



Agenda

January 10, 2022

- 5G, the Major Opportunity Today and Tomorrow
- Magma Mission and Overview
- Magma Architecture
- Magma 5G SA supported features
- How we test Magma 5G SA & Demo
- Q&A



Magma for 5G From Jan.'22 DTF



Agenda

January 10, 2022

- Features Under Development
- Magma and LFN
- 3GPP Standardization and Requirements
- TIP Private 5G Scenarios
- Magma Compliance to TIP FWA Requirements
- Requirement Validation for Network Slicing & Security Enhancements (Backup)
- Q&A



AI-First Technology Company for the Digital, Cognitive & Industry 4.0 Era



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Magma for 5G

Understanding ongoing (existing) feature development and testing

LFN Developer and Testing Forum
15 June 2022

<https://www.magmacore.org/>
<https://github.com/magma/magma>


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Agenda

June 15, 2022

- Recap: Magma Mission, Overview & Architecture
- Magma 5G SA in Release 1.7
- Magma 5G SA in upcoming Release 1.8
- Magma 5G SA after Release 1.8
- Q&A

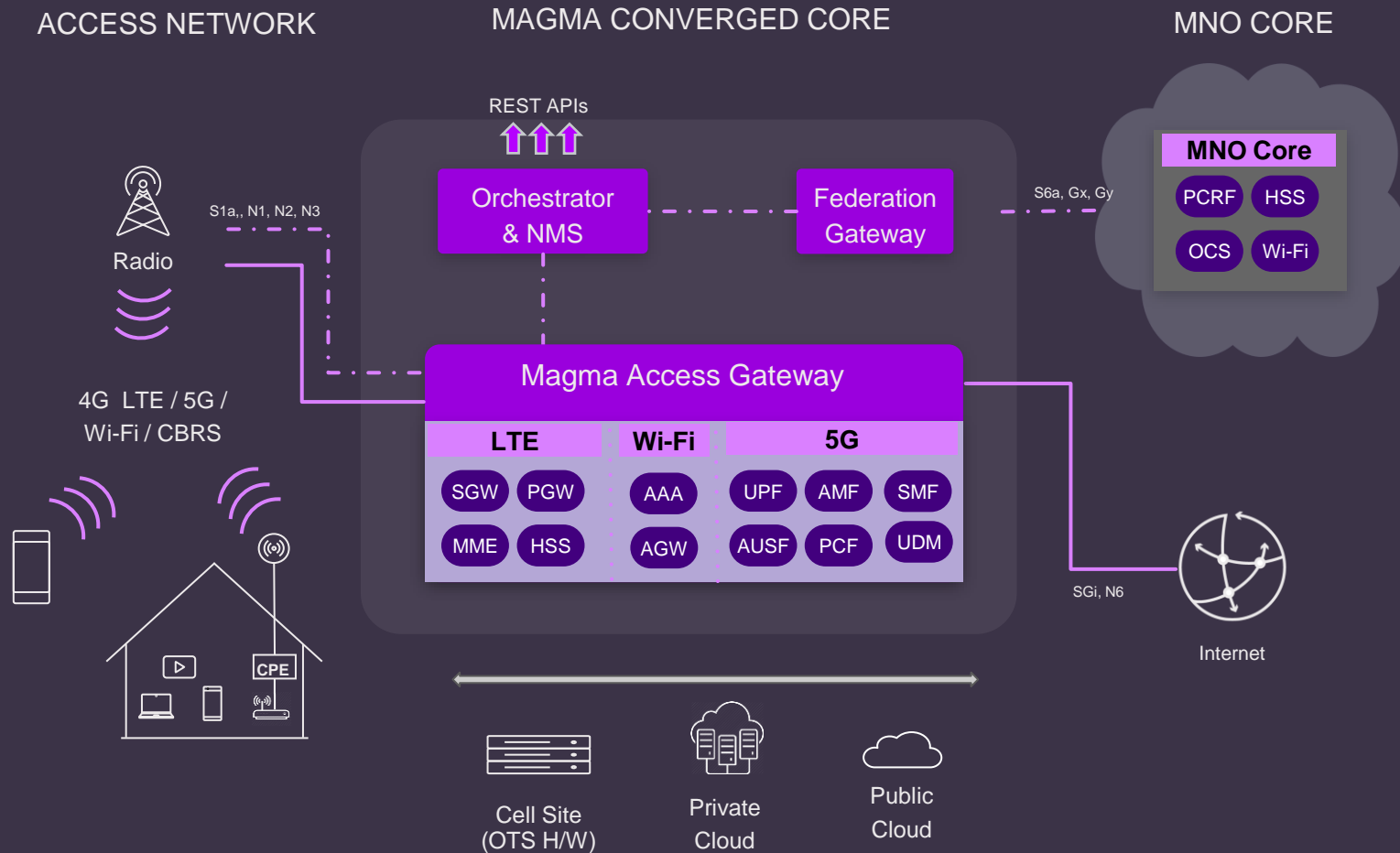
Connect the world to a faster network by enabling service providers to build cost-effective, extensible, and carrier-grade networks.

MAGMA OVERVIEW

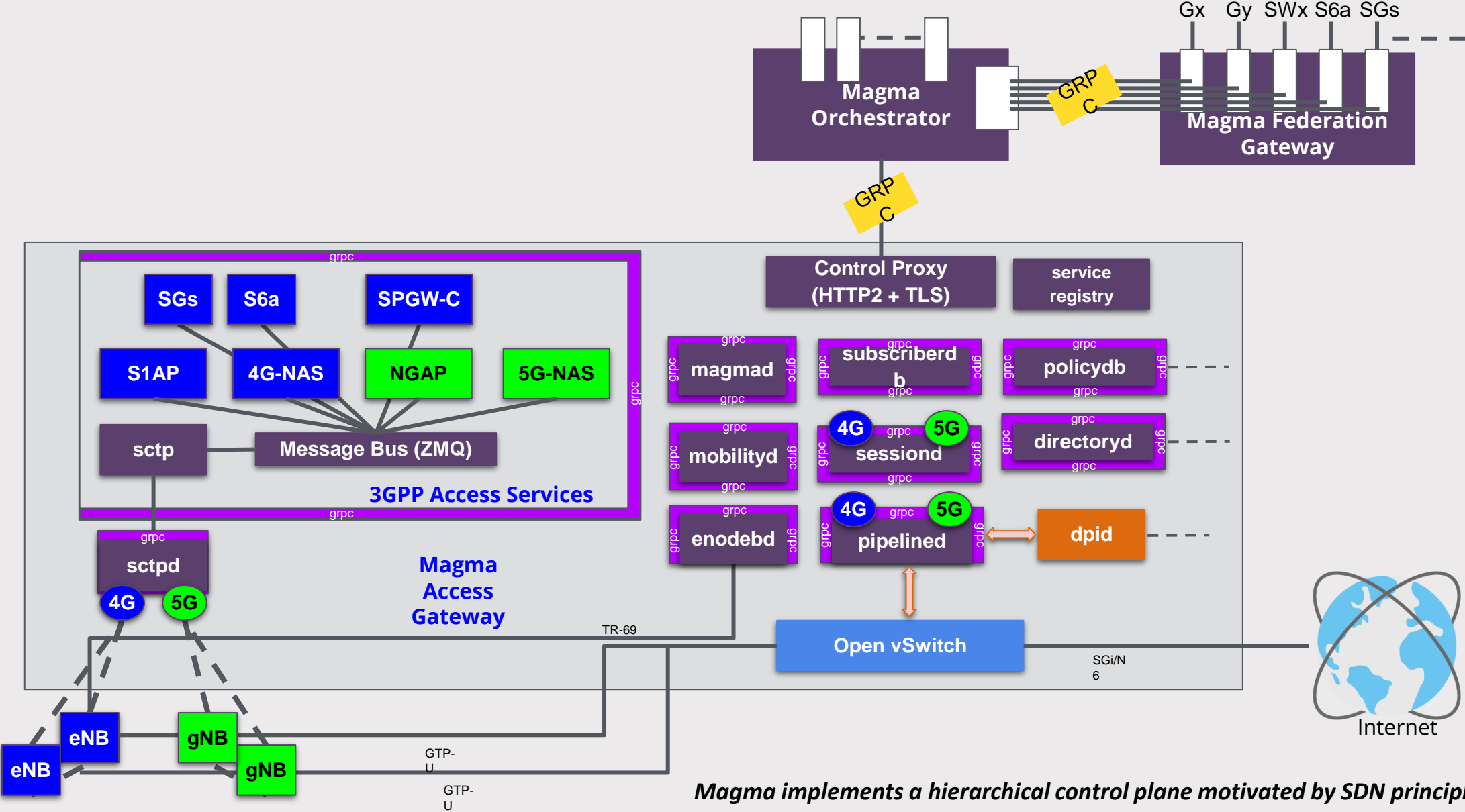
Magma enables network operators to offer an **open, flexible** and **scalable** FWA and Private Wireless Network solution

