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Technical Report

**3rd Generation Partnership Project;
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Integration of device management information with Itf-N
(Release 10)**

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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1 presented to TSG for information;

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1 Scope

UE Management provides the network operator with the opportunity to manage and monitor the actual user experience of their subscribers via the remote management of the user equipement.

UE management over Itf-N provides the ability to minimize the complexibity and reduce the OPEX and CAPEX costs of managing the UE by the ingegrated management capabilities.

UE management over Itf-N provides the capabilites for service provisioning and personalized subscriber profile backup for the UE via DMS, to improve the subscriber satisfaction and thus contribute to subscriber retention.

The UE can provide measurments of the quality of radio network and the actual service being delivered to the user, collection of these measurements via Itf-N can be used by Centralized SON or manual optimization.

This document is to study UE management over Itf-N, including the following aspects:

- Subscriber profile configuration over Itf-N;
- Collection of UE measurements over Itf-N. Includes protocol definition over Itf-N and study of appropriate UE measurements defined in RAN WGs;
- Retrieval of UE measurement logs over Itf-N. Includes file format definition over Itf-N and study of appropriate solutions for measurement logging policy configuration and log retrieval over Itf-N.

To support the UE measurement log collection via Itf-N, this document will study how to support the UE measurement log transfer mechanisms measurement logging policy configuration and measurement log retrieval by DMS using existing UE management protocol procedures, and identify a suitable protocol from a network management perspective. This document will also study how to do the mapping between the selected protocol and Itf-N.

2 References

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

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 32.101: "Telecommunication management; Principles and high level requirements".

[2] 3GPP TS 32.102: "Telecommunication management; Architecture".

[3] Void.

[4] Void.

[5] Void.

[6] OMA-TP-DMBCAST-2009-0035R03, "DMBCAST BoF Final Report"

[7] 3GPP TR 36.805: "Study on Minimization of drive-tests in Next Generation Networks"

[8] 3GPP TS 32.421: "Telecommunication management; Subscriber and equipment trace: Trace concepts and requirements".

[9] 3GPP TS 32.423: "Telecommunication management; Subscriber and equipment trace: Trace data definition and management".

[10]-[15] Void.

3 Abbreviations

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

DM	Device Management
GUI	Graphical User Interface
IOC	Information Object Class
IRP	Integration Reference Point
MDT	Minimizing Drive Test
NM	Network Manager
NRM	Network Resource Model
OAM	Operations, Administration, Maintenance
OMA	Open Mobile Alliance
OPEX	OPerational EXpenditure
RAT	Radio Access Technology
RRC	Radio Resource Control
RRM	Radio Resource Management
SON	Self Organizing Network
UE	User Equipment

4 UE management over Itf-N

4.1 Use Cases

4.1.1 Management aspects of MDT/SON

4.1.1.1 Device management aspect

Selection of devices participating in data collection

Mobile devices are expected to be used for data collection for MDT and SON purposes. Mobile devices do not belong to network operators. It is certain that operators' use of users' devices for purposes of reducing OPEX will be met with strong public scrutiny. Consequently, devices involvement in data collection for MDT/SON will need to be controlled by the operator according to specific policies, which will need to be configurable on a per-device basis.

For example, operator may decide to obtain the right to involve in MDT/SON data collection selective users in exchange for a service discount. Or, operator might want to involve in MDT/SON data collection only devices from users who subscribed to a specific service. It is relatively easy to envision various other groups of users who could be selected for participation in MDT/SON efforts (e.g. operator employees, data-only users, users with a particular device model, VIP users etc.).

In parallel to the above, operator might want to involve only devices that have more than certain amount of battery life and/or storage space remaining, for example more than 75%.

Similarly, operators might need the ability to configure the intensity at which each device is involved in MDT/SON data collection. For example, some users might be willing to take 20% hit on their battery life, whereas others could take more or less. Or, some users may be willing to participate on weekends only. Or, some users may accept to participate only when they are located inside certain geographic area, e.g. close to their home or office.

One could also envision that, for privacy/billing or any other reason, operators might need to keep records of which devices were involved in data collection and at what times.

Device management policy using any combination of the above elements is feasible.

Retrieval of device capabilities and user preferences

UEs terminal used for measurement logging/reporting for MDT shall be able to indicate a set of capabilities which allows the network to carefully select the appropriate devices for specific measurements. Device capabilities might reflect capabilities for log storage and battery capacity, as well as capabilities for logging and reporting specific failures and/or measurements.

Alternatively, the policy for log storage, battery capacity, triggering conditions, etc shall be communicated to all UE terminals in an area of the network and the UEs will self-select themselves for measurement logging/reporting for MDT according to the policy.

Users may be engaged in selective data collection depending on their preferences. Users may configure their preferences in their profiles. Operator may provide users with tools to configure their preferences with respect to the use of their devices for MDT/SON via GUI.

Summary

OAM is the network entity responsible for configuring policies and retrieving user preferences and profiles. OAM has all the required information to be able to implement policies for device management aspect of MDT/SON described above and/or any other. OAM should also be able to retrieve user preferences and profiles.

