FOG COMPUTING

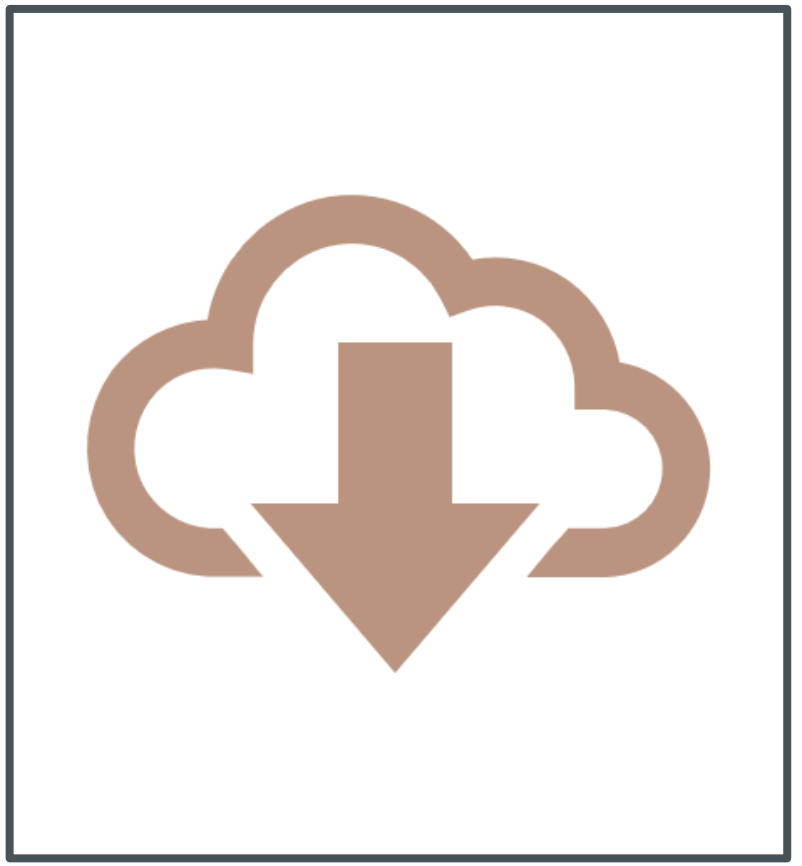
Present day model of compute

Recap

- RTOS
- Scheduling techniques
- RMS – Rate Monotonic Scheduling
- EDF – Earliest Deadline First
- Utilization – $U = \Sigma Ci/Pi$
- RMS – $2(2^{1/n} - 1) <= U$
- EDF – $U <= 1$
- Smart Agriculture

FOG COMPUTING - INTRODUCTION

- **BY 2025, IDC SAYS WORLDWIDE *DATA* WILL GROW 61% TO 175 ZETTABYTES**
- **90% OF THE WORLD'S DATA WERE GENERATED ONLY DURING THE PERIOD OF LAST TWO YEARS.**
- **2.5 QUINTILLION BYTES OF DATA IS GENERATED PER DAY.**
- **TOTAL EXPENDITURE ON IOT DEVICES WILL BE $1.7 TRILLION BY 2022**
- **90ZB OF DATA WILL BE CREATED ON IOT DEVICES BY 2025.**
- **BY 2025, 49 PERCENT OF DATA WILL BE STORED IN PUBLIC CLOUD ENVIRONMENTS.**
- **NEARLY 30 PERCENT OF THE DATA GENERATED WILL BE CONSUMED IN REAL-TIME BY 2025.**



WHY IS FOG NEEDED

Volume of the data is growing at exponential rate.

