Deutsche Bank
COO Group Technology

Accelerating SAS Workloads with Spectrum Scale and Excelero NVMesh

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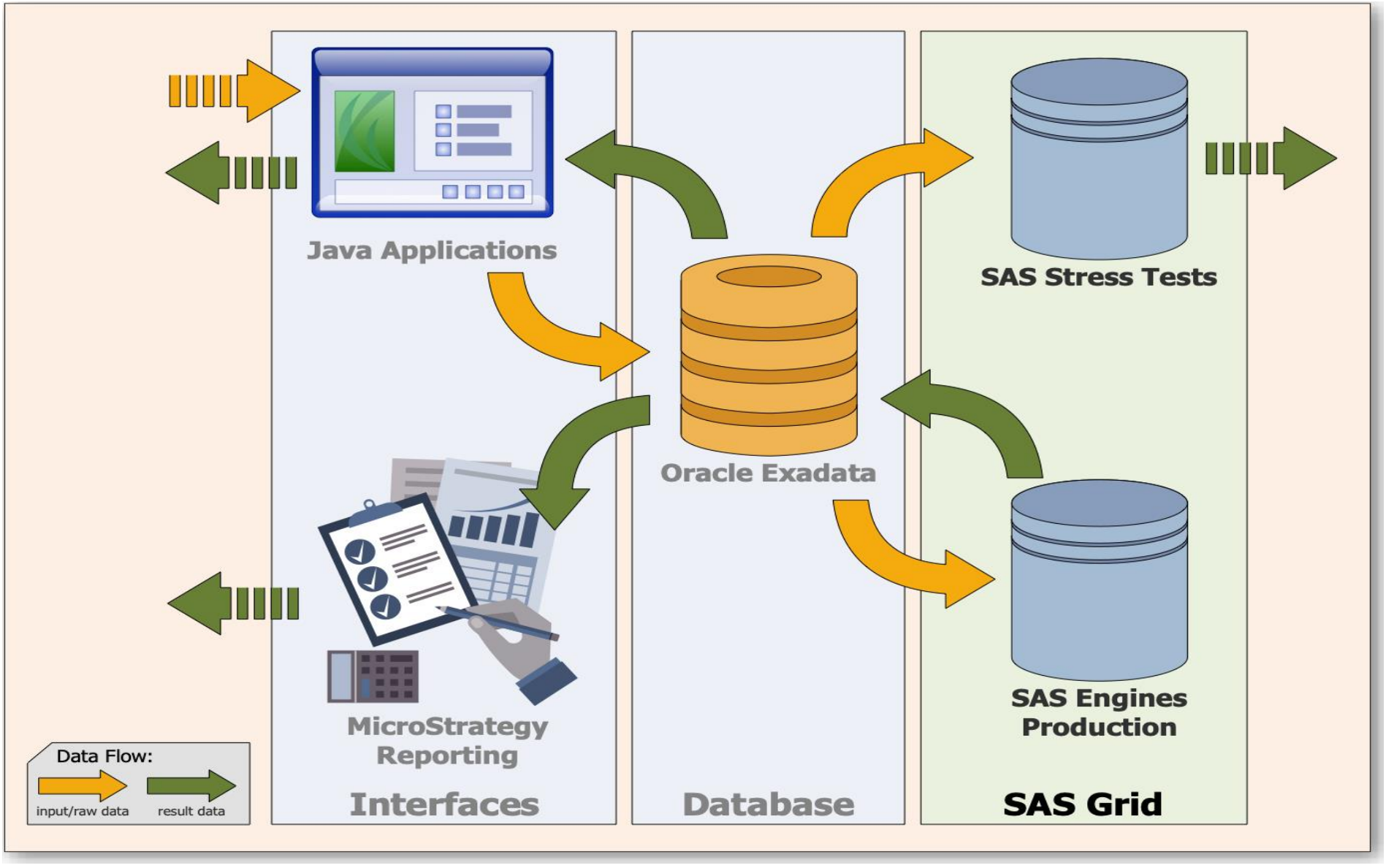
Finance Data Warehouse: Our Technical Components



