AviChainDB: Blockchain Integration on Aviation Databases

Conference Paper · February 2021

CITATIONS
0

READS
31

3 authors, including:

Mustafa Takaoğlu
Istanbul Aydin University
15 PUBLICATIONS **9** CITATIONS
SEE PROFILE

Naim Ajlouni
Istanbul Aydin University
48 PUBLICATIONS **150** CITATIONS
SEE PROFILE

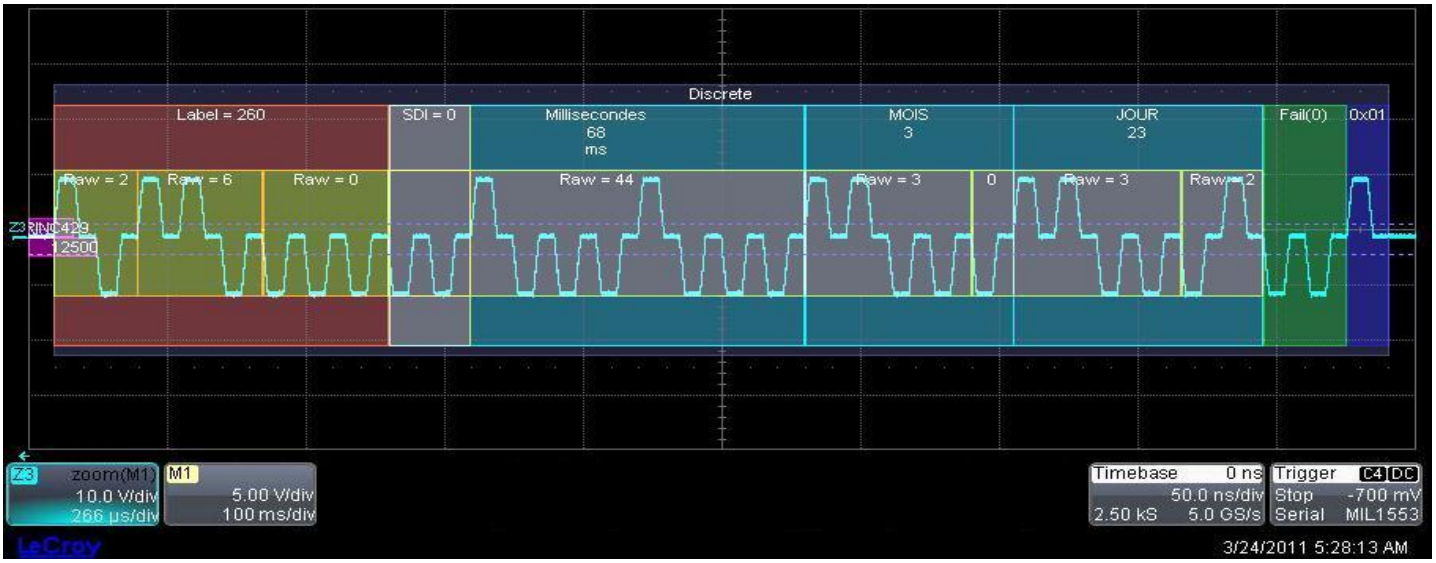
AviChainDB: Blockchain Integration on Aviation Databases

Mustafa Takaoğlu[1],Adem Özyavaş[2] and Naim Ajlouni[3]
[1]Istanbul Aydin University, Faculty of Eng., Dept. of Computer Eng., 34295, Istanbul, Turkey, mustafatakaoglu@aydin.edu.tr
[1]Istanbul Aydin University, Faculty of Eng., Dept. of Computer Eng., 34295, Istanbul, Turkey, ademozyavas@aydin.edu.tr
[2]Istanbul Aydin University, Faculty of Eng., Dept. of Software Eng., 34295, Istanbul, Turkey, naimajlouni@aydin.edu.tr

Presented at the on-line
Organisation Scientifique et Technique Internationale du Vol a' Voile (OSTIV)
Meteorological Panel meeting, 17 – 18 February 2021

