Data center supportability using predictive analytics

Vikrant Dhimate, Sachin Desai, Mark Stratton, Kuldeep Sharma, Susanta Adhikary
Compute Cloud
vikrant.mah.dhimate@hpe.com, sachinmd@hpe.com, mark.stratton@hpe.com,
kuldeep.sharma@hpe.com, susanta.adhikary@hpe.com

Abstract

Managing multi-site data center on-prem or cloud-based is a challenge as there are a lot of compute, storage, and networking devices. These data centers produce a large number of user alerts that may load the trouble-ticketing system and takes longer time to resolve the issues. Also, sometimes due to time bound maintenance window the support team may end up in the replacing of good hardware resulting cost to the user. Hence the capability of a self-healing, predictive and trend analysis has been in demand for enterprise data center applications. Self-healing driven by the insights of predictive algorithms helps in reducing the load on the trouble-ticketing systems, mitigating data/management traffic outage, clearing the false positive notifications, and saves dollars.

HPE OneView (OV)[1] is a converged infrastructure management software for HPE hardware that simplifies data center management. OV allows users to configure and monitor the servers, storage, and network resources via a single global dashboard. When OV detects an anomaly condition with managed/monitored infrastructure, it notifies the user via alert/task and records it in a log file.

As part of Compute group, we are designing and implementing a cloud based OneView manager for OV to scale HPE hardware multi-site management. This aligns with the HPE edge-to-cloud initiative. The OV cloud manager[2] act as orchestrator to perform the task.

The cloud adaptor, an integral part of OV is subscribed to critical alerts and task failures. On receiving events, OV agent notifies the OV cloud manager with the required metadata. Since the OV cloud manager is aware of multi-site configuration, helps OneView Analytics Service (OVAS) – "the decision intelligence component", that can predict the resolution for the similar conditions occurring on the other enrolled OV instances. If OVAS finds the issue is fixed in the newer release of firmware, then as resolution it will notify the OV instances to update firmware. If user consent is already registered then, it will schedule a firmware update. Also, based on the OVAS response OV cloud manager performs non-disruptive self-healing operation to mitigate anomaly and effectively reduce the number of tickets.

Problem statement

In an enterprise data center, managing hybrid IT is a challenge for the Infrastructure Administrator as well as HPE support team due to the scale of a modern data center in a larger ecosystem. The major pitfalls in the traditional analysis process/tools are, that they require expertise, they are labor-intensive, error-prone and the learnings of a one instance may not be directly applied to occurrence on another data center. Also, it is very cumbersome activity to identify the sequence of operations to recover the condition by going through the multiple alerts/activity on different managed resources, identify the false positive alert and clear the notification within a short time. Identifying the root cause for an anomaly may be tricky if it is impacting the multiple resources. As an example, an issue with frame link topology may leave server hardware, server profile, enclosure or/and interconnects in a critical state when wrongly configured. Due to a lack of knowledge in the log analysis, cost management/data traffic outages may lead to production downtime resulting in halting of business or losses due to replacement of good hardware.

It's tough to get early insights or futuristic view of hardware wear and tear, carbon footprint (frequent raise in power utilization) etc. without trend analysis. Trend analysis allows predicting what's going to happen, based on what's already happened. It provides information regarding device performance and enables one to make data-driven decisions with regard to future events.

Our solution

Here we introduce the OneView Analytics Service, in integration with OV cloud manager. Figure 1 below shows a high-level block diagram of architecture elements of our solution. The OVAS performs tasks like detecting anomaly and false positive alerts, understanding series of alerts on related resources, and providing precise recovery steps. Also, predicts occurrences of similar conditions on other data centers without violating security. Provides recommendation on firmware management of OneView ecosystem including managed devices and cloud adaptor based on historical data. These insights can be integrated with product release notes, bug tracking tool JIRA, support dump analysis tool Herkules. Solution also provides trend analysis based on telemetry data like rise in carbon footprint (Power utilization and Ambient temperature), increasing interface Error counters, number of writes on SSD disk etc. This solution is fusion of power of cloud and ML to diagnose anomalies based on learnings from one customer/data center without violating data privacy and security.

