



CMP4204 Wireless Technologies

Lecture 11

Cellular Mobile

4G Long Term Evolution (LTE)

CISSP®

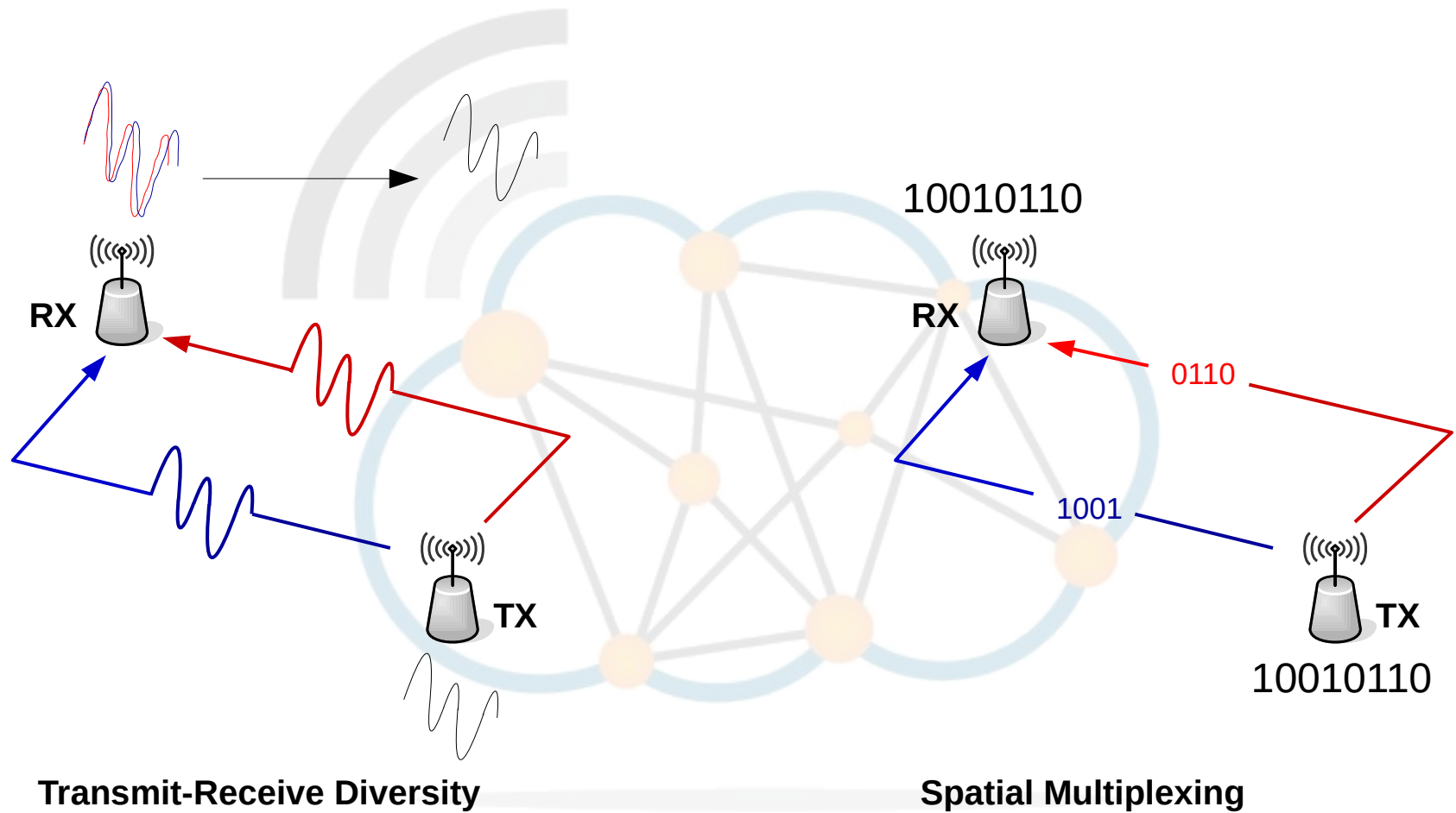
Diarmuid Ó Briain

CEng, FIEI, FIET, CISSP

diarmuid@obriain.com



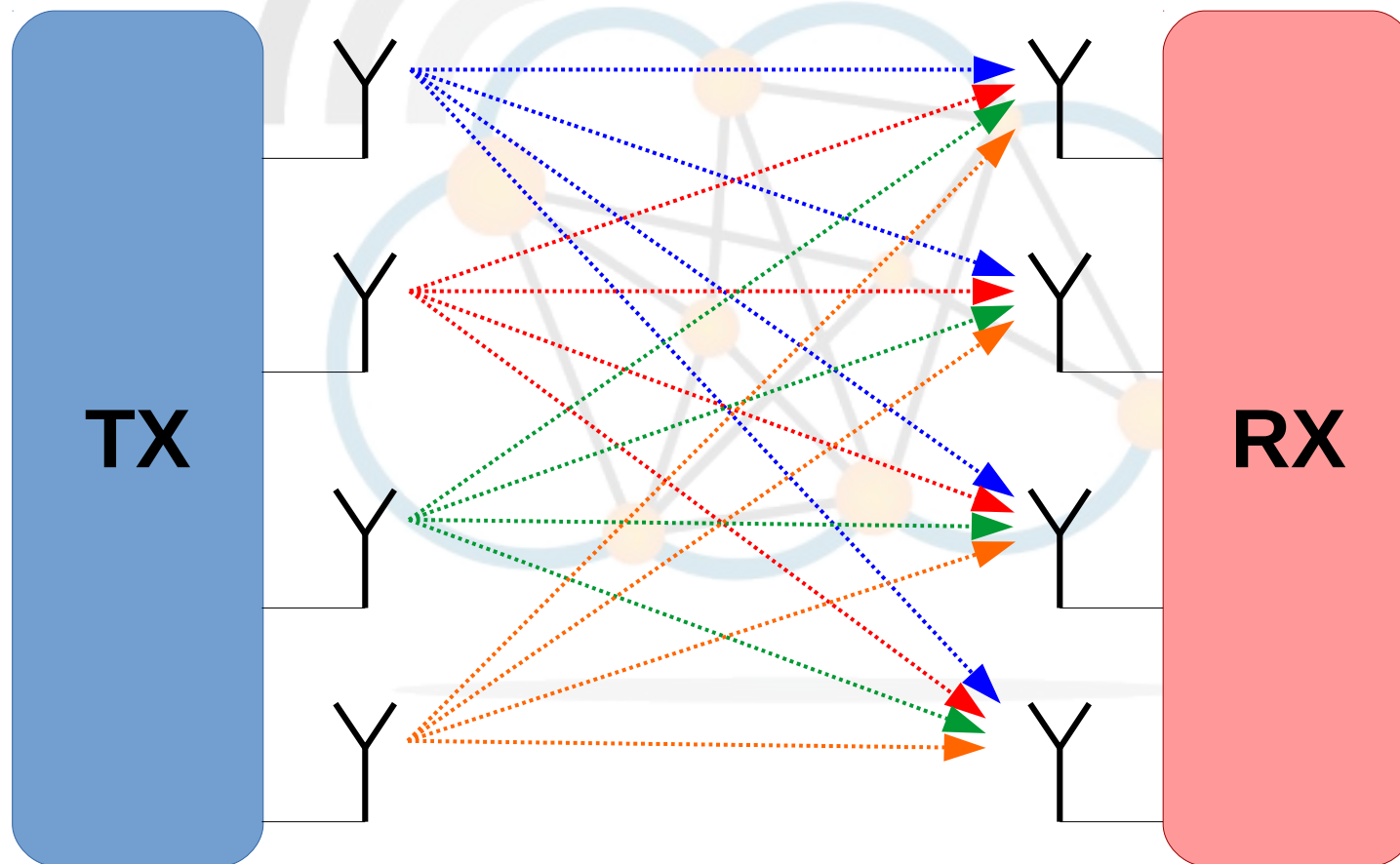
Multiple In, Multiple Out (MIMO)



