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Power Efficient QoS and Failover Routing in Tethernet

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Abstract: ***Wi-Fi tethering (i.e., sharing the Internet connection of a mobile phone via its Wi-Fi interface) is a useful functionality and is widely supported on commercial smartphones. Yet existing Wi-Fi tethering schemes consume excessive power: they keep the Wi-Fi interface in a high power state regardless if there is ongoing traffic or not. In this paper we propose System to improve the power efficiency of Wi-Fi tethering. Based on measurements in typical applications, we identify many opportunities that a tethering phone could sleep to save power. We design a simple yet reliable sleep protocol to coordinate the sleep schedule of the tethering phone with its clients without requiring tight time synchronization using Route Discovery Protocol and Crank Bank enabling Quality of Service and Fail Over Feture. Furthermore, we develop a two-stage, sleep interval adaptation algorithm to automatically adapt the sleep intervals to ongoing traffic patterns of various applications. System does not require any changes to the 802.11 protocol and is incrementally deployable through software updates. We have implemented System on commercial smartphones. Experimental results show that, while retaining comparable user experiences, our implementation can allow the Wi-Fi interface to sleep for up to 88% of the total time in several different applications, and reduce the system power consumption by up to 33% under the restricted programmability of current Wi-Fi hardware. it.***

Keywords: Tethernet, Failover and RDP, Energy Efficiency, QosAP, Wi-Fi Tethering

1. Introduction

Wi-Fi tethering, also known as a “mobile hotspot”, means sharing the Internet connection (e.g., a 3G connection) of an Internet-capable mobile phone with other devices over Wi-Fi. As shown in Figure 1, a Wi-Fi tethering mobile phone acts as a mobile software access point (QosAP). Other devices can connect to the mobile QosAP through their Wi-Fi interfaces. The mobile QosAP routes the data packets between its 3G interface and its Wi-Fi interface. Consequently,all the devices connected to the mobile QosAP are able to access the Internet.

Figure 1: Wi-Fi Tethering

Wi-Fi tethering is highly desired. For example, even be-fore the Android platform provided built-in support on Wi-Fi tethering, there were already some third-party Wi-Fi tethering tools on Android Market. Two of them, called “Barnacle Wi-Fi Tether” and “Wireless Tether for Root Users”, are very popular, each with more than one million installs. There are two main reasons why Wi-Fi tethering is desirable.

First, cellular data networks provide ubiquitous Internet access but the coverage of Wi-Fi networks is spotty. Second, it is common for people to own multiple mobile devices but likely they do not have a dedicated cellular data plan for every device. Hence, it is desirable to share a data plan among multiple devices, e.g. sharing the 3G connection of an iPhone with a Wi-Fi only iPad. In response to this common user desire, Wi-Fi tethering is now widely sup-ported, as a built-in feature on most smartphone platforms, including iPhones (iOS 4.3+), Android phones (Android 2.2+) and Windows phones (Windows Phone 7.5).However, existing Wi-Fi tethering schemes significantly increase the power consumption of smartphones.

When operating in the QosAP mode, the Wi-Fi interface of a smartphone is always put in the high power state and never sleeps even when there is no data traffic going on. This increases the power consumption by one order of magnitude and reduces the battery life from days to hours. To save power, Windows Phone automatically turns off Wi-Fi tethering if the Wi-Fi network is inactive for a time threshold of several minutes. However, this simple scheme has two drawbacks. First, the Wi-Fi interface still operates in the high power state for all the idle intervals less than the threshold, leading to waste of energy. Second, it harms usability. If a user does not generate any traffic for Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.MobiSys’12, June 25–29, 2012, Low Wood Bay, Lake District, UK. Copyright 2012 ACM 978-1-4503-1301-8/12/06...$10.00.a time period longer than the threshold (e.g., while reading a long news article) and then starts to use the network again(e.g., by clicking another news link), the user will have to go back to the smartphone and manually re-enable Wi-Fi tethering, which results in poor user experience.

