ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 3, March 2014

Cognitive Radio Network Modeling Using Game Theoretic Approach for Effective Resource Allocation

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Abstract: Spectrum Sensing, Resource Sharing and Enhanced Multihop Modelling scenarios have seen much change in the last decade, leading to better probability of choosing near perfection assumptions and working models for Cognitive Radio Networks. In continuation to the contributions of the world for the improvements of intelligent radio networks, this project is aimed at developing an optimal solution for maximising throughput and resource allocation link stability, using Game Theory concepts. Primarily, three different versions of game models will be used for enhancing resource allocation – "Vernacular Flow Game", "Global Knowledge Flow Game" and "Link Cooperation Game". With the results of these condition-based simulations in hand, further enhancements has made using another viable game theory model called "Bayesian Signalling Game", whose comparison results has shown and tabulated, along with a comparative study inference.

Keywords: Cognitive Radio Network- Spectrum sensing- Resource sharing- Game theory- Throughput

I. INTRODUCTION

CRN, is a kind of two-way radio that automatically changes its transmission or reception parameters, in such a way that the entire wireless communication network of which it is a node communicates efficiently, while avoiding interference with licensed or unlicensed users. This alteration of parameters is based on active monitoring of several factors in the external and internal radio environment, such as radio frequency spectrum, user behaviour and network state.

A cognitive radio is "a software defined radio with a cognitive engine brain". It was thought of as an ideal goal towards which a Software-designed radio platform should evolve: a fully reconfigurable wireless black-box that automatically changes its communication variables in response to network and user demand. A cognitive radio is an intelligent radio that can be programmed and configured dynamically.

Its transceiver is designed to use the best wireless channels in its vicinity. Such a radio automatically detects available channels in wireless spectrum, then accordingly changes its transmission or reception parameters to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management.

Cognitive radio network is a new paradigm that provides the capability to share or use the spectrum in an opportunistic manner. It is used in many applications such as, Leased network, Cellular network, Emergency network, Military network, CR mesh network and Multimedia.

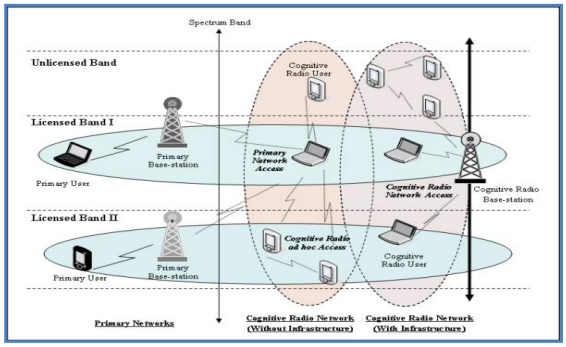

Fig 1.1: CR Network Architecture

Flow of CRN

i) Spectrum Sensing
ii) Spectrum Sharing
iii) Spectrum Mobility
iv) Spectrum Management

Game Theory is the formal study of conflict and cooperation. Game theoretic concepts apply whenever the actions of several agents are interdependent. These agents may be individuals, groups, firms or any combination of these. It deals with the study of decision making in which there were players. A player is the one who makes decision in game. The concept of game theory provides a language to formulate structure, analyse and understand strategic scenarios. The main drawback of the flow games is the complexity that they pose in terms of the necessity of sharing information amongst the nodes of the network and the computational load required to perform the strategy selection. To solve this problem, we propose a cooperative link game which does not require a central

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International Journal of Advanced Research in Computer and Communication Engineering
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entity in each flow to perform the strategy selection. This decreases both the amount of information shared between the nodes of the network and the complexity of the selection of the strategy profile.

Generally there are two types of Game theories.
1.Co-operation Game Theory Ex:football
2.Non-cooperative Game Theory Ex:chess

Some of the important games are,

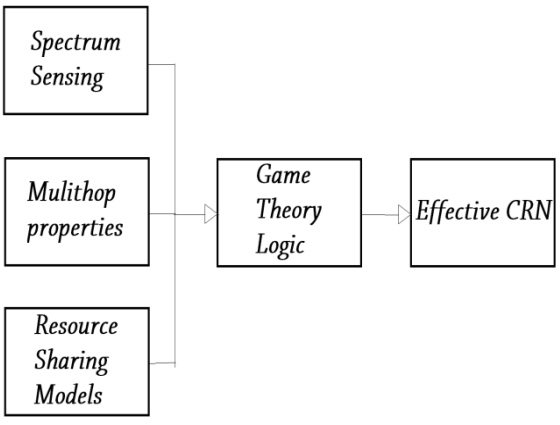
i) Nash equilibrium
ii) Private information game
iii) Pirate game and so on.,

Out of many important games we have chosen "Vernacular Flow Game", "Global Knowledge Flow Game" and "Link Cooperation Game". Vernacular flow Game means the nodes get only before and next hop's information. Global knowledge flow game means every node has information about all the hops or nodes. Co-operative flow game means node gets only the required hop's or node's information. Adding one additional game theory model is called as Bayesian game theory. A Bayesian game is one in which information about characteristics of the other players (i.e. payoffs) is incomplete. If the information is incomplete at any stage, it means that at least one player is unsure of the type (and so the payoff function) of another player.

