Magma for 5G
From Jan.'22 DTF

Magma for 5G
Understanding ongoing (existing) feature development and testing

LFN Developer and Testing Forum

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

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Digital, Cognitive & Industry 4.0 Era

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Magma for 5G
Exploring future feature development and testing

LFN Developer and Testing Forum

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

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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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

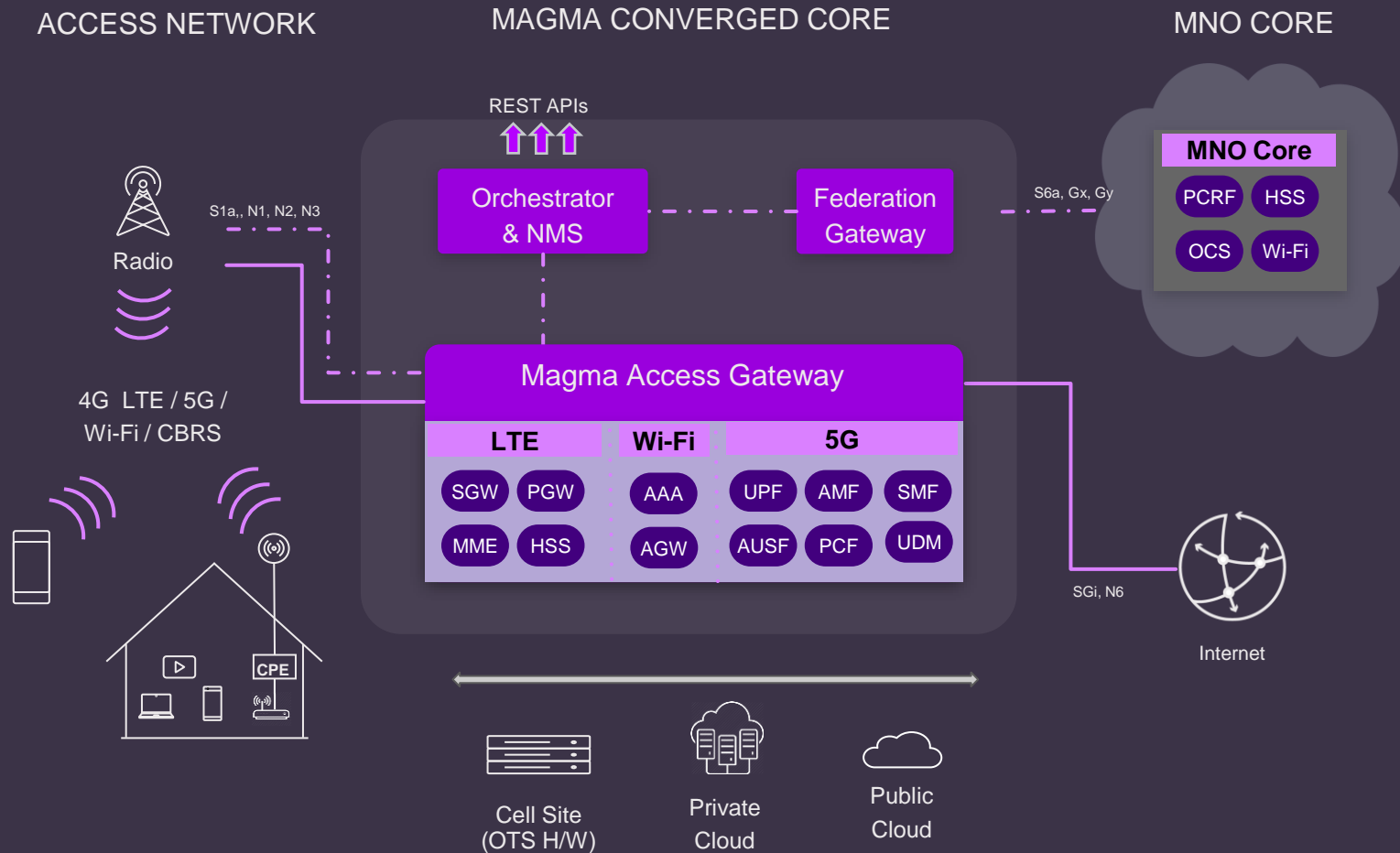- Magma 5G SA after Release 1.8

- Q&A

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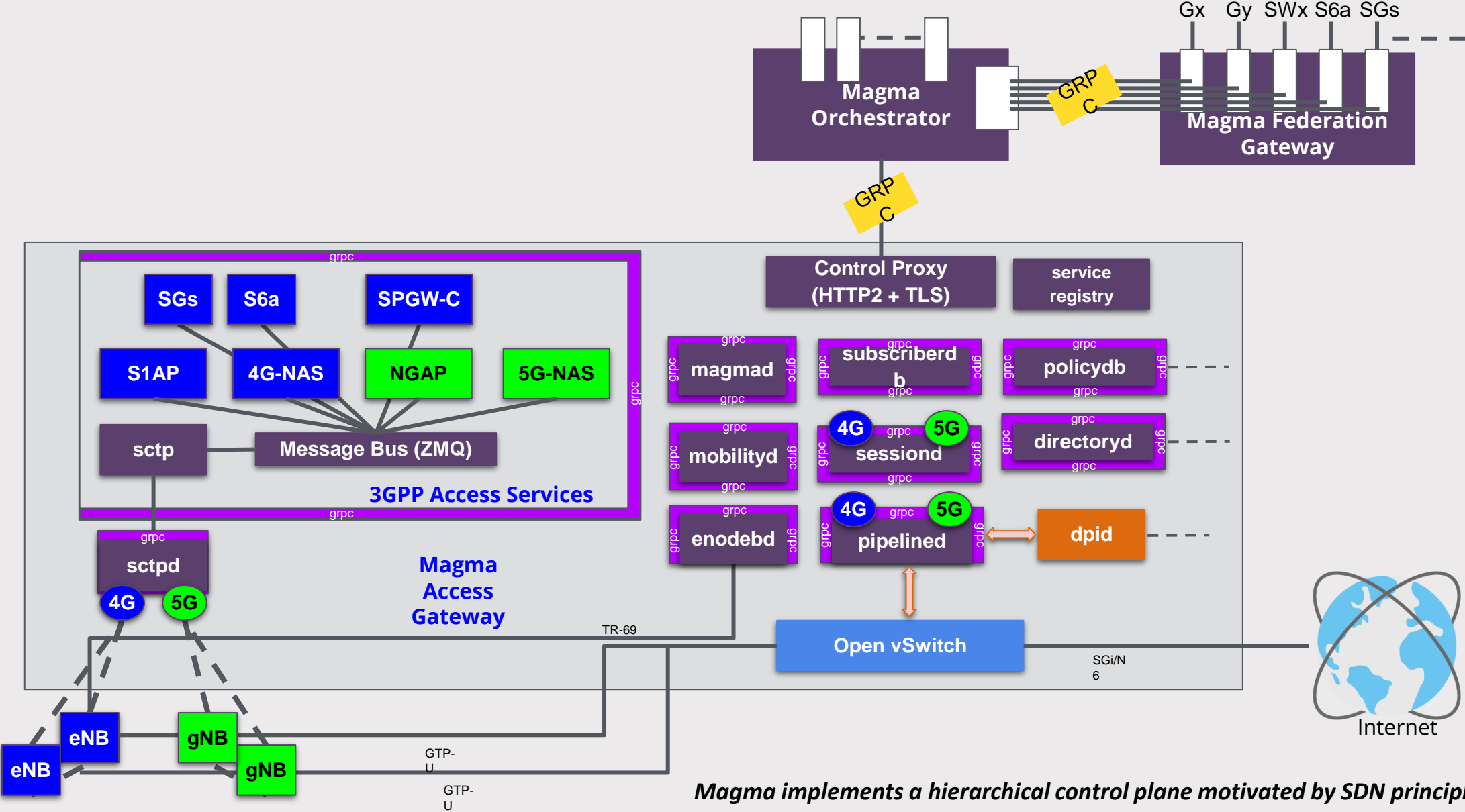
MAGMA OVERVIEW

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

ACCESS NETWORK

MAGMA CONVERGED CORE

MNO CORE

REST APIs

Orchestrator & NMS

Federation Gateway

MNO Core

PCRF   HSS

OCS   Wi-Fi

S6a, Gx, Gy

Radio

S1a,, N1, N2, N3

4G LTE / 5G / Wi-Fi / CBRS

Magma Access Gateway

LTE	Wi-Fi	5G
SGW PGW	AAA	UPF AMF SMF
MME HSS	AGW	AUSF PCF UDM

CPE

SGi, N6

Internet

Cell Site (OTS H/W)