The IEEE 802.11 standard defines a Power Saving Mode (PSM) [10] that allows the Wi-Fi interface of a device to stay in a lower-power state to save power. However, PSM is designed for client devices only. An AP should never enter PSM according to the IEEE 802.11 standard. It is not an issue for APs in traditional scenarios because they are externally powered. However, such old design wisdom does not work for the battery-powered QosAP in Wi-Fi tethering. The IEEE 802.11 standard also defines a power saving mechanism for stations operating in ad hoc mode. In ad hoc mode all the stations equally share the responsibility for beacon generation. One station may sleep when another station generates beacons.

However, in Wi-Fi tethering,a QosAP is the single gateway to the Internet and can hardly sleep. Ad hoc mode is much less used than the infrastructure mode (i.e., AP mode) in practice. Interestingly, despite that the Wi-Fi hardware does support ad hoc mode, the OS on many mobile devices, including Windows phones, Android phones and iPhones, hides it preventing a device from connecting to an ad hoc network. Thus, in this paper we focus on Wi-Fi tethering in the infrastructure mode.

We propose and design QosAP, a system to reduce power consumption of Wi-Fi tethering on smartphones while still retaining a good user experience. The key idea of QosAP is to put the Wi-Fi interface of a application into sleep mode to save power when possible and along with the master fails to render the data to client it should forward the request to another master or slave available to SSID to established the connection with client and vide SSID and return the rest and remaining packets to or data to client. We measure the traffic pattern of various online applications used in Wi-Fi tethering. We find that the Wi-Fi network stays in the idle state for a large portion of the total application time which means there are many opportunities to reduce the power consumption. With QosAP, an application can automatically sleep to save power when the network is idle and wake up on demand if the network becomes active. Putting a QosAP to sleep imposes two challenges. First, without a careful design, it may cause packet loss. Existing Wi-Fi clients assume that APs are always available for receiving packets, so whenever a client receives an outgoing packet from applications, it will immediately send the pack-et to its AP. However, if the AP is in the sleep mode, this packet will be lost, even after the retrials that occur at the low layers of the network stack. Second, putting an AP to sleep will introduce increased network latency and may impair user experiences if the extra latency is user perceivable.

Wi-Fi tethering is widely supported on most smartphones but also has disadvantage that it increases the power consumption as in this mode Wi-Fi interface is always put in in high power state reducing the battery life of the phones. In smartphones the radio energy consumption dominates the overall energy consumption that in laptops example HP iPAC 6965 smartphones energy consumption ranges in 200-700mW while in laptop it is of 20W [1].On comparison, Wi-Fi radio consumes between 1-2W while transmitting therefore it is efficient to use Wi-Fi of a smart phone. Wi-Fi has better performance in terms of energy as compared to Bluetooth [2]. The figure 2 shows the power consumption of Bluetooth and Wi-Fi [1].It is found that Bluetooth has lower active cost so it is best suited for applications of low bandwidth and Wi-Fi is best for application with high traffic like web browsing.

