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**Pan-European eCall employing  
AMR-WB and LTE CSFB**

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# Outline

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- Introduction
- eCall Implementation in Europe
- eCall Transmission Chain
- Special Investigations
  - AMR-WB performance
  - LTE CSFB performance
- Conclusions



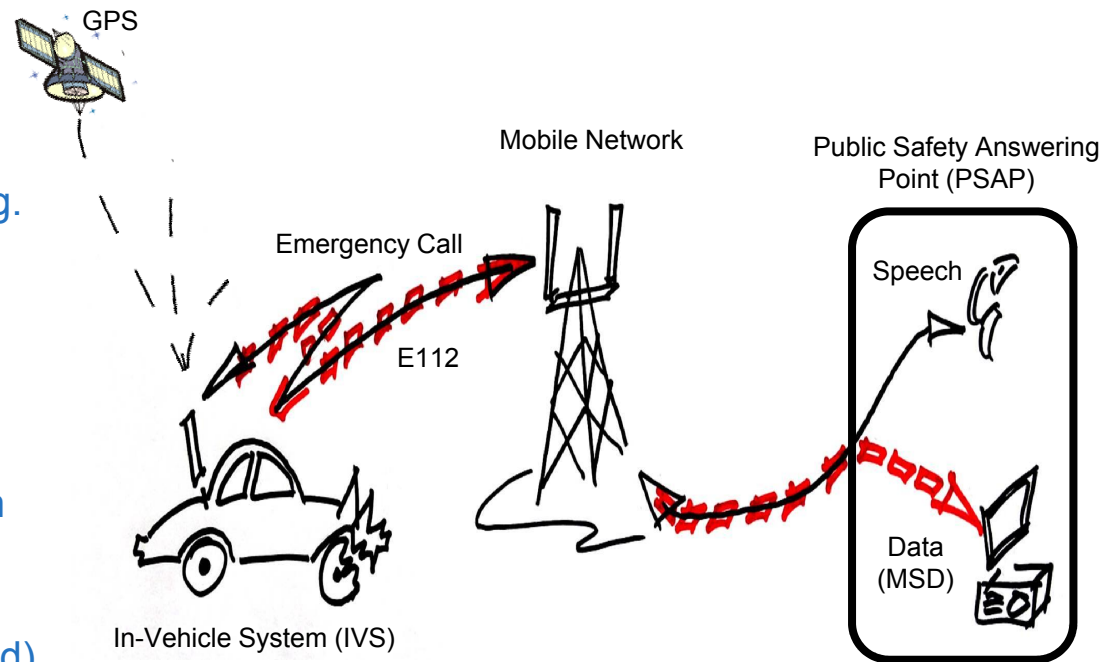
# Introduction

## What is eCall?

- eCall is the upcoming pan-European and Russian in-vehicle emergency call system utilizing connectivity over mobile networks
- eCall IVS to be installed in all new vehicles in the EU and Russia starting 2015

- Requirements

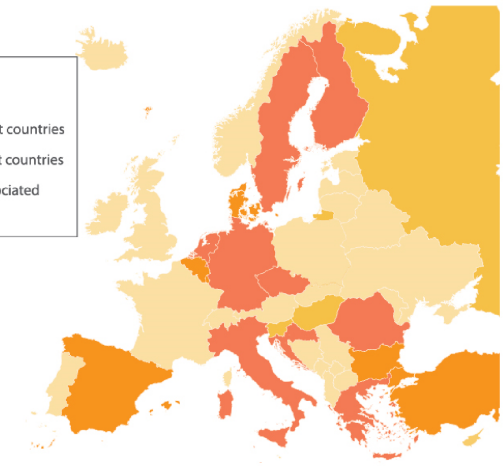
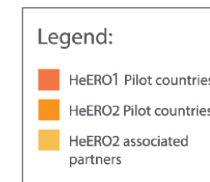
- Allow automatic and manual data transmission
- `Minimum Set of Data` (MSD) e.g.
  - Position, orientation, direction, time
  - Car and fuel type
  - Severity of incident, # passengers
- Employing existing emergency mechanisms (call prioritization)
- Simultaneous speech connection to PSAP personnel
- Data transmission over in-band modem (3GPP/ETSI standardized)