- Private firms, Factories, airplane companies produces colossus amount of data everyday
- Current cloud model cannot store all these data

Latency

- Reducing the time for decision making
- Time to send request + time for processing + time to respond

Bandwidth

- Clogging of information with number of growing devices and capabilities

Architecture of Fog

- Cloud services are extended to IoT devices through fog
- Fog is a layer between cloud and IoT devices many fog nodes can be present
- Sensor data are processed in the fog before it is sent to the cloud
- Reduces latency, save bandwidth and save the storage of the cloud

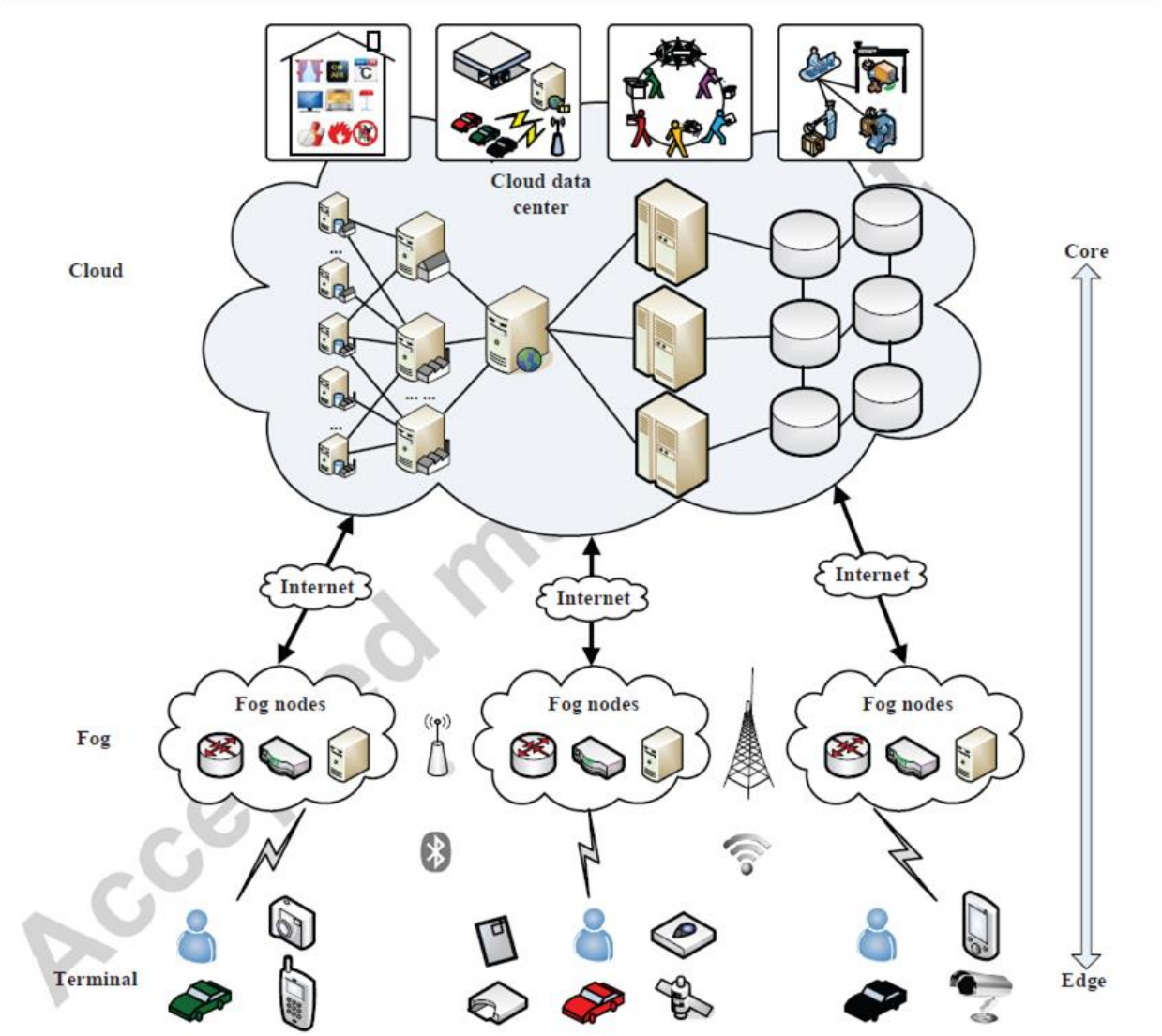


Figure 1: The hierarchical architecture of fog computing

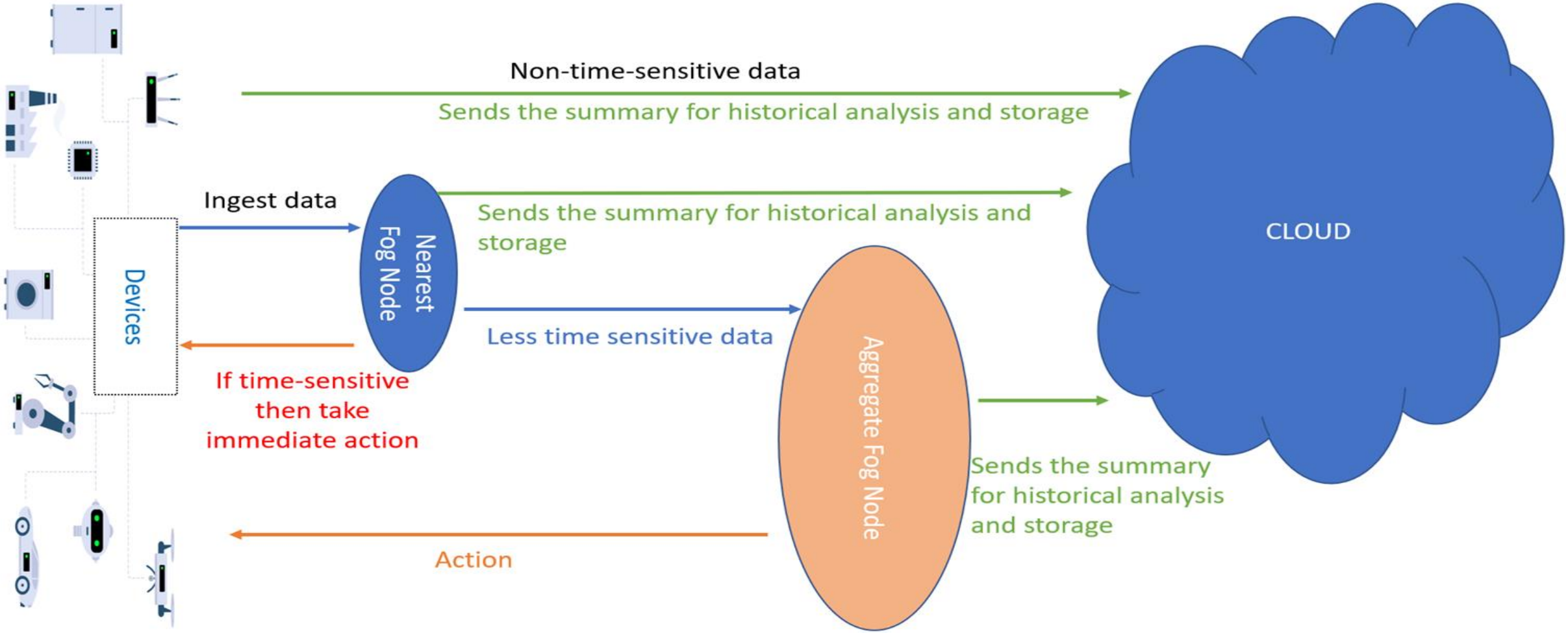
https://doi.org/10.1016/j.jnca.2017.09.002

Fog Nodes

Characteristics for a fog node

- Storage - To give transient storage
- Computing facility
  - To process the data before it is sent to cloud
  - To take quick decisions
- Network connectivity
- Ex: Routers, embedded servers, switches, video surveillance cameras, etc.
- Deployable anywhere inside the network.
- Each fog nodes have their aggregate fog node

Working of Fog Nodes



Working of Fog

	Fog node closest to devices	Fog aggregate nodes	Cloud
Analysis Duration	Fraction of Second	Seconds to minutes	Hours to weeks
IoT Data storage duration	Transient	Hour, days	Months to years
Geographical coverage	Very local	Widespread	Global

Advantages of Fog

Security

- Provides better security
- Fog nodes can use the same security policy

Low operation cost

- Data are processed in the fog nodes before sending to cloud
- Reduces the bandwidth consumption

Reduces unwanted accidents

- Latency will be reduced during decision making
- Quick decision making

Better privacy

- Every industry can analyze their data locally
- Store confidential data in their local servers
- Send only those data which can be shared to the cloud

Advantages of Fog

Business agility

- Fog application can be easily developed according to tools available
- Can be deployed anywhere we need
- Can be programed according to the customer's need

