Review Paper on 5G Technology and Attach Procedure

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Abstract*— 5G stands for 5th generation mobile technology. 5G offers high speed along with low latency and because of this 5G opens a way for so many new technologies whose `foundation will be on 5G. 5G architecture has three components – gnodeb, core network and Data network. In this Review paper, we are discussing the standalone 5g network and its attach procedure. Attach procedure is an exchange of messages between the UE and gnodeB, so that UE connects to the network and establishes the services which the user expects and attach procedure is one of the important things in order to understand the working of the 5g. In the attach procedure, only those messages are contained which are received or sent by gnodeB and UE.

I. INTRODUCTION

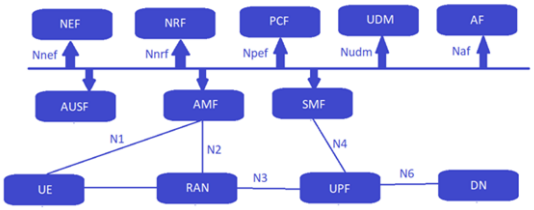
5G stands for 5th generation mobile network. It is the new global standard after 1G, 2G,3G and 4G and where "G" means generation. 5G meant to deliver high speed, very low latency, reliable, more uniform user experience and massive network capacity. With the increase in users exponentially, 4G can be easily replaced by 5G to cater the demand of the user. 5G network can tackle obstacles which are not addressed by 4G network: -

1. 1.Low Latency
2. 2.Higher data rate
3. 3.Consistent Quality
4. 4.Low Data Cost
5. Connectivity is massive machine
6. Low error rate

5G is a collection of technology which aims to achieve the following tasks

- enhanced Mobile Broadband(eMBB)
- Ultra-Reliable and Low Latency Communication (URLLC)
- massive Machine Type Communication (mMTC)

- 5G Core Network architecture



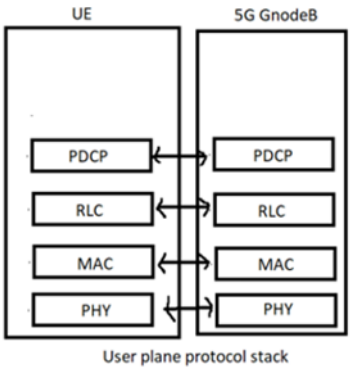
Components of 5G core Network architecture

- User Equipment (UE) – All those devices which are connected to the 5G network and use the 5G services and such devices are 5G mobile, car sensor etc.
- Radio Access Network (RAN) – It is also called gnodeb in the 5g network which is a gateway between the core network and UE.
- Access and Mobility Management Function (AMF) - It is the single-entry point for all the UE and it is responsible for UE authentication, NAS ciphering and integration and mobility function.
- Authentication Service Function (AUSF) – It is responsible for authenticating the UE and it is controlled by the AMF.
- Unified Data Management (UDM) – It is a database of the user subscriber which stores the SUPI key.
- Session Management Function (SMF) – It gets the command from AMF and is responsible for creating, modifying and removing PDU sessions.
- User Plan Function (UDF) – It is responsible for transport of the IP data traffic between UE and external data network.

5G Protocol Stack
There are two types of protocol stack: -

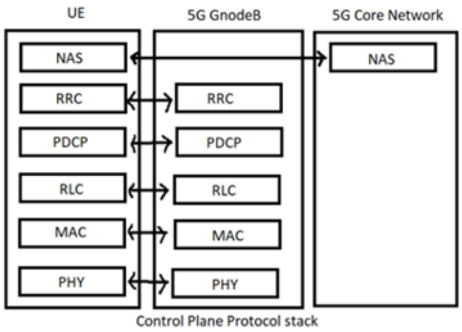
- User Plane Protocol Stack

This stack comes into play when the signal is a user plane signal which simply means that data is important and related to the user.



User plane protocol stack

Control Plane Protocol Stack
This stack comes into Play when the signal is control plan signal and it is not related to the users but important for the gnodeB and Core network to establish the connection.



Control Plane Protocol stack

Overview of 5G Protocol Stack

- Radio Resource Control (RRC) – It is responsible for Configuring the other protocol of 5G, signal refresh, attach procedure, handover and paging and it configures the other layer during the cell startup process.
- Packet Data Convergence Protocol (PDCP) – It is responsible for giving serial numbers to the packets. So, packets can be combined on the receiving end. It is also responsible for finding the duplicate packets coming from the lower layers and it also compresses the header. This Layer also cipher and decipher the packets to check the integrity of the packets and it also performs encryption on the packet, so only specific UE is able to encrypt the given message.
- Radio Link Control (RLC) – It is responsible for segmentation, Re-segmentation, and combining the packets. This Layer adds the RLC header to those packets which come from the PDCP layer or RRC Layer and passes it through TM, UM and AM Entity.

