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

Source: ITU, Internet Inclusivity Index 2019, Economist Intelligence Unit
The Internet Has Become A Crucial Tool For Improving Livelihoods

- Learn job related skills: 77%
- Discover new job opportunities: 74%
- Pursue an education: 60%

Source: Internet Inclusivity Index 2019, The Economist Intelligence Unit.
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

Source: GSMA Intelligence, 2019
Why Facebook And Connectivity?

Our Business Depends On Good Connectivity
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

FBC Projects / FB OS Projects
Non-FB OS Projects
Startups
Stack Vendors
Cloud Service Providers
Hardware Vendors

Network Orchestration
Network Federation
Core Convergence

OEM Integration
System Integration
Partner Engineering
Deployments
Managed Services
OS Community
Industry Influencers

END CUSTOMERS
MNOS
ISPS
MNOS
NAAS PROVIDERS / RMIOS
OTHER OPERATORS
ENTERPRISES
Magma End Game
Vision 2020 and beyond …

“The unified packet core supporting any wireless access networks”

Software Components
- FBC, FB / non-FB open source projects, e.g., NMS, OAI, PyTorch, etc.
- Startup and vendor licensed components, e.g., Qosmos, Quortos, etc.

Deployment Infrastructure
- Cloud and on-premise infra, e.g., AWS, Docker, OpenStack, K8s, etc.
- OS and data plane infra, e.g., Linux, OVS, KVM, VMware, etc.

Intelligent Platform

Federation Gateway

Converged Access Gateway

MBB Expansion (4G/LTE, 5G)
Massive and Industrial IoT
Network-as-a-Service
Fixed Wireless Access
Private LTE / CBRS
Carrier Wi-Fi

“Magma Core Network” Platform
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 abstractions

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

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

- 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

THE INTERNET

Cloud Managed

Dist. EPC. - eNodeB
Dist. EPC. - eNodeB
Dist. EPC - eNodeB
Dist. EPC - eNodeB
Dist. EPC. - eNodeB
Dist. MSC, GGSN - BTS/BSC
Dist. MSC, GGSN - BTS/BSC
Dist. EPC - eNodeB
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 ...
Redeﬁne EPC into an open, distributed and intelligent “Core Network Platform” usable by any wireless access networks

How will Magma add Value to the Industry?

2019

Distributed EPC, Orchestration

2020

Multi-access, Deployment Simpliﬁcation, Operations Automation

Converged Access Gateway, Plug-n-Play Integration, Operations Feedback Loop

2021

Scalable Converged Access Gateway, Scalable Federation & MNO Interconnect

“Magma Core Network” Platform
Magma Project by the Numbers

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

Commits to-date: 1,585
Top 3 Committers:
- Jacky Tian
- Marie Bremner
- Scott Smith

Clones in last 14 days: 887
- 369 Unique Cloners

Views in last 14 days: 5,596
- 437 Unique Visitors
Thank You

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https://github.com/facebookincubator/magma