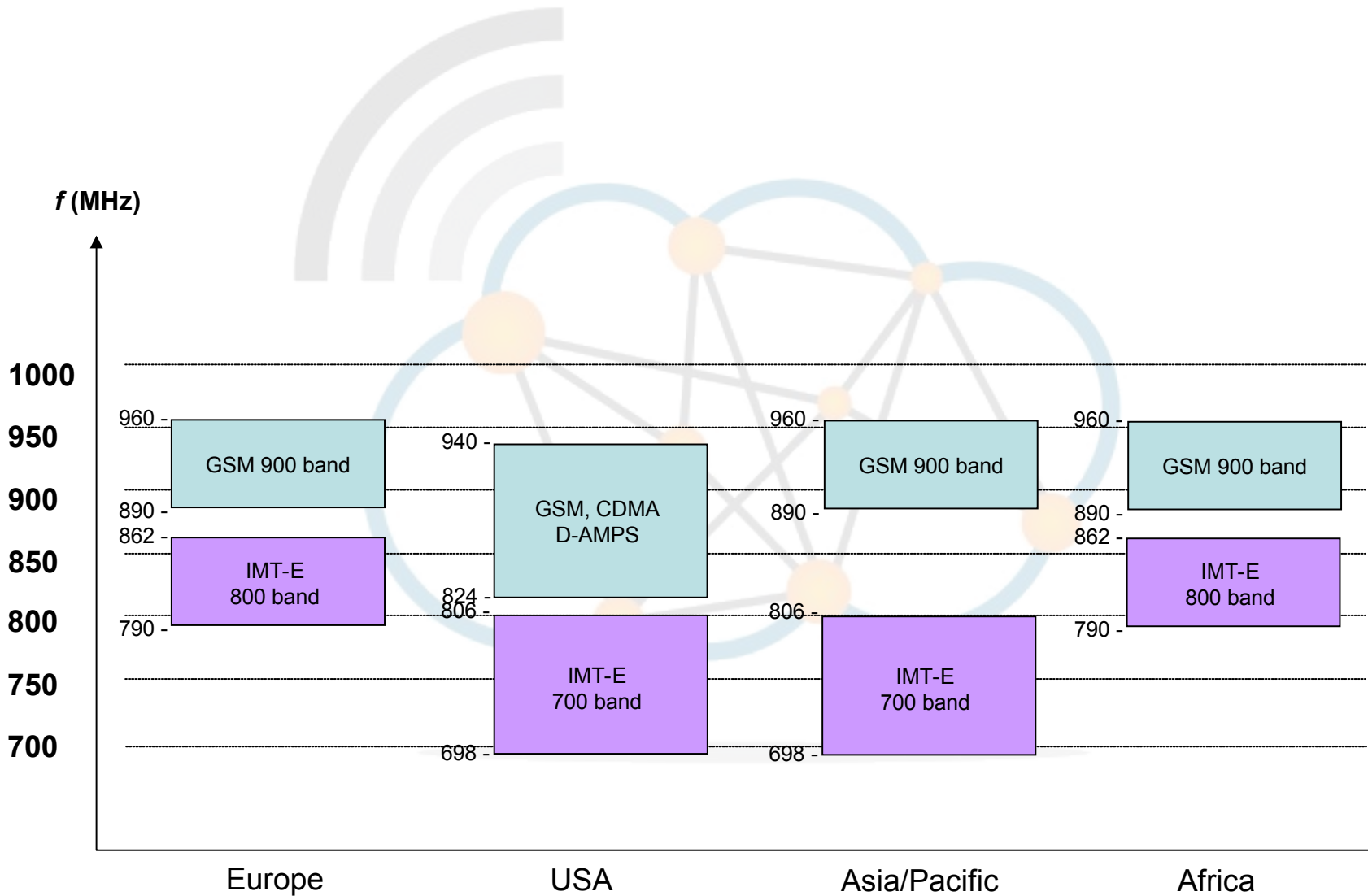
Multiple In, Multiple Out (MIMO)



