IEEE COMMUNICATIONS SOCIETY

Technical Committee on
Transmission, Access, and Optical Systems (TAOS)

Authors: Walter Cerroni, Mauro Biagi, and Murat Yuksel

Date/Time: Wednesday November 30th 2022 (9:00am-10:00pm EST)

Meeting Location: Before Globecom 2022 – Online meeting due to COVID-19 emergency

Officers: Steve Hranilovic, Chair, hranilovic@mcmaster.ca
                  Walter Cerroni, Vice-Chair, walter.cerroni@unibo.it
                  Mauro Biagi, Secretary, mauro.biagi@uniroma1.it

Meeting agenda:
1. Welcome and introductions
2. Approval of the ICC 2022 TAOS Meeting Minutes
3. Report on TC Restructuring
4. Conferences and Activities update
5. Election of TAOS Secretary
6. 2022 TAOS awards
7. Business arising from Members
8. Guest speaker
9. Adjourn

The meeting was called to order at 10:35am

Participants (23)

- Hanaa Abumarshoud, University of Glasgow, UK
- Nicola Andriolli, CNR-IEIIT, Italy
- Imran Shafique Ansari, University of Glasgow, UK
- Chedlia Ben Naila, Nagoja University, Japan
- Mauro Biagi, University of Rome "La Sapienza", Italy
- Stefano Bregni, Politecnico di Milano, Italy
- Walter Cerroni, University of Bologna, Italy
- Taisir Elgorashi, University of Leeds, UK
- Minsu Kim, Virginia Tech, USA

- Nitin Gupta, National Institute of Technology Hamirpur India
- Steve Hranilovic, McMaster University, Canada
- Ahmed Kamal, Iowa State University, USA
- Ruidong, Li, Kanazawa University, Japan
- Pascal Lorenz, University of Haute Alsace, France
- Shiwen Mao, Auburn University, USA
- Symeon Papavassiliou, National Technical University of Athens, Greece
- Roberto Rojas-Cessa, New jersey Institute of Technology, USA
- Majid Safari, University of Edimbourgh, UK
- Bassant Selim, Ecole de technologie Superieure, Canada
- Cynthia Sikora, IEEE ComSoc, USA
- Daniel So, University of Manchester, UK
- Eirini Eleni Tsiropoulou, University of New Mexico, USA
- Murat Yuksel, University of Central Florida, USA

1. Welcome and round table introduction

The meeting was held online due to the COVID-19 emergency that caused all IEEE events, including partially sessions of GC 2022, to run on a teleconferencing platform. The Chair, Steve Hranilovic, welcomed all connected participants and presented the meeting agenda. The attached slides were presented by the Chair and discussed item-by-item.

2. Approval of the ICC 2020 TAOS Meeting Minutes

A motion was made by Imran Shafique Ansari to approve the minutes of the previous meeting held online after ICC 2022. The draft of the minutes was previously made available on the TAOS website (http://taos.committees.comsoc.org/meetings) and distributed to the TAOS members through the mailing list. The motion was seconded by Murat Yuksel and the minutes were approved unanimously without further remarks.

3. Report on TC Restructuring

Walter Cerroni exposes the restructuring that is going on based the work of the dedicated IEEE COMSOC committee. The Vice-Chair details the reasons for restructuring TCs including overlapping and lack of some elements, like educational services to members, industry participation and standard development.

4. Conference activities update

A commitment of TAOS is to proposed chairs for ONS and GCSN symposia at ICC and Globecom. This is in coordination with other TCs. The conventional analysis of "numbers" in terms of submissions and accepted papers have been proposed by some of the Chairs involved in the last conferences. The representation of TAOS is scheduled both for ICC 2023 as well as GC 2023 while the chair for ICC 2024 is still pending.

Secretary Mauro Biagi reported the organization of a workshop about "Underwater communication, access and networking (U-CAN)" at ICC 2023 together with Valeria Loscri and Anna Maria Vegni. The Vice-Chair recall that TAOS provided its sponsorship also to the conference "Optical Network Design and Modeling" (ONDM), held in May 2023 in Portugal.

Mauro Biagi explains the contribution of TAOS to COMSOC newsletter with the recent activities of the Technical Committee.

5. Election of TAOS Secretary

The Chair informed that the 2-year term of the TAOS officers will end by Dec. 31, 2022. As per TAOS' tradition, Chair and Vice-Chair positions are filled by promoting Vice-Chair and Secretary, respectively. The position of TAOS Secretary was open for candidacy and elections took place via email in November 2022. Only TAOS active members were eligible to vote. Two candidates participated in the elections: Murat Yuksel (University of Central Florida, USA) and Taisir Elgorashi (University of Leeds, UK). Murat obtained the majority of the votes and was then elected new TAOS Secretary. The results of the election were approved by ComSoc. The Chair congratulated M. Yuksel on his new position and expressed gratitude to T. Elgorashi for volunteering as a candidate. Effective immediately after the meeting, the TAOS officers for the term 2023-2024 are then:

- Walter Cerroni (Chair)
- Mauro Biagi (Vice-Chair)
- Murat Yuksel (Secretary)

The next TAOS officer elections will take place at GC 2024 meeting.

