Wireless Communication System Reliability and a Cooperative Approach to improve the same

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Abstract— Recently wireless network reliability has become fundamental issue for all stake holders in telecommunication department. Service providers are obliged to maintain give QoS guarantee and regularity bodies are under pressure to ensure that service providers are delivering what they promise.
This recent state can be attributed to many technological advancements in telecommunication networks and related fields. These advancements have basically resulted in emergence of a lot of applications; both consumer and industrial, giving rise to tremendous growth in data consumption. Moreover many of these applications have huge dependability on high network availability, which means a less than very high availability would result in a disaster. Due to its complexity and dynamic nature wireless communication systems pose many challenges, which make it difficult for system analyst to give a better estimate of reliability of the system. System reliability is an important concern and must be addressed taking all system aspects into consideration. We thus need an accurate method to assess reliability and availability of wireless systems and improve the same. Towards this end this paper presents various reliability analysis techniques in practice along with our proposed approach which can improve system reliability under specific conditions.

Keywords—Wireless, reliability, assessment

I. INTRODUCTION

We use the concept of Reliability in our daily life very frequently. While making any decision we make some guesses about how reliable our decision is. The more accurate the guess, the better is the decision. In this section we present some background on wireless reliability and recent work done in this area.

There are many challenges in mobile networks. Mobility makes the channel highly dynamic and unpredictable[1]. Apart from dynamic nature other issues includes special requirement that must meet such as availability of communication infrastructure, security mechanisms for secure communication etc. Although Ad-hoc networks have been suggested for many of such cases, it has its own drawbacks and limitation. One specific limitation in ZRP (Zone Routing Protocol) in Ad-hoc network routing is lack of security measures because there is no central monitoring authority to ensure secure communication among nodes[2]. Due to these and other reasons low connectivity and frequent black outs in many areas are common. Tackling such network failure is most foremost priority and responsibility of a network designer and service provider. More so because they have to fulfill the QoS guarantee. Often fulfillment of a "Five Nine" availability criteria (i.e. average availability of 99.999%) is expected. For "Five Nine" availability it means a maximum allowed yearly downtime of 5.26 minutes[3]. This availability has to be maintained because the service provider is obliged to fulfill QoS guarantee.

In this paper we demonstrate our proposed idea that can help us develop a more reliable wireless communication networks. This would help us improve reliability in communication across areas where there is very low connectivity. We have chosen a specific scenario for demonstration of our technique , but we argue that our technique can be extended to many other cases, and this is the future scope of this work. In the following sections we first present a summary of the survey conducted and in subsequent section we describe these ideas along with various assumptions we have made.

II. SURYEY

We present our survey results in the form of a table that may prove handy to future researchers who want explore these areas further.

Reference No.	**Basic Concept and Technique Discussed**
7	Reliability, hardware, software and human factors
8	Vulnerabilities in cloud computing such as outages, downtimes, and data loss
9	Reliability in Cloud Computing
10	General concept of reliability
11	Reliability measures
12	General concept of reliability and a comparative analysis

13	Reliability Vs Availability
14	Probabilistic Inclusion-exclusion principle to evaluate failure probability
15	What all we get from better Reliability predictions?
16	Application of formal methods to networking
17	MTBF, MTTR, MTTF & FIT explanation of these terms
18	MTBF overview
19	Network modeling using RBD
20	Reliability analysis of WSN
21	Reliability analysis of WSN, determination of MMTF and MTTR for WSN
22	Reliability analysis of Software systems.
23	Mathematical expressions for Reliability and availability analysis for RBD
24	Describes a theorem that helps in reducing state-space of a Markov chain. The theorem says that given the steady-state probabilities of original Markov chain, the probabilities for smaller chain are proportional to the corresponding states in the original Markov chain.
25	Application of Fuzzy logic, normally applicable for systems that can tolerate less accuracy.
26	What is Fuzzy logic: a generalization of classical logic where we have more answers than simple, Yes and No. Fuzzy Logic for RBD analysis.
27	Analysis of FT with Fuzzy Logic
38	Bayesian Theorem. It is used with Bayesian model of reliability for evaluating child conditional probability.
29	Calculation of joint probability in context of Bayesian network and marginalization

III. WHAT DO WE CONCLUDE FROM THE SURVEY

So far we have concluded following where we think more work could be done:

a. There is no recent detailed and exhaustive survey on Software tools available for communication systems (especially for mobile wireless comm.) reliability assessment.

b. Formal Methods have a lot of scope and we found the attempt to apply Formal Methods to model and analyze wireless communication systems has not been judiciously made. Although formal methods have been applied in plethora of other areas.

c. In most of the research studied in this survey, authors have assumed only two states of systems: failure and functional. But we think an intermediate state should also be explored to find some interesting results.

IV. IMPROVING RELIABILITY USING COOPERATIVE APPROACH

Having presented recent work done in the area of wireless reliability analysis, we now turn our attention to our proposed reliability improvement technique.

