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Preface

These proceedings represent the work of contributors to the 21st European Conference on Cyber Warfare and Security (ECCWS 2022), supported by University of Chester, UK on 16-17 June 2022. The Conference Co-chairs are Dr Thaddeus Eze and Dr Nabeel Khan, University of Chester and the Programme Chair is Dr Cyril Onwubiko from IEEE and Director, Cyber Security Intelligence at Research Series Limited.

ECCWS is a well-established event on the academic research calendar and now in its 21st year the key aim remains the opportunity for participants to network and share ideas. The scope of papers will ensure an interesting conference. The subjects covered illustrate the wide range of topics that fall into this important and ever-growing area of research.

The opening keynote presentation is given by Dr Charles Clarke, Senior Lecturer in Cyber Security and Programme Convenor, University of Roehampton, UK on the topic of *Employability by Design: A Strategy for Career Ownership in Cyber*. The second day of the conference will open with an address by Dr Brett Van Niekerk, Noëlle Van der Waag-Cowling and Dr Trishana Ramluckan speaking on *Multidisciplinarity and Multistakeholderism for Cyber Resilience of Emerging Economies: Lessons from Cyber Challenges*.

With an initial submission of 105 abstracts, after the double blind, peer review process there are 41 Academic research papers, 5 PhD research papers, 4 Masters research paper and 3 work-in-progress papers published in these Conference Proceedings. These papers represent research from Australia, Austria, Czech Republic, Finland, Germany, India, Japan, Lithuania, Netherlands, New Zealand, Norway, Pakistan, South Africa, Spain, Netherlands, UK and USA.

We hope you enjoy the conference.

Dr Thaddeus Eze
University of Chester
UK
June 2022

ECCWS Conference Committee

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Biographies

Conference and Programme Chairs



Dr Thaddeus Eze is a Senior Lecturer in Cyber Security at the University of Chester. He is the founder and convener of the IEEE UK & Ireland YP Postgraduate STEM Research [Symposium](#), Vice Chair, IEEE UK & Ireland Young Professionals, a technical committee member for a number of international conferences (e.g., ICAS, CYBERWORLDS, EMERGING etc.), and currently runs the Computer Science departmental [research seminar series](#). His research interests include Trustworthy Autonomics, MANET and Cyber Security (specifically, Return Oriented Programming, Policing the Cyber Threat and Cyber Education) and he has a number of publications in these areas.



Dr Nabeel Khan is a Senior Lecturer and Programme Lead for BSc Cybersecurity at the University of Chester. Nabeel has been the lead researcher for numerous national and international research projects, funded by the European Commission (e.g., CONCERTO), U.K. research councils (e.g., EPSRC), U.K. Technology Strategy Board/Innovate-UK., and international industries (DoCoMo Eurolabs Munich). He gained his PhD in Resource Allocation in Wireless Networks from Kingston University, London, in 2013. He joined the University of Chester in 2021 as the Program Leader to further develop and deliver Cybersecurity courses. His research interests are in Network Security, Machine Learning techniques for threat hunting, and Cloud computing.



Dr Cyril Onwubiko is the Secretary, IEEE UK & Ireland, Chair, IEEE UK & Ireland Blockchain Group, and Director, Cyber Security Intelligence at Research Series Limited, where he is responsible for directing strategy, IA governance and cyber security. Prior to Research Series, he had worked in the Financial Services, Telecommunication, Health sector and Government and Public services Sectors. He is a leading scholar in Cyber Situational Awareness (Cyber SA), Cyber Security, Security Information and Event Management (SIEM), Data Fusion & SOC; and interests in Blockchain and Machine Learning. He is the founder of the Centre for Multidisciplinary Research, Innovation & Collaboration (C-MRIC) <https://www.c-mric.com> Detailed profile for Cyril can be found on <https://www.c-mric.com/cyril>

Keynote Speakers



Dr Charles Clarke is a Senior Lecturer in Cyber Security and Programme Convenor (Course Leader) for the Undergraduate Computer Science Programme at the University of Roehampton. He has extensive experience of delivering creative, engaging, and innovative learning experiences at both undergraduate and postgraduate levels. Charles is also a co-founder of CISSE UK, a national network of Cyber Security Education (CSE) strategists, practitioners, and learners. CISSE UK works closely with government, industry, and academia, to establish a culture of innovative cyber security education across the UK. Prior to academia, Charles worked extensively in the IT industry at all levels, including senior management and

directorships. He has many technical interests which include cloud computing, data visualisation for cyber security and steganographic messaging protocols.



