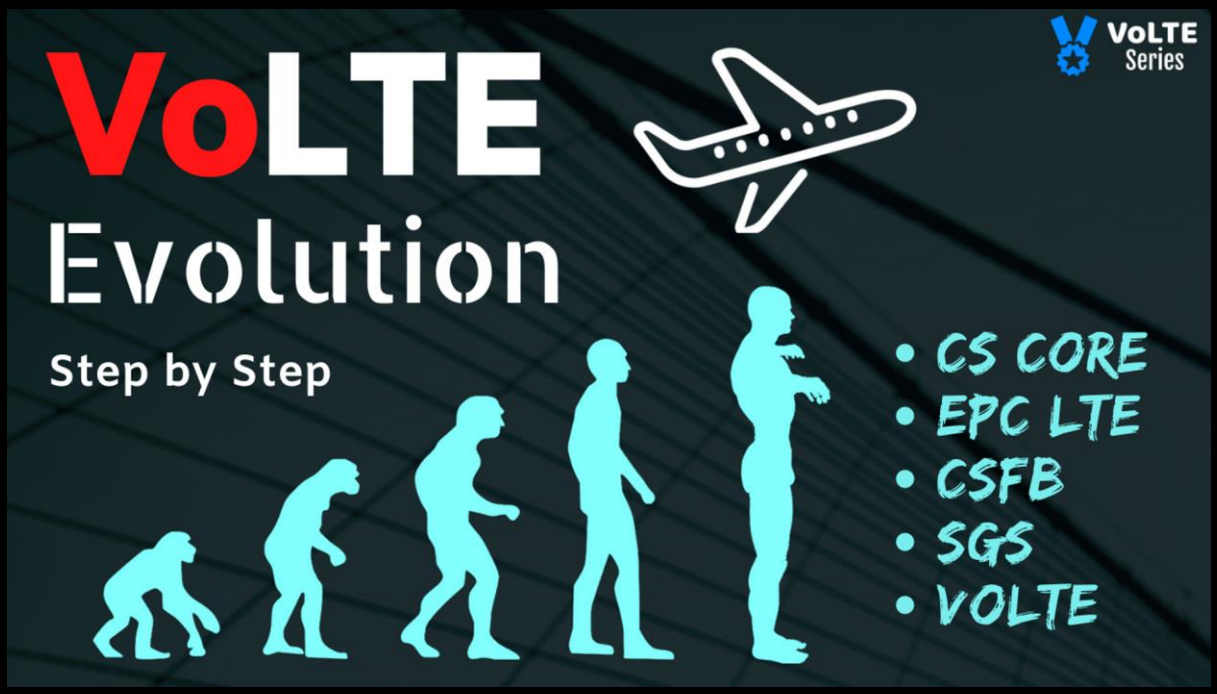
08 - Volte Evolution



Section # 1 (Evolution of Telephony)

- Difference between 2G / 3G –vs- 4G Non-VoLTE –vs- VoLTE Networks
- Services in Non-VoLTE 4G Vs VoLTE Networks
- The Problem with 4G (Non-VoLTE) Network?

Section # 2 (Voice Service Flow)

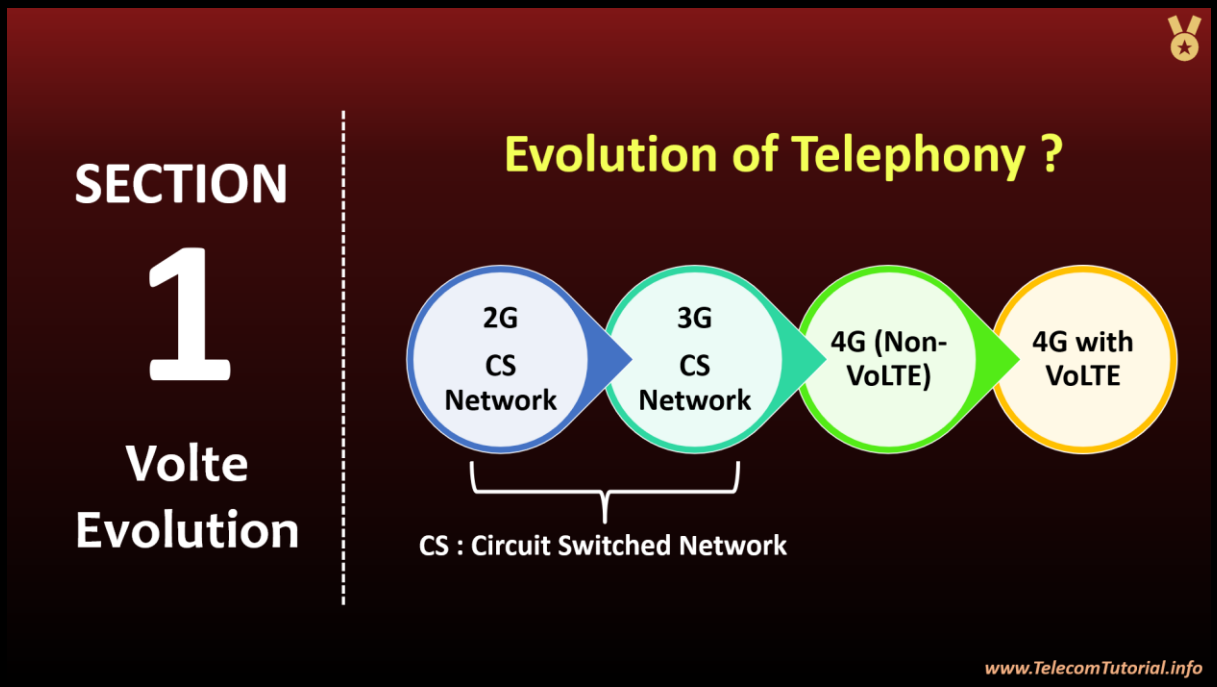
- Call in CS Core 2G / 3G Networks
- Call via CSFB where VoLTE is not available along with 4G
- Call in VoLTE where both 4G & VoLTE exists

Section # 3 (SMS Service Flow)

- SMS in CS Network: Using 2G / 3G
- SMS over SGs: SMS transit via SGs Link between 4G & 2G/3G
- SMS in VoLTE: over 4G Network using IP SM GW

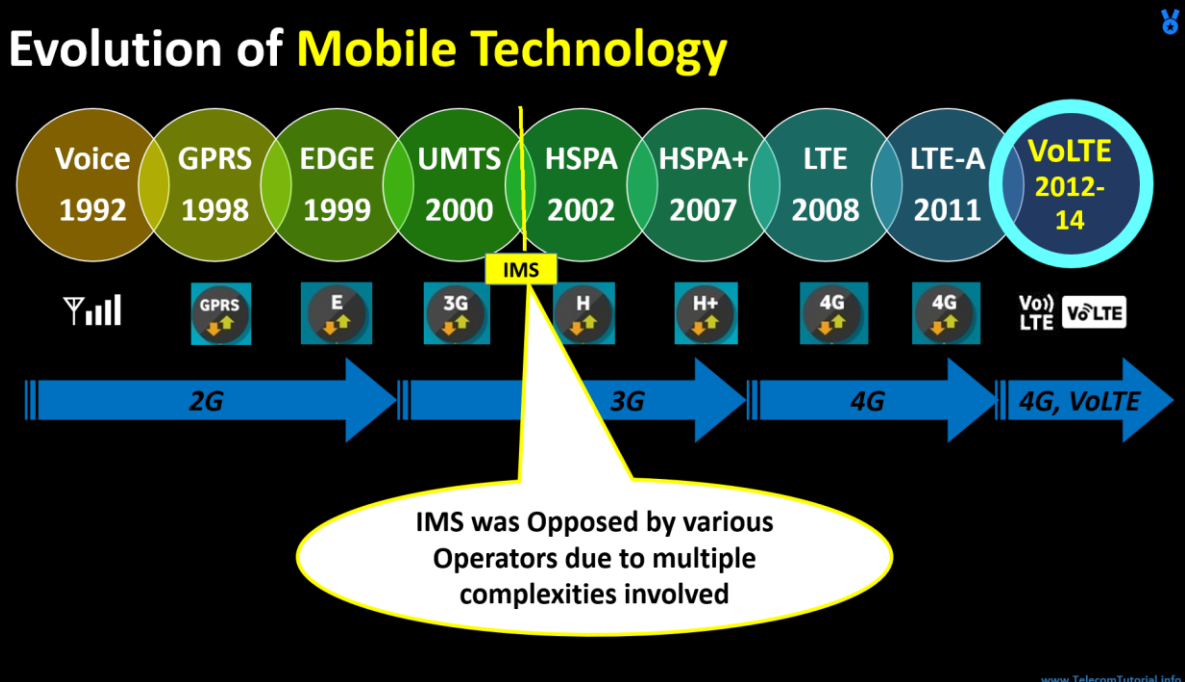
Section # 4 (CS Network Integration with VoLTE Networks)

