Connected Living

Embedded Mobile Guidelines

Network Aspects
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Table of Contents

1 Introduction 3
- **1.1** The Embedded Mobile (EM) Initiative 3
- **1.2** Reading Guide 3
- **1.3** Definition of Terms 3

2 Guidelines for Network Aspects 5
- **2.1** 3GPP Release 10 deployment guidelines 5
- **2.2** 3GPP Rel-10 Implementation Guidelines for Devices 5
- **2.3** 3GPP Rel-10 Implementation Guidelines for setting subscription & device parameters by the home MNO 6
- **2.4** 3GPP Rel-10 Implementation guidelines for networks serving the device 11
- **2.5** Implementation guidelines for device application designers 13
- **2.6** Network Management and Optimisation 14
- **2.7** Signalling Traffic from Non-Activated or Out-of-Subscription SIMs 14
- **2.8** Numbering Resources 15
- **2.9** Network Selection Guideline 16
- **2.10** Future Requirements 16

3 Document Management 18
- Document History 18
- Other Information 18

4 References 19

5 List of Acronyms 20

1 Introduction

Embedded Mobile (EM) refers to a family of devices and services that use wide-area mobile network technologies to enable communications between machines themselves and also with humans. The genesis of this initiative stems from a GSMA objective to explore new market opportunities for the mobile industry beyond traditional handset and PC data card hardware.

The goal of this document, which is an extract from the full Embedded Mobile Guidelines Release 3, is to share information and recommendations related to network aspects of managing EM devices in mobile networks. The document is intended to be used by mobile network operators (MNOs).

1.1 The Embedded Mobile (EM) Initiative

The GSMA EM initiative is a market development programme designed to accelerate the usage of wireless connectivity by a wide range of devices across the education, healthcare, automotive and utilities sectors. In most cases, a wireless modem will be embedded into the device. The short-term goal is to trigger market expansion to achieve 500 million connected EM devices by 2013.

The GSMA is supported by some of the world's leading mobile operators, and is focused on identifying and lowering the main barriers for each of the key sectors and bringing embedded devices to market via appropriate, simple and streamlined processes. Some of the objectives are common across the sectors; for example, helping to bring costs down through economies of scale by introducing common design guidelines for new embedded modules, such as those contained within this document, and stimulating and participating in regulatory discussions.

1.2 Reading Guide

Throughout this document, the following convention is used for points of discussion:

High Level Requirement	A short statement of the needs from the point of view of one or more of the stakeholders/ecosystem players based on identified usage scenarios (use cases).
Considerations	The rationale or justification for the requirement and a description of the relevant solutions and options concerning the identified needs, which are available and achievable in the market today.
Guideline	A guideline or recommendation for use in addressing the stated requirement. This guideline uses best practices as a guidance and notes targets for the future development

1.3 Definition of Terms

Term	Description
2.xG	GSM, GPRS, EDGE network technologies.
3G	WCDMA, HSPA and HSPA evolution radio technologies referred to as UTRAN in 3GPP standardization.
LTE	OFDMA based radio access in 3GPP Release 8 referred to as Evolved UTRAN. Further evolution called also LTE-Advanced starting 3GPP Release 10.

Mobile Network Operator (MNO)	A mobile network providing the data communication service to an end-user.
Embedded Mobile (EM)	A family of devices and services that use wide-area mobile network technologies to enable communications between machines themselves and also with humans
Embedded Module	The hardware component including its embedded software, which will be integrated into a host device to provide wide area (2G/3G/LTE) radio capabilities.
Embedded Device or Host Device	A device that contains an embedded module.
Embedded Device Manufacturers	The provider of end-user devices that deliver services using embedded modules.
End-User	A person using the embedded device functionality. This can be both 'private' users (consumer market) and business users. The corporate (purchasing) perspective is also considered from this point of view.

Table 1: Key terms and definitions

2 Guidelines for Network Aspects

2.1 3GPP Release 10 deployment guidelines

3GPP Release 10 provides a number of features for overload control, in order to protect the network from excessive signaling from large numbers of devices. The features work whether the device is an embedded mobile device, or not.

