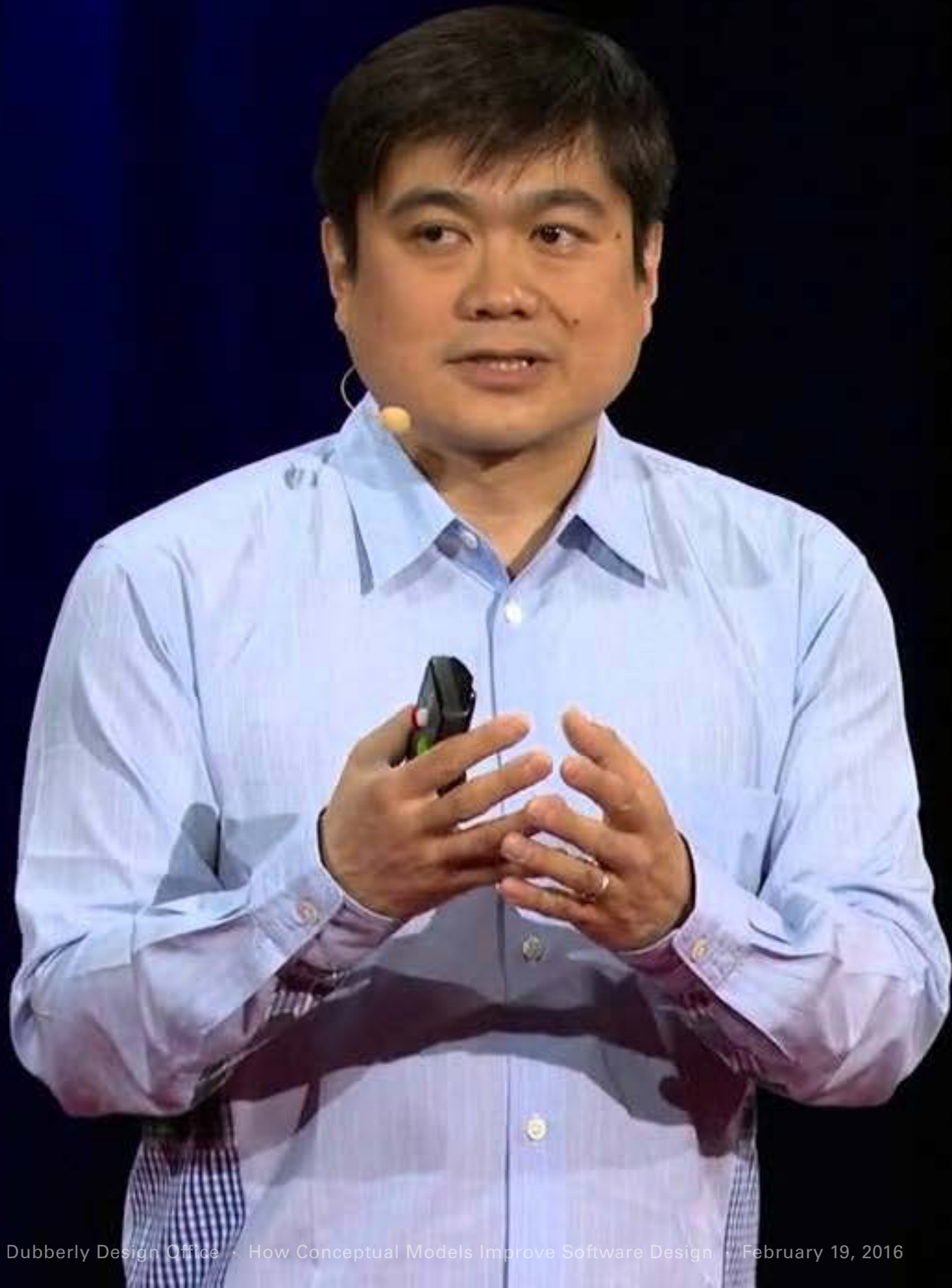


GE Software, San Ramon  
February 19, 2016

# How Conceptual Models Improve Software Design

Hugh Dubberly  
Dubberly Design Office

[presentations.dubberly.com/GE\\_Conceptual\\_Models.pdf](http://presentations.dubberly.com/GE_Conceptual_Models.pdf)



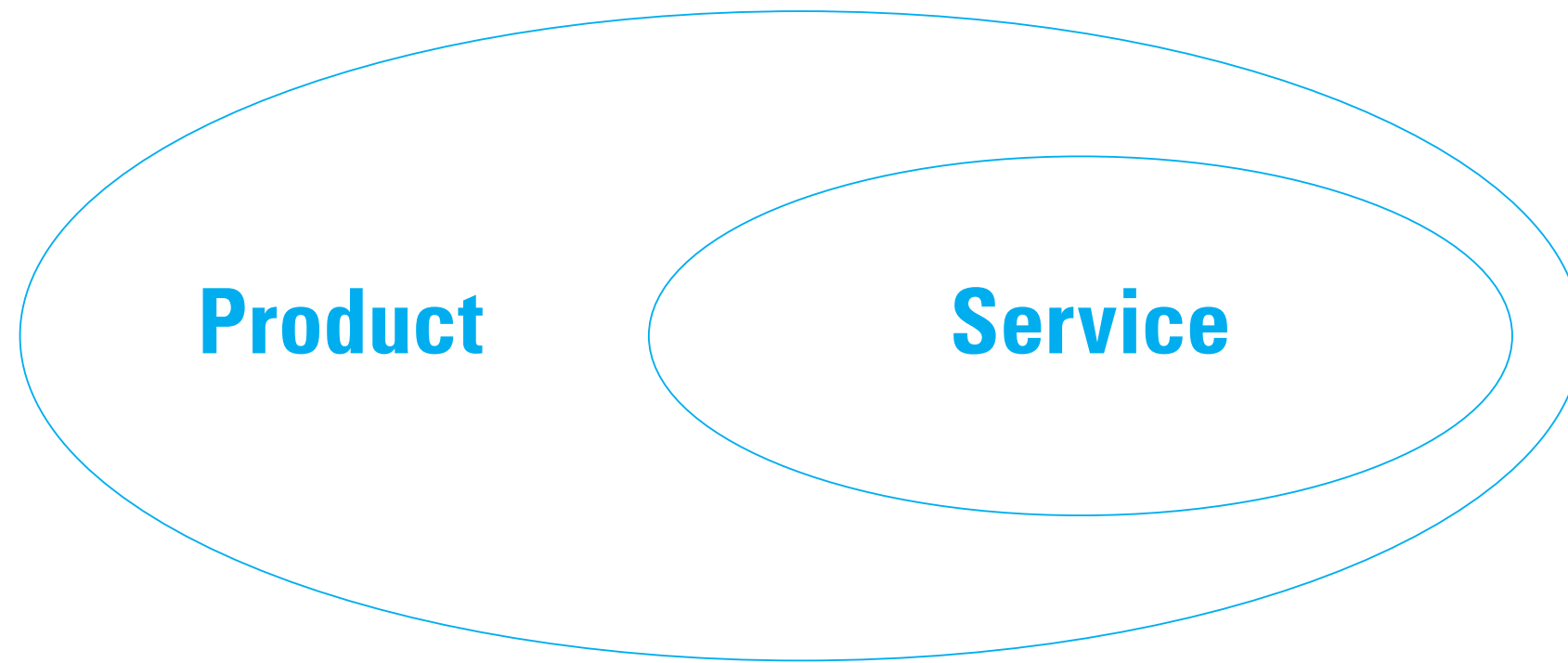
**“Design has also evolved from the design of objects both physical and immaterial, to the design of systems, to the design of complex adaptive systems.**

**This evolution is shifting the role of designers; they are no longer the central planner, but rather participants within the systems they exist in.**

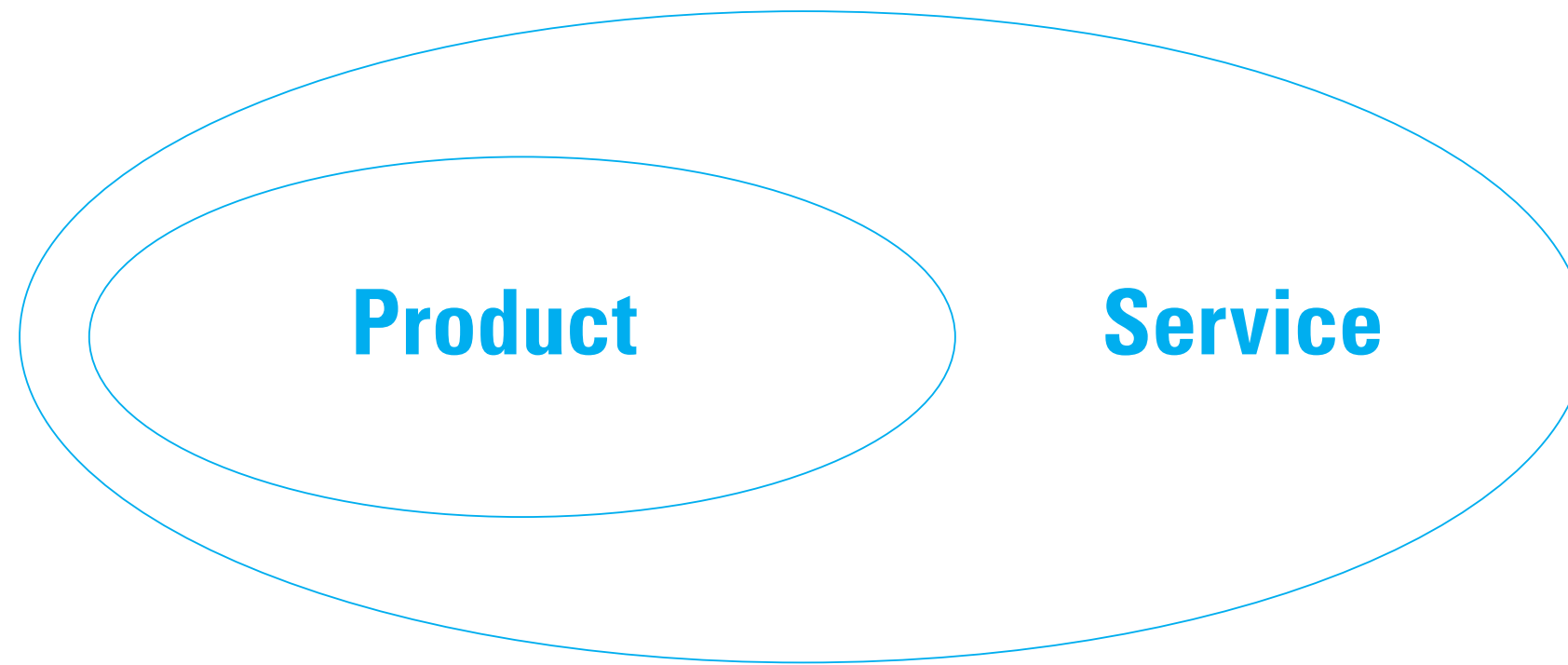
**This is a fundamental shift—one that requires a new set of values.”**

