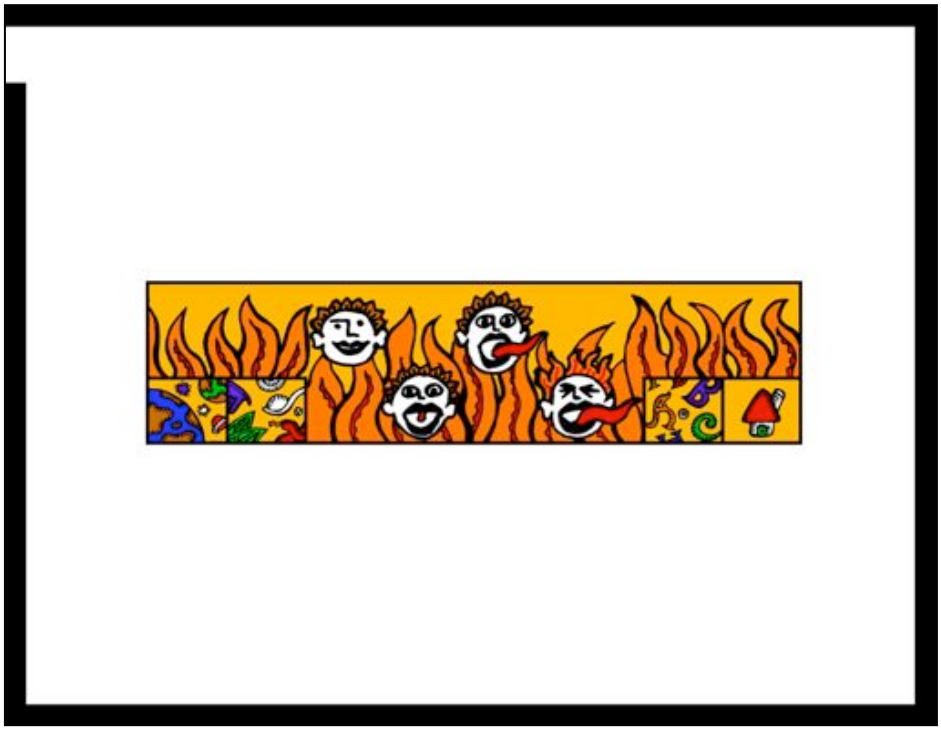
DESIGNING SMART THINGS

USER EXPERIENCE DESIGN FOR NETWORKED DEVICES

Mike Kuniavsky
UX-LX
Lisbon
May, 2012

SCHEDULE FOR TODAY

- 15:00-16:00 Theory!
  - History/Background
  - Ubicomp UX and trends
  - Service Avatars
  - Product Service Systems
- 16:00-16:30 Q&A and Discussion
- 16:30-17:00 BREAK!
- 17-18:30PM Practice!



First, let me tell you a bit about my background. I’m a user experience designer. I was one of the first professional Web designers in 1993, where I was lucky enough to be present for the birth of such things as the online shopping cart and the search engine. This is the navigation for a hot sauce shopping site I designed in 1994.

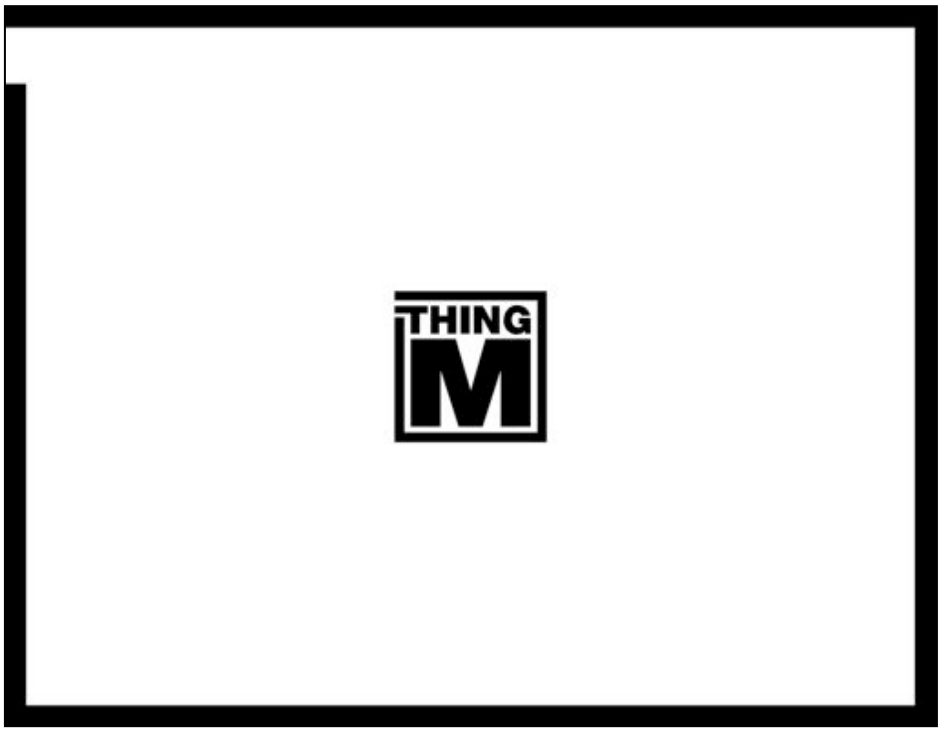
I'm proud of the fact that 16 years later they were still using the same visual identity. These were some of the oldest pixels on the Web.

