Conservation of Mobile Energy and Optimum Usage of Radio Resources in Cellular Networks

Idle Leverage

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Abstract— While assessing the nature of cellular networks, it is noticed that inactivity timers are employed to control the release of radio assets. It is commonly noticed that there is disruption during the period of inactivity timers. This disruption is called Tail time. This results in the wastage of a large proportion of energy in client gadgets and a lot of radio assets. This research study proposes that this problem called Tail time can be overcome by employing a technique known as Idle Leverage. This Idle Leverage is for batching and prefetching which in turn would reduce energy consumption. Idle Leverage provides a customized application programming interface to distinguish requests and then schedules delay tolerant and prefetchable requests in the Tail time to save energy. Idle Leverage utilizes a virtual Tail time mechanism to identify the amount of Tail time that can be used and a dual queue scheduling algorithm to schedule transmissions. This research study implements Idle Leverage in the Network Simulator with a model for estimating energy consumption that is based on parameters measured from handsets. As a result of this experiment, it has been proved that Idle Leverage can achieve significant savings on battery energy and avoid wastage in the case of radio assets. As per assessment 70% of savings has been achieved in mobile battery energy, and it dedicates radio assets up to 60%, compared to the existing system.

Keywords- *cellular network, Dedicating radio assets, Energy saving, Idle leverage, Tail time.*

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I. INTRODUCTION

In cellular networks a large proportion of energy in user devices and a lot of radio assets are wasted due to the following reasons:

i. After the consummation of a transmission the telephone does not switch from the high to the low power state properly. Yet sits tight for a time of time (tail time).
ii. A lot of tail time itself brings about huge energy waste.

To mitigate the tail time effect this paper propose Idle Leverage a scheme that leverages the tail time for batching and prefetching to save energy. To the best of my knowledge it is the best to consider using the tail time, rather than eliminating the inevitable tail time specified by cellular specifications.

The Idle Leverage steals the tail time for two cases namely, to transfer delay tolerant requests in batches and to prefetch data that are likely to be requested in the future [1]. To utilize the tail time with lesser impact on existing systems , a virtual tail time mechanism and dual queue scheduling are proposed. Virtual tail time mechanism maintains tail timers that communicate to physical tail timers after a transmission is completed. These virtual timers finding the time during which Idle Leverage can achieve batching and prefetching. It also terminates Tail transmission at the end of the virtual tail time. Dual queue scheduling handles Idle leverage requests, controls transmission rate [2].

In the remaining part of this paper formulates the problem defines trade-offs, and explains the applied energy consumption model and presents the design of Idle Leverage.

II. BACKGROUND

A. *Application Resource Optimizer [4]*

Author Name: Feng Qian, Zhaoguang Wang, Alexandre Gerber, Z. Morley Mao, Subhabrata Sen, Oliver Spatscheck (2011)

Despite the popularity of mobile applications, their performance and energy bottlenecks remain hidden due to a lack of visibility into the resource-constrained mobile execution environment with potentially complex interaction with the application behavior. We design and implement ARO, the mobile Application Resource Optimizer, the first tool that efficiently and accurately exposes the cross-layer interaction among various layers including radio resource channel state, transport layer, application layer, and the user interaction layer to enable the discovery of inefficient resource usage for smartphone applications. To realize this, ARO provides three key novel analyses: (i) accurate inference of lower-layer radio resource control states, (ii) quantification of the resource impact of application traffic patterns, and (iii) detection of energy and radio resource bottlenecks by jointly analyzing cross-layer information. We have implemented ARO and demonstrated its benefit on several essential categories of popular Android applications to detect radio resource and energy inefficiencies, such as unacceptably high (46%) energy overhead of periodic audience measurements and inefficient content prefetching behavior. But this technique has some limitations. ARO addresses a new problem of quantifying resource consumption of traffic bursts due to a certain triggering factor

Analyzing data collected at one single layer does not provide such insight due to incomplete information.

B. Characterizing Radio Resource Allocation for 3G Networks [5]

Author Name: Feng Qian, Zhaoguang Wang, Alexandre Gerber, Z. Morley Mao, Subhabrata Sen, Oliver Spatscheck (2010)

Systematically characterize the impact of operational state machine settings by analyzing traces collected from a commercial UMTS network, and pinpoint the inefficiencies caused by the interplay between smartphone applications and the state machine behavior. Besides basic characterizations, we explore the optimal state machine settings in terms of several critical timer values evaluated using real network traces. Our findings suggest that the fundamental limitation of the current state machine design is its static nature of treating all traffic according to the same inactivity timers, making it difficult to balance tradeoffs among radio resource usage efficiency, network management overhead, device radio energy consumption, and performance.

