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- **SECRESO: Secure Storage Model for Cloud Data based on Reed-Solomon Code**
  Muhra Ahmed, Quang Hieu Vu, Rasool Asal, Chan Yeob Yeun, Hassan Al Muhairi
- **On the Design of LTE-Advanced Relay Architecture with Multi-RAT Support**
  Jeng-Yueng Chen, Chun-Chuan Yang, Yi-Ting Mai, Chih-Chiang Wu, Shu-Tsz Liu

13:00 - 14:00 **Invited Talk**

(Room: Ophrys - 1st floor)
(Chair: Seungmin Rho)

- **Who Knows What You Want? Smart environments based on the convergence of IT and AI**
  Prof. Runhe Huang Hosei, Japan

14:20 - 16:20 **Session 2-A**
(Room: Azalea - 2nd floor)
(Chair: Sang Hoon Lee)

- **Role-based workspace model for enterprise 2.0 social software**
  Kyoungwon Beak, Jungtae Lee, Ki-yeol Ryu, Seok-Won Lee
- **An OSA Prediction Model Based on Decision Tree Algorithm**
  MING-HSENG TSENG, HSUEH-CHEN HSU, HUA TING, YI-TING MAI
- **A Grid Service Based Virtual Screening System**
  HwaMin Lee, DooSoon Park
- **A Robust Face Recognition Based on Local Transitional Pattern Variance (LTPv)**
  Md. Mehedi Hasan, Taskeed Jabid, Oksam Chae

14:20 - 16:20 **Session 2-B**
(Room: Violet - 2nd floor)
(Chair: Jiangbing Shuai)

- **A novel classification model for non-stationary data streams**
  Yuan Yao, Lin Feng, Feng Chen, Bo Jin
- **Finding Images Containing Personal Identification Information for Privacy Incident Response System**
  JongBae Kim
- **Improving Watermark Capacity of Hamming Code**
  Cheonshik Kim, Ching-Nung Yang
- **A Countermeasure against Wormhole Attacks in MANETs using Analytical Hierarchy Process Methodology**
  Fei Shi, Weijie Liu, Dongxu Jin, Jooseok Song
- **A Study on the Job Execution Time in the Smart Grid Network**
  Sung-Min Jung, Tae-Kyung Kim, Hee-Suk Seo, Seung-jae Lee, Jin Kwak
- **A study on password-based user authentication technology using pattern type**
  Hee-suk Seo, Jin Kwak, Seung-hwan Ju

On the Design of LTE-Advanced Relay Architecture with Multi-RAT Support

Jeng-Yueng Chen[1], Chun-Chuan Yang[2], *Yi-Ting Mai[1], Chih-Chiang Wu[3], and Shu-Tsz Liu[3]
[1] Dept. of Information Networking Technology, Hsiuping University of Science and Technology, Taiwan
[2] Dept. of Computer Science and Information Engineering, National Chi Nan University, Taiwan
[3] Smart Network System Institute, Institute for Information Industry, Taiwan
Correspondence: wkb@mail.hust.edu.tw, No. 11, Gungye Road, Dali, Taichung, Taiwan, R.O.C.

Abstract

LTE/LTE-Advanced [1][2] and IEEE 802.16 WiMAX [3] are competing access network technologies in 4G wireless networks. LTE is one of 3GPP standard versions while 802.16 WiMAX is standardized by IEEE. Although WiMAX already commercially operates in Taiwan, it is limited to the independently new system that cannot compatible with current 3G system. Hence, the cost of system construction is higher and cannot be popularized fast. On the other hand, LTE and LTE-Advanced are developed by 3GPP which is organized by telecommunication manufactories and operators. Moreover, LTE and LTE-Advanced are backward compatible with 3G/UMTS [4] cellular systems. The LTE-Advanced adds a new entity called *relay node (RN)* to enlarge service coverage and provides flexibility of deployment. If RN can support *Multiple Radio Access Technologies (Multi-RATs)* including UMTS, IEEE 802.11 and 802.16, the LTE-advanced system can further provide more flexible services. However, the system architecture for Multi-RAT support is still under development. This paper focuses on integrated architecture design by which RN can provide radio services for both UMTS UEs and LTE UEs. The proposed architecture can integrate 3G UMTS Core Network, UTRAN and 4G LTE-Advanced E-UTRAN. Thus, the transition between 3G and 4G becomes more easily for Multi-RAT UEs without core network connection for control messages.

