Chapter 5

# Cellular Networks and Location Management

## 5.1 Overview of Cellular Systems

Table 5.1 Overview of cellular systems

| System | Multiple access | Frequency range | Deployment |
|---|---|---|---|
| **1st Generation** | | | |
| NMT | FDMA | 450/900 MHz | North Europe |
| AMPS/IS-88 | FDMA | 800 MHz | North America |
| **2nd Generation** | | | |
| GSM/GPRS | TDMA | 850 MHz | North America |
| | | 900 MHz | Worldwide excl. North America |
| | | 1,800 MHz | Worldwide excl. North America |
| | | 1,900 MHz | North America |
| DAMPS/IS-136 | TDMA | 800 MHz | North America |
| CdmaOne/IS-95 | CDMA | 800/1,900 MHz | North/Central/South America and Asia |
| PDC | TDMA | 800/1,500 MHz | Japan |
| **3rd Generation** | | | |
| UMTS/WCDMA | CDMA | around 2 GHz | Europe/Japan/South Korea |
| Cdma2000 | CDMA | around 2 GHz | North America/Asia |

## 5.2 Principles of Cellular Networks

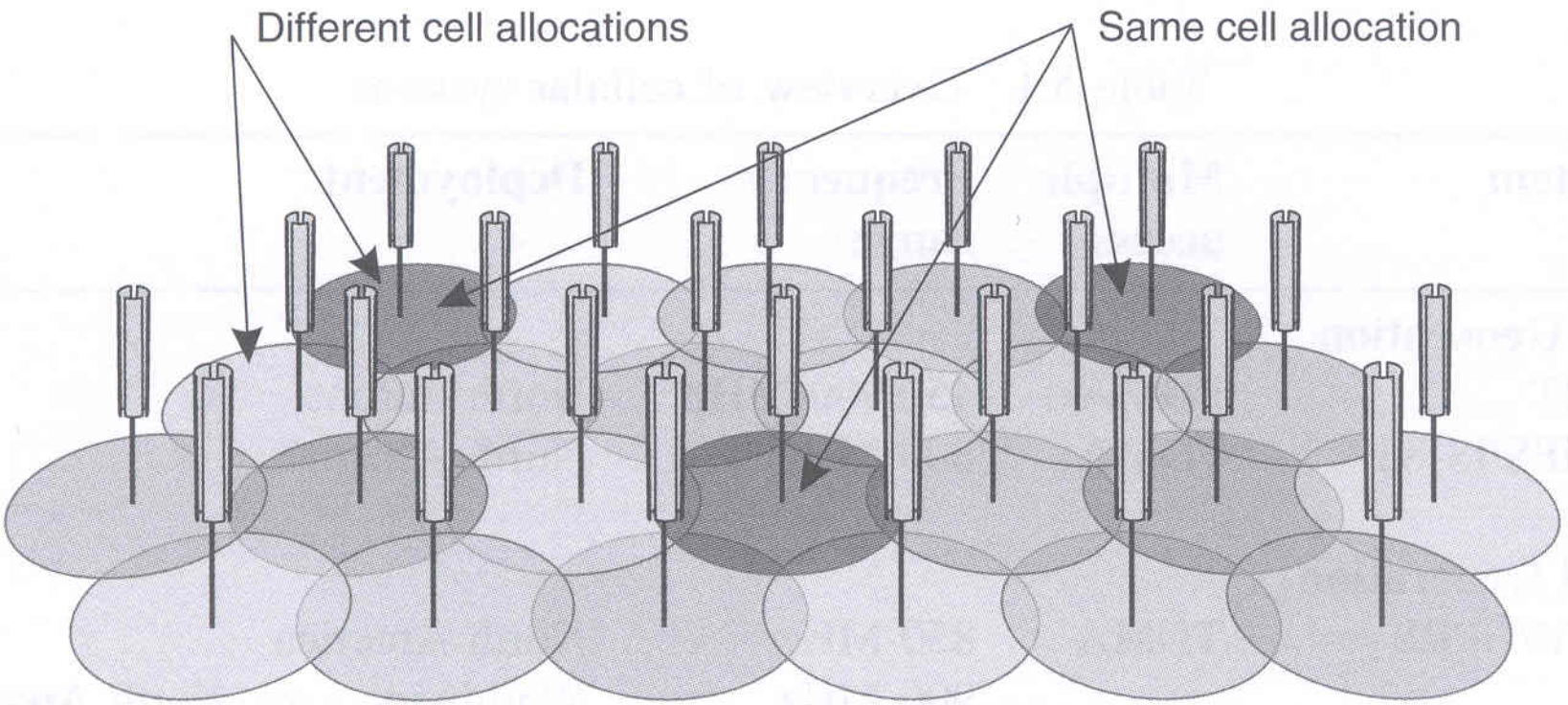



Figure 5.1 Cellular networks.

## 5.2.1 GSM Architecture

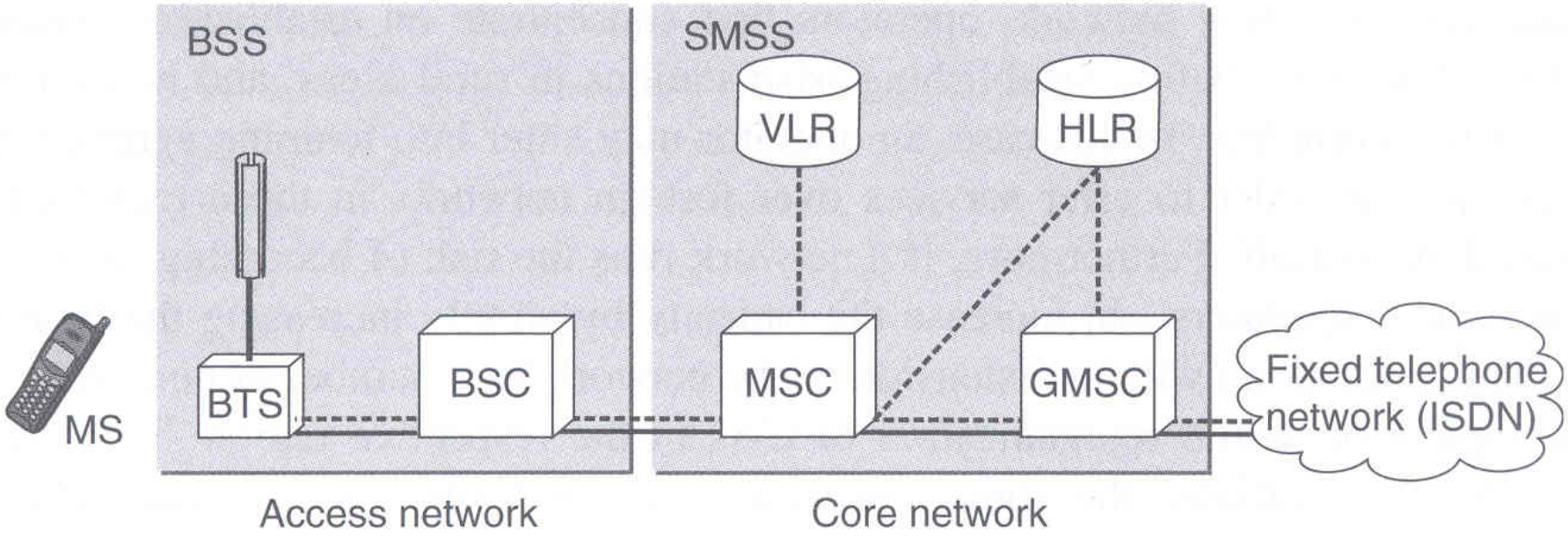



Figure 5.2 GSM architecture.