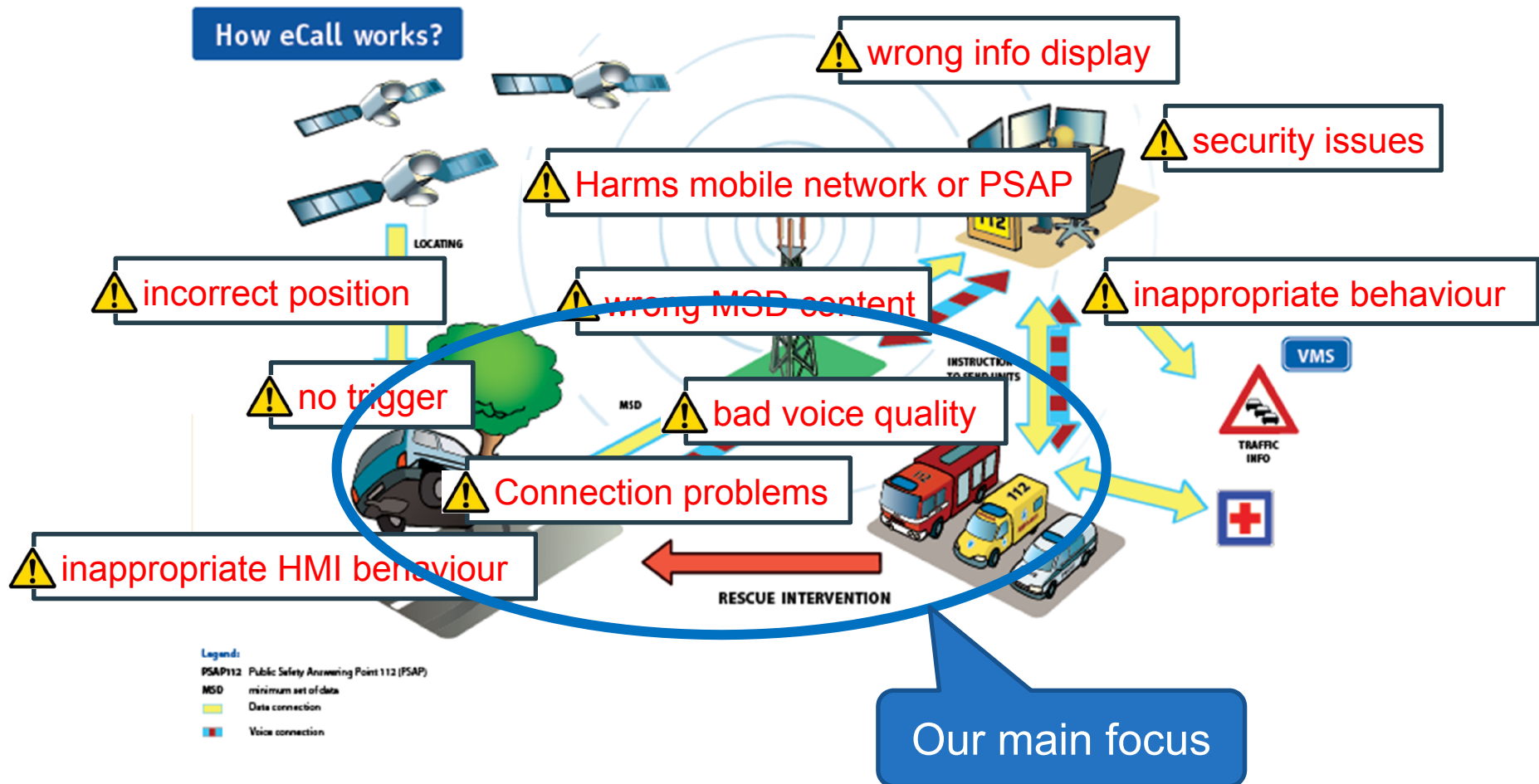
# eCall Implementation in Europe

- eCall to be mandated for all new vehicles in EU and Russia from 2015
- QCOM's contribution
  - Standardization, certification, technical consultancy, IOTs, prototyping and commercialization of products
  - QCOM's eCall solution was selected by ETSI/3GPP after a competition in 2008
- HeERO = European Commission-sponsored pre-deployment trials for eCall
  - 82 HeERO Partners, 19 pilot sites, 15 countries
  - QCOM conducted an own trial prior to the official national HeERO pilots
    - Results serve as reference for all national HeERO pilots
    - eCall modem performance is now considered to be reliable enough for public safety services
- Our Europe field test campaign has greatly promoted eCall
  - Qualcomm established as independent trusted technical advisor in the community
  - Qualcomm received HeERO award in November 2013 for our contribution toward the deployment of Pan European eCall



