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# Design And Analysis of A Novel Secure Cognitive Terrestrial Satellite Communication System using Joint Beamforming Approach

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**Abstract:** This paper explores the secure communication of a cognitive satellite terrestrial system with programming characterized engineering, where a portal is going about as a control focus to offer the asset designation for the remote frameworks. In particular, we propose beamforming (BF) plans to use the obstruction from the terrestrial system as a green source to improve the physical-layer security for the satellite system, gave that the two systems share the bit of millimeter-wave frequencies. Assuming that the satellite utilizes multibeam radio wire while the base station is furnished with a uniform planar cluster, we initially define an obliged joint improvement issue to limit the complete transmit control while fulfilling both the nature of-administration prerequisite of the terrestrial client and the mystery rate (SR) necessities of the satellite clients. Since the figured improvement issue is nonconvex and scientifically immovable, we at that point propose two BF plans to get the ideal arrangements with high computational productivity.

**Keywords:** Beam Forming (BF), Uniform Direct Cluster (ULA), Maximal Proportion Transmission (MRT).

## I. INTRODUCTION

Satellite communication (SATCOM) makes use of modern aerospace and communication technologies to provide seamless connectivity and high-speed broadband access for worldwide fixed and mobile users. It is particularly important in areas, where the terrestrial wireless systems are very difficult or impossible to be deployed or the traffic is seriously congested [1]–[3]. According to recent studies, the total number of European households that will use broadband satellite services is expected to reach five to ten million by 2020 [4]. Although a number of high throughput Ka-band multi-beam satellite systems have been deployed, there is still a large gap between the presently available bandwidth and the increasing data rate demands for the next generation Terabit/s satellites. The most interesting solution to solve the bandwidth issue is the exploitation of both exclusive spectrum and non-exclusive spectrum for future SATCOM systems [4]. In this regard, the concept of cognitive satellite terrestrial network (CSTN) has been proposed [4], [7]–[10]. According to the CSTN framework, the terrestrial network termed as secondary network (SN) shares the radio frequency band withthe satellite network termed as primary network (PN) through dynamic spectrum access technology, thereby enhancing the utilization of limited spectrum significantly. To implement the coexistence of these two systems, the terrestrial base station (BS) often employs interference management schemes such as transmit beamforming (BF) [11], [12], resource allocation [13] or cooperative scheduling [14] to guarantee that the interference imposed to the incumbent user is limited below a predefined threshold.

## II. LITERATURE REVIEW

The CSTN has as of late been effectively considered in the open writings. Lagunas et al. [13] proposed asset allotment plans for a cognitive range use situation in which the SATCOM utilizes the range designated to terrestrial systems without forcing destructive impedance. In view of a game theoretic structure that receives simple BF at the BS, Guidolin et al. [14] displayed an agreeable planning calculation, and demonstrated that it is conceivable to accomplish a decent otherworldly proficiency by organizing the BS booking and abusing the qualities of the mmWave frequencies. An et al. [15] determined a shut structure blackout likelihood (OP) articulation for the terrestrial client (SU), gave that the impedance temperature requirement at the satellite essential client (PU) is fulfilled. An et al. broke down the ergodic limit of a CSTN, where the BS utilized uniform direct cluster (ULA) and maximal proportion transmission (MRT). Moreover, the OP of cognitive broadband satellite frameworks and terrestrial cell organize in mmWave situation was researched. Additionally, Maleki et al. broke down the cognitive zone in broadband SATCOM frameworks by utilizing a visually impaired and interface based methodology. In light of the suspicion of great and flawed channel estimation, a power assignment system for CSTN was proposed in , where the nature of-administration (QoS) limitation of the SN and the OP prerequisite of the PN are both fulfilled. In , the straightly compelled least difference (LCMV) and the subsequent request cone programming (SOCP) based BF plans were proposed to augment the sign to-obstruction in addition to clamor proportion (SINR) of the ideal terrestrial client while limiting the impedance towards the satellite PU. It ought to be called attention to that in the previously mentioned works about CSTN, for example, [15] and , the BS was accepted to have a solitary radio wire and its transmit control was controlled so the SN can coincide with PN. Despite the fact that these works have been reached out to the instance of multi-reception apparatus BS in  and , just the situation of single PU with BS applying MRT was considered in that. Plus, the fundamental disadvantage of  is that the impact of satellite multibeam reception apparatus on the framework execution has not been considered.

