Prestige Fluido Documentation

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Note: This is a documentation and no user's guide. The user's guide is supposed to be much easier to understand, but won't be as comprehensive as this document. Also consider that I'm not a native English speaker.
Feel free to contact me (*radivis@radivis.com*) if you notice a mistake or have a suggestion how to improve the phrasing of any part of this documentation.

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Part I.
What is Prestige Fluido?

Prestige Fluido is an experimental hybrid digital money system featuring a reputation index called *Prestige* and a digital currency called *Fluido*. It can be used within organizations, or as global online service. Several different implementations of Prestige Fluido can run in parallel.

Fluido is distributed to each participant of the system proportionaly to his Prestige. The Prestige of a participant depends on how many distribution points he gets from other users. All users have the same constant amount of distribution points which they can attribute to other users.

Part II.
What is it good for?

Classically, in economics there is a distinction between physical goods and intangible services. In our digital age this simple distinction is too coarse. A third category of goods needs to be considered: *Digital goods*. These digital goods can be defined as objects which can be copied and distributed for a negligible cost. This attribute distinguishes them from physical goods and services. Some examples of digital goods are:

- Software
- Patents
- Texts saved in digital form, e.g. ebooks, scanned and digitized books, static webpages, scientific papers
- Audiobooks
- Music
- Photos, graphics and images
- Videos
- Objects in virtual worlds
- Digital data in general
- Genetic codes

Treating digital goods either as material goods or as services is inappropriate and creates serious problems.

What's the reason for these problems? In our current economic system the replication and distribution of digital goods often is severely restricted. That's rather bad from the consumers' perspective. However, distributing digital goods for free is an economic model that looks problematic for producers, as they need to invest work and possibly money to create their goods in the first place. They still can make quite a profit if they sell services and material goods for which the free ditital goods act as promotion. Nevertheless, adding those complementary goods and services requires a lot of additional effort and money. This makes it very difficult to invest a lot of time into creating digital goods. It can be argued that this represents a significant loss for the vast majority of consumers.

Theoretically, a donation economy could fix that problem. Producers would create digital goods, give them away for free, and get rewarded with donations. In reality, this concept doesn't work out very well, as donating is not an overly popular form of payment. Schemes in which consumers are free to decide about the price they want to pay for a digital product on their own (with the possibility of paying a price of 0) look more promising - even if the difference is only psychological. So, that's a relatively good system, but there's still the fact that paying for something is usually irreversible, unless there's a money-back guarantee. Now let's assume you pay for a product that you thought was rather good, but disappointed you somewhat, but not enough to demand your money back. You rather feel like it would be appropriate to demand half of the price back, because the product's not terribly bad after all. Actually doing so would feel rather awkward in the current system. After all, you paid for a product freely and it's not broken - you just didn't know in advance that it would disappoint your hopes.

What's the solution here? Paying for a product what you want and also having a "get back $x\%$ of your money back, where you choose freely what x is"-guarantee? Indeed, in very many cases that would be a pretty good solution (at least for the customers). Nevertheless, as nice as this sounds, it would be cumbersome to implement such a solution for all kinds of digital products. If you wanted to get really serious with it, you'd need to include a payment plug-in into every text you write, every photo you take, every video you make, and every line of code you type. Apart from being technical overkill, it would also be annoying and somewhat detrimental to the experience and enjoyment of the product itself.

If you pay for a product that's available for free, you actually want to reward the creator of that product and not the product itself. So, it would be much more convenient to implement a system that enables consumers to reward creators of digital products without making the detour through the payment for a specific product. Since donations aren't the sexiest solution, something different is needed: A reputation system with direct economic consequnces. And that's what Prestige Fluido is.

With the Prestige Fluido system you simply reward people for the things they do and create by increasing their Prestige score. Participants of the system who have a high Prestige score get gratified with a high *continuous income* in the digital currency Fluido. This currency works similarly to any other currency: You can trade it, you can accumulate it, you can buy goods and services with it (if payment with Fluido is seen as valid option).

So, Prestige Fluido is a system that couples positive reputation with money. This opens up completely new possibilities: For example you can write an article and get rewarded for it with Prestige (and indirectly also with Fluido) even though you didn't ask for payment or donations! How conventient is that? You'd only need a single Prestige Fluido account.

Even though the primary motivation for the implementation of a system like Prestige Fluido was to make it easier to reward producers of digital goods, it isn't restricted to that purpose. By it's hybrid nature it's even more flexible and versatile than the current forms of money. As Fluido behaves in many respects like a normal currency, it is possible to buy regular goods and services with it, once the required infrastructure for this kind of payment is in place. But it's also possible to increase the regular income of someone you like simply by increasing her Prestige score. You can even transfer Fluido to her *continuously* - not every year, or every month, or every day, but *every second*! And it's just as simple as transfering Fluido the regular way.

All these new options mean that Prestige Fluido represents the **next level of economy**!

Main Highlights of Prestige Fluido:

- A more democratic form of economy: Users "vote" for others in order to increase their Prestige.
- Bonuses for voting for a large number of different users.
- Optional basic income.
- The digital currency Fluido is generated continuously by Prestige.
- Continuous money transfers: Inflows and outflows.
- Evaporation: Conditional (Prestige dependent) demurrage for the Fluido currency. This is a counter-measure against inflation.
- A user interface with an extensive set of customization and privacy options.