6. 2022 TAOS Awards

Walter Cerroni, chair of the TAOS Award sub-committee reported that there were 6 nominations: 3 from ICC 2022 ONS (Steve Hranilovic), 3 from GC 2022 ONS (Anas Chaaban) for Best symposium paper award for 2022 ICC/Globecom ONS symposia chaired by a TAOS representative and 6 nominations: 3 from ICC 2022 GCSN (Fabrizio Granelli), 3 from GC 2022 GCSN (Eirini Tsiropoulou) for Best symposium paper award for 2022 ICC/Globecom GCSN symposia chaired by a TAOS representative. The award sub-committee is composed by the following members:

- Walter Cerroni (University of Bologna, Italy) - Sub-committee Chair
- Abdelmoula Bekkali (TOYO Electric Corporation, Japan)
- Melike Erol-Kantarci (University of Ottawa, Canada)
- Ahmed Kamal (Iowa State University, USA)
- Daniel K. C. So (University of Manchester, UK)

The awards went to
"Intelligent Reflecting Surfaces for Enhanced NOMA-based Visible Light Communications" by Hanaa Abumarshoud, Bassant Selim, Mallik Tatipamula, and Harald Haas, presented at ICC 2022 ONS

and

"On the Tradeoff between Energy, Precision, and Accuracy in Federated Quantized Neural Networks" by Minsu Kim, Walid Saad, Mohammad Mozaffari, and Merouane Debbah, presented at ICC 2022 GCNS.

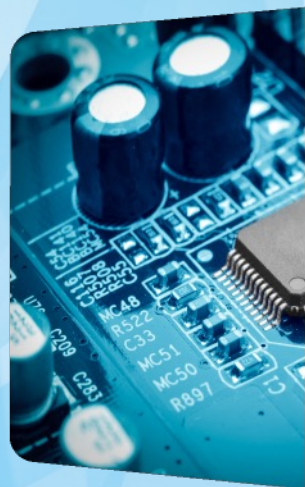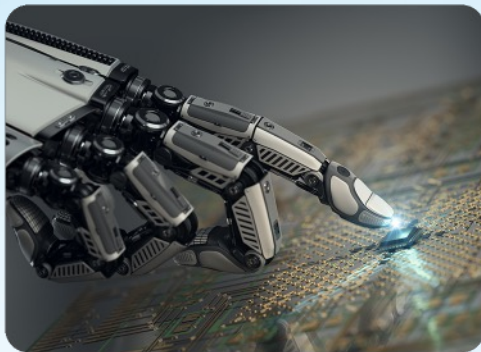**7. Business arising from Members.**
Walter Cerroni presented the Outstanding Service Award to Steve Hranilovic for serving as TAOS Chair in the 2021-2022 term.

A discussion about call for papers of upcoming ONS and GCSN was held.

8. Adjourn

The meeting was adjourned at 11:00am.

Attachments: 1. Meeting Slides, 2. Presentations slides.

Transmission, Access and Optical Systems TC
Virtual Meeting for Globecom 2022– November 30, 2022
Steve Hranilovic (Chair)

Attendance

▸ Please register your attendance at this meeting!

− Link will be pasted periodically in the chat during the meeting

https://docs.google.com/forms/d/e/1FAIpQLSdXzdjgkThJm0ZrqkOZBRkp18o_JqK5kMVBsdEpr5Xsr5dO7w/viewform?usp=sf_link

Agenda

▶ Welcome and Introductions

▶ Approval of the ICC 2022 TAOS Meeting Minutes (available online)

▶ Report on TC Restructuring

▶ Conferences and Activities update

▶ Election of TAOS Secretary

▶ TAOS Awards

▶ Business Arising from Members

▶ Guest Speaker

▶ Adjourn

TAOS Officers for 2021-2022

As as January 2021

▸ Steve Hranilovic (Chair)

▸ Walter Cerroni (Vice-Chair)

▸ Mauro Biagi (Secretary)

Minutes approval

Meeting at IEEE ICC 2022 May 6, 2022

▸ Available on the website:
http://taos.committees.comsoc.org/meetings/
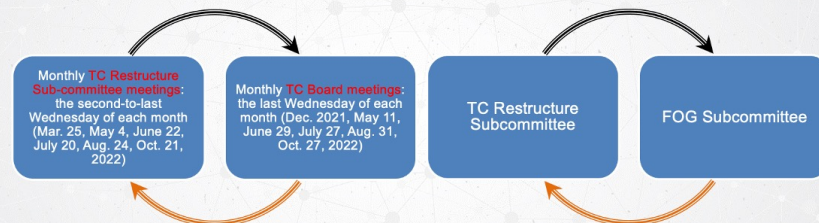
TC Restructure (update & draft)

Why Should We Restructure the TCs?

- Lack of industry participation
- Lack of diversity in YP & Students members
- Lack of coordination to form SIGs
- Lack of support for local chapters globally
- Lack of support for standard development
- Lack of educational services to members
- Lack of guidelines in creating TC awards
- Significant overlapping areas among some TCs

What we've done in 2022?