4.1.1.2 Device management aspect of data collection

According to [1], Section 4, operators must have the ability to configure measurement logging/reporting for MDT independently from RRM tasks. The following considerations must be addressed with respect to the management of data collection for MDT/SON:

Policy-based vs. on-demand (real-time) data collection and reporting

Logging and reporting of failure-inducing conditions and failure events is the main purpose of data collection using mobile devices. By definition, failures are coupled with the loss of connectivity to the radio network. Also, data collection in idle mode must be possible. Therefore, devices cannot report failure logs to the radio network in real time. Consequently, either devices must have a pre-configured policy for data collection and reporting or some mechanism for communication of policy for data collection and reporting to devices (both in active and idle modes, e.g. by broadcast communication) to avoid the need for constant radio connectivity.

Type of data to be collected

Operator may also need to have the ability to configure which data needs to be collected and when. As explained in section 4.1.1.1, this needs to be doable on a per-user basis. For example, mobile devices might be configured to log failures that they experience most frequently.

Selection of geographic areas inside which the data will be collected

Operators may want to limit the scope of data collection for MDT/SON to within specific geographic areas. Examples of such scenarios include addressing customer complaints, improving coverage along roads or train lines, ensuring good coverage for special events etc. Since these areas will depend on the user distribution, these areas will not overlap with cell/eNB boundaries. In order to resolve this, the operator might want to configure the devices to autonomnously trigger data collection when they enter certain geographic area. As discussed above, devices can initiate data collection without the need for a connection (e.g. RRC connectivity) with the radio network.

Selection of data collection and reporting times

Certain data related to MDT/SON might be of interest to operators only in certain times. For example, data collection can be configured during busy hour, when the probability of failures is largest, whereas reporting can be configured during off-peak hours to better distribute network load over time. Moreover, peak hours and off-peak hours for different services (e.g. voice, data) might be different.

Summary

Similar to the conclusion in Section 4.1.1.1, the conclusion of this section is that OAM should be able to configure policies for configuration of data collection for MDT/SON purposes, as described above.

4.1.2 Other aspects of device management related to MDT/SON

4.1.2.1 Simplicity

Device management aspects of MDT/SON discussed in previous sections need to be resolved prior to use of these functionalities in the network. Therefore, the adopted management solution must be easy to standardize in a short period of time so that MDT/SON functionality is available for early network deployments. Otherwise, the benefits of MDT/SON will be greatly diminished.

4.1.2.2 Applicability to multiple RATs

The number of radio access networks operated simultaneously by wireless operators will increase with emergence of LTE. LTE networks are expected to be often deployed in hot-spots in early phases of deployments, creating significant areas along inter-radio access technology boundaries. Network performance in these boundary areas will therefore be of high priority for operators, calling for increased drive test activity. Device management aspects of MDT/SON solution should be addressed in a way that is transparent inter-RAT boundaries.

4.1.3 RAN uUse cases for MDT

The use cases for MDT are documented in Ref. [7] 3GPP TR 36.805 clause 5.

4.2 Requirements

4.2.1 RAN requirements for MDT

The requirements for MDT are documented in Ref. [7] 3GPP TR 36.805 clause 4.

4.3 Solutions

4.3.1 eNB involved solution for UE measurement collection

4.3.1.1 General

The eNB involved architecture is shown in figure 4-1.

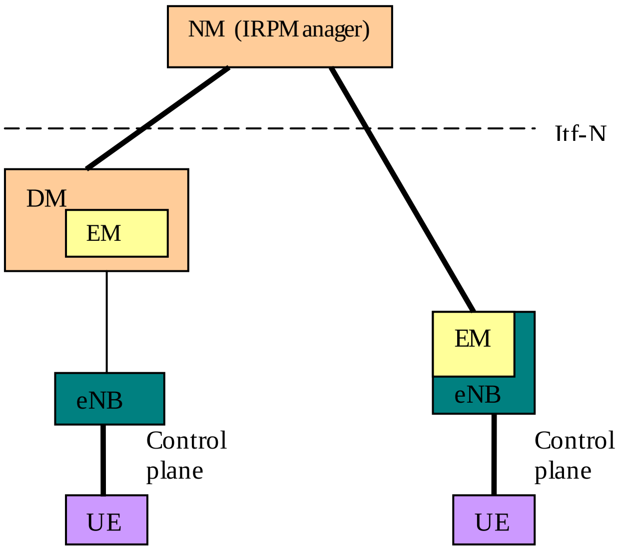

Figure 4-1: eNB involved architecture

As described in 4.1.1.2, a capability is needed to gather data from UEs experiencing specific network conditions (such as poor coverage, high interference, low throughput, high packet loss rate), in certain locations or other criteria. The eNB has insight into the conditions of its active UEs. For instance, the eNB will know something about the level of coverage the UE is experiencing. Thus for certain triggering criteria, the eNB can select from its active UEs and configure only those UEs that satisfy those triggering criteria.

But the eNB likely cannot know everything about its active UEs. For instance, it likely has no idea about how many UL packets are erased in the UL queue at the UE. Also, the eNB knows nothing about the network conditions of the idle UEs in its coverage area. Only the UE knows the complete story. Thus for many triggering criteria, the ideal place to decide whether UEs are included is the UE itself.

In summary, entities in the network have, at best, incomplete knowledge of which UEs are most suited to collecting the data required for the current application. Only the UEs have this information. So for some data collection applications, large swathes of UEs, or even all UEs, must be configured to perform measurements if those UEs are within certain policy groups and specified triggering criteria are met. Configuration in this way might induce an unacceptable load on the network if unicast configuration messages are used, in which case broadcast configuration messages that achieve the same would be more appropriate and avoid network congestion.

