How the Internet of Things is Changing Healthcare Products

Hugh Dubberly, Dubberly Design Office
Stephen B. Wilcox, Design Science

"...software is eating the world.

...*we are in the middle of a dramatic and broad technological and economic shift in which software companies are poised to take over large swathes of the economy...*

Health care and education, in my view, are next up for fundamental software-based transformation."

— Marc Andreessen, founder, Netscape and Andreessen-Horowitz

Technological change comes in waves, which interact to create "combinatorial innovation." [1]

– Work has *gone digital*.
– People *got connected*.
– Now, *things* are connecting, too.

SaaS

Drones   Robots

Social

Cloud computing   Virtual reality
on-demand   Augmented reality

Mobile

Glasses   Big data
Goggles   Linked data
Wearables   Open data

Voice UIs

AI 2.0
Machine learning
Predictive analytics

CNC
3D printing

Personal Computers   **The Internet**   **Internet of Things (IoT)**

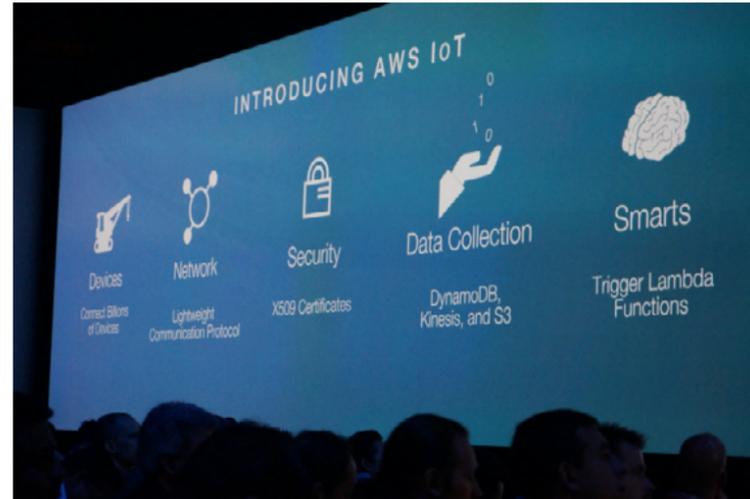1975   1995   2015

[1] Hal Varian
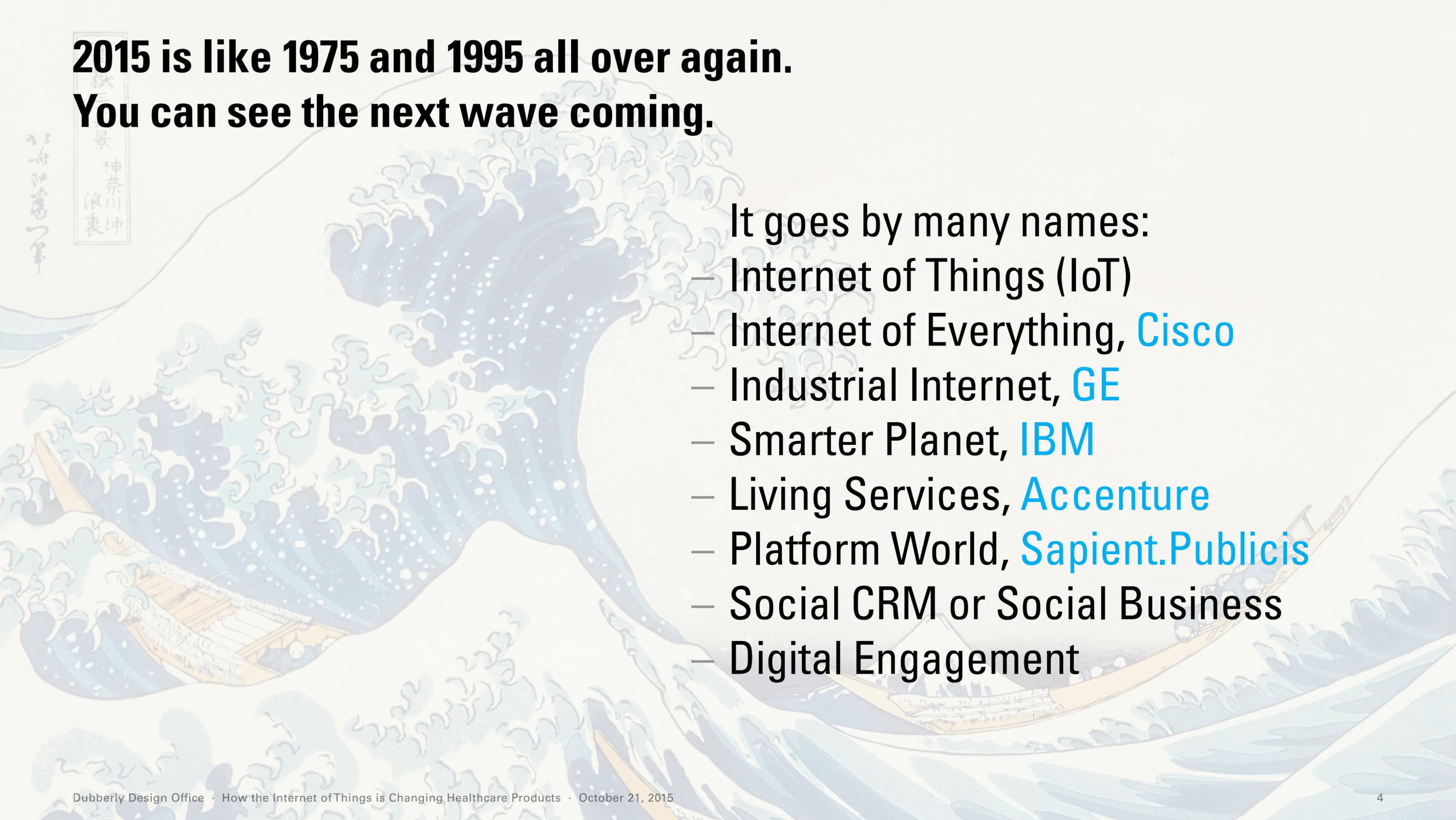
2015 is like 1975 and 1995 all over again.
You can see the next wave coming.
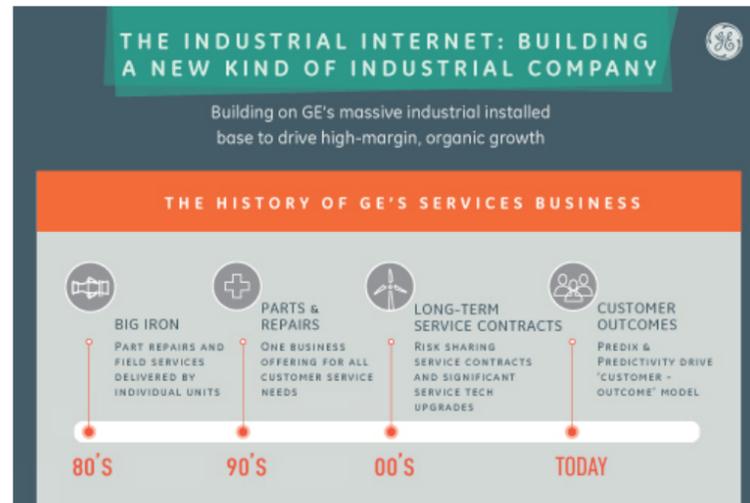
It goes by many names:
– Internet of Things (IoT)
– Internet of Everything, Cisco
– Industrial Internet, GE
– Smarter Planet, IBM
– Living Services, Accenture
– Platform World, Sapient.Publicis
– Social CRM or Social Business
– Digital Engagement

The change has already begun,
for example

Amazon just announced **AWS IoT**, also testing pop-up stores in malls featuring IoT devices.

Sears opens a series of **"Connected Home"** showcase stores.

GE hires 2,000 engineers in San Ramon, builds **Predix platform**, just announced Current.

Target launches **"Open House"** IoT showcase store in San Francisco.

Products no longer stand alone.
Increasingly, they exist in complex service webs.

Product   **Service**   **Ecologies**
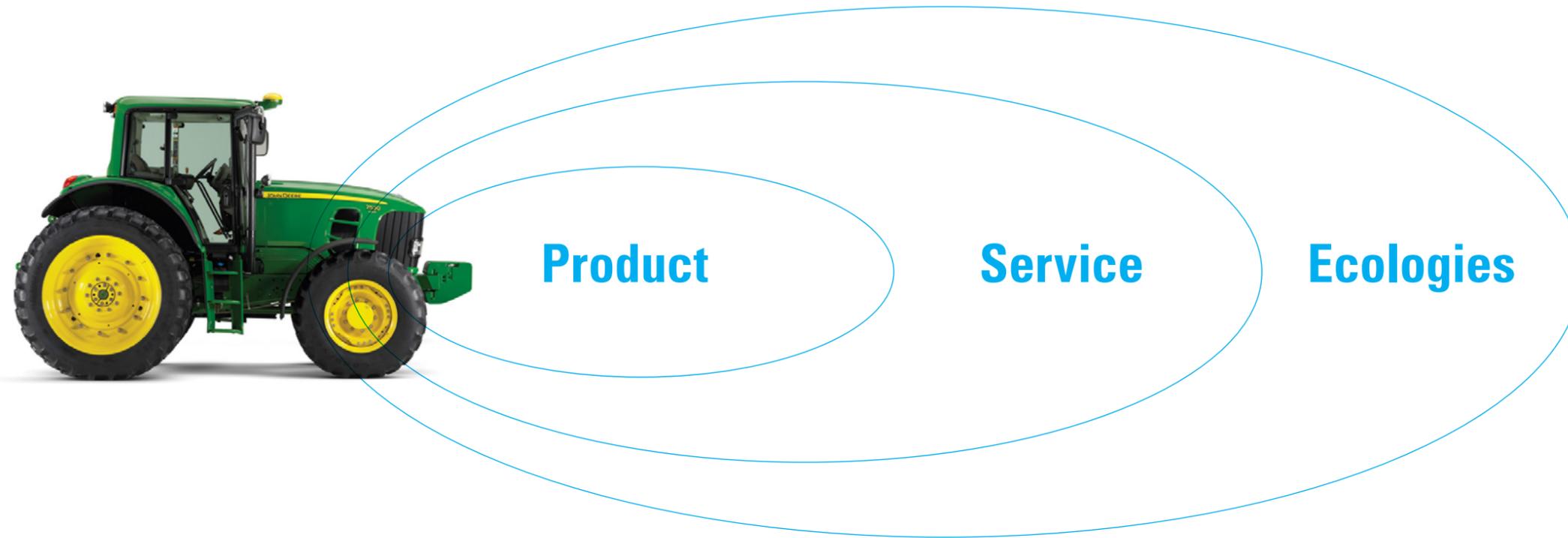
The average vehicle includes 60–100 sensors; that figure may grow to 200 by 2020. [1]

In 2010, basic cars included 30 microprocessors; luxury cars had as many as 100. [2]

[1] Source: Automotive Sensors and Electronics Expo 2015
http://www.automotivesensors2015.com/

[2] Source: The New York Times
http://www.nytimes.com/2010/02/05/technology/05electronics.html

Products no longer stand alone.

