



Introducing Magma: A Converged Core Network Solution

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Facebook Connectivity

GLOBAL ACCESS IS IMPROVING

51%

INDIVIDUALS CONNECTED
TO THE INTERNET

4G PENETRATION IS INCREASING

33% TO 60%

GLOBAL 4G COVERAGE
BY 2022



The Internet Has Become A Crucial Tool For Improving Livelihoods



77%

Learn job related skills



74%

Discover new job opportunities



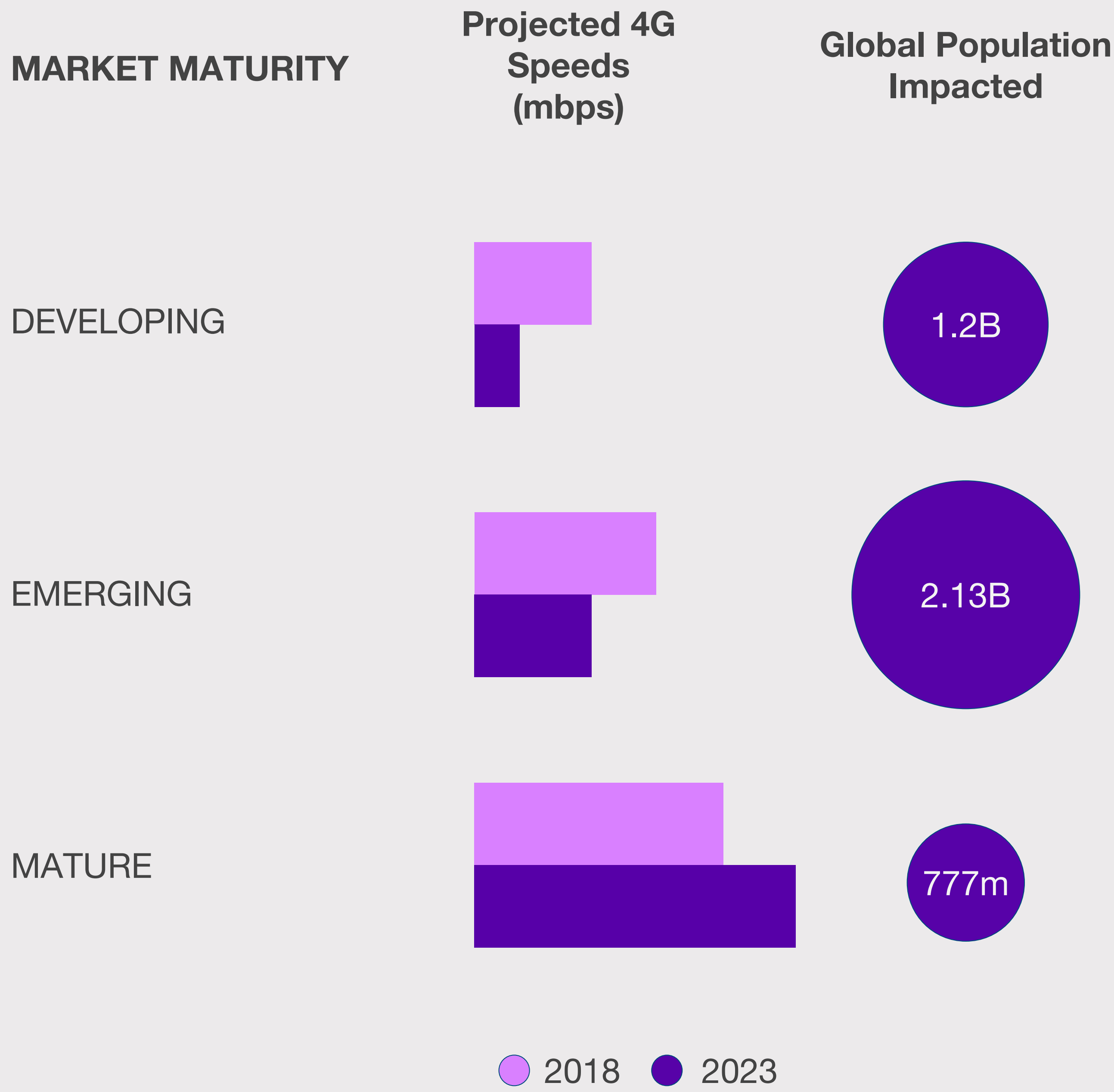
60%

Pursue an education

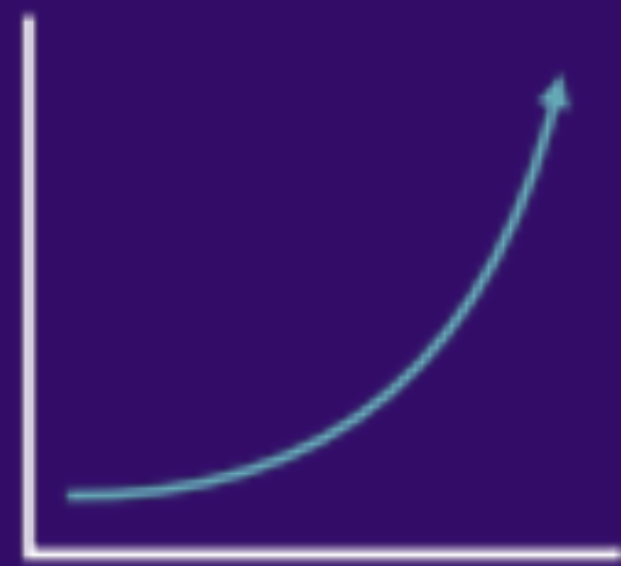
Network Performance is At Risk

3.3 billion people in **developing** and **emerging** markets are at risk of degraded network performance by 2023

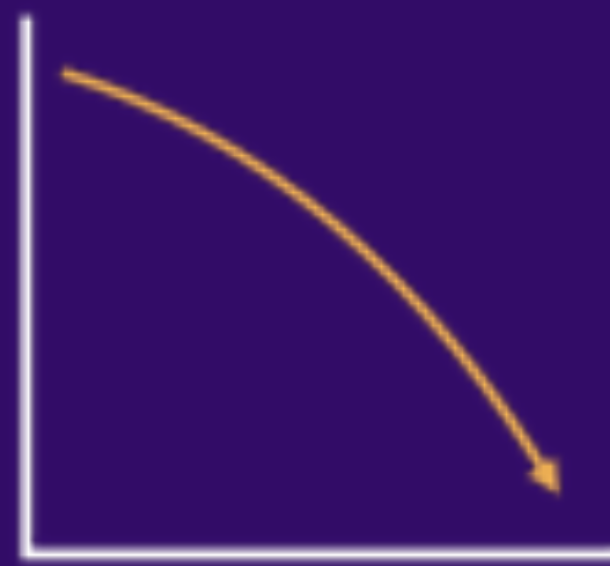
Source: Facebook Connectivity Internal Research 2019
connectivity measurements exclude China



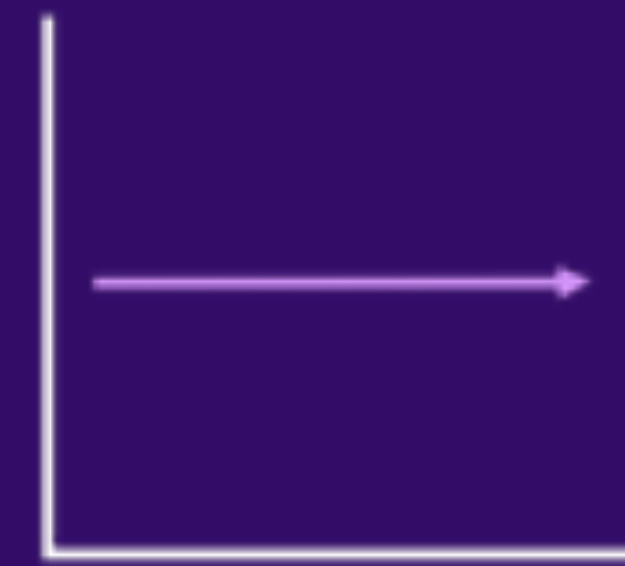
The Challenges Facing Global Operators Today



DATA CONSUMPTION



ARPU



OPEX

Why Facebook And Connectivity?

