ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

POSUDEK OPONENTA ZÁVĚREČNÉ PRÁCE

I. IDENTIFIKAČNÍ ÚDAJE

Název práce:	**Methodology for verifying characteristics of cooperative systems in a real world**
Jméno autora:	**Bc. Pavel Matějka**
Typ práce:	diplomová
Fakulta/ústav:	Fakulta dopravní (FD)
Katedra/ústav:	K620 Department of Transport Telematics
Oponent práce:	Ing. Martin Volný
Pracoviště oponenta práce:	INTENS Corporation s.r.o.

II. HODNOCENÍ JEDNOTLIVÝCH KRITÉRIÍ

Zadání **průměrně náročné**

Hodnocení náročnosti zadání závěrečné práce.

I consider the Master's thesis assignment as average demanding. The reason for this evaluation is supported by usage of existing testing principles defined by telecommunication and standardization bodies and neither scientific nor innovative approaches used. On the other hand such extensive testing has not been performed in the Czech Republic yet and this work will set criteria for further evaluation of cooperative systems.

Splnění zadání **splněno**

Posuďte, zda předložená závěrečná práce splňuje zadání. V komentáři případně uveďte body zadání, které nebyly zcela splněny, nebo zda je práce oproti zadání rozšířena. Nebylo-li zadání zcela splněno, pokuste se posoudit závažnost, dopady a případně i příčiny jednotlivých nedostatků.

Author has met the assignment requirements.

Zvolený postup řešení **správný**

Posuďte, zda student zvolil správný postup nebo metody řešení.

Author has chosen correct methods and approaches for developing his document. He followed as well standard testing and evaluation procedures related to cooperative ITS systems operating on 5,9 GHz frequency band (5.855 – 5.925 MHz) defined by standardization bodies as ETSI, CEN, IEEE etc, which he has analysed in initial stages of his work. Based on theoretical knowledge author defined methodology for verification qualitative and quantitative characteristics for cooperative ITS systems, which than were used for practical testing, data collection and evaluation in next phases – in real motorway environment.

Odborná úroveň **A - výborně**

Posuďte úroveň odbornosti závěrečné práce, využití znalostí získaných studiem a z odborné literatury, využití podkladů a dat získaných z praxe.

From quality point of view is this master's thesis final document on very good level reflecting knowledge and general technical overview from author's perspective. Off course, author's missing long term experience and consultation with industry experts are limiting final evaluation and conclusion, but cooperative ITS systems are very complex issue ranging from radio frequency band issues (allocation in 7 bandwidth where only 3 are being used for ITS safety applications, issues related to Out of Bandwidth and spurious emission defined in ETSI EN 302 571 causing possible misinterpretation in the conclusion part), definition of communication protocols (only CAM and DENM has been used and evaluated), safety issues by using PKI security key model etc. Despite of this I can see that the knowledge and practical experience gained during the final document development is very high and more than satisfactory for purpose of this work. Authors orientation in large number of technical standards and specification related to Cooperative ITS could be evaluated as excellent. Just to clarify missing information, European Commission has granted mandate M/453 focused on joined standardization activities between all standardization bodies e.g. CEN, ETSI etc. purely focused on cooperative ITS systems.

Formální a jazyková úroveň, rozsah práce **B - velmi dobře**

Posuďte správnost používání formálních zápisů obsažených v práci. Posuďte typografickou a jazykovou stránku.

From the formal point of view the document has understandable structure, where all chapters and paragraphs are properly numbered, pictures and tables are labelled and numbered in list of content. The document has short abstract, list of used abbreviations and list of references (these are not linked to the particular sentences / statements in the document, but being used as general list of materials used for developing this document). In grammar and English language point of view is the document understandable with some minor incorrect wording used and better usage of passive in sentences replacing e.g. we found in our test, for it has been found in our test. This will make this document more professional.
In regards to the scope of work I can recommend for future reference to better structure the conclusion, because this is the most important part, which will be read as a summary of work being accomplished and recommendations for future activities.

Výběr zdrojů, korektnost citací **A - výborně**

Vyjádřete se k aktivitě studenta při získávání a využívání studijních materiálů k řešení závěrečné práce. Charakterizujte výběr pramenů. Posuďte, zda student využil všechny relevantní zdroje. Ověřte, zda jsou všechny převzaté prvky řádně odlišeny od vlastních výsledků a úvah, zda nedošlo k porušení citační etiky a zda jsou bibliografické citace úplné a v souladu s citačními zvyklostmi a normami.

Author has used correct references and sources to meet defined scope of his work and have used Czech and English sources at the same time. Generally I can confirm, that author has used the source documents wisely, but some statements made by him could be misinterpreted or misleading. This could be done by his understanding of particular problem.

Další komentáře a hodnocení

Vyjádřete se k úrovni dosažených hlavních výsledků závěrečné práce, např. k úrovni teoretických výsledků, nebo k úrovni a funkčnosti technického nebo programového vytvořeného řešení, publikačním výstupům, experimentální zručnosti apod.

Vložte komentář (nepovinné hodnocení).

III. CELKOVÉ HODNOCENÍ, OTÁZKY K OBHAJOBĚ, NÁVRH KLASIFIKACE

Final document of master's thesis named "Methodology for verifying characteristics of cooperative systems in a real world" proposed for my evaluation is focusing on new field of Intelligent transport systems called Cooperative ITS systems (C-ITS). This area of C-ITS is widely promoted by European Commission and being recognised as future tolls for meeting defied safety, environmental and traffic objectives. Due to principles of C-ITS is this area very broad and includes aspects from frequency allocation, end used application and scenarios development, safety and security aspects, technical problems in RSU and OBU integration with existing systems etc. Despite of this author has correctly identified available standards and specification, references of similar type of projects in Czech and EU, defined methodology for testing and evaluation. He as well performed testing in real environment, where initial data were collected for future evaluation. As a result of evaluation recommendation for improvements has been made to the C-ITS system integrator, who deployed the system on motorway D5 and based on these recommendations the system performance has been modified.

I do evaluate this master's thesis document with classification **A - výborně.**

Additional questions to be answered:

1) **How could be eliminated packet loss on longer distances? Eg. will it be possible to use more powerful or directional instead omnidirectional antenna to lover packet loss?**
2) **What emission power has been used during the test and what is the maxim of power allowed for cooperative ITS transmission in RSU / OBU?**

Datum: 16.6.2016

Podpis: