Special Issue: Smart Satellite Systems

Guest Editorial

The prominence of satellite communications and its niche roles in facilitating global connectivity and remote sensing have long been recognised and exploited. The use of satellites has grown beyond inceptive applications in international telephony and TV program distribution and broadcast to embrace other key areas. Navigation; assets tracking and management; remote sensing and imaging of the Earth for military and civil purposes; extension of broadband communications (including high speed Internet access) to domains outside the reach of terrestrial infrastructure, such as offshore facilities for the oil and gas industries, people on the move in the air and at sea as well as those in remote, rural, undeveloped, inhospitable or disaster-stricken locations; backhaul and transit connection services for telecom operators and Internet Service Providers (ISPs); these are just a few of the many modern applications of satellite communications.

In 2016 we are on the verge of a data transmission deluge arising from smart homes and cities, driverless vehicles, and connectivity for billions of sensors, functional objects and assets, which is commonly referred to as *Internet of Things* (IoT). Around the world there is a huge and growing appetite for data-rich multimedia services, including video-on-the-move to billions of small mobile devices, smart phones and fixed terminals. This has contributed in no small measure to the explosion in data consumption which we have witnessed in recent years. Furthermore, 150 years of telecommunication has only catered to around 40% of our human capacity to experience and interact with information, engaging only our senses of sight and hearing through a multimedia communication network. Looking beyond 5G, it could be expected that by year 2040 a mobile 6G network operating under a canopy of interlinked geostationary and non-geostationary satellites will exploit advances in biosensors, touch sensors and haptic displays to usher in a *multisensory Internet* that adds tactile and olfactory functionalities to the audio-visual capabilities of today's multimedia Internet. This will tap into the goldmine of information contained in feeling and smell, and will usher in revolutionary applications in medicine, commerce, entertainment, law enforcement and all walks of life. Such multisensory network could deliver true ubiquity and ample-speed anytime anywhere, using the most effective transmission path based on location and circumstances, and catering to 80% of human interactive capacity.

Wireless and satellite communication capabilities must therefore be prepared for the coming data transmission deluge serving a growing population of users and vast arrays of sensor devices and IoT. Meeting this need into the foreseeable future in order to fulfil the dream of '*broadband anytime, anywhere on earth'* requires bold new thinking to devise innovative solutions to major challenges in terrestrial and satellite mobile networks design and implementation. Some of these challenges include super-efficient utilisation of radio spectrum, security and reliability, use of radio spectrum above Ka-band and dealing effectively with the attendant increased propagation impairments, designing intelligent link-adaptable transmitters, building high throughput satellite (HTS) systems with capacities approaching one terabit per second (Tbps), interference mitigation, delivering broadband services in extreme-latitude regions that are invisible to geostationary satellites, energy efficiency and resource management, latency, and so on.

The contributions in this special section address a few of the challenges of developing smart satellite systems to enable a truly ubiquitous broadband future. Benjamin Rohrdantz *et al.* present a novel digital beam forming antenna array with polarisation multiplexing suitable for the 4-colour spot beam scheme employed in emerging high throughput satellite (HTS) systems operating at Ka-band. The modular array system facilitates fast beam scanning and tracking and its flat design makes it highly suited for aeronautical applications. Leshan Uggalla *et al.* report on a novel method of improving Ka-band link resilience during intense rain by employing short-delay time-diversity with maximal ratio combining of channels. Simulation-based testing of the new technique on a hypothetical satellite link at 20 GHz (downlink) and 30 GHz (uplink) shows reliable performance down to a negative carrier-to-noise ratio of -6 dB. Abdulkareem Karasuwa *et al.* investigate the problem of cross-polarisation discrimination-induced interference in dual-polarised HTS systems. Their analysis employs actual measured satellite beacon data in South Wales, United Kingdom (a temperate region) and prediction models from the International Telecommunications Union – Radio Sector (ITU-R) in a tropical location, and demonstrates the performance-limiting impact of depolarisation-induced co-channel interference and hence the need for effective mitigating measures. K'ufre-Mfon Ekerete *et al.* provide new insights into parameters and factors influencing multimodality in the modelling of rainfall drop size distribution which should be useful in the design of satellite communication links and rain fade mitigation strategies. Slim Abdellatif *et al.* discuss a prototype for the virtualization of the satellite segment to give virtual network operators (VNOs) enhanced flexibility and control over products purchased from satellite network operators (SNOs) and hence allow a more fine-grained dynamic allocation of satellite network resources.

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