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A Study on Radio Access Technology Selection Algorithms

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Chapter 2
Common Radio Resource Management

Radio Resource Management (RRM) refers to a group of mechanisms that are collectively responsible for efficiently utilizing RRUs within a RAT to provide services with an acceptable level of QoS. RRM mechanisms contain Power Control (PC), Handover Control (HC), Packet Scheduling (PS), Congestion Control (CC), and Admission Control (AC).

At present, Radio Resource Management (RRM) strategies are implemented independently in each RAT. None of the RRM strategies is suitable for the heterogeneous network, because each RRM strategy only considers the situation of one particular RAT. The Common RRM (CRRM) strategy, also known as Multi-access RRM (MRRM) or Joint RRM (JRRM), has been proposed in the literature to coordinate RRU utilization among a number of RATs in an optimized way. One of the earliest work in CRRM [1] shows that networks using CRRM outperform those without CRRM for both real time (RT) and non-real time (NRT) services in terms of call blocking probability and capacity gain.

2.1 CRRM Operation

The CRRM concept is based on a two-tier RRM model [2], consisting of CRRM and RRM entities as shown in Fig. 2.1. The RRM entity is located at the lower tier and manages RRUs within a RAT. The CRRM entity is at the upper tier of the two-tier RRM model. It controls a number of RRM entities and can communicate with other CRRM entities. Based on the information gathered from its controlling RRM entities, the CRRM entity is able to know the RRU availability of multiple RATs and allocate a user to the most suitable RAT.

The interactions between RRM and CRRM entities support two basic functions. The first function is referred to as the information reporting function, which allows RRM entities to report relevant information to their controlling CRRM entity. The information reporting can be performed either periodically or be triggered by an

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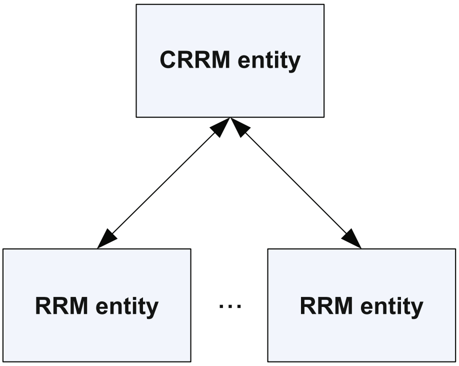

Fig. 2.1 Two-tier RRM model

event. The reported information contains static cell information (cell relations, capabilities, capacities, QoS, maximum bit rate for a given service, and average buffer delay, etc.) and dynamic cell information (cell load, received power level, transmit power level, and interference measurements, etc.) [3]. The information reporting function is also used for information exchange and sharing between different CRRM entities as shown in Fig. 2.2.

The second function is RRM decision support function, which describes the way that RRM and CRRM entities interact with each other to make decisions as shown in Fig. 2.2. There are two RRM decision-making methods. One is CRRM centered decision making, in which the CRRM entity makes decisions and informs RRM entities to execute them. The second is local RRM centered decision-making, where the CRRM entity only advises RRM entities but the final decision is made by the RRM entities rather than the CRRM entity.

A number of interaction degrees exist between CRRM and RRM entities according to the split of functionalities. Pérez-Romero et al. [4] introduced four interaction degrees, which are summarized in Table 2.1. The first column of the table shows the four possible interaction degrees: Low, Intermediate, High, and Very High. Low interaction degree means that the majority of RRM functions are performed in the local RRM entities whereas the Very High interaction degree means that the majority of functions are performed in the CRRM entities. The second column (the interaction time scale) in the table indicates how often the CRRM entities need to communicate with RRM entities. A higher interaction degree between RRM and CRRM entities can achieve a more efficient radio resource management, because more functions are performed at the CRRM level, and the interaction time scale between RRM and CRRM entities is shorter. However, a higher interaction degree means more interaction activities, therefore leads to higher amount of overhead.