- Re-use CS Network for VoLTE
- SRVCC between 4G and 2G/3G Networks
- Break-out Call to PSTN, or Break-in Call from PSTN



The entire Module is divided into 4 Sections . Now Welcome to Section-1 of this Module . Here we will discuss the background & evolution of Telephony services along with Network Evolution from 2G to 3G to 4G to VoLTE

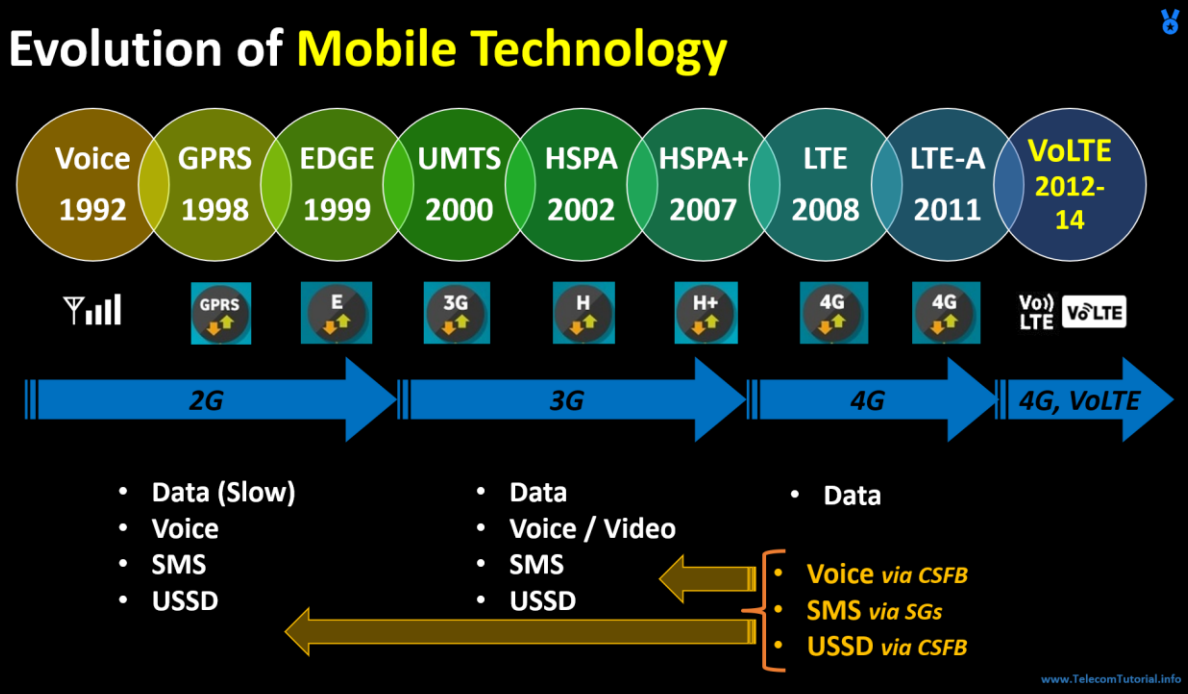
Here , I am calling 2G/3G Network as CS - **Circuit Switched Network** . I will using this terminology multiple times in coming Slides



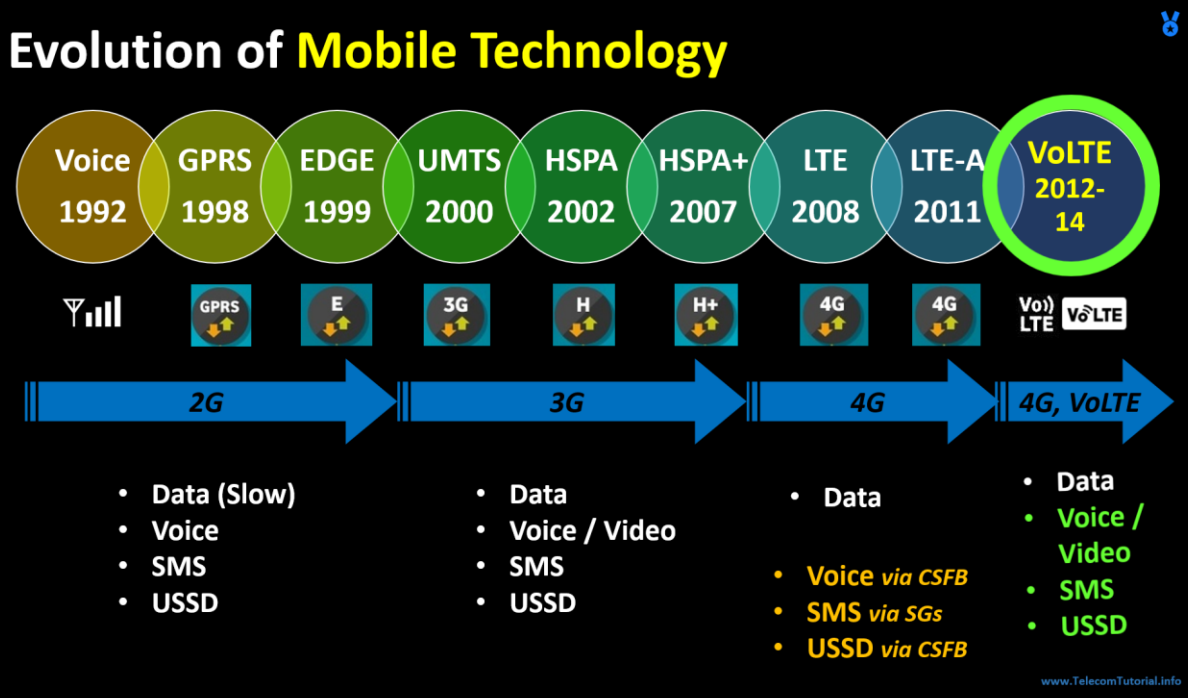
Do you know , When 2G Services were offered in late 90's , It came with GPRS & Edge . Which means it was complete package of voice , data & all telephony services . Similarly 3G was again evolved for supporting all type of voice and data services . It was also a complete Package of all Services

At same time , Work on IMS started late back in 1999 & it was introduced in year 2002 during Release 5 during evolution from 2G to 3G networks . During that time , SIP-based multimedia was added to support 3G and Fix line Networks .

At that time , IMS was Opposed by various Operators due to multiple complexities involved . Since 2G and 3G was able to provide almost all required data and voice services , No one felt need of IMS at that time in Year 20002 .