Product

$+$ Sensor

$+$ Computer

$=$ Smart Product
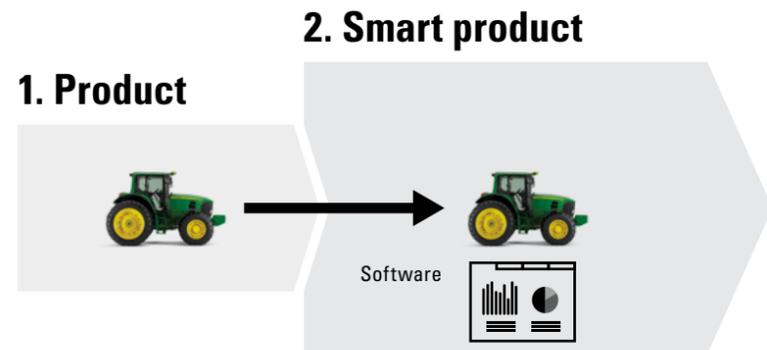
2. Smart product

1. Product

Software

—Michael Porter and James Heppelmann, How Smart, Connected Products Are Transforming Competition
Harvard Business Review, November 2014
https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

Products no longer stand alone.

Smart Product

$+$ Network

$+$ Cloud Service

$=$ Smart, Connected Product

3. Smart, connected product

2. Smart product

1. Product

Remote devices

Software

Software

—Michael Porter and James Heppelmann, How Smart, Connected Products Are Transforming Competition
Harvard Business Review, November 2014
https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

Products no longer stand alone.

Smart, Connected Product
+ other Smart, Connected Products
= Product System

1. Product

2. Smart product

Software

3. Smart, connected product

Remote devices

Software

4. Product system

Remote devices

Planters

Tillers

Farm Equipment System

Tractors

Combine harvesters

Software

—Michael Porter and James Heppelmann, How Smart, Connected Products Are Transforming Competition
Harvard Business Review, November 2014
https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition
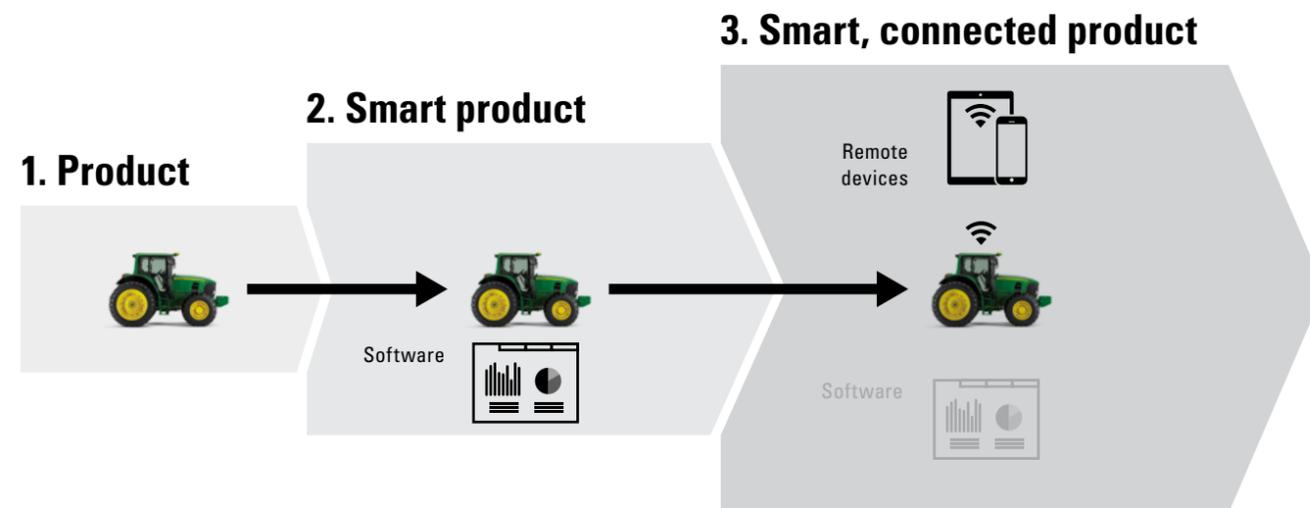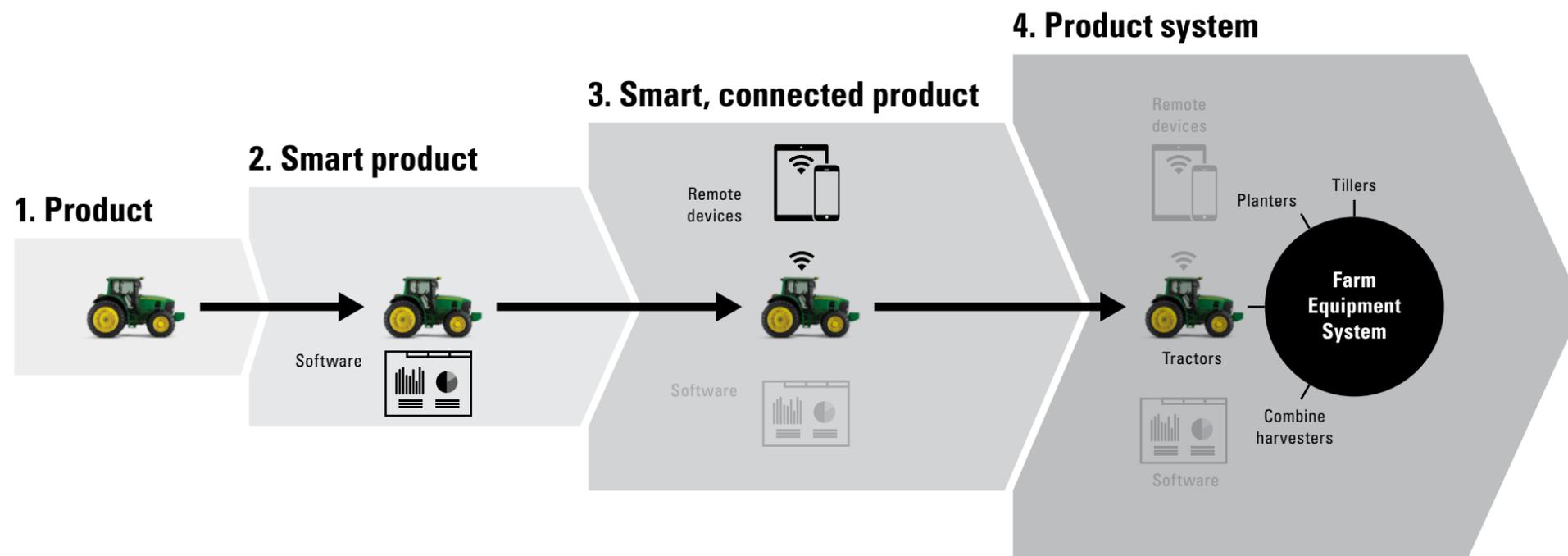
Products no longer stand alone.

