EMC²
Mixed Criticality Medical Imaging
co-location of real-time and non-real-time processing on a single chip/board

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Use-case

A day in the life of a hospital MR department

Image removed; redaction of confidential information
The next slide contains abstraction of removed image
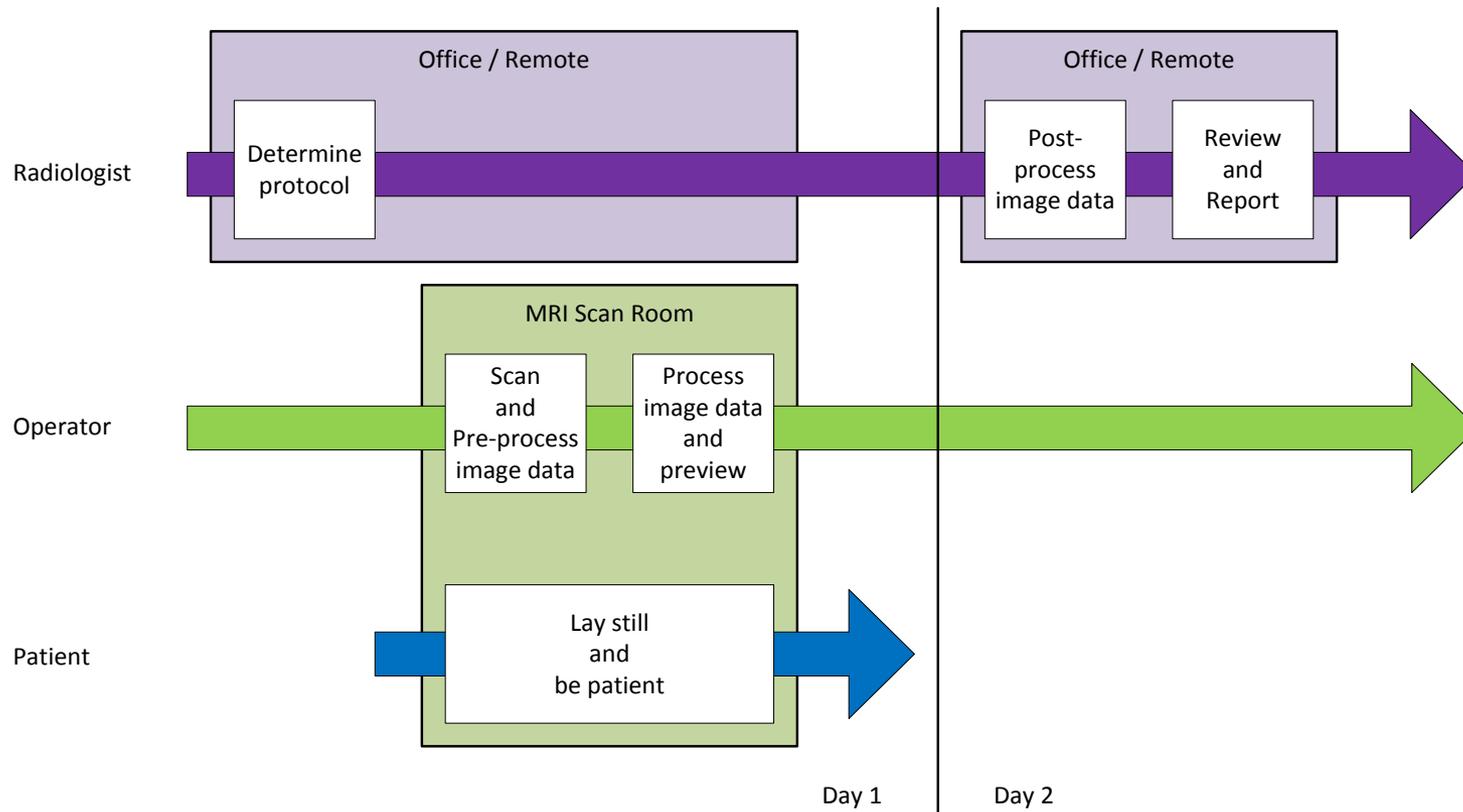
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Use-case