— Joi Ito  
Director, MIT Media Lab  
“Design and Science,” January 11, 2016

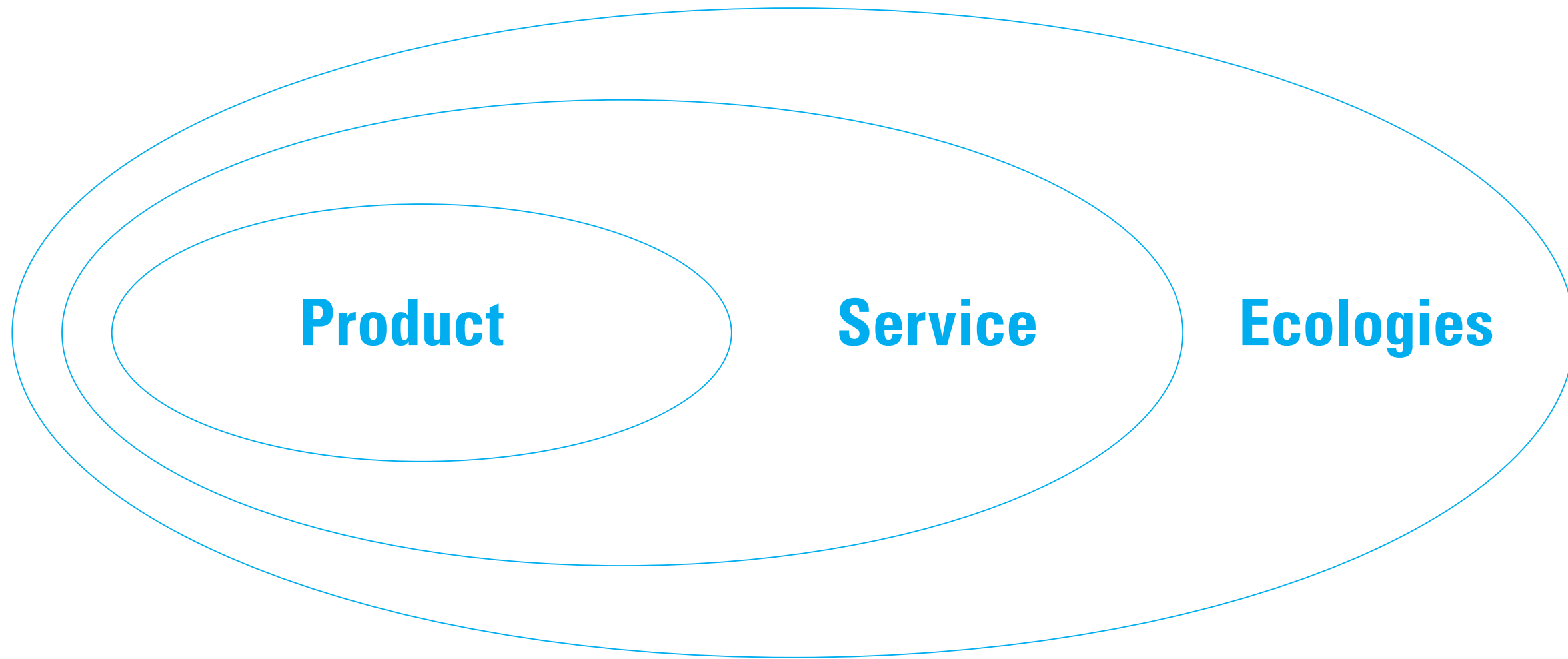
Traditionally, “**products**” has meant  
not just hard goods  
but also information and **services**.



In the last 20–30 years,  
“**services**” have become a way  
to deliver “**products**.”



More recently,  
**services** are connecting to **integrated systems**,  
forming **product service ecologies**.

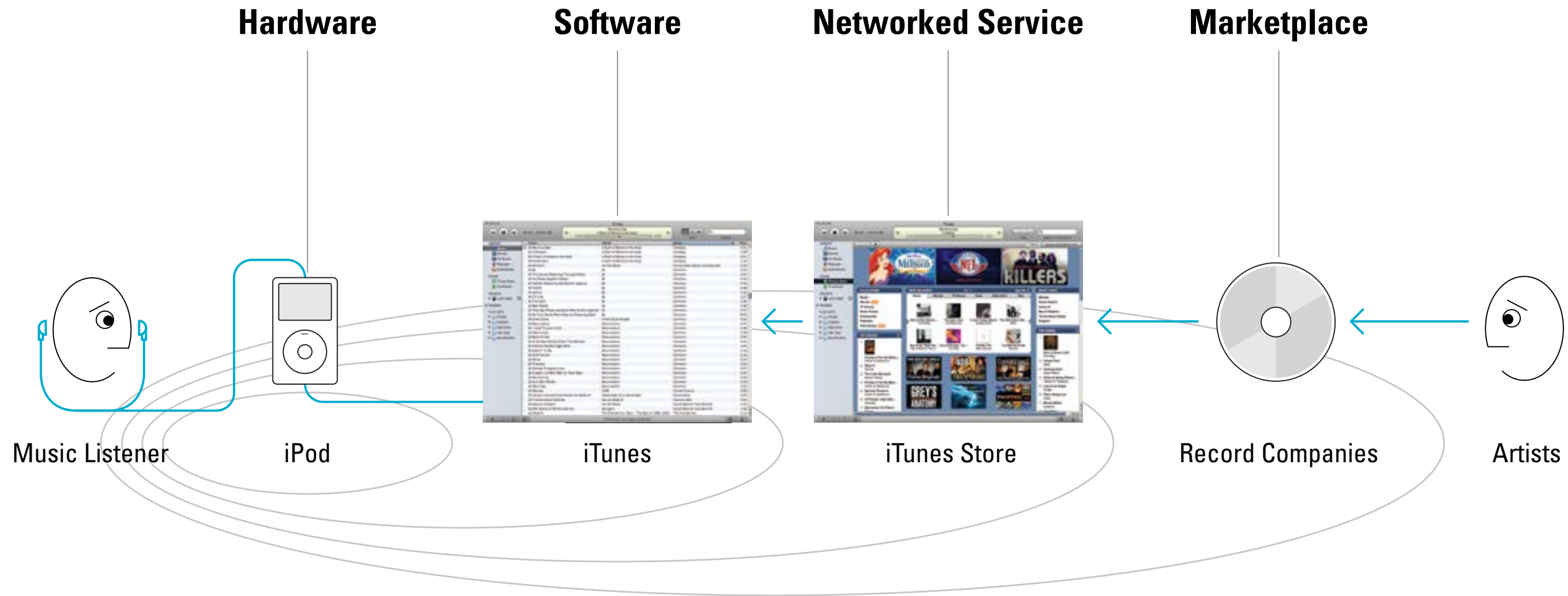


*“... networks of products,  
services, technology, people,  
and collective and collaborative interaction  
are generating value  
for the populations they serve.”*

— Jodi Forlizzi, CMU

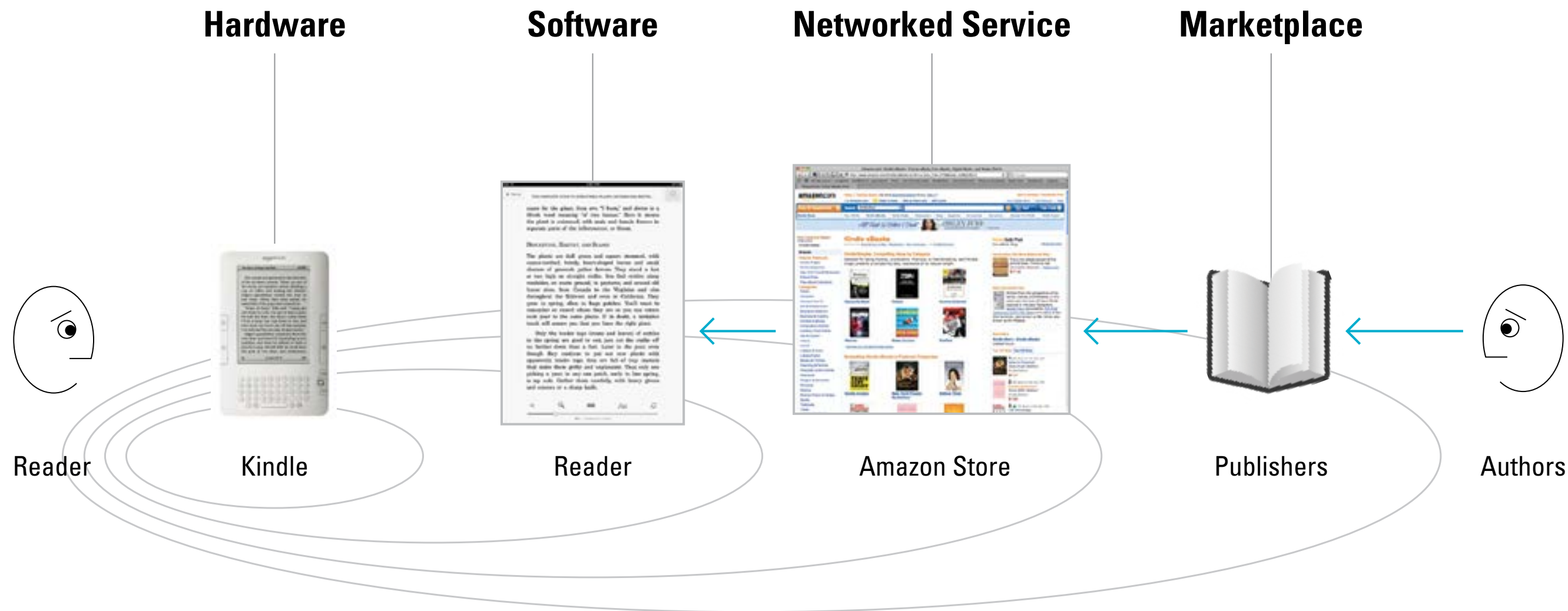


iPod is not a stand-alone product; it's an integrated system—  
a **product-service ecology**.



