



FOG Computing

Mario Nemirovsky – ICREA/BSC

With the collaboration

Rodolfo Mito - CISCO

Marcelo Yanuzzi - UPC

Fog Computing

Non-trivial Extension of Cloud Computing from the Core to the Edge that enables a whole new wave of services and applications
Hierarchical, Virtualization, Multi-tenancy, & some distinctive features



fog = cloud close to the ground

Suites of Use Cases

- (Mobile) Content Delivery
 - Low latency Apps (gaming, streaming, augmented reality ...)
- Geo-distributed apps
 - Sensor/actuator networks, Smart Cities
- Large-scale distributed control systems
 - Connected Vehicle, Int.Transportation, Smart Grid

Fog is the platform where the Internet meets the physical world

Fog Computing

Non-trivial Extension of Cloud Computing from
The Fog is not a replacement of the Cloud

wave of services and applications
Virtualization, Multi-tenancy, & some distinctive features



fog = cloud close to the ground

Suites of Use Cases
The Fog does not cannibalize the Cloud

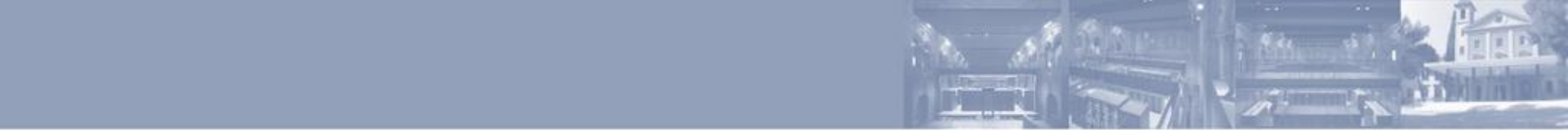
- (Mobile) Content Delivery
 - Low latency Apps (gaming, streaming, augmented reality ...)

Geo-distributed apps
The Fog aims at emerging services & apps

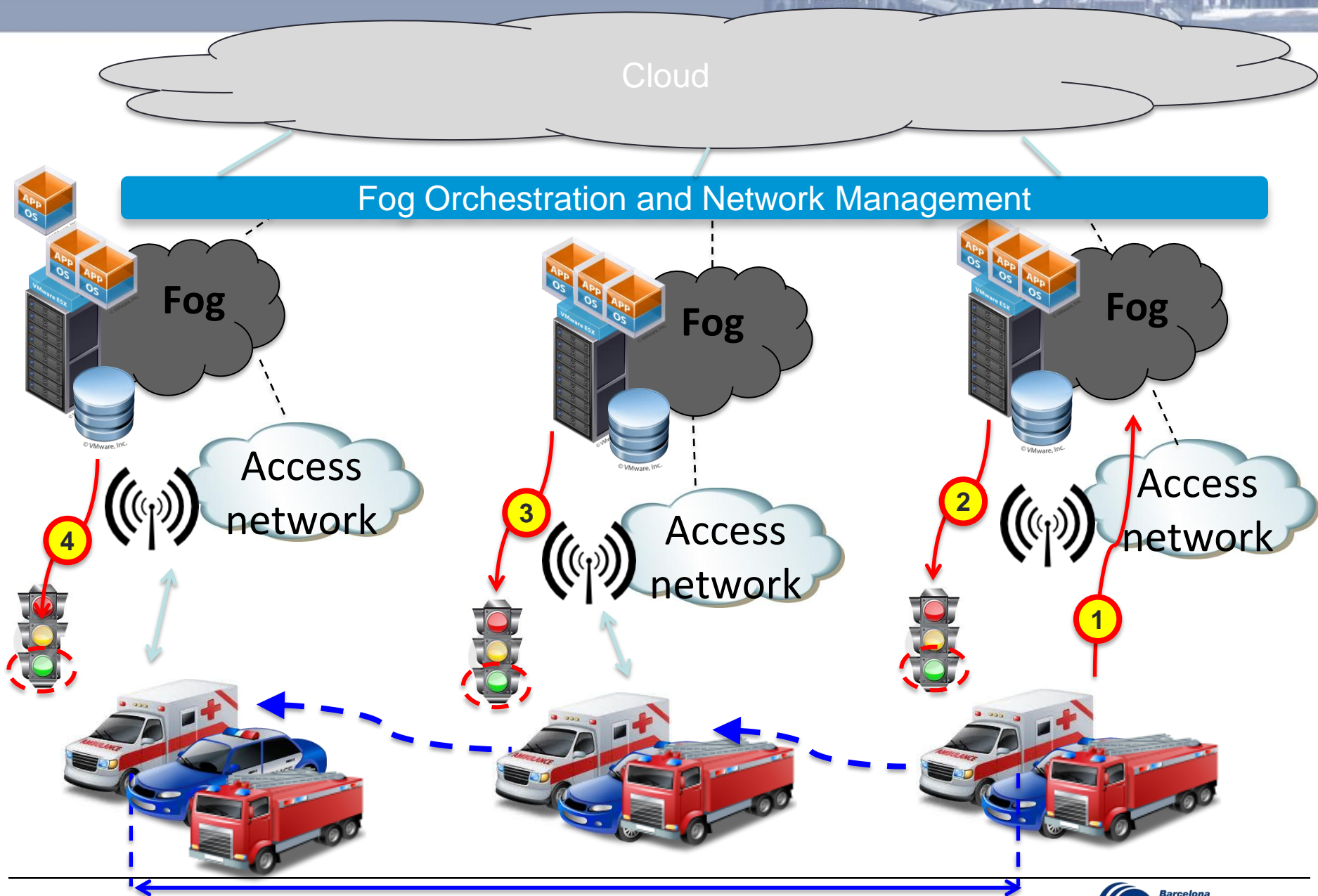
- Large-scale distributed control systems
 - Connected Vehicle, Int. Transportation, Smart Grid