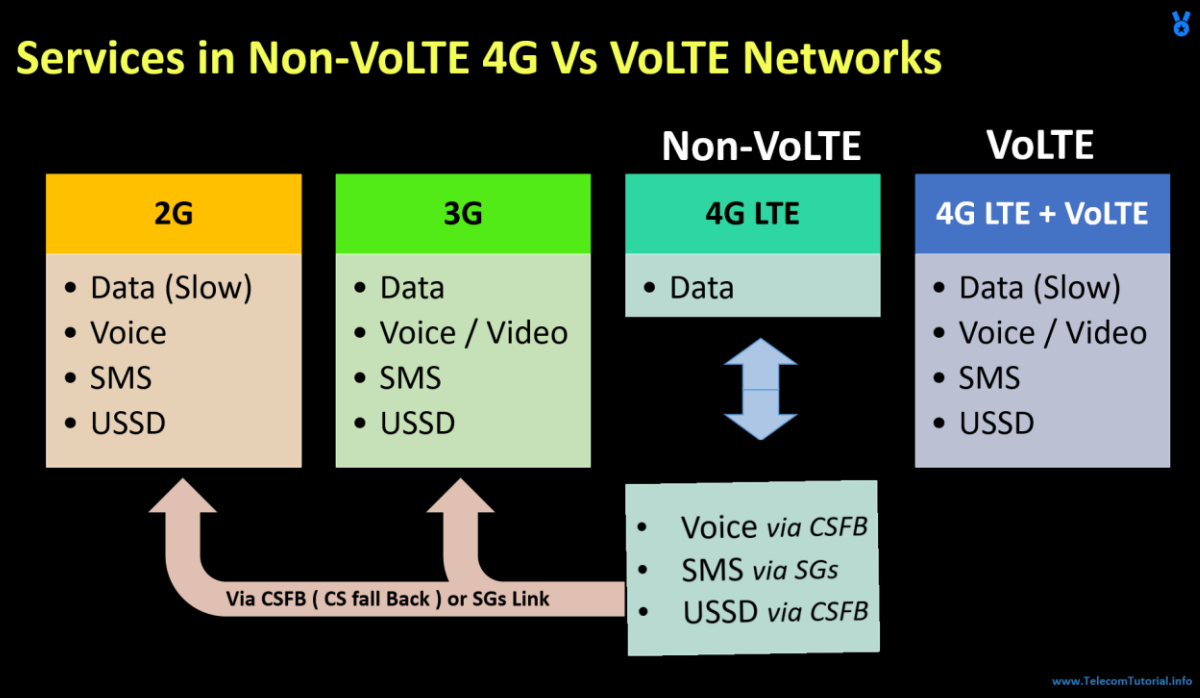


However, When 4G was launched in 2008 , it came with Data support only , there was practically no option for voice communication . For making voice calls , Customers have go to underlying 2G / 3G Networks . Which means 4G LTE was not complete . Operators can't have 4G only network . They need 2G or 3G network for support for Voice and telephony services . To support voice and other CS services CS Fallback was introduced



At this point of time Operators and Equipment manufacturers realized that they need to work on bringing Voice support over 4G LTE Network so that dependency on underlying 2G / 3G network can be eliminated . Further VoLTE was introduced on IMS technology to support Voice & other telephony services over 4G network making it comprehensive & complete

The revolution to bring VoLTE on ground started in year 2009, This initiative was called “One Voice” and the proposed solution was supposed to provide a seamless and common solution for voice over IP networks such as 4G or Wifi . Further , GSMA (Global System for Mobile Communication) got attention on this Subject & they started to work towards standardizing this as an official solution to provide next generation voice over LTE networks along with 3GPP , Finally we have seen initial working trial of VoLTE happening in Year 2012



Before we start , Let's understand which are broader services which are offered on any technology

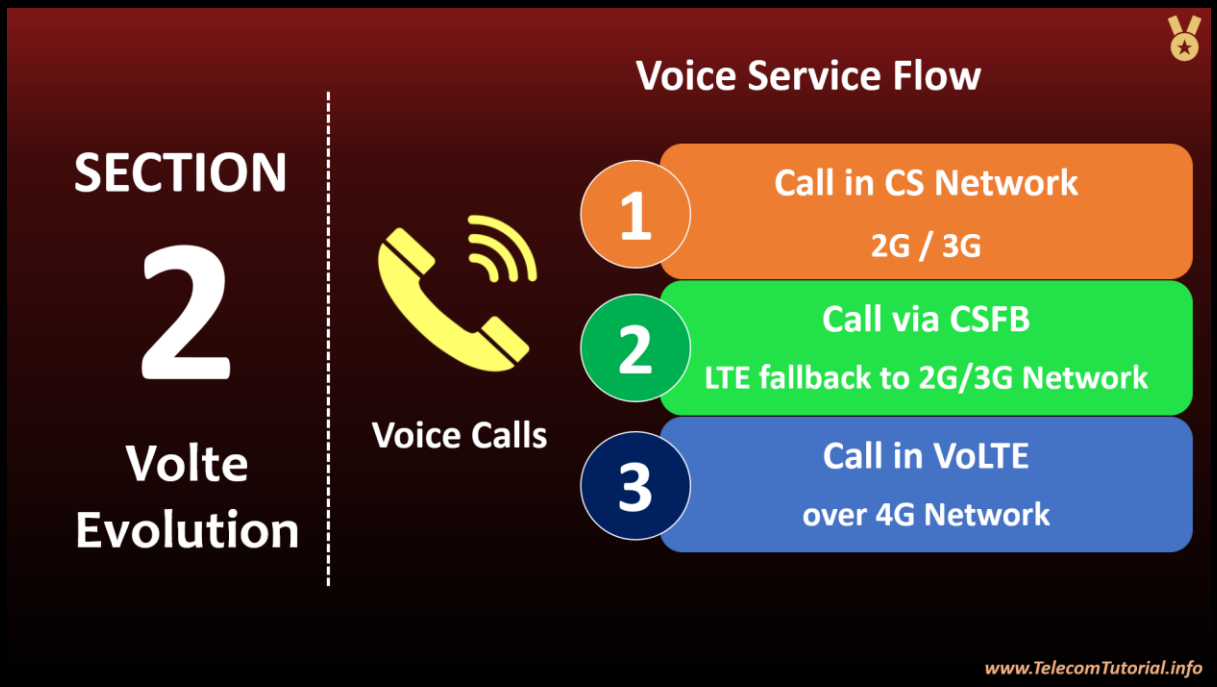
- **Voice Services :** Outgoing / Incoming call , Audio Conference & Short Codes etc..
- **VAS Services :** Missed Call Alert , CUG , Voice Mail Service etc..
- **SMS & USSD :** Outgoing / Incoming SMS , These start with.. *#
- **Roaming :** National & Intl. Roaming

In case of 4G Network which doesn't have VoLTE launched yet , Underlying 2G or 3G networks are used for basic telephony services

- Voice runs *via CSFB (Circuit Switched Fall Back)* on 2G / 3G Networks . We will discuss this in coming slides
- SMS *via SGs* & USSD *via CSFB* . These SMS and USSD goes back to 2G / 3G networks via SGs link and CSFB methods

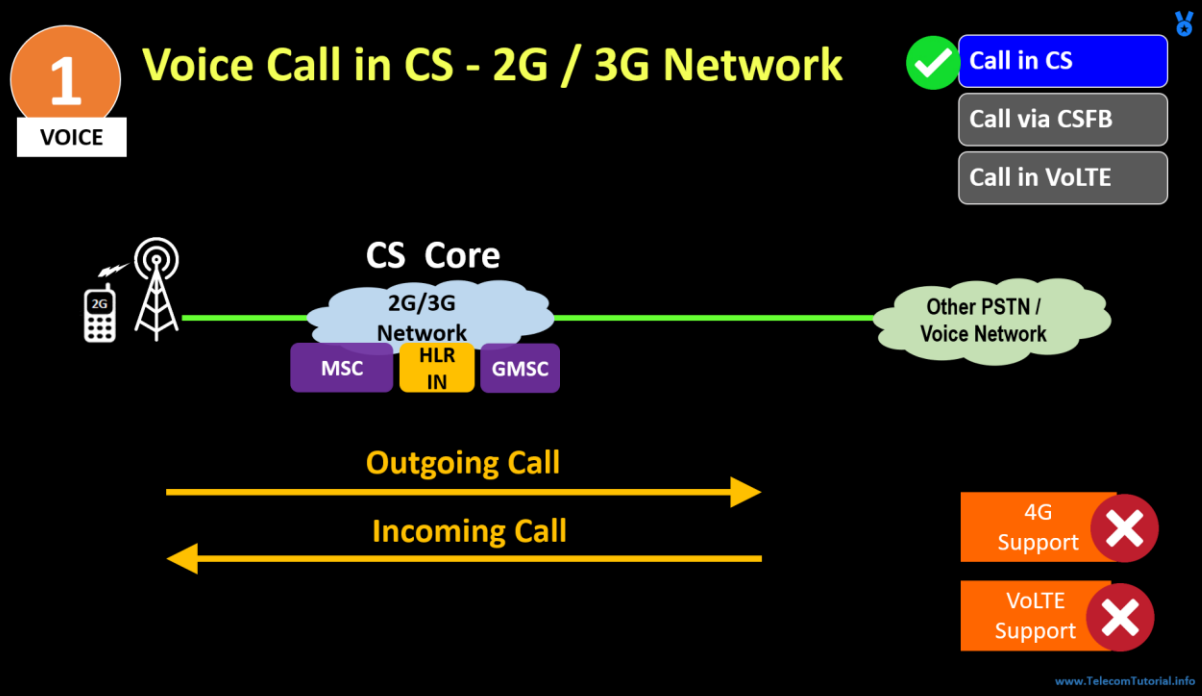
Net-Net , Non-VoLTE supporting 4G network needs 2G / 3G underlying networks for telephony services