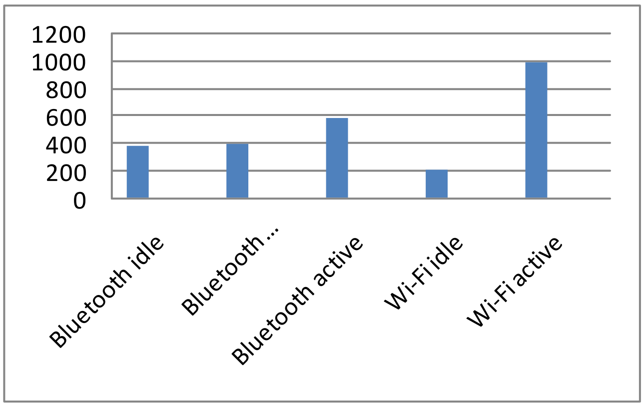


Figure 2: Power Consumption of Bluetooth and WiFi in Different States

Communication of Tethering devices follows a strict master-slave scheme (i.e. there is no way for slave devices to communicate directly with each other). Instead, a master and up to seven slaves form a so-called tethernet, two or more tethernet can interconnect to form a scatternet , where the master defines the timing and the hop pattern [3]. The slaves have to stay synchronized to the master while participating in the tethernet. Since two slave nodes cannot be linked together directly, the path of a packet must alternate between master and slave nodes, until it reaches its final destination. Failover is a procedure by which a system automatically transfer control to a duplicate system when it detects a fault or failure. It is a backup operational mode in which the function of a system component example server, network, database, and processor are summed by a secondary system component, when primarily components become unavailable through failure. It is used to make system more faults tolerant. It is typically an integral part of mission critical system that must be constantly available.

It can be applied to any aspect of a system within a PC, within a network, to any network component or system of component such as connection path, storage device etc.

2. Related Work

Tethered is energy efficient and connect Wi-Fi equipped and internet enabled smartphones very affordably[1]. It harnesses smartphones to build on the fly Wi-Fi hotspots. In 3-G, for higher energy efficiency radio use its nonlinear energy profile hence a proxy clouds first gather necessary data before transmitting it over the WAN link. In Wi-Fi to establish tethernet, smartphones acts as Wi-Fi client who associates with laptop client acting as a Wi-Fi access point to offer greater energy efficiency as smartphones are gateways of Wi-Fi interfaces which can sleep more effectively when not in use.

Reverse infrastructure Wi-Fi mode of cool tethernet is 50% more profitable than traditional Wi-Fi ad-hoc Passive State mode proving that it is an energy efficient affordable internet access [1].It is an alternate way for mobile hotspots problems inspite of higher power consumption and not supporting multiple clients.

QosAP improve power efficiency of Wi-Fi tethering,it coordinates sleep schedule of tethering with clients for that it needs night time synchronization[4].In order to adapt automatically the sleep intervals of traffic patterns, reducing power consumption upto 30% a two stage sleep interval adaptational algorithm developed to automatically put Wi-Fi interface of smartphones into sleep mode to save power. QosAP with sleep request response protocol, QosAP and its clients agreed on a valid sleep schedule of SoftAP so that the client can transmit package only when the QosAP is active. With its sleep scheme it can limit the maximum sleep duration so QosAP can reduce its power consumption and even one goes down over the master mode it ensures fail over and data availability to others.

3. Problem Context

MANETS (Mobile Ad hoc Networks) are distributed networks where mobile nodes are connected together by wireless links without any fixed infrastructure, base stations, routers or centralized servers. There topology is not static and depends on mobility of nodes. The following are some challenges for MANETS:-

- Limited wireless transmission range.
- Broadcast nature of wireless medium.
- Packet losses due to transmission errors.
- Estimated change in route, battery constraints and security problems.

After all study done above, a basic question arises, why there is a need of an energy efficient solution? Here is its answer:-

- Power level affects many features of operation in network like throughput.
- Power control also affects conflicts of medium. The number of hops will increase the delay time.
- Transmission power influences the metric of energy consumption.

Energy preservation is an open issue to all layers of network. Energy is main anxiety in MANETS and different techniques and studies are there and focus has been on different layer design to preserve energy efficiently. Energy preservation on mobiles devices must be maintained not only during active communication but also when they are inactive. Many standard protocols were proposed and they have two types of power management-

- Power Save (PS) mode for infrastructure based wireless networks and
- Independent Basic Service Set Power Save (IBSS) mode for infrastructure less network.

Nodes in PS mode have less power consumption than that in active mode. The power saving mechanism is implemented using access points in the network. But this is not suitable for ad hoc network environment since there is no central coordinator like access point.

DPSM (Dynamics Power Saving Mechanism) uses the concept of ATIM (Ad hoc Traffic Indication message) window and beacon interval. During this window, all nodes are conscious and those that have no traffic to receive or send goes to sleep mode after end of ATIM window [6]. But if the window is fixed, energy saving cannot be sufficient. This energy saving performance of DPSM is better but it is more complex in computation.

