SOFTWARE-DEFINED ROUTING PROTOCOL FOR MOBILE COGNITIVE RADIO NETWORKS: A CROSS-LAYER PERSPECTIVE

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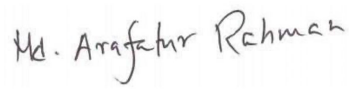

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ABSTRAK

Permintaan yang semakin meningkat untuk aplikasi tanpa wayar, serta penggunaan spektrum yang tidak cekap, memerlukan kepada komunikasi tanpa wayar baru yang memfokuskan kepada akses spektrum dinamik berbanding spektrum tetap menggunakan teknologi radio kognitif. Pengguna tidak berlesen, yang dikenali sebagai pengguna sekunder atau pengguna kognitif, menggunakan teknologi radio kognitif untuk mengembangkan komunikasi oportunis melalui jalur spektrum berlesen dan meningkatkan prestasi pengurusan spektrum. Protokol penghalaan dalam Rangkaian Radio Kognitif (RRK) berfungsi sebagai tulang belakang komunikasi, yang membenarkan paket data dihantar di antara nod pengguna radio kognitif melalui pelbagai jalur dan saluran. Walau bagaimanapun, masalah penghalaan di dalam RRK adalah untuk menyediakan laluan yang teguh dan stabil di atas saluran yang mempunyai ketersediaan yang tinggi. Protokol yang dibangunkan sebelum ini telah terlepas peluang untuk mengeklsploitasikan teknik anggaran variasi masa saluran, yang memilih laluan terbaik dengan menggunakan enjin pembuat keputusan penghalaan rentas lapisan untuk mengesan kesan buruk mobiliti pengguna kognitif dan aktiviti pengguna utama. Kajian ini bertujuan untuk membina laluan penghalaan yang teguh serta mengehadkan gangguan aktiviti pengguna utama, penundaan penghalaan, dan memaksimumkan daya pemprosesan. Kerangka penghalaan baru telah dicipta di dalam kajian ini untuk meneroka fungsi tambahan penalaan baru dan ciri-ciri dari maklum balas lapisan bawah (lapisan fizikal dan lapisan pautan data) untuk menambah baik prestasi penalaan. Kemudian, ketersediaan saluran berorientasikan pautan dan kualiti saluran telah dibangunkan berdasarkan kepada dua metrik yang boleh dipercayai, iaitu kebarangkalian ketersediaan saluran dan kualiti saluran, untuk menganggarkan dan memilih saluran yang memaksimumkan pemprosesan pautan. Sebagai tambahan, kajian ini mencadangkan protokol penghalaan berorientasikan rentas lapisan yang baru, dengan nama Protokol Penghalaan yang Ditetapkan Perisian. Ia adalah berasaskan kaedah rentas lapisan yang menggabungkan penderiaan lapisan bawah (lapisan fizikal dan lapisan pautan data) yang diperolehi daripada model anggaran saluran. Ia mengemas kini jadual penghalaan secara berkala untuk membuat keputusan laluan yang optimum. Output simulasi daripada kaedah anggaran saluran menunjukkan bahawa ia telah menghasilkan strategi pemilihan saluran yang berkuasa untuk memaksimumkan kadar purata daya pemprosesan pautan dan mencapai anggaran saluran di bawah kesan varian masa. Simulasi eksperimen yang meluas telah dilakukan untuk menilai protokol yang dicadangkan dan perbandingan dengan protokol penanda aras sedia ada, iaitu, protokol penghalaan ad hoc kognitif dwi kepelbagaian dan vektor jarak atas permintaan ad hoc kognitif. Protokol yang dicadangkan mengatasi penanda aras, menghasilkan nisbah penghantaran paket meningkat sekitar (11.89%-12.80%), mengurangkan kelewatan sekitar (2.74%-4.05%), mengurangkan overhed sekitar (14.31%-18.36%), dan meningkatkan daya pengeluaran sekitar (23.94%-28.35%). Walau bagaimanapun, protokol penghalaan yang ditetapkan perisian tidak mempunyai keupayaan untuk menentukan saluran terbiar yang lebih baik pada mobiliti nod berkelajuan tinggi. Kesimpulannya, protokol penghalaan rentas lapisan berjaya mencapai prestasi penghalaan yang tinggi dalam mencari laluan yang teguh, memilih kestabilan saluran yang tinggi, dan mengurangkan kebarangkalian gangguan dengan pengguna utama untuk komunikasi berterusan.

ABSTRACT

The growing demand for wireless applications, combined with inefficient spectrum use, necessitates developing a new wireless communication paradigm that focuses on dynamic spectrum access rather than the fixed spectrum using cognitive radio technology. The unlicensed user, known as secondary user or cognitive user, uses cognitive radio technology to grow opportunistic communication over licensed spectrum bands and improve spectrum management performance. The routing protocol in Cognitive Radio Networks (CRNs) serves as a communication backbone, allowing data packets to transfer between cognitive user nodes through multiple paths and channels. However, the problem of routing in CRNs is to create a robust-stable route over higher channel availability. The previously developed protocols missed opportunities to exploit the time-variant channel estimation technique, which selects the best route using the cross-layer routing decision engine to track the adverse impact of cognitive user mobility and primary user activity. This study aims to construct a robust routing path while limiting interference with primary user activity, delaying routing, and maximizing routing throughput. Here, a new routing framework is created in this study to explore new extended routing functions and features from the lower layers (Physical layer and Data Link layer) feedback to improve routing performance. Then, the link-oriented channel availability and channel quality have been developed based on two reliable metrics, which are channel availability probability and channel quality, to estimate and select a channel that maximizes link-throughput. Furthermore, this study proposes a novel cross-layer routing protocol, namely, the Software-Defined Routing Protocol. It is a cross-layer method to combine the lower layer (Physical layer and Data Link layer) sensing derived from the channel estimation model. It periodically updates the routing table for optimal route decision making. The output simulation of the channel estimation method has shown that it has produced a powerful channel selection strategy to maximize the average rate of link throughput and achieved a channel estimate under the time-variant effect. Extensive simulation experiments have been performed to evaluate the proposed protocol in compression with the existing benchmark protocols, namely, dual diversity cognitive Ad-hoc routing protocol and cognitive Ad-hoc on-demand distance vector. The proposed protocol outperforms the benchmarks, resulting in increasing the packet delivery ratio by around (11.89%-12.80%), reducing delay by around (2.74%-4.05%), reducing overhead by around (14.31%-18.36%), and increasing throughput by around (23.94%-28.35%). The software-defined routing protocol, however, lacks the ability to determine the better idle channel at high-speed node mobility. In conclusion, the cross-layer routing protocol successfully achieves high routing performance in finding a robust route, selecting high channel stability, and reducing the probability of interference with primary users for continued communication.

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