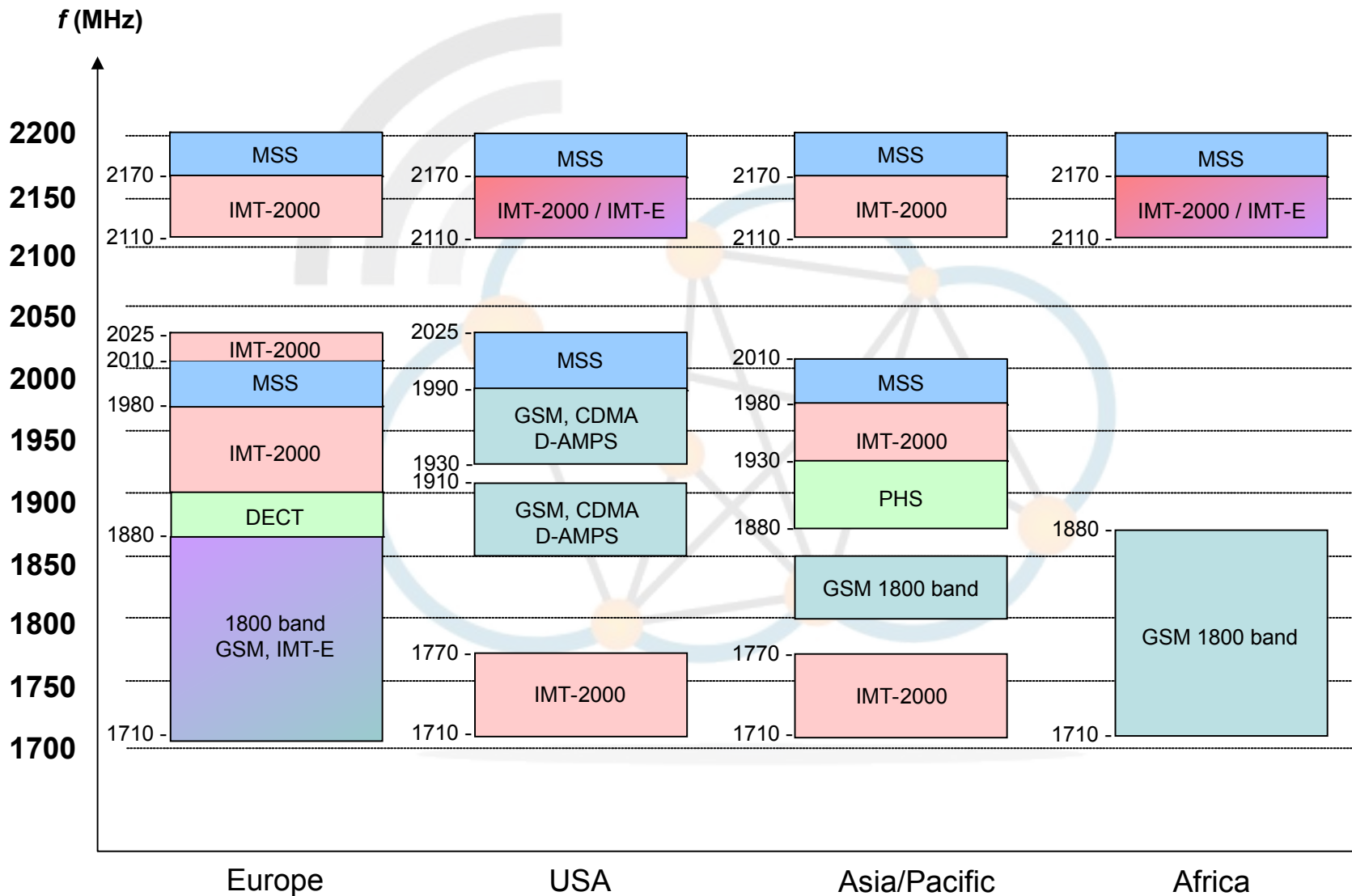
- 4X4 MIMO
 - Four transmit antennas, Four receive antennas.



