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Interference Analysis of IEEE 802.11n

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Abstract*—Several radio technologies such as IEEE 802.11 and Bluetooth operating in the 2.4 GHz license-free ISM frequency band when present in the same environment leads to signal interference and result in performance degradation. The main objective of this paper is to analyze the effect of mutual interference on the performance of IEEE 802.11n system in presence of bluetooth devices. We develop a simulation framework for modeling interference based on detailed MAC and PHY models. First we studied a simple wireless simulation scenario and then moved to more complex scenarios involving multiple Bluetooth nodes and WLAN devices based on the practical implementation. These helped us to highlight the effects on Transfer data rate, Average delay, Packet drop ratio and eventually on Throughput.

***Index Terms*—Signal to interference Ratio (SIR),Wireless Local Area Network (WLAN), Bluetooth (BT), IEEE 802.11n (802.11n), Network Simlator (ns-2), Transmission Control Protocol (TCP), File Transfer Protocol (FTP), Industrial Scientific Medical (ISM), High Throughput (HT), Space-Time Block Coding (STBC).**

I. INTRODUCTION

Bluetooth is one of the dominant technologies in the wireless world. Large number of bluetooth-enabled devices are present in the surrounding and so it of atmost important to study the interference caused due to it. Also the increasing penetration of heterogeneous communication devices sharing the unlicenced world-wide available ISM band makes the issue of mutual interference a key aspect to be investigated.

In our paper the main goal is to present our findings on the performance of IEEE 802.11n system when operating in close proximity with other wireless devices. Our results are based on details models for MAC, PHY and wireless channel. Recently a number of research activities has led to the development of tools for wireless network simulation [17] .

Efforts to study interference in the 2.4 GHz band are relatively recent. For example interference caused by microwave ovens operating in the vicinity WLAN network has been investigated [6] and requirements on the signal-to-noise ratio (SNR) are presented by Kamerman and Erkocevic [13].In addition there has been several attempts at quantifying the impact of interference on both the WLAN and Bluetooth performance.

Analysis of interference between 802.11 and Bluetooth is not new as indicated by literature such as [1] jim. Early attempts to quantify the mutual interference effects [3] were based on simple geometric models of Bluetooth deployment rather than on actual usage models. Previously relative power levels between BT and 802.11n packets were not considered which is considered in this paper. The prior efforts lacked details on the physical layer (PHY) (e.g. hopping spectral masks filter selectivity) and its implementations.

In our complete analysis we have done Software based implementation, concluded results on it and then Practical implemented the same scenario in order to verify the results.

Other networks in the same frequency band cause interference with IEEE 802.11 networks. The scenario for practical implementation is taken from [9] and report on it is done using open source softwares based on linux operating system such as inssider [22], Netstumbler [23] and iWscanner [24]. The analysis of the interference pattern of IEEE 802.11n with other standards in same ISM 2.4 GHz band is based on Network simulator (commonly addressed as ns-2) a simulation software based on Linux platform. The simulation program is written with the help of tcl [17] script. Its output is taken on NAM (network animator) [25] and plotted with the help of perl/awk scripting language on Fedora, Linux operating system [30].

II. OVERVIEW OF PROTOCOLS

A. *IEEE 802.11n*

The IEEE 802.11n [20] is an amendment which improves upon the previous 802.11 standards by adding multiple-input multiple-output antennas (MIMO). IEEE 802.11n operates on both the 2.4 GHz and the lesser used 5 GHz bands. The IEEE has approved the amendment and it was published in October 2009 [20] Prior to the final ratification enterprises were already migrating to 802.11n networks based on the Wi-Fi Alliance's certification of products conforming to a 2007 draft of the 802.11n proposal.

802.11n incorporates all earlier amendments to 802.11, including the MAC enhancements in 802.11e for QoS and power savings.

The design goal of the 802.11n amendment is High Throughput (HT). The throughput it claims is high up to 600 Mbps in raw bit-rate [21]. The maximum speed of 802.11g is 54 Mbps and the techniques are applied to boost it to 600 Mbps by using 802.11n [21].

1) More subcarriers:
   802.11g has 48 OFDM data subcarriers. 802.11n increases this number to 52, thereby boosting throughput from 54Mbps to 58.5 Mbps [21].

2) FEC:
802.11g has a maximum FEC (Forward Error Correction) coding rate of 3/4. 802.11n squeezes some redundancy out of this with a 5/6 coding rate, boosting the link rate from 58.5 Mbps to 65 Mbps [21].

3) Guard Interval:
802.11a has Guard Interval between transmissions of 800ns. 802.11n has an option to reduce this to 400ns, which boosts the throughput from 65 Mbps to 72.2 Mbps [21].

4) MIMO:
Due to the effect of spatial multiplexing, provided there are sufficient multi-path reflections, the throughput of a system goes up linearly with each extra antenna at both ends. Two antennas at each end double the throughput, three antennas at each end triple it, and four quadruple it. The maximum number of antennas in the receive and transmit arrays specified by 802.11n is four. This allows four simultaneous 72.2 Mbps streams, yielding a total throughput of 288.9 Mbps [21].

5) 40 MHz channels:
All previous versions of 802.11 have a channel bandwidth of 20MHz. 802.11n has an optional mode (controversial and not usable in many circumstances) where the channel bandwidth is 40 MHz. While the channel bandwidth is doubled, the number of data subcarriers is slightly more than doubled, going from 52 to 108. This yields a total channel throughput of 150 Mbps. So again combining four channels with MIMO, we get 600 Mbps [21].

