MakeMyTechnology

"Welcome to Make My Technology — where innovation meets education in the world of wireless and telecom.

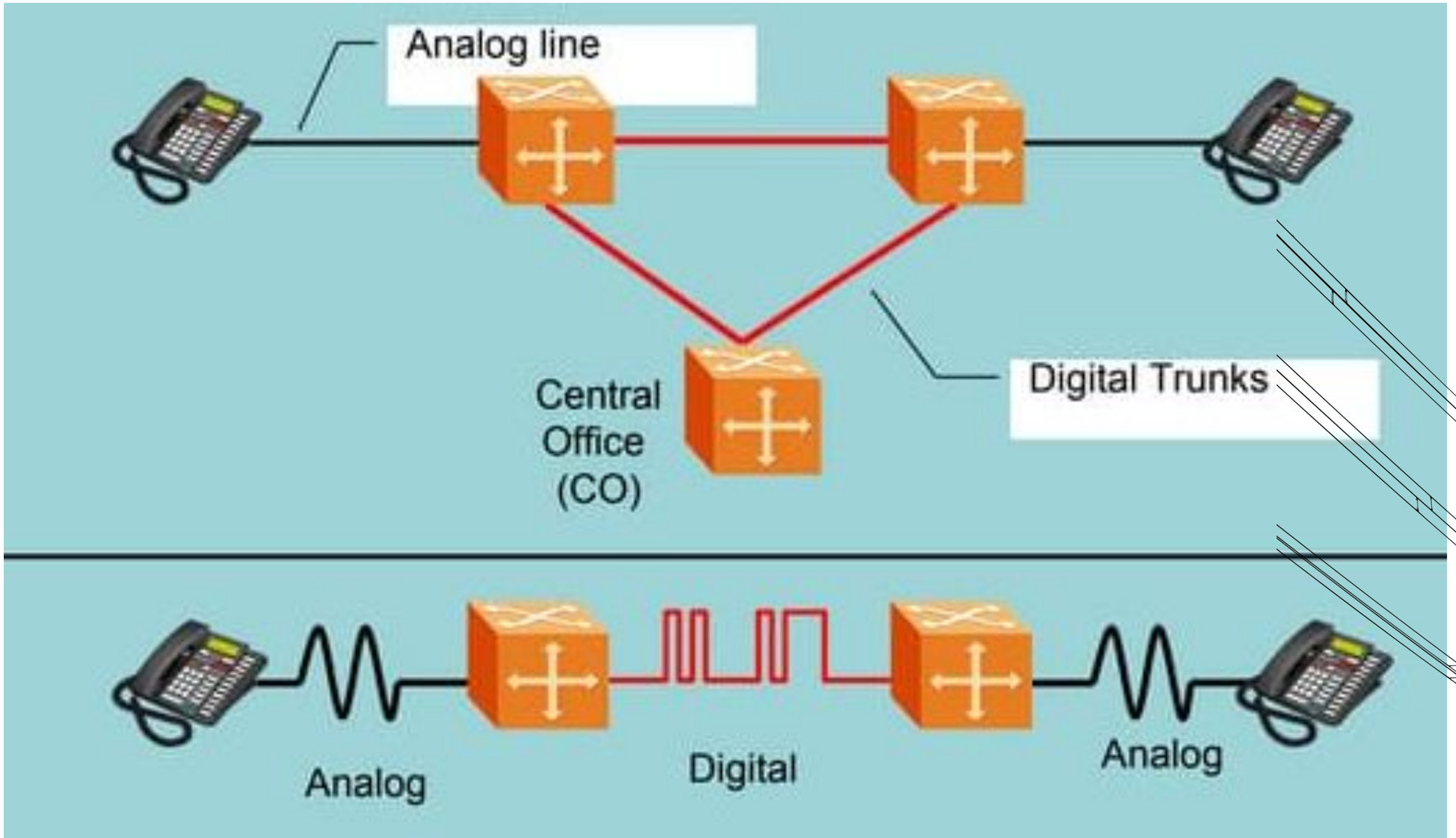
How It Works

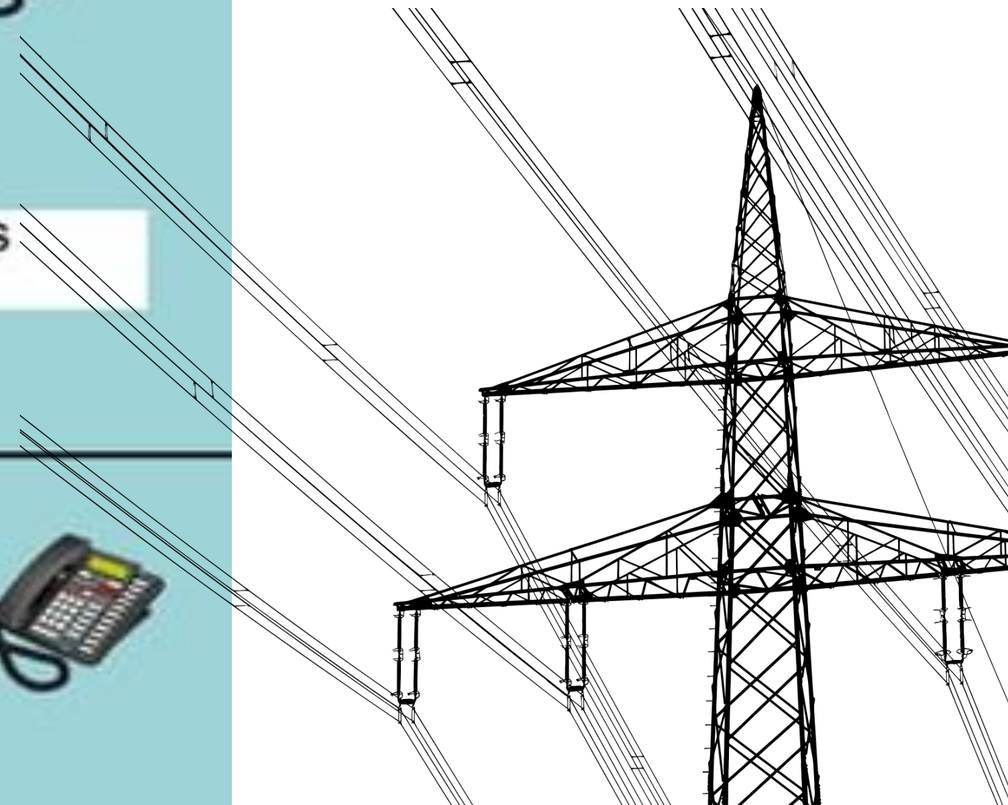
FROM PSTN TO 5G: THE EVOLUTION OF TELECOMMUNICATION

RACING THE JOURNEY OF CONNECTIVITY, INNOVATION, AND TRANSFORMATION

PSTN: THE FOUNDATION OF COMMUNICATION

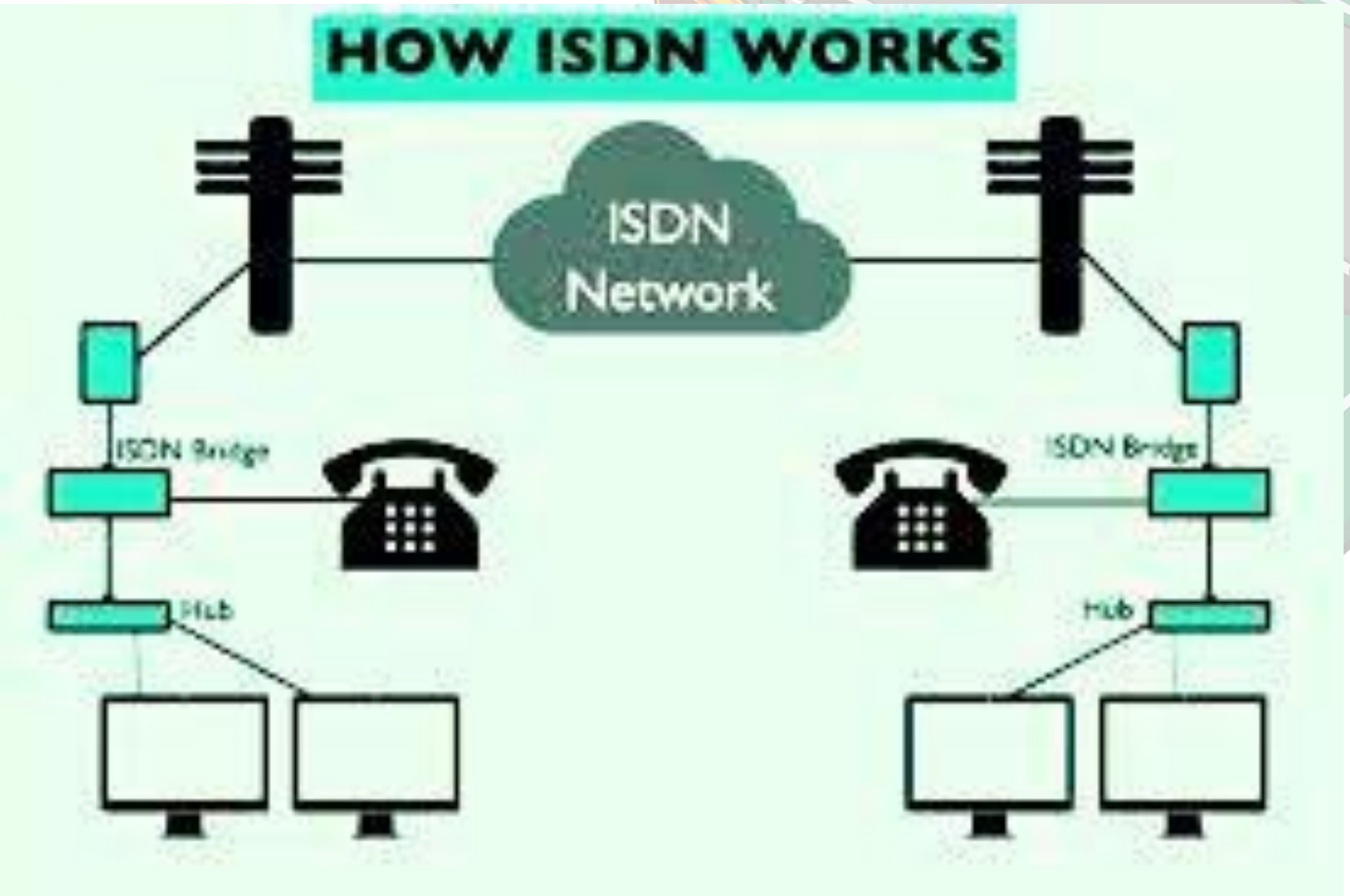
"ANALOG LINES, TRUNK CALL EXCHANGES, AND GLOBAL CONNECTIVITY