Support mobility

- Nodes can be mobile
- Nodes can join and leave the network anytime

Deployable in remote places

- Can be deployed in remote places
- Can be subjected to harsh environmental conditions
- Under sea, railway tracks, vehicles, factory floor etc

Better data handling

- Can operate with less bandwidth
- Data can be analyzed locally
- Reduce the risk of latency

Applications of Fog

Real time health analysis

Intelligent Power Management

Real time rail monitoring systems

Pipeline Optimization

Windmill and Turbine Analysis

Challenges in Fog

Power consumption

Fog use addition nodes

Power consumption is higher than centralized cloud

Data Security

Data generating nodes are distributed

Providing authentication and authorization system for the whole nodes is not an easy task

Reliability

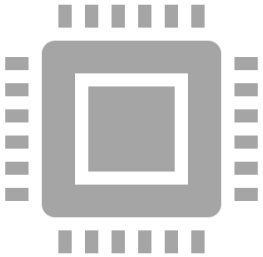
Maintaining data integrity and availability for millions of nodes is difficult failure of a node cannot affect the network

Challenges in Fog

Fault tolerance

Failure of a node should be immediately fixed

Individual failure should not affect the whole scenario



Programming architecture

Fog nodes may be mobile

Nodes can connect and leave the network when necessary

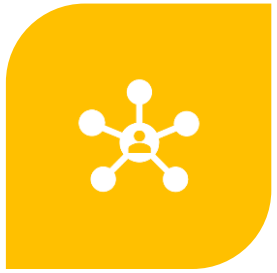
Many data processing frameworks are statically configured

