

Table of contents

1. INTRODUCTION	2
2. DEVICES & TECHNOLOGY	2
A. DEVICE	2
B. QUANTITY, TECHNOLOGY & LOCATION	2
C. TOOLS	4
3. MEASUREMENT ITINERARY	4
A. DYNAMIC ITINERARY	4
B. MEASUREMENTS IN STORAGE AREAS	4
4. MEASUREMENT PROTOCOL	5
A. DYNAMIC ACCESSIBILITY MEASUREMENTS	5
B. DYNAMIC DATA AVAILABILITY MEASUREMENTS	6
C. STATIC ACCESSIBILITY MEASUREMENTS	6
D. STATIC DATA AVAILABILITY MEASUREMENTS	7
E. STATIC SMS EFFICIENCY & LATENCY MEASUREMENTS	7
5. MEASUREMENTS INPUT	8
6. MEASUREMENTS OUTPUT	8
7. MEASUREMENT AVAILABILITY	11
8. REQUIREMENTS CHECKLIST	11
GLOSSARY	13
ANNEX	14

Table of figures

Figure 1 – Example of Outside view of the measurement car with antennae positions	3
Figure 2 – Example of Inside view of the measurement car with antennae positions	3
Figure 3 – Example of types of coverage maps and quality of zoom mandatory in deliverables	9
Figure 4 - Requirements Checklist	12

1. Introduction

The aim of this document is to describe the protocol to follow for measurements on logistics sites. The output of the measurements must give a clear and detailed view of the radio network coverage from “Gate-In” to “Gate-Out”.

A complete file must be submitted separately for each of the logistics sites of the logistics provider.

The assessment of the coverage will be based on the measurements made in the field, verifying the possibility for a SIM card to be located on site and check accessibility for each tested Mobile Network Operator (MNO).

The goal of these measurements is to check if all vehicles have adequate coverage when stored and also during transfers, and if a data connection can be maintained when car is moving from one area to other.

2. Devices & Technology

a. Device

For accuracy purposes, 2 types of devices must be used simultaneously:

- Mobile Phone
 - 2G/3G/4G capable
 - VoLTE capable
 - LTE 2x2 MIMO capable
- InCar measurements using Car Rooftop antennae (~Voiture Hérissou)

The goal is to measure the signal strength received by the antenna as placed in the connected cars to be tracked.

For each chosen mobile phone, the frequency band compatibility must be provided for potential further investigation.

The auditor must provide the brand as well as the model of the measurement vehicle.

b. Quantity, technology & location

A minimum of 4 mobile phones must be used for InCar measurements:

- 1 Mobile phone locked on 2G technology
- 1 Mobile phone locked on 3G technology
- 1 Mobile phone locked on 4G technology
- 1 Mobile phone unlocked for Handover testing
- In the future, additional mobile phone for any new technology available (5G...)

A minimum of 4 mobile phones connected to the Car RoofTop antennae must be used for InCar measurements:

- 1 Mobile phone locked on 2G technology
- 1 Mobile phone locked on 3G technology
- 1 Mobile phone locked on 4G technology
- 1 Mobile phone unlocked for Handover testing

- In the future, additional mobile phone for any new technology available (5G...)

The purpose is to have at least 8 mobile phones measuring radio signal at the same time for the same MNO.

A graphical view must be provided with the position of each antenna/mobile phone on the car.