4. Proposed Work

In this work I have created energy efficient failover routing that works when a master node about to fail while transmitting packets to a slave node due to low energy then it transfers its control to the other node and request that node to transfer the remaining packets to the slave node on its behalf. Hence by this we can assure the data transmission.

A tethernet is formed with few nodes. All the nodes are tethering Smartphones and together they share their Wi-Fi network interface.For QoS routing, a connection table is required for each node to establish a route. The connection table stored in each master device contains the essential information, which includes the nodes connected, the master address, the bridge address and the slave. The QoS routing mechanism uses the connection table to find the destination. When it locates the destination address in the table, it checks it's either a master or slave. Then, it searches the routing table and the data packet can be sent to the destination. Using the routing table, a source can decide the path that the data packet can be transmitted and meet the QoS requirements. This table helps the routing mechanism dynamically find the better path even if one master holds the less power or battery. To establish a route to meet the QoS requirements, the route discovery protocol is used. As for the on-demand routing protocols, there are some QoS requirements and no complete route information can be used for routing. Thus, a route discovery packet (RDP) is flooded into the network to find the destination.

Upon receiving the first RDP, the destination sends a route reply packet (RRP) back to the source along the route. While the source receives the first RRP, it knows that this is the shortest route. And accompanying with the feedback of the RRP, point-to-point Tethering links are created to connect the devices along the new route and at the same time the routing tables of these devices are filled in with the information about the new discovered route. When the RRP arrives at the source device, the route is also ready for transmitting data packets from the source to the destination.

In this proposed work, the transmitting node will send frame sets to the other node after it has stopped due to power loss. The other node will only send the remaining file to the receiving node.Hence it prevents the stoppage of transmission occurring due to less power which is caused because of the continuous active involvement of the node in the network formed by tethering.

On the purpose of establishing a route to meet the QoS requirements, we can employ the route discovery protocol as shown in Figure. 3. As for the on-demand routing protocols, there are some QoS requirements and no complete route information can be used for routing. Thus, a route discovery packet (RDP) is flooded into the network to find the destination. Upon receiving the first RDP, the destination sends a route reply packet (RRP) back to the source along the route. While the source receives the first RRP, it knows that this is the shortest route. And accompanying with the feedback of the RRP, point-to-point Bluetooth links are created to connect the devices along the new route and at the same time the routing tables of these devices are filled in with the information about the new discovered route. When the RRP arrives at the source device, the scatternet route is also ready for transmitting data packets from the source to the destination.

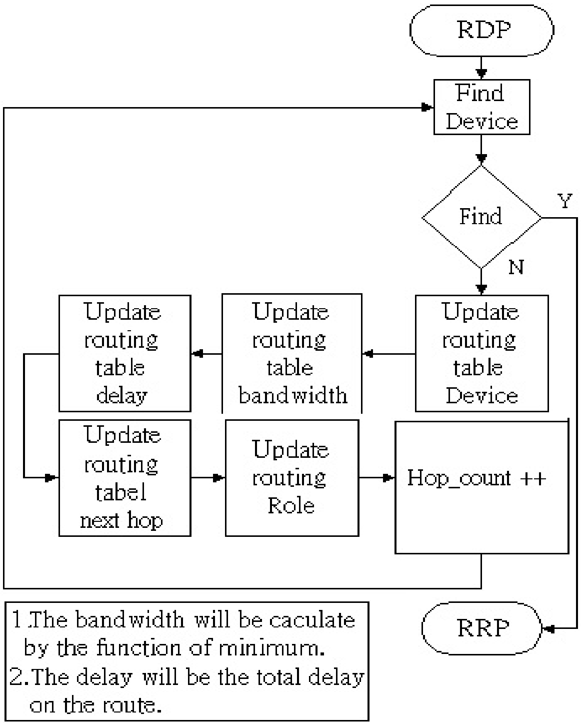


Figure 3: Route Discovery Protocol

With proper packet broadcast mechanism, the source, as well as all the relay devices, is able to send the RDP out quickly and efficiently. Before the rebroadcast of the new received RDP, the relay device needs to check if it's not being visited and creates an item in the routing table to record the new route request. We use Table 1 as an example for describing how the RDP works.

