How to hijack VoLTE network

Pavel Novikov
Pavel.Novikov@security-gen.com

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Telecom Security. Transcending Generations.

Bio

-10 years in telecom security,
-co-author of GSMA FS.20 GPRS Tunneling Protocol (GTP) Security document
-Head of telecom security research in SecurityGen
-Focused on telecom vulnerabilities: RAN, VoLTE, VoWiFi, GTP, Diameter, 5G SA and NSA.
-Conducting telecom security assessments for mobile operators for many years.

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Research Team

-Pavel Novikov (SecurityGen)
-Alex Onegov (ex-SecurityGen)
-Sergey Mashukov (SecurityGen)

Relevance of the topic

Why now?

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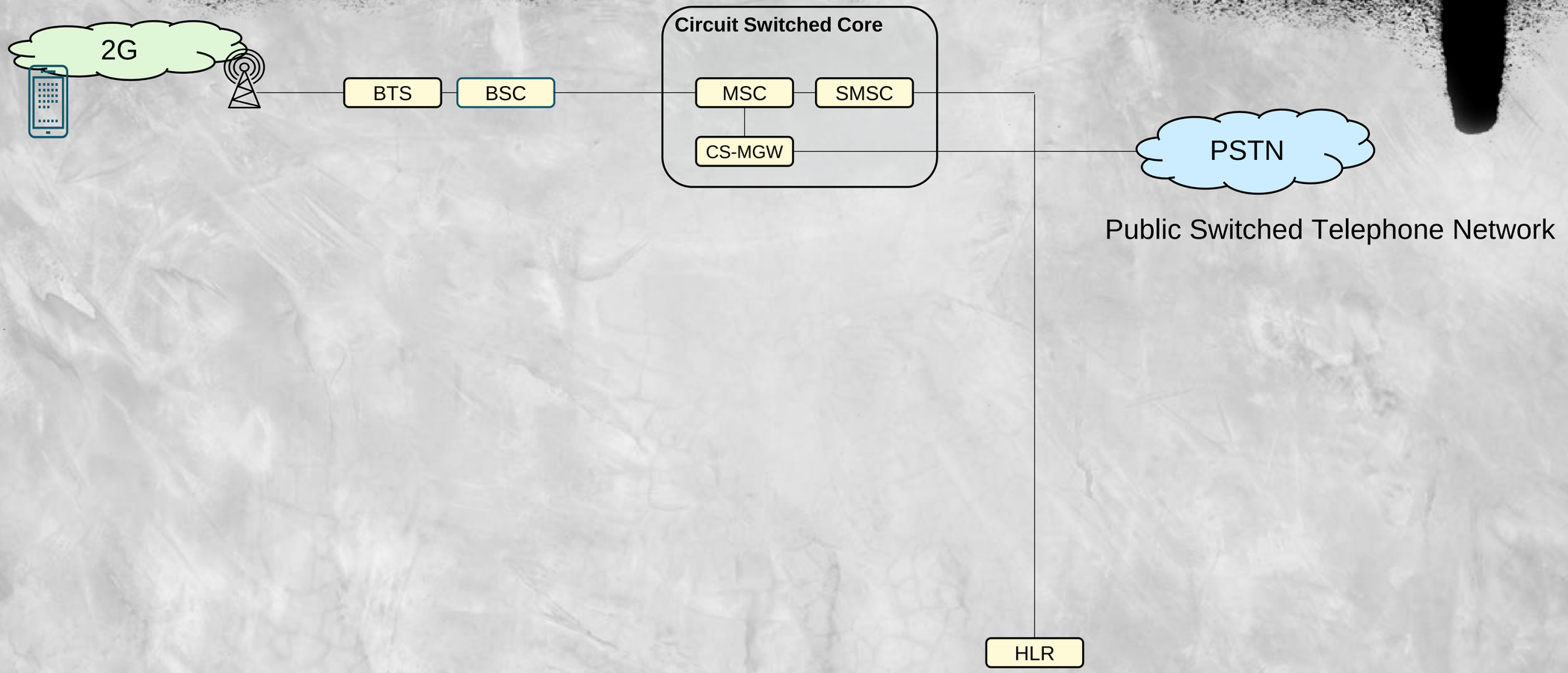
Short course of mobile network evolution

2G voice-only



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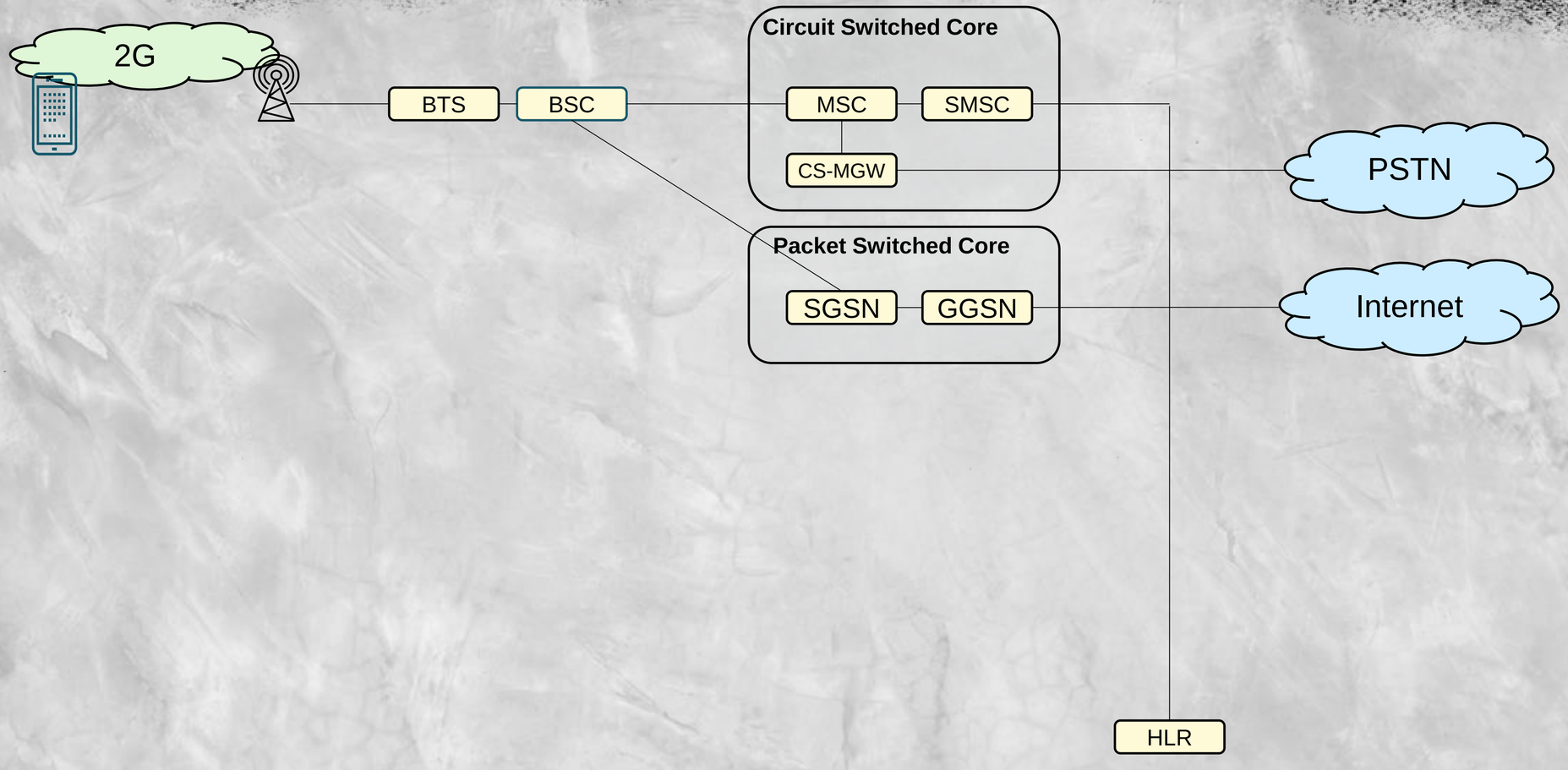
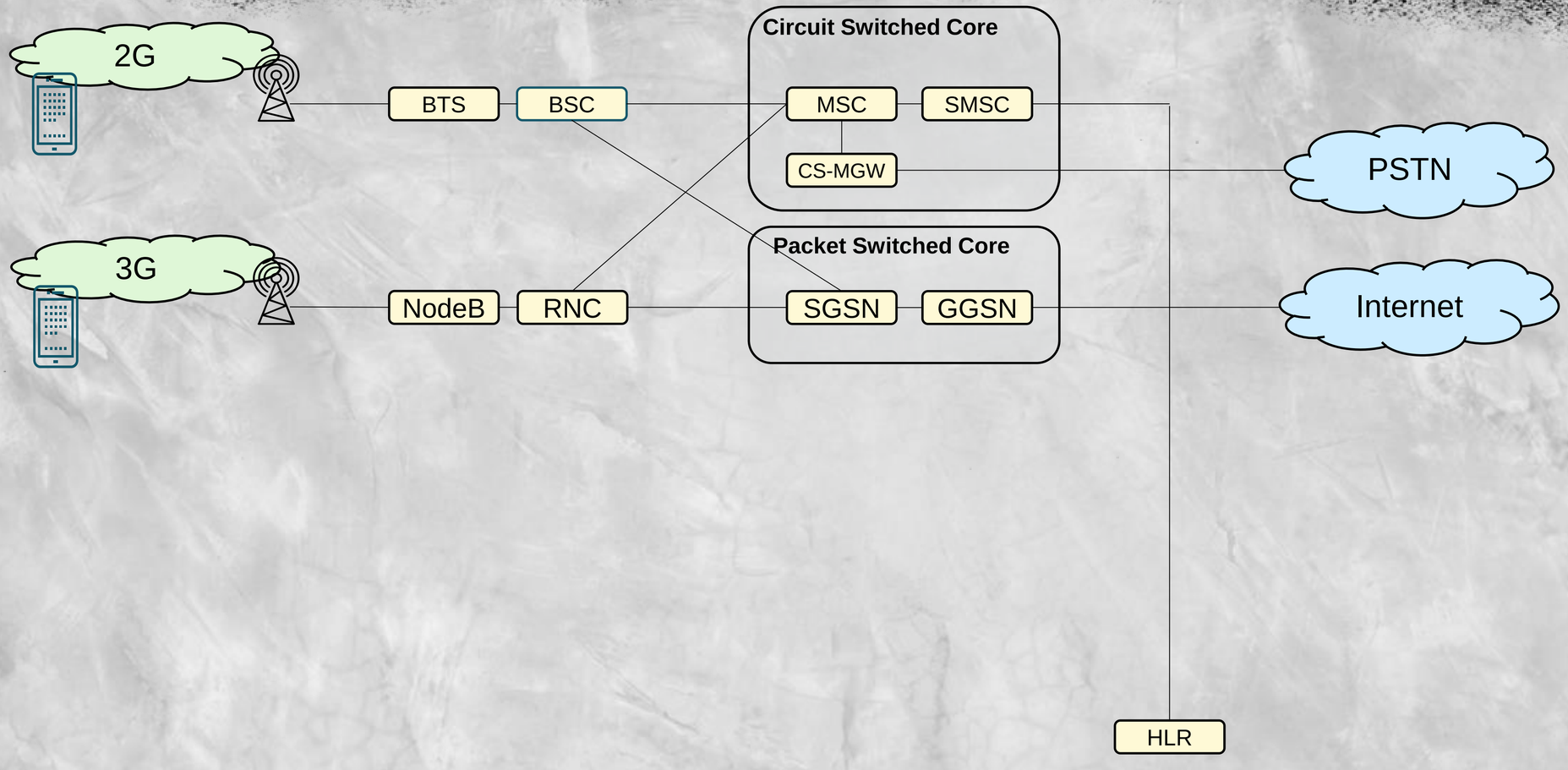
2G +Data


2G
BTS
BSC
Circuit Switched Core
MSC
SMSC
CS-MGW
Packet Switched Core
SGSN
GGSN
PSTN
Internet
HLR

+3G network


2G
3G
BTS
BSC
NodeB
RNC
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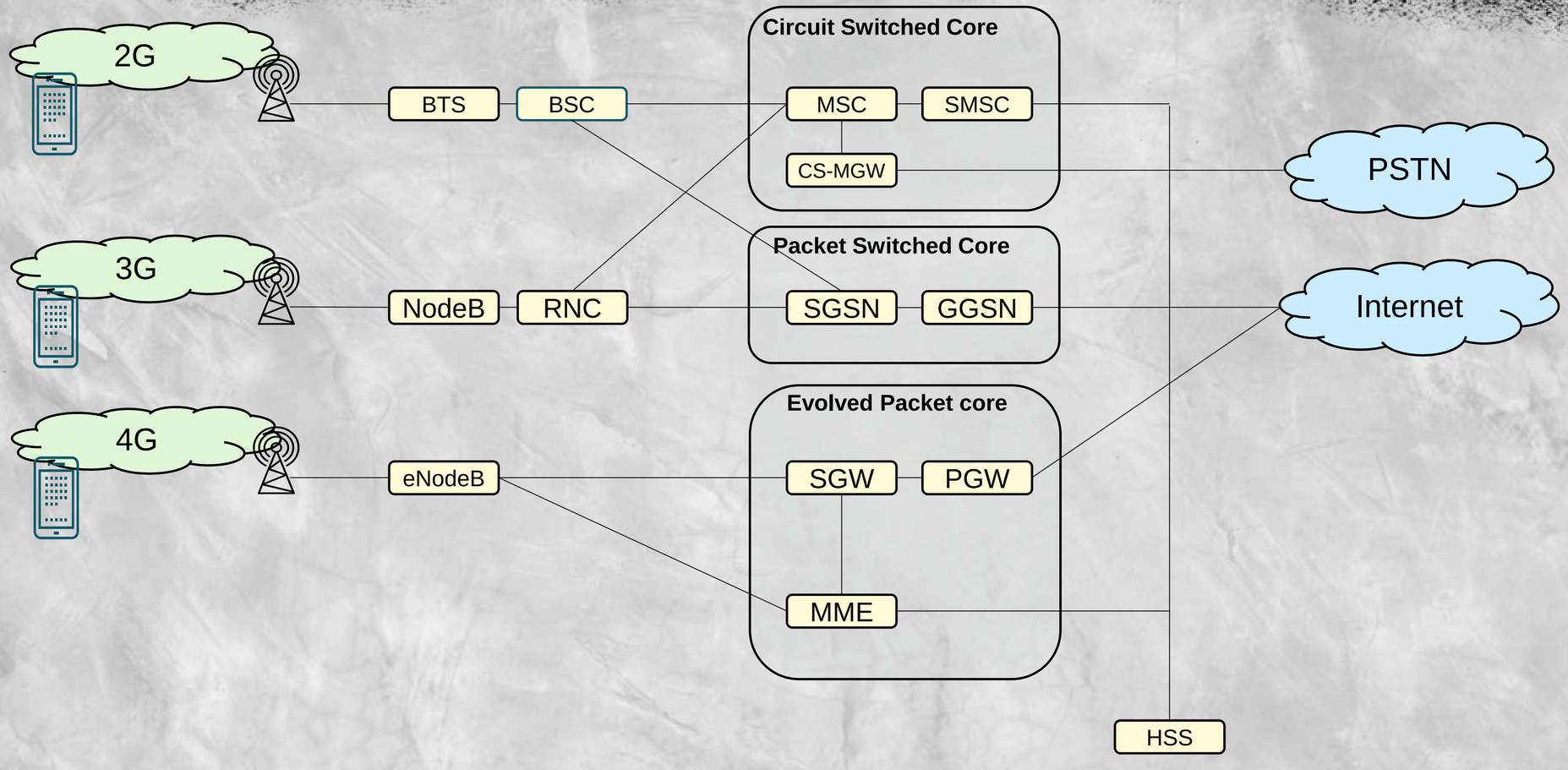
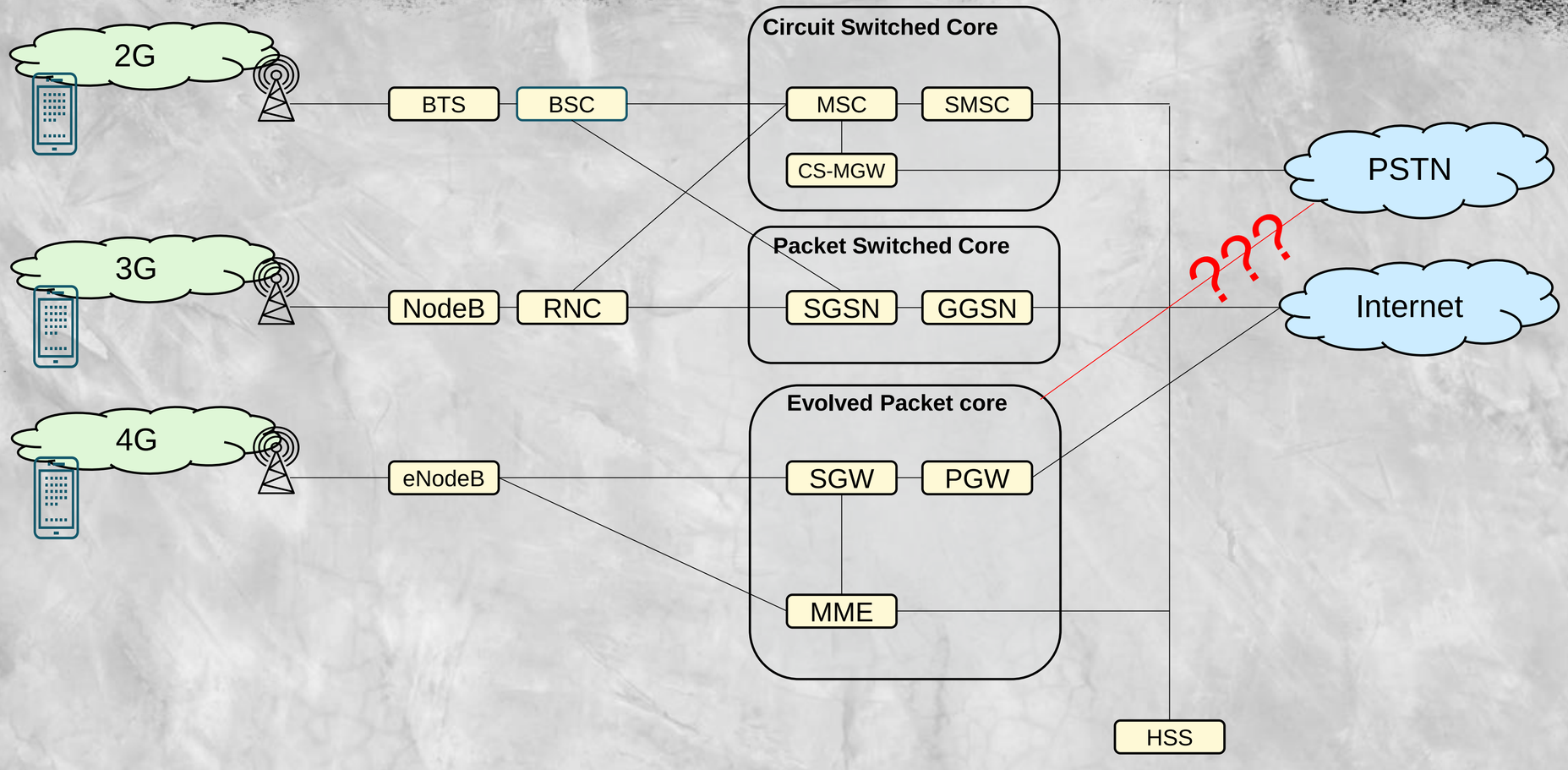
+4G data


2G
3G
4G
BTS
BSC
NodeB
RNC
eNodeB
Circuit Switched Core
MSC
SMSC
CS-MGW
Packet Switched Core
SGSN
GGSN
Evolved Packet core
SGW
PGW
MME
HSS
PSTN
Internet

4G voice?