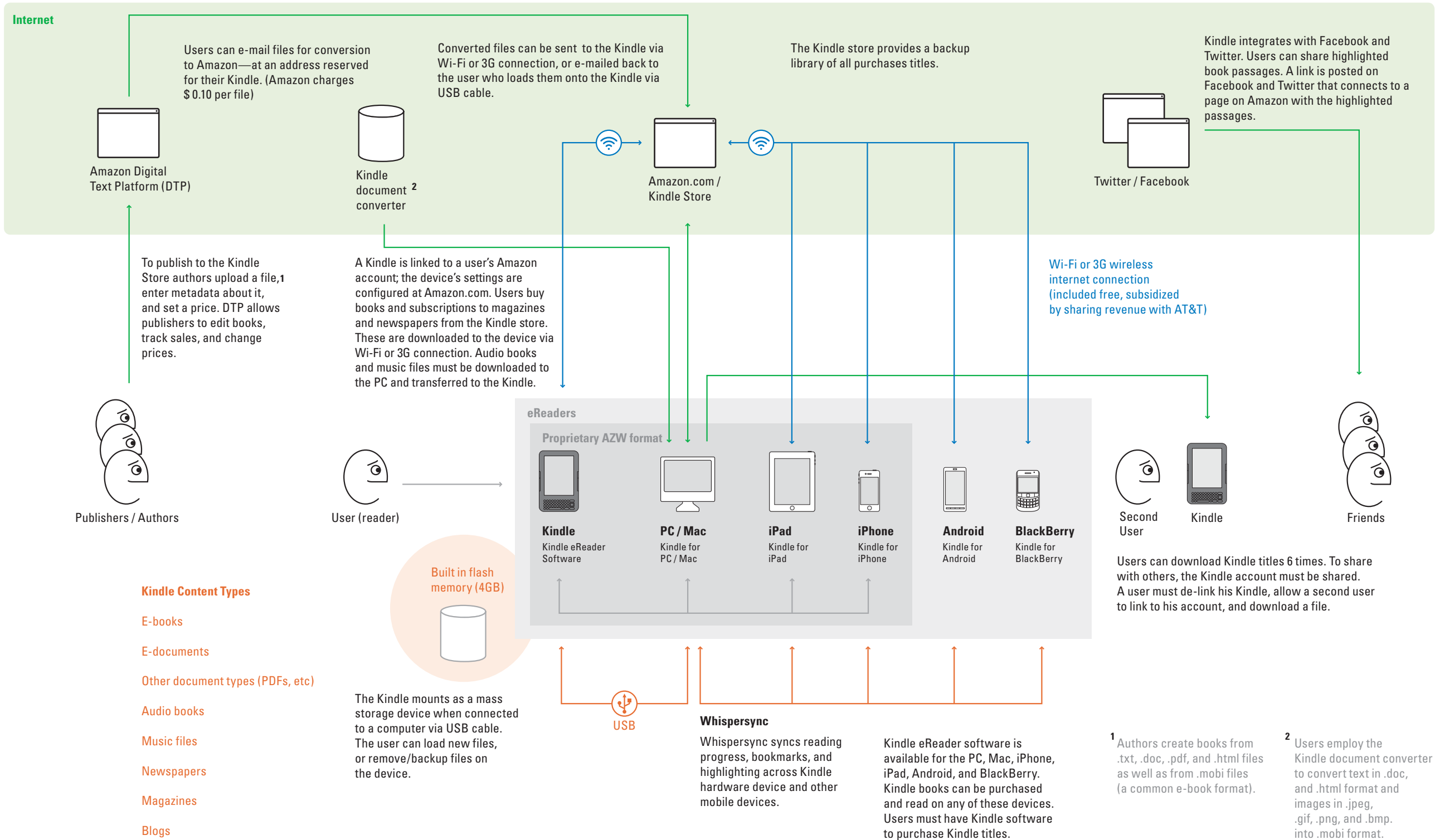


# Amazon's Kindle-Reader-Wispernet-Store system is another product-services ecology.





# In fact, the Kindle ecology is even more complex.

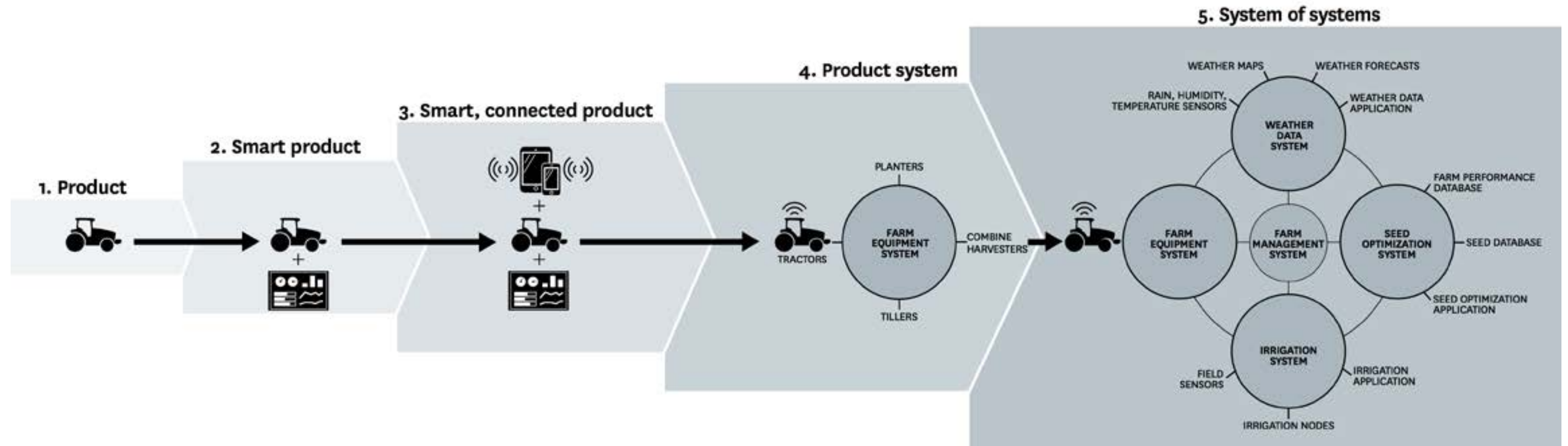


*“I think of [the Kindle] as a service.  
Part of [it] is of course the hardware,  
but really, it’s the software, the content,  
it’s the seamless integration of those things.”*



— Jeff Bezos, founder of Amazon

# Michael Porter writes about systems of systems



*“A ‘platform’ is a system that can be programmed and therefore customized by outside developers—users—and in that way, adapted to countless needs and niches that the platform’s original developers could not have possibly contemplated, much less had time to accommodate.”*

—Marc Andreessen, co-founder of Netscape and Andreessen-Horowitz



# Remember Blockbuster, Kodak, Nokia, RIM?

## 46 of the Fortune 100 from 1995 didn't make the 2015 list.

## Many no longer exist.

As organizations grow older and larger, many of them become siloed; communicating becomes harder; getting things done takes longer and requires more effort; progress slows; effectiveness decreases.

And what makes things worse: this aging process now takes place in the context of increasingly rapid socio-technological change.

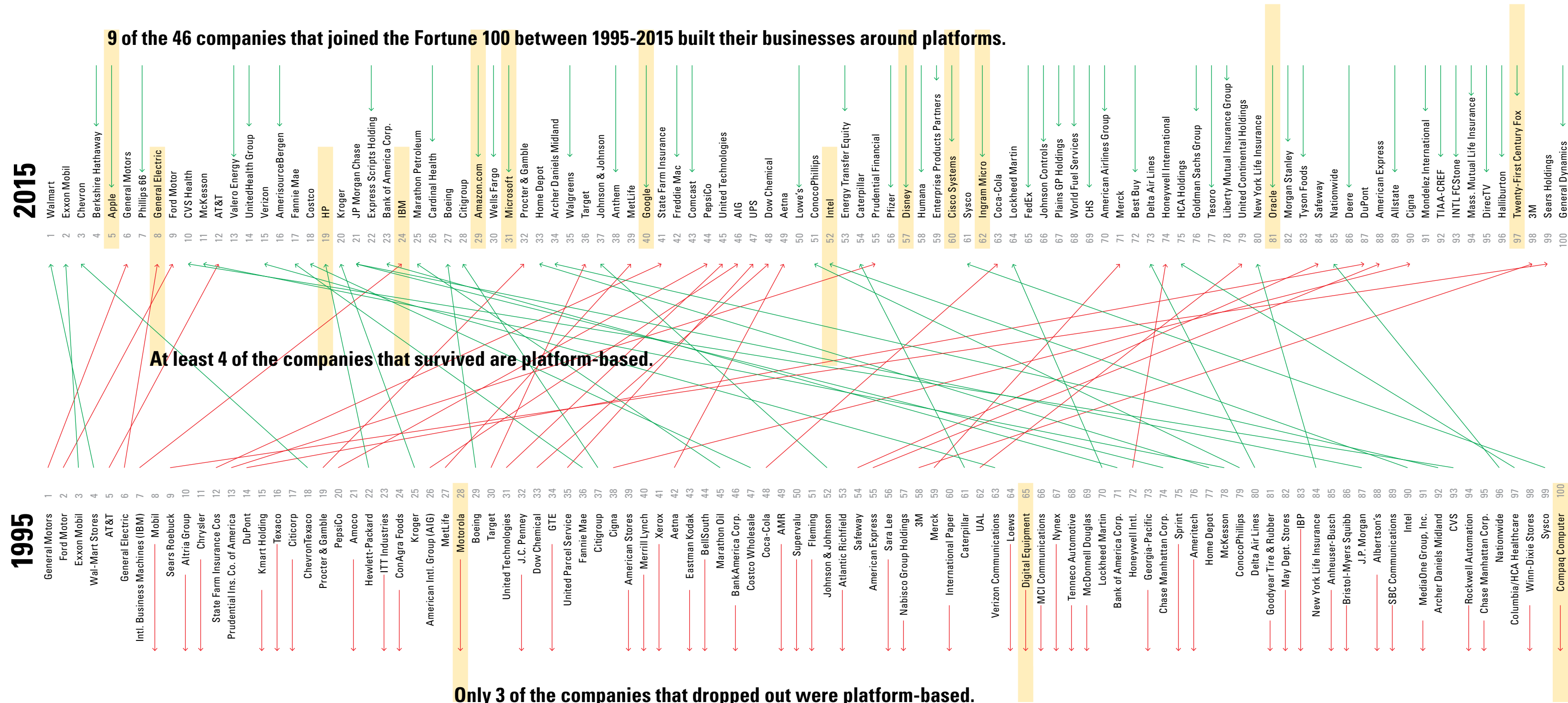
**Key**  
Surviving  
Surviving but reorganized  
Exiting

1	General Motors*	26	American Intl. Group (AIG)*	51	Fleming	76	Ameritech
2	Ford Motor	27	MetLife	52	Johnson & Johnson	77	Home Depot
3	Exxon Mobil	28	Motorola	53	Atlantic Richfield	78	McKesson
4	Wal-Mart Stores	29	Boeing	54	Safeway	79	ConocoPhillips
5	AT&T	30	Target	55	American Express	80	Delta Air Lines
6	General Electric	31	United Technologies	56	Sara Lee	81	Goodyear Tire & Rubber
7	Intl. Business Machines (IBM)	32	J.C. Penney	57	Nabisco Group Holdings	82	May Dept. Stores
8	Mobil	33	Dow Chemical	58	3M	83	IBP
9	Sears Roebuck*	34	GTE	59	Merck	84	New York Life Insurance
10	Altria Group	35	United Parcel Service	60	International Paper	85	Anheuser-Busch
11	Chrysler	36	Fannie Mae	61	Caterpillar	86	Bristol-Myers Squibb
12	State Farm Insurance Cos	37	Citigroup	62	UAL*	87	J.P. Morgan
13	Prudential Ins. Co. of America	38	Cigna	63	Verizon Communications	88	Albertson's
14	DuPont	39	American Stores	64	Loews	89	SBC Communications
15	Kmart Holding	40	Merrill Lynch	65	Digital Equipment	90	Intel
16	Texaco	41	Xerox	66	MCI Communications	91	MediaOne Group, Inc.
17	Citicorp	42	Aetna	67	Nynex	92	Archer Daniels Midland
18	ChevronTexaco	43	Eastman-Kodak	68	Tenneco Automotive	93	CVS
19	Procter & Gamble	44	BellSouth	69	McDonnell Douglas	94	Rockwell Automation
20	PepsiCo	45	Marathon Oil	70	Lockheed Martin	95	Chase Manhattan Corp.
21	Amoco	46	BankAmerica Corp.	71	Bank of America Corp.*	96	Nationwide
22	Hewlett-Packard	47	Costco Wholesale	72	Honeywell Intl.	97	Columbia/HCA Healthcare
23	ITT Industries	48	Coca-Cola	73	Georgia-Pacific	98	Winn-Dixie Stores
24	GonAgra Foods	49	AMR	74	Chase Manhattan Corp.*	99	Sysco
25	Kroger	50	Supervalu	75	Sprint	100	Compaq Computer



# Increasingly, value comes from creating platforms, on which others can create value.

Key  
Rising / Entering  
Falling / Exiting  
Platforms



**Designing products was never easy.**

**Service systems are more challenging.**

**Platforms and product service ecologies—  
even more so.**



**Rare is the system that can be seen all at once.**

Many systems are hidden in part.

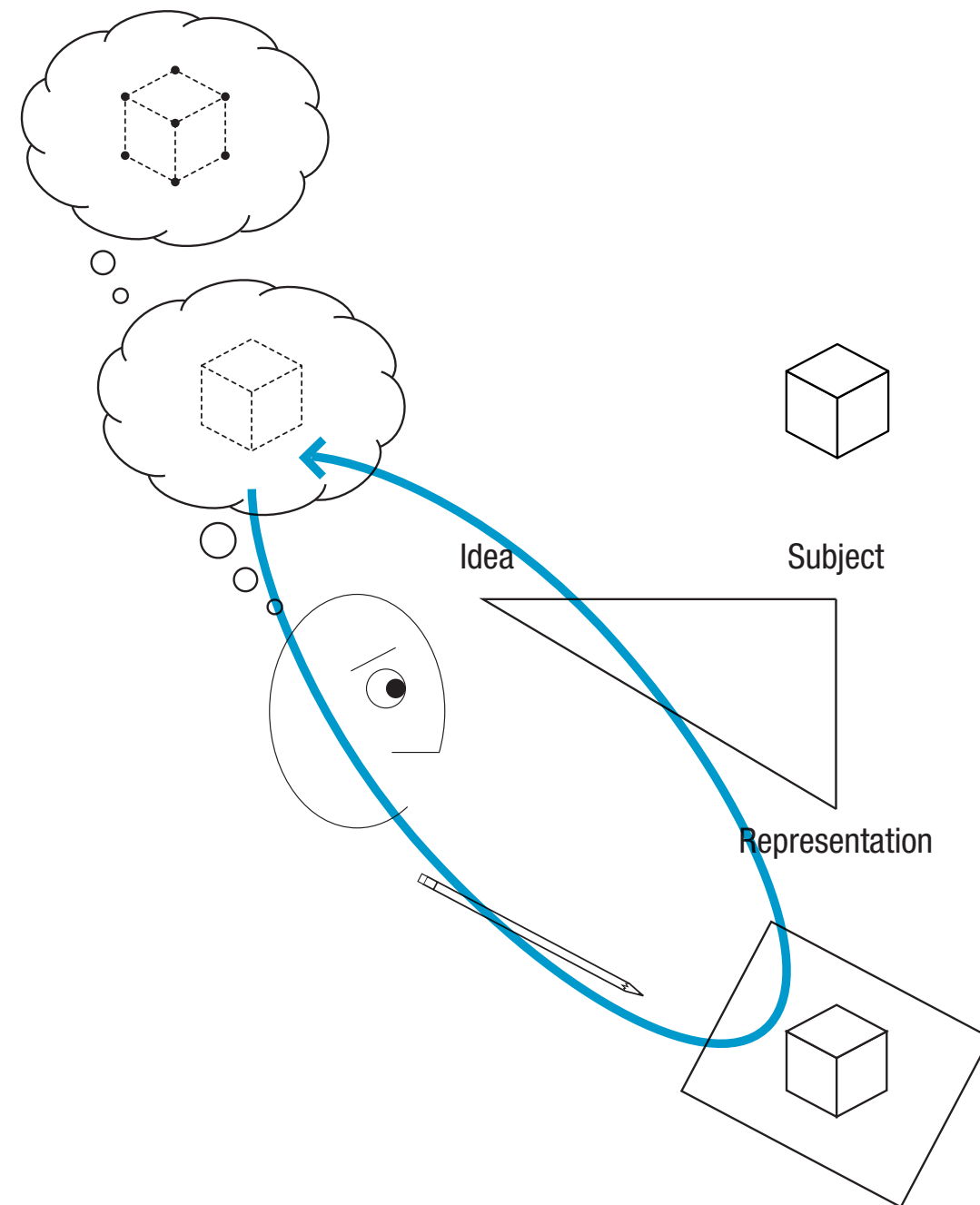
Often systems stretch across time and space.

