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ANALYSIS OF THE CURRENT STATE OF TELECOMMUNICATION NETWORK TOPOLOGIES

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Rapid growth in telecommunication systems, such as mobile communication, satellite communication, wireless networks like Wi-Fi and Wi-MAX, has created a significant challenge: virtually the entire frequency spectrum is already allocated, while the demand for data transmission continues to rise. Additionally, modern wireless devices interfere with each other, causing disruptions and competing for bandwidth. Unlike static traditional networks, cognitive telecommunications networks have dynamic topologies that can adapt based on spectrum availability, network congestion, user requirements, and environmental conditions. This adaptability helps optimize network performance and resource allocation [1].

Analyzing the topology of cognitive telecommunications networks involves understanding their configurational, operational, and technological aspects. Among the most promising topologies are:

1. Mesh topologies, which are particularly common in cognitive networks as they provide resilience, redundancy, and a high degree of connectivity between nodes, allowing for efficient data routing and rerouting based on changing network conditions. The network can compensate for the failure of one node through alternative connection paths via other nodes. Reducing the load on central nodes is achieved by allowing each node to cooperate directly with others, evenly distributing the workload. Greater flexibility and scalability,

consequently allowing for easy addition of new nodes to the network, are vital for supporting service continuity in dynamic spectral environments [2].

2. Cognitive radio ad hoc networks (CRAHN). In wireless networks based on cognitive radio (CRAHN), a distributed multi-hop architecture, dynamic network topology, and the variability of spectrum availability in time and space are some key distinguishing factors. Recent technological advancements have led to the development of CRAHN, consisting of devices that self-organize and can be deployed without infrastructure support. These devices typically have small form factors and built-in capabilities for storage, processing, and communication. Although ad hoc networks can support various wireless standards, the current state-of-the-art mostly limits their operation to the 900 MHz and 2.4 GHz ranges designated for industrial, scientific, and medical (ISM) purposes. As the proliferation of wireless devices grows, these bands are becoming increasingly saturated. The main challenge in CRAHNs is integrating these functions into protocol stack layers so that cognitive radio users can reliably communicate in a distributed mode in a multi-channel/multi-spectrum environment without any infrastructure support [3].

3. Heterogeneous networks (HETEROGENEOUS NETWORK). Cognitive networks often operate in heterogeneous environments, integrating different types of networks (such as cellular, Wi-Fi, satellite) to provide seamless connectivity. It is projected that heterogeneous wireless connections of cognitive and primary networks will become a component of future wireless networks. This coexistence between systems is likely to be used for interference avoidance and resource sharing [4].

The current state of topology in cognitive telecommunications networks is dynamic, integrative, and increasingly decentralized. These networks employ genetic algorithms, artificial intelligence, machine learning, and advanced networking technologies to adapt to changing environments, ensuring efficient operation. With technological advancements, we can overcome existing limitations and enhance the efficiency of radio frequency resource utilization, leading to even greater increases in network productivity and flexibility.

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