## 5.2.2 GPRS Architecture

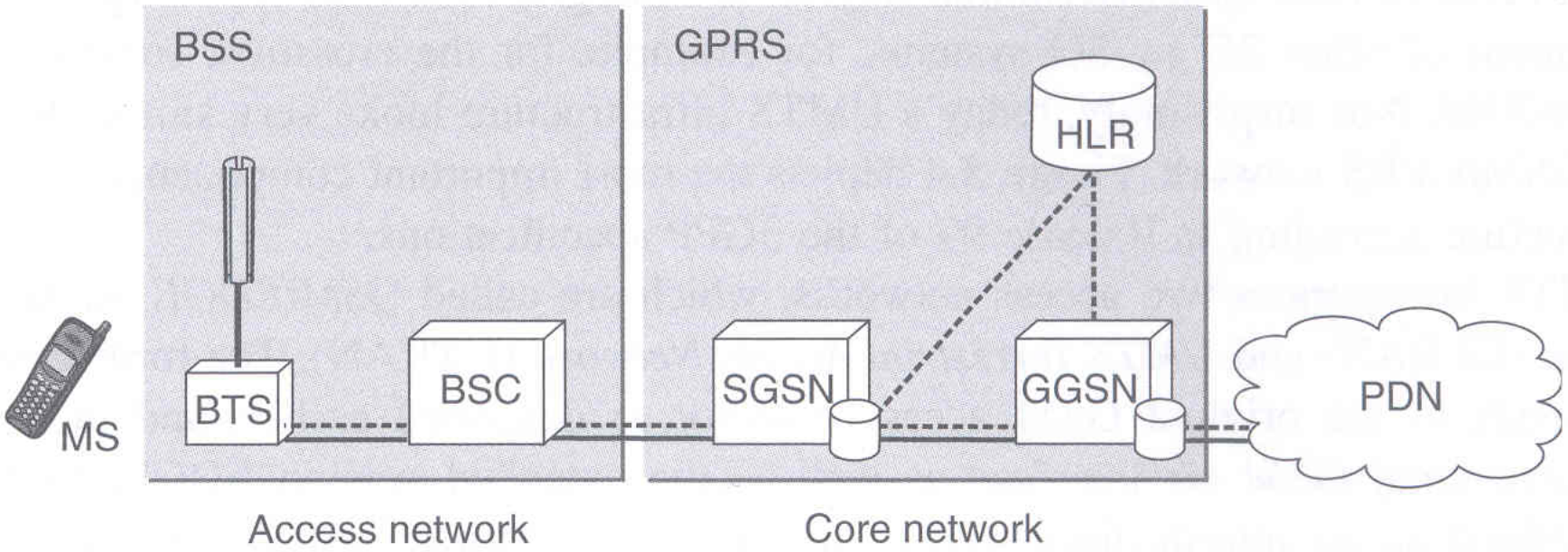



Figure 5.3 GPRS architecture.

## 5.2.3 UMTS Architecture

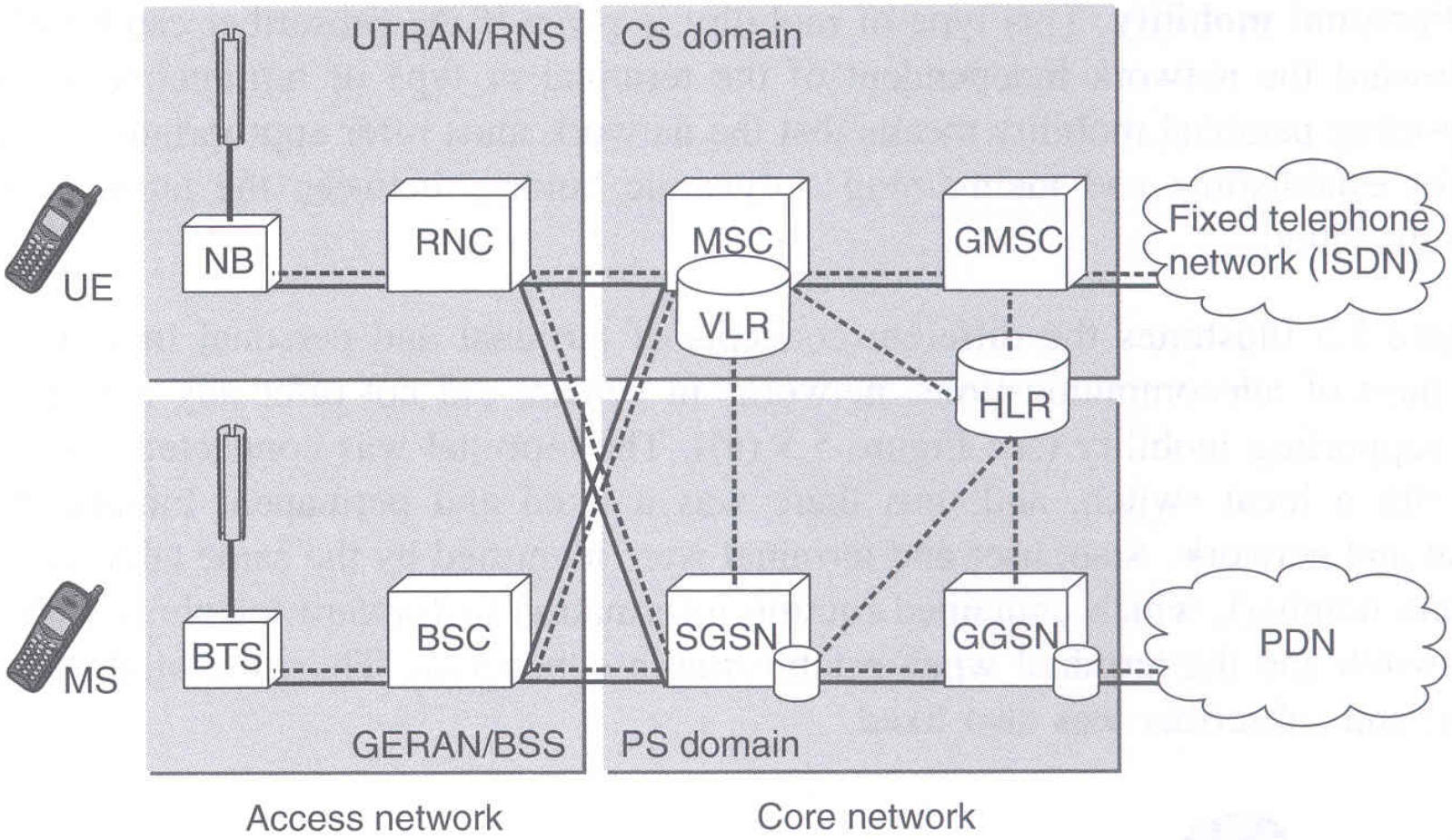



Figure 5.4 UMTS architecture.

# 5.3 Mobility Management

- **Terminal mobility**
- **Personal mobility**

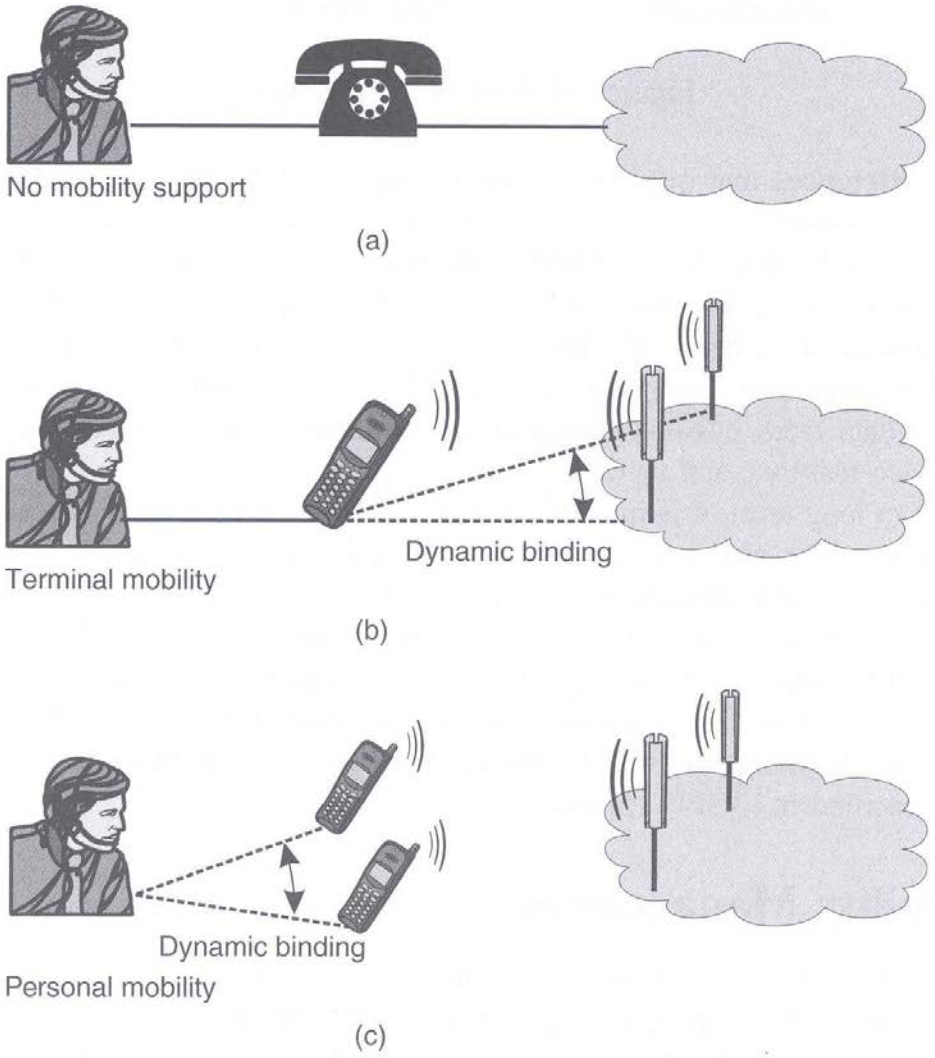



Figure 5.5 Mobility types. Adapted from (Roth 2002).

