



**PRISMTECH**

The Cloudy, Foggy and Misty Internet of Things  
**Toward Fluid IoT Architectures**

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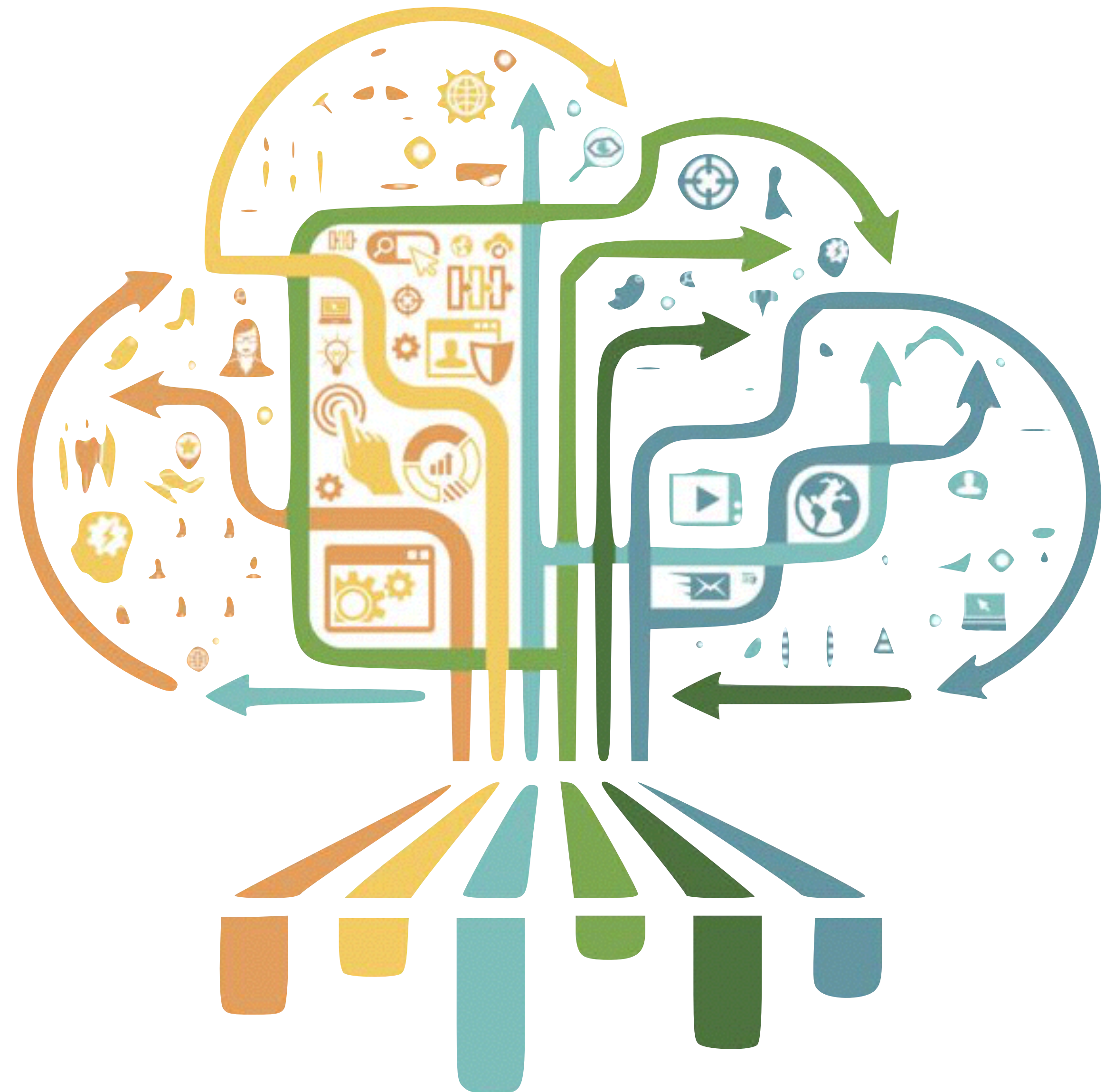
# IoT Architectures' Evolution

# Cloud-Centric Architectures

# CLOUD-CENTRIC ARCHITECTURES

The majority of IoT systems are today cloud-centric

These systems are characterised by **device-to-cloud** communication and **in-cloud analytics**



# CLOUD-CENTRIC IOT PLATFORMS

The large majority of IoT platform have been built with Cloud-Centric architectures in mind

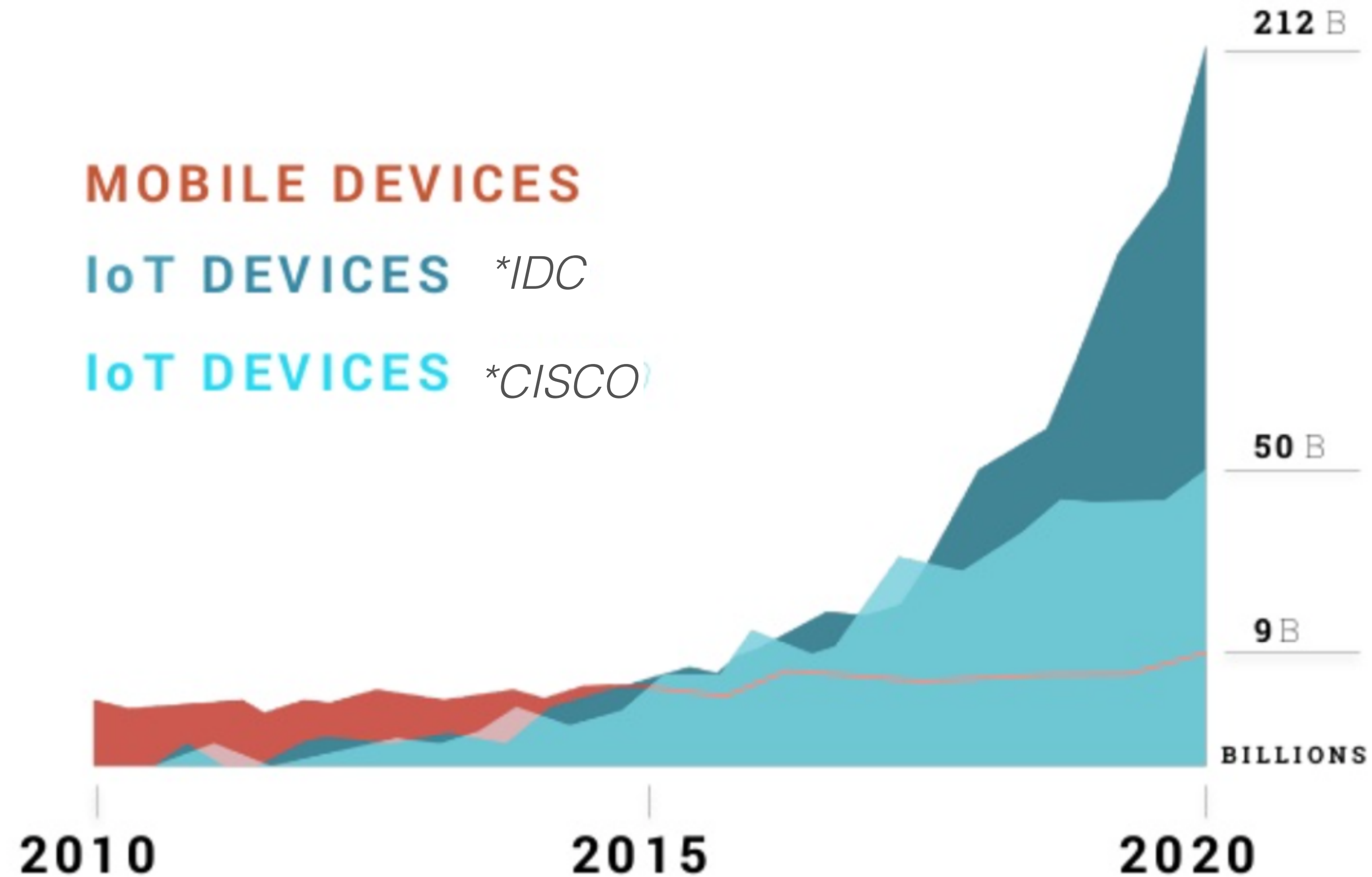


# Challenges

# TOO MANY DEVICES

CISCO estimates an average of 6.6 devices per person leading to **50B** devices in 2020.

