

MC2E: Meta-Cloud Computing Environment for HPC

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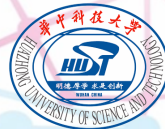
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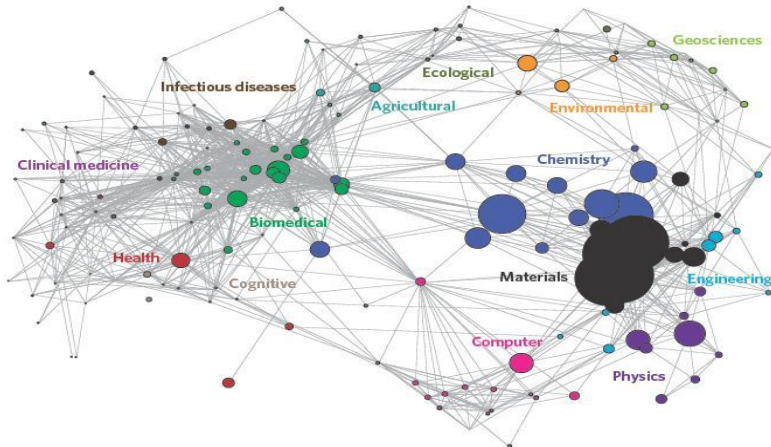


Background



Current state:

- Huge data arrays in various science fields
- Large number of research teams
- Infrastructures are scattered
- Each new project requires additional infrastructure investments
- Experiments in many areas are not reproducible

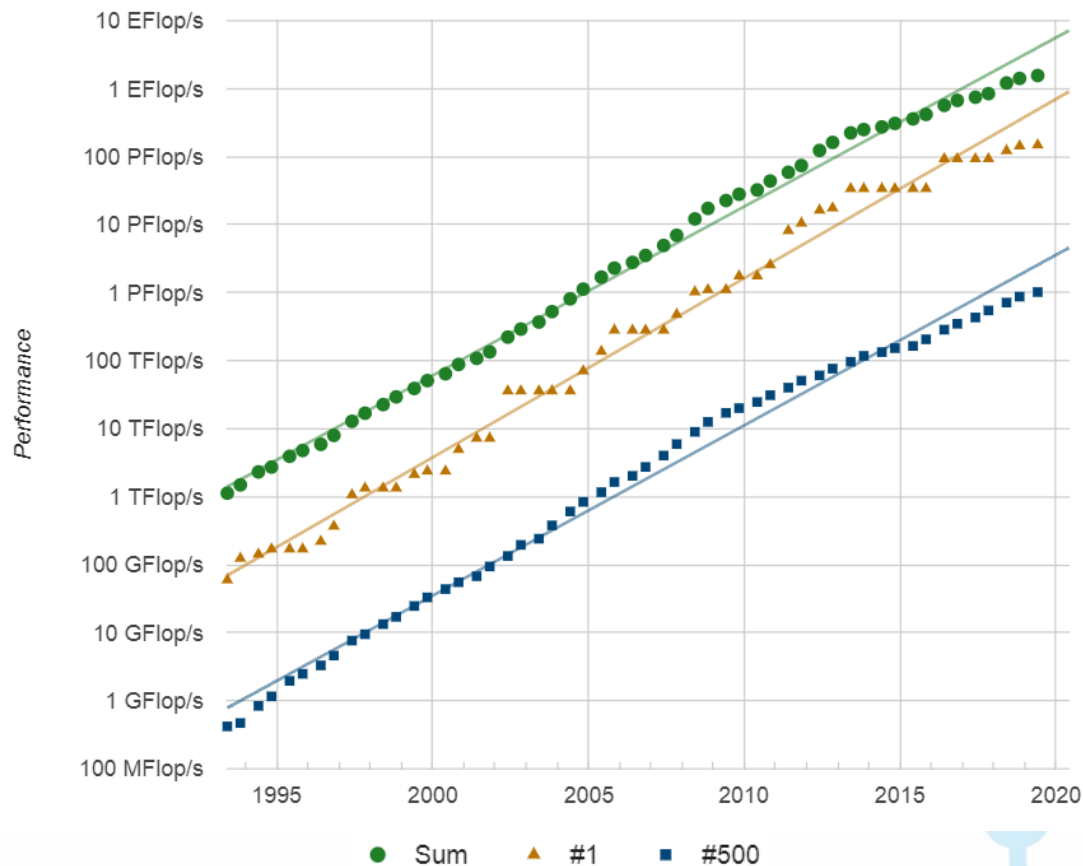


The rise of multidisciplinary research:

