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# Next Generation (NG) eCall vs Legacy eCall - Principles and Differences

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Introduction

- **eCall standardisation began 2004**
  - A GSM & UMTS world employing circuit switched (CS) networks
  - The chosen solution was in-band modem and CS 112 call
  - The in-band modem was optimised for GSM (2G) and UMTS (3G) – standard completed in 2008
- **eCall for 4G (NG eCall) standardisation was started 2013 (completed 2017)**
  - There is no circuit switched domain in 4G/5G
  - IMS emergency call will replace circuit switched emergency call
  - Next generation (NG) eCall provides an extension to IMS emergency calls
  - Support for 5G (NR) has since been added
- **Deployment aspects**
  - Motor vehicles last longer than phones
  - PSAPs investments must be protected
  - GSM and UMTS spectrum is being re-farmed to 4G/5G
  - 4G coverage is better than 2G/3G in many regions
  - 5G is already being deployed in many regions

Operation of CS eCall (with Inband Modem)
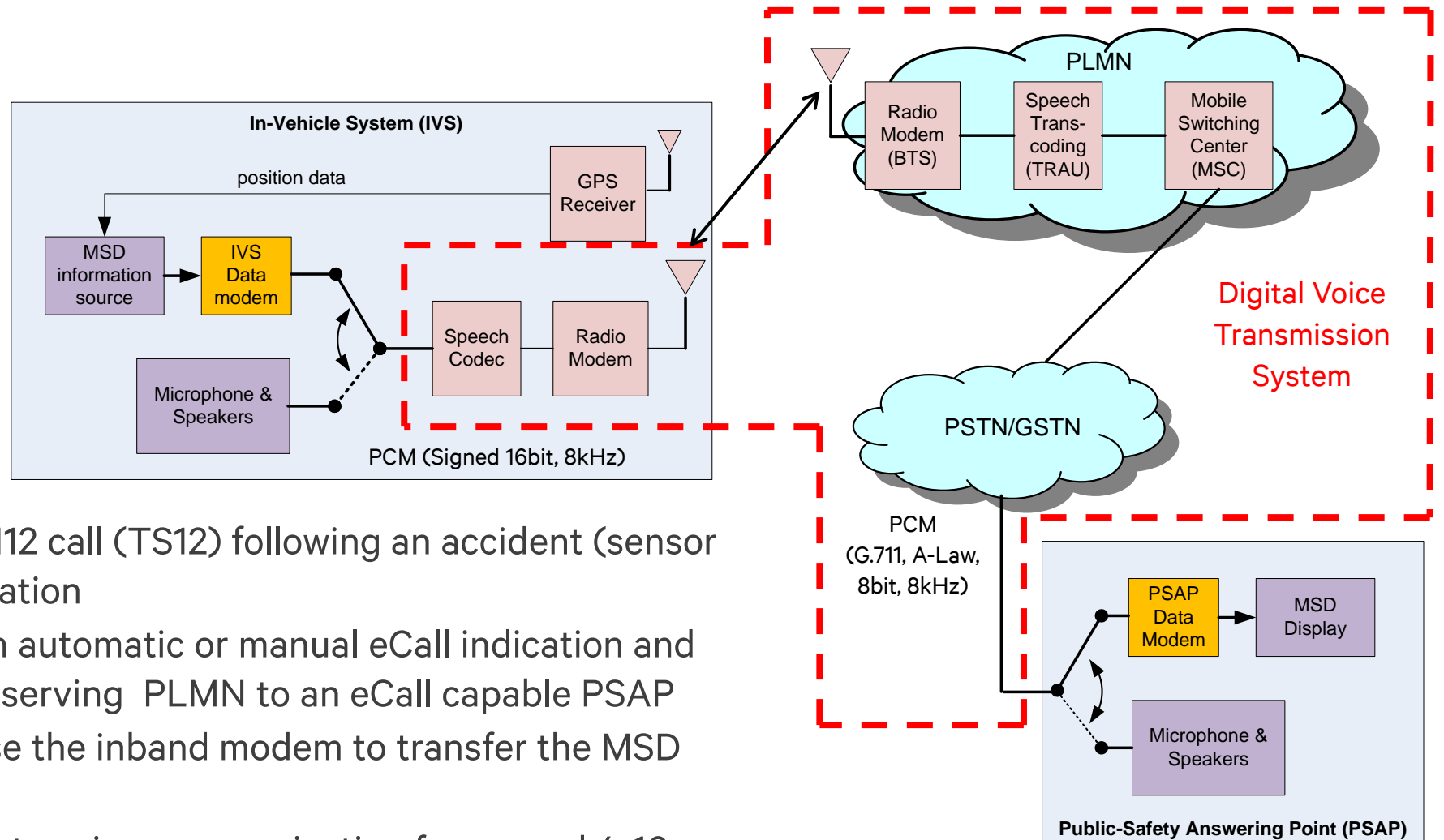
- The IVS instigates a 112 call (TS12) following an accident (sensor trigger) or user invocation
- The 112 call carries an automatic or manual eCall indication and can be routed by the serving PLMN to an eCall capable PSAP
- The PSAP and IVS use the inband modem to transfer the MSD over the voice path
- MSD transfer interrupts voice communication for around 4-10 secs at the start of the eCall

