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RESEARCH ARTICLE

CENTRALIZED CONTROL OVER GREENING RESIDENTIAL WIFI NETWORKS

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Abstract- With the rapid growth in information and communication technology, reducing energy consumption of residential Wi-Fi networks has attracted increasing attention in recent years. Today's household equipments are not only limited to traditional devices but also devices for VoIP, health monitoring, security surveillance etc. Wireless access points are always on so as to give continuous online presence to such devices. Also with the continuously growing popularity of Wi-Fi networks, there is a considerable growth in user premises equipments. A typical home gateway comprises a modem; router and wireless access point and such devices consume high per bit energy even in the case of light traffic. A solution for reducing energy consumption in residential Wi-Fi networks is to aggregate all client traffic on some suitable access points and put remaining APs to sleep. In this scheme, a centralized approach is used for reducing energy consumption with the benefits of fairness, no client modification, explicit control of migrations and allowing for heterogeneity amongst households. A central operator takes all the responsibility of minimizing energy consumption and reduces the burden on users.

Index Terms- Residential Wi-Fi networks, energy consumption, centralized approach.

I. INTRODUCTION

Wi-Fi is a technology that is used to provide internet access to devices that are within the range of a network that is connected to the Internet. It is wireless networking technology that uses radio waves to provide wireless high-speed internet and network connections that is no physical wired connection between sender and receiver.

Wi-Fi:

Wi-Fi works with a frequency within the electromagnetic spectrum associated with radio wave propagation. When a RF current is supplied to an antenna, electromagnetic fields are created that then are able to propagate through space. An access point(AP) is a central device that broadband a Wi-Fi signal for Wi-Fi clients to connect to. The primary job of an access point is to broadband a wireless signal that computers can detect and tune into. In order to connect to an APs and join a wireless network connection, computers and devices must be equipped with wireless network adapters.

Energy Consumption:

Wi-Fi provides service in business, organization, hotels, cafes etc. In recent years Wi-Fi connectivity is not limited to only such places but has been extended for residential buildings. The number of wireless devices has

increased tremendously in the recent year. Due to rapid evolution of information as communication technology (ICT) energy consumption is also increasing at a high rate. Information communication technology equipment's also major amount of energy is consumed in the access network due to user equipment like VoIP, health monitoring, smart metering, security surveillance etc. and their high per bit energy consumption. As such devices are not energy proportional that is they consume maximum amount of energy even if light traffic is there, need to provide continuous online presence. Also, straight forward techniques for sleeping during idle periods are not appropriate in this environment because of the continuous lightweight traffic.

The pressure on reduction of the energy consumption of ICT has become more and more prominent, because of the reason: Economic the total cost of ownership of network is increasing because of higher capacity network equipment are used and they are more power hungry and requires more cooling, as well as due to increasing energy prices.

Approaches to reduce the Energy Consumption:

These issues can be better addressed by using centralized approach rather than distributed approach. The system gives following specific contribution:

a. Architecture for reducing energy consumption in residential Wi-Fi networks is based on a centralized approach.

b. It addresses fairness in energy savings, allowing heterogeneity among households equipments and no client modification is required.

c. Algorithm is developed that maximize reduction of energy consumption and demonstrated on the performance of real traffic.

Centralized approach:

An ISP or a third party referred to as operator works as the central controller. This operator takes on the responsibility of reduction of energy consumption in residential Wi-Fi networks. The central controller runs the energy savings

algorithm periodically to determine the set of access points that need to be on. As operator works as a controller for whole system, the proposed system also minimizes the burden on users to participate in the energy savings scheme. Due to centralization, users do not need to implement any new mechanism and this will remove a barrier to adaption.

The green operator:

A central controller takes on the responsibility of reduction in energy consumption of residential Wi-Fi networks which is called as green operator or sometimes operator. An ISP or a third party can work as an operator. This operator has control residential gateways or APs and takes decisions of states of APs. That is whether the APs are in awake state or in asleep state. This operator periodically runs the proposed algorithm and find out which APs should be on and its client association in order to perform all these functions operator need to install following capabilities at this APs:

1. Dual-SSIDs
2. Client monitoring
3. Radio management.

Set-and-Forget approach

The proposed system reduces the burden on clients. Clients only need to choose the greening service by ticking a box during signing up, hand over control of their AP to the operator, configure one new SSID on their client devices, and then use their devices as normal.