Finance Data Warehouse: Business Content

Regulatory Background

- **FDW is performing group-wide consolidation, calculation and reporting of Credit Risk values, including:**
  - BASEL III and IV
  - IFRS
  - AnaCredit
  - KWG 13 & 14
  - CoRep & FinRep
  - EBA

Risk Background

- **Several risk figures are calculated or consolidate in the FDW SAS Engines, among others:**
  - Risk Weighted Assets
  - CVA / CCR / CCP
  - Expected Loss (EL)
  - Country Risk
  - Provision Reporting
  - Economic Capital (EC)

Stress Testing

- **The FDW StressTest Environment is fulfilling various key requirements:**
  - Group wide stress tests
  - EBA stress tests
  - Validating of rating methodologies
  - RWA impact runs
  - Empowerment of clients in the Risk Group to run test and impact calculations

Finance Data Warehouse: Our Environments

Processes in Place

- **FDW has to deliver several production and stress test runs:**
  - ~ 10 monthly production runs incl. several shadow runs
  - 4 to 5 weekly runs per month
  - 6 daily runs per week
  - Continuous stress tests

Environments Used

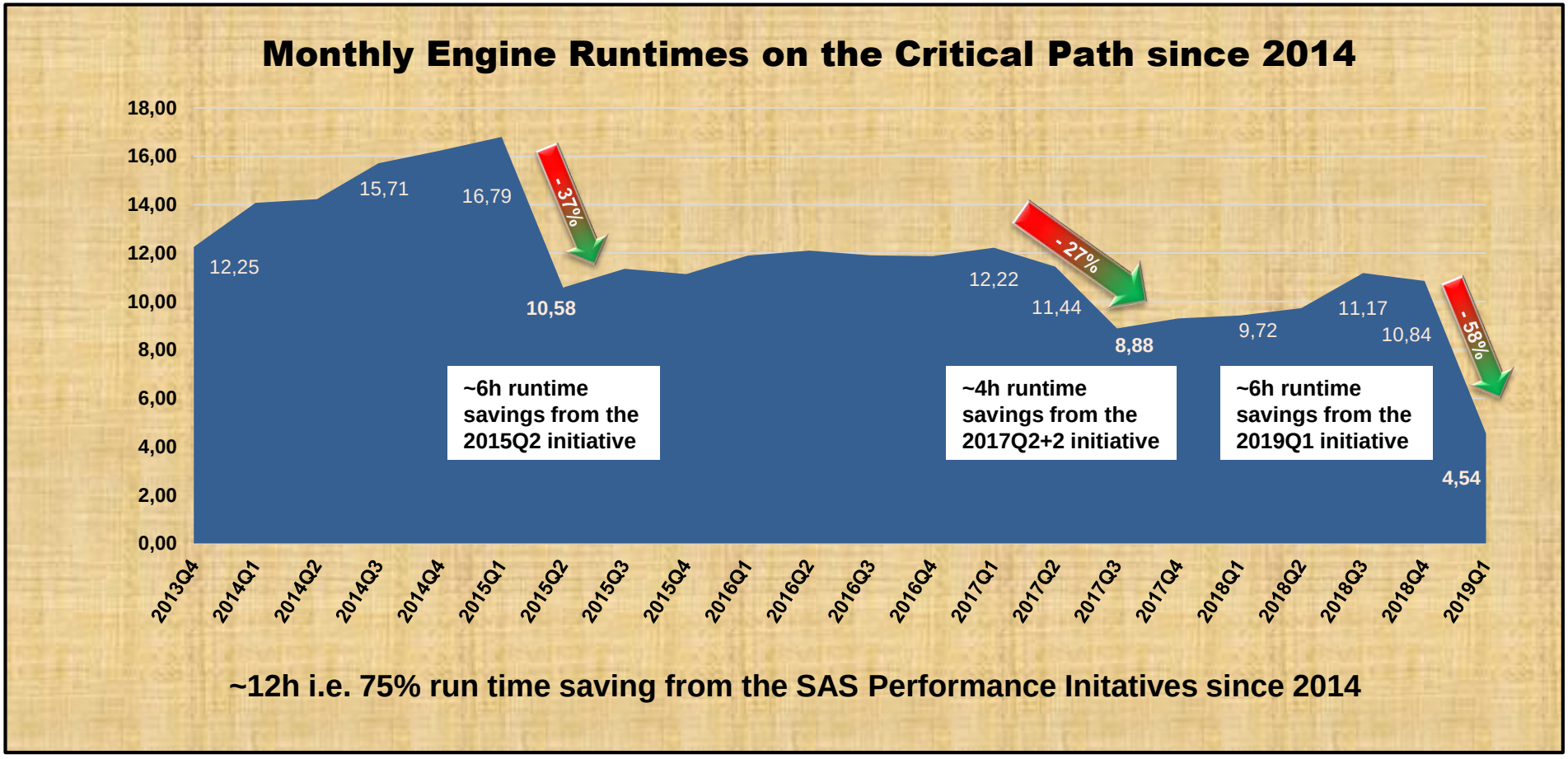
- **FDW is running a high number of production and test systems:**
  - 4 production environments
  - 5 stress test environments
  - 3 CI environments
  - 10 UAT environments
  - 10 SIT environments
  - 2 development environments