In easy words , when mobile phone makes a voice call the network move the mobile phone to legacy 2G / 3G network. The mobile use the legacy network to initiate and complete the call. Once the call is over, Mobile phone again move back to the LTE network and enjoy high speed data services



Welcome to Section-2 of this Module . Here We will compare all 3 different type of Voice Scenarios , viz :-

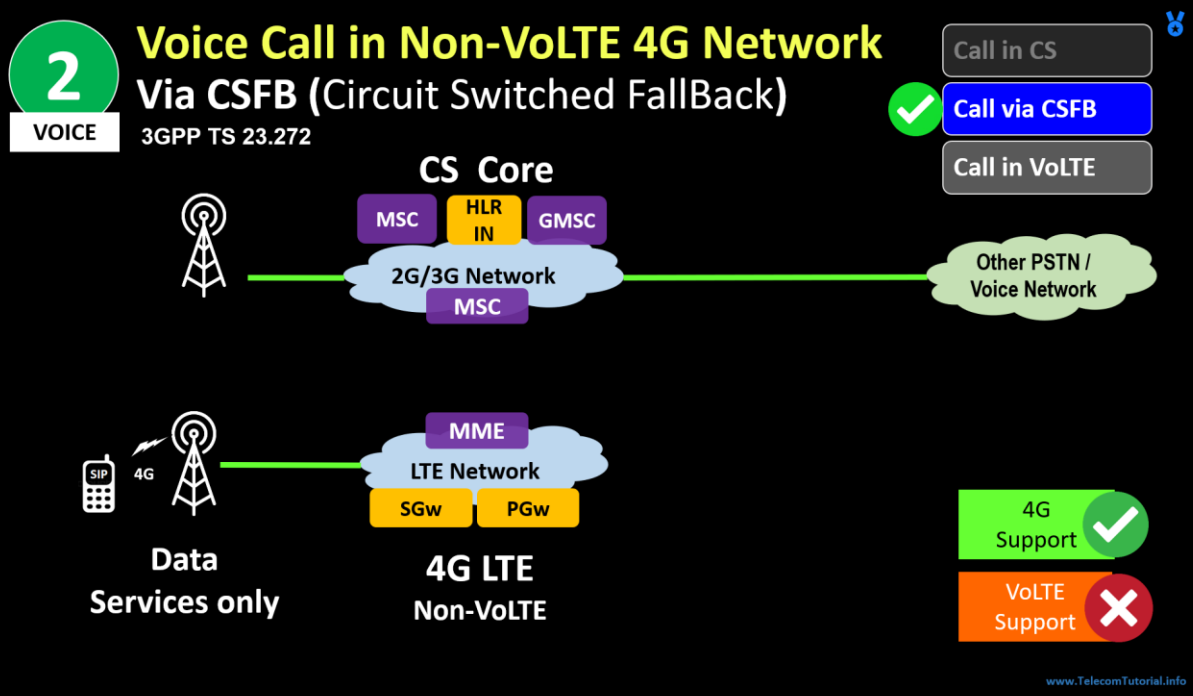
1. Call in CS Core 2G / 3G Networks
2. Call via CSFB where VoLTE is not available along with 4G
3. Call in VoLTE where both 4G & VoLTE exists



Voice Call in 2G / 3G Network

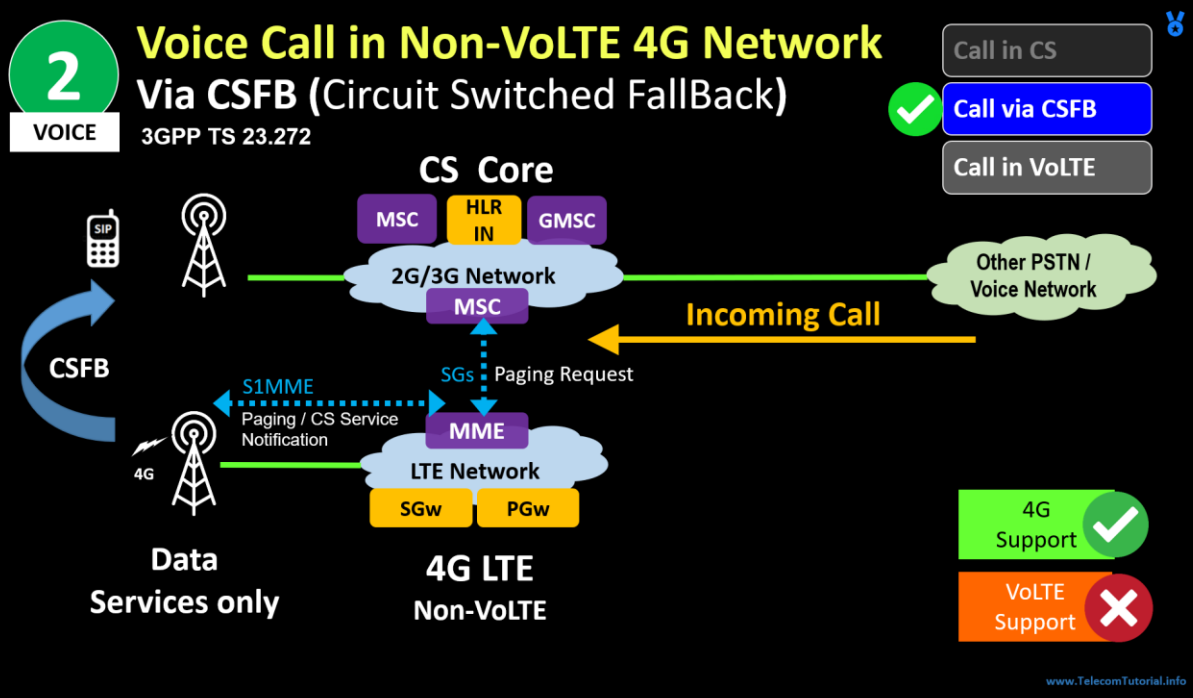
Here we are considering Non-4G network , obviously without any VoLTE support . The call goes directly CS Core Nodes to PSTN . i.e. User to MSC . MSC to GMSC & GMSC to POI or PSTN based upon routing defined in Network

The call is routed from UE to corresponding serving MSC . Here MSC takes a decision – Where to route the call . If B Party Number belongs to other Operator or PSTN , call is sent to PSTN via GMSC . Here GMSC is Gateway which serving all external traffic



