

Five Mental Models of Identity

a white paper from Rebooting the Web of Trust VII

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ABSTRACT

Engineers of identity systems, both digital and non-digital, have assumptions and requirements that often lead to fundamentally different ideas about useful solutions. One's preferred use cases establish mental models tailored to those uses, which in turn shape discussion and engineering of identity systems. The differences between these mental models consistently cause confusion and disagreement when advocates of different models collaborate, often without the parties realizing that others may be speaking from a distinctly different, yet valid, notion of identity. Considering different mental models allows for constructive dialogue and reconciliation of requirements, creating opportunities to address a wider set of use cases and to build systems with better overall applicability and quality.

We present five distinct mental models observed in conversations among technologists and laypeople when discussing identity. We then discuss observed patterns of discussion and design that result from the intersection of some pairs of mental models. Finally, we close with guidance for incorporating all five mental models when evaluating or designing any real-world or digital identity system. We propose that understanding and considering these different mental models will result in more fruitful collaboration and ultimately in better identity systems.



BACKGROUND

The authors have been participants, speakers, and organizers at identity-related professional gatherings for over a decade, including the Internet Identity Workshop[1], Rebooting the Web of Trust[2], ID2020[3], and EIC[4], to name just a few. They have held leadership roles in identity-related standards efforts at the W3C[5], IETF[6], Kantara Initiative[7], and ISO[8].

As active contributors to industry conversations about interoperable digital identity systems, we have witnessed how different communities engage with emerging technologies to solve real-world identity problems. In these conversations we have seen participants consistently struggle to communicate clearly about “identity”, “digital identity”, and “identity systems”. New participants often misconstrue established jargon used by well-versed veterans, who themselves tend to make several key assumptions. The motivation for simple and informal discourse leads to unrigorous language that makes it hard to establish a common understanding of identity.

While simple and informal terms can communicate and share ideas, they risk introducing false understanding and confusion. Mistakes seep in around the edges as developers, regulators, decision makers, and end-users shift their use of language. What feels natural to one speaker may not be understood with the same nuance by listeners. What is intended to be specific and limited is often heard more broadly and generally. These informalities ultimately undermine the shared goals of building robust identity systems. As digital identity becomes increasingly relevant to businesses, governments, and society at large, it is vital that we find simpler, yet more rigorous, ways to communicate more clearly about identity.

The ideas behind this paper were initially presented at *Rebooting the Web of Trust V* in Boston in 2017[9] as a brief one-hour discussion, followed by a session the next month at the 25th *Internet Identity Workshop* in Mountain View[10].

The initial discussion proposed three mental models. Since then, a fourth and fifth mental model have been incorporated based on feedback from fellow professionals. The first presentation of the current set of five mental models was submitted as an advanced reading topic paper [11] for the *Rebooting the Web of Trust VII* [12] workshop that was held in Toronto in September 2018. The same month, these mental models of identity were adopted as a key framework for the design workshop of the *International Identity Summit*[13] at the University of Washington. It was at *Rebooting the Web of Trust VII* that the current authors began collaborating on this paper.

We look forward to receiving feedback and suggestions about this mental model approach and the five mental models we describe. Our hope is that the ideas we present will help identity professionals, developers, regulators, decision makers, and end-users communicate more clearly and effectively, and as a result create digital identity systems that better address the needs of all potential stakeholders.

MENTAL MODELS

Mental models are psychological representations of real, hypothetical, or imaginary situations [14]. In this paper, we are referring to the psychological representations people have for “identity”. Our experiences have shown that different people approach identity in different ways, consistent with the mental models we discuss in this paper.

From our observations, we have identified five distinct mental models for identity, each with its own framing, its own purpose, and its own defining question. These are five orthogonal mental models of identity. By understanding them, we can better understand how apparently disjoint ideas of identity relate to each other, enabling the discussion and engineering of better, more broadly useful, and more secure identity systems.

