

qBase. A Databased Application for Advanced Failure-Handling and -Tracking to Increase Accelerators Reliability @ DESY



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Abstract

During operation of DESY's accelerator facilities, different failures and their root causes are repeatedly observed and analyzed to increase the existing high availability:

- subsystems or components,
- operational issues,
- failures of complex technical systems.

The in-house developed database application **qBase** links the three most important sources of information particularly from the accelerators **PETRA III**, **FLASH** and **European XFEL** together and makes them accessible throughout DESY's Accelerator Division for advanced analytical investigations:

- expert knowledge from the operators' electronic machine logbooks (eLogs),
- status information and measured values from associated databases,
- and detailed root causes from written failure event reports.

1 : Motivation! – DESY's Quality Initiative for Accelerators

- The Quality Assurance Programme is a quality initiative that was launched by the management in 2019.
- It complements the already existing efforts of the individual groups in the division.
- The long-term aim is to establish a quality assurance system that focusses on the management of processes and knowledge, as well as increasing / stabilising the availability of the accelerator facilities.
- Both locations of DESY in Hamburg and Zeuthen have been taking part in the initiative, since September 2022.

"Developing a knowledge database supports the implementation of the Quality Programme and is a step towards the realisation of our digitalisation strategy."

Wim Leemans, Director of the Accelerator Division

3 : Performing Analysis

- 1) "List all Failure reports linked to 'power supplies' or 'Netzgeräte' performed from group 'MFL' and group 'MXL'."
- 2) Define an a) appropriate filter or b) an applicable calculation and run the filter/calculation.
- 3) If needed, restructure the results for more details, according to your request.
- 4) Generate tables, pivots, diagrams out of the results or download or email the complete set of data for further activities outside the database.
- 5) Provide the filter/calculation to the community as a new public tool and share your knowledge to let others learn.

Excursus : Root Cause Analysis with 8D

By launching the Accelerator Division's Quality Assurance Programme in 2019, the 8D – method was established as one of the key processes shown in figure 1. Since the implementation the number of failures with downtime have been visibly reduced. [1] The diagramm in figure 2 shows the reduction of failures by processing failure management with 8D.

8D in a nutshell:

- method to solve technical issues,
- non sequential process in 8 disciplines,
- documentation (paper, QDX, »SQL«, ...). [2]

It can be customized by:

- paralyze a couple of steps,
- adapting the effort per discipline,
- reducing to a 4D report: D2 → D3 → D4 → D6.