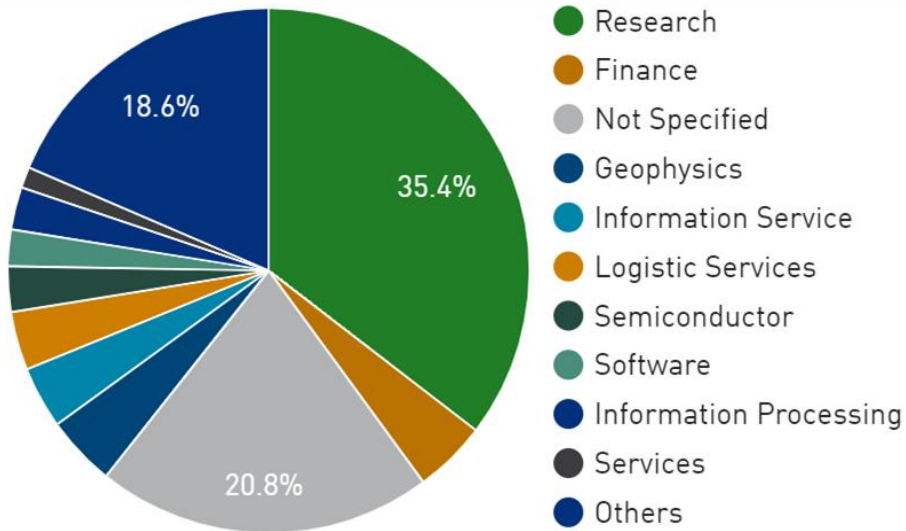
Multidisciplinary – a property of knowledge domains, when objects are studied in different research fields simultaneously: each field maintains its own methodology and is not influenced by other fields.

- Thomson Reuters: **more than 50% of 170000** papers published in 60 scientific journals are multidisciplinary by their nature
- The number of multidisciplinary projects in US, EU, Japan, Canada and **others increased by 50%** since 1996
- The amount of departments working of multidisciplinary fields in the university of Columbia US increased **from 105 in 1996 up to 277 in 2004**

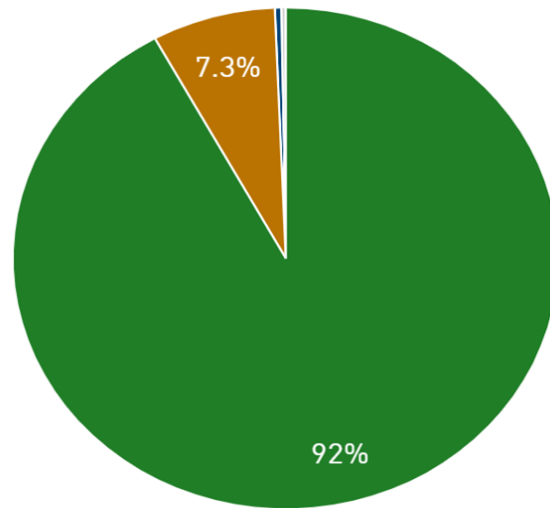
Supercomputer Performance Growth



Application Area Performance Share



2009



2019

Top500.org

4

A global system of e-Infrastructures

Africa-Arabia, Asia and Pacific region, China, Europe, India
North and South America, Ukraine



Europe (mainly)



