

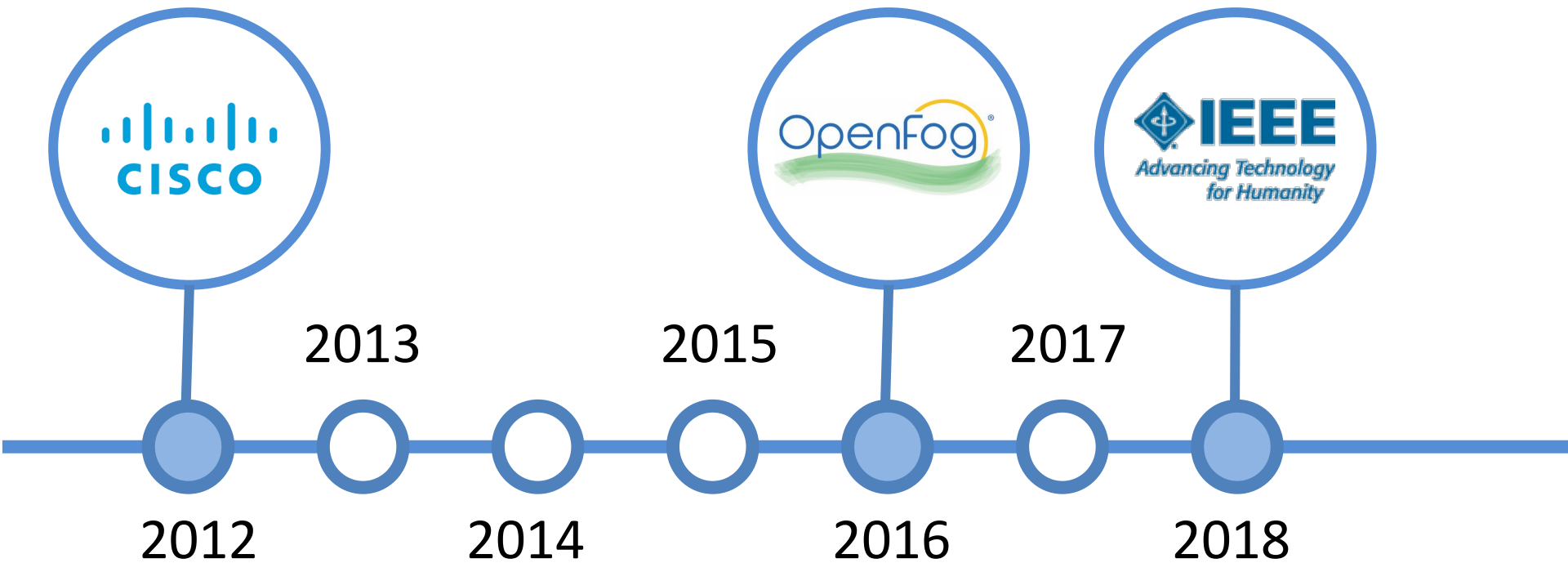


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Introducing the Fog Computing

