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AGGREGATION OF BANDWIDTH WITH 4G BACKHAUL

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Abstract - *The Internet of Things covers various range of industries and uses cases that are scaled from a single constrained device up to a massive cross platform deployments of multiple embedded technologies and cloud systems that are connecting in real-time. The router size also needs to be reduced so it can be easy to move. Hence a network processor development board is used. The firmware image is flashed on to the development board along with the required packages to make it as a router. Later, this is configured to make Wi-Fi enabled and it acts as a mini router with multiple local area network connections and various Internet service provides SIM cards with data by Bandwidth Aggregation, it covers up to 100 meters and provides simultaneous access up to 15-18 devices at a time. An additional feature is add-on to it which ensures secured access to the Wi-Fi by providing a backhaul network.*

Key Words: **Internet of things, Network Processor, Bandwidth Aggregation, Backhaul Network.**

1. INTRODUCTION

The Internet of Things (IoT) and machine-to-machine communications (M2M) together helps in the development of potential applications and it is huge. From personal fitness to healthcare to security of any physical system to industrial to energy management lets our imagination to be our guide – the M2M/IoT universe is filled with various opportunities that are delight to engineers, manufacturers, marketers, software developers, and investors alike. Wi-Fi technology is ready today to connect billions of IoT devices to each other, to the internet and to billions of consumer computing and electronics devices that are already in use. Wi-Fi's security, longstanding commitment, interoperability and legacy to interoperability that makes it an ideal platform for innovation – unlocking limitless potential of the IoT.

The on-board Wi-Fi is fast becoming a popular feature and it is expanding fast around the globe. There are many countries currently testing and installing Wi-Fi to offer it as a free service, while using it for internal communications and facility management due to its high speed connectivity. Wi-Fi service on buses and coaches has proven several business model for long-distance journeys, ride to the school and even for running marketing campaigns. Business travelers can now use Wi-Fi while they are travelling on the bus (making it cool again to take the bus), while students can get online via Wi-Fi on the bus, which helps keeping noise levels down and let the drivers focus on the road.

1.1 BANDWIDTH AGGREGATOR

Bandwidth Aggregation (BAG) is a process where it merges two or more internet connections and gives the internet application access to the total bandwidth available. This results in exponential increase in reliability with link redundancy. This implementation process could be either a simple one or complex and could include two different types i.e. load balancing or failover modes [1]. Aggregation of bandwidth could be carried out through software. The bandwidth aggregation solutions are vast and available at varying costs.

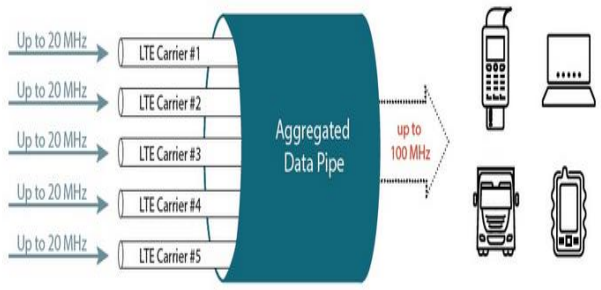

Fig-1: Bandwidth aggregator

The explosive growth in internet is a major driving force in the proliferation for a variety of wireless technology which includes different IEEE bands such as 802.11 (a, b, g, n, ac), GPRS, CDMA2000 etc.

The use of single wireless technology at mobile client has been explored these days. With the incidence of variety of wireless technology seamless migration of these connections from one particular interface[3] to the next one like in the case of vertical hand-off adaption technique.

Existing wireless technologies differ widely in terms of services offered - bandwidth, coverage, Quality of service (QoS) support, pricing etc. Restricting usage to one single interface at a time limits the flexibility. These help the users to use resources that are available on the interface.

1.2 BACKHAUL

There is a rapid increase in number of mobile subscribers as well as the deployment of 3G technologies are strained on mobile backhaul service [2]. Manufacturers of the network switching equipment use this term backhaul to

refer to the process of getting data to network backbone while the subscriber get connected via captive portal. In satellite communication, backhaul is meant in getting data to a point from which it is transmitted to satellite [5]. Backhaul is used to get audio and video materials which needs for distribution points at major broadcast news organization. Backhaul connection for 4G here is referred to get authentication to the radius server.

2. METHODOLOGY

Aggregation of bandwidth is done using a network processor board, PCIe bus for connection of multiple SIM cards with 4G data and Dongles. In this method the Network Processor board is programmed as a router by adding additional interfaces, PCIe bus and different modem chips for the same. First and foremost the network processor board needs to be flashed with an OS image. Here this image is built using an open source tool. Once the build is successful the appropriate image is flashed on to the network processor.