Highlights

- **Open source** packet core and **free** to use
- 3GPP generation (4G or 5G) & access **network agnostic** (cellular or Wi-Fi)
- Distributed and EDGE ready, local breakout for internet traffic
- **Cloud Managed** - Orchestrator can be deployed on a public/private cloud
- **Vendor agnostic** - works with standardized RAN H/W
- **Scales horizontally**
- Exposes REST APIs to **integrate** with 3rd-party OSS/BSS



UNDERSTANDING MAGMA ARCHITECTURE



Magma implements a hierarchical control plane motivated by SDN principles

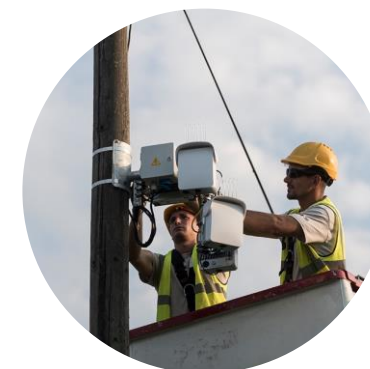
MAGMA 5G SA IN RELEASE 1.7

Procedures / Features Available today

- (1) Registration
- (2) 5g specific Authentication
- (3) PDU Session Establishment
- (4) Idle mode and Paging
- (5) Service Request
- (6) UE initiated Session Release
- (7) UE initiated De-registration
- (8) Usage reporting & Charging



FWA



Private Wireless

MAGMA 5G SA IN RELEASE 1.7

Release/Source Code/Test Reports/Documentations/Support Channel

(1) Release Page: <https://github.com/magma/magma/releases/tag/v1.7.0>

(2) Source Code: <https://github.com/magma/magma/archive/refs/tags/v1.7.0.tar.gz>

(3) Image Version: - 1.7.0-1648152173-73e61141b

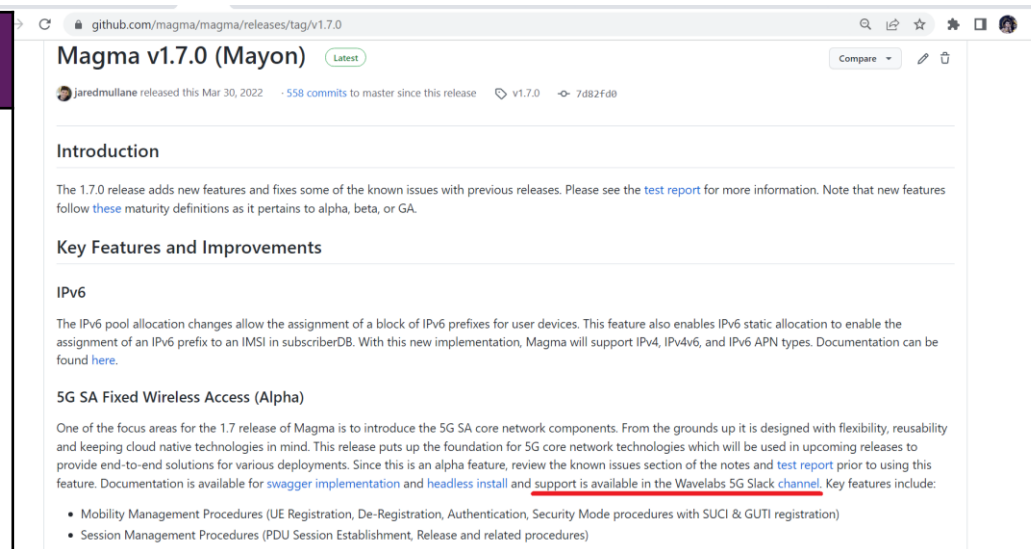
(4) AGW Headless Install

configs: <https://gist.github.com/shanku9/60a37bf6ce892f9cd90a093009af1f3b>

(5) 5G SA Test/Validation Reports:

<https://docs.google.com/document/d/1ZESAclqI7uBG9WxzSMJMSIKv7Usfxb1z/edi?tusp=sharing&oid=112274860638393563688&rtpof=true&sd=true>

(6) 5G SA Documentation: https://docs.magmacore.org/docs/lte/integrated_5g_sa



Magma v1.7.0 (Mayon) Latest

jaredmullane released this Mar 30, 2022 · 558 commits to master since this release · v1.7.0 · 7082f00

Introduction

The 1.7.0 release adds new features and fixes some of the known issues with previous releases. Please see the [test report](#) for more information. Note that new features follow [these](#) maturity definitions as it pertains to alpha, beta, or GA.

