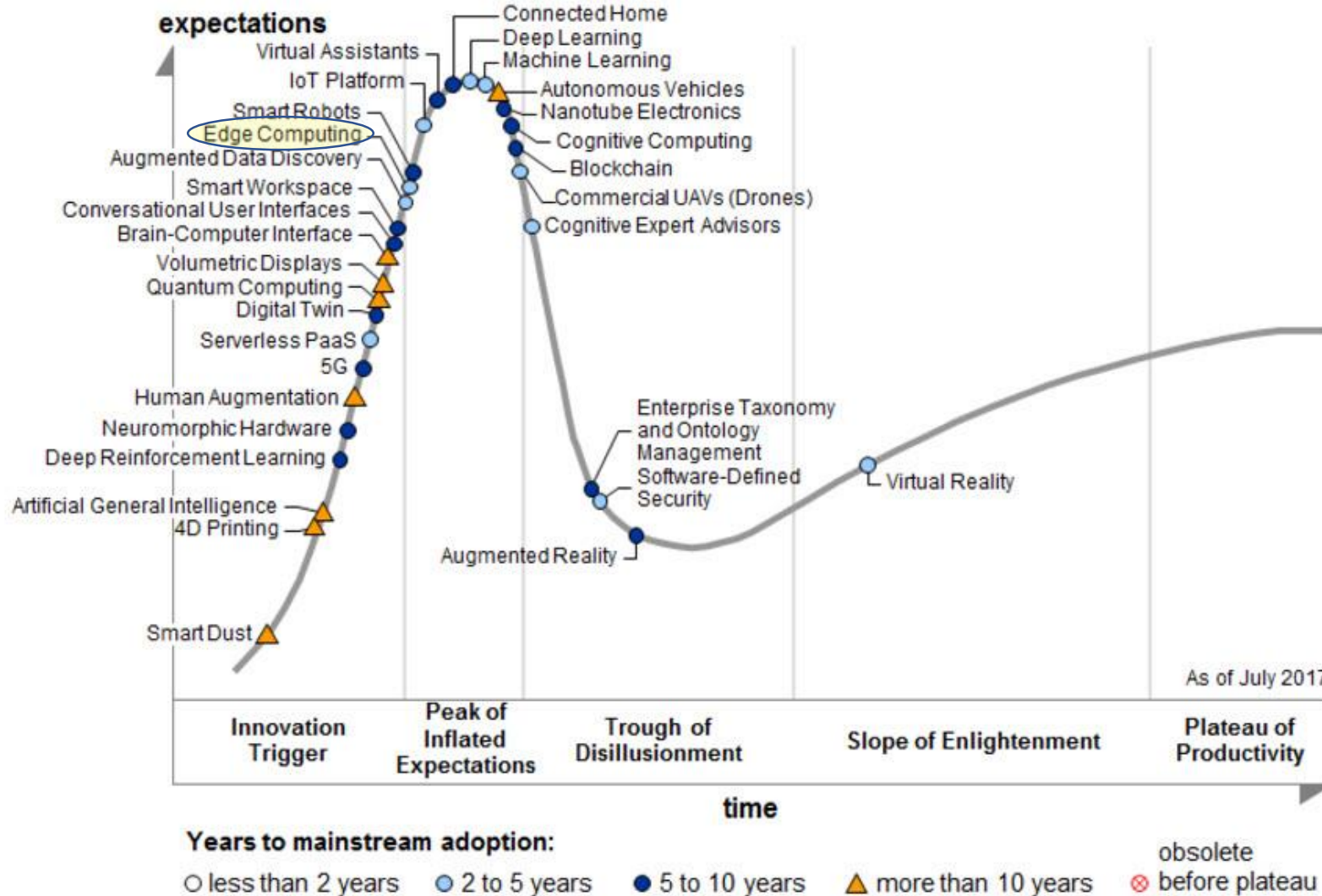# Cloud to The Edge

How the technology is transitioning

Agenda

- Hype cycle for emerging technologies 2017
- Introduction
- Cloud computing
- Understanding Edge computing
- Where it begins
- Challenges and opportunities
- Market players
- Conclusion
- Further reading

Hype Cycle for Emerging Technologies, 2017
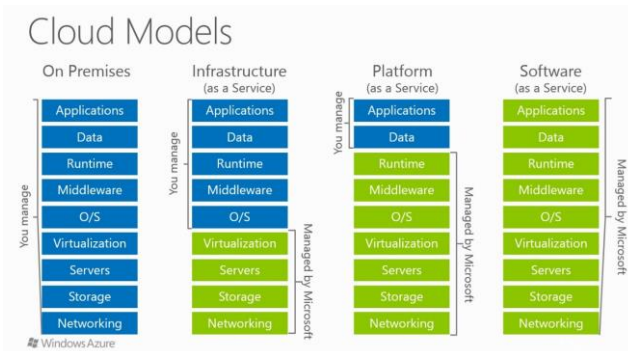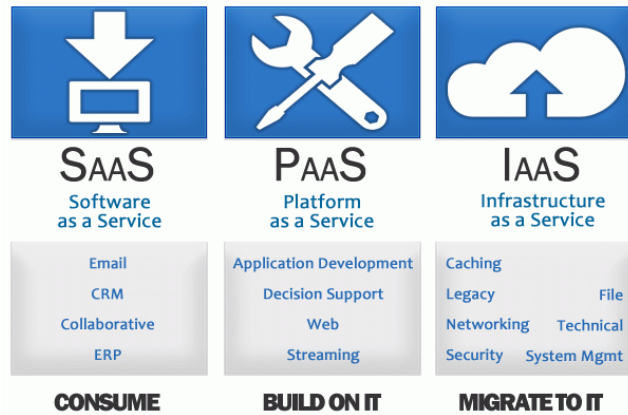