## 5.4 Common Concepts of Location Management

### 5.4.1 Location Update and Paging

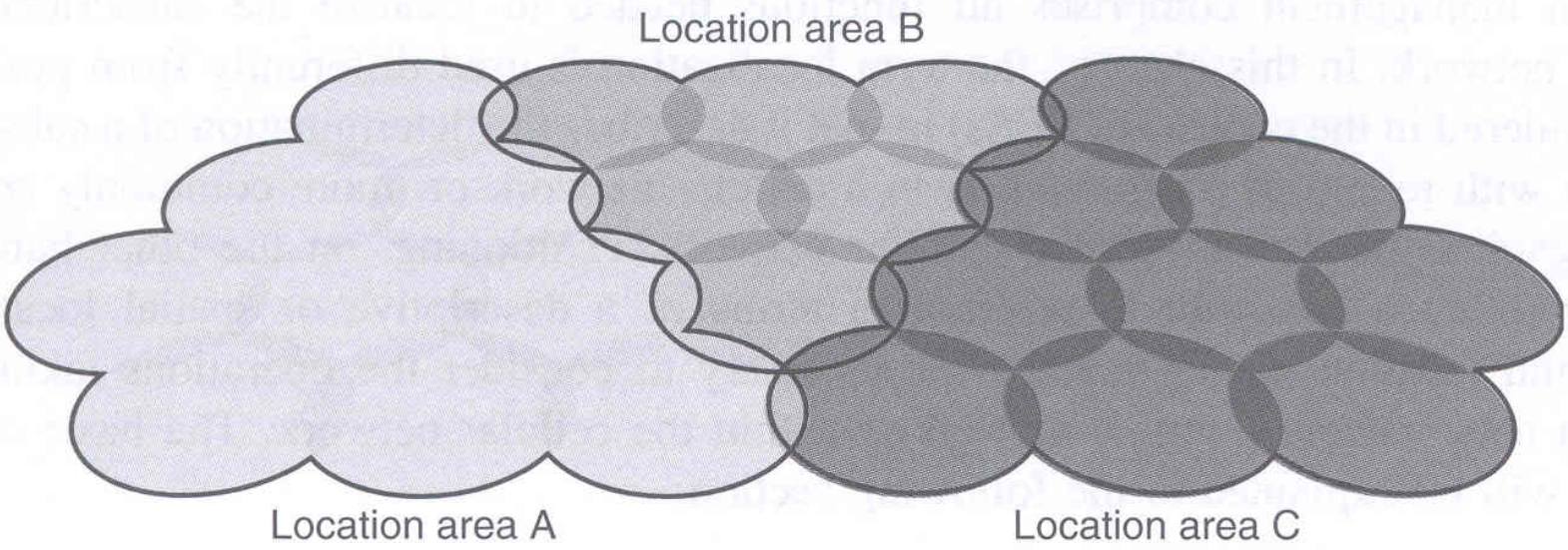



Figure 5.6 Location areas.

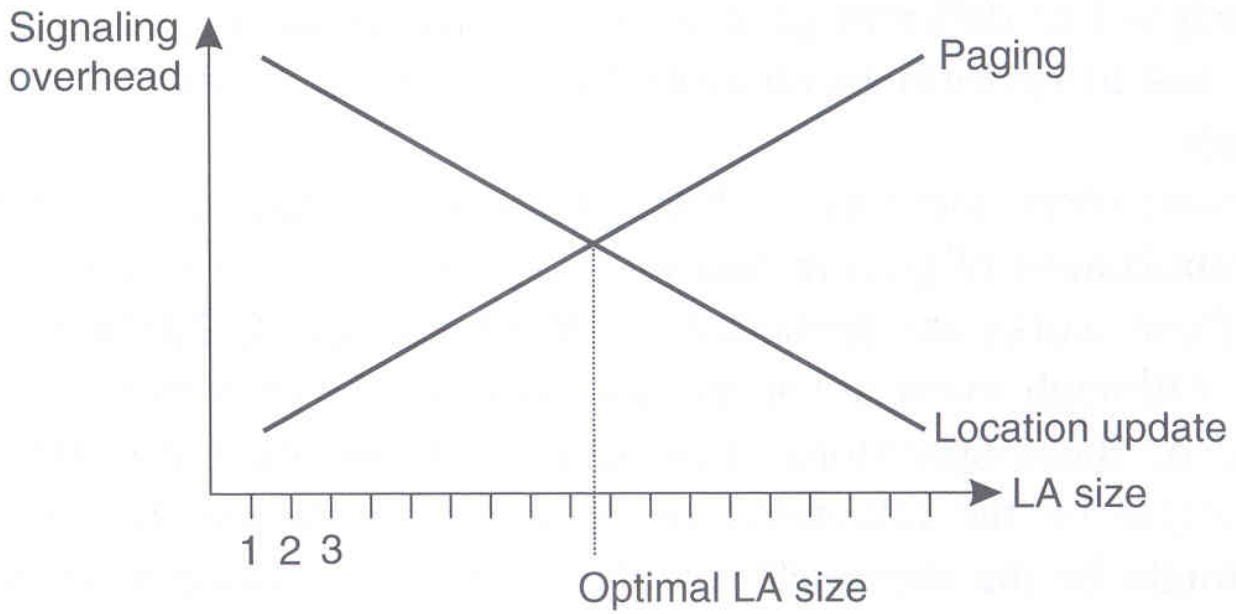



Figure 5.7 Overhead of paging and location updates depending on LA size.

### 5.4.2 Database Concepts

## 5.5 Location Management in CS Networks

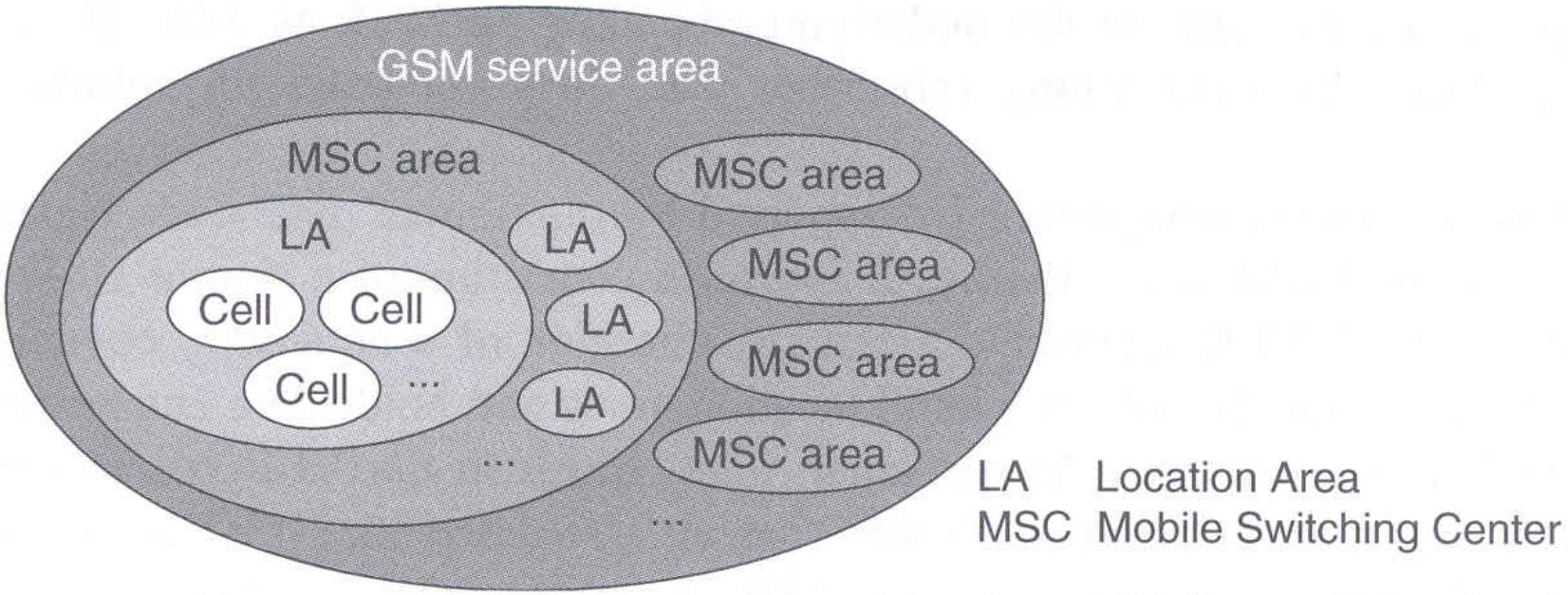



Figure 5.8 GSM/UMTS topology for location management.

