Big data enabled farm wide drivetrain load distribution analysis for O&M and lifetime optimization

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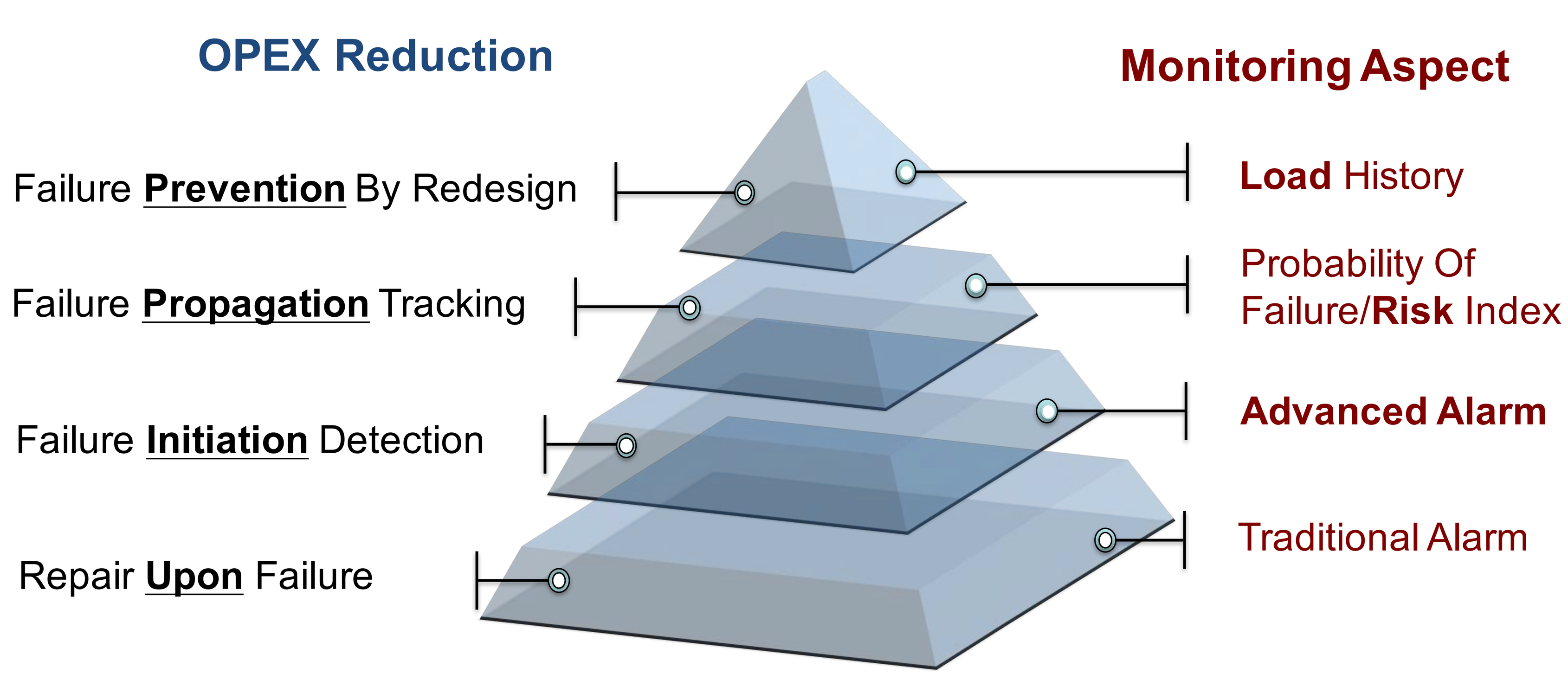
Context