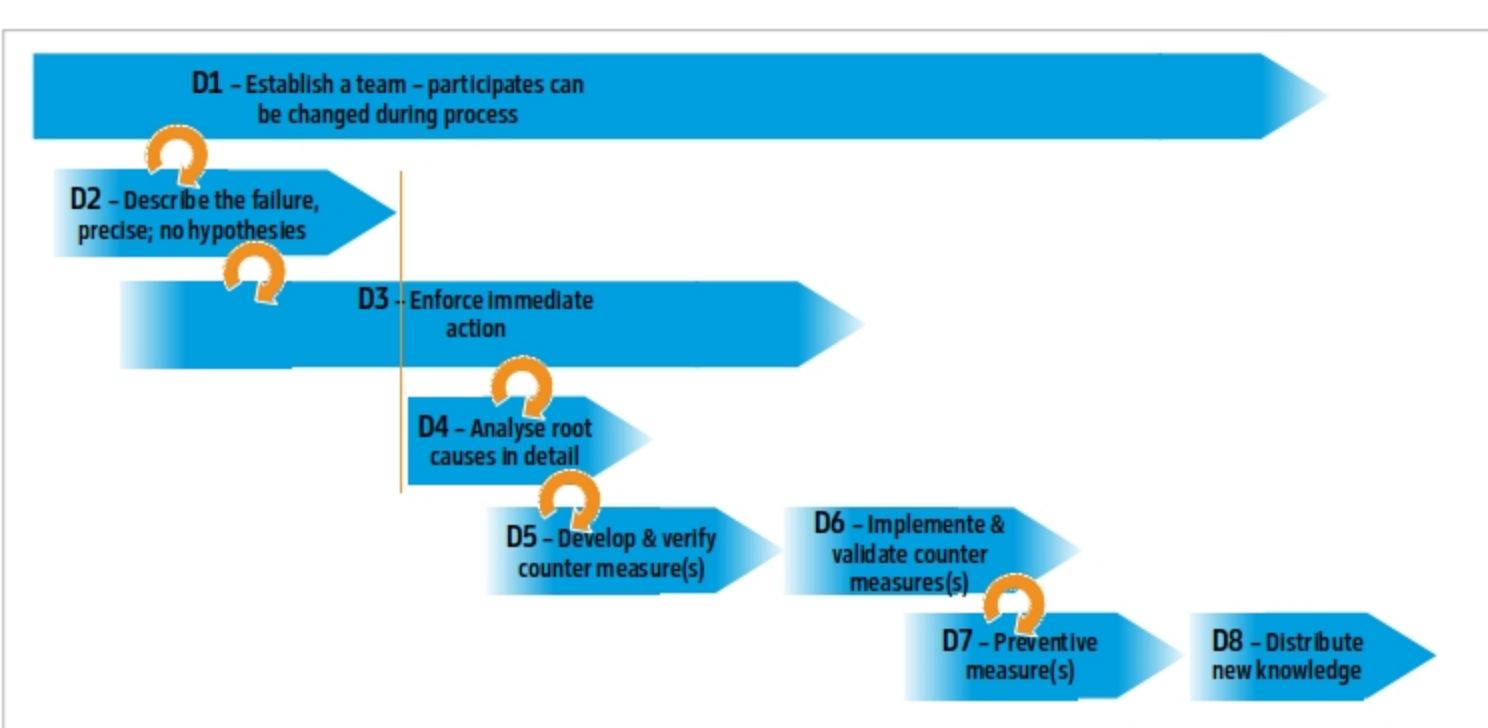


Figure 1: Performing an 8D or the reduced alternative 4D follows a simple flow chart. Process according VDA. [3]

