UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF WASHINGTON

SWIRLATE IP LLC, Plaintiff, v. **FLUKE CORPORATION,** Defendant.	Case No. 2:21-cv-1174 COMPLAINT FOR PATENT INFRINGEMENT DEMAND FOR JURY TRIAL

Plaintiff Swirlate IP LLC files this Complaint for Patent Infringement against Fluke Corporation, and would respectfully show the Court as follows:

I. NATURE OF THE LAWSUIT

1. This is an action for patent infringement under the Patent Laws of the United States, Title 35 United States Code ("U.S.C.") resulting from Fluke Corporation infringing, in an illegal and unauthorized manner and without authorization and/or consent from Swirlate IP LLC, United States Patent Nos. 7,154,961 and 7,567,662 pursuant to 35 U.S.C. §271, and to recover damages, attorney's fees, and costs.

II. THE PARTIES

2. Plaintiff Swirlate IP LLC ("Swirlate" or "Plaintiff") is a Texas limited liability company having an address at 6009 W Parker Rd, Ste 149 – 1090, Plano, TX 75093-8121.

3. On information and belief, Defendant Fluke Corporation ("Defendant") is a corporation organized and existing under the laws of Washington, with a place of business at

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6920 Seaway Blvd, Everett, WA 98203. Defendant has a registered agent at CT Corporation System, 711 Capitol Way S Ste 204, Olympia, WA, 98501.

III. JURISDICTION AND VENUE

4. This action arises under the patent laws of the United States, Title 35 of the United States Code. This Court has subject matter jurisdiction of such action under 28 U.S.C. §§ 1331 and 1338(a).

5. On information and belief, Defendant is subject to this Court's specific and general personal jurisdiction, pursuant to due process and the Washington Long-Arm Statute, due at least to its business in this forum, including at least a portion of the infringements alleged herein. Furthermore, Defendant is subject to this Court's specific and general personal jurisdiction because Defendant is a Washington corporation.

6. Without limitation, on information and belief, within this State and this District, Defendant has used the patented inventions thereby committing, and continuing to commit, acts of patent infringement alleged herein. In addition, on information and belief, Defendant has derived revenues from its infringing acts occurring within Washington and the Western District of Washington. Further, on information and belief, Defendant is subject to the Court's general jurisdiction, including from regularly doing or soliciting business, engaging in other persistent courses of conduct, and deriving substantial revenue from goods and services provided to persons or entities in Washington and the Western District of Washington. Further, on information and belief, Defendant is subject to the Court's personal jurisdiction at least due to its sale of products and/or services within Washington and the Western District of Washington. Defendant has committed such purposeful acts and/or transactions in Washington and the

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Western District of Washington such that it reasonably should know and expect that it could be haled into this Court as a consequence of such activity.

7. Venue is proper in this district under 28 U.S.C. § 1400(b). On information and belief, Defendant is incorporated in Washington, and therefore resides in Washington. Defendant also has a place of business within this District. On information and belief, from and within this District Defendant has committed at least a portion of the infringements at issue in this case.

8. For these reasons, personal jurisdiction exists and venue is proper in this Court under 28 U.S.C. § 1400(b).

IV. COUNT I
(PATENT INFRINGEMENT OF UNITED STATES PATENT NO. 7,154,961)

9. Plaintiff incorporates the above paragraphs herein by reference.

10. On December 26, 2006, United States Patent No. 7,154,961 ("the '961 Patent") was duly and legally issued by the United States Patent and Trademark Office. The application leading to the '961 Patent was filed on December 6, 2004 (Ex. A at cover).

11. The '961 Patent is titled "Constellation Rearrangement for ARQ Transmit Diversity Schemes." A true and correct copy of the '961 Patent is attached hereto as Exhibit A and incorporated herein by reference.

12. Plaintiff is the assignee of all right, title, and interest in the '961 patent, including all rights to enforce and prosecute actions for infringement and to collect damages for all relevant times against infringers of the '961 Patent. Accordingly, Plaintiff possesses the exclusive right and standing to prosecute the present action for infringement of the '961 Patent by Defendant.

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13. The invention in the '961 Patent relates to the field of Automatic Repeat reQuest ("ARQ") transmission techniques in wireless communication systems. (Ex. A at col. 1:6-8). In particular, it relates to a method for transmitting data using transmit diversity schemes in which data packets are transmitted using a first and second transmission based on a repeat request and the bit-to-symbol mapping is performed differently for different transmitted diversity branches. (*Id.* at col. 1:8-12). The inventors recognized a problem in prior art of the use of ARQ transmission techniques in wireless communication systems with unreliable and time-varying channel conditions and the invention results in an improved performance avoiding transmission errors. (*Id.* at col. 1:12-15).

14. In telecommunications, in order to improve the reliability of data transmissions, the prior art had several transmit diversity techniques in which redundant versions of identical data are transmitted in at least two diversity branches by default without explicitly requesting further diversity branches. (*Id.* at col. 1:19-24). Such transmit diversity techniques included (i) site diversity (transmitted signal originates from different sites), (ii) antenna diversity (transmitted signal originates from different antennas), (iii) polarization diversity (transmitted signal is mapped onto different polarization), (iv) frequency diversity (transmitted signal is mapped on different carrier frequencies or frequency hopping sequences), (v) time diversity (transmitted signal is mapped on different interleaving sequences), and (vi) multicode diversity (transmitted signal is mapped on different codes). (*Id.* at col. 1:24-42). The diversity branches would then be combined in order to improve the reliability of the received data. These diversity combining techniques included (a) selection combining (selecting the diversity branch with the highest Signal-to-Noise Ratio ("SNR") for decoding and ignoring the remaining ones), (b) equal gain combining (combining received diversity branches with ignoring the differences

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in received SNR), and (c) maximum ratio combining (combining received diversity branches taking the received SNR of each diversity branch into account).

15. The prior art also had techniques for error detection/correction with respect to the transmission of data. For example, the prior art would use ARQ schemes together with Forward Error Correction (FEC),[1] which is called hybrid ARQ ("HARQ"). If an error is detected within a packet by the Cyclic Redundancy Check ("CRC"), the receiver requests that the transmitter send additional information (*e.g.*, retransmission) to improve the probability to correctly decode the erroneous packet. (*Id.* at col. 1: 59-63).

16. The '961 discussed a particular prior art reference that had the shortcomings of the prior art. WO-02/067491 A1 disclosed a method for HARQ transmission that averages the bit reliability over successively requested retransmissions by means of signal constellation rearrangement. (*Id.* at col. 1: 64-67). The reference showed that when more than 2 bits of data were mapped onto one modulation symbol, the bits have different reliability depending on the chosen mapping. (*Id.* at col. 2: 1-5). For most FEC schemes, this leads to a degraded decoder performance compared to an input of more equally distributed bit reliabilities. (*Id.* at col. 2:5-7). As a result, in conventional communications systems the modulation dependent variations in bit reliabilities are not considered and, therefore, usually the variations remain after combining the diversity branches at the receiver. (*Id.* at col. 2:8-11).

17. The inventors therefore developed a method that improved performance with regard to transmission errors. (*Id.* at col. 2:15-18). The idea of the invention is to improve

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1 FEC is a technique used for controlling errors in data transmission over unreliable or noisy communication channels. The general idea of FED is that a sender encodes the message in a redundant way, most often using an error correction code. The redundancy allows the receiver to detect a limited number of errors that may occur anywhere in the message, and to potentially correct these errors without re-transmission.

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performance at the receiver by applying different signal constellation mappings to the available distinguishable transmit diversity branches and ARQ retransmissions. (*Id.* at col. 2:20-23). The invention is applicable to modulation formats in which more than 2 bits are mapped onto one modulation symbol, since this implies a variation in reliabilities for the bits mapped onto the signal constellation. (*Id.* at col. 2:23-29).

18. **Direct Infringement.** Upon information and belief, Defendant has been directly infringing at least claim 1 of the '961 patent in Washington, and elsewhere in the United States, by performing actions comprising at least performing the claimed ARQ re-transmission method by performing the steps of the claimed invention using the Fluke 3504 Gateway to transmit data ("Accused Instrumentality") (*e.g.*, https://dam-assets.fluke.com/s3fs-public/Fluke-3562-Screening-Vibration-Sensor-Data-Sheet.pdf?xqnnB.k.Zr42OJ3HzZULmo8tsk0SwoUx).

19. The Accused Instrumentality uses an ARQ retransmission method in a wireless communication system in which data packets are transmitted from a transmitter to a receiver using a first transmission and at least a second transmission based on a repeat request. For example, at least in its internal testing and usage, the Accused Instrumentality uses an HARQ method in an LTE network in which data is transmitted from the Accused Instrumentality to an LTE base station using at least an HARQ transmission and an HARQ retransmission based on a repeat request, such as an HARQ retransmission request in the form of a negative acknowledgement ("NAK").

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Fluke 3504 Gateway

Power supply options	
AC main power	AC input 85-264 VAC, 0.35A/115V, 0.25A / 230V, 47-63 Hz
Power-over-Ethernet	Compliant with IEEE 802.3af
Wireless communication	
Protocol to gateway	Proprietary sub-GHz link
Protocol to cloud	WIFI: IEEE 802.11 ac/a/b/g/n LTE Ethernet: 10/100/1000 MBits/s
Number of connectable sensors	Up to 1000
Mechanical	
Ingress protection class	IP66
Temperature	Operation: -30°C to 70°C (-22°F to 158°F) Storage: -40°C to 85°C (-40°F to 185°F)
Vibration resistance	10-60Hz @ 0.44mm 60-3,200Hz @ 3.0g
Shock & impact resistance	100g @ 6 mS
Dimensions	Approx. 267 x 221 x 133 mm (10.5" x 8.7" x 5.3")
Weight	Approx. 2.64 kg (5.8 pounds)
Mounting	Mounting tabs
Material	Polycarbonate

(*E.g.*, https://dam-assets.fluke.com/s3fs-public/Fluke-3562-Screening-Vibration-Sensor-Data-Sheet.pdf?xqnnB.k.Zr42OJ3HzZULmo8tsk0SwoUx).

Hybrid Automatic Repeat Request (HARQ) in LTE FDD

October 18, 2018 admin Future Network Optimization, LTE, RF Basics, Tech Fundas

HARQ stands for Hybrid Automatic Repeat Request. **HARQ** = **ARQ** + **FEC** (Forward Error Correction)/Soft Combining.

ARQ refers to Automatic Repeat Request i.e. if sender doesn't receive Acknowledgement (ACK) before timeout, the receiver discards the bad packet and sender shall re-transmits the packet. ARQ procedure is illustrated below :

(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

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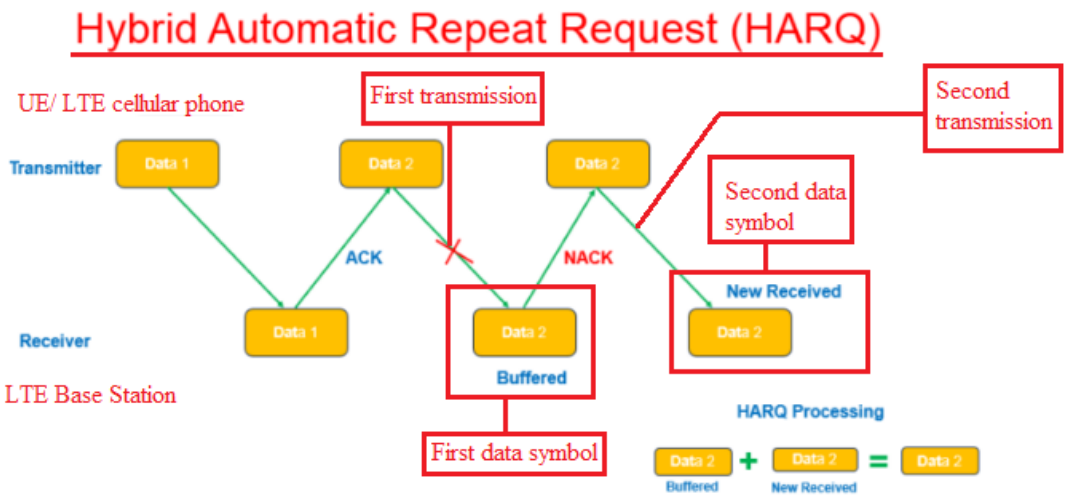
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

6.1 Uplink model

Data packets transmitted from a transmitter i.e. UE/ LTE cellular phone to a receiver i.e. LTE base station

6.1.1 Uplink Shared Channel

The physical-layer model for Uplink Shared Channel transmission is described based on the corresponding physical-layer-processing chain, see Figure 6.1.1. Processing steps that are relevant for the physical-layer model, e.g. in the sense that they are configurable by higher layers, are highlighted in blue. It should be noted that, in case PUSCH, the scheduling decision is partly made at the network side, if there is no blind decoding it is fully done at the network side. The uplink transmission control in the UE then configures the uplink physical-layer processing, based on uplink transport-format and resource-assignment information received on the downlink.

- **Higher-layer data passed to/from the physical layer**
- One transport block of dynamic size delivered to the physical layer once every TTI.
- **CRC and transport-block-error indication**
- Transport-block-error indication delivered to higher layers.
- **FEC and rate matching**
- Channel coding rate is implicitly given by the combination of transport block size, modulation scheme and resource assignment;

ARQ re-transmission method

- Physical layer model support of HARQ: in case of Incremental Redundancy, the corresponding Layer 2 Hybrid-ARQ process controls what redundancy version is to be used for the physical layer transmission for each TTI.
- **Interleaving**

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment.
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

Second transmission i.e. re-transmission based on a repeat request i.e. NAK

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

5.3 L1 interactions with MAC retransmission functionality

Second transmission i.e. HARQ retransmission based on a repeat request

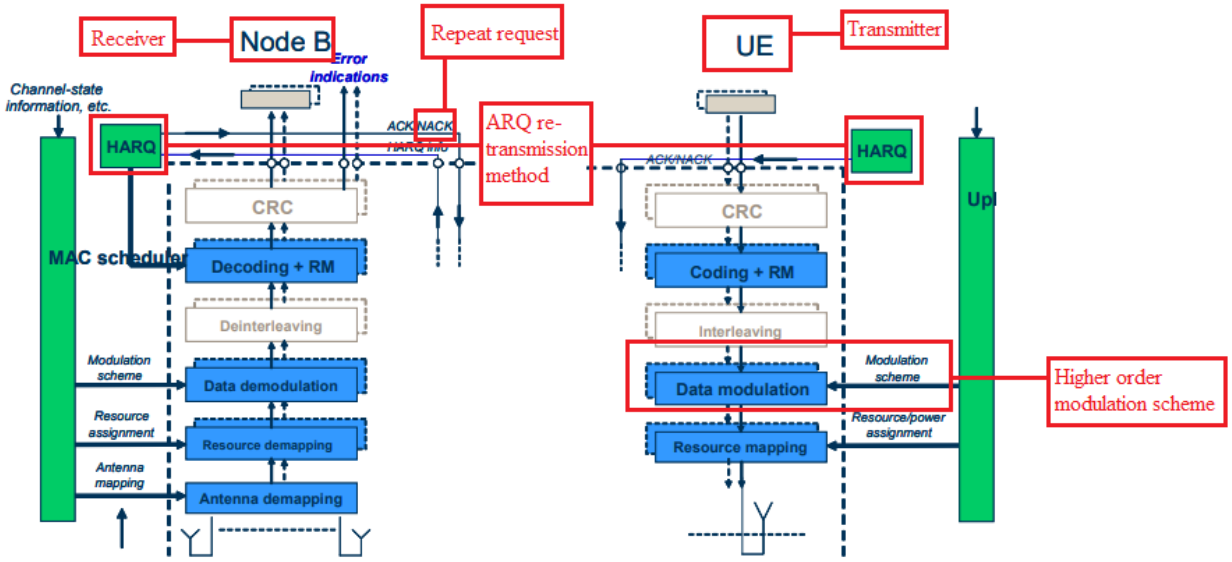

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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20. Upon information and belief, the Accused Instrumentality performs the step of modulating data packets at the transmitter using a first modulation scheme to obtain first data symbols. For example, at least in its internal testing and usage, the Accused Instrumentality uses 16QAM and/or 64QAM to obtain first data symbols for the purposes of an LTE transmission.

- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment.

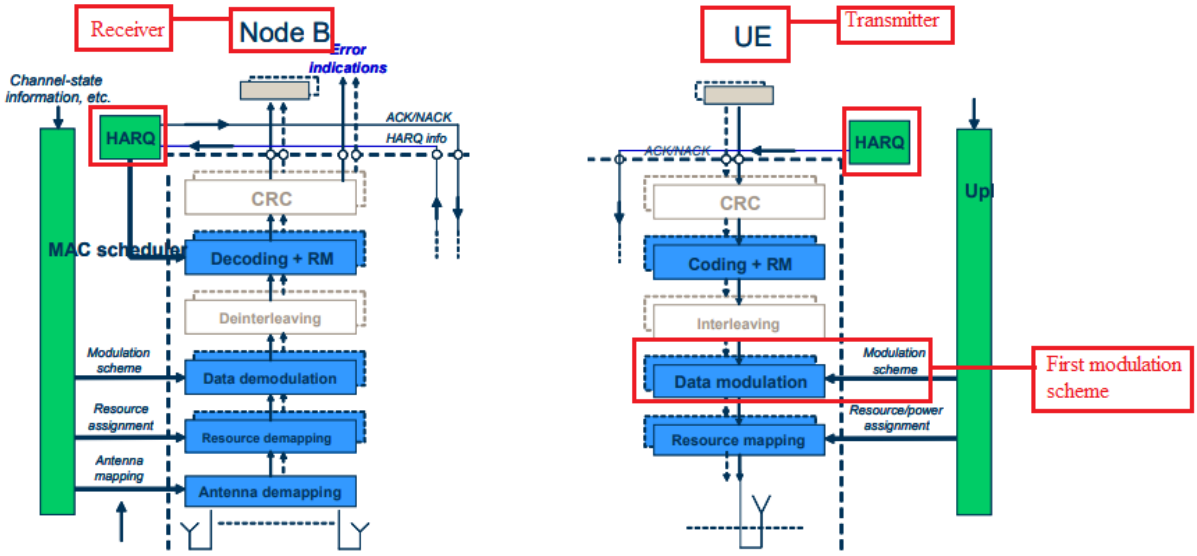

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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7.1.3 16QAM

In case of 16QAM modulation, quadruplets of bits, $b(i), b(i+1), b(i+2), b(i+3)$, are mapped to complex-valued modulation symbols $x = I + jQ$ according to Table 7.1.3-1.

Table 7.1.3-1: 16QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3)$	I	Q
0000	$1/\sqrt{10}$	$1/\sqrt{10}$
0001	$1/\sqrt{10}$	$3/\sqrt{10}$
0010	$3/\sqrt{10}$	$1/\sqrt{10}$
0011	$3/\sqrt{10}$	$3/\sqrt{10}$
0100	$1/\sqrt{10}$	$-1/\sqrt{10}$
0101	$1/\sqrt{10}$	$-3/\sqrt{10}$
0110	$3/\sqrt{10}$	$-1/\sqrt{10}$
0111	$3/\sqrt{10}$	$-3/\sqrt{10}$
1000	$-1/\sqrt{10}$	$1/\sqrt{10}$
1001	$-1/\sqrt{10}$	$3/\sqrt{10}$
1010	$-3/\sqrt{10}$	$1/\sqrt{10}$
1011	$-3/\sqrt{10}$	$3/\sqrt{10}$
1100	$-1/\sqrt{10}$	$-1/\sqrt{10}$
1101	$-1/\sqrt{10}$	$-3/\sqrt{10}$
1110	$-3/\sqrt{10}$	$-1/\sqrt{10}$
1111	$-3/\sqrt{10}$	$-3/\sqrt{10}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

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7.1.4 64QAM

In case of 64QAM modulation, hextuplets of bits, $b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$, are mapped to complex-valued modulation symbols $x = I + jQ$ according to Table 7.1.4-1.

Table 7.1.4-1: 64QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q	$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q
000000	$3/\sqrt{42}$	$3/\sqrt{42}$	100000	$-3/\sqrt{42}$	$3/\sqrt{42}$
000001	$3/\sqrt{42}$	$1/\sqrt{42}$	100001	$-3/\sqrt{42}$	$1/\sqrt{42}$
000010	$1/\sqrt{42}$	$3/\sqrt{42}$	100010	$-1/\sqrt{42}$	$3/\sqrt{42}$
000011	$1/\sqrt{42}$	$1/\sqrt{42}$	100011	$-1/\sqrt{42}$	$1/\sqrt{42}$
000100	$3/\sqrt{42}$	$5/\sqrt{42}$	100100	$-3/\sqrt{42}$	$5/\sqrt{42}$
000101	$3/\sqrt{42}$	$7/\sqrt{42}$	100101	$-3/\sqrt{42}$	$7/\sqrt{42}$
000110	$1/\sqrt{42}$	$5/\sqrt{42}$	100110	$-1/\sqrt{42}$	$5/\sqrt{42}$
000111	$1/\sqrt{42}$	$7/\sqrt{42}$	100111	$-1/\sqrt{42}$	$7/\sqrt{42}$
001000	$5/\sqrt{42}$	$3/\sqrt{42}$	101000	$-5/\sqrt{42}$	$3/\sqrt{42}$
001001	$5/\sqrt{42}$	$1/\sqrt{42}$	101001	$-5/\sqrt{42}$	$1/\sqrt{42}$
001010	$7/\sqrt{42}$	$3/\sqrt{42}$	101010	$-7/\sqrt{42}$	$3/\sqrt{42}$
001011	$7/\sqrt{42}$	$1/\sqrt{42}$	101011	$-7/\sqrt{42}$	$1/\sqrt{42}$
001100	$5/\sqrt{42}$	$5/\sqrt{42}$	101100	$-5/\sqrt{42}$	$5/\sqrt{42}$
001101	$5/\sqrt{42}$	$7/\sqrt{42}$	101101	$-5/\sqrt{42}$	$7/\sqrt{42}$
001110	$7/\sqrt{42}$	$5/\sqrt{42}$	101110	$-7/\sqrt{42}$	$5/\sqrt{42}$
001111	$7/\sqrt{42}$	$7/\sqrt{42}$	101111	$-7/\sqrt{42}$	$7/\sqrt{42}$
010000	$3/\sqrt{42}$	$-3/\sqrt{42}$	110000	$-3/\sqrt{42}$	$-3/\sqrt{42}$
010001	$3/\sqrt{42}$	$-1/\sqrt{42}$	110001	$-3/\sqrt{42}$	$-1/\sqrt{42}$
010010	$1/\sqrt{42}$	$-3/\sqrt{42}$	110010	$-1/\sqrt{42}$	$-3/\sqrt{42}$
010011	$1/\sqrt{42}$	$-1/\sqrt{42}$	110011	$-1/\sqrt{42}$	$-1/\sqrt{42}$
010100	$3/\sqrt{42}$	$-5/\sqrt{42}$	110100	$-3/\sqrt{42}$	$-5/\sqrt{42}$
010101	$3/\sqrt{42}$	$-7/\sqrt{42}$	110101	$-3/\sqrt{42}$	$-7/\sqrt{42}$
010110	$1/\sqrt{42}$	$-5/\sqrt{42}$	110110	$-1/\sqrt{42}$	$-5/\sqrt{42}$
010111	$1/\sqrt{42}$	$-7/\sqrt{42}$	110111	$-1/\sqrt{42}$	$-7/\sqrt{42}$
011000	$5/\sqrt{42}$	$-3/\sqrt{42}$	111000	$-5/\sqrt{42}$	$-3/\sqrt{42}$
011001	$5/\sqrt{42}$	$-1/\sqrt{42}$	111001	$-5/\sqrt{42}$	$-1/\sqrt{42}$
011010	$7/\sqrt{42}$	$-3/\sqrt{42}$	111010	$-7/\sqrt{42}$	$-3/\sqrt{42}$
011011	$7/\sqrt{42}$	$-1/\sqrt{42}$	111011	$-7/\sqrt{42}$	$-1/\sqrt{42}$
011100	$5/\sqrt{42}$	$-5/\sqrt{42}$	111100	$-5/\sqrt{42}$	$-5/\sqrt{42}$
011101	$5/\sqrt{42}$	$-7/\sqrt{42}$	111101	$-5/\sqrt{42}$	$-7/\sqrt{42}$
011110	$7/\sqrt{42}$	$-5/\sqrt{42}$	111110	$-7/\sqrt{42}$	$-5/\sqrt{42}$
011111	$7/\sqrt{42}$	$-7/\sqrt{42}$	111111	$-7/\sqrt{42}$	$-7/\sqrt{42}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

21. Upon information and belief, the Accused Instrumentality performs the step of performing the first transmission (*e.g.*, HARQ transmission) by transmitting the first data symbols (*e.g.*, output of modulation block performing said first modulation scheme) over a first diversity branch to the receiver (*e.g.*, mapping from assigned resource blocks to the first available number of antenna ports). For example, at least in its internal testing and usage, the Accused Instrumentality when performing an HARQ transmission transmits the first data

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symbols over a first diversity branch using multi-antenna processing which maps from assigned resource blocks to the first available number of antenna ports.

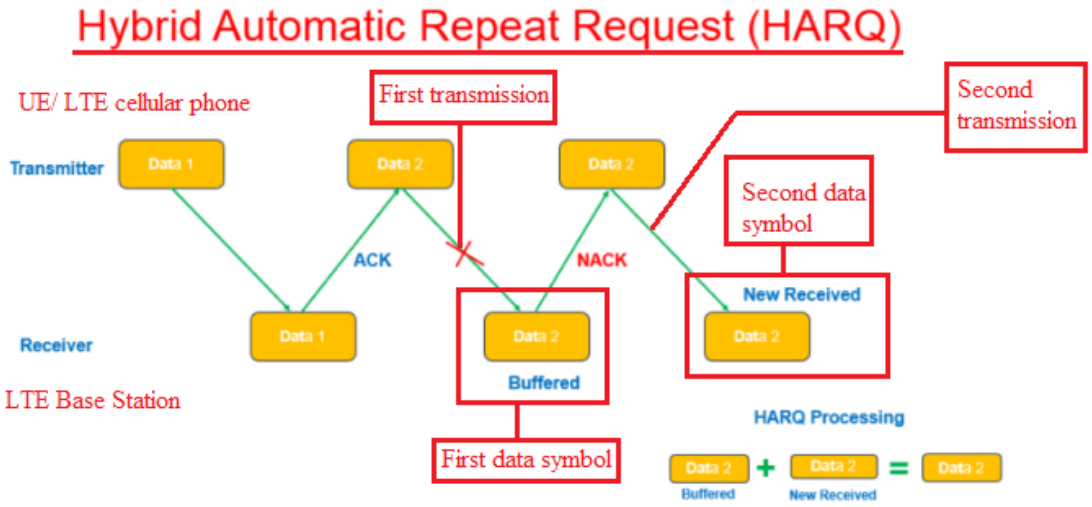
Hybrid Automatic Repeat Request (HARQ) in LTE FDD

October 18, 2018 admin Future Network Optimization, LTE, RF Basics, Tech Fundas

HARQ stands for Hybrid Automatic Repeat Request. **HARQ** = **ARQ** + **FEC** (Forward Error Correction)/Soft Combining.

ARQ refers to Automatic Repeat Request i.e. if sender doesn't receive Acknowledgement (ACK) before timeout, the receiver discards the bad packet and sender shall re-transmits the packet. ARQ procedure is illustrated below :

Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

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- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment. Transmitting the first data symbols over a first diversity branch to the receiver
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

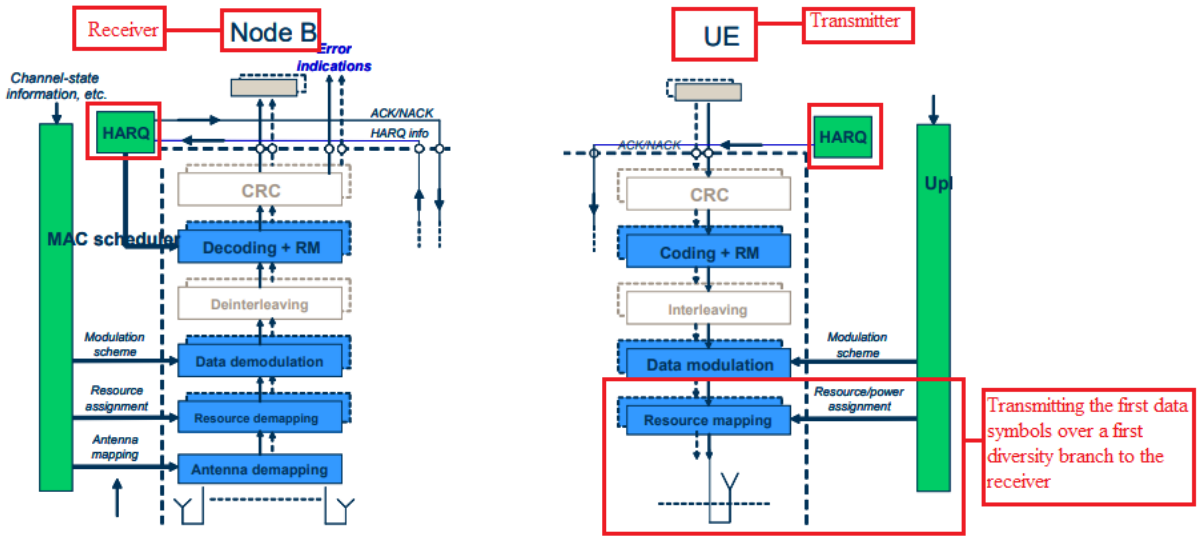

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

specific reference signals within the considered measurement frequency bandwidth. For RSRP determination the cell-specific reference signals R_0 and if available R_1 according to [8] can be used.

