A systems approach to access networks

Project Magma

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Global Access is **Improving**

55% Households Connected

4G Penetration Is **increasing**

33% to 60% Global 4G Coverage by 2022

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

- **Effective job search**: 74%
- **Develop relevant skills**: 77%
- **Pursue an education**: 60%

Source: Internet inclusivity Index 2019, The Economist Intelligence Unit.
Network Performance Is Declining

3.3B people will experience poor network performance by 2023

Source: Facebook Connectivity Internal Research 2019
Why Facebook and Connectivity?

Our business depends on great connectivity

Bringing more people online to a faster internet
The problem of connecting the next billion to a faster internet is a problem of heterogeneity.
SDN Abstractions: A connectivity OS

Controller

Common policy API up

eNodeB/WiFi AP

Legacy 3GPP in

Access Gateway

User IP traffic out

THE INTERNET
IP Access @ The Edge

- Access interface heterogeneity abstracted at the edge
- Any IP Access and Backhaul network
- Maintain SLAs even with local breakout with uniform policy APIs
Scaling & Software delivery

Architected for scale out and upgrades
- Simple to add and remove nodes
- Separate upgrade tiers for test and production networks with incremental rollouts

EPC components are too large to fail

Distribution to constrain fault
API First: From Devices to Networks

**Decouple** business logic from network controller over standard REST APIs

**Cloud-based** network config and management (off critical path)

**Introspectable** devices with separate channels for config, events and statistics
Magma Solution Overview

Magma Platform offering has three distinct components

1. Orchestrator
2. Federation Gateway
3. Access Gateway
Provides flexibility to breakout traffic at edge of network with full EPC treatment

Enables rapid trial and adoption of licensed and shared spectrum with a viable business model

Exposes standardized KPIs from the edge network for automation and operation

Supports subscriber level services including auth, policy charging in the cloud

Protects existing business and accelerates deployment of new networks
Distributed Mobile Core with Federation

- **Orchestrator**: Provides flexibility to breakout traffic at the edge of the network with full EPC treatment.
- **Magma Federation Gateway**: Enables rapid trial and adoption of licensed and shared spectrum with a viable business model.
- **Magma Access Gateway**: Exposes standardized KPIs from the edge network for automation and operation.
- **Local Breakout**: Allows for federation into existing mobile networks by supporting 3GPP Interfaces.
- **IP Edge**: Protects existing business and accelerates deployment of new networks.

**Public/Private Cloud**

- **REST API**
- **HTTP/2**

**Operator Core**

- **HSS**
- **PCRF**
- **OCS**
- **Gx**
- **Gy**
- **S6a**

**NOC Dashboard**

**Distributed Mobile Core with Federation**
Thank you!

- [https://github.com/facebookincubator/magma](https://github.com/facebookincubator/magma) : GitHub link

- [magma-dev@googlegroups.com](mailto:magma-dev@googlegroups.com) : For more information on Magma

- [magma-announce@googlegroups.com](mailto:magma-announce@googlegroups.com) : Join our mailing list to receive updates and announcements

- [https://connectivity.fb.com/magma](https://connectivity.fb.com/magma) : For a broader perspective on how Magma fits into Facebook’s other connectivity programs

Looking for collaborators!! And we are HIRING!!!
Backup
• Support for UE state transition from Connected to Idle and back to Connected
• Service Request
• Periodic Tracking Area Update w/o Active Flag and with Active Flag
• MME UE Context - Key Management
• Move allocation of MME_UE_S1AP_ID from NAS to MME_APP module
• Handling of S1AP: Initial UE message when it comes with S-TMSI
• Handling the UE Context Release Request with Cause User Inactivity
• UE Context Release Request Procedure- Enhancements, cleanup and fixes
• Support for Mobile Reachability Timer and Implicit Detach timer
• Support for Implicit Detach
• EPC Statistics – New Stats
• S1AP UE context release implicitly
• ERROR IND - Graceful handling
• UE Context Release Procedure Guard Timer in S1AP
• T3450 timer expiry - Retx of Attach Accept
• T3460 Timer expiry - Retx of SMC and AUTH request whichever is applicable
• Fix for MME segmentation fault during repeated UE Attach/Detach using GUTI
• Removal of assert in the code for any incoming S1AP initiating message that is not handled currently
• DL and UL AMBR in Initial context setup Request – Align it with APN-AMBR value sent in NAS message
• Local clean up and UE context release procedure after sending Reject message to UE NAS.
• UE IP address allocation Failure : Attach + PDN Connectivity Reject
• UE not known in HSS/Subscriber : Attach Reject - Session Cleanup
• MME Crash during encoding of Attach Reject + PDN Connectivity Reject encoding
• PDN Connectivity Request - Optional IE Device Properties - Decode Failure (LTE UE Samsung Galaxy S7 phone
• Fix for Authentication failure with cause sync failure
• Authentication Failure: S1 Signaling release, S1, MME and NAS context release
• Handling for the scenario when IMSI is not present in HSS
• Duplicate Session/Context due to incomplete cleanup
• Fail if MTU cannot be read correctly
• Remove hash table insert from emm_ctx_set_valid_imsi
• Fix free_wrapper to actually set the underlying pointer to NULL
• Handle SCTP reset
• Clear out s11 state after session delete
• Fix for heap overflow crash
• Fix double free of emm_data args pointer
• Fix SCTP handling in MME preventing double frees
• Fix EMM integrity protection
- Enhance Detach by generating “UEContextRelease” message after Detach-Accept
- Prevent stack overwrite while accessing IMSI
- Cleanup UE-initiated detach (non-switchoff/normal) scenario
- Remove SGW check for optional “address_allocation_via_nas_signalling”
- Send UE security capability in Initial Context Setup
- Attach result message now depends on attach request type. “EPS-only” succeeds as normal, with EPS-only attach. Combined EPS/IMSI succeeds with EPS-only attach and an EMM cause IE.
- IPv4 Allocation mechanism defaults to via NAS signaling in the absence of UE preference in PCO
- Handling UE-initiated idle detach
- Caching UE radio capabilities data in MME to be used in subsequent Initial context setup request message to optimize radio resource usage b/w eNB and UE
- Fix for ue radio cap for not enough buffer space (UEs with inter RAT capabilities)
- Misc cleanup and fixes related to cleanup of EMM and ESM context during UE context deletion
• Stability /Robustness – 32 UEs simultaneous signaling and data
• [OAI - Enhancement] Memory Leaks
• Integration of OVS kernel module - Replacing the osmocom GTP-U kernel module with OVS kernel module
• Paging for DL data arrival for the UE in idle mode (no S1-U tunnel)
• Support for Handling of eNB Reset
• Guard Timer in NAS for auth_info_request/rsp (S6a message) procedure with HSS over S6a interface
• Add Support for sending EMM Information message just after completion of successful Attach.
• Handling of EMM status message
• Initial context setup - Timer expiry and failure
• OAI Feature: Detach (Network initiated)
• CSFB
• PCEF – Policy and Charging
• Multiple eNB – Fixes and Enhancements
• X2 HO
• VoLTE – Ongoing
• SCTP shutdown and abort handling
Magma in Production

Daily production build qualification against extensive acceptance plans

20+ Production Trials (including Tier1 operators)

Open Source development model for wider adoption from the ecosystem