IDC estimates 27.9 devices per person leading to **212B**



# INDUSTRIAL IOT

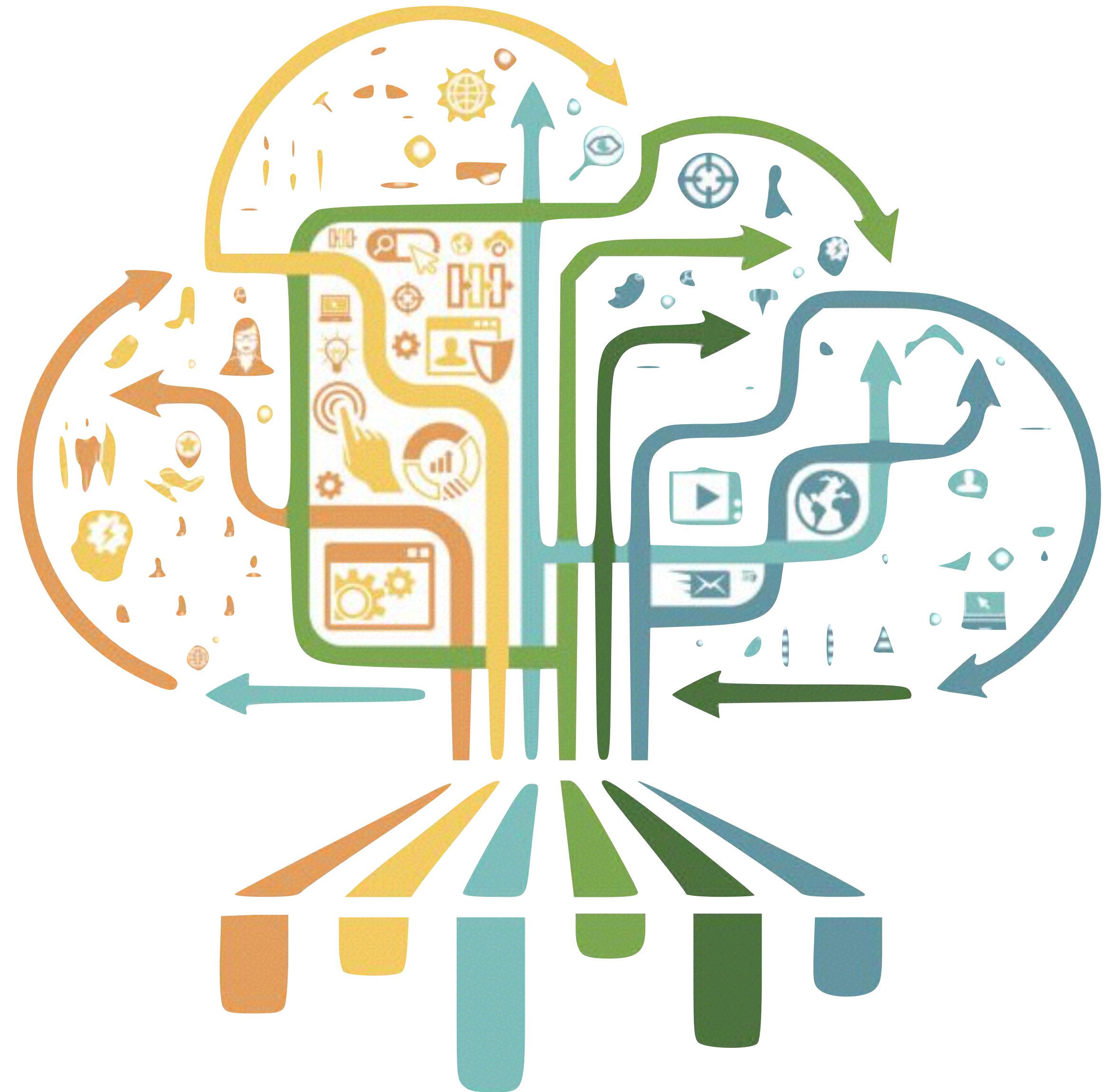
Industrial IoT applications such as Smart Grids, Smart Factories, Smart Farming, Connected Vehicles and Smart Cities are **not compatible with** the assumptions of **Cloud Centric Architectures**





# CLOUD-CENTRIC ARCHITECTURES ASSUMPTION #1

There is sufficient  
**bandwidth** to push data to  
the Cloud.



