

Template – Title of the Article

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Abstract — Recent development in optical networking employing wavelength division multiplexing (WDM) fulfills the high bandwidth demand applications. Failure of such networks, leads to enormous data and revenue loss. Protection is one of the key techniques, which is used in designing survivable WDM networks. In this paper we compare dedicated and shared protection strategies employed in WDM mesh networks to protect optical networks failure, particularly fiber failure. Dijkstra's shortest path algorithm is considered for carrying out simulations. The paper compares the performance of protection schemes, such as, dedicated path protection (DPP), shared path protection (SPP) and shared link protection (SLP) schemes. Capacity utilization, switching time and blocking probability are the parameters considered to measure the performance of the protection schemes.

Keywords — keywords in alphabetical order, keywords in alphabetical order, max 5 items

1. Introduction

One of the OFDM system disadvantages is its sensitivity to frequency offset and phase noise, which lead to losing the orthogonality between the sub-carriers and thereby degrade the system performance. In this paper a joint scheme for frequency offset and pilot-based channel estimation is introduced in which the frequency offset is first estimated using an autocorrelation method, and then is fined further by applying an iterative phase correction by means of pilot-based Wiener filtering method. In order to verify the capability of the estimation algorithm, the scheme has been implemented and tested using a real measurement system in a multipath indoor environment. The results show the algorithm capability of compensating for the frequency offset with different transmission and channel conditions.

The chaotic signals have some properties such as broadband, orthogonality and complexity aspects, which motivate researches in the area of communication and signal processing to investigate if chaos based communication offers advantages over classical communication systems in the last years [1], [2].

The power of the second component, initially negligible, increases with time due to rising number of fiber cracks and other defects serving as couplers for external radiation. Thermal radiation may interfere with measurements of fiber attenuation during fire test, but is rather unlikely to prevent data transmission with typical GbE and 10GbE transceivers during fire. Remedies to this problem, which can be combined, include use of single mode fibers instead of multimode fibers, filters for blocking thermal radiation with bandpass,

and proper selection of emitter power, wavelength and photodetector [3], [4].

The rest of the paper is structured as follows. Section 6 reviews different conventional schemes, while Section 3 portrays the model of a CRN. Section 5 describes the approach developed by the authors. Section 7 discusses the results achieved, while Section 8 presents the conclusions.

2. Related Works

Many researchers have used various feeding techniques in recent years to develop MPAs of various shapes and used them in various applications. Sharma proposed, in [2], a small, high gain multiband antenna with a glass-shaped radiating patch and a rectangular ground plane. A unique rectangular-shaped, DGS-based effective multi-band frequency reconfigurable antenna was proposed by Sathikbasha *et al.* in [5]. A portable multi-band MPA with resonances at 23.9, 35.5, and 70.9 GHz, suitable for 5G mobile applications, was demonstrated by Punith *et al.* [6].

A graphene-packed dual band mmWave antenna for 28.1 GHz and 37.4 GHz with a DC bias was proposed by Luo *et al.* [7]. A tiny, portable ultra-wideband microstrip antenna for 5G applications was developed by Araujo *et al.* [8], while a small and dual-polarized triple-band antenna for sub-6 GHz 5G applications was created by Alieldin *et al.* [9].

To examine formulation of conventions, Kandori *et al* [3] deal with 2×2 coordination games which are repeatedly played by randomly matched pairs of players in a population. Fagiolo [9] focus on locality of interaction between players. Redondo [10] consider location models where the population is divided into several groups and players choose which group to join. In the recent years, similar attempts in network environments have been attracting attention . In such models, players are allowed to choose partners for playing the game as well as actions in the game. It should be noted that the network game models are related with studies on formation of networks [2] (Tab. 1). Some of the issues faced by the conventional approaches include the following:

- The use of machine learning in the resource allocation mechanism [4].
- The significant difficulties continue to be faced [5].
- Problems related to the computational time required [6].
- It faced issues related to signal-to-noise-ratio complexity and interferences [7].

Tab. 1. Simulation parameters for the first scenario.