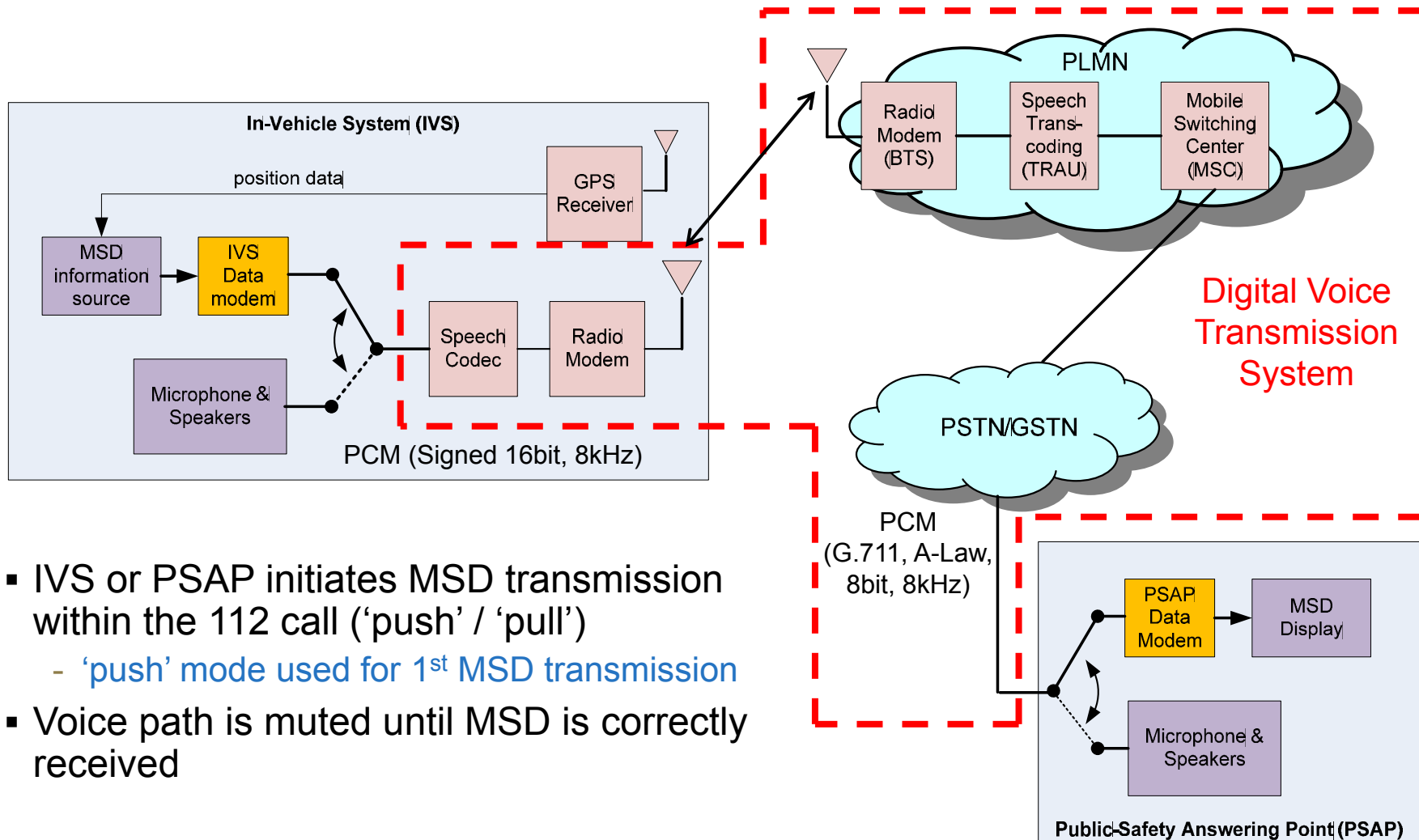
# eCall Transmission Chain

What can go wrong ... will go wrong



# eCall Transmission Chain (cont'd)

## eCall In-band Modem in MNO Environment

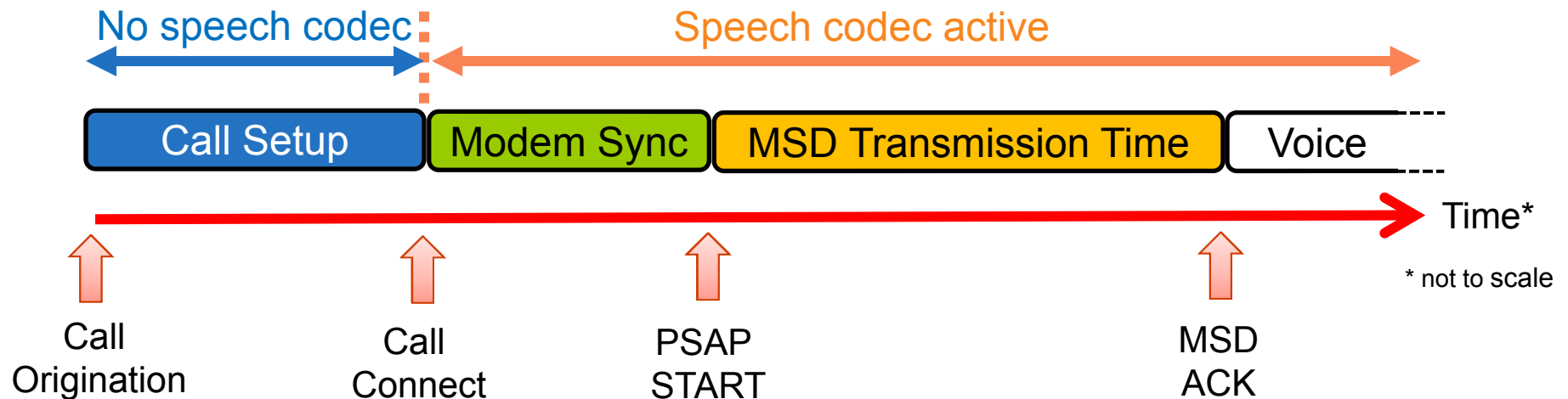


- IVS or PSAP initiates MSD transmission within the 112 call ('push' / 'pull')
  - 'push' mode used for 1<sup>st</sup> MSD transmission
- Voice path is muted until MSD is correctly received



# eCall Timeline

Call process from call origination to voice communication



- Operator decides upon used network technology and speech codec
  - Based on IVS advertised capabilities
- Typical speech codecs used
  - GSM:
    - EFR (12,2 kbps), FR (13 kbps), HR (5.6 kbps) – all @ 8 kHz sampling frequency
  - UMTS:
    - AMR-NB (4.75 - 12.2 kbps @ 8 kHz), AMR-WB (6.6 - 23.85 kbps @ 16 kHz)





# eCall AMR-WB Investigation

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- AMR-WB codecs are designed to enhance AMR-NB audio perception
  - Achieved by higher sampling rates and adapted code books
  - AMR-WB is advertised as IVS capability during network registration