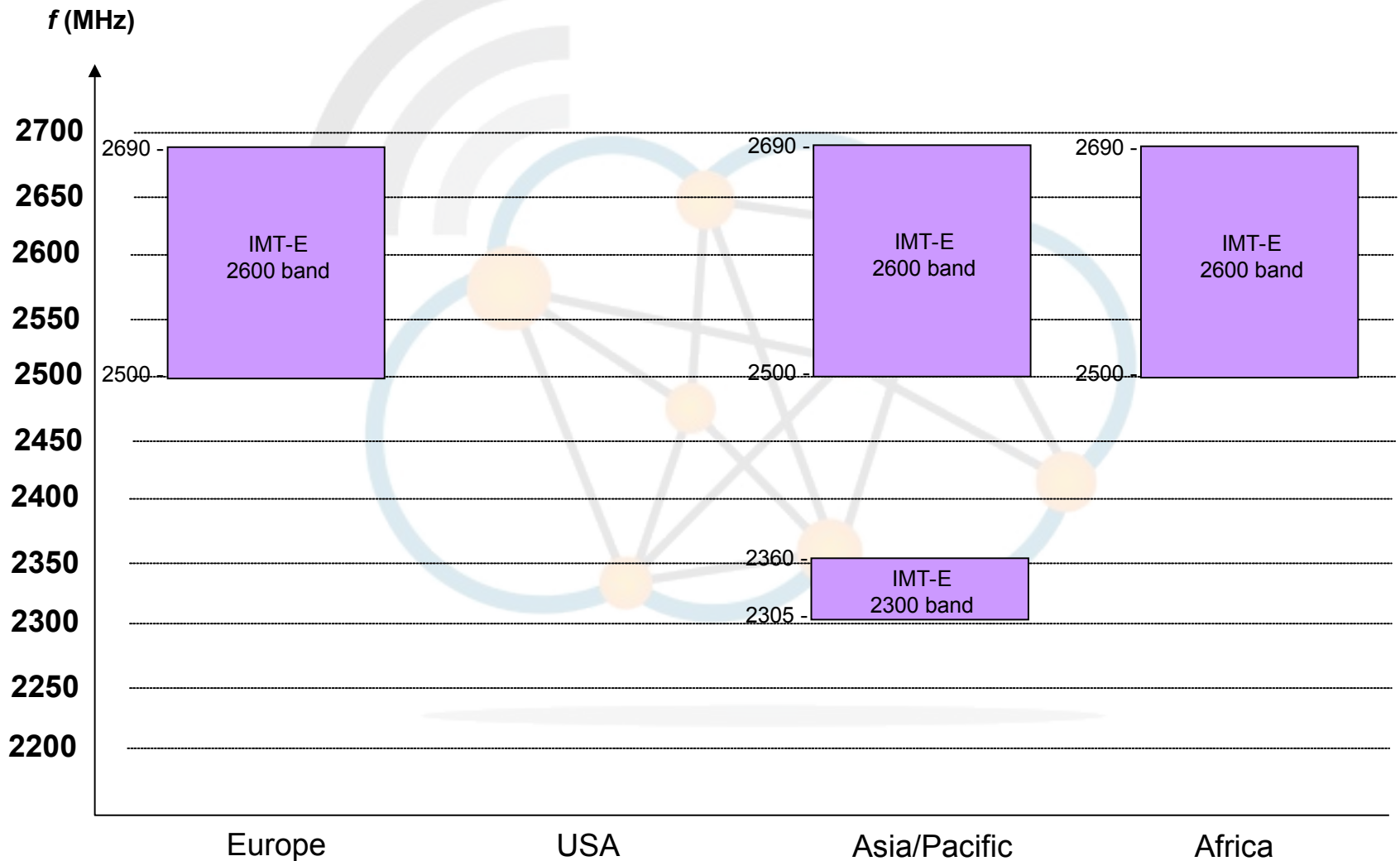
IMT-2000/IMT-Adv – Spectrum > 1 GHz



IMT-2000/IMT-E – Spectrum 1 \leftrightarrow 2 GHz



IMT-2000/IMT-E – Spectrum > 2 GHz



Long Term Evolution



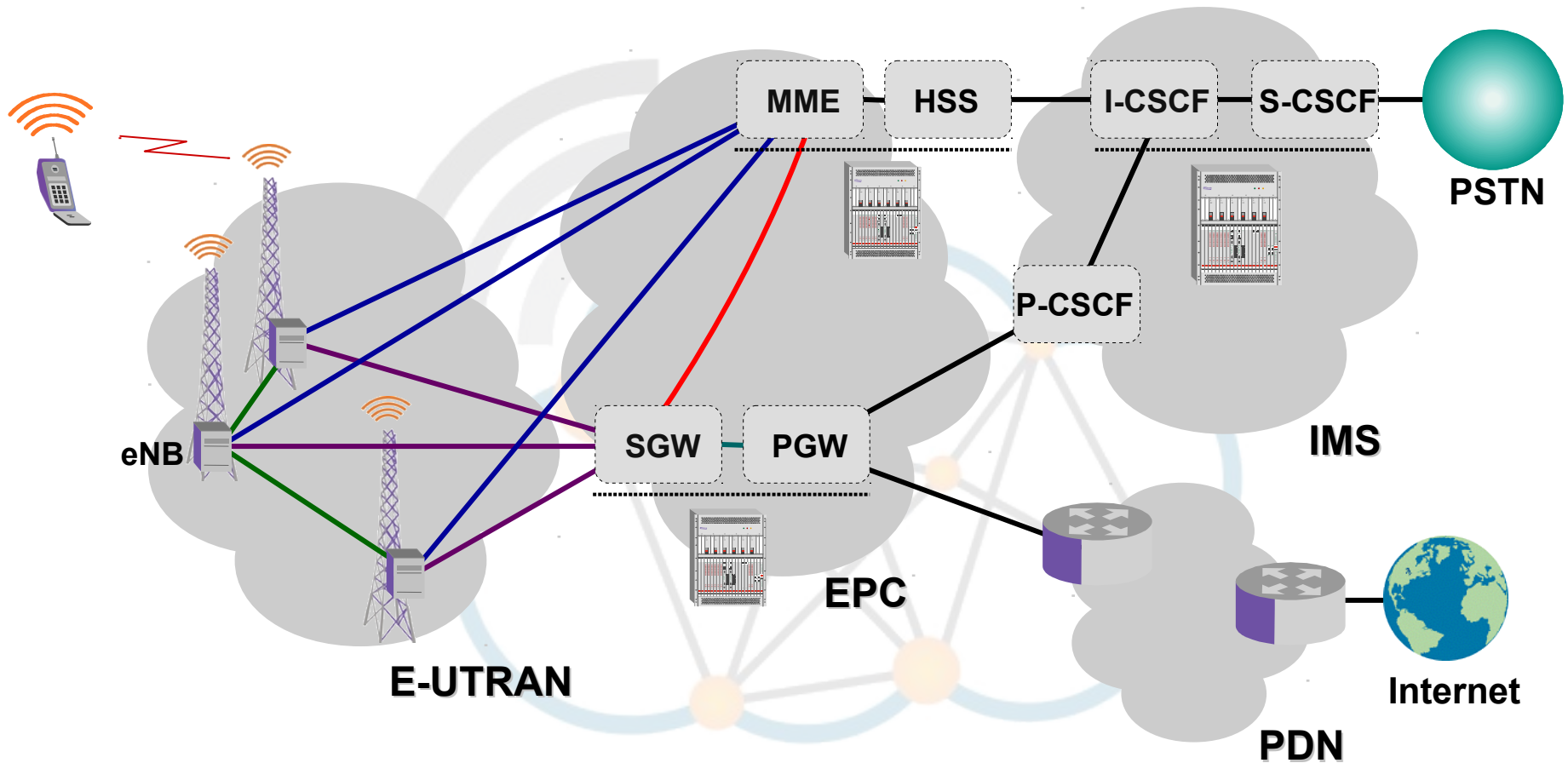
- 4G wireless broadband technology developed by the 3GPP.
- Radio interface provides improved coverage and throughput as it uses:
 - Orthogonal Frequency Division Multiplexing (OFDM)
 - Multiple Input Multiple Output (MIMO)
- Peak data rates DL: 300 Mb/s, UL: 75 Mb/s
- Transfer latency of less than 5 ms.
- Flat all-IP Based Evolved Packet Core.
- No circuit switched voice.
- Voice over LTE (VoLTE), SIP based VoIP.

Long Term Evolution - Voice



- **No circuit switched voice**
- **Circuit-switched fallback (CSFB)**
 - Voice calls detected and transferred to circuit switched 3G MSC.
 - When there's an active voice call and data session, the device's radio will use HSPA+ for both the phone call and the data session.
- **Simultaneous voice and LTE (SVLTE)**
 - UE uses LTE for data and circuit switched 3G for voice.
 - Handset needs to have two radios that are on simultaneously.
 - Power consumption higher as two radios are on during voice call.
 - Data speeds are not affected by ongoing voice call.
- **Voice over LTE (VoLTE)**
 - SIP based VoIP.

