Ad Hoc Networks – Function and Usage in Exceptional Situations

Bachelorarbeit

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1. Introduction

“The current technology and development of mobile devices is progressing as fast as never before. Smartphones and tablets are so powerful that they can provide video telephony, Internet use, a wide variety of on-demand services and many more” (Bacca et al. 2014. 133.). The advantage of mobile terminals is that they can usually afford this application completely independent of location and time. It only needs to be ensured that there is a robust connection to the mobile network. Mobile communication has significantly influenced of the social and economic structures in the last decades. The growth rates of the fourth generation of mobile communication are enormous and LTE[1] is considered one of the most successful technologies worldwide (cf. Reichl et al. 2017. 4.). More than half of the German population now owns a smartphone, and among young people between the age of 13 and 19 there is almost full provision (cf. Groneberg et al. 2017. 5.). In all other age groups, there is an increasing trend towards smartphone usage (cf. Feierabend et al. 2014. 23.). The previous use is usually based on a well-known scheme, the client-server structure. Applications such as e-mail services, chats, social networks and augmented reality[2] are built on this basic communication architecture (cf. Miess et al. 2007. 121 ff.). The web based communication can not be removed from the networked world, and future generations are confronted with it at a very early age and they are growing up with this type of technology. The majority of humanity would not want to miss the benefits of a networked world anymore. Today people have the possibility to keep in contact with friends and family around the world at any time, or just congratulate your neighbour on his/her birthday. No matter if the message goes around the world or across the hall, normally the process is the same. However, this does not have to be the case as there is another technique. “The process of peer-to-peer communication in mobile computing is currently completely neglected and could be an extension of current usage. The peer-to-peer systems consist of at least two terminals which establish an independent, decentralized and equal network” (cf. Ghosh. 2009.). How important ad hoc communication can be is being illustrated by the example of the city of Hagen in October 2016. The local TV station WDR1 reports on the local events on their homepage. There were 30,000 citizens for a period of time without electricity and thus without landline telephony and TV. The phone network collapsed due to the overload caused by too many requests by clients - according to the police of Hagen an indirect consequence of power failure, since the mobile phones are actually connected to its

[1] LTE – Long Term Evolution, Represents the standard and the fourth generation of mobile data usage and was launched in 2010

[2] An application that displays additional information about landmarks and virtual objects in a camera image.

own power supply (cf. Waßermann.2016.). A good example of recognizing and using the ad hoc communication is the following industry. The automotive industry has discovered ad hoc technology and it is becoming more important for this industry. Safe roads, less congestion, autonomous vehicles - this is the promise of car-to-x or car-to-car communication. Thanks to ad hoc networks between cars among themselves or between vehicles and infrastructure elements such as traffic signs or traffic lights, the drivers get an up-date of traffic information for their route. This decade is about to introduce this vision that transcends brands and national borders. According to the US-Market research firm Navigant Research, global sales of these technologies are expected to increase from 96 million to 36 billion US Dollar between 2016 and 2025 (cf. Vogel. 2015.). The technical possibilities to build and use an ad hoc network are already present, but this technology of communication for the private user is currently not widely used. The next section explains how society needs another way to communicate and whether ad hoc networks could be a possible alternative. Furthermore, the current relevance of the technology will be explained.

1.1 Motivation and Relevance

Nowadays, constant contact with family and friends is more important than ever. People are used to communicate at anytime and anywhere. Especially in exceptional situations people want to stay in contact with their loved ones to know how their conditions are. The example of Google Crisis Response and the Facebook Safety Check shows that even large and innovative companies like Google and Facebook have recognized the value of communication in the respective situations (cf. Pottebaum et al. 2017. 1339.). Usually the exchange works well over the existing mobile network but what happens when it breaks down? Crises and catastrophes are triggered by natural force, technical or human failure as well as violence and terrorist attacks. In these cases communication takes a highly significant role as an instrument allowing the population to contribute to active disaster management, which cannot be provided classical media such as TV or newspapers (cf. Lange et al. 2013. 165.). The catastrophes threaten lives, public safety in the affected area and the economy nationwide. Experts undoubtedly explain the increasing frequency of natural disasters with the climate change – a man-made problem. Professor Höppe, expert for geo-risk research at the worlds largest reinsurance company Munich Re, made this clear: “ Also, wir übertreiben und wir untertreiben nicht, wir haben die Zahlen. Wir haben die Schadenszahlen aus den Naturkatastrophen, wir sehen ganz klar, dass wir in den letzten zehn Jahren drei Mal so viele große wetterbedingte Naturkatastrophen hatten wie in den 60-er Jahren zum Beispiel. Wir haben sogar 14 Mal so hohe versicherte

Schäden. Also wir sehen ganz klar diesen Trend, dass hier in der Atmosphäre Dinge sich verändern, die auch zu vermehrten Katastrophen führen“ (Wittmann. 2005.). This statement by Prof. Höppe confirms the relevance of the expansion and development of ad hoc networks. Furthermore, terrorism is a sincere and omnipresent threat. The World Map of Terrorists and Political Risks 2017 from Aon Risk Solutions' shows the challenges that Germany and the world have changed over the past year. The number of extremist attacks worldwide increased by 14 percent in 2016. Terror in Germany has increased and worsened the risk level of the Federal Republic (cf. Hinz. 2017.). Technical infrastructures are damaged or fail in this situation. In front of increasingly sophisticated and advanced technological attacks such as cyber-attacks, cyber-wars and cyber-espionage, not only private consumers and businesses need to protect themselves more than a few years ago, but it is also increasingly important that the policies of the various states more concrete and sustainable deal with the issue (cf. Leopold et al. 2015. 5). How can people communicate with each other and build up an intact autonomous and decentralized network as quickly as possible in order to network with each other and to organize help?