Product Systems
+ other Product Systems
= Product-Services Ecology

5. Systems of systems

4. Product system

3. Smart, connected product

2. Smart product

1. Product

Remote devices

Software

Remote devices

Software

Tractors

Planters

Tillers

Combine harvesters

Farm Equipment System

Remote devices

Software

Tractors

Planters

Tillers

Combine harvesters

Farm Equipment System

Weather maps

Weather forecasts

Rain, humidity, temperature sensors

Weather data application

Weather Data System

Farm Management System

Seed Optimization System

Farm performance database

Seed database

Seed optimization application

Irrigation System
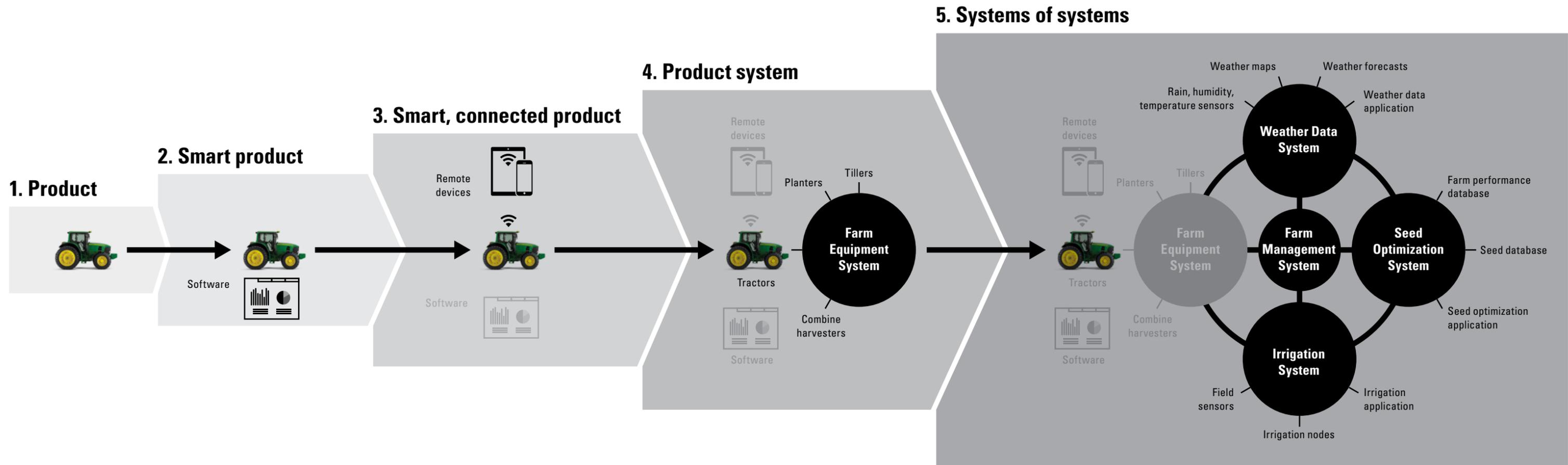
Field sensors

Irrigation application

Irrigation nodes

—Michael Porter and James Heppelmann, How Smart, Connected Products Are Transforming Competition
Harvard Business Review, November 2014
https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

Farms are becoming automated factories.
Plants are attached to sensors, connected to networks, generating data.

iPod was the proto-IoT device—an integrated system of hardware, software, and networked services.

Hardware · **Software** · **Networked Service** · **Marketplace**

Music Listener · iPod · iTunes · iTunes Store · Record Companies · Artists
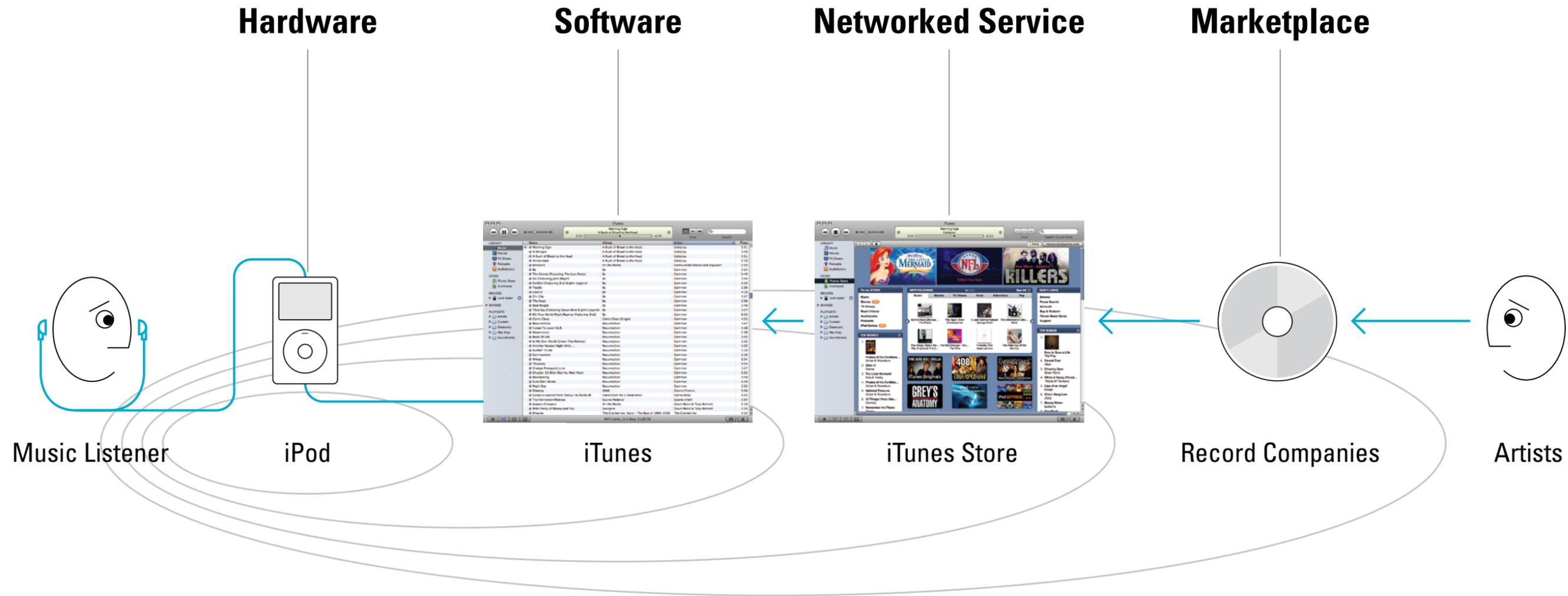
VCs are no longer funding stand-alone apps;
Uber isn't just an app; it's an IoT platform for logistics.

GPS

Ride Seeker — Phone — Matching Service — Phone — Driver — Car

Database
Maps
Members
Drivers
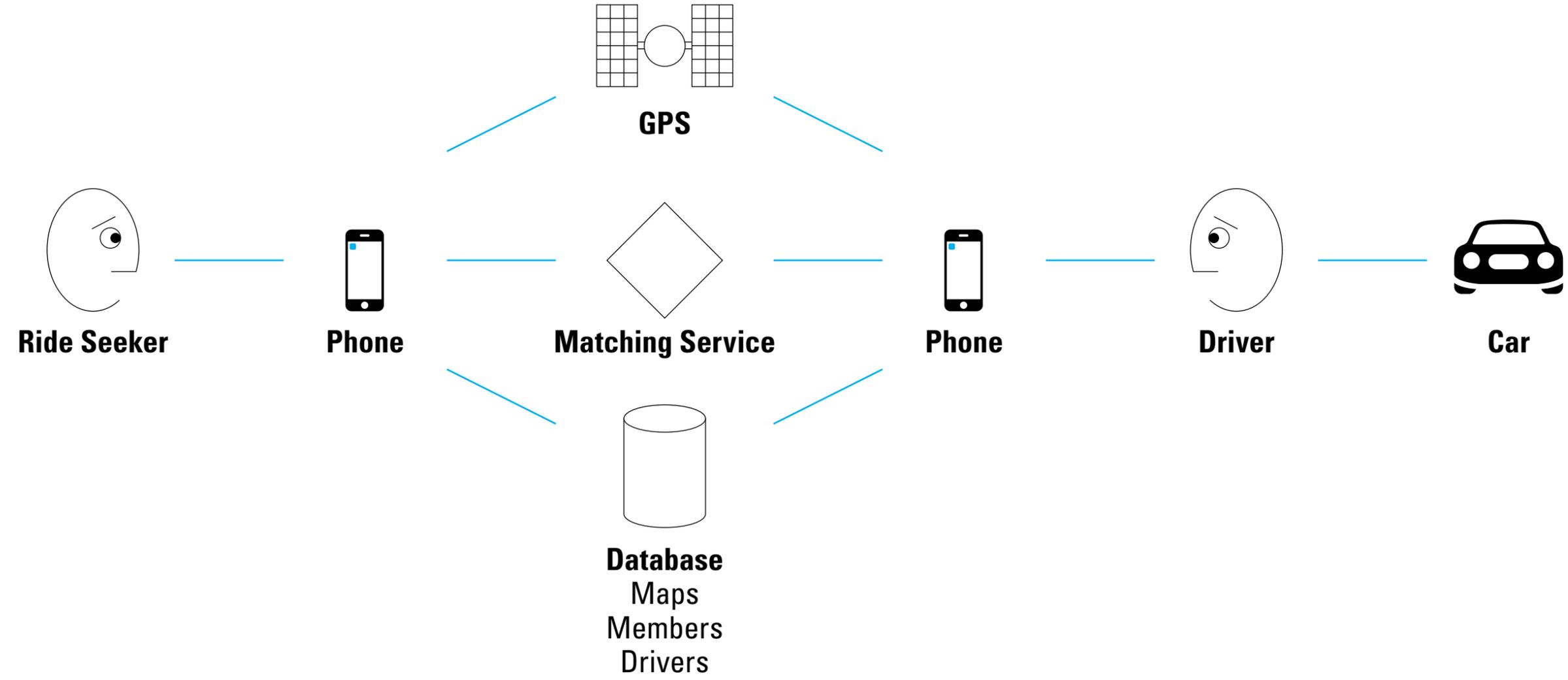
This fall, Mattel is relaunching Barbie, as a smart, connected product.