These mental models are naturally emergent notions that arise from the needs people have for identity. While these models can be taught, our observations show that these models are more often argued for and assumed (with the exception of the Attribute mental model, which is enshrined in an international standard). This is the subtle nuance of language: when we have internalized a particular notion we generally assume that notion is what the concept means, even though a more rigorous understanding would recognize that the notion is merely what the concept means to us. It is exactly this implicit acceptance of “what identity means” that makes it so hard to communicate with people who have internalized a different notion of identity. The different purposes we have for these identity processes and assets - why we use identity in the first place - shapes our internal mental models, which in turn shapes the conversations we engage in and the kinds of solutions we build.

While these different mental models are orthogonal and distinct, we believe that they are all, in fact, valid notions for identity. By recognizing these “alternative” mental models, people will be able to communicate more clearly and collaborate more effectively to build identity systems that resolve the identity needs of all relevant stakeholders.

IDENTITY

In this paper we use the definition of functional identity [15] when we refer to “identity”. As a consequence, “identity” is how we **recognize**, **remember**, and **respond** to specific people and things. The processes of identity systems *acquire*, *correlate*, *apply*, *reason over*, and *govern* the information assets of *subjects*, *identifiers*, *attributes*, *raw data*, and *context*. If a system **recognizes**, **remembers**, or **responds** to specific people or things, it is using identity in some form - even if those identities are neither linked to traditional identifying information such as names and addresses, nor represented in official documents like a birth certificate or passport.

This paper addresses the search for a notionally objective “truth” of the identity of a specific person or thing. Recognition of a subject depends on evaluating available evidence in search of that truth. The evidence may be flawed and the interpretation may be flawed, but the fundamental goal of each mental model is to answer truthfully its core question. We may not be able to determine that objective truth with 100% certainty, but we must try. Every identity system attempts to resolve the question of truth to its best ability based on the

fundamental needs of its stakeholders.

We distinguish essential truth of an identity from the means, quality, and confidence of the subjective conclusion derived from the available evidence. The question we are seeking to answer in this paper is the following: “*When we are evaluating the evidence, what are we trying to determine?*”. Each mental model approaches this differently.

FIVE MENTAL MODELS

Each mental model takes a different approach to recognizing, remembering, and responding to the “Who”. How do you determine uniqueness? How do you recognize a candidate individual? How do you record and correlate your observations about a subject? How do you correlate external assertions to subjects? And how do you apply that knowledge in interactions with the subject or with others? Answers to these questions vary not just based on different technologies and techniques, but also based on the mental model brought to bear on the question of identity.

Technical solutions optimized for different mental models answer different questions of identity. Failing to account for these different questions can lead to systems insufficient to the task, creating end-user frustration and system insecurities.

The models we have identified may not be the complete set, and the language we have used here may not be the best “canonical” definition. However, these models capture the breadth of conversations we have seen over time among and between identity professionals and laypeople.

Space-time

The space-time mental model sees identity as resolving the question of the physical continuity of an entity through space and time.

Does the physical body under evaluation have a continuous link through space and time to a known entity?

This is the dominant perspective in real-world security and is advocated by many for online security.

The space-time mental model is necessary when enforcement targets the physical body. We put bodies in jail. We keep bodies out of restricted areas and off airplanes. If we are going to restrict the liberty of, apply harm to, or even protect a person, it is vital to know the target is in fact the right physical body, based on its literal physical continuity through space and time with the physical body we intend to restrict, harm, or protect.

Presentation

The presentation mental model sees identity as how we present ourselves to society. This is the mental model behind Vendor Relationship Management [16], user-centric identity, and self-sovereign identity.

Is this how the subject chooses to be known?

Whether you are gay, a Republican, or a gay Republican, it is your choice how you present yourself to the world. This mental model sees individually expressed identity as fundamental to privacy, self-determination, free speech, and a free society. Adherents advocate for technical and regulatory systems that allow people to fulfill their own self-actualization, to become who they want to be, rather than simply playing a role assigned by someone else.