## 5.5.1 Identifiers and Addresses

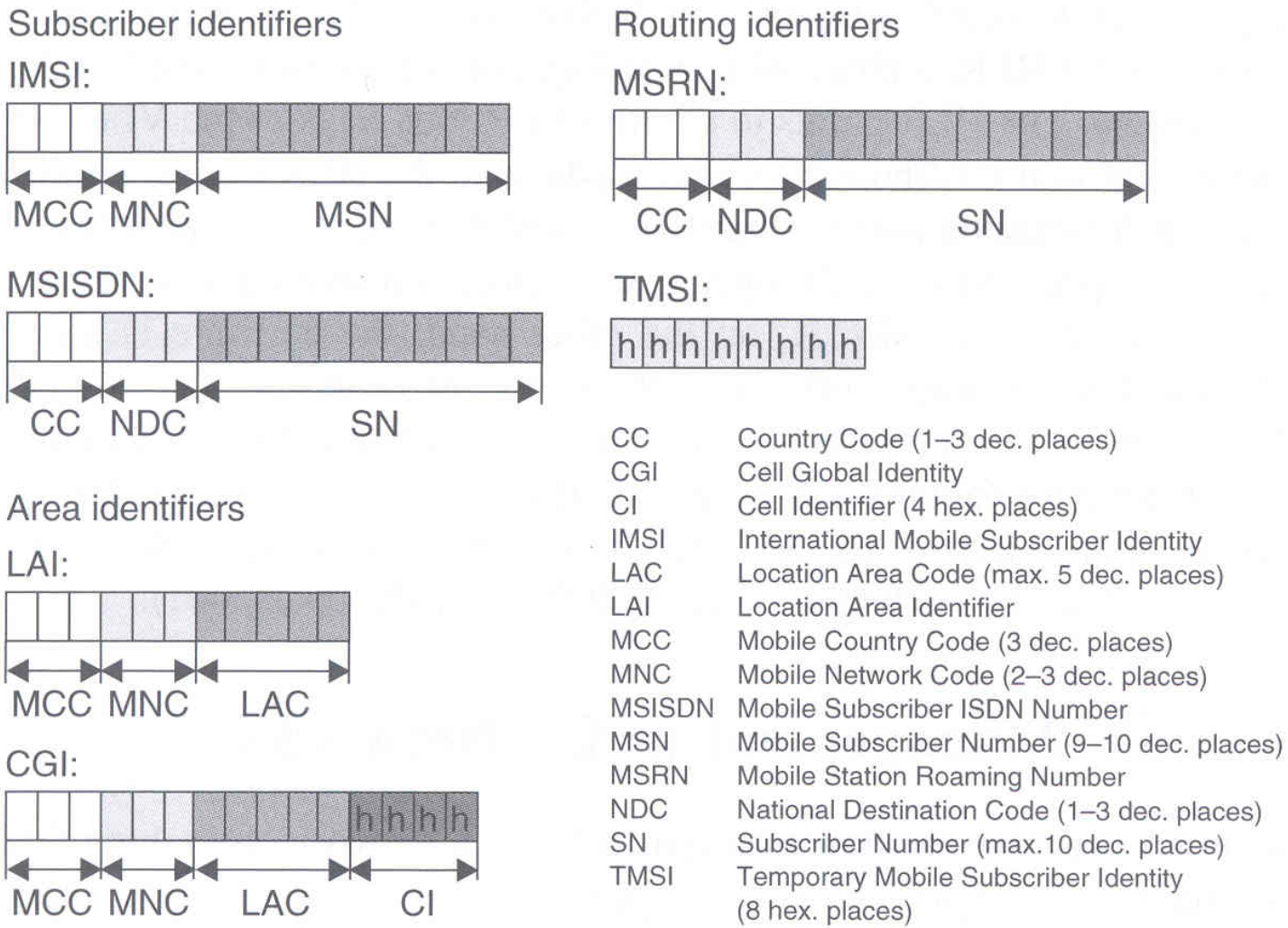



Figure 5.9 Identifiers used for CS location management.

- **International Mobile Subscriber Identity (IMSI)**
- **Mobile Subscriber ISDN Number (MSISDN)**
- **Mobile Station Roaming Number (MSRN)**
- **Temporary Mobile Subscriber Identity (TMSI)**
- **Location Area Identifier (LAI)**
- **Cell Global Identity (CGI)**

## 5.5.2 Localization and Routing

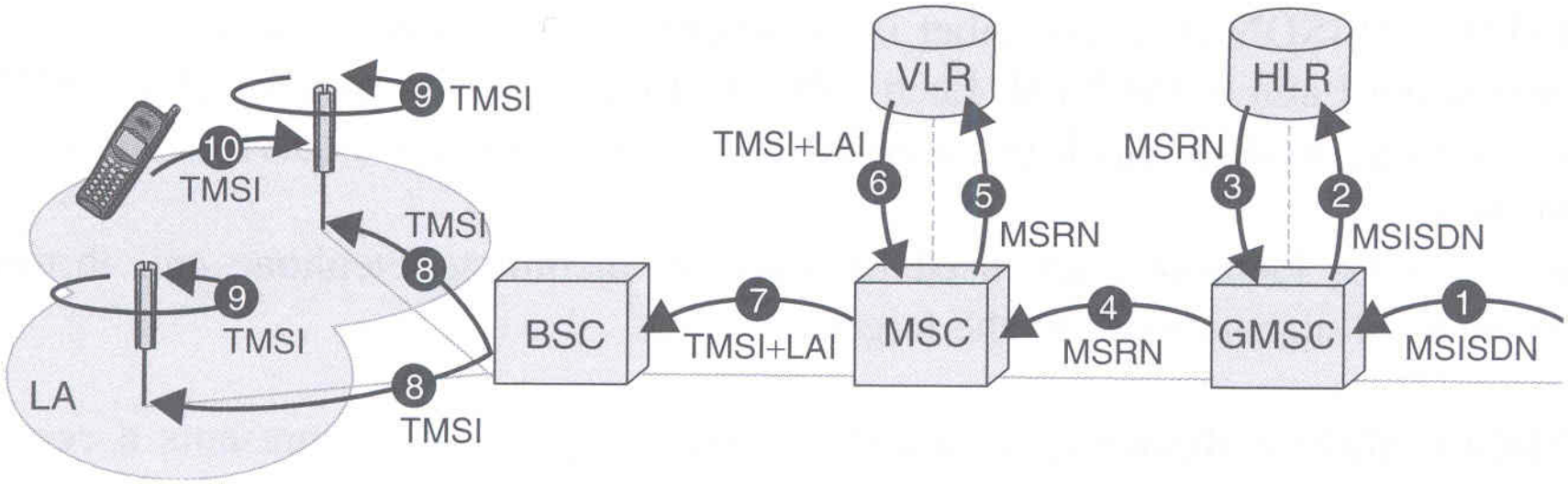



Figure 5.10 Localization and routing of incoming calls.

## 5.5.3 Location Updates

- **Location update on location-area crossing**
- **Periodic location update**

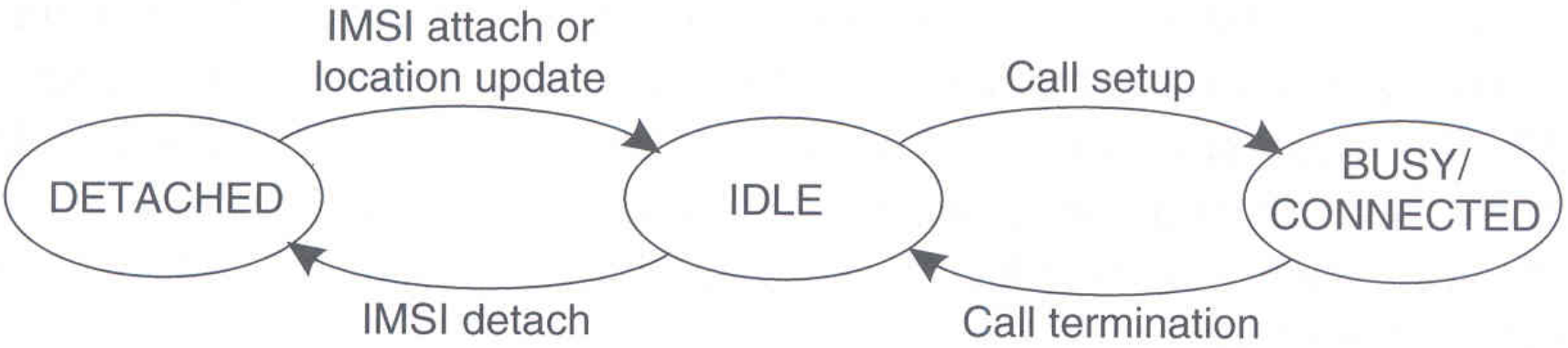



Figure 5.11 CS location management state model.