- **Lower MAC overhead:**
  The IEEE 802.11a/g link rate is 54 Mbps, but the higher layer throughput is only 26 Mbps; the MAC overhead is over 50%. In IEEE 802.11n when the link rate is 65 Mbps, the higher layer throughput is about 50 Mbps; the MAC overhead is down to 25%. But to minimize these fall-backs, IEEE 802.11n contains additional improvements to make the effective throughput as high as possible [21].
- **Space-Time Block Coding:**
  In a phone one Wi-Fi antenna is present, so there will be only one spatial channel. Still the MIMO technique of STBC enables the handset to take advantage of the multiple antennas on the Access Point to improve range, both rate-at-range and limiting range. It yields the robustness of MIMO without a second radio, which saves all the power of second radio. This power saving is compounded with another because of the greater rate-at-range. The radio is ON for less time while transmitting a given quantity of data. STBC is optional in 802.11n, though it should always be implemented for systems that support 802.11n handsets [21].
- **Hardware assistance:**
  Many of the features impose a considerable compute load. STBC falls into this category. This is an issue for handsets, since computation costs battery life. This feature is amenable to hardware implementation. With dedicated hardware the computation happens rapidly and with little cost and power [21].

B. Bluetooth

Bluetooth is a proprietary open wireless technology standard for exchanging data over short distances (using short-wavelength radio transmissions in the ISM band from 2400 - 2480 MHz) from fixed and mobile devices, creating personal area networks (PANs) with high levels of security [28]. It can connect several devices, overcoming problems of synchronization. Bluetooth is a short range (0-10 m) wireless link technology aimed at replacing non-interoperable proprietary cables that connect phones laptops, PDAs and other portable devices together. The signal is modulated using binary Gaussian Frequency Shift Keying (GFSK).A Time Division Multiplexing (TDM) technique divides the channel into 625 μs slots. Transmission occurs in packet is transmitted on a different hop frequency with a maximum frequency hopping rate of 1600 hops/s.

1) Synchronous Connection Oriented (SCO) Link: Bluetooth voice transmission is done by SCO (Synchronous Connection Oriented). The SCO link is a symmetric point to point voice link for sending and receiving voice packets at regular intervals of time. The SCO packets are transmitted in only every sixth slot. This period of time is equal to 3.75ms. The return path of transmission from the slave to master takes place on the next slot. Bluetooth can support a maximum of up to three voice calls at the same time.

A master device initializes and controls the SCO link. When a master device sends SCO a packet in a slot the slave device sends back in the following slot. So the data rate is same in both direction. The length of Bluetooth-SCO packet is always one slot. There is no acknowledgement for SCO packets. SCO packet transmission happens always in reserved slots at regular time intervals every two, four or six slots. There are different types of SCO voice packets like HV1, HV2, HV3 all with data rate 64Kbps.

2) Asynchronous Connection Less (ACL) Link: Bluetooth data transmission is called asynchronous connection-less (ACL) which is different from SCO transmission in many respects. In data transmission there is no margin for error allowed. If an error occurs those packets must be transmitted again. In the case of Bluetooth ACL transmission the system will wait for acknowledgment from the receiver [2]. It will send the packets repeatedly till an acknowledgment is received. The receiver will check the packet and verify the CRC to make sure the packet is received correctly. The through-put will go down if a packet has to be transmitted again. Data packet types are DH1, DH3, DH5 for high and DM1, DM3, DM5 for medium priority. They may be symmetric or Asymmetric.

III. Simulation Model

For the stimulation purpose same Reference [9] is used to implement the scenario and the software used is ns-2 [17] which is an open source available freely. ns-2 is an object oriented simulator written in C++ with an OTcl (Object oriented tool command language) interpreter as a front end. The simulator supports a class hierarchy in C++ and OTcl interpreter. C++ is fast to run but slower to change making it suitable for detailed protocol implementation while OTcl runs much slower but can be changed very quickly (and interactively) making it ideal for simulation configuration.

A. MAC Model

We used Network simulator (ns-2) to develop a simulation model for the IEEE 802.11n and bluetooth protocol. We assume that a connection is already established between the master and the slave and that the synchronization process is complete. For the IEEE 802.11n protocol we used the inbuilt wireless model available in the wireless educational scripts and modified it to use as MAC/PHY interface module.

At the MAC layer, probability of packet loss is calculated because Packet loss measures the number of packets discarded at the MAC layer due to errors in the bit stream.

B. Channel model

The signal range depends on propagation characteristics of the environment, processing gains of receivers and transmitted power from different services [8]. Since IEEE 802.11n AP is usually located on the wall to provide better coverage, it is less likely to interfere with BT (1). Interference occurs when the MS receives information from the AP, and BT-1 transmits information to BT-2; or when the MS transmits and BT-1 receives. We assume the interference from the AP to the BT devices and the interference of the BT-2 to the IEEE 802.11n device are negligible. When the MS is receiving and BT-1 is transmitting, the signal-to-noise ratio at the MS will be :

$$SIR = \frac{P_{AP}}{P_{BT}} \times \{\frac{r}{d}\}^{\gamma} \tag{1}$$

$$r_{max} = d \times \lfloor (SIR)_{min} \times \frac{P_{BT}}{P_{AP}} \rfloor^{\frac{1}{\gamma}} \tag{2}$$