Keyword: LTE, LTE-A, Multi-RAT, UMTS, 4G

1. Introduction and Method

1.1 LTE-Advanced

Each eNB has a limited serving area. But it is more difficult to deploy a new eNB as *Donor eNB (DeNB)* since residents have much healthy concern about the electromagnetic wave. Thus, the idea of signal relaying by a smaller entity called RN has been proposed and becomes an LTE-Advanced specification.

1.2 Proposed Multi-RAT integrated RN structure

The LTE standard is designed to support Multi-RATs such as GSM, UMTS, WiFi and WiMAX. The architecture for inter-working with LTE and different access technologies are simply connecting their core networks. Although this architecture is workable, the packets are routed and exchanged via core networks.

LTE-Advanced adds a new entity called RN to enlarge service coverage and provides flexibility of deployment. If RN is able to deal with different radio signals from different access technologies, then packets from UEs with different technologies are routed and exchanged via RN and DeNB directly without passing through core networks. Thus, the system performance can be improved due to shorter route path than core network transmission. Figure 1 shows our proposed system architecture for supporting Multi-RAT including UMTS and GSM.

Since the radio access technologies are various in different styles, this paper focuses on the design of the integrated radio access networks between LTE-Advanced and UMTS. The architecture for inter-working with UMTS and LTE is simply connecting the core networks in both systems. However, the functionalities of RN are still under development in LTE-Advanced. We assume that RN is able to deal with different radio signals from different access technologies, i.e. RN is able to provide services for both UMTS UEs and LTE UEs. This paper proposes two different architectures for inter-connecting UMTS and LTE via RN and DeNB. The key motivation of proposed architectures is to improve system performance without modifying LTE-Advanced and UMTS core networks. The RN can serve UMTS UEs by integrating UMTS functionalities into RN. Moreover, interfaces between DeNB and UMTS core network are also added to improve system efficiency. The packets from UMTS UEs are exchanged between DeNB and UMTS entities without routing through LTE core network. Two different approaches, namely *Alternative 1 (Alt 1)* and *Alternative 2 (Alt 2)* are proposed in this paper.

2. Performance evaluation

In Alt1, we assume that the DeNB is implemented based on LTE release 10 specification. Therefore, the functionalities of S-GW and P-GW are embedded in the DeNB. DeNB connects UMTS core network with intranet and new interface between DeNB and UMTS is added as shown in Figure 2-Alt 1. In order to serve UMTS UEs, the RN is embedded with functionalities of NodeB. DeNB exchanges messages with RNC via IP tunnel between them. In Alt 2 approach, the RN not only implements functionalities of NodeB, but also implements the functionalities of RNC. Therefore, the traffic from UMTS UE can be processing in RN and then forwarded to UMTS core network via DeNB interface which connects DeNB and UMTS core network as shown in Figure 2-Alt 2. In this architecture, if a group of UMTS UEs is moving with its serving RN, the UE handover signaling can be removed since RNC is located in RN. Alt 2 has the potential ability to support group mobility of UMTS UEs. Both of two alternatives of the protocol stack with control plane have shown as Figure 3 and Figure 4. To compare with two alternatives, Table 1 has shown some criteria and results.

3. Conclusion

Both LTE and LTE-Advanced are backward compatible with 3G/UMTS cellular systems. The LTE-Advanced adds a new entity called RN to enlarge service coverage. To support Multi-RATs in RN, this paper focuses on designing an integrated architecture by which RN is able to provide services for both UMTS UEs and LTE UEs. Two novel and different inter-connected architectures are proposed for UEs transmission in this paper.