Africa and Arabia:
Council for Scientific and
Industrial Research, South Africa



India:
Centre for Development of
Advanced Computing



USA

Open Science Grid



China:
Institute of HEP,
Chinese Academy of Sciences



Latin America:
Universidade Federal
do Rio de Janeiro

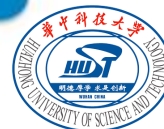


Australia:
Nectar Research Cloud

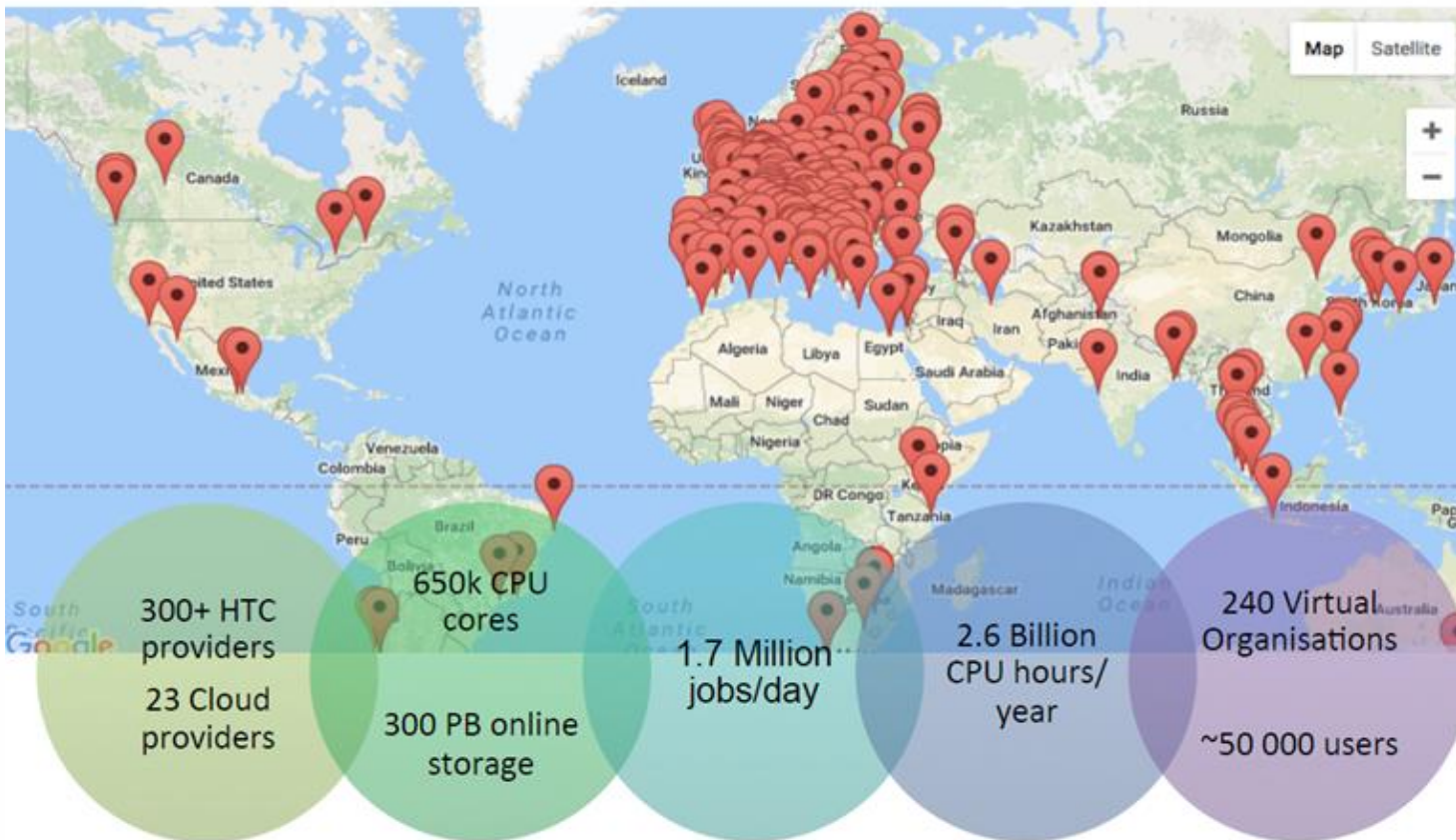


compute
canada | calcul
canada

Canada



EGI Federated Infrastructure



E-Infrastructure Research Projects



- **GENI (US)** - is an open infrastructure for large scale experiments in networking and distributed systems, with its servers located throughout the United States