Connections between parts are learned slowly—  
through experience with operation of the whole.

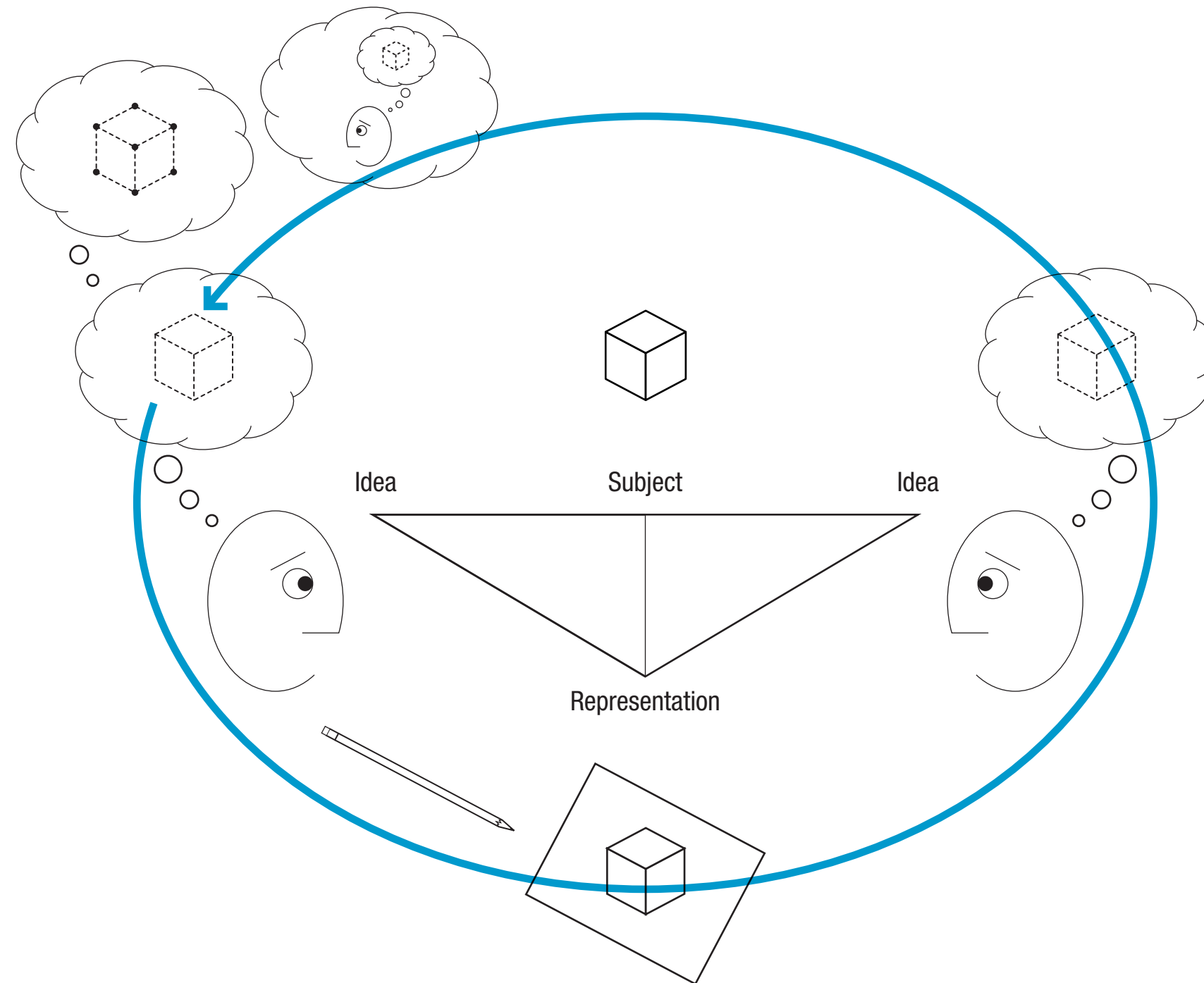
In addition, systems evolve.

**In order to work with systems,  
people need to understand them—  
and to understand systems requires models.**

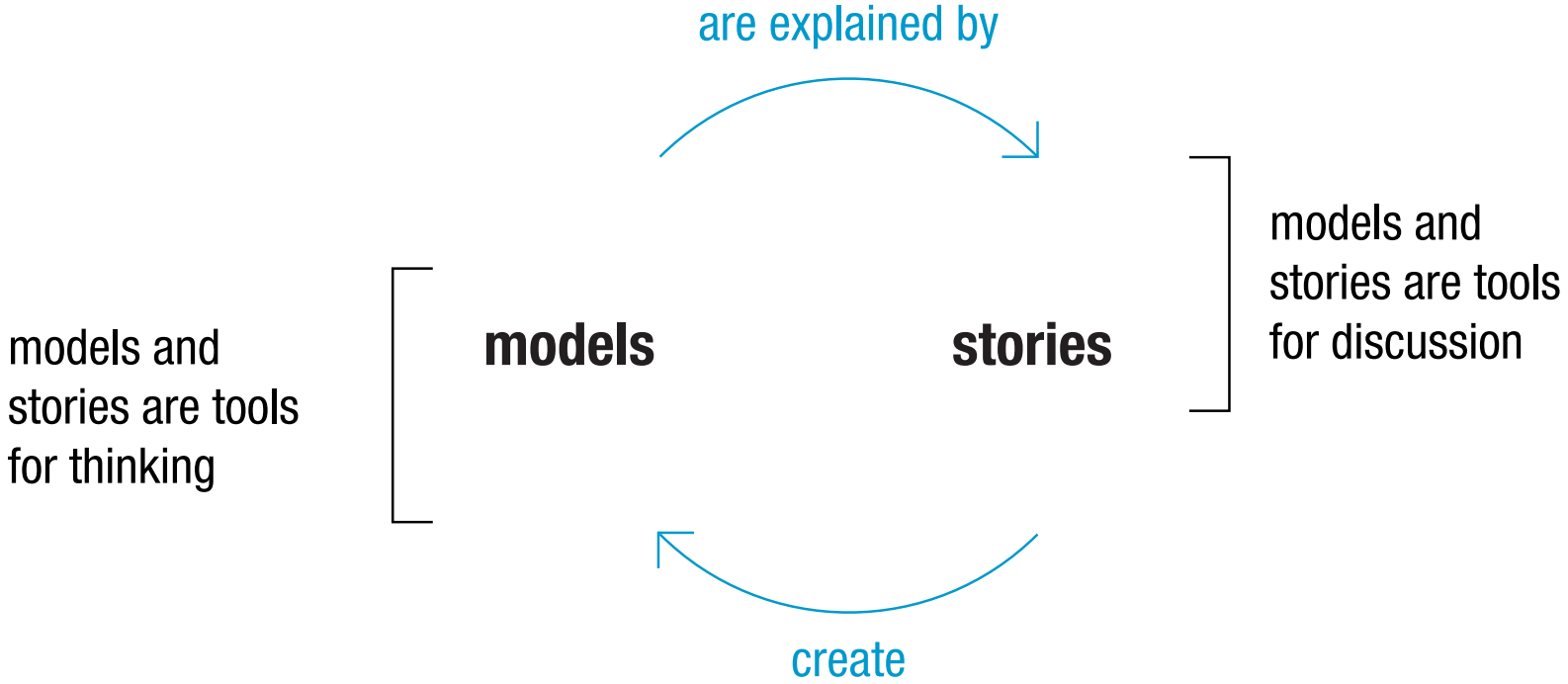
# A model is an idea about how part of the world works; representing the idea aids its refinement.



# Models are a form of 'boundary object'— artifacts that bridge the gap between disciplines.



# Models tell stories, and stories build models in our minds.

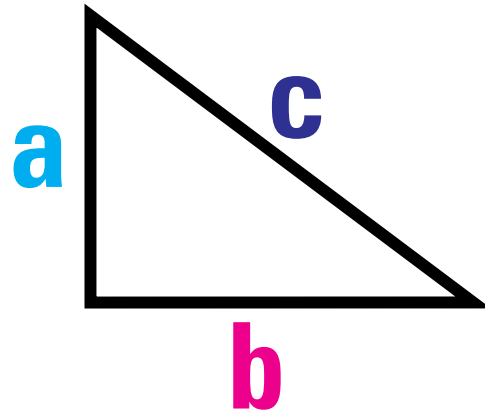


*“Models are our voodoo dolls.  
We do most of our thinking in models.”*

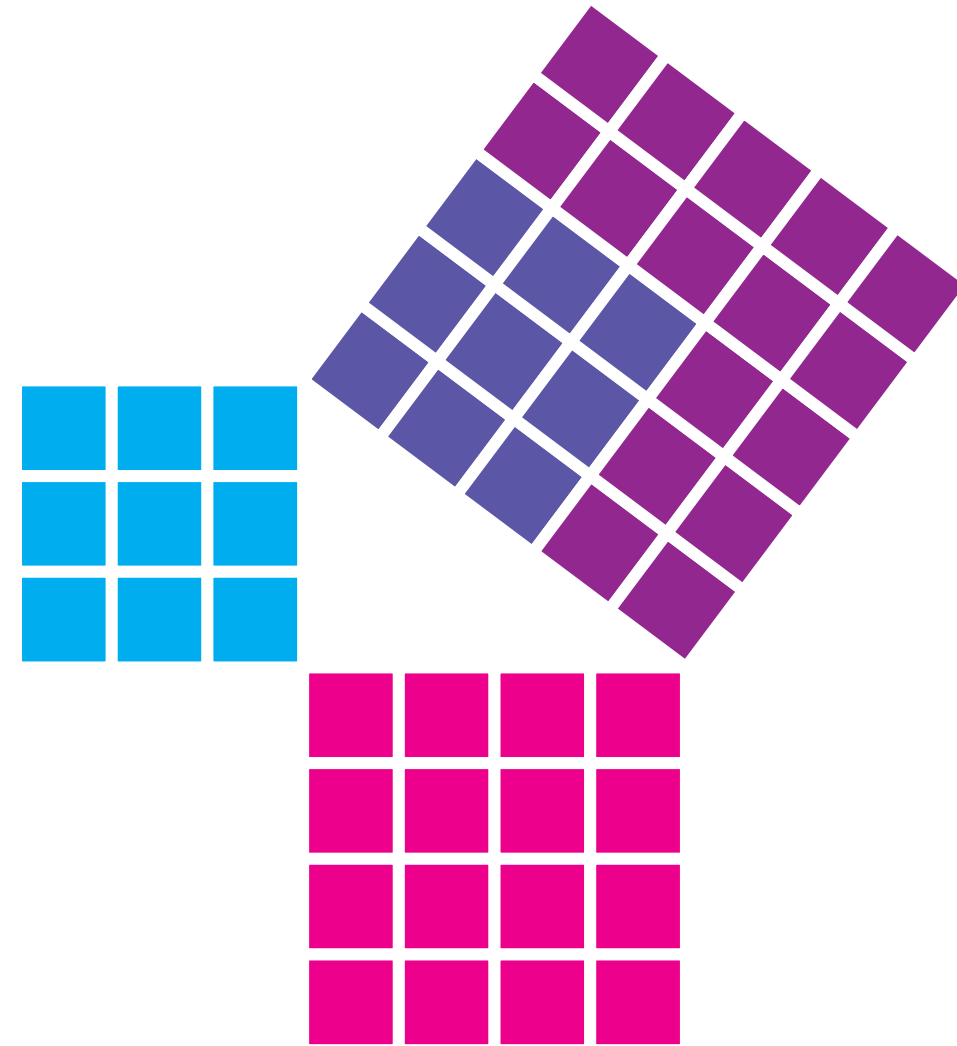


— Alan Kay

# Example: The Pythagorean Theorem

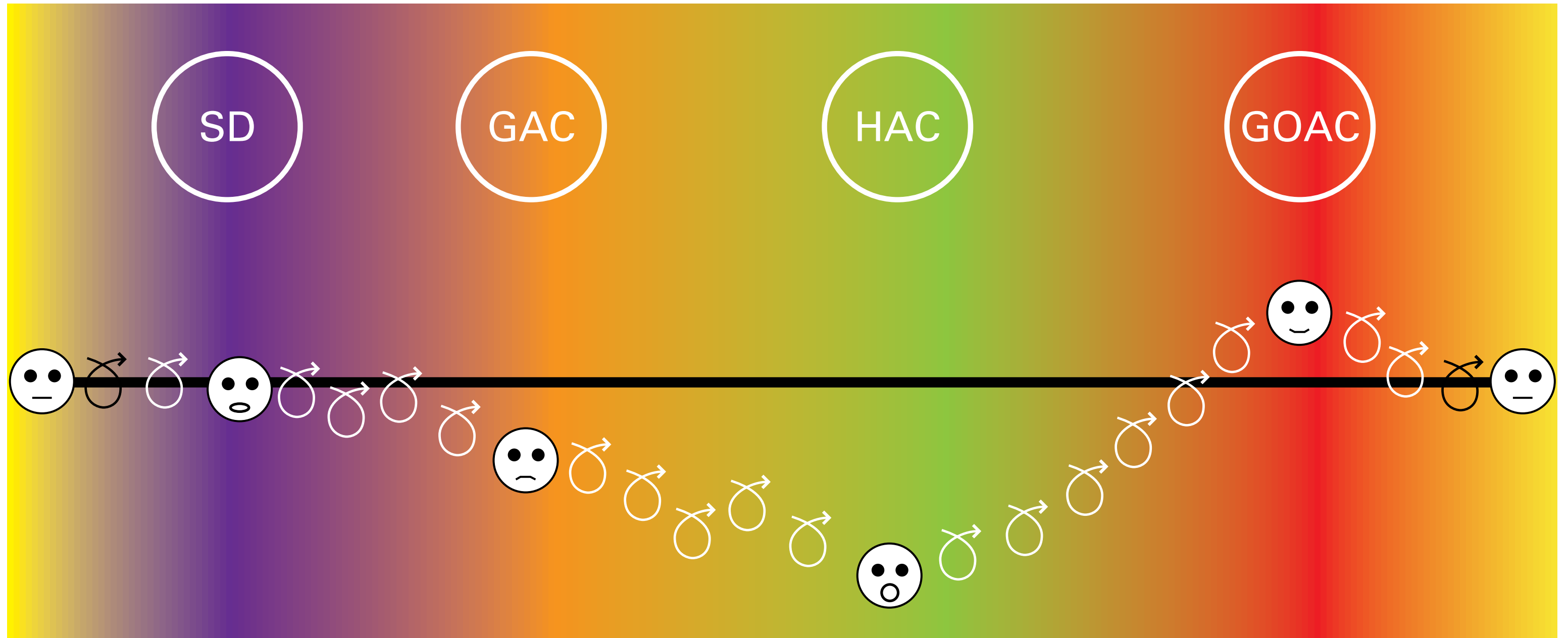


$$a^2 + b^2 = c^2$$



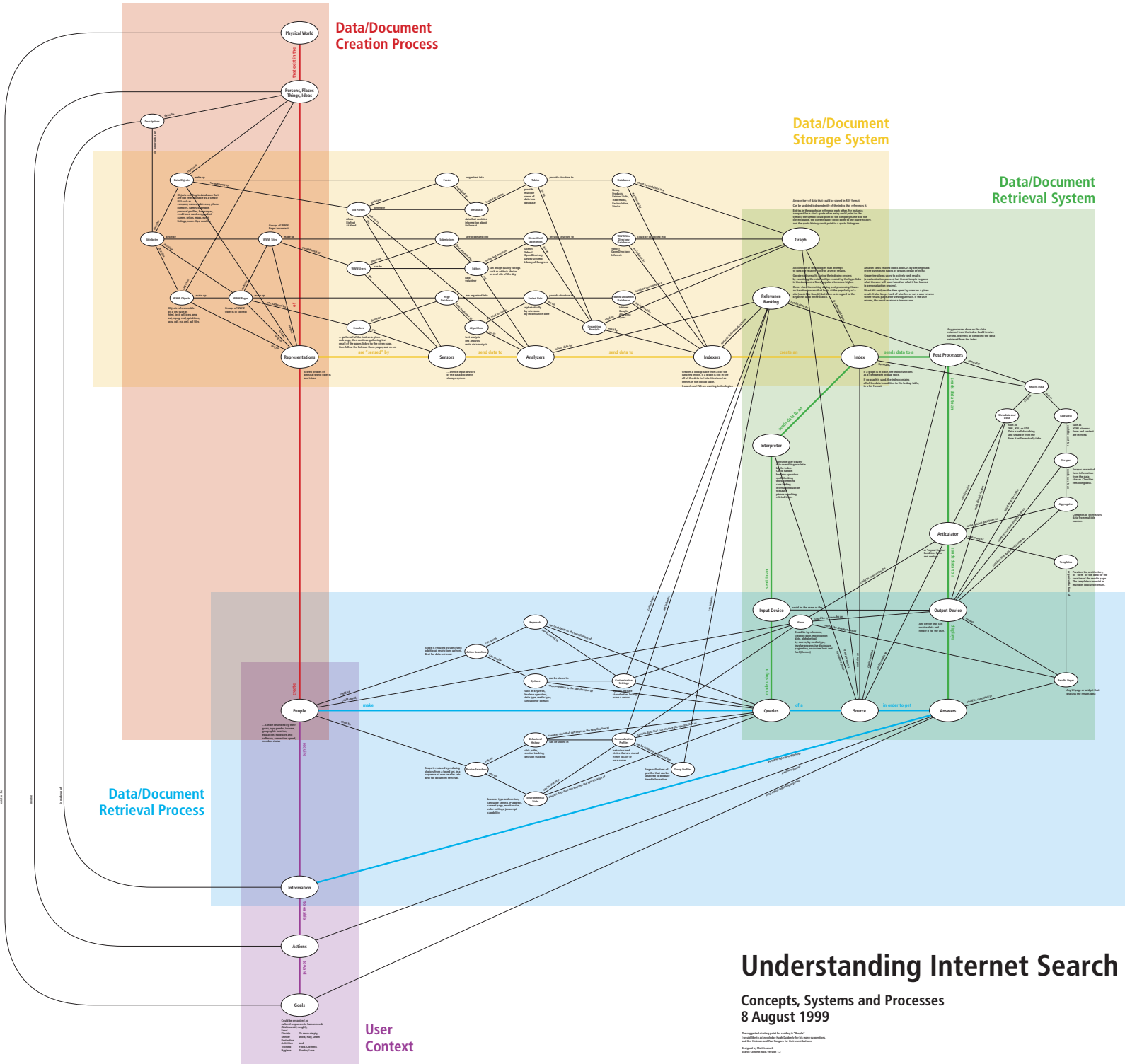