Network conditions can change rapidly. For example, an eNB may fail and change the network characteristics for UEs temporarily. UEs in the region of the failed eNB will suddenly experience a fall in coverage. If those UEs are configured to trigger reporting on poor coverage then many UEs will simultaneously want to report measurements, adding to network load and compounding the problem of eNB failure. To avoid this, there must be a mechanism that is able to deactivate triggering and reporting of measurements in all UEs rapidly.

Sometimes it is appropriate to collect data from subscribers in a variety of conditions. For example, the operator may wish to perform an optimisation of the RF coverage in the network, by tuning antenna orientations and transmission powers, adding new eNBs, etc. The purpose would be to improve the coverage for UEs currently in poor coverage. But a secondary goal would be to maintain the coverage for UEs that have adequate coverage. To achieve the first goal, the operator can collect measurements, locations, etc from UEs experiencing poor coverage. But to satisfy the second goal some data must be collected from the UEs with adequate coverage, so that whatever is performed maintains their coverage. As explained previously, the best way to collect from UEs with certain coverage conditions is to instruct UEs to trigger collection and reporting of measurements if/when they experience certain coverage. But many UEs are likely to have adequate coverage and this can lead to excessive data being transmitted by the UEs. A solution to this is to down-sample the reporting of measurements from UEs associated with certain triggering criteria. The concept of reporting probability is introduced. This could exist alongside the triggering criteria as follows. If the UE experiences conditions that satisfy the triggering criteria then the measurements associated with those criteria are performed and reported with a specified probability. The reporting probability factor would be greater than 0 and at most 1. In the case of RF optimisation above, UEs in poor coverage are of more interest. Thus the reporting probability factor might be varied with coverage so that those UEs in poor coverage would be more likely to report their coverage data than UEs with adequate coverage.

4.3.1.2 Definitions

<u>Immediate reporting from UE to eNB</u>:

The UE will report immediately at the end of the collection period the measurements to the connected eNB through RRC whenever UE is in active mode (collection period = reporting period).

<u>Logging and reporting from UE to eNB</u>:

The UE performs separate measurement collection and reporting. The time interval for measurement collection and reporting can be separately configurable in order to limit the impact on the UE battery consumption and the network signalling load.

4.3.1.3 Operator configured policy

The operator sends the measurement configuration to the eNB, which may include:

1. Evaluation area(s) (e.g. a region, a limited group of cells, one cell)
2. Collection period
3. Collected measurements
4. Reporting triggers (e.g. RSRP < Threshold)
5. Probability that measurements are reported or logged when trigger condition(s) are met
6. Reporting period
7. Immediate or logging mode configuration.
8. Other constraints like UE/eNB memory usage, UE battery, UE type etc.

4.3.1.4 Selection of devices participating in data collection

Two methods for configuration of UEs selected for participation in data collection are possible; one involving unicast configuration messages from the eNB to the UEs and one using broadcast messages. Using either method, the eNB can direct UEs to perform measurements, either as a result of being directed to do so by the IRPManager, or autonomously in order to gather data for distributed SON applications.

The first alternative is that the eNB selects UEs to perform measurement for drive test minimization according to operator's policy.

The eNB selects suitable UEs to perform measurements and the policy configured by the operator is then transferred to the selected UEs via dedicated unicast.

The second method for selection of UEs is for the eNB to broadcast the policy configured by the operator to all the UEs in the service area of that eNB.

Using either unicast or broadcast configuration, the eNB configures the UE to use “immediate” or ”logging” mode for the UE measurements reporting (see 5.3.2 Definitions).

In the case of unicast messages, idle mode UEs cannot be configured without the expense of first making them active. To arrange for UEs to perform measurements while in idle mode, either they must be configured while active prior to entering idle mode, or broadcast configuration must be used.

It is noted that for the eNB solution, either methods for configuring UEs might be implemented, or both together. There is a different set of advantages of each. The Unicast method allows specific UEs to be configured simply and efficiently. This is useful for example in the case that the subscriber has complained of poor performance. The broadcast method has the advantages that UEs can self select based on their unique conditions, such as poor performance characteristics. The broadcast method is also able to communicate measurement and reporting policies to idle UEs.

4.3.1.5 Data collection from UE to eNB

According to immediate/logging mode configuration, the UE will collect and report the measurements to the connected eNB.

The measurement reports include time information, location information if available, radio environment measurements.

4.3.1.6 Data collection from eNB to Network Manager through Itf-N

The eNB transmits the measurement reports of drive test minimization to the Network Manager through Itf-N according to preconfigured reporting period. The reports may be compressed by the eNB.

The eNB can make use of the UE measurements for SON or other functionality purpose. In case the eNB does not need to use UE measurements, the eNB will only forward those measurements to OAM.

4.3.2 User plane option for MDT management

4.3.2.1 High-level Description

Figure 4-2 provides a high-level view of the user plane architecture for MDT management.

