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AIS-Based Son Approach for Ultra-Dense Small Cell Network

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Abstract: In order to meet the demand in wireless traffic, operators are underlying macro-cellular network with low power base station in a denser manner. This network is known as ultra-dense small cell networks. But this network faces problems like backhauling, capacity provision and dynamic in spatio-temporal fluctuating traffic load. To overcome these problem we proposed an artificial immune system based self-organizing network. This AIS-SON system activate or deactivate small cell in response to the local traffic network. It also enhance energy efficiency and improve cell-edge throughput.

I. Introduction

On wireless network, there occurs many problems due to the traffic growth in the mobile data. In future 5G network, they are supposed to have high data rates and low latency. These 5G networks supports Self Organizing Network (SON), which helps in the management of mobile networks simpler and faster. Whereas these requirements can only be fulfilled by doing some dramatic changes in the current 4G wireless network. By using small cell switching strategy the energy of macro-cellular networks can be maintained very efficiently.

A. 3G Networks

Third Generation wireless network technologies are said to be 3G networks. It deals with the interoperability between the service providers. 3G has high bandwidth broadcast and high power consumption. The highest download speed of 3G is 14Mbps and the upload speed is upto 5.8 Mbps.

B. 4G Networks

4G networks are the extension of 3G network technology which has more bandwidth than the 3G technologies. The maximum download speed for moving users in 4G is upto 100Mbps and for stationary users it is about 1Gbps. 4G is an enactment of switching of packets in voice and video calls. 4G wireless technologies uses LTE, GSH/EDGE and UMTS/HSPA. LTE was the first technology which makes use of Self-organizing Network.

C. 5G Networks

5G is not an improved version of 4G network technology. It consists of high carrier frequencies using very large bandwidths, extreme base stations, numerous antennas and device densities. It provides very high data rates and also provide decreased latencies. The main benefits of 5G network are lower energy consumption and it is capable of supporting several low-rate connection.

D. Self-Organizing Networks (SON)

SON is an automation technology. This technology is designed to plan, configure, manage, optimize and heal the mobile radio access networks faster and simpler. This process facilitates a constant observing of service and network performance. It is capable of analysing of data and providing the feedback that can be very much useful for decision making. SON operations are mainly based on three areas. They are said to be self-configuration, self-optimization and self-healing. SON also analyses data collected from variety of the network which can be used for making better decisions. Son are mainly aimed to support mobile broadband and to manage the network complexity in keen way. Long Term Evolution (LTE) was the first technology which makes use of SON features.

II. Immune System

Immune system are responsible for protecting our body from pathogen that affects and causes diseases to our body. During proper function, the immune system detects the external threats and attacks it. These external threads may be of bacteria, viruses and parasites.

The primary function of the immune system is to protect human bodies from pathogens. The immune system of the mammalians are the most fascinating organ which protect from the pathogens. It is responsible for the clearance of dead particles in the body. It remains idle until any pathogens affect our body. When any bacteria or viruses enter into our body, the innate immune system are activated against the bacteria or viruses but the innate immune system is not specific for the particular pathogens attack. If the pathogens often evade our body. The innate immune system responses and then it activates the functionality of adaptive immune system which is responsible for producing the specific antigen against that anti-body. When once the pathogen is destroyed, it is stored in the immune memory. If the same bacteria invade our body, again the immune system fight against that pathogen efficiently.

There are two types of lymphocytes in our immune system. They are B-cells and T-cells. B-cells are responsible for making the antibodies which helps to attack the bacteria and T-cells are responsible for destroying the infected or cancerous cells. T-cells consists of Tc-cells (Cytotoxic T-cells) and Th-cells (Helper cells). T-cells are capable of detecting the infected cells and destroy them. Whereas Th-cells helps to activate B-cells for the secretion of antibodies and macrophages which destroys the ingested microbes and they also help to activate the Tc-cells to kill the infected cells.

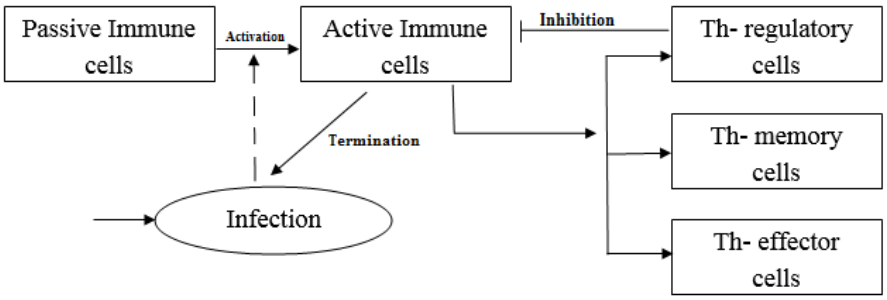

Fig 1: Mammalian Immune System

III. Artificial Immune System

AIS are adaptive systems which are inspired by the theoretical model of immune system and pragmatic immune functions, models and their principles that are used to apply for complex problem domains. The main aim for inspiring the human immune system is that they are adaptive, robust, decentralized and error tolerant in nature.

There are some main properties of immune system of tremendous interest for the computer engineer. Such properties are uniqueness, recognition of foreigners, distributed detected, reinforcement learning and memory.

