RELAY BASED ROBUST AND RESILIENCE CONNECTIVITY FOR HYBRID WIRELESS NETWORKS UNDER HIGH DYNAMICS

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Abstract— The increasing popularity and utilization of smart devices in the world made Hybrid Networks as backbonefor today's wireless communication, because of its dual core connectivity interfaces to support bothcellular and ad-hoc networks. Hybrid Network protocols and implementations become a better solution for today Wireless Data Networks (WDN) to avoid poor cellular signal quality, infrastructure less connectivity, low data transfer rate, coverage and capacity, bandwidth limitations etc. Although Hybrid wireless networks are more efficient than other individual wireless networks for smart devices, they are still suffering from unsatisfied service of quality due toless throughput, weak/dead signal quality, underutilization of frequency, loss of connectivity under high dynamics of mobility and proximity range of cellular nodes from base station in Private Network Groups (PNG's). To overcome the above mentioned limitations, in this paper we introduced Relay based Robust and Resilience connectivity for Hybrid wireless Networks under high dynamics.Mobility aware routing, Virtual tree structured path creation, on-demand relay node selection [10] were implemented and integrated with PNG's to design the proposed networking methodology for hybrid wireless networks. Our simulation results show that, proposed hybrid methodology recorded the improved throughput, max utilization of frequency and robust connectivity under high dynamics.

Keywords— Hybrid Networks, Wireless Data Networks, Throughput, Relay networks, multi-hop connectivity

I. INTRODUCTION

Wireless communications become an integral part of human life today, either directly or indirectly to accomplish the needs. Widespread of powerful and smart mobile computing devices (like smart phones, net books, tablets, smart watches etc.) in the world today cause to start a new riot in wireless communications to exchange the vast amount of information across the globe. One in every five is having a smart device today according to the popular survey company "business insider" [1].

Today smart devices are more advanced and support the dual core connectivity for networking through ad-hoc interface (IEEE 802.11a&b) and cellular interface (2G, 3G and 4G). Most of all smart devices of today are equipped with the respective data cards (hardware) for cellular connectivity and ad-hoc connectivity. In order to maintain the communication in this dual core network interface environment sake we can use any of the IEEE standard Hybrid Protocols [2] like EIGRP [3], DVMRP [4], IGP and HSRP. At core level of these protocols we should do insist of our proposed methodology and patterns to achieve the expected performance in hybrid networks as we stated.

Hybrid wireless networks and opportunistic networks are interchangeable, which are widely used in military applications, disaster management, emergency services, civilian public applications and private group data exchanges etc. By adopting the hybrid networks in public wireless communications [5] caused to improve the throughput and high usage of network frequency dramatically. Private Network Groups (PNGs) are become so popular today to share and forward the sensitive information among the registered users in a secured way. Most of the PNGs are equipped with rich configuration and the most popular PNGs are Business Administration Groups, Military Battle Fields, Retail Customer Groups and Corporate Health and Wellness Forums etc. PNGs will be created at the level wide area networks and exchanges the information among the group members but not with others. Due to the improvements of data format, today sharing of video, audio and image data is increased approximately 10 times more than the text data. In order to exchange these large volumes of data among the private group members, we need high bandwidth and frequency channels and strong cellular signal connectivity.

Weak cellular signal connectivity is the major problem of mobile networks (for 3G and 4G), which is subjective to distance from the base station is also called the range from access point. While applying the classic hybrid networking methodology for Private Network Groups (PNGs) they are suffering from unsatisfied service of quality due to less throughput, weak/dead signal quality, underutilization of frequency, loss of connectivity under high dynamics of mobility and proximity range of cellular nodes from base station in Private Network Groups (PNG's).

To overcome the above mentioned limitations, in this paper we proposed a Relay based Robust and Resilience connectivity for Hybrid wireless Networks under high dynamics, by customizing the existing hybrid wireless networking methodology. Mobility aware routing, Virtual tree structured path creation, on-demand relay node selection were implemented and integrated with PNG's to design the proposed

networking methodology for hybrid wireless networks. Our simulation results show that, proposed hybrid methodology recorded the improved throughput, max utilization of frequency and robust connectivity under high dynamics.