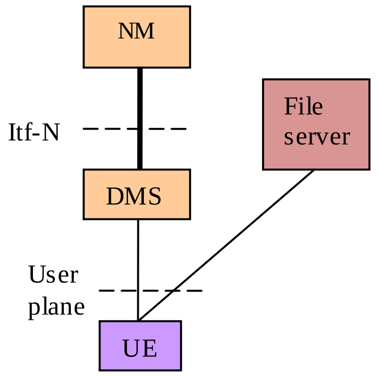

Figure 4-2: User plane MDT management

The following are the entities in this architecture and their roles:

Device Management Server (DMS)

DMS provides the following functionalities:

1. MDT management services to network operator, including:
    - Configuration of policy for selecting UEs to be included in the MDT campaign, based on:
        - subscription profiles, e.g. friendly users, operator employees, VIP users, users with service discount, users subscribed to specific operator-provided services or service plans etc.
        - UE type/capabilities, e.g. GPS capability, PDA vs. voice only, specific UE models etc.
        - device status, e.g. storage/battery available
        - individual UEs can be selected to address customer complaints
        - geographic coordinates of the target area
        - NW area identifiers, e.g. TAI, CGI, eNB ID.
    - Configuration of logging and reporting policies
        - types of measurements and/or events to be logged
        - logging/reporting triggering and ending conditions, date/time, amount of data collected etc.
        - logfile upload target (e.g. file server URL)
    - Fault and performance management related to MDT functionality

    The above services may be offered directly or DMS can implement the functionality of IRPAgent, which provides MDT management services over Itf-N to IRPManager located in the NM. In this case, MDT management can be performed at the NM level.

2. Management of the MDT function in the UE. In this role, the DMS:
    - selects the UEs to be included in the MDT campaign based on the criteria configured by operator/NM
    - establishes and manages connections with selected UEs via a user plane protocol. These connections are transparent to RAN and core network and they do not require constant RAN/CN connectivity;
    - translates MDT configuration requests received from the operator/NM to requests to the selected UEs. The requests include configuring: type of measurements to be logged, logging/reporting triggering conditions (e.g. entering/leaving target area, time, occurrence of an event, amount of data collected, battery/memory status etc.), logfile upload server's URL etc.;

Network Manager (NM)

NM implements the functionality of IRPManager that uses MDT management services offered by IRPAgent in the DMS, described above, over Itf-N. This allows the operator to integrate their MDT management into their network management platform at the NM level.

UE

UE implements the functionality of an agent that provides the DMS with the services described in the previous section. These services are provided via user plane, which means that they will be fully handled by the UE at the application layer. It has been discussed in [2] that no new measurements will need to be defined in support for the MDT functionality, i.e. UE will only log the existing measurements. Therefore, the agent functionality in the UE would have no impact on the RAN and CN protocol stacks.
UE may also implement FTP client functionality for log file upload to a file server.

File Server

File server implements is an optional functionality of providing secure logfile upload destination. File server may be embedded with DMS, NM or another operator-controlled server.

4.3.2.2 Impacted interfaces

Itf-N (Type-2)

In order to support integration of MDT management at the NM level, Itf-N interface would need to be extended to support services provided by IRPAgent in DMS, listed in the previous section. Whether this should be done by creating a new Interface/NRM IRP(s) or by extending the existing ones is FFS.

DMS – UE interface (user plane)

User plane interface between UE and DMS will need to support the functionalities in DMS and in UE relative to MDT management, as described in the clause 4.3.2.1. Protocol used on this interface will need to match the needs of these functionalities, including:

1. No need for continuous RAN/CN connectivity
2. Capability of configuring elaborate logging/reporting configurations and policies. In particular, capability to create “traps”, i.e. to configure logging/reporting triggering conditions based on location, NW area ID, time, occurrence of an event, amount of data collected, battery/memory status etc. is essential to avoid the need for continuous connectivity.
3. Security

4.3.2.3 Example of a flow of an MDT campaign using user plane transport solution

<u>Step 1: Configuration of MDT in DMS by NW operator (directly or via Itf-N)</u>

- NW operator configures the policy for selecting UEs to participate in the MDT campaign. As described above, this can be based on subscription profile, device type/capabilities, device status, customer complaints etc.
- NW operator configures the NW area in which the MDT campaign should be executed
- NW operator configures the type of measurements/events to be logged, logging/reporting triggers

<u>Step 2: Configuration of MDT in selected UEs by DMS via user plane protocol</u>

- DMS selects the UEs to participate in the campaign. This can be based on UE IMSI, IMEI, phone number etc.(customer complaints), phone number area code, user locations obtained from the location server, information received from OAM via Itf-N or other information available to DMS or supplied to it.
- DMS establishes connections with selected UEs
- DMS configures each UE with the MDT target area, type of measurements/events to be logged, logging/reporting triggers and file server URL for logfile upload
- DMS terminates the connection with the selected UEs

<u>Step 3: Measurement collection and reporting</u>

- UE logs measurements/events based on logging triggers without the need for constant connectivity with RAN/CN
- UE uploads logfiles to the file server based on reporting triggers

<u>Step 4: MDT campaign termination</u>

- DMS pre-configures MDT campaign termination criteria (e.g. time, amount of data etc.) UE locally terminates the MDT campaign instance based on the termination criteria, hence no need for interaction between DMS and UE or RAN/CN connectivity.

4.3.3 Study of MDT connection to Subscriber and Equipment Trace

4.3.3.1 Use case study

Minimisation of Drive Tests has the use cases ref [7] TR 36.805 clause 5:

1. Coverage optimization
2. Mobility optimization
3. Capacity optimization
4. Parameterization for common channels
5. QoS verification

Subscriber and Equipment Trace have the use cases ref [8] TS 32.421 Annex A:

1. Mulit-vendor UE validation
2. Subscriber complaint
3. Malfunctioning UE
4. Checking radio coverage
5. Testing of new feature
6. Fine-tuning and optimization of algorithms/procedures
7. Automated testing of Service Porvider services
8. Regression testing following network fix
9. Service fault localization with a Service Provider network.
10. Service fault localization when a service is hosted by a third party Service Provider.