The signaling from large numbers of devices is a concern in at least two situations:

- When an application (running in many devices) requests many devices to do "something" at the same time; and/or
- When many devices are roamers and their serving network fails, then they can all move onto the local competing networks, and potentially overload the network(s) which have not (yet) failed.

The main Release 10 features for overload protection cover:

- In GSM, “implicit reject” functionality for devices configured for “low access priority”
- In GSM, UMTS and LTE signaling from the device to the radio access network and to the core network to indicate that the device is configured for “low access priority”. In the LTE and UMTS radio access network specifications, the indicator is named “delay tolerant”.
- Congestion control using Backoff timers and Extended Wait Timer
- Congestion control using Extended Access Barring
- Per device, periodic updating timers.
- Some additional signaling optimizations as described in 3GPP TS 23.060 [2], Release 10 chapter 5.3.13.2.

2.1.1 Guideline

GSMA recommends the implementation of the 3GPP Release 10 overload protection features outlined in this chapter. Specific guidelines for devices, home network, and serving network are described below.

2.2 3GPP Rel-10 Implementation Guidelines for Devices

2.2.1 Support of extended periodic timers

2.2.1.1 Description

3GPP Release 10 introduced per-device timers for Periodic Location Area Update (PLU) and Periodic Routing Area / Tracking Area Update (PRU, PTU). Release 10 also increased the maximum value of these timers.

2.2.1.2 Considerations:

Periodic Updating is a useful feature for devices that move in and out of coverage and might miss a mobile terminating event while out of coverage.

An operator can for instance configure subscriptions for a M2M service provider with stationary smart meters with a longer update timer compared to subscriptions for a M2M service provider within the automotive industry.

A Visited Public Mobile Network (VPMN) can either use the timer configured by the HPMN for a particular device in the roaming scenario, or if this isn't available, use its locally defined timer.

2.2.1.3 Guidelines

It will be necessary for the device to support the extended periodic timers, both for PLU (for circuit switched (CS) domain), PRU/PTU (for packet-switched (PS) domain).

Support for both PLU and PRU is needed, as the device needs to operate in networks which do not support combined CS-PS attach (via the Gs interface from SGSN-MSC).

2.2.2 Interface with USIM

2.2.2.1 Considerations

The overload protection configuration parameters can be stored on a USIM.

2.2.2.2 Guidelines

The device must be able to read a USIM, even if it is a 2G only device.

2.3 3GPP Rel-10 Implementation Guidelines for setting subscription & device parameters by the home MNO

Correct operation of the 3GPP Release 10 congestion control mechanisms in the visited network relies on optimal configuration of the device and/or subscription parameters by the home network.

Without widespread adoption of the settings across the operator community, the protection mechanisms will not work effectively. Specifically, incoming visitors will not have suitable settings and local competitors of the hosting network will be unable to protect themselves.

2.3.1 Device Parameters set by the home network

This section describes the six configuration parameters defined for the device. It provides a description of each parameter, describes the possible values of the parameter, considerations to be taken when setting the parameter value, and associated implementation guidelines.

In some cases, the expected behaviour of the application, or the revenue value of the traffic, need to be considered when setting the parameter value. Section 2.3.3 gives examples of how the parameters could be set for some M2M verticals.

There are several means to configure these parameters:

- **OMA DM**: to re-configure the terminal's NAS configuration Management Object (MO), see 3GPP TS 24.368 [3]
- **SIM OTA**: to configure the USIM's file EFNASCONFIG (Non Access Stratum Configuration), see 3GPP TS 31.102 [1].
- The terminal can also be configured using device-specific method (e.g. at production time)

Note that if both USIM and OMA DM values are present, 3GPP have specified that the USIM values take precedence (see TS 22.368 [4] section 7.1.1, and TS 31.102 [1] section 4.2.94).