Where, SIR= signal to noise ratio at the MS

P_{AP} = Power Transmitted by Access Point
and P_{BT}= Power Transmitted by Bluetooth Node
γ = Path Loss Exponent
d = Distance between AP and IEEE 802.11n device
r = Distance between BT Device And IEEE 802.11

Here the calculation of throughput (in kbps) is done by using simple commonly used formula:

$$\eta = \frac{\varphi}{\tau} \times \{\frac{8}{1000}\} \tag{3}$$

Where, η = Throughput

φ = Total Packet Transffered
τ = Total Simulation Time

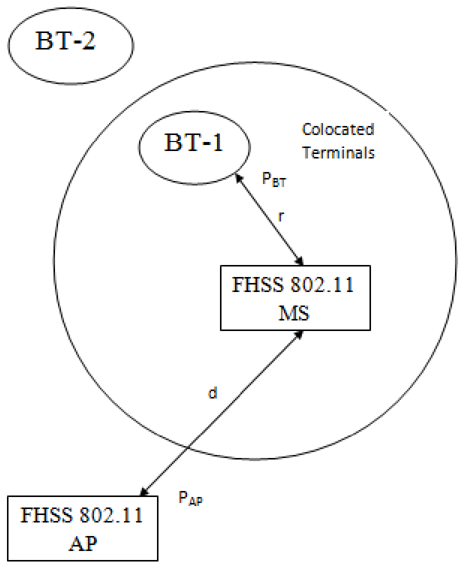

Fig. 1. The Basic Interference Scenario between Bluetooth and IEEE802.11 FHSS

CASE 1:
In ideal case only two nodes are considered. The n0 (AP) and n1 (client) are transmitting and receiving nodes respectively. None of the other nodes are present in the vicinity, due to which the interference is unavailable. Throughput is plotted for this scenario between Transfer data rate and delay time required by the NAM {Refer Fig. (2)}.

CASE 2:
This case is based on the Practical scenario. The TCL script consists of 6 wireless nodes in ISM 2.4 GHz band { Refer Fig. (3)}. The 'n0' (TCP/FTP) (in Red Color and Hexagonal shape) is used as the transmitting node and act as AP, while n1 (TCP/FTP)(in Golden color and in Box shape) is used as the receiving node and act as client. There are four more nodes which are Referred as BT nodes (in Blue color and in circular shape) communicating within the prescribed range (of n0 and n1) to create interference between the nodes. All the BT nodes are also communicating with each other through sending data. BT1 is sending to BT2 while BT3 is sending to BT4 node

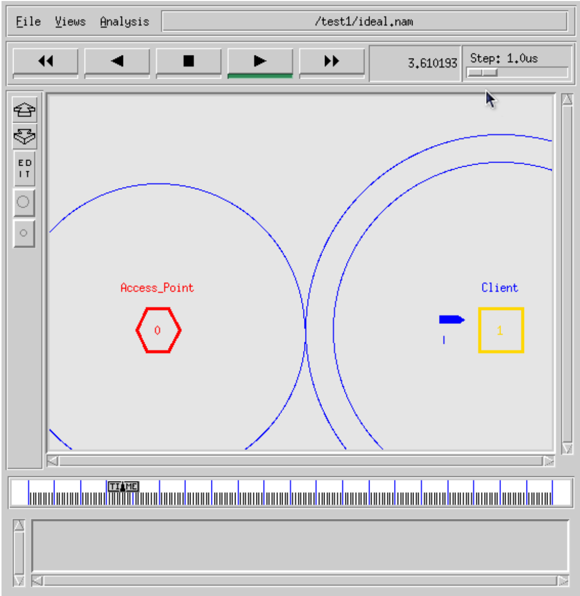

Fig. 2. Ideal Case Simulation Scenario - Communicating AP - Client

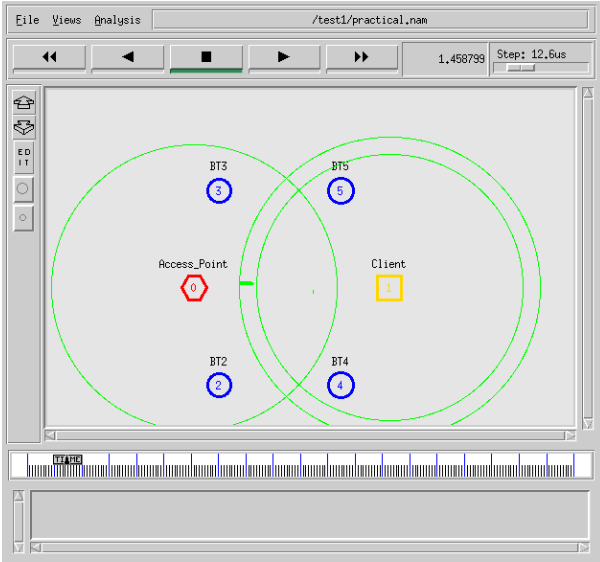

Fig. 3. Practical Case Simulation Scenario

as shown in the (1). When these nodes are in active mode (after 1.5 seconds of simulation i.e. in transferring data mode) they reduces the transfer data rate between the transmitting and receiving nodes of the Access point and Client as shown in figure (3) causing reduction in the throughput of the system see (6). An Error function is implemented manually in order to show the effect of interference on the transfer data rate. This Error function used is a exponential decay function according to [8]. The Transfer data rate Vs Time delay plot is obtained in gnuplot [26] and the required trace file for this system is found by using awk/Perl script [18] to extract information from original Trace file obtained by ns-2 after simulation. The python scipt [27] is used to extract Throughput Vs Delay information in Ideal as well as in Practical case where the decrease in **Throughput** in Bytes/sec, **Average Delay** in Seconds (Due to interference) and Increase in **Drop rate** in % of packets can be seen clearly in Table I. According to [9] The