  - AMR-WB needs to be supported and configured by the mobile network operator
- Many networks enable AMR-WB only for mobile-to-mobile calls
  - No improvements in audio perception expected for mobile-to-fixed calls
  - However, AMR-WB could provide NW capacity benefits at same audio perception
- Tests were conducted in stationary and mobility scenarios w/ and w/o NEC disabler tone (WT=with tone, NT=no tone)
- IVS was forced to 3G-only mode on order to avoid handover to 2G without AMR-WB support



# eCall Comparison AMR-NB vs AMR-WB

Separated by NW operator

- Overall comparison (excluding non-relevant failures)
  - WT=with tone, NT=no tone, gt20s=MSD TX greater than 20s regarded as failure

Codec	%Succ-gt20s WT	avg MSD time WT	%Succ NT	%Succ-gt20s NT	avg MSD time NT	%Succ	%Succ-gt20s	avg MSD time
AMR-NB (NW-B)	100.0	3.5	100.0	100.0	3.8	100.0	100.0	3.6
AMR-WB (NW-B)	100.0	3.4	100.0	100.0	3.8	100.0	100.0	3.6
AMR-NB (NW-A)	100.0	2.8	100.0	100.0	3.5	100.0	100.0	3.2
AMR-WB (NW-A Region 1)	100.0	3.2	100.0	100.0	3.8	100.0	100.0	3.5
AMR-WB (NW-A Region 2)	99.8	9.0	75.7	55.9	5.8	87.1	76.7	7.8