A day in the life of a hospital MR department

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Use-case

Post-processing: track fibers in the brain

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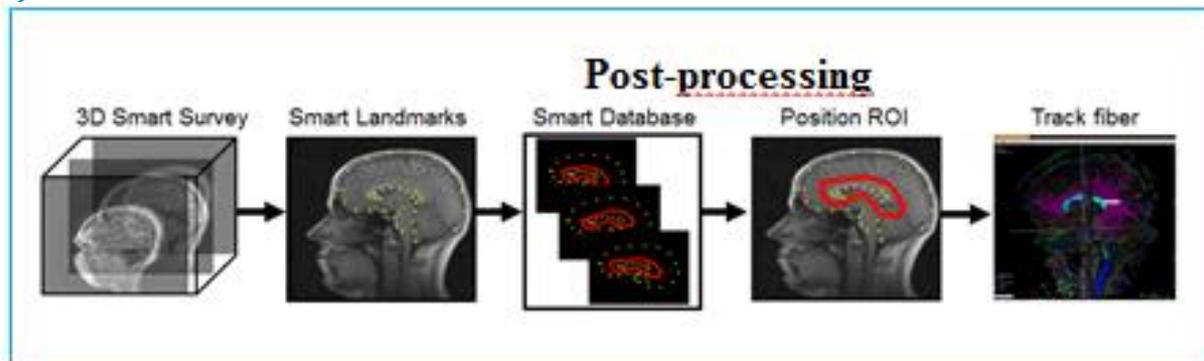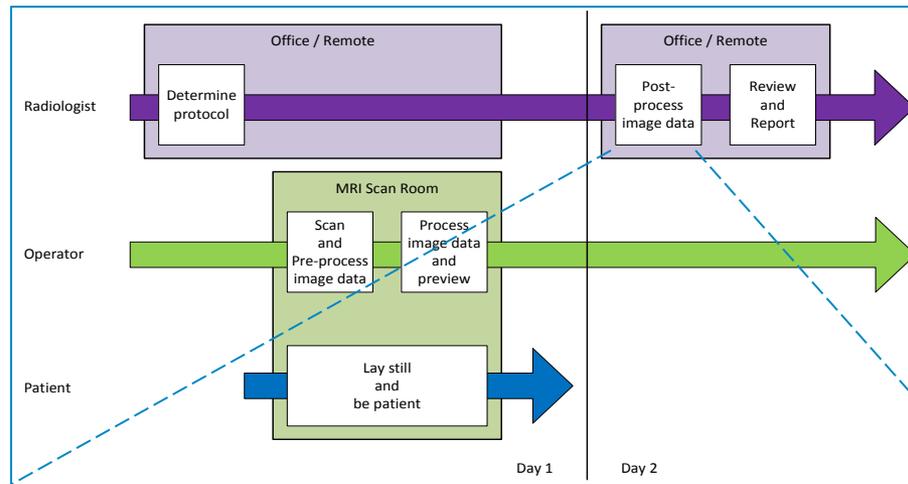
Use-case

Post-processing: track fibers in the brain

- In some cases the fibers cannot be tracked or show poor results
  - Cause is in the source data
  - Requires a patient callback
    - Not pleasant for the patient
    - Not pleasant for the schedule
    - Not pleasant for the costs
    - Not pleasant for anybody

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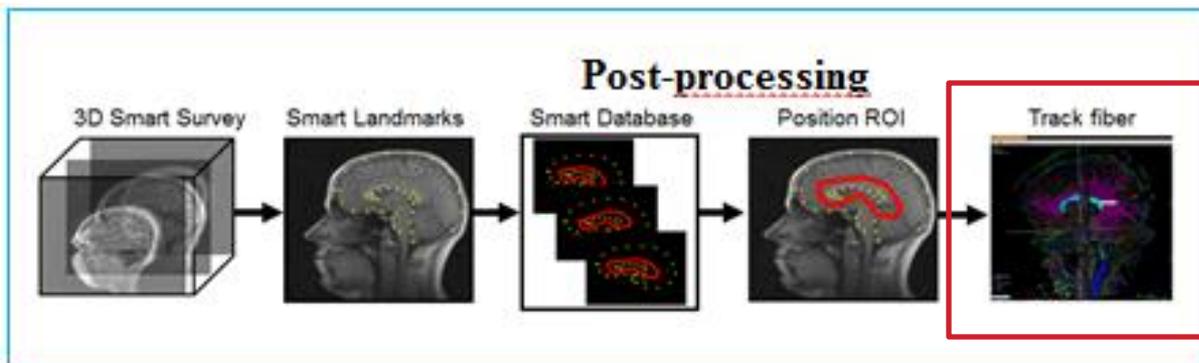
EMC^2 Goal