Barbie + sensor + computer + network + cloud services = Eliza 2015

- Recognizes you and what you say
- Learns about you
- Converses with you,
  using 8,000 pre-recorded phrases
- Extends up to 120 exchanges

Wi-Fi

View-Master
VR headset
by Google

AI
machine-learning
system

Speaker

Batteries

Microprocessor

Cloud

Microphone

Customer
database
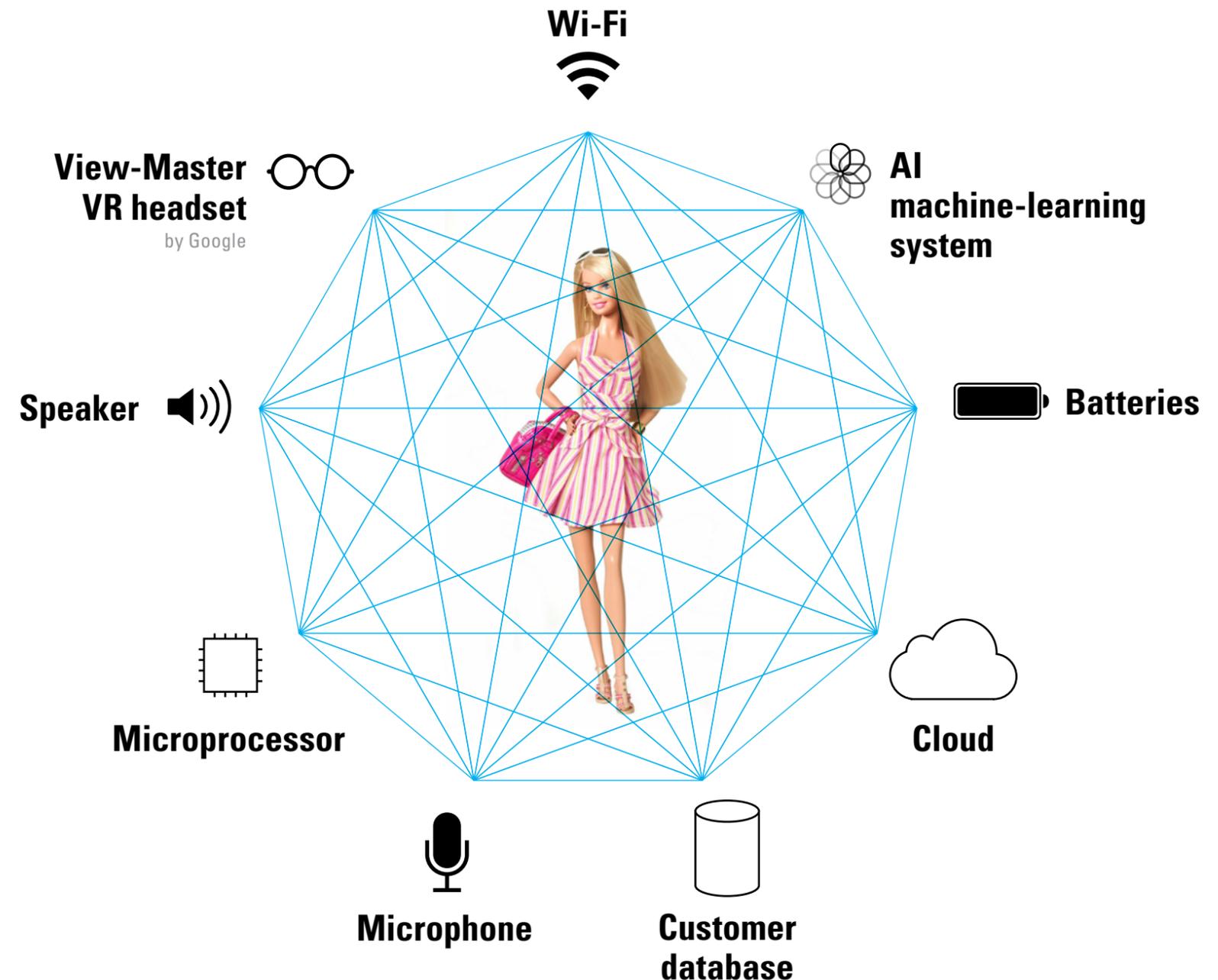
Now imagine Barbie's AI connected to a CRM system.

"Have you told Grandma what you'd like for your birthday?"

New products + services
built on the MMDB.

Business

Marketing

Mar-com

CRM

MM
DB

Member
Marketing
Database

Business

MM
DB

CRM

Mar-com

Marketing
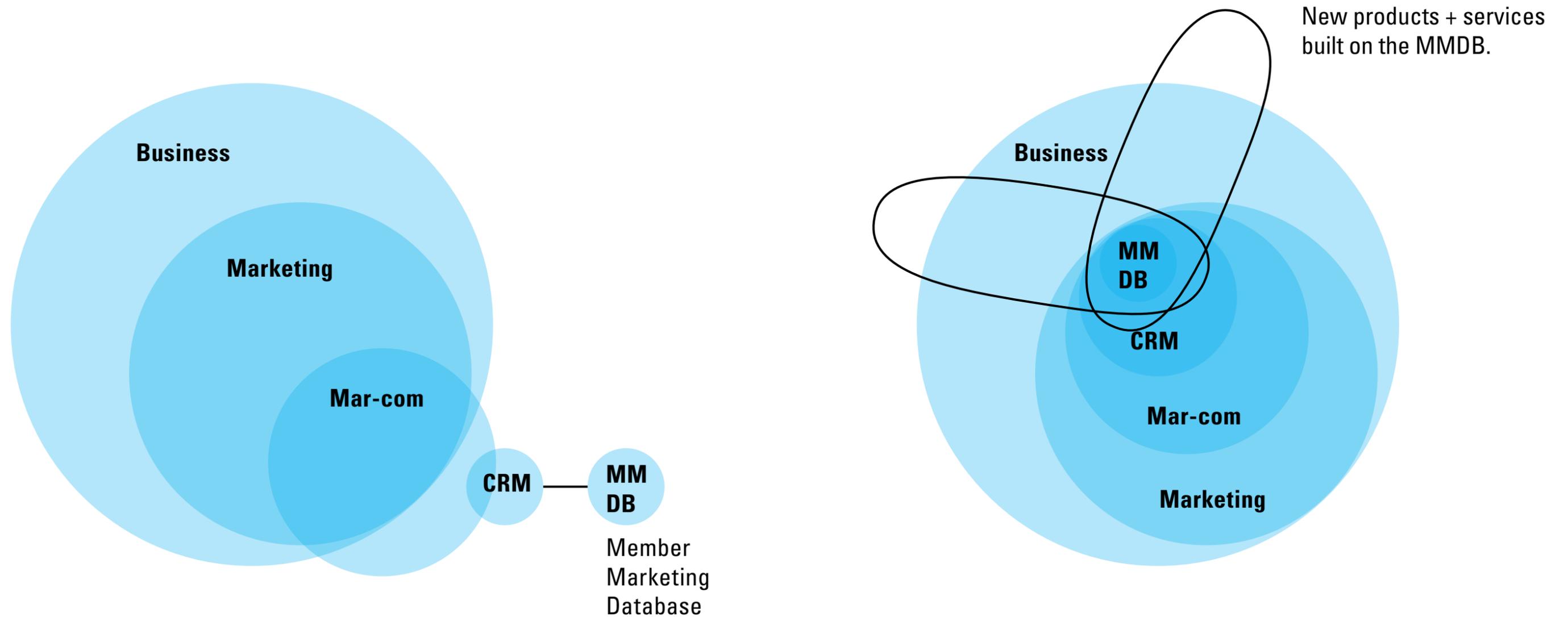
What does the IoT mean for healthcare?

Consumer tracking devices (AKA "wearables") have become common.

Apple Watch

Basis B1

Fitbit Flex

Garmin Vivofit

Jawbone Up

Microsoft Band

Misfit Shine

Moto 360

Narrative Clip

Nike Fuel

Pebble Classic

Samsung Gear

Sensors collect data and pass it to web-based apps; users set goals and share data with friends and family.

Feedback loops can promote change and help manage health.

