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MAESTRO
DATA ORCHESTRATION

Maestro Project Introduction

1st European Communities Workshop on Exascale Computing

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cea
appentra make code parallel
ETH zürich
CSCS
ECMWF
SEAGATE
CRAY

Today's Shortcomings: Lacking Data Awareness

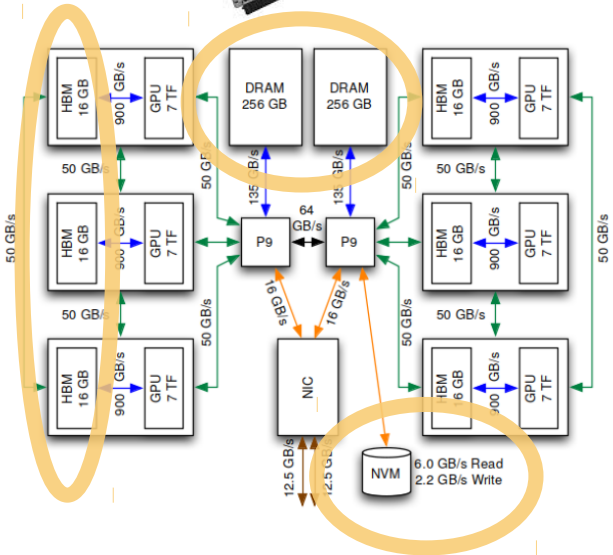
- Software stacks focussing on data processing
  - Optimised for filling of processing pipelines
  - Provide means for leveraging parallelism
- Lacking focus on basic data handling
  - Lacking functionality for controlling data handling
  - Lacking (unified) semantics for guiding data transport

Today's Shortcomings: Lacking Memory Awareness

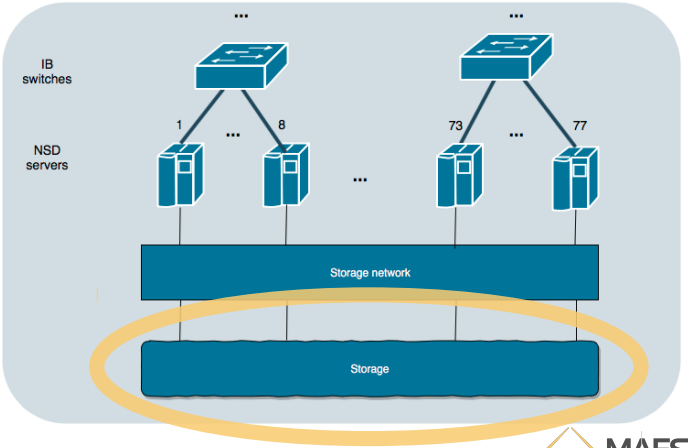
- Missing information about available memory/storage hardware and its characteristics
  - Lacking ability for making data transport decisions
  - Missing information leads to hardware-neutral decisions
- Challenging variety of data access methods
  - Example storage class memory:
    Block store, file system, object storage
- This becomes more critical with deeper memory and storage hierarchies