Long Term Evolution elements

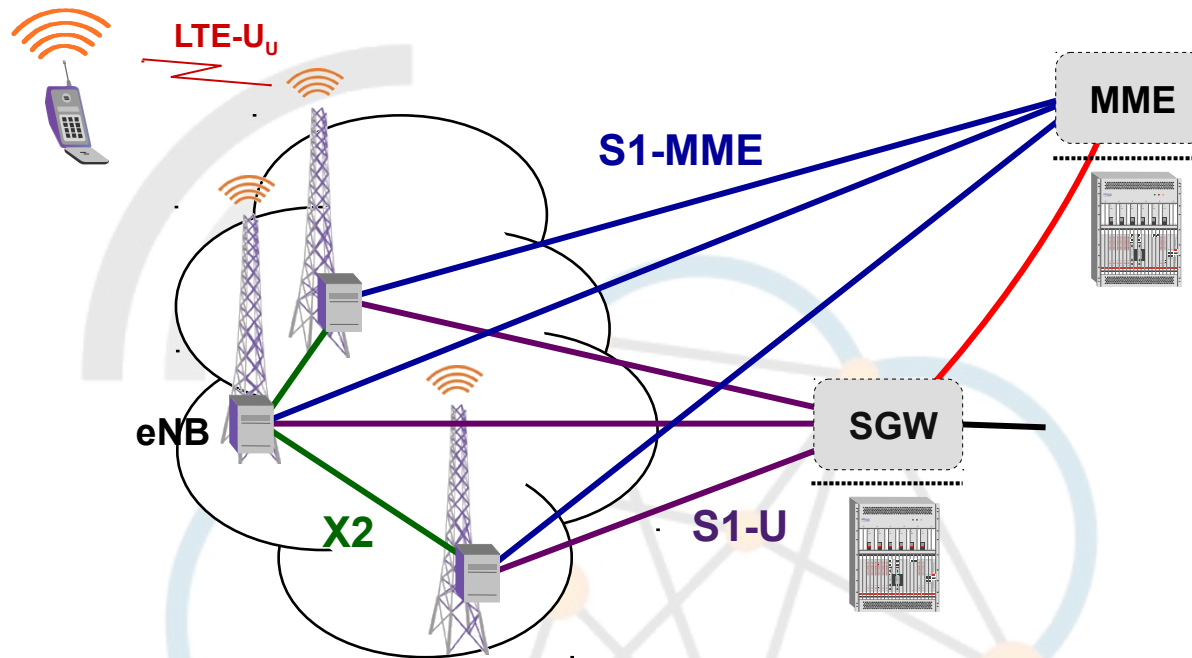


- Evolved Universal Terrestrial Radio Access Network (E-UTRAN)
 - Evolved NodeB (eNB)
- Evolved Packet Core (EPC)
- Packet Data Network (PDN)
- IP Multimedia Subsystem (IMS)

Multiple In, Multiple Out (MIMO)



- Multiple antennas on TX and RX to send and receive multiple data streams simultaneously.
- Increased Spectral efficiency.
- SISO
 - Spectral efficiency in the region of 4 b/s/Hz
- 4X4 MIMO
 - Four transmit antennas, four receive antennas
 - 16.32 b/s/Hz for LTE with 4x4 MIMO.
- 8X8 MIMO
 - Eight transmit antennas, eight receive antennas
 - 30 b/s/Hz for LTE-Advanced with 8x8 MIMO.



- **Uu** – eNB to UE, Mobility management, Call control, Session management, Identity management.
- **X2** - eNB to eNB using IP/SCTP.
- **S1-U** - User plane interface between eNB and SGW.
 - **GTP-U** v1 is the application protocol that encapsulates the UE payload.
 - GTP-U runs on UDP.
- **S1-MME** - eNB to MME using IP/SCTP.

Stream Control Transmission Protocol (SCTP)



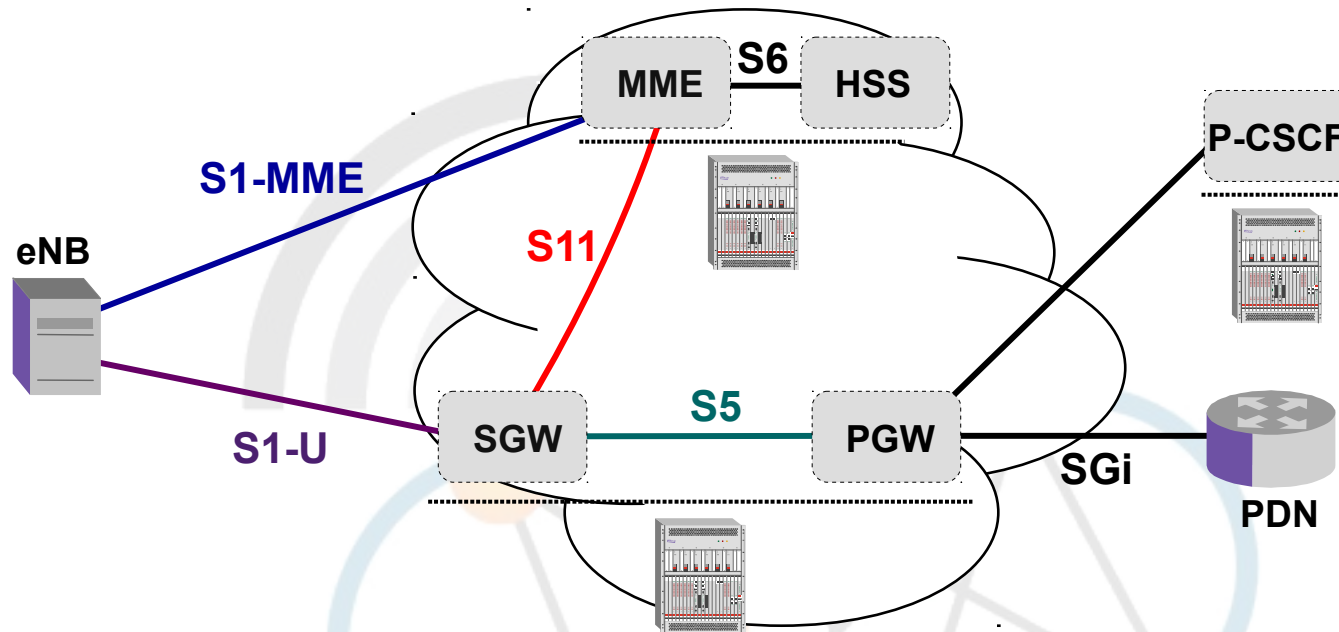
- RFC 4960.
- Transport protocol.
- Protocol number 132.
- message-oriented like UDP.
- ensures reliable, in-sequence transport with congestion control like TCP.

GPRS Tunneling Protocol (GTP)



- IP based tunnelling protocol which permits many tunnels between each set of end points.
- GTP can be used with UDP or TCP.
 - UDP is either recommended or mandatory.
- 3 versions GTP, GTPv1 and GTPv2.
 - Not compatible with each-other.
- Evolved GTP (eGTP) - GTPv2
 - Additional functionality for LTE.