ISDN: THE DIGITAL LEAP

VOICE, VIDEO, AND DATA OVER DIGITAL LINES

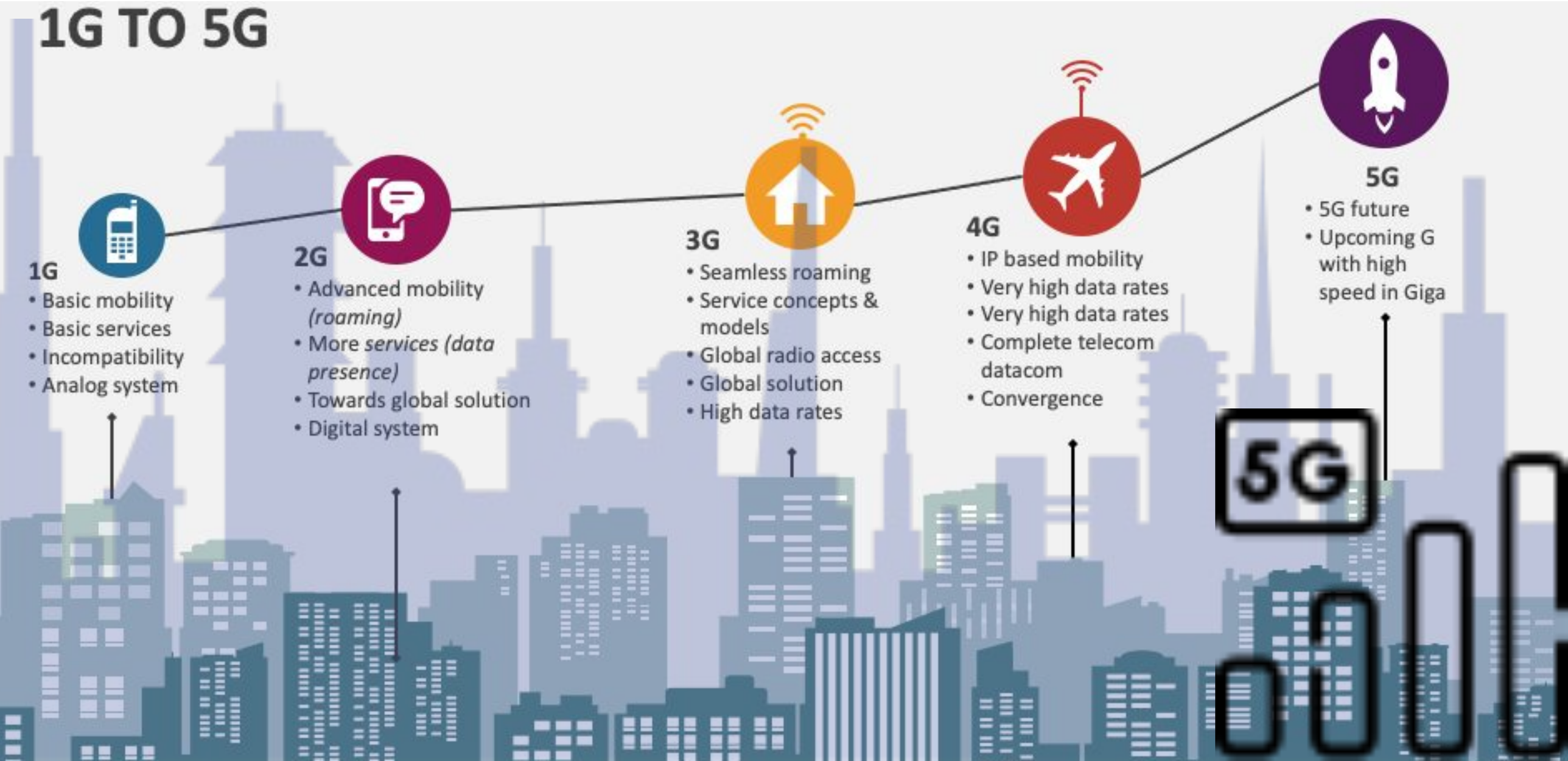


VOIP: THE INTERNET REVOLUTION

VOICE PACKETS, ENCRYPTION, AND FLEXIBILITY

THE CELLULAR REVOLUTION: FROM 1G TO 5G"

ANALOG TO ULTRA-FAST CONNECTIVITY



THE FUTURE OF CONNECTIVITY

THE FUTURE OF CONNECTIVITY

PSTN vs. IDSN vs. VoIP

	PSTN	ISDN	VoIP
Technology	Analog, copper wires	Digital, copper/fiber	Digital, internet
Cost	High costs for hardware, installation, and maintenance	Lower costs than PSTN, but still requires dedicated infrastructure	Low costs, especially for long-distance and international calls
Reliability	Reliable, but susceptible to line damage	Reliable, but susceptible to line damage	Depends on internet connection
Call Quality	Low quality, susceptible to interference	Higher quality than PSTN	High quality, comparable to or better than ISDN
Scalability	Difficult and expensive to scale	More scalable than PSTN, but requires infrastructure changes	Highly scalable

To better understand how your phone connects to a 5G network, we used **Wireshark** to capture the real-time communication between a mobile device, the 5G base station (gNB), and the Core Network. These messages show how the device asks for access, how the network replies, and how they complete the registration process. This simple message flow helps us see what happens behind the scenes when a phone joins a 5G network. The next slides explain each step clearly using actual packet data from Wireshark.

