



WIRELESS WORLD
RESEARCH FORUM®

The Connected Vehicle

Presented
By
(WWRF VIP CV WG Chair Seshadri Mohan)
at
ITU-CITS Meeting, September 9, 2020



WWRF Role and principles of operation

- Develop future vision of the wireless world
- Inform and educate on trends and developments
- Enable and facilitate the translation of the vision into reality
- Bring a wide range of parties together to identify and overcome significant roadblocks to the vision

- Global
- Open to all
- Covers every platform
- Not
 - standards body
 - research funding body
 - A typical research conference
- Based on membership
- All can attend meetings and make contributions



Membership



- Manufacturer
- Network operator
- Industry organization
- Academic institute



- Africa
- Americas
- Asia
- Europe



How does WWRF work?

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- Hold two meeting per year
 - as well as the WWRF 5G Huddle and other special and invited sessions
- Take input from our members and meeting participants
- Put the results together and bring out a vision of the future research challenges
- Promote the vision through publication and working with global and regional partners



WORKING GROUPS

WGA/B

User Needs & Requirements; Services, and Devices, in a Wireless World.

Promoting a secure communications environment across multiple Socio-Economic settings based on user needs and requirements.

WG HF

High Frequencies (mmWAVE and THz) Radio Communications Technologies

Higher frequency radio communication technologies are expected to enable the vision of wireless transmissions towards the region of 1 Tbit/s. Improved channel modelling and the design of appropriate waveforms, baseband processing, medium access control (MAC) schemes and antenna array configurations are addressed.

VIP Water

Vertical Industry Platform - 5G for smart water management

A discussion platform about water management and study of the communication requirements, to assess whether 5G can take us faster and further than existing ICTs.

VIP RAIL

Track-to-Train communications

The focus identifying the potential benefits and hurdles for the future adoption of what today is known as 5G by rail transport systems worldwide. Security, reliability, IoT and dependability are playing a focal role in future radio communication systems for efficient train operations and safety.

WGC

New directions in communication architectures and Technologies

Guiding the mobile industry in the use of software, virtualization and cloud computing in future networks (both wireless and wired) by developing end-to-end network architectures, identifying the specific requirements and issues and addressing them by providing solutions that are practical and business driven.

WGD

Radio Communication Technologies

Advanced radio technologies and spectrum issues are investigated, to optimise the design of the air interface, medium access and heterogeneous multi-user, multi-RAT systems and identify trends and impact the wireless evolution towards 5g and beyond.

WG WAI

AI for Wireless Communications

Artificial Intelligence applied to the wireless communications domain is referred to as Wireless Intelligence (WI). This will be in all sub-systems within the wireless ecosystem. WI is expected by the market to not only reduce operational expenditures (OPEX), but also to increase user quality of experience (QoE) as well as help the introduction of new value chains in an increasingly competitive and complex business environment.

VIP CV

Connected vehicles

Focuses on research that looks five to ten years ahead in order to meet the requirements of the automotive and transport industries based on the next generation wireless technology.

VIP EMW

Ehealth, mobile health and wearables

Developing an e/m-Health and wearables vertical industry paradigm to expose the requirements of such systems to be 5G-enabled