Iterative Procedure

▸ Iterative procedure to involve TCs/ICs in the process:

Monthly TC Restructure Sub-committee meetings: the second-to-last Wednesday of each month (Mar. 25, May 4, June 22, July 20, Aug. 24, Oct. 21, 2022)

Monthly TC Board meetings: the last Wednesday of each month (Dec. 2021, May 11, June 29, July 27, Aug. 31, Oct. 27, 2022)

TC Restructure Subcommittee

FOG Subcommittee

All meeting docs and slides are available at: https://tc.boards.comsoc.org/meeting-documents/

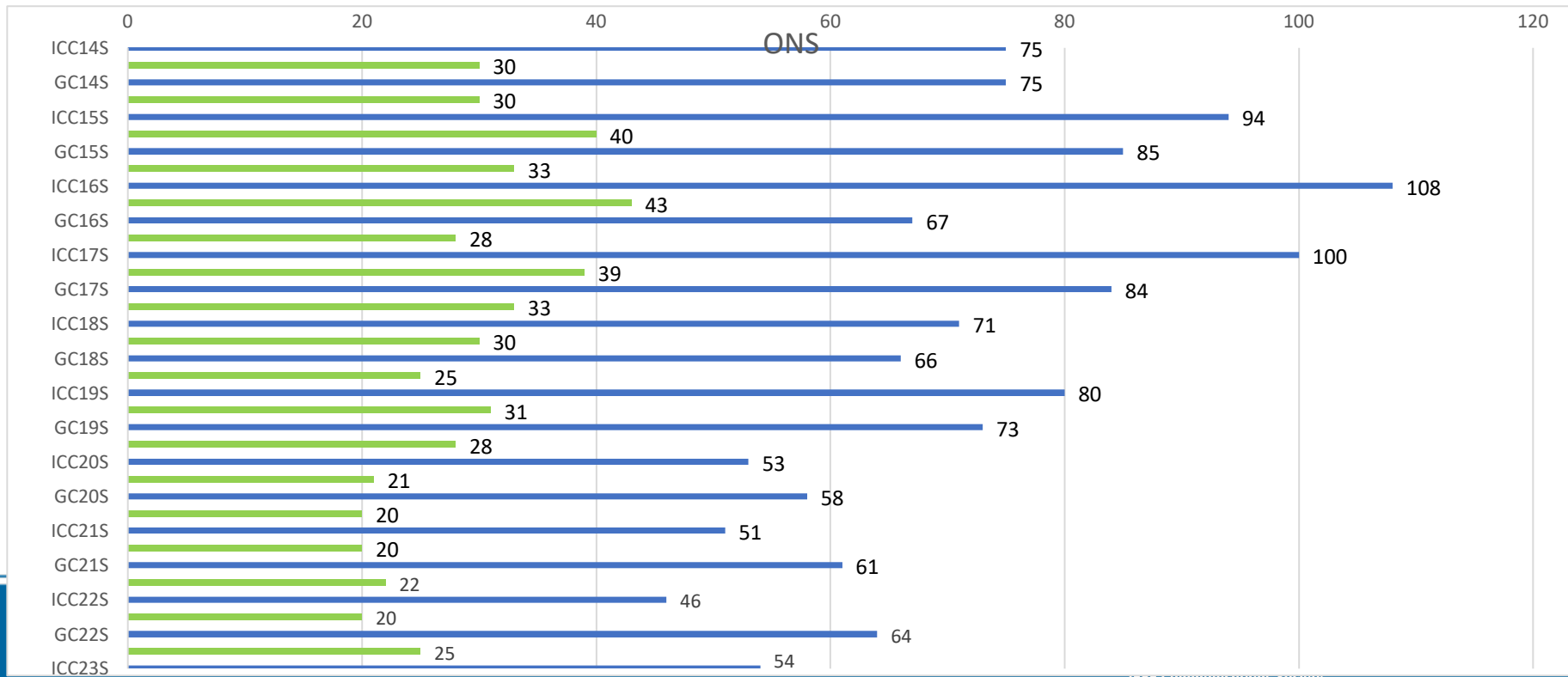## Your feedback is very important to us!

