

Terms

- AAT - antenna array tool
 - Software tool for embedding antenna parameters and radiation patterns in test scenarios.
- ACLR - adjacent channel leakage ratio
 - The ratio of the transmitted power on the assigned channel to the power received on the adjacent channel after passing through a root raised-cosine filter.
- ACP - adjacent channel power
 - Power contained in a frequency channel next to the specified channel
- ACPR - adjacent channel power ratio
 - Ratio of power contained in a specified frequency channel bandwidth relative to the total carrier power
- AGGR - aggregation
 - Carrier Aggregation is the foundation for deploying high-performing 4G and 5G networks. It provides the unique capability of aggregating several frequency bands for higher peak rates and increased cell coverage.
- AM distortion
 - Undesirable distortion caused by amplitude variation in a communications system

- AMF - Access and Mobility Management Function
 - A component of the 3GPP core network architecture that manages user equipment registration, authentication, identification, and mobility. AMF also terminates non-access stratum signaling.
- AM/PM distortion
 - Undesirable distortion that causes signal degradation in a communications system, typically as the result of the interaction between an amplifier's phase response and the power level (or amplitude) of the input signal.
- Antenna reciprocity
 - A theory that states that the transmit properties of an antenna will be identical to the receive properties of that antenna in a given medium.
- AUSF – Authentication server function
 - A major component of the 5G core network used to facilitate security processes. The AUSF authenticates UEs and stores authentication keys.
- AWG – Arbitrary waveform generator
 - Electronic equipment used to generate signals for injection into a device under test (DUT) to characterize its performance.
- Backhaul

- The part of the network responsible for transporting communication data between the baseband unit (BBU) and the core network. Connects smaller outlying networks with the core network. Backhaul was often proprietary in earlier cellular generations but is moving to ethernet in 5G.
- Base station network emulator
 - A tool for simulating protocol and network traffic in a test environment. Works in concert with UE emulation and channel emulation to provide an end-to-end system for testing and measuring 5G network performance at scale.
- BBU – Baseband unit
 - A component of the base station. Equipment which handles radio communications and radio control processing functions. The baseband unit converts data into a digital signal and sends it on to the remote radio head (RRH), which then converts it into an analog signal. In a C-RAN architecture, the baseband unit is usually geographically separated from the radio head.
- BCCH - broadcast control channel
 - The BCCH is used within the downlink, and it is used for sending broadcast style information to the user equipments within that cell. The

system information transmitted by the 5G NR BCCH is divided into different blocks:

- Master Information Block, MIB: There is one MIB and this is mapped onto the BCH transport channel and then to the PBCH physical channel.
 - System Information Block, SIB: There are several system information blocks, SIBs. These are mapped onto the DL-SCH transport channel and then onto the PDSCH physical channel.
- BCH - Broadcast Channel
 - The BCH 5G channel is used in the downlink only for transmitting the BCCH system information and specifically the Master Information Block, MIB, information. In order that the data can be utilised, it has a specific format.
 - Beam acquisition
 - The process of discovering and connecting with UEs. This process is substantially changing in 5G with the deployment of highly directional antenna arrays and beamforming techniques.
 - Beamforming
 - The method of applying relative phase and amplitude shifts to each antenna element to shape and provide discrete control of the direction of

a transmitted beam. Beamforming requires communication channel feedback to implement real-time control of the beam.

- Beam steering
 - A set of techniques used to focus the direction and shape of a radiation pattern. In wireless communications, beam steering changes the direction of the signal and narrows the width of the transmitted signal, typically by manipulating relative phase and amplitude shifts of the signal through an array of multiple antenna elements.
- Bearer Splitting
 - Split bearer is a function to allow the split of data going to gNB from the core side into two paths, the 1st path through the 5G air interface toward the UE and the 2nd one is toward X2 interface with the anchored eNB and then eNB will transfer this data through the 4G air interface to the UE.
- BSR - Buffer Status reporting
 - a MAC layer procedure which is used by the UE to provide information about the amount of data available for transmission in the UL buffers to the serving gNB.
- Carrier aggregation

- A major feature introduced with LTE-Advanced, enabling mobile network operators to combine multiple carriers in fragmented spectrum bands to increase peak user data rates and overall capacity of the network.
- CATR – Compact antenna test range
 - Equipment for testing of antennas at frequencies when difficult to obtain far-field spacing. The CATR uses the 3GPP-approved indirect far-field (IFF) test method to overcome the path loss and excessive far-field distance issues associated with 5G cellular communications.
- Cc-control channel
 - Transfer of data from the control plane
- CCE - Control Channel Element
 - A CCE is a combination of multiple REGs. The number REG bundles within a CCE varies. Aggregation Level: Aggregation Level indicates the number of CCEs allocated for a PDCCH.
- CCH - control channel
 - Transmit channel used for transmitting control data
- CE – Channel emulator
 - Electronic equipment that enables real-time performance testing of wireless devices and base stations. Channel emulators simulate the

impairments of real-world radio channel conditions to validate the performance of base stations, chipsets, and devices.