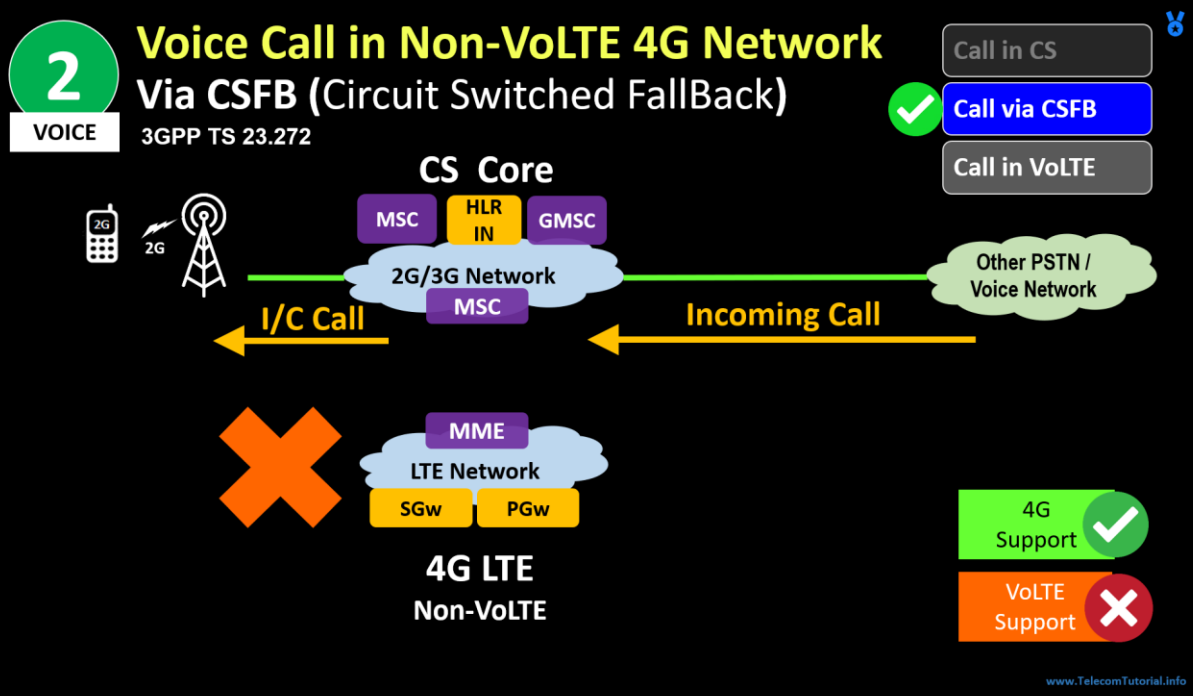
Voice Call in Non-VoLTE 4G Network Via CSFB (Circuit Switched Fallback)

We will see what is going to happen when Operator have 4G Network but VoLTE is not launched or supported yet . We will observe what happens during CSFB & How users switch between 4G and 2G / 3G networks during incoming or Outgoing call . In current scenario , User is attached to 4G Network where he is using data network for browsing Internet . The POI and PSTN connectives are still terminated on GMSCs which are part of CS core network (or 2G / 3G Networks)



For this incoming call , Since user is latched in 4G network . Here MSC of CS Network informs MME for incoming call by sending Paging Request via SGs link

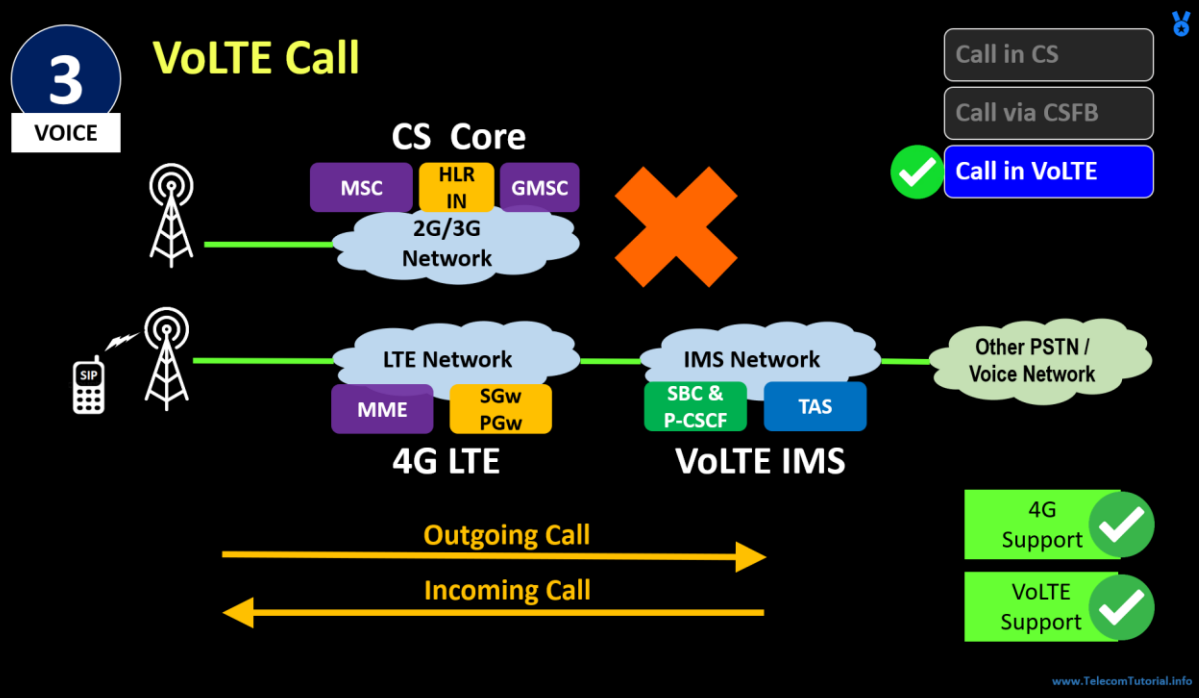
The MME receives a Paging Request with IMSI details from the MSC over a SGs interface . Now MME reaches out to user via Paging or CS Service Notification message depending upon Idle / Active state of user . Basically MME tells to UE that there is call for you & UE must move to underlying 2G or 3G Network . You can see UE moving to 2G / 3G network in diagram



Now Call is terminated to user in 2G / 3G network and CSFB Process is completed

There is similar flow for Originating call where UE goes to CS network for making outgoing calls , Once call is complete UE comes back to 4G network

Please Refer to 3GPP Specs ~ **3GPP TS 23.272** for further studies on CS Fall back or CSFB

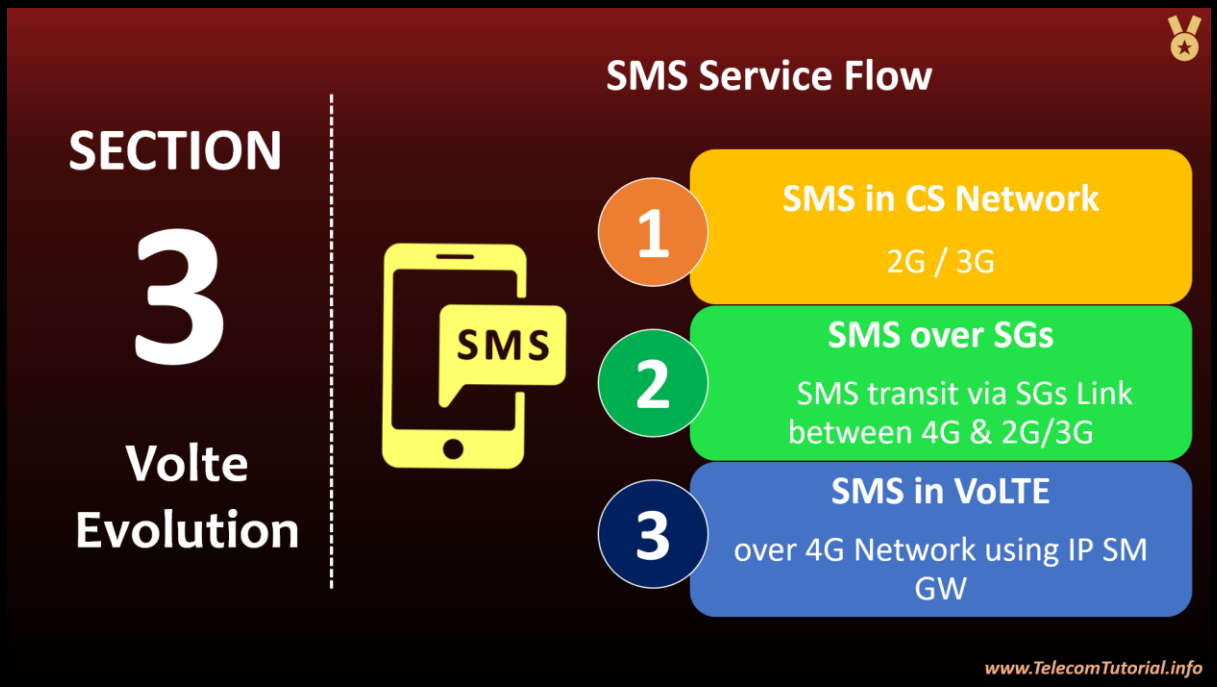


VoLTE Call

Since VoLTE SBC is capable of sending out call directly to External Networks , We will breaking out outgoing call directly from VoLTE Network . This means all POIs and Other Operator Interconnects can be established on IMS VoLTE Networks