Extended Abstract

This is an introduction to AviChainDB system presented at the OSTIV Meteorological panel. AviChainDB is designed to save the data generated in the Aeronautical Radio, Incorporated (ARINC) standards also known as "Mark33 Digital Information Transfer System (DITS) " to a special blockchain network developed on the Ethereum [2] platform. The data is also preprocessed and saved into the MySql database to get more secure hibrit model [5]. We use Byzantine Fault Tolerance consensus algorithm to avoid mining. Because of the smart contracts [8] developed in our project, the data produced in the ARINC 424 (ARINC 424-13, ARINC 424-15, and ARINC 424-18) or ARINC 429 standard [11] were firstly recorded in the blockchain system and then in the MySql database. Keeping data in a blockchain in addition to a relational database serves as a tamper-proof back up if any malicious attempt is made to modify the data in the relational database[3]. Figure 1 below shows an ARINC 429 Word, viewed as a signal, with overlaid decoding.



Figrue 1. An ARINC 429 Word, viewed as a signal, with overlaid decoding

Aviation management software is mostly provided by Jeppesen and AeroNavData companies. Both companies offer navigation database solutions using ARINC standards. Today, there is few comprehensive research on blockchain technology developed or proposed for use with ARINC standards. For this reason, it is of great importance to investigate the possibilities that blockchain technology can provide for storing aviation data produced in ARINC standards on blockchain systems. To our knowledge the AviChainDB project is the first blockchain-based aviation database proposed [1] [10].

Blockchain technology is an innovative and decentralized [6] secure database applied in many areas other than cryptocurrencies and finance with the advent of Blockchain 3.0. Its rapid growth in terms of diverse applicatins is made possible by the fact that blockchain technology can be added to existing systems as a layer. To name a few non-financial applications: Secure sharing of medical data, music royalties tracking, cross-border payments, real-time IoT operating systems, personal identity security, anti-money laundering tracking system, supply chain and logistics monitoring and voting mechanism. Figure 2 summarizes different blockchain application areas [12].

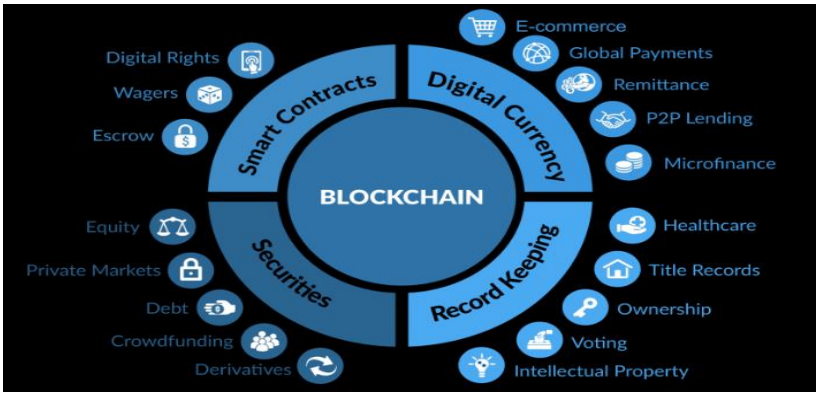


Figure 2. Blockchain application areas

Blockchain creates and shares a tamper-resistant digital transaction book, ensuring transparency [4]. Any modification of data in the blockchain either by malicious attacks or mistake could be detected because of the consensus algorithm used unless the majority of the nodes in the netwrork is compromised. For this reason, a blockchain can be defined as a distributed and invariant data structure managed by a consensus algorithm that runs on a network [7]. Securing the ARINC data using the blockchain technology will add another layer of security [9].

One of the ARINC standards widely used today is the ARINC424. ARINC 424 files are ASCII text files with a fixed length of 132 characters per line. One line represents one record. Optional continuation records may be used for additional information to primary record. Depending on the record type, each column has a well-defined meaning. The data included in an airborne navigation database is organized into ARINC 424 records. These records are strings of characters that make up complex descriptions of each navigation entity. There are 132 columns or spaces for characters in each record. Not all of the 132 character-positions are used for every record — some of the positions are left blank to permit like information to appear in the same columns of different records, and others are reserved for possible future record expansion.

The AviChainDB project is a hybrid blockchain-based aviation database currently under development. AviChainDB works only on the storage of data produced in ARINC standards from a wide range of aviation devices. AviChainDB is designed to take the security of the existing aviation databases to the next level. The image below also shows the differences between AviChainDB and other comparable systems.