2.3.1.1 Allocation of Low Access Priority (LAP) to subscribers

Description

3GPP Release 10 introduces the concept Low Access Priority indicator. The operator can set the LAP indicator in “low priority” devices, where the application(s) can tolerate longer access delays. The LAP indicator can be used by the network to reject such a device from access, and assign a back-off timer preventing the device from immediately repeating the access attempt. The mechanism is primarily intended to combat high network load in radio access network and core network nodes.

Possible Values

The parameter can either have the value 1 (low priority) or not be present at all.

Considerations

A well suited allocation of LAP to subscriptions is critical to make overload protection work. For example 3GPP Release 10 congestion control via back-off timers in the visited radio access network is only applied to LAP subscribers.

In Release 10, the Low Access Priority indicator is a device property, meaning that communication from all applications on the device (except emergency-related and the special SIM access classes 11-15) is considered as low priority.

Guideline

In general, the home operator should provision the LAP indicator for embedded mobile subscriptions which are susceptible to cause network overload. The LAP indicator should be provisioned even for subscriptions that are permanently or mostly roaming, in order to protect the visited network.

As described by TS 23.060 [2], the setting for LAP shall be identical to the setting for Extended Access Barring for applicable embedded mobile devices.

2.3.1.2 Extended access barring

Description

Under certain circumstances, it is desirable to prevent mobile devices from making access attempts or responding to pages in specified areas of a mobile network (so called Access Barring). It is possible for the mobile to decode if it is barred or not with the help of broadcasted information. Extended Access Barring (EAB) is an additional access barring feature introduced in GERAN for Release 10 which makes it possible for the operator to either only bar roaming devices, or to only bar roaming devices not on the most preferred network in that country.

Possible Values

1= EAB is applied for the device

0= EAB does not apply for the device

Guideline

The home operator shall only apply EAB for those devices which have LAP applied, and shall not apply EAB for those devices which do not have LAP applied.

2.3.1.3 Minimum periodic search timer

Description

Before Release 10, roaming mobiles do a background search for “more preferred” mobile networks in that country using the timer EF_{HPPLMN} (Higher Priority PLMN search period) typically set to 6 or 12 minutes.

Consequentially if the most preferred network fails, masses of devices would move to a non-preferred network in that country, do location area and routeing area updates on that network, and every 6 or 12 minutes attempt (and fail) to return to the preferred network.

The “minimum periodic search timer” is intended to reduce the frequency of this behaviour.

The device uses the larger of the “minimum periodic search timer” and the value in EF_{HPPLMN}, to control is background search for more preferred networks.

Possible Values:

The parameter can be in the range 0-255 minutes.

Considerations

If the timer is set too short, the preferred network may not have recovered. If it is set too long, a lot of traffic may have been carried by networks other than the preferred network.

Guideline

For low revenue devices, recommendation is to use a high value, 255 minutes. For high revenue devices, recommend to use a lower value, 20 minutes.

2.3.1.4 Control of ‘Network Mode of Operation I’ behaviour

Description

NMO-I (Network Mode of Operation I) enables a device to perform combined attach towards the packet switched domain. Otherwise, the device will perform individual attaches to the circuit switched and packet switched domains.

The use of combined attach reduces the signalling load on the serving network. However, this might not be beneficial for the operator to apply for all categories of devices.

Extended NMO-I is introduced in Release 10 to allow the operator to control if a device should perform combined attach, or not. The serving network must broadcast that it supports “extended NMO-I” for this feature to work.

Possible Values

1=NMO-I indication is used, if available;

0=NMO-I is not used

Considerations

A VPMN can choose whether or not to use “long PLU and long PRU” timers, or whether or not to use “long PRU timer and extended NMO-I”. It is therefore important that the HPMN configures the device to be able to use extended NMO-I, unless there is some compelling service requirement to not do so.

Guideline

It is recommended that all data centric devices are configured 'NMO-I indication is used, if available'.