Our Business Depends On Good Connectivity

FBC
INFRASTRUCTURE



FBC
ANALYTICS



FBC
EXPERIENCES



FBC Infrastructure

EXPRESS Wi-Fi

Providing fast, reliable, Wi-Fi when and where people need it.

TERRAGRAPH

Innovative, high-speed mmWave backhaul solutions for dense urban and suburban environments.

MAGMA

Open source mobile packet core designed to help operators extend the reach of their existing network.





Facebook Connectivity Mission

Bring more people online to a faster internet

Magma Mission

Bring more people online by enabling service providers with open, flexible, and extensible network solutions

Magma + Ecosystem

The de-facto cloud-native, DevOps core network stack in the industry

Magma Ecosystem

Where in the industry we will influence and impact



=

**Network
Orchestration**

+

**Network
Federation**

+

Core Convergence

OEM Integration

System Integration

Partner Engineering

Deployments

Managed Services

OS Community

Industry Influencers

END CUSTOMERS

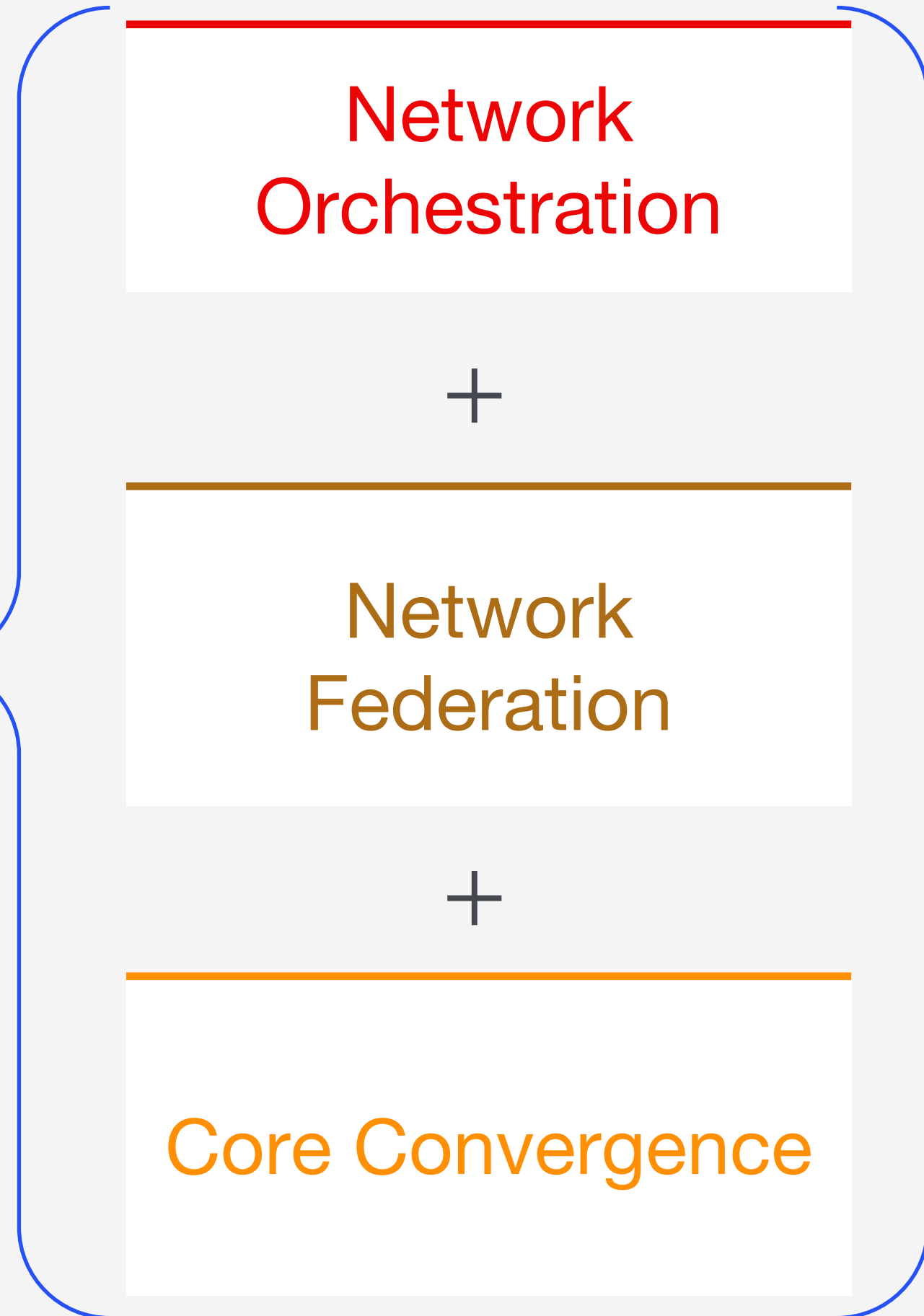
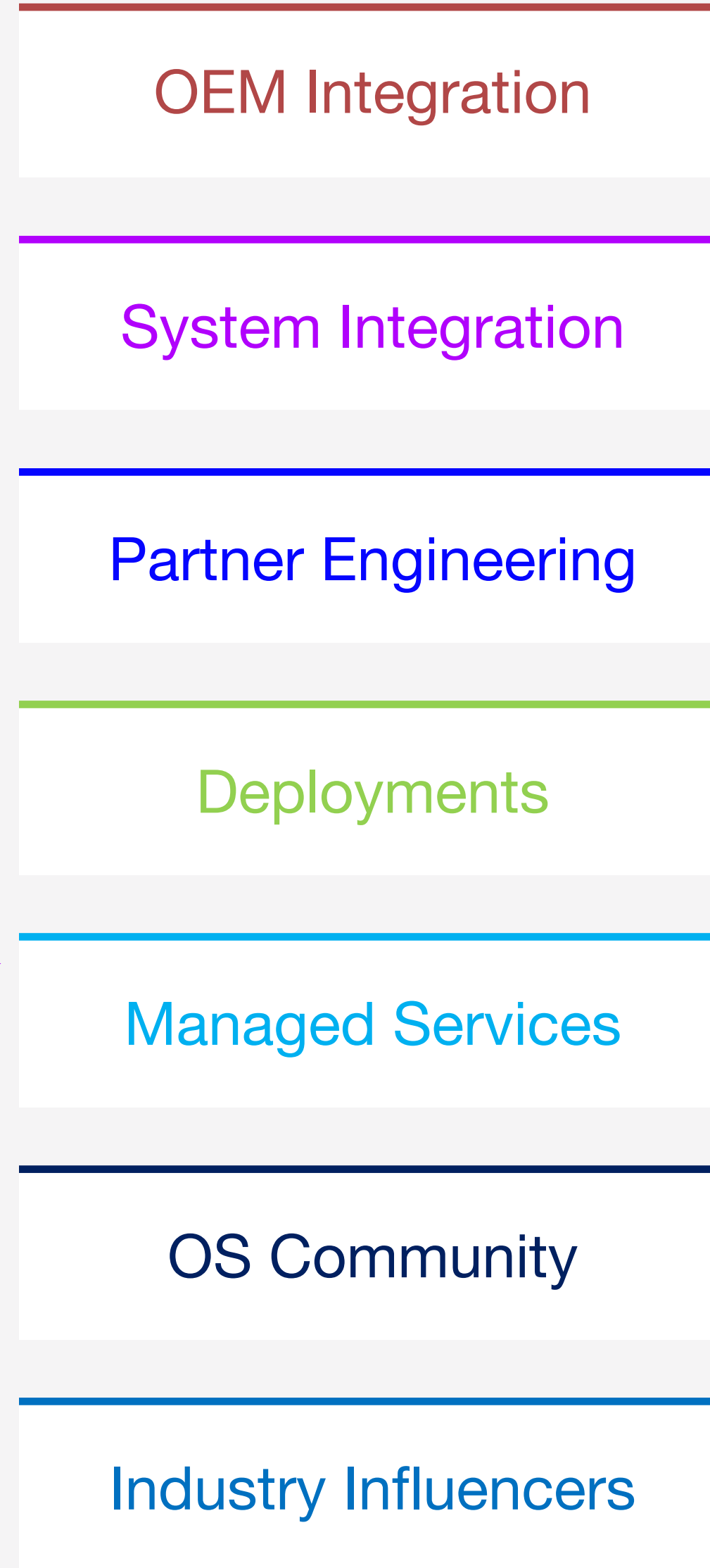
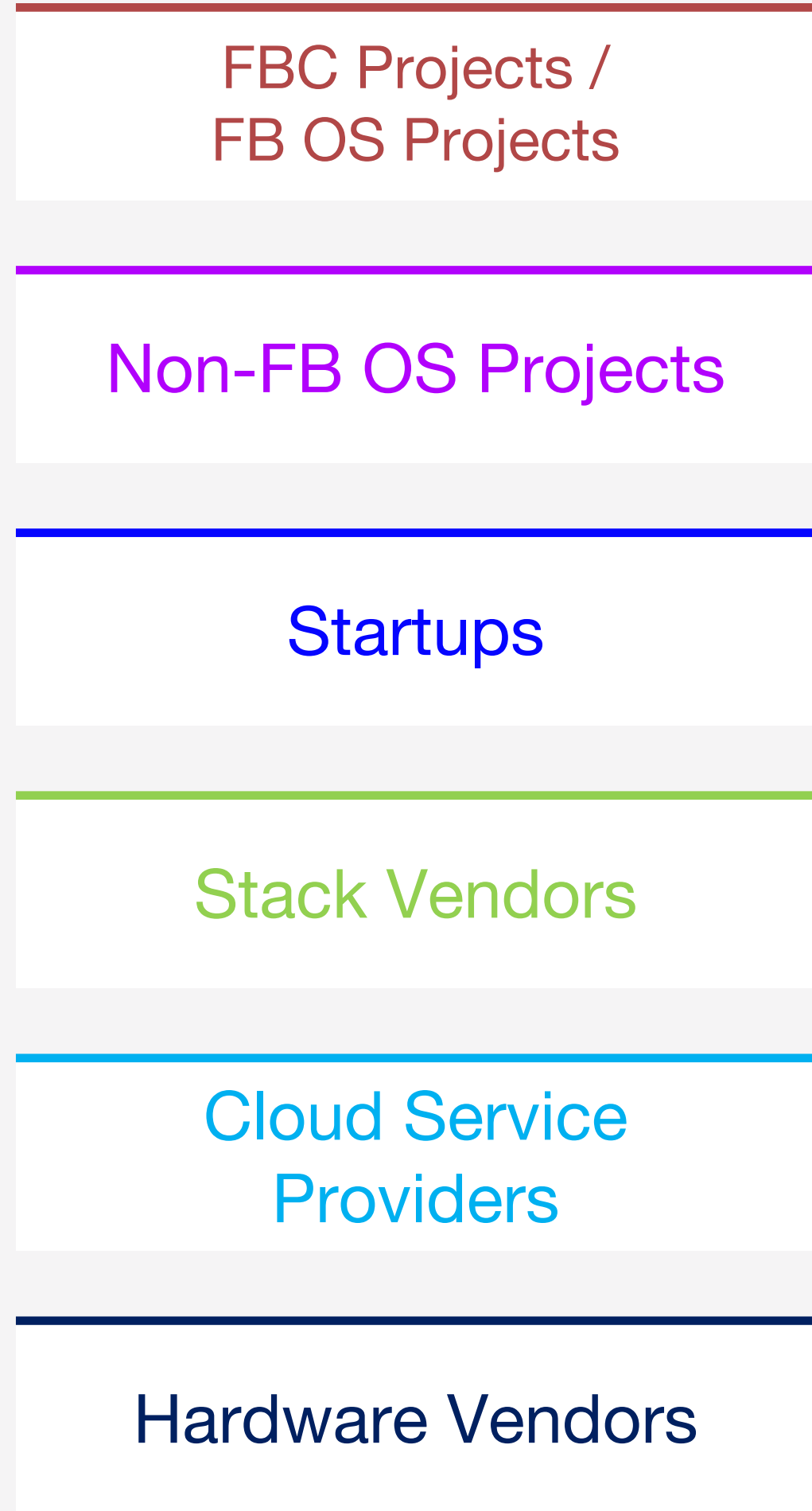
MNOS