Parameter	Value
Number of nodes	10, 12, 14, 16, 18, 20
Duration of simulation	260 s
Routing algorithm	RPL
Packet size	90 bytes
Packet transmission period	60 s

3. System Description

To simplify the analysis, we consider a downlink NOMA system with a base station and two users to derive the SINRs and sum rates. Additionally, we assume that the base station and users are equipped with a single antenna and the system bandwidth B is one. The information-bearing signals, x_N for the near user UE_1 and x_F for the far user UE_2 , are superimposed at the transmitter as follows:

$$x = \sqrt{P_N}x_N + \sqrt{P_F}x_F, \quad (1)$$

where P_N and P_F denote the transmission power allocation coefficients for the near and far users, respectively. P_{tot} represents the total transmit power which equals the sum of P_N and P_F .

The operation of wavelength division multiplexing (WDM) networks involves not only the establishment of lightpaths, defining the sequence of optical fibres and the wavelength in each fibre for traffic flow, but also a fault management scheme in order to avoid the huge loss of data that can result from a single link failure. Dedicated path protection, which establishes two end-to-end disjoint routes between the source–destination node pair, is an effective scheme to preserve customers' connections. This paper reviews a bicriteria model for dedicated path protection, that obtains a topological path pair of node-disjoint routes for each lightpath request in a WDM network, developed by the authors. An extensive performance analysis of the bicriteria model is then presented, comparing the performance metrics obtained with the mono-criterion models using the same objective functions, in four different reference networks commonly used in literature.

$$L_{ln}(r) = \overline{L_{ln}(r_0)} + 10 n \log \frac{r}{r_0} + X_\sigma + \frac{L_r(f, r_0 = 1 \text{ km})}{1 \text{ km}} r + \frac{L_{at}(f, r_0 = 1 \text{ km})}{1 \text{ km}} r + L_{fol}(f, r) \text{ [dB]} \quad (2)$$

where h_i denotes the channel coefficient between the BS and user UE_i and n_i represents the additive white Gaussian noise (AWGN) with zero mean and σ_i^2 variance for UE_i . Let's assume the users are ordered using the CSI-based method at the receiver and the near user has a strong signal than of the far user, i.e., $\frac{|h_N|^2}{\sigma_N^2} \geq \frac{|h_F|^2}{\sigma_F^2}$. Therefore, the SINR expression of the near user and far user are given by:

$$SINR_N = \frac{P_N |h_N|^2}{\sigma_N^2}, \quad (3)$$

$$SINR_F = \frac{P_F |h_F|^2}{P_N |h_N|^2 + \sigma_F^2}. \quad (4)$$

Accordingly, the data rate for the near user and far user can be written as follows:

$$R_N = \log_2 \left(1 + \frac{P_N |h_N|^2}{\sigma_N^2} \right), \quad (5)$$

$$R_F = \log_2 \left(1 + \frac{P_F |h_F|^2}{P_N |h_N|^2 + \sigma_F^2} \right). \quad (6)$$

The radar cross section σ of an RIS element is modeled in this paper by a metallic sphere with a radius r as an idealized approach [1]–[2]:

$$\frac{\sigma}{\pi r^2} = \frac{1}{k r} \sum_{n=1}^{\infty} (-1)^n (2n+1) \cdot \left[\left(\frac{k r J_n(k r) - n J_n(k r)}{k r H_{n-1}(k r) - n H_n^1(k r)} \right) - \left(\frac{J_n(k r)}{H_n^1(k r)} \right) \right], \quad (7)$$

where: r is the radius of the sphere, $k = \frac{2\pi}{\lambda}$, λ is the wavelength, J_n is the spherical Bessel function of the first kind of order n , H_n^1 is the Hankel function of order n , described by $H_n^1(k r) = J_n(k r) + j Y_n(k r)$, and Y_n is spherical Bessel function of the second kind of order n .

3.1. Uplink Network

The high capacity of a single fibre in optical networks, however, has the drawback that a failure on a link can potentially lead to a huge amount of data loss (and revenue), and service disruption for a large number of customers.

In this scenario, network survivability becomes a critical concern for service providers (both in the network design phase and in the real-time network operation) and fast and efficient fault-recovery mechanisms are then needed to ensure a high degree of network resilience and minimize losses.