Wi-Fi

Website

Analytics engine

RAM

Accelerometer

Phone

App

Friends
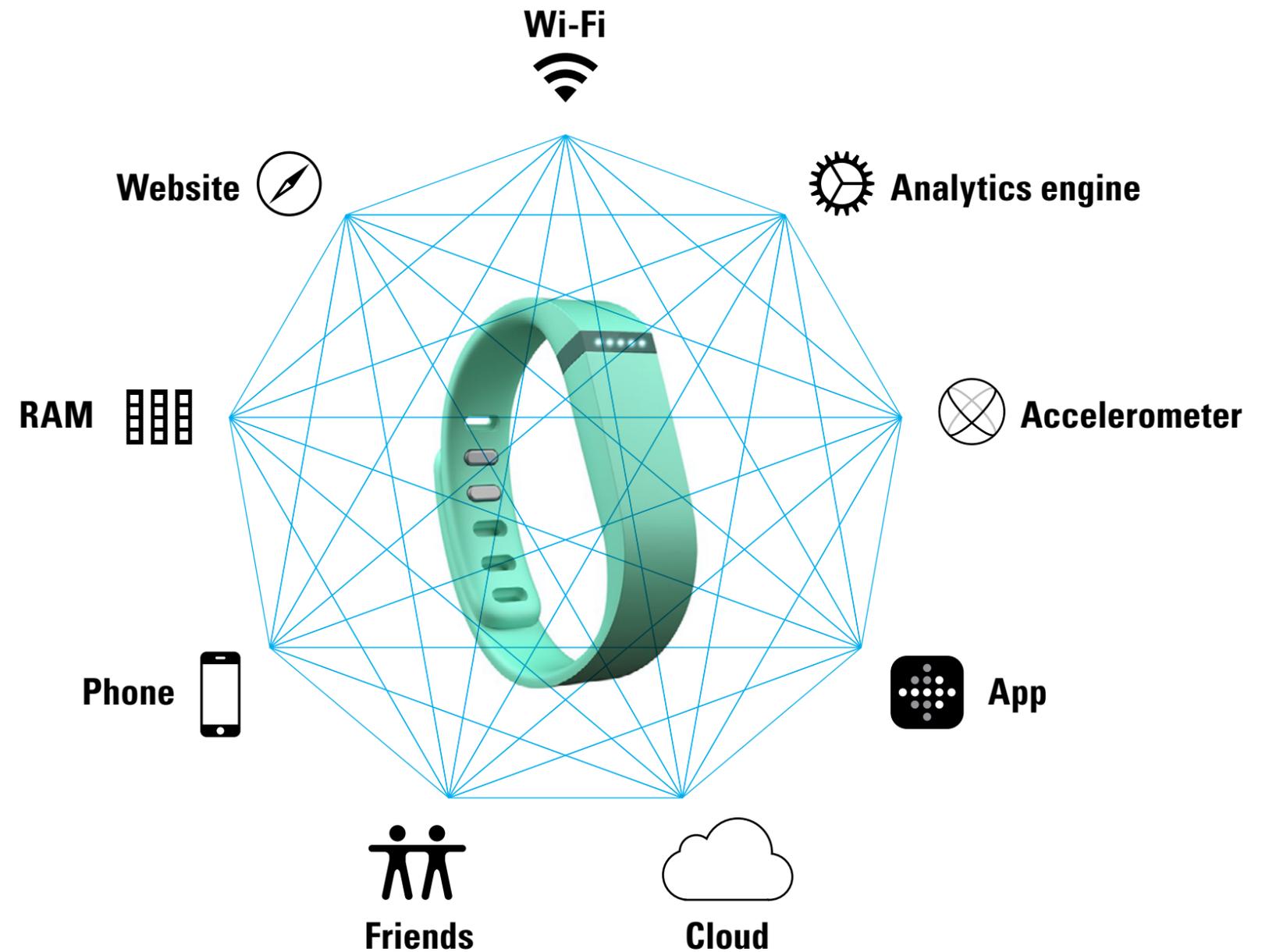
Cloud

Advanced sensors will change the meaning of "wearables". Google's Project Jacquard is creating touch-sensitive fabric.
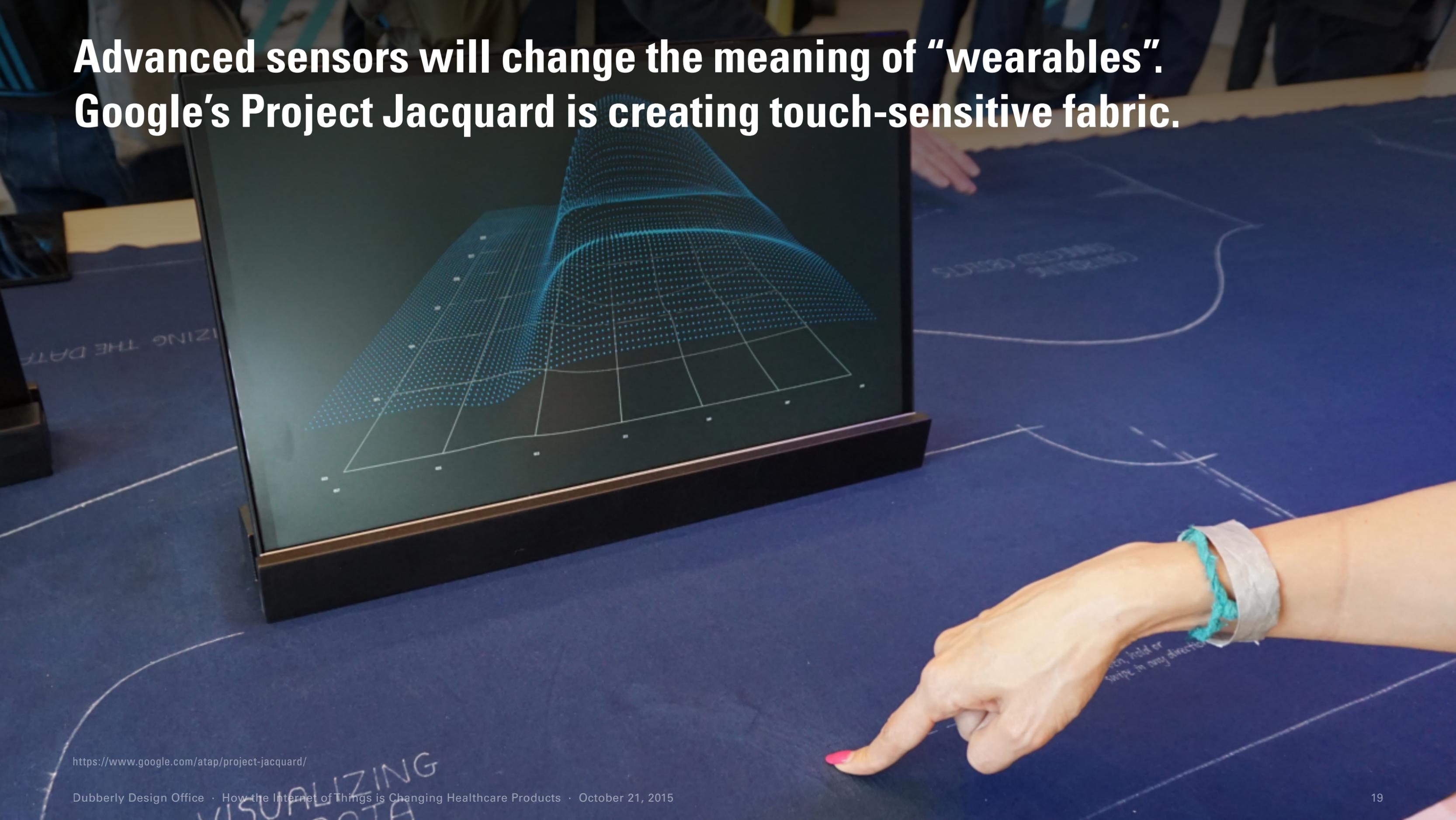
Medical devices are connecting to the cloud, too,

including pacemaker-defibrillators, autoinjectors, and glucometers.

Smart, connected glucometers
can alert family and HCPs about extreme lows;
they also collect data automatically
and help users see trends and make correlations.
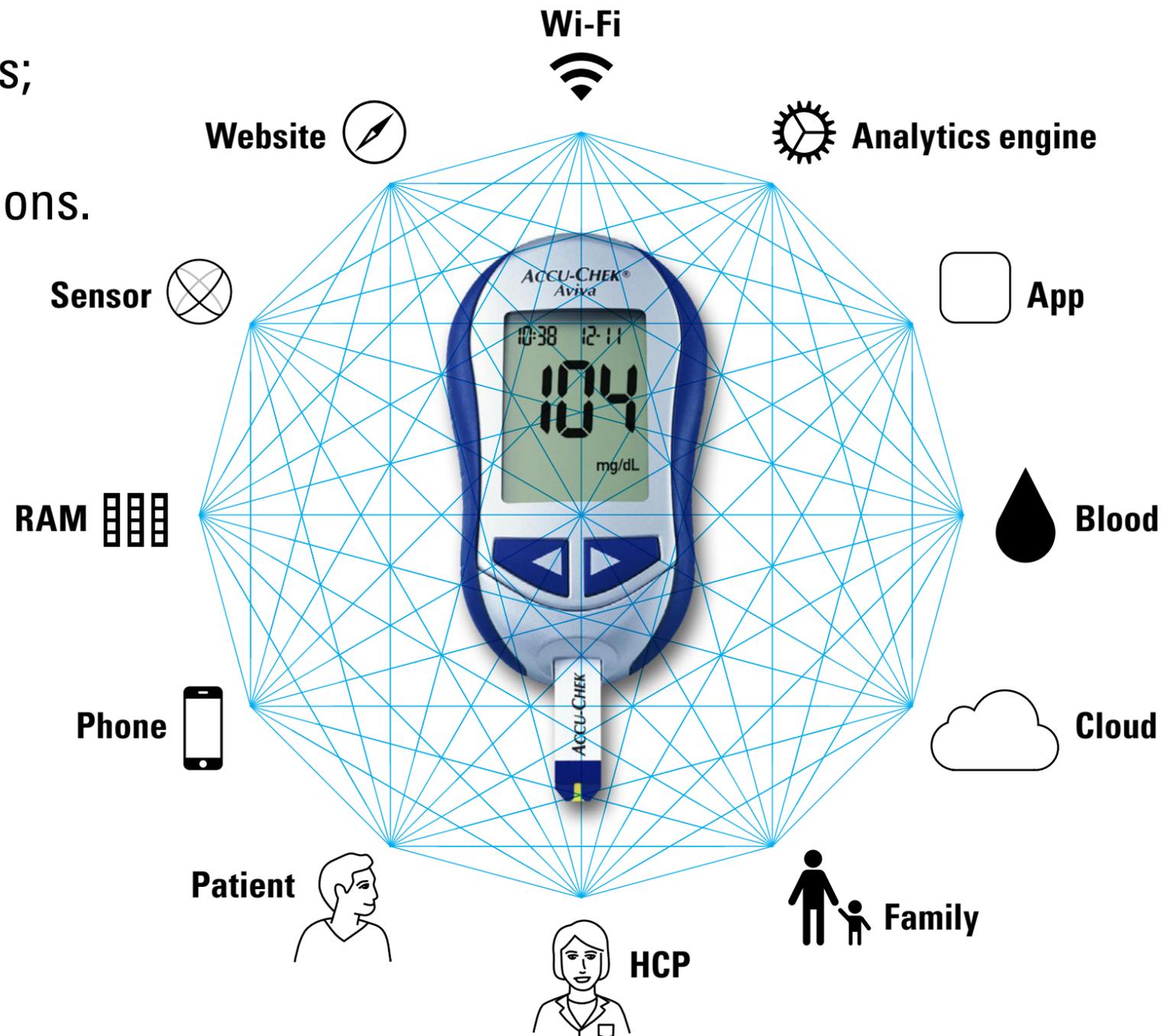
And they are connecting to other smart, connected devices.