These frameworks cannot provide proper scalability and flexibility

Conclusion

FOG IS A PERFECT PARTNER FOR CLOUD AND IOT

SOLVES THE PRIMARY PROBLEMS FACED BY CLOUD WHILE HANDLING IOT DATA



BENEFITS EXTENDS FROM AN INDIVIDUAL PERSON TO HUGE FIRMS

PROVIDES REAL TIME ANALYSIS AND MONITORING

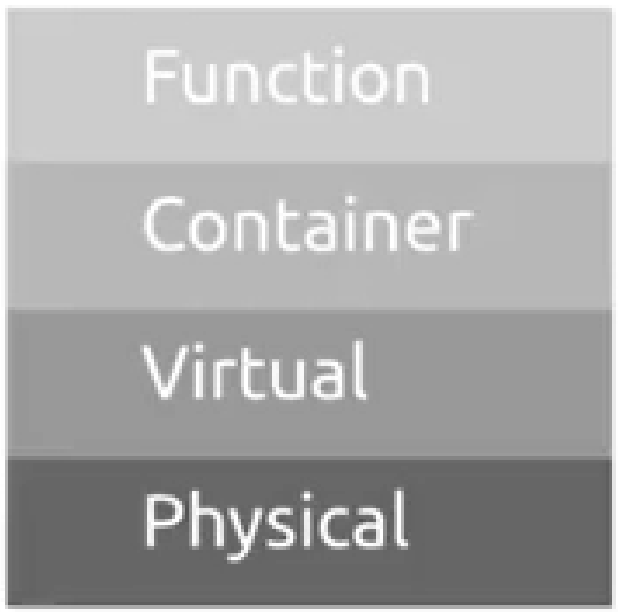
Courtesy : Prof. Sudip Mishra, IIT KGP

Cognitive Cloud/IoT

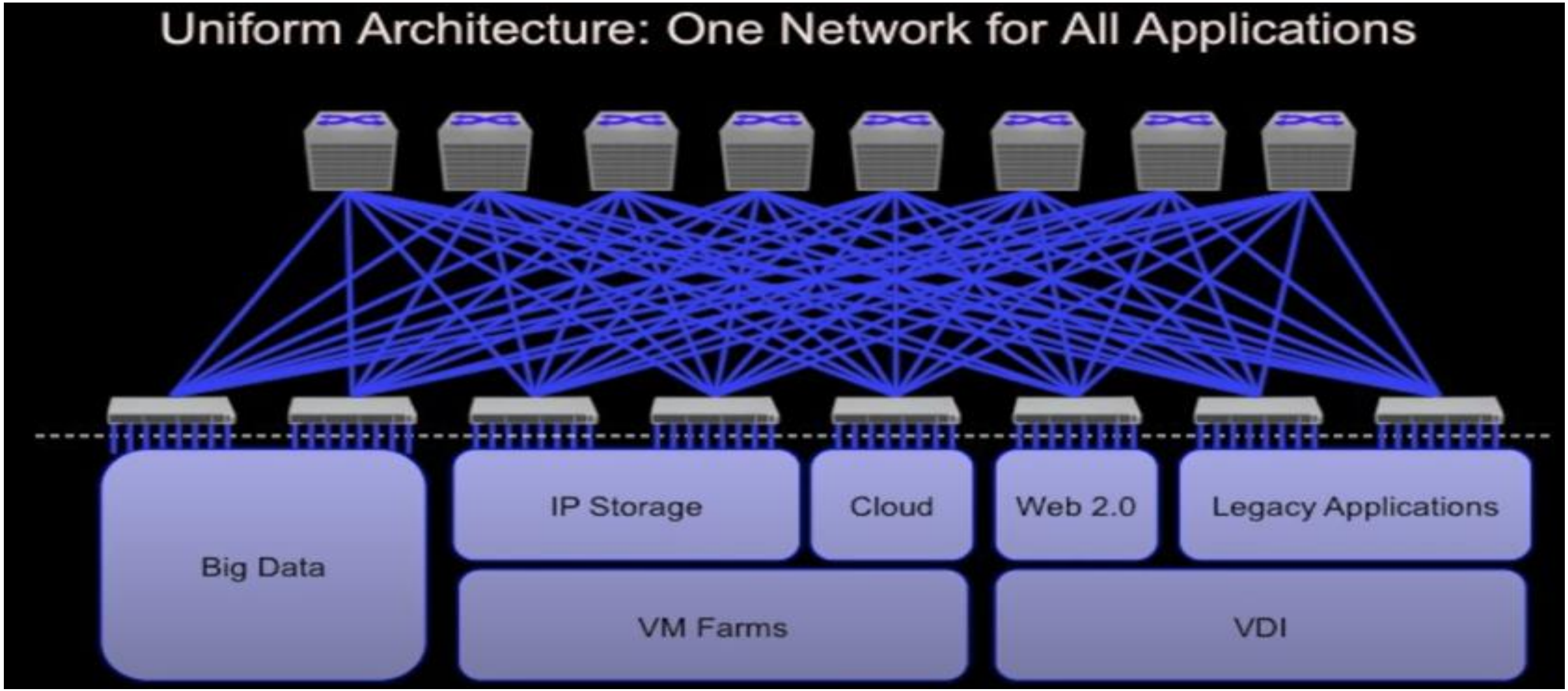
Cognitive IoT is the process of implementing cognitive computing technologies on the data generated by connected devices.

According to research firm Frost & Sullivan, IoT will transition to cognitive, predictive computing over the next 12 to 18 months