It is clear that they overlap and that both addresses network issues, it would be very good to corrulate the data from the UE and the network.

Minimisation of Drive Tests, ref [7] TR 36.805 clause 4 have requirments on

1. UE measurement configuration
2. UE measurement collection and reporting
3. Geographical scope of measurement logging
4. Location information
5. Time information
6. Device type information
7. Dependancy of SON

It also has constraints for

1. UE measurments
2. Location information

An extension of Subscriber and Equipment Trace by including the UE as a node that can perform tracing would mean that the

- requirment 1 is fulfilled
- requirement 2 would be quite acceptable, due to battery consumption requirmements

- requirement 3 is covered by Cell Trace.
- requirement 4 would fit very well with the intentions in Subscriber and Equipment Trace, even if no such requirments exist so far.
- requirement 5 is fulfilled. The accuracy from Subscriber and Equipmement Trace is millisecond level, ref [9] TS 32.423.
- requirement 6 is not yet covered, other than that IMEISV is reported. To extend the Subacriber and Equipment Trace requirments with this requirement would be natural.
- requirement 7 is not covered at all by Subscriber and Equipment Trace.

To include MDT in Subscriber and Equipment Trace gives the advantages that

- The log files are sent to the same place (Trace Collection Entity) in the Network Management System.
- The logs contain the same identifications so it is very easy to correlate the data from the network and the UE.

4.3.3.2 Issues needing resolution

4.3.3.2.1 General

The inclusion of MDT can be done with either a control plane solution or a use plane soltution. The solutions are quite different why both are studied below.

4.3.3.2.2 User plane solution

The user plane solution is to establish a normal connection between the DM and UE (comparable to a connection between a UE and a web-server) and send data as user data over the Uu interface.

What needs to be solved are:

1. The architecture for the user plane solution needs to be included in the 3GPP management architecture. SA2, SA5, RAN2, RAN3 and OMA DM WG need to be involved.
2. The OMA DM needs to have a Itf-N to the Network Manager. SA5 and OMA DM WG need to be involved.
3. The DiagMon function needs to have a Trace IRP interface on the Itf-N. SA5 and OMA DM WG need to be involved.
4. The Trace IRP and Subscriber and Equipment Trace specifications need to include UE in the Subscriber and Equipment Trace Function, i.e. to specify the UE as a node that is possible to trace data in. SA5 and OMA DM WG need to be involved.
5. Thearchitecture for trace administration, i.e. that the signalling to the UE needs to carry the information for Subscriber and Equipment Trace for configuring the Trace function and the reporting of the result. RAN3, RAN2, SA2, SA5, OMA DM WG and possibly SA3 need to be involved.
6. The inclusion of the not covered requirements from 36.805 into Subscriber and Equipment Trace. SA5, RAN2 and RAN3 need to be involved.

4.3.3.2.3 Control plane solution

The control plane solution is that the communicatin between the management system and the UE is done via existing management interfaces, the traffic control signalling interfaces, which implies RRC signalling over the Uu interface.

What needs to be solved are:

1. The Trace IRP and Subscriber and Equipment Trace specifications need to include UE in the Subscriber and Equipment Trace Function, i.e. to specify the UE as a node that is possible to trace data in.. SA5, RAN2 and RAN3 need to be involved.
2. The architecute for trace andministration, i.e. that the signalling to the UE needs to carry the information for Subscriber and Equipment Trace Trace for configuring the Trace function and the reporting of the result. RAN3, RAN2 and SA5, need to be involved.

3. The inclusion of the not covered requirements from 36.805 into Subscriber and Equipment Trace. SA5, RAN2 and RAN3 need to be involved.

4.3.3.3 MDT utilizing 3GPP Cell Trace capabilities

Cell Traffic Trace is an already specified functionality in 3GPP. Cell Traffic Trace can be used to monitor one or more specific cell. AS part of the Cell Traffic Trace function all UEs in a certain area (the area is defined by the Cell ID) are traced. The collected trace data can include (depending on the trace configuration) all singalling messages exchanged between the UE and the network, containing also the RRC MEASUREMENT REPORT, which contains already a lot of information from the UE.

RAN#46 has decided on the architecture that shall be used for MDT (Control Plane approach), therefore new UE measurements will be transferred to the network via RRC signalling. In this case utilising Cell Traffic Trace to collect the additional UE measurement is straightforward and allowing reuse of an existing functionality, as the RRC signalling can be captured already by the Cell Traffic Trace function.

The additional standardization work that is required to utilize Cell Traffic Trace for MDT is the configuration of the UEs for MDT as well as to take into account the Mobility of UEs (e.g. given that the important information to capture is the Radio Link failures, and this information might not be reported to the network in the same cell where the RLF happened - therefore mobility needs to be taken into account).

This can be achieved as proposed earlier in S5-094093, to forward the trace activation signal to the UE. Within this trace activation signal, it will be possible also to configure the UE for the MDT data collection. Therefore this Trace Activation signal to the UE should be a special trace activation message, that contains the information that is necessary for the MDT data collection, plus the IP address of the TCE. With this solution the UEs are configured for MDT data collection and the UE can report the RLF events whenever it detects and can report it to the network. The report should contain also the IP address of the TCE so the receiving entity in the network can know where to send the MDT trace log.