- Cell tower
 - Physical location of electronic communications equipment, including antennas to support cellular communication in a network.
- Cfg – configuration
 - Refers to the configuration of something
- CFI - Control format indicator
 - an indicator telling how many OFDM symbols are used for carrying control channel (e.g, PDCCH and PHICH) at each subframe. If CFI is set to be 1 for a subframe, it means one symbol (the first symbol) at the subframe is used for PDCCH allocation.
- CIR – Channel impulse response
 - The correlation of the received signal against the transmitted signal during testing.
- CNA - cloud-native architecture
 - an approach to building and running applications that fully exploits the benefits of the cloud computing model. For communications service providers (CoSPs), applications are network functions. Examples of these

functions include the Session Management Function (SMF) and the User Plane Function (UPF).

- CoMP – Coordinated multipoint
 - A technique where multiple base stations can coordinate downlink transmission (from base station (BS) to user equipment (UE)) and uplink transmission (UE to BS) to improve the overall reliability and performance.
- Control plane
 - The part of a network that carries information that establishes and controls the network. It controls the flow of user information packets between network interfaces.
- Core network
 - The part of the network that provides services to mobile subscribers through the radio access network (RAN). It is also the gateway to other networks, for instance to the public- switched telephone network or public clouds.
- CPE – Common phase error
 - A measurement of noise in orthogonal frequency division multiplexing (OFDM). CPE describes the average of the phase noise sequence spanning an OFDM symbol.

- CP-OFDM – Cyclic prefix orthogonal frequency division multiplexing
 - An orthogonal frequency division multiplexing (OFDM) technique that uses cyclic prefixes (CP) instead of null guards, protecting OFDM signals from intersymbol interference (ISI).
- CPRI – Common public radio interface
 - An interface specification standard that defines a layer-1 and layer-2 interface for connecting radio equipment such as radio heads on towers to other radio equipment control infrastructure located at the base of the tower or in a centralized facility.
- CQI - channel quality indicators
 - Indicator carrying the information on how good/bad the communication channel quality is
- C-RAN – Centralized RAN
 - A radio access network (RAN) architecture that separates baseband functions from antennas and remote radio heads (RRH) and pools baseband functions in centralized baseband units (BBU). A competing architecture to multi-access edge computing (MEC).
- CRC - cyclic redundancy check

- indicates when data is corrupted. Calculating from all data, CRC validates packets of information sent by devices and verifies it against the data extracted, ensuring its accuracy.
- CRNTI - Cell Radio Network Temporary Identifier
 - the C-RNTI is a UE identifier allocated by a controlling RNC and it is unique within one cell controlled by the allocating CRNC. C-RNTI can be reallocated when a UE accesses a new cell with the cell update procedure
- (C)RS -(cell-specific) reference signal
 - A signal transmitted to estimate the channel between the base station and the user equipment as a reference point for downlink power.
- CSI - Channel state Information
 - Refers to known properties of a communication link. 5G NR specifies a new beam management framework for CSI acquisition to reduce coupling between measurements and reporting to control different beams dynamically.
- CUPS – Control user plane separation
 - Foundational concept for 5G networks that enables operators to independently scale the control plane and user plane of the mobile network as needed.
- Data plane

- The part of a network through which user packets are transmitted. It is often included in diagrams and illustrations to give a visual representation of user traffic. Also known as the user plane, forwarding plane, or carrier plane.
- DCI - Downlink control information
 - carries control information used to schedule user data, PDSCH on the downlink and PUSCH on the uplink. It is carried by the PDCCH or physical downlink control channel. The user equipment needs to decode the DCI before they can decode downlink data or transmit uplink data.
- DFF – Direct far field
 - An over-the-air (OTA) test method used in 5G that involves mounting the device under test (DUT) on a positioner that rotates in azimuth and elevation. This process enables measurement of the DUT at any angle on the full 3D sphere. The DFF method can perform the most comprehensive tests measuring multiple signals and requires a larger test chamber for mmWave devices.
- DFT-s-OFDM – Discrete Fourier transform spread orthogonal frequency division multiplexing
 - An optional modulation format used in the uplink in 5G NR. DFT-s-OFDM uses the mathematical concept of discrete Fourier transform to encode

digital data on multiple frequency channels in a frequency division multiplexing scheme, increasing bandwidth, and decreasing response time.

- DL - downlink
- DL-SCH - Downlink Shared Channel
 - As the name indicates, this is a downlink only channel. It is the main transport channel used for transmitting downlink data and it supports all the key 5G NR features. These include: dynamic rate adaptation; HARQ, channel aware scheduling, and spatial multiplexing.
- DUT – Device under test
 - Device under test (DUT), equipment under test (EUT), system under test (SUT) and unit under test (UUT) are terms used to refer to a device undergoing measurement procedures.
- EIRP – Effective isotropic radiated power
 - An IEEE standardized definition for the measurement of the radiated power of an antenna in a specific direction.
- eMBB – Enhanced mobile broadband
 - One of three primary use cases defined in the IMT-2020 vision. Enhanced Mobile Broadband refers to target 5G peak and average data rates, capacity, and coverage as compared to conventional mobile broadband

(MBB). eMBB specifies a 5G design capable of supporting up to 20 Gbps in the downlink, and 10 Gbps in the uplink.

- Enb - e nodeB
 - base station
- EN-DC – E-UTRAN New Radio – dual connectivity
 - A term for the simultaneous 4G LTE and 5G NR connectivity prescribed by 3GPP Release 15. EN-DC enables user equipment to connect simultaneously to an LTE base station and a 5G base station.
- EPC - evolved packet core
 - Features a flat architecture to handle voice and data efficiently and requires network nodes to handle traffic. Serves as anchor in 5G fixed wireless access initial implementations.
- EPS – Evolved packet system
 - Evolved end-to-end-architecture composed of the base station and evolved packet core (EPC) that enables 4G mobile communication.
- ERTA – Extended range transmission analysis
 - A technique used to measure the scalar transmission gain or loss of an RF system.
- E-UTRAN – Evolved UMTS terrestrial radio access network

- A new radio interface specified by the 3GPP consortium and introduced with LTE in 2008. It was designed to meet ever-increasing data transfer rates while reducing the radio operation latency.
- EVM – Error vector magnitude
 - Error vector magnitude is a measurement used to quantify the quality of a digital radio signal. The measurement is a representation of how far the actual signal deviates from an ideal representation of that same signal.
- FAPI - 5G femto application platform interface
 - is a suite of specifications that enable small cells to be built up piece-by-piece using components from different suppliers
- FBMC – Filter bank multicarrier
 - A form of multicarrier modulation that deploys without synchronization of mobile user nodes signals. It offers better usage of available channel capacity, higher data rates within a given spectrum bandwidth, and higher spectrum efficiency. FBMC is considered inferior to orthogonal frequency division multiplexing (OFDM) in handling multiple-input / multiple-output (MIMO) channels.
- FDD – Frequency division duplex
 - Using two different radio frequencies for transmitter and receiver operation to establish a full-duplex communications link.

- separates uplink and downlink and has seamless interoperability with TDD. Then as standards evolve, the FDD benefit will continue to increase with a capacity gain of up to three times and boost the user throughput with up to five times.
- FD-MIMO – Full dimension MIMO
 - A MIMO technique added to the 3GPP specification with LTE- Advanced Pro (Release 13). FD-MIMO extends MIMO concepts to work in three dimensions: azimuth (horizontal), control (range), and elevation (vertical).
- Fmt - filtered multitone
 - According to the FMT modulation, each user symbols in subbands are filtered by the frequency-shifted versions of a low-pass prototype filter after upsampling operations
- Fsm - Qualcomm 5G Platform for Small Cells
 - uniquely positioned to deliver next-generation indoor and outdoor networks at scale by supporting the deployment of high-performance, virtualized, interoperable, and modular 5G networks.
- HARQ - Hybrid Automatic Repeat request
 - In 5G NR, 3GPP specification has defined HARQ Codebook to provide the feedback to base station for Downlink data transmission i.e., PDSCH Data.

Multiple HARQ process (upto 16) is supported per UE and there has to be separate feedback for each HARQ Process.