MRI Exam cards selection, MRI Acquistion, (pre)processing, and viewing (UI) on single system

- Create a system that allows identification of such issues in early stage
  - Requires post-processing to run while, or right after, scanning
  - Requires advanced viewing at the MRI Scan Room
  - Requires to be ready within the time the patient is available
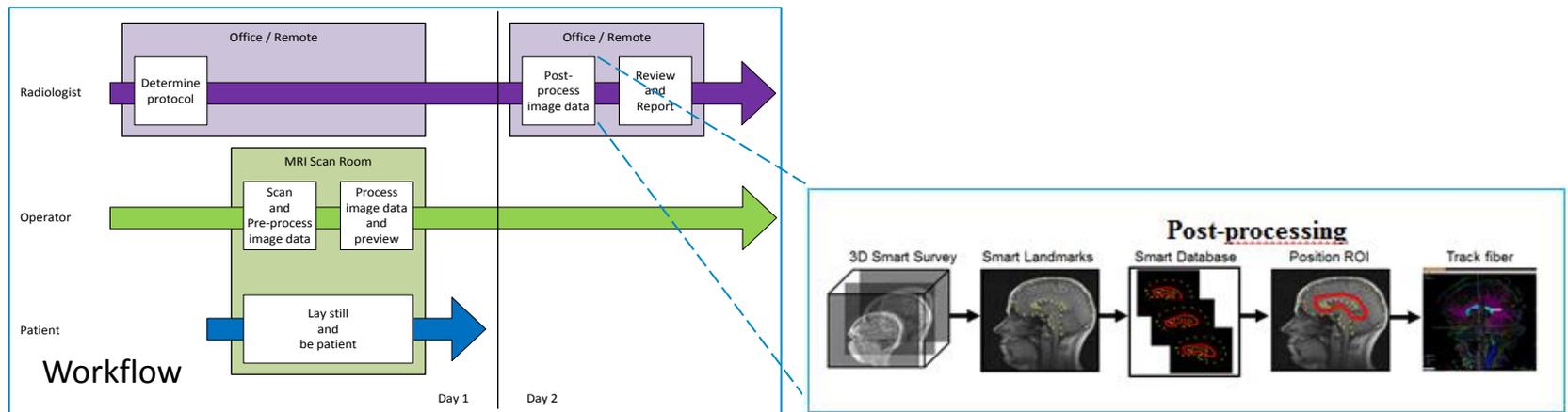
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EMC^2 Challenges