II. LITERATURE REVIEW

1. Paper:" Insomnia in the access or how to curb access network related energy consumption"

Author: E. Goma, M. Canini, A. L. Toledo, N. Laoutaris, D. Kostic, P. Rodriguez, R. Stanojevic, and P. Y. Valentin

Description: Authors have proposed a method for greening residential Wi-Fi networks which takes a distributed approach and embeds intelligence in clients. They have also taken a look at the problem of greening access networks, identify root problem and propose practical solutions for users and ISP. To address this, Broadband Hitch-Hiking (BH2) is introduced, that takes use of the overlap of wireless networks to aggregate user traffic in as few gateways as possible. Which is the suggested approach dynamically aggregates user traffic on some access points hence put remaining to sleep.

Advantages: It formalizes the problem of energy savings in the DSL-based access networks with two simple techniques: a wireless user traffic aggregation that enables access devices to sleep and switching at the ISP that significantly increases the number of access points that can sleep.

Disadvantages: Given method is not appropriate for large system as it requires complex client side machinery such as interface virtualization, traffic snooping etc which imposes a heavy burden on users and does not extend easily to diverse client platforms. It does not address fairness and also falls apart when network includes careless clients.

2. Paper:" Green WLANs: On-demand WLAN infrastructures"
Author: A. P. Jardosh, K. Papagiannaki, E. M. Belding, K. C. Almeroth, G. Iannaccone, and B.Vinnakota

Description: Authors have suggested the method for greening enterprise Wi-Fi networks. This method is based on the adoption of resource on-demand wireless LAN strategies that can efficiently reduce energy consumption of a wireless LAN without adversely impacting the performance of clients in the network. RoD strategies power on or off wireless LAN access points dynamically, based on the volume and location of user demand. As a specific solution, a practical RoD strategy, called SEAR, is proposed. SEAR is a demand-driven RoD strategy for WLANs that efficiently manages wireless access points in high rate density wireless Local Area Networks and adheres to the design requirements. This proposed system includes description of resource management strategies for power conservation in WLANs and the impact of design choices, the design of a new policy-driven resources on-demand strategy called SEAR. SEAR uses measurements to dynamically power on or off WLAN access points based on the location and volume of user demand, and manages user associations to ensure the complete coverage and sufficient bandwidth to the users.

Disadvantages: It cannot be applicable to residential Wi-Fi networks as it does not address issues related to heterogeneity and fairness.

3. Paper: ” CUBS: Coordinated upload bandwidth sharing in residential networks ”
Author: E. Tan, L. Guo, S. Chen, and X. Zhang

Description **:** Author concluded that CUBS: Coordinated upload bandwidth sharing in residential networks as the energy savings schemes primarily rely on bandwidth from neighbouring wireless gateways being pooled and shared across many users, authors has proposed CUBS to enable residential user to share available bandwidth of its neighbours in a coordinated manner.

Advantages: CUBS to enable a residential user to share available idle upload bandwidth of its neighbours in a coordinated manner to improve the performance of various applications. CUBS flexibly share the idle upload bandwidth while providing fairness guarantees to all users in the same residential network without demanding additional bandwidth supply.

4. Paper:” Energy in ICT-trends and research directions”
Author: M. Pickavet

Description: Author has suggested trends and research directions of energy savings in information and communication technology. These trends include improving energy efficiency of hardware components, better power management of devices and technologies, switching to new network paradigms and adapting policy supporting actions. This research concentrates on energy consumption of ICT during its use phase and does not focus on life cycle assessment which includes energy consumption during excavation, production, transport and end-of-life.

5. Paper: ” NAPman : Network-assisted power management for Wi-Fi devices
Author: Rozner, V. Navda, R. Ramjee, and S. Rayanchu

Description: In this paper, authors have proposed NAPman, a system to minimize Wi- Fi energy consumption in mobile devices. Although Power Save Mode (PSM) is part of the Wi-Fi standard, the authors note that competing background traffic can adversely impact energy consumption. An energy-aware fair scheduling algorithm is developed.
6. Paper:” CENTAUR: Realizing the full potential of centralized WLANs through a hybrid Data path”
Author: V. Shrivastava

Description: Author has developed a framework called CENTAUR for mitigating hidden or exposed terminal interference in enterprise WLANs. CENTAUR is shown to improve the performance of the network substantially due to improved utilization of the wireless medium. The centralization functionality of CENTAUR is implemented in a single central server and requires minor modifications to the APs.

III. EXISTING SYSTEM

The existing approaches for reducing energy consumption are based on are based on distributed approach which is not that much appropriate for residential Wi-Fi networks. But in such systems clients have the whole responsibility of reducing energy consumption in Wi-Fi networks hence all clients need to work together to aggregate user traffic on fewer access points thus remaining to sleep. If malicious clients are there in network, the whole system falls apart. It also requires complex client side machinery.
Other greening approaches are proposed for enterprise energy savings rather than residential areas. But any such system faces several barriers such as heterogeneity amongst households in Wi-Fi security settings, ISP connectivity, IP ranges etc. The solution is not specific to client platform or operating system and has to protect

user experience. It is not directly converted into residential setting as it does not properly address fairness related issues.