**Please send your comments to
Shiwen Mao, TC Board Director, E-mail: smao@ieee.org
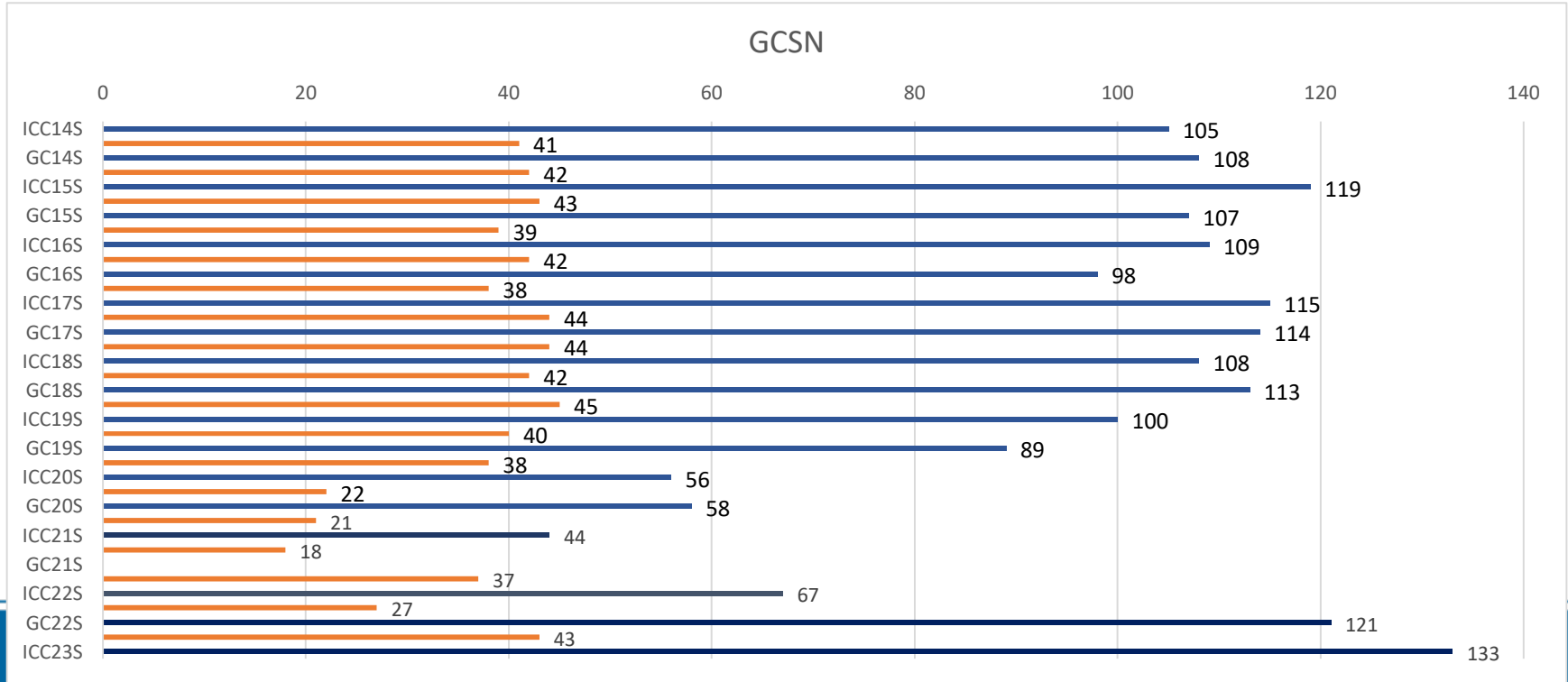Wei Zhang, VP TEA, E-mail: weizhang@ieee.org**

Update

Sponsored Symposia

▸ TAOS TC has consistently sponsored two symposia:
  – Symposium on *Optical Networks and Systems* (ONS)
  – Symposium on *Green Communications Systems and Networks* (GCSN)

▸ Moreover, TAOS TC technically endorses several other technical events
  – Co-located w/ ICC and GC, or many stand-alone

▸ ***Action:*** Our TC needs to coordinate with Symposium TPC Co-Chairs and update the topics to keep tracking hot-topics. e.g,
  – Writing of CfP
  – TPC nominations
  – New ideas!

Optical Network and Systems (ONS) Symposium

	ONS
ICC14S	75
GC14S	30 / 75
ICC15S	30 / 94
GC15S	40 / 85
ICC16S	33 / 108
GC16S	43 / 67
ICC17S	28 / 100
GC17S	39 / 84
ICC18S	33 / 71
GC18S	30 / 66
ICC19S	25 / 80
GC19S	31 / 73
ICC20S	28 / 53
GC20S	21 / 58
ICC21S	20 / 51
GC21S	20 / 61
ICC22S	22 / 46
GC22S	20 / 64
ICC23S	25 / 54

Green Communication Systems and Network Symposium

GCSN

	Orange	Blue
ICC14S	41	105
GC14S	42	108
ICC15S	43	119
GC15S	39	107
ICC16S	42	109
GC16S	38	98
ICC17S	44	115
GC17S	44	114
ICC18S	42	108
GC18S	45	113
ICC19S	40	100
GC19S	38	89
ICC20S	22	56
GC20S	21	58
ICC21S	18	44
GC21S	37	
ICC22S	27	67
GC22S	43	121
ICC23S		133

Conferences and Activities Update

Current & Upcoming Events

▸ IEEE Globecom 2021 (Madrid)
 – GCSN: *** no TAOS representative ***
 – ONS: Mauro Biagi (University of Rome Sapienza, Italy) and Jaafar Elmirghani (University of Leeds, U.K.)

▸ IEEE ICC 2022 (Seoul)
 – ONS: Steve Hranilovic (McMaster University, Canada)
 – GCSN: Fabrizio Granelli (University of Trento, Italy)

▸ IEEE Globecom 2022 (Rio de Janeiro)
 – GCSN: Eirini Eleni Tsiropoulou (U. New Mexico, USA)
 – ONS: Anas Chaaban (U. British Columbia, Canada)

Conferences and Activities Update

Upcoming Events

▸ IEEE ICC 2023 (Rome)
- GCSN: Taisir Elgorashi (U. Leeds)
- ONS: Murat Yuksel (U. Central Florida)

▸ IEEE Globecom 2023 (Kuala Lumpur)
- GCSN: Emad Alsusa (U. Manchester)
- ONS: Nicola Andriolli (National Research Council of Italy (CNR))

▸ IEEE ICC 2024 (Denver)
- Nominations Pending

Upcoming Conferences

▸ You are kindly invited to submit a paper to the

1st workshop on Underwater Communication Access and Networking (UCAN) at ICC 2023

 TPC co-chairs, Mauro Biagi, Valeria Loscrì, Anna Maria Vegni

Please see ICC 2023 website for deadlines and details for submission.