- IDX – index
 - Used for counting through lists or arrays
- LCG - Logic Channel Group
 - Logical channels can be one of two groups: control channels and traffic channels
 - Control: used for the transfer of data from the control plane
 - Traffic: used for transfer of user data plane
- LCH - logical channel
 - Transmit channel used for transmitting logic data
- LCID - Logical channel ID
- MCS - modulation and coding scheme
 - defines the numbers of useful bits which can carried by one symbol.
- MIB - Master Information Block
 - includes system information transmitted on xBCH transport channel and xBCCH logical channel. It uses RLC-SAP Transparent Mode (TM). Defines the transmission period of Beam Reference Symbol. Value in number of milliseconds
- MSG3 - Scheduled UL Transmission

- The UE sends uplink scheduling information over the PUSCH. The signaling messages and information sent by the UE varies across different RA scenarios.
- NCCE - narrowband control channel element
 - The basic resource allocation unit for NPDCCH is defined as narrowband control channel element (NCCE), which is the basic resource unit (RU) allocated for DCI transport.
- NPDCCH - narrowband physical downlink control channel
 - NPDCCH carries scheduling information for downlink and uplink data channels and further carries HARQ ACK/NACK information for the uplink data channel as well as paging indication and random-access response (RAR) scheduling information.
- NR - new radio
 - is the global standard for a unified, more capable 5G wireless air interface. It will deliver significantly faster and more responsive mobile broadband experiences, and extend mobile technology to connect and redefine a multitude of new industries.
- NRB - new radio bandwidth
 - Bandwidths of new radio carriers
- OFDM - Orthogonal Frequency Division Multiplexing

- an efficient modulation format used in modern wireless communication systems including 5G. OFDM combines the benefits of Quadrature Amplitude Modulation (QAM) and Frequency Division Multiplexing (FDM) to produce a high-data-rate communication system
- OTA - over the air
 - Transmission done over the air instead of through cables
- PCAP-API for capturing network traffic
- PDCCH - Physical Downlink Control Channel
 - As in LTE, NR PDCCH is the physical channel that carries DCI and this would be one of the most important channel which is supposed to be very robust and easily decoded even in harsh radio condition.
- PDR - packet delivery reliability
 - Measurement of whether delivery of data is successful or not(packet loss, packet drop, ..)
- PDSCH -Physical Downlink Shared Channel
 - the data-bearing channel in 5G-NR. For acquiring the channel quality, NR specifies a special type of cell-specific reference signal which can be configured for transmission on up-to 32 antenna ports. The CSI-RS resources are code, frequency and time division multiplexed.
- PDU - Protocol Data Unit

- An RLC PDU consists of an RLC header and an RLC payload. A MAC PDU is packaged as a Transport Block (TB) and sent on a transport channel to PHY layer for transmission. While 5G NR MAC has a general structure for its PDU s, there are differences across downlink, uplink and sidelink channels
- Phich - Physical Hybrid ARQ Indicator Channel
 - it is a serially designed downlink only channel which carries ACK or NACK for the PUSCH received by the network.
- PHR - Power Headroom Report
 - Power headroom indicates how much transmission power left for a UE to use in addition to the power being used by current transmission.
- PMI - Precoding Matrix Indicator
 - Allows the UE to report its preferred precoding for downlink transmissions on the PDSCH.
- PRACH - Physical Random Access Channel
 - in 5G new radio (NR) systems transmits random access preamble for the user equipment (UE) to access the network. In 5G NR systems, Zadoff-Chu (ZC) sequences are used as random access preamble sequences. Moreover, PRACH preamble miss detection rate and timing error are analyzed.
- PRB - physical resource block

- is defined as consisting of 12 consecutive subcarriers for one slot (0.5 ms).
A PRB is the smallest element of resource allocation assigned by the eNB scheduler.
- PTRS - phase tracking reference signal
 - can be seen as an extension to DM-RS for PDSCH/PUSCH and are intended for phase-noise compensation. The PT-RS is denser in time but sparser in frequency than the DM-RS, and, if configured, occurs only in combination with DM-RS. A discussion of the phase-tracking reference signal is found later in this chapter.
- PUCCH - Physical uplink control channel
 - PUCCH is an uplink physical channel that carries UCI (Uplink Control Information). As DCI (Downlink Control Information) is carried by PDCCH, UCI is carried by PUCCH.
- PUSCH - Physical uplink shared channel
 - PUSCH, is the counterpart of the PDSCH. It is used to carry data from the UL-SCH and its higher mapped channels on a frequency and time-shared basis. Like the PDSCH, The PUSCH also has a very flexible format.
- RA - Random Access
 - the core channel access mechanism to set up the wireless communication association between a UE and eNB

