

Holo Fuel Model

Perry Kundert

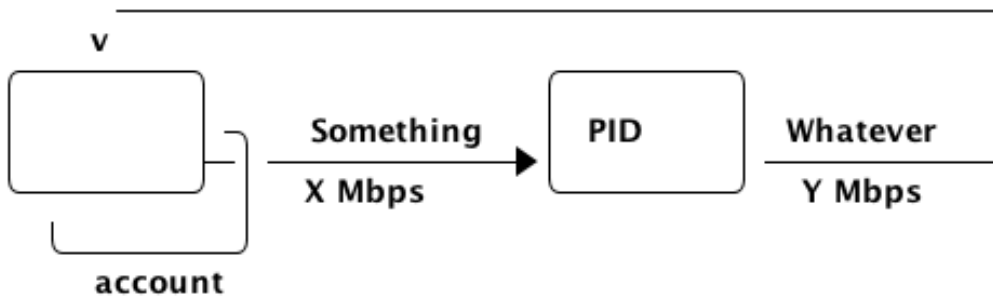
July 20, 2018

Contents

1	Holo Fuel Valuation	1
1.1	The Computational Resources Basket	1
1.1.1	Holo Hosting Premium	2
1.1.2	Resource Price Stability	2
1.2	Commodity Price Discovery	3
1.2.1	Recovering Commodity Basket Costs	3
1.2.2	Holo Hosting Receipts	3
1.2.3	Commodity Basket Valuation	5
2	Holo Fuel Value Stabilization	5
2.1	Wealth Monetization	5
2.1.1	Reserve Accounts	5

1 Holo Fuel Valuation

A value-stable wealth-backed cryptocurrency platform, where each unit is defined in terms of a basket of computational resources, operating in a powerful decentralized verification environment.



1.1 The Computational Resources Basket

One Holo Fuel (HOT) is defined as being able to purchase 1 month of Holo Hosting services for the front-end (ie. web API, databases, etc.) portion of a typical dApp.

This might be roughly equivalent to the 2018 price of (and actual utilization of) a small cloud hosting setup (eg. several \$5/month Droplet on Digital Ocean at partial utilization hosting front-ends, DBs, backups, etc.), plus ancillary hosting services (represented by a premium for inclusion in the Holo system).

If the minimal Hosting costs for a small Web app is estimated at USD\$100/mo., and comprises 5 cloud hosting nodes and ancillary services for the various aspects of the system. An equivalent Holo Host based system would have similar CPU and storage requirements overall, but a greater redundancy (say, 5 x, so all DHTs spread across 25 Holo Hosts).

Thus, the basket of commodities defining the value of USD\$100 == HOT\$100 could be defined as:

Commodity	Amount	Units	Weight	Description
holo	25.00	Host	50.000%	Inclusion in the Holo system
net	1.00	TB	12.500%	Internet bandwidth
ram	1.00	GB	12.500%	Processor memory
data	0.10	TB	12.500%	Persistent storage (DHT/DB/file)
cpu	1.00	Core	12.500%	A processing core

1.1.1 Holo Hosting Premium

A Holochain Distributed Application (dApp) hosted on Holo provides a valuable set of features, over and above simply hosting a typical web application on a set of cloud servers. These services must usually be either purchased, or architected by hand and distributed across multiple cloud hosting nodes for redundancy.

- ☐ Reliability. Few single points of failure.
- ☐ Backup. All DHT data is spread across many nodes.
- ☐ Scalability. Automatically scales to absorb increased load.

The value of Holo is substantial in terms of real costs to traditional app developers, and is a component of the basket of commodities defining the price of Holo Fuel. However, it's real monetary value will emerge over time, as the developer community comprehends it. Our pricing algorithm must be able to dig this Holo premium component out of the historical hosting prices, as a separate component.

1.1.2 Resource Price Stability

There are many detailed requirements for each of these commodities, which may be required for certain Holochain applications; CPU flags (eg. AVX-512, cache size, ...), RAM (GB/s bandwidth), HDD (time to first byte, random/sequential I/O bandwidth), Internet (bandwidth/latency to various Internet backbone routers).

The relative distribution of these features will change over time; RAM becomes faster, CPU cores more powerful. The definition of a typical unit of these commodities therefore changes; as Moore's law decreases the price, the specifications of the typical computer also improve, counterbalancing this inflationary trend.

For each metric, the price of service on the median Holo Host node will be used; 1/2 will be below (weaker, priced at a discount), 1/2 above (more powerful, priced at a premium). This will nullify the natural inflationary nature of Holo Fuel, if we simply defined it in terms of fixed 2018 computational resources.