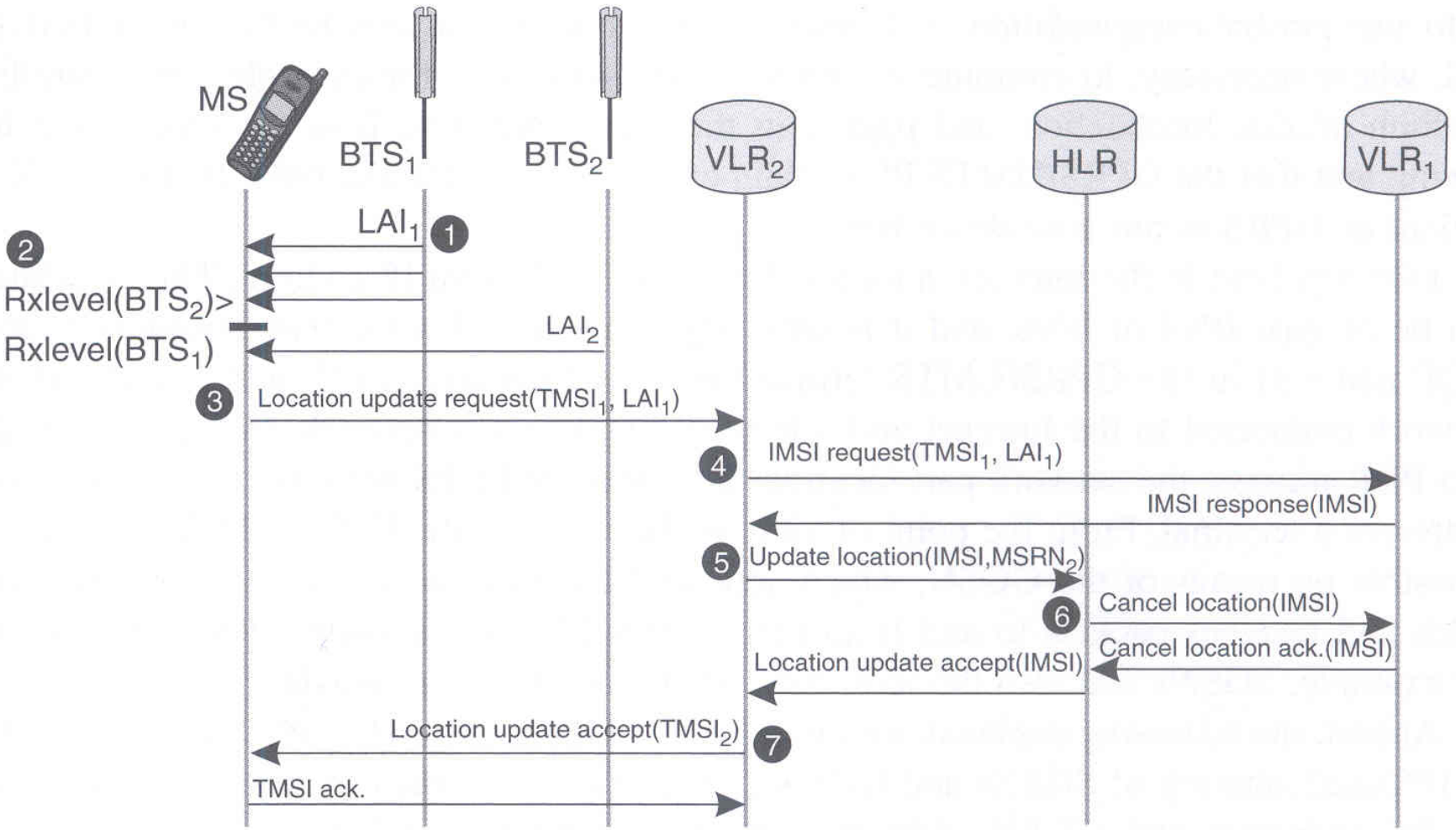



Figure 5.12 Location update procedure in CS networks (simplified).

## 5.6 Location Management in PS Networks

### 5.6.1 Localization and Routing

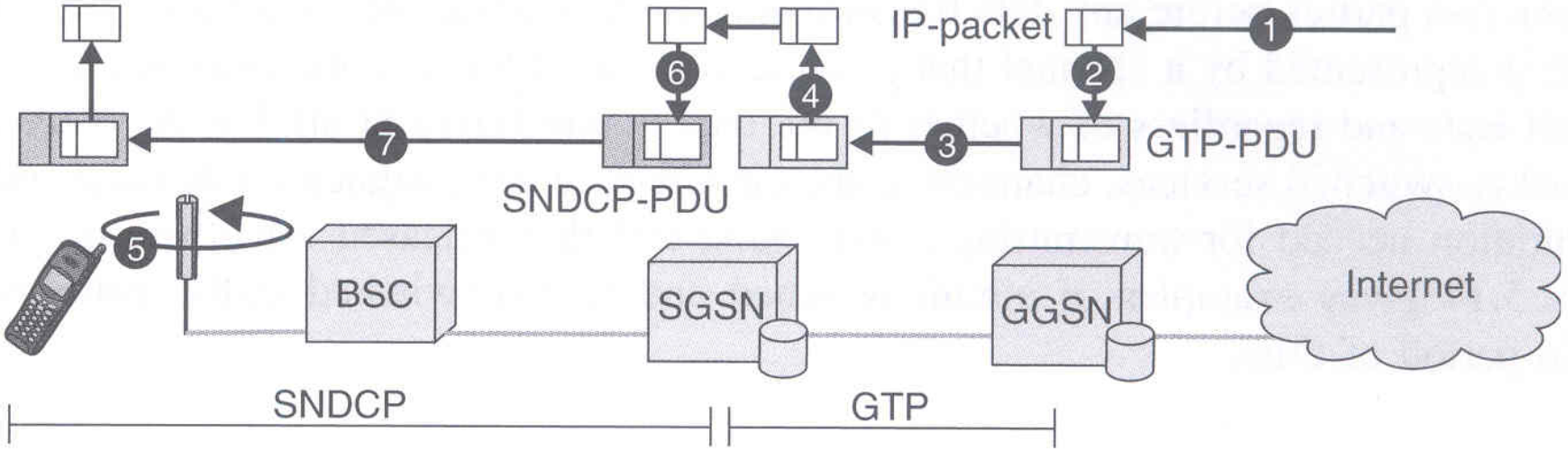



Figure 5.13 Routing of incoming packets.