If receiver diversity is in use by the UE, the reported value shall be equivalent to the linear average of the power values of all diversity branches.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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5.2 Overview of L1 functions

The physical layer offers data transport services to higher layers. The access to these services is through the use of a transport channel via the MAC sub-layer. The physical layer is expected to perform the following functions in order to provide the data transport service:

- Error detection on the transport channel and indication to higher layers
- FEC encoding/decoding of the transport channel
- Hybrid ARQ soft-combining
- Rate matching of the coded transport channel to physical channels
- Mapping of the coded transport channel onto physical channels
- Power weighting of physical channels
- Modulation and demodulation of physical channels
- Frequency and time synchronisation
- Radio characteristics measurements and indication to higher layers
- Multiple Input Multiple Output (MIMO) antenna processing
- Transmit Diversity (TX diversity)
- Beamforming
- RF processing. (Note: RF processing aspects are specified in the TS 36.100)

L1 functions are modelled for each transport channel in subclauses 6.1 and 6.2.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

22. Upon information and belief, the Accused Instrumentality performs the step of modulating the data packets at the transmitter (*e.g.*, the Accused Instrumentality) using a second modulation scheme (*e.g.*, one of QPSK, 16QAM and 64 QAM which is distinct from the first modulation scheme) to obtain second data symbols. For example, at least in its internal testing and usage, the Accused Instrumentality on a repeat request, *i.e.*, receiving the retransmission request in the form of NAK, enables a second mapping of a higher order modulation scheme (*i.e.*, an adaptive re-transmission having a different Modulation Coding Scheme (MCS) than the one used for HARQ transmission such as first higher order modulation scheme, *e.g.*, 64QAM).

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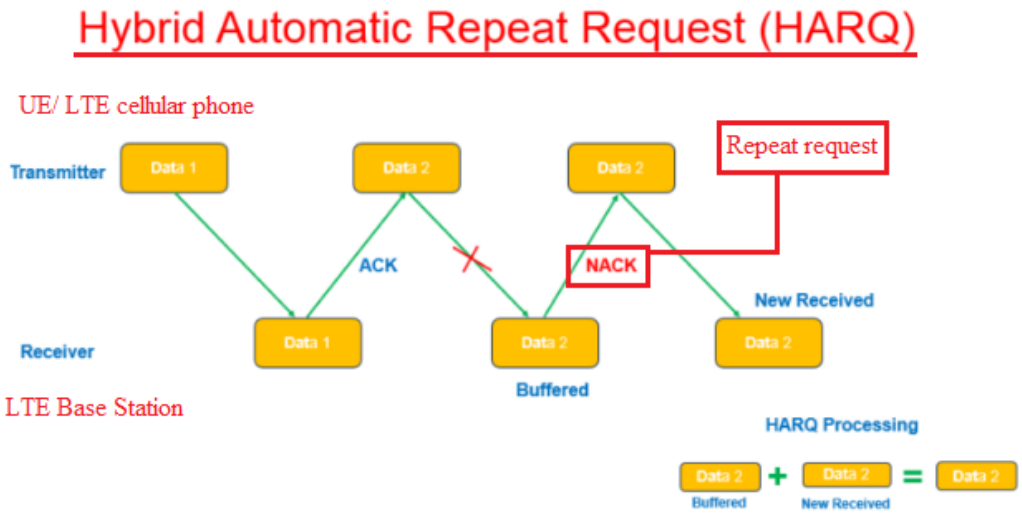
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



HARQ Re-transmissions Types

HARQ Re-transmissions are also of 2 types:-

- Adaptive re-transmission,
- Non-adaptive re-transmission.

Adaptive Re-transmission: Second mapping of said higher order modulation scheme for re-transmission

Here, the transmission attributes like Modulation Coding Scheme **(MCS)**, Redundancy Version **(RV)**, **sub-carrier** on which transmission is going to occur, does not remain same during each re-transmission but are notified by the sender. These attributes can be changed according to radio channel conditions, hence, it again provides flexibility but increases overhead.

(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

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- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).

Higher order modulation scheme

- **Mapping to physical resource**
- L2-controlled resource assignment.
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

Second transmission i.e. re-transmission based on a repeat request i.e. NAK

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

5.3 L1 interactions with MAC retransmission functionality

Second transmission i.e. HARQ retransmission based on a repeat request

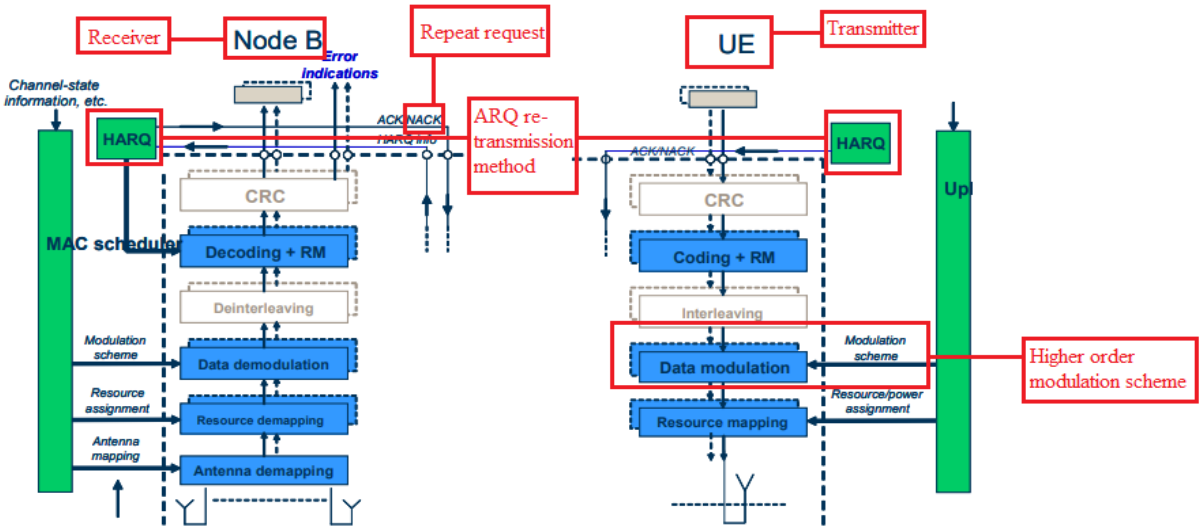

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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QAM bits per symbol

Higher order modulation scheme

The advantage of using QAM is that it is a higher order form of modulation and as a result it is able to carry more bits of information per symbol. By selecting a higher order format of QAM, the data rate of a link can be increased.

QAM FORMATS & BIT RATES COMPARISON

MODULATION	BITS PER SYMBOL	SYMBOL RATE
BPSK	1	1 x bit rate
QPSK	2	1/2 bit rate
8PSK	3	1/3 bit rate
16QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64QAM	6	1/6 bit rate

Respresenting more than two data bits are mapped onto one data symbol

(*E.g.*, https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php).

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7.1.3 16QAM

In case of 16QAM modulation, quadruplets of bits, $b(i), b(i+1), b(i+2), b(i+3)$, are mapped to complex-valued modulation symbols $x=I+jQ$ according to Table 7.1.3-1.

Table 7.1.3-1: 16QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3)$	I	Q
0000	$1/\sqrt{10}$	$1/\sqrt{10}$
0001	$1/\sqrt{10}$	$3/\sqrt{10}$
0010	$3/\sqrt{10}$	$1/\sqrt{10}$
0011	$3/\sqrt{10}$	$3/\sqrt{10}$
0100	$1/\sqrt{10}$	$-1/\sqrt{10}$
0101	$1/\sqrt{10}$	$-3/\sqrt{10}$
0110	$3/\sqrt{10}$	$-1/\sqrt{10}$
0111	$3/\sqrt{10}$	$-3/\sqrt{10}$
1000	$-1/\sqrt{10}$	$1/\sqrt{10}$
1001	$-1/\sqrt{10}$	$3/\sqrt{10}$
1010	$-3/\sqrt{10}$	$1/\sqrt{10}$
1011	$-3/\sqrt{10}$	$3/\sqrt{10}$
1100	$-1/\sqrt{10}$	$-1/\sqrt{10}$
1101	$-1/\sqrt{10}$	$-3/\sqrt{10}$
1110	$-3/\sqrt{10}$	$-1/\sqrt{10}$
1111	$-3/\sqrt{10}$	$-3/\sqrt{10}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

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7.1.4 64QAM

In case of 64QAM modulation, hextuplets of bits, $b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$, are mapped to complex-valued modulation symbols $x = I + jQ$ according to Table 7.1.4-1.

Table 7.1.4-1: 64QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q	$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q
000000	$3/\sqrt{42}$	$3/\sqrt{42}$	100000	$-3/\sqrt{42}$	$3/\sqrt{42}$
000001	$3/\sqrt{42}$	$1/\sqrt{42}$	100001	$-3/\sqrt{42}$	$1/\sqrt{42}$
000010	$1/\sqrt{42}$	$3/\sqrt{42}$	100010	$-1/\sqrt{42}$	$3/\sqrt{42}$
000011	$1/\sqrt{42}$	$1/\sqrt{42}$	100011	$-1/\sqrt{42}$	$1/\sqrt{42}$
000100	$3/\sqrt{42}$	$5/\sqrt{42}$	100100	$-3/\sqrt{42}$	$5/\sqrt{42}$
000101	$3/\sqrt{42}$	$7/\sqrt{42}$	100101	$-3/\sqrt{42}$	$7/\sqrt{42}$
000110	$1/\sqrt{42}$	$5/\sqrt{42}$	100110	$-1/\sqrt{42}$	$5/\sqrt{42}$
000111	$1/\sqrt{42}$	$7/\sqrt{42}$	100111	$-1/\sqrt{42}$	$7/\sqrt{42}$
001000	$5/\sqrt{42}$	$3/\sqrt{42}$	101000	$-5/\sqrt{42}$	$3/\sqrt{42}$
001001	$5/\sqrt{42}$	$1/\sqrt{42}$	101001	$-5/\sqrt{42}$	$1/\sqrt{42}$
001010	$7/\sqrt{42}$	$3/\sqrt{42}$	101010	$-7/\sqrt{42}$	$3/\sqrt{42}$
001011	$7/\sqrt{42}$	$1/\sqrt{42}$	101011	$-7/\sqrt{42}$	$1/\sqrt{42}$
001100	$5/\sqrt{42}$	$5/\sqrt{42}$	101100	$-5/\sqrt{42}$	$5/\sqrt{42}$
001101	$5/\sqrt{42}$	$7/\sqrt{42}$	101101	$-5/\sqrt{42}$	$7/\sqrt{42}$
001110	$7/\sqrt{42}$	$5/\sqrt{42}$	101110	$-7/\sqrt{42}$	$5/\sqrt{42}$
001111	$7/\sqrt{42}$	$7/\sqrt{42}$	101111	$-7/\sqrt{42}$	$7/\sqrt{42}$
010000	$3/\sqrt{42}$	$-3/\sqrt{42}$	110000	$-3/\sqrt{42}$	$-3/\sqrt{42}$
010001	$3/\sqrt{42}$	$-1/\sqrt{42}$	110001	$-3/\sqrt{42}$	$-1/\sqrt{42}$
010010	$1/\sqrt{42}$	$-3/\sqrt{42}$	110010	$-1/\sqrt{42}$	$-3/\sqrt{42}$
010011	$1/\sqrt{42}$	$-1/\sqrt{42}$	110011	$-1/\sqrt{42}$	$-1/\sqrt{42}$
010100	$3/\sqrt{42}$	$-5/\sqrt{42}$	110100	$-3/\sqrt{42}$	$-5/\sqrt{42}$
010101	$3/\sqrt{42}$	$-7/\sqrt{42}$	110101	$-3/\sqrt{42}$	$-7/\sqrt{42}$
010110	$1/\sqrt{42}$	$-5/\sqrt{42}$	110110	$-1/\sqrt{42}$	$-5/\sqrt{42}$
010111	$1/\sqrt{42}$	$-7/\sqrt{42}$	110111	$-1/\sqrt{42}$	$-7/\sqrt{42}$
011000	$5/\sqrt{42}$	$-3/\sqrt{42}$	111000	$-5/\sqrt{42}$	$-3/\sqrt{42}$
011001	$5/\sqrt{42}$	$-1/\sqrt{42}$	111001	$-5/\sqrt{42}$	$-1/\sqrt{42}$
011010	$7/\sqrt{42}$	$-3/\sqrt{42}$	111010	$-7/\sqrt{42}$	$-3/\sqrt{42}$
011011	$7/\sqrt{42}$	$-1/\sqrt{42}$	111011	$-7/\sqrt{42}$	$-1/\sqrt{42}$
011100	$5/\sqrt{42}$	$-5/\sqrt{42}$	111100	$-5/\sqrt{42}$	$-5/\sqrt{42}$
011101	$5/\sqrt{42}$	$-7/\sqrt{42}$	111101	$-5/\sqrt{42}$	$-7/\sqrt{42}$
011110	$7/\sqrt{42}$	$-5/\sqrt{42}$	111110	$-7/\sqrt{42}$	$-5/\sqrt{42}$
011111	$7/\sqrt{42}$	$-7/\sqrt{42}$	111111	$-7/\sqrt{42}$	$-7/\sqrt{42}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

23. Upon information and belief, the Accused Instrumentality performs the step of performing the second transmission (*e.g.*, HARQ retransmission) by transmitting the second data symbols (*e.g.*, output of modulation block using a second modulation scheme) over a second diversity branch (*e.g.*, mapping from assigned resource blocks to the later available number of antenna ports) to the receiver (*e.g.*, LTE base station). For example, at least in its internal testing and usage, the Accused Instrumentality transmits second data symbols over a

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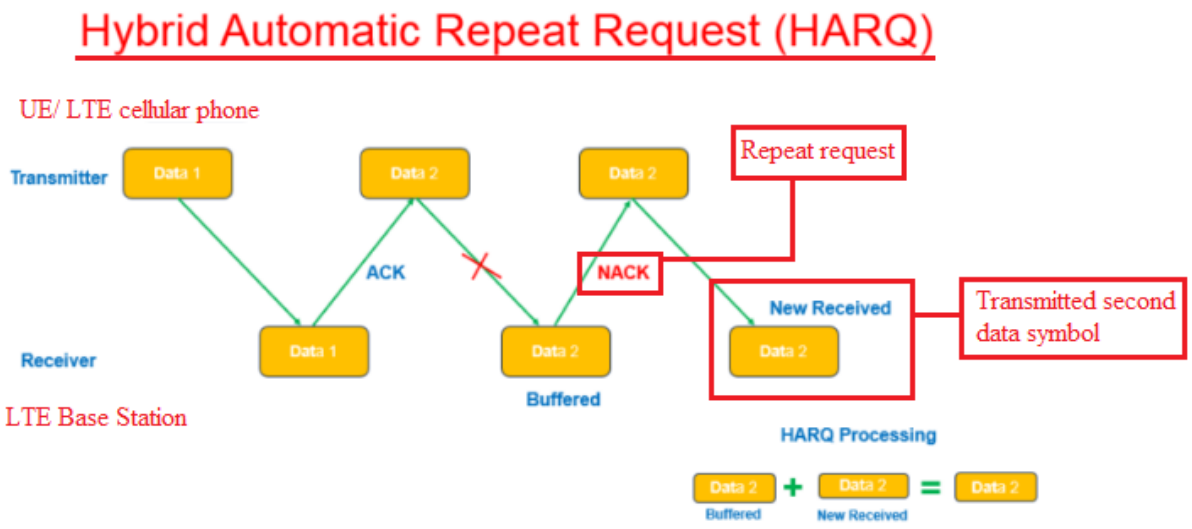
second or later diversity branch using multi-antenna processing which maps from assigned resource blocks to the later available number of antenna ports.

Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



HARQ Re-transmissions Types

HARQ Re-transmissions are also of 2 types:-

- Adaptive re-transmission,
- Non-adaptive re-transmission.

Adaptive Re-transmission: Second mapping of said higher order modulation scheme for re-transmission

Here, the transmission attributes like Modulation Coding Scheme **(MCS)**, Redundancy Version **(RV)**, **sub-carrier** on which transmission is going to occur, does not remain same during each re-transmission but are notified by the sender. These attributes can be changed according to radio channel conditions, hence, it again provides flexibility but increases overhead.

(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

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- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment.

Transmitting the second data symbols over a second diversity branch

- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

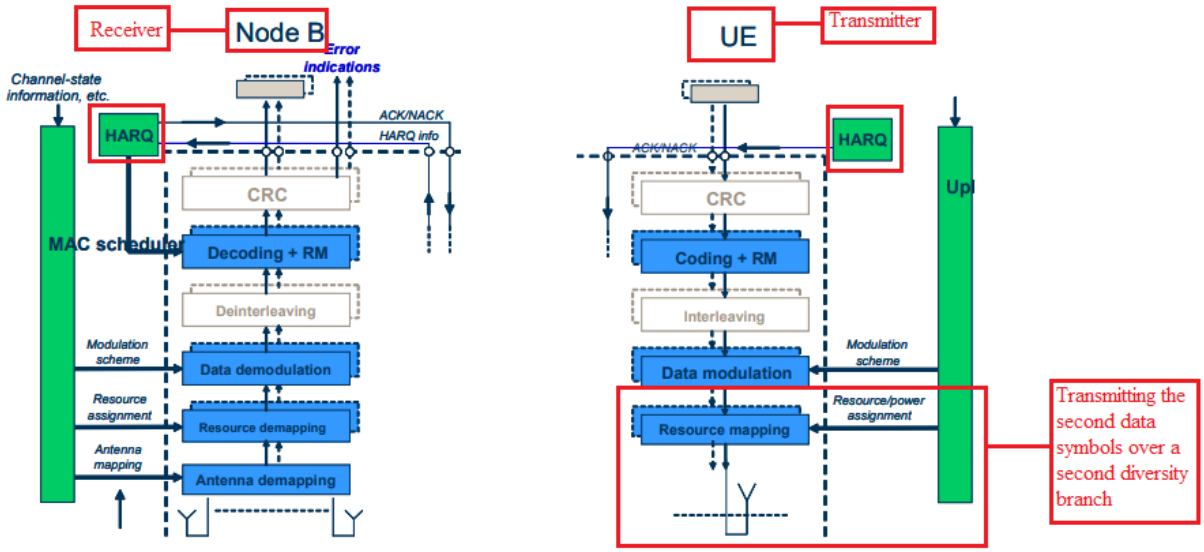

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

specific reference signals within the considered measurement frequency bandwidth. For RSRP determination the cell-specific reference signals R_0 and if available R_1 according to [8] can be used.

If receiver diversity is in use by the UE, the reported value shall be equivalent to the linear average of the power values of all diversity branches.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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5.3 L1 interactions with MAC retransmission functionality

Second transmission i.e. HARQ retransmission based on a repeat request

5.2 Overview of L1 functions

The physical layer offers data transport services to higher layers. The access to these services is through the use of a transport channel via the MAC sub-layer. The physical layer is expected to perform the following functions in order to provide the data transport service:

- Error detection on the transport channel and indication to higher layers
- FEC encoding/decoding of the transport channel
- Hybrid ARQ soft-combining
- Rate matching of the coded transport channel to physical channels
- Mapping of the coded transport channel onto physical channels
- Power weighting of physical channels
- Modulation and demodulation of physical channels
- Frequency and time synchronisation
- Radio characteristics measurements and indication to higher layers

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24. Upon information and belief, the Accused Instrumentality, at least in its internal testing and usage, utilizes a base station which practices demodulating the received first (e.g., output of modulation block performing said first modulation scheme) and second data symbols (e.g., output of modulation block using a second modulation scheme) at the receiver (e.g., LTE Base Station) using the first and second modulation schemes (e.g., the mappings corresponding to transmission and retransmission Modulation Coding Scheme) respectively. For example, the Accused Instrumentality, at least in its internal testing and usage, uses a base station which practices demodulation of first data symbols (*e.g.*, output of modulation block performing said first modulation scheme) and second data symbols (*e.g.*, output of modulation block using a second modulation scheme) at the LTE base station using the first and second modulation scheme, *i.e.*, Modulation Coding Scheme (MCS) which are distinct for transmission and Adaptive Re-transmission (*i.e.*, an Adaptive Re-transmission having a different MCS than the one used for transmission, *i.e.*, first higher order modulation scheme).

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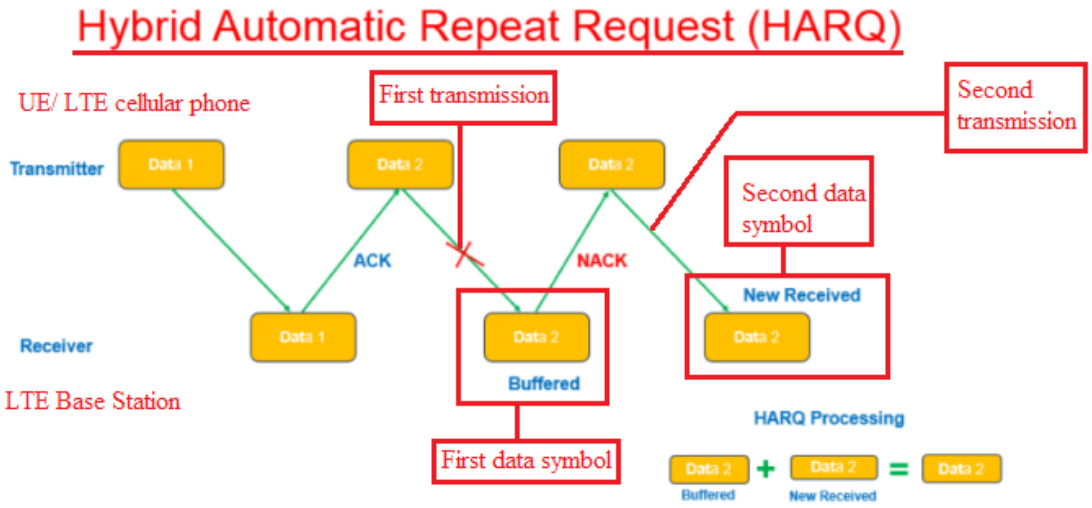
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



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HARQ Re-transmissions Types

HARQ Re-transmissions are also of 2 types:-

- Adaptive re-transmission,
- Non-adaptive re-transmission.

Adaptive Re-transmission: Second mapping of said higher order modulation scheme for re-transmission

Here, the transmission attributes like Modulation Coding Scheme **(MCS)**, Redundancy Version **(RV)**, **sub-carrier** on which transmission is going to occur, does not remain same during each re-transmission but are notified by the sender. These attributes can be changed according to radio channel conditions, hence, it again provides flexibility but increases overhead.

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- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).

Higher order modulation scheme

- **Mapping to physical resource**
- L2-controlled resource assignment.
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

Second transmission i.e. re-transmission based on a repeat request i.e. NAK

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

5.3 L1 interactions with MAC retransmission functionality

Second transmission i.e. HARQ retransmission based on a repeat request

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

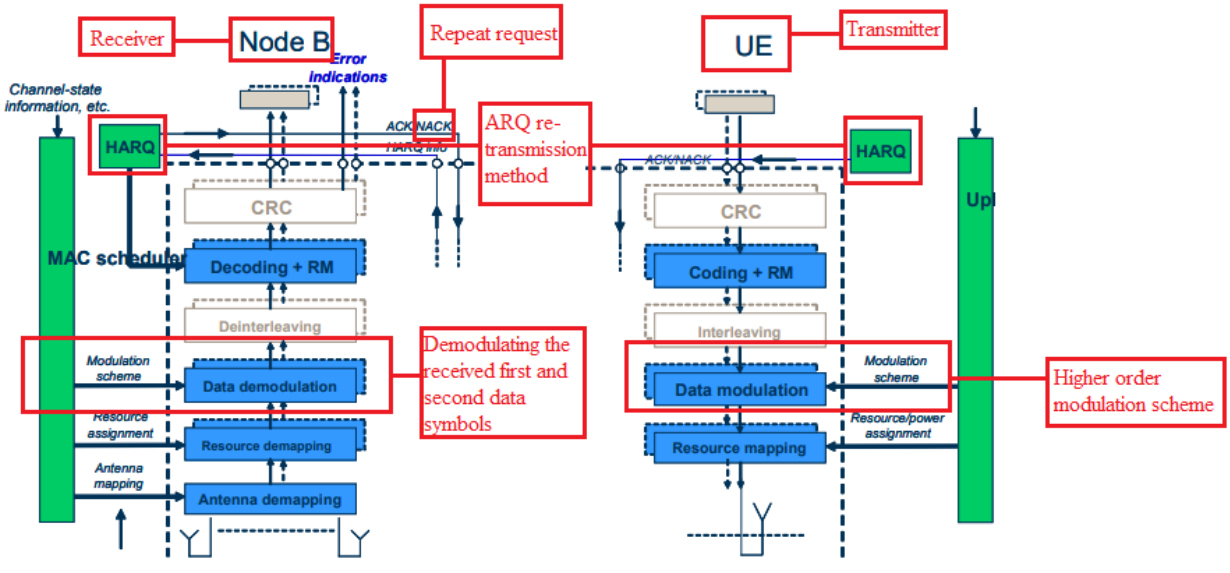

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

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(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

QAM bits per symbol

Higher order modulation scheme

The advantage of using QAM is that it is a higher order form of modulation and as a result it is able to carry more bits of information per symbol. By selecting a higher order format of QAM, the data rate of a link can be increased.

(*E.g.*, https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php).

QAM FORMATS & BIT RATES COMPARISON

MODULATION	BITS PER SYMBOL	SYMBOL RATE
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8PSK	3	1/3 bit rate
16QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64QAM	6	1/6 bit rate

Respresenting more than two data bits are mapped onto one data symbol

(*E.g.*, https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php).

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7.1.3 16QAM

In case of 16QAM modulation, quadruplets of bits, $b(i), b(i+1), b(i+2), b(i+3)$, are mapped to complex-valued modulation symbols $x=I+jQ$ according to Table 7.1.3-1.

Table 7.1.3-1: 16QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3)$	I	Q
0000	$1/\sqrt{10}$	$1/\sqrt{10}$
0001	$1/\sqrt{10}$	$3/\sqrt{10}$
0010	$3/\sqrt{10}$	$1/\sqrt{10}$
0011	$3/\sqrt{10}$	$3/\sqrt{10}$
0100	$1/\sqrt{10}$	$-1/\sqrt{10}$
0101	$1/\sqrt{10}$	$-3/\sqrt{10}$
0110	$3/\sqrt{10}$	$-1/\sqrt{10}$
0111	$3/\sqrt{10}$	$-3/\sqrt{10}$
1000	$-1/\sqrt{10}$	$1/\sqrt{10}$
1001	$-1/\sqrt{10}$	$3/\sqrt{10}$
1010	$-3/\sqrt{10}$	$1/\sqrt{10}$
1011	$-3/\sqrt{10}$	$3/\sqrt{10}$
1100	$-1/\sqrt{10}$	$-1/\sqrt{10}$
1101	$-1/\sqrt{10}$	$-3/\sqrt{10}$
1110	$-3/\sqrt{10}$	$-1/\sqrt{10}$
1111	$-3/\sqrt{10}$	$-3/\sqrt{10}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

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7.1.4 64QAM

In case of 64QAM modulation, hextuplets of bits, $b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$, are mapped to complex-valued modulation symbols $x = I + jQ$ according to Table 7.1.4-1.