Private Cloud

Public Cloud

UNDERSTANDING MAGMA ARCHITECTURE

Magma implements a hierarchical control plane motivated by SDN principles

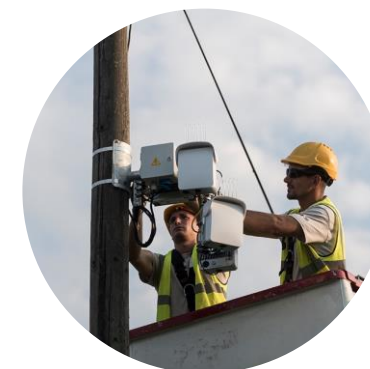# MAGMA 5G SA IN RELEASE 1.7

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
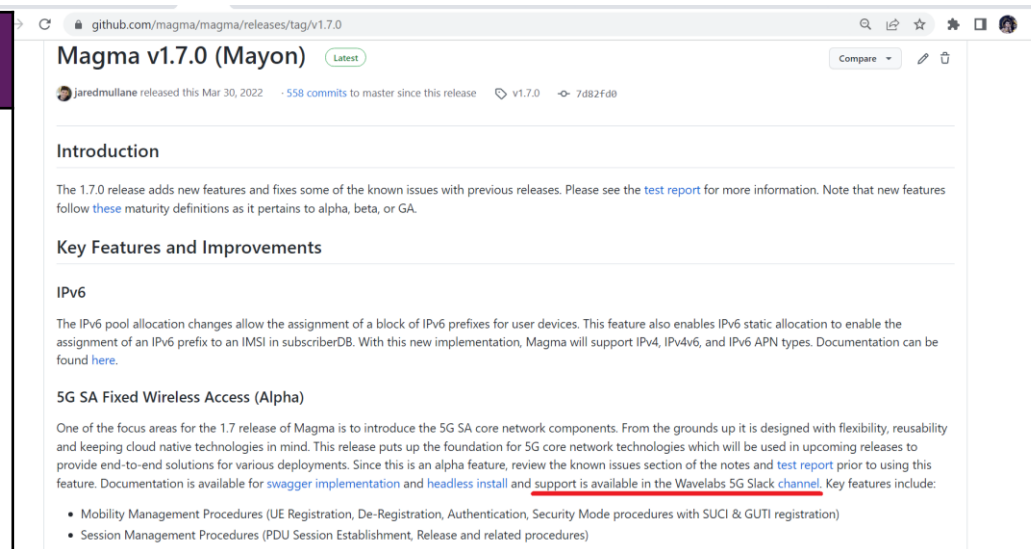
(4) AGW Headless Install

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

(5) 5G SA Test/Validation Reports:

https://docs.google.com/document/d/1ZESAclqI7uBG9WxzSMJMslKv7Usfxb1z/edi
t?usp=sharing&ouid=112274860638393563688&rtpof=true&sd=true

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

THE DEMO

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

YouTube Link:

https://www.youtube.com/watch?v=YNrXf0dVRi0&list=PLJbCWXM7NAtkb_
nEAO7Db2CupE7E8PKfI&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_chache) 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) "s1ap_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) "s1ap_imsi_map"
16) "mobilityd:assigned_ip_blocks"
17) "NO_VLAN_1:mobilityd_gw_info"
18) "amf_nas_state"
127.0.0.1:6380>
```

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
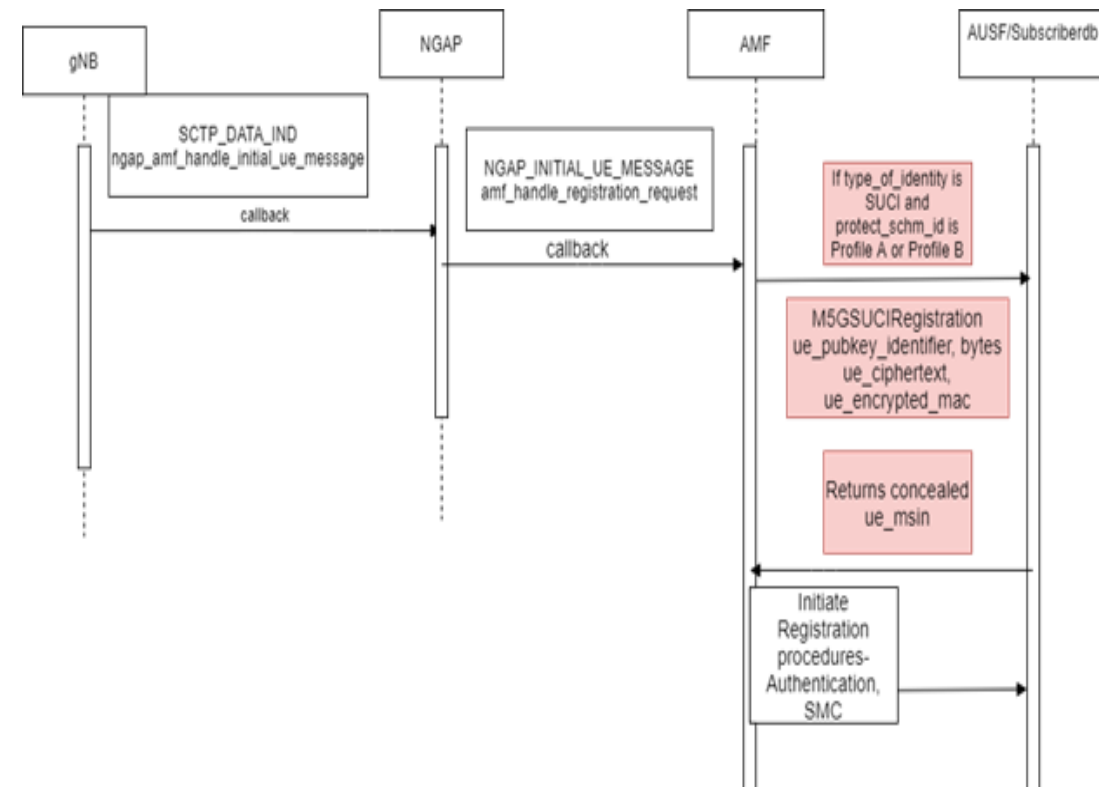
MOBILE IDENTITY WITH SUCI PROFILE-B ENCRYPTION

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
```