The Fog interplays with the Cloud

Fog is the platform where the Internet meets the physical world

- 
- What is really Fog Computing?
 - *Unifying platform at the edge of the networks that supports a wide range of emerging apps and services requiring*
 - Low latency
 - Geo- distribution
 - Mobility support (decoupling location from identity)
 - Orchestration of large scale controlled systems)
 - What is new with the Fog platform?
 - Support for large scale distributed control systems
 - New actors (agencies) and new business models
 - What are some of the Fog *distinctive* characteristics?
 - Multi-tiered hierarchical organization
 - Hierarchically organized orchestration plane
 - App-dependent for consistency, availability, and partitioning trade-offs
 - *CAP trade-offs exist in any distributed system*
 - *FOG adds the latency dimension*
 - *Diverse apps – one size does not fit all*

Several domains and/or agencies traversed in a few miles



What is the “Common” IoT Platform Architecture ?

Energy

Connected
Transportation

Industrial

Smart Cities ...

Data Center Cloud

Hosting IoT analytics



Network Management

Applications

Core

IP/MPLS, Security,
QoS, Multicast

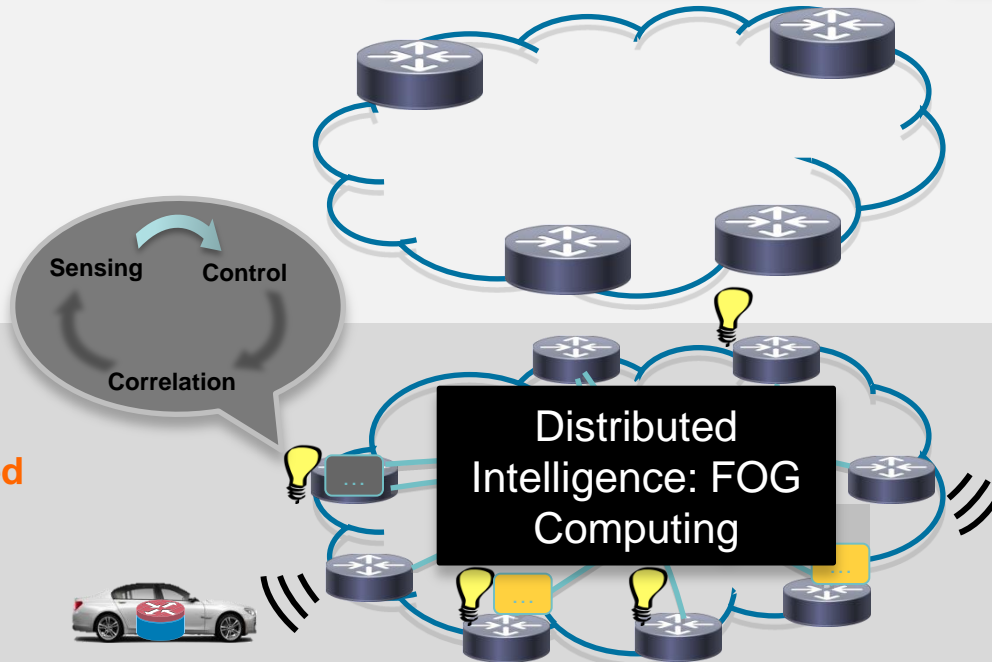
Thousands

IP/MPLS Core

Multi-Service
Edge

3G/4G/LTE/WiFi/Wired

Dozens of
Thousands



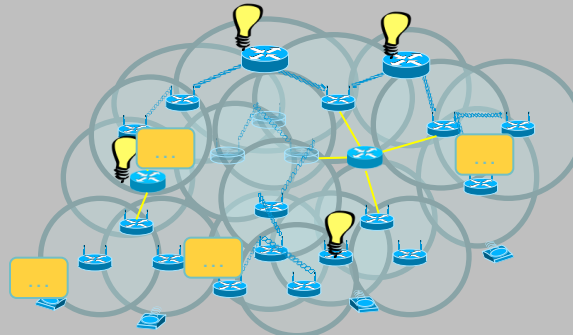
Field Area Network

Embedded Systems
and Sensors

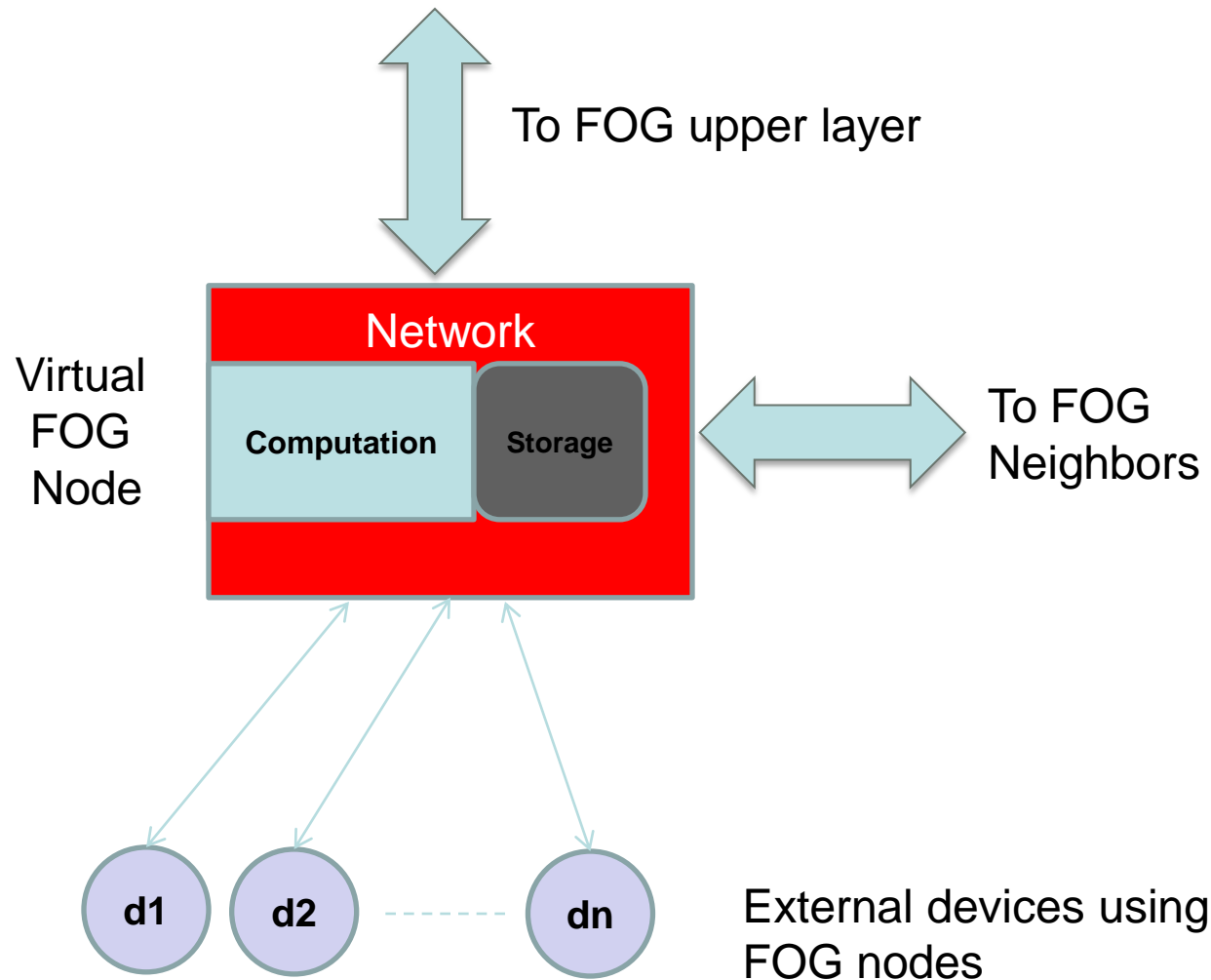
Low power & bandwidth,
smart things, vehicles,
machines