In-band eCall Signals and Timings
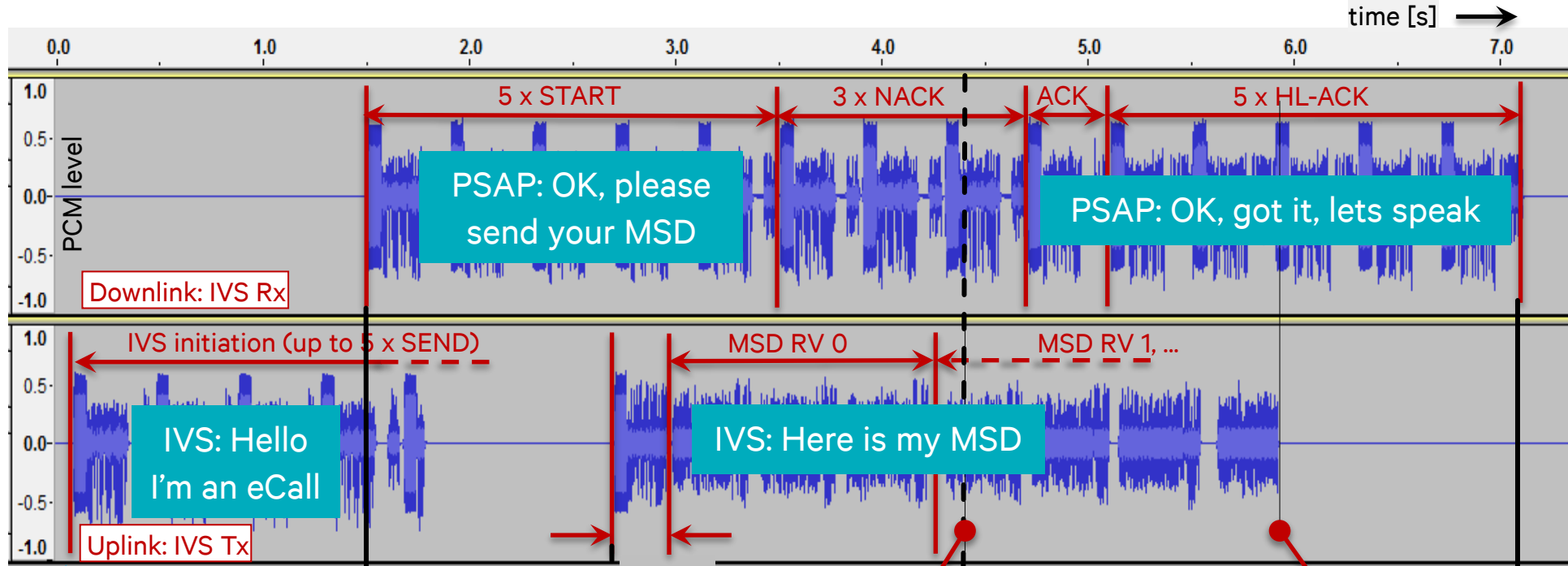
Operation of NG eCall for 4G (LTE)