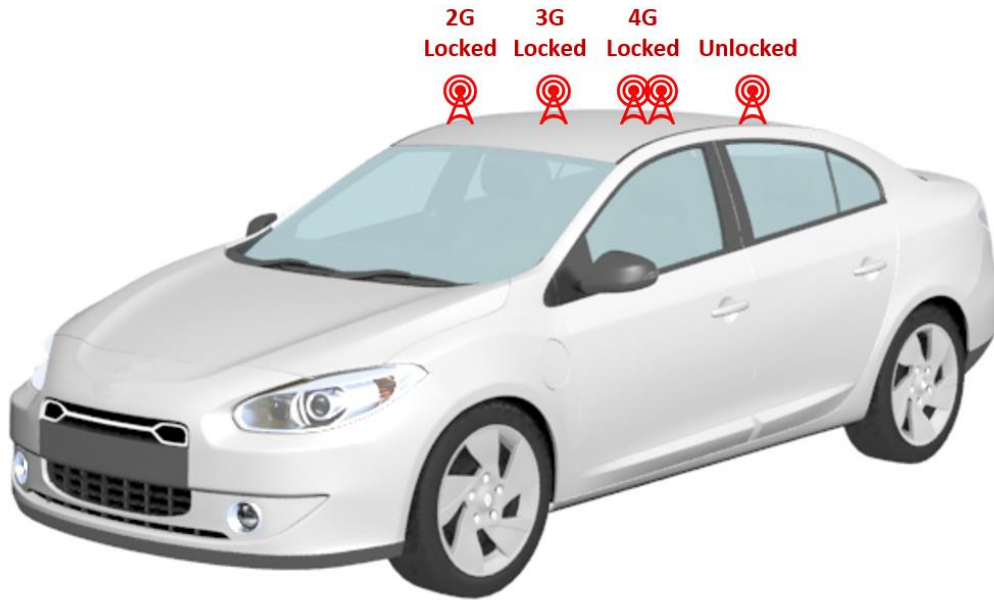


Figure 1 – Example of Outside view of the measurement car with antennae positions



Figure 2 – Example of Inside view of the measurement car with antennae positions

c. Tools

Measurements must be carried out using a tool capable of collecting the mobiles radio traces based on GPS information for post treatment on a computer. Preferred tools would be:

- Keysight's Nemo Handy/Outdoor
- Ascom's Symphony
- Rohde & Schwarz' SwissQual
- Accuver's XCAL

3. Measurement Itinerary

Measurements must be done while meeting safety obligations, obeying traffic rules, speed limitations, signals and respecting the safety of pedestrians. On-Site contact will provide traffic and intervention rules inside the site.

a. Dynamic itinerary

The measurement itinerary will be based on the logistic site location. Measures must be done according to the same itinerary as the one taken by the vehicles from "Gate-In" until "Gate-Out".

This includes:

- Loading and unloading areas for trucks, vessels, trains and barges from the access ramp.
- Regular and occasional parking areas.
- Access roads.
- Building used in the compound.

An itinerary can be suggested by the auditor but must be validated by the logistics site operator.

b. Measurements in storage areas

Measurements in storage areas and regular and occasional parking areas of connected vehicles can be static or dynamic. The exact list of these areas will be provided by the on-site contact.

Measurements must be done on various locations inside the zones, depending on the size.

In any case, a map must be delivered summarizing the mobile radio coverage inside each area, and the exact spots where the measurements took place.

4. Measurement Protocol

To achieve the required accuracy, several passes over each measurement area can be considered. The auditor must provide the number of passes necessary to obtain good data quality.

a. Dynamic Accessibility measurements

To analyse accessibility on site, voice calls must start simultaneously on the 8 mobiles at the beginning of the itinerary on the same MNO. Calls must be to fixed landline numbers.

During the whole procedure the following data must be collected:

- Duration of each call (x calls depending on number of call drops)
- Date /Time
- GPS Longitude
- GPS Latitude
- MNO Name
- Techno
- LAC/RAC/TAC
- CID
- Signal Level (dBm) (RSRP/RSCP/RxLev)
- Signal Quality (dB) (RSRQ/ECNO/RxQual)
- Best Server
- Call Drop Cause
- Indoor or Outdoor
- Specific comments about the call

Measurement accuracy: The spacing between two measuring points must be of the order of 1 metre and must not exceed 10 metres.

Call Drop on unlocked mobile phone

If a call drop occurs on one of the 2 unlocked mobile phones, calls on all other trace mobile phones must be stopped and restarted. The call drop must be analysed, and root cause identified.

