ISSN: 2348 - 2117

Available Online at www.ijetcr.org

International Journal of Engineering Technology and Computer Research (IJETCR) 2 (1) 2014, 05-09

WIRELESS MULTICASTING OPERATION WITH COGNITIVE NETWORKS SYSTEM

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Received 30 December 2013; Accepted 25 January 2014

ABSTRACT

Multicasting is a more resourceful technique of maintain grouping communication than uni-casting or broad-casting, that allows transmission and routing of packets to multiple destinations using cognitive network resources. The multicast networking structure involves the communication network from one source to many destinations. The wireless network is made up of a collection of network elements with varying energy capacity.

Key Words: Wireless, Multicast, Network, Frame, Protocol.

1. INTRODUCTION:

Wireless communication is the transfer of information between two or more destination places that are not associated with an electrical conductor. The information is delivered to each of the links only once, and copies are created when the links to the destinations split, thus creating an optimal distribution path. Multicasting reduces unnecessary packet duplication. A wireless network utilizes radio communication, unlike wired networks which employ electrical conductors [1]. Wireless multicasting can therefore be loosely defined as the process of multicasting over wireless networks. The cognitive network consists of radios with fully directional antennas in receive mode1 each element transmits omni-directionally and receives directionally with a fixed beam width **"θ"**, that can take on a bore sight angle ***Ø 2 (0, 2π).*** The cognitive network framework encompasses a wide spectrum of possible implementations and solutions. The cognitive process consists of three cognitive elements that distribute the operation of the cognitive process both functionally and spatially.

2. Cognitive Networking System:

The multicast networking system involves the communication network from one source to many destinations. Many factors may affect a wireless multicast flow's lifetime. For instance, traffic congestion can cause timeouts in upper layer protocols, interference can cause loss of connectivity at the physical layer, and mobility can cause unexpected disconnections in traffic routing. However, for mobile and portable devices, one of the chief factors in the lifetime of a flow is the utilization of the energy contained in the batteries of the mobile radios. Particularly for multi-hop wireless flows, the lifetime is limited by the radios whose battery fails first. This is the radio whose lifetime our cognitive network attempts to maximize [2].

The wireless network is made up of a collection of network elements with varying energy capacity. Some elements may be battery powered, with limited capacity, while others may be less mobile, with large and high capacity batteries. The lifetime of a data path, however, is limited by the radio utilizing the largest fraction of its battery capacity. By minimizing the utilization of this bottleneck radio, the lifetime of the path can be maximized. Furthermore, consider a network where radios are equipped with directional antennas, which are useful to reduce interference, improve spatial multiplexing, and increase range.

We model a network consisting of a set of radios N = {1, 2, . . . , n}, in which the objective is to create a maximum lifetime multicast tree between source s and destination set D. As described earlier, the cognitive network controls three modifiable network parameters: the radio transmission power contained in the elements of vector ***"pt"***, the antenna directionality angles are contained in the elements of vector **"Ø"** and element routing tables (contained in each node of the multicast tree ***"T"***. The states of the modifiable elements are part of the action set **"*A*",** of which the action vector a contains the current state of each modifiable element [3]. In the model used here, the lifetime of a radio is inversely proportional to the utilization of the radio's battery, that is define in the equation………. ***"I".***

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$$\mu_i = \frac{pt_i}{ca_i}$$ ……………………*I*

Where ***"pt**$_i$**"*** is radio ***"i's"*** transmission power and ***"ca**$_i$**"*** is the remaining energy capacity of its battery. The lifetime of a data path is limited by the radio utilizing the largest fraction of its battery capacity, so over the entire multicast tree ***"T"***, the lifetime will be inversely proportional to the utilization of the max-utilization radio, that is define in the equation………. ***"II".***

$$\mu_T = \max_{j \in T} \{\mu_j\}$$ **…………………..*II***

3. Multicasting Operation with Directional Receive Mode:

The network consists of radios with fully directional antennas in receive mode1 each element transmits omni-directionally and receives directionally with a fixed beam width **"θ"**, that can take on a bore sight angle ***Ø 2 (0, 2π).*** The operation of an ad-hoc network with directional antennas system in receive mode shown in ***figure 1.1*** *"A" is* Omni-directional receive operation *"B" is* Directional receive operation *and "C"* is Multi cast tree**.** The shaded areas extending from the radios represent regions of increased gain [4].

