TSG-RAN Working Group 3 meeting #4
Warwick, England 1 - 4 June 1999

TSGW3#4(99)557

Agenda Item:

Source: **Nortel Networks**

Title: Draft Technical Report : Turbo Charger

Document for:

This contribution is a companion of Liaison R3-99524.

3GPP TSG-CN WG1
Sophia Antipolis, FRANCE
1 – 4 June 1999

Tdoc 3GPP N1-99 419

Title: **Draft Technical Report: Turbo-Charger**

Source: **Nortel Networks**

Purpose: **For Reveiw**

This is the first draft of the technical report on the use of the Turbo-Charger mechanism in UMTS to reduce the signalling traffic associated with mobility.

1 Intellectual Property Rights

2 Foreword

3 Introduction

UMTS will build on the success of GSM and is likely to become even more widespread. In addition, the continued growth of international travel for business and leisure means that the number of roaming UMTS and GSM subscribers is set to increase significantly.

Every time a subscriber moves to a location area served by a different MSC/VLR or SGSN, the subscriber data must be downloaded from the HLR in the home PLMN to the new entity serving the user and deleted in the old MSC/VLR or SGSN. If the coverage areas associated with these entities are small or the subscriber frequently moves between location areas the subscriber will represent a large signalling load. This is equally applicable to subscribers moving within their home network and roaming subscribers except in the latter case international signalling costs are incurred.

The Turbo-Charger concept provides an architecture that is scalable to compensate for loading levels and able to service any subscriber distribution. This is achieved by modifying the subscriber data management to reduce the signalling load associated with mobility. The reduction in signalling load is achieved without introducing a new node but does require new functionality within the network.

4 Scope

This Technical Report describes the use of Turbo-Charger mechanism in UMTS to reduce the signalling traffic associated with mobility. This document provides a technical proposal and example uses of the Turbo-Charger concept but also identifies issues that require further study. Finally, this document highlights the advantages and disadvantages, and identifies the UMTS Technical Specifications that would require enhancing to support his functionality.

5 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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

6 Definitions and Abbreviations

6.1 Definitions

Turbo-Charged Network	A UMTS network in which the Turbo-Charger mechanism is being used to optimise mobility management signalling.
Turbo-Charger Routeing Function	The function used to assign specific network resources (i.e. MSC/VLR and/or SGSN) to serve a mobile station and subsequently route C-Plane traffic to the associated network resource.
Network Resource Identifier	A specific parameter used to identify the core network resource assigned to serve a mobile station.

6.2 Abbreviations

NRI	Network Resource Identifier
TMSI	Temporary Mobile Station Identity
TRF	Turbo-Charger Routeing Function
URA	UTRAN Routeing Area

7 General Description

The aims of the Turbo-Charger concept are to reduce the intra and inter-PLMN mobility management costs and to provide automatic load-sharing between available core network resources i.e. the MSC/VLR and/or SGSN.

The Turbo-Charger constitutes a change to the network architecture. Despite this, the Turbo-Charger enhancement should not require significant modifications of the GSM/UMTS standards.

The current network philosophy is to geographically divide the region between the available core network resources. An alternative architectural philosophy is to equally divide the subscribers between the available core network resources, irrespective of their location. The consequence of this new philosophy is the virtual elimination of handovers and location updates. Hence, signalling associated with mobility management is reduced. This reduction in signalling is equally applicable to subscribers moving within their home network and roaming subscribers.

In addition, this philosophy provides scalability by enabling operators to introduce new network resources without tying the new capacity to a particular geographical area. This is extremely important for new entrants wishing to minimise the initial deployment costs while maximising coverage.

In the context of GSM, this is achieved by placing a Turbo-Charger Routeing Function between the BSC and the ‘pool’ of network resources i.e. MSC/VLR and SGSN. The purpose of the Turbo-Charger Routeing Function is to assign specific network resources to serve a mobile station and to subsequently route A and Gb-interface messages to the assigned MSC/VLR and/or SGSN, respectively.