As long as no disconnection occurs on the 2 unblocked trace mobiles, calls on the other mobiles must be continued or restarted in the event of loss of coverage of a technology.

b. Dynamic Data availability measurements

Data availability means that a vehicle can open and maintain a data session at low throughput. Any drop in the data connexion shall be reported. As an option, a data throughput measurement can be done.

Areas with ~0kbps up/down throughput (no download or upload possible) must be reported and logs analysed for further investigations of these areas.

During the whole procedure the following data must be collected:

- Duration of download/upload
- Date /Time
- GPS Longitude
- GPS Latitude
- MNO Name
- Techno
- LAC/RAC/TAC
- CID
- Signal Level (dBm) (RSRP/RSCP/RxLev)
- Throughput
- RTT
- Packet Loss %

c. Static Accessibility measurements

Static measurements concern areas where vehicles will be parked. Depending on the surface of the area, one or many measurement points must be performed, and a graphical view must be provided showing the exact positions of each measurement. Some specific points of measurements may be directly provided by the On-Site contact for specific purposes. In any case, the mapping of the measurement points must be validated with the site operator.

To perform accessibility measurements, calls must start simultaneously on the 8 mobiles at the beginning of the tests on the same MNO. Calls must be to fixed landline numbers.

During the whole procedures the following data must be collected from the trace mobiles:

- Duration of each call (x calls depending on number of call drops)
- Date /Time
- GPS Longitude
- GPS Latitude
- MNO Name
- Techno
- LAC/RAC/TAC
- CID
- Signal Level (dBm) (RSRP/RSCP/RxLev)
- Signal Quality (dB) (RSRQ/ECNO/RxQual)
- Best Server
- Call Drop
- Indoor or Outdoor
- Specific comments about the call

d. Static Data availability measurements

Data availability means that a vehicle can open and maintain a data session at low throughput. Any drop in the data connexion shall be reported. As an option, a data throughput measurement can be done.

Areas with ~0kbps up/down throughput (no download or upload possible) must be reported and logs analysed for further investigations of these areas.

During the whole procedures the following data must be collected:

- Duration of download/upload
- Date /Time
- GPS Longitude
- GPS Latitude
- MNO Name
- Techno
- LAC/RAC/TAC
- CID
- Signal Level (dBm) (RSRP/RSCP/RxLev)
- Throughput
- RTT
- Packet Loss %

e. Static SMS Efficiency & Latency measurements

For SMS latency and efficiency measurements, the tests must be static on vehicle parking areas. A specific protocol can be suggested by the auditor. However, the following points must be respected:

SMS-MT:

- Calculate efficiency on a minimum of 50 SMS in a fixed period
- Calculate latency on a minimum of 50 SMS in a fixed period

SMS-MO:

- Calculate efficiency on a minimum of 50 SMS in a fixed period
- Calculate efficiency on received RP-ACK
- Calculate latency on received RP-ACK
- Calculate latency on a minimum of 50 SMS in a fixed period

For tests to be considered as “Passed”, the following conditions must be respected:

90% of SMS shall be delivered in:

- < 10s in 2G // < 5s in 3G // < 2s in 4G

95% of SMS shall be delivered in:

- < 20s in 2G // < 10s in 3G // < 5s in 4G

99% of SMS shall be delivered in:

- < 30s in 2G // < 20s in 3G // < 10s in 4G

5. Measurements Input

The on-site contact will provide the following documents:

- On-site detailed map
- Access instructions, safety and traffic rules On-site
- On-site itinerary of the tracked vehicles
- On-site location of storage/parking areas for connected vehicles from "Gate-In" to "Gate-Out"

6. Measurements Output

Mandatory deliverables are listed below. Deliverables must be specific to the logistics site and not to the logistics operator. An example of mentioned charts is available in the Excel file *Requirements deliverables summary.xlsx* sent with this file.

1. The data must be returned in the form of:

- Image:** One or many .jpg files with minimum resolution of 600dpi/ppp, with maps of the measured site that shows average signal level (in dBm), data availability per technology (2G,3G,4G) per MNO (MNO1, MNO2, etc..) and Call Drops locations.
- Cartography in GIS format:** the map must be based on the chosen itinerary which must be also delivered.

