CARLETON UNIVERSITY

Department of Systems and Computer Engineering
SYSC4700 Telecommunications Engineering 2018

Professor Halim Yanikomeroglu

TERM PROJECT OUTLINE (v3)

CAN-V 2030: CONNECTED, AUTONOMOUS, NETWORKED VEHICLES OF THE 2030s

SUBMIT THE REPORT IN PDF FORMAT AS AN EMAIL ATTACHMENT BY 11:59 PM, WEDNESDAY, APRIL 11.

Late submission without penalty: 11:59 pm, Friday, April 13.

Award: The best project group members will receive individual certificates

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The term project is one of the most important components of this course. You should consider this project as an *opportunity* (not a hassle!) for you to learn more in an interesting area. Make sure that you get most out of this project.

1. Context

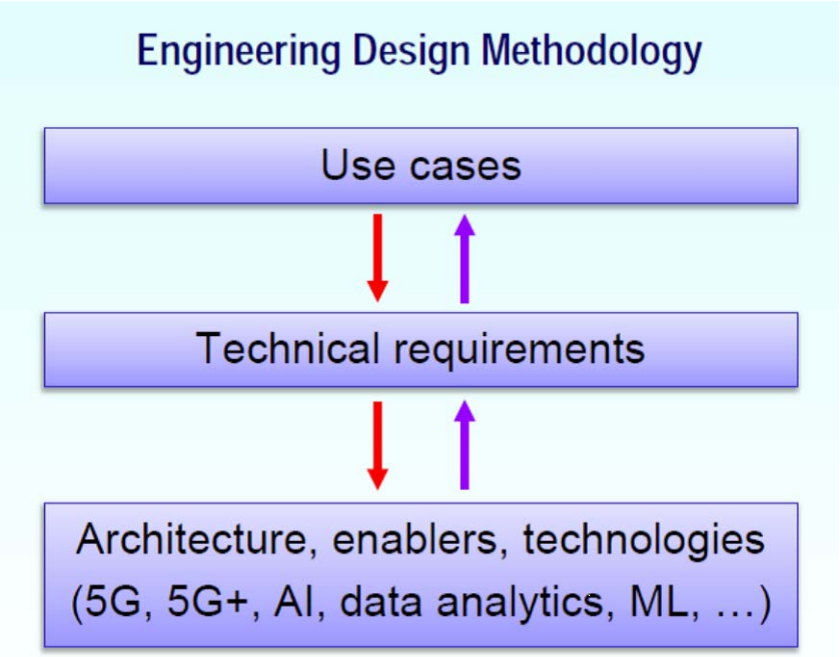
As we move deep into the 21st century, advances in technology are creating unprecedented opportunities by enabling paradigms which, until recently, have been only within the realm of fiction. The application of information and communication technologies (ICT) in vertical sectors is transforming those industries in remarkable ways. Among the most prominent examples is the "connected, autonomous, networked vehicles (CAN-V)" paradigm.

The automotive industry started in the late 19th century and at the heart of that revolutionary 'horseless carriage' was the development of the engine. The importance of the automotive revolution in human history, which impacts almost every facet of our lives, has been unparalleled. Now, the application of the novel ICT concepts in the well-established automotive sector is creating a second revolution; this time, it is even larger and more far-reaching. The CAN-V revolution aims at a 'driverless carriage', with information now being the transforming power. We are only at the dawn of this new revolution; yet, the

global market is expected to exceed $130B by 2019. The CAN-V paradigm will continue to unfold steadily and progressively throughout the 2020s and 2030s with more and more ICT functionalities in place (such as accurate sensing, robust/secure/low-latency connectivity, and reliable decision making) onboard and in the infrastructure. The global CAN-V market is expected to reach $7T by 2050 becoming one of the biggest markets in the world, according to a recent Intel whitepaper. One of the significant benefits of this paradigm is the estimated 585,000 lives that could be saved due to the autonomous operation between 2035 and 2045, according to a study by Strategy Analytics. Persons with mobility issues (notably the elderly or physically disabled) are among the people who will potentially benefit the most from the CAN-V paradigm. As we move to increasingly more automated vehicles, old paradigms of licensing, insurance, and driver examination will shift, opening new opportunities for personal mobility that these populations have previously been precluded from.

Canada is a strong player in both the global automotive and ICT sectors, which have evolved rather independently until recently; however, the global landscape is changing rapidly and the world economy is increasingly competitive with some of the developing countries expected to enter the G20 ranks based on their population advantage. For Canada to remain competitive, despite its relatively small population, it must invest strategically in value-added high-return areas, such as CAN-V. The potential of the CAN-V paradigm is well recognized globally; many countries (developed or developing) and regions are investing in this area with long-term strategic planning. A good example is the consolidated efforts in the European Union (EU). For instance, the EU launched a high-level group “GEAR 2030” in 2015 to guide discussions and to develop a master plan to boost the European automotive sector’s competitiveness in changing global dynamics. Unfortunately, Canada is lacking behind among the G7 countries in preparing for the arrival of CAN-V.