2.3.1.5 Attach with IMSI indicator

Description

If set, then when registering with a new mobile network, the device will present its IMSI rather than a temporary identify. This reduces the signalling load on the new network, as it doesn't have to try and resolve the temporary id and subsequently request the IMSI from the device. This will help a recipient network if it has to manage an incoming 'avalanche' of device registrations coming from a failed network.

Possible values:

1=attach with IMSI performed when moving to non-equivalent PLMN;

0=normal behaviour

Considerations:

The disadvantage of setting this parameter is that if the device moves between networks and attaches using the IMSI, then any active PDP context will be torn down. This would also be the case if the device presented an unresolvable TMSI to the new network.

Note that if the device is moving between equivalent mobile networks (based on the Release 99 equivalent feature) then Attach with IMSI is not invoked.

Guideline

This parameter should be set to 1 for all embedded mobile devices, unless the home MNO has national roaming agreements which allow the use of the previous network's TMSI without using equivalent functionality.

It should always be set to 1 for stationary devices, even if national roaming is in place.

2.3.1.6 Timer T3245 behaviour

Description

This parameter controls whether timer T3245 is used by the device. If T3245 is used, then on expiry it causes the device to erase the forbidden network list and to remove any "invalid SIM" setting. The value of T3245 is defined in 3GPP TS 24.008 [5], and is randomly chosen by the device from the range 24 to 48 hours.

Possible Values

1=T3245 used

0=T3245 not used

Considerations

If T3245 is not used, then the device needs to be power-cycled to remove the "invalid SIM" setting and successful 'manual network reselection' is needed to remove entries from the forbidden PLMN list itself. This requires manual intervention (e.g. a site visit to every electricity meter), or, discourages application developers to automatically power cycle the device when a reject message is received (which causes other kinds of problems)

The T3245 timer should be used by embedded mobile devices which are not easy to service. For example, if a smart meter receives a fatal error such as "IMSI unknown" it will

add the network to the forbidden list and never connect to it. It is expensive to send a service technician to the smart meter to power cycle it. Therefore, the T3245 expiry acts as an automated mechanism to flush the forbidden network list, thereby enabling the smart meter to function again.

Guideline

This timer is recommended to be used for devices which are intended to run without human intervention.

2.3.2 Subscription parameters to be transferred to the visited MNO

It is necessary that, where possible, the HPMN sets the PRU/PTU and PLU values for M2M devices to large values. This protects other mobile networks in the country of the VPMN in case the VPMN fails. Use of large values is useful because this slows down the rate at which devices detect the failure of the VPMN, giving more time for the VPMN to be returned to service.

2.3.2.1 PLU timer value per subscriber

Description

This is a subscription parameter set in the Home Subscriber Server (HSS) and stored in the VPMN, to set the Periodic Location Updating value for the CS domain.

Possible Values

0 – 4294967295 seconds.

Considerations

A relatively short PLU timer value is needed for applications which have a need for immediacy with mobile terminating communications, i.e. there is a need to contact the device as soon as possible once it comes back into coverage. The downside of using a large PLU timer is that if the nature of the device is that it can be expected to regularly move in and out of network coverage (for example a track & trace device), then the application may take longer to become aware of an attempted mobile terminating communication.

Guideline

Recommend typical value of PLU for embedded mobile devices to be 24 hours, unless the nature of the application calls for immediacy of mobile terminating CS domain (voice and/or SMS) communications.

2.3.2.2 PRU/PTU timer value per subscriber

Description

This is a subscription parameter set in HSS and stored in the VPMN, to set the Periodic Routing Update value for the PS domain. It works on the same basis as the PLU timer described above.

Possible values

0 – 4294967295 seconds

Considerations

None

Guideline

Recommend typical value of PRU for embedded mobile devices to be 24 hours, unless the nature of the application calls for immediacy of PS domain mobile terminating communications.