# Example: Phases of a cold.

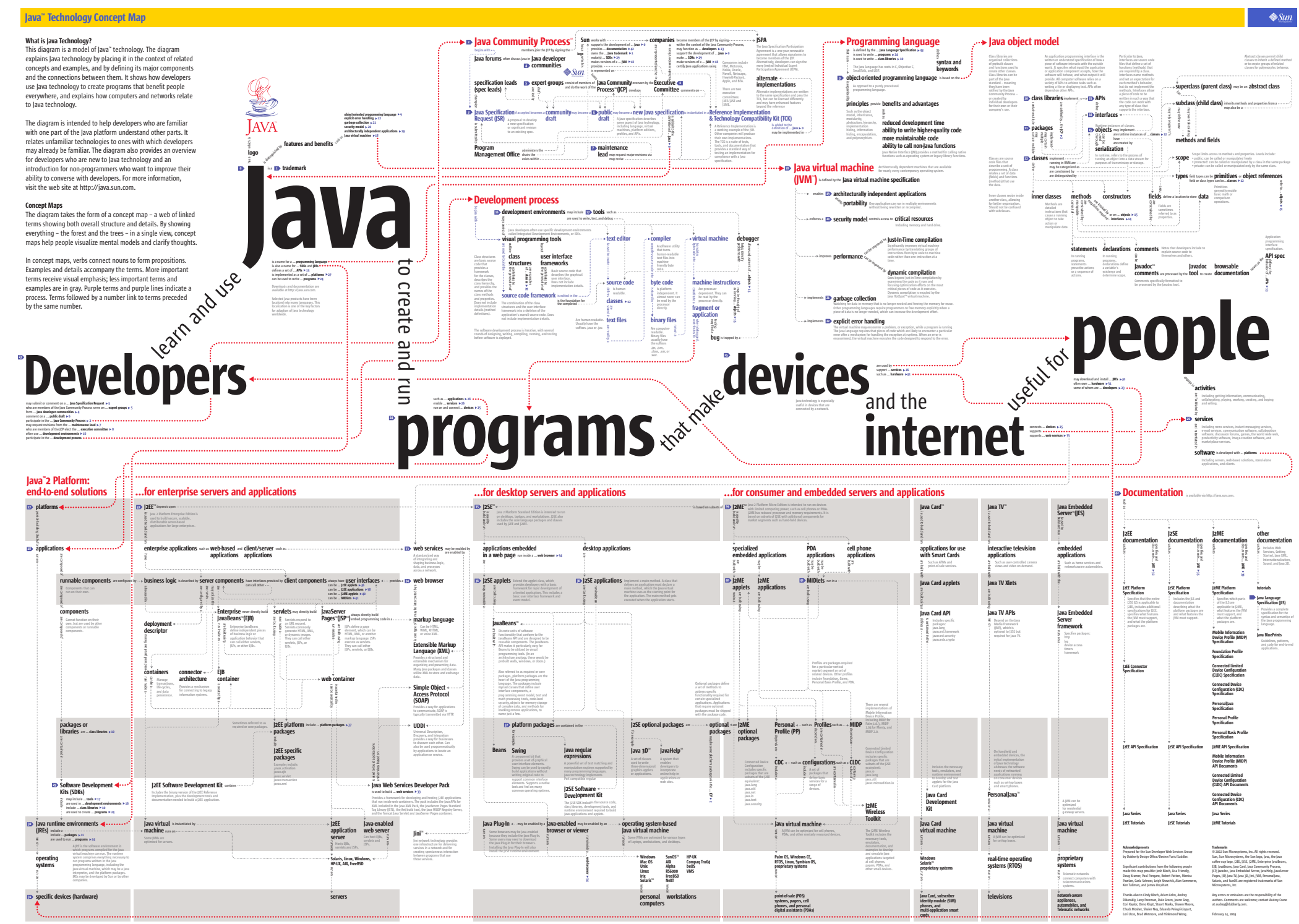


— E-Lab, Rick Robinson

# Example: Search concept map

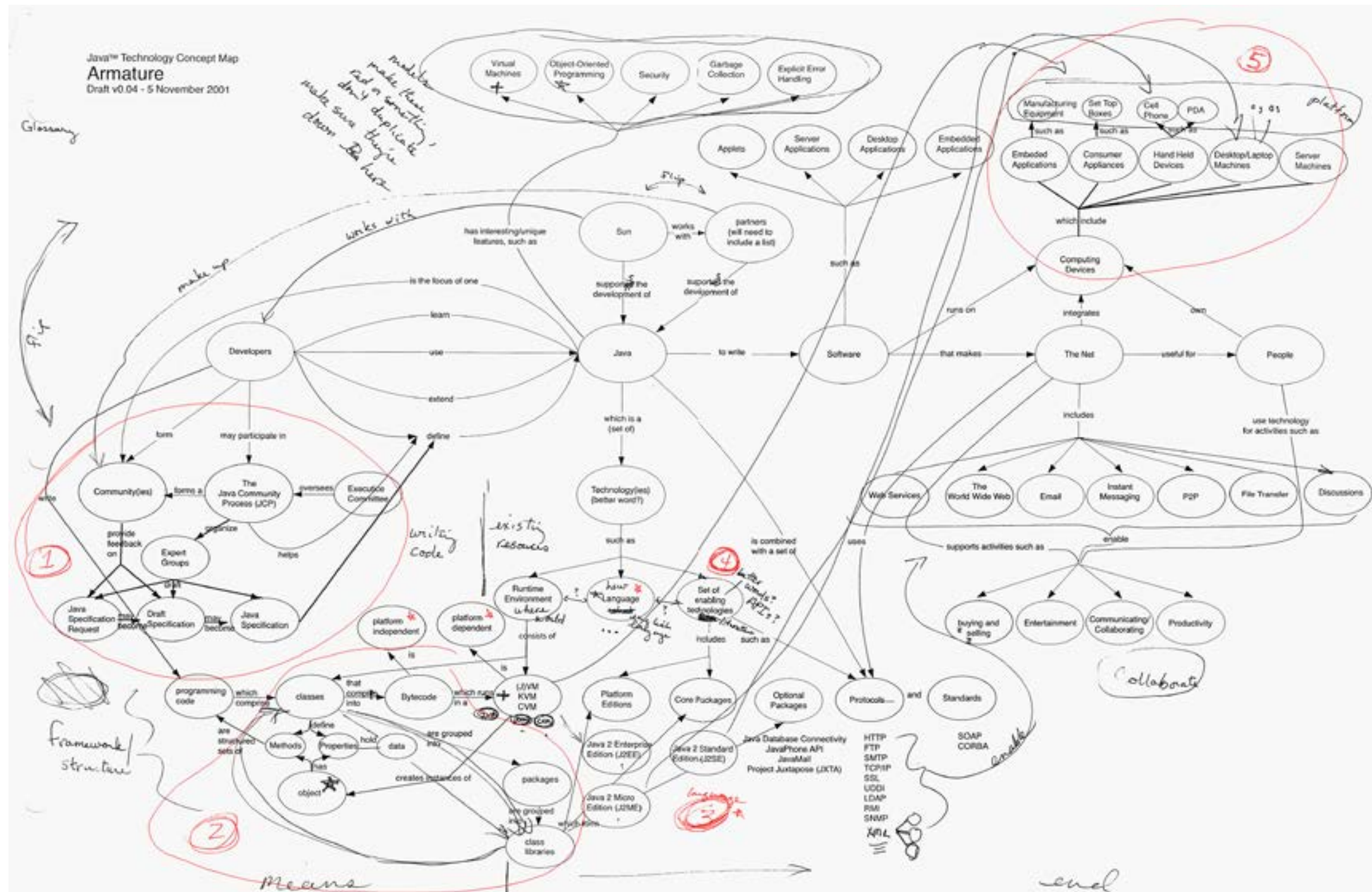


# Example: Java concept map

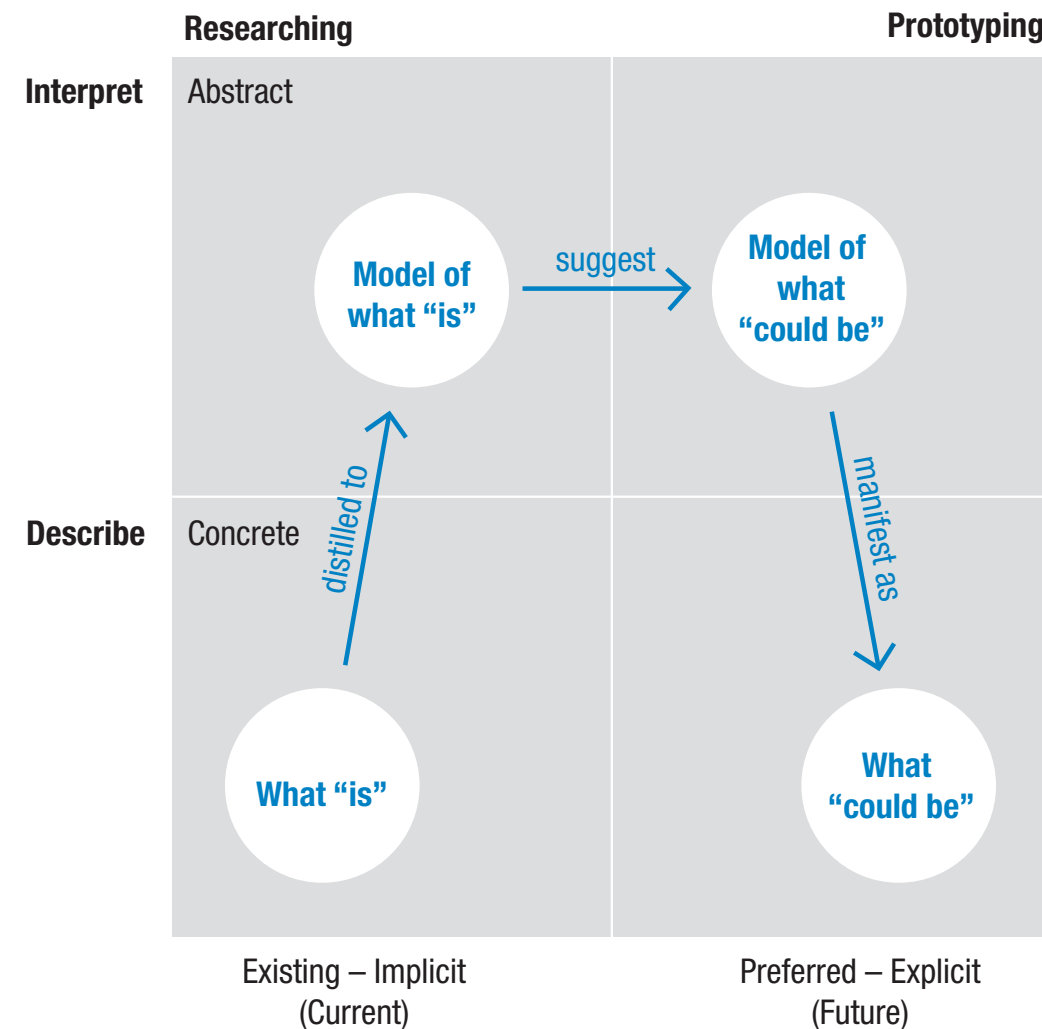




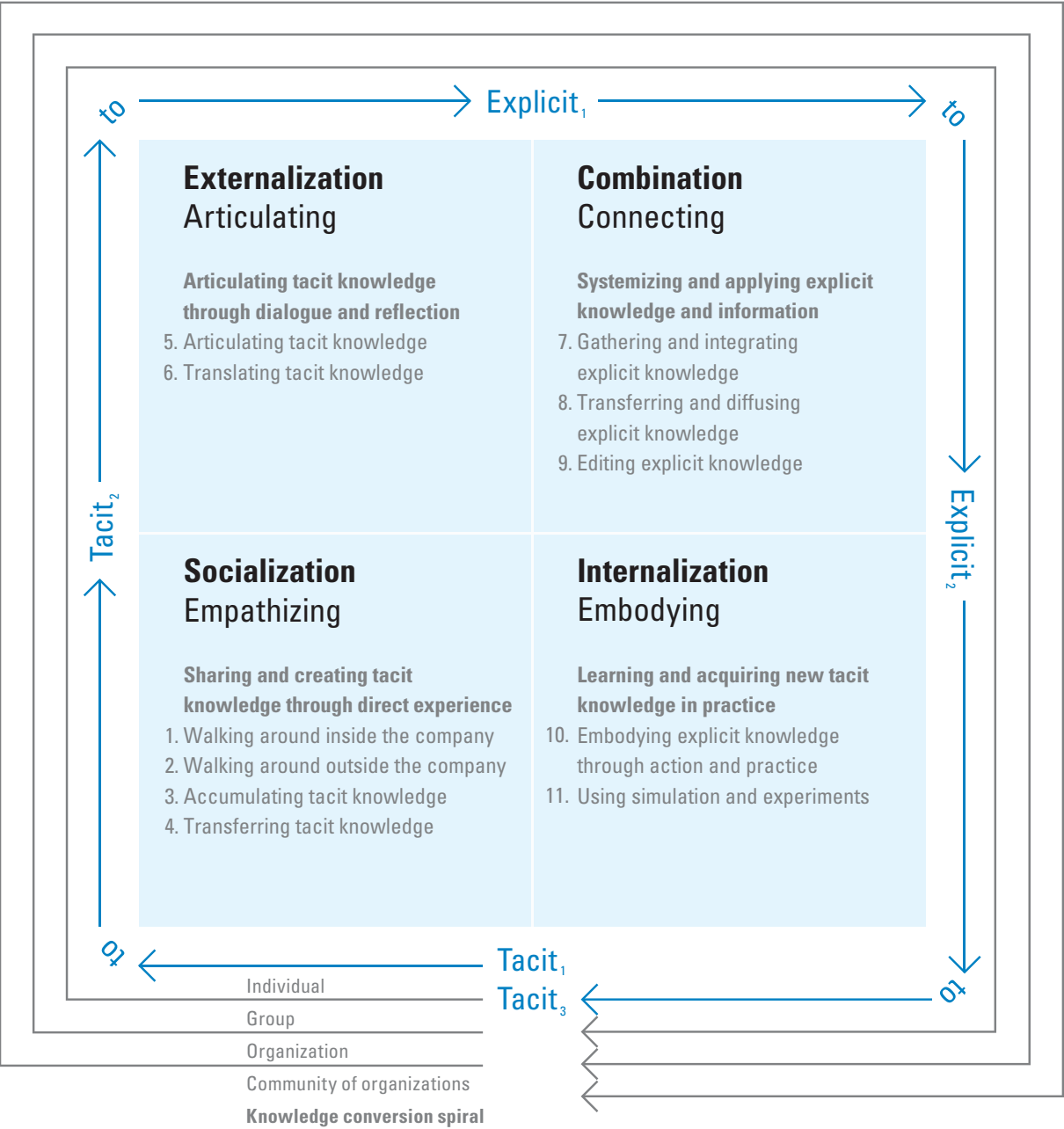
# Example: Draft of the Java concept map



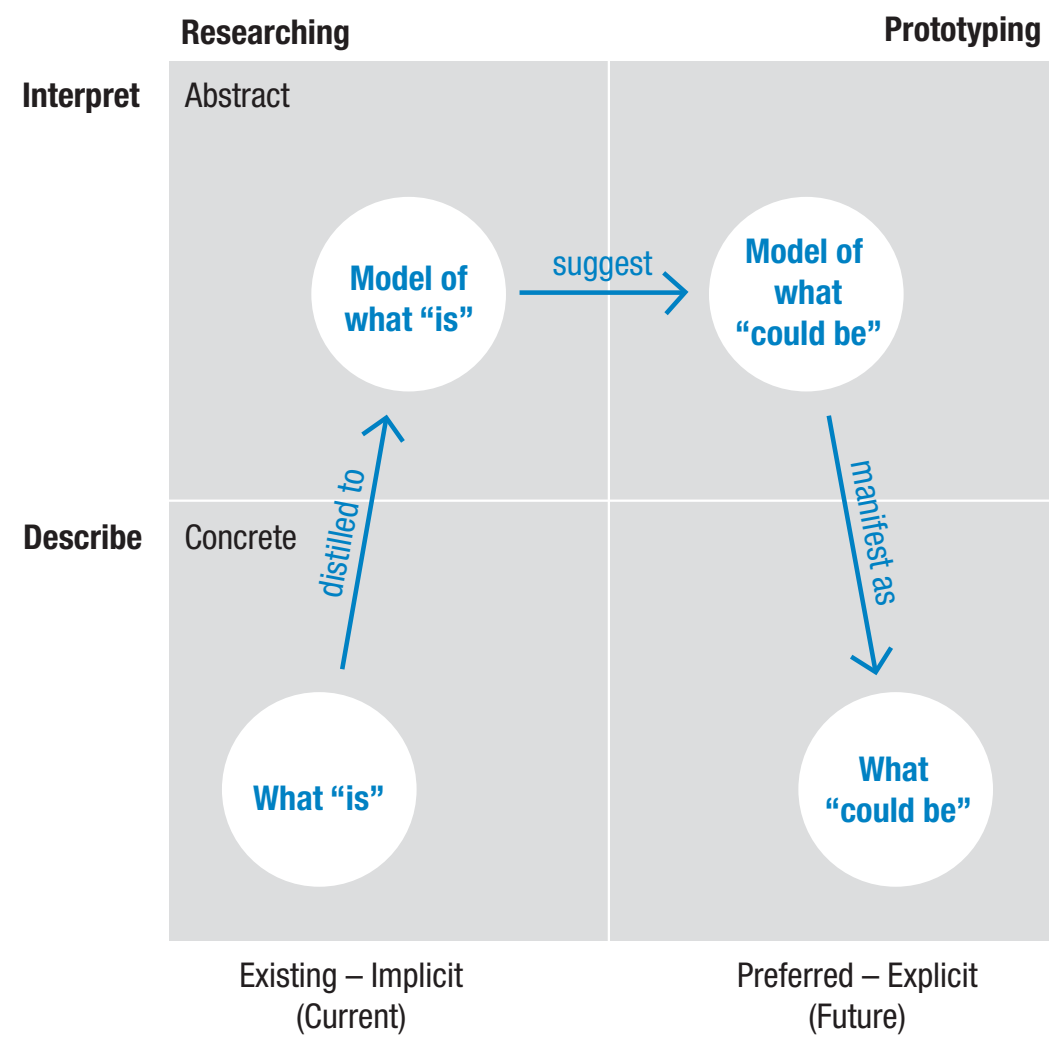
# Models are tools designers use to bridge the gap between what is and what should be.