Survivability of a network refers to the network capability to provide continuous service in the presence of failures.

4. Simulation

At an external PC, the baseband IQ OFDM signal based on IEEE802.11g standard is generated using Matlab code. The OFDM symbols are arranged in a few frames to be transmitted. At the beginning of each frame, some training symbols (preambles) are inserted, which are used for packet detection and frequency and time offset estimation. The time domain baseband signal is sent via LAN connection to the transmitter, in order to be up-converted and transmitted through the wireless channel.

The commands for controlling the power and the carrier frequency are sent to the transmitter before sending the baseband signal.

On the other hand, the IQ data from the captured signal at the receiver is sent back to the external PC via the LAN for processing. Packet detection, frequency and time offset

estimation and pilot based channel estimation are all accomplished using Matlab.

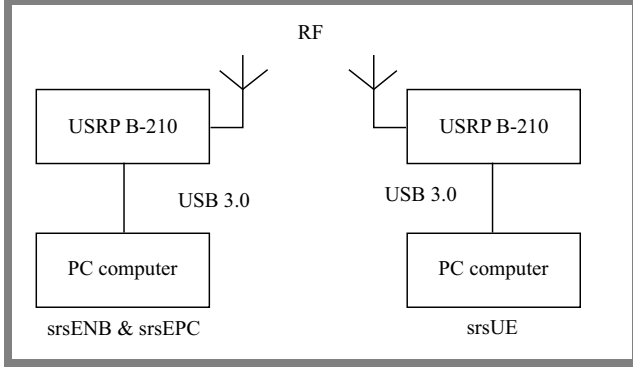


Fig. 1. ULA geometry of M antennas [10].

Our goal is to estimate the direction of arrival of L wideband sources using an ULA of M antennas supposing that all sources are uncorrelated and occur in the bandwidth between the smallest ω_s and the largest ω_L source frequency. Thus, the received data at the m -th antenna are given as follows:

$$x_m(t) = \sum_{l=1}^L s_l(t - v_m \sin \theta_l) + n_m(t), \quad (8)$$

where $s_l(t)$ is the l -th source, $n_m(t)$ is an additive white Gaussian noise (AWGN) at the m -th component, $v_m = (m-1)d/c$, where d is the distance between the components of ULA, and c is the velocity of light. θ_l is the angle to be computed. The received data is split into K narrowband signals. Thus, the discrete Fourier transform (DFT) of the received signals at m -th element is:

$$x_m(\omega) = \sum_{l=1}^L s_l(\omega) e^{-j\omega v_m \sin \theta_l} + n_m(\omega). \quad (9)$$

The DFT output signals can then be represented in vector form [10]:

$$x(\omega_i) = A(\omega_i, \theta) s(\omega_i) + n(\omega_i), \quad i = 1, 2, \dots, K, \quad (10)$$

The correlation matrix is calculated in the following manner [10]:

$$\begin{aligned} R_{xx}(\omega_i) &= E[x(\omega_i) x^H(\omega_i)] \\ &= A(\omega_i, \theta) R_{ss}(\omega_i) A^H(\omega_i, \theta) + \sigma_n^2 I, \end{aligned} \quad (11)$$

where $E[\cdot]$ is the expectation value operator, H is the Hermitian operator, $R_{ss}(\omega_i) = E[s(\omega_i) s^H(\omega_i)]$, σ_n^2 is the noise power, and I is the $M \times M$ unit matrix. Supposing that $R_{ss}(\omega_i)$ has a complete rank, the signal subspace $F_s(\omega_i)$ and the noise subspace $F_n(\omega_i)$ matrices at the frequency ω_i can be generated using the eigen-values decomposition (EVD) or the singular value decomposition (SVD) of the correlation array as:

$$F_s(\omega_i) = [e_1(\omega_i), e_2(\omega_i), \dots, e_L(\omega_i)], \quad (12)$$

$$F_n(\omega_i) = [e_{L+1}(\omega_i), e_{L+2}(\omega_i), \dots, e_M(\omega_i)], \quad (13)$$

where $e_1(\omega_i), \dots, e_M(\omega_i)$ are the perpendicular eigenvectors of $R_{xx}(\omega_i)$, ranked in decreasing order by their corresponding eigen-values as follows:

$$\lambda_1(\omega_i) \geq \dots \geq \lambda_L(\omega_i) \geq \lambda_{L+1}(\omega_i), \dots, \lambda_M(\omega_i) = \sigma_n^2. \quad (14)$$