Key Features and Improvements

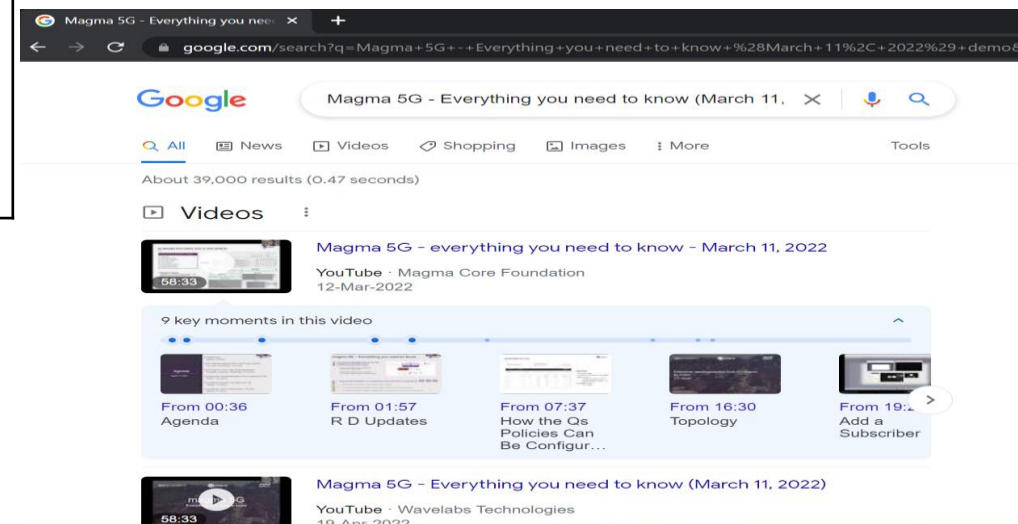
IPv6

The IPv6 pool allocation changes allow the assignment of a block of IPv6 prefixes for user devices. This feature also enables IPv6 static allocation to enable the assignment of an IPv6 prefix to an IMSI in subscriberDB. With this new implementation, Magma will support IPv4, IPv4v6, and IPv6 APN types. Documentation can be found [here](#).

5G SA Fixed Wireless Access (Alpha)

One of the focus areas for the 1.7 release of Magma is to introduce the 5G SA core network components. From the grounds up it is designed with flexibility, reusability and keeping cloud native technologies in mind. This release puts up the foundation for 5G core network technologies which will be used in upcoming releases to provide end-to-end solutions for various deployments. Since this is an alpha feature, review the known issues section of the notes and [test report](#) prior to using this feature. Documentation is available for [swagger implementation](#) and [headless install](#) and [support is available in the Wavelabs 5G Slack channel](#). Key features include:

- Mobility Management Procedures (UE Registration, De-Registration, Authentication, Security Mode procedures with SUCI & GUTI registration)
- Session Management Procedures (PDU Session Establishment, Release and related procedures)

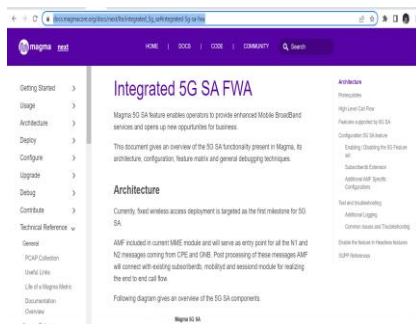


Google search results for "Magma 5G - Everything you need to know (March 11, 2022)".

About 39,000 results (0.47 seconds)

Videos

- Magma 5G - everything you need to know - March 11, 2022**
YouTube · Magma Core Foundation
12-Mar-2022
- 9 key moments in this video
 - From 00:36 Agenda
 - From 01:57 R D Updates
 - From 07:37 How the QoS Policies Can Be Configur...
 - From 16:30 Topology
 - From 19:20 Add a Subscriber
- Magma 5G - Everything you need to know (March 11, 2022)**
YouTube · Wavelabs Technologies
19-Apr-2022



Magma Core Foundation website page: Integrated 5G SA FWA

Integrated 5G SA FWA

Magma 5G SA feature enables operators to provide enhanced Mobile BroadBand services and opens up new opportunities for business.

This document gives an overview of the 5G SA functionality present in Magma, its architecture, configuration, feature matrix and general debugging techniques.

Architecture

Currently, fixed wireless access deployment is targeted as the first milestone for 5G SA.

AMF included in current SBC module and will serve as an entry point for all the N1 and N2 messages coming from CPE and O-RAN. Post processing of these messages AMF will connect with existing subscriberDB, mobility and session module for handling the end-to-end call flow.

Following diagram gives an overview of the 5G SA components.

THE DEMO

Magma 5G SA Real Equipment
(Baicells gNB + Huawei Mate30 Demo)

YouTube Link:

https://www.youtube.com/watch?v=YNrXf0dVRi0&list=PLJbCWXM7NAtkb_nEAO7Db2CupE7E8PKfl&index=6&t=3s



5G MAGMA 5G SA IN RELEASE 1.8

Procedures / Features Targeted for 1.8 GA by end of June 2022

(9) 5G QOS

(10) Feature Parity with 4G (Stateless feature)

(11) Network initiated Session modification

(12) SUCI Extensions

(13) IPV6 & Dual IPv4/v6 Support

(14) GTP extension header support with QFI

(15) Remove Gateway Access to Orc8r-Internal Endpoints

(16) Support for NG Reset full and partial



FWA



Private Wireless

(10) FEATURE PARITY WITH 4G (STATELESS FEATURE)

OVERVIEW of STATELESS FEATURE SUPPORT IN AMF

- The stateless feature allows decoupling of state data and state functions. This is achieved by syncing(storing) **amf_nas_state** (state_cache) and **amf_ue_state** (ue_context) with Redis DB.
- The amf_nas_state sync is controlled by is_task_state_same flag. If is_task_state_same flag is false, it is synced. The amf_ue_state is synced if UE is in REGISTERED_CONNECTED state, or if force_ue_write flag is set to True.

REDIS DB ENTRIES for UE CONTEXT

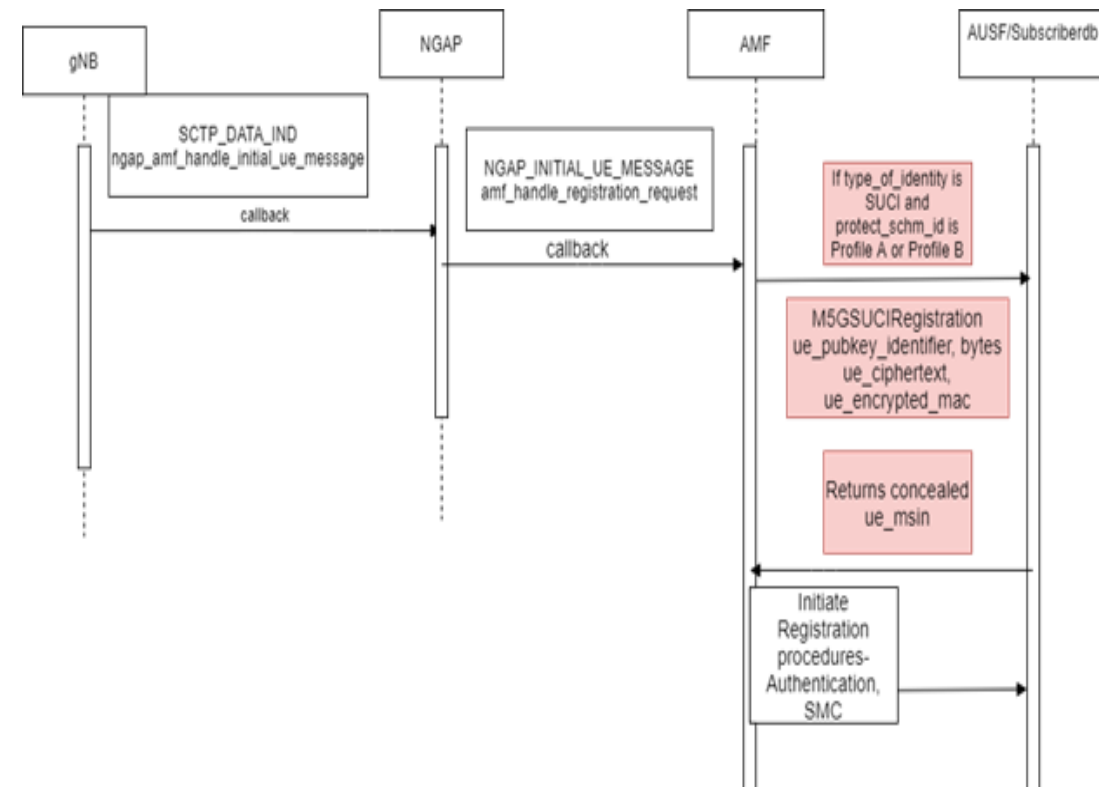
```
vagrant@magma-dev-focal:~/magma/lte/gateway$ redis-cli -p 6380
127.0.0.1:6380> keys *
 1) "NO_VLAN_0:mobilityd_gw_info"
 2) "spgw_state"
 3) "sessiond:sessions"
 4) "IMSI901700000000001:AMF"
 5) "pipelined:enforcement_stats_info"
 6) "slap_state"
 7) "ngap_imsi_map"
 8) "mobilityd:ip_states:IPState.RESERVED"
 9) "IMSI901700000000001:NGAP"
10) "mobilityd:ip_states:IPState.ALLOCATED"
11) "IMSI901700000000001.internet,ipv4:mobilityd_ipdesc_record"
12) "mobilityd:ip_states:IPState.FREE"
13) "ngap_state"
14) "mme_nas_state"
15) "slap_imsi_map"
16) "mobilityd:assigned_ip_blocks"
17) "NO_VLAN_1:mobilityd_gw_info"
18) "amf_nas_state"
127.0.0.1:6380> █
```