A further requirement in MDT is to select appropriate devices that can participate in the MDT campaign. The current specificationfor the Cell Trace function is such that using Cell Trace all devices activities are loggedtraced in the cell. Therefore it is proposed to modify the Cell Trace function to allow the tracing in a cell of only the MDT capable or suitable devices.

The Trace Activation operation (that is used to activate the cell trace function) needs to be extended to send the UE capability requirements. This requirement should state e.g. what kind of devices, and what kind of states of the devices can be participating in the MDT data collection (such requirement can be e.g. higher battery capacity then 70%, min 100Kbyte free memory, GPS availability, e.t.c.). Once the UE capability requirements (that is given by the operators) are sent to the eNB/RNC, the eNB/RNC can decide and can select the required devices in the given cell.

Figure 4-3 summarizes the MDT functionality utilizing Trace capabilities:

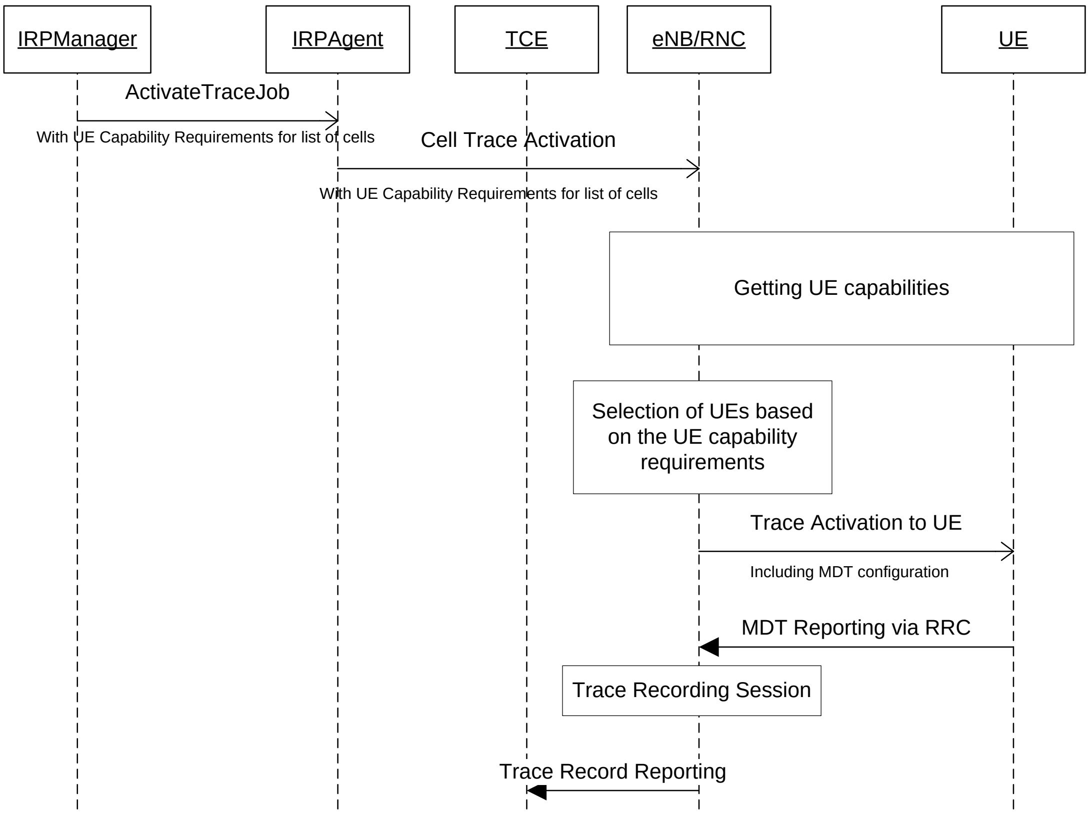

Figure 4-3: MDT functionality utilizing Trace capabilities

5 Architecture of UE management

5.1 Interface for UE measurement collection

5.1.1 Interface A: UE-OAM direct interface (user-plane)

In this architecture the eNB is not involved. A drive test server in the OAM domain can initiate a connection to a UE to request measurements. The UE then performs measurements and establishes a connection to report the results to the server. All communication between server and UE is based on user-plane bearers.

This solution is similar to existing non-standardized product solutions for test UEs reporting through user-plane.

Some additional mechanism is required to satisfy some of the examples in section 4.1.1, such as selection by geographic area. One possibility is to introduce an interface between the EPS (such as the MME) and the DMS such that the DMS is informed of changes in the serving cell for active UEs and TA changes for idle UEs. Using this information, candidate devices connected in certain sectors, or idle in certain TAs, can be selected by the DMS and commanded to start collection and logging of measurements.

Another alternative is to use broadcast device management messages. For example [6] describes how this could work within the framework of OMA using the DMBCAST concept. The level of maturity of this solution and its application to drive test minimization is FFS.

5.1.2 Interface B: eNB involved (control-plane)

In this architecture the eNB is involved. The eNB can request UEs to make measurements. The UE then performs measurements and reports the results to eNB. The communication between UE and eNB is assumed to be control plane communication.

The eNB can then be managed by a drive test server in the OAM domain that requests the desired measurements from eNB and that receives measurement results from eNB.

Editor's Note: A hybrid architecture which could combine the interface A and interface B could be studied as well.