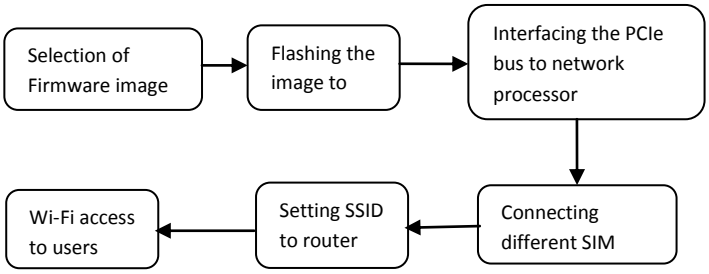

Fig-2: Implementation of BAG with 4G backhaul

Fig-2 shows the implementation of bandwidth aggregator with various SIM cards connected on the PCIe bus. Later Network processor is programmed as a router by connecting to various Wi-Fi drivers. This router designed is added with a backhaul feature i.e. Captive porta using an open source tool named as Wi-FIDog. This Wi-FiDog provides captive portal solution for 4G backhaul networks. Via this any user who needs to access this network will be selecting this particular SSID while nearby Wi-Fi devices are scanned. Once the user selects this network processor SSID a login page is displayed as shown in Fig-5. Here the user needs to enter Mobile number later the user will receive One Time Password(OTP) Once this OTP is entered correctly in the specified fields the authentication becomes successful. If the OTP is not matching then the user will not be able to access data out of it. This aggregation method helps for load balancing. Load balancing means equal distribution of bandwidth across different users. This particular allocation of data is similar to that of round robin technique. First and foremost the first user getting connected to this device can log-in to the ISP havingwith highest bit rate. Next user gets logged in to the immediate next highest bit rate and this process continues.

Fig-3 shows the exact flow diagram of how a user gets connected to the Wi-Fi device. There are multiple Wi-Fi devices SSID while scanned in a Wi-Fi enabled devices. Once this particular SSID is selected the user is requested his mobile number so that he receives OTP once the password entered is right the user gets the complete access to the internet.

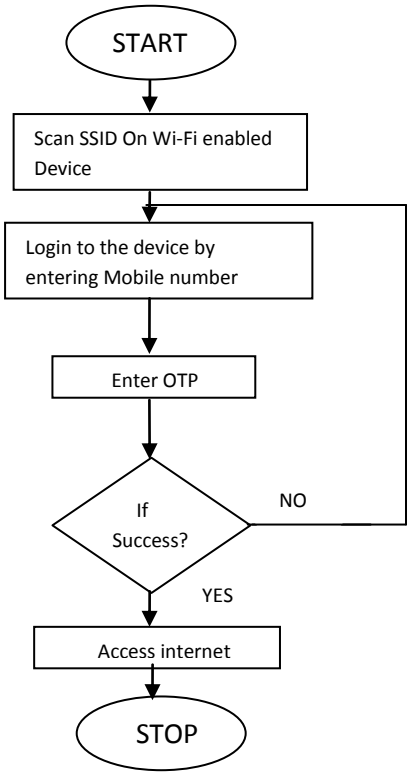

Fig-3: Flow chart for Wi-Fi access

The entire design is based on making a network processor to act as a Wi-Fi module with captive portal solution such that one can keep track of what exactly as been accessed. This helps the Service provider to fetch more business by providing its customers with all these extra additional features.

3. APPLICATIONS

4G aggregation technology connects people globally with much faster speed to access for the net. The data connection is maximized based on the signal strength which is set to be in 4G/3G/2G. These are mainly used in various transportation modes where the user gets special privilege to access Wi-Fi on the go. Another major advantage is that it connects various 3rd party service providers for aggregating different bandwidths. This system as data encryption and highest security standards for establishing a backhaul connection. Using 4G/3G/2G aggregator maximizes data connection can be maximized.

4. ADVANTAGES AND DISADVANTAGES

The major advantages of 4g backhaul services are listed below:

1) Application will drive next-generation networking systems

2) High data rates are established by this aggregating methods.
3) These networks have fail-over and load balancing capabilities.

The major dis-advantages are listed below:

1) Range of Wi-Fi is up to 150 meters. The signal strength might be increased by placing boosters.
2) While travelling, the router may not function during the time of hand-off from one base station to another.