Table 7.1.4-1: 64QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q	$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q
000000	$3/\sqrt{42}$	$3/\sqrt{42}$	100000	$-3/\sqrt{42}$	$3/\sqrt{42}$
000001	$3/\sqrt{42}$	$1/\sqrt{42}$	100001	$-3/\sqrt{42}$	$1/\sqrt{42}$
000010	$1/\sqrt{42}$	$3/\sqrt{42}$	100010	$-1/\sqrt{42}$	$3/\sqrt{42}$
000011	$1/\sqrt{42}$	$1/\sqrt{42}$	100011	$-1/\sqrt{42}$	$1/\sqrt{42}$
000100	$3/\sqrt{42}$	$5/\sqrt{42}$	100100	$-3/\sqrt{42}$	$5/\sqrt{42}$
000101	$3/\sqrt{42}$	$7/\sqrt{42}$	100101	$-3/\sqrt{42}$	$7/\sqrt{42}$
000110	$1/\sqrt{42}$	$5/\sqrt{42}$	100110	$-1/\sqrt{42}$	$5/\sqrt{42}$
000111	$1/\sqrt{42}$	$7/\sqrt{42}$	100111	$-1/\sqrt{42}$	$7/\sqrt{42}$
001000	$5/\sqrt{42}$	$3/\sqrt{42}$	101000	$-5/\sqrt{42}$	$3/\sqrt{42}$
001001	$5/\sqrt{42}$	$1/\sqrt{42}$	101001	$-5/\sqrt{42}$	$1/\sqrt{42}$
001010	$7/\sqrt{42}$	$3/\sqrt{42}$	101010	$-7/\sqrt{42}$	$3/\sqrt{42}$
001011	$7/\sqrt{42}$	$1/\sqrt{42}$	101011	$-7/\sqrt{42}$	$1/\sqrt{42}$
001100	$5/\sqrt{42}$	$5/\sqrt{42}$	101100	$-5/\sqrt{42}$	$5/\sqrt{42}$
001101	$5/\sqrt{42}$	$7/\sqrt{42}$	101101	$-5/\sqrt{42}$	$7/\sqrt{42}$
001110	$7/\sqrt{42}$	$5/\sqrt{42}$	101110	$-7/\sqrt{42}$	$5/\sqrt{42}$
001111	$7/\sqrt{42}$	$7/\sqrt{42}$	101111	$-7/\sqrt{42}$	$7/\sqrt{42}$
010000	$3/\sqrt{42}$	$-3/\sqrt{42}$	110000	$-3/\sqrt{42}$	$-3/\sqrt{42}$
010001	$3/\sqrt{42}$	$-1/\sqrt{42}$	110001	$-3/\sqrt{42}$	$-1/\sqrt{42}$
010010	$1/\sqrt{42}$	$-3/\sqrt{42}$	110010	$-1/\sqrt{42}$	$-3/\sqrt{42}$
010011	$1/\sqrt{42}$	$-1/\sqrt{42}$	110011	$-1/\sqrt{42}$	$-1/\sqrt{42}$
010100	$3/\sqrt{42}$	$-5/\sqrt{42}$	110100	$-3/\sqrt{42}$	$-5/\sqrt{42}$
010101	$3/\sqrt{42}$	$-7/\sqrt{42}$	110101	$-3/\sqrt{42}$	$-7/\sqrt{42}$
010110	$1/\sqrt{42}$	$-5/\sqrt{42}$	110110	$-1/\sqrt{42}$	$-5/\sqrt{42}$
010111	$1/\sqrt{42}$	$-7/\sqrt{42}$	110111	$-1/\sqrt{42}$	$-7/\sqrt{42}$
011000	$5/\sqrt{42}$	$-3/\sqrt{42}$	111000	$-5/\sqrt{42}$	$-3/\sqrt{42}$
011001	$5/\sqrt{42}$	$-1/\sqrt{42}$	111001	$-5/\sqrt{42}$	$-1/\sqrt{42}$
011010	$7/\sqrt{42}$	$-3/\sqrt{42}$	111010	$-7/\sqrt{42}$	$-3/\sqrt{42}$
011011	$7/\sqrt{42}$	$-1/\sqrt{42}$	111011	$-7/\sqrt{42}$	$-1/\sqrt{42}$
011100	$5/\sqrt{42}$	$-5/\sqrt{42}$	111100	$-5/\sqrt{42}$	$-5/\sqrt{42}$
011101	$5/\sqrt{42}$	$-7/\sqrt{42}$	111101	$-5/\sqrt{42}$	$-7/\sqrt{42}$
011110	$7/\sqrt{42}$	$-5/\sqrt{42}$	111110	$-7/\sqrt{42}$	$-5/\sqrt{42}$
011111	$7/\sqrt{42}$	$-7/\sqrt{42}$	111111	$-7/\sqrt{42}$	$-7/\sqrt{42}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

25. Upon information and belief, the Accused Instrumentality performs the step of combining (e.g., Hybrid ARQ soft-combining) the demodulated data received over the first (e.g., mapping from assigned resource blocks to the first available number of antenna ports) and second diversity branches (e.g., mapping from assigned resource blocks to the later available number of antenna ports). For example, the Accused Instrumentality, at least in its

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internal testing and usage, uses a base station which performs a diversity combining, *i.e.*, Hybrid ARQ soft-combining of data from multiple received antenna ports.

- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment.
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

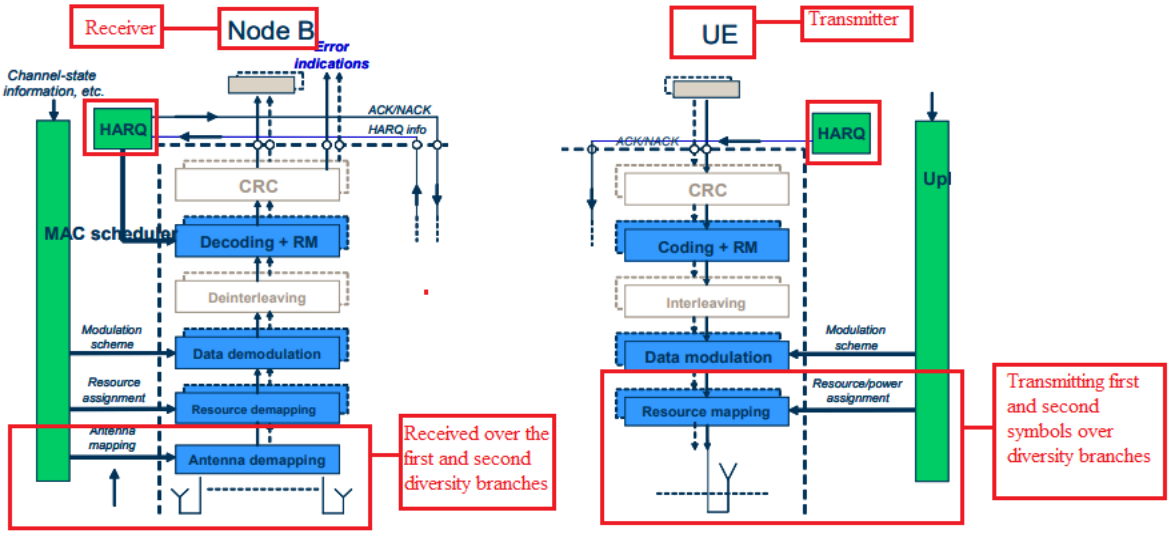

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

specific reference signals within the considered measurement frequency bandwidth. For RSRP determination the cell-specific reference signals R_0 and if available R_1 according to [8] can be used.

If receiver diversity is in use by the UE, the reported value shall be equivalent to the linear average of the power values of all diversity branches.

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(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

5.3 L1 interactions with MAC retransmission functionality

Second transmission i.e. HARQ retransmission based on a repeat request

5.2 Overview of L1 functions

The physical layer offers data transport services to higher layers. The access to these services is through the use of a transport channel via the MAC sub-layer. The physical layer is expected to perform the following functions in order to provide the data transport service:

- Error detection on the transport channel and indication to higher layers
- FEC encoding/decoding of the transport channel
- Hybrid ARQ soft-combining Diversity combining
- Rate matching of the coded transport channel to physical channels
- Mapping of the coded transport channel onto physical channels
- Power weighting of physical channels
- Modulation and demodulation of physical channels
- Frequency and time synchronisation
- Radio characteristics measurements and indication to higher layers
- Multiple Input Multiple Output (MIMO) antenna processing
- Transmit Diversity (TX diversity)
- Beamforming
- RF processing. (Note: RF processing aspects are specified in the TS 36.100)

L1 functions are modelled for each transport channel in subclauses 6.1 and 6.2.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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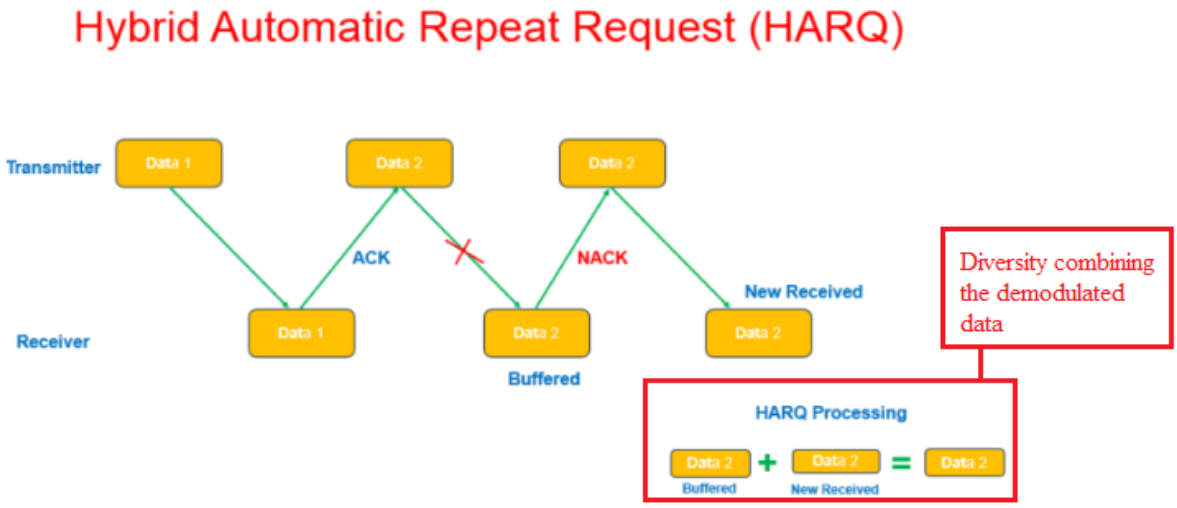
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

26. Upon information and belief, the Accused Instrumentality performs the step using modulation schemes that are 16 QAM and a number of $\log_2$ (M) modulation schemes. For example, the Accused Instrumentality, at least in its internal testing and usage, uses 16 QAM and 64 QAM wherein the M-ary Quadrature Amplitude Modulation is basically a $\log_2$ (M) modulation schemes, *i.e.*, 16QAM stands for $\log_2$ (16) modulation schemes and 64 QAM stands for $\log_2$ (64) modulation schemes.

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- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment.
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

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- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

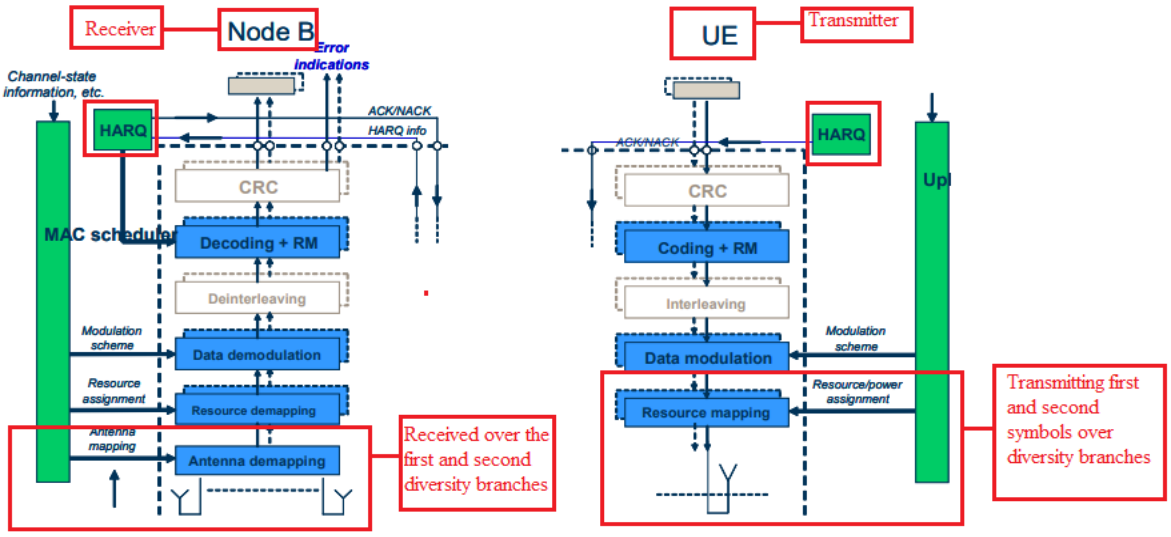

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

specific reference signals within the considered measurement frequency bandwidth. For RSRP determination the cell-specific reference signals R_0 and if available R_1 according to [8] can be used.

If receiver diversity is in use by the UE, the reported value shall be equivalent to the linear average of the power values of all diversity branches.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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5.3 L1 interactions with MAC retransmission functionality

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The physical layer offers data transport services to higher layers. The access to these services is through the use of a transport channel via the MAC sub-layer. The physical layer is expected to perform the following functions in order to provide the data transport service:

- Error detection on the transport channel and indication to higher layers
- FEC encoding/decoding of the transport channel
- Hybrid ARQ soft-combining Diversity combining
- Rate matching of the coded transport channel to physical channels
- Mapping of the coded transport channel onto physical channels
- Power weighting of physical channels
- Modulation and demodulation of physical channels
- Frequency and time synchronisation
- Radio characteristics measurements and indication to higher layers
- Multiple Input Multiple Output (MIMO) antenna processing
- Transmit Diversity (TX diversity)
- Beamforming
- RF processing. (Note: RF processing aspects are specified in the TS 36.100)

L1 functions are modelled for each transport channel in subclauses 6.1 and 6.2.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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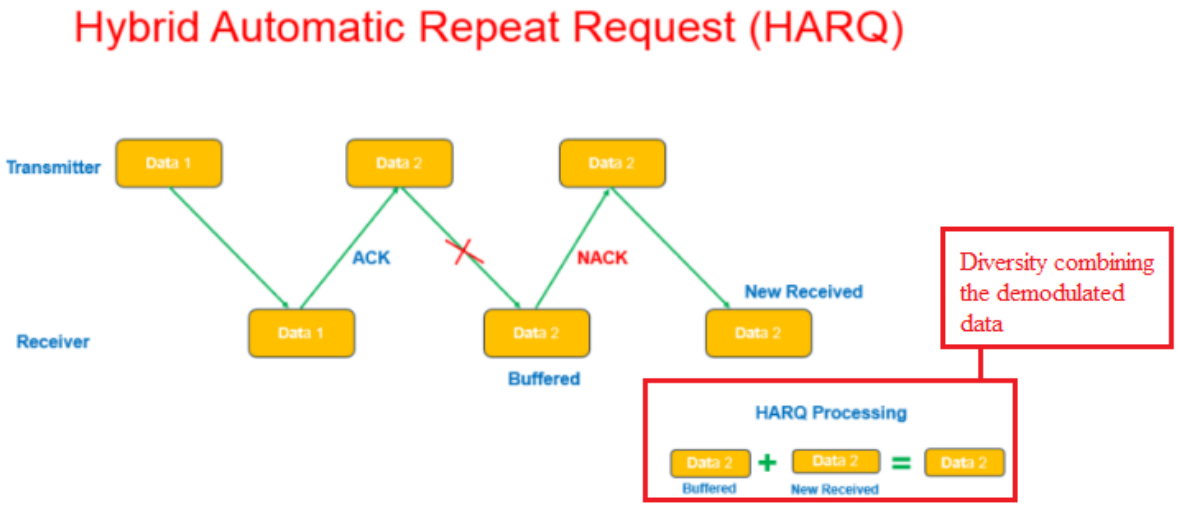
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

V. COUNT II
(PATENT INFRINGEMENT OF UNITED STATES PATENT NO. 7,567,622)

27. Plaintiff incorporates the above paragraphs herein by reference.

28. On July 28, 2009, United States Patent No. 7,567,622 ("the '622 Patent") was duly and legally issued by the United States Patent and Trademark Office. The application leading to the '622 Patent was filed on December 5, 2006 (Ex. B at cover). The '622 Patent is titled "Constellation Rearrangement for ARQ Transmit Diversity Schemes." The '622 patent issued from an application that is a continuation of the application leading to the '961 patent. A true and correct copy of the '622 Patent is attached hereto as Exhibit B and incorporated herein by reference.