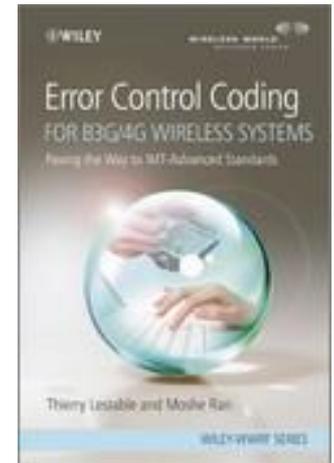
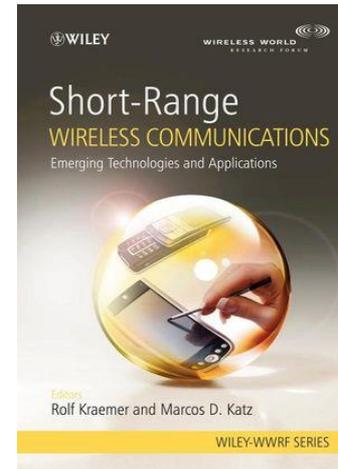
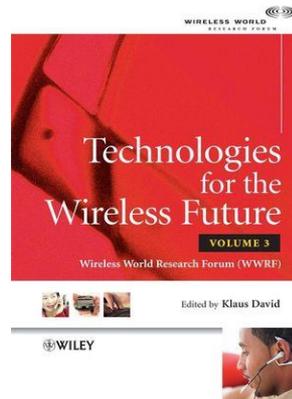
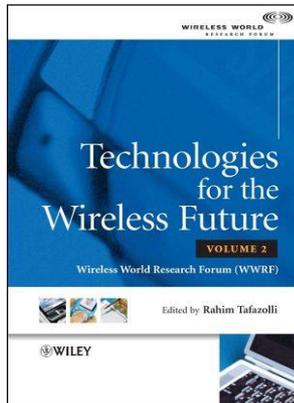
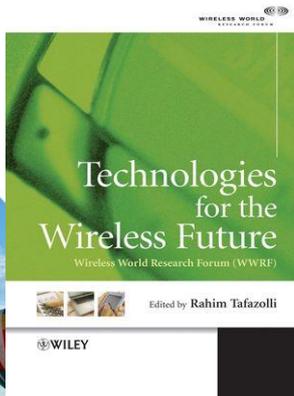
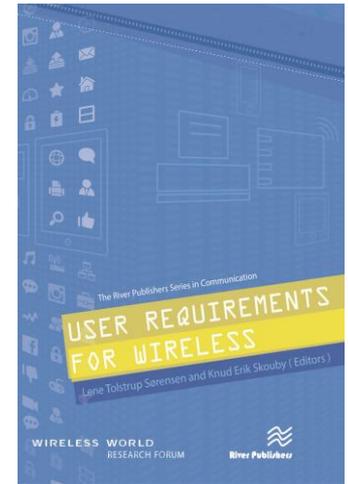
What is WWRF?

- Founded in 2001
 - Through WSI an EU-funded research landscaping project
- Based in Switzerland
- Independent and owned by its members
- Promoting visions of the wireless future



WWRF outputs

- WWRF Outlook – published version of White Paper
- WWRF Library – proceedings of each meeting
- WWRF – Wiley and River book series



Outlooks to look out for

- Published in 2019
 - WWRF Outlook 24 - Artificial Intelligence in the Wireless Arena
 - WWRF Outlook 25 - Connected vehicles
- In development
 - 5G business models
 - 5G and the water industry
 - Millennial users in a 5G context
 - Cybersecurity challenges in the Wireless World
 - Ehealth enabled by 5G and machine learning
 - Network slicing
 - High speed rail services and 5G
 - Thz communications and system architectures
 - 6G/Beyond 5G



WWRF Overview

- Develop future vision of the wireless world
- Enable and facilitate the translation of the vision into reality
- Bring a wide range of parties together to identify and overcome significant roadblocks to the vision
- Inform and educate on trends and developments

- Global operation
- Covers every technical field of wireless communications and mobile networking
- Open to all
- Based on membership

60 member organizations



- Manufacturer
- Network operator
- Industry organization
- Academic institute
- Research organization



- Africa
- Americas
- Asia
- Europe

VIP CV WG: The Connected Vehicle

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Scope

The VIP CV WG focuses on research that looks five to ten years ahead in order to meet the requirements of the automotive and transport industries based on the next generation wireless technology. It also is aimed at the identification of use cases for these industries.



Objectives

- Leverage academic research to develop technologies for connected vehicles (CV) that complement developments in standards bodies.
- Provide relevant input to government in order to maximize the advantages of CV technologies while addressing concerns with respect to security and privacy.
- Develop WWRF as a bridge between the automotive industries and industry organizations such as 5GAA and the wireless standards organizations (such as 3GPP) to provide input to help prepare for standardization.
- Create a better understanding in the automotive industries of the potential and capabilities of future wireless technologies.
- Enable the telecom and automotive industries to jointly discuss the vision, usage scenarios, requirements and enabling technologies to achieve the targets of future vertical industry communications in 5G and beyond.
- Develop use cases and study any gaps that may need to be addressed with respect to existing and evolving standards (e.g., DSRC) for the support of connected car and associated industries
- Develop use cases and technical requirements for 5G and beyond support of the connected car and associated industries.