2.3.3 Example settings for M2M verticals

2.3.3.1 Low mobility, low revenue (e.g. a Smart meter)

Parameter	Value	Meaning
LAP	1	Set
EAB	1	Set
Min periodic search timer	255 minutes	-
NMO-I	1	Set
Attach with IMSI	1	Yes
T3245	1	Used

Table 2: Low mobility, low revenue

2.3.3.2 High mobility, high revenue (e.g. Automotive with infoservices)

Parameter	Value	Meaning
LAP	not present	-
EAB	0	Not set
Min periodic search timer	20 minutes	-
NMO-I	1	Set
Attach with IMSI	1	Yes
T3245	1	Used

Table 3: High mobility, high revenue

2.4 3GPP Rel-10 Implementation guidelines for networks serving the device

Without prior preparation, with large numbers of roaming devices, failure of one mobile network might have a domino effect on the other local competing networks, potentially leading to failure of all the networks.

2.4.1 Long PRU/PTU timer – default value in SGSN

The PRU (periodic routing update) / PTU (periodic tracking update) timer is used in the Packet Switched domain.

2.4.1.1 Guideline

If the mobile supports a long PRU/PTU, and the SGSN does not receive a timer value from the HLR/HSS, then the SGSN should allocate default value to a device configured for LAP.

Recommended value: 12 hours.

2.4.2 Extended NMO-I or Long PLU

2.4.2.1 Guidelines

The visited network should support either a long PLU timer, or the extended NMO-I feature to manage M2M devices with a circuit switched service (e.g. SMS).

It is recommended that the VPMN supports the extended NMO-I feature, meaning that combined packet-switched and circuit-switched attach is supported, using the Gs interface.

If extended NMO-I is deployed, then its use must be broadcast continually (i.e. don't wait for overload situation), and it must be broadcast on all cells within a location area.

Changing the NMO will cause all mobile devices in that area to immediately perform updates to the network.

If the VPMN chooses not to implement extended NMO-I (for example, if Gs isn't supported) then the VPMN should implement a long default PLU timer for Low Access Priority devices.

2.4.3 Reject causes with back-off timer: for core network

2.4.3.1 Description

When performing mobility management procedures (e.g. location update or routing area update), or session management procedures (e.g. PDP context activation) the serving core network can send a back-off timer to the requesting device - "don't retry for time x". Two different types of control of the back-off timer are available:

- General mobility management control. The network may reject messages including the "low access priority indicator" before rejecting messages without the "low access priority indicator".
- APN based congestion control. The network may reject requests from UEs to a certain APN. This can help the operator to control applications using a specific APN.

2.4.3.2 Guideline

Serving networks should consider using:

- The general mobility management control for the devices with LAP indicator.
- APN based congestion control for the APNs as a means to identify embedded mobile devices, if a dedicated APN is used for such devices.

2.4.4 Reject causes with back-off timer: for Radio Resource

2.4.4.1 Description

3GPP Release 10 provides the ability for the radio access network to reject a request with a longer back-off timer than was defined previously, also called Extended Wait Timer.

2.4.4.2 Possible values

- UTRA/EUTRA: time = 1..1800s (was previously 16 seconds)
- GERAN: time = 0..255 s

The radio access network will only use the extended wait timer if the device had signalled LAP in its access request, see 3GPP TS 23.060 section 5.3.13.3.

2.4.4.3 Guideline

The visited network must decide the back-off timer values to apply. Networks are recommended to spread the values given to the back-off timer over a range, to avoid the same access problem occurring at a predictable time in the future.

2.4.5 Implicit Reject in GSM Radio Network

This Release 10 feature is a powerful tool which the GSM base transceiver station (BTS) in the serving network can use to dynamically and quickly control the (over)load from Low Access Priority devices on its RACH, AGCH and SDCCH channels.

Before requesting a signalling channel, a device that has LAP assigned will check the 'Paging' and 'Access Grant' broadcast channels for 20ms. If the BTS has set the 'implicit reject' flag (one flag for circuit switched and one flag for packet switched) then the mobile will not request a signalling channel, but will back off for a locally generated random period.

2.4.5.1 Guideline

The visited network should procure the 'Implicit Reject' functionality.

