Engineering a Market for Personal Data: The Hub-of-all-Things (HAT)
A Briefing Paper

RCUK Digital Economy HAT Project
http://hubofallthings.org
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Executive Summary

To establish meaningful information from the volume of personal data generated by the trillions of transactions and behaviours of individuals recorded each day, it is necessary to recognise two categories of personal data: content data and metadata. Metadata describes the instances and contexts of personal content data; it is 'data about data'. For instance, where content data may tell us calories consumed, metadata tells us who consumed them, when they were consumed, where they were consumed, who and what else was present etc. In this respect, it has the potential to make content data meaningful, through an understanding of its context.

The issue, however, is that currently personal data is collected in silos by firms for their own benefit, through technologies designed to gather, store and analyse data for those purposes. The result, we contend, is 'raw' personal metadata, which is a side effect (an externality) of the commercial activity of these firms. Typically of an externality, it can either be internalized through other offerings in different markets, or regulated by government to prevent abuse. The core objective of the HAT project is to internalise personal metadata into the economy, so that it becomes the viable asset, owned by individuals and available for exchange instead of being a negative externality (e.g. loss of privacy) of existing digital economy transactions.

To do this, the HAT project sets out to create the HAT (Hub-of-All-Things); a technical and market platform owned and controlled by the individual, that digitally facilitates exchange between stakeholders of personal metadata. To meet this aim, the project is faced with four key challenges:

1. Access to and acquisition of 'raw' personal data for individuals
2. Re-categorisation of 'raw' personal data in to content and metadata
3. Understanding and co-creating context in the personal data
4. Creating a market for transformed (i.e. categorised and contextualised) personal metadata

In the first three, the challenge is in the assembly and transformation of 'raw' personal metadata into meaningful information for decision-making of individuals because effective and efficient purchasing and consumption in day-to-day lives will be the value proposed to individuals in adopting the HAT to store their own personal data. The final challenge is a marketplace to trade personal metadata. Technical platforms, like the HAT, are in themselves 'multi-sided' markets that facilitate exchange between different parties. In this respect the HAT will facilitate three markets for exchange:

1. Supply market; where sellers offer technologies that supply personal metadata to individuals
2. Use market; where sellers offer services to help individuals use personal data
3. Exchange market; where individuals exchange their transformed metadata for discounts, personalised products and services etc.

These markets provide opportunity at both sides of the exchange: they give individuals an opportunity to buy services which make their data useful in day-to-day living or exchange their data for various purposes, while preserving their privacy; and, they give firms the opportunity to design and bundle offerings more suited to the way individuals experience and consume their products and services on a day to day basis.

As a platform, the HAT is 'a building block' and a 'market maker', upon which other firms can develop complementary products, technologies or services. It aims to be a open and standardized platform that can be scaled as well as having the ability to be personalized by every individual i.e. a global market of one, emerging a new generation of digital economy businesses that is individual centric, privacy preserving and yet providing opportunities for new business models, new jobs and greater employment. In so doing, the HAT aims to achieve the potential of a democratic digital society for both economic and societal wellbeing.

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Background

Reports produced by the World Economic Forum in 2011 and 2013 suggest that users around the globe send over 45 billion emails, 10 billion text messages and submit 95 million tweets in an average day.

In fact, trillions of individuals' transactions and behaviours are being recorded each day via billions of connected devices and sensors. Data is collected on who we are, who we know, what we like and dislike, where we are, have been and plan to go[1]. What's more, the volume of this data is only set to grow, as is the technology and services it spurs, with expected growth rates at about seven times the ICT market overall, reaching a market value of USD16.9 billion in 2015.[2]

The collection, management and sharing of this data in the digital era by firms, governments and individuals is said to generate new opportunity for economic and societal value creation[3]. Yet, up until now at least, it is questionable whether a market for this personal data truly exists.

Of course, there are many examples of business models in which firms enabled by digital technologies collect, transform and monetise elements of personal data. Devices like Fitbit, for example, record and monitor our physical activity, and by integrating this with other applications, enable individuals to collect information about calories expended and food consumed. This allows the creation of new business models that sell this information on to insurance companies to better calculate risks. Whether this sale of data is done explicitly or user consent was implicitly given as part of the terms of conditions of use is of some debate. What is relevant here is the increasing amount of personal data being generated, collected and visible as personal and home devices become ubiquitous. To understand what we are dealing with, we begin with the understanding of how data comes about.