Edge computing

Predictions

- Expected adoption : 2 to 5 years
- Expectations: Are high
- Innovation has triggered and on the verge of Peak of inflated expectations

Note: PaaS = platform as a service; UAVs = unmanned aerial vehicles

Source: Gartner (July 2017)

Introduction

- Currently, around 10% of enterprise-generated data is created and processed outside a traditional centralized data center or cloud. By 2022, Gartner predicts this figure will reach 50%.

- A wearable health monitor is an example of a basic edge solution. It can locally analyze data like heart rate or sleep patterns and provide recommendations without a frequent need to connect to the cloud," says Rao

- Gartner puts it more colorfully in the title of its September 2017 research note by analyst Thomas J. Bittman, "Maverick Research: The Edge Will Eat the Cloud."
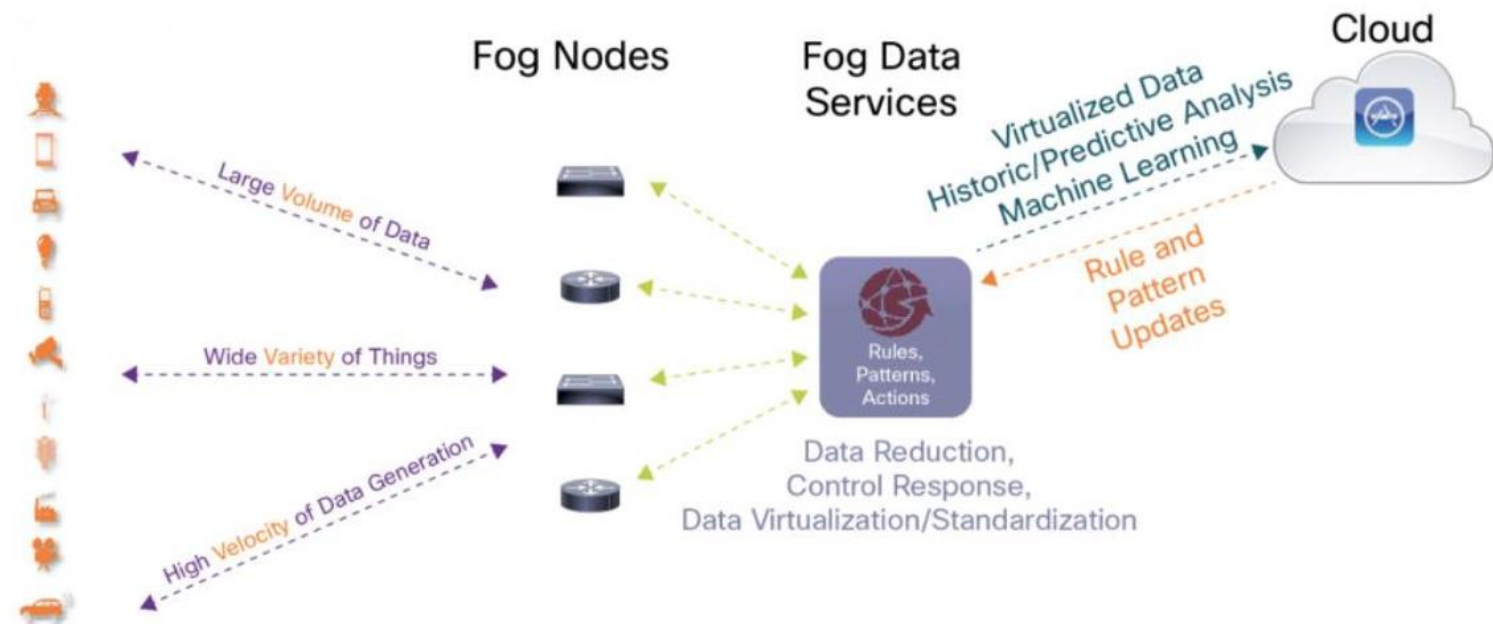
Cloud computing