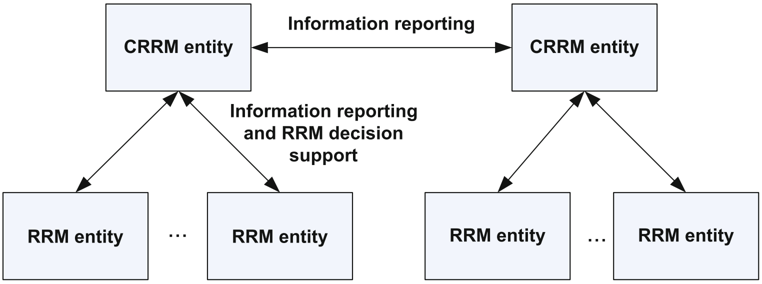

Fig. 2.2 CRRM interaction model

Table 2.1 Interaction degrees between RRM/CRRM entities

Interaction degree	Interaction time scale	Functions in CRRM entities	Functions in local RRM entities
Low	Hours/days	Policy translation and configuration	Initial RAT selection, VHO, admission control, congestion control, horizontal handover, packet scheduling, power control
Intermediate	Minutes	Policy translation and configuration, initial RAT selection, VHO	Admission control, congestion control, horizontal handover, packet scheduling, power control
High	Seconds	Policy translation and configuration, initial RAT selection, VHO, admission control, congestion control, horizontal handover	Packet scheduling, power control
Very high	Milliseconds	Policy translation and configuration, initial RAT selection, VHO, admission control, congestion control, horizontal handover, packet scheduling	Power control

2.2 CRRM Topologies

In the previous section, CRRM was introduced from the functional point of view. From the network point of view, the implementation of CRRM has a number of alternatives. RRM entities are usually integrated into Base Station Controllers (BSCs)

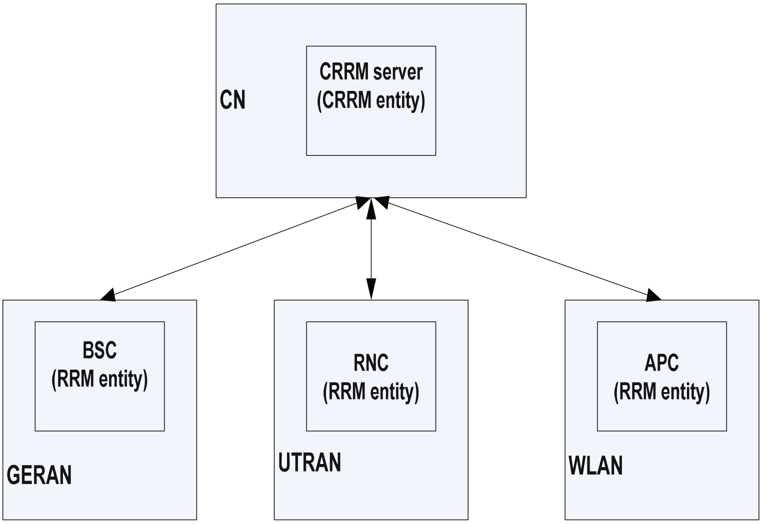

Fig. 2.3 CRRM server approach network topology

in GERAN, Radio Network Controllers (RNCs) in UTRAN, and Access Point Controllers (APCs) in WLAN. The CRRM entity can be implemented in a number of ways.

2.2.1 CRRM Server Topology

In [5, 6], a CRRM server topology as shown in Fig. 2.3 is proposed. A new logical node referred to as the CRRM server is added in the Core Network (CN). It contains all CRRM functions and is connected with a number of RRM entities. The CRRM server topology is centralized so that it can achieve high scalability. However, the introduction of a new network element will increase the cost of network implementation. The communication between RRM entities and the CRRM server introduces additional signalling delays.