MakeMyTechnology

Real Time Call Flow in Wireshark

Initial UE Message to Registration Complete

	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.11.…	192.168.8.33	NGAP	122	NGSetupRequest
2	0.000322825	192.168.8.33	192.168.11.…	NGAP	154	NGSetupResponse
3	36.9328990…	192.168.11.…	192.168.8.33	NGAP/NAS-5GS	130	InitialUEMessage, Registration request [RRCEstablishmentCause=mo-Signalling]
4	36.9340427…	192.168.8.33	192.168.11.…	NGAP/NAS-5GS	146	SACK (Ack=1, Arwnd=106496) , DownlinkNASTransport, Authentication request
5	37.2328891…	192.168.11.…	192.168.8.33	NGAP/NAS-5GS	126	UplinkNASTransport, Authentication response
6	37.2340513…	192.168.8.33	192.168.11.…	NGAP/NAS-5GS	122	SACK (Ack=2, Arwnd=106496) , DownlinkNASTransport, Security mode command
7	37.2728085…	192.168.11.…	192.168.8.33	NGAP/NAS-5GS/NAS-…	190	SACK (Ack=2, Arwnd=106496) , UplinkNASTransport, Security mode complete, Registration request
8	37.2754428…	192.168.8.33	192.168.11.…	NGAP/NAS-5GS	234	SACK (Ack=3, Arwnd=106496) , InitialContextSetupRequest, Registration accept
9	37.3296995…	192.168.11.…	192.168.8.33	NGAP	1366	SACK (Ack=3, Arwnd=106496) , UERadioCapabilityInfoIndication[Malformed Packet]
10	37.5334769…	192.168.11.…	192.168.8.33	NGAP	82	InitialContextSetupResponse
11	43.2779900…	192.168.8.33	192.168.11.…	NGAP/NAS-5GS	142	DownlinkNASTransport, Registration accept
12	43.3127874…	192.168.11.…	192.168.8.33	NGAP/NAS-5GS	134	SACK (Ack=4, Arwnd=106496) , UplinkNASTransport, Registration complete
13	43.3129923…	192.168.8.33	192.168.11.…	NGAP/NAS-5GS	150	SACK (Ack=6, Arwnd=106496) , DownlinkNASTransport, Configuration update command
14	43.5529975…	192.168.11.…	192.168.8.33	NGAP/NAS-5GS	182	UplinkNASTransport, UL NAS transport, PDU session establishment request
15	43.5718288…	192.168.8.33	192.168.11.…	NGAP/NAS-5GS	286	SACK (Ack=7, Arwnd=106496) , PDUSessionResourceSetupRequest, DL NAS transport, PDU session establishment accept (PDU sessio
16	59.5527599…	192.168.11.…	192.168.8.33	NGAP/NAS-5GS	182	UplinkNASTransport, UL NAS transport, PDU session establishment request
17	59.5530931…	192.168.8.33	192.168.11.…	NGAP	110	SACK (Ack=8, Arwnd=106496) , PDUSessionResourceReleaseCommand [Cause: RadioNetwork=release-due-to-5gc-generated-reason]
18	59.5532316…	192.168.8.33	192.168.11.…	NGAP/NAS-5GS	270	PDUSessionResourceSetupRequest, DL NAS transport, PDU session establishment accept (PDU session type IPv4 only allowed)

NAS Call Flow Between Phone and 5G Core

1. Registration Request

```
3 36.9328990… 192.168.11.…  192.168.8.33  NGAP/NAS-5GS          130 InitialUEMessage, Registration request [RRCEstablishmentCause=mo-Signalling]
```

```
Item 2: id-UserLocationInformation
v ProtocolIE-Field
      id: id-UserLocationInformation (121)
      criticality: reject (0)
   v value
      v UserLocationInformation: userLocationInformationNR (1)
         v userLocationInformationNR
            v nR-CGI
               v pLMNIdentity: 04f402
                     Mobile Country Code (MCC): India (404)
                     Mobile Network Code (MNC): Hutchison Essar Ltd, Mumbai (20)
                  0000 0000 0000 0000 0000 0000 1110 0000 0000 .... = nRCellIdentity: 0x000000e00
            v tAI
               v pLMNIdentity: 04f402
                     Mobile Country Code (MCC): India (404)
                     Mobile Network Code (MNC): Hutchison Essar Ltd, Mumbai (20)
                  tAC: 10 (0x00000a)
```

