RAPTOR: From heterogeneous data to actionable information in AIT

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ABSTRACT

The objective of this paper is to present RAPTOR, a software solution developed by OHB AIT Software team to support assembly, integration and test (AIT) to find, explore, and share data-driven insights to identify and solve problems. RAPTOR easily creates and distributes compelling analysis reports and eye-catching graphs that guides users to actionable information and enabling confident decision-making.

INTRODUCTION

Within AIT test campaigns, the main purpose of an analysis/report is to investigate anomalies, report any misbehaviour and eventually take corrective actions. This process involves many stakeholders like test engineers, subsystem engineers, but also software engineers, amongst the others. The landscape of skills, competences and needs is quite diverse. The AIT reaction time to the problem plays a crucial role, and both the amount of data and their diversity (types, formats, standards etc.) increases the complexity of the problem. Nevertheless the problem can be identified by analysing the data.
Data needs to be translated into **actionable information** in a reasonable amount of time (during a Thermal Vacuum Test, for instance, this time is hours). Therefore, the report is not the goal but the mean to take corrective actions.

THE TOWER OF BABEL

In the AIT domain, multiple sources of information are available: the spacecraft, the EGSEs and the simulators, and each of them contributes to the puzzle of testing, with its own trove of data. In its original systems, this data is stored like grain in silo on a farm is closed off from the outside. Actually, data silos are an example on how technology can inhibits collaboration and problems solving, because it's pretty common that not everyone uses the same terminology and the same technology in their systems to record data and create problem reports. In the biblical literature, the construction of the tower of Babel was never completed because the worker could not understand one another: the lack of the same language was a barrier to effective collaboration.

Remove the barrier to collaboration: Harmonization

In order to understand an anomaly, testers needed to see outliers, trends, and the cause and effect across data sets (e.g. telemetry reports, critical events, telecommands acknowledges). RAPTOR aims to bring together all data in one platform to enhance collaboration among stakeholders, improve the users experience and foster data-driven decision making. Moreover a RAPTOR analysis can be stored in the data pool and can be shared amongst the team to enable internal collaboration and boost the teamwork

But even getting all data together without unifying data types or getting naming convention standardized, the data acquired during test campaigns will be still in different formats. Side-by-side reporting is no more useful than analysis in the original tools themselves, thus a harmonization process is needed.

Extract, Transform, Load (ETL)

RAPTOR harmonizes data through a tree steps process: extraction**,** transformation and loading [2] [3]. Those are three operations responsible for actually moving data into a common data pool. Extraction reads the data in the original database, transformation changes the format so it's ready for querying and analysis, while loading writes the data to the destination database [Fig. 1].

