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Use case overview

# Abstract

This document discusses the use cases for broadband measurements applied to mobile domain, in order to provide a guideline for regulatory groups to consider such scenarios in addition to fixed broadband measurements.

The specifics related to mobile domain are discussed considering them as possible extensions of IETF LMAP measurements or even implementation of dedicated measurements.

# Status of this memo

This document is a draft to be submitted to IETF workgroup for discussion.

To be completed with comments…

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To be completed with comments…

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# Introduction

Mobile traffic is increasing exponentially and networks and services have to deal with such service profiling.

Such traffic explosion has changed significantly the network architectures and even the way the networks are controlled and measured. The same for services: service providers have to deal with specific problems related to traffic profiles coming from mobile domain, that can have specific requirements, different from fixed broadband access.

IEEE 802.16.3 considered a measurement framework for mobile broadband measurements scenarios useful for several stakeholders: such model allow performing measurements in flexible way and provide a standardized framework that facilitates the measurement comparison and validation.

But, at the first stage, it is necessary characterizing why specific measurements are necessary over mobile domain, in order to expand current scope for IETF LMAP regulatory group.

This draft is describing a set of use cases for the broadband measurements applied to mobile domain. Some of these use cases could make sense even for the fixed network, not only for the mobile.

The stakeholders involved in these use cases are summarized in the table below while the use cases overview is described in the next sections.

List of possible measurement applications:

|  |  |
| --- | --- |
| No | MEASUREMENT APPLICATION |
| 1 | Overall data on Quality of Experience of set of networks available to consumers |
| 2 | Quality of Experience of a specific network |
| 3 | Identify limitations in deployment of a specific network |
| 4 | Monitor for changes in operation of a specific network |
| 5 | Diagnose problems in a specific network |
| 6 | improve knowledge of system performance |
| 7 | lead the market toward more effective networks |
| 8 | encourage the redeployment of scarce spectrum using efficient technologies and implementations |
| 9 | compare measured performance data to simulated results |
| 10 | assess theoretical models |
| 11 | assess technology elements proposed during standards development |
| 12 | Service measurements geo-located |

Note: numbers for measurement application are included in the next table within each text box.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Stakeholder** | | | | | | | | |
| **Use case** | **Governmental policy maker** | **User (individual or enterprise)** | **Cell tower operator** | **Wireless carrier / Network operator** | **Researcher** | **Standards developer** | **User device vendor** | **Application developer** | **Mobile Application Service Provider** |
| POLICY CHECK | 1 |  |  |  |  |  |  |  |  |
| COMPETITION CHECK | 1 |  |  |  |  |  |  |  |  |
| STRATEGIC DIRECTION | 1,12 |  |  |  |  |  |  |  |  |
| EFFICIENCY IMPROVEMENT | 1,12 |  |  |  |  |  |  |  |  |
| SERVICE CHECK |  | 1,3,4,12 |  |  |  |  |  |  |  |
| TRENDS |  | 1,12 |  |  |  |  |  |  |  |
| COMPARISONS |  | 2,12 |  |  |  |  |  |  |  |
| AUTONOUMOUS NETWORK PERFORMANCE ACCESS |  |  | 2,4,5 |  |  |  |  |  |  |
| AUTONOMOUS RADIO NETWORK ACCESS |  |  | 2,5,8 |  |  |  |  |  |  |
| MOBILITY |  |  |  | 2,6 |  |  |  |  |  |
| SERVICE LEVEL AGREEMENT |  |  |  | 1,2 |  |  |  |  |  |
| RESOURCE USAGE |  |  |  | 2,5 |  |  |  |  |  |
| TEST OF NEW RELEASE INTRODUCTION |  |  |  | 2,5 |  |  |  |  |  |
| CHECK MODELS |  |  |  |  | 1,2,6,10 |  |  |  |  |
| GET ACCESS TO REAL IN-FIELD DATA |  |  |  |  | 1,2,6,10 |  |  |  |  |
| METRICS AVAILABILITY |  |  |  |  |  | 2,10 |  |  |  |
| CHECK OF OPTIONS |  |  |  |  |  | 2,6,11 |  |  |  |
| UE CHARACTERIZATION |  |  |  |  |  |  | 1,2 |  |  |
| APP CHARACTERIZATION |  |  |  |  |  |  |  | 1,2 |  |
| MOBILE SERVICE CHARACTERIZATION |  |  |  |  |  |  |  |  | 1,2,8 |