II. EXISTING METHOD

There were many models of CRN without using Game theory concepts. In those models resource allocation is not effectively done. Point to point communication is not enough for CRN; it requires end to end communication. Ineffective sensing and sharing brings down network's QoS. To overcome those drawbacks Game theory concepts were used in CRN.

III. PROPOSED METHOD



Spectrum sensing, Multihop properties, Resource sharing models have been made more effective by using Game Theory logic.

IV. SIMULATION ENVIRONMENT

NS2 is the software used in our project. NS2 is the discrete event simulator targeted at networking research. It is an open source. Discrete and Continuous are the two event simulator. Continuous event simulator takes infinite time but discrete event simulator depends on time. So, discrete event simulator is used. Tools Command Language is the language used in NS2. TCL is the modification of c & c++. It covers multiple layers such as Physical, Data link, Network, Transport and Application layers. We have used 66 users in same environmental condition

V. SIMULATION WINDOW/RESULTS

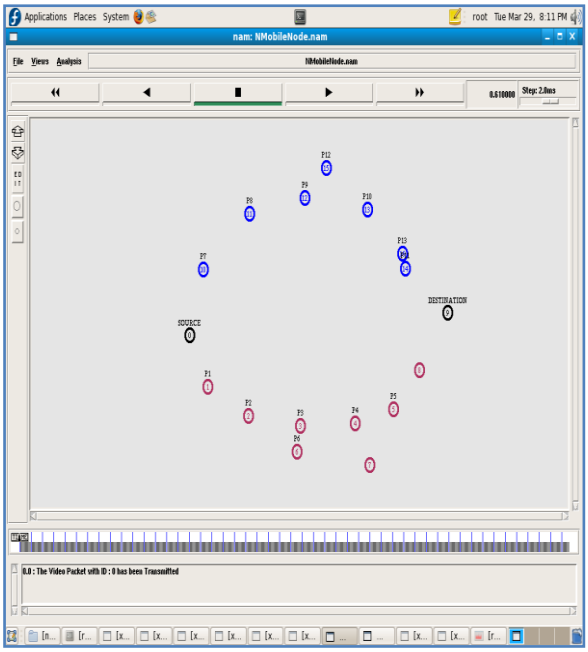


Fig 5.1: Selection of path

The sender senses two paths for transmission using the modified routing protocol. The multiple paths are indicated by various colors. The paths are SRC-P1-P2-P6-P3-P4-P5-P8-DST AND SRC-P7-P8-P9-P12-P10-P13-P14-DST. Here the two paths are chosen for transmission of the video packets to the receiver from the sender.

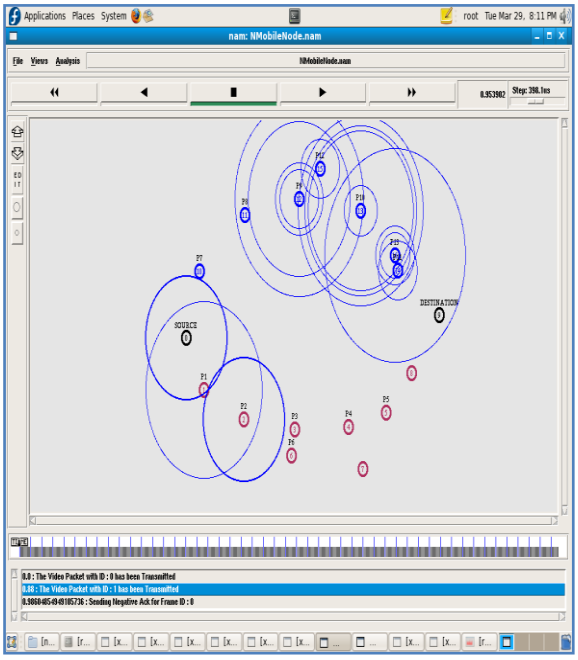


Fig 5.2: Range Detection for transfer

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Here each node detects its range of transmission, to check the presence of nodes in the path for transmission. Range detection for the transfer of packets

