NGMN Field Trial Requirements

by NGMN Alliance

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Abstract: Introduction and Scope of document

Introduction

The mission of the NGMN Alliance is to complement and support the work within standardization bodies by providing a coherent view of what the operator community is going to require in the decade beyond 2010. In 2008 the Alliance will provide its guidance on the NGMN-preferred technology candidate(s) following an assessment against the NGMN performance, functional and timeline requirements. This assessment and evaluation is based on the requirements formulated in the NGMN Whitepaper [2] and a Methodology for the Radio Access Network performance evaluation [9]. In continuation of the technology evaluation through simulations trials will play an important role in the assessment of technology capabilities under realistic deployment conditions.

NGMN has established a trial working group to:

Validate technology candidates by the means of trials
Evidence the technology capabilities in a realistic deployment scenario
Compare technologies and benchmark results against NGMN whitepaper requirements
Ensure a effective collaboration on trials

The work of the trial group is based on the results that have been achieved within NGMNs Technical Working Group and will complement the technology evaluation activity. The trial group aims to verify the results of the theoretical considerations and simulations in practical implementations.

NGMN encourages the industry to conduct trials within the scope of trial initiatives. Associations like the LTE/SAE Trial Initiative (LSTI) allow an effective cooperation and will help to accelerate the growth of technology ecosystems. Trial results achieved in individual trials will be considered if the trials meet the requirements defined by NGMN.

NGMN contributes to trial activities by formulating common requirements that represent the coherent view of operators. While most requirements are technology independent others may focus on specific properties of a technology candidate.

Scope of document

NGMN has defined a common simulation environment to ensure the comparability of different simulation results [2]. Based on this common prerequisites different system level simulations have been performed. The simulation results aid the technology evaluation activity of the technical working group.

The scope of this document is to extend this concept to the area of trials. It describes a set of requirements to verify to which extend each technology meets the NGMN White Paper requirements in field trials. Additionally this document includes definitions of environmental factors that are important to facilitate a comparison between various technologies.

The Field Trial Requirements document is structured in three areas:

NGMN Trial Setup Requirements
NGMN Trial Test Requirements

NGMN Trial Reporting Requirements

The Trial Setup Requirements sections defines key parameters for the setup of field trials. These parameters are important to be documented to allow the comparison and consolidation of results from different trials.

The Test Requirements section describes tests that should be performed in field trials. The description of the setup to be applied during the test as well as expected results for the tests are given.

The reporting requirements define the procedures how results of trials can be input to the NGMN trial Group. A template is provided that enables the consolidation of different trial results.

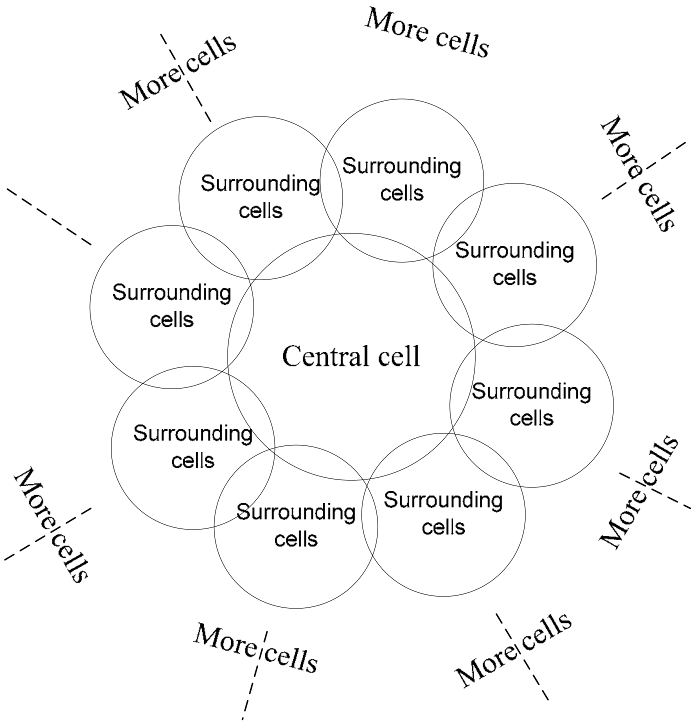
The first NGMN Field Trial Requirements focuses on the metrics and features that are anticipated for the first field trials. In a second release additional Test Requirements will be added reflecting the development of systems under test.

Content

1 NGMN TRIAL SETUP REQUIREMENTS

The typical topographical scenario for the trial is dense urban area including both outdoor and indoor case. Other scenarios such as suburban outdoor area can also be applied to verify the performance under different environment.

Support of Inter cell interference areas. There is at least one cell in the middle of the pattern which is completely surrounded by at least 1 layer of cells to evaluate performance under interference.
The trial setup needs to support the minimum requirements listed in the following bullets below.
The following illustration serves as an example:



Picture 2.1-1

Area with excellent SNR for maximum performance measurements.

Area with poor SNR for minimum performance measurements.

Areas interfered by far serving cells – cells which are not planned as neighbour cells.

Intra BS and inter BS handover areas are required. The base stations must constitute a whole coverage as needed by handover test.

Out of NGMN technology coverage scenario is required.

Possibility of various speed scenarios, supporting velocity ranges of:

Range 1	Range 2	Range 3	Range 4
0-15 km/h	15-60 km/h	60-120 km/h	120-350 km/h

Security features like firewalls, ciphering / encryption is activated during trials, including, but not limited to the following requirements:
Authentication, authorization, integration and confidentiality functionalities should be applied in both access network and services
Protection is applied on all communication planes: the management plane, the control plane and the user plane.

NGMN White Paper V3.0, Chapter 4.1.16 is referred for more information.

Multi-cell scenario with constantly loaded cells (base load of the trial network) are generally requested. The cells in the trial network shall contain a base load equally to 50% of available RF resources. This could be achieved by performing DL and UL data transfer with same share generated by asynchronous users.

Multi-vendor scenario are encouraged. Multi-vendor trials should include terminal devices, BS and CN elements from different vendors. Trials are not limited to single vendors. In addition scenarios which include BS from different vendors are recommended. In case of multi-vendor setups the involved parties need to be reported.

Each trial initiative is asked to provide for every measured KPI, a comparison with the performance of existing deployed systems (e.g. 2G/3G systems) in similar conditions.

The following deployment parameters are required to achieve comparable results among different trials. The document NGMN Performance Evaluation Methodology; Version 1.3 should serve as the reference document for NGMN trial parameter recommendations. In cases of variation from these recommendations then the parameter configurations need to be reported:

These parameters should be reported:

Carrier frequency
Operating bandwidth
Duplex mode (e.g. FDD, TDD). TDD specific configuration data needs to be specified (e.g. downlink and uplink allocation configuration)
Site layout and site location. A kind of map including site information need to be reported.
Site-to-site distance
BS, Terminal Device antenna heights
BS, Terminal Device antenna gain
BS, Terminal Device antenna diversity configuration (number of antenna, cross polar, vertical separation...)
BS, Terminal Device antenna spatial separation and/or correlation
BS, Terminal Device Max output power (including BS feeder loss)
Type of environment (dense urban, urban, suburban, rural), details on building heights etc.
Terminal Device Antenna position (car roof top, indoor etc)
User location based on GPS position together with trial area map
Approximate proportion of Line of Site
Link budget calculation shall be provided by trial initiatives

Recommendation is that logging tools used during trials should cover the following listed parameters:

At the BS side:
Transmitted carrier power
Received total power
Noise rise over thermal
DL user and cell throughput (L1, RLC)

UL user and cell throughput (L1, RLC)
UL BLER
Channel indicator reported by the Terminal Device
MIMO mode used
Modulation and coding used

At the Terminal Device side:
UL transmitted power
RSSI
Signal to interference and noise ratio
DL throughput (L1, RLC)
UL throughput (L1, RLC)
DL BLER
Channel indicator
MIMO mode used
Modulation and coding used
GPS location

Reporting of typical Application Server / Client PC configuration data required:
Operating Systems of Application Server and of the client PC/Laptop
MTU Size
TCP Receiving Window Size
Default Sent Window
Selective Acks
etc….

General recommendation: Logging data on BS and terminal side should be time synchronized.

2 NGMN TRIAL TEST REQUIREMENTS

In order to proof the NGMN provided platforms against the NGMN whitepaper requirements, the scope of this chapter is to define executable proof points. The NGMN platform under test includes the whole chain of required network elements (terminals, base stations, routers, gateways switches and application server) which are setup according to the definitions in chapter 1 “NGMN Trial Setup Requirements”.

Performance verification is based on traditional measurements like latency, throughput, intra NGMN platform mobility, traditional O&M cases. Also more complex scenarios like inter system mobility and more advanced features like QoS are covered. The general expectation is that already within the trial phase the Network Element Manager (NEM) will be available to provide support for operational tasks. Also it is assumed that SON related functions will be supported via NEM.

The NGMN platform shall provide a enhanced platform to deliver a benefit for the end customer of each operator. Therefore the NGMN trial group have defined benchmark measurements with various representative applications like FTP, HTTP or Email. This shall demonstrate how a customer will experience the new platform demonstrating all the performance related improvements.

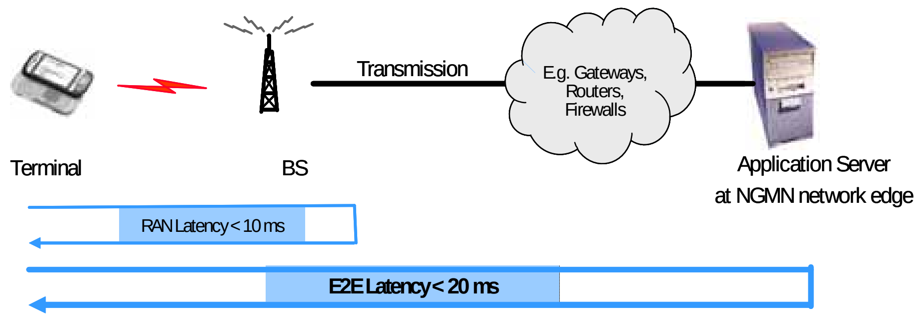
2.1 Latency

The NGMN trial group sees the latency as one of the key requirements to ensure full customer satisfaction based on a new NGMN platform. Latency or Round Trip Delay, is the most essential value which pays out as most for user perception of various dialogue oriented (interactive) applications. Shorter latencies lead to improved customer experience for applications like web browsing or mail synchronization services.

Latency should be measured for terminal devices that are in-sync, with an prescheduled and unscheduled uplink, and for terminal devices in inactive (or DRX) state separately.

The latency measurement for un-scheduled users shall reflect the situation how fast an inactive user can access a service. The scheduled case covers the response times of an active data transfer.

Principle scenario to verify latencies:



Picture 2.1-1

2.1.1 Latency

2.1.1.1 Basic configuration

Latency is measured end-to-end covering user equipment, NGMN network structure and ending with a target server located at the edge of the NGMN network platform. Single user per cell scenario is to be considered.

2.1.1.2 Scenario Considered

A ping with defined payload shall be used (details see below).

32 Byte ping latency (non-scheduled): The delay time between two pings should be larger than the inactivity time. The terminal is still IP connected, but all other resources like radio link, BS internal resources and transmission links have been released.

32 Byte ping latency (pre-scheduled): There is no delay between two consecutive pings. All system resources are still occupied and available.

1000 Byte ping latency (non-scheduled): The delay time between two pings should be larger than the inactivity time. The terminal is still IP connected, but all other resources like radio link, BS internal resources and transmission links have been released.

1500 Byte ping latency (non-scheduled): The delay time between two pings should be larger than the inactivity time. The terminal is still IP connected, but all other resources like radio link, BS internal resources and transmission links have been released.

2.1.1.3 Expected Output

Minimum 100 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 100 samples.

Result evaluation: Minimum value, Maximum value and Average value measured in msec.

Expected target value for 32 Byte Ping pre-scheduled and non-scheduled:

NGMN essential recommendations	< 30 ms (Note: RAN < 10 ms, Core < 10 ms)
NGMN preferred recommendations	< 20 ms (Note: RAN < 10 ms, Core < 5 ms)

Reference to NGMN WP 3.0: Chapter 3.1

2.1.2 32 Byte ping latency associated with different levels of loading

This test shall validate the Over-The-Air latency performance of the NGMN BS under different RF conditions and under different interference environments.

2.1.2.1 Basic configuration

Latency is measured end-to-end covering user equipment, NGMN network structure and ending with a target server located at the edge of the NGMN network platform. Multi-cell scenario considered with basic load in neighbour cells.

2.1.2.2 Scenario Considered

32 Byte ping latency (pre-scheduled): There is no delay between two consecutive pings. All system resources are still occupied and available.
Measurements with different amount of users in considered cell under test
Start with no load in cell under test. Same result expected as verified in chapter 2.1.1.
Increase number of users in cell by steps of 1 user until 10 other users are active in cell under test. Perform measurement with each increase of user.
Users are performing UL and DL traffic in at same time, like FTP UL and FTP DL with same terminal device.

2.1.2.3 Expected Output

Minimum 100 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 100 samples.

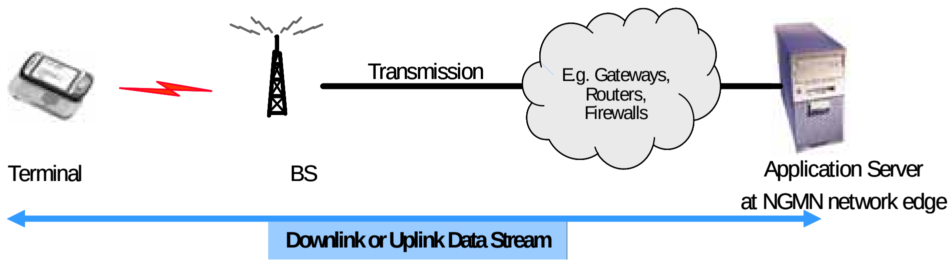
Result evaluation:
Graph is expected depicting the results with increasing number of additional users in cell under test. Minimum value, Maximum value and Average value measured in msec per measurement.

2.2 Throughput

The intention to verify data throughput under various conditions is that the NGMN group requests certain bandwidth for user data transfer. Maximum achievable data rates, average user data rates and data rates at various radio conditions are requested by NGMN. The NGMN trial group expects the requested data rates to be understood as user data rates.

Principle scenario to verify downlink and uplink data rates is shown below. NGMN trial group recommends to use a common tool like “iperf” to verify UDP or TCP throughput.

Note: Typical TCP based applications like FTP or HTTP, etc. are covered in a separate chapter dealing with user experience.



Picture 2.2-1

2.2.1 Peak Rate

Average DL data throughput with stationary end user equipment.

2.2.1.1 Basic configuration

Measurements are executed with optimal RF conditions. Area in the trial network providing reproducible maximum data rates.

2.2.1.2 Scenario Considered

The measured average throughput represents the peak data rate of a single user in a cell (unloaded condition). UDP or TCP throughput is requested.

2.2.1.3 Expected Output

The peak rate shall be the average value out of at least 10 samples. Each sample represents the average data rate of an at least 30 sec active data transfer with full buffer.

