Research Challenges in Cloud Computing

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European Commission

Cloud Computing Consultation

Orange Labs

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next big things for the digital future

Big Data → 21st century knowledge industry

Priority : Artificial Intelligence

Internet of Things → augmented world

Priority : Large-scale IoT

Cloud → networked clouds

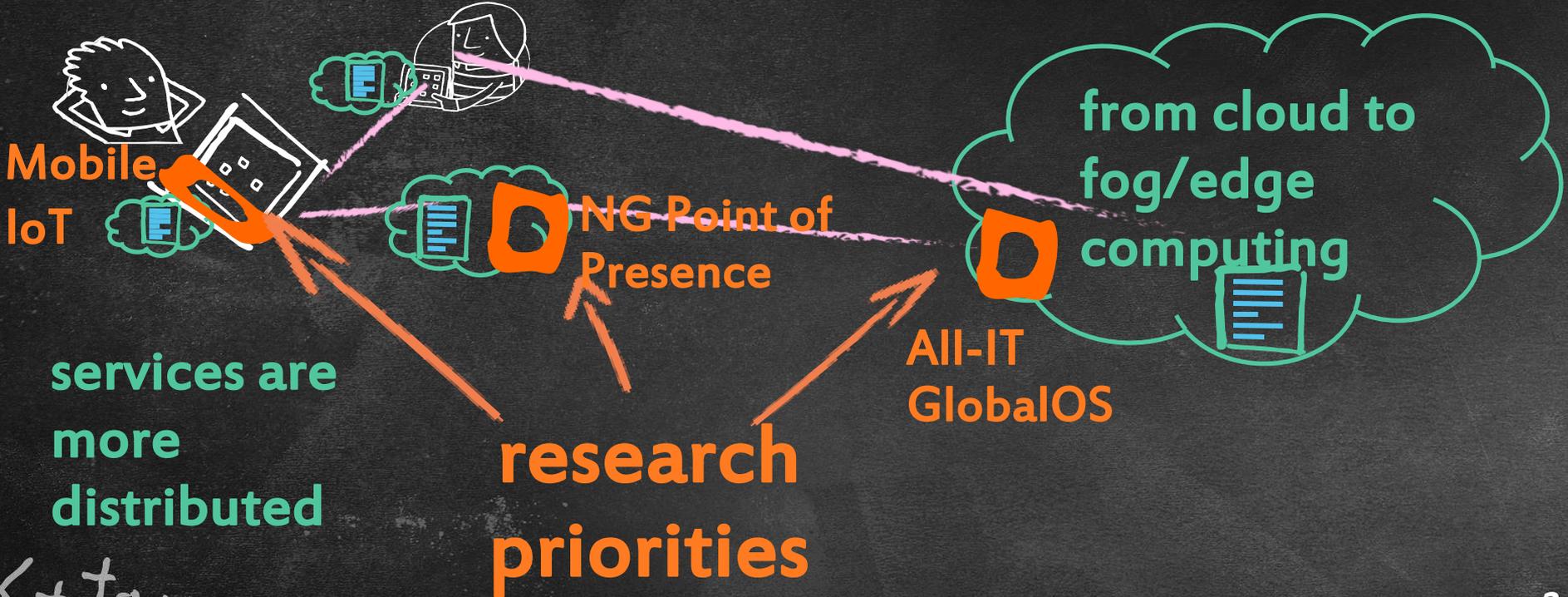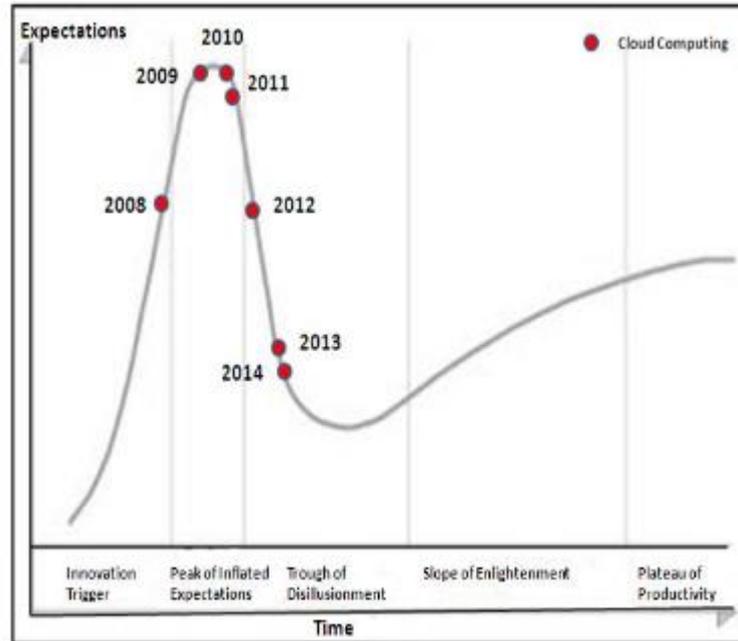Priority : Distributed Software Insfrastructure