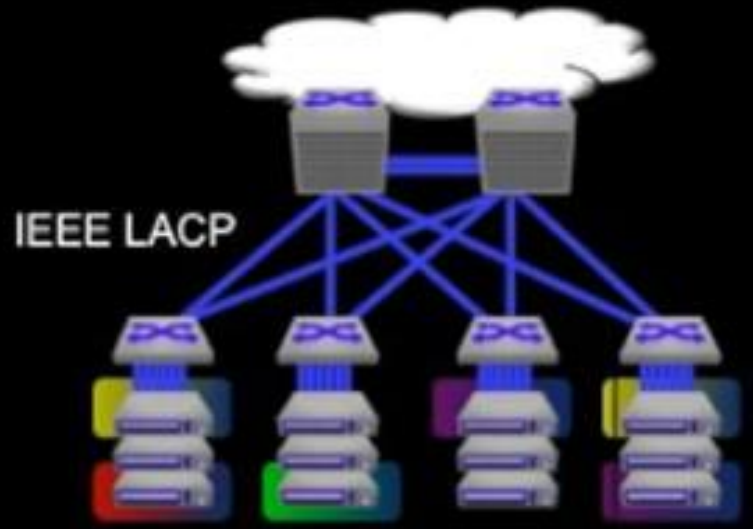
Increasing layers of abstraction



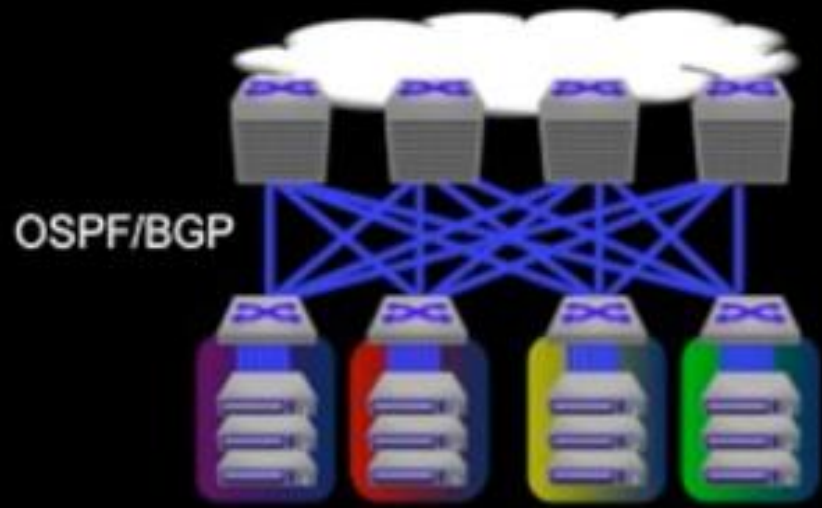
Software Defined Cloud



Consistent Cloud Networking Designs – Standards based L2, L3

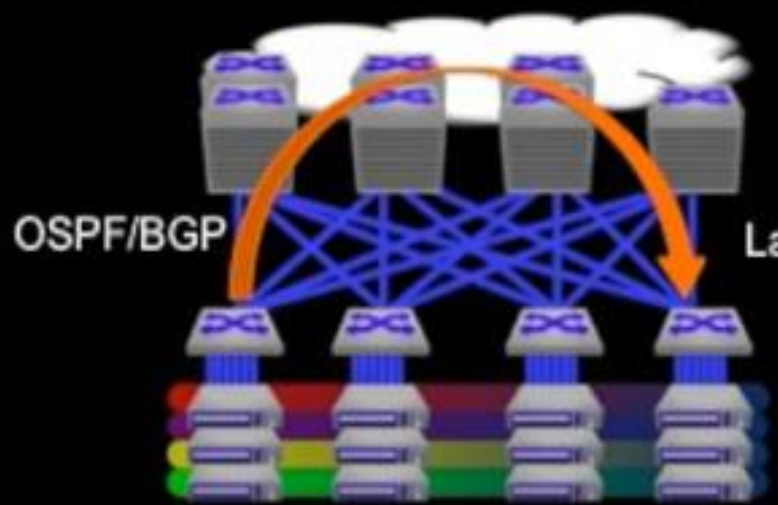


Layer 2 MLAG
Up to 6,912 10G



Layer 3 ECMP
Up to 13,000 10G
(4-way ECMP)