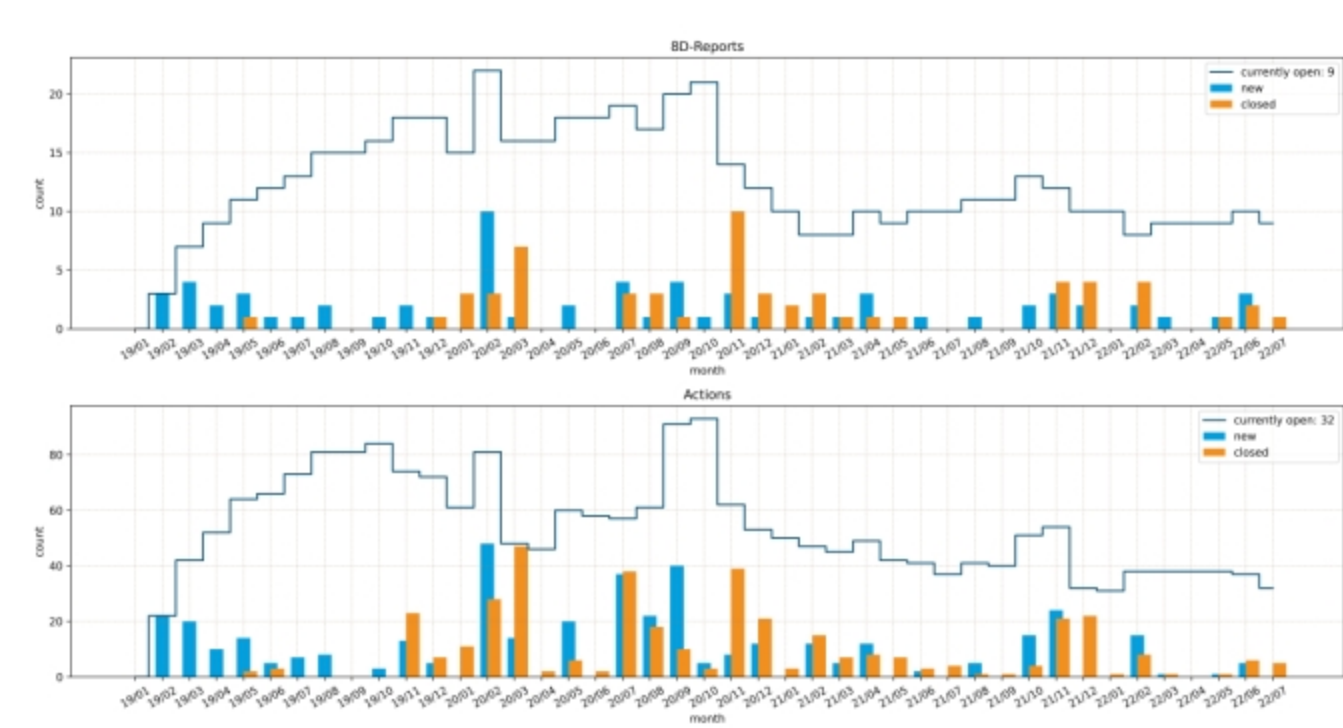
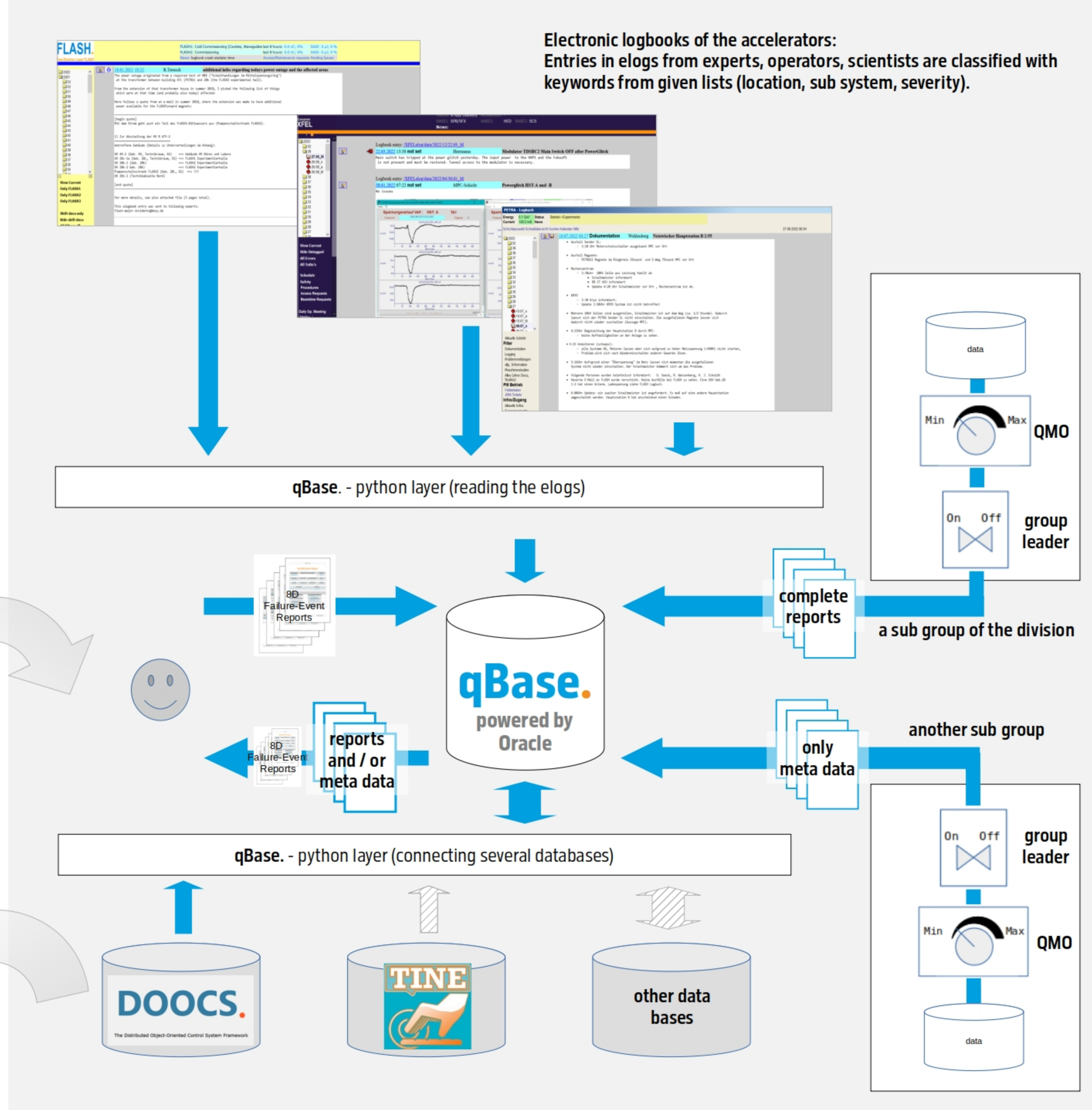


Figure 2: 8D's initiated and completed each month (top), associated measures (bottom). Data from European XFEL. [3]