The current design of the RRC state machine appears to be ad-hoc with statically configured parameters. Our work systematically studies its design using real cellular traces from a large cellular ISP and analyzes the effect on important factors from both the network operator's perspectives, namely radio resource usage efficiency and management overhead, and from end-user's perspective, namely device energy consumption and application performance. We examine tradeoffs among these factors. In particular, we focus on settings of critical inactivity timer values that determine when to release radio resources after a period of inactivity. But this technique has some limitations. They are the problem from the perspective of network capacity as to reducing the call blocking and dropping rate. In their scenario, the same timer values are applied globally to all UEs at any given time.Theory and Practice of RRC State Transitions in LTE Networks

All the above said works are with more demerits than merits. Hence a new model is proposed by name Idle Leverage.

III. SYSTEM MODULES

There are several modules are in use in Idle Leverage, They are given below,

A) Resource Optimizer
B) Traffic Aggregations
C) Tail time Mechanism

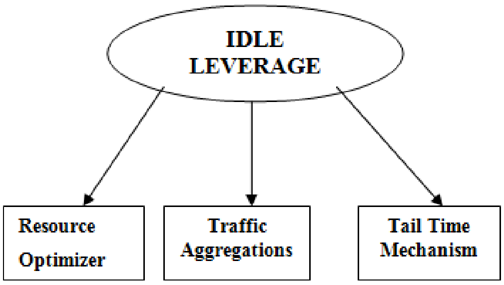

Fig 1. System Modules

A. Resource Optimizer

This module of resource optimization in general that aim to open access environment can be promoted and the collection development possibly assist by incorporate open access resources. The mobile Application Resource Optimizer the primary tool that exposes the cross layer interface for layers starting from radio resource management to application layer. Technique significantly helps to the developers finding resource usage inefficiencies and achieves their applications.

B. Traffic Aggregations

It schedules transmission based on traffic patterns.Small transmissions are aggregated into large once. So that the tails and energy consumption are reduced and data transmission can be prefetched to achieve aggregations.

C. Tail Time Mechanism

The cellular network in actively transfer data, the device stay at a high power state called Active; when only a low-speed transmission is possibly desired, the device stays at a sub-high power state called FACH; and when there is no traffic, the user gadgets stays at the IDLE sate. And it consume very small amount of power.

This period of time is referred to as Tail time, while it consumes power but does not transfer data. The necessity of the Tail time deceit in the fact that if the device switches to the IDLE state immediately a transmission completes, the device would have to switch from the IDLE to the Active state (state promotion) if there is a transmission in the near future.

In this module using two mechanisms are used to leverage the Tail Time namely, Virtual tail time and Dual queue Scheduling methods.

IV. SYSTEM DESIGN

An Idle Leverage, a plan that manipulates the Tail time for batching and prefetching to lessen energy consumption is proposed. The design of Idle Leverage for reducing energy consumption in cellular networks. The Radio Network Controller (RNC) is an imperative part of the LTE network [1]. The Tail time issue makes from the power state supervision for cellular networks (e.g., GSM, 3G & 4G). Take the 4G case as an example. In LTE, during the idle state, a user device periodically wakes up to check paging messages and sleeps for the remaining time. LTE supports both RRC_CONNECTED and RRC_IDLE modes [7]. When the cellular line is actively transfer data, the device stay at a high power state called Active (DCH); when only a low-speed communication is possibly desired, the device stays at a sub-high power state called FACH; and when there is no traffic, the device stable at the IDLE sate and consumes very small amount of power. After the achievement of every transmission, the device stays at active and sub high state for a period of time.

This period of time is referred to as tail time, since it consumes power but does not transfer data. The necessity of the Tail time lies in the fact that if the apparatus switches to the IDLE state as soon as a diffusion completes, the device would have to switch from the IDLE to the DCH state (state promotion) if there is a transmission in the near future. This state promotion would result in high delay and large energy transparency, in which case the applications would suffer severely. There are two mechanism are used in idle leverage. First, Virtual time mechanism and second, Dual queue scheduling method. Int thus methods are explain below.

A. Virtual Time Mechanism

To determine the time during which batching and prefetching can be performed. It has two jobs,

- Determining the amount of Tail Time
- Terminating Tail transmission.

B. Dual Queue Scheduling

To scheduling requests that must be scheduled instantaneously and that can be delayed dual queue scheduling is introduced. It handles Idle leverage requests and controls packets transmission rate.