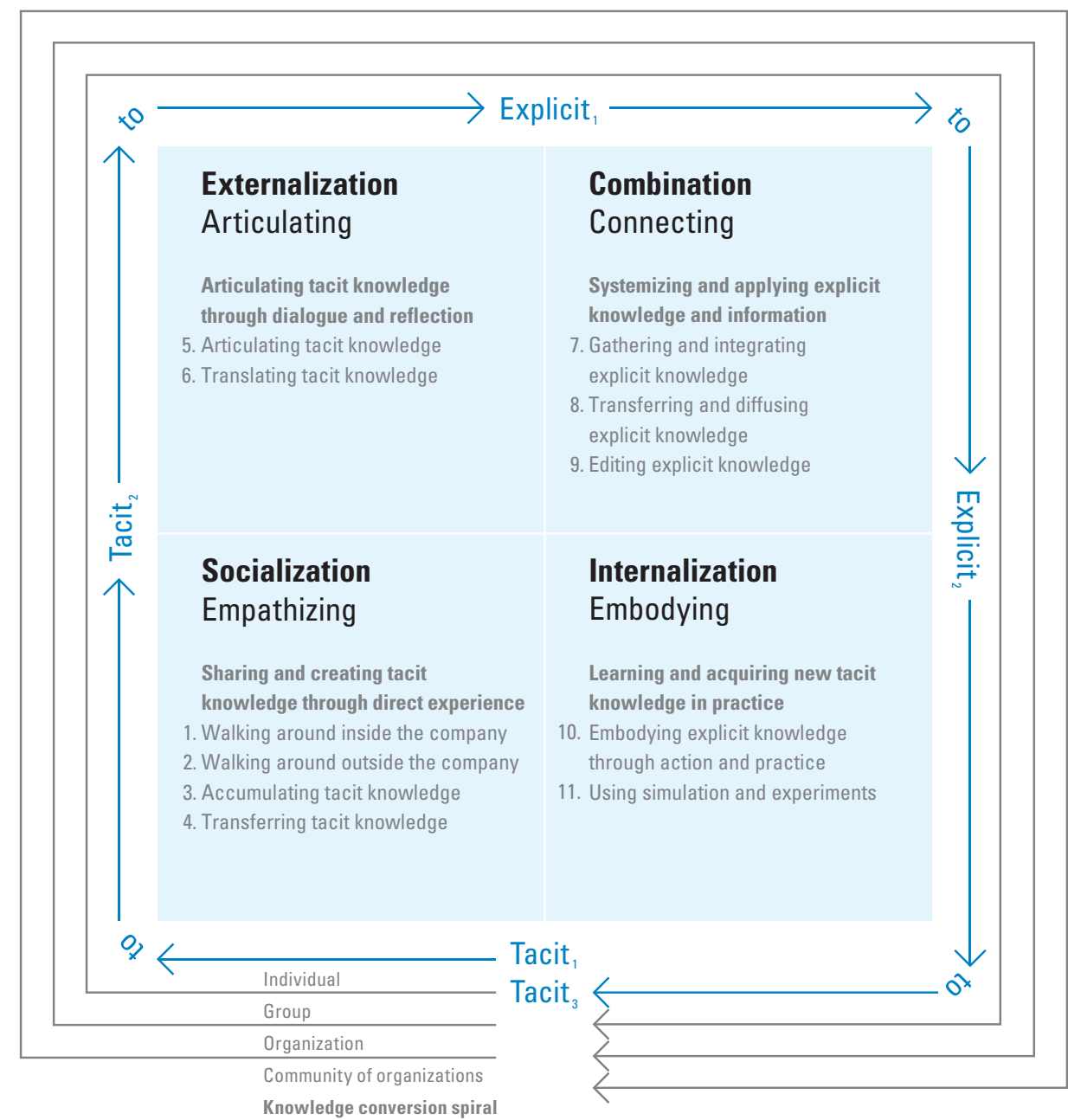
# Organizational learning follows a similar process, turning tacit knowledge into explicit knowledge and back again.



# Both processes have the same structure— designing is learning.



**Analysis-Synthesis Bridge Model**  
Dubberly, Evenson & Robison (2008)



**SECI model of knowledge create**  
Ikujiro Nonaka (1995)



*“At its heart, software design is about creating virtual worlds in which users work, learn, and play.*

*Virtuality has two aspects:*

- 1. Conceptual structure—the ideas and how they unfold, connect, and lodge in the mind*
- 2. Feel—how things look and the other sensations we experience (crude or slick, bumpy or smooth, warm or cool)*

*The real issue is designing a consistent conceptual structure, one that fits the domain as much as possible, as comprehensively and comprehensibly as possible.*

*Consistency, completeness, and clarity are the objectives.”*

— Ted Nelson, the inventor of hypertext



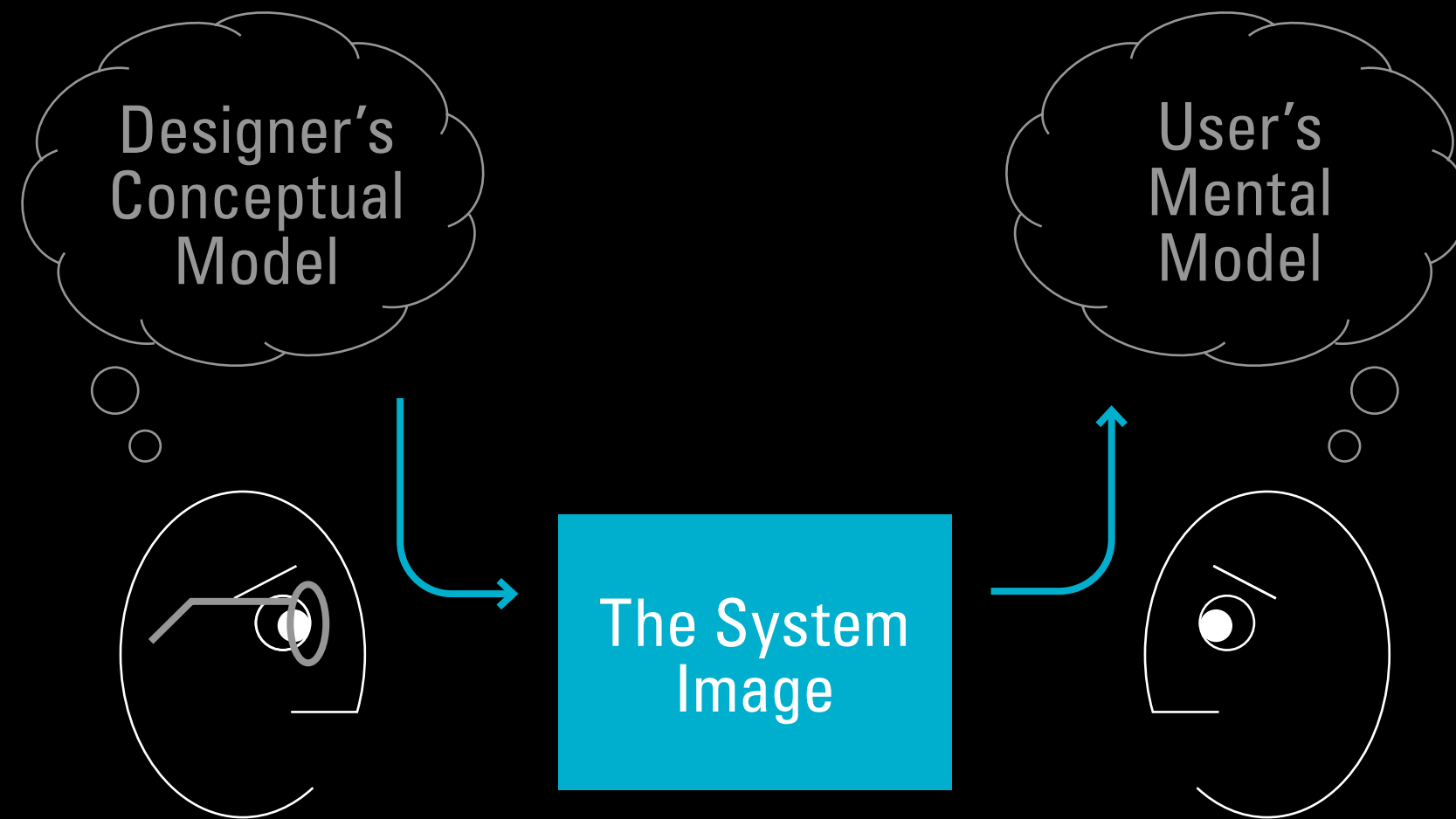
*“For people to use a product successfully, they must have the same mental model (the user’s model) as that of the designer (the designer’s model). But the designer only talks to the user via the product itself, so the entire communication must take place through the ‘system image’: the information conveyed by the physical product itself.”*

— Don Norman, *The Design of Everyday Things*, 1988



**“...most digital systems fail when they fail to provide a story,  
when there is a poor **conceptual model**.”**

— Don Norman



*“A conceptual model is a high-level description of an application. It enumerates all concepts in the application that users can encounter, describes how those concepts relate to each other, and how those concepts fit into tasks that users perform with the application.”*

— Jeff Johnson + Austin Henderson, *Conceptual Models: Core to Good Design*, 2012



# As an example of a conceptual model Johnson + Henderson describe an **alarm clock**.

The clock **stores** the **current time** of day,  
continually **updating** it to track the passage of time.

It **displays** the current time constantly.

**Users** can **set** the current time.

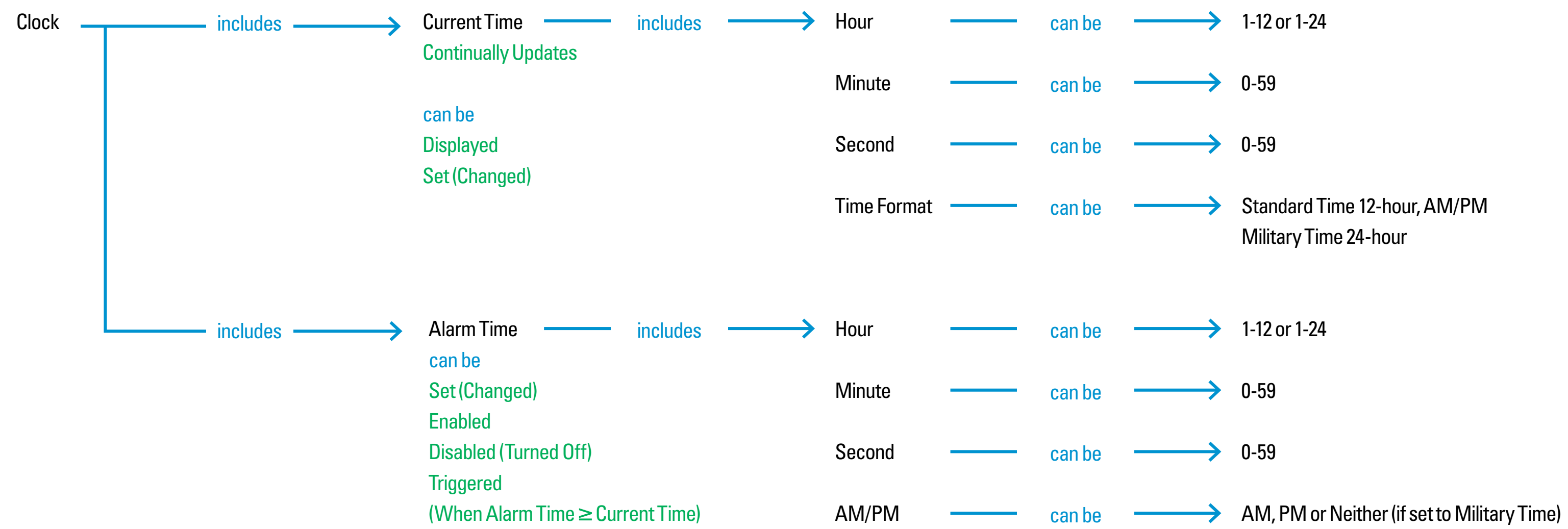
Users can set an **alarm** at a **specified time**, or no alarm.