Section 1

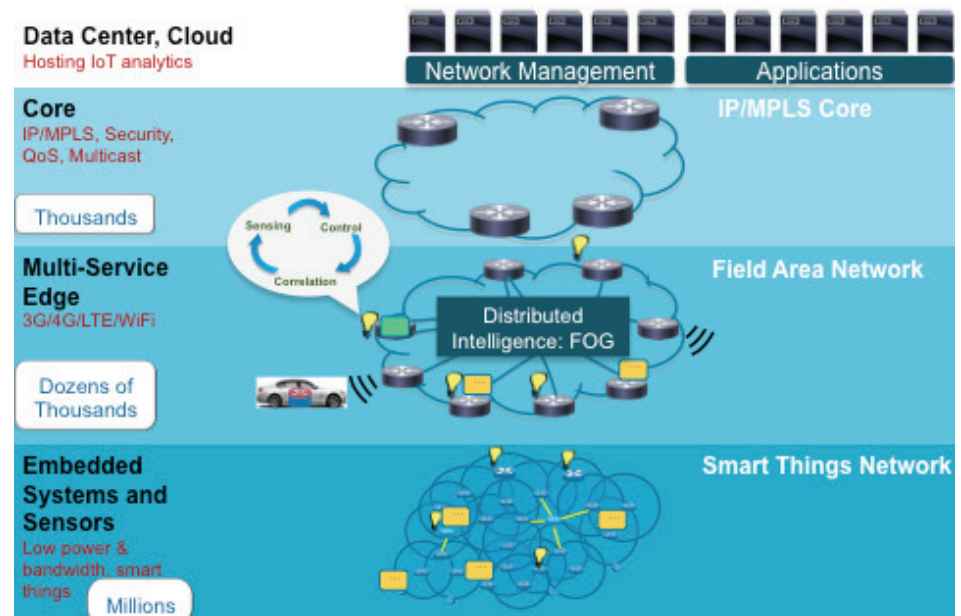
Timeline



The CISCO definition

“Fog Computing is a **highly virtualized** platform that provides **compute, storage, and networking services** between end devices and traditional Cloud Computing Data Centers, typically, but not exclusively located at the edge of network.”

The Internet of Thing Architecture and Fog Computing



Bonomi, F., Milito, R., Zhu, J., Addepalli, S.: Fog computing and its role in the internet of things. In: Proceedings of the First Edition of the MCC Workshop on Mobile Cloud Computing. pp. 13–16. MCC '12 (2012)

The OpenFog Consortium definition

A **horizontal, system-level architecture** that distributes computing, storage, control and networking functions closer to the users along a **cloud-to-thing continuum**



OpenFog Consortium, OpenFog Reference Architecture for Fog Computing, February 2017