The Turbo-Charger Routeing Function may use a TMSI (Temporary Mobile Subscriber Identity) partitioning scheme or a new parameter to identify the serving MSC/VLR or SGSN for signalling. The TMSI partitioning scheme would allocate a sub-set of the TMSI range to each MSC/VLR, see Figure 1. The A-interface signalling traffic is then routed to the correct MSC/VLR based on the TMSI or the value of a new parameter defined specifically for this purpose. For GPRS a similar TLLI (Temporary Logical Link Identity) partitioning scheme could be used although this scheme may be slightly complicated by the internal structure of the TLLI. The exact Turbo-Charger Routeing Function mechanism is for further study.

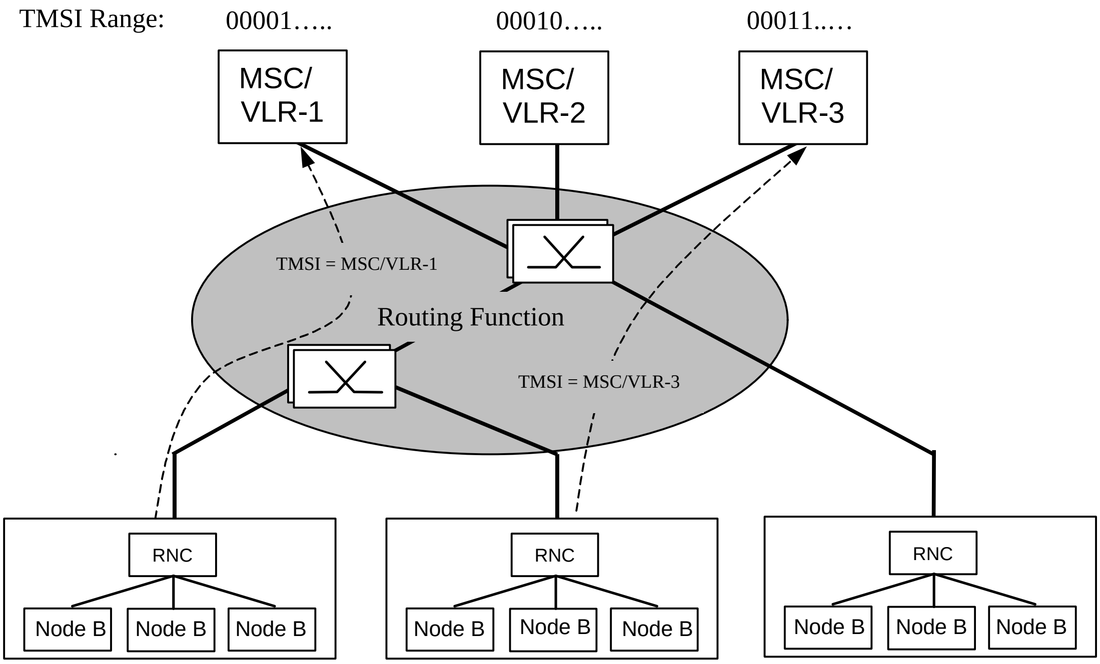

Figure 1: An example GSM Turbo-Charged Network Architecture

In large metropolitan areas where subscribers are currently served by multiple MSC/VLRs, some MSC/VLRs may be very busy while others are not fully utilised. Since the Turbo-Charger Routeing Function would route all A/Gb interface traffic and it can participate in load-sharing and balancing based on the current loading of the network. Two mechanism to assign network resources to serve a particular subscriber and provide load-sharing are envisaged, random load-sharing and dynamic load-sharing.

- Random load-sharing requires the Turbo-Charger Routeing Function to randomly assign a MSC/VLR and/or SGSN to serve a particular mobile station when it first comes in to the network.

- Dynamic load-sharing requires the implementation of an intelligent router or appropriate signalling to determine the current loading of the network. Using this information the Turbo-Charger Routeing Function can assign network resources to the mobile and potentially redistribute traffic as required.