2. Authentication Request

```
4 36.9340427… 192.168.8.33  192.168.11.…  NGAP/NAS-5GS        146 SACK (Ack=1, Arwnd=106496) , DownlinkNASTransport, Authentication request
```

```
Item 2: id-NAS-PDU
▾ ProtocolIE-Field
    id: id-NAS-PDU (38)
    criticality: reject (0)
  ▾ value
    ▾ NAS-PDU: 7e005600020000210bf750c68ed3218a58eb093a1e4d06bf20106e14d8ac99589001792a92b506d8cec4
      ▾ Non-Access-Stratum 5GS (NAS)PDU
        ▾ Plain NAS 5GS Message
            Extended protocol discriminator: 5G mobility management messages (126)
            0000 .... = Spare Half Octet: 0
            .... 0000 = Security header type: Plain NAS message, not security protected (0)
            Message type: Authentication request (0x56)
            0000 .... = Spare Half Octet: 0
          ▾ NAS key set identifier - ngKSI
              .... 0... = Type of security context flag (TSC): Native security context (for KSIAMF)
              .... .000 = NAS key set identifier: 0
          ▾ ABBA
              Length: 2
              ABBA Contents: 0000
          ▾ Authentication Parameter RAND - 5G authentication challenge
              Element ID: 0x21
              RAND value: 0bf750c68ed3218a58eb093a1e4d06bf
          ▾ Authentication Parameter AUTN (UMTS and EPS authentication challenge) - 5G authentication challenge
              Element ID: 0x20
              Length: 16
            ▾ AUTN value: 6e14d8ac99589001792a92b506d8cec4
                SQN xor AK: 6e14d8ac9958
                AMF: 9001
                MAC: 792a92b506d8cec4
```

3. Authentication Response

```
5 37.2328891… 192.168.11.…  192.168.8.33  NGAP/NAS-5GS          126 UplinkNASTransport, Authentication response
```

```
Item 2: id-NAS-PDU
  ProtocolIE-Field
      id: id-NAS-PDU (38)
      criticality: reject (0)
    value
      NAS-PDU: 7e00572d101655bbc584d088fdda195067282095b0
        Non-Access-Stratum 5GS (NAS)PDU
          Plain NAS 5GS Message
              Extended protocol discriminator: 5G mobility management messages (126)
              0000 .... = Spare Half Octet: 0
              .... 0000 = Security header type: Plain NAS message, not security protected (0)
              Message type: Authentication response (0x57)
            Authentication response parameter
                Element ID: 0x2d
                Length: 16
                RES: 1655bbc584d088fdda195067282095b0
```

4. Downlink NAS Transport

```
6 37.2340513… 192.168.8.33  192.168.11.…  NGAP/NAS-5GS        122 SACK (Ack=2, Arwnd=106496) , DownlinkNASTransport, Security mode command
```

```
Item 2: id-NAS-PDU
▾ ProtocolIE-Field
    id: id-NAS-PDU (38)
    criticality: reject (0)
  ▾ value
    ▾ NAS-PDU: 7e03a04665f6007e005d020002f070e1360102
      ▾ Non-Access-Stratum 5GS (NAS)PDU
        ▾ Security protected NAS 5GS message
            Extended protocol discriminator: 5G mobility management messages (126)
            0000 .... = Spare Half Octet: 0
            .... 0011 = Security header type: Integrity protected with new 5GS security context (3)
            Message authentication code: 0xa04665f6
            Sequence number: 0
        ▾ Plain NAS 5GS Message
            Extended protocol discriminator: 5G mobility management messages (126)
            0000 .... = Spare Half Octet: 0
            .... 0000 = Security header type: Plain NAS message, not security protected (0)
            Message type: Security mode command (0x5d)
          ▾ NAS security algorithms
              0000 .... = Type of ciphering algorithm: 5G-EA0 (null ciphering algorithm) (0)
              .... 0010 = Type of integrity protection algorithm: 128-5G-IA2 (2)
            0000 .... = Spare Half Octet: 0
          ▾ NAS key set identifier - ngKSI
              .... 0... = Type of security context flag (TSC): Native security context (for KSIAMF)
              .... .000 = NAS key set identifier: 0
          ▾ UE security capability - Replayed UE security capabilities
              Length: 2
                1... .... = 5G-EA0: Supported
                .1.. .... = 128-5G-EA1: Supported
                ..1. .... = 128-5G-EA2: Supported
                ...1 .... = 128-5G-EA3: Supported
                .... 0... = 5G-EA4: Not supported
                .... .0.. = 5G-EA5: Not supported
                .... ..0. = 5G-EA6: Not supported
                .... ...0 = 5G-EA7: Not supported
                0... .... = 5G-IA0: Not supported
                .1.. .... = 128-5G-IA1: Supported
                ..1. .... = 128-5G-IA2: Supported
                ...1 .... = 128-5G-IA3: Supported
                .... 0... = 5G-IA4: Not supported
                .... .0.. = 5G-IA5: Not supported
                .... ..0. = 5G-IA6: Not supported
                .... ...0 = 5G-IA7: Not supported
            ▾ IMEISV request
                1110 .... = Element ID: 0xe-
                .... 0... = Spare bit(s): 0x00
                .... .001 = IMEISV request: IMEISV requested (1)
            ▾ Additional 5G security information
                Element ID: 0x36
                Length: 1
                0... .... = Spare: 0
                .0.. .... = Spare: 0
                ..0. .... = Spare: 0
                ...0 .... = Spare: 0
                .... 0... = Spare: 0
                .... .0.. = Spare: 0
                .... ..1. = Retransmission of initial NAS message request (RINMR): Requested
                .... ...0 = Horizontal derivation parameter (HDP): Not required
```