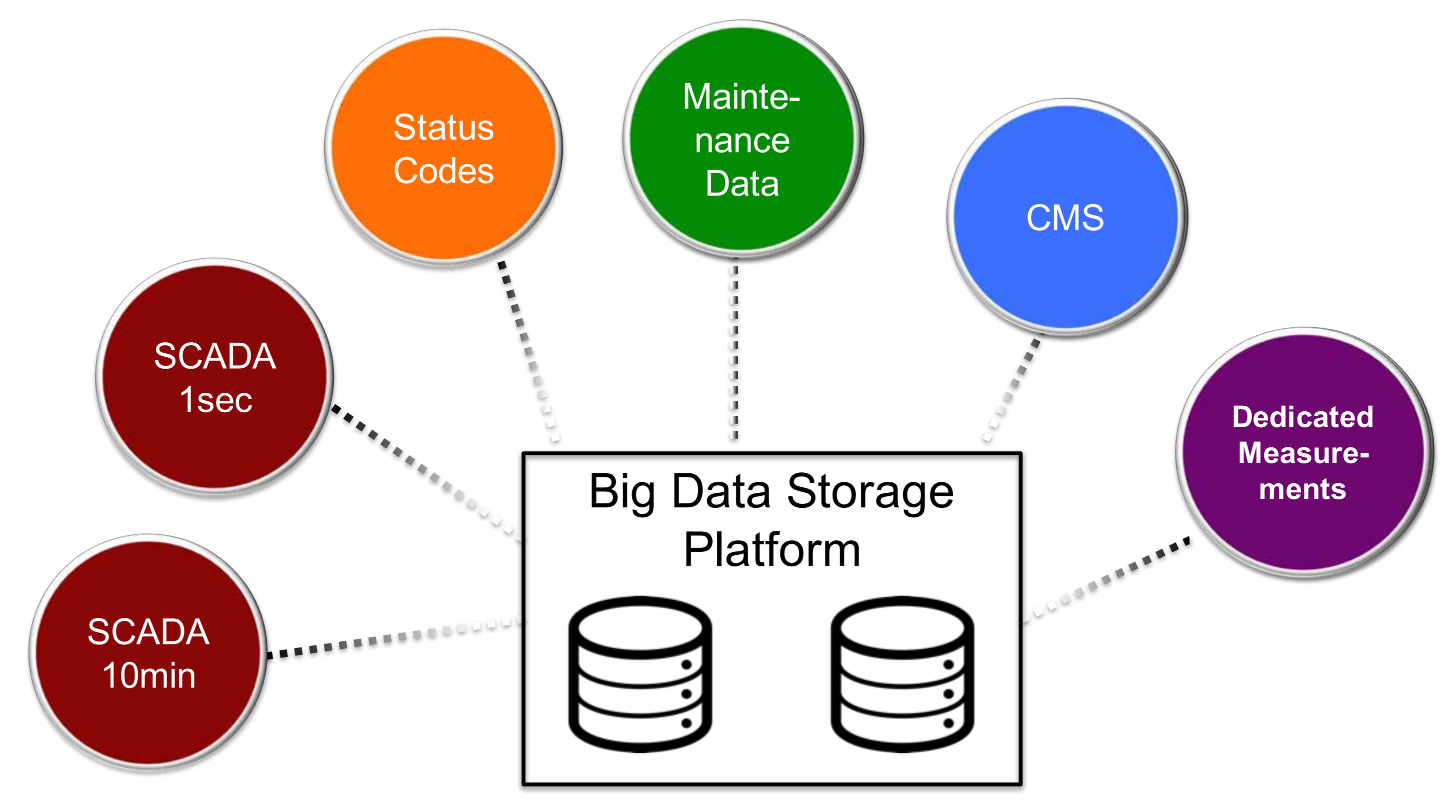
Operations and maintenance actions in offshore wind farms take ±30% of the total production cost. New advanced monitoring - and decision support tools can contribute in reducing this cost.

Load history has been used only limitedly in monitoring approaches. Nonetheless it offers important insights in the degradation of wind turbine subcomponents such as the drivetrain. Detailed knowledge of the load history for each turbine brings essential information to the table for investigating which loading conditions lead to failure initiation and how the real loads drive the consumed lifetime.



Equipping turbines with strain gauges can provide the necessary load information. However, these devices have a cost and limited lifetime.

To gain additional insights in a more cost effective way this paper suggests the use of traditional design calculation approaches running on an integrated big data platform that stores 1Hz and 10min sampled operating signals from turbine Supervisory Control and Data acquisition systems (SCADA) for all turbines in the farm. Particularly for the 1Hz data this results in big datasets if data is kept over long periods of time for allowing historical analysis on long-term data.