Firstly, the source D0 is trying to send a data packet to destination D5. D0 then sends the RDP out to find the device D5. The next device that is in the radio range will compare the BD_ADDR with the corresponding field in its connection table. If it is not the destination, it will record the QoS information into its routing table and goes to the next hop. We use the min (bandwidth) and delay=delay+next_hop_delay to update the QoS information, to ensure that the bandwidth on the route is available and the total delay of the route is less than the delay requirement.

Table 1: RDP Table

find_device	*QoS*		*Hop_Count*	*next_hop*
	bandwidth	*delay*		
D5	30K	0.2ms	1	D1
	30K	1.2ms	2	D2
	30K	2.2ms	3	D3
	25K	3.2ms	4	D4
	25K	5.2ms	5	D5

4.1 Route Reply Protocol

As the destination device receives a RDP and reply with a RRP immediately as shown in Figure 4, the RRP will be transmitted backward along the route. The RRP that comes back to the source quickly means that the route that the RRP traverses is shorter. On receiving the RRP, a device confirms the establishment of the route and updates its connection table and routing table. In the proposed QoS routing, the device that receives a RRP will check role of the bridge. If it is a slave or a double-role node, the crank back mechanism starts to search a new route that consists of all single-role nodes. If the node is not a bridge or a master, it will pass to the next hop.

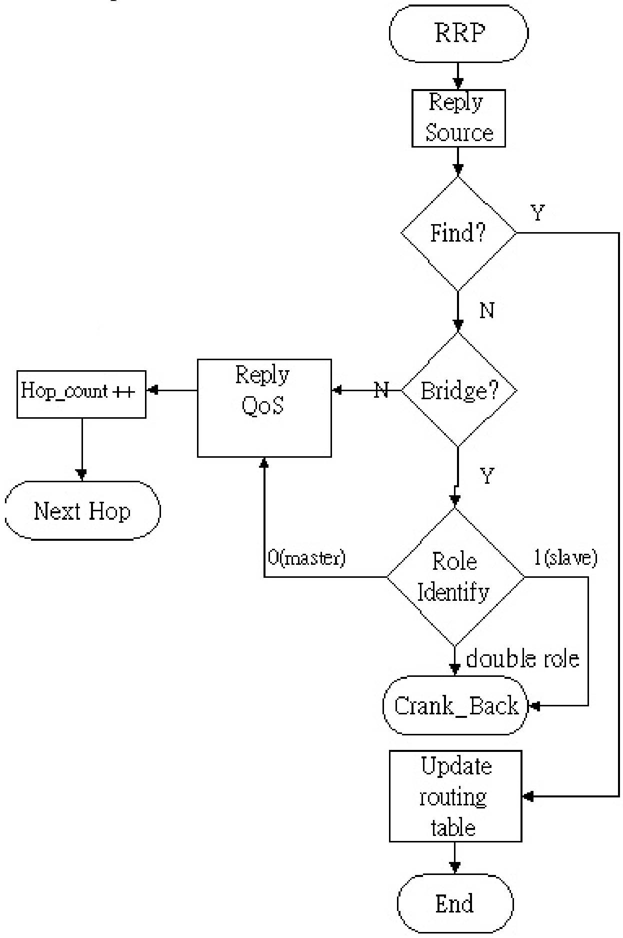


Figure 4: Route Reply Protocol

4.2 Route Discovery with Role Protocol

The double-role device is with lower performance. Thus, we propose a crank-back routing to resolve the double-role node on a route.The crank-back routing employs the route discovery with role protocol RDRP as shown in Figure 5. In the routing table, every device will be associated with a role parameter. For the backbone route, each device is with a specific role. When the on-demand route is established, the RRP is sent from the destination and the bridge that receives the RRP will compare its role with the role recorded in the RRP for this device.