2.5 Implementation guidelines for device application designers

2.5.1 Data aggregation within terminals

All communication over cellular systems triggers events which generates signalling between network entities. Sending a small or large chunk of data generates the same amount of signalling. Thus to keep the signalling load on the network low, it is better to send larger chunks of data less frequently compared to small chunks frequent.

2.5.1.1 Guideline

Reduce the number of connections between the terminal and network by collecting data in lager chunks before sending. If several applications reside on the same terminal, coordinate the application's network communication.

Within each connection, send data in as concentrated a manner as possible since even small time separations of a few seconds may (depending on network settings) generate unnecessary network signalling load.

2.5.2 Avoid synchronized network access between terminals

To avoid signalling and user data traffic peaks in the network, communication with different terminals should not be synchronized in time. Preferably, non time critical communication should be deferred to off network load peak time.

Examples of synchronized communications are provided below

- Automotive - periodic reporting of diagnostic information on a daily / weekly basis. If the same client is present in a large number of vehicles from a manufacturer, the client should ensure that reporting at a specific time but is randomised within a time window.
- Energy - *r*eporting of a change in energy generation. If the same client is present in a large number of homes within a city region, and the client detects a change of energy generation due to a change in local weather, then the client should be aware that this event is shared by possibly many other clients in the region – so avoid the risk of synchronised reporting to the server by introducing a randomising element.
- Energy - reporting of a power failure by a smart meter. This is likely to be highly synchronised and (for the PLMN operator) unexpected. (The GSM base station's

Implicit Reject function is useful in this case – provided that the smart meters have been configured to use Low Access Priority).

2.5.2.1 Guideline

To avoid synchronization effects, communication with different terminals should be spread out in time over off-peak traffic hours. This applies both for terminal and server initiated communication. A means to do this is to randomize communication in time.

2.6 Network Management and Optimisation

2.6.1 High Level Requirement

As embedded devices connect to the network, they will occupy network resources - both RF elements (channel, power, codes, etc.) and Core Network elements (backhaul, IP addressing, etc.).

These new connected devices and associated applications have a need for network connectivity that may be intermittent and sometimes scheduled. Any service request denials from the network, due to lack of availability of the above stated network resources, could have severe consequences on the operation of these embedded devices within vertical market segments such as automotive and healthcare.

2.6.2 Guidelines

Since the needs of the embedded devices for network resources are more ad hoc than mobile devices, mobile network operators (MNOs) should develop some network monitoring tools and diagnostics capability to plan their networks efficiently. Also, MNOs should pro-actively manage their resource utilization to avoid denying any service requests from the ad hoc embedded devices:

- Develop network monitoring capabilities for embedded modules
- Develop guidelines for activation, provisioning and registering of modules for efficient network planning
- Develop network management tools for optimal network capacity management

2.7 Signalling Traffic from Non-Activated or Out-of-Subscription SIMs

2.7.1 High Level Requirement

As the number of EM devices and traffic from these devices increase, it must be possible to stop unexpected signalling effectively monitor network quality and detect authentication problems.

2.7.2 Considerations

There are several use cases that might lead to the potentially disruptive high volumes of signalling traffic. These include non-activated SIMs, expired SIMs or SIMs temporarily out of subscription:

- Non-activated SIMs: Increasingly, embedded device manufacturers (for example, car manufacturers) fit a SIM by default to every device (for example, in-vehicle systems (IVS)). This SIM card is not activated in any networks' HLR until the owner of the device subscribes to an EM-related service (which they can do at any time, or never).

- Expired SIMs or SIMs temporarily out of subscription: new EM devices are sometimes sold to end-users bundled with free EM-enabled service for a year (for example, navigation service in a car), which is not renewed upon its expiration. Similarly, EM-enabled services might be stopped temporarily with a view to be renewed at a later date; as a result, the EM SIM will be temporarily out of subscription.