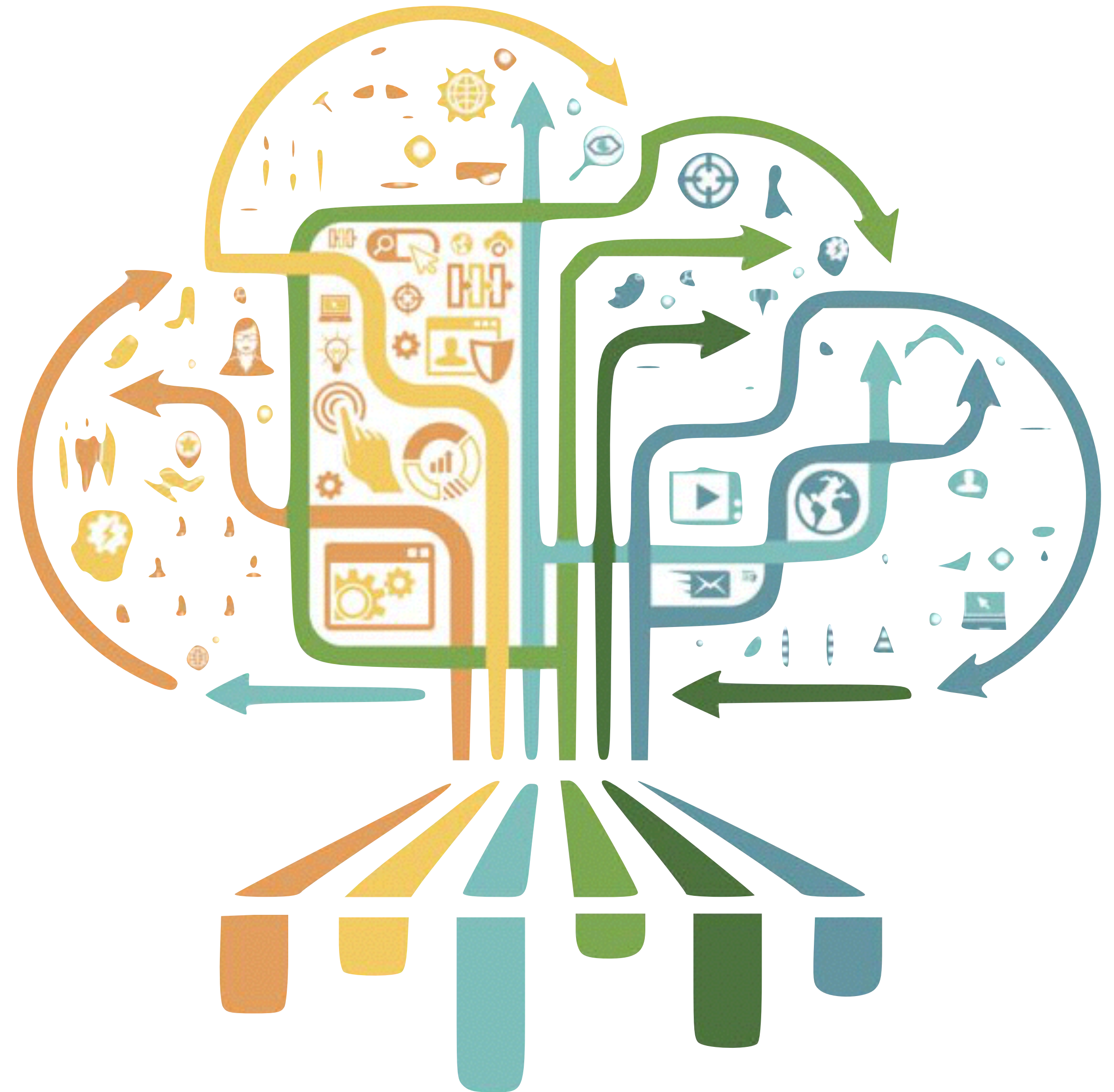
# Smart Factory

● 0.5 TB of data  
produced per day



# CLOUD-CENTRIC ARCHITECTURES ASSUMPTION #2

**Connectivity** is not an issue. A device will (almost) always be connected to the cloud.

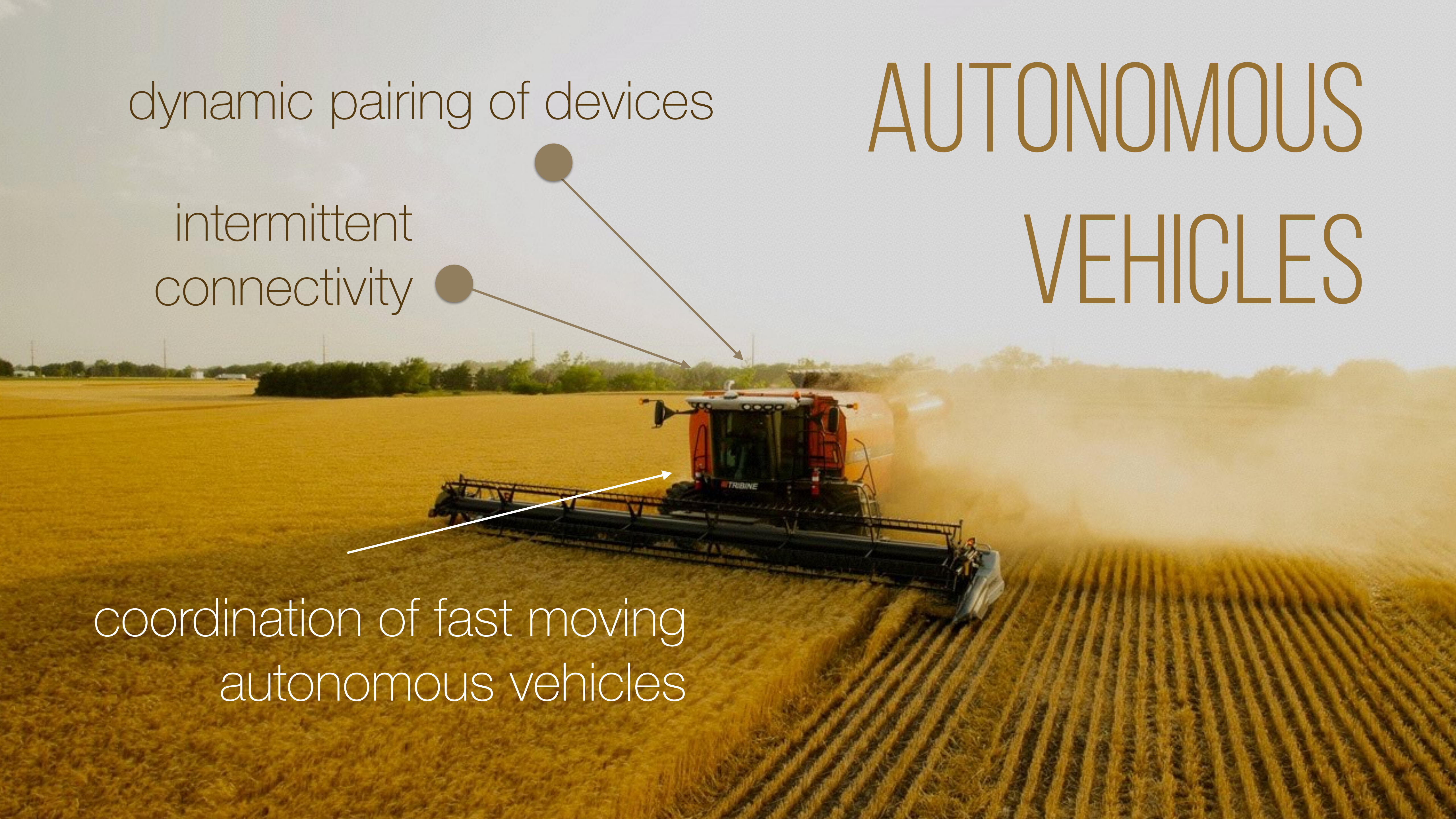


# AUTONOMOUS VEHICLES

dynamic pairing of devices

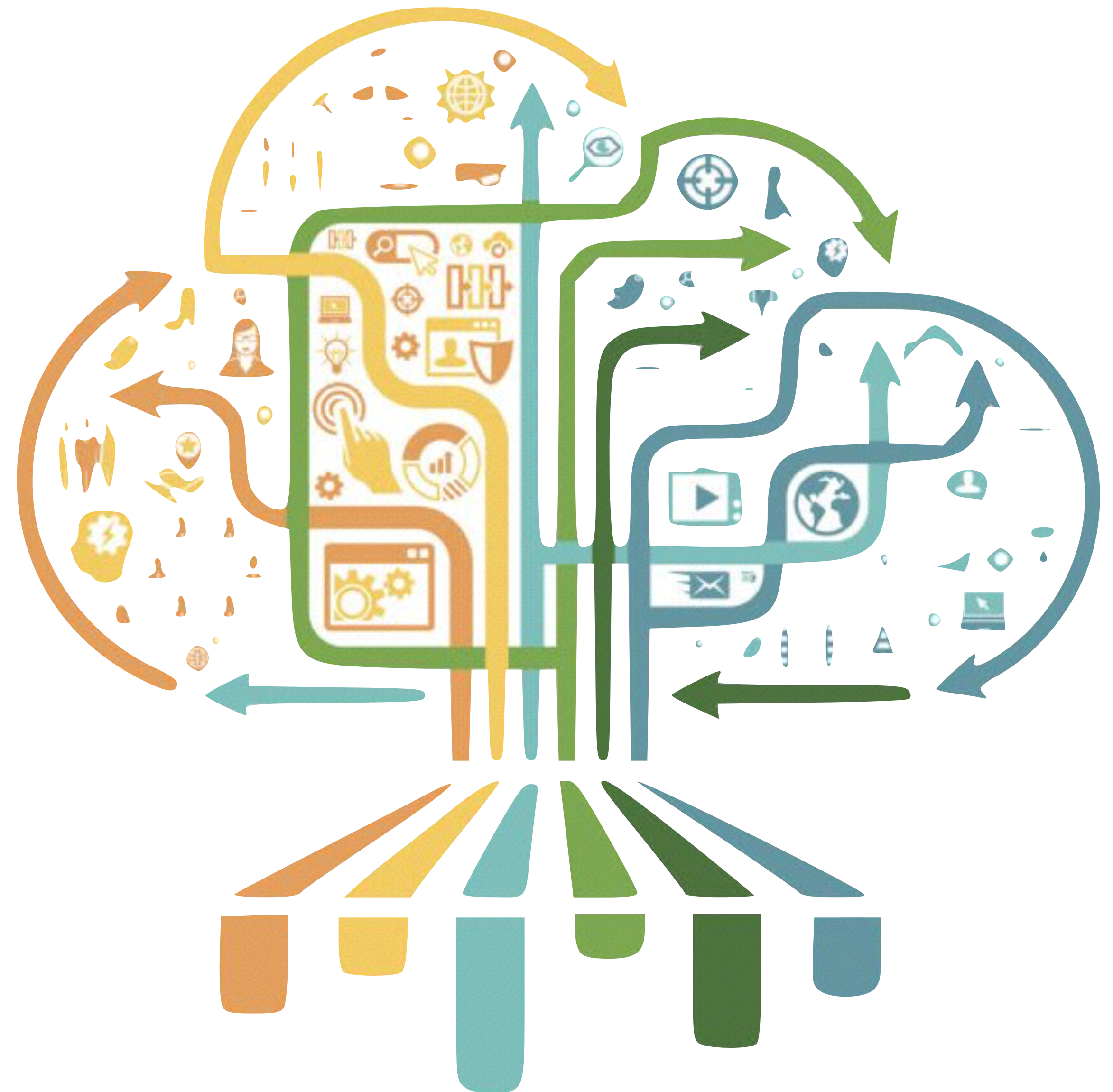
intermittent  
connectivity

coordination of fast moving  
autonomous vehicles



# CLOUD-CENTRIC ARCHITECTURES ASSUMPTION #3

The **latency** induced by cloud-centralised analytics and control is compatible with the dynamic of the IoT system