Table 1: Assessment of USE CASES per STAKEHOLDER

# Terminology

The following acronyms are used over the document:

HPLMN Home Public Land Mobile Network

KPI Key Performance Indicator

NE Network Equipment

NO Network Operator

QoS Quality of Service

SLA Service Level Agreement

SON Self-Organizing Networks

UE User Equipment

VPLMN Visited Public Land Mobile Network

# Why mobile broadband measurements framework use cases?

There are several basic reasons for considering even mobile scenarios for broadband measurements.

First of all, **mobility** can be the reason for different service experience over time, with huge impact on the user perception.

Secondly, mobile networks in general are affected by **varying radio conditions** that impact services: measuring such radio conditions together with the service indicators can provide a better characterization of service perception and user experience.

Last but not least, **roaming scenarios** and **multiple operators** are other scenarios that are distinctive of mobile domain.

So, considering the specifics of mobile domain allow completing the picture for broadband measurements, avoiding to standardize and design solutions that are strictly tailored only for one of them.

In addition, if mobile broadband measurements framework wouldn’t be standardized, the consequence would be an increasing complexity in comparing network performances for whatever stakeholder, and in essence being exposed to more qualitative than quantitative judgments about final service behavior.

# Stakeholder: Governmental policy maker

Governmental policy maker has several use cases:

* POLICY CHECK: assure that current policies are satisfied by current players
* COMPETITION CHECK: assure correct competition between current players
* STRATEGIC DIRECTION: enforce new policies with strategic guidelines (eco-sustainability, support of specific geographical areas, drive changes for geographical migration of specific activities, …)
* EFFICIENCY IMPROVEMENT: drive the evolution path to more effective, integrated and cheap communication solutions

## POLICY CHECK

In order to check the behavior of network players against current policies it is needed to act as a final end user and measure the behavior of the different networks.

So, as an example, if current policies need that emergency calls shall be supported by all the network operator players even when the UE is SIM-less or belonging to a different operator, then it is needed to make measurements and check the compliance against this requirement.

Measurement application that can be useful for this use case are ***overall data on quality of experience*** measured by UEs across different networks. It is important to characterize the measurements with dimensions that support the policy check under test: so, again in the previous example, it is needed to associate the measurements to the bins of HPLMN users, roamers and SIM-less UEs.

## COMPETION CHECK

Governmental policy maker could be also in charge to control correct competition between NOs. So, in case of resources shared by different actors (e.g. sites, shared network entities, radio spectrum, …) it could be necessary to measure current behavior for different NOs.

As an example, if there is the coexistence of two operators at the same tower site with dedicated antennas, it could be needed checking the power strength to assure that each one is not transmitting out of allowed thresholds, generating unexpected interference. In some cases, these use cases could be also in charge of technical teams belonging to each NO.

Another example could be the support of legacy services that the governmental policy maker cannot drop (e.g. former radio technologies to be maintained for a certain period of time with specific level of services). In case a NO is dropping such services to avoid costs it is breaking the correct competition because it is getting an inappropriate economic advantage.

In this use case it could be used again the ***overall data on quality of experience*** measured by UEs across different networks.

## STRATEGIC DIRECTION and EFFICIENCY IMPROVEMENT

Governmental policy makers could encourage the adoption of technologies with a strategic plan, for example to achieve a better environmental sustainability.

Measurements with this perspective can be related for example to battery usage per services, spectrum needs, or correlated to specific geographical areas.