Probability of an 802.11 packet surviving in BT interference, is approximated by:

$$P_{Survive} = (1 - P_{hit})^n P_n + (1 - P_{hit})^{n+1} P_{n+1} \quad (4)$$

Where P_{hit} is the probability of having the same frequency for both 802.11 and Bluetooth. The probaility of cillision is given by

$$P_{collision} = 1 - P_{survive} \quad (5)$$

IV. Practical Scenario Setup and Calibration

For the practical analysis of the interference we used the vaio laptop which has Atheros A298 series 802.11n enabled Access point set up in it [31] and mobile phones { BT1-nokia/bluetooth version-3.0; BT2-nokia/bluetooth version-3.0 } [32] as the bluetooth devices. Audio data (Size-6.4 MB) was transferred from BT1 to BT2 and from BT3 to BT4 while the internet was accessed by client PC from above mentioned WLAN Access point. More specifications are given in Table II. The practical scenario is implemented in our laboratory for analysis [9]. we plotted the signal strength of the WLAN

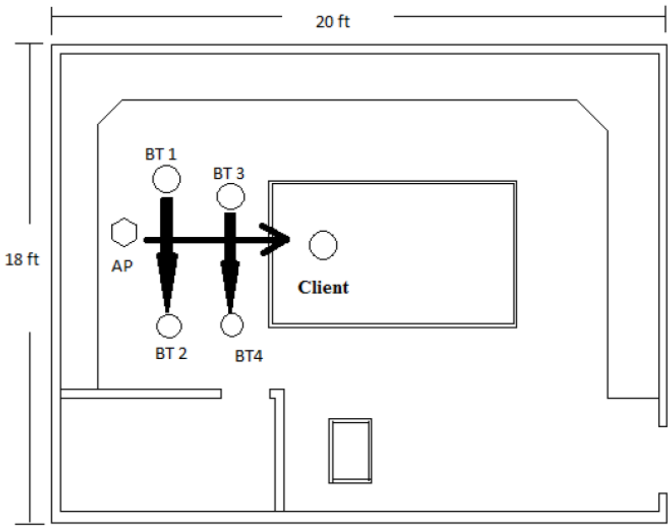

Fig. 4. Schematic of Project lab

(dB) Vs the delay (ms) using connectivity analyzer software on symbian (Belle) platform (on Nokia N8-00) {Refer Fig. (5)} and also using iWscanner software {Refer Fig. (7)} on Linux operating system. The screenshots are taken which are shown in Figure (7) and (5). As seen from the graph when the bluetooth device changed its state from ideal mode (searching)

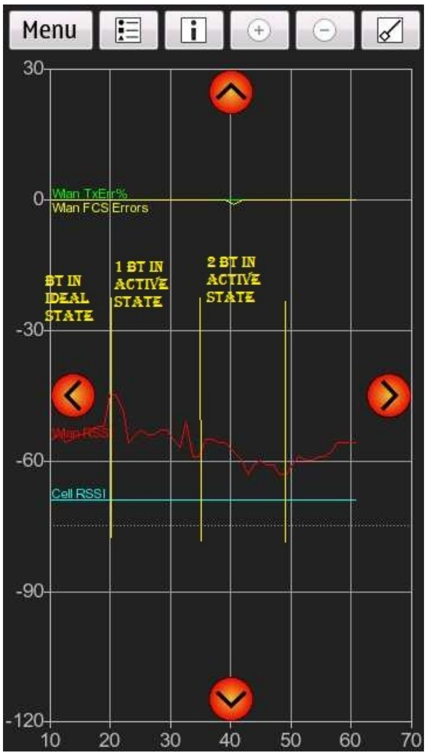

Fig. 5. Connectivity Analyzer

to active mode (transferring or receiving data) a drastic fall in signal strength is seen only initially and then a abrupt change is its value is experienced due to *bursty* traffic (data is sent in packet format).The graph also gives information about the cell RSSI (Received signal strength value) which helps to understand the interference phenomenon much better.

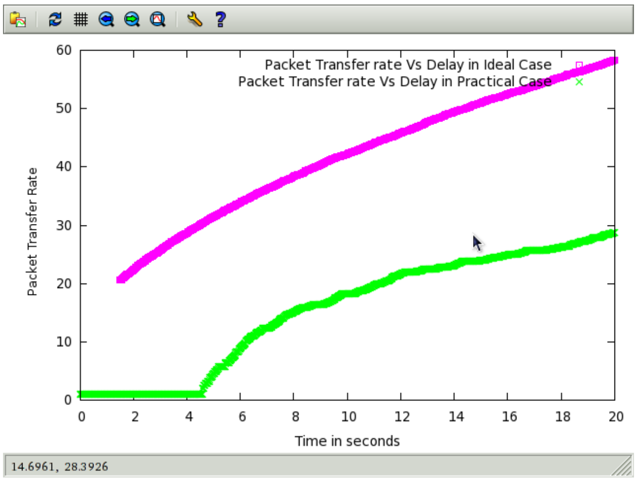

Fig. 6. Plot of Packet Transfer Rate Vs Time in Ideal and Practcal Case

V. Results Analysis

The statistical results comparing two cases according to our ns-2 simulation are as follows:

1) Throughput of IEEE 802.11n system decreases by 6.27 dB due to the presence of bluetooth devices.
2) Delay Time for packet transfer is increased by 0.26 sec (which is more than twice).
3) Packet drop rate increased by 2.73 times.