Our approach is based on a kind of cooperation that is agreed among the mobile nodes situated on-site. Our proposed framework help us develop protocols that takes into considerations this fact. An example protocol works as described below:

We assume that most of the information is often common among the users/employees working onsite. So the idea is to develop a mechanism which enable them to cooperatively exchange this common information on-site. This cooperative information exchange at the project site can be accomplished by various short range communication modes such as BT, Wi-Fi, as the mobile nodes in such situations are expected to be in close proximity.

For example, consider a situation where a large number of employees of a company work on a project on-site. The connectivity between Head office and the project site is poor due to lack of communication infrastructure and other reasons. Assume that at any point of time a large portion of the information required by employees at the project site is common. The Head office then need to take care of that small percentage of user-specific data or employee-specific data which is not common.

This user-specific data can be communicated through low bandwidth global communication media such as SMS, and/or a combination of SMS and GPRS (Low speed internet connection), for example.

V. PROCESS FLOW

The process flow is shown in the following chart:

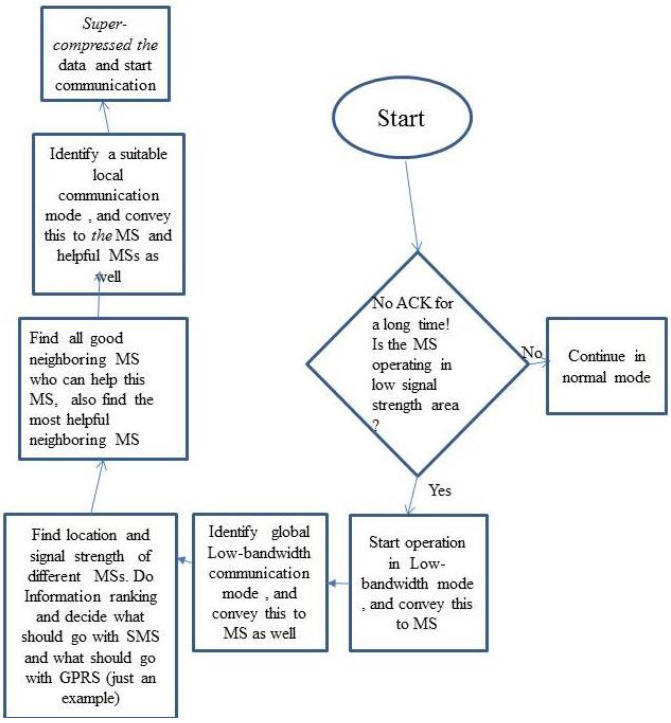

Fig. 1. Framework process flow chart

For the purpose of explanation assume that MS6 need some information, and we show here how this information is conveyed in a low bandwidth mode.

The process starts when the server receives no response form the Mobile Station (MS) or nodes for predefined period of time. If the response is coming as expected the server site and the project site work in normal mode. But in case there is no acknowledgement, the framework forces the system to work in Low-Bandwidth Mode. Once the network operation is switched to Low bandwidth mode, the server at the Head office starts making a list of participating nodes or MS and decides communication medium for each MS. The communication media can also be SMS or GPRS. Which Information is sent by which media is also decided.

As shown in the flow chart, server identifies a list of neighboring nodes or MSs who can help MS6. It also finds most helpful neighbor of MS6. .
The idea is that these helpful; MSs have information which is required by MS6, so these helpful MSs will provide this information in the local network at the project site. That is why we say this is a cooperative approach where each node cooperatively helps achieve the successful communication, avoiding as much global communication as possible, which is more prone to fail as compared to the local shared short range communication.

Then the communication link among these helpful nodes and MS6 is decided, which can be any of the short range communication technologies. Before communication starts, a security layer comes into action which does encryption job. Also what information is required by MS6 is instructed to all the other helpful neighboring MS. This shared data is partial data which has no meaning on its own, so even if a security breach happen, an eavesdropper only get a portion of a some data which is of no meaning in itself. Therefore this system is inherently secure as well.

VI. CONCLUSION

In this paper we have presented a detailed survey of wireless reliability analysis techniques. Main references are along with their contributions have been presented in tabular format. The main conclusions drawn from the survey has been presented. We can say that Formal methods have not been applied in wireless reliability analysis and thus is an unexplored area. Further, Most of the authors have assumed only two states(Failure & Success). Therefore research should be conducted with parameters which are not limited to these two states. A second contribution of this paper is our proposed reliability improvement technique which is the part of our on-going research. Our idea is that when we have large number of mobile nodes which have common data requirement, they can exchange it from their nearest peers in a cooperative manner using low bandwidth communication means such as SMS or BT, instead of requesting it from the main server which may be less reliable due to low connectivity. By using our cooperative approach way we can ensure better reliability at least in our specific scenario.

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