- Has 3 offerings
  - IaaS, PaaS, SaaS
- Based on the need and type of application, the right offering is chosen
- For Analytics, the suggested offering is SaaS
- Current model for Analytics involves data dump from multiple data sources in raw form and build data islands, that helps with Analytics.
- Continuously growing Storage is a huge challenge and the high computing power is another challenge
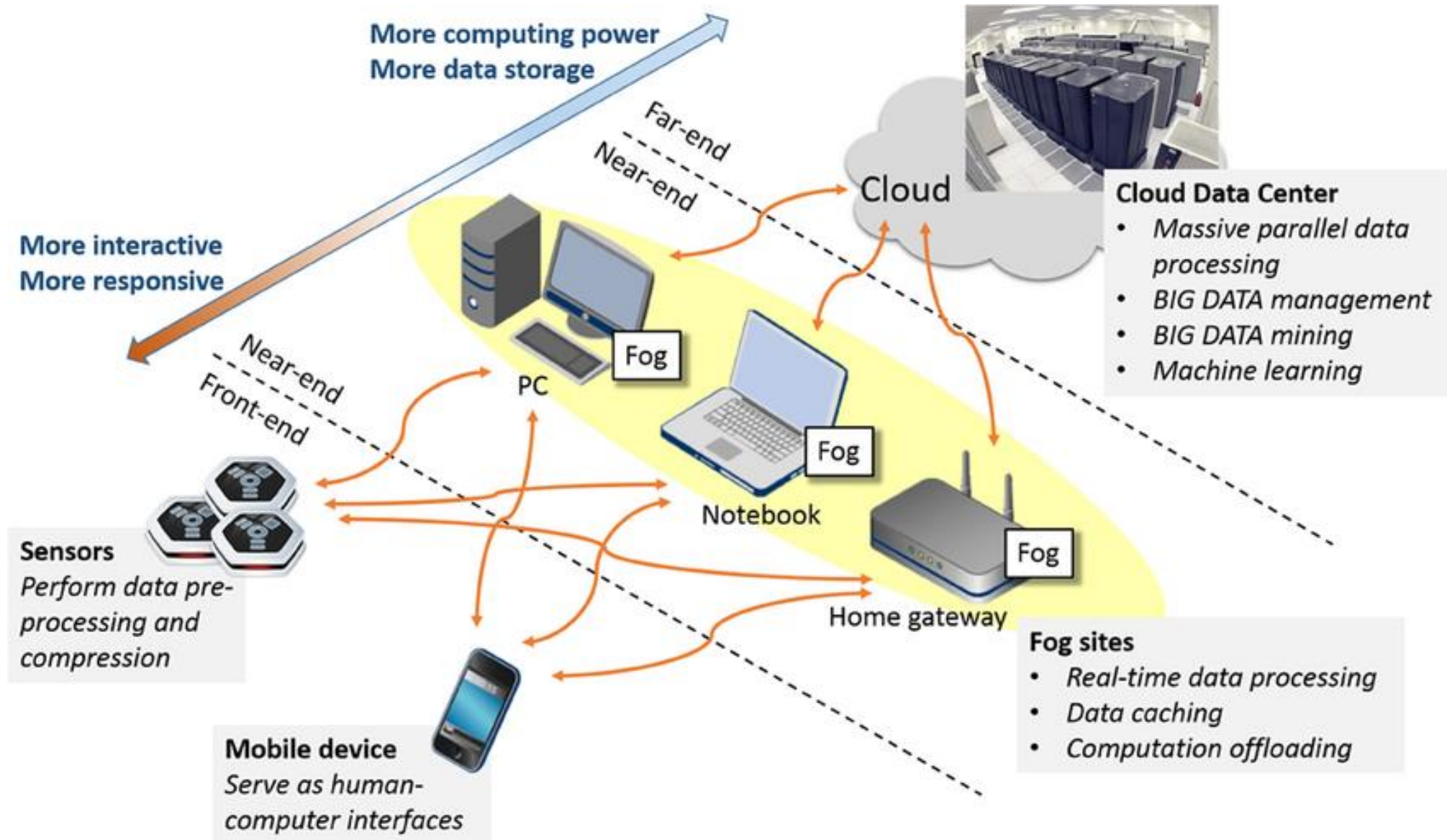
Cloud – Re Look

Cloud computing

- **Pay as you use:** IoT is here to stay. These days all the devices are interconnected and share the data among them. The Analytics built on top of data accumulated by IoT and other sources. As IoT generates huge data, the storage need to be very dynamic. Pay as you use will be a boon for dynamic IoT data.

- **Almost Unlimited Storage :** Storing information in the cloud gives you almost unlimited storage capacity

- **Backup and Recovery:** When data is stored in the cloud, backing it up and restoring the same is relatively much easier than storing the same on a physical device

Understanding Edge computing

Fog Nodes

Fog Data Services

Cloud

Large Volume of Data

Wide Variety of Things

High Velocity of Data Generation

Virtualized Data
Historic/Predictive Analysis
Machine Learning

Rule and Pattern Updates

Rules, Patterns, Actions

Data Reduction,
Control Response,
Data Virtualization/Standardization

Edge - Real world scenario

- Fog computing is a term for placing some of transactions and resources at the edge of the cloud

- Rather than establishing channels for cloud storage and utilization, Fog computing reduces the need for bandwidth by not sending every bit of information over cloud channels, and instead aggregating it at certain access points [edge of source data].

- Using distributed strategy, we can lower costs on bandwidth, Storage, computing and improve efficiencies