Here's one of my UI designs for the advanced search for HotBot, an early search engine, from 1997. If you're wondering why Google's front page is no minimal, I think it was because we were doing this.

Since then I've consulted on the user experience design of dozens, maybe hundreds of web sites. Here's one for credit.com, who were fantastic clients a couple of years ago.

I sat out the first dotcom crash writing a book based on the work I had been doing. It's a cookbook of user research methods. It came out in 2003 and the second edition [CLICK] will come out this fall.

And 2001 I co-founded a design and consulting company called Adaptive Path.



I left the Web behind in 2004 and founded a company with Tod E. Kurt called ThingM in 2006.

ThingM is a micro-OEM and an R&D lab. We design and manufacture a range of smart LEDs for architects, industrial designers and hackers. Our products appear on everything from flying robots to Lady Gaga's stage show. This is an RFID wine rack that we did about four years ago. The different light colors represent different facets of information that's pulled down from a cloud-based service, such as current market price. This is a capacitive sensing kitchen cabinet knob we did two years ago. It glows when you touch it to creates a little bit of magic in your everyday environment and was an exploration in making a digital product that would still be useful 20 years after it was made.

In 2010 I wrote a book on the user experience design of ubiquitous computing devices, which I define as things that do information processing and networking, but are not experienced as general purpose computing or communication devices.

However, ThingM and books are primarily side projects. My primary day job is as an innovation and user experience design consultant focusing on the design of digital consumer products. Here are some I've worked on for Yamaha, Whirlpool, sifteo.

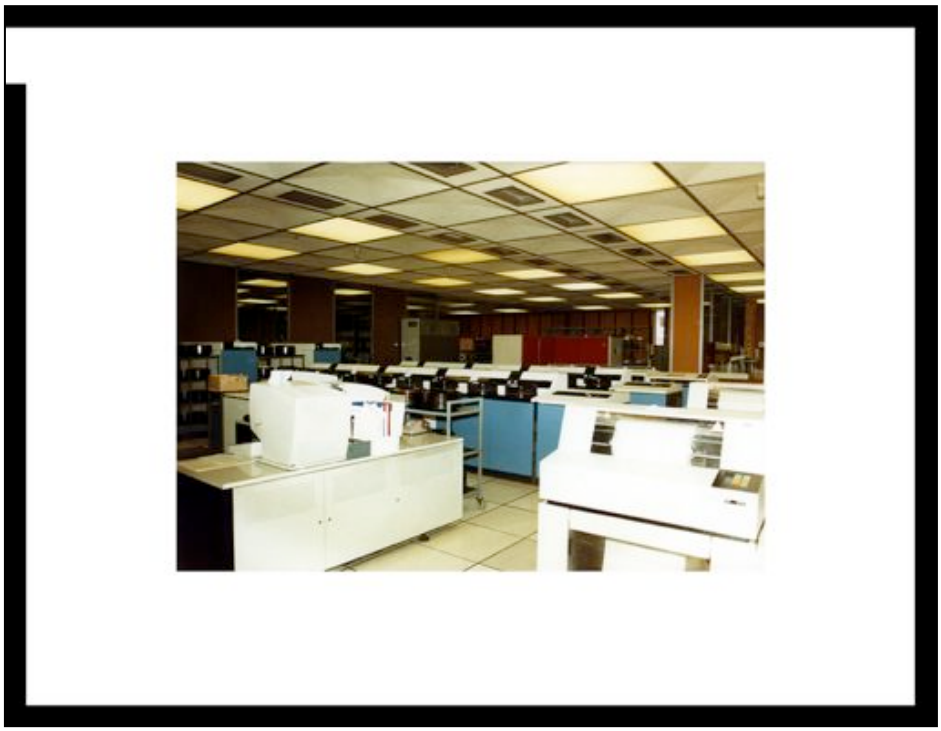
The last couple of years my clients have been large consumer electronics companies and my focus has been on creating experiences that span multiple devices. I can’t give you any details.

This is a workshop on user experience design for networked devices, and I mean that in the broadest sense. My focus is not just on designing apps for tablets connected TVs Uis, but the challenges and possibilities when any device becomes connected. This means rethinking the possibilities of many things from the ground up.

