REVIEWER'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	**Measurement of multi-antenna communication channels – study of upper bound channel capacity based on eigenvalue decomposition**
Author's name:	**Bc. Tomáš Janák**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Electromagnetic Field
Thesis reviewer:	Dr.-Ing. Michael Walter
Reviewer's department:	German Aerospace Center (DLR)

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

Evaluation of thesis difficulty of assignment.

The assignment consisted of both theoretical and practical tasks. The theoretical part comprised simulation of multi-antenna systems for a non-line-of-sight scenario. After the simulation the scenario was recreated in an anechoic chamber and validated. Finally, a measurement method for multi-antenna system was proposed and measurements were conducted in a dynamic indoor scenario. The results were analyzed and compared to state-of-the-art results.

Satisfaction of assignment **fulfilled**

Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.

The results in the theoretical part agree with state-of-the-art result. In the measurements the results show a very good match with the theoretical results, especially the antenna patterns of transmitter and receiver.

Method of conception **correct**

Assess that student has chosen correct approach or solution methods.

In the thesis several different approaches of determining the channel capacity both in time and in frequency domain were introduced. A time domain method was chosen, since it provided a better fit for the proposed measurements. Furthermore, the focus of the measurements was put on the gaps in the literature.

Technical level **A - excellent.**

Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.

For the thesis several fields of wireless communications had to be addressed. Channel modeling is the fundamental theory that covers the propagation mechanisms for wireless communication. Additionally, a thorough understanding of Shannon's channel capacity and its extensions to MIMO systems is needed. Practical skills in order to conduct the measurements were gained by the hands on experiments.

Formal and language level, scope of thesis **B - very good.**

Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.

The language used in the thesis is adequate and the explanations given were readily understandable. The structure of the text is good and there are very few typos or notation errors.

Selection of sources, citation correctness **A - excellent.**

Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.

The state-of-the-art was mainly presented in the first four chapters of the thesis. It included literature about space-time

coding, MIMO communication, wireless communications, and channel capacity. The results obtained from the literature were clearly distinguished from own results. The citation ethics haven't been breached and the citations are complete and in accordance with citation standards.

Additional commentary and evaluation

Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.

I was very impressed with the very good agreement between simulation and measurement results. It probably is due to a very thorough preparation and execution of the measurements.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

The thesis is well-balanced between theoretical and practical investigation and it addresses an interesting topic, which is important for future 5G wireless systems. In the theoretical part several options for the channel capacity were discussed and the most useful one selected. The antenna patterns that were obtained by measurements in the anechoic chamber match the simulation results very well.

I evaluate handed thesis with classification grade **A - excellent.**

Date: **29.5.2019** Signature: