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A Survey of Cyber Security Countermeasures Using Hardware Performance Counters

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***Abstract*—Cyber attacks and malware are now more prevalent than ever and the trend is ever upward. There have been several approaches to attack detection including resident software applications at the root or user level, e.g., virus detection, and modifications to the OS, e.g., encryption, application signing, etc. Some approaches have moved to lower level detection and prevention, e.g., Data Execution Prevention. An emerging approach in countermeasure development is the use of hardware performance counters existing in the micro-architecture of modern processors. These are at the lowest level, implemented in processor hardware, and the wealth of data collected by these counters affords some very promising countermeasures with minimal overhead as well as protection from being sabotaged themselves by attackers. Here, we conduct a survey of recent techniques in realizing effective countermeasures for cyber attack detection from these hardware performance counters.**

I. Introduction

Cyber security has been at the forefront of mainstream media for several years now as a critical problem for our society to overcome. Attackers are increasingly motivated and enabled to compromise software and computing infrastructure. Cyber security countermeasures are of prime interest in mitigating such attacks and associated malware.

There are many types of countermeasures that are built as software applications, e.g., virus checkers, based on controlling physical access, e.g., biometrics, or enforced as policies, etc. Our investigation is to survey the state of the art in the utilization of Hardware Performance Counters (HPC) to build cyber security countermeasures. HPCs are a promising new resource to address the limitations of typical software, and other countermeasures.

Hardware performance counters are special purpose registers and logic incorporated in the micro-architecture of modern processors and CPUs. They are typically used as debugging tools that run at the lowest level, i.e., on chip, for performance tuning and analysis by collecting information on processor events and the running processes. As the name implies, HPCs are used to count events, such as cache misses, and aid in timing events, such as counting CPU cycles per unit time. This information that is typically used to debug software can now also be used to detect cyber attacks. Their residence in micro-architecture, i.e., in silicon, is a safeguard against their tampering.

A. Recent Related Surveys

Several related surveys have been performed, e.g., [1] examines the feasibility of using HPCs to detect malware with several specific examples of HPC data triggers and detection techniques, and others that focus on Control Flow Integrity[2] (CFI), hardware trojans[3], and side-channel timing attacks[4]. Our survey updates the current state of knowledge and focuses on HPCs in particular, examining several examples and categorizing them by method and attack vector.

B. Using Hardware Performance Counters as Countermeasures

Hardware performance counters afford a highly granular and low footprint method of detecting anomalous behavior. HPCs reside on the processor chip, implemented in dedicated hardware, so they typically consume minimal resources from the processor. Their inclusion by major processor vendors alleviates the need to develop custom IP cores for cyber attack detection. HPCs collect a wealth of information such as cache misses, event timing, branch mis/predictions, etc. about the running processes. They also execute at the kernel/hardware privilege level, and are difficult to spoof or sabotage by attackers due to their physical persistence in the micro-architecture.

Table #1 lists some of the commonly used HPCs. Many additional HPCs are available depending on the processor manufacturer, e.g., Intel[5]. This table is more thoroughly discussed with supporting data collected from anomaly testing in [6].

The *perf* utility in Linux is an example method of access. Direct access through machine coding, e.g., inline in C, and custom monitoring software are possible as well. Software development tools should allow HPCs to be activated without source code modification or in some cases rebuilding. In this case, HPCs are in contrast to code instrumentation as they exist to passively and externally monitor the processor behavior. The wealth of data from HPCs lends itself to the discovery of anomalous behavior that is an indicator of a potential attack.

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TABLE I
TYPICAL HARDWARE PERFORMANCE COUNTERS, *adapted from [6]*.

cpu-cycles	L1-dcache-loads	dTLB-loads
branches	L1-dcache-stores	iTLB-loads
instructions	L1-icache-loads	dTLB-load-misses
branch-misses	L1-icache-load-misses	iTLB-load-misses
branch-loads	LLC-loads	dTLB-stores
branch-load-misses	LLC-load-misses	dTLB-store-misses
cache-references	LLC-stores	
cache-misses	LLC-store-misses	
ref-cycles		
bus-cycles		

HPCs employ one or more of the approaches in detecting attacks.

1) Signature based: HPCs collect information about the suspect process and determine if this information corresponds to either known attacks, e.g., *blacklist*, or known safe applications, e.g., *whitelist*. This is similar to approaches used by many virus scanning applications. The whitelist, if practical, has the added benefit of denying any activity that has not been validated, thus mitigating unknown and zero day attacks.
2) Heuristic based: HPCs monitor the suspect process to determine if behavior is anomalous, such as if there are a high number of cache misses or a high number of branch mis-predictions (above a heuristic threshold) to indicate a potential attack.
3) Advanced approaches: HPC data are analyzed and used in more advanced statistical analysis, machine learning, or other artificial intelligence approaches with supervised or unsupervised learning.
4) Hybrid approaches: A combination of one or more of these, possibly also in cooperation with other security countermeasures.
5) Context sensitivity: In addition to monitoring blacklist, whitelist, and heuristic behavior, the context in which the application is running can be part of the classification. This can be realized when the countermeasure creates a Control Flow Graph (CFG) during initial configuration and then monitors when syntactically-correct, though functionally invalid, paths are attempted, such as during code reuse attacks.

The selection of an approach depends on the application and environment. Forming signatures requires specific knowledge of the attack to form a blacklist, or knowledge of all valid (acceptable) applications to form a whitelist. Heuristics are used when this knowledge is less specific, and general knowledge of trends are available through monitoring of the system to set guidelines, e.g., thresholds. Machine learning becomes a better alternative when the system needs to adapt to unknown threats or the execution environment is too dynamic to predict anomalous behavior.

C. Notes for IoT and Embedded Systems

Embedded systems and systems that comprise the Internet of Things (IoT) usually have the characteristics of limited resources, such as memory, processing power, and network bandwidth. IoT specifically may also include high deployment where many devices are managed. The use of HPCs for countermeasures are still a viable alternative for these, perhaps more so due to the low overhead of HPCs, though the following points should be considered.

1) Some embedded systems may have limited HPCs available, especially in custom or application specific implementations.
2) The use of black/white lists may require too much storage and the use of machine learning algorithms may require too much processing power. Heuristic approaches tend to work best, though when used alone they may not provide adequate protection.
3) In deployments with many devices, a centralized database or machine learning engine may be able to offset some of the local limitations to provide good protection, providing that network bandwidth is available. Distributed approaches may alleviate limitations when a centralized authority is not practical.
4) Many embedded systems only run a limited selection of applications and/or have static configurations. A whitelist may be more practical and effective in these cases.

D. Notes for Cloud Usage

Cloud usage and usage in Virtual Machines (VM) should be possible as most VM hypervisors have the option of enabling virtual HPCs. Cloud providers would need to enable this functionality as it is usually not enabled by default. Otherwise, the use of HPCs for countermeasures should be largely transparent to the cloud provider and users. When HPCs are enabled in VMs, it should be ensured that the HPC values presented to the VM OS are only for that VM's activities, which is usually the case and again, managed by the hypervisor. Cloud providers may choose to enable these methods rather than rely on users' requests.

E. Structure of this Paper

Section I introduces the topic of cyber attack detection via HPCs, discusses similar surveys, and includes notes on specific application areas. Section II discusses the types of attacks, i.e. attack categories, including their capabilities and how they are carried out. Section III analyzes several example cyber attack countermeasures using HPCs, categorizing these by countermeasure approach. Section IV provides a summary of this analysis with insights into countermeasure characteristics, implementation, and hybridization of multiple countermeasures that may be utilized for more complete detection coverage while mitigating false positives and false negatives.

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Finally, Section V discusses future directions for HPC-based countermeasures.

II. Types of Cyber Attacks and Attack Vectors

The types of cyber attacks possible have been well covered in the literature. A brief summary of cyber attack categories is provided in Fig. #1.

Code Reuse Attacks (CRA) that compromise control flow integrity seek to alter the normal control flow of a software application to perform malicious activities. Examples include Return Oriented Programming (ROP), in which the attacker gains control of the call stack to rewrite the return address from a function call, and Jump Oriented Programming (JOP), in which the attacker maliciously uses the jump instruction to piece together malicious code fragments. The attack uses existing instructions in executable code or resident libraries that are chained together to form gadgets. These gadgets are similar to functions, i.e., sets of instructions, that are used to perform the malicious activity of the attacker. In most cases, the attacker needs to know the executable code and libraries from which to select gadgets. For commodity operating systems and applications, these are known to the attacker. Address space layout randomization, e.g., code randomization, is an effort to make this more difficult. Also, side channel leaks may allow an attacker to uncover enough information from which to build useful gadgets anyway. Such CRA mitigation has been a primary focus of HPC-based countermeasures as the HPC information collected, such as cache misses, branch mis-predictions, etc., are good heuristic indicators of CRA where control flow becomes detectably anomalous.

False Code Injection (FCI) and modification attacks seek to inject a malicious software payload or overwrite existing application code with such a payload to perform malicious activities. Many of these are done via buffer overflows, and may be performed by other various means. In some cases, false data may be injected to alter program behavior, such as false sensor readings in process control systems. The goals of such attacks may be to seize control, sabotage, or to damage the system being attacked so as to interfere with the performance of its mission. HPC countermeasures for these generally look for anomalous behavior, i.e., contrary to the valid functioning of the application software. Depending on the code overwritten, the counts for various errors may dramatically increase in a short time, e.g., buffer overflow events.

Information leakage attacks seek to steal information from the target system. Usually, these are passwords or other secrets, and may be executable code fragments in preparation for a code reuse attack. Side channel leakage is the most common vector using cache operation attacks such as flush+reload[7], evict+time, prime+probe, and evict+reload. HPCs can detect these from excessive cache misses. HPCs may also monitor event counts for correlation with secret keys when attackers seek to employ HPCs in side channel attacks. Due to the high level of detail HPCs can provide, some attackers may exploit HPCs, for example, to leak the secret key when encryption operations are performed. Martin et al. [8] have proposed disabling or adding noise to HPCs to reduce their accuracy and subsequent efficacy in an effort to prevent attackers from leveraging these.

In other scenarios, more specific hardware events such as memory corruption by *rowhammer*, which repeatedly accesses (hammers) RAM in a very atypical manner to induce errors in adjacent memory cells, may occur and be detected by HPCs acting as hardware monitors based on RAM access. Some Denial of Service (DoS) attacks may also be detected by HPCs noting that most event counts for normal operation often differ greatly from operation during a DoS, which is typically characterized by extremely high activity.

III. Approaches to Attack Detection

From the list of approaches for attack detection in the previous section, several specific examples are examined to establish the current state of the art in HPC cyber security countermeasures.

A. Signature Based Examples

Three signature based examples, SIGDROP[9], ConFirm[10], [11], and another by Chiappetta et al.[12] are examined in their use of HPCs to detect cyber attacks. SIGDROP focuses on detecting Return Oriented Programming (ROP) attacks using two characteristics of such attacks. The first is a high level of mis-prediction by the Return Address Stack (RAS) due to the attackers mis-direction in returns. The second characteristic is that of calls to functions that are very short in instruction length, i.e., gadgets, that are artificially crafted from existing code to perform attack functions. Many such gadgets must be chained together to perform useful work for the attack, thus long chains of very short functions are another signature. Recent studies show that most ROP gadgets have fewer than 6 instructions [13], [14], [15] and may require chaining of dozens to hundreds of gadgets to perform an attack function. SIGDROP configures hardware performance counters to count if the number of consecutive return address predictor misses is above a threshold, T_M, and compares this to the total number of return instructions, N_R. If these are nearly equal, then the return address predictor is missing almost all the time, which is one of the characteristics of a ROP attack. A HPC is also configured to count total instructions executed, N_I, to check the average number of instructions per missed return address prediction. Noting that the typical number of instructions per gadget or per return is $T_I \leq 6$ for ROP attacks, the second signature is found by $N_I \leq (T_I \times T_M)$, which is true when the total number of instructions is less than or equal to the typical ROP gadget length times the number of return address predictor misses. Thus, SIGDROP is an example of a blacklist signature approach. The blacklist behavior is determined by comparison against known attacks.

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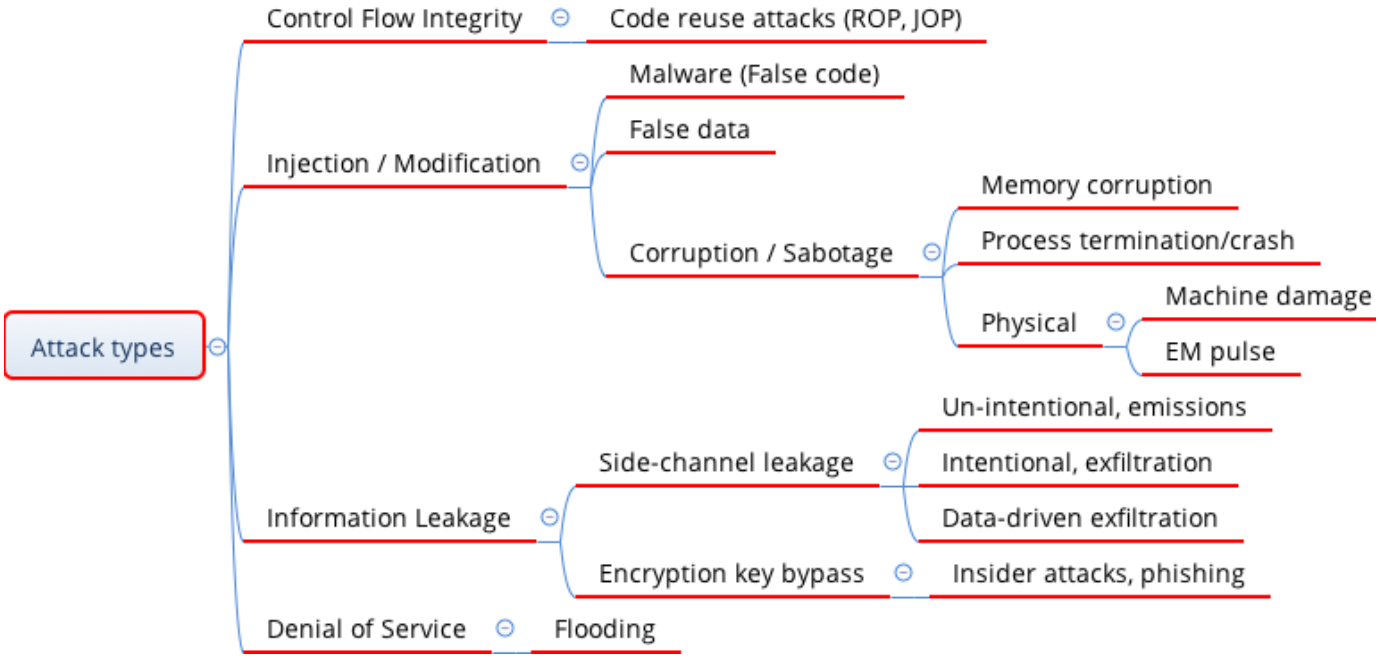

Fig. 1. Types of cyber attack.

ConFirm[10], [11] uses hardware performance counters to detect malicious software either injected into firmware or by performing CRAs using firmware code. ConFirm is a whitelist signature approach since firmware is known in advance and rarely changes. ConFirm performs HPC checks at various points in the firmware code execution process to determine if configured HPCs are at typical values. Since the same code always executes under normal circumstances, these should be very consistent. An attack would introduce new operations and thus change the HPCs. The whitelist behavior is determined by profiling the valid code (firmware) prior to deployment (offline) to collect good HPC values and determine optimal checkpoints.

Chiappetta et al.[12] proposed using HPCs to detect side channel attacks, specifically on cache memory to compromise encryption through information leakage, such as flush+reload. The countermeasure employs a utility, *quickhpc*, that allows the HPC to be queried much faster, at microsecond resolution. Under normal circumstances, the encryption process would be expected to benefit from the cache for a significant portion of the process time. However, when under attack the encryption process never benefits from the cache, because the flush+reload side channel attack is constantly flushing the cache and timing the reload to determine program flow of the encryption process. These cache misses are collected by the HPC which can signal anomalous operation. If using simple threshold heuristics, there could be many false positives, so Chiappetta employs simple machine learning to determine a signature for the encryption process. This is another example of a whitelist approach that uses unsupervised training.

B. Heuristic Based Examples

Heuristic based examples, such as ANVIL[16], CacheShield[17], by Lui et al.[18], by Torres et al.[19], and Eunomia[20], provide direct detection of attacks when certain events count past preset thresholds, either individually or in some combination. These tend to perform better when the effects of attacks are more generally known, e.g., when jump oriented attacks result in high branch mis-predictions. These may result in a higher number of false positives depending on the process being executed, especially when there is a wide range of potentially valid processes. However, they are simple to implement and can act as a pre-filter for more advanced and resource consuming detection approaches. ANVIL is a Linux-based kernel module to mitigate rowhammer attacks, specifically new forms of rowhammer that seek to evade simple rowhammer countermeasures that DRAM manufacturers are now employing, such as on-DRAM caches. ANVIL works by monitoring the locality of DRAM row accesses out of the LLC misses (LONGEST LAT CACHE.MISS). Once a preset threshold of LLC misses is exceeded, a second stage of detection samples virtual addresses for a time duration using Load Latency (MEM TRANS RETIRED.LOAD LATENCY) and Precise Store (MEM TRANS RETIRED.PRECISE STORE) events to determine locality. Once an attack is detected, the rows adjacent to the rows being attacked are refreshed through a read operation. This is only performed as needed so that false positives have very little effect on the system. Thresholds can be determined by observation of bit flips, and may also be empirically set based on DRAM specifications.

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CacheShield[17] is designed to be a user-level tool, with low performance impact for legacy systems, that specifically targets cache attacks. Cache misses, a common symptom of cache attacks, are counted using various cache miss HPCs. CacheShield is configured by monitoring known valid and malicious applications to determine cache miss thresholds for detection, and selects the specific HPCs that are most affected for the application. The example given in the paper was for OpenSSL and the L3 cache. A cache attack is detected when an abrupt change in the statistical distribution of cache misses occurs.

Lui et al.[18] developed a countermeasure to stack buffer overflow attacks used to compromise control flow integrity. A two-level approach is used with the first level being a heuristic pre-filter to facilitate low overhead on embedded systems. Stack buffer overflow attacks redirect control flow through dynamically overwriting the return address of a procedure, which results in instruction cache misses and mis-prediction of return addresses. Anomalous behavior is detected when these occur above an established threshold.

Torres et al.[19] investigated if data-only exploits could be detected at runtime with HPCs. Examples of data oriented attacks are SQL injections or any other mis-information whereby malformed data sent to a host causes the host to disclose secret information. The Heartbleed attack, studied specifically in this work, uses an overestimate of the size of keep-alive packets that keep secure channels open, causing the host to respond with extra data, which contain sensitive information.

Eunomia[20] is another example of earlier work that is similar to these where deviations in PMU-event counts signal malicious activity versus valid processes. This paper includes a good quantitive discussion of HPC deviation values in general under attack scenarios for reference.

C. Examples of Machine Learning and Context Sensitivity

Machine learning includes most approaches in the area of artificial intelligence. Learning may be supervised, such as training HPC data against known valid and known malicious applications. This learning is usually offline, i.e., the classification engine for detecting malicious behavior is developed before runtime or deployment. Learning may also be unsupervised, such as online during runtime based on accumulated information, e.g., information from HPCs. Security policy may still be specified for unsupervised learning and the classification engine will learn violations to this policy. Context sensitivity implies knowledge of the operating environment or application. This knowledge may include information from the source or binary code such as the proper execution paths, e.g., control flow graph verification, or mathematical rules, such as those extracted from the code or based in physics for physical processes, to validate proper operation of the compiled application. Instrumentation of the binary may be performed to provide checkpoints within the application to facilitate these checks. Knowledge of the user environment may be used to detect deviation from expected user behaviors, or even the behaviors of the machine hardware.

The goal of machine learning is to provide a more advanced detection scheme that eliminates the false positives from simple signatures and heuristics as well as eliminating the false negatives when sophisticated attacks are launched that use valid code fragments and other seemingly valid approaches. Machine learning is typically of much higher processing overheads and is often deployed as a second layer to a signature or heuristic first layer, which acts as a pre-filter to minimize the performance impact.

Torres et al.[19] performed a survey of approaches that were essentially intelligent outlier rejection. The desired approach characteristic was unsupervised learning by using collected HPC data only, i.e., a data-driven approach. Cache misses and branch mis-predictions were common variables studied. During runtime, HPC data was collected for specific intervals (1ms, 10ms, 100ms) with the assumption that valid activity was more common (normal) and that invalid activity (attacks) would be statistical outliers to the HPC data. The countermeasure behaved similarly to heuristic analysis without the necessity of pre-determining heuristic thresholds. The machine learning portion would build a model in memory of the valid state space as the statistical norm.

HPCMalHunter[21] dynamically monitors HPC data to classify malicious behavior. This approach uses supervised learning and offline pre-training to build a database for classification. The HPC data assembled into vectors (monitored) in the example were: Branch instructions retired (BIR), load instructions retired (LIR), store instructions retired (SIR), and mis-predicted branch instructions (MBI). The database is a matrix and HPC event data is formatted as a vector input for classification, similar to an artificial neural network except by a Support Vector Machine[22] (SVM) in this case. As HPC data are typically very sparse, the SVM matrix is optimized by Single Value Decomposition (SVD) to reduce its dimensionality and reduce storage and processing overheads resulting in the final classification engine. This particular countermeasure examined HPC data in blocks of 100,000 machine instructions, and the span of examining multiple HPC data (BIR, LIR, SIR, MBI) facilitated a very low false positive rate.

Nomani et al.[23] developed an Artificial Neural Network (ANN) classifier to determine the *phase* of a running application as a countermeasure against side channel attacks. Here, side channel attacks refer to attacks that attempt to capture secret information or perform malicious activities on shared resources. Phase refers to the types of resources and functional units that are utilized at that time, such as a memory phase during high memory accesses, a floating point phase during floating point operations, an integer phase, etc. When multiple applications, or an application and a malicious program, share resources, the potential for an attack is much higher[24], and thus monitoring should be more vigilant. The ANN provides a

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black-box approach to determining the phase in which running applications reside or are in transition and purposely influences the OS scheduler to avoid scheduling other applications on the same processor using the same functional resources. Contrary to increasing overhead, the countermeasure on average reduced resource load by as much as 25% in some cases as a side benefit. Once trained via supervised learning, the ANN was able to perform classification well under the average time between context switches allowing the scheduler sufficient time to recalculate thread scheduling in most cases.

Alam et al.[25] developed a countermeasure that employed two novel methods. The first was consideration that lots of HPC data were known or could be generated for valid applications, while HPC data for attacks were rare or would be unknown due to zero-day attacks. Therefore, a single-class SVM was developed to only classify valid behavior. The failure to classify valid behavior determined potential invalid (malicious) behavior. The behavior was further analyzed to select the most likely HPC variables for attack classification based on how the anomalous behavior deviated from valid behavior. The second novel method used in the countermeasure was Dynamic Time Warping[26] (DTW). HPC data represent time series of various event counts, such as cache misses. A side channel attack may seek to exploit HPCs by superimposing the secret key or other sensitive information on these time series through seemingly benign operations to exfiltrate the sensitive information. Therefore, these time series (HPC events) are monitored and correlated with sensitive information to see if there is a match. The DTW algorithm allows detection even when the time series is compressed, stretched, or scaled with respect to the sensitive information pattern.

BehavioR based Adaptive Intrusion detection in Networks[27] (BRAIN) is a countermeasure for distributed Denial of Service (DoS) attacks in networks. Most network-based DoS countermeasures use heuristics on network traffic by examining packets for attack signatures or specific attack behavior. BRAIN enhances this by adding HPC data in the analysis of DoS attacks under the assumption that processors also behave differently during such attacks. BRAIN is trained during idle and normal operation as well as during known DoS attacks, i.e., supervised and online. Network heuristics from traditional approaches are combined with BRAIN's HPC-based information via unsupervised K-means clustering that is then used to form a SVM for final classification. Claimed results are zero false positives with 99.8% true positive detection, conditional on the span of the DoS attack scenarios used in training.

FlowGuard[28] is a countermeasure approach worth mentioning here although it does not use HPCs. It does, however, utilize Intel Processor Trace[29], a debugging tool also implemented in micro-architecture. FlowGuard uses machine learning of control flow paths to form a valid Control Flow Graph (CFG). It then compresses the CFG information in the same format as that supplied by Intel Processor Trace to allow rapid, direct comparison of runtime control flow with these learned valid paths. Paths are ranked with the most common paths ranked highest. During runtime, deviation from valid paths will indicate an anomaly and potential attack that can then be examined with additional analysis, such as a hybrid approach with HPCs.

IV. Comparison of Countermeasure Approaches

In this section, a comparison of countermeasures approaches as exemplified in Section III is given. Table II tabulates the examples given in Section III with respect to name and citation, HPCs utilized, the general category also from Section III, and the types of attacks for which that example is good for detecting. Table III provides a comparison of the general categories with respect to characteristics of countermeasures within that category and application notes that fit that category. Figure 2 illustrates the process flow of countermeasure categories and how multiple approaches may be used in hybrid configurations.

The following terms are used in Table II. Branch instructions retired (BIR), load instructions retired (LIR), store instructions retired (SIR), and mis-predicted branch instructions (MBI), Processor Management Unit events (PMU), Code Reuse Attacks (CRA), Machine Learning (ML), self-directed Outlier Rejection (OR), Support Vector Machine (SVM), Single value Decomposition (SVD), Artificial Neural Network (ANN), Dynamic Time Warping (DTW), Control Flow Graph (CFG), and Return Oriented Programming (ROP). General attack effectiveness, usually in machine learning, implies the countermeasure is used to detect general attack behavior versus a specific class. Chooses by learning implies the countermeasure selects HPCs that are best suited, i.e. most affected, by the attack class to be detected.
†Torres et al. incorporates both heuristic and machine learning aspects to its approach.

In Fig. 2, attacks of all types, as denoted in Fig. 1, enter the target system. Signature countermeasures, Section III-A scan attack activity in various HPCs for specific patterns. The assumption is that known attacks impact various counters in a predictable and repeatable manner. Another approach may be the use of heuristics, Section III-B. Heuristics look for anomalous activity in HPCs as the exceeding a preset threshold. These are usually quick and simple in implementation. Machine learning approaches, Section III-C, may be utilized through any number of more advanced approaches. Any one of these may be used as a first layer of detection of cyber attack. Hybrid approaches will use one or more of these as a pre-filter in combination with one or more of these at a second layer of detection in an effort to mitigate false positives/negatives, incorporate intelligent approaches, and minimize resource requirements by reserving complex countermeasure activities only after passing through simpler pre-filtering. A typical hybrid approach would be using a heuristic as a pre-filter at the first layer and (&) using machine learning for further analysis at the second layer.

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TABLE II
EXAMPLES OF HPC COUNTERMEASURES.

Name	Category	HPCs used	Attacks targeted
SIGDROP [9]	signature	return address predictor misses, total number of return instructions	ROP and other CRAs
ConFirm [10], [11]	signature	various HPCs, code instrumentation via checkpoints	malicious software injected into firmware or CRAs using firmware
Chiappetta et al. [12]	signature	cache misses and high speed HPC query	side channel attacks, cache memory, information leakage, e.g., flush+reload
ANVIL [16]	heuristic	LLC misses, Load Latency, Precise Store	rowhammer
CacheShield [17]	heuristic	various cache misses	cache attacks on legacy systems
Lui et al. [18]	heuristic	instruction cache misses and mis-prediction	stack buffer overflow attacks
Torres et al. [19] †	heuristic	Cache misses and branch mis-predictions	general, anything outside the norm, Heartbleed
Eunomia [20]	heuristic	PMU events	general
Torres et al. [19] †	ML, OR	Cache misses and branch mis-predictions	general, anything outside the norm, Heartbleed
HPCMal-Hunter[21]	ML, SVM, SVD	BIR, LIR, SIR, MBI	general
Nomani et al. [23]	ML, ANN	HPCs by resource (memory, floating point, integer, etc.)	general
Alam et al. [25]	ML, SVM, DTW	chooses HPCs from learning	general
BRAIN [27]	ML, k-means, SVM	chooses HPCs from learning	distributed denial of service
FlowGuard [28]	ML, CFG	Intel Processor Trace	ROP and others that alter process flow

TABLE III
COMPARISON OF HPC COUNTERMEASURE CATEGORIES.

Category	Characteristics/requirements	Application (Use cases)
Signature	memory intensive, not adaptive, training of signatures, simple	specific/known attacks and apps, black-list/whitelist
Heuristic	minimal footprint, generally quickest, tuning of thresholds, false posi/negatives may be higher	when general behaviors are known, attack exceeds some threshold
Machine learning	generally largest footprint, potentially best with minimal false posi/negatives, context sensitivity	dynamic/unknown attack and app behaviors, deep attacks, zero day attacks
Hybrid	large footprint offset by filtering (multi-layer), minimal impact with minimal false posi/negatives	when the combined features of two or more countermeasure layers is beneficial

V. FUTURE DIRECTIONS

From this survey, hardware performance counters have already been used in a variety of cyber attack countermeasure approaches. In most cases, they are an existing resource and implemented in on-chip in separate hardware, thus minimizing their impact both on application performance and in application development.

The motivations for including HPCs in micro-architecture have been towards improved debugging and application stability. If additional micro-architectural features are incorporated that have cyber security as a primary mission, more approaches may be possible in the near future. Additional micro-architectural approaches already available include execution and information flow monitoring, e.g., Intel Processor Trace[29], built in self tests, subroutines from Joint Test Action Group (JTAG) interfaces, and others. Also of note are the increasing reliance on cloud systems and computing as a service. In the same method of using micro-architectural approaches, hypervisor based approaches should also be examined. Research should continue in such approaches as an additional front in the prevention of cyber attacks, especially noting the

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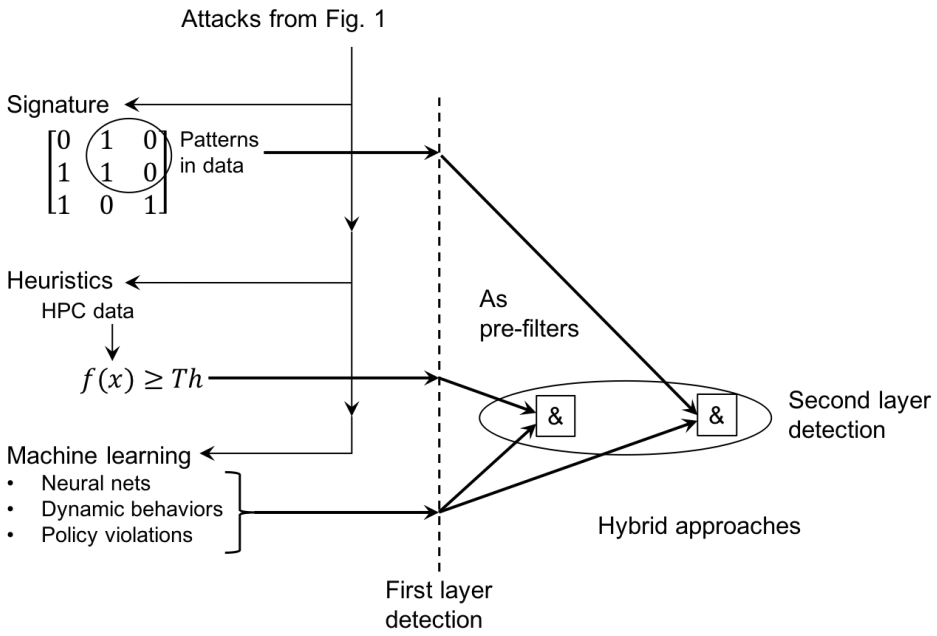

Fig. 2. Summary of HPC countermeasures.

ever increasing footprint of software based approaches. As the number and complexity of attacks increases, these applications utilize more resources and become more difficult to develop and manage.

While cyber attacks are increasing in number and sophistication, the vast majority of these are still not able to perform much malicious activity without leaving basic hardware signatures, such as missed branch predictions, cache misses, hammering of rows, etc. HPC based countermeasures need to move out of research and into to the mainstream of attack detection software as quickly as possible. In cases where a hardware/software system configuration is completely known, HPCs could theoretically detect most any direct attack. In many cases, side channels can be detected as well, e.g., Dynamic Time Warping.

A. Special Note Meltdown and Spectre

Currently, the cyber attacks of Meltdown and Spectre [30] have emerged at the micro-architectural level. In Meltdown, an attack attempts an unauthorized read of privileged memory, to which it is not allowed access. Though the processor will eventually deny access to this memory, it will still fetch and in most cases perform some processing, i.e., speculative processing, with this memory. The attacker then attempts to intercept this information or the result prior to failing the privilege check, or in some cases as a residual after the privilege check. HPCs that count privilege check violations, if developed, might indicate this attack. Spectre is a more generalized class of vulnerabilities similar to Meltdown, focusing on branch prediction. In speculative execution schemes, both branch options may be followed until the correct branch is finally determined. The processor would then discard the mis-predicted branch, though side effects of this would remain and encourage a side channel attack. These types of branch mis-predictions are common whether the attack is present or not, i.e., the attack does not cause these mis-predictions. Some mitigations involve preventing out of order execution for vulnerable processes, but this carries significant performance impacts. Perhaps future work in HPCs as cyber attack countermeasures could employ multiple event counts to selectively classify Meltdown and Spectre attacks since HPCs work at the micro-architectural level with these attacks.

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Factors of Cloud Computing Adoption by Small and Medium Size Enterprises (SMEs)

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***Abstract*— The main objective of this study is to determine the factors influencing cloud computing adoption by Small and Medium-sized Enterprises (SMEs). Based on two dominant theories in the field of diffusion of innovation, a conceptual model is proposed. In order to test the model empirically, an online survey was designed and launched. Decision makers of 101 SMEs agreed to participate in this survey. In order to evaluate the internal, convergent, and discriminant validity of the instrument, factor analysis and reliability tests were performed. Logistic regression is employed to test our hypotheses. The results of regression reveal that decision maker's knowledge about cloud computing is the main influential factor in decision making about its adoption.**

Keywords: Cloud computing, SMEs, adoption

I. INTRODUCTION

Small and Medium-sized Enterprises (SMEs) significantly contribute to each nation's Gross Domestic Product (GDP) and its labour market. Therefore, proposing strategies and developing new systems are not only beneficial for SMEs, but also for the economy as a whole. According to Tan et al. [1], using appropriate Information and Communication Technologies (ICT) helps SMEs become more efficient and productive; however, SMEs do not have access to enough resources (e.g. financial resources). Cloud computing, which is an alternative to deploying applications and systems on-premises, helps SMEs tackle many issues such as the high cost and risk that are involved in IT projects. According to [5] cloud computing has four advantages: 1) Data storage are secure; the teams of the backend Cloud are so professional that manage data also protect them from different attacks of viruses and cracks. 2) The different application can be supported by cloud computing. 3). The share of data and applications are easy. 4) Thousands of servers exist in Cloud, which has strong storage and computing ability. By considering the advantages and key challenges of cloud computing adoption, it is clear that cloud computing adoption is still as a question for some organization. The organization avoiding adopting cloud computing but due to advantages, they are in favour to move cloud computing adoption. Amazon, Google, Microsoft, IBM contributing in terms of cloud computing. According to International Data Corporation (IDC) 53% of Asian organizations already applying some of the cloud computing services, and remaining 47% of the organizations have decided to adopt Cloud services [9].

II. Literature review

SMEs are vital players of each market. One strategy which has been proven to enhance SMEs' ability to compete against larger companies is the use of appropriate Information and Communication Technologies (ICT) [1]. Although adopting new technologies helps SMEs gain a competitive advantage, it usually involves high costs. Cloud computing, as a new computing paradigm, offers many advantages to companies, especially smaller ones. Flexibility, scalability, and reduced cost are just some of many advantages that cloud computing offers to SMEs. To date, there is no universal definition for cloud computing. Perhaps the most accurate definition of cloud computing is the one offered by the National Institute of Standards and Technology (NIST). They de- defined cloud computing as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models." [2] Following the success of cloud computing, the new cloud-based delivery model of cloud computing has emerged. These cloud computing solutions are market to offer similar functionality as their on-premise counterparts, but the infrastructure (software, computational power, hardware etc.) is provide on-demand by the vendors in a pay-per-use model. As with cloud computing, this new cloud computing delivery model gains success increasingly growing its market share. Most companies at least consider a cloud-cloud computing solution and this trend were illustrates by [11] where approximately 70 per cent of the CFOs stated that they would consider using a Cloud-based version of their cloud computing. Cloud computing Report quantifies the momentum of cloud-cloud computing as it revealed that the market share

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of cloud-based cloud computing systems has grown from 6 percent to 18 percent just in one year, from 2011 to 2012 (Panorama Consulting) [10]. As the market moves to a cloud environment, traditional cloud computing providers are also force to develop their own cloud-based solutions, otherwise they risk losing market shares to the emerging Cloud computing software vendors such as Netsuite and Plex. However, a question that still appears to lack a clear answer is whether cloud computing is a viable solution for companies of all sizes.

III. Theory Review

The conceptual framework that is proposed in this research originated from two well-known theoretical frameworks in this field of study, which are Diffusion of Innovation (DOI) theory developed by Rogers [30-31] and the Technology, Organization, Environment (TOE) framework proposed by Tornatzky and Fleischer [32]. Diffusion of Innovation Theory (DOI) is a theory that tries to discover the factors that influence the spread of a new idea or technology in a society [31]. Rogers [30] defined diffusion of innovation as "the process by which an innovation is communicated through certain channels over time among the members of a social system". Any idea, process, product, or technology constitutes an innovation, as long as it is perceived as new by individuals. Rogers [30] argues that each innovation has different attributes that influence its diffusion in society. Relative advantage, compatibility, complexity, trialability, and observability are the five key attributes of innovation. DOI does not take into account the environmental and organizational aspects of the context; therefore, in this study, I used the Technology Organization Environment (TOE) framework, which takes into account other aspects of enterprises' context.

IV. Research Model and Hypotheses

In order to study the adoption of cloud computing by SMEs, a conceptual model is proposed. According to this model, twelve variables influence the decision to adopt cloud computing, which is depicted in Figure 1. All factors except complexity have a positive influence on the adoption of cloud computing. A very important study by Tornatzky and Klein [33] reveals that relative advantage, complexity, and compatibility are the characteristics of innovation that have the most influence on the adoption of an innovation.

Hypotheses

Based on the model, 12 different hypotheses have been proposed. Chau and Hui [34] argue that the size and structure of SMEs force them to rely on external parties. In this context, external support is defined as "The perceived importance of support offered by cloud providers". The first hypothesis is:

H1: Higher levels of perceived external support from cloud providers positively affects the likelihood of cloud computing adoption by SMEs

Competitive pressure is the level of competition among firms within the specific industry in which the company operates [35]. The following hypothesis is developed:

H2: Businesses that operate in more competitive environments are more likely to adopt cloud computing.

Having enough knowledge about an innovation is the first step in the adoption process. Therefore, in the context of cloud computing, the following hypotheses have been developed:

H3: Decision Makers' knowledge about cloud computing is positively related to the decision to adopt cloud computing.

H4: Employees' knowledge about cloud computing is positively related to the adoption of cloud computing

Innovativeness is defined as "the level of decision-makers' preference to try solutions that have not been tried out; and therefore, are risky" [34]. Hypothesis 5 is:

H5: Decision Makers' innovativeness is positively related to the adoption of cloud computing.

According to Thong [35], information intensity is defined as "the degree to which information is present in the product or service of a business". The following hypothesis is related to this construct:

H6: Information intensity is positively related to the adoption of cloud computing

An advantageous technology is one that enables companies to perform their tasks more quickly, easily, and efficiently. Moreover, it improves the quality, productivity, and performance of the company. The following hypothesis below is formulated: H7: Decision makers' perception of the relative advantage of using cloud computing is positively related to cloud adoption

A technology that is difficult to understand, and whose use is considered to be complex, is less likely to be successfully adopted. Therefore, the following hypothesis is developed:

H8: The perceived level of complexity of the cloud computing has a negative impact on the adoption of cloud computing.

In this research, compatibility is defined as "the degree to which cloud computing is perceived as consistent with the existing values, past experience, and needs of companies". The related hypothesis is as follows:

H9: High levels of compatibility between cloud computing and a company's norms and technologies have a positive influence on cloud adoption.

We believe that the opportunity to use cloud computing on a trial basis positively influences the adoption of cloud computing; therefore, the next hypothesis is:

H10: a Higher level of trialability has a positive influence on the adoption of cloud computing

In this study, the cost of cloud computing is defined as "the degree to which decision makers perceive the total cost of using cloud computing to be lower than other computing paradigms". In the context of cloud computing the next hypothesis is:

H11. Decision makers who perceive cloud computing as being less costly than other computing paradigms are more likely to adopt cloud computing

In the context of cloud computing, security is defined as the security of the service, data centres, and media. It also takes into account the privacy and confidentiality of the companies' data. Therefore, in the context of cloud computing:

H12: The more secure that decision makers perceive cloud computing to be, the more they are willing to adopt cloud computing.

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V. Research Methodology

Data collection procedure of this research is based on a survey. We developed a questionnaire which was reviewed and modified by a panel of experts, consisting of three ITM professors and four PhD students. We used Qualtrics to develop our online questionnaire. The responses to our questions were captured on a 5-point Likert-type scale. The survey was sent to more than 500 decision makers. The response rate of 20% left us with 101 completed questionnaires. Both adopter and non-adopter companies were asked to participate in this survey. In order to assure the quality of the responses, several quality assurance (QA) questions were added to the questionnaire. The questions asked of participants were adapted mainly from papers already published in this field. In addition to the standard questions, we also developed some questions that are specific to the context of cloud computing.

VI. Limitations and Future Studies

This research has some limitations, because of which the results cannot be generalized to all SMEs. Our main limitation is related to sample size. Sample size becomes problematic because, in order to get significant results, there should be at least 10 observations per each group of the dependent variable. Having eight different variables, our ideal sample size is 160, which is well beyond our actual sample size. Moreover, our sample is selected from North American companies. The results of this research are thus only applicable to SMEs located in North America. Moreover, the data is not restricted to a specific industry; this is problematic because each industry has its own characteristics and requirements. Performing further research in this field is highly recommended. Cloud computing is a new phenomenon; not many studies have been conducted in this field. The same study may be replicated using larger sample sizes and in different industries. Performing a longitudinal study would also prove useful.

VII. Conclusion

Similar to any innovation, the diffusion of cloud computing depends on various factors. In this research, we not only study the technical aspects of cloud computing, but also others such as environmental, organizational, and managerial factors. For this purpose, a conceptual model is proposed and empirically tested. The proposed model is developed based on two well-known theoretical frameworks in the field of technology adoption, which is: DOI developed by Rogers [30], and the TOE framework developed by Tornatzky and Fleischer [32]. Based on the research model, a set of hypotheses were proposed. In order to empirically test the model, we asked decision makers of SMEs to participate in an online survey. After the internal validity of the items was checked, factor analysis was performed. At this stage, some of the items were deleted. Removing these items left us with nine different factors.

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DEVELOPMENT OF A PREDICTIVE MODEL FOR AUDIO QUALITY OF SERVICE IN NIGERIA

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Abstract—**The unavailability of user-based data for audio quality of service and user's complaint about services rendered by mobile network providers are on the increase. The concern about the poor quality of service (QoS), especially for voice callers, motivated this work. The objective of this research is to develop a predictive model using decision tree algorithm and Fuzzy logic derived for the mobile telecommunication users and evaluates the performance of the model. The study proposed a predictive model; the model can enhance monitoring of the quality of service delivery.**

Keywords: **Quality of Service, classification, voice calls, prediction, C4.5 and ID3 decision trees**

***Index Terms*—Enter key words or phrases in alphabetical order, separated by commas.**

I. BACKGROUND OF THE STUDY

They are numerous advantages the citizen enjoyed with the deployment of cellular network (CN) services into any developing economy. The CN services in the mobile telecommunication sector have some challenges. The numbers of services and subscribers of CN increases drastically, and that also increases the worry of users about QoS rendered [1]. NCC sanctions some mobile network operators (MNO) in Nigeria namely MNO_3, MNO_4, MNO_2 and MNO_1 due to the poor quality of service. Also, the National Assembly in Nigeria debated on the citizen complaints of poor quality of services in the sector. The second challenge is the need to document and analyze the past and present data with the aim of predicting future trends. The GSM providers in Nigeria are far from providing reliable services to their clients [2, 3, 4, 5]. In this work, KPIs in cellular network data were captured for 21 out of 36 states in the country using crowdsourcing paradigm. The call success rate (CSSR), call drop rate (CDR), congestion rate (TCHR) and received signal strength (RSS) parameters used for this work. So concerned about the poor quality of service especially for voice callers justify or motivated this work. This research work focused on voice service. This work has five sections. Section two discusses literature review, section three is about methodology, and section four and five discuss results and conclusion respectively.

II. LITERATURE REVIEW

The data collection is very crucial for any meaningful analysis. Incidentally, telecommunication data are classified data which make data collection a difficult task. The other older methods of data collections have their shortcomings. The new emerging technique called crowdsourcing is considered appropriate for this work. In [4], Crowdsourcing Application for Cellular Network voice QoS analysis and Evaluation using mobile devices is reported. The development of an android application that measured some KPIs, using Java programming language on Android smartphones reported. The work succeeded in measuring KPIs using subscriber's mobile devices (used in accessing the network). However, the app could not successfully measure KPIs on the server.

The aim of this study is to access GSM services in Nigeria [6]. Secondary data was collected and used for the analysis. Theories of Performance tools were employed. The work reported that GSM services performed below expectation. The limitation of the work is that the researcher used secondary data. Given the mass data generated from mobile telecommunication industry, data mining technique is used to analyze the captured data. The data mining tools are used to determine various models, summaries and derived values from a given large collection of data. There are other different approaches to mine data such as clustering, Decision tree/rules, Genetic algorithm/programming, statistical method, Neural Network, Support Vector Machine, Fuzzy logic. The aim of data mining is either to classify, model evaluate and predict. The DM tools applied to several sectors. An example is its application to medical field. Idowu *et al*., (2015) applied one of the tools to depict changes in the model used in the management of one of the deadly disease in the medical sector. The management of deadly disease in medical line is similar to management of poor quality of service in telecommunication. The objectives of this research are to analyze the QoS of CN based on crowd sourced data; develop a platform to group captured data using decision tree

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algorithm in predicting user-based voice QoS for the mobile telecommunication users

III METHODOLOGY

This section explained the method used to achieve the objective of this work. The first step is the collection of datasets from the crowd sourced data; the next step is preprocessing of data and the formulation of the desired model using the decision trees algorithms (C4.5 and ID3). Finally, the Fuzzy logic tool used for the modeling [7, 8, 9].

Decision Trees Algorithm

The rules used by DT algorithm are inducted by definition from each respective node to branch leaf. Given a set of j number of cases, the decision trees algorithm grows an initial tree using the divide-and-conquer algorithm

ID3 and C4.5 algorithms used for audio QoS modeling. C4.5 is superior due to its ability to: handle different types of variables; handle missing values; handle attributes with differing costs; and prune trees after creation. Equation (1) used in determining which attribute is used to split the dataset, which of the selected attribute split is most useful in splitting the dataset after attribute selection by equation (1).

Let X_{ij} be a dataset containing records of i numbers of attributes alongside their respective level of QoS. X_{ij} is a set of attributes of j numbers of cases, X_i is a single attribute with two or more outcome. H_k assumes values $H_1$for poor, H_2 for fair and H_3 for good. T is the set of values for a given attributes Xi. IG is the information gain. Split (T) is introduced to avoid bias.

$$IG(X_i) = H(X_i) - \sum_{t \epsilon T} \frac{|t|}{|X_{ij}|} . H(X_i) \qquad (1)$$

Where:

$$H(X_i) = -\sum_{t \epsilon T} \frac{|t|}{|X_{ij}|} . log_2 \frac{|t,\ X_i|}{|X_{ij}|}$$

$$Split\ (T)$$

$$= -\sum_{t \epsilon T} \frac{|t|}{|X_{ij}|} . log_2 \frac{|t|}{|X_{ij}|} \qquad (2)$$

T is the set of values for a given attribute.

Fuzzy Logic Model

Fuzzy Logic using triangular membership function was used for the modeling [10]:

$$v= \{(x, \mu v(x))|x \epsilon V, \mu v(x) \epsilon [0,1] \qquad (3)$$

where μv(x) is the membership function of xv and μv is the degree of membership of xv in the interval of [0, 1].

Data Pre-processing:

Input Variables: Input parameters collected are the Call Set-up Success Rate (CSSR), the TCH Congestion (TCHCR), the Received Signal Strength Indicator (RSS) and the Call Drop Rate (CDR). Good, fair and poor are represented by 0,1.2 respectively. Table 1 shows the description of input variables used.

TABLE 1: INPUT DATA TRANSFORMATION

S/ No.	Input Variable	Input Variable Codes	Domain Values	Normalized Values
1	Received Signal Strength	(RSS)dMb	X < 1 4 14<=X<20 20<=X<=31	0 1 2
2	Call Setup Success Rate	KPI – CSSR (X_1)%	X_1 < 9 0 90<=X_1<=95.9 X_1 > = 9 6	0 1 2
3	Call drop rate	KPI – CSSR (X_2)%	X_2 > 5 2 < X_2 < = 5 X_2 < = 2 %	0 1 2
4	Congestion rate	KPI – CSSR (X_3)%	X_3 > 5 % 2 < X_3 < = 5 X_3 = < 2	0 1 2

TABLE 2: PERFORMANCE OF VOICE CALL QOS OUTPUT

OUTPUT VARIABLE DOMAIN			
S/ NO		VALUES	NORMALISED QoS VALUES
1	Excellent QoS	08 – 09	2 (Excellent)
2	Moderate QoS	06 – 7.9	1 (Moderate)
3	Poor QoS	0.0 – 5.9	0 (Poor)

The output variable represents the performance of voice call QoS. The output make use of three levels grading systems, detail is shown in Table 2.

(i) Data Identification

In this study, the needed variables to measure QoS of mobile telecommunications companies identified by experts. KPIs selected based on the review of related works concerning the quality of service of mobile telecommunications companies. Based on the feature selection, the considered variables for this work were received signal strength (RSS), congestion rate (TCHR), call success rate (CSSR) and the call drop rate (CDR).

(ii) Data Collection-

For this study, data were collected from156,180 voice calls using crowdsourcing technique the captured data cut across 21 states and Federal Capital Territory in Nigeria. The information collected from the sites was collected in the cloud and downloaded into a spreadsheet application – Microsoft Excel of the Microsoft Office 2016. Information collected from the sites contained the explanatory variables alongside QoS of the mobile telecommunications companies.

(iii) Data-Preprocessing

Following the collection of data, the 156,180 voice calls pre-processed [11] into dataset file that contained 4280 records alongside the ten (10) attributes, the data collected was processed for the presence of an error in data entry including misspellings and missing data. The data stored in the comma separated variable (.csv) format was transformed into the attribute file format (.arff). Figure 1 depicts format of the .arff used for model development – a light-weight java application composed of supervised and unsupervised machine learning tools. The tariff file is composed of three parts, namely:

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a. *The relation name section which contains the tag @QoS-data, that contains the data needed for simulation;*
b. *The attribute names section which contains the tag @attribute attribute_name label was used to identify the attributes that describe the dataset stored in the .arff file needed for simulation.; and*
c. *The primary data is in tag @data*

The crowd-sourced data can be found in QoS-data.arff while the number of attributes listed in the attribute section was 9 including the target attribute. Following this, the result dataset contains 4280 records preprocessed after downloading.

3.4 Model Formulation

Supervised machine learning algorithms make it possible to assign a set of records (input variables of QoS) to a target class – the measure of QoS (Poor, Fair and Good). Supervised machine learning algorithms are Black-boxed models, thus it is not possible to give an exact description of the mathematical relationship existing among the independent variables (input variables) to the target variable (output variable – a measure of QoS). Cost functions are used by supervised machine learning algorithms to estimate the error in prediction during the training of data for model development. The decision trees algorithm is a white-boxed model owing to its ability to be interpreted as a tree-structure. The tree structure was extended to support the construction of IF-THEN statements using the edges (attributes) of the decision trees.

IV RESULTS

Figure 1depicts DT constructed with the aid of a C4.5 algorithm. The tree indicates size 40 (edges) present while the number of leaves is 27.The parameters with the highest information used in DT construction, the results used to estimate QoS of Nigerian Mobile Network Operators. The parameters are TCHR, CSSR, RSS and the CDR in order of importance based on the hierarchical position on the tree. Samples of the rules derived from DT as containing in Figure 1 are as follows:

a. *IF (CSSR = "Poor") AND (TCHR="Poor") AND (RSS="Poor") AND (CDR="Poor") THEN (QOS = Poor) [rule 1]*
b. *IF (CSSR = "Poor") AND (TCHR="Fair") AND (RSS="Poor") AND (CDR="Fair") THEN (QOS = Poor) [rule 5]*
c. *IF (CSSR = "Poor") AND (TCHR="Fair") AND (RSS="Fair") AND (CDR="Fair") THEN (QOS = Poor) [rule 32]*
d. *IF (CSSR = "Poor") AND (TCHR="Fair") AND (RSS="Good") AND (CDR="Fair") THEN (QOS = Poor). [rule 59]*
e. *IF (CSSR = "Poor") AND (TCHR="Fair") AND (RSS="Good") AND (CDR="Good") THEN (QOS = Moderate). [rule 60]*
f. *IF (CSSR = "Fair") AND (RSS="Fair") AND (TCHR="Fair") AND (CDR="Fair") THEN (QOS = Moderate). [rule 41]*
g. *IF (CSSR = "Good") AND (TCHR="Good") AND (RSS="Poor") AND (CDR="Fair") THEN (QOS = Moderate). [rule 26]*
h. *IF (CSSR = "Good") AND (TCHR="Good") AND (RSS="Fair") AND (CDR="Good") THEN (QOS = Excellent). So [rule 54]*

IF (CSSR = "Good") AND (TCHR="Good") AND (RSS="Good") AND (CDR="Good") THEN (QOS = Excellent). [rule 81]

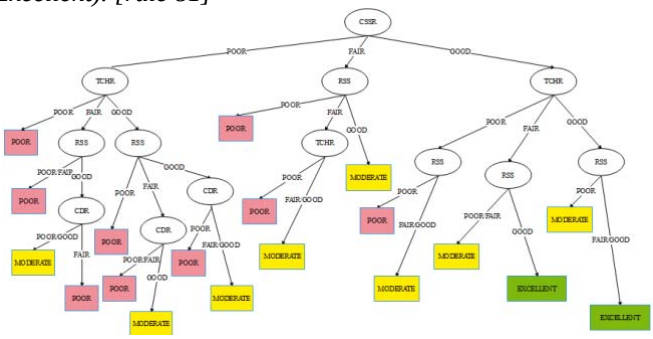

Figure 1: C4.5 Decision Trees for QOS

The decision trees generated with the aid of ID3 decision trees algorithm displayed in Figure 2. The tree has a size of 39 edges present while there are 26 leaves. The parameters with the highest information used in DT construction, the results used to estimate QoS of Nigeria Mobile Network Operators. The parameters are TCHR, CSSR, RSS and the CDR in order of importance based on the hierarchical position on the tree. The ID3 decision trees algorithm has differences at certain nodes as shown in Figure 2. IDE was unable to decode the following rules:

a. *IF (CSSR=" Fair") AND (RSS=" Fair") AND (TCHR=" Good") AND (CDR="Poor")[rule 43 of id3]*
b. *IF (CSSR="Poor") AND (RSS="Fair") AND (TCHR="Good") AND (CDR="Poor") and [rule 34 of id3]*
c. *IF (CSSR="Fair") AND (RSS="Fair") AND (TCHR="Good") AND (CDR="Fair") [rule 45].*

The extra rules that could be determined by the ID3 presented as follows:

a. *IF (CSSR = "Poor") AND (TCHR="Poor") AND (RSS="Poor") AND (CDR="Fair") THEN (QOS = Poor) [rule 2]*
b. *IF (CSSR = "Fair") AND (TCHR="Good") AND (RSS="Poor") AND (CDR="Poor") THEN (QOS = Poor) [rule 16]*
c. *IF (CSSR = "Good") AND (TCHR="Fair") AND (RSS="Fair") AND (CDR="Fair") THEN (QOS = Moderate). [rule 50]*
d. *IF (CSSR = "Fair") AND (RSS="Fair") AND (TCHR="Fair") AND (CDR="Good") THEN (QOS = Moderate). [rule 42]*
e. *IF (CSSR = "Good") AND (TCHR="Fair") AND (RSS="Good") AND (CDR="Good") THEN (QOS = Excellent). And [rule 78]*

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f. IF (CSSR = "Good") AND (TCHR="Good") AND (RSS="Good") AND (CDR="Fair") THEN (QOS = Excellent). [rule 80]

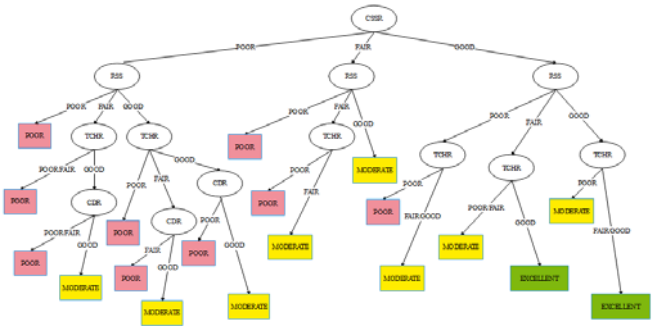

Figure 2: ID3 Decision Trees for QOS

So the combination of C4.5 and ID3 rules are used as rules for the fuzzy logic. The combination of the two algorithms makes the Fuzzy to be robust.

Fuzzy Logic Interface and Output

The membership function interface displayed in figure 3. The figure 3 displays the four variables used with the output. Supplying different values of input parameters will generate equivalent output. The other outputs of different relationships demonstrated in figures 4 to 7.

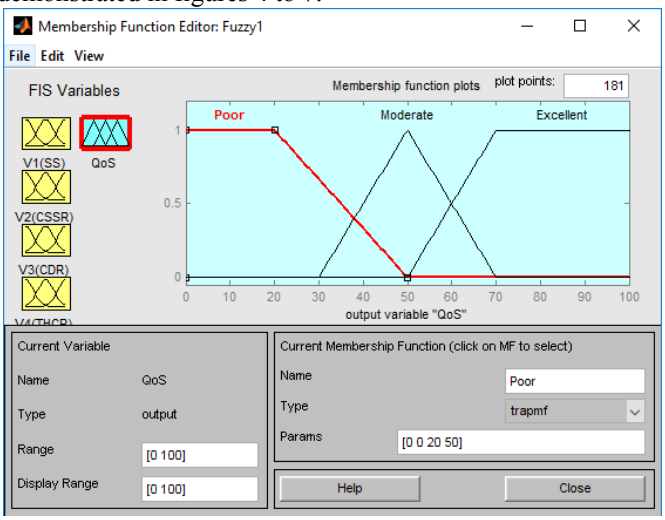

Figure 3: Membership Function interface

Figure 3 is an interface where the rules for voice calls QoS captured in the editor mode. The parameters specified in this section.

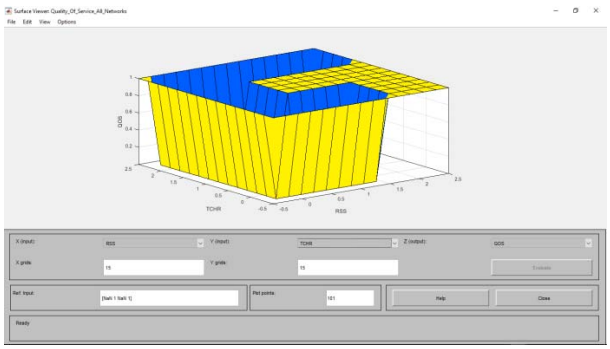

Figure 4: Surface view of QoS showing the relationship between RSS against TCHR

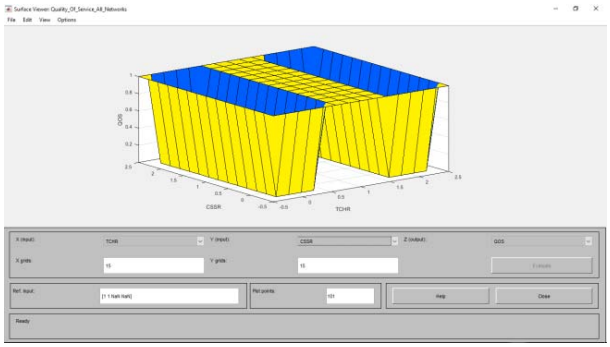

Figure 5: Surface view of QoS showing the relationship between TCHR against CSSR

Figure 4 shows the surface diagram of the relationship between received signal strength (RSS) and congestion rate (THCR). This diagram shows that whenever the RSS is good (2) and the TCHR is good (2) then the QoS is excellent else it is moderate.

Figure 5 shows the surface diagram of the relationship between congestion rate (THCR) and call set up success rate (CSSR).This diagram shows that whenever the (THCR) is good (2) and the CSSR is good (2) then the QoS is excellent else it is moderate.

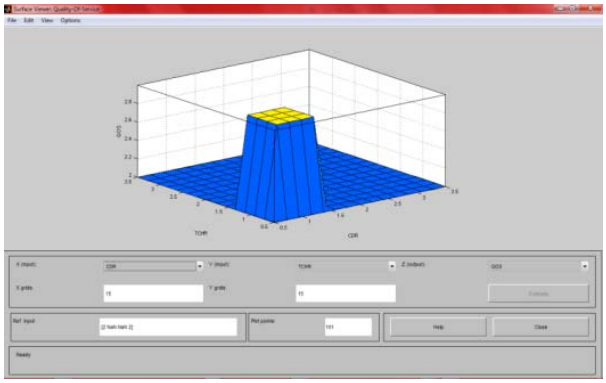

Figure 6: Surface view of QoS showing the relationship between TCHR against CDR

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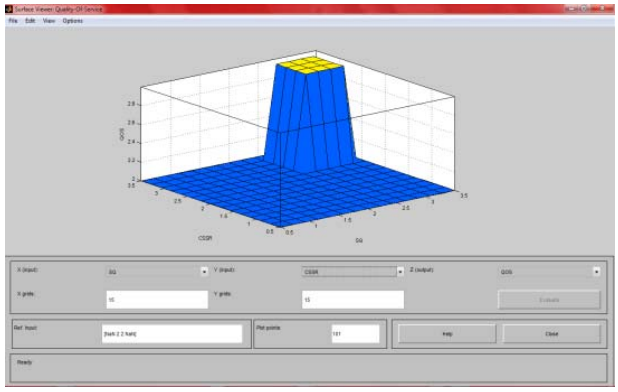

Figure 7: Surface view of QoS showing the relationships between CDR against RSS.

Figure 6 shows the surface diagram of the relationship between call drop rate (CDR) and congestion rate (THCR). This diagram shows that whenever the TCHR is good (0) and the CDR is good (0) then the QoS is excellent else it is moderate. Figure 7 showed the surface diagram of the relationship between call drop rate (CDR) and received signal strength congestion rate (RSS).This diagram shows that whenever the (RSS) is good (2) and the CDR is good (0) then the QoS is excellent else it is moderate.

TABLE 3: DESCRIPTION OF THE SOME IDENTIFIED VARIABLES IN THE DATASET

Variables	Codes	Frequency	Percentage (%)
Network	MNO_1	1013	23.67
	MNO_2	911	21.29
	MNO_3	829	19.37
	Others	285	6.66
Day	Monday	615	14.37
	Tuesday	605	14.14
	Wednesday	680	15.89
	Thursday	598	13.97
	Friday	607	14.18
	Saturday	618	14.44
	Sunday	557	13.01
Month	March	513	11.99
	April	461	10.77
	May	241	5.63
	June	223	5.21
	July	463	10.82
	August	541	12.64
	September	165	3.86
	October	365	8.53
	November	573	13.39
	December	735	17.17
Year	2016	2375	55.49
	2017	1905	44.51
Received Signal Strength (RSS)	Poor	1045	24.42
	Fair	2263	52.87
	Good	972	22.71
Congestion Rate (TCHR)	Poor	685	16.00
	Fair	1175	27.45
	Good	2420	56.54
Call Setup Success Rate (CSSR)	Poor	3549	82.92
	Fair	104	2.43
	Good	627	14.65
Call Drop Rate (CDR)	Poor	12	0.28
	Fair	108	2.52
	Good	4160	97.20
Quality of Service (QoS)	Poor	2023	47.27
	Moderate	1952	45.61
	Excellent	305	7.13

Statistics of data collected regarding frequency and percentage of each variable shown in Table 3

3.5 Performance Evaluation

This section aimed at evaluating the performance of the supervised machine learning algorithms used for the classification of the audio services in Nigeria mobile networks. The confusion matrix used for the assessment.

IV RESULTS OF DATA DESCRIPTION

This part contains a brief description and analysis of the captured data. The result in table 3 shows that 2375 (55.5%) records were collected in 2016 while 1905 (44.5%) records collected in 2017. Is observed that majority of the records were collected from MNO_4 constituting 29.0% followed by MNO_1 (23.7%) and MNO_2 constituting 21.3% of records. The results of the days within which the data collected showed that majority data recorded on Wednesdays (15.9%) followed by the data collected on Saturdays (14.4%) and the data collected on Mondays (14.4%). December (17.2%) has the highest captured data followed by those collected in November (13.4%) and in August (12.6%).

The results also showed that regarding the received signal strength (RSS), the majority of records were fair (52.9%) followed by poor (24.4%) and good (22.7%). The results showed that regarding the congestion rate (TCHR), the majority were good (56.5%) followed by fair (27.5%) and poor (16.0%). The results showed that regarding the call success rate (CSSR), the results showed that majority were poor (82.9%) followed by good (14.7%) and fair (2.4%). The results showed that regarding the call drop rate (CDR), the results showed that majority of the records were good (97.2%), followed by fair (2.5%) and poor (0.3%). Besides, the majority were classified as poor (47.3%), followed by moderate service quality (45.6%) and excellent (7.1%).

4.2 Simulation Results

Two different decision trees algorithms were used to formulate the predictive model for the measure of the QOS of Nigerian telecommunications companies. The C4.5 decision trees algorithm was simulated on the WEKA explorer interface while the ID3 was simulated using the ID3 algorithm both available in the Trees Classifier class of the WEKA Package using the dataset containing 4280 records. The 10-fold cross-validation method used for the derived model.

4.2.1 Results of the C4.5 decision trees algorithm

Using the C4.5 decision trees algorithm classifier available in WEKA to train the predictive model developed using the training data via the 10-fold cross-validation method. There were 4276 (99.91%) correct classifications containing 2021 for Poor, 1950 for Moderate and 305 for Excellent – along with the diagonal). However, 4 (0.09%) containing 2 Poor as Moderate and 2 Moderate as Poor misclassified as a display in figure 3. Hence, the predictive model for the QOS showed an accuracy of 99.91%. Besides, out of the 2023 poor cases, 2021 were correctly classified with 2 misclassified as

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moderate; out of the 1952 moderate cases, 1950 correctly classified with 2 misclassified as poor all 305 cases of excellent were correctly classified.

Based on the C4.5 algorithm results, as shown in Table 4, the TP rate of the model was the same for the moderate and poor cases with a value of 0.999 – 99.9% of the actual cases correctly classified. The case of excellent was 1; FP rate of the model was the same for the moderate and poor cases, a value of 0.001 – 0.1% of the actual cases misclassified. Concerning precision, the model performed equally in predicting the moderate and poor cases, a value of 0.999 – 99.9% of the predicted cases correctly classified as excellent having a value of 1.

TABLE 4: PERFORMANCE EVALUATION OF THE C4.5 DECISION TREES CLASSIFIER

Class	TP rate	FP rate	Precision
Poor	0.999	0.001	0.999
Moderate	0.999	0.001	0.999
Excellent	1.000	0.000	1.000
Average	0.999	0.001	0.999

4.2.2 Results of the ID3 decision trees classifier

The predictive model developed was trained using the training data through the 10-fold cross-validation technique. There were 4274 (99.86%) correct classifications containing 2022 for Poor, 1947 for Moderate and 305 for Excellent – along with the diagonal). However, and 3 (0.07%) misclassified are as follows: 1 Poor as Moderate and 2 Moderate as Poor. Hence, the predictive model for the QoS showed an accuracy of 99.86%. Also, out of the 2023 poor cases, 2022 correctly classified with 1 misclassified as moderate; out of the 1952 moderate cases, 1947 were correctly classified with 2 misclassified as poor and 3 not determined by the ID3 while all 305 cases of excellent were correctly classified.

Table 5 displays ID3 algorithm results, the TP rate of the model was the same for the moderate and poor cases with a value of 0.999 – 99.9% of the actual cases correctly classified. Excellent was 1; the FP rate of the model was the same for the moderate and poor cases, a value of 0.001 – 0.1% of the actual cases misclassified. Regarding precision, the model performed equally in predicting the moderate and poor cases, a value of 0.999 – 99.9% of the predicted cases correctly classified with excellent having a value of 1. correctly classified, excellent class, having a value of 1.

TABLE 5: PERFORMANCE EVALUATION OF THE ID3 DECISION TREES CLASSIFIER

Class	TP rate	FP rate	Precision
Poor	1.000	0.001	0.999
Moderate	0.999	0.000	0.999
Excellent	1.000	0.000	1.000
Average	0.999	0.000	0.999

4.3 Discussions

Summary of the simulation results is in Table 5. The sensitivity, 1-specificity, precision, accuracy metrics used. The ID3 algorithm could not predict the output for 3 records out of the dataset due to the null output value of the rules for such records presented in the dataset. Generally, the evaluation of the performance of both decision trees models was equally good. Since the rules generated can be used to estimate any combination of the values of the input variables, so, C4.5 decision trees algorithm is a more reliable model compared to that of the ID3. Also, both models reveal that the user based QoS determination carried out through the RSS, TCHR, CDR, and CSSR KPIs. Table 6 gives the Summary of simulation results.

TABLE 6: SUMMARY OF SIMULATION RESULTS

Decision Trees Algorithm	Accuracy (%)	TP rate	FP rate	Precision
C4.5	99.91	0.999	0.001	0.999
ID 3	99.86	0.999	0.000	0.999

CONCLUSIONS

The model for determining the voice CN QoS in the Nigerian telecommunications' quality of service achieved. The 156,180 voice calls transformed into dataset file that contained 4280 records. The KPIs identified as being related to QoS for which a dataset containing information on 4280 records from sites located across 22 states of Nigeria. The quality of service grouped into poor, moderate and excellent classes. After the process of data collection and pre-processing, two decision trees algorithms were used to develop the predictive model for the measurement of QoS using the crowd sourced dataset from which the training and testing dataset collected. The decision trees performed very well at identifying the QoS of telecommunication companies in Nigeria by identifying the values of the TCHR, CSSR, CDR and the RSS.

The study also concluded that the measure of the QoS was not dependent on the location, date and the type of telecommunication network used by clients but by the values of the TCHR, CSSR, CDR, and RSS alone. The models performed well but C4.5 decision trees algorithm is a more reliable model compared to that of the ID3. The study also concluded that the predictive model integrated into a telecommunications network system for monitoring the quality of service delivery. Further research is still going on in this work. Also, Fuzzy systems used for a knowledge-based process monitoring systems in mobile networks could help to determine the performance of mobile network operators from the user's end.

RECOMMENDATION

The results from this work show structured classification of user based audio QoS with the aid of decision tree. The QoS delivered by MNOs is only fair and the pattern reported. The likelihood of voice call going through is only moderate due to high congestion rate and low signal strength. So, prompt action required in this sector, therefore, faulty hardware replacement and hardware maintenance or replacement recommended so that voice call users can enjoy service for money paid. The developed model could be used to enhance

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management of the audio QoS in mobile telecommunication networks system. Further research is going on this work.

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Thinging for Software Engineers

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***Abstract*—The aim of this paper is to promote the terms *thing* and *thinging* (which refers to the act of defining a boundary around some portion of reality and labeling it with a name) as valued notions that play an important role in software engineering modeling. Additionally, we attempt to furnish operational definitions for terms *thing*, *object*, *process*, and *thinging*. The substantive discussion is based on the conception of an (abstract) machine, named the Thinging Machine (TM), used in several research works. The TM creates, processes, receives, releases, and transfers things. Accordingly, a diagrammatic representation of the TM is used to model reality. In the discussion section, this paper clarifies interesting issues related to conceptual modeling in software engineering. The substance of this paper and its conclusion suggest that thinging should be more meaningfully emphasized as a valuable research and teaching topic, at least in the requirement analysis phase of the software development cycle.**

Keywords-conceptual modeling; thing vs. object; thinging; diagrammatic representation

I. INTRODUCTION

The current norm in software engineering is the object model, in which object orientation has become the standard for the analysis and design phases of the software development process. This model "in object-oriented analysis and design provides a more realistic representation, which an end user can more readily understand" [1]. The model has assimilated ontological issues that explicitly specify the conceptualization of the domain of concern, for which the term *object* represents a fundamental notion in the object-orientation paradigm. This paper is oriented toward modeling the domain of interest with *things*, a notion that is more general than that of objects. *Thing* is interchangeable with *entity* and is applicable to any item that is acknowledged by a system, whether that item be particular, universal, abstract, or concrete [2].

A. Specific Aim of This Paper

Several papers submitted to software engineering journals and conferences have advanced objections to the use of the term *thing* as "a vague and empty word [that lacks] any definition." One purpose of writing this paper is to defend this term and demonstrate that *thing* specifically and *thinging* in general are as "celebrated" [3] as the terms *object* and *class*. *Thinging* refers to "defining a boundary around some portion of reality separating it from everything else and then labeling that portion of reality with a name" [4]. According to Heidegger, to understand the thingness of things, one needs to reflect on the power of things to "gather" space and time [5]. Thinging expresses how a "thing things", which he explained as "gathering", uniting, or tying together its constituents. Uniting here can be illustrated by the bridge that makes the environment (banks, stream, and landscape) into a unified whole.

According to Fry [6], "The thingly character of the thing does not consist in its being a represented object, nor can it be defined in any way in terms of the objectness, the over-againstness, of the object." "Things" are irreducible to "objects" [7], and the two notions are "incommensurable" [8].

The notions of thing and thinging play an important role in modeling contending with the salience of the widely acclaimed significance of the word *object*, the term currently in vogue among most software engineers.

In computer science, interest in things and thing-orientation [9] dates back to ThingLab (1979) and Self (1987), the programming languages. More recently, Water, a prototype-based language, has linked every XML tag with its top-level ancestor, a "Thing". Imbusch et al. [9] noted that "Thing-oriented programming is the art of creating software composed of Things."

This article is about modeling thinging. Additionally, this paper unpacks philosophical issues that inform the world of computing.

> Philosophers attempt to find the essential or deeper meanings of . . . words that refer to important concepts that we use to guide us in making important decisions . . . [and] to a large extent, is to organize these meanings into coherent frameworks that help us make sense out of the world around us. [10]

That being said, a similar value is attached to the potential insights from recognizing the capacity of computers and information technology to shed new light on philosophical issues and pose questions that cannot readily be approached within traditional philosophical frameworks [11].

Specifically, this paper discusses the ontological status of objects and related notions, such as processes and events. Many research works use the term *entity*, but "there is little, in the texts, to differentiate between entities and objects" [12]. Most of the time, an entity is defined in terms of a thing (e.g., in Chen's [13] description of an entity, it is a thing that can be distinctly identified).

The substantive discussion is based on the conception of an (abstract) machine (an assemblage) named the Thinging Machine (TM), which has been used in several research works

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[14-23]. The main motivation is to justify adopting a terminology that relies more on the notion of things than it does on objects, particularly in the context of the TM.