- **PRAGMA (US, Japan, Taiwan, Thailand)** - is a scalable international networking testbed created for SDN/OpenFlow research



- **EGI (EU, Netherlands)** - is an infrastructure for interdisciplinary research, that incorporates computational resources based on the federation principle



- **Chameleon (US)** - is a configurable experimental environment for large-scale experiments with cloud HPC



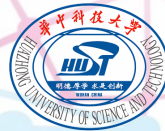
- **Sea-Cloud Innovation Environment (China)** - is an SDN&NFV based infrastructure for research in computational resources' virtualization methods



- **FABRIC (US)** - is an adaptive programmable research infrastructure for research in networking, cybersecurity, distributed computing and storage systems, machine learning and science applications

Multidisciplinary Project Attributes

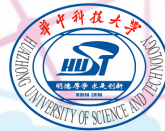
- Research teams are geographically distributed
- Heterogeneous data collections need a unified interface for accessing
- The necessity to integrate computational infrastructures and data storage with a policy defining shared data processing methods and experiments evaluation
- The groups of researchers form the project may already have tools, software for processing, collecting and storing data. Creating or mastering new ones for a project is usually unacceptable.
- Project teams often have different internal business processes, tools, specialize in different subject areas, have their own hardware and software preferences and are may be located far from each other;



MC2E Project goals

Based on SDN&NFV approach develop methods and tools enabling to build an information infrastructure based on the federation of heterogeneous clouds and HPC units for multidisciplinary research.

- The infrastructure is created as a federation of local computing units called federates
- All physical resources are aggregated and virtualized
- Federation resources can be shared between virtual infrastructure of the different projects
- Resources have a high level of abstraction
- Results of the experiments could be saved and loaded
- Data processing is provided as a virtual service
- Users can bring their own images of the services