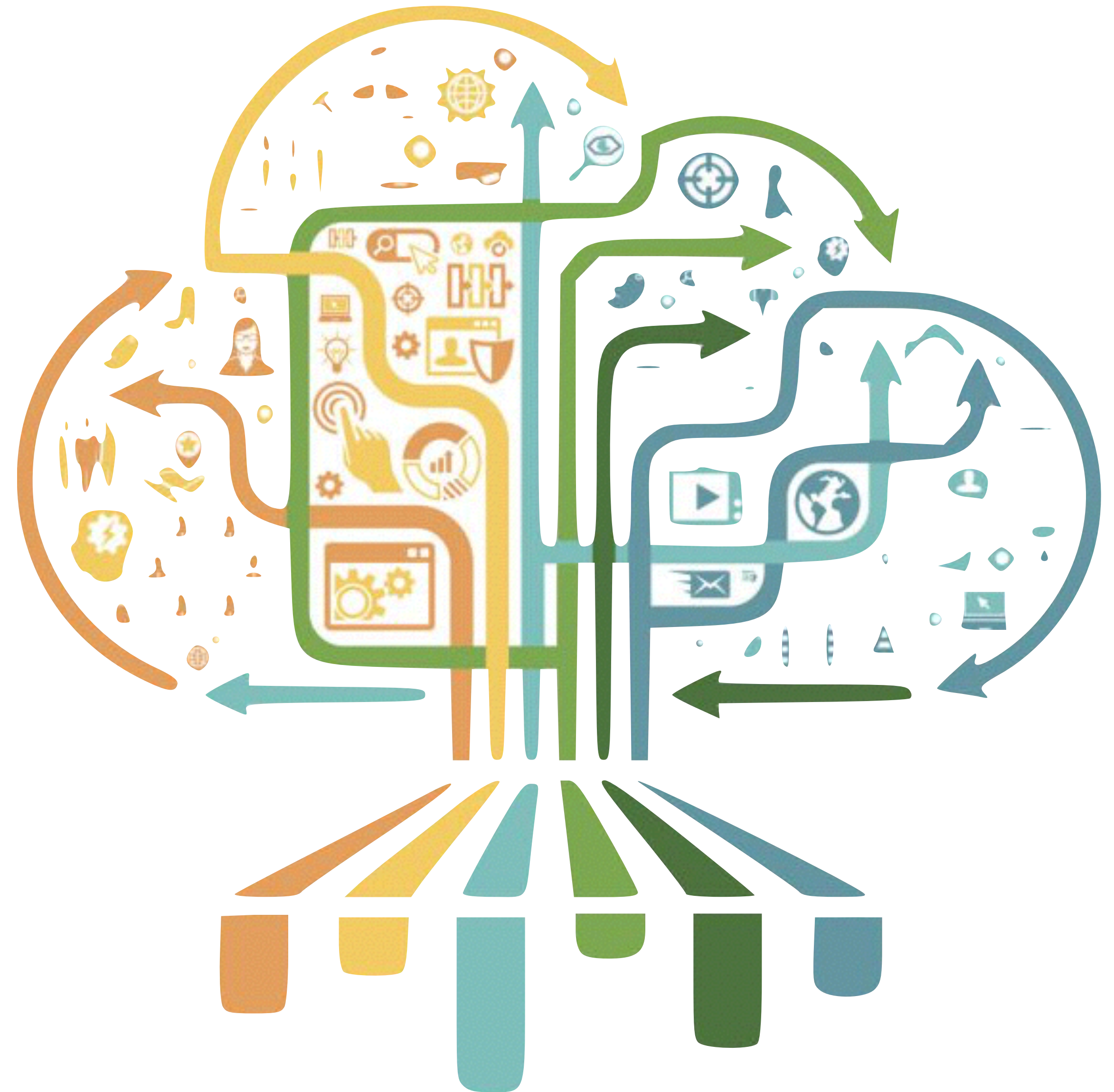




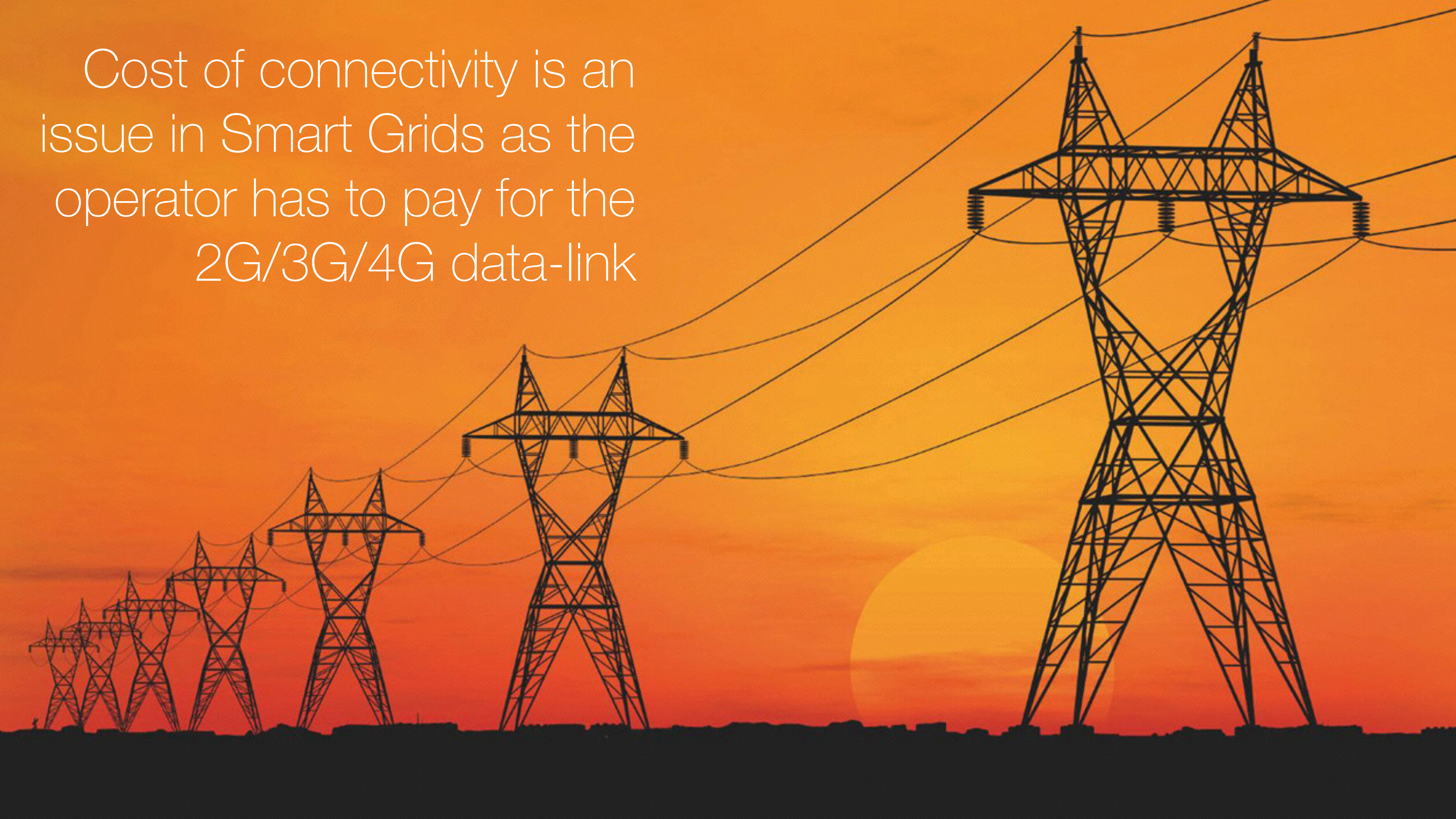
● Latency  
● Constraints

# CLOUD-CENTRIC ARCHITECTURES ASSUMPTION #4

The connectivity **cost** is  
negligible



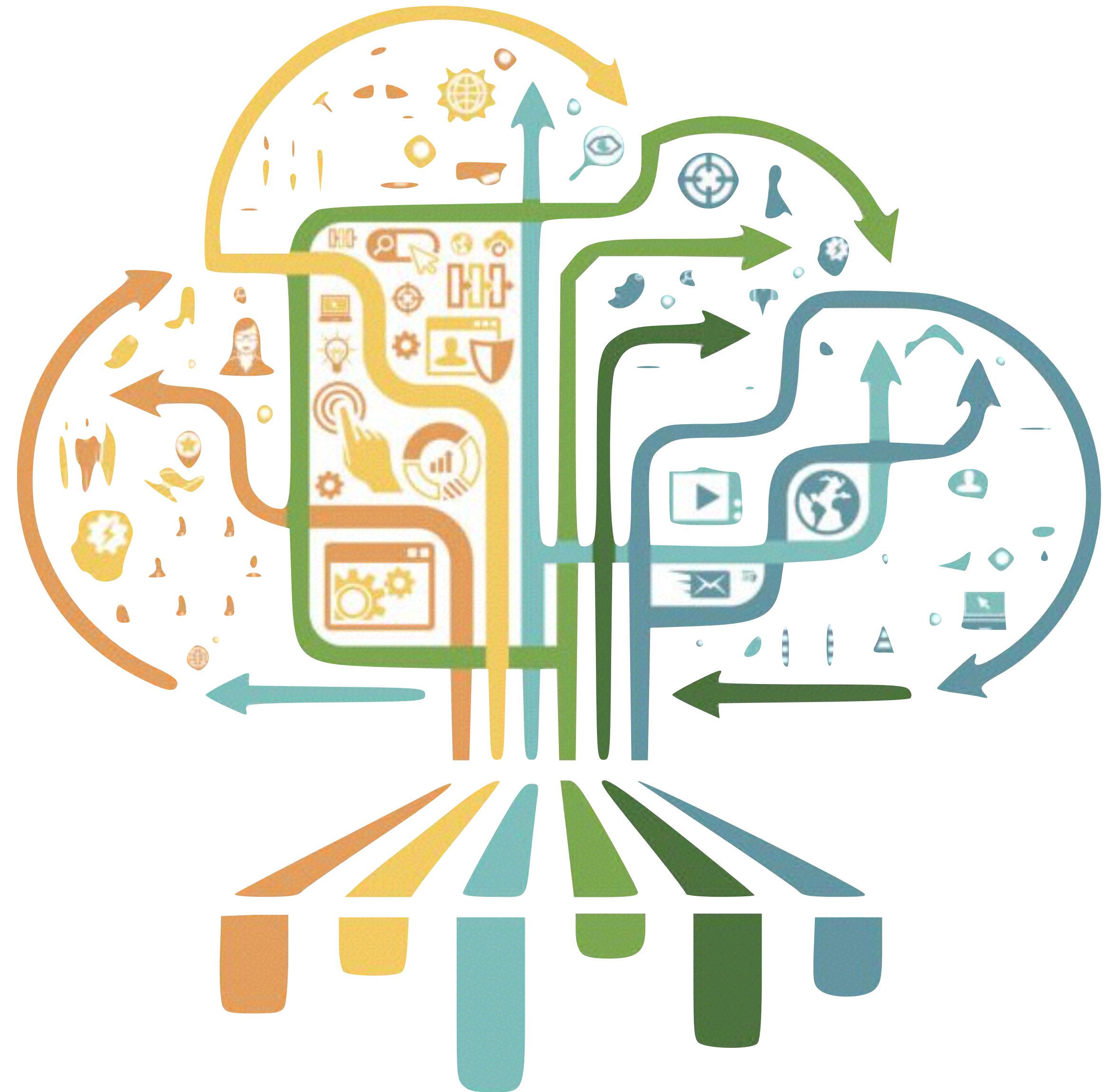
Cost of connectivity is an issue in Smart Grids as the operator has to pay for the 2G/3G/4G data-link





# CLOUD-CENTRIC ARCHITECTURES ASSUMPTION #5

Industrial companies are **comfortable** in **exposing** their **data** to the **cloud**.





# Fog-Centric Architectures

# FOG-CENTRIC ARCHITECTURES

Fog Computing Architectures **extend** elastic compute, networking and storage across the cloud **through** to the **edge** of the network



