# Hybrid Adaptive Transaction Injection Protocol

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Latency is a critical issue that impacts the performance of decentralized systems. Recently we designed various protocols to regulate the injection rate of unverified transactions into the system to improve system performance. Each of the protocols is designed to address issues related to some particular network traffic syndrome. In this work, we first provide the review of our prior protocols.We then provide a hybrid scheme that combines our transaction injection protocols and provides an optimal linear combination of the protocols based on the syndromes in the network. The goal is to speed up the verification process of systems that rely on only one single basic protocol. The underlying basic protocols are Periodic Injection of Transaction via Evaluation Corridor (PITEC), Probabilistic Injection of Transactions (PIT), and Adaptive Semi-synchronous Transaction Injection (ASTI).

Keywords: optimization, blockchain, ; synchronous, decentralized

## 1. Distributed Systems

Distributed systems provide convenience for dealing with online activities. With some enhanced techniques, such as cryptography, they provide secure and scalable architectures with a wide applicability. One of the most prominent examples is the crypto-currency system. In recent years, distributed crypto-currency systems have provided an architecture that offers transparency and enables a communication ecosystem that generates billions of transactions. For instance, Internet of Things (IoT) Tangle [1] is one architecture that uses a distributed Directed Acyclic Graph (DAG) structure. However, distributed systems might suffer from the lack of synchronization in databases. To overcome this disadvantage, a semi-synchronous architecture IOTA-Tango was introduced in [2] based on the basic architecture of IOTA-Tangle.

Synchronicity is achieved when the transactions for validation are picked by the validators without ever being idle. The goal is to minimize the average waiting time for transactions without ignoring any transactions. It is important that the waiting time for an average transaction is minimized and no transaction is ignored. To ensure the system is synchronous with respect to the new transactions, an assignment mechanism was designed for scheduling those transactions to the verifiers with these following characteristics

- transactions are seen across the underlying ledger system;
- first come first serve mode is used to release the transactions to the verifiers before they are sent to the controller;
- the placement order of transactions in Tango is decided by the controllers.

## 2. Tango

Tango is a distributed ledger architecture that is similar to the Iota-tangle design as articulated in [1]. Transactions are released to a system for validation and subsequent affixation to Tango. The lifetime of a typical transaction has three types (1) unevaluated (2) evaluated, and (3) committed. Upon arriving to the system, the transactions are immediately visible to all the evaluators. In [2] the decentralized semi-synchronous pulse diffusion (DSPD) protocol was proposed to make the system more semi-synchronous. The DSPD protocol aims at providing a more synchronous arrival of transactions via scheduled injection. Interested readers can refer to that work.

While the transactions are inside the system awaiting verification, it is necessary to lower the latency of the system. PITEC, PIT and ASTI protocols help the controllers regulate injection of unevaluated transactions to the verifiers. The scheduling, both in terms of quantity and time, of the injections by the controllers determines how the system would reach stability (equilibrium). The injection/scheduling problems are quite similar to logistic problems in supply chain research [3] [4].

PITEC, PIT, and ASTI protocols are designed for a fixed cycle time T of the system for scenarios with assumptions on the consumption speed. The three protocols vary in the assumption of the network ecosystem. PITEC assumes a constant consumption rate, while PIT takes a probabilistic approach while ASTI applies the smoothing factor technique (simple reinforcement learning) for prediction. Each protocol has its own assumptions regarding the traffic behavior of the network. Without assuming the condition of the consumption rate in the network, an HAI protocol is introduced. HAI is a linear combination of the three aforementioned protocols. Future work will involve the implementation of the hybrid model for obtaining the empirical data and fine tuning for finding a good smoothing factor.

## References


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