Networks → connectivity experience and business model

Priority : Ambient Connectivity

road towards distributed software infrastructure

Performance

Software - Big Data - Artificial Intelligence

Processing & Storage

Communication

Year

Mobile IoT

from cloud to fog/edge computing

NG Point of Presence

All-IT GlobalOS

services are more distributed

research priorities

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Context

credit: Gartner

On-demand network – "Cloudified" SDN based Network

Problem

Nowadays, virtual machines and Cloud storage are largely spreading in big datacenters. However, network remains relatively stagnant. Software defined network (SDN) is becoming the major arm to get network flexible. However, more needs to be done for the applications to get really "on-demand" networks.

Research Challenge

Technically speaking, the network is a mean allowing to

- establish the connectivity between some equipment

- provide the bandwidth capacity for a given data path

- deliver data transfer between equipments

- guarantee isolation

Is there a way to "cloudify" the network architecture so that any application can initiate, update or terminate networks according to its business requirements through programmatic API, automatically and instantly?

In-network distributed Cloud – Cloud for network and services virtualization

Problem

Many Cloud providers (Amazon, Google, Microsoft) implement their Cloud infrastructures by building centralized huge datacenters with thousands servers. For the telecom operators, it may be interesting to implement Cloud infrastructures based on the existing datacenters and distributed network PoPs, which is called here in-network distributed Cloud.

However, there is not yet appropriated Cloud management platform (CMP) capable of dealing with this architecture.

Research Challenge

Are adaptations of existing CMP sufficient or do we need to design a new generation with built-in support of distributed infrastructure with tools to help engineer large scale systems (emerging behaviours, dynamic adaptation,…)?

How to provide rich and flexible interaction interfaces between the distributed CMP and the backbone network for establishing connectivity and higher layer networking services for intra-PoP, multi-PoP, PoP to DC and PoP to end users resources ?

How to optimize communication and data location in a federation of distributed cloud storage?

How to apply the latest innovations into the CMP, such as machine learning, policy/intention based management?

Security

Security is always a key issue in any complex system. In the Cloud, especially, we need the security to be omnipresent and as less as possible human intervention.

Research Challenge

Self-Managed Security: Enable full automation of security management in order to reduce operational costs while adding more flexibility and providing a unified view of security in distributed and heterogeneous cloud and network environments.

Self-Service Security: Enable self-service of security in heterogeneous cloud and network infrastructures and provide flexible mechanisms to control in a fine-grained manner the security of resources.

End-to-End Security: Implement a distributed security abstraction layer between endpoints to overcome the heterogeneity of security technologies across the cloud and the network and to create trust relationships between different locations, to provide a unified user experience of security.

Resilience: Enhance robustness by providing appropriate abstraction mechanisms enabling the composition of redundant resources across distributed and heterogeneous cloud and network infrastructures in a transparent way to the end-user.

« Cloud ready » application programming paradigm

Problem

The infrastructure layer has been completely transformed by the Cloud. However little has been done on the application level: many architectural recommendations but not yet generic framework or middleware to help us to develop applications on top of major Clouds. Worse, we are often struggling to migrate running legacy applications to a Cloud infrastructure.

Some PaaS or frameworks (Helix, Hystrix,…) already provide limited implementations of distributed architecture patterns.

Research Challenge

A brand new programming paradigm to develop "Clouds ready" application, in which we write only business logic and the Cloud infrastructure, the framework and the middleware should be able to take in charge of all concerns of deployment, monitoring, self-scaling, …

It implies also a reasonably sophisticated IaaS/PaaS level API, exposed by the Cloud infrastructure, supporting directly application developer's' needs, such as generic application lifecycle management.

More concretely, in the field of NFV, a "Cloud ready" application architecture/model cloud be proposed to simplify its design and implementation.

Thank you