Part III.
How does it work?

The Prestige Fluido system has three basic components:

1. A **distribution system** in which users assign distribution points to other users.
2. The reputation index **Prestige**. The more distribution points a user gets from others, the more Prestige he gets.
3. The digital currency **Fluido**. This currency is generated directly in the accounts of the users, in proportion to their Prestige.

1. The distribution system

Each user has a total of 6000 *distribution points* (*DPs*) which he can assign to other users. The number of 6000 isn't essential here, because rational fractions of the total number of DPs can be attributed to others, but $6000 = 60 \cdot 100 = (2^2 \cdot 3 \cdot 5) \cdot (2^2 \cdot 5^2) = 2^4 \cdot 3 \cdot 5^3$ is a nice "round" integer which can be divided by $2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 25, 30, 40, 48, 50, 60, 75, 80, 100$ and larger numbers (so, if you want to spread your points evenly among 75 people, you would just give 80 DPs to each of them, for example). What's important is that the amount of DPs of each user is fixed at 6000. Nobody can get more DPs or lose some of them. The only thing you can do with DPs is assign them to other people. You can reassign them at any time you want to. It is not possible to trade DPs. And it's also not possible to assign DPs to yourself.

1.1. Default System

There are basically two types of DPs: *Assigned DPs* and *unassigned DPs*.

Assigned DPs are those which you have assigned to another user. Unassigned DPs are those which you haven't assigned to anyone yet. You can turn unassigned DPs into assigned DPs by taking some of them and assigning another user to them. Say, you have 2000 unassigned DPs and assign 500 of them to user A. Then you have 1500 unassigned DPs afterwards and 4500 assigned DPs (since they need to sum up to 6000 DPs in total). Obviously, DPs can be either assigned or unassigned. They cannot be both at once.

You can unassign some of the DPs that you already assigned to a certain user in order to get more unassigned DPs. Those can be reassigned to any other user or just kept idle.

If you want to assign DPs to a user and you don't have enough unassigned DPs, the default option is to take unassigned DPs from all other users proportionally, which means that each of those users will lose the same fraction DPs assigned to him. For example, if you only have 1000 unassigned DPs left and want to assign 2000 DPs to a user A, first he gets the 1000 unassigned DPs and then 1000 DPs which you have already assigned. The users which got those assigned DPs had in total 5000 DPs, but now have to share only 4000 DPs among them. The result is that each of those users will only have $4000/5000 = 4/5$ left of his former DPs assigned to him.

Of course, this automatic reassignment option can be switched off. The reason why it's the default option is to eliminate the need for manual reassignment of DPs once (almost) all DPs are assigned. There's also the effect that Prestige tends to decline after a while with this system. So, you would need to renew your DPs for a certain user regularly, if you want him to have a large fraction of your DPs - unless you use the advanced features.

1.2. Advanced System

1.2.1. Subtypes of assigned DPs

Whenever you give DPs to a participant, you have the option to chose the subtype of DPs you want to assign to her. There are three different subtypes of assigned DPs:

1. *Stable DPs*, which are immune to automatic reassignment.
2. *Flexible DPs*, which are the standard option and behave as described in the preceding paragraph.
3. *Volatile DPs*, which are used up first when automatic reassignment happens.

Flexible and volatile DPs are also called unstable DPs, as they tend to be shifted around a lot, once automatic reassignment of DPs kicks in. The only difference between those subtypes is their behavior under automatic reassignment. How that works out becomes clear when considering some examples.

1. Suppose you have 500 unassigned DPs and 1000 volatile DPs. If you assign 1300 DPs to a participant, first the unassigned DPs are used up. Still, 800 DPs need to be taken from the assigned DPs in order to make the reassignment possible. Those DPs will be taken exclusively from the volatile DPs, because you have enough of them. Your volatile DPs will be reduced to 200 uniformly, which means that each user which got APs from you will only have $20\% = 200/1000$ of those volatile DPs left after the reassignment. Stable and flexible DPs aren't touched

2. Let's imagine that you want to assign 2000 DPs to a participant in the situation above. You have 500 unassigned DPs, 1000 volatile DPs and 1500 flexible DPs. Now, the unassigned and volatile DPs are all used up for the reassignment. But you still need to take 500 assigned DPs in order to complete the transaction. Those are taken from the flexible DPs, all of which are reduced to $2/3 = 1500 - (500/1500)$ of their former value. So, you will have 1000 of those previous flexible DPs left. Again, your stable DPs remain untouched by this transaction.

3. In the situation of the previous point you cannot reassign more than 3000 DPs (as that's the total of your unassigned and unstable DPs), unless you turn some of your stable DPs into unstable or unassigned ones.

1.2.2. Groups

You can create user groups in order to manage your DPs better. Externally, user groups are handled exactly as regular users you have in your distribution list, so you can assign stable, flexible, or volatile DPs to groups. It's just that internally a user group behaves similarly to the distribution list as a whole. Every group has 6000 internal distribution points, or IDPs. You can assign different types (stable, flexible, or volatile) IDPs to the users within a group. If the group gets a certain amount of DPs, those are split up according to the IDPs. For example, if a group gets 600 DPs, then a single user within that group has 200 IDPs, she will only get $200 \cdot (600/6000) = 200 \cdot (1/10) = 20$ DPs. The DPs that a group gets divided by 6000 is the *distribution ratio* of that group. In the previous example the distribution ratio was 1/10. So group members will get "IDPs $\cdot$ distribution ratio" DPs.