For example, it could be required that some specific geographical areas will support at least a certain number of concurrent calls per location area. So, admission control and network allocated resources have to deal with this requirements.

Another example is about technological evolution: it could be measured the amount of traffic for specific services encouraging the deployment of newest technologies (e.g. LTE or HSxPA) to support better usage of scarce spectrum, for example with a better bit/Hz ratio or the need to reduce radio signal power.

Measurement application for these use cases can be again the ***overall data on quality of experience*** measured by UEs but also ***service measurements geo-located or correlated to radio conditions,*** even associated to other UE parameters (e.g. type of device, radio access technology, battery consumption, radio signal strength).

# Stakeholder: User (individual or enterprise)

Use cases for User (individual or enterprise) can be the following ones:

* SERVICE CHECK: Check the service performance correlated to the network type, the location and the mobility either for SLA-control or for a generic network assessment.
* TRENDS: check the trends of service performances over time, to identify changes in the network behaviors that could be unexpected and/or unacceptable.
* COMPARISON: Check if other customers in the same area are experiencing problems with services, in order to discriminate individual issues against global issues, and also compare performances across similar subscribers.

## SERVICE CHECK

Individual or enterprise users are obviously interested in getting the best service from the mobile network and from the service provider.

The performances measured on specific services can be compared by the stakeholders in relation to the measurement conditions (end service host, type of service, location, mobility, radio signal levels, …).

The results could be checked against SLA, in order to push either the NO or the service provider to respect the level of services.

Measurement applications that are useful for these purposes are ***overall data on quality of experience*** measured by UEs but also ***service measurements geo-located or correlated to radio conditions.*** Even ***measurements of changes*** on a specific network behavior or on a specific service can be interesting and ***identification of limitations*** on a specific network.

An example of network limitation could be the absence of single radio voice call continuity on a certain geographical location, so call is dropped as soon as the UE moves from a PS domain to a CS domain.

## TRENDS

Analyzing trends is a use case relevant for example to enterprise organizations that need to assure certain connection reliability over time to their associated or customers.

Checking trends is also useful for profiling the customer access and identifying bottlenecks in the service or overload conditions.

An example of such a use case is an enterprise that has to size and maintain the network resources for customers accessing its network, for example for e-commerce or customer support, and desire to measure the service experience of mobile access over time, to identify bottleneck conditions.

Measurement application that can be used for such purposes are ***overall data on quality of experience*** measured by UEs but also ***service measurements geo-locate.***

All these measurements have to be analyzed as trends over time correlating also with enterprise network conditions and host behavior.

## COMPARISON

An enterprise or individual user could be interested in understand the relevance of a specific issue that it is experiencing, comparing with other UEs located in the same area and accessing similar services.

This could be used to check for example UE configuration for correct behavior, getting access also to blogs and discussions on the internet forums.

Measurements application useful for this purposes could be a ***public (anonymous) repository of end-user measurements*** toward specific services, geo-located and providing the type of device as possible aggregation criteria for measurements.

# Stakeholder: Cell tower operator

Use cases for Cell tower operator can be the following ones:

* AUTONOMOUS NETWORK PERFORMANCE ACCESS: get access to performance, admission control and load of a specific network.
* AUTONOMOUS RADIO NETWORK ACCESS: understand the level of usage of a specific cell tower and the radio conditions configured for its working.

## AUTONOMOUS NETWORK PERFORMANCE ACCESS

Cell tower operator could be blind about overall network performance and so, in case of issues, it depends entirely from the Network Operator that performs the system surveillance overall. On the contrary it has to perform specific expensive drive tests to get information.

So, acquiring knowledge about a specific network behavior is essential to be more effective in solving issues and also being more conscious of the overall service, even from the business point of view.

This knowledge could be also used in getting better conditions for the leasing of the cell tower to the main network operator (in the scenarios where Cell Tower and the rest of the network are owned by different business entities).