Hundreds of
Millions

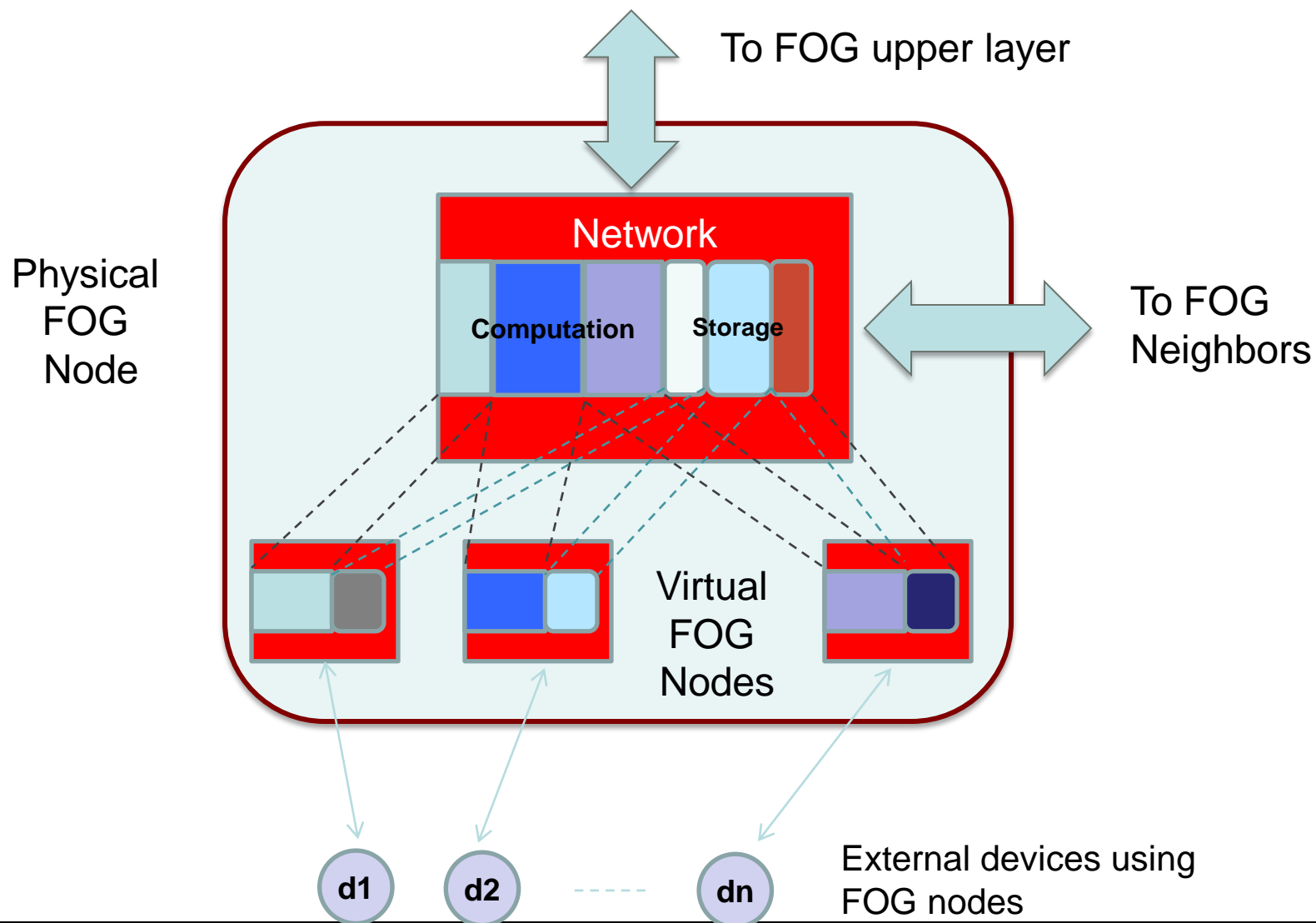
Smart Things Network



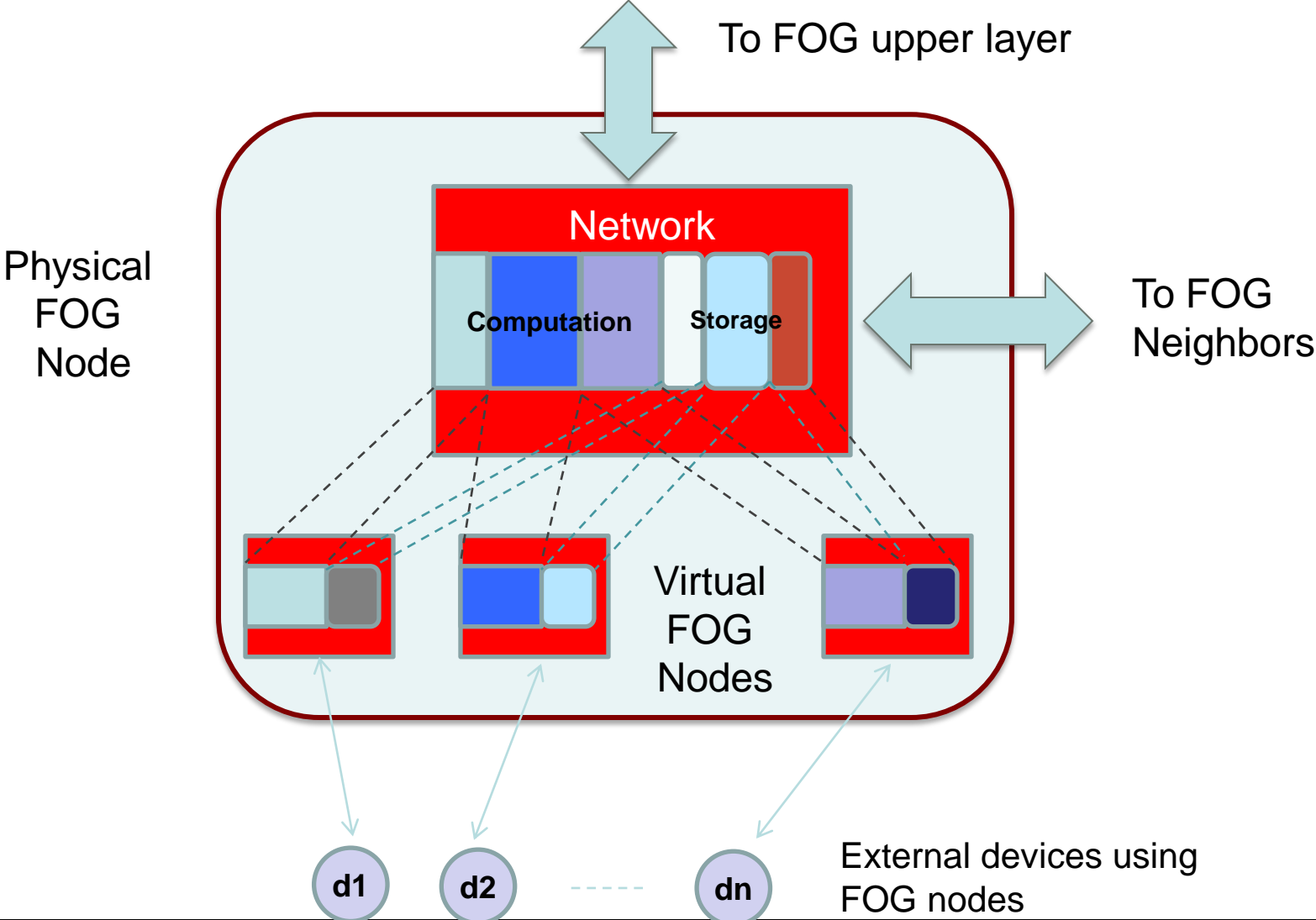
Physical (or Virtual) Fog nodes



Physical Fog nodes

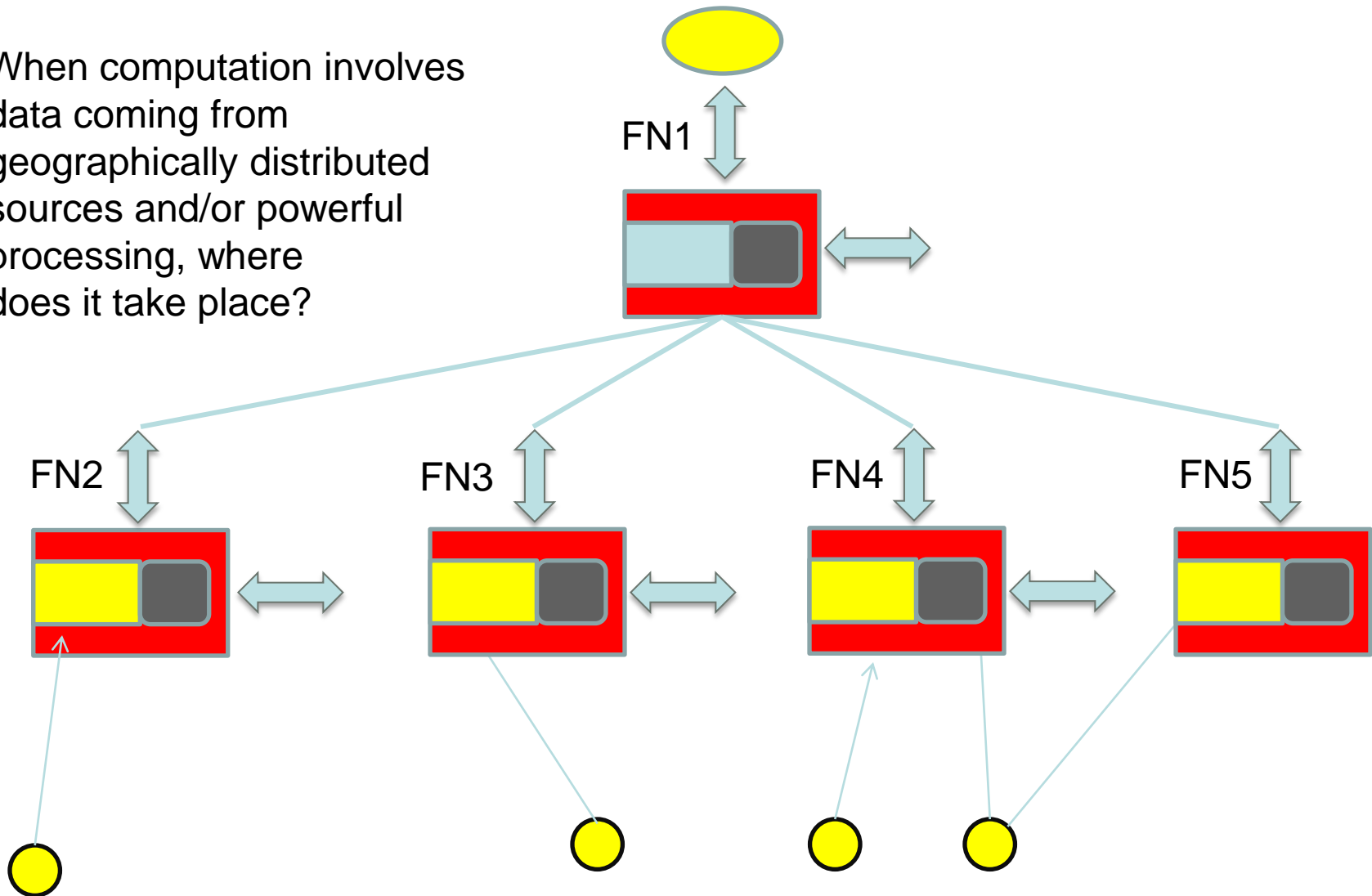


Physical Fog nodes



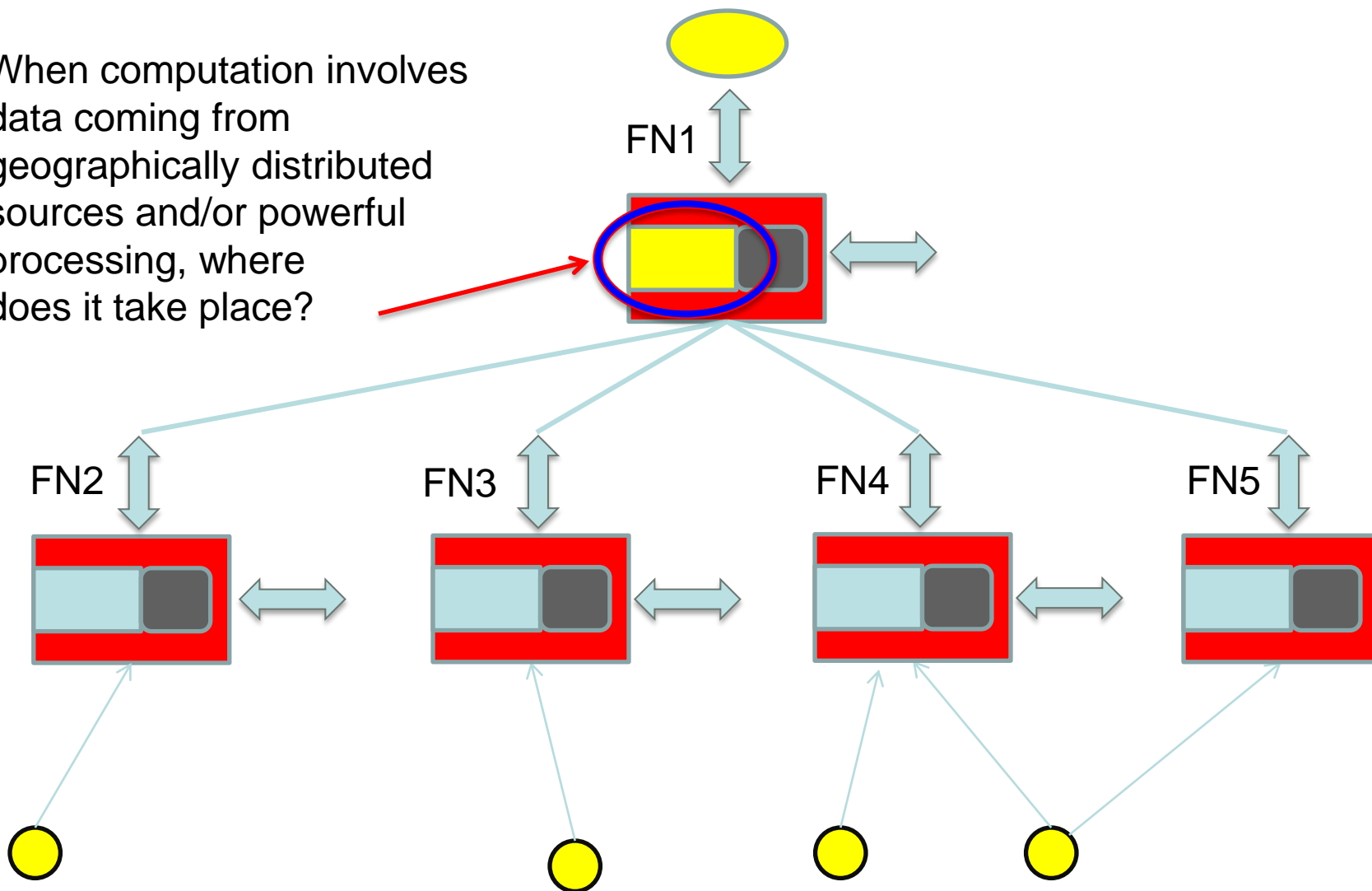
Processing

When computation involves data coming from geographically distributed sources and/or powerful processing, where does it take place?



Processing

When computation involves data coming from geographically distributed sources and/or powerful processing, where does it take place?



“The Ground” Differentiates the Fog from the Cloud

Tiered organization involving multiple administrations in the access

Hierarchical control and management supporting interplay with the Cloud

Expanded mobility model

Geo-distribution of computational power with strong focus on service locality

Read-time analytics at different tiers

Orchestration involving coordinated control and actuation in multi-tier settings

Unified exposure of virtualized resources (consolidated virtualization)

Negligible latency

Distributed policy exposure and policy management involving multiple tiers

opportunities

- Telcos (carriers) → New revenue by leasing/owning computation foglets
- Cloud Providers → New services today not possible
- Routers manufacturers → New hardware needed to deploy computation within the routers
- End users → New applications not possible today
- SMEs → New business opportunities
- **FOG creates a new market**

IoT and Big Data

- *Big Data (BD) is not just about volume*
- *Volume, Velocity, and Variety are today associated with BD*
- *IoT brings a fourth dimension: Geo-distribution*
- Typical Cloud/DC BD problem: run analytics on humungous data
- Standard approach: distribute workload across large number of machines (Hadoop/MR)
- Typical sensor network architecture
 - Fuse and process data from multiple sources at the first tier
 - Aggregate data from the fusion nodes at the second tier
 - Aggregate and process data in the Cloud

Cloud, Fog and Computing