Approach

For rotating components bearings are critical. Therefore, we focus on those loads influencing the rotating components. Since SCADA signals are used, our focus is on torque. Rather than investigating discrete loading events we aim to get more high level insights in the changes in the relative loading of turbines over time and in the comparison of relative loading between different turbines in a farm.

Drivetrain fatigue is accurately captured in the design standards. Two metrics are often used: Load Duration Distribution (LDD) and Load Revolution Distribution (LRD). We focus on LDD. It is shown that the load metrics change strongly throughout the farm, showing the need for individual turbine load history assessment and corresponding remaining useful life of the rotating components.

Figure 2 shows the LDD for four example turbines at four different rows in the farm. The LDD was generated based on SCADA 1sec data for a period of 1 week. There is a clear difference in the overall loading of the turbine based on its' position in the farm. Therefore individual load history tracking offers big potential for tracking relative differences in lifetime consumption of rotating components in the farm

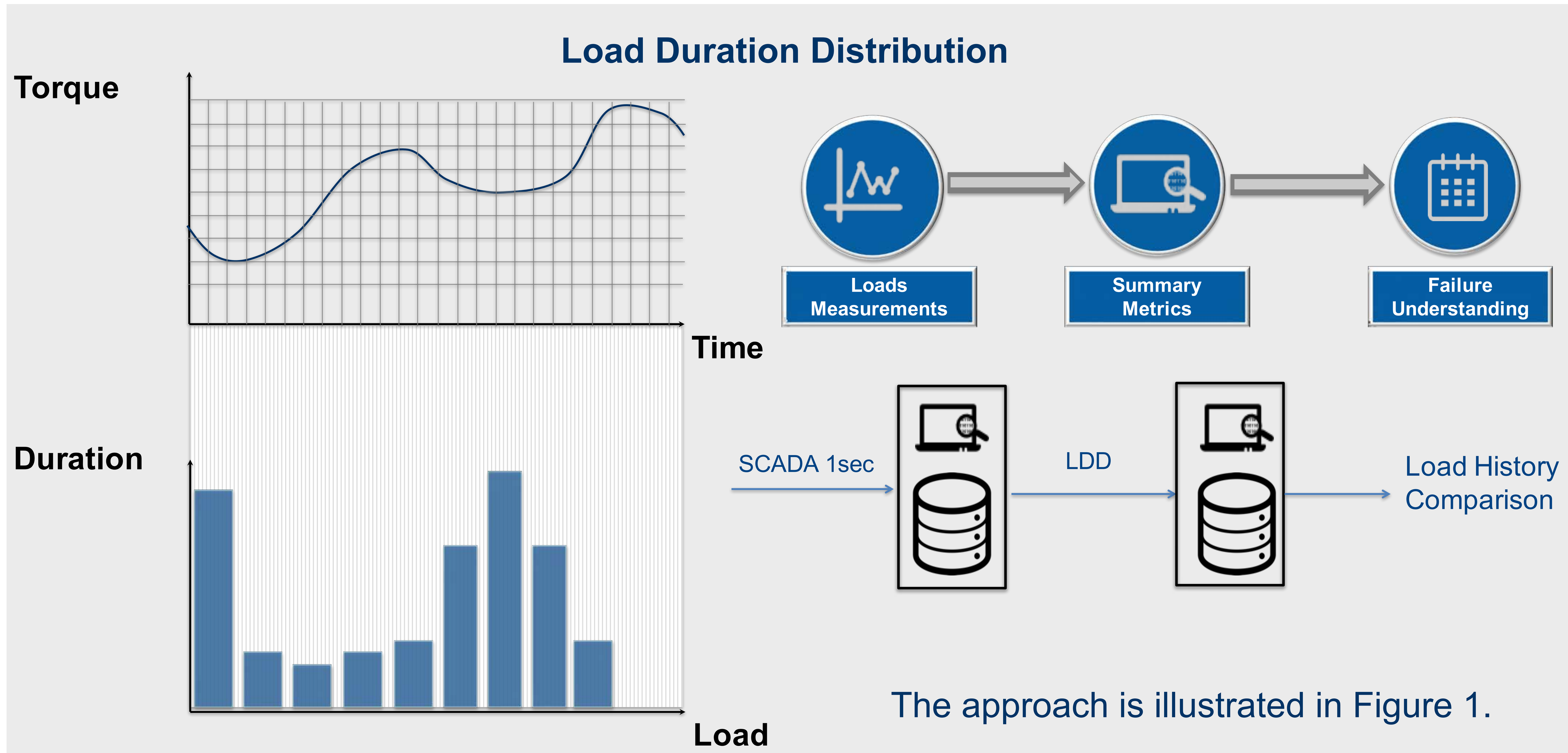


Figure 1: Schematic Representation Of Binning Approach

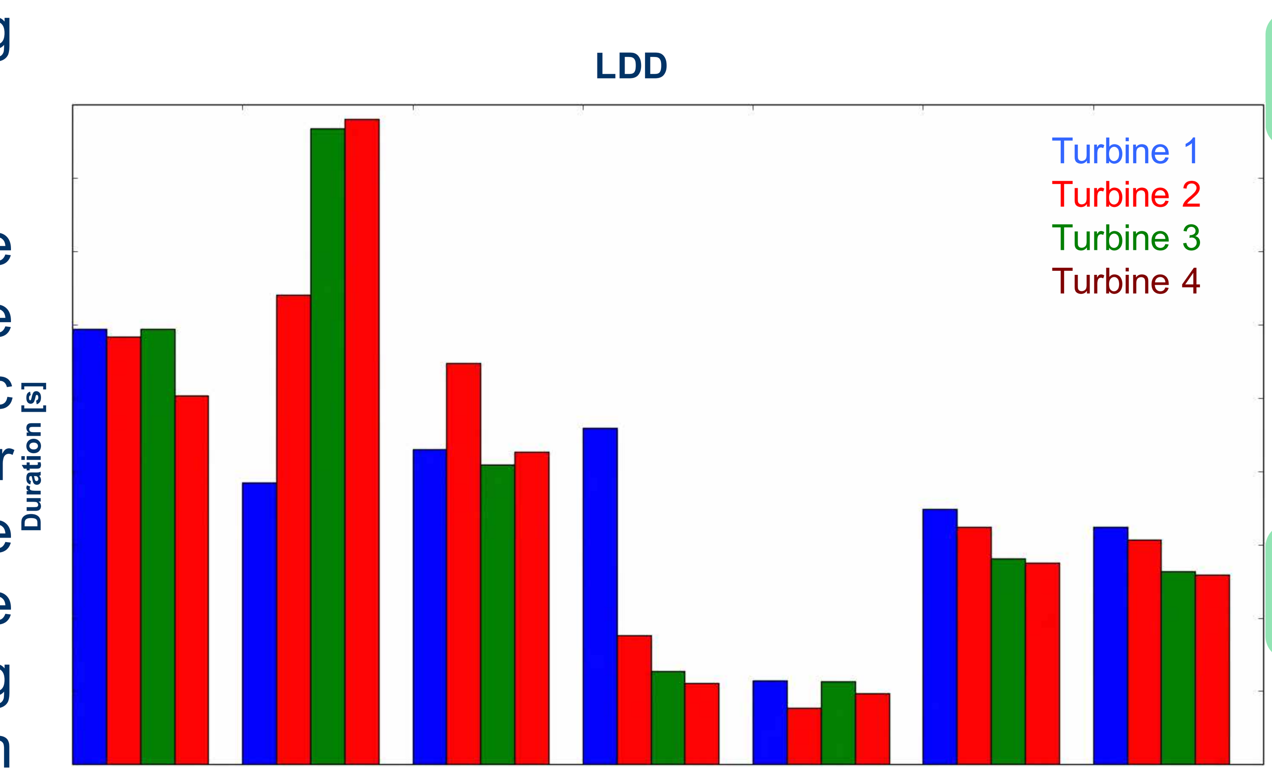


Figure 2: LDD for different rows in the farm

Conclusions

Differences in the relative lifetime consumption across the farm during operating life showed the need for individual load history tracking per individual turbine

Acknowledgements

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