5. RESULTS

The firmware image is successfully flashed onto the selected network processor board. The users are successfully getting connected to the Wi-Fi device and access to the device. Figure 4 and Figure 5 gives the clear picture about the login. This design helps one to connect to Wi-Fi with much higher bandwidth so that the user gets access to fastest internet.

```
Board: Ralink APSoC DRAM:  128 MB
relocate_code Pointer at: 87f68000
flash manufacture id: c2, device id 20 19
find flash: MX25L25635E
============================================
Ralink UBoot Version: 4.3.0.0
--------------------------------------------
ASIC 7628_MP (Port5<->None)
DRAM component: 1024 Mbits DDR, width 16
DRAM bus: 16 bit
Total memory: 128 MBytes
Flash component: SPI Flash
[illegible]
============================================
icache: sets:512, ways:4, linesz:32 ,total:65536
dcache: sets:256, ways:4, linesz:32 ,total:32768

 ##### The CPU freq = 580 MHZ ####
 estimate memory size =128 Mbytes
RESET MT7628 PHY!!!!!!
GPIOMODE --> 50054404
```

Fig-4: New firmware image flashed onto the network processor.

Fig-4 shows that the new firmware image is flashed on to the network processor chip. It also specifies the RAM memory, SPI flash memory, the i-cache and D-cache. It even consists of the board design architecture details. Different designs can contain different sets of architectures.

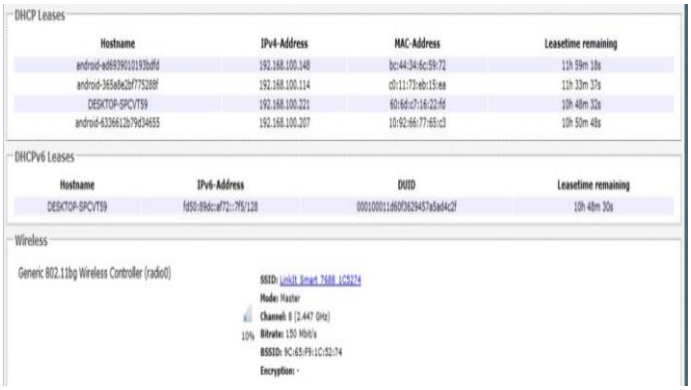

Fig-5: Number of devices connected and their access time.

Fig-5 shows the number of devices connected and their hostname i.e. name of the device which is connected, the IPV4 address of that particular host, its corresponding MAC address and the amount of time it is connected to the internet.

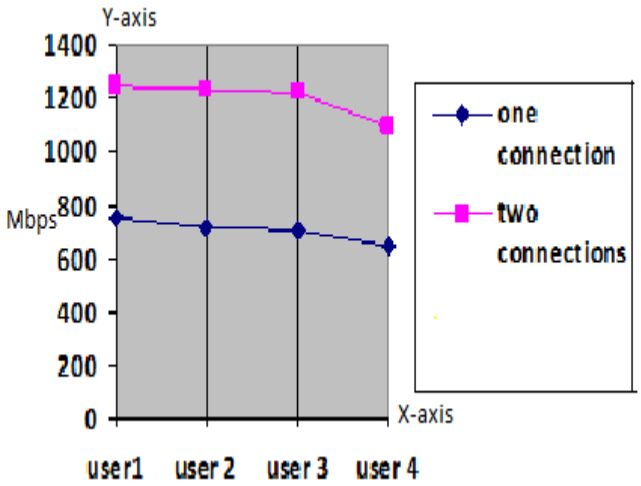

Fig-6: Analysis of bandwidth based on number of users.

Fig-6 shows the graphical representation of number of users connected to this particular router and amount of data each Wi-Fi enabled device is getting in Mbps. The above graph depicts that when number of users are less then the bandwidth is high in other words the data rate is more per user. When the number of users are increasing the data rate slightly deteriorates but never fails to get connected.

6. CONCLUSIONS

There is increasing interest in the field of IoT where small computing sensors and mobile devices are embedded in everyday objects and environments. This router is smaller in size with a network processor and it is configured with captive portal solutions. Increasing the speed or the throughput by combining 'carriers' of same or varying bandwidths is done by using this particular methodology.

These are much reliable and flexible. These routers use bandwidth aggregation so that it's much reliable. It is low cost and it can connect up to 18 users with a good data-rate.

7. Future scope

This particular design is made to connect various 3rd party ISP's. This work can be further extended to connect various Broadband providers as it can cover large area with much higher speed. Here the design can support up to 3 individual dongles this might be extended to connect many more dongles and get much higher bandwidth. These routers might be deployed in transportation vehicles so that the user can make best use of it. These can even fetch more business to owners by providing additional services the charges can be increased.

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