5. Proposed Algorithm

Telecommunication networks are intrinsically multi-layered, a single failure at a lower level usually corresponds to a multi-failure scenario at an upper layer. In this context, the concept of shared risk link group (SRLG) allows an upper layer to select, for a given active path (AP), a backup path (BP), which avoids every SRLG that may involve the selected AP, in the event of a failure. That is a SRLG diverse path set maybe defined as a set of paths, between an origin and a destination, such that no pair of paths can be simultaneously affected by any given failure (or risk) in a single failure scenario.

Firstly we present the formulation of the SRLG diverse path pair calculation problem in a directed network. An algorithm for enumerating SRLG diverse paths, by non decreasing cost of their total (additive) cost will be presented, which is based on an algorithm proposed for generating minimal cost node disjoint path pairs. The SRLG diverse path pairs may be node or arc disjoint, with or without length constraints. Computational results will be presented to show the efficiency of the proposed algorithm for obtaining node or arc disjoint SRLG diverse path pairs in undirected networks.

6. Literature Review

Algorithm 1 shows our concept details.

7. Proposed model

Rostami *et al.* [2] proposed an algorithm, named CoSE (conflicting SRLG exclusion), which is an extension to SRLG-disjoint routing of a link-disjoint routing algorithm called CoLE (conflicting link exclusion), proposed in [3], which can quickly find an optimal solution path pair. The CoSE algorithm iteratively separates the network SRLGs into two sets and then computes the working and backup paths.

Furthermore, in [5] the authors also propose a way of calculating two maximally SRLG diverse paths in a network where no two completely-disjoint paths exist. The CoSE algorithm can be used for solving the min-min problem, by selecting the appropriate solution from the set of generated solutions (although the optimality of the solution is not guaranteed).

8. Conclusion

Spectrum is a valuable and limited resource. Therefore for an operator, cost effective improvement in capacity is always an important goal. Capacity gain, both for voice and new data services, is crucial for an operator's competitiveness. It

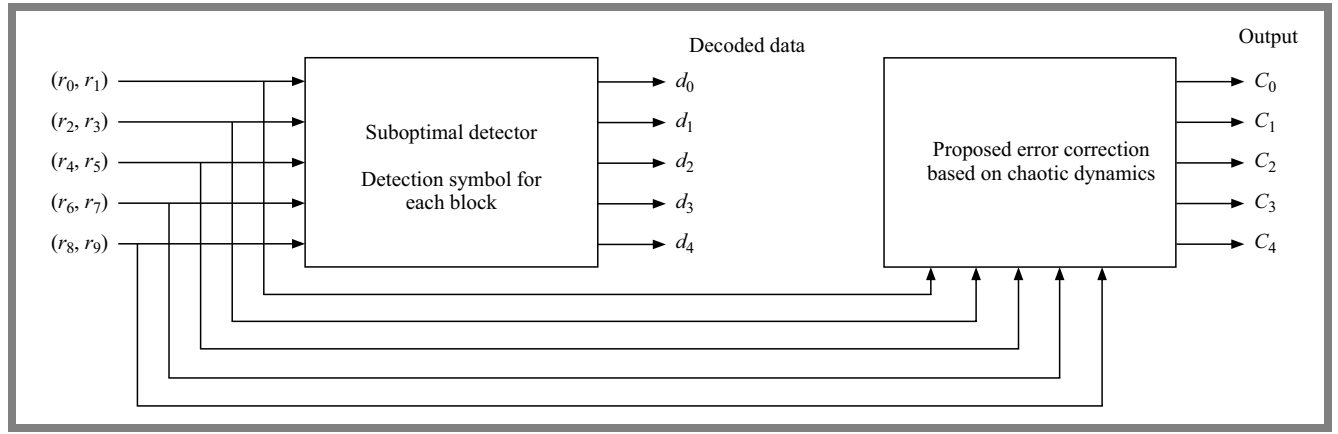


Fig. 2. Block diagram of proposed system.