When an alarm is set and the current time equals the set **alarm time**,  
the **alarm** is triggered.

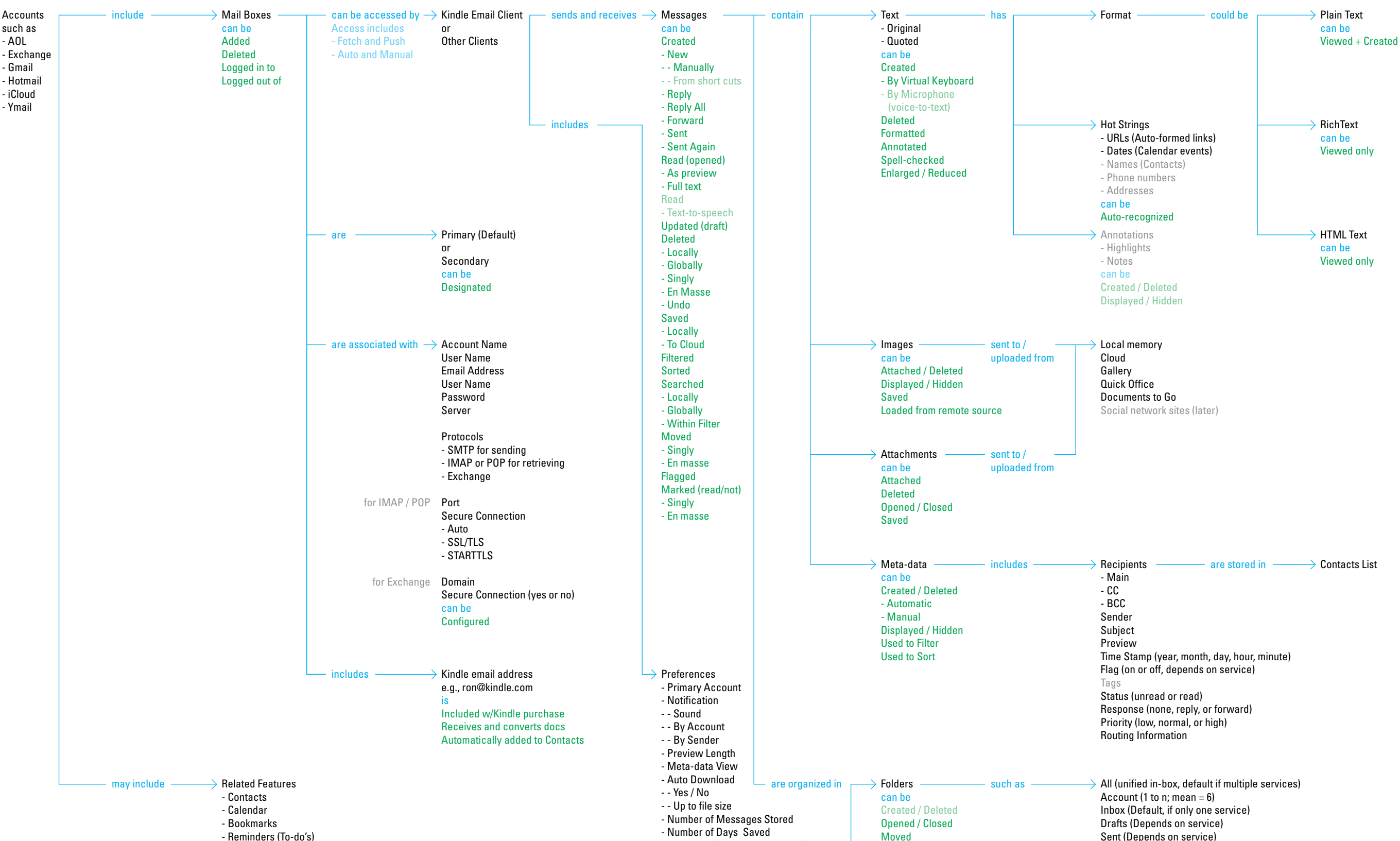
Users can **turn off** an alarm.



# User conceptual model of an alarm clock, represented as a node-link diagrams—or concept map.

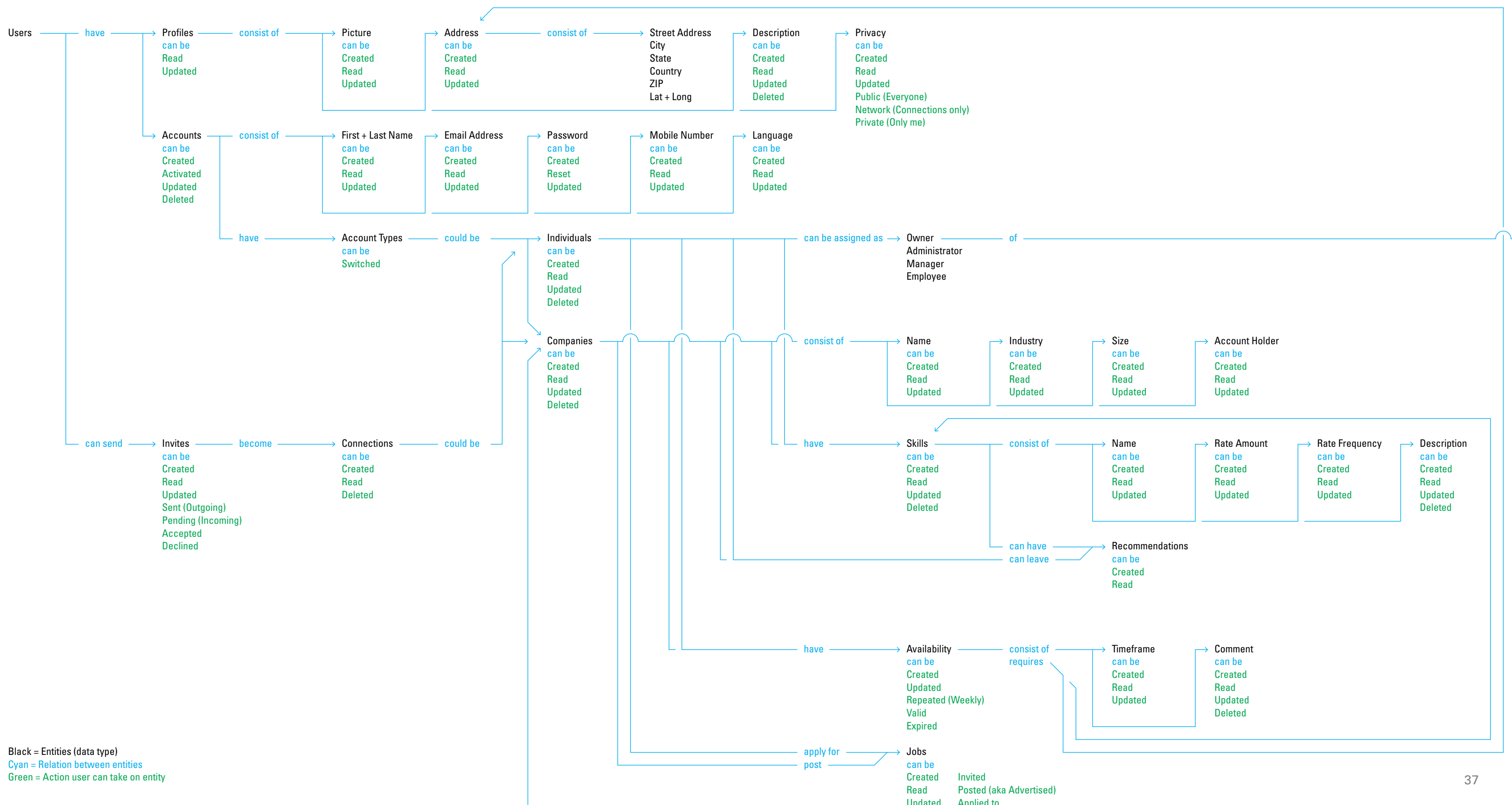


# Example user conceptual model: an email client app

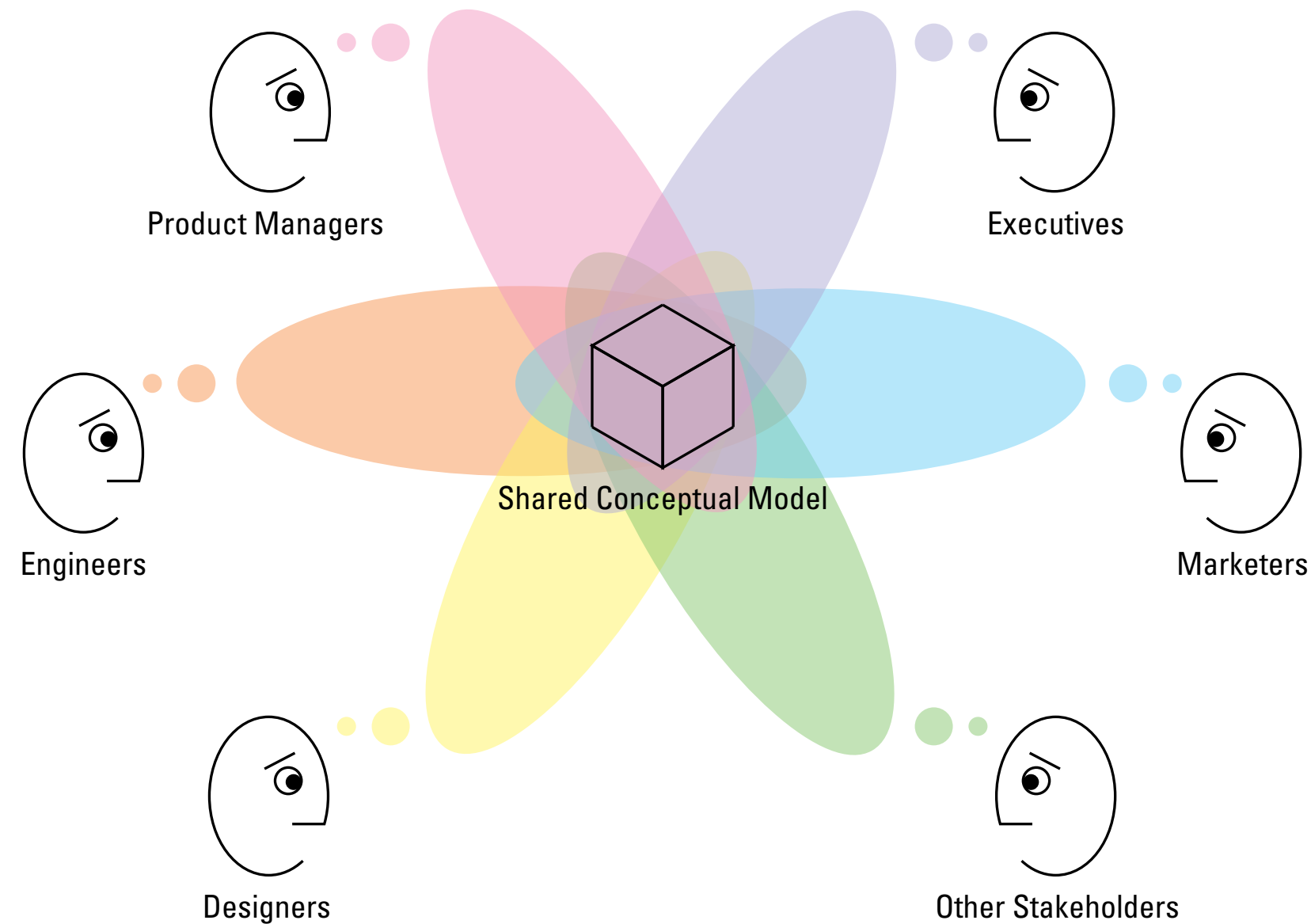




# Example user conceptual model: restaurant staff scheduling app



# Conceptual models help a product team communicate.



The communication needs to go two ways; it needs to be a conversation.

That means designers don't own the model; the designer's role is to facilitate the conversation, by representing the model and prototyping.

**Special thanks to**  
**Eric Knudson**  
**Knut Synstad**

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