Once network resources have been assigned further update requests are not required because the service area of each MSC/VLR and SGSN could potentially incorporate the whole network. The access network continues to store the mobile station’s location at the URA and cell level.

In the context of UMTS, the Turbo-Charger Routeing Function may become a feature of the RNC or core network, see Figure 2. Furthermore, there may be the opportunity to specify a new parameter to enable the Turbo-Charger Routeing Function to identify a particular MSC/VLR or SGSN. This is a matter for further study.

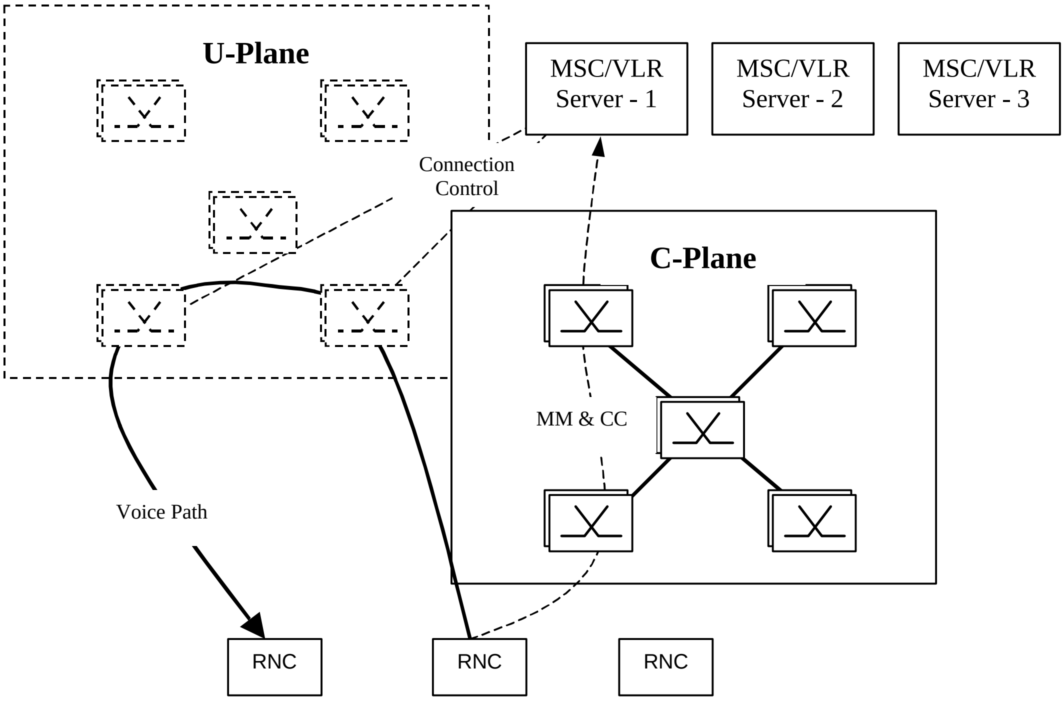

Figure 2: Proposed UMTS Turbo-Charged Network Architecture

8 Functional Description

The Turbo-Charger introduces a flexible mechanism to assign network resources to serve a particular mobile station that is independent of the geographical location.

Specifically, the Turbo-Charger mechanism proposes the modification of Iu-interface procedures:

- An optional new parameter i.e. "network resource identifier" in Iu signalling that may be used to identify the network resource assigned to serve the mobile station.
- The introduction of an optional Turbo-Charger Routeing Function (TRF), which assigns a specific network resource to serve a mobile station and optionally uses the temporary mobile identity or "network resource identifier" to route C-Plane traffic to the assigned core network resource.
- Enhanced core network functionality to assign temporary mobile identities and/or "network resource identifiers" from a specific range.