B. What Is an Object?

In the object-orientation literature, an object is described in terms of having an identity, state, behavior, and properties, as well as a specified set of operations. Objects, here, include virtual objects (e.g., a web page), ordinary physical objects, (e.g., a building), and institutional entities [24] (e.g., the act of buying). "The world being modelled is made up of objects . . . objects are just there for the picking!" [25]. "Identifying objects is pretty easy to do. Start out by focusing on the problem at hand and ask yourself 'what are the *things* [italics mine] in this problem?'" [26]. Objects have a dual nature that turns on their two sets of properties: functional properties and structural properties [27]. Functional properties are related to what an object does (e.g., a car is used for transportation) and its structural properties pertain to its physical makeup (e.g., the car is red and has white seats) [28].

> In object-oriented analysis and design, an object models some *unity* [italics mine] that exists in physical or conceptual space, or some new *unity* [italics mine] that could be realized in the physical space because someone has thought it out. [12]

Many descriptions of objects may oftentimes include examples of relevant things that fit into an object's category [9]. According to Maciaszek [29], "an object is an instance of a 'thing'," and "a generic description of a 'thing' is called a class." All the objects common to everyday life, such as paper clips, tablets, and dog collars, are intentionally produced things [28]. Interestingly, in image analysis studies, an object is defined as "a set of regions located near the center of the image, which has significant color distribution compared with its surrounding (or background) region" [30]. Thus, an empty beach at sunset, with red sky, blue sea, and gray sand, has no object but certainly is a (beautiful) thing.

According to Atkins [31], to objectify a thing is to reduce it, to break it down into increasingly smaller parts instead of taking it holistically as it is. An object consists of its universal form with shared particular qualities (e.g., its color, shape, size, and texture are accidental or unnecessary).

> What separates an object from any ordinary "thing" is its phenomena of perception as conjured by a subject. Thus, objects are entities that a subject projects desire and necessity, supporting the theory of objectivity and establishing objecthood. [32]

C. What Is a Thing?

According to Edwards [33], a thing is surely among the most colorless of English words. Almost anything can be labeled with the word *thing*—a word that seems simultaneously essential and empty—and is essential because of its very emptiness. *Thing* is "a banal term we use for designating what is out there, unquestionably . . . what lies out of any dispute, out of language" [3].

Heidegger [5] distinguished between objects and things: "The handmade jug can be a thing, while the industrially made can of Coke remains an object" [3]. For Heidegger [5], things have unique "thingy Qualities" [3] that are related to reality and therefore not typically found in industrially generated objects. According to Heidegger [5], a thing is self-sustained, self-supporting, or independent—something that stands on its own. The condition of being self-supporting transpires by means of *producing* the thing.

The TM, which is based on the concept of thinging, is an abstract machine that creates, processes, and exchanges things. Although, as noted above, several works have described the TM, the following section provides an interpretation of it from a novel perspective.

II. Thinging Machine

Thinging signifies the following:

- Forming, molding, shaping, and refining the "clay-like stuff" of reality to generate things: diverse pieces have their own identities and different compositions, in terms of parts and wholes. The resultant (so-called mereological) universe consists of conceptualized things that we refer to as components of a system.
- The flow of these things in terms of five stages: creation, processing, receiving, transferring, and releasing. "Not only do things exist in the world, but stuff *happens* to them, There are occurrences. There is movement" [31].

Thinging, from our perspective—which deviates from the Heideggerrian thought—is a thing forming itself in the world as a machine. A *thinging machine* (this term is taken from [34]) generates and handles the thing and its constituent subthings (e.g., an object is a machine and its qualities are submachines). The machine (human and non-human) can craft things. Accordingly, this (abstract) machine is defined in terms of its functions to create, process (change), receive, release, and transfer things, as shown in Fig. 1. Additionally, the TM model utilizes triggering (denoted by a **dashed arrow**) to establish connection with other machines that have different type of things. The machine is the building block of that what things.

A machine that crafts things is itself a thing that is crafted by other machines. For example, a human being *is a machine* that includes sensory and cognitive submachines and so forth; simultaneously, a human being *is a thing* in other larger machines such as social machinery (see Fig. 2). Thus, every "thing" is a machine (environment/place) of thinging other things.

Going by the function of a TM, we define a thing as follows:

A thing (material and immaterial) is what manifests itself in creation, processing, receiving, releasing, and transferring stages of a thinging machine.

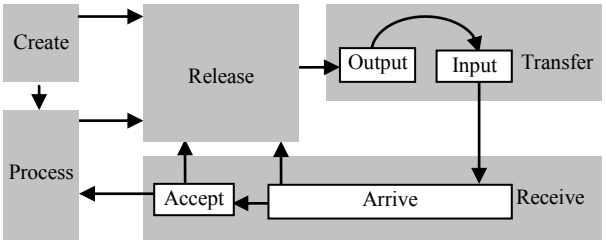

Figure 1. Thinging machine.

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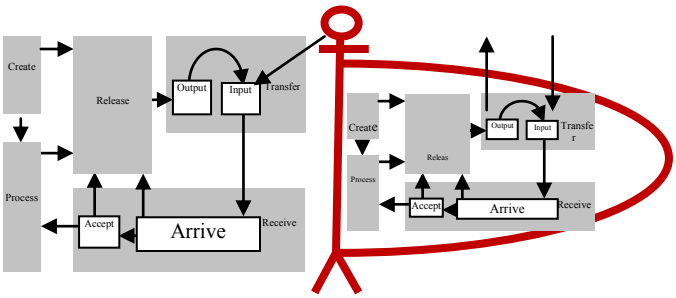

Figure 2. A human being is a thing and a machine.

Examples of things include numbers, time, events, and data. A TM is the "context" of a thing. For example, according to Grigg [35], "The rain, of course, must be raining because it can do nothing else. The 'rain' is its 'raining', just as a 'thing' is its 'thinging.'" The rain is not to be separated from its context and made a static "thing"; rather, it is an operating, dynamic machine (Grigg [35] calls it a *PROCESS*), through which rain is created (in the atmosphere), released, and transferred, to be received by Earth.

Accordingly, instead of "the thing *things*", in a TM, we have five kinds of thingings: the thing *emerges*, *changes*, *arrives*, *transfers*, and *waits* (*for departure*). Thinging is the emergence, changing, arriving, departing, and transferring of things. Heidegger's fourfold concerns the creation type of thing.

Heidegger's notion of thinging has influenced thinking in many scientific fields (e.g., design thinking [36], information services [37], and organization/management studies [38]). The utilization of thinging in this paper is not about the philosophical issues related to the ontology of things and their nature; rather, it concerns the representation of things in software engineering modeling. This representation is utilized in documentation and in the early phases of building software systems.

In several papers submitted to software engineering journals and conferences, some referees rejected the use of the term *thing*. According to one referee, "the system is badly described and many terms are not well defined (e.g., 'thing')." Another referee stated:

> "Things can be concepts, actions, or information." This is a very fuzzy explanation. First of all, concepts are independent of space and time, though things are closely related to processes, which are in space and time.

However, the sentence "Things can be concepts, actions, or information" furnishes examples of what can be created, processed, received, released, and transferred. For instance, a *concept* is created, or generated, in the brain; it is processed to create a corresponding proposition; it is received by a listener or reader after being embedded into a speech; it is released in the form of a linguistic expression; and it is transferred from one person to another.

According to Malafouris [39], we are creative "thingers" in the sense that "We make new things that scaffold the ecology of our minds, shape the boundaries of our thinking and form new ways to engage and make sense of the world." The aforementioned referees' comments show little appreciation for thinging and the issue of "defining boundaries around portions of reality" [4] or a significant disregard to the difficulty of defining the problem of *what a thing is.* This is an important aspect to consider with regard to the TM. Lacking a clear description of the most basic term in the model would undermine the potential viability of judging its research value. We claim that the definition—*a* thing *is what can be created, processed, received, released, and transferred*—is of some worth in making the term more well-defined and less fuzzy. Malfouris [39] explains:

> The notion of thinging seeks to encapsulate the major phenomenological ingredients . . . , shifting our attention away from the sphere of isolated and fixed categories (objects, artefacts, etc.) to the sphere of the fluid and relational transactions . . . [39]

- Current approaches to things are somewhat limited in comparison to TM. Heidegger [5] emphasized only the ontological thinging of a thing (*producing* [5] – *creation* in the TM) in response to "what is – ness". Heidegger's "thing" is the name we give to a discrete yet unspecifiable entity [7].

- The TM's definition of thing broadens its characterization by including other secondary aspects: process-ness, receive-ness, transfer-ness, and release-ness. All four features form possible "thingy Qualities" [3] after production (creation). In a TM, "things" take the characteristics of "objects" as discrete specifiable entities.

A thing that has been created refers to a thing that has been born, is acknowledged, exists, appears, and emerges as a separate item in reality and with respect to other things. A black swan was acknowledged as a metaphor based on a pre-1697 observation that all swans are white. In this case, a black swan was created as a metaphorical thing before 1697. This metaphor was processed and communicated among people at that time. It is the black swan machine. In 1697, a black swan was created in the sphere of knowledge by the appearance of the physical thing. The black swan machine is now a machine that consists of the metaphor and the bird. Note that a thing is a machine and vice versa. A factory can be a thing that is constructed and inspected as well as a machine that receives other things (e.g., materials) to create products. A factory is a thing when it processed (e.g., created), and it is a machine when it is processing things (e.g., creating products).

Is there a thing in a machine—or world—that is not created? Here, creation may refer to physical things (e.g., the sky or an animal), social things (e.g., a society or a celebration), mental things, (e.g., a thought, a feeling, or literature), and nonphysical things (e.g., music). Note that some machines are only processors, receivers, releasers, and/or transferors of a thing. Thus, processing, receiving, releasing, and transferring are important in defining a thing in a noncreating machine.

It is clear why we have opted to use the term *thing* instead of *object*, which, in Heidegger's [5] view, is a manufactured thing, such as a computational *artifact* (e.g., computer-oriented,

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manufactured data). A thing can be created, processed, received, released, and/or transferred.

Create a thing means that it *comes about* and this implies the possibility of its un-thinging within a machine. A collection of machines of a thing forms a larger machine. The stomach machine is a food-processing machine in the digestive machine. The digestive system is one machine in the human being machine, with respect to the thing, food, which is digested (processed) to create waste. A human being is a thing in a school machine.

Processing indicates a type of change that a machine performs on a thing without turning it into a new thing (e.g., a car is processed when its color is changed).

Receiving is the flow of a thing to a machine from an outside machine. *Releasing* is exporting a thing outside the machine. It stays as a released thing if the exporting channel is not available. *Transferring* is the released thing departing to outside the machine.

Note that the relevant purpose involves thinging machines that are relevant for this purpose. After all, a machine is a thing. For example, in a hospital, a human being includes broken or nonfunctioning machines or infectious machines (viral or bacterial machines), and other characteristics used to represent a human thing (machine).

The world of a TM consists of an arrangement of machines, wherein each thing has its own unique stream of flow. TM modeling puts together all of the things/machines required to assemble a system (a grand machine).

The example below illustrates these concepts in terms of the software engineering sphere.

III. Example

Deitel and Deitel's book *C++ How to Program* [40] gives an object-oriented program that uses the class *Time*:

```
Functions:
   void setTime(int, int, int); // set hour, minute, second
   void printUniversal();       // print universal-time format
   void printStandard();        // print standard-time format
The attributes: int hour, int minute, and int second.
The main program includes such statements as:
   Time t;  // instantiate object t of class Time
   t.printUniversal();   // 00:00:00
   t.printStandard();    // 12:00:00 AM
   t.setTime(13, 27, 6);   // change time
```

Fig. 3 shows the TM's static (independent of time) representation of this program. Note that in the following discussion Time denotes the class *Time*, while time denotes the notion of time as generally understood and used.

In the figure, the Time machine (circle 1) includes the hour (2), minute (3), and second (4) submachines. All Time submachines are fed by the integer machine (5). When an integer is created, it is processed to verify its constraints (e.g., the second must be is between 0 and 60). The created *Time thing* (instance) is processed (6 and 7) in the Time machine to either convert it to the standard or universal format, after which it will flow (8) to the printer to be printed (9).

Fig. 3 represents the program's static description, which we call the *machine*. To specify the *behavior* of the C++ program's execution, we identify different possible events and their chronologies.

An event is a machine in a TM that contains at least three submachines: the time, the region, and the event itself. The region is where the event *takes place* or site of its unfolding. We can bring here Heidegger's notion of gathering, in the sense that the event brings into presence the value (meaningfulness) of the region that was previously hidden. Thus, the event (as a machine) emerges as a thing by gathering (enclosing) the time and region (and other things). Such dwelling (Heidegger's term) can be applied to all phases of the TM modeling, but we want to emphasize engineering here, not philosophical thought.

Fig. 4 shows the representation of the event: *Create the constructor of the class Time*. It includes the three machines: the region of the event (circle 1), which is a subdiagram of Fig. 3; the (real) time submachine (2); and the event submachine itself (3).

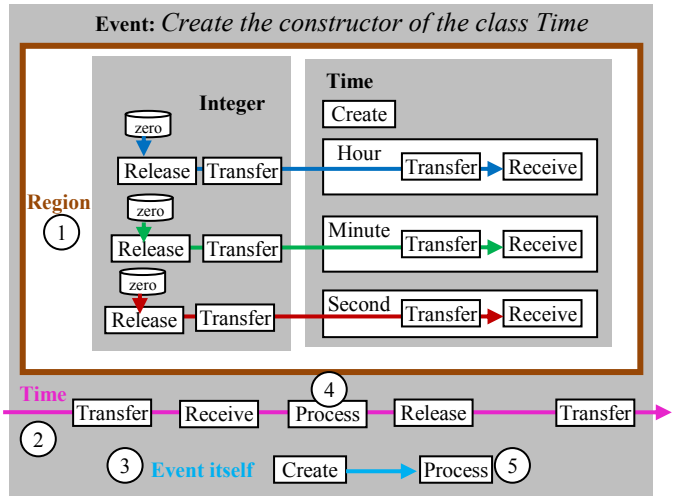

Figure 4. The event creating the constructor.

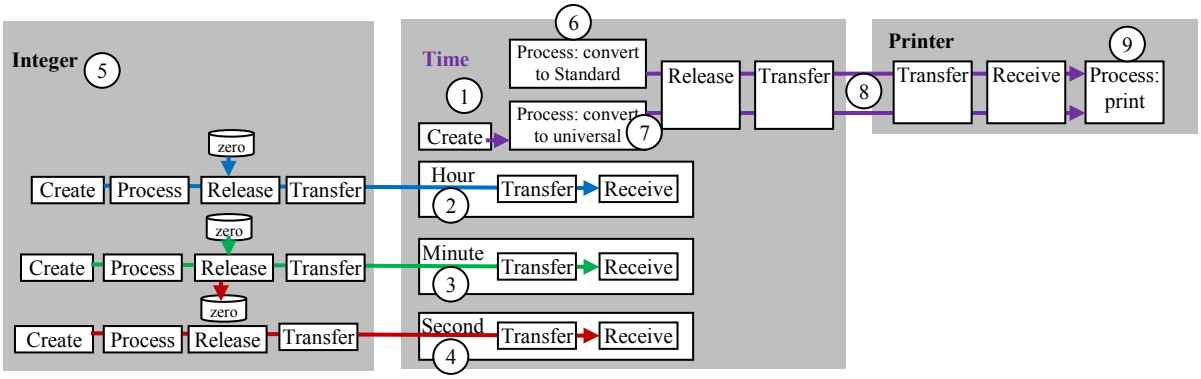

Figure 3. The TM representation of the class Time.

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Note that, in general, an event may have other features, such as its intensity. In the figure, the processing of time (4) reflects the consumption of time, whereas the processing of the event (5) indicates that the event is taking its course. For the sake of simplification, we will represent an event only by its region.

Accordingly, we identify the following four events:
Event 1 (E_1): *Create the constructor of the class Time* (Fig. 4);
Event 2 (E_2): *Set Time* (Fig. 5);
Event 3 (E_3): *Print Time in standard form* (Fig. 6); and
Event 4 (E_4): *Print Time in universal form* (Fig. 7).
Fig. 8 shows the chronology of execution of these events. Fig. 9 represents the execution of Deitel and Deitel's program [40].

In philosophical language, this chronology of events is an ordering setting-up, through which "enframing" (gathering things/machines together) is applied to all submachines to enable the program machine to "reveal" itself.

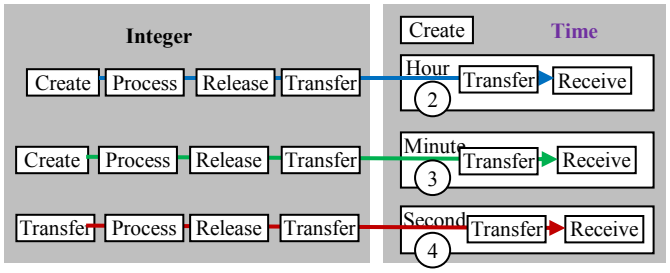

Figure 5. The setting of *Time*.

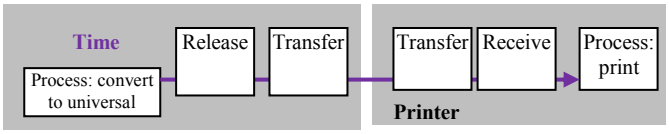

Figure 6. The event *Print Time in standard form.*

IV. Process versus Machine

What is the difference between a machine and a *PROCESS*? The term *PROCESS*, written in capital letters to avoid confusion with Process (change) in the TM machine, denotes what is typically defined as a sequence of operations that transforms input into output. According to Tanaka [41], PROCESS is "a collection of steps taking place in a prescribed manner and leading to an objective."

A. An Example from the PROCESS Specification Language

In the PROCESS specification language (PSL), a standard exchange language for PROCESSing information in the manufacturing industry [42-43]. "Most PROCESS models support the notions of input and output, which are data or objects provided to a behavior execution before it starts, and data produced when it finishes, respectively" [44].

Bock and Gruninger [44] use Fig. 10 to show an example of a PROCESS change in a car's color using one of the UML 2 notations for object flow. According to Bock and Gruninger [44],

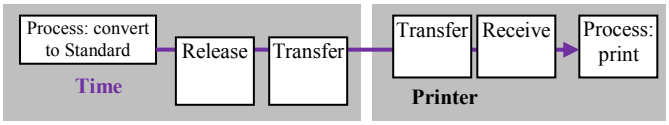

Figure 7. The event *Print Time in universal form.*

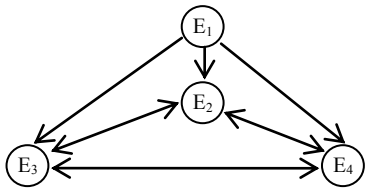

Figure 8. Chronology of the execution.

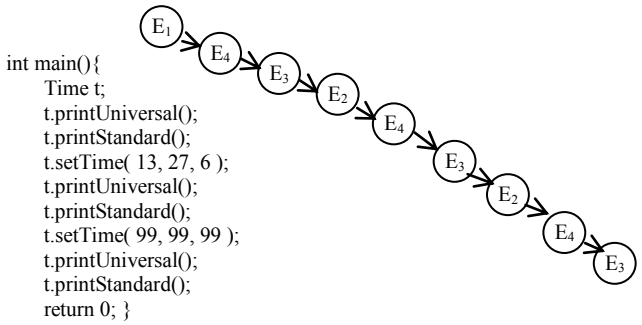

Figure 9. A sample C++ program and its events.

[The figure] is ambiguous not because it is graphical, textual languages have the same problem, but because it is specifying execution with constructs that only implicitly refer to runtime, rather than explicitly. For example, the nodes labeled ChangeColor, Paint, and Dry will be executed many times in many situations, and the diagram does not clarify which executions are referred to, or how the graphical nesting and arcs constrain them.

In addition, Bock and Gruninger [44] use Fig. 11, called the occurrence tree, to demonstrate a runtime execution of an activity: "It has no analog in UML, because UML does not have a direct model of runtime execution yet" [44].

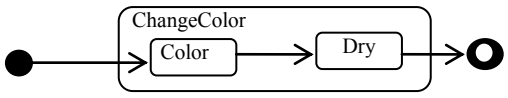

Figure 10. Example UML 2 (redrawn from Bock and Gruninger [44]).

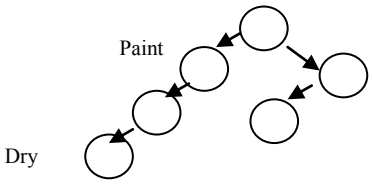

Figure 11. PSL occurrence tree (partially redrawn from Bock and Gruninger [44]).

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Fig. 12 shows the corresponding TM representation. Note that the coloring/drying machine includes the PROCESSes of transferring, receiving, releasing, and processing (change). This TM representation, which is illustrated in Fig. 12, can be used to specify the execution of a sequence of events. Fig. 13 shows two possible *thingings* of events; each of them represent a different "slicing" of regions in Fig. 12, depending on the design mode of *thinging* for the events.

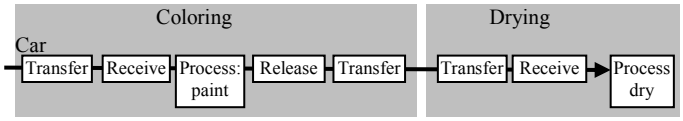

Figure 12. TM representation of the color/dry machine.

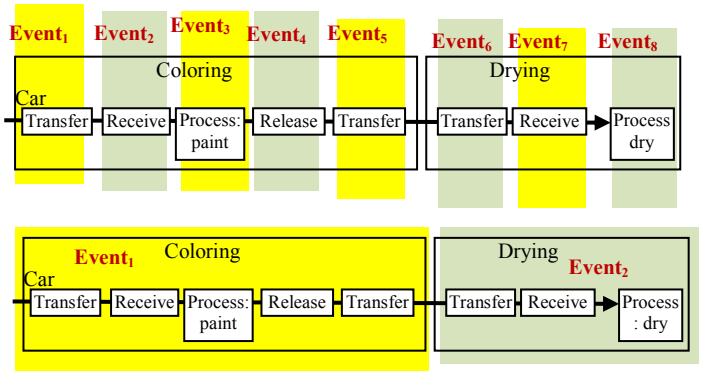

Figure 13. Two possible thingings of events.

B. *Chronology of Events*

To make the example more compelling, let us assume that

- A first test is performed to check whether the car has been colored to a satisfactory level, and
- A second test is conducted to check whether the car is completely dry.

Accordingly, Fig. 14 shows the new TM representation. We inserted the machine testing after the car is first colored (circle 1 in the figure). If the paint is satisfactory, the car continues to drying (2); otherwise, the car is sent back (3) to be painted again (4).

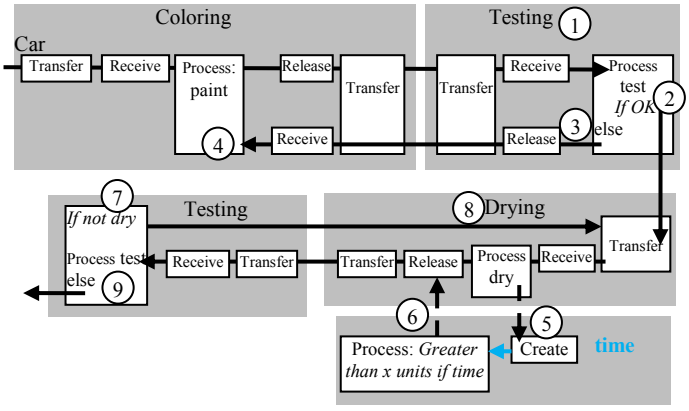

Figure 14. The TM representation with testing.

When drying starts, a time is set (5) (e.g., 1 hour). At the end of that time, the car is sent to be checked (6). If it is not dry, the car is dried again for the set time. If the car is dry, then it has been finished (9).

To model the machine's behavior for a single car, Fig. 15 shows seven selected events:

Event 1 (E_1): A car arrives and is painted.
Event 2 (E_2): The car is tested to see whether the paint is satisfactory.
Event 3 (E_3): The car is returned to be repainted.
Event 4 (E_4): The car is dried.
Event 5 (E_5): The car is sent to be tested for dryness.
Event 6 (E_6): The car is sent back to be dried again.
Event 7 (E_7): The car is dry and released from the station.

Fig. 16 renders the chronology of these events, exemplified by a single car.

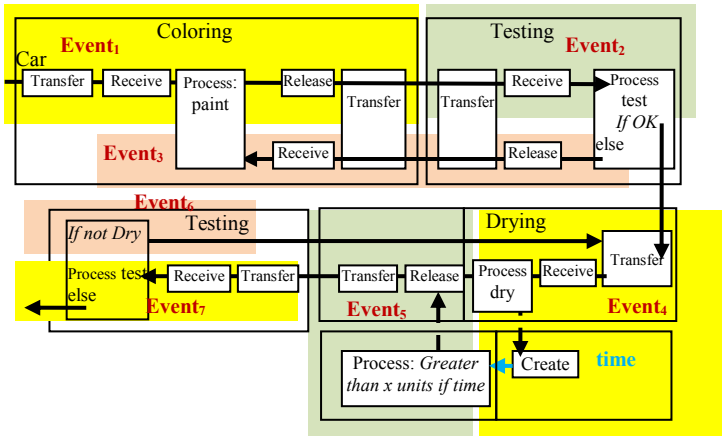

Figure 15. Events.

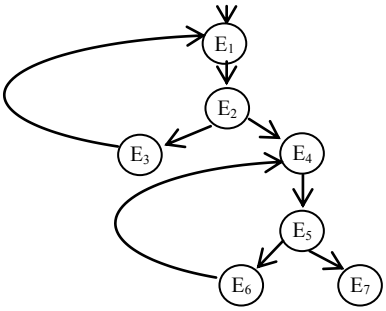

Figure 16. The chronology of execution for a car.

Note that the thinging of the events is rendered pursuant to their "meaningfulness" to the modeler of the coloring/drying machine. In E_1, *a car arrives and is colored*. Subevents such as receiving the car are not of interest (e.g., to report, register, note these events), so they are subsumed in E_1. This is an example of thinging events. The execution of events in Fig. 15 represents the lifecycle of a single car in the coloring/drying machine (one *occurrence* of the behavior of the machine). It is interesting to investigate the intersection of multiple occurrences.

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C. Behavior with Multiple Cars

Consider a situation in which we can maximize the use of the coloring/drying machine with multiple cars. In this case, we have to add queues to the coloring and drying submachines, as shown in Fig. 17. In Fig. 17, cars arriving in the coloring machine are queued (circle 1). They are processed one by one (2). When a car is being colored, the state of the coloring submachine is set to *busy* (3). When a car leaves the coloring submachine, the state is set to *not busy* to allow another car from the queue to be colored. A similar procedure is installed in the drying machine (5, 6, 7, and 8).

Fig. 18 shows the results of thinging "meaningful" events, whereas Fig. 19 shows the chronology of the events for one car. To "run" (execute) the coloring/drying machine such that multiple cars can be processed simultaneously, we simplify the process by assuming that no car is returned to be colored or dried twice; that is, the color and dryness are satisfactory after the first time. Fig. 20 demonstrates a situation with different cars during which events overlap. Car 1 "enters" E_1 and then flows to E_2. As soon as it "leaves" from E_2 to E_3, car 2 "enters" E_2. Accordingly, different cars progress to different events of the coloring/drying machine. Eventually, in the last column of Fig. 20, seven cars are being processed simultaneously.

This illustrates parallel car processing chronologies (multiple iterations of Fig. 19) in the behavior of the machine. This illustration of the TM's specification advances smoothly from thinging things and machines to thinging events to modeling the machine's dynamic activity.

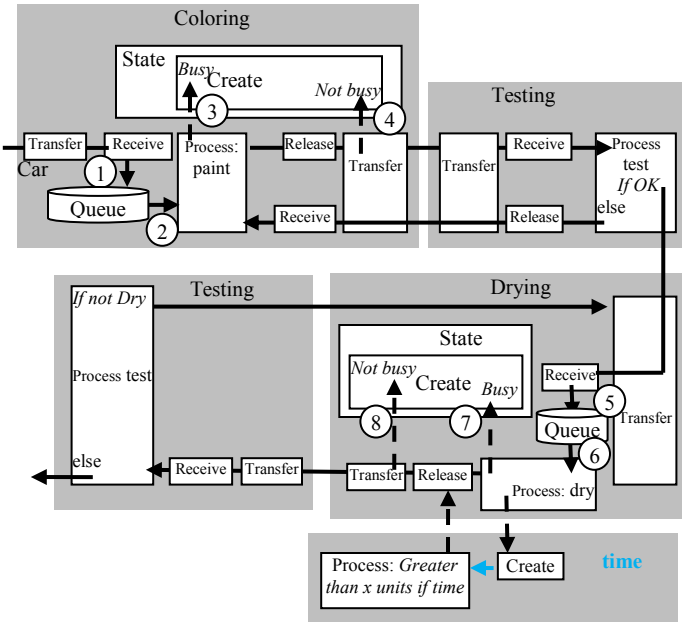

Figure 17. The TM representation with queues.

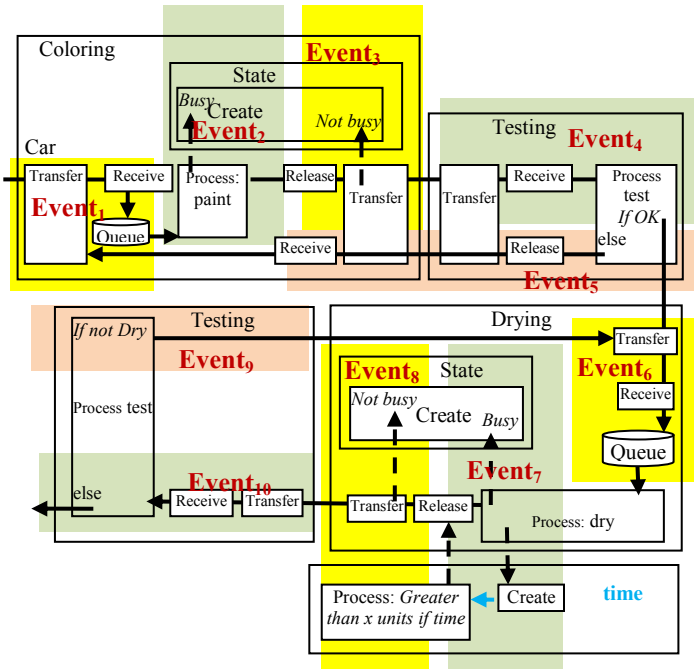

Figure 18. Events in the example.

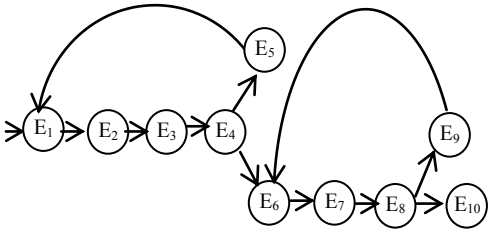

Figure 19. The chronology of execution for a car using the queue.

Sequence of arrivals	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Car 7
	E_1	E_1	E_1	E_1	E_1	E_1	E_1
Time period 1	E_2						
Time period 2	E_3	E_2					
Time period 3	E_4	E_3	E_2				
Time period 4	E_6	E_4	E_3	E_2			
Time period 5	E_7	E_6	E_4	E_3	E_2		
Time period 6	E_8	E_7	E_6	E_4	E_3	E_2	
Time period 7	E_{10}	E_8	E_7	E_6	E_4	E_3	E_2

Figure 20. The chronology of execution for multiple cars.

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V. THINGING AND EVENTING

The previous section stated that an event in the TM includes at least three submachines: the time, region, and event itself. According to Heidegger [5], "the particularity of things seems to depend completely on their *space* and *time*" [44]. Space in the TM is called the region of the event, as shown in the previous examples. From this perspective, TM events are of sources that generate particularities. If we focus on the space aspect of regions in events, we find that it is a logical space:

> Even if we break a thing to get to the space "inside" we find external relations between its parts, bits, and pieces. Space seems to be not really "in" the thing but only the "possibility" of arrangements of its parts (in, out, next to, etc.). [44]

For Heidegger [5], time and space are the realms in which things can be given. Edwards [33] expands, "They stabilize the flow of sentience; they make it into something. They bring it to a lasting stand". In TM events, time and space even out the flow of things (e.g., in the Time class example, the three flows of integers [hour, minute, and second] reach their destination to create a particular time [thing]). Analogous to analyzing a connection between a subject and a predicate [44], the TM conceptualizes a connection between a machine (system) and an event (region/time diagram). In the context of the machine, the region diagram expresses itself as a situation in which facets of itself are stated and in which something (the creation) is asserted about the thing. (The last two sentences express an alternative account of Gendlin's [44] description of a connection between a thing and a human being.)

VI. CONCLUSION

This paper has presented the term *thing* and showed that this specific term and the general term *thinging* are valued notions that play an important role in the need to distinguish separable entities in software engineering modeling. Additionally, the paper attempted to answer the question, what is a thing, object, or process? As a result, this may raise the issue of thinging in software engineering.

An (abstract) TM is reintroduced and proposed as a foundation for the clarification of these notions.

The substance of this paper suggests that thinging should be more meaningfully emphasized as a research and teaching topic, at least in the requirement analysis phase of the software development cycle. According to Umans [45], "the quest for knowledge is not a quest for truth but a challenge to understand the processes of thinging."

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A Service Differentiation Aware Dynamic Random Early Detection and Optimized Fuzzy Proportional Integral Derivative for Active Queue Management Congestion Control in Mobile Wireless Sensor Network

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***Abstract*—**In Wireless Sensor Network (WSN), extremely vital challenges are congestion control and service differentiation, while traffic becomes greater than the aggregated or individual capacity of the underlying channels. For this case, special considerations are required for developing more sophisticated mechanism for detecting, avoiding and resolving congestion. As a result, a Dynamic Random Early Detection (DRED) with Fuzzy Proportional Integral Derivative (FuzzyPID) controller has been designed to control the target buffer queue and sending rate of each node. However, a service differentiation mechanism was not considered which also controls the traffic flow of each node. Hence in this article, a DRED is improved by integrating service differentiation mechanism to differentiate high priority and low priority traffic based on the weighted load metric and services the input traffic according to its priority. Here, high priority traffic is buffered in a separate queue with low buffer size whereas low priority traffic is controlled by using DRED algorithm. Moreover, fuzzy inference system is enhanced by applying Deep Neural Network (DNN) optimization algorithm which provides DRED with self-adaptation and enhanced performance. This optimization algorithm also tries to optimize sending rate and average queuing delay. Finally, the experimental results show that the improvements on DRED in terms of packet loss ratio, packet loss probability, mean end-to-end delay, mean queue length and mean energy consumption.

***Keywords*—** Wireless sensor networks, Congestion control, Service differentiation, Dynamic random early detection, Deep neural network, Fuzzy PID

1. INTRODUCTION

A Wireless Sensor Network (WSN) is a spatially distributed autonomous sensor for monitoring physical and atmosphere conditions like temperature, pressure, humidity, etc. Sensor nodes can record this information and transmitted them over to a central unit known as sink. Sensor nodes must be cheap, simple to use, battery-powered, ability of self-configuration, ability to deal with node failures and resist harsh surrounding conditions. Such networks have a vital role in different applications like military, healthcare, medical, etc. Mostly utilized for monitoring

patient's health status i.e., remotely monitored patients who do not need the doctor's presence. In medical and emergency applications, sensors are installed on the body and more information are collected in a short duration and then transmitted to the sink (Gentili, C., et al. 2017). This load of outgoing data packets can lead to information explosion and so congestion in intermediate nodes is occurred which is predictable.

Congestion directly affects the end-to-end delay, packet loss and energy consumption in the nodes and network connectivity. If the battery on a sensor dies or it malfunctions or a data packet gets lost, then it may result in exacerbation of the illness or death of an individual. This makes congestion management in medical applications more essential. Therefore, one of the major challenges in such networks is reducing the congestion since the data packets containing health information are directly linked to life and well-being of the patient and loss of these data packets might endanger a human life. Over the past decades, different congestion control protocols such as congestion detection, congestion notification and rate adjustment were proposed.

Congestion control protocols in Healthcare WSN are classified into traditional protocols and soft computing based protocols. Traditional protocols are proposed according to the rate control, priority, queue management and class. Soft computing techniques are intellectual techniques which are based on learning automata, fuzzy and game theory and may enhance an effectiveness of the wireless networks. When the link bandwidth exceeds than the router capacity, this causes delay and later packet drop occurs. As a result, Active Queue Management (AQM) protocol has been designed which notifies about the initiatory congestion proactively to the terminals (Adams, R. 2013). AQM is a technique based on router which is used for magnifying the performance of Transmission Control Protocol (TCP) and also an effective congestion control mechanism that controls the queue size for ensuring higher throughput. Hence, an effective congestion control and Quality of Service (QoS) can be achieved.

Earlier AQM based technology for congestion control relies on classical control principles such as Random Early Detection (RED), Proportional Derivative (PD) control, Proportional Integral (PI), Proportional Integral Derivative (PID). With the traditional principles, the congestion control was not that much satisfied (Sharma, A. K., & Behra, A. K. 2016). To achieve better control, Dynamic RED (DRED) was integrated with Fuzzy PID controller together based on AQM mechanism (Rezaee, A. A., & Pasandideh, F. 2018). When fuzzy logic combines with PID, the target buffer queue was controlled. In addition, the sending rate of each node was estimated and adjusted by fuzzy logical controller. However, the other significant issue in WSN such as service differentiation of packet flow was not considered.

In this article, a DRED is enhanced by considering the service differentiation mechanism. In this proposed DRED-FDNNPID mechanism, priority-based rate control for service differentiation is introduced according to a weighted load metric related to the queue status of the nodes is computed for providing a distributed and stateless traffic control mechanism. Here, each traffic class is assigned a different priority since ensuring a low delay bound is a significant issue for real-time traffic. High priority based traffic is buffered in a separate queue along low buffer size and low priority based traffic is controlled by using

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DRED algorithm. Moreover, fuzzy inference system is enhanced based on the machine learning approach such as Deep Neural Network (DNN) known as FDNN which uses more inputs for learning process. This improves the DRED-FDNNPID with self-adaptation to enhance the performance and optimize the average queuing delay.

The rest of the article is structured as follows: Section 2 presents the literature survey related to the AQM based congestion control mechanisms in WSN. Section 3 explains the proposed methodology. Section 4 illustrates the experimental results of the proposed mechanism. Finally, Section 5 concludes the research work and presents the future enhancement.

2. LITERATURE SURVEY

A compensated PID AQM controller was proposed (Kahe, G., et al. 2013) by using an improved queue dynamic model. In this approach, an improved queue dynamic model was proposed when the packet drop probability was incorporated. Based on this model, a novel compensated PID AQM controller was designed for TCP/IP networks. A parameter-varying dynamic compensator that operates on tracking error and internal dynamics was proposed for capturing an unstable internal dynamics and also reducing the effect of uncertainties by unresponsive flows. This dynamic compensator was utilized for designing PID AQM controller whose gains were directly obtained from the state-space representation of the system with no further gain tuning requirements. However, an adaptive controller was required for improving the performance by considering time-varying network parameters.

An optimized congestion management protocol (Rezaee, A. A., et al. 2014) was proposed for healthcare WSN. Initially, a novel AQM scheme was proposed for avoiding congestion and providing QoS by utilizing individual virtual queues on a single physical queue for storing the input packets from each child node according to the significance and priority of the source's traffic. If the incoming packet was accepted, then three mechanisms were used for controlling the congestion. It detects congestion by a three-state machine and virtual queue status and also modifies the child's transmitting rate by an optimization function. However, the efficiency was less in detection and classification of heterogeneous traffic flows in a dynamic atmosphere.

A robust AQM scheme was proposed (Zhou, C., et al. 2013) based on H-infinity feedback control theory for network congestion control. A TCP model with link capacity distribution, modeling uncertainties and time-varying delay was investigated and the objective was designing a feedback controller which guarantees the queue length stability and robustness against the external distributions and model perturbations. Temporarily, a simple on-line estimation of TCP window size was adopted for reducing the computation complexity significantly. Moreover, the controller parameters were obtained via the standard linear matrix inequality techniques. However, it suffers from the problem of tuning over different network parameters.

A congestion control protocol (Aghdam, S. M., et al. 2014) was proposed for Wireless Multimedia Sensor Networks (WMSN). A new content-aware cross layer WMSN Congestion Control Protocol (WCCP) was proposed based on the consideration of characteristics of multimedia content. A Source Congestion Avoidance Protocol (SCAP) was employed in the source nodes and a Receiver Congestion Control Protocol (RCCP) in

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the intermediate nodes. In SCAP, Group of Picture (GoP) size was used for detecting the congestion in network and avoiding the congestion based on the modification of transmitting rate of source nodes and distribution of the departing packets from the source nodes. As well, RCCP was used for monitoring the queue length of intermediate nodes for detecting congestion in both monitoring and event-driven traffics. Furthermore, I-frames were controlled and the other frame types of compressed video were ignored in the congestion conditions for improving the received video quality in base station. However, average network throughput of this method was less.

Hierarchical tree based congestion control (Sayyada, J., & Choudhari, N. K. 2014) was proposed by using fuzzy logic for heterogeneous traffic in WSN. Initially, the hierarchical tree was built by using topology control algorithm and then the congestion detection was performed based on the fuzzy logic technique according to the parameters like packet service ratio, number of contenders and buffer occupancy. A dynamic rate adaptation or adjustment was also proposed for congestion control. If rate adjustment was not feasible, then an alternating path was selected from the established hierarchical tree by the source node. However, packet delivery ratio of this method was not improved.

Congestion-aware routing and fuzzy-based rate controller were proposed (Hatamian, M., et al. 2016) for WSN. In this method, a novel congestion-aware routing was proposed by using greedy approach. This approach was used for finding more affordable paths. Then, a fuzzy rate controller was used for rate controlling that utilizes two criteria as its inputs with congestion score and buffer occupancy. Such parameters were according to the total packet input rate, packet forwarding rate at MAC layer, number of packets in the queue buffer and total buffer size at each node. Once congestion was detected, the notification signal was transmitted to the offspring nodes. Thus, they were able for modifying their data transmission rate. However, only two inputs were considered in this approach.

Priority-based queuing and transmission rate management were proposed (Bouazzi, I., et al. 2017) by using a fuzzy logic controller in WSN. The main objective of this approach was introducing a fuzzy logic algorithm to solve the issues in maintaining the message latency, reliability and maximizing the battery life of sensor nodes. Here, a fuzzy logic scheme was employed for optimizing the energy consumption and minimizing the packet drops. The fuzzy logic was implemented in the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism by filling queue length and traffic rate at each node. However, the efficiency of this approach was less.

3. PROPOSED METHODOLOGY

In this section, the proposed **DRED-FDNNPID mechanism in WSN healthcare application** is explained in brief. The main goal of this mechanism is differentiating the services as well as detecting and controlling the congestion in the networks. In this proposed protocol, low, intermediate and high priority levels of traffics are considered. Low priority traffic is designed for transferring normal data traffic. Intermediate priority is used for transferring the image data which require intermediate delay whereas high priority traffics are used for transferring high priority data. This proposed system consists of four units which are shown in Figure 1:

- Service Differentiation Unit (SDU)
- Congestion Detection Unit (CDU)

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- Congestion Notification Unit (CNU)
- Rate Adjustment Unit (RAU)

3.1 Service Differentiation Unit (SDU)

The service differentiation unit is required for supporting differentiated services in WMSN or other wireless networks. Network traffic classification facilitates to organize traffic into traffic classes on the basis of whether the traffic matches a certain criteria (Yaghmaee, M. H., & Adjeroh, D. A. 2009). The classification of network traffic is the essential to enable several QoS characteristics on the network. The main aim of this scheme is aligning traffic according to the user-defined criteria thus the resulted network traffic may be subjected to certain QoS requirements. The QoS requirements may include faster transmitting by intermediate nodes or reduced probability of the traffic being dropped due to lack of buffering resources.

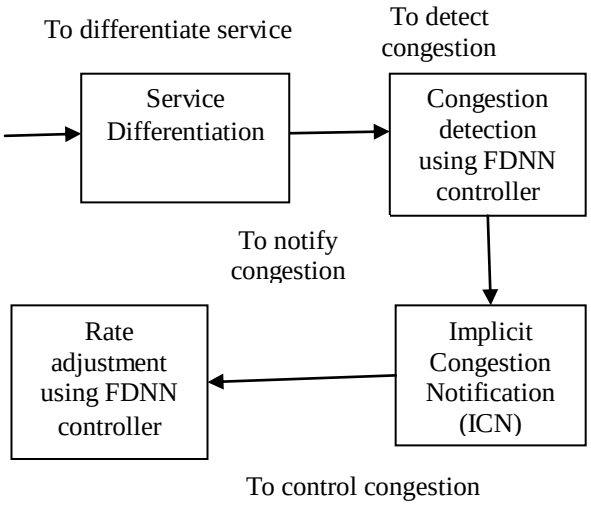

Figure.1 Overall Concept of the Proposed Mechanism

An aggregated weighted load metric is determined as a total of the priority values of the packets in the queue. The priority of a packet is determined as a function of the precedence and the number of efforts:

$$W_k = \sum_l p_l \quad (1)$$

$$p_l = f(wp_a, pr_l, wn_a, n_l) \quad (2)$$

In above equations, W_k refers the aggregated weight for node k, p_l refers the priority level of l^{th} packet, wp_a and wn_a are the weight factors for precedence (pr_l) and number of efforts (n_l) of the packet i.e., packets in the queue is assigned for class c, correspondingly. The priority can be estimated as a linear function $(p_l = wp_a pr_l + wn_a n_l)$. The weighted load metric is defined the throttle time between successive transmissions. It is normalized (W_{nk}) based on the minimum throttle time (T_{min}) and maximum weight level (W_{max}).

$$W_{nk} = \frac{W_k T_{min}}{W_{max}} \quad (3)$$

Each node accesses the channel based on its priority level. Moreover, high priority traffic classes are required to have high throughput and low delay bound.

3.2 Congestion Detection Unit (CDU)

This unit computes the amount of traffic in the queues of each node in the network. The packet drop rate poses a linear relationship while the network holds thresholds between the minimal and maximum values identically for certain time duration in RED system (Chen, J. V., et al. 2012). As a result, FDNN-PID is proposed in CDU for an AQM method for solving non-linear network congestion and reducing the packet drop rate between the two threshold values. One of the input variables of the fuzzy CDU is $e(i)$ which measures the difference between current queue length and expected queue length over time. According to the cross-layer design and window-based flow control of TCP congestion control, $e(i)$ is given as,

$$e(i) = q(i) - q_T \quad (4)$$

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The other input variable is $\Delta e(i)$ which refers the deviation of error (e) between time slots i and $i-1$. As well, it is calculated as,

$$\Delta e(i) = e(i) - e(i-1) \qquad (5)$$

Moreover, the output $p(i)$ is measured as follows:

$$p(i) = p(i-1) + p \qquad (6)$$

$$\text{Where } p = \alpha e + \beta \Delta e + \gamma \int_0^\infty e di \qquad (7)$$

In above equations, $q(i)$ refers the running queue length in sample time $i \in [0, \infty]$, q_T refers the target queue length, p denotes the probability of packet drop and $\int_0^\infty e di$ is equivalent to total of $e(i)$. These parameters are used for defining seven linguistic variables such as Negative High (NH), Negative Average (NA), Negative Low (NL), Zero (ZR), Positive Low (PL), Positive Average (PA) and Positive High (PH).

$$T(e) = \{NH, NA, NL, ZR, PL, PA, PH\}$$

$$T(\Delta e) = \{NH, NA, NL, ZR, PL, PA, PH\}$$

$$T\left(\int_0^\infty e\right) = \{NH, NA, NL, ZR, PL, PA, PH\}$$

$$T(p) = \{NH, NA, NL, ZR, PL, PA, PH\}$$

Then, DNN is applied for regularization and learning of those input and output parameters in a fuzzy membership function. DNN consists of huge amount of neurons with multiple inputs and a single output known as activation (Yan, F., et al. 2018). Neurons are linked hierarchically i.e., layer-by-layer with the activations of neurons in layer $y-1$ serving as inputs to neurons in layer y. In DNN, each parameter is computed layer by layer in a forward propagation manner where the output of a layer $y-1$ becomes the input of layer y. Especially, o_i is defined as the activation of neuron i in layer y. The value of o_i is estimated as a function of its J inputs from neurons in the preceding layer $y-1$ as follows:

$$o_i = f\left(\left(\sum_{m=1}^{J} w_{im} \times o_m\right) + b_i\right) \qquad (8)$$

In equation (8), w_{im} refers the weight associated with the link between neuron i in layer y and neuron m in layer $y-1$ and b_i denotes the bias associated with neuron i. The activation function f associated with all neurons in the network is a predefined non-linear function. Hence for a given parameters, its main computation at each layer y is a matrix-vector multiplication of the weight of the layer with activation vector from layer $y-1$. By using the activation values, the parameters of fuzzy system are regularized efficiently. Then, the fuzzy rules are generated which are given in Table 1 and based on those rules congestion level is predicted.

Table.1 Fuzzy Rule Base

e /$\Delta e(i)$	NH	NA	NL	ZR	PL	PA	PH
NH	ZR	ZR	ZR	ZR	ZR	ZR	ZR
NA	NH	NA	NA	NL	ZR	ZR	PL
NL	NH	NA	NA	NL	ZR	ZR	ZR
ZR	NA	NL	NL	ZR	PL	PL	PA
PL	ZR	ZR	ZR	PL	PA	PA	PH
PA	NL	ZR	ZR	PL	PA	PA	PH
PH	ZR	ZR	ZR	ZR	ZR	ZR	ZR

3.3 Congestion Notification Unit (CNU)

Once the congestion is detected, the signal will be transmitted to the intermediate nodes. For this process, two schemes of Implicit Congestion Notification (ICN) and Explicit Congestion Notification (ECN) are utilized. This approach piggybacks congestion information in the header of data packets and evades transmitting additional

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control messages that improves the energy-efficiency.

3.4 Rate Adjustment Unit (RAU)

A fuzzy system is also utilized in RAU and as the congestion signal is received, the rate is controlled in each node. The main aim of this system is controlling the sending rate of each node to improve the efficiency by reducing packet loss and increased conductivity. In this system, Packet Loss Rate (PLR), Packet Delivery Ratio (PDR) and Residual Energy (RE) are used as input to the fuzzy system and the Optimal Transmission Rate (OTR) as output variable. Similar to CDU unit, the considered parameters are learned by using DNN algorithm and the fuzzy rules are generated as based on the fuzzy variables as follows:

$$T(PLR, PDR, RE) = \{Low\ (L), Medium\ (M), High\ (H)\}$$

$$T(OTR) = \{NH, NL, PL, PH\}$$

For example, if both RE and PDR are high and PLR is low, then the OTR will be set to Positive High (PH). Once the optimal rate is computed, the nodes can adjust their transmission rate to control the congestion through the network. Thus, this proposed mechanism provides service differentiation and controls the congestion through the network efficiently.

4. EXPERIMENTAL RESULTS

In this section, performance effectiveness of the proposed protocol is illustrated. The proposed DRED-FDNNPID is implemented and simulated by using Network Simulator version 2.35 (NS2.35). This DRED-FDNNPID is compared with the existing DRED-FPID scheme. When an event is detected, the sensor nodes transmit number of data packets and while number of nodes can transmit data packets at the same time, congestion may occur. Once congestion is detected, each node can adjust its transmission rate for controlling congestion. The simulation parameters are given in Table.2.

Table.2 Simulation Parameters

Parameter	Value
Network size	300×400 sqm
Number of sensor nodes	30
Number of sink nodes	1
Packet size	512 bytes
Packet rate	120 packets/sec
Node's initial energy	5000 Joule
Buffer size	100

4.1 Packet Loss Ratio (PLR)

PLR is defined as the amount of packets lost during its transmission in a unit time and is computed as,

$$PLR = \frac{Packet\ Loss}{Time\ Duration}$$

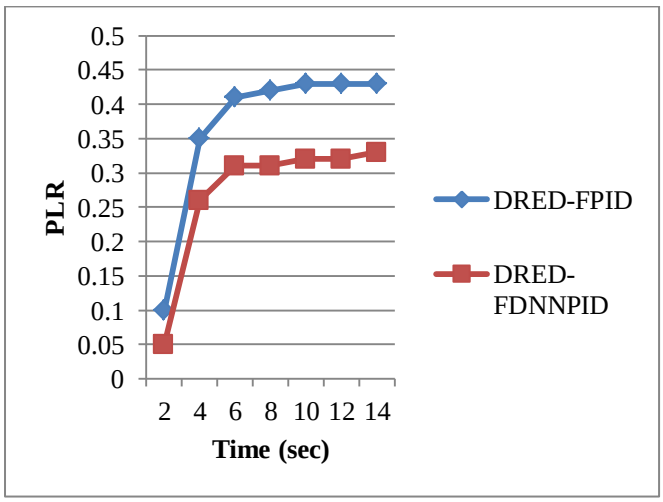

Figure.2 Comparison of PLR

In Figure 2, comparison of PLR in the network for both DRED-FPID and DRED-FDNNPID scheme is shown with respect to time. It

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is observed that when service is not yet differentiated, the PLR is high. Alternatively, as service differentiation process is performed with congestion control and rate adjustment process, the PLR is reduced significantly.

4.2 Packet Loss Probability

The packet loss probability is computed as,

$$P_{loss} = \frac{Number\ of\ packets\ lost}{Number\ of\ packets\ lost + Number\ of\ packets\ received}$$

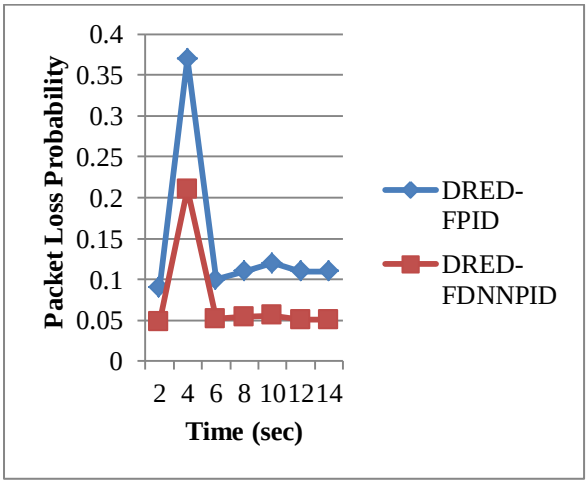

Figure.3 Comparison of Packet Loss Probability

In Figure 3, comparison of packet loss probability in the network for both DRED-FPID and DRED-FDNNPID scheme is shown with respect to time. It is observed that the proposed DRED-FDNNPID scheme using service differentiation with congestion control and rate adjustment can serve to maintain less packet loss probability compared to the DRED-FPID scheme.

4.3 Mean End-to-end Delay

It defines the time between generation of data packets and reaching the destination.

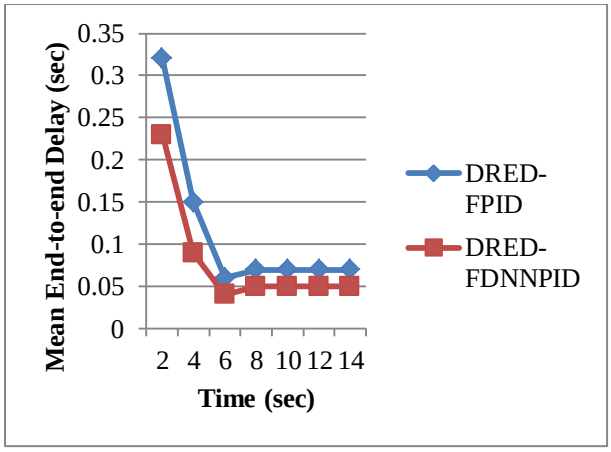

Figure.4 Comparison of Mean End-to-end Delay

In Figure 4, comparison of mean end-to-end delay in the network for both DRED-FPID and DRED-FDNNPID scheme is shown with respect to time. It is observed that end-to-end delay in the proposed DRED-FDNNPID scheme is less than the DRED-FPID method and low delay is crucial for packets containing patient's information.

4.4 Mean Queue Length

The queue length is defined as the amount of packets in the queue and the mean queue length is the most essential criterion in delay measurement. When the packet inter-arrival time longer than the packet service time, the queue length is increased and thus a delay is increased in the network. It is based on the delay status and waiting time in intermediate nodes.

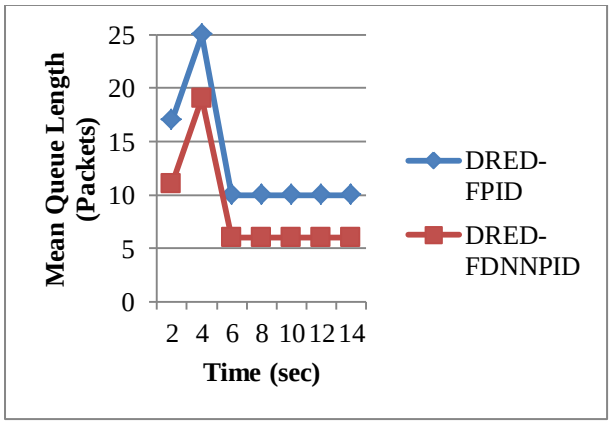

Figure.5 Comparison of Mean Queue Length

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In Figure 5, comparison of mean queue length in the network for both DRED-FPID and DRED-FDNNPID scheme is shown with respect to time. It is observed that the proposed DRED-FDNNPID scheme controls the queue length. Therefore, the mean queue length is less than 6 packets per second. Thus, the proposed scheme controls queue length by differentiating the services to remove the congestion in the network.

4.5 Transmission Rate Adjustment

The transmission rate is defined as the speed that data is being transmitted from source to destination in a given time duration. Rate adjustment is occurred from the node with congestion to the source node of the traffic in hop-by-hop manner. In addition, it is performed until the network congestion is removed and there is no notification transmitted to the source for adjusting the transmission rate.

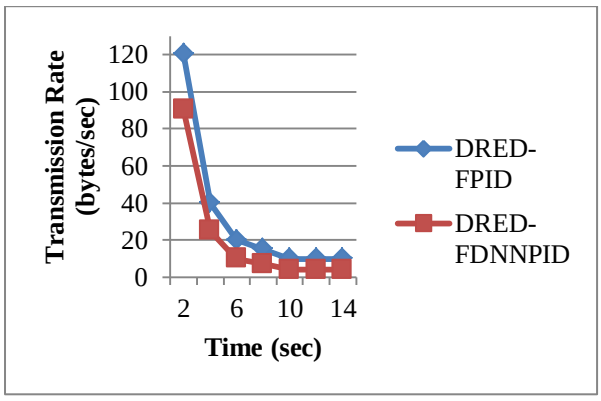

Figure.6 Comparison of Transmission Rate

In Figure 6, comparison of transmission rate in the network for both DRED-FPID and DRED-FDNNPID scheme is shown with respect to time. It is observed that the transmission rate of proposed DRED-FDNNPID scheme in each time period is less than the DRED-FPID method resulting in reducing the congestion through the network.

4.6 Mean Energy Consumption

It is defined as the amount of energy consumed by sensor node during transmitting the data packets from source node to destination node.

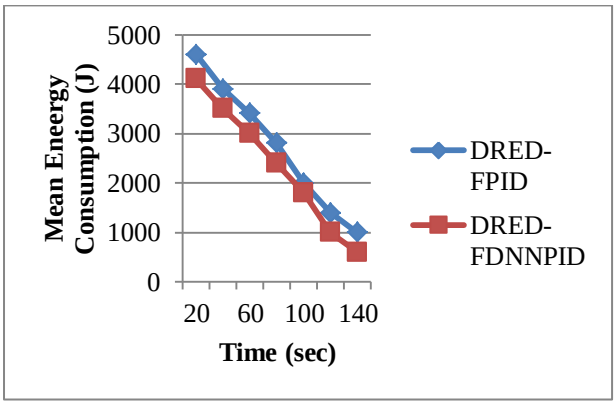

Figure.7 Comparison of Mean Energy Consumption

In Figure 7, comparison of mean energy consumption in the network for both DRED-FPID and DRED-FDNNPID scheme is shown with respect to time. It is observed that the energy consumption of proposed DRED-FDNNPID scheme in each time period is lesser than the DRED-FPID method resulting in increasing the network lifetime by using both service differentiation and congestion control mechanism.

5. CONCLUSION

In this article, an enhanced DRED-based congestion control with service differentiation is proposed for healthcare WSN. Initially, priority-based i.e., low or high priority service differentiation based on the weighted load metric which is associated with the queue status of nodes. This metric is computed to provide a distributed and stateless traffic control mechanism. In this mechanism, low priority traffic is managed and high priority traffic is buffered in an individual queue. In addition, fuzzy system is improved by applying DNN for learning the fuzzy input and

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output variables which enhances the self-adaptation and performance of DRED significantly. Finally, the experimental results prove that the effectiveness of the proposed service differentiation and congestion control mechanism in healthcare WSN. In Future, this approach will be enhanced by considering network traffic diversion scheme to remove the congested path during transmission.

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Medical Image Segmentation Based On Generalized Gamma Distribution for Effective Identification of Diseases in Brain

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***Abstract*—Medical image processing has gained significant importance with the increase in the number of medical cases globally. To combat this increase, sophisticated medical equipments were developed and made into use. However in particular cases of medical diseases like-; Alzimeer diseases, Parksions diseases, Acoustic Neuroma, these technological developments could not able to identify the early onsets of the diseases. Therefore to overcome this disadvantage, the present article makes an attempt for identifying the medical diseases at the earlier stages by proposing a methodology based on generalized gamma distribution with k-Means algorithm. The performance evaluation carried out by using metrics like Average Difference, Maximum Distance, Image Fedility, Mean squared Error and Signal to Noise Ratio showcase that the developed model exhibits an accuracy rate of above 90 percent in most of the cases.**

Index terms: *Medical image analysis, Acoustic Neuroma, Parksions diseases, Performance evaluation metrics, AD, IF, MSE, PSNR*

I. INTRODUCTION

Image processing is a area of specialization that deals with mainly the analysis and enhancement of the images under consideration. This area was popularized with the addition of medical analysis and had wide applications ranging from security to military. Medical image processing mainly deals with the analysis of the images and thereby helps in the identification of the diseases, such that more appropriate details regarding the medical data can be extracted. This analysis has helped to resolve in many of the medical related diseases identification. As the number of medical cases are increasing on daily basis, to identify these diseases accurately with the available recourses of specialized Medical Radiologists has become a challenging task. Therefore, many models were developed by researchers to help in the identification process [1], [2], [3], [4]. Most of these methods were based on models based on neural network approach based, SVM classifier based, Data mining based approaches. However, as the number of cases is increasing, the disease identification is mostly based on manual interpretation of the Radiologists in many on the previous instances. But as the number of cases is increasing, the manual identification process has become extremely difficult and hence effective identification is mostly at stake. To overcome this disadvantages, automated devices are into existence, however whenever a disease is affected, there are many factors that influence the disease. Therefore, to underline these factors is an essential task before ratifying a disease. With this very purpose, approaches based on both generative and degenerative model based techniques were proposed by many reviewers [5], [6], [7], [8], [9], Among these approaches, generative approaches are most commonly and widely recognized because of their ability to interpret the disease more precisely, since they consider the associated parameters of the human anatomy into consideration and thereby ensures better recognition rates (S.K.Pal, N.R.Pal (1993)).

Among the medical diseases, brain related diseases are mostly highlighted in the recent past. The numbers of mortality cases are increasing as a result of this deformity. The main reason is that every human brain enclose three main tissues, namely White Matter (WM), Grey Matter (GM) and Cerebrum Spinal Fluid (CSF) . Most of these diseases of the brain are obscured with either WM or GM. Therefore identification of the diseases more aptly has become a challenging task. To overcome this disadvantage, in the present article an methodology was proposed by using Generalized Gamma Distribution (GGM). The main advantage behind the consideration of this model is that all the pixels inside the medical region exhibit random phenomena, and as a result, the output results into several shapes of distributions. Most of these shapes are the particular cases of GGM. Hence the choice of the model is justified. The rest of the paper is structured as follows; section-2 of the paper deals with the GGM and its PDF, this section also highlights the updated parameters of the proposed model, Section-3 highlights the clustering methodology based on K-Means algorithm, the Dataset considered is presented in section 4, the section 5 of the paper highlights the experimentation carried out and in the section 6, the performance of the model is carried out using evaluation metrics like Average Difference, Maximum distance, Image Fedility, Mean Squared Error and

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Signal to Noise Ratio, and the concluding section 7, summarizes the article.

II. Generalized Gamma Distribution

Every image is a collection of several image regions. In each image region, the image data is quantized by pixel, which is a random variable because of the fact it is influenced by random factors like Vision, brightness, contrast etc. To model the pixel intensities in a image region, it is necessary to assume that the pixels in each image region follow a Generalized Gamma Distribution.

The probability density function of generalized gamma distribution is given by

$$f(x,k,c,a,b) = \frac{c(x-a)^{ck-1}e^{-\left(\frac{x-a}{b}\right)^c}}{b^{ck}\Gamma(k)} \quad \text{--2.2.1}$$

Where a, b, c, k are called the gamma variants and c, k are called shape parameters such that c, k >0.

a is called location parameter, b is called shape parameter with a ,b >0.

The mean of the generalized gamma distribution is given by

$$\frac{a+b\Gamma\left(c+\frac{1}{k}\right)}{\Gamma(c)} \quad \text{--2.2.2}$$

The variance of the generalized gamma distribution is given by

$$b^2\frac{\Gamma\left(c+\frac{2}{k}\right)}{\Gamma(c)} - \left\{\Gamma\left(c+\frac{1}{k}\right)/\Gamma(c)\right]^2\right\} \quad \text{--2.2.3}$$

The mode of generalized gamma distribution is given by

$$a + b\left(c-\frac{1}{k}\right)^{\frac{1}{k}}, c > \frac{1}{k} \quad \text{--2.2.4}$$

The r^{th} moment about the location parameter 'a' is given by

$$b^k(\Gamma(c+r/k)\,/\,(\Gamma(c)) \quad \text{--2.2.5}$$

III. K-Means Algorithm

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The K-Means clustering is a popular approach to segment the image into K-Clusters. The steps to be performed are:

Step 1: Begin with initial value of k=Number of segments.

Step 2: Select the number of clusters k with initial cluster centroids Vi; i=1,2…k.

Step 3: Partition the input pixels into k clusters by assigning each pixel xj to the closest Cluster centroid Vi using the selected distance measure, e.g. Euclidean distance defined as:

$$d_{ij} = \| x_j - V_i \|$$

Step 4: Compute a cluster assignment matrix U representing the partition of the pixels with the binary membership value of the jth pixel to the i^{th} cluster such that:
U = [μij], Where,

$$u_{ij} \in \{0,1\}\ \forall\ i,j$$

$$\sum_{i=1}^{k} u_{ij} = 1\ \forall\ j\ and\ 0 < \sum_{j=1}^{n} u_{ij} < n\ \forall\ i.$$

Step 5: Recompute the centroids using the membership values as

$$V_i = \frac{\sum_{j=1}^{n} u_{ij}\, x_j}{\sum_{j=1}^{n} u_{ij}} \quad \forall\ i.$$

Step 6: If the cluster centroids or the assignment matrix does not change from the previous iteration, stop otherwise goto step 3.

A. Segmentation Algorithm

After refining the parameters, the first step in image reconstruction by allocating pixels to the segments. This operation is done by the segmentation algorithm. The segmentation algorithm consists of 7 steps.

***Step 1*:** Obtain the pixel intensities of the gray image. Let they be represented by x_{ij}.

***Step 2*:** Obtain the number of regions by k-means algorithm and divide the (image) pixel into regions.

***Step 3*:** For each region obtain the initial estimates using moment methods of estimation for μ_i, σ_i. Let α_i=1/k is the initial estimate for α_i.

***Step 4*:** Obtain the refined estimates of μ_i, σ_i, α_i for i=1….k using updated equations for the parameters derived by EM algorithm with step 3 estimates as initial estimates.

***Step 5*:** Implement the segmentation and retrieval algorithm by considering maximum likelihood estimate.

Step 6: With the step 5 obtain the image quality metric.

Step 7: The image segmentation is carried out by assigning each pixel into a proper region (segment) according to maximum likelihood estimates of the j^{th} element L_j according to the following equation

$$L_j = \text{Max}_j \left\{ \sqrt{\frac{2}{\pi}} \cdot e^{-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2} \left[\int_{-\infty}^{\alpha\left(\frac{y-\mu}{\sigma}\right)} \frac{e^{-\frac{1}{2}\left(\frac{t-\mu}{\sigma}\right)^2}}{\sqrt{2\pi}} dy \right] \right\}$$

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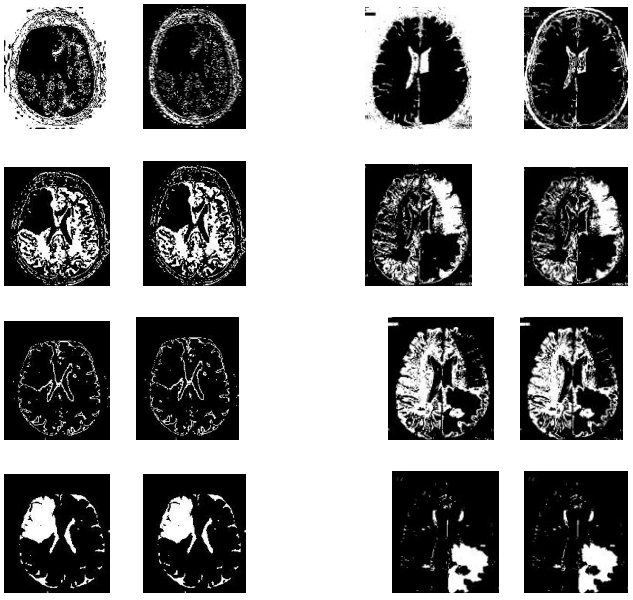
IV. Data Set Considered

In order to propose the present model; we have considered a Dataset obtained from, Brain Web Data. This database consists of several images pertaining to several images with several diseases. Every image consists of fixed sizes each of size 150 x 150.

V. Experimentation

Each image is pre-processed such that it is free from noise, each proceed image is given as input to the K-means Algorithm to segment the image. The segmented image is given as input to the segmentation algorithm, presented in section 3.1.

Using the probability density function of Generalized Gamma Distribution given in section 2. The image retrieval process is carried out by using the inverse transformation method and the performance of the model is performed using subjective image quality testing by comparing the original and retrieved image. The original and the reconstructed images obtained by using the image retrieval process are shown in figure-2.1.



(a) (b) (c) (d)

Figure-2.1 (a)

a) Input images of B0
b) Output Images of B0
(c) Input images of B1
(d) Output Images of B1

VI. Performance Evaluation

To evaluate the proposed methodology, we have considered the following metrics and the formulas for the calculation of each of the metrics is presented in the following table-1.

TABLE I
Performance Evaluation Metrics

Quality metric	Formula to Evaluate
Average Difference (AD)	$\sum_{j=1}^{M}\sum_{k=1}^{N}[F(j,k) - \hat{F}(j,k)] / MN$ Where M,N are image matrix rows and columns
Maximum Distance (MD)	$\text{Max}\{\lvert F(j,k) - \ddot{F}(j,k)\rvert\}$
Image Fidelity (IF)	$1 - \left[\sum_{j=1}^{M}\sum_{k=1}^{N}[F(j,k) - \hat{F}(j,k)]^2 / \sum_{j=1}^{M}\sum_{k=1}^{N}[F(j,k))]^2\right]$ Where M,N are image matrix rows and columns
Mean Squared error (MSE)	$\frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}[O\{F(j,k)\} - O\{\hat{F}(j,k)\}]^2 / \sum_{j=1}^{M}\sum_{k=1}^{N}[O\{F(j,k)^2$ Where M,N are image matrix rows and columns
Signal to noise ratio (SNR)	$20.\log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right)$ Where, MAX_I is maximum possible pixel value of image, MSE is the Mean squared error

The methodology is tested against the metrics and compared with that of the models presented in the literature, GMM and the results show case that the developed model performs better that the existing algorithms and the results derived are showcased in the following table-1.

TABLE 2
Performance Evaluation of the Proposed Model

Image	Quality Metric	GMM	GGD with K-Means	Standard Limits	Standard Criteria
	Average Difference	0.573	0.773	-1 to 1	Closer to 1
	Maximum Distance	0.422	*0.922*	-1 to 1	Closer to 1
	Image Fidelity	*0.416*	*0.875*	0 to 1	Closer to 1
	Mean Squared error	*0.04*	*0.134*	0 to 1	Closer to 0
	Signal to Noise ratio	*17.41*	*29.23*	-∞ to ∞	As big Possible
	Average Difference	0.37	0.876	-1 to 1	Closer to 1
	Maximum Distance	0.221	*0.897*	-1 to 1	Closer to 1
	Image Fidelity	*0.336*	*0.876*	0 to 1	Closer to 1
	Mean Squared error	*0.2404*	*0.211*	0 to 1	Closer to 0
	Signal to Noise ratio	*14.45*	*35.65*	-∞ to ∞	As big Possible

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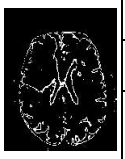	Average Difference	0.456	0.76	-1 to 1	Closer to 1
	Maximum Distance	0.345	*0.879*	-1 to 1	Closer to 1
	Image Fidelity	*0.44*	*0.86*	0 to 1	Closer to 1
	Mean Squared error	*0.22*	*0.23*	0 to 1	Closer to 0
	Signal to Noise ratio	*19.88*	*37.98*	-∞ to ∞	As big Possible
	Average Difference	0.231	0.473	-1 to 1	Closer to 1
	Maximum Distance	0.224	*0.977*	-1 to 1	Closer to 1
	Image Fidelity	*0.212*	*0.813*	0 to 1	Closer to 1
	Mean Squared error	*0.24*	*0.121*	0 to 1	Closer to 0
	Signal to Noise ratio	*21.42*	*33.28*	-∞ to ∞	As big Possible
	Average Difference	0.342	0.764	-1 to 1	Closer to 1
	Maximum Distance	0.317	*0.819*	-1 to 1	Closer to 1
	Image Fidelity	*0.391*	*0.812*	0 to 1	Closer to 1
	Mean Squared error	*0.2514*	*0.228*	0 to 1	Closer to 0
	Signal to Noise ratio	*3.241*	*5.514*	-∞ to ∞	As big Possible
	Average Difference	0.21	0.3653	-1 to 1	Closer to 1
	Maximum Distance	0.21	*0.892*	-1 to 1	Closer to 1
	Image Fidelity	*0.2134*	*0.787*	0 to 1	Closer to 1
	Mean Squared error	*0.06*	*0.145*	0 to 1	Closer to 0
	Signal to Noise ratio	*13.43*	*49.22*	-∞ to ∞	As big Possible
	Average Difference	0.3232	0.322	-1 to 1	Closer to 1
	Maximum Distance	0.123	*0.212*	-1 to 1	Closer to 1
	Image Fidelity	*0.233*	*0.897*	0 to 1	Closer to 1
	Mean Squared error	*0.01*	*0.4345*	0 to 1	Closer to 0
	Signal to Noise ratio	*11.11*	*27.267*	-∞ to ∞	As big Possible

	Average Difference	0.314	0.338	-1 to 1	Closer to 1
	Maximum Distance	0.241	*0.249*	-1 to 1	Closer to 1
	Image Fidelity	*0.293*	*0.683*	0 to 1	Closer to 1
	Mean Squared error	*0.18*	*0.197*	0 to 1	Closer to 0
	Signal to Noise ratio	*21.214*	*78.19*	-∞ to ∞	As big Possible

From the above table-2, it can be observed that the MSE of the developed model is very less in comparison with the existing algorithm. The MSE values of the proposed model is approaching towards 0, which clearly shows that the error is minimal, since the error is less, implies that the retrieved image is more in accordance with that of the original image. The SNR is high in case of the existing model, which clearly shows that the retrieval signal. The same is in case with the other metrics.