For people living in a cave in prehistoric times, a mother using a rock to etch a line on the cave wall to measure her son's height is probably the first example of personal data on the son. This personal data is created because of the wall and the rock, which is a manifestation of 'technology' in its broadest sense i.e. the application of knowledge for practical purpose. Fast forward to modern day and it is clear that personal data will not exist if not for the technology that generates it, whether the technology is old, such as the Domesday book or it is new, such as the point-of-sale data that supermarkets hold on individual purchases.

We can separate personal data into two types. The first is the actual *personal (content) data,* for example, date of birth, steps taken, caloric intake, food purchased, credit card numbers; and the

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[1] World Economic Forum, (2011). Personal Data: The Emergence of a New Asset Class

[2] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions: Towards a thriving data-driven economy (2014)

[3] World Economic Forum, W. E. (2011). Personal Data: The Emergence of a New Asset Class; World Economic Forum, W. E. (2013). Unlocking the Value of Personal Data: From Collection to Usage.

second is *personal metadata*. Metadata, defined as 'data about data' describes the instances and contexts of the personal content data. For example, 'How many calories consumed' in a meal is content data while 'the time the calories were consumed' and 'the location of the calories consumed' is metadata. However, the relationship between the data and the metadata is a little complex as in one context data may be content data, but in another the same data could be metadata. They could also be one and the same; i.e. the time on one's watch and the time one looked at the time on one's watch.

The connected digital economy has generated a huge amount of personal metadata, as a 'side-effect' (or what economists would call an 'externality') of commercial activity. Bees provide an example of externality; they may be kept to make honey, but will also pollinate local crops – a positive externality. A factory making goods may also pollute the environment – a negative externality. Externalities need to be internalised, in order to be productive in the economy. Sometimes, they are internalised by the companies themselves, i.e. by bringing in social and environmental costs into the firm's own costs and benefits, and sometimes internalisation occurs through regulation, e.g. through the imposition of a tax.

Where a service provision generates a lot of personal metadata, many service providers have internalised this for their own benefit. A case in point is Google. An individual's search is just a few words so it is hard to determine the context of what the individual might be searching for. Google combine search data with personal metadata such as browser used, location, cookies etc., to give search results as well as advertisements which more effectively match what the individual is searching for. The result is a win-win for all, with the individual using Google's search engine more frequently and advertisers increasingly drawn to their superior targeting algorithms.

The challenge of personal metadata

The HAT project seeks to address the big data and personal data challenge. Earlier, we proposed that personal data only exists because of the technology that collects it. The technology that created personal data and metadata created the systems and structures in which the data is used and stored. If the supermarket collected personal data and personal metadata, it was used for their own in-store loyalty programme, or to inform the logistics of replenishment, etc. This is the same with financial, health and various other institutions'. These data is referred to as the 'raw personal metadata', silo-ed within the verticals. Think of them as 'columns' on a spreadsheet.

Big data scientists often think that aggregating the 'columns' might provide interesting insights into individuals and the way individuals live their lives. It isn't yet clear what the use of the personal metadata could be, nor is it clear what the worth of the data is. Data scientists are working on how exactly the final combined personal metadata could be used in the market, but doing this analysis in isolation of actual business cases of personal data use is incredibly challenging.

Even if aggregating 'columns' is useful, it is often not possible to do so. Due to privacy concerns institutions are rightly prevented by law from sharing their data with other institutions. This creates a dilemma; since anonymisation may strip personal metadata of its worth, what then is its use when it is aggregated with other anonymised personal metadata?

Finally, who should be benefiting from this externality? There is already a backlash on firms holding too much personal data. The global debate on privacy of personal data was ignited by Edward Snowden's whistle-blowing on the National Security Agency which collected, mined and analysed telephone and internet data of American citizens. This is a worrying trend for those who want to see the digital economy survive and prevail. With concerns about privacy and trust, there are already those who choose to opt out of any connectivity, hence disrupting the 'supply' of personal data and obscuring the quality of the data collected. The petabytes of personal metadata out there as an externality of the digital economy is starting to be perceived as a negative externality, and we are beginning to see it being treated as such by regulators, in ways not dissimilar to pollution or environmental hazards.