Vehicle with IVS in accident — eNB — SGW/PDG — IMS — MGW — PLMN — Signaling Path — Voice Path — PSAP
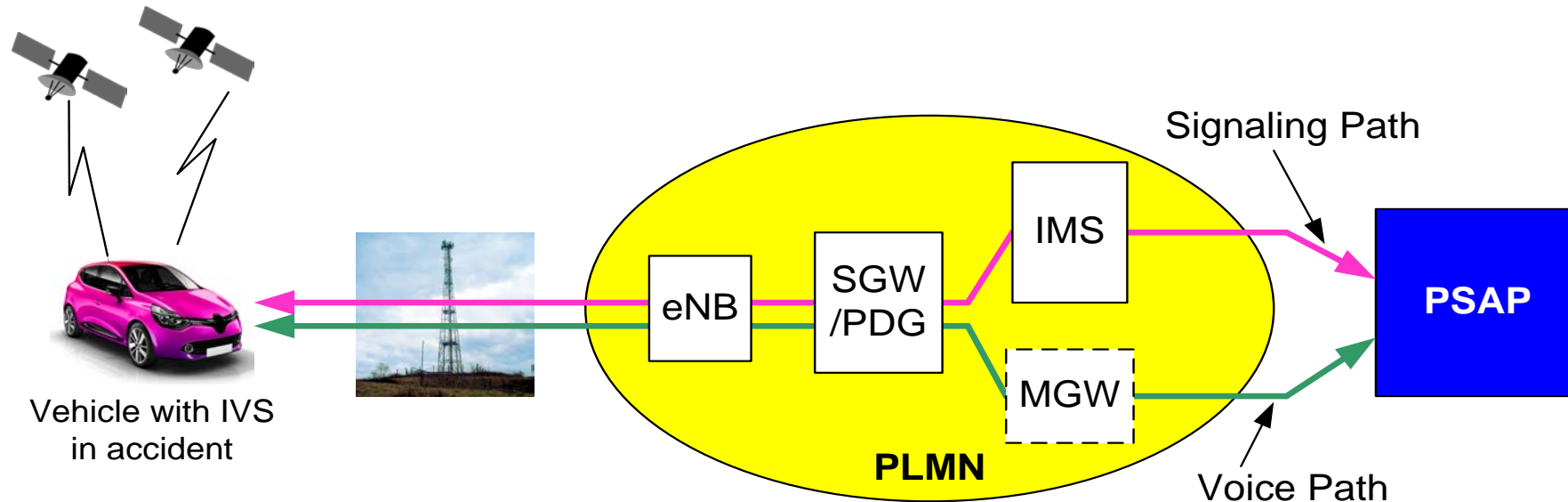
- The IVS instigates an emergency call over IMS following an accident or user invocation
- The serving PLMN establishes a call to a PSAP with a SIP/IP signaling path through an IMS (pink arrow) and a separate voice path (green arrow) for transfer of VoIP
- If the PSAP uses CS access and not IP, an MGW transforms the VoIP into CS voice
