# 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
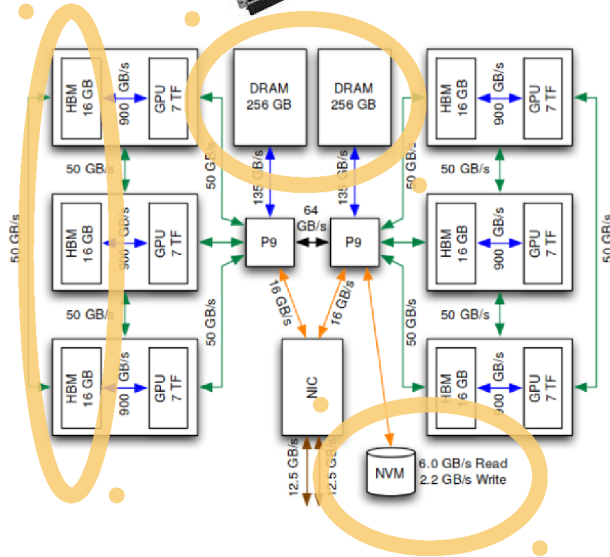
External storage
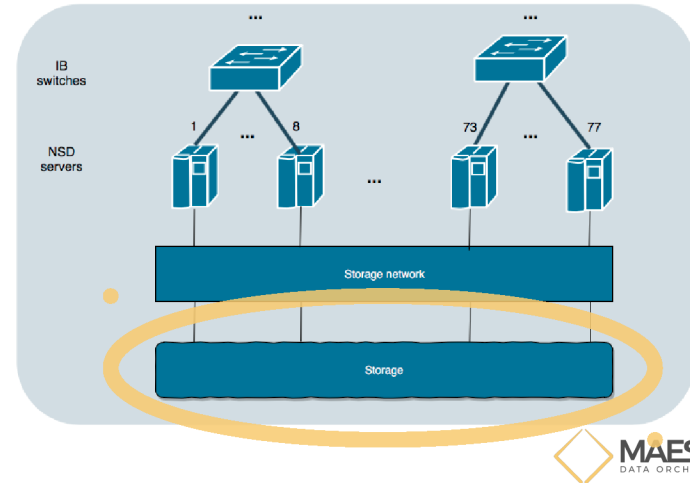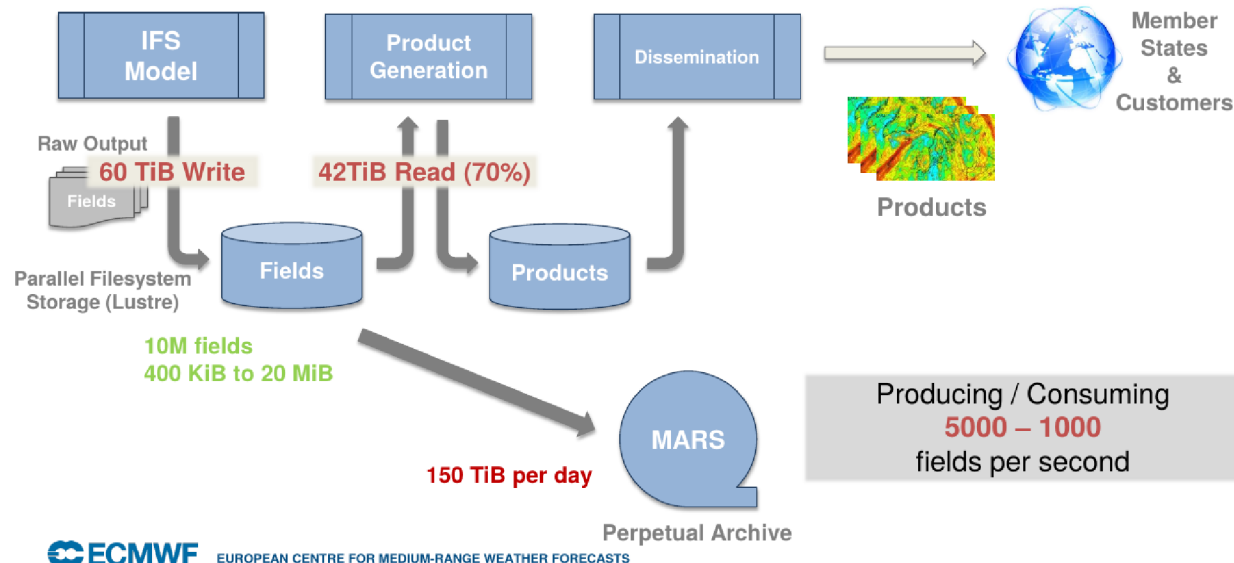
Co-Design Applications

