ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

CLOUD COMPUTING ECOSYSTEM

Infrastructures and ecosystems for advanced cloud computing, including optimizations for cloud continuum (fog), big data management, and latency-sensitive Industry 4.0.

Advanced cloud computing is the primary building block for effective distributed computing ecosystems where applications with industrial requirements can be efficiently built and run, e.g., from I4.0 applications with highly stringent latency and reliability constraints, to elastic and high-demanding big data management services, and to distributed and heterogeneous orchestration of virtualized resources.

The University of Bologna cloud computing research overview:

- Platforms for the integrated monitoring, control, and management of multi-cloud resources (both virtual machine- and container-oriented)
- Edge/fog computing middleware for latency-sensitive and high-reliability applications and for distributed machine learning and distributed AI
- Multi-access Edge Computing (MEC) middleware for 5G/6G-based distributed networking, caching, and processing
- Distributed and interoperable orchestration of resources in the cloud continuum
- Platforms for geographically distributed, federated, and sustainable datacenters, and associated testbeds
- Cloud computing ecosystems for:
  - big data management, in particular for online stream processing
  - I4.0 applications over the industrial Internet
  - smart cities, in particular for citizens' profiling and mobility trends
  - quality-enabled support of 5G mobile services

HIGHLIGHTS

FIBRA UNIBO-UDESC Joint Lab on Big Data for I4.0

The **FIBRA Joint Lab** joins public/private efforts in Italy and Brazil to propose innovative models of information management, technology transfer, and ways to develop high value-added ICT companies in cloud computing, in particular for big data support in I4.0.

Federated and Sustainable Cloud Testbeds

The University of Bologna hosts a relatively large private cloud multi-site (Bologna and Cesena) infrastructure, consisting of heterogeneous nodes and Software Defined Networking programmable switches. It is integrated with other public data centers for cloud bursting and large-scale federated testbeds like, for example, EXE.it for low carbon sustainable cloud architectures and Amazon Web Services EC2.

The University of Bologna has contributed to the European research and innovation progress about multi-cloud and cloud continuum paradigms with several projects, starting with "**Mobile Cloud Networking**" (2012-2016) and more recently with the large IA "**IoTwins** - Distributed Digital Twins for industrial SMEs: a big-data platform" (2019-2022) and the RIA "**Change2Twin** - Create and Harvest Offerings to support Manufacturing SMEs to become Digital Twin Champions" (2020-2023).

In addition, the University of Bologna has participated to several national and regional projects for the exploitation of cloud continuum techniques in digital manufacturing (e.g., funded by MISE and the BI-REX competence center), smart cities (e.g., Ippodamo), and cultural heritage (e.g., Sacher).