Summary of Resource Management for QoS Support in Cellular/WLAN Interworking

The following is a summary of the findings of Wei Song and others about resource management for QoS support in cellular-WLAN interworking.[[1]](#endnote-1) Between 1995 and 2005, the most promising technologies were WLANs and cellular networks. 2G transformed us from analog to digital technologies. Then, the 2.5G cellular networks provided low-rate packet-switched data services. The demand for high-speed multimedia services led to the development of 3G, with a maximum bit rate of 2Mb/s. WLANs showed the capacity to offer data services at maximum rates of 11 Mb/s and 54Mb/s at a cheaper cost. To enable smooth Internet access for mobile customers with multimode access capabilities, it was intended to make 4G wireless networks heterogeneous.

To achieve the previous intention, it was needed to look at the cellular/WLAN interworking which presents many challenges. This raised the question of how to make the most of WLAN's fast data rates and cellular networks' extensive coverage and roaming support.

The interworking designs are divided into two groups: tight coupling architecture and loose coupling architecture. The cellular core network perceives the WLAN as a single cellular radio access network. The cellular networks’ mobility management protocols serve as the foundation for a user traveling between the two domains. The need for an interface in the cellular core network that is exposed to WLANs, the likelihood that the cellular core network will experience a network bottleneck due to the amount of WLAN traffic it will likely receive, and the requirement for compatible protocol stacks between WLANs and cellular networks are drawbacks to the tight coupling approach.

Loose coupling architecture links WLANs to the internet backbone directly. The deployment of two domains is its key benefit. The drawback is that mobility signals may take a path that is somewhat lengthy.

The growing trend toward an all-IP 4G infrastructure complements the loosely connected interworking of cellular networks and WLANs nicely, and it can be easily implemented in a domain-based DiffServ architecture. The MS has access to the Internet through the BS or AP. The DiffServ Internet backbone connects every wireless domain, enabling an MS to receive end-to-end Internet services.

As for resource allocation, it is crucial for cellular networks because it helps each MS receive a QoS guarantee while maximizing the use of limited radio resources. However, it is considerably harder to ensure QoS provisioning and effective resource usage when cellular networks are interworking with WLANs. If we want to come up with a resource allocation method that works, there are several things we need to account for.

Several resource allocation strategies are used. In cellular networks with centralized design, the BS can assure QoS guarantee to MSs through schedulers which can communicate with other schedulers in other BSs. The necessary DCF and optional PCF for two-channel access are defined in the present WLAN in a centralized way.

Within WLAN-covered locations, MSs have access to both cellular and WLAN networks. It is optional to switch from a cellular network to its overlay WLANs which will influence QoS guarantee and resource allocation and may increase latency, packet losses, and connection disruption. The vertical handoff’s situation will be worse.

Cellular networks can efficiently handle real-time traffic. In contrast, WLAN can efficiently handle bursty data flow. Cellular networks cannot support asymmetric traffic load. WLANs may be thought of as functioning in a virtual form of TDD, which can handle the asymmetry in the demand placed on the data stream.

Resource allocation will face additional difficulties when WLAN and cellular networks are integrated. A choice must be made on whether to permit an incoming service request to the WLAN or the overlying cell when it enters a WLAN-covered area. The user's active call may be transferred to the WLAN for load balancing, cost reduction, and other reasons. The WLAN or the covering cell is first chosen for admission for new calls coming from inside a WLAN-covered region, depending on the service type, user mobility, and current network state. The service request might overflow to the other network for admission if the preferred network rejects it.

Restrictive access mechanisms are used to correctly divide the total bandwidth between voice and data services. Voice traffic is given preemptive precedence over data traffic and uses a specific amount of bandwidth; the remaining bandwidth is reserved for data traffic. Current data flows share equitably all available bandwidth that is not being consumed by voice traffic. The number of data calls permitted in a cell or WLAN should be limited.

Voice calls are permitted; however, the cellular network is preferred.

A WLAN's increased bandwidth makes it possible to use the allotted resources more quickly. A new voice and data call must ask to be admitted to the covering cell when there is only cellular coverage in the region. For the new voice calls, there are two options in a "double-coverage area": a new voice call will attempt to enter the cell first. If there is not enough bandwidth to support the new voice call, the request is declined. The WLAN is the primary option for new data calls in the double-coverage region. If the WLAN rejects the admission request of a data call, it will not attempt the cell. In the cellular-only region, an LFG policy is employed to give voice calls precedence which are allotted a specific amount of cell bandwidth. The call will end when the covering cell and WLAN concurrently reject the voice service request.

In evaluation, versus the WLAN-first strategy, a voice call's typical number of handoffs is drastically decreased, which results in much less delay and handoff-related packet losses. With greater user mobility, the improvement grows.

1. Wei Song, Hai Jiang, Weihua Zhuang, and Xuemin (Sherman) Shen. Resource Management for QoS Support in

   Cellular/WLAN Interworking University of Waterloo, 2005 [↑](#endnote-ref-1)