(12) SUBSCRIPTION CONCEAL IDENTIFIER SUPPORT (1 of 2)

SUCI FEATURE SUPPORT

- Encrypting Subscriber's Identity before sending it in any registration request
- Difficult to derive identity of subscribers by sniffers, IMSI-Catchers
- MSIN part of IMSI get concealed by ECIES based protection scheme
- Two protection scheme defined Profile A, Profile B

SUCI CALL FLOW IN AGW



(12) SUBSCRIPTION CONCELEAD IDENTIFIER SUPPORT (2 of 2)

MOBILE IDENTITY WITH SUCI PROFILE-B ENCRYPTION

PDN type | Info

NGSetupResponse

InitialUEMessage, Registration request

DownlinkNASTransport, Authentication request

UplinkNASTransport, Authentication response

DownlinkNASTransport, Security mode command

UplinkNASTransport, Security mode complete

>

Routing indicator: 0

.... 0010 = Protection scheme Id: ECIES scheme profile B (2)

Home network public key identifier: 2

▼ Scheme output: 03f83a94b565d324578a4f88836c90e843977aeaf83853f87fd521f6eb438b0c25f14080...

ECC ephemeral public key: 03f83a94b565d324578a4f88836c90e843977aeaf83853f87fd521f6eb438b0c25

Ciphertext: f14080c5fa

MAC tag: 0x089ce276818d377f

(14) GTP EXTENSION HEADER SUPPORT PROCESSING WITH QFI (1 of 1)

PACKET PROCESSING IN OVS KERNEL MODULE

- QFI value is set, in match (for uplink) and actions(for downlink) in OVS table for GTP.
- gtpu_ext_hdr and gtpu_ext_hdr_pdu_sc processing in OVS kernel module
- Uplink (GTP) traffic with qfi will be matched while entering the AGW (using table 0)
- Downlink (GTP header) will have the QFI value which is set in the packet going towards UE

FASTPATH Entries

```
sudo ovs-ofctl -O OpenFlow13 dump-flows gtp_br0 table=0
```

```
cookie=0x0, duration=108.530s, table=0,
n_packets=200, n_bytes=18400, reset_counts
priority=65503,tun_id=0x7fffffff,qfi=6,in_port=g-
tp0 actions=set_field:02:00:00:00:00:01-
>eth_src,set_field:ff:ff:ff:ff:ff:ff-
>eth_dst,load:0->NXM_NX_REG9[],load:0x181c9-
>OXM_OF_METADATA[],resubmit(,1)
```

```
cookie=0x0, duration=10.742s, table=0,
n_packets=0, n_bytes=0, reset_counts
priority=65503,ip,in_port=LOCAL,nw_dst=192.168.1
28.11 actions=load:0x2710-
>NXM_NX_TUN_ID[],load:0xc0a83c10-
>NXM_NX_TUN_IPV4_DST[],load:0x8000-
>NXM_NX_REG8[],load:0x1-
>NXM_NX_TUN_FLAGS[],load:0x6-
>NXM_NX_QFI[],load:0x181c9-
>OXM_OF_METADATA[],resubmit(,1)
```

(14) GTP EXTENSION HEADER SUPPORT PROCESSING WITH QFI (2 of 2)

QFI PROCESSING IN EXTENSION HEADER OF GTP (UPLINK AND DOWNLINK)

```

22 2022-04-07 01:10:40.898556 192.168.128.11 192.168.129.17 GTP <UDP>
23 2022-04-07 01:10:43.932507 192.168.128.1 192.168.128.11 GTP <ICMP>
24 2022-04-07 01:10:43.932563 192.168.60.16 192.168.60.51 ICMP
  
```

```

23 2022-04-07 01:10:43.932507 192.168.128.1 192.168.128.11 GTP <ICMP>
24 2022-04-07 01:10:43.932563 192.168.60.16 192.168.60.51 ICMP
  
```

· GPRS Tunneling Protocol

› Flags: 0x34

Message Type: T-PDU (0xff)

Length: 100

TEID: 0x7fffffff (2147483647)

Next extension header type: PDU Session container (0x85)

▼ Extension header (PDU Session container)

Extension Header Length: 1

▼ PDU Session Container

0001 = PDU Type: UL PDU SESSION INFORMATION (1)

.... 0000 = Spare: 0x0

00.. = Spare: 0x0

..00 0110 = QoS Flow Identifier (QFI): 6

Next extension header type: No more extension headers (0x00)

· GPRS Tunneling Protocol

› Flags: 0x34

Message Type: T-PDU (0xff)

Length: 128

TEID: 0x00002710 (10000)

Next extension header type: PDU Session container (0x85)

▼ Extension header (PDU Session container)

Extension Header Length: 1

▼ PDU Session Container

0000 = PDU Type: DL PDU SESSION INFORMATION (0)

.... 0000 = Spare: 0x0

0... = Paging Policy Presence (PPP): Not Present

.0.. = Reflective QoS Indicator (RQI): Not Present

..00 0110 = QoS Flow Identifier (QFI): 6

(16) SUPPORT FOR NG RESET FULL AND PARTIAL

OVERVIEW OF NG-RESET FEATURE

- NG Reset procedure is to initialise or re-initialise the RAN, or part of RAN NGAP UE-relate contexts, in the event of a failure in the 5GC or vice versa
- Cleans up the related ue context (or all based on options from GNB)
- In AGW the message is read by NGAP and the related cleanups are done in NGAP and AMF tasks respectively