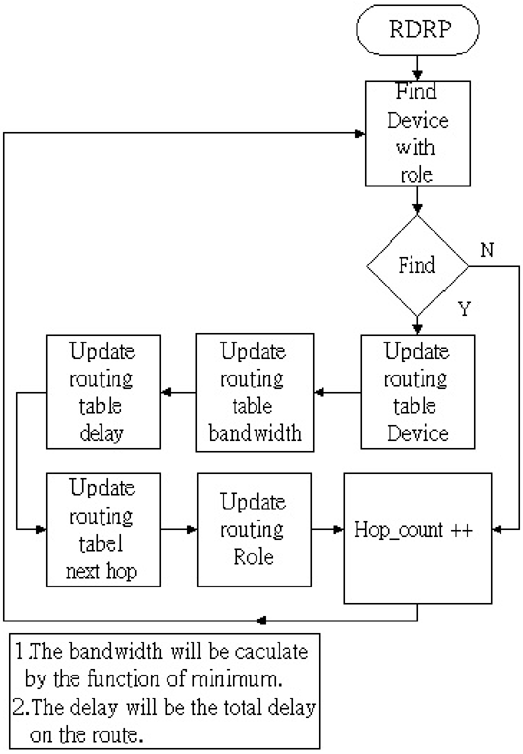


Figure 5: Route Discovery with Role Protocol

If the role for the device on the route is the number 0, it knows that it is a master. However, if the role number is 1, it means that the device is a slave on the route. When a device is associated with two roles (both the master and the slave), it is a double-role device. When the new bridge knows that it is not a master, it will cancel the crank-back procedure and tell the device that initiates the crank-back routing to find another route. If the procedure falls into a loop, the new crank-back route can't be established. Then, a time limit is set to resolve the infinite loop issue. If the time limit expires, the new route is not established. Then, the original route that is with a slave or double-role devices is still used for data transmission. To evaluate the performance of the proposed QoS routing, we develop a simulation model and conduct simulation study. Now we present the simulation model and discuss the simulation results.

4.3 Simulation Model

The following notations are used in this study.

D_i : end-to-end delay for route R_i

B_i : the route of bits per second through R_i

t_s : the length of a time slot (i.e., 0.625 ms)

t_g : guard time for a bridge switching among piconets

N_i^n : the number of nodes on route R_i

N_i^b : the number of bridges on route R_i

L : is the length of the packet size (2745bits)

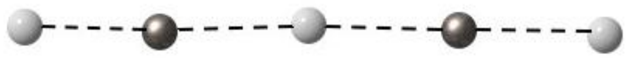
e_m : the number of masters on the endpoints of R_i

We can calculate the end-to-end delay and the bandwidth by using Eq. (2) and Eq. (3).

$$D_i = \begin{cases} 2t_s\left(N_i^n - 1\right) + N_i^b\left(t_g + t_p\right), & for \quad 1-slot \\ 4t_s\left(N_i^n - 1\right) + N_i^b\left(t_g + t_p\right), & for \quad 3-slots \\ 6t_s\left(N_i^n - 1\right) + N_i^b\left(t_g + t_p\right), & for \quad 5-slots \end{cases} \quad (2)$$

$$B_i = \begin{cases} \dfrac{L}{2t_s\left(N_i^n - 1\right) + N_i^b\left(t_g + t_p\right)}, & for \quad 1-slot \\ \dfrac{3L}{4t_s\left(N_i^n - 1\right) + N_i^b\left(t_g + t_p\right)} & for \quad 3-slots \\ \dfrac{5L}{6t_s\left(N_i^n - 1\right) + N_i^b\left(t_g + t_p\right)} & for \quad 5-slots \end{cases} \quad (3)$$