8.1 Turbo-Charger Routeing Function

The Turbo-Charger Routeing Function performs two functions:

- Selection of the specific core network resources i.e. MSC/VLR or SGSN to serve the subscriber,
- Routes C-plane traffic to the correct serving entity.

The Turbo-Charger Routeing Function assigns specific network resources to serve each mobile station to provide load-sharing among the available network resources. In determining the network resource assignment, the Turbo-Charger Routeing Function takes into account the current loading of the network and other system considerations that may affect the suitability of the assignment.

The mechanism used to determine the current network loading is outside the scope of standardisation. However, possible mechanisms might be to periodically query network entities to determine their loading or to query network entities when assignment is required. Alternatively, the Turbo-Charger Routeing Function may randomly select an appropriate network resource to serve the mobile station.

Following the allocation of network resources to serve the mobile station by the Turbo-Charger Routeing Function, the core network may assign a temporary mobile identity or a "network resource identifier" to identify the serving entity. The Turbo-Charger Routeing Function uses this identifier to route signalling to the correct network entity at the SCCP or IP layer. Figure 3 provides an example flow diagram for the Turbo-Charger Routeing Function.

The receipt of a Location Update Request message or other signalling containing an identifier that is not recognised by the Turbo-Charger Routeing Function would typically trigger network resource assignment. After the network resources have been assigned to serve a particular mobile station the standard UMTS location procedures are used towards the HLR. The serving entity or entities will then handle all signalling for the associated mobile subscriber and initiate the establishment of U-Plane channels.

UMTS is sufficiently flexible to provide load-sharing for traffic channels and allows the core network to specify the AAL2, AAL5 or IP address and binding identity to be used by the RNC to establish radio bearers. Consequently, in the U-Plane there is no permanent association between the mobile station and core network entities.

The Turbo-Charger Routeing Function may be implemented as a centralised entity or in a distributed fashion, as part of the RNC, SGSN and/or MSC/VLR.

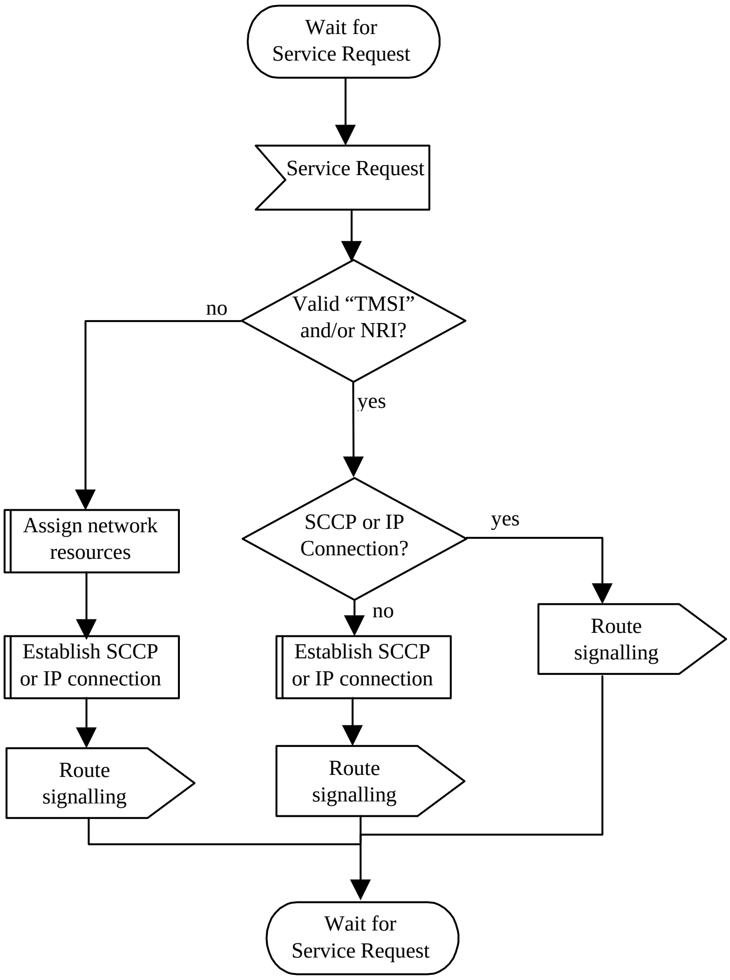

Figure 3: An example flow diagram for a Turbo-Charger Routeing Function.