2.2.2 Integrated CRRM Topology

In [5–7], an integrated CRRM topology has been proposed (as shown in Fig. 2.4). Unlike the centralized CRRM server topology, the integrated CRRM topology distributes CRRM functionalities into existing network nodes (BSCs, RNCs, and APCs), which requires minimum infrastructure changes. The execution of CRRM functions can be performed directly between RATs rather than through the CN, so that no

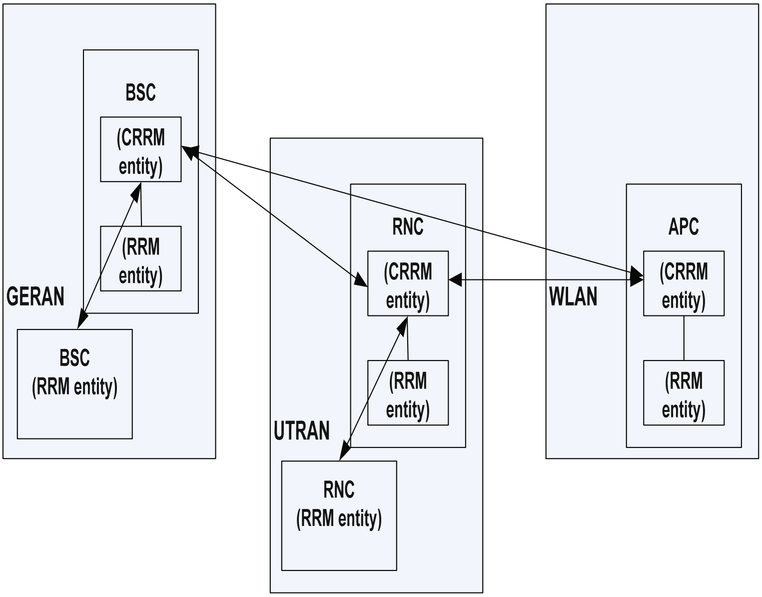

Fig. 2.4 Integrated CRRM approach network topology

additional delay will be incurred. However, the distributed nature of this approach causes a scalability problem. With the increase of the number of RRM entities, the number of connections between the RRM entities will grow exponentially.

In the integrated CRRM topology, CRRM entities may be located either within every BSC, RNC, and APC nodes, or only in some of them [4, 8]. In the first case, the RRM decision support function does not need to be standardized because decision-making processes between CRRM and RRM entities are performed locally in the same physical entity. However, in the latter case, the RRM support function needs to be standardized because some RRM entities are not co-located with the CRRM entity and open interfaces exist between them.

2.2.3 Hierarchical CRRM Topology

In [9], a hierarchical CRRM topology, which is a tradeoff between the centralized and distributed topologies is proposed. As shown in Fig. 2.5, the hierarchical CRRM topology has four layers. The BS is located at the lowest layer, the RAT Resource Management Entity (RRME) manages BSs belonging to the same RAT, the Base Layer Joint Radio Resource Management Entity (BLJRRME) coordinates a number of RRMEs and the Upper Layer Joint Radio Resource Management Entity (ULJR-RME) controls a number of BLJRRMEs. When a new call arrives, RRMEs will

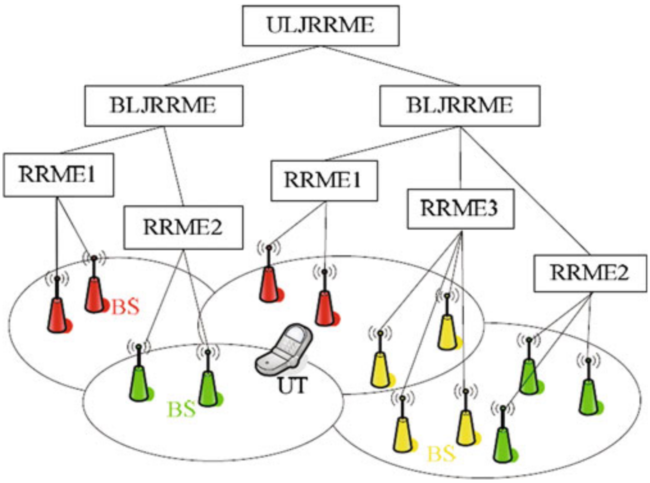

Fig. 2.5 Hierarchical CRRM approach network topology [9]