Unique Performance Requirements

- **High-performance and scalability requirements for the calculation engines are driven by:**
  - Intense and frequent calculation operations, e.g. core flat file with >2,600 variables
  - 1 daily run, 4 to 5 weekly runs per month and several monthly runs
  - High data volume with continuous growth, e.g. >1 TB per run
  - Changing requirements, also regulator demanding more granular data

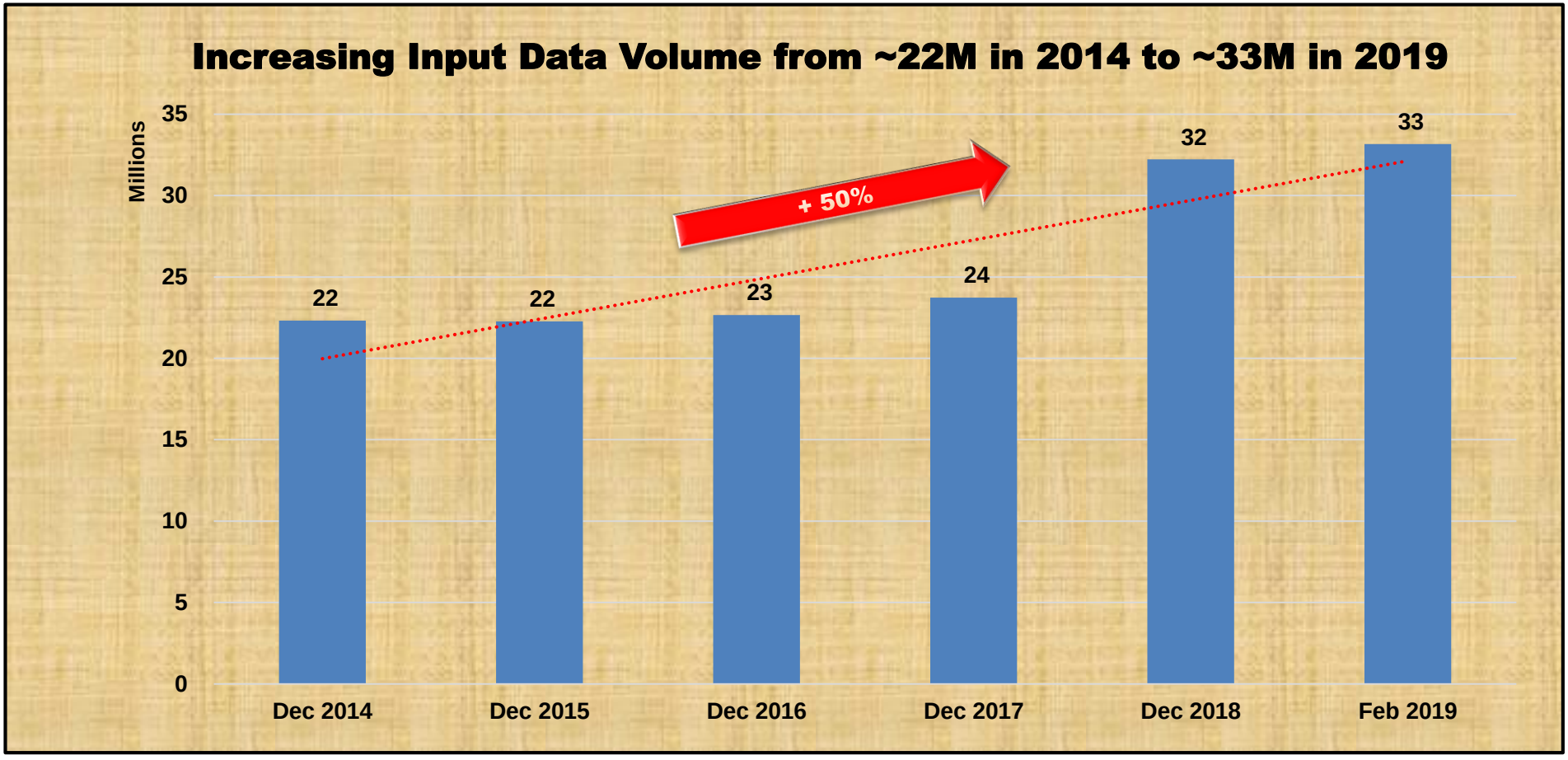
Finance Data Warehouse, Challenges: Runtime Increase