9 Specific Examples

This section describes the operation of a Turbo-Charged network. The examples make no assumptions about the location of the Turbo-Charger Routeing Function within the network as a whole.

Since the Turbo-Charger mechanism does not impact the mobility management procedures, these procedures are not described in this technical report.

9.1 Circuit Switched Services

9.1.1 Network Registration

Figure 4 provides the message flow for a mobile station registering in the CS-domain.

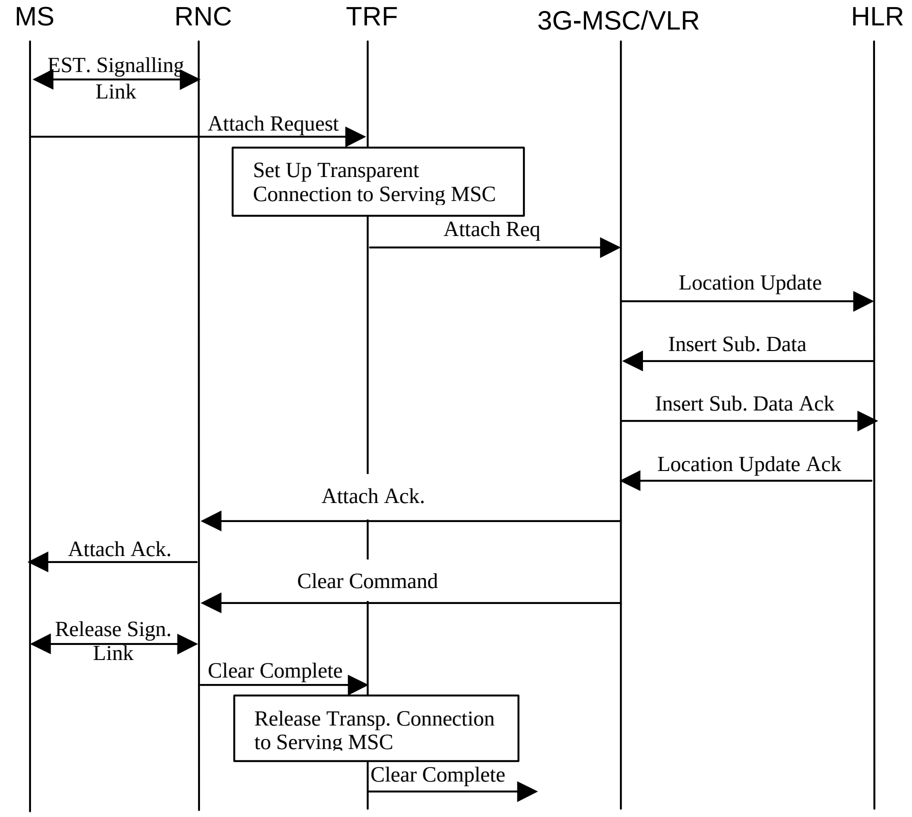

Figure 4: The message flow for a mobile station registering in a network.

The mobile station sends an attach request to the core network. The attach request is intercepted by the Turbo-Charger Routeing Function (TRF), which selects an MSC/VLR to serve the mobile station and sets up a transparent SCCP connection to the serving MSC/VLR. The Turbo-Charger Routeing Function passes the attach request to the serving MSC/VLR.

Subsequently, the MSC/VLR creates/updates the entry for the mobile station and requests subscriber data from the HLR using the Location Update procedure. If the procedure is successful the MSC/VLR assigns a new temporary ID (such as the TMSI) to the mobile station and optionally a “network resource identifier”. The serving MSC/VLR responds to the attach request with an attach acknowledge message to the RNC, which forwards the acknowledgement to the MS.