Evolved Packet Core (EPC)



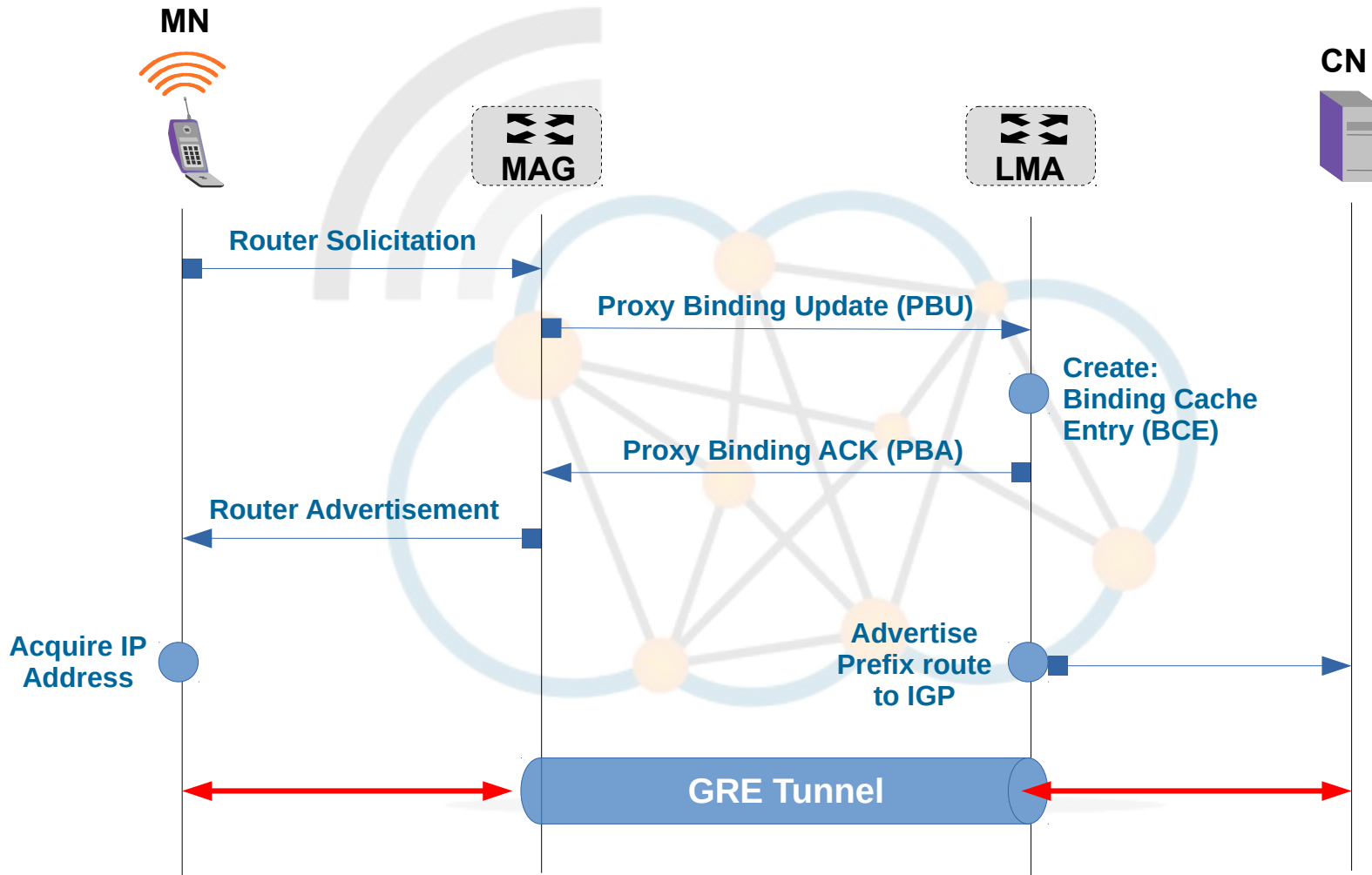
- **Mobility Management Entity (MME)** - the control node for LTE access network.
- **Serving Gateway (SGW)** - terminates the interface towards E-UTRAN.
- **Packet Data Network Gateway (PGW)** - terminates the **SGi** interface towards PDN/IMS.
- **S11** - MME to SGW. IP/UDP with GTPv2 as application protocol.
- **S5** - SGW to PGW. IP/UDP with GTP or PMIP interface.
 - **PMIP** used to support non-trusted 3GPP network access.
- **S6** - MME to HSS. IP/SCTP. Transfer of subscription and AAA data.

Proxy Mobile IP (PMIP)

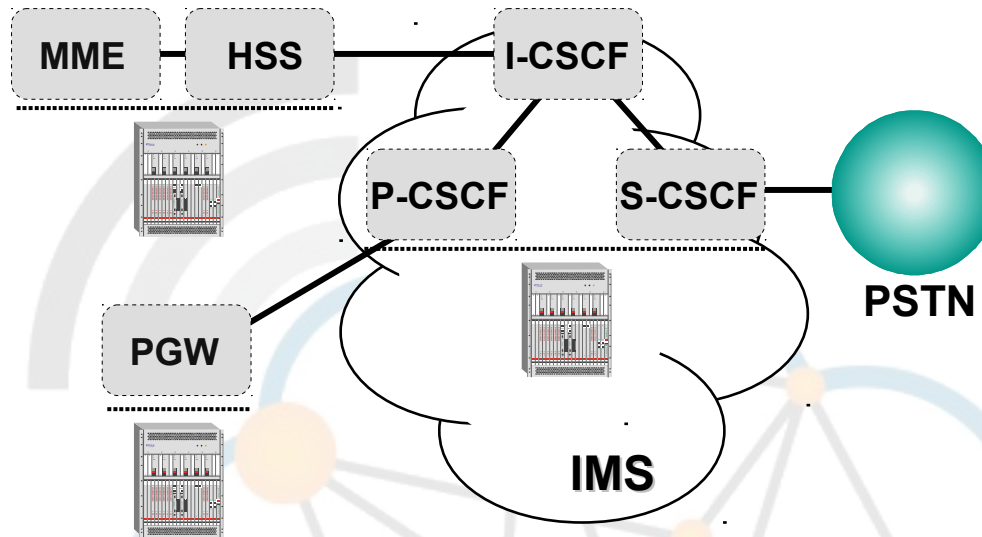


- RFC 5213.
- Functional entities
 - Local Mobility Anchor (LMA)
 - Mobile Access Gateway (MAG)
 - Mobile Node (MN)
 - Correspondent Node (CN).
- Essentially creates GRE tunnel between MAG and LMA to permit traffic from MN to CN.