ComSoc Newsletter

▸ In the last issues of ComSoC Newsletter TAOS activities are described. See:

– https://tc.boards.comsoc.org/wp-content/uploads/sites/197/2022/11/TCN_10-2022_v5.pdf

▸ Link is also pasted in the chat

Transmission, Access, & Optical Systems TC (contributor: Mauro Biagi)

Highlight Events:

The Transmission, Access and Optical Systems Technical Committee is involved in several research technical and scientific activities ranging from Non-Orthogonal Multiple Access (NOMA) techniques, to the wireless world including the emerging optical-wireless topic. The Technical Committee favorite the organization and publicity of several conferences, workshops as well as sessions and symposia at Globecom and ICC.

It will also work with the publication departments of ComSoc, existing ComSoc TCs and related societies to organize timely journal and magazine publications, including on-line publications at the ComSoc portal.

The Technical Committee is also involved in the emerging IEEE initiative about Sustainable ICT. It favorites activities also in the emerging field of aerial communications.

TAOS TC is also involved in standardization activities as IEEE standards for Green Communications - 9 approved - green coms IEEE 1922.1, 1923.1 to 1929.1.

More Recent Events:

Recent and upcoming Conferences:

• ICC 2021 Optical Networks and Systems Symposium
• ICC 2021 Green Communication Symposium
• Globecom 2021 Optical Networks and Systems Symposium
• Globecom 2021 Green Communication Symposium
• Globecom 2021 Spotlight Talk Entitled "When data brings light: from pure research to a real illuminated world"
• ICC 2022 Optical Networks and Systems Symposium
• ICC 2022 Green Communication Symposium
• Globecom 2022 Optical Networks and Systems Symposium
• Globecom 2022 Green Communication Symposium
• ICC 2023 Optical Networks and Systems Symposium

IEEE ComSoc TCN Oct. 2022   23

IEEE Communications Society   October 2022

• ICC 2023 1st workshop on Underwater Communication, Access and Networking (UCAN)

TAOS Members are associated Editors of:

• IEEE/OSA Journal of Lightwave Technology
• IEEE Communication Magazine (EiC)
• IEEE Transactions on Green communications and networking

Election of TAOS Secretary

▸ The term of the current slate of officers ends on December 31, 2022

▸ Per TAOS Policies and Procedures
- On completion of the term, the TAOS Chair retires, the Vice-Chair steps up to the position of the Chair, the Secretary steps up to Vice-Chair and a new Secretary is elected.
- TC officers (Chair, Vice-Chair, and Secretary) are elected for two-year terms.
- Candidates for these positions are ComSoc members nominated by the TAOS steering committee.

▸ Call for candidates was opened in July 2022

▸ Voting process initiated electronically starting Nov. 10, 2022 at 9am EST.
- Voting is restricted to **Active TAOS Members**
  - Individuals that have attended (physically or virtually) two or more of the prior five regularly scheduled TC meetings.

▸ This election process was vetted and approved by IEEE Governance staff.

2022 TAOS Awards

▶ Nominations received

- Best symposium paper award for 2022 ICC/Globecom ONS symposia chaired by a TAOS representative
  - 6 nominations: 3 from ICC 2022 ONS (Steve Hranilovic), 3 from GC 2022 ONS (Anas Chaaban)
- Best symposium paper award for 2022 ICC/Globecom GCSN symposia chaired by a TAOS representative
  - 6 nominations: 3 from ICC 2022 GCSN (Fabrizio Granelli), 3 from GC 2022 GCSN (Eirini Tsiropoulou)

▶ Selection made by the TAOS Awards Sub-committee

- Walter Cerroni (University of Bologna, Italy) - Sub-committee Chair
- Abdelmoula Bekkali (TOYO Electric Corporation, Japan)
- Melike Erol-Kantarci (University of Ottawa, Canada)
- Ahmed Kamal (Iowa State University, USA)
- Daniel K. C. So (University of Manchester, UK)

Intelligent Reflecting Surfaces for Enhanced NOMA-based Visible Light Communications

▸ Authors: <u>Hanaa Abumarshoud</u>, Bassant Selim, Mallik Tatipamula, and Harald Haas

▸ *The paper brings a new vision and a strong technical contribution to the emerging and very promising research area on Intelligent Reflecting Surfaces for Visible Light Communications. The proposed framework and methodology are expected to have relevant impact on future research directions.*

▸ Link to the paper on IEEE Xplore: https://ieeexplore.ieee.org/document/9838853

On the Tradeoff between Energy, Precision, and Accuracy in Federated Quantized Neural Networks

▸ Authors: <u>Minsu Kim</u>, Walid Saad, Mohammad Mozaffari, and Merouane Debbah

▸ *The paper represents a pioneering work on the relevant problem of energy consumption in Federated Learning deployments, looking at the trade-off between energy, precision and accuracy. It offers innovative ideas and important findings that can have major impact on future research directions.*

▸ Link to the paper on IEEE Xplore: https://ieeexplore.ieee.org/document/9838362

IEEE ComSoc™
IEEE Communications Society

◆IEEE

2022 IEEE TAOS TC Outstanding Service Award

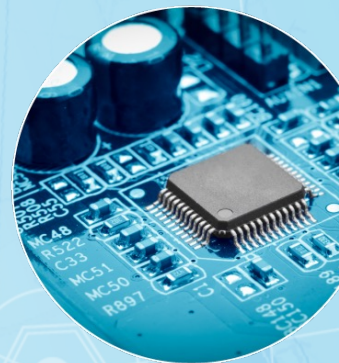*Nominated by the TAOS TC Vice-Chair and Secretary*

Steve Hranilovic

for serving as TAOS Chair in the 2021-2022 term

Business Arising

Input from TAOS TC Members

▸ Any topics of interest for discussion?