MakeMyTechnology

5. Uplink NAS Transport

```
7 37.2728085… 192.168.11.…  192.168.8.33  NGAP/NAS-5GS/NAS-…   190 SACK (Ack=2, Arwnd=106496) , UplinkNASTransport, Security mode complete, Registration request
```

```
ProtocolIE-Field
    id: id-NAS-PDU (38)
    criticality: reject (0)
  value
    NAS-PDU: 7e04588770fd007e005e770009359558150041890 4f171002b7e004179000d0104f402f0ff00001000001192100 1002e02f0702f0504010000001801017400009053010 1
      Non-Access-Stratum 5GS (NAS)PDU
        Security protected NAS 5GS message
            Extended protocol discriminator: 5G mobility management messages (126)
            0000 .... = Spare Half Octet: 0
            .... 0100 = Security header type: Integrity protected and ciphered with new 5GS security context (4)
            Message authentication code: 0x588770fd
            Sequence number: 0
        Plain NAS 5GS Message
            Extended protocol discriminator: 5G mobility management messages (126)
            0000 .... = Spare Half Octet: 0
            .... 0000 = Security header type: Plain NAS message, not security protected (0)
            Message type: Security mode complete (0x5e)
          5GS mobile identity
              Element ID: 0x77
              Length: 9
              .... 0... = Odd/even indication: Even number of identity digits
              .... .101 = Type of identity: IMEISV (5)
              IMEISV: 3598551001498401
          NAS message container
              Element ID: 0x71
              Length: 43
            Non-Access-Stratum 5GS (NAS)PDU
              Plain NAS 5GS Message
                  Extended protocol discriminator: 5G mobility management messages (126)
                  0000 .... = Spare Half Octet: 0
                  Message type: Registration request (0x41)
                5GS registration type
                  .... 1... = Follow-On Request bit (FOR): Follow-on request pending
                  .... .001 = 5GS registration type: initial registration (1)
                NAS key set identifier
                  0... .... = Type of security context flag (TSC): Native security context (for KSIAMF)
                  .111 .... = NAS key set identifier: 7
                5GS mobile identity
                  Length: 13
                  0... .... = Spare: 0
                  .000 .... = SUPI format: IMSI (0)
                  .... 0... = Spare: 0
                  .... .001 = Type of identity: SUCI (1)
                  Mobile Country Code (MCC): India (404)
                  Mobile Network Code (MNC): Hutchison Essar Ltd, Mumbai (20)
                  Routing indicator: 0
                  .... 0000 = Protection scheme Id: NULL scheme (0)
                  Home network public key identifier: 0
                  MSIN: 0100001129
                5GMM capability
                  Element ID: 0x10
                  Length: 1
                  0... .... = Service gap control (SGC): Not supported
                  .0.. .... = IP header compression for control plane CIoT 5GS optimization (5G-IPHC-CP CIoT): Not supported
                  ..0. .... = N3 data transfer (N3 data): Not supported
                  ...0 .... = Control plane CIoT 5GS optimization (5G-CP CIoT): Not supported
                  .... 0... = Restriction on use of enhanced coverage support (RestrictEC): Not supported
                  .... .0.. = LTE Positioning Protocol (LPP) capability: Not supported
                  .... ..0. = ATTACH REQUEST message containing PDN CONNECTIVITY REQUEST message for handover support (HO attach): Not supported
                  .... ...0 = EPC NAS supported (S1 mode): Not supported
```