Result evaluation: Minimum value, Maximum value and Average value measured in kbps.

Expected target value for Downlink Peak Rate:

NGMN essential recommendations	> 100 Mbps
NGMN preferred recommendations	> 100 Mbps

Expected target value for Uplink Peak Rate:

NGMN essential recommendations	> 30 - 50 Mbps
NGMN preferred recommendations	> 50 Mbps

Reference to NGMN WP 3.0: Chapter 3.1

2.2.2 Average User Throughput

Average User Throughput is the throughput what a user experiences in average at various equally distributed locations within one cell.

2.2.2.1 Basic configuration

The radio conditions vary with the different locations, means different SNR and receiving levels characterize each location. UDP or TCP throughput is requested.

2.2.2.2 Scenario Considered

Multi cell scenario where each cell is interfered by neighbour cells and far server cells (cells not considered as neighbour cell).

2.2.2.3 Expected Output

At least 10 equally distributed location within one cell are required. The DL average user throughput shall be the average value out of at least 5 samples per measurement location. Each sample represents the average data rate of an at least 30 sec active data transfer with full buffer.

Result evaluation: Minimum value, Maximum value and Average value measured in kbps.

Expected target value for Downlink Average User Throughput:

NGMN essential recommendations	> 0.15 – 0.25	bps/Hz/sector
NGMN preferred recommendations	> 0.3 – 0.4	bps/Hz/sector

Expected target value for Uplink Average User Throughput:

NGMN essential recommendations	> 0.0099 – 0.165	bps/Hz/sector
NGMN preferred recommendations	> 0.198 – 0.264	bps/Hz/sector

Reference: NGMN TWG TE WP1 Phase 2 Performance Report [10]

2.2.3 Throughput at Cell Edge

2.2.3.1 Basic configuration

Average data throughput with stationary end user equipment in unloaded network - single user per cell at cell edge. UDP or TCP throughput is requested.

2.2.3.2 Scenario Considered

Multi cell scenario. Considered cell is interfered by neighbour cells. Reference to Definition of Cell Edge, case b).

2.2.3.3 Expected Output

The DL throughput at cell edge shall be the average value out of at least 10 samples. Each sample represents the average data rate of an at least 30 sec active data transfer with full buffer.

Result evaluation: Minimum value, Maximum value and Average value measured in kbps.

Expected target value for Downlink Throughput at Cell Edge:

NGMN essential recommendations	> 0.06 – 0.1	bps/Hz/sector
NGMN preferred recommendations	> 0.12 – 0.16	bps/Hz/sector

Expected target value for Uplink Throughput at Cell Edge:

NGMN essential recommendations	> 0.03 – 0.05	bps/Hz/sector
NGMN preferred recommendations	> 0.06 – 0.08	bps/Hz/sector

Reference: NGMN TWG TE WP1 Phase 2 Performance Report [10]

2.2.4 Interference (TDD-TDD or FDD-FDD)

Evaluate NGMN system's performance in synchronous configuration when presented with interference environment from asynchronous TDD/FDD configuration, as well as other TDD/FDD system operating on adjacent channel. For TDD/TDD interference, the interference caused by adjacent cells having different DL/UL allocation should be tested. For example the interference should be tested in such scenario: one cell is configured as 2:2 DL/UL allocation and the adjacent area is configured as 3:1 (Including both cases that the interfered cell shares the same frequency band with adjacent area, and the interfered cell uses different frequency band with the adjacent area.).

2.2.4.1 Basic configuration

One TDD system and one FDD system, deployed in two adjacent bands with variable guard bands.
Two adjacent and synchronous TDD systems, configured with different DL/UL allocation. One system is configured as 2:2 (DL: UL) and another system is configured as 3:1(DL: UL). The two TDD systems can be deployed in the same frequency band or in different bands.

2.2.4.2 Scenario considered

1. At least one BS for each system

2.
a) same frequency band
- At least one BS for each system
b) different bands
For adjacent channel interference test,
- Two BSs are located very near each other
- Two BSs are separated sufficiently and mobile is located near the cell edge of one BS (where is near from the other BS)

2.2.4.3 Expected output

Measured C/I distribution
Call drop rate
The minimum required guard band that can keep the interference under the acceptable level. (Applicable only for configuration 2. i.e. TDD/TDD interference)

2.2.5 Path loss and system coverage performance

Verify NGMN system's path loss (or transmission loss) as submitted in the link budget tables and maximum coverage range supported in the field environment.

2.2.5.1 Basic configuration

Influence of interference effects should be avoided as much as possible. DL throughput measurement shall be considered. Only receiving level need to be taken into account.

2.2.5.2 Scenario Considered

Single user in cell scenario. Single cell scenario. The system is unloaded. Velocity Range 1 shall be considered.

One user is moving from good BS receiving level to lower BS receiving levels measured at terminal side or user is moving from cell centre to cell edge until loss of coverage.

The data measurement shall be taken from a drive test using constant data streams with full buffer. UDP or TCP data flow can be used.

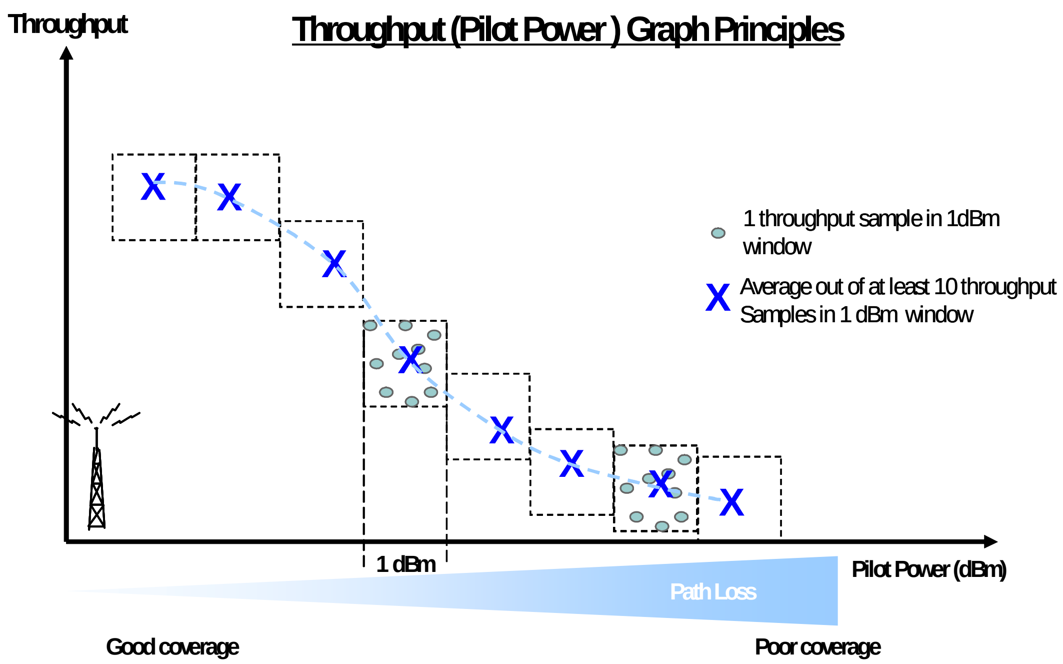
The following antenna configurations shall be considered and verified:
SIMO
2x2 MIMO
4x4 MIMO

2.2.5.3 Expected Output

As result a graph shall be provided showing the dependency of average throughput over receiving signal level for each antenna configuration.

The trial initiative shall provide a detailed description about the exact MIMO configuration used (Beam-forming, TX diversity, Rx Diversity, …).

The graph shall be scaled on x-axis in 1 dBm steps. Each valid point in the graph represents the average value of at least 10 samples of a 1 dBm window. See example below.



Picture 2.2-2

2.2.6 Throughput depending on radio link quality

Evaluate NGMN base station performance under realistic intra-cell and inter-cell interference in the downlink path.

2.2.6.1 Basic configuration

Single user in cell scenario. Cell is interfered by neighbour cells. The system is unloaded.

2.2.6.2 Considered Scenario

Measurement of data throughput for Uplink and Downlink direction with various radio quality conditions. Dependency of achievable data rates vs. various radio link qualities shall be verified.

The data measurement shall be taken from a drive test using constant data streams with full buffer. UDP or TCP data flow can be used.

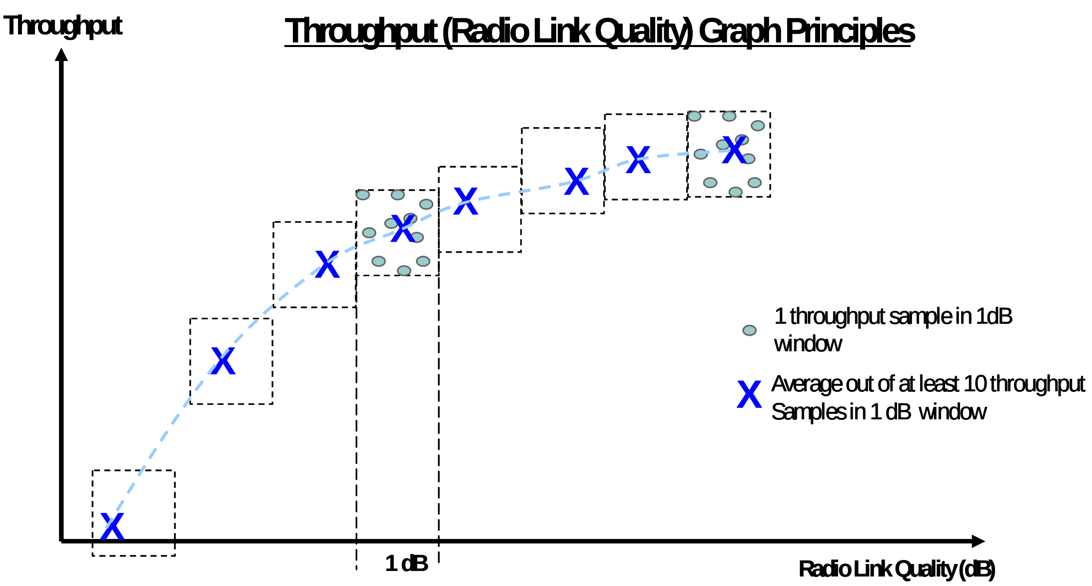
The following antenna configurations shall be considered and verified:
SIMO
2x2 MIMO
4x4 MIMO

2.2.6.3 Expected Output

As result a graph shall be provided depicting the average achieved throughput in dependency of radio link quality in 1 dB steps (0..1dB, 1..2dB, etc.). Each reported graph point is averaged at least from 10 samples to get statistical assurance.

The trial initiative shall provide a detailed description about the exact MIMO configuration used (Beam-forming, TX diversity, Rx Diversity, …).

One graph per transmission direction is expected (Uplink and Downlink). For both transmission directions all antenna configurations shall be considered. See example below.



Picture 2.2-3

2.3 Cell Capacity, Cell Load

This chapter considers system capabilities like cell capacity and cell load. Cell load is not well defined in the NGMN WP document. For trial purposes NGMN proposes a call mix with a certain amount of users distributed in a cell and to consider this as load. Furthermore cell capacity and the linked measurement of spectrum efficiency is covered by cell throughput measurements which do consider multi user scenarios and results which can be interpreted as spectrum efficiency.

2.3.1 Cell Throughput

2.3.1.1 Basic configuration

Average data throughput with stationary end user equipment in loaded network.
Cell under test is surrounded by neighbour cells.

2.3.1.2 Considered Scenario

10 users or more equally distributed in same cell (refer also to definition of loaded network).
Various Rx pilot levels from cell core to cell edge are represented. All users got a constant data transfer ongoing with permanent full sending buffer.

2.3.1.3 Expected Output

Averaging the sums of throughputs of all users will provide the average cell throughput. This cell throughput represents the downlink cell capacity provided by the system. The cell under test is interfered by neighbour cells.

Expected target value for Downlink Cell Throughput:

NGMN essential recommendations	> 1.59 – 2.65	bps/Hz/sector
NGMN preferred recommendations	> 3.18 – 4.24	bps/Hz/sector

Expected target value for Uplink Cell Throughput:

NGMN essential recommendations	> 0.99 – 1.65	bps/Hz/sector
NGMN preferred recommendations	> 1.98 – 2.64	bps/Hz/sector

Reference: NGMN TWG TE WP1 Phase 2 Performance Report [10]

2.3.2 VOIP call capacity

Multiple parallel VOIP calls including a call mix out of active MOC, MTC and MMC can be handled within one cell.

2.3.2.1 Basic configuration

The test scenario shall include mobility and different velocities according to velocities ranges defined.

2.3.2.2 Considered Scenario

VOIP calls executed in one cell.

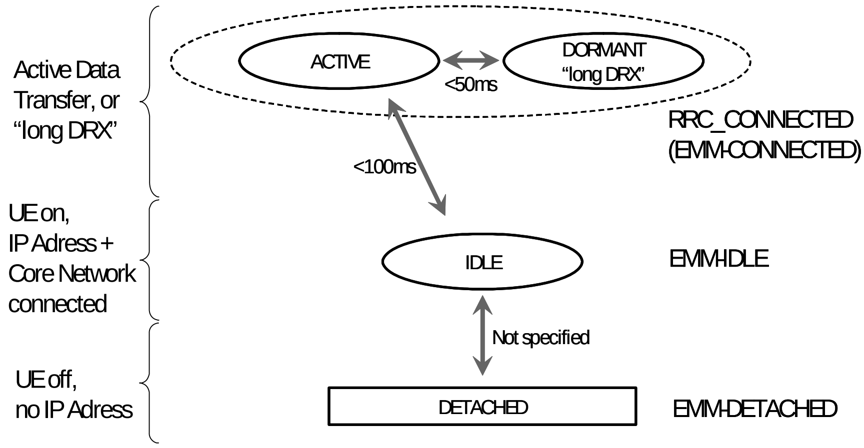
2.3.2.3 Expected Output

Expected target value:

NGMN essential recommendations	> 60 VOIP calls/cell/MHz
NGMN preferred recommendations	> 80 VOIP calls/cell/MHz

Reference to NGMN WP 3.0: Chapter 4.2.3.5

2.4 State Transitions



Picture 2.4-1

2.4.1 Sleep, idle and paging modes

These tests are intended to validate different mobility state transitions (control plane) and their transitions times. In concrete:

Validate the paging procedure for idle state users under varied channel condition and fully loaded system environment
Quantify "idle to active"/"active to idle", and "sleep to active"/"active to sleep" state transition times
Idle state is defined as the behaviour of a user when it is registered to network, but inactive for a long time, so radio resources have been release.
Sleep state is defined as the behaviour of a user when it is registered to network, but inactive for a short period of time, so it changes to long DRX cycle times.
Active State is defined as the behaviour of a user when it is making use of a service.
Verify the associated process for each type of state transition.

2.4.1.1 Basic configuration

A basic configuration is established in order to facilitate implementation of tests and comparison of results.

Number of users: 10 users per cell on average and a homogeneous user distribution across each cell shall be assumed as a reference case.

2.4.1.2 Scenarios Considered

For this test users are considered to be in the same cell.