That, of course, can't be covered in a single workshop.

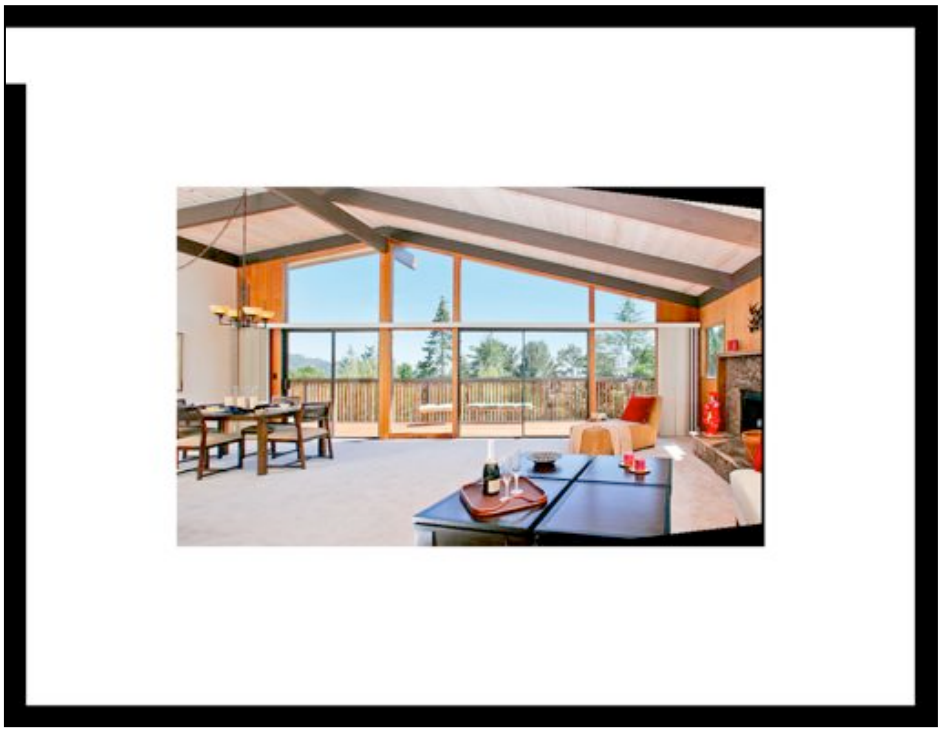
What I'm going going to do today is give you a feel for how design of connected objects is different than the user experience design of familiar digital experiences, and to give you some concepts and tools that may help you with that. We will focus less on specific techniques than on thinking about how to deploy concepts and critically to ask questions about these sorts of projects so that you can be a better judge of your own designs and the designs of others.

First, I'd like to set some foundational definitions, and that starts with what it is that we're talking about here. I define all digital connected device design as part of the same larger trend that was identified and named by the late Mark Weiser, then the CTO of Xerox PARC.



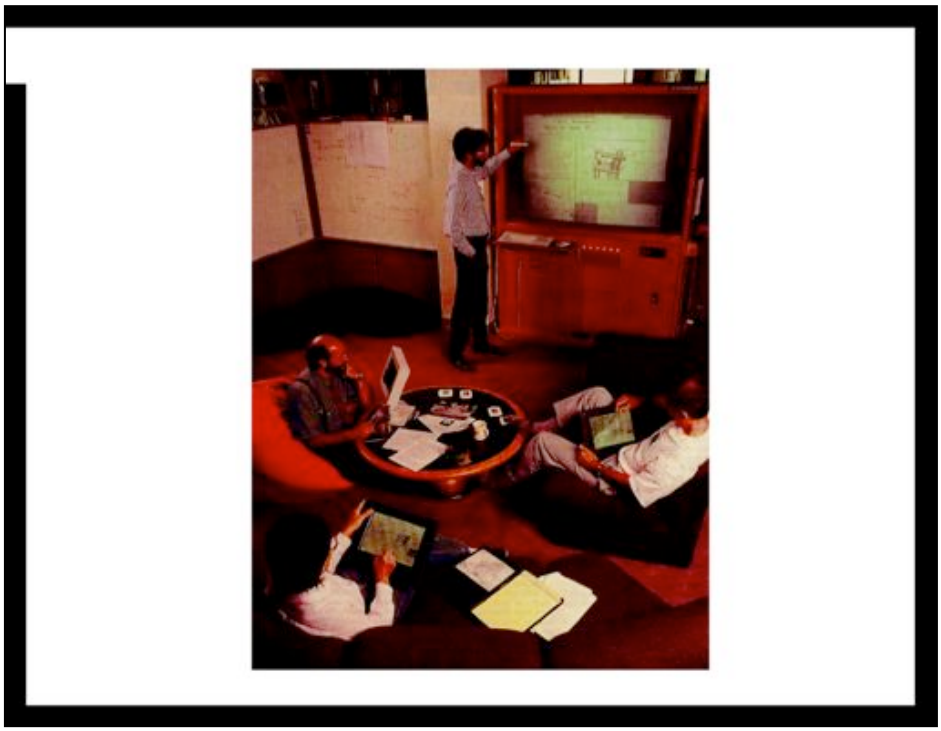
In the late 80s he envisioned a world that didn't have one big general purpose computer per household, but many computers distributed throughout the environment. He called this trend "ubiquitous computing," or "ubicomp." And he predicted that it wouldn't look like this…

