



**Universal Mobile Telecommunications System (UMTS);  
LTE;  
User Equipment (UE)  
application layer data throughput performance  
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# Foreword

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---

# 1 Scope

The present document contains the findings of the Study Item on UE Application Layer Data Throughput Performance and the proposed test procedures.

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## 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 36.521-1: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification Radio transmission and reception Part 1: Conformance Testing".
- [3] 3GPP TS 34.121-1: "User Equipment (UE) conformance specification; Radio transmission and reception (FDD); Part 1: Conformance specification".
- [4] 3GPP TS 34.122: "Terminal conformance specification; Radio transmission and reception (TDD)".
- [5] 3GPP TS 34.123-1: "User Equipment (UE) conformance specification; Part 1: Protocol conformance specification".
- [6] 3GPP TS 25.214: "Physical layer procedures (FDD)".
- [7] 3GPP TS 25.224: "Physical Layer Procedures (TDD)".
- [8] 3GPP TS 33.401: "3GPP System Architecture Evolution (SAE): Security architecture".
- [9] 3GPP TS 36.211: "Physical Channels and Modulation".
- [10] 3GPP TS 36.213: "E-UTRA Physical layer procedures".
- [11] 3GPP TS 36.508: "Common test environments for User Equipment (UE)".
- [12] 3GPP TS 25.101: "UE Radio transmission and reception (FDD)".
- [13] 3GPP TS 36.101: "E-UTRA UE radio transmission and reception".
- [14] 3GPP TS 34.108: "Common Test Environments for User Equipment (UE) Conformance Testing".
- [15] L. J. Greenstein, V. Erceg, Y. S. Yeh, and M. V. Clark, "A new path-gain/delay-spread propagation model for digital cellular channels", IEEE Trans. on Vehicular Technology, Vol. 46, No. 2, May 1997, pp. 477-485.
- [16] 3GPP TS 36.306: "E-UTRA User Equipment (UE) radio access capabilities".
- [17] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**Channel bandwidth:** The RF bandwidth supporting a single E-UTRA RF carrier with the transmission bandwidth configured in the uplink or downlink of a cell. The channel bandwidth is measured in MHz and is used as a reference for transmitter and receiver RF requirements.

### 3.2 Symbols

For the purposes of the present document, the following symbols apply:

$\hat{E}_s$	The received energy per RE of the wanted signal during the useful part of the symbol, i.e. excluding the cyclic prefix, averaged across the allocated RB(s) (average power within the allocated RB(s), divided by the number of RE within this allocation, and normalized to the subcarrier spacing) at the UE antenna connector
$I_{MCS}$	Modulation Coding Scheme Index
$\hat{I}_{or} \text{ (LTE)}$	The total transmitted power spectral density of the own-cell downlink signal (power averaged over the useful part of the symbols within the transmission bandwidth configuration, divided by the total number of RE for this configuration and normalised to the subcarrier spacing) at the UE antenna connector.
$\hat{I}_{or} \text{ (HSPA)}$	The received power spectral density (integrated in a bandwidth of $(1+\alpha)$ times the chip rate and normalized to the chip rate) of the downlink signal as measured at the UE antenna connector.
$N_{oc}$	The power spectral density of a white noise source (average power per RE normalised to the subcarrier spacing), simulating interference from cells that are not defined in a test procedure, as measured at the UE antenna connector
$N_{Offs-DL}$	Offset used for calculating downlink EARFCN
$N_{Offs-UL}$	Offset used for calculating uplink EARFCN
$N_{PRB}$	Total number of allocated PRBs

### 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

ACK	Acknowledgement
AES	Advanced Encryption Standard
AWGN	Additive White Gaussian Noise
BDP	Bandwidth Delay Product
BLER	Block Error Rate
BS	Base Station
CAT	Category
CDF	Cumulative Distribution Function
C/I	Carrier-to-Interference Power Ratio
CP	Cyclic Prefix
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
C_RNTI	Cell RNTI
DCH	Dedicated Channel
DCCH	Dedicated Control Channel
DL	Downlink

DRB	Data Radio Bearer
DRX	Discontinuous Reception
DTX	Discontinuous Transmission
EPS	Evolved Packet System
ETU	Extended Typical Urban
E-UTRA	Evolved UMTS Terrestrial Radio Access
EVA	Extended Vehicular A
EVM	Error Vector Magnitude
FDD	Frequency Division Duplex
FFS	For Further Study
FTP	File Transfer Protocol
G	Geometry Factor
GCF	Global Certification Forum
GSM	Global System for Mobile Communications
HARQ	Hybrid ARQ
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
HS-DPCCH	High Speed-Dedicated Physical Control Channel
HS-PDSCH	High Speed-Physical Downlink Shared Channel
HS-SCCH	High Speed-Shared Control Channel
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
IPv4	Internet Protocol, version 4
IPv6	Internet Protocol, version 6
ISD	Inter Site Distance
kbps	Kilobits per second
LNA	Low Noise Amplifier
LTE	Long Term Evolution (common expression, in other 3GPP specifications defined as EUTRA and EPC)
MAC	Medium Access Control
Mbps	Megabits per second
MCS	Modulation and Coding Scheme
MIMO	Multiple Input Multiple Output
MTU	Maximum Transmission Unit
NACK	Negative Acknowledgement
NIC	Network Interface Connection
OFDM	Orthogonal Frequency Division Multiplexing
PA	Pedestrian A (Fading model, depending on context)
PB	Pedestrian B
PDCP	Packet Data Convergence Protocol
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PDU	Protocol Data Unit
PHY	Physical layer
QAM	Quadrature Amplitude Modulation
QCI	QoS Class Identifier
QPSK	Quadrature Phase Shift Keying
RAB	Radio Access Bearer
RB	Resource Block
RF	Radio Frequency
RLC	Radio Link Control
RNTI	Radio Network Temporary Identity
RRC	Radio Resource Control
RTP	Real-Time Transport Protocol
RTT	Round Trip Time
SFTP	SecureFile Transfer Protocol
SIMO	Single Input Multiple Output
SNR	Signal-to-Noise Ratio
SS	System Simulator
TBS	Transport Block Size
TCP	Transmission Control Protocol

TDD	Time Division Duplex
TFT	Traffic Flow Template
TFTP	Trivial File Transfer Protocol
TM	Transparent Mode
TTI	Transmission Time Interval
UDP	User Datagram Protocol
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network
USB	Universal Serial Bus
VA	Vehicular-A
VoIP	Voice over IP

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## 4 Background

The currently-used HSPA and the newly-deployed LTE radio access technologies are providing a very large increase in data transmission capacity in mobile networks. This is being matched and even exceeded by a corresponding increase in the demand for data from users of the latest data-hungry devices and applications.

It is therefore essential that data devices achieve high efficiency when using data services and do not unduly load the network regardless of the maximum data rate that they are capable of achieving.

The GCF has indicated that they wish to add UE Application-Layer Data Throughput Measurements under various simulated network conditions to their Performance Items area of activity and has requested RAN5 to recommend and produce the necessary test procedures. It is also noted that the PTCRB, TCG might additionally be able to take advantage of the results of such work in 3GPP.

### 4.1 Study Item Objective

The objective of this Study Item is to define test procedures to measure UE data throughput performance at the application-layer, with no qualification of the results (i.e. no verdicts such as "pass/fail", "good", "medium", "bad" will be supplied).

The test procedures developed will measure the achieved average application-layer data rates (e.g. using FTP or UDP) of the UE standalone or/and in combination with a laptop under simulated realistic network scheduling and radio conditions in a repeatable lab-based environment (i.e. using lab-based simulators and other necessary equipment).

**Note:** The point of measurement on the UE side will be either in a connected PC for terminals that support tethered mode only, or inside the UE in case of a terminal that does not support tethered mode, or in both places for UEs that support both modes.

The test procedures will be developed in a flexible manner to accommodate various test conditions. The exact simulated network scheduling and down link radio conditions to be used will be determined during the study. It is envisaged that in addition to some measurements under "ideal conditions", an initial set of suitable scheduling/radio conditions to be used by the test systems, will be defined to simulate typical network conditions. Additional optional conditions may be developed later as and when required.

The study will aim to reuse wherever possible conditions already specified by RAN4 (e.g. radio conditions) and test procedures used in current conformance testing by RAN5. Although utilising existing test procedures without any modification is unlikely, adaptation of existing test cases may well be possible. The study should determine the best candidates.

**Note:** Test cases for example in clause 8 of TS 36.521-1 [2] could possibly be adapted for the study and test procedures could be based on the existing single antenna port, transmit diversity, and open and closed loop spatial multiplexing test cases.

The study will determine suitable test procedures for downlink data transfers, uplink data transfers and bidirectional data transfers.

The study will determine the Applications and the related Application requirements (e.g. FTP, UDP, quality of service, TCP settings, etc.) to be used.

GCF has stated that the Radio connection should be limited to LTE and W-CDMA Rel-5 (HSDPA) and later and the study will only consider these.

Other issues that the Study Item may investigate include:

- The definition of a reliable and repeatable test environment to ensure the best possible repeatability of the results. This could include the definition of a reference laptop configuration, applications in the UE or/and the Laptop that would measure the throughput, etc.
- The impact from the lower layers data throughput on the application-layer data throughput, especially when variable radio conditions are applied.

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## 5 Study of UE Application Layer Data Throughput Performance

### 5.1 Definition of UE Application Layer Data Throughput Performance

#### 5.1.1 Definition of End Points

For tethered connections, the UE is tethered to a laptop using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers as recommended by the UE manufacturer for the intended use by the customer/user. In most cases, a laptop with an embedded modem is considered to be a tethered data configuration as opposed to an embedded data configuration due to the UE to PC interface.

For tethered connections, the end points are the application running on the PC connected to the UE and a corresponding Data Server that is adjacent to the simulated lab-based Core Network. In this case, the PC drivers (typically USB) will also play a role in the UE Application Layer Data Throughput performance.

For non-tethered connections as in the case of embedded applications or applications running on the UE itself, the end points are the application running on the UE and a corresponding Data Server that is adjacent to the simulated lab-based Core Network.

#### 5.1.2 Definition of UE Application Layer Data Throughput

The measured UE Application Layer Throughput,  $T$ , is defined as the number of useful user data bits per unit of time delivered by the network from the source end point to the destination end point, excluding protocol overhead (TCP header, UDP header, etc.) and retransmitted data packets. The end points are defined in clause 5.1.1.

### 5.2 Parameters for Measurement

#### 5.2.1 Throughput

The UE Application Layer Data Throughput as defined in clause 5.1.2 shall be a parameter for measurement. The parameter would apply for any chosen application. The throughput can be measured in each direction (downlink and uplink).



## 5.3 Test Configurations

### 5.3.1 UE Application Layer Data Throughput Test Equipment

The test equipment utilized for UE Application Layer Data Throughput shall consist of the following items. Some of the elements below may be implemented in the same piece of test equipment depending on implementation.

- UE
- For tethered mode operation, Laptop/PC and appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers and any associated cabling as recommended by the UE manufacturer for the intended use by the customer/user
- Data client test application for the PC for tethered mode operation
- Data client test application(s) for the UE for embedded mode operation
- System Simulator(s) suitable for the radio technology(s) used for testing with necessary IP connectivity
- Application Servers
- Faders and AWGN Sources capable of supporting the radio environments defined

### 5.3.2 UE Application Layer Data Throughput Connection Diagrams

#### 5.3.2.1 UE Application Layer Data Throughput Connection Diagram for Tethered

The UE Application Layer Data Throughput connection diagram for tethered operation is shown in Figure C.2.1-1.

#### 5.3.2.2 UE Application Layer Data Throughput Connection Diagram for Embedded

The UE Application Layer Data Throughput connection diagram for embedded operation is shown in Figure C.2.2-1.

### 5.3.3 RF Connection Diagrams for UE Application Layer Data Throughput

The RF connections between the SS and the UE shall be in compliance with the associated RF connection diagrams specified in the test procedure clauses in Annex A. As the RF connection diagrams vary based on device type and UE category, it is preferable to reference appropriate RF connection diagrams for similar test configurations in the core test specifications. The RF connection diagrams are to be based on the representative RF connection diagrams referenced in 36.521-1 [2], 34.121-1 [3], or 34.122 [4].

### 5.3.4 UE Specific Items

There are no UE specific items identified at this time that are required to support the UE Application Layer Data Throughput testing herein.

### 5.3.5 Reference Laptop

The reference laptop should be used in the tethered connections as defined in sub-clause 5.1.1. It is necessary to specify drivers and electronic characteristics of hardware interface (typically power and ground noise) in the UE Application Layer Data Throughput performance. The physical interface towards the UE may be for example a standard USB interface. Other interfaces of proprietary or standardized type shall not be precluded. The laptop should be equipped with the appropriate processing power in order to support high data rates. The laptop should be "Stand Alone" and not embedded in any network, for example company network. The laptop configuration, including hardware and software is subject to change in order to follow the latest development in the market.

The laptop should not be equipped with SW that influences the data transfer. The laptop should be configured with standard modem driver or driver provided by the UE manufacturer.

## 5.4 Transport and Application Layer Protocols

### 5.4.1 Transport Layer Protocol

For the transport layer protocol, TCP and UDP are considered. It is proposed to test with both TCP and UDP as measurements utilizing each transport protocol are relevant.

The following items highlight the need for TCP transport.

- Most of the applications that need reliable data transfers use TCP as transport layer.
- The throughput is sensitive to the end-to-end delay.
- Good for testing FTP/HTTP in bi-directional tests in asymmetric data rate links because the downlink speeds are limited by uplink speeds. For FTP/HTTP data transfers in one direction, the TCP ACKs are transmitted in the other direction, therefore delay in receiving TCP ACK in one direction negatively impacts FTP/HTTP throughput in the other direction.

The following items highlight the need for UDP transport.

- The performance of UDP based data transfer, unlike TCP based transfer, is Operating System agnostic
- Real-Time Transport Protocols used by most of Multi Media Applications are based on UDP protocol.
- UDP Data Transfer in one direction (uplink/downlink) is not dependent on the other direction characteristics, unlike with TCP.

### 5.4.2 Application Layer Protocol

The following items have been considered for appropriate application layer protocols that utilize TCP as a transport protocol.

- FTP
- TFTP
- SFTP
- HTTP
- VoIP (RTP-based)

To reduce the amount of testing, it is proposed to use FTP only. FTP (File Transfer Protocol) runs on top of TCP/IP and is frequently used in applications where download/upload performance would be noticeable to the end user.

The following list identifies the reasons not to duplicate testing across the other application layer protocols.

- SFTP and HTTP both use TCP as a transport protocol. So it is redundant to use HTTP/SFTP protocols to test data throughput when FTP protocol is used.
- For test purposes, HTTP is typically used to benchmark the browser's rendering capabilities as a functional test. Download performance in terms of relative throughput is not as noticeable to the end user as it would be for file downloads.
- SFTP is process intensive and used to exercise the security engine within the UE.
- TFTP is typically used in embedded devices to update the firmware in a reliable way using a low footprint stack to avoid using the full TCP stack. TFTP is a request-response protocol and is not a candidate for performance analysis.
- VoIP (RTP-based) applications are diverse in nature and application compatibility is an issue for a standard set of UE Application Layer Data Throughput Performance test procedures.

For UDP, it is proposed to use raw data transfer as opposed to defining a streaming protocol to simplify the UDP transfer application requirements.

### 5.4.2.1 FTP Settings

It is recommended that the FTP server used for testing meet the following requirements:

- The TCP send/receive buffer sizes at the FTP server should be set to values sufficiently large to ensure they do not limit the maximum throughput achievable at the UE
- The tx queue length should be set to a value sufficiently large value to ensure flow control between the network interface (ppp) and TCP is not triggered

It is recommended that the FTP application used on the tethered PC for tethered testing meet the following requirements:

- The tethered FTP application should allow the user to transfer files of any format supported by the tethered PC, in binary mode, in both the Downlink and the Uplink
- The tethered FTP application should provide the means to compute the throughput T as defined in subclause 5.1.2 at the end of each file transfer
- The tethered FTP application should provide an interface allowing automation of testing
- The tethered FTP application should not implement hidden optimizations that might impact the throughput

An example of an FTP application meeting these requirements is the Windows FTP command line application. This example is cited for information only and does not in any way preclude the use of other applications meeting the recommended requirements.

For embedded testing, the FTP client will reside in the UE under test. This will require an FTP application to be installed on the UE. It is recommended that this application meet the following requirements:

- The embedded FTP application should allow the user to transfer files of formats supported by the UE, in binary mode, both in the Downlink and the Uplink.
- The embedded FTP application should provide the means to compute the throughput T as defined in subclause 5.1.2 at the end of each file transfer.
- The embedded FTP application should provide an interface allowing automation of testing. If an interface for automation of testing is implemented, it is recommended to use the embedded data client automation recommendations in Annex E.
- The embedded FTP application should not implement hidden optimizations that might impact the throughput.

The following settings are to be used.

- The TCPWindowSize is derived based on the bandwidth-delay product (BDP) for the particular radio access bearer used in the test. Refer to clause 5.4.2.1.1 for guidance concerning the TCP advertised receiver window size setting.
- The TCPWindowSize is adjusted to near even-multiple of TCP MTU. The Windows Scaling is enabled for all FTP transfers.
- The socket buffer sizes are set to even-multiples of TCP MTU in use and set to values equal or greater than the BDP.
- The TCP MTU size is set to a value comprised between 1280 and 1500 bytes as recommended by the manufacturer.
- The FTP transfers are always carried out in Binary mode.
- The contents of the files to be transferred over FTP are chosen in such a way that they are statistically random, with least compressibility.
- No application level compression protocols are used to compress the FTP files.
- Either IPv4 or IPv6 can be used, but only results obtained with the same IP address type can be compared, since the IP address type will affect the measured throughput.

#### 5.4.2.1.1 TCP advertised receiver window size setting

In order to achieve maximum throughput during FTP testing, the TCP advertised receiver window size must be equal to or greater than the BDP (Bandwidth Delay Product), which can be expressed as follows:

$$\text{BDP} = \text{TCP data rate} * \text{RTT}$$

Where:

TCP data rate is the portion of the radio bearer used to send TCP data

RTT is the unloaded Round Trip Time between TCP end-points (FTP server and tethered laptop/embedded FTP app) as seen by the TCP sender.

Note that the TCP data rate and the RTT may be different for different test procedures.

#### 5.4.2.2 UDP Settings

It is recommended that the UDP server used for testing meet the following requirements:

- UDP blast duration shall be selected to meet the minimum test times using a sufficient rate to prevent physical layer DTX based upon the UE Category.

It is recommended that the UDP application used on the tethered PC for tethered testing meet the following requirements:

- The tethered UDP application should allow the user to transfer files of any format supported by the tethered PC, in binary mode, in both the Downlink and the Uplink.
- The tethered UDP application should provide the means to compute the throughput T as defined in subclause 5.1.2.
- The tethered UDP application should provide an interface allowing automation of testing.
- The tethered UDP application should not implement hidden optimizations that might impact the throughput.

For embedded testing, the UDP client will reside in the UE under test. This will require an UDP application to be installed on the UE. It is recommended that this application meet the following requirements:

- The embedded UDP application should allow the user to transfer files of formats supported by the UE, in binary mode, both in the Downlink and the Uplink.
- The embedded UDP application should provide the means to compute the throughput T as defined in subclause 5.1.2.
- The embedded UDP application should provide an interface allowing automation of testing. If an interface for automation of testing is implemented, it is recommended to use the embedded data client automation recommendations in Annex E.
- The embedded UDP application should not implement hidden optimizations that might impact the throughput.

The following settings are to be used.

- The UDP MTU size is set to a value comprised between 1280 and 1500 bytes as recommended by the manufacturer.
- The UDP transfers are always carried out in Binary mode.
- The contents of the files to be transferred over UDP are chosen in such a way that they are statistically random, with least compressibility.
- No application level compression protocols are used to compress the UDP files..
- Either IPv4 or IPv6 can be used, but only results obtained with the same IP address type can be compared, since the IP address type will affect the measured throughput.

## 5.5 Test Environment

**Editor's Note:** As per RAN4 recommendations, Recommendation #4 as stated in response LS R4-122042, RAN 5 is investigating the possibility to add multicell scenario's in to the TR.

### 5.5.1 Signal Levels

The signal levels chosen for test should either be representative of field conditions or appropriate for the test purpose of the particular test procedure defined.

In order to optimize test time and to focus on the appropriate set of signal levels for test, it is proposed to leverage the signal levels for test associated with the associated performance test cases in 34.121-1 [3], 34.122 [4], and 36.521-1 [2] or to limit the number of signal levels for the majority of the downlink performance tests to a representative range. For test cases that would require specific geometries to be set, this approach is reasonable and allows as much re-use of existing test setups as possible.

However, one aspect of a receiver's performance that is not typically addressed in the conformance testing is the ability of the receiver to perform well across a range of signal levels in a relatively low-noise environment where the UE noise floor may be the dominant factor in determining SNR. The end user would expect the UE Application Layer Data Throughput to increase as the signal level is increased in relation to the UE noise floor or to achieve relatively consistent UE Application Layer Data Throughput if located in a sufficient signal strength area such that the throughput has reached a maximum. However, it has been shown across different radio designs that the data performance can vary significantly due to LNA switch points which may impact the perceived SNR to the modem and thus impacting the end user perception of throughput performance even in a strong signal environment. Therefore, it is proposed to use a power sweep test to characterize the UE performance within a limited range of power levels. Also, in order to exercise the hysteresis associated with the LNA switch points under realistic RF conditions, it is proposed to make use of a vehicular fading profile from 34.121-1 [3], 34.122 [4], and 36.521-1 [2].

By addressing the power sweep test in the UE Application Layer Data Throughput performance testing, one achieves the ability to evaluate the impact of this receiver aspect and its impact at the user level without impacting the industry conformance test cases. For LTE, typical transmission modes that would be used in operation based on the downlink signal level presented to the UE should also be considered.

### 5.5.2 Fading Profiles

The request from the GCF Steering Group was to measure the average UE Application Layer Data Throughput using simulated realistic radio conditions. In order to support this requirement, it is proposed to consider the following fading profiles to maintain consistency with 3GPP defined fading profiles that have been developed to assess a UE's capability of performing in various multi-path environments. Also, a static propagation condition should be considered for any uplink testing and any downlink performance testing where the test purpose does not specifically require fading (e.g. maximum throughput testing, stress testing where the focus is on processor utilization aspects, etc.).

For HSPA, the following defined 3GPP profiles have been considered depending on the particular test procedure.

- Static
- PB3
- PA3
- VA3
- VA30
- VA120

For LTE, the following defined 3GPP profiles have been considered depending on the particular test procedure.

- Static
- EPA5
- EVA5

- EVA70
- EVA200
- ETU70
- ETU300
- HST

See clause 5.5.4.5 for the conclusion of selected fading profiles to be used for UE application layer data throughput measurements.

### 5.5.3 Noise and Interference Levels

In order to assess the end user perception of UE Application Layer Data Throughput, it is desirable to vary  $I_{or}/I_{oc}$  over a range of values that are representative of the majority of the conditions experienced by the end user. It is also desirable to utilize very high SNR cases for maximum data rate testing or for high order modulation testing. The range of values chosen should either match existing performance test cases in 3GPP or represent a reasonable number of discrete SNR values for test with the exception of any test procedure where the test purpose is to evaluate the throughput performance versus geometry. In this case, the step size for the SNR values should be chosen appropriately.

See clause 5.5.4.5 for the conclusion of selected noise and interference levels to be used for UE application layer data throughput measurements.

### 5.5.4 Selection of combinations of Fading Profiles and Noise and Interference Levels

#### 5.5.4.1 General

The objective of the study item is to define testing procedures to measure the UE data throughput at the application layer and give an assessment on the data-rate variation with various levels of fading and speed profiles. The throughput at a UE application level includes the combined performance of the

1. Radio link RF performance
2. Radio link protocol data processing performance (MAC, RLC, PDCP)
3. TCP/IP processing performance
4. Internet Application and driver process performance

The radio link performance is thoroughly tested in TS 34.121-1 [3] /TS 34.122[4]/ TS 36.521-1 [2] under various propagation conditions, but the higher layer performance is not. The selection of test points should thus be taken from the upper-layer perspective, while keeping the assessment of the actual data-rate variations of different implementations in mind. This is consistent with the justification of the study item

“The proposed Work Item will define test procedures to measure the data throughput under various network conditions that will provide absolute measured results as evidence that, even with an excellent radio connection or optimised equaliser, the net data rate is not reduced due to, for example, a non-optimised software architecture or sub-optimal components in the device. Furthermore unsuitable drivers connecting the Data device with a PC could have also a negative impact on the measured data throughput rate.”

that address finding evidence of bottlenecks in the protocol stack limiting the application layer throughput. This requires that the physical-layer test conditions are chosen so that relevant mechanisms of the higher-layers are triggered.

#### 5.5.4.2 Lower-layer (PHY) testing

The physical layer is thoroughly tested in TS 34.121-1 [3]/ TS 34.122 [4]/ TS 36.521-1 [2] and dominates the end-to-end performance as discussed in clause 5.8. In order to avoid duplication of tests, the aim should not be to go through all the existing tests and configurations.

In clause 5.8 it is proposed to consider application-layer performance tests measuring higher layer throughput in noise-free non fading single-path conditions suggesting such tests are the best in revealing higher layer UE bugs affecting throughput. The static and noise-free scenario is certainly one possible test condition, but in order to make sure the entire protocol stack is tested with regard to implementation errors and mismatch under transport block size variability and fast variations similar to what occurs in e.g. the field tests under live conditions, relevant fading scenarios that trigger these variations should also be included. This will not only complement the higher-layer tests in TS 34.123-1 [5] (UTRA) and TS 36.523-1 (E-UTRA) performed under ideal radio conditions, but also meet the objective of providing an assessment of the UE data-rate variations with various fading- and speed profiles.

#### 5.5.4.3 Higher-layer impact on application layer throughput

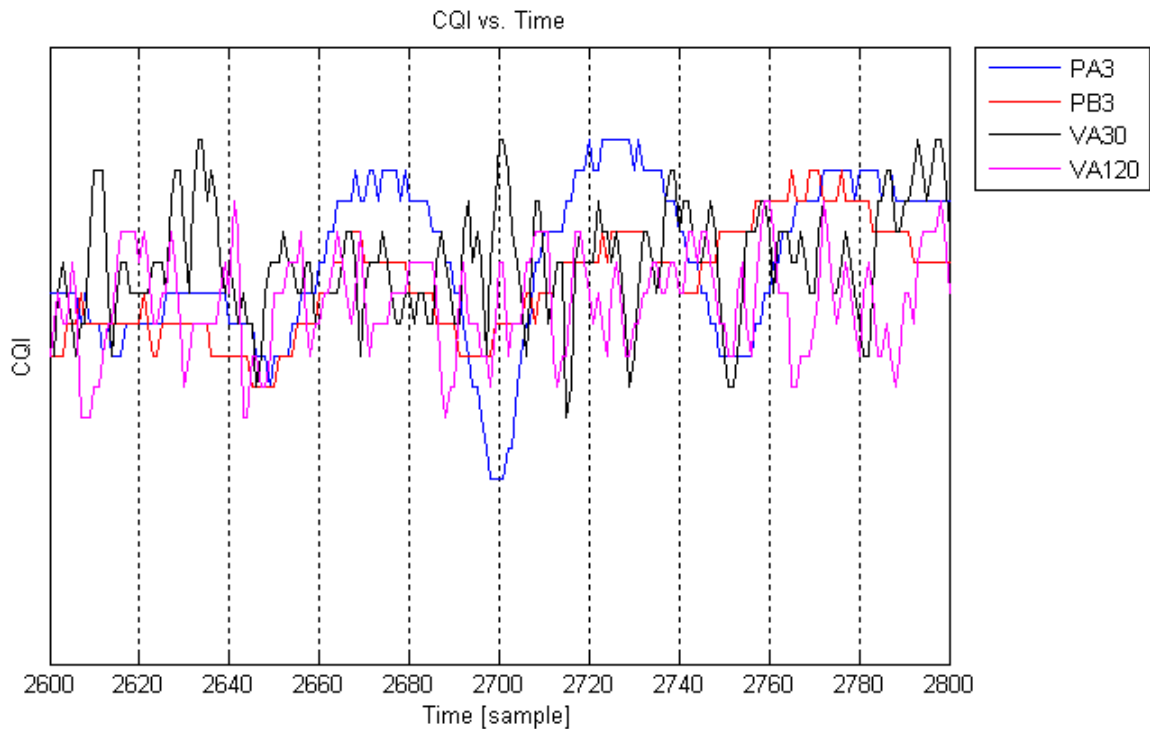
Table 5.5.4.3-1 shows the test aspects that should be considered in addition to the static and noise-free scenario for some selected HSPA and LTE scenarios to check that upper-layers do not constrain (often by errors or mismatch) the throughput under dynamic the channel conditions as experienced in field (drive) tests. The application and associated channel profiles and geometries are just examples.

The dynamic conditions can trigger undesired behaviours of the upper-layers not covered in the signalling tests, e.g. when RLC retransmissions occur or being caused.

**Table 5.5.4.3-1: Aspects covered for identifying high-layer performance**

Conditions	Test aspect
HSPA, Download UDP/FTP Throughput, follow-CQI, PA3, Geometry = 10dB	Big TBS variations
HSPA, Download UDP/FTP Throughput, follow-CQI, VA30, Geometry = 10dB	Fast variations
HSPA, Download UDP/FTP Throughput, follow-CQI, VA120, Geometry = 0dB	High BLER and fast variations
HSPA, Bi-Directional UDP/FTP Throughput, follow-CQI, Static, Geometry = 20 dB	Processing capability
HSPA Cat8, Bi-Directional FTP Throughput, AMR Multi RAB, follow-CQI, Static, Geometry = 20 dB	Processing capability
LTE, Download UDP/FTP Throughput, follow-CQI sub band reporting, EPA3, SNR = 20dB	Big TBS variations
LTE, Download UDP/FTP Throughput, follow-CQI sub band reporting ETU70, SNR = 0dB	Fast variations
LTE, Download UDP/FTP Throughput, follow-CQI wideband reporting, ETU300, SNR = 0dB	High BLER and fast variations
LTE, Download UDP/FTP Throughput, follow-CQI wideband reporting, Static, SNR = 20dB	Processing capability
LTE, Bi-Directional FTP Throughput, follow-CQI wideband reporting, Static, SNR = 20dB	Processing capability

Figure 5.5.4.3-1 shows the variation of the reported CQI (TBS) and the time-variability of some of the propagation conditions typically used in the radio-link test cases.