No AMR-WB issues seen

Good WT MSD success rate

Increased MSD TX Time

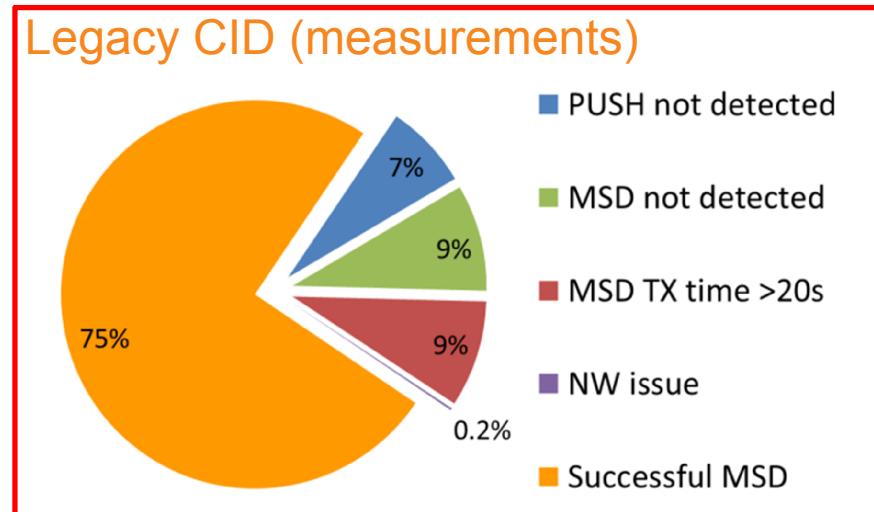
Unsatisfactory NT MSD success rate



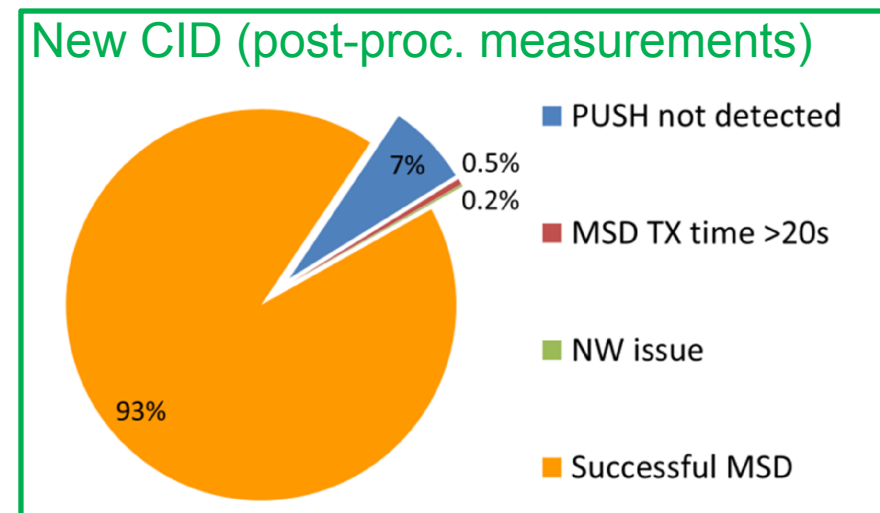
# eCall AMR-WB Performance in NW-A

Separated by overall failure causes

- NW-A exhibits unexpected performance issue
  - Overall success rate only 75%
- Main failures
  - PSAP cannot detect PUSH sequence
  - MSD cannot be detected within the system timeout T7=20s



