



Critical research for critical mobile communication

Computer engineer **Mazin Alshamrani** details his promising research and academic career so far, highlighting his work to bring improved wireless communication systems to Mobile Ad-hoc Networks

To begin, could you introduce your electronic engineering research, outlining your core aims and objectives?

My research is focused on enhancing the performance of the Session Initiation Protocol (SIP) for voice applications over a Mobile Ad-hoc Network (MANET). A MANET is a dynamic wireless network system that provides an infrastructure of less connectivity for variable users and different applications, and implementations such as data exchange, Voice over Internet Protocol (VoIP) and video conferencing. The significance of this study is based on the idea of securing a simple effective backup network system for current mobile wireless communication systems. These systems are very important during natural disasters, such as earthquakes; in rural communications, such as in remote villages; and in military application and implementation systems.

Can you explain SIP in more detail?

SIP is an Internet Engineering Task Force (IETF) standard for signalling protocol released in RFC 3261. It's commonly used for controlling communication sessions such as voice and video calls over IP. SIP is used for initiating, managing and terminating such multimedia sessions. These features have made SIP a better choice for providing VoIP services in the last few years, especially for the implementation of backup systems in the communications arena. My research is considering a development and enhancement of voice applications for emergency and limited resources scenarios. I focus on enhancing the performance of the SIP signalling system over MANET to fulfil these requirements.

You are presently a Research Fellow at the Centre of Excellence in Mobile Applications and Services (CEMAS) at the University of South Wales. What does this position entail?

Working at CEMAS is a great privilege. My role in the CEMAS research group complements related research efforts through my PhD

studies at the Institute for Communication Systems (ICS) within the University of Surrey, UK.

I'm involved in interesting studies related to the implementation and evaluation of SIP-based VoIP applications over Long Term Evolution (LTE) access networks or what is known as VoLTE. The research considers both OPNET simulation tools and IP Multimedia Subsystem (Multimedia) test beds using different scenarios to evaluate and enhance VoLTE performance for mission-critical communication systems.

Is funding an issue for early-stage researchers like yourself? Do you feel you receive adequate training at this point in your career?

Research funding is a very important issue for any PhD student as it reflects on the research quality and the required level of outcomes. The continuous support and encouragement provided to me by my sponsors, the Saudi Arabian Cultural Bureau in London, have made my research journey a great and fruitful experience which I'm sure will continue in my future research and academic career.

Studying at ICS – which is a distinguished research centre that develops research students with the required level of support – has provided me with a great chance to achieve my research goals. I have also received great support from my supervisors Dr Haitham Cruickshank and Professor Zhili Sun who put my PhD research on the right track.

How important is a collaborative, multidisciplinary approach to your studies?

In general, both academic and industrial communication technology research sits in a diverse and constantly shifting landscape, based on market needs and technology developments in related communication and computing services. Therefore, collaborative efforts between relevant researchers is a must, through joint cooperation, publications, specialised research groups and conferences.

In my research, I have been keen to consider recent breakthroughs and relevant research efforts in SIP signalling systems, performance metrics, performance enhancement and MANET routing systems. Attending specialist conferences was an amazing opportunity to discuss and exchange valuable thoughts, new approaches and findings with experts in both my research area and related disciplines.