**ISPS
MVNOS**

**NAAS PROVIDERS /
RMIOS**

OTHER OPERATORS

ENTERPRISES

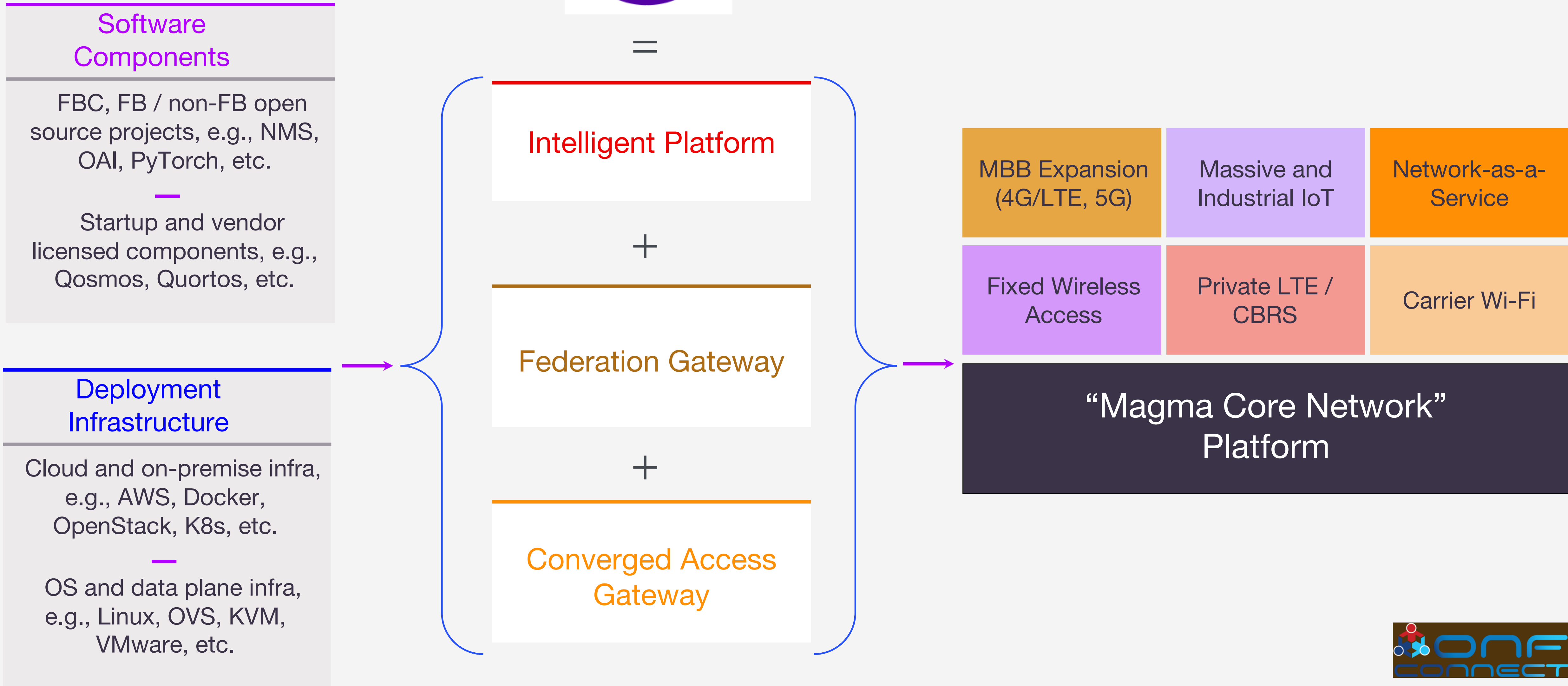


Magma End Game

Vision 2020 and beyond ...



"The unified packet core supporting any wireless access networks"