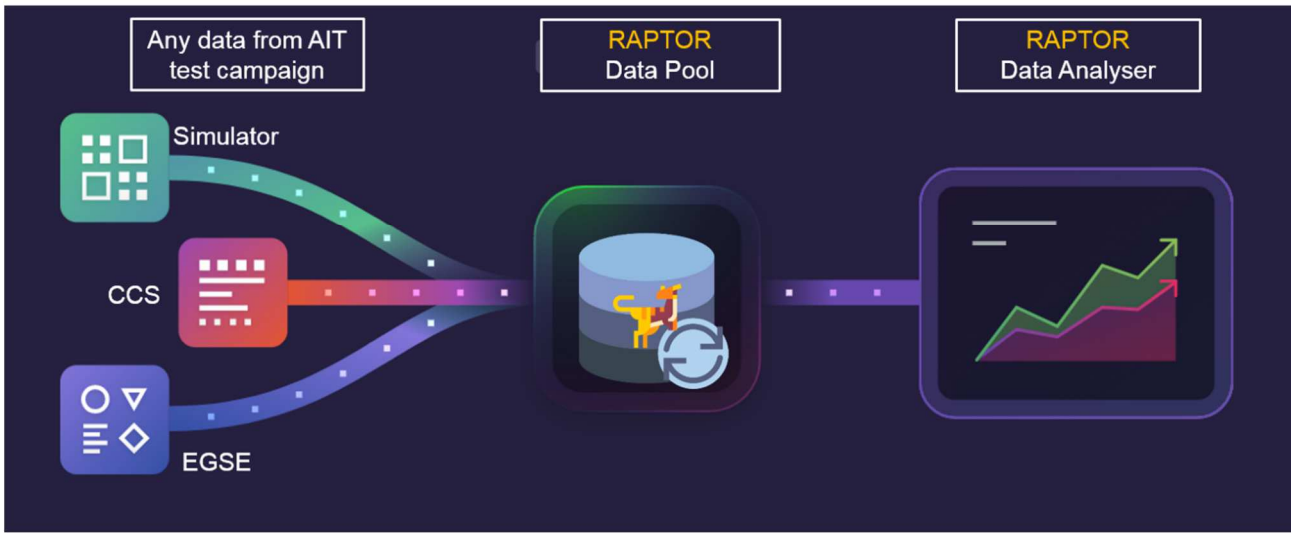

Fig. 1: From heterogeneous data to actionable information

USER EXPERIENCE DESIGN

On top of the harmonized data RAPTOR provides a data analyzer [Fig.1]. This is a user interface (UI) meant to provide the users with an experience as good as it can possibly be. The relative design, which focuses on the layout and its functionalities, is just part of the whole user experience, which aims instead to achieve a more extensive, and therefore more useful result [4].

Know Our User

RAPTOR is intended for a very special environment: space-craft AIT test campaigns. It is hard to imagine another field of engineering science bringing together expertise and resources from so many diverse scientific disciplines [1]. In order to design RAPTOR, the biggest challenge to face was not to understand what the different users want, but what they actually need. As a matter of fact, desires are just outgrowths of needs and if we can address these, we'll satisfy their wants while also fulfilling more fundamental requirements. Here are the principles used:

- The design is built starting from a deep understanding of the users, their tasks and environments.
- Users are involved throughout design and development, and their feedbacks are significantly taken into account.
- The process is iterative: users will always be in the loop.

Give Fast Feedback

RAPTOR works with big amount of data: in one day of test the average amount of data collected can exceed 50 GBytes. It is very likely to make the users waiting several seconds before obtaining the desired information. Fortunately nowadays, all personal computer and workstations come with multiple cores processors. A core can be seen as a little processor within a processor [Fig. 4]

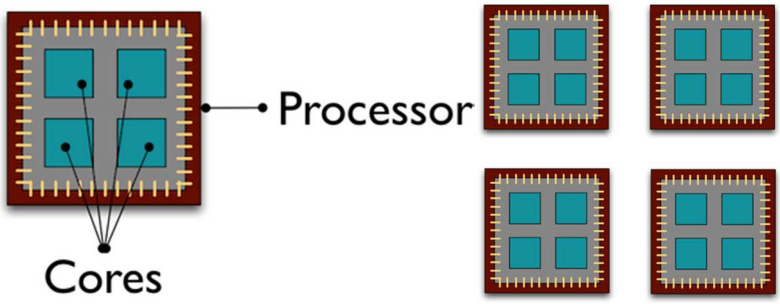

Fig. 2 Processors (CPUs) and Cores

RAPTOR leverages the full potential of this philosophy: in this way, the code will be more human readable, less error prone, and self-adjusting in proportion of the number of cores available. So the users will be sure that RAPTOR will always exploit the full potential of the available hardware.