IV. System Model

In this system model, the wireless cellular network are described which contains number of base stations and they are modeled on a large scale. Here we defined the quality and the speed of services based on realistic mobile data traffic model.

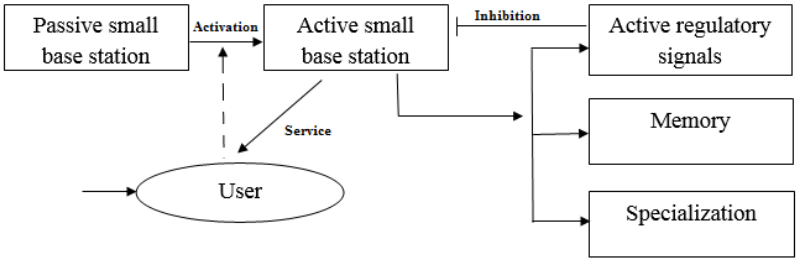

Fig 2: AIS-based SON approach for ultra-dense small cell network

A. Comparison Between Immune System and Wireless Cellular Network

In this phase we had attempt to relate mammalians immune system with the ultra-dense cellular network. There are two main reason for choosing immune system. They are adaptability and extensibility. Here, we focus on a selected features of the immune system that contains the regulation process of activation and deactivation of cells, when the pathogen attacks and leave out from the body.

Infections are compared to users. Passive immune cells are compared to base stations which are in passive state. Active immune cells are compared to active base stations. Th-reg cells are compared to Regulatory signals, Th-memory cells are compared to Memory and Th-effector cells are compared to specialization services provided to specific user.

B. AIS-Based Son Approach for Ultra-Dense Small Cell Network

Initially the bacteria or viruses are relate to active mobile users. When the pathogen enters, the passive immune cells will become active immune cells and it starts to act against that pathogen. Likewise when the user enter into the network, the passive base stations are transformed to active state which provides services to the active user. At once the pathogen is destroyed, it is stored in the The memory whereas the usage capability and requirements of the users whoever entered into the network are stored in the memory. If the same pathogen invade our body, again the immune system fight against that pathogen efficiently. Similarly, in wireless cellular network when the same user enters, it can able to provide services to the user very efficiently. Once the services are provided to the user, Regulatory Signals are responsible for the de-activation of that base stations.

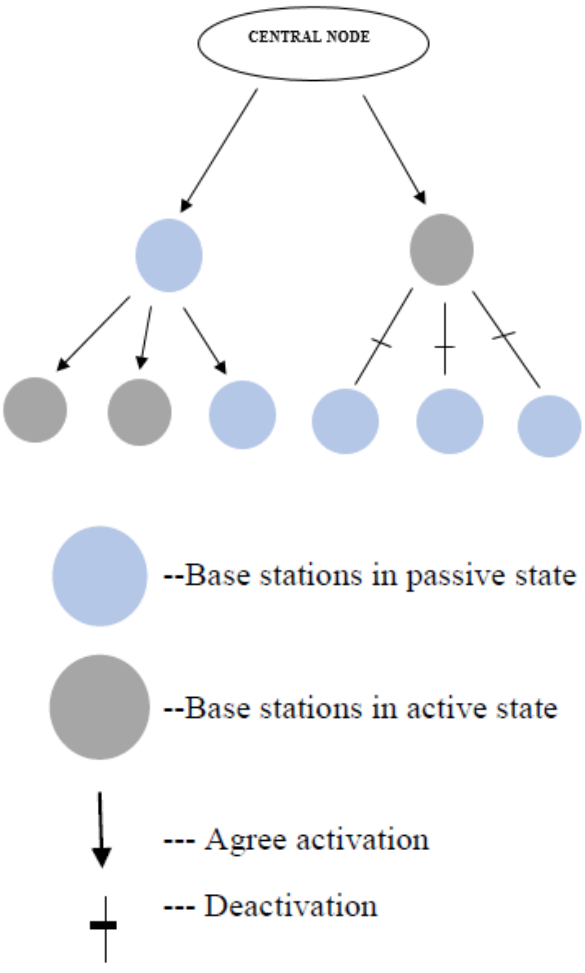

FIG 3: Decision making model of base stations

Initially, the base stations are in passive state except the centralized base station. The centralized base station will always be in active mode. If any new user enter into the network, the centralized base station recognize it and trigger the passive base station which are nearer to the user. Those base station entered into active state and start to provide services to the user. The quality of the services provided to the user are based on the number of base station which are in active state. Those base station are in active state until the user remains

in the network. When the user completes his process or leaves out from network, the base station go back to the passive state (i.e) deactivated. By switching on and off strategy the energy consumption can be lowered and the data rates can be maintained efficiently.

If once the user utilize the network the requirement of the user is stored in the memory. This can be used for further extensibility of the network. Specialization means providing special services to the VIP clients or group of users.

V. Conclusion and Future Work

By switching on and off strategy of base stations, energy can be maintained efficiently and also the traffic load can be decreased. It is also useful to improve the cell-edge throughput. It is capable of extensible and adaptable to the environment. We mainly focused on regulation features whereas Active learning and specialization of responses to specific user demands or groups had to be improved in future work.

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