1. TM mode stands for Transparent mode and in this no header is added to receive packet from the upper layer and transfer the packet as it is to the MAC Layer.
2. UM mode stands for Unacknowledged mode and in this RLC adds headers to the packet but it is connectionless protocol which simply means it does have a way to acknowledge the packet that it reaches the destination or not.
3. AM mode stands for Acknowledge mode and in this RLC adds headers to the packet which receives from the upper layer and it is a connection-oriented protocol.

- Medium Access Control (MAC) – It is response for giving resources to those packets which are received from the RLC layer and this protocol send indication to the RLC layer and request for particular length packet in bytes and transfer the packet after adding the MAC header to the packet to the physical layer.
- Physical Layer (PHY) – PHY is responsible for the transmission and receiving of data between gnodeB and UE.

5G Attach Procedure

1. Synchronization Signal Block (SSB)

This message contains information about the at which Numerology SIB will be transmitted and it also contains the Master Information Block (MIB), Primary Synchronization Signal (PSS) and Secondary Synchronization Signal (SSS). And this message takes 20 RBs and 4 OFDM symbols. And with the help of these parameters which present in the MIB we get the location of the SIB1 in frequency and time domain. These messages are broadcast by gnodeB.

2. System Information Block Type 1 (SIB1)

It carries the information which tells if UE is allowed to access a cell and defines the scheduling of the other system information block (SIB). These messages are broadcast by gnodeb at every 20ms.

3. Preamble [MSG1]

This is sent by the UE to the gnodeB and this message is sent on a particular time occasion which is found

using the table which is present to both UE and gnodeB before the attach procedure. There are two 64 preamble types of preambles.

4. Random Access Response [MSG2]
This message is sent by the enodeB to UE and it carries the timing advanced, uplink grant and Temporary C-RNTI. This message is scrambled by the RA-RNTI.

5. RRC Setup Request [MSG3]
This message is sent from UE to gnodeB and in these two things are sent one is UE ID(TMSI) and second is establishment Cause.

6. RRC Setup [MSG4]
Before gnodeB send this message to UE, gnodeB create SRB1 which is created by RRC which send command to PDPC, RLC and MAC and RRCSetup message send through SRB0 which is default on both gnodeB and UE and in this there are two things, first is RadioBearerConfig which tells to create SRB1 and second if masterCellGroup which tell more information about the SRB1.

7. RRC Setup Complete
After UE creates SRB1 on its side then it sends RRCSetupComplete message to gnodeB and this message contains NAS message Registration Request and this message cannot be decoded by gnodeB.

8. NGAP Initial UE message
This message is sent by gnodeB to AMF and this message contains RAN UE NGAP ID, NAS Registration Request, User location information, RRC establishment cause, TSMI.

9. NAS Identity Request
This message is sent by AMF to UE and this message is optional if AMF already has a SUPI key in the database, then this message is not sent if it has no SUPI key then this message is sent by AMF to UE.

10. NAS Identity Response
This message is sent by UE to AMF to get UE's SUPI key.

11. NAS Authentication Request
This message is sent by AMF to UE to check whether the UE has permission to be on the network or not.

12. NAS Authentication Response
This message is sent by UE to AMF and here UE sends Authentication Parameters to AMF.

13. NAS Security Mode command
This message is sent by AMF to UE and signifies that the message should be transmitted in encrypted form from now on.

14. NAS Security Mode Complete
This message is sent by UE to AMF and says that from now on the message will be in encrypted mode.

15. Initial Context Setup Request
Before sending this message AMF created a QOS flow to UPF.

16. Security Mode Command
Here gnodeB select the encryption algorithm and send message to UE which encryption algorithm to be used and there is no key send to the UE and UE use its kasma key which is only known by UE and AMF and uses this key to find other keys which are called krrc-int and krrc-cip and uses this key for the decryption.

17. Security Mode Complete
If UE is able to decrypt the message, then UE is real and if not, then UE is not real and this message is sent to gnodeB.

18. RRC Reconfiguration
After the encryption is established, after that gnodeB creates SRB2 and all the control plane signals are sent through this bearer. And SDAP maps the Quality of Service (QOS) which is known by the core network.

19. RRC Reconfiguration Complete
This message is sent by UE and UE also creates a SRB2 and sends an acknowledge message to gnodeB.

20. NAS Registration Complete
This message is sent by UE to AMF and this message signifies that Registration accepted and PDU session Establishment and attach procedure is complete and after this Data can be transferred between UE and gnodeB.

II. CONCLUSION

5G technology stands for 5th Generation mobile technology which provides very high bandwidth and low latency. 5G will provide a platform on which many new technologies will operate like cloud computing, self-driving cars, medical industry, virtual reality and many more. 5G will be able to provide consistent experience on a wide variety of scenarios. It will bring a new revolution in the wireless network.

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