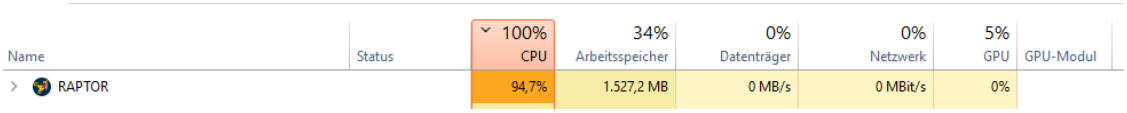

Fig. 3 Usage of all the CPU resources

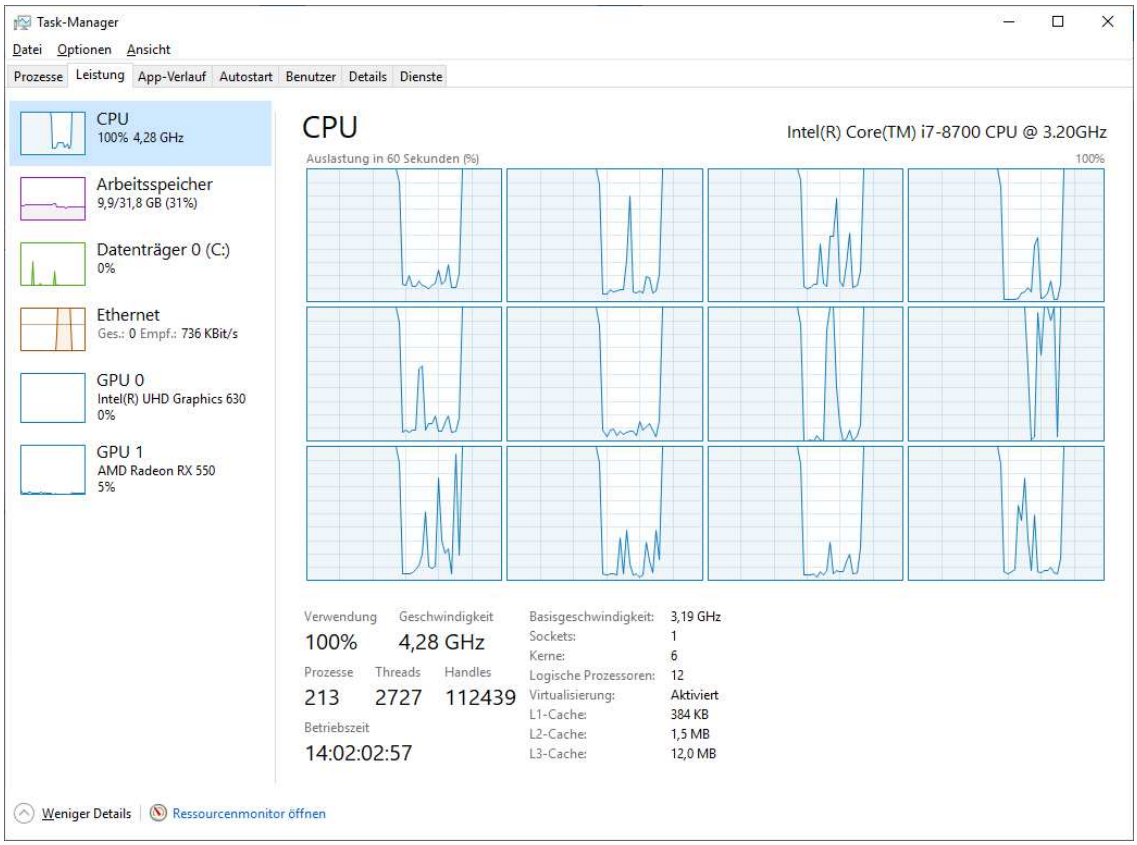

Fig. 4 All 12 cores used

Visual Battle: Tables vs. Graphs

At the very core RAPTOR provide a data-driven message to the users. The data can be listed in a table or depicted over a graph. Both approaches have pros and cons. Again, the users' requirements drove the design and the development to achieve the best choices. The most important thing we understood is that user interact very differently with these two types of visuals.
Tables, with their rows and columns of data, interact primarily with user's verbal system. They read tables.
Users consider tables very useful when their need is to:

- Look up individual values.
- Compare individual values but not entire series of values to one another.
- Evaluate information with more than one unit of measure.
- Have additional features like searching for a specific value or filtering through the data, amongst the others thus making the whole activity easier

Graphs, on the other hand, interact with user's visual system. The visual system is a high bandwidth information flow from what our eyes see to the comprehension in our brain, which can be extremely powerful. Graphs can present an immense amount of data quickly and in an easy-to-consume fashion; they are particularly useful for showing how different things (variables) behave and also relate to each other.

RAPTOR promotes a **win-win** mind set: in the data visualization battle of tables against graphs both win.
A **double fold data visualization** is used. For each data analysis both graphs and tables are created and then connected, as the transition from one point listed in the table to the corresponding one over the graph [Fig. 2], and the other way around, is possible [Fig. 3]. With such an approach the user will have a broader overview over the results at his disposal.