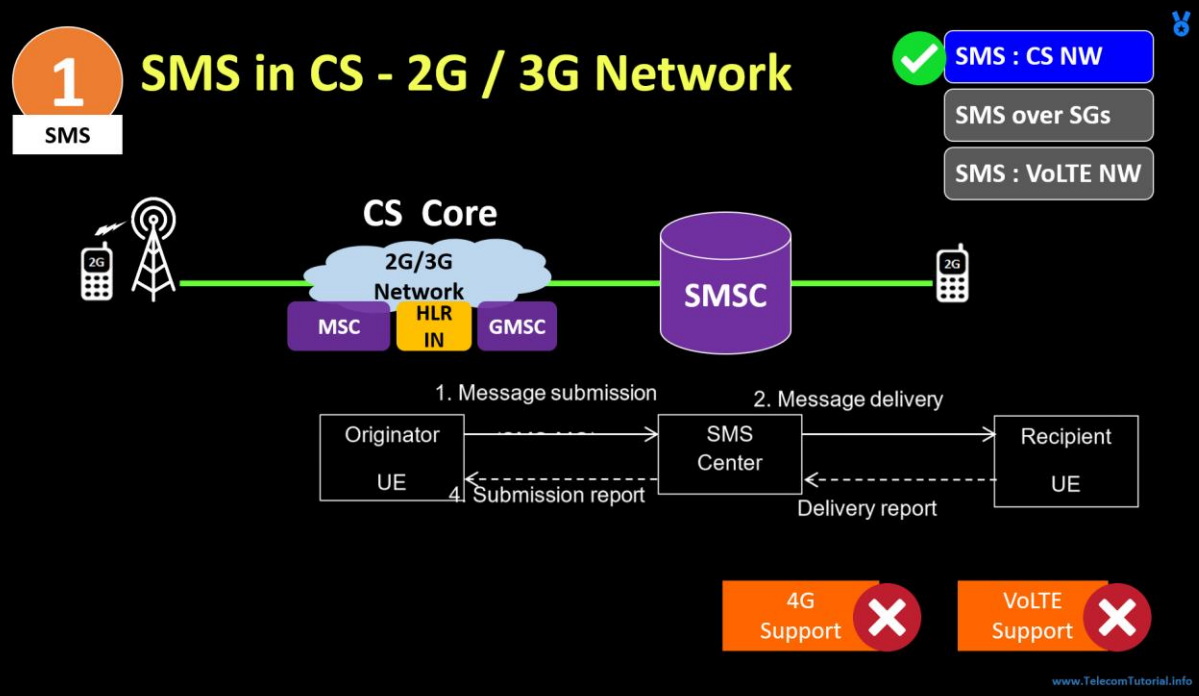
Whenever UE is making outgoing call , It goes from SGW to PGW to SBC . Here SBC process all SIP messages & process the call prior to breaking out to PSTN Networks

Similarly , Incoming calls can be processed directly within VoLTE Network without involving physical path via CS Networks



Welcome to Section-3 of this Module . Here we will see , How SMS goes on all different type of technologies – CS , SGs & VoLTE . Objective to get high level understanding on flows so that we build our fundamental here

1. SMS in CS Network : Using 2G / 3G
2. SMS over SGs : SMS transit via SGs Link between 4G & 2G/3G
3. SMS in VoLTE : over 4G Network using IP SM GW

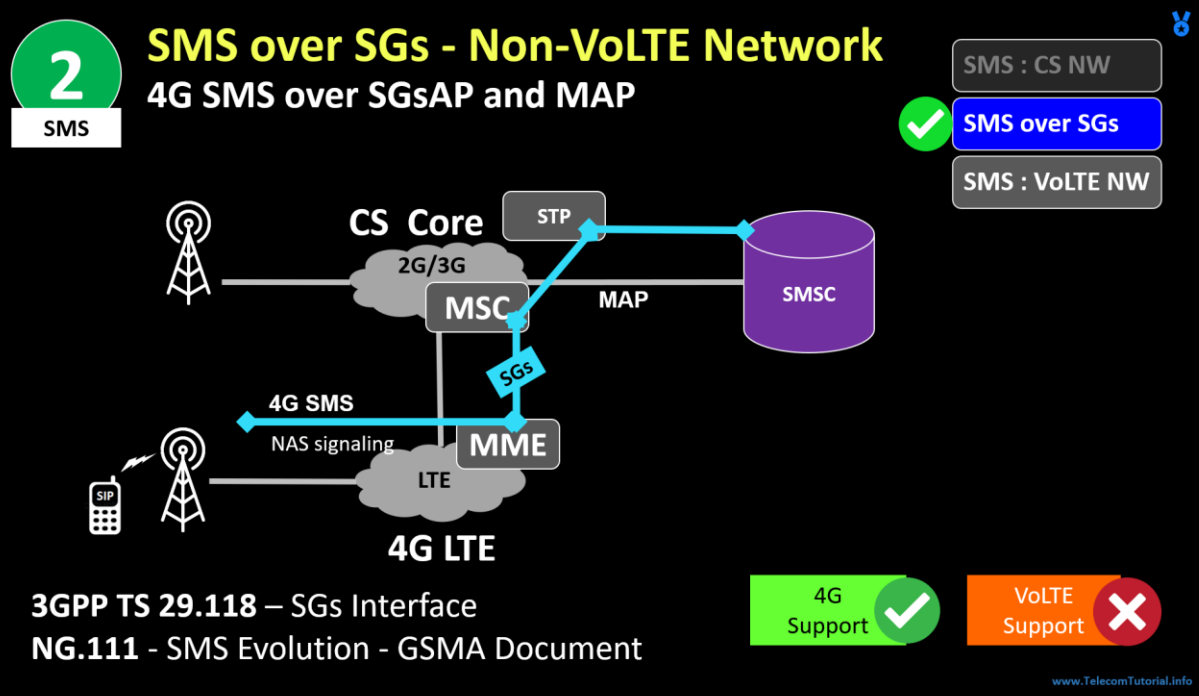


SMS on CS Network – 2G / 3G

As you are aware , There are 2 types of SMS :- Person-to-Person (P2P) & Application-to-Person (A2P)

The SMS or Text messages are routed to SMSC . We also call this as Short Message Service Centre . Once , SMSC receives the SMS successfully, It sends the acknowledgement back to the originating UE which shows to sender “Message sent“

However , this does not mean that the recipient has received the text message . SMSC Stores the SMS & forward to B Party whenever it is available