REDIS DB ENTRIES for UE CONTEXT

SA_TC56a_Verify_NgAP_Reset_flow_N2_N1_Multiple_Connection_Global_220320_221249-1.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help



ngap

No.	Time	Source	Destination	Protocol	Length	Info
73	1.527577	10.22.120.81	10.22.120.144	NGAP	82	NGReset
74	1.536693	10.22.120.144	10.22.120.81	NGAP	86	NGResetAcknowledge

> Frame 73: 82 bytes on wire (656 bits), 82 bytes captured (656 bits) on interface ens192, id 1
 > Ethernet II, Src: VMware_6b:33:65 (00:0c:29:6b:33:65), Dst: VMware_7c:76:a8 (00:0c:29:7c:76:a8)
 > Internet Protocol Version 4, Src: 10.22.120.81, Dst: 10.22.120.144
 > Stream Control Transmission Protocol, Src Port: 38412 (38412), Dst Port: 38412 (38412)
 > NG Application Protocol (NGReset)

MAGMA 5G SA IN RELEASE 1.8 (Ongoing)

Release/Source Code/Documentations/Support Channel

- (1) 5G SA Documentation: https://docs.magmacore.org/docs/next/lte/integrated_5g_sa#integrated-5g-sa-fwa
- (2) Release 1.8 feature related information : <https://wiki.magmacore.org/display/HOME/Release+Features>
- (3) Release 1.8 Meeting : <https://wiki.magmacore.org/display/HOME/1.8+Release+Meeting+Notes>
- (4) [Join us in the Magma Slack for more collaborations](#)

UNDERSTANDING MAGMA 5G IN THE GITHUB

Join and contribute @ <https://github.com/magma/magma/tree/master/>

Folder	Commit Message
amf	fix(amf): Authentication reject for Security mode failure (#10751)
grpc_service	fix(amf): Correct SubscriberID set as "IMSI +number" in amf (#10972)
gtpv1-u	chore(mme): add arp flow for paging event (#10448)
ha	chore(mme): update all oai/tasks to full include paths (#9870)
mme_app	feat(agw): Added handling of EPS bearer context status IE in TAU requ...
nas	fix(agw): Added code to log emm cause in string format (#11049)
nas5g	fix(amf): Support for dotted dnn encoding and decoding (#11008)
ngap	fix(amf): criticality of different IE's changed for spirent related o...
s11	feat(agw): Added handling of EPS bearer context status IE in TAU requ...
s1ap	feat(mme): Send context release command on successful handover (#10683)
s6a	chore(mme): migrate non-system includes to use of quotes (#10270)
sctp	chore(mme): update all oai/tasks to full include paths (#9870)

Folder	Commit Message
connection_tracker	fix(agw): Convert log level from mconfig correctly (#10969)
core	fix(agw): Added code to log emm cause in string format (#11049)
li_agent	fix(agw): Convert log level from mconfig correctly (#10969)
sctpd	fix(agw): update lte/gateway/c/ -core to clang-format-11 Google style (...)
session_manager	fix(agw): Convert log level from mconfig correctly (#10969)

Folder	Commit Message
app	feat(agw): EXPERIMENTAL: introduce eBPF datapath (#11010)
ebpf	feat(agw): EXPERIMENTAL: introduce eBPF datapath (#11010)
ng_manager	feat(pipelined): Adding UE IPv6 and IPv4v6 address support in pipelin...
openflow	chore: Apply formatting script to all Pipelined files (#8256)
qos	feat(agw): EXPERIMENTAL: introduce eBPF datapath (#11010)

THE DEMO

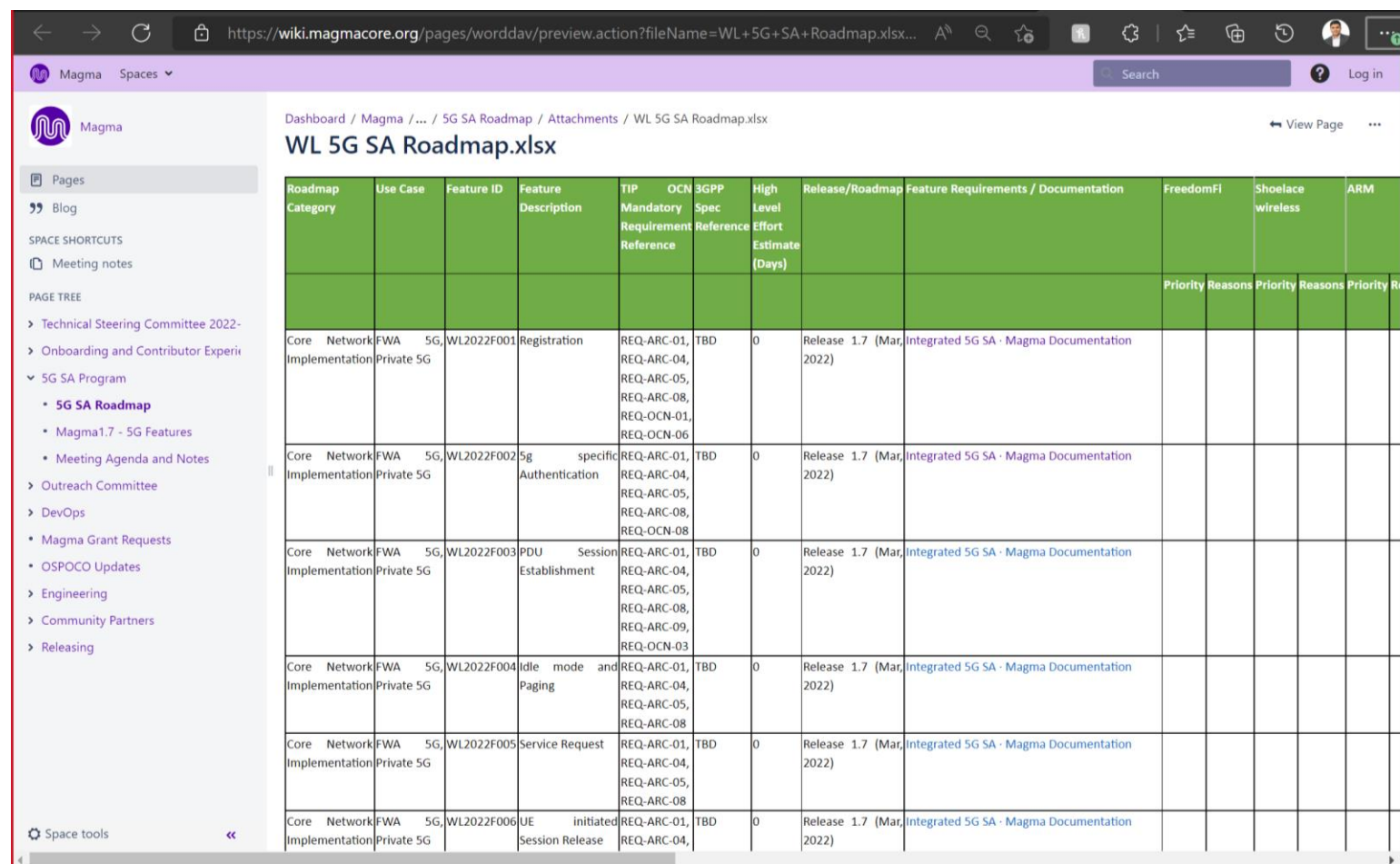
Magma 5G SA Call to demonstrate SUCI
Concealment