- Fog computing is also referred to as Edge computing, which essentially means that rather than hosting and working from a centralized cloud, fog systems operate on network ends.
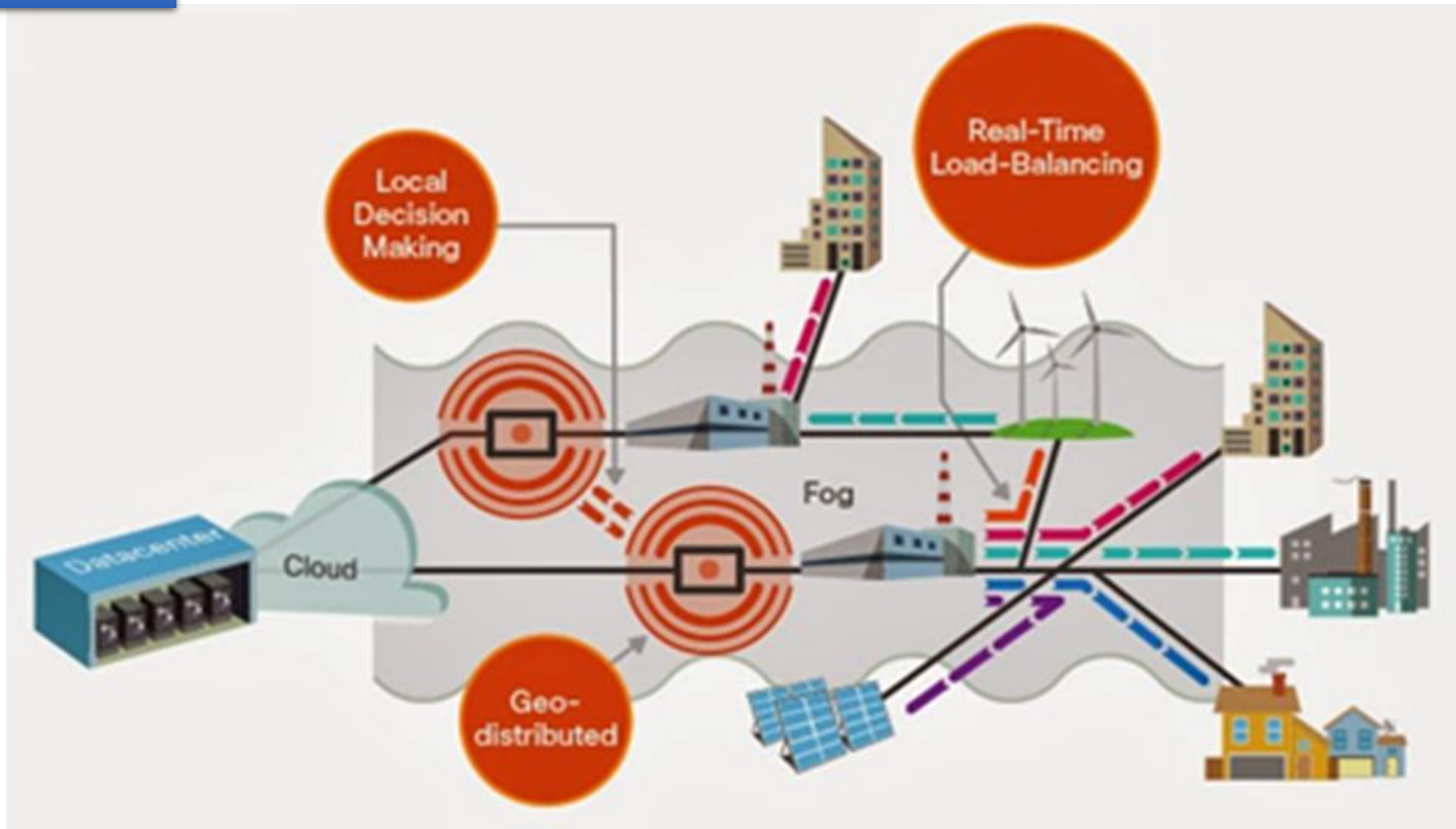