If automatic reassignment of DPs happens on the global level, the distribution ratio of your groups will sink (unless you are actually assigning DPs to that group).Global automatic reassignment doesn't mess with IDPs, but if the distribution ratio of a group sinks, the DPs every member of that group gets will also decrease.

Automatic reassignment within a group works like the regular automatic reassignmeent on the global level, as described in the previous subsection, but restricted to the members of the group. So, internal automatic reassignment will change nothing outside of that group

2. Prestige

While the distribution system is about "giving" DPs, in this section it's all about receiving Prestige.

2.1. Received distribution points

The distribution points another users assigns to you are your received distribution points, or RDPs. The more distribution points you receive, the better.

2.2. Distribution factor

Prestige is supposed to be more meaningful if users esteem a lot of other users. Otherwise, if you don't esteem many other users, only your top favorites would get DPs and everyone else gets nothing from you. That's not really fair, because there are probably many people which deserve at least some recognition and Prestige. And that's why there is an incentive for granting significant amounts of DPs to many different users: The *distribution factor* (or simply DF).

The distribution factor is the rounded down square root of the number of users you assign at least 20 DPs to, but it's capped at 10 and won't grow any further from that point on. So, let n be the number of participants who get at least 20 DPs (of any kind) from you, then your distribution factor $DF(n)$ can be found in the following table:

n	$DF(n)$
$1-3$	1
$4-8$	2
$9-15$	3
$16-24$	4
$25-35$	5
$36-48$	6
$49-63$	7
$64-80$	8
$81-99$	9
$100-300$	10

2.3. How the Prestige score is calculated

Suppose you get 50 RDPs from a user who has a distribution factor of 5 and you have a distribution factor of 3. Then you will get $50 \cdot 5 \cdot 3 = 450$ Prestige from that user. So, the factor of the users you get RDPs from, as well as your own distribution factor play an important role in determining the Prestige you have in the end. Your total Prestige score is simply the sum of all Prestige points you get from all users which have assigned DPs to you.

Written as formula, your Prestige score is the following: Suppose that every user has a number i between 1 and N, and the distribution factor of user i is denoted as F_i.

Your own distribution factor is simply written as F. The received distribution points you get from user i are R_i. Then your prestige score P is calculated as

$$P = \sum_{i=1}^{N} R_i \cdot F_i \cdot F = F \cdot \sum_{i=1}^{N} R_i \cdot F_i,$$

where the sign $\sum_{i=1}^{N}$ means that you add up the term on the right side for each i from 1 to N (replacing the i's in the term with the number you are counting through), so

$$P = F \cdot (R_1 \cdot F_1 + R_2 \cdot F_2 + R_3 \cdot F_3 + \cdots + R_N \cdot F_N).$$

2.4. Why your Prestige doesn't depend on the Prestige of your supporters.

At first, I considered making the Prestige you get from a user depenent on the Prestige of that user. So, users with a lot of Prestige would be able to grant others lots of Prestige. You could argue that such a system would be less democratic than the system described above, and that having a lot of Prestige doesn't automatically mean that can esteem others "better" in some way. But there's also a more basic (less philosophical) reason why I didn't use that scheme: It faces some nasty mathematical problems.

To understand the rest of this section, you need some knowledge about a mathematical discipline called linear algebra.

Let's say we simplify the formula for the Prestige score by leaving out the distribution factors (or setting all of them to 1), but making it dependent on the Prestige scores of those users who give you distribution points. A sensible approach would be just to multiply the distribution points R_i you receive from user i with her Prestige score P_i and sum over all users:

$$P = \sum_{i=1}^{N} R_i \cdot P_i$$

But how are the P_i's determined? As all Prestige scores are calculated the same way, the P_i's are determined by a similar formula. If D_{ij} denotes the distribution points that user j receives from user i, then the Prestige score of user j is determined by the formula

$$P_j = \sum_{i=1}^{N} D_{ij} \cdot P_i$$

Now, let's write this formula in a different way. First, note that the numbers D_{ij} define a matrix with N rows and N columns, which I call the *distribution matrix* D. Secondly, the numbers P_i define a column vector with N entries, which I call the *Prestige vector*. Thus, the entry P_j is determined by summing up the entries in the j-th **column** of R multiplied with the i-th entry of P. This is almost the usual multiplication of a matrix with a vector, except that we sum up over rows of R instead of colums to get an entry of P. If we exchange the row- and column-indices of D we get the transpose D^T, which we define as R, of the distribution matrix and we get the ordinary matrix multiplication of R with P. So, we can rewrite the formula as

$$P = R \cdot P$$

This says nothing else than that P needs to be a fixed point of mapping

$$R : \mathbf{R} \to \mathbf{R},\ v \mapsto D^T \cdot v.$$

Therefore, in order to compute the Prestige vector P, we need to make sure that there exists a non-trivial solution to this fixed point problem (obviously $P = 0$ is always a solution). It would also be very nice if the solution was unique. For this purpose we can rewrite the formula to

$$(R - I) \cdot P = 0,$$

where I is the identity matrix, so $I \cdot P = P$. Therefore, the fixed points we look for are exactly the elements of the kernel of the linear mapping

$$R - I : \mathbf{R} \to \mathbf{R},\ v \mapsto (R - I) \cdot v.$$

Because kernels of linear mappings are always linear subspaces, there are an infinite number of solutions once there is a non-trivial solution which is a really awkward situation.