MAGMA 5G SA AFTER RELEASE 1.8

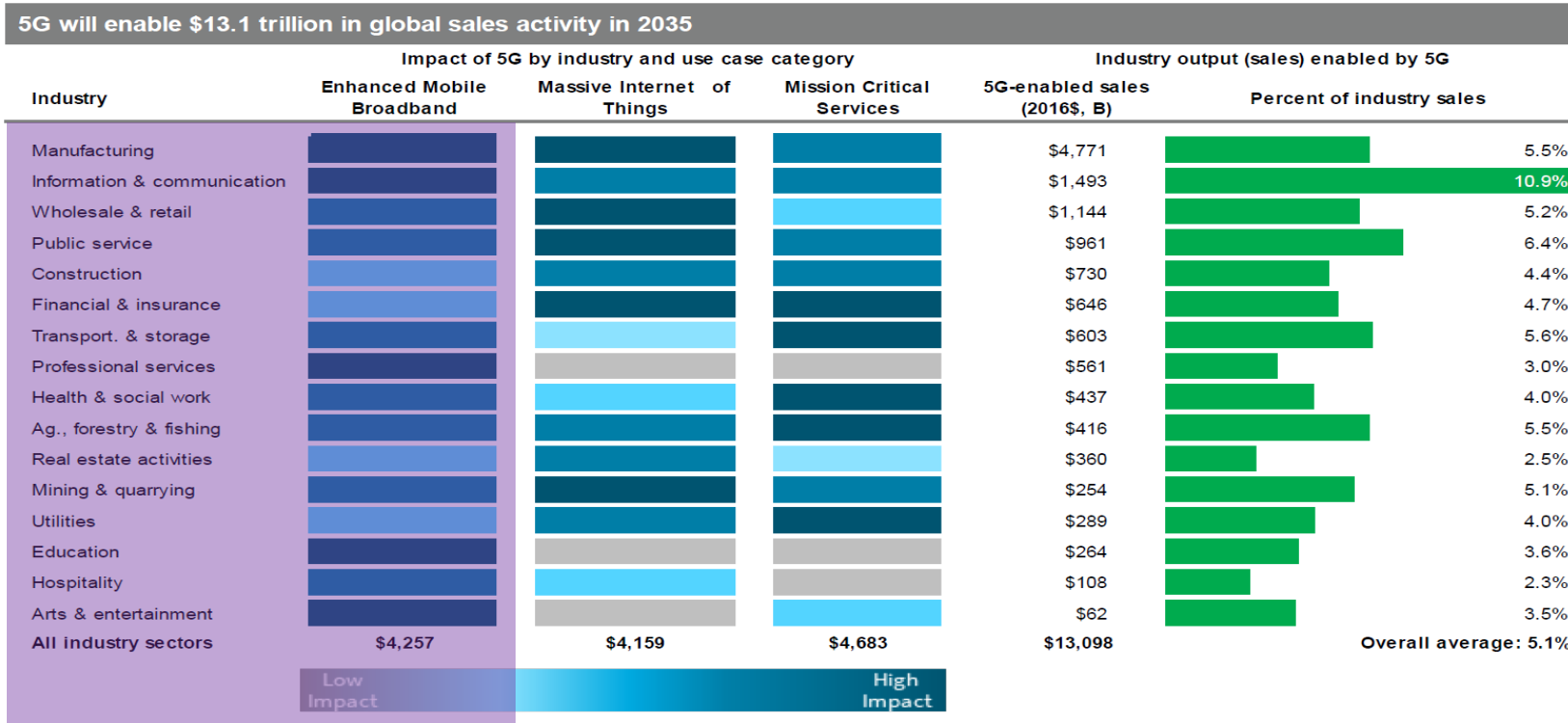
Magma 5G SA Roadmap Confluence Link:

<https://wiki.magmacore.org/pages/worddav/preview.action?fileName=WL+5G+SA+Roadmap.xlsx&pageId=12255291>



Roadmap Category	Use Case	Feature ID	Feature Description	TIP	OCN	3GPP Spec Reference	High Level Effort Estimate (Days)	Release/Roadmap	Feature Requirements / Documentation	FreedomFI	Shoelace wireless	ARM			
										Priority	Reasons	Priority	Reasons	Priority	Reasons
Core Network Implementation	FWA Private 5G	5G, WL2022F001	Registration			REQ-ARC-01, REQ-ARC-04, REQ-ARC-05, REQ-ARC-08, REQ-OCN-01, REQ-OCN-06	TBD	0	Release 1.7 (Mar, 2022)	Integrated 5G SA - Magma Documentation					
Core Network Implementation	FWA Private 5G	5G, WL2022F002	5g specific Authentication			REQ-ARC-01, REQ-ARC-04, REQ-ARC-05, REQ-ARC-08, REQ-OCN-08	TBD	0	Release 1.7 (Mar, 2022)	Integrated 5G SA - Magma Documentation					
Core Network Implementation	FWA Private 5G	5G, WL2022F003	PDU Session Establishment			REQ-ARC-01, REQ-ARC-04, REQ-ARC-05, REQ-ARC-08, REQ-ARC-09, REQ-OCN-03	TBD	0	Release 1.7 (Mar, 2022)	Integrated 5G SA - Magma Documentation					
Core Network Implementation	FWA Private 5G	5G, WL2022F004	Idle mode and Paging			REQ-ARC-01, REQ-ARC-04, REQ-ARC-05, REQ-ARC-08	TBD	0	Release 1.7 (Mar, 2022)	Integrated 5G SA - Magma Documentation					
Core Network Implementation	FWA Private 5G	5G, WL2022F005	Service Request			REQ-ARC-01, REQ-ARC-04, REQ-ARC-05, REQ-ARC-08	TBD	0	Release 1.7 (Mar, 2022)	Integrated 5G SA - Magma Documentation					
Core Network Implementation	FWA Private 5G	5G, WL2022F006	UE initiated Session Release			REQ-ARC-01, REQ-ARC-04,	TBD	0	Release 1.7 (Mar, 2022)	Integrated 5G SA - Magma Documentation					

5G TO PLAY BIG ROLE IN THE INDUSTRY 4.0 ECOSYSTEM



Source: IHS Markit

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5G PRIVATE NETWORK PROJECTS HAVE DOUBLED IN THE PAST YEAR
 (e.g.) US\$ 75 billion by 2020 from ABIresearch