The degree of accuracy of the measurements must be to at least 10 metres, and preferably 1 metre, which explains the high-resolution requirement.

There shall be 8 maps/MNO:

- 2G coverage map
- 3G coverage map
- 4G coverage map
- Multi-technology coverage map
- 2G itinerary map
- 3G itinerary map
- 4G itinerary map
- Multi-technology itinerary map

Example of coverage maps:

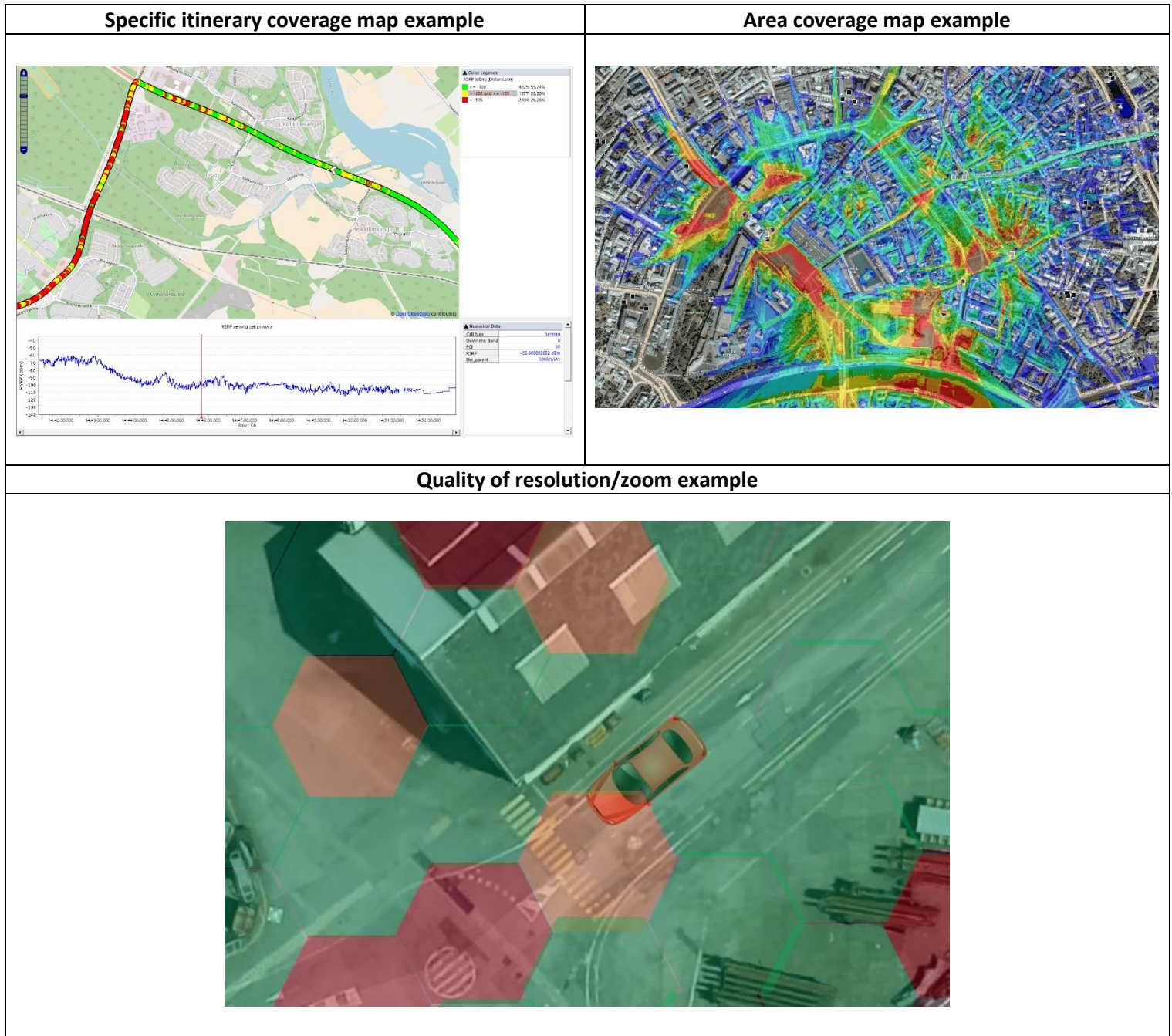


Figure 3 – Example of types of coverage maps and quality of zoom mandatory in deliverables