Hardware Architecture Examples: Summit

Compute nodes



External storage



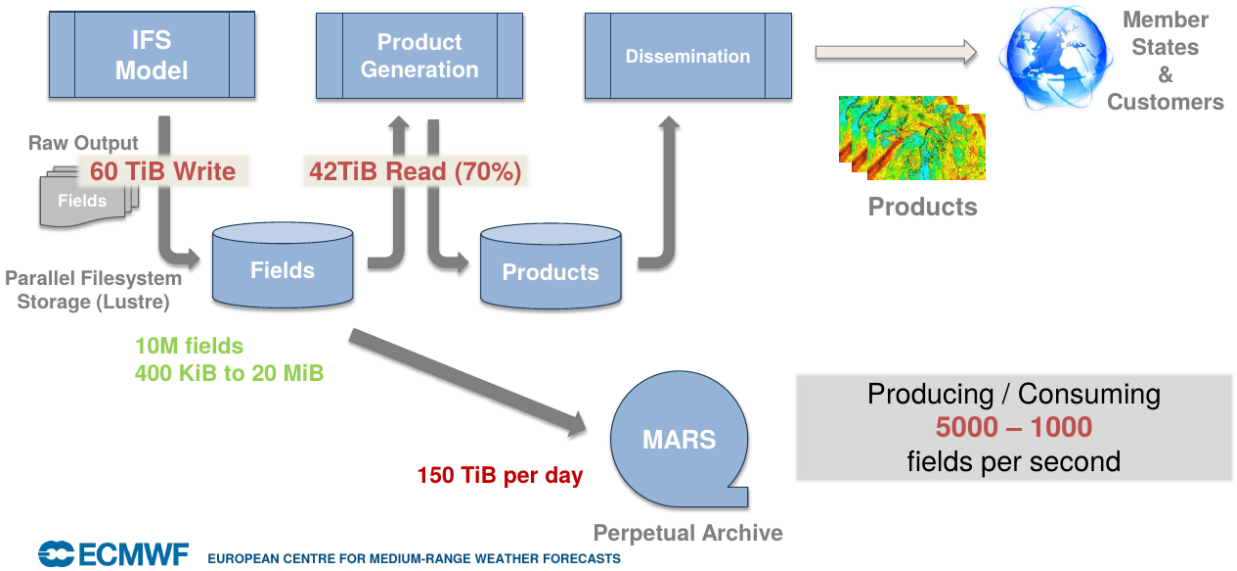
Co-Design Applications

- IFS numerical weather prediction system (ECMWF)
  - Complex data processing and simulation system with multiple data producers and consumers
- Computational Fluid Dynamics plus in-situ analysis (CEA)
  - Pipeline coupling multiple simulations plus data post-processing
- Electronic structure calculation library SIRIUS (CSCS)
  - Simulations involving GPU acceleration
- Global Earth Modelling system TerrSysMP (JSC)
  - Coupled simulations

Co-Design Approach

- Usage scenarios
  - Description of a characteristic set of components and manner of use that is meaningful for application domain expert
- Use cases
  - Specific actions, functions or instances extracted from usage scenarios
- Requirements
  - capture anything that should influence the design or implementation of the Maestro middleware

Example: Weather Prediction Workflow



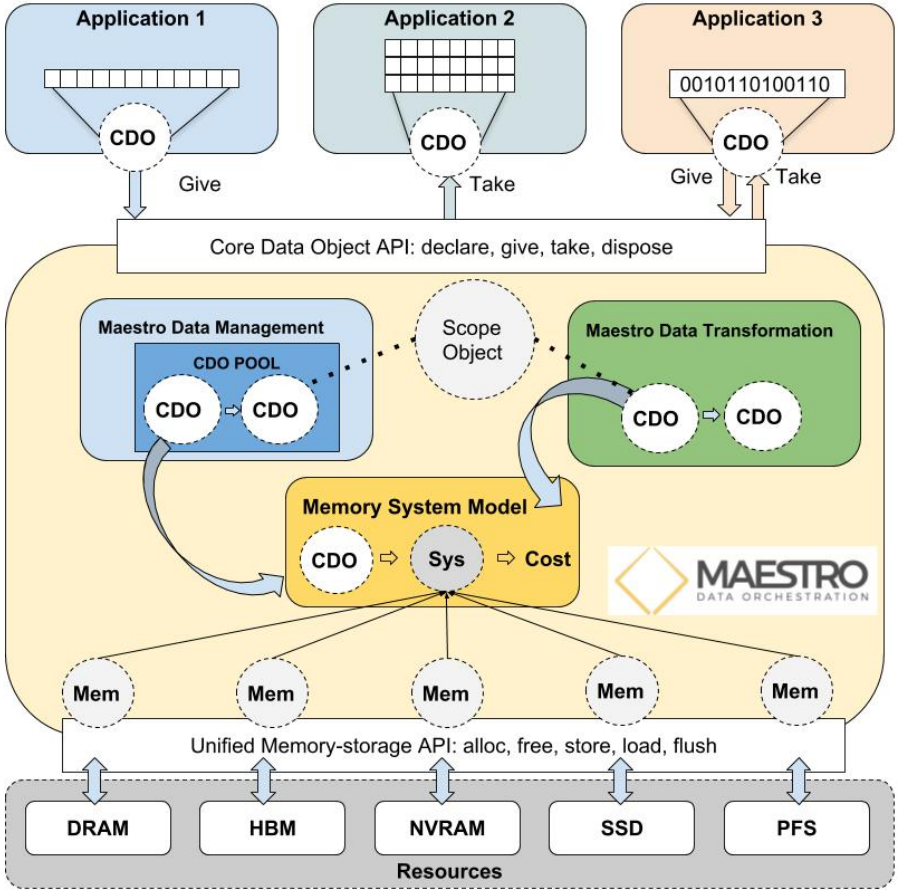
Today's bottlenecks

- Data movement between forecast stages and product generation
- Irregular archiving of output from research workflows

Maestro Solution Concepts

- Object-based approach to encapsulate data with application and Maestro related metadata
  - Core data objects
- Data movement decision based on workflow annotations and real-time I/O monitoring
  - Data object producer/consumer model

Architecture Overview



Project Schedule

- Requirements definition completed by August 2019
- Core design fully specified by April 2020
- Start system software and application demonstration in autumn 2019
- Project completion in August 2021

Summary and Outlook

- Today's HPC (and HPDA) solutions lack data and memory awareness
- Maestro will develop a data and memory aware middleware
  - Abstractions based on data objects
  - Memory-aware data transport and placement in middleware
- Open for providing early access to technology

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