1.2 Commodity Price Discovery

Value stabilization requires knowledge of the current prices of each commodity in the currency's valuation basket, ideally denominated in the currency itself. If these commodities are traded within the cryptocurrency implementation, then we can directly discover them on a distributed basis. If outside commodity prices are used, then each independent actor computing the control loop must either reach consensus on the price history (as collected from external sources, such as Distributed Oracles), or trust a separate module to do so. In Holo Fuel, we host the sale of Holo Host services to dApp owners, so we know the historical prices.

When a history of Holo Hosting service prices is available, Linear Regression can be used to discover the average fixed (Holo Hosting premium) and variable (CPU, ...) component costs included in the prices, and therefore the current commodity basket price.

1.2.1 Recovering Commodity Basket Costs

To illustrate price recovery, lets begin with simulated prices of a basket of commodities. A typical dApp owner would select HOT\$100 of these resources, eg. 25x holo Hosts, .05 TB data, .5 cpu, etc. as appropriate for their specific application's needs.

```
# To simulate initial pricing, lets start with an estimate of proportion of basket value represented
# by each amount of the basket's commodities.
price_mean      = basket_value      # target price: 1.00 Holo Fuel == 1 basket / basket_value
price_sigma     = price_mean / 10   # difference allowed; about +/- 10% of target
prices          = { k: ( price_sigma * numpy.random.randn() + price_mean ) * basket[k].weight / basket[k].amount
    for k in basket }
[ [ "Commodity", "HOT$", "Per" ],
  None ] \
+ [ [ k, "%5.2f" % ( prices[k] ), "/" %s / mo." % ( commodities[k].units ) ]
    for k in basket ]
```

Commodity	HOT\$	Per
holo	2.01	/ Host / mo.
net	13.86	/ TB / mo.
ram	11.54	/ GB / mo.
data	140.68	/ TB / mo.
cpu	11.40	/ Core / mo.

From this set of current assumed commodity prices, we can compute the current price of the HOT currency's basket:

$$\frac{\text{HOT\$ Basket Price}}{\$101.17 / 100.00}$$

If the current price of this basket is >100, then we are experiencing commodity price inflation; if <100, price deflation. Feedback control loops will act to bring the price back to HOT\$100 per basket.

1.2.2 Holo Hosting Receipts

Once we have the currency's underlying commodity basket, lets simulate a sequence of trades of various amounts of these commodities. In the Holo system, this is represented by Hosts issuing receipts for services to dApp owners.

We will not know the exact costs of each commodity used to compute the price, or how much is the baseline Holo system premium. However, it will be dependant on the capability of the Host (stronger hosts can charge more, for hosting more specialized dApps), and the amount of various services used.

```

amounts_mean      = 1.00
amounts_sigma     = 0.50
error_sigma       = 0.10 # +/- 10% variance in bids (error) vs. price
trades            = []
number            = 10000
for _ in range( number ):
    amounts        = { k: 1 if k == 'holo' else max( 0, basket[k].amount * ( amounts_sigma * numpy.random.randn() + amounts_mean ) ) for k in basket }
    price          = sum( amounts[k] * prices[k] for k in amounts )
    error          = price * error_sigma * numpy.random.randn()
    bid            = price + error
    trades.append( dict( bid = bid, price = price, error = error, amounts = amounts ) )

[ [ "HOT$", "calc/err", "dApp Requirements" ], None ] \
+ [ [
    "%5.2f" % t['bid'],
    "%5.2f%+5.2f" % ( t['price'], t['error'] ),
    ", ".join( "%5.4f %s %s" % ( v * basket[k].amount, k, commodities[k].units ) for k,v in t['amounts'].items() ),
    ]
    for t in trades[:5] ]

```

HOT\$	calc/err	dApp Requirements
38.76	39.62-0.86	25.0000 holo Host, 0.6409 net TB, 0.1043 ram GB, 0.0085 data TB, 1.3657 cpu Core
35.45	34.93+0.52	25.0000 holo Host, 1.0063 net TB, 0.3302 ram GB, 0.0108 data TB, 0.0000 cpu Core
49.59	52.11-2.52	25.0000 holo Host, 1.0970 net TB, 0.9349 ram GB, 0.0091 data TB, 0.9876 cpu Core
61.79	61.86-0.07	25.0000 holo Host, 0.8037 net TB, 1.5737 ram GB, 0.0155 data TB, 0.7663 cpu Core
49.21	48.34+0.88	25.0000 holo Host, 0.9104 net TB, 0.1694 ram GB, 0.0145 data TB, 0.9972 cpu Core

Lets see if we can recover the approximate Holo baseline and per-commodity costs from a sequence of trades. Create some trades of 1 x Holo + random amounts of commodities around the requirements of a typical Holo dApp, adjusted by a random amount (ie. 'holo' always equals 1 unit, so that all non-varying remainder is ascribed to the "baseline" Holo Hosting premium).