## III. EXISTING SYSTEM

Albeit many trend setting innovations have just been received to improve the range proficiency, one of the principle bottlenecks in meeting this prerequisite is the way that the present range between 700 MHz and 2.6 GHz is saturated.It is anticipated that range clogs will make the sending of future mmW remote communications increasingly troublesome. The part of range somewhere in the range of 20 and 90 GHz is considered as the applicant radio band for the cutting edge terrestrial cell arrange. Notwithstanding, some portion of this band has just been allotted to satellite networks. The CSTN has as of late been effectively examined in the open written works. Lagunas et al. [13] proposed asset designation plans for a cognitive range use situation in which the SATCOM utilizes the range dispensed to terrestrial systems without forcing unsafe interference. Guidolin et al. [14] introduced a helpful booking calculation, and demonstrated that it is conceivable to accomplish a decent otherworldly productivity by organizing the BS planning and abusing the attributes of the mm Wave frequencies. An et al. [15] determined a shut structure blackout likelihood (OP) articulation for the terrestrial client (SU), gave that the obstruction temperature imperative at the satellite essential client (PU) is fulfilled. An et al.  broke down the ergodic limit of a CSTN, where the BS utilized uniform straight cluster (ULA) and maximal proportion transmission (MRT). Because of the inborn attributes of broadcasting and immense inclusion, the issues of protection and security assume a significant job in SATCOM.

## IV. PROPOSED SYSTEM

The schematic block outline of the proposed system is appeared in fig(1). The proposed system first considers the sign from different sign sources. Next we play out the worldly investigation of the all the information data signals. After that, all the individual data signals are joined into a solitary composite sign utilizing a multiplexer. All the individual data flag in the composite sign are basically multiplexed with Orthogonal Frequency Division Multiplexing (OFDM) Technique. This OFDM multiplexed composite sign of all the individual data signals are transmitted into the air through Gateway Beam forming. This Gateway Beamforming is utilized to transmit the multiplexed data signal with various Beams. These multiple beams may propagate through the free space in multiple paths. All  the beams arrived at the receiver will be buffered together To combine the received multiplexed composite signal. All the received beams are buffered together into one composite signal which is given to the receiver which demodulates it. Next the demodulated composite signal is passed to the signal demultiplexer, where the individual signals are separted and sent to the destimations  Finally the demultiplexed individual information signals are separated with inverse OFDM process and Sent to the different output channels. The quality of the received signals will be tested to verify the effectiveness of the system.

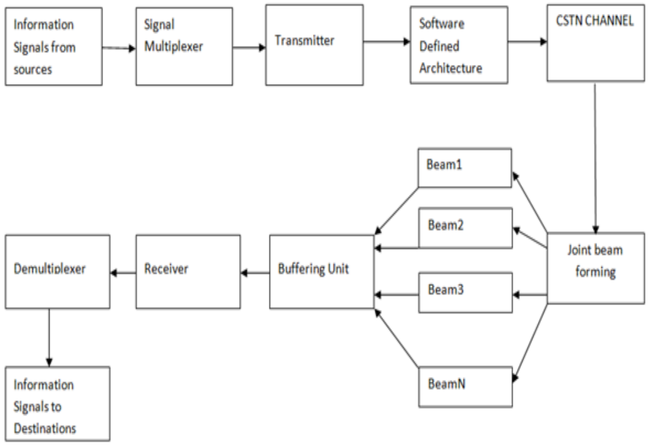
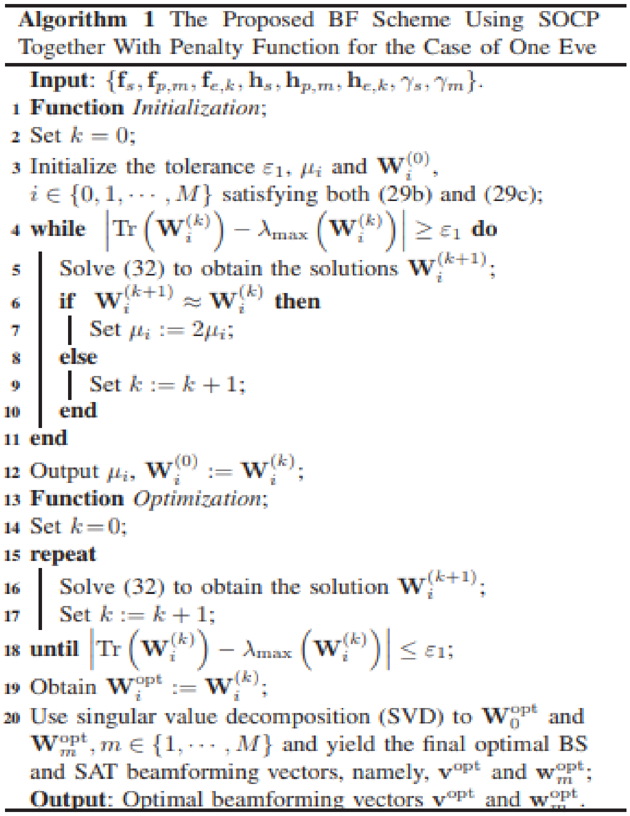