29. Swirlate is the assignee of all right, title, and interest in the '622 patent, including all rights to enforce and prosecute actions for infringement and to collect damages for all relevant times against infringers of the '622 Patent. Accordingly, Swirlate possesses the

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exclusive right and standing to prosecute the present action for infringement of the '622 Patent by Defendant.

30. The '622 patent shares the same specification as the '961 patent and therefore the background information regarding the '961 patent in paragraphs 11 through 15 are incorporated by reference.

31. During the prosecution history, applicant explained the benefits of the claimed invention. The claim "defines an ARQ retransmission method in which more than two data bits are mapped onto one data symbol in each of the initial transmission and a retransmission. The symbols of the initial transmission and the retransmission represent the same bit information, but are different symbols due to different bit mappings. Since different bits of a modulation symbol have different communications reliabilities, the claimed subject matter supports averaging the communication reliabilities for each bit mapped onto a transmission symbol and a retransmission symbol so as to improve the likelihood of receiving the bit." (Ex. C at 16).

32. An advantage of the claimed subject matter "lies in reducing the overall data traffic, since the claimed retransmission is only needed in situations where any initial transmission cannot be successfully received by a receiver. The claimed subject matter employs retransmission and diversity combining only when the initial transmission is not received properly, whereas [the prior art] communications scheme always transmits identical data over three parallel paths for diversity combining by a receiver and does not retransmit data in accordance with a repeat request by a receiver." (Ex. C at 17).

33. **Direct Infringement.** Upon information and belief, Defendant has been directly infringing at least claim 1 of the '622 patent in Washington, and elsewhere in the United States, by performing actions comprising at least performing the claimed ARQ re-

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transmission method by performing the steps of the claimed invention using the Fluke 3504 Gateway to transmit data ("Accused Instrumentality") (*E.g.*, https://dam-assets.fluke.com/s3fs-public/Fluke-3562-Screening-Vibration-Sensor-Data-Sheet.pdf?xqnnB.k.Zr42OJ3HzZULmo8tsk0SwoUx).

34. The Accused Instrumentality uses an ARQ re-transmission method in a wireless communication system wherein data packets are transmitted from a transmitter to a receiver using a higher order modulation scheme wherein more than two data bits are mapped onto one data symbol to perform a first transmission and at least a second transmission based on a repeat request. For example, the Accused Instrumentality uses an HARQ method in an LTE network in which data packets are transmitted from the Accused Instrumentality to an LTE base station using a higher order modulation scheme (*e.g.*, 16QAM and 64 QAM) wherein more than two data bits are mapped onto one data symbol to perform a first transmission and at least a second transmission (*e.g.*, HARQ retransmission) based on a repeat request (*e.g.*, HARQ retransmission request in the form of NAK). For example, the Accused Instrumentality, at least in its internal testing and usage, performs a higher order data modulation such as 16QAM and 64 QAM wherein has more than two data bits are mapped onto one data symbol (*i.e.*, in case of 16QAM it transmits 4 bits per symbol whereas in the case of 64QAM it transmits 6 bits per symbol). (*Id.*).

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Fluke 3504 Gateway

Power supply options	
AC main power	AC input 85-264 VAC, 0.35A/115V, 0.25A / 230V, 47-63 Hz
Power-over-Ethernet	Compliant with IEEE 802.3af
Wireless communication	
Protocol to gateway	Proprietary sub-GHz link
Protocol to cloud	WIFI: IEEE 802.11 ac/a/b/g/n LTE Ethernet: 10/100/1000 MBits/s
Number of connectable sensors	Up to 1000
Mechanical	
Ingress protection class	IP66
Temperature	Operation: -30°C to 70°C (-22°F to 158°F) Storage: -40°C to 85°C (-40°F to 185°F)
Vibration resistance	10-60Hz @ 0.44mm 60-3,200Hz @ 3.0g
Shock & impact resistance	100g @ 6 mS
Dimensions	Approx. 267 x 221 x 133 mm (10.5" x 8.7" x 5.3")
Weight	Approx. 2.64 kg (5.8 pounds)
Mounting	Mounting tabs
Material	Polycarbonate

(*E.g.*, https://dam-assets.fluke.com/s3fs-public/Fluke-3562-Screening-Vibration-Sensor-Data-Sheet.pdf?xqnnB.k.Zr42OJ3HzZULmo8tsk0SwoUx).

Hybrid Automatic Repeat Request (HARQ) in LTE FDD

October 18, 2018 admin Future Network Optimization, LTE, RF Basics, Tech Fundas

HARQ stands for Hybrid Automatic Repeat Request. **HARQ** = **ARQ** + **FEC** (Forward Error Correction)/Soft Combining.

ARQ refers to Automatic Repeat Request i.e. if sender doesn't receive Acknowledgement (ACK) before timeout, the receiver discards the bad packet and sender shall re-transmits the packet. ARQ procedure is illustrated below :

(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

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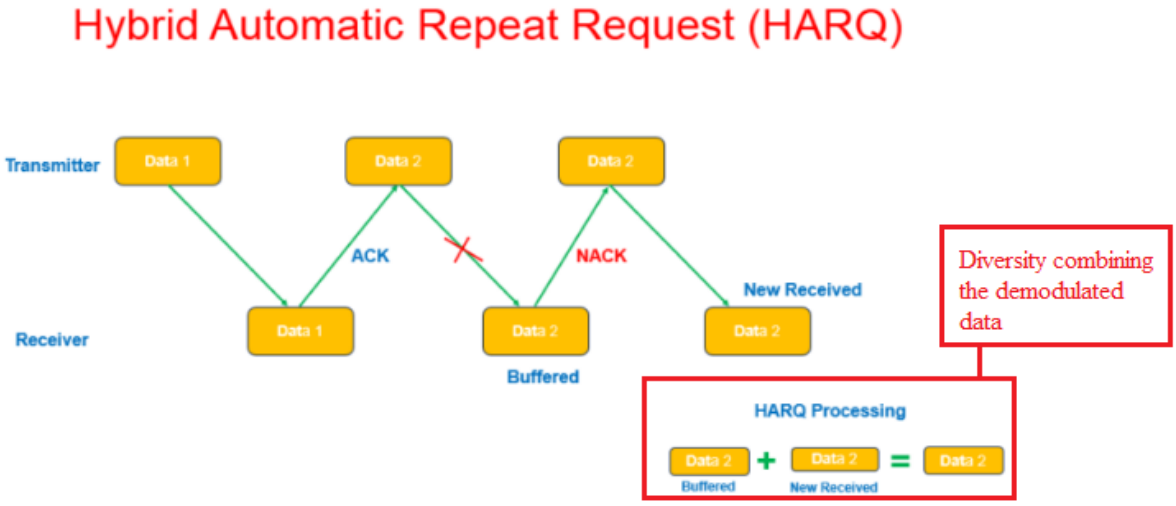
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

6.1 Uplink model

Data packets transmitted from a transmitter i.e. UE/ LTE cellular phone to a receiver i.e. LTE base station

6.1.1 Uplink Shared Channel

The physical-layer model for Uplink Shared Channel transmission is described based on the corresponding physical-layer-processing chain, see Figure 6.1.1. Processing steps that are relevant for the physical-layer model, e.g. in the sense that they are configurable by higher layers, are highlighted in blue. It should be noted that, in case PUSCH, the scheduling decision is partly made at the network side, if there is no blind decoding it is fully done at the network side. The uplink transmission control in the UE then configures the uplink physical-layer processing, based on uplink transport-format and resource-assignment information received on the downlink.

- **Higher-layer data passed to/from the physical layer**
- One transport block of dynamic size delivered to the physical layer once every TTI.
- **CRC and transport-block-error indication**
- Transport-block-error indication delivered to higher layers.
- **FEC and rate matching**
- Channel coding rate is implicitly given by the combination of transport block size, modulation scheme and resource assignment;

ARQ re-transmission method

- Physical layer model support of HARQ: in case of Incremental Redundancy, the corresponding Layer 2 Hybrid-ARQ process controls what redundancy version is to be used for the physical layer transmission for each TTI.
- **Interleaving**

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).

Higher order modulation scheme

- **Mapping to physical resource**
- L2-controlled resource assignment.
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

Second transmission i.e. re-transmission based on a repeat request i.e. NAK

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

5.3 L1 interactions with MAC retransmission functionality

Second transmission i.e. HARQ retransmission based on a repeat request

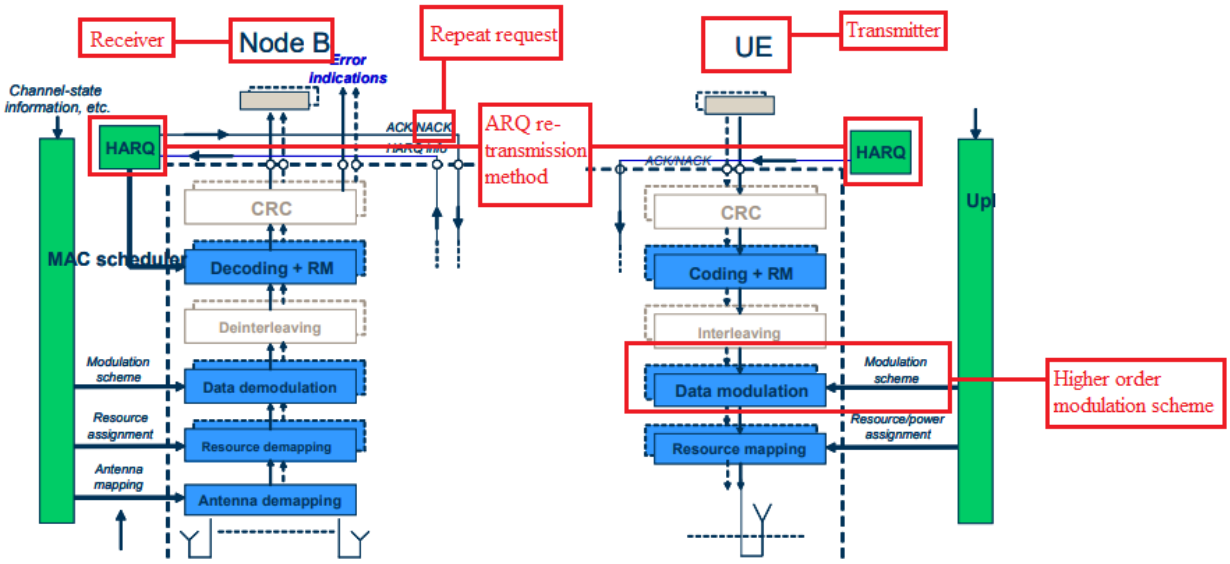

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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QAM bits per symbol

Higher order modulation scheme

The advantage of using QAM is that it is a higher order form of modulation and as a result it is able to carry more bits of information per symbol. By selecting a higher order format of QAM, the data rate of a link can be increased.

QAM FORMATS & BIT RATES COMPARISON

MODULATION	BITS PER SYMBOL	SYMBOL RATE
BPSK	1	1 x bit rate
QPSK	2	1/2 bit rate
8PSK	3	1/3 bit rate
16QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64QAM	6	1/6 bit rate

Respresenting more than two data bits are mapped onto one data symbol

(*E.g.*, https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php).

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7.1.3 16QAM

In case of 16QAM modulation, quadruplets of bits, $b(i), b(i+1), b(i+2), b(i+3)$, are mapped to complex-valued modulation symbols $x = I + jQ$ according to Table 7.1.3-1.

Table 7.1.3-1: 16QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3)$	I	Q
0000	$1/\sqrt{10}$	$1/\sqrt{10}$
0001	$1/\sqrt{10}$	$3/\sqrt{10}$
0010	$3/\sqrt{10}$	$1/\sqrt{10}$
0011	$3/\sqrt{10}$	$3/\sqrt{10}$
0100	$1/\sqrt{10}$	$-1/\sqrt{10}$
0101	$1/\sqrt{10}$	$-3/\sqrt{10}$
0110	$3/\sqrt{10}$	$-1/\sqrt{10}$
0111	$3/\sqrt{10}$	$-3/\sqrt{10}$
1000	$-1/\sqrt{10}$	$1/\sqrt{10}$
1001	$-1/\sqrt{10}$	$3/\sqrt{10}$
1010	$-3/\sqrt{10}$	$1/\sqrt{10}$
1011	$-3/\sqrt{10}$	$3/\sqrt{10}$
1100	$-1/\sqrt{10}$	$-1/\sqrt{10}$
1101	$-1/\sqrt{10}$	$-3/\sqrt{10}$
1110	$-3/\sqrt{10}$	$-1/\sqrt{10}$
1111	$-3/\sqrt{10}$	$-3/\sqrt{10}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

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7.1.4 64QAM

In case of 64QAM modulation, hextuplets of bits, $b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$, are mapped to complex-valued modulation symbols $x = I + jQ$ according to Table 7.1.4-1.