The mobile station receives the new temporary ID and optionally a “network resource identifier” from the MSC/VLR in the Attach Acknowledgement message and stores these IDs at a register inside the mobile station. The mobile station will use these temporary identifiers as an identity in future requests sent to the MSC/VLR.

After the attach has been acknowledged, the serving MSC/VLR sends a clear message to the RNC. The RNC releases the signalling link and the RNC sends a clear complete message to the MSC/VLR. This results in the termination of the SCCP connection between the RNC and MSC/VLR.

9.1.2 Pageing

Figure 5 provides the message flow diagram for a mobile terminated call set-up.

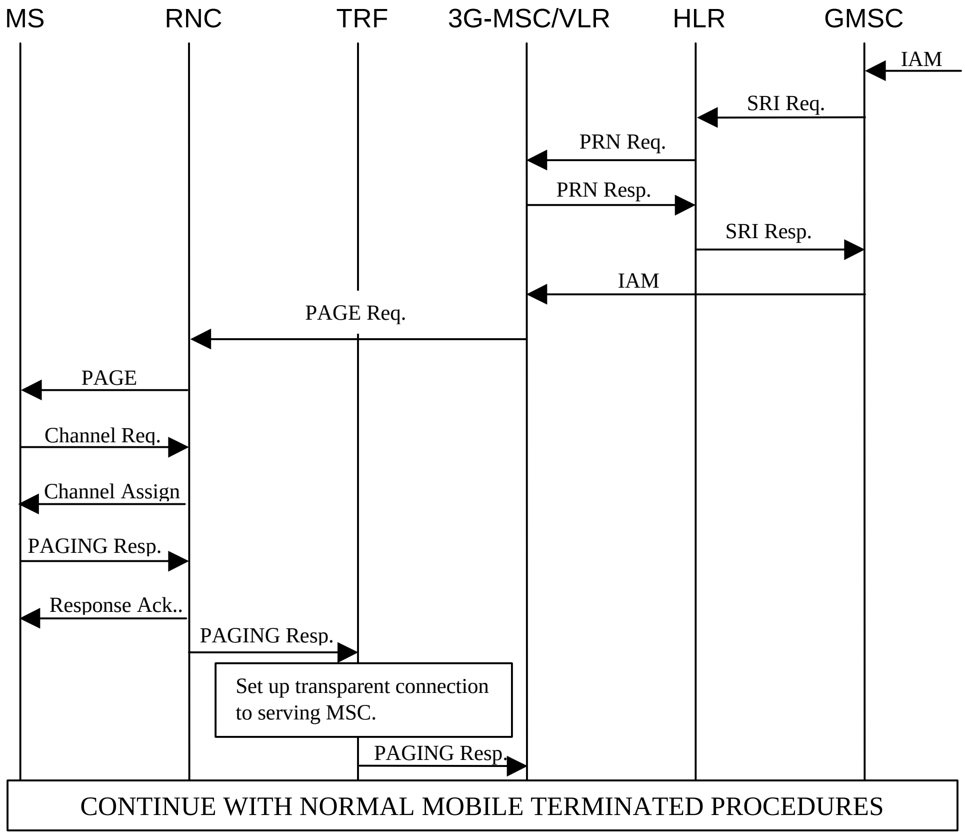

Figure 5: An example of the mobile terminated call set-up procedures in a Turbo-Charged network.

Upon receipt of a mobile terminated call the gateway MSC generates a MAP Send Routeing Information query to the HLR. The HLR sends a MAP Provide Roaming Number to the MSC/VLR serving the MS. Normally, the MSC/VLR will respond with a roaming number that is communicated to the gateway MSC. The gateway MSC then forwards the mobile terminated call to the MSC/VLR serving the mobile station.