**Figure 5.5.4.3-1: TBS- and time variability for various propagation conditions.**

The PA channel gives rise to larger TBS variations than the more dispersive VA and PB channels. This is due to the wide-sense stationary uncorrelated channels used, in which the likelihood that the single dominant tap in the PA model experiences a fading dip is larger than the likelihood that the taps in the dispersive models will experience fading dips simultaneously. The SNR and wanted-signal variability tracked by the CSI reporting is therefore smaller for the latter channels.

Higher geometries will allow larger TBS and MCS variations and verification of the processing capabilities at good radio conditions. For lower geometries and high speed the BLER is typically high such as under the VA120 at 0 dB geometry.

To pick relevant propagation conditions, then scenarios that users typically experience and that also challenge the upper layers should be selected.

#### 5.5.4.4 Typical physical parameters for verifying higher-layer impact

The typical physical parameters should be chosen to trigger mechanisms in the higher layers whilst finding relevant conditions for assessment of UE performance beyond PASS/FAIL.

The empirical Greenstein model [15] has constituted the basis for many models including the 3GPP/3GPP2 spatial channel model described in TR 25.996. The path gain and delay spread follow [15] with the shadow correlated with the delay spread, and assuming uncorrelated shadowing between sites. The geometry ( $C/I$ ) is the ratio between the path gain from best site and sum of path gains from all other sites. 100 sites has been laid out at various ISD (inter-site distance) assuming an urban, sub-urban and rural scenario.

Figures 5.5.4.4-1 and 5.5.4.4-2 show the results for urban environment with ISD = 0.5 km and 3 km, respectively. The CDF curves display the cumulative distribution of the delay spread conditioned on a certain range of  $C/I$ .



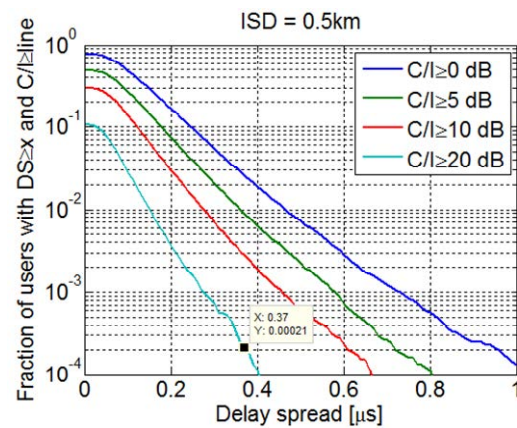
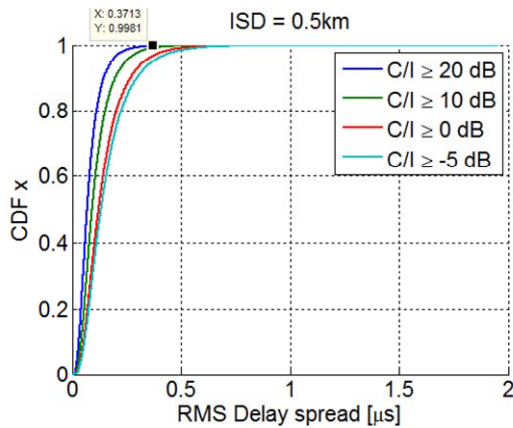


Figure 5.5.4.4-1: Urban environment with small microcells

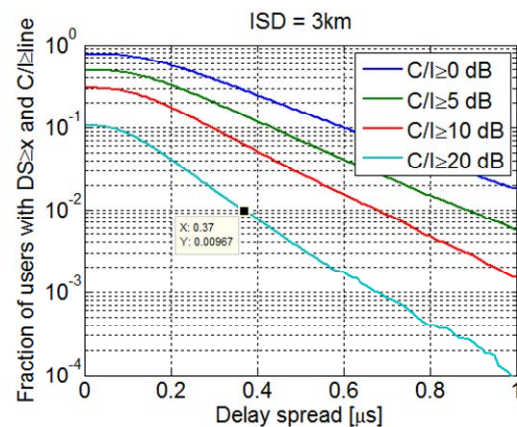
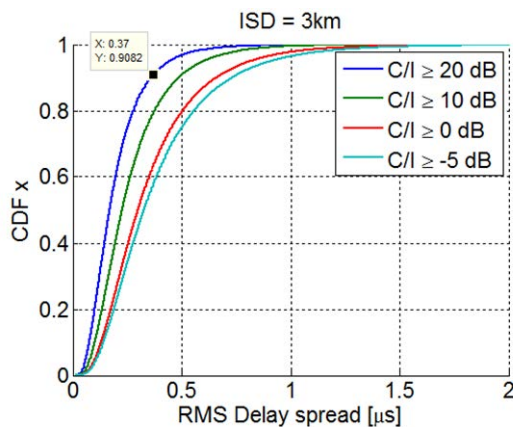
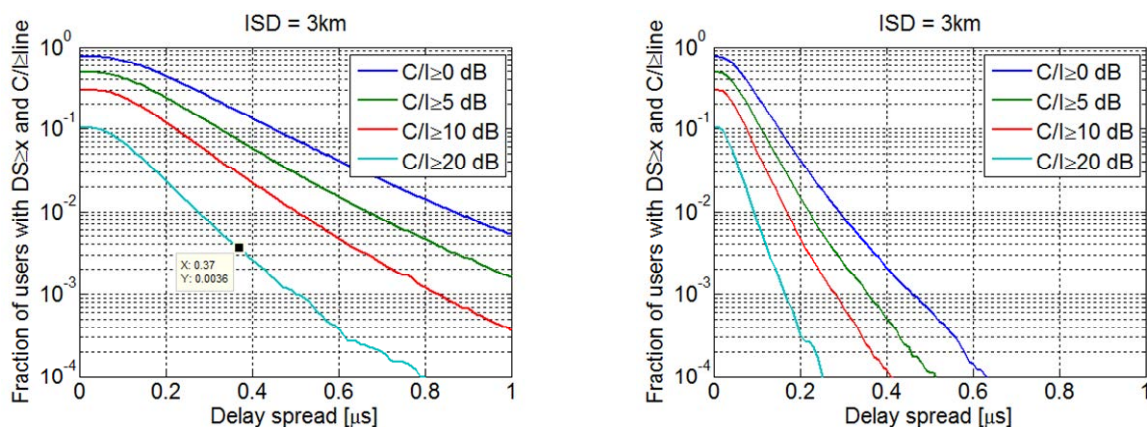


Figure 5.5.4.4-2: Urban environment with microcells

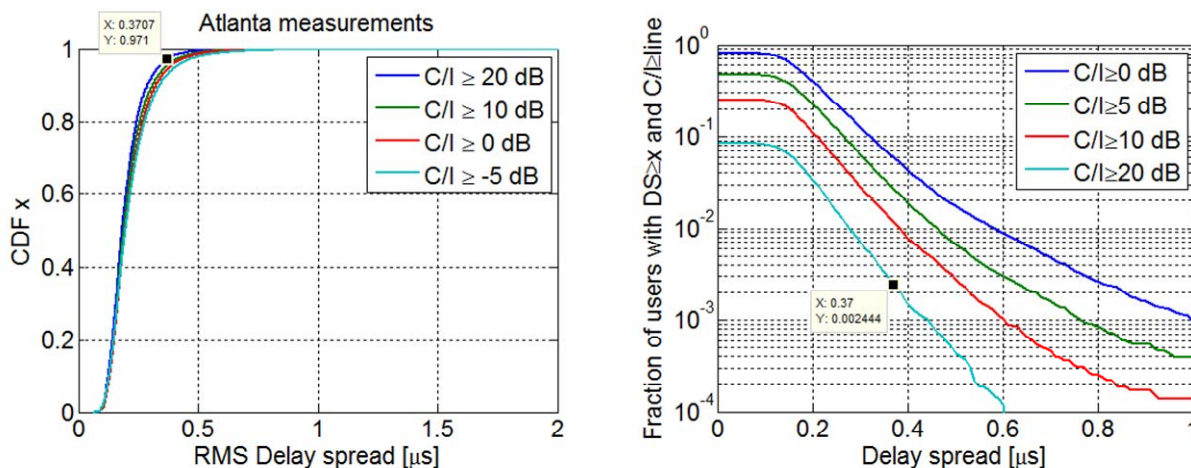
The delay spread of the Pedestrian A (PA), Pedestrian B (PB), Vehicular A (VA) and Typical Urban (TU) are  $0.05 \mu\text{s}$ ,  $0.75 \mu\text{s}$ ,  $0.37 \mu\text{s}$  and  $1 \mu\text{s}$ , respectively. The results in Figure 5.5.4.4-1 indicate that 0.02% of all users have a  $C/I > 20 \text{ dB}$  and a delay spread larger or equal to that of VA, while 0.2% has  $C/I > 10 \text{ dB}$  and a delay spread larger or equal to that of VA. The corresponding results for the larger microcells are 1% with  $C/I > 20 \text{ dB}$  and 8% with  $C/I > 10 \text{ dB}$ . It appears that the typical urban is not very typical (it was developed in early GSM days with very large cells), and we note that only 1% has  $C/I > 0 \text{ dB}$  and a more dispersive profile than PB.

The results from the sub-urban and rural scenarios are shown in Figure 5.5.4.4-3. It can be observed that 0.4% of all users have  $C/I > 20 \text{ dB}$  and a delay spread larger or equal to that of VA for the sub-urban, while 0.1% of all users in rural macro cells have  $C/I > 0 \text{ dB}$  and a delay spread of  $0.5 \mu\text{s}$  or larger.



**Figure 5.5.4.4-3: Fraction of users with a certain delay spread and geometry for sub-urban (left) and rural (right)**

The simulations have some weak points: BS antenna tilt has not been considered and the Greenstein model from 1994 may be slightly outdated considering more recent network deployments. However, a comparison with measured results taken in Atlanta, GA, reveals that there is good agreement between measurements and simulations. The measurements are car-based with a test terminal inside the vehicle, and with routes covering urban, suburban and highways. From Figure 5.5.4.4-4 we note that 0.2% of all locations have a C/I > 20 dB and a delay spread exceeding that of VA.



**Figure 5.5.4.4-4: Measured results from Atlanta, GA**

To sum up the results, it seems that the VA channel could cover the great majority of locations in field tests. For LTE the corresponding channel is EVA. The typical urban case (ETU for LTE) occurs infrequently in urban areas, less than 0.1% of measured locations with C/I > 0 dB have a delay spread exceeding that of the TU.

#### 5.5.4.5 Selection of test points

Based on the discussion in clauses 5.5.4.1 to 5.5.4.4 the channel profiles as listed in Table 5.5.4.5-1 for HSPA and Table 5.5.4.5-2 for LTE testing have been selected to challenge the higher layers, but also cover the vast majority of propagation scenarios experienced in field tests. The simulations and measurements as discussed in clause 5.5.4.4 indicate that the VA channel would cover most scenarios experienced in drive tests. The number of test cases should be reasonable as there is no need to repeat all the radio-link tests in TS 34.121-1 [3], TS 34.122[4] or TS 36.521-1 [2]. It is more important to cover the missing aspects. The aim has been to find a limited number of relevant propagation conditions (4-6) to achieve a reasonable test count, including the static condition.

**Table 5.5.4.5-1: Test Points for HSPA**

Propagation Condition	Geometry	Justification
Static	No interference Note 1	To check that upper-layers do not constrain data throughput
PA3	20dB	To exhibits large TBS variations (see clause 5.5.4.3) and very common scenarios for high-data rate requiring processing capability
VA30	10dB	Fast variations and VA occurs frequently in deployments
VA120	0dB	A high BLER scenario may trigger higher layer retransmissions, and also addresses the high speed scenario in the work item objective
PB3	0dB	Most common high-dispersion case
Note 1: In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.		

**Table 5.5.4.5-2: Test Points for LTE**

Propagation Condition	SNR	Justification
Static	No interference Note 1	To check that upper-layers do not constrain data throughput
EPA5	20dB	To exhibits large TBS variations (see clause 5.5.4.3) and very common scenarios for high-data rate requiring processing capability
EVA5	10dB	EVA occurs frequently in deployments
EVA70	20 dB	Adds EVA70, high SNR coverage which is common in low frequency(<1GHz) band networks
EVA200	20 dB	Covers high Doppler, high SNR scenario which is common in high frequency ( $\geq 1$ GHz)band networks
ETU70	0dB	Fast variations and most common high-dispersion case
ETU300	0dB	A high BLER scenario may trigger higher layer retransmissions, and also addresses the high speed scenario in the work item objective
Note 1: In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.		

## 5.5.5 Traffic Profiles

The request from the GCF Steering Group was to measure the average UE Application Layer Data Throughput using simulated realistic radio conditions. In order to support this requirement, it is proposed to consider QCI 9 to keep the UE Application Layer Data Throughput testing in-line with TS 36.508 and the QCI used for all of the 36.521-1 clause 8 test cases including the max sustained data rate test.

## 5.6 Data Transfer Scenarios

### 5.6.1 FTP Transfers

It is proposed to execute the following data transfer scenarios for FTP.

- Downlink Only
- Uplink Only
- Bi-Directional (concurrent and alternating based on test purpose)

### 5.6.2 UDP Transfers

It is proposed to execute the following data transfer scenarios for UDP.

- Downlink Only
- Uplink Only
- Bi-Directional (concurrent)

## 5.7 Statistical Analysis

### 5.7.1 Layer 1 Receiver and Performance Tests

When L1 throughput (payload bits/time) is measured during receiver and performance tests, one has to consider the question: In what range around  $T_{\text{measured}}$  is the true throughput,  $T_{\text{true}}$ ? The parameters in receiver and performance tests are better known and allow us to answer this question.

In L1 throughput tests, we have a fixed reference channel so the number of payload bits per block is constant. In a fixed reference channel, we know the maximum throughput.

If the throughput limit is defined as 70% of the maximum throughput, a UE near the limit receives 70% correct blocks of constant TBS (returns an ACK) and 30% corrupted or missed blocks (returns NACK or statDTX). If a process works within an incremental redundancy sequence, the samples are not independent. Nevertheless, the error events (corrupted or missed blocks) are mainly independent.

These facts allow one to derive statistics which tells us the variance of the true throughput around the measured one. These statistics are used to determine the minimum number of samples for a given confidence level for the pass/fail decision.

Another aspect that impacts minimum test time is fading. The minimum test time due to fading is long for slow speed propagation profiles and short for high speed ones. The longer minimum test time of the two aspects (statistical or fading) applies.

For UTRAN, each minimum test time is derived from the speed in the profile. The longest time is 164 seconds for the slow speed fading profiles.

For LTE the minimum test time is simulated for each test case, hence we have a large variety of minimum test times.

- Longest: 150 000 minimum number of active samples = 1500 seconds net test time
- Shortest: 1366 minimum number of active samples = 13.66 seconds net test time

Most of the layer 1 receiver and performance tests in UTRAN and LTE are governed by the test time due to fading.

### 5.7.2 Application Layer Data Throughput

During the application layer data throughput, we can also record ACK, NACK and stat DTX in order to calculate the L1 payload bit throughput, although this is not the main target of the application layer test. We can consider the same

question: In what range around  $T_{\text{measured}}$  is the true throughput,  $T_{\text{true}}$ ? However, the parameters for this measurement are not as controlled for us to answer the same question.

In contrast to fixed reference channel, the TBS variation is intended to be high and/or fast to exercise aspects of the UE that may impact application layer data throughput. This means that we have high variability in the range of payload bits per block. Therefore, the definition of a maximum throughput at the physical layer is not meaningful as the target throughput is not easily defined.

While throughput is composed of one ratio, (correct blocks) / (correct blocks + (corrupted or missed blocks)), the throughput can be achieved by different compositions of correctly received TBS's. Of course, L1 throughput is still of a statistical nature but the characteristic of the statistics are unknown to us. Hence it is not possible for us to derive a variance of true throughput around the measured throughput.

In contrast to layer 1 receiver and performance tests above, the measured throughput is the final result and not the pass/fail decision.

For fixed reference channel testing, the UE is compared against a predefined limit. Therefore, statistics can be derived to determine the minimum number of samples for a given confidence level for the pass/fail decision. In UE application layer throughput testing, it is desirable to compare the throughput against a variable throughput target or a reference UE. The confidence level in this context is more complex than for a predefined pass/fail limit. We are not necessarily able to calculate the confidence level.

The application layer data throughput is impacted by the L1 throughput. The L1 throughput is inaccessible for analytical statistics as shown above. It can also be expected that the application layer SDUs are not independent. Quite to the contrary, they are dependent in an unknown way. Hence the application layer throughput is inaccessible for statistics as well. Nevertheless, the application layer data throughput is of a statistical nature.

### 5.7.3 Minimum Test Time

Application layer throughput is of a statistical nature but the statistics are unknown to us.

Hence, we are not able to give a variance of the measured throughput around the true throughput which results in the following complementary statements.

- We are not able to give a confidence level of the measurement when given a predefined test time
- We are not able to calculate a minimum test time for a given confidence level.

Therefore, for HSPA, the recommendation for minimum test time is 164 seconds which is derived from lowest speed fading (crossing of 990 wavelengths when travelling with the speed given in the fading profile). This proved its worth during the past and seems meaningful and applicable for the other higher speeds. For static testing, 60 seconds is recommended.

For LTE, the recommended minimum test time for static testing is also set to 60s.

For fading cases, Annex G.3.5 of TS 36.521-1 [2] contains approximately 50 test times for throughput tests with different demodulation scenarios. These scenarios contain the fading profiles that have been proposed in clause 5.5.2 of this document.

The demodulation scenarios are characterised by certain parameters: BW, RB allocation, modulation and coding, antenna configuration. These parameters are similar but not entirely consistent for all of the UE application layer data throughput test conditions. Therefore, it is not possible to select specific test times from Annex G.3.5 of TS 36.521-1 [2] for the purpose of UE application layer data throughput testing. However, when deciding the minimum test times based on the parameters in this document, it is proposed to reuse, as far as possible, the minimum test times from Annex G.3.5 of TS 36.521-1 [2].

## 5.8 Impact of Modem Performance in Application Layer Throughput

The modem performance has a very big role in application layer data throughput performance when tests are performed in noisy conditions under multipath fading scenarios. The sub-clause 5.8.1 demonstrates how big differences there are in modem performance when measured from many different UEs in commercial conformance test systems. Then sub-

clause 5.8.2 discusses about modem performance in application layer throughput tests and gives some easy-to-understand reasons why modem performance also dominates in application layer throughput tests.

### 5.8.1 Modem Performance in current TS 34.121-1/TS 34.122 Conformance Tests

Section 9 of TS 34.121-1 [3] / TS 34.122 [4] contains a lot of HSDPA throughput test cases for different UE categories and for different UE performance types such as Type 0 (based on basic Rake receiver), Type 1 (based on Rx Diversity), Type 2 (Based on Equaliser), Type 3 (based on RxDiv + EQU) and Type 3i (based on Interference aware Type3 receiver). Each of these test cases includes a lot of test points where following parameters are being varied:

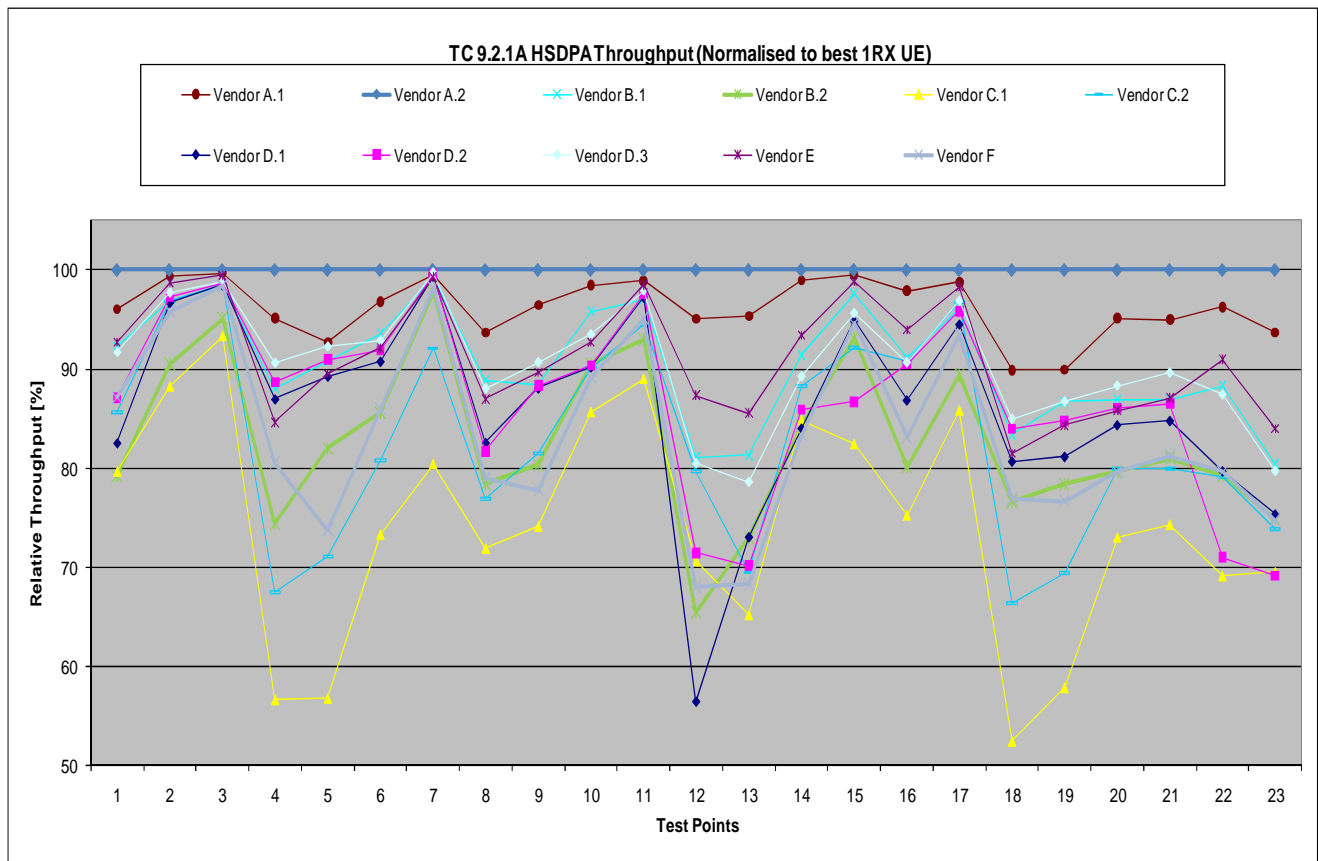
- Noise level (Low, Mid and High Geometry)
- Fading Type and UE speed (PA3, PB3, VA30, VA120)
- HSDPA power level (Low or High Power)
- Modulation type (QPSK, 16QAM, 64QAM)

Most of these section 9 test cases have been verified and validated in multiple commercially available conformance test platforms. For UE conformance purposes these validated test cases declare only PASS or FAIL but detailed test reports contain also the measured throughput results of each test points.

While conformance test cases verify that UE fulfils the 3GPP minimum requirements, the detailed test reports can be also used to evaluate how good modem performance UE has by evaluating how big margins each UE has to 3GPP minimum requirements.

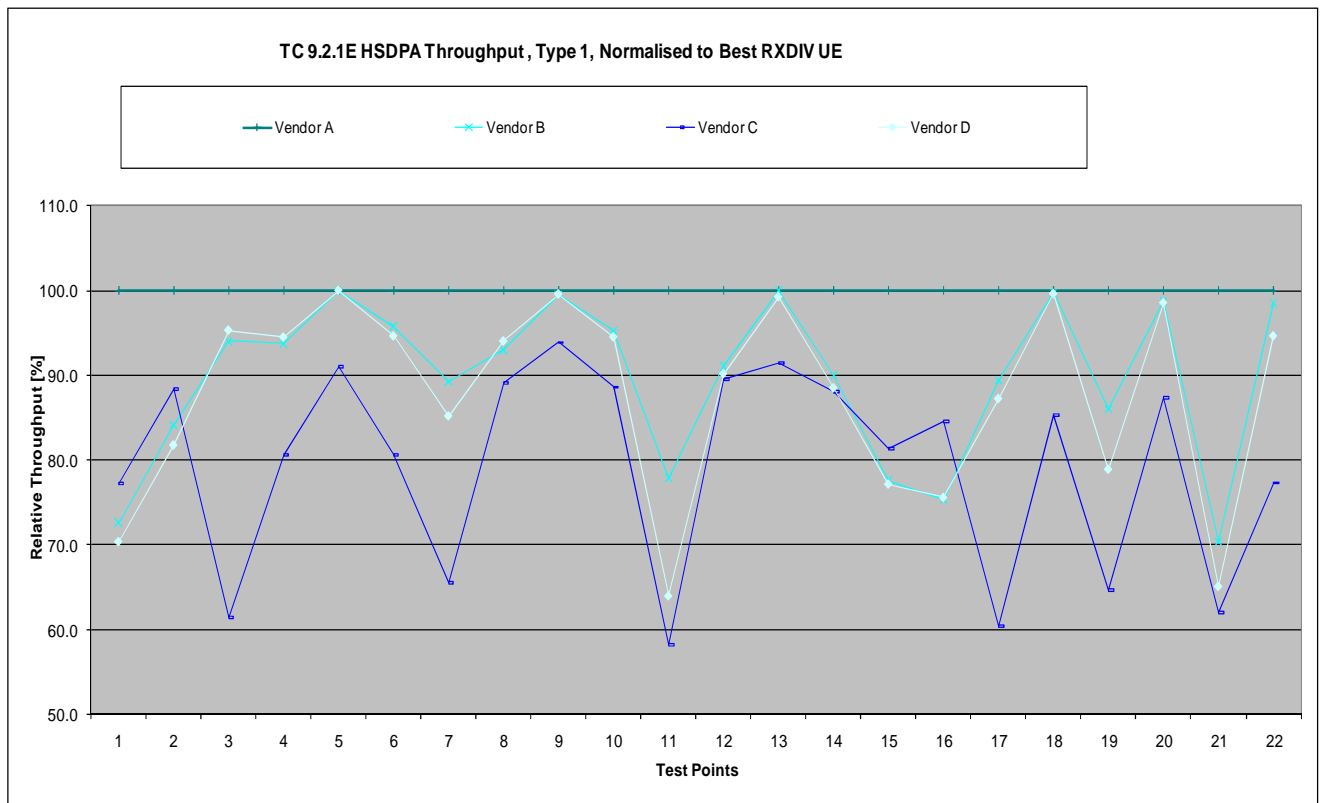
As an example, below there are three different figures to evaluate the modem performance in some selected TS 34.121-1 [3] test cases. The results have been collected from official conformance test platform where test equipment is calibrated to fulfil the tight 3GPP accuracy requirements, and testing time also follows 3GPP requirements to give statistically reliable and reproducible test results. The throughput results have been normalised to the best performing UE in each test point to give better understanding about relative UE throughput performance. Note that each of these UEs fulfils the 3GPP minimum requirements but nevertheless the differences in throughput performance among UEs are quite big.

Figure 5.8.1-1 shows HSDPA throughput performance in TC 9.2.1A that is testing UEs supporting 5 HSDPA codes (CAT6). Results have been collected from 11 different UEs from 6 different UE vendors. The 3GPP minimum requirements in this test case are based on Type 0 (Basic RAKE receiver), and thus many UEs fulfil 3GPP requirements with quite a big margins. This figure also shows how different UE vendors have been managed to improve the throughput in their different platform versions. The Figure 5.8.1-1 shows that in most demanding test points some UE can achieve only about 50% of the best UE's throughput. On the other hand, some of these tests points are so easy that almost every UE has achieved the best possible throughput in given test point conditions.