There is an urgent need to internalise personal metadata in a way that treats it as a positive externality. To do so, personal metadata must be internalised into the economy in such a way that is privacy-preserving, able to create value for individuals, and for the data to be exchanged in such a way that a market for personal metadata could exist.

Such an internalisation is the core objective of the HAT project.

The HAT (Hub-of-All-Things)

The HAT project is a £1.2m multi-disciplinary project funded by the Research Councils UK (RCUK) Digital Economy Programme. It involves academic investigators from Economics, Business, Computing and the Arts, across six UK universities of Warwick, Exeter, Nottingham, Cambridge, West England and Edinburgh. The project's objective is to create the HAT (Hub-of-All-Things), a Multi-Sided Market Platform for personal data generated from connected services and products, in particular from Internet-of-Things (IoT) devices.

The project recruited six volunteers i.e. Digital Person Zeroes (DPOs), each of whom has consented to donate their body (of data) to research. The homes and personal lives of each DPO have been instrumented to collect data over a three-to-six-month period. At the outset, we use ethnographic research such as keeping detailed person diaries, to discover what was going on in the home that created the data e.g. making tea, family after-dinner chats, taking medicine, etc.
These 'contextual archetypes' are then made digitally visible through sensor data collected from objects around the home. This data is used to populate the HAT (Hub-of-all-Things). In simple terms, the HAT becomes a digital data vault, acting as a repository of personal data.

The data was then analysed to understand how human beings interact with technology and use information – be it to monitor the past, plan for the future or to act for the present. It seeks to understand what information is needed when, and how creating value with objects in day-to-day lives gave us the understanding of the 'mundane' life. The project sought to understand the "crises of the mundane" e.g. being 5 minutes late, not bringing a jacket, forgetting the phone and how human beings use information to cope as they live their daily lives.

From this understanding, the team developed a human-centric database schema for individuals to acquire, use and exchange their personal data. In doing so, the HAT project aims to engineer a **market** for personal data that would generate opportunities for new business models, new businesses, new jobs and greater employment in the digital economy.

Engineering the Market: The HAT explained

What is a market?

Modern markets are not restricted to visible public events that happen at regular times and places. [4] The digital economy is liberating us from the constraints of when an exchange can be conducted, where it can be done, who can do it and who they can do it with.[5] The HAT is a technical platform, a modern marketplace, where buyers and sellers of personal data can interact and exchange can be facilitated digitally.

The challenge of the personal metadata market

To create a market for personal metadata the HAT team proposes that the starting point is to take the perspective of individuals, rather than firms:

- Individuals are able to share their own metadata from various industries without any **privacy** restrictions, if they are given access to their own data;
- Individuals are best able to **co-create** and **contextualise** their own metadata based on what it means in their own lives;
- Individuals are stakeholders of the **quality** of the metadata if they can see the benefit in the use of their own metadata for their own decisions;
- Individuals are stakeholders of the **supply** of the metadata as they can actively seek out ways to acquire more personal metadata (e.g. buying IoT devices) if it is beneficial for their lives.

The proposed approach towards engineering the market from the perspective of individuals comes with its own set of challenges:

Challenge 1: Access and Acquisition of Personal data (Mining)

Personal metadata belongs to the technology that created it and often that technology sits within institutions. This means that access to personal metadata has to be granted. In fact, in terms of the requirements of a market, there is no 'raw' personal metadata supply; individuals do not currently have their own metadata, nor do they have access to it, and there is no standardised process to acquire it. Put simply, the first challenge in a market for personal metadata is the supply of data.

Addressing the challenge:

Depending on the source, "vertical" data generated technologies may come in numerous different data schema, which means that it is almost impossible for individuals to understand and interpret the data in its raw form. The transformation from different 'vertical' data schemas to the HAT schema will be handled by HAT "Inbound" APIs (application programming interface). The API will take the form of REST[6] and provide interoperability to any organisation or developer wishing to

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[4] Slater, D. & Tonkiss, F. (2013). *Market society: Markets and modern social theory*, John Wiley & Sons.
[5] Normann, R. (2001). *Reframing business: When the map changes the landscape,* Chichester, Wiley.
[6] Fielding, R.T. (2000). *Architectural styles and the design of network-based software architectures.* Diss. University of California, Irvine

make their device "HAT-Ready". The Inbound APIs are designed for device/thing manufacturers to allow flexible present "raw" data to flow the HAT database as useful and re-usable artefacts.

