Abstract

Cooperative relaying has gained significant interest due to its ability to increase the network coverage and reliability of wireless communication systems. In conventional cooperative networks, the source node communicates with the destination node via relay node(s) by following a pre-fixed schedule of transmitting or receiving data packets, irrespective of channel qualities. Due to this pre-fixed scheduling of data transmission/reception, at any given time instant, we might not be using the best available link (source-relay (S-R) or relay-destination (R-D)), which might lead to performance degradation. Because of this constraint, buffer-aided relaying has gained significant traction as it helps us to schedule the data packets over S-R or R-D links based on channel quality and buffer status. It helps with achieving a higher diversity order and throughput. Motivated by this, in this thesis, we present a detailed analysis of the buffer-aided relaying for different setups, like differential modulation (DM), double differential modulation (DDM), and free space optical (FSO) networks.

In the beginning, we propose a buffer-aided cooperative relaying for multi-relay scenario using the DM technique. A decode-and-forward (DF) relaying setup is considered, where each relay node consists of a finite-size buffer. All the nodes apply DM for the transmission or the reception of the data; hence channel state information (CSI) is not required at any of the receiving nodes for decoding the transmitted symbols. A priority-based max-link approach is adopted to select the best available link, and then the state transition matrix ($\mathbf{A}$) of the system is obtained by using Markov chain (MC) approach. We then obtain analytical expressions of average bit error rate (ABER) and outage probability (OP). Numerical results demonstrate that the considered setup outperforms the non-buffer-aided (NBA) differential DF and amplify-and-forward (AF) systems. Also, in comparison to coherent counterparts, the proposed configuration suffers negligible signal-to-noise-ratio (SNR) penalty.

DM approach assumes that the channel remains static for at least two consecutive intervals.

However, most practical wireless systems consist of mobile nodes, and due to the relative movement of these nodes, the problem of carrier frequency offset (CFO) arises. Due to this, the channel state does not remain constant over two consecutive time intervals, and hence DM suffers huge performance loss; for such systems, DDM comes in handy as it avoids the need for CSI and CFO. Therefore, we analyzed a multi-relay buffer-aided system using DD encoding and decoding. Similar to DM-based scheme, the link selection is performed using the priority-based max link approach, and then the steady-state probability (SSP) of the system is developed using the MC approach, an then the expressions of the OP and ABER are derived. The obtained numerical results are compared to those of the coherent buffer-aided system, and it is observed that the proposed scheme narrows down the existing SNR gap of 6 dB between NBA coherent and DDM systems.

In the next work, we focus on FSO networks, which despite having several advantages, find limited usage because of the effects of atmospheric turbulence (AT). Also, in two-hop FSO cooperative networks, both the hops suffer from AT independently, and even if one of the two hops observes high AT, the end-to-end communication gets disrupted. Therefore, we introduce buffer-aided relaying for the FSO systems to overcome this limitation. The system is assumed to suffer from path loss and AT-induced fading, and the performance is evaluated for weak and high AT regimes. Similar to DM and DDM-based analysis of buffer-aided systems, the MC approach is used to develop the matrix $\mathbf{A}$, and the expressions of OP and ABER are obtained with the help of that. The average packet delay (APD) of the system is also evaluated with the help of OP. Numerical results demonstrate that the proposed setup outperforms its NBA counterparts.

FSO communication networks offer limited wavelength and large field-of-view (FoV). Hence, FSO networks are susceptible to jamming; to overcome this, we propose a buffer-aided relaying setup for an FSO system suffering from jamming attacks. We employ a buffer at the relay node, and data transmission or reception occurs through the designated max-link. The system's performance is evaluated using OP and ABER. Numerical results demonstrate that the considered buffer-aided setup outperforms the NBA cooperative FSO systems affected by jamming.