Table 1. Comparison between Alt 1 and Alt 2

Metric	Alt 1	Alt 2
UMTS RNC Complexity	IP intranet btw DeNB and RNC Serving UMTS-UE via E-UTRAN	No impact
RN Complexity	+ UMTS-Uu	+ UMTS-Uu + Node B/RNC functionality
DeNB Complexity	Bearer management + P-GW/S-GW	Bearer management + P-GW/S-GW
LTE/UMTS CN Complexity	No impact	IP Intranet btw E-UTRAN and UMTS-CN
Standardization Effort and Complexity	Medium impact	High impact
UMTS-UE Transmission Efficiency	High	High
Security Concern	Low	Low

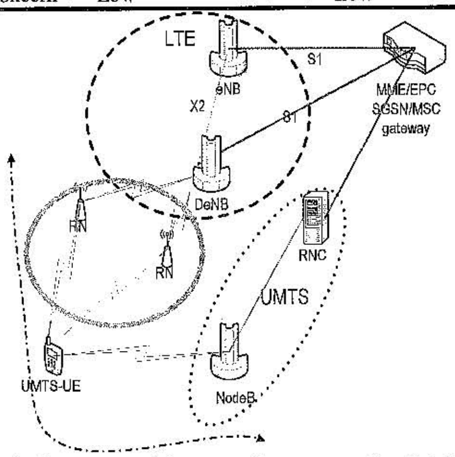

Figure 1. System architecture for supporting Multi-RAT

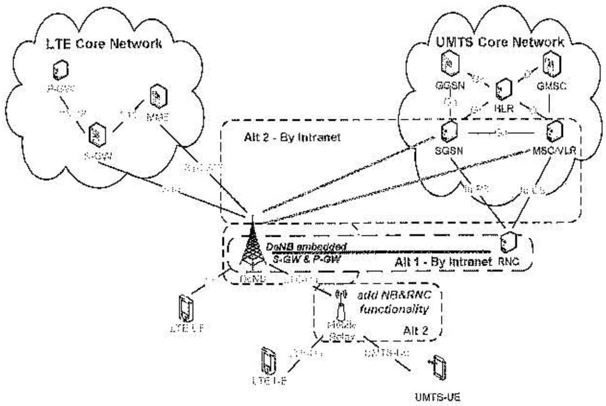

Figure 2. System architecture for inetgrated LTE-Advanced and UMTS

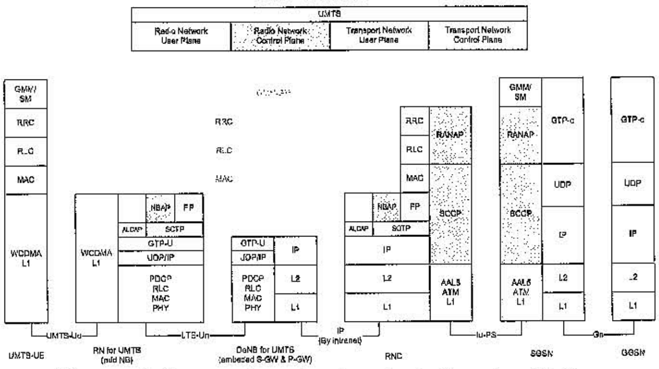

Figure 3. Protocol stack of control plane in Alt 1

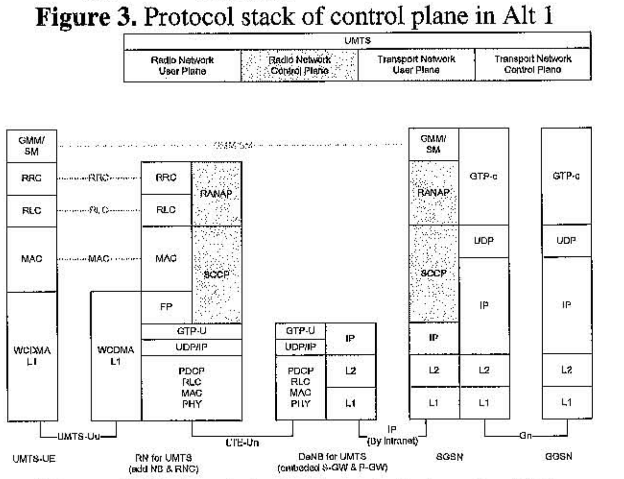

Figure 4. Protocol stack of control plane in Alt 2

References

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