<https://www.openfogconsortium.org/ra>

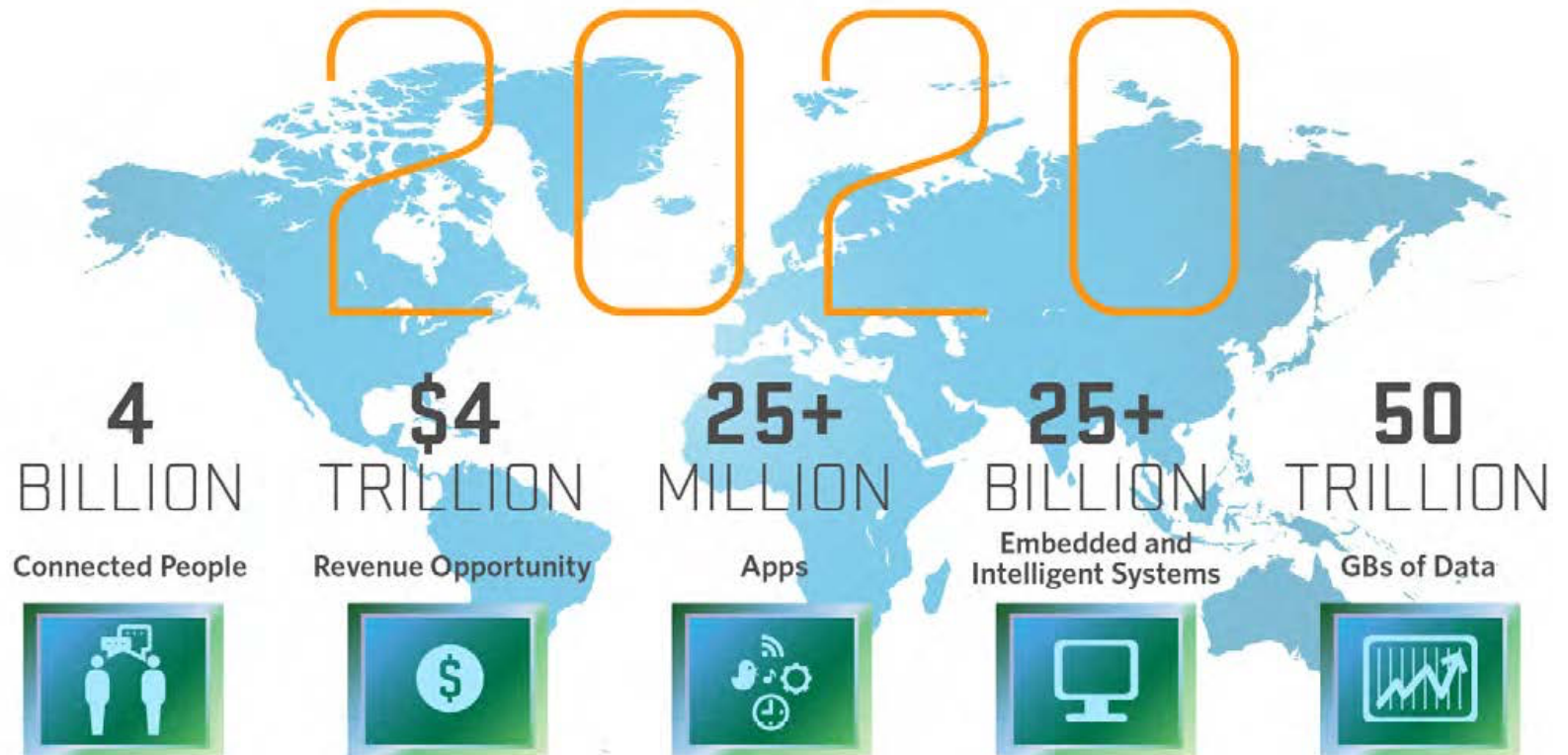
Fog is **not** Edge

Fog works **with** the cloud

Fog **extends the cloud** and the cloud technologies can be adopted (virtualization, containerization, orchestration)

Fog node is the elementary computational/storage/communication node

Why Fog Computing



Source: Mario Morales, IDC

Why Fog Computing

Industry 4.0 issues:

- Heterogeneity
- Real time
- Security/privacy



[Business & Information Systems Engineering](#)


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Fog Computing

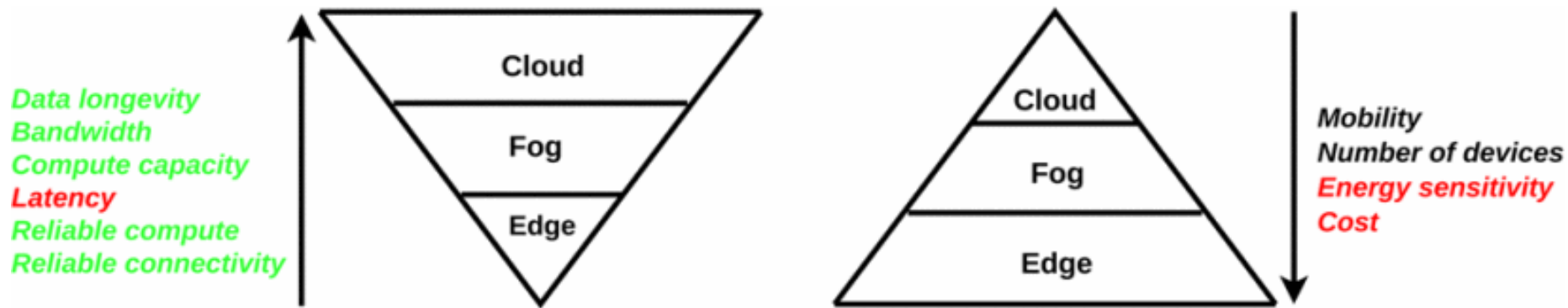
Complementing Cloud Computing to Facilitate Industry 4.0

Authors

[Authors and affiliations](#)