VII. CONCLUSION

In this article, a methodology based on GGM is proposed for analysing the medical data. The methodology is applied on to the Brain web images, obtained from the web data. This method is tested against the existing model based on GMM and the results are tested against the metrics like Average Difference, Maximum Distance, Image Fedility, Mean Squared Error and Signal to Noise Ratio. From the above results presented in Table-2, it clearly showcased that the developed model outperforms than that of the existing model based on GMM, from the results it can be seen that MSE is very less in case of the developed model, which specifies that it is more acceptable than that of the existing model, the other metrics like IF, SNR, AD, MD showcase better results to the developed model when compared to that of the existing model. The overall efficiency is around 92% recognition rate.

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Using Safety Case to Automotive and IoT Systems

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***Abstract*- Along with the growth of engineering and hardware, it is taken for granted that whatever device will contribute in the future. In the automobile industry, everything is expected to lead Automotives to provide advanced services such as automatic driving. In IoT society, as each lead is one or more systems, each quality characteristic is different like safety. For this reason, there is a concern that troubles may occur due to differences in posture regarding safety. In order to avoid the problem, it is important to visualize the design quality of each other system. It is necessary to obtain a common understanding among stakeholders. In this paper, as a method to visualize the design quality of the system, in order to prepare a description document of automatic operation system using GSN, based on the assumption and evidence, to be able to objectively explain the validity of the design quality. Check each other's system and after verification, it was shown that items should be described mutually among systems by providing items for measures against expected risks and threats in relationships between systems in the automatic operation system. When a such descriptor structure is shared between systems, a common understanding can be standardized obtained amongst stakeholders, and the quality required for products can be predicted. As a result, it is thought that problems caused by differences in corporate culture can be prevented.**

Keywords*- *GSN; stakeholders; software quality; hazard; threat; conflict.

I. INTRODUCTION

In the future IoT society, in order to develop a high quality and safe system, it is essential to have obtained the common understanding for the quality and safety among the stakeholders related to the development. For this purpose, it is necessary to document, sufficient information capable of convincing the stakeholders and to visualize the design quality of the system.

In this paper, for the target of the automatic driving system, we will organize the products and stakeholders leading to the automatic driving system to create a document explaining the safety (validity of quality) of each product among the stakeholders using the GSN. We will clarify the process for creating an explanation document and consider the explanation document to be required in the future it society. Discusses related research in Section 2, describes the safety of the described procedure of automatic driving system using the GSN in Section 3. We will add the discussions in Section 4, and finally make the summary and clarify the future challenges in Section 5.

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II. RELATED WORK

Reference [1][5] describe notation of safety and dependability of the description document of the system. In this paper, we have adopted the GSN to the notation of the safety knowledge representation.

Reference [1][10][14] proposes knowledge system related to safety or dependability, but it does not provide a way to describe the GSN. Reference [3][4][5][6] proposes the notation or patterns related to a safety argument. However, it does not describe the relation between HAZOP, FTA and GSN. Reference [2][7][15] proposes the method combined HAZOP or FTA with D-Case, but it does not describe the relation between HAZOP and FTA. Reference [8][9] shows the relation of safety analysis methods such as HAZOP, FTA, but it does not show the relation with GSN. Reference [11][12] proposes the method of generating safety case, but it does not describe concrete analysis methods such as HAZOP. Reference [13] proposes the method of generating D-Case based on Context Dependency Matrix. However, it does not consider about HAZOP and FTA.

Any of the research, the applied case to the automatic driving system are not included. Therefore, in the system development in the future of the IoT society, the safety knowledge representation of automatic driving system shown in this paper is considered to be effective.

III. ADOPTED SAFETY ANALYSIS PROCESS

Here, we describe the procedure for creating an explanation document that the stakeholders involved in the development of the automatic driving system confirm the quality of each other's product and verify the quality of the entire system.

(1) Define (Agree) the quality requirements the system should achieve.

(2) Organize the context, such as the configuration of the target system.

(3) To confirm the quality of the system based on the context.

A. Defining the quality requirements the system should achieve

In the automatic drive system, various devices will be connected. Due to having been connected, threats such as the falsification of communication data are considered to increase. Furthermore, with the falsification or reception error of communication data, it is also conceivable that hazards may occur in the system. Therefore, in this explanation, we will explain that the following quality requirements have been achieved:

(A) Countermeasures against the possible hazards have been established.

(B) Countermeasures against the possible threats have been established.

(C) Countermeasures against the possible conflicts between services have been established.

B. Organizing the context

(1) Component devices and stakeholders of the automatic driving system

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The actual automatic driving system is discussed that the various devices will be connected, and many stakeholders are also involved in it, but this time, we consider a simple relationship as shown below.

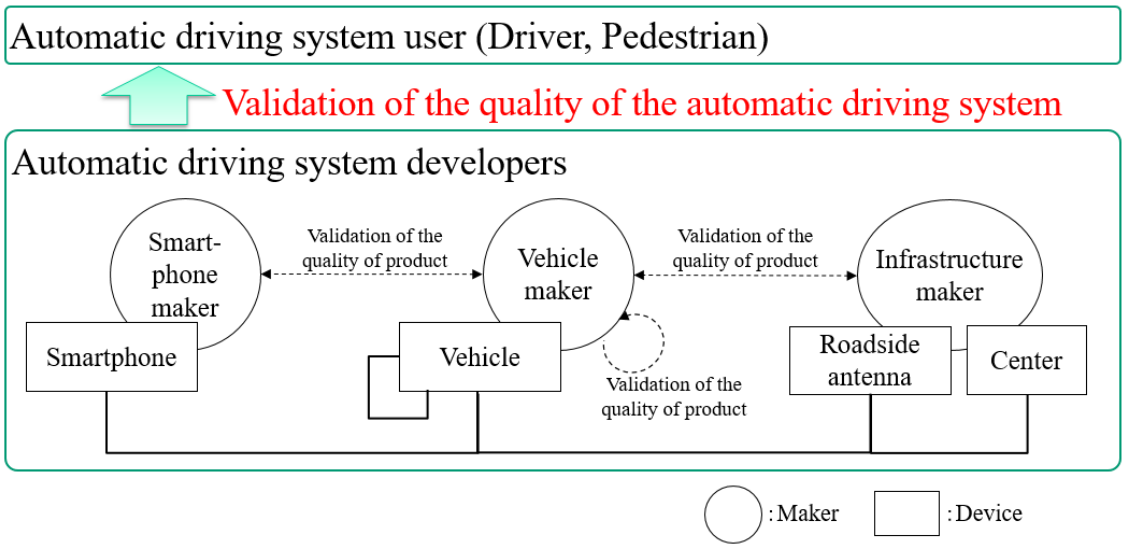

Figure 1. Component devices and stakeholders of the automatic driving system.

(2) Hardware configuration of the automatic driving system

For analyzing the possible hazards, we define the hardware configuration of the automatic driving system. Here, we show a configuration in which some of the hardware is omitted in accordance with the "collision prevention service of invisible people and vehicle" to be described later.

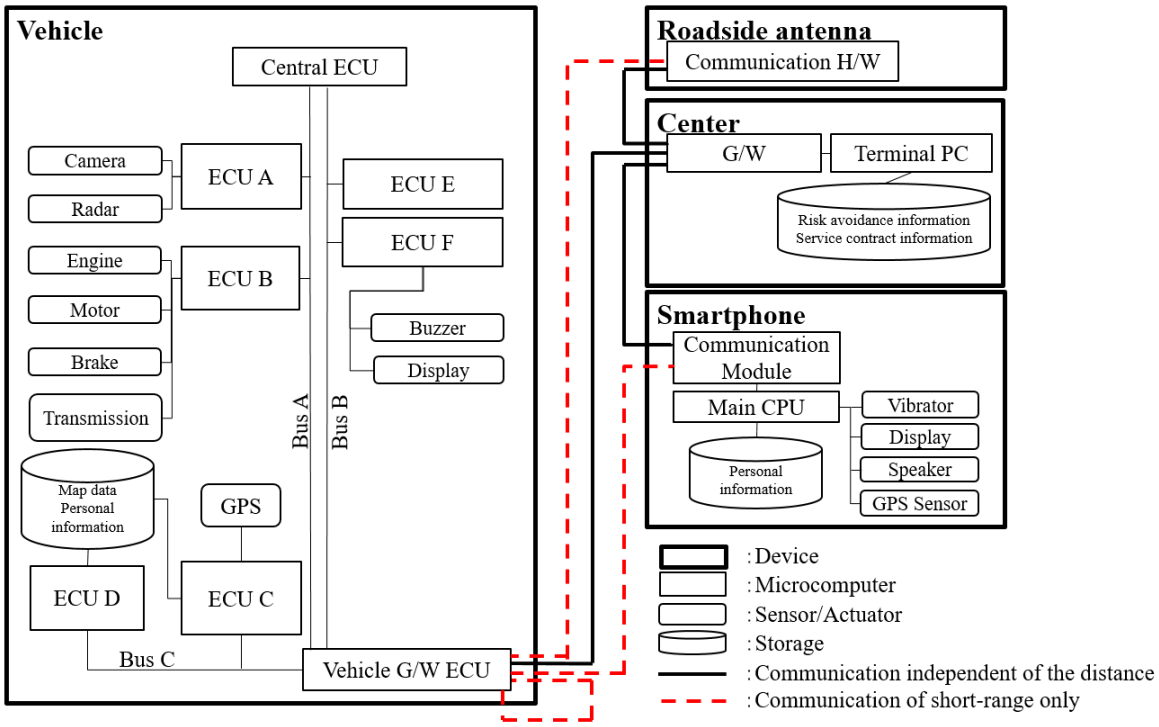

Figure 2. Hardware configuration of the automatic driving system.

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(3) Services to be provided by the automatic driving system

A list of services to be provided by the automatic driving system is shown in Table I. To provide multiple services from one system, it is necessary to check the quality of each service.

TABLE I. PROVIDING SERVICES.

ID.	Service	ID.	Service
1.	Collision prevention between invisible people and vehicle	7.	Idling stop support
2.	Crossing road accident prevention	8.	Start delay prevention
3.	Collision prevention when turning right or left	9.	Securing the safety of passengers
4.	Rear-end collision and crash prevention	10.	Securing the punctuality of public transportation
5.	Sag part transportation facilitation	11.	Overall optimization of public transportation
6.	Track convoy travel	12.	Movement support of vulnerable road users

(4) Collision prevention service of invisible people and vehicle

The specifications for the “Collision prevention with invisible people and vehicle”, one of the services to be provided by the automatic driving system, are shown below.

[For vehicle drivers]

- Using the following information to be obtained from the outside of vehicle, issues a warning by detecting the risk of collision in advance with invisible people and vehicle due to the wall and the like. Slows down the vehicle automatically as necessary.
- Position information of pedestrians obtained from a smartphone
- Vehicle position information obtained from the other vehicle
- Risk avoidance information obtained via the roadside antenna from the Center

[For pedestrians]

- Using the vehicle position information transmitted from the vehicle, issues a warning by detecting the risk of collision in advance with invisible people and vehicle due to the wall and the like.

(5) Life cycle of the services

The behavior of the system will change according to the user's contract status. The behavior of the system for the contract status of the “Collision prevention with invisible people and vehicle” is shown in Table II.

TABLE II. LIFE CYCLE OF THE SERVICES.

Service	Life cycle	Behavior
Collision prevention with invisible people and vehicle	When closing the service contract	Sends the personal information such as name and vehicle ID to the Center to close the service contract.
	During the service contract	Provides the collision prevention services with other invisible vehicles and people due to the wall and the like.
	When terminating the service contract	Terminates the service contract based on the contract and deletes the personal information stored in the Center.

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(6) Parameters transmitted and received between devices during the service contract

A list of parameters transmitted and received between the products during the service contract of "Collision prevention with invisible people and vehicle" is shown Table III. In the table, Tx and Rx represent transmission and reception, respectively.

TABLE III. PARAMETERS BETWEEN THE DEVICES.

Parameter	**Device**				
	Own vehicle	**Other vehicles**	**Smartphone**	**Roadside antenna**	**Center**
Vehicle position information (own vehicle)	Tx	Rx	Rx	-	-
Vehicle position information (other vehicles)	Rx	Tx	Rx	-	-
Pedestrian position information	Rx	Rx	Tx	-	-
Risk avoidance information (Roadside antenna)	Rx	Rx	-	Tx	-
Risk avoidance information (Center)	-	-	-	Rx	Tx

(7) Characteristics of the parameters between devices

The parameters between devices can be divided into two categories: "dynamic parameters" transmitted and received only when the devices have come close with each other within the communication distance and "static parameters" capable of always transmitting and receiving. The characteristics of the parameters between devices are shown in Table IV.

TABLE IV. CHARACTERISTICS OF THE PARAMETERS BETWEEN DEVICES.

Characteristics	**Definition**
Static	The partner to transmit and receive has been statically decided, and the transmission and reception can always occur.
Dynamic	The partner to transmit and receive may change dynamically. The transmission and reception don't occur during the period when the partner to transmit and receive is not decided.

(8) A list of provided service and operation product type

Table V. shows the product categories that each service operates as necessary.

TABLE V. PROVIDED SERVICE AND OPERATION PRODUCT TYPE.

Service	**Product type to be operated**
Collision prevention between invisible people and vehicle	Vehicle and Smartphone
Crossing road accident prevention	Vehicle and Smartphone

(9) A list of provided services and operation actuators

Table VI. shows the actuators actually driven by instructions from each service.

TABLE VI. PROVIDED SERVICE AND OPERATION ACTUATOR.

Service	**Product type to operate**	**Actuator to be operated**
Collision prevention between invisible people and vehicle	Vehicle	Brake, Steering and Speaker
	Smartphone	Display, Speaker and Vibrator

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Crossing road accident prevention	Vehicle	Brake and Steering
	Smartphone	Display and Speaker

C. Assure the system quality with the assumption

We assure the quality based on the assumption arranged in Section III.B. while setting "the quality of the automatic driving system is reasonable" as the highest goal.

We assure mainly by the following 4 procedures.

(1) Subdivide the goal per component for the automatic driving system.

(2) Assure if a measure is established for a potential hazard of a parameter between devices (III.A-(A)).

(3) Assure if a measure is established for a potential threat of a parameter between devices (III.A-(B)).

(4) Assure if a measure is established for against conflict of actuator operation between the services (III.A-(C)).

In order to clarify each procedure, the following case studies have executed (1) to (3) earlier and added (4) later.

(1) Subdivide the goal per component for the automatic driving system.

Show the result after subdividing the goal per component for the automatic driving system as Fig.3. Analysis is conducted in the following sequence:

[Step.1] Assure the quality over the system.

Explain the quality of the automatic driving system by subdividing per service which the automatic driving system provides.

[Step2.] Assure the quality per service.

We explain including a service "collision prevention between invisible people and vehicle". In this service, the system behavior will be changed depending on three status of users such as before/after service contract or at the time of service contract, under service contract, and at the time of termination of service contracts. Accordingly, we explain per status which changes the system behavior in order to explain that the service quality is reasonable.

[Step.3] Assure the quality per service component.

We explain including the status, "under service contract". Services are composed of several devices and each device performs the cooperative behavior. In the world such as automatic driving service which can connect to several devices, we need to explain the quality per device is reasonable as well as the quality of relationship between devices is reasonable. The quality per device should be assured by individual developer and we link the assurance result as evidence. Also, the normal function related to the connection between devices should be assured by assuring the reasonability of quality per device.

In addition, concerning the relationship between devices, we consider that each type of parameters is sent and received between devices in order to realize the service and assure that the quality of relationship between devices is reasonable by subdividing per parameter sent and received in this step.

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[Step.4] Assure the quality per parameter between devices.

As explained above, we showed that we can subdivide into; assuring that the quality per system component device is reasonable and assuring that the quality per parameter between devices is reasonable when assuring the reasonability of service quality. We actually assure the followings against sending and receiving a parameter in order to actually assure the reasonability of system quality.

- Safety:

  A measure is established for a potential hazard in sending and receiving a parameter.
- Security:

  A measure is established for a potential threat in sending and receiving a parameter.

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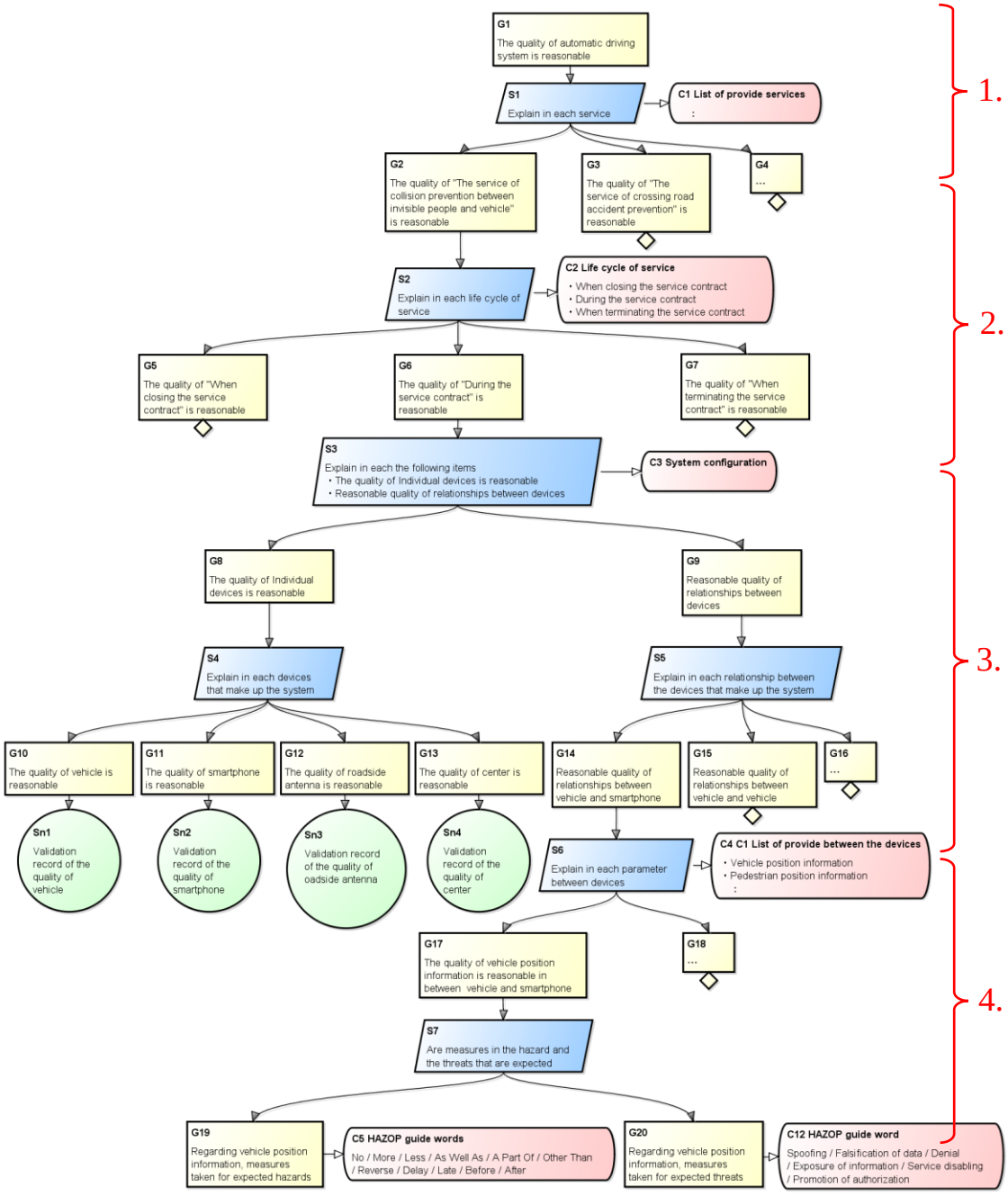

Area	Explanation contents
1.	Assure the reasonability of quality over the system.
2.	Assure the reasonability of quality per service.
3.	Assure the reasonability of quality per service component.
4.	Assure the reasonability of quality per parameter between product types.

Figure 3. Subdivide per service and system component.

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(2) Assure if a measure is established for a potential hazard of a parameter between devices.

We show the case for explanation to assure if a measure is established for a potential hazard as Fig.5. We now analyze the parameter of vehicle position information sent and received between devices.

Analysis is conducted in the following sequence:

[Step.5] Description of what is measured hazard expected.

Subdivide per hazard and assure if a measure is established for a potential hazard in sending and receiving a parameter between devices. We now explain including the vehicle position information.

In order to extract a hazard, we conduct HAZOP analysis by Guide Words. Guide Words included "No / More / Less / Extra / Insufficiently / Other than / Reverse / Early / Delay / Before / After".

We apply Guide Words to parameters to extract a potential hazard. We now assume that there is a period without any sending and receiving and a period with them since the vehicle position information is a dynamic parameter as shown in Table IV. We show how we think about it as below.

■ How to consider a dynamic parameter at the time of extracting a hazard.

[Guide Word: Delay]

- Vehicle as well as smartphones (pedestrians) may detect a vehicle position after they reached a position with high risk of collision since they are moving therefore the connection is "delayed".
  => Hazard: A vehicle detection is delayed and no warning appears on the smartphone.

[Guide Word: No]

- Even though the connection is established between the vehicle and smartphone, the vehicle position information "cannot be received".
  => Hazard: No warning appears when a vehicle is closing.
- Both vehicles and smartphone are moving therefore the vehicle position information "cannot be received" when they have a long distance each other.
  => Hazard: None
  (It is normal not to receive a parameter and any undesirable situation will not occur.)

TABLE VII. RESULTS OF HAZARD EXTRACTION ON VEHICLE POSITION INFORMATION PARAMETERS.

Parameter	Characteristics	Guide Words	Hazard
Vehicle position information	Dynamic	No	No warning appears when a vehicle is closing.
		More	The smartphone erroneously recognizes the position of the vehicle and issues an unnecessary warning.
		Less	The smartphone erroneously recognizes the position of the vehicle and issues an unnecessary warning.
		Extra	The smartphone is the illusion that there are multiple vehicles, and multiple warnings are issued when the vehicle approaches.
		Insufficiently	Since part of the data is not acquired, the smartphone can't detect the approach of the vehicle and does not issue a warning when the vehicle approaches.
		Other than	The smartphone erroneously recognizes the position of the vehicle and does not issue a warning when the vehicle approaches.
		Reverse	The smartphone erroneously recognizes the position of the vehicle and does not issue a warning when the vehicle approaches.
		Early	Since the smartphone can't detect the approach of the vehicle, do not issue a warning when the vehicle approaches.

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		Delay	A vehicle detection is delayed and no warning appears on the smartphone.
		Before	Since the smartphone can't detect the approach of the vehicle, do not issue a warning when the vehicle approaches.
		After	Since the smartphone can't detect the approach of the vehicle, do not issue a warning when the vehicle approaches.

[Step.6] Analyze the damage factor against a hazard.

We conducted FTA analysis against an extracted hazard of system structure and specify the damage factor. The results of FTA analysis are shown below.

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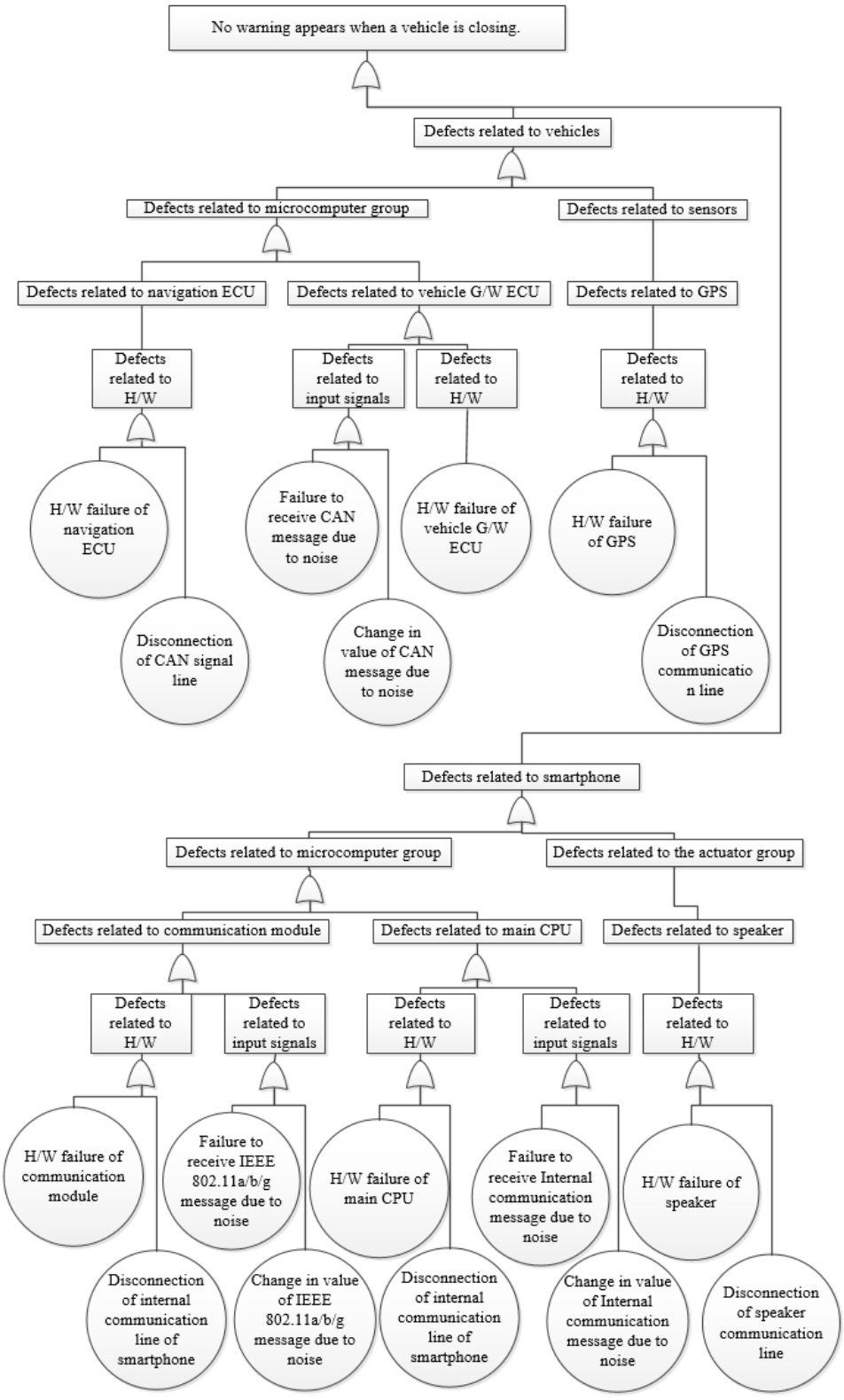

Figure 4. FTA analysis(hazard).

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The following explanation shows a hazard, “no warning appears when a vehicle is closing since the smartphone cannot detect the closing vehicle”.

[Step.7] Assure if a measure is established for a damage factor.

We consider a measure per damage factor extracted from FTA and explain to assure that a measure is established for a hazard by linking a record assuring that the measure is involved to a portion where the measure is required as evidence. The results of the examination of countermeasures and the measures taken against hazards are shown below.

TABLE VIII. RESULTS OF HAZARD EXTRACTION ON VEHICLE POSITION INFORMATION PARAMETERS.

Countermeasure targets product type	**Factor of hazard**	**Measures**
Vehicle	Change in value of CAN message due to noise	Detecting an error in the CRC, to request retransmission
Smartphone	Change in value of IEEE 802.11a/b/g message due to noise	Detecting an error in the CRC, to request retransmission

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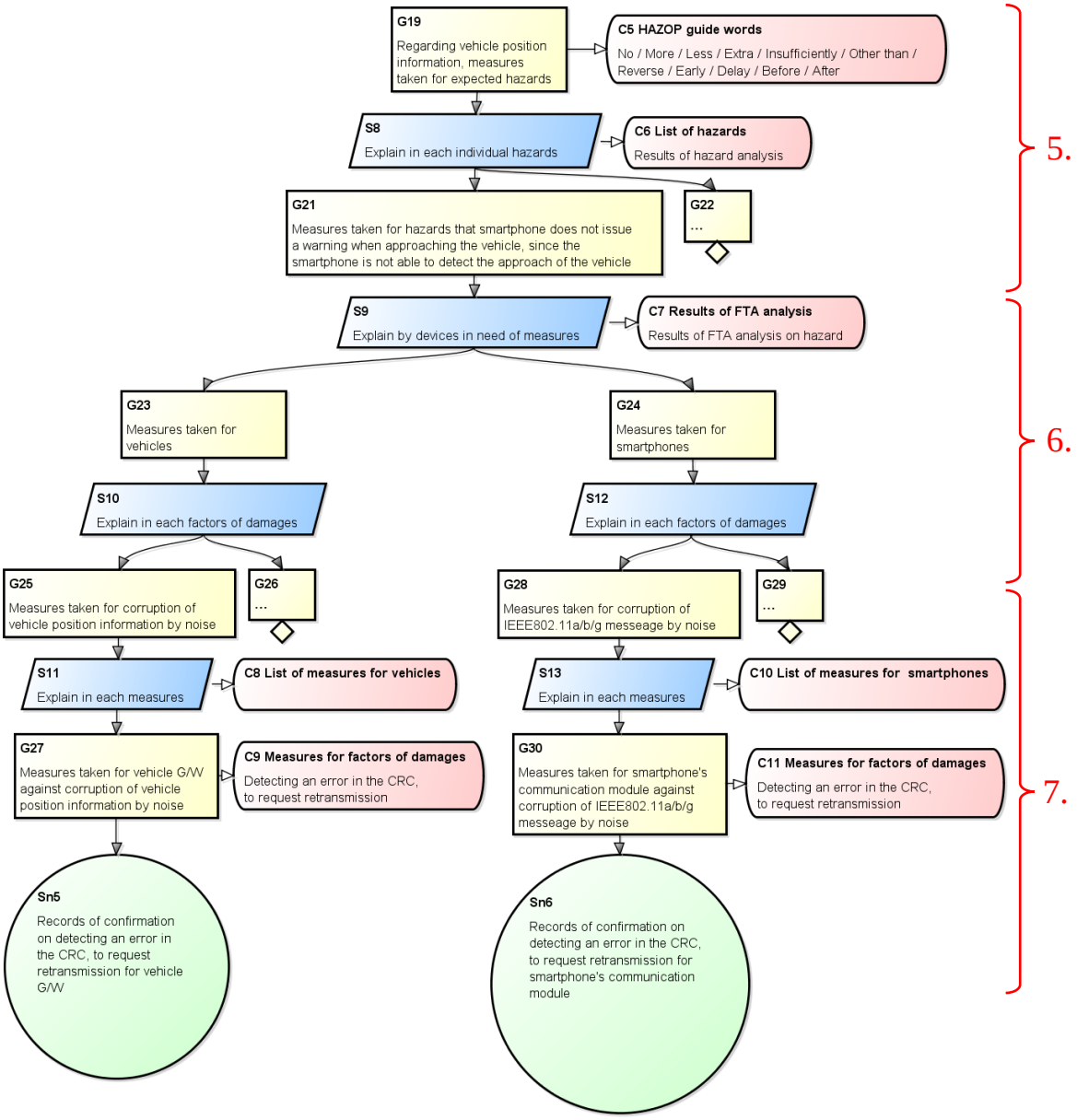

Area	Explanation contents
5.	Assure per potential hazard.
6.	Assure per factor of hazard.
7.	Assure that it is measured for each device.

Figure 5. Explanation of measures to deal with expected hazards.

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(3) Assure if a measure is established for a potential threat of a parameter between devices.

Fig.7 shows an illustrative case of dealing with expected threats. Here, vehicle position information parameters which are sent and received between devices are analyzed.

Analysis is conducted in the following sequence:

[Step.8] Description of what is measures threat expected.

Regarding sending and receiving of parameters between devices, confirm that measures have been taken for expected threats by decomposing into individual threats. Here, the explanation is given using vehicle position information.

In order to identify threats, HAZOP analysis is conducted using Guide Words. For Guide Words, "Spoofing / Tampering / Repudiation / Information Disclosure / Denial of Service / Elevation of Privilege" are used. Moreover, since vehicle position data are dynamic parameters, identification of threats is conducted taking into consideration of their characteristics, as with hazards. The results of extracting assumed threats are shown below.

TABLE IX. ANALYSIS OF FACTORS OF THREAT.

Parameter	Characteristics	Guide Words	Threat
Vehicle position information	Dynamic	Spoofing	A third party transmits unauthorized vehicle position information, and the smartphone gives an unnecessary warning.
		Tampering	A third party transmits unauthorized vehicle position information, and the smartphone gives an unnecessary warning.
		Repudiation	Not applicable. (Since the authentication of transmission content is not done)
		Information Disclosure	Third parties eavesdrop on vehicle position information and personal information such as vehicle ID is stolen.
		Denial of Service	The vehicle position information can't be transmitted, and the smartphone can't issue a warning when the vehicle approaches.
		Elevation of Privilege	A third party transmits unauthorized vehicle position information, and the smartphone gives an unnecessary warning.

[Step.9] Analysis of factors of threat.

For the identified threats, FTA analysis is conducted using the system composition, to identify factors which give threats to the system. The results of FTA analysis are shown below.

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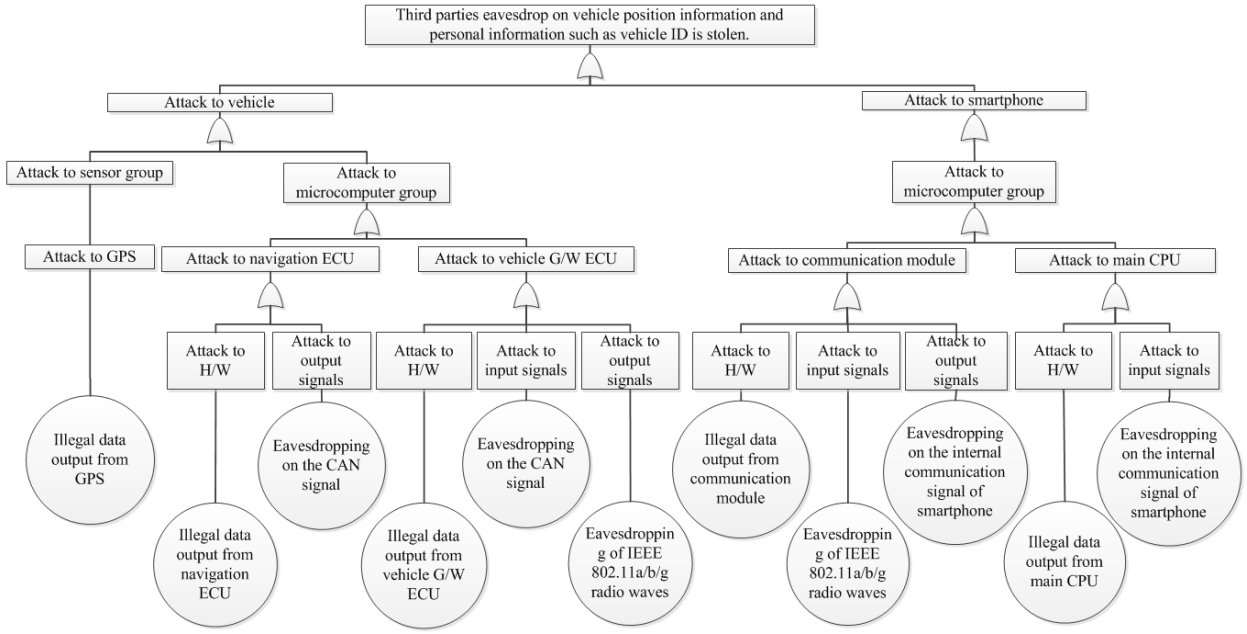

Figure 6. FTA analysis(threats).

In the explanation below, the threat that "A third party eavesdrops vehicle position information, and information such as vehicle IDs is stolen" is taken up.

[Step.10] Confirmation of measures to deal with the factors of threats.

Examine measures for each factor of threats identified from FTA, and explain that measures have been taken to deal with threats by linking, as evidence, the record of confirmation that such measures are incorporated in the necessary places. The results of the examination of countermeasures and the measures against threats are shown below.

TABLE X. RESULTS OF THREAT EXTRACTION ON VEHICLE POSITION INFORMATION PARAMETERS.

Countermeasure targets product type	**Factor of threat**	**Measures**
Vehicle	Eavesdropping of IEEE 802.11a/b/g radio waves	Encryption of telecommunications contents of IEEE 802 11a/b/g
Smartphone	Eavesdropping of IEEE 802.11a/b/g radio waves	Encryption of telecommunications contents of IEEE 802 11a/b/g

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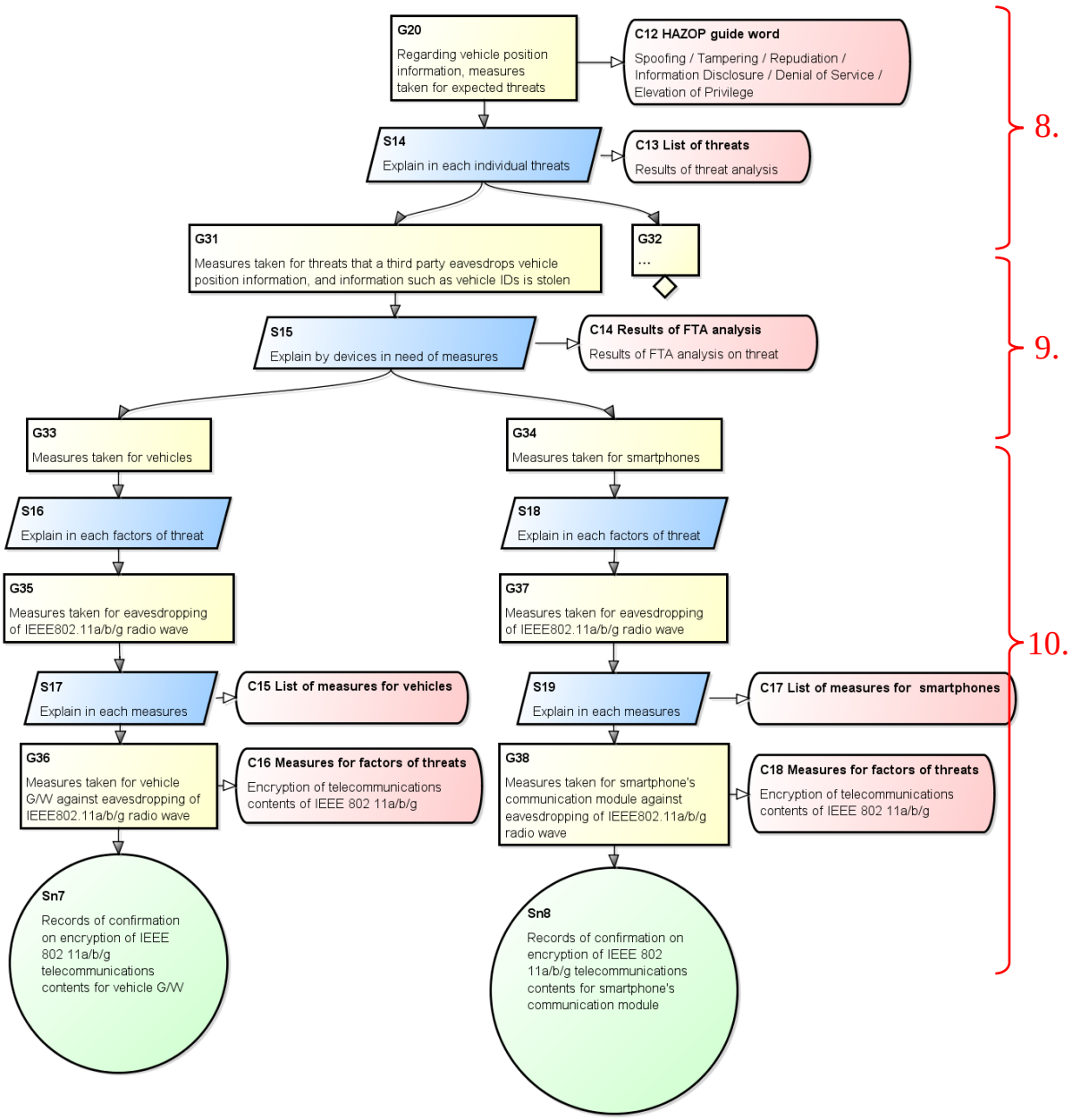

Area	Explanation contents
8.	Assure per potential threat.
9.	Assure per factor of threat.
10.	Assure that it is measured for each device.

Figure 7. Explanation of measures to deal with expected threats.

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(4) Assure if a measure is established for against conflict of actuator operation between the services.

In [Step 1], we decided to describe the quality of the entire system by service. However, since multiple services actually operate at the same time, it is necessary to explain that the quality of the relationship between the services is appropriate.

[Step.11] Add quality check of relationship between services.

We decompose the top goal “the quality of the automatic operation system is reasonable” into “the quality of each provided service is reasonable” and “the quality of the relationship between the provided services is reasonable”. For quality confirmation of individual services, combine the GSNs confirmed in [Step 2] - [Step. 10] as they are.

[Step.12] Confirmation of service that instructs operation for the same product type.

It is conceivable that multiple services simultaneously refer to devices and parameters used by each service. However, there is no big problem if only reference. The problem is competition against actuator operation such that a plurality of services simultaneously operates the steering of the vehicle. Organize product categories for which each service instructs operation and extract combinations of services that instruct operation of the same product type.

[Step.13] Confirmation of services that instruct operation to the same actuator.

Furthermore, a combination of services instructing operation to the same actuator is extracted.

[Step.14] Confirmation that countermeasures against the contention of operation instructions can be taken.

We explain how measures can be taken against action instruction conflicts by considering countermeasures at every competition of action instructions and associating the record confirming that the countermeasure is incorporated as evidence.

The results of confirmation are shown below

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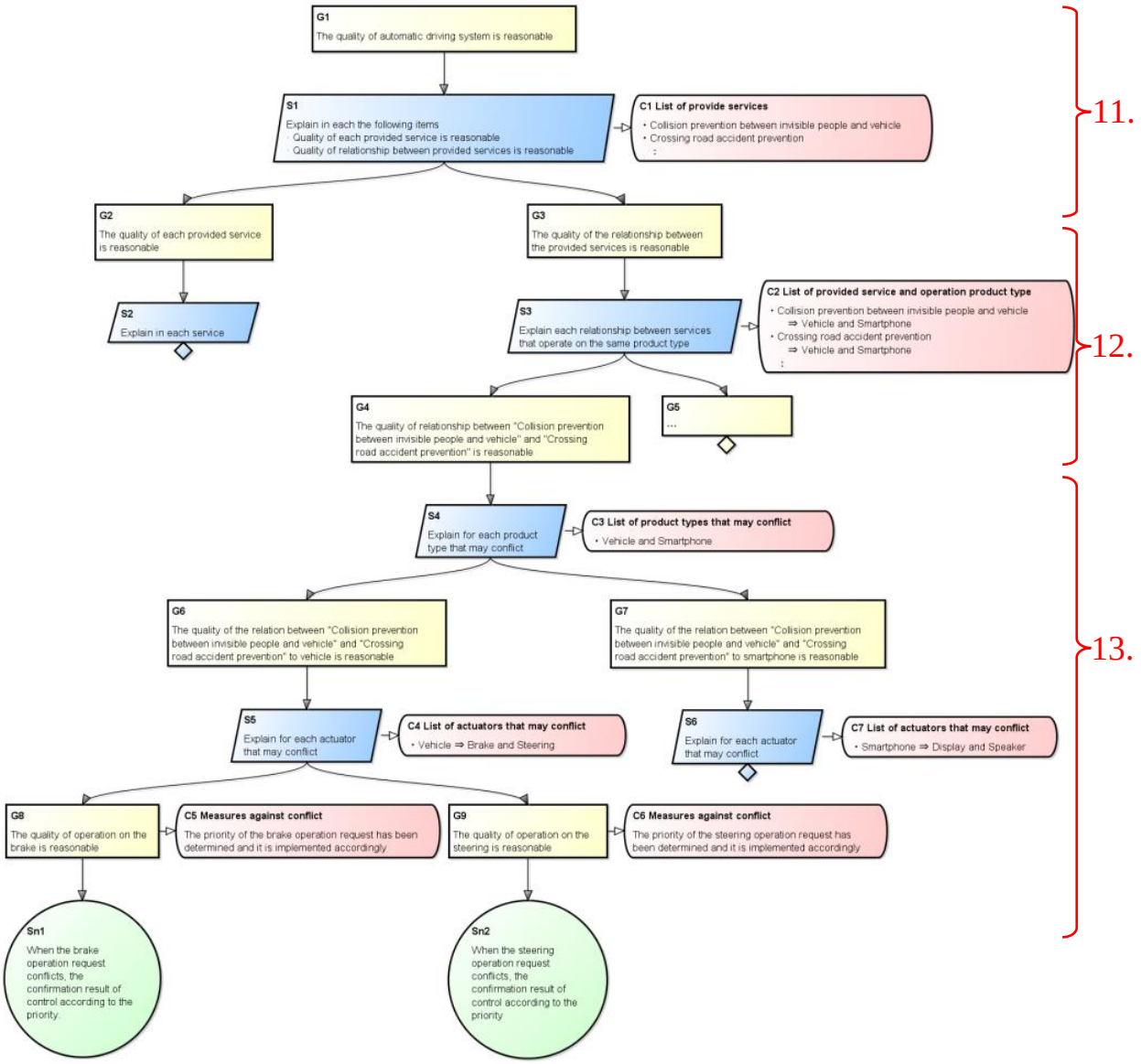

Area	Explanation contents
11.	Assure the reasonability of quality over the system.
12.	Assure the reasonability of quality each service and the relationship between services.
13.	Assure the reasonability of quality of conflicting behavior between services.

Figure 8. Explanation of the countermeasures against continuation of actuator operation between services.

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IV. DISCUSSION

In the illustrative case prepared this time, GSN is selected for the notation method. By visualizing, as preconditions, the reasons to decompose the assertion in the upper ranks, it is expected that explanation will be easy to confirm and nonconformity parts can be pointed out among developers of linked systems.

Moreover, it is possible to derive from the structure of the case a framework to explain the appropriateness of quality of linked systems. This framework has a possibility of becoming standardized because it consists of widely known techniques and those that are not dependent on industries.

Next, techniques to be used for visualizing the preconditions of GSN will be examined.

In the HAZOP analysis utilized to identify impediments, characteristics of parameters are defined to identify impediments caused by the characteristics of the automatic driving system, and analysis is conducted taking into account the characteristics of parameters when Guide Words are applied. On the other hand, while I have selected well-known standard Guide Words advocated by IPA and Guide Words from STRIDE which is a standard model for threat analysis, I think it will be necessary to discuss further as to whether Guide Words are sufficient to identify impediments of linked systems going forward.

Moreover, in the FTA analysis of impediments, many of those that are expected from analysts' experience in the industry have been identified for factors of failures as the results of analysis, including H/W failure of telecommunications IC and disconnection of telecommunication lines. In the FTA analysis as well, there is a possibility to visualize tacit knowledge in the industry and analysts' experiences by setting Guide Words such as "H/W failure" and "disconnection".

In addition, in order to confirm the quality of the relationship between multiple services, we propose analytical methods focused on competing actuator operations. It seems that when enterprises cooperate to provide services, they are analyzed steadily. However, by visualizing with GSN and linking the result of confirming that there is no problem, it is thought that the recognition level improves and it is possible to reduce the trouble due to recognition discrepancies among companies.

A. Limit of this process

The explanatory process conducted in this article has the following limits:

- It limits the relation between devices to sending/receiving of parameters, and does not take into account positional relations.

V. CONCLUSION

In an IoT society in which a plurality of devices cooperatively operate, in a system that realizes the automatic operation and the like, it is necessary to cooperate a plurality of systems having different quality characteristics including safety, so that a failure occurs due to a different approach based on safety It is expected that. In order to prevent this, there is the possibility of standardizing the technology to visualize the design quality of each other's system and gain mutual understanding among companies. As a technology for visualizing the design quality of the system, it is possible to prepare a manual of the automatic driving system

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and objectively explain the adequacy of the design quality of each system based on the preconditions and the evidence It has been confirmed.

At the time of confirmation, measures to deal with the risks and threats expected in relation between the products in the automatic operation system and explanation items on items to be explained mutually among the products were set. By standardizing such explanation system and sharing among the companies, it is necessary to have a common understanding between companies, predict the product quality necessary for collaborating with the system in advance, and to prevent malfunction due to the difference in corporate culture I think that I can do it.

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Perceived Usability Using Arabic System Usability Scale (A-SUS): Student Perspective of Smart PAAET App

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***Abstract*—Educational institutions are making use of academic management apps to satisfy the needs of their stakeholders. Perceived usability of such apps determines their sustainability, and thus there is an urgent need for usability scholars to develop benchmarks for comparisons. Research in app usability in the academic realm is scarce, and it is even more scarce for Arabic apps. This research calls to build a database of usability evaluation findings of academic management apps using a standard usability tool that is adapted to the Arabic language. A case study is administered at the Public Authority for Applied Education and Training (PAAET) in Kuwait. The Arabic System Usability Scale (A-SUS) questionnaire which is an adaptation of the standard System Usability Scale (System Usability Scale) is used to evaluate female students perceived usability of PAAETs' "Smart PAAET" app. Results are employed in two folds: to evaluate the perceived usability of the app, and to start a repository of perceived usability data for Arabic academic apps. By using A-SUS, results will contribute to the ultimate goal of establishing system usability benchmarks.**

Keywords- App Usability; System Usability Scale; SUS; Standard Usability Questionnaire; Arabic-System Usability Scale, A-SUS; Usability Benchmarks; Academic Management App.

I. INTRODUCTION

Database repositories of standard system usability evaluation results is essential. They are used in software engineering to compare against previous studies to ensure the quality of systems. Usability results of software are used as part of a learning process, patterns of previous studies are compared with the ultimate goal of enhancing the system under focus [1] [2]. Such data is collected over time and space, spanning diverse genres for the purpose of generalization and establishing benchmarks for each system.

Smartphones and their mobile applications are considered systems. The mobile application industry is expanding and app users are increasing at a great scale [3]. This is evident in the increase number of app downloads for all platform users [4]. Smartphones and apps revolutionised how things are being done, [5] specifically in the current era of technological advancement [5] [6]. Usability of these apps is crucial as it represents a users satisfaction of the app. Specifically if these apps are integrated within the processes of an educational institution, as these apps may either facilitate users experiences or add to their frustration. A specific process needs to be followed to ensure the apps quality [6]. Usability evaluation is used as a mean to ensure quality, and quality in return ensures continuous use of the app. There is a need to keep users from various stakeholder categories engaged, satisfied and continue using the app. This need is extended to academic management apps to support the academic process.

The paper starts with an outline of a literature review of standard usability questionnaires, and translations of standard tools to languages other then English. The literature review emphasises that the Arabic region lacks research in perceived usability and standard usability tools, and an overview specifically SUS is presented. To help advance the Arabic region in usability studies a standard usability tool is administered on "Smart PAAET" app. This study presents a female student perspective of usability evaluation of an academic management app. It is administered using the Arabic-System Usability Scale (A-SUS) tool [7]; an Arabic adaptation of the standard System Usability Scale (SUS)

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[1][8]. "Smart PAAET" app is an academic management app that is specifically developed for users of the Public Authority for Applied Education and Training (PAAET) in Kuwait. The research conducts psychometric evaluation on the perceived usability data of "Smart PAAET" app. Which will contribute to the ultimate goal of building a corpus of research administered on A-SUS, with hope of establishing benchmarks for usability practitioners, and scholars that are of need of usability questionnaires administered in the Arabic native language. Results are then presented followed by a discussion of the empirical implementation of A-SUS. The paper concludes that there is a need to promote future work in the field of app usability, and continue collecting data for the usability database, specifically on native Arabic language speakers using Arabic usability tools.

II. Litrerature Review

A. *Standard Usability Tools*

Usability is a multidimensional construct that is context specific, where it is defined as the effectiveness, efficiency and ease of use of a specific system in a specific context [9]. Usability evaluation results vary according to the system's environment and the participants involved in the evaluation process. Where usability measure is conducted at any point of system development [10] [11]; as it serves a specific goal at each development phase. Using standard usability tools after an initial launch of an app, developers and clients will have a prominent way to gain initial acceptance of its usability. The advantage of specifically using a standard tool is that there is common understanding of how the evaluation is to be performed, and how to interpret the results. Employing this act as part of system development promotes the overall usability of the system [6].

Standard usability tools are a reliable mean to evaluate the usability of systems [12] [13]. They are developed by practitioners and scholars to measure usability with confidence. Various literature in standard usability is evident with documented processes, approaches and findings [7][11][14][15][16][17]. Many usability practitioners and scholars are adopting and adapting standard tools as part of their practice because they appreciated the reliability of their results [13]. Most standard usability tools that evaluate user perceptions are in the form of questionnaires [13]. Standard usability questionnaires use psychometric methodologies. There is a need to prove that these questionnaires are reliable, valid, and sensitive [14]. Results of such studies are used to set benchmarks that are beneficial for system comparison. A usability benchmark of a system in a specific environment from a certain perspective and goal informs the system developers if improvements are needed.

Standard usability questionnaires if followed correctly can be conducted and interpreted in a fast, and simple manner. The literature is evident with various standard usability questionnaires in the English language. The most commonly used are the System Usability Scale (SUS) [1][15], Computer System Usability Questionnaire (CSUQ) [15], Usability Metric for User Experience (UMUX) [13], Usability Metric for User Experience Light (UMUX-Light) [12], and Post-Study System Usability Questionnaire (PSSUQ) [15][16][17].

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B. *Translations of Usability Tools in Arabic Language*

Usability questionnaires are used globally in different countries by different language speakers. However, usability practitioners find that it can be beneficial if these standard tools are adapted to the native language of the users [7] [8] [18] [19] [20] [21] [22] [23].

The literature shows how these tools have been transformed into the native language of the participants. Psychometric evaluation ensures that these translations reflect the original English versions tools [18] [24] [25]. A certain level of validity, reliability, and sensitivity gives confidence in the questionnaires. They answer questions such as does the questionnaire evaluates what it is supposed to evaluate?, does it stand the duration of time and space?, and can it depict small differences and variations in the system?. Questionnaires conducted in the native language avoids misunderstanding of the statements, and thus more accurate results of usability are measured.

Systems developers in the Arab region find difficulties in acquiring standard tools to accommodate system usability for native Arabic speakers. The authors are aware of two documented attempts of such Arabic tools, Arabic System Usability Scale (A-SUS) [7] and Arabic Computer System Usability Questionnaire (A-CSUQ) [26]. The first has been applied to several systems, and the later is still under development. It should be noted that Arabic usability questionnaires should still be used casually and in need of further investigation. There is a crucial need to further administer A-SUS studies, document them, and analyse their results for the optimal goal of benchmarking.

C. *Usability of Academic Apps*

Academic life in diverse institutions has already made use of apps and they have had them integrated within their academic processes (for example student application, registration, employees services,..etc.). The usability of their apps is vital to support the management flow for all stakeholders using it. Standard usability assessment of such apps would be beneficial and provides a usability measure, that is widely acceptable by practitioners and scholars. More and more practitioners and scholars are using and coming up with various standard usability tools and measures.

In the mobile application realm, usability has been and is still a major interest of practitioners [10] [27] [28] [29]. Mobile app usability is considered crucial and very important, however literature shows that there is scare literature that taps it, specifically on app usability [30]. It also calls for the development of a processes to be followed by software researchers and practitioners to specifically measure mobile usability within its context. A rigorous process when followed will ensure both quality and efficiency of the app. There is a gap in the literature conc

D. *Usability Tool Dellima*

In this research, we are concerned with particularly studying students perception which is subjective. Student experience and perceive the academic management app differently then faculty, administration or other users. Also,

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each student might experience the use of the same app differently depending on the capabilities of the device used to access the app [6][31] and the students experience with the smart phone. In the literature, minimum studies exist that support better understanding of app usability perception [6], specifically academic management apps. The added technology usage may add onto the stress of students that are less technical savvy. In general, it's vital to realise the importance of software usability [29] [11], and it is more vital to realize the importance of usability for app acceptance [32]. Reference [33] shows that it is important to evaluate academic systems. Therefore, academic management apps would benefit from administering usability evaluation on them.

Usability practitioners and researchers are faced with a major dilemma [34]. They need to consider what usability tool to use to evaluate a system [11]. The decision of usability measurement tool relies on the goal of the evaluation [7] [35] [36]. References [11] [23] [24] [25], [26] span some of the literature in usability and documents what usability evaluation methods adopted and used for what purpose and at what point of systems development.

Usability measurement tools in both the literature and industry are originally developed for desktops and laptops software. Some have been developed for universal systems and only one is found in the literature that is specifically developed for mobile usability [8]. Smart phones and mobile devices have features devices [5] [6] [31] that evolve constantly [31], which makes them very different than software systems and websites. One of the most prominent feature is the global positioning system (GPS), other features include: use of cameras, accessing the app without the internet, and many more features that are evolving constantly as new functions are being adapted to smartphones. Academic apps when developed for academic management in educational institutions recognises these evolving smartphone feature and makes use of them in. Users of academic apps need the usability of such apps to be high or at least acceptable in order for them to continue using them. Therefore their usability measures is crucial, and the viability of such apps definitely depends on their usability. Literature shows apps are developed in a rapid manner [37], it also shows a massive increase of app downloads [38] [39]; however downloading does not sustain the use of the app [9]. The distinguished characteristics and features of smart phones [5] [6] [31] has promoted innovated usage of apps. The mobile app industry needs to makes use of usability to ensure the successfulness of their apps [9]. Taking into consideration the revolution of app development and how they are being more integrated into every aspect of our lives. There is a need of a fast way to conduct usability and to acquire a certain level of quality in the app development process to ensure app use sustainability.

Results of usability studies can be used to correct errors, and/or enhance the software [1] [2]. Mobile applications benefit from the use of standardised usability questionnaires for their evaluation [7]. Following a process ensures improved app usability and this will enable developers to cope with the evolving next generation of mobile technology.

E. System Usability Scale(SUS) and Arabic System Usability Scale(A-SUS)

In our research, the goal is evaluating perceived usability. Literature shows that standard questionnaires are widely used in practice to evaluate such usability [12]. Evidence shows that they are adequate tools to be used in order to satisfy the goal of the research of perceived usability. As presented in the previous section one such standard

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usability questionnaire is called "The System Usability Scale" (SUS) [15]. We believe that SUS best fits our research because of the following reasons: it is short and fast; which appeals to the respondents, easy to administer, easy to complete, has a guided analysis process, and it is psychometrically evaluated. It is beneficial to find the usability of Arabic mobile apps using the adaptations of the standard usability tools. One such implementation uses A-SUS to evaluate the perceived usability of a payment app from its users who are Arabic native speakers [9]. It is also noteworthy to point that the literature highly advocates the use of SUS on systems [6], as it is considered a universal usability tool [8], therefore, the authors choose to use its Arabic version in our study .

SUS, is a standard questionnaire for system usability that is psychometrically proven [1] [30]. In 1986, SUS was developed by Digital Equipment Corporation (DEC), in the UK by John Brooke. It consists of a ten statements questionnaire that starts with a negative statement followed by a positive statement alternatively. Respondents choose from a five level Likert scale that ranges from (1) being least agreed upon to (5) being the most agreed upon. The SUS questionnaire is then analysed using specific guidelines to obtain a single numeric value that represents the subjective measure of perceived usability. The SUS usability single value is interpreted differently depending on the users and genres [1] [40].

Interpretation of results SUS is systemic and easy to conduct. The process of dealing with the statements is divided into two ways. First: the odd statements, a one is to be subtracted from the choice of the evaluator. Second: the even statements the evaluators' choice is subtracted from five. The resulted values for all standard are transformed values in the range of (0 to 4); where four indicates the most positive response. At the end, the transformed responses of each evaluator is summed and multiplied by 2.5, the final SUS result is a single value in the range of (0 to 100). It should be noted that this value from zero to one hundred is not a percentiles, and there is specific representation for the SUS values as presented [41]. The literature shows that SUS values of usability are interpreted differently when conducted on different environments [41]. This importance of environment reflection on usability is in sync with [11] who stressed on the effect of the environment on usability measures. As a conclusion identical scores for two different users in different genres might give different indications of usability. To make the evaluation more comprehendible, researchers have transformed the numerical value to an adjective representation [28]. The evaluation of perceived satisfaction of apps is essential [17] and there is a demand in the literature for further research [9].

There is a need to find confidence in Arabic standard usability tools. Native Arabic language apps are rapidly becoming popular and being developed for the public sector specifically the public educational sector in Kuwait. Scarce literature exists that documents perceived usability measures using standard usability tools adapted for the Arabic language. The state of Kuwait and its goal of integrating technology to meet the "*New Kuwait*" motto calls for public institutions to initiate and the use of apps. Institutions all over Kuwait are moving into the use mobile apps, and academic tertiary institutions in Kuwait are no exceptions. At this time of fast pace and working on the go, academic management apps are essential in Kuwait because it inhabits in students, academics and staff a culture of mobile process. Specific attention to the student perceived usability of these apps is of vital importance because they are

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considered the input of our market place and workforce. We need to integrate the use of such apps seamlessly within their academic life.

A case study is chosen to add onto the collected database of perceived usability of mobile apps. The usability tool A-SUS is administered on an "Smart PAAET" app in one of Kuwaits' tertiary educational sectors; The Public Authority for Applied Education and Training (PAAET). The next section provides detailed description of how the case study was administered utilising the chosen usability tool.

III. Methods

A. Process and Tools

The process below outlines the steps and tools used, it follows an adaptation of steps developed from a previous study of usability evaluation [9] and changed accordingly.

1) *An academic management app is chosen for usability evaluation.*
2) *An in-depth interview was conducted to encapsulate app environment.*
3) *A Usability Evaluation tool was chosen to measure the perceived usability of the app taking into consideration the goal of the study.*
4) *Results of usability are documented in a repository with an emphasis of the systems environment , user and goal.*
5) *Focus groups to discuss results.*

Steps 1 to 5 need to be repeated on other apps to establish benchmark.

B. Participants and Setting

"Smart PAAET" is chosen as a case study to measure the usability of a mobile app in Kuwait within the educational realm. The app is a web-based Academic/Educational Management software tool, that is becoming a popular course management app in the Public Authority of Applied Education and Training (PAAET) in Kuwait. It offers easy paperless solution that can be used with confidence.

The app is used by various stakeholders (students, faculty, employees, administrators ,.. etc.) to promote organization and cooperation between them. "Smart PAAET" is used to facilitate the learning process. An interview with the IT staff in PAAET informed the authors that "Smart PAAET" was designed with the goal to increase productivity and improve communications between PAAETs' stakeholders, thus in return the use of the app will reduce time and cost. To achieve this goal, "Smart PAAET" offers a variety of academic and management-related tasks to its stakeholders.

The focus of this study is from a students perspective. For students, "Smart PAAET" provides a number of tools, including the academic year calendar, general announcement, electronic mail, student schedule, grade maintenance,

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student progress tracking and student reward financial record. It also provides an access to track student enrollment, progress reports and verify course completion.

"Smart PAAET" app fills the gap of a needed communication tool between students and academics in PAAET. The authors are from PAAET Enviroment, and each is with more than 15 years. The first and third author have experiences as instructors and teachers, while the second author is an experienced trainer within PAAET. According to their experience, E-mail is not favorable by students in PAAET, and students are gradually forced to use it as a communication tool to contact the instructor. The authors feel that the students are still reluctant to use E-mail. There still is no student email created by PAAET. The faculty has resolved to using social media tools to communicate with students. Some instructors utilized Twitter, WhatsApp, and recently many instructors are using my which is a Kuwaiti app that is privately owned specifically meets the need of student-faculty interactions.

C. *Procedure and Analysis*

The standard tool SUS is used in this research to measure the perceived usability. The literature presents various attempts of using SUS [42], psychometric analysis of SUS indicates that it is a valid, reliable and sensitive tool.

The importance of administrating SUS in the native language of the user [7] where many scholars have used such language adaptations to various standard usability tools [18] [19] [20] [21] [22] . For that reason, in this research, we employ the Arabic adaptation of the SUS standard evaluation tool called Arabic- System Usability Scale (A-SUS) [7].

Psychometric Evaluation considers the validity, reliability, and sensitivity of a questionnaire [15]. It is essential to examine the psychometric evaluation of the usability tool [24], specifically if it's adapted in a different language. The literature shows many standard tools used in other languages have gone through psychometric evaluation [18] [25] The psychometric process conducted previously for A-SUS in conjunction with the communication disorder app [7] is to be followed in this study. Reliability, validity, and sensitivity is of concern and once established. A-SUS results will indicate usability as perceived satisfaction [7].

The A-SUS score is calculated using the same procedure used to calculate SUS presented in the literature review. Psychometric evaluation of A-SUS ensures that the essence of SUS is reflected upon it; where it has similar results to previously conducted research using SUS [7].

IV. RESULTS

The A-SUS questionnaires was distributed to female students through a link sent via WhatsApp app messages. Student users were asked to download the questionnaires link from the message. The link opens a questionnaire; where Google forms was used to create and collect the responses. The total number of students who responded was 159 students.

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Reliability of 0.83 alpha Cronbach is calculated from the collected data. This score is considered a valid and reliable result; where reliable results have a minimum of 0.70 alpha coefficient. Also Pearson correlation ranges between the values 0.528 and 0.732 and this range is within the accepted range of valid results.

A score of 68.8 represents the total of a single number of A-SUS as discussed in the methods section. This represents an acceptable result of usability; where SUS average benchmark is a score of <= 68 [25]. Perceived usability of the system under study is just above benchmark of usability. However it is under the benchmark of software products of 72 [25].

Item A7 such states " *would imagine that most people would learn to use this system very quickly*", has the highest mean, which indicates that "Smart PAAET" seams acceptable, easy to learn and students would adapt to using it in minimum time. While item A10 which states "*needed to learn a lot of things before I could get going with this system*" has the lowest mean, which gives us an indication that it is most not agreed on item between students, thus confirms that "Smart PAAET" seams acceptable and easy to learn.

V. Discussion

A-SUS tool was administered on "Smart PAAET" app; an academic management mobile application. The data was collected electronically by google forms, however students were given direct information on how to use and fill the questionnaires. Calculation of A-SUS score followed the same calculation process of SUS. Usability results found in general was acceptable. However, they are considered a below average result if we take into consideration the realm of SUS application of software products. Benchmarks are vital to find where a system falls. Even though usability results are acceptable, there is a need for improvement. Early interviews with the developers indicate that some services are still not functioning, which explains the relatively low result of A-SUS score. Post A-SUS evaluation focus groups with students confirmed that although "Smart PAAET" is easy to use but it still has to resolve some services that are still not functioning creating a negative impact on its effectiveness and efficiency.

Results of A-SUS are stored in a database of app usability, specifically academic management, with the emphasis of student users perspective. There was a need to add a descriptive explanation of what might have affected the results of the A-SUS. Qualitative data enhances the findings of the questionnaires and provides further understanding. Figures and numbers alone are indicators of benchmarks, and descriptive data articulate context to the numeric value. The authors based their analysis on benchmarks of software in general using SUS. This gives emphasis to develop benchmarks specific to academic management apps. If by time a benchmark is set for such apps, then the discussion part of this research needs revaluation.

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VI. Conclusion and Further Studies

This study is significant to the usability literature because its findings will help in time build up confidence in an Arabic standard usability tool. Results are obtained from students feedback in hope of finding a measure of their perceived usability using an adapted Arabic standard usability tool. The results will also enable practitioners and scholars of usability to better understand students perceptions of apps used for academic management purposes specifically with an Arabic interface.

This research shows results of a single case study that measures perceived usability of an academic management app called "Smart PAAET". A-SUS questionnaire showed an acceptable level of reliability. It captures the essence of SUS; where SUS provides a reliable mean to measure usability. Results not only help collect data related to A-SUS, but also sheds insight to how students perceive the new " Smart PAAET" app and if it needs to be improved. A-SUS score was found just above the acceptable average of software genre in general, which indicates that the app would benefit from further enhancements. This result of needed enhancing is supported by post evaluation focus group discussions with students and initial interviews with the developers.

The findings of this single case study will be added to the corpus of data collected from A-SUS other empirical administrations. A-SUS score is stored in a database repository in hope to perusing the goal to generalise A-SUS as a standard usability tool by promoting similar studies. Collected repository of A-SUS results, builds confidence in the tool, and will further be used to set benchmarks for usability to compare systems for enhancement purposes.

Future studies would be beneficial if further qualitative practice is to be integrated with A-SUS which will provide further better understanding. Furthermore the collection of data over time in diverse studies will allow generalisation.

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Evaluating the Proposed Public Budget Ontological Model

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***Abstract*- Ontology plays an important role in the emerging semantic web as it captures background knowledge for a specific domain and provides relevant concepts and relationships between them. From these vital domains, is the budget domain. In order to provide budget transparency, the ontology is going to be used to share and formalize conceptualization of the budget in order to enable humans and machines to read and understand the data that is being exchanged. The fluency of the ontology can be measured only by its evaluation of its quality from different perspectives. Consequently this paper intends to show how we can use the evaluation methods and metrics to measure the quality of an ontology based on the proposed public budget ontological model as an area of study, In order to ensure the quality of the ontology design an OntoMetric tool is used and obtained a reasonable results compared to the ideal results of the standards. As well as to measure the validity of the ontology towards the real world, a Protégé tool employing the reasoner is used to check the consistency of the concepts and subconcepts.**

I. INTRODUCTION

Public budget is an important field of study due to its importance in including all government revenues and expenses during a coming period of time mainly a year. It reflects the main instructions of the general policy for the government [15]. The governmental public budget needs to be transparent and accurate. because budget transparency means that it includes a full disclosure of all relevant financial information in a timely, accurate and systematic manner [27].But in fact, there is a difficulty in the budget preparation process and It's found that there are non- experienced employees with a misunderstanding of the whole budget structure, as well as the technical aspects that are could be used to achieve the work efficiently are not employed [25]. All of these issues are found similarly in the Egyptian public sector, which affects badly the process of the public budget structure and preparation. So in order to ensure the public budget transparency, which is significantly important due to its ability to facilitate understanding the basic structure of the budget, as well as help the recipient government make their budget processes more predictable and efficiently make the budget information accessible [26]. According to these, we sought to use the ontology which considered the backbone of the semantic web, to facilitate representing, storing, sharing, reusing and inferring new knowledge of the public budget domain in an efficient way. Ontology plays an important role in knowledge sharing with its ability to capture the real world information into a machine-readable format [24]. As well as it provides an explicitly defined and formal requirement specification in the initial stage of the requirement engineering [28].Unfortunately, according to the Standish group, 19% of the projects are failed because of the requirement engineering, which takes the highest proportion of the elements that affect the software

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projects, as a result, it could make an effect in whole software project construction [29].To overcome these requirement engineering problems, many researchers tend to use the semantic web and ontology to increase the quality of the project and reduce failure[30]. So in order to take the steps towards the transparency of the budget an ontological model is developed for a public budget for the first time in Egypt. As well as to ensure the quality of this budget ontological model, This paper provides an evaluation for the quality of the proposed public budget ontological model using an OntoMetrics tool based on a set of well-defined metrics and the validation method to check whether the ontological model really model the real world for which it is created using the protégé tool.

In order to effectively start the journey of evaluating the quality of the proposed ontological public budget model, we will begin by introducing the concepts of the public budget domain, the basics of ontology and the ontology evaluation metrics and methods.

II. PUBLIC BUDGET DOMAIN

Budget is a public planning document which simultaneously projects revenues and expenditure, the budget is an itemized summary of likely income and expenses for a given period of time mainly one year [15]. The budget structure contains all the features of the socio-economic and political relations of the cities in which the budget is passed. It's important to know that Planning and monitoring the budget will help in identifying wasteful expenditures, adapt quickly the financial situation changes, and achieve the financial goals. Budget planners and adopters should know that budget is an administrative document valid for a period of one financial year, accurately determining the structure of revenues and expenditure, prepared and adopted prior to the start of a budget year, it contains general provisions essential to the process of execution while it must be in accordance with economic policy [6]. The budget also considers the main guidance of the public policy. According to the state's general budget in the Arab Republic of Egypt, It is stated that The General Budget life cycle process is consisted of four stages as follows [15].

Stage 1: Preparation

The first stage of the budget process is to actually generate the budget. Done right, this process starts with a careful thought at the ground level as to what is needed and what new initiatives can be started. At the same time, leadership and vision from the top offer some guidance as to what the departments can expect. Once each department makes its spending decisions, their requests are sent to the decision makers for inclusion in, or exclusion from, the final document. The preparation of the budget should pass through the following six phases that are shown in Fig. 1.

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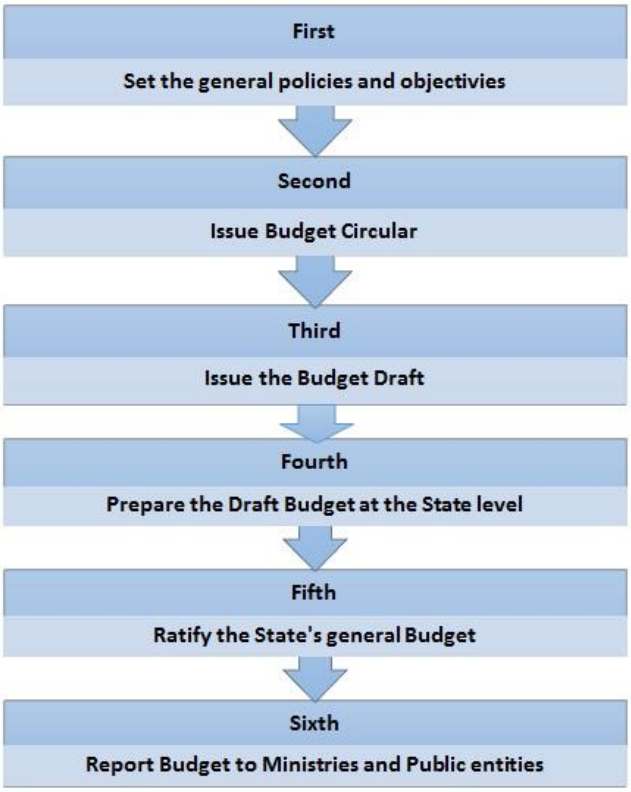

Figure 1: Budget Preparation Phases

Stage 2: Ratification

Once the parliament ratified the budget, the budget law is issued. The legislator has authorized, under certain controls and does not prejudice the financial planning accuracy.

Stage 3: Implementation

After the budget's ratification from the parliament, the budget law is issued and starts to work in it at the beginning of the financial year. And after the beginning of the implementation stage, The Minister of the finance starts the spending on the chapters.

Stage 4: Revising the actual implementation outputs and prepare the final accounts

The final accounts are prepared for three main entities which are:

First, Final account for the ministries and governmental departments, here after preparing the final accounts of the ministry which consists of the revenues, expenses and accounts settlements. The statements should be signed by the president of the authority, then send a copy of the final account statement to the ministry of finance. Second, Final account for public entities, each entity should list the financial positions of all the assets and liabilities as well as revenues, expenses. Third, Final account for the state, the general department of accounts of the ministry of finance review the final accounts received from the ministries and government entities and match them with the monthly tables for the same entities through the year.