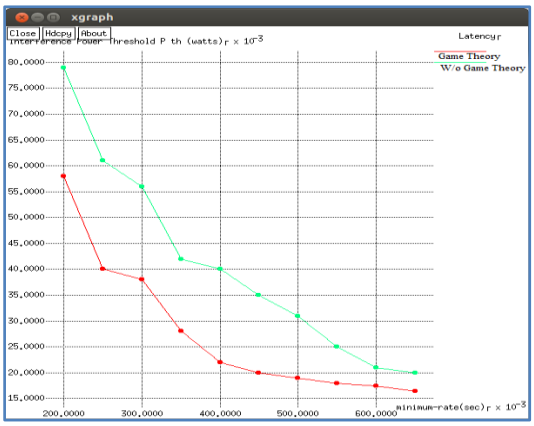

Fig 5.3: Comparison between Game theory and non-Game theory model CRN in terms of latency

It is observed that when using Game Theory model decisions are taken quickly and so others is very less delay in sending the packets... Interference power noted in Game Theory model CRN is found to be below admissible levels than Non Game Theory model.

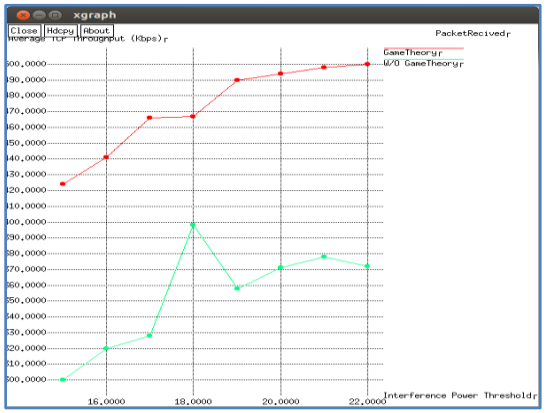

Fig 5.4: Comparison between Game theory and non-Game theory model CRN in terms of packets received at destination.

It is observed that when using Game Theory model decisions are taken quickly and so loss of packet is controlled. As a result packets received at each node are higher than non-Game theory model CRN.

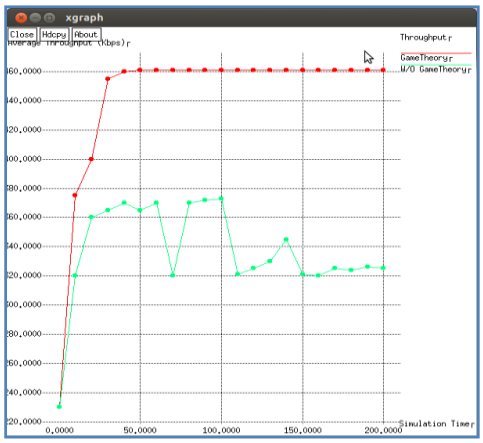

Fig 5.5: Comparison between Game theory and non-Game theory model CRN in terms of node to node throughput

It is observed that when using Game Theory model decisions are taken quickly and so throughput between individuals nodes are higher than Non Game Theory model CRN.

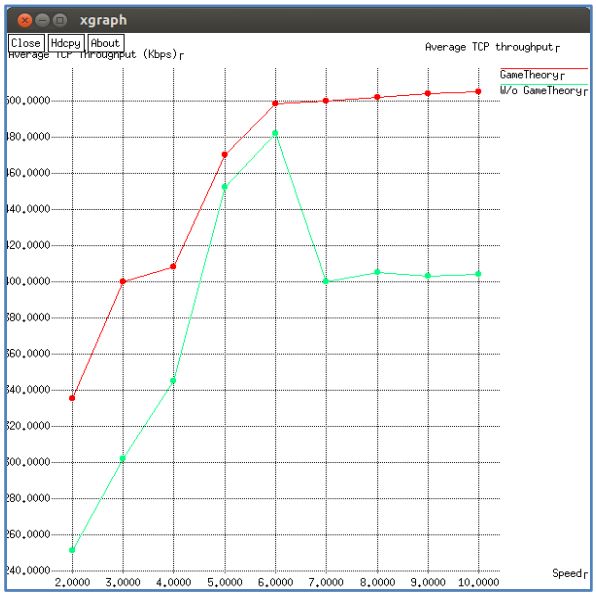

Fig 5.6 :Comparison between Game theory and non-Game theory model CRN in terms of overall throughput

It is observed that when using Game Theory model decisions are taken quickly and so throughput between End to End nodes (Source node to Destination node) is found to be are higher than Non Game Theory model CRN.