Milestones and deliverables

- Outputs include white papers and technical proposals which will be submitted to major standardization bodies of 5G, including ITU and 3GPP, as well as industry organizations such as 5GAA
 - Launch of working group at WWRF39 meeting in Barcelona (October 2017)
 - A White Paper was completed – WWRF Outlook 25: Connected Vehicles, and distributed to participants at WWRF Meeting 43 held in London in October 2019.



Participation

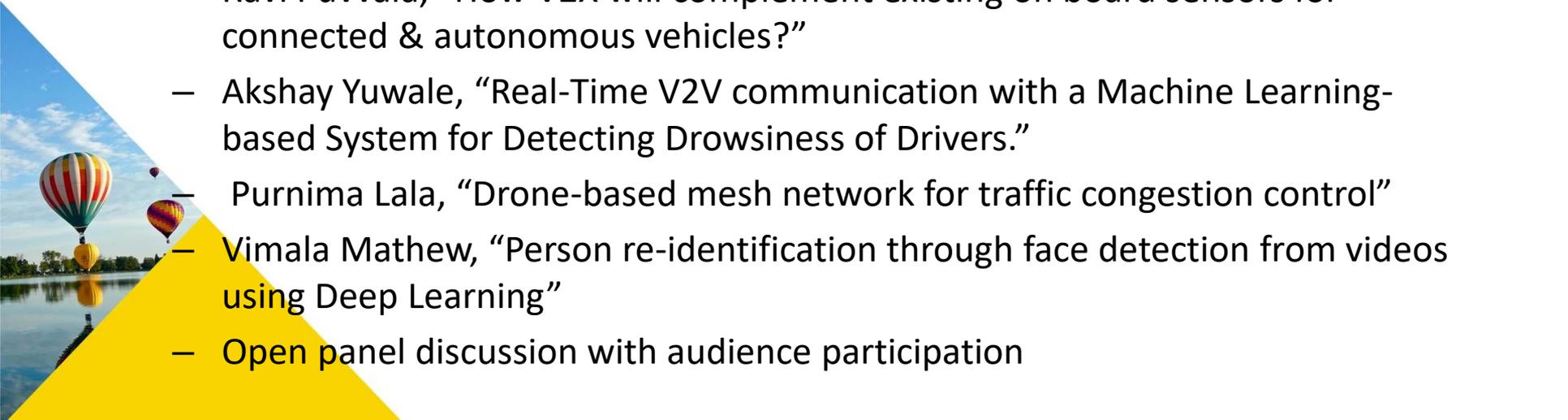
- The major companies, universities and organizations active in the area of V2X, including China Mobile, Intel, the Society of Motor Manufacturers & Traders (SMMT), ITU CITS, King's College London, UA Little Rock, USA, and Huawei.
- Many telecom operators, vendors and car manufacturers have shown interest and some of them are expected to join and contribute.



Connected Vehicles Workshop at 2019 ANTS, BITS Pilani, Goa, India, Dec. 16-19, 2019

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- **A Workshop titled “Impact of Emerging Standards, 5G and Beyond, and Machine Learning on Connected Vehicles,” was organized on Dec. 16, 2019 at IEEE ANTS, Goa, India.**
- **The following papers were presented at the Workshop**
 - Seshadri Mohan, “Impact of Emerging Standards, 5G and Beyond, and Machine Learning on Connected Vehicles,”
 - Ashok Chandra, “Spectrum issues related to connected vehicles.”
 - Ravi Puvvala, “How V2X will complement existing on board sensors for connected & autonomous vehicles?”
 - Akshay Yuwale, “Real-Time V2V communication with a Machine Learning-based System for Detecting Drowsiness of Drivers.”
 - Purnima Lala, “Drone-based mesh network for traffic congestion control”
 - Vimala Mathew, “Person re-identification through face detection from videos using Deep Learning”
 - Open panel discussion with audience participation



- WWRF 5G Huddle in New Delhi, Feb. 5-6, 2020
 - A panel session was organized on the topic of “Driving digital transformation in urban environments” in which the following papers and panel were organized.
 - Bipin Pradeep Kumar, “Case Study: 5G & Smart Cities”
 - Seshadri Mohan, “The Impact of Emerging Standards, 5G and Beyond, and Machine Learning on Connected Vehicles.”
 - A Panel Discussion ensued following the above two papers.