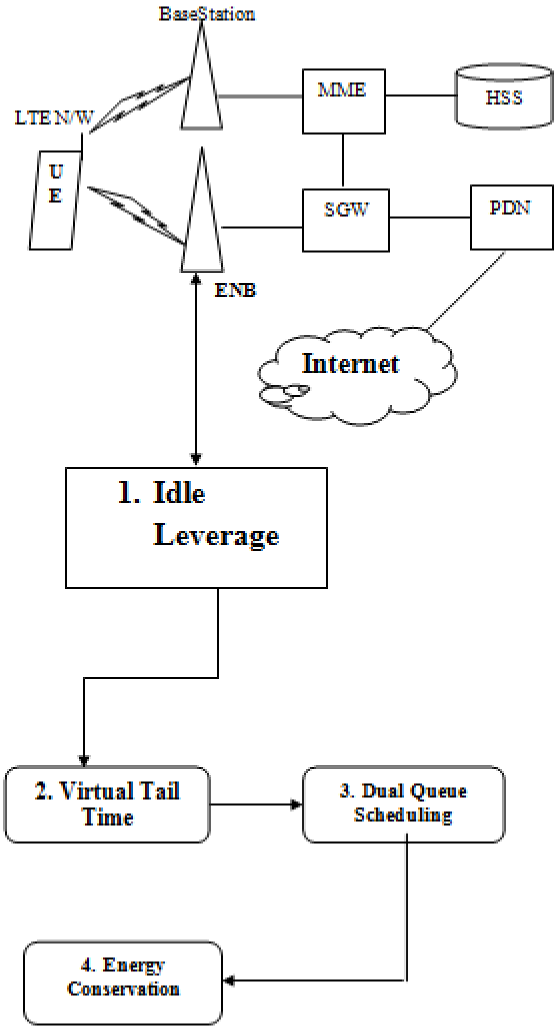

Figure2: System Architecture

V. PERFORMANCE OF IDLE LEVERAGE

Idle Leverage can achieve significant savings on battery energy and avoid wastage in the case of radio assets. As per assessment 70% of savings has been achieved in mobile battery energy, and it dedicates radio assets up to 60%, compared to the existing system.

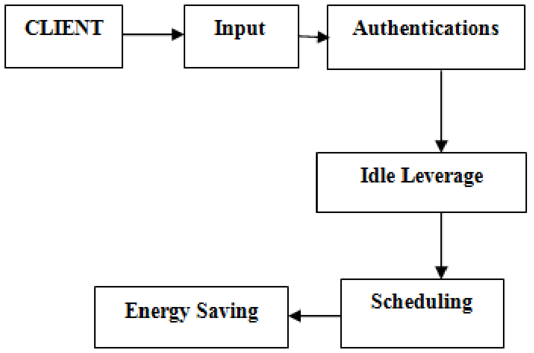

Fig 3. Idle Leverage Process

In thus above mentioned figure are explained the flow of the idle leverage method. The idle leverage method is control radio asserts, when the client give a input for transmission. Since a large fraction of transmission could be scheduled to the wasted tail time, the energy consumption could be reduced significantly and the prefetching and delayed transferred can improve user perceived performance.

VI. CONCLUSION

The technology proposed in this paper is idle leverage technology, that leverages the tail time for batching and prefetching to save energy. By scheduling a number of requests in the tail time energy consumption is significantly reduced as unused tail time is utilized and total transmission time is reduced. The experimental results show that Idle Leverage achieves more significant savings on battery energy and dedicated radio asserts up to 60%.

The tail optimization approach reduces traffic aggregation up to 62% and tail time tuning up to 15% compared other systems.

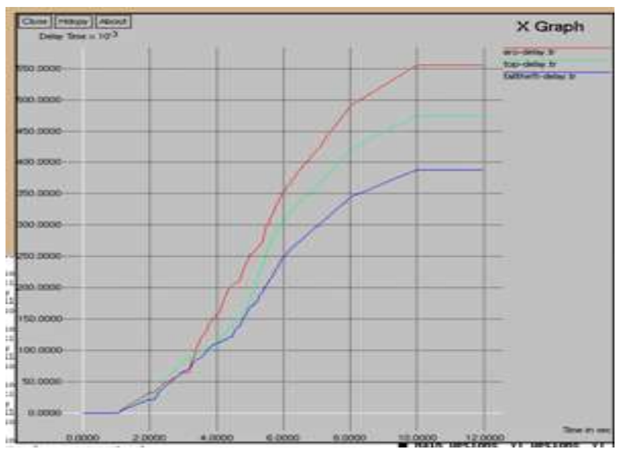

Fig4. Performance analysis

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Compared with previously used other technologies this has a better performance in energy consumption 60 to 62% under using traffic pattern analysis this technology is performing well without affecting user devices.

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