SDPP: Streaming Data Payment Protocol for Data Economy

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***Abstract*—Applications in the area of IoT and smart cities rely heavily on data to manage and control their operational environments. In such applications, machine learning and artificial intelligence algorithms help the government officials, city administrators, and industries to make an informed decision on managing their cities and factories using the data collected from various sources. As we step into the era where "data is termed as new oil", there is a need for protocols with support for selling and buying data without giving up the data ownership to third-parties. In this demo, we present Streaming Data Payment Protocol (SDPP), which is an application layer protocol for selling and buying data. SDPP uses blockchain and distributed ledger technology for micropayments and immutable storage of transaction records. In addition, our protocol has a built-in mechanism to set data granularity since the bulk transfer of data between a seller and a buyer may lead to a loss for the seller if the buyer terminates the connection after receiving the data without making a payment. In this demo, we present SDPP and explain how it can contribute to the emerging data economy using a proof-of-concept implementation that uses TCP protocol for data communication and IOTA as both cryptocurrency and a distributed ledger.**

***Index Terms*—SDPP, Data Economy, IoT, Data Marketplace**

I. Introduction

Data-driven applications are on the rise due to the maturity of artificial intelligence and machine learning algorithms and cheap computational power. As cities, governments, and industries start to adopt these emerging technologies, there is a growing need for data, which has already paved the way for data economy. IoT device owners, mobile phone users, vehicles, machines, among other things, all collect and own data. Sharing these data with other organizations including governments and cities would enable the administrators and policy-makers to apply machine learning and AI algorithms to better understand our society, climate, and other natural resources.

The privacy concerns and data ownership issues inhibit the users from sharing their data with other parties especially in the wake of incidents around data mishandling at large corporations such as Facebook and Google. Data marketplaces are being developed to monetize IoT data [1] and to combine data sources from multiple devices and organizations to create novel applications. Such initiatives are pointing at a future in which more and more devices and applications will start to sell their data. Therefore, a protocol is needed to enable the users to sell their data and in exchange for an economic incentive.

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To support these emerging data economy, we developed a "data-for-value" protocol called *SDPP* [2], which is an acronym for Streaming Data Payment Protocol. We presented the SDPP [2] research paper at Blockchain for the IoT workshop that was part of the IEEE Blockchain conference in July, 2018. SDPP allow the data owners including IoT devices, vehicles, and smartphones to sell their data to other third-parties in return for a monetary benefit. Buyers can buy the data directly from sellers without a centralized intermediary. SDPP has three channels, which include a *data channel* for streaming data from seller's device to buyer's device, a *payment channel* for exchanging payments, and a *records channel* to store the transaction receipts.

SDPP's platform and currency-agnostic architecture work with various cryptocurrencies and distributed ledger technology. Our proof-of-concept implementation uses TCP (data channel) protocol for data communication, IOTA tangle as both a cryptocurrency for payment (payment channel) and a ledger for storing the receipts (records channel). To our knowledge, SDPP is the first integrated data-payment-record protocol for streaming data that leverages the traditional TCP as well as the innovative decentralized blockchain and DAG-based distributed ledger technologies.

II. SDPP: Streaming Data Payment Protocol

As shown in Figure II, the streaming data payment protocol consists of three channels.**Data Channel through TCP** is responsible for delivering the data through a secure channel from a seller's machine to a buyer's machine. We use a client-server architecture atop TCP protocol to enable data

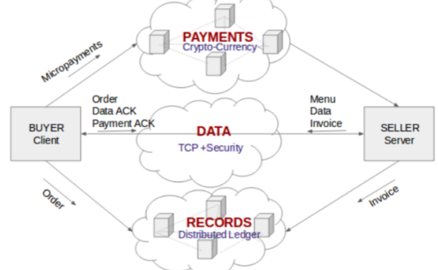

Fig. 1. Architecture of the Streaming Data Payment Protocol [2].