**Figure 5.8.1-1: HSDPA Throughput in TC 9.2.1A targeted for UEs supporting HSDPA CAT6.**

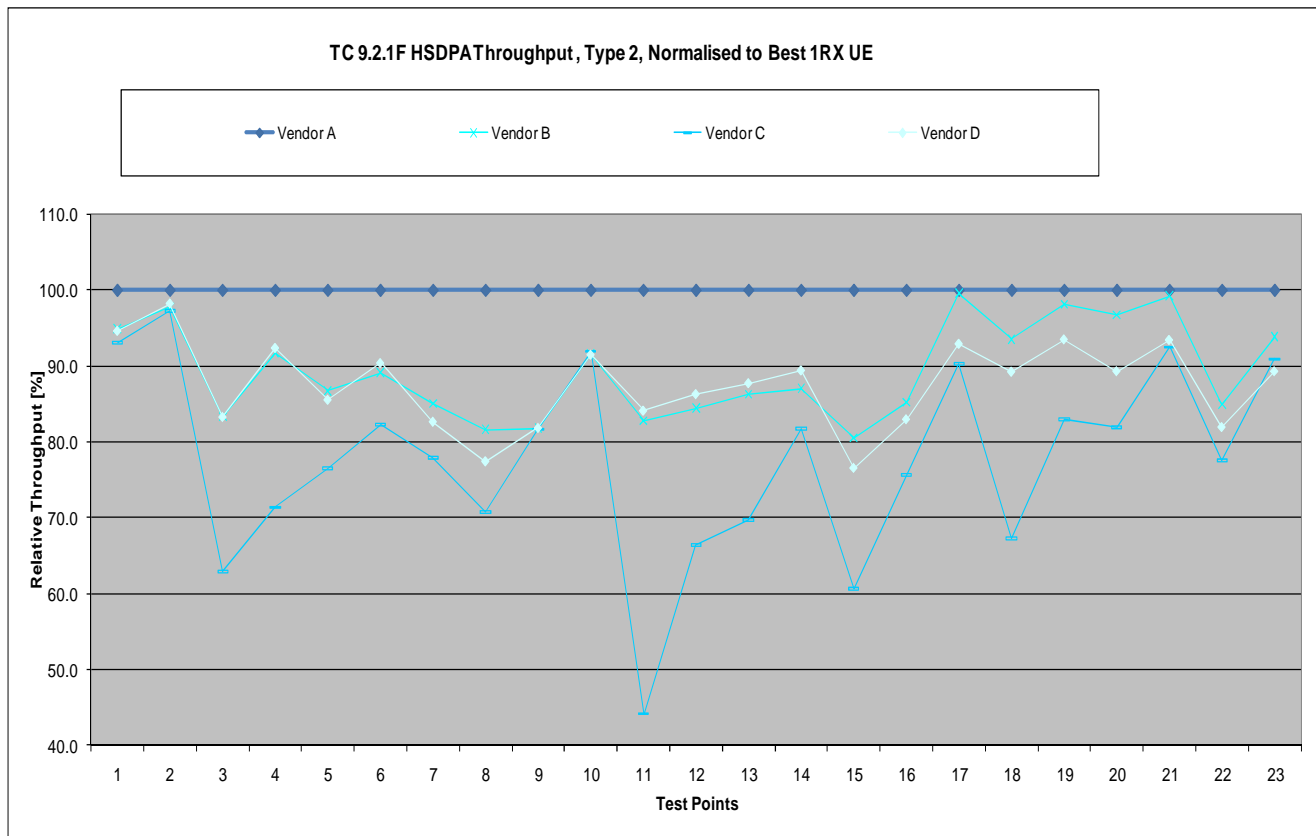
Figure 5.8.1-2 shows HSDPA throughput performance in TC 9.2.1E that is testing UEs supporting 10 HSDPA codes (CAT8). The 3GPP minimum requirements in this test case are based on enhanced performance Type 1 (RXDIV). There are not so many UEs commercially available that support Rx Diversity but nevertheless this figure shows that UEs that had the best receivers in one antenna branch are also the best ones when the same receiver is put into two branches, and those UEs that have not so good receiver in one antenna are also among the worst in two antenna tests. Now in this figure the worst UE can achieve only about 60% of the best UE's throughput.



**Figure 5.8.1-2: HSDPA Throughput in TC 9.2.1E targeted for Rx Diversity UEs supporting HSDPA CAT8.**

Figure 5.8.1-3 shows HSDPA throughput performance in TC 9.2.1F that is testing UEs supporting 10 HSDPA codes (CAT8). The 3GPP minimum requirements in this test case are based on enhanced performance Type 2 (EQU). In this test case individual test points are now much more demanding than TC 9.2.1A (Figure 1) and thus the difference in throughput performance has increased compared to differences in Figure 5.8.1-1. Now in Figure 5.8.1-3 the worst UE can achieve only about 45% of the best UE's throughput but nevertheless the worst UE fulfils the 3GPP minimum requirements.





**Figure 5.8.1-3: HSDPA Throughput in TC 9.2.1F targeted for UEs supporting HSDPA CAT8.**

The three figures above give just three examples from the big set of validated tests cases. But in section 9 of TS 34.121-1 [3] / TS 34.122 [4] there are about twenty more test cases specified that have been validated or will be very soon validated and those tests could also be used to evaluate the modem performance in conformance test systems,

## 5.8.2 Modem Performance in Application Layer Data Throughput Tests

Data Throughput Performance testers measure the application layer throughput revealing possible UE bugs in higher layers. When there are problems in higher layers, the tester has to re-transmit the packets whenever UE has not ACKed the packets or have not been fast enough to ACK packets in higher layers due to whatever higher layer problem that UE may have.

It is good to understand that the nature of 3GPP WCDMA/TD-SCDMA system is such that the best possible application layer throughput in fading conditions is achieved when some ratio of packets are re-transmitted at physical layer using fast L1 HARQ retransmission process. By this way network can transmit much bigger HSDPA block sizes and even some of them need to be re-transmitted at layer 1 one or more times, the total throughput is much higher than in the case where network tries to guarantee zero block error ratio for L1 packets by sending small HSDPA blocks.

Each network vendor may have their own view what is the best L1 BLER target in their live networks, and this may depend on many parameters, such as fading type, UE speed and so on. However, some basic field measurements in different live networks indicate that this L1 BLER is somewhere between 15 % and 40% in fading multipath scenarios. Also “Follow CQI” method used in Data Throughput Performance Testers is such that L1 re-transmission ratio (or BLER) is between 15 to 40% in various test points covering different noise conditions and fading profiles.

However 3GPP compliant and GCF certified UE has been tested in so many higher layer tests (TS 34.123-1 [5]) that higher layer re-transmissions occur rather infrequently in real live networks. Since also mandatory field tests are part of GCF certification, the GCF certified UEs higher layer re-transmissions occur significantly less often than L1 re-transmissions in multipath fading scenarios. Comparison of L1 packet re-transmission ratio to higher layer packet re-transmission ratio indicates that it is the L1 modem performance that also dominates in these kind Data Throughput Performance test outputs.

The importance of L1 modem performance in these kind application layer data throughput performance tests can be easily demonstrated. For this purpose three UEs that were tested against TS 34.121 tester were tested also in one commercially available application layer data throughput performance test system. Figure 5.8.2-1 shows these results.

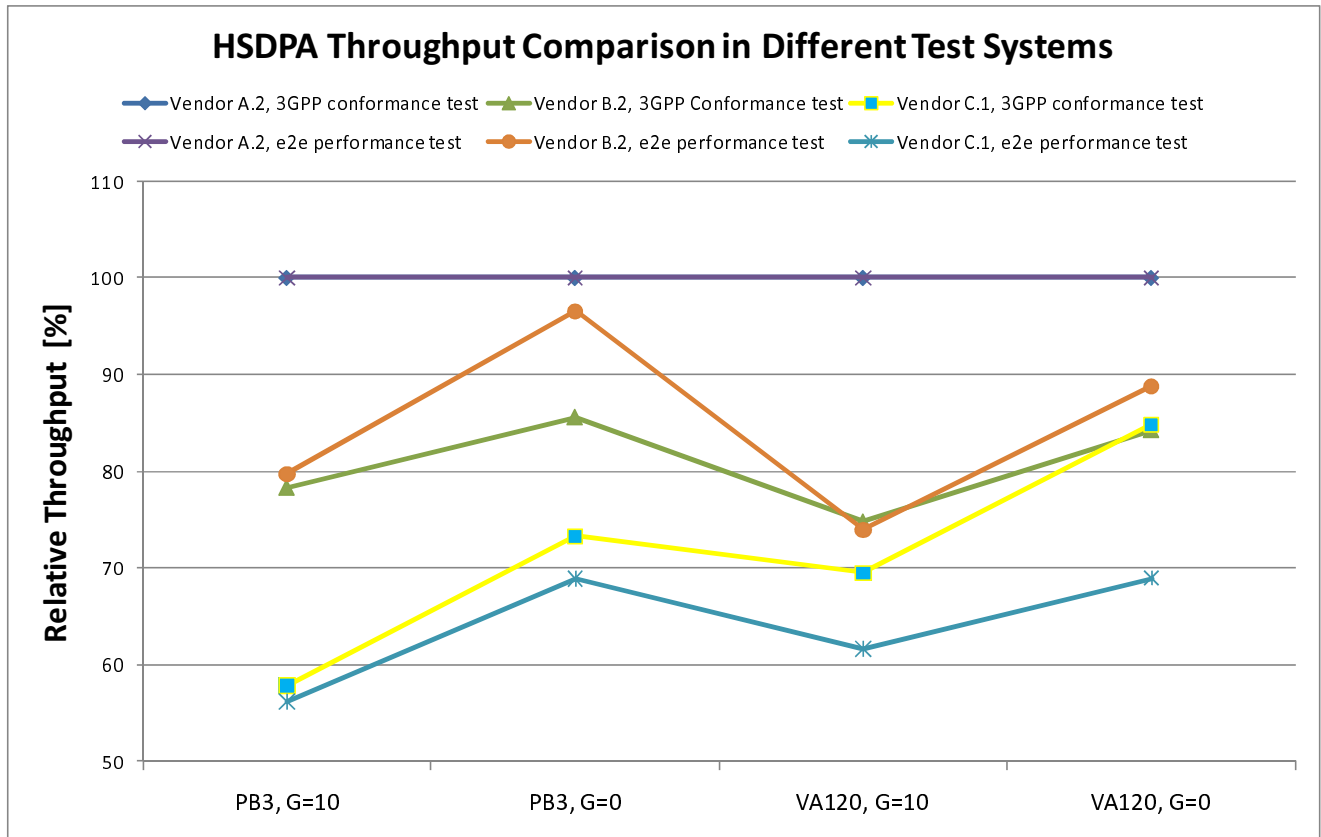


Figure 5.8.2-1: HSDPA Throughput comparison in different test systems

In Figure 5.8.2-1 results have been collected from same tests points (Fading type and Geometry) from TS 34.121-1 [3] TC 9.2.1A and from application layer data throughput performance test cases using FTP transfer. Figure 5.8.2-1 shows that the UE that achieved the best throughput in TS 34.121 test system achieved also the best throughput in FTP test cases in an application layer data throughput (e2e) in all measured test points. Also the UE that was performing worst in TS 34.121 test system was also the worst in an e2e tester. The 3<sup>rd</sup> UE that was in between these two other UEs in TS 34.121 test system kept its position in an e2e tester.

Then from detailed test reports of higher layer Data Throughput Performance Tester L1-retransmission ratios from the best and the worst UE and compared it to higher layer re-transmission ratios. The Table 5.8.2-1 shows the both L1 and L3 re-transmission ratios in all measured test points.

Table 5.8.2-1: L1 and L3 Re-transmission ratios in application layer throughput data throughput tester

Test Point	Vendor A.2		Vendor C.1	
	L1 re-transmission ratio [%]	L3 re-transmission ratio: Re-transmitted PDUs / Transmitted PDUs	L1 re-transmission ratio	L3 re-transmission ratio: Re-transmitted PDUs / Transmitted PDUs
PB3, G=10	17	10/931378 = 0.001%	12	10/932901 = 0.001%
PB3, G=0	17	12/399429 = 0.003%	30	11/399866 = 0.003%
VA120, G=10	33	9/665125 = 0.001%	23	9/666562 = 0.001%
VA120, G=0	37	11/266946 = 0.004%	44	10/272171 = 0.004%

Table 5.8.2-1 demonstrates that L1 re-transmissions ratios vary between 17% and 37% for the UE that was performing best in an application layer data throughput tester while L1 re-transmission ratio was between 12 and 44% for the worst

performing UE. Table 5.8.2-1 also indicates that the higher layer re-transmission ratios were between 0.001% and 0.004% for both UEs. So the throughput differences in a application layer data throughput tester were not because the higher layer issues but just because the L1 modem performance was so much better in one UE than in the other UE. Comparison of L1 and L3 re-transmission numbers clearly indicate that the L1 modem performance dominates in higher layer throughput tests when test system covers demanding noisy fading multipath scenarios. Note that in case the L3 re-transmission ratio had been even 100 times bigger due to some higher layer UE bug, still the L3 retransmission ratio would have been significantly smaller than L1 re-transmission ratio ( $100 \times 0.004\% = 0.4\%$  that is significantly lower than 12%). In other words, this kind of higher layer test system would not have been able to reveal higher layer bugs even higher layer re-transmission had occurred 100 times more often than in a good UE.

All these measurement results indicate that in order to be able to find easily higher layer bugs it is essential to have application layer data throughput test cases in test environments where L1 modem performance does not dominate i.e., where noise is not present and neither multipath fading condition is activated.

## 5.9 Test System Uncertainty and Test Tolerance

### 5.9.1 Recommended Uncertainty of Test System

The test system should fulfil the 3GPP test system uncertainty values for HSDPA and E-UTRA throughput tests specified in Annex F of TS 34.121-1 [3] and TS 34.122 [4] and Annex F of TS 36.521-1 [2]. If a test system cannot fulfil the 3GPP test system uncertainty requirements then the test system vendor shall declare its test system uncertainty values.

### 5.9.2 Test Tolerances

Since there are no absolute minimum requirements nor PASS/FAIL requirements in tests specified in the present TR the test tolerances are not defined which should be understood the applicable test tolerance being set to zero in all tests.

### 5.9.3 Impact of Test System Uncertainty on Test Results

*Editor's note: This analysis is assuming a WCDMA system. The analysis for LTE is TBD.*

Test system uncertainties play a big role in application layer throughput results. The tighter the uncertainty requirements are the more re-producible and comparable the results are.

In TS 34.121-1 [3] applicable test system uncertainty has been specified for each test case. Test System Uncertainty is a measure how accurately tester can setup the certain parameter/signal level to the specified level. In HSDPA throughput tests the most meaningful test system uncertainties are:

- Accuracy to setup the  $E_c/I_{or}$  for any downlink channel, for which the allowed test system uncertainty is  $\pm 0.1$  dB
- Accuracy to setup the  $\hat{I}_{or}/I_{oc}$  ratio, for which the allowed test system uncertainty is  $\pm 0.3$  dB in static conditions and  $\pm 0.6$  dB in fading conditions
- Accuracy for AWGN flatness across the minimum bandwidth, for which the allowed test system uncertainty is  $\pm 0.5$  dB and the peak to average ratio at a probability of 0.001% shall exceed 10 dB

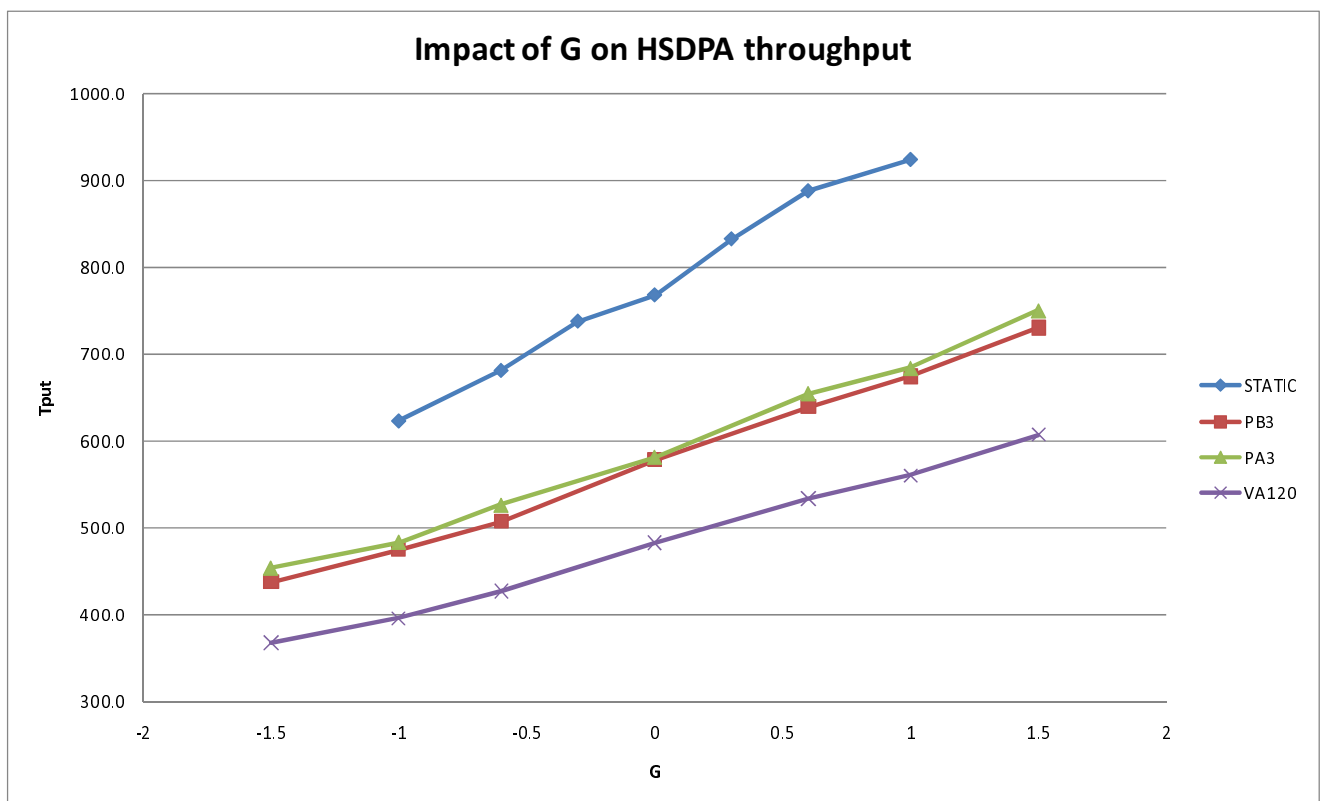
These specified test system uncertainties are very tight requirements for test systems. Typically the specified uncertainty values are the best that test system vendors can achieve when their test systems are fully calibrated. Full calibration means that each individual device, signal route and cable has to be calibrated. Hence the calibration costs take quite a big share of total costs of 3GPP compliant test systems.

There are several reasons why 3GPP has specified very tight requirements for test system uncertainties. Some reason being highlighted below:

- There is strong industry requirement that test systems should not PASS a bad UE.
- Loose test system uncertainties results big test tolerances. The smaller the test tolerances are the smaller is the probability that a test system passes a bad UE. (Since minimum requirements are relaxed by the amount of test tolerances there is a small chance that a bad UE passes the test thanks to relaxed test requirements but UE would fail if test tolerances were zero)

- The tests should be as reproducible as possible
- Without accurate test system calibration the test result may change from day to day / from frequency to frequency
- The test results should be as comparable as possible from device to device and from test system vendor to test system vendor
- All test systems should give a same PASS/FAIL verdict for one UE, and also each test system should give roughly the same actual test results (e.g., for HSDPA throughput).

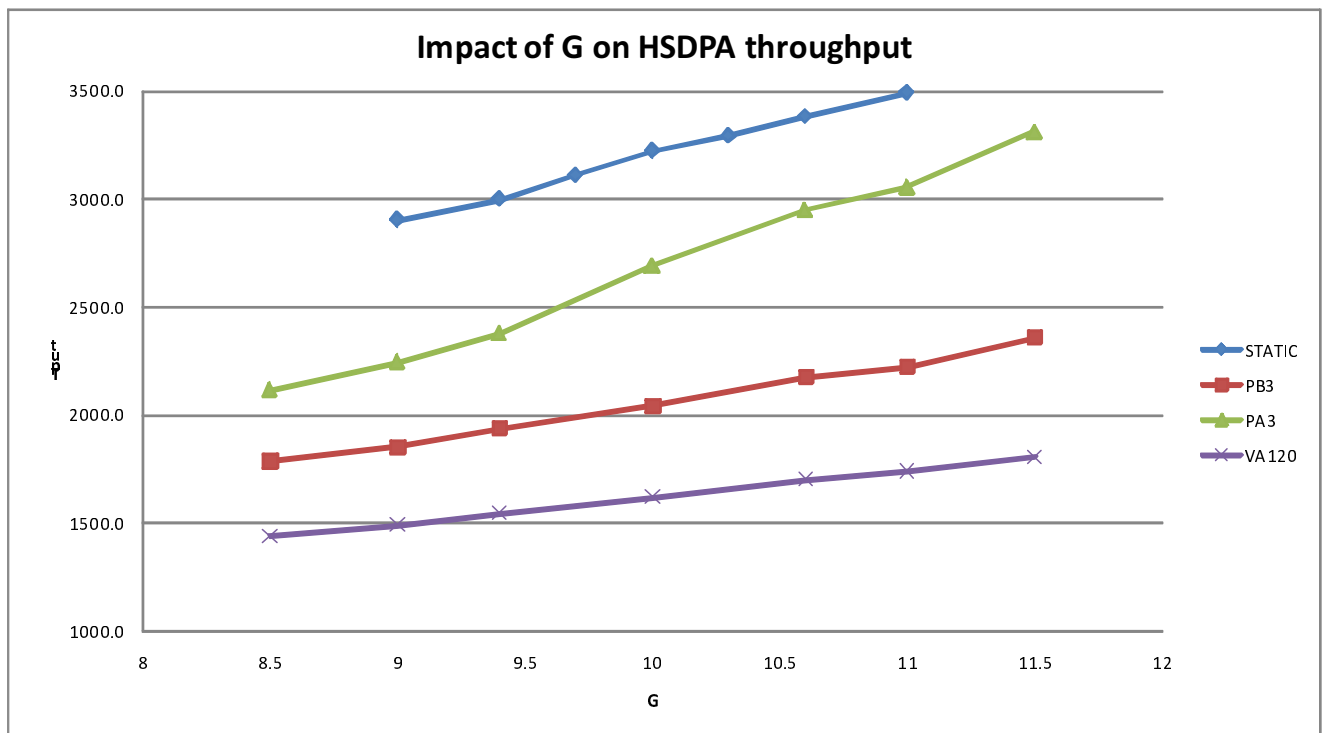
The impact of test system uncertainties on HSDPA throughput in different scenarios are demonstrated in Figures 5.9.3-1 and 5.9.3-2 that show the HSDPA throughput in different fading scenarios as a function of  $\hat{I}_{or}/I_{oc}$  ( $=G$ ) value. The nominal  $G$  value is 0 dB in Figure 5.9.3-1 and 10 dB in Figure 5.9.3-2.



**Figure 5.9.3-1: Impact of G on HSDPA throughput in fading scenarios when G is low**

Figure 5.9.3-1 shows that absolute throughput can vary more than 100 kbps even when test system uncertainties for  $G$  fulfil the 3GPP requirements given. When uncertainties of  $G$  are looser than 3GPP requirements then absolute throughput values differ more than 300 kbps.

Figure 5.9.3-2 shows the same phenomena when test system uncertainties are applied to area when  $G$  is high. But now when absolute throughput values are higher due to less noise in scenario ( $G$  is high) the absolute throughput values differ even more than 1 Mbps when test system uncertainty for  $G$  is  $\pm 1.5$  dB.



**Figure 5.9.3-2: Impact of G on HSDPA throughput in fading scenarios when G is high**

Figure 5.9.3-3 and 5.9.3-4 illustrate how much uncertainty of setting the G value affects to normalised HSDPA throughput. Now from Figure 5.9.3-3 one can conclude that when test systems fulfil the 3GPP test system requirements the normalised throughput is within 15% from the nominal throughput while with looser test system uncertainty ( $\pm 1.5$  dB) for G the normalised throughput is within the 30% from the nominal throughput. Figure 5.9.3-4 shows the same trend but now impact of test system uncertainty with high G on normalised throughput is slightly lower than with low G scenario but on the other hand it is more sensitive to fading channel profile.

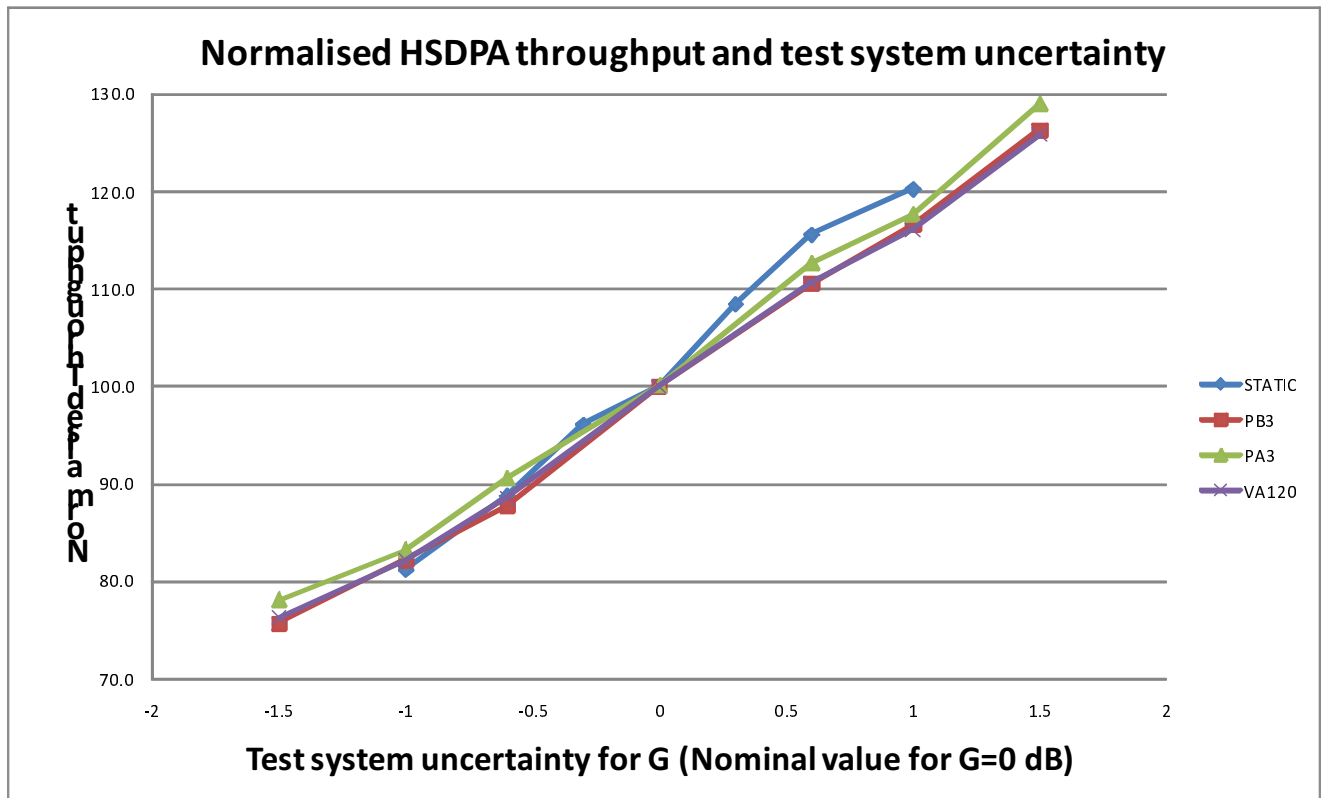


Figure 5.9.3-3: Impact of test system uncertainty on normalised HSDPA throughput in fading scenarios when G is low

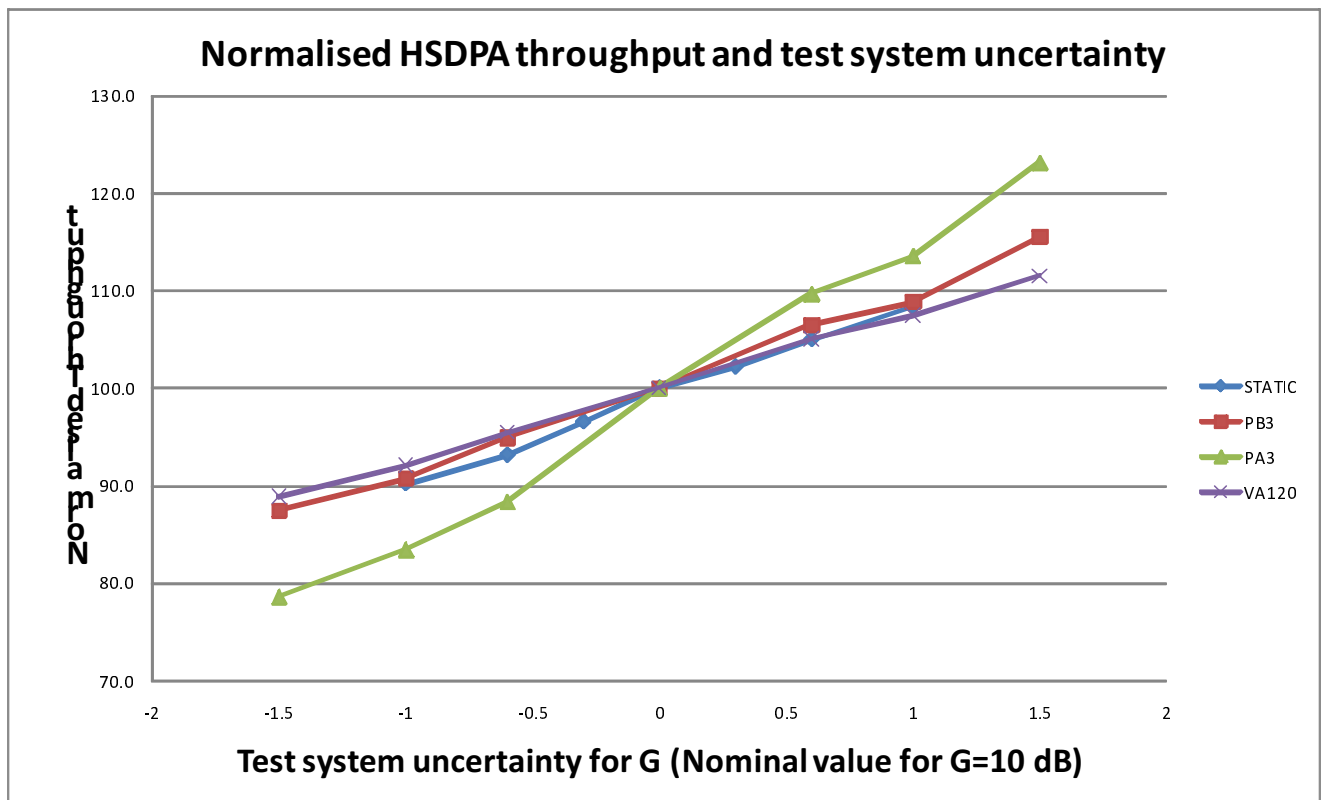


Figure 5.9.3-4: Impact of test system uncertainty on normalised HSDPA throughput in fading scenarios when G is high

It should be noted that the analysis above takes into account only one test system uncertainty parameter (G) while the HSDPA throughput is also sensitive to other test system uncertainties like accuracy of setting the  $E_c/I_{or}$  and flatness of AWGN. In worst case scenarios test system uncertainties can be summed up and hence the impact of all test system uncertainties on HSDPA throughput is even bigger than shown in Figures 5.9.3-1 to 5.9.3-4.