Main challenge: go from separate tasks deployed on separate systems to a single system solution
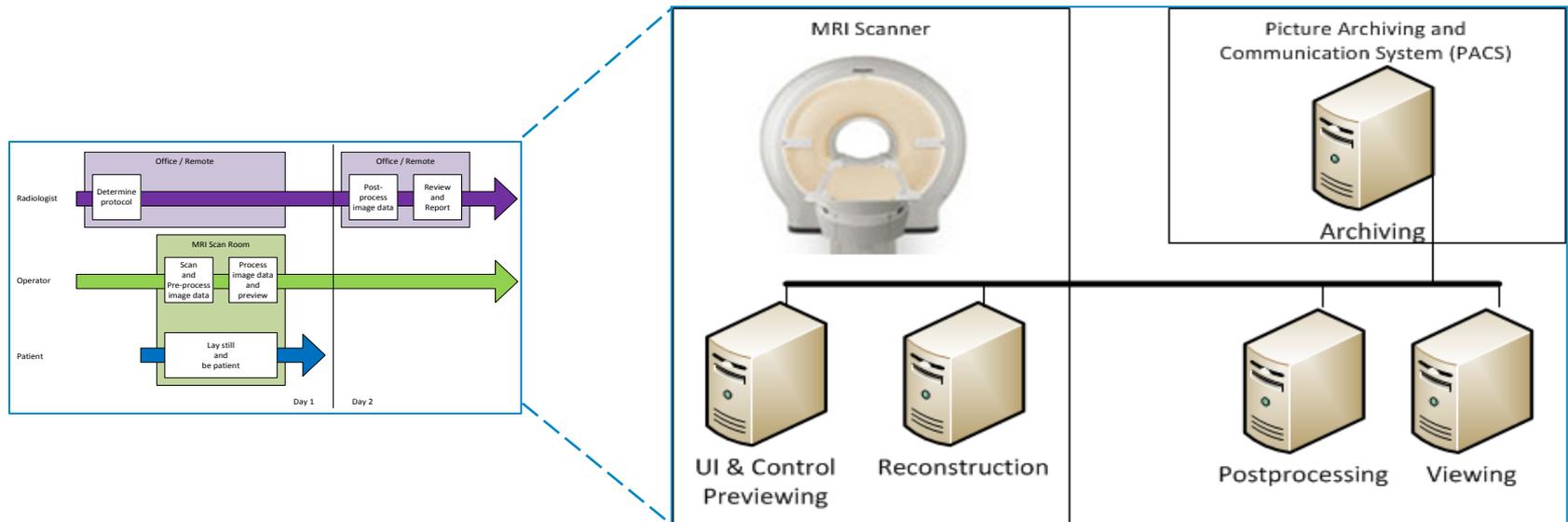
- Detecting issues in the early stage requires advanced viewing at the MRI room
  - Advanced viewing of post-processed data requires the post-processed data
    - Post-processing executed on separate machine
    - Post-processing executed only after the storage system (PACS)
    - Post-processing requires the reconstructed data
      - Reconstruction requires acquisition data (MRI)

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EMC^2 Challenges

Main challenge: go from separate tasks deployed on separate systems to a single system solution

- Combine multiple applications on a single system
  - Acquisition High criticality; Medium performance req. Cannot be blocked
  - Reconstruction Medium criticality; High performance req. Block only temporary
  - Post-processing Low criticality; High performance req.
  - Viewing Low criticality; Low performance req.

- But:
  - Multi-critical applications
  - Performance requirements
    - Resource management
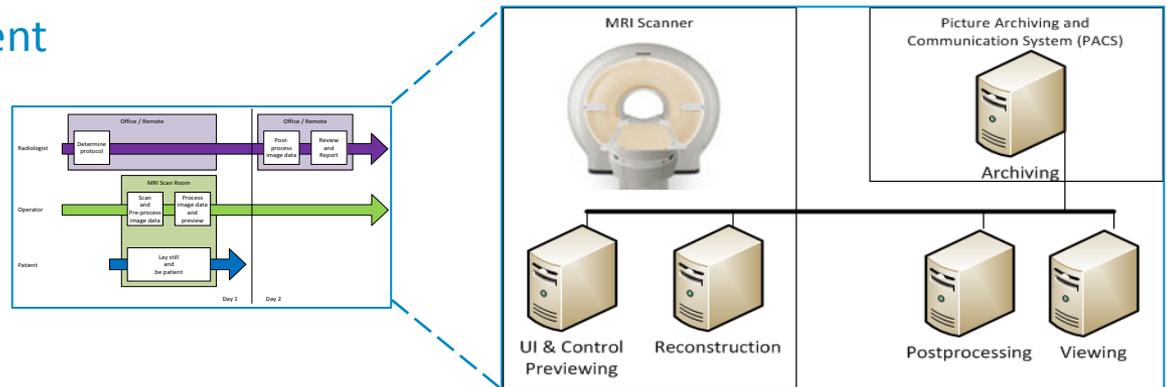
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EMC^2 Challenges

Main challenge: go from separate tasks deployed on separate systems to a single system solution