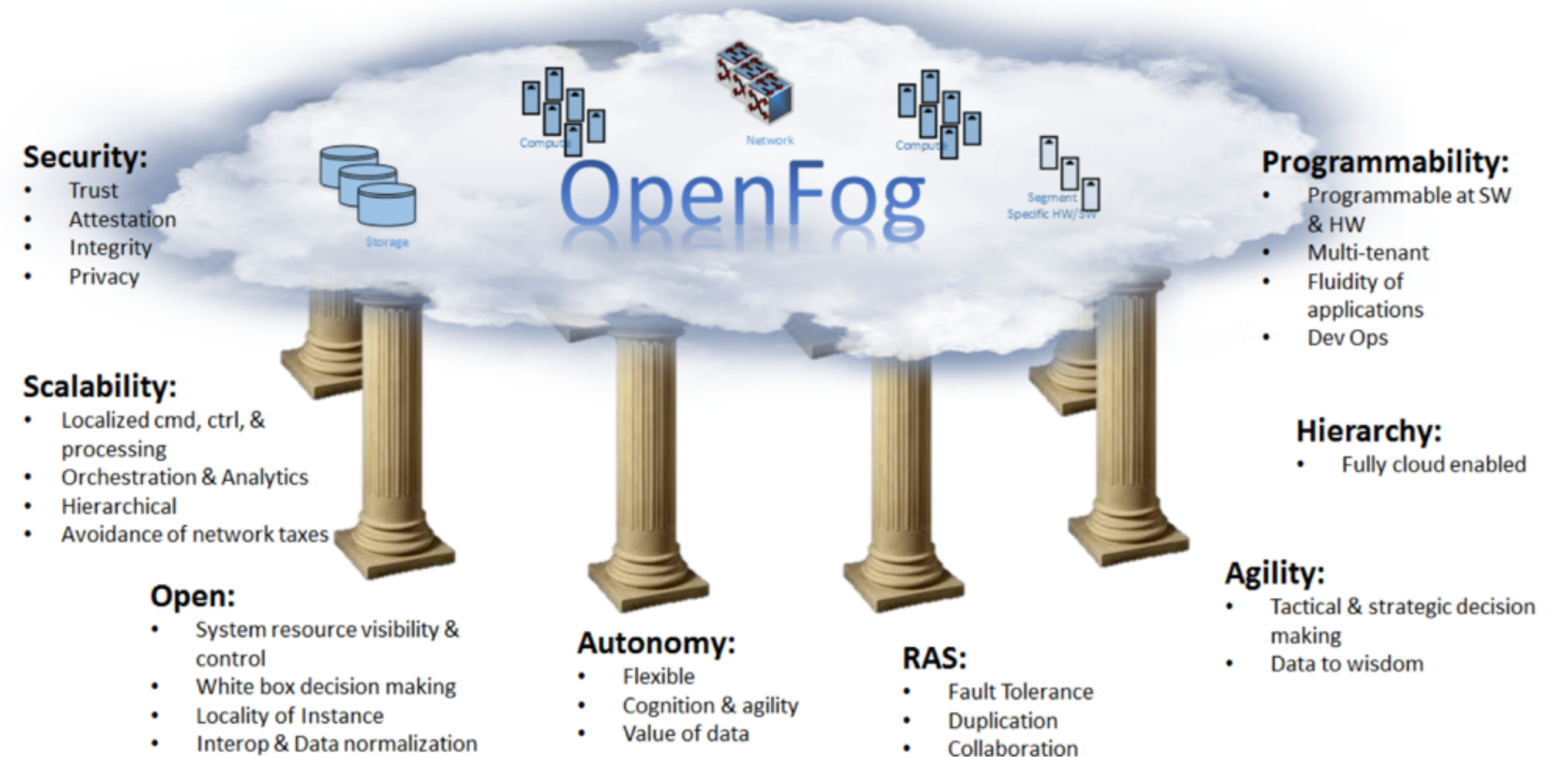
# FOG/MEC-CENTRIC IOT PLATFORMS

IoT Platforms support for  
Fog /MEC computing is  
rapidly emerging



# OPENFOG CONSORTIUM

The recently established OpenFog is accelerating and facilitating the expansion, convergence and interoperability of Fog computing infrastructures



[source: OpenFog Whitepaper <http://bit.ly/openfog-wp>]

# Challenges

# WHAT ABOUT THE THINGS?

[most of] **Fog** centric infrastructures rely on **edge servers** to provide elastic compute, store and communicate abstractions.