Dr Brett van Niekerk is a senior lecturer at the Durban University of Technology, chairs the International Federation of Information Processing Working Group on ICT in Peace and War, and is co-Editor-in-Chief of the International Journal of Cyber Warfare and Terrorism. He actively participates in international cybersecurity forums (Global Commission on the Stability of Cyberspace, Paris Call working groups, Carnegie Endowment for International Peace's project on countering influence operations). He is CISM certified, with over 50 academic publications and 20 presentations at industry events.



Dr Trishana Ramluckan is the research manager at Educor Holdings, prior to which she was a Postdoctoral Researcher in the School of Law and an Adjunct Lecturer in the Graduate School of Business at the University of KwaZulu-Natal. She is a member of the IFIP working group on ICT Uses in Peace and War and is an Academic Advocate for ISACA. She graduated with a Doctor of Administration specialising in IT and Public Governance (2017) and was listed as in the Top 50 Women in Cybersecurity in Africa (2020). Her current research areas include Cyber Law and Information Technology Governance.



Noëlle Van der Waag-Cowling is the Cyber Programme Lead at the Security Institute for Governance and Leadership and teaches cyberwarfare in the Department of Strategic Studies, Stellenbosch University. She is a member of the International Journal of Cyber Warfare and Terrorism review board, the Tana High-Level Forum on Security in Africa, the International Committee of the Red Cross Group of Global Experts on protecting civilians during cyber-attacks, the Carnegie Endowment for International Peace's Project for Cybersecurity, Capacity-Building, and Financial Inclusion. She is an affiliate member of the University of Canberra's National Security Hub, and was voted one of the Top 50 Women in Cyber in Africa.

Mini Track Chairs



Dr Edwin "Leigh" Armistead is the Principal of ArmisteadTec LLC, a Veteran-Owned Small Business (VOSB) that is certified by the Small Business Administration (SBA) as a Historically Underutilized Business Zone (HBZ), <https://www.armisteadtec.com/>. This company primarily focuses on the academic functions of Information Warfare (IW), to include curriculum development, teaching as well as other related tasks to include lecturing and writing. A retired United States Naval Officer, Dr Armistead has significant Information Operations academic credentials having written his PhD on the conduct of Cyber Warfare by the federal government and has published three books, in an unclassified format in 2004, 2007 and 2010, all focusing on full Information Warfare. He is also the Chief Editor of the Journal of Information Warfare (JIW) <https://www.jinfowar.com/>; the Program Director of the International Conference of Cyber Warfare and Security and the Vice-Chair Working Group 9.10, ICT Uses in Peace and War.



Dr Chris Flaherty has had a varied career within the cyber domain. He is now retired, but a regular contributor. on various topics on in “Space and Defence” <https://spaceanddefense.io/?s=flaherty>



Dr. Char Sample is the Chief Cybersecurity Research Scientist for the Cybercore division at Idaho National Laboratory. Dr. Sample is a visiting academic at the University of Warwick, Coventry, UK and a guest lecturer at Bournemouth University, Rensselaer Polytechnic University and Royal Holloway University. Dr. Sample has over 20 years’ experience in the information security industry. Dr. Sample’s research focuses on deception, and the role of cultural values in cybersecurity events. More recently she has begun researching the relationship between human cognition and machines. Presently Dr. Sample is continuing research on modeling cyber behaviors by culture, other areas of research are data resilience, cyber-physical systems and industrial control systems.

Biographies of Contributing Authors

BKirsi Aaltola is director of development at the Finnish Institute of Public Management, with background in educational science and information technology (University of Jyväskylä) focusing on modern learning environments and skills acquisition, with experience of coordinating European Commission funded development projects, leadership and management, and training programs in peacebuilding, international security leadership and cybersecurity.

Jonathan Adkins has a PhD in Information Assurance from Nova Southeastern University in Fort Lauderdale, Florida in the United States. Currently he teaches Digital Forensics and Topics in Information Assurance at Norwich University in Vermont. His research interests include deepfakes, sentiment analysis and machine learning applied in the field of disinformation.

Pascal Ahr, B.Sc., is a Master of Science student of Electrical and Computer Engineering in Embedded Systems at the University of Kaiserslautern Germany. He works as Junior Researcher at German Research Center for Artificial Intelligence and researches in the field of Hardware Physical Layer Security. The main focus of his work is the Static Random Access Memory Physical Unclonable Function and its usage in security applications.