This behaviour has been observed with the cars of at least one specific car manufacturer, where embedded SIM cards are periodically attempting to authenticate to a network; if the SIM is not activated or out of subscription, the authentication fails. Although the number of SIM authentication attempts is not significantly high today compared with all other attempts, the number of authentication failures is significant. For example, in the specific case observed between two roaming partners, the normal 1% authentication failure rate has increased to anything up to 60%. This means that it is very difficult to detect real authentication problems, thus impacting roaming quality monitoring.

2.7.3 Guideline

It is not recommended that the EM device signalling capability is stopped altogether, for example, when the connectivity is turned off completely via an instruction from the network, as this would introduce a significant new denial-of-service security risk,

It is recommended that some limitations are imposed on the frequency of signalling either via embedded devices or network-based modifications.

One to reduce the volume of signalling traffic would be to use the T3245 timer (see section 2.3.1.6). For example, the network could configure the device to use the T3245 timer, then send it a forbidden PLMN error message (e.g. IMSI unknown in HLR), which will cause the device to not retry for 24 to 48 hours, after which it will automatically clear it's forbidden PLMN list and retry.

It might also be possible to modify the provisioning process for the EM SIM activation. More specific guidelines may be identified once the Embedded SIM TF output becomes available.

2.8 Numbering Resources

2.8.1 High Level Requirement

The anticipated growth of embedded devices is expected to increase the demand for E.164 [6] MSISDN resources. A large number of EM services are deployed using circuit switched architecture, even where a traditional "dialable" number may not be required. This might lead to the shortage of the numbering resources for new Machine Type Communications (MTC) services. Providing for the expected future growth means ensuring that alternatives to public numbering resources need to be considered as addresses.

2.8.2 Considerations

Numbering resources are already in short supply in some markets, for example, in the US and a number of European markets [7]. To address this issue, in the short term, geographic numbers are likely to be migrated to 12+ digit numbers by 2020 and incur significant costs. Where EM services require no human interaction, alternatives to the existing public numbering schemes need to be considered. Work on the development of such alternatives currently takes place in such standards bodies as ETSI, 3GPP and ITU.

At 3GPP SA1, different alternative solutions for short, midterm and long term are proposed in the Study on Alternatives to E.164 for Machine-Type Communications. These solutions are subject to 3GPP technical specification group modifications and approval.

An interim midterm solution for number shortage is to extend the number of digits in the E.164 number on dedicated ranges that are currently spare and not yet assigned.

The suggested long term solution for E.164 number shortage for M2M is to use IPV6 addressing with corresponding identifiers (for example SIP addresses URIs/URLs) and remove the reliance on MSISDNs. This solution requires an evolved packet core network and may need an upgrade of mobile operators' networks. This long term solution will need actions in 3GPP standards.

While planning the migration to IPv6, the issues that need to be considered include the strategy for the development of EM applications, impact on the infrastructure, operational costs and security.

2.8.3 Guideline

It is recommended that industry wide solution is developed for the numbering problem to avoid the implementation of costly interim single-market solutions.

2.9 Network Selection Guideline

Different network types with different characteristics (e.g. GSM, WCDMA, LTE, WLAN) may be available to a mobile network operator. Mobile network operators should consider distributing different types of EM traffic across their different networks based on the capabilities of the network, the characteristics of the traffic and the requirements of the application. This should be done to satisfy end-user quality requirements and to protect the MNO's network from signalling congestion and overload.

EM device and application developers should consider the appropriate access network to be used when designing applications. The choice of network to be requested by an EM device or application should also consider whether the device is roaming or not in order to avoid any negative effect on the visited network.

2.10 Future Requirements

2.10.1 Device application Requirement – Managing Multi-Application EM Devices

It will certainly occur that a single device, with a single subscription, will need to be used for low priority transmissions and normal/high priority transmissions. e.g. automotive (diagnostics = LAP, eCall = not LAP); burglar alarm (heartbeat = LAP; move PLMN = LAP; alarm = not LAP).

3GPP Release 10 standards do not address the need for a single device, with multiple resident applications, to generate both LAP communications and non-LAP communications. 3GPP is working on supporting this for Release 11.