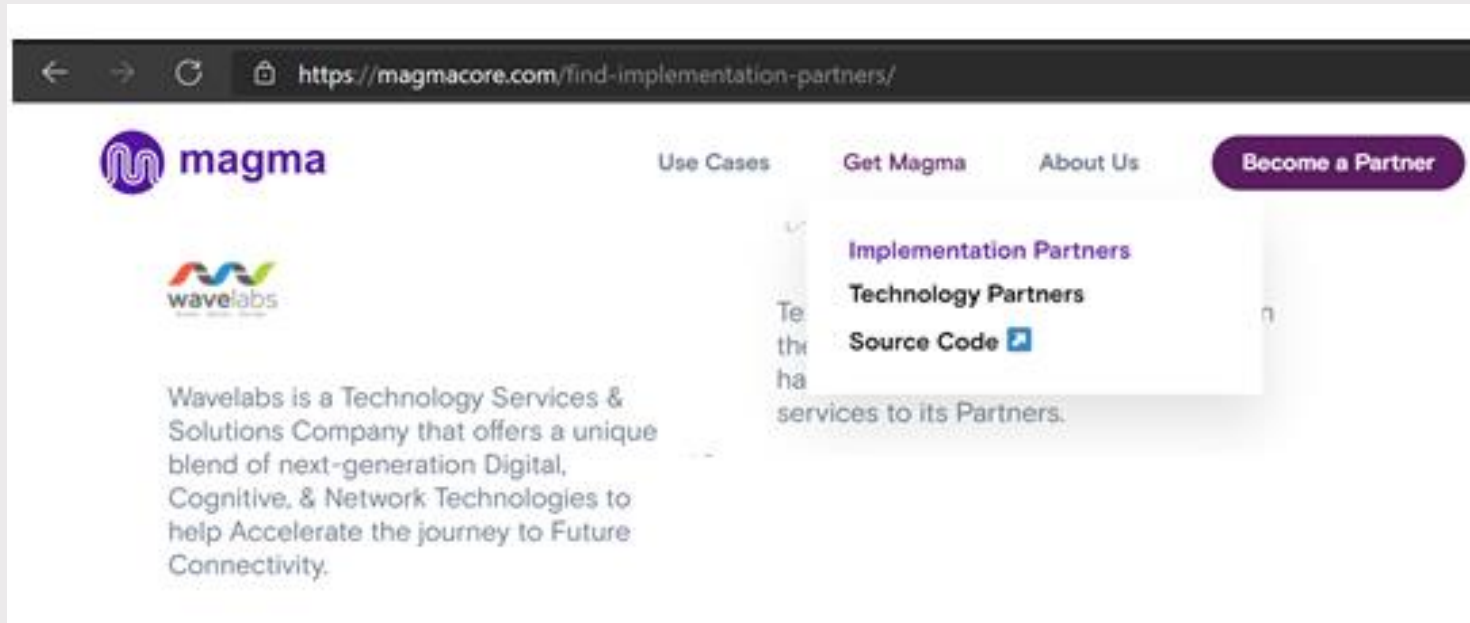
Integration Services for Private 5G Networks reach US\$5.8 billion by 2026

SYSTEMS INTEGRATION WILL SOON COST MORE THAN ACTUAL PRIVATE CELLULAR INFRASTRUCTURE

New York, New York - October 26, 2021

WAVELABS COMMITMENT TO MAGMA 5G SA OPEN SOURCE

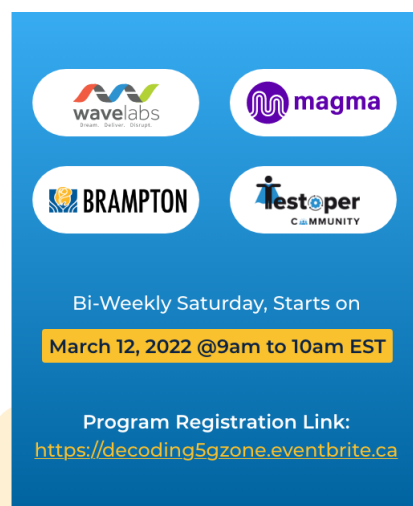
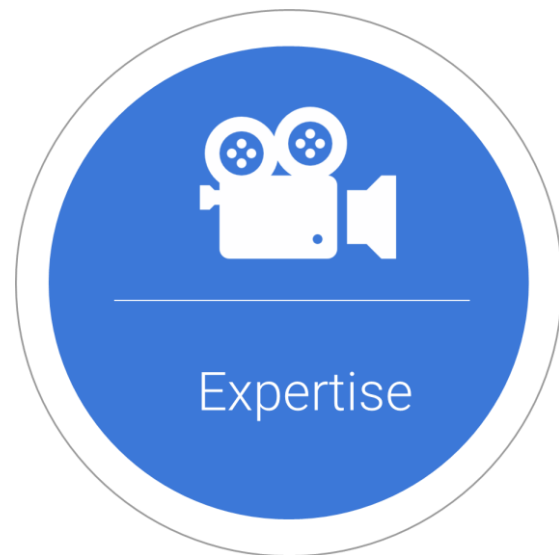
EMBRACE 'OPEN X' NETWORK VISION WITH WAVELABS



Wavelabs is an ardent proponent of 'OPEN X' network vision that enables unprecedented innovation, agility, choice, cost efficiency, and speed to market.

We help our clients to overcome challenges and realize the vision of the open and disaggregated 'White Box' connectivity products and solutions a reality.