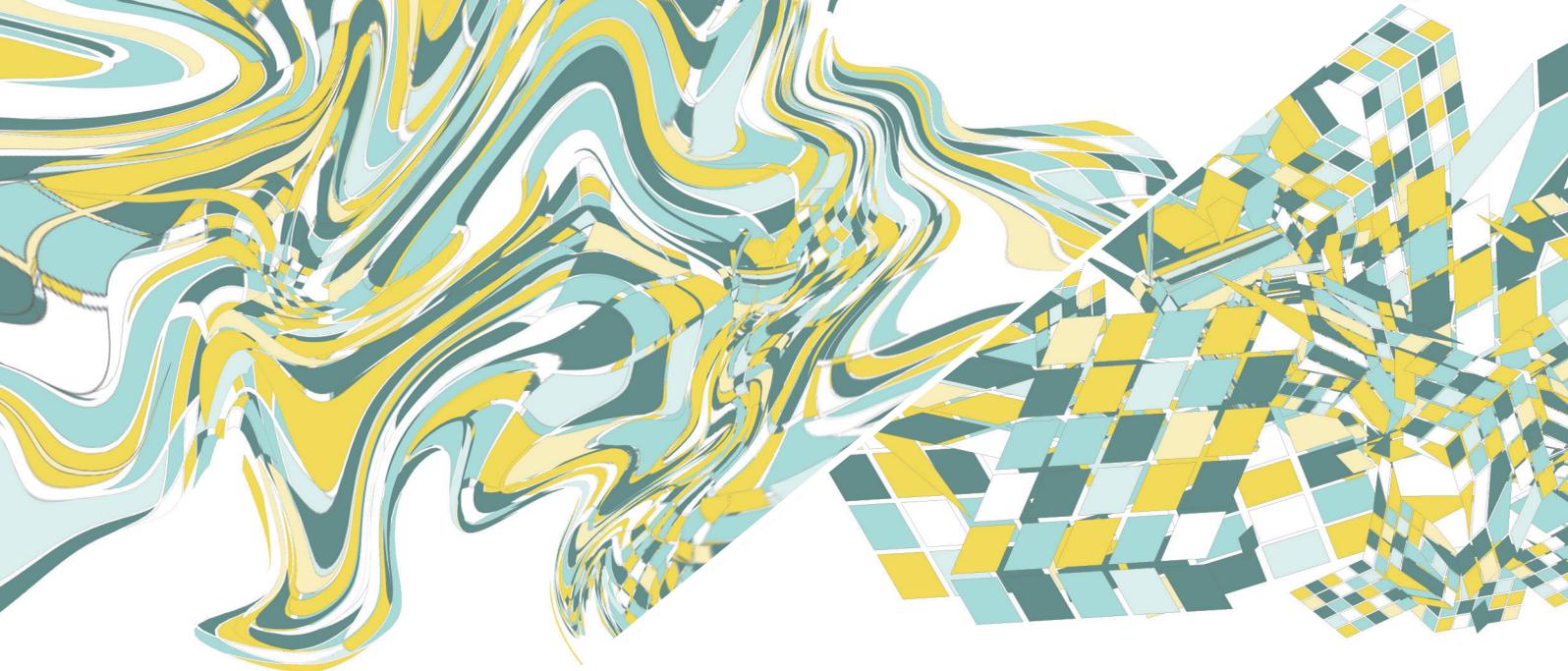
RESEARCH EXPERIENCE FROM TWO CENTRES

Institute for Communication Systems (ICS), University of Surrey

ICS is one of the largest academic research centres in the UK specialising in ICT. Housing ~160 researchers including over 90 undertaking a PhD, postdoctoral researchers and academic staff, ICS research focuses on future communication systems. Facilitating this cutting-edge research is a network of partners stretching across the UK, EU, India, China, Korea, Japan and the US.

Centre of Excellence in Mobile Applications and Services (CEMAS), University of South Wales

CEMAS helps Welsh SMEs and startup companies develop, test and find a route to market for their mobile application products. Capable of working across a number of platforms and minimising the initial risks associated with developing a mobile application to such businesses, CEMAS has a fully funded app development programme. In addition, the Centre has set up the Mobile Innovation Network which gives like-minded national and international companies opportunities to network, foster new ideas and find commercial opportunities through mutual collaboration.



Enhancing the performance of Session Initiation Protocol

Research originating from the Institute for Communication Systems at the **University of Surrey**, UK, is enhancing Session Initiation Protocol performance for better voice applications in wireless communications

SESSION INITIATION PROTOCOL (SIP)

enables the activation of real-time multimedia communications between two or more participants. Commonly used in internet telephony (also referred to as Voice over Internet Protocol (VoIP)), SIP allows video conferencing, instant messaging and interactive gaming. It is recognised as the industry standard IP signalling mechanism for voice and multimedia calling services, playing a key role in many aspects of digital communication and collaboration systems. For example, a user in a cafe could locate another user in another part of the world who agrees to start a gaming or chat session; or during a meeting, inviting colleagues from around the world to participate via internet video conferencing, and sharing information through a wireless network.

Mobile Ad-hoc Networks (MANETs) have emerged as an attractive type of wireless networking due to their flexibility, ability to self-configure and rapid deployment. MANETs can be formed heterogeneously and on-demand, allowing different networks to connect and perform independently without any existing infrastructure in place. However, there is a common requirement for these sessions before an internet user can activate such multimedia

applications: the need for a controlling signalling system such as SIP. Recently, SIP has emerged as an essential signalling system for multimedia services to be able to locate the right support for real-time applications, emphasising the importance of creating systems and infrastructure to ensure it works effectively and efficiently.

VOICE OVER IP

Advances in wireless technologies have meant that internet users are able to connect via IP clouds and, thus, a number of different applications and devices. But there are some major challenges in this area of communications. For one, the unstable nature of MANETs over different wireless topologies and mobile models can affect the Quality of Service (QoS). "Furthermore, the nodes' mobility in MANETs causes dynamic changes on the route calculations, topology, hop numbers and the connectivity status between the corresponding nodes," details computer engineer Mazin Alshamrani.

Alshamrani is presently a Research Fellow at the Centre of Excellence in Mobile Applications and Services (CEMAS) at the University of South Wales, while recently having completed his PhD studies at the Institute for Communication Systems (ICS) at the University of Surrey, UK. "As SIP-based VoIP depends on the caller's registration, call initiation and termination processes, SIP signalling performance has an important role in the overall QoS of SIP-based VoIP applications over IPv4 and IPv6 MANET."