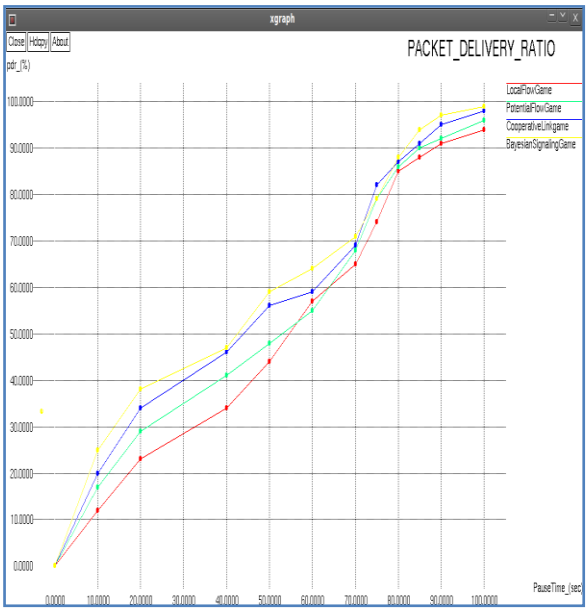

Fig 5.7: Comparison for all the four Game theory modelsim terms of Packet Delivery Ratio

By comparing all the four models Bayesian Signalling Game has the good Packet Delivery Ratio. Packet Delivery Ratio is ratio between numbers of packets sent to the number of packets received.

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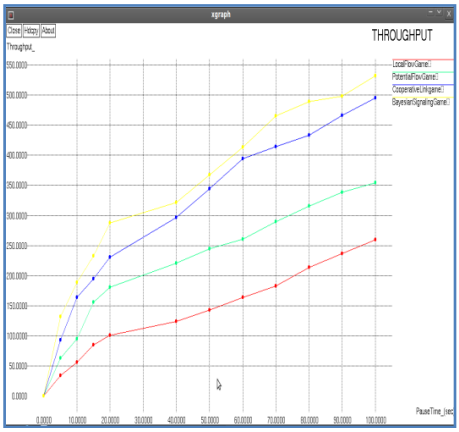

Fig 5.8: Comparison for all the four Game theory models in terms of Throughput.

By comparing all the four models Bayesian Signalling Game has the high throughput.[As the result number of Data packets received for certain time increases]

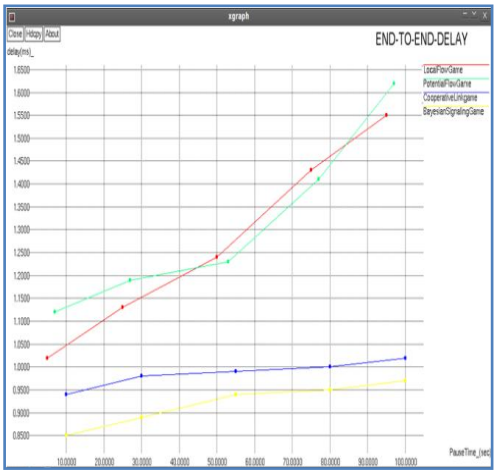

Fig 5.9: Comparison for all the four Game theory models in terms of End to End Delay.

By comparing all the four models Bayesian Signalling Game has the low End to End Delay. As the result it is seen that the decisions are taken quickly and so there is very less delay in sending the Packets.

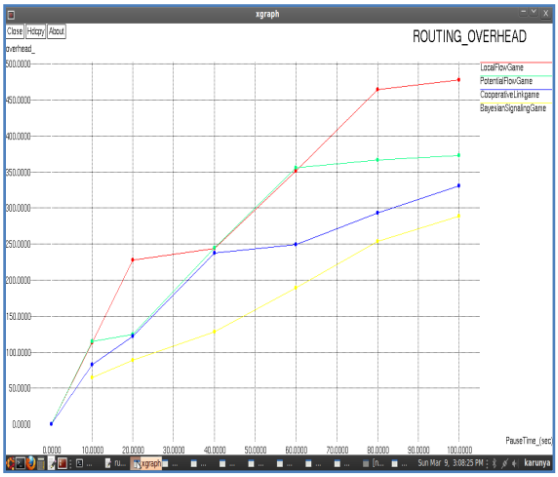

Fig 9.10: Comparison for all the four Game theory models in terms of Routing Overhead

VI. CONCLUSION

The delay for the proposed method is reduced by 2%, the packet delivery ratio is increased by 1% by varying the number of paths for transmission, the overall throughput is increased by 2% and the Routing overhead is reduced by 1.7%. Therefore the overall transmission efficiency of the game theory model CRN is improved when compared to that of the existing case. In future, some aspects of the proposed algorithm could be improved for multipath selection for multiple streams, packet schedule strategy to improve data sending quality, compression of multiple data packets and optimized routing in interference environment.

FUTURE WORK

More Game Theory models for the same environmental condition can be included for better performance.

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