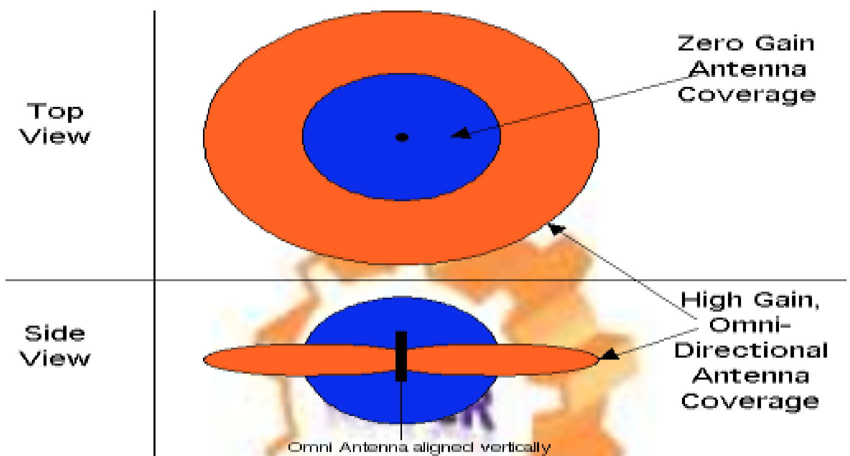

Figure 1.1 (A): Omni-directional receives operation

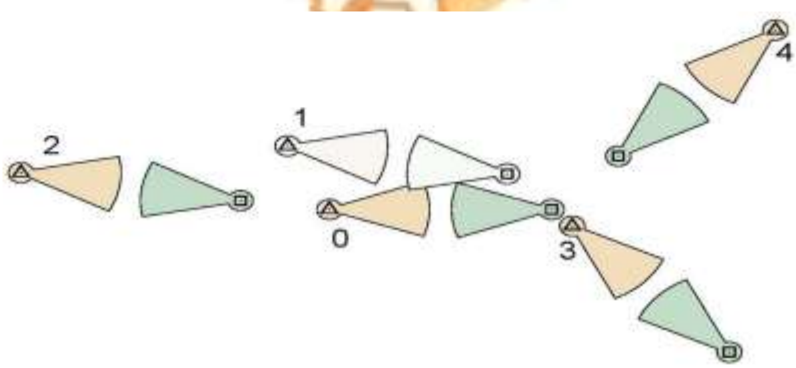

Figure 1.1 (B): Directional receives operation

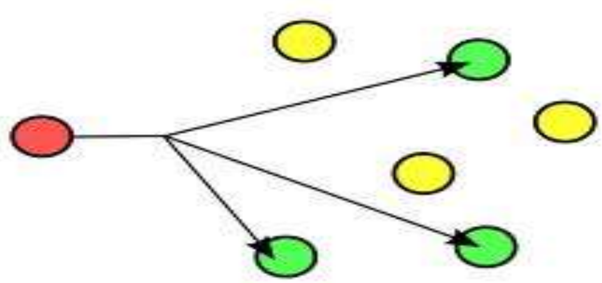

Figure 1.1 (C): Multi cast tree

When radio ***"I"*** transmits, the signal experiences gain factor ***"gb"*** within the main beam of the antenna system that is define with equation ***"III"***.

$$gb = \frac{2\pi}{\theta}$$

…………………..III

Some energy leaks outside the main beam in side lobes. The fraction that ends up in the beam is pct ε (0, 1) and the fraction outside the beam is (1 − pct). We also consider a path loss attenuation factor, proportional to equation ***"IV"***.

$$gp_{ij} = \frac{1}{d(i,j)^{\alpha}}$$

……………IV

where ***d(i, j)*** is the Euclidean distance between source ***"i"*** and destination" j" and ***"α"*** is the path loss exponent. Combining these gains and attenuations, the overall gain from a transmission by radio ***"i"*** received at radio ***"j"*** is shown with equation ***"V"***.

$$g_{ij}(\phi_j) = \begin{cases} gb \cdot gp_{ij} \cdot pct & \phi_j \in a(i,j) \pm \frac{\theta}{2} \\ gp_{ij} \cdot (1 - pct) \end{cases}$$

……….V

Where a ***(i, j)*** is the angular function between radios ***"i"*** and ***" j"***.

4. Cognitive Network Frame Structure:

The cognitive network framework encompasses a wide spectrum of possible implementations and solutions. This approach allows the framework to be a method for approaching problems in complex networks, rather than a specific solution [5]. The framework sits on top of existing network layers, processes, and protocols, adjusting elements of the software adaptable network to achieve an end-to-end goal. In this, how a cognitive network that solves the multicast lifetime problem fits into the framework. We examine each layer, showing how the requirements layer provides goals to the cognitive elements, how the cognitive process performs the feedback loop, and identify the functionality of the software adaptable network and its idea define in the ***figure 1.2***.