Push data directly to Cloud from **IoT**
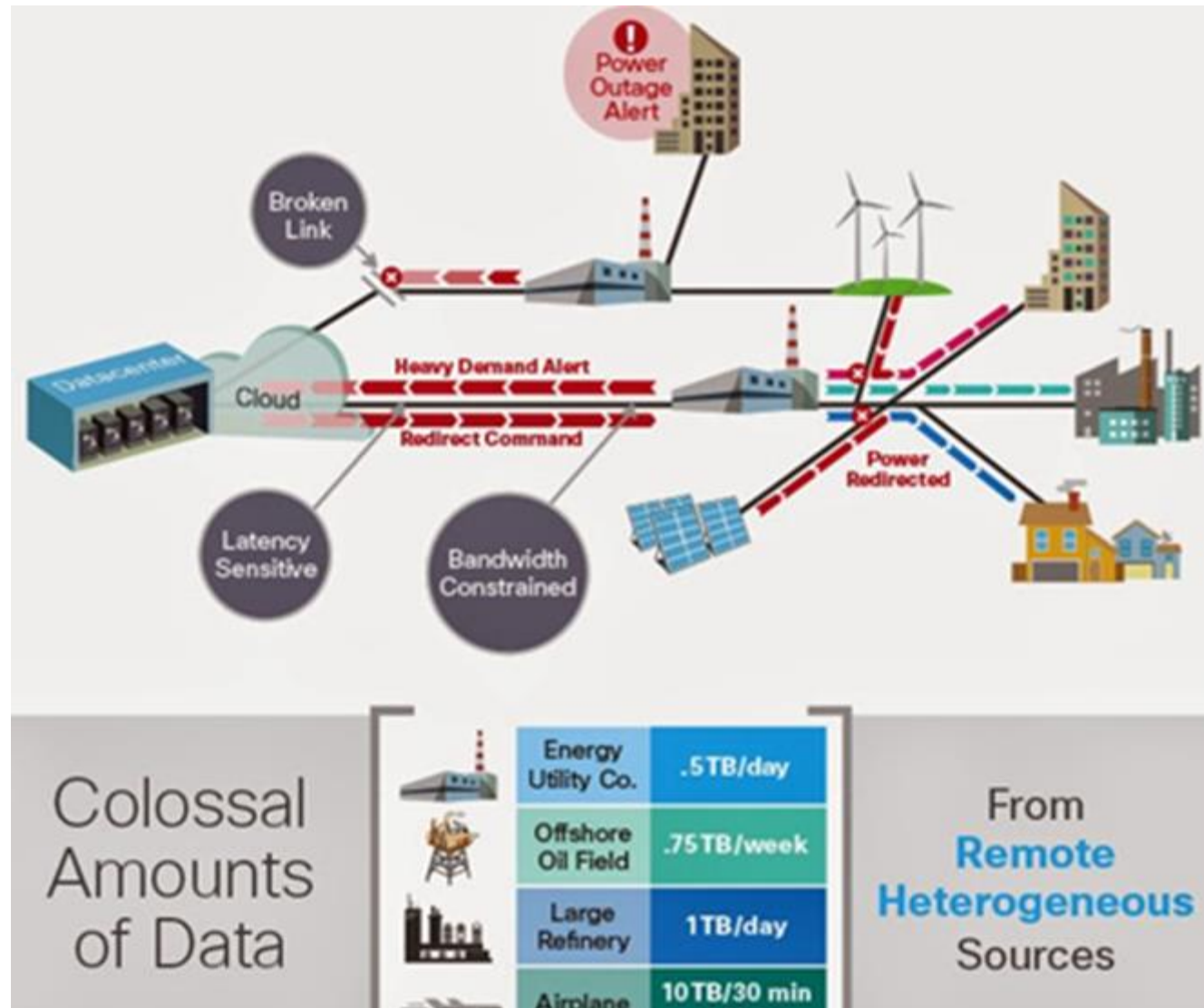
Perform Analytics on Cloud
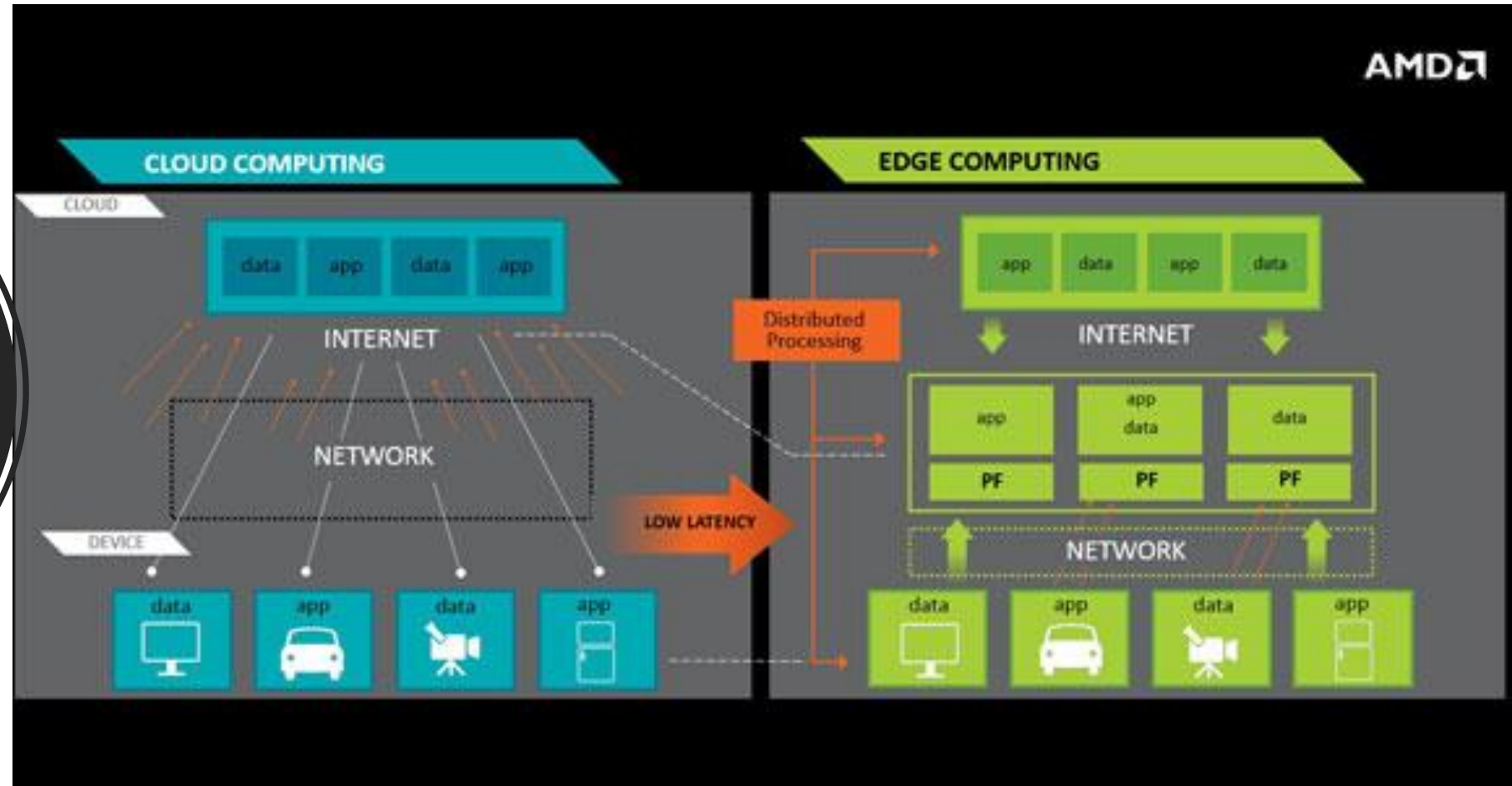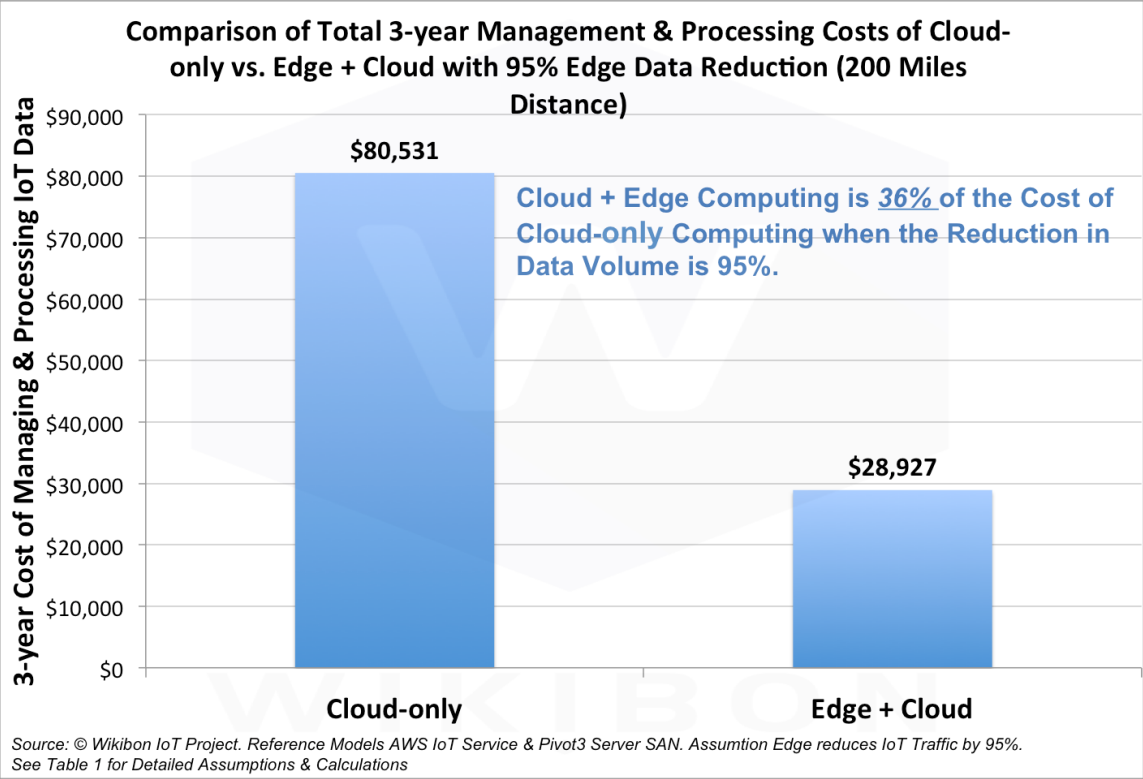
Local Decision making