- The MSD is transferred in an SIP INVITE message sent to the PSAP over the signaling path
- The voice path is not interrupted or affected by the MSD transfer
- 5G support is similar (e.g. a gNB replaces the eNB and a UPF replaces the SGW/PDG)
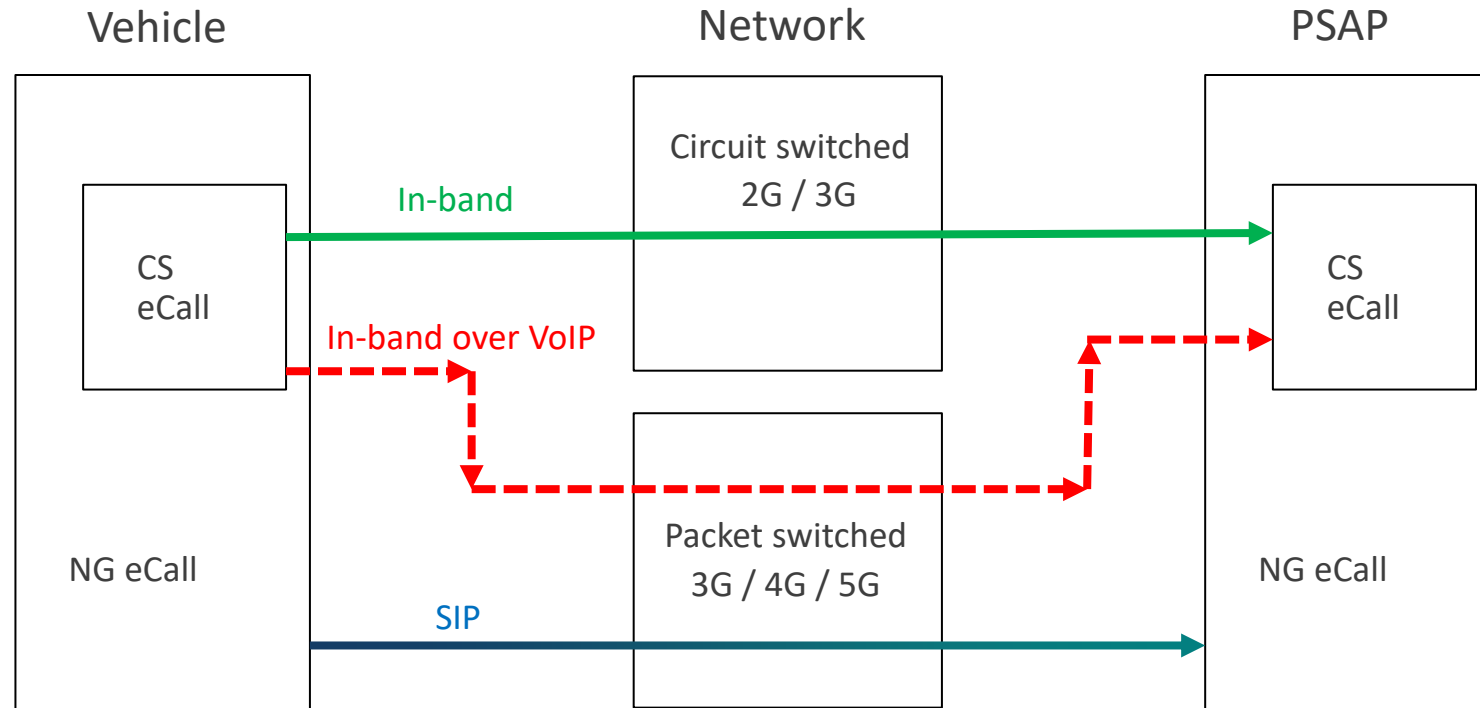
Example: End to End SIP Call Flow for an IP capable PSAP
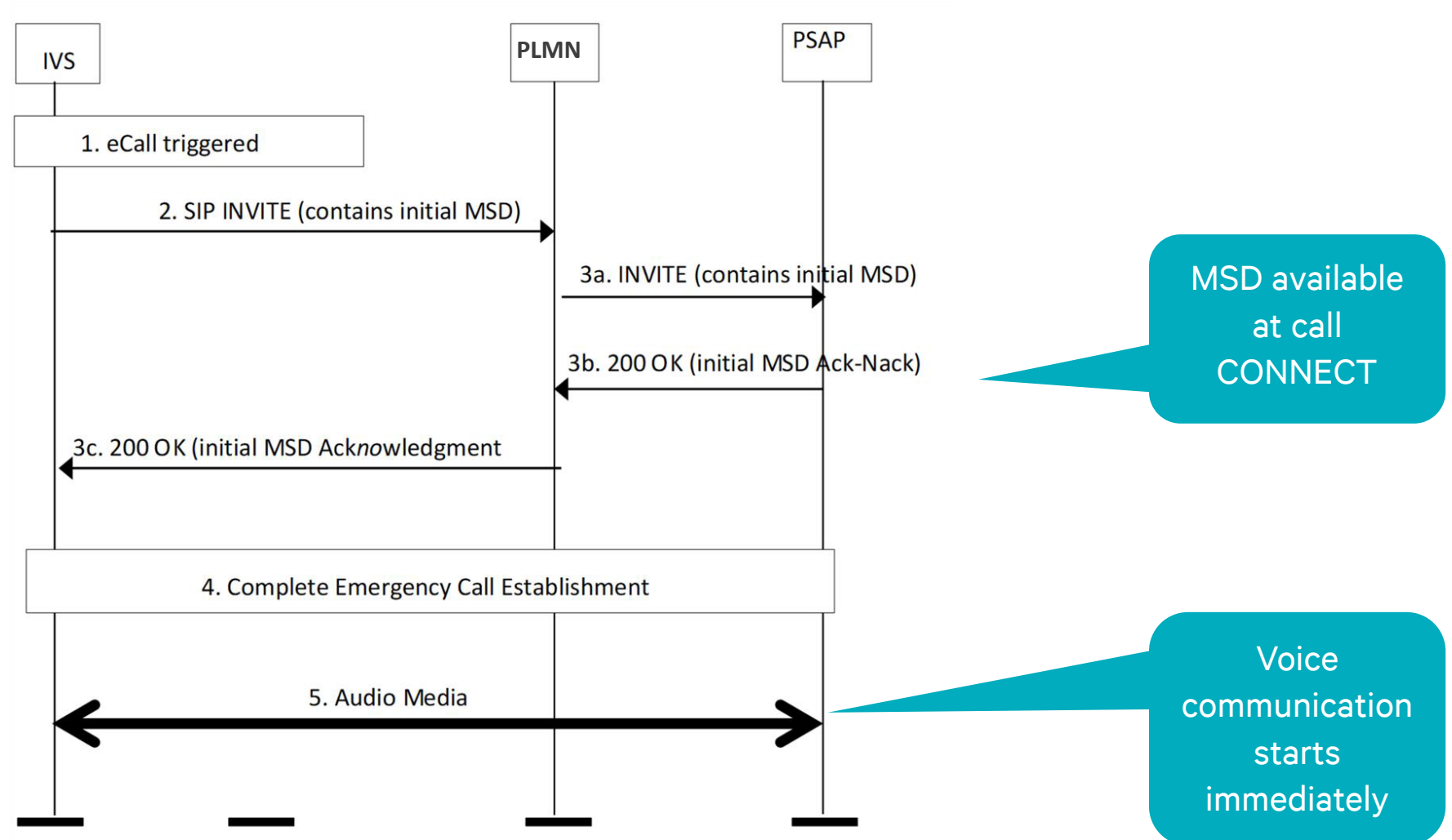
Comparison of NG eCall with CS eCall