Project Participants



- Lomonosov Moscow State University

Lomonosov Supercomputer, MAN Platform, DC



- Peking University

docklet – MPI container

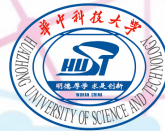


- Huazhong University

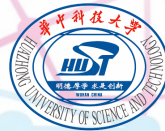
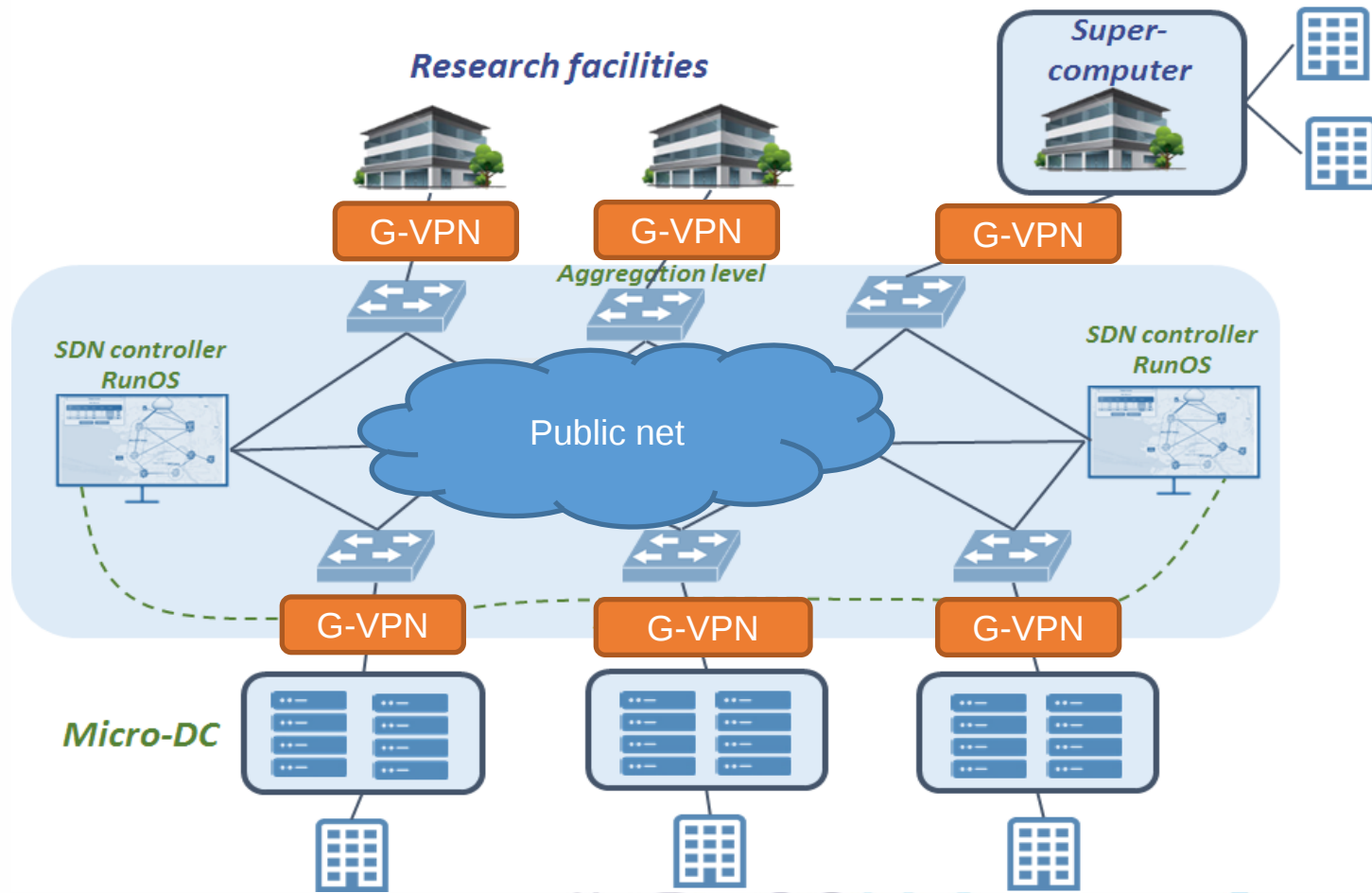
- Tsinghua University