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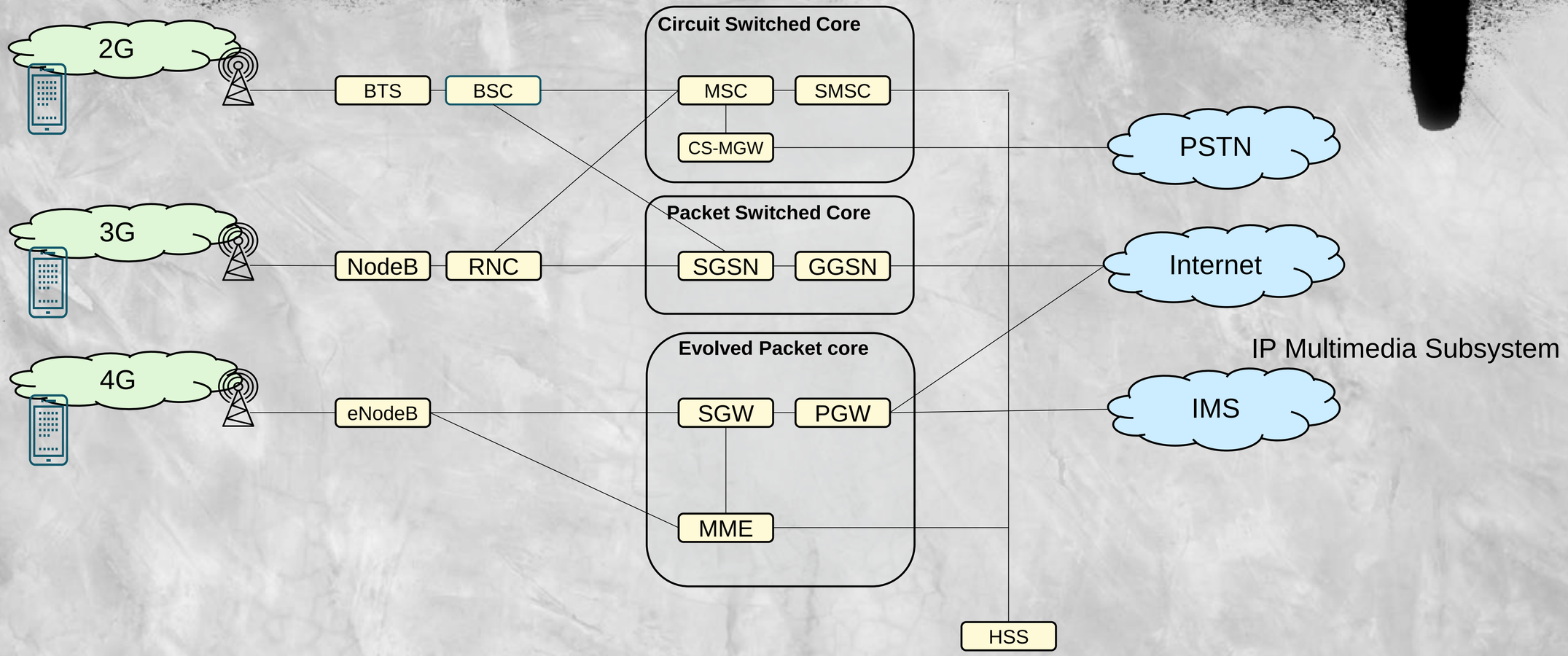
4G native voice



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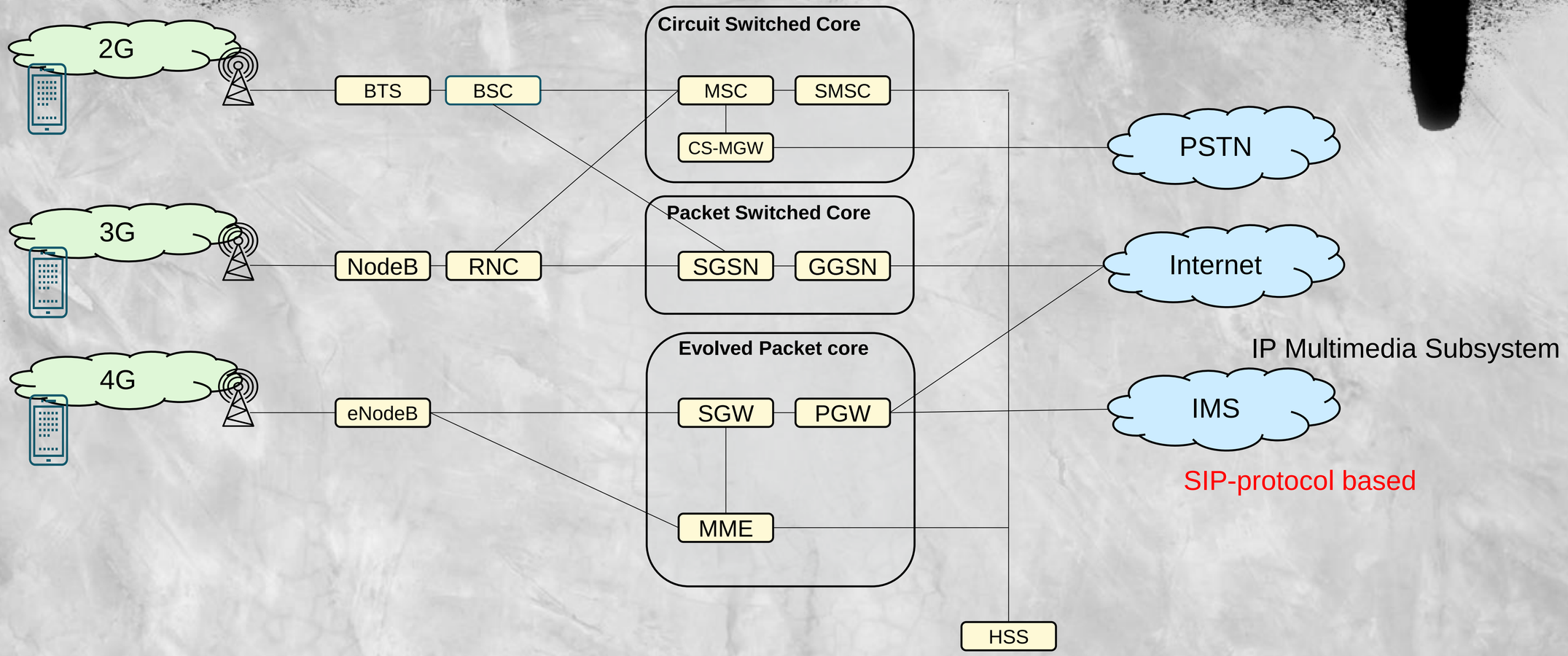
4G native voice



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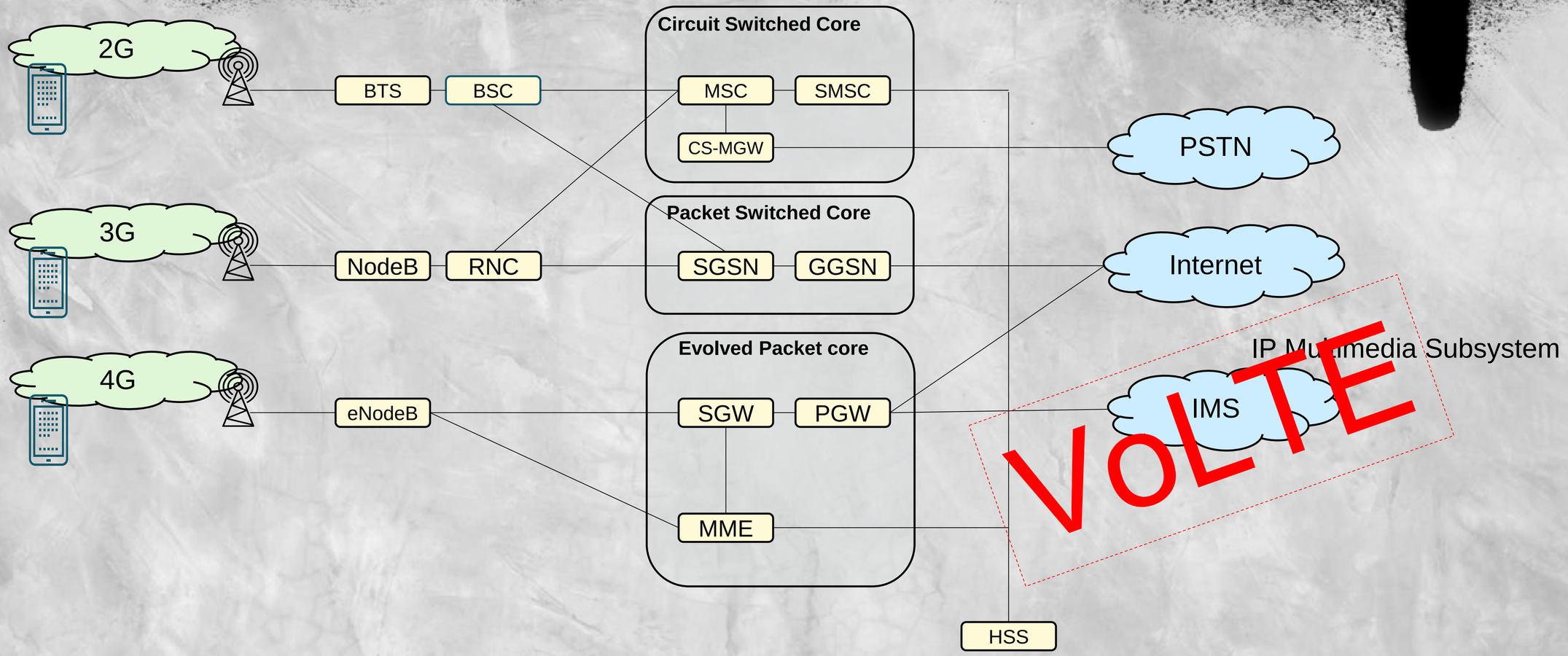
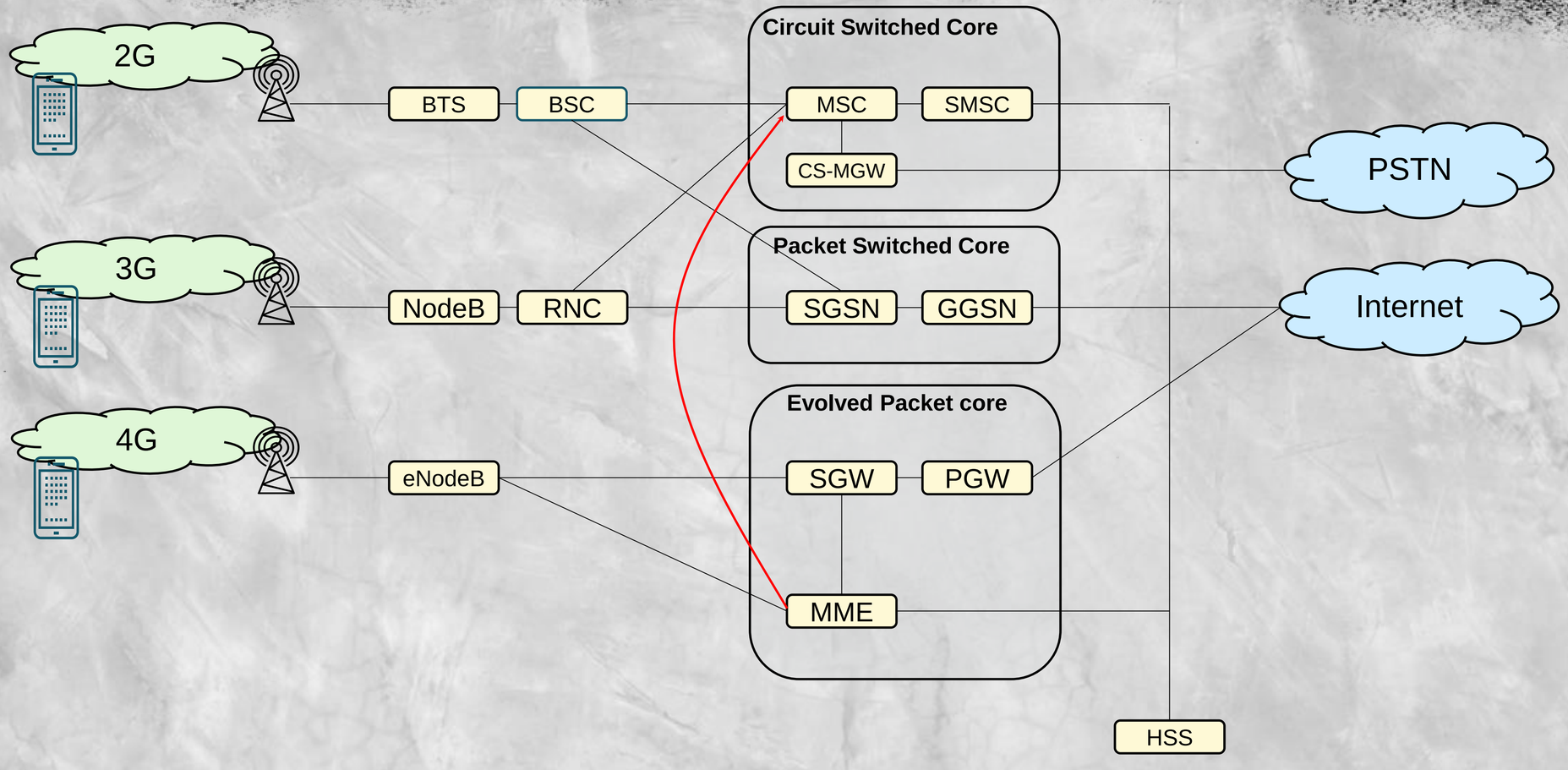
Voice-over-LTE = VoLTE



CS-Fallback voice



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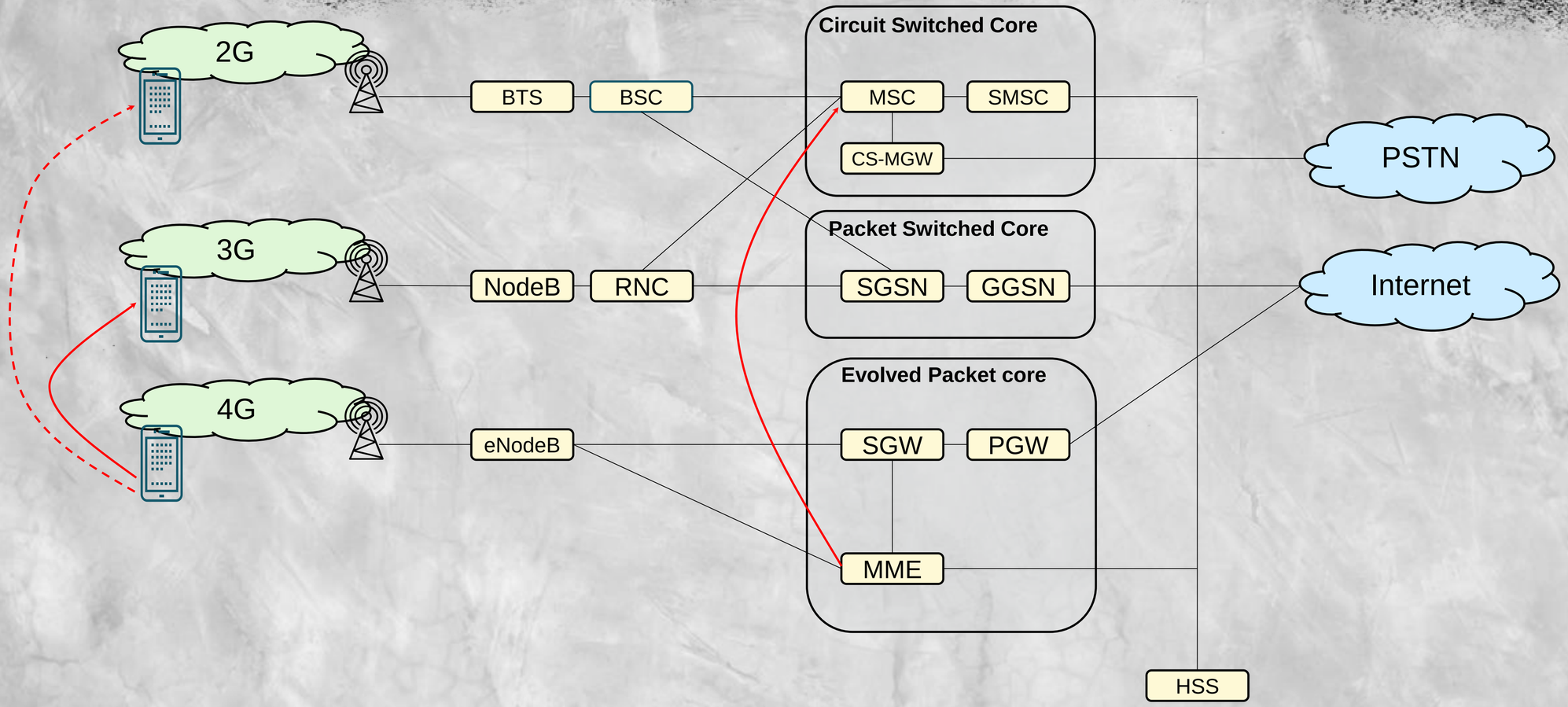

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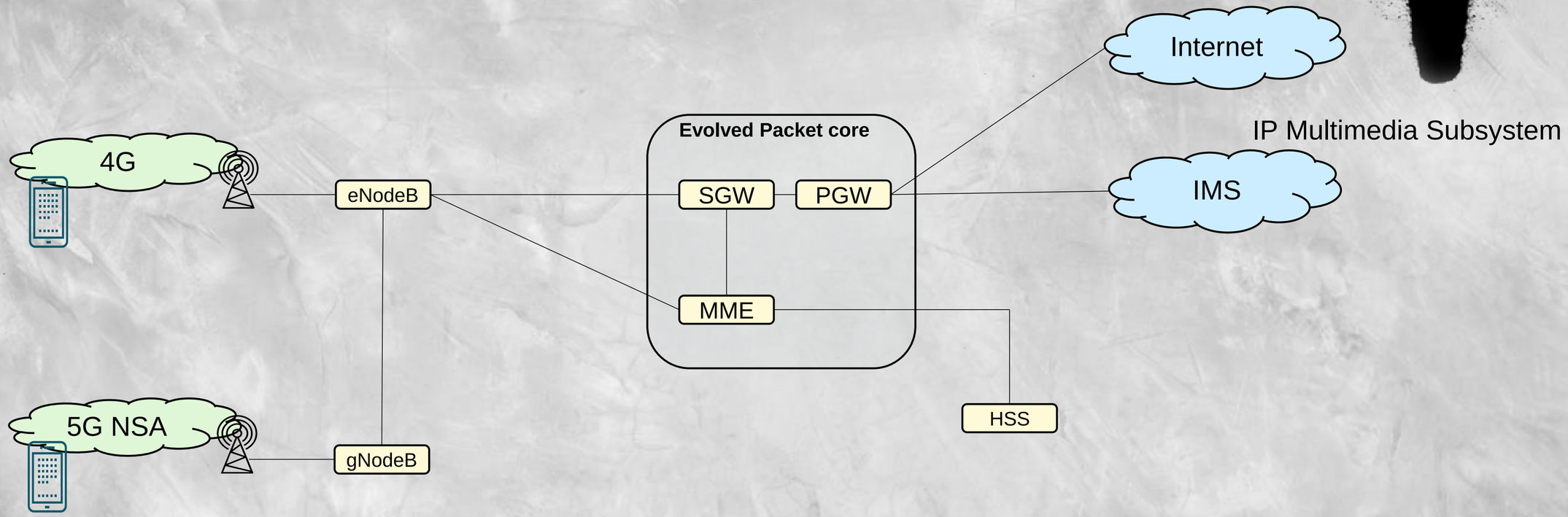
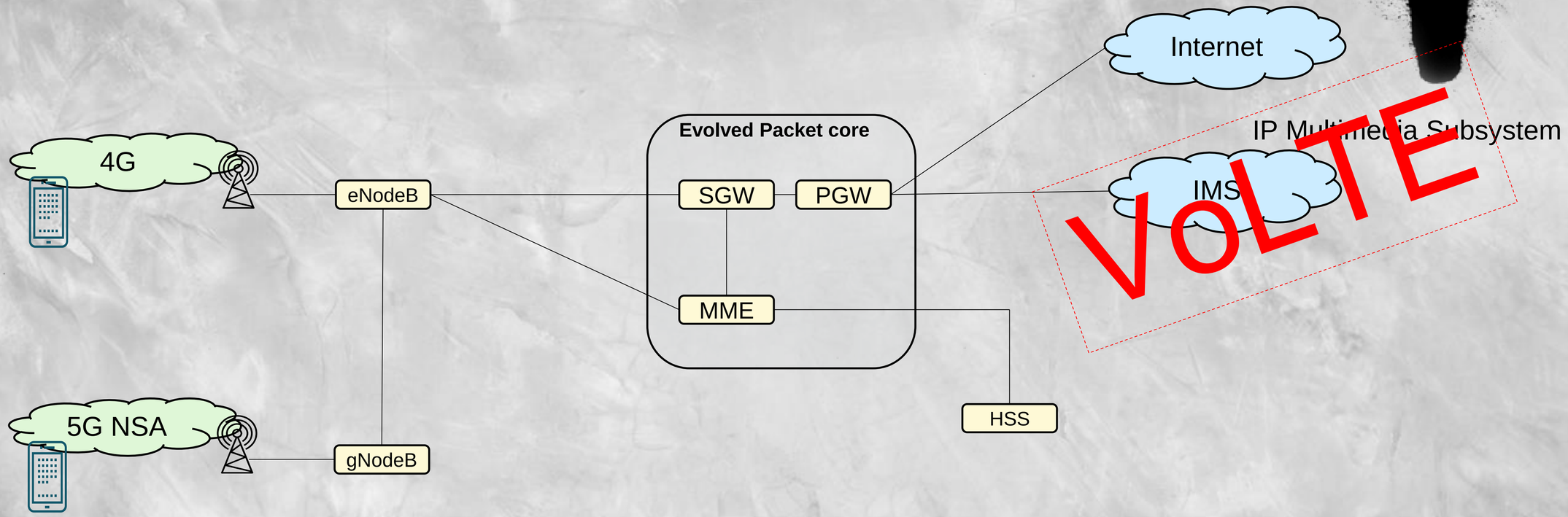
5G NSA native voice



5G NSA native voice



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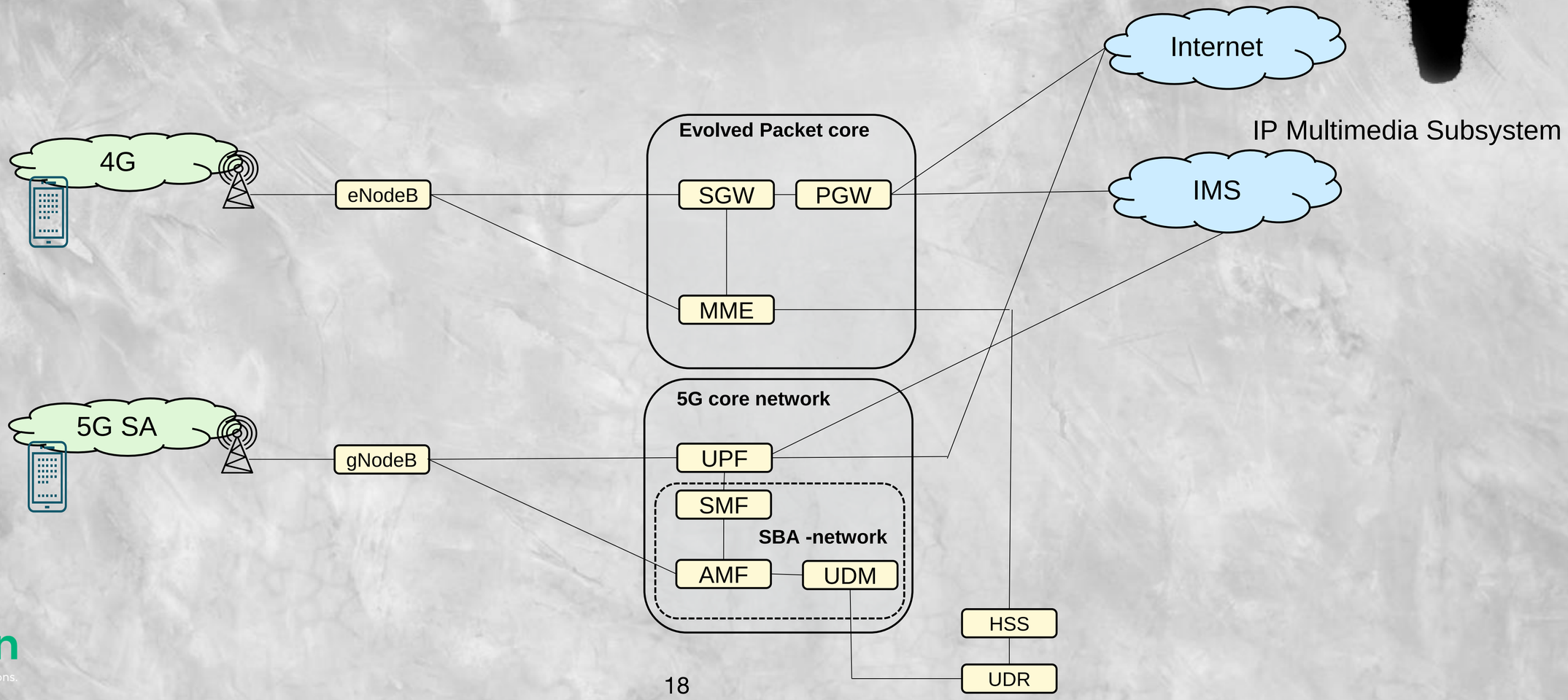
5G native voice



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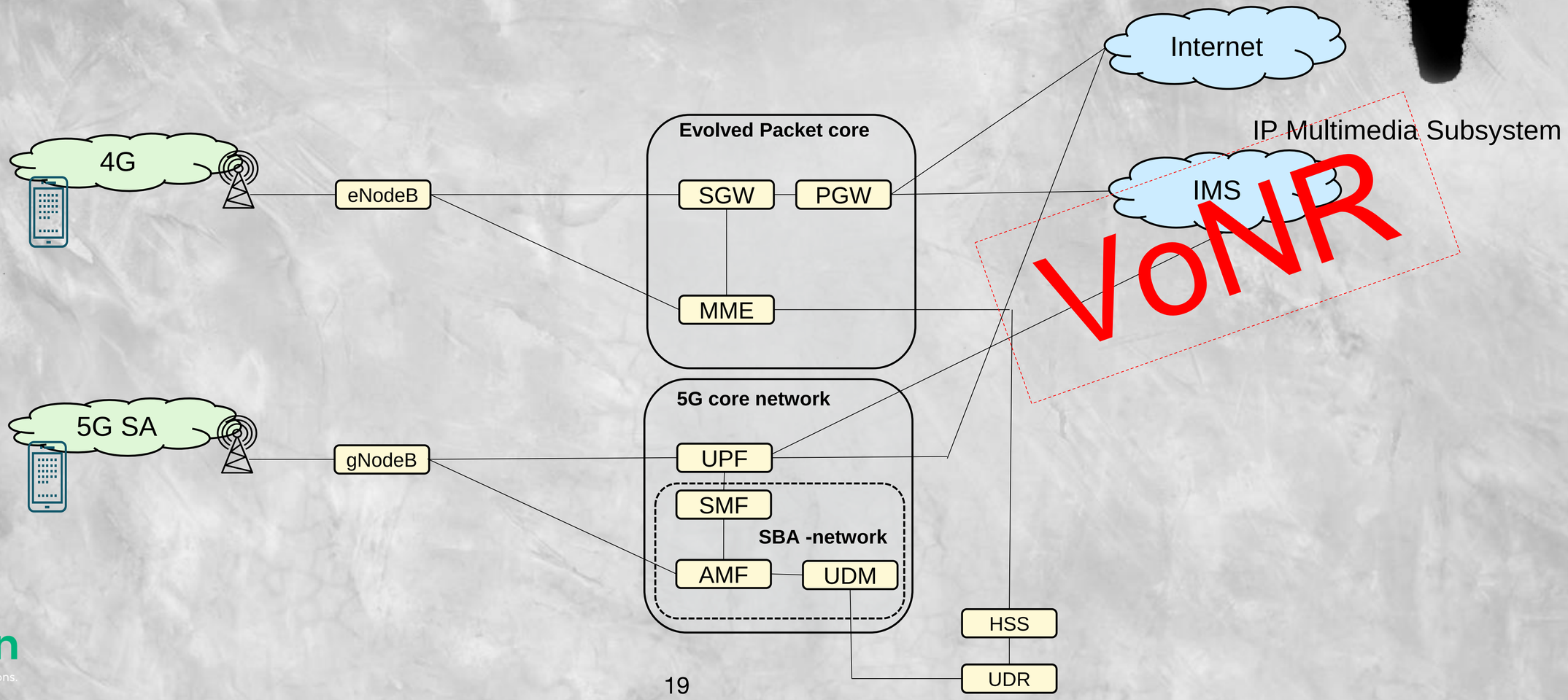
Voice-over-New-Radio = VoNR



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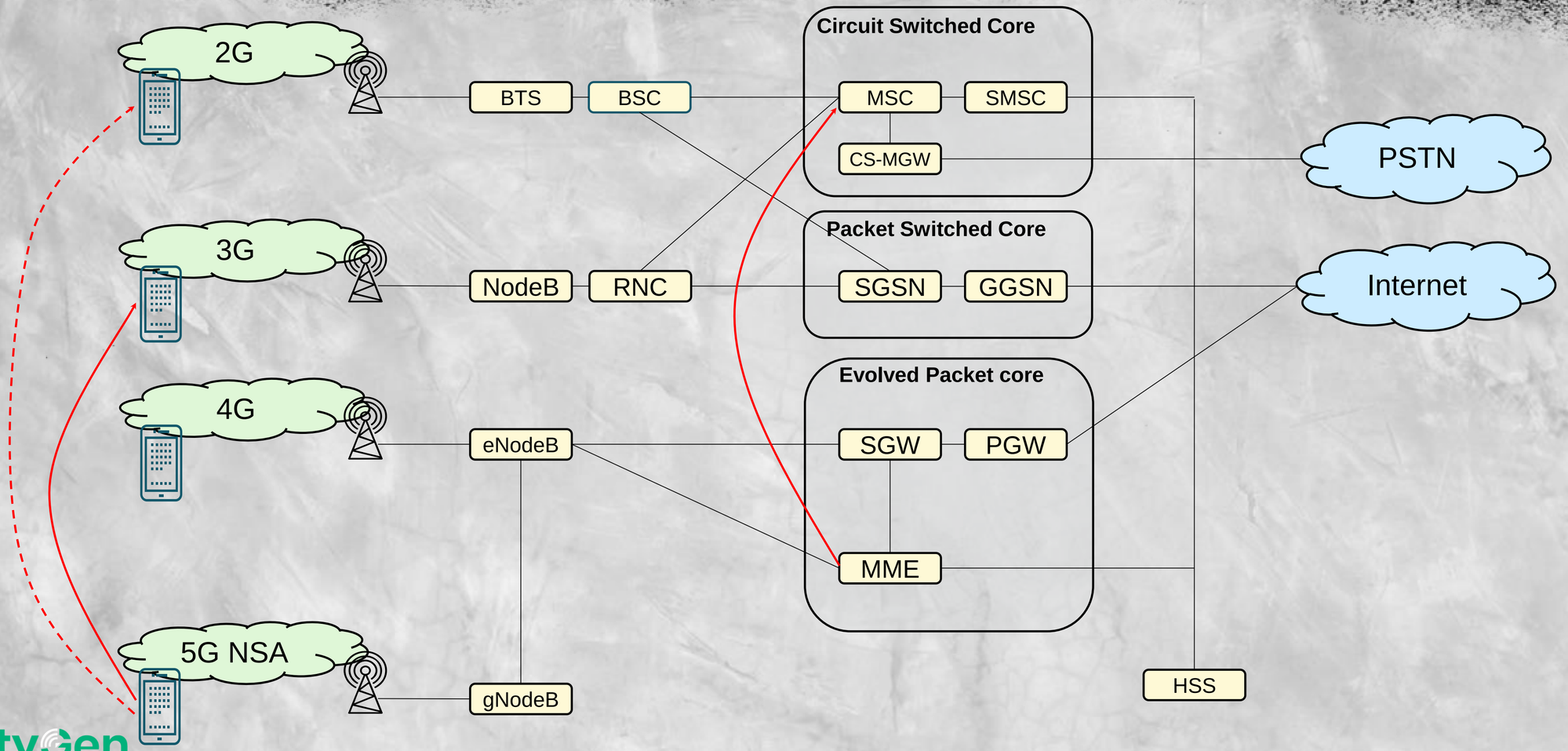
5G NSA fallback



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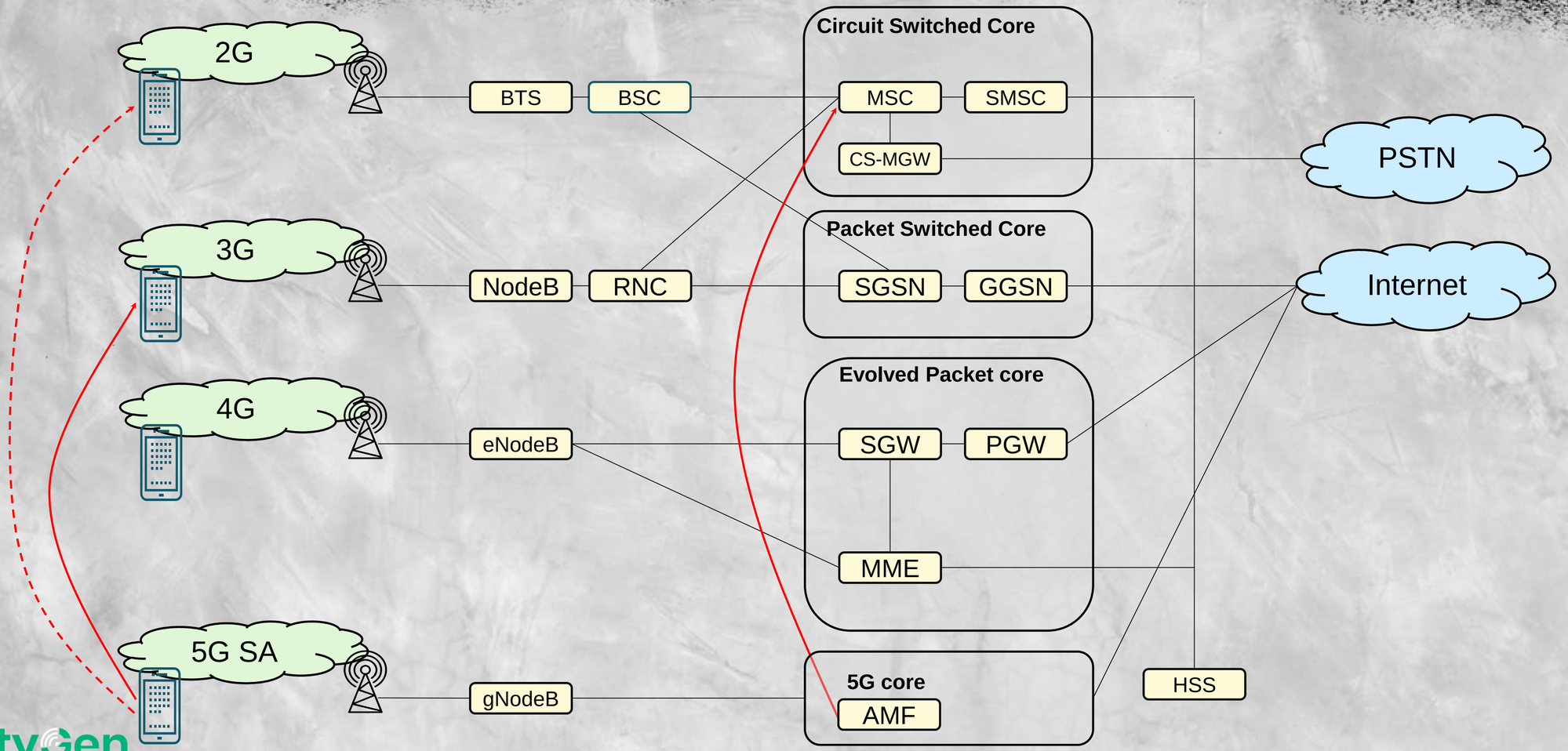
5G SA fallback



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Let’s dig into the history

-1st LTE network deployed in December 2009 (TeliaSonera, Sweden + Norway)

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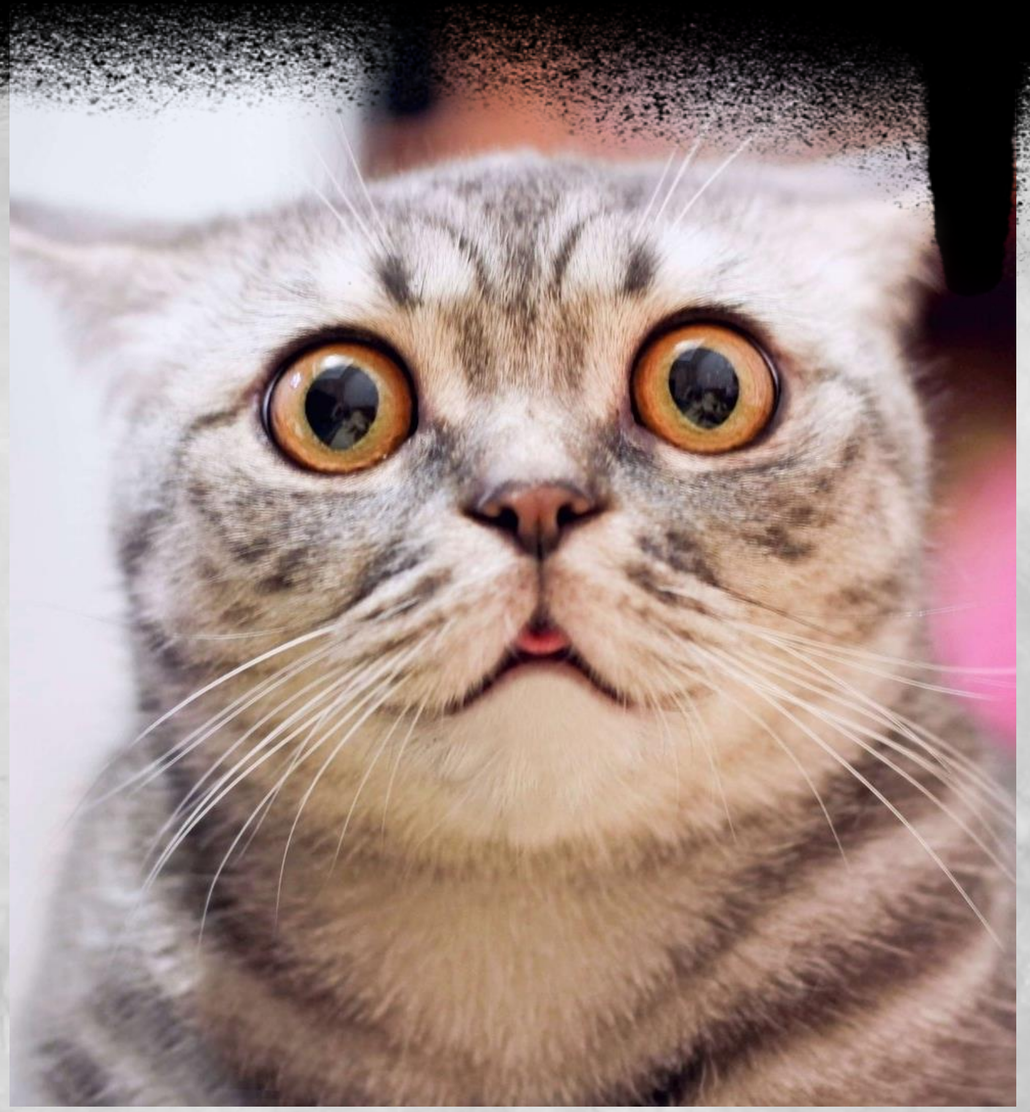
-almost all new phones having VoLTE support in 2020

Let’s dig into the history

Almost all new phones having VoLTE support ONLY in 2020…
10 years after LTE network was deployed



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MNO: It seems time to deploy VoLTE...

Telco industry

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Bombshell

Verizon (USA) retire their 2G and 3G network by 31 December 2022

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Bombshell

Verizon (USA) retire their 2G and 3G network by 31 December 2022

Initially they said that it will happen in the end of 2019, but they postponed, because industry was not ready, that’s why many other haven’t believed that in the end of 2022 they will do that.

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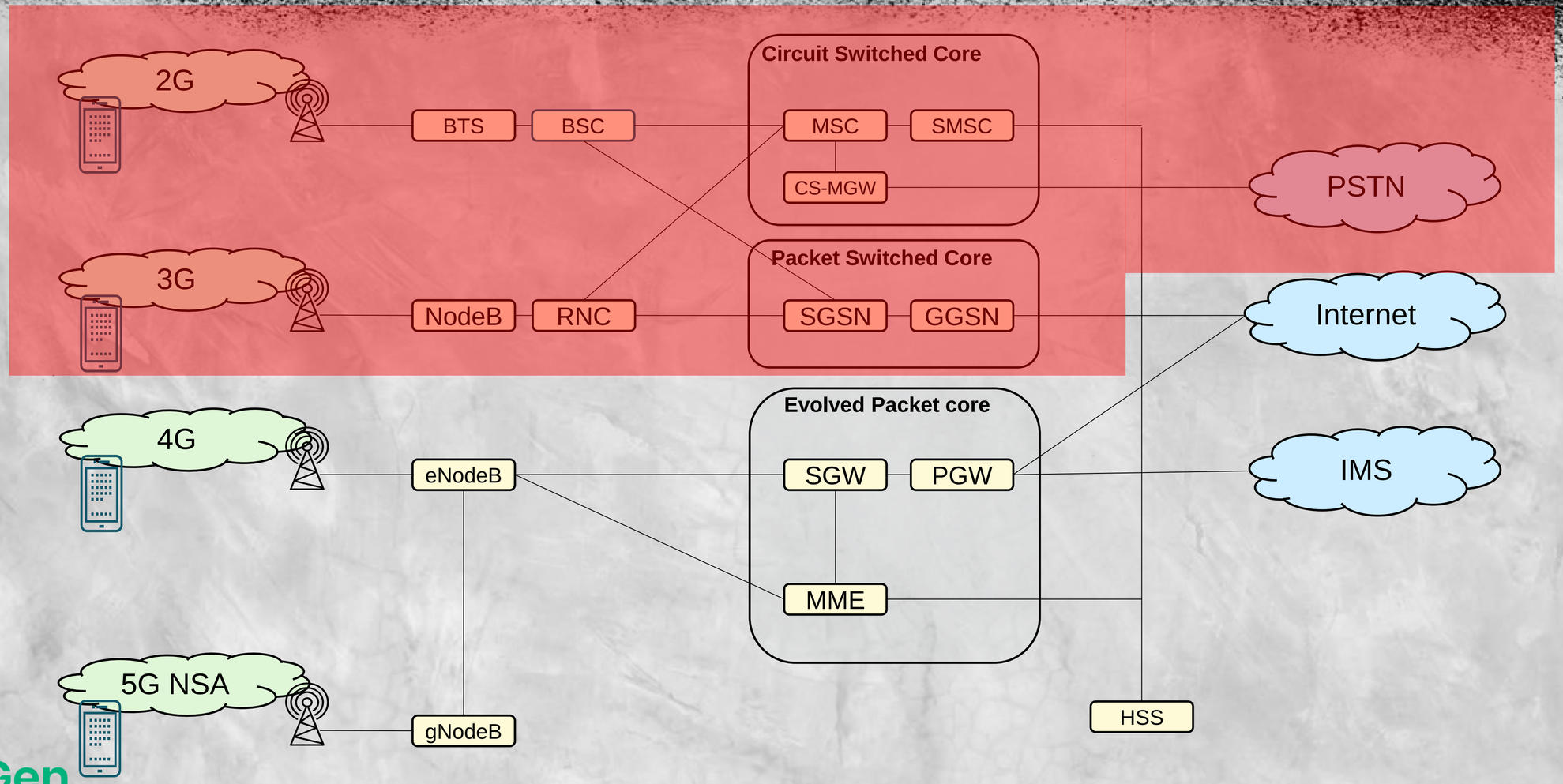
2G/3G retire



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All the networks in the world was affected

- Verizon (USA) retire their 2G and 3G network by 31 December 2022

- It means, that if subscriber of some network without VoLTE goes to the USA, he will not be able to call anymore.

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- Verizon (USA) retire their 2G and 3G network by 31 December 2022

- It means, that if subscriber of some network without VoLTE goes to the USA, he will not be able to call anymore.
- Money and reputation are affected

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Build VoLTE network in 60 seconds…

- Operators started to build their VoLTE network very fast, many of them built it in few months.

Build VoLTE network in 60 seconds…

- Operators started to build their VoLTE network very fast, many of them built it in few months.
- Many configuration mistakes were made

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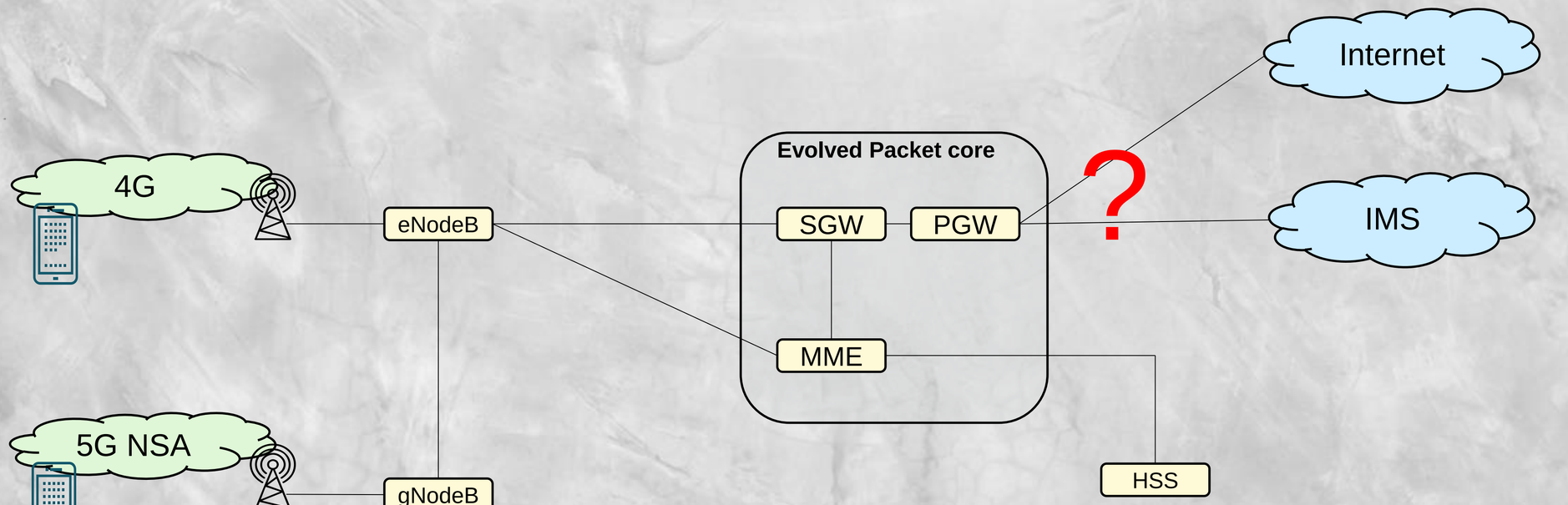
IMS network

APN – outside network



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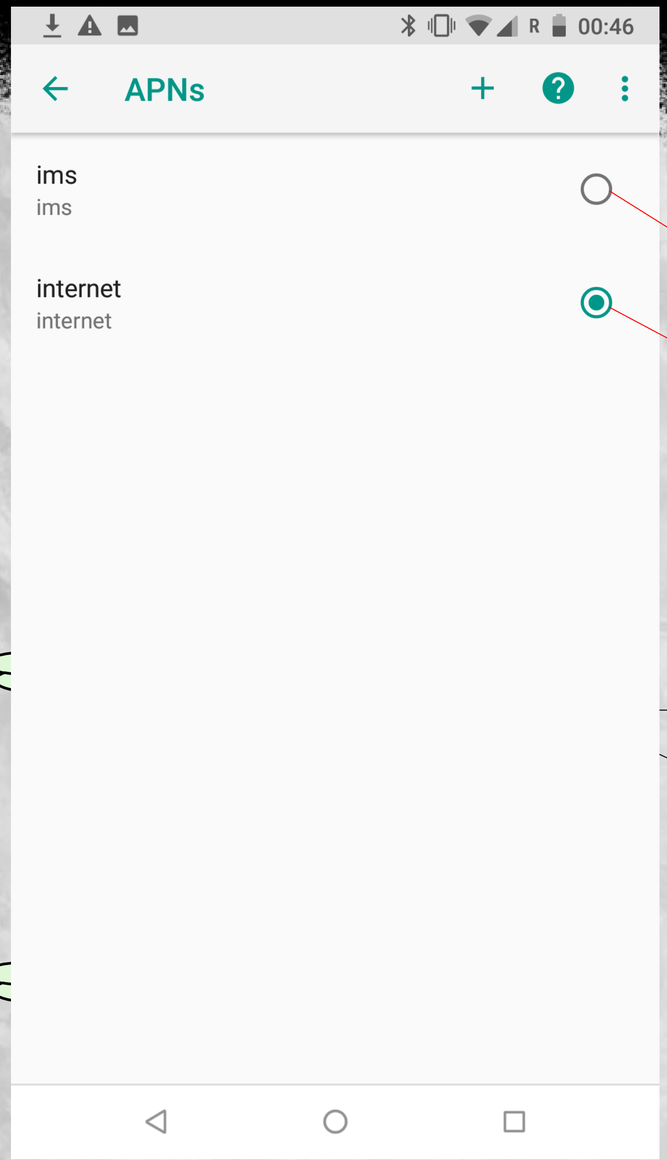
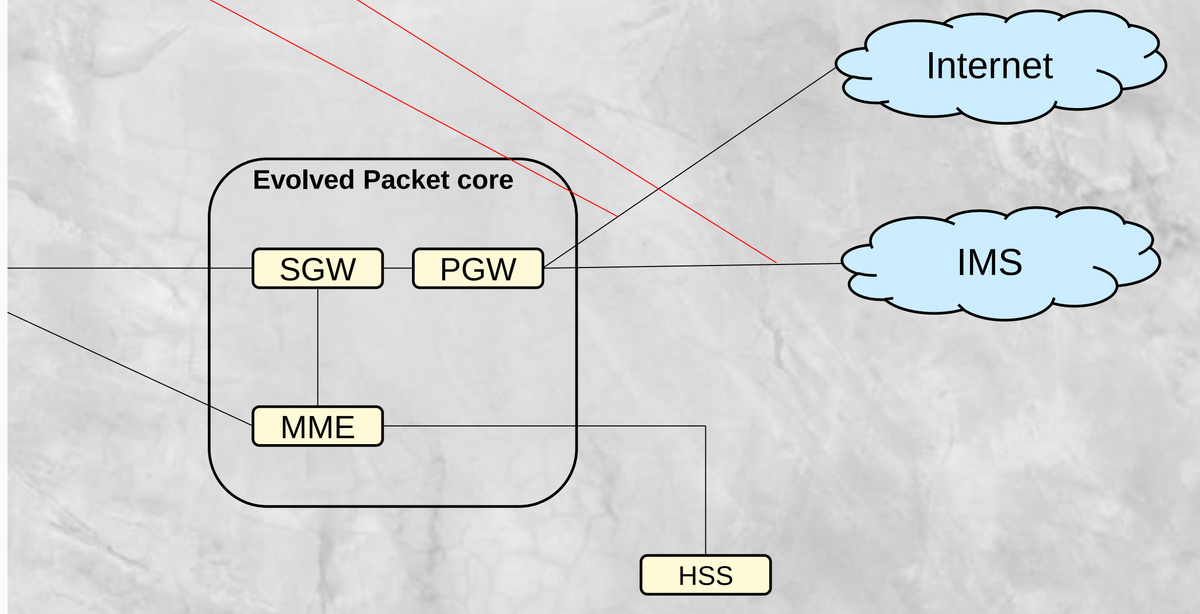
APN – outside network





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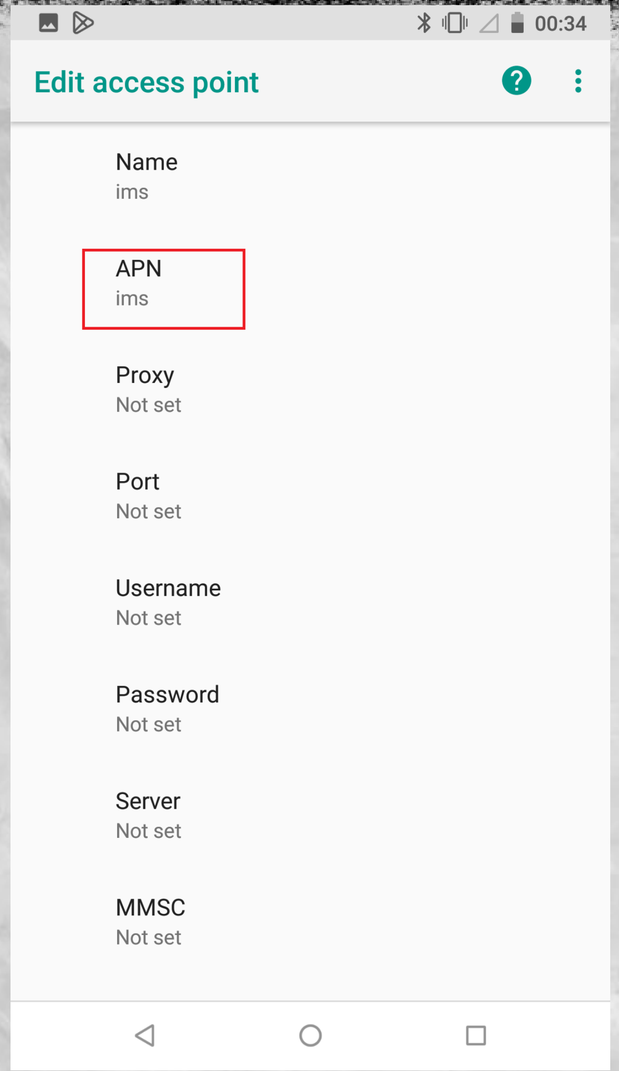
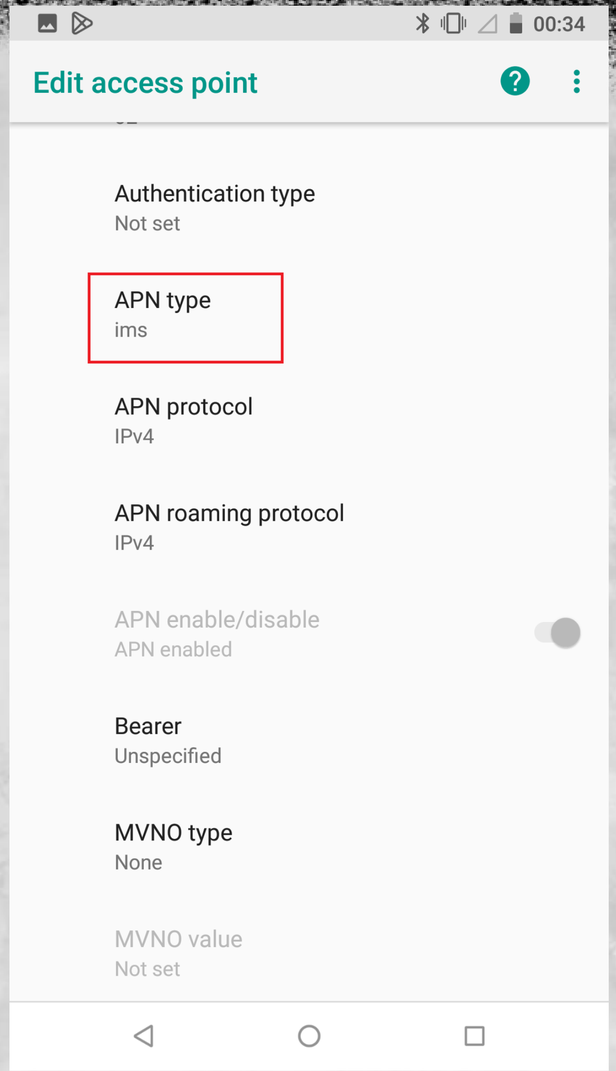
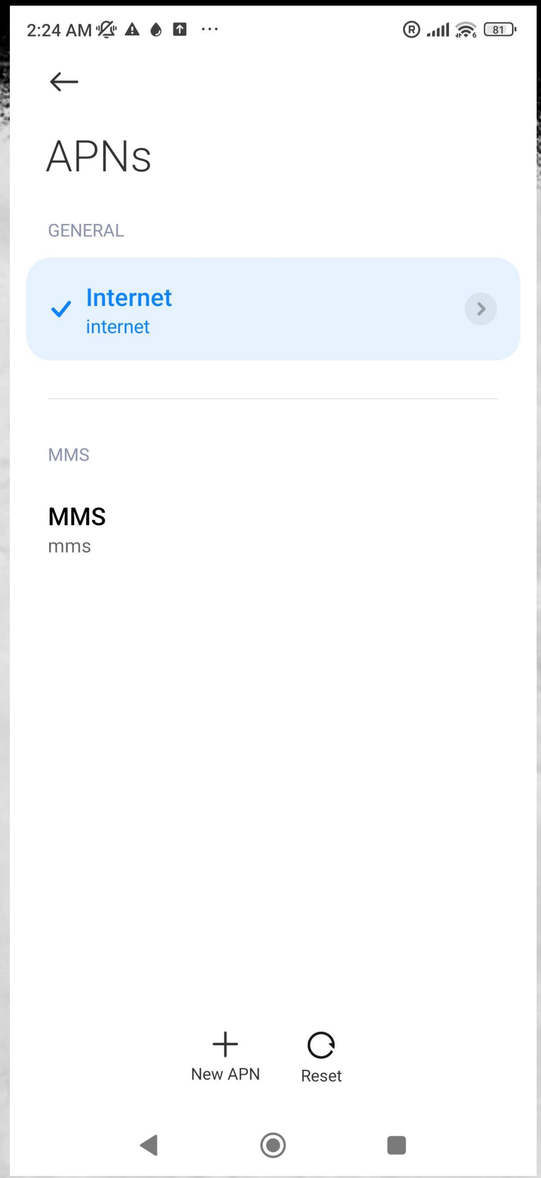
IMS APN


00:34
Edit access point
Name
ims
APN
ims
Proxy
Not set
Port
Not set
Username
Not set
Password
Not set
Server
Not set
MMSC
Not set


00:34
Edit access point
Authentication type
Not set
APN type
ims
APN protocol
IPv4
APN roaming protocol
IPv4
APN enable/disable
APN enabled
Bearer
Unspecified
MVNO type
None
MVNO value
Not set

Security by obscurity

Modern phones are hiding IMS APN from list of APNs



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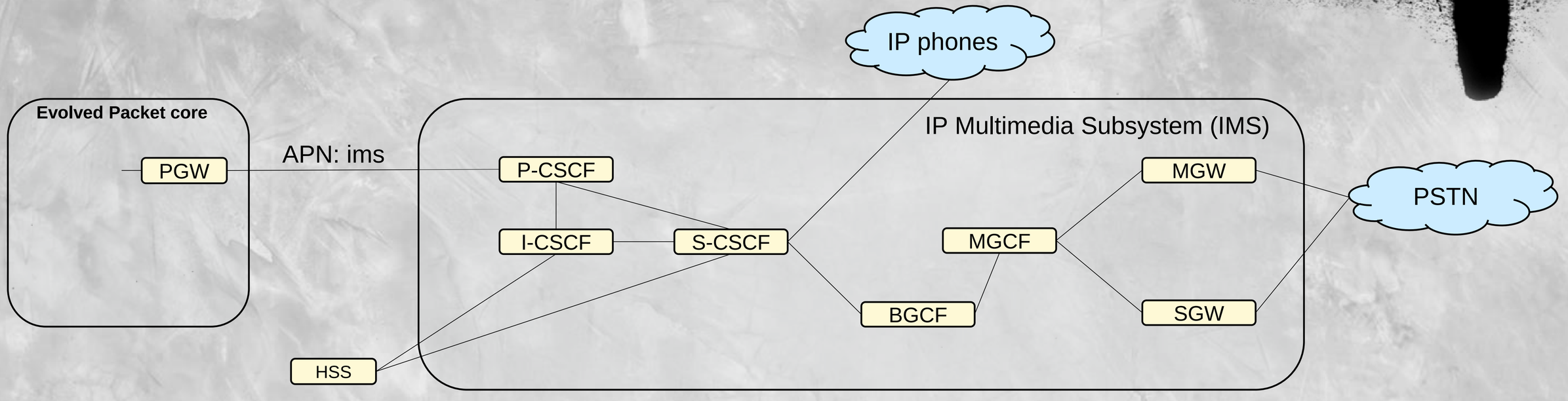
IMS network


IP phones
Evolved Packet core
PGW
APN: ims
IP Multimedia Subsystem (IMS)
P-CSCF
I-CSCF
S-CSCF
BGCF
MGCF
MGW
SGW
PSTN
HSS

So.. How to hijack VoLTE network?

Break rules!

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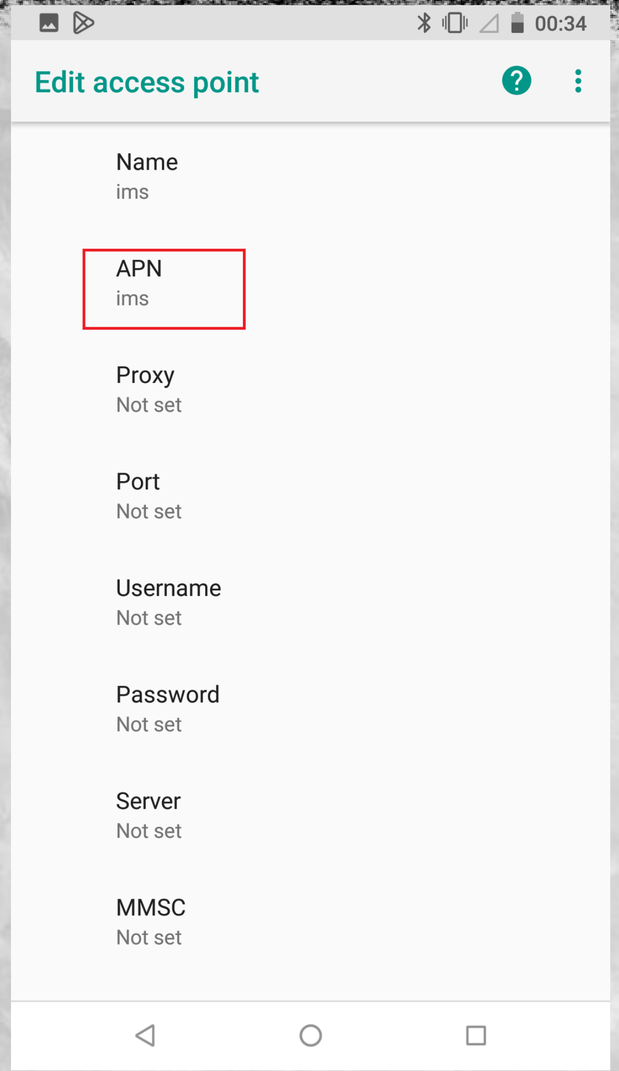
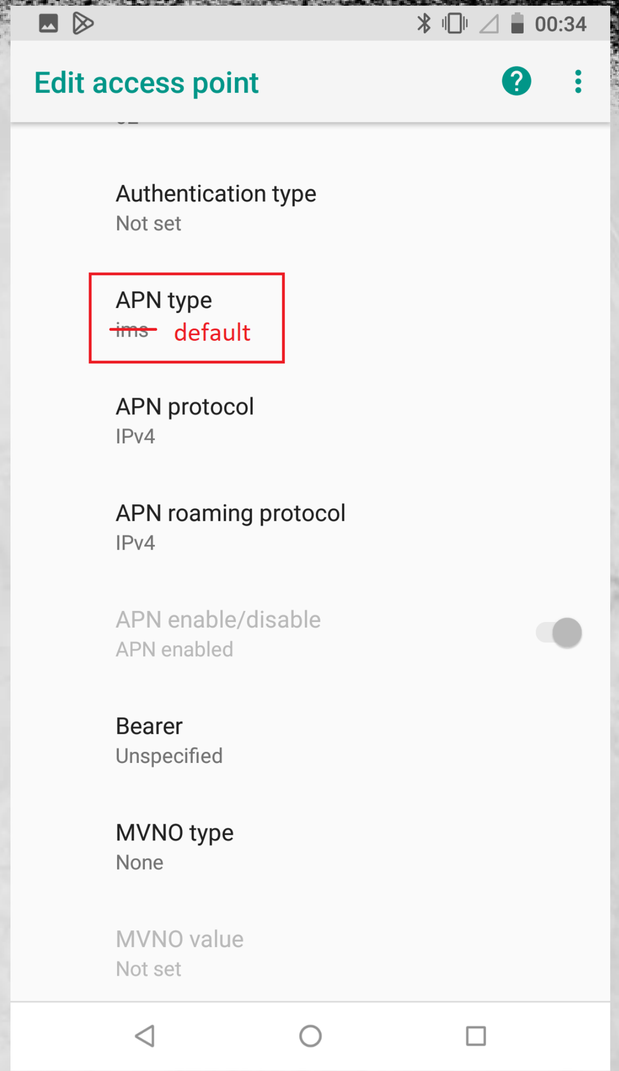
IMS APN





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Run nmap?

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Better to use common tools

1. LTE modem + laptop
2. Configure APN: ims
3. Take profit!

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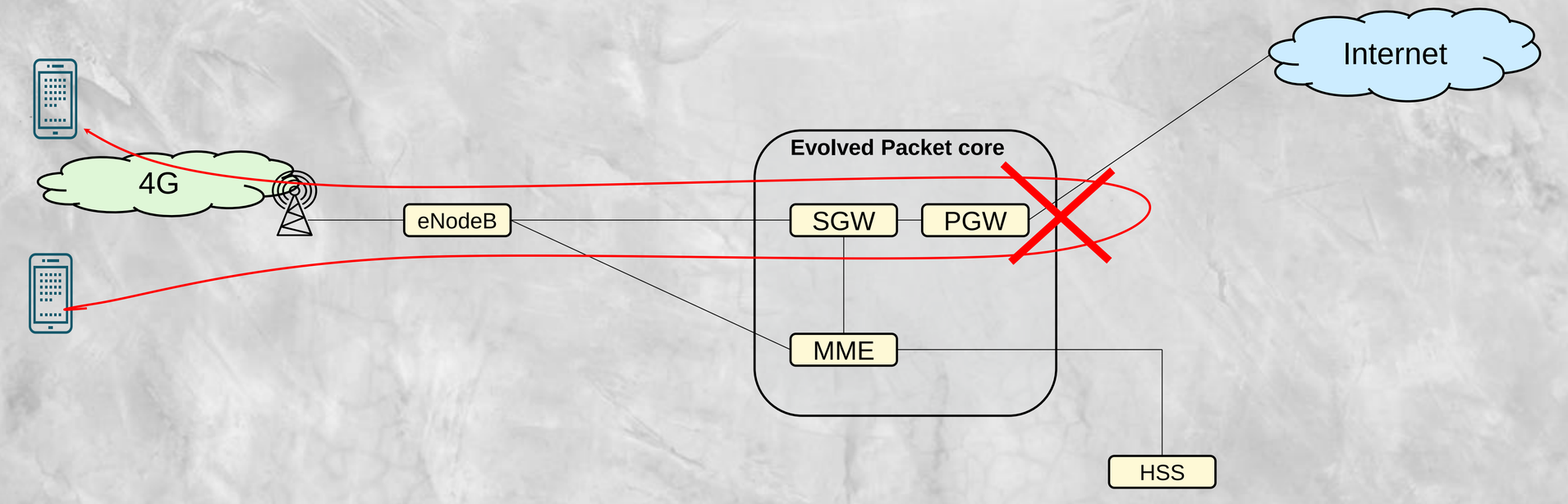
Subscriber isolation for internet connection



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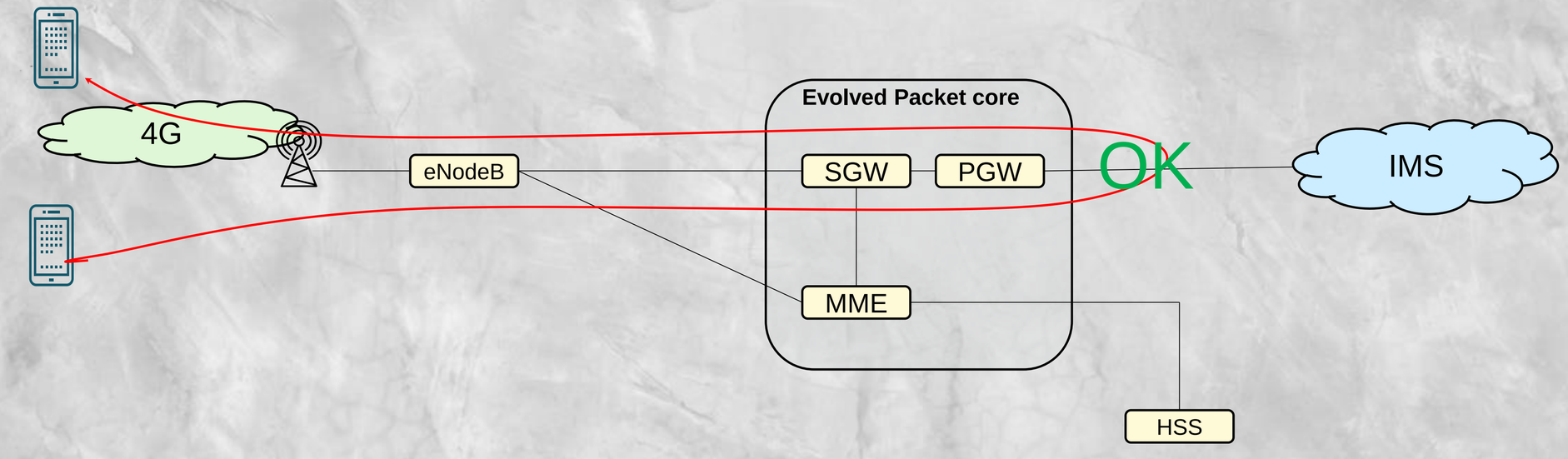
No isolation for IMS interface



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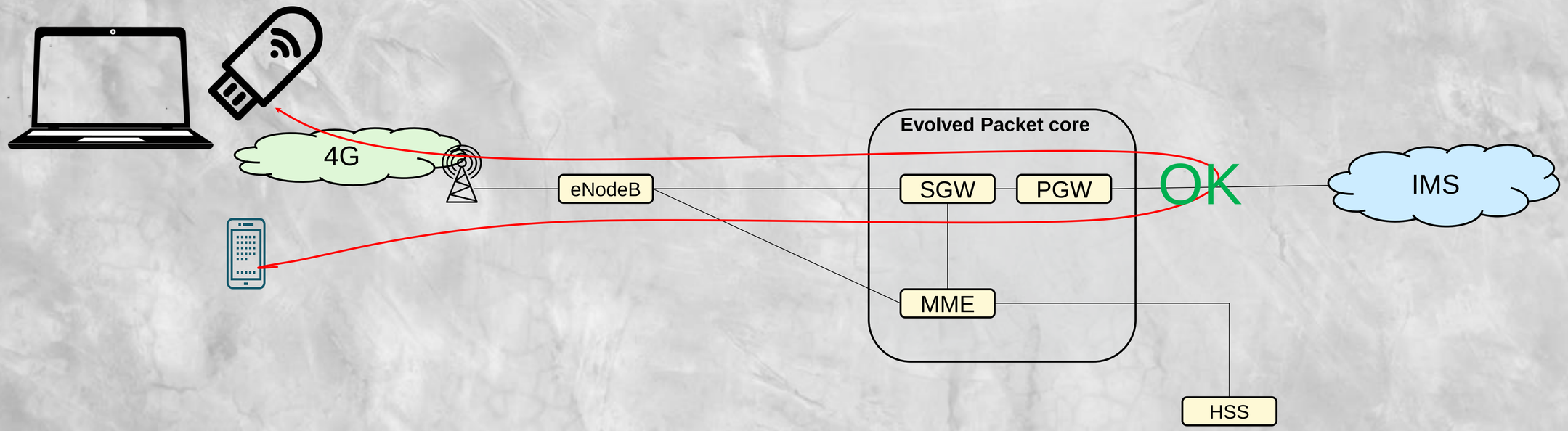
Let’s get access as legal subscriber



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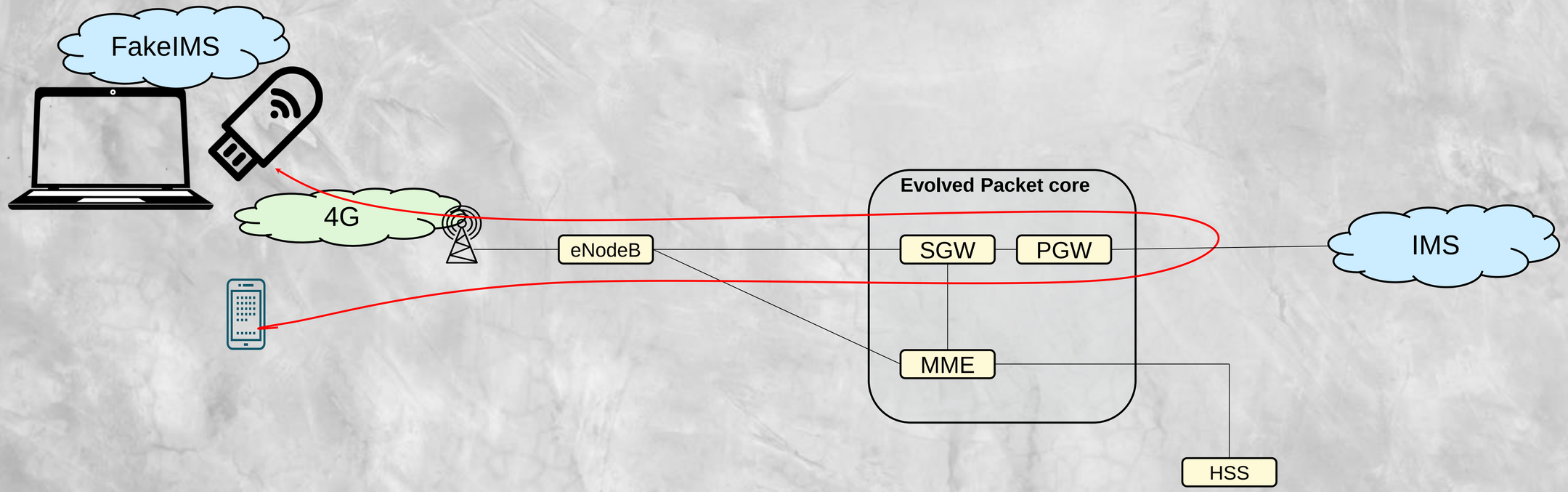
Build own fakeIMS infra?



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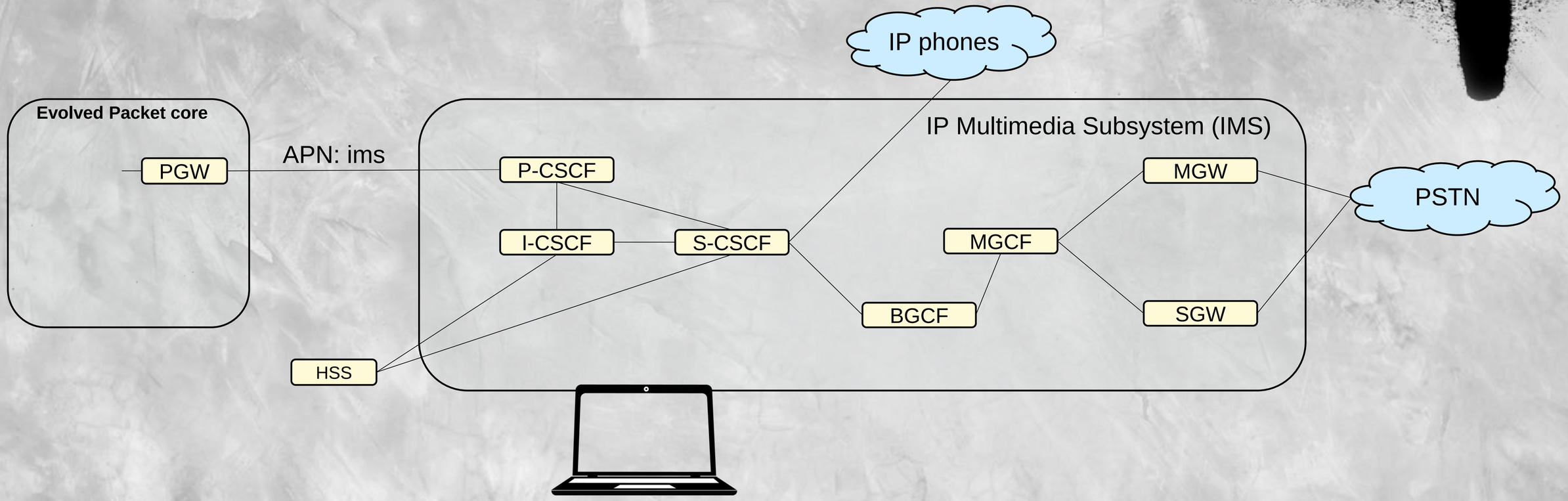
Emulate IMS network



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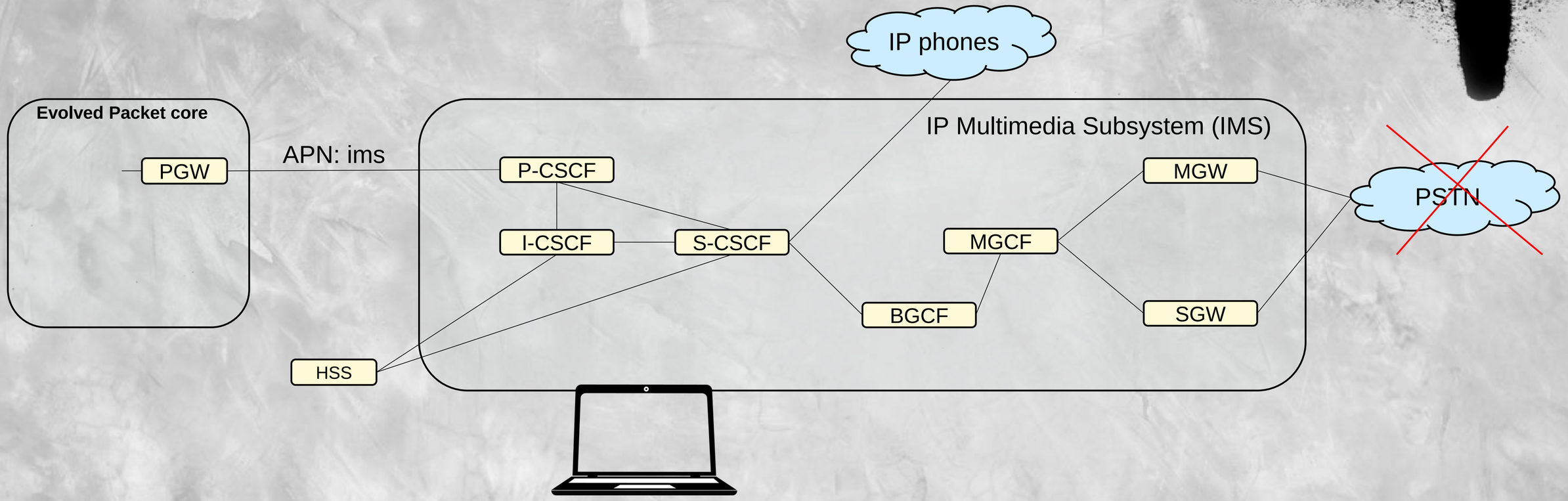

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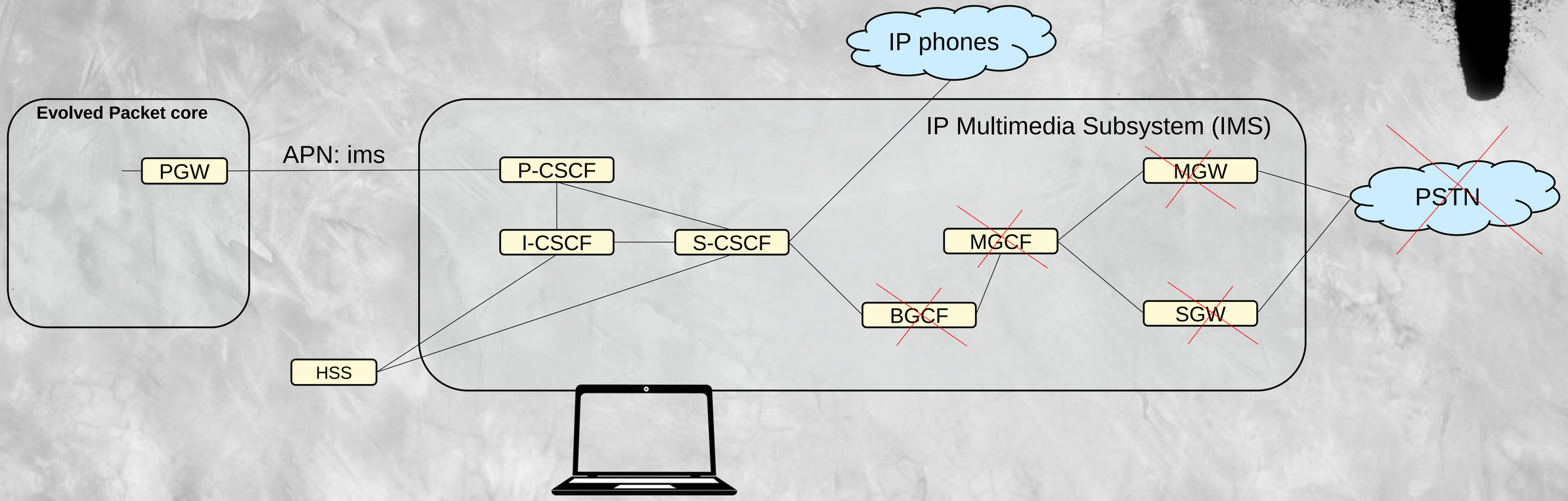

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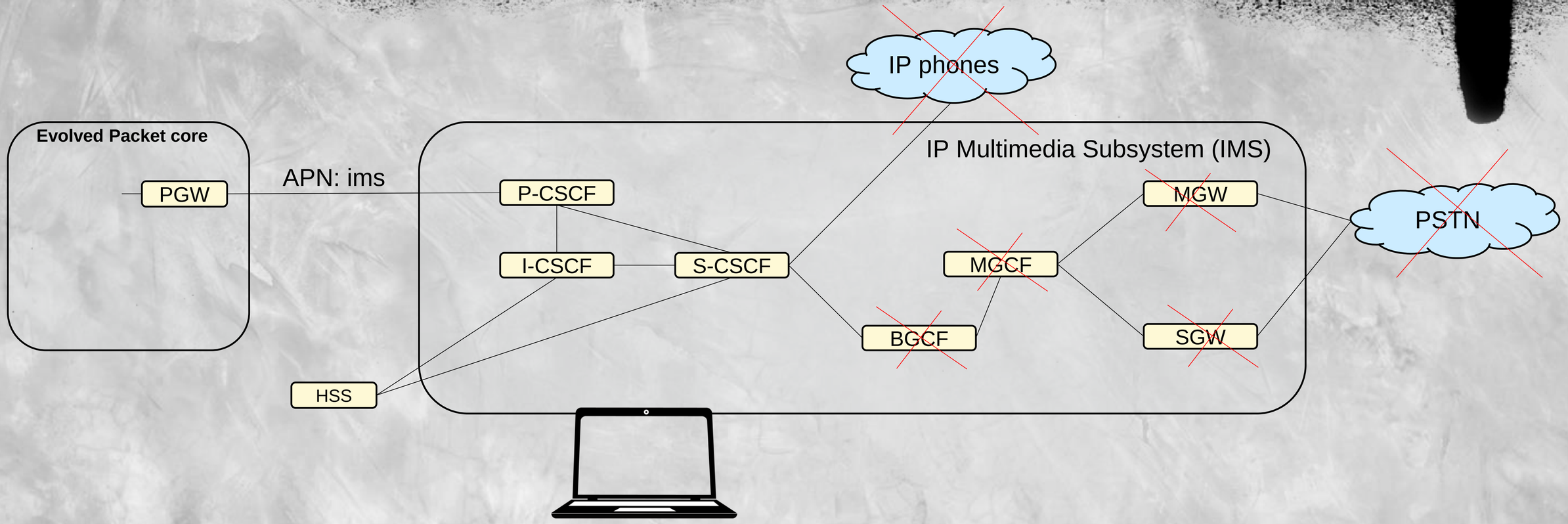

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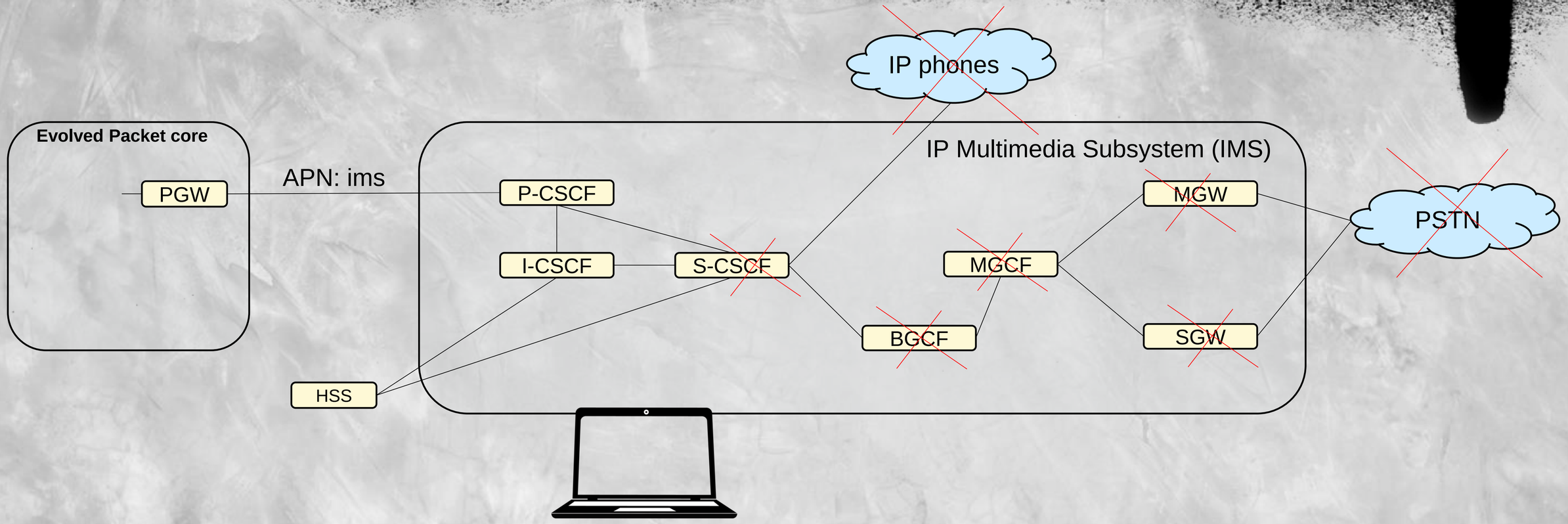