CASE	Node (From -> To)	Throughput	Drop Rate	Average Delay
Ideal	0->1	85754.0000	0.0000	0.165358
Practical	0->1	65528.0000	2.7325	0.428136

TABLE I
Statistical Result of Ideal & Practical Case

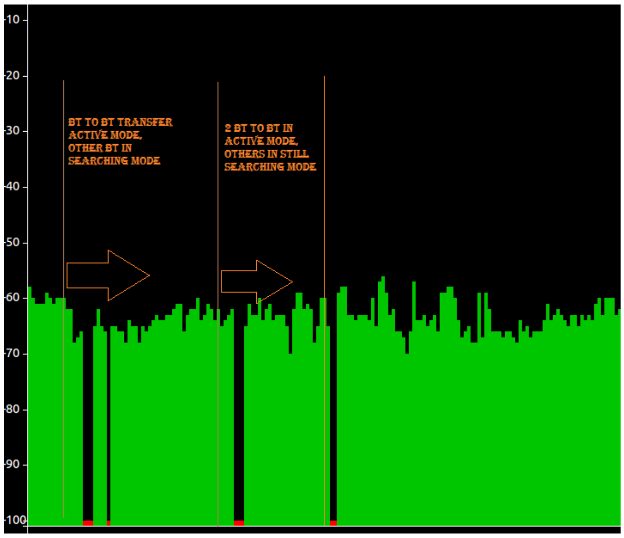

Fig. 7. iWScanner open source software based on Ubuntu 11.10 OS

Here we observe the Packet transfer rate in Ideal case is more and in practical case it is less. As shown in plot plotted by gnuplot [26] the plot of ideal case is plotted in Magenta color and for practical case we have used green color to distiguish between these packet transfer rates. The more precise parameters given in table below :

The Parameters Used for Simulation	Distribution	Values
Length of simulation		20 Sec
Bluetooth Parameters		
Transmitted power		1 mW
File Size (in kbytes)	Exponential change	[0.5 500]
WAN Paramaters		
Transmitted power	Constant	20 mW
Packet Header	NS2 Fixed Std	224 bits
Packet Payload	NS2 Fixed Std	12000 bits

TABLE II
Simulation Parameters

VI. Conclusions

Co-existence and ultimately simultaneous operation between 802.11n and Bluetooth is a highly desirable goal. Both technologies are expected to grow rapidly over the next few years offering new levels of portability, convenience and many critical usage model require collocation and simultaneous operation of both standards in the same device. Such robust wireless system design technology will become increasingly important in the unlicensed bands as Bluetooth, Wi-Fi and other unlicensed wireless technologies proliferate.This paper has focused on the effects of BT interference on IEEE 802.11n wireless LANs. A model has been on ns-2 which provides a means of estimating the degree of interference inflicted on an IEEE 802.11n WLAN by a number of BT piconets operating in close proximity. Thus, the Throughput of the WLAN standard IEEE 802.11n reduces as the interference increases.So care must be taken during the installation of WLAN in-order to minimize the effects of interference on the system and to get most of the desirable speed.

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Optimum Utilization of Private cloud with predefined Reservation Policy

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Abstract— **Cloud computing is considered as one of the most promising and fast growing technology due to it's flexibility, scalability and cost-reducing Facility. There are two types of cloud one is private and other is Public. The public cloud is considered to have unlimited resource but the private cloud may face some problem since the elastic behaviour property fails due to limited resources. In this paper we study the Infrastructure As A Service cloud environment through our laboratory practical running on private cloud based service, check for legitimately utilized machine and if unnecessary resource is being utilized with no operation being performed then by forcefuly terminating their instance to provide Machine instance to other legitimate users who are waiting for resource by using predefined reservation policy.**

Keywords— **Parallel computing, machine instance, cloud computing, Virtual Machine, Enforcing policy.**

I. INTRODUCTION

The National Institute of Standards and Technology (NIST)[3] defines defines cloud computing as "A model for user convenience, on demand network access contribute the computing resources (Eg. Network, Storage, Application, Server and services) that can be rapidly implemented with minimal management effort service provider interference." The services in cloud computing are given on X as a Services (XaaS) which is splitted into three services viz. "Platform", "Software" and "Infrastructure".

This is the reason behind the accronym of Services and are called as SaaS ie. Software As A Services, PaaS ie. Platform As A Service, IaaS ie. Infrastructure As A Service. Cloud Service is classified as shown in Fig. 1 called as SPI model. SPI referes Software, Platform and Infrastructure (as a servies) respectively defined.

A. *Cloud Service Models*

- **Cloud Software As A Service (SaaS):** In the SaaS model, cloud providers install and executes application software in the cloud and their users access the software from cloud clients. The user dont have to care about how the cloud infrastructure has been maintained and how the application is running. Examples of SaaS include: Google Apps, Microsoft Office 365, GT Nexus, Marketo and TradeCard.
- **Platform As A Service (PaaS):** In the PaaS model, the platform is provided to the user which includes OS, database, programming language execution and web server. Application developers can develop and run their application on cloud without cost and complexity of buying and managing the required hardware and software layers.