2.4.1.3 Expected Output

The metric for validate the tests shall be the transition times between states.

Trial initiatives shall report on used trigger points to evaluate the state transitions times.

Minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

Result evaluation: Minimum value, Maximum value and Average value measured in msec.

Expected target value:
NGMN recommendations = Idle<->Active transition time < 100ms
NGMN recommendations = Sleep<->Active transition time < 50ms

Reference to NGMN WP 3.0: Chapter 4.1.7

2.5 VOIP

NGMN packet data systems should support an efficient use of system capacity for Voice over IP service. For this reason VOIP service has to be tested in an NGMN network. For a definition of a VOIP Call, please refer to Annex 5.1.7

2.5.1 VOIP Speech Quality

2.5.1.1 Basic configuration

VoIP service has to be tested in stationary conditions.
Mobile terminals as well as data card have to be used.

2.5.1.2 Scenario Considered

Single cell scenario, without interference as reference.
Multi cell scenario. Considered cell is interfered by neighbour cells. In this case, the terminals under test have to be in different cells.

Evaluate speech quality also with increasing number of terminals (10%, 30%, 60% and 80% of VOIP cell capacity) that have VOIP calls on the same cell.

2.5.1.3 Expected Output

For each configuration (in all scenarios), VoIP speech quality shall be tested according with the support of next indication:

The metric for validating the requirement will be the support of both codecs below mentioned with a speech quality measured by two different parameters:

- MOS (Mean Opinion Score) (ITU-T P.800, ITU-T P.862). For this last a comparative table is provided in the next:

Mean Opinion Score (MOS)

MOS	Quality	Impairment
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

Table 2.5-1

- PLR (Packet Loss Rate)
- Jitter
- Latency

Call Setup Time

Call Success Rate
Call Set-up Success Rate

For both metrics (PLR and MOS), minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

- Result evaluation: Minimum value, Maximum value and Average value.

Expected target value:
NGMN essential recommendations = NB-AMR 12.2 kbps codec under comparable conditions
NGMN preferred recommendations = WB-AMR 12.65 kbps codec under comparable conditions

Reference to NGMN WP 3.0: Chapter 4.2.3.5

2.5.2 VOIP Call Setup Times

Time required to establish a VOIP call..

2.5.2.1 Basic configuration

Mobile terminals as well as data card have to be used (in particular, the configurations "data card originating – mobile terminal terminating" and "mobile terminal originating – data card terminating" have to be used).

The VOIP call setup time has to be tested in the following configurations:
Mobile to PSTN Call (Mobile Originated Call, MOC)
Mobile Terminated Call (MTC)
Mobile to Mobile Call (MMC)

In all the test cases described below, the call setup time is measured on the originating node and includes service request procedure (for Mobile Originated Call and Mobile to Mobile Call) or paging procedures (for Mobile Terminated Call and Mobile to Mobile Call).
The pre-condition is that the involved mobile terminals are attached to the network and IMS (or SIP) registered. It is also assumed that when the VOIP call is started the mobile terminals are in IDLE state, which means that all radio and transmission resources must have been released as the result of a sufficiently long period of inactivity.

Two types of delays have to be considered:
Call setup signalling delay (E2E signalling).
Start trigger: The mobile terminal delivers the initial session setup message (e.g. INVITE). This triggers Service Request procedure, so that the mobile terminal transitions to ACTIVE state and an appropriate radio bearer to convey IMS signalling is established.
Stop trigger: The mobile terminal receives the signalling message that bring the ringing message (e.g. 180 Ringing).

Total call setup (including E2E bearer setup).
Start trigger: The mobile terminal delivers the initial session setup message (e.g. INVITE). This triggers Service Request procedure, so that the mobile terminal transitions to ACTIVE state and an appropriate radio bearer to convey IMS signalling is established.
Stop trigger: The mobile terminal receives the signalling message that confirms the successful completion of the call setup procedure (e.g. 200 OK).

2.5.2.2 Scenario Considered

Single cell scenario, without interference, as reference.

Multi cell scenario. Considered cell is interfered by neighbour cells. In this case, the terminals under test have to be in different cells.

2.5.2.3 Expected Output

The metric for validate the tests shall be the VOIP call setup latency time for the different configurations (MOC,MTC, MMC) and for the different types of delays.

In case that the trigger points for the measurement are different than the proposed ones, the deviation needs to be reported.

Minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

Result evaluation: Minimum value, Maximum value and Average value measured in msec.

2.5.3 VOIP End to End Latency

2.5.3.1 Basic configuration

This is the mouth to ear delay as perceived by the calling parties. It includes voice coding on the originating terminal, end-to-end transmission and voice decoding on the receiving terminal.
Mobile terminals as well as data card have to be used (in particular, the configurations "data card originating – mobile terminal terminating" and "mobile terminal originating – data card terminating" have to be used).

2.5.3.2 Scenario Considered

Single cell scenario, without interference, as reference.
Multi cell scenario. Considered cell is interfered by neighbour cells. In this case, the terminals under test have to be in different cells.

Evaluate speech quality also with increasing number of terminals (10%, 30%, 60% and 80% of VOIP cell capacity) that have VOIP calls on the same cell.

2.5.3.3 Expected Output

The metric for validate the tests shall be the end-to-end latency time.

Minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

Result evaluation: Minimum value, Maximum value and Average value measured in msec.

2.5.4 Coexistence of VOIP with other applications

2.5.4.1 Basic configuration

The VOIP test cases described in the previous sub-sections should be repeated in case the VOIP call is established when other applications are running on the mobile terminal. The following scenarios should be considered:

- VOIP coexistence with a packet data call (use TCP via iperf). VOIP call shall have a duration of at least 20 sec and the data call shall take longer than the VOIP call. The data call shall fulfil a full buffer scenario to stress the scheduler.
- VOIP coexistence with an on-going UDP streaming. The reference codec configuration for the UDP stream has to determined (e.g. MPEG4).

- VOIP coexistence with an on-going TCP streaming application. The reference codec configuration for the TCP stream has to determined (e.g. MPEG4).
- VOIP coexistence with bursty TCP traffic, such as web browsing and presence. The exact definition of the reference model for such bursty traffic requires further consideration.
- Mobile terminals as well as data card have to be used.

2.5.4.2 Scenario Considered

Single cell scenario, without interference, as reference.
Multi cell scenario. Considered cell is interfered by neighbour cells. In this case, the terminals under test have to be in different cells.
Evaluate speech quality also with increasing number of terminals (10%, 30%, 60% and 80% of VOIP cell capacity) that have VOIP calls on the same cell.

2.5.4.3 Expected Output

Refer also to chapter 2.5.1.3.

2.6 Mobility within NGMN system

2.6.1 VOIP Call at different velocities

VoIP speech quality shall be verified in different speed ranges (i.e. different fading profiles) during mobility scenarios including cell changes.

2.6.1.1 Basic configuration

A basic configuration is established in order to facilitate implementation of tests and comparison of results.

Load: 2 configurations
Loaded network: 10 devices per cell on average, homogeneously distributed in each cell as defined in chapter 1.
Unloaded network: Only one moving terminal device in the network.
Speed ranges indicated in chapter 5.1 are considered.

So, this scheme provides 8 possible configurations for the tests, detailed in the next table

Load Model/Speed Range	1 (0-15km/h)	2 (15-60km/h)	3 (60-120km/h)	4 (120-350km/h)
Load network: 10UE	Configuration 1	Configuration 2	Configuration 3	Configuration 4
Unload network: 1UE	Configuration 5	Configuration 6	Configuration 7	Configuration 8

Table 2.6-1

2.6.1.2 Scenarios Considered

For each configuration above considered several scenarios shall be proved:

User moving inside a cell
Intra Base Station handover inside a particular NGMN access technology (e.g. LTE, WiMAX, UMB) (Intra/Inter-Frequency)
Inter Base Station handover inside a particular NGMN access (Intra/Inter-Frequency)

2.6.1.3 Expected Output

For each configuration (in all scenarios), VOIP speech quality shall be tested according with the support of next indication:

The metric for validating the requirement will be the support of both codecs below mentioned with a speech quality measured by two different parameters:

MOS (Mean Opinion Score) (ITU-T P.800, ITU-T P.862). For this last a comparative table is provided in the next:

Mean Opinion Score (MOS)

MOS	Quality	Impairment
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

Table 2.6-2

PLR (Packet Loss Rate)
Jitter
Latency
Call Setup Time
Call Success Rate

For both metrics (BER and MOS), minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

- Result evaluation: Minimum value, Maximum value and Average value.

Expected target value:
NGMN essential recommendations = NB-AMR 12.2 kbps codec under comparable conditions
NGMN preferred recommendations = WB-AMR 12.65 kbps codec under comparable conditions

Reference to NGMN WP 3.0: Chapter 4.2.3.5

2.6.2 Downlink and Uplink Throughput in Mobile use

DL and UL throughput should be measured and verified in mobility situations. Handover interruption time should be evaluated in different scenarios and configurations.

2.6.2.1 Basic configuration

Trial configurations are set up for all scenarios:
Number of cells: at least 2 in order to trigger at least one HO during drive tests.
Load: 2 configurations
Loaded network: 10 UEs per cell on average, homogeneously distributed in each cell, as described in section 4.1.6 , loaded network also as defined in chapter 1.
Unloaded network: Only one moving UE in the network.
Speed ranges indicated in chapter 5.1 are considered.

16 possible configurations are derived for the tests:

Load / Speed Range	1		2		3		4	
	TCP	UDP	TCP	TCP	UDP	UDP	TCP	UDP
Loaded	Config 1	Config 2	Config 3	Config 4	Config 5	Config 6	Config 7	Config 8
Unloaded	Config 9	Config 10	Config 11	Config 12	Config 13	Config 14	Config 15	Config 16

Table 2.6-3: DL and UL Throughput trial configuration

2.6.2.2 Scenarios Considered

For each configuration from the table above, several scenarios shall be considered:
Intra Base Station handover inside a particular NGMN access technology (e.g. LTE, WiMAX, UMB) (Intra/Inter-Frequency)
Inter Base Station handover inside a particular NGMN access technology (Intra/Inter-Frequency). Particular NGMN access technology feature gain related to HO should be evaluated (e.g. data forwarding on X2 interface for LTE)

2.6.2.3 Expected Output

For each configuration (in all scenarios), DL and UL interruption time shall be evaluated. At least 20 samples are required.

Expected target value:

NGMN essential recommendations:
Seamless mobility management across all bearers with service continuity through a minimum of 120 km/h

NGMN preferred recommendations:
Seamless mobility management based on intelligent infrastructure e.g., a unified network & service layer to serve in all environments

Reference to NGMN WP 3.0: Chapter 3.1

The metrics for validating the requirements will be:
Interruption time on MAC layer
Interruption time on UDP/TCP layer.
FTP applicative throughput during the HO process in DL and UL.

2.6.3 Packet Loss

The trial purpose is to evaluate and verify the performance of mobile networks in terms of packet and information loss in different mobility scenarios:
Stationary use
Mobile use
Intra Base Station
Inter Base Station

Performance requirements and target values in terms of packet loss rate (PLR, packet loss in network layer) and frame erasure rate (FER, information loss at application layer) generally depend on the type of service. Thus, several tests with different types of service shall be performed for all mobility scenarios.

2.6.3.1 Basic configuration

Only one user in the whole test network
The trial shall be done for several services which have different behaviours compared to packet and information loss:
UDP and TCP data stream (UL and DL to be considered)
VOIP

2.6.3.2 Scenarios Considered

For each configuration above, several mobility scenarios shall be verified and evaluated:

In stationary use:

Cell #1 uses Carrier #1 and BW #1; it belongs to BS #1.
Put the single user in the center of cell #1.
Start a UDP or TCP transfer (Downlink and Uplink), or a VoIP call in good radio conditions to avoid inopportune mobility procedure during the ongoing transfer. This stationary case will be used as a reference.

In mobile use:

Intra Base Station
Cell #1 uses Carrier #1 and BW #1; it belongs to BS #1.
Cell #2 uses Carrier #1 and BW #1; it belongs to BS #1.
In this test case, the cells #1 and #2 belong to same Base Station #1.
Put the single user in the center of cell #1.
Start a UDP or TCP transfer (Downlink and Uplink), or a VoIP call in good radio conditions.
Attenuate the signal level of cell #1 and increase the signal level of cell #2 to trigger the intra BS handover procedure from cell #1 to cell #2.
After the handover procedure is complete, attenuate the signal level of cell #2 and increase the signal level of cell #1 to trigger the intra BS handover procedure from cell #2 to cell #1.
It is possible to repeat the same operation several times as long as the transfer is active.
Inter Base Station
Cell #1 uses Carrier #1 and BW #1; it belongs to BS #1.
Cell #2 uses Carrier #1 and BW #1; it belongs to BS #2.
In this test case, the cells #1 and #2 belong to different Base Station.
Put the single user in the center of cell #1.
Start a UDP or TCP transfer (Downlink and Uplink), or a VoIP call in good radio conditions.
Attenuate the signal level of cell #1 and increase the signal level of cell #2 to trigger the inter BS handover procedure from cell #1 to cell #2.
After the handover procedure is complete, attenuate the signal level of cell #2 and increase the signal level of cell #1 to trigger the inter BS handover procedure from cell #2 to cell #1.
It is possible to repeat the same operation several times as long as the transfer is active.
I

2.6.3.3 Expected Output

At least 20 cell changes are expected.
Count the number of packet loss due to handover procedure.
The packet loss can be measured at different layers in the network system. So, it is necessary to report precisely in which layer the packet loss is measured in the trial:

At network layer (layer 3 in OSI model)

IP Packet Loss Rate (IP PLR)
At transport layer (layer 4 in OSI model)
TCP PLR or UDP PLR (equal to IP PLR)
At application layer (layer 5 in OSI model)
Frame erasure rate (FER) to evaluate the information loss

2.6.4 Service continuity of a RT / NRT session

NGMN technology shall provide seamless mobility functions. Seamless mobility implies handover of services within NGMN with no interruptions or perceptible drop in performance (e.g. VCC).

Consequently, NGMN shall provide seamless mobility management across all required NGMN bearers with service continuity, so user experience shall not be damaged during a mobility procedure.

Service Continuity of Real Time and non-Real Time Sessions shall be verified in different scenarios. The metric used for validating results will be the interruption time of the service in successful situations.

2.6.4.1 Basic configuration

A basic configuration is established in order to facilitate implementation of tests and comparison of results.

Number of users: 10 users per cell on average and a homogeneous user distribution across each cell shall be assumed as a reference case, refer also to definition in chapter 1.
For simplicity a specific service will be analyzed in both RT and non-RT sessions
RT session: considering videoconference service
Codecs Audio: NB-AMR (12,2 Kbps), WB-AMR (12,65 Kbps)
Codecs Video: H.263, MPEG 4; BW: 128 Kbps
NRT session: considering web browsing service
Maximum BW: 128 kbps
Load: 2 configurations
Loaded network: 10 terminal devices per cell on average, homogeneously distributed in each cell, refer also to definition in chapter 1.
Unloaded network: Only one moving UE in the network

So, this scheme allows for a configuration in the RT scenario and the NRT one.