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)

```
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: 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)

magma

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 collobarations

UNDERSTANDING MAGMA 5G IN THE GITHUB

magma

Join and contribute @ https://github.com/magma/magma/tree/master/
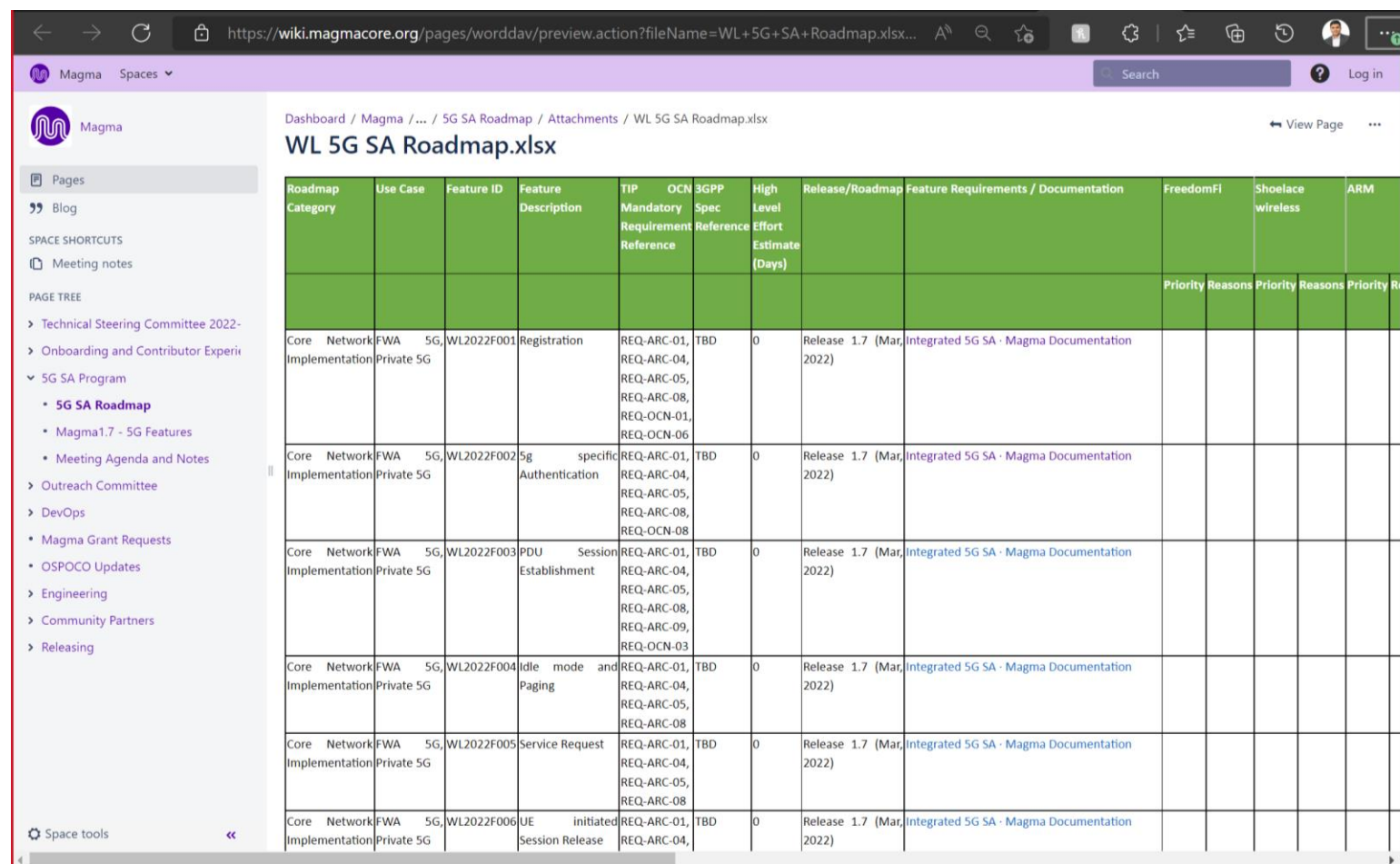
THE DEMO

Magma 5G SA Call to demonstrate SUCI Concealment

MAGMA 5G SA AFTER RELEASE 1.8

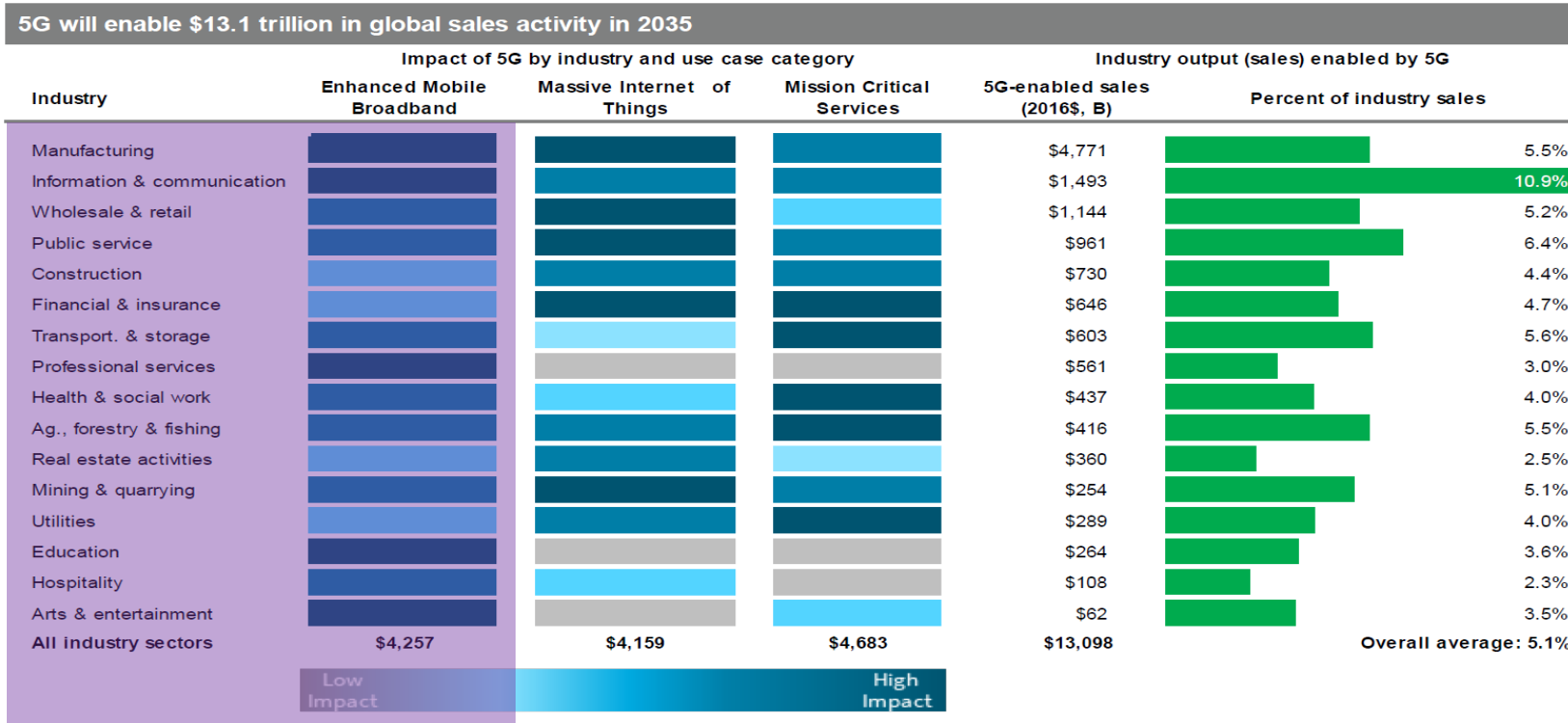**Magma 5G SA Roadmap Confluence Link:**

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

5G TO PLAY BIG ROLE IN THE INDUSTRY 4.0 ECOSYSTEM

5G will enable $13.1 trillion in global sales activity in 2035

Industry	Impact of 5G by industry and use case category			Industry output (sales) enabled by 5G	
	Enhanced Mobile Broadband	Massive Internet of Things	Mission Critical Services	5G-enabled sales (2016$, B)	Percent of industry sales
Manufacturing				$4,771	5.5%
Information & communication				$1,493	10.9%
Wholesale & retail				$1,144	5.2%
Public service				$961	6.4%
Construction				$730	4.4%
Financial & insurance				$646	4.7%
Transport. & storage				$603	5.6%
Professional services				$561	3.0%
Health & social work				$437	4.0%
Ag., forestry & fishing				$416	5.5%
Real estate activities				$360	2.5%
Mining & quarrying				$254	5.1%
Utilities				$289	4.0%
Education				$264	3.6%
Hospitality				$108	2.3%
Arts & entertainment				$62	3.5%
All industry sectors	$4,257	$4,159	$4,683	$13,098	Overall average: 5.1%

Low Impact — High Impact

Source: IHS Markit

© 2020 IHS Markit

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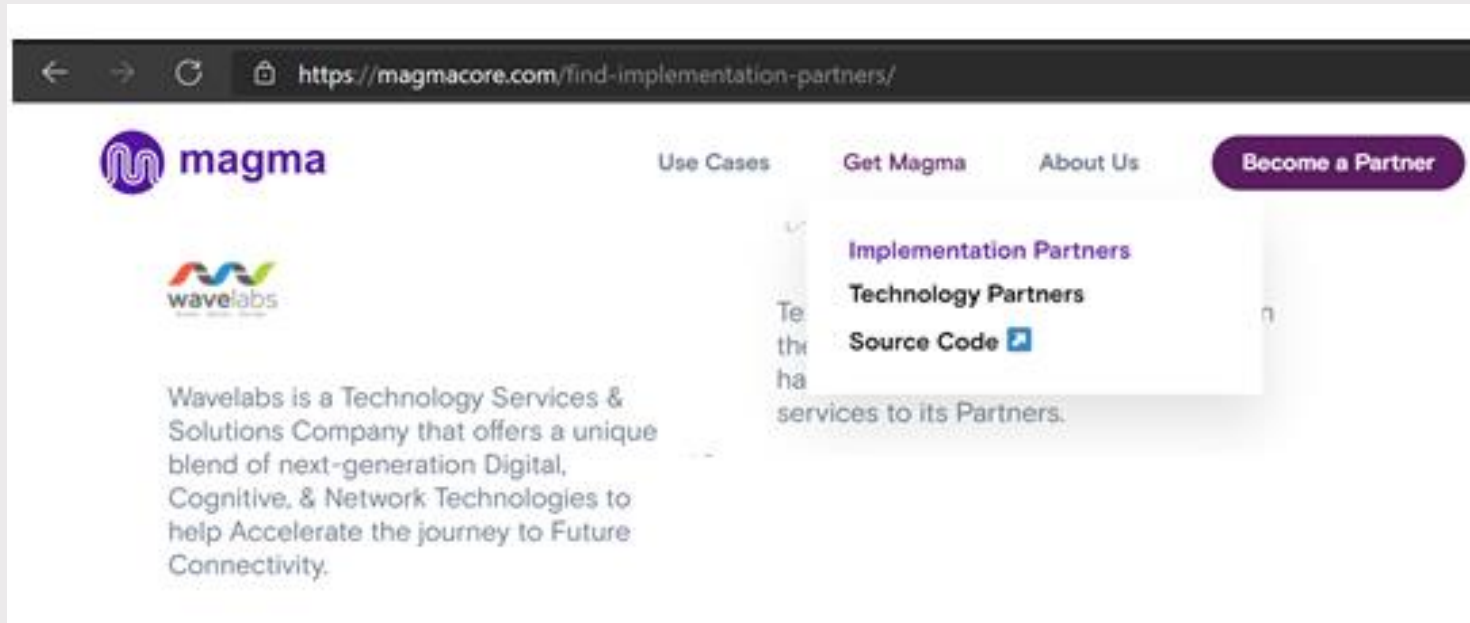
ABIresearch
THE TECH INTELLIGENCE EXPERTS

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

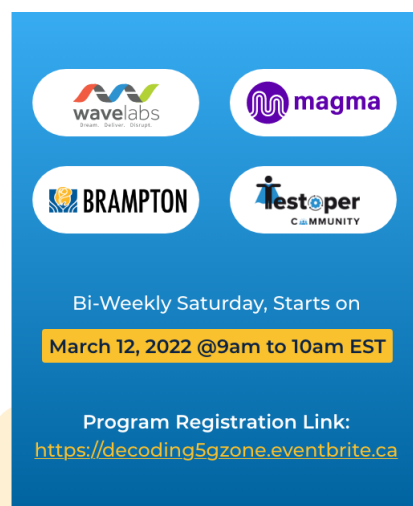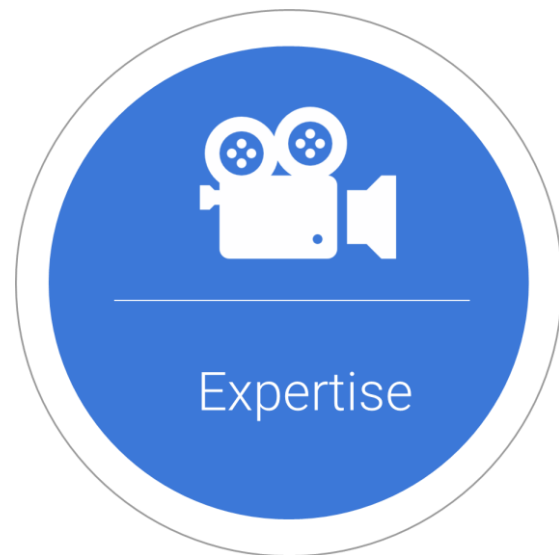# WAVELABS COMMITMENT TO MAGMA 5G SA OPEN SOURCE

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.

23

TWO 'E'YE STRATEGY TO ENABLE ADOPTION OF MAGMA

magma

Expertise

Ecosystem

DECODING 5G
Skill-Up | Innovation-Up

wavelabs
magma
BRAMPTON
Testoper COMMUNITY

Bi-Weekly Saturday, Starts on

March 12, 2022 @9am to 10am EST

Program Registration Link:
https://decoding5gzone.eventbrite.ca

TELECOM INFRA PROJECT

FWA 5G TEST PLAN

FWA Functional Test Plan

Subgroup Version 0.2

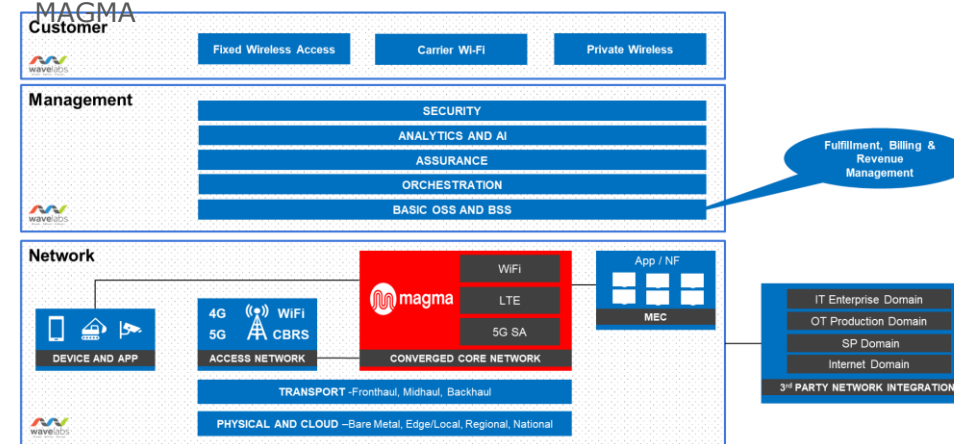January 25, 2021

TWO 'E'YE STRATEGY TO ENABLE ADOPTION OF MAGMA

Expertise
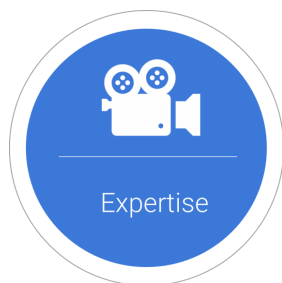
Ecosystem

INNOVATION & RESEARCH LAB
Catalyze Innovation for the Future

