When Should Machines Settle Metered Usage?

Electricity, compute, and the cost of correcting provisional readings

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Abstract

Fine-grained meters can record electricity or computing use more often than counterparties need to transfer money. This paper develops the machine-to-machine settlement example in Chapter 13 of Target Money into a comparison of immediate provisional payment and periodic payment against validated readings. It proposes a decision rule that weighs avoided credit exposure against transfer, liquidity, and correction costs. A signed reading can support a payment decision while still being revised later. The model shows how a correction can be reconciled without replacing the original payment record and outlines a replay study using versioned meter data.

1. A five-minute reading and a daily payment

Suppose a data center pays a service provider for electricity delivered under a bilateral contract. One meter sends a reading every five minutes. At the end of the day, the meter operator discovers that part of the data was estimated while a device was offline. The estimated record may already have prompted an automated transfer. The buyer and seller now have a pricing obligation that has changed and a transfer that has already happened.

Australia's energy market operator describes changes to meter configurations for five-minute data. That example concerns an established market with its own rules. This paper considers a separate bilateral payment workflow and holds the contractual pricing intervals fixed. A five-minute price and a daily transfer can coexist when the daily bill sums each interval at its own price. The paper also applies to compute contracts if the service defines an auditable unit such as GPU-seconds and specifies how to handle failed or duplicated jobs.

2. What is metered machine-to-machine settlement?

In this framework it is the movement of funds under a standing agreement based on measured service use, with a defined process for revising earlier measurements. Four events can have different timestamps: recording use, validating a reading, calculating the charge, and transferring funds. The contract specifies the source of the measurement, time zone, unit, applicable rate, and treatment of estimated or missing data. It also specifies who may change a reading and how the counterparty can challenge the decision.

Store each interval under a stable identifier and retain the sequence of authorized revisions. The charge for settlement window W is the sum of the agreed interval price times the latest eligible quantity for each interval in W. A correction changes the obligation by the difference between the revised total and the amount already allocated to that window. Record that amount as a debit or credit against the next bill or resolve it

through the agreed refund procedure. A unique settlement reference links each transfer to the obligations it covers and helps prevent duplicate payouts.

3. How much is earlier payment worth?

Compare fast provisional payment with a slower validated batch at the same prices and consumption. Let G be the expected financing and nonpayment costs that faster collection avoids after accounting for any burden shifted to the buyer. Let F be additional transfer and conversion costs. Let R be additional correction administration and expected unrecovered overpayments. Prefer fast settlement on the measured margin when G exceeds F plus R. Report components separately and track how often interim balances exceed the contractual exposure cap. At high usage, a capped unpaid balance can trigger an extra payment before the next scheduled batch.

In a hypothetical interval, a provisional reading of 100 kWh at 0.12 currency units per kWh leads to a payment of 12. The approved revision is 90 kWh, so the seller owes a credit of 1.20. A validated batch would have included only 10.80 if the change arrived before its cutoff. If an illustrative immediate schedule produces 288 transfers in a day and a daily batch produces one, a fixed fee of 0.01 implies a difference of 2.87 units before financing, revision, and conversion costs. That comparison is separate from the one-interval correction. It leaves the buyer and seller free to price each interval identically.

4. Applying and testing the design

Replay versioned meter or compute logs, preserving the time when each reading became available. Compare interval payout on provisional data, daily payout after initial validation, and a daily schedule with an exposure cap. Apply the same prices, exception definitions, and conversion assumptions. Simulate late or missing readings, duplicate messages, and a counterparty exit when a credit is owed. Measure time to usable funds, peak unpaid balances, transfer counts, correction frequency, unresolved credits, and net operating costs. Sensitivity tests should vary the timing and size of revisions and the parties' funding costs.

A stablecoin may carry an approved transfer. Compare it with an alternative rail under the same schedule and include fees, custody and any time needed to obtain spendable proceeds. Keep underlying telemetry in access-controlled systems where appropriate. Technical confirmation of a transfer is one event in the workflow. The applicable contract and market rules determine whether the obligation is discharged. The model is conceptual and the examples report no observed performance.

5. Relationship to the earlier papers

The API micropayments paper compares billing frequency for repeated, completed requests. In this paper a billable quantity can change after initial approval. The primary design question is who bears provisional measurement risk and how later debits or credits are recovered. The carbon settlement paper also studies revisions, but concerns independently verified reductions and potential registry rights. This paper concerns recurring service consumption under one tariff or contract. The voucher paper studies use qualification at checkout, while these rules reconcile amounts over repeated settlement windows.

Keywords

Machine-to-machine payments, metered settlement, smart meter data, GPU usage billing, reconciliation, stablecoin settlement.

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