But let's assume we could choose a suitable non-trivial solution. When are there any non-trivial solutions at all? The kernel of $R - I$ must be non-trivial, which means that the matrix $R - I$ may not have full rank. Or equivalently, the determinant of $R - I$ must be exactly 0. As the product of the entries on the main diagonal of $R - I$ is 1 or -1 (due to the fact that users cannot assign distribution points to themselves), all other terms in the determinant formula

$$\det(A) = \prod_{\sigma \in \Sigma_n} \operatorname{sign}(\sigma) \sum_{i=1}^{N} a_{i,\sigma(i)},$$

where $A = (a_{ij})_{i,j=1,\ldots,N} := R - I$ and Σ_n is the set of all permutations of the set $\{1, \ldots, N\}$, must sum up to -1, respectively 1, which almost certainly does not happen.

Consequently, the modified formula usually cannot hold. And even if there is a non-trivial solution there are infinitely many of them, so we would need to use some ad-hoc criteria to single out the "most sensible" one.

3. Fluido

While Prestige is quite interesting in itself, in the Prestige Fluido system it has the purpose of creating Fluido, a digital currency. Fluido is generated directly in you account in proportion to your Prestige score.

There are two different systems, a discrete and a continuous one. In the discrete system Fluido is created regularly after a fixed time interval, for example 24 hours. Whereas, in the continuous system Fluido is created continuously all the time, like a river flows into the sea continuously all the time. So, in the continuous system you would get more and more Fluido every microsecond, if you have some Prestige.

Because there are some peculiar problems with the discrete system, I favor the continuous system, in which those special problems don't appear. On the other hand, the continuous system is more difficult to understand, so I explain the discete system first.

3.1. Discrete system

The basic idea is simple: The amount of Prestige you have equals your annual income in Fluido. If you want to get Fluido more often, say every day, you would get 1/365 of your Prestige score as daily income in Fluido. So far, so easy. A problem of this scheme is that it is rather inflationary, as more and more money is produced all the time. To counter this effect, you first need to understand the principle of demurrage.

3.1.1. Demurrage

Demurrage is like a tax on having money in a certain currency. A currency with demurrage is devalued regularly, which means that the amount of money is reduced systematically, and not due to the relation between the amount of money in circulation and the amount of available goods and services. One possible way to implement demurrage is to require owners of a currency to pay a fee of some percentage of the value of their banknotes. For example, the Chiemgauer is a local currency with demurrage, and to maintain the validity of a Chiemgauer banknote you have to pay 2 % of the value of that banknote every three months.

In Prestige Fluido there is a similar mechanism. In the discrete system with unconditional demurrage, the amount of Fluido on your account is reduced by a certain percentage regularly. This percentage is 5 % per year. It works like a negative interest rate of -5 %.

First your money is devalued and then you get more Fluido in proportion to your Prestige. (It would be possible to exchange the order and first create Fluido and then devalue everything, even the freshly created Fluido, but that system would make less sense.)

To see how the demurrage works out in Prestige Fluido, let's assume for simplicity that you have a fixed Prestige score P, that your Fluido is devalued only every year by 5 %, and that it stays idle on your account all the time. At the beginning of the second year there would be $F_2 = P$ Fluido on your account, because Prestige basically is your yearly income in Fluido (at least if you don't have Fluido yet). Let $p = 0.05$ and $q = 1 - p = 0.95$, then at the begining of the third year, you would have $F_3 = P + q \cdot P = (1 + q)P$ Fluido. At the end of the third year your Fluido count would be

$$F_4 = q(1 + q)P + P = (1 + q + q^2)P.$$

And at the end of the fourth year:

$$F_5 = q(1 + q + q^2)P + P = (1 + q + q^2 + q^3)P$$

It's easy to see how this goes on. You always add another $q^{Y-2}P$, where Y is the year at whose begining you check your account. This is known as finite geometric series and there's a nice formula for it. At the begining of the n-th year, the amount of Fluido on your account would be

$$\boxed{F_n = P\sum_{i=0}^{n-2} q^i = P\frac{1-q^{n-1}}{1-q} = 20P \cdot (1 - (0.95)^{n-1})}$$

If n goes to infinity this converges to

$$F_\infty = \frac{1}{1-q}P = \frac{1}{p}P = \frac{1}{0.05}P = 20P$$

Here's a table with the values of F_n in multiples of P:

Year	2	3	4	5	6	7	8	9	10	15
F_n in multiples of P	1	1.95	2.85	3.71	4.52	5.30	6.03	6.73	7.40	10.25

Year	20	25	30	35	40	50	75	100
F_n in multiples of P	12.45	14.16	15.48	16.50	17.29	18.38	19.55	19.88

3.1.2. Evaporation

Actually, the real discrete model of Prestige Fluido doesn't use demurrage exactly as described above, but rather uses a conditional system of demurrage which I call *evaporation*.