The serving MSC/VLR then sends a page request to the RNC, which pages the mobile station. In response to the page, the mobile station makes a channel request to which the RNC responds with a channel assignment. The mobile station then sends a page response message to the RNC in the form of a SABM Page response message on the SDCCH Uplink. The BSS acknowledges this message and subsequently sends a paging response message to the serving MSC/VLR

The Turbo-Charger Routeing Function intercepts the paging response message and based upon the identity of the mobile station and/or “network resource identifier” sets up an internal transparent SCCP connection between the RNC and MSC/VLR. After this path has been established the Turbo-Charger Routeing Function forwards the paging response to the serving MSC/VLR. The system then continues with the remainder of the mobile terminated call set-up sequence as standardised in GSM.

No inter-working problems have been identified with using Pre-Paging in a Turbo-Charged Network.

9.1.3 Location Update Procedure

Figure 6 provides the message flow diagram for the case when a mobile station roams from a standard GSM network to a Turbo-Charged UMTS network. DTAP messages are used to indicate type of service requested by the mobile station.

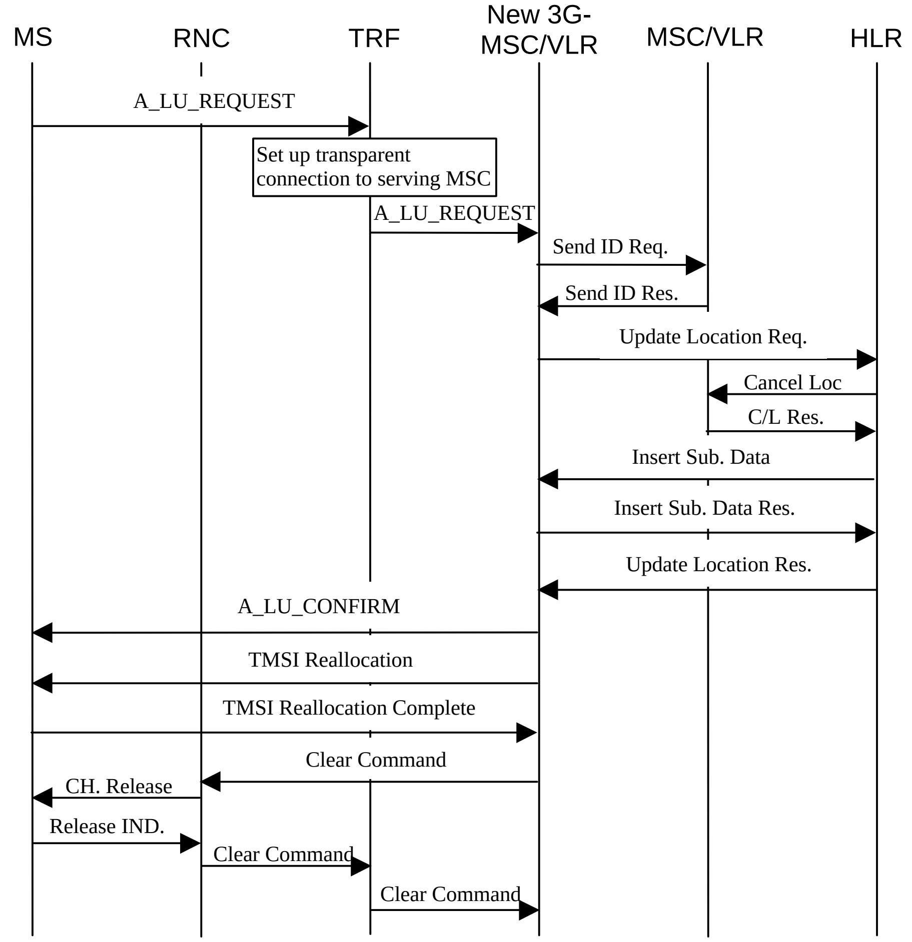

Figure 6: A message flow diagram for the case when a mobile station roams from a standard GSM network to a Turbo-Charged network.