II. PROBLEM STATEMENT AND OBJECTIVES

In this section we discuss about the Hybrid wireless Networks, Limitations of Hybrid networks for PNGs and the main objectives of this paper will be described along with architecture diagrams.

Hybrid wireless network is a network with dual core interface nodes, which supports the cellular connectivity and ad-hoc connectivity. Today hybrid networks are widely deployed for wireless communications to improve the throughput, frequency utilization and efficient resource management [6]. These networks are useful while creating the public groups to design the applications for disaster management, emergency services and business promoting groups etc. For example a cellular user of a public emergency group may place a request for the First-Aid video under the poor signal quality cause to decrease the data transfer rate, which also effects on throughput in general wireless networks. To overcome this problem in wireless networks, we are redeploying the architecture with hybrid networks to use cellular base station connectivity and ad-hoc (IEEE 802.11x) connectivity for efficient transmission as shown in below figure 1.

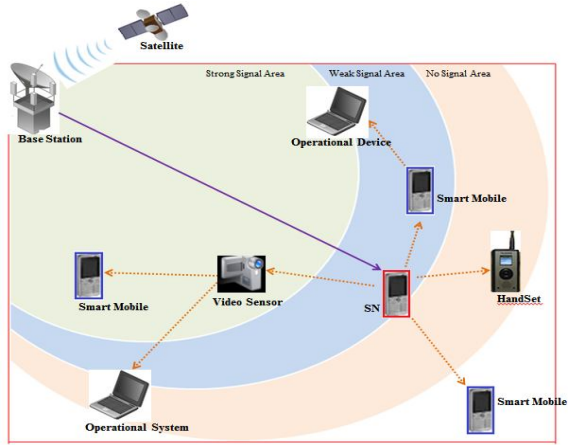


Figure 1 Conventional Hybrid Networks

A. Network Architecture

The above diagram is describing the hybrid network region of a military camp which is deployed for miles of area coverage as shown above as a Private Network Group (PNG). There is a base station (MD8475A) to receive the cellular signals from satellite and is having the range (the network coverage area) from 16 KM to 21 KM.

The whole network region is outlined into three different areas based on the base station network coverage capability. They are Strong Signal Area (from 0-16 KM) with light green color, Weak Signal Area (from 16 – 21 KM sky blue area) and No Signal Area (from 21 KM light orange color). SN is the direct subscribed nodemeans currently connected with Base Station (MD8475A) for communication. Along with there are some other nodes called as wireless member nodes connected to SN through Wireless Wide Area Network (WWAN) are the smart mobiles, Operational Systems, Videos Sensors and Hand Sets etc. Most of these devices are equipped with wireless 3G and WWAN facilities for hybrid communication. In above figure 1 member nodes are connected either directly or indirectly connected to the subscribed node SN for 3G connectivity [8] sake. Each device is having the capability to run the hybrid protocols and can act as routers for wide area network development.

B. Motivation

Due to the non-residential area there are no much base stations to cover the whole network region. Deploying the base stations only for the military operations is a cost effective and income less operation for the governments. This is the situation at borders of all developing countries in the world today. However, the robust communication signaling is required to maintain the communications among the soldiers for video conferences, Technology sharing, Location information sharing and for some other purposes.

C. Problem Statement

As we know the network signals become weak when the subscribed node is moving far from the base stations. In the figure-1 all the nodes (smart mobiles, Laptops, Handsets and other communication devices) of this region are equipped with the 3G data cards(Mobi-Fi E5151)with speed up to HSPA + 21.6 MBPS and IEEE 802.a (OFDM (3.7)) with speed up to 54 MBPS. If the subscribed node (NS) is moving towards to no signal area (light orange color) cause to destruct the whole network due to the below limitations are:

- Weak or No Cellular Signal density while moving far from Base station coverage area
- Whole architecture in SN dependent
- Multi hop or Relying were not implemented for cellular connectivity
- Uncovered network region with insufficient Base Stations

The above limitations will directly effects on the whole network throughput, frequency utilization percentage, data transfer rate, network node connectivity etc.