The following graph shows the trend of the FDW Engines execution times over the releases. The time increase is caused by implementation of additional business rules and the increased data volume processed. It is then reduced by regular application and architecture/hardware optimization's.

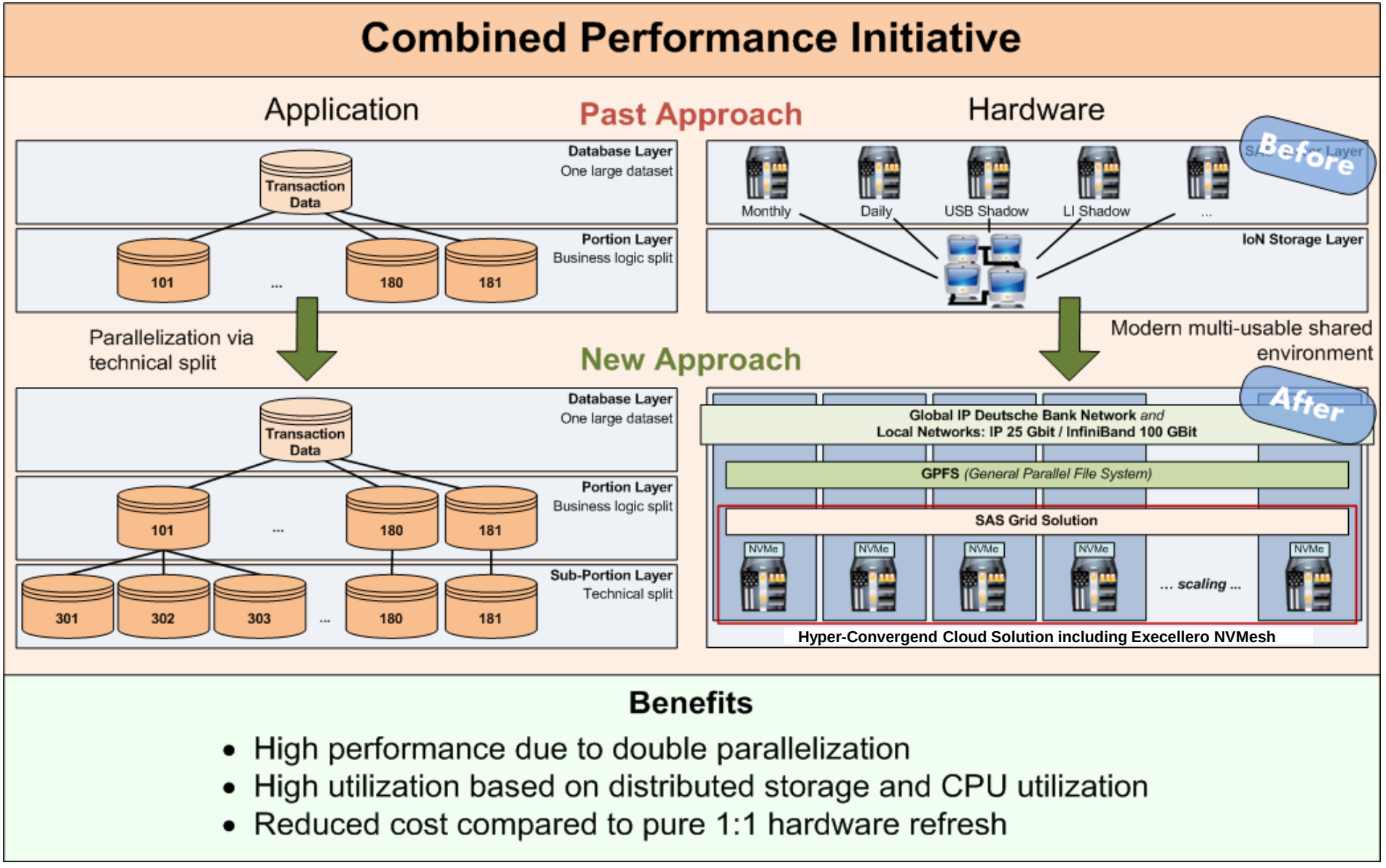


Finance Data Warehouse, Challenges: Volume Increase

Input data volume has increased in the last 5 years from 22 million to 33 million transactions based on the SAS flatfile. This slide below shows the yearly growth over the last five years in the FDW area and hence one reason for the continuous runtime increase.