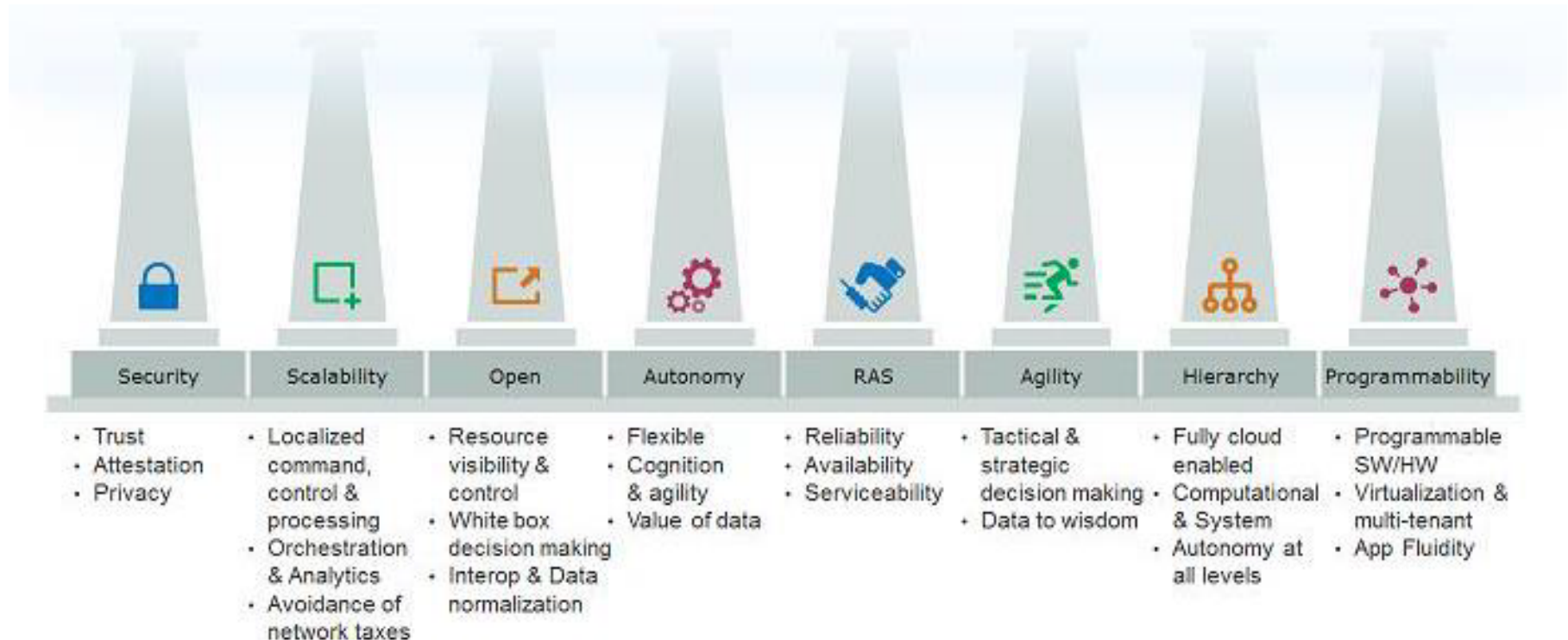
Christian Matt 

Why Fog Computing



P. Varshney and Y. Simmhan , Demystifying Fog Computing: Characterizing Architectures, Applications and Abstractions , IEEE 1st International Conference on Fog and Edge Computing (ICFEC), 2017