Application 1	Application 2	Application 3
Guest OS	Guest OS	Guest OS

Virtual Machine

Hypervisor
Host Operating System
Multi-core Hardware Platform

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EMC^2 Challenges

Main challenge: go from separate tasks deployed on separate systems to a single system solution

Application 1	Application 2	Application 3
App Container	App Container	App Container

Management Layer

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Host Operating System

Multi-core Hardware Platform

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EMC^2 Challenges

Main challenge: go from separate tasks deployed on separate systems to a single system solution
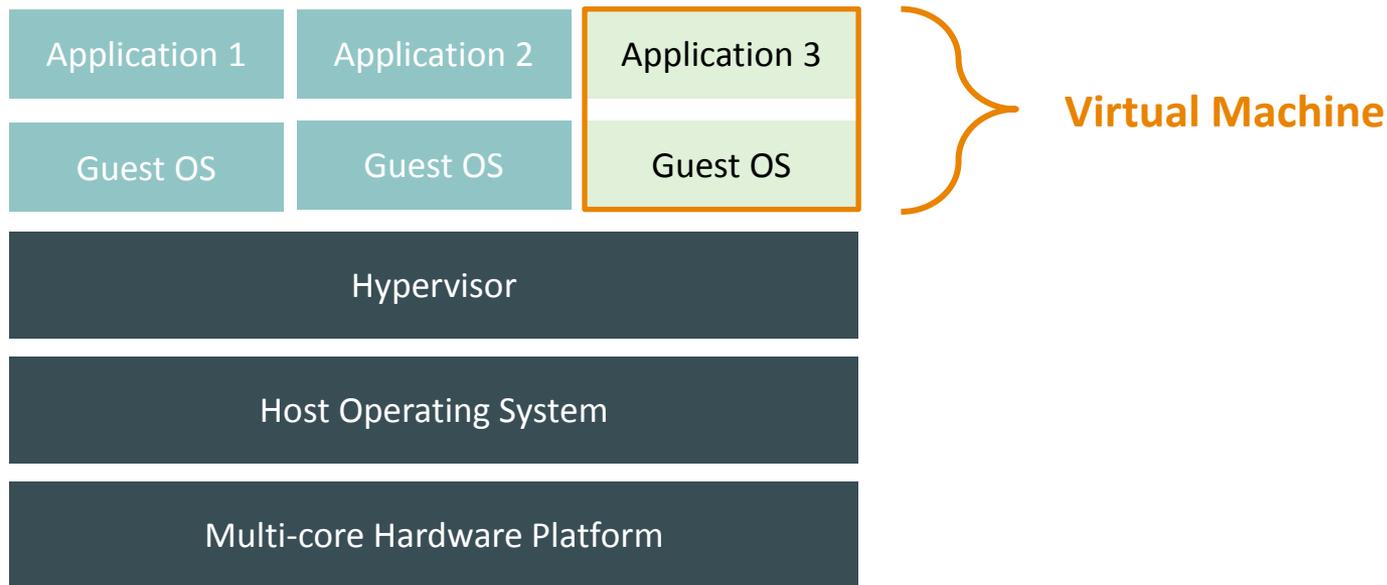
Application 1	Application 2	Application 3
App Container	App Container	App Container
Management Layer		
Host Operating System		
Multi-core Hardware Platform		
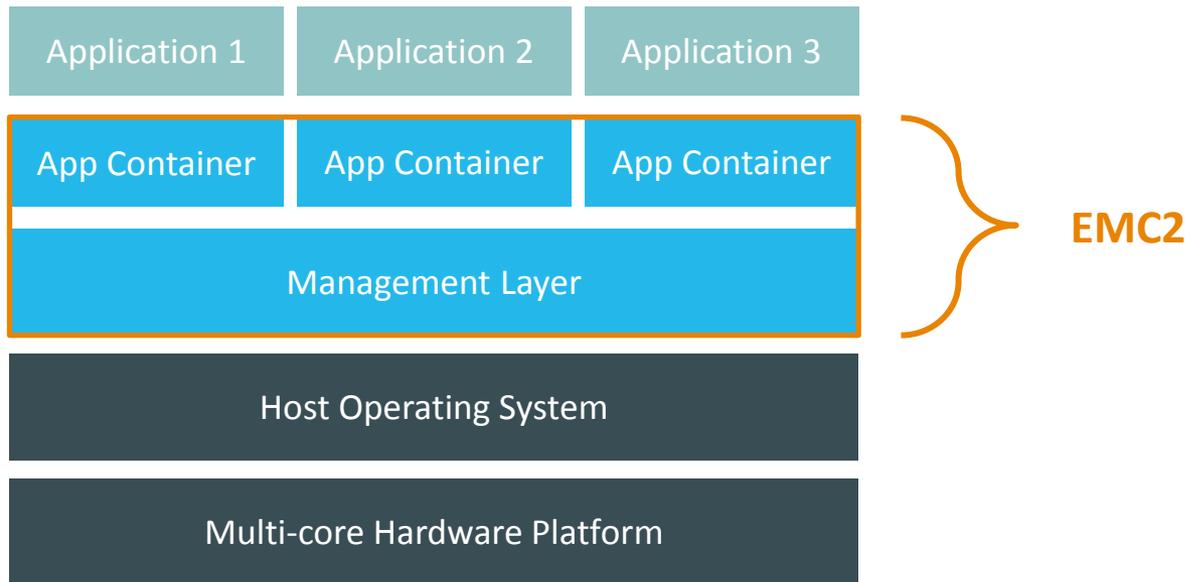
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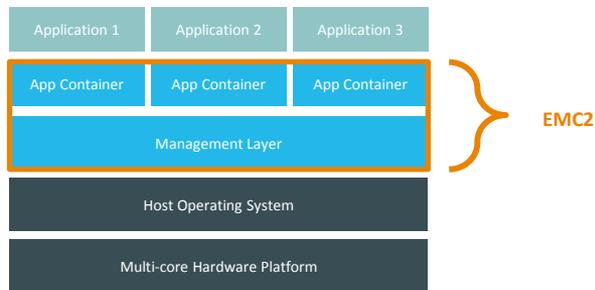
- **Application modeling**
  - Specify required amount of resources
  - Specify criticality level
  - Specify temporal information regarding required resources to enable DSE.
- **Platform modeling**
  - Service to request resources for applications with given criticality
  - Specify available resources
- **DSE**
  - Feasibility analysis based upon mapping, criticality, and temporal information
  - Determine resource requirements
  - Identify bottlenecks
  - Identify utilization