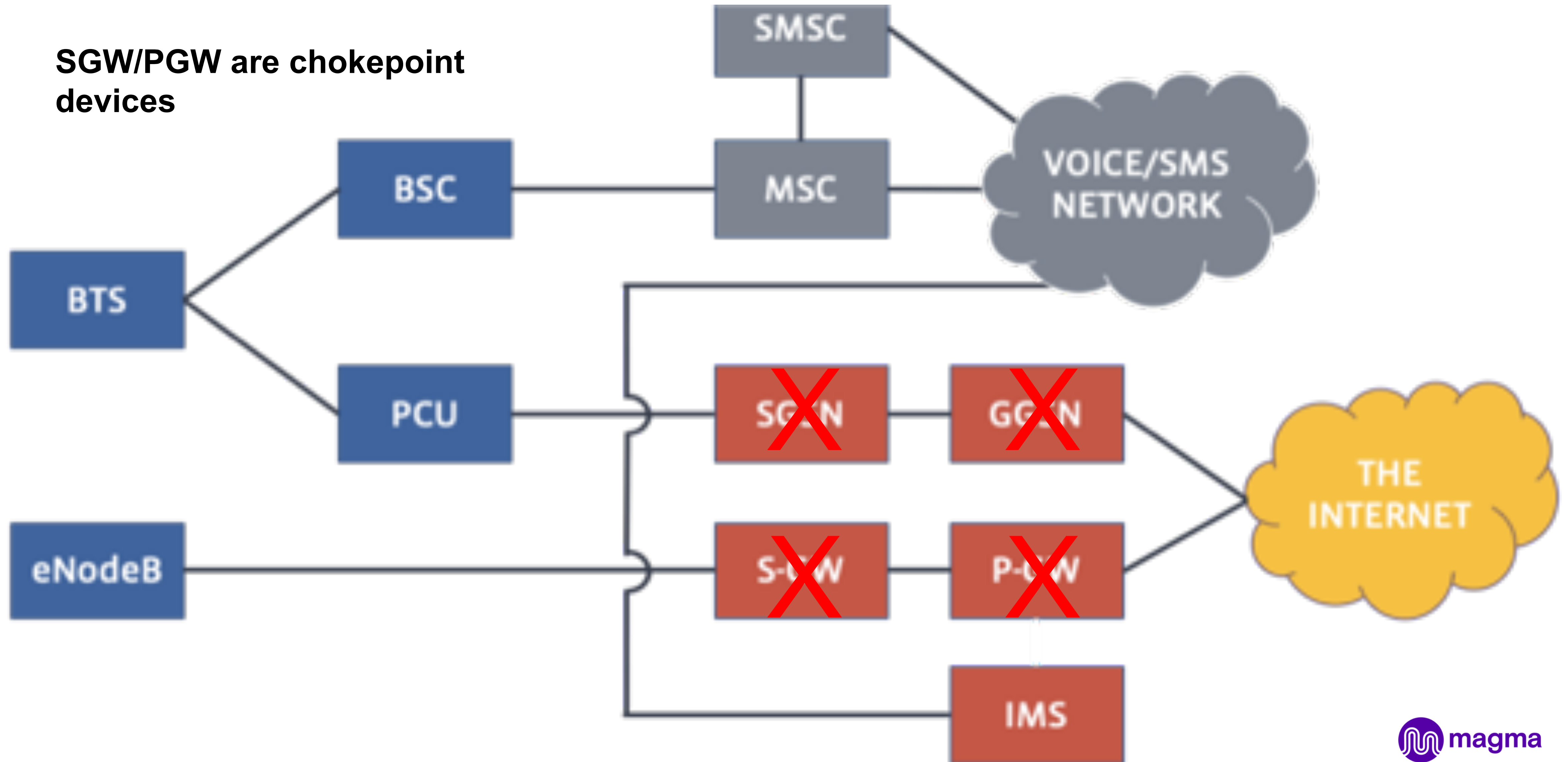


Magma

A Technical introduction

Today's GSM/LTE architecture

SGW/PGW are chokepoint devices

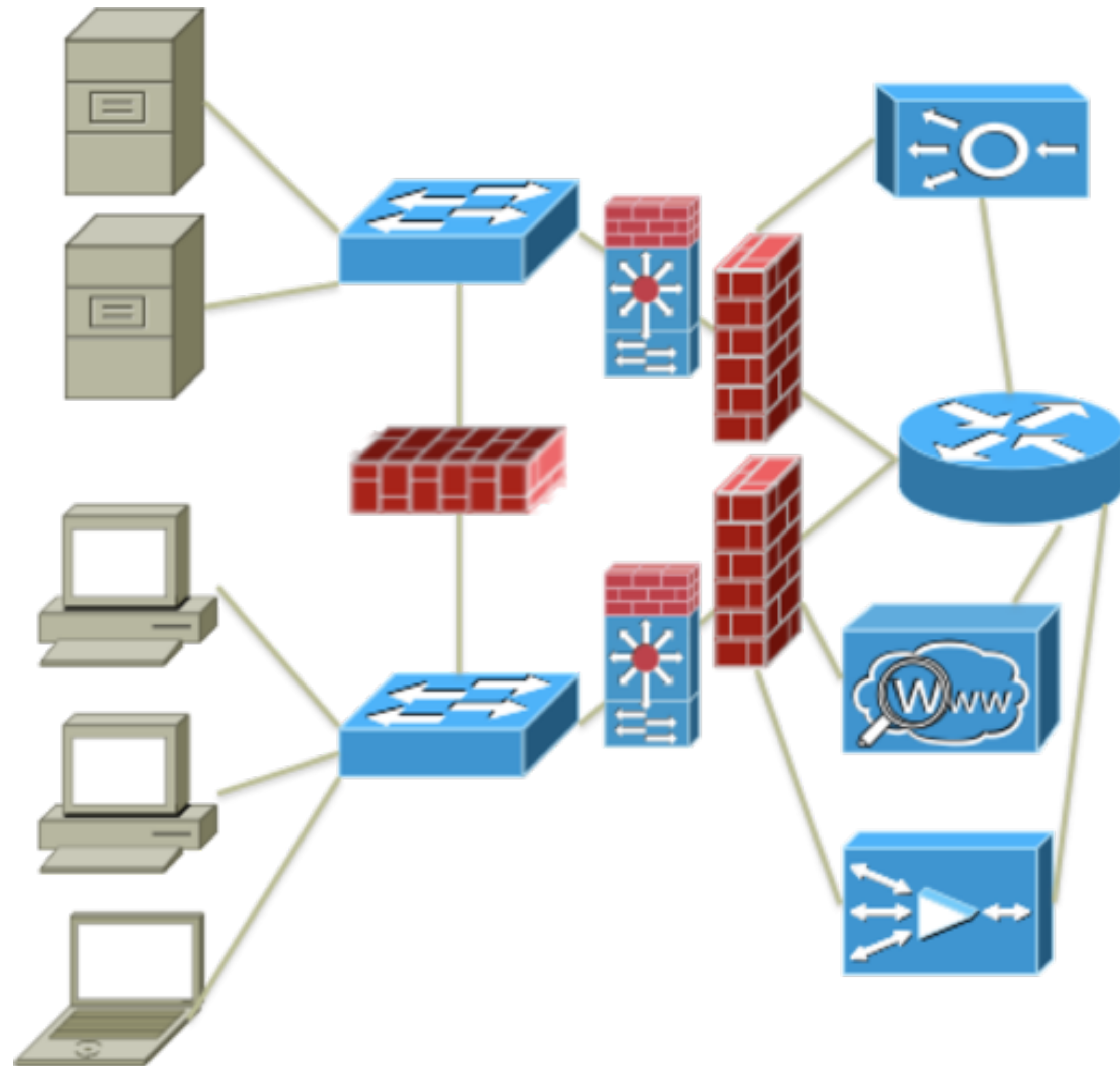


Magma takeaway 1: Modularize the cellular network

- Distribute the policy enforcement points
 - Let the ideal topology decide the policy enforcement points
- Move policy enforcement point to software
 - Leverage rapid iteration and programmability of software.
- Keep core network simple
 - Cheap: Core networks only need to move packets fast.
 - Allows for easy scale up/down.

Encapsulation of state

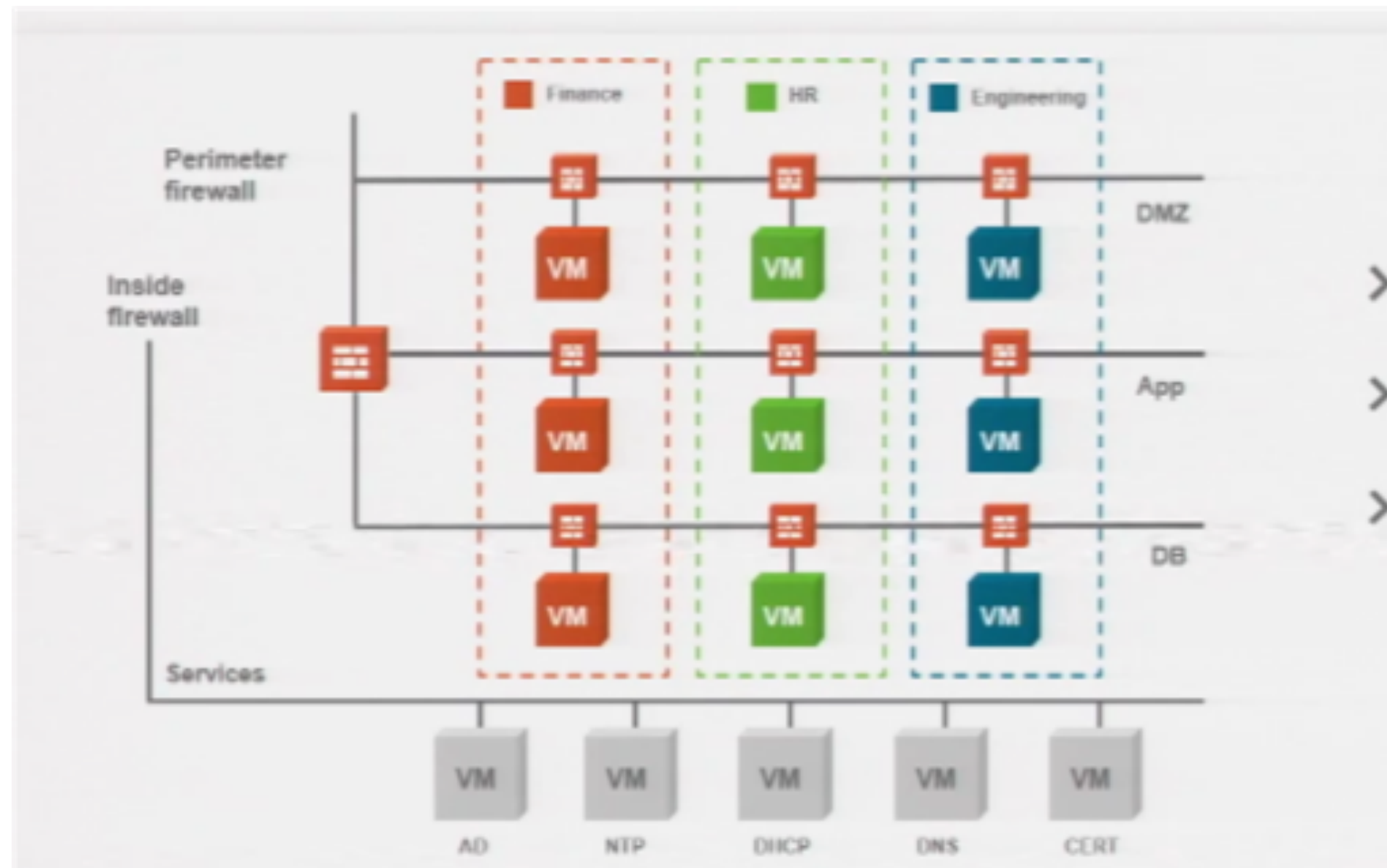
Traditional datacenters: State throughout the network