This analysis indicates that if application layer data throughput results are used to compare the performance of different UEs the impact of test system uncertainties on throughput results should be taken into account.

Therefore in order to compare the test results from one test system to another, or taken at different times on the same test system, it is necessary to analyse the impact of the test system uncertainties of the most relevant test parameters.

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## 6 Conclusions

The UE Application Layer Data Throughput Study Item was initiated at the request of the GCF to add UE Application Layer Data Throughput Measurements under various simulated network conditions to their Performance Items area of activity. The following aspects related to UE Application Layer Data Throughput testing were included as part of the study.

- Definition of UE Application Layer Data Throughput Performance
- Parameters for Measurement
- Test Configurations
- Transport and Application Layer Protocols
- Test Environment
- Data Transfer Scenarios
- Statistical Analysis
- Impact of Modem Performance in Application Layer Throughput
- Test System Uncertainty and Test Tolerance

As a result, the following items have been identified at the conclusion of the study item

- Definition of UE Application Layer Data Throughput Performance and identification of the test end points
- Identification of the test environment to include signal levels, fading profiles, and noise and interference levels to simulate typical network conditions with re-use of already specified RAN4 radio conditions.
- Selection of particular test environment combinations from the above for test points
- Selection of particular test environments that create conditions that can trigger undesired behaviour at the upper layers that are not covered in other RAN5 test cases
- Identification of the complete set of downlink, uplink, and bi-directional UDP and FTP test procedures for HSPA and FDD and TDD LTE
- Identification of the test points for the above test procedures
- Identification of flexible test procedures which were adapted from existing RAN5 test procedures and conditions and extended to UE Application Layer Data Throughput
- Selection of transport and application layer protocols and data transfer scenarios
- Identification of FTP and UDP Settings, Reference FTP and UDP Server Requirements, and FTP and UDP Application Requirements
- Identification of LTE and HSPA reference system configurations and traffic profiles

- Completion of Embedded and Tethered Testing Considerations
- Consideration about the impact of test system uncertainty on test results and confirmation of the Test System Uncertainty Recommendations
- Definition of a reliable and repeatable test environment to ensure the best possible repeatability of the results
- Impact from the lower layers data throughput on the application-layer data throughput
- Identification of the test applicability based on UE capabilities

This technical report includes a set of recommended test procedures for UE Application Layer Data Throughput that is in-line with the study item objectives identified in clause 4.1.

The test procedures are contained in Annex A with the specific test conditions and environments covered in Annex B. The test procedures herein provide a measure of UE data performance at the application layer with no qualification of results (i.e. no verdicts such as "pass/fail", "good", "medium", "bad" will be supplied).



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## Annex A: Test Procedures

### A.1 Purpose of annex

This annex specifies the test procedures for UE Application Layer Data Throughput Performance. The test procedures are the result of the study item and are the recommended test procedures to be used when evaluating UE Application Layer Data Throughput Performance. The use of "shall" or "must" in the test procedures listed herein is only used to indicate that the test purpose, procedure, and/or result may not be as expected if the specified "shall" or "must" item is not used or followed. As the Technical Report is informative in nature, the use of "shall" or "must" in the test procedures is not meant to imply a specific requirement. Their use is meant to indicate instances where the test objectives of the recommended test procedures may not be achieved.

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### A.2 UE Application Layer Data Throughput Performance Test Procedures for HSPA

*Editor's Note: The following aspects are either missing or not yet determined:*

- *MIMO aspects are missing.*

#### A.2.1 General

The following test procedures will evaluate the UE Application Layer Data Throughput Performance for HSPA.

For a tethered data configuration, the UE will be tethered to a laptop using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers as recommended by the UE manufacturer for the intended use by the customer/user. In most cases, a laptop with an embedded modem is considered to be a tethered data configuration as opposed to an embedded data configuration due to the UE to PC interface. Refer to the Tethered Data connection diagram in figure C.2.1-1.

For an embedded data configuration, the UE will be the endpoint of the measurement and will have the appropriate data client test applications called out in the test procedures. Refer to the Embedded Data connection diagram in figure C.2.2-1.

The UE should be tested in any data configuration that it supports (tethered and/or embedded).

The performance characteristics for a particular UE will be determined by both the UE's HS-DSCH category and receiver design albeit type 1, 2 or 3. Results shall be recorded for the following clauses which characterize the UE performance across a variety of application layer scenarios utilizing both FTP and UDP protocols.

- FTP Downlink Performance
- UDP Downlink Performance
- FTP Uplink Performance
- UDP Uplink Performance
- Stress Test Performance
- UDP Power Sweep Performance
- UDP Downlink vs. Geometry Factor Performance

All tests shall be performed with a variable reference channel using real-time CQI scheduling with next available TTI corresponding to the UE Category as defined in clause 6A.2.3 CQI Tables of TS 25.214 [6].

The recorded UE throughput for the FTP and UDP Downlink and Uplink Performance test procedures shall be based upon the simple average of 5 transfers for each test condition. (The Ior Sweep and Stress Test Performance tests do not require averaging).

The propagation conditions are specified in Annex D of TS 34.121-1 [3] for FDD and Annex D of TS 34.122 [4] for TDD. The Downlink Physical channels are specified in Annex E TS 34.121-1 [3] for FDD and Annex E TS 34.122 [4] for TDD. Unless stated otherwise, DL power control is OFF.

The AWGN interferer is specified in clause D.1.1 of TS 34.121-1 [3]. for FDD and the test environment defined in clause D.1 of TS 34.122 [4] for TDD.

The common RF test conditions for the performance test procedures are defined in clause E.5 of TS 34.121-1 [3] and each test condition herein should refer to clause E.5 of TS 34.121-1 [3] as applicable. Individual test conditions are defined in the paragraph of each test.

All throughput measurements in Annex A.2 shall be performed according to the following general rules:

- The measured UE Application Layer Throughput, T, is defined in clause 5.1.2.
- Minimum test time is necessary for both static and multipath fading profiles to ensure stabilization of the FTP or UDP Application throughput. The following table provides statistical accuracy and simplifies the process by breaking it down into Static and faded profiles where the faded profile duration is sufficient for all faded standard fade models.

**Table A.2.1-1: Transfer Duration Times**

Profile	Minimum Test Time
Static and No interference	60s
Faded (PA3, VA3, PB3, VA30, VA120)	164s

- FTP file size shall be selected according to the UE Category and Receive design to meet the minimum test times.
- UDP blast duration shall be selected to meet the minimum test times using a sufficient rate to prevent physical layer DTX based upon the UE Category.
- Downlink tests are performed with an R99 384Kbps Uplink for FDD and Rel-5 64kbps Uplink for TDD unless otherwise noted.

Downlink FTP tests are performed with a Rel-99 384 kbps Uplink for FDD except for the tests in which the Downlink peak rate is greater than [21] Mbps, in which case HSUPA shall be configured in the Uplink to allow the UE under test to achieve maximum Downlink throughput.

Unless otherwise stated, the UE output power for the tests shall be 12 dBm  $\pm$  2 dB for a Rel-99 384 kbps Uplink FDD or for a Rel-5 64kbps TDD and -7 dBm  $\pm$  2 dB for a HSUPA Uplink.

In addition to any recommendations made in this clause and the uplink test procedures herein, the downlink shall be configured to allow the UE under test to achieve the maximum Uplink throughput.

The UE shall be tested according to the declared UE HS-DSCH/E-DCH category and with the test system configured to enable the highest supported throughput. Refer to Annex A of TS 34.121-1 [3] for FDD and Annex A of TS 34.122 [4] for TDD for the appropriate RF connection based upon UE receiver type.

## A.2.2 HSPA / FTP Downlink Performance

### A.2.2.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

### A.2.2.2 Test Purpose

To measure the performance of the UE while downloading TCP based data with both static and multi path faded environments using FTP as a transfer protocol.

### A.2.2.3 Test Parameters

Tables A.2.2.3-1 and A.2.2.3-2 define the relevant test parameters for all relevant throughput tests.

**Table A.2.2.3-1: Test Parameters for FTP Downlink Testing**

Parameter	Unit	All Tests
Phase reference		P-CPICH (FDD) / P-CCPCH (TDD)
Redundancy and constellation version coding sequence		{6,2,1,5}
Maximum number of HARQ transmission		4
Note: The HS-SCCH channel(s) and HS-PDSCH shall be transmitted continuously with constant power. HS-SCCH channel(s) shall only use the identity of the UE under test for those TTI intended for the UE.		

**Table A.2.2.3-2: Test Points for FTP Downlink Testing**

Test Number	Reference test point Note 1	Propagation Conditions Note 1	Ior/loc (dB) Note 1	Ior (dBm)	HS-PDSCH Ec/Ior (dB)
1 Note 2	HSPA-1	Static	No interference	-60	-1.4
2	HSPA-2	PA3	20	-65	-3
3	HSPA-2	PA3	20	-80	-6
4	HSPA-2	PA3	10	-65	-3
5	HSPA-2	PA3	10	-80	-6
6	HSPA-3	VA30	10	-65	-3
7	HSPA-3	VA30	10	-80	-6
8	HSPA-4	VA120	0	-65	-3
9	HSPA-4	VA120	0	-80	-6
10	HSPA-5	PB3	0	-65	-3
11	HSPA-5	PB3	0	-80	-6
12	HSPA-5	PB3	10	-65	-3
13	HSPA-5	PB3	10	-80	-6
Note 1: The test points is according to Table B.1.1-1 in Annex B.1.1. Note 2: In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.					

### A.2.2.4 Test Description

#### A.2.2.4.1 Initial Conditions

Test environment: normal; see clauses G.2.1 and G.2.2 of TS 34.121-1 [3] for FDD and clauses G.2.1 and G.2.2 of TS 34.122 [4] for TDD.

Frequencies to be tested: mid range; see clause G.2.4 of TS 34.121-1 [3] for FDD and clause G.2.4 of TS 34.122 [4] for TDD.

- 1) Connect the SS (node B emulator) and fader and AWGN noise source to the UE antenna connector based upon UE receiver type as referenced in Annex A of TS 34.121-1 [3] for FDD and Annex A of TS 34.122 [4] for TDD. The downlink connection between the System Simulator and the UE shall be without Additive White Gaussian Noise and have no fading or multipath effects.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) Set up an HSDPA call using Modem or NIC interface with levels according to table E.5.0 of TS 34.121-1 [3].
- 5) The test parameters shall be set according to Table A.2.2.3-1 and the configuration of the downlink channels shall be set as defined in clause E.5 of TS 34.121-1 [3] according to UE capability.

#### A.2.2.4.2 Procedure

- 1) Once the HSDPA connection is setup, set the parameters for propagation conditions, Ior levels, Ec/Ior, and  $\hat{I}_{or}/I_{oc}$  according to Table A.2.2.3-2, as appropriate. The fading simulator shall be configured for static conditions as described in clause D.2.1 of TS 34.121-1 [3] for FDD and clause D.2.1 of TS 34.122 [4] for TDD or for fading conditions as described in table D.2.2.1.A of TS 34.121-1[3] for FDD and clause G.2.4 of TS 34.122 [4] for TDD, as appropriate.
- 2) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.2.1-1 and record Throughput T result. The transport block size used by the SS shall be determined based on UE reported CQI as described in subclause B.2.1.1 (This is iteration 1)
- 3) Count the number of NACK, ACK and statDTX on the UL HS-DPCCH during the test iteration interval.
- 4) Repeat steps 2 and 3 for iterations 2 through 5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Record the overall number of NACK, ACK and statDTX on the UL HS-DPCCH during the entire test for information.
- 7) If the HSDPA connection setup needs to be re-established after the subtest, perform the initial HSDPA call setup in accordance with the initial conditions in clause A.2.2.4.1.
- 8) Repeat steps 1 to 7 for each subtest in Table A.2.2.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.2.3 HSPA / UDP Downlink Performance

#### A.2.3.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

#### A.2.3.2 Test Purpose

To measure the performance of the UE while downloading UDP based data with both static and multi path faded environments.

#### A.2.3.3 Test Parameters

Tables A.2.3.3-1 and A.2.3.3-2 define the relevant test parameters for all relevant throughput tests.

**Table A.2.3.3-1: Test Parameters for UDP Downlink Testing**

Parameter	Unit	All Tests
Phase reference		P-CPICH(FDD) / P-CCPCH (TDD)
Redundancy and constellation version coding sequence		{6,2,1,5}
Maximum number of HARQ transmission		4
Note: The HS-SCCH channel(s) and HS-PDSCH shall be transmitted continuously with constant power. HS-SCCH channel(s) shall only use the identity of the UE under test for those TTI intended for the UE.		

**Table A.2.3.3-2: Test Points for UDP Downlink Testing**

Test Number	Reference test point Note 1	Propagation Conditions Note 1	Ior/loc (dB) Note 1	Ior (dBm)	HS-PDSCH Ec/Ior (dB)
1 Note 2	HSPA-1	Static	No interference	-60	-1.4
2	HSPA-2	PA3	20	-65	-3
3	HSPA-2	PA3	20	-80	-6
4	HSPA-2	PA3	10	-65	-3
5	HSPA-2	PA3	10	-80	-6
6	HSPA-3	VA30	10	-65	-3
7	HSPA-3	VA30	10	-80	-6
8	HSPA-4	VA120	0	-65	-3
9	HSPA-4	VA120	0	-80	-6
10	HSPA-5	PB3	0	-65	-3
11	HSPA-5	PB3	0	-80	-6
12	HSPA-5	PB3	10	-65	-3
13	HSPA-5	PB3	10	-80	-6
Note 1: The test points is according to Table B.1.1-1 in Annex B.1.1. Note 2: In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.					

## A.2.3.4 Test Description

### A.2.3.4.1 Initial Conditions

Test environment: normal; see clauses G.2.1 and G.2.2 of TS 34.121-1 [3] for FDD and clauses G.2.1 and G.2.2 of TS 34.122 [4] for TDD.

Frequencies to be tested: mid range; see clause G.2.4 of TS 34.121-1 [3] for FDD and clause G.2.4 of TS 34.122 [4] for TDD.

- 1) Connect the SS (node B emulator) and fader and AWGN noise source to the UE antenna connector based upon UE receiver type as referenced in Annex A of TS 34.121-1 [3] for FDD and Annex A of TS 34.122 [4] for TDD. The downlink connection between the System Simulator and the UE shall be without Additive White Gaussian Noise and have no fading or multipath effects.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.

- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) Set up an HSDPA call using Modem or NIC interface with levels according to table E.5.0 of TS 34.121-1 [3].
- 5) The test parameters shall be set according to Table A.2.3.3-1 and the configuration of the downlink channels shall be set as defined in clause E.5 of TS 34.121-1 [3] according to UE capability.

#### A.2.3.4.2 Procedure

- 1) Once the HSDPA connection is setup, set the parameters for propagation conditions, Ior levels, Ec/Ior, and  $\hat{I}_{or}/I_{oc}$  according to Table A.2.3.3-2, as appropriate. The fading simulator shall be configured for static conditions as described in clause D.2.1 of TS 34.121-1 [3] for FDD and clause D.2.1 of TS 34.122 [4] for TDD or for fading conditions as described in table D.2.2.1.A of TS 34.121-1[3] for FDD and table D.2.2.2 of TS 34.122 [4] for TDD, as appropriate.
- 2) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.2.1-1 and record Throughput T result. The transport block size used by the SS shall be determined based on UE reported CQI as described in subclause B.2.1.1 (This is iteration 1)
- 3) Count the number of NACK, ACK and statDTX on the UL HS-DPCCH during the test iteration interval.
- 4) Repeat steps 2 and 3 for iterations 2 through 5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Record the overall number of NACK, ACK and statDTX on the UL HS-DPCCH during the entire test for information.
- 7) If the HSDPA connection setup needs to be re-established after the subtest, perform the initial HSDPA call setup in accordance with the initial conditions in clause A.2.3.4.1.
- 8) Repeat steps 1 to 7 for each subtest in Table A.2.3.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.2.4 HSPA / FTP Uplink Performance

#### A.2.4.1 Definition

The UE application layer uplink performance for FTP under static conditions is determined by the UE application layer FTP throughput T.

#### A.2.4.2 Test Purpose

To measure the performance of the UE while uploading TCP based data using FTP as a transfer protocol.

#### A.2.4.3 Test Parameters

Tables A.2.4.3-1 and A.2.4.3-2 define the relevant test parameters and test points for all relevant throughput tests.

**Table A.2.4.3-1: Test Parameters for FTP Uplink Testing**

Parameter	Unit	All Tests
Phase reference		P-CPICH(FDD) / P-CCPCH (TDD)
Redundancy and constellation version coding sequence		{6,2,1,5}
Maximum number of HARQ transmission		4
Note: The HS-SCCH channel(s) and HS-PDSCH shall be transmitted continuously with constant power. HS-SCCH channel(s) shall only use the identity of the UE under test for those TTI intended for the UE. Although the test procedures are defined for uplink tests, the test parameters in this table represent the downlink configuration.		

**Table A.2.4.3-2: Test Points for FTP Uplink Testing**

Test Number	Propagation Conditions	Ior (dBm)	HS-PDSCH Ec/Ior (dB)	Target UE Tx Power (dBm)	Uplink
1	Static	-65	-1.4	12	R99 (384 kbps) (FDD) / HSUPA (TDD)
2	Static	-65	-1.4	-7	HSUPA

## A.2.4.4 Test Description

### A.2.4.4.1 Initial Conditions

Test environment: normal; see clauses G.2.1 and G.2.2 of TS 34.121-1 [3]. for FDD; see clauses G.2.1 and G.2.2 of TS 34.122-1[4] for LCR TDD mode.

Frequencies to be tested: mid range; see clause G.2.4 of TS 34.121-1 [3] for FDD; see clause G.2.4 of TS 34.122-1[4] for LCR TDD mode.

- 1) Connect the SS (node B emulator) and fader and AWGN noise source to the UE antenna connector based upon UE receiver type as referenced in Annex A of TS 34.121-1 [3] for FDD mode or Annex A of TS 34.122-2[4] for LCR TDD mode. The downlink connection between the System Simulator and the UE shall be without Additive White Gaussian Noise and have no fading or multipath effects.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) Set up an HSDPA call using Modem or NIC interface with levels according to table E.5.0 of TS 34.121-1 [3] for FDD mode or clause E.2 of table TS 34.122-2[4] for LCR TDD mode.
- 5) The test parameters shall be set according to Table A.2.4.3-1 and the configuration of the downlink channels shall be set as defined in clause E.5 of TS 34.121-1 [3] for FDD mode or clauses E.1 and E.2 of TS 34.122-2[4] for LCR TDD mode according to UE capability.

### A.2.4.4.2 Procedure

- 1) Once the HSDPA connection is setup, set the parameters for propagation conditions, Ior levels, and Ec/Ior according to Table A.2.4.3-2, as appropriate. The fading simulator shall be configured for static conditions as

described in clause D.2.1 of TS 34.121-1 [3] for FDD mode and clause D.2.1 of TS 34.122-1 [4] for LCR TDD mode with the exception that AWGN is not used.

- 2) Using the FTP client, begin FTP upload to the application server of a file sufficient in size for the test duration outlined in Table A.2.1-1 and record Throughput T result. The transport block size used by the SS shall be determined based on UE reported CQI as described in subclause B.2.1.1 (This is iteration 1)
- 3) Count the number of NACK, ACK and statDTX on the UL HS-DPCCH during the test iteration interval.
- 4) Repeat steps 2 and 3 for iterations 2 through 5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Record the overall number of NACK, ACK and statDTX on the UL HS-DPCCH during the entire test for information.
- 7) If the HSDPA connection setup needs to be re-established after the subtest, perform the initial HSDPA call setup in accordance with the initial conditions in clause A.2.4.4.1.
- 8) Repeat steps 1 to 7 for each subtest in Table A.2.4.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.2.5 HSPA / UDP Uplink Performance

### A.2.5.1 Definition

The UE application layer uplink performance for UDP under static conditions is determined by the UE application layer FTP throughput T.

### A.2.5.2 Test Purpose

To measure the performance of the UE while uploading UDP based data.

### A.2.5.3 Test Parameters

Tables A.2.5.3-1 and A.2.5.3-2 define the relevant test parameters and test points for all relevant throughput tests.

**Table A.2.5.3-1: Test Parameters for UDP Uplink Testing**

Parameter	Unit	All Tests
Phase reference		P-CPICH (FDD) / P-CCPCH (TDD)
Redundancy and constellation version coding sequence		{6,2,1,5}
Maximum number of HARQ transmission		4
Note: The HS-SCCH channel(s) and HS-PDSCH shall be transmitted continuously with constant power. HS-SCCH channel(s) shall only use the identity of the UE under test for those TTI intended for the UE. Although the test procedures are defined for uplink tests, the test parameters in this table represent the downlink configuration.		



**Table A.2.5.3-2: Test Points for UDP Uplink Testing**

Test Number	Propagation Conditions	Ior (dBm)	HS-PDSCH Ec/Ior (dB)	Target UE Tx Power (dBm)	Uplink
1	Static	-65	-1.4	12	R99 (384 kbps) (FDD) / HSUPA (TDD)
2	Static	-65	-1.4	-7	HSUPA

## A.2.5.4 Test Description

### A.2.5.4.1 Initial Conditions

Test environment: normal; see clauses G.2.1 and G.2.2 of TS 34.121-1 [3] for FDD; see clauses G.2.1 and G.2.2 of TS 34.122-1[4] for LCR TDD mode..

Frequencies to be tested: mid range; see clause G.2.4 of TS 34.121-1 [3] for FDD; see clause G.2.4 of TS 34.122-1[4] for LCR TDD mode.].

- 1) Connect the SS (node B emulator) and fader and AWGN noise source to the UE antenna connector based upon UE receiver type as referenced in Annex A of TS 34.121-1 [3] for FDD mode or Annex A of TS 34.122-2[4] for LCR TDD mode. The downlink connection between the System Simulator and the UE shall be without Additive White Gaussian Noise and have no fading or multipath effects.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) Set up an HSDPA call using Modem or NIC interface with levels according to table E.5.0 of TS 34.121-1 [3] for FDD mode or clause E.2 of table TS 34.122-2[4] for LCR TDD mode.
- 5) The test parameters shall be set according to Table A.2.5.3-1 and the configuration of the downlink channels shall be set as defined in clause E.5 of TS 34.121-1 [3] according to UE capability for FDD mode or clauses E.1 and E.2 of TS 34.122-2[4] for LCR TDD mode.

### A.2.5.4.2 Procedure

- 1) Once the HSDPA connection is setup, set the parameters for propagation conditions, Ior levels, and Ec/Ior according to Table A.2.5.3-2, as appropriate. The fading simulator shall be configured for static conditions as described in clause D.2.1 of TS 34.121-1 [3] for FDD mode and clause D.2.1 of TS 34.122-1 [4] for LCR TDD mode with the exception that AWGN is not used.
- 2) Using the UDP client, begin UDP upload to the application server of a file sufficient in size for the test duration outlined in Table A.2.1-1 and record Throughput T result. The transport block size used by the SS shall be determined based on UE reported CQI as described in subclause B.2.1.1 (This is iteration 1)
- 3) Count the number of NACK, ACK and statDTX on the UL HS-DPCCH during the test iteration interval.
- 4) Repeat steps 2 and 3 for iterations 2 through 5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Record the overall number of NACK, ACK and statDTX on the UL HS-DPCCH during the entire test for information.
- 7) If the HSDPA connection setup needs to be re-established after the subtest, perform the initial HSDPA call setup in accordance with the initial conditions in clause A.2.5.4.1.

- 8) Repeat steps 1 to 7 for each subtest in Table A.2.5.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.2.6 HSPA / Stress Test Performance

### A.2.6.1 Definition

The UE application layer stress test performance is determined by the UE application layer bi-directional UDP and alternating direction FTP throughput T over extended transfer duration.

### A.2.6.2 Test Purpose

To measure the performance of the UE over extended transfer durations while simultaneously uploading and downloading UDP based data or alternating upload and download FTP transfers with single and multi-RAB configurations.

### A.2.6.3 Test Parameters

Tables A.2.6.3-1 and A.2.6.3-2 define the relevant test parameters for all relevant throughput tests.

**Table A.2.6.3-1: Test Parameters for UDP/FTP Stress Testing**

Parameter	Unit	All Tests
Phase reference		P-CPICH (FDD) / P-CCPCH (TDD)
Redundancy and constellation version coding sequence		{6,2,1,5}
Maximum number of HARQ transmission		4
Note: The HS-SCCH channel(s) and HS-PDSCH shall be transmitted continuously with constant power. HS-SCCH channel(s) shall only use the identity of the UE under test for those TTI intended for the UE.		

**Table A.2.6.3-2: Test Points for UDP/FTP Stress Testing**

Test Number	Propagation Conditions	Ior (dBm)	HS-PDSCH Ec/Ior (dB)	Protocol (FTP/UDP)
1	Static	-65	-3	Alternating FTP (Single RAB)
2	Static	-65	-3	Alternating FTP (Multi-RAB)
3	Static	-65	-3	Bi-directional UDP (Single RAB)
4	Static	-65	-3	Bi-directional UDP (Multi-RAB)
Note 1: FTP File size should allow a minimum transfer duration of 1 minute per transfer with the number of transfers equal to 10.				
Note 2: UDP bidirectional duration shall be set to 10 minutes with a sufficient blast rates to prevent physical layer DTX on either the UL or DL.				

## A.2.6.4 Test Description

### A.2.6.4.1 Initial Conditions

Test environment: normal; see clauses G.2.1 and G.2.2 of TS 34.121-1 [3] for FDD and clauses G.2.1 and G.2.2 of TS 34.122 [4] for TDD.

Frequencies to be tested: mid range; see clause G.2.4 of TS 34.121-1 [3] for FDD and clause G.2.4 of TS 34.122 [4] for TDD.

- 1) Connect the SS (node B emulator) and fader and AWGN noise source to the UE antenna connector based upon UE receiver type as referenced in Annex A of TS 34.121-1 [3] for FDD and Annex A of TS 34.122 [4] for TDD. The downlink connection between the System Simulator and the UE shall be without Additive White Gaussian Noise and have no fading or multipath effects.
- 2) Connect an application server to the IP output of the SS configured with both a FTP and UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with both FTP and UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has both FTP and UDP client test applications available.
- 4) Set up an HSDPA call using Modem or NIC interface with levels according to table E.5.0 of TS 34.121-1 [3].
- 5) The test parameters shall be set according to Table A.2.6.3-1 and the configuration of the downlink channels shall be set as defined in clause E.5 of TS 34.121-1 [3] according to UE capability.

### A.2.6.4.2 Procedure

- 1) Once the HSDPA connection is setup, set the parameters for propagation conditions, Ior levels, and Ec/Ior according to Table A.2.6.3-2, as appropriate. The fading simulator shall be configured for static conditions as described in clause D.2.1 of TS 34.121-1 [3] for FDD and clause D.2.1 of TS 34.122 [4] for TDD with the exception that AWGN is not used.
- 2) Using the FTP or UDP client, begin FTP or UDP transfers to/from the application server per Table A.2.6.3-2 and record Throughput T results. The transport block size used by the SS shall be determined based on UE reported CQI as described in subclause B.2.1.1.
- 3) Record the overall number of NACK, ACK and statDTX on the UL HS-DPCCH for FDD and HS-SICH for TDD during the entire test for information.
- 4) If the HSDPA connection setup needs to be re-established after the subtest, perform the initial HSDPA call setup in accordance with the initial conditions in clause A.2.6.4.1.
- 5) Repeat steps 1 to 4 for each subtest in Table A.2.6.3-2, as appropriate.
- 6) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.2.7 HSPA / UDP Power Sweep Performance

### A.2.7.1 Definition

The UE application layer power sweep performance for UDP under a multi-path fading environment is determined by the UE application layer UDP throughput T.

### A.2.7.2 Test Purpose

To measure the consistency of downlink performance of the UE across Ior values while downloading UDP based data with a multi path faded environment.

### A.2.7.3 Test Parameters

Tables A.2.7.3-1 and A.2.7.3-2 define the relevant test parameters for all relevant throughput tests.

**Table A.2.7.3-1: Test Parameters for UDP Power Sweep Testing**

Parameter	Unit	All Tests
Phase reference		P-CPICH (FDD) / P-CCPCH (TDD)
Redundancy and constellation version coding sequence		{6,2,1,5}
Maximum number of HARQ transmission		4
Note: The HS-SCCH channel(s) and HS-PDSCH shall be transmitted continuously with constant power. HS-SCCH channel(s) shall only use the identity of the UE under test for those TTI intended for the UE.		

**Table A.2.7.3-2: Test Points for UDP Power Sweep Testing**

Test Number	Propagation Conditions	Ior (dBm)	HS-PDSCH Ec/Ior (dB)	Ior/Ioc (dB)
1	VA30	-60	-3	20
2	VA30	-61	-3	20
3	VA30	-62	-3	20
4	VA30	-63	-3	20
5	VA30	-64	-3	20
6	VA30	-65	-3	20
7	VA30	-66	-3	20
8	VA30	-67	-3	20
9	VA30	-68	-3	20
10	VA30	-69	-3	20
11	VA30	-70	-3	20
12	VA30	-71	-3	20
13	VA30	-72	-3	20
14	VA30	-73	-3	20
15	VA30	-74	-3	20
16	VA30	-75	-3	20
Note: Throughput should remain consistent across Ior within a reasonable tolerance.				

### A.2.7.4 Test Description

#### A.2.7.4.1 Initial Conditions

Test environment: normal; see clauses G.2.1 and G.2.2 of TS 34.121-1 [3] for FDD and clauses G.2.1 and G.2.2 of TS 34.122 [4] for TDD.