2.6.4.2 Scenarios Considered

For each configuration above considered several scenarios shall be proved:

User moving inside a cell (no service interruption should be experienced by the user)
Intra Base Station handover inside a particular NGMN access technology (e.g. LTE, WiMAX, UMB) (Intra/Inter-Frequency)
Inter Base Station handover inside a particular NGMN access (Intra/Inter-Frequency)

2.6.4.3 Expected Output

The metric for validating the results for both configurations (in all scenarios considered) shall be interruption time of the service in the handover process, by measuring the outage time at UDP/TCP level. Only the specific service (videoconference, web browsing) will be evaluated.

Minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

Result evaluation: Minimum value, Maximum value and Average value measured in msec.

Expected target value:
NGMN recommendations = RT session (videoconference) interruption time < 300 ms
NGMN recommendations = NRT session (web browsing) interruption time < 500 ms

Reference to NGMN WP 3.0: Chapter 4.1.1.1

2.7 Inter-working Requirements / IRAT mobility

This section presents the inter-working and IRAT mobility trial requirement between NGMN network and legacy networks. In case NGMN network does not provide a reliable voice call service at its initial stage, alternative solutions have to be provided.

2.7.1 Inter-working with legacy networks

2.7.1.1 Basic configuration

A basic configuration is established in order to facilitate implementation of tests and comparison of results.

Inter-working capability should be tested in unloaded network.
Inter-working capability should be tested with the following services:
RT services:
Voice call. Codec: NB-AMR (12.2 Kbps)
Video call. Codec: H.263, MPEG 4. BW:128 Kbps
NRT services:
TCP and UDP. The testing tool “iperf” is recommended.
Session duration: 1 minute

Inter-working capability should be tested in the following 2 scenarios:

	NGMN RT	NGMN NRT
legacy CS	Scenario 1	
legacy PS		Scenario 2

Table 2.7-1

<u>Note:</u> Each inter-working scenario should be tested bi-directional, i.e. NGMN network ←→ legacy networks.

This is illustrated with the arrows in the table above.

All together 4 possible configurations are derived for the tests:

Scenario	1		2	1 + 2
Service	voice call	video call (if applicable)	TCP/UDP download	voice call (or video call) + TCP/UDP download
Configuration	Config 1	Config 2	Config 3	Config 4
Scenario	1		2	1 + 2
Service	voice call	video call (if applicable)	TCP/UDP download	voice call (or video call) + TCP/UDP download
Configuration	Config 1	Config 2	Config 3	Config 4

Table 2.7-2

2.7.1.2 Scenarios considered

Inter-working capability should be tested in stationary condition.

2.7.1.3 Expected output

For each configuration, the expected outputs:

Call setup time (Both ends of terminal device should be in IDLE mode)
Call success rate (For VoIP service)
Call Set-up Success Rate
Mouth to ear delay as perceived by the calling parties

- MOS (Mean Opinion Score) (ITU-T P.800, ITU-T P.862). For this last a comparative table is provided in the next:
-

Mean Opinion Score (MOS)

MOS	Quality	Impairment
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

Table 2.7-3

- PLR (Packet Loss Rate)
- Jitter
- Latency

Minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

2.7.2 IRAT mobility

IRAT mobility is tested in two categories:

Terminal device Idle mode cell reselection
Terminal device active mode IRAT handover

2.7.2.1 Basic configuration

2.7.2.1.1 IRAT Cell Reselection

IRAT cell reselection is tested by checking whether a terminal device is able to reselect a cell that belongs to another RAT. The testing area should be covered by cells of multiple RATs so that IRAT cell reselection is possible.

Two configurations should be tested:

Scenario	Terminal camped on NGMN cell can reselect to a legacy cell	Terminal camped on legacy cell can reselect to a NGMN cell
Configuration	Config 1	Config 2

Table 2.7-4

2.7.2.1.2 IRAT Handover

IRAT handover is tested by checking whether a terminal device is able to handover to a cell that belongs to another RAT and the quality of handover.

IRAT handover should be tested in unloaded NGMN network. However legacy networks are not required to be unloaded.
IRAT handover should be tested with the following services:
RT services:
Voice call. Codec: NB-AMR (12.2 Kbps)
Video call. Codec: H.263, MPEG 4. BW:128 Kbps
NRT services:
TCP and UDP. The testing tool "iperf" is recommended.

IRAT handover should be tested with the following scenarios.

	NGMN RT	NGMN NRT
legacy CS	Scenario 1	
legacy PS		Scenario 2

Table 2.7-5

All together 4 possible configurations are derived for the tests:

Scenario	1	2	1 + 2	
Service	voice call	video call (if applicable)	TCP/UDP download	voice call (or video call) + TCP/UDP download
Configuration	Config 3	Config 4	Config 5	Config 6

Table 2.7-6

2.7.2.2 Scenarios considered

IRAT cell reselection is tested in stationary condition at multiple cell boundaries.

IRAT handover is tested in mobile condition.

2.7.2.3 Expected output

For configuration 1 and 2, the expected outputs:

Terminal device should be able to reselect a cell that belongs to a different RAT.

For configuration 3 ~ 6, the expected outputs:

Handover Interruption time in U-plane. Practically this can be measured by checking the timeout duration of ping command.
Handover success rate
MOS after handover
Throughput variation during HO. This can be measured by iperf tool.
Call Success Rate

Minimum 20 valid samples are required for result evaluation. The result will be calculated and reported as an average from these 20 samples.

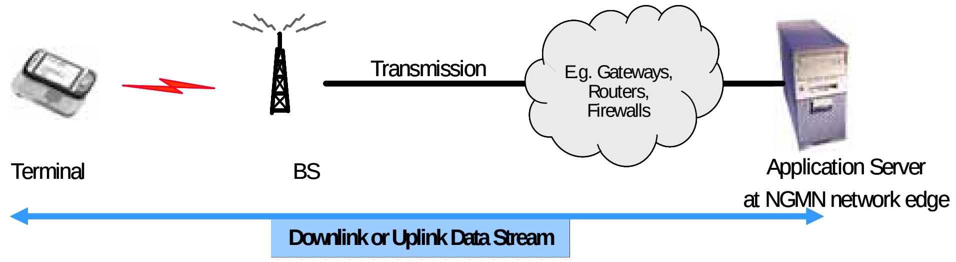
2.8 User Experience

Application benchmark is required to verify customer experience with pure end-to-end approach and all protocol depending aspects.

All following application benchmarks shall be measured 1) under ideal radio conditions in single user scenarios and 2) subjected to different RF conditions.

Because of the (K)PIs are designed to measure the end-to-end customer experience, there is a need to be measured individually for each service, as the performance is likely to differ between services. The test scenarios will be executed in loaded and unloaded conditions as defined in chapter1.

The general test setup shall be same as already requested in previous chapters.



Picture 2.8-1

2.8.1 FTP Throughput

2.8.1.1 Basic configuration

Good radio conditions expected
Reference Content for downlink FTP throughput:
50 MB binary file for loaded cell scenario
650 MB binary file (CD capacity equivalent) for unloaded cell scenario
Reference Content for uplink FTP throughput:
25 MB binary file for the loaded scenario
650 MB (CD capacity equivalent) for unloaded cell scenario
The measurement to be done in a stationary mode

2.8.1.2 Scenarios Considered

System shall be in IDLE state. System resources are released before each data transfer, but terminal device is still IP connected.
Attempt to **download / upload a specified binary file** and measure the time until the start of the content data transfer
Measure the average Throughput after the transfer completed.
ETSI TS102 250-2 [12] provides definitions of the timing trigger points. For example in Section 4.6.2.6, the start timing trigger for an FTP download is specified as the transmitting of the first [SYN] and the stop timing trigger is the receipt of the last data packet which contains a “set” FIN bit.

2.8.1.3 Expected output

The test cycle to be repeated for 20 times for loaded and unloaded cell scenario. The Min/Max/Average download time shall be measured in seconds.

2.8.2 Video streaming / live data streaming

Once the connection has been established, a specific stream shall be requested and the time for having the buffering message and reproduction started shall be measured.

As most of customers are using the streaming services in Mobility, the measurements test scenario has to represents the customer experience.

Also a different reference stream could be used. The duration of the stream should be 120 s.

2.8.2.1 Basic configuration

Duration of the stream content: 120 sec and should be stored in live content server.
The measurement to be done in a Mobility mode, drive testing

2.8.2.2 Scenarios Considered

System shall be in IDLE state. System resources are released before each data transfer, but terminal device is still IP connected.
Request the specific stream and measure time for having the buffering message
Measure time for reproduction start.
Then measure the following
Audio quality
Video quality
Audio/video synchronization

2.8.2.3 Expected output

The test cycle has to be repeated 20 times. For loaded and unloaded cell scenario.

Once stream reproduction has been started measure:
Success/failure
Audio quality
Video quality as per:
ITU J.144 Objective perceptual video quality measurement techniques for digital cable television in the presence of a full reference
Number of picture "freezes" in 60 seconds
Audio/video synchronization

2.8.3 Broadcast, Multicast and Unicast Services

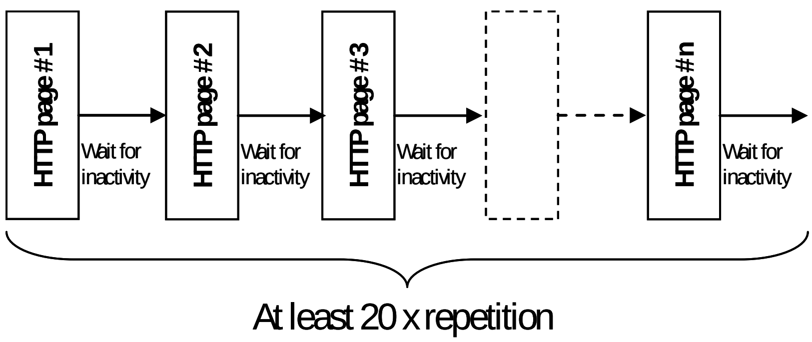
(To be studied in future releases).

2.8.4 HTTP / Web browsing

For performing the web browsing, a web browser application supporting HTTP 1.1 (see RFC 2616) shall be used.
The behaviour/performance of the web browser should be comparable to popular browsers (e.g. Microsoft Internet Explorer, Mozilla Firefox, Netscape Navigator, Opera).

An appropriate guard time must be maintained between two web page download attempts in order to ensure that the radio resource is released. Otherwise there will be no “channel request” but immediately a “packet uplink (downlink) assignment”.

“Copernicus” reference web page (209,282 byte) is recommended by ETSI to be used in HTTP / Web browsing test. This reference web page has been selected as a "good mixture" between text and graphics - related to the customer behaviour



Picture 2.8-2

2.8.4.1 Basic configuration

Reference content : “Copernicus” reference web page (209,282 byte)
No TCP optimizer containing parallel TCP streams, multiple HTTP downloads as background task.
No Acceleration and Compression services shall be used.
Tests shall be performed stationary mode

2.8.4.2 Scenarios Considered

Clear all objects in the cache except cookies and java-scripts
System shall be in IDLE state. System resources are released before each data transfer, but terminal device is still IP connected.
Attempt to download a specific web page (Copernicus). Measure the time until the start of the content data transfer and the time needed for transfer of complete file.

2.8.4.3 Expected output

The test cycle to be repeated for 20 times. For loaded and unloaded cell scenario.
The average time needed to download the reference web page successfully.

2.8.5 HTTP downloads

This case is a mixture of FTP download and HTTP test scenarios. e.g. the customer tries to download a specific file such as MP3 from the internet over http protocol.

2.8.5.1 Basic configuration

Reference Content:
50 MB binary file for loaded cell scenario
650 MB binary file (CD capacity equivalent) for unloaded cell scenario
Reference web page to be used
The measurement to be done in a stationary mode

2.8.5.2 Scenarios Considered

System shall be in IDLE state. System resources are released before each data transfer, but terminal device is still IP connected.
Attempt to access a predefined webpage and **download a specified binary file** and measure the time until the start of the content data transfer
Measure the average Throughput after the transfer is completed.
ETSI TS102 250-2 [12] provides definitions of the timing trigger points. For example in Section 4.6.2.6 the start timing trigger for an HTTP download is specified as the transmitting of the first [SYN] and the stop timing trigger is the receipt of the last packet which contains content.

2.8.5.3 Expected output

The test cycle to be repeated for 20 times. For loaded and unloaded cell scenario.
Min / Max / Average download time shall be measured in seconds.

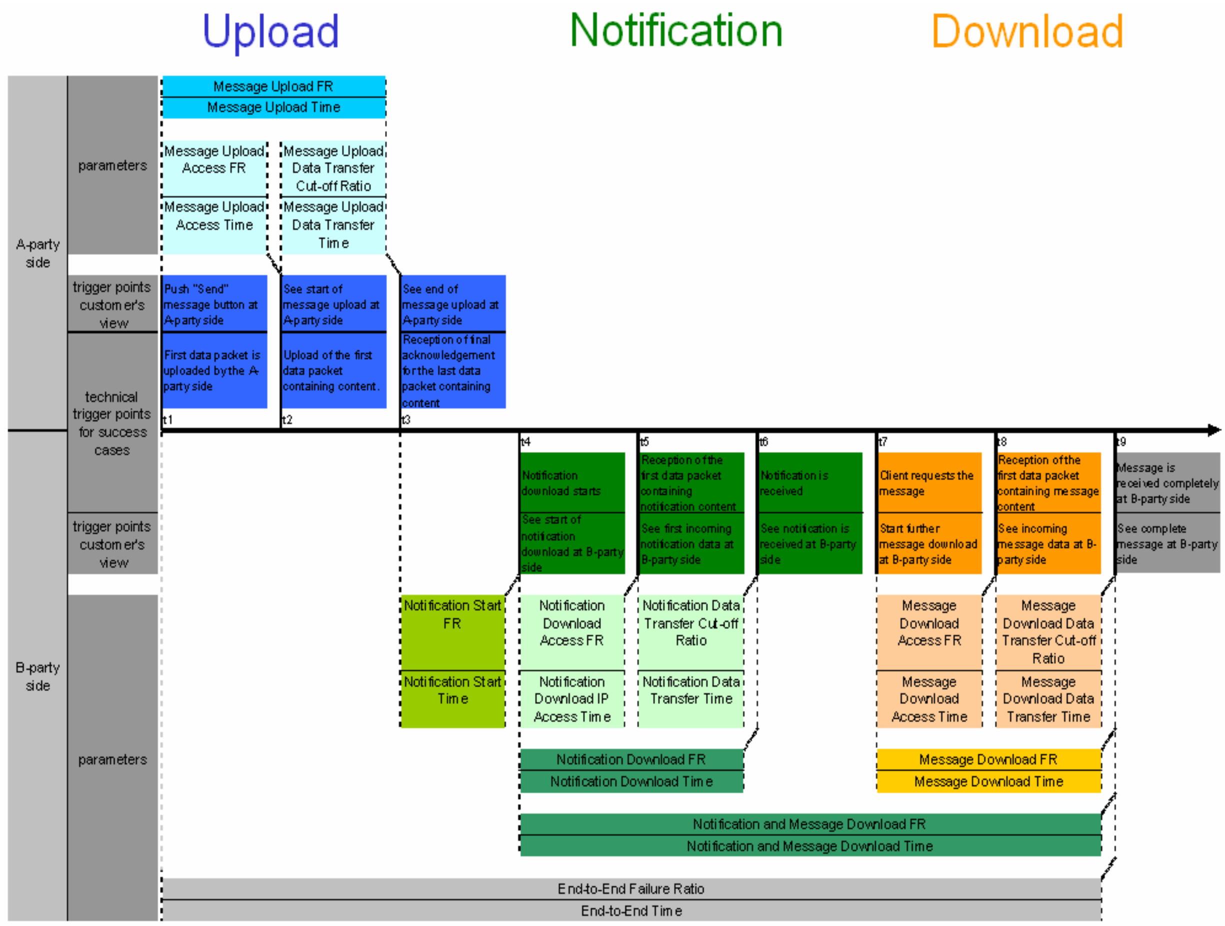
2.8.6 Email services (POP3 & SMTP)

General observations on user experiences are that…
a) The customer is able to use the email service everywhere.
Approx 80% stationary indoor: hotel, at home, office, meeting rooms and lounge at the airport.
Approx.10% in Mobility: on train, in the car
Approx.10% stationary outdoor: outdoor coffee bars, in the park.

b) The customers generally download more and bigger attachments than they will upload.

