WM917-15 Networks and Communications for the Connected Car

24/25

Department
WMG
Level
Taught Postgraduate Level
Module leader
Karim El Haloui
Credit value
15
Module duration
2 weeks
Assessment
100% coursework
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This module aims to provide the students with an up to date, comprehensive knowledge of the main wired and wireless communications technologies that are used, or will be used, in current and future production consumer vehicles.

Module aims

Through providing a knowledge base of core telecommunications theories, the student is taken forward into the application domain, such that the various wired and wireless technologies in the context of the automotive space is understood. Key concepts of theory vs. application are discussed based upon the inference and understanding of the performance of the technologies both at the component and system level. Topics are introduced from both the theoretical and practical viewpoints to encourage independent critical evaluation of the subject matter.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Indicative outline

Introduction: Taxonomy of modern communications. OSI Model. Context of Networks and Communications.

Telecommunications Theory:

- Pulse Modulation: Analog to digital conversion. Sampling, aliasing, and Nyquist, Equalisation. Digitisation, quantisation and errors. Encoding and decoding.
- Baseband and Passband Modulation: baseband and applications of baseband transmission. ISI. Pulse shaping Baseband to pass-band. Carrier waves. Basic modulation types. Error rates and bandwidth relationships.
- Coding Theory: BER, basic coding schemes, AWGN. Error detection and correction, basic ECC Shannon limits and/or capacity.
- Multiple Access: Single channel communications. Multiple access motivation and techniques. Multiple access in practice.

Wireless Technologies

- Link Budget and Channel: Spectrum Reuse. Noise, origins and types. Free space losses. Carrier to Noise Ratio. Propagation models.
- GNSS: Core principles and motivation in the context of automotive. Performance metrics. Automotive integration.
- 5G: Key Technologies and Roadmap for 5G. Background and Demands. 5G Specifications. Absorptions and specific channel limitations. OFDM/multicarrier transmitter and receiver. Convergence including IoT. Backward (and forward) compatibility.

Wired Technologies

- CAN/CAN-FD: Context and principle applications. Physical layer (low speed and high speed), and architecture. Protocol - Message frames, headers, addressing, message IDs. Usage and standards compliance.
- LIN: Context and principle applications. Physical layer. Protocol - Message frames, headers, addressing etc. Topology. Usage and compliance. API.
- Ethernet: General Ethernet principles. Networking model, and comparison between other technologies. Terminology. Standards. Topologies e.g. bridges, nodes, stations etc. Common physical layers and IEEE 802.3.

Learning outcomes

By the end of the module, students should be able to:

- Critically evaluate communication building blocks and how they fit within a communication system [AHEP:4, M1, M2, M3, M4, M5, M7, M16, M17]
- Evaluate a complete communication system within the wider automotive eco-system with a view towards future communication systems. [AHEP:4, M1, M4, M5, M7, M16, M17]
- Apply relevant practical communications techniques and understand how their results may

be used to inform judgements, develop and advance ideas and/or practice. [AHEP:4, M1, M2, M3, M4, M5, M7, M17]
- Demonstrate the ability to design communication systems to support connectivity aspect of connected and/or autonomous systems. [AHEP:4, M1, M2, M3, M4, M5, M7, M16, M17]
- Demonstrate a comprehensive understanding of and competence in the use of appropriate channel modelling tools and techniques for the purpose of system performance prediction. [AHEP:4, M1, M2, M3, M4, M5, M7, M17]

Indicative reading list

- JIANG H., Channel modeling in 5G wireless communication systems, (2020), ISBN: 9783030328696.
- TOSKAL A., 5G technology : 3GPP new radio, (2020), ISBN: 1119236290
- GOLDSMITH, A., Wireless Communications, Cambridge University Press, (2005), ISBN: 0521837162.
- TSE, D., Fundamentals of Wireless Communications, Cambridge University Press, (2005), ISBN: 0521845270.
- MATHEUS, K., Automotive Ethernet, Cambridge University Press, (2017), ISBN: 1107183227.
- PARET, D., Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire, (2007), ISBN: 0470034165.
- MEAD, N.R., Cyber Security Engineering: A Practical Approach for Systems and Software Assurance, (2016), ISBN: 0134189809.
- Wiley 5G Ref: The Essential 5G reference Online, (2019), ISBN: 9781119471509. (Optional Depending on Library Availability)

View reading list on Talis Aspire

Subject specific skills

Equipment Handling, Equipment Usage, Test and Measurement, Matlab Analysis.

Transferable skills

group work, time management, presentation skills.

Study

Study time

Type	Required
Lectures	26 sessions of 1 hour (17%)
Seminars	1 session of 1 hour (1%)
Total	150 hours

Type	Required
Practical classes	8 sessions of 1 hour (5%)
Private study	55 hours (37%)
Assessment	60 hours (40%)
Total	150 hours

Private study description

In-depth reading around the subject

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group A4

	Weighting	Study time
Post Module Assignment	80%	42 hours
6 to 8 problems depending on their length and complexity to be solved by students.		
In-module Assignment	20%	18 hours
Laboratory results submission - 1000 to 1200 words.		

Feedback on assessment

PMA and IMA: Scaled ratings for Comprehension, Effort, and Presentation. Individual written feedback and overall marks.
Formative assessment will be provided during the laboratory activities and class interactions

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Availability

Courses

This module is Core for:

- Year 1 of TWMS-H33L Postgraduate Award Smart, Connected and Autonomous Vehicles
- EWMS-H1U2 Postgraduate Taught Engineering Competence (Smart, Connected and

Autonomous Vehicles) (Degree Apprenticeship)
    - Year 1 of H1U2 Engineering Competence (Smart, Connected and Autonomous Vehicles) (PGDip) (DA)
    - Year 1 of H1TE Smart, Connected and Autonomous Vehicles (Part-time)
- Year 1 of TWMS-H1SE Postgraduate Taught Smart, Connected and Autonomous Vehicles (Full-time)
- Year 1 of TWMS-H1TE Postgraduate Taught Smart, Connected and Autonomous Vehicles (Part-time)

This module is Core optional for:

- Year 1 of TWMS-H33M Postgraduate Certificate Smart, Connected and Autonomous Vehicles
- Year 1 of TWMS-H33N Postgraduate Diploma Smart, Connected and Autonomous Vehicles
- Year 1 of TWMS-H33P Postgraduate Taught Smart, Connected and Autonomous Vehicles