Examples of PaaS include: AWS Elastic Beanstalk, Cloud Foundry, Heroku, Google App Engine, Windows Azure Compute and OrangeScape.

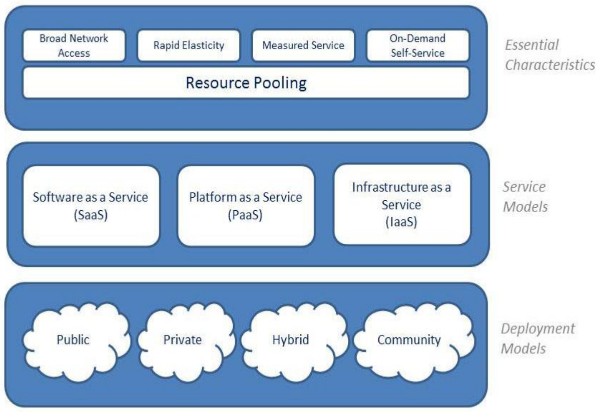


Fig. 1 Cloud Computing Models and Deployment

- **Cloud Infrastructure As A Service (IaaS):** The highly used and widely in use model of cloud is IaaS, which provides physical or virtual machines including other resources to the user by using a concept of Hypervisor. Resources such as images in VM as given in [2] image-library, firewall, IP Address, VLANs and software bundles.

Examples of IaaS providers include Amazon EC2, Windows Azure Virtual Machines, Google Compute Engine, HP Cloud, Oracle Infrastructure as a Service.

B. *Cloud Deployment Models*

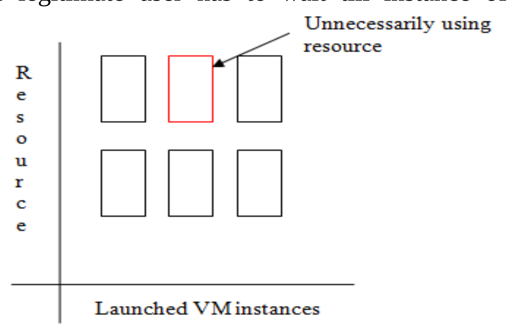
- **Public Cloud:** Public cloud applications, storage, and other resources are made available to the general public by a service provider. These services are free or offered on a pay-per-use model. Generally, public cloud service providers like Microsoft, Amazon AWS and Google own and operate the infrastructure and offer access only via Internet as given in [4] (direct connectivity is not offered).

- **Community Cloud:** Community cloud shares infrastructure between several organizations from a specific community with common concerns (security, compliance etc.), whether managed internally or externally. The costs are spread over fewer users than a public cloud (more than a private cloud), so only some of the cost savings potential of cloud computing are realized as given in [3].
- **Hybrid Cloud:** Hybrid cloud is a composition of two or more clouds (private, community or public) that remain unique entities but are bound together, offering the benefits of multiple deployments as discussed in [3].
- **Private Cloud:** Private cloud is cloud infrastructure operated only for a single organization, weather they be hosted internally or externally like explained [3]. Private cloud requires a optimum level and degree of engagement to virtualize the infrastructure environment which will also require the organization to re-evaluate decisions about existing resources.

The private cloud is implemented within as Infrastructure but with limited resources. If we consider the IaaS model case in private cloud deployment, the elasticity property does not hold good enough once these cloud services are deployed over the institute of commercial complex.

II. RESERVATION POLICY IMPLEMENTATION

We studied the practical laboratory in our infrastructure where private cloud is implemented. The lab consists of 20 machines and maximum instance that cloud can run is 18. The Fig. 2 shows the average utilization of machine instances when they are started while doing practicals. The part of resource utilization is shown where the machine instance shown in red color launches the instance on cloud server but does nothing while performing practical and due to this the students that are actually in need to perform practical or the legitimate user has to wait till instance of



other machine is closed.

Fig. 2 Resource Utilization in Lab – Partly

III. IMPLEMENTATION

To solve this discussed issue we study this resource utilization content and forcefully terminate those virtual machine instances which are unnecessarily occupying the resources. The solution can be implemented by using simple script which takes the input parameters of utilization of each