- **PDP type**
- **PDP address**
- **QoS class**
- **GGSN address**

## 5.6.2 Characteristics of CS and PS Traffic

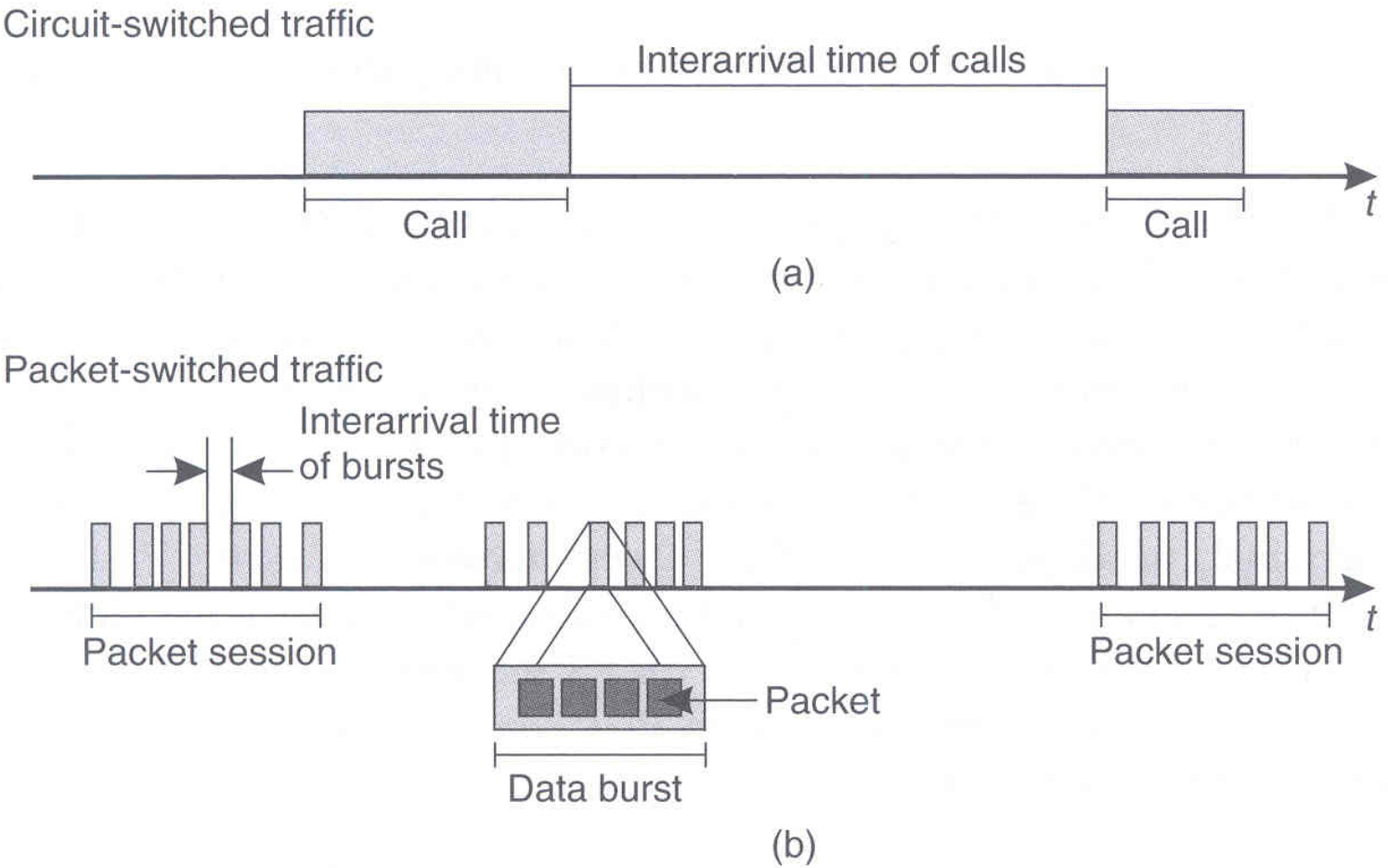



Figure 5.14 Characteristics of circuit and packet-switched traffic.

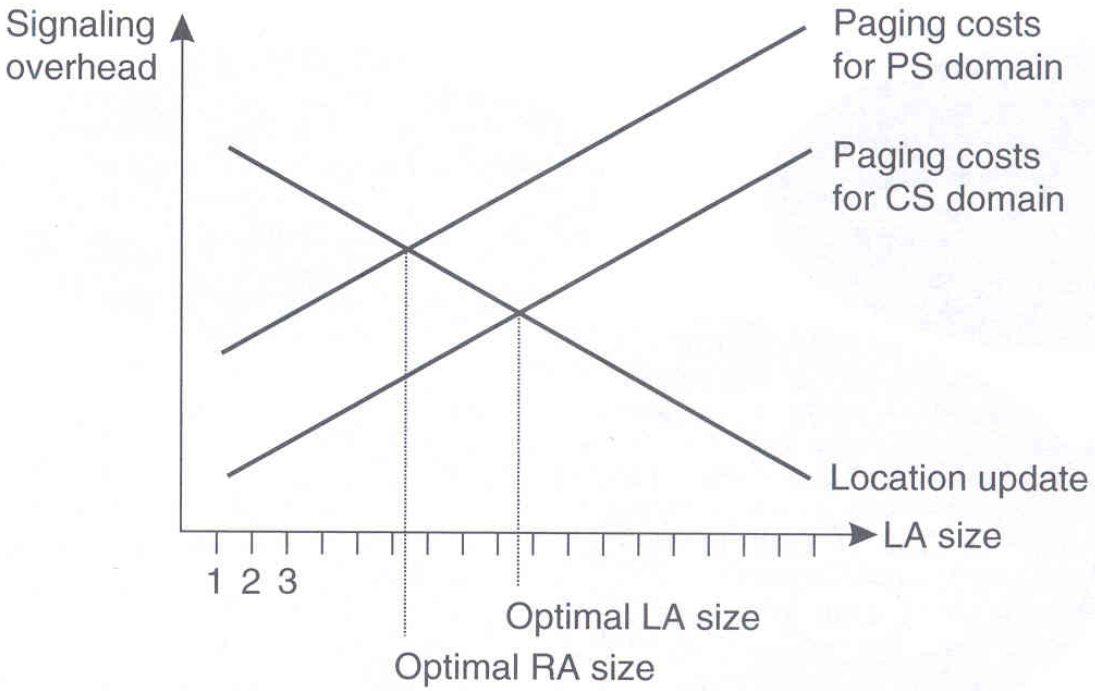



Figure 5.15 Comparison of location management overhead in CS and PS domains. Adapted from (Sanders et al. 2003).

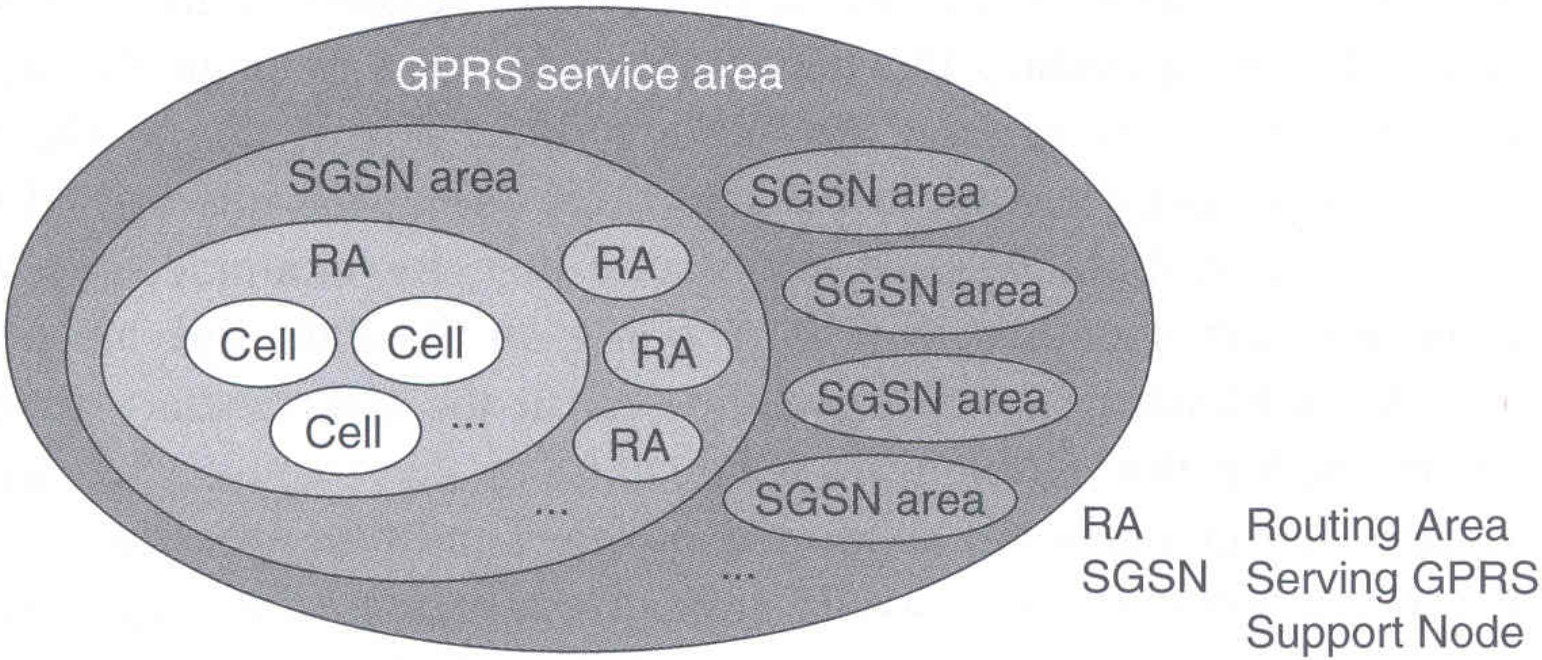



Figure 5.16 GPRS topology for location management.