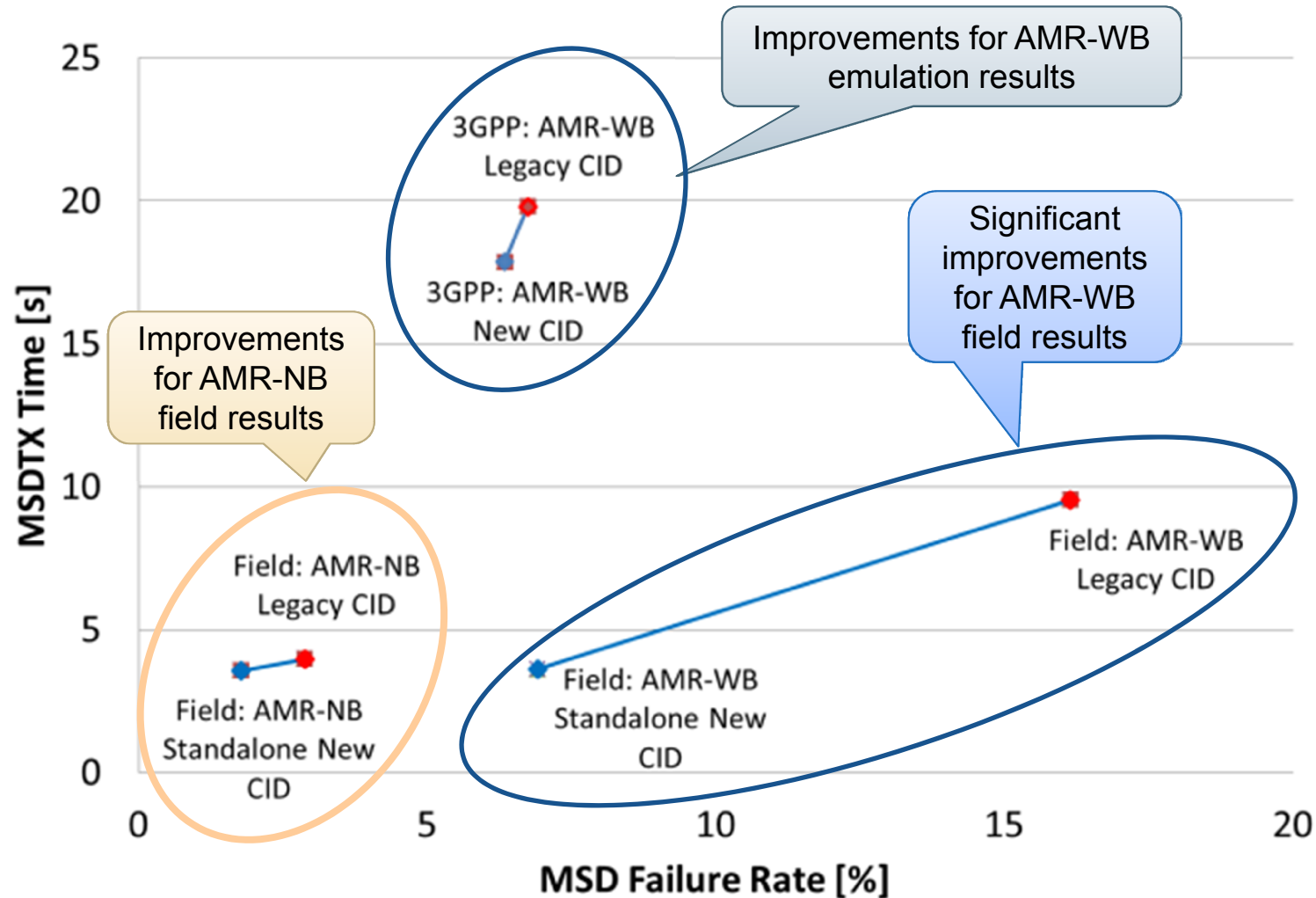
- Root issue cause
  - Resampling artifacts leading to misdetections of signal sign reversals, resulting in synchronization failures
- Solution
  - Improvement of codec inversion detection (CID) algorithm