Each middlebox has state associated with workloads

1. State needs to be in sync across services (config + runtime)
2. Independently solved scaleout + high availability
3. Hard to adapt to dynamic workloads (tasks/VMs lifecycle/moving)

Modern networks: Encapsulation as an abstraction



Encapsulation of state:

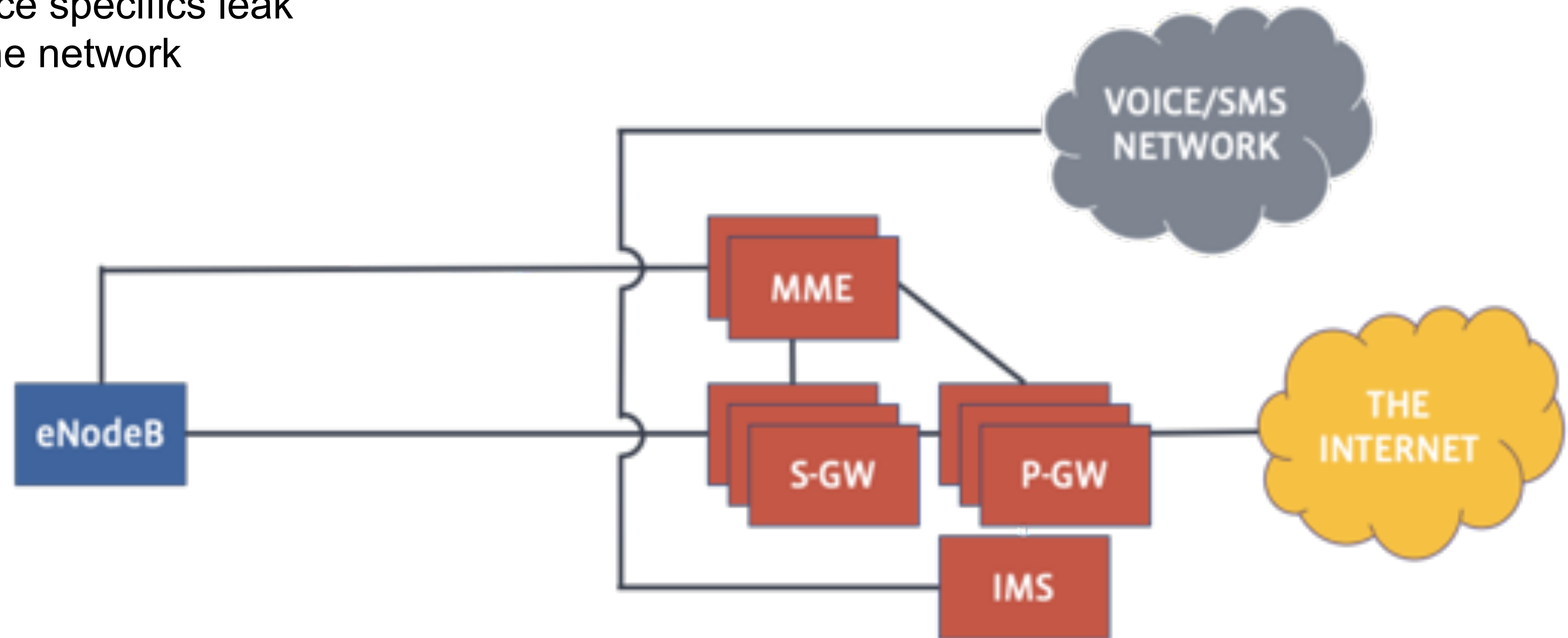
1. Network state coupled with workloads, allows for dynamism.
 - a. Provision the network for the workload
2. Fate sharing with workload. i.e. workload fails with the network service.
3. Natural scaleout.

Use modern production grade distributed system techniques to manage state.

Encapsulation in traditional LTE networks

UE state exists in all nodes

- No clear abstractions
- Air interface specifics leak through the network



State in traditional LTE networks example

UE State in MME	UE State in SGW	UE State in PGW
NAS state, Identifiers	Bearer state/lifecycle	UE IP address allocation
Auth vectors	Lawful intercept	UE policy enforcement
User APN profiles	Idle state buffering	Bearer state/lifecycle
User plane state for multiple SGWs (S11)	Per UE transport marking	Per UE transport marking

- State spread across nodes for the same UE
- Symmetrically maintained between nodes