Side by Side comparison

Cloud vs. Edge

Cost Comparison of Cloud-only Management & Processing vs. Edge + Cloud

		Cloud-only Processing			Edge + Cloud Processing		
		# Sensors	Video (MPEG)	Total	# Sensors	Video (MPEG)	Total
	# Inputs	100	2		100	2	
Edge Transport Costs	Readings/minute	20	60		20	60	
	Bytes/Read	20	672		20	672	
	GB/Month	1.7	3.5	5.2	1.7	3.5	5.2
	3-year GB	62	125	188	62	125	188
	Local Consolidation	0%	0%		95%	95%	
	Miles	200	200		200	200	
	$/GB/Month/Mile	$2	$2		$2	$2	
	Monthly Cost	$691	$1,393		$35	$70	
	Edge 3-year Transport Costs	$24,883	$50,165	$75,048	$1,244	$2,508	$3,752
Cloud Costs	AWS $/Million Messages	$5	$5		$5	$5	
	AWS Message Size (Bytes)	512	512		512	512	
	AWS Cloud Cost/Month	$86	$10		$4	$1	
	AWS 3-year Cloud Costs	$3,110	$373	$3,484	$156	$19	$174
	On-site Equipment 3-year Costs			$2,000			$25,000
	Total 3-year Costs			$80,531			$28,927

Source: © Wikibon IoT Project. Reference Models for Cloud is AWS IoT Service. Reference Model for On-site Server SAN is Pivot3 with an Open Source Time Series Database On-site & in the AWS Cloud

Comparison of Total 3-year Management & Processing Costs of Cloud-only vs. Edge + Cloud with 95% Edge Data Reduction (200 Miles Distance)

Cloud + Edge Computing is *36%* of the Cost of Cloud-only Computing when the Reduction in Data Volume is 95%.