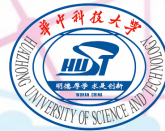
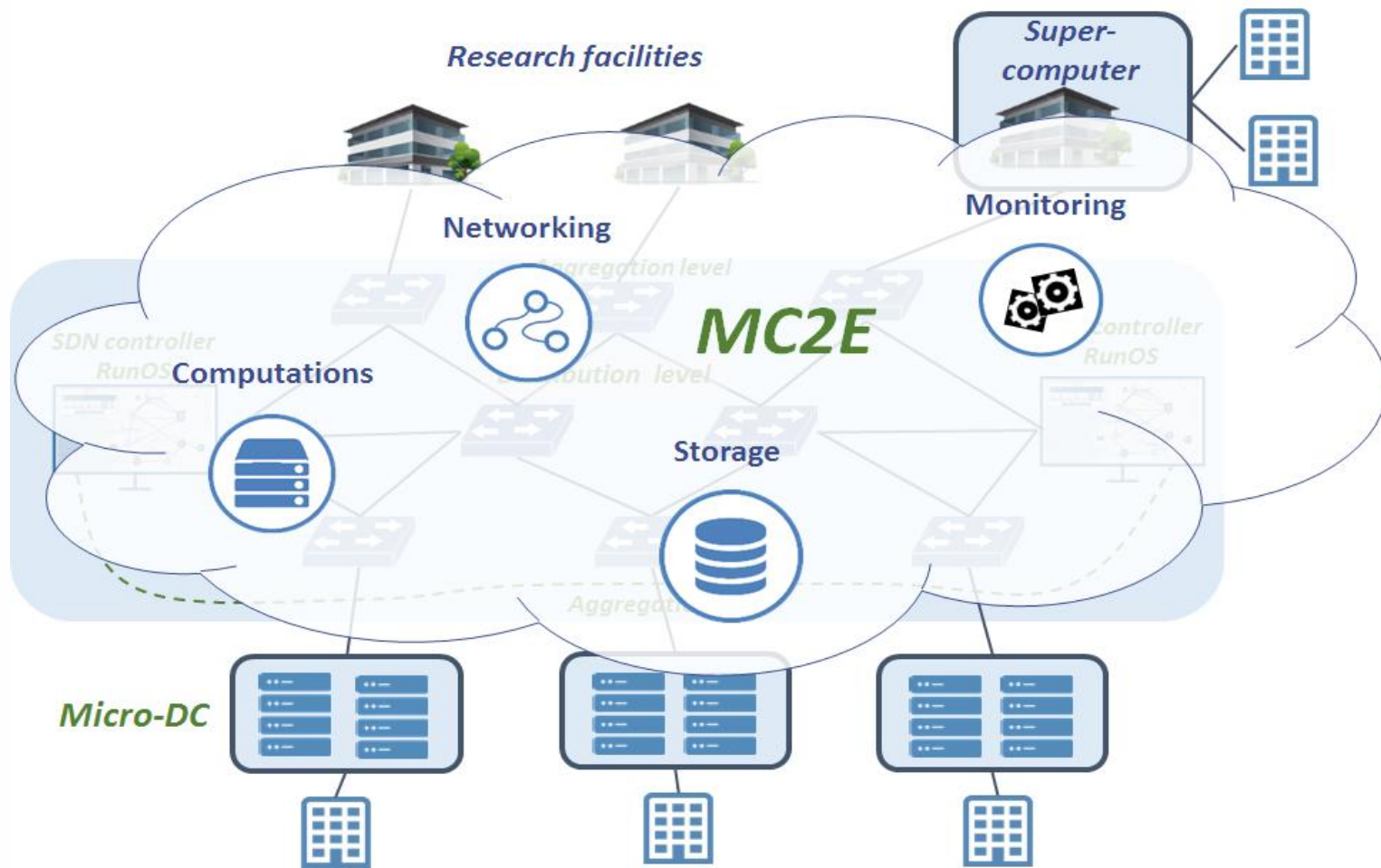
- The Sunway TaihuLight #3 Top500



Main idea of proposed approach

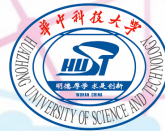


Main idea of proposed approach



Main Problems

- Integrate HPC-C and HPC-S environments
 - Automatically recognition those tasks in the queue to HPC-S that can be solved in HPC-C in the current resource amount/configuration and transferred to the HPC-C queue as a request for services.
- Verify the efficiency of virtualization techniques (sharing physical computational infrastructures) in a cloud environment with multiple HPC tenants
- Evaluate Capacity on Demand service feasibility for federates interconnection



Core Components

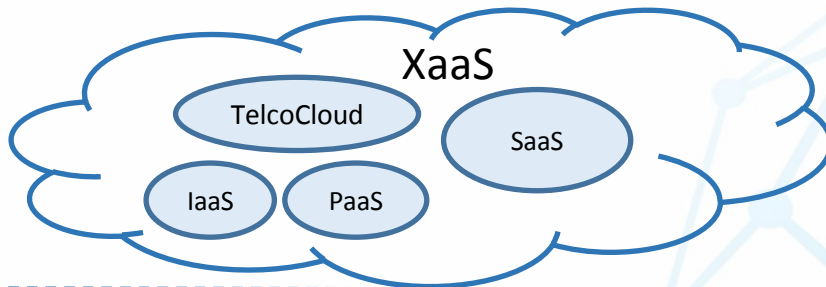
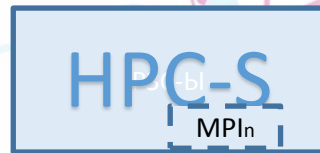
- MANO system
- Resource scheduler
- Virtual resource description API
- Gateway to other cloud initiatives
- Intra-federation transport connections
- Monitoring System
- User-oriented QoS provider