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III. Ontology

Ontologies are considered the important component and the building block of the semantic Web and are becoming increasingly popular since they allow for delivering a shared common description of data that does not depend on the particular context of a data source and can be freely communicated between information systems and people [3]. The ontology describes a hierarchy of concepts that are usually related to other concepts by the relationships. A simple example that illustrates its use is when two communicating organizations refer to the same concept using different names then if one application needs to access the databases of both organizations, it needs to be able to recognize that those two concepts refer to the same subject. Therefore, this system may need to refer to an ontology file that defines concepts using a logic-based machine-readable format so that the machines would be able to resolve the name mismatch and infer whether the two concepts share the same semantics. Ontology types based on the level of generality as summarized as Top-level ontologies -Domain ontologies -Task-based ontologies -Application ontologies where ontologies are used to represent a conceptualization of a specific domain and a specific task. And it is a very broad term and act as a more conceptual idea rather than a strictly defined formalism for expressing knowledge and it can be seen as a dictionary of terms formulated in a canonical syntax and with commonly accepted definitions designed to yield as a taxonomical framework for knowledge representation which can be shared by different information system communities [2]. It considered being important to share information in internal activities of government administration and to facilitate information access in e-government services. It describes an area with a given terminology, basic concept, classification of these concepts and the connection between concepts while defining the rules between them. It also provides a detailed description of the structure of an area of knowledge with formal definitions of mutual relationships and connections among the various elements of the area. Ontologies are used for knowledge representation, knowledge management, and organization, as well as for the search and retrieving of desired knowledge it is beneficial because it can be updated, new concepts and connections. Creating ontology is an iterative and continuous upgradable process. In Computer and information, science Ontology is a data model that represents the concepts within a domain and the relationships that can exist for an agent or a community of agents [6].

In the context of database systems, ontology can be viewed as a level of abstraction of data models, analogous to hierarchical and relational models, but intended for modeling knowledge about individuals, their attributes, and their relationships to other individuals. Ontologies are typically specified in languages that allow abstraction away from data structures and implementation strategies; in practice, the languages of ontologies are closer in expressive power to first-order logic than languages used to model databases. For this reason, ontologies are said to be at the "semantic" level, whereas database schema is models of data at the "logical" or "physical" level. Due to their independence from lower level data models, ontologies are used for integrating heterogeneous databases, enabling interoperability among disparate systems, and specifying interfaces to independent, knowledge-based services.

So reasons that allow people to develop ontology are: 1) to share a common understanding of the structure of information among people or software agents. 2) To enable reuse of domain knowledge. 3) To make domain

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assumptions explicit. 4) To separate domain knowledge from the operational knowledge, 5) to analyze domain knowledge, 6) provide an organizational framework that allows reasoning knowledge.

A. Ontology Development Processes

To support engineer and building of ontology we are going to use methods and tools from software engineering. In general, the ontology development process can be divided into three main phases: Specification, Conceptualization, and Implementation. Atanasova Stated that the objective of the specification subprocess is to acquire informal knowledge about the domain. To fulfill this objective this subprocess is divided into four main tasks: determine ontology goal and scope, describe the domain, define motivating scenarios and competency questions and, define granularity and ontology type. With regards to the conceptualization subprocess, its objective is to define a domain conceptual model organizing the relevant knowledge acquired in the previous subprocess [1]. To this aim, this subprocess is divided into three main tasks: define the domain conceptual model, identify classes, relations, and attributes and, create instances. And in order to engineer and develop an ontology for business analysis domain, there are two main groups of methodologies to be concerned in which the first group is experience based methodologies and the second group is evaluative prototype methodologies. Finally, the goal of the implementation subprocess is to build a correct ontology represented in a machine-processable language. With this goal in mind, this subprocess is divided into three main tasks: implement the ontology, verify the ontology and, validate competency questions. Radivojevic Stated that adopting ontologies and knowledge bases improved the process of creating and adopting budgets faster and more efficiently and also provide monitoring as well as better understanding of the budget structure [6]. Brusa stated that the ontology development process can be divided into two main phases: specification and conceptualization. The goal of the specification phase is to acquire knowledge about the domain. The goal of the conceptualization phase is to organize and structure this knowledge using external representations that are independent of the implementation languages and environments. In order to define the ontology for the budget domain, we have followed the 101 Method which guides for creating the first ontology and used the analysis steps from METHONTOLOGY in the conceptualization process. Both consider an incremental construction that allows refining the original model in successive steps and they offer different representations for the conceptualization task [2]. Salah M. has developed an ontology in the financial investment domain in order to facilitate the process of collection, organization, representation, and formalization in the finance, they used the METHONTOLOGY as development process to facilitate the sharing of knowledge in the field [5].

B. The Proposed Public Budget Ontological Model

This section demonstrates an excerpt of the development of the proposed public budget ontological model developed for the first time for the Egyptian public sector.

Ontologies are considered as descriptions of certain application domains of knowledge which include sets of concepts and links between them. Also, it consists of properties and individuals. Different languages may be used for ontology description. Such languages as RDFS and OWL were developed within the Semantic Web framework. These languages have different capabilities that enable to facilities the creation of detailed concept descriptions and

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performance of logical inference. RDFS allows description of concept hierarchies and relations between them [12]. There are also various tools used as infrastructure for the ontology. From this tools that are employed in this study is the Protégé. The protégé is an open source platform that enables users to read and save OWL ontologies, update and visualize concepts, performance reasons. It also allows users to display the meanings of terms and the relationships between those terms. It provides a rich set of structures and modeling activities that support the creation, visualization and manipulation of ontologies represented in different formats [13].

In order to build the public budget ontology, the concepts should be defined. Concepts in the domain act as a collection of objects. It considered as the fundamental element of the domain and usually represent a group whose members share common properties. This component is represented in form of hierarchical graphs [14]. Annotation properties can be used to add information (metadata-data about data) to classes. Ontologies can define their own annotation properties or reuse existing ones. In contrast to other properties, annotation properties do not have any formal meaning for external OWL components like reasoners, but they are an extremely important vehicle for maintaining project information. A typical use for annotation property in the budget field is to design concepts that describe the functionality of each class. Therefore we should first illustrate the main concepts of the budget where it consists of five main concepts: Budget Basics, Budget Classification, Budget Phases, Budget Report and Budget Setup. Fig. 2 presented An Excerpt view of the Public Budget Ontology. An OntoGraf is used to give the support for interactively navigating the relationships in the ontology [16].

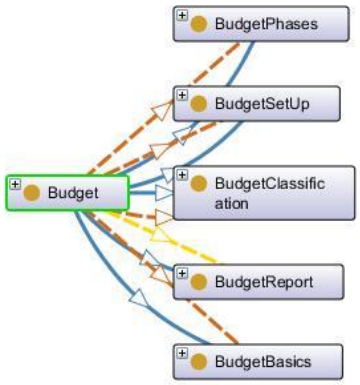

Figure 2: Excerpt view of the Public Budget Ontology

IV. Ontology Evaluation Methods and Metrics

As Ontologies become the widely used methodology for knowledge representation, so the need for its effectiveness and quality are increased. Subsequently, the importance of the ontology can be measured only by its evaluation. Accordingly, evaluation is recommended during the whole life cycle of the ontology. Brank, Stated that there is no single best approach to evaluate the ontology. Instead, the approach should be chosen according to the purpose of the ontology, the application in which the ontology will be applied on, and on what aspect of the ontology trying to evaluate. While Bilgin indicated that ontology evaluation methods are defined according to two basic concepts

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which are: The verification method that ensures the structure of the ontology meets the domain requirement and the validation method that examines the applicability of the ontology in the real world [8]. According to Gómez, Ontology evaluation can be defined as “A technical judgment of the content of the ontology with respect to a frame of reference during every phase and between phases of their lifecycle". As well as, the author indicated that the evaluation should consist of two main terms. The first is the verification which referred to “building the ontology correctly, that is, ensuring that its definitions (written in informal or the formal language) implement correctly the ontology requirements and competency questions, or function correctly in the real world”. The second is the validation which referred to “whether the ontology definitions really model the real world for which the ontology was created. So the goal is to prove that the world model is compliant with the world modeled formally"[9]. Lovrencic and others indicated that in order to develop an appropriate and usable ontology, several evaluation methods should be applied to ensure the quality of ontology. They applied it on domain ontology for university studies in Croatia as an example by employing two independent evaluation methods for both verification and validation. They use the ontology taxonomy evaluation method and ontoclean method for the verification. While they use the application ontology and ontology content evaluation methods for the verification. They found that it is beneficial to apply multiple evaluation methods that comprise both the verification and validation methods [10]. Tan provides the evaluation procedures for real-life application ontology, the evaluation is based on three ontology quality features such as usability, correctness, and usability. First, the usability means that ontology should be user-friendly and the users should put a trust in it and be confident that it carries their tasks effectively and efficiently. Usability can be measured using the protégé tool to visualize the application ontology in the evaluation through the VOWL tool. The correctness of ontology is probably the most important quality feature that needs to be evaluated. The Correctness is measured through using competency questions which compare the information represented in the ontology with the information found in the required document. As well as, the web-based application is an ontology verbalization tool that is used to evaluate the correctness. Finally, Applicability means the quality of the ontology regarding its appropriateness, and it can be evaluated by the person who develops the application and who use the ontology to implement its functionality [11]. According to Tartir, the quality of the ontology can be evaluated from different dimensions such as the quality metrics which can be used to evaluate how much the schema succeeded in modeling a real world domain. Then, the quality of the populated ontology (knowledge base) can be measured to ensure whether it is rich and represent the real-world entities and relationships accurately or not. Finally, the quality of the knowledge base itself can be measured to check if the instances and relations agree with the schema. The study used the OntoQA approach to analyze the ontology schema and their population [18].

A. Ontology Metrics

Metrics are used to evaluate the ontology fast and in a simple way [19]. Ontology metrics offers a quantitative representation of the ontology quality through scanning the ontology and returning a statistics about the knowledge represented in the ontology [18]. It also considered an important approach as they can help to evaluate and qualify ontology. From the ontology developer’s perspective, assessing the quality of ontology, can define areas that might need more work and recognize some parts of the ontology that may cause problems. Furthermore, metrics are

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helpful in the process of reusing because before using a previously defined ontology it should be evaluated in order to determine the worthiness of using it. Metrics can always evaluate ontologies both during engineering and application processes [20]. The metrics are divided into two main categories which are: the schema metrics and the instance metrics. The First category assesses the ontology design and measures the inheritance level, while the second category assesses the placement of the instance data in the ontology and measure how the ontology is used to represent the knowledge model [18]. There are various tools that are used to implement the metrics from this tools are OntoQA, Protégé, OntoMetrics, and OntoClean.

In this study, we are going to use the OntoMetrics tool which is a web-based tool and works to validate and display the statistics about the OWL ontology. Based on the schema metrics which are includes three important metrics: base metrics, schema metrics, and graph metrics.

The first metric is; Base Metrics [21] encompasses simple metrics, such as the counting of classes, axioms, and objects. It shows the number of ontology elements. These metrics include measurement of:

Axioms: which are a basic statement of the ontology and also act as a main component, they indicate what is actually true in a domain. It is possible that classes, properties, datatype definitions, assertions, and annotations have axioms.

Logical Axiom: An axiom which affects the logical meaning of the ontology

Class: The class or the concept in the ontology includes a set of individuals. This metric counts the number of the classes in ontology.

There are two types of the properties in the ontology which are; Data property which is used to link individuals or the attributes to data values. And, Object property which is used to describe the relationships between classes.

Individuals: the individual is the instance of the class, it represents the actual object of the domain. This metric counts the number of the instances in the class of the ontology.

Annotation: the annotation can be used to add information with the ontology. It consists of annotation value and annotation property.

DL expressivity: Description Logics (DL) is used to describe the relevant concepts of an application domain. It gets the human-readable name of the metric.

The second metric is; the Schema Metrics [22] which is used to evaluate the design of the ontology, as well as indicates the richness and inheritance of the ontology schema design. Schema metrics provide the richness of attributes, inheritance, and relationships in the ontology schema.

Attribute Richness: This metric measures the number of attributes that are defined for each class. It can evaluate the quality of both the ontology design and the amount of the information inside the instance data. The more attributes that are defined the more knowledge the ontology could have. Formally, The Attribute Richness (AR) is defined as

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the average number of the attributes per class. It is calculated as the number of the attributes for all classes (att) divided by the number of classes (C).

$$AR = \frac{|ATT|}{|C|} \quad (1)$$

The result will be a real number that represents the average number of attributes per class, which indicates how much the knowledge is acquired in the schema. An ontology with a high value for the AR means that each class has a high number of attributes, while a lower value indicates that less information is provided about each class [18].

Inheritance Richness: This metric defines the distribution of the information across the ontology's inheritance tree. It is considered as a good indicator to measure how well the knowledge is grouped into different categories and subcategories in the ontology.

This Metric can also differentiate between the horizontal ontology (which indicates high inheritance richness to represent a deep knowledge, through having a large number of subclasses) and the vertical ontology (which indicates low inheritance richness, through having a few numbers of subclasses), this can be measured for the whole schema or for a subtree of the schema.

Formally, the inheritance schema (IR) is defined as the average number of subclasses per class. The number of subclasses of a class is defined as the average number of subclasses (C_1) for a class (C_i) is defined as ($|H^c(C_{1,}C_i)|$), Where (H) is the number of the inheritance relationships.

$$IR = \frac{\sum c_{1\in C} |H^C(C_{1,}C_i)|}{C} \quad (2)$$

The result of the equation will be a real number, which represents the average number of subclasses per class. The high (IR) indicates a horizontal nature ontology with a deep knowledge. Otherwise, the low (IR) indicates a vertical ontology which contains very detailed type of knowledge [18].

Relationship Richness: This metric describes the different types of relations in the ontology. An ontology that includes only inheritance relationships usually results from a less information than an ontology that contains a different set of relationships. An ontology that includes many relations other than the class-subclass relationship is fruitful than a taxonomy with an only class-subclass relationship.

Formally, the relationship richness (RR) of the schema is defined as the average number of the non-inheritance relationships (P), divided by the total number of the relationships in the schema (which is the summation of the number of inheritance relationship (H) and non-inheritance relationship (P)).

$$RR = \frac{|P|}{|H|+|P|} \quad (3)$$

The result of this metric will be represented in a percentage number which indicates how much are the connections between classes of rich relationships compared to all of the possible connections that can include rich relationships and inheritance relationships. if an ontology has an RR near to zero, this means that most of the relationships are

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class-subclass relationships. While ontology with an RR near one this means that most of the relationships are other than class-subclass [18].

The third metric is the Graph Metrics [23] calculates the structure of the ontology from different perspectives such as the absolute root, leaf, and sibling cardinality. As well as, the absolute, average and maximal count of the depth and breadth.

B. The Proposed Public Budget Ontology's Evaluation Results

According to The metrics mentioned above in Section 3 in order to ensure the verification of the ontology. The metrics of the schema are used by employing attribute richness, inheritance richness, and relationship richness. The schema metrics are implemented using the OntoMetrics tool, which is used to display the statistics about the OWL of the public budget ontology.

Making the evaluation based on equation (1), equation (2), and equation (3). The results are shown in table 1 as follow.

TABLE I: RESULTS OF THE BUDGET ONTOLOGY 'S EVALUATION BASED ON THE SCHEMA METRICS

Metrics	Results	Logical Interpretation
Classes	34	Number of the classes found in the public budget ontology
Attribute Richness	1.04	moderate
Inheritance Richness	2.97	Horizontal
Relationship Richness	0.83	Good

Evaluating the ontology during its building has a disadvantage and an advantage. Its disadvantage is that it returns unfair results because the work does not complete yet. But, its advantage is that can allow us to evaluate the work in its initial phase and identify if there any area that will require further enhance.

The above results presented in table II reflects back the evaluation of the proposed public budget ontology which includes 34 classes. Equation (1) is used to calculate the attribute richness the result equal 1.04 which is mean that it is a moderate result that reflects the average number of attributes per class. Equation (2) is used to measure the inheritance richness, the result is equal to 2.97 which is near to be horizontal ontology (it is going to represent the general knowledge as modeled). Equation (3) is used to evaluate the relationship richness and by comparing the ideal results for this metric and the obtained result it's found that the result is good because it is near to one so this means that the relationships are other-than class-subclass relations. This evaluation will be repeated after completing all the development of the ontology in order to enhance the results of the evaluation using these metrics.

As a result of the importance of developing the ontology for the budget domain in the public sector, the results need to be obtained accurately and with a high-quality. We didn't depend only on the OntoMetrics for evaluating the budget ontology but the ontology is also evaluated using the Protégé tool, in order to measure the quality using the validation method by applying the Reasoner using Pellet 1.5.2 in order to check the inconsistency of the concepts, subconcepts and the properties in a general way.

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The results show that the overall ontology concepts, subconcepts, and properties are consistent and there is no any issue as shown in Fig. 3.

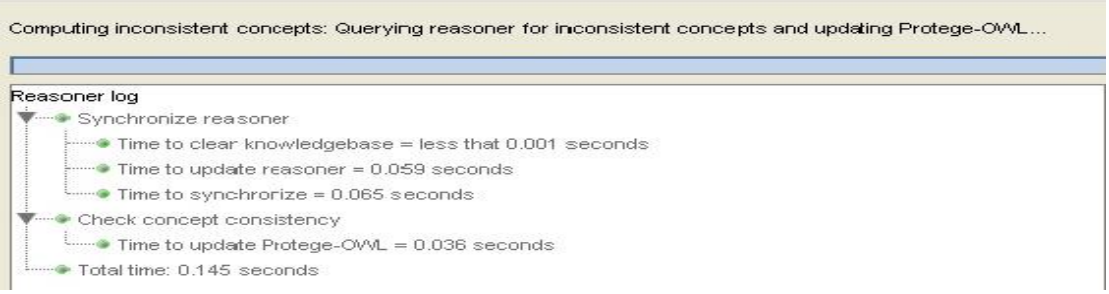

Figure 3: checking budget ontology consistency

V. CONCLUSION AND FUTURE WORK

This research shows that the issues that face the public budget preparation could affect its transparency. Whereas, ontology played an important role in developing the public budget ontology as it is considered the cornerstone of the semantic web due to its importance in representing, storing, sharing and inferring new knowledge of the domain. But the challenge that we face, is how to ensure the quality of the budget ontology development without failing into reaching the domain requirement. Consequently, this paper indicates that evaluating the quality of the ontology domain in its early stages of the building is better than completing it incorrectly. The proposed public budget ontology is evaluated using the OntoMetrics tool and a well- defined set of metrics especially the schema metrics to verify the ontology design. The results show that by measuring the richness of the attributes, relationships, and the inheritance it obtained reasonable results near to the ideal standard results. As well as the ontology is evaluated to ensure its validity and to measure the consistency of the concepts and subconcepts using the protégé tool. The results indicated that all the concepts and the subconcepts are consistent and validated. because we evaluate the budget ontology in its initial iteration as mentioned before so the future work of this study is to evaluate the public budget ontology after completion of its development.as well as using another methods or metrics for evaluation such as the instance metrics which is used to measure the effectiveness of the ontology in representing the knowledge of the real world.

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Reliable Multicast Notification System on Mobile Location Indexing

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***Abstract*—Today, many people in their daily activities include searching for required data and getting information on the mobile phones. The mobile technology is fully supported for such activities so that the mobile stands the most important and common in the telecommunications. Typically, there is also the need for many people to receive information automatically rather than the self-query and search for it. In other words, there is no person who does not want to receive important news, environmental reminding for them. This paper proposed a complete notification system with relevant architecture, research methods and experimental results. In this system, a novel Range* tree- based location index structure is proposed and mobile users in the imminent emergency area are searched by range query. Then, notification is sent by multicast to the mobile users according to the current locations.**

Keywords- range query, FCM, location update, index tree, Google API

I. INTRODUCTION

Mobile has been significantly improved that acts as a king in digital marketing today. With the growth of the mobile, its technologies are widely applied to business areas, government and public environment. Push notification, one of the mobile technologies is a clickable real-time message system which appears on the screen even mobile is in an idle state. For this technology, there is an inexpensive way of communication that interacts between a third-party server and application. Moreover, it can create the rich push messages with valuable notification and information. This is called Firebase Cloud Messaging that allows queuing and delivering the message to mobile devices to the server [10] [5]. Besides, as push comes from location-based services (LBS), it also has a similar service called pull [8]. However, apart from each of functional differences, the results of two types are quite different in energy consumption [2]. In pull type, the mobile application pulls the server whenever it requires new messages. In this way, pull may suffer battery consumption and message delays when the pulling frequency is too high or too low [11]. Nevertheless, both approaches are used in risk reduction management, such as natural disaster alert system and other information accessing systems such as advertising, product promotions and so on[1].

Normally, the special issues and requirements related to LBS have grown since LBS together with the variety of research areas of positioning, modelling, and analysis of location-based data are rapidly increase [4]. In addition, there has been a significant improvement in location-based techniques in the modern era. These techniques or services are normally based on the current location of the user that receives from the location providers. GPS signals are uncertain to estimate moving object locations under weak conditions of Satellite [9]. Sometimes, Google Map is used to map the road and places of interest in the location-based system. But lack of details in Google Map especially in developing countries brings the main challenge in such a system [7]. Google API is one of the location access techniques that combine the effectiveness of location providers such as Cellular Network, Global Positioning System and Network Provider.

In this system, getting locations of mobile users are undertaken by using Google API with relevant location update policies. Besides, the appropriate update is done by taking distance and time predefined thresholds at the client side. In order to quickly access query, Range* tree-based index structure is proposed for storing and managing of moving objects' locations. Normally, indexing technology has been used for moving data in recent years. It is used as an optimization technique in real time that manages and stores moving locations and query based on them. The objective of a moving index structure is both query and update to be running smoothly. Thus, moving object databases are created along with relevant structure query language for accessing [3]. In fact, the index structure that can quickly access the query is not easy to take the appropriate update. In other words, it is rarely to be perfect index structure for both updating and querying. Therefore, moving object types and behaviours are classified and stored them separately in the indexes [6]. In this paper, thus, the duty of the update consistently undertakes at the client side and efficient and fast query processing is done on the server side by proposed index structure.

II. RESEARCH METHODOLOGIES

In this system, there are three aspects of methods that fully support to be a complete multicast notification. Each of them has certain facts and reasons to promote for a multicast notification system. The appropriate explanations and motivations of these methodologies are explained in the following.

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A. *Range* Tree-based Indexing and Range Searching*

The proposed Range* tree come from Range tree thus this index structure is a two-dimensional relationship that recursively builds based on one dimensional Range tree structure. The only difference is that the data is added by sorted lists and it is taken as input parameters. Thus, the creation of an index is faster than the usual because it does not have to search for the correct space to store the new value, and it saves both I/O and CPU costs. The new value that will always be joined adjacent to the last value that was stored. The index tree would be fast as it is built sequentially and range search easily.

Normally, the index is built by unsorted two-dimensional data. When it is built by unsorted data, it might be bigger than the index structure of the sorted data. Especially it is going to be hard to build and store in a large amount of data size. Ordering or sorting the data may take additional extra time, but it will be faster than any other unsorted structure and thus it will bring to be a fast and compact index including range searching.

B. *Location Updating based on Policies*

A moving object database and server, client locations are changing instantly as soon as the motion forwards. And then, the new locations have received constantly from the database and server. As it moves to multiple locations occur being updated often and network traffic. In other words, whether required or not the required update a request arriving at the server so the update cost is very expensive.

In addition, a repeated narrow range updating is busy and not easy in the database workload. There is a mutually convenient way that delivers the location updates in a necessary time or a pre-defined distance. Thus, a location update policy is needed between the mobile objects, database and server. In this system, location update occurs when distance and time reach predefined threshold values of distance and time with the mobile current position.

$$mobile_{loc\text{-}update} = (time_{update} * distance_{update}) + mobile_{loc} \quad (1)$$

where $time_{update} \geq$ time threshold,
$distance_{update} \geq$ distance threshold

C. *Firebase Cloud Messaging*

In a client-server environment, the client usually initiates requests for desired data to the server. It means the client pulls the data from the server. Sometimes, there is a push type that the data is initially transferred by the server.

This is achieved by keeping a persistent network that definitely connects between the client-server communications. But it takes high cost because of maintaining thousands of connections for each app between the server and user's device.

Firebase Cloud Messaging (FCM) solves this problem that stays intermediate between the server and the user's device. This is because Google cloud server supports to manage all of the persistent connections with FCM. It also queues the messages while the mobiles are in offline. Besides, notifications are delivered reliably and securely. The activities of FCM between client app and server are shown in fig.1.

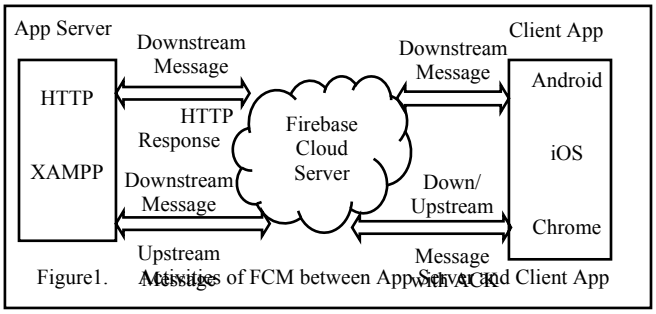

Figure1. Activities of FCM between App Server and Client App

The goal of FCM is sending a notification message to the correct place. To get FCM service, a project is created in the Google Developer Console firstly that releases project number and API Key. Then, the required credentials are shown with explanations in table 1.

TABLE I CREDENTIAL AND PARAMETER EXPLANATION

Credential	Explanation
Sender ID	unique numerical value API project (Google Developer Console)
API Key	save on app server (header post)
Application ID	client app register to receive the message
Token ID	FCM connection servers issue ID that uses the client app and receives the notification message

III. SYSTEM REQUIREMENTS

The proposed notification system uses the following technologies:

- Android SDK: It is built by API tools and libraries that can be used for testing, debugging and building Android, a software environment built for mobile device applications.
- Apache Http Client: It operates HTTP/HTTPS protocol with client-side application libraries.
- XML: It is used for transporting, storing and encoding documents. It is widely used in web-services with data structure representation.
- Spring Scheduler: To schedule tasks without re-compiling and re-deploying the entire system, Spring scheduler is used that supports as the abstraction layer with flexibility and loose coupling. It is used in many application systems such as marketing and production system, transportation and distribution system, Information processing system and other communication systems. It has functions that are taken by schedule plans.
- Mybatis: It is a framework that provides data access tier especially for data manipulation. It is an open source, lightweight, and persistent framework. It automates the mapping between a database and objects.

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- JBoss Server: It is known as the JBoss application server (JBoss AS) that developed by JBoss. It is an open source, cross-platform, supports the executions of Java 2 Enterprise Edition (J2EE) that can be used for Web-based and Java applications.
- Firebase Cloud Messaging: It is a free service for delivering cross-platform messaging by multicast or broadcasting techniques. It supports push notification well and queuing of messages. The connections between Application Server, Android Mobile and FCM are shown in Fig.2.

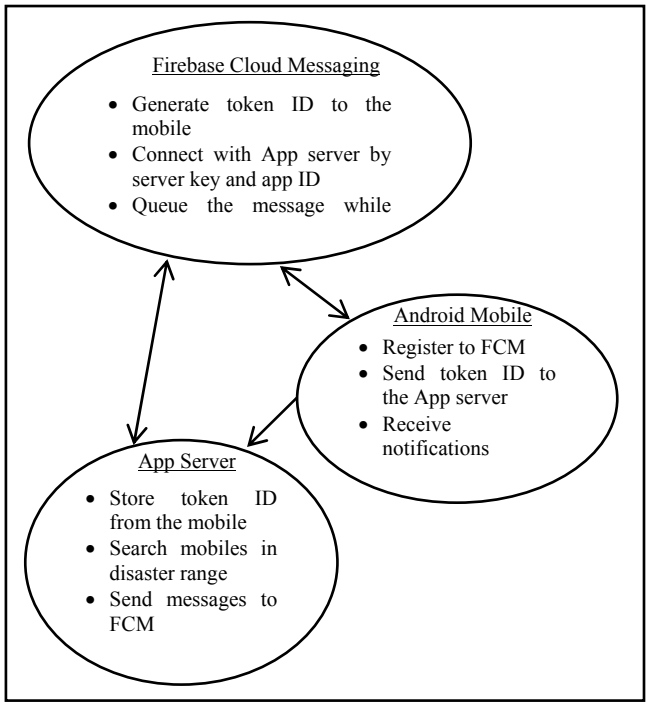

Figure2. App Server, Android Mobile and FCM relations

IV. PROPOSED SYSTEM

A. *Notification Architecture*

Android application from the mobile phone receives the current position through a special location provider called Google API. Then, the application registers to FCM with application ID that generates Token ID. Then the application communicates with the server not only giving token ID but also sending the location of the mobile current position.

After that, the server keeps mobile's latitude and longitude to the database which has built index structure. For users who are located in an imminent emergency area, the server searches all of the users who are in the service area by indexing tree based range query. Then, the server sends the message to FCM with the lists of mobile users in the emergency area. Afterwards, the application fetches the message from FCM push technology by multicasting. The architecture of this system is given in fig. 3.

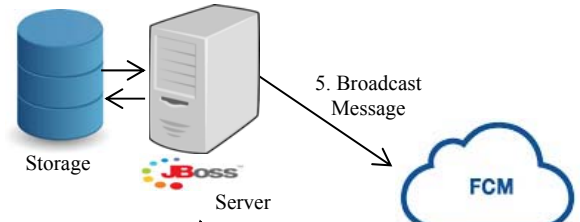

Figure3. Notification System Architecture

B. *Notification System Steps*

The proposed system has the following phases:

- **Information Acquiring and sending:**
  The application server acquires disaster information from disaster server and sends a message through firebase cloud server to the intended mobiles. The cloud server sends all of the messages by multicasting with push type of service.
- **Mobile Location Tracking and Updating:**
  Android Application gets the user's mobile position with latitude and longitude of location by Google API. It connects to the application server and sends the current and update positions by update policy conveniently.
- **Index Tree Building:**
  It is used for handling of two-dimensional mobile locations systematically. It stores mobile locations structurally and supports dynamic and continuous range queries.
- **Range Searching:**
  The disaster area is defined by a range, and then the mobile locations which are within the disaster region search by circular range queries.
- **Locking:**
  It is used to ensure a conflict-serializable program that protects the concurrent update between index tree and range searching.
- **Device Messaging Via Cloud:**
  Firebase cloud server sends a message to the application on the android devices which are in the disaster area. Devices receive these messages with pop up notifications.
- **Notification:**
  Whenever a disaster occurs, users in the disaster region receive notification that shows outside of the Android applications' UI. A notification message consists of disaster information and emergency guideline.

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C. *Client Side Prototype*

There are three tabs in the client side: Home, News and Supply. In-home tab, current weather conditions are shown. In the News tab, the information about the disaster in Myanmar is shown. In Supply tab, there are two phases namely help button for phone numbers of emergency aid foundations and their addresses. The prototype of the client side is shown in fig .4.

Figure 4. Client Side Prototype

V. EXPERIMENTAL RESULTS AND DISCUSSION

A. *Evaluation of Processing Time*

In figure shows the evaluation of the processing time of the index structure with the range searching implemented by this system. It has been conducted with various location ranges with the number of mobile locations over index structure. The test of processing time determines to start to end the computing time of indexing with the range search query.

$$T_p = T_{end} - T_{start} \quad (2)$$

where, T_p= indexing with range search query/processing time

T_{start}= Computation start time

T_{end} = Computation end time

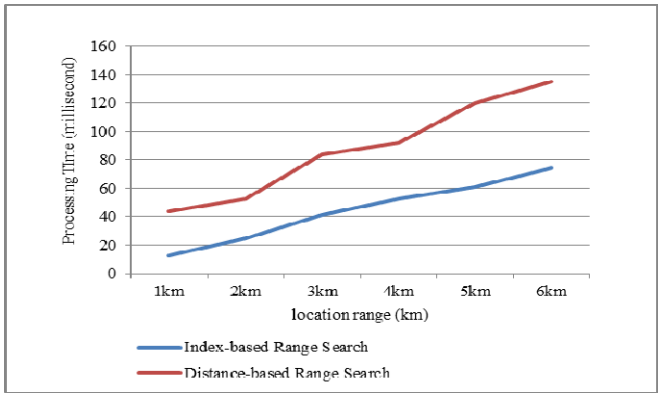

Figure5. Comparison of processing time

The processing time comparison between index-based range search and distance based range search approach is displayed in the fig.5. The experiment is conducted upon 1M mobile locations in the database server. Each query was done 25 times and the average was recorded. In this experiment, the processing time of the two approaches is slightly increased when the requested location range is greater. But the processing time for index-based range search is about two times speedy than the distance based range searching.

B. *Execution Time over Number of Mobile Locations*

The range query execution time over mobile locations is calculated and displayed in the fig.6. There is no significant difference in the number of mobile objects in index-based range searching. All of these are already ordered before tree structure thus it is saved time and support to query performance.

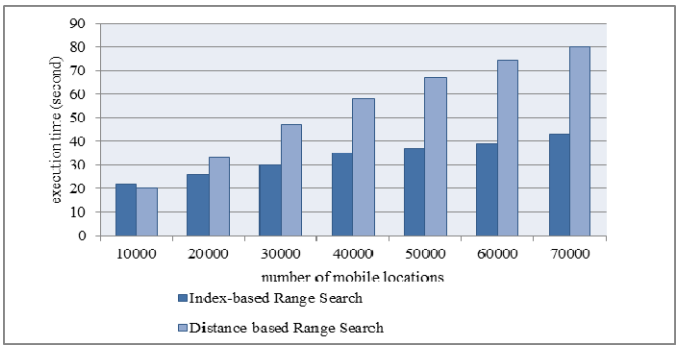

Figure6. Execution time between index-based and distance-based range search

C. *Evaluation of Computational Responsiveness Time*

This system is evaluated by response time that starts message list query from the database to indexing with range query calculation. This experiment consists of various location ranges and comparison of index-based range and distance based range are conducted. It takes the time between marking a region for multicasting and sending notification by searching range query.

$$T_{resp} = T_{mreg} + T_p + T_{noti} \quad (3)$$

where T_{resp}=Response Time of the notification service

T_{mreg}=acquiring message by admin and marking the service region

T_p= indexing with range search query/processing time

T_{noti}=sending notification by multicasting

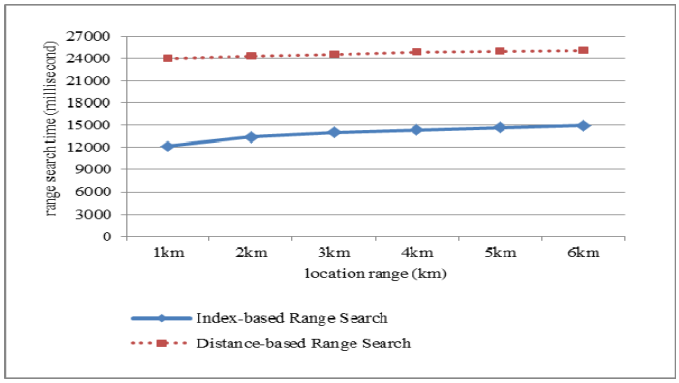

Figure7. Comparison of response time

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The response time comparison between index-based range and the distance based range is shown in the fig.7. It is done by different location ranges and range search times are marked on millisecond. The experiment is conducted with 1million mobile locations in the database server. Both of them gradually increase in range search time along with the increasing number of location range. According to this fig.7, even though the response time increases based on location range, the response time of the index-based approach is about two times faster than distance based range search approach.

D. Discussion

The experiment has been conducted on a Core i7 CPU and 8 GB memory. It basically performs for range search along with processing time and response time from range searching. The proposed index structure has three activities such as preprocessing, querying, and updating. It is compared to distance-based range searching for processing time, responsiveness time and execution time on mobile locations. The range searching time of the proposed index structure is about two times faster than the distance based range searching. The index-based range search takes better performance when it is used for both a larger range area and the number of datasets. Especially, it needs the less number of seconds when it is used for a large number of moving dataset.

CONCLUSION

This system is aimed at sending multicast notification of emergency conditions that are too bad and facing difficulties. Notifications or alerts will be delivered to users who are in the emergency area such as Tsunami, earthquake, cyclone and so on. This system provides finding the location of mobile users in an emergency region. Then, the message is delivered to users who are actually needed for notification so that they are saved with lives and property. The application is intended to use on Android mobile. It will be used in all the mobiles which are equipped with location provider in our future work. This system can be used not only for emergency notification but also product promotion and business notification of any environment. This system takes not to be receiving duplicate messages in multiple times and not to be expiring messages during a time-to-live period. Moreover, the proposed Range* tree structure allows for storing other moving objects such as temperature, vehicle location and so on.

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Building an Effective Intrusion Detection System using Genetic Algorithm based Feature Selection

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***Abstract*-Conventional methods of intrusion prevention like firewalls, cryptography techniques or access management schemes, have not proved themselves to completely defend networks and systems from refined malwares and attacks. Intrusion Detection Systems (IDS) are providing better solution to the current issues and thus became an important element of any security infrastructure to detect these threats so as to prevent widespread harm. The basic aim of IDS is to detect attacks and their nature and prevent damage to the computer systems.**

A signature-based IDS builds a classifier model using training data. The trained model is then used to detect and classify various attacks. As like any other classification applications, the issues in building such IDS is to pre-process the training dataset by selecting only a handful of important features to build a compact model in least amount of time without degradation in detection rate, accuracy etc.

Several different algorithms are available for feature selection. FMIFS is one of such reported feature selection approach. This paper investigates the performance of IDS that employs genetic algorithm for features selection. The empirical results presented here are encouraging and show superiority of Genetic based feature selection over FMIFS and other state-of-the-art feature selection algorithms with respect to time required to build the model, detection rate, accuracy, false positive rate and F-measure.

Keywords: Intrusion Detection, Security, Signature, Features.

I. INTRODUCTION

Security attacks are classified into two types: passive and active. The passive attacks are usually invisible (hidden) and do tapping of the communication link to gather data or destroy the network functioning. Passive attacks are classified as eavesdropping, tampering, traffic monitoring and analysis. Active attacks affect the operations within the network [1]. The performance of networking services may get degraded or come to a halt because of these attacks. Active attacks are classified as hole attacks, Denial-of-Service (DoS), jamming, flooding etc. The security solutions for two types of networks (wireless or wired) are as given below:

Prevention: It provides preventing before happening of any attack. Signature based technique can used to protect against the targeted attack.

Detection: If an attacker break the precautions made by the prevention system, then defending is difficult for such types of attacks. At this point, the protection answer would instantly use the 'detection' section of the attack to find which parts of the nodes are being compromised.

Mitigation: In this step the affected nodes were removed from the network and securing the network [18].

In any security system, if prevention does not stop intrusions, then detection system will be used for further process. Detection means finding suspicious behavior of user during a network communications. In the security set up, IDS offer information to the opposite systems such as identification, location (single node or group of nodes from particular region), time of the intrusion, type of intrusion (active or passive), specific attack name, OSI layer such as physical, data link, network from where attack is happened. This data would be terribly useful in defense like mitigating and analyzing the results of attacks. So, IDS plays important role in network security.

Intrusion is referred as: "any set of actions that plan to compromise the integrity, confidentiality, or handiness of a resource" and intrusion interference techniques such as encoding, authentication, access management, secure routing, etc. are parts of the initial phase of defense against intrusions. But till there are security systems does not provide fully preventions for intrusions. The discovery of security keys to the intruders can compromise the security of nodes. So this will break the defined mechanism of preventive security. So the IDS will play the role of disclosure of intrusions for preventing important system resources. The IDS should posses as: "low false positive rate, calculated because the proportion of normalcy variations detected as anomalies,

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and high true positive rate, calculated because the proportion of anomalies detected". So there is plenty of scope for analysis in detection performance for unknown attacks & detection speed.

II. Motivations and Related Work

Detection using Misuse or Signatures: -These types of methods are used to recognize known attacks using signatures of previously known attacks. These methods always gives accurate & efficient finding of attacks which are known with low false positive rate[19].The limitation is that it only works for known attack, if any new kind of attack then it will not useful to detect. Sobh [19] says that such systems works like anti-virus systems, which will be useful for only detecting some or all known attacks.

These systems used known attack dataset like KDD Cup 99 which contains 41 attributes for each signature of different types (DOS, R2L, U2R, and Probe) attacks [5].

Malki and Shun [13] have developed signature based IDS using neural network with the back propagation training algorithm. It was used to determine and predict current and possibly future attacks. For training & testing of classifier KDD Cup (1999) dataset was used.

Siva Sivatha Sindhu, S.Geetha and A. Kannan [6] have developed decision tree based light weight signature based detection using a wrapper approach for features selection and nerotree for classification of attacks. They have used genetic algorithm for optimizing selection of signature features from given 41 features of KDD Cup 99 dataset.

Chung and Wahid [21] proposed a classification methodology in which they used dynamic swarm based rough set and simplified swarm optimization (SSO) with hybrid feature selection. They used weighted local search (WLS) strategy to enhance the performance of SSO to find a better solution from the neighborhood. They achieved the 93.3% accuracy in classifying intrusions. Kuang et al. had proposed a hybrid methodology for intrusion detection by combining multi-layered SVM with kernel principal component analysis (KPCA) and genetic algorithm (GA) to increase the accuracy of the model. The dimension of features set and the training time is reduced using KPCA. In the KDD Cup99 dataset there are 41 features from which few features have no effect or have high levels of noise. So, they find the suitable features using SVM, decision tree and simulated annealing (SA) [19].

Kim et al. [21] used C4.5 decision tree algorithm in hybrid misuse detection system and proposed an autonomous labeling approach to support vector machine algorithms. They excluded the well known attacks from the dataset which improves the performance of SVM. So to improve efficiency of intrusion detection, features selection is important. So, they proposed a method based on gradually feature removal combined with SVM and ant colony algorithm. SVM may be inefficient in large scale intrusion detection datasets because it will take more time to train a model. So this drawback can be removed by using Core Vector Machine (CVM) and Partial Least Square(PLS) features extraction to increase the training speed and detection capability.

Mukkamala and Sung [22] selected 6 features from 41 using a novel feature selection algorithm and evaluated using SVM model. So selected features improves the classification accuracy by 1%.

Chebrolu et al. [23] had reduced features from 41 to 12 of KDD Cup99 using a Markov blanket model and decision tree analysis.

Chen et al. [24] had selected 4 features using a pre-processing feature selection phase and implemented IDS based on Flexible Neural Tree (FNT). The model achieved 99.19% detection accuracy.

Amiri had build the IDS using LS-SVM classifier with a forward feature selection algorithm which uses the mutual information method to measure the relation among features [2].

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Horng et al. had built the IDS by combining a hierarchical clustering and the SVM. The training data is selected using hierarchical clustering algorithm which reduced the average training and testing time as well as improves the classification performance. Experiment was performed on the corrected labels KDD Cup 99 dataset, which includes some new attacks. The IDS which is based on SVM gives false positive rate as 0.7% and overall accuracy is 95.75% [2].

III. Implementation Methodologies

Signature based IDS can be trained by using previously known attack pattern. Whenever new record comes to system it compares that pattern with previously known attack pattern and based on comparison decision will be given. Figure 1 shows proposed architecture of Effective IDS, in which signature based detection system will be used for detection of known & unknown attacks.

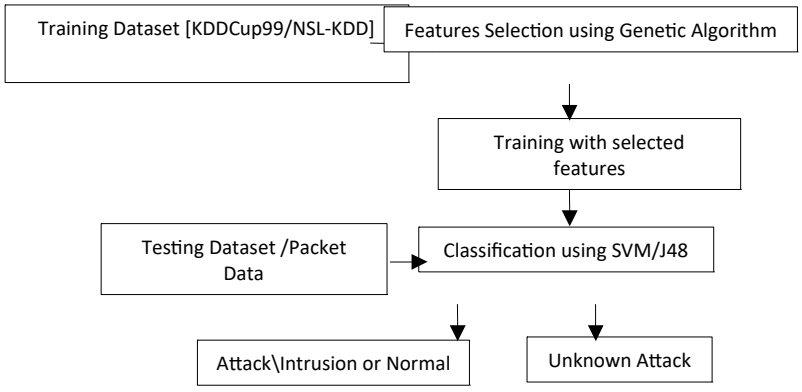

Figure 1. Framework of EIDS

Before applying any learning algorithm data processing step is essential. By reducing attribute space a good understandable model can be designed. Feature reduction can be done by two approaches as1] wrapper which uses the learning algorithm to find out the usefulness of features, 2] the filter which uses general characteristics of the data. The wrapper approach runs much slower but produces better result than filter.

As per the survey, from the total 41 features of signature based dataset, 5 features for Probe attack, 9 features for DoS attack, 14 features for R2L attack and 8 features for U2R attack are important. So to get these numbers of optimized features GA (Genetic Algorithm) is used [28].

Features selection using Genetic Algorithm (GA) requires taking care of encoding & fitness function. For IDS, a fixed-length binary string encoding can be used in which the value of the gene 0 or 1 is decided from the number of features. So, each individual chromosome with fixed length in population represents the given features set.

Fitness Function: - The fitness feedback is required to evaluate feature subset which is represented in GA population. This will be helpful for enhancing detection accuracy of the IDS i.e. it is indirectly achieved by maximizing the sensitivity and specificity of the classifier.

The GA works as filter approach for selecting number of features from given dataset. So the length of chromosome is depending on number of features in dataset. The population size is decided on number of records in given dataset. The number of generations and termination condition can be used to generate new population to get best solution or expected solution. The tournament selection is a method of selecting individual from a population of individuals and used to choose few individuals at random from the population and which is fittest will be selected for crossover operation.

The crossover probability will decide to select two individuals from population to form new individual in new population. The mutation with low probability need to add a little bit randomness into population's genetics otherwise every combination of solutions would be initial population.

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Algorithm Steps:

Input- Binary encoded string which is having length n (where n is the number of features), population size, Uniform crossover probability (Pc), Mutation probability (Pm), Empty solution (All bits value '0').

Output- Selected important features.

1. Initialize the population with chromosome which has size n and each gene value can be '0' or '1'. (0-means feature value zero and 1- means feature value other than zero)
2. Initialize Maximum Fitness = Solution length (n), previous fitness = 0 & calculate current fitness (initial value is zero) of chromosome by incrementing fitness value by one if solution bits match with gene bits.
3. While ((current fitness – previous fitness)>0.001) {
    a. With the specified probability Pc & Pm do uniform crossover and mutation operations.
    b. Increment fitness value if solution bits match with gene bits.
    c. Make previous fitness = current fitness.
4. Using tournament selections find the best of chromosomes into new population. }
5. Display the solution with selected features.

Figure 2. Pseudo code for Genetic Algorithm to select features

This implies that some of the bits in the bit string can be flipped. The algorithm termination condition will decide the population has converged i.e. does not produce solution which are significantly different from the previous generation. The different values are set as 0.1 to 1.0 for crossover probability and 0.0001 to 0.1 for mutation probability to get different important features from the three different datasets. These features are used with J48 classifier to get best accuracy, detection rate and false positive rate. In this paper we have shown the best results with less time for building model and minimum number of features [28].

IV. Experimental Results and Analysis

A. Datasets

To test and evaluate IDS only a few public datasets are available currently. The commonly used datasets in the literature are KDD Cup99 dataset; NSLKDD dataset and Kyoto 2006+ dataset to assess the performance of IDS. These datasets are of different data sizes and have varying number of features which is useful for validating feature selection methods. Therefore, testing of proposed approach with these datasets facilitates a fair and rational comparison with other state-of-the-art detection approaches.

To evaluate the performance of intrusion detection systems mostly the KDD Cup99 dataset is widely used. It consists of five different classes: 'normal' and four types of attacks, namely, the 'DoS', 'Probe', 'U2R' and 'R2L'. It contains training data with approximately five million connection records and test data with about two million connection records. Each record in the dataset has 41 different quantitative and qualitative features and labeled as either 'normal' or one of the attacks mentioned above.

Tavallaee had proposed a new revised version of the KDD Cup99 as NSLKDD dataset. A huge number of redundant records are the problem of the KDD Cup99 dataset is resolved in NSLKDD dataset. The 41 different quantitative and qualitative features are available in each record of NSLKDD as like the KDD Cup99 dataset.

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Both the KDD Cup 99 and NSL-KDD benchmarks include different datasets: 1) the training sets called the "10% KDD Cup 99" and "KDDTrain+", the testing sets called "KDD Cup test data" and "KDDTest+" and sets containing samples of new attacks previously unseen in the training data called the corrected labels KDD Cup 99 and KDDTest-21.

Song presented the Kyoto 2006+ dataset which contains three years of real traffic data between November 2006 and August 2009. The data was collected from both honeypots and regular servers that were deployed at Kyoto University. Each record in this dataset has 24 different features. The Table 1 provides the details of datasets used in experiments.

TABLE 1: Dataset details

Dataset	# Features	Records
KDD Cup 99 10%	41	494021
KDD Cup Corrected Test	41	311029
NSLKDD	41	125973
Kyoto 2006+ (1-3 Nov 2007)	24	237718
Kyoto 2006+ (27-31 Aug 2009)	24	777110

B. Experimental Setup

Feature selection algorithms aim at selecting optimum features from the given set of features. The selected features are then used by a classifier to build a trained model without compromising the detection rate and/or accuracy of the model.

Table 2 shows number of features selected by different feature selection methods such as Genetic Algorithm (GA), FMIFS [2] and three in-built attribute selection algorithms such as AttributeSelection, RandomProjection, RandomSubset from Weka 3.8.1for each of the five datasets. It can be seen from Table 2 that Genetic algorithm based feature selection algorithm selects lesser number of features in case of all five datasets when compared with FMIFS and Randomsubset while the algorithm AttributeSelection selects the least value of features. Number of features selected by 'RandomProjection' is intermediate. The time required for selection of attribute by the GA algorithm is also shown and it is directly proportional to number of attributes and instances. Time required by FMIFS or other algorithms in WEKA are not available and thus not shown. The best Pc=0.3 and Pm=0.001, Pc=0.9 and Pm=0.001,Pc=0.6 and Pm=0.0001, Pc=0.8 and Pm=0.001 for KDD Cup 99, NSLKDD, Kyoto 2006+ 27-31 Aug 2009 and Kyoto 2006+ 1-3 Nov 2007 was selected respectively.

TABLE 2: Number of Features selected

Dataset	#Attributes	#Records	# Attributes selected by					
			FMIFS	GA		Attribute Selection	Random Projection	Random Subset
				# Attributes	Time needed (sec)			
KDD Cup 99	41	494021	19	12	13.711	11	10	21
NSL-KDD	41	125973	18	14	4.185	19	10	21
Kyoto 2006 + (27-31 August 2009)	24	777110	4	6	21.645	4	10	9
Kyoto 2006 + (1-3 Nov 2007)	24	237718	5	6	6.688	2	10	9
KDD Cup 99 Corrected	41	311029	19	14	8.476	12	10	21

In order to test and compare effectiveness of a IDS constructed using attributes selected by GA, FMIS and other approaches, in terms of time need to build the system, detection rate, false positive rate and accuracy using the J48 classifier in WEKA 3.8.1 and LIBSVM classifier in and MATLAB. J48 is decision tree based classifier and normally needs lesser time to construct. To evaluate the performance three different datasets are used as KDD Cup99, NSLKDD and Kyoto 2006+ dataset. The experimental results of the J48 and LIBSVM based on GA are compared with the results using the other LSSVM-IDSs with FMIFS as feature selection.

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The latest updated data of 27, 28, 29, 30 and 31 August 2009 are selected for the experiments from Kyoto 2006+ dataset. For the experimental on each dataset, KDD Cup 99 (494021 samples) and using Weka Instance Filter "StratifiedRmoveFolds" (n=3) (164674 samples), NSLKDD (125973 samples) and for Kyoto 2006+ (777110 of 27-31 August 2009 samples) and using Weka Instance Filter StratifiedRmoveFolds (n=5) (155422 samples), (154517 of 1-3 Nov 2007 samples randomly) are selected. To evaluate the detection performance a 10-fold cross-validation and Use Training sets are used.

C. Performance Evaluation

Performance of implemented system has been evaluated using accuracy, detection rate, false positive rate and are defined by

$$Accuracy = \frac{TP + TN}{TP + TN + FN + FP} \quad (1)$$

$$Detection\ Rate = \frac{TP}{TP + FN} \quad (2)$$

$$False\ Positive\ Rate = \frac{FP}{FP + TN} \quad (3)$$

where, True Positive (TP) is the number of actual attacks classified as attacks, True Negative (TN) is the number of actual normal records classified as normal ones, False Positive (FP) is the number of actual normal records classified as attacks, and False Negative (FN) is the number of actual attacks classified as normal or unknown records.

The F-measure is a harmonic mean between precision and recall.

$$F - measure = \frac{2(Precision * Recall)}{Precision + Recall} \quad (4)$$

The precision is the proportion of predicted positives values which are actually positive. The precision value directly affects the performance of the system. A higher value of precision means a lower false positive rate and vice versa. The precision is given by (6).

$$Precision = \frac{TP}{TP + FP} \quad (5)$$

The recall is another important value for measuring the performance of the detection system and to indicate the proportion of the actual number of positives which are correctly identified. The recall is defined as:

$$Recall = \frac{TP}{TP + FN} \quad (6)$$

D. Results and Discussion with J48

The classification performance of the intrusion detection model (J48) combined with GA (proposed), FMIFS and filters from Weka 3.8.1 and using all features based on the three datasets are shown in Table 3, 4,5,6 and average over all datasets in Table 7. Table 3-7 summarizes the classification results of the different selection methods in regard to detection rates, false positive rates and accuracy rates. The results clearly demonstrate that the classification performance of IDS is enhanced by the feature selection step. In addition, the proposed feature selection algorithm GA shows promising results in terms of low computational

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cost and high classification results. It shows clearly that the detection model combined with the GA has achieved an accuracy rate of 99.95%, 99.49%, 99.71% and 99.80% using J48 for KDD Cup 99, NSL-KDD, Kyoto 2006+ (August 2009) and Kyoto 2006+ (Nov 2007), respectively, and significantly up to the mark with all other methods. In addition, the proposed detection model combined with GA gives the lowest build time and the lowest false positive rate in comparison with other combined detection models on all three datasets with highest precision 99.70%. The Figure 3 shows the comparison of build time over all datasets and methods.

TABLE 3: Performance classification for all attacks based on the KDD Cup 99 (494021)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
J48 + All	40.35	99.92	99.99	0.00	99.90	99.99	99.94
J48 + FMIFS	8.53	99.93	99.99	0.00	99.90	99.99	99.94
J48 + GA	21.22	**99.95**	**100**	**0.00**	**100**	**100**	**100**
J48 + AttributeSelection	**5.66**	99.89	99.90	0.00	99.90	99.90	99.90
J48 + RandomProjection	10.75	99.85	99.90	0.00	99.80	99.90	99.90
J48 + RandomSubset	11.22	99.90	99.90	0.00	99.90	99.90	99.90
LSSVM + FMIFS	n/a	99.79	99.46	0.13	n/a	99.46	n/a

TABLE 4: Performance classification for all attacks based on the NSL-KDD (125973)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
J48 + All	74.45	99.75	99.98	0.2	99.70	99.98	99.70
J48 + FMIFS	27.13	99.72	**99.70**	**0.2**	**99.70**	**99.70**	**99.70**
J48 + GA	**13.08**	99.49	99.50	**0.2**	99.50	99.50	99.50
J48 + AttributeSelection	30.5	99.74	**99.70**	**0.2**	**99.70**	**99.70**	**99.70**
J48 + RandomProjection	18.95	99.50	99.50	0.3	99.50	99.50	99.50
J48 + RandomSubset	23.88	99.60	99.60	**0.2**	99.60	99.60	99.60
LSSVM + FMIFS	n/a	**99.91**	98.76	0.28	n/a	98.76	n/a

Table 5: Performance classification for all attacks based on the Kyoto 2006 + (27-31 Aug 2009) (155422)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
J48 + All	23.39	98.88	98.90	1.5	97.90	98.90	98.40
J48 + FMIFS	17.2	98.33	98.35	1.65	98.15	98.35	98.25
J48 + GA	**2.47**	99.71	**99.70**	**0.3**	99.50	**99.70**	99.60
J48 + AttributeSelection	3.36	99.60	99.60	0.4	99.40	99.60	99.60
J48 + RandomProjection	25.89	99.71	**99.70**	**0.3**	**99.60**	**99.70**	99.60
J48 + RandomSubset	16.42	99.73	**99.70**	**0.3**	**99.60**	**99.70**	**99.70**
LSSVM + FMIFS	n/a	**99.77**	99.64	0.13	n/a	99.64	n/a

TABLE 6: Performance classification for all attacks based on the Kyoto 2006 + (1-3 Nov 2007) (154507)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
J48 + All	12.55	99.92	99.90	0.1	99.90	99.90	99.90
J48 + FMIFS	5.8	99.18	99.20	0.8	99.20	99.20	99.20
J48 + GA	6.84	**99.80**	**99.80**	**0.2**	**99.80**	**99.80**	**99.80**
J48 + AttributeSelection	**1.89**	96.79	96.80	3.1	97.00	96.80	96.80
J48 + RandomProjection	21.38	98.90	98.90	1.1	98.90	98.90	98.90
J48 + RandomSubset	5.67	97.67	97.70	2.3	97.70	97.70	97.70
LSSVM + FMIFS	n/a	n/a	97.80	0.43	n/a	97.80	n/a

Table 7: Average performance over all datasets

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
J48 + All	37.68	99.61	99.69	0.45	99.35	99.69	99.48
J48 + FMIFS	14.66	99.29	99.31	0.66	99.24	99.31	99.27
J48 + GA	**10.90**	**99.74**	**99.75**	**0.17**	**99.70**	**99.75**	**99.72**
J48 + AttributeSelection	**10.35**	99.00	99.00	0.92	99.00	99.00	99.00
J48 + RandomProjection	19.24	99.49	99.50	0.42	99.45	99.50	99.47
J48 + RandomSubset	14.30	99.22	99.22	0.70	99.20	99.22	99.22
LSSVM + FMIFS	n/a	**99.82**	98.91	0.24	n/a	98.91	n/a

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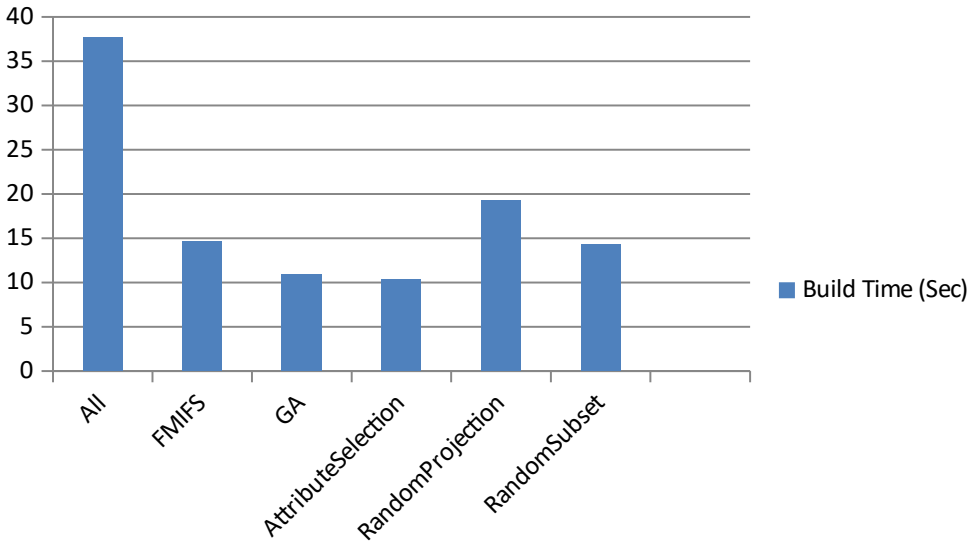

Figure 3. Average building times of J48-IDS using all features and J48 combined with GA and other methods respectively, on three datasets.

The proposed feature selection algorithm is computationally efficient when it is applied to the J48-IDS. Figure 3 shows the building (training) times consumed by the detection model using GA compared with the detection model using all other features selection methods. The figure shows that the J48-IDS + GA perform better than GA-IDS with all 41 features and other methods on all datasets.

E. Results and Discussion with LIBSVM

The classification performance of the intrusion detection model (LIBSVM) combined with GA (proposed), FMIFS and filters from Weka 3.8.1 and using all features based on the three datasets are shown in Table 8, 9,10,11 and average over all datasets in Table 12. Table 8-11 summarizes the classification results of the different selection methods in regard to detection rates, false positive rates and accuracy rates. The results clearly demonstrate that the classification performance of IDS is enhanced by the feature selection step. In addition, the proposed feature selection algorithm GA shows promising results in terms of low computational cost and high classification results. It shows clearly that the detection model combined with the GA has achieved an accuracy rate of 99.87%, 99.86%, 99.42% and 99.04% using LIBSVM for KDD Cup 99, NSL-KDD, Kyoto 2006+ (August 2009) and Kyoto 2006+ (Nov 2007), respectively, and significantly up to the mark with all other methods. In addition, the proposed detection model combined with GA gives the lowest build time and the good false positive rate in comparison with other combined detection models on all three datasets with precision 99.37%. The Figure 4 shows the comparison of build time over all datasets and methods.

TABLE 8: Performance classification for all attacks based on the KDD Cup 99 (164674)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
LIBSVM + All	7497	99.97	99.99	0.32	99.91	99.99	99.94
LIBSVM + FMIFS	6049.51	99.88	99.91	0.22	99.95	99.91	99.93
LIBSVM + GA	2004.31	99.87	99.84	0.3	99.84	99.84	99.84
LIBSVM + AttributeSelection	**8.74**	99.87	99.91	0.3	99.92	99.91	99.91
LIBSVM + RandomProjection	6979.88	**99.99**	**99.99**	**0.00**	**100**	**99.99**	**99.99**
LIBSVM + RandomSubset	4749.10	99.98	99.97	0.30	99.99	99.97	99.98
LSSVM + FMIFS	n/a	99.79	99.46	0.13	n/a	99.46	n/a

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TABLE 9: Performance classification for all attacks based on the NSL-KDD (125973)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
LIBSVM + All	39733	99.99	99.96	0.015	99.98	99.96	99.96
LIBSVM + FMIFS	25481	99.93	99.90	0.028	99.96	99.90	99.93
LIBSVM + GA	6514	99.86	99.89	0.15	99.81	99.89	99.85
LIBSVM + AttributeSelection	**3458.80**	99.31	99.63	0.95	98.91	99.63	99.27
LIBSVM + RandomProjection	33248	**99.96**	**99.93**	**0.00**	**99.99**	**99.93**	**99.96**
LIBSVM + RandomSubset	31846	99.86	99.77	0.057	99.93	99.77	99.85
LSSVM + FMIFS	n/a	99.91	98.76	0.28	n/a	98.76	n/a

TABLE 10: Performance classification for all attacks based on the Kyoto 2006 + (27-31 Aug 2009) (155422)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
LIBSVM + All	14043	99.96	99.97	0.04	99.94	99.97	99.95
LIBSVM + FMIFS	7192	99.66	99.76	0.43	99.57	99.76	99.66
LIBSVM + GA	6785	99.42	99.46	0.61	99.45	99.46	99.45
LIBSVM + AttributeSelection	**93.76**	99.80	99.73	0.23	99.77	99.73	99.75
LIBSVM + RandomProjection	24847	**99.98**	**99.99**	**0.02**	**99.97**	**99.99**	**99.98**
LIBSVM + RandomSubset	6837	99.90	99.96	0.15	99.83	99.96	99.89
LSSVM + FMIFS	n/a	99.77	99.64	0.13	n/a	99.64	n/a

TABLE 11: Performance classification for all attacks based on the Kyoto 2006 + (1-3 Nov 2007) (154507)

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
LIBSVM + All	11110	98.83	99.60	1.9	98.06	99.60	98.82
LIBSVM + FMIFS	7742	92.43	97.08	12.10	88.65	97.08	92.67
LIBSVM + GA	8935	99.04	99.70	1.59	98.38	99.70	99.03
LIBSVM + AttributeSelection	**127.81**	96.82	**99.96**	6.2	93.98	**99.96**	96.88
LIBSVM + RandomProjection	10217	**99.70**	99.67	**0.26**	**99.73**	99.67	**99.70**
LIBSVM + RandomSubset	4677	97.66	97.55	2.23	97.70	97.55	97.62
LSSVM + FMIFS	n/a	n/a	97.80	0.43	n/a	97.80	n/a

Table 12: Average performance over all datasets

Method	Build Time(Sec)	Accuracy	DR	FPR	Precision	Recall	F-measure
LIBSVM + All	18096	99.56	99.88	0.57	99.47	99.88	99.67
LIBSVM + FMIFS	11616	97.97	99.16	3.19	97.03	99.16	98.04
LIBSVM + GA	6060	99.55	99.74	0.66	99.37	99.74	99.54
LIBSVM + AttributeSelection	**922.27**	98.95	99.80	1.92	98.14	99.80	98.95
LIBSVM + RandomProjection	18822.97	99.90	**99.89**	**0.07**	**99.92**	**99.89**	**99.91**
LIBSVM + RandomSubset	12027.27	99.35	99.31	0.68	99.36	99.31	99.33
LSSVM + FMIFS	n/a	**99.82**	98.91	0.24	n/a	98.91	n/a

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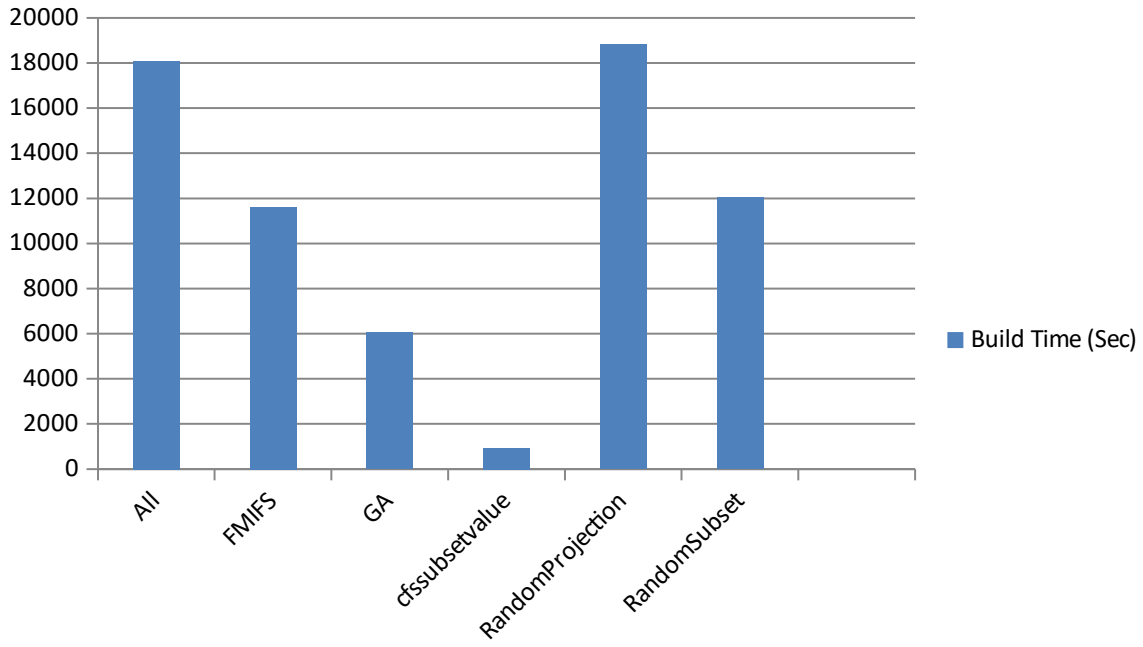

Figure 4. Average building times of LIBSVM-IDS using all features and LIBSVM combined with GA and other methods respectively, on three datasets.

The proposed feature selection algorithm is computationally efficient when it is applied to the LIBSVM-IDS. Figure 4 shows the building (training) times consumed by the detection model using GA compared with the detection model using all other features selection methods. The figure shows that the LIBSVM-IDS + GA perform better than LIBSVM-IDS with all 41 features on all datasets.

F. Comparative Study

Table 13 shows a comparison with the results achieved by CSV-ISVM, LSSVM + FMIFS proposed in [2] that have been tested on Kyoto 2006+ dataset (1-3 Nov. 2007). Through the results, both systems show improvement in detection rates and reduction in false positive rates. However, the obtained results of the J48-IDS + GA and LIBSVM-IDS +GA are better, compared to LSSVM + FMIFS and CSV-ISVM. The final results achieved by J48-IDS + GA show 99.80% ,0.2% and LIBSVM-IDS + GA show 99.70%, 1.59% of the final detection and false positive rates respectively, while LSSVM + FMIFS produces 97.80% and 0.43% of the final detection and false positive rates respectively.

TABLE 13: Performance classification for all attacks based on the Kyoto 2006 + (1-3 Nov 2007)

Method	# Feature	Accuracy	DR	FPR
J48 + All	21	99.92	99.90	0.1
J48 + FMIFS	5	99.18	99.20	0.8
J48 + GA	6	**99.80**	**99.80**	**0.2**
LIBSVM + All	41	98.83	99.60	1.9
LIBSVM + FMIPS	4	92.43	97.08	12.10
LIBSVM + GA	6	99.04	99.70	1.59
LSSVM + FMIFS[2]	5	n/a	97.80	0.43
CSV-ISVM [2]	5	n/a	90.15	2.31

Table 14: Detection rate (%) for different algorithm performances on the test dataset with Corrected Labels of KDD Cup 99 dataset

System	Normal	DoS	Probe	U2R	R2L	Overall
J48 + GA	95.6	91.25	91.11	33.05	63.17	74.83
J48 + FMIFS	94.8	96.68	**98.77**	**92.75**	70.91	76.74
LSSVM + FMIFS [2]	98.98	98.76	86.08	22.11	**88.38**	78.86
KDD'99 winner [2]	**99.50**	**97.10**	83.30	13.20	8.40	60.30

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Furthermore, the detection rate of J48 + GA has been compared with some other approaches that have also been tested on the Corrected Labels dataset and the results are shown in Table 14. Through Table, compared to the KDD Cup 99 winner's detection system and other systems, J48-IDS + GA achieves the best detection rates for Probe,U2R and R2L attacks with rates of 91.11%, 33.05% and 63.17% respectively. For the normal class, all of KDD Cup 99 winner [2], Association rule [22] and PNrule [2] achieve the best result with 99.50% detection rate. However, overall, J48 + GA have achieved the 74.83 detection rate among all systems.

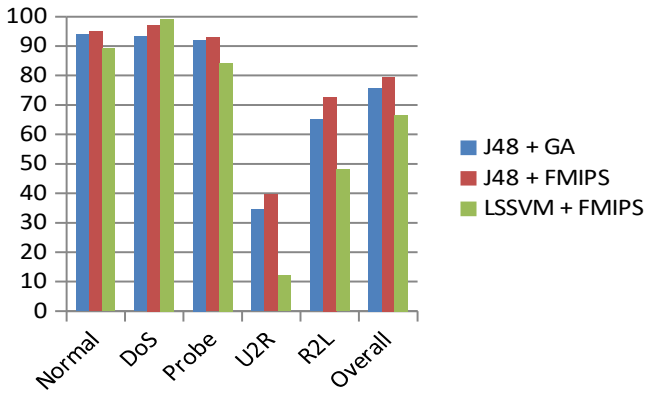

Figure 5. Comparison results of F-measure rate on the Corrected Labels of KDD Cup 99 dataset

Figure 5 illustrates a comparison between J48-IDS+GA, J48-IDS+FMIFS and LSSVM+FMIFS proposed by Ambusaidi [2] in terms of F-measure rates. This figure makes it obvious that the proposed model outperforms the LSSVM+FMIFS models in most of the classes including Normal, Probe, U2R, and R2L with 93.90%, 92.08%, 34.50% and 65.13%, respectively.
LSSVM+FMIFS provide the highest result in DoS class of 99.27%. Overall, the results of J48-IDS+GA the shown in this figure demonstrate satisfying performance compared with the other methods.
Figure 6 shows a comparison of the proposed system with those systems proposed in [2] that have been tested on the three datasets in terms of the classification accuracy. Among those systems, the proposed detection model achieved the classification accuracy of 99.55%

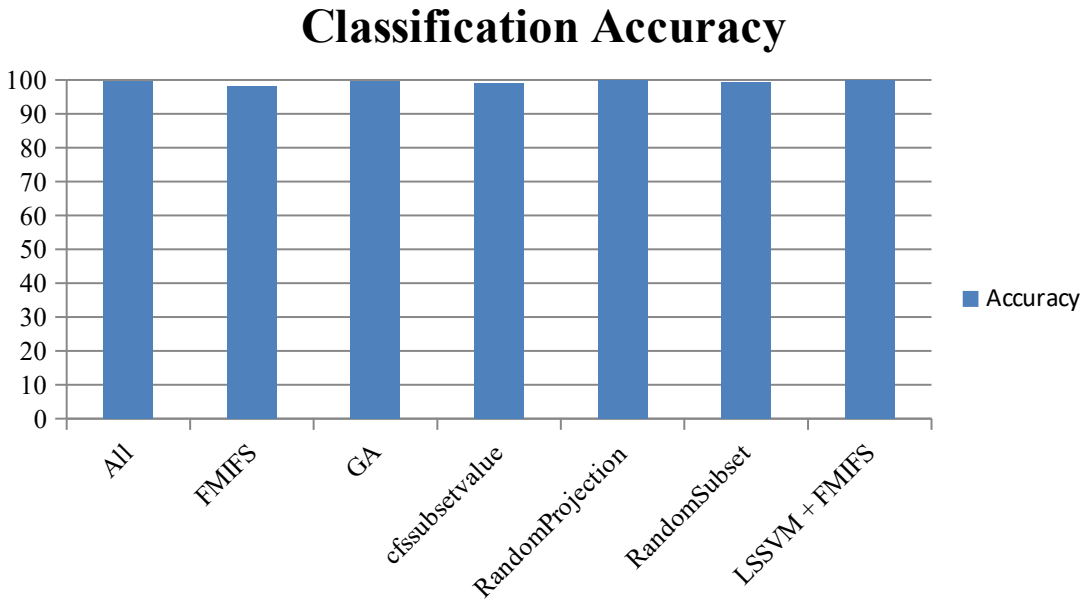

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Figure 6. Comparison results of classification accuracy with LSSVM+FMIFS and LIBSVM-IDS on three datasets

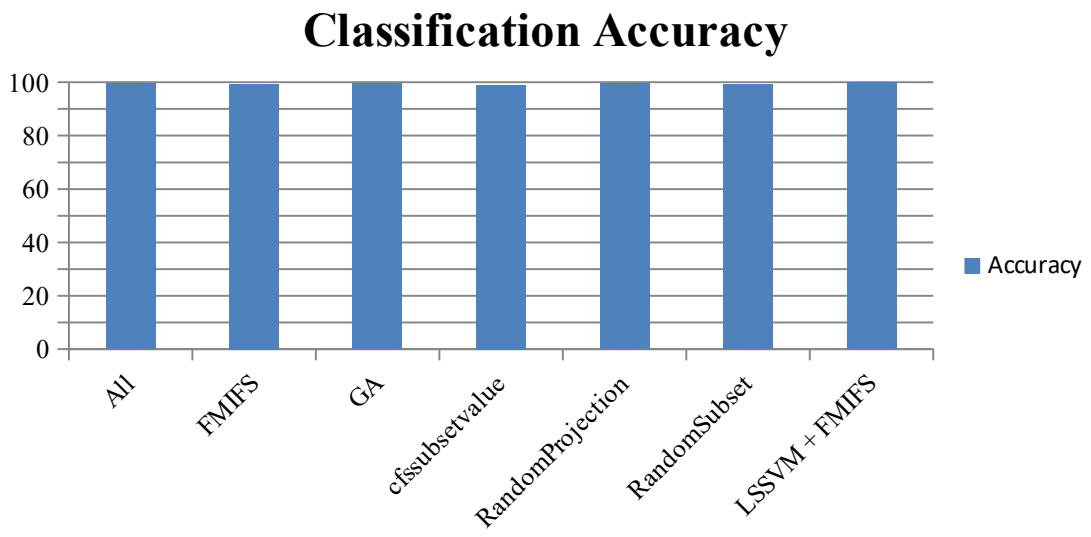

Figure 7. Comparison results of classification accuracy with LSSVM+FMIFS and J48-IDS on three datasets

Figure 7 shows a comparison of the proposed system with those systems proposed in [2] that have been tested on the three datasets in terms of the classification accuracy. Among those systems, the proposed detection model achieved the classification accuracy of 99.74%

V. Conclusion & Future Scope

Since the current IDS technologies are not sufficient enough to provide a reliable detection rate so work should be carried on to improve the rate. The speed of detection is another research problem.