Challenge 2: Transformation of Personal Data: re-categorisation (Sorting)

Even if data access and acquisition could be standardised, these are raw, vertically silo-ed personal metadata. To use it requires a level of transformation capability that individuals often do not have. For example, there could be data about the temperature in one's house, one's car, one's office and everywhere one expect to go within the day but at 7.30am in the morning, the question in one's mind is 'should I bring a jacket today'. There is considerable effort to transform the different vertical temperature data to fit into what is essentially a human decision. The totality of our personal data needs to be sorted in order to transform it into a value proposition for individuals' use and for the market. As such, the second challenge in creating a market for personal metadata is the creation of a value proposition, an offering for individual personal usage.

Addressing the challenge

The transformation of personal metadata from unrelated 'verticals' into a 'matrix' format requires; first, the separation of contextual metadata (parameters that change in context – feeling hot or hungry) from acontextual metadata (parameters that do not change in context – eye colour, a shoes brand). The value of offerings are realised in context, hence, it is within the context of 'horizontal' lived lives that offerings create value with individuals. This implies a need to separate what is acontextual with what is contextual so that the 'horizontal' can be derived.

The HAT takes the parameters of a value proposition as acontextual and the parameters of value creation as contextual [7],[8]. Metadata of 'in-use' and 'in-context' must be separated from 'static' metadata on objects and services. For example, a T-shirt 'in-context' (contextual) have the following parameters: (1) start/end time of use (duration), and (2) location of use etc. Whilst a T-shirt that is acontextual have the following parameters: (1) colour, (2) size, and (3) supplier identifier ID. By extracting contextual parameters away from acontextual parameters, for every relevant object or service, the personal metadata becomes ready for contexts and 'horizontal' relationships to be formed.

	Shower Tap	**Towel**	**Toilet roll**	**Shower Gel**	**Water**	**Electricity (light)**	**Electricity (vent)**
Value Proposition parameters (acontextual parameters)	ID Number (linked the manufacturing parameters of type, material, colour etc.)	ID Number (linked the manufacturing parameters of size, colour, material etc.)	SKU Number (linked to supply chain parameters such as weight, thickness etc.	SKU Number (linked to supply chain parameters such as weight, thickness etc.	Contract reference (linked to water contract details)	Contract reference (linked to electricity contract details	Contract reference (linked to electricity contract details
Nature of	Interaction	Experience	Depletion	Depletion	Consumption	Consumption	Consumption

[7] Vargo, S. L. & Lusch, R. F. (2004). "Evolving to a New Dominant Logic for Marketing". Journal of Marketing, Vol. 68, No. 1, pp.1-17; Vargo, S. L. & Lusch, R. F. (2008). "Service-dominant logic: continuing the evolution". Journal of the Academy of Marketing Science, Vol. 36, No. 1, pp.1-10.
[8] Ng, I. C. L. (2014). Creating new markets in the digital economy: Value & Worth. Cambridge: Cambridge Univeristy Press.

Value creation							
Value Creating parameters (contextual parameters)	Time series data on States (on, off, temperature)	Time series data on towel movement	Time series data on toilet roll depletion	Time series data on shower gel depletion	Time series data on water consumption	Time series data on electricity consumption	Time series data on electricity consumption

Table 1: Separating acontextual parameters from contextual parameters

The concept is then translated into the HAT database schema by creating a "human-think-alike" database model, which considers all data-generating technologies/devices as "things", the type of data describing them as "property of things", and the actual data from use/experience/interaction as "value creation of things". In this case, the HAT is transforming the numerous data schemas from the verticals into a unified ("person-oriented") structure and represents the "what" (thing) and "when" (timestamp) has recorded "what data" (type of data and its value). The HAT provides a separate data storage layer, called the "lower level" database.