Attribute

The attribute mental model sees identity as the set of attributes related to an entity as recorded in a specific system. Enshrined in ISO/IEC 24760-1, an international standard for identity management, this mental model is the primary focus for many engineers.

Who is this data about?

ISO/IEC 24760-1 limits the model of identity to correlated data within a single system, making such systems simpler and easier to build. It draws a bright line for engineers to focus on the accepted facts and information within the system they are developing, insofar as that data are related to specific individuals or entities.

This model ignores the consequences of common identification across different systems for the sake of simplicity and feature management. It also ignores how that data came to be, what is done with it, and how it is governed. In effect, it focuses on the bits and bytes and not on the processes involved. It is the simplest model for engineering a system; in part, because of that, it is the only mental model that has a formal definition as an international standard.

Relationship

The relationship mental model sees identity emerging through interactions and relationships with others. Our identity is not about what we are in isolation from others, but is rather defined by the relationships we have. This is the fundamental model in the South African idea of “Ubuntu”, meaning “I am because we are.”

How is this person related?

We are our children’s parents. Our teachers’ students. Our ex-spouse’s ex-husband. We are the guy who helped a friend move, the kind neighbor who let a friend borrow a cup of sugar, the jerk in 4th grade who kept pulling a girl’s pigtails.

Or as Senator McCarthy famously asked “*Are you now, or have you ever been, a member of the communist party?*” [17] The relationship of membership in the communist party was used by McCarthy to argue that individuals were enemies of the state.

Our appearance changes. Our age changes. Our height and weight change. Every cell in our body goes through a life cycle of birth, life, and death. We literally are not the same set of physical cells we were just a year ago. Presumed static traits often aren’t.

However, relationships often hold true across contexts when our physical traits do not. Relationships are given and earned through interactions with others, never to be fully perceived by any one observer, never to be fully known or captured at any point in time. The relationship mental model is the mental model that most directly embraces the fundamental fluidity of identity, rejecting the objective assessment of static, categorical identity for the emergent societal bonds that define us within our communities.

Capability

The capability mental model pragmatically defines identity in terms of an individual’s actual capability to perform some task, including their physical ability now, in the past, or in the future. It is the inevitable approach for anyone in an emergency.

What can a subject actually do?

Capabilities combine both the ability and the will to execute. The question of an identity’s capability is truly a test of one’s willingness and ability to take action.

Sometimes what you really need is a pilot[18]. It does not matter if they are licensed or if they physically have a license. What matters is whether or not they can safely land that plane. If they can, that’s a defining element of who they are, just as much as if they can’t.

You are a killer if you can actually pull the trigger when faced with a situation that demands it. In theory, anyone in good health is able to physically pull a trigger, but not everyone can actually do it when it needs to be done. If you are capable of doing so, this very capability defines part of who you are.

To spend bitcoin, you must be able to generate the correct ScriptSig [19], one that returns TRUE when evaluated against the scriptPubkey [20] of an input transaction. Bitcoin doesn’t care what your name is or what is recorded in some database. If you can post a transaction that produces the right output, you can spend the coins.

Included in this mental model are demonstrable physical traits, such as the test for being “At least this tall” to ride a roller coaster. It also includes historically recognized abilities even though they may no longer apply, e.g., “She’s a murderer,” as well as speculation of future capability “He’ll never last, he’s a quitter.” Ultimately, you can

only truly know a capability by testing it, and that test may prove valid only in a highly specific context, like “I didn’t know I could do it, but when I saw my child in harms way, I had to stop that car.”

INTERSECTIONS OF MENTAL MODELS: PATTERNS AND PITFALLS

When two people discuss identity with different mental models, the conversation inevitably focuses on the intersection between those models, sometimes without either party realizing they are coming from different perspectives.