Table 7.1.4-1: 64QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q	$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q
000000	$3/\sqrt{42}$	$3/\sqrt{42}$	100000	$-3/\sqrt{42}$	$3/\sqrt{42}$
000001	$3/\sqrt{42}$	$1/\sqrt{42}$	100001	$-3/\sqrt{42}$	$1/\sqrt{42}$
000010	$1/\sqrt{42}$	$3/\sqrt{42}$	100010	$-1/\sqrt{42}$	$3/\sqrt{42}$
000011	$1/\sqrt{42}$	$1/\sqrt{42}$	100011	$-1/\sqrt{42}$	$1/\sqrt{42}$
000100	$3/\sqrt{42}$	$5/\sqrt{42}$	100100	$-3/\sqrt{42}$	$5/\sqrt{42}$
000101	$3/\sqrt{42}$	$7/\sqrt{42}$	100101	$-3/\sqrt{42}$	$7/\sqrt{42}$
000110	$1/\sqrt{42}$	$5/\sqrt{42}$	100110	$-1/\sqrt{42}$	$5/\sqrt{42}$
000111	$1/\sqrt{42}$	$7/\sqrt{42}$	100111	$-1/\sqrt{42}$	$7/\sqrt{42}$
001000	$5/\sqrt{42}$	$3/\sqrt{42}$	101000	$-5/\sqrt{42}$	$3/\sqrt{42}$
001001	$5/\sqrt{42}$	$1/\sqrt{42}$	101001	$-5/\sqrt{42}$	$1/\sqrt{42}$
001010	$7/\sqrt{42}$	$3/\sqrt{42}$	101010	$-7/\sqrt{42}$	$3/\sqrt{42}$
001011	$7/\sqrt{42}$	$1/\sqrt{42}$	101011	$-7/\sqrt{42}$	$1/\sqrt{42}$
001100	$5/\sqrt{42}$	$5/\sqrt{42}$	101100	$-5/\sqrt{42}$	$5/\sqrt{42}$
001101	$5/\sqrt{42}$	$7/\sqrt{42}$	101101	$-5/\sqrt{42}$	$7/\sqrt{42}$
001110	$7/\sqrt{42}$	$5/\sqrt{42}$	101110	$-7/\sqrt{42}$	$5/\sqrt{42}$
001111	$7/\sqrt{42}$	$7/\sqrt{42}$	101111	$-7/\sqrt{42}$	$7/\sqrt{42}$
010000	$3/\sqrt{42}$	$-3/\sqrt{42}$	110000	$-3/\sqrt{42}$	$-3/\sqrt{42}$
010001	$3/\sqrt{42}$	$-1/\sqrt{42}$	110001	$-3/\sqrt{42}$	$-1/\sqrt{42}$
010010	$1/\sqrt{42}$	$-3/\sqrt{42}$	110010	$-1/\sqrt{42}$	$-3/\sqrt{42}$
010011	$1/\sqrt{42}$	$-1/\sqrt{42}$	110011	$-1/\sqrt{42}$	$-1/\sqrt{42}$
010100	$3/\sqrt{42}$	$-5/\sqrt{42}$	110100	$-3/\sqrt{42}$	$-5/\sqrt{42}$
010101	$3/\sqrt{42}$	$-7/\sqrt{42}$	110101	$-3/\sqrt{42}$	$-7/\sqrt{42}$
010110	$1/\sqrt{42}$	$-5/\sqrt{42}$	110110	$-1/\sqrt{42}$	$-5/\sqrt{42}$
010111	$1/\sqrt{42}$	$-7/\sqrt{42}$	110111	$-1/\sqrt{42}$	$-7/\sqrt{42}$
011000	$5/\sqrt{42}$	$-3/\sqrt{42}$	111000	$-5/\sqrt{42}$	$-3/\sqrt{42}$
011001	$5/\sqrt{42}$	$-1/\sqrt{42}$	111001	$-5/\sqrt{42}$	$-1/\sqrt{42}$
011010	$7/\sqrt{42}$	$-3/\sqrt{42}$	111010	$-7/\sqrt{42}$	$-3/\sqrt{42}$
011011	$7/\sqrt{42}$	$-1/\sqrt{42}$	111011	$-7/\sqrt{42}$	$-1/\sqrt{42}$
011100	$5/\sqrt{42}$	$-5/\sqrt{42}$	111100	$-5/\sqrt{42}$	$-5/\sqrt{42}$
011101	$5/\sqrt{42}$	$-7/\sqrt{42}$	111101	$-5/\sqrt{42}$	$-7/\sqrt{42}$
011110	$7/\sqrt{42}$	$-5/\sqrt{42}$	111110	$-7/\sqrt{42}$	$-5/\sqrt{42}$
011111	$7/\sqrt{42}$	$-7/\sqrt{42}$	111111	$-7/\sqrt{42}$	$-7/\sqrt{42}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

35. Upon information and belief, the Accused instrumentality performs the step of modulating data packets at the transmitter using a first mapping of said higher order modulation scheme to obtain first data symbols. For example, the Accused Instrumentality, at least in its internal testing and usage, performs a higher order data modulation such as 16QAM and 64 QAM which have more than two data bits are mapped onto one data symbol (*i.e.*, in case of

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16QAM it transmits 4 bits per symbol whereas in the case of 64QAM it transmits 6 bits per symbol) so as to obtain a said first data symbols which is the output of the modulation block.

- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment.

Higher order modulation scheme

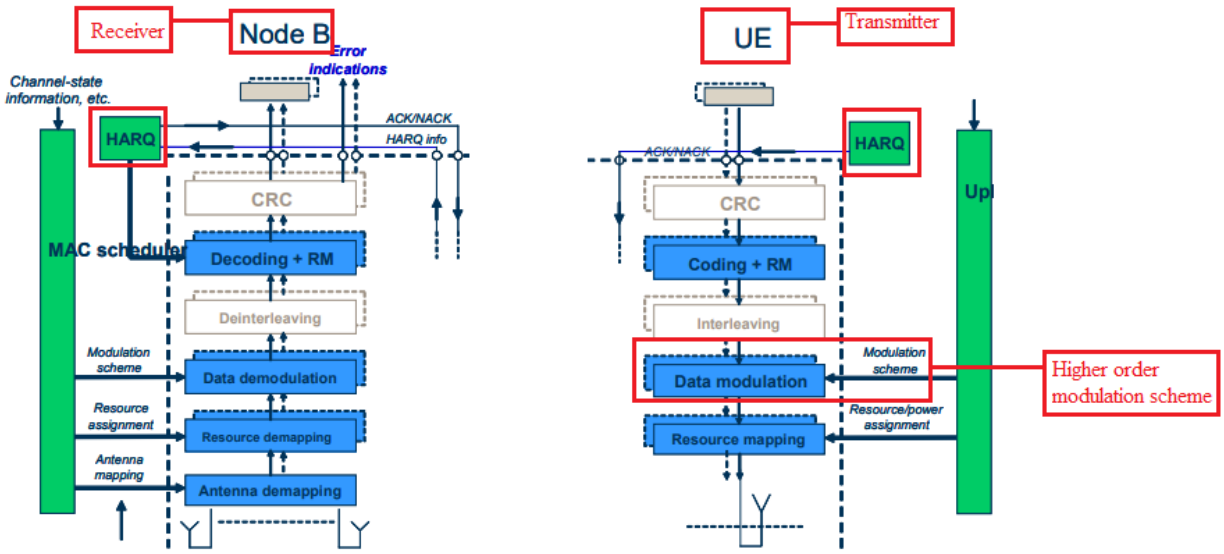

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

QAM bits per symbol

Higher order modulation scheme

The advantage of using QAM is that it is a higher order form of modulation and as a result it is able to carry more bits of information per symbol. By selecting a higher order format of QAM, the data rate of a link can be increased.

(*E.g.*, https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php).

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7.1.3 16QAM

In case of 16QAM modulation, quadruplets of bits, $b(i), b(i+1), b(i+2), b(i+3)$, are mapped to complex-valued modulation symbols $x=I+jQ$ according to Table 7.1.3-1.

Table 7.1.3-1: 16QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3)$	I	Q
0000	$1/\sqrt{10}$	$1/\sqrt{10}$
0001	$1/\sqrt{10}$	$3/\sqrt{10}$
0010	$3/\sqrt{10}$	$1/\sqrt{10}$
0011	$3/\sqrt{10}$	$3/\sqrt{10}$
0100	$1/\sqrt{10}$	$-1/\sqrt{10}$
0101	$1/\sqrt{10}$	$-3/\sqrt{10}$
0110	$3/\sqrt{10}$	$-1/\sqrt{10}$
0111	$3/\sqrt{10}$	$-3/\sqrt{10}$
1000	$-1/\sqrt{10}$	$1/\sqrt{10}$
1001	$-1/\sqrt{10}$	$3/\sqrt{10}$
1010	$-3/\sqrt{10}$	$1/\sqrt{10}$
1011	$-3/\sqrt{10}$	$3/\sqrt{10}$
1100	$-1/\sqrt{10}$	$-1/\sqrt{10}$
1101	$-1/\sqrt{10}$	$-3/\sqrt{10}$
1110	$-3/\sqrt{10}$	$-1/\sqrt{10}$
1111	$-3/\sqrt{10}$	$-3/\sqrt{10}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

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7.1.4 64QAM

In case of 64QAM modulation, hextuplets of bits, $b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$, are mapped to complex-valued modulation symbols $x = I + jQ$ according to Table 7.1.4-1.

Table 7.1.4-1: 64QAM modulation mapping

$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q	$b(i), b(i+1), b(i+2), b(i+3), b(i+4), b(i+5)$	I	Q
000000	$3/\sqrt{42}$	$3/\sqrt{42}$	100000	$-3/\sqrt{42}$	$3/\sqrt{42}$
000001	$3/\sqrt{42}$	$1/\sqrt{42}$	100001	$-3/\sqrt{42}$	$1/\sqrt{42}$
000010	$1/\sqrt{42}$	$3/\sqrt{42}$	100010	$-1/\sqrt{42}$	$3/\sqrt{42}$
000011	$1/\sqrt{42}$	$1/\sqrt{42}$	100011	$-1/\sqrt{42}$	$1/\sqrt{42}$
000100	$3/\sqrt{42}$	$5/\sqrt{42}$	100100	$-3/\sqrt{42}$	$5/\sqrt{42}$
000101	$3/\sqrt{42}$	$7/\sqrt{42}$	100101	$-3/\sqrt{42}$	$7/\sqrt{42}$
000110	$1/\sqrt{42}$	$5/\sqrt{42}$	100110	$-1/\sqrt{42}$	$5/\sqrt{42}$
000111	$1/\sqrt{42}$	$7/\sqrt{42}$	100111	$-1/\sqrt{42}$	$7/\sqrt{42}$
001000	$5/\sqrt{42}$	$3/\sqrt{42}$	101000	$-5/\sqrt{42}$	$3/\sqrt{42}$
001001	$5/\sqrt{42}$	$1/\sqrt{42}$	101001	$-5/\sqrt{42}$	$1/\sqrt{42}$
001010	$7/\sqrt{42}$	$3/\sqrt{42}$	101010	$-7/\sqrt{42}$	$3/\sqrt{42}$
001011	$7/\sqrt{42}$	$1/\sqrt{42}$	101011	$-7/\sqrt{42}$	$1/\sqrt{42}$
001100	$5/\sqrt{42}$	$5/\sqrt{42}$	101100	$-5/\sqrt{42}$	$5/\sqrt{42}$
001101	$5/\sqrt{42}$	$7/\sqrt{42}$	101101	$-5/\sqrt{42}$	$7/\sqrt{42}$
001110	$7/\sqrt{42}$	$5/\sqrt{42}$	101110	$-7/\sqrt{42}$	$5/\sqrt{42}$
001111	$7/\sqrt{42}$	$7/\sqrt{42}$	101111	$-7/\sqrt{42}$	$7/\sqrt{42}$
010000	$3/\sqrt{42}$	$-3/\sqrt{42}$	110000	$-3/\sqrt{42}$	$-3/\sqrt{42}$
010001	$3/\sqrt{42}$	$-1/\sqrt{42}$	110001	$-3/\sqrt{42}$	$-1/\sqrt{42}$
010010	$1/\sqrt{42}$	$-3/\sqrt{42}$	110010	$-1/\sqrt{42}$	$-3/\sqrt{42}$
010011	$1/\sqrt{42}$	$-1/\sqrt{42}$	110011	$-1/\sqrt{42}$	$-1/\sqrt{42}$
010100	$3/\sqrt{42}$	$-5/\sqrt{42}$	110100	$-3/\sqrt{42}$	$-5/\sqrt{42}$
010101	$3/\sqrt{42}$	$-7/\sqrt{42}$	110101	$-3/\sqrt{42}$	$-7/\sqrt{42}$
010110	$1/\sqrt{42}$	$-5/\sqrt{42}$	110110	$-1/\sqrt{42}$	$-5/\sqrt{42}$
010111	$1/\sqrt{42}$	$-7/\sqrt{42}$	110111	$-1/\sqrt{42}$	$-7/\sqrt{42}$
011000	$5/\sqrt{42}$	$-3/\sqrt{42}$	111000	$-5/\sqrt{42}$	$-3/\sqrt{42}$
011001	$5/\sqrt{42}$	$-1/\sqrt{42}$	111001	$-5/\sqrt{42}$	$-1/\sqrt{42}$
011010	$7/\sqrt{42}$	$-3/\sqrt{42}$	111010	$-7/\sqrt{42}$	$-3/\sqrt{42}$
011011	$7/\sqrt{42}$	$-1/\sqrt{42}$	111011	$-7/\sqrt{42}$	$-1/\sqrt{42}$
011100	$5/\sqrt{42}$	$-5/\sqrt{42}$	111100	$-5/\sqrt{42}$	$-5/\sqrt{42}$
011101	$5/\sqrt{42}$	$-7/\sqrt{42}$	111101	$-5/\sqrt{42}$	$-7/\sqrt{42}$
011110	$7/\sqrt{42}$	$-5/\sqrt{42}$	111110	$-7/\sqrt{42}$	$-5/\sqrt{42}$
011111	$7/\sqrt{42}$	$-7/\sqrt{42}$	111111	$-7/\sqrt{42}$	$-7/\sqrt{42}$

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

36. Upon information and belief, the Accused Instrumentality performs the step of performing the first transmission by transmitting the first data symbols (e.g., output of modulation block performing said first modulation scheme) over a first diversity branch to the receiver (e.g., mapping from assigned resource blocks to the first available number of antenna ports). For example, the Accused Instrumentality, at least in its internal testing and usage, when performing an HARQ transmission, transmits the first data symbols over a first diversity

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branch using multi-antenna processing which maps from assigned resource blocks to the first available number of antenna ports.

- No control of interleaving by higher layers.
- **Data modulation**
- Modulation scheme is decided by MAC Scheduler (QPSK, 16QAM and 64QAM).
- **Mapping to physical resource**
- L2-controlled resource assignment. Transmitting the first data symbols over a first diversity branch to the receiver
- **Multi-antenna processing**
- MAC Scheduler partly configures mapping from assigned resource blocks to the available number of antenna ports.
- **Support of L1 control signalling**
- Transmission of ACK/NAK and CQI feedback related to DL data transmission

The model of Figure 6.1.1 also captures

- Transport via physical layer of Hybrid-ARQ related information (exact info is FFS) associated with the PUSCH, to the peer HARQ process at the receiver side;
- Transport via physical layer of corresponding HARQ acknowledgements to PUSCH transmitter side.