The information presented gives how the features selection is an important to increase speed of detection & detection accuracy. The filter based features selection genetic algorithm is proposed and used combined with J48 and LIBSVM method. The proposed IDS have been evaluated using three well known datasets as KDD Cup 99, NSL-KDD and Kyoto 2006+ datasets. The proposed work performance up to the mark in terms of classification accuracy, detection rate, false positive rate and F-measure with existing detection approaches. Finally based on the experimental results achieved on all datasets, it can be concluded that proposed detection system has achieved promising performance in detecting intrusions over computer network.

Although the proposed feature selection algorithm has shown encouraging performance, it could be further enhanced by optimizing search strategy.

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Master-Slave Clustering Technique for High Density Traffic in Urban VANET Scenario

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***Abstract*—Moving vehicle is never free of traffic congestion especially in the cities. Every day commuters wastes hours in travelling just because of traffic congestion. This has led to the emergence of vehicular management which will be beneficial for Road Transport department to control and manage the traffic flow on congested roads. Thus to support above idea we have Vehicular Ad-Hoc Network, or VANET technology that turns every participating car into a node, allowing cars to connect with each other and in turn create a network. There are wealthy numbers of approaches were highlighted to solve several thriving challenges of VANET. Clustering technique in vehicle is one of them which made a great impact on VANET. But it fails to fulfill a crucial requirement. Several protocols wanted to build a cluster in low density traffic where the numbers of vehicles are less with respect to transmission range & there is a less chance of broadcast storming which is not a practical scenario. So that cluster formation in high density traffic has arisen as an issue where there is a great possibility to broadcast storm. This paper suggests a "Priority Based Master-Slave Cluster Formation Process" in high density traffic for an urban scenario using "fidelity" metric. With the help of this metric it will be easier to find high density traffic & form priority based Master-Slave dynamically by reducing broadcast storm problem.**

In this paper CHP function runs on the vehicular environment which carried out to select a vehicle as Master. In this Ad-hoc wireless environment a dataset is assumed which create a proper environment & generate a graph. Graph results can be analyzed to have the highest one selects as a Master. Thus for the final result, real aspects of vehicular traffic is very essential and scenarios play a very crucial role.

I. INTRODUCTION

A. *Vehicular Ad-hoc Network (VANET)*

Vehicular Ad-hoc Network (VANET) has been a focus point for the researchers for the last few years. Tremendous amount of developments have taken place in the field of wireless communication, as well as in vehicle industry. Disbursing road related safety and non-safety information to vehicles while running on the roads is the main objective of VANET. Vehicles get connected and create an ad-hoc network to accomplish their desired task.

VANET is basically a form Mobile Ad-hoc Network (MANET). But in the case of VANET, mobility rate of the nodes, which are the vehicles, is higher than of MANET. Along this high mobility issue there are several more issues that have made VANET a challenging sector for research. Besides of the high mobility rate, number of nodes exists in a VANET environment. But for the issues and challenges mentioned previously many new and optimized protocols were proposed and developed for VANETs.

B. *Infrastructure Of VANET*

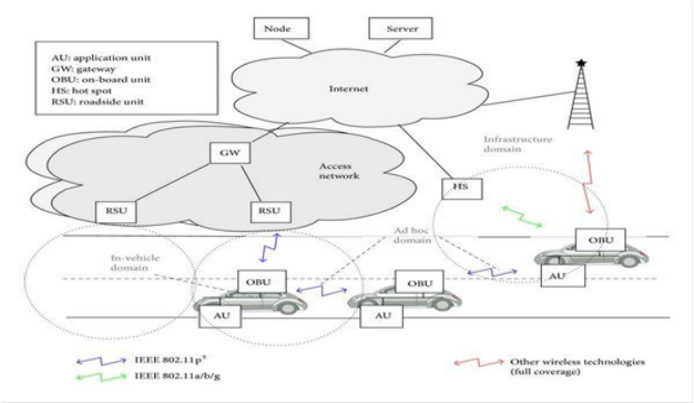

Fig. 1. Infrastructure Of VANET[12]

The structure of VANET is quite different from others. Integrating on-board devices with the network interface, different types of sensors and GPS receivers is used to collect process and disseminate information. According to the IEEE 802.11p architecture standard guidelines, VANETs can be divided into three domains: the mobile domain, the infrastructure domain, and the generic domain. First the mobile domain consists of two parts: the vehicle domain and

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the mobile device domain where The vehicle domain comprises all kinds of vehicles such as cars and buses. The mobile domain comprises all kinds of portable devices like navigation devices and smartphones. Within the infrastructure domain, there are two domains: the roadside infrastructure domain and the central infrastructure domain. The roadside infrastructure domain contains roadside unit entities like traffic lights, lamp etc. . then The central infrastructure domain contains infrastructure management centers such as traffic management centers (TMCs) and vehicle management centers. However, the development of VANETs architecture varies from domain to domain. In the CAR-2-X communication system which is pursued by the CAR-2-CAR communication consortium, the reference architecture is a bit different.CAR-2-CAR communication consortium (C2C-CC) is the major driving force for vehicular communication. This system architecture comprises three domains: in-vehicle, ad hoc, and infrastructure domain. Infrastructure, Ad-hoc & Generic Domain. In infrastructure domain it needs to maintain a relationship in On Board Unit & AU using wired or wireless communication. Ad hoc domain maintains the relationship between OBU and road side unit (RSU) such as lamp post or traffic light. The relationship is build using DSRC medium which focus physical layer & add the wireless functionality in vehicle. Application unit (AU) The AU is attached within the vehicle that uses the applications provided by the provider with the help of OBU. The AU can be a dedicated device for safety applications which is utilized to improve the safety on the road. In any emergency situation, the surrounding vehicle must be informed as soon as possible. Otherwise, the safety system works as useless in helping the driver to deal with the emergency situations. Hence, It is required that the DSRC safety-related Vehicle to vehicle communication must provide a service delivering messages within their lifetime with high reliability but under high-speed. The AU may reside with the OBU in a single physical unit the distinction between the AU and the OBU is logical. Then, Roadside unit (RSU) The RSU which is a wave device usually fixed along the road side or in dedicated locations such as at near parking spaces. The RSU is connected via one network device for a dedicated short range communication based on IEEE802.11p standard, and can also be attached with other network devices for the purpose of communication within the infrastructural network. Extending the communication range of the ad hoc network by disseminate the information to other OBUs and by sending the information to other RSUs in order to forward it to other OBUs. Integrating with this environment VANET communicate either V2V or V2I depends on the necessity.

C. *Motivation*

Vehicular Ad-Hoc Networks (VANETS) are a promising field for increasing comfort and safety on the road in Bangladesh where the traffic jam is like a nightmare. [14] According to the world bank data the average traffic rate has been reduced from 21km per hour to 7km per hour. But sometimes using some techniques we can avoid these unbearable traffic jam. Let's assume that you are on the way in a car & wants to know the traffic jam condition at the next turn or want to know that any vehicle met any accidents or not. Sometimes the answer of these questions are found in VANET. [16]To find these answers there are several routing protocols works, such as – Topology Based Routing Protocols, who utilize the information regarding the links between nodes for routing protocols. This topological protocols can also be subcategorized in to proactive, reactive and hybrid. Another one is Position based routing protocols who decides the packet routing based on the source to destination node position and one hop position. Examples are: GyTAR[15], LOUVRE, DIR etc. .Again Cluster based routing protocols form a group and select a head among themselves in order to pass packet from a source to a destination. Examples are : CBLR, LORA-DCBF, HCB etc. But the drawback of these protocols are most of the time they applied in a low density traffic area where the no of vehicles are less with respect to transmission range. As a result there is a less possibility of broadcast storming which means at a time less no of vehicles wants to communicate their head if we applied a clustering scenario. But this is not a practical scenario in our country like Bangladesh where there are max no of vehicles exist in one road segment.

So, in this concern a Master Slave clustering technique is proposed which effectively works in high density traffic in urban scenario though some key challenges still exist.

This paper divided into the six chapters. The remainder of this paper is organized as follows: In Section I, we have discussed the Introduction which gives overview of VANET, Domain in VANET, Types of routing protocols in VANET & the overall structure. In Section II, we have described dedicated pioneering approaches of the literature. In Section III, we have thoroughly described the proposed scheme of ours. In Section IV, the environment with parameters and the preliminary evaluation of our proposed protocol are presented. We have also shown some graph of the proposed algorithm. Finally, the paper is concluded in last section which sketches issues regarding the future work.

II. Background Study

Researches has found a vast amount of interest in VANET due to the low cost of embedded sensor but frequent movement in this environment make the whole scenario more complex[18]. Strategies focused around the vehicle's location, in the same way as the Floating Car Data (FCD).[1] But it is better to disseminate all the data in a group based so that it can be easier to control all the vehicles. In the literature, it has been demonstrated that clustering made a great impact in the performance of VANETs and can be utilized in various application. Daeinabi et al.[2] proposed an efficient clustering algorithm for VANETs getting the direction of vehicle and number of neighbors to perform clustering. In [3] an open inter-vehicle communication network, algorithm for clustering was proposed by taking into account the dynamic topology in

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VANET .In [4] Fan et al. suggested a clustering algorithm based upon the direction of vehicle. In [5] an adaptive connectivity proposed by Yang et al demonstrated the choice of the optimal path based on collecting data from diverse regions by decreasing the total of the weight between source and Destination. In [6] Wu et al proposed mobility-sensitive data dissemination protocol for VANET environment. In [7] Kumar et al proposed an agent learning–based clustering algorithm to evaluate the performance by taking into different metrics like node participation, percentage of connectivity, cluster head period, connectivity preservation ratio, transmission ratio etc. Due to continuous expansion of this structure, clustering is a popular means of organizing clustering process which is attracted by many Researchers.

Many clustering technique, including topology-based clustering, mobility-based clustering, identifier neighbor-based clustering, energy-based clustering and weight-based clustering, have been proposed [8]. In Most of the clustering technique, the selection of the gateway is based on the speed of the CH, signal strength and communication connectivity [9].One of the popular clustering algorithms is the affinity propagation (AP) algorithm, which is a distance-based clustering algorithm, results in the frequent changing of CHs when speed effectively changes[10].Some other literature works introduced a clustering routing protocol in which CH selects another head in order to forward packets [11].The majority of these research works only considered the location or the speed of the vehicles for constructing the clusters, while the density or broadcast issue of the vehicles have not been thoroughly considered. Most importantly, all of these protocols and solutions have never been investigated in high density traffic to test the broadcast storm. The majority of vehicles , maintain a constant distance between them which is not a practical scenario in Bangladesh perspective .

III. Proposed Scheme

In this paper, first it is assumed that in an urban scenario where all the vehicles are equipped with Global Position System (GPS.) Here moving nodes are basically vehicles and vehicles are equipped with On Board Unit (OBU). Vehicles can also communicate with Road Side Unit (RSU) and this communication is based on Dedicated Short Range Communication (DSRC). DSRC functions at frequency of 5.9 GHz & cover the radius of 1000m.

The proposed method is Master-Slave Clustering Technique which is consists of RSU, OBU & local DB. OBU & RSU communicate each other using DSRC as a medium. Vehicle connects itself to the RSU when it enters the road& send a request message to RSU.RSU check its local database that if the vehicle is registered or not. Assumption made in my scenario that there are n vehicles in the network & each one has a unique vehicle ID during registration V= {v1, v2….vn} also there are x roads& each one has a unique road id, R={r1,r2,r3…rn}.Road length and the number of lanes of road ri are denoted as Lni & LORi that are saved in road database which is accessed by RSU.

For selecting a node as Master efficiently it must fulfill four criteria's. First, it required to have minimum average distance to its members. Secondly, the velocity has to be the closest to the average speed. Third, maximum number of neighbor vehicle around that node. Fourth, nodal degree of directly connected node is in same direction. This searching is repeated to the maximum number of iteration.

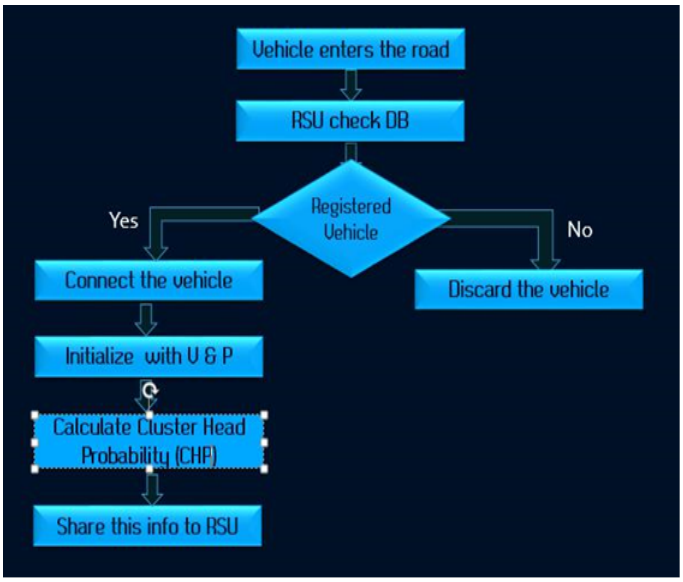

Fig. 2. Flow-chart Of Vehicles connectivity with RSU

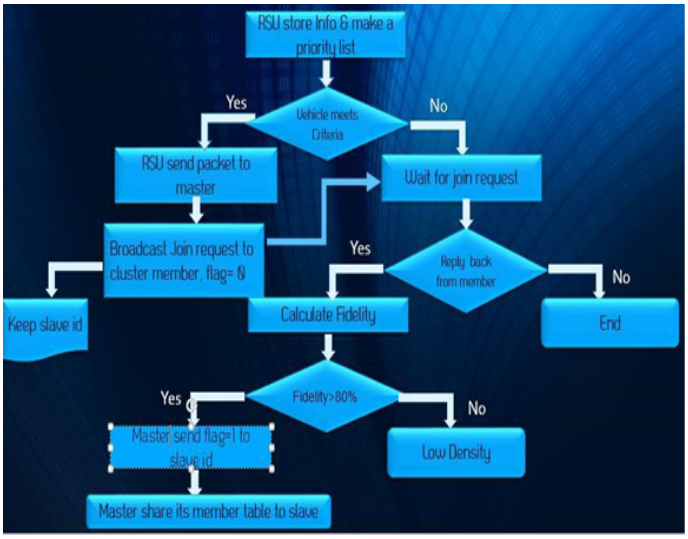

Fig. 3. Flow-chart of Finding Master & Slave

On the basis of the above requirements, Cluster Head Probability (CHP) as follows is stated:

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CHP=C1.C1.Dvi,j+C2|Avg.vi-Svi.degi|+C3.Nneig.Vi]) (1)

Where, SVi means speed value of vehicle Vi ; Nneig denoted as the number of the neighbors of vehicle Vi; Nit is the maximum no of iterations starts from 1; C1, C2, and C3 are acceleration coefficient supplied to this function.

$$D_{Vi,Vj} = \sqrt{(x_{Vi} - x_{Vj})^2 + (y_{Vi} - y_{Vj})^2} \quad (2)$$

AvgVi is the average speed of vehicle Vi. It is calculated as follow:

$$Avg_{Vi} = \frac{1}{Neigh_{Vi}} \sum_{k=1}^{Neigh_{Vi}} S_{Vi}; Vi \in [1, N] \quad (3)$$

Nodal degree for node i (Degi), which is defined that clusters are formed by vehicles traveling in the same direction,

Degi =|Ni|

Each vehicle initialize itself with position & velocity which is collected from OBU. After initializing within a given transmission range R. All the nodes calculate the CHP & immediately transfer this calculation to RSU because this calculation is carried out to identify this node as Master.

After receiving the value from each vehicle RSU make a priority list to its local Db. Master is then selected which has the highest priority based on the max CHP value. RSU selects a Master through sending a packet which contains position, speed of its neighboring vehicle, Cluster_id & Slave_id.

Master save the packet information in its table and set flag=0 while disseminating a Join Request as a beacon message within transmission Range R. Beacon message contains Cluster id, Master id as source_add, Nodal_degree, Position, Vehicle id as destination. Each time when reply is sent back to Master, master save all the member info in member table &OBU calculates fidelity metric.

Fidelity=$Total\_Joined\_Vehicle/Total\_Informed\_Vehicle$

If fidelity is greater than 80%, that means at a time max vehicle wants to communicate with master resulting broadcast storm in high density area. So in this case Master send a packet to slave_id and set flag=1. Now Master share its member table to slave & according to the transmission range vehicle connects either Master or Slave. So that, one vehicle does not need to handle too much traffic all alone.

IV. Simulation and Result

In this section, we have evaluated the performance using our approach described in the previous section. Then we have presented the performance results of our proposed method. First we have created an environment.

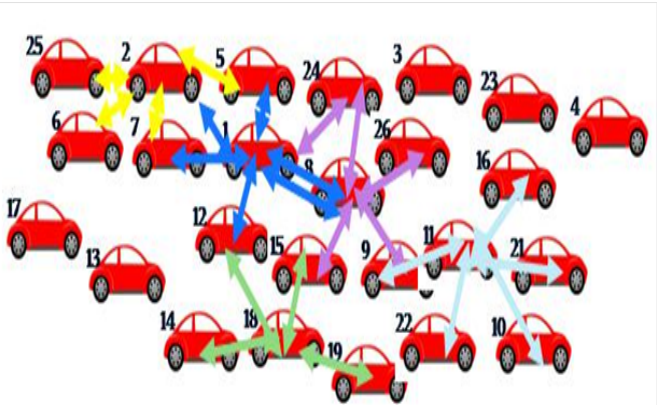

Fig. 4. High Density Traffic In Road With Neighbor Relationship

The parameters of the simulated environment are briefly shown in Table 1.

Table I: Simulation Parameters (Distance)

Neighbor relationship with distance	
For V1	
Neighbor	Euclidean Distance
V1,V2	6
V1,V5	5
V1,V24	3
V1,V8	1
V1,V12	2
V1,V7	3
For V2	
Neighbor	Euclidean Distance
V2,V25	8
V2,V7	8
V2,V5	6
V2,V1	6
V2,V6	2
For V8	
Neighbor	Euclidean Distance
V8,V1	1
V8,V24	3
V8,V26	4
V8,V9	4
V8,V15	3
V8,V12	3

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Neighbor relationship with distance	
For V11	
Neighbor	Euclidean Distance
V11,V9	7
V11,V10	8
V11,V21	8
V11,V16	6
V11,V22	6
For V18	
Neighbor	Euclidean Distance
V18,V14	7
V18,V15	8
V18,V19	8
V18.V12	6

Table II: Simulation Parameters (Speed)

Vehicles	Speed
V1	**5**
V2	**2**
V8	**8**
V11	**6**
V12	**1**
V25	**3**
V6	**2**
V7	**7**
V5	**5**
V14	**5**
V18	**4**
V24	**3**
V8	**2**
V15	**2**
V26	**1**
V9	**2**
V16	**7**
V19	**5**
V22	**4**
V11	**3**
V21	**4**
V10	**3**

To measure the performance of our proposed method, we have considered above scenario. We then studied the impact of growing no of vehicles on the performance of our proposed approach. First a High Density scenario using 25 vehicles is created & assumed speed & distance value between the cars. Randomly selected 5 cars & judged them according to the formula. Our proposed method applied to the high density area to efficiently select the Master node to reduce the broadcast storm problem. We have put all the above values in our equation to find out an efficient master for above scenario. Here value of C1,C2,C3 are 1,2,3.Below CHP, Avg speed & iteration values are given.

Table 3: Parameters For High Density Environment(CHP, Average Speed, Max No Of Iteration)

CHP	
Vehicle	CHP
V1	168
V2	129
V8	130
V11	120
V18	103

Average Speed	
Vehicle	Average Speed
V1	3.33
V2	2.4
V8	0.33
V11	2
V18	6.5

Max No of Iteration	
Vehicle	Iteration
V1	6
V2	5
V8	6
V11	5
V18	4

According to the value from above we can find a CHP graph containing all the values & identify the highest one as Master & second highest as Slave vehicle. The id of this vehicle is saved in priority table & used as Master and Slave for this clustering process. The graph carries the proof of itself.

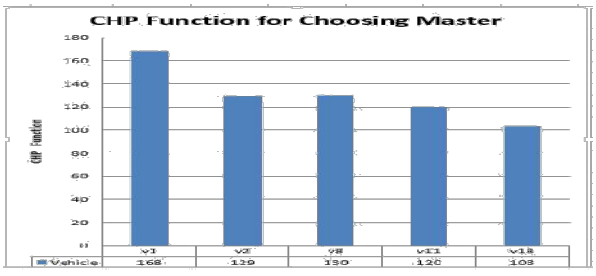

Fig. 5. *CHP Function Vs. Vehicle As Master*

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This graph shows that V1 has the capability to handle entire member as Master & V8 as slave. So, all these simulation prove the above scenario that we have done for this research.

V. Conclusion

VANET is a hot topic of research for the last decade in the vehicle industry. Lots of new routing protocols have been proposed previously for making routing more efficient in the rapidly changing topology in VANET. In this paper a cluster based routing method is introduced where the cluster head will be released from excess pressure while being the leader in the cluster. The broadcast storm can be mitigated with the introduced mechanism. In the introduced scheme, a cluster will be having multiple cluster heads from where the master and slave heads will be chosen from the value derived from the CHP function. This slave will be used when the broadcast will increase in the master CH. This will efficiently reduce the broadcast overhead of the master CH. In the future the scheme can be more optimized. Also in real time simulation environments can be tested to make it more efficient and trustworthy.

Acknowledgment

First of all we express our gratefulness to the Almighty Allah, without His divine blessing it would not be possible for us to complete this research. We sincerely like to thank our honourable supervisor Md. Manirul Islam, Department of Computer Science, American International University Bangladesh (AIUB) for his great inspiration and proper guidance throughout the whole research work. We are also grateful to all of our respected teachers without whom we would never be at this educational stage. We would like to show our gratitude to our parents for being so understanding. Last but not least we would like to express gratitude to our Department Head Dr. Khandaker Tabin Hasan for his proper direction to complete this work.

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Prediction of Suicidal Case Poisoning by Modeling and Simulation of Time Series

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***Abstract*- In Morocco, poisoning is a real public health challenge with its frequency and severity. In period of 1980 and 2007, more than 77,000 cases are listed by the Poison Control Center of Morocco (PCCM), such as the highest number of deaths in was the Souss-Massa-Daraa region, it is a PPD. This work aims to study the evolution of health indicators, and to determine the substance influencing intoxicated patients in the studied region. This study allowed drawing and for the first time the epidemiology of poisoning in the Souss-Massa-Daraa region during the last 21 years and the treatment is based on data of period 1992 2012. The forecast, based on modeling and simulation of time series, results show an increase in cases of suicide attempts in the year 2013Thus, the results show that the number of cases of poisoning and the mortality rate in our region are far from negligible. Besides, this modeling presents a decision making tools destined to reduce morbidity and mortality due to poisoning.**

I. INTRODUCTION

Poisoning is a set of the organism functioning disorders due to the absorption of a foreign substance, called toxic. A substance is said to be a poison when, after penetration into the body, by any means, at a relatively high dose (once or several times very close together) or in small, long-repeated doses, it causes, in the immediate or after a latent phase more or less prolonged, temporarily or lasting, disorders of one or more functions of the body up to their complete suppression and bring death [2]. Thus, poisoning is considered a major health problem worldwide (WHO, 2005). The available statistics is not exhaustive. In 2004, the World Health Organization [16] recorded 345,814 cases of poisoning deaths in the world, or 5.35 deaths per 100,000 of people. The victims were mostly adults (20-74 years old), but 13% were children (5-14 years old) [12]. In adolescents (15-19 years), poisoning is the 13th leading cause of death, while among children under 15; they are the 4th cause (2000-2001) after road accidents, fires and drowning [13].

In Morocco, according to data from the Anti Poison Center and Pharmacovigilance Morocco [17], 77 133 cases of poisoning were recorded with 1203 deaths in the period 1980-2007 [10]. The geographical distribution of cases of poisoning in different regions of Morocco shows that there is a difference between the regions of country. The number of returns, the number of deaths, the type of toxic as suspected, the effect, mortality, with the highest number of reports reported in the Grand Casablanca region (17.5% of the total cases). And, the highest number of deaths observed in the Souss-Massa region Daraa area (187 deaths) with a 3.9% case fatality rate [10].

Thus, the development of the strategies of antitoxic control is not uniform for all the regions, requires knowledge of the epidemiology of poisoning in each region. To evaluate the incidence, the mortality and to determine the risk factors, so to reduce the morbidity and mortality of these poisonings. Unfortunately, the exact dimensions of this phenomenon in the Souss-Massa-Daraa region are still poorly defined. This study is a retrospective epidemiological

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study of a series of cases that form the database of poisoning cases collected between 1992 and 2012 in the region of Souss Massa Daraa by PCCM. The objective of this study is:

To study the epidemiological profile of poisonings and to determine the risk factors influencing the vital prognosis of intoxicated patients in the Souss-Massa-Daraa region from 1992 to 2012, we will also study the evolution of health indicators in the different provinces. Using a model that provides monthly forecasts, cases of poisoning in the region of Souss Massa Daraa, whose dynamics are random, in order to provide stakeholders in the decision making tools. First, we discussed the epidemiology of poisoning in three parts, they are: determining the overall characteristics of poisoning for suicidal attempts and suicidal poisoning. In the second part, we have introduced new devices that we used mathematical modeling and simulation of time series. The goal is to provide decision support tools that by forecasting of suicidal cases poisoning.

A. Collect of information

Specialized in managing toxicological problems, the toxicant monitoring system based on the information management system (Information Technology IT) on the standardization of reporting cases of poisoning. The toxicovigilance and prevention programs are based on integrated data addict in local and regional situation (age and sex…) Fig. 1, the suspected product and poisoning (the time, place, circumstances, symptomatology, treatment and evolution). This qualitative and quantitative information's are useful for highlighting warnings and plan a strategy to antitoxic. Between 1992 and 2012, 5792 cases of poisoning were collected: at the level of the Toxicovigilance unit, the Toxicovigilance system had collected 3958 cases; the Toxicological Information had recorded 1834 cases. The frequency of reporting varied from one source to another and from one service to another (sees Table I).

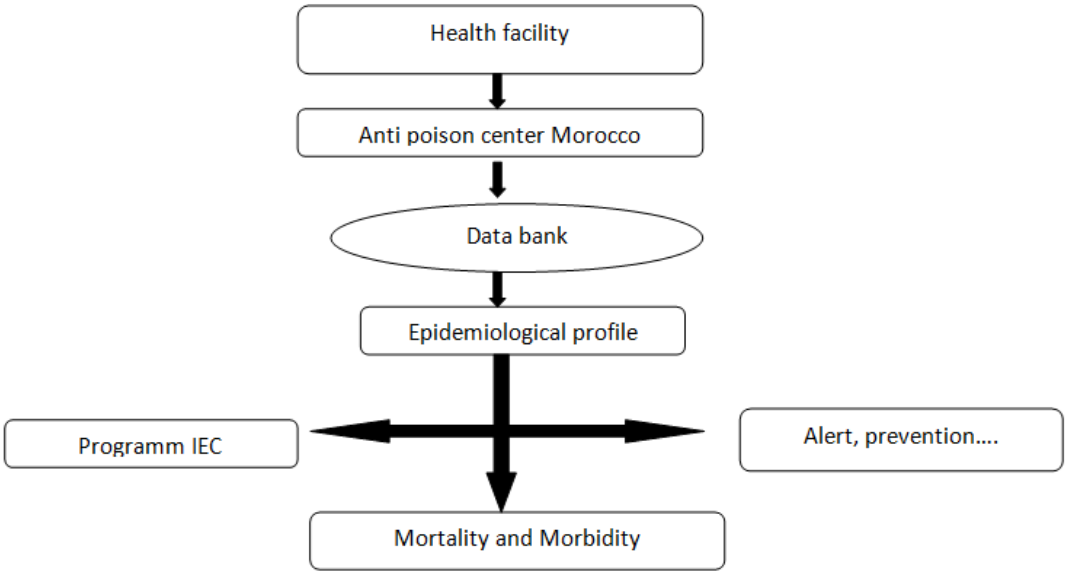

Figure 1. Magnetization as a function of applied field. IT of data collecte

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Table I

Number of cases recorded by information system, by source and by service

Center Information Technology	Provenance	Service	n (%)
Information of Toxicology (31,66%)	Home	-	217 (11,83)
	Hospital structure	Emergency	1364 (74,37)
		Pediatrics	33 (01,79)
		Resuscitation	16 (00,87)
		Dermatology	3 (00,16)
		Psychiatry	1 (00,05
	Pharmacy	-	42 (02,29)
	Telephone Cabinet	-	7 (00, 38)
	Other	-	5 (00,27)
	Unknown	-	247 (13,46)
			1834 (100,00)
Toxicovigilance (68,34%)	Hospital Structures	Emergency	3864 (90,67)
		Medicine	60 (00,08)
		Dermatology	6 (00,05)
		Pediatrics	28 (00,02)
			3958 (100,00)
Total			5792 (100,00)

The Toxicovigilance system had collected the most information. He was able to collect up to 68.34% of all reports, coming only from hospitals. The vast majority came from emergencies, most likely because of the dangerousness of poisoning. The telephone response, she had particularly interested the home, which could show that the population alert, declare and frequently seeks advice and recommendations.

The objective of the descriptive statistics is to describe, that is to summarize or represent by statistics, the available data when they are numerous. It consists of identifying the frequencies and characteristics of each studied parameter, which allowed us to draw up an epidemiological profile of poisoning in the Souss-Massa-Daraa region.

The results are expressed in raw values for the qualitative and average variables ± 1 the standard deviation for quantitative variables. The analytic statistics was based on association tests such as the Khi-2 test ($\chi 2$). (for more details) [15].

B. Data analysis

- Time parameters

The average annual number of reports was 275 cases. The year 1994 had the lowest number of cases (174 cases). While the year 2010 had notified the most cases (424 cases). Fig 2, illustrates the distribution of cases of poisoning reported by year, from 1992 to 2012 [4].

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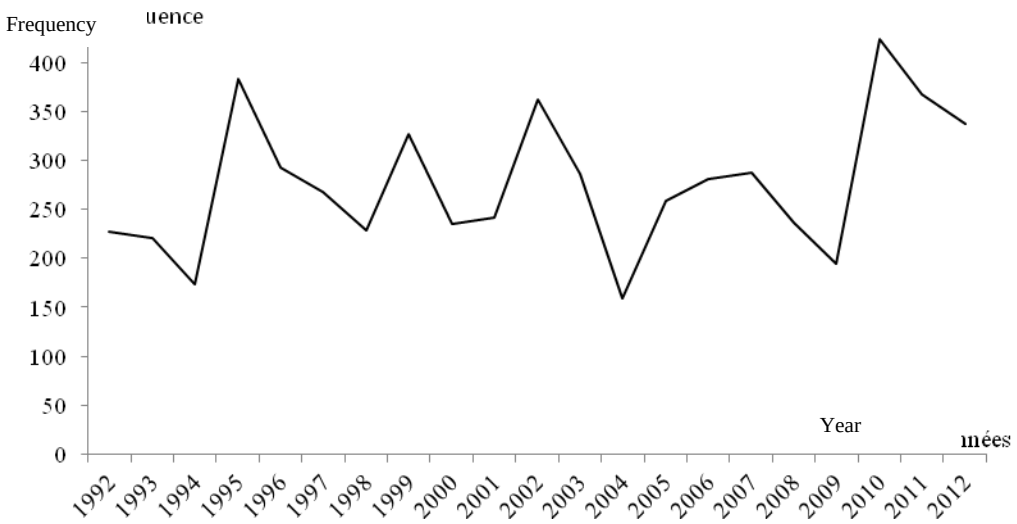

Figure 2. Annual distribution of cases of poisoning

The annual distribution of reported cases shows that reporting has been increasing since 1994 with a first peak in 1999, coinciding with the period when awareness became increasingly active in the reporting of PCCM poisoning cases. Through provincial stimulus letters, continuing education of health staff and open awareness days. The period between 2003 and 2004 had resulted in a remarkable decrease in the number of poisonings, with a minimum of cases in 2004. This decrease can be explained by the fact that in 2003, several awareness campaigns were conducted intensively and good dissemination of information has been done [9].

III. Prediction of Cases of Suicidal Poisoning by Time Series

A. Annual distribution of suicidal poisonings by the P-PhenyleneDiamine (PPD)

Ref. [15] the results presented in Fig. 3, show that each year, the suicidal poisonings by the PPD appear, on average in 6 cases, generating 2 deaths per year. In addition, the results of the evolution of the cases of attempted suicide by the PPD show a decrease in cases of suicide attempts and deaths between 1992 and 2012. It is also observed that between 2005 and 2012, there were no deaths at all been registered.

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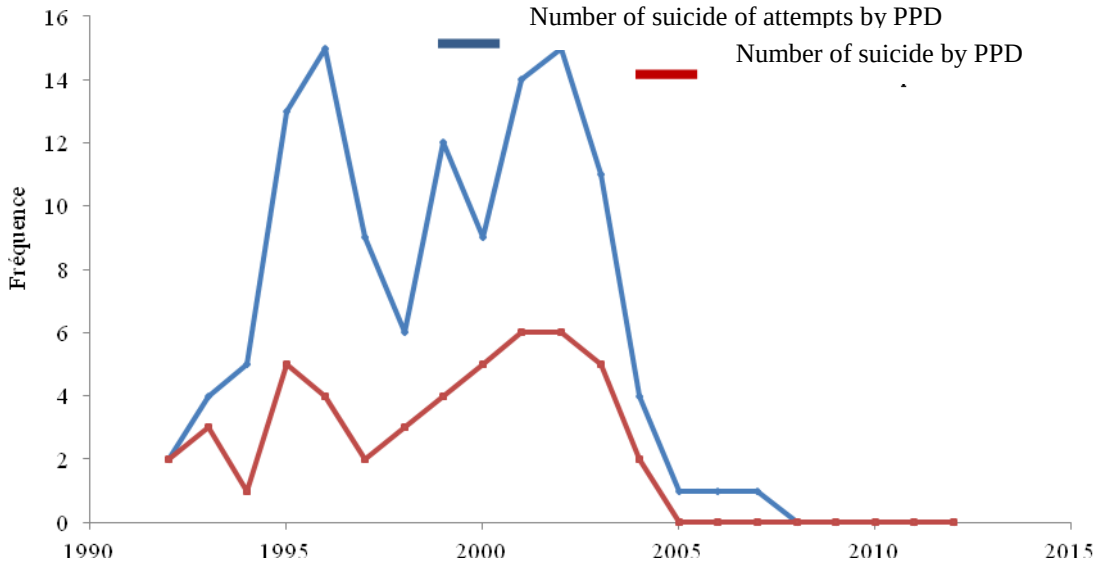

Figure 3. The annual evolution of suicidal poisonings by the PPD

Ref. [6] the number of addicts varies according to the year, such that the year 1994 had recorded the least number of cases, while the year 2010 had notified the most cases, after the year 2010 there was a slight decrease in the number of reports. This study was limited to 2012 due to lack of data (the databases are not always easy to grasp because the declarations are very numerous). Because of this, it is necessary to know the future forecasts.

The preceding remarks therefore lead to the conclusion that decision-makers (in the field of health, education, politics, etc.) have great difficulty in making the best decision for reducing the morbidity and mortality of poisoning in our region. For this reason, that we are using a model that allows obtaining monthly forecasts, cases of poisoning in the Souss-Massa-Daraa, whose dynamics are random, in order to offer stakeholders of the decision making tools in public health sector.

B. Problematic and objective

According to the epidemiological profile results of poisoning in the Souss-Massa-Daraa and the risk factors we recorded 1154 cases of suicide attempts with 91 cases of death and a risk of 3 times more than the other circumstances of death. Poisoning which shows the seriousness of suicidal poisoning [15, chapter 2].

Indeed, the annual distribution of cases of suicidal poisoning shows that the year 1996 had recorded the most cases, or 118 cases, while the year 2009 had notified the least case, or 20 cases. According to the results of the distribution of the evolution of suicide attempts, the years 1993, 1995 and 2002 recorded the most cases of fatal suicidal poisoning, with respectively, 11 deaths, 12 deaths and 11 deaths.

After 2003, there has been a remarkable decrease in cases of suicide attempts and suicide during the period 2003 and 2009. Starting in 2010, cases of suicide attempts and suicide have increased again Fig. 4,. This can be explained by the following events:

- Prohibiting the sale of PPD (a toxic substance widely used in this region for suicide) in 2003 plays a very important role in reducing cases of suicide attempts during the period 2004-2009.

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- After the year 2010, we recorded a successive increase of suicide attempts. This may be because of, people are looking for other toxic products for use in suicide after the prohibition of PPD. It has been confirmed by [15], which shows an increase in the use of drugs, pesticides and agricultural products [4, 9].

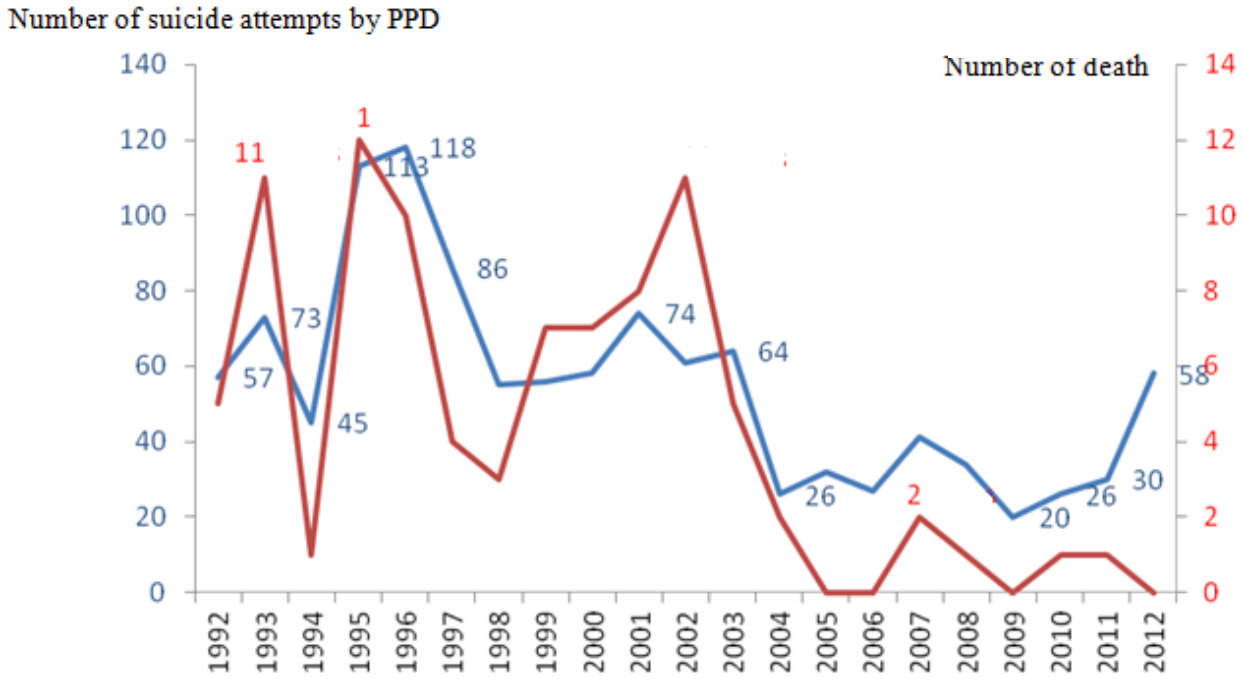

Figure 4. Annual distributions of cases of suicide and suicide attempts by toxic products between 1992 and 2012

Increased cases of suicide attempts through the use of toxic products ranging from 20 cases in 2009 to 58 cases in 2012. So, given this dynamic of this series, we are obliged to know its tendency. At least general, to understand this dynamic, using a model that provides monthly forecasts, suicidal poisoning cases in the Souss-Massa-Daraa , in order to offer industry stakeholders decision-making tools to minimize the damage.

C. The methodology of forecasting

The development forecasts cases of suicidal poisonings in this area is based on historical statements of cases of suicidal poisoning have been recorded by the PCCM for the period 1992 and 2012. Thus, the data are a series of case of suicidal poisoning evolved over time. So the prediction of many of the suicide attempts is based on past values to predict future values. The most appropriate prediction technique with data by time series modeling.

To decrease the uncertainty of prediction, we chose a short-term horizon to predict the number of cases of suicidal poisoning in the Souss-Massa-Daraa. Thus, we measured the monthly number of cases of suicidal poisoning during 2013.

Indeed, there are several predictive models for time series. We chose a basic model, it is "Autoregressive Integrated Moving Average" (ARIMA), developed by Box & Jenkins (1976) [3], which treats only phenomena that are linear or approximately but does not allow “capture "the properties of nonlinear phenomena. In addition, the ARIMA model is used in short-term forecasting.

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Ref. [3] the Box & Jenkins methodology aims to formulate a model to represent a chronicle with the purpose of predicting future values. As such, the purpose of this methodology is to model a time series based on its past and present values to determine the appropriate ARIMA process by parsimony [1]. This methodology suggests a following procedure: Identification, Model estimation, Model validation and Prediction.

D. Analysis and simulation of the prediction model

1. Identification

Before using the ARIMA procedure, we must first examine the series and verify its stationarity with a time chart Fig.5,. If the average of the series or its variance shows a variation over time, then it is necessary to differentiate the series or to use a transformation which makes the series stationary and to verify the stationarity.

2. Sequential diagram

The sequence diagram is very important because it allows us to determine if a series is stationary or not. It is important to begin the study with this diagram.

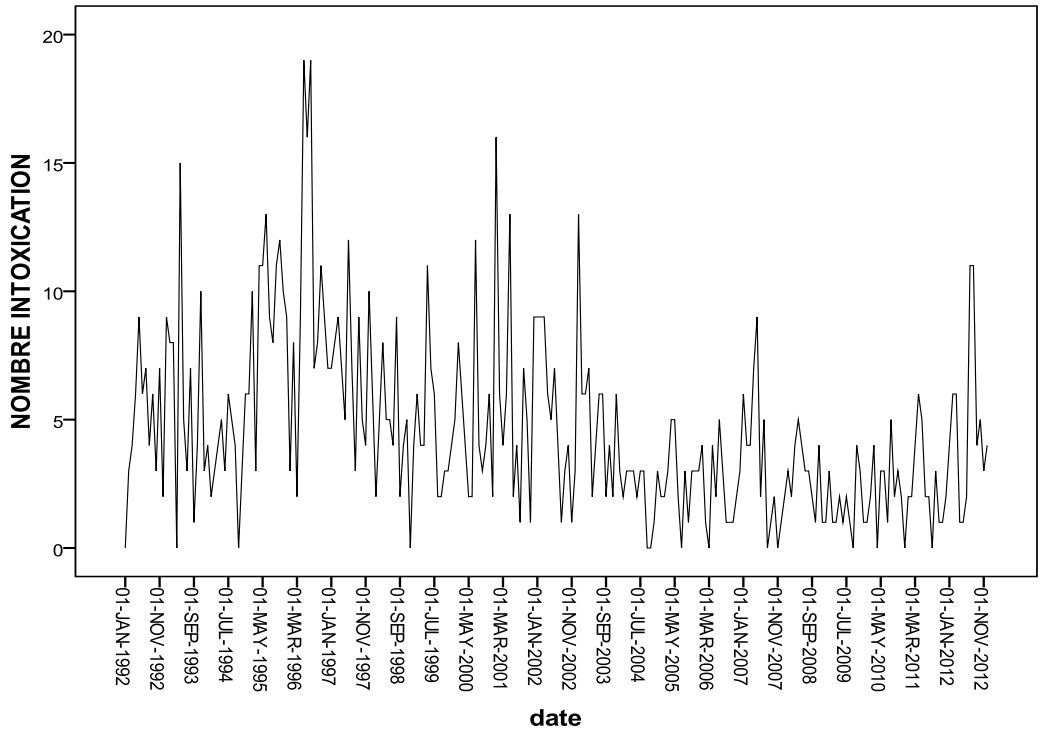

Figure 5. Monthly distributions of suicidal poisonings between 1992 and 2012

Apparently, this series is not stationary: it seems to be present on the one hand a break of trend and on the other hand a volatility of values which diminished over time

3. Stationarity of serie:

To improve the trend, it gives the difference in the value 1 this variable corresponds to the ARIMA model.

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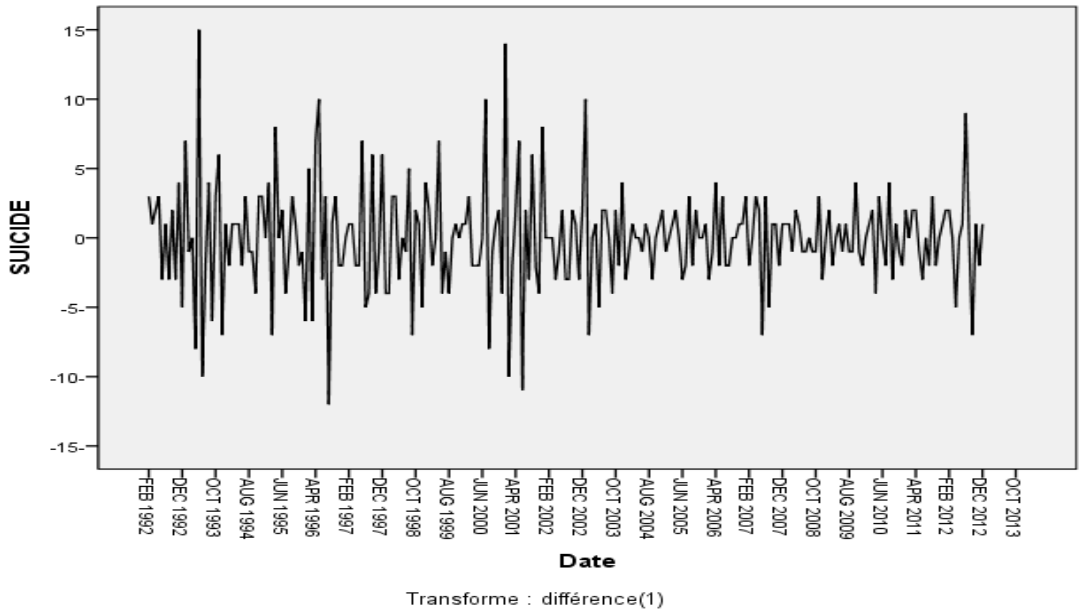

Figure 6. Diagram of the differentiated series of order 1

.

From the figure above, we note that there is still a trend, so we give the difference d the value 2. The graph thus obtained shows the effect of the differentiation: the differentiated series no longer seems to present trend and its volatility does not seem to increase anymore with time. Indeed, the series presents a kind of stationary but to be sure we will try to stabilize the variance.

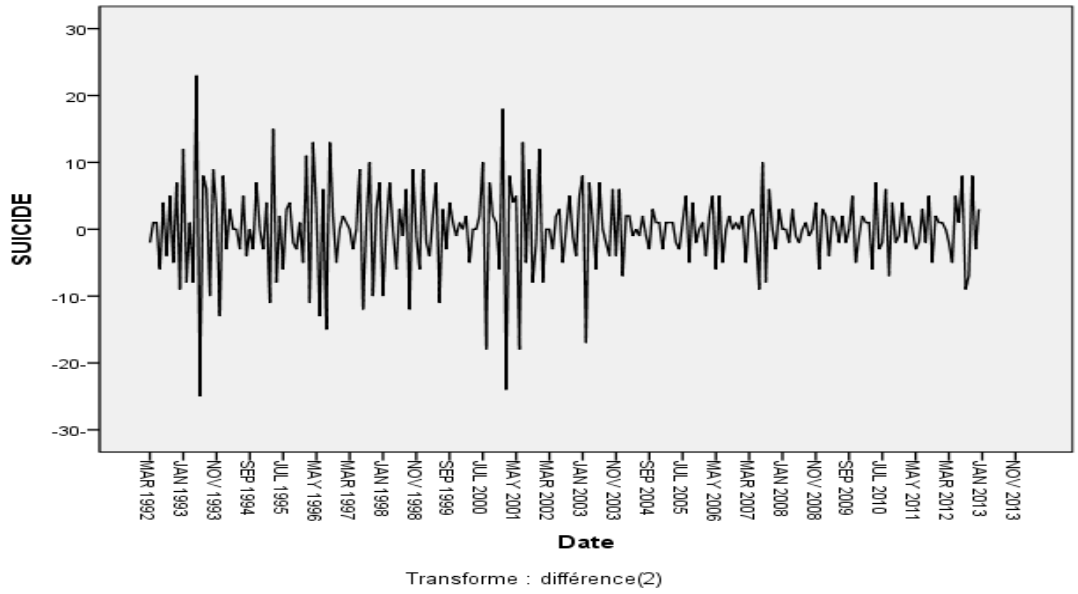

Figure 7. Diagram of the differentiated series of order 2

The time series is ready for use in the following. Seasonality: Values are given for each month so periodicity does not exist.

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4. Verification of stationarity of serie

The visual examination of the correlogram (ACF, PACF) shows that the coefficients of the autocorrelation function are close to 0 for all offsets, which indicates that the series is probably stationary Fig.8,.

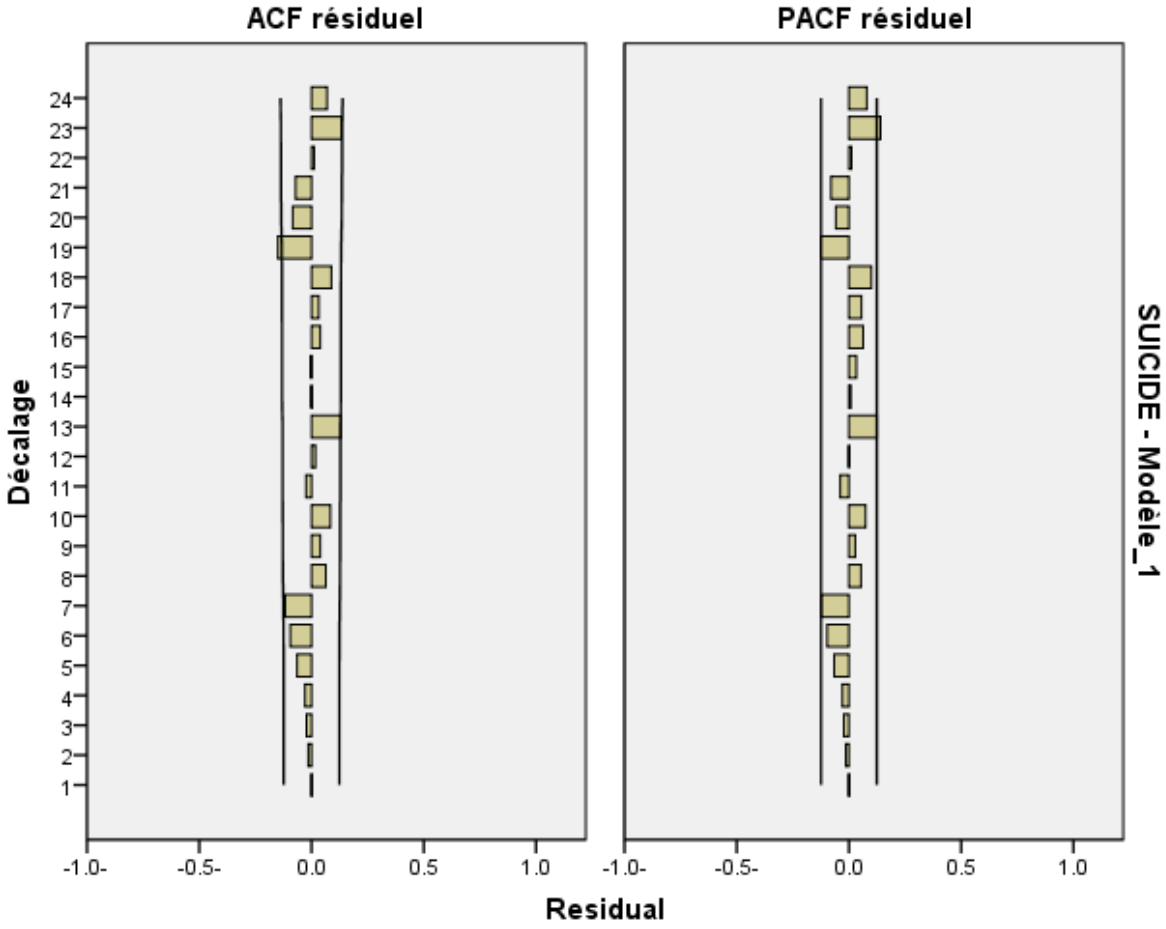

Figure 8. Correlogram (ACF, PACF) of the stationary series

5. Estimation

After obtaining the stationary of the series, the next step is to analyze the autocorrelogram ACF and that of PACF to determine *p* and *q*.

The parameter d is already fixed by the number of differentiations made to make the series stationary, then $d = 2$.

Indeed, we tested several models by the variation of the value of p and we find that the most suitable is *ARIMA (5,2,1).*

E. Validation of ARIMA (5, 2,1) model

- *Independence of residuals*

The residuals between the observed values and the values estimated by the model must behave like white noise. These residues follow a white noise whereas the autocorrelation function of the residues does not contain

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autocorrelations significantly different from 0. According to the previous correlograms (ACF, PACF), all the coefficients of the autocorrelation function are close to 0.

A statistic is used to test for white noise is the Ljung-Box statistic. This verification can easily be done using the SPSS Autocorrelation procedure which gives the Ljung-Box statistic so if the test value is greater than a risk threshold already set (sig>0,05), then we accept that residues are white noises. The Ljung-Box test on our model gives a value of 0.1 which is greater than 0.05, so we accept the hypothesis (see Table II).

Tableau II

Estimation of parameters

Tableau I Estimation of parameters							
Model	Number of independents variables	Statistics of quality of model adjustment		Ljung-Box Q(18)			Number of far values
		R² stationary	BIC standardized	Statistics	Degree of freedom	Sig.	
SUICIDE-Model_1	0	0.751	2.611	18.304	12	0.107	0

- *Normality of residuals*

The Kolmogrov-Smirnov test was used to verify the normality of the residues. In fact, if the test value is greater than a fixed a priori risk (0.05), it is significant in other words we accept the normality of the residuals. From the chart below our test gives a higher value of Z is 0.05, and then we accept the normality of residuals.

Table III

Test of Kolmogorov-Smirnov applied to sample

		Residual fo bruit fo SUICIDE-Model _1
N(size of sample)		250
Normal parameters a, b	Average	-0.07-
	Sd	0.792
Most extreme Differences	Absolute	0.070
	Positive	0.038
	Negative	-0.070-
Z of Kolmogorov-Smirnov		1.100
Asymptotic Meaning (bilateral)		0.178
a. The distribution to be tested is Gaussian. b. Calculated from the data.		

Another test to check the normality is the stationary R² test if it is close to 1 so we have a white noise. We have a stationary R² value of 0,75 which are close to 1, then one accepts the hypothesis of the normality of the residuals.

F. Model Comparison Criteria

If there are models whose verification of independence and normality on residues are verified, it is imperative to choose among these models the one that is the most significant. One criterion is available. This is the Bayesian

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Information Criterion (BIC) (see Table IV). The best of the models is the model that minimizes this statistic. The results in table below show the BIC of our model to a value of 2.6 is a minimum value relative to the models tested.

Table IV

Quality of adjustment

Statistic of quality of adjustment	Average	SE	Minimum	Maximum	Percentile						
					5	10	25	50	75	90	95
R^2 stationary	0.751	.	0.751	0.751	0.751	0.751	0.751	0.751	0.751	0.751	0.751
R^2	0.041	.	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
BIC standardized	2.611	.	2.611	2.611	2.611	2.611	2.611	2.611	2.611	2.611	2.611

From the previous steps, our model *(5,2,1)* is valid. Our model is adequate and will then be used to predict values for the months of the following year.

G. Making of forecasting

From Fig. 9, we note the model chosen is well adjusted the observations that allowed us to make forecasts whose purpose to know the type of trend of cases of suicide attempts for the year 2013 based on data collected from 1992 to 2012.

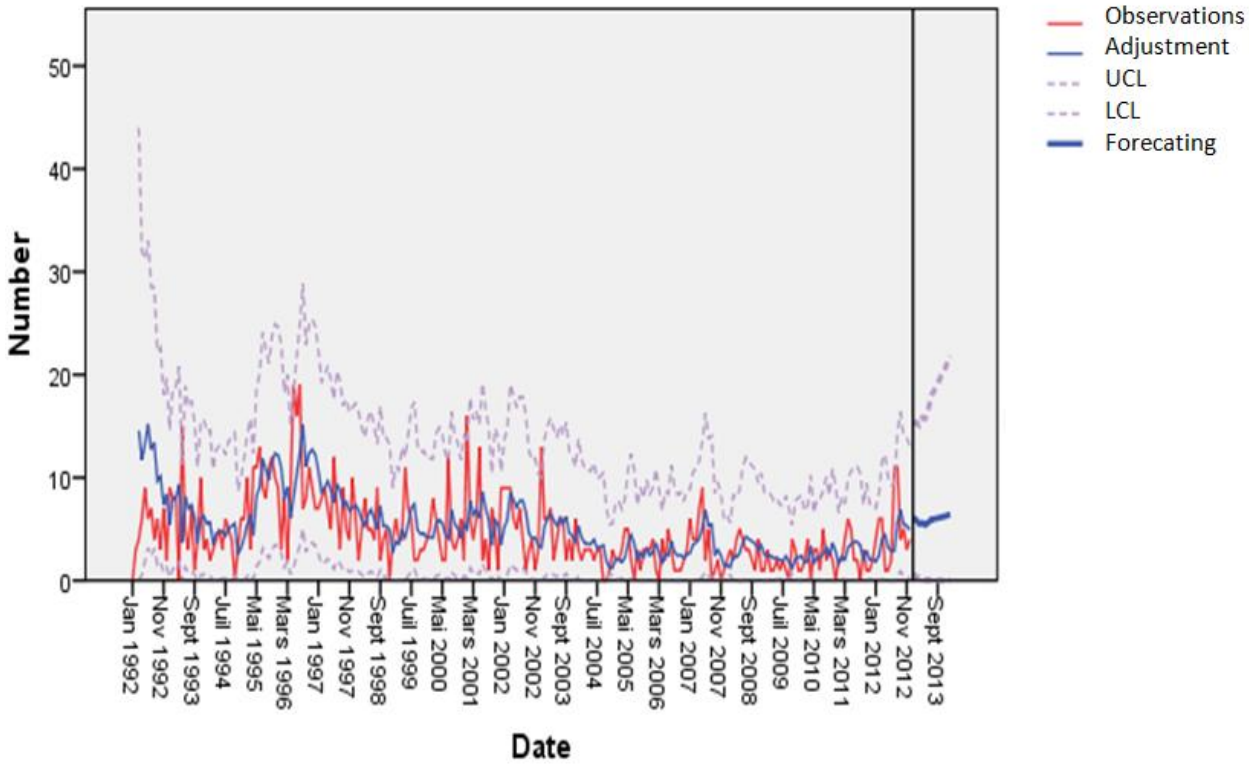

Figure 9. Forecasting of *ARIMA (5, 2, 2)* for poisonings suicidal cases since the month of 2013

The graph shows that the number of cases of suicidal poisoning shows an increasing trend with a forecast interval that covers the values of cases of suicidal poisoning at 95%. This growth confirms our results, which show an

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increase in cases of suicide attempts through the use of other toxic products (drugs, pesticides and agricultural products, etc.) after the ban on the sale of PPD.

VI. Conclusion

The results of the predictions showed that the growth of the number of cases of suicidal poisoning in 2013 in our region studied is far from negligible. These data are important to consider in public health, especially in the area of mental health. The majority of cases of suicidal poisoning are preventable, and in many cases, preventive measures are available. the databases are not always easy to grasp because the declarations are very numerous.

The development of forecasts could be carried out for each category of products, in order to better determine the evolution of the use of each type of toxic product in suicides. The regulation and control of the sale of drugs, pesticides and agricultural products is mandatory in order to limit the use of these products in suicides.

Acknowledgment

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A New Communication Architecture Model for Smart Grid

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***Abstract*-Nowadays, the power grid infrastructure becomes more intelligent by using advanced information and communication technologies (ICT). The Smart Grid, which is the new generation power grid, requires a scalable, sophisticated, reliable and fast communication infrastructure. Countries around the world are dealing with the problem of finding the most appropriate architecture that can satisfy their future communication needs. This article focuses on the Smart Grid communication architecture. We describe the conceptual models proposed by international organizations: NIST (National Institute for Standards and Technology), IEEE and ITU. A simulation study is performed to understand the requirements and limitations of these models. Then, we present a new model based on these international roadmaps and guides, with the possible communication technologies that can be used to interconnect the components and standards for each section. This model fulfills the six functionalities that Smart Grid network must achieve. Finally, we give attention to the customer side or the Home Area Network.**

Keywords: Smart Grid; Communication infrastructure; SG services; HAN

I. INTRODUCTION

Smart Grid is a vision, a collection of technologies and services, and a series of projects to upgrade our current electrical system, using two-way communication technologies and computer processing. The main role of a Smart Grid is to perform continuous self assessments to monitor and analyze its interconnected elements, and to predict potential failures and future outages. It is composed of a large number of heterogeneous entities which forms a whole system hard to predict and hard to describe. For this reason, Smart Grid is classified as a complex system [1].

On the other hand, Smart Grid requires a flexible and efficient framework to ensure the collection of real-time and accurate information from various locations in power grid to provide continuous and reliable operation. Most of the technologies required to create a Smart Grid are available today, and many utility companies are also implementing Smart Grid in their countries (e.g. US, China, India, Finland) [2]. However, in order to analyze this system of systems, the network architecture must be defined. Many international organizations, such as NIST, ITU-T (Telecommunication Standardization Sector) and IEEE, propose their own models. These models are conceptual and can't be used to grasp the relationship between the system components. They represent only guides and roadmaps to understand the general operation of the system, and introduce basis to discuss the characteristics, uses, behavior, interfaces, requirements, and standards of the Smart Grid. So, these models are only a tool to describe Smart Grid architecture.

One of the most challenging aspects in Smart Grid is the communication and information network. The later has not been clearly investigated. In this article we intend to propose our own Smart Grid architecture, based on the international guides mentioned above. This architecture supports the six functionalities that Smart Grid must fulfill, as described in the U.S. Department of Energy (DOE) [3]. This issue has been investigated by many researchers. Aggarwal et al [4] modeled the communication bandwidth requirements for the distribution network in the future

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grid using mathematical formulas. They focused on the advanced metering infrastructure (AMI) and proposed an IP-based network to provide predictive information and suggestions to both customers and utilities. Nagesh et al [5] studied also the AMI network, and especially the real time management system. They used the business intelligent tools to study the distribution network and extend the study to the transmission network. They present the benefits of this new architecture. Another work [6] presents a new architecture security model for Smart Grid communication network. This architecture incorporates three services among the six Smart Grid functionalities, namely, the Advanced Metering Infrastructure (AMI), the Demand Response and the Distributed Energy Resources (DER). Authors identified the security requirements for this group and proposed a model that fulfills these requirements and focused on the communication aspect.

Unlike the aforementioned contributions, we defined an architecture that takes into account all the six services. We aim mainly to identify the requirements and limitations for communication architecture to get an efficient topology from the customer side to the utility. And we explain the functioning of essential components of a robust architecture. We divide the analysis into three parts depending on the network studied: Home Area Network (HAN), Neighborhood Area Network (NAN) or Wide Area Network (WAN). Once the architecture is detailed and the interaction between its components is explained, we propose, for each communication interface, the possible technologies and standards that we can use for these links.

This article is structured as follows. The next section provides a brief review of the Smart Grid history and the international models proposed by NIST, ITU and IEEE. Moreover, it introduces the six services and details the architecture's three parts of our analysis. Then we identify the communication requirements of a simple architecture model between the customer side and the utility. The section after, describes our new model architecture based on the international guides and roadmaps, the interfaces between sections and the communication standards and technologies used in the interconnection. In the fifth section, we give attention to customer side which is the HAN network. We detail its interfaces and communication network, before concluding.

II. BACKGROUND

The first official definition of smart grid has been published in the Energy Independence and Security Act of 2007 [7]. This act aimed to move the United States toward greater energy independence and security, by increasing the utilization of renewable energy sources, the development of smart technologies including appliances, devices and vehicles, and the development of standards for communication and interoperability of appliances and equipment connected to the grid [7]. Many international organizations have integrated the movement and presented their own models. In this section, we present the well-known international models, the services or functionalities that Smart Grid architecture must fulfill, and the sections of this architecture.

A. International architecture models

In order to establish a standard and develop recommendations for the Smart Grid from the communication technologies perspective, the international organizations of standardization have proposed their own models. We discuss here three of the famous models.

The Smart Grid is comprised of many networks (domains) that have to be interconnected to provide end-to-end services. The challenge is to design network architectures that can meet the interoperability requirements for inter-

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domain and intra-domain communications. One of the first and well known models is the NIST conceptual mode [8]. It developed a framework that includes protocols and standards for information management to achieve interoperability of Smart Grid devices and systems. This model is composed of seven domains, as shown in Fig.1. These four domains in the lower layer (bulk generation, transmission, distribution and customer) are related to electrical power system. The three remained domains (the market, operations, and service providers) are related to the regulatory operation. Each domain embodies the Smart Grid actors and applications. Actors include devices, systems, or software programs that make decisions and exchange information, with other actors, necessary for performing applications. On the other hand, applications are tasks performed by actors within a domain [8]. This model provides a foundation for utilities in the development of their particular Smart Grid architectures and to serve as a guide for implementing specific features designed to make their electric grid smarter. It defines the potential communication and information flow and the interconnection between domains. So, this is a descriptive model that does not define any solution for the implementation purpose, but it can be used only to understand the functioning of Smart Grid.

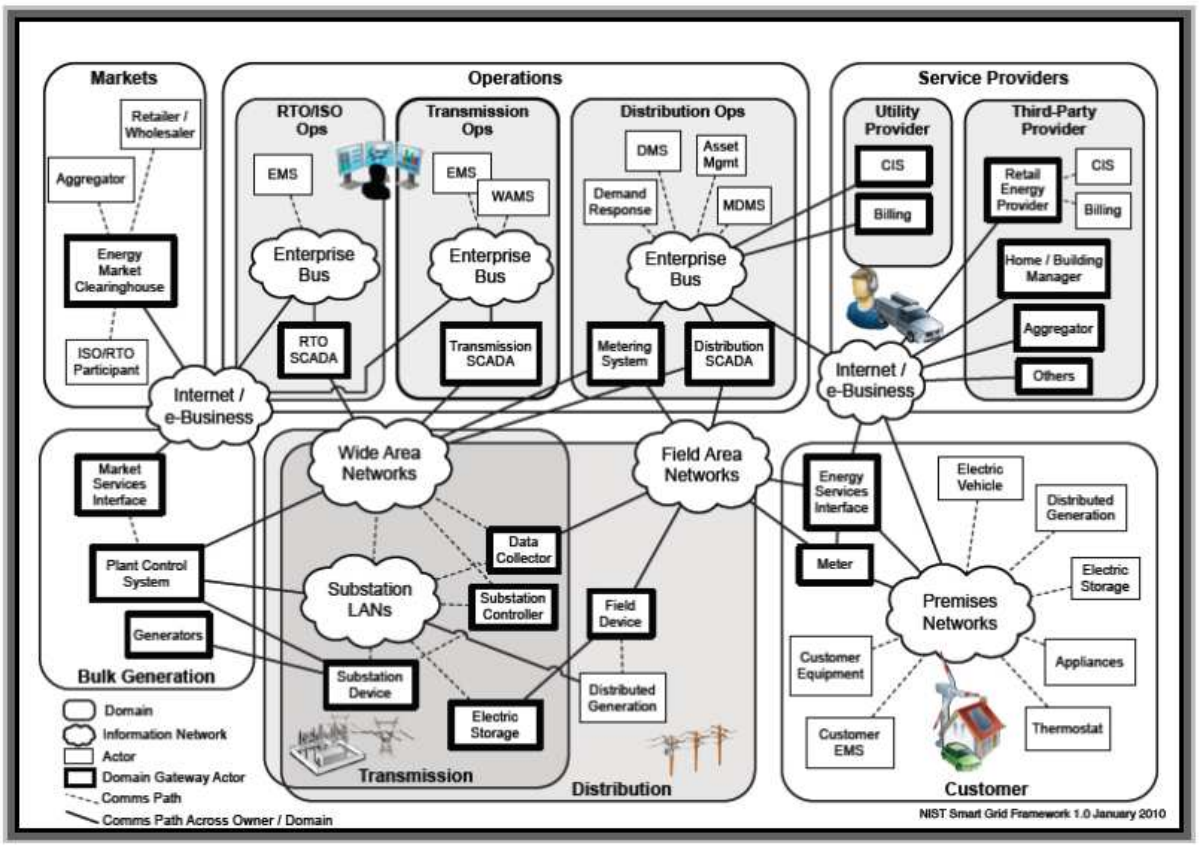

Figure 1. Conceptual Reference Diagram for Smart Grid [8]

Explicit efforts have been made to adopt the terminology used by NIST to ensure a consistent architectural framework for the Smart Grid. IEEE Std 2030 SGIRM (Smart Grid Interoperability Reference Model) provides alternative approaches and best practices for achieving Smart Grid interoperability [9]. It is a conceptual

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representation of the Smart Grid architecture from three perspectives: 1) power systems; 2) communications; and 3) information technology. This model aims to provide organizations with standards-based architectural direction to achieve Smart Grid interoperability, and the ability to communicate effectively and transfer meaningful data, even though they may be using a variety of different information systems over widely different communication infrastructures. It is composed of many domains. Within each domain or between different domains, the entities are connected to each other through one or more interfaces. The number of interfaces connecting one or more entities represents the available, future and most relevant interconnection alternatives. However, it is not meant to give all details required for the designer of new architectures, it provides only generic and standard framework elements and view of domains and how they are connected to each other, with coded entities and interfaces that can be detailed and refined for particular needs by each organization.

The third model we discuss is the ITU-T model [10, 11]. This is another conceptual model, which is a simplified reference model derived from the NIST one. It reduces the number of domains from seven to five as shown in Fig. 2, and defines five external interfaces between various domains, that should be the focal point of standardization efforts, named: reference points. However, this model can be used only as roadmap for Smart Grid implementation. Also, the choice of what type of network is needed to support a particular Smart Grid function shall be driven by the requirements of that function.

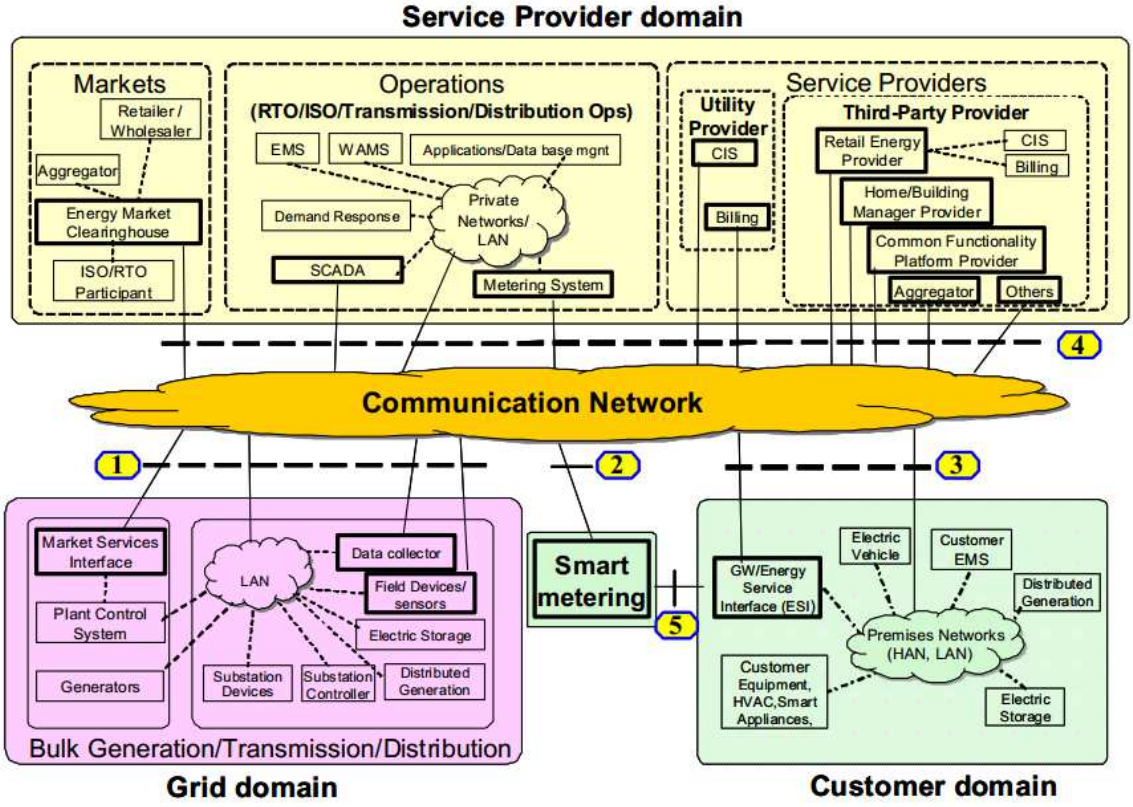

Figure 2. Simplified reference architecture for Smart Grid [10]

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B. Smart Grid services and sections

In 2010, the U.S Department of Energy published a report on the communications requirements of electric utilities and proposes specific recommendations for next steps to support these requirements [3]. This report is built upon Federal Energy Regulatory Commission (FERC) work, completed by NIST. It identified six key priority functionalities of the Smart Grid as follow: AMI, DR, EV (Electric Vehicles), DER, WASA (Wide-Area Situational Awareness), and DA (Distribution Automation).

Based on communication requirements (data rate, coverage range...), the Smart Grid architecture can be divided into three sub-networks, which we will detail later: HAN, NAN, and WAN. Each network supports different functionalities as shown in Table I.

TABLE 1. SMART GRID FUNCTIONALITIES BY NETWORK

	AMI	DR	DER	EV	DA	WASA
HAN	X	X	X	X		
NAN	X	X	X	X	X	
WAN	X	X	X	X	X	X

III. ANALYSIS OF SMART GRID REQUIREMENTS

In this section, we study a simple Smart Grid architecture named the last mile. This is a part of the network that connects the customer side or HAN to utility network. The goal of this study is to show the limitations of communication network in Smart Grid, and that this network needs a more attention. The architecture is shown in Fig. 3. Each customer has an Energy Services Interface (ESI), also known as HAN gateway through which a customer's HAN communicates with the utility. This device sends data to concentrators or Data Aggregation Points (DAP) via multiple nodes associated to feeders and then the aggregated information is sent to the Substation via a backbone network. We basically consider a linear communication chain that is a radial multi-hop topology formed by nodes in top of feeders. The first node is the one that receive that receive traffic from ESI, and the last one is the DAP. Distance between poles varies by country and grid architecture. We choose an average of 100 meters in our example. So, nodes are separated by a constant inter-node distance of 100m. We can use either the wired or wireless technologies. However, the implementation of wireless technologies offers many advantages over wired ones, e.g. low installation cost, mobility, rapid installation, etc. So, we choose WiFi as an example. Data traffic in the feeder network can be estimated by a few hundred kilobytes. Nodes transmit data continuously and in regular intervals. Since data is sampled periodically, Continuous Bit Rate (CBR) traffic is assumed in our model to simulate the traffic in the network. For simulation we have used NS-2 (Network Simulator-2 version 2.34) under fedora 14. The routing protocol is AODV; it is the best choice for ad-hoc network and performs better than other reactive and proactive protocols [12, 13]. We define two metrics to measure the performance of our chain:

1) Packet Delivery Fraction: defined as the number of packets successfully received by a receiver over the expected number of packets. The Smart Grid network comprises millions and even billions of devices. The generated traffic is high, and then the transmission of lost packets once again will generate an additional traffic. This parameter is used to show the ability of the network to send data without loss.