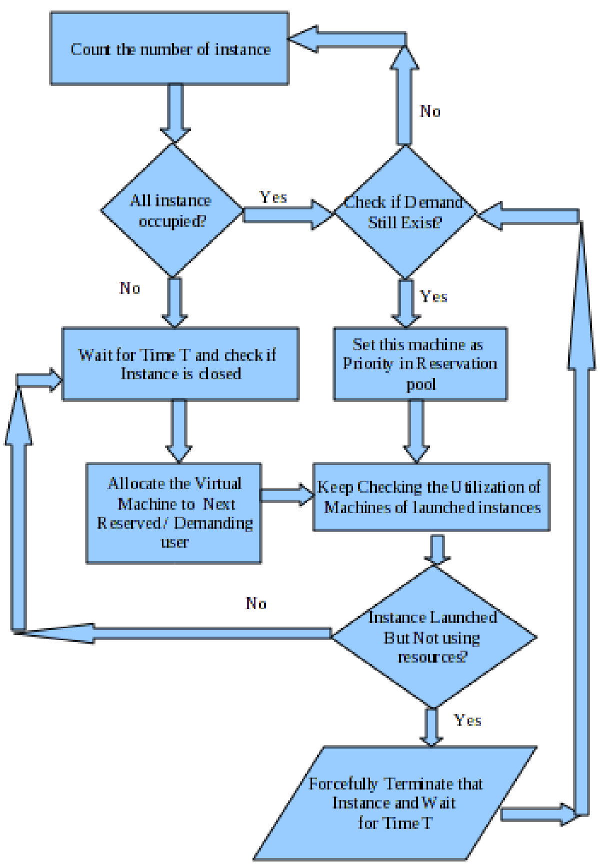
Fig. 3 Implementation Algorithm

machine in lab as a value compares it with standard predefined threshold level, and if demand for machine instance comes in between when all Vms (Virtual Machines) are launched, the user is assigned with flag for high priority after any of instance closed. If the demand for machine instance increases we can make the reservation pool in which all machine would be registered and they will be given preferences when next time machine instances are launched.

The input parameter of utilization of each machine will be compared with threshold value and as shown (in fig 2 - the red marked VM instance), if the machine is occupying instance and doing nothing, that instance will be terminated forcefully. Then the reservation list will be checked and the highest priority machine as shown in [8] will have chance to get instance for his work.

The Algorithm is shown in Figure 3, where the discussed scenario is completely shown and represented as a script working at the service provider side. This will keep checking if the instance are actually utilizing the resources of the launched instances or just occupying the resource by holding the instance. And the Highest processing power required block is shown tilted since it requires the Administrator privilege of the root privilege for forcefully terminating the instance.

This script will keep on executing in the background with root privilege and loop will be maintained including the reservation policy to accurately utilize the resource and give service to legitimate students or users.



IV. CONCLUSIONS

Hence we have studied that the machine instance of cloud server can be forcefully terminated whenever required and the reservation policy can be implemented if necessary so as to give service to the legitimate user. In this way we can save the cost of modification in infrastructure to accommodate more number of user within institute. This reservation policy also helps in enforcing some user to keep doing there work regularly and in limited time otherwise timer system can be setup that will discard any changes or program that are running on that machine if they take more than required time. This could be the great idea of taking practicals in lab from students within specified time and if student fails to complete his program or his work he have to start it all over again and learn to do it fast by demanding for next machine instance and that will be provided based on reservation policy whether to give him instance or not.

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Remastering OS For Optimum Usability (HCOS)

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***Abstract*— The operating systems these days are very much resource hungry. The OS mostly starts its own processes itself which user may not even use in that session, this indirectly reduces an efficiency or performance of the Device. The customization of an OS would provide good access to the physical resources that are available and the indirect throughput of system would increase. The paper mainly focuses on increasing usability by improving these indirect delays caused by OS by reducing the size and highly customizing it for specific users which in-turns improves the usability score of a system. That os will be addressed as Highly Customized Operating System ie. HCOS.**

Keywords—Customization; Throughput, Performance; LOC – Lines of Codes.

I. INTRODUCTION

An operating system (OS) is a collection of software that manages computer hardware resources and provides common services for computer programs. The operating system is a vital component of the system software in a computer system. Application programs require an operating system to function [1]. Time-sharing operating systems schedule tasks for efficient use of the system and may also include accounting for cost allocation of processor time, mass storage, printing, and other resources.

For hardware functions such as input and output and memory allocation, the operating system acts as an intermediary between programs and the computer hardware, [2] [3]. Although the application code is usually executed directly by the hardware and will frequently make a system call to an OS function or be interrupted by it.

Now days almost each and every OS consist of thousands of LOCs. When the OS Boots, it starts many application by default, these applications in-turns steals M/C of CPU, Occupy unnecessary RAM space or memory and this indirectly affects the performance of the system.

If we make an OS which has only the necessary programs or applications that user will be using (Based on prior knowledge of frequent user of that device), we can reduce the RAM occupied space, CPU M/Cs which will in-turn improve usability and performance of an OS itself.

The User may have to create this Customized OS once and then he may use it efficiently even on older Machines which had low configuration and still get the same performance as of Latest processor.

II. IMPLEMENTATION

There are various ways to implement this concept. We have many Unix or Linux based OS which are Open source and allows itself to be customized using Live CD, software or Virtual Machine. The easiest way to customize own OS is install it make necessary changes i.e. remove unnecessary applications/programs, unnecessary advance setting (options provided by OS), and user might install/add his required software too (if he would like to use that software most frequently) and then take whole backup of system to create new ISO image in ISO 9660 format for CD/DVD or to install it on USB device, which can be easily taken anywhere and OS can be installed through it.

In this way the OS becomes bootable in users environment and it can be installed to any of the (compatible) machine via CD/DVD/USB and used efficiently. This will also reduce the Booting time of an OS and response time of any command that is entered by the user.

A. Software Requirement

There is no software requirement since we are going to create a whole new operating system which will have different softwares required by user who might A Doctor/ Housewife/ Engineering student/Businessman. In some case Remastering software might be required depending on the method that we chose to customize our OS. The softwares that are mostly used by It engineer is as follows:

- LXDE, a lightweight X11 desktop environment (default for 6.0.1 and later), or KDE 3, a more feature-complete desktop which is the default for 5.3.1 and earlier releases.
- MPlayer, with MP3 audio, and Ogg Vorbis audio playback support
- Internet access software, with KPPP dialer & ISDN
- The Iceweasel web browser (based on Mozilla Firefox)
- The Icedove e-mail client (based on Mozilla Thunderbird)
- GIMP, an image manipulation program
- Tools for data rescue and system repair
- Network analysis and administration tools
- LibreOffice, a comprehensive office suite

- Terminal server
- Network sniffer like wireshark

So for an Engineer, he/she might keep only these programs and remove all unnecessary programs.