Photo CC by Richard Pluck, found on Flickr.



But like this. In his words, computers would be woven "into the fabric of everyday life until they are indistinguishable from it."

Photo: CC Mark Lacoste, original: http://www.flickr.com/photos/croco/914189024/



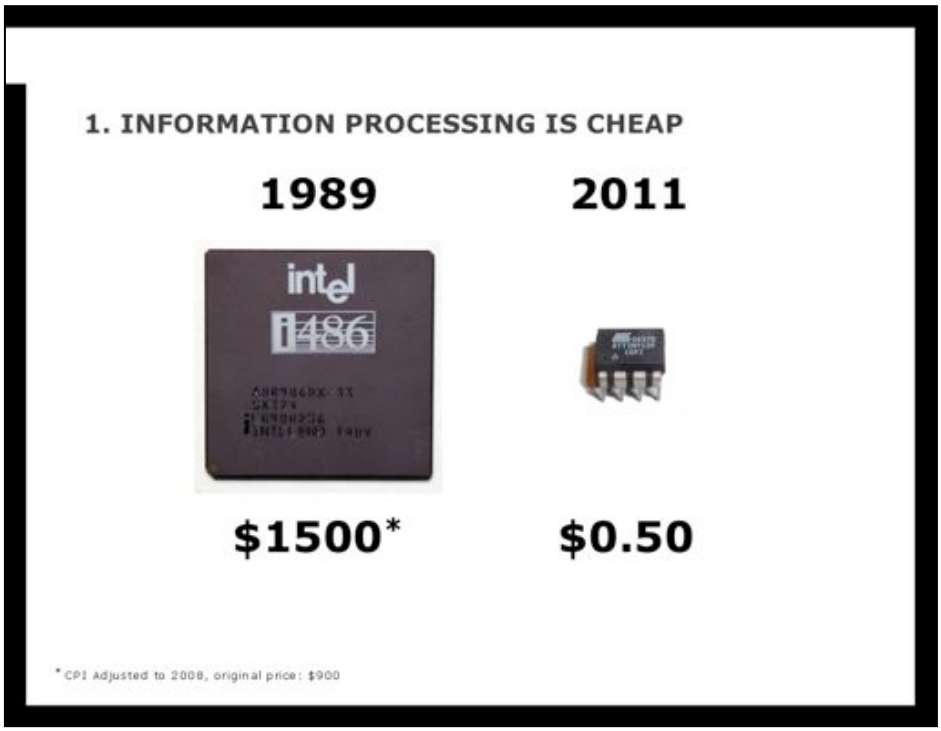
We're basically in the world that PARC predicted in the early 90s—this is from 1990—though of course there are fundamental differences.

As electronics consumers we're most clearly experiencing this as a proliferation of device form factors. Our general purpose computers now come in many shapes and sizes.

But more importantly, our relationship to the environment is fundamentally changing through embedded networked technology throughout our everyday environment. This looks like a typical San Francisco parking meter, but it's actually part of an extensive network of overlapping services.

San Francisco hired a company that connects parking meters to sensors in the pavement that look like speed bumps but actually identify which parking spaces have cars in them. This allows the city to know which spaces are open when so that they can write tickets more efficiently and change the price of parking based on demand. It also allows parkers to get a real time map of where there are open parking spaces. This isn't some research project, it's an actual system that's installed in San Francisco.

Now how did we get here? I believe that this is happening because of an intersection of three trends.



I want to start by talking about Moore's Law, since that's where all conversations about the implication of digital technology start. When people talk about Moore's Law, it's often in the context of maximum processing power. But it's actually something different. It's actually a description of the cost of processing power. It's a model of how much more processing power we can fit into a single chip that's priced at a predictable pricing point this year than we could last year. This means that it's not just that processors are getting more powerful, it's that PROCESSING is getting cheaper.

For example, at the beginning of the Internet era we had the 486 as the state of the art and it cost $1500 in today' s dollars. It' s the processor that the Web was built for and with. Today, you can buy that same amount of processing power for 50 cents. The decrease in price is the same orders of magnitude drop as the increase in speed.