From the previous observations, the test measurements should represent the customer behaviour. Both stationary and mobility tests are needed but it is more important to concentrate on stationary than mobility tests.

The diagram below shows the overall concept and scope of Email services as envisaged to the tests which are subsequently described.



Picture 2.8-3

Once the connection has been established, email message transfer shall be initiated attempting to download/upload a specific reference email. This download shall be repeated in a test cycle in order to achieve a statistical representative amount of samples. The average time for transfer emails will be reported.

2.8.6.1 Basic configuration

Reference Content: Reference files should include both plain text email and email with attachments as the following:

- 10 KB plain text to be used as plain text for send and receive
  - 2 MB file to be used as an attachment for upload/send and for download/receive
    - The attachment shall be a binary file.

The measurement to be done in a stationary mode.

2.8.6.2 Scenarios Considered

System shall be in IDLE state. System resources are released before each data transfer, but terminal device is still IP connected.
Attempt to **download/read a specific e-mail message** (as specified before) and measure the time from the "request for download" until the completion of the content data transfer.
Attempt to **upload/send a specific e-mail message** (as specified before) and measure the time from the "upload request" until the completion of the content data transfer.
ETSI TS102 250-2 [12] provides definitions of the timing trigger points. For example in Section 4.6.2.6 for a POP3 download , the start of timing trigger is the sending of the first [SYN] and the stop of timing is the reception of the data packet containing the finish sequence (CRLF,CRLF). For the SMTP upload start trigger is the sending of the first [SYN] and the stop trigger is the reception of the positive acknowledgement (250) for the EOM command.

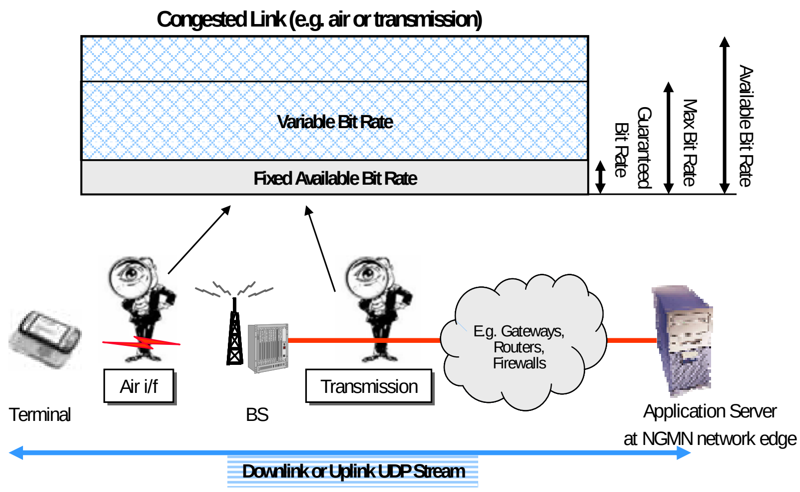
2.8.6.3 Expected output

The test cycle of an upload and a download to be repeated 20 times.
Test cycles shall us a mix of loaded and unloaded cell scenarios.
The times needed to download and to upload the reference email shall be independently recorded.

2.9 Basic QoS

This chapter verifies first basic QoS implementations of the NGMN platform based on quite simplified test scenarios. These basics QoS functionalities are seen as essential for a NGMN system to steer user performance and to guarantee a certain minimum service availability.

Principle setup and understanding of the congestion scenario, see picture below.



Picture 2.9-1

2.9.1 Verification of static QoS Profiles

2.9.1.1 Basic Configuration

The environment used shall be a multi-cell scenario. It should be possible to assign different QoS profiles to users like a subscribed profile in an HLR.

The following parameters shall be configurable per user:

Max Downlink Bit Rate
Max Uplink Bit Rate
Downlink Guaranteed Bit Rate
Uplink Guaranteed Bit Rate

To simulate increasing load in the cell considered, a noise / interference generator for uplink and downlink can be used.

Furthermore a server providing an UDP tool like IPerf and a client PC with an corresponding tool shall be available.

2.9.1.2 Scenarios Considered

Max Downlink Bit Rate limited: Send a UDP stream from server to terminal device with a user data bandwidth larger than the subscribed max bit rate. No part of the end-to-end service chain is congested.

Max Uplink Bit Rate limited: Send a UDP stream from terminal device to server with a user data bandwidth larger than the subscribed max bit rate. No part of the end-to-end service chain is congested.

Downlink Guaranteed Bit Rate: Send a UDP stream from server to terminal device with a user data bandwidth larger than the subscribed guaranteed bit rate. 2 congestion scenarios shall be verified as an example for congested cases:
Transmission link between BS and next network element is congested
Interference level is increased to congest the air interface

Uplink Guaranteed Bit Rate: Send a UDP stream from terminal device to server with a user data bandwidth larger than the subscribed guaranteed bit rate. 2 congestion scenarios shall be verified as an example for congested cases:
Transmission link between BS and next network element is congested
Interference level is increased to congest the air interface

2.9.1.3 Expected Output

The following checklist needs to be answered:
Downlink bit rate was capped according to max bit rate subscription
Uplink bit rate was capped according to max bit rate subscription
Downlink bit rate could be provided even with a) air interface congestion or b) transmission link congestion according to their subscribed guaranteed bit rate.
Uplink bit rate could be provided even with a) air interface congestion or b) transmission link congestion according to their subscribed guaranteed bit rate.

2.9.2 Multi user scenarios with concurrent data sessions and different QoS profiles

2.9.2.1 Basic Configuration

Same configuration as defined in chapter 2.9.1.1.

2.9.2.2 Scenarios Considered

More than 3 users with individual subscribed QoS profiles, see example in table below
All users are in same cell
Load increase on RF and on transmission interface:
Cell load will be increased by a RF simulator in the cell under test, no limitation on transmission.
Transmission link load between BS and Core Net will be increased by any simulator, no limitation on RF.
All users performing data transfers in parallel, both directions shall be considered:

All users performing downlink traffic with UDP
All users performing uplink traffic with UDP

User A	User B	User C	User D	…..
GBR_A	GBR_B	GBR_C	GBR_D	
MaxBR_A	MaxBR_B	MaxBR_C	MaxBR_D	
Priority Level_X	Priority Level_X	Priority Level_X	Priority Level_X	
Guaranteed Bit Rate (GBR) < Maximum Bit Rate (MaxBR) GBR_A < GBR_B < GBR_C ….. All priority levels are same				

Table 2.9-1

2.9.2.3 Expected Output

The following checklist needs to be answered:

RF load:
In an initial state of the cell all users achieve in parallel their subscribed MaxBR
With increasing traffic load the data rates are decreasing per user. During that phase 1 additional user can be added via call attempt to the cell.
As soon as cell load allows for all users GBR data rates, no additional user can enter the cell via call attempt.
Even with slight increase of further load, GBR can be kept for all users.

Transmission load:
All users can achieve MaxBR as subscribed in unloaded case
With increasing traffic load on transmission link the data rates are decreasing per user. During that phase 1 additional user can be added via call attempt to the cell.
As soon as transmission link usage allows for all users GBR data rates, no additional user can enter the cell via call attempt.
What happens to users in the test cell if an additional user from another cell using same transmission line is added to the link is added?

2.9.3 Weighting verification during congestion

2.9.3.1 Basic Configuration

Same configuration as defined in chapter 2.9.1.1.

2.9.3.2 Scenarios Considered

More than 3 users with individual subscribed QoS profiles, see example in table below
All users are in same cell
Load increase on RF and on transmission interface:
Cell load will be increased by a RF simulator in the cell under test, no limitation on transmission.
Transmission link load between BS and Core Net will be increased by any simulator, no limitation on RF.
All users performing data transfers in parallel, both directions shall be considered:
All users performing downlink traffic with UDP

All users performing uplink traffic with UDP

User A	User B	User C	User D	…..
GBR_A	GBR_B	GBR_C	GBR_D	
MaxBR_A	MaxBR_B	MaxBR_C	MaxBR_D	
Priority Level_A	Priority Level_B	Priority Level_C	Priority Level_D	
Guaranteed Bit Rate (GBR) < Maximum Bit Rate (MaxBR) GBR_A < GBR_B < GBR_C ….. Priority Level_A < PL_B < PL_C …				

Table 2.9-2

2.9.3.3 Expected Output

The following checklist needs to be answered:

RF load:
No extra interference in cell: All users achieve in parallel their subscribed MaxBR
With increasing traffic load the data rates are decreasing per user / per priority level. The highest priority level will be affected last.
What happens if an additional high priority user enters cell in loaded scenario?

Transmission load:
No transmission limitation and no interference in cell: All users achieve in parallel their subscribed MaxBR
With increasing traffic load on the transmission link the data rates are decreasing per user / per priority level. The highest priority level will be affected last.
What happens if an additional high priority user enters cell in loaded scenario?

2.10 Advance Features

2.10.1 Beam forming gain evaluation

In beam forming, steering vectors are applied to the transmit signal to direct the signal power in a specific direction. This scheme is well suited for deployment with small angle spread (ideally line of sight) and correlated fading at the antenna elements. It is expected that beam forming schemes will bring throughput gains for cell edge users. As beam forming is not applied to control channels, it does not bring any real coverage gain.

2.10.1.1 Basic Configuration

Single user at cell edge in a multi-cell environment (see reference to definition of Cell Edge, case b).)
It is required that beam forming can be activated/de-activated at the base station for the purpose of this test.
The default mode when beam forming is not used should be transmit diversity (if not, please indicate which multi-antenna mode is used by default)

2.10.1.2 Scenario considered

Beam forming is de-activated (TX diversity used by default): The average data throughput with stationary end user equipment is measured (UDP or TCP). Same test as 2.2.3.
Beam forming is activated: the average data throughput is measured again

2.10.1.3 Expected output

The DL throughput at cell edge shall be the average value out of at least 10 samples. Each sample represents the average data rate of an at least 30 sec active data transfer with full buffer.

Result to provide: Minimum value, Maximum value and Average DL data throughput value measured in kbps with and without beam forming. The beam forming gain at cell edge is the difference in throughput.

2.10.2 Demonstration of interference mitigation schemes

Interference is the main limiting factor of the capacity and user throughputs in a mobile communication system. In OFDMA systems like those considered here, three main interference sources exist:

inter-cell interference is the main interference source, and the only one that is always present, since intra-cell interference is normally excluded in OFDMA due to the orthogonality of the sub-carriers and the orthogonality of the resource allocation between different users (unless if SDMA is used). Inter-cell interference affects especially the users located in the cell-edge area.

Inter-stream interference is present when MIMO spatial multiplexing is employed, which involves transmitting several data streams in parallel on the same time-frequency resources. In that case, each stream interferers with the other. However, since the different streams are intended to be detected by the same users, the detection can take advantage of the previously detected streams through successive interference cancellation (SIC) schemes.

Intra-cell interference can be present when Space Division Multiple Access (SDMA) is used, which involves allocating the same time-frequency resources to different users, provided they can be separated in the space dimension. SDMA can be achieved in the downlink by allocating different beams to different users when beam forming is employed. In the uplink, SDMA can be achieved by making pairs of terminals having channels such that the separation of their data stream is possible at the base station receiver.

Interference in general reduces the link throughput and thus requires to allow more resources to the user in order to meet a given quality of service, which impairs the system capacity. For best-effort services like file downloads, inter-cell interference degrades significantly the user experience, and introduces large discrepancies between the data rates observed in different locations in the cell.

In order to provide the best user experience to everyone while achieving a good system capacity, interference needs then to be reduced as much as possible, either through transmitter strategies or receiver processing. The two following interference mitigation techniques should be addressed.

Interference coordination

Interference coordination: coordinates the transmit power on given resource blocks between neighbouring base stations in order to create resources with low levels of inter-cell interference. This technique can be applied in the uplink (through power control) and in the downlink (by applying power masks to the base station resources). Interference coordination is limited to inter-cell interference mitigation. Four variants of ICIC techniques are considered as interesting to be trial in both UL and DL.

<u>UL power control, with or without Fractional Frequency Reuse</u>

<u>Static (soft) FFR for UL and DL</u>

Semi-static (soft) FFR for UL and DL

Dynamic (soft) FFR for UL and DL

The first one could be combined with one of the three last ones.

Interference suppression

Interference suppression at the receiver: this family of techniques is based on signal processing at the receiver, and accounts for interference cancellation (the interfering signal is first estimated, then cancelled from the received signal prior to the useful signal detection), or interference rejection in the spatial domain (exploits the different spatial signatures of the interferers and the desired signal, provided the receiver is equipped with several antennas). Interference suppression at the receiver can be employed for inter-cell, intra-cell and inter-stream interference mitigation, although with specific implementation constraints. The mainstream for interference suppression is to use advanced receivers such as but not limited to IRC (Interference Rejection Combining). It can be applied in both uplink and downlink.

2.10.2.1 Basic configuration

The test requires to measure full buffer throughputs in several radio conditions. It is especially important to be able to measure the throughputs in different load conditions. Multi cell scenario where each cell is interfered by neighbour cells and far server cells (cells not considered as neighbour cell). Each of the individual feature listed in the next section will be tested independently and in all the possible combinations. Therefore, the basic configuration will enable independent activation of each oh these features.

2.10.2.2 Scenario Considered

The scenario and test described in 2.2.2, 2.2.3 and 2.3.1 applies with the additional following parameters to combine:

Low, mid and high cell load
UL power control, with or without Fractional Frequency Reuse [on/off]
Static (soft) FFR for UL and DL [on/off] or Semi-static (soft) FFR for UL and DL [on/off] or Dynamic (soft) FFR for UL and DL [on/off]
Advanced receivers [on/off]

2.10.2.3 Expected Output

Expected outputs described in 2.2.2, 2.2.3 and 2.3.1 applies. Each metric will be produced with all the possible features combinations, as well as with none of them as a witness value.