MakeMyTechnology

6. Initial Context Setup Request or registration accept

```
8 37.2754428… 192.168.8.33  192.168.11.…  NGAP/NAS-5GS        234 SACK (Ack=3, Arwnd=106496) , InitialContextSetupRequest, Registration accept
```

```
Item 2: id-GUAMI
 ProtocolIE-Field
      id: id-GUAMI (28)
      criticality: reject (0)
   value
      GUAMI
         pLMNIdentity: 04f402
            Mobile Country Code (MCC): India (404)
            Mobile Network Code (MNC): Hutchison Essar Ltd, Mumbai (20)
         aMFRegionID: 80 [bit length 8, 1000 0000 decimal value 128]
         aMFSetID: 0100 [bit length 10, 6 LSB pad bits, 0000 0001  00.. .... decimal value 4]
         aMFPointer: 04 [bit length 6, 2 LSB pad bits, 0000 01.. decimal value 1]
```

7. Downlink NAS Transport

```
11 43.2779900… 192.168.8.33  192.168.11.…  NGAP/NAS-5GS  142 DownlinkNASTransport, Registration accept
```

```
      1... .... = Spare: 1
      .1.. .... = Spare: 1
      ..1. .... = Spare: 1
      ...1 .... = Spare: 1
      .... 0... = Spare: 0
      .... .010 = Type of identity: 5G-GUTI (2)
      Mobile Country Code (MCC): India (404)
      Mobile Network Code (MNC): Hutchison Essar Ltd, Mumbai (20)
      AMF Region ID: 128
      0000 0001 00.. .... = AMF Set ID: 4
      ..00 0001 = AMF Pointer: 1
      5G-TMSI: 156170581 (0x094ef955)
  5GS tracking area identity list
      Element ID: 0x54
      Length: 7
    Partial tracking area list  1
        .00. .... = Type of list: list of TACs belonging to one PLMN or SNPN, with non-consecutive TAC values (0)
        ...0 0000 = Number of elements: 1 element (0)
        Mobile Country Code (MCC): India (404)
        Mobile Network Code (MNC): Hutchison Essar Ltd, Mumbai (20)
        TAC: 10
  NSSAI - Allowed NSSAI
      Element ID: 0x15
      Length: 5
    S-NSSAI 1
        Length: 4
        Slice/service type (SST): eMBB (1)
        Slice differentiator (SD): 0
```

```
  GPRS Timer 3 - T3512 value
      Element ID: 0x5e
      Length: 1
    GPRS Timer: 30 min
        101. .... = Unit: value is incremented in multiples of 1 minute (5)
        ...1 1110 = Timer value: 30
  Emergency Number List
      Element ID: 0x34
      Length: 8
    Emergency Number Information: 1
        Emergency Number Info length: 3
        000. .... = Spare bit(s): 0
        ...1 .... = Mountain Rescue: True
        .... 1... = Marine Guard: True
        .... .1.. = Fire Brigade: True
        .... ..1. = Ambulance: True
        .... ...1 = Police: True
        Emergency BCD Number: 911
    Emergency Number Information: 2
        Emergency Number Info length: 3
        000. .... = Spare bit(s): 0
        ...1 .... = Mountain Rescue: True
        .... 1... = Marine Guard: True
        .... .1.. = Fire Brigade: True
        .... ..1. = Ambulance: True
        .... ...1 = Police: True
        Emergency BCD Number: 112
```

MakeMyTechnology

What We Do?

5G Lab Setup for Educational Institutions

Complete design, installation, and deployment of on-campus 5G labs tailored for research and student training

Read More ->

Faculty & Student Training Programs

Workshops, certifications, and hands-on modules on emerging technologies like 5G, AI, ML, and Edge Computing.

Read More->

MakeMyTechnology

Our Products

5G - gNB
Base Station

5G Core

Ethernet Switch

[Mobile Phone (UE)] → [Base Station (gNB)] → [Ethernet Switch] → [5G Core Network]