"(a)" Both the source and the destination are masters



"(b)" Both the source and the destination are slaves

Figure 6: The number of nodes along the route is odd

We make the following assumptions for this simulation study. We assume that the number of nodes on the route is odd in order to simplify the study. In other words, the source and the destination devices are either two masters or two slaves as shown in Figure. 6(a) and Figure.6(b), respectively. And the number of nodes on the route that we would like to evaluate is from 5 to 39. Thus, the value of e_m in our study is either 0 or 2, and we can figure out the number of bridges on R_i according to Eq. (4).

$$N_i^b = \frac{1}{2}\left(N_i^n - 3 + e_m\right) \quad (4)$$

For example, the route shown in Figure.6(a) has two slave bridges to connect three piconets. We can substitute N_i^n by 5 and e_m by 2 into Eq. (4) to calculate the value of N_i^b to be 2 (bridges). The other assumptions are as follows.

- There is no error occurring during data transmission and, thus, the retransmission is not required.
- The guard time is considered as the worst case, i.e., two time slots ($t_g = 2t_s$).
- We assume that the scheduling is perfect. In other words, when a bridge switches from a piconet to the other piconet, it requires only two time slots (guard time) to adjust its radio frequency to a new frequency according to the new hopping sequence. And the master polls the bridge immediately for data transmission.
- The traffic on R_i is unidirectional.
- The number of intersections on a route is proportional to the length of the route. Though the above assumptions much simplify the study, it does not lose the generality and fairness and can provide us with a quick evaluation of the performance of scatternet routes.

Tethernet is a network that allows sharing of internet connection of phones with other devices such as laptops.

Failover is a procedure by which a system automatically transfers control to a duplicate system when it detects a fault or failure. Wi-Fi has better performance in terms of energy as compared to Bluetooth but also has disadvantage that it increases the power consumption as in this mode Wi-Fi interface is always put in in high power state reducing the battery life of the phones. The failover routing prevents the stoppage of transmission if the transmitting node about to fail. It will pass its control to another node and allow it to transmit instead of it. The on-demand routing provides the suitable route to transmit. When one node stops while transmitting, it will send the frame sets to the other node and ask it to send the remaining frame sets. In this work I have created a failover routing that works when a master node about to fail while transmitting packets to a slave node due to low energy then it transfers its control to the other node and request that node to transfer the remaining packets to the slave node on its behalf. Hence by this we can assure the data transmission.

A tethernet is formed with few nodes. All the nodes are tethering Smartphones and together they share their Wi-Fi network interface. For QoS routing, a connection table is required for each node to establish a route. The connection table stored in each master device contains the essential information, which includes the nodes connected, the master address, the bridge address and the slave. The QoS routing mechanism uses the connection table to find the destination. When it locates the destination address in the table, it checks it's either a master or slave. Then, it searches the routing table and the data packet can be sent to the destination. Using the routing table, a source can decide the path that the data packet can be transmitted and meet the QoS requirements. This table helps the routing mechanism dynamically find the better path even if one master holds the less power or battery. To establish a route to meet the QoS requirements, the route discovery protocol is used. As for the on-demand routing protocols, there are some QoS requirements and no complete route information can be used for routing. Thus, a route discovery packet (RDP) is flooded into the network to find the destination.
Upon receiving the first RDP, the destination sends a route reply packet (RRP) back to the source along the route. While the source receives the first RRP, it knows that this is the shortest route. And accompanying with the feedback of the RRP, point-to-point Tethering links are created to connect the devices along the new route and at the same time the routing tables of these devices are filled in with the information about the new discovered route. When the RRP arrives at the source device, the route is also ready for transmitting data packets from the source to the destination.

In this proposed work, the transmitting node will send frame sets to the other node after it has stopped due to all the nodes are tethering Smartphones and together they share their Wi-Fi network interface. In this work I will be creating a failover routing that works when a node about to fail while transmitting packets to another node due to low energy then it transfers its control to the other node in the same SSID and request that node to transfer the remaining packets to the receiving node on its behalf. Hence by this we can assure the data transmission and thus acquires QoS.

4.4 The Proposed QoS Routing

For forming a route in this QoS routing, the tethering devices use many tables like a connection table which is stored in device containing the important information including the connected nodes, the addresses, in the scatternet.