A smart glucometer + a smart insulin pump = artificial pancreas

Endocrinologists may be able to
set doses remotely.
Systems could enable direct contact;
e.g., "Do you feel nausea?"

patient recieves → **Reservoir Packaging** (disposable)

contains 10 single use → **Reservoir Kit** (disposable)

consists of →

Cartridge (disposable)

Needle (medical sharps, disposable)

Needle Cap (disposable)

Plunger (disposable)

Cartridge Cap (disposable)

creates → **Syringe**

fill the syringe

→ **Filled cartridge** syringe disassembled & cartridge cap connected.

attach infusion kit tubing → **Filled cartridge** casket cap threaded onto tubing & infusion kit connected to cartridge. (cartridge and tubing disposable)

load into → **OneTouch® Ping® Insulin Pump**

flexible plastic tube

patient recieves → **Insulin Packaging** (disposable)

contains → **Insulin Vial** (disposable)

attach infusion kit tubing to cartridge

patient recieves → **Animas® Inset® Packaging** (disposable)

contains 10 single use → **Inset Kit** (disposable)

contains → **Animas® Inset®** (medical sharps, disposable)

use inserter to apply → **Infusion Set** (disposable)

Similar changes are beginning in clinical settings, too.
Large volume infusion pumps (LVPs) used to stand-alone.
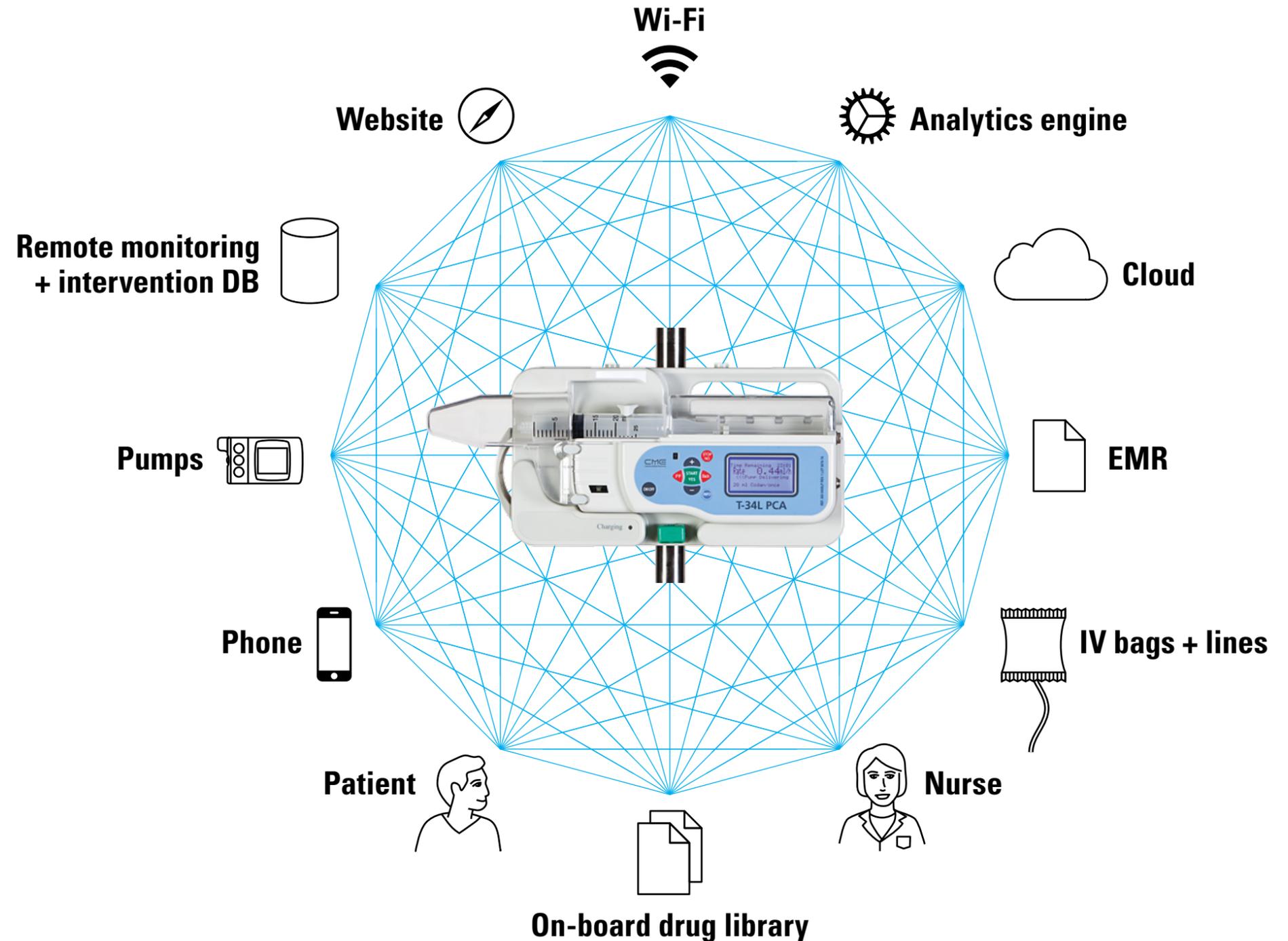
Even hospital beds will become smart, connected devices and join the medical product-services ecology.

Already, some beds can measure:

- Patient weight
- Heart rate
- Breathing rate
- Intensity and duration of movement
- Bed entrance + exit
- Sleep

Wi-Fi

Website

Air mattress sensors

Phone

App

Patient

Cloud

Nurse

http://smartbed.goodmarkmedical.com/smart-bed-technology-new/learn-smart-bed-solution/
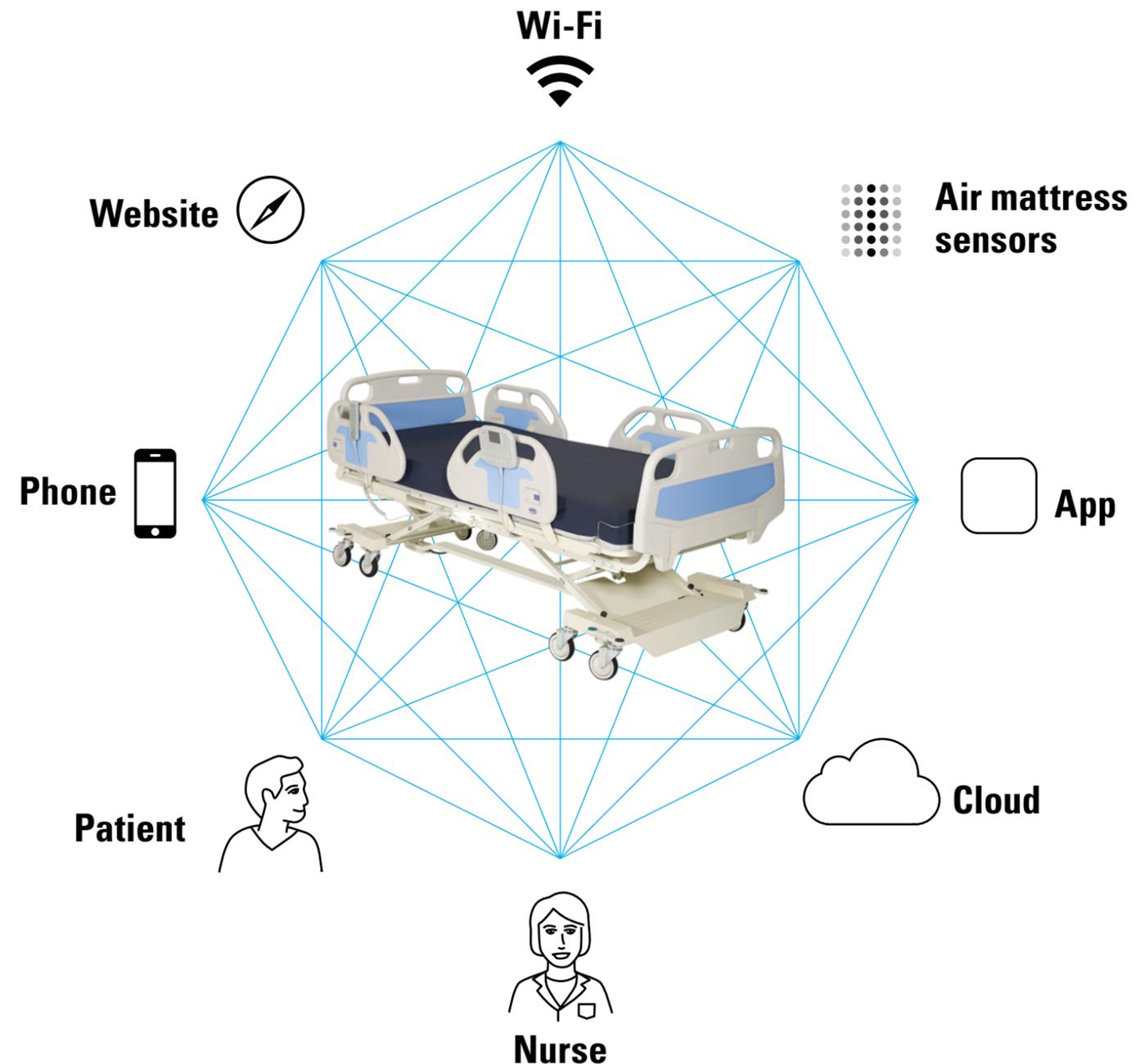
Catalia Health is developing Mabu, a personal healthcare companion.