2) Average End-to-end Delay: defined as the average time taken for packets to be transmitted from the sending application to the receiving application. This metric measures the network ability to send packets in a real-time or

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near-real-time manner depending on the NAN application. In this article, we will not discuss the requirement latency for NAN functions. We will only try to minimize as much as possible the value of this metric.

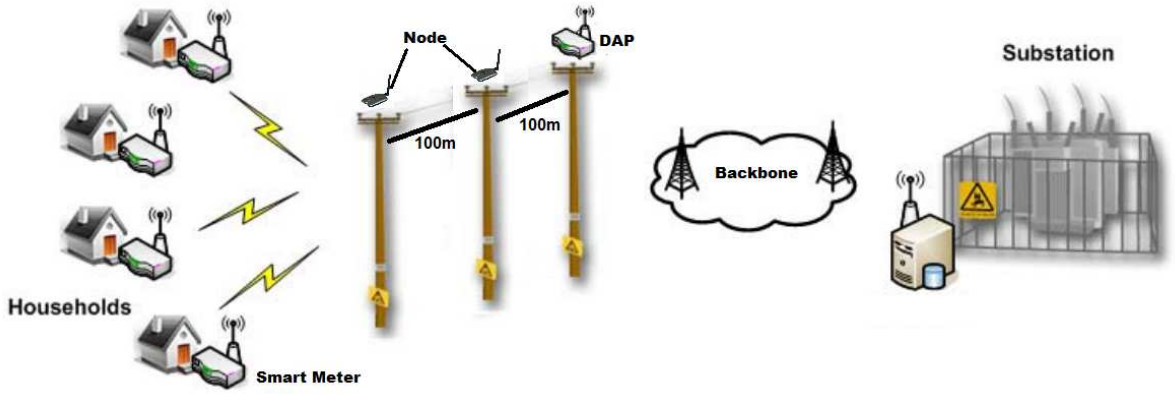

Figure 3. NAN communication architecture

In the first three scenarios, we suppose that only the first node generates the traffic and the DAP is the sink. Other nodes just route data from the source to the destination.

A. Scenario 1

In our first scenario, we fixed the length of the radial chain to 10 km, which is the maximum communication range requirement for Smart Grid NAN network [14]. We varied data rate from a low value to 1 Mbps. Results are shown in Fig. 4. We can see that when the data rate is less than 0.2 Mbps, the packet delivery fraction is approximately 100%. However, when data rate exceeds this value the packet delivery fraction would decrease from 100% to a value less than 20%. The average end-to-end delay also increases significantly after 0.2 Mbps. The exact value from which the fraction of packets received successfully decrease from 100% and the average delay increases is 0.12 Mbps. From these results we can conclude that the optimum value for communication data rate for a length chain of 10 km to achieve a good performance is 0.12 Mbps.

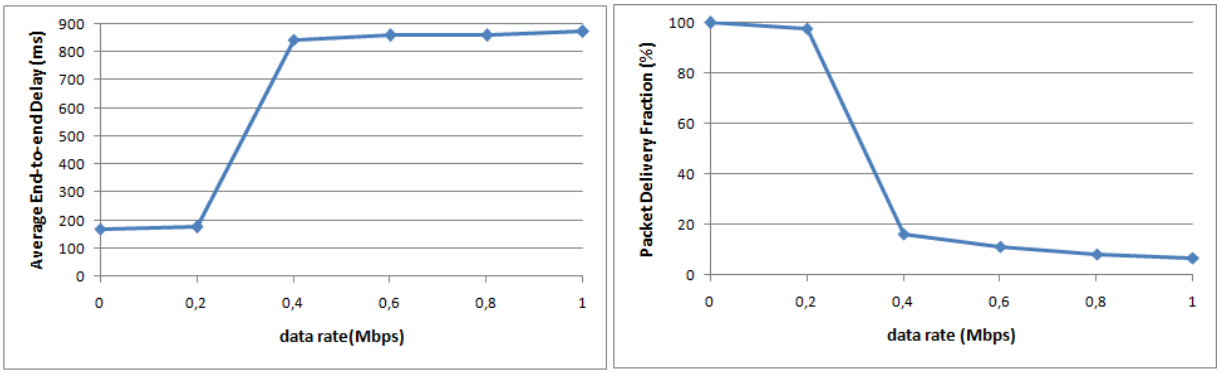

Figure 4. Results for different data rate

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B. Scenario 2

Under this scenario, we fixed data rate to 0.12 Mbps and varied the chain length from 2 to 26 km to calculate the maximum length that ensures the communication performance. Fig. 5 highlights this simulation. When the chain length increases from 2 to 25 km there is a linear increase in the average end-to-end delay and the packet delivery fraction is generally 100%. Once the length exceeds 25 km we observe a remarkable fall in the packet delivery fraction value. Thus the maximum length of this radial topology is 25 km.

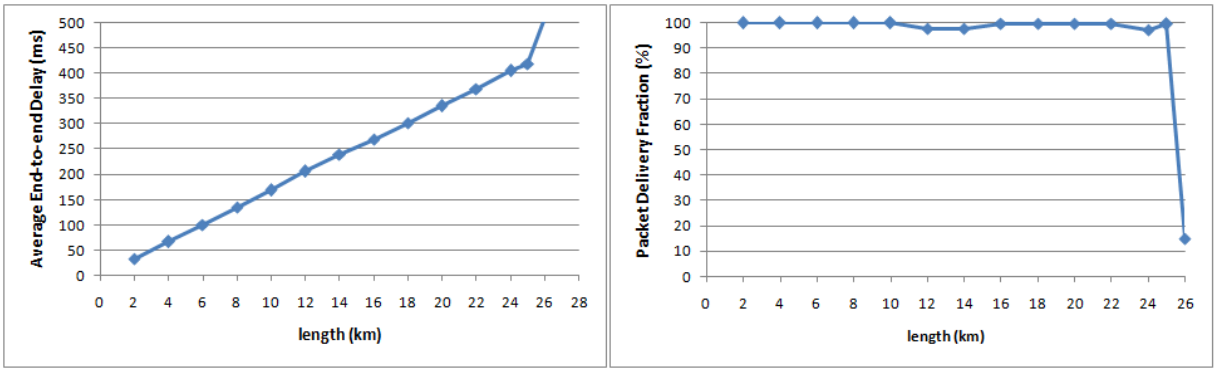

Figure 5. Results for different chain length

C. Scenario 3

The two metrics against varying the packet size were evaluated in this scenario to decide the optimum value for this parameter required to provide a relevant performance. Data rate was fixed to 0.12 Mbps and we simulated the performance for both 10 and 25 km. packet delivery fraction and average delay for these two cases are plotted in Fig.6. It can be seen from this figure that the average delay increases with data rate in both cases. To ensure a packet delivery fraction of 100% with acceptable delay the optimum value must be 500 to 600 bytes.

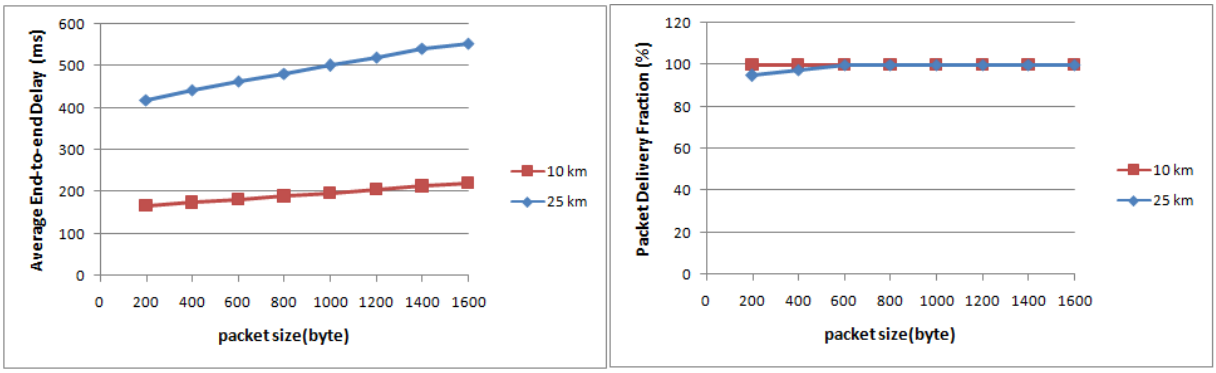

Figure 6. Results for different packet sizes

To find the exact value we simulated another metric: Average Throughput. It is defined as the average of the total number of packets delivered over the total simulation time. From Fig. 7 we can see that 600 bytes is the optimum value for the packet size.

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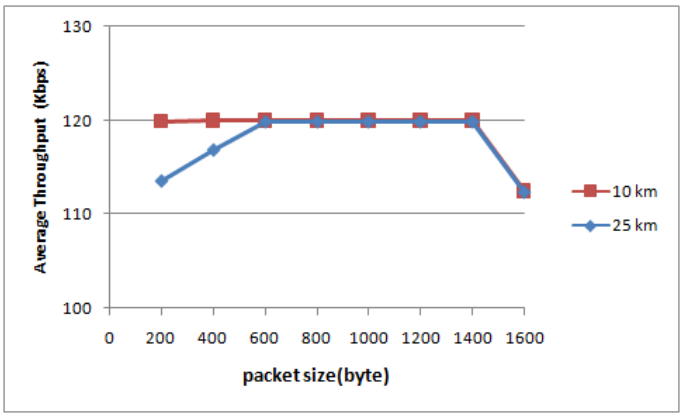

Figure 7. Average Throughput vs packet size

D. Scenario 4

In the previous simulations we assumed that only the first node sends data which is an ideal scenario. If all nodes send packets to the sink node we would see performance degradation (Fig. 8). The packet delivery fraction decrease from 100% (one node sends data in 25 km) to 2.44% (all nodes send data in 25 km) and 6.25% (all nodes send data in 10 km). Nodes cannot transmit together without packet collisions. The network model suffers from other problems. However, finding solutions for these problems is out the scope of this article.

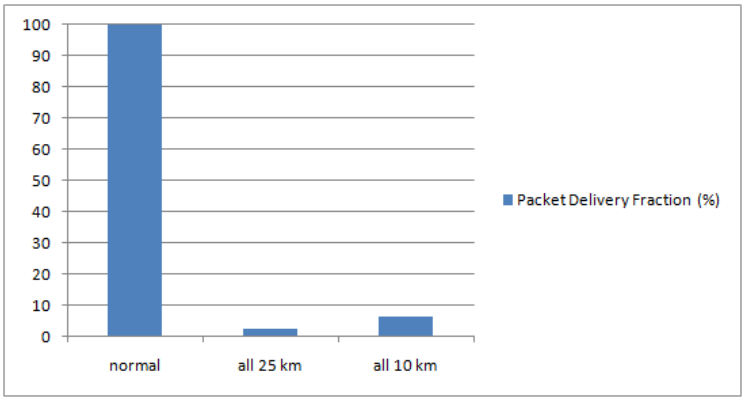

Figure 8. Real scenario vs ideal scenario

To summarize, when data rate exceeds 0.12 Mbps, the queuing and transmission operations take more time than the small data rate value (less than 0.12 Mbps). So, the delay and packet loss augment due to collision. The 25 km limitation is related to the route discovery which is an obstacle in multi-hop network. It takes longer time to complete as the number of hops increases. However, this length can be increased by using a multi-tier multi-hop architecture [15]. The idea of this architecture is to divide a very long chain-topology network into several shorter segments and each segment is connected to neighboring segments using a longer-distance communication approach, such as WiMAX, to greatly reduce the number of hops required for route discovery and data forwarding. For the packet size, the optimum value is 600 bytes. It minimizes the delay and avoids congestion in the network by avoiding fragmentation. We presented here a simple architecture for the last mile, with an ideal communication network.

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Since this architecture represents limitations in term of communication, it is important to define new robust architecture and optimize it. In the rest of this article, we will present our new model.

IV. NEW ARCHITECTURE MODEL

As we mentioned early in second section, the architectures model presented by NIST, IEEE and ITU are conceptual. We aim to present a new architecture adapted from the three given models, and we detail, in particular, the communication network. The analysis is divided on two big parts. The first is devoted to architecture and the components of each network, namely, HAN, NAN and WAN. We present the main and essential components and systems of Smart Grid, and not the whole system and all its details. Therefore, we mention the mandatory systems for the proper functioning of Smart Grid. The second part is the communication between these components. We define external interfaces without discussing the communication intra-system.

A. Architecture description

A Home Area Network (HAN) is a network contained within a user's home that connects user's appliances and electrical vehicles to a common network. It also contains renewable energy resources and storage equipments to save the generated energy, as well as software applications to manage and control all these devices.

Appliances are all devices in the home that can be connected to the electricity network, and they may include a technology known as Smart Plug (SP), which allow devices to communicate with other equipments. Another special device is the Plug-in Electrical Vehicle (PEV). Smart Grid must support the connection of huge number of PEV. So, this is a challenge that must be taken into account while designing a new network. Then, to control this network, the home is equipped with an In-Home Display (IHD). This is an interface between the customer and the HAN. It shows a list of all devices plugged in the network, and statistics about their energy consumption, allowing the user to send command to a specific device (power off...), and visualize load equipment information in the home (such as air conditioner, storage battery and EV) and controlling it properly. In addition, we find the main component in the HAN: Energy Management System (EMS). It controls and optimizes the performance of energy generation, consumption and storage in the HAN. It delivers control commands or events from utilities to smart appliances, and gathers all types of information from HAN devices. So, to establish a secure communication connection between utilities and HAN, all HAN customer devices must register themselves firstly to EMS. In order to communicate with utility companies or any other entity that provides energy management services, HAN must be equipped with a gateway. The Energy Services Interface (ESI) plays this role, and routes data between the HAN and the NAN. Generally, the ESI is embedded in the Smart Meter device physically, but, it is logically separate from meter. In fact, the SM collects information about energy usage in customer side, as well as manages control services such as circuit disconnection. It can store the metering data internally, and send it to utility via ESI through a two-way communication.

Multiple HANs can be grouped and form NAN network. The NAN is the core of the Smart Grid. It collects sensed data from customers in a neighborhood to send it to an electric utility company after aggregation. Sometimes, the NAN contains field devices such as intelligent electronic devices (IEDs). In this case the NAN can be called Field Area Network (FAN).

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The traffic sent by Smart Meters is concentrated at Data Collection Unit (DCU) on the border between HAN and NAN. This equipment transmits the metering data receiving from a set of Smart Meters to equipment named Head End System (HES). This later is a central data collection point for AMI network [16]. It receives data several times a day (e.g., 4–6 times per residential meter per day or 12–24 times per commercial/industrial meter per day). Another main system in the NAN is the Meter/Load Controller [17]. It routes messages (commands, requests) between the WAN and customer side, and it is designed to perform demand response service.

The last part of Smart Grid architecture is the WAN. It is a robust network with many systems and components interconnected to each other forming a complex architecture. It covers vast zone from NAN to control center, and provides communication between the electric utility and substations. It also supports real-time monitoring, control and protection applications, which help detecting problems in real-time and diagnose the network state to prevent cascading outages. Here, we describe the most important and mandatory systems for the Smart Grid.

The first system we present is Meter Data Management System (MDMS). This is the main system in WAN. It acts as a database system for storing and analyzing metering data. In fact, it collects raw data sent by HES, via two-way communication network, stores and processes it before making it available to other applications [10]. Moreover, it has other capabilities such as managing all kinds of meters (electric, gas, heat), transmitting other type of data than tariff and turn electricity on/off, etc. This system is directly affects some critical applications such as DR, outage management and dynamic pricing that need information provided by MDMS. It is interconnected with the Distribution Management System (DMS), responsible for monitoring, controlling and optimizing the distribution system performance as an attempt to manage its complexity [18]. The ultimate goal of a DMS is to enable a smart, self-healing distribution system and to provide improvements in supply reliability and quality, efficiency and effectiveness of system operation. It is one of the most important systems in the power industry, and it was qualified as the actual brain of future distribution grids [19], because DMS leads to better asset management, the provision of new services and greater customer satisfaction. Nowadays, DMS systems are based on existing Supervisory Control And Data Acquisition (SCADA) system. This last is the core system in the DA service. Indeed, DA can be defined as the use of SCADA for the remote monitoring and control of the distribution network [20]. Its basic functions include data acquisition, remote control, historical data analysis and report writing. But generally it is used for remote manipulation to allow dispatchers to see the system failures and make remote changes easier. To achieve these goals, it coordinates with other systems, i.e., SCADA/Automatic Generation Control (AGC), EMS, DMS and Distribution Automation System (DAS) [20]. We can classify the DAS system role into three groups: for the substation automation, feeder automation and customer automation. So, it provides utilities with the capability to monitor distribution equipments remotely, gather information from a widespread network of equipments and sensors, and, then, take appropriate control actions, even automatically or with human supervision [21]. For the EMS system, it manages the energy generation and storage from different sources (wind, solar…).

On the other hand, the service DR is managed by two essential systems. The first is the DR Manager that generates the DR messages (commands, requests) to be transferred to the meters/load controllers [17]. And the second one is Demand Response Management System (DRMS). This is the utility system managing the DR capabilities from the

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utility down to the consumer. The DRMS also interfaces and operates with other utility operational and information systems, such as DMS, Outage Management System (OMS), and Customer Information System (CIS) [22].

Until now, we discussed five among the six services. The remainder service, WASA, aims at providing system data in real-time from a group of Intelligent Electronic Devices (IEDs) and Phasor Measurement Units (PMUs), and then passes to the decision-making process (Perception, Comprehension, Projection) [23]. IEDs transmit snapshots of device status and measurement data to SCADA over a WAN communication. PMUs, on the other hand, enable time-synchronized snapshots of a power network including voltage and current phase angles. The data generated by the PMU/IED sensors is sent, via a Phasor Data Concentrator (PDC), to the Central Equipment (CE)/ Wide-Area Measurement Systems (WAMS). This information, measured over a wide area, is used to create a countermeasure which is the control scenario to be used when the instability phenomenon occurs as expected from simulation of severe power system faults and sends it to the IED.

In addition to systems above, the architecture is composed of other systems, specifically; OMS, CIS and billing system. The OMS identify, diagnose and locate faults, then isolate the problems and restore supply. It notifies customers affected by the faults, analyses the event and maintains historical records of the outage as well as calculating statistical indices of interruptions. The CIS maintains databases of customers' names, addresses, and network connection. And the billing system preserves all necessary information about the billing process.

B. Communication technologies

Once the architecture is defined, we resume the communication technologies for the majority of the linked interfaces between its components. Many technologies to be adopted by Smart Grid have already been used in other industrial applications, such as sensor networks in manufacturing and wireless networks in telecommunications, and are being adapted for use in new intelligent and interconnected paradigm. In fact, technical standards underpinning the Smart Grid are being developed by several Standard Development Organizations (SDOs) such as the American National Standards Institute (ANSI), The International Electrotechnical Commission (IEC), IEEE, the International Organization for Standardization (ISO), and ITU organizations. Also, Independent Organizations (e.g. NIST) and Alliances (e.g. ZigBee alliance) proposed their solutions for Smart Grid [24-26]. Since all the standards need to work together to support an overall system, coordination of efforts by these organizations is critically important.

Our architecture is presented in Fig.9. It indicates the components and the communication interfaces between them. The Energy Market is considered as an external component, so we will not take it into account in this article. TABLE II resumes the technologies and standards for each communication interface between two components based on the networks requirements in terms of transmission range, scalability, latency. We indicate the Smart Grid components involved, the technologies used and the underlying standards/ recommendations. For instance, the interface C1 concerns the communication between appliances and IHD. This interface is used by customers to control their HAN devices through protocols such as ZigBee, PLC or other short range protocols. Another interface related to IHD is C3, which is used to transmit information regarding customer energy consumption to the smart meter and then all the way to the utility via the AMI network. However, the interface C16, between the ESI and the meter/load controller, is used, as mentioned above, to route HAN information to utility through a TCP/IP network.

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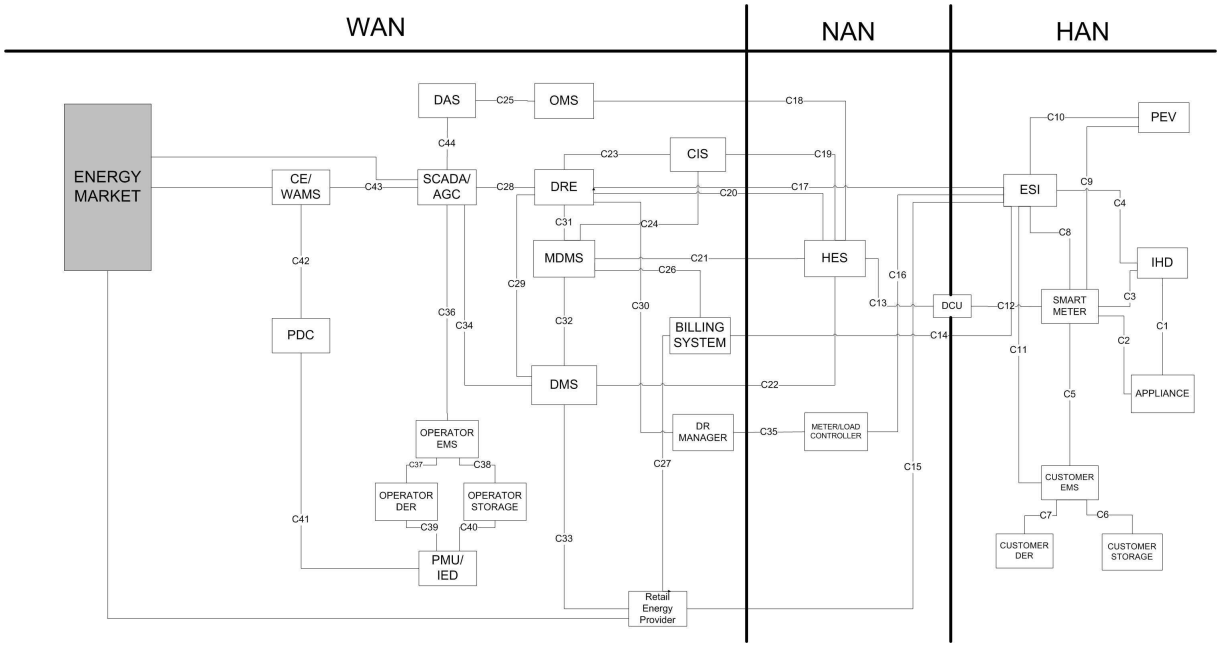

Figure 9. Our Smart Grid Architecture

Other examples are given in the table. We cite the well-used standards for each section, but other standards may be added. The communication with the energy market is out the scope of this article. In HAN network, we can use a hybrid mix of technologies like TCP/IP technologies, ZigBee, PLC (Power Line Communication), RS232C [27] and others. Generally, the choice between these technologies depends either on the constraints imposed by the utilities network (according to each country), or, in case this network supports more than one technology, the choice is up to the user especially for the appliances and EV. While NAN is responsible for transferring data from HANs to WAN, it is connected through a multiple of Wireless or wired technologies like PLC, TCP/IP etc. However; the NAN can be developed with the use of small range coverage network technologies, especially in the last mile network, as we showed before in the third section. On the other hand, WAN can be developed using one or many technologies including wired and/or wireless technologies like fiber optics, WIMAX, cellular (GPRS/UMTS/LTE), ICCP [28] (Inter Control Center Protocol), ModBus [29], DNP [30] (Distributed Network Protocol), MMS [31] (Manufacturing Message Specification).

TABLE II: Communication TECHNOLOGIES AND STANDARDS FOR SMART GRID ARCHITECTURE

Interfaces	1st component	2nd component	Technologies	Standard
C1	Appliance	IHD	PLC, ZigBee, TCP/IP	IEC61968-9, C12.19, TCP/IP
C2	Appliance	Smart Meter	PLC, ZigBee, TCP/IP	IEC61968-9, C12.19, TCP/IP
C3	IHD	Smart Meter	PLC, ZigBee, TCP/IP	IEC61968-9, C12.19, TCP/IP
C4	IHD	ESI	PLC, ZigBee, TCP/IP	IEC61968-9, C12.19, TCP/IP
C5	Customer EMS	Smart Meter	PLC, ZigBee	IEC61968-9, C12.19
C6	Customer EMS	Customer Storage	RS232C	IEC 61850 -7-420
C7	Customer EMS	Customer DER	RS232C	IEC 61850 -7-420
C8	Smart Meter	ESI	PLC, ZigBee	IEC61968-9, C12.19
C9	Smart Meter	PEV	PLC, ZigBee	IEC 61851
C10	ESI	PEV	PLC, ZigBee	IEC 61851
C11	ESI	Customer EMS	PLC, ZigBee	IEC61968-9, C12.19
C12	Smart Meter	DCU	PLC, ZigBee	IEC61968-9, C12.19
C13	HES	DCU	PLC, ZigBee, Binary CDMA	IEC61968-9, C12.19
C14	ESI	Billing System	TCP/IP	TCP/IP

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C15	ESI	REP	TCP/IP	TCP/IP
C16	ESI	Load Controller	TCP/IP	TCP/IP
C17	ESI	DRE	TCP/IP	TCP/IP
C18	HES	OMS	PLC, ZigBee, Binary CDMA	IEC61968-9, C12.19
C19	HES	CIS	PLC, ZigBee, Binary CDMA	IEC61968-9, C12.19
C20	HES	DRE	PLC, ZigBee, Binary CDMA	IEC61968-9, C12.19
C21	HES	MDMS	PLC, ZigBee, Binary CDMA	IEC61968-9, C12.19
C22	HES	DMS	PLC, ZigBee, Binary CDMA	IEC61968-9, C12.19
C23	CIS	DRE	PLC, ZigBee	IEC61968-9, C12.19
C24	CIS	MDMS	PLC, ZigBee	IEC61968-9, C12.19
C25	OMS	DAS	ICCP	IEC 60870-6
C26	Billing System	MDMS	TCP/IP	TCP/IP
C27	Billing System	REP	TCP/IP	TCP/IP
C28	DRE	SCADA/AGC	ICCP	IEC 60870-6
C29	DRE	DMS	TCP/IP	TCP/IP
C30	DRE	DR Manager	TCP/IP	OpenADR, TCP/IP
C31	DRE	MDMS	TCP/IP	TCP/IP
C32	DMS	MDMS	TCP/IP	TCP/IP
C33	DMS	REP	TCP/IP	TCP/IP
C34	DMS	SCADA/AGC	ICCP	IEC 60870-6
C35	DR Manager	Load Controller	TCP/IP	OpenADR, TCP/IP
C36	Operator EMS	SCADA/AGC	MMS, DNP, ModBus	IEC 61850
C37	Operator EMS	Operator DER	RS232C	IEC 61850 -7-420
C38	Operator EMS	Operator Storage	RS232C	IEC 61850 -7-420
C39	PMU/IED	Operator DER	TCP/IP	IEC61850
C40	PMU/IED	Operator Storage	TCP/IP	IEC61850
C41	PMU/IED	PDC	TCP/IP	IEC61850-90-1, IEC61850-90-1, C37.118.2
C42	CE/WAMS	PDC	TCP/IP	IEC61970
C43	CE/WAMS	SCADA/AGC	ICCP	IEC61970
C44	DAS	SCADA/AGC	ICCP	IEC61970

V. THE HOME AREA NETWORK

To understand the functioning of HAN network, we present here a use case diagram. Generally, this network is related to three actors: the customer, the utility and the environment. Fig.10 represents this diagram. The "generalization" relationship between the "control device" use case and the two use cases "control appliance" and "control EV", show that a customer can control all devices inside the home. He can power on/off any appliances, plug/unplug the EV and launch the charge process. While the Smart Grid is characterized by its two way power flow, the actor can also define parameters to authorize the storage change (allowing the sale of energy) generated by the environment (wind, solar...). The last actor is the utility. It can read the metering data from the Smart Meter, propose an offer to buy energy and also control the devices in customer side.

In order to satisfy these customer needs, the HAN must meet the communication requirements of each component. For example, in term of latency, some Smart Grid applications require real-time communication. They may not tolerate any latency. For other applications, such as advanced metering infrastructure (AMI) or home energy management (HEMS), latency is not critical. But in general, latency must not exceed a few seconds [14]. On the other side, the communication nodes should always be reliable for the continuity of communications. Even though some of applications can tolerate some outages in data transfer, reliability must be higher than 98% [14].

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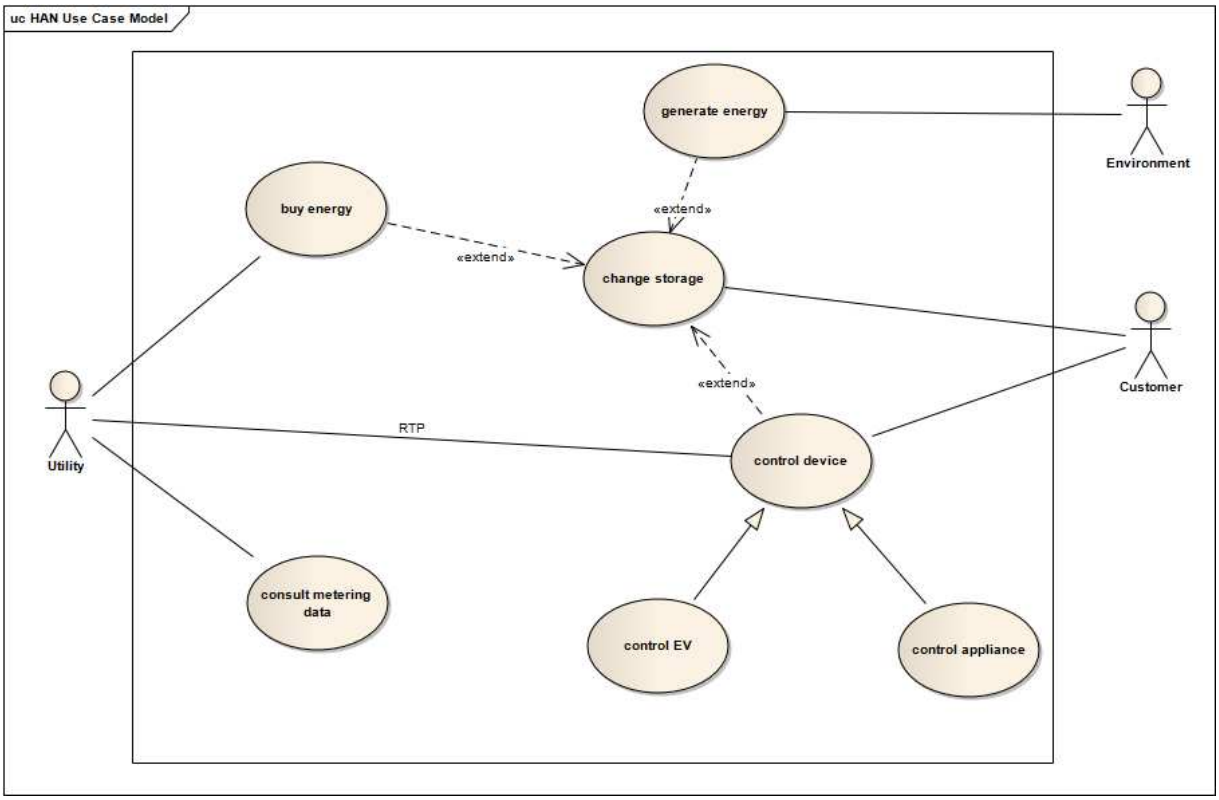

Figure 10. The use case diagram of the HAN

VI. Conclusion

Technologies involved in the Smart Grid communication represent a fundamental element in the growth and performance of Smart Grid. A scalable, sophisticated, reliable and fast communication infrastructure is crucial in both construction and operation of the network. In this article we introduced the international guides and roadmaps for Smart Grid architecture. Then we identified the requirements and limitations of these conceptual models, in particular the last mile network, through simulation scenarios. This led us to propose a new architecture model based on the models above. This model takes into account the six functionalities that a Smart Grid must fulfill. We propose a set of possible standard and technologies for the communication purpose. And finally, we give more attention to the Home Area Network. In the next step, we aim at modeling this network and validating it using reachability analysis and model checking methods; before we will trait the NAN and WAN.

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AN IMPROVED LOGIC DESIGN SIMULATOR

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Abstract -An improved logic gate simulator was design to make the to simulate the behavior of logic gate and to make the learning of logic gate easier and simple as the existing software was not user friendly and the result does not usually show in a way that can be easily understood by the students. With the proposed new system, the process of logic simulation has been made much easier because it simulates the behaviour of logic gate and has Graphic User Interface (GUI) features coupled with an help content which would assist the user with being familiar with the software. The automated system helps to connects logic gates together, display their result via LCD, the study outlines the main concepts of the analysis and design methodology of the proposed system, compare it to the existing and goes further to explain the design and implementation of the system. The logic gate simulator will assist the students taking the topic (logic gate) under the Digital Electronics course to fully understand how the gates behaves under different situations and thus assisting in making life easier for their lectures and Technologists.

Keyword: Simulation, Logic gate, computer simulation, JAVA, Digital Electronics, software

I. INTRODUCTION

Computer simulation is the use of computer to represent the dynamic responses of another system modeled after it. A simulation uses a mathematical model of a real system in the form of a computer program. A mathematical model is a method of simulating real life situations mathematical equations to forecast their future behavior.

Computer simulation have become a useful tool for the mathematical modeling of many natural systems in physics, astrophysics, climatology, chemistry and biology, human systems in economics and in engineering. Simulation of a system is represented as running of the system's model. It can be used to explore and gain new insight into the new technology and to estimate the performance of system too complex for analytical solutions.

Computer simulations are computer programs that can be either small, running almost instantly on small devices, or large-scale programs that run for hours or days on network based on groups of computers. the scale events being stimulated by computer simulations has far exceeded anything possible, using traditional way of paper and pencil mathematical modeling.

A compute-based model is a computer program that is designed to stimulate what might happen in a situation. They are used in many ways including in astronomy, economics and in sciences such as physics and biology.

A computer model is the algorithm and equation study the behavior being modeled. On contrary, computer simulation is the actual running of the program that contain these equations of algorithms. Simulation, therefore, is the process of running the model. In one word the simulator cannot build an algorithm while model cannot run a simulation

Logic simulation is a field of technology that uses automated methods for representing logic circuits using software that can be used to design such circuit. The method uses circuit simulating software to draw digital circuit which can later be used in the real world for its actual implementation. Because such software's are computer based, they do not make mistakes like that of the manual representation, the only mistake that can occur is from the user of the software when the rule is not followed. Also, such a circuit design cannot be easily lost, because it can be saved on a computer, and can also be backup on another device.

The existing logic Friday desktop application software which allow users to have access to a toolbar which in it contains logic gate and also an arrow to represent an input and output for gate construction which makes use of drag and drop to draw digital circuits and shows their truth table.

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Logic Friday lets you design logic circuit and convert the digital logic circuit into truth table as well as the logic expression for the same, this approach does not show how the circuit would work. The proposed logic simulation software deals with this problem by creating an approach that shows how the circuit would work, and that is the simulation aspect of it. The application will help student to have better understanding of what they are being taught and thereby help students build their skills on this logic aspect of electronics. It allows the users to draw logic components and know how it works

The proposed system is a simulation software which simulates logic circuit diagram, this diagram would be drawn by the user, it automatically shows how the circuit would work while the user is drawing the circuit.

II. RELATED WORKS

HISTORY OF SIMULATION

Simulation is used in many contexts, such as simulation of technology for performance optimization, safety engineering, testing, training, education, and video games. Simulation is also used with scientific modeling of natural systems or human systems to gain insight in their functioning. Simulation is also used when the real system cannot be engaged, because it may be accessible.

Historically, simulation used in different fields developed largely independently, but 20th century studies of system theory and cybernetics combined with spreading use of computer across all those field have led to some unification and a more systematic view of concept.

The binary number system was by Gottfried Wilhelm Leibniz (published in 1705), influenced by the ancient I Ching's binary system. [4]

In an 1886 letter, Charles Sanders Peirce described how logical operations could be carried out by electrical switching circuits. Lee De Forest's modification, in 1907, of the Fleming valve can be used as an AND logic gate. Ludwig Wittgenstein introduced a version of the 16-row truth table as proposition 5.101 of TractatusLogico-Philosophicus (1921).

[10,] His work was later cited by Claude E. Shannon, who elaborated on the use of Boolean algebra in the analysis and design of switching circuits in 1937. ([11] Using this property of electrical switches to implement logic is the fundamental concept that underlies all electronic digital computers. As it became widely known in the electrical engineering community during and after world war 11, with theoretical rigor superseding the ad hoc methods that had prevailed previously. [11]

SIMULATION SOFTWARE

Simulation software's are programs that imitate of the operation of real world process or system over time. The act of simulating something first requires that a model be developed; the model represents the system itself, whereas the simulation represents the operation of the system overtime.

LOGIC FRIDAY

This is the previous system. Logic Friday is free Windows program that provides a graphical interface to ESPRESSO, as well as to miss II, another module in the Berkeley octtools package.

COMPUTER SIMULATION

A computer simulation is an attempt to model a real life of hypothetical simulation on a computer so that it can be study to see how it can be study to see how the system works.

TYPES OF COMPUTER SIMULATION

1. Deterministic
   This is an algorithm which given a particular input, will always produce the same output, with the underlying machine always passing through the same sequence of state. (Edward A.Lee)
2. Dynamic system simulation
   This is the use of computer to model the time varying behavior of a system.
3. Stochastics models
   This model uses random number generators to model chance or random events
4. Discrete event simulation(DES)
   Manages events in time. Logic test and fault free simulations are of this type. its often more important to be able to access the data produced by the simulation and to discover logic defects in the design or the sequence or events. [13]
5. Continuous dynamic simulation
   It performs the numerical solutions of differential algebraic equation or differential equation (partially or ordinary)

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LOGIC GATES

In electronics, a logic gate is an idealized or physical device implementing a Boolean function: that is, it performs a logical operation on one or more binary input produces a single binary output.

TYPES OF LOGIC GATES

AND

Functions the same way as a logical “and” operator. Thinking about 0’s as false and 1’s as true, the AND gate only outputs true if both input are true, otherwise it outputs false.

OR

Functions as logical “or” operator. Its outputs true if one or more of the inputs are true and false otherwise.

NOT

it is used in logic diagram to indicate a logic negation between the external logic state and the logic state (i.e. from 1 to 0 or vice versa), (ex. If the input is true, it output will be false).

NAND

Is the AND gate followed by the NOT gate. As a result, the output are the inverses of what the output would have been for the AND gate. The output of a NAND is true if any of the input are false and false otherwise.

NOR

Similar to NAND gate. A NOR gate is an OR gate followed by a NOT gate. The output of a NOR gate are false if any of the inputs are true, and true otherwise.

X-OR

The XOR gate(exclusive-OR) given an output of true if either of the inputs are true, but not if both input are true. If both inputs are false then the output is false.

X-NOR

Exclusive-NOR is opposite of X-OR gate if either, but not both, of the inputs are true, then the output is false and true otherwise.

III. METHODOLOGY

SYSTEM INVESTIGATION

The investigation was carried out on the existing system on how the logic design simulation is build and work and also the learning and teaching of logic gate in digital electronics was being carried out.

3.2 THE EXISTING SYSTEM

Logic Friday performs its operation using drag and drop features, that helps to draw logic gates and connect them together and thereafter the user can generate the truth table for the gates that has been drawn.

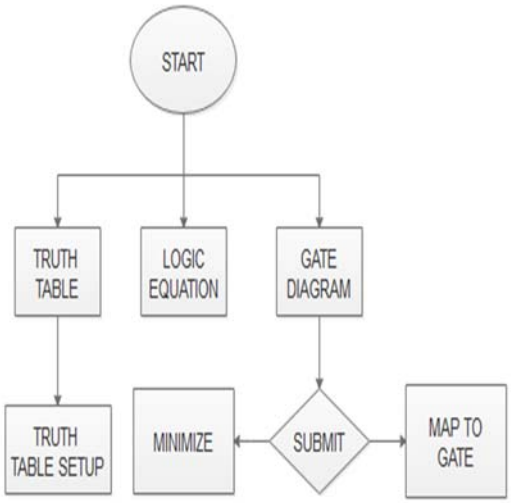

Fig 1, System Flowchart of the operation of the old Software.

IIIA PROBLEM OF THE EXISTING SYSTEM

Due to old system being used in learning digital electronics, the problem encountered includes:

- It does not make the learning of digital electronics more attractive by students.
- The former software only draws logic components but not simulate their behaviour.
- It is difficult to use by students that are just learning the concepts of logic gates.

IIIB. Proposed Alternative Systems

Identifying the limitations of the existing system, we then came about a way of solving the problem by designing a

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software which can be run a desktop computer and can This application would have to respond to the behavior of the logic gate in order to achieve the stated aim and objectives of the Logic Simulation Software.

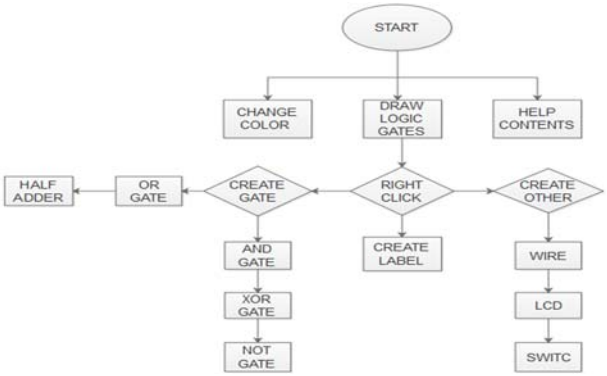

Fig 2, System Flowchart of the operation of Logic Simulation Software.

IIIC.`APPROACH OF SYSTEM DESIGN

Coding and the design of the system was done using JAVA programming language, and the IDE used to test run the code was NetBeans IDE 8.1.

Flow Chart

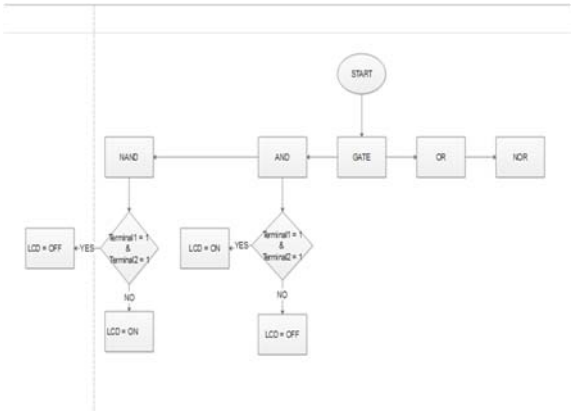

Fig 3 System Flowchart.

IV SYSTEM IMPLEMENTATION

IVA. DESCRIPTION OF THE NEW SYSTEM

The proposed system has in it basics logic gates which can then be simulated to know their behaviour, these gates includes: AND Gate, OR Gate, XOR Gate, NOT Gate, Half Adder. Each of these gates can be resized to whatever size the user wants and can also be labeled with any character.

When the software is run the user would be prompted to right click on the empty panel to add and then draw the logic gate and then simulate it. Each gate can be connected together using wires, the value of each gates would be determined by the state of the switch whether it is ON of OFF and the output would be known by the by state of the LCD.

IVB. INPUT DESIGN

This is the frame that is first displayed when the software is launched, it not only shows the software name but also shows the version of the software.

Fig 4 Start Interface

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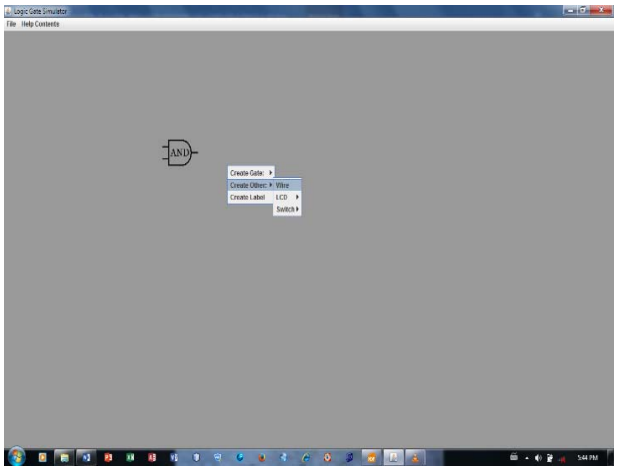

Fig 5. AND Gate

This is the pictorial illustration that shows what happens when the user presses some key on the keyboard or right click on the draw panel, for example if the key a is pressed then an AND Gate is drawn on the keyboard.

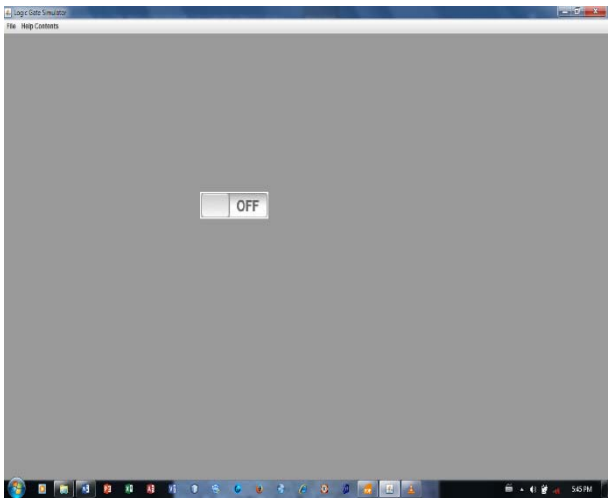

Fig 6. Switch OFF

This is what a switch looks like on the software, it is a toggle button that changes when it is clicked or pressed by the user. It helps to give value to any gate connected to it be it a high constant or a low constant

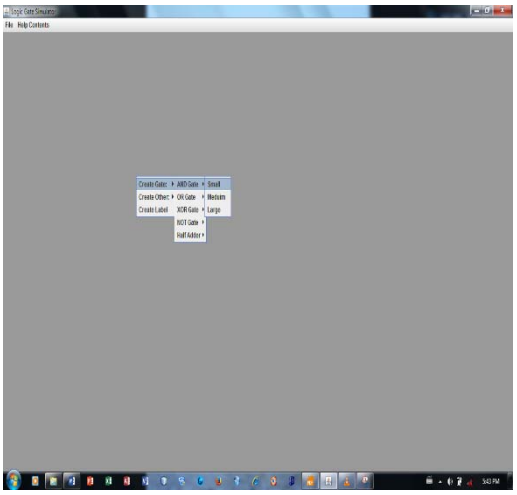

Fig 7. JPopmenu for Gate, Switch and Label

This is what happens when the user right clicks on the draw panel, the user can choose to create a gate or create other or to create a label.

This shows how an AND Gate works, when the two inputs are high then the output would be high but when either of the input is low then the output would be low. This shows two switches, 1 AND Gate and one LCD, the two switch is connected to the two input of the and gate, and to display the output the LCD is used, here one of the switch is a low constant so the output would be LOW, and the value of the LCD would be 0.

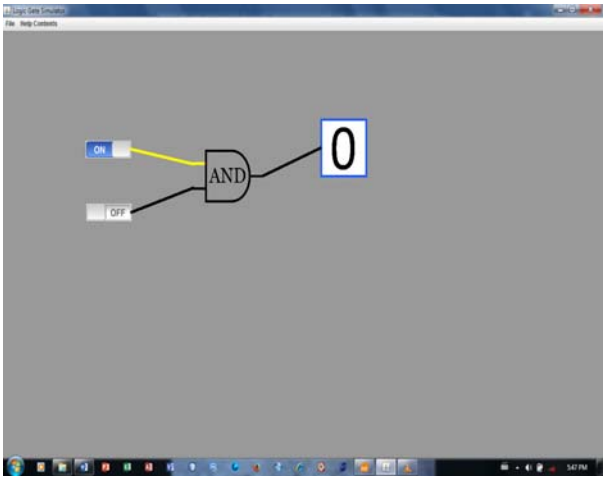

Fig 8. AND Gate connecting to switch

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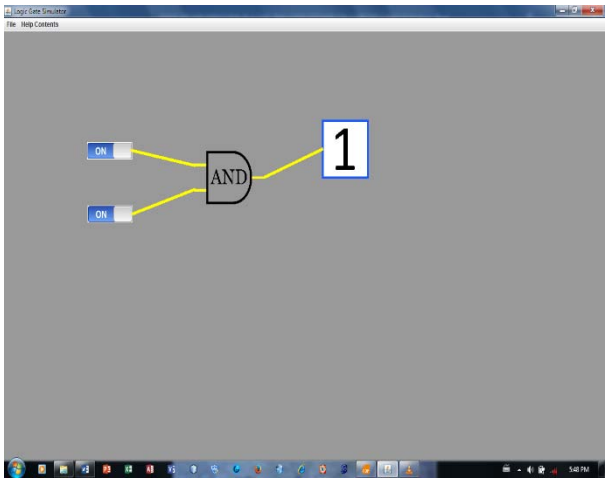

Fig 9. AND Gate ON

This shows two switches, one AND Gate and one LCD, the two switch is which have an High constant are connected to the two inputs of the AND Gate and the result of this is the LCD having a value of 1.

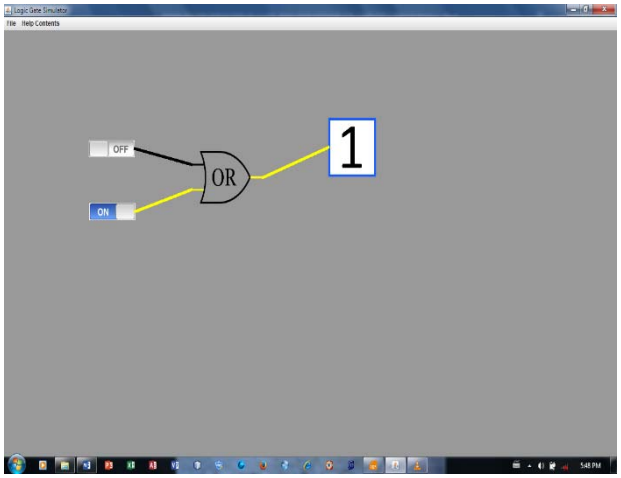

Fig 10. OR Gate OFF

This shows the behaviour of an OR Gate, and this is how it works when either of the input is LOW i.e., OFF then the output would be ON, but when the two switch is of then the output would be ON.

HALF ADDER. An XOR Gate is Gate where a true output will only occur when anyone of the inputs to the gate is one, when both inputs are 0 or 1, a false or 0 output will occur.

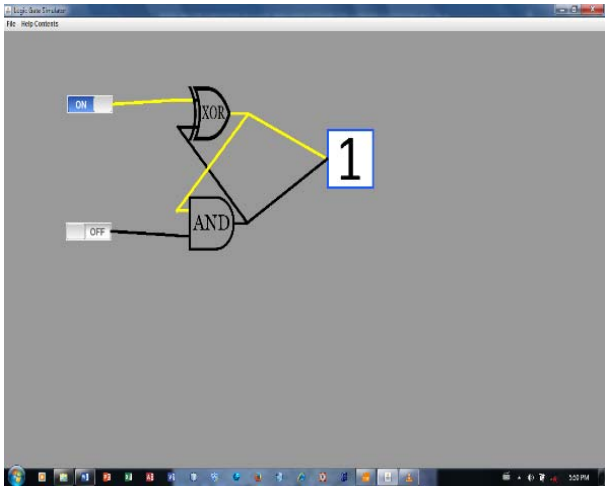

Fig 11. HALF ADDER

This is an HALF ADDER, when either of the input is ON then the output would be ON but when the two input is OFF then the output would be OFF. Here the two input is ON so the S_{out} would be OFF while the C_{out} would be ON

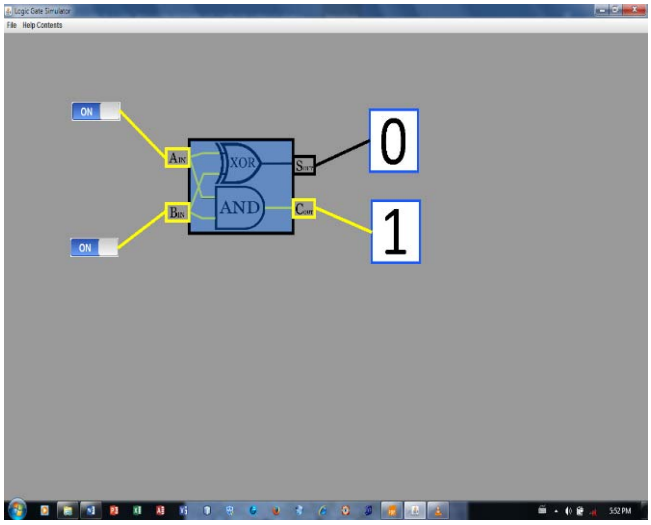

Fig 12. HALF ADDER ON and OFF

This is an HALF ADDER, when either of the input is ON then the output would be ON but when the two input is OFF then the output would be OFF. Here the one of the switch is ON while the other is OFF so the S_{out} would be ON while the C_{out} would be OFF

V. CONCLUSION

This project mainly comprised of development of a Logic Simulation software. Simulation is very helpful

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in showing the behaviour of a system or how a system would work, Logic Simulation is very helpful in helping students to better understand the properties of each Logic gate and how they would respond even when different gates are connected to together. This project has been able to connect logic gate together and also shows their behaviour when connected to different gates. The success of this project is a solution to the problems with the manual system of drawing and connecting logic gate.

It is hoped that This work will help students to better understand Logic gate operation and behaviour and also serve as an aid for lecturers to teach students the topic. It will also have a positive impact on the students as knowing the behaviour of each logic gates, and will help students to have more interest in the course and also in electronics

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EDUCATION GAME FOR TEACHING STACK AND LINK- LIST AS AN ASPECT OF DATA STRUCTURE AND ALGORITHM

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Abstract -This project focused on designing educational games for teaching stack and link-list which are the most challenging and difficult aspect of Data structure and Algorithm. Due to the nature of the course, and from research findings, it was observed that most students find it difficult to understand stack and linked list despite the effort of the lecturer. Therefore, the introduction of this educational game will enable the student to learn fast and understand the major content of the course. This application was developed to eradicate the abstractness of teaching stack and link-list and make the learning an interactive one, it is application software that can be installed java mobile environment for the use of students most especially those in the higher institutions. This application can be installed in a JAVA environment just like any other app and can be updated from time to time which makes the application accessible on the mobile device for students. It's also help in the simplification of the teaching of stack and link-list in tertiary institutions most especially for Computer Science students.

Keywords: Data Structure, Java, Stack, Link-list, Educational game, Algorithm

I. INTRODUCTION

Computer Games are software systems that involve interaction with a user interface to generate visual feedback on a computer or a video device and utilize many elements, such as fun, play, winning/losing, and competition. Computer games that involve learning of certain knowledge are called Educational Computer Games [20]

Computer games have made a significant cultural, social, economic, political, and technological impact on society [16]. Given the widespread popularity of computer games, and their ability to sustain long engagement with challenging tasks, it should come as no great surprise that educators have become increasingly interested in the potential of such games as learning tools. Since computer games have the capacity to engage children in learning experiences, it is important to assess the extent that computer game technology had an impact on childhood education. However, it appears that very few games on the commercial market have educational value; some evidence suggests that important skills may be built or reinforced by computer game. For example, spatial visualization ability (i.e. mentally, rotating and manipulating two- and three-dimensional objects) improve with video game playing.

The educational games are computer games that can be integrated into the educational domain to generate new trend in technologies and make learning process more effective and efficient [10].

[15], defined teaching as an intimate contact between a more mature personality and less mature one which is designed to further education of the letters. Effective teaching is an approach to help teacher to change their teaching practices to meet the need of the students by data gathering, provide information to assist in monitoring student's engagement progress and achievement adapting learning program and identifying students who needs further challenges for additional support. Teaching is also an act, practice and profession of impacting knowledge or is an act of interpretation and self-expression on the part of education.

Data structure is a way of organizing data in a computer memory so that it can be use efficiently. An algorithm is a formula or set of steps for solving a particular problem. An Algorithm is defined as "a sequence of computational steps that takes a value, or set of values, as input and produces a value, or set of values, as output" [8]. Algorithms usually model complicated concepts, refer to abstract mathematical notions, or describe complex dynamic changes in data structures to solve relatively difficult problems. Stack and linked list is an aspect of data structure and algorithm.

A stack is an Abstract Data Type (ADT), commonly used in most programming languages. It is named stack as it behaves like a real-world stack, for example – a deck of cards or a pile of plates, etc. ADT allows all data operations at one end only. At any given time, we can only access the top element of a stack, this feature makes it LIFO (Last-in-first-out). Here, the element which is placed (inserted or added) in last, is accessed first. In stack terminology, insertion operation is called PUSH operation and removal operation is called POP operation.

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A linked list is a sequence of data structures, which are connected together via links. Linked List is a sequence of links which contains items. Each link contains a connection to another link. Linked list is the second most-used data structure after array. Linked list can be visualized as a chain of nodes, where every node points to the next node.[3]

However, most student find it difficult to understand the basic concept of stack and linked list, not that the lecturer did not know it but it is not explainable despite the effort of the lecturer students still find it difficult to understand because of the nature of the course, it requires much explanation and illustration. Teaching aids other than chalkboard and view-graph are always needed to help students learn and understand stack and linked list better and that is the reason this game is been implemented.

The aim of this project work is design an educational game for teaching stack and linked list on data structure and algorithm which will motivate and arouse the interest of student towards learning. It can also increase their thinking ability by giving them confidence to do things by themselves with or without supervision.

II RELATED WORKS

IIA. THE HISTORY OF EDUCATIONAL GAME

The history of educational game can generally be broken down into two separate areas of interest. First, is the conception of educational gaming and further justification of why the gaming paradigm lends particularly strong synergy with classical approaches to the way people learn? Second, is the study of what's known about good educational game design – in essence, what works well and with whom?

[6], recorded that educational video games are importance for individualized learning, given that every learner is different, teachers are always looking for adequate resources that will provide every learner with an individualized learning plan. Video games allow students to learn new concepts at their own pace without having a constant overlook from parents and teachers.

Furthermore, the experience of the players can be tailored based on their preferences and performance. The game automatically adjusted to prevent high level challenges after solving each problem, if they are having difficulty with concept in a different manner until the student understand it. Video games balance enjoyment with appropriate challenge level, which keeps players in an optimally engaging and challenging learning zone.

IIB. EDUCATIONAL GAME BASED LEARNING

According to Dickers [9] Game Based Learning (GBL) is a type of game play that defined learning outcome. Generally, game base learning is designed to balance subject matter with game play and ability of the player to retain and apply said subject matter to the real-world .The built in learning processes of game is what makes a game enjoyable. The progress of a player makes in a game is through learning, it is the process of the human mind grasping and able to understand a new system. The progress of understanding a new concept through gaming makes an individual feel a sense of reward whether the game is considered entertainment or edutainment.

[4], reported that Game based teaching and learning can be quite effective if one understood what is and how it can be implemented to enhance instruction and learning. Game based learning is not gamification, game based learning is using games to enhance the learner in the classroom, when discussing game for learning it is essential that educators see a benefit to the use of the game. Gamification can be described as a way to add game elements to a non- game situation.

[5] explain that one difference between gaming for fun and gaming for educational purposes is that educators start with learning goals,; and gaming media choices will be made based on the games potential to meet those goals

[13], recorded four keys ingredients to game which are:

- Goal-a game has to have a desired outcome that everyone is working to accomplish.
- Rules-in order to achieve a goal there has to be some parameters put into place that eliminate or make it difficult to achieve the goal.
- Feedback system- this is a process where the player knows where they are in system to achieve the goal.
- Voluntarily participation- basically this means that everyone involved in the game understands the rules, has a clear sense of the goal, and how to receive feedback.

[14] discovered that educational games have been a common place part of the K-12 experience since the beginning of the 1980s (and in some places well before that), with early titles introducing students to fundamental math, history, and problem solving concepts just as games do today. While the graphics may not have been great, the games helped to engage a generation of kids with technology and laid a solid foundation for the educational games that were to come.

IIC. REVIEW OF EXISTING TEACHING SYSTEM

This involve the collection of information in respect to the existing operations, procedures with respect to this project study, the existing method of teaching is the manual and traditional way which does not involve the use of computer device to stimulate the teaching and learning

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process. In this existing system student assemble in classroom where teachers will present in order to pass knowledge to them.

IID. REVIEW OF PAST PROJECT ON THE RELATED RESEARCH

In the decades following the establishment of the original psychological basis for education gaming, many studies looked not only at valuable subjects such as the genres of learners and how game design can be applied to these varied behaviours, but also the different game play activity modes and how these can be best applied based on individual preferences.

A landmark studied by [12] provided the basis for differentiation in learning behaviour not in accordance with classically known educational psychology, but rather specifically in the paradigm of education and gaming. In his study, the genre of learner's game behaviour was divided into six categories: creative learners, exploring learners, collaborate learners, trial and error learners, inquiring learners, and entertaining learners. Each of these different types of learners required that specific design strategies should be used regardless of their learning type and all students remain engaged. These categories are explained below:

I. Creative learners need an environment that allows for a diverse set of solutions, whereas exploring learners need the game to lead them freely.
II. Collaborative learners need effective interaction and communication, trial and error learners need a large base of support and help, inquiring learners need the ability to discuss and play different roles, and entertaining learners need choices, challenges, and an engaging story.

He concluded that these various types of needs provide the basis for good game design – taking into account the differentiation in player preferences in vital for creating educational games that have widespread appeal and efficacy.

Junjie's study was built upon by [12], they divided types of gameplay into six corresponding categories that mirrored some of Junjie's chosen areas, and looked at play preferences among test subjects. The categories of play their study focused were:

i. Active play was characterized as involving intensely performative input that involved response time and combination input.
ii. Explorative play, on the other hand, is where physical travel is simulated so that the player is allowed to discover new areas and challenges.
iii. Problem-solving play and strategic play have the same basis of interaction, but problem-solving focuses more on short-term puzzles and challenges, whereas strategic play focuses more on long-term resource management.
iv. Social play focuses on the interactions and collaborations between characters.
v. Creative play focuses on the ability to create and interact with elements during the game.

[12], also gave breakdowns of preferences between the two genders, Boys actually preferred active play most by a fair margin, but active play was least preferential for girls tied for last with strategic play. Boys preferred explorative play second best and girls' preferred explorative play most the reason why explorative play is, on average, the most preferred genre of game. For reference purposes, the top three types of play for boys were active, explorative, and strategic, the top three for girls were explorative, creative, and problem solving, the bottom three for boys were creative, social, and problem solving, and the bottom three for girls were strategic, active, and social.

IIE. RESEARCH RELATED GAME

SNAKE AND LADDER GAME

[18] recorded that the game has been interpreted and used as a tool for teaching the effects of good deeds. The board was covered with symbolic images, the top featuring gods, angels, and majestic beings, while the rest of the board was covered with pictures of animals, flowers and people. The ladders represented virtues such as generosity, faith, and humility, while the snakes represented vices such as lust, anger, murder, and theft. The morality lesson of the game was that a person can attain salvation through doing well, whereas by doing evil one will inherit rebirth to lower forms of life.

[2], recorded that the central mechanism of Snakes and Ladders makes it an effective tool for teaching young children about various subjects. In two separate Indonesian schools, the implementation of the game as media in English lessons of fifth graders not only improved the students' vocabulary but also stimulated their interest and excitement about the learning process.

[19], found that pre-scholars from low income backgrounds who played an hour of numerical board games like Snakes and Ladders matched the performance of their middle-class counterparts by showing improvements in counting and recognizing number shapes. the game was also used to teach students and teachers about climate change and environmental sustainability.

READER RABBIT GAME

[11], explained that Reader Rabbit game has taught scores of toddlers and young students how to read and spell

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through simple but fun mini-games, is among the most influential and successful educational games of all time.

The Learning Company has added many more titles to the Reader Rabbit series (branching out to math and higher grade levels), which continue to be popular educational titles in homes and schools today. Reader Rabbit was one of the first educational gaming brands to become a household name and with a new title for the Nintendo Wii announced in 2011, it remains a powerful force in the edutainment market today.

SNOOPER TROOPS GAME

According to [1] Snooper Troops was one of several popular and successful educational titles released by Spinnaker Software (others included FaceMaker, Kidwriter, and The Story Machine) in the early 1980s and is comprised of two episodes: The Case of the Granite Point Ghost and The Case of the Disappearing Dolphin. Players comb the streets looking for clues, question witnesses, investigate homes while occupants are away, and use the Snoop Net computers to solve crimes.

[7] recorded that the games are fun, interesting, and boost problem solving and creative thinking skills while teaching kids how to take notes, organize information, and expand their knowledge about police work. While the series would be short-lived, the problem-solving game play geared towards kids would inspire many games.

III METHODOLOGY

The educational game design and development model for this work is based on agile game development methodology.

IIIA THE PROPOSED SYSTEM

This new system is design at working out how best educational computer game application can be used in teaching most especially stack and link-list as an aspect in data structure and algorithm.

This new system will reduce the slim less effort of

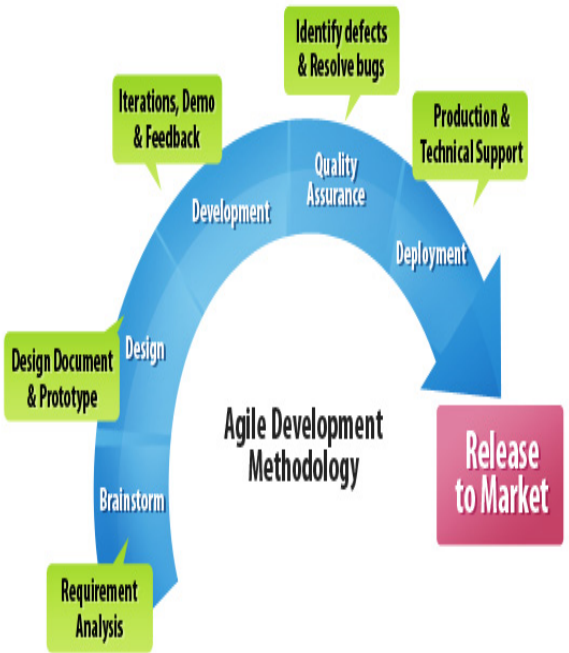

Fig. 1 The proposed methodology development process

the lecture in charge, because the game will be designed in a way that a dullard in the class will understand the course.

The learning package application has a home page where the user will select the game to be played, after which a question will be displayed to test the ability of the user. The game is being design in a way that the user can play a single game more than one time, just a matter of making selection through the home page.

IIIB. FLOW CHART DIAGRAM FOR THE PROPOSED SYSTEM

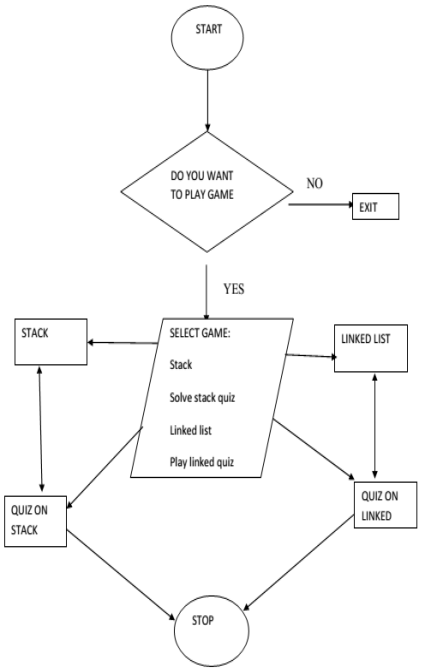

Fig 2: Flow Chart Diagram for Teaching Stack and Linked list.

IV.RESULTS AND DISCUSSION

IVA.PROCEDURE FOR USE OF THE SYSTEM

a. Homepage
b. Selected game
c. Game displayed
d. Quiz interface

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This procedure shows the steps to follow in playing the computer educational game. From the Home Page, the users select the game to be played, whether stack or link-list. However, the selected game will be displayed where the user is expected to click on play. After clicking on play, the game will be displayed. Moreover, after each game a question will be display to test the user's understanding of each course and the result for each quiz will also be shown, this will serve as a feedback for the user.

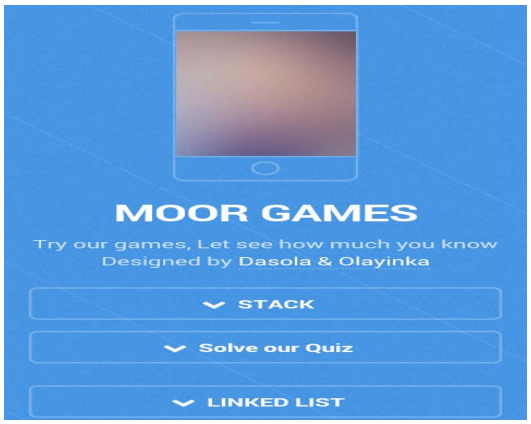


Fig.3: Home page

In fig 3 above, the user select the game to be played and proceed to the next level.

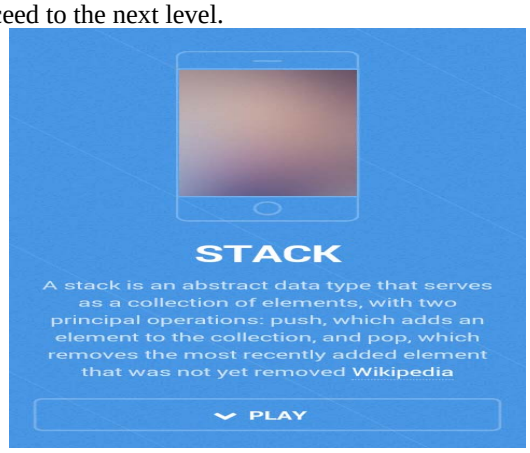
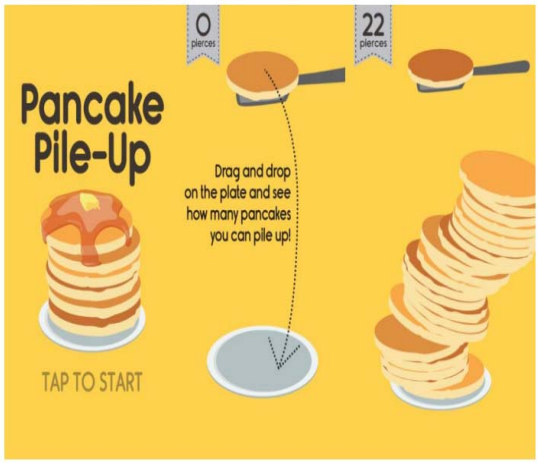
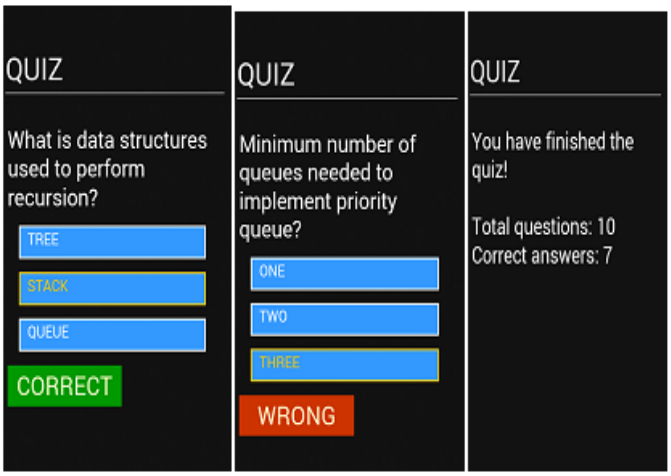


Fig.4: Selected game

The diagram in fig.4 above shows that the users have selected stack game.



In fig.5 above, the pancake pile-up game is displayed the by dragging and dropping in the plate. Depending on the number of pancake the player can pileup, the last in pancake will first out.



The diagram in fig.6 displayed questions to be answered by the user's after playing the game to test the user ability on stack.

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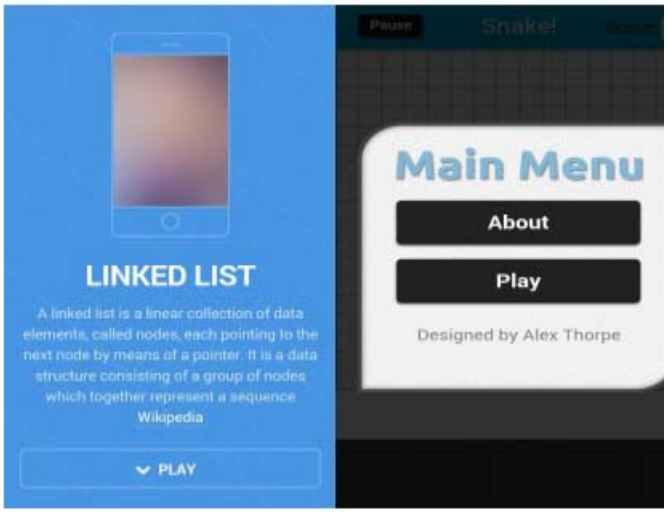

Fig.7: Selected game

The diagram in fig.7 above shows that the users have selected linked list game. The user can select on the play mode.

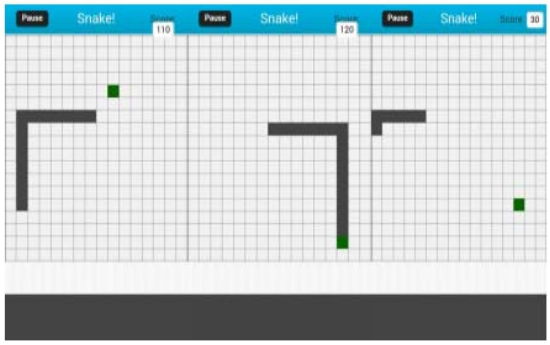

Fig.8: Display game

In fig.8 above the snake game is displayed. The user will tap to start by making the nodes to allocate at heap, the nodes continue until it is explicitly de-allocated.

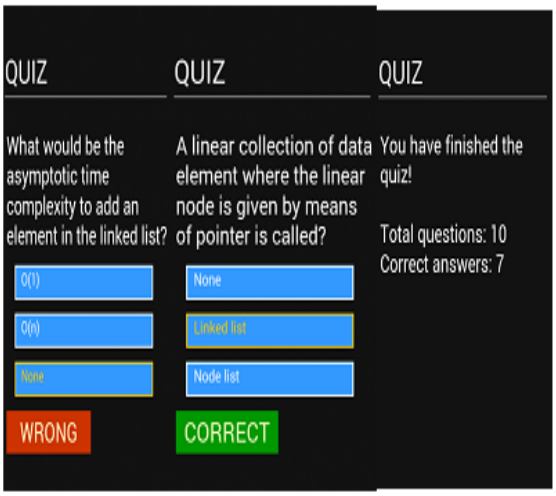

Fig.9: Quiz interface

The diagram in fig.9 display questions to be answered by the user after playing the game to test the user's ability on linked list.

V. CONCLUSION AND RECOMMENDATIONS

The educational game for teaching stack and linked list on data structure and algorithm has been the main focus of this project. When it was implemented, it helps to remove a lot of problem and explain more effective of learning for teaching stack and linked list.

The educational game was been tested by the student after the game has been designed properly and was confirmed working on any android phone running (android OS 4.0 and above). This project was designed in such a way that it will be very convenient for users to play.

We hereby recommend that

- Student should make use of the game effectively to have positive impact on their academics.
- The lectures in charge of the course should make use of it in the classroom for physical and better explanation.
- Due to the time constraint, this work covers on stack and linked list under data structure and algorithm therefore, it is recommended that student who which to proceed on this word should work on other topic in data structure and algorithm.