When scatternet is formed, it is assumed that the connection table is filled and stored in device. To find destination, the connection table can be used by QoS routing. After locating the address of the destination in the table, it looks for the routing table and send the data packet to destination.

For QoS routing, there is a need of a routing table. With this, the data packet path is decided by the source to transmit it. Also, the utilization of bandwidth is more efficient as the routing table dynamically locates the much efficient path. The following figure 7 depicts the scatternet communication model. It consists of several number of nodes having different amount of battery or power capacities. The model exhibits which is the better way or option to go for in order to fulfills the transmission requirements and hence it can be done successfully.

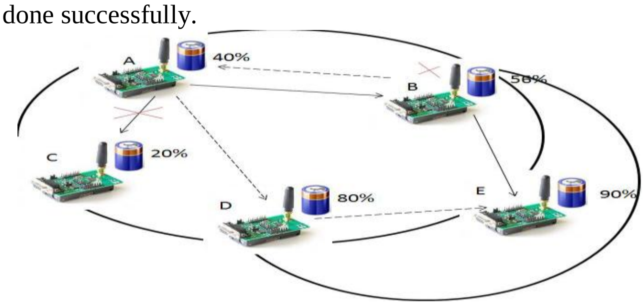


Figure 7: Scatternet Communication Model

To establish a route meeting the QoS requirements, the route discovery protocol can be used. To find the destination, a RDP is swamped into the network. A route reply packet (RRP) is sent by the destination after getting the first RDP along the route to the source. On the receipt of the first RRP, it implies to be the shortest route. To connect the devices, tethering links are created along the new route filling the routing tables with the information of the new route. On the arrival of RRP at the source, route is ready to transmit data packets.

The received RDP is broadcasted again but in advance, the relay device checks whether it is being visited earlier or not and then forms an item in the routing table for new route request. The following Table 2 shows the working of RDP. The source 0D wants to send a packet to destination 5D. In order to find device 5D, 0D sends the RDP. The other device in the range will then matches the BD_ADDR with the field in its connection table. If it does not matches then it implies that it is not the destination, the QoS information will be recorded into its routing table and the moves to the next device.

Table 2: Working Mechanism of RDP

Destination device	QoS		Hop_Count	Next_device
	Bandwidth	Delay		
5D	30K	0.2ms	1	1D
	30K	1.2ms	2	2D
	30K	2.2ms	3	3D
	25K	3.2ms	4	4D
	25K	5.2ms	5	5D

The RRP is transmitted back along the route as soon as destination gets a RDP. The RRP coming back quickly to the source implies that the RRP navigates a shorter route. The device approves the route establishment and its connection table and routing table are updated as soon as it gets the RRP.

4.5 Energy efficient Routing Mechanism

Suppose there are few nodes that are tethering enabled smartphones connected into the same SSID. When a request is send to a node to have an access to a file by the browser created, the RDP is sent and with the reception of RRP by the source, the connection is established. Now, if while transmitting the data packets the transmitting node halts due to power failure then the transmitting node will pass on the request to the neighboring node by using the RDP. The browser will look into the RDP and request is sent to the next node. The same procedure follows and the connection is established. The frame sets of the file that has been sent before the first node gets faulty is provided to the next transmitting device and then it will send the remaining file to the source.

5. Conclusion

Tethernet is a network that allows sharing of internet connection of phones with other devices such as laptops. Failover is a procedure by which a system automatically transfers control to a duplicate system when it detects a fault or failure. Wi-Fi has better performance in terms of energy as compared to Bluetooth but also has disadvantage that it increases the power consumption as in this mode Wi-Fi interface is always put in in high power state reducing the battery life of the phones. The failover routing prevents the stoppage of transmission if the transmitting node about to fail. It will pass its control to another node and allow it to transmit instead of it. The on-demand routing provides the suitable route to transmit. When one node stops while transmitting, it will send the frame sets to the other node and ask it to send the remaining frame sets.

6. Acknowledgment

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