Robot + touch-screen + network + cloud services = Mabu

– Recognizes you and what you say
– Learns about you
– Imports data from health trackers
– Converses with you about your condition
– Reminds you to take medications
– Connects with HCPs

Wi-Fi

AI
machine-learning
system

Speaker

Microprocessor

Batteries

Microphone

Cloud

Customer database

Hello, I am Mabu!
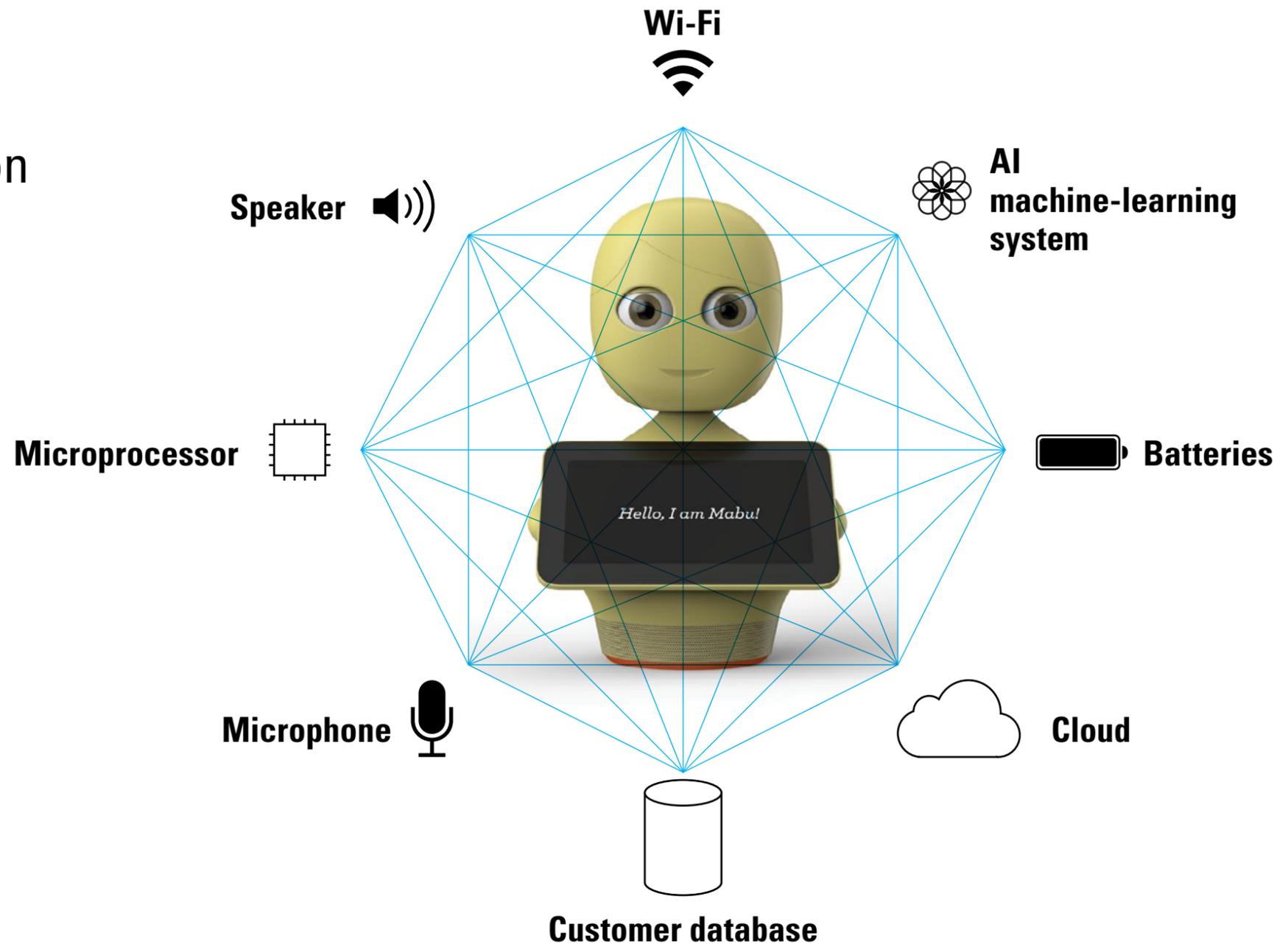
In the future, medical products will no longer stand alone. Increasingly, they will exist in complex service webs.

1. Product

2. Smart product

Software

3. Smart, connected product

Remote devices

Software

4. Product system

Remote devices

Syringe
Vial

Monitor
Pump
Cartridge

Glucose Management System

Software

5. Systems of systems

Remote devices

Syringe
Vial

Monitor
Pump
Cartridge

Glucose Management System

EMR System

Remote Alerting System

Patient Population Management System

Health Management System

Drug Interaction Monitoring System

Billing System

Pharmacy Order Management System

Software

Glucometer + processor = computer that can run apps; e.g., bolus calculator, calorie estimator and tracker.

When a glucometer connects to a smart-phone, cost can come down, because the meter can build on the phone's processor and display. Plus data can be shared with family and HCPs.

A near continuous glucose monitor can be coupled with an insulin pump, forming a glucose management system.

The glucose management system can connect with many other systems, such as EMRs, remote alerting, patient population management, drug interaction monitoring, pharmacy order management, and billing.

Unified patient and device data will afford useful views to many constituents.

Devices

Cloud

Patient

Web + mobile

My Record

Patient view
- My Record
- Messages
- Appointments
- Billing
- Support

Integrated databases

Patient ID#

Patient ID#

Patient ID#

All Patient Data

Company views

HCPs
Individual view

Bio-med engineers
Individual view

Researchers
Individual view

Designers
Aggregate view

Patients can know much more about what's happening and can share information with family, friends, and HCPs.

Benefit = better experience
- Clearer picture of health status
- Alerts on possible problems
- Personalized communications
- Record of appointments

Devices

Cloud

Patient

Web + mobile

My Record

Patient view
- My Record
- Messages
- Appointments
- Billing
- Support

Integrated databases

Patient ID#

Patient ID#

Patient ID#

All Patient Data

Company views

HCPs
Individual view

Bio-med engineers
Individual view

Researchers
Individual view

Designers
Aggregate view

HCPs can receive a more holistic view of each patient and can manage groups of patients more efficiently.

Devices

Cloud

Benefit = higher patient sat

Patient ID#

HCPs
Individual view

Patient

Web + mobile

Patient view
- My Record
- Messages
- Appointments
- Billing
- Support

My Record

Integrated databases

Patient ID#

Bio-med engineers
Individual view

Patient ID#

Researchers
Individual view

All Patient Data

Company views

Designers
Aggregate view
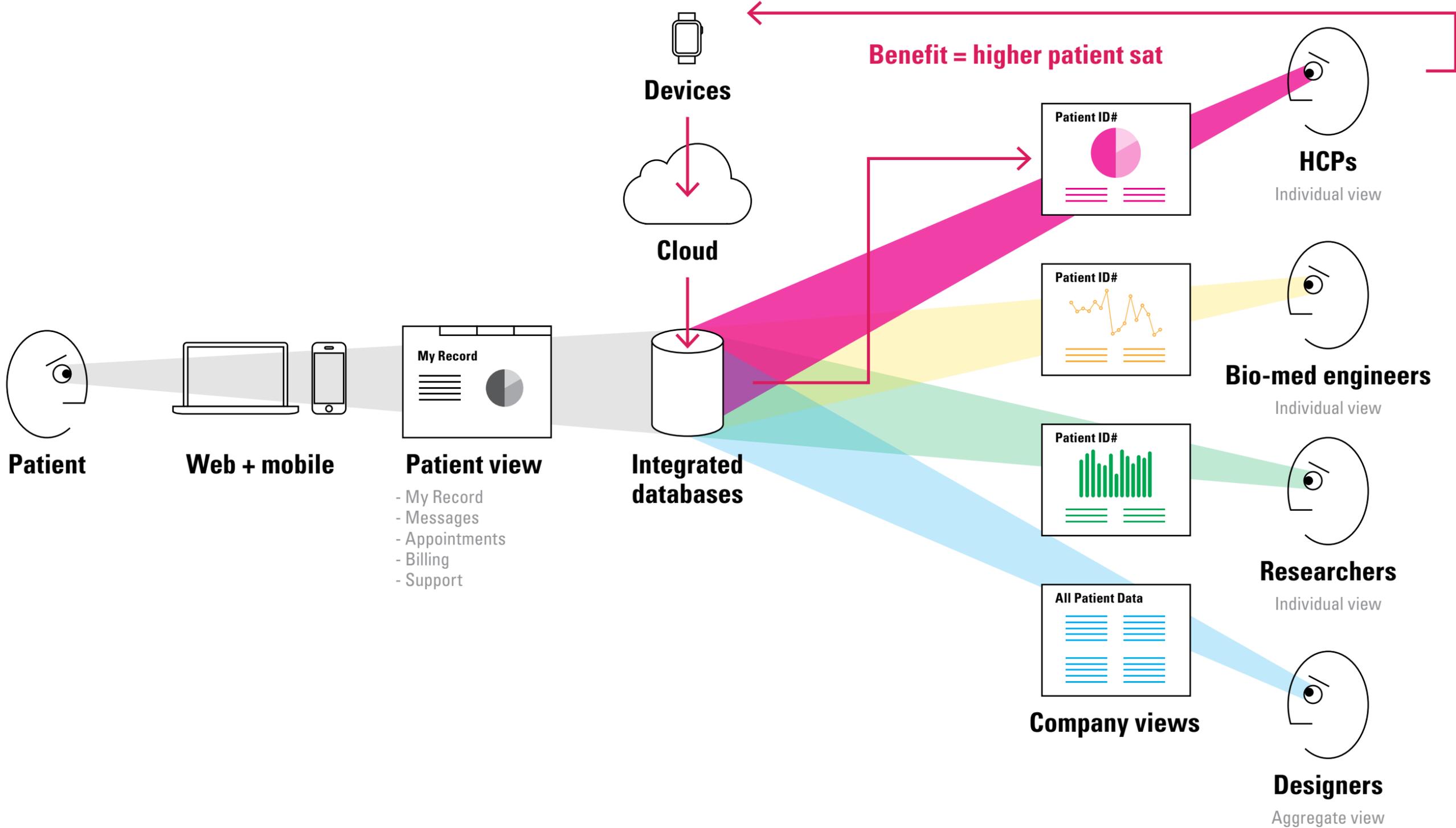
Bio-med engineers can better manage equipment, improve service, and reduce support costs.