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DESIGN AND IMPLEMENTATION OF A VIRTUAL PROJECT REPOSITORY SYSTEM

(A CASE STUDY OF FEDERAL COLLEGE OF ANIMAL HEALTH AND PRODUCTION TECHNOLOGY)

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Abstract-The project work emphasizes the application of Project Repository System to educational administration as an alternative to the manual method of storing past project documents and class materials. It takes Federal College of Animal Health and Production Technology as a case study. However, the application of Project Repository System focus on the past project works of the institution with a view to reducing the stress, errors, loss and other damages which arises as a result of manual method of keeping past project works in an educational institution like Federal College of Animal Health and Production Technology, Ibadan in particular. This project has been specifically carried out and presented in a concise manner to cover the necessary background information and to satisfy the needs for designing a project repository system. Visual Basic programing language and Windows form application was used to in order to satisfy the needs for designing a project repository system for an institution. The software developed will be able eradicate the difficulties experienced in the old system and make work easier, timely, reliable, efficient in work flow which in turn will assist management in decision making to meet up with global challenges of the recent age.

Keywords: Repository, Project, Educational institution, Information

I. INTRODUCTION

The present technology age is faster moving to the digital level and almost everyone has accessed to the electronic versions of textbooks, projects reports, and notes whether there are online or offline. Many students found it difficult to have access to past project materials due to factors beyond their control, some of those factors may include lack of digital content in schools etc.

A Repository System which is also referred to as digital repository according to Larry lannom of the Corporation for National Research Initiatives (CNRI) is a collection of digital objects that include text, visual materials, audio materials, video materials stored as electronic media formats (as opposed to print, micro form, or other media), along with means for organizing, storing, and retrieving the files and media contained in a library collection. [1]., A digital repository is a mechanism for managing and storing digital content and can be subject or institutional in their focus. therefore, deriving maximum value from it and in the process supporting research, learning, and administrative processes [7].

Reference [4]. explained that the term digital library is used synonymously with e-library, universal library, future library, virtual library and library without walls.

Digital libraries can be very immense in size and scope, and can be maintained by individuals, organizations or can be affiliated with established physical library buildings or institution or with academic institutions. The electronic content may be stored locally, or accessed remotely via computer networks, [6]. A Project Repository System can therefore be regarded to as a type of information retrieval system.

II. RELATED WORKS

Reference [2]. defines a repository as a digital archive of the intellectual product created by the faculty, research staff, and students of an institution.

There are different types of Project Repository System for the diverse information needs of the targeted group of users. Some are developed by groups or organizations, higher education institutions, research centers, national libraries, as well as public libraries. They include contents that are born digital and those that have been digitized [3].

Reference [5]. observes that is the ability to make efficient and effective use of information sources, and that an information literate person today should possess specific online searching

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skills, which include the ability to select appropriate search terminology, construct a logical search strategy, and evaluate information appropriately.

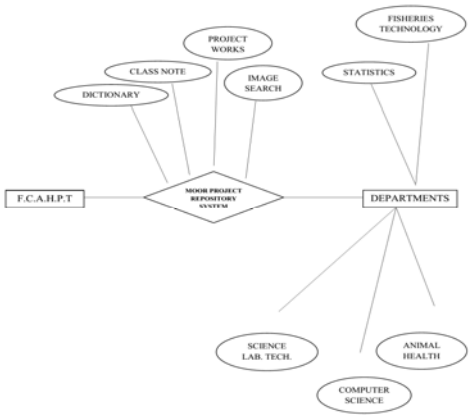

Fig 1.ER diagram of the Project Repository System

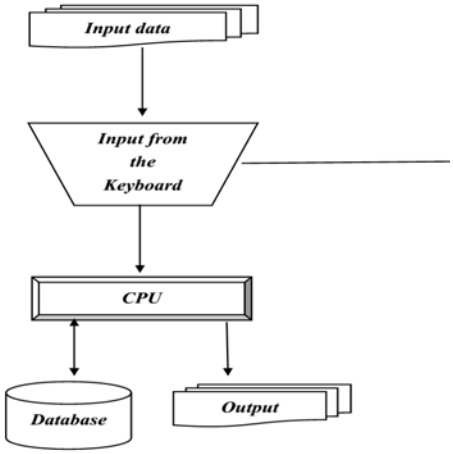

Fig. 2 System Flowchart

E. System Coding / Building the new System

1) The system was built using the following resources Visual Studio 2013, .Net Framework 4.0, Notepad and the code used is VB.NET.
2) For the system to operate seamlessly, the following are the operational requirement that the users need to adhere to:

F. Software Requirement

1) The software (moor project repository system) will have to be installed on the users operating system e.g. A window 7, 8, and 8.1
2) The user system must have a utility software name .net frame work 4.0 on the system to allow proper function of the software.
3) The user system must have a high definition of Adobe Reader which allows display of the other tools in the software.

G. Hardware Requirement

1) The user system should have Intel Pentium 4 or AMD AthlonR 32-bits or 64-bits processor.
2) The Random-Access Memory of the user system should be at least 1GB or more recommended.
3) The user system should have a hard disk of at least 500MB space for installation
4) The computer system should have 1024x768 display (1280x800 recommended) with qualified hardware-accelerated OpenGL graphics card, 16-bit color, and 256MB of VRAM.

III. RESULT AND DISCUSSION

Procedure for the use of System

1) Home.
2) Student Department.
3) Response from the System ---> Department Fields (Dictionary, Class Note, Project Works, Picture Search).
4) Response from the System ---> Users Inputs or Information Search. ---> Output.
5) Exit.

This procedure explains the steps and procedure to follow in accessing the Moor project repository system. From the software home in Figure 3, the user will see the college department which are Animal Health Technology, Computer Science, Fisheries Technology, Science Laboratory Technology and Statistics then the user selects his own area of specification. Now under the user area of specification, the user will find its department fields contained in the moor project repository system which are dictionary, class note, project works and picture search as shown in figure 4. Then the user selects its field under its department, if it's to be dictionary, the user will have to input the words he/she required information about and if the request is accepted by the system, the system will process the information out to the user and if the user data is not meet; the system will show

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a notification message that. “no result found” and a pop-up message will display to the user if he / she will like to use the embedded browser to search the necessary information in which he / she will needs internet connection as shown in figure 7 and 8.; this process also operates for picture search (Figure 6). If the user is selecting project work in his/her department field contained in the moor project repository, the user will have to click the year he / she is interested in searching for, then a drop down will be shown to the user containing project works of the year the user has selected. Once the user clicks a project works, the system will generate the output of the year selected to the user as shown in figure 5. In term of class note contained has a department field in the moor project repository system, the user will have to select the level he / she is interested for either ND I or ND II, after selecting the level, the system will show a drop down showing whether first semester or second semester then the user selects its semester of its own choice. After which the system generates the course under the semester the user has selected and the user select the course he / she intended to generate information from. After the course is selected then the system generates output of the course selected to the user from software resource.

Fig. 3. System Home Page

Fig.4. A department homepage showing its field

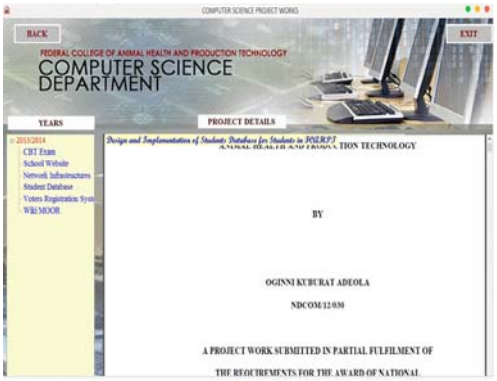

Fig 5. Project works as a field of computer science department in moor project repository system

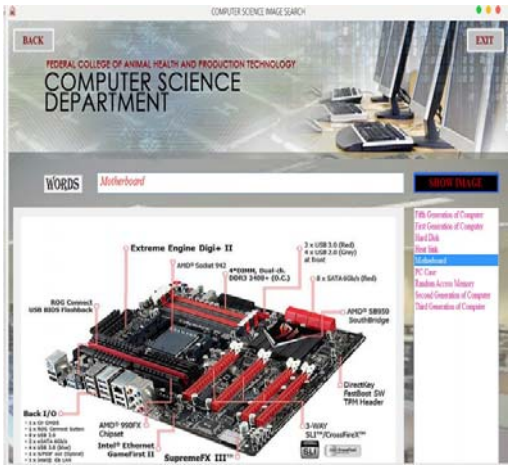

Fig 6. Picture Search as a field of computer science department in moor project repository system

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Fig 7. Moor Project Repository System Browser

Fig. 8 Browser embedded in moor project repository system to display more information if the result is not meet

IV. CONCLUSION

The overall aim of this study was to develop a flexible and yet easy to use repository system that will contains student project, the repository system will assist students and their lecturers in accessing past projects work done by the graduating students in the National Diploma programme.

The design and implementation of a project repository system for the Federal College of Animal Health and Production Technology, Moor Plantation Ibadan has provided a solution to most of the challenges encountered in keeping hardcopy of past project works done by the students and also aided in the process of digitization of student's project work.

This repository system tool is expected to impact positively on the process of digitization of student's projects write up in the school and other places where there may be needed. The system helps librarians and other people that are concern with the process of digitization and making project writeup more accessible to students.

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Anonymous Safe Routing Scheme for Compromised Network Environment

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***Abstract*— The security of communication in Ad hoc wireless networks is very vital, particularly in military applications. Providing security in MANET has been a great issue since these nodes have a lot of constraints. Hiding the identity of nodes that participate in routing will be the most efficient and reliable way of ensuring packet delivery. This paper proposes a protocol that stops strong adversaries from tracing a packet flow from source to destination and compare it to other existing anonymous routing protocol which based on hop-to-hop encryption. This protocol also inhibits attackers or compromised nodes from interfering with uncompromised routes made up of uncompromised nodes and prevents many types of Denial of service attacks.**

Keywords-communication; security; anonymouse; denial of service attacks; MANET

I. INTRODUCTION

Designing a foolproof security protocol for an ad hoc wireless network is an exceptional task. This is largely as a result of some distinctive features of ad hoc wireless networks[1]. The operating environments where ad hoc wireless networks are utilized might not always be secure. One vital use of such network is in war zones. The system topology in an ad hoc wireless network is extremely dynamic because of the movement of nodes, therefore, an on-going session's regular path breaks. Interruption happens either because of the movement of the intermediate nodes in the path or because of the movement of end nodes. Such conditions do not happen due to dependable links in wired networks. Although the wired network protocols discover alternative routes during breaks, their convergence occurs slowly. Hence, wired network routing protocols to be utilized in ad hoc wireless networks where the movement of nodes lead to recurrently changing network topologies. Routing protocols for ad hoc wireless networks should be able to carry out efficient and effective mobility management [2]. The broadcast nature of the radio channel presents peculiar issues in ad hoc wireless networks. The wireless links possess time-varying features in relation to link capacity and link-error possibility. This necessitates that the ad hoc wireless network routing protocol communicates with the MAC layer to discover alternative routes through better-quality links. Likewise, transmissions in ad hoc wireless networks lead to clash of data and control packets. This is ascribed to concealed terminal issues [1]. Therefore, it is necessary that ad hoc wireless network routing protocols discover routes with less traffic [3].

Moreover, in wireless networks, the radio band is restricted and therefore, the data levels it can provide are lesser than the amount a wired network can give. This necessitates that the routing protocols utilize the bandwidth optimally by ensuring that the overhead is as low as possible. The restricted bandwidth availability also places a limitation on routing protocols in keeping regular topological information. Owing to the regular alterations in topology, keeping consistent topological information at all the nodes involves more control overhead which leads to the wasting of more bandwidth.

II. RELATED WORK

Many studies have suggested protected routing protocols. For instance, Pathak [4] suggested the flooding NPBR, an on demand protocol developed for wired networks that floods each packet via the network. Flooding NPBR allots a fraction of the bandwidth beside every link to every node and utilizes digital signatures to verify all packets. However, this protocol possesses high overhead with regard to the computational resources required for digital signature authentication and in relation to the bandwidths it requires. Also, estimation and guarantee of available bandwidth in a wireless environment is complicated [5].

Other wired network protocols possess safe or protected periodic routing protocols with asymmetric cryptography, like Defray et al. [6], Pathak's link-state NPBR, Hu's secure link state protocol [7], and Hubaux et al. [8, 9]. Nevertheless, nodes in an ad hoc network might not have enough resources to authenticate an asymmetric signature; specifically, a hacker can trivially flood a victim with packets which contain invalid signatures, but authentication can be excessively expensive for the victim. Additionally, these protocols might suffer in some cases as periodic protocols might not be able to handle the high levels of movement in an ad hoc network. Similarly, Hubaux analyzes threats to both distance-vector protocols and link-state protocols and defines procedures for protecting distance-vector protocols. Nevertheless, these procedures are susceptible to the compromise of just one node.

Beresford and Stajano [12], X. Wu [10], and El-Khatib et al. [14] suggest the utilization of asymmetric cryptography to

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protect ondemand ad hoc network routing protocols. Nonetheless, as indicated above, when the nodes in an ad hoc network are usually not able to authenticate asymmetric signatures fast enough, or when the network bandwidth is not enough, these protocols might not be appropriate. Zhu [11], Ratnasamy et al. [15], and Raymond [16] describe symmetric-key approaches to the validation of link-state updates; however, they do not discuss techniques for the detection of the status of these links. In wired networks, a common procedure for verifying HELLO packets is to confirm that the incoming network's interface is the anticipated interface and that the IP TTL of the packet is 255. In a wireless ad hoc network, this procedure cannot be utilized. In addition, these protocols take up the utilization of periodic routing protocols, which are not at all times appropriate in ad hoc networks. Wu [20] utilizes cryptographic techniques similar to the ones utilized in Ariadne with TESLA but positively integrates routing data before it is verified, which seriously affects security.

Several other studies have similarly suggested the utilization of symmetric schemes for verifying routing control packets. Hong [18] suggests a technique which requires shared keys between all communicating routers. This technique might not scale to huge ad hoc networks and might be open to single-node compromise. Camp et al. [17] utilizes symmetric primitives to protect routing between nodes and a reliable base station. Mokbel et al. [21] utilize a network-wide symmetric key to protect routing communication that is open to single node compromises, even though they specify the utilization of secure hardware to reduce the harm that can be caused by a compromised node. Xue,Li and Nahrstedt [23] have developed a mechanism that offers protection against non-colluding attackers, and they do not verify intermediate nodes which pass on route requests, and therefore, do not run authorization. Jannotti et al. [22] analyze challenges related to authorization. SEAD [26] utilizes hash chains to verify routing updates sent by a distance-vector protocol; nonetheless, that method builds on a periodic protocol, and protocols like that are likely to have higher overhead than on-demand protocols and might not therefore be appropriate in highly mobile networks. A previous version of the Ariadne protocol was discussed in [22]. In addition, Routing protocol intrusion detection has been analyzed as a technique for the detection of malfunctioning routers [7, 11, 24].

III. THREATS IN MOBILE NETWORKS

There are many different forms of attacks against MANETs, therefore, in this section, we do not attempt to give a comprehensive list of all mobile routing attacks. We based on few ones that have direct effect on this research.

A. Black Hole:

This form of attack is generally performed against reactive protocols through the injection of route reply which advertises the attacker as possessing the shortest path, which compels the data flow to pass by the attacker so as to alter or simply to listen in on the exchanged traffic [15]. It can also be utilized to make the attacker appear as the actual node.

B. Replay:

The attacker introduces into the network routing information that had been taken earlier to disturb the functioning of routing in the network or to promote the attacker as an authentic node and execute a black hole attack [12]. This attack can only be performed against poorly developed routing protocols since any extra security mechanism such as digital signature can end this attack.

C. Blackmail:

This attack is carried out against routing protocols that are based on node behaviour to detect malicious nodes [16], which are saved in a black list to be utilized for route selection. The attacker normally creates such messages against real nodes. A mechanism of digital signature and PKI are useful against these attacks.

D. Routing table poisoning:

This attack is carried out against table driven routing protocols, in the manner that the attacker diffuses false routing data to its neighbours so as to interfere with or block the traffic over the network. In addition, the attacker can introduce fabricated routing information to entice all the network activity to him so as to alter or just listening to the data flow [16].

E. Denial of service attacks:

These attacks attempt to stop the activity on the network by disrupting the routing function in the network [17].

IV. SECURING ROUTING PROTOCOLS

Available studies indicate that there are many techniques for securing routing protocols by including new security challenges over existing routing techniques utilized by these protocols. In this part of the study, a summary of some secured routing protocols is provided:

A. The Secure Routing Protocol (SRP):

is a set of security extensions which can be used in any ad hoc routing protocol that uses broadcasting as its route querying technique [18]. It utilizes a security connection between the source and the destination so as to share a secret key to encrypt traffic over the discovered path.

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B. The Authenticated Routing for Ad hoc Networks (ARAN):

suggested in [19], is a stand-alone solution to secure on demand routing protocols in ad hoc networking utilizing asymmetric cryptography and certificates to guarantee both verification and non-repudiation. It requires the presence of a trusted certificate authority to provide certificates.

C. Secure Ad hoc On-demand Distance Vector (SAODV):

is a security extension used in the AODV protocol [7]. The recommended extensions use digital signatures and hash chains so as to protect route discovery by the application of a digital signature on particular fields of the header of routing packets, the aim of this suggestion is to guarantee the authentication of the discovered routes.

D. The Secure Link State Routing Protocol (SLSP):

has been proposed in [21] to give safe proactive routing for mobile ad hoc networks. It protects the detection and the supply of link state information utilizing public key cryptography in order to circumvent the burden because of the deployment of a certificate authority; nodes communicate their certificate during flooding routing information which ensures the verification of routing messages.

V. PUBLIC KEY INFRASTRUCTURE (PKI)

A PKI is a set of mechanisms which take care of digital certificates as publishing, distributing, renewing and cancellation in a given community or network. A PKI is basically made up of Certificate Authority (CA), Registration Authority (RA) and Certificate Revocation List (CRL). Contingent on the application and the setting where a PKI is sent all or just a subset of these elements are utilized. The most vital element of a PKI is the certificate authority since it is the trusted party which signs and authenticates certificates. A certificate is an electronic document which ties pieces of information (name, serial numbers, address, IP and MAC address) signed by the certificate authority. The present version of certificate is X.509 V3, nevertheless, based on the requirement of each system new fields can be added to permit a perfect identification within the community. For instance, in a wireless ad hoc network, an IP or MAC address [13] can be added to be utilized so as to directly localize the corresponding node without using other servers or infrastructure.

PKI is perceived as the most effective tool for provision of authentication and nonrepudiation in conventional networks. However, the provision of such infrastructure for MANETs is a challenging mission because of the nature of these networks. Many studies propose several solutions like partially distributed certification suggested in [22] and completely distributed certification proposed in [23]. Nevertheless, present studies propose solutions that exploit some new features like clustering so as to make the management of PKI services easier [13].

To secure routing protocols in MANETs it appears that PKI is a very great tool to guarantee verification and data integrity utilizing digital signature. Nonetheless, the challenge is how to issue certificates and how to keep them safe.

The proposed scheme in this paper attempts to utilize the underlying routing protocol thought to be reactive as a support for certificate publishing. In the manner that the route discovery and reply mechanisms are utilized to publish certificate within the entire network; the route discovery is flooded over the whole network which guarantees that the certificate is known by all nodes in the network with the least overhead.

VI. DESIGN ELEMENTS

- *Zone Leader:* These nodes create a key and share it with other nodes to form a zone. General accessibility of location information: every node will be fortified with a device that is able to obtain position information. In addition, it is in charge of the administration of the group; introducing the group and controlling who joins and leaves (revocations). Likewise, it is in charge of revealing the owner of a signature in the event of a dispute.
- *Group Members:* users/entities that stand for the present set of authorized signers. Every member should have a unique private key which enables the member to sign on behalf of the group.

VII. ANONYMOUS ROUTING

The proposed secure anonymous routing protocol is made up of two parts: the route construction phase and the data transfer phase.

A. Route construction phase

The simple approach of this protocol during the route creation phase is to create a route by flooding RouteRequest packets in the network.

Location-aid routing protocol [5] uses the location information to improve on the effectiveness of routing by the reduction of the control overhead. LAR takes up the accessibility of the global positioning system (GPS) to obtain the geographical position information required for routing. LAR assigns two geographical regions for selectivity forwarding of control packets known as ExpectedZone and RequestZone. The ExpectedZone is the location where the destination node is required to be available, providing information in relation to its location in the past and its mobility information. In case of non-availability of the past information about destination, the whole network area is thought to be the ExpectedZone of the destination. Likewise, with the accessibility of more data about its mobility, the ExpectedZone of the destination can be fixed with more accurately and efficiency enhanced. The RequestZone is a geographic area within which the route discovery control packets are allowed to be circulated. This region is decided by the sender of a data transfer session. The control packets utilized for route discovery are sent by nodes which are available in the RequestZone and are disposed of by nodes outside the zone. In circumstances where the sender or the intermediate relay nodes are absent from the RequestZone, an extra zone is add for forwarding the packets. This is done when the initial attempt to obtain a route to a destination

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utilizing the first RequestZone does not yield a route within an adequately long waiting period. In this instance, the second attempt repeats the procedure with a bigger RequestZone size to account for mobility and error in location estimation.

For instance, when the source node *S* needs to interact with the intended destination node *D*, it must create a secure anonymous route between them in the network and then data traffic can be securely transmitted on the route.

1) The RREQ in source node:

Source node *S* generates a key pair (*pk, sk*) and random number *rS* before it interacts with destination node *D*. It is assumed that the localized trust management has separated trust nodes and circulated trust key *K* to them. Likewise, it is assumed that *sk* will be known by all the zone leaders. At this point node *S will* communicate a route request (RREQ) message to all of its neighbors and fills ”null” in the zone leader node field of its route table. The message will be gotten by the leader in that zone. In other words, the zone leaders will decrypt the message to identify whether the destination node is within its zone.

There are two features in the proposed protocol:

- The whole RREQ message is encrypted with trust key before the node sends the RREQ.It ensures that a malignant node cannot take part in the path-finding. Although the localized trust management has quarantined malignant nodes from the network, the circumstance must be considered as a node that had been previously confirmed as trusted has been seized by an enemy and its neighbors or central nodes do not know about that. It is serious whenever on the processes of route establishment or data transfer. Nevertheless, since trust key is distributed from time to time and malicious nodes cannot determine the trust key K of this session, it cannot decode a received message and take part in the protocol.
- When a trust node receives the RREQ, it transmits Hello message to its zonal leaders within the message expiration time e. The aim of this is to verify that it is a trust node to its zonal leader. This phase together with the encryption of the whole RREQ message can completely bar malicious nodes and shield attacks.

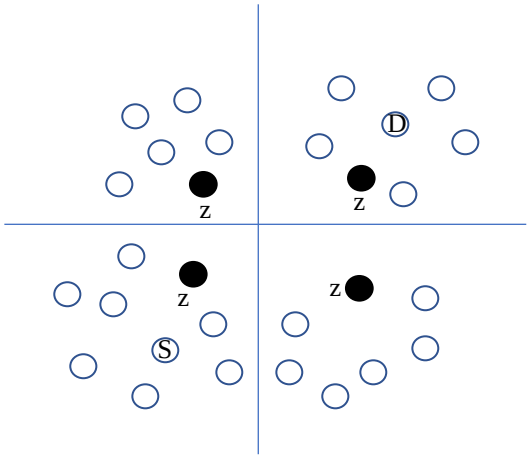

Fig1: network topology

2) The intermediate node:

As presented in Fig.1, when the intermediate nodes get the RREQ, it passes through the following process:

• Check if the intermediate node has the trust key to decode the message, if this is the case, it is a trusted node as Z.

• Without the trust key, the intermediate node is deemed a malicious node and cannot transmit Hello message to its leader node within the time *e*. At the end of the waiting period, the leader marks this specific node as a malicious node and notifies its central nodes, then the node is separated from the network.

3) The RREQ in destination node: Decrypting

Node *D* discovers that it is the intended destination node and forwards Hello message to its zone leader. Here, the leader can identify the route. Also, it can identify the shortest route between the two nodes. The zone leader will encrypt the route to the source node.

B. How it works

It is computationally simple for a party *S* to generate a pair (public key sk, private key pk).

It is computationally simple for a sender *S* knowing the public key and the message to be encrypted, M, to generate the corresponding ciphertext

$$X= E(\sigma\kappa, M) \quad (1)$$

It is computationally simple for the receiver *D* to decode the resultant ciphertext utilizing the private key to retrieve the original message:

$$M= D(pk, C)=D[pk,E(sk,M)] \quad (2)$$

It is computationally not possible for an attacker which knows the public key sk to define the private key pk

It is computationally not possible for an attacker which knows the public key sk and a ciphertext *C* to retrieve the original message, *M*.

These are difficult requirements as is evident by the fact that just some algorithms (RSA, elliptic curve cryptography, Diffie Hellman, DSS) have been widely accepted in over the decades since the notion of public key cryptography was proposed.

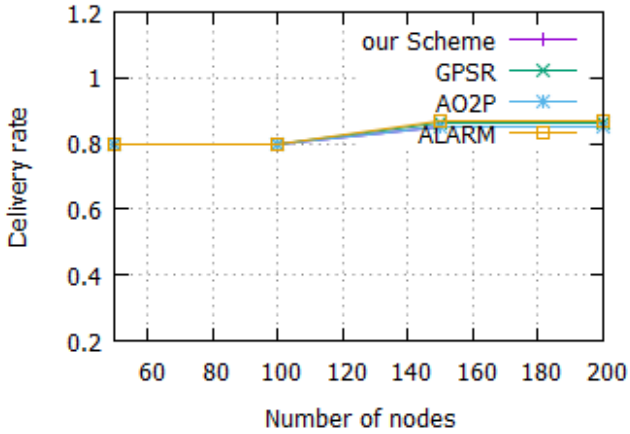

Fig. 2 Different node density

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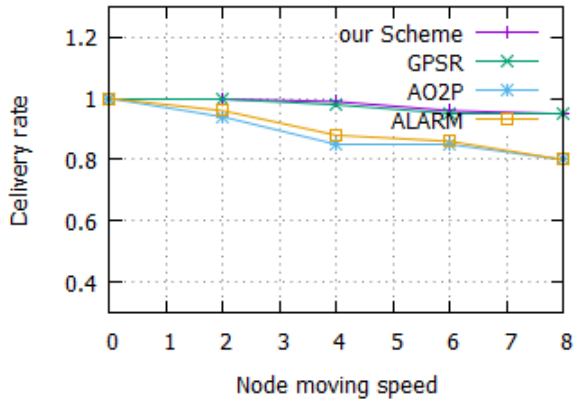

Fig. 3 Different moving speed

VIII. Performance Evaluation

In this area, empirical valuation of the scheme was done, which shows uniformity with the analytical results. The proposed scheme shows more superior performance in providing anonymity with low computation cost overhead. The performance of the proposed scheme is compared with two recently proposed anonymous geographical routing protocols: AO2P [10] and ALARM [5], which are supported on hop-by-hop cryptography and redundant traffic. The proposed scheme, AO2P and ALARM are all based on geographic routing, therefore, the present scheme is compared with the baseline routing protocol GPSR[15] in its evaluations. In GPSR, a packet is forwarded to the nodes close to the direction of destination node.

When close nodes are not available, GPSR utilizes perimeter furtherance to discover nodes that are very close to the destination device. In ALARM also, nodes frequently send and receive information about their current position on the network with its true neighbors. Therefore, the nodes are able to build good map for geographical routing. During routing processes, each node encrypts the packet using its key which can be substantiated by the true neighbors (next hop).

In AO2P, the protocol has a contention phase in which the neighboring nodes of the current packet holder will try to be the next hop. AO2P uses contention phase to group nodes based on their distance from the destination node and choose a node in the group that is closer to the destination node.

Fig. 2 shows the performance of our scheme, ALARM, AO2P, and GPSR at different delivery rate. We can observe that the delivery rate all close to 1, the in the sparse settings where node density is 50 nodes/km2. in In Fig. 16b, when there is destination update, the scheme and other protocols can also maintain a delivery rate steadily with different node moving speeds from 2 to 8 m/s.

Fig 4 demonstrate the performance of end-to-end delay versus mobility. The figure shows that our scheme has lower end-to-end delay. During light traffic load of 2 packets/second our scheme's delay increases from 0.1ms to 0.75ms when node speed increases from 0m/s to 10m/s but other protocols have longer latency.

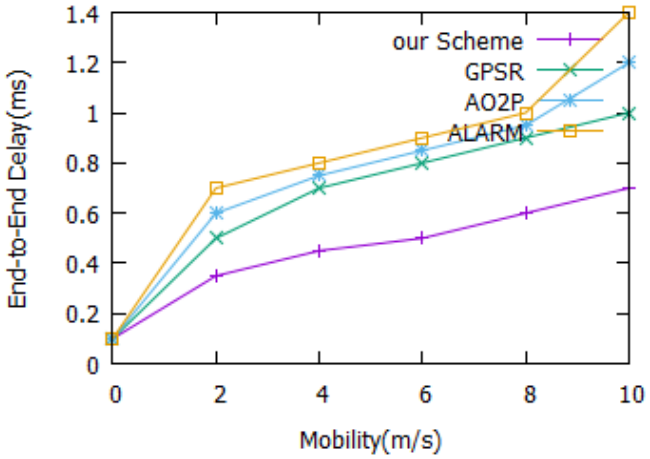

Fig. 4 End-to-End delay Vs Mobility

Fig. 5 illustrates the routing cost for delivery a unit of data payload. Our scheme has less overhead than AO2P, ALARM and GPSR because we based on one-time cryptographic encryption.

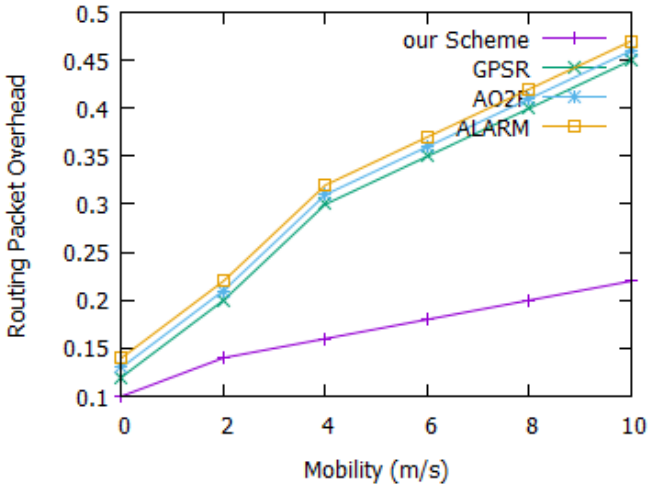

Fig. 5 Routing packet Overhead

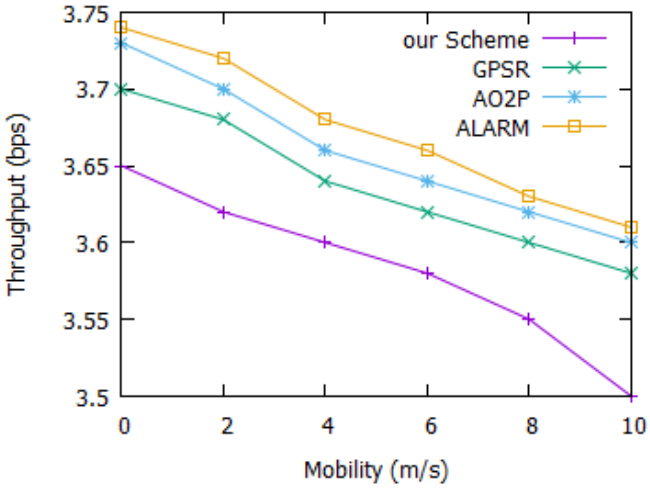

Fig. 6 Throughput vs Mobility

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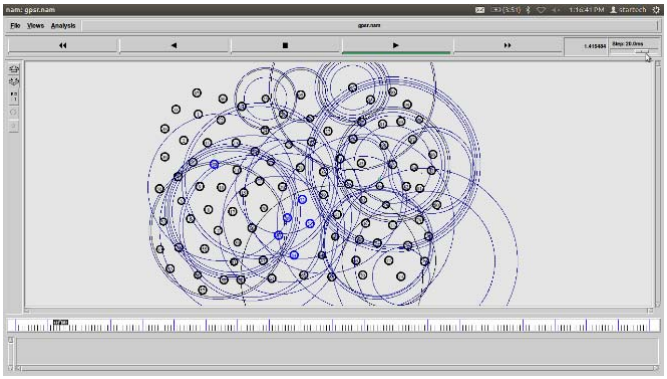
In terms of throughput, our scheme provides a better throughput than other protocols as shown in fig. 6. The throughput decreases as node speed increases in all the protocols.

IX. SIMULATION

The random way point model [17] is used as the default settings and set the environment range of every group to 150m with 10 groups[8] and 200m with five groups.

The test was done on NS2 simulator utilizing 802.11 as MAC protocol with a standard wireless transmission range of 250 m and UDP/CBR traffic [16] with a packet size of 512 bytes. The field in the trial was set to a 1000m X 1000 m area with 200 nodes moving at a speed of 2 m/s. The concentration was set to 50, 100, 150, and 200 nodes per square meters. The length of every simulation was set to 100 s. The number of pairs of S-D communication nodes was set to 10 and S-D pairs were randomly produced. S transmits a packet to D at an interval of 2 s. The final results are the average of results of 30 runs. For encryption, the symmetric encryption algorithm is AES and the public key encryption is RSA. Data are produced randomly based on the packet size indicated in the paper. Packets are encrypted whenever necessary. The encryption algorithm is single threaded running besides other parts of the experiment on a 1.8 Ghzprocessor. A typical symmetric encryption costs quite a few milliseconds while public key encryption operation costs 2-3 hundred milliseconds.



X. CONCLUSION

This study has highlighted the design and assessment of our scheme, a new safe ad hoc network routing protocol. This scheme offers protection against a compromised node and arbitrary active attackers. It depends on solely on effective *symmetric* cryptographic processes. It also runs on-demand, dynamically finding paths between nodes only as required. The model is centered on the simple operation of the DSR protocol. Instead of the application of cryptography to an existent protocol to attain protection, this study cautiously recreated each protocol message and its processing. The protection techniques which were developed are very effective and general. This is so that they can be used to secure different types of routing protocols.

However, due to the fact that the optimizations of DSR in our scheme were not secured, the subsequent protocol is not as effective as the much optimized version of DSR that runs in a trustworthy environment

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A Multi-metric and Multi-deme Multiagent System Applied on Some Multiobjective Optimization Problems

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Abstract: ***This article proposes a multiagent system consisting of a number of multiobjective metaheuristic agents working towards the optimization of a Pareto front using multiple performance metrics in a session wise manner. At the beginning of each session, main population is divided into a number of subpopulations that are assigned to individual agents randomly. The system runs in consecutive sessions such that agents start running after being assigned with a subpopulation and return the optimized subpopulations together with the corresponding set of nondominated solutions at the end of the session. There are three multiobjective assessment metrics in use and a different metric is considered for each session to measure the success of each metaheuristic agent. Evaluation of individual agents using a particular assessment metric is used in two ways: first, number of fitness evaluations for each agent is adjusted based on their performance; second, the subpopulation improved by an individual agent might be rejected based on its evaluation score. At the end of each session, individual subpopulations are merged to get the updated main population while individual sets of nondominated solutions are combined to form the global Pareto front. In addition to the individual multiobjective metaheuristic agents, the system also contains a number of coordination and synchronization agents that run the whole system towards its objectives. The proposed system is tested using ZDT and DTLZ real-valued multiobjective benchmark problems. Experimental results and statistical evaluations exhibited that the achieved success is better than many of state-of-the-art algorithms.***

Keywords**: Multi-agent systems, Metaheuristics, Multi-objective optimization, Multiobjective assessment metrics.**

1 Introduction

Modeling real-world usually involves the simultaneous optimization of a number of objectives which usually contradict with each other. In this respect, a multiobjective optimization (MOO) method aims to provide more than one solutions (so-called Pareto-optimal set) representing a number of tradeoff alternatives among the problem objectives. The main goal is to obtain a global Pareto optimum set of feasible solutions (so-called Pareto Front) such that all solutions within this set are pairwise non-dominated [1].

For a decade, metaheuristic-based approaches gain high popularity due to their low computational complexity and success in extracting optimal or very close-to-optimal Pareto fronts for high-dimensional difficult problems. Among numerous proposals of MOO metaheuristics, some of those that are well-known by their success are non-dominated sorting genetic algorithm (NSGA II) [2], multiobjective genetic algorithm (MOGA) [3], strength Pareto evolutionary algorithm (SPEA 2) [4], multiobjective differential evolution (MODE) [5], multiobjective simulated annealing (AMOSA) [6], and multiobjective particle swarm optimization (MOPSO) [7]. The method proposed in this article implements a multiagent system in which the above mentioned MOO metaheuristics act as individual agents.

A multiagent system (MAS) is a social environment for a population of agents that perform a goal-oriented task on the environment using their own operators. Basically, each agent gets a set of percepts from their environment,

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processes the percepts under light of their accumulated knowledge, and act on the environment through their available operators to achieve a predefined design goal. MASs are designed to carry out a particular task through social interaction of its agents. This social interaction is also usually of two types, namely cooperation or competition. Both of these social interactions require agents to use communication mechanisms through which they can share or exchange information.

This paper presents a novel multiagent system for the solution of real-valued multiobjective optimization problems. The proposed architecture contains implementations of a number of MO metaheuristics as individual agents that cooperatively work on different randomly sampled subpopulations and returns the improved subpopulation and the extracted Pareto front. Individual agents have their own local archives of non-dominated solutions extracted in a session, while there is a global archive keeping all non-dominated solutions found so far. At the end of each session, all subpopulations are combined into one global population to be used for the initialization of the next session. Similarly, all local archives are merged with the global archive to get the set of all non-dominated solutions found by all metaheuristics. This way, the metaheuristics cooperate with each other by sharing their search experiences through collecting them in a common population and a common global archive. The proposed MAS is experimentally evaluated using the well-known sets of ZDT and DTLZ benchmark problems [8, 9] and comparative analysis of the experimental results demonstrated that the proposed architecture achieves better performance than majority of its state-of-the-art competitors in most of the problem instances. Detailed descriptions of the proposed MAS are given in Section 4.

The rest of this paper is organized as follows: Fundamental subjects and components of a multiagent system are illustrated in Section 2. The proposed heterogeneous, multi-deme multi-metric MAS for real valued multiobjective optimization is described in detail in Section 3. Section 4 comprises description of experimental suit, test problems, algorithm parameters, results and comparative analyses in terms of quantitative and statistical computations. Section 5 presents conclusions and some future research directions.

2 Multiagent systems

Fundamentally, a MAS comprises a set of agents and their environment in which the agents are designed to perform particular tasks. In this respect, individual agents are computational procedures that perceive their environment, make inferences based on the received percepts and their learned experience and acts on their environment to reach predefined design goals [10]. In intelligent MASs, individual agents are required to be autonomous that means learning capability through interactions with the environment as well as adapting to changes in the environment caused by agents' actions internally and the environments' dynamics externally [11]. Communication channel is another major part of a MAS which let the agents in a MAS to interact and communicate with each other through it [12].

The other fundamental part of a MAS is the environment which is sensed and changed by its agents to reach their goals. The environment is a shared common resource for all agents and it takes the role of specifying positions, locality, and limitations on actions of agents [13].

Multiagent systems including metaheuristics as individual agents are widely used to provide cooperative/competitive frameworks for optimization [12, 14]. There exists significantly large literature in this field and a detailed literature review together with descriptions of some of the pioneering studies are presented in [15].

The method proposed in this paper comprises some MOO metaheuristic agents acting on subsets of a common population. In addition to an assigned subset of population elements, agents also maintain their local archives keeping the non-dominated solutions extracted during a particular session. The proposed method runs in consecutive sessions

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and each session includes two phases as follows: in the first phase, a population of solutions is divided into subpopulations of individual solutions (by uniform random sampling) such that an individual may be selected for more than one subpopulation but there is exactly one copy of an individual in a subpopulation. In the second phase, each agent works on its subpopulation using its own MO search strategies and tools, and then returns the improved subpopulation and the extracted Pareto front. Each extracted Pareto front is evaluated using the current assessment metric under consideration and evaluations scores are used in two ways; first, number of fitness evaluations for each agent is adjusted based on their performance and, the second, the subpopulation improved by an individual agent might be rejected based on its evaluation score. In each session, extracted non-dominated solutions are kept in local archives and all non-dominated solutions found so far are combined into a global archive at the end of the session. This way, metaheuristic agents share their experiences through improved solutions when collecting them in a common population and a common global archive. The proposed MAS includes one supervisory agent that controls communication and coordination of agents' activities through monitoring individual sessions, common population and the common archive. The resulting MAS architecture is used to solve real-valued multiobjective optimization problems within the well-known ZDT and DTLZ benchmarks sets. Analysis of the obtained results showed that the resulting MAS is in fact a powerful alternative for the solution of hard numerical MOO problems.

3 The Proposed Multi-metric and Multi-deme Multiagent Architecture

The main idea presented in this paper is a multiagent architecture in which basic forms of a number of metaheuristics for multiobjective optimization are implemented as individual agents that are controlled and coordinated by strategy and population management agents. Individual agents are assigned to subpopulations and their success is evaluated in a session-wise manner using multiple MO assessment metrics. In this implementation, there are five MO metaheuristic agents and three MO assessment metrics under consideration. Hence, the overall execution of the proposed MAS is completed in three sessions such that performances of individual agents are measured based on one of the three assessment metrics. Each assessment metric, namely ε–indicator, generalized spread metric and IGD, is used only once and experimental results showed that the order in which they are used has no significant effect on the overall success of the proposed method. In this respect, individual agents try to improve Pareto fronts based on different quality measures in each session. Fundamentally, ε–indicator and generalized spread metrics are used to measure the degree of convergence and diversity along a reference Pareto front, respectively, whereas inverted generalized distance can be considered as an indicator of both convergence and diversity. Consequently, the proposed MAS aims to extract Pareto fronts having high quality indicators in terms of convergence and diversity metrics. In each session, the proposed method assigns different parts of the whole population to individual agents and grades their performance based on the same assessment metric. If an agent does not exhibit enough success in a session, then the subpopulation returned after its execution is rejected while its extracted nondominated set of solutions are sent to archive agent for a possible inclusion of some of them into the global Pareto front. This way, instead of working on a fixed agent-owned population and getting stuck at locally optimal solutions due to bias caused by a fixed set of search operators, different parts of the whole population are processed by different agents (methods) in a coordinated manner. Another important concern here is the knowledge sharing (cooperation) among individual agents trough combining their subpopulations and the discovered Pareto fronts. Even though there is no direct communication among MOEA agents, they cooperate with each other through sharing their search experiences within a common global population and within a common global archive at the end of each session. This way, in consecutive sessions, improved solutions resulting from search efforts of several metaheuristics constitute starting populations of individual metaheuristics.

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Architectural description of the proposed method is presented in Figure 1. This architecture can also be implicitly interpreted as a two-layer system in which the first layer contains organizational agents whereas the second layer consists of the individual MOEAs. There is a problem agent to read formulation of the multiobjective optimization problem and to initialize the related parameters such as number of variables, variable domains and number of objectives. The problem agent sends the problem description and its parameter values to the Solution Pool Agent (SPA) which manages all the transactions associated with the shared global population. As a first task, SPA initializes the solution pool with randomly built solutions and computes their objective function values. The next operation carried out by SPA is the distribution of global population into subpopulations of randomly sampled individuals. Due to the number of agents in the system, an individual solution in the global population may be selected for more than one subpopulation, and a few individuals might not be present in any subpopulation, although this is a very small probability. Based on the retrieve message of the strategy agent, SPA sends the subpopulations, corresponding objective function values, initial order of multiobjective assessment metrics and initial order of agents to be used for the task assignment purpose.

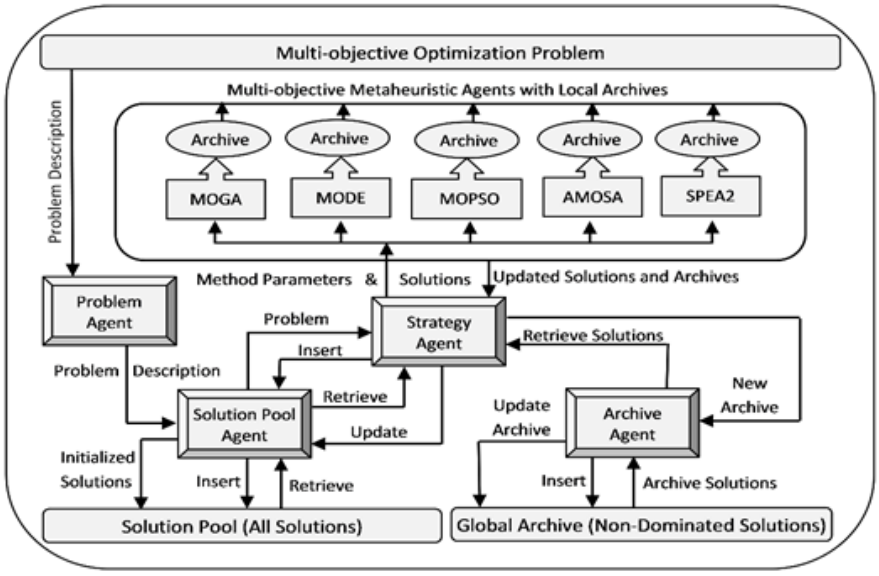

Figure 1. Architectural description of the proposed multiagent system.

The archive agent deals with all transactions associated with the global archive and it communicates with the strategy agent for initialization, retrieval and update operations. Upon receiving the current sets of non-dominated solutions from MOO agents through the strategy agent, archive agent unites its current contents with the received sets and eliminates those dominated solutions from this combination. The updated global archive is sent back to the strategy agent to be used as a shared resource for all agents during their executions. The heart of the proposed system is the strategy agent (SA) that communicates with all other agents and carries out task assignments, data collection, data transfer and control of all agent activities.

In its current implementation, the proposed system runs in three sessions and a different MO assessment metric is used to measure the success of individual agents. In the first session, all individual agents are given the same number of fitness evaluations in execution of their subpopulation. For the second and the third sessions, number of fitness evaluations for each agent is adjusted based on their success in the previous session. That is, at the end of first and second sessions, the strategy agent computes the score of each individual agent based on their returned populations and the current MO assessment metric under consideration. A better score means higher number of iterations for the

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next session. For this purpose, a weight w_i is computed for each agent i based on its current metric score and the number of fitness evaluations for the next sessions is computed as w_i times the number of fitness evaluations for the first session. For the first session, number of fitness evaluations for each agent is set to a fixed value α. However, in every session, number of fitness evaluations for each individual agent is limited to an interval $[\beta_1 * \alpha, \beta_2 * \alpha]$.

Calculation of the weights w_i is based on the following idea: w_i's take values from the range $[w_{min}, w_{max}]$ such that the best performing agent is assigned with the weight w_{max}, whereas the worst performing one takes the weight w_{min}. Weights of other agents are determined linearly based on the following simple formula,

$$w_i = w_{min} + \frac{w_{max} - w_{min}}{S_{max} - S_{min}} (S_i - S_{\min})$$

where S_i, S_{max} and S_{min} represents the metric score of agent i, maximum metric score and minimum metric score, respectively, at the end the current session. Agents' weights are also used for accepting or rejecting their subpopulations. In this respect, if $S_i/S_{best} \leq w_i$, then the subpopulation returned by agent i is rejected. However, the set of nondominated solutions extracted by agent i is sent to the archive agent for a possible inclusion of some its elements within the global set of nondominated solutions. As it was also mentioned above, the strategy agent is performing the most critical operations of the proposed MAS. A flowchart description of the strategy agent that describes the flow of above explained operations is given below in Figure 2.

In each session, the best Pareto front found so far, stored in the global archive, is taken as the reference Pareto front needed to compute the associated performance metrics. Also, at the beginning of each session, the algorithmic parameters of individual agents are set as described in Table 1.

4 Experimental results and evaluations

Performance evaluations of the proposed algorithm are carried out over the difficult ZDT and DTLZ benchmark [8, 9] problems. For each of the test functions, number of variables, number of independent runs and the termination criterion, in terms of the number of fitness evaluations, are set the same as the ones mentioned in these references so that fairness is guaranteed for comparative evaluations. Algorithmic parameters of the proposed method are kept the same for all the test functions and no interactive intervention is made throughout the program executions.

Algorithmic parameters of the metaheuristic methods used within the proposed multiagent system are given in Table 1 where the proposed multi-metric multi-deme MAS is named as M^3D/MAS. All of the parameters in Table 1 are collected from well-known conventional implementations of the corresponding metaheuristic algorithms. Except for AMOSA, that is a trajectory based metaheuristic running over single solutions, initial population size, α, is set to 20 individuals for all other metaheuristic agents. Implementation of the proposed system is carried out using Matlab® programming language environment and a personal PC with 8 GB main memory and 2.1 GHz clock speed.

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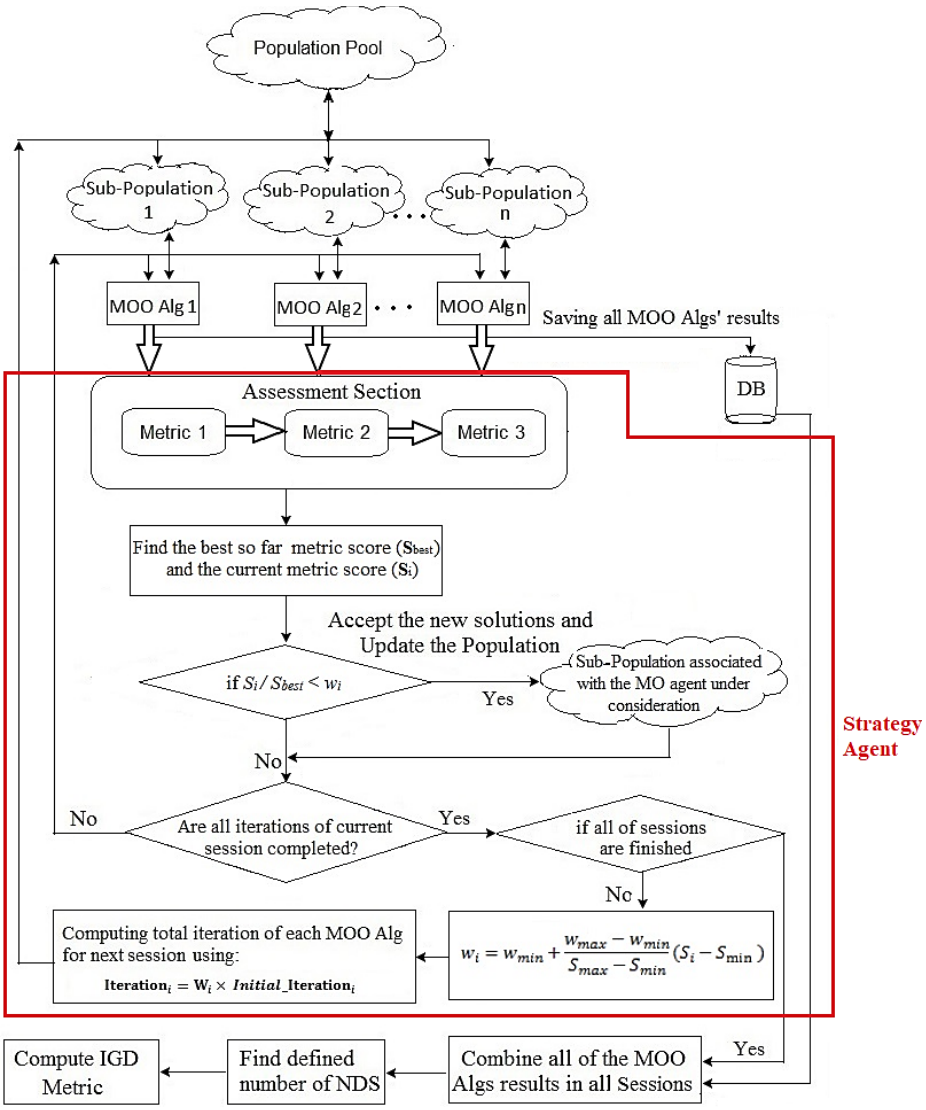

Figure 2. Process flowchart of the proposed multi-agent system

Table 1. Algorithmic parameters of the metaheuristic methods used within the proposed system.

Metaheuristic Agent	Algorithm Parameters
MOGA	P_C =0.7, P_m=0.2, Gaussian_Sigma_Pm=20
MOPSO	C1=2.0, C2=2.0, ω_{max}=0.9, ω_{min}=0.4
MODE	Scaling_Factor=0.5, P_C =0.7
SPEA2	P_C =0.9, P_m=1.0/Num_Vars, Distribution_Index=20
AMOSA	Archive_H_{limit}=20, Archive_S_{limit}=50, Max_Temp=200, Gamma=2.0, Min_Temp=0.00025, Cooling_Rate=0.95, Hill_Climbing_Num=20,
NSGAII	P_C =0.9, P_m=1.0/ Num_Vars, Distribution_Index=20,
M^{3}D/MAS	α=20, w_{min}= 0.6 w_{max}=1.4 β_1=0.1 β_2=1.9

In the recent decade, a number of MOO assessment metrics have been proposed to quantify the performance and facilitate the comparative evaluation of MOO algorithms. In this research two well-known MOO assessment metrics, namely ε –indicator and inverted generational distance (IGD) are used to evaluate the success of MOO algorithms in terms of additive distance, diversity, and Euclidean mean distance, respectively. Detailed description of these metrics are given in [16, 17, 18, and 19].

Average scores of M^{3}D/MAS for ZDT and DTLZ benchmark problems over 30 runs are compared to published values in [20, 21, and 22]. In all the tables within this section, results of best performing algorithms are indicated in

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bold. Table 3 and Table 4 illustrate the Min, Max and Average IGD and ε –indicator values associated with the proposed M^{3}D/MAS algorithm for the 10 mentioned above. It can be seen from these tables that small values of standard deviations indicate that the proposed algorithm is a stable and robust alternative numerical MOO. Additionally, small values of IGD and ε –indicator metrics show that the proposed algorithm successfully extracts Pareto fronts that close to the optimal one.

Table 2. Variable ranges, number of variables and maximum number of fitness evaluations for each benchmark problem instance

Instance	Number and Range of Variables	# Fitness Evaluations
ZDT1	$[0, 1]^n$ **n** = 30	300 000
ZDT2	$[0, 1]^n$ **n** = 30	300 000
ZDT3	$[0, 1]^n$ **n** = 30	300 000
ZDT4	$x_1 \in [0,1]$, $x_i \in [-5,5]$, **n** = 30	300 000
ZDT6	$[0, 1]^n$ **n** = 30	300 000
DTLZ1	$[0, 1]^n$ **n** = 30	300 000
DTLZ2	$[0, 1]^n$ **n** = 30	300 000
DTLZ3	$[0, 1]^n$ **n** = 30	300 000
DTLZ4	$[0, 1]^n$ **n** = 30	300 000
DTLZ7	$[0, 1]^n$ **n** = 30	300 000

Table 3. Min, Max and Average IGD values of M3D/MAS in 30 runs.

Function	Average	Min	Max	Std
ZDT1	3.19e – 03	2.96e – 03	3.58 e – 03	2.1e – 04
ZDT2	3.33e – 03	3.08e – 03	3.63 e – 03	2.0e – 04
ZDT3	3.77e – 03	3.50e – 03	4.33e – 03	2.2e – 04
ZDT4	3.01e – 03	2.59e – 03	3.52e – 03	2.3e – 04
ZDT6	2.54e – 03	2.30e – 03	2.89e – 03	1.9e – 04
DTLZ1	1.40e – 03	1.37e – 03	1.55e – 03	1.2e – 04
DTLZ2	2.97e – 03	2.77e – 03	3.23e – 03	2.0e – 04
DTLZ3	3.47e – 03	3.36e – 03	3.59e – 03	1.8e – 04
DTLZ4	2.95e – 03	2.82e – 03	3.17e – 03	1.7e – 04
DTLZ7	5.55e – 03	5.35e – 03	5.95e – 03	4.2e – 04

Table 4. Min, Max and Average ε values of M3D/MAS in 30 runs.

Function	Average	Min	Max	Std
ZDT1	5.30e – 03	4.80e – 03	5.66e – 03	3.6e – 04
ZDT2	4.96e – 03	4.75e – 03	5.13e – 03	2.7e – 04
ZDT3	5.34e – 03	4.90e – 03	5.78e – 03	4.3e – 04
ZDT4	4.36e – 03	4.08e – 03	4.88e – 03	4.1e – 04
ZDT6	4.04e – 03	3.89e – 03	4.47e – 03	3.2e – 04
DTLZ1	2.27e – 03	2.16e – 03	2.44e – 03	1.8e – 04
DTLZ2	4.29e – 03	3.79e – 03	4.70e – 03	3.2e – 04
DTLZ3	5.63e – 03	5.40e – 03	6.05e – 03	3.8e – 04
DTLZ4	5.87e – 03	5.72e – 03	6.22e – 03	3.1e – 04
DTLZ7	8.75e – 03	8.31e – 03	9.32e – 03	5.4e – 04

Tables 5 exhibit IGD results of M3D/MAS and 5 other recently published state-of-the-art MOO methods for comparative evaluations. For ZTD benchmarks, the best performing algorithm is BX-NU that achieved the best IGD scores for 3 test problems whereas M3D/MAS took the second position and exhibited the best scores for 2 of ZDT instances. For the 6 DTLZ instances, BLX-NU and SBX-PN are the best performing methods while the proposed algorithm is taking the third position.

Table 5. Comparing average IGD values of M^{3}D/MAS with 5 MOO methods

Function	BLX-NU [20]	SBX-PN [20]	MOEA/D [21]	MOEA/D-DE+PSO [21]	MOEA/D-CPDE [21]	M3D/MAS
ZDT1	5.58e − 03	2.99e – 02	4.05e − 03	4.14e − 03	4.03e − 03	**3.19e – 03**
ZDT2	4.37e − 03	7.44e − 03	3.81e − 03	3.87e − 03	3.80e − 03	**3.33e – 03**
ZDT3	**3.10e − 03**	5.92e – 03	7.08e − 03	9.02e − 03	7.08e − 03	3.77e – 03
ZDT4	**7.90e − 04**	2.15e – 03	1.96e − 01	7.55e − 03	3.95e − 03	3.01e – 03
ZDT6	**1.07e − 03**	1.22e – 03	1.34e − 02	1.45e − 02	5.97e − 03	2.54e – 03
DTLZ1	**2.70e − 04**	5.50e – 04	NA	NA	NA	1.40e – 03
DTLZ2	**7.60e − 04**	2.68e – 03	NA	NA	NA	2.97e – 03
DTLZ3	4.00e − 04	**3.90**e – 04	NA	NA	NA	3.47e – 03
DTLZ4	2.93e − 03	**2.74**e – 03	NA	NA	NA	2.95e – 03
DTLZ7	6.96e − 03	1.17e − 02	NA	NA	NA	**5.55e – 03**

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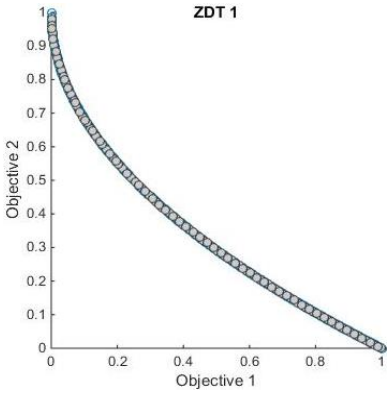
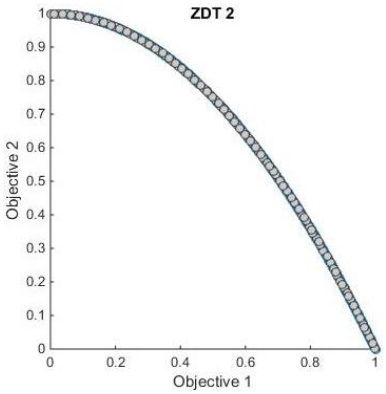
Tables 6 illustrates ε-indicator values of 7 MOO metheuristics including M^{3}D /MAS and 6 other well-known MOO methods. It clear that the proposed methods is the winner against its competitors and achieved the best scores for 6 of the 10 benchmark problems. The second best performing method is SMPSO that took the first position for 4 test instances.

Table 6. Comparing average ε values of M^{3}D/MAS with 6 MOO methods [22]

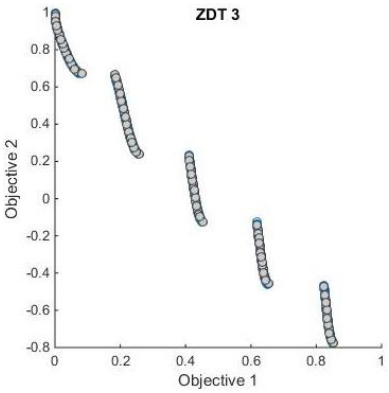
Function	NSGA-II	SPEA2	OMOPSO	AbYSS	MOCell	SMPSO	M3D/MAS
ZDT1	1.37e – 02	8.69e – 03	6.36e – 03	7.72e – 03	6.23e – 03	5.39e − 03	**5.30e – 03**
ZDT2	1.28e – 02	8.73e − 03	6.19e − 03	7.10e − 03	5.57e – 03	5.33e − 03	**4.96e – 03**
ZDT3	8.13e – 03	9.72e − 03	1.32e − 02	6.10e – 03	5.66e – 03	**5.10e – 03**	5.34e – 03
ZDT4	1.49e – 02	3.42e − 02	5.79e + 00	1.14e − 02	8.17e – 03	6.02e − 03	**4.36e – 03**
ZDT6	1.47e – 02	2.42e − 02	4.65e − 03	5.06e − 03	6.53e – 03	4.43e − 03	**4.04e – 03**
DTLZ1	7.13e – 03	5.89e − 03	1.92e + 01	5.85e − 03	4.02e – 03	2.97e − 03	**2.27e – 03**
DTLZ2	1.11e – 02	7.34e − 03	6.72e − 03	5.39e − 03	5.09e – 03	5.17e − 03	**4.29e – 03**
DTLZ3	1.04e + 0	2.28e + 00	8.86e + 01	1.66e + 00	7.91e – 01	**5.39e − 03**	5.63e – 03
DTLZ4	1.13e – 02	7.66e − 03	3.18e − 02	**5.39e − 03**	5.74e – 03	**5.39e − 03**	5.87e – 03
DTLZ7	1.04e – 02	9.09e − 03	7.13e − 03	5.51e − 03	5.19e – 03	**4.95e − 03**	8.75e – 03



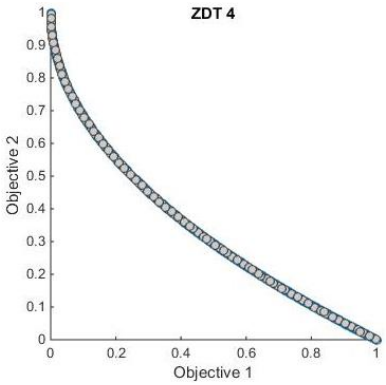
a) PF true and extracted PF for ZDT1



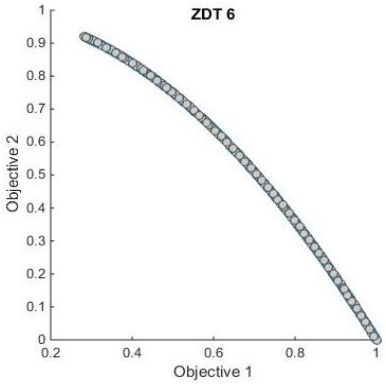
b) PF true and extracted PF for ZDT2



c) PF true and extracted PF for ZDT3



d) PF true and extracted PF for ZDT4



e) PF true and extracted PF for ZDT6

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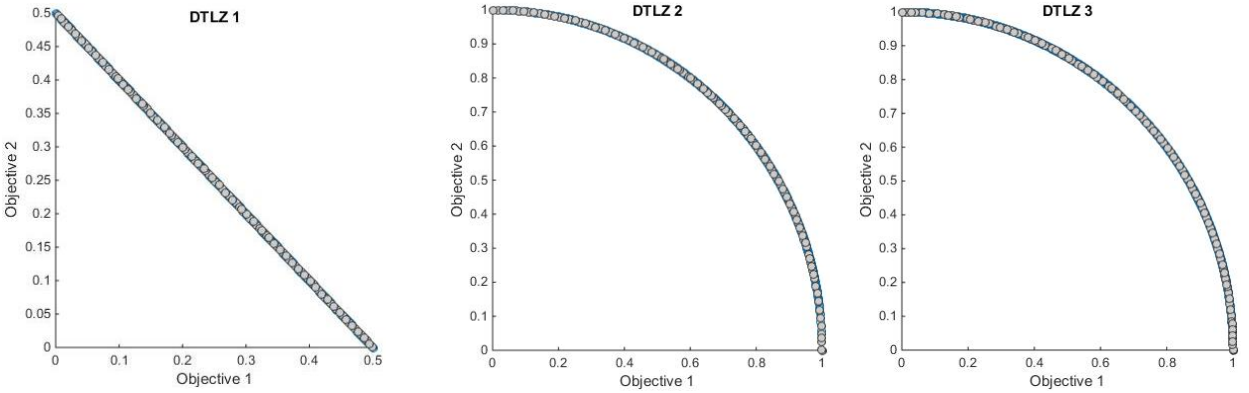
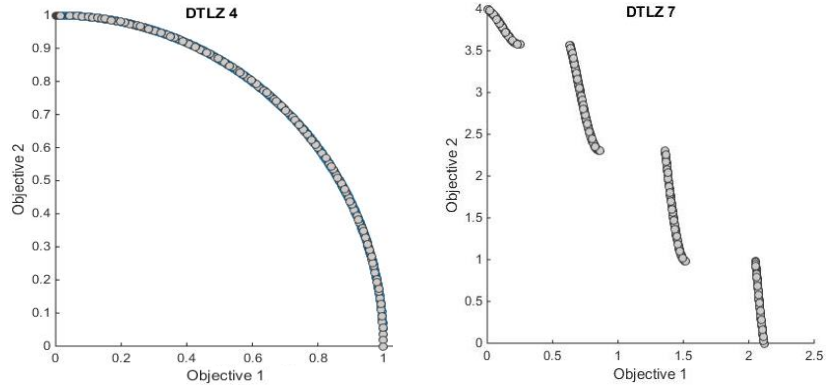


f) PF true and extracted PF for DTLZ1 g) PF true and extracted PF for DTLZ2 h) PF true and extracted PF for DTLZ3



i) PF true and extracted PF for DTLZ4 j) PF true and extracted PF for DTLZ7

Figure 3. Plots of Pareto fronts computed by M3D/MAS and optimal Pareto fronts of the ten ZDT and DTLZ benchmark problems: Subplots a-e illustrate the computed and optimal PFs of ZDT benchmarks, whereas subplots f-j show those for the DTLZ test instances.

Figure 3 shows the Pareto fronts computed by M3D/MAS and the optimal Pareto fronts for the ZDT and DTLZ benchmark instances. It is seen that both the spread and convergence of the computed Pareto fronts are close to optimal for all the problems under consideration.

5 Conclusions and future works

This study presents a new approach for the design of a cooperative multiagent system of metaheuristic agents for the solution of real-valued multiobjective optimization problems. Basic descriptions of a number of metaheuristics for MOO are implemented as individual agents. The global population is randomly divided into subpopulations and each subpopulation is optimized by an assigned agent based on a session-wise specified MOO assessment metric. The effectiveness of the proposed MAS is tested using a well-known sets of benchmark problems and its performance is comparatively evaluated against well-known modern MOO algorithms. Experimental results exhibited that significant improvements have been obtained using the proposed algorithm in comparison to well-known methods. Both the quantitative and statistical analysis put the proposed approach, M3D/MAS to a promising position against its competitors.

Further research is planned to extend the proposed MAS with additional MOO agents and consider its use for practical real-valued and combinatorial optimization problems.

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SPASMODIC WATERMARKING OF COMPARATIVE IMAGES USING DISCRETE WAVELET TRANSFORM (DWT) AND HISTOGRAM CHANGING

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ABSTRACT- **A innovative Double Faced watermarking scheme Using histogram changing inflection which flexible takes care of the confined specification of the picture contented. By registering it to the picture calculation-problems and by making an allowance for their next locality, the techniques we used to placing information in textured areas that should be encrypted & decrypted properly. in addition, our methods makes utilize of a categorization process for notifying the parts of the picture so it has been watermarkened with the nearly everyone suitable double faced (spasmodic) intonation. These categorization can be done on a orientation picture derived from the original picture itself, a predict of which have the resources of being relative to the watermark embeded. In this method, these watermark implanted plus extractor stay coordinated for message removal and image rebuilding. The test arrangement happening on a number of general images and on medicinal picture as of variety of modalities, our plan can include with lower twist than any existing technique In histogram changing the pixel can be well-organized and lesser difficulty than applying it on calculation-errors. since, the histogram maxima corresponds to the void gray value; capability is increased and underflow are simply evade by changing pixel value to the correct, i.e. by adding up a productive gray scale value.**

Keyword - Double Faced , Proportional, Histogram Changing, DWT.

At present digital acoustic watermark have been recognized as latent as well as sensible answer toward the problem of the acoustic reasonable assets right guard and acknowledged extensive attraction [1, 2]. The majority of the acoustic watermark techniques uses the permanent values devoid of some optimization inside the text [3-6]. As an alternative can be used by permanent parameter, one more trend is witness clever systems in addition to inventing algorithms are included into watermark technique to optimize the variables [7-12]. A popular intellectual devoid of using its incline, If

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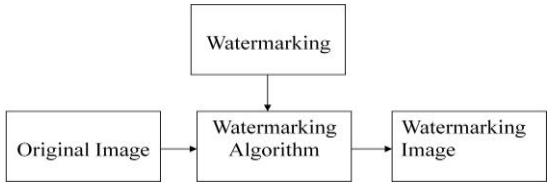
the incline is difficult or smooth not possible to develop, DE is extremely helpful to calculate the estimated solution for such troubles. The recommend of watermark method, Double level major except incompatible requirements (i.e. imperceptibile and strength) are supposed to be in use into reflection so the embattled stability between the two requirements.

An auditory & image watermark is a exceptional electronic identifier implanted in an auditory & image typically used to identify rights of patent. It is identical to a watermark on a snap. Watermark is the procedure of implanted data into auditory (e.g. auditory, videocassette or movies) in a method that is hard to take away. when the signal is derivative, then the data is also agreed in the print. Watermarking has become more and more significant to allow patent guard and rights confirmation.

A watermark, in appearance software, is frequently used in a slightly different manner. A watermark is frequently a dreary image or manuscript used as a surroundings of a glide. It is meant to improve, but not be the important point of the glide. Watermarks are sometimes used in the form of a symbol discreetly located on a glide to brand the appearance. Watermarking technique causes enduring distortion to the original data. Double Faced watermarking is used for both extraction and restitution of the original image. The extracted information and restored image can be compared to confirm with acknowledged image is genuine and has not been alter marked. Double Faced termarking emes be o led invertible or loss less and re n to be applied mainly in scenarios where the authority of a digital image has to be set and the inventive contented is promptorily preferred at the decoding side.



Basic Watermarking Method

The procedure of embedding the watermark into a digital information is known as Digital Watermark. It is a procedure of embedding ordinary logos or labels or information data or prototype into the digital information. The notion of digital watermark is connected with stenography. It is denned as covered writing, which hides the key message in a sheltered media while,

digital watermarking is a way of hitting a covert or character message to provide copyrights and the information reliability. Digital image watermarking is a new approach, which is suitable for medical, military, and archival base application. The embedded watermarks are hard to eliminate and typically invisible, could be in the form of text, image, audio, or video.

The embedding of covert watermark in digital data, no matter how much unseen it may be. However it leads to some filth in the resultant embedded digital data. To defeat this and to recover the unique data, Double Faced watermarking has been implemented, which considered as a best move toward over the cryptography. In cryptography after encryption the consequential data may not be able to be seen or clear also at the time of salvage this may lead to defeat of semantic information of congregation data, which is not in case of watermarking. In digital data more than a few watermarks can be entrenched at the same time and this is known as numerous watermarking techniques. A digital watermark also measured as digital cross which

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provides the genuineness.

II. PROPOSED SYSTEM

In my planned move toward, participation Image has to be taken and Discrete Wavelet Transform (DWT) is applied to the scrupulous image. After that that Image is obtained as watermarked image. In that watermarked image, we are going to insert particular image. And the hided image has to given as the form of mean value and LSB insertion. That exacting insert information is extracted by means of converse Discrete Wavelet Transform (IDWT). To bring to a close up, the original image and the hided picture is attain individually.

First involvement is histogram changing accent can adapt take care of limited specification in image contented. Additionally, our method will be categorization procedure for recognize part of the picture that be able to be watermark with the nearly everyone right Double Faced modulation. classes by allow for the local specification of the image.

Everyone just propose uses the locality of every calculation-problem in organize to conclude the majority personalized carrier-class designed for message enclosure. A different upgrading is based on the collection of the majority of locally adapted lossless intonation. Double Faced modulations are extra or less well-organized depending on image contented.

III. TECHNOLOGY WORN

In this planned system, three techniques are mainly used to watermark image.

A. Vibrant histogram changing

In histogram changing the pixels might be added well-organized and of slighter difficulty for applying it on calculation-troubles. since, these histogram maxima correspond towards the void gray value; capability is increased and underflow basically avoid for changing pixels rate towards right, i.e. by adding up together up a optimistic gray value. The watermark embedded and extractor remains coordinated because the extractor will recover the same orientation image. The presentation investigation of our system in term of imperceptiable and capability on dissimilar sets of medicinal picture from similar modalities as fighting fit as on some well-recognized normal test images. The Watermarking system which innovation stands in identify part of the image to facilitate the watermark use two separate HS intonation: Pixels Histogram changing and lively calculation mistake Histogram changing These planning are still in enhanced. Indeed, like the majority current method, our DPEHS shall be shared with the enlargement embed (EE) modulation, since as fit as with a improved pixel calculation. Though, this technique is delicate as some modifications will contact the watermarking.

B.DWT (Discrete Wavelet Transform):

DWT is the discrete option of the wavelet transform. Wavelet change represents a valid alternative to the cosine change used in ordinary JPEG. The DWT of video is a change based on the tree arrangement with D levels that can be implement by using an suitable store of filters .Fundamentally it is probable to follow two approach that vary from each other fundamentally because of the measure used to extract strings of image (frame) samples to be elaborated by the store of filters.

IV PROCEDURE:

1. choose a wrap image of dimension P*Q as an input.
2. The note to be secreted is implanted in RGB segment simply of an image.

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3. Utilize a pixel choice filter to attain the best areas to secrete information in the wrap image to obtain a improved charge. The filter is functional to Least Significant Bit (LSB) of each pixel to put out of sight away information, parting most significant bits (MSB).

4. After that note is hidden using Bit alternate method. A.Embedding algorithm

Input:

1- wrap Image

2-Watermark passage.

Output:

Watermarked
Image start

1- Verify the measurement lengthwise of the watermark passage to know how many copies will be implanted in the first LSB and if it will implant in the next LSB.

2- Embedding the measurement lengthwise of the watermark passage in the first LSB.

3- Translate the watermark text from characters to bits. 4- converse the watermark bit.

5- Verify the organize of X; if it is strange, the algorithm will add 1 to X, and if it is smooth, the algorithm will subtract 1 from X.

6- Implant the watermark bit in the first LSB.

7- Go to 4 until concluding the complete watermark.

8- Go to 4 if we need to implant one more print of the watermark passage

9- Save the Image as bitmap
image End

B. Extracting Steps
Key in:

WatermarkedImage.