TWO 'E'YE STRATEGY TO ENABLE ADOPTION OF MAGMA



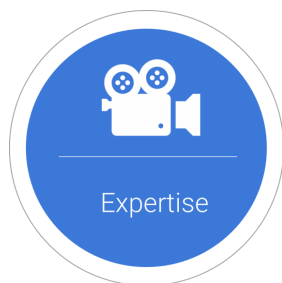
FWA 5G TEST PLAN

FWA Functional Test Plan

Subgroup Version 0.2

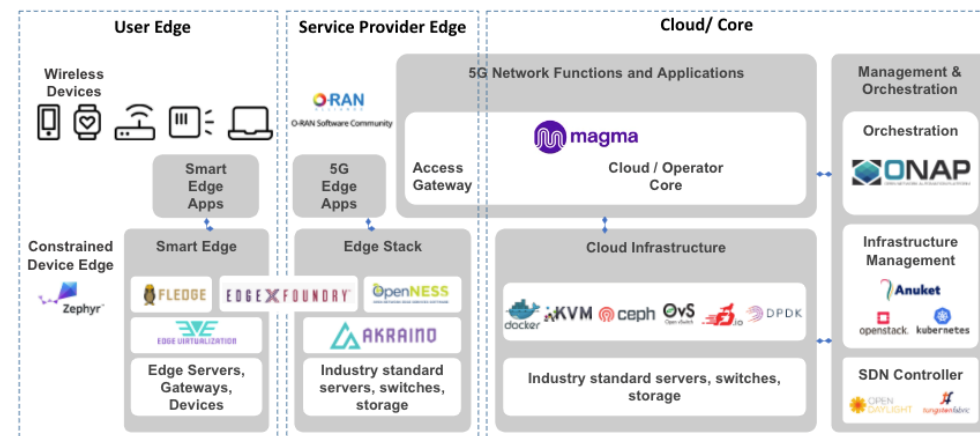
January 25, 2021

TWO 'E'YE STRATEGY TO ENABLE ADOPTION OF MAGMA

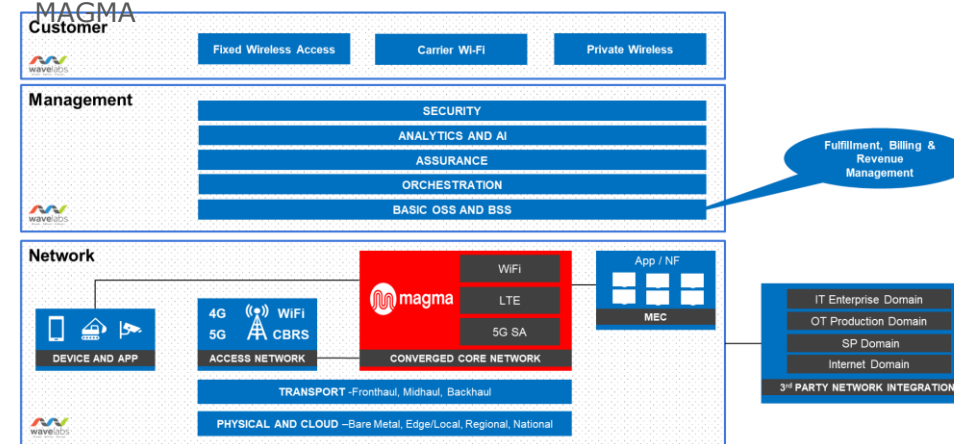


INNOVATION & RESEARCH LAB
Catalyze Innovation for the Future

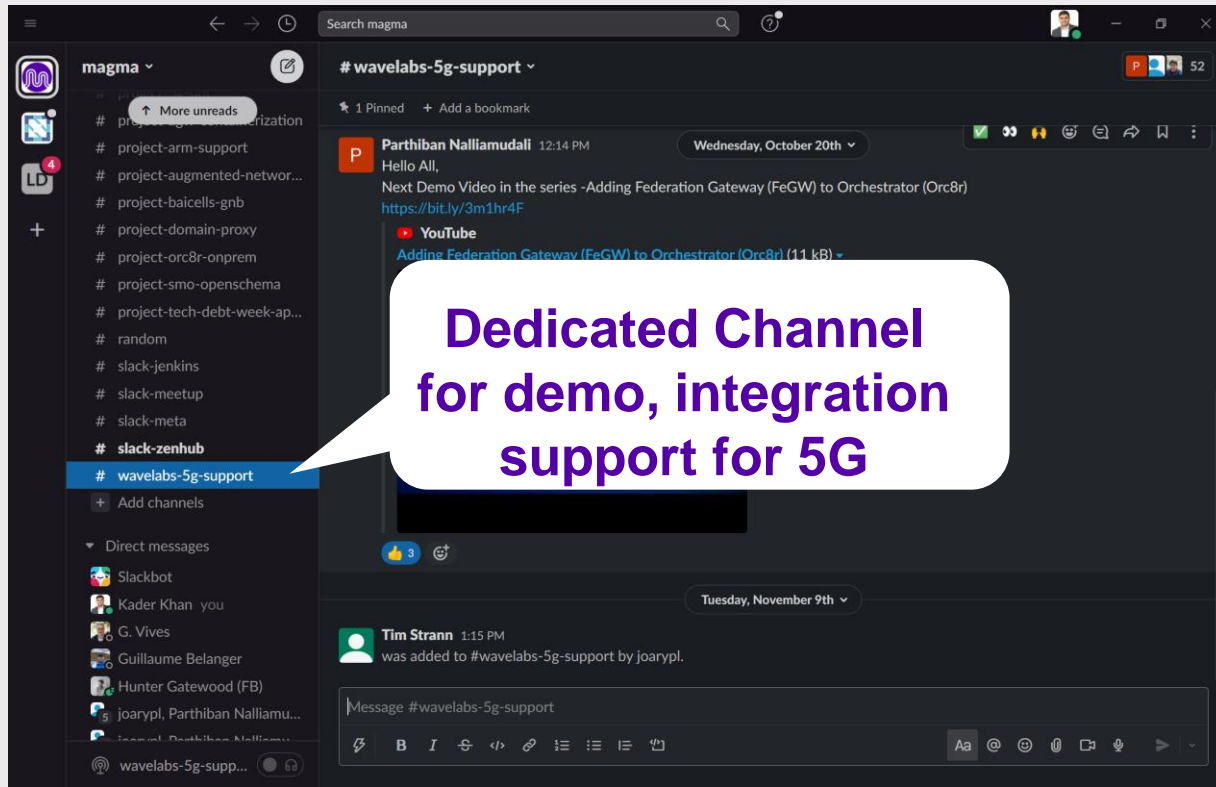
LF Open Source Component Projects for 5G



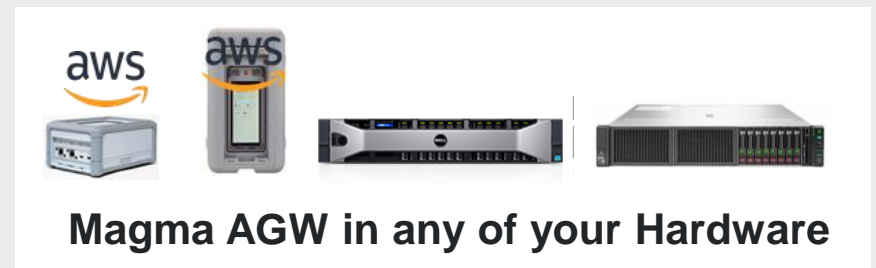
THE PARTNER ECOSYSTEM CENTER AROUND MAGMA



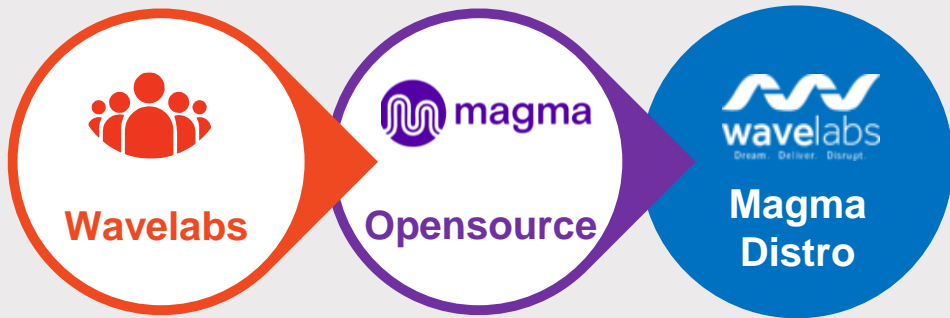
ENABLING THE ADOPTION OF MAGMA FOR 5G



Try it ! We are Ready to Support it !



ENABLING ENGAGEMENT, COLLABORATION, AND ADOPTION OF MAGMA FOR 5G



Fixed Wireless Access Private Wireless Network	Equipment Vendors (OEM, ISV, Silicon)	<ul style="list-style-type: none"> • Integrated or Joint solution • Engineering, value added and support Services
	Service Providers (Telecom, WISP, Satellite)	<ul style="list-style-type: none"> • Lab, PoC or Commercial deployments • Consulting, delivery, integration, support, value added and managed services
	Hyperscales (AWS, Azure, Google)	<ul style="list-style-type: none"> • Wavelabs Magma distro in Hyperscales Market Place • Consulting, delivery, integration, support, value added and managed services
	Enterprises (Education, Manufacturing..)	<ul style="list-style-type: none"> • Lab, PoC or Commercial deployments • Consulting, delivery, integration, support, value added and managed services
	System Integrators (E2E, RAN, Orchestration..)	<ul style="list-style-type: none"> • Integrated or Joint solution • Consulting, delivery, integration, support, value added and managed services

Q & A



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Thank You!

<https://www.magmacore.org/>
<https://github.com/magma/magma>