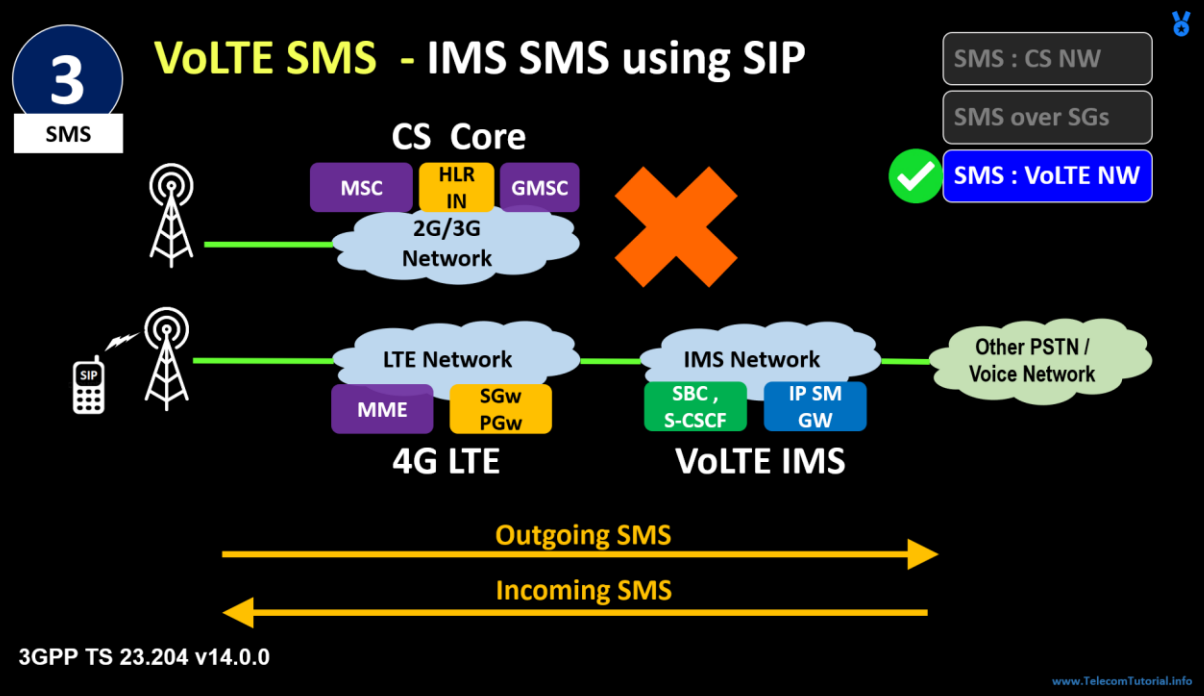


SMS over SGs

There are two main ways SMS is carried over LTE or 4G Network . We are going to discuss SMS Over SGs method which is used in Non-VoLTE 4G Networks

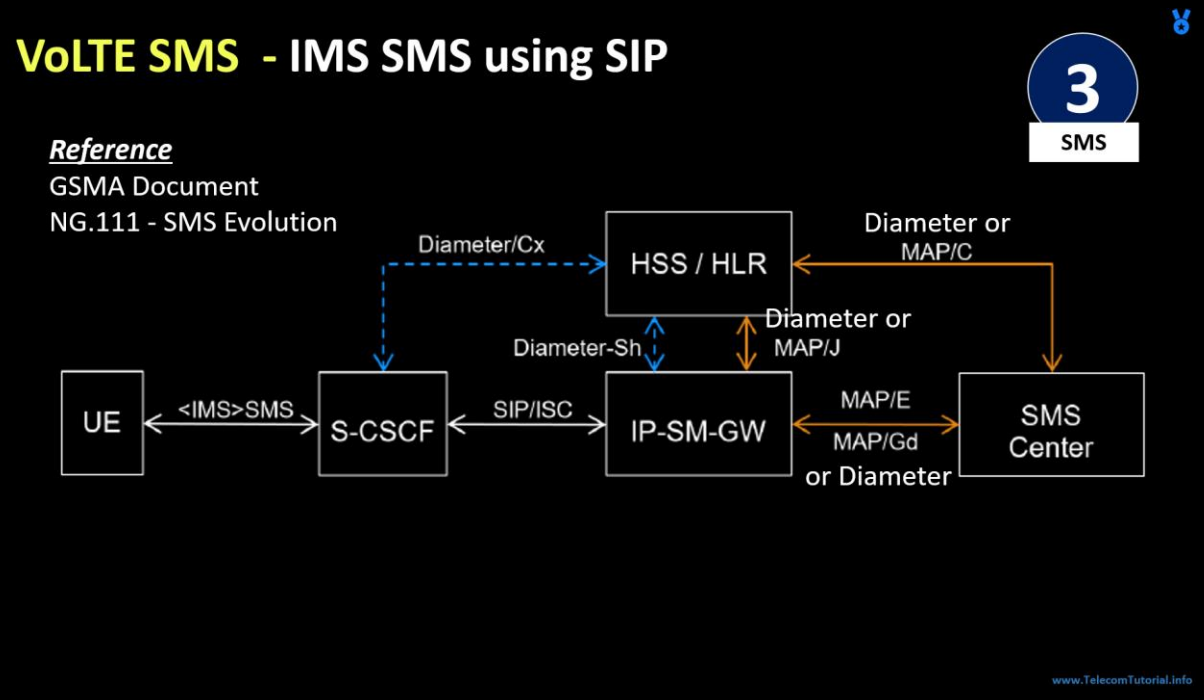
This is also called as SMS over the Signaling Gateways SGs (it is evolved Gs interface) . Well this is hybrid approach that allows the transmission of traditional SMS from LTE 4G Network using underlying CS Core as transit layer . Going by Specs , SMS over SGs was specified in 3GPP TS 29.118 . The SGs based on GS is also used to handle mobility management and paging procedures between the LTE 4G and CS domain , For example it is also used for Voice call happening on CSFB we have seen some time back

Here , 4G enabled UE device sends and retrieves SMS messages via CS Network using SGs link between MME and MSC . This SGs link act as bridge for providing Telephony services to user . Point to be noted here , In this type the UE does not fall back to legacy 2G / 3G Network and stick to 4G Network while sending or receiving messages