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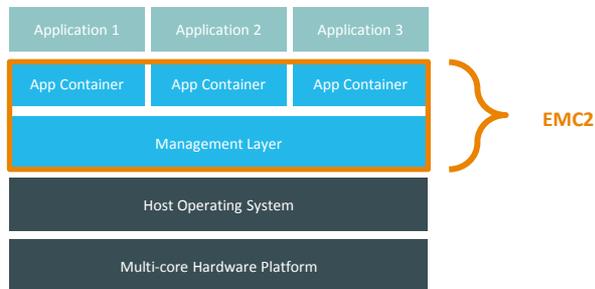
- Legacy code
  - Two major archives, 11M+ LOC, >10Y development
  - Resource requirements not known in detail
    - Temporal behavior
- 'Macro' vs. 'Micro'
  - We have applications requesting resources, not a low-level task breakdown
- Online vs. offline allocation
  - DSE typically offline, we want to explore runtime analysis and allocation management (in addition to offline)

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Partners in EMC^2

VectorFabrics
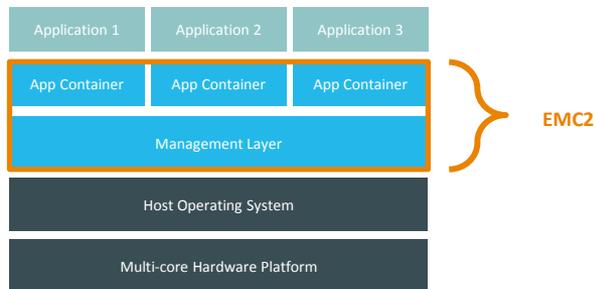
Program verification tools to check safety of memory accesses in sequential and parallel programs

TU Delft
Delft University of Technology

Design tools to enable analysis of system communication patterns

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Thank you