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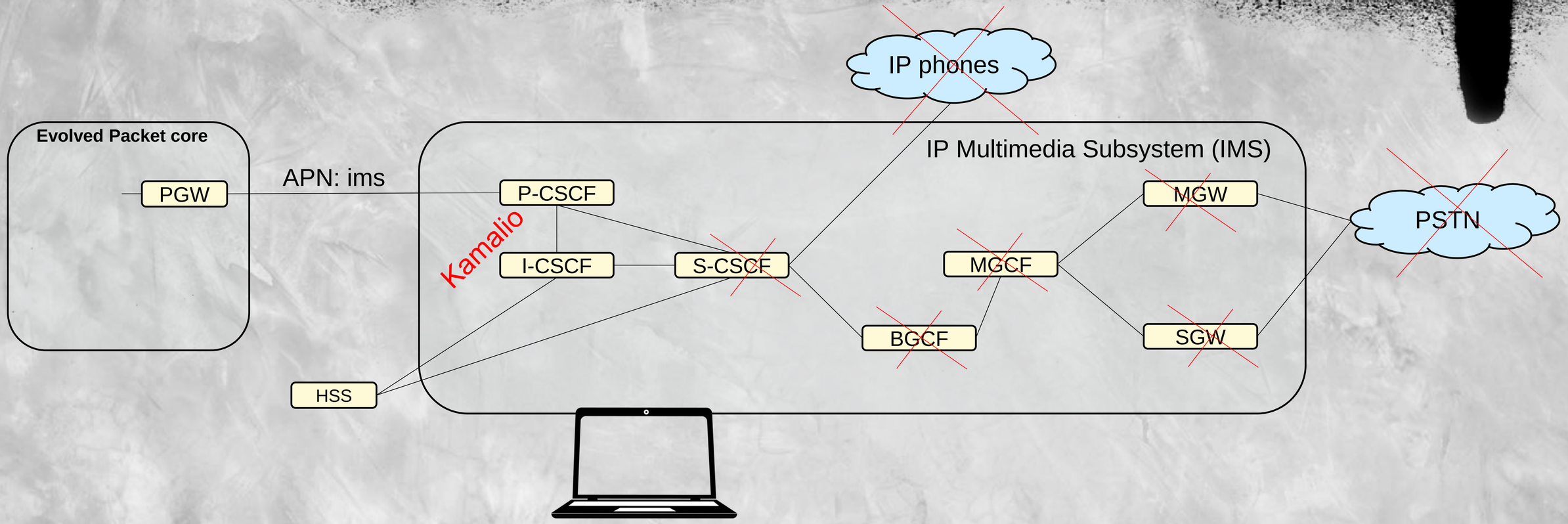

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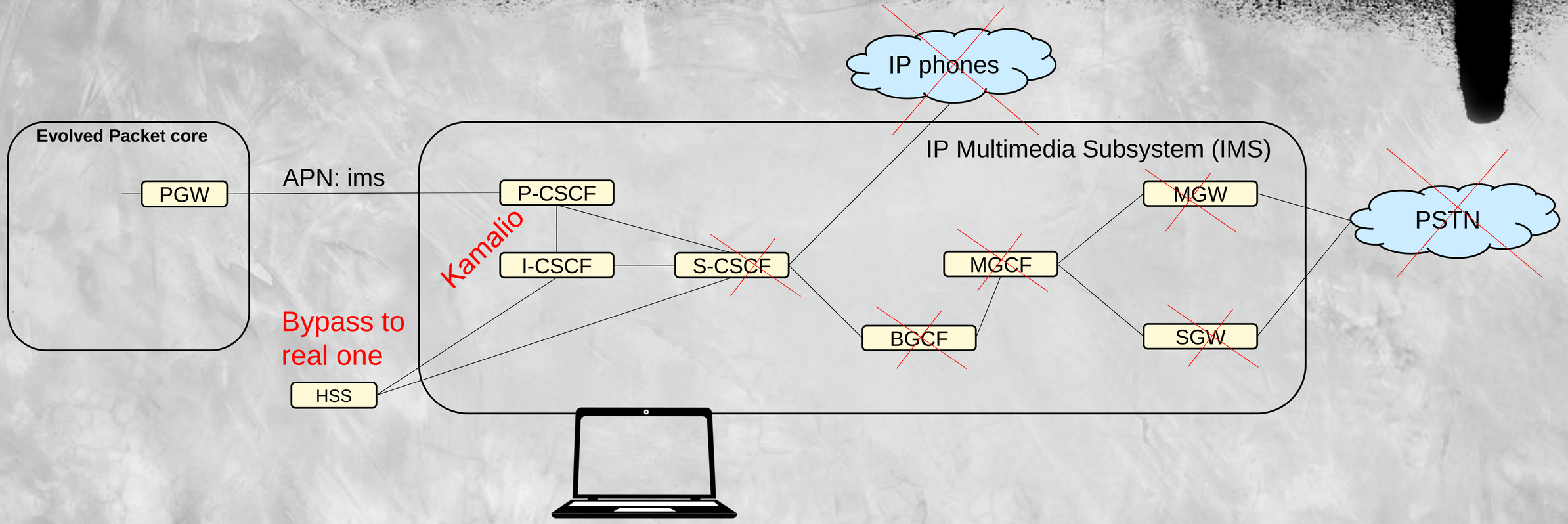

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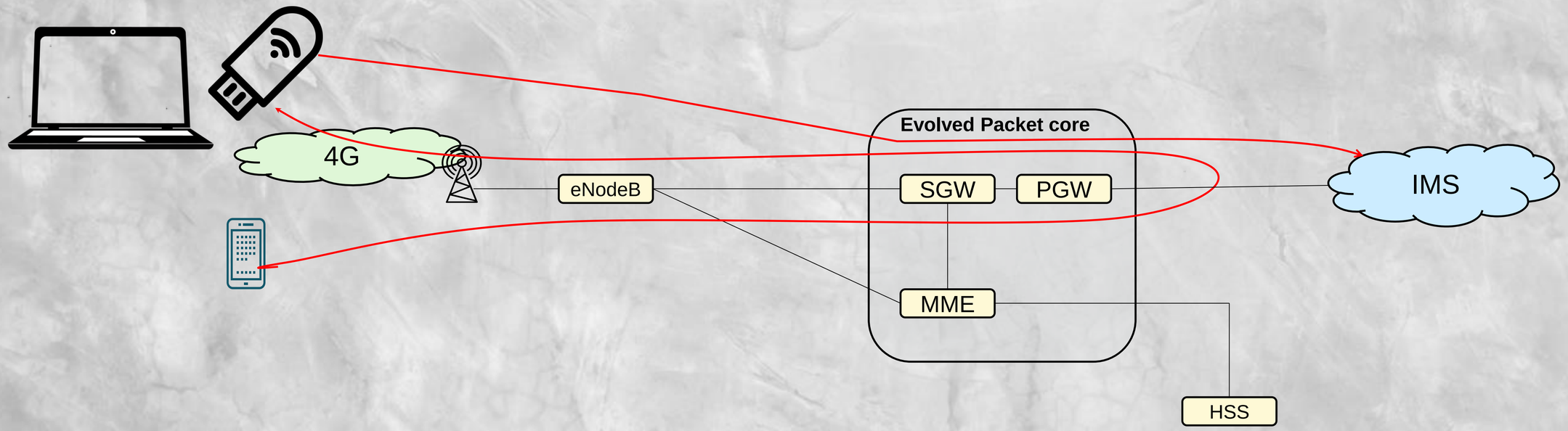
MiTM?

Simple proxy script
as P-CSCF



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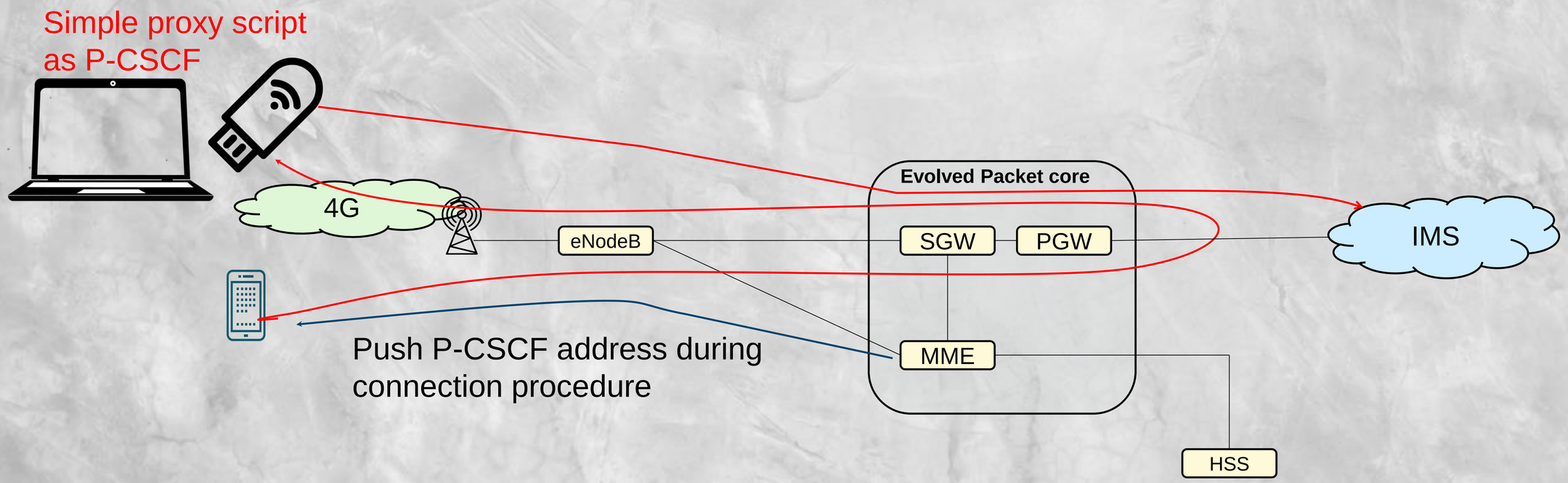
Need to push P-CSCF address to the phone



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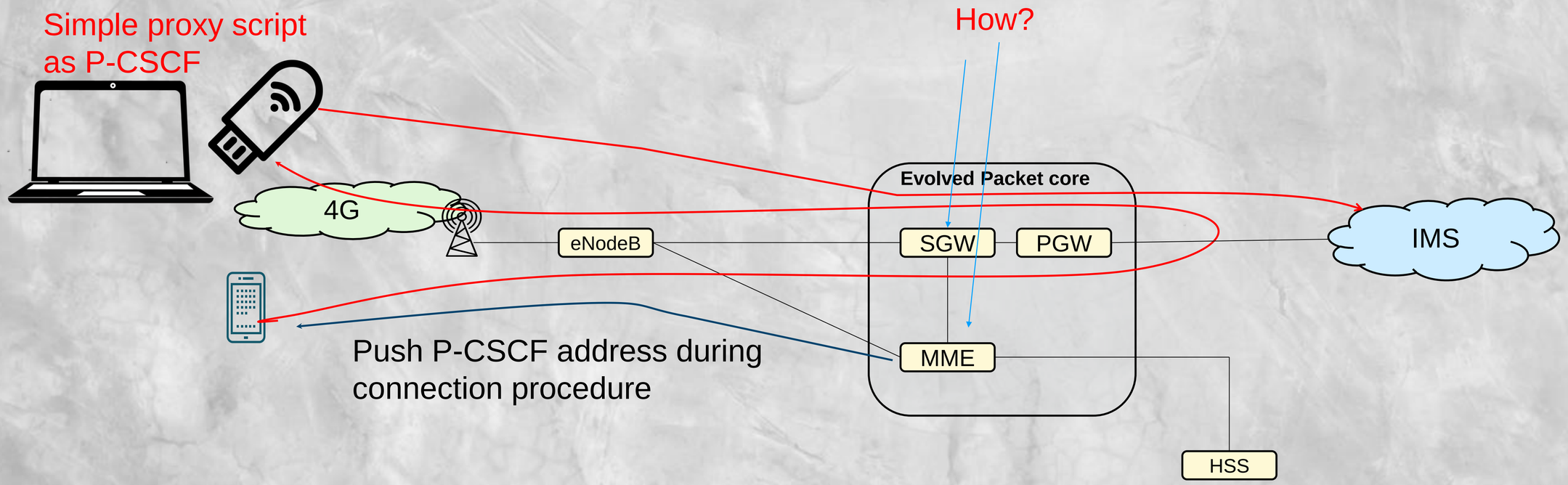

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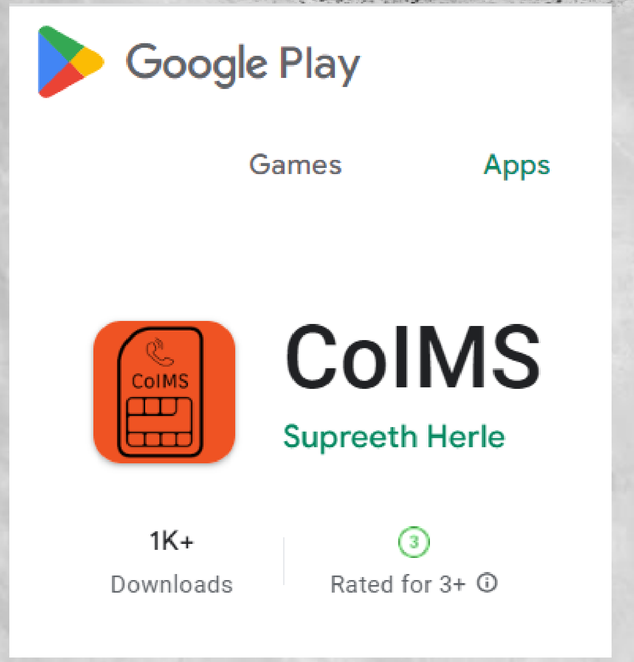
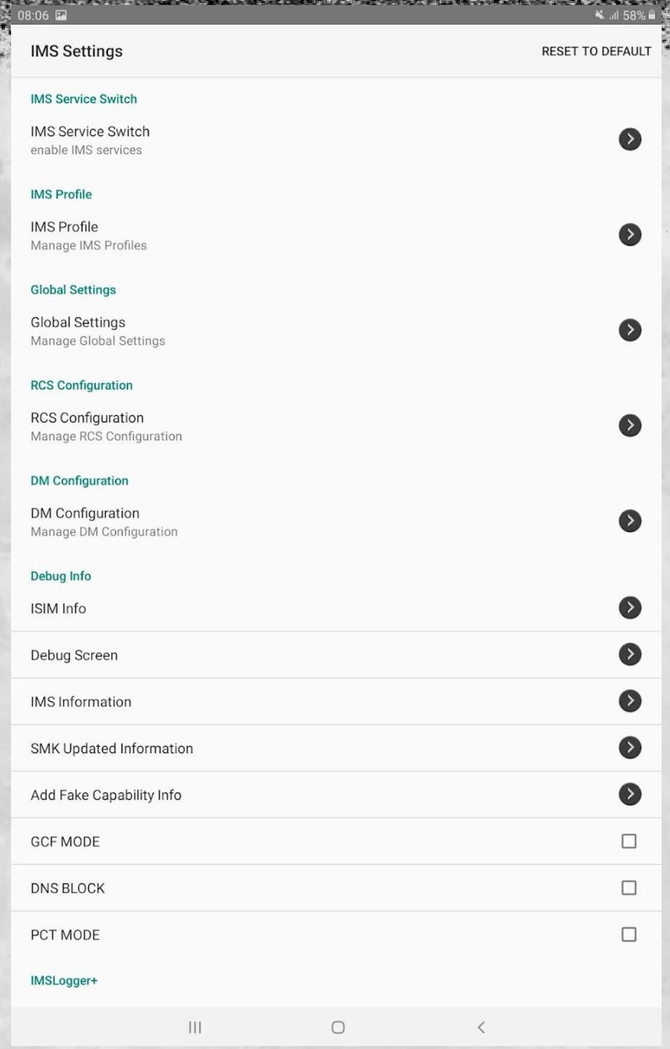
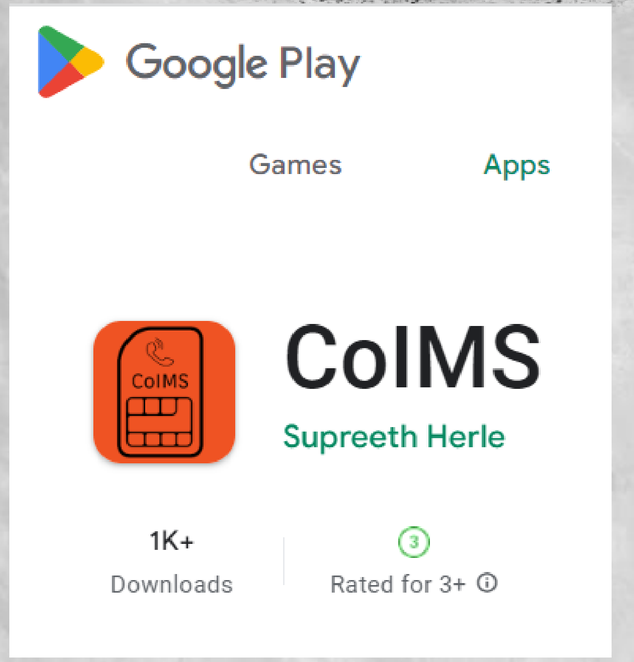
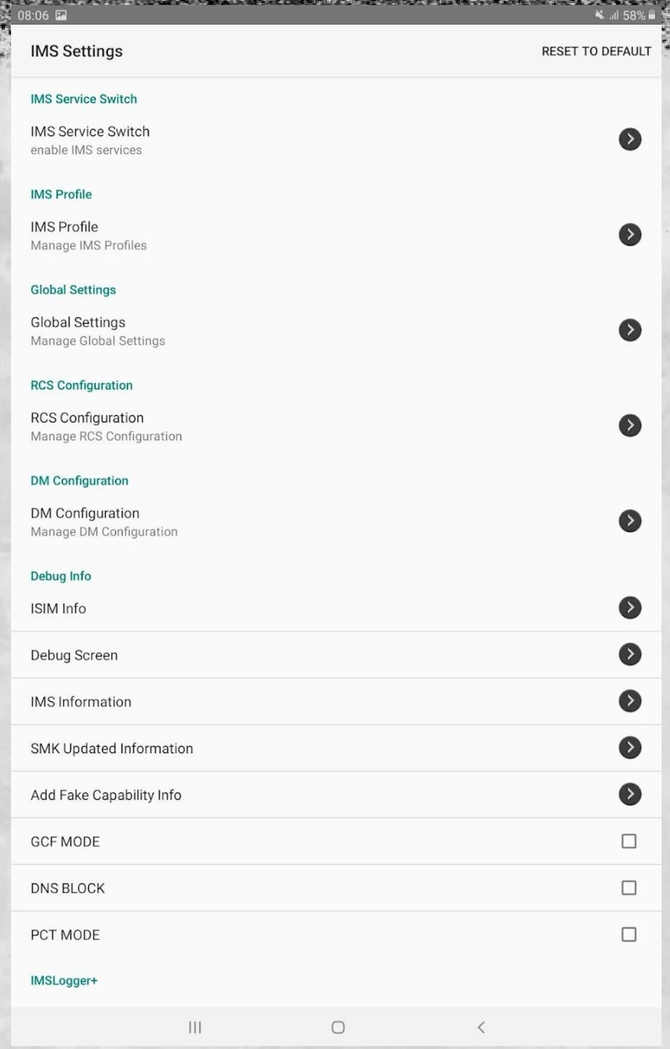
Decided to hack phone