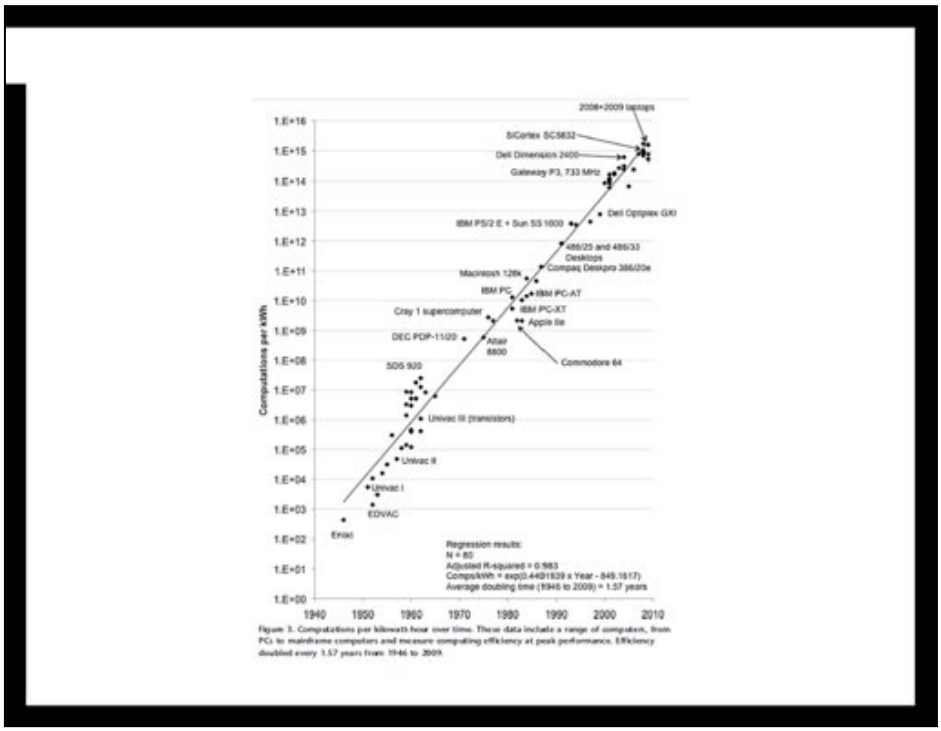
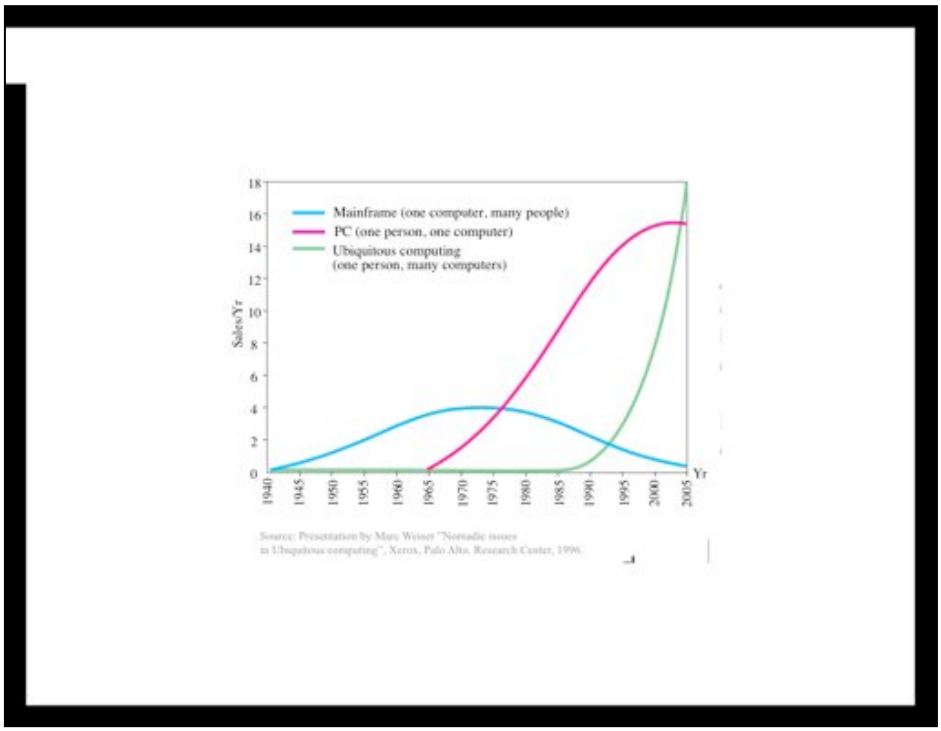


Figure 3. Computations per kilowatt-hour over time. These data include a range of computers, from PCs to mainframe computers and measure computing efficiency at peak performance. Efficiency doubled every 1.57 years from 1946 to 2009.