III. RELAY BASED ROBUST AND RESILIENCE CONNECTIVITY FOR HYBRID WIRELESS NETWORKS

In order to overcome the above mentioned limitations, we introduced the “Relay based Robust

and Resilience connectivity for Hybrid Wireless Networks" Under High Dynamics. The main aim of this research is to design a robust hybrid wireless network, with the help of relaying technique to make that as resilience. Here we implemented the proxy connections through non subscription nodes to maintain the strong connectivity. Our approach is not expecting to deploy any new base station but extends the network range through WWANs and relayed techniques. The proposed network architecture is described in below figure-2 and explained in this section in detail.

In Figure 2, we updated the traditional hybrid networks with Mobility aware routing, Virtual tree structured path creation, on-demand relay node selection were implemented and integrated with PNG's to design the proposed networking methodology for hybrid wireless networks. In general military groups are always private to share the sensitive information among the trusted people and always the nodes in the region will move from one location to another location (high dynamics) as they are smart mobile devise. To implement the routing under these circumstances we considered EIGRP [3] protocols from cisco and customized this protocol by insisting mobility aware routing.

Mobility aware routing [8] concept allows us to avoid the problem of path breaking by predicating the future connection failures based on node movements and distances from neighbor or community nodes in private network groups. This concept mainly use the cognitive techniques to assess the path breaking based on current node signal strength, past history, moving direction etc. We insisted this methodology to EIGRP protocol to update and to mitigate the network destructions.

Virtual Tree Paths [9] are implemented for data transfer initiation and node connectivity purpose sake. These paths are on-demand and light weight by default to eliminate the complexity in generation of a separate route for acknowledgement. Virtual tree structure will be created dynamically with help of mobility aware routing to initiate the data transfers at fast rate. The same paths will be used to return the acknowledgements to the sender.

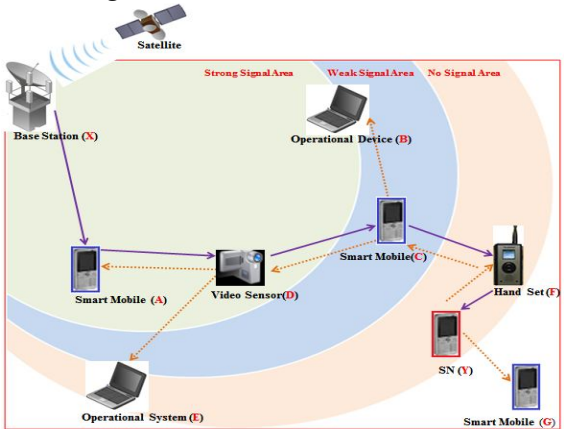


Figure 2 Relay based Robust and Resilience connectivity for Hybrid Wireless Networks

On Demand Relay Node Selection plays an important role in our proposed methodology to implement the robust and resilience connectivity among the nodes under high dynamics. Relay networks [7] are introduced in wireless communications to extend the range of network coverage area and to connect the source and destination through some intermediate nodes establish the robust network connections. As per the requirement the relay nodes will be selected to boost up the signal strength from neighbor nodes which are nearer and same group members with dual core connectivity interface.

If we considered the figure1 with hybrid network connectivity is suffering from the weak signal problem while moving the SN towards no signal area from base station. Once the SN moves to "No Signal Area" the signal from base station become weak or not available, leads to break the whole network connectivity because of the nodes are completely dependent on SN. This network is having the high failure rate and is not extendable on demand.

To overcome this problem we implemented the relay network based hybrid wireless connectivity is represented in figure 2. This is the redesign of figure1 with relaying node connectivity and our proposed methodologies. In this diagram if we observe SN(Y) is the subscribed node which is already in "No Signal Area", but still maintaining the robust connectivity due to the relaying nodes (works like proxy nodes to connect the base station (X) and destination devices). Here SN(Y) is having the strong signals in "No Signal Area" by implementing the connectivity through X →A→D→F→Y. In this chain connectivity, Base Station (X) signals are received first by A which is a smart device dual core connectivity interfaces (cellular and WWAN). Than A diverts the encrypted signals received from X to its nearest dual core interface neighbor D, through its IEEE 802.a (OFDM (3.7)) interface. Like this the strong signal will be passed to the final destination SN(Y). In this architecture A, D and F are the private group members helps as relay nodes (proxy) to extend the network coverage area through IEEE 802.a (OFDM (3.7)) and to pass the strong signal to destination through their WWANs.