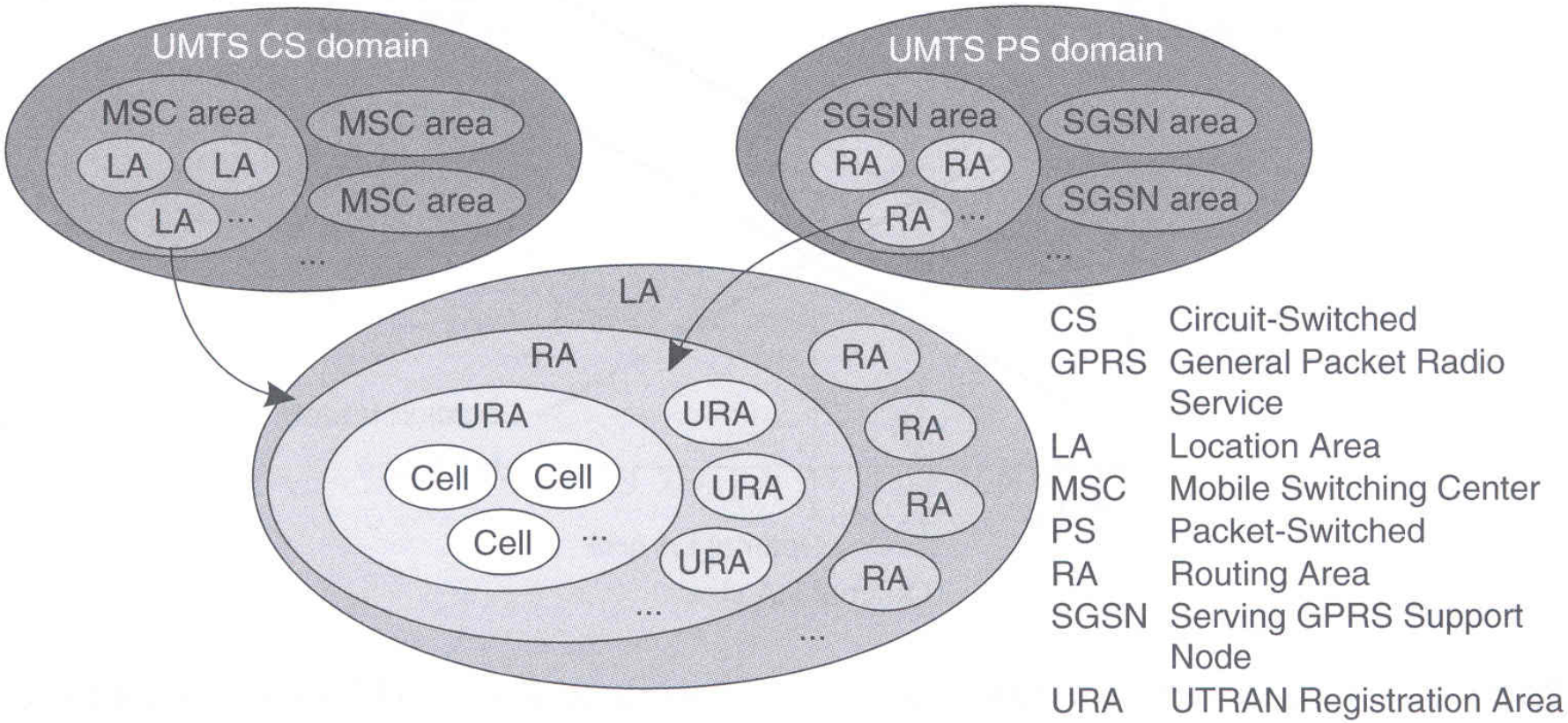



Figure 5.17 UMTS topology for location management.

## 5.6.3 Location Updates

- Location update on routing-area crossing
- Location update on URA crossing
- Location update on cell crossing
- Periodic location update

### 5.6.3.1 Location Updates in GPRS

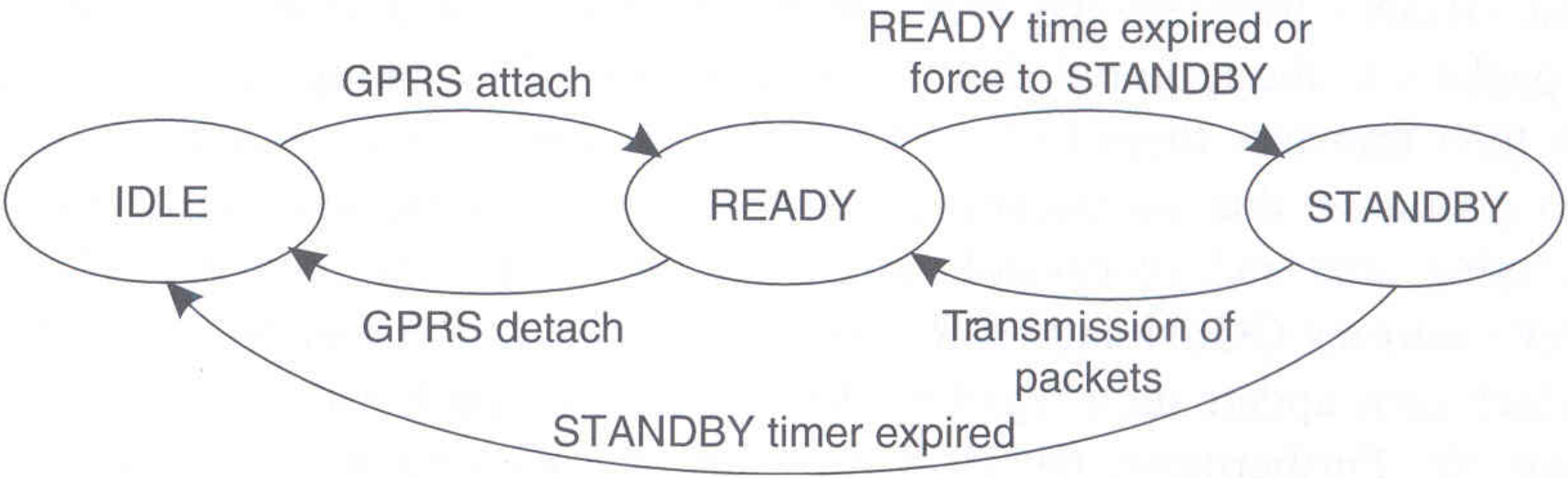



Figure 5.18 GPRS location management state model.