Summary of VIP CV Activities –Sesh Mohan

- A WWRF Connected Vehicle Session was organized on February 9, 2020 at International Symposium on 5G and Beyond for Rural Upliftment, hosted jointly by BIT Sindri and IIT (ISM) Dhanbad. Six papers were presented including a talk by the VIP CV Chair based on the Connected Vehicles White Paper (Outlook 25).
- At WWRF Meeting 44, held at Aarhus University, Denmark during June 29 to July 1, 2020, two sessions of connected vehicles were organized in which eight papers were presented covering a wide ranging set of topics including:
 - V2X standards,
 - 5G V2X security,
 - V2X multimedia services,
 - visible light communications,
 - automotive joint sensing and radar communications,
 - detection of driver's physical conditions with the use of biomarkers sensing,
 - urban railway communications with V2X, and
 - data challenges in connected vehicles.



WWRF Meeting 44

VIP CV Papers Presented

WG Session 2B – WG CV 1		WG Session 5 VIP CV 2	
Chaired by Seshadri Mohan, University of Arkansas at Little Rock		Chaired by Seshadri Mohan	
Subhash Mondal & Subodh Gajare	Standards landscape for Connected vehicles	Sayon Karmakar & Seshadri Mohan	Monitoring Biomarkers of Drivers with Medical Wireless Sensor Networks deployed in Connected Vehicles
Marcus Wong	Update on Security Standards for Connected Vehicles	Stephan Sand	Digital Urban Rail Communications with Vehicle-to-Everything Radio Technologies
Ahmed Y. Awad & Seshadri Mohan	Integrated V2X Services with GCSE Over IMS	Andre Burgess	Addressing the data challenges in Connected Vehicles
Gurinder Singh et al	Optical Power domain NOMA, Visible Light Communication, Stochastic Geometry	Bhavani Shankar	Automotive Joint Sensing and Communication: Enhancing Automated Driver Assistance Systems Using 5G

Summary of VIP CV Activities

- The CV White Paper (WWRF Outlook 25) is scheduled to be published as a book chapter by Springer.
- Plans are being made for the second white paper on connected vehicles on the topic of 'The Role of AI/Machine Learning in Connected Vehicles.' Members of Telecommunications Standards Development Society, India (TSDSI), and other organizations have formed a team to partner with WWRF CV VIP working group to develop the white paper.
- Those interested in contributing to the white paper, please contact VIP CV Chair Seshadri Mohan at sxmohan@ualr.edu.



Summary of VIP CV Activities

- The CV White Paper (WWRF Outlook 25) is scheduled to be published as a book chapter by Springer.
- A Workshop on Connected Vehicles is being planned at IEEE ANTS 2020,, India, December 14-17, 2020.
- Those interested in contributing to the workshop, please contact VIP CV Chair Seshadri Mohan at sxmohan@ualr.edu.



White Paper on Connected Vehicles Published as Outlook 25

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OUTLOOK

Visions and research directions for the Wireless World

Connected Vehicles



October 2019, No 25



Outlook 25 Connected Vehicles

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- **1. Introduction**
- **2. Relevant Standards**
- **3. Heterogeneous Connectivity and Requirements of CV**
- **4. Spectrum Issues**
- **5. Security and Privacy in Connected Vehicles**
- **6. Cyber Security Issues Relevant to Connected Vehicles**
- **7. Current Research Relevant to IoV**
- **8. Conclusions**



Future 2020 Events

- VIP CV will meet at the forthcoming WWRF meetings:
 - WWRF45 in Kuala Lumpur, Malaysia, in February 2021 (www.wwrf43.ch)
- Contributions to WWRF Meetings
 - Open calls are advertised on the website www.wwrf.ch
 - Full papers will be published in IEEE VT Magazine (if successfully reviewed)
 - Contributions can be made by all including non-members



Contact

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