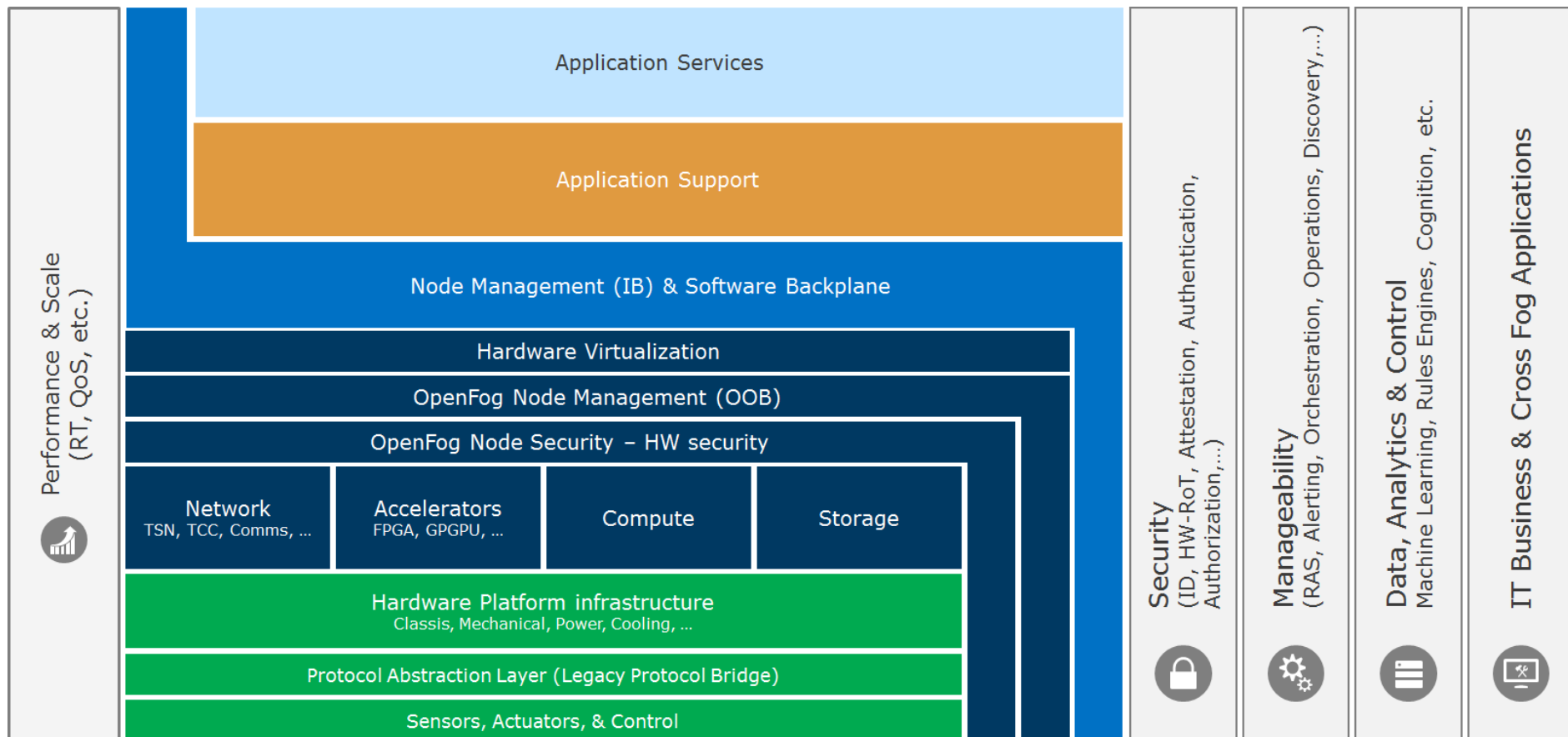
Fog Pillars



OpenFog Consortium, OpenFog Reference Architecture for Fog Computing, February 2017

<https://www.openfogconsortium.org/ra>

The OpenFog Consortium approach



The relevance of data movement

Fog Computing is usually focused on placing the computation near to where the data are produced:

- Privacy issues
- Reduced latency

What about also considering the opposite?

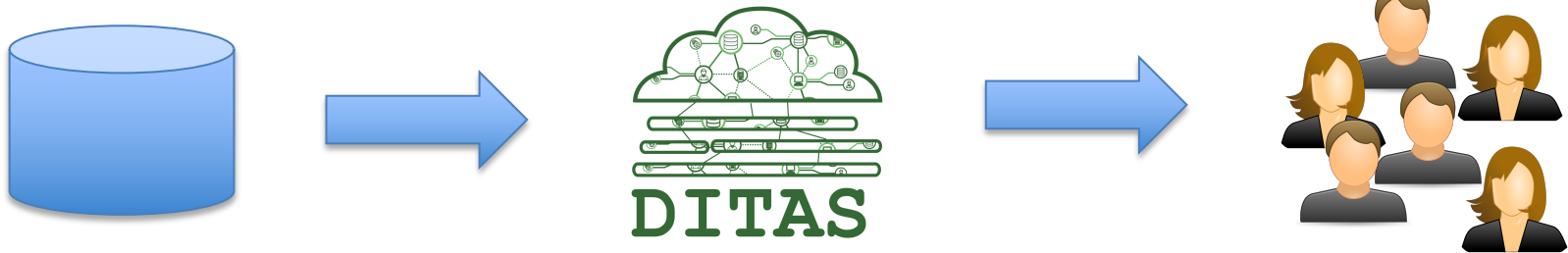
- To put the data to where they can be processed more efficiently

To simplify with an SDK the development of **data-intensive applications...**

... proposing the concept of **Virtual Data Containers ...**

... that take care of data and computation movement in a Fog Computing **execution environment**

Virtual Data Container



For data providers

Virtual Data Container offers to solve problems about scalability and movement to achieve a certain QoS level

Virtual Data Container embeds the logic to move data and computation in the Fog architecture

For data consumers

Virtual Data Container offers an abstraction layer hiding the complexity of the edge

Enhancing data management

- From the generation to the usage also considering data utility

Ensuring Security/Privacy

- Data must be safe and used only by people having the rights

Reducing Latency

- Request for data should be satisfied in a limited time

A Research Perspective on Fog Computing

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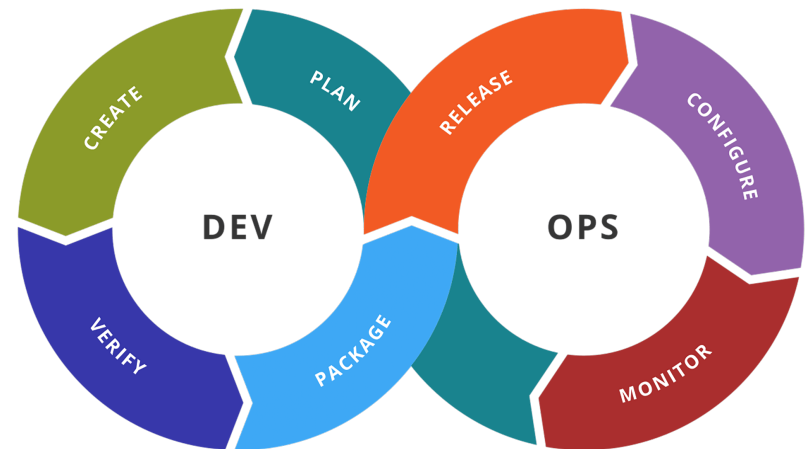
⁴ IBM Research Haifa
{mayaa,ronenkat}@il.ibm.com

