International Network Generations Roadmap

-2021 Edition-

Satellite

An IEEE 5G and Beyond Technology Roadmap

futurenetworks.ieee.org/roadmap

This edition of the INGR is dedicated to the memory of Earl McCune Jr., who left us tragically and too soon on 27 May 2020. Earl was a microwave/RF guru, brilliant technologist, major industry/IEEE contributor, global visionary, keen skeptic, and all around fantastic human being. He was a major contributor to the INGR's early work on energy efficiency, millimeter-wave, and hardware. He worked for a technologically advanced yet more energy efficient world, and the contents of the INGR are a tribute to that vision. Rest in peace, Earl!

Table of Contents

Tables

Figures

ABSTRACT

The fifth-generation (5G) Wireless Communication systems development has brought out a paradigm shift using advanced technologies e.g., softwarization, virtualization, Massive MIMO, ultra-densification and introduction of new frequency bands. However, as the societal needs grow, and to satisfy UN's Sustainable Development Goals (SDGs), 6G and beyond systems are envisioned. Non-Terrestrial Networks including satellite systems, Unmanned Aerial Vehicles (UAVs) and High Altitude Platforms (HAPs) provide the best solutions to connect the unconnected, unserved and underserved in remote and rural areas in particular.

Over the past few decades, Geo Synchronous Orbits (GSO) satellite systems have been deployed to support broadband services, backhauling, Disaster Recovery and Continuity of Operations (DR-COOP) and emergency services. Recently, there is a considerable renewed interest in planning and developing non-GSO satellite systems. Within the next few years there will be several thousands of Low Earth Orbit (LEO) satellite systems, mega constellations, will be ready to provide global Internet services.

This report is the 2021 Edition of the INGR Satellite Working Group Report, subsequent to the First Edition [1]. The topics considered in this INGR Satellite WG 2021 Edition of the roadmap are the following: applications and services, reference architectures, new MIMO-based PHY, antenna and payload, machine learning and artificial intelligence, edge computing, QoS/QoE, security, network management and standardization. The work on the roadmap will continue towards the next edition of the roadmap addressing the details of the challenges and potential solutions for future networks such as 6G and beyond.

Key words: Satellite Communications, Satellite Networks, Waveforms, MIMO, OFDM, QoS, Security, Network Architecture, LEO, MEO, GEO, HAP, UAV, MEC, AI/ML