In the classic science fiction story *Flatland: A Romance of Many Dimensions* by Edwin Abbot [21], the author uses a fictional world to explain how two-dimensional creatures would perceive three-dimensional objects as they travel through the plane of their two-dimensional world. The hero of the story realizes that these objects are, in fact, three dimensional, and struggles to explain his insight to his fellow two-dimensional beings. While they all think he is crazy, the hero eventually prevails. The romance is in the hero’s struggle.

If we think of our mental models as two-dimensional planes, and accept that most of us approach identity from a single perspective, then we can consider how the intersection of these planes shape conversations. The intersection of two planes is a line, which in both planes and, in our metaphor, is fully understandable from within each model’s two-dimensional context. That is, people speaking from each mental model can fully perceive, understand, and discuss the line. In contrast, they would each struggle to understand concepts outside their mental model, just as people living in a single plane would struggle to understand the idea of things outside that plane.

The following sections provide a few examples of intersections between mental models.

Intersection between Space-time and Attribute

When space-time-minded people discuss identity with attribute-minded people, the conversation often leads to two key questions:

1. “What are the minimum attributes to identify a particular (physical) individual?”, and
2. “Given the data we have, how can we identify particular individuals?”

Because all modern information systems rely on data, it is inevitable that space-time-minded applications intersect with the attribute mental model. In naive implementations, this can lead to oversampling in an attempt to increase certainty about a physical person, often referred to as surveillance. If you record all the data possible about every observable interaction throughout an individual’s day, you can dramatically increase the likelihood that the system will correctly identify that the person from the start of the day is actually, physically the same person at the end of the day. If prison records the actions of a prisoner 24 hours/day, 7 days/week, the prison can be assured that the physical body being imprisoned has not escaped the cell without their knowledge.

This intersection can also lead to overconfidence in the conclusions about a physical person based on attributes

stored in a database, occasionally referred to as the “Tyranny of data”. Humorous consequences can be seen in fiction when an official record indicates someone is dead, when clearly they are not. Less humorous consequences occur, for example, when subsidies people need to live are denied as a result of errors in the Aadhaar identity service [22].

Intersection between Capability and Relationship

Capabilities and relationship mental models intersect when a capability implies a relationship or vice versa.

For example, US military academies offer guaranteed admission for children of Congressional Medal of Honor recipients, the nation’s highest honor. The reasoning is that, whether genetic or cultural, the child of a Medal of Honor winner has at least as high potential to become an outstanding officer as candidates vetted by congressional representatives (the primary route for admissions).

We also see this in caste systems, including in European aristocracy and Indian society. The presumption is that your familial relationships are suitable indicators of your ability to perform certain societal roles.

As a mythical example, King Arthur’s ability to remove the sword from the stone proved his lineage and right to govern the kingdom. His capability re-established his relationship with the kingdom.

Intersection between Presentation and Relationship

An identity does not belong to one entity alone. It is built on the perception the observer has of the subject, based on how the subject presents themselves combined with other information. That information is applied by the observer on their own judgment, which may change, distort or recast the the presentation in non-obvious ways. While a subject may present however they want, different observers will interpret those presentations differently based on their relationship with the subject. How you react when a friend or lover claims a privilege is often different than if a rival or enemy claims the same.

As relationships move beyond bilateral interactions to societal engagement, social norms dictate what information sharing is expected, conventional, and allowed. Social agreements compel the disclosure of certain data, such as giving a driver’s license to a law enforcement officer or giving a passport to cross a border. They may also lead one to take a topic out of civil discourse altogether; consider the quaint but still relevant idea that it is rude to ask a woman about her age, a man about his income, or a gender-neutral individual about their Y chromosome. These social norms -- based on our relationships with others -- shape a framework for presenting information that both enables and restricts freedom of presentation [23].

Finally, self-asserting information may be enough for relying on certain types of data (“this is my favorite food”), but not others (“I am not a crook”). Many systems build trust or authority by involving other parties, using systems of credentials to establish a sense of truth based on the assertions of known actors. This information is

projected from the source, filtered and presented by the holder, and interpreted through the lens of the relying party. This shared meaning is based on multiple relationships and as such, is beyond the sole control of any of these parties. The relationships enable and transform the presentations. This is the architecture embodied in Verifiable Credentials [24] as well as physical credentials such as driver's licenses and passports.