exchange. **Micropayment Channel** is used for the exchanging micropayments. As illustrated in Figure 1, this channel is agnostic to currencies and payment platforms. **Records Channel** maintains the transaction record and receipts. Figure 2 shows the timeline of SDPP protocols, and it works as follows:

- The buyer is assumed to be the client and the seller the server. The public-key change between the seller and buyer is handled through out-of-band communication.
- The buyer (client) contacts the seller (server) with a hello message, which is used for the handshake. In response to the hello message, the seller sends a menu with a list of data products and their unit price along with a list of possible payment options as well as the granularity of data items.
- Buyer responds to the menu message with an order message through a data channel. Simultaneously, the buyer will also post the order on the blockchain/tangle for recording the details of the order that includes the data being purchased, how many items are being purchased, the invoice address for the buyer, and its public keys to be used for signing and encryption (exchanged out-of-band), and finally, a signed hash for message integrity.
- Once the order has been placed, the seller notifies the session key encrypted by the buyers public key for encrypting all data transactions from this point onwards.
- The data then starts to flow from the seller to the buyer. Note that the data can be encrypted using the session key, and the signature of the seller applied to a hash of the data could also give message integrity guarantees.
- As shown in Figure 2, after receiving K messages, the buyer (client) initiates a payment transaction to transfer the money to the seller's account.
- When the client/buyer wants, it can turn off the service and make a final payment to settle the bill and terminate the connection. The server can then go back to waiting for new connections.

Significance of K parameter: The problem with peer-to-peer data and payment is the classic "Buyer and Seller's dilemma [3]", wherein the seller may leave after accepting the payment without providing the data, or the buyer may receive the data and leave without paying for the data. SDPP uses the K-parameter as a moving window to exchange data and payment in multiple steps and to terminate the transaction when one of the parties are not adhering to the protocol specifications. We refer the reader to our earlier research paper on SDPP [2] to learn more about the protocol specifications.

III. Proof-of-Concept Implementation and Demonstration

Our reference SDPP client and SDPP server implementation use Python. For both the payments and the records channel, we used IOTA because of its low transaction fees and ease of use including API support. Our SDPP client and server implementations have been made available as open source online at http://github.com/anrgusc/SDPP. Our demonstration of SDPP will use IOTA for payment and records channels and a laptop running the SDPP client and server. We will set up the demonstration following the architecture presented in Figure 1.

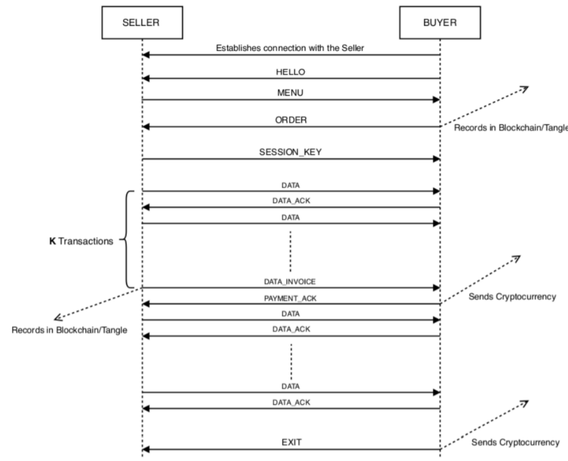

Fig. 2. Timeline of SDPP [2].

IV. Conclusion

We have presented an application layer payment protocol, SDPP, to support the emerging "Data-for-value" applications. The client-server architecture of SDPP through TCP allows the seller and the buyer to exchange data through a secured channel. The payment and records channel make it easier for the seller and the buyer to not only exchange payments but also record all the activities in a distributed ledger platform to generate invoices. The technology-agnostic design of SDPP allows the application developers to easily support different cryptocurrencies and distributed ledger platforms to handle micropayments and the recording of transactions. To the best of our knowledge, SDPP is the first application layer protocol with built-in support for micropayments. A decentralized data marketplace for smart cities [4] was developed using SDPP protocol, which demonstrates its practical use.

Acknowledgment

This work is supported by the USC Viterbi Center for Cyber-Physical Systems and the Internet of Things (CCI).

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