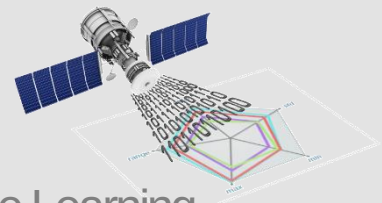
Context Aware Spacecraft Telemetry Checking



Satellite Health monitoring by means of Machine Learning

CASTeC is a software tool intended to ease the labour-intensive task of spacecraft telemetry checking, by automating the telemetry signals trend analysis and the detection of anomalous behaviours and novelties.

It provides a **predictive** and **proactive** monitoring based on data mining and **innovative machine learning techniques**, so allows to relieve the Flight Control Engineers from manually setting alarm and warning thresholds over the thousands of parameters of housekeeping telemetry shaping satellite's health status.

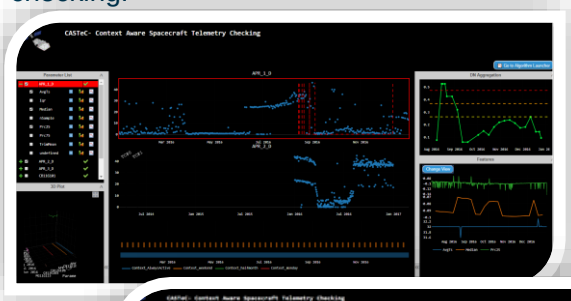
CASTeC learns from the nominal system behaviour, derived either from models and simulations, or from real telemetry data labelled by operators during routine operation.

The telemetry checking is performed by evaluating a large number of statistical features over distributed time intervals, identifying the significant ones and comparing them with reference values.

When a feature deviates from these references values, autonomously defined, the tool highlights the novelty or the trend anomaly in the parameters, raising alarms and warnings based on smarter criteria than usual simple signal range check, and, in addition, with thresholds that are autonomously tailored by the application.

CASTeC output information consists in the S/C **nominal behavior characterization** and the **check output**, which is a **priority score** assigned to all telemetries indicating the degree of novelty of the parameters in the checked period. This allows users to focus on most relevant events and novelties first.

A further great advantage of CASTeC is that it works "**context aware**", which means it is able to distinguish several different nominal behaviors, related to satellite position in the orbit track (e.g. Earth/ orbiting body distance, sunlight or umbra…) and subsystems' status. Knowledge of the operational conditions increase the effectiveness of AI algorithms, allowing to significantly enhance telemetry checking.



Thanks to its autonomous, continuous learning capabilities, to the possibility of comparing long time series, to detect the novelties and thanks to the advantage of "context" based analysis,
CASTeC will make the telemetry monitoring operations effective and straightforward, enabling predictive strategies and reducing the operational costs while increasing spacecraft operations safety.
This especially fits to the *Space 4.0* key principles and will be effective in view of the management of the forthcoming large constellations of small satellites.

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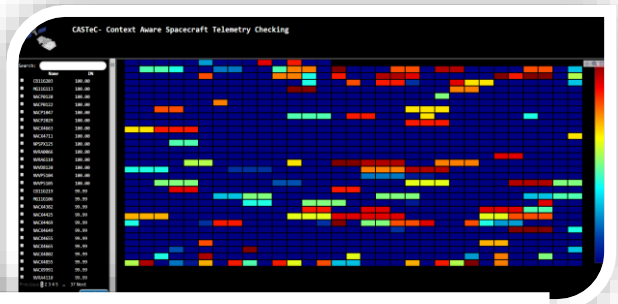
FEATURES:

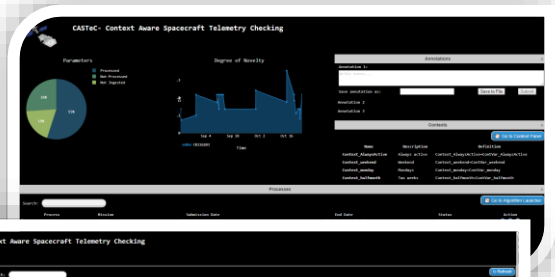
- Autonomous mining of monitoring key features
- Autonomous thresholds learning
- Autonomous anomalies detection
- Contexts management
- Synoptic views of the health status of the spacecraft
- Housekeeping drill down and cross-comparison
- 3D models and videos for advanced investigation
- Collaboration tools for analyses sharing and discussion
- Report generation

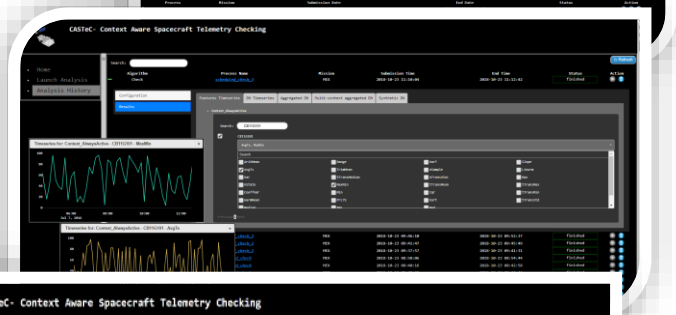


Its graphical interface provides a toolset intended to a quick and friendly browsing and drill-down of the (huge) telemetry time series; provides navigable views like heatmaps (also animated as video sequences) and 3D satellite models highlighting sub-systems according their detected health status.

It also integrates dashboard and team collaboration tools for sharing the results of each flight engineer custom analysis.

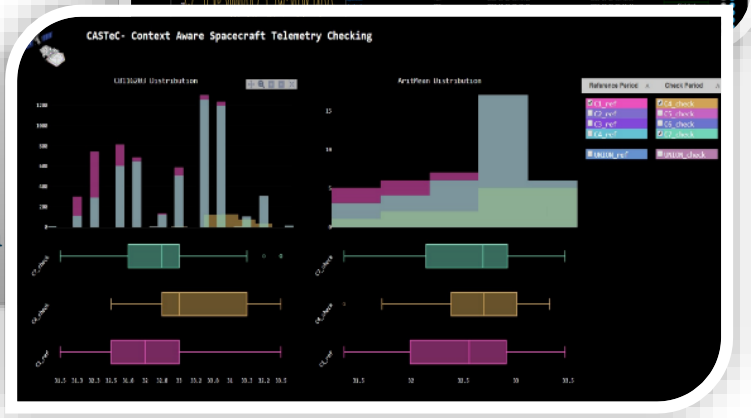
System is based on **Docker** containers that collect each component of the system so to make it very modular and ease the installation on different environments.





CASTeC allows to integrate AI algorithms, configure and execute them in a **Spark** environment.

The graphical user interfaces exploit Web Technologies, REST interfaces are adopted at system's components level and JSON structure format for data exchange.



TECHNOLOGIES:

- Spark
- Docker
- NodeJS
- ElasticSearch-Logstash-Kibana
- Python

CASTeC has been developed by S.A.T.E. and Planetek in the frame of a contract with the Advanced Operations Technology group at ESOC. The view expressed herewith shall in no way be taken to reflect the official opinion of the European Space Agency.

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