Problems can arise when routeing initial messages of a mobile station that enters a Turbo-Charged network from a standard GSM network. Firstly, the mobile station does not have a TMSI number assigned by the present network. Secondly, some mobile stations elect to use their IMSI numbers instead of the TMSI number as an identifier.

When a mobile station enters the Turbo-Charged network it will initiate an inter-VLR location update as indicated by the A_LU_REQUEST message. The Turbo-Charger Routeing Function intercepts this message and detects that the TMSI and optionally the “network resource identifier” does not belong to any MSC/VLR in the current network. The Turbo-Charger Routeing Function selects a serving MSC/VLR for the mobile station either randomly or based on the network loading conditions and forwards the message to the serving MSC/VLR.

The serving MSC/VLR (New MSC/VLR) then completes the location update for the mobile station according to the normal UMTS location update procedures. Finally, the serving MSC/VLR assigns a new temporary mobile identity and optionally a “network resource identifier” to the mobile station.

The inter-VLR location update procedure informs the HLR that 3G-MSC/VLR is now the new serving MSC/VLR for the mobile station. The HLR will then cancel the registration of the mobile station at the previous serving MSC/VLR of the mobile station.

9.1.4 Modification of Subscription Data

The Insert Subscriber Data and Delete Subscriber Data procedures are not impacted by the Turbo-Charger concept.

9.1.5 Cancel Location

The Cancel Location procedure is not impacted by the Turbo-Charger concept.

9.1.6 Reset

The Reset procedures are not impacted by the Turbo-Charger concept.

9.1.7 Short Message Service

The Short Message Service is not impacted by the Turbo-Charger concept.

9.2 Packet Switched Service

No specific requirements for Packet Switched services have been identified.

10 Benefits and Drawbacks

10.1 Advantages

- Reduces mobility management signalling at source. The estimated reduction is for further study.
- Turbo-Charger reduces mobility management costs for both home and roaming subscribers moving within the Turbo-Charged Network.
- A Turbo-Charged Network reduces international signalling in roaming scenarios, which is of benefit to the home network.
- Subscribers are only required to authenticate once, upon arriving in the network, removing the need for subsequent authentication procedures towards the home network.
- A Turbo-Charged Network does not require additional inter-working MSCs and GSNs as the HLR continues to track the location of the subscriber at the MSC/VLR and SGSN level.
- The Turbo-Charger philosophy benefits new entrants by enabling operators to introduce new network resources without tying the new capacity to a particular geographical area. In the initial deployment of a system, an overall goal is to support the highest number of subscribers with the smallest infrastructure. This initial deployment not only minimises the initial cost of deployment but also reduces the networking overhead that results from subscriber mobility.
- The Turbo-Charger philosophy provides scalability by enabling operators to introduce new network resources without tying the new capacity to a particular geographical area. For example when an MSC (or multiple MSCs) serving a system become overloaded, additional MSCs must be deployed. In deploying additional MSCs within a system, the area served by the system is typically geographically partitioned to equalise loading among the MSCs. As the number of deployed MSCs increases, each served area becomes smaller and the number of boundaries between serving MSCs increases. The additional boundaries cause an increase in subscriber mobility between MSCs, the subscriber mobility consuming additional MSC CPU capacity. Consequently, as additional MSCs are added within a system, the marginal benefit of each MSC deployment is reduced as the total number of deployed MSCs increases. In a Turbo-Charged network the addition of network resources benefits the network as a whole and does not require further subdivision of location areas.

10.2 Disadvantages

- Potentially limits the number of subscribers that can be registered in a network as a consequence of the TMSI/TLLI partitioning scheme. However, this problem may be resolved for UMTS.
- Requires Turbo-Charger Routeing Function between the access and core network.

10.3 Open Issues

To be identified.

11 Impact on GSM Release 98 Specifications

For further study.

GSM04.08

12 Conclusions

This section is to be completed following review by TSG-CN2.