Moreover, as processing technology evolves, it gets more efficient. This is called Koomey's Law, named after an Intel scientist who figured out that, over time, the amount of energy you need to do processing goes down proportionately to Moore's Law.

What this means in practice is that embedding powerful information processing technology into anything is quickly approaching becoming very cheap from a material and energy.

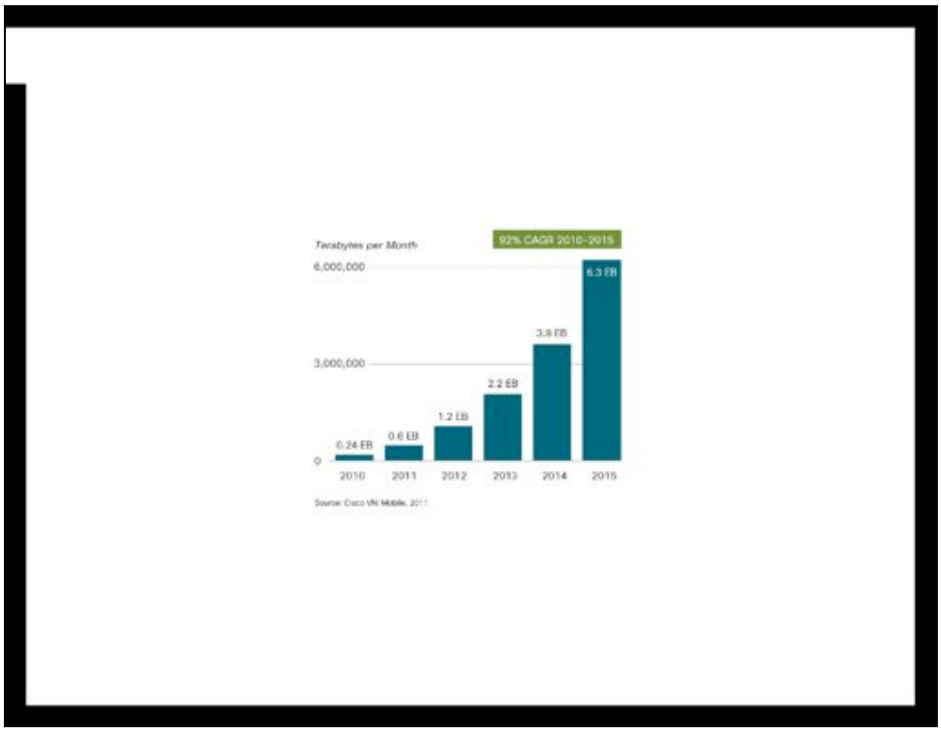


This, in turn, is driving designers and manufacturers to experiment by putting into all kinds of cheap things to create a competitive advantage. And THAT is what is driving the move to ubiquitous computing/ubicomp/whatever you want to call it.

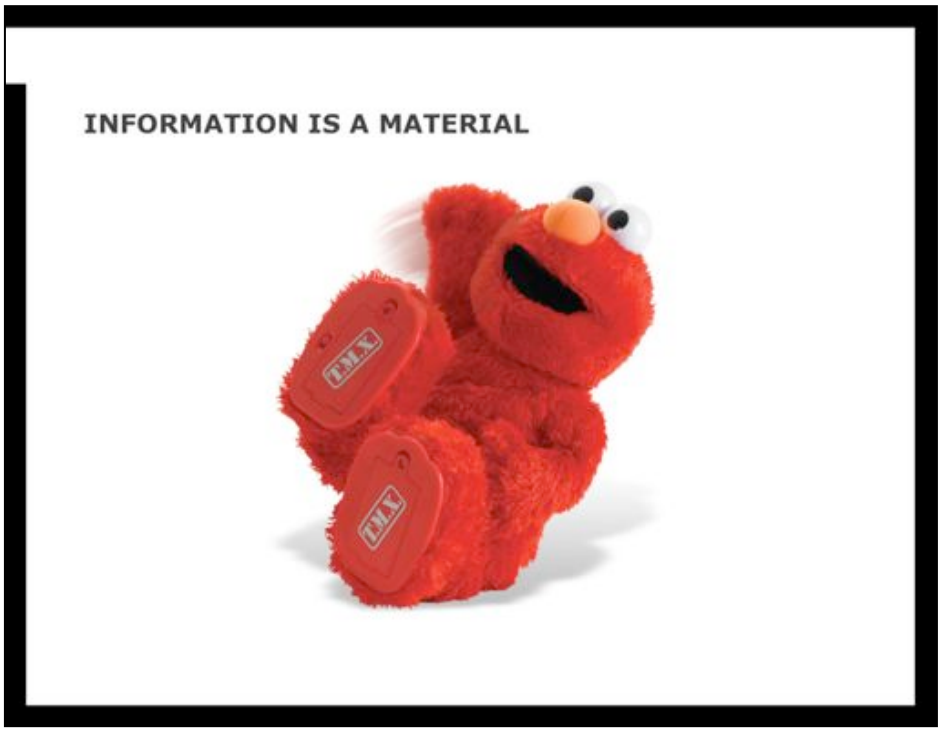
Here's Mark Weiser's diagram showing the shift from mainframes to ubiquitous computing from 15 years ago. He missed cloud services, so this isn't technically true, but it's generally a good model to think about how our world is changing because of all of the inexpensive applications for processing.