# eCall AMR-WB Performance in NW-A

## Improvements by new CID algorithm





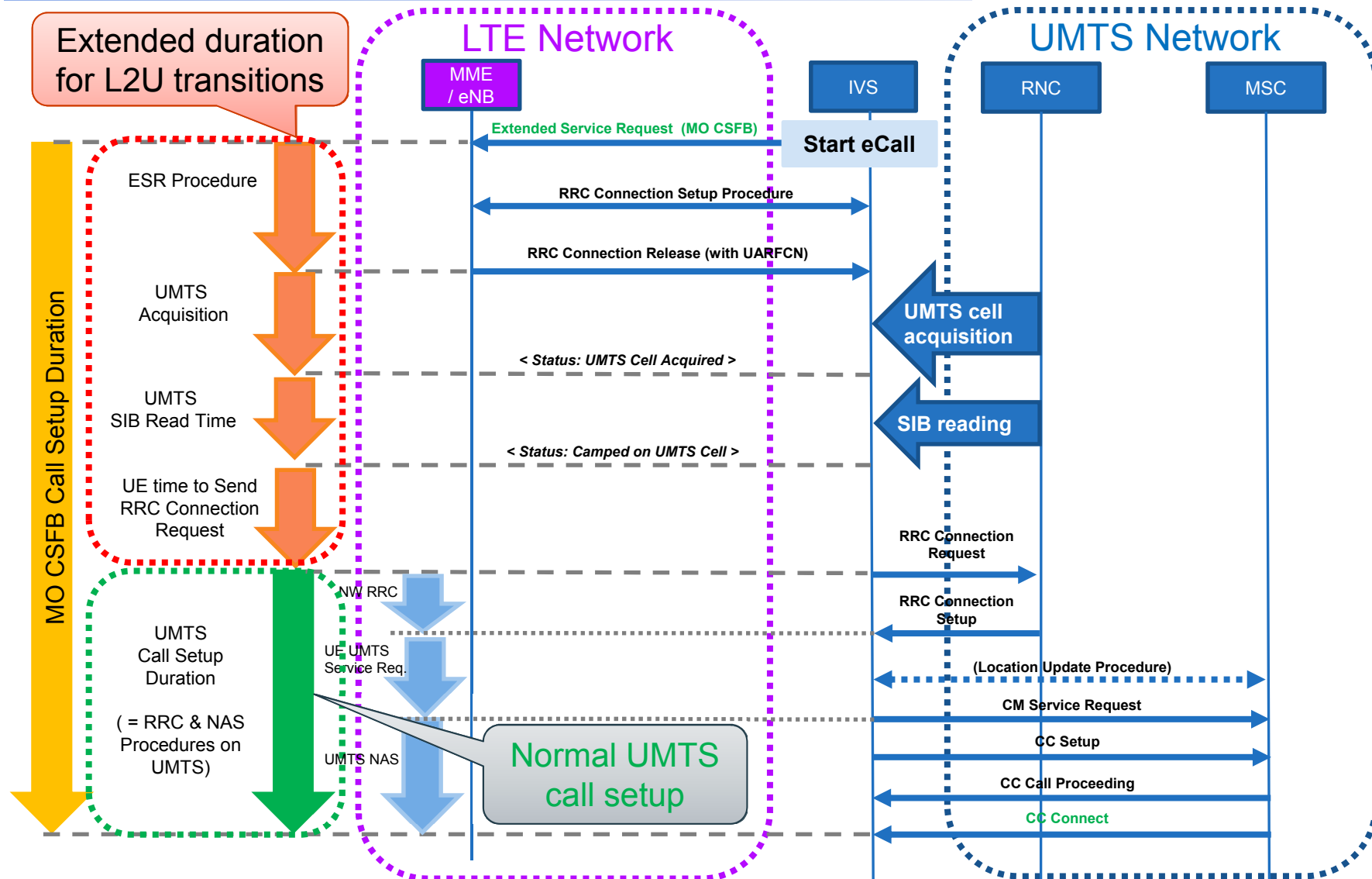
# eCall LTE CSFB Investigation

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- Many networks have already LTE deployed
  - LTE is a packet-switched technology primarily used for data transmission
  - Voice and especially emergency calls over LTE are not yet available in most European networks
  
- A circuit-switched fallback (CSFB) mechanism is used to establish speech services for devices connected to LTE networks
  - The devices transition first to a GSM or UMTS CS domain before starting a voice call
  
- Main goal of this investigation was to assess the performance of eCall in case LTE CSFB mechanisms are used
  - Call setups employing CSFB are expected to take longer than normal GSM or UMTS call setups
  