Consistent Cloud Networking Designs – L2, L3, VXLAN



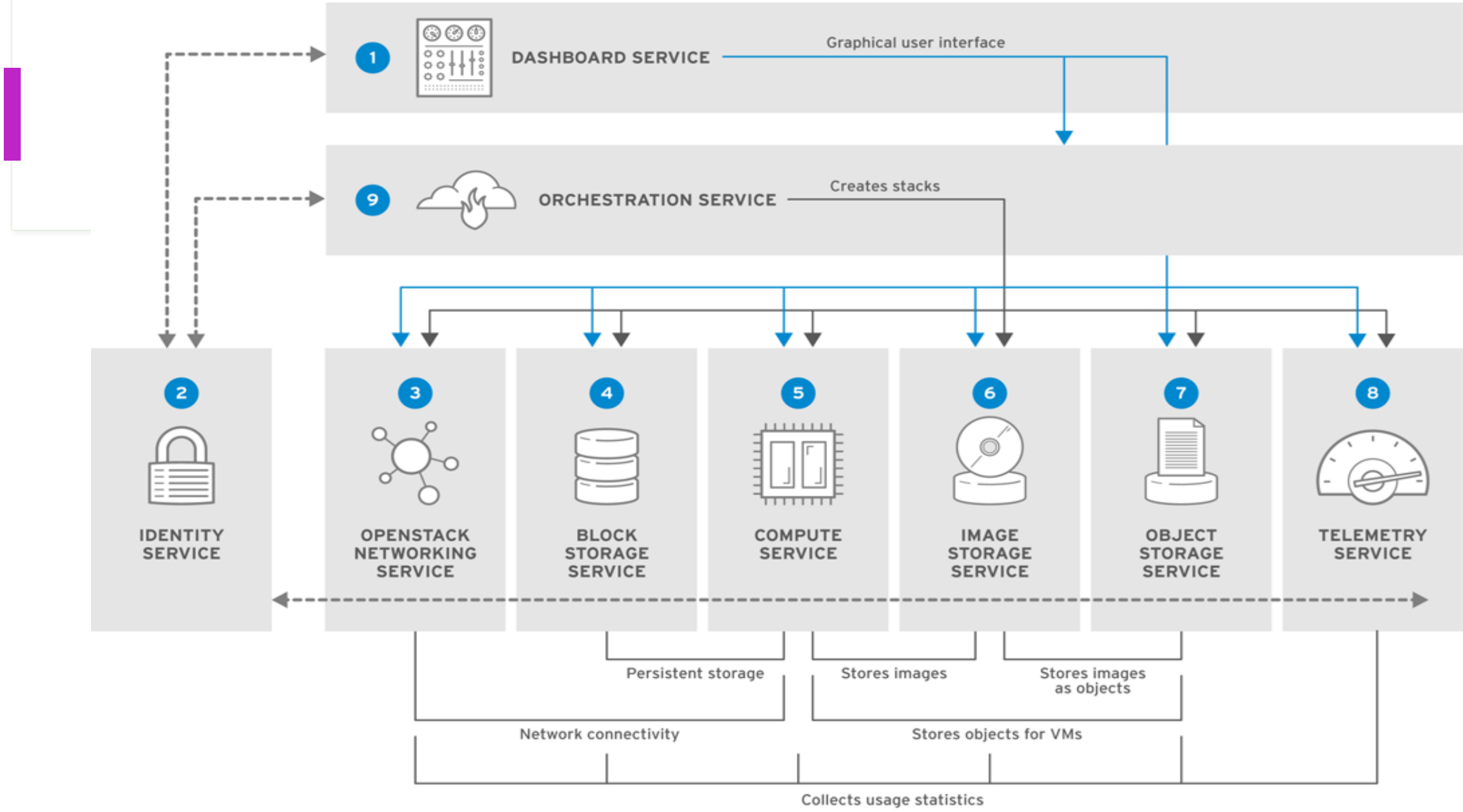
Layer 2 over Layer 3 using VXLAN Tunnels