Cloud-only: $80,531
Edge + Cloud: $28,927

Source: © Wikibon IoT Project. Reference Models AWS IoT Service & Pivot3 Server SAN. Assumtion Edge reduces IoT Traffic by 95%. See Table 1 for Detailed Assumptions & Calculations
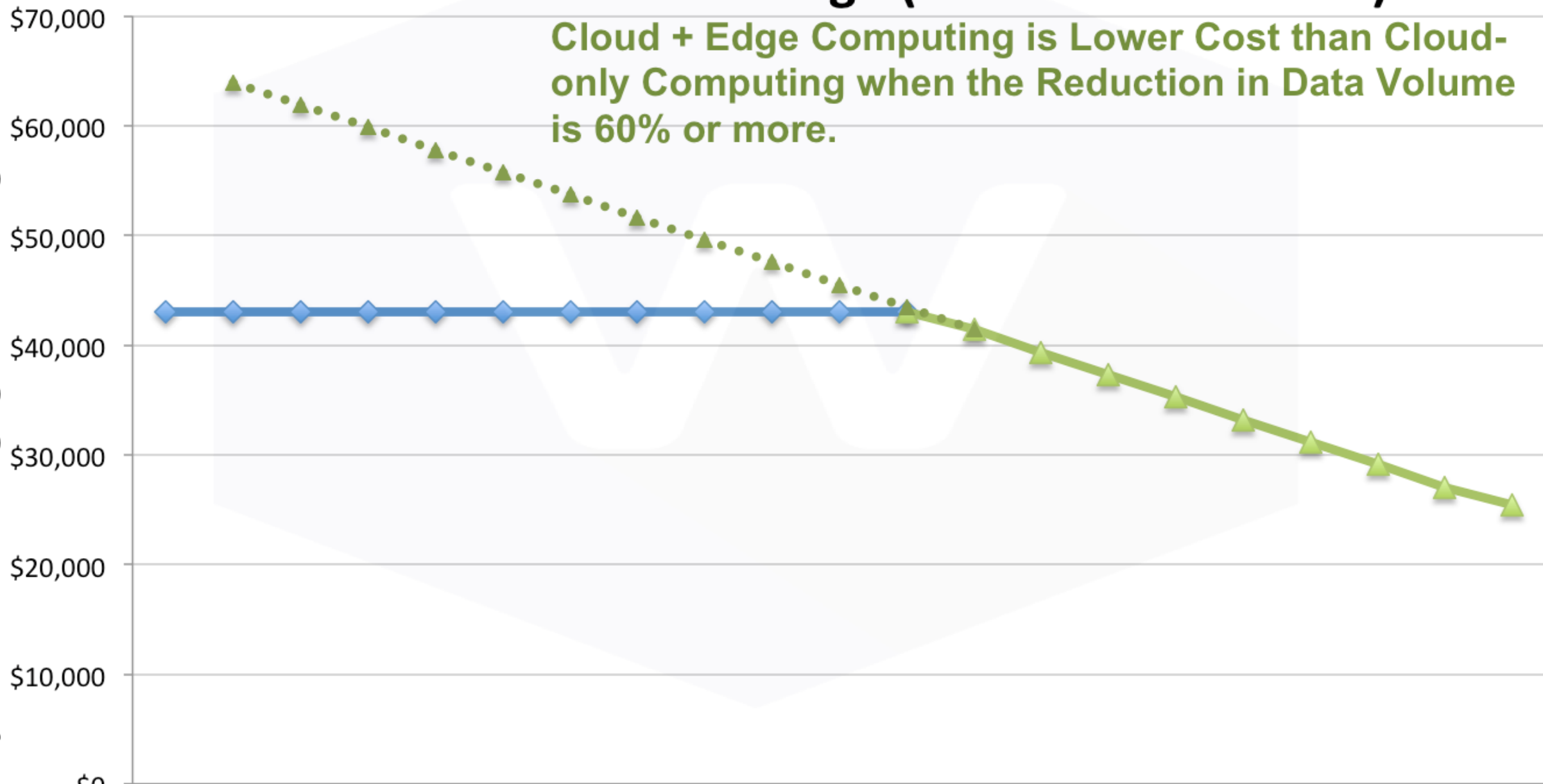
Cost Comparison

Total Cost of Remote IoT Processing as a Function of Data Reduction at the Edge (100 Miles Distance)

**3-year Cost of Managing & Processing IoT Data**

$70,000

$60,000

$50,000

$40,000

$30,000

$20,000

$10,000

$0

Cloud + Edge Computing is Lower Cost than Cloud-only Computing when the Reduction in Data Volume is 60% or more.

Can Cloud eat Edge?