Challenge 3: Transformation of Personal Data: Contextualisation (Cutting)

The full worth of data is in understanding the context. However, contextualisation is a big challenge for industry because privacy laws restrict firms from sharing data with one another. One might reasonably ask if it would it not be easier to just let the individual acquire the vertical personal metadata and sell it? This could, indeed, be possible. However, re-selling personal data acquired is much like selling a diamond in the raw. There could be a market for it, but there would be a bigger market if it was sorted, and cut, to yield its greatest worth. The next step is to create a system where individuals are able to contextualise their own data, which is the third challenge.

Addressing the challenge

The HAT allows individuals to contextualise their own data according to what data holds the greatest meaning to them for the events in their lives. As the table below shows, an individual can create an event on the HAT and based on the time of the event (which could be a few minutes or a few days), as well as the devices or services that the individual has access to, the data generated can be acquired into the individual's context. Acontextual parameter are set and the user can then create an event, such as 'Megan's shower', which allows the content of the contextual parameters (contextual data) to be acquired, creating a horizontal 'row' of time-sensitive contextual data relevant to the event.

		Shower Tap	**Towel**	**Toilet roll**	**Shower Gel**	**Water**	**Electricity (light)**	**Electricity (vent)**
	Value Proposition parameters (acontextual parameters)	ID Number (linked the manufacturing parameters of type, material, colour etc.)	ID Number (linked the manufacturing parameters of size, colour, material etc.)	SKU Number (linked to supply chain parameters such as weight, thickness etc.	SKU Number (linked to supply chain parameters such as weight, thickness etc.	Contract reference (linked to water contract details)	Contract reference (linked to electricity contract details	Contract reference (linked to electricity contract details
	Nature of Value creation	Interaction	Experience	Depletion	Depletion	Consumption	Consumption	Consumption

	Value Creating parameters (contextual parameters)	Time series data on States (on, off, temperature)	Time series data on towel movement	Time series data on toilet roll depletion	Time series data on shower gel depletion	Time series data on water consumption	Time series data on electricity consumption	Time series data on electricity consumption
Horizontal Context: **Shower** (0830-0900)		Contextual data of Shower tap: states from 0830-0900	Contextual data of towel: time of use from 0830-0900	Contextual data of Toilet roll: rol depletion from 0830-0900	Contextual data of Shower gel: consumption from 0830-0900	Contextual data of water: consumption from 0830-0900	Contextual data of Electricity: consumption from 0830-0900	Contextual data of Electricity: consumption from 0830-0900

Table 2: An example of a 'horizontal' event (Shower) that draws contextual data from contextual parameters

Individuals can track their own data based on their own events and stories e.g. 'driving to work' or 'mother-in-law's visit'. Data that was previously vertical now becomes linked in a rough horizontal events co-created with individuals. Creating relationships between contextual metadata through events completes the transformation of personal data into a usable resource for human decision-making. It also implicitly creates relationships between value propositions which highlights opportunities for new and possibly disruptive business models.

By allowing individuals to create events and stories and decide which contextual data is relevant to these events and stories, the HAT creates a crowdsourcing environment where individuals can learn from one another, seeing what data sets are collected and used, even though they would not be able to see the detail. By doing so, the HAT makes visible innovative uses of data for human decision-making.

Up to this point, the data has merely been categorised and contextualised. It is ready for use and exchange, but to exchange a marketplace of goods and services must be in place.

Challenge 4: The Market for Personal Data

The final challenge of the HAT is in developing a place to trade. There is a need to create a market platform where individuals can buy services to use their data or exchange their data for some benefit. To create impact, personal metadata must have worth to trade for goods and services. Only when personal metadata has worth for the market can the internalisation to the economy be complete.

Addressing the challenge

With HAT-transformed personal data that includes re-categorisation and contextualisation, individuals are able to put their data to good use . Yet, the HAT will not be able to provide solutions to all possibilities. To be able to cater to the limitless variety of demands of data use and analysis, the HAT will create a technical platform where buyers and sellers of personal data can interact and exchanges can be facilitated digitally. In economics, platforms are special kinds of markets, often termed 'two-sided' or 'multi-sided' markets, which play the role of facilitating exchange between different parties that could not otherwise transact with each other.[9] Thus,

[9] Gawer A. R. (2014) Bridging Differing Perspectives on Technological Platforms: Toward an Integrative Framework, *Research Policy*, Vol:43, ISSN:0048-7333, pp:1239-1249

individuals should be able to buy applications to help them in creating nudges and prompts, to assist them in making decisions by good visualisations, match consumption data with special deals and even match what they own (e.g. wardrobe of clothes) with what they wish to buy.

