysis tool for the EUVE project
Hopr	Programmed High Voltage
ISW	Instrument SoftWare
RIF	Relay InterFace unit
SEU	Single Event Upset
TBD	To be determined
TIF	Telescope InterFace unit