Milla Alaraatikka MA is a researcher at the Finnish National Defence University Department of Leadership and Military Pedagogy. Alaraatikka's main focus area is communication studies in which she received her master's degree. In addition, she has studied municipal and regional management and political science.

Elie Alhajjar is a senior research scientist at the US Army Cyber Institute. His research interests include mathematical modelling, machine learning and network analysis, from a cybersecurity viewpoint. He is a recipient of the Civilian Service Achievement Medal and the NSF Trusted Cybersecurity Fellowship. He holds a PhD in mathematics from George Mason University.

Dimah Almani is a Computer Science lecturer at Shaqra University in Saudi Arabia and is currently undertaking a PhD in cyber security at the University of Nottingham. She holds a Master's degree with honours in Computer Science from Nova Southeastern University, Florida and IBM Mastery Award as an Artificial Intelligence Analyst.

Tina AlSadhan has over 25 years of experience working in Information Technology and Cyber Security within the United States Department of Defense. She holds the following professional certifications: CISSP, CISA, and CISM. She is presently working towards a doctorate degree with her research focused on Cyber Security, specifically, Information Security Continuous Monitoring, in the United States Federal government.

Franck Baylor B.S. degree in Electrical Engineering (2019), Masters in (2021). Now working on PhD all from University of Dayton, Dayton, OH, USA Phd has an expected graduation date in 2024. Currently works for NASIC (National Air and Space Intelligence Center) at WPAFB (Wright-Patterson Air Force Base) as electronics engineer. Research interests revolve around electrical hardware cybersecurity with focus micro/nanoelectronics with defense and medical industries, also cybersecurity theory and policy.

Micki Boland is a global cybersecurity warrior and evangelist with Check Point Software Technologies Office of the CTO. A practitioner with 20 years in IT, cybersecurity, emerging technology innovation, Micki holds ISC2 CISSP, Master of Science in Technology Commercialization from the University of Texas at Austin, MBA with Global Security concentration from East Carolina University.

Jacob Chan is an officer in the U.S. Space Force and a master's student at the Air Force Institute of Technology, OH. His area of study is in Cyber Operations, with a thesis focused on the value proposition of digital badges to the Air Force.

Henry Collier is an associate professor and the Director for the MS in Cybersecurity, BS in Cybersecurity and BS in Computer Science & Information Systems programs at Norwich University. He received his Ph.D. in engineering security from the University of Colorado Colorado Springs. His main research areas are human factors in cybersecurity and networking.

Jaco du Toit is working as a senior lecturer at the Academy of Computer Science and Software Engineering at the University of Johannesburg. He is responsible for lecturing courses in Computer Science and Information Security. He is also the deputy director at the Centre for Cyber Security at the University of Johannesburg.

Petrus ('Beer') Duvenage has been in the field of information security for more than 30 years. He holds a PhD (Political Science) from the University of Pretoria and a PhD (Computer Science) from the University of Johannesburg. His extensive academic research in Counterintelligence and Cyber Counterintelligence has been published in various journals and proceedings of conferences.

John Gray received his Ph.D. in Information Systems Security from Nova Southeastern University and is employed in the U.S. defense industry as an Information Systems Security Manager. Areas of research interest include the effects of human factors on information assurance and cybersecurity, insider threats, and information systems ethics.

Pauliina Hirvonen is a PhD student in the Information Technology Faculty of University of Jyväskylä, in Finland. Her on-going dissertation relates to Information Systems and more specifically on information and/or cyber security field. The research considers the overall impacts and situational awareness related to GDPR from the organizational perspectives.

Bhaiyat Yacoob Humairaa is from Johannesburg and holds a Bachelor of Science Honours in Information Technology (University of Johannesburg). She is currently a software developer at Business Systems Group (Africa).

Aarne Hummelholm, PhD in Information Technology (University of Jyväskylä, 2019). He has over 30 years' experience in the design, development of architectures of authorities' telecommunications networks and information systems. Key themes in his work have been critical service availability, usability, cyber security and preparedness issues.

Aydan Huseynova Tomas Bata University in Zlin Faculty of Management and Economics: Univerzita Tomase Bati ve Zline Fakulta managementu a ekonomiky Zlin, CZECH REPUBLIC.

Her main research interest areas are employer branding, marketing, HR, social media and digitalization.