Who's Buying and Who's Selling on the HAT: the HAT Stakeholders

The HAT as a multi-sided market platform, facilitates three markets of personal data: data supply, data use, and data exchange (see Table 3)

Markets	Value Proposition (offerings)	Potential Sellers	Potential Buyers
Data Supply (access & acquire)	Technologies that supply personal metadata, such as: • IOT devices • wearable devices • social media	IOT device manufacturers Social media platform providers Producers of wearable devices	Individuals
Data Use	Services to help individuals use personal data, for example: • visualise • advice • match • compare • benchmark	Software app developers	Individuals
Data Exchange	HAT-Transformed personal data (in exchange for discounts, personalised products and services)	Individuals	Suppliers to the Home e.g.: Retailers of personalised products and services Data companies CRM companies Aggregators Auto-replenishment, FMCG industry Health and wellbeing industry

Table 3: HAT and the Three Markets of Personal Data

As with all platforms for individuals, the heterogeneity presents a significant cost issue. Thus, the market to be engineered must sit on a technological platform that is both fully personalisable and yet fully scalable, in a similar way that all smart phones are fully scalable and yet can be fully personalisable with the individual's own data and apps. In so doing, a global 'market of one' can be achieved in a scalable way.

The Business Case for the HAT stakeholders

Individuals

In most developed nations, home consumption accounts for 60% of the country's GDP. With individuals in control of their own data, they can make more informed decisions on the way they purchase. In addition, wellbeing concerns can be addressed with the collection of personal data by the individual over time, resulting in more robust and accurate analysis of health concerns.

Firms

The supply chain currently ends at the high street; companies have no visibility of consumption. By giving firms the opportunity for visibility of consumption and experience, subject to individual's motivation to trade and exchange their own personal data, the HAT offers unprecedented potential for companies to design offerings and experiences that match individuals' consumption in an equitable and democratic environment.

Introspections and the HAT Economic Model

The HAT is a market maker - its principle aim is to generate new businesses, new innovation, new jobs, employment and a buoyant digital economy. For that reason, the platform must be free for use by firms and individuals.

To achieve this goal the HAT project will evolve into a HAT Foundation and managed by the HAT stakeholders community whose task is to ensure an equitable, buoyant and healthy ecosystem. On 17 July 2014, HAT Project team released the HAT Database Schema Beta and begins the process of engagement with the development community. The HAT database schema beta by RCUK HAT Project Universities will be released under a Creative Commons Attribution-No Derivative 4.0 International License. This means the schema is free to be copied and redistributed in any medium or form, for any purpose, even commercially. However, there is currently no allowance for the schema, in its beta form, to be remixed, transformed, or built upon for redistribution. The HAT team is seeking early adopters to collectively contribute to the development of the HAT, and would appreciate fellow innovators' feedback. However, the HAT project will remain the central portal for releasing future versions of the HAT platform. Version control is necessary to maintain consistency and support to the community of HAT developers (the Mad Hatters). For the community of developers, creating an app to work on one HAT must work on all HATs.

The HAT website – www.hubofallthings.org – will facilitate interactions between the development community, industry, and consumers with the HAT team, including the download of the HAT Database Schema Beta, a data dictionary as well as a forum for discussion on the HAT.

Advocacy, Aspirations and Ambition

We would like to think of the HAT as the next stage of the Internet, with empowered individuals making better decisions using their own data, and with firms innovating to provide novel service and goods based on personal data. In an age where one of the biggest companies on the World Wide Web is a search engine, we would like to advocate a future world where the biggest company on the HAT could be a Match engine, brokering innovative goods and services that integrates both data held by industry (e.g. supply chain, logistics, product attributes etc.) and individual personal data of consumption, depletion and experience.

Hub-of-all-Things (HAT) Research Team (incorporating the HARRIET team)

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