▸ Feel free to follow up with any questions/comments at any time via email to officers

Transmission, Access and Optical Systems TC

Thank you and see you at ICC 2023!

▸ **Please register your attendance at this meeting! (Link posted in chat)**

On the Tradeoff Between Energy, Precision, and Accuracy in Federated Quantized Neural Networks

Minsu Kim, Walid Saad, Mohammad Mozaffari,

and Merouane Debbah

Electrical and Computer Engineering Department

Network, sciEnce, Wireless, and Security (NEWS) Group

Virginia Tech

Motivation

- **Federated Learning (FL)**

  - Multiple devices collaborate in solving a machine learning problem under the coordination of a central unit

  - NVIDIA Clara FL platform: Software Development Kit for healthcare

- **Energy Efficiency Problem**

  - Complex and larger deep neural networks have been widely deployed to achieve high performance in FL [BG:21]

  - Mobile and IoT devices have limited computing power and memory

    - It is highly energy inefficient to compute billions of operations and to process millions of parameters

  - Quantized neural network (QNN)

  - ✓ Need to balance accuracy and energy consumption by optimizing the number of bits in data representation

[BG:21] B. Guler and A. Yener, "A Framework for Sustainable Federated Learning," in *Proc* of 19th International Symposium on Modeling and Optimization in Mobile, Ad hoc, and Wireless Networks (WiOpT), Philadelphia, PA, USA, Oct. 2021.

Problem Formulation

- **Energy Minimization Problem**

$$\min_{n} \quad \mathbb{E}\left[\sum_{t=1}^{T}\sum_{k \in N_t}\{E^{UL,k}(n) + IE^{C,k}(n)\}\right]$$

$$s.\,t. \qquad n \in [1, \ldots, n_{\max}]$$

$$\mathbb{E}[F(\boldsymbol{w}_T) - F(\boldsymbol{w}^*)] \leq \epsilon$$

> Energy consumption for local training

> Energy consumption for uplink transmission

> n is the # of bits for quantization

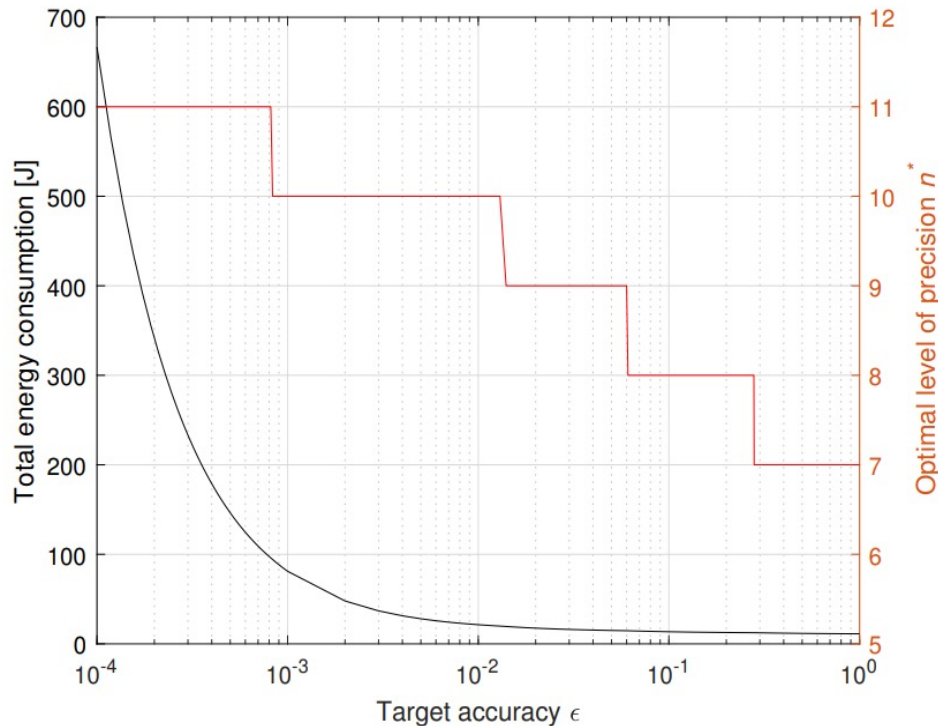> Accuracy constraint ϵ after T rounds

- **To solve the problem, we derived the convergence rate**

  - $\mathbb{E}[F(\boldsymbol{w}_T) - F(\boldsymbol{w}^*)] \leq \frac{L\beta^2}{2(\beta\mu-1)}\frac{1}{T+\gamma}\left(\sum_{k=1}^{N}\frac{\sigma_k^2}{N^2} + \frac{d}{2^{2n}}\left(1+\frac{1}{K}\right) + 4(I-1)^2G^2 + \frac{4(N-K)}{K(N-1)}IG^2\right)$