	Bitcoin Blockchain	Distributed Database	AvichainDB
Immutability	✓		✓
No Central Authority	✓		
Assets Over Network	✓		✓
High Throughput		✓	✓
Low Latency		✓	✓
Rich Permissioning		✓	
Query Capabilities		✓	✓

Comparison of AviChainDB with other systems

References

[1]. M. Raikwar, D. Gligoroski and G. Velinov, "Trends in Development of Databases and Blockchain," 2020 Seventh International Conference on Software Defined Systems (SDS), Paris, France, 2020, pp. 177-182, doi: 10.1109/SDS49854.2020.9143893.

[2]. M. Ramkumar, "A blockchain based framework for information system integrity," in China Communications, vol. 16, no. 6, pp. 1-17, June 2019, doi: 10.23919/JCC.2019.06.001.

[3]. M. Zhaofeng, W. Xiaochang, D. K. Jain, H. Khan, G. Hongmin and W. Zhen, "A Blockchain-Based Trusted Data Management Scheme in Edge Computing," in IEEE Transactions on Industrial Informatics, vol. 16, no. 3, pp. 2013-2021, March 2020, doi: 10.1109/TII.2019.2933482.

[4]. L. Aniello, R. Baldoni, E. Gaetani, F. Lombardi, A. Margheri and V. Sassone, "A Prototype Evaluation of a Tamper-Resistant High Performance Blockchain-Based Transaction Log for a Distributed Database," 2017 13th European Dependable Computing Conference (EDCC), Geneva, 2017, pp. 151-154, doi: 10.1109/EDCC.2017.31.

[5]. G. Ra and I. Lee, "A Study on Hybrid Blockchain-based XGS (XOR Global State) Injection Technology for Efficient Contents Modification and Deletion," 2019 Sixth International Conference on Software Defined Systems (SDS), Rome, Italy, 2019, pp. 300-305, doi: 10.1109/SDS.2019.8768696.

[6]. F. Baig and F. Wang, "Blockchain Enabled Distributed Data Management - A Vision," 2019 IEEE 35th International Conference on Data Engineering Workshops (ICDEW), Macao, Macao, 2019, pp. 28-30, doi: 10.1109/ICDEW.2019.00-39.

[7]. N. Al-Zaben, M. M. Hassan Onik, J. Yang, N. Lee and C. Kim, "General Data Protection Regulation Complied Blockchain Architecture for Personally Identifiable Information Management," 2018 International Conference on Computing, Electronics & Communications Engineering (iCCECE), Southend, United Kingdom, 2018, pp. 77-82, doi: 10.1109/iCCECOME.2018.8658586.

[8]. C. Molina-Jimenez et al., "Implementation of Smart Contracts Using Hybrid Architectures with On and Off–Blockchain Components," 2018 IEEE 8th International Symposium on Cloud and Service Computing (SC2), Paris, 2018, pp. 83-90, doi: 10.1109/SC2.2018.00018.

[9]. E. BANDARA et al., "Mystiko—Blockchain Meets Big Data," 2018 IEEE International Conference on Big Data (Big Data), Seattle, WA, USA, 2018, pp. 3024-3032, doi: 10.1109/BigData.2018.8622341.

[10]. Y. Chen, L. Zhou, J. Yang and Y. Yan, "Big Data Platform of Air Traffic Management," 2019 IEEE 1st International Conference on Civil Aviation Safety and Information Technology (ICCASIT), Kunming, China, 2019, pp. 137-141, doi: 10.1109/ICCASIT48058.2019.8973192.

[11]. C. Pschierer et al., "ARINC 424A — A next generation navigation database specification," 2009 IEEE/AIAA 28th Digital Avionics Systems Conference, Orlando, FL, 2009, pp. 4.D.2-1-4.D.2-10, doi: 10.1109/DASC.2009.5347485.

[12]. Takaoğlu, M , Özer, Ç , Parlak, E . (2019). Blokzinciri Teknolojisi ve Türkiye'deki Muhtemel Uygulanma Alanları . Uluslararası Doğu Anadolu Fen Mühendislik ve Tasarım Dergisi , 1 (2) , 260-295 . Retrieved from https://dergipark.org.tr/tr/pub/ijeased/issue/47170/643683