Tab. 2. Analysis summary for SNR = 5 dB.

Channel type	Metrics	Kernel-based spectrum sensing	DNN	Cooperative reinforcement learning	Deep learning	Proposed Adam GD algorithm
Rayleigh	Probability of detection	0.4704	0.3889	0.3303	0.5300	0.7099
	Probability of false alarm	0.7578	0.5820	0.5173	0.4423	0.3892
Rician	Probability of detection	0.4563	0.3772	0.3204	0.5141	0.6886
	Probability of false alarm	0.7888	0.5077	0.5759	0.4578	0.4029
Gaussian	Probability of detection	0.5967	0.5105	0.5319	0.6693	0.6909
	Probability of false alarm	0.7781	0.4570	0.5723	0.4656	0.4097

is possible to achieve significant capacity improvements in existing networks without deploying additional carrier and base stations or drafting new standards. By following proper *radio frequency* (RF) network planning and optimization techniques; CDMA operators would see immediate benefits on their network capacity. CDMA is a digital cellular technology that uses spread-spectrum techniques [2]. It does not assign a specific frequency to each user. Rather, every channel uses the full available spectrum. Individual conversations are encoded with a pseudo-random digital sequence.

The utilization of front-end characteristics may extend far beyond link-level optimization, providing new degrees of design freedom. The phenomenon of non-linearity should be considered while analyzing 5G and future wireless solutions on a system level. In this context, especially in a complex solution composed of multiple transmit antennas, multiple base stations that interfere with each other, and utilizing multistage processing, i.e. some proprietary traffic steering or scheduling algorithms, control and optimization are complicated. In such a case, no analytical models are available or they are highly simplified.

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Tab. 3. Comparison of the proposed scheme with other rule-mining methods and metrics.

D1 dataset			
Metrics	CIAO-TME	Proposed with existing ARM	Proposed with no CIAO-TME
Fitness	0.0429	0.8012	0.1987
HR	0.6859	0.5573	0.5573
IPR	244	108	108
DOM	0.7486	1	1
D2 dataset			
Metrics	CIAO-TME	Proposed with existing ARM	Proposed with no CIAO-TME
Fitness	0.1638	0.597	1.097
HR	1	0.9324	0.7891
IPR	174	5	54
DOM	0.7589	1	1
D3 dataset			
Metrics	CIAO-TME	Proposed with existing ARM	Proposed with no CIAO-TME
Fitness	0.4263	0.9637	0.5495
HR	1	0.8624	0
IPR	458	0	411
DOM	0.4823	1	0.9951

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Algorithm 1 ROHAS-TBAC Initial Setup**Input:** System Parameters**Output:** Pkey and Mkey**Start**

```

1: Randomly choose S and  $\beta$  over  $Z$ 
2: for each attributes in U do
3:   Randomly choose L in G
4: end for
5: Compute,  $X = e(g, g)^\alpha$  and  $Y = g^\beta$ 
6: for  $i=1$  to T do
7:   Randomly select  $vt_i$  over  $Zp$ 
8:   Compute  $vt'_i = g^{vt_i}$ 
9: end for
10: if  $i \geq 5$  then
11:    $i \leftarrow i - 1$ 
12: else
13:   if  $i \leq 3$  then
14:      $i \leftarrow i + 2$ 
15:   end if
16: end if
17: while  $N \neq 0$  do
18:   if  $N$  is even then
19:      $X \leftarrow X \times X$ 
20:      $N \leftarrow \frac{N}{2}$   $\triangleright$  This is a comment
21:   else if  $N$  is odd then
22:      $y \leftarrow y \times X$ 
23:      $N \leftarrow N - 1$ 
24:   end if
25: end while
26: for  $k=1$  to  $2m-2$  do
27:   Randomly choose  $ar_k$  over  $Zp$ 
28:   Compute  $ar'_k = g^{ar_k}$ 
29: end for

```

End

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