2. Description



The above diagram explains the basic engineering design methodology, which can be top-down or bottom-up.

In the top-down approach, the starting point is a use case (ex: wireless virtual reality goggles). Then, the technical requirements for the proper operation of this use case are figured out (ex: the QoS values, such as minimum rate = 50 Mbps and minimum latency = 1 ms). Eventually, the overall architecture and the enabling technologies are identified (ex: it is not possible to guarantee a user experienced rate of 50 Mbps with the 4G LTE air-interface; but this may be possible with the 5G air-interface. Likewise, the ultra-low latency requirement cannot be fulfilled with the conventional cloud computing architecture in the core network; instead, this may require fog computing).

The bottom-up approach generally starts with an invention or a novel systems design. With this invention, it may become possible to attain a more demanding set of QoS values; alternatively, the invention or the novel design may result in a cost-efficient implementation in comparison to the existing alternatives. In turn, the invention/design may facilitate a novel use case which requires such demanding QoS values, or may yield a feasible business case for an application which has failed market penetration due to high cost.

3. Requirements

In this project you will envision a future-looking use case (scenario, application) to be implemented in 2030s in the context of connected, autonomous, and networked vehicles (CAN-V).

3.1 – Provide an outline of the use case as a high-level description that could be understood by people without technical background. Innovative thinking is essential for defining an interesting use case.

3.2 – Define the key technical requirements (in the broad context of this course, SYSC 4700) and their values to implement the envisioned use case.

3.3 – Subsequently, identify two key enablers in terms of the system architecture and technologies. Substantiate your choices.

3.4 – Provide an overview of the identified enablers.

3.5 – Describe why this use case cannot be implemented today and why the maturing of the enablers is required. Support your arguments with a timeline.

3.6 – If you start-up a technology company to deliver the envisioned novel use case, explain to which other companies you would approach for business alliance (ex: Alibaba, Alphabet, SpaceX, …) and why.

3.7 – Provide a reference list at the end of the report.

Carefully substantiate your claims throughout the report.

4. Sample References

- IEEE Vehicular Technology Magazine
- Qualcomm Cellular V2X
  - Qualcomm C-V2X presentation 1
  - Qualcomm C-V2X presentation 2
- Center for Advanced Automotive Technology
- Mobile Technology Association of Michigan
- The Verge – Autonomous Cars
- Driverless Car Market Watch
- RAND Research – Autonomous Vehicles
- Wired – Autonomous Vehicles
- 5G Automotive Association
- 3GPP Release 14 – initial Cellular V2X standard

- IEEE Communications Magazine
- IEEE Wireless Communications
- IEEE Vehicular Technology Magazine

These are just a set of sample references. You will find many more (and, arguably, much more interesting) material when you make a thorough search.

5. Report

A group is normally formed by three or four students. Five-member groups are not allowed.

There are two deadlines ahead of you:

- Deadline 1: 4:00 pm, Friday, March 09. Email the names of your group members to the course TAs Mohamed Alzenad (mohamed.alzenad@sce.carleton.ca) and Hossein Khoshnevis (khoshnevis@sce.carleton.ca), with cc to me (halim@sce.carleton.ca). This e-mail must be copied to all the group members (only Carleton cmail addresses should be used).

- Deadline 2: 11:59 pm, Wednesday, April 11. Send the report as a PDF attachment to the course TAs and myself, with cc to all the group members.

- Deadline 3 (for those who miss Deadline 2): 11:59 pm, Friday, April 13 (no penalty).

Each group will write one report. All group members will get the same mark. It is up to your group to organize the work and allocate tasks to group members. Your group output will be a report which addresses the above issues. Include references (papers, internet, etc.), with enough information that they can be verified by readers.

- Do not cut-and-paste from other sources (especially online sources) or use others' ideas, unless they are acknowledged and properly referenced. Violating this rule amounts to plagiarism, which is a serious instructional offence (see "instructional offences" in the undergraduate calendar, and www.plagiarism.org for definitions and examples of plagiarism). Reference to "other sources" also includes any overlap of your own work in other courses, such as fourth year projects, for example.

The report itself (without figures) should be no more than 15 pages of double-spaced text; you may put as many figures as you deem appropriate. Your marks will be based on the correct knowledge and persuasiveness revealed in your report, its organization, coherence and clarity, and use of references.

6. SYSC 4700 PROJECT MARKING FORM – Winter 2018

		Mark	Max	Comments
Overall organization and clarity, including presentation format (proper acronyms, coherence, informative pictures, …)			**10**	
Proper use of **references throughout the report (no cut-and-paste from internet)**			**10**	
Completeness and persuasiveness in answering requirements posed in project description:				
Q3.1	High-level description		**15**	
Q3.2	Key technical requirements		**15**	
Q3.3	Key enablers		**10**	
Q3.4	Overview of key enablers		**20**	
Q3.5	Why not today?		**10**	
Q3.6	Business alliances		**05**	
Q3.7	References		**05**	
Total			**100**	