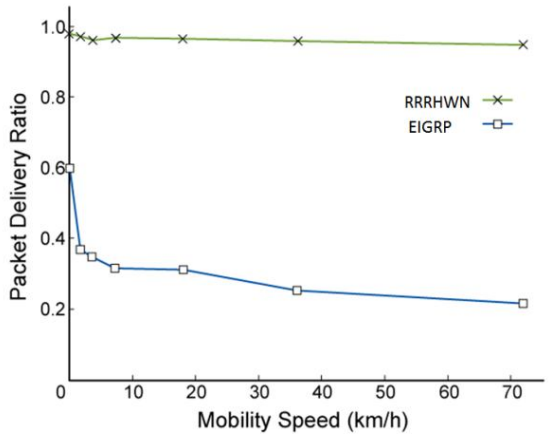
This network is resilience because of all nodes of this network are equipped with strong wide area network cards (OFDM (3.7) and be able to become as relay nodes to pass the cellular signal to destination node. This network is robust because of the connectivity became very strong and extensible by using WWANs.

IV. EXPERIMENTAL SETUP AND RESULTS

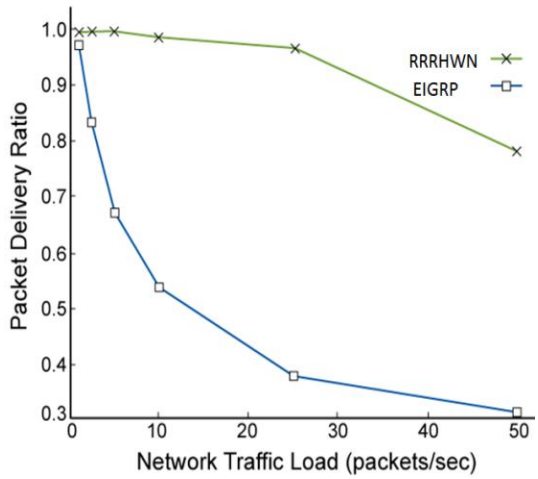
In order to implement the simulations sake we set up an environment with 12 devices (mobiles and laptops) with dual core connectivity interfaces like 3G cards and WWANs (IEEE 802.a (OFDM (3.7)).

We used the base station simulator is Mobi-Fi E5151 to maintain the cellular connectivity and we customized the EIGRP protocol to support relay networks approach and cellular signal passing through WWANs.

We set up a Linux server platform deploy and manage the whole application; nodes are running under high mobility speed like 45 to 60 km/h to test the robustness of the network. We are screening the connectivity from the interface of Mobi-Fi E5151 base station simulator system. We collected the results from this machine and composed in a respective way to perform the results comparison of our methodology RRRHWN (Relay based Robust and Resilience connectivity for Hybrid Wireless Networks) with the other hybrid protocols likeEIGRP. Our simulation results show that, proposed hybrid methodology recorded the improved throughput, max utilization of frequency and robust connectivity under high dynamics as shown in graph 1 and graph2.



Graph 1 Mobility vs PDR comparison



Graph 2 Network traffic load vs PDR for throughput

CONCLUSION & FUTURE WORK

In this paper we enriched the Hybrid Networks to maintain the Private Network Groups under high dynamics and limited coverage area. We introduced Relay based Robust and Resilience connectivity for Hybrid Wireless Networks methodology to extend network range and to maintain the longer connectivity among the nodes. Mobility aware routing, Virtual tree structured path creation, on-demand relay node selection were implemented and integrated with PNG's to design the proposed networking methodology for hybrid wireless networks. Our simulation results show that, proposed hybrid methodology recorded the improved throughput, max utilization of frequency and robust connectivity under high dynamics.

In future we extend this research with introducing a new protocol for relaying technique to implement hybrid connectivity in for private and public network groups.

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