2.11 Self-Configuration

2.11.1 Planning of a new BS

A powerful planning tool can be used to support the initial planning process of a base station. It uses geographical information to propose the position, basic antenna and radio parameters of a base station It shall also propose the detailed hardware configuration from the vendors equipment.

After this all necessary data for the auto configuration process shall be generated and possibly distributed to the necessary servers.

2.11.1.1 Basic Configuration

Configuration A: green field approach: cluster of new BS is planned. Existing and preferred sites must be considered.

Configuration B: one single BS is integrated in an existing cell cluster. Existing and preferred sites must be considered.

2.11.1.2 Scenarios Considered

A planning tool supports the decision of location and basic characteristics of new Base Stations for both configurations. The network management system can derive based on these basic characteristics the configuration of the new BS.

2.11.1.3 Expected Output

The planning tool is available and is integrated in the network management system to simplify configuration efforts. The location of new BS and their basic characteristics (cell specific: antenna azimuths, tilts, power values) is derived and can be considered in network management system. The network management system is prepared to configure the BS respective radio parameter, neighbour relation, transmission parameter.

Checklist:
The time for these tasks shall be monitored and a KPI “Planning time per BS” shall be reported.

(Planning time per BS = Number of complete planning resources X work time / complete number of BS in the network)

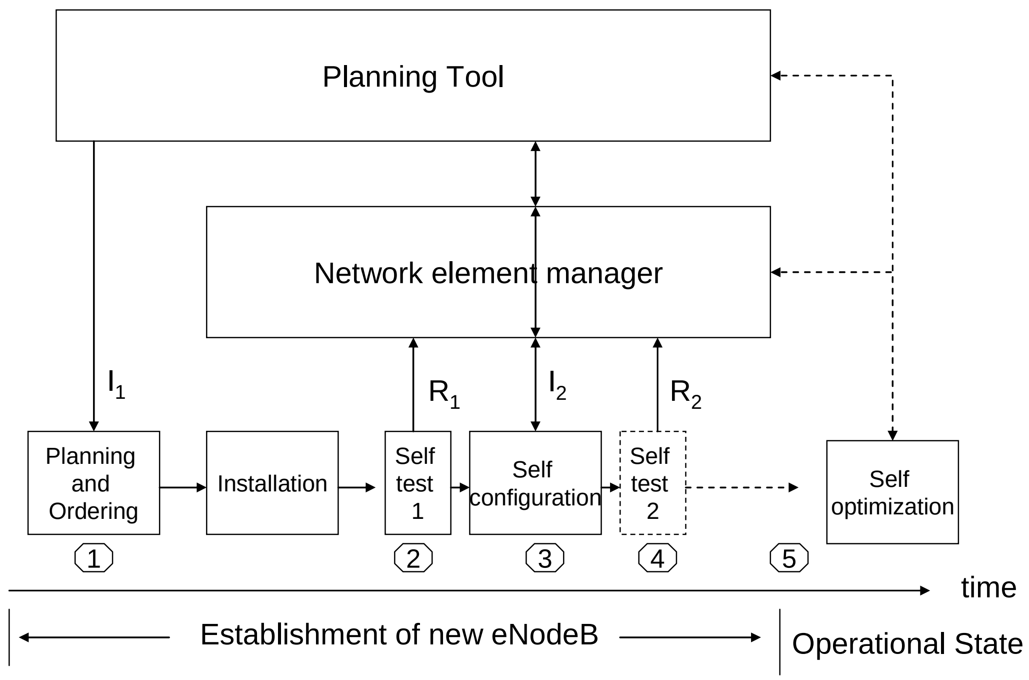
2.11.2 BS installation at the site

2.11.2.1 Basic configuration

The BS configuration is planned and configured in network management system. The BS is delivered at the site which is prepared with necessary external equipment like power supply, antenna system and transmission equipment. All pre-requisites at the site and in the network are available to bring the BS into operational state.

2.11.2.2 Scenarios Considered

The BS is physically installed, all external equipment is connected. The BS is switched on. The transport tunnel is established. The BS connected with the network management system, the SW and configuration is downloaded or updated. Cell individual settings can be configured automatically if not planned by operator like physical cell identifier. The interfaces to core network nodes are established automatically. The neighbour interfaces and relationships to neighbour cell are configured automatically. Following this stage, the interfaces to neighbouring BS supporting neighbour cells can be established. The BS indicates it status after a self-test. A first test call can be established.



Picture 2.11-1

2.11.2.3 Expected Output

The test call can successfully be operated.
The BS and its configuration and status are visible in the network management system.
The BS can remotely configured by the network management system.

The time for these tasks shall be monitored and a KPI "Installation time per BS" shall be reported.
Installation time per BS = Sum of all BS [Number of installation resources X installation time] / complete number of BS in the network

Installation time per site = End timer – Start timer
Start of timer: BS is physically connected and switched on
End of timer: test call is successfully set up

The number of site visits shall be monitored and a KPI "Site visits per BS" reported.

Site visits per BS = Complete number of site visits / complete number of BS in the network

2.11.3 Automatic Neighbour Cell List Configuration

2.11.3.1 Basic configuration

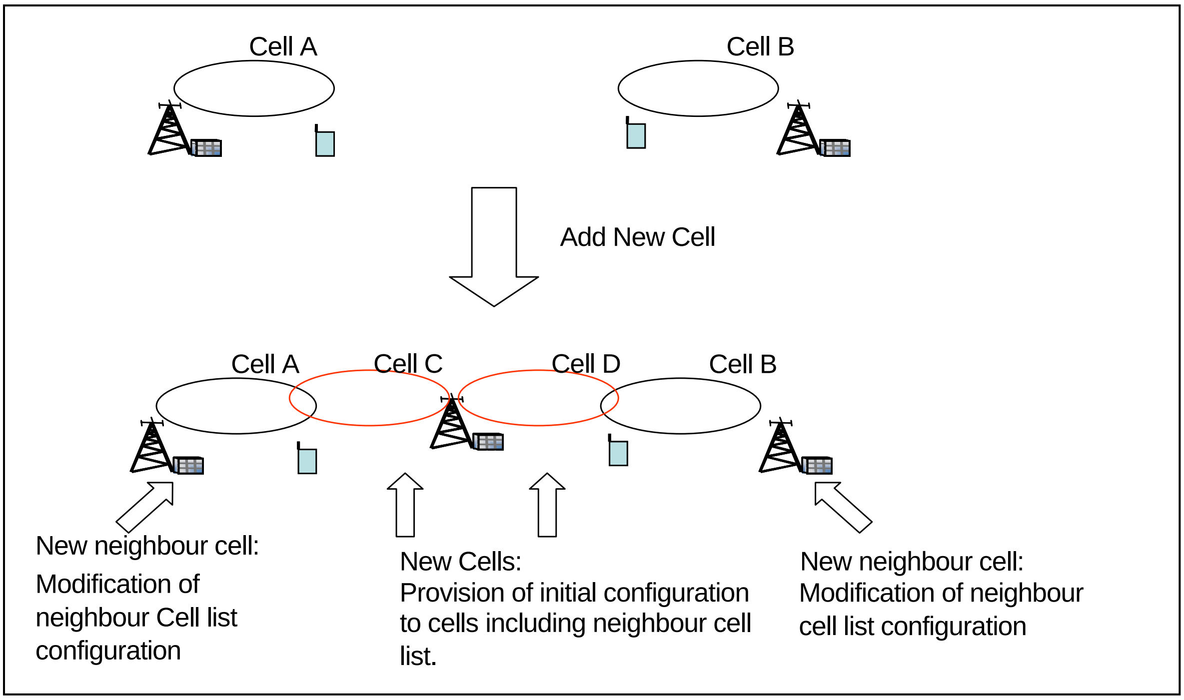
The network is in operational state and under traffic.

2.11.3.2 Scenarios Considered

A new cell is integrated in the network with no dedicated planning and configuration of neighbour relationships. The configuration of neighbour relationships of the new cell and of the already existing ones is adapted automatically.

The operator can define a list of neighbouring cells for which the neighbour relationship shall not be added (blacklist principle).

The operator can also define a list neighbouring cells for which the neighbour relationship must be added (white-list principle).



Picture 2.11-2

The same scenario applies for the removal of a cell.

2.11.3.3 Expected Output

Checklist for Trial:

Prerequisite:
It is possible to read out neighbour cell configuration for each cell on the O&M system.

Introduce / remove a cell and check if:
The neighbour cell lists of the neighbour cells and the affected cells are updated automatically.
The white list concept is supported
The blacklist concept is supported

Drive test can be done to proof neighbour and HO relations. The analysis of Handover performance counters and KPI (number of handovers performed per neighbour relationship, handover success rate per neighbour relationship) can also be made to assess the reliability of the automatic mechanism. A test aiming at checking the non-addition of a cell contained in a blacklist can also be performed.

2.11.4 Physical Cell Identifier Configuration

2.11.4.1 Basic configuration

The network is in operational state and under traffic.

2.11.4.2 Scenarios Considered

A new cell is integrated in the network with no dedicated planning and configuration of Physical Cell Identifier. The configuration of the Physical Cell Identifier of the new cell is adapted automatically depending on the already configured ones.

2.11.4.3 Expected Output

A manual check can be performed to verify that the Physical cell Identifier assigned to the new cell is not the same as the one already assigned to a cell in the vicinity of the new cell, in order to avoid any confusion and collision.

Verify in test:
The new cell has a cell identifier which is not in conflict with any cell identifier of neighbour cells.

2.12 Self-Optimization (SON)

Target: using trial experiences to assess the reliability and efficiency of SON functionalities. Get experience on top parameter settings responsible for system performance. Get feedback from manual optimization work in the trial.

2.12.1 Subscriber and equipment trace

A trace interface is supported to enable the operator to gather all relevant traces.

2.12.1.1 Basic configuration

The network is in operational state.

2.12.1.2 Scenarios considered

Trace data is available to collect information from all relevant interfaces:

Interface between BS and core network nodes
Interfaces between BS
Air interface trace data shall be available to third party application for analysis

The trace data includes measurements as well from terminal device as from BS side and events messages on different call states (e.g. call setup, release message, handover message etc.). On a deep trace level all raw data of the interfaces are accessible.

2.12.1.3 Expected Output

Trace information is available on the BS locally. If so, to what extend.
Trace information is available on the Network Management System (OMC).
Trace information can be provided to a third party application for analysis.

2.12.2 Support of centralized optimization entity

A list of measurements and configuration management possibilities shall be available to support an optimisation entity possibly located in network management.

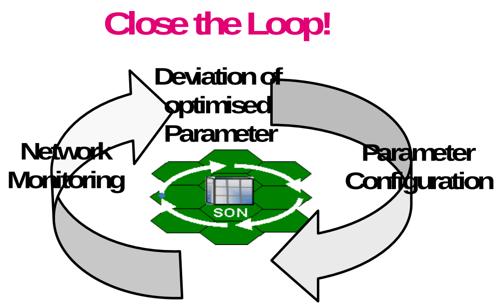
This use case aims to check the availability of the messages and measurements that are needed to support this.

2.12.2.1 Basic configuration

The network is in operational state and under traffic.

2.12.2.2 Scenarios Considered

The network is monitored and based on delivered input data in an optimization entity an optimized set of parameter is downloaded to the network elements.



Picture 2.12-1

2.12.2.3 Expected Output

Provision of network state messaging, (Alarms, Events) AND network performance (HW and Traffic measurements, KPI) towards NMS level via N-Itf.
As a result checklist please verify if that the following essential measurements can be accessed by the operator and third party tools:

Average cell throughput per QoS class
Maximum cell throughput per QoS class
Percentage of terminal devices whose average throughput are unsatisfactory.
Average packet delay per QoS class
Average packet drop rate per QoS class
Average cell throughput
Maximum cell throughput
Average throughput per terminal device
UL/DL throughput per QoS class
Drop rates per QoS class
Packet delay per QoS class
Packet drop rate per QoS class
Number of Connection Requests
Number of rejected Connection Requests per QoS class
Number of times congestion control is triggered in a given period
Time of the day congestion control is triggered
Duration of congestion situation once triggered
Number of admitted connections of a given QoS class dropped as a result of congestion control
Number of triggered intra-system handovers (source cells)
Number of successful intra-system handovers (target cells)
Number of successful inter-RAT handovers.
UL/DL Noise Indicator

Verify if the following configuration messages can be fed into the system by operator and third party tools :

Reset of BS
Setting HO parameter (HO offsets)
Setting power values of cells

2.12.3 Interference Control

2.12.3.1 Basic configuration

Configuration A: in a given cell cluster a defined network load is being generated.

Configuration B: one single new cell is added to an existing cell cluster with defined network load.

2.12.3.2 Scenarios Considered

An automatic algorithm is available to tune frequency and power related configuration in a sense that the overall interference in the observed cluster is minimized. and performance is optimal.

2.12.3.3 Expected Output

The quality of the automatic algorithm is measured by comparing the following results with and without the function activated (for both configurations):

Throughput per cells
Cell capacity

2.12.4 Handover Parameters Optimization – Performance Optimization

Optimize handover parameters with minimal operational effort to optimize performance and network quality.

2.12.4.1 Basic configuration

A given cell cluster with default (non optimised) HO parameter is the starting point.

2.12.4.2 Scenarios Considered

The network optimizes handover parameters (HO thresholds or offsets, timer) in a way that optimal performance can be expected: minimized HO failures and call drops – maximum throughputs at the cell edges.

2.12.4.3 Expected Output

A drive test can be done with monitoring and reporting HO failure rate, call drop rate and average throughputs per cell. These KPI are generated without and with optimization of HO parameter and are compared. A correlation with KPI and counters could also confirm the conclusion brought by the drive test.

2.12.5 Handover/cell reselection Parameters Optimisation – Capacity Optimisation

Optimise handover parameter with minimal operational effort to balance load among cells.

2.12.5.1 Basic configuration

A given cell cluster with default (non optimized) Handover/cell reselection parameters is the starting point. One cell has been operated with maximum traffic.

2.12.5.2 Scenarios Considered

The network optimizes Handover/cell reselection parameters (HO and cell reselection thresholds or offsets, timer) in a way that optimal capacity can be expected. The load is distributed on neighbour cells as far as quality targets are not endangered.

2.12.5.3 Expected Output

A drive test can be done with monitoring and reporting HO failure rate, failure at call establishment, call drop rate and average throughputs per cell. These KPI are generated without and with optimization of HO parameter and are compared.

2.12.6 Cell Outage Compensation

A major operational task in current operator Fault Management processes is the detection of cells where there is for whatever reasons no service available AND there is no alarm generated for the missing service. These kind of faults are usually reported from customers or by statistical traffic analysis. They require broad investigations by fault management and are though the most expensive faults. Since there is no alarm generated from the originating system they are called 'sleeping cells'.

1. The system shall provide intelligent monitor capabilities to detect sleeping cells as good as possible.
2. It shall automatically compensate for the service loss.

2.12.6.1 Basic configuration

A given cell cluster is the starting point. One cell is been taken out of operational service simulating a fault. E.g. by interrupting HF connection to antenna.