> Quantization error

Simulation Results

- **Precision and Energy Tradeoff**

Case1: # of weights $= 25.6 * 10^6$
Case2:# of weights $= 61.6 * 10^6$
Case3:# of weights $= 83.5 * 10^6$
Case4:# of weights $= 11.5 * 10^7$
Case5:# of weights $= 13.8 * 10^7$
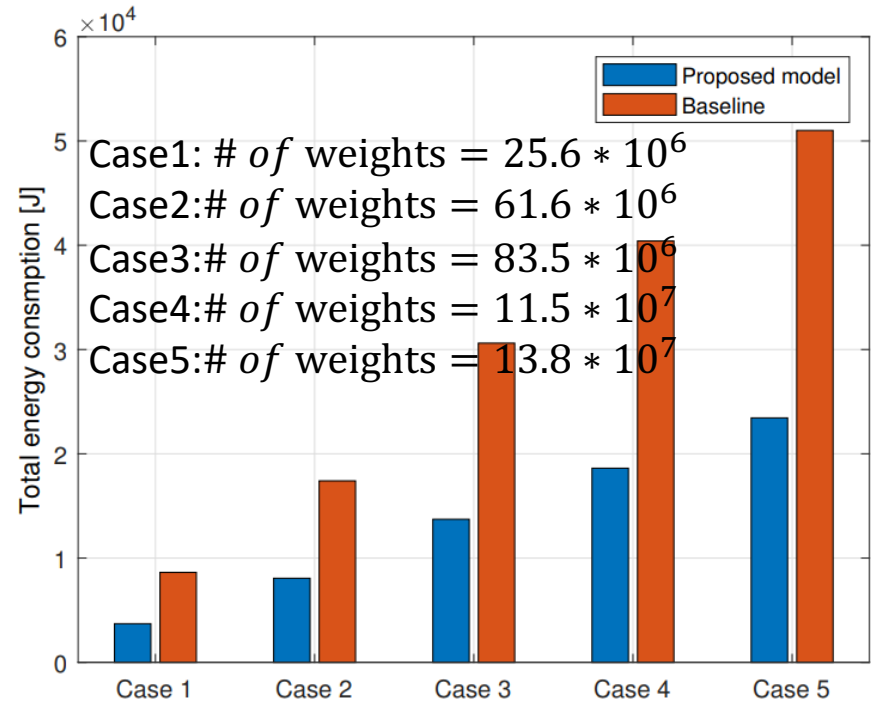
- As we require more accuracy, the corresponding value of n^* increases

- The baseline uses 32 bits for the computation and the transmission

- We can save up to 53% of the energy consumption compared with the baseline

# Thank you

Questions?

Email : msukim@vt.edu

INTELLIGENT REFLECTING SURFACES FOR ENHANCED NOMA-BASED VISIBLE LIGHT COMMUNICATIONS

Hanaa Abumarshoud, Bassant Selim, Mallik Tatipamula, and Harald Haas

Hanaa Abumarshoud
University of Glasgow
hanaa.abumarshoud@glasgow.ac.uk

BACKGROUND & MOTIVATION

▪**Visible light communication** (VLC) is an optical wireless communication technology which utilises uses visible light (380–750 nm) for wireless data transmission. Based on VLC, **LiFi** systems provide bidirectional connectivity, mobility support, and multi-user access.

▪**Non-orthogonal multiple access** (NOMA) is a spectrally-efficient technique in which users are multiplexed in the power domain. The spectral efficiency gain offered by NOMA is dependant on having distinct channel conditions for different users, which is not always guaranteed in LiFi.
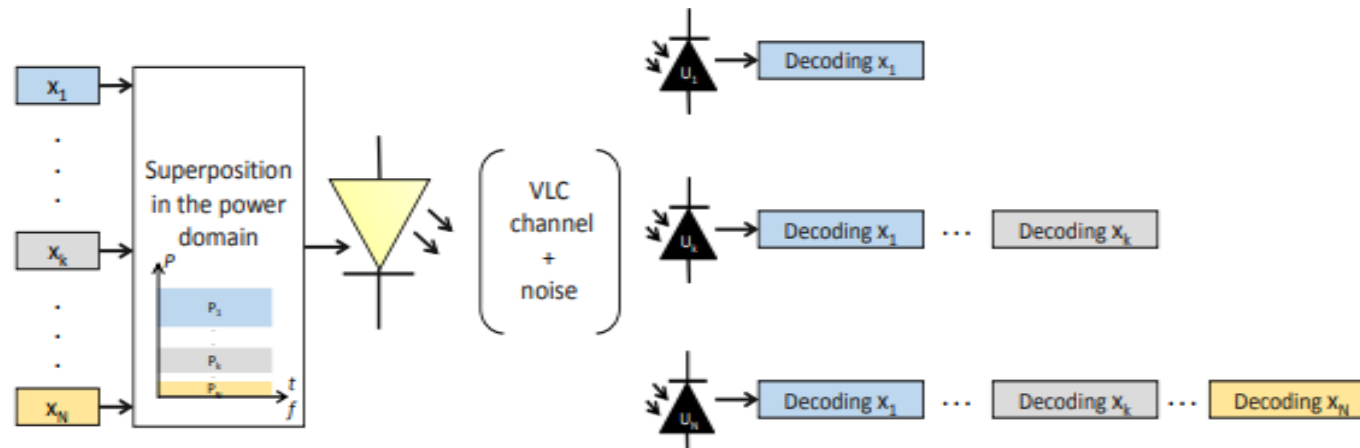
PROPOSED SOLUTION

- We propose the use of **intelligent reflecting surfaces (IRSs)** for enhancing the reliability of NOMA-VLC systems.