Note: eNB also has per UE state

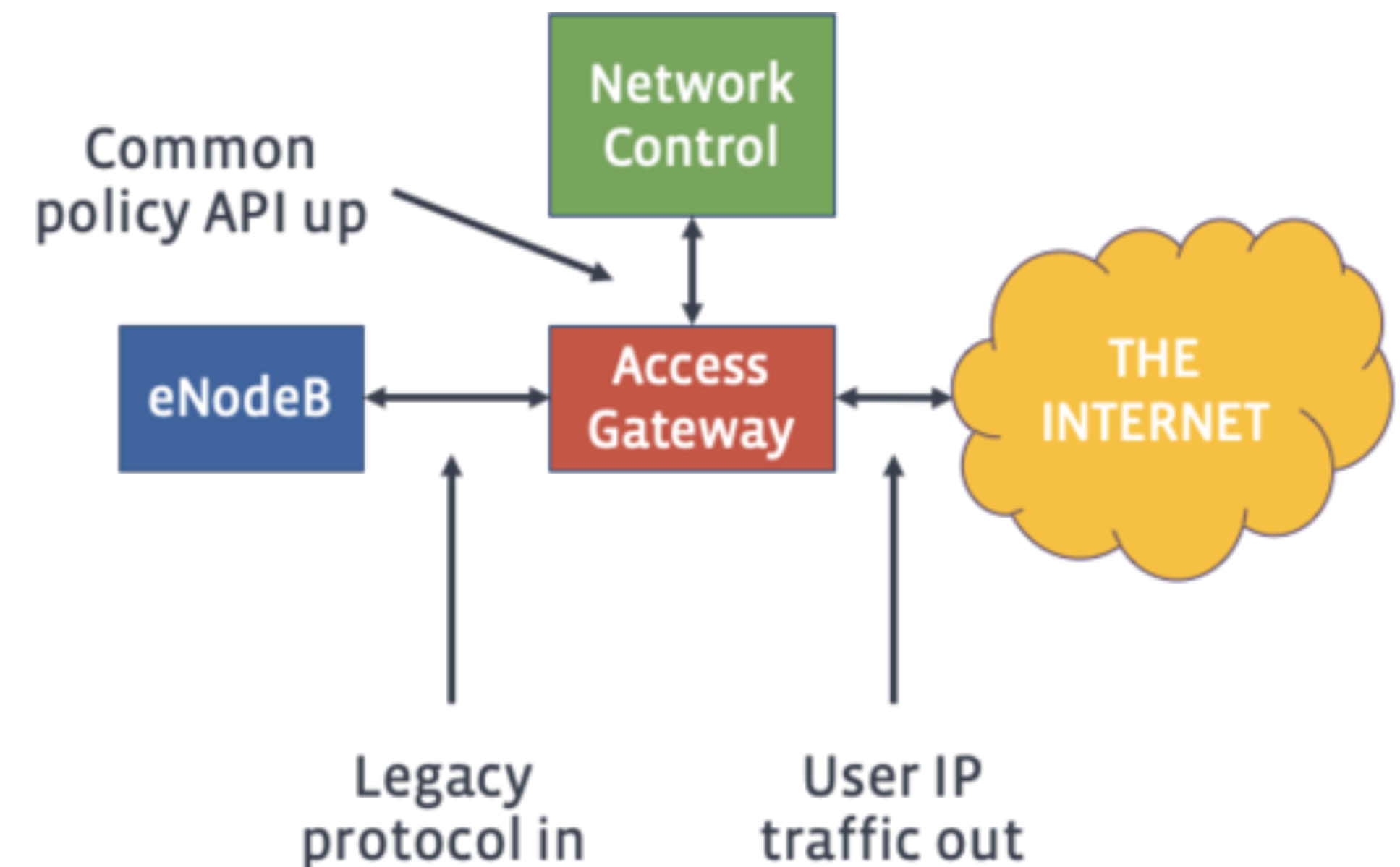
Magma takeaway 2: Encapsulate

- Encapsulate UE state
 - Config: Maintained in a central location and propagated to the edge
 - Runtime state: Encapsulated at the edge
- Move state to the edge to allow for fate sharing with the Radio
- Abstract away radio specific technology
 - Normalize protocol specifics early

State in control planes

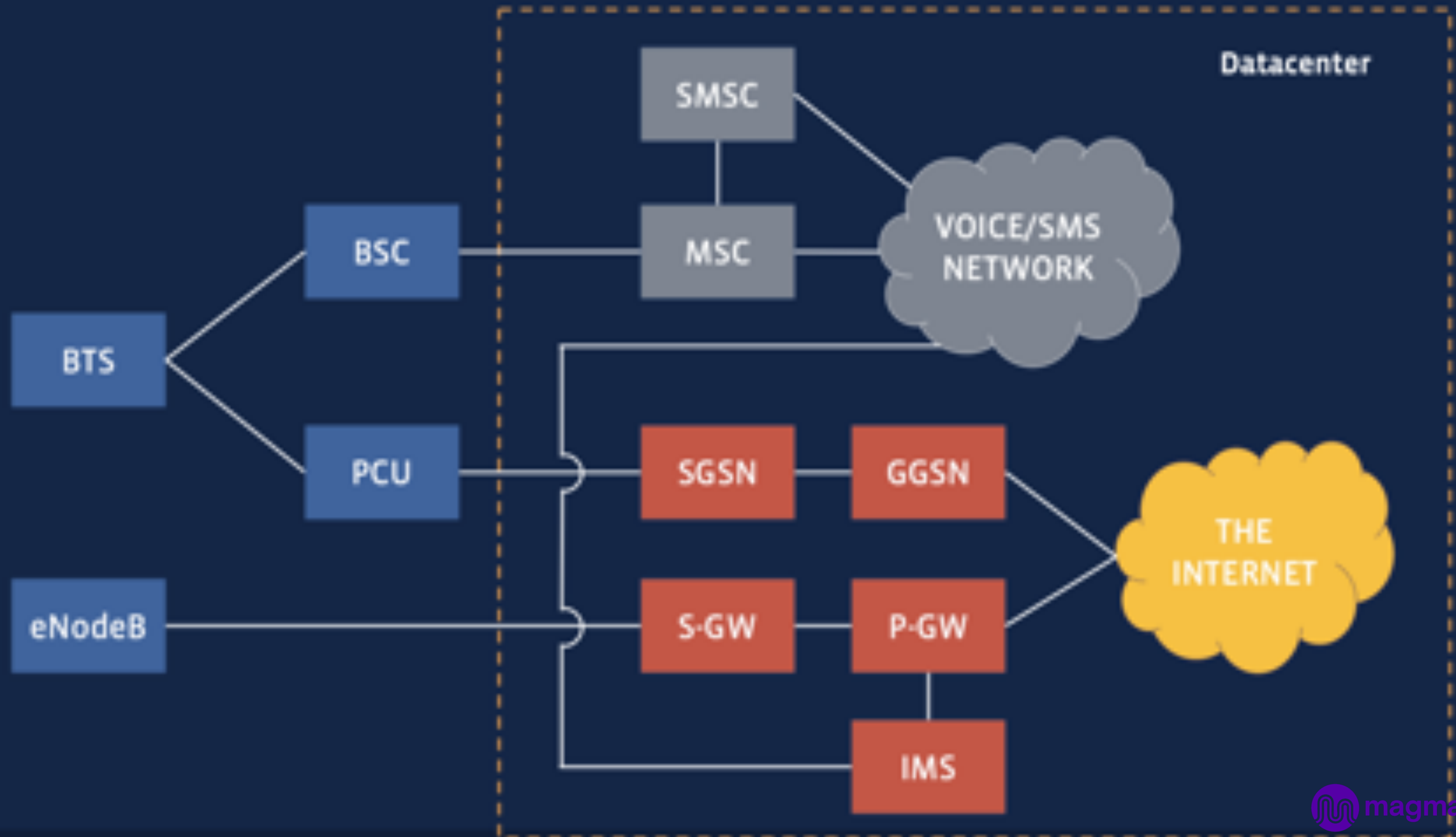
Magma takeaway 3: State in the control plane

- Desired state model
 - Centralized through APIs
 - User inputs intent, control plane enforces it
- Control logic completely decoupled from datapath
 - Independent evolution of control + datapath
- Use modern distributed systems to propagate state
 - Http2, Protobuf, K/V store