2.12.6.2 Scenarios Considered

The network optimizes parameter (neighbour relationships, power, and tilts) in a way that optimal quality can be expected. The load is distributed on neighbour cells as far as quality targets are not endangered.

2.12.6.3 Expected Output

A drive test can be done with monitoring and reporting HO failure rate, call drop rate and average throughputs per cell. These KPI are generated without and with optimization of appropriate parameter and are compared.

2.13 "State of the Art" O&M

Sufficient support for the Operation and Maintenance available from the very beginning of the deployment is expected. This section addresses the most important use cases that need to be covered not only for continuous operation and maintenance but especially for smooth deployment.

2.13.1 O&M KPIs

2.13.1.1 Basic Configuration

Basic O&M KPIs as defined below shall be monitored and documented throughout the trial activity to get a general feeling on thte operability and stability of the management system.

2.13.1.2 Scenarios Considered

The KPIs are continuously monitored throughout the trial. The Measurement period has to be specified.

2.13.1.3 Expected Output

The following KPIs shall be generated.

2.13.1.3.1 Equipment Downtime/Availability

2.13.1.3.2 For measuring the KPI Downtime the below mentioned Downtime definitions shall apply, whereas:

Downtimes shall not be counted twice, e.g. if a controlling Network Element is down the resulting Downtime of controlled Network Elements shall not be counted as separate Downtime of such controlled Network Elements

external incidents which are not caused by the Seller or Equipment supplied by the Seller shall not be included in the Downtime calculation, e.g. link outages, power supply outages

Unplanned Total Downtime Definition
The sum of the duration of individual incidents during the measuring period where a total loss (100%) of traffic/data capacity or services or operability occurs in a certain Network Element divided by the total number of that Network Element type provided.

Planned Downtime Definition
The sum of the duration of individual Update/Upgrade, configuration or maintenance measures during the measuring period where a total loss (100%) of traffic/data capacity or services or operability occurs in a certain Network Element type divided by the total number of that Network Element type.

2.13.1.3.3 Number of on Site visits required for Repairs/maintenance

The number of Site visits per Network Element type for Repair and maintenance purposes divided by the total number of that Network Element type supplied.

2.13.1.3.4 Repair Rate of Hardware Units

The Repair rate is defined as the relation of Hardware units of the same type submitted for Repair by the Buyer to the total volume of those Hardware units equipped.

2.13.1.3.5 Number of Alarms

The average of absolutely necessary alarms originated in the Software and/or Hardware of a Network Element type.

2.13.2 Fault Management (FM)

It shall be proven that all network elements create meaningful alarms in case of a malfunction and that these alarms can be reported to a third party application or displayed in a proprietary application.

2.13.2.1 Basic Configuration

The network is in operating state.

2.13.2.2 Scenarios Considered

A fault is injected into a Network Element. This can be done by unscrewing / removing cables, pulling boards, switching off power supplies, usage of faulty hardware and many other means.

2.13.2.3 Expected Output

The following bullets may be used as checklist in trial:

The fault can be displayed on a proprietary Fault Management Application.
The fault shall be reported to a third party Fault Management Application via an open and standardized interface.

In the event of communication loss between the NE and the Fault Management Application the NE shall store alarms/notifications in a log file for 24 hours. Once the communication is resumed then the OMC shall automatically be synchronised by the NE in chronological order
At any time an "active alarm list" of the System shall be available
External alarms which can occur in the environment of an NE shall be registered by suitable sensors and shall be part of the alarm list.
Alarms from the operating system of the NE (e.g. disc utilization, processor failure, ..) if available shall be Part of the alarm list
A causal event shall lead to only one alarm, i.e. the root cause alarm, at least by means of alarm correlation
The root cause of an alarm shall be unambiguously contained in the alarm text, e.g. Hardware Fault, with exact location, Software Fault, Overload, Line Fault
A fault clearance procedure shall guide the operator to easily clear the fault without expert knowledge required.

2.13.3 Performance Management (PM)

It shall be proven that all network elements create meaningful Stats and that these can be reported to a proprietary or third party application for PM analysis.

2.13.3.1 Basic Configuration

The network is in operating state.

2.13.3.2 Scenarios Considered

Basic Function
The system continuously provides a high number of useful counters enabling…

System monitoring, i.e. supplementing the FM process
Network planning and optimisation i.e. the measuring of all relevant dimensioning parameters influencing the performance and capacity of the System and indicating potential bottlenecks and System limits.
Monitoring of services and supplementary services
Measurements that are needed for automated optimization (see SON chapter)

Remark: A description of the useful performance data for a 3GPP system can be found in [3G TS 32.40x].

Verification of Measurements
PM counters provided by the O&M system shall be compared to drive respective test results to verify the results.

2.13.3.3 Expected Output

Basic Function
This is a checklist for trials:
The counters / reports / measurements are available to a third party centralized performance management application via a standardized interface.
The counters / reports / measurements are available to a proprietary PM application.
Defining a reporting period in steps of 5 minutes up to 24 hours per measurement shall be supported.
The operator shall be allowed to define
the NE(s) to be reported on (smallest physical or logical unit, e.g. a single link)
different aggregation level, e.g. selected or all links of a selected Network Element
the measurements to be reported by which NE
the Services to be reported

Verification of Measurements
Drive test are used to determine KPIs e.g. CSSR(Call Setup Success Rate), CDR(Call Drop Rate) and results are compared to system PM reports.

2.13.4 Configuration Management (CM)

A basic management of the most important parameters on all network elements is possible via remote management. The specification of the data format for configuration changes is available.

2.13.4.1 Basic Configuration

The network is in operating state

2.13.4.2 Scenarios Considered

Upload, modification, download and activation of all NE configuration data (parameters, timers etc.) shall be supported for

Single value modifications
Provisioning interface

2.13.4.3 Expected Output

Single value modifications

The operator can set any parameter that is configurable remotely.
Syntax, semantic and range plausibility and consistency verification for all data modifications shall be performed prior to their activation.
Dependencies between different parameters/timers shall be verified prior to a parameter/timer modification (e.g. if there is a relation Timer1 > Timer2 this relation shall be checked whenever one of these timers is changed)

Provisioning interface
The following functions shall be supported:
an import interface (XML) for command files generated by an external planning tool
a minimum of 50 command files shall be saveable under Operator-defined names
sufficient disk space for the storage of at least 50 different command files
A command file shall handle up to 5000 commands, whereas the transfer of such a file shall take no longer than 20 minutes
a workflow control of command files considering functions like
all commands: stop at failure/ ignore failures
marked commands: stop at failure/ ignore failures
continue after a stop

Whereas such events during a workflow shall be notified to - and displayed at the CM Application. In addition a workflow report for each NE shall be available within a log file.

The following checklist shall be used to check availability of the parameter for single value modification as well as for the provisioning interface

General Cell and network setup
Cell ID, PLMN-ID (with MCC and MNC), Tracking Area ID(s), EARFCN (UL and DL), Max Tx Power, Min Tx Power

Hardware related setup
Cell level: Cell blocking (on/off), Local Cell ID, Antenna configuration, Other external BS equipment (TMA etc)
BS level: IP address(es), Software Licensing info, BS ID

External BS Equipment
Antenna configuration (including RET control per cell, can take from RET spec), TMA configuration (including any control, can take from TMA spec)

Transport Link setup
Interface configuration, QoS provisioning, Interface Admission control settings, Interface Congestion control settings, ,IP address of parented BS.

Neighbour cell configuration
External cell configuration: Cell ID, Tracking Area Code, PLMN-ID (with MCC and MNC), IP address,
External UTRA cell configuration: Cell ID, UARFCN UL, UARFCN DL, RAC, LAC, PLMN-ID (with MCC and MNC), RNC-ID, Scrambling code, P-CPICH power,
External GSM cell configuration: Similar to above
External cdma2000 cell configuration: Similar to above

Shared Channel Parameters
Admission control parameters (max power in DL, max interference in UL, min rate allowed for nonGBR RABs, effective resource required per service type, etc etc), Congestion control parameters, Interference co-ordination configuration parameters, Load balancing parameters

Tracing Parameters
Set of parameters to establish tracing in the BS.

Performance Counter Reporting
Performance Counter reporting configuration - events needed to setup reporting of different counter types in BS.

2.13.5 Inventory Management (IM)

Inventory Information is reported from each Node to a proprietary or third party inventory management system.

2.13.5.1 Basic Configuration

The network is in operating state.

2.13.5.2 Scenarios Considered

New NE is being installed
Hardware on existing NE is extended / removed
Hardware is being exchanged

2.13.5.3 Expected Output

Every unit that can be installed in the BS shall carry a unique hardware identifier / label that can be used for inventory purposes
Commissioning data; information about connected equipment can also be reported.
The actual inventory information is made available on
a proprietary , or

a third party via a standardized open interface
Inventory System. No manual intervention is needed to update this information.
Hardware information is synchronized with Network Management after every change.

2.13.6 Software Management (SWM)

Software deployment to BS shall be autonomously managed from O&M system or an independent Software deployment application. It shall not need major attention from the operator.

2.13.6.1 Basic Configuration

Network is in normal operation.

2.13.6.2 Scenarios Considered

A software update for BS is available for implementation for a dedicated BS type.

2.13.6.3 Expected Output

The following shall be seen as a checklist for trials:
The software of the BS can be made available on a Software Deployment Server.
The Software Deployment Server owns a list of all managed BSs.
This list is updated autonomously. In this list the software levels of the BS are displayed.
If new software is to be installed a single BS, a group of BSs or all BSs can be marked for software deployment.
The BS checks in regular intervals and after reboot if there is a newer software version to be downloaded.
The BS downloads latest software versions as background activity without influencing bandwidth for customer.
The BS switches to the new software version with no customer impact:
at a dedicated time configured by the operator in the Software Deployment Application, or
in a low traffic period, or
as soon as possible (directly after download is finished), or
in a sequence. This shall allow neighbour cells to partly carry traffic of affected areas.
The downtime of the BS is to be measured.
In case of unsuccessful software update the BS autonomously reloads the latest working software version and sends an appropriate message to the software deployment server.
Firmware (if applicable) can also be managed the same way as software.

2.13.7 Capacity Extension / Reduction on BS

The capacity adaptation of a BS shall be done with minimum operational effort.

2.13.7.1 Basic Configuration

Network is in normal operation.

2.13.7.2 Scenarios Considered

One cell is continuously overloaded. Capacity can be extended easily.
One cell is continuously under loaded. Maximum capacity can be reduced to save license fees and electrical energy.

2.13.7.3 Expected Output

The following shall be seen as a checklist for both scenarios trial:
The system surveys hardware capacity and provides reaction and warning mechanism in case of possible capacity problems
A license concept for a flexible capacity management is available

Any hardware extension / removal for capacity reason can be done with minimum operational effort:
Hot plug'n'play
Immediate self test of new HW to ensure 1 site visit concept
No reboot of the site
No manual editing of databases
Automatic SW/firmware control
Automatic inventory update

2.13.8 Automated Fault Correction

The O&M system provides a functionality that can carry out automated fault corrections on base of the alarm information.

2.13.8.1 Basic Configuration

Network is in normal operation.

2.13.8.2 Scenarios Considered

A fault occurs in the system that requires always the same reaction from the operator. The system provides a possibility to trigger automatic actions if this specific fault occurs.
Prerequisite is that the fault is detected unambiguously. Therefore the system should provide all available information like PM data, traces, Alarms,… and correlate this.

2.13.8.3 Expected Output

The following shall be seen as a checklist for trials:
Advanced alarm correlation is used to increase alarm quality with the help of several data sources (e.g. alarm , measurements, traces, terminal device information, neighbour cell information, BS heartbeat).
Alarm correlation is done on all layers preferably on the lowest possible layer.
The alarm information is unambiguous for the alarm root cause and the location where the alarm is generated.
Important alarm information (root cause, location) can be easily accessed. Useless information is suppressed.
There are several possibilities for (partly) automated fault correction:
The system proposes specific corrective actions to the operator. The operator needs to confirm execution with one mouse click.
The system provides a user friendly interface to enable the operator to define his own corrective actions to be carried out as reaction to a specific fault.
The operator can choose to allow this corrective action by default / for limited number of occurrences / only once
The operators is being notified accordingly when an autonomous fault correction has been carried out

3

3.1 User Experience Data Rate

3.1.1 Basic Configuration

User experience data rate is measured by testing the average throughput out of a number of measurement points with different radio conditions. The min and max of those values may also be presented to better reflect the range of UEDR.

Measurement should be taken with stationary end user equipment in both unloaded and loaded network.

3.1.2 Scenarios Considered

Two scenarios to be considered:

Single UE, single cell, no interference. TCP or UDP throughput is measured

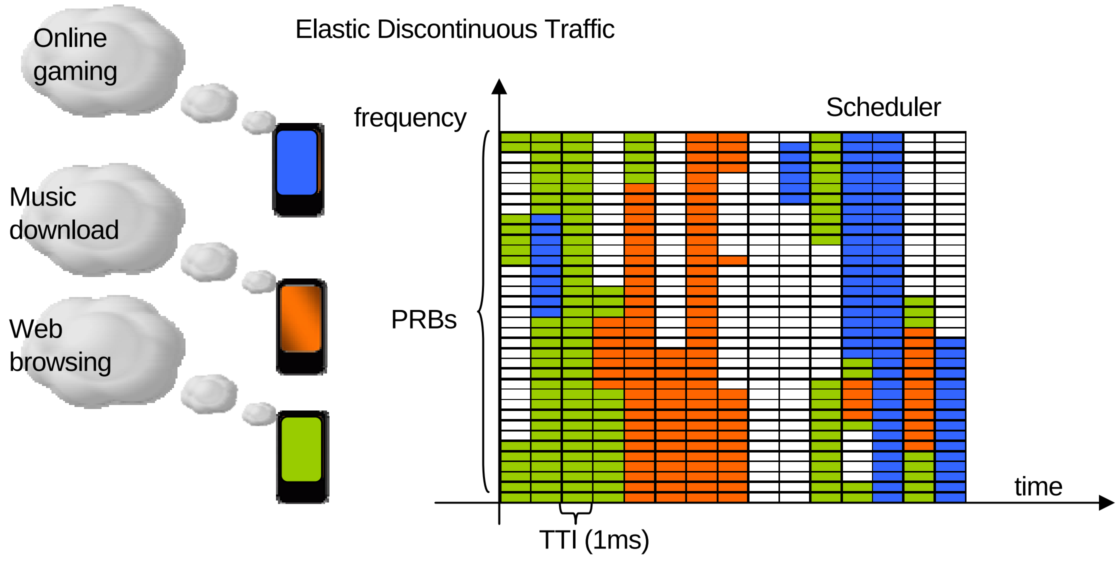
Multi cell scenario where the measurement cell is interfered by surrounding cells and the resources in the measurement cell are shared by other UEs. The following load levels are recommended:

50%
70%
100%

Definition of load:

- In surrounding cells, a certain level of load means the percentage of resources which are occupied and transmitted over the air thus causes interference to the measurement cell. In practice this can be achieved by OCNG (dummy data transmission) or real UEs.

- In measurement cell, a certain level of load means the percentage of resources which are occupied by other UEs in the same cell. In practice this can be achieved by real UEs (UEs have to produce elastic discontinuous traffic to actually generate a certain level of load other than 100%, see figure 1 below) or capacity test tool which usually provide ways to simulate traffic and loads.



Picture 2.14-1 Generating a certain load within the measurement cell

3.1.3 Test Procedures

3.1.3.1 Unloaded scenario

Test Condition

- No interference, single UE
- UE is in CONNECTED mode
- At least 10 equally distributed locations in the cell should be identified

Detailed Procedures

1. UE performs TCP or UDP traffic for at least 30 seconds in location A, throughput and associated radio metrics are recorded.
2. The test is repeated for all the static locations

3.1.3.2 Loaded scenario

Test Condition

- Interference is generated to the required level.
- Resource in the measurement cell is also occupied by other UEs to the same level by applying one of following methods:
  - Use capacity testing tool. Connect capacity testing tool to eNB and adjust parameters such as number of UE, traffic type, UE location, so that the intra-cell load reaches the preferable level
  - Use real UEs in the measurement cell to generate the preferable level of load.
- UE is in CONNECTED mode

At least 10 equally distributed locations in the cell should be identified

Detailed Procedures

3. UE performs TCP or UDP traffic for at least 30 seconds in location A, throughput and associated radio metrics are recorded.
4. The test is repeated for all the static locations

3.1.4 Expected Output

Minimum 10 equally distributed locations with measurement cell are required. The throughput measurements should be produced in each location with at least 30 seconds of data transfer.

3.1.5 Note about Comparison of UEDR and Cell Capacity

There is already *Cell Capacity, Cell Load* Testcase in NGMN Field Trial Requirement (section 2.3). The basic test methodology of Cell Capacity is:

- Several UEs perform full buffer traffic within measurement cell
- Surrounding cells generates certain level of interference (e.g. 70%)

Comparably, UEDR testcase requires surrounding interference in the same way, but there is major difference in intra-cell load condition. In UEDR testcase, the intra-cell load is specifically controlled to a certain level (e.g. 50%), because this reflects the real situation. After the commercial launch of a wireless network, the network load should typically reach certain low level. As the subscriber base grows, when the network approaches overload state (e.g. 70% of load), operator should usually setup more carriers to lower the cell load.

Cell Capacity Testcase, however, aims to test the system capability so all the UEs are generating full buffer traffic consequently all radio resources are occupied (i.e. 100% load). This way the system capacity can be found but in real life 100% load seldom happens. UE throughput, in such 100% loaded condition, would be therefore lower than in real condition e.g. 50% loaded condition.

In conclusion, UEDR testcase differ Cell Capacity testcase in intra-cell load. Using Cell Capacity testcase will provide inaccurate conclusion on the throughput that real user can experience in live network.

4 NGMN TRIAL REPORTING REQUIREMENTS

The main objective of the NGMN Trial working group is to achieve a validation of the candidate technologies for the Next Generation of Broadband Mobile Networks. In order to do that, several recommendations and requirements are set to guide the trial execution and results reporting within a close collaboration environment. This procedure will allow to obtain comparable results and will ease the validation of candidate technologies as NGMN compliant according to the requirements defined in NGMN White Paper 3.0.

This chapter describes the proposed procedures to provide trial results to the NGMN trial WG.
The ultimate goal of the process hereby defined is the submission of results in an appropriate manner and facilitate the final comparison of technologies against NGMN White Paper Requirements.

4.1 Communication interfaces and structure

This point describes the communication channel between the NGMN Trials group and the trials initiatives, particularly the reporting policies and items of information exchanged. The requirements are described as follows:

Clear and transparent bidirectional communication between the NGMN trial WG and the different trial initiatives is a key requirement in order to support an efficient work.

For this purpose NGMN Trial Group has defined a focal contact point for information exchange. In any communication with the NGMN trial group both contacts shall be included.

	Tino Puch (NGMN Trial WG)	Franck Emmerich (NGMN Office)
Email:	tino.puch@t-mobile.de	franck.emmerich@ngmn.org
Phone:	+491712086128	+491752691743

Initiatives contact details should be included inside the result reporting template

NGMN Proposes 3 steps to efficiently interact with Trial Initiatives:

Introduction of NGMN Field Trial Requirements Document
Agree on a common Time Plan
Introduction and discussion of Results

4.2 NGMN Trial Reporting Template

To facilitate the comparison of different technologies towards a common set of requirements NGMN provides a Reporting Template to the Trial Initiatives. This Template enables the description of the individual Trial set up as well as the documentation of Trial Results.

NGMN Trial Reporting Template structure

The NGMN Trial Reporting Template is implemented in a spreadsheet format and consists of three main parts:

Administrative Information: this section includes the identification details of the trial initiative which submit the results, participants involved in the specific test (providers and operators), contact information of the submitter, date, version of NGMN Trial Requirements document in which the Reporting Template is based on.
Trial Setup Information*:* this section includes a list of parameters that are important for the alignment of results. If individual Trials setups require other parameters than specified in section 1, these parameters need to be documented in this section.

Results Information**:** this section contains all results of the tests described in chapter 2. For any deviation of the basic configuration or considered scenario (as defined in chapter 2), a correction factor should be provided in order to obtain a comparable result.

Additionally to the NGMN reporting template, the participating trial initiatives may submit other data or documents considered of importance.

5 ANNEX

5.1 Definitions

5.1.1 Speed / Velocity

Ranges of Speed / Velocity, several ranges of speed shall be considered:

Range 1	Range 2	Range 3	Range 4
0-15 km/h	15-60 km/h	60-120 km/h	120-350 km/h

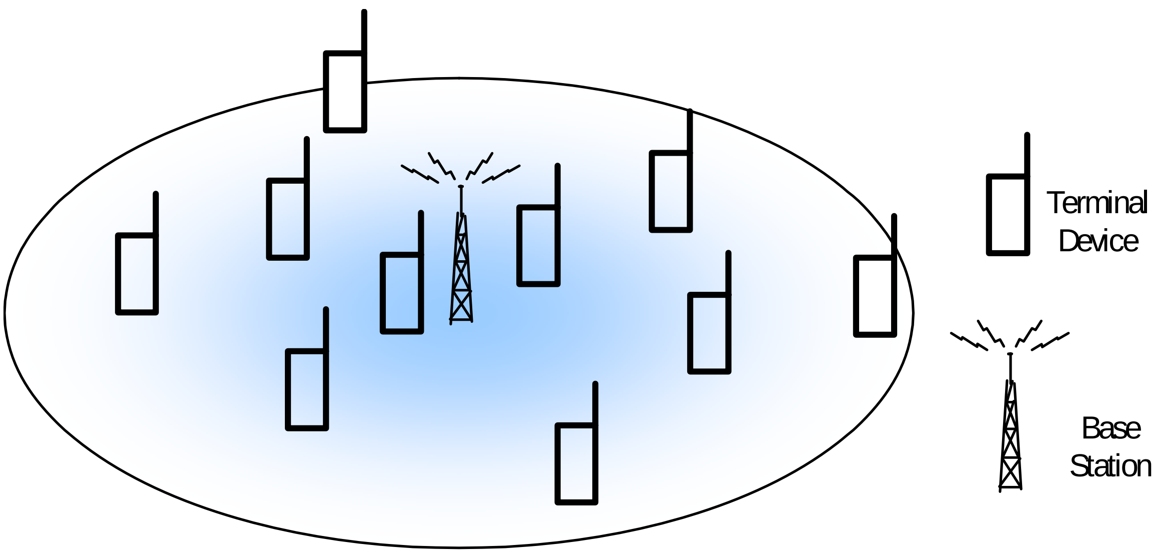
5.1.2 Peak Rates

Peak rate is the maximum achievable application data rate in trial environment with an average data rate value of 30 sec duration. Unloaded network and single user per cell scenario considered.

5.1.3 Average User Throughput

Test locations are equally distributed over a cell area. Unloaded network, single user scenario at various test locations to be considered. At each location a data transfer is performed according to throughput measurement method. Average user throughput from all considered test locations in a cell represents the Average User Throughput a customer will experience in a cell.

Comment: In practical this could be achieved by users with different radio quality and receiving signal strength conditions.



Picture 5.1-1

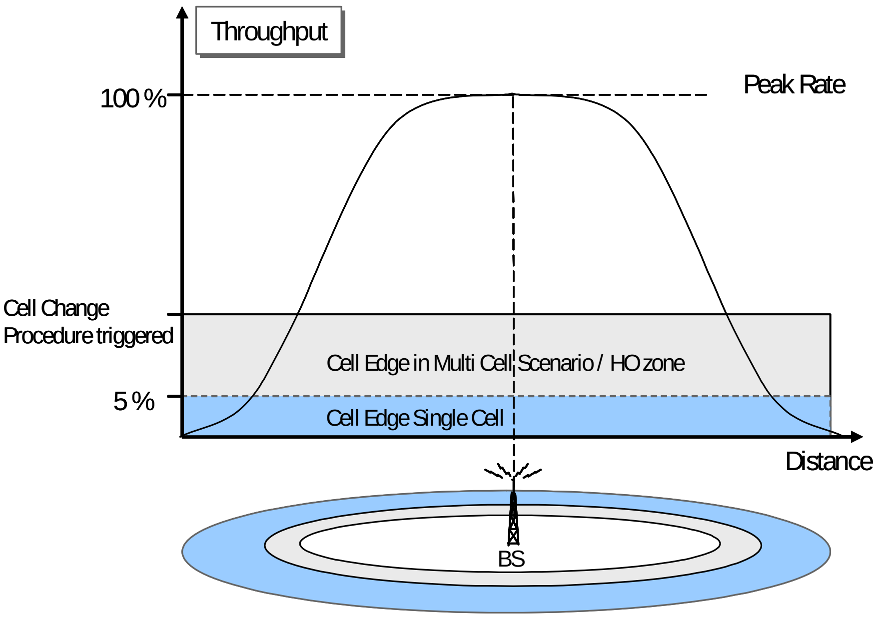
5.1.4 Throughput

Definition Throughput: Throughput is considered to be the data rate at application layer like UDP or TCP.

5.1.5 Cell Edge

Definition Cell Edge, See Picture 5.1-2.

For cells at NGMN network edge / network border: Range of cell providing less than 5% of maximum possible data rate in single cell scenario or out of coverage scenario.
For cells surrounded from other cells (neighbour cells) in NGMN network: Cell fulfils cell change conditions and neighbour cell reporting is started. Zone between starting neighbour cell reporting and cell change execution is defined as cell edge.



Picture 5.1-2

5.1.6 Cell Load

Amount of users (e.g. minimum 10 asynchronous users per cell) who are performing continuously FTP transfer in DL and UL with same share.

5.1.7 VOIP Call

VoIP calls are performed using the system specific VoIP bearer with the related QoS class.

5.1.8 VoIP cell capacity

The VoIP cell capacity is defined as the number of users in the cell when more than 98% of the users are satisfied. A VoIP user is in outage (not satisfied) if 98% radio interface tail latency of this user is greater than 50 ms. This assumes an end-to-end delay below 200 ms for mobile-to-mobile communications. Reference [13].

5.1.9 Call Success Rate and Call Setup Time Definitions

Mobile Originated Calls (MOC), Mobile Terminated Calls (MTC) and Mobile to Mobile Calls (MMC) will be considered. MOC and MTC are calls to/from PSTN.

5.1.9.1 Call Success Rate

Definition:

The percentage of voice calls connected with success at the first attempt, maintained for 2 minutes, presenting a MOS score higher than or equal to 4 and and correctly released.
Measurement method:

The number of voice calls connected with success at the first attempt is evaluated by the test leader.
The number of voice calls maintained for 2 minutes without loss or degradation and correctly released is evaluated by the test leader.
The number of voice calls presenting a correct level of voice quality is evaluated manually by the test leader.

KPIs:
Call Set-up Success Rate : The percentage of successfully established calls .
The percentage of voice calls maintained for 2 minutes and correctly released.
The percentage of voice calls presenting a correct level of voice quality.
The 3 obtained percentages are combined (multiplied) in order to evaluate the “**Call Success Rate** of voice calls maintained for 2 minutes and presenting a correct voice quality”.
Each percentage is compared with the committed values defined in chapter 3.

5.1.9.2 Call Set-up Times

Only call set-up times of successful connections are considered.

5.2 References

[1] 3GPP TR 21.905: “Vocabulary for 3GPP Specifications”

[2] NGMN white paper: “Next Generation Mobile Networks Beyond HSPA & EVDO A White Paper”

[3] GSM Association PRD DG.11: “Field Trial Guidelines”

[4] 3GPP TR25.913: “Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN)”

[5] 3GPP TS 31.121: “UICC Terminal Interface; Universal Subscriber Identity Module (USIM) application test specification”

[6] 3GPP TS 34.123: “User Equipment (UE) Conformance Specification”

[7] R5-072424 (skeleton of TS36.521-1: “Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); User Equipment (UE) Conformance Specification Radio Transmission and Reception Part 1: Conformance testing”)

[8] R5-072514 (skeleton of TS36.523-1: “Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); User Equipment (UE) Conformance Specification; Part 1: Conformance testing”)

[9] NGMN white paper: “Next Generation Mobile Network Radio Access Performance Evaluation Methodology”, version 1.2, June 2007

[10] NGMN TWG TE WP1 Phase 2 Performance Report Final version 5th March 2008

[11] NGMN Performance Evaluation Methodology; Version 1.3, January 31st, 2007

[12] “Speech Processing, Transmission and Quality Aspects (STQ), …”, ETSI TS 102 250-2 V1.3.1 (2005-07)

[13] “Next Generation Mobile Networks Radio Access Performance Evaluation Methodology”, December 2007, Annex B.

[14] “NGMN Field Trial KPIs”, KPI definition document

5.3 Abbreviations

3GPP	Third Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
AMR	Adaptive Multi Rate
BS	Base Station
CDF	Complementary Distribution Function
C-Plane	Control Plane
E2E	End to End
FDD	Frequency Division Duplex
IEEE	Institute of Electrical and Electronics Engineers
ISD	Inter Site Distance
HARQ	Hybrid ARQ
IMS	Integrated Multimedia System
L1/L2/L3	Layer 1/2/3
LTE	Long Term Evolution
MAC	Media Access Control
Mbps	Megabits per second
MBMS	Multimedia Broadcast Multicast Service
MIMO	Multiple Input Multiple Output
MOC	Mobile Originating Call
MTC	Mobile Terminating Call
MMC	Mobile to Mobile Call
DL	Downlink
UL	Uplink
NGMN	Next Generation Mobile Networks
PER	Packet Error Rate
PHY	Physical Layer
QoS	Quality of Service
PDF	Probability Density Function
PCRF	Policy Control Rule Function
RAN	Radio Access Network
RF	Radio Frequency
RLC	Radio Link Control
RRM	Radio Resource Management
SDMA	Space Division Multiple Access
SFN	Single Frequency Network
TCP	Transmission Control Protocol
TDD	Time Division Duplex
Tx	Transmit
U-Plane	User Plane
UTRAN	UMTS Terrestrial Radio Access Network
VoIP	Voice over IP