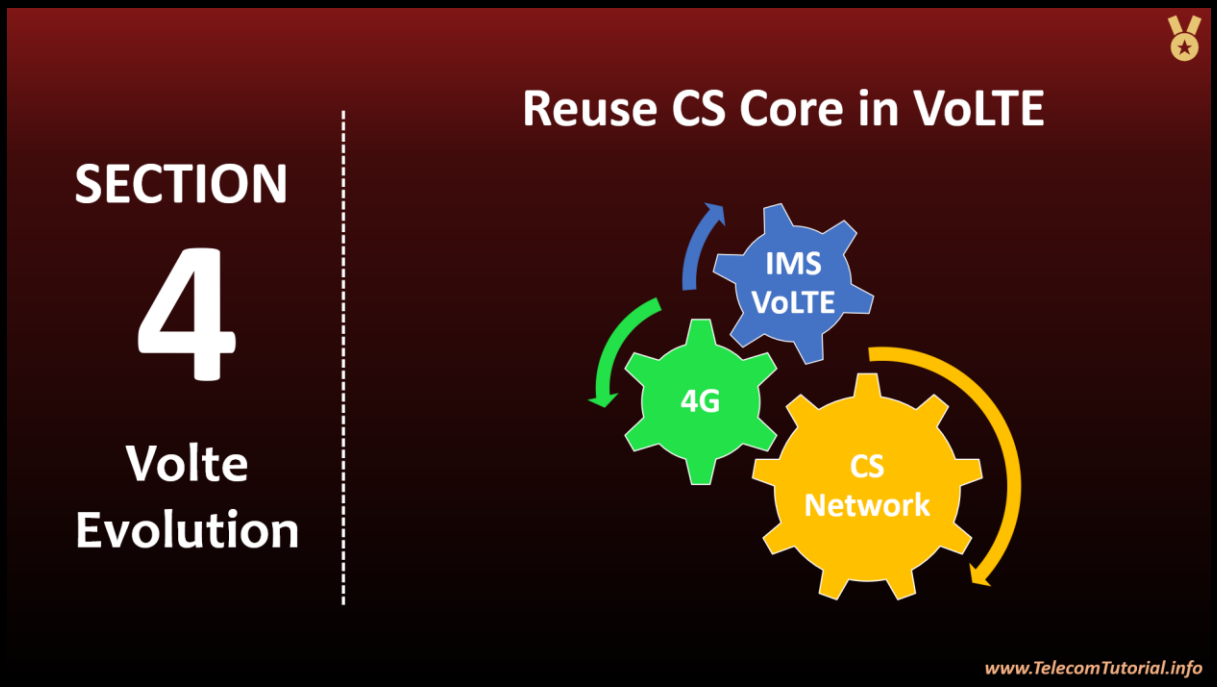


VoLTE SMS

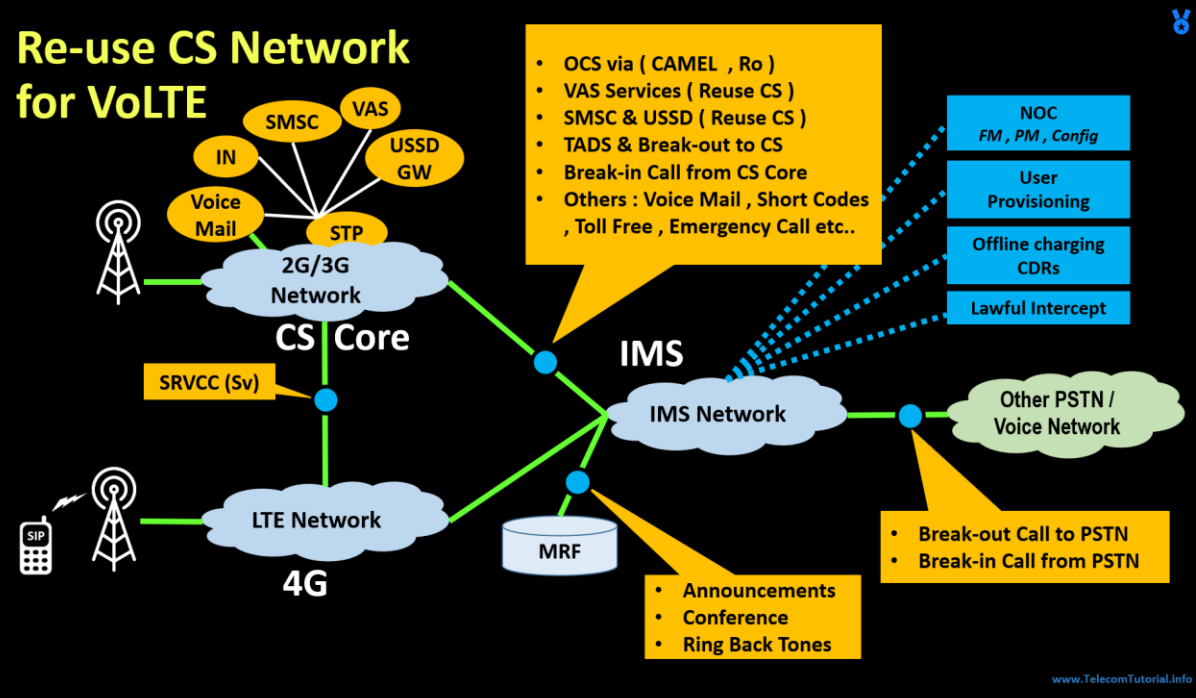
As you are aware , There is better way to handle SMS on 4G Networks . VoLTE network has inbuilt support for SMS over SIP . The VoLTE phone have binary which support native SIP client . There are 2 main difference in this solution .. 1) The SMS is sent all over 4G Network without any use of underlying CS Network 2) This time , the SMS is sent from an IMS network over SIP protocol



This is referral diagram from GSMA Document : NG.111 - SMS Evolution . This explains the high level flow and architecture for SMS over 4G IMS VoLTE Networks . The 4G network have become self sufficient to support the SMS sent over SIP here . There is new Node **“IP-SM-GW”**, placed between the IMS core and the legacy domains . This **IP-SM-GW** further communicate with HLR / HSS and SMSC for handling SMS transactions . Please Note , Communication between IP-SM-GW to HLR / HSS and SMSC can happen over either MAP or Diameter protocols



Welcome to Section-4 & last of this Module . Here we will how VoLTE Deployment can leverage various services served from CS Network



Re-use CS Network for VoLTE

The objective of this diagram is to explain you how many things we can leverage while growing from CS to VoLTE . We will also cover deep Integration which works between CS & VOLTE Networks

1. **SRVCC between 4G and 2G/3G Networks** : The 1st One is SRVCC where you can see Sv link connectivity between CS Core MSCs and 4G Network MME . SRVCC Stands for Single Radio Voice Call Continuity , It provides a solution for handing over VoLTE (Voice over LTE) to 2G/3G networks when you go out of 4G coverage area during VoLTE Call

2. **Break-out Call to PSTN , or Break-in Call from PSTN** : You can see connectivity with other Operators in Diagram which connects IMS VoLTE network to Other PSTN networks , Yes VoLTE Network is capable to handover calls directly to other Operators . The Breakout Gateway Control Function or BGCF selects next hop or Destination to PSTN Networks .. These calls may be exchanged over TDM or IP

3. **IMS to CS Network connectivity for General Purpose** :- For Operators , Who evolved from 2G / 3G Network to 4G VoLTE , There are so many integrations which still reside on 2G / 3G , i.e. CS Core Network . We Re-Use many of these existing Integrations for VoLTE Network . Let's some of these examples :-

    - **OCS via (CAMEL , Ro)** – Your IN or Prepaid Charging Nodes may still be connected to CS Core STP / DRA Networks over MAP / Ro Protocols . Here STP / DRA are part of old CS Core network . We simply build connectivity from TAS to DRA & STP to reach to all such Nodes such as IN

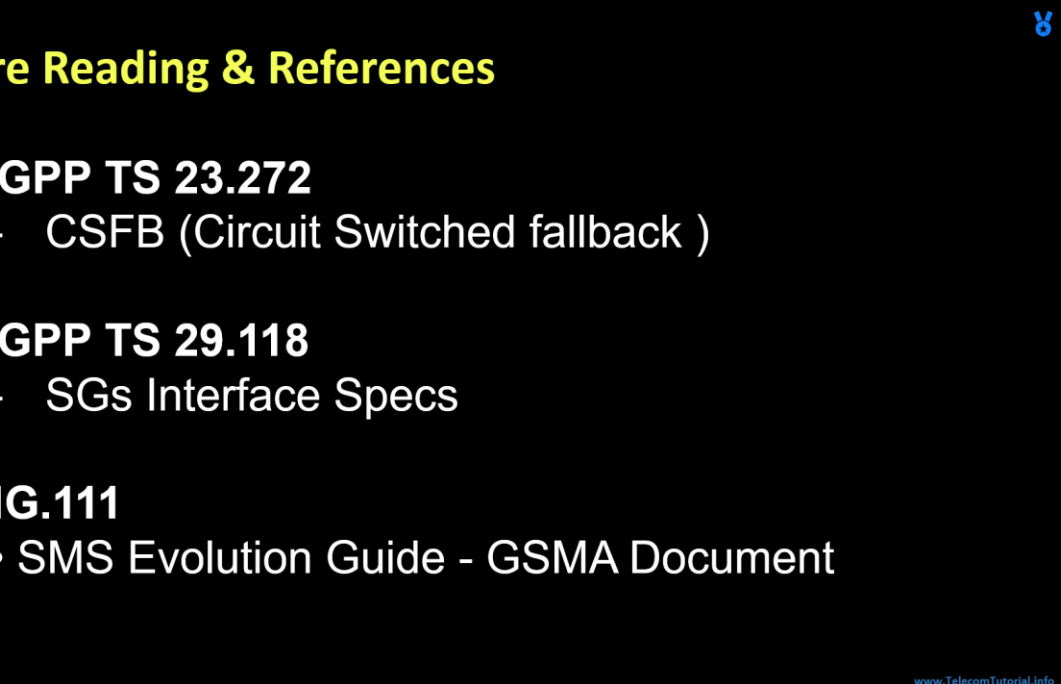
    - **VAS Services (Reuse CS)** : We re-use existing VAS Services which are connected in CS Network . Example for such services are Hello Tunes and Caller Ring Back Tone(CRBT) , Voice Mail , Missed call alerts , Call filtering

    - **SMSC & USSD (Reuse CS)** : We can also re-use existing SMSC & USSD Gateway which are already connected in CS Core Network

    - **TADS & Break-out to CS** : T-ADS features implement the routing decisions for a terminating call. It provides support for route call towards CS Core or VoLTE network on basis of current state of user . In case user is not reachable in VoLTE Network , Mobile Operators page & search customer in 2G / 3G network as well with help of this

    - **Break-in Call from CS Core** : For VoLTE to 2G/3G Calls within same network we can break-in / break-out call to CS Networks

    - **Others Traffic** : We can also route other traffic to CS Core for further routing . This involves **Voice Mail , Short Codes , Toll Free , Emergency Call**



Well now we are at the end of this Module , You can refer to these documents for Future Reading & References

You need to simply type them in google & download PDF copy

- **3GPP TS 23.272** will tell you about CSFB (Circuit Switched fallback)
- **3GPP TS 29.118** will tell you about SGs Interface Specs which is key to run 4G Network for Voice / SMS
- **NG.111 –** This is SMS Evolution Guide - GSMA Document . My personal recommendation for you to learn bits and bytes on SMS