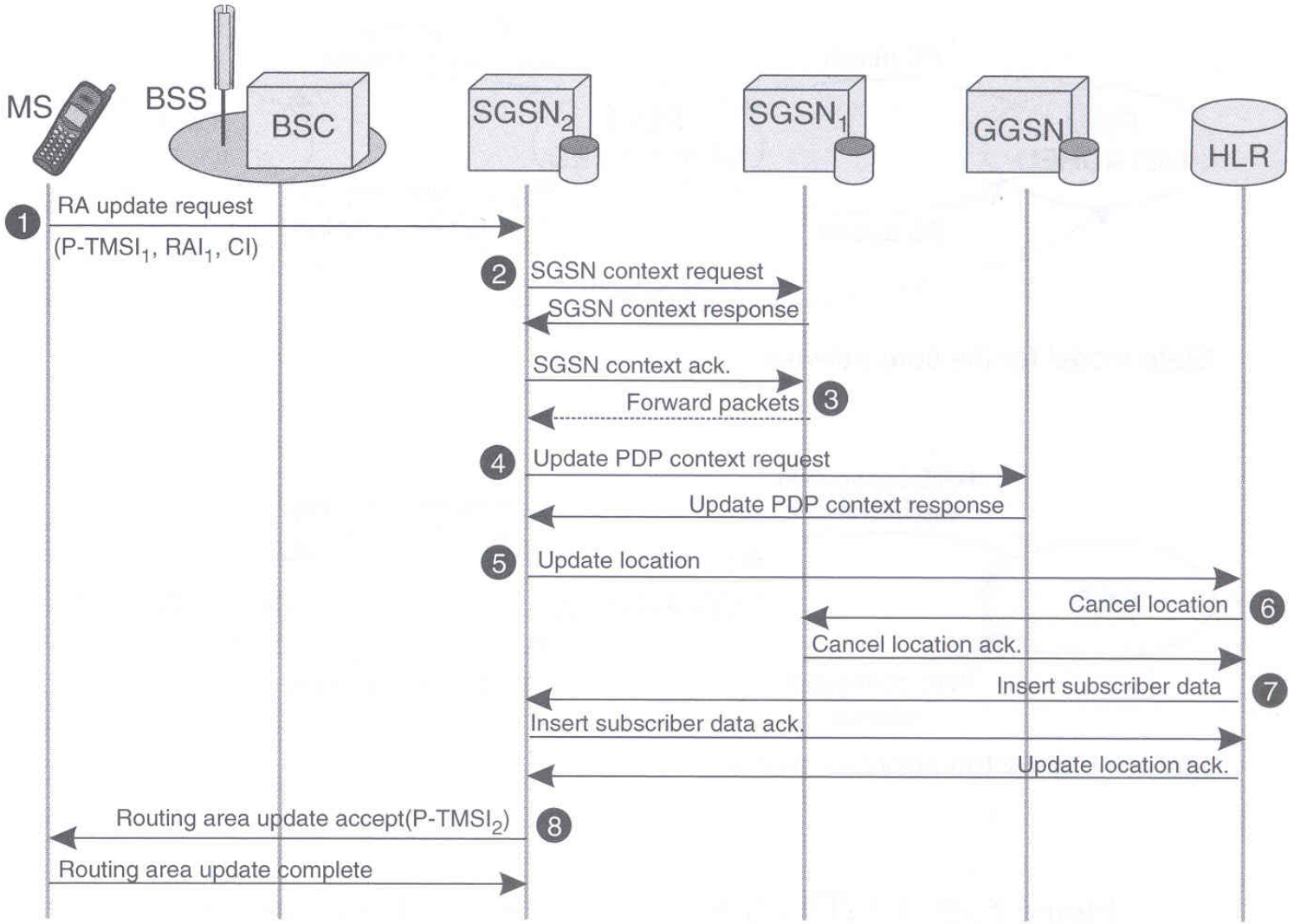
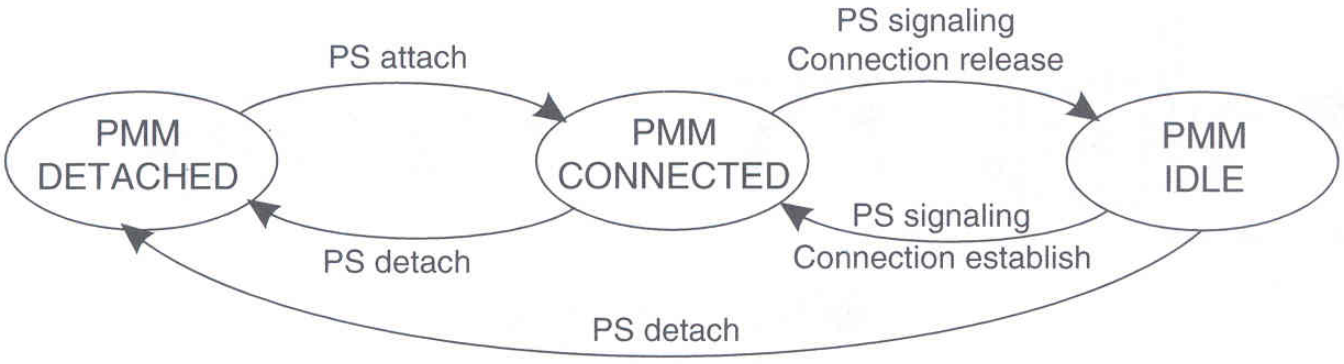


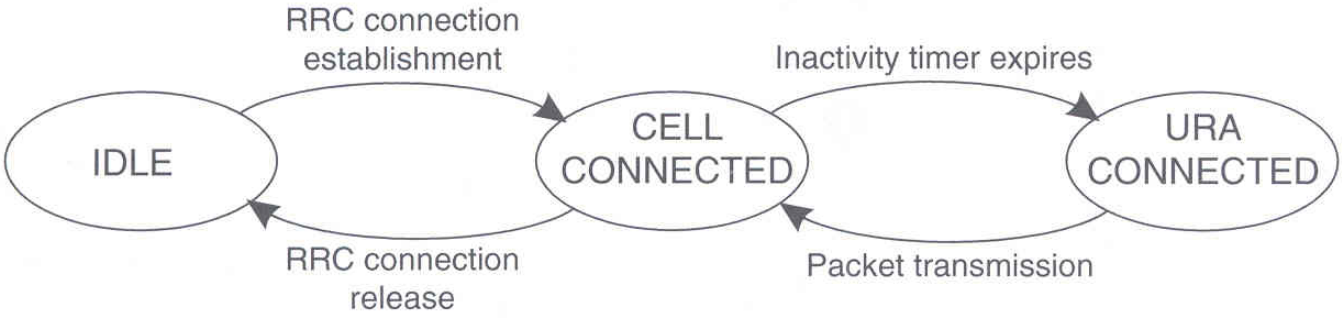

Figure 5.19 RA update procedure in GPRS.

### 5.6.3.2 Location Updates in the UMTS PS Domain




State model for the core network

(a)




State model for the access network

(b)

Figure 5.20 UMTS PS location management state models.

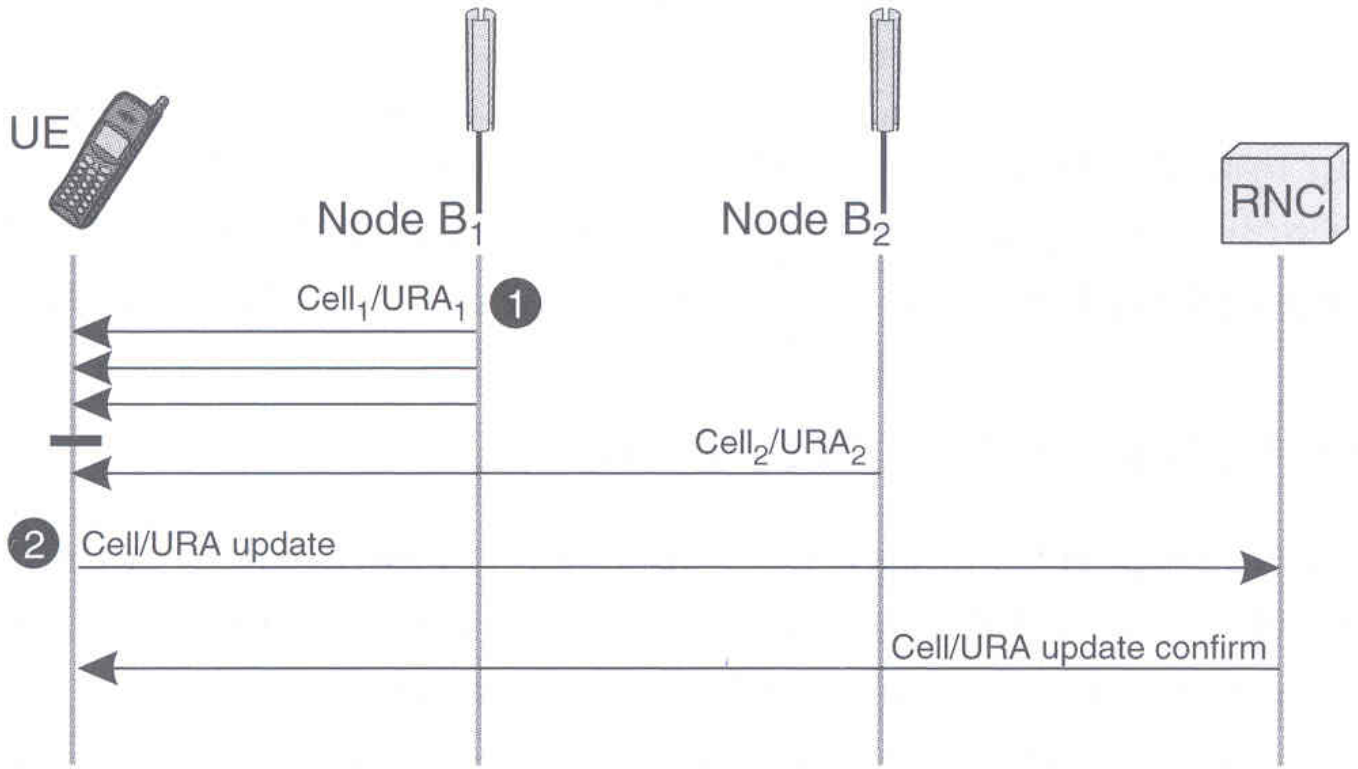



Figure 5.21 Location update procedure in UTRAN.

## 5.7 Conclusion

Table 5.2 Areas tracked by network nodes (Lin et al. 2001)

| | MSC/VLR | | | SGSN | | UTRAN |
|---|---|---|---|---|---|---|
| | **GSM** | **GPRS** | **UMTS** | **GPRS** | **UMTS** | **UMTS** |
| Cell | No | No | No | Yes | No | Yes |
| URA | – | – | No | – | No | Yes |
| Routing area | – | No | No | Yes | Yes | No |
| Location area | Yes | Yes | Yes | No | No | No |