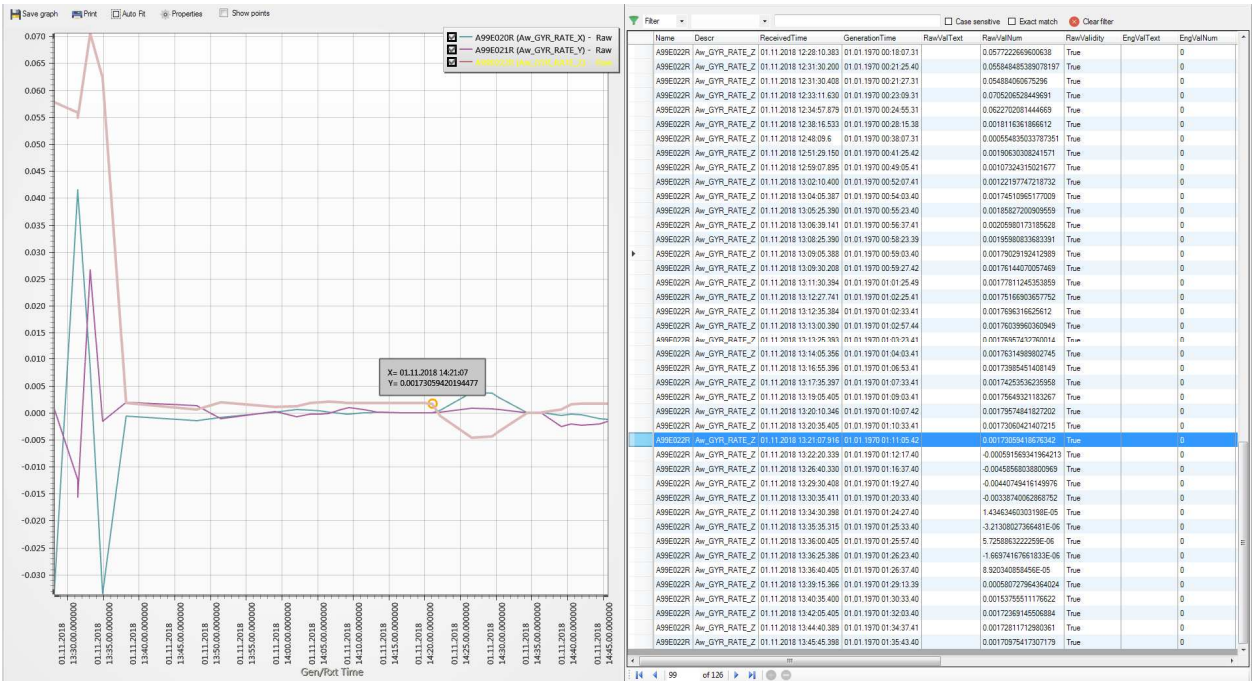

Fig. 5 Jump from graph to table

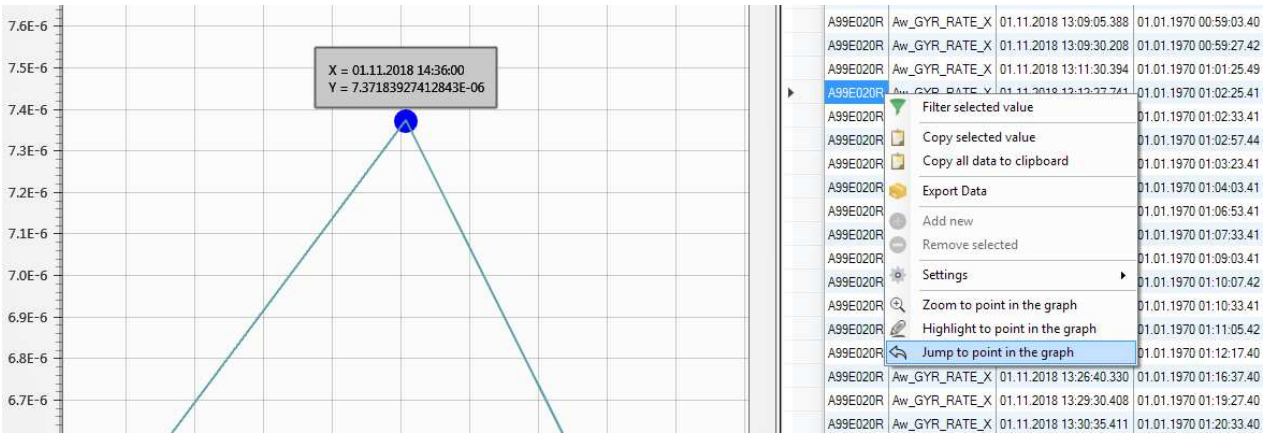

Fig. 6 Jump from table to graph

CONCLUSION

Data visualization and analysis plays a pivotal role when working with various data source during AIT test campaigns. Once the flow of data is harmonized and represented by graphs and tables, decision making becomes much easier. In order to meet the user's expectations, RAPTOR provides:

- Capability to process and harmonize multiple types of incoming data from CCS, simulators and EGSEs alike.
- Capability to apply various filters to adjust the results.
- Capacity to underline patterns in data not traceable otherwise trough interconnected graphs and tables.
- Capability to provide collaboration options to brainstorming on data and make rapid decisions.
- Capability to ask more questions about test results.

The usage of RAPTOR creates an environment that encourages creativity, out of the box thinking, and increased critical and analytic analyses.

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REFERENCES

[1] Wilfried Ley, Klaus Wittmann, and Willi Hallmann, "*Handbook of Space Technology*"
[2] https://en.wikipedia.org/wiki/Extract,_transform,_load
[3] Zhao, Shirley,"*What is ETL? (Extract, Transform, Load) Experian*".
[4] https://www.usability.gov/what-and-why/user-centered-design.html