Yet, are incapable of exploiting resources available on the **Things**





# Mist-Centric Architectures

# MIST-CENTRIC ARCHITECTURES

Mist Computing Architectures **extend elastic compute, networking and storage** across the Fog through to the Things



cloudy . . . foggy . . . misty . . .

The Answer is...

42

maybe...

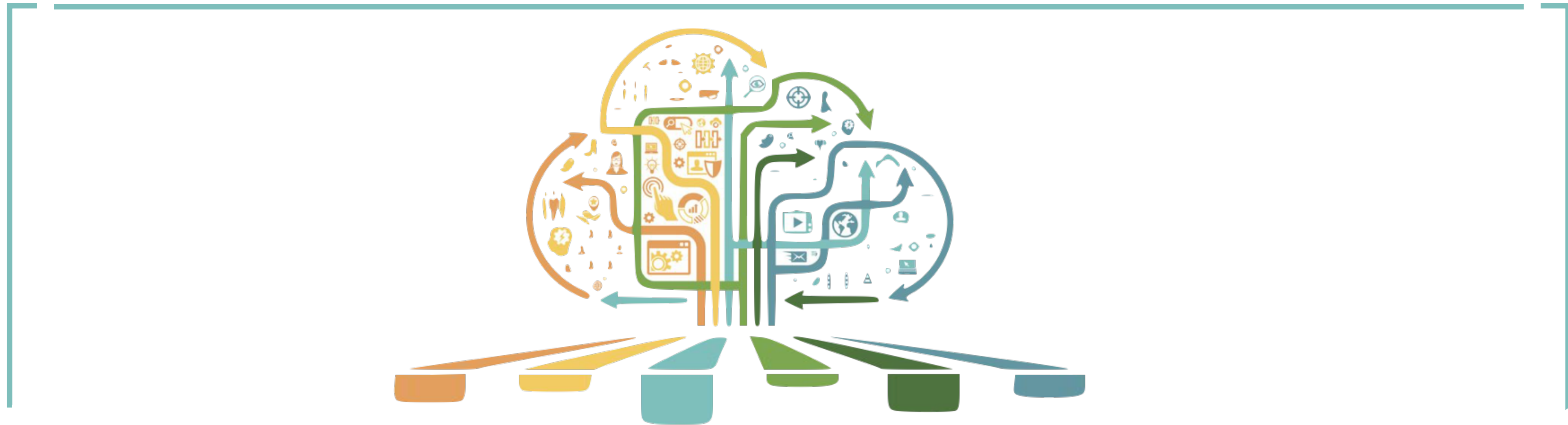
but that doesn't help

Let's do some more analysis

# Technology Fragmentation



Cloud



Cloud Servers

Fog



Fog Nodes

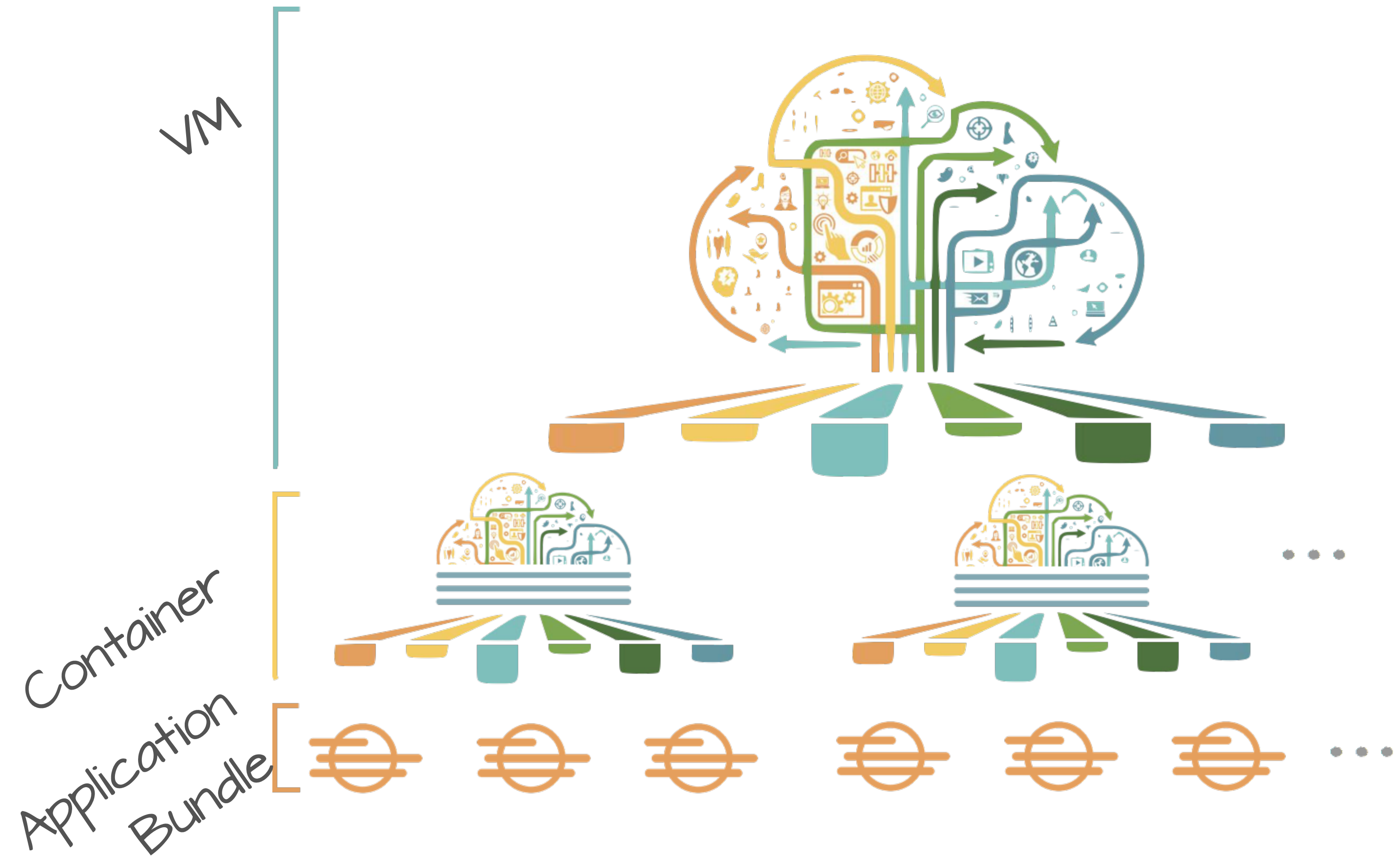
Mist



Things

# PROVISIONING, DEPLOYMENT & MANAGEMENT

The unit of provisioning  
and deployment  
supported by Cloud, Fog  
and Mist infrastructure  
are different