Productivity:Watermark

Way. Begin:

1- Get the measurement lengthwise of the watermark text from the first LSB.

2- The client can choose which print he wants if there is more than one copy.

3- Verify the coordinate of X, if it is strange, the algorithm will add 1 to X, and if it is smooth, the algorithm will sub 1 from X.

4- obtain the bit as of the first LSB.

5- Contrary the bit and save it in array.

6- Go to 3 until concluding all the watermark passage 7- Translate the array to characters.

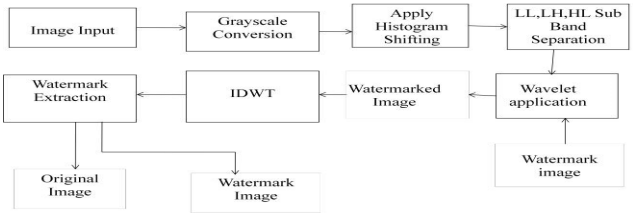
End

V. FUNCTIONING ENVIRONMENT

This planned method is implement using MATLAB 11.10.0(R2011a). The unique image is taken into input image.

A. ARCHITECTURE DIAGRAM

The image in which the contented has to be hided motivation be in make use of as an input and then be appropriate the grayscale change which converts the unique image into grayscale image. Then the transformed grayscale image is applied to histogram changing procedure that produces the apparent and precise image which is further practical for the sub band division that includes four types of sub bands (i.e) LH, LL, HL, and HH.



Architecture of the Planned System

The resultant sub band will be chosen and given to the wavelet function as an input. One supplementary input that is watermark image which is to be hided also given to the wavelet application. Then the watermarked image is applied for IDWT method which is used for extract

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the watermarked image along with watermark extraction process.

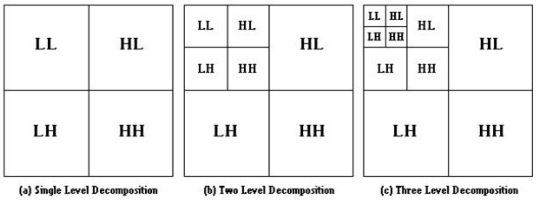
B. MODULE DESCRIPTION:

The system for the watermarking consists of the following modules they are Grayscale change, DWT application, Sub bands taking apart (Classifying image data), Obtaining Watermarked Image, Mean Value & LSB insertion, contrary Discrete Wavelet Transform function**.**

A grayscale digital picture is a picture inside the value of each pixel is a only representation, it carry a single strength in sequence. picture of this type, also called as black & white, completely of shade of gray, variable from black at the lesser attention to white on the strong. Grayvalue imagery is discrete from one-bit double-tonal dark-and-bright imagery,in which the circumstances of processor pictureing are picture with only the double colors, black, and white (also known as double -altitude or double imagery). Gray value imagery have lots of colored lenses of dark in stuck between Grayvalue images are also known as monochrome, indicate that there of only one (single) color (chrome).

C. DWT Application

DWT is functional to the Input image. The DWT decomposes a digital signal into diverse sub bands so that the subordinate frequency sub bands have higher frequency decree and coarser time decree compared to the higher frequency sub bands.



D. Histogram Changing:

A lower pass filter as well as a higher pass filter are selected, so that they accurately cut in two the occurrence variety in the middle of themselves. This riddle pair is called the examination Filter pair. Primary, the Low Pass Filter is practical for every line of data, by getting the lower frequency mechanism of the line. But since the LPF is a half band filter, the efficiency data contain frequency only in the primary halved of the unique frequency series. So, by Shannon's Sampling Theorem, they can be subsamples by two, so that manufacture information now hold partially unique number of sample. currently, a high pass filter is sensible for the same line of information, and likewise the higher pass workings are divided, and located by the side of the low pass mechanism. This procedure is complete for all rows.

E. Obtaining Watermark Image

The digital watermarking is a variety of indicator secretly fixed inside a sound-broadminded indication such as auditory or picture information. It is normally use to recognize rights of patent of such indication. "Watermark" is a procedure of hitting digital in sequence in a mover signal; secreted in sequence, need not to enclose a relative to delivery service indication. Digital watermarking used to confirm the genuineness otherwise veracity of the delivery signal or toward reveal individuality of it proprietor. It highly use for trace the patent infringement and for bank note verification. similar to conventional watermark, digital watermarking are detectable beneath certain situation, i.e. subsequent using of a few algorithm, hardly noticeable . when a digital watermarking distort the delivery service signal becomes perceivable, it is of no uses conventional Watermarking may be applied to able to be seen media (like imagery or videocassette), while in digital watermark, the signal may be auditory,

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movies, videotape, text or 3D model. A indication may take more than a few dissimilar watermarks at identical time. Unlike interiordata that is additional to the delivery service signal, a digital watermarking did not modify the dimension of the delivery service signal.

F. Steps for obtaining watermarked image:

Input**:** Single 8 bit grayvalue image I, with PxQ pixels and watermarking iw.

Output**:** Watermarked image iw, hit the highest peak P, the minimal point Q, extent of watermark and the position map a.

Level 1: Scrutinize the picture i and build the histogram C(c)Є[0, 255]. In these histogram get hold of hit the highest peak a and less peak b which is equivalent to (b+c) .

Level 2**:** Verification the place of pixel value whose assessments deceit between position a and b.

Level 3**:** Scrutinize these wrap image i once more. place counter Y for measurement lengthwise of watermark. If counter k is lesser than measurement lengthwise of watermark. If scan pixel value fabrication surrounded by x and y, increased it by (L-1) .

b. The pixel value fabrication above b, then keep pixel value as same.

c. The pixel values recline under a-(L-2), then also keep hold of that pixel values as same.

d. Scrutinize the watermarking, if scan value is 1, then augment pixel value of a-(L-2)

by (L-1), a-(L-3) by (L-1), a-(L-4) by (L-1)……a-(L-L) by (L-1). If scan assessment of watermarking is 0 then did not augment pixel value.

Level 4**:** Maintain level 3 towards the end of watermarking. If counter k becomes better than measurement lengthwise of watermark, does not modify any charge upto ending of picture scan completes

VI. EXPERIMENTAL RESULTS:

A wrap image used is a 512×512 gray scale image and the watermark logo is a 32×32 binary logo. For extracting the binary watermark logo, each pixel of the watermark logo needs one block in the host to furnish its embedded, where any change due to attacks on the block, only one pixel of the host image is affected, also one pixel of the watermark logo is affected. Figure 4.1 shows the 512×512 bit gray scale cover image Barbara, and mandrill, the 32×32 binary image watermark, the watermarkeded wrap picture and the watermark construct from HH sub band. A Normalized

Table 1 size of the image

e of wrap image (gray scale)	2×512
e of logo image (binary)	×32
aluate :ellence termarkeded image	SE, PSNR
asure ıilarity racted logo	

The Watermark Embedded Algorithm in Wavelet Domain The signal in this channel are process separately. likewise, in multi resolution disintegration, the picture is divided into bands of in the region of one and the similar bandwidth on a log scale. It is predictable that make use of of the discrete wavelet convert will permit for self-determining process of the resultant works with no major perceptible interface among them, and thus makes the procedure of imperceptible markes more efficient. DWT Watermarking implanted procedure is collected of 4 subdivision: inventive picture, computation of multi-level threshes olds intended for select perceptually important coefficients, watermarking placing progression, and inverse wavelet of the coefficients

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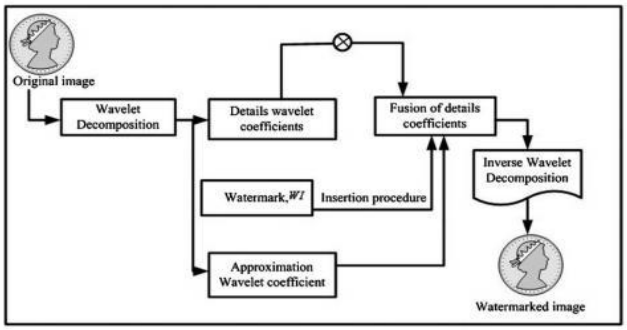
with marking process.



The embedded algorithm in wavelet domain

Algorithm-1: Watermark embeded procedure

key:

– R be the unique picture of dimension$P1 \times P2$,

$Q1 \times Q2$.

Process

1. Let $a = 1$ to A
2. Let $b = 1$ to B

◦ compute $fk,l(p, q)$

3. produce random key in $Key \in \{0, 2\}$

◦ where $Key = 0$ then does not implant a spot Else

– arrange the feature coefficients such that: $fb1,i(p, q) \leq fb2,i(p, q) \leq fb3,i(p, n)$

– quantization by subdivided by $fb1,l(p, q)$ and $fb3,l(p, q)$ into bins using the

4. A merged convert coefficients in every band are scale backside to the stage of the unique picture alter coefficient by means of the smallest amount are most coefficient values.

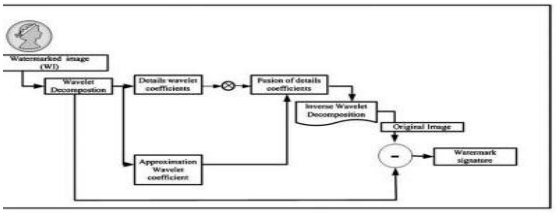
◦ the merged coefficients *fused* are compute as follows: $fused = \alpha fb,a(p, q) + W(x, y)$.

5. A inverse change is currently compute to provide the watermarked image.

Result: Watermarked picture.

A. The Watermarking recognition Algorithm in Wavelet Domain

The plan of the watermarking removal procedure is to consistently find a estimation of unique watermarking from a probably unclear edition of the watermarked picture. A recognition procedure was converse method of the watermarking placing processing. It require understanding of the watermark picture W I(p, q) as well as the key Key(p, q). the recompense of wavelet-base watermark is its capability towards extend the watermarking each and every one more than the picture. If a division of the picture is cropped, it might at a halt cling to part of the watermark. These part of watermark can be identified by convinced process still if the picture has been more measured or rotate. The watermark removal techniqueis presented in



Watermarking removal procedure in wavelet domain

Procedure-2: Watermarking removal technique

key in:

– The watermark picture (attack picture) $Wi(p, q)$

– The *Key*

Process

1. For $a = 1$ to A
2. For $b = 1$ to B

◦ *A*pply *A*th level DWT on the watermarked image $WI(p,q)$;

◦ *C*ompute $fb,l(p, q)$ // Get the image details coefficients;

◦ *l*ocate the neighboring quantize value Q from comparative position of $fb2,l(p, q)$;

◦ *a*rrange the detail coefficients such that:

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$fb1,l(p, q)$ _ $fb2,l(p, q)$ _ $fb3,l(p, q)$.

3. ensure if Q be used to implant a one or a pessimistic one.

4. If the watermark have been implanted in different locations more than a few times, then the almost all common small piece value extracted is assigned for the expected watermark.

5. If an equivalent number of ones and negative ones were extracted, then a arbitrary guess is ended to its value.

6. locate a threshold→ T.

7. calculate the relationship coefficient $\rho(,Z^{\sim})$ between Z (given watermark) and $\tilde{}\ Z$ (extracted watermark) with the subsequent equation:

$\rho(Z, \tilde{}\ Z) = Z(q)\ \tilde{}\ Z(q) \leq z2(q) \leq \tilde{}\ Z2(q)$.

8. If $\rho(Z,Z^{\sim})$ _> T then the watermarked be extracted else set off to Step 6.

Output: The inventive image.

VII. EXISTING SYSTEM PERFORMANCE ANALYSIS

Several Double Faced watermarking methods contain the proposed system for shielding images of perceptive substance, like medicinal or armed images, for which some alteration might contact their explanation. These techniques permit the customer to renovate precisely the inventive image as of its watermarked edition by means of extracts the watermark. consequently it becomes probable to revise the watermark contented, as for example safety measures attributes (e.g., single digital cross or some authority codes), at any time missing of adding novel image distortions. However, if the reversibility resources relaxes constraint of invisibility, it may also introduce discontinuity in data protection. In reality, the image is not sheltered once the watermark is unconcerned. So, still watermark exclusion is probable, its imperceptibility have to exist assured as most applications contain a high importance in keeping the watermark in the image as long as achievable, enchanting benefit of the uninterrupted protection watermarking offers in the storage.

The below table describes about the performance of the existing system. Here an image is taken and the bit rate and PSNR value is calculated in order to find the efficiency of the system.

Performance of Existing System

Image (512× 512)	Bit rate	PSNR (dB)	
		DCSPIHT	SPIHT
LENA	0.25	31.400	31.805
	0.50	35.160	35.045
	0.65	36.000	36.456
Girl 512	0.25	25.800	27.300
	0.50	29.450	30.000
	0.65	30.750	31.150
Gorilla	0.25	20.050	22.30
	0.50	23.75	24.20
	0.65	24.85	25.60

Proposed System Performance Analysis

The below table describes about the performance of the proposed system, here Δ pixel shifting magnitude, Capacity, PSNR Peak Signal Noise Ratio. Here the PSNR value for the different parts of image is calculated and the value is high compared to the existing system. Therefore the proposed system produces a high quality image than the existing system.

The smallest amount significant bit i.e. the eighth bit is use to alter toward a bit of the covert message. as soon as by means of a 24-bit image, one be able to accumulate 3 bits in every pixel as a result of changing a small piece of every of the red, green and blue color gears. Suppose that we contain three neighboring pixels (9 bytes) with the RGB encoding

When the figure 300, can be which binary

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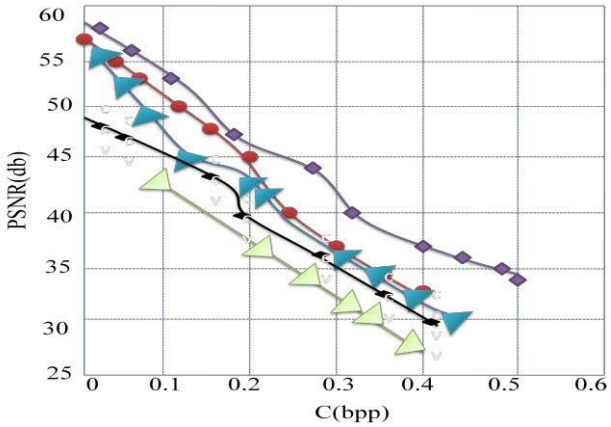
representation is 100101100 implanted into the least significant bits of this measurement of the image. If we overlay these 9 bits over the LSB of the 9 bytes higher than we get the following (where bits in bold have been changed)

Table 2 Performance of Proposed System

Δ=2	Use of 2/4 of the image		Use f 2/2 image		Use hole image	
LENA		N		N		N
	2 3 4	42 54 37	4 8 7	51 78 54	9 1 5	29 58 72
B BOO N		N		N		N
	05 1 12	66 92 02	1 1 2	46 80 07	2 3 4	11 97 16



VIII. CONCLUSION AND FUTURE WORK

improve the inventive image without any alteration from the distinct image after the unseen data have been extracted. The SPIHT algorithm does not provide the required hiding capacity. This also provide the high PSNR value. But the proposed algorithm produce thebetter hiding capacity and produce the better pixel prediction.The proposed algorithm is a extremely high-quality negotiation in terms of capability and image quality safeguarding for both medicinal and natural images. This method can still be improved. DPEHS can be joint with the expansion embedding (EE) modulation, as healthy as with a enhanced pixel prediction. However, this technique is easily broken as any modifications will impact the watermark. This is one of the upcoming challenges.

Acknowledged

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THE ROLE OF ICT ON E-GOVERNANCE FRAMEWORK IN NIGERIAN AVIATION INDUSTRY

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ABSTRACT

In this study, the researcher evaluated the role of ICT on e-governance framework in Nigerian Aviation Industry. The objectives of the study are; to examine the factors responsible for the application of ICT in the selected airlines in aviation industry in Nigeria; and to examine if the impact of ICT on e-governance has significantly improve the performance of selected airlines in aviation industry in Nigeria. Due to the inability to get the exact population of the study, the study used Cochran's formula at 95% confidence level to obtain a sample size of 384. Cronbach alpha was employed to obtain a reliability instrument that yielded an index coefficient of 0.924, which made the instrument reliable. In line with the design of this study, the data that were collected for this study were analyzed using both descriptive and inferential statistics. The objectives posed for the study were answered using mean, standard deviation, and sample independent t-test statistics. The hypothesis was tested at 5% level of significance. Based on the findings of the study, it was concluded that the effective applications of ICT on e-governance has helped the Airlines in the Nigerian Aviation industry in providing superior services to their passengers and ease a powerful performance of their operations. Even though there has been an effective application of ICT on e-governance for better services in the aviation industry in Nigeria, but not to a very large extent. Hence the study recommends that Airlines in Nigeria aviation industry should improve on their performances at a very large extent and the factors contributing to the effective application of ICT on e-governance in the aviation industry.

Keywords: Aviation Industry**,** E-governance, Information and Communication Technologies (ICT), Nigeria

Introduction

Technology has been on the increase worldwide, and has really transformed the ideology of the masses on their activities. Whatever one does is being influence technologically. The capability of people to navigate the World Wide Web has significantly improved, as one can check e-mails or texting or sending messages with phones, mobile communication is growing. People employ the internet to shop on-line, do banking transactions, book for flight tickets and make payment on-line, check the weather, do research on any subject matter and connect with network. One may be wondering how this has led to Nigerian Aviation industry. It is obvious that as the Internet consumption improves, and the usage of technology in general improves, it directly implies that the application of technology and Internet by government also improves. Hence, the

term E-governance is used to narrate the government's practice of technology in discharge its multiple responsibilities (Holzer and Schwester, 2011).

Methodological speaking, E-Governance has been generally accepted in the areas of the use of Information Technology in improving transparency, providing information rapidly to all citizens, improving administration efficiency, improving public services such as aviation industry, power, health, water, security and municipal services. Over the years, governance has been relying on technology, in the widest sense of knowledge, skills, techniques and epistemological strategies, as well as devices, hardware, software and power circuits. As the reach of governance has spread into new areas of the globe as well as new aspects of hitherto personal relationships, it has come to depend upon more compound accumulation of technically stored and disseminated knowledge (Coleman, 2008).

According to Gholami *et al* (2008), information technology causes fundamental variations in the nature and approach of technology in business. Information Communication Technologies (ICT) can supply strong deliberate and calculated instruments for organizations, which could bring substantial merits in encouraging and reinforcing their competitiveness, if carefully employed and applied. The growth of the Internet, as a main flow communication means and as an infrastructure for business transactions has produced a broad scope of deliberate suggestions for businesses in general as well as for the travel and airline industries in specific (Li-Hua and Khalil, 2006).

Werthner and Klein (2005) are in the opinion that Internet technology and web based commerce have spectacularly changed the airline industry in the decade. Information and Communication Technologies (ICTs) have always engaged in a principal part in the airline sector but with the emergence of the Internet and open source technology, their influence is getting progressively more essential and obvious (Buhalis, 2004; Jacobsen *et al*., 2008). According to Dennis (2007), Buhalis and Law (2008), Web distribution merged with inexpensive and extra workable technologies enables new players on the market, Low Cost Airlines (LCCs), to execute functional low-cost direct distribution strategies and increase competition in the sector.

Meaning of E-Governance

It is necessary to understand the term governance before proceeding to e-governance. The word "governance" means the technique of decision-making and the approach by which decisions are executed (or not executed). The phrase "governance" can be employed in many circumstances like corporate governance, international governance, national governance and local governance. Governance can be seen as the compound techniques, processes, associations and institutions by which citizens and categories articulate their interests, exercise their rights and responsibilities and conciliate their disagreements (Olufemi, 2012)

It has been normally accepted that e-governance proffers enough future to enlarge the influence of government pursuits for citizens, which implies that the meaning of e-governance is wholly different and wide (Fang, 2002). The phrase e-governance simply means the application of information technologies like the Internet, World Wide Web, and mobile computing by government agencies that can change their association with citizens, businesses, various areas of government, and other governments. These technologies assist to carry out government services

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to citizens, enhance interactions with businesses and industries, and provide entrance to information. The phrase e-governance can be explained as the application of emerging information and communication technologies to ease the procedures of government and public administration (Moon, 2002). E-governance according to Basu (2004) means the application by government agencies, like the aviation industry, of information technologies that have the capability to change relations with citizens, businesses and other arms of government.

Statement of Problem

The airline industry is strongly acquiring different ways of technological transformation in a bid to minimize expenses without affecting the quality of services (Feldman, 2007). The airline industry specifically has encouraged a reliance on technology on their functional and tactical management. Gholami *et al.* (2008) affirm that airlines were early adopters of ICT and have a long history of technological alteration, in contrast to other travel and tourism businesses. ICT and E-governance usage have assisted the airline industry enhance its administration strategy and minimize expenses.

Nigerian aviation has been growing persistently as an industry over the years. This has involved a variation in its performances. There has been reasonable improvement in the cases of hand held current technological devices being employed by staff in the Nigerian Airways, and it is imperative to unveil the rationale behind this occurrence, whether the movement for the industry has ICT and E-governance contributed positively to industry performance. Corporate culture according to Dennis (2007) has welcomed ICT and E-governance as the most important factors of business; this implies that corporate bodies are investing maximally in ICT and E-governance in which Nigerian Airways is no exception.

E-governance and ICT have increased and create an avenue for revolution. Industries/firms have been investing maximally in technology so to be in a profitable edge. Hence, this study is on the belief that the entrance of time and the very innumerable and outstanding variations in the aviation industry have led to wholly various components affecting the application of ICT and E-governance in the industry. Many studies in one way or the other have attempted to explain on the subject matter under study by generalizing it but did not succeed to explicitly analyze the issues by the present study. This therefore creates a knowledge lacuna on the role of ICT on E-governance framework in Nigerian Aviation Industry. To the widest imagination of the researcher, no known study has attempted the role of ICT and E-governance framework in Nigerian Aviation Industry.

Aim and Objectives of the Study

The aim of this study is to evaluate the role of ICT on e-governance framework in Nigerian Aviation Industry. Hence, the specific objectives are

i. To examine the factors responsible for the application of ICT in the selected airlines in aviation industry in Nigeria
ii. To examine if the impact of ICT on e-governance has significantly improve the performance of selected airlines in aviation industry in Nigeria

Related Literature Review

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Abasilim and Edet (2015) carried out a research on E-Governance and its implementation challenges in the Nigerian Public Service. In the study, the researchers said that E-governance is an improved tool that is geared in regards to effective public service delivery that is postulated on the expectation that the significant use of Information and Communication Technologies (ICT) technique in the day to day tasks of government will bring productive service delivery. It was as a result of many confrontations that hinder the effectual application of e-governance in Nigerian public service that led researcher to identifying some confrontations to e-governance application in Nigerian public service. The study did not employ any strong statistical analysis, as it was based on quality related study done by past researchers and inferences were drawn from them, and the findings concluded that e-governance was the ultimate in encouraging transparency and accountability in government business. The study further recommended that government should be more committed to the application of e-governance, and also embarks on sufficient enlightenment about e-governance.

Adegun (2014) carried a research on the use of ICT among women of tertiary institutions in Ekiti State, Nigeria. To achieve the goals of the study, three research questions and one hypothesis guided the study based on knowledge, usage and challenges facing women in the use of ICT. The study was a descriptive research design of the survey type. The population of the study comprised all the tertiary institutions in the state. A sample of one university, only one existing polytechnic and college of education was purposively employed for the study. A self designed and validated questionnaire was used for data collection. Data obtained were analyzed using the simple percentage, mean and one way ANOVA. The study showed that the women have adequate knowledge of the ICT tools that could enhance their capability; the usage of ICT was low among women and a number of challenges such as domestic pressure, erratic power failure, unavailability of the necessary tools, lack of adequate training and others were faced by women. Based on the findings from the study, the researcher recommended that an enabling environment that will encourage the usage of ICT by women in the tertiary institutions should be created. In addition, an effective and sustainable ICT policy and programmes that will enhance ICT usage by women should be put in place.

Usman (2016) researched on ICT and Online Social Movements for Good Governance in Nigeria. The study first explained how the existence of various Internet-enabled social media has led to the arrival of online social movements supporting the principle of good governance in the affairs of the state. The study examined the evolution of online social movements in Nigeria, and the impact of ICT in their mobilization for good governance. Resource mobilization theory was used as the explanatory framework. The study maintained that though online social movements in Nigeria are generally in their embryonic stage, they are, nonetheless, increasingly affecting the three organs of government and shaping public policies in the country.

Okeudo and Nwokoro (2015) worked on Enhancing Airlines Operations through ICT Integration into Reservation Procedures: An Evaluation of Its Prospects in Nigeria. The study assessed the impact of ICT enhanced reservation procedures on the performance of airline industries with an intention that the information provided will guide airline operators and policy makers in their bid to sustain productivity and maintain efficiency. The study adopted an exploratory framework to evaluate the role of Airline Reservation System on the performance of airline companies with offices located in Sam-Mbakwe International Cargo Airport Owerri, Imo state Nigeria as the

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target populations. Two hypotheses were guided to achieve the objectives of the study, and the findings of the study revealed that there is significant relationship between the use of airline reservation system and the performance. Again there is correlation between the performance of an airline (Return on Asset) and the use of the Airline Reservation system.

Binuyo et al (2016) embarked a Study of the Application of Information and Communications Technology in Customer Relationship Management in Selected Airlines in Nigeria. The study examined the Customer Relationship Management (CRM) practices employed in selected airlines in the Nigerian Aviation industry. Again, the researchers conducted an enquiry on the factors affecting the successful deployment of Information and Communications Technology (ICT) for CRM and determined the effects of ICT on the performance of the industry. The study was carried out in the Head Offices of the local airlines (Lagos state and the Federal Capital Territory Abuja). The sampling technique employed was a multistage, which was used to choose ten local airlines and ten travel agencies. A random sample of two hundred Airline passengers was chosen for the study. The method of data collection was by Primary means via questionnaire. The data collected were collated and analyzed using statistical techniques such as descriptive and inferential statistics. The result of the analysis revealed that the adoption of ICT in airlines operations significantly reduced operational costs, improved service quality and improved identification of high value customers; hence concluded that the effective deployment of ICT assisted the Airlines in rendering better services to their passengers and ease an utmost performance of their operations.

Having reviewed these past researches, this study shall focus on the role of ICT on e-governance framework in Nigerian aviation industry.

Methodology

In line with the design of this study, the data that were collected for this study were analyzed using both descriptive and inferential statistics. The objectives posed for the study were answered using mean, standard deviation, and sample independent t-test statistics. The hypothesis was tested at 5% level of significance.

Sample Size Determination and Questionnaire Distributed

Onyenakeya (2001) states that sample are the number of people drawn from a population large and good enough to represent the entire population. A representative size is an essential requirement of any research study. As a result, it is pertinent to apply a mathematical approach to obtain such representative sample. Due to the inability to get the exact population of the study, the sample size will be derived using Cochran's formula at 95% confidence level, computed as;

$$n = \frac{z^2 pq}{e^2}$$

$n = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384.16 \approx 384$. Based on the calculation, the sample size is 384.

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Where: n = sample size, z = 1.96 (selected critical value of desired confidence level), p = 0.5 (the estimated proportion of an attribute that is present in the population), q = 0.5 (1-p), and e = 0.05 (the desired level of precision).

A total figure of three hundred and eighty four (384) was distributed in the selected airlines to the respondents (airline passengers, airline agencies and airline officials) using purposive sampling technique. Out of the total figure distributed, three hundred and forty one (341) questionnaires were retrieved, that is 88.8%, while forty three (43) questionnaires were not retrieved, which is 11.2%.

Reliability of the Instrument

The reliability of the instrument was achieved through a one-shot method of trial testing using sixty (60) respondents. The instruments were administered to the group and the scores were collated. Their responses (scores) were analyzed using Cronbach alpha which yielded an index coefficient of 0.924 via SPSS package as displayed in Table 1. The researcher therefore considered the instrument suitable and adequate for the study.

Table 1: SPSS output for the Reliability Test

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.924	.928	16

Results and Discussion

Table 2: The following factors are efficient in the selected airlines as a result of application of ICT on e-governance

S/N	Indicators	$\overline{X}$	SD
1	Accuracy in information provided	3.42	0.66
2	Quantitative and qualitative information on website	3.55	0.61
3	Reliability in information provided	3.55	0.62
4	User friendly applications	3.40	0.66
5	Assist in making informed decisions	3.41	0.71
6	Prompt response to customer queries/enquires	3.21	0.77
7	Comfort	3.42	0.66
8	Time efficiency	3.55	0.62
	Cluster mean	**3.44**	**0.67**

Key: VLE= Very Large Extent (4 Points), LE = Large Extent (3 Points), LE=Low Extent (2 Points) and VLE =Very Low Extent (1 Point)

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Among the factors responsible for the application of ICT in the selected Airlines, as displayed in Table 2; quantitative and qualitative information on website, reliability in information provided, and time efficiency all obtained an approximate average value of 4.00 which implies that they have influence to a very large extent on the effective application of ICT in aviation industry. However, the low standard deviations of 0.61, 0.62 and 0.62 for qualitative information on website, reliability in information provided and time efficiency respectively show high homogeneity in agreement. On the other hand, accuracy in information provided, user friendly applications, assist in making informed decisions, prompt response to customers' queries/enquiries and comfort all had an approximate average value of 3 which means that they have influence to a large extent on the effective application of ICT in aviation industry.

Table 3: Extent of Impact of ICT (devices, applications and networks) on Airline Performance

S/N	Indicators	$\overline{X}$	SD
1	Increased number of passengers	3.11	0.66
2	Increased number of cargo	3.75	0.62
3	Additional destinations	3.06	0.73
4	Diverse new markets	3.14	0.71
5	Customer loyalty	3.70	0.62
6	Increased number of employees	3.83	0.61
7	Employee turnover	3.40	0.62
8	Large number of assets owned	3.05	0.75
9	Positive cash flows	3.78	0.63
	Cluster mean	**3.42**	**0.66**

Key: VLE= Very Large Extent (4 Points), LE = Large Extent (3 Points), LE=Low Extent (2 Points) and VLE =Very Low Extent (1 Point)

Table 4: SPSS Output impact of ICT on Airline Performance

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
VAR00002	9	3.5467	.21331	.07110

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
VAR00002	49.881	8	.000	3.54667	3.3827	3.7106

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From the SPSS output, the p-value (0.000) is less than 0.05, which implies that the impact of ICT on e-governance has significantly improved the performance of Aviation industry. The clusters mean of approximately 3 (See Table 3) shows that the extent of impact is to a large extent.

Conclusion and Recommendation

Based on the findings of the study, it has concluded that the effective applications of ICT on e-governance has helped the Airlines in the Nigerian Aviation industry in providing superior services to their passengers and ease a powerful performance of their operations. Even though there has been an effective application of ICT on e-governance for better services in the aviation industry in Nigeria, but not to a very large extent. Hence the study recommends that Airlines in Nigeria aviation industry should improve on their performances at a very large extent and the factors contributing to the effective application of ICT on e-governance in the aviation industry.

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Integration and Combination of Cryptographic Algorithm for Data Security in Cloud

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***Abstract*—Cloud computing has no doubt many benefits but it also has some critical security issues which have become a hurdle to achieve the trust of clients for migration of data to the cloud. For security, the number of terminologies and mechanisms are used, one of them is cryptography. Encryption is a technique of cryptography which conceals message in such a way that only destined receiver can use it. But currently, encryption can be broken by cyber-criminals due to many security loopholes like unsecured distribution of key. There is a need to find a solution to these barriers to ensure security. The issues and solutions of DES, One-time pad, Honey encryption will be discussed in this paper. These solutions will help to minimize the flaws of these algorithms and provide the secure novel model. In this model, data and key encrypt and decrypt by integration and combination of Data encryption standard, One-time pad, and Honey encryption. The key is distributed by steganography and public key cryptography. The comparison of cookies is used for data integrity. It will be difficult for an intruder to break multiple encryption without the valid key. The proposed model will provide more security to cloud storage than previous models.**

Keywords-Data Security; One-Time Pad; Data Encryption Standard; Information; Honey encryption

I. INTRODUCTION

Cloud computing revolutionize the IT industry. In cloud computing, users register indispensable service from the cloud provider. They are free from the frivolous task of purchasing and installing of basic hardware and software structures. This type of environment allows them to concentrate on the core parts of the organization which leads to more production and more profit. There are a lot of benefits of cloud computing. It reduces the cost of business because vendors have not to purchase new equipment but they simply request to cloud provider for resources.

There are a lot of services provided by cloud computing to business organization e.g. document preparing or searching the internet. Organizations are migrating their data to the cloud. As data is stored in the cloud means organizations gives permission to cloud to manage their data. Now its cloud responsibility to ensure data security. Security is the most challenging phase of cloud because of virus attack, worms, phishing, spoofing, and hacking. Enterprises must think about these threats before uploading data to the cloud. When you transferring company's most important data to cloud provider's servers, you must have knowledge either this cloud has the ability to secure your details from intruders or not. While data on the cloud, it faces many challenges and these challenges are increasing with the advancement. The number of users is increasing so security, privacy and trust issues are also increasing.

There are a lot of solutions provided by security experts to secure the client information of which cryptography has stood out. In cryptography, data must be encrypted before uploading to the cloud. Data owner permits only particular group member to access data. Organization's data is stored on distributed and connected resources that consist of a cloud. Encryption plays a vital role to provide a secure environment to distributed and connected resources. In encryption algorithm, data is transformed into an unreadable format by using "key". At decryption side, data is transformed into a readable format by using the "key" (the key with which sender has decrypted the data) at the receiver side. Encryption is used by many IT experts by using a single algorithm with the large key or public key algorithm [6] to build a secure system. A single algorithm is fast as compared to hybrid but what is the value of speed if data is stolen? A single system [5] is not more secure than the hybrid. If the key is stolen whole data will be breach by an intruder. The problem in public key algorithm is private key theft.

A hybrid cryptographic algorithms are more secure than single algorithm because of integration of different algorithms. In this paper, there is a brief explanation of integration and combination of One-time pad,Data Encryption Standard, Honey Encryption and secure distribution of key, encryption of key and source authentication.

II. LITERATURE REVIEW

AES and RSA [1]: In this Paper, the cloud is secured by authentication, secure sharing.

Enhanced data security using AES, RSA and SHA algorithm [2]: In this paper, enhanced data security using AES, RSA and SHA algorithm with the minimal cost and effort is achieved.

Diffie Hellman algorithm for key generation, digital signature for authentication, AES to encrypt/ decrypt [3]: A,

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model is presented which provide facility to avoid data modification at the server end.

AES, Elliptic curve cryptography, Elliptic curve Diffie Hellman, Blowfish Algorithm, Digital Signature [4]: In this paper, authentication and access control mechanism is presented.

One-time pad using 512 key size [5]: An algorithm which reduces the occurrences of brute force attack.

Data security is provided by implementing RSA algorithm [6]: This paper present mechanism in which only authorized user can access the data.

DES, S-CEM [9]: A model is presented which provide confidentiality and privacy of data.

III. Proposed Model

The model is proposed for the data security and also provide the secure way for the distribution of key. In this model, simple algorithms are used which are not commonly used nowadays because of their weaknesses. This model will cover these weaknesses. It consists of three layers.

- The first layer assures the security by XORing of data with a Public key of receiver and integration of Xored data into DES and DES data into the One-time pad.
- The second layer consists of encryption of data and key. The final key is encrypted by public key of the receiver which is accessed by that receiver which has the private key of the paired public key. There is a question arises why encryption of key is needed? While using public key cryptography. The answer is, there will be a chance of private key theft. In that case, if the attacker has the private key, the attacker will not be able to read message due to combination and integration of keys. The knowledge of the order of combination and integration of algorithms must only known to sender and receiver.
- The Third layer consists of Integrity check by cookies comparison mechanism.

This model is used for critical data which needs to be secure at any cost. The below Figure1 presents the overview of the proposed model.

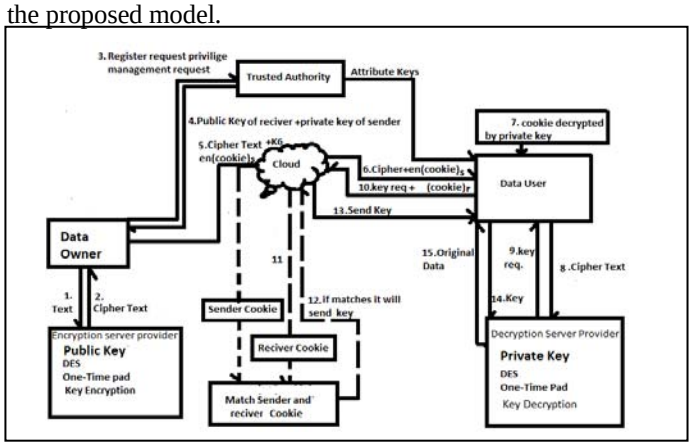

Figure 1. Proposed Model

IV. Explanation

At the sender side and receiver side below algorithms are implemented.

A. DES (Data Encryption Standard)

DES consist of 16 round and each round consist of expansion, round function, s-box, permutation. It consists of the 64-bit key but uses only 56 bit and these 56 bits are further converted into different 48 bits for encryption and decryption. Encryption side consist of two permutation one is initial permutation and second is final permutation and these permutations are called p-Boxes. At encryption side, plain-text is transformed into cipher-text by passing 16 rounds of the algorithm. At the decryption side, the cipher-text is transformed into plain text by passing through 16 rounds of DES algorithm but in inverse order by using same keys as used in encryption. Each round is decrypted or encrypted by different 48-bit keys.

Permutation of 64-bit input X and then it divides into half 32 bits left L0, 32 bits right RO. The right half goes to function F and go through the process of expansion, 32 bits now become 48 bits. The key generator generates the key. Key is XORed with R0 48 bits. Then 8 S-boxes receive 6 bits each (8*6=48).S-boxes convert 6 bits to 4 bits in each box, and now we have 4*8=32 bits. Permutation has done and now have 32 bits. These 32 bits XOR with left 32 bit and then Lo becomes R1 and so on. After the 16th round, permutation takes place in reverse and got output Y.

B. One-Time Pad

A one-time pad is an algorithm in which unique keys are randomly generated. One key is used only once to encrypt information and send to the receiver. And at the decryption side, only that receiver is able to read information which has the similar one-time pad key generated by the sender. Each encryption is not related to next so that no one finds out the key by brute force. Each encryption and key is unique.

C. Honey Encryption:

It is a type of encryption in which when an incorrect key as guessed by an attacker is used to decrypt the message, it creates seeming reasonable yet incorrect plain-text. It protects against brute force attack.

D. Steganography

Hide the message into image, audio or video or any other media. It is used to avoid the attacker. An attacker will have no idea that these media contain any type of sensitive information.

E. Trusted Authority

A trusted third party that establishes a shared secret key distribution between two parties. Each user has its own unique private key.

F. Public Key Cryptography

Public key cryptography consists of the public and private key. Public key spread widely and the private key is only

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known to the owner. These keys are provided by a trusted authority (as mentioned above).

G. Authentication

In this cookies are used for assurance of data integrity. The comparison of cookies of sender and receiver ensure that data reach the destination without any malfunction.In this model,sender's cookie is encrypted by public cryptography. Public key cryptography is used to ensure that cookies are decrypted by the only destined receiver. In this model, cookies contain sender and receiver address.

H. Traffic padding

Integrate some bits in stream of message to frustrate attacker.In this paper adding of parity bits is called traffic padding.

V. Methodology

A. First Layer

First Layer consists of five steps which are explained below.

- First Step: The message is scrambled by first encryption. Data (D1) is first XORed with the public key (Public Keyr) of the receiver. The output of the first step is represented by D2 (eq.1). So, before entering into rounds of DES, the message is converted into an unreadable format.

(D1 (Xored) Public Keyr) =D2 (1)

- Second Step: The Xored data (D2) is passed through 16 rounds of DES. The Output of this Step is D3 and K2 (eq.2). D3 is the cipher data of DES and K2 is the key to that data.

(D2 (en) DES) =D3, K2 (2)

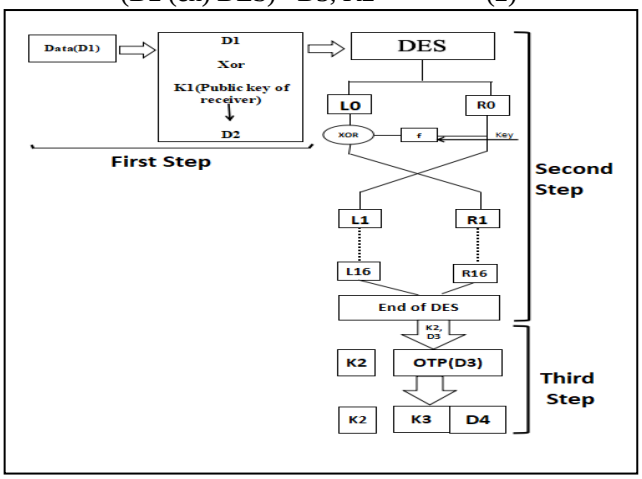

Figure 2. First Layer of Proposed Model

- Third Step: The data (D3) is ciphered by the one-time pad. Each time unique encryption takes place by the one-time pad. The key (K2) of DES remains intact and the data (D3) produced by DES is pass through the one-time pad and produce data (D4). So, the output of the third step is D4 and K3(eq.3).D4 is cipher data of One-time pad and K3 is the key to that data (D4).The Figure 2 shows the first layer of encryption of sensitive data.

D3 (en) OTP=D4, K3 (3)

B. Second Layer

There may be the chances of key stealing by an intruder. There is a need for the secure way to transfer key to the receiver.

- Before sending the key to the receiver, the key of DES (K2 in eq.2) combined with the key of one-time-pad (K3 in eq.3) and produced K4 (K4 shown in eq. 4).

K2 (combine) K3=K4 (4)

- Data (D4 in eq.3) produced by One-time pad is combined with parity bits as a result D5 is obtained (Shown in eq.5). The parity bits are garbage, these are only used to increase the length of output as compared to input.

(D4 (+) parity bits=D5 (5)

- Finally, data (D5 in eq.5) is encrypted by honey encryption and gives an output of D6and K5 (shown in eq.6). Honey encryption is used to avoid any brute force attack and send to the cloud.

D5 (en) Honey Encryption=D6, K5 (6)

- The key (K5 in eq.6) of Honey encryption is Combine with K4 (K4 shown in eq.4)and as a result, final key(K6) is obtained (shown in eq.7) .K4 is produced by the combination of one-time pad key and DES key.

K4 (+) K5= K6 (7)

- The final key is now encrypted by the public key of the receiver and hides in any media by steganography. Then D6 with encrypted cookie (It contain the sender address, from which receiver expecting data) is send to cloud.Below Figure 3 shows the second layer of encryption of sensitive data.

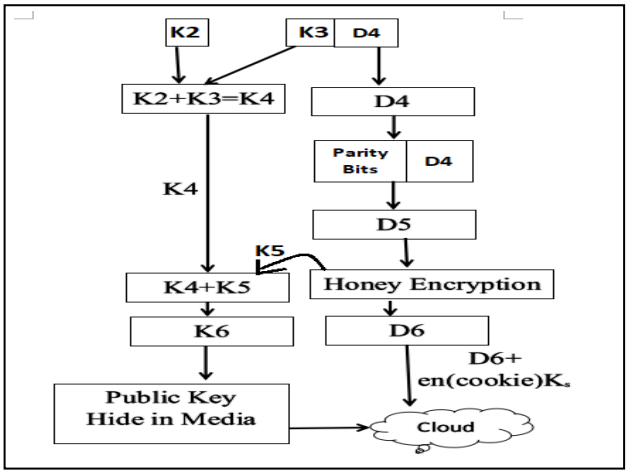

Figure 3. Second Layer of Proposed Model

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C. Third Layer

There may be a possibility that a user wants to confirm that either the message is from the destined sender or from the fake person. This layer gives the assurance that data reach the destination without malfunction. And request the key to read data. The distribution of key consist of five steps which are explained below.

- 1st: The cloud receives the data (D6) and the cookie which contain the sender address which is encrypted by public key of the receiver (en (cookie) ks).Then, Cloud sends that data (D6) and en (cookie) Ks to the receiver.
- 2nd: Receiver receive data and cookie, and decrypt cookie by its private key to check either data is from expected source or not. If the source is authentic then receiver send the request for key and also a cookie which contains receiver address.
- 3rd: Cloud now has the address of both receiver and sender.
- 4rth: Now cloud compares the sender and receiver address to check that either data reach the destined receiver or not.
- 5th: If the cookies match then cloud send encrypted key of data to the receiver.
- 6th: Receiver get key by steganography and apply its private key and get K6.And receiver decrypts the key by using same algorithms which are used in encryption but in reverse direction. Below Figure 4 is the image representation of the third layer.

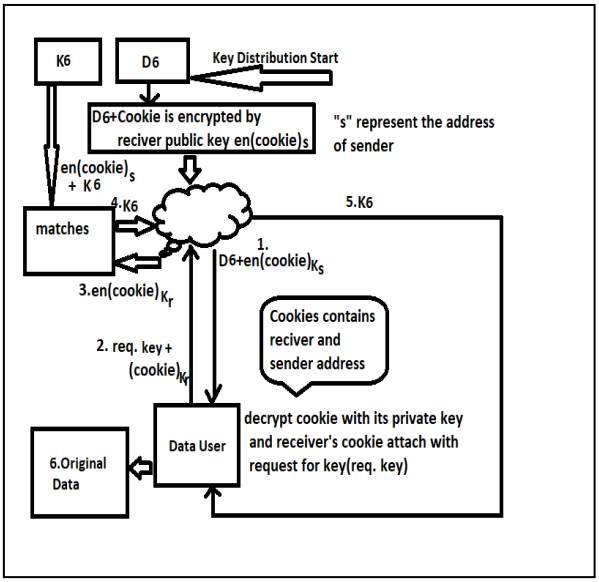

Figure 4. Third Layer of Proposed Model

The pseudo code for comparison of cookie is given below. This program will run on the cloud to authenticate the receiver and sender.

1) Get sender address // Cloud get from sender
2) Get receiver address // Cloud gets the address of the receiver. It is obtained from the sender.
3) Get cookie and key request from receiver //cookie has the address of receiver who received data
4) If cookie address matches receiver address then //receiver address(Step 2)and cookie address(Step 3)
5) Send Key
6) Else
7) Reject the request For key

VI. Structure of Sender and Receiver Responsibilities

The responsibilities to encrypt the data by sender are shown in below Figure 5.

- The arrows on left side in data encryption figure represent input and
- The small box on right side of data encryption shows output.
- Each output data of the previous step become the input of next step.
- The key encryption Figure 5 explains the key encryption.

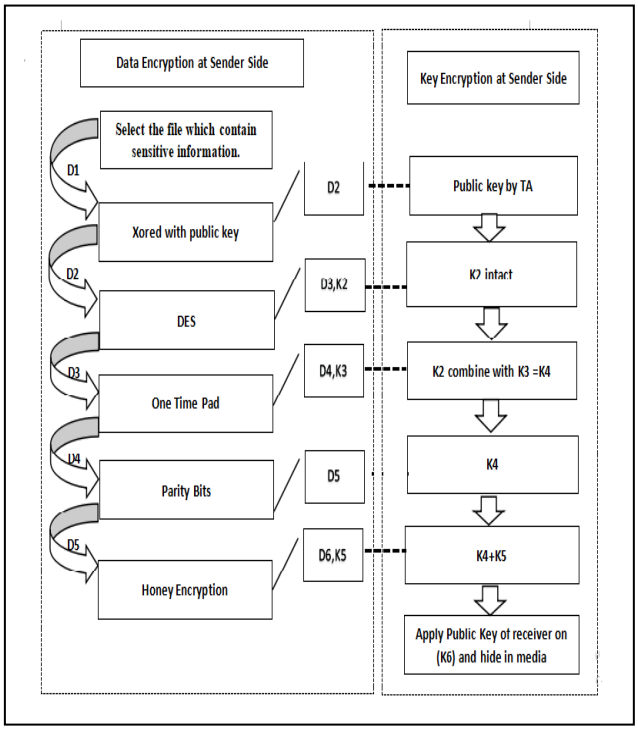

Figure 5. Sender Responsibilities

The decryption side repeats the same steps but in the inverse direction.In key decryption diagram,when keys decrypted then these keys are used to decrypt the data in data decryption side.The responsibilities to decrypt the data by the receiver are shown in below Figure 6.

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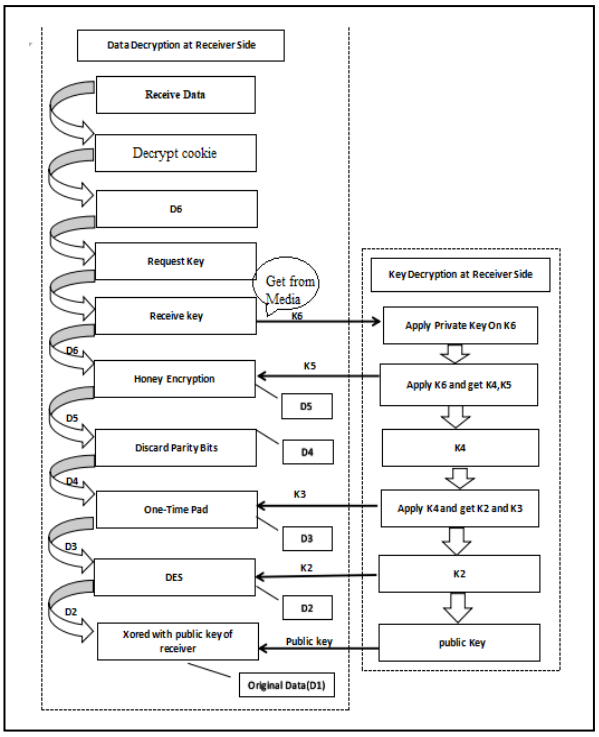

Figure 6. Receiver Responsibilities

VII. Results and Discussion

A. Weakness and their Solutions

- Two chosen input to an S-box it can give the same output in DES

In this model, public key XORed with data solved this problem. Because before entering into DES, data is scrambled by XORing. So, if the intruder tries to guess the data by two chosen input to an S-box it will not produce any readable data.

- The problem with the one-time pad is that it requires a pad of the same length as the message to be encrypted, and it must need to transmit securely. Now intruder knows the length of data which may cause brute force attack.

In this model, the length of output text is greater than input text. The parity bits are used to increase the length of the output of encryption.

- Known-plain text in honey encryption

If the intruder has an idea that plain-text must match in order to licit, they can guess the data encrypted by honey encryption. This problem is solved by integration of more than one algorithm.

- Private key theft

If the private key is stolen.The hacker will not able to use this key to decrypt data because key is also encrypted.The way(order of algorithm) to decrypt key is only known to receiver and sender.

B. Encryption Server Provider And Decryption Server Provider

Below Table 1 and Table 2 summarize the whole encryption and decryption processes.

TABLE I. Encryption

Data Encryption	**Key Encryption**
(**D1**(Xored)PublicKeyr=D2(eq.1)	K1 is the public key of the receiver.
D2(en)DES=D3,K2 (eq.2)	K2 remain intact
D3(en)OTP=D4,K3 (eq.3)	K2(combine)K3=K4(eq.4)
(D4(comb)parity bits=D5 (eq.5)	
D5(en)Honey Encryption=D6,K5 (eq.6)	K4(comb)K5= K6 (eq.7) Apply Public Key Hide by Steganography

TABLE II. Decryption

Key Decryption	**Data Decryption**
Get Key from media Apply Private key and get K6 Apply K6=K4, K5	Apply K5 on D6=D5
Apply K4=K2,K3	Get D4 by discarding parity bits
K3	Apply K3 on D4=D3
K2	Apply K2 on D3=D2
Public Key of receiver(K1)	D2(Xored)Public Key(K1)=**D1**

VIII. Conclusion

In this paper, a novel model is discussed to make data secure from the intruder. The mechanisms used in model are used to overcome the risk of security breaching in cloud computing system. The model is used to send data and key without alteration and breaching. This model consists of three layers. The first layer encrypts data, the second include integration and combination of keys, public key cryptography, steganography, data combination with parity bits and encryption, and the third layer provide source authentication.

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RFID READER COLLISION AVOIDANCE USING CSMA/CA WITH FIBONACCI BACKOFF ALGORITHM

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***Abstract*—The perception of risks in the usage of information and information systems especially over public and private network in recent times is becoming higher due to increased activities in cyber-crimes. There are various security measures that have been adopted to curb these malicious activities. One of these measures is the Radio Frequency Identification (RFID) system. However, the performance of RFID is reduced due to inherent collisions of information during transmission. This paper seeks to improve performance of RFID by introducing an algorithm that reduces RFID reader collision during transmission of information. The algorithm uses Carrier Sense Multiple Access with Collision Avoidance together with Fibonacci Backoff. The performance of this new algorithm is compared with an existing Binary Exponential Backoff algorithm using collision percent and throughput as performance metrics. The results shows that Fibonacci Backoff algorithm has lower collision percent and higher throughput when compared with Binary Exponential Backoff algorithm in a simulation carried out using MATLAB. This paper therefore, presents an algorithm that reduces collision problems in RFID readers and better throughput during transmission to enhance RFID performance in cyber security.**

Keywords: cyber security, RFID, RFID collisions, CSMA/CA

1 INTRODUCTION

To curtail network security breaches in every aspect of cyberspace which encompasses not only the online world and the Internet but also the wired and wireless world of communication in general is the concern of cyber-security measures where information and information systems are protected from unauthorized users and attack [1], [2] (Williams and Sawyer 2003 and Pande, 2017). One major and developing technology to achieve the goal of cyber security is the Radio Frequency Identification (RFID) system [3] (Konidala and Kim, 2007). Among many uses of RFID for cyber security is the one presented by [4] Swati (2014) where RFID used to track stolen devices is used together with "kill switch system to remotely destroy the stolen devices data making it useless for the thieves.

RFID is a means by which objects are tracked and identified by the use of radio frequency transmission. A RFID consists of readers which use radio frequency to communicate with tags. RFID technology is used wildly in large industries such as logistics and transportation and even in government [5] (Kamdar et al, 2016). RFID improves on the regular barcode technology in that with RFID, larger sets of unique IDs can be identified. Also, objects can be identified from long distances unlike barcode technology. Based on power and modulation modes, the two types of RFID systems are the active and the passive system [6] (Finkenzeller, 2010). The difference between the two systems is the means by which they are powered which are by battery and magnetic energies respectively.

A great fall back in the RFID technology is Reader collision and tag collision which definitely affects the performance of RFID in ensuring prompt and adequate cyber security [7] (Waldrop et al, 2003). Reader collision is a situation where close by readers establish communication with a tag simultaneously while tag collision is a situation where a reader cannot identify a tag data when more than a tag occupies the same communication channel. Signals from one reader might interfere with signals from other readers. This interference is called Reader collision. Reader collision is categorized into two. The first is the reader-reader collision which occurs when a reader transmits a signal which is interfered by the signal transmitted by another reader. The second is reader-tag collision when a tag is in the transmission zone of more than one reader.

Different algorithms have been used in the past to solve reader collision problems in RFID systems [7] (Waldrop et al, 2003). This research focuses on solving reader-to-tag collision problems in large-scale RFID networks to improve its performance in cyber security. This research aims to improve RFID reader collision avoidance through carrier sense multiple access with collision avoidance (CSMA/CA) mechanism with FibonacciBack-off Algorithm. The Objectives include using CSMA/CA with Fibonacci Backoff Algorithm to perform channel reservation with almost zero-collision among RFID Readers and to evaluate the performance of CSMA/CA in collision avoidance in RFID system in terms of throughput and collision minimizing behaviour.

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2 LITERATURE REVIEW

RFID is defined as technology that uses radio waves to transfer data from an electronic tag, RFID tag or label that has been attached to an object through a reader for the purpose of identifying and tracking the object. RFID automatically identifies and tracks tags attached to objects through the transmission from its readers [5] (Kamdar et al, 2016). Active tags have a local power source and can therefore operate hundreds of meters from the RFID reader while the passive tags collect energy from a nearby RFID reader's interrogating radio waves. Radio frequency has moved from obscurity into mainstream applications which help speed the handling of manufactured goods and materials because of its ability to identify from a distance. Unlike Barcode technology, RFID can support a larger set of data such as manufacturer of devices, product type and even environmental factors such as temperature. In addition, RFID can differentiate from different tags located in the same area.

RFID-enabled systems help companies cut costs, improve customer service and reduce labour. A major advantage of all kinds of RFID system is that they work contactless and require no line of site. They are also reliable in tough environments and allow for bulk detection because of their remarkable speed even in difficult conditions.

The major components of RFID systems are the tag, antenna and reader. Tags are devices made up of an electronic circuit and an integrated antenna which hold data [8] (HKSAR, 2008). It is a microchip combined with an antenna in a compact package. The antenna is responsible for the transmission of information between the reader and tag using radio waves. There are two classes of tags which are the active tags and passive tags [9] (Sridhar, 2005). Active tags require a power source and they are either connected to a powered infrastructure or they use energy stored in an integrated battery. An example of an active tag is the transponder attached to an aircraft that identifies its national origin. Passive RFID attracts more attention because they do not require batteries or maintenance. Passive tags have no power source or transmitter. They are powered by the signals that are sent by the reader to the tags [10] (Roy, 2006). Passive tags are cheaper and have a shorter range of about 4-15 feet. Reader is the source of the RF energy used to activate and power the passive RFID tags. RFID readers are capable of reading the information stored on tags laced in their vicinity. The reader energizes the tags in the vicinity with Radio Frequency (RF) power continuously for the entire read operation. For the tag response, part of the RF power is transmitted back to the reader using a process called backscattering. Most radio frequency identification applications such as supply markets, localization and object tracking activity use passive RFID tags. Figure 1 shows the components of RFID systems.

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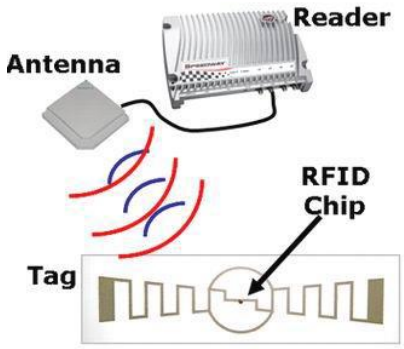

Figure1: RFID components

RFID tags can be attached to equipment/user personal/official belongings such as organization ID and vehicles. By using RFID, permission can be granted, revoked or access can be recorded. RFID is also used for auditing and controlling security persons. Its application provides checkpoints for patrolling security guards. In this case, checkpoints are RFID tags which security guards need to scan during their sequential patrols. Airline industries also employ RFID in their packaging and delivery service. Handling large amount of packages from many places to various destinations on different routes can be very complex. In this scenario, RFID application provides best resource management. The transportation industry also benefits from the RFID technology by making toll collecting/charging better with improved traffic flow. This application helps to keep good traffic flow and to identify traffic patterns.

Tag collisions and reader collisions are the two types of RFID collisions.The reader collision also known as the reader interference problem occurs when a tag is within the interrogation zone of a reader A and within the interference zone of another reader B. Due to the interference of the readers, either the tag cannot receive the request command from reader A correctly or reader A cannot interpret the response from the tag properly. This is called the reader collision problem [6] (Finkenzeller, 2010). For tags to be identified in the interference zone, a reader sends a request to ask tags to send back their IDs. When multiple tags within a reader's interrogation zone responds to this request simultaneously, collision occurs and the reader cannot identify any tag properly. This is called tag collision [6] (Finkenzeller, 2010).

Anti-collision in RFID refers to the different ways to keep radio waves from one device from interfering with radio waves from another device. Anti-collision algorithms are used

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in RFID readers to enable a single reader to read more than one tag in the interference zone. Anti-collision Algorithms can be divided into tag anti-collision and reader anti-collision algorithms [6] (Finkenzeller, 2010).The reader Anti-collision Algorithm is classified into three which are the TDMA (Time Division Multiple Access), FDMA (Frequency Division Multiple Access) and CSMA (Carrier Sense Multiple Access).

In TDMA, the time period is divided into intervals and to allow a reader to transmit messages only within its allocated intervals. There are two more anti-collision protocols under TDMA which are Distributed Colour Selection (DCS) and Colorwave algorithms [11] (Daniel, 2002). FDMA technique allows multiple transmission channels to work together at the same time by using different operating frequencies. In this technique, a tag not only receives power from the reader broadcasted signal but also utilized the signal as the carrier of its modulated backscatter signals [6] (Finkenzeller, 2010). CSMA entails listening of the transmission channel so if the channel is sensed free, transmission is enabled and if the channel is sensed busy, transmission is inhibited. There are several types of CSMA protocols: 1-Persistent CSMA, Non-Persistent CSMA, P-Persistent CSMA. Each of these kinds has different way of dealing with the collisions that can occur when more than one station attempts to transmit on the shared medium at the same time

3 METHODOLOGY

3.1 *Introduction*

Since it is not easy to detect collisions in wireless medium such as Radio Frequency Identification, CSMA based MAC protocol has been developed to avoid collisions in dense RFID networks. This paper proposes the use of CSMA/CA with Fibonacci Backoff Algorithm. The algorithm is commonly used to schedule re-transmissions after RFID reader collisions. The retransmission is delayed by an amount of time derived from the slot time and the number of attempts to retransmit called back-off timer. The MAC layer specified by The IEEE 802.11 standard and its contention free service provided by the Distributed Coordination Function (DCF) to control channel access is adopted in this paper.

3.2 *System model*

A large-scale RFID system is considered with multiple readers and homogeneous local density of RFID tags within the interrogation area. Readers are assumed to have homogeneous properties. Therefore, their communication range is assumed to be the same with the assumption of the existing of an overlapping area in their interrogation areas.

Before transmitting a data frame, a station must sense the channel to determine whether any other station is transmitting. If the medium is sensed to be free for a DCF inter-frame space (DIFS) time interval, the transmission will proceed otherwise the transmission is deferred until the end of the current transmission. A random interval, henceforth referred to as the Backoff time, is then selected, which is used to initialize the Backoff timer. The Backoff timer is decreased for as long as the channel is sensed as idle, stopped when a transmission is detected on the channel, and reactivated when the channel is sensed as idle again for more than a DIFS. The station is enabled to transmit its frame when the Backoff timer reaches zero. The ACK is transmitted by the receiver immediately after a period of duration equal to SIFS. The Backoff time is slotted. Specifically, the Backoff time is an integer number of slots uniformly chosen in the interval (0, CW-1), where CW is the contention window defined as the Backoff window. In addition, whenever a nodedetects an erroneous frame, the node defers its transmission by a fixed duration indicated by EIFS, i.e., extended inter-frame space time. This time is equal to the SIFS + ACKtime + DIFS time.

This paper also employ RTS/CTS access method which is an additional four-way handshaking technique and very effective in solving the hidden terminal problem. When the sender wants to transmit a packet, it sends a short frame called request to send (RTS) instead of the packet first after the channel has been sensed idle for a DIFS. When the receiver detects the RTS, it responses, after a SIFS, with a clear to send (CTS) frame. A successful RTS/CTS exchange reserves the channel for the sender-receiver pair. Other stations adjust their Network Allocation Vectors (NAVs) based on the duration field of the RTS or of the CTS. The sender starts to transmit the packet after a SIFS only if it received the CTS frame correctly.

As a part of an efficient MAC protocol, an efficient Backoff algorithm is needed for a high throughput while ensuring collision free transmission when many nodes try to access the medium. Only one of the nodes is granted access to the channel, while other contending nodes are suspended into a Backoff state for some period (BO). Since Contention Window size determines amount of collisions, it is important to adopt a good Backoff algorithm to minimize collision. To achieve this, Fibonacci Backoff (FIB) algorithm was used over traditional Binary exponential Backoff Algorithm. Increasing the size of CW in case of failure to transmit tends to rapidly increase the size of CW to even larger sizes. Reaching such large window sizes decreases the expected wait time for a given node to gain access to the shared medium. Moreover, a large window size tends to contribute to increasing channel idle times, leading to a major waste in the shared channel bandwidth. FIB algorithm aims to reduce the difference between contention windows sizes generated, resulting in a higher network throughput and decreasing the chances of collision among the contending stations.

$$F(n) = F(n-2) + F(n-1) \quad F(0) = 1, F(1) = 1, n \geq 0$$

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F(n) is the new contention window size, leading to a smaller increment on large window.

After c collision, a random number of slot times between 0 and 2c − 1 is chosen. For the first collision, each sender will wait 0 or 1 slot times. After the second collision, the senders will wait anywhere from 0 to 3 times. By the third collision, the senders will wait anywhere from 0 to 7 slot times and so forth. As the number of retransmission attempts increases, the number of possibilities for delay increases exponentially. A small window tends to reduce channel idle times, leading to an optimal usage of the shared limited communication channel. For example, if the ceiling is set at I = 0 then the maximum delay is at i = 10 then the maximum delay is 34 slot times.
The incremental behaviour of Fibonacci mechanism is expected to minimize the possibility that two or more nodes choose the same Backoff period in dense networks or networks with intensive traffic loads and hence avoid collision caused by Binary Exponential Backoff (BEB) mechanism. Figure 2 shows the flow diagram of how Fibonacci Backoff algorithm works.

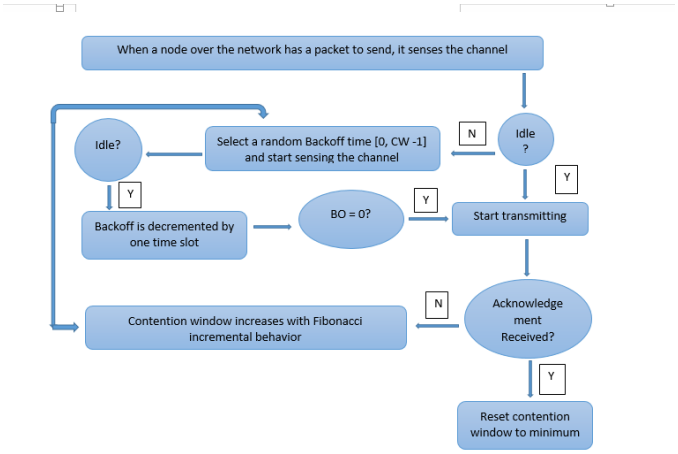
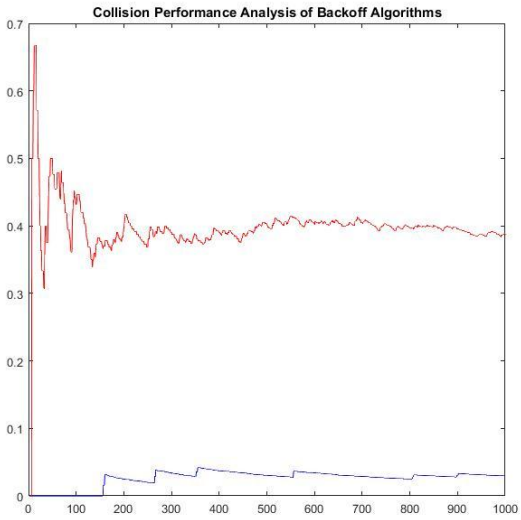


Figure 2: Flow diagram of how Fibonacci Backoff Algorithm works

3.3 *Simulation*
The network was simulated using MATLAB. C++ served as the programming language used to interpret the algorithm. The wireless network was first simulated using 10 stations with minimum Contention Window being 3 and Maximum Contention Window being 10. More stations are added in multiples of 10 until the number of stations got to 100 to get more accurate result. Other parameters that were taking into consideration are the frame size, the time slot, time scale for random motion.
Fibonacci Backoff was first simulated and the graph generated can be shown in Figure 3 below.



Figuer 3: Simulation graph of collision percent for Fibonacci and Exponential Backoff Algorithm

From figure 3 above, the red line indicates the Collision percent for Binary Exponential algorithm and the blue line indicates that of the Fibonacci Backoff Algorithm.

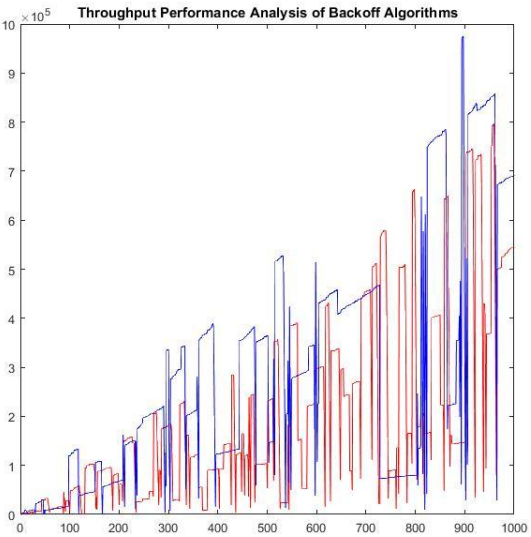


Figure 4: Simulation graph of Throughput for Fibonacci and Exponential Backoff Algorithm

Figure 4 above shows the simulation result in terms of throughput for both Fibonacci Backoff Algorithm and Binary Exponential Algorithm. The red line indicates Binary Exponential Backoff while the blue line indicates Fibonacci Backoff Algorithm.

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4 RESULTS AND DISCUSSION

MATLAB was used to design a wireless network. A dense RFID wireless network was taken into consideration to see if higher throughput can be derived and if collision among the stations could be reduced. The anti-collision algorithm is used in RFID systems to improve Readers success rate during transmission. Initially, 10 stations were considered and the number was increased to 100. A slot time of 2 and an interface range of 100 were increased to 100 stations. The slot time used was 2 and the interference range between each station was 100.The table below shows simulation parameter values that we used

Table 1: Parameters considered for Simulation

Parameters	Values
Number of stations	10
Simulation time	600
Frame Size	1500bytes
Time Scale for random motion	0 – 10
Range of each station	100
Compared Algorithms	Binary Exponential and Fibonacci
Slot time for RFID Readers	2
CWmin	3
CWmax	10
Maximum iteration	1000

Table 2: Simulation test data for the Collision percent of Fibonacci and Exponential Backoff

Iteration	**Collision Percent with Binary Backoff**	**Collision Percent with Fibonacci backoff**
1		0
100	0.386363636	0
200	0.397849462	0.025974026
300	0.35971223	0.01754386
400	0.37704918	0.013513514
500	0.377777778	0.010810811
600	0.366300366	0.018181818
700	0.37037037	0.014981273
780	0.375	0.013422819
800	0.377358491	0.012861736
900	0.380487805	0.011494253
1000	0.375545852	0.010335917
Average	**0.37671047**	**0.013556366**

The table 2 above shows the average collision percentage and throughput. It shows that the FibonacciBackoff performs better when the average number of iterations increases.

Table 3:Test data for the Throughput of Fibonacci and Binary Exponential Backoff

Iteration	**Throughput with Binary Backoff (Bps)**	**Throughput with Fibonacci Backoff(Bps)**
1	0	0
100	19419.61662	6118.062165
200	28431.30712	73288.31191
300	173899.239	71268.63734
400	320378.8133	424656.8281
500	36310.97499	532275.3393
600	191796.1457	307615.5839
700	421922.2744	424117.2691
780	602783.4675	745990.9512
800	110320.2376	823632.1087
900	365688.5334	379443.1812

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1000	92641.07844	844346.5272
Average	**214871.9716**	**421159.3455**

The throughput of Fibonacci Backoff was higher than Binary Exponential Backoff as shown in table 3 above.It is expected that the Fibonacci Backoff will perform better when adopted with CSMA CA in terms of throughput in RFID System.

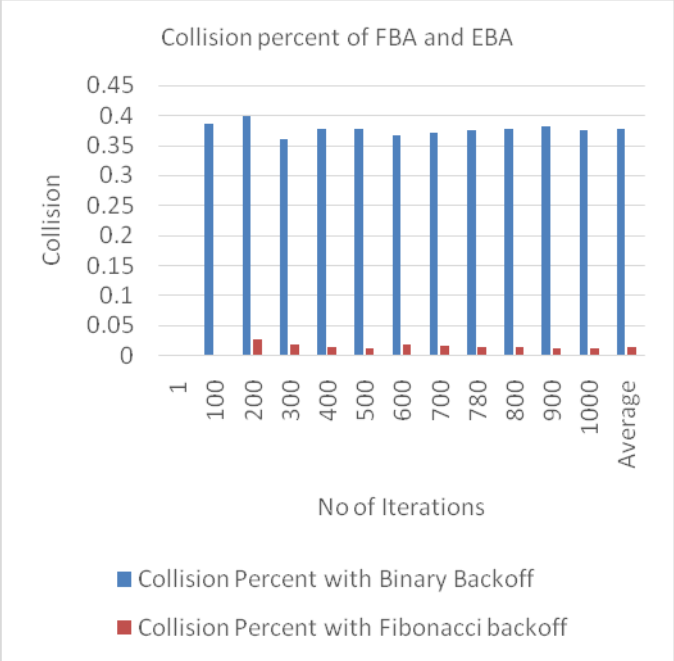

Figure 5: Collision Percent of Fibonacci Backoff and Exponential Backoff

Figure 5 shows that the collision percentage of Fibonacci Backoff Algorithm decreases as the number of iteration increases. In comparison, Fibonacci Backoff has a lesser collision than the binary Backoff Algorithm as shown clearly from the graph above.

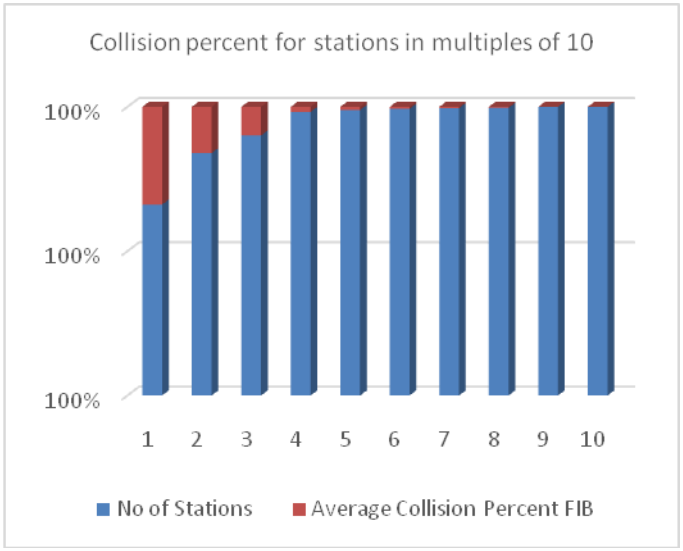

Figure 6 Collision Percent for stations in multiples of 10

From figure 6 above, it can be observed that increasing the number of stations does not increase the collision among the stations. This shows that using the Fibonacci Backoff Algorithm along with CSMA CA will reduce collisions as the number of stations increases.

Table 4: Test data for Throughput of stations in multiples of 10

No of Stations	Average Throughput FIB
10	343760.1636
20	344448.0878
30	356544.2111
40	362225.5444
50	389999.0112
60	410001.1211
70	438707.0001
80	439777.0008
90	688880.7787
100	890000.8776

From Table 4 above, the throughput for stations in multiples of 10 was also computed from simulation and the result shows that throughput is maximum when 100 stations were used.

5 CONCLUSIONS

In this paper, a better algorithm for improving collision avoidance and throughput when RFID readers and tags exchange signals was presented. MAC layer protocol, Carrier

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Sense Multiple Access with Collision Avoidance (CSMA/CA) was used alongside with a better Backoff algorithm which helps to reschedule transmission of frames by RFID Readers after the first collision. Due to its characteristics, Fibonacci Backoff algorithm was chosen as the algorithm to help lower the contention window size between two successive backoff times. Fibonacci Backoff Algorithm was simulated alongside Binary Exponential Algorithm for evaluation purposes in other to make comparisons between the two protocols based on two major metrics which are throughput and collision minimization behaviour.

This research has presented a way to minimize collision among RFID readers through proper and efficient channel reservation to ensure a better throughput during transmission of data. The two major factors which were considered during the implementation were collision minimization and throughput. The results show that a more efficient algorithm such as the Fibonacci Backoff algorithm can be used together with CSMA CA to reduce collisions of RFID Readers and increase their throughput.

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