**Fig1. Schematic Block Overview of the proposed system.**

**Advantages of Proposed System:**

- Removes all  harmful Interferences.
- Quality of service is good.
- Spectral Efficiency is improved.
- Noise immunity is high.
- Can efficiently minimize Signal-to Noise & Interference Ratio.
- Better security.
- High secrecy rate.
- Effect of interferences is less.
- Highly Reliable.



**Algorithm 1** The Proposed BF Scheme Using SOCP Together With Penalty Function for the Case of One Eve

```
Input: ${\mathbf{f}_s, \mathbf{f}_{p,m}, \mathbf{f}_{e,k}, \mathbf{h}_s, \mathbf{h}_{p,m}, \mathbf{h}_{e,k}, \gamma_s, \gamma_m}$.
Function Initialization;
Set $k = 0$;
Initialize the tolerance $\varepsilon_1$, $\mu_i$ and $\mathbf{W}_i^{(0)}$,
  $i \in \{0, 1, \cdots, M\}$ satisfying both (29b) and (29c);
while $\left|\mathrm{Tr}\left(\mathbf{W}_i^{(k)}\right) - \lambda_{\max}\left(\mathbf{W}_i^{(k)}\right)\right| \geq \varepsilon_1$ do
    Solve (32) to obtain the solutions $\mathbf{W}_i^{(k+1)}$;
    if $\mathbf{W}_i^{(k+1)} \approx \mathbf{W}_i^{(k)}$ then
        Set $\mu_i := 2\mu_i$;
    else
        Set $k := k + 1$;
    end
end
Output $\mu_i$, $\mathbf{W}_i^{(0)} := \mathbf{W}_i^{(k)}$;
Function Optimization;
Set $k = 0$;
repeat
    Solve (32) to obtain the solution $\mathbf{W}_i^{(k+1)}$;
    Set $k := k + 1$;
until $\left|\mathrm{Tr}\left(\mathbf{W}_i^{(k)}\right) - \lambda_{\max}\left(\mathbf{W}_i^{(k)}\right)\right| \leq \varepsilon_1$;
Obtain $\mathbf{W}_i^{\mathrm{opt}} := \mathbf{W}_i^{(k)}$;
Use singular value decomposition (SVD) to $\mathbf{W}_0^{\mathrm{opt}}$ and
  $\mathbf{W}_m^{\mathrm{opt}}, m \in \{1, \cdots, M\}$ and yield the final optimal BS
  and SAT beamforming vectors, namely, $\mathbf{v}^{\mathrm{opt}}$ and $\mathbf{w}_m^{\mathrm{opt}}$;
Output: Optimal beamforming vectors $\mathbf{v}^{\mathrm{opt}}$ and $\mathbf{w}_m^{\mathrm{opt}}$.
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**Algorithm 2** Proposed two layer iterative BF scheme for the case of multiple Eves.

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Input: $\{\mathbf{f}_s, \mathbf{f}_{p,m}, \mathbf{f}_{e,k}, \mathbf{h}_s, \mathbf{h}_{p,m}, \mathbf{h}_{e,k}, \gamma_s, \gamma_m\}$.
Function Outer Iteration % Optimize $\mathbf{t}$ ;
Set $k = 0$;
Initialize a proper $\mathbf{t}^{(0)}$, the tolerance $\varepsilon_2$, and calculate $f_b\left(\mathbf{t}^{(0)}\right)$;
repeat
    Call Function Inner Iteration to obtain $\mu_i$ and $\mathbf{W}_i^{(k)}$;
    Calculate $f_b\left(\mathbf{t}^{(k+1)}\right)$;
    Solve the dual problem (40) to obtain $\mathbf{x}$, $\mathbf{Y}$, $z$, and then yield the gradient of Lagrangian function $\frac{\partial L}{\partial t_m}$ through (41);
    Use gradient-based algorithm such as Newton method to update $\mathbf{t}^{(k+1)}$;
    Set $k := k + 1$;
until $\left|f_b\left(\mathbf{t}^{(k)}\right) - f_b\left(\mathbf{t}^{(k-1)}\right)\right| \le \varepsilon_2$;
Output $\mathbf{W}_i^{\text{opt}} := \mathbf{W}_i^{(k)}$;
Use SVD to $\mathbf{W}_0^{\text{opt}}$ and $\mathbf{W}_m^{\text{opt}}, m \in \{1, \cdots, M\}$ and yield the final optimal BS and SAT beamforming vectors, namely, $\mathbf{v}^{\text{opt}}$ and $\mathbf{w}_m^{\text{opt}}$;
end;
Function Inner Iteration % Optimize $\mathbf{W}_i$ with $\mathbf{t}$ fixed;
Initialize $\mu_i$, and the solutions $\mathbf{W}_i^{(0)}$ to satisfy (37b)-(37d), $i \in \{0, 1, \cdots, M\}$;
Obtain optimal $\mu_i$ and $\mathbf{W}_i^{(k)}$ through solving (38) with the steps similar to Algorithm 1;
end;
Output: Optimal beamforming vectors $\mathbf{v}^{\text{opt}}$ and $\mathbf{w}_m^{\text{opt}}$.
```