Frequencies to be tested: mid range; see clause G.2.4 of TS 34.121-1 [3] for FDD and clause G.2.4 of TS 34.122 [4] for TDD.

- 1) Connect the SS (node B emulator) and fader and AWGN noise source to the UE antenna connector based upon UE receiver type as referenced in Annex A of TS 34.121-1 [3] for FDD and Annex A of TS 34.122 [4] for TDD. The downlink connection between the System Simulator and the UE shall be without Additive White Gaussian Noise and have no fading or multipath effects.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.

- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) Set up an HSDPA call using Modem or NIC interface with levels according to table E.5.0 of TS 34.121-1 [3].
- 5) The test parameters shall be set according to Table A.2.7.3-1 and the configuration of the downlink channels shall be set as defined in clause E.5 of TS 34.121-1 [3] according to UE capability.

#### A.2.7.4.2 Procedure

- 1) Once the HSDPA connection is setup, set the parameters for propagation conditions, Ior levels, Ec/Ior, and  $\hat{I}_{or}/I_{oc}$  according to Table A.2.7.3-2, as appropriate. The fading simulator shall be configured for fading conditions as described in table D.2.2.1.A of TS 34.121-1[3] for FDD and table D.2.2.2.2 of TS 34.122 [4] for TDD, as appropriate.
- 2) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.2.1-1 and record Throughput T result for each iteration. The transport block size used by the SS shall be determined based on UE reported CQI as described in subclause B.2.1.1.
- 3) Count and record the number of NACK, ACK and statDTX on the UL HS-DPCCH for FDD and HS-SICH for TDD during the subtest interval.
- 4) Repeat steps 2 and 3 for each subtest in Table A.2.7.3-2.
- 5) Calculate and record the maximum difference in throughput, T, across all subtests.
- 6) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.2.8 HSPA / Throughput vs. Geometry Factor Performance

#### A.2.8.1 Definition

The UE application layer Throughput vs. G for UDP under both a static and a multi-path fading environment is determined by the UE application layer UDP throughput T.

#### A.2.8.2 Test Purpose

To measure the HSDPA throughput over Geometry Factor (G) while downloading UDP based data with both a static and a multi path faded environment.

#### A.2.8.3 Test Parameters

Tables A.2.8.3-1 and A.2.8.3-2 define the relevant test parameters for all relevant throughput tests.

**Table A.2.8.3-1: Test Parameters for UDP throughput vs. G factor**

Parameter	Unit	All Tests
Phase reference		P-CPICH
Redundancy and constellation version coding sequence		{6,2,1,5}
Maximum number of HARQ transmission		4
Note: The HS-SCCH channel(s) and HS-PDSCH shall be transmitted continuously with constant power. HS-SCCH channel(s) shall only use the identity of the UE under test for those TTI intended for the UE.		

**Table A.2.8.3-2: Test Points for HSDPA UDP throughput vs. G factor**

Test Number	Propagation Conditions	Ior (dBm)	HS-PDSCH Ec/Ior (dB)	Ioc (dBm)	G = Ior/Ioc (dB)
1	static	-60	-2	-80	20
2	static	-65	-2	-80	15
3	static	-70	-2	-80	10
4	static	-75	-2	-80	5
5	static	-80	-2	-80	0
6	static	-85	-2	-80	-5
7	PA3	-60	-2	-80	20
8	PA3	-65	-2	-80	15
9	PA3	-70	-2	-80	10
10	PA3	-75	-2	-80	5
11	PA3	-80	-2	-80	0
12	PA3	-85	-2	-80	-5
13	PB3	-60	-2	-80	20
14	PB3	-65	-2	-80	15
15	PB3	-70	-2	-80	10
16	PB3	-75	-2	-80	5
17	PB3	-80	-2	-80	0
18	PB3	-85	-2	-80	-5
19	VA30	-60	-2	-80	20
20	VA30	-65	-2	-80	15
21	VA30	-70	-2	-80	10
22	VA30	-75	-2	-80	5
23	VA30	-80	-2	-80	0
24	VA30	-85	-2	-80	-5
25	VA120	-60	-2	-80	20
26	VA120	-65	-2	-80	15
27	VA120	-70	-2	-80	10
28	VA120	-75	-2	-80	5
29	VA120	-80	-2	-80	0
30	VA120	-85	-2	-80	-5

## A.2.8.4 Test Description

### A.2.8.4.1 Initial Conditions

Test environment: normal; see clauses G.2.1 and G.2.2 of TS 34.121-1 [3].

Frequencies to be tested: mid range; see clause G.2.4 of TS 34.121-1 [3].

- 1) Connect the SS (node B emulator) and fader and AWGN noise source to the UE antenna connector based upon UE receiver type as referenced in Annex A of TS 34.121-1 [3]. The downlink connection between the System Simulator and the UE shall be without Additive White Gaussian Noise and have no fading or multipath effects.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) Set up an HSDPA call using Modem or NIC interface with levels according to table E.5.0 of TS 34.121-1 [3].
- 5) The test parameters shall be set according to Table A.2.8.3-1 and the configuration of the downlink channels shall be set as defined in clause E.5 of TS 34.121-1 [3] according to UE capability.

### A.2.8.4.2 Procedure

- 1) Once the HSDPA connection is setup, set the parameters for propagation conditions, Ior levels, Ec/Ior, and Ior/Ioc according to Table A.2.3.3-2, as appropriate. The fading simulator shall be configured for static

conditions as described in clause D.2.1 of TS 34.121-1 [3] or for fading conditions as described in table D.2.2.1.A of TS 34.121-1[3], as appropriate.

- 2) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.2.1-1 and record Throughput T result. The transport block size used by the SS shall be determined based on UE reported CQI as described in subclause B.2.1.1.
- 3) Count the number of NACK, ACK and statDTX on the UL HS-DPCCH during the subtest interval.
- 4) Repeat steps 2 and 3 for each subtest in Table A.2.8.3-2.
- 5) Record the overall number of NACK, ACK and statDTX on the UL HS-DPCCH during the entire test for information.
- 6) If the HSDPA connection setup needs to be re-established after the subtest, perform the initial HSDPA call setup in accordance with the initial conditions in clause A.2.8.4.1.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

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## A.3 UE Application Layer Data Throughput Performance Test Procedures for LTE

**Editor's Note:** The following aspects are either missing or not yet determined:

- 4X2 MIMO aspects will be considered for a future release.
- To allow for test system implementation based on the clarifications applied in Notes 3 and 4 in the test parameter tables for the downlink performance tests in A.3.2 and A.3.3, the existing functionality based on TR 37.901 v11.10.0 may be used until RAN5 #65.

### A.3.1 General

The following test procedures will evaluate the UE Application Layer Data Throughput Performance for LTE.

For a tethered data configuration, the UE will be tethered to a laptop using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers as recommended by the UE manufacturer for the intended use by the customer/user. In most cases, a laptop with an embedded modem is considered to be a tethered data configuration as opposed to an embedded data configuration due to the UE to PC interface. Refer to the Tethered Data connection diagram in figure C.2.1-1.

For an embedded data configuration, the UE will be the endpoint of the measurement and will have the appropriate data client test applications called out in the test procedures. Refer to the Embedded Data connection diagram in figure C.2.2-1.

The UE should be tested in any data configuration that it supports (tethered and/or embedded).

The propagation conditions are specified in Annex B of TS 36.521-1 [2] and the Down link Physical channels are specified in Annex C TS 36.521-1 [2]. Unless stated otherwise, DL power control is OFF.

The common RF test conditions of Performance requirements are defined in clause A.3 of TS 36.521-1 [2], and each test conditions in clause 9 should refer to clause A.5 of TS 36.521-1 [2]. Individual test conditions are defined in the paragraph of each test.

All throughput measurements in Annex A.3 shall be performed according to the following general rules:

- The measured UE Application Layer Throughput, T, is defined in clause 5.1.2.
- Minimum test time is necessary for both static and multipath fading profiles to ensure stabilization of the FTP or UDP Application throughput. The following table provides statistical accuracy and simplifies the process by breaking it down into Static and faded profiles where the faded profile duration is sufficient for all faded standard fade models.

**Table A.3.1-1: Transfer Duration Times**

Profile	Minimum Test Time
Static	60s
Faded (EPA5,EVA5, ETU70, ETU300)	Note: Reuse, as far as possible, the minimum test times from 36.521-1 Annex G.3.5

- FTP file size shall be selected according to the test purpose and receive design to meet the minimum test times.
- UDP blast duration shall be selected to meet the minimum test times using a sufficient rate to prevent physical layer DTX based upon the UE Category.

The performance characteristics for a particular UE will be determined by all possible LTE transmission modes, i.e. SIMO, Transmit Diversity, Open loop MIMO and Closed loop MIMO. Results shall be recorded for the following sections which characterize the UE performance across a variety of application layer scenarios utilizing both FTP and UDP protocols.

- FTP Downlink Performance
- UDP Downlink Performance
- FTP Uplink Performance
- UDP Uplink Performance
- Stress Test Performance
- UDP Power Sweep Performance
- UDP Downlink vs. SNR Performance

IP header compression will not be used.

Ciphering and integrity of RRC and NAS messages and user plane data will be set to null for UDP and AES for FTP to check CPU processing ability of UE. Refer to TS 33.401 [8].

The recorded UE throughput for the FTP and UDP Downlink and Uplink Performance test procedures shall be based upon the simple average of 5 transfers for each test condition.

Unless otherwise stated, the UE output power for the tests shall be set 0 dBm with  $\pm 2$  dBm tolerance.

Unless stated otherwise, power control of the Downlink is OFF.

The physical channels specified in TS 36.211 [9] clause 6 (for downlink physical channels) shall be as defined in the respective sections below.

In addition to any recommendations made in this clause and the downlink test procedures herein, the uplink shall be configured to allow the UE under test to achieve the maximum downlink throughput.

In addition to any recommendations made in this clause and the uplink test procedures herein, the uplink shall be configured to allow the uplink to achieve maximum uplink throughput as per Annex F.2. For a given UE category and channel bandwidth the reference channel with highest throughput supported by that UE category is chosen. The downlink shall be configured accordingly to allow the UE under test to achieve said uplink throughput.

The requirement for a UE that support E-UTRA in downlink shall be tested according to the declared UE PDSCH category.

The fading of the signals and the AWGN signals applied to each receiver antenna connector shall be uncorrelated. The levels of the test signal applied to each of the antenna connectors shall be as defined in the respective test cases.

The test procedures defined herein are based on UE(s) that utilize a dual-antenna receiver.

For all test procedures, the SNR is defined as:



$$SNR = \frac{\hat{E}_s^{(1)} + \hat{E}_s^{(2)}}{N_{oc}^{(1)} + N_{oc}^{(2)}},$$

where the superscript indicates the receiver antenna connector. The SNR requirement applies for the UE categories given for each test.

The parameters specified in Table A.3.1-2 are valid for all FDD tests unless otherwise stated.

**Table A.3.1-2: Common Test Parameters (FDD)**

Parameter	Unit	Value	Comments
Inter-TTI Distance		1	
Number of HARQ processes	Processes	8	For FDD, 8 HARQ processes in the DL, as specified in TS 36.213 [10] clause 7. All 8 HARQ processes are used.
Total number of soft channel bits		UE category dependent value	The value depends on UE category as specified in TS 36.306 [16] clause 4.1.
Scheduling of retransmissions			1. Retransmissions use the same Transport Block Size (TBS) as the initial transmission. 2. HARQ processes are scheduled consecutively, independent of the fact, whether retransmissions (for negatively acknowledged HARQ processes) or new transmissions (for positively acknowledged HARQ processes) occur.
Maximum number of HARQ transmission		4	It is always 4 for FDD, as specified in TS 36.213 [10] clause 8
Redundancy version coding sequence		{0,1,2,3} for QPSK and 16QAM {0,0,1,2} for 64QAM	
Number of OFDM symbols for PDCCH	OFDM symbols	4 for 1.4 MHz bandwidth, 3 for 3 MHz and 5 MHz bandwidths, 2 for 10 MHz, 15 MHz and 20 MHz bandwidths	The PCFICH carries information about the number of OFDM symbols used for transmission of PDCCHs in a subframe, as specified in TS 36.211 [9] clause 6.7
Cyclic Prefix		Normal	CP consist of the following physical resource blocks (RBs) parameters: 12 consecutive subcarriers at a 15 kHz spacing and 7 OFDM symbols, as specified in TS 36.211 [9] clause 6.2.3
Cell ID		0	The Cell ID is uniquely defined by a number in the range of 0 to 503, representing the physical-layer cell identity, as specified in TS 36.211 [9] clause 6.11.

The parameters specified in Table A.3.1-3 are valid for all TDD tests unless otherwise stated.

Table A.3.1-3: Common Test Parameters (TDD)

Parameter	Unit	Value	Comments
Uplink downlink configuration (Note 1)		2	
Special subframe configuration (Note 2)		4	
Inter-TTI Distance		1	
Number of HARQ processes	Processes	7	For TDD, 7 HARQ processes in the DL, as specified in TS 36.213 [10] clause 7. All 7 HARQ processes are used.
Total number of soft channel bits		UE category dependent value	The value depends on UE category as specified in TS 36.306 [16] clause 4.1.
Scheduling of retransmissions			1. Retransmissions use the same Transport Block Size (TBS) as the initial transmission. 2. HARQ processes are scheduled consecutively, independent of the fact, whether retransmissions (for negatively acknowledged HARQ processes) or new transmissions (for positively acknowledged HARQ processes) occur. 3. In case when the initial transmission and the retransmissions are scheduled in subframes with a different $N_{PRB}$ (in terms of TS 36.213 [10] subclause 7.1.7) $29 \leq I_{MCS} \leq 31$ according to TS 36.213 [10] subclause 7.1.7.2 and the appropriate modulation is used.
Maximum number of HARQ transmission		4	It is always 4 for TDD, as specified in TS 36.213 [10] clause 8
Redundancy version coding sequence		{0,1,2,3} for QPSK and 16QAM {0,0,1,2} for 64QAM	
Number of OFDM symbols for PDCCH	OFDM symbols	4 for 1.4 MHz bandwidth, 3 for 3 MHz and 5 MHz bandwidths, 2 for 10 MHz, 15 MHz and 20 MHz bandwidths	The PCFICH carries information about the number of OFDM symbols used for transmission of PDCCHs in a subframe, as specified in TS 36.211 [9] clause 6.7
Cyclic Prefix		Normal	CP consist of the following physical resource blocks (RBs) parameters: 12 consecutive subcarriers at a 15 kHz spacing and 7 OFDM symbols, as specified in TS 36.211 [9] clause 6.2.3
Cell ID		0	The Cell ID is uniquely defined by a number in the range of 0 to 503, representing the physical-layer cell identity, as specified in TS 36.211 [9] clause 6.11.
Note 1: as specified in Table 4.2-2 in TS 36.211 [9] Note 2: as specified in Table 4.2-1 in TS 36.211 [9]			

## A.3.2 LTE / FTP Downlink Performance

### A.3.2.1 LTE / FTP Downlink / PDSCH Single Antenna Port Performance (Cell-Specific Reference Symbols)

#### A.3.2.1.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

#### A.3.2.1.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.2.1.3 Test Parameters

Test parameters are defined in Table A.3.2.1.3-1 and A.3.2.1.3-2.

**Table A.3.2.1.3-1: Test Parameters for SIMO Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	0(1 Tx)
	$\rho_B$	dB	0(1 Tx)(Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			1
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-0
Note 1: $P_B = 0$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.2.1.3-2: Test points for SIMO Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.2.1.3-2: Test points for SIMO Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1: See Annex B.3 for the recommended channel bandwidth				
Note 2: The test points is according to Table B.1.2-1 in Annex B.1.2.				
Note 3: In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.				

#### A.3.2.1.4 Test Description

##### A.3.2.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.9 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.2.1.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.2.1.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.2.1.3-2, as appropriate.
- 3) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.2.1.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.2.1.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.2.2 LTE / FTP Downlink / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)

#### A.3.2.2.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

#### A.3.2.2.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.2.2.3 Test Parameters

Test parameters are defined in Table A.3.2.3-1 and A.3.2.3-2.

**Table A.3.2.2.3-1: Test Parameters for TxDiversity Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			2
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.2.2.3-2: Test points for TxDiversity Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.2.2.3-2: Test points for TxDiversity Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

#### A.3.2.2.4 Test Description

##### A.3.2.2.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.2.2.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.2.2.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.2.2.3-2, as appropriate.
- 3) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.2.2.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.2.2.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.2.3 LTE / FTP Downlink / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

#### A.3.2.3.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

#### A.3.2.3.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.2.3.3 Test Parameters

Test parameters are defined in Table A.3.2.3-1 and A.3.2.3-2.

**Table A.3.2.3.3-1: Test Parameters for Open Loop Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			3
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
<i>ri-ConfigurationInd</i>			1 (Note 4)
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-0
CodeBookSubsetRestriction bitmap			11
Note 1: $P_B = 1$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.2.3.3-2: Test points for Open Loop Spatial Multiplexing Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			
Note 4: To avoid the ambiguity of SS behaviour when applying CQI during rank switching, RI reports are to be applied at the SS with one subframe delay in addition to Note 3 to align with CQI reports.			

**Table A.3.2.3.3-2: Test points for Open Loop Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Low
3	LTE-3	EVA5	10	Low
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

#### A.3.2.3.4 Test Description

##### A.3.2.3.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.2.3.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.2.3.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A. 3.2.3.3-2, as appropriate.
- 3) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)



- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.2.3.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.2.3.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.2.4 LTE / FTP Downlink / PDSCH Closed Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

#### A.3.2.4.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

#### A.3.2.4.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.2.4.3 Test Parameters

Test parameters are defined in Table A.3.2.4.3-1 and A.3.2.4.3-2.

**Table A.3.2.4.3-1: Test Parameters for Closed Loop Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			4
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
<i>ri-ConfigurationInd</i>			1 (Note 4)
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-1
CodeBookSubsetRestriction bitmap			111111
Note 1: $P_B = 1$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.2.4.3-2: Test points for Closed Loop Spatial Multiplexing Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			
Note 4: To avoid the ambiguity of SS behaviour when applying CQI and PMI during rank switching, RI reports are to be applied at the SS with one subframe delay in addition to Note 3 to align with CQI and PMI reports.			

**Table A.3.2.4.3-2: Test points for Closed Loop Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Low
3	LTE-3	EVA5	10	low
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1: See Annex B.3 for the recommended channel bandwidth				
Note 2: The test points is according to Table B.1.2-1in Annex B.1.2.				
Note 3: In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.				

#### A.3.2.4.4 Test Description

##### A.3.2.4.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.2.4.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.2.4.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2 for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.2.4.3-2, as appropriate.
- 3) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.2.4.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.2.3.4-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.2.5 LTE / FTP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (Port 5, UE-Specific Reference Symbols)

#### A.3.2.5.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

#### A.3.2.5.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.2.5.3 Test Parameters

Test parameters are defined in Table A.3.2.5.3-1 and A.3.2.5.3-2.

**Table A.3.2.5.3-1: Test Parameters for Single-layer Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	0 (1 Tx)
	$\rho_B$	dB	0 (1 Tx) (Note 1)
	$\sigma$	dB	0
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			7
Beamforming model			Annex B.4.1 in TS 36.521-1 [2]
Precoder update granularity			Frequency domain: 1 PRB Time domain: 1 ms
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
Reporting mode			PUCCH 1-0
Note 1: $P_B = 0$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.2.5.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.2.5.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1: See Annex B.3 for the recommended channel bandwidth				
Note 2: The test points is according to Table B.1.2-1in Annex B.1.2.				
Note 3: In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.				

#### A.3.2.5.4 Test Description

##### A.3.2.5.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.2.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-3 and A.3.2.5.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.2.5.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1 for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in sub-clause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.2.5.3-2, as appropriate.
- 3) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.2.5.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.2.5.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.2.6 LTE / FTP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (Port 7 or 8, UE-Specific Reference Symbols)

#### A.3.2.6.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

#### A.3.2.6.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.2.6.3 Test Parameters

Test parameters are defined in Table A.3.2.6.3-1 and A.3.2.6.3-2.

**Table A.3.2.6.3-1: Test Parameters for Single-layer Spatial Multiplexing Downlink Testing**

Parameter	Unit	All Tests
Downlink power allocation	$\rho_A$	dB
	$\rho_B$	dB
	$\sigma$	dB
$\hat{E}_s$ at antenna port	dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port	dBm/15kHz	-98
Transmission mode		8
Beamforming model		Annex B.4.1 in TS 36.521-1 [2]
Precoder update granularity		Frequency domain: 1 PRB Time domain: 1 ms
Reporting periodicity	ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>		4
Reporting mode		PUCCH 1-0
Note 1: $P_B = 1$ Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.2.6.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4).		

**Table A.3.2.6.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

#### A.3.2.6.4 Test Description

##### A.3.2.6.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.2.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-3 and A.3.2.6.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.2.6.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2B for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in sub-clause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.2.5.3-2, as appropriate.
- 3) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.2.6.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.2.6.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.2.7 LTE / FTP Downlink / PDSCH Dual-layer Spatial Multiplexing Performance (port 7 and 8, User-Specific Reference Symbols)

#### A.3.2.7.1 Definition

The UE application layer downlink performance for FTP under different multi-path fading environments is determined by the UE application layer FTP throughput T.

#### A.3.2.7.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.2.7.3 Test Parameters

Test parameters are defined in Table A.3.2.7.3-1 and A.3.2.7.3-2.

**Table A.3.2.7.3-1: Test Parameters for Dual-layer Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	0
	$\rho_B$	dB	0 (Note 1)
	$\sigma$	dB	-3
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			8
Beamforming model			Annex B.4.2 in TS 36.521-1 [2]
Precoder update granularity			Frequency domain: 1 PRB Time domain: 1 ms
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
<i>ri-ConfigurationInd</i>			1 (Note 4)
Reporting mode			PUCCH 1-1
Note 1: $P_B = 1$ Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.2.7.3-2: Test points for Dual-layer Spatial Multiplexing Downlink Testing Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4). Note 4: To avoid the ambiguity of SS behaviour when applying CQI and PMI during rank switching, RI reports are to be applied at the SS with one subframe delay in addition to Note 3 to align with CQI and PMI reports.			

**Table A.3.2.7.3-2: Test points for Dual-layer Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

#### A.3.2.7.4 Test Description

##### A.3.2.7.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.2.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-3 and A.3.2.7.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.2.7.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2B for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in sub-clause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.2.7.3-2, as appropriate.
- 3) Using the FTP client, begin FTP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)



- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.2.7.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.2.7.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.3 LTE / UDP Downlink Performance

#### A.3.3.1 LTE / UDP Downlink / PDSCH Single Antenna Port Performance (Cell-Specific Reference Symbols)

##### A.3.3.1.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

##### A.3.3.1.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

##### A.3.3.1.3 Test Parameters

Test parameters are defined in Table A.3.3.1.3-1 and A.3.3.1.3-2.

**Table A.3.3.1.3-1: Test Parameters for SIMO Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	0(1 Tx)
	$\rho_B$	dB	0(1 Tx)(Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			1
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-0
Note 1: $P_B = 0$ Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.3.1.3-2: Test points for SIMO Downlink Testing Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.3.1.3-2: Test points for SIMO Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

### A.3.3.1.4 Test Description

#### A.3.3.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.9 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.3.1.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.3.1.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.3.1.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.3.1.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.3.1.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.3.2 LTE / UDP Downlink / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)

#### A.3.3.2.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

#### A.3.3.2.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.3.2.3 Test Parameters

Test parameters are defined in Table A.3.3.3-1 and A.3.3.3-2.

**Table A.3.3.2.3-1: Test Parameters for TxDiversity Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			2
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
CQI delay		Ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.3.2.3-2: Test points for TxDiversity Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.3.2.3-2: Test points for TxDiversity Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

### A.3.3.2.4 Test Description

#### A.3.3.2.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.3.2.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.3.2.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.3.2.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.3.2.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.3.2.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.3.3 LTE / UDP Downlink / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

#### A.3.3.3.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

#### A.3.3.3.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

#### A.3.3.3.3 Test Parameters

Test parameters are defined in Table A.3.3.3-1 and A.3.3.3-2.

**Table A.3.3.3-1: Test Parameters for Open Loop Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			3
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
<i>ri-ConfigurationInd</i>			1 (Note 4)
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-0
CodeBookSubsetRestriction bitmap			11
Note 1: $P_B = 1$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.3.3-2: Test points for Open Loop Spatial Multiplexing Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on and CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			
Note 4: To avoid the ambiguity of SS behaviour when applying CQI and PMI during rank switching, RI reports are to be applied at the SS with one subframe delay in addition to Note 3 to align with CQI reports.			

**Table A.3.3.3.2: Test points for Open Loop Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
6	LTE-6	EVA70	20 (Note 4)	Low
7	LTE-7	EVA200	20 (Note 5)	Low
2	LTE-2	EPA5	20	Low
3	LTE-3	EVA5	10	Low
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test point is according to Table B.1.2-1 in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			
Note 4:	The test point to be run on Low frequency(<1GHz) bands			
Note 5:	The test point to be run on High Frequency(≥1GHz) bands			

#### A.3.3.3.4 Test Description

##### A.3.3.3.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.3.3.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.3.3.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.

- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.3.3.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)
- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.3.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.3.3.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

#### A.3.3.4 LTE / UDP Downlink / PDSCH Closed Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

##### A.3.3.4.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

##### A.3.3.4.2 Test Purpose

To measure the performance of the UE while downloading TCP based data within both static and multi path faded environments.

##### A.3.3.4.3 Test Parameters

Test parameters are defined in Table A.3.3.4.3-1 and A.3.3.4.3-2.

**Table A.3.3.4.3-1: Test Parameters for Closed Loop Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			4
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
<i>ri-ConfigurationInd</i>			1 (Note 4)
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUCCH 1-1
CodeBookSubsetRestriction bitmap			111111
Note 1: $P_B = 1$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.3.4.3-2: Test points for Closed Loop Spatial Multiplexing Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			
Note 4: To avoid the ambiguity of SS behaviour when applying CQI and PMI during rank switching, RI reports are to be applied at the SS with one subframe delay in addition to Note 3 to align with CQI and PMI reports.			

**Table A.3.3.4.3-2: Test points for Closed Loop Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Low
3	LTE-3	EVA5	10	Low
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
6	LTE-6	EVA70	20 (Note 4)	Low
7	LTE-7	EVA200	20 (Note 5)	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1 in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			
Note 4:	The test point to be run on Low frequency (<1GHz) bands			
Note 5:	The test point to be run on High Frequency(≥1GHz) bands			



#### A.3.3.4.4 Test Description

##### A.3.3.4.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.3.4.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.3.4.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2 for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.3.4.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)
- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.3.4.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.3.4.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

#### A.3.3.5 LTE / UDP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (port 5, User-Specific Reference Symbols)

##### A.3.3.5.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

### A.3.3.5.2 Test Purpose

To measure the performance of the UE while downloading UDP based data within both static and multi path faded environments.

### A.3.3.5.3 Test Parameters

Test parameters are defined in Table A.3.3.5.3-1 and A.3.3.5.3-2.

**Table A.3.3.5.3-1: Test Parameters for Single-layer Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	0 (1 Tx)
	$\rho_B$	dB	0 (1 Tx) (Note 1)
	$\sigma$	dB	0
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			7
Beamforming model			Annex B.4.1 in TS 36.521-1 [2]
Precoder update granularity			Frequency domain: 1 PRB Time domain: 1 ms
Reporting periodicity		ms	$N_{pd} = 5$
cqi-pmi-ConfigurationIndex			4
Reporting mode			PUCCH 1-0
Note 1: $P_B = 0$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.3.5.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on CQI estimation at a downlink subframe not later than SF#(n-4), this reported wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.3.5.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1 in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

#### A.3.3.5.4 Test Description

##### A.3.3.5.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.2.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-3 and A.3.3.5.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.3.5.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1 for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in sub-clause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.3.5.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)
- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.3.5.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.3.5.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

#### A.3.3.6 LTE / UDP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (Port 7 or 8, UE-Specific Reference Symbols)

##### A.3.3.6.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

### A.3.3.6.2 Test Purpose

To measure the performance of the UE while downloading UDP based data within both static and multi path faded environments.

### A.3.3.6.3 Test Parameters

Test parameters are defined in Table A.3.3.6.3-1 and A.3.3.6.3-2.

**Table A.3.3.6.3-1: Test Parameters for Single-layer Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	0
	$\rho_B$	dB	0 (Note 1)
	$\sigma$	dB	-3
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			8
Beamforming model			Annex B.4.1 in TS 36.521-1 [2]
Precoder update granularity			Frequency domain: 1 PRB Time domain: 1 ms
Reporting periodicity		ms	$N_{pd} = 5$
cqi-pmi-ConfigurationIndex			4
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			
Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.3.6.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.3.6.3-2: Test points for Single-layer Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1 in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

#### A.3.3.6.4 Test Description

##### A.3.3.6.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.2.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-3 and A.3.3.6.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.3.6.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2B for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in sub-clause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.3.6.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)
- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.3.6.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.3.6.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

#### A.3.3.7 LTE / UDP Downlink / PDSCH Dual-layer Spatial Multiplexing Performance (port 7 and 8, User-Specific Reference Symbols)

##### A.3.3.7.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

### A.3.3.7.2 Test Purpose

To measure the performance of the UE while downloading UDP based data within both static and multi path faded environments.

### A.3.3.7.3 Test Parameters

Test parameters are defined in Table A.3.3.7.3-1 and A.3.3.7.3-2.