- BER performance in NOMA depends on having distinct channel conditions.

- In IRS-assisted systems, the perceived channel gain at users is governed by the combined LoS and reflected paths.

- There is a need to jointly optimise the users' *decoding order*, *power allocation*, and *IRS reflection coefficients.*

- We utilise propose an adaptive-restart genetic algorithm (GA) to solve this NP-hard multi-dimensional optimisation problem.

RESULTS
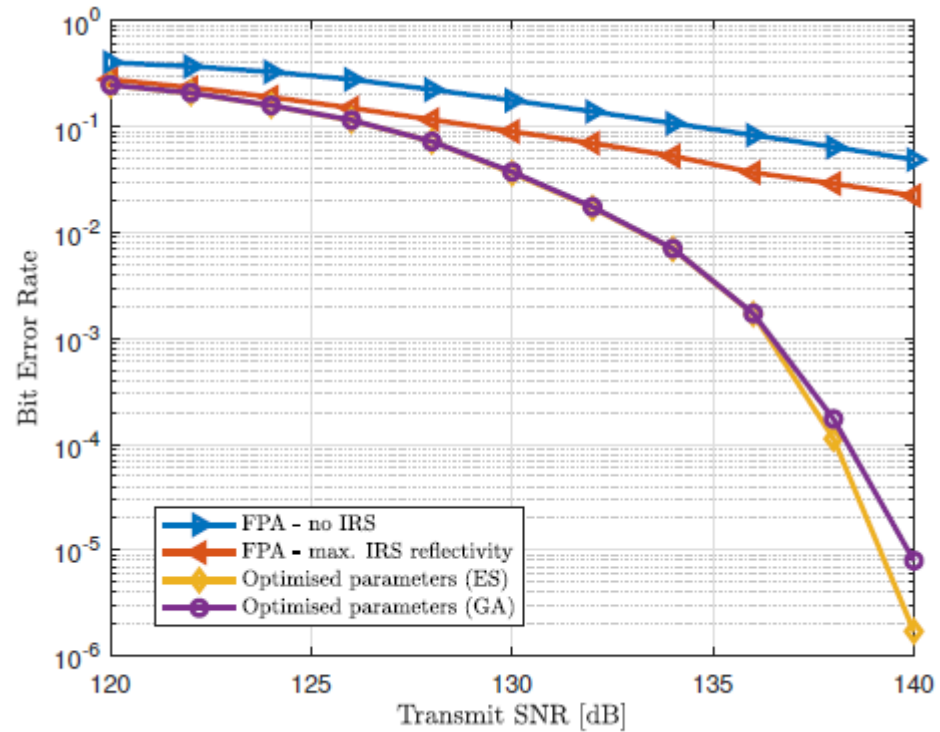
BER of the user in the first decoding order vs SNR
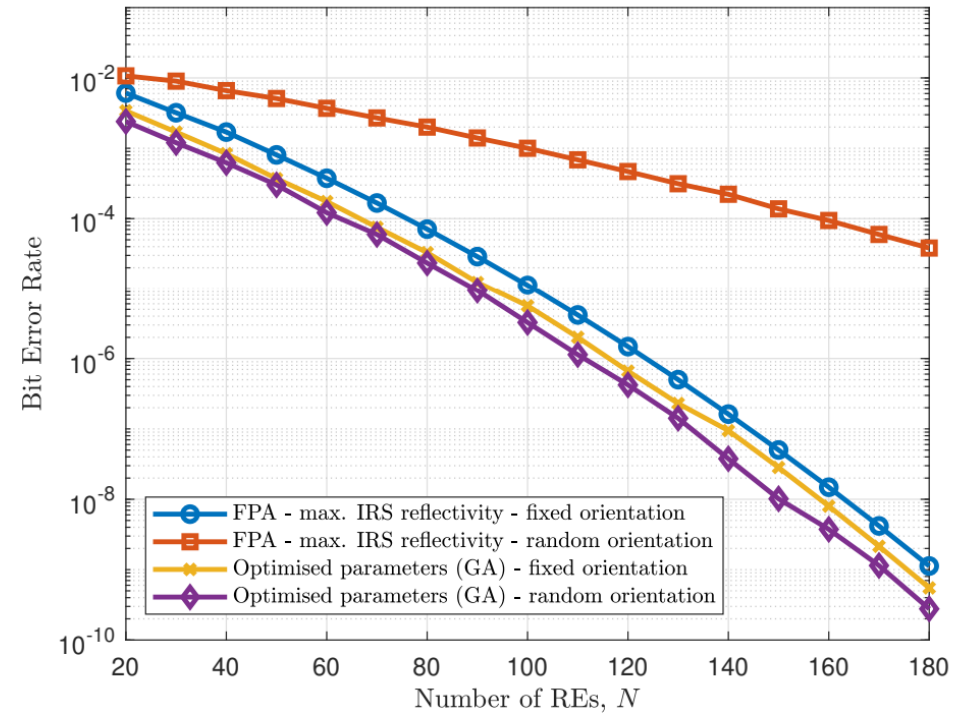
BER performance vs the number of REs when random device orientation