This thesis deals with the questions in how far the technical requirements are already established today and how they work. In addition, this paper seeks to find how ad-hoc networks can be used in the situations described above and thus provide added value for those affected and their helpers. The expert questionnaire should not only give insights into current possible fields of application, but also examine the areas in which the ad-hoc networks can be used in the future. Will innovations and expansions through the soon to be on road use and the associated investments of automobile companies make a positive contribution to mobile ad-hoc networks?

1.2 Research Questions and Structure of the Thesis

After the introduction and the resulting motivation, the following chapter 2 describes the functions and different procedures of ad-hoc networks. Following this, the exceptional situation is described in more detail and various situations are presented. Chapter 3 deals with the developers and potential users of mobile ad hoc networks. The following question is asked in this paper and will be discussed and summarized after the interviews and the literature review.

> "How can ad hoc networks in exceptional situations provide added value for those affected and helpers?"

First, the functionality and usage of the ad hoc network will be explained in more detail in order to provide insight. Then, potential types of technology that can be used in exceptional situations and their value will be described. To answer the questions in the best possible way, this study is based on expert interviews. In order to portray the developer side, two different interview partners were selected. Their statements and theses will allow for a deeper insight into the function of ad hoc networks. Two other experts were interviewed to provide a better understanding of the strengths and weaknesses from a user´s perspective. The interview groups are asked various questions. The developers should focus on the fact that the function and design can shed light on facets. Whereas users or potential users should be asked if and if so how, they would find mobile ad hoc networks useful and helpful. The interviews are described in more detail in the appendix and summarized in chapter 3.

5. Limitation

The thesis at hand is limited by the processing time and the given scope. As a result, statements and findings of this work are subject to certain limitations. With regard to the collection of subjective theories and ideas, the influence of the researcher should not be neglected. During the interview, the researcher navigates the interview process and reconstructs and interprets the interviews as well. Readers of this paper should bare in mind that the qualitative survey questions do shed light on various aspects but that the survey size of the four respondents is does not allow representativity. An extensive expert survey would be desirable and appropriate for a continuing work. Unfortunately, no directly affected people could be acquired, which leads to the lack of experiences concerning this group of people. Furthermore, only participants working in Germany were interviewed, which results in the fact that foreign developers and potential users could not contribute. Another limitation of the literature search is given by the fact that only German and English-language literature were used.

6. Conclusion and outlook

Summing up, one can say that the possibility of communication via mobile ad hoc networks can add a certain value to the society. The MANET communication was proven in 2017 by the project Smarter. It should be considered that people are used to all kinds of situations and have the desire to communicate. In scenarios in which the usual infrastructure breaks down, a communication platform can generate socially added value via ad hoc networks and stability for helpers and those affected. The advantage of equal rights which predominates in MANETs gives users a sense of security. Since an ad hoc network does not have a single point of failure, it will be difficult to extinguish this communication. A disadvantage of the communication via ad hoc networks can be found in nodes that are outside the transmission range or in individual devices that are switched off and thus will not enable a stable connection. Hence, users depend on the related members of the network (cf. Cyberport. 2017). It should also be mentioned that the operation and the general use should be intuitive and easy to apply for the user. The design of the interface should follow and be based on known patterns. People do not want to be confronted with for new things in emotional situations. Furthermore, it should be mentioned that mobile ad hoc networks for the new LTE standard, the car-to-x communication and smart cities, can create added value in different areas of application and thus this technology will become a

more widely used. Communication in exceptional situations will to benefit from the other fields which rely on ad hoc networks. Ad hoc networks will not replace the usual communication but will provide actual added value and contribution to the economy and society. To give a further outlook for communication via ad hoc networks, reference should be made to the quote from Primavera De Filippi Ph.D.. She is a permanent researcher at the National Center of Scientific Research in Paris and a faculty associate at the Berkman-Klein Center for Internet & Society at Harvard University (cf. LinkedIn. 2018.). Di Filippi holds the view that the independence of communication serves as a major advantage of ad hoc networks. Besides, she explains the relevance for mesh networking communication: ”What’s really revolutionary about mesh networking isn’t the novel use of technology. It’s the fact that it provides a means for people to self-organize into communities and share resources amongst themselves: Mesh networks are operated by the community, for the community. Especially because the internet has become essential to our everyday life” (De Filippi Ph.D. 2014.). This statement concerning independence and online privacy emphasizes the fact that our society should remind themselves about the relevance of everyday communication and about how much information everyone wants to share. The attention the research community devotes to MANETs suggests another area of application concerning this technique. Up to this point, there are still many questions and challenges to deal with.