Compute a linear regression over the trades, to try to recover an estimate of the prices.

```

items            = [ [ t['amounts'][k] for k in basket ] for t in trades ]
bids             = [ t['bid'] for t in trades ]
regression       = linear_model.LinearRegression( fit_intercept=False, normalize=False )
regression.fit( items, bids )
select           = { k: [ int( k == k2 ) for k2 in basket ] for k in basket }
predict          = { k: regression.predict( select[k] ) for k in basket }

# + """\
#.: Score(R^2): %r
#"" % ( regression.score( items, bids ) )
[ [ "Commodity", "Predicted", "Actual", "Error",
    # "selected"
    ],
    None ] \
+ [ [ k,
    "%5.2f" % ( predict[k] ),
    "%5.2f" % ( prices[k] ),
    "%+5.3f%%" % (( predict[k] - prices[k] ) * 100 / prices[k] ),
    # select[k]
    ]
    for k in basket ]

```

Commodity	Predicted	Actual	Error
holo	1.86	2.01	-7.371%
net	14.00	13.86	+1.047%
ram	11.55	11.54	+0.046%
data	139.50	140.68	-0.836%
cpu	11.53	11.40	+1.217%

1.2.3 Commodity Basket Valuation

Finally, we can estimate the current HOT\$ basket price from the recovered commodity prices:

HOT\$ Basket Price	Error
\$97.63 / 100.00	-3.496%

We have shown that we should be able to recover the underlying commodity prices, and hence the basket price with a high degree of certainty, even in the face of relatively large differences in the mix of prices paid for hosting.

2 Holo Fuel Value Stabilization

Price discovery gives us the tools we need to detect {in,de}flation as it occurs. Control of credit available in the marketplace gives us the levers we need to eliminate it.

2.1 Wealth Monetization

In a wealth-backed currency, credit is created by the attachment of wealth to the monetary system. Depending on savings rates, monetary velocity, public sentiment etc., the amount of credit available to be spent varies. Since this available credit is split between possible expenditures in priority order, the amount available to spend on each specific commodity therefore varies, driving the market price up and down.

2.1.1 Reserve Accounts

The Reserve Accounts provide the interface between external currencies (eg. USD\$, HOT ERC20 tokens) and HOT\$ Holo Fuel.

Deposits to the reserve creates HOT\$ credit limit (debt) at a current rate of exchange (TBD; eg. market rate + premium/discount). The corresponding HOT\$ credits created are deposited to the recipients HOT\$ account.

If HOT\$ inflation occurs within the system, credit must be withdrawn. One way to accomplish this is to discourage creation of HOT\$ (and encourage the redemption of HOT), *by increasing the exchange rate. Their* creating (less redemption), reducing the HOT\$ available, and thus reduce deflation.

The Reserve Accounts can respond very quickly, inducing Holo Hosts with HOT\$ balances to quickly convert them out to other currencies when exchange rates rise. Inversely, reducing rates would release waiting dApp owners to purchase more HOT\$ for hosting their dApps, deploying it into the economy to address deflation (increasing computational commodity prices).

A PD (Proportional Differential) control might be ideal for this. This type of control responds quickly both to direct errors (things being the wrong price), but most importantly to changes in the 2nd derivative (changes in rate of rate of change); eg. things getting more/less expensive at an increasing rate.

By eliminating the I (Integral) component of the PID loop, it does **not** slowly build up a systematic output bias; it simply adjusts the instantaneous premium/discount added to the current market exchange rate (eg. the HOT ERC20 market), to arrive at the Reserve Account exchange rate. When inflation/deflation disappears, then the Reserve Account will have the same exchange rate as the market.

Beginning with a set of reserves:

Currency	Rate avg.	Reserves	Holo Fuel Credits
HOT ERC20	1.000000	1000000.00	1000000.00
USD	0.000456	900.00	2000000.00
EUR	0.000000	0.00	0.00
			3000000.0

As a simple proxy for price stability, lets assume that we strive to maintain a certain stock of Holo Fuel credits in the system for it to be at equilibrium. We'll randomly do exchanges of Holo Fuel out through exchanges at a randomly varying rate (also varied by the rate premium/discount), and purchases of Holo Fuel through exchanges at a rate proportional to the premium/discount.

```
t_last          = -1
for t in range( 1000 ):
    dt           = t - t_last
```