## V. RESULTS

The Joint Beam Forming Process Done in Three Stages For Obtaining Secure And Reliable Response. The Major three Stages are: (a) Beam Forming Schemes (b) Secure Cognitive Satellite Terrestrial Communication System (c) Satellite Ground Tracking

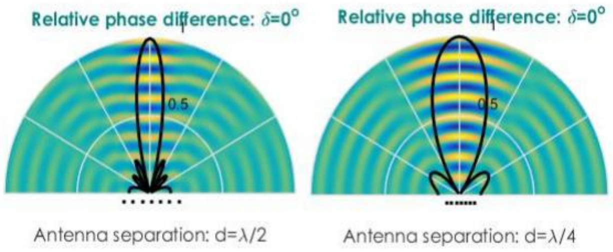

**Fig2. Beam Forming Schemes.**

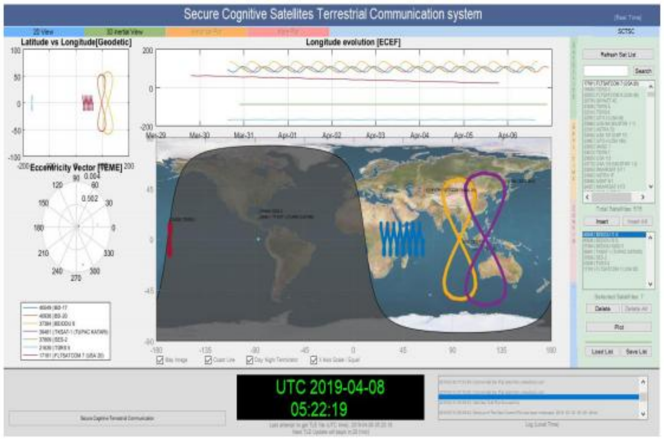

**Fig3. Secure Cognitive Satellite Terrestrial Communication System.**

This is the Main System Approach For Cognitive Satellite Terrestrial System in that we will have too many satellites that should be selected by the user and then it will be on position. The above system shows the how satellite should be revolve and what latitude &longitude position it should travel and also polarity should be noted.

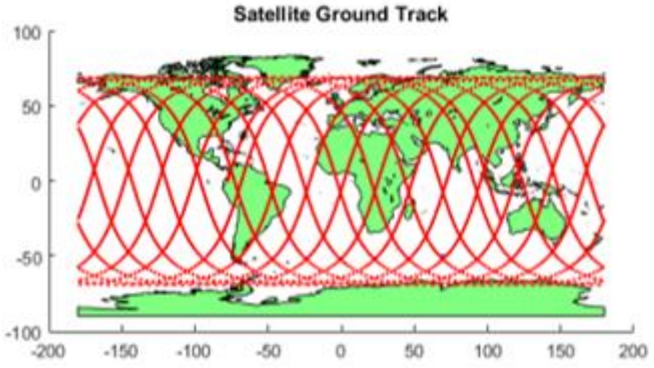

**Fig4. Satellite Ground Tracking.**

This is the final stage for obtaining the proper and secure communication, the satellite revolving around the earth in helical manner and then capture the information and it will send to the ground station with less noise figure.