- 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

IFS Model → Product Generation → Dissemination → Member States & Customers

Raw Output: 60 TiB Write
Fields

42TiB Read (70%)

Parallel Filesystem Storage (Lustre)

Fields

Products

Products

10M fields
400 KiB to 20 MiB

150 TiB per day

MARS

Perpetual Archive

Producing / Consuming
5000 – 1000
fields per second

ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Today's bottlenecks

- Data movement between forecast stages and product generation

- Irregular archiving of output from research workflows

MAESTRO DATA ORCHESTRATION

7

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
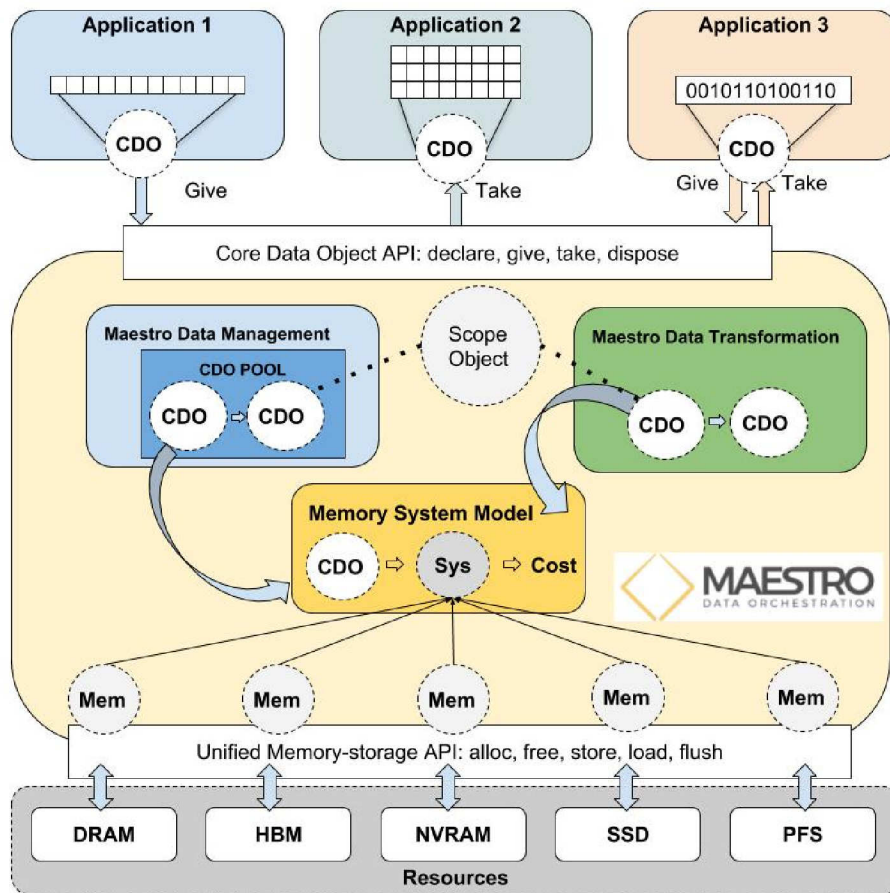
Project Schedule

- 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