PMIP call flow

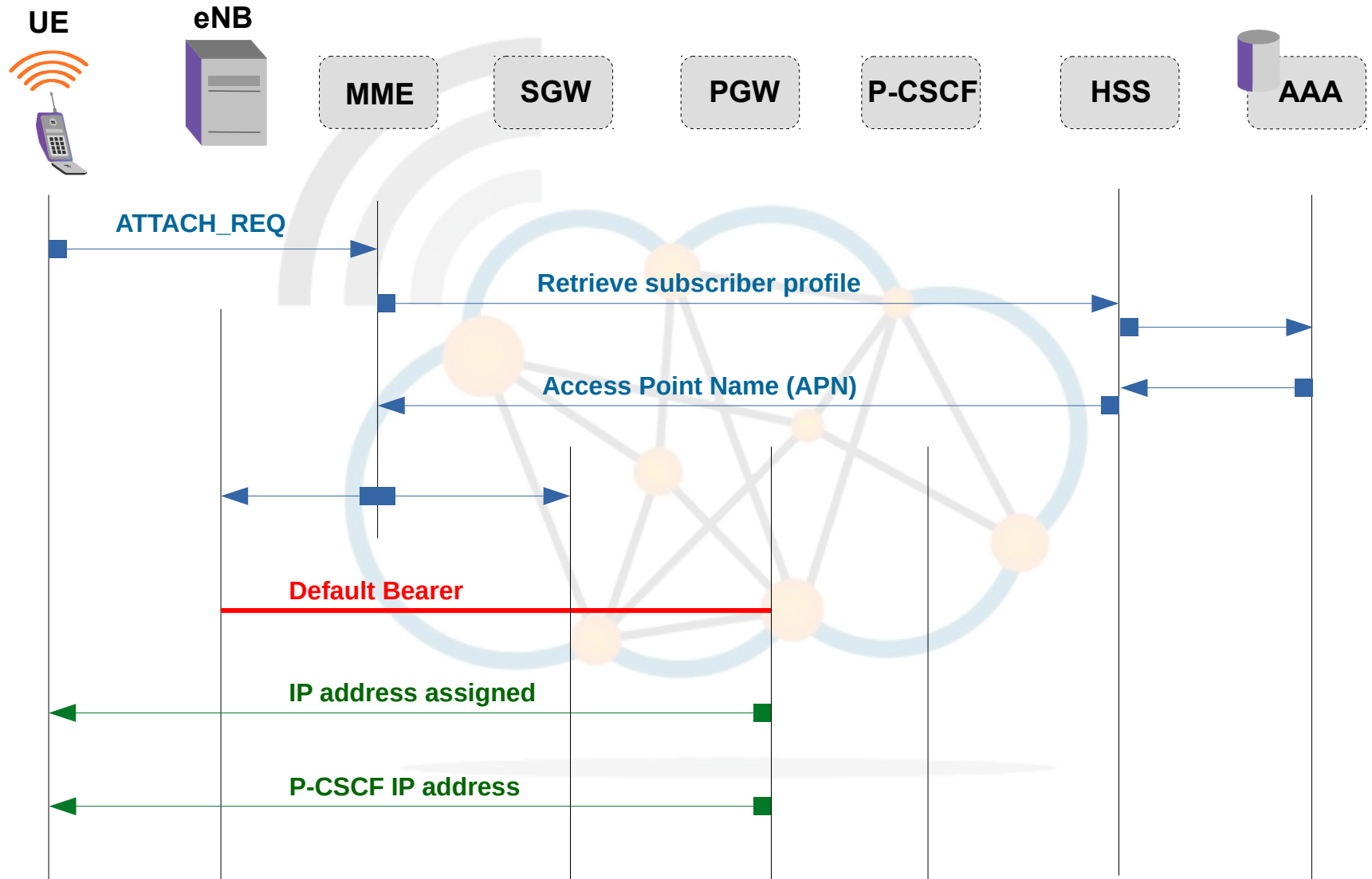


IP Multimedia Subsystem (IMS)



- **Session Border Controller (SBC)**
 - VoIP firewall function that is involved in setting up, conducting, and tearing down SIP calls.
- **Proxy-CSCF (P-CSCF)**
 - SIP Proxy, specialised SBC.
- **Interrogating-CSCF (I-CSCF)**
 - SIP Proxy function at the edge of the IMS domain.
 - Can be found by UEs via DNS.
- **Serving-CSCF (S-CSCF)**
 - Proxy SIP Server assigned to UE by I-CSCF depending on the profile from HSS.

UE attach to the network





Telephone call on LTE using Voice over LTE (VoLTE)

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Diarmuid Ó Briain

CEng, FIEI, FIET, CISSP

diarmuid@obriain.com

Voice over LTE (VoLTE)