Characteristic	CS eCall	NG eCall
Allowed Access Types	GSM CS, UMTS CS	4G, 5G
Voice Path	CS end to end	VoIP end to end for IP capable PSAP VoIP to MGW and then CS for legacy PSAP
Call Signaling	SS7 ISUP	SIP (IMS)
Initial MSD Transfer	Inband over CS voice path	Out of band SIP with IP capable PSAP Inband over voice path with legacy CS PSAP
Updated MSD Transfer	Supported via inband request/response	Supported via SIP INFO request/response Also supported inband for a legacy CS PSAP
Handover	GSM/UMTS ←→ GSM/UMTS	4G/5G ←→ 4G/5G 4G/5G → GSM/UMTS CS (one way only)
PLMN support	Transparent to PLMN except for routing based on an eCall flag	PLMN needs to support IMS emergency calls, MSD transfer, updated MSD transfer and routing based on an eCall service URN
PLMN support indication	None	SIB1 indicates PLMN/PSAP support for NG eCall
eCall only mode	Supported	Supported

Co-existence of NG eCall and CS eCall

Vehicle

Network

PSAP

CS eCall

In-band

Circuit switched
2G / 3G

CS eCall

In-band over VoIP

NG eCall

Packet switched
3G / 4G / 5G

NG eCall

SIP

Only CS eCall supported in network or PSAP

NG eCall supported in network and PSAP

No CS network available & no NG eCall support

In-band over VoIP is only a solution of last resort as performance cannot be guaranteed