Finance Data Warehouse: The New High-Performance Architecture

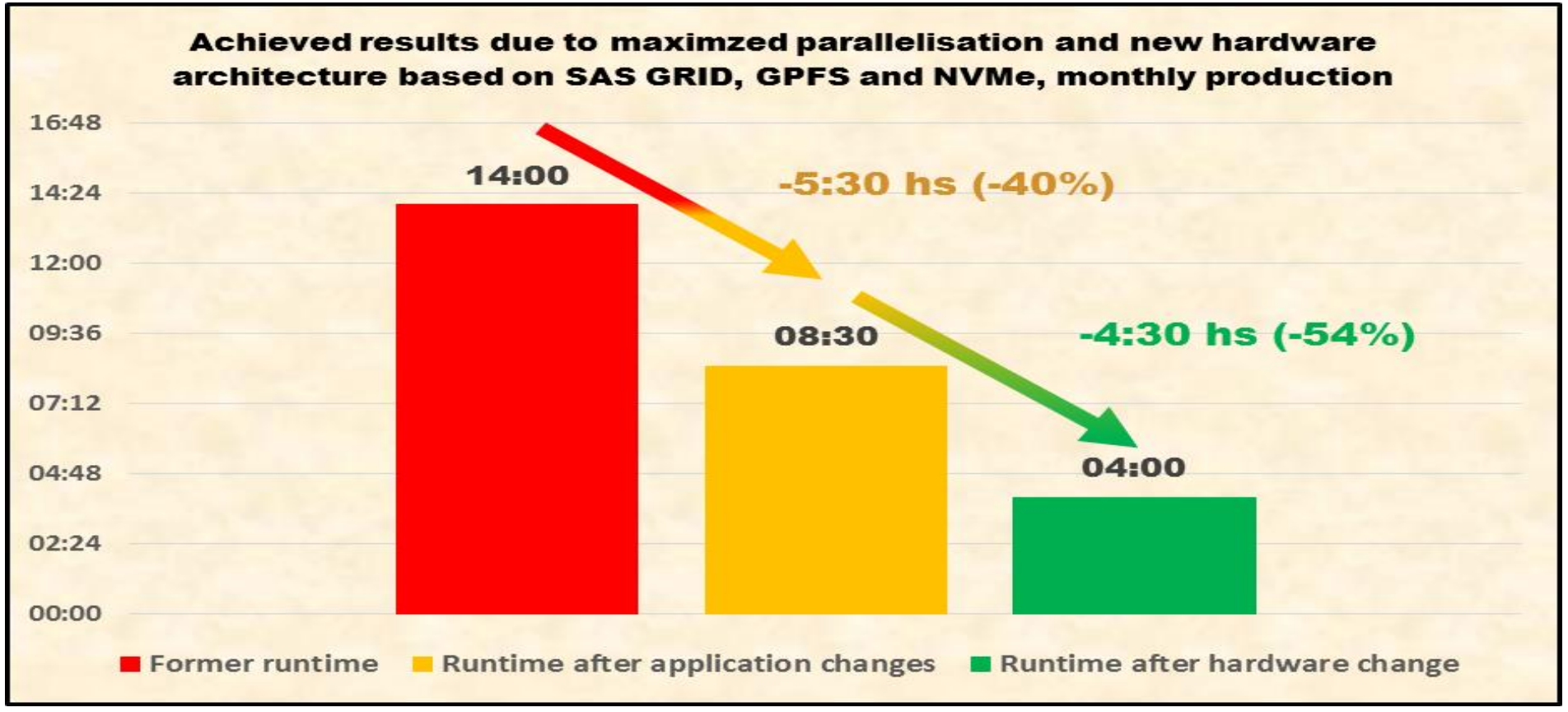


Benefits

- High performance due to double parallelization
- High utilization based on distributed storage and CPU utilization
- Reduced cost compared to pure 1:1 hardware refresh

Finance Data Warehouse: Improvements by high-performance platform

After intensive and successful tests in the DB Innovation LAB in Berlin, on the new hardware architecture the following **significant runtime improvements for SAS on the critical path** could be verified:



Combined Savings:

Runtime improvement: -10:00 hs (-72%) / Application speed up: + 3,5 times.

Finance Data Warehouse: Benefits of the New Platform

Performance	• **Performance: 72% savings in production, hence the application runs 3.5 times faster** • Double amount of workspace and NFS space compared to previous architecture
Flexibility and Utilization	• **Higher utilization of the overall platform** due to a distributed high-performance file system • Allows sharing of the platform between different runs (Monthly, Daily, Shadow, Stress Tests, etc.) and different users
Safety and Soundness	• **Higher reliability** due to mirroring plus adequate fail-over processes • Software defined storage solution via Excelero RDMA • **Stability proved over one year in production and several test environments**
Costs	• **>50% cost reduction** compared to previous architecture due to the new SAS GRID contract • Savings are for one-off new order and annual renewal
Contractual Basis for Further Savings	• Contract contains the option to increase the platform size per 24 cores • **Hence only 10% of the actual cost increase for development and production areas, and only 30% of the increased cost for test environments**
Strong Platform to Scale with Further Savings	• A Strong & scalable platform for high-performance requirements has been established • Other departments are interested in onboarding their SAS applications with similar high-performance requirements, would benefit technically and financially from using this platform ***Proposal: For other parties to leverage this platform, discuss an operating model based on Shared Platform Services.***

QUESTIONS & ANSWERS