This says that information processing used to be expensive and was limited to expensive, general purpose devices, but now it is cheap and can be used in all kinds of specialized devices.

The other dominant trend right now is of course pervasive data communication. This is an image from Timo Arnall that envisions how saturated our environment is with networks, and it's not even counting the mobile phone network. This means that virtually any device, anywhere can share data with the cloud at any time. People right now are excited about moving processing and data storage to the cloud and treating devices as terminals. That's certainly interesting, but it's also just the tip of the iceberg.

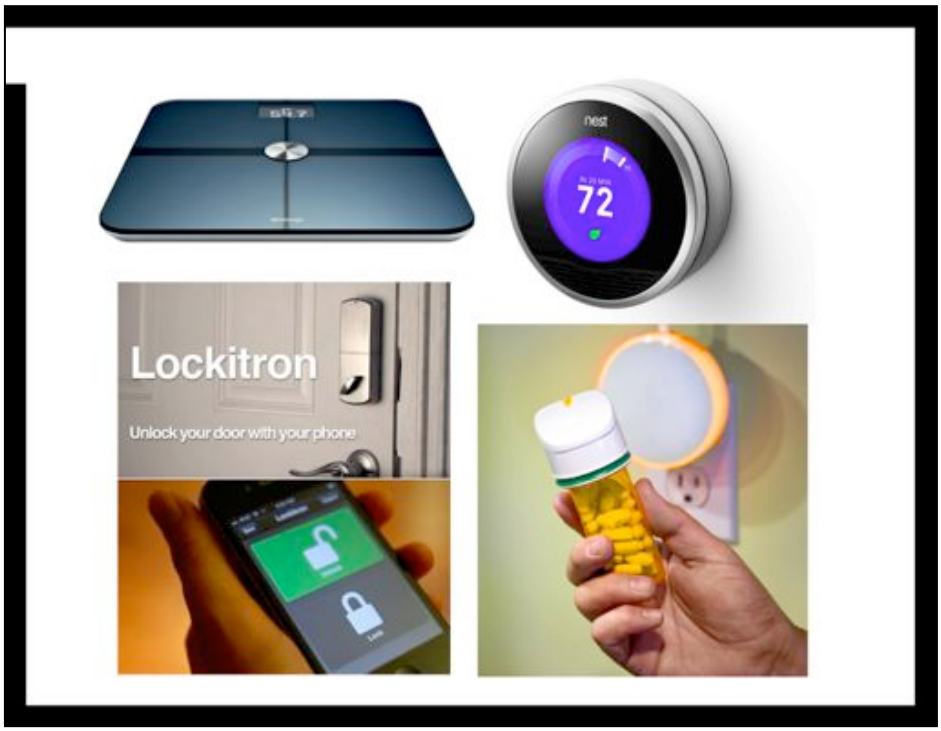


Here's what Cisco estimates the trend of wireless data traffic is going to look like. The baseline here is last year. For comparison, to represent the amount of data for 2008 you need a line that's 1/8th as thick as that small line on the left and 2006 was 1/24th as thick. You get the idea. Wireless data has gotten pervasive and, judging by this level of adoption, very cheap.



It is no longer unthinkable to have an everyday object use an embedded processor to take a small piece of information—say the temperature, or the orientation of a device, or your meeting schedule—and autonomously act on it to help the device do its job better. Information processing is now part of the set of options we can practically consider when designing just about any object.

In other words, information is quickly becoming a material to design with.



The Internet of Things is the result of designers, developers and entrepreneurs treating information as a material when rethinking everyday objects such as bathroom scales, thermometers, locks and pill bottles.