# DATA ACCESS



data flow

time

# DATA ACCESS

## Data Stores

Data at Rest

past

## Data Streams

Data in Movement

near past

data flow

time

now-t

now

# DATA ACCESS

## Data Stores



Data at Rest

past

## Data Streams

Data in Movement

near past



now-t

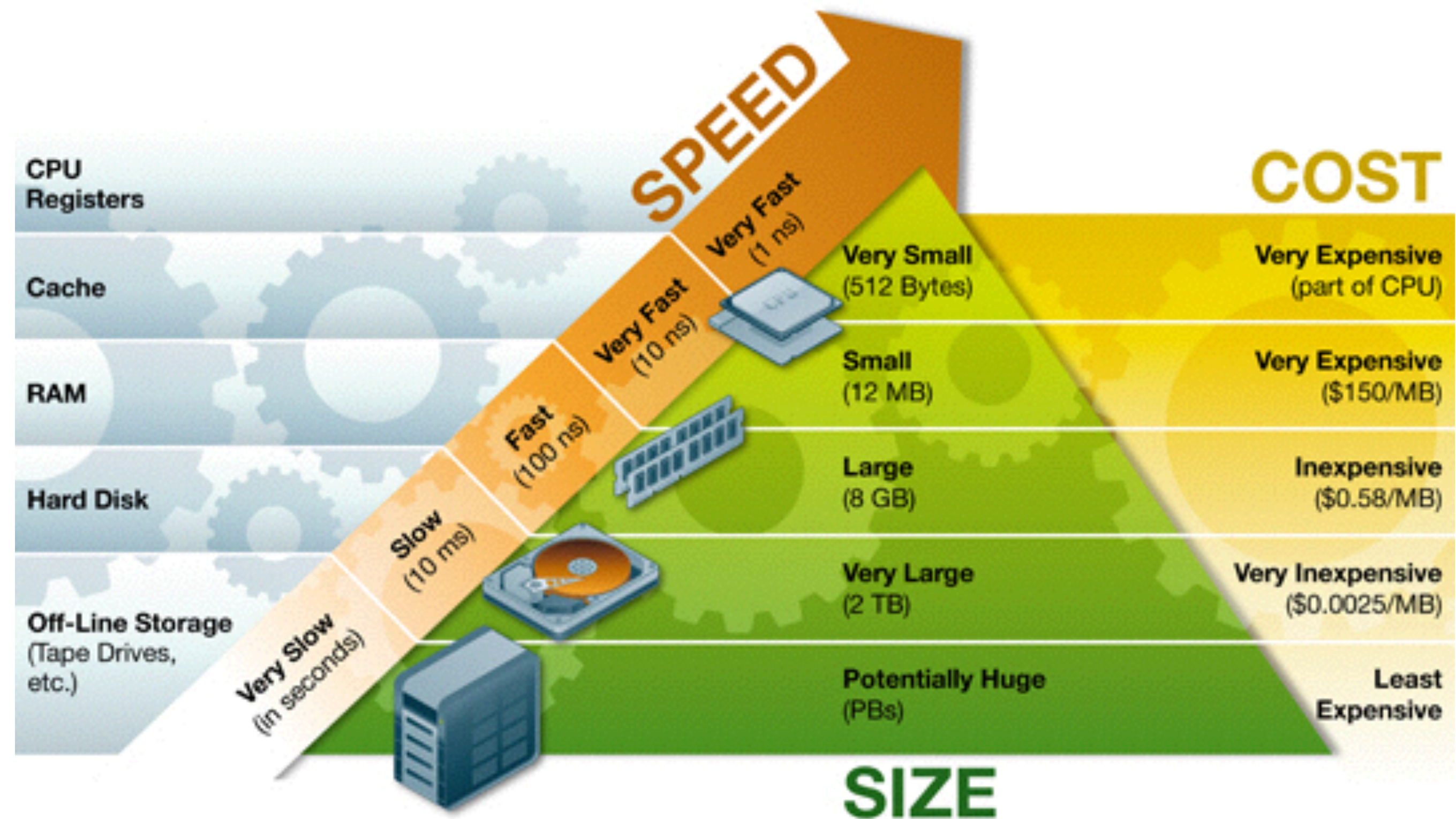
now

time

# MEMORY HIERARCHY

Everyone gives for granted that the **memory hierarchy** present in computing systems should be transparent

Why shouldn't the same be true for data access in IoT



# ANALYTICS

Different analytics technologies are applicable for Cloud, Fog and Mist Computing

As a result there is **no decoupling between the algorithm and the deployment!**

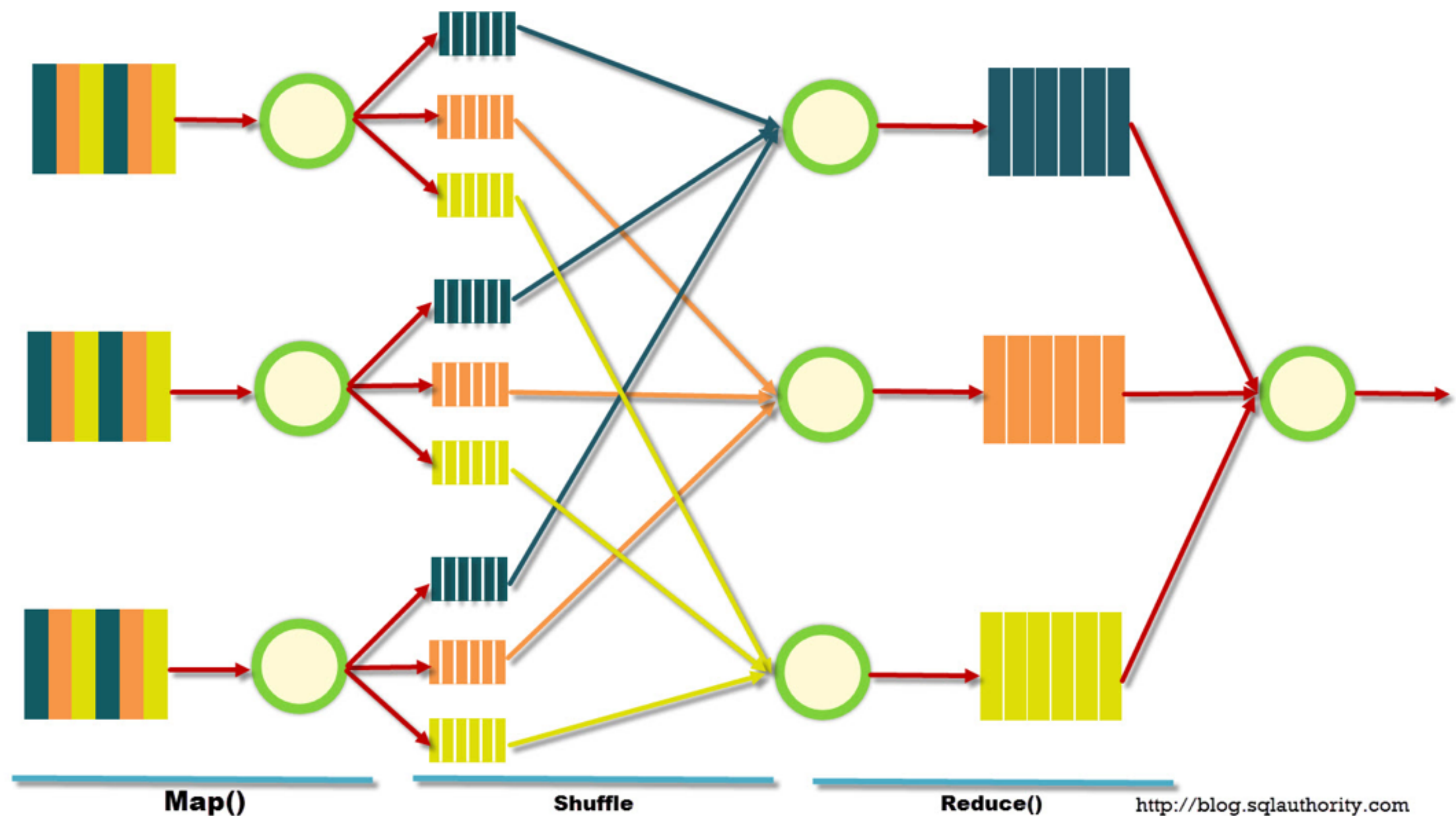


# MAP/REDUCE

## APPLICABILITY

Most analytics framework built for cloud are based on Map/Reduce

Map/Reduce is applicable to **embarrassing parallel** computational problems. These are a small subset of analytics required in IoT!





What's the Answer?