[1] J. Branlard et al., "Four years of successful operation of the European XFEL", presented at the International Conference on RF Superconducting (SRF'21), FRIB, Michigan State University, Michigan, USA, June 2021, paper MO0FAV06
 [2] Verband der Automobilindustrie e. V. (VDA), Austausch von Qualitätsdaten QDX-Quality Data eXchange V2.1, VDA Berlin 2017
 [3] Verband der Automobilindustrie e. V. (VDA), 8D-Problemlösung in 8 Disziplinen, VDA Berlin 2018

2 : Implementation! – Getting Connected with the IT Landscape



4 : Failure Tracking, a Preview to qBase. V2.0.0:

Extension of the given functionality of qBase. V1.4.2.:

- Mapping of the technical structures of the accelerators and the technical systems.
- Alignment of components to the structures (figure 1).
- Linking of failures with structure and components.
- Linking individual failures to error chains.
- Failure analyses, measures as digital 8D reports.

ACCELERATOR TREE	Number	Start	End	Title	Description	Logbook	Accelerator Station	Machine	Technical System	Parent Number	Last Updated
FLASH	#00383	2022-09-29 09:22		FLASH was going down	FLASH had a failure at the gun		Development	FLASH → Gun	Wassersage		2022-09-29 09:26
FLASH	#00176	2022-06-02 12:18	2022-06-02 14:18	Beamless due to magnet power supply failure	Beamless magnet power supply ME166 failed. Reset not possible, on call service informed.		UserRun02	PETRA II → LINAC2		#00166	2022-06-28 23:37
XFEL	#00196	2022-06-02 11:08	2022-06-02 12:08	Modulator 11 Klystron Fokus	Ausfall Klystron Fokus 1 Fokus Netzwerk defekt			LINAC3			2022-07-27 17:12
XFEL	#00086	2022-07-27 17:02		Testbaun	#Testbaun			XFEL			2022-07-27 17:04
XFEL	#00390	2022-07-27 16:56		Testbaun	Testbaun			XFEL			2022-07-27 17:02
XFEL	#00349	2022-07-27 16:39		Fehlerbaun 23	Qualität in Produktion: Transmissionsaufbau aufgrund von überhöhten Schwingungen der Kompressionsrollen im kochenden			XFEL			2022-07-27 16:44
XFEL	#00347	2022-07-27 16:36		Fehlerbaun 07	Kühlmachine im Gdn. 24 Kühlmittel abgebrannt. Soll der Netzwechsel gesamt sein.			XFEL			2022-07-27 16:37
XFEL	#00346	2022-07-27 16:12		Fehlerbaun 23	Elektronisches Zugabegerätungs-system aufgrund ungenügender Speicherwerkzeuge ausser Betrieb in Gebäude EMBL.			XFEL			2022-07-27 16:15
XFEL	#00344	2022-07-27 16:09		Fehlerbaun 4	Sicherheitsserver ausgefallen. War wohl der power gleich vom Batterie. Abschaltung der Interface und Strahlverlust in XFEL, XFEL, down.			XFEL			2022-07-27 16:12
XFEL	#00343	2022-07-27 16:08		Fehlerbaun 3	Batterie wurde nicht geladen. Temperaturkontrolle liess aus und gab keine Batterie von der XFEL ab. Dadurch wurde der Server alarmiert.			XFEL			2022-07-27 16:08
XFEL	#00342	2022-07-27 16:01		Fehlerbaun 2	Batterienummer in XFEL ausgefallen. Ursache war wohl der Netzwechsel. Entweder Netzwechsel in Hauptstation D oder in			XFEL			2022-07-27 16:06
XFEL	#00323	2022-07-27 15:57		Fehlerbaun 1	Einzel-Netzwechsel in Hauptstation D			XFEL			2022-07-27 16:01

Figure 1: Each failure and its measures are linked to the accelerators section and the technical SubSystem.

Conclusions about critical systems or components can be derived from the resulting fault trees. The resulting and growing fault trees identify critical substructures and components.

Conclusion and Future Perspectives

Conclusion:

The final goal to develop and install a knowledge database for the entire accelerator division is still in its beginning and we noticed already that more and more colleagues from several sub groups are interested in using this database and they do.

Future Perspectives:

The first step of a knowledge transfer has been well-established and we assume that this will grow in the future due to the fact that 8D reporting, supported by more functionalities of the database particularly calculating statistics like MTBF and MTTR, becomes common in the failure management.

Acknowledgement

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