B. Hardware Requirement

The Hardware required are very basic for a latest devices, these requirements are very small and cheap as compared to latest products:

- Intel-compatible processor (i486 or later)
- 32 MB of RAM for text mode, at least 64 MB for graphics mode with LXDE (at least 128 MB of RAM is recommended to use the various office products)
- Bootable CD-ROM drive, or a boot floppy and standard CD-ROM (IDE/ATAPI or SCSI)
- Standard SVGA-compatible graphics card
- Serial or PS/2 standard mouse or IMPS/2-compatible USB-mouse

So there is hardware requirement which is available almost everywhere and even it is more cheaper that the latest configuration like Quad core CPU and 3 GHZ processor with 8GB RAM, etc.

Here are two screen-shots which gives the performance analysis of normal OS and Highly customized OS. We have used Fedora Live OS to customize same OS shown in figure II-B and II-B. The HCOS OS is compared with normal running Fedora Live OS running in normal mode with necessary applications in background. The Resource TAB in system monitor is shown after launching an application called gimp on both OS.

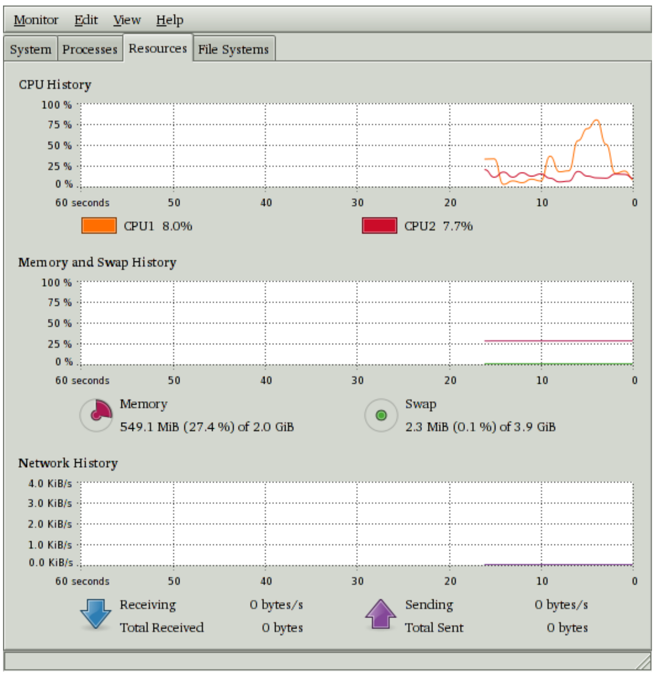

Fig. 1. System Analyzer on Fedora Live OS – NORMAL

This indicates, how the usability score is improved by taking account RAM Usage, CPU Usage and Throughput of the system.

III. Conclusion

Hence the Customization of OS provides better throughput and performance and in this way the usability score of Machine on which the OS is installed improves.

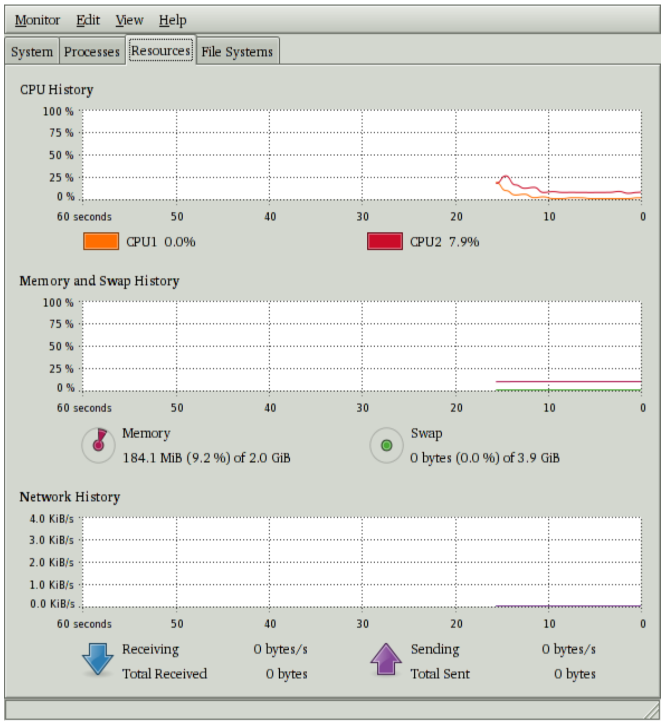

Fig. 2. System Analyzer on Fedora Live OS - HCOS

A. Limitations and Drawbacks

The operating system need to be optimized or modified or created for each and every type of user in different iso file formats. Once file format is finalized user can use it efficiently. Normal user or client will not be able to build his/her own OS unless having knowledge of customizing or building new OS.

IV. Future Modifications And Enhancements

The future use of this concept of Customizing or Remastering would be use in Cloud since the whole image gets loaded into cloud RAM when the instance is started. But if we have size near about 1-2GB then this would take so much amount o RAM as well as some time to load. By customizing we can fit more number of Virtual machine instance in the same cloud without modifying RAM size. User will only get what he/she requires and there will be very high throughput since no unnecessary background processes would be running.

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