You may have up to five times your Prestige Score P in Fluido on your account without losing anything due to demurrage. Conditional demurrage is only applied to the amount of Fluido that's above five times your Prestige Score in Fluido. So, if you have $10P$ Fluido on your account, the first $5P$ of them are safe and the 5% evaporation only applies to the other $5P$, so there's an effective *annual evaporation rate* of only 2.5%. And if you somehow manage to have exactly $25P$ Fluido you your account, your effective annual evaporation rate of

$$\frac{20 \cdot 0.05}{25} = \frac{1}{25} = 0.04 = 4\%,$$

which exactly eats up $25 \cdot 0.04P = 1P$ Fluido, so no new Fluido is generated in your account, but effectively you also lose nothing. The amount of Fluido on your account only decreases due to evaporation if you have more than $25P$ Fluido. With evaporation, the formula for your Fluido count if your Prestige doesn't change and you remain inactive is slightly more complicated. Let s be the amount of Fluido which are safe from evaporation. Here, we have $s = 5P$.

$$\boxed{F_n = \begin{cases} (n-1)P & \text{,if } (n-1)P \leq s \\ s + P\frac{1-q^{n-6}}{1-q} = P\left(s + \frac{1-q^{n-6}}{1-q}\right) & \text{, if } (n-1)P \geq s \end{cases}}$$

This time the exponent is $n-6$, because evaporation only starts in the 6th year.

Here's the table with the values of F_n in multiples of P for this situation:

Year	2	3	4	5	6	7	8	9	10	15
F_n in multiples of P	1	2	3	4	5	6	6.95	7.85	8.71	12.40

Year	20	25	30	35	40	50	75	100
F_n in multiples of P	15.25	17.45	19.16	20.48	21.50	22.91	24.42	24.84

3.1.3. Adjusting the timescale

Actually using a timescale of a whole year for the discrete system is far too long, because Prestige changes much faster than that. If you want to change the timescale to a $\frac{1}{m}$th of a year, you need to replace the demurrage factor q with q', where

$$q'^m = q, \text{ so } q' = \sqrt[m]{q}$$

Because in one mth of a year, you only get one mth of your Prestige Score P in Fluido, the Fluido formula for the system with unconditional demurrage then becomes:

$$\boxed{F_n = \frac{P}{m}\sum_{i=0}^{n-2} q'^i = \frac{P}{m}\frac{1-q'^{n-1}}{1-q'}},$$

where n denotes the beginning of the nth mth fraction of a year.

The Fluido formula for sytem with evaporation (where s is still $5P$) becomes:

$$\boxed{F_n = \begin{cases} (n-1)\frac{P}{m} & \text{,if } (n-1)\frac{P}{m} \le s \\ s + \frac{P}{m}\frac{1-q^{n-1-(5m)}}{1-q} & \text{, if } (n-1)\frac{P}{m} \ge s \end{cases}}$$

3.1.4. Problems of the discrete model

Whenever the time comes that the demurrage fee is applied, there's an incentive to get rid of as many of your Fluido which exceed your safe amount as possible (in order to minimze your losses from demurrage). One of the most obvious ways to do that is to sell some of your Fluido. But shortly before the devaluation happens, the demand for Fluido is low, because buyers probably know that they will soon lose a fraction of the Fluido they want to buy. This effect creates unnecessary fluctuations of the Fluido exchange rates. And it's also a general inconvenience for buyers and sellers, because the discrete model incentivizes tactical Fluido trading, which is mostly just a waste of time.

Using the discrete model is also problematic, because the same time that the demurrage fee is applied (and only at that time) the Prestige score becomes effective by creating new Fluido. So, if you are unlucky and have a low Prestige score just at that time, it doesn't help you if you have a higher Prestige score at other times.

Minimizing those problems by changing the timescale to minutes, seconds, or even milliseconds would enforce unneccesarily frequent updates of all Fluido counts, while still not solving the above problems completely.

The ideal solution is to update the Fluido count just in time when a relevant Fluido transaction happens. But that's best done with a...

3.2. Continuous system

In this system Fluido is generated continuously. Regardless how recently you checked your Fluido count the last time, it always changes (that is if you have a suitable amount of Prestige). This system is mathematically more complicated than the discrete case, but it makes more sense and has less problems.

Remember, Fluido is first devaluated and then created by Prestige. So, what happens within a small time interval Δt (sufficiently small, so that your Prestige score doesn't change and there are no external Fluido transactions happen), if you start with a Fluido count $F(t)$? For the begining, let's consider the case with unconditional demurrage. First, that amount is devalued by a certain fraction $\rho(\Delta t)$, and then a small amount of new Fluido $\phi\Delta t$ is created:

$$F(t+\Delta t) = \rho(\Delta t)F(t) + \phi\Delta t.$$

Dividing by Δt leads to

$$\frac{F(t+\Delta t)}{\Delta t} = \frac{\rho(\Delta t)}{\Delta t}F(t) + \phi.$$

If Δt goes to 0, this becomes

$$F'(t) = \lim_{\Delta t \to 0} \frac{F(t+\Delta t)}{\Delta t} = \rho'(0)F(t) + \phi,$$

where $\rho'(0)$ is just a simple constant, which we can abbreviate with ϱ, so we get the ordinary differential equation

$$F'(t) = \varrho F(t) + \phi.$$

The general solution of this ODE is

$$F(t) = Ce^{\varrho t} - \frac{\phi}{\varrho},$$

where C is just a simple constant and e is Euler's contant ($e = 2.71828...$). That this function is actually a solution can be verified easily by differentiating it:

$$F'(t) = \varrho Ce^{\varrho t} = \varrho\left(Ce^{\varrho t} - \frac{\phi}{\varrho} + \frac{\phi}{\varrho}\right) = \varrho\left(F(t) + \frac{\phi}{\varrho}\right) = \varrho F(t) + \phi.$$

Now, what are the right constants C, ϱ and ϕ? Let's do that by comparing this function with the discrete case. If t goes to infinity, $F(t)$ ought to go to

$$F_\infty = \frac{P}{1-q} = 20P.$$

But if ϱ was positive, the exponential term $e^{\varrho t}$ would go to infinity, so it must be negative. Therefore, the exponential term goes to 0 and we get:

$$\lim_{t\to\infty} F(t) = -\frac{\phi}{\varrho} = F_\infty.$$

If we start with F_0 Fluido at $t = 0$, we get

$$F_0 = F(0) = C - \frac{\phi}{\varrho} = C + F_\infty,$$

so $C = F_0 - F_\infty$.

As timescale we chose a year, so after a year we would have $qF_0 + P = 0.95F_0 + P$ Fluido, as P is the amount of Fluido that are generated every year:

$$qF_0 + P = F(1) = (F_0 - F_\infty)e^{\varrho} + F_\infty,$$

from which we get for $F_0 \neq F_\infty$:

$$e^{\varrho} = \frac{qF_0 + P - F_\infty}{F_0 - F_\infty},$$

which results in

$$\varrho = \ln\left(\frac{qF_0 + P - F_\infty}{F_0 - F_\infty}\right).$$

With $\frac{\phi}{\varrho} = -F_\infty$ we can compute ϕ:

$$\phi = -\varrho F_\infty = -\ln\left(\frac{qF_0 + P - F_\infty}{F_0 - F_\infty}\right) F_\infty.$$

Thus, the Fluido formula for the case with unconditional demurrage is

$$\boxed{F(t) = \begin{cases} (F_0 - F_\infty)\exp\left(\ln\left(\frac{qF_0+P-F_\infty}{F_0-F_\infty}\right) t\right) + F_\infty. & \text{, for } F_0 \neq F_\infty \\ F_\infty & \text{, for } F_0 = F_\infty \end{cases}}$$

Essentially, this formula means that the difference between F_0 and F_∞ decreases exponentially and the difference between F_0 and F_∞ determines the speed of the convergence. If it's large, the decrease happens fast. And if it's small, the decrease happens slowly.

In fact, F is continuous as function of t and F_0, since for $F_0 \to F_\infty$ we have

$$\lim_{F_0\to F_\infty} \frac{qF_0 + P - F_\infty}{F_0 - F_\infty} = \lim_{F_0\to F_\infty} \frac{\frac{d}{dF_0}(qF_0 + P - F_\infty)}{\frac{d}{dF_0}(F_0 - F_\infty)} = q$$

(due to the rule of L'Hospital), so

$$\lim_{F_0\to F_\infty} \exp\left(\ln\left(\frac{qF_0 + P - F_\infty}{F_0 - F_\infty}\right) t\right) = \exp(\ln(q)t), \text{ and}$$

$$\lim_{F_0\to F_\infty} (F_0 - F_\infty)\exp\left(\ln\left(\frac{qF_0 + P - F_\infty}{F_0 - F_\infty}\right) t\right) + F_\infty = F_\infty.$$

3.2.1. Fluido computation with evaporation

For the system with evaporation it is convenient to split the problem into two parts: First, determine whether $F_0 < s = 5P$. Then, if the answer is yes, apply linear growth. And if the answer is no, then we use the formula with the exponential term, but apply it to

$$F_0^e := F_0 - s,$$

because that's the part of your Fluido that's prone to evaporation. Also note that $F(t)$ now converges to

$$F_\infty^s := F_\infty + s,$$

because the safe amount s needs to be added to the evaporating Fluido $F(t)-s$, which converge to F_∞.

If $F_0 < s$ and as long as $F(t) < s$ use
$F(t) = F_0 + Pt$
Otherwise use
$$F(t) = \begin{cases} (F_0^e - F_\infty)\exp\left(\ln\left(\frac{qF_0^e+P-F_\infty}{F_0^e-F_\infty}\right)t\right) + F_\infty^s. & \text{, for } F_0^e \neq F_\infty^s \\ F_\infty^s & \text{, for } F_0 = F_\infty^s \end{cases}$$

3.2.2. Continuous Fluido transfer: Inflows and outflows

It's possible to move Fluido from one account to another instantly, but the continuous system opens up a new option: Transfering Fluido continuously! An incoming continuous Fluido transfer from another user is called *inflow*, and an outgoing continuous Fluido transfer to another user is called *outflow*.

Quite surprisingly, it is rather simple to implement this into the continuous system. For that purpose you need to consider that an inflow just works like the continuous generation of Fluido by Prestige. For example, if you have 1000 Prestige and an inflow of 500 Fluido per year, for you that's the same as having 1500 Prestige - with the difference that the inflow doesn't increase your safe amount $s = 5P$ of Fluido which don't evaporate. Since an inflow behaves partially like real Prestige, the 500 Fluido you get per year count as *virtual Prestige* $P_V = 500$, which is added to your *real Prestige* $P = 1000$ to get an *effective Prestige* $P_E = P + P_V = 1500$.