Alshamrani is examining the performance enhancement of SIP for VoIP application

over MANET, with the ambition of developing voice applications for emergency and limited-resource scenarios. VoIP is widely used in internet applications, its quality and performance often measured in terms of signalling (the predominant control and management mechanism for VoIP calls), bandwidth, packet loss, delay and jitter. Through analysing such performance metrics of SIP-based VoIP services over IPv6 MANET and how this affects VoIP QoS, Alshamrani has concluded that SIP acts poorly in IPv6. These results emphasise the need for both SIP signalling and routing performance to be advanced for real-time applications over MANET.

LONG TERM EVOLUTION AND IP MULTIMEDIA SUBSYSTEMS

Long Term Evolution (LTE), a 4G standard wireless broadband technology for mobile networks, has recently been introduced to provide improved bandwidth capacity, coverage, reduced latency and increased peak data rates. LTE is a packet-only technology, developed to effectively manage voice multimedia services and offer support for mobile internet access. Voice over LTE (VoLTE) is basically based on the IP Multimedia Subsystem (Multimedia), a framework for delivering a wide range of multimedia services. "For supporting the functionalities of multimedia services, Multimedia consists of multiple SIP proxies, known as Call Session Control of Functions (CSCFs), which are used for SIP signalling with other variants," Alshamrani explains. "The emergence of enormous LTE capabilities along with Multimedia-based services such as video conferencing, voice calls and Push-to-talk over Cellular (PoC), is based on effective VoLTE systems." His mission here is to further



MULTIMEDIA IMPLEMENTATIONS OVER MOBILE WIRELESS NETWORK SYSTEMS

OBJECTIVES

- To enhance the performance of the Session Initiation Protocol (SIP) for Voice over Internet Protocol (VoIP) application over Mobile Ad-hoc Networks (MANETs)
- To study the emerging Long Term Evolution (LTE) capabilities along with IP Multimedia Subsystem (Multimedia)-based services such as Push-to-talk over Cellular (PoC) based on the Voice over LTE (VoLTE) system

SUPERVISORS

Dr Haitham Cruickshank; Professor Zhili Sun,
University of Surrey, UK

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Ministry of Higher Education, Kingdom of Saudi Arabia

CONTACT

Mazin Alshamrani
Former PhD student

Institute for Communication Systems (ICS)
Faculty of Engineering and Physical Science (FEPS)
University of Surrey, Guildford, UK

Research Fellow
The Centre of Excellence in Mobile Applications and Services (CEMAS)
University of South Wales
Faculty of Computing, Engineering and Science
J339, Johnstown Building
Treforest Campus
Pontypridd
Wales, UK

T +44 144 348 2108

E mazin.alshamrani@southwales.ac.uk

 <http://bit.ly/LinkedInMazinAlshamrani>

 <http://bit.ly/ResearchGateMazinAlshamrani>



MAZIN ALSHAMRANI recently completed a PhD in ICS, University of Surrey. He is currently a Research Fellow at CEMAS, University of South Wales. His research interests centre on the performance of multimedia applications and VoLTE.

Alshamrani's main aim is to enhance SIP's role as a substitute communication scheme in disasters, emergency recovery systems, military operations, rural communications, as well as collaborative applications

integrate and optimise efforts in order to meet the communication requirements for the desired services.

ENHANCING SIP SIGNALLING

Alshamrani is incredibly proud of his achievements to date, particularly his work on a performance evaluation that examined the SIP signalling system over the Ad-hoc On Demand Distance Vector (AODV) and Optimised Link State Routing (OLSR) based MANET in various mobile models. Here, he employed an end-to-end performance evaluation to investigate enhancement efforts for the SIP signalling system: "The evaluation study was used to benchmark the related performance metrics for the SIP signalling system in general," he outlines. "In addition, my research study evaluated implementations of the Robust Header Compression (ROHC)-based system over IPv6 MANET for SIP-based VoIP." This study again revealed the limitations of using SIP signalling over IPv6 – a challenge that Alshamrani remains focused on in his research today.

In addition, he created and implemented a novel cross-layer approach with the aim of enhancing performance of the SIP signalling system over MANET based on simple dynamic modifications for the routing parameter. Through the

development of this tool, he was able to reduce the number of total delays in the SIP process, enhancing performance and increasing the utilisation level in the system bandwidth and routing processes.

FROM IDEA TO INDUSTRY

Alshamrani's main aim is to enhance SIP's role as a substitute communication scheme in disasters, emergency recovery systems, military operations, rural communications, as well as collaborative applications. In order to put this into effect, Alshamrani will next need to modify the routing parameters to enhance SIP signalling in MANET.

Currently, his work is being supported by CEMAS, which enables him to thrive and learn more about the communications arena. However, in the future he sees a move towards more involvement with the industrial sector – although conducting research and maintaining his position within academia will still be fundamental aspects of Alshamrani's career. With significant advances already showcased in his current research and a clear plan ahead, the future looks promising for Alshamrani as he begins to put his research into practice.

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