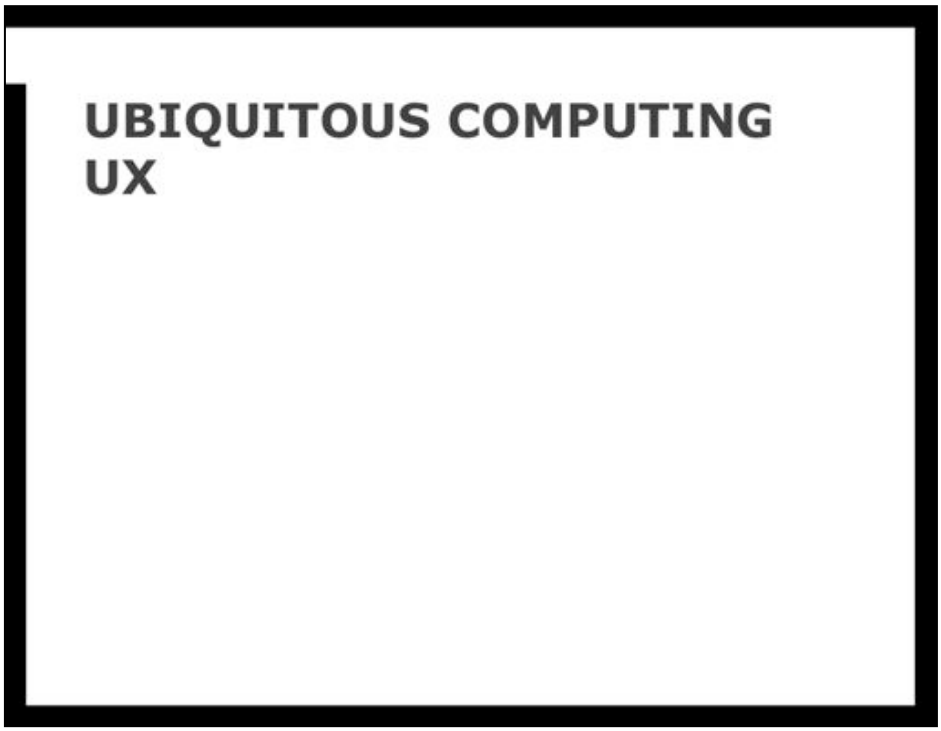
This capability of everyday objects to make autonomous decisions and act using arbitrary information is as deep an infrastructural change in our world as electrification, steam power, and mechanical printing. Maybe it's as big of a deal as bricks. Seriously, it's a huge change in how the world works, and we're just at the beginning of it.

SUMMARY

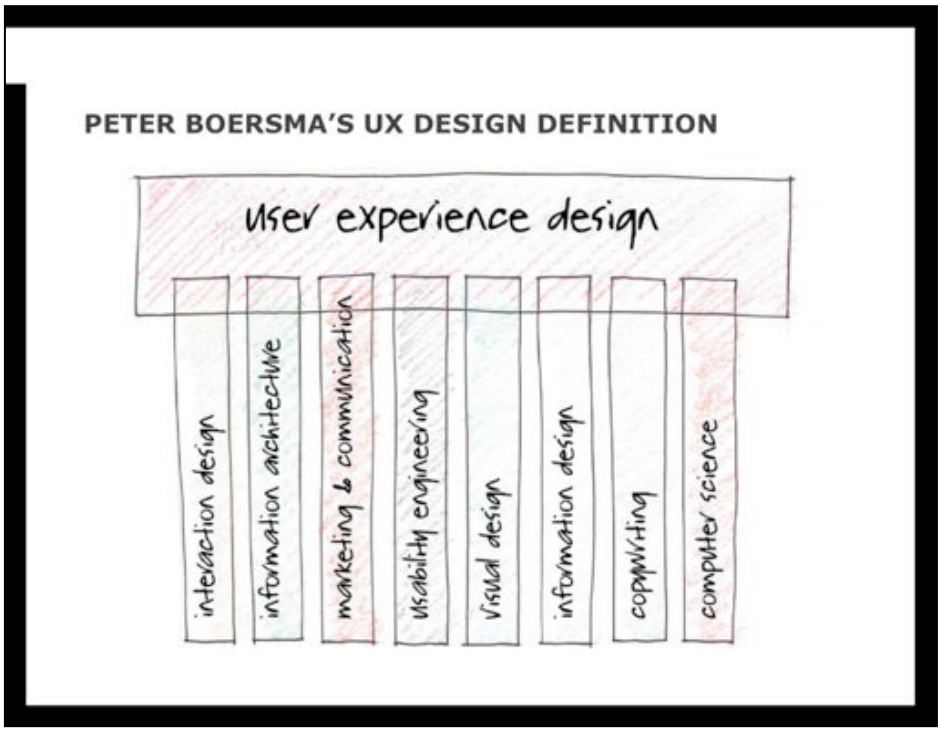
- Mark Weiser coined the term "ubiquitous computing" (ubicomp) in the late 1980s to describe a world where one person uses many computers simultaneously. This phenomenon has other names—pervasive computing, ambient intelligence, the Internet of Things, etc.—but it's all the same thing.
- As a result of:
  - Cheap, low power processing
  - Cheap, pervasive networking

  It's now cost-effective to embed information processing and connections to networked services to create competitive advantage.
- In effect treating information as a material to design with.
- Which fundamentally changes our relationship to the designed environment.