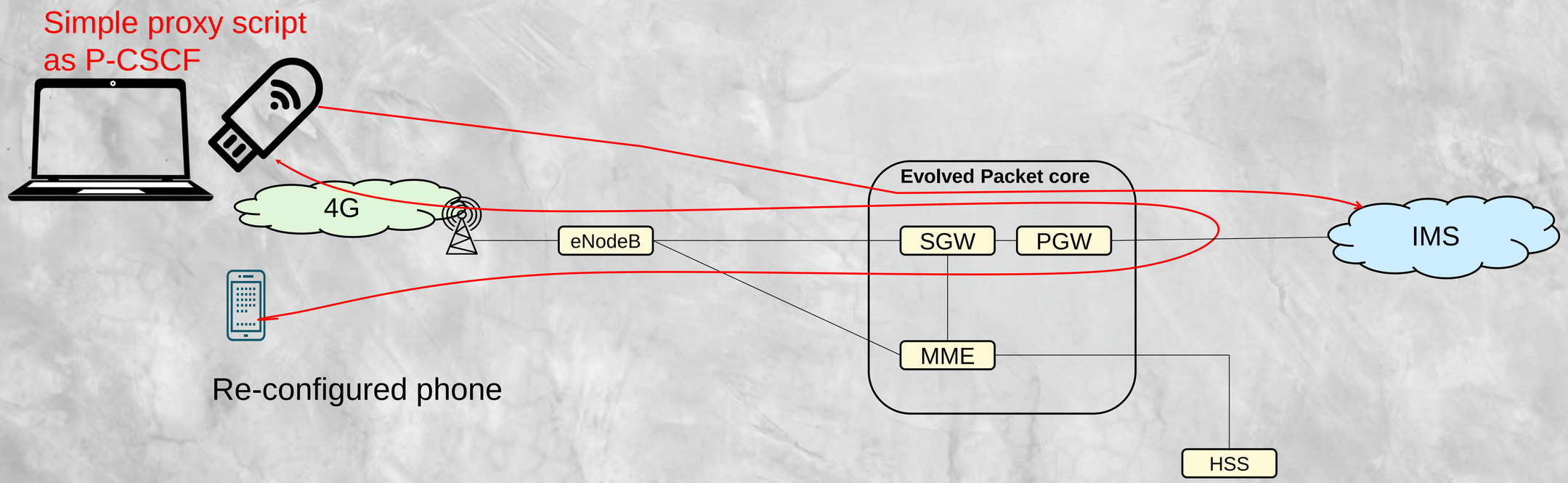
Decided to hack phone





If it is not enough – “root” may help
Or editing “mbn” config on Qualcomm based devices

MiTM successful?



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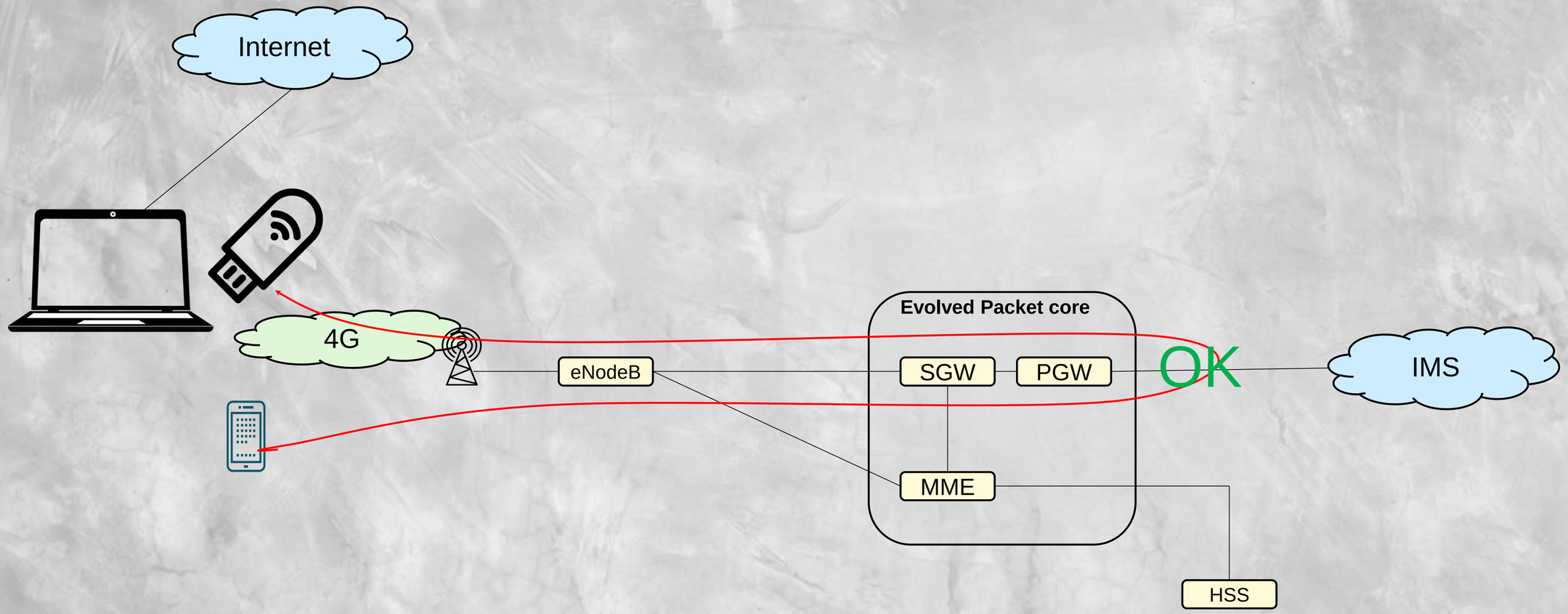
Hijack VoLTE network



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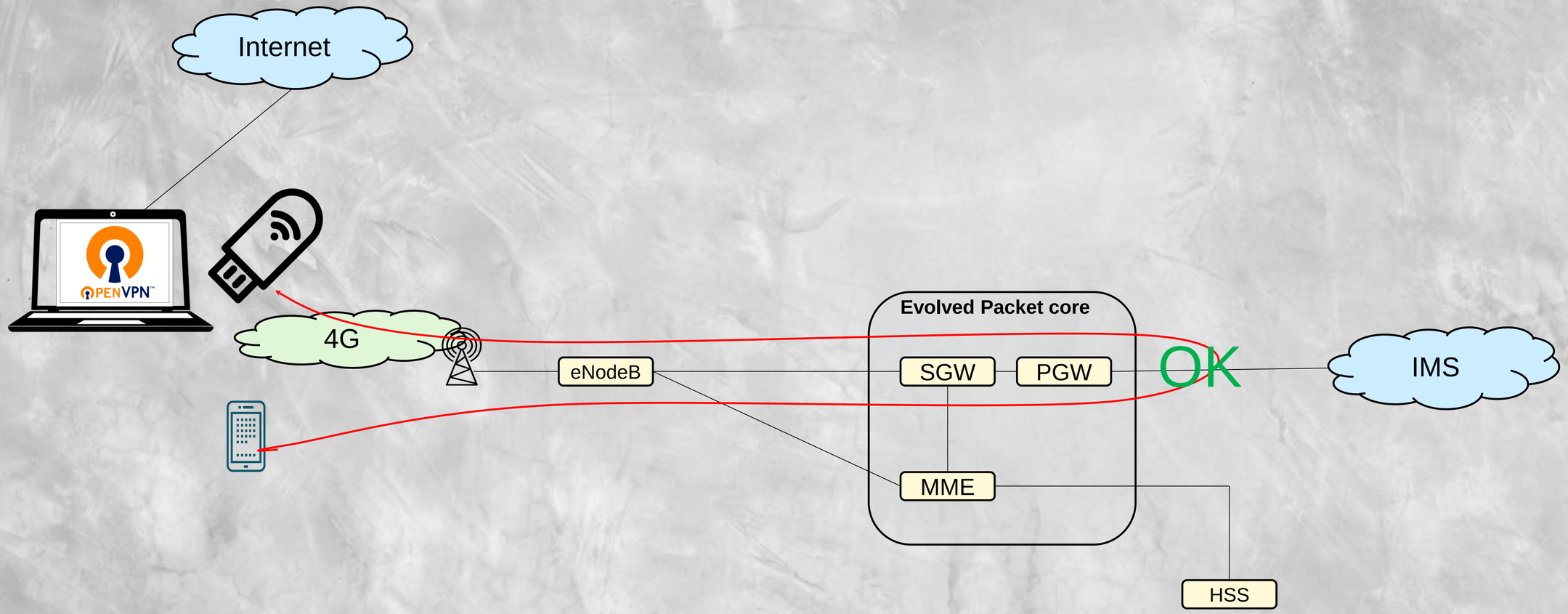
Hijack VoLTE network



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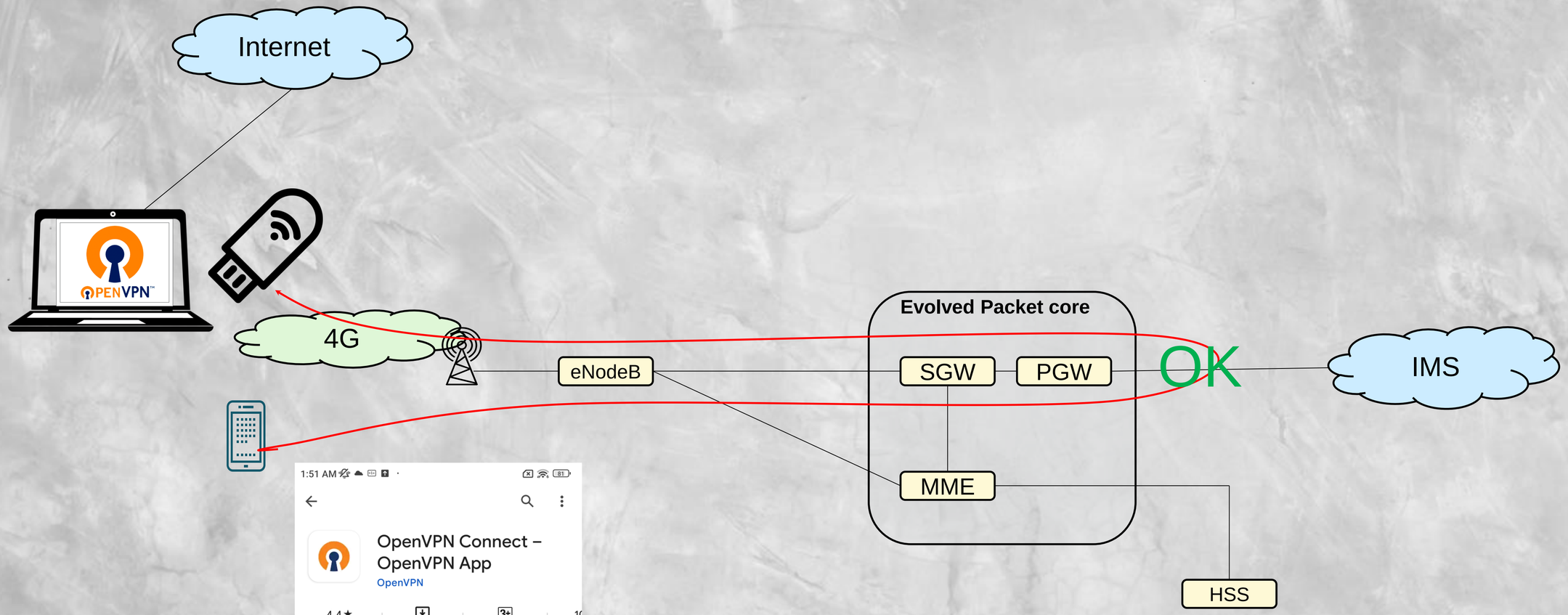
Hijack VoLTE network



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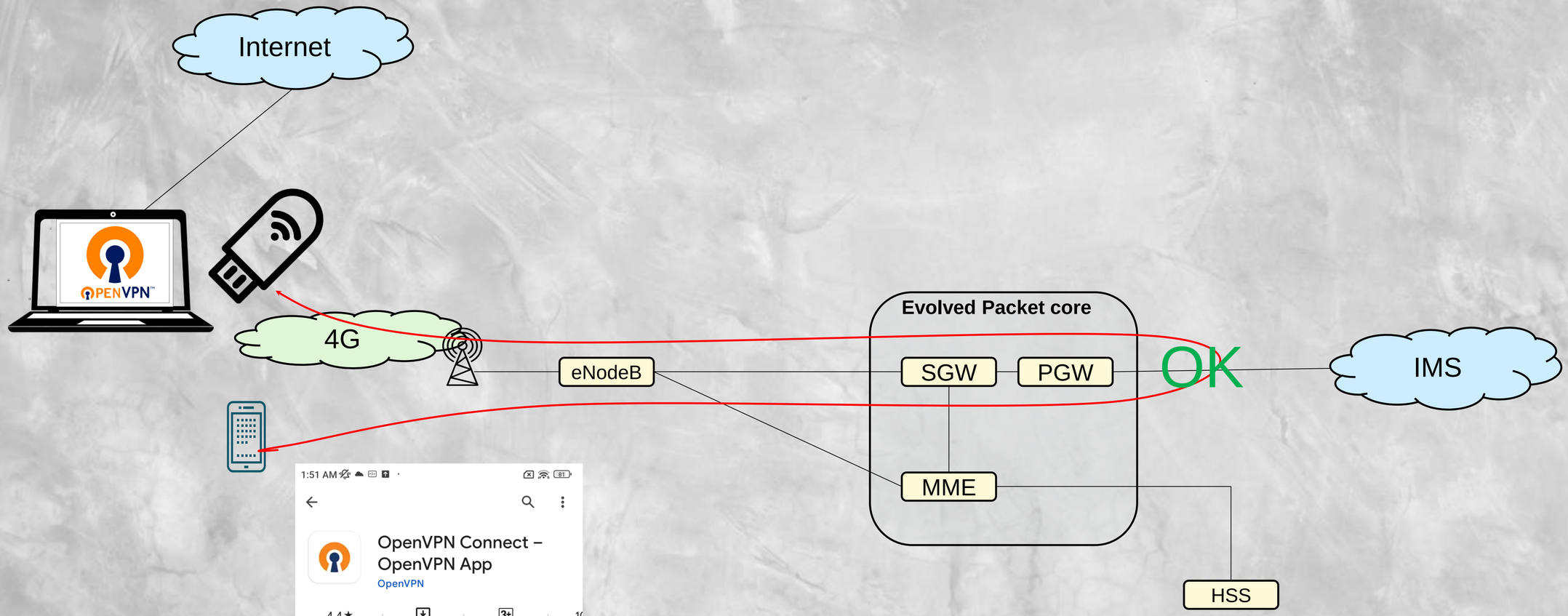
Use internet for free



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Profit

1. Internet APN charging based on used amount of data, but IMS network charging based on minutes and implemented into IMS infrastructure
2. As we don’t use IMS infrastructure at all, data over IMS APN will not be charged
3. Due to lack of isolation we can establish direct subscriber-to-subscriber communication
4. We can set up OpenVPN tunnel to another subscriber and use his internet
5. Other kind of tunnels are also work, or even p2p networks
6. If network provides VoLTE roaming – then we can implement free internet in Roaming (leaving laptop in home network)

Mitigation for MNO

1. Turn on subscriber isolation, as it is usually done for Internet APN
2. Implement IMS network monitoring

Conclusion

1. Such misconfiguration (lack of subscriber isolation on ims APN) we see in more then 50% of tested network
2. Mobile operators are very big and slow, they were not interested in deploying IMS infrastructure for more then 10 years of LTE network. But now they are in hurry and deploying VoLTE network very fast and not secure.

Thank you!

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