Measurement applications useful for these use cases could be the ***quality of experience of the specific network,*** the ***network diagnosis*** and the ***change of operation in the specific network.***

## AUTONOMOUS RADIO NETWORK ACCESS

Cell tower operator is interested in getting the most from each site, checking the correctness of the configuration against the radio conditions and suggest improvements to NO that own the rest of the network.

Getting autonomous access to the end-user experience correlated with radio conditions and cell identification helps Cell Tower operator to be more proactive in suggesting network improvements. Measurements could be also used to suggest migration to other radio access technologies upgrading the cell site and gain business from this.

Measurement applications useful for these use cases could be the ***quality of experience of the specific network***, the ***diagnose of problems*** and the ***encourage of deployment of more efficient RAT technologies.***

# Stakeholder: Wireless carrier / Network operator

Use cases for Wireless carrier/Network operator can be the following ones:

* MOBILITY: characterize mobile broadband service during mobility events. Such correlation can be correlated to specific cells and radio conditions.
* SERVICE LEVEL AGREEMENT: checking the level of service from end-user perspective in homogeneous way can be useful to compare different networks, assessing the NO figures against the competition.
* RESOURCE USAGE: checking the usage of resources (that is correlated to the concurrent UE access to the network from a certain area) is necessary to size correctly the network.
* TEST OF NEW RELEASE INTRODUCTION: new releases on part of the network could affect performances. So, checking end-user measurements before and after the change can be beneficial to assess final performances in operating network.

## MOBILITY

As usual in mobile domain, it is necessary to characterize the broadband services even during mobility events.

Such characterization can be correlated to specific cells and/or specific services.

The adoption of measurements at end user premises can be reused even for setting proper values for handover settings.

This scenario can be useful also for the so called “SON networks”, where the network is automatically setting its configuration values. The availability of end user measurements related to mobility can be used to check the correctness of SON methodology.

So, measurements application are ***quality of experience of a specific network,*** correlated with radio conditions, location information and device information.

All these measurements have the consequence that the stakeholder can improve knowledge of its network performances, useful also to optimize and design better updates of the network.

Mobility characterization can be used even to characterize the radio technology behavior that is supporting them during service lifetime. Such characterization could suggest even improvements of the mobile network or add-on of additional features to support better mobility (e.g. SRVCC).

## SERVICE LEVEL AGREEMENT

Checking the Service Level Agreement is needed not only to be sure that the contract to customers is satisfied but also could be useful to check the performances of different Nos homogeneously. This could imply understanding limitations and trigger analysis to improve the core network or redesign radio deployment to make it more efficient or to move to new RAT.

Measurement applications are the ***quality of experience of a specific network*** but also ***overall data on quality of experience of set of networks available to customers.***

## RESOURCE USAGE

Traffic and performance measurements are useful also to optimize network parameter configuration, feeding optimization systems as in the Self-Organizing Networks.

Even if this job is typically done at network level, the availability of the UE perspective can help especially for network technologies that don’t provide a complete reporting of the UE measurements.

For example, spectrum allocation and configuration parameters can be modified according to the traffic and performance measurements provided by UEs, for example to avoid network overload and congestion and reducing the radio contact lost with UE.

Measurement applications are the ***quality of experience of a specific network*** and ***diagnose problems in a specific network.***

## TEST OF A NEW RELEASE INTRODUCTION

Measurements provided by end-user can be used to characterize the performance after network equipment release changes.

Aggregated per cell and radio technology, it is possible providing KPIs that can be used to compare the network performances before and after new release changes at access network level, with the end user perspective.

Measurement applications are the ***quality of experience of a specific network*** and ***diagnose problems in a specific network.***

# Stakeholder: Researcher

Use cases for Researcher can be the following ones:

* CHECK MODELS: characterize mobile broadband services against theoretical models.
* GET ACCESS TO REAL IN-FIELD DATA for post processing.

## CHECK MODELS

A researcher can be interested also in checking the correctness of some hypothesis or theoretical models he’s working about, starting from in-field data.

For example, the statistical model for service request arrival rate by customers can be checked against real conditions.