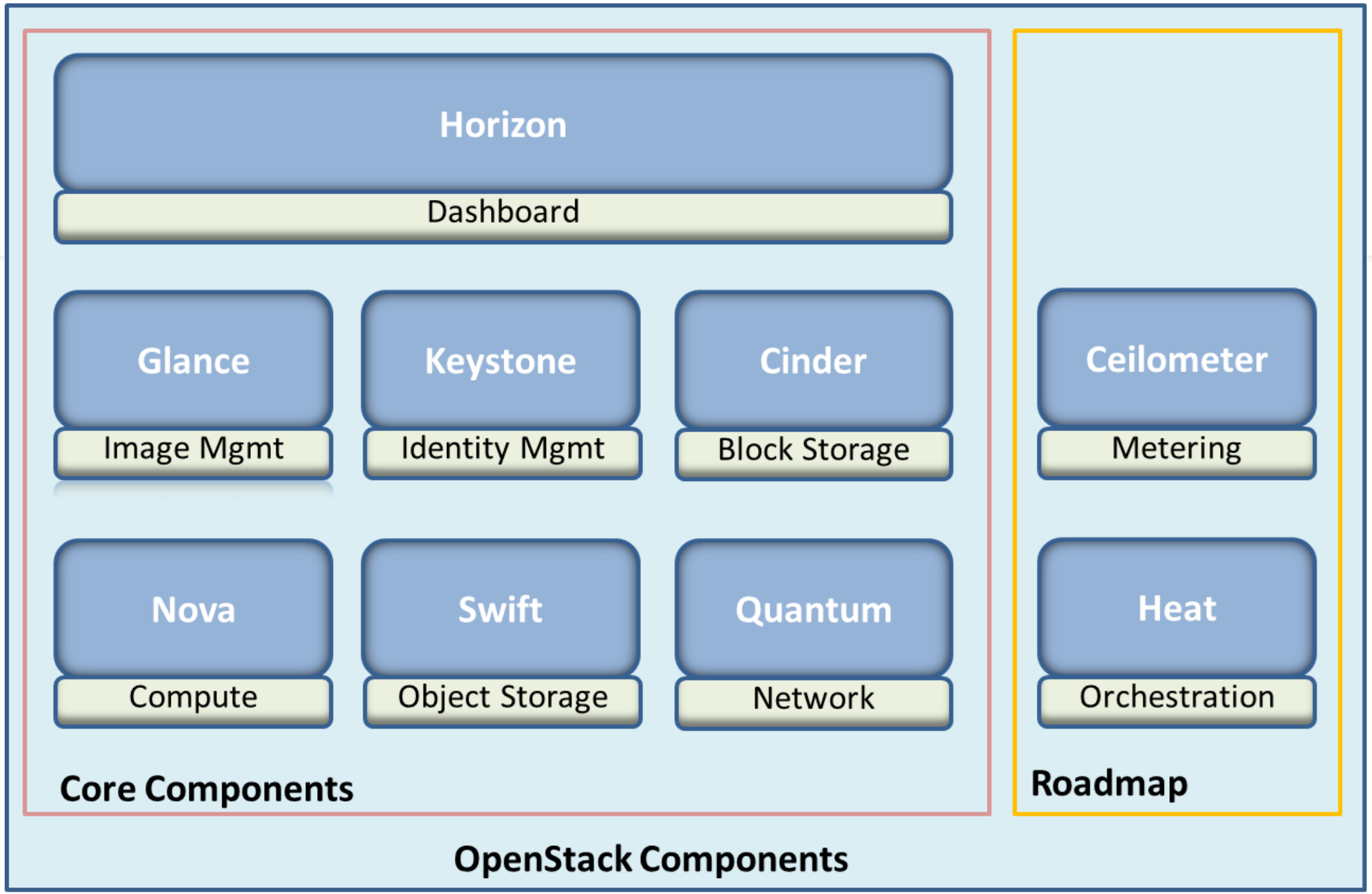
VNIs spanning multiple racks

L2 over L3 VXLAN
100,000+ 10G Nodes, 1 Million+ VMs in 2-Tiers.

Open Stack

- An Open software to create a cloud infrastructure
- Launched as a joint project of Rackspace Hosting and NASA in 2010
- Presently many companies are contributing to Openstack
- Eg. IBM, CISCO, HP, Dell, Vmware, Redhat, Suse, Rackspace hosting
- Can be used to develop private cloud or public cloud
- Versions:
  Austin, Bexar, Cactus, Diablo, Essex, Folsom, Grizzly, Havana, Icehouse, Juno, Kilo, Liberty, Mitaka, Newton, Ocata (Latest)


1
DASHBOARD SERVICE
Graphical user interface
9
ORCHESTRATION SERVICE
Creates stacks
2
IDENTITY SERVICE
3
OPENSTACK NETWORKING SERVICE
4
BLOCK STORAGE SERVICE
5
COMPUTE SERVICE
6
IMAGE STORAGE SERVICE
7
OBJECT STORAGE SERVICE
8
TELEMETRY SERVICE
Persistent storage
Stores images
Stores images as objects
Network connectivity
Stores objects for VMs
Collects usage statistics
RHELOSP_347192_1015


Horizon
Dashboard
Glance
Image Mgmt
Keystone
Identity Mgmt
Cinder
Block Storage
Nova
Compute
Swift
Object Storage
Quantum
Network
Core Components
Ceilometer
Metering
Heat
Orchestration
Roadmap
OpenStack Components