# "Evaluating Data Marshalling Approaches for Embedded Real-Time Systems on the Example of Autonomous scaled Cars”

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## 1. Main idea for your study

One of the most important factors in designing complex systems is to divide it in different components in order to improve maintainability, fault isolation and code reuse [4] [5]. For that reason it is crucial to assure a reliable and fast exchange of information between those components. Therefore we are interested in different data marshalling approaches on the low-level, especially in comparison with the current implementation in the OpenDaVINCI [6] environment, which is based on Netstring. Thus, we are interested in overhead in terms of control data and encoding/decoding for typical data structures (i.e. the data structures that are exchanged in the miniature car which was used for the Carolo Cup 2015 competition). Further data marshalling approaches will be compared in terms of descriptive expressiveness with the current interface description language ODVD.

## 2. Background / Related work / Literature review

Marshalling is the process of converting data to the suitable format for sending data between different software components.It is a crucial part of the real time systems. However, there are different approaches towards the marshaling within the system. Therefore, each of them provides different features, and different performance.

Lightweight Communications and Marshalling (LCM) is a library for the data marshalling and message exchange between different software components. This library is made for the robotics and real-time systems, where fast exchange of information is crucial [2]. In our research we are interested just in marshalling approach on low level in LCM, therefore we are ignoring all other features provided by this library.

Google Protobuf is marshalling approach developed by Google and its main aim is resources constrained, distributed and embedded real-time systems [2].

LCM and Google Protobuf are approaches we will be evaluating for the data marshalling in the system.

Schwitzer and Popa [1] discuss how to use and implement Google Protobuf, together with few test performances, while Huang, Albert S., Edwin Olson, and David C. Moore [2], provide more details about testing and several case studies of the LCM approach. In order to be able to evaluate Google Protobuf and LCM, we will implement and test both approaches on the same system. In our case we will use OpenDaVINCI environment and current implementation, which is Netstring [3], in order to evaluate three different approaches towards data marshalling/unmarshalling within real-time embedded systems.

Describe previous results that are relevant for your study. Keep it short and focus on the main results (1–2 paragraphs).

## 3. Research questions / hypothesis

RQ1: How efficient are the marshalling approaches (Protobuf, Netstring or LCM) for encoding/decoding messages in the embedded real-time systems?

RQ2: How expressive are the marshalling approaches (Protobuf, Netstring or LCM) in embedded real-time systems, when compared to the existing ODVD interface description language?

## 4. Research strategy

We chose to conduct a design research to evaluate three different data marshalling approaches on the low-level. The reason for this is because we would like to understand and assess the current implementation and try to improve it by substituting the serialization/deserialization process with different analogic approaches, like LCM and Protobuf. These three different approaches have only been evaluated in different environments but were never compared with each other, from different perspectives, in the same environment. Our research will include an assessment between these three actors in the same environment, in terms of their effectiveness and efficiency. The research will be conducted by implementing, assessing and discussing the findings based on the assessments.

Our main data collection method will be Measurement. The data that we will be working with, are: messages which are sent between different components; amount of bytes it takes to serialize/deserialize messages; and how much time it takes to serialize/deserialize the message. Therefore we will be able to measure the cost in terms of time and resources for the serialization/deserialization process. Also we will be testing the overall runtime of each approach in part in order to determine the robustness while running it for a longer period of time.Furthermore we will be compare them in terms of the descriptive expressiveness with the current interface description language, which is ODVD.. Thus, the assessment will include a comparison between numbers of each assessment process from the new approaches, and from the current one. Finally we will conclude the findings and include them in the paper.

As the environment we will use Open Source Development Architecture for Virtualization of Networked Cyber-Physical System Infrastructures (Open DaVINCI).

\*\*Describe the overall research strategy (e.g., Case study, Experiment, or Survey) and the data collection methods (e.g., Interview or Questionnaire) you intend to use. If you intend to use multiple strategies and/or methods, describe how they will be used and for what (sub)question.

List any software/systems/scripts that you need to develop to make the study a reality.\*\*

## 5. Time plan

\*\*Provide start and end dates for the main phases of your study.

We will create few milestones that will cove the main phases of our study:

* Planning and designing the research project;
* Implementation of the new approaches used for Serialization/Deserialization;
* Assessment of the new approaches and current implementation;
* Discussion and Conclusion of the new results from the new findings.

The estimated dates will be included in the table below.

|  |  |  |
| --- | --- | --- |
| Milestone | Start Date | End Date |
| Planning and designing the research project | February 23rd  2015 | March 3rd  2015 |
| Implementation of the new approaches | March 4th  2015 | April 5th  2015 |
| Assessment of the raw data | April 6th  2015 | April 15th  2015 |
| Discussion and Conclusion of the Findings | April 16th  2015 | May 15th  2015 |

## 6. References

[1] Wolfgang Schwitzer, Vlad Popa. “Using Protocol Buffers for Resource-Constrained Distributed Embedded Systems”. Technical Report, TUM-I1120, Technische Universitaet Muenchen, 2011.

[2] Huang, Albert S., Edwin Olson, and David C. Moore. "LCM: Lightweight communications and marshalling." *Intelligent robots and systems (IROS), 2010 IEEE/RSJ international conference on*. IEEE, 2010.

[3] D. J. Bernstein, “Netstrings”, [djb@pobox.com](mailto:djb@pobox.com), 19970201, <http://cr.yp.to/proto/netstrings.txt>

[4] D. L. Parnas, “On the criteria to be used in decomposing systems into modules,” Commun. ACM, vol. 15, no. 12, pp. 1053–1058, 1972. 1

[5] B. Meyer, Object-Oriented Software Construction. Prentice Hall PTR, March 2000.

[6] <http://www.cse.chalmers.se/~bergerc/opendavinci/>