Phased Migration from CS eCall to NG eCall

- We expect EU MNOs to phase out 2G/3G CS and shift spectrum to more spectral efficient and higher bandwidth 4G and 5G
- This can be accompanied by IVS migration to dual mode (supporting CS and NG eCall) and PSAP migration from CS eCall to NG eCall through the following phases

  - **Phase 1 – predominantly CS eCall**
    - 4G coverage with PLMN support of NG eCall is zero or low, all PSAPs support CS eCall
  - **Phase 2 – mixed CS eCall and NG eCall**
    - 4G coverage with PLMN support of NG eCall is widespread, PSAPs support CS eCall and/or NG eCall
  - **Phase 3 – predominantly NG eCall with some CS fallback**
    - 4G/5G coverage with PLMN support of NG eCall is universal
    - some PSAPs and/or IVS only support CS eCall
  - **Phase 4 – universal NG eCall**
    - IVS, PLMNs and PSAPs all support NG eCall

CS and PS Domain Selection

- A IVS that supports NG eCall is also required to support CS eCall
- Hence an IVS supporting NG eCall will need to perform CS vs PS domain selection
- An NG eCall flag broadcast in an 4G or 5G cell (on SIB1) indicates whether NG eCall is supported in the cell
- A MNO can set the flag to indicate NG eCall support if:
  - The PLMN (or all PLMNs with 4G/5G RAN sharing) supports NG eCall
  - AND
  - At least one PSAP associated with (or reachable from) the cell is NG eCall capable
- Domain selection for eCall is performed based on this preference order:
  1. 4G or 5G with NG eCall flag set
  2. GSM or UMTS CS
  3. 4G or 5G with normal IMS emergency call support but with the NG eCall flag not set

- Note:
  - The IMS SIP protocol allows capable PSAPs to detect whether an IVS can use NG eCall or not

Conclusions

- **IMS emergency call and NG eCall standards are ready**
  - Provide robust and richer emergency services over PS networks
  - Framework that can easily be extended to provide value-added 3rd party services
- **Network coverage depends on MNOs**
  - MNOs are currently upgrading to packet-switched 4G/5G networks
  - 2G/3G networks are already or will be phased down in several regions/countries
- **eCall service continuity needs to be maintained**
  - Current EU regulation only provides 2G/3G as minimum requirement
  - Car manufactures are strongly advised to ensure that eCalls will be possible over the lifetime of a car by employing common best practice and state-of-the-art technologies
  - IVS deployment of NG eCall with in-band modem guarantees uninterrupted support of eCall for vehicle lifetime
- **PSAPs need to make provisions now such that they can easily upgrade to IMS**
  - NG eCall leverages commercial IP/SIP based protocols and equipment, reducing investment upgrade costs (especially when ISDN lines gets replaced by all-IP lines)

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Thank you

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Abbreviations

CS	Circuit Switched		NR	New Radio
EATF	Emergency Access Transfer Function		P-CSCF	Proxy Call Session Control Function
E-CSCF	Emergency Call Session Control Function		PDG	Packet Data Network Gateway
eNB	evolved Node B (for LTE access)		PLMN	Public Land Mobile Network
EPS	Evolved Packet System		PS	Packet Switched
gNB	NR NodeB (for 5G NR access)		PSAP	Public-Safety Answering Point
IAM	Initial Address Message		SGW	Serving Gateway
IMS	IP Multimedia System		SIB	System Information Block
IP-CAN	IP-Connectivity Access Network		SIP	Session Initiation Protocol
ISUP	ISDN User Part		UE	User Equipment
IVS	In-vehicle system		UPF	User Plane Function
MGCF	Media Gateway Control Function		URI	Uniform Resource Identifier
MGW	Media Gateway		URN	Uniform Resource Name
MNO	Mobile Network Operator		USIM	Universal Subscriber Identity Module
MSD	Minimum Set of Data		VoIP	Voice over IP
NG	Next Generation			