Therefore, the fomulas above already include inflows and outflows (which count as negative Prestige), if you replace P with P_E, except where the real Prestige P is used to determine the safe amount $p = 5P$.

However, something new happens here: It is possible to spend more Fluido with outflows than are generated by your Prestige and inflows together. So, it is necessary to check whether you are still over the critical level $s = 5P$. Inflows and outflows also change the value F_∞^s (respectively F_∞) to which your Fluido (respectively your evaporating Fluido) converge. It is replaced with

$$F_\infty^{E,s} := \frac{P_E}{1-q} + s = \frac{P + P_V}{1-q} + s$$

$$\left(\text{respectively } F_\infty^E := \frac{P_E}{1-q} = \frac{P+P_V}{1-q}\right)$$

Once your Fluido count falls to 0, all your outflows are stopped automatically, because having a negative amount of Fluido is not allowed.

Finally, the Fluido computation formulas which also implement inflows and outflows are:

If $F_0 < s$ and as long as $F(t) < s$ use

$$F(t) = F_0 + P_E t$$

If $F_0 \geq s$ and as long as $F(t) \geq s$ use

$$F(t) = \begin{cases} (F_0^e - F_\infty^E)\exp\left(\ln\left(\frac{qF_0^e + P_E - F_\infty^E}{F_0^e - F_\infty^E}\right)t\right) + F_\infty^{E,s} & \text{, for } F_0 \neq F_\infty^{E,s} \\ F_\infty^{E,s} & \text{, for } F_0 = F_\infty^{E,s} \end{cases}$$

3.2.3. How does the computation really work?

You may have noticed that the above formulas are only valid if your (effective) Prestige doesn't change and no discrete (non-continuous) Fluido transfers happen. So, the system has to deal with these kinds of *discrete transactions* somehow. The system works this way:

The system saves the following dynamic data:

- Your Fluido count F_0 after the last update.
- The time t since the last update of the Fluido count $F(t)$.
- The expected time t_T at which your Fluido will reach one of the thresholds 0, or s.
- Your Prestige P.
- Your virtual Prestige P_V.

For computing the current Fluido count $F(t)$, the Fluido formula is used. If a discrete transaction happens or your Fluido count reaches the thresholds of 0, or s (of course the system needs to compute when that is about to happen and react once that time is reached), the following things happen.

1. The current Fluido count $F(t)$ is computed and F_0 is redefined as $F(t)$.
2. The time t is reset to 0.
3. If you reach the threshold of 0, all outflows are canceled.
4. If there's a Fluido transfer, F_0 is reduced or increased by the appropriate amount.
5. If your (virtual or real) Prestige has changed, the variables P, respectively P_V, and P_E are updated.
6. The time t_T is updated with the new data.

Between those events, the current Fluido count $F(t)$ is always checked by using the Fluido formula.

Now, there's still the problem of computing the time t_T at which your Fluido count is expected to reach one of the thresholds 0, or s. Under the following conditions t_T has a finite value:

1. Your effective Prestige $P_E = P + P_V$ is positive and your Fluido count $F(t)$ is below s.
2. Your effective Prestige P_E is negative and your Fluido count $F(t)$ is below or equal to s.
3. Your effective Prestige P_E is negative and your Fluido count $F(t)$ is above s.

In the first case, the system needs to solve the equation $F(t) = s$. Because your Fluido count is below s, the linear formula is used:

$$s \stackrel{!}{=} F(t) = F_0 + P_E t \quad \Leftrightarrow \quad t = \frac{s - F_0}{P_E}$$

So, in that case, the time t_T would simply be set to $\frac{s-F_0}{P_E}$.

Also in the second case the linear formula is used:

$$0 \stackrel{!}{=} F(t) = F_0 + P_E t \quad \Leftrightarrow \quad t = \frac{-F_0}{P_E}$$

Here, the time $t_T := \frac{-F_0}{P_E}$ is actually positive, because P_E is negative.

The third case is more complicated, because the exponential formula is used.

$$\begin{aligned}
& s & \stackrel{!}{=} & \; F(t) = (F_0^e - F_\infty^E) \exp\left(\ln\left(\frac{qF_0^e + P_E - F_\infty^E}{F_0^e - F_\infty^E}\right) t\right) + F_\infty^{E,s} \\
\Leftrightarrow & \frac{s - F_\infty^{E,s}}{F_0^e - F_\infty^E} & = & \; \exp\left(\ln\left(\frac{qF_0^e + P_E - F_\infty^E}{F_0^e - F_\infty^E}\right) t\right) \\
\Leftrightarrow & \ln\left(\frac{-F_\infty^E}{F_0^e - F_\infty^E}\right) & = & \; \ln\left(\frac{qF_0^e + P_E - F_\infty^E}{F_0^e - F_\infty^E}\right) t \\
\Leftrightarrow & t & = & \; \frac{\ln\left(\frac{F_\infty^E}{F_\infty^E - F_0^e}\right)}{\ln\left(\frac{qF_0^e + P_E - F_\infty^E}{F_0^e - F_\infty^E}\right)}
\end{aligned}$$

This time, t_T as defined by the solution above is positive, because both numbers in the enumerator and the denominator are negative (as logarithms of numbers that are smaller than 1).

Part IV. The user interface

...work in progress ...

Part V.
Appendix

A. Possible issues of Prestige Fluido

A.1. Wealthy participants could simply buy Prestige

This would work by paying other participants for giving you DPs. Such Prestige might be quite undeserved. But it's difficult to distinguish illegitimate from legitimate transactions. After all you would probably thank a friend for helping you out with financial problems. It's reasonable that generous persons are rewarded with high Prestige. So, where do you draw the line between these meaningful transactions and transaction made only out of greed for Prestige? Helping others for selfish reasons might not be ideal, but it still does some good after all.

If the user base really takes offense at a transaction that look like "Prestige purchasing" it can react by pointing out that issue. Then users would be free to reduce the DPs they give to the buyer - or even the Prestige sellers. In extreme cases it might be considered to ban participants who behave in an unethical way, so that they end up with no Prestige at all.

A.2. Celebrities and widely popular persons are favored in this system

Indeed, this is likely. However, it doesn't need to be seen as problem. If someone is popular, one could reason that he is good at satisfying a real desire, even if it's not a very noble desire, for example the desire for shallow entertainment. What are the long-term consequences of not rewarding those who fulfill such desires? It's hard to say. Those desires would be harder to fulfill in that case. This would create an incentive to seek other ways of keeping up a relatively high level of well-being. Those alternatives could be healther, but they could also be less healthy. As humans tend to prefer easy alternatives, I'd argue that it's more likely that they'd switch to less healthy alternatives.

A.3. General popularity doesn't mean that someone or something is actually good

Sure, but neither do other methods guarantee that someone or something is actually good. Prestige Fluido just adds an additional democratic layer to economy. Of course, there are other meaningful metrics to determine "goodness", but implementing them into Prestige Fluido would distort the purpose of the system as tool for expressing and rewarding popular esteem. And not using such a tool would only be justified if it was shown that it does more bad than good.

A.4. This system could favor already wealthy persons

Prestige Fluido ought to favor persons who do good. If those wealthy persons which are favored do good, then that's fine. And if they don't, it is to be expected that their Prestige scores would be relatively low.

A.5. Minorities could be discriminated against

That is, members of minorities might be less likely to get DPs from others, just because they are members of that minority. Thus, minorities would have an unfair disadvantage. Unfortunately, this is a real problem that can harly be prevented. Nevertheless, it's possible to compensate for such biases by voluntary affirmative action, that is giving members of minorities slightly more DPs than usual, because they are members of a minority that gets discriminated against.

A.6. Multiple user accounts per person could distort Prestige scores

Yes, that's a serious problem that could threaten the meaningfulness of Prestige and Fluido. Therefore, it is justified to use very serious identity verification methods to minimize the distortion coming from this problem. One possibility would be to send an activation code by snail mail. Users without valid activation code would only have restricted possibilities to grant Prestige to others.

A.7. Fluido is just another "fiat currency" that's backed by nothing

Fluido is not backed by tangible goods, but receives its value through its initial democratic legitimation as expression of popular esteem, and through its relative scarcity. Even though Fluido is produced continuously, it doesn't need to lose its value. Due to evaporation, the average maximum amount of Fluido per person is limited to 25 times the average Prestige score. And the average Prestige score per person can never exceed 600000. In any case, every currency only has value because people think it has value. Having a high positive reputation is generally seen as quite valuable. So, Prestige has a clear value as representation of positive reputation. Fluido can be seen as Prestige summed up over time. So, Fluido has value as tradable accumulated manifestation of positive reputation. That's something that isn't wholly true for classical currencies, because you don't have to think highly of someone you purchase a good or get a credit from, and vice versa. Consequently, it is not true that classical currencies have a clear link to positive reputation. These advantages of Fluido ought to be enough to be seen as valuable by lots of people.

B. Where do these ideas come from?

Even before I finished high school I was somewhat intrigued about the difference between goods that can be replicated easily and those which can't. It seemed quite artificial to me that you need to pay a price for the former that resembles the price of usual mass-produced goods, which is still relatively high when considering that you only buy information which can be distributed for free. However, I didn't see a good solution to this issue.

It was only years later that I realized that a full-fledged reputation economy would be a really elegant solution. People could produce and distribute digital products in order to gain reputation, which could somehow be used to pay for all kinds of goods and services. But I didn't have a good idea how that would actually work. After I read the science fiction novels *Accelerando* by *Charles Stross* and *Down and Out in the Magic Kingdom* by *Cory Doctorov* I thought it would work roughly as pictured in those stories. Unfortunately, those novels didn't feature precise descriptions how their reputation systems actually work.

In the meanwhile, I stumbled upon alternative concepts like basic income guarantees and currencies with demurrage (the latter was an idea of the perhaps underappreciated economist *Silvio Gesell*). When I started to think about how to implement a reputation based economy, I noticed that these idea fit into my schemes quite naturally and easily - actually my first idea was to apply the basic income and the demurrage directly to the reputation score. My first ideas of a reputation economy only featured a reputation index, but no additional digital currency. Only later on I realized that including a currency that is generated by reputation would be much more practical than a reputation score alone. I called that combined system *Repo Fluido*.

There were many different versions of Repo Fluido, as I always changed the system once I noticed a major flaw. During the November of 2011 I worked a lot on developing that system, so that it finally arrived at the form it has now. The last major change was to call the system *Prestige Fluido* (due to a comment that "Repo Fluido" sounds like a laxative), because "Prestige" is a more positive and descriptive term than "Repo", since reputation can be positive as well as negative.