Benefit = lower costs

Devices

Cloud

Patient

Web + mobile

Patient view
- My Record
- Messages
- Appointments
- Billing
- Support

Integrated databases

Patient ID#

HCPs
Individual view

Patient ID#

Bio-med engineers
Individual view

Patient ID#

Researchers
Individual view

All Patient Data

Company views

Designers
Aggregate view
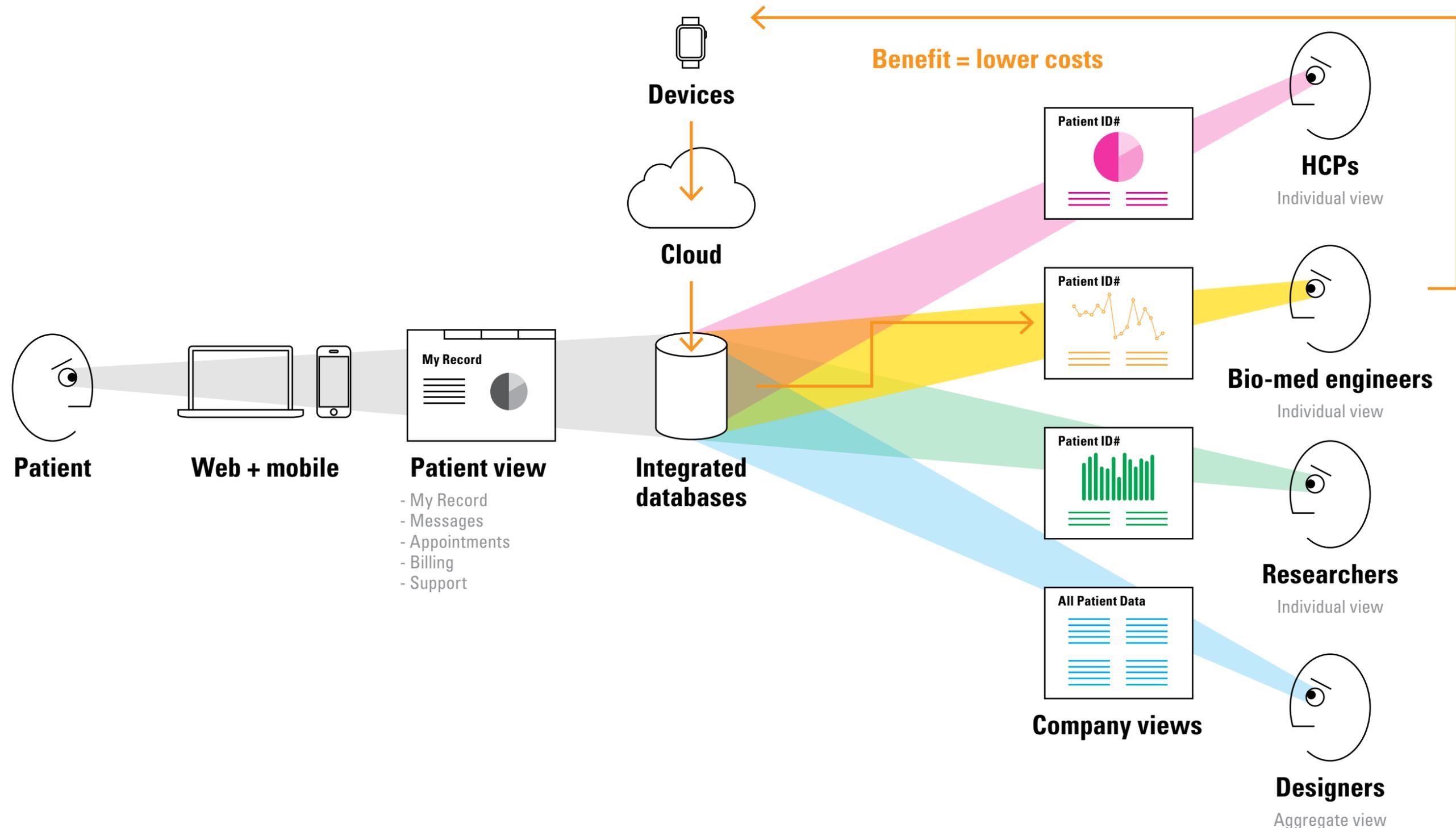
Researchers can learn from aggregate data, to improve procedures and care-facility operations.

Devices

Cloud

Benefit = more efficient ops

Patient

Web + mobile

Patient view
- My Record
- Messages
- Appointments
- Billing
- Support

My Record

Integrated databases

Patient ID#

Patient ID#

Patient ID#

All Patient Data

Company views

HCPs
Individual view

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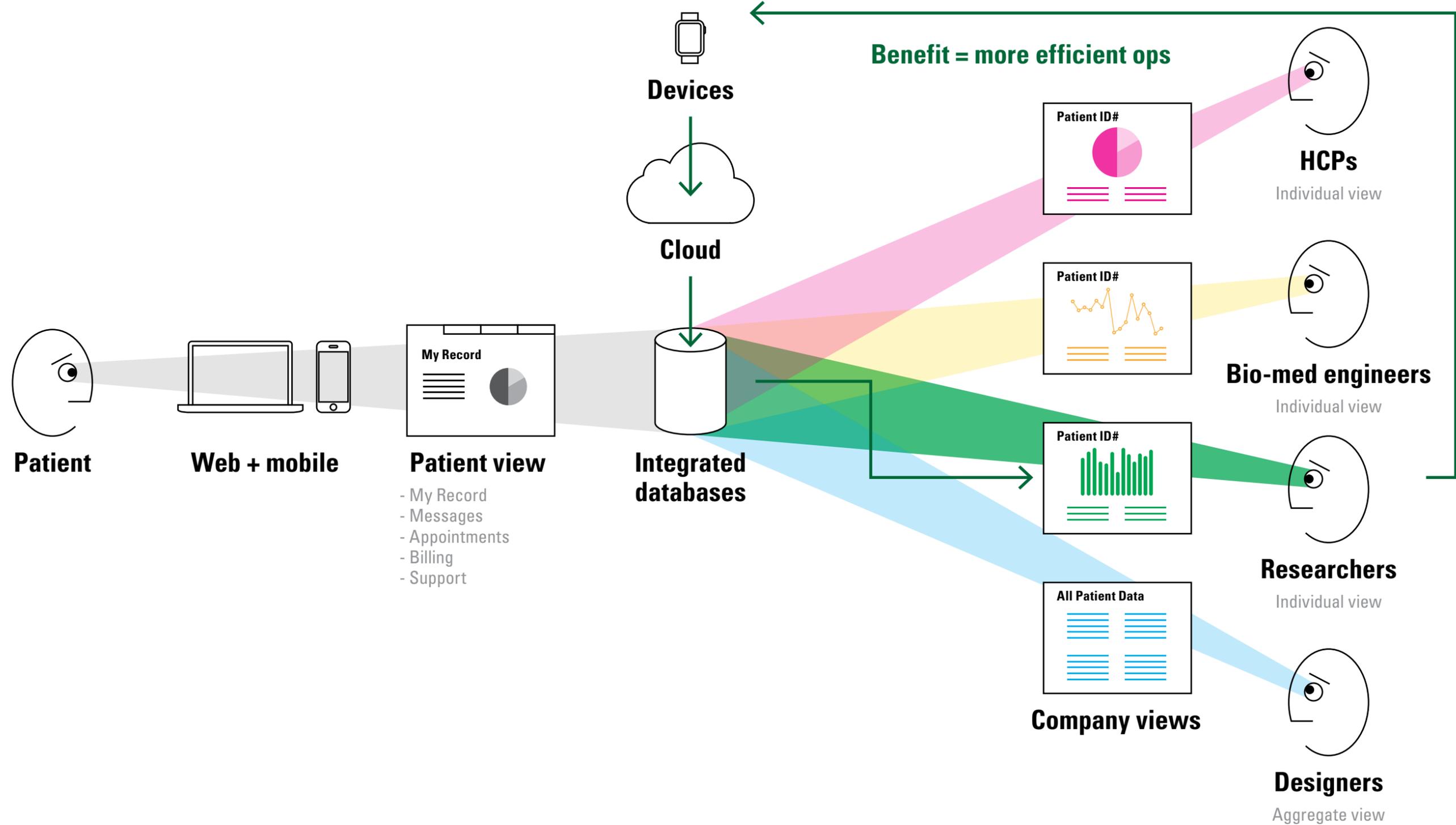
Designers can get detailed usage data, to improve next generation products.

Benefit = improved next gen products

Devices

Cloud

Patient

Web + mobile

Patient view
- My Record
- Messages
- Appointments
- Billing
- Support

My Record

Integrated databases

Patient ID#

Patient ID#

Patient ID#

All Patient Data

Company views

HCPs
Individual view

Bio-med engineers
Individual view

Researchers
Individual view

Designers
Aggregate view

Additional implications of IoT for designers:

- **Form still matters**—it's necessary but no longer sufficient
- **Systems thinking is more important than ever**—
providing a holistic view, understanding how all the parts fit together
- **Software is an integral part of the product experience**—
designers must work closely with coders
- **Product conceptual structures are much more complex**—
designers have a role in defining them
- **The future is platforms**—creating systems in which others can create
- **Huge potential and reach**— there will simply be more things to design

"*If you went to bed last night thinking you're an* industrial company, *you're going to wake up this morning as a* software and analytics company."

— Jeff Immelt, Chairman and CEO, General Electric

Special thanks to

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Ryan Reposar

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Presentation posted at
http://presentations.dubberly.com/IDSA_health.pdf