- Tests were conducted in multiple stationary and mobility scenarios



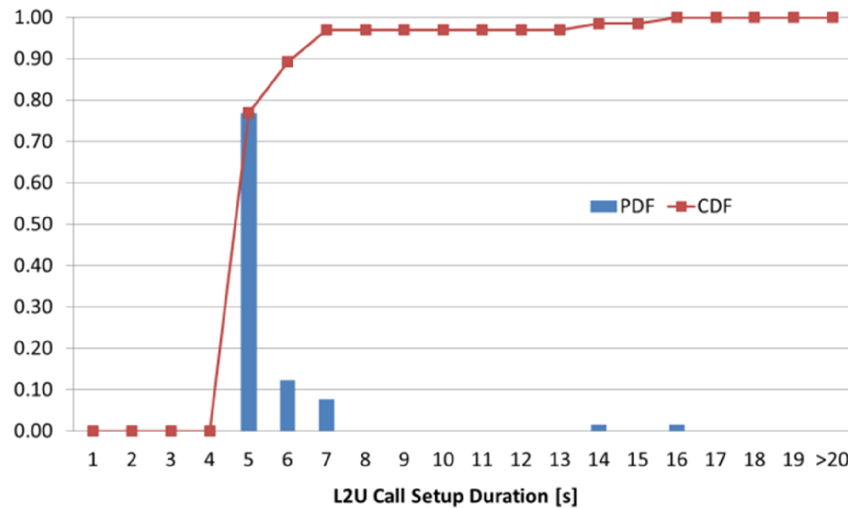
# LTE→UMTS (L2U) CSFB Call Flow



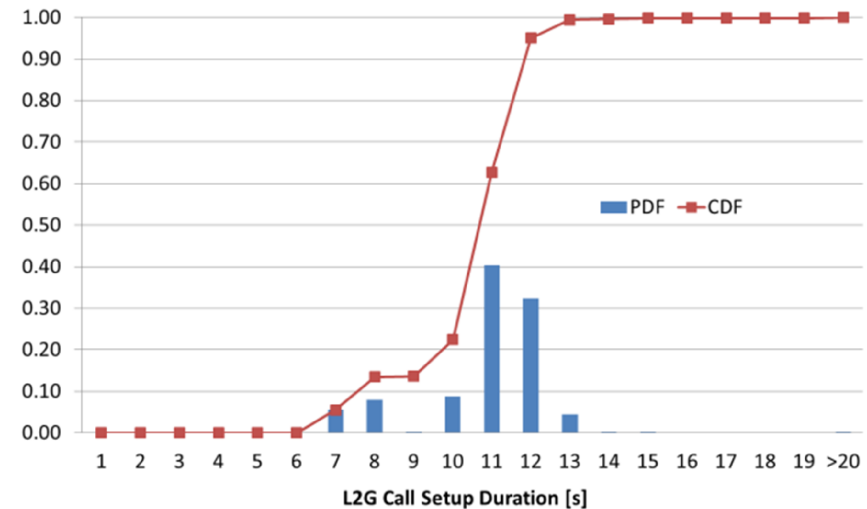


# eCall CSFB Performance

**LTE→UMTS (L2U) Call Setup**



**LTE→GSM (L2G) Call Setup**



L2U call setup time  
50% lower than L2G

Scenario	Avg. Call Orig to LTE inactive [s]	Avg Call Setup [s]	Avg MSD TX time [s]
L2G	0.3	10.4	4.6
L2U	0.6	5.2	3.0

L2U MSD TX time  
lower than L2G



# Conclusions

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- General eCall performance confirmed to be good
  - Main issues occurred due to implementation or configuration deficiencies
- Reasonable performance of AMR-WB when using NEC disabler tone
  - Success rate without NEC effects > 99% is in-line with expectations
  - Average MSD TX time of 9s is quite high
- Significant differences between AMR-NB and AMR-WB w/o NEC disabler tone
  - Average AMR-WB success rate in NW-A Region 1 below 56% not satisfactory
  - Root cause identified to stem from severe resampling artifacts
- New CID algorithm shows promising results for both AMR-NB and AMR-WB
  - Could improve performance in terms of MSD success rate and MSD TX time
  - Provides better robustness against misdetection of signal sign reversal
- eCall CSFB performance is in-line with results obtained for normal voice calls
  - Network parameters for CSFB transitions, call setup and retention are the same
  - Average call setup and MSD TX times are higher for L2G than for L2U transitions
  - Additional time required for CSFB transitions could be critical for emergency situations





# Thank You !

Questions?



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