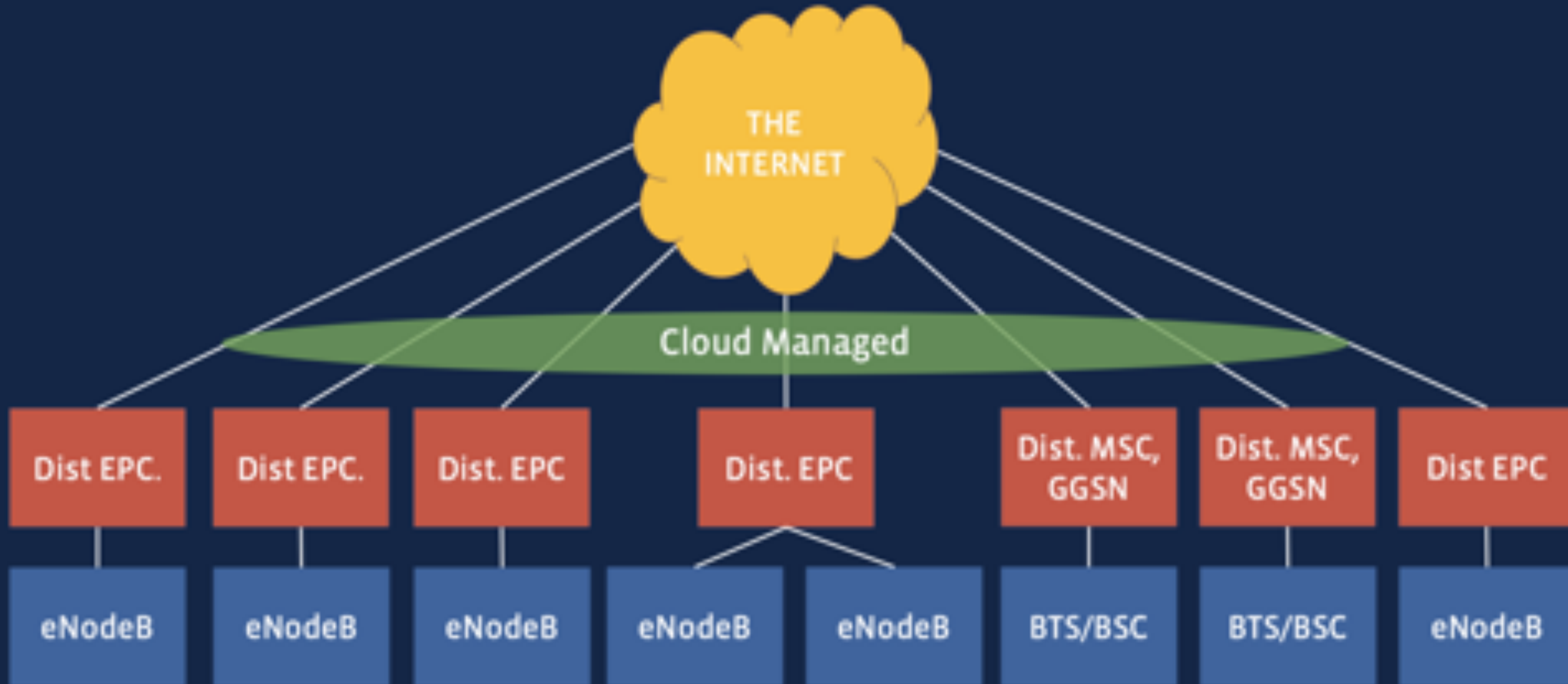


Software release and fault domains

Software delivery: Too big to fail



Software delivery: Fault isolation a necessity



Magma takeaway 4: Software upgrades

- Design for localized fault domains
 - Small upgrade domains for dataplane elements enabling gradual rollout
 - Control plane independent from dataplane operations.

Summary

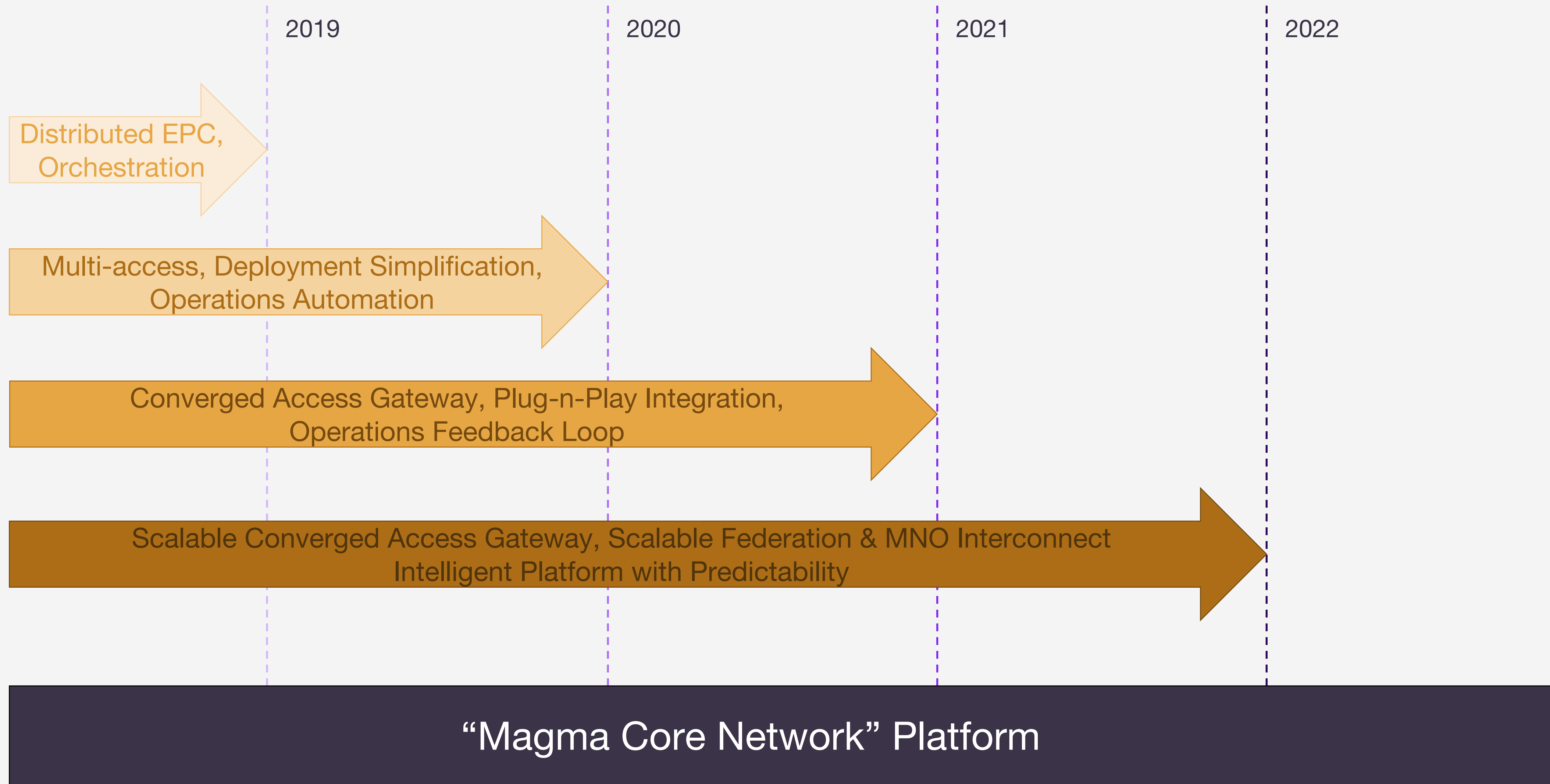
- Modularize the network into a policy rich edge in software and simple fabric to allow for network flexibility
- Encapsulate UE state and use proven techniques to distribute the state.
- Abstract away air interface specifics to the edge
- Adopt a desired state store model with a logically centralized controller
- Design for upgrades by minimizing fault domains

Hence Magma!

To Sum Up ...

How will Magma add Value to the Industry?

Redefine EPC into an open, distributed and intelligent “Core Network Platform” usable by any wireless access networks



Magma Project by the Numbers

6 months old, 294 stars, 71 forks (42 external to Facebook), 49 contributors (8 external)

1,585

Commits to-date

Top 3 Committers:

Jacky Tian

Marie Bremner

Scott Smith

887


Clones in last 14 days

369 Unique Cloners

5,596

Views in last 14 days

437 Unique Visitors

An aerial photograph of a city, likely in Africa, showing a multi-lane highway with a central green median. The city is built on a hillside, with numerous buildings and a prominent communication tower on the peak. The sky is overcast with grey clouds.

facebook
connectivity



Thank You

Follow Up Links:

<https://github.com/facebookincubator/magma>