So, measurement application useful for researchers can be ***quality of experience of a specific network*** or ***quality of experience on a set of networks available to the user.*** Other applications useful can be ***improving knowledge of system performances*** and ***checking the network behavior against theoretical models.***

## GET ACCESS TO REAL IN-FIELD DATA

Another possible use case is getting access to real data in order to achieve additional information useful for researches, as for example test set or traffic profiles and consistency.

Measurement application useful for this use case are similar to the previous one.

# Stakeholder: Standards developer

Use cases for Standards developer can be the following ones:

* METRICS AVAILABILITY to make decisions.
* CHECK OF OPTIONS impact on the network

## METRICS AVAILABILITY

The end user measurements are useful to understand actual mobile performances and so make decisions on standard improvements based on facts.

For example, latency metrics available on specific RAT allow to propose changes on standards in order to simplify processing at access network and improve transit rate for PDUs.

Measurement application useful for standards developer can be ***quality of experience of a specific network*** or ***comparing measured results with theoretical models.***

## CHECK OF OPTIONS

Performance measurements allow to compare expected results with current results, in order to validate technical choices. An example could be the adoption of specific codec for voice or the adoption of specific protocols for data services.

Another example is the impact of security on UE performances, because authentication and ciphering techniques could affect overall performances.

Measurement application are the ***performance*** ***assessment***, correlated to radio, location and technology details. Other measurement applications are the ***assessment of technology elements proposed during the standard development.***

# Stakeholder: User device vendor

Use cases for User device vendor can be the following one:

* UE CHARACTERIZATION of device performances across different network conditions or different networks at all.

## UE CHARACTERIZATION

User device manufacturers can be interested in the adoption of UE broadband measurements to characterize the inter-operability of the device against real networks.

The adoption of KPIs divided per user device is helpful for this type of characterization.

In fact, different network settings can be the reason for a different interoperability between network and the UE.

So, measurement application useful for User device vendors can be ***quality of experience of a specific network*** or ***quality of experience on a set of networks available to the user.***

# Stakeholder: Application developer

Use cases for Application developer can be the following one:

* APP CHARACTERIZATION in terms of performances, usage and effectiveness.

## APP CHARACTERIZATION

In case of mobile applications, it is important characterizing how well the app is performing through the network.

This can be useful for two purposes: ask for better network level of service to NOs and also check how the app is performing on the real network.

This characterization can be also the trigger for app changes that minimize the drawbacks with the network interaction.

It is possible for mobile application developers also to include monitoring callbacks that can be useful for passive measurements.

Other use cases for APP developer are a sort of usage profiling, understanding when and how much an APP is used by customers.

Even the timing the APP is getting services from the network is important, to notice also possible early drop by the user due to poor quality of service experience.

Measurement application useful for APP developer can be ***quality of experience of a specific network*** or ***quality of experience on a set of networks available to the user.***

# Stakeholder: Mobile Application service provider

Use cases for Mobile application service provider can be the following one:

* MOBILE SERVICE CHARACTERIZATION in terms of performances, usage and effectiveness.

## MOBILE SERVICE CHARACTERIZATION

Mobile application service providers are interested in mobile broadband measurement characterization. Obviously this makes sense provided that it is possible correlating the measurements to the specific invoked application.

In fact, the service accessed by mobile has to satisfy certain conditions that services accessed from fixed are not required.

From one side it is possible measuring the volume of mobile application transactions, as typically available in the market, but also it is possible correlating such usage with the actual performance level.

A consequence of such analysis could be marketing initiatives to sponsor specific radio technologies, more performing, with some critical mobile app.

In case of networks that don’t support the bandwidth needed for a specific application, it is needed to trigger modifications either in the application itself or in the network. The trade-off decision can be driven even by end user measurements.

Measurement application useful for APP developer can be ***quality of experience of a specific network*** or ***quality of experience on a set of networks available to the user.***

However, measurements can be used to push network operator to adopt ***more efficient radio technologies*** to support services that could be limited by network efficiency so far.