While it is conceivable that future new enhancements of home gateways will implement sleep-on-idle(SoI) capability, this will show that it is ineffective when the household has devices that generate continuous light traffic. A typical household devices today is estimated to have between 3 and 8 wireless devices, and this number is estimated to grow 15 within a few years.

IV. PROPOSED SYSTEM

The proposed system includes an algorithm and a methodology for reducing energy consumption of residential Wi-Fi networks using a centralized approach which will address fairness related issues and minimize the burden on users.

The work includes investigate the feasibility of reducing the combined Energy footprint of home gateways by pooling their wireless resources and dynamically aggregate the user traffic on to a subset of gateways.

The centralized entity could be an Internet Service Provider or any over the top third party. Centralization comes with the benefit of realizing optimal or near optimal solution more easily.

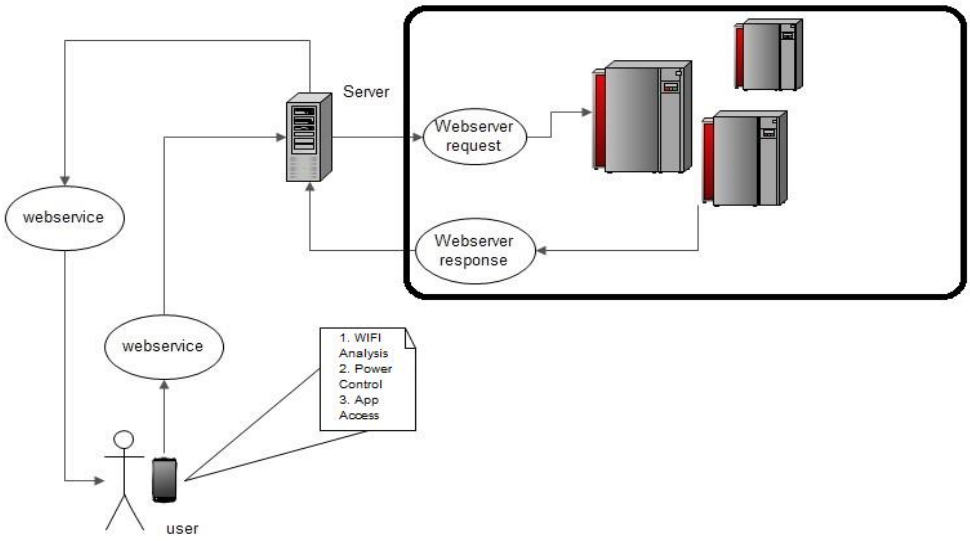

Fig: System Architecture

The system is a Three-tier architecture having User, web-services, local and main server respectively.

User:
User can be any android user who will be using the Wifi network at residential areas.

Local Server:
The duty of the local server is to maintain the details of user (basic details, verification, authentication and communication between the user and main server)

Main Server:
The main server is used to store the user details, the required data by the user,

Web services:
Web services is the mediator between the internet and user software without the presence LAN

ALGORITHM

TO FIND ACTIVE NODE
The algorithm takes as input these to f clients U and their data rates for each APj. It also has set of visible clients Sj to each AP and weight Wj. A temporary variable X is taken to keep track of these to f clients that are not yet covered and it is initialized to all set of clients in the beginning.
1. To store the selected APs, a variable I is taken which is initially null.
2. The algorithm operates in a loop till all clients are covered, i.e. X=φ in step 2.
3. In each iteration, the APj which has the maximum ratio of unconnected clients is selected in step 3.
4. This AP is added to the set I of selected APs and the clients Sj it covers are removed from X in step 4.
5. The set of active APs I is output in step 5. The best set of APs to be turned on, so as to reduce energy consumption.

V. CONCLUSION

The proposed system gives solution architecture for reducing energy consumption in residential Wi-Fi networks. This architecture is also applicable for large scale system as it provides centralized approach for energy savings. A central operator works as a controller hence reducing the burden on users. The system aggregates users onto some Wi-Fi access points and put remaining to sleep to reduce energy savings. It works across heterogeneous ISPs and clients, and allows for fairness in energy savings. An algorithm is developed to find best set of APs that should be on at any given time interval. It also gives association of clients with selected APs. The algorithm shows tradeoff between energy savings and session disruption using campus Wi-Fi traces.

VI. FUTURE SCOPE

In the future, the capability of gateways can be enhanced so that gateways will have sleep-on idle and remote wake-up capability. Due to this enhancement the entire gateway can be put to sleep and wake up and greater energy savings can be achieved. Also the revised algorithm can be developed to overcome the problem of coverage black holes.

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