Eveliina Hytönen is a Senior lecturer of Security and risk management at Laurea University of Applied Sciences, a project expert in related projects, and Dissemination Manager in SAFETY4RAILS (Data-based analysis for SAFETY and security protection, FOR detection, prevention, mitigation and response in trans-modal metro and RAILway networkS).

Pierre Jacobs has over 20 years consultation experience in the IT Security industry. He is currently with CyberAntix where he serves as Head of Security Operations and Compliance. He holds a MSc with Specialisation in Information Security from Rhodes University, a Ph.D at the University of Johannesburg and various Industry certifications.

Dr. Connie Justice has over 30 years' experience in cybersecurity, computer, and systems engineering. She designed courses in cybersecurity curriculum to NSA/DHS Center of Academic Excellence and NIST National Initiative for Cybersecurity Education standards. Research areas include: misinformation, industrial controls risk, experiential learning, information and security risk management, digital forensics.

Miina Kaarkoski (Dr) is a researcher at the Finnish National Defence University Department of Leadership and Military Pedagogy. Her areas of expertise are crisis talk and influence on public opinion, societal beliefs and political decision-making processes.

Anni Karinsalo is working as a Research Scientist in the applied cryptography team at VTT Technical Research Centre of Finland. She has background in various fields of cybersecurity, such as distributed ledgers, privacy and post-quantum cryptography.

Sithembiso Khumalo is Lecturer and a Deputy HoD of Information and Knowledge Management IKM at the University of Johannesburg, SA. He received his Master's in IKM in 2016. His main research areas are Knowledge Portals, Strategic Information Management, entrepreneurial institutions, commercialisation dynamics. Miss Amanda Sibiyi and Miss Teballo A. Kekana are IKM Honours graduates.

Jan Kleiner is a PhD student of Political Science at Masaryk University in the Czech Republic. He focuses primarily on cybersecurity, the relationship between a state and citizens in cyberspace (e.g., how states secure their citizens in cyberspace), and propaganda and information warfare. He mainly employs quantitative (statistical) and mixed methods research designs.

Pekka Koistinen Msc is a researcher and a PhD student at the Finnish National Defence University Department of Leadership and Military Pedagogy. His main research areas are national security and cooperation between authorities.

Aphile Kondlo is a part-time master's student at University of the Western Cape majoring in Cybersecurity. He is currently a full-time employee at Woolworths Holdings Limited as an intermediate software developer. He is also, a member of the Golden Key International Society and UWC-CPUT Space Association.

Markku Kylänpää is a senior scientist in the applied cybersecurity research group at VTT Technical Research Centre of Finland. He received M.Sc. and Lic.Tech. from Information Technology in Helsinki University of Technology in 1985 and 1989, respectively. His main research area is platform security.

Janne Lahdenperä is a 3rd year Business Information Technology student at Laurea University of Applied Sciences, Finland. His interests include cyber security and ethical hacking.

Dr Yee Wei Law is a Senior Lecturer at UniSA STEM, University of South Australia. He is also a founder of the start-up Mesh In Space, which specialises in secure mesh networking for space vehicles. His research is currently focusing on space system security, adversarial machine learning and machine diagnostics.

Christoph Lipps, M.Sc., graduated in Electrical and Computer Engineering at the University of Kaiserslautern where he meanwhile lectures as well. He is the Lead of the *Cyber Resilience & Security* Team and Ph.D. candidate at the German Research Center for Artificial Intelligence (DFKI) in Kaiserslautern. His research focuses on Physical Layer Security (PhySec), Physically Unclonable Functions (PUFs), Artificial Intelligence (AI), entity authentication and all aspects of network and cyber security.

Clara Maathuis is Assistant Professor in AI and Cyber Security at Open University in the Netherlands. With a PhD in AI and Military Cyber Operations from Delft University of Technology, she is involved in teaching different AI and cyber security courses and conducts research in AI, cyber/information operations, military technologies, and social manipulation.

Juha Kai Mattila is a freelance researcher and a postdoc at Aalto University, Helsinki, Finland. He received his D.Sc. (Tech) from Aalto University in 2020 and G.S. Officer (C4ISTAR) from National Defence University, Finland in 1993. He is consulting Armed Forces in their digitalization or digital transformations. His main research areas are organizational evolution, enterprise architecture in modelling complex open systems, use of power in the cyber domain, and implementing digital transformations.

Qazi Muhammad Ali is a PhD Scholar at Superior University Lahore, Pakistan. I am perusing my PhD in Business Administration. I had attended many conferences in my research life. My main research area is on Behaviours and Human Resource Management.

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