A basic key coverage must be joined to the map, making it possible for any reader to understand the coverage. Suggested key map:

2G & 3G Signal Strength Equivalency

-50dBm to -65 dBm	Excellent Signal (good voice and data)
-66dBm to -75 dBm	Good Signal (good voice and data)
-76dBm to -85 dBm	Average Signal (good voice data, marginal data with drop-outs)
-86dBm to -109 dBm	Weak Signal (Voice can be OK, no data)
-110dBm to -113 dBm	No signal

4G Signal Strength Equivalency

-70dBm to -90dBm – Excellent Signal (good voice and data)
-91dBm to -105dBm – Good Signal (good voice and data)
-106dBm to -125dBm – Average Signal (good voice data, marginal data with drop-outs)
-126dBm to -136dBm – Weak Signal (Voice can be OK, no data)
-136dBm to -140dBm – No signal

If cars are parked in an indoor area, an indoor map of this area must be provided as well.

2. A pdf/Word file with a global summary of the measured site, and action plan suggestion to be delivered to the MNO for application.
3. A comparison analysis between what is observed on the 4 mobile phones inside the vehicle and what is observed on the mobile phones connected to the antennae on top of the vehicle.
4. A chart for each MNO with detailed measurements. All accessibility measurements must be summarized as per the following chart example:

Date /Time	Device Reference	Longitude	Latitude	MNO Name	Techno	LAC RAC TAC	CID	Signal Level (dBm) (RSRP/RSCP/RxLev)	Signal Quality (dB) (RSRQ/ECNO/RxQual)	Best Server	Call Drop	Indoor or Outdoor	Comments

5. A chart for each MNO’s “Blind Spot”. If “Blind Spot” is confirmed, environment must be studied. Suggestion of chart:

	Date /Time	Device Reference	GPS Coordinates of the Blind Spot on site	Vehicles parked in buildings without connectivity access (Y/N)	If Yes, Number of Vehicles	Multi storage building for vehicle storage (Y/N)	If Yes, Number levels in the building	Action plan suggestion
Blind Spot #1								
Blind Spot #2								
...								

6. A chart for each MNO’s call drops. If a call drop occurs, signal strength and quality must be analysed. Suggestion of chart:

	Date /Time	Device Reference	GPS Coordinate of the Call Drop on site	Technology when call drops	Call drop cause	Action plan suggestion	LAC/RAC/TAC	CID	Signal Level (dBm) (RSRP/RSCP/RxLev)	Signal Quality (dB) (RSRQ/ECNO/RxQual)	Best Server
Call Drop #1											
Call Drop #2											
...											

7. A chart for each MNO's Data measurements.

<i>Date /Time</i>	<i>Device Reference</i>	<i>Longitude</i>	<i>Latitude</i>	<i>MNO Name</i>	<i>Techno</i>	<i>LAC/ RAC/ TAC</i>	<i>CID</i>	<i>Signal Level (dBm) (RSRP/RSCP/RxLev)</i>	<i>Signal Quality (dB) (RSRQ/ECNO/RxQual)</i>	<i>Throughput</i>	<i>RTT</i>	<i>Packet Loss (%)</i>

8. A chart for each MNO's SMS measurements.

										<i>SMS-MT</i>		<i>SMS-MO</i>			
<i>Date /Time</i>	<i>Device Reference</i>	<i>Longitude</i>	<i>Latitude</i>	<i>MNO Name</i>	<i>Techno</i>	<i>LAC/ RAC/ TAC</i>	<i>CID</i>	<i>Signal Level (dBm) (RSRP/RSCP/RxLev)</i>	<i>Signal Quality (dB) (RSRQ/ECNO/RxQual)</i>	<i>Efficiency</i>	<i>Latency</i>	<i>Efficiency</i>	<i>Latency</i>	<i>RP-ACK Efficiency</i>	<i>RP-ACK Latency</i>

7. Measurement Availability

Source files of raw measurement must be made available on an FTP server or USB key for possible future investigations.