- RA-RNTI - random access Radio Network Temporary Identifier
 - The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as: $RA-RNTI = 1 + t_id + 10 * f_id$
 - Where t_id is the index of the first subframe of the specified PRACH ($0 \leq t_id < 10$), and f_id is the index of the specified PRACH within that subframe,
- RACH - random access channel
 - procedure is the core channel access mechanism to set up the wireless communication association between a UE and eNB.
- RAR-Random Access Response
 - After decoding SIB 1, UE get all required information for uplink synchronization(Random Access Procedure)
 - <https://www.techplayon.com/5g-nr-msg2-random-access-response-rar-sa-mode/>
 - Msg1: Random Access Preamble (RA)
 - Msg2: Random Access Response (RAR)
 - Msg3: RRC Connection Request
 - Msg4: Contention Resolution
- RBGs - resource block groups

- A group of resource blocks(RB) that contain 12 sub-carriers in frequency domain similar to LTE in each RB.
- RET - remote electrical tilt
 - Specification for the control interface of antenna devices that allows the tilt angle of the antenna to be controlled remotely.
 - http://www.5g-bullets.com/5G%20in%20Bullets%20-%20PMI_Sample.pdf
- RLC - Radio Link Controls
- RNTI - Radio network temporary identifier
 - RNTIs are used to differentiate/identify a connected UE in the cell, a specific radio channel, a group of UEs in case of paging, a group of UEs for which power control is issued by the eNB, system information transmitted for all the UEs by 5G gNB.
- Rrc - radio resource control
 - It is a layer 3 (Network Layer) protocol used between UE and Base Station. The operation of the RRC is guided by a state machine which defines certain specific states that a UE may be present in.
- Rwlock - read-write lock
 - allows concurrent access for read-only operations, while write operations require exclusive access.
- RX – receive

- Any receive signal or port
- SI - system information
 - SI for UEs is classified into the Master Information Block (MIB) and a set of System Information Blocks (SIBs)
- SI windows-System Information windows
 - Each system information message is sent within periodically occurring time domain windows called SI windows and only one window length is defined for for all SI messages
 - <http://howltestuffworks.blogspot.com/2019/10/5g-nr-system-information.html>
- SIB-System Information Block
 - Carries information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information
- SNR - signal to noise ratio
 - is a measure that compares the level of a desired signal to the level of background noise. SNR is defined as the ratio of signal power to the noise power, often expressed in decibels.
- SR - segment routing

- SR is mainly hailed for its traffic engineering capabilities and simplification by reducing the signaling components as compared to traditional IP/MPLS.
- Std- standard
- TA - Timing Advance
 - a command sent by Base Station (BS) to UE to adjust its uplink transmission means that the UE sends UL symbols in advance according to command for i.e. PUSCH, PUCCH and SRS transmission.
- Tbs - Transport Block Size
 - Like the LTE system, in 5G NR also TBs are split into smaller size multiple CBs (Code Blocks). Moreover, new concept of CBGs have been introduced in 5G NR in which multiple CBs are combined to form CBG (Code Block Group).
- TDD - time division Duplex
 - TDD uses the same frequency for each duplex direction, with a frame that includes different time periods and slots for uplink or downlink communications.
- TPC - transmission power control
 - mechanism used to reduce the power of a radio transmitter to the minimum necessary to maintain the link with a certain quality. TPC is

used to avoid interference into other devices and/or to extend the battery life.

- TTI - transmission time interval
 - TTI refers to the duration of a transmission on the radio link. The TTI is related to the size of the data blocks passed from the higher network layers to the radio link layer.
- TX – transmit
 - Any transmit signal or port
- UCI - uplink control information
 - Control channels carry information and indicators from the user equipment (UE), such as uplink control information (UCI) messages. UCI messages are encoded and transmitted through the physical uplink control channel (PUCCH) or are multiplexed onto the physical uplink shared channel (PUSCH).
- UE - user equipment
 - Devices like phones or computers using the system
- Ue_db - user equipment database
 - Database storing UE information
- UL - uplink
- ULSCH - uplink share channel

- Transmit channel used for transmitting uplink data