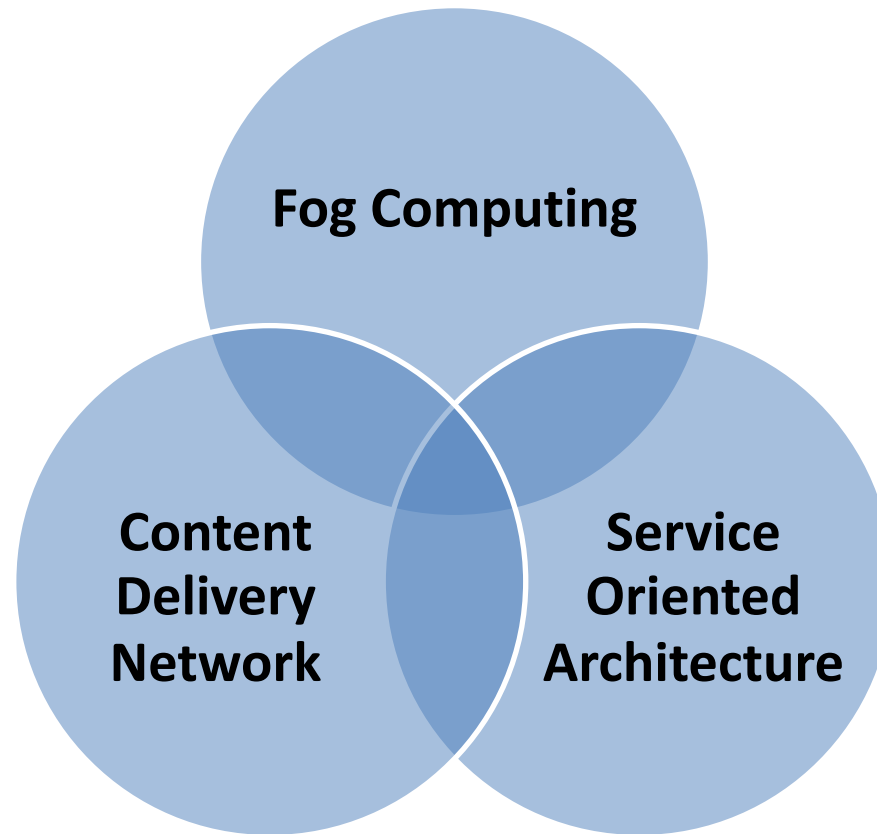
The main objectives

Make easy the development of data-intensive applications

- Providing data efficiently
- Consuming data easily

Make the resulting platform easy to manage





Design principles: Service Oriented Computing

Visibility

- VDC Blueprint

Abstraction

- Virtual Data Container

Policy and contract

- Data utility

Reference Model for Service Oriented Architecture 1.0

OASIS Standard, 12 October 2006

Document identifier:

soa-rm

Location:

<http://docs.oasis-open.org/soa-rm/v1.0/>

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Abstract:

This Reference Model for Service Oriented Architecture is an abstract framework for understanding significant entities and relationships between them within a service-oriented environment, and for the development of consistent standards or specifications supporting that environment. It is based on unifying concepts of SOA and may be used by architects developing specific service oriented architectures or in training and explaining SOA.

A reference model is not directly tied to any standards, technologies or other concrete implementation details. It does seek to provide a common semantics that can be used unambiguously across and between different implementations. The relationship between the Reference Model and particular architectures, technologies and other aspects of SOA is illustrated in Figure 1.

While service-orientation may be a popular concept found in a broad variety of applications, this reference model focuses on the field of software architecture. The concepts and relationships described may apply to other "service" environments; however, this specification makes no attempt to completely account for use outside of the software domain.

Design principles: Content Delivery Network

Data distribution

- One data provider more data consumers

Scalable infrastructure

- Number of consumers can unpredictably change