## VI. CONCLUSION

In this paper, we have proposed the joint SAT/BS BF schemes for secure communication of SDA-CSTN operating in mmWave frequencies. We have first formulated a constrained optimization problem to minimize the total transmit power of SDA-CSTN subject to QoS constraint of the SU as well as the SR constraints of the PUs. Then, we have presented two BF schemes, namely, the BF scheme using SOCP together with penalty function approach and two layer iterative BF scheme combining penalty function and gradient based algorithm associated with the cases of one Eve and multiple Eves, respectively. The advantage of the proposed joint BF schemes is that it exploits the interference from the SN as a green source to enhance the performance of PLS for the PN while does not deteriorate the performance of the SN.

## VII. REFERENCES

[1] F. Alagoz and G. Gur, “Energy efficiency and satellite networking: A holistic overview,” Proc. IEEE, vol. 99, no. 11, pp. 1954–1979, Nov. 2011.

[2] M. A. Vazquez et al., “Precoding in multibeam satellite communications: Present and future challenges,” IEEE Wireless Commun., vol. 22, no. 6, pp. 88–95, Dec. 2016.

[3] M. K. Arti and M. R. Bhatnagar, “Beamforming and combining in hybrid satellite-terrestrial cooperative systems,” IEEE Commun. Lett., vol. 18, no. 3, pp. 483–486, Mar. 2014.

[4] S. Maleki et al., “Cognitive spectrum utilization in Ka band multibeam Satellite communications,” IEEE Commun. Mag., vol. 53, no. 3, pp. 24–29, Mar. 2015.

[5] S. He, J. Wang, Y. Huang, B. Ottersten, and W. Hong, “Codebookbased hybrid precoding for millimeter wave

multiuser systems," IEEE Trans. Signal Process., vol. 65, no. 20, pp. 5289–5304, Oct. 2017.

[6] M. Xiao et al., "Millimeter wave communications for future mobile networks," IEEE J. Sel. Areas Commun., vol. 35, no. 9, pp. 1909–1935, Sep. 2017.

[7] S. Kandeepan, L. De Nardis, M.-G. Di Benedetto, A. Guidotti, and G. E. Corazza, "Cognitive satellite terrestrial radios," in Proc. IEEE Global Telecommun. Conf., Dec. 2010, pp. 1–6.

[8] S. K. Sharma, S. Chatzinotas, and B. Ottersten, "Cognitive radio techniques for satellite communication systems," in Proc. IEEE Veh. Technol. Conf. (VTC Fall), Sep. 2013, pp. 1–5.

[9] G. Ziaragkas et al., "SANSA—Hybrid terrestrialâŁ "satellite backhaul network: Scenarios, use cases, KPIs, architecture, network and physical layer techniques," Int. J. Satell. Commun. Netw., vol. 35, no. 3, pp. 379–405, 2017.

[10] X. Artiga et al., "Spectrum sharing in hybrid terrestrial-satellite backhaul networks in the Ka band," in Proc. Eur. Conf. Netw. Commun. (EuCNC), Jun. 2017, pp. 1–5.

[11] B. Li, Z. Fei, and Z. Chu, "Optimal transmit beamforming for secure SWIPT in a two-tier HetNet," IEEE Commun. Lett., vol. 21, no. 11, pp. 2476–2479, Nov. 2017.

[12] M. Lin, J. Ouyang, and W.-P. Zhu, "Joint beamforming and power control for device-to-device communications underlaying cellular networks," IEEE J. Sel. Areas Commun., vol. 34, no. 1, pp. 138–150, Jan. 2016. [13] E. Lagunas, S. K. Sharma, S. Maleki, S. Chatzinotas, and B. Ottersten, "Resource allocation for cognitive satellite communications with incumbent terrestrial networks," IEEE Trans. Cognit. Commun. Netw., vol. 1, no. 3, pp. 305–317, Mar. 2015.

[14] F. Guidolin, M. Nekovee, L. Badia, and M. Zorzi, "A cooperative scheduling algorithm for the coexistence of fixed satellite services and 5G cellular network," in Proc. IEEE Int. Conf. Commun. (ICC), Jun. 2015, pp. 1322–1327.

[15] K. An, M. Lin, W.-P. Zhu, Y. Huang, and G. Zheng, "Outage performance of cognitive hybrid satelliteâŁ"terrestrial networks with interference constraint," IEEE Trans. Veh. Technol., vol. 65, no. 11, pp. 9397– 9404, Nov. 2016.