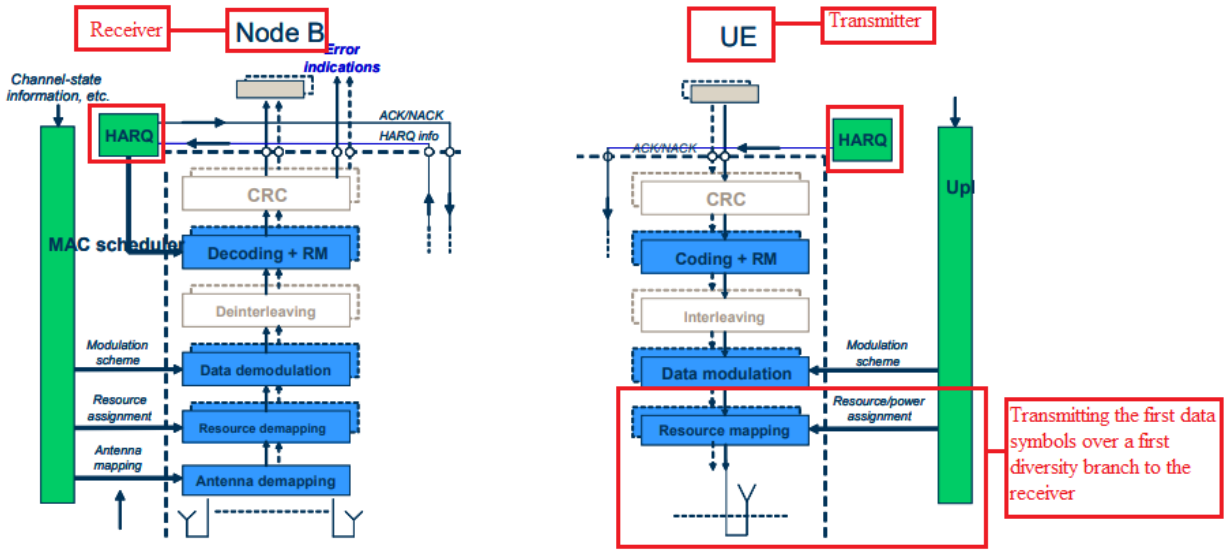

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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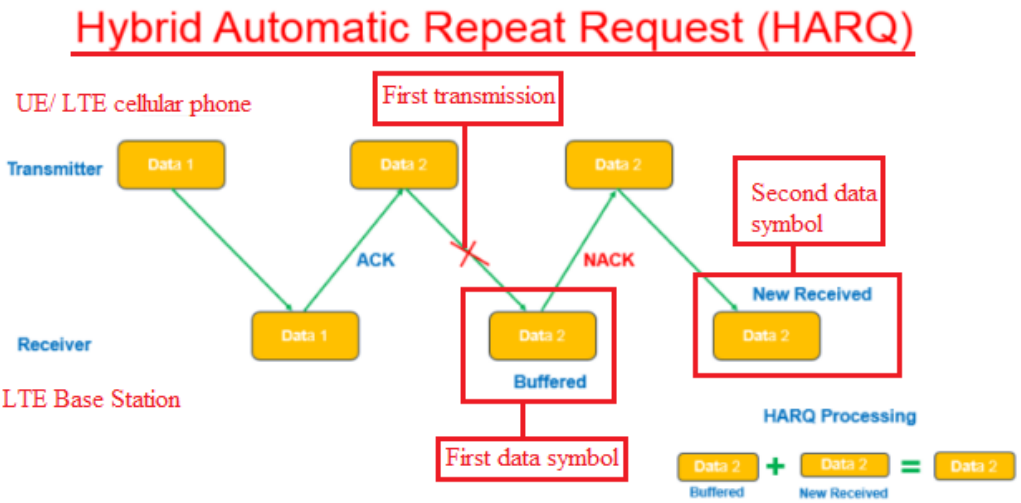
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

specific reference signals within the considered measurement frequency bandwidth. For RSRP determination the cell-specific reference signals R_0 and if available R_1 according to [8] can be used.

If receiver diversity is in use by the UE, the reported value shall be equivalent to the linear average of the power values of all diversity branches.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

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5.2 Overview of L1 functions

The physical layer offers data transport services to higher layers. The access to these services is through the use of a transport channel via the MAC sub-layer. The physical layer is expected to perform the following functions in order to provide the data transport service:

- Error detection on the transport channel and indication to higher layers
- FEC encoding/decoding of the transport channel
- Hybrid ARQ soft-combining
- Rate matching of the coded transport channel to physical channels
- Mapping of the coded transport channel onto physical channels
- Power weighting of physical channels
- Modulation and demodulation of physical channels
- Frequency and time synchronisation
- Radio characteristics measurements and indication to higher layers
- Multiple Input Multiple Output (MIMO) antenna processing
- Transmit Diversity (TX diversity)
- Beamforming
- RF processing. (Note: RF processing aspects are specified in the TS 36.100)

L1 functions are modelled for each transport channel in subclauses 6.1 and 6.2.

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

37. Upon information and belief, the Accused Instrumentality performs the step of receiving at the transmitter the repeat request issued by the receiver to retransmit the data packets in case the data packets of the first transmission have not been successfully decoded. For example, the Accused Instrumentality, at least in its internal testing and usage, receives a repeat request (*e.g.*, an HARQ retransmission request in the form of a NAK) issued by the receiver to retransmit the data packets in case the data packets of the first transmission have not been successfully decoded (*e.g.*, there was an error indication in the data received).

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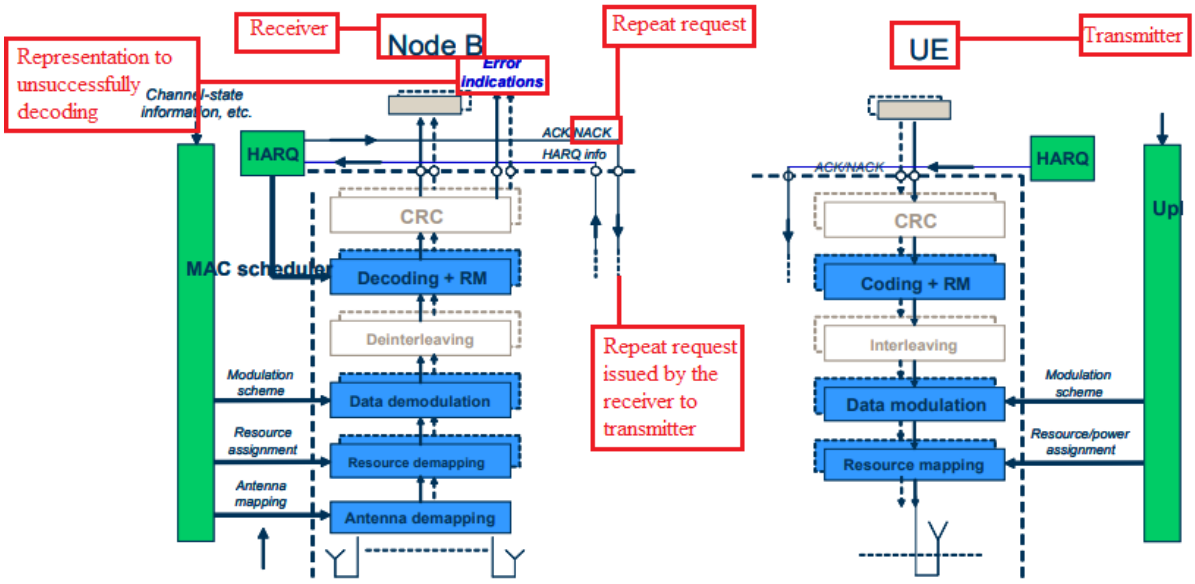

Figure 6.1.1-1: Physical-layer model for UL-SCH transmission

(*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

Hybrid Automatic Repeat Request (HARQ) in LTE FDD

October 18, 2018 admin Future Network Optimization, LTE, RF Basics, Tech Fundas

HARQ stands for Hybrid Automatic Repeat Request. **HARQ** = **ARQ** + **FEC** (Forward Error Correction)/Soft Combining.

ARQ refers to Automatic Repeat Request i.e. if sender doesn't receive Acknowledgement (ACK) before timeout, the receiver discards the bad packet and sender shall re-transmits the packet. ARQ procedure is illustrated below :

(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

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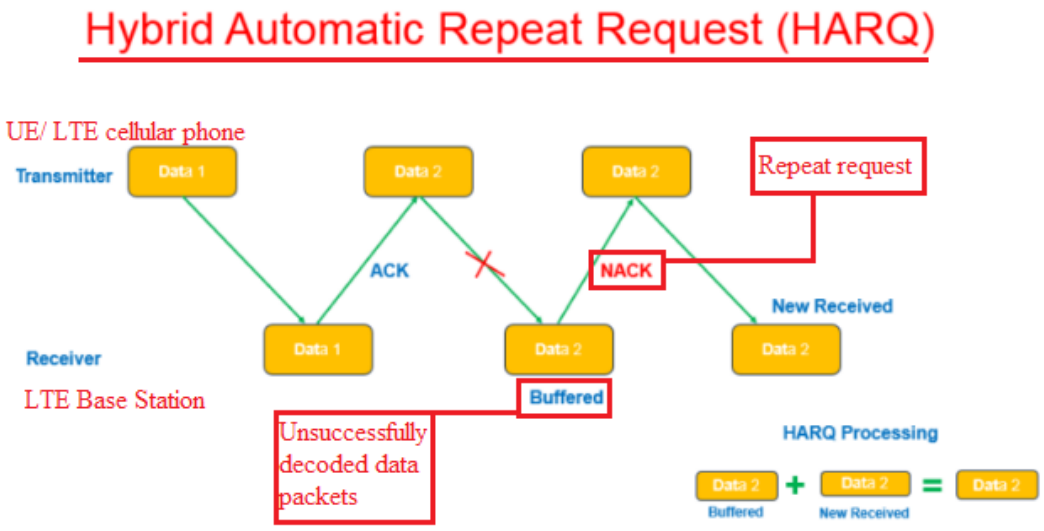
Soft Combining is an error correction technique in which the bad packets are not discarded but stored in a buffer. The basic idea is that 2 or more packets received with insufficient information can be combined together in such a way that total signal can be decoded. HARQ procedure is as follows



(*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

38. Upon information and belief, the Accused Instrumentality performs the step of modulating, in response to the received repeat request, said data packets at the transmitter using a second mapping of a higher order modulation scheme to obtain second data symbols. For example, the Accused Instrumentality, at least in its internal testing and usage, upon receiving a retransmission request in the form of a NAK, enables a second mapping of a higher order modulation scheme (*i.e.*, an adaptive re-transmission having a different Modulation Coding Scheme (MCS) than the one used for transmission, *i.e.*, first higher order modulation scheme). (*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/; https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf; https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php;

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https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

39. Upon information and belief, the Accused Instrumentality performs the step of performing, in response to the received repeat request, the second transmission by transmitting the second data symbols over a second diversity branch to the receiver. For example, the Accused Instrumentality, at least in its internal testing and usage, in response to a retransmission request in the form of a NAK, transmits second data symbols over a second or later diversity branch using multi-antenna processing which maps from assigned resource blocks to the later available number of antenna ports. (*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/; https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf).

40. Upon information and belief, the Accused Instrumentality performs the step of demodulating the received first and second data symbols at the receiver using the first and second mappings respectively. For example, the Accused Instrumentality, at least in its internal testing and usage, uses a base station which practices demodulation of first data symbols (*e.g.*, output of modulation block performing said first modulation scheme) and second data symbols (*e.g.*, output of modulation block using a second modulation scheme) at the LTE base station using the first and second modulation scheme, *i.e.*, Modulation Coding Scheme (MCS) which are distinct for transmission and Adaptive Re-transmission (*i.e.*, an Adaptive Re-transmission having a different MCS than the one used for transmission, *i.e.*, first higher order modulation scheme). (*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/; https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/

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ts_136302v080000p.pdf;
https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php;
https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

41. Upon information and belief, the Accused Instrumentality performs the step of diversity combining the demodulated data received over the first and second diversity branches. For example, the Accused Instrumentality, at least in its internal testing and usage, uses a base station which performs a diversity combining, *i.e.*, Hybrid ARQ soft-combining of data from multiple received antenna ports. (*E.g.*, https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf; http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/).

42. Upon information and belief, the Accused Instrumentality performs the step using first and second mapping of said higher order modulation schemes that are pre-stored in a memory table. For example, the Accused Instrumentality, at least in its internal testing and usage, uses higher order modulation schemes (*e.g.*, 16QAM and 64 QAM) that are pre-stored in a memory table such as those schemes used by a MAC scheduler. (*E.g.*, http://www.techplayon.com/hybrid-automatic-repeat-request-harq-in-lte-fdd/;
https://www.etsi.org/deliver/etsi_ts/136300_136399/136302/08.00.00_60/ts_136302v080000p.pdf;
https://www.electronics-notes.com/articles/radio/modulation/quadrature-amplitude-modulation-types-8qam-16qam-32qam-64qam-128qam-256qam.php;

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https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.07.00_60/ts_136211v080700p.pdf).

43. Plaintiff has been damaged as a result of Defendant's infringing conduct. Defendant is thus liable to Plaintiff for damages in an amount that adequately compensates Plaintiff for such Defendant's infringement of the '961 patent and '622 patent, *i.e.*, in an amount that by law cannot be less than would constitute a reasonable royalty for the use of the patented technology, together with interest and costs as fixed by this Court under 35 U.S.C. § 284.

44. On information and belief, Defendant has had at least constructive notice of the '961 patent and '622 patent by operation of law and marking requirements have been complied with.

JURY DEMAND

Plaintiff, under Rule 38 of the Federal Rules of Civil Procedure, requests a trial by jury of any issues so triable by right.

VI. PRAYER FOR RELIEF

WHEREFORE, Plaintiff respectfully requests that the Court find in its favor and against Defendant, and that the Court grant Plaintiff the following relief:

a. Judgment that one or more claims of United States Patent Nos. 7,154,961 and 7,567,622 have been infringed, either literally and/or under the doctrine of equivalents, by Defendant;

b. Judgment that Defendant account for and pay to Plaintiff all damages to and costs incurred by Plaintiff because of Defendant's infringing activities and other conduct complained of herein;

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c. That Plaintiff be granted pre-judgment and post-judgment interest on the damages caused by Defendant's infringing activities and other conduct complained of herein;

d. That Plaintiff be granted such other and further relief as the Court may deem just and proper under the circumstances.

August 30, 2021

By *s/ Philip P. Mann*

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