# ARCHITECTURAL CONSISTENCY

Architectural consistency  
and composability is key  
to scale

A unifying architectural  
principle should be the  
reference for IoT Platforms



# FLUID IOT ARCHITECTURE

The **Fluid IoT** Architecture **eliminates** the **technological segregation** created by Cloud, Fog and Mist technologies and **abstracts compute, storage and networking end-to-end**



# Fluid IoT Manifesto

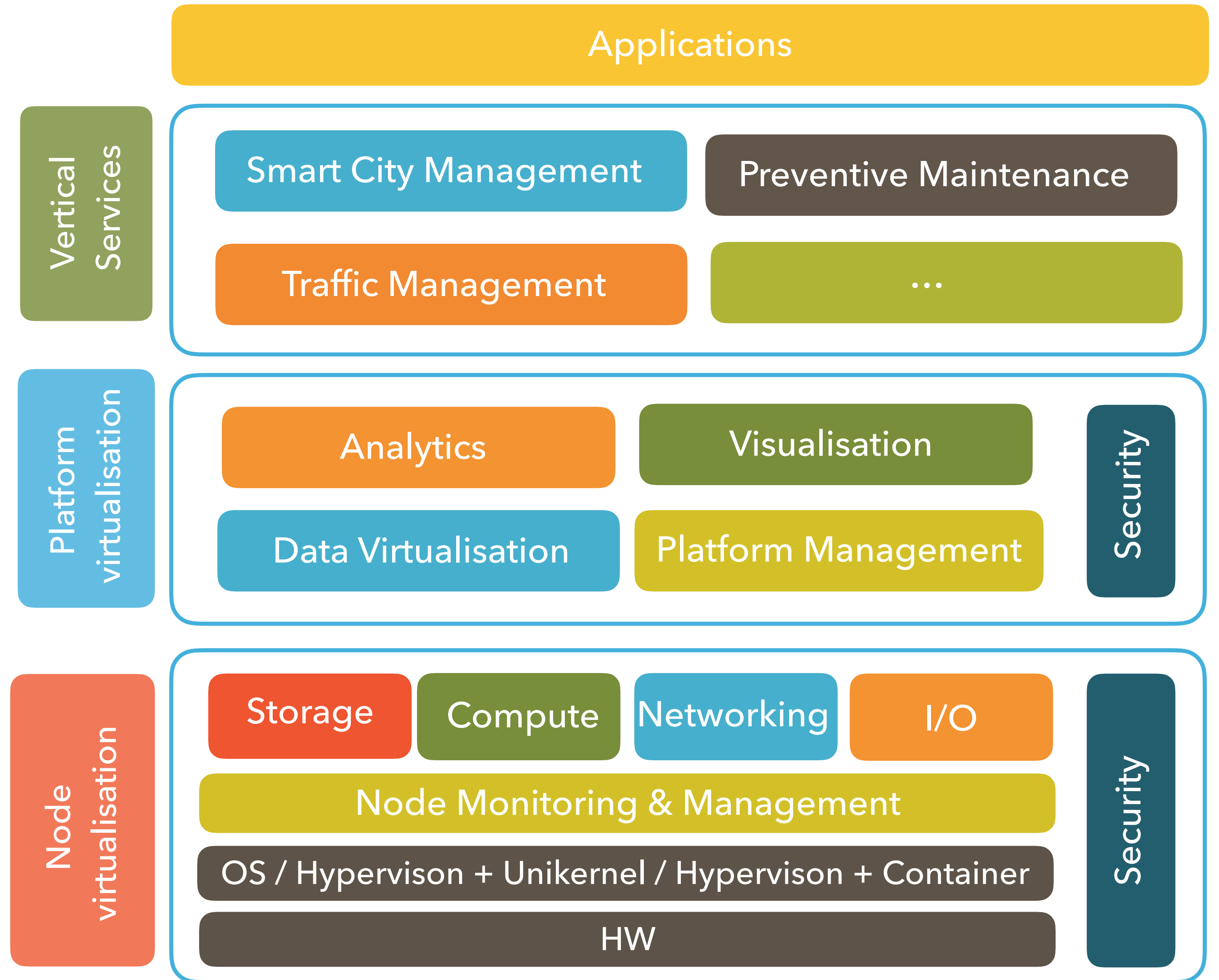
# FLUID IOT PLATFORM

Allow users to **express, provision and manage computations** operating over **virtualised resources** (e.g. devices) and **data** (potentially loads of these)



# IOT PLATFORM

The **Fluid IoT Platform** virtualises resources end-to-end and unifies abstractions



# FLUID IOT PLATFORM

Fluid IoT Platform will provide **uniform abstractions** to **provision, manage** and **deploy** applications

Fluid IoT will **virtualise data access** and unify analytics across Cloud, Fog and Mist



# PROVISIONING, DEPLOYMENT & MANAGEMENT

A Fluid IoT Platform provides a uniform way of provisioning, deploying and managing bundles across computational resources that may be available on Things, Edge Nodes of IaaS

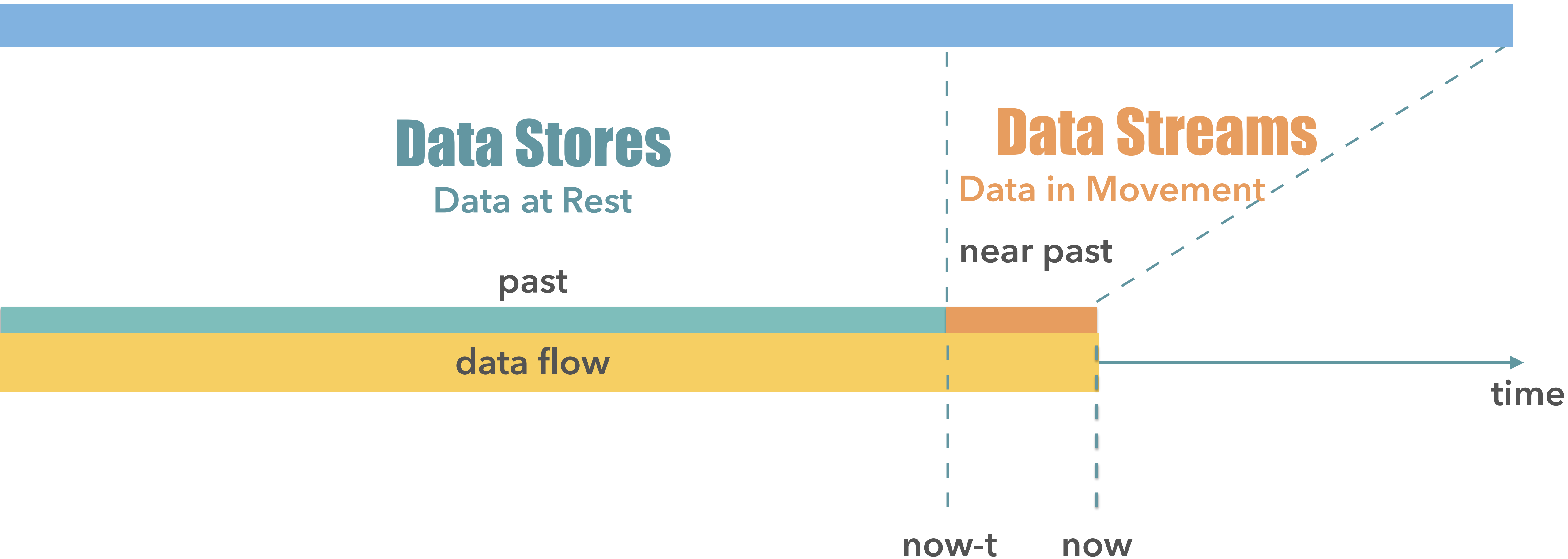
"Fluid"  
Bundle





# DATA ACCESS

## Virtualised Data Streams



# ANALYTICS

A Fluid IoT platform allows  
to define Analysts  
independently of their  
deployment

This strongly leverages the  
Data Virtualisation  
provided by the platform

*"Fluid"  
Analytic*



Call for Action

# FLUID IOT PLATFORM

Good **Abstraction** are at the core of good Science and good Engineering

Industry and Academia have to work together to ensure we build our future on strong abstractions as opposed to technology puzzles