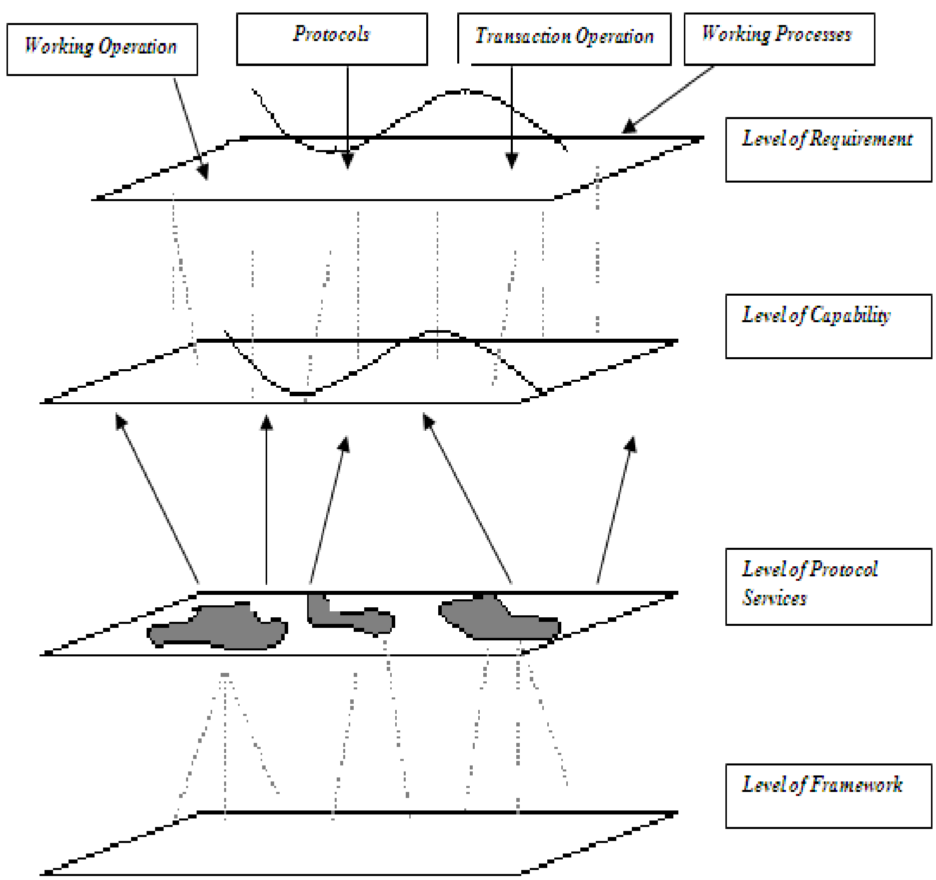

Figure 1.2: Cognitive Network Frame Structure

5. Cognitive Network Process:

The cognitive process consists of three cognitive elements that distribute the operation of the cognitive process both functionally and spatially: power control, direction control and routing control. Power control adjusts the physical transmission power **(pt_i),** direction control adjusts the medium access control spatial operation **($\emptyset_i$)**, and routing control adjusts the network layer's routing functionality ***(T).***

The software adaptive network status sensors provide each cognitive element with partial-knowledge of the network. Battery utilization and routing tables are only reported within a radio's k-hop neighborhood [6]. The k-hop neighborhood of a radio is defined to be every radio reachable in the routing tree via k hops, following the routing tree both up and down branches that is shown in the ***figure 1.3***.

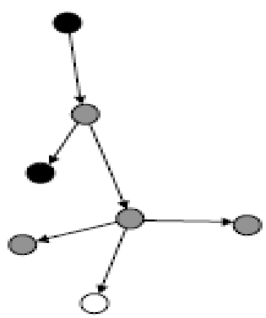

Figure 1.3: Routing tree both up and down branches

The set of k-hop neighbors for radio i is represented by N_i^K. The software adaptive network also provides information about the required power needed to meet the signal to interference and noise ratio requirement of each of the next hop child radios in the multicast route. The set of child radios for radio are represented by ***C_i.***

6. Cognitive Network Process Elements:

The cognitive process consist by the three cognitive elements such as power control, direction control, routing control described above, and each operating on every radio in the network [7]. In this, the strategies utilized by these elements to achieve the above objectives goals and identify the critical design decisions used by each cognitive element.

A. Power Control:

Power Control's purpose is to minimize the transmission power on every radio subject to the system constraint. This means that a radio will attempt to transmit at the minimum power that connects it to all of its children through the local control of **"pt_i".** The objective can be represented by the utility function, define by the equation ***"VI".***

$$u_i^{\mathrm{PC}}(\mathbf{a}) = -\left(\max_{k \in \mathcal{C}_i}\left\{\frac{no_k}{g_{ik}}\right\} - pt_i\right)^2$$

…….VI

Which is maximized when the transmitting radio has exactly the power needed to reach the child radio with the greatest noise and least gain factor? ***"C_i"*** is the set of child radios that receive from radio ***"i"*** in the multicast tree.

B. Direction Control:

Direction control purpose is to maximize the receiving radio's SINR by controlling the directional angle of the antenna beam ***"$\emptyset_i$" locally*** at every antenna. One form that the utility can take is in following equation **"VII".**

$$u_i^{\mathrm{DC}}(\mathbf{a}) = pr_i - no_i$$

……………….VII

By rotating the directional antenna, the radio can increase the gain from the parent radio, while attenuating interfering signals.

C. Routing Control:

The purpose of routing control is to minimize each radio's battery utilization by manipulating the routing tree ***(T)*** used by the network. The utility can be expressed as equation ***"VII".***

$$u_i^{\mathrm{RC}}(\mathbf{a}) = \frac{1}{\mu_i}$$

…………………….VII

By manipulating the children radios that it has to transmit to, radios can reduce their transmission power and battery utilization.

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