Intersection between Presentation and Attribute

A persona represents, in data, information about a subject, as presented by that subject to others. It is a subset of the information that a subject could present, and independent of what the recipient may have recorded about the subject. It is the attribute-centric vehicle for presenting identity information. It is neither the totality of the subject's information, nor is it the only data known about them.

An individual may present different persona in different context, sharing different information with different recipients or at different times.

Self-asserted claims are fully in the intersection between presentation and attributes. When an individual self-asserts a statement about themselves, they are presenting an attribute on their own authority.

Intersection between Attribute and Relationship

We all interpret data differently based on the relationship we have with its source. If one of our siblings tells us something, we take it differently than if our parent tells us the same thing. A teacher informing us about our children's performance is perceived differently than that a child's self-reported assertion.

Moreover, social constructs shape the way entities deal with matters of fact. The way to handle time, for example, differs tremendously depending on where you originally come from. While several calendars exist around the world, a person's date of birth is a matter of fact. A person is born at a specific moment in time. Nevertheless, the way to construct and attribute this moment in time as a birth date is a social construct. How we record and interpret that moment in time depends on the social context of those recording it.

It is often assumed that entities with similar attributes are likely to establish relationships, i.e., "birds of a feather flock together". Dating or matchmaking services often try to create relationships between individuals based on their affinity as measured by their common attributes. Of course, such matchmaking ignores the equally resonant wisdom that "opposites attract". Both, however, are examples where attributes are used to evaluate the quality of a potential relationship.

Data analytics do something similar when evaluating known attributes of individuals to seek out patterns and relationships. Sometimes this data is used to infer a common group dynamic related to life events (a belief the subject is pregnant) and buying patterns (the subject is likely to buy a car) or even explicit relationships (the subject is a supporter or member of a terrorist organization).

In short, one can use attributes to infer relationships (and vice-versa) and relationships affect our interpretation of attributes.

RECOMMENDATION AND CONCLUSION

When collaborating with others, consider multiple mental models for better communication and better identity systems.

Whatever your own goals, we believe you are more likely to achieve them if you can communicate clearly in terms others understand and can incorporate the needs of others into your own work.

None of us have a complete picture of the universe. None of us have a monopoly on the truth. The best identity solutions will come from a frank and open engagement where every individual's, and every organization's, needs are heard and considered. Implementations will necessarily be a collection of trade-offs between security and freedom, features and costs, and the needs of those building the systems and the needs of those using them. We believe the best way to build the most effective systems is to thoroughly understand where your collaborators are coming from and what they need from identity and then to work together to devise mechanisms that best achieve the common goals of all stakeholders.

In short, be excellent to each other. Be open to new ideas and seek first to understand, then incorporate the perspectives of others. What might seem "wrong" at first hearing may turn out to be a vital component simply unperceivable from your own initial mental model. Working together is our best chance at getting it right.

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About Rebooting the Web of Trust

This paper was produced as part of the [Rebooting the Web of Trust VII](#) design workshop. On September 26th through 28th, 2018, over 40 tech visionaries came together in Mississauga, Ontario to talk about the future of decentralized trust on the internet with the goal of writing 3-5 white papers and specs. This is one of them.

Leadership Team: Christopher Allen, Joe Andrieu, Kim Hamilton Duffy, Manu Sporny, and Heather Vescent

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Thanks to our other contributors and sponsors!

What's Next?

The design workshop and this paper are just starting points for Rebooting the Web of Trust. If you have any comments, thoughts, or expansions on this paper, please post them to our GitHub issues page:

<https://github.com/WebOfTrustInfo/rwot7/issues>

The ninth Rebooting the Web of Trust design workshop is scheduled for fall 2019 in Europe. If you'd like to be involved or would like to help sponsor the event, email:

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