Core Components: MC2E Actors



customer portal



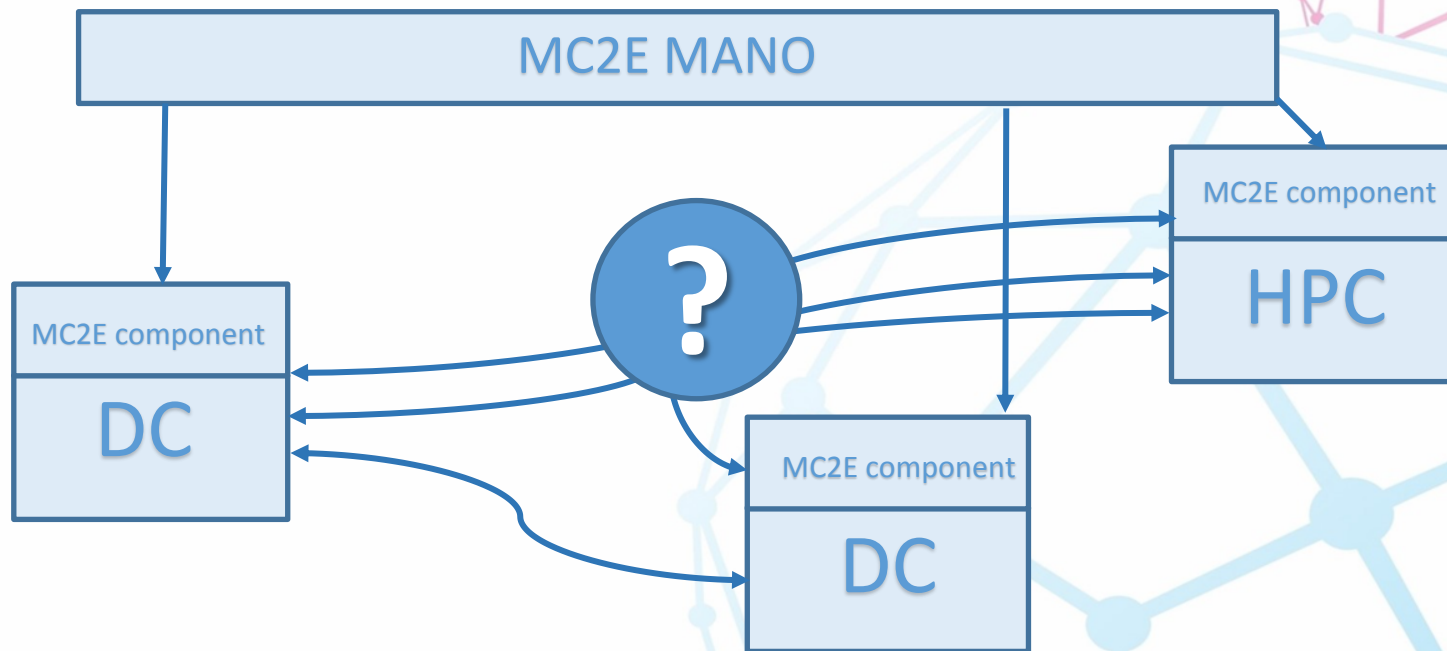
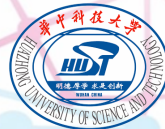
VS



developer



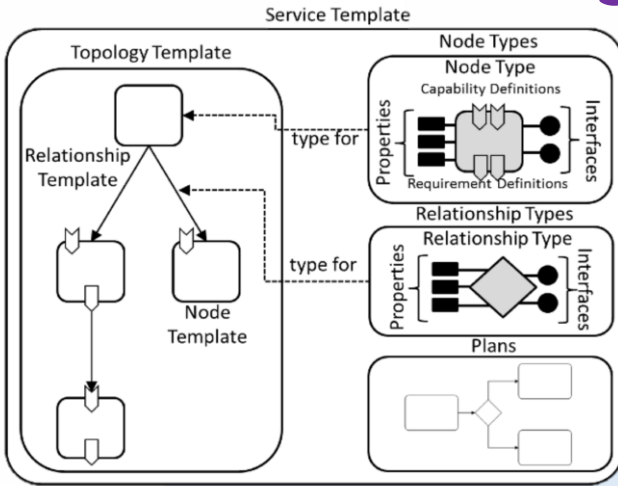
Interfederates communication Infrastructures



Services Description



Service?