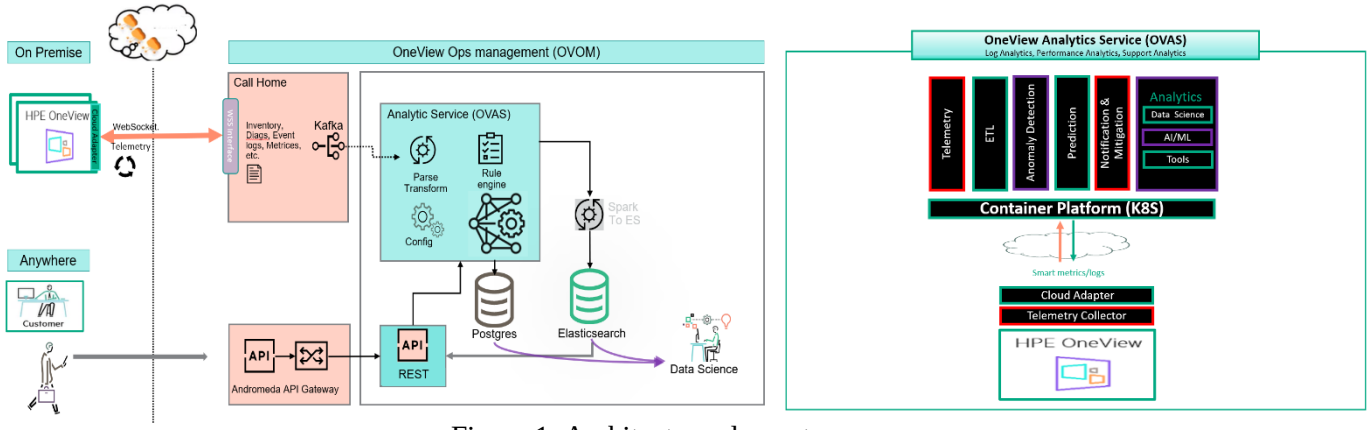


Figure 1. Architecture elements

The OVAS is trained by the technical support engineer with sufficient set of training data. When the system is in training phase the engineer manually updates the knowledge database with case id, problem title, pattern, type (alert/log), exception stack, resource type, resource sub type and label(resolution). Creates an analogue structured labeled data, representing the issue and corresponding recommendation. Execution details are summarized in figure 3. As a POC, Hand crafted data (figure 2 table) of around 150 records is prepared and collected in the knowledgebase which contains the field label representing the resolution action is classified using state-of-the-art model. We started with data mining technique that uses rule-based approach using regular expressions to extract required pattern of data from available knowledgebase. To improve the accuracy, we went ahead with transfer learning technique using Bidirectional Encoder Representations from Transformers (BERT)[3] to solve our multiclass classification problem. BERT is s a transformer-based ML technique for pre-training and known for producing state-of-the-art results in a variety of NLP problems. BERT expects data in a specific format hence for experimentation, preprocessing was done using BERT's own tokenizer. Model is defined as the preprocessor and encoder layers followed by a dropout and a dense layer with a SoftMax activation function and an output layer having dimensionality equal to the number of classes in label. During model improvisation we observed improvement in F1 score and finally the BERT outperformed compared to traditional rule-based classifier.

guid	pattern	type	case id	label
98	Interconnect is no longer responding to communication.	alert	27809	raise_fw_update_alert
68	Interconnect has a new firmware version	alert	98445	enlosure_refresh
67	An AxisFault was encountered during SOAP call getFCPortList.	log	27899	icm_reset
31	Unable to delete the logical switch	log	68764	li_refresh
18	The request to set the hostname for interconnect has failed	log	20987	raise_fw_update_alert
45	Encountered errors while extracting the embedded licenses on the interconnect.	log	75634	enlosure_refresh
71	The subport is unlinked	alert	10894	li_refresh

Figure 2 dataset

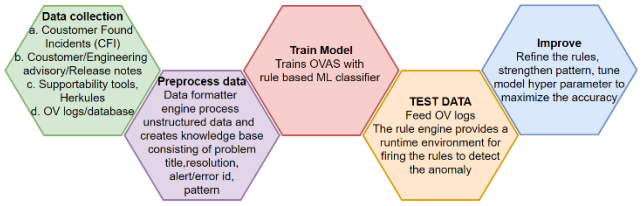
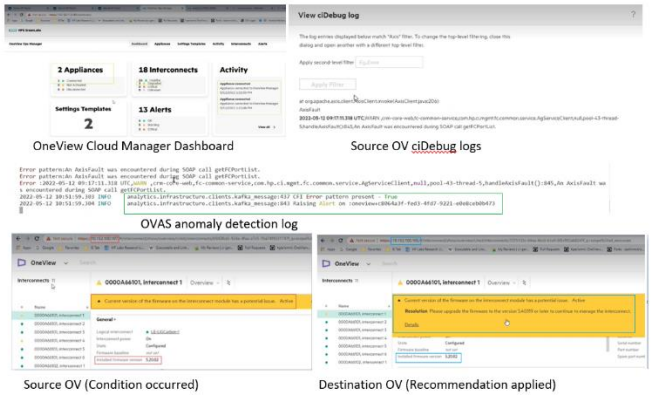


Figure 3 Execution Summary

Evidence the solution works



On receiving events, OVAS with built-in ML model, predicts precise resolution and

- Asks OV cloud manager to trigger a self-healing operation like Enclosure refresh, Logical Enclosure/Logical Interconnect Reapply configuration, Logical Interconnect refresh, Interconnect refresh.
- Clear false positive alerts based on user consent to mitigate the condition.
- Or notifies the recommendation via push notifications (i.e alerts).

Competitive approaches

Instead of going for cloud-based solution, one possibility was to have decision intelligence integrated with the OV agent and have it available for individual OneView instance. But such a solution will not be able to predict and percolate the alerts for detected anomalies to the other one view instances.

We also studied the systems like Intersight[4] and CloudIQ[5] for the similar capabilities. These systems do have trend analysis, predictive analysis and they provide the recommendation based on the analysis for users to take action. We did not see that capability of dynamic learning and self-healing in these systems.

Current status

A working prototype exists for detecting the condition that can occur on OV instances based on alert or log pattern. Providing the recommendations for the issue by raising the alert on enrolled OV instances with matching configuration.

Next steps

We are working on enhancing the OVAS with self-healing operations like Refresh/Reapply resources, detect false positive and clear the alerts. Streamlining the data collection process to include data from CFI, Advisories, and support dump analysis tool Herkules to enrich knowledgebase and continue to work on improvising model accuracy using ensemble techniques. Future plans include integrating solution with Infosight.

Acknowledgements

The authors would like to thank the entire OV cloud manger team for their continued innovation focused on edge-to-cloud solution.

References

[1] OneView https://www.hpe.com/in/en/integrated-systems/software.html

[2] Cloud manager https://www.hpe.com/us/en/compute/management-software.html

[3] BERT https://en.wikipedia.org/wiki/BERT_(language_model)

[4] Intersight https://www.cisco.com/c/en/us/products/collateral/cloud-systems-management/intersight/intersight-ds.html

[5] CloudIQ https://www.dell.com/en-in/dt/storage/cloudiq.htm

Keywords: data center supportability, Self-healing data center, automatic maintenance of datacenters