



ERCIM "ALAIN BENSOUSSAN"
FELLOWSHIP PROGRAMME



Scientific Report

First name / Family name

Md Sadek Ferdous

Nationality

Bangladeshi

Name of the *Host Organisation*

Fraunhofer Institute for Applied
Information Technology (FIT)

First Name / family name
of the *Scientific Coordinator*

Wolfgang Prinz

Period of the fellowship

01/09/2021 to 31/08/2022

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

The main research objectives of this fellowship were to deeply understand different aspects of Self-sovereign Identity (SSI) and investigate how it can be applied in novel ways within different applications. Initially, I had plans to work both in the theoretical as well as practical aspects with respect to the research objectives. With these goals in mind, I started the fellowship at Fraunhofer Institute for Applied Information Technology (FIT) on September 1, 2022.

On my first visit, Prof. Wolfgang Prinz met with me and introduced me to the other team members who were also working in different blockchain projects. Then, we discussed about my research goals during the research fellowship. I was informed about the overall vision of FIT and I came to know that FIT mostly focused on applied researches. Therefore, after a thorough review of my initial research goals, we mutually decided to focus on the practical aspects of SSI. I was given a few weeks to finalise my research goals. In the meantime, I was invited to provide a presentation about my research and academic profile as well as the overall research objective to the respective research group of the FIT.

In order to find a suitable application domain, I started my research by reading the existing books and reviewing previous research papers on SSI. After a rigorous reviewing of the existing working I decided to work on applying SSI within the web domain, particularly to investigate how we could utilise SSI to access web services in a secure and privacy friendly way. I informed this to Prof. Prinz and he agreed to it. He also tagged me with another colleague (Andrei Ionita) to work collaboratively as he was also interested to work with SSI.

In the next five months I developed the first version of an SSI-based prototype which could be utilised to access web services securely. I presented this work to Prof. Prinz and a few other colleagues and they highly appreciated the work. However, Prof. Prinz gave some suggestions for some further improvement.

Next, I travelled to the Norwegian University of Science and Technology (NTNU), Norway for my research exchange programme (REP). I stayed there for around three weeks and came back with some exciting research ideas.

After returning back to Germany, I continued to improve the SSI Framework and the completed the development of the first SSI Framework for the Web. I and my other colleague Andrei, under the supervision of Prof. Prinz, jointly wrote a research paper which was submitted and subsequently accepted at the 4th International Congress on Blockchain and Applications, 2022. The conference took place in between 13 to 15 July, 2022 at l'Aquila, Italy. I participated the conference virtually and presented the paper online.

After the submission of the research paper, I started a couple of collaborative works with some academics of NTNU. Before finishing my fellowship, I jointly wrote a journal paper within the intersection of SSI and Renewable Energy Certificate. The journal article is almost completed and will soon be submitted to a Q1 journal. In addition, another collaborative work with the NTNU academic has been submitted to an international conference. Moreover, a few other collaborative works have been initiated in which we were investigating how SSI could be leveraged in different application domains.

In the last month of my fellowship. I presented the works carried out during my fellowship at the respective research groups at FIT and we had a lively discussion about the impact of my research and how we could continue our research collaboration in future.

Due to the COVID pandemic and the associated regulations regarding office visit in Germany, I had to spend most of my time away from my office at FIT, mostly working from home. This has been my biggest regret. However, the overall experience has been quite satisfying. I researched in a cutting-edge topic which might have long-lasting implications in the years to come. I am happy that I was able to carry out research in such an international setting with renowned international researchers. I was able to create new connections and collaborate in different ways which would be really beneficial for my future development. That is why I am really grateful to ERCIM for supporting my fellowship. I will look forward to giving back to the ERCIM community in any possible way.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Accepted & Presented:

1. SSI4Web: A Self-sovereign Identity (SSI) Framework for the Web. Md Sadek Ferdous, Andrei Ionita and Wolfgang Prinz. Presented at the 4th International Congress on Blockchain and Applications, 2022. The paper is to be published soon under the Lecture Notes in Computer Science (LNCS) Springer series.

Submitted Papers:

1. Improved Resilience of Local Energy Markets using Blockchain Technology and Self-Sovereign Identity. Umit Cali, Marthe Fogstad Dyrne, Md Sadek Ferdous and Ugur Halden. Submitted to the 2022 IEEE 1st Global Emerging Technology (GET) Blockchain Forum.

Working Papers:

1. Leveraging Self-sovereign Identity & DLT in Renewable Energy Certificate Ecosystems. Md Sadek Ferdous, Umit Cali and Wolfgang Prinz. To be submitted to a Q1 journal.
2. SSI meets Metaverse for Industry 4.0 and Beyond. Umit Cali and Md Sadek Ferdous. To be submitted to an international conference, symposium or workshop.
3. A Critical Analysis of SSI and Its Layers. Abylay Satybaldy, Md Sadek Ferdous, Mariusz Nowostawski and Wolfgang Prinz. To be submitted to a Q1 journal.
4. Integrating SSI Wallets with Solid Pods. Md Sadek Ferdous, Wolfgang Prinz, and possibly other authors. To be submitted to a Q1/Q2 journal.
5. An extended version of the “SSI4Web: A Self-sovereign Identity (SSI) Framework for the Web”. Md Sadek Ferdous, Andrei Ionita and Wolfgang Prinz. To be submitted to a Q1 journal.

III – ATTENDED SEMINARS, WORKSHOPS, CONFERENCES

During the fellowship period, I have virtually attended the 4th International Congress on Blockchain and Applications in between July 13, 2022 to Jul 15, 2022 at L'Aquila, Italy.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

The Research Exchange Programme (REP) was carried out at the Norwegian University of Science and Technology (NTNU) at its Trondheim Campus. I was hosted by Professor Colin Boyd who is a Professor at the Department of Information Security and Communication Technology at NTNU. I spent three weeks at NTNU during my REP.

As part of REP, I was given the opportunity to present the research in front of the members of the NTNU Applied Cryptology Lab (NaCl) research group. The NaCl research group also

has a number of members who are also part of an ongoing research project called “Trust and Transparency in Digital Society Through Blockchain Technology”. I had a number of interesting discussions with a couple of members from this research project regarding how we could collaborate. Unfortunately, most of the members were final year PhD students writing their theses and that is why we could not plan anything concrete for any future collaboration.

However, Professor Boyd has connected me with two of his colleagues who also work with blockchain technology. One of them is Dr. Ümit Cali who is an Associate Professor at the Department of Electric Power Engineering, NTNU. Dr Cali’s major expertise lies in the Energy Informatics domain. We had a fruitful discussion regarding we could leverage the SSI for different applications within the Energy Informatics domain. Since then we have collaborated in multiple papers. One of the papers has already been submitted into a conference. Other papers are being prepared to be submitted in different journals, conferences and workshops.

Another colleague of Prof. Boyd is Dr. Mariusz Nowostawski who is an Associate Professor at the Department of Computer Science of NTNU Gjøvik campus. He has a PhD student (Abylay Satybaldy) whose main topic is SSI. Therefore, we had a number of good discussions regarding how we could collaborate. Finally, as an initial work, we decided to work on a journal article which will critically analyse SSI and the different components of its layers. Once completed we have plans to collaborate further.

Therefore, considering the number of connections I made and the number of research papers I had and will have the opportunity to collaborate with, I can undoubtedly say that the REP was a very successful part of my fellowship.