**Table A.3.3.7.3-1: Test Parameters for Dual-layer Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	0
	$\rho_B$	dB	0 (Note 1)
	$\sigma$	dB	-3
$\hat{E}_s$ at antenna port		dBm/15kHz	-85 (Note 2)
$N_{oc}$ at antenna port		dBm/15kHz	-98
Transmission mode			8
Beamforming model			Annex B.4.2 in TS 36.521-1 [2]
Precoder update granularity			Frequency domain: 1 PRB Time domain: 1 ms
Reporting periodicity		ms	$N_{pd} = 5$
<i>cqi-pmi-ConfigurationIndex</i>			4
<i>ri-ConfigurationInd</i>			1 (Note 4)
Reporting mode			PUCCH 1-1
Note 1: $P_B = 0$ Note 2: $\hat{E}_s$ is applied to only Test Number 1 in Table A.3.3.7.3-2: Test points for Dual-layer Spatial Multiplexing Downlink Testing Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4). Note 4: To avoid the ambiguity of SS behaviour when applying CQI and PMI during rank switching, RI reports are to be applied at the SS with one subframe delay in addition to Note 3 to align with CQI and PMI reports.			

**Table A.3.3.7.3-2: Test points for Dual-layer Spatial Multiplexing Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No interference Note 3	N/A
2	LTE-2	EPA5	20	Mid
3	LTE-3	EVA5	10	Mid
4	LTE-4	ETU70	0	Low
5	LTE-5	ETU300	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth			
Note 2:	The test points is according to Table B.1.2-1in Annex B.1.2.			
Note 3:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘no interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			

#### A.3.3.7.4 Test Description

##### A.3.3.7.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.2.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-3 and A.3.3.7.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.3.7.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2B for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in sub-clause B.2.2.1.
- 2) Set the parameters of the bandwidth, MCS, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.3.7.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)

- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.3.7.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.3.7.3-2, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.3.4 LTE / FTP Uplink Performance

### A.3.4.1 LTE / FTP Uplink / PUSCH Single Antenna Port Performance

#### A.3.4.1.1 Definition

The UE application layer uplink performance for FTP under Static environment is determined by the UE application layer FTP throughput T.

#### A.3.4.1.2 Test Purpose

To measure the performance of the UE while uploading FTP based data with static environment while transmitting on single antenna ports.

#### A.3.4.1.3 Test Parameters

Test parameters are defined in Table A.3.4.1.3-1.

**Table A.3.4.1.3-1: Test points**

Initial conditions		
Channel bandwidth	Note 1	
SNR	$\infty$ for Static	
Test parameters for each bandwidth		
Test No	Propagation Conditions	Correlation
1	Static	N/A
Note 1: See Annex B.3 for the recommended channel bandwidth		

#### A.3.4.1.4 Test Description

##### A.3.4.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a FTP server.



- 3) For a tethered configuration, tether the UE to a laptop configured with FTP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an FTP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2 and A.3.1-3 as appropriate. UE CSI reporting will be disabled.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2]. The downlink power allocation shall be set such that  $\rho_A$  and  $\rho_B$  are equal to -3dB ( $P_B = 1$ ).
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.4.1.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2A for C\_RNTI to transmit the DL data using the transport format and transport block size based on an assumed UE reported CQI Index of 8 as described in subclause B.2.2.1. This DL allocation would be in-line with the guidance provided in Annex A.3.1 which would use a fixed reference channel based on a similar coding rate utilized for the RMCs used for TM3 performance tests in TS 36.521-1 Annex A.3.3.2.1 or A.3.4.2.1 with the exception that subframe 0 will also be empty in addition to subframe 5 in accordance with Annex B.2.2.1.
- 2) Set the downlink parameters of the bandwidth, the propagation condition, the correlation matrix, and the SNR according to Table A.3.4.1.3-1, as appropriate. Set the uplink parameters of the bandwidth, MCS, reference channel according to Annex A.3.1 as appropriate.
- 3) Using the FTP client, begin FTP upload from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)
- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.
- 6) Count and record the overall number of ACK and NACK on the PHICH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.4.1.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.4.1.3-1, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.3.5 LTE / UDP Uplink Performance

### A.3.5.1 LTE / UDP Uplink / PUSCH Single Antenna Port Performance

#### A.3.5.1.1 Definition

The UE application layer uplink performance for UDP under Static environment is determined by the UE application layer UDP throughput T.

#### A.3.5.1.2 Test Purpose

To measure the performance of the UE while uploading UDP based data with static environment while transmitting on single antenna ports.

#### A.3.5.1.3 Test Parameters

Test parameters are defined in Table A.3.5.1.3-1.

**Table A.3.5.1.3-1: Test points**

Initial conditions		
Channel bandwidth	Note 1	
SNR	$\infty$ for Static	
Test parameters for each bandwidth		
Test No	Propagation Conditions	Correlation
1	Static	N/A
Note 1: See Annex B.3 for the recommended channel bandwidth		

#### A.3.5.1.4 Test Description

##### A.3.5.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2 and A.3.1-3 as appropriate. UE CSI reporting will be disabled.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2]. The downlink power allocation shall be set such that  $\rho_A$  and  $\rho_B$  are equal to -3dB ( $P_B = 1$ ).
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.5.1.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2A for C\_RNTI to transmit the DL data using the transport format and transport block size based on an assumed UE reported CQI Index of 8 as described in subclause B.2.2.1. This DL allocation would be in-line with the guidance provided in Annex A.3.1 which would use a fixed reference channel based on a similar coding rate utilized for the RMCs used for TM3 performance tests in TS 36.521-1 Annex A.3.3.2.1 or A.3.4.2.1 with the exception that subframe 0 will also be empty in addition to subframe 5 in accordance with Annex B.2.2.1.
- 2) Set the downlink parameters of the bandwidth, the propagation condition, the correlation matrix, and the SNR according to Table A.3.5.1.3-1, as appropriate. Set the uplink parameters of the bandwidth, MCS, reference channel according to Annex A.3.1 as appropriate.
- 3) Using the UDP client, begin UDP upload from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result. (This is iteration 1)
- 4) Repeat transfer for iterations 2-5 within the same call as the first iteration.
- 5) Calculate and record the average throughput of the five iterations.

- 6) Count and record the overall number of ACK and NACK on the PHICH during the test interval.
- 7) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.5.1.4.1.
- 8) Repeat steps 1 to 6 for each subtest in Table A.3.5.1.3-1, as appropriate.
- 9) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.3.6 LTE / Stress Test Performance

### A.3.6.1 LTE / Stress Test Performance / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)

#### A.3.6.1.1 Definition

The UE application layer stress test performance is determined by the UE application layer bi-directional UDP and alternating direction FTP throughput T over an extended transfer duration.

#### A.3.6.1.2 Test Purpose

To measure the performance of the UE over extended transfer durations while simultaneously uploading and downloading UDP based data or alternating upload and download FTP transfers with static conditions.

#### A.3.6.1.3 Test Parameters

Test parameters are defined in Table A.3.6.1.3-1 and A.3.6.1.3-2.

**Table A.3.6.1.3-1: Test Parameters for Transmit Diversity UDP/FTP Stress Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$N_{oc}$ at antenna port		dBm/15kHz	N/A
Transmission mode			2
Reporting interval		ms	5
CQI delay		ms	8
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			

**Table A.3.6.1.3-2: Test points for Transmit Diversity UDP/FTP Stress Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Protocol (FTP/UDP)
1	LTE-1	Static	No Interference Note 5	Alternating FTP
2	LTE-1	Static	No Interference Note 5	Bi-directional UDP
Note 1: See Annex B.3 for the recommended channel bandwidth				
Note 2: The test points is according to Table B.1.2-1in Annex B.1.2.				
Note 3: FTP File size should allow a minimum transfer duration of 1 minute per transfer with the number of transfers equal to 10.				
Note 4: UDP bidirectional duration shall be set to 10 minutes with a sufficient blast rates to prevent physical layer DTX on either the UL or DL.				
Note 5: In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.				

### A.3.6.1.4 Test Description

#### A.3.6.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with both a FTP and UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with both FTP and UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has both FTP and UDP client test applications available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.6.1.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.6.1.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.

- 2) Set the downlink parameters of the bandwidth, propagation condition, and SNR according to Table A.3.6.1.3-2, as appropriate. Set the UL parameters of the bandwidth, MCS, reference channel according to Annex A.3.1 as appropriate.
- 3) Using the FTP or UDP client, begin FTP or UDP transfers to/from the application server per Table A.3.6.1.3-2 and record Throughput T results.
- 4) Record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 5) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.6.1.4.1.
- 6) Repeat steps 1 to 5 for each subtest in Table A.3.6.1.3-2, as appropriate.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.3.6.2 LTE / Stress Test Performance / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

### A.3.6.2.1 Definition

The UE application layer stress test performance is determined by the UE application layer bi-directional UDP and alternating direction FTP throughput T over an extended transfer duration.

### A.3.6.2.2 Test Purpose

To measure the performance of the UE over extended transfer durations while simultaneously uploading and downloading UDP based data or alternating upload and download FTP transfers with static conditions.

### A.3.6.2.3 Test Parameters

Test parameters are defined in Table A.3.6.2.3-1 and A.3.6.2.3-2.

**Table A.3.6.2.3-1: Test Parameters for Open Loop Spatial Multiplexing UDP/FTP Stress Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$N_{oc}$ at antenna port		dBm/15kHz	N/A
Transmission mode			3
Reporting interval		ms	5
CQI delay		ms	8
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			

**Table A.3.6.2.3-2: Test points for Open Loop Spatial Multiplexing UDP/FTP Stress Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test Number	Reference test point Note 2	Propagation Conditions Note 2	SNR (dB) Note 2	Correlation
1	LTE-1	Static	No Interference Note 5	Alternating FTP
2	LTE-1	Static	No Interference Note 5	Bi-directional UDP
Note 1: See Annex B.3 for the recommended channel bandwidth				
Note 2: The test points is according to Table B.1.2-1in Annex B.1.2.				
Note 3: FTP File size should allow a minimum transfer duration of 1 minute per transfer with the number of transfers equal to 10.				
Note 4: UDP bidirectional duration shall be set to 10 minutes with a sufficient blast rates to prevent physical layer DTX on either the UL or DL.				
Note 5: In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'no interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.				

### A.3.6.2.4 Test Description

#### A.3.6.2.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with both a FTP and UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with both FTP and UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has both FTP and UDP client test applications available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.6.2.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.6.2.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.

- 2) Set the downlink parameters of the bandwidth, propagation condition, and SNR according to Table A.3.6.2.3-2, as appropriate. Set the UL parameters of the bandwidth, MCS, reference channel according to Annex A.3.1 as appropriate.
- 3) Using the FTP or UDP client, begin FTP or UDP transfers to/from the application server per Table A.3.6.2.3-2 and record Throughput T results.
- 4) Record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 5) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.6.2.4.1.
- 6) Repeat steps 1 to 5 for each subtest in Table A.3.6.2.3-2, as appropriate.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## A.3.7 LTE / UDP Power Sweep Performance

### A.3.7.1 LTE / UDP Power Sweep Performance / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)

#### A.3.7.1.1 Definition

The UE application layer power sweep performance for UDP under a multi-path fading environment is determined by the UE application layer UDP throughput T.

#### A.3.7.1.2 Test Purpose

To determine if the UE Application Layer Data Throughput increases as the signal level is increased in relation to the UE noise floor and the consistency of the UE Application Layer Data Throughput across Ior values once the throughput has reached a maximum while downloading UDP based data with a multi path faded environment.

#### A.3.7.1.3 Test Parameters

Test parameters are defined in Table A.3.7.1.3-1 and A.3.7.1.3-2.

**Table A.3.7.1.3-1: Test Parameters for Transmit Diversity UDP Power Sweep Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
Transmission mode			2
Reporting interval		Ms	5
CQI delay		Ms	8
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			

**Table A.3.7.1.3-2: Test Points for Transmit Diversity UDP Power Sweep Testing**

Initial conditions			
Channel bandwidth		Note1	
Test parameters for each bandwidth			
Test Number	Propagation Conditions	Ior (dBm)	Correlation
1	EVA70	-78	Low
2	EVA70	-80	Low
3	EVA70	-82	Low
4	EVA70	-84	Low
5	EVA70	-86	Low
6	EVA70	-88	Low
.	.	.	.
.	.	.	.
.	.	.	.
N	EVA70	REFSENS + 6 dB [Note 5]	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth		
Note 2:	Determine if throughput increases as the signal level is increased in relation to the UE noise floor and remains consistent across Ior values within a reasonable tolerance once the throughput has reached a maximum.		
Note 3:	Ior (dBm) power levels are specified for 10 MHz channel bandwidth. For other channel bandwidths, add the offset defined in table A.3.7.1.3-3.		
Note 4:	When testing at lower signal levels care should be taken so the test system can fulfil the test uncertainties defined in section 5.9.1		
Note 5:	REFSENS as defined in TS 36.101 [13] clause 7.3 for the applicable operating band and channel BW. The test points between -88 dBm and test point N shall decrement by 2 dB until REFSENS + 6 dB is reached.		
Note 6:	In the performance report, the tester shall indicate that the throughput is expected to reach a maximum. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.		

**Table A.3.7.1.3-3: Ior Power level offsets for Transmit Diversity UDP Power Sweep Testing**

Channel bandwidth BW <sub>Channel</sub> [MHz]	1.4	3	5	10	15	20
Ior power level offset (dB)	-9.2	-5.2	-3.0	0.0	1.8	3.0

#### A.3.7.1.4 Test Description

##### A.3.7.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS and the faders to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.



- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.7.1.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.7.1.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, the propagation condition, the correlation matrix, and the signal level according to Table A.3.7.1.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result for each iteration.
- 4) Count and record the number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 5) Repeat steps 3 and 4 for each subtest in Table A.3.7.1.3-2.
- 6) Determine if throughput increases as the signal level is increased in relation to the UE noise floor and remains consistent across Ior values within a reasonable tolerance once the throughput has reached a maximum.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.7.2 LTE / UDP Power Sweep Performance / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

#### A.3.7.2.1 Definition

The UE application layer power sweep performance for UDP under a multi-path fading environment is determined by the UE application layer UDP throughput T.

#### A.3.7.2.2 Test Purpose

To determine if the UE Application Layer Data Throughput increases as the signal level is increased in relation to the UE noise floor and the consistency of the UE Application Layer Data Throughput across Ior values once the throughput has reached a maximum while downloading UDP based data with a multi path faded environment.

#### A.3.7.2.3 Test Parameters

Test parameters are defined in Table A.3.7.2.3-1 and A.3.7.2.3-2.

**Table A.3.7.2.3-1: Test Parameters for Open Loop Spatial Multiplexing UDP Power Sweep Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
Transmission mode			3
Reporting interval		ms	5
CQI delay		ms	8
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			

**Table A.3.7.2.3-2: Test Points for Open Loop Spatial Multiplexing UDP Power Sweep Testing**

Initial conditions			
Channel bandwidth		Note1	
Test parameters for each bandwidth			
Test Number	Propagation Conditions	lor (dBm)	Correlation
1	EVA70	-60	Low
2	EVA70	-62	Low
3	EVA70	-64	Low
4	EVA70	-66	Low
5	EVA70	-68	Low
6	EVA70	-70	Low
7	EVA70	-72	Low
8	EVA70	-74	Low
9	EVA70	-76	Low
10	EVA70	-78	Low
11	EVA70	-80	Low
12	EVA70	-82	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth		
Note 2:	Determine if throughput increases as the signal level is increased in relation to the UE noise floor and remains consistent across lor values within a reasonable tolerance once the throughput has reached a maximum.		
Note 3:	lor (dBm) power levels are specified for 10 MHz channel bandwidth. For other channel bandwidths, add the offset defined in Table A.3.7.2.3-3.		
Note 4:	In the performance report, the tester shall indicate that the throughput is expected to reach a maximum. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.		

**Table A.3.7.2.3-3: lor Power level offsets for Open Loop Spatial Multiplexing UDP Power Sweep Testing**

Channel bandwidth BW <sub>Channel</sub> [MHz]	1.4	3	5	10	15	20
lor power level offset (dB)	-9.2	-5.2	-3.0	0.0	1.8	3.0

## A.3.7.2.4 Test Description

### A.3.7.2.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS and the faders to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.7.2.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.7.2.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, the propagation condition, the correlation matrix, and the signal level according to Table A.3.7.2.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result for each iteration.
- 4) Count and record the number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 5) Repeat steps 3 and 4 for each subtest in Table A.3.7.2.3-2.
- 6) Determine if throughput increases as the signal level is increased in relation to the UE noise floor and remains consistent across Ior values within a reasonable tolerance once the throughput has reached a maximum.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.8 LTE / UDP Downlink vs. SNR Performance

#### A.3.8.1 LTE / UDP Downlink vs. SNR Performance / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)

##### A.3.8.1.1 Definition

The UE application layer UDP Downlink vs. SNR Performance for UDP under both static and a multi-path fading environment is determined by the UE application layer UDP throughput T.

##### A.3.8.1.2 Test Purpose

To measure the Application Throughput over SNR while downloading UDP based data with both static and a multi path faded environment.

### A.3.8.1.3 Test Parameters

Test parameters are defined in Table A.3.8.1.3-1 and A.3.8.1.3-2. Selection of typical channel bandwidth for each Band No is FFS.

**Table A.3.8.1.3-1: Test Parameters for Tx Diversity Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$N_{oc}$ at antenna port		dBm/15kHz	As needed per Test No
Transmission mode			2
Reporting interval		Ms	5
CQI delay		Ms	8
Reporting mode			PUCCH 1-0
Note 1: $P_B = 1$			

**Table A.3.8.1.3-2: Test points for Tx Diversity Downlink Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test No	Propagation Conditions	Ior (dBm)	SNR (dB)	Correlation
1	Static	-60	20	N/A
2	Static	-65	15	N/A
3	Static	-70	10	N/A
4	Static	-75	5	N/A
5	Static	-80	0	N/A
6	Static	-85	-5	N/A
7	EPA5	-60	20	Mid
8	EPA5	-65	15	Mid
9	EPA5	-70	10	Mid
10	EPA5	-75	5	Mid
11	EPA5	-80	0	Mid
12	EPA5	-85	-5	Mid
13	EVA70	-60	20	Mid
14	EVA70	-65	15	Mid
15	EVA70	-70	10	Mid
16	EVA70	-75	5	Mid
17	EVA70	-80	0	Mid
18	EVA70	-85	-5	Mid
Note 1: See Annex B.3 for the recommended channel bandwidth.				

### A.3.8.1.4 Test Description

#### A.3.8.1.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.

- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.8.1.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.8.1.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.8.1.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result
- 4) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the subtest interval.
- 5) Repeat steps 3 and 4 for each subtest in Table A.3.8.1.3-2.
- 6) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.8.1.4.1.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.8.2 LTE / UDP Downlink vs. SNR Performance / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

#### A.3.8.2.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

#### A.3.8.2.2 Test Purpose

To measure the performance of the UE while downloading UDP based data within both static and multi path faded environments.

#### A.3.8.2.3 Test Parameters

Test parameters are defined in Table A.3.8.2.3-1 and A.3.8.2.3-2.

Table A.3.8.2.3-1: Test Parameters for Open Loop Spatial Multiplexing Downlink Testing

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$N_{oc}$ at antenna port		dBm/15kHz	As needed per Test No
Transmission mode			3
Reporting interval		ms	5
CQI delay		ms	8
Reporting mode			PUCCH 1-0
CodeBookSubsetRestriction bitmap			11
Note 1: $P_B = 1$			

Table A.3.8.2.3-2: Test points for Open Loop Spatial Multiplexing Testing

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test No	Propagation Conditions	lor (dBm)	SNR (dB)	Correlation
1 Note 3	Static	-50	No Interference Note 2	N/A
2	Static	-55	25	N/A
3	Static	-60	20	N/A
4	Static	-65	15	N/A
5	Static	-70	10	N/A
6	Static	-75	5	N/A
7	Static	-80	0	N/A
8	EPA5	-50	No External Noise	Low
9	EPA5	-55	25	Low
10	EPA5	-60	20	Low
11	EPA5	-65	15	Low
12	EPA5	-70	10	Low
13	EPA5	-75	5	Low
14	EPA5	-80	0	Low
15	EVA70	-50	No External Noise	Low
16	EVA70	-55	25	Low
17	EVA70	-60	20	Low
18	EVA70	-65	15	Low
19	EVA70	-70	10	Low
20	EVA70	-75	5	Low
21	EVA70	-80	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth.			
Note 2:	In the performance report, the tester shall indicate for the 'No Interference' condition, the following note: In case of 'No Interference', the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			
Note 3:	If this test point is part of another test there is no need to repeat. The previous result can be used.			

#### A.3.8.2.4 Test Description

##### A.3.8.2.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.8.2.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

##### A.3.8.2.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2A for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1.
- 2) Set the parameters of the bandwidth, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.8.2.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result.
- 4) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the subtest interval.
- 5) Repeat steps 3 and 4 for each subtest in Table A.3.8.2.3-2.
- 6) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.8.2.4.1.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.8.3 LTE / UDP Downlink vs. SNR Performance / PDSCH Closed Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)

#### A.3.8.3.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

#### A.3.8.3.2 Test Purpose

To measure the performance of the UE while downloading UDP based data within both static and multi path faded environments.

### A.3.8.3.3 Test Parameters

Test parameters are defined in Table A.3.8.3.3-1 and A.3.8.3.3-2.

**Table A.3.8.3.3-1: Test Parameters for Closed Loop Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$N_{oc}$ at antenna port		dBm/15kHz	As needed per Test No
Transmission mode			4
Reporting interval		ms	5 (Note 2)
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUSCH 1-2
CodeBookSubsetRestriction bitmap			111111
Note 1: $P_B = 1$ Note 2: SS schedules the UL transmission to carry the PUSCH CQI feedback via PDCCH DCI format 0 with CQI request bit set to 1 Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			



**Table A.3.8.3.3-2: Test points for Closed Loop Spatial Multiplexing Testing**

Initial conditions				
Channel bandwidth	Note1			
Test parameters for each bandwidth				
Test No	Propagation Conditions	lor (dBm)	SNR (dB)	Correlation
1 Note 3	Static	-50	No Interference Note 2	N/A
2	Static	-55	25	N/A
3	Static	-60	20	N/A
4	Static	-65	15	N/A
5	Static	-70	10	N/A
6	Static	-75	5	N/A
7	Static	-80	0	N/A
8	EPA5	-50	No External Noise	Low
9	EPA5	-55	25	Low
10	EPA5	-60	20	Low
11	EPA5	-65	15	Low
12	EPA5	-70	10	Low
13	EPA5	-75	5	Low
14	EPA5	-80	0	Low
15	EVA70	-50	No External Noise	Low
16	EVA70	-55	25	Low
17	EVA70	-60	20	Low
18	EVA70	-65	15	Low
19	EVA70	-70	10	Low
20	EVA70	-75	5	Low
21	EVA70	-80	0	Low
Note 1:	See Annex B.3 for the recommended channel bandwidth.			
Note 2:	In the performance report, the tester shall indicate for the ‘No Interference’ condition, the following note: In case of ‘No Interference’, the throughput is expected to be maximal. This may be the maximum theoretical throughput or below. In the latter case it cannot be distinguished, whether UE limitations, or signal generator limitations with respect to EVM, or both contribute to this.			
Note 3:	If this test point is part of another test there is no need to repeat. The previous result can be used.			

### A.3.8.3.4 Test Description

#### A.3.8.3.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.

- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.8.3.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.8.3.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 2 for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1. The PMI used by the SS is determined as described in subclause B.2.2.6. The transmission rank used by the SS is determined as described in subclause B.2.2.7.
- 2) Set the parameters of the bandwidth, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.8.3.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result.
- 4) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 5) Repeat steps 3 and 4 for each subtest in Table A.3.8.3.3-2.
- 6) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.8.3.4.1.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

### A.3.8.4 LTE / UDP Downlink vs. SNR Performance / PDSCH Closed Loop Spatial Multiplexing using a single transmission layer Performance (Cell-Specific Reference Symbols)

#### A.3.8.4.1 Definition

The UE application layer downlink performance for UDP under different multi-path fading environments is determined by the UE application layer UDP throughput T.

#### A.3.8.4.2 Test Purpose

To measure the performance of the UE while downloading UDP based data within both static and multi path faded environments.

#### A.3.8.4.3 Test Parameters

Test parameters are defined in Table A.3.8.4.3-1 and A.3.8.4.3-2.

**Table A.3.8.4.3-1: Test Parameters for Single Layer Closed Loop Spatial Multiplexing Downlink Testing**

Parameter		Unit	All Tests
Downlink power allocation	$\rho_A$	dB	-3
	$\rho_B$	dB	-3 (Note 1)
$N_{oc}$ at antenna port		dBm/15kHz	As needed per Test No
Transmission mode			6
Reporting interval		ms	5 (Note 2)
CQI delay		ms	8 for FDD 10 for TDD (Note 3)
Reporting mode			PUSCH 1-2
Note 1: $P_B = 1$			
Note 2: SS schedules the UL transmission to carry the PUSCH CQI feedback via PDCCH DCI format 0 with CQI request bit set to 1			
Note 3: If the UE reports in an available uplink reporting instance at subframe SF#n based on PMI and CQI estimation at a downlink subframe not later than SF#(n-4), this reported PMI and wideband CQI cannot be applied at the eNB downlink before SF#(n+4).			

**Table A.3.8.4.3-2: Test points for Single Layer Closed Loop Spatial Multiplexing Testing**

Initial conditions				
Channel bandwidth		Note1		
Test parameters for each bandwidth				
Test No	Propagation Conditions	lor	SNR (dB)	Correlation
1	Static	-60	20	N/A
2	Static	-65	15	N/A
3	Static	-70	10	N/A
4	Static	-75	5	N/A
5	Static	-80	0	N/A
6	Static	-85	-5	N/A
7	EPA5	-60	20	Mid
8	EPA5	-65	15	Mid
9	EPA5	-70	10	Mid
10	EPA5	-75	5	Mid
11	EPA5	-80	0	Mid
12	EPA5	-85	-5	Mid
13	EVA70	-60	20	Mid
14	EVA70	-65	15	Mid
15	EVA70	-70	10	Mid
16	EVA70	-75	5	Mid
17	EVA70	-80	0	Mid
18	EVA70	-85	-5	Mid
Note 1: See Annex B.3 for the recommended channel bandwidth.				

#### A.3.8.4.4 Test Description

##### A.3.8.4.4.1 Initial Conditions

Initial conditions are a set of test configurations the UE needs to be tested in and the steps for the SS to take with the UE to reach the correct measurement state.

Configurations of PDSCH and PDCCH before measurement are specified in Annex C.2 of TS 36.521-1 [2].

Test Environment: Normal, as defined in TS 36.508 [11] clause 4.1.

Frequencies to be tested: Mid Range, as defined in TS 36.508 [11] clause 4.3.1.1 for FDD and 4.3.1.2 for TDD.

- 1) Connect the SS, the faders and AWGN noise sources to the UE antenna connectors as shown in TS 36.508 [11] Annex A, Figure A.10 for antenna configuration 2x2.
- 2) Connect an application server to the IP output of the SS configured with a UDP server.
- 3) For a tethered configuration, tether the UE to a laptop configured with UDP client software using the appropriate UE to PC interface Modem or Network Interface Connection (NIC) drivers. For an embedded configuration, ensure that the UE has an UDP client test application available.
- 4) The parameter settings for the cell are set up according to Tables A.3.1-2, A.3.1-3 and A.3.8.4.3-1 as appropriate.
- 5) Downlink signals are initially set up according to Annex C0, C.1 and Annex C.3.2 in TS 36.521-1 [2] and uplink signals according to Annex H.1 and H.3.2 in TS 36.521-1 [2].
- 6) Propagation conditions are set according to Annex B.0 in TS 36.521-1 [2].

#### A.3.8.4.4.2 Procedure

- 1) SS transmits PDSCH via PDCCH DCI format 1 for C\_RNTI to transmit the DL data using the transport format and transport block size determined based on UE reported CQI as described in subclause B.2.2.1. The PMI used by the SS is determined as described in subclause B.2.2.6.
- 2) Set the parameters of the bandwidth, reference channel, the propagation condition, the correlation matrix, antenna configuration and the SNR according to Table A.3.8.4.3-2, as appropriate.
- 3) Using the UDP client, begin UDP download from the application server of a file sufficient in size for the test duration outlined in Table A.3.1-1 and record Throughput T result.
- 4) Count and record the overall number of ACK and NACK/DTX on the PUSCH/PUCCH during the test interval.
- 5) Repeat steps 3 and 4 for each subtest in Table A.3.8.4.3-2.
- 6) If the RRC connection setup needs to be re-established after the subtest, perform the initial call setup in accordance with the initial conditions in clause A.3.8.4.4.1.
- 7) Record the IP address type (IPv4 or IPv6) used during the file transfers.

## Annex B: Specific Test Conditions and Environment

### B.0 Purpose of Annex

This annex specifies the test conditions and test environment to be used for UE Application Layer Data Throughput Performance testing.

It includes details of the Reference Test Points, the system configurations, the simulated network environments and recommendations for operating band and channel bandwidth selections.

### B.1 Reference Test Points

#### B.1.1 Reference Test Points for HSPA

**Table B.1.1-1: Reference Test Points for HSPA**

Test point index	Propagation Condition	Geometry	Other test point parameters	Justification
HSPA-1 Note 1	Static	No interference	As defined in test case	To check that upper-layers do not constrain data throughput
HSPA-2	PA3 Note 2	20dB	As defined in test case	To exhibits large TBS variations (see clause 5.5.4.3) and very common scenarios for high-data rate requiring processing capability
HSPA-3	VA30 Note 2	10dB	As defined in test case	Fast variations and VA occurs frequently in deployments
HSPA-4	VA120 Note 2	0dB	As defined in test case	A high BLER scenario may trigger higher layer retransmissions, and also addresses the high speed scenario in the work item objective
HSPA-5	PB3 Note 2	0dB	As defined in test case	Most common high-dispersion case
Note 1:	Definition of the Static and No Interference condition for the HSPA-1 test point index: The downlink connection between the System Simulator and the UE is without Additive White Gaussian Noise, and has no fading or multipath effects.			
Note 2:	See TS 25.101 [12], Annex B.2 for definition of PA3, PB3, VA30 and VA120			

## B.1.2 Reference Test Points for LTE

**Table B.1.2-1: Reference Test Points for LTE**

Test point index	Propagation Condition	SNR	Other test point parameters	Justification
LTE-1	Static	No interference Note 1	As defined in test case	To check that upper-layers do not constrain data throughput
LTE-2	EPA5 Note 2	20dB	As defined in test case	To exhibits large TBS variations (see clause 5.5.4.3) and very common scenarios for high-data rate requiring processing capability
LTE-3	EVA5 Note 2	10dB	As defined in test case	EVA occurs frequently in deployments
LTE-4	ETU70 Note 2	0dB	As defined in test case	Fast variations and most common high-dispersion case
LTE-5	ETU300 Note 2	0dB	As defined in test case	A high BLER scenario may trigger higher layer retransmissions, and also addresses the high speed scenario in the work item objective
LTE-6	EVA70	20 dB	As defined in test case	Adds EVA70, high SNR coverage which is common in low frequency (<1GHz) band networks
LTE-7	EVA200	20 dB	As defined in test case	Covers high Doppler, high SNR scenario which is common in high frequency (≥1GHz) band networks
Note 1: See TS 36.521-1 [2], Annex B.0 for definition of No interference.				
Note 2: See TS 36.101 [13], Annex B.2 for definition of EVA5, EPA5, EVA70, ETU70 and ETU300				

## B.2 Reference system configurations

### B.2.1 HSPA reference system configurations

#### B.2.1.1 Mapping of UE reported CQI and TBS (HSPA)

The transport block size to be used by the SS is dependent on the UE reported CQI, and is determined by the tables in TS 25.214, clause 6A.2.3.

For the case in which RLC PDU size settings (i.e. for the case flexible RLC PDU size is not utilized) are such that the reported CQI value causes the mapped transport block size to not fit in the RLC PDU then the SS shall not transmit any data.

#### B.2.1.2 MAC Configurations

For UEs supporting HS-DSCH Category 12 or lower, MAC-hs should be configured. For UEs supporting HS-DSCH Category 13 or higher, MAC-ehs should be configured.

#### B.2.1.3 RLC Configuration

For HSPA data throughput testing purposes RLC in AM mode only will be used. The RLC configuration parameters shall follow the parameters as defined for RLC AM in the default RADIO BEARER SETUP message in clause 9.1 of TS 34.108 [14] for condition A31.

## B.2.1.4 PDCP Configuration

For HSPA data throughput testing compression will not be enabled. The PDCP configuration parameters shall follow the parameters as defined for RLC AM in the default RADIO BEARER SETUP message in clause 9.1 of TS 34.108 [14] for condition A31.

## B.2.2 LTE reference system configurations

### B.2.2.1 Mapping of UE reported CQI and MCS (LTE)

*Editor's Note:*

- To allow for test system implementation based on the clarifications in the second paragraph below for the TM 3, 4, 8, and 9 test cases and the SS behaviour when applying CQI during rank switching, the existing functionality based on TR 37.901 v11.10.0 may be used until RAN5 #65.

The mapping between UE signalled CQI and the MCS used by the SS for downlink transmissions is based on full RB allocation and wideband CQI reporting mode. The mapping follows the rules specified in TS 36.101 [13] clause A.2.1.2 and in TS 36.213 [10] clauses and 7.1.7 and 7.2.3.

For Transmission mode 3, 4, 8 and 9 test cases in annex A.3.2 and A.3.3, the CQI is calculated conditioned on the last reported periodic RI. For other transmission modes it is calculated conditioned on transmission rank 1. To avoid the ambiguity of SS behaviour when applying CQI during rank switching, RI reports are to be applied at the SS with one subframe delay to align with CQI and PMI reports. This follows the rules specified in TS 36.213 [10] clause 7.2.2.

Tables B.2.2.1-1 to B.2.2.1-12 show CQI to MCS mapping tables that SS shall use for testing single and dual antenna transmission cases at different channel bandwidth.

When applying the CQI mapping tables for different UE categories the SS shall take into account UE category dependent capabilities related to a maximum number of DL-SCH transport block bits received within a TTI as specified in TS 36.306 Table 4.1-1. For a CAT 3 UE these limitations have been added into tables B.2.2.1-9 to B.2.2.1-12.

For LTE TDD testing, UL-DL configuration 2 according to Table A.3.1-3 is used and only SF#3, SF#4, SF#8 and SF#9 are allocated to avoid PBCH and synchronization signal overhead. The DwPTS part of the special subframe is also not allocated.

**Table B.2.2.1-1: CQI to MCS mapping table for the single antenna transmission case, 1.4 MHz channel bandwidth**

1.4 MHz, 6 PRBs (full allocation), 1 Tx antenna, CFI3				
CQI index	MCS Index			Target Code Rate
	SF#0	SF#5	Other	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	6	0.4385
6	DTX	DTX	8	0.5879
7	DTX	DTX	11	0.3691
8	DTX	DTX	13	0.4785
9	DTX	DTX	14	0.6016
10	DTX	DTX	17	0.4551
11	DTX	DTX	20	0.5537
12	DTX	DTX	21	0.6504
13	DTX	DTX	23	0.7539
14	DTX	DTX	25	0.8525
15	DTX	DTX	27	0.9258

**Table B.2.2.1-2: CQI to MCS mapping table for the dual antenna transmission case, 1.4 MHz channel bandwidth**

<b>1.4 MHz, 6 PRBs (full allocation), 2 Tx antenna, CFI3</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	1	0.1885
4	DTX	DTX	3	0.3008
5	DTX	DTX	5	0.4385
6	DTX	DTX	7	0.5879
7	DTX	DTX	10	0.3691
8	DTX	DTX	12	0.4785
9	DTX	DTX	14	0.6016
10	DTX	DTX	17	0.4551
11	DTX	DTX	19	0.5537
12	DTX	DTX	21	0.6504
13	DTX	DTX	23	0.7539
14	DTX	DTX	24	0.8525
15	DTX	DTX	25	0.9258

**Table B.2.2.1-3: CQI to MCS mapping table for the single antenna transmission case, 3 MHz channel bandwidth**

<b>3 MHz, 15 PRBs (full allocation), 1 Tx antenna, CFI3</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	6	0.4385
6	DTX	DTX	8	0.5879
7	DTX	DTX	11	0.3691
8	DTX	DTX	13	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	18	0.4551
11	DTX	DTX	21	0.5537
12	DTX	DTX	23	0.6504
13	DTX	DTX	25	0.7539
14	DTX	DTX	27	0.8525
15	DTX	DTX	27	0.9258



**Table B.2.2.1-4: CQI to MCS mapping table for the dual antenna transmission case, 3 MHz channel bandwidth**

<b>3 MHz, 15 PRBs (full allocation), 2 Tx antenna, CFI3</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	6	0.4385
6	DTX	DTX	8	0.5879
7	DTX	DTX	11	0.3691
8	DTX	DTX	13	0.4785
9	DTX	DTX	15	0.6016
10	DTX	DTX	18	0.4551
11	DTX	DTX	20	0.5537
12	DTX	DTX	22	0.6504
13	DTX	DTX	24	0.7539
14	DTX	DTX	26	0.8525
15	DTX	DTX	27	0.9258

**Table B.2.2.1-5: CQI to MCS mapping table for the single antenna transmission case, 5 MHz channel bandwidth**

<b>5 MHz, 25 PRBs (full allocation), 1 Tx antenna, CFI3</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	6	0.4385
6	DTX	DTX	8	0.5879
7	DTX	DTX	11	0.3691
8	DTX	DTX	13	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	19	0.4551
11	DTX	DTX	21	0.5537
12	DTX	DTX	23	0.6504
13	DTX	DTX	25	0.7539
14	DTX	DTX	27	0.8525
15	DTX	DTX	27	0.9258

**Table B.2.2.1-6: CQI to MCS mapping table for the dual antenna transmission case, 5 MHz channel bandwidth**

<b>5 MHz, 25 PRBs (full allocation), 2 Tx antenna, CFI3</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	6	0.4385
6	DTX	DTX	8	0.5879
7	DTX	DTX	11	0.3691
8	DTX	DTX	13	0.4785
9	DTX	DTX	15	0.6016
10	DTX	DTX	18	0.4551
11	DTX	DTX	20	0.5537
12	DTX	DTX	22	0.6504
13	DTX	DTX	24	0.7539
14	DTX	DTX	26	0.8525
15	DTX	DTX	27	0.9258

**Table B.2.2.1-7: CQI to MCS mapping table for the single antenna transmission case, 10 MHz channel bandwidth**

<b>10 MHz, 50 PRBs (full allocation), 1 Tx antenna, CFI2</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	1	0.1172
3	DTX	DTX	3	0.1885
4	DTX	DTX	5	0.3008
5	DTX	DTX	7	0.4385
6	DTX	DTX	9	0.5879
7	DTX	DTX	12	0.3691
8	DTX	DTX	14	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	19	0.4551
11	DTX	DTX	22	0.5537
12	DTX	DTX	24	0.6504
13	DTX	DTX	27	0.7539
14	DTX	DTX	28	0.8525
15	DTX	DTX	28	0.9258

**Table B.2.2.1-8: CQI to MCS mapping table for the dual antenna transmission case, 10 MHz channel bandwidth**

<b>10 MHz, 50 PRBs (full allocation), 2 Tx antenna, CFI2</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	7	0.4385
6	DTX	DTX	9	0.5879
7	DTX	DTX	12	0.3691
8	DTX	DTX	14	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	19	0.4551
11	DTX	DTX	21	0.5537
12	DTX	DTX	23	0.6504
13	DTX	DTX	26	0.7539
14	DTX	DTX	27	0.8525
15	DTX	DTX	27	0.8525

**Table B.2.2.1-9: CQI to MCS mapping table for the single antenna transmission case, 15 MHz channel bandwidth**

<b>15 MHz, 75 PRBs (full allocation), 1 Tx antennas, CFI2</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	5	0.3008
5	DTX	DTX	7	0.4385
6	DTX	DTX	9	0.5879
7	DTX	DTX	12	0.3691
8	DTX	DTX	14	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	19	0.4551
11	DTX	DTX	22	0.5537
12	DTX	DTX	24	0.6504
13	DTX	DTX	27	0.7539
14	DTX	DTX	28	0.8525
15	DTX	DTX	28	0.9258
Note 1:	In TM3 mode the maximum MCS in any sub-frame shall be limited to 27 for a CAT 3 UE due to the sum of transport block bits in two streams shall be less than or equal to 102048.			
Note 2:	In TM4 mode the sum of transport block bits in two streams shall be less than or equal to 102048 for a CAT 3 UE. MCS per stream is not limited.			

**Table B.2.2.1-10: CQI to MCS mapping table for the dual antenna transmission case, 15 MHz channel bandwidth**

<b>15 MHz, 75 PRBs (full allocation), 2 Tx antennas, CFI2</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	7	0.4385
6	DTX	DTX	9	0.5879
7	DTX	DTX	12	0.3691
8	DTX	DTX	14	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	19	0.4551
11	DTX	DTX	21	0.5537
12	DTX	DTX	23	0.6504
13	DTX	DTX	26	0.7539
14	DTX	DTX	27	0.8525
15	DTX	DTX	27	0.8525
Note 1: In TM3 mode the maximum MCS in any sub-frame shall be limited to 27 for a CAT 3 UE due to the sum of transport block bits in two streams shall be less than or equal to 102048.				
Note 2: In TM4 mode the sum of transport block bits in two streams shall be less than or equal to 102048 for a CAT 3 UE. MCS per stream is not limited.				

**Table B.2.2.1-11: CQI to MCS mapping table for the single antenna transmission case, 20 MHz channel bandwidth**

<b>20 MHz, 100 PRBs (full allocation), 1 Tx antennas, CFI2</b>				
<b>CQI index</b>	<b>MCS Index</b>			<b>Target Code Rate</b>
	<b>SF#0</b>	<b>SF#5</b>	<b>Other</b>	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	1	0.1172
3	DTX	DTX	3	0.1885
4	DTX	DTX	5	0.3008
5	DTX	DTX	7	0.4385
6	DTX	DTX	9	0.5879
7	DTX	DTX	12	0.3691
8	DTX	DTX	14	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	19	0.4551
11	DTX	DTX	22	0.5537
12	DTX	DTX	24	0.6504
13	DTX	DTX	26	0.7539
14	DTX	DTX	28	0.8525
15	DTX	DTX	28	0.9258
Note 1: In TM3 mode the maximum MCS in any sub-frame shall be limited to 23 for a CAT 3 UE due to the sum of transport block bits in two streams shall be less than or equal to 102048.				
Note 2: In TM4 mode the sum of transport block bits in two streams shall be less than or equal to 102048 for a CAT 3 UE. MCS per stream is not limited.				

**Table B.2.2.1-12: CQI to MCS mapping table for the dual antenna transmission case, 20 MHz channel bandwidth**

20 MHz, 100 PRBs (full allocation), 2 Tx antennas, CFI2				
CQI index	MCS Index			Target Code Rate
	SF#0	SF#5	Other	
0	DTX	DTX	DTX	out of range
1	DTX	DTX	0	0.0762
2	DTX	DTX	0	0.1172
3	DTX	DTX	2	0.1885
4	DTX	DTX	4	0.3008
5	DTX	DTX	7	0.4385
6	DTX	DTX	9	0.5879
7	DTX	DTX	12	0.3691
8	DTX	DTX	14	0.4785
9	DTX	DTX	16	0.6016
10	DTX	DTX	19	0.4551
11	DTX	DTX	21	0.5537
12	DTX	DTX	23	0.6504
13	DTX	DTX	26	0.7539
14	DTX	DTX	27	0.8525
15	DTX	DTX	27	0.9258
Note 1: In TM3 mode the maximum MCS in any sub-frame shall be limited to 23 for a CAT 3 UE due to the sum of transport block bits in two streams shall be less than or equal to 102048.				
Note 2: In TM4 mode the sum of transport block bits in two streams shall be less than or equal to 102048 for a CAT 3 UE. MCS per stream is not limited.				

## B.2.2.2 MAC Configurations

For data throughput testing will be using one DRB configuration and there will be no SRB data in the downlink and uplink. The Modulation order and transport block size are determined as per section 7.1.7 of TS 36.213 [10]. The parameters for MAC configuration and the DRB Logical channel configurations will follow the Table 4.8.2.1.5-1 and Table 4.8.2.1.4-1 of TS 36.508 [11] respectively.

Derivation Path: TS 36.331 [17] clause 6.3.2			
Information Element	Value/remark	Comment	Condition
MAC-MainConfig-RBC ::= SEQUENCE {			
ul-SCH-Config SEQUENCE {			
periodicBSR-Timer	Infinity		no_periodic_BSR_or_PHR
}			
drx-Config	Not present		NOT pc_FeatrGrp_5
shortDRX	Not present		
}			
}			
phr-Config CHOICE {			no_periodic_BSR_or_PHR
Release	NULL		
}			
}			

### B.2.2.3 RLC Configuration

For LTE data throughput testing purposes RLC in AM mode only will be used. The RLC configuration parameters shall follow Table 4.8.2.1.3.2-1 of TS 36.508 [11].

### B.2.2.4 PDCP Configuration

For LTE data throughput testing compression will not be enabled. PDCP configuration for DRB in RLC AM mode shall follow Table 4.8.2.1.2.2-1 of TS 36.508 [11].

### B.2.2.5 System Information

Maximum channel bandwidth shall be considered for testing. Hence dl-Bandwidth will be set to downlink system bandwidth under test. The SIB periodicity is mentioned in table 4.4.3.4-1 for bandwidth under test. Other system information IE's are used as per TS 36.508 [11] section 4.4.3.2.

### B.2.2.6 Mapping of UE reported PMI

The PMI to be used by the SS is determined by the following procedure:

The SS shall transmit PDSCH with selected precoding matrix from codebook (Table 6.3.4.2.3-1 in TS 36.211 [8]) every subframe according to PMI reports from the UE. In case of multiple PMI reporting the precoding matrix corresponding to the PMI reported by the UE is applied on the respective sub band.

### B.2.2.7 Mapping of UE reported RI

In Transmission Modes 3 and 4 the SS shall follow UE RI reports and apply reported rank even when retransmissions are required.

The following guidelines are provided to clarify the operation in regard to retransmissions based on the proposal above. This guidance is based on the 2 downlink antenna ports case. In the following *RI change* means a change of the UE RI reported value between initial transmission / first retransmission or retransmission / next retransmission of a codeword.

- a. If RI = 1 and does not change, rank = 1 transmission consists of retransmitting one codeword.
- b. If RI = 2 and does not change, it depends on how many codewords need to be retransmitted:
  - If both codewords need to be retransmitted, rank = 2 transmission consists of retransmitting both codewords.
  - If only one codeword needs to be retransmitted, rank = 2 transmission consists of retransmitting one codeword + transmitting another new codeword.
- c. If RI changes from 1 to 2, rank = 2 transmission consists of retransmitting one codeword + transmitting another new codeword.
- d. If RI changes from 2 to 1, it depends on how many codewords need to be retransmitted:
  - If both codewords need to be retransmitted, rank = 1 transmission consists of retransmitting each of the codewords alternately in different TTI-s.
  - If only one codeword needs to be retransmitted, rank = 1 transmission consists of retransmitting one codeword.

## B.2.3 Network, Transport and Application Layers reference system configurations

### B.2.3.1 FTP Reference System Configuration

The FTP server should be configured to meet the following requirements:

- The TCP send/receive buffer sizes at the FTP server should be set to values sufficiently large to ensure they do not limit the maximum throughput achievable at the UE
- The tx queue length should be set to a value sufficiently large value to ensure flow control between the network interface (ppp) and TCP is not triggered

The FTP application used on the tethered PC for tethered testing should meet the following requirements:

- The tethered FTP application should allow the user to transfer files of any format supported by the tethered PC, in binary mode, in both the Downlink and the Uplink
- The tethered FTP application should provide the means to compute the throughput T as defined in subclause 5.1.2 at the end of each file transfer
- The tethered FTP application should provide an interface allowing automation of testing
- The tethered FTP application should not implement hidden optimizations that might impact the throughput

For embedded testing, the FTP client will reside in the UE under test. This will require an FTP application to be installed on the UE. The FTP application used for embedded testing should meet the following requirements:

- The embedded FTP application should allow the user to transfer files of formats supported by the UE, in binary mode, both in the Downlink and the Uplink.
- The embedded FTP application should provide the means to compute the throughput T as defined in subclause 5.1.2 at the end of each file transfer.
- The embedded FTP application should provide an interface allowing automation of testing. If an interface for automation of testing is implemented, it is recommended to use the embedded data client automation recommendations in Annex E.
- The embedded FTP application should not implement hidden optimizations that might impact the throughput.

At both the FTP client and the FTP server, the following settings should be used:

- The TCPWindowSize is set to a value greater than the BDP (bandwidth-delay product), with BDP computed as (max TCP data rate \* RTT upper bound). Refer to clause 5.4.2.1.1 for guidance concerning the TCP advertised receiver window size setting.
- The TCPWindowSize is adjusted to near even-multiple of TCP MTU. The Windows Scaling is enabled for all FTP transfers.
- The socket buffer sizes are set to even-multiples of TCP MTU in use and set to values close to the BDP.
- The TCP MTU size is set to a value comprised between 1280 and 1500 bytes as recommended by the manufacturer.
- The FTP transfers are always carried out in Binary mode.
- The contents of the files to be transferred over FTP are chosen in such a way that they are statistically random, with least compressibility.
- No application level compression protocols are used to compress the FTP files.
- Either IPv4 or IPv6 can be used, but only results obtained with the same IP address type can be compared, since the IP address type will affect the measured throughput.

### B.2.3.2 UDP Reference System Configuration

The UDP server should be configured to meet the following requirements:

- UDP blast duration shall be selected to meet the minimum test times using a sufficient rate to prevent physical layer DTX based upon the UE Category.

The UDP application used on the tethered PC for tethered testing should meet the following requirements:

- The tethered UDP application should allow the user to transfer files of any format supported by the tethered PC, in binary mode, in both the Downlink and the Uplink.
- The tethered UDP application should provide the means to compute the throughput T as defined in subclause 5.1.2.
- The tethered UDP application should provide an interface allowing automation of testing.
- The tethered UDP application should not implement hidden optimizations that might impact the throughput.

For embedded testing, the UDP client will reside in the UE under test. This will require an UDP application to be installed on the UE. The UDP application used for embedded testing should meet the following requirements:

- The embedded UDP application should allow the user to transfer files of formats supported by the UE, in binary mode, both in the Downlink and the Uplink.
- The embedded UDP application should provide the means to compute the throughput T as defined in subclause 5.1.2.
- The embedded UDP application should provide an interface allowing automation of testing. If an interface for automation of testing is implemented, it is recommended to use the embedded data client automation recommendations in Annex E.
- The embedded UDP application should not implement hidden optimizations that might impact the throughput.

The following settings are to be used.

- The UDP MTU size is set to a value comprised between 1280 and 1500 bytes as recommended by the manufacturer.
- The UDP transfers are always carried out in Binary mode.
- The contents of the files to be transferred over UDP are chosen in such a way that they are statistically random, with least compressibility.
- No application level compression protocols are used to compress the UDP files.
- It is recommended that no control characters be used in the files as this may cause unexpected behaviour.
- Either IPv4 or IPv6 can be used, but only results obtained with the same IP address type can be compared, since the IP address type will affect the measured throughput.

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## B.3 Recommendation for Operating band and Channel Bandwidth selection for application layer data throughput measurements

The UE application layer data throughput measurements as described in this TR is considered to be operating band independent unless specified in a particular test point. Therefore, unless noted in the test point the application layer data throughput measurement can be verified in one of the operating bands supported by the UE under test for HSPA and LTE respectively.

For LTE it is recommended that the measurements are performed using the maximum channel bandwidth

**NOTE:** For HSPA and LTE the measurement procedures as specified in Annex A of this TR are transparent to which operating band is used for the measurements. For LTE the measurement procedures as specified in Annex A of this TR are transparent to which channel bandwidth is used for the measurements.



## Annex C: Specific Connection Diagrams

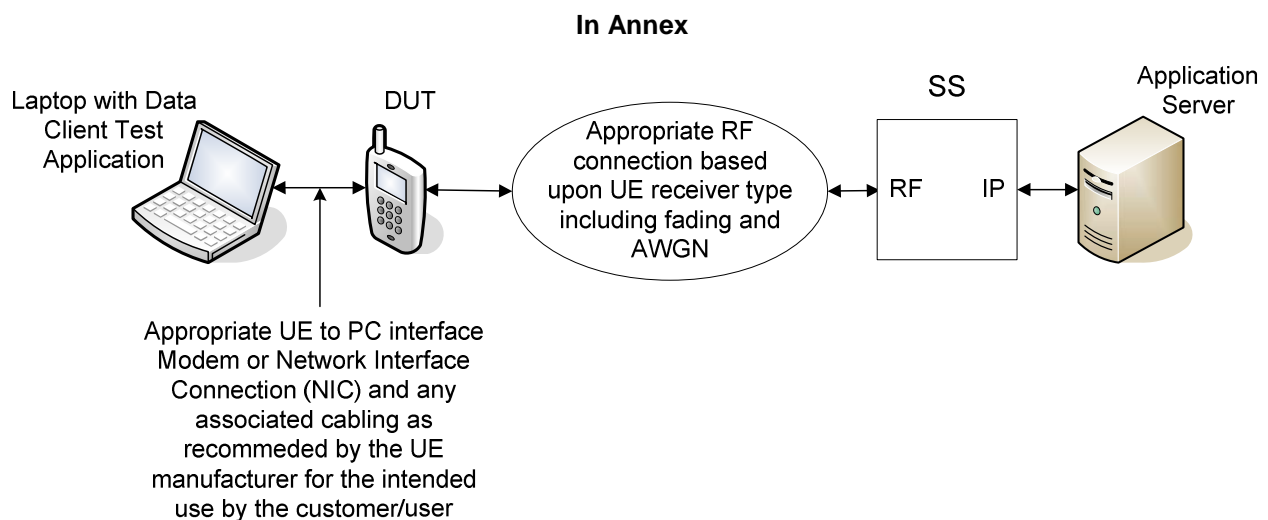
### C.1 Purpose of annex

This annex identifies the specific connection diagrams necessary for the test procedures for UE Application Layer Data Throughput Performance.

### C.2 UE Application Layer Data Throughput Connection Diagrams

#### C.2.1 UE Application Layer Data Throughput Connection Diagram for Tethered

The UE Application Layer Data Throughput connection diagram for tethered operation is shown in Figure C.2.1-1.

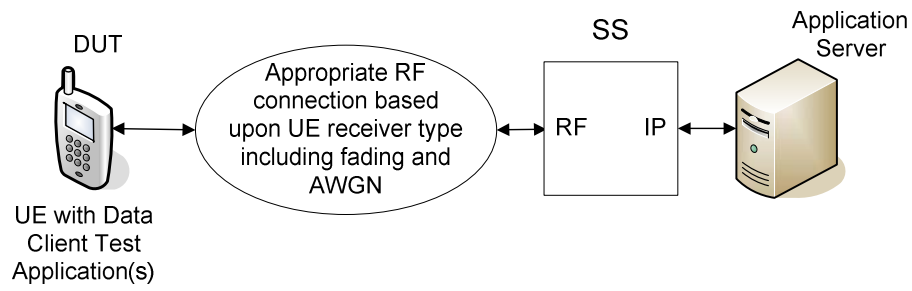


**Figure C.2.1-1: UE Application Layer Data Throughput Connection Diagram for Tethered**

NOTE: Some of the elements may be implemented in the same piece of test equipment depending on implementation.

#### C.2.2 UE Application Layer Data Throughput Connection Diagram for Embedded

The UE Application Layer Data Throughput connection diagram for embedded operation is shown in Figure C.2.2-1.



**Figure C.2.2-1: UE Application Layer Data Throughput Connection Diagram for Embedded**

**NOTE:** Some of the elements may be implemented in the same piece of test equipment depending on implementation.

## Annex D: Applicability

### D.1 Purpose of annex

The present annex specifies a recommended applicability statement for the test cases included in Annex A. These applicability statements are based on the features implemented in the UE for the indication of which an Implementation Conformance Statement (ICS) proforma is also provided.

### D.2 Recommended Test Case Applicability

The applicability of each individual test is identified in Table D.2-1. This is just a recommendation based on the purpose for which the test case was written.

The applicability of every test is formally expressed by the use of Boolean expression that are based on parameters (ICS) included in section D.3 of the present document.

Additional information related to the Test Case (TC), e.g. affecting its dynamic behaviour or its execution may be provided as well.

The columns in Table D.2-1 have the following meaning:

#### Clause

The clause column indicates the clause number in Annex A that contains the test body.

#### Title

The title column describes the name of the test and contains the clause title of the clause in Annex A that contains the test body.

#### Release

The release column indicates the earliest release from which each the test case is applicable.

#### Applicability - Condition

The following notations are used for the applicability column:

R	recommended - the test case is recommended
O	optional – the test case is optional
N/A	not applicable - in the given context, the test case is not recommended.
Ci	conditional - the test is recommended ("R") or not ("N/A") depending on the support of other items. "i" is an integer identifying a unique conditional status expression which is defined immediately following the table. For nested conditional expressions, the syntax "IF ... THEN (IF ... THEN ... ELSE...) ELSE ..." is used to avoid ambiguities.

NOTE: The conditions are defined in Table D.2-1a.

#### Applicability - Comments

This column contains a verbal description of the condition.

**Additional Information - Specific ICS**

This column contains the mnemonics of ICS(s) affecting the dynamic behaviour of the TC.

**Additional Information - Specific IXIT**

This column contains the mnemonics of IXIT(s) affecting the dynamic behaviour of the TC.

**Additional Information - Number of TC Executions**

This column contains, wherever applicable, the recommended for performance data throughput capability number of TC executions. Clarifying notes are listed in Table D.2-1b.

Table D.2-1: Applicability of tests and additional information for testing

Clause	TC Title	Release	Applicability		Additional Information		
			Condition	Comment	Specific ICS	Specific IXIT	Number of TC Executions
A.2	HSPA TCs						
A.2.2	HSPA / FTP Downlink Performance	Rel-5 Rel-7	C01	All UE supporting UTRA and Tethered or Embedded data configuration and FTP	pc_FDD pc_TDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 1)
A.2.3	HSPA / UDP Downlink Performance	Rel-5 Rel-7	C02	All UE supporting UTRA and Tethered or Embedded data configuration and UDP	pc_FDD pc_TDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 1)
A.2.4	HSPA / FTP Uplink Performance	Rel-5 Rel-7	C01	All UE supporting UTRA and Tethered or Embedded data configuration and FTP	pc_FDD pc_TDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 1)
A.2.5	HSPA / UDP Uplink Performance	Rel-5 Rel-7	C02	All UE supporting UTRA and Tethered or Embedded data configuration and UDP	pc_FDD pc_TDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 1)
A.2.6	HSPA / Stress Test Performance	Rel-5 Rel-7	C03	All UE supporting UTRA and Tethered or Embedded data configuration and FTP and UDP	pc_FDD pc_TDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 1)
A.2.7	HSPA / UDP Power Sweep Performance	Rel-5 Rel-7	C02	All UE supporting UTRA and Tethered or Embedded data configuration and UDP	pc_FDD pc_TDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 1)
A.2.8	HSPA / Throughput vs. Geometry Factor Performance	Rel-5 Rel-7	C02	All UE supporting UTRA and Tethered or Embedded data configuration and UDP	pc_FDD pc_TDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 1)
A.3	LTE TCs						
A.3.2.1	LTE / FTP Downlink / PDSCH Single Antenna Port Performance (Cell-Specific Reference Symbols)	Rel-8	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD pc_eTDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
A.3.2.2	LTE / FTP Downlink / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)	Rel-8	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD pc_eTDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
A.3.2.3	LTE / FTP Downlink / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD pc_eTDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
A.3.2.4	LTE / FTP Downlink / PDSCH Closed Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD pc_eTDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
A.3.2.5	LTE / FTP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (Port 5, UE-Specific Reference Symbols)	Rel-8	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD pc_eTDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
A.3.2.6	LTE / FTP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (Port 7 or 8, UE-Specific Reference Symbols)	Rel-9	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD pc_eTDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)

A.3.2.7	LTE / FTP Downlink / PDSCH Dual-layer Spatial Multiplexing Performance (port 7 and 8, User-Specific Reference Symbols)	Rel-9	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.3.1	LTE / UDP Downlink / PDSCH Single Antenna Port Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.3.2	LTE / UDP Downlink / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.3.3	LTE / UDP Downlink / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.3.4	LTE / UDP Downlink / PDSCH Closed Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.3.5	LTE / UDP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (port 5, User-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.3.6	LTE / UDP Downlink / PDSCH Single-layer Spatial Multiplexing Performance (Port 7 or 8, UE-Specific Reference Symbols)	Rel-9	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.3.7	LTE / UDP Downlink / PDSCH Dual-layer Spatial Multiplexing Performance (port 7 and 8, User-Specific Reference Symbols)	Rel-9	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.4.1	LTE / FTP Uplink / PUSCH Single Antenna Port Performance	Rel-8	C04	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.5.1	LTE / UDP Uplink / PUSCH Single Antenna Port Performance	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.6.1	LTE / Stress Test Performance / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)	Rel-8	C06	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.6.2	LTE / Stress Test Performance / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C06	All UE supporting E-UTRA and Tethered or Embedded data configuration and FTP and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.7.1	LTE / UDP Power Sweep / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		

A.3.7.2	LTE / UDP Power Sweep / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.8.1	LTE / UDP Downlink vs. SNR Performance / PDSCH Transmit Diversity Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.8.2	LTE / UDP Downlink vs. SNR Performance / PDSCH Open Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.8.3	LTE / UDP Downlink vs. SNR Performance / PDSCH Closed Loop Spatial Multiplexing Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		
A.3.8.4	LTE / UDP Downlink vs. SNR Performance / PDSCH Closed Loop Spatial Multiplexing using a single transmission layer Performance (Cell-Specific Reference Symbols)	Rel-8	C05	All UE supporting E-UTRA and Tethered or Embedded data configuration and UDP	pc_eFDD	px_Tethered px_Embedded	1/2 Execution(s) (Note 2)
					pc_eTDD		

Table D.2-1a: Applicability of tests Conditions

C01	IF (D.3.3.1-1/3 OR D.3.3.1-1/4) AND D.3.3.1-2/1 AND (D.3.4.1-1/1 OR D.3.4.1-1/2) THEN R ELSE N/A
C02	IF (D.3.3.1-1/3 OR D.3.3.1-1/4) AND D.3.3.1-2/2 AND (D.3.4.1-1/1 OR D.3.4.1-1/2) THEN R ELSE N/A
C03	IF D.3.3.1-1/3 AND (D.3.3.1-2/1 AND D.3.3.1-2/2) AND (D.3.4.1-1/1 OR D.3.4.1-1/2) THEN R ELSE N/A
C04	IF (D.3.3.1-1/1 OR D.3.3.1-1/2) AND D.3.3.1-2/1 AND (D.3.4.1-1/1 OR D.3.4.1-1/2) THEN R ELSE N/A
C05	IF (D.3.3.1-1/1 OR D.3.3.1-1/2) AND D.3.3.1-2/2 AND (D.3.4.1-1/1 OR D.3.4.1-1/2) THEN R ELSE N/A
C06	IF (D.3.3.1-1/1 OR D.3.3.1-1/2) AND (D.3.3.1-2/1 AND D.3.3.1-2/2) AND (D.3.4.1-1/1 OR D.3.4.1-1/2) THEN R ELSE N/A

Table D.2-1b: Number of TC Executions - Notes

Note 1: For HSPA the measurement procedures as specified in Annex A of this TR are transparent to which operating band is used for the measurements therefore it is recommended that the TC is executed once in one supported UTRA Band. See TS 34.121-1 section D.2.2 for any FDD Band related differences that may need to be taken into account. If the UE supports both Tethered and Embedded configuration one execution in each configuration in a chosen band should be performed.
Note 2: For EPS the measurement procedures as specified in Annex A of this TR are transparent to which operating band and to which channel bandwidth is used for the measurements therefore it is recommended that the TC is executed once in the supported E-UTRA Band with the highest maximum channel bandwidth. If the UE supports both Tethered and Embedded configuration one execution in each configuration in a chosen band should be performed.

## D.3 ICS / IXIT proforma

### D.3.1 General

#### D.3.1.1 Introduction

The purposes of an ICS and IXIT proformas are to provide mechanism whereby a supplier of an implementation of the requirements defined in relevant specifications may provide information about the implementation in regard to protocol capabilities or extra information needed for testing in a standardised manner.

Due to the nature of the present document a complete ICS proforma is not specified and instead only the ICS proforma tables needed for the TC applicability defined in D.2 are included. If such might be needed by an implementation supplier or an organisation that may like to conduct UE Application Layer Data Throughput Performance assessment an example of the parts of a complete ICS proforma omitted here can be found e.g. in TS 36.523-2.

#### D.3.1.2 Abbreviations and conventions

The partial ICS / IXIT proforma contained in this annex is comprised of information in tabular form with the meaning of the separate table columns as follows:

##### Item column

The item column contains a number which identifies the item in the table.

##### Item description column

The item description column describes in free text each respective item (e.g. parameters, timers, etc.). It implicitly means "is <item description> supported by the implementation?".

##### Reference column

The reference column gives reference to the relevant 3GPP core specifications.

##### Release column

The release column indicates the earliest release from which the capability or option is relevant.

##### Mnemonic column

The Mnemonic column contains mnemonic identifiers for each item.

##### Comments column

This column is left blank for particular use by the reader of the present document.

##### References to items

For each possible item answer (answer in the support column) within the ICS proforma there exists a unique reference, used, for example, in the conditional expressions. It is defined as the table identifier, followed by a solidus character "/", followed by the item number in the table. If there is more than one support column in a table, the columns shall be discriminated by letters (a, b, etc.), respectively.

#### D.3.1.3 Instructions for completing the ICS proforma

The supplier of the implementation may complete the ICS proforma in each of the spaces provided. More detailed instructions are given at the beginning of the different clauses of the ICS proforma.



## D.3.2 Identification of the protocol

This ICS proforma applies to the 3GPP standards listed in the normative references clause of the present document.

## D.3.3 ICS proforma tables

### D.3.3.1 UE Implementation Types

**Table D.3.3.1-1: UE Radio Technologies**

Item	UE Radio Technologies	Ref.	Release	Mnemonics	Comments
1	E-UTRA FDD	36.101	Rel-8	pc_eFDD	
2	E-UTRA TDD	36.101	Rel-8	pc_eTDD	
3	UTRA FDD	25.101	Rel-5	pc_FDD	
4	UTRA TDD	25.102	Rel-7	pc_TDD	

**Table D.3.3.1-2: UE Internet Protocol Technologies**

Item	Internet Protocol Technologies	Ref.	Release	Comments
1	FTP	RFC 959	n/a	
2	UDP	RFC 768	n/a	

### D.3.3.2 UE UTRA related capabilities

**Table D.3.3.2-1: Layer 1 UE Radio Access Capabilities**

Item	Layer 1 UE Radio Access Capabilities	Ref.	Release	Comments
1	Support of HS-PDSCH	25.306, 4.5.3	Rel-5	
2	UTRA FDD Support of E-DPDCH	25.306, 4.5.4	Rel-6	
3	UTRA TDD Support of E-PUCH	25.306, 4.5.6	Rel-7	Applicable for 3.84 Mcps and 1.28 Mcps and 7.68 Mcps

**Table D.3.3.2-2: UEs HS-DSCH category**

Item	UE HS-DSCH Category	Ref.	Release	Comments
1	Category 1	25.306, 5.1	Rel-6	
2	Category 2	25.306, 5.1	Rel-6	
3	Category 3	25.306, 5.1	Rel-6	
4	Category 4	25.306, 5.1	Rel-5	
5	Category 5	25.306, 5.1	Rel-5	
6	Category 6	25.306, 5.1	Rel-5	
7	Category 7	25.306, 5.1	Rel-5	
8	Category 8	25.306, 5.1	Rel-5	
9	Category 9	25.306, 5.1	Rel-5	
10	Category 10	25.306, 5.1	Rel-5	
11	Category 11	25.306, 5.1	Rel-5	
12	Category 12	25.306, 5.1	Rel-5	
13	Category 13	25.306, 5.1	Rel-7	
14	Category 14	25.306, 5.1	Rel-7	
15	Category 15	25.306, 5.1	Rel-7	
16	Category 16	25.306, 5.1	Rel-7	
17	Category 17	25.306, 5.1	Rel-7	
18	Category 18	25.306, 5.1	Rel-7	
19	Category 19	25.306, 5.1	Rel-8	
20	Category 20	25.306, 5.1	Rel-8	
21	Category 21	25.306, 5.1	Rel-8	
22	Category 22	25.306, 5.1	Rel-8	
23	Category 23	25.306, 5.1	Rel-8	
24	Category 24	25.306, 5.1	Rel-8	
25	Category 25	25.306, 5.1	Rel-9	
26	Category 26	25.306, 5.1	Rel-9	
27	Category 27	25.306, 5.1	Rel-9	
28	Category 28	25.306, 5.1	Rel-9	

**Table D.3.3.2-3: UEs receiver design type**

Item	UEs receiver design type	Ref.	Release	Comments
1	Enhanced performance requirements type 1 for HSDPA	25.101, 9	Rel-6	UEs which utilise receiver diversity
2	Enhanced performance requirements type 2	25.101, 9	Rel-6	UEs which utilise a chip equaliser receiver structure
3	Enhanced performance requirements type 3	25.101, 9	Rel-7	UEs which utilise a chip equaliser receiver structure with receiver diversity

### D.3.3.3 UE E-UTRA related capabilities

**Table D.3.3.3-1: PUSCH physical layer Categories**

Item	PUSCH physical layer categories	Ref.	Release	Comments
1	Category 1	36.306, 4.1	Rel-8	
2	Category 2	36.306, 4.1	Rel-8	
3	Category 3	36.306, 4.1	Rel-8	
4	Category 4	36.306, 4.1	Rel-8	
5	Category 5	36.306, 4.1	Rel-8	Support for 64QAM in UL

**Table D.3.3.3-2: PDSCH physical layer Categories**

Item	PDSCH physical layer categories	Ref.	Release	Comments
1	Category 1	36.306, 4.1	Rel-8	
2	Category 2	36.306, 4.1	Rel-8	
3	Category 3	36.306, 4.1	Rel-8	
4	Category 4	36.306, 4.1	Rel-8	
5	Category 5	36.306, 4.1	Rel-8	

## D.3.4 IXIT proforma tables

### D.3.4.1 UE data configuration capabilities types

**Table D.3.4.1-1: UE data configuration capabilities types**

Item	UE data configuration types	Ref.	Release	Mnemonics	Comments
1	Tethered Data	C.2.1	n/a	px_Tethered	
2	Embedded data	C.2.2	n/a	px_Embedded	

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## Annex E: Embedded Data Client Automation Recommendations

*Editor's Note: The following aspects are either missing or not yet determined:*

- It is for further study to determine if any additional items are required to be provisioned prior to command interface establishment.
- The command set and test parameters that are needed for automation of embedded data throughput performance in TR 37.901 are missing.
- The fields required to support result reporting are missing.

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### E.1 Purpose of annex

This annex identifies the recommendations and details concerning a common application interface to allow for automation of testing for the UE Application Layer Data Throughput Performance test procedures that utilize an embedded data client.

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### E.2 Embedded Data Client Automation

#### E.2.1 Embedded Data Client Functionality

The following functionality is recommended for the embedded data client to support automation.

- The application may start automatically on device power-up or reset. If the application does not support this feature, the operator manually starts the application at the beginning of the test campaign.
- The application automatically sets up a data call using the expected radio bearer that is used for test and establishes a connection to the test server.
- The application may periodically poll the test server with the Poll for Task command when not actively performing a task to determine if the test server has a new task.
- The application will be informed by the test server about the task list to be performed either in response to the Poll for Task command or via a command that is pushed to the application from the test server.
- The application should not send, or limits as much as possible, any commands, responses and status updates during a measurement unless the time-out period has expired so that the UE application layer data throughput results are not impacted. If the application does send limited updates, the downlink and uplink performance loss should be declared in the test results and should not exceed 0.4 kbps.
- The application should listen for commands at all times so that the test server can interrupt the measurement.

#### E.2.2 Embedded Data Client Provisioning

The embedded data client may provide a mechanism to provision common parameters required for interfacing with test systems. The following captures aspects that should be considered if the application provides for such provisioning.

- Provisioning of the data client does not need to be automated.
- A manual interface or parameter file approach could be used. Instructions for operation should be provided.
- The items expected to be provisioned prior to command interface establishment are as follows:
  - IP address and port number, if necessary, for the test server

- Poll for Task Command Polling Period (if the polling approach is used, this may be a configurable item or a hardcoded value)
- FFS

If certain parameters are hard-coded, these parameters should be documented to allow for the test systems to be properly configured.

## E.2.3 Embedded Data Client Command Set and Operation

The embedded data client should use the specified command set and follow the operational structure defined in this clause.

### E.2.3.1 Poll for Task Command

The embedded data client application may make use of a polling mechanism to query the test server for tasks to perform. If polling is used, the following instructions apply.

The Poll for Task command shall be substantiated with FFS.

If there is no task for the application to perform, an FFS error is returned. The application shall start its Waiting for Task Polling Period timer. When the timer expires, another Poll for Task command shall be sent.

If there is a task for the application to perform, the test server may return an FFS.

### E.2.3.2 Task List

The test server will deliver a task list to the application. The task list will be delivered over the IP connection using HTTP(S) or raw TCP. The task list can contain multiple tasks that are listed sequentially for the application to execute or can also contain a single task. The format for the task list is XML for ASCII text string.

For each task, the following lists the valid parameters and valid strings for each parameter. The list of items should be considered as logical representations of the required parameters and content. The actual syntax may vary. The instructions for the application should provide the recommended usage for each particular test type.

- FFS

If the requested task list is unknown to the application, the application may ignore it or return an error of FFS. The application will then go back to a waiting for command state.

### E.2.3.3 Result Reporting

Upon completion of the specified test sequence, the application shall upload the test results to the test server over the IP connection using HTTP(S) POST or raw TCP.

The result files shall be in CSV or XML format. The fields required to support result reporting are FFS.

## Annex F: Measurement Channels

### F.1 Purpose of annex

FFS.

### F.2 UL reference measurement channels

#### F.2.1 FDD

Table F.2.1-1: Reference Channels for maximal UL throughput for FDD

Parameter	Ch BW	Allocated RBs	DFT-OFDM Symbols per Sub-Frame	Mod'n	Target Coding rate	Payload size	Transport block CRC	Number of code blocks per Sub-Frame (Note 1)	Total number of bits per Sub-Frame	Total symbols per Sub-Frame	Supported by UE Category
Unit	MHz					Bits	Bits		Bits		
	1.4	6	12	16QAM	3/4	2600	24	1	3456	864	≥ 1
	3	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	3	15	12	16QAM	3/4	6456	24	2	8640	2160	≥ 2
	5	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	5	25	12	16QAM	3/4	10680	24	2	14400	3600	≥ 2
	10	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	10	50	12	16QAM	3/4	21384	24	4	28800	7200	≥ 2
	15	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	15	60	12	16QAM	3/4	25456	24	5	34560	8640	≥ 2
	15	75	12	16QAM	3/4	32856	24	6	43200	10800	≥ 3
	20	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	20	60	12	16QAM	3/4	25456	24	5	34560	8640	≥ 2
	20	100	12	16QAM	3/4	43816	24	6	57600	14400	≥ 3
Note 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)											

## F.2.2 TDD

Table F.2.2-1: Reference Channels for maximal UL throughput for TDD

Parameter	Ch BW	Allocated RBs	DFT-OFDM Symbols per Sub-Frame	Mod'n	Target Coding rate (Note 2)	Payload size (Note 2)	Transport block CRC	Number of code blocks per Sub-Frame (Note 1, 2)	Total number of bits per Sub-Frame (Note 2)	Total symbols per Sub-Frame (Note 2)	Supported by UE Category
Unit	MHz					Bits	Bits		Bits		
	1.4	6	12	16QAM	3/4	2600	24	1	3456	864	≥ 1
	3	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	3	15	12	16QAM	3/4	6456	24	2	8640	2160	≥ 2
	5	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	5	25	12	16QAM	3/4	10680	24	2	14400	3600	≥ 2
	10	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	10	50	12	16QAM	3/4	21384	24	4	28800	7200	≥ 2
	15	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	15	60	12	16QAM	3/4	25456	24	5	34560	8640	≥ 2
	15	75	12	16QAM	3/4	32856	24	6	43200	10800	≥ 3
	20	12	12	16QAM	3/4	5160	24	1	6912	1728	≥ 1
	20	60	12	16QAM	3/4	25456	24	5	34560	8640	≥ 2
	20	100	12	16QAM	3/4	43816	24	6	57600	14400	≥ 3
Note 1: If more than one Code Block is present, an additional CRC sequence of L = 24 Bits is attached to each Code Block (otherwise L = 0 Bit)											
Note 2: For uplink subframes according to UL-DL configuration as per Table 4.2-2 in TS 36.211 [9]											



## Annex G:

### Change history

Change history							
Date	TSG #	TSG Doc.	CR	R e v	Subject/Comment	Old	New
2011-02	RAN5#50	R5-110518			Initial draft created	N/A	0.0.0
2011-02	RAN5#50	R5-110853			Editorial Changes to Document Structure	0.0.0	0.0.1
2011-04	RAN5#50 bis	R5-111013			TR 37.901 after RAN5 #50bis	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111016			Discussion on the sub-title of test procedure in TR 37.901	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111029			TP for TR 37.901 on Data Transfer Scenarios	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111032			Criteria for Study Item Completion	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111039			TP for TR 37.901 on Parameters for Measurement	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111040			Discussion and text proposal on Uplink configuration for UTRA FTP Downlink test cases	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111042			Discussion and text proposal for TR 37.901 on specification of test environment and test configurations for UE application-layer data throughput measurements	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111044			TP for TR 37.901 on Definition of UE Application Layer Data Throughput	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111045			TP for TR 37.901 on Test Configurations	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111046			TP for TR 37.901 on Impact of Modem Performance on UE Data Throughput Testing	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111047			TP for TR 37.901 on Test Environment	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111048			Discussion and text proposal for LTE Test Procedures	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111049			TP for TR 37.901 on test system uncertainties and test tolerances	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111050			TP for TR 37.901 on Transport and Application Layer Protocols	0.0.1	0.1.0
2011-04	RAN5#50 bis	R5-111053			TP for TR 37.901 on UTRA/UTRAN Test Procedure Structure and Content for Tethered Operation	0.0.1	0.1.0
2011-05	RAN5#51	R5-112484			Minor Update to Change History to Fix Formatting and Update Reference to Final Tdoc R5-111053	0.1.0	0.1.1
2011-05	RAN5#51	R5-112473			TP for TR 37.901 on References	0.1.1	1.0.0
2011-05	RAN5#51	R5-112478			Discussion and TP for TR 37.901 on Default UE Transmit Power for HSPA	0.1.1	1.0.0
2011-05	RAN5#51	R5-112691			TP for 37.901 on Reference Laptop or PC configuration	0.1.1	1.0.0
2011-05	RAN5#51	R5-112724			TP for TR 37.901 on Connection Diagrams	0.1.1	1.0.0
2011-05	RAN5#51	R5-112725			Text proposal to TR 37.901 v0.1.0 on test environment and test conditions	0.1.1	1.0.0
2011-05	RAN5#51	R5-112726			Text proposal to TR 37.901 v0.1.0 on HSPA and LTE test configurations	0.1.1	1.0.0
2011-05	RAN5#51	R5-112727			Discussion and text proposal for TR 37.901 on Test Environment	0.1.1	1.0.0
2011-05	RAN5#51	R5-112728			TP for TR 37.901 on Test Points for UDP Power Sweep Testing for HSPA	0.1.1	1.0.0
2011-05	RAN5#51	R5-112729			TP for TR 37.901 on LTE TDD Test Structure and Content for Tethered mode	0.1.1	1.0.0
2011-05	RAN5#51	R5-112730			TP for TR 37.901 on Stress Test Performance and UDP Power Sweep Testing for LTE	0.1.1	1.0.0
2011-05	RAN5#51	R5-112559			TR 37.901 after RAN5 #51	0.1.1	1.0.0
2011-08	RAN5#52	R5-113083			Text proposal to TR 37.901 v1.0.0 on HSPA test parameters for static test	1.0.0	2.0.0
2011-08	RAN5#52	R5-113194			TP Updates for TR 37.901 concerning Embedded Testing	1.0.0	2.0.0
2011-08	RAN5#52	R5-113251			Discussion and text proposal on embedded FTP application requirements	1.0.0	2.0.0
2011-08	RAN5#52	R5-113417			Editorial Updates for TR 37.901	1.0.0	2.0.0
2011-08	RAN5#52	R5-113488			Text proposal to TR 37.901 v1.0.0 on LTE test procedures and configurations	1.0.0	2.0.0
2011-08	RAN5#52	R5-113555			TP Updates for TR 37.901 concerning Definition of UE Application Layer Data Throughput	1.0.0	2.0.0
2011-08	RAN5#52	R5-113556			TP Updates for TR 37.901 concerning UDP Settings	1.0.0	2.0.0

2011-08	RAN5#52	R5-113560			TP Updates for TR 37.901 concerning Downlink Configurations for Uplink Test Cases	1.0.0	2.0.0
2011-08	RAN5#52	R5-113570			TP for TR 37.901 concerning Study Item Conclusions	1.0.0	2.0.0
2011-08	RAN5#52	R5-113571			TP for TR 37.901 concerning Stress Tests for LTE	1.0.0	2.0.0
2011-08	RAN5#52	R5-113572			TP for TR 37.901 concerning UE Specific Items	1.0.0	2.0.0
2011-08	RAN5#52	R5-113670			TP for B.2.2 section of TR 37.901 in LTE reference system configurations	1.0.0	2.0.0
2011-08	RAN5#52	R5-113671			Discussion on Traffic profiling to be used for Performance Testing	1.0.0	2.0.0
2011-08	RAN5#52	R5-113818			Discussion and text proposal for 'A3 Final determination of clean channel maximum data rate test' (LTE) into TR 37.901	1.0.0	2.0.0
2011-08	RAN5#52	R5-113819			Discussion and text proposal on tethered FTP application requirements and FTP settings	1.0.0	2.0.0
2011-08	RAN5#52	R5-113841			Applicability for TCs in Application Layer Data Throughput spec	1.0.0	2.0.0
2011-08	RAN5#52	R5-113821			Text proposal to TR 37.901 on Throughput vs. G factor	1.0.0	2.0.0
2011-08	RAN5#52	R5-113825			Text proposal to TR 37.901 v1.0.0 on HSPA CQI mapping	1.0.0	2.0.0
2011-08	RAN5#52	R5-113827			TP Updates for TR 37.901 concerning Definitions, Symbols and Abbreviations	1.0.0	2.0.0
2011-08	RAN5#52	R5-113828			Text proposal to TR 37.901 - Final determination of clean channel maximum data rate test for HSPA	1.0.0	2.0.0
2011-08	RAN5#52	R5-113829			TP Updates for TR 37.901 concerning UDP Power Sweep Testing	1.0.0	2.0.0
2011-08	RAN5#52	R5-113830			Text proposal for TR 37.901 on LTE TDD Content",	1.0.0	2.0.0
2011-08	RAN5#52	R5-113842			TR 37.901 after RAN5#52	1.0.0	2.0.0
2011-09	RAN5#53	RP-111189			Approved TR 37.901 after RAN#53	2.0.0	11.0.0
2011-12	RAN5#53	R5-115286	0001	-	Addition of LCR TDD part in A.2.6 and A.2.7	11.0.0	11.1.0
2011-12	RAN5#53	R5-115697	0002	-	CR for TR 37.901 Concerning the Study Item Conclusions	11.0.0	11.1.0
2011-12	RAN5#53	R5-115698	0003	-	Add the TDD parts in 37.901 Annex A.2 for FTP/UDP Uplink Performance	11.0.0	11.1.0
2011-12	RAN5#53	R5-115701	0004	-	Addition of LCR TDD part in TR37.901	11.0.0	11.1.0
2011-12	RAN5#53	R5-115702	0005	-	CR for TR 37.901 Concerning HSPA General Settings and Test Parameters	11.0.0	11.1.0
2011-12	RAN5#53	R5-115703	0006	-	Corrections to TR 37.901	11.0.0	11.1.0
2011-12	RAN5#53	R5-115704	0006	-	CR for TR 37.901 Concerning the Completeness of Test Procedures for LTE	11.0.0	11.1.0
2011-12	RAN5#53	R5-115705	0007	-	Update on LTE / UDP Downlink vs. SNR Performance test	11.0.0	11.1.0
2011-12	RAN5#53	R5-115707	0008	-	CR for TR 37.901 Concerning the Statistical Analysis Clause	11.0.0	11.1.0
2011-12	RAN5#53	R5-115779	0009	-	Add the TDD parts in 37.901 Annex A.2 for Downlink HSPA FTP/UDP Performance	11.0.0	11.1.0
2011-12	RAN5#53	R5-115286	0010	-	Addition of LCR TDD part in A.2.6 and A.2.7	11.0.0	11.1.0
2012-03	RAN5#54	R5-120717	0011	-	Completion of LTE / UDP Downlink vs. SNR Performance Test cases A.3.8.3 and A.3.8.4	11.1.0	11.2.0
2012-03	RAN5#54	R5-120718	0012	-	Editors notes updates	11.1.0	11.2.0
2012-06	RAN5#55	R5-121371	0013	-	Modification of D.2 and D3.4.1	11.2.0	11.3.0
2012-06	RAN5#55	R5-121810	0014	-	Update of TR 37.901 to include various geometries per RAN4 LS	11.2.0	11.3.0
2012-06	RAN5#55	R5-122135	0015	-	Update of TR 37.901 to include Multi-cell tests per RAN4 LS	11.2.0	11.3.0
2012-09	RAN5#56	R5-123076	0016	-	Correction to Table A.2.2.3-2: Test Points for FTP Downlink Testing	11.3.0	11.4.0
2012-09	RAN5#56	R5-123795	0017	-	TR 37.901: Power levels revision	11.3.0	11.4.0
2012-12	RAN5#57	R5-125371	0018	-	Correction to Tables in relation to Reference Test Points for LTE	11.4.0	11.5.0
2012-12	RAN5#57	R5-126048	0019	-	Adding editors notes to LTE reference system configurations	11.4.0	11.5.0
2012-12	RAN5#57	R5-126054	0020	-	Update for LTE/UDP Power Sweep Performance Test	11.4.0	11.5.0
2013-03	RAN5#58	R5-130442	0021	-	Applicability change for LTE TDD tests using Port 7 and 8 (TM8)	11.5.0	11.6.0
2013-03	RAN5#58	R5-130773	0022	-	Clarifications to LTE CQI mapping tables in Annex B.2.2	11.5.0	11.6.0
2013-03	RAN5#58	R5-130776	0024	-	Clarification to Soft Channel Bit size in LTE tests	11.5.0	11.6.0
2013-03	RAN5#58	R5-130787	0023	-	Changing the RI selection method in TM3 and TM4 tests	11.5.0	11.6.0
2013-03	RAN5#58	-	-	-	Correction of the wrongly implemented Steps 8 in Table A.3.8.2.3-2 and Table A.3.8.3.3-2 of R5-130787	11.6.0	11.6.1
2013-06	RAN5#59	R5-131362	0025	-	Embedded Data Client Automation Recommendations for TR 37.901	11.6.1	11.7.0
2013-06	RAN5#59	R5-131674	0026	-	Removing the square brackets from channel correlation in TC A.3.8.2 and A.3.8.3	11.6.1	11.7.0
2013-06	RAN5#59	R5-132009	0027	-	Addition of high Doppler, high SNR test scenarios to the 37.901 spec	11.6.1	11.7.0
2013-09	RAN5#60	R5-133071	0028	-	Removing the notes related to soft channel bits size in clause A.3.1	11.7.0	11.8.0
2013-09	RAN5#60	R5-133072	0029	-	Removing the notes related to sub frame allocation in clause B.2.2	11.7.0	11.8.0
2013-12	RAN5#61	R5-134428	0030	-	Removing the note related to follow RI functionality	11.8.0	11.9.0
2014-03	RAN5#62	R5-140113	0031	-	Update References and Definitions in TR 37.901	11.9.0	11.10.0

2014-03	RAN5#62	R5-140569	0034	-	Correction to Mapping of UE reported CQI and MCS (LTE)	11.9.0	11.10.0
2014-03	RAN5#62	R5-141054	0033	-	Beamforming model and power allocation for DL performance tests with user specific reference symbols	11.9.0	11.10.0
2014-03	RAN5#62	R5-141055	0032	-	Missing uplink reference channel for uplink tests	11.9.0	11.10.0
2014-06	RAN5#63	R5-142124	0035	-	Correction to Tables A.3.2.7.3-1 and A.3.3.7.3-1	11.10.0	11.11.0
2014-06	RAN5#63	R5-143194	0037	-	Corrections to Symbol and Abbreviation references	11.10.0	11.11.0
2014-06	RAN5#63	R5-143195	0038	-	Correction to Tables A.3.8.3.3-1 and A.3.8.4.3-1	11.10.0	11.11.0
2014-06	RAN5#63	R5-143196	0039	-	Clarification on scheduling of user data in special subframe for TDD LTE Downlink Performance test cases	11.10.0	11.11.0
2014-06	RAN5#63	R5-143197	0040	-	Clarification on system simulator usage of UE reported CQI and RI in LTE Downlink Performance test cases	11.10.0	11.11.0
2014-06	RAN5#63	R5-143210	0036	-	Correction to A.3.4.1 and A.3.5.1	11.10.0	11.11.0

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