LF Open Source Component Projects for 5G
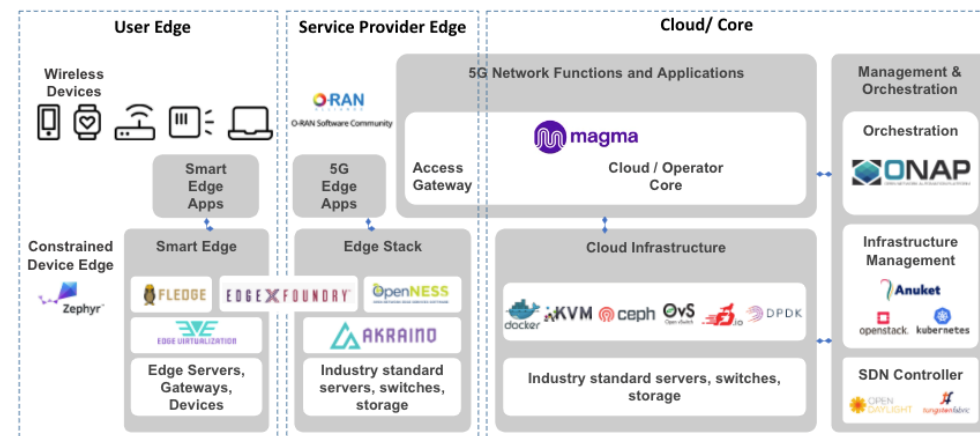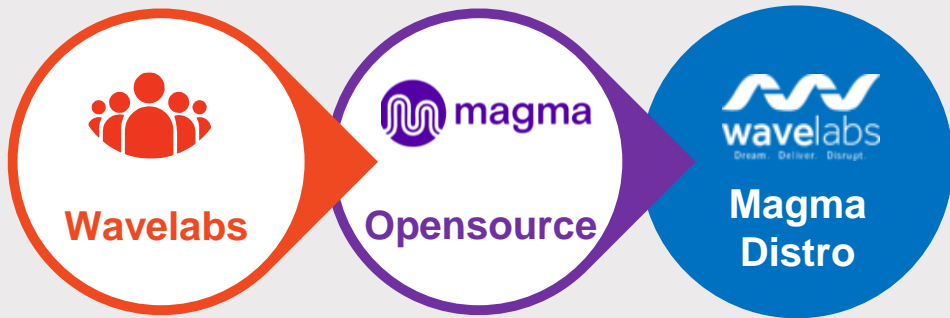

THE PARTNER ECOSYSTEM CENTER AROUND MAGMA

ENABLING THE ADOPTION OF MAGMA FOR 5G

Dedicated Channel for demo, integration support for 5G
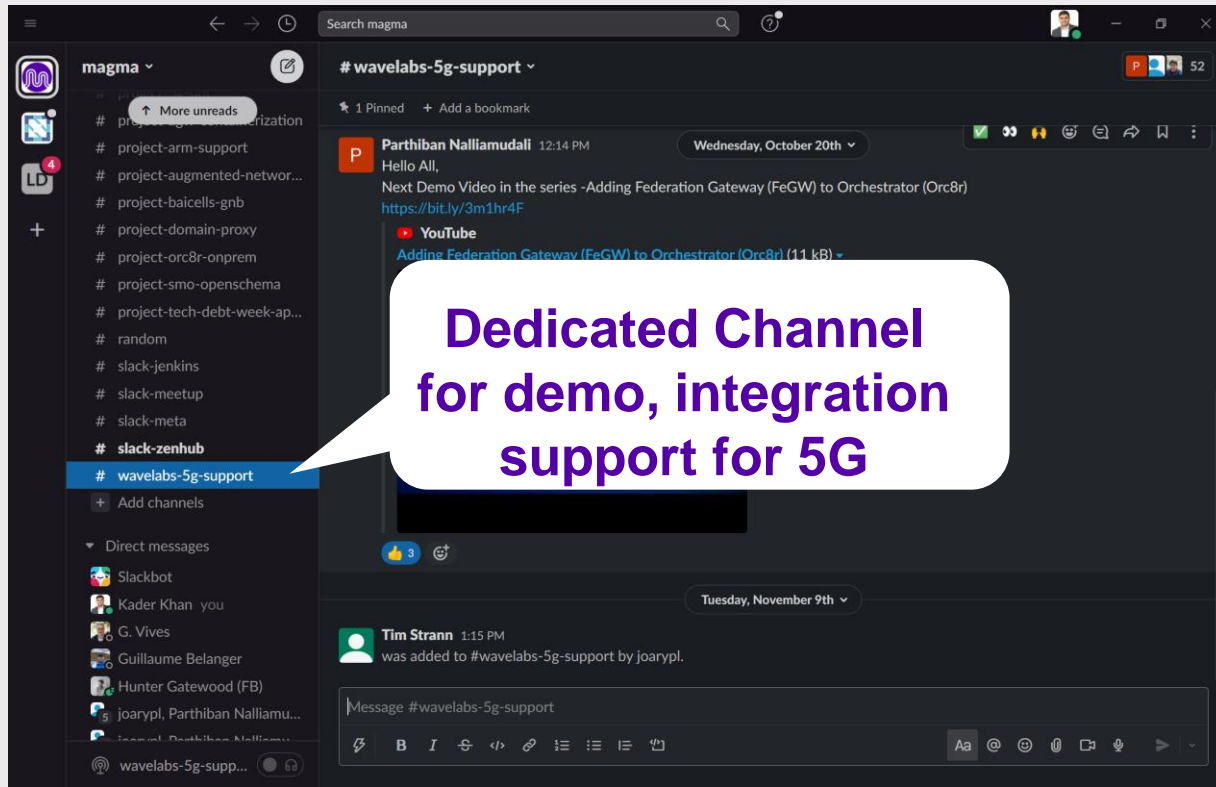
Try it ! We are Ready to Support it !

Magma Orchestrator in AWS

Magma AGW in any of your Hardware
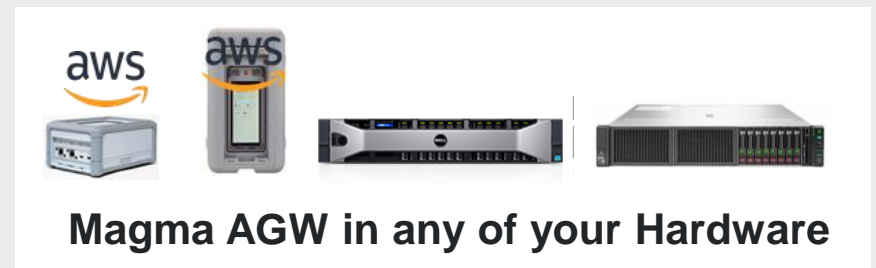
ENABLING ENGAGEMENT, COLLABORATON, AND ADOPTION OF MAGMA FOR 5G

Q & A

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Thank You!

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