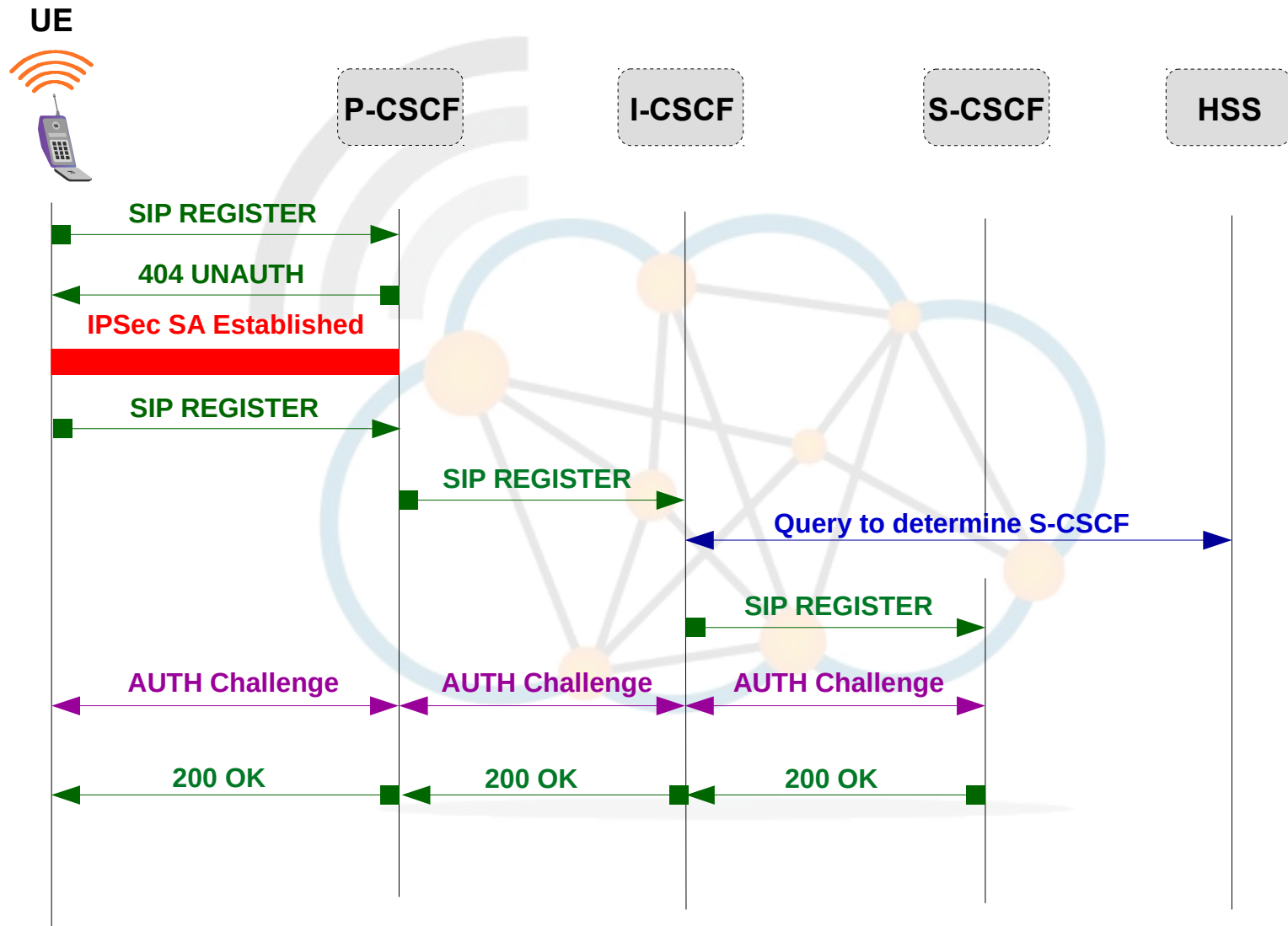
- IP Multimedia Subsystem (IMS) network, with specific profiles for control and media planes of voice service on LTE delivered as data flows within the LTE data bearer.
- VoLTE essentially uses IMS SIP Gateways and establishes VoIP calls.
- VoLTE has up to three times more voice and data capacity than 3G UMTS and up to six times more than 2G GSM.
- VoLTE's packets headers are smaller than those of unoptimised VoIP over LTE.

Call Session Control Function (CSCF)

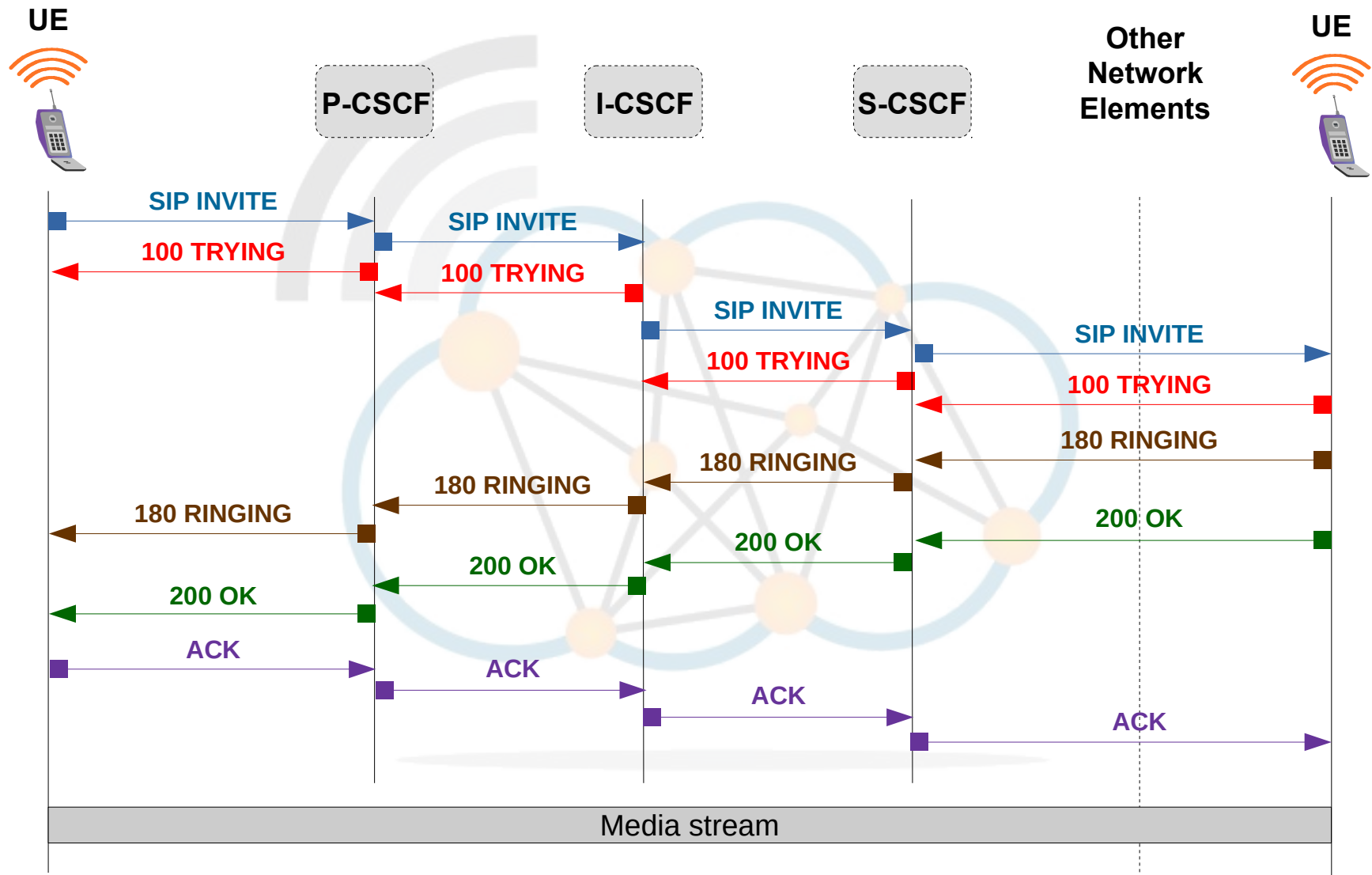


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- Serving-CSCF (S-CSCF)
 - Proxy SIP Server assigned to UE by I-CSCF depending on the profile from HSS.
- Home Subscriber Server (HSS)
 - Database that stores user profiles.

UE Register with S-CSCF



UE SIP Call call





Thank You

CISSP®

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