2.10.2 HSS/HLR Overload Control

The 3GPP Release 10 LAP and EAB mechanisms (described in section 2.3) can be used to resolve overload or congestion in the radio access network and the core network. However, scenarios may arise in which the HSS/HLR may be suffering from overload or congestion when the core and radio access networks are not. Enhancements to the 3GPP standards may be required to define HSS/HLR specific overload control mechanisms in such scenarios where the EAB/LAP based congestion control mechanisms may not be effective.

2.10.3 Support for Indication of Subscriber Types and Services/Applications

In addition to implementing access network enhancements to support the anticipated growth of EM traffic, enhancements should also be considered for protecting the core network. To efficiently use network resources and prevent core network overload, dynamic policy control

and charging (PCC) should be considered for use in managing the network, and scheduling and routing traffic according to network congestion status, subscriber and service /application types, user rate plans etc.

To allow the network to be subscriber and services aware, a mechanism would be required to provide the interaction between network control and applications and devices. Indications of subscriber types and services/applications will give the subscriber or the application provider the option of easily selecting how the network should treat different applications or application classes for a specific subscriber. It will also give the network the means to handle the traffic priorities accordingly. The subscriber type and service/ application information could also be used for billing, reporting etc., subject to net neutrality considerations in some regions depending on regulatory requirements.

2.10.4 Roaming Transparency for EM Devices

The GSMA Billing, Accounting and Roaming Group (BARG) is working to define principles and a mechanism for facilitating visibility of EM traffic in a roaming scenario.

3 Document Management

Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
3.0	28/03/2012	Network Aspects chapter extracted from Embedded Mobile Guidelines Release 3	Executive Management Committee	David Maxwell, GSMA

Other Information

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Document Owner	GSMA Connected Living Programme
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Your comments or suggestions & questions are always welcome.

4 References

Ref	Title
[1]	3GPP TS 31.102: “Universal Subscriber Identity Module (USIM) application”
[2]	3GPP TS 23.060 “General Packet Radio Service (GPRS); Service description; Stage 2“ Release 10
[3]	3GPP TS 24.368 “Non-Access Stratum (NAS) configuration Management Object (MO)”
[4]	3GPP TS 22.368 “Service requirements for Machine-Type Communications (MTC); Stage 1”
[5]	3GPP TS 24.008 “Mobile radio interface Layer 3 specification; Core network protocols; Stage 3”
[6]	ITU-T E.164 “List of ITU-T Recommendation E.164 Assigned Country Codes”
[7]	European Conference of Postal and Telecommunications Administrations (CEPT), Numbering and Addressing In Machine-To-Machine (M2M) Communications, ECC Report 153, November 2010

5 List of Acronyms

Term	Description
3GPP	Third Generation Partnership Project
APN	Access Point Name
BARG	Billing, Accounting and Roaming Group (GSMA)
CS	Circuit Switched
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
EAB	Extended Access Barring
EDGE	Enhanced Data rates for Global Evolution
ETSI	European Telecommunications Standards Institute
GERAN	GSM/Edge Radio Access Network
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communications
HLR	Home Location Register
HPMN	Home Public Mobile Network
HSS	Home Subscriber Server
IMSI	International Mobile Subscriber Identity
LAP	Low Access Priority
LTE	Long Term Evolution
M2M	Machine-to-Machine
MSISDN	Mobile Station International Subscriber Directory Number
NMO-I	Network Mode of Operation I
OFDMA	Orthogonal Frequency-Division Multiple Access
OTA	Over the Air
PLMN	Public Land Mobile Network
PLU	Periodic Locations Area Update
PRU	Periodic Routing Area Update
PS	Packet Switched
PTU	Periodic Tracking Area Update
RF	Radio Frequency
SGSN	Serving Gateway Support Node
SMS	Short Message Service
TMSI	Temporary Mobile Subscriber Identity
SIM	Subscriber Identity Module
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
UTRAN	UMTS Terrestrial Radio Access Network
VLR	Visited Location Register
VPMN	Visited Public Mobile Network
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network