Assessment of a MACsec-based security system for use in critical Infrastructure Communication

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Abstract—**Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.**

Index Terms—**MACsec, IEC61850, IEC62351, GOOSE, Secure Communication**

I. INTRODUCTION

Companies that are classified as critical infrastructure as for example water supply facilities, power plants and their corresponding distribution systems, can constitute a vulnerability which may be exploited to disrupt the supply of basic resources to entire countries. For this reason, laws such as the Network and Information Security Act (NIS-2) [1] of the European Union or the IT Act 2.0 [6] of the German Federal Office for Information Security (BSI) demand a unified level of cybersecurity for these entities. In these regulations, the councils prescribe that the companies will be required to implement security features to detect and prevent intrusions, as well as remove faults caused through intrusion attempts during system runtime. [6, §11 (1d)] Additionally the extension of this paragraph dictates, that these companies are obliged to provide proof of compliance with the safety requirements in a two year period. [6, §11 (1e)] This decision is intended to ensure the future working of the security systems with respect to adapting changes of the latest technologies.

This paper evaluates the currently established implementation of protection systems securing communication in Substation Automation Systems (SASs) and thereby provides a brief overview of the communication standard used in these facilities. Following this we propose a Media Access Control Security (MACsec) based security system with the security goals set for these applications. The further course of the paper is structured as follows: Chapter III displays relevant information presented by related works assessing the current state of technology in this topic. Chapter II-A provides a general overview of the IEC 61850 communication standard and the associated IEC 62351 safety standard with special focus placed on the different message types and their respective protection. Chapter IV explains the test setup used to measure the efficiency of the MACsec-based security system. Lastly the data gathered from this is then evaluated in chapter V.

II. BACKGROUND

A. Overview of the IEC 61850 & IEC 62351 Standard

Among other stadards used for communication is SASs, the facilities utilize the IEC 61850 standard, which is published and maintained by the International Electrotechnical Comission (IEC). This standard is used to transmit diagnostical information, measurement information or control signals between Supervisory Control and Data Acquisition (SCADA) entities and the associated substation components. The major advantage here consists of the object-oriented data structure specified in this standard, which enables the integration of various components developed by different vendors [2, p. 5643].

-- HIER NOCH WEITER MIT IEC61850 & IEC62351

B. Fundamentals of the MACsec Security System

-- HIER NOCH WEITER MIT MACsec

III. RELATED WORKS

To assess the operating principal of a MACsec-based security system in IEC 61850 compliant communication it is necessary to understand both the working method of the communication inside a substation as well as the corresponding functionality of the MACsec security standard. The following related works display these important aspects and are therefore relevant for the implementation of an experimental set up for MACsec secured industrial communication.

Mackiewicz [4] describes the overall usage of the IEC 61850 protocol by displaying key features as well as the general aspects of IEC 61850 compliant communication. Since this standard represents a core part of the communication inside of power grid systems, it is vital to understand the corresponding aspects such as communication paths, model

structures or data addressing in order to design a representative test environment.

Hussain *et al.* [2] published a paper assessing the IEC 62351 standard and its security mechanisms towards IEC 61850 compliant messaging. The publication initially describes the basic values and security goals of the safety standard and, building on this, which attacks can potentially be carried out on IEC 1850 messages to manipulate the internal workings of a SAS. At this point the paper primarily focuses on the Ethernet-based message types Generic Object Oriented Substation Event (GOOSE) and Sampled Values (SV) and the associated decision not to encrypt them due to strict time delivery requirements.

Moreira *et al.* [5] evaluate various approaches to introduce cyber security in SASs. Initially, a brief outline of the communication structures in substations is presented. Building on this, various established security approaches are explained and evaluated based on the protection objectives of the IEC 62351 standard. The authors also point out possible implementation problems, such as incompatibilities between the security systems and the communication protocols or the handling of redundant packets inside ring-topology networks. In the further course of the paper, they present the idea of MACsec based communication security in SASs and the and the associated advantages and challenges that arise with it.

Lackorzynski *et al.* [3]

IV. Implementation

V. Evaluation

VI. Conclusion

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