8. Requirements Checklist

Auditor must fill the following checklist regarding the requirements of this document.

COMPANY NAME	
NAME OF PORT/ STORAGE/TRANSIT SITE	
COMPANY CONTACT	
<i>Name</i>	
<i>Phone Number</i>	
<i>e-mail address</i>	
DATE OF ANSWER	

Requirement Reference	Requirement Description	Checked
Req-01	2 types of measuring devices: Mobile phones & InCar integrated antennae	
Req-02	Number of mobile phones/antennae with specific configuration on each device	
Req-03	Position of antennae & phones	
Req-04	Measurement tool choice	
Req-05	Itinerary map for dynamic measurements	
Req-06	Itinerary map for warehouses measurements	
Req-07	Observance of traffic rules on-site	
Req-08	Dynamic Accessibility measurements attributes	
Req-09	Dynamic Data measurements attributes	
Req-10	Static Accessibility measurements attributes	
Req-11	Static Data measurements attributes	
Req-12	Static SMS measurements attributes	
Req-13	SMS-MT: Calculate efficiency on a minimum of 50 SMS in a fixed period of time Calculate latency on a minimum of 50 SMS in a fixed period of time	
Req-14	SMS-MO: Calculate efficiency on a minimum of 50 SMS in a fixed period of time Calculate efficiency on received RP-ACK Calculate latency on received RP-ACK Calculate latency on a minimum of 50 SMS in a fixed period of time	
Req-15	90% of SMS shall be delivered in: - < 10s in 2G - < 5s in 3G - < 2s in 4G	
Req-16	95% of SMS shall be delivered in: - < 20s in 2G - < 10s in 3G - < 5s in 4G	
Req-17	99% of SMS shall be delivered in: - < 30s in 2G - < 20s in 3G - < 10s in 4G	
Req-18	Measurement Accuracy between 1 and 10 meters	
Req-19	Deliverable 1: Coverage maps with basic key in specific format	
Req-20	Deliverable 1: Coverage maps images with a minimum of 600 dpi/ppp	
Req-21	Deliverable 1: 8 maps/MNO	
Req-22	Deliverable 1: Location of all call drops displayed on each map	
Req-23	Deliverable 2: Analysis summary and advised action plan	
Req-24	Deliverable 3: Analysis of inside/outside antennas mobile phones	
Req-25	Deliverable 4: Measurements chart with specific attributes	
Req-26	Deliverable 5: Detailed analysis of Blind Spots with advised action plan	
Req-27	Deliverable 6: Detailed analysis for call drop on the unlocked mobile phones	
Req-28	Deliverable 7: Detailed analysis for Data measurements	
Req-29	Deliverable 8: Detailed analysis for SMS measurements	
Req-30	Source files availability on USB Key or FTP Server	

Figure 4 - Requirements Checklist

Glossary

Best Server: Best signal received by the UE

Blind Spot: Area with no radio network coverage

CID: Cell Identifier

LAC: Location Area Code

MCC: Mobile Country Code (ex: 208 for France)

MNC: Mobile Network Code (ex: 01 for Orange in France)

MNO: Mobile Network Operator - Telecom operator (ex: Orange, AT&T...)

RAC: Routing Area Code

RSCP: Received Signal Code Power - power measured by a receiver on a particular physical communication channel in 3G cell network

RSRP: Reference signal Receive Power - measurement of the received power level in an LTE cell network

RSRQ: Reference Signal Received Quality - measurement of the received quality level in LTE cell network

RxLev: Received Level

RxQual: Received Quality

TAC: Tracking Area Code

UE: User equipment (ex: mobile phone, tablet...)

Annex