Service template

Specifications

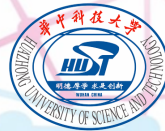
Scripts

Image
(optional)

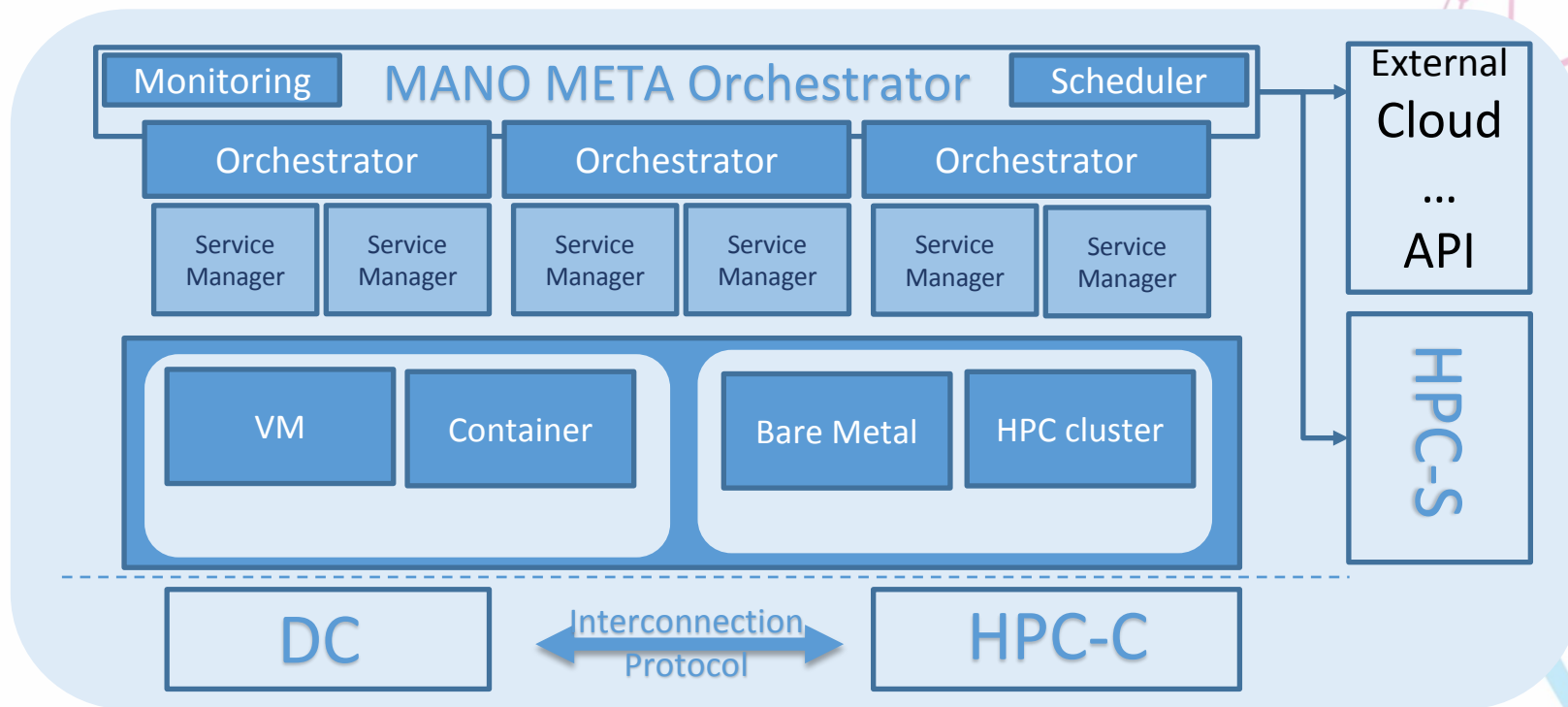
TOSCA

Bash/Shell

RAW, OVA, VMDK



MANO Platform Architecture



MC2E Architecture