- Thomas J. Bittman in his research note says "Maverick Research: The Edge Will Eat the Cloud"

- His idea was to express how Edge computing will reduce the utilization of Cloud

- Edge CANT replace cloud in any scenario

- Edge can complement the cloud and reduce the storage, network and computing footprint.
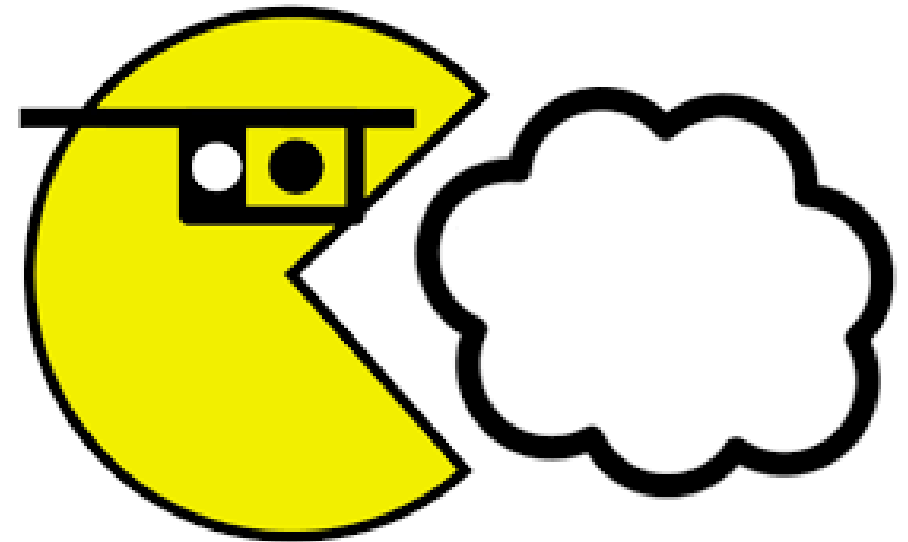
Where it begins

- **Dynamic Developer Community**: The next generation of edge computing platforms are going to emerge from companies that already have large and vibrant developers communities which can easily make the transition into the new trend. At least in the near future, building a brand new developer community in addition to achieving market credibility can result on an impossible challenge for startups in the edge computing space.

- **Existing Platform Capabilities**: Complementing the previous point, the first group of successful edge computing platforms is likely to emerge ass an extension to existing platforms with relevant capabilities in areas such as compute, storage, messaging, analytics and many other fundamental building blocks of edge computing solutions.

- **Domain Expertise** in Industrial-Decentralized Applications: A large percentage of the first generation of edge computing solutions will take place in the industrial enterprise space. Expertise in that domain or a relevant presence building decentralized applications will incredibly important for the success of the first group of edge computing platforms.

Challenges and opportunities

- Programmability

    Usually, the program is written in one programing language and compiled for a certain target platform, since the program only runs in the cloud. However, in the edge computing, computation is offloaded from the cloud, and the edge nodes are most likely heterogeneous platforms. In this case, the runtime of these nodes differ from each other, and the programmer faces huge difficulties to write an application that may be deployed in the edge computing paradigm.

    To address the programmability of edge computing, we propose the concept of computing stream that is defined as a serial of functions/computing applied on the data along the data propagation path.

Challenges and opportunities …

- Naming

    In edge computing, one important assumption is that the number of things is tremendously large. At the top of the edge nodes, there are a lot of applications running, and each application has its own structure about how the service is provided. Similar to all computer systems, the naming scheme in edge computing is very important for programing, addressing, things identification, and data communication.

    New naming mechanisms such as named data networking (NDN) and MobilityFirst could also be applied to edge computing. NDN provide a hierarchically structured name for content/data centric network, and it is human friendly for service management and provides good scalability for

    edge.

Challenges and opportunities …

- Data Abstraction

Various applications can run on the edgeOS consuming data or providing service by communicating through the air position indicators from the service management layer

Data reported from different things comes with various formats. For the concern of privacy and security, applications running on the gateway should be blinded from raw data. Moreover, they should extract the knowledge they are interested in from an integrated data table

Market players

- **Microsoft**: Azure IOT Edge represents Microsoft's first serious attempt in the edge computing space. Microsoft's edge computing capabilities are initially delivered as an extension of the Azure cloud platform .

- Amazon: Similarly to Microsoft, Amazon has been developing edge computing capabilities to extend the AWS platform. AWS Greengrass is a primary example of AWS' ventures into the edge computing space.

- **Alphabet**: Android, Nest, Waymo are some of Alphabet's top assets in the edge computing space. Those assets plus the strong growth of the Google Cloud platform position Alphabet in a solid place to become a leader in the edge computing market.

- **GE**: GE Predix is one of the best adopted IOT platforms in the market which already include relevant edge computing capabilities. Additionally, GE's unique expertise delivering edge computing solutions across different industries such as aerospace or manufacturing can result a unique advantage in its market position.

- **Ethereum**: Blockchain technologies can be a powerful enabler of edge computing solutions. Ethereum is in a unique position to extend some of its capabilities such as Smart Contracts or DAOs to edge devices. More than any other company, Ethereum has the opportunity to define a new type of blockchain-powered architecture as the standard for edge computing solutions.

Conclusion

Mobile Edge Computing (MEC) Market
By Region, 2016 (US$ Mn)

32.1
(US$ Mn)

XX.X
North America

XX.X
South America

Europe

XX.X
Middle East
and Africa

XX.X
Asia Pacific

2017 – 25 at a
CAGR of **51.0%**

Source: TMR Analysis, May 2017

Further reading ...

- Edge computing will blow away the cloud

https://www.cio.com/article/3176036/it-industry/edge-computing-will-blow-away-the-cloud.html

Clint Boulton

- Edge computing could push the cloud to the fringe

https://techcrunch.com/2017/08/03/edge-computing-could-push-the-cloud-to-the-fringe/

Ron Miller (@ron_miller)

The Growing Complexity with IoT, Cloud, and the Edge

https://blogs.cisco.com/cloud/iot-cloud-edge

Kip Compton