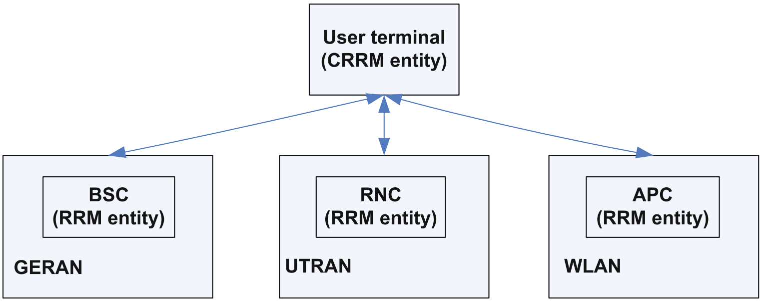

Fig. 2.6 CRRM functions in UT topology

select available cells for it, and subsequently BLJRRMEs will choose the best RAT under its control, finally, the ULJRRME will allocate the call to the most suitable RAT among the RATs recommended by BLJRRMEs.

2.2.4 CRRM Functions in UT Topology

Magnusson et al. [10] proposed a CRRM functions in User Terminal (UT) topology as shown in Fig. 2.6. This topology allows the end user, rather than the network operator to make the RAT selection decisions.

All CRRM topologies given above have their pros and cons. The CRRM server topology is best suited for long-term RRM functions, such as overall load balancing. The integrated CRRM approach combined with the CRRM functions in UT works well for dynamic RRM handling, which requires frequent signal exchanges. The hierarchical CRRM topology is a tradeoff between the two.

2.3 Summary

In this chapter, we have discussed the basic concepts of CRRM, including different interaction functions, interaction degrees, and topologies. In the following chapters, we will look at the most important part of CRRM-RAT selection.

References

1. A. Tolli, P. Hakalin, H. Holma, Performance evaluation of common radio resource management (CRRM), in *IEEE International Conference on Communications 2002*, New York, USA, pp. 3429–3433, May 2002
2. N. Passas, S. Paskalis, A. Kaloxylos, F. Bader, R. Narcisi, E. Tsontsis, A.S. Jahan, H. Aghvami, M. O'Droma, I. Ganchev, Enabling technologies for the always best connected concept. Wirel Commun Mob Comput **6**, 523–540 (2006)
3. J. Pérez-Romero, O. Sal1ent, R. Agustí, P. Karlssont, A. Barbaresit, L. Wang, F. Casadevall, M. Dohler, H. Gonzfilezt, F. Cabral-Pintot, Common radio resource management: functional models and implementation requirements, in *IEEE 16th International Symposium on Personal, Indoor and Mobile Radio Communications*, Berlin, Germany, pp. 2067–2071, Sept 2005
4. J. Pérez-Romero, O. Sallent, R. Agustí, M.A. Diaz-Guerra, *Radio Resource Management Strategies in UMTS*, 2nd edn. (Wiley, Chichester, 2005)
5. J. Pérez-Romero, O. Sallent, R. Agustí On Evaluating beyond 3G radio access networks: architectures, approaches and tools, in *IEEE 61st Vehicular Technology Conference*, Stockholm, Sweden, pp. 2964–2968, May-June 2005
6. 3GPP TR v5.0.0, Improvement of RRM across RNS and RNS/BSS (Release 5), 2001
7. F. Casadevall, P. Karlsson, O. Sallent, H. Gonzalez, A. Barbaresi, M. Dohler, *Overview of the EVEREST Project, 13th IST Mobile & Wireless Communications Summit* (Lion, France, 2004)
8. 3GPP TR v0.3.0, Improvement of RRM across RNS and RNS/BSS (Post Rel-5) (Release 6), 2003
9. Y. Cui, Y. Xue, H. Shang, X. Sha, Z. Ding, A novel scheme and access architecture for joint radio resource management in heterogeneous networks, in *International Forum on Information Technology and Applications, 2009 (IFITA'09)*, Chengdu, China, pp. 24–27, May 2009
10. P. Magnusson, J. Lundsjö, J. Sachs, P. Wallentin, Radio resource management distribution in a beyond 3G multi-radio access architecture, in *IEEE Global Telecommunication Conference*, pp. 3472–3477, 2004