5.2 Comparison of UE management architectures

5.2.1 Criteria for comparison

The following criteria are applied for comparison of UE management architectures:

- UE measurements data collection in a specific geographical area
- CapEx saving
- OPEX saving
- Over-the-air overhead
- Backhaul overhead
- Reusability of UE measurements
  Note: the UE measurements are being defined by RAN2

- Selection of devices participating in MDT
- Retrieval of device capabilities and user preferences
- Non-real-time data collection and reporting
- Ability to configure type of data to be collected per user
- Selection of data collection and reporting times
- Time to market
- Applicability to multiple RATs and backward compatibility with UMTS/GSM

5.2.2 Benefits of Correlating UE Data with Network Data

It is important to recognize that measuring actual user performance has significant potential for surpassing conventional DT in a more fundamental way. Specifically, it also holds the potential to diagnose a wide class of issues and thereby provide important insight for prompt action via manual and/or automatic means.

- Understanding network state provides additional information and accuracy. When *time-correlated* with UE data, it can enable *network diagnosis from the captured data set* with no additional manual DT.

    - Relevant network state data Examples :
        - eNB data: e.g., Tx pwr, antenna gain/azimuth/tilt (can be time-dependent).
        - eNB load: e.g., DL load and UL noise rise (again t-dep).
        - Network state: e.g., HO state, backhaul and MME loading.
        - Call/session specifics: e.g., SON state for call (ICIC, load balancing, etc)
        - Priority state of calls on eNB: (e.g., public safety pre-emption, etc.)
        - Call failure data (e.g., from PCMD, network OAM)
        - E2E measurements (e.g., latency)
        - etc.

  - Capturing extensive network data poses added processing load for relevant network elements – must be efficiently managed during periods of high load. Close coordination between network & UE data acquisition essential for minimizing impact.

  - Dropped calls are often dependent upon loading and/or interference levels at time of drop

  - Some dropped calls are not preventable (user went deep into a building with very high penetration loss)

  - Pathloss requires knowledge of TxPower and other network parameters.

  - Interference levels are load dependent. The service provider will want to measure performance data during the "busy hour"

  - Gathering UE data implies additional air interface traffic. This load can be altered by using different UE sampling percentages, using delayed UE reporting schemes, etc. Lowering the sampling rate (thereby increasing time for obtaining statistically significant data) and delayed reporting both reduce the time responsiveness of the data gathering scheme. Knowing the network state allows one to tune these UE measurement parameters so as to optimize the tradeoff between network impact and response time.

  - In fact, network and UE measurements support not just the optimization efforts but also in the verification process that the optimization yielded desired benefits.

  - UE measurements around dropped calls provide powerful mechanisms to optimize various coverage parameters such as antenna tilt and pilot (reference signal in LTE) power. Analysis of RACH messages and delay will help optimize the RACH process. This means, that UE measurements form a critical part of RAN optimization

  - In many of the SON use cases, the footprint of a cell is intrinsically a part of the optimization problem. Footprint of a cell is the region where a UE can "hear" the cell with significant quality. The UE "hears" the cell-specific reference signal, RS for short. It measures its RSRP and RSRQ. While RSRP is unaffected by the location of the neighbors, RSRQ is lower when there are more interfering neighbors. Coverage optimization, capacity optimization, HO optimization, cell selection/reselection, outage compensation and even load-balancing are all impacted by the power setting on the RS as well as the antenna tilt value. RSRP and RSRQ are two fundamental and critical measurements for coverage and capacity optimization problems. These values are measured on the DL and are usually reported only when HO thresholds are met. There is, all the same, the possibility for periodic reporting.

6 Mapping of existing UE management protocols to Itf-N

6.1 Study of existing protocols for UE management by DMS

In this section, we discuss the existing management prototols suitable to address device managemet aspects of MDT/SON i.e. configuration of device-specific data collection and reporting policies, device capabilities and user preferences.

6.1.1 Comparison of existing management protocols

Different exisiting management protocols were compared with respect to their use for configuration of data collection and reporting policies. OMA DM was suggested as the preferred option. The main advantages of OMA DM are:

- existing capabilities for configuration of policies for logging and log reporting and for configuring user preferences
- flexible data model easy to extend
- wide-spread deployment in the UEs
- auto-discovery of DMS and registration
- no need for IP addressability of the UE
- existing relationship between OMA and 3GPP.

It is recommended to consider OMA DM as the leading candidate for device management protocol for southbound DMS interface.

6.2 Study of the mapping of UE management protocols to Itf-N

6.2.1 Mapping between OMA DM and Itf-N

6.2.1.1 Overview

Figure 6-1 below depicts thehigh-level view of the mapping function between Itf-N and OMA DM.

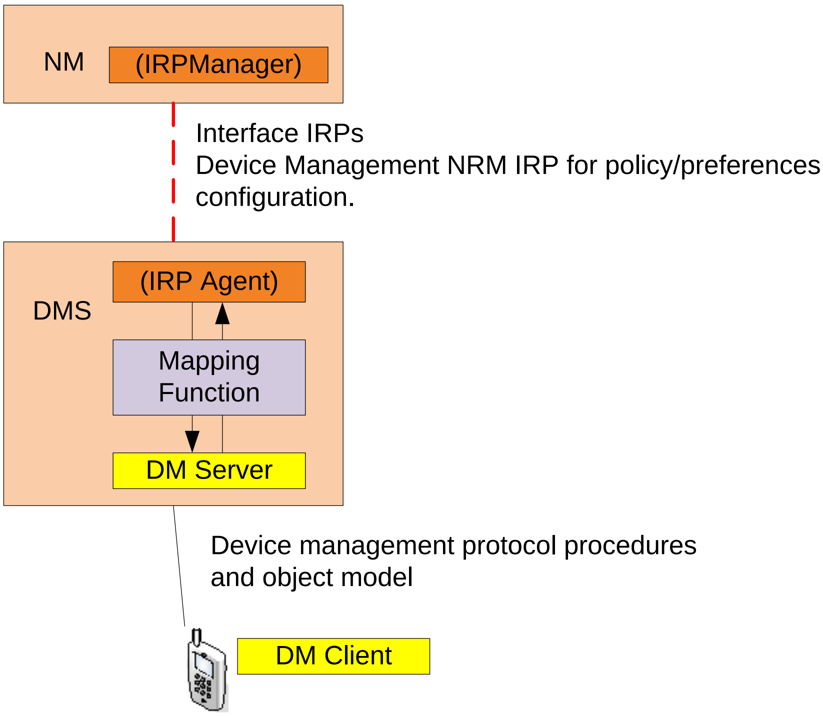

Figure 6-1: Mapping Function between Itf-N and OMA DM

The role of the Mapping Function is twofold:

- Map Interface IRP operations and arguments onto OMA DM operations and arguments (e.g. Add, Replace, Get, Alert) and vice-versa
- Map NRM IRP IOCs for device management onto OMA DM Management Objects (e.g. DiagMon MO)

6.2.2.2 Mapping of Interface IRPs onto OMA DM operations

This mapping aspect would be the most complicated to perform. In order to simplify the task, only a limited number of Interface IRPs and Interface IRP operations would be used and would need to be mapped. Existing IRPs may be re-used in the existing or in a reduced form and/or new IRPs may be defined. The set of used IRPs should satisfy all the needs for policy configuration, which is the essential part of UE management requirements for MDT/SON. On the OMA DM side, the list of basic configuration operations could be limited to Add, Replace, Get and Alert.

6.2.2.3 Mapping of NRM IRP IOCs onto DiagMon MO

In OMA DM, the data strauture for configuring logging mechanisms and policies is contained in the DiagMon Management Object, shown in Figure 6-2.

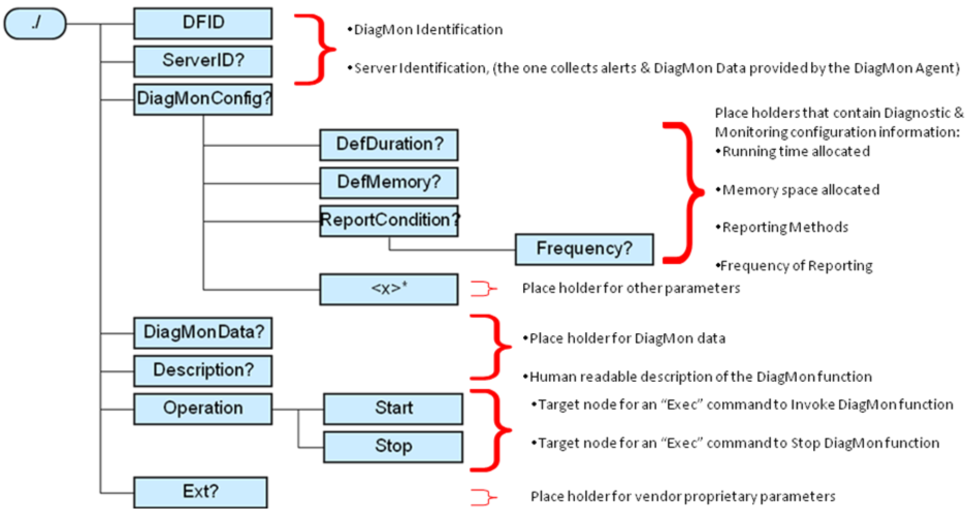

Figure 6-2: OMA DM DiagMon management object structure

It would be the simplerst solution to specify a set of NRM IRP IOCs over Itf-N to mimic the same data structure. The mapping would then be straighfroward and simple.

The DiagMon MO might need to be extended to accommodate specific requirements for data collection and reporting policy configuration. OMA allows other SDOs to define extensions to their MOs. The corresponding NRM IRP IOCs could be developed in parallel to the extension of the OMA DM DiagMon MO. SA5 would maintain the specifications of both data models.

6.2.2.4 Summary

Based on the above, it is recommended to study and recommend the mapping between Interface IRPs on the Itf-N and OMA DM operations. A set of existing IRPs to be used and/or a set of new IRPs to be defined should be studied. It is also recommended to study the requirements for a new NRM IRP IOCs to model the data collection and reporting policy parameters and to study the required extension of the OMA DM DiagMon MO to achieve the same goal. The new NRM IRP IOCs should be proposed in such way to maximize the overlap with the OMA DM DiagMon MO.

7 Conclusions

In order to speed up progress for MDT, a conclusion will not be made in this TR.

Annex A: Change history

Change history								
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Cat**	**Old**	**New**
Mar 2010	SP-47	SP-100070	--	--	Presentation to SA for information and approval	--	--	1.0.0
Mar 2010	SP-47	SP-100228	--	--	Corrections following comments at SA#47	--	1.0.0	1.1.0
Mar 2010	--	--	--	--	Publication of SA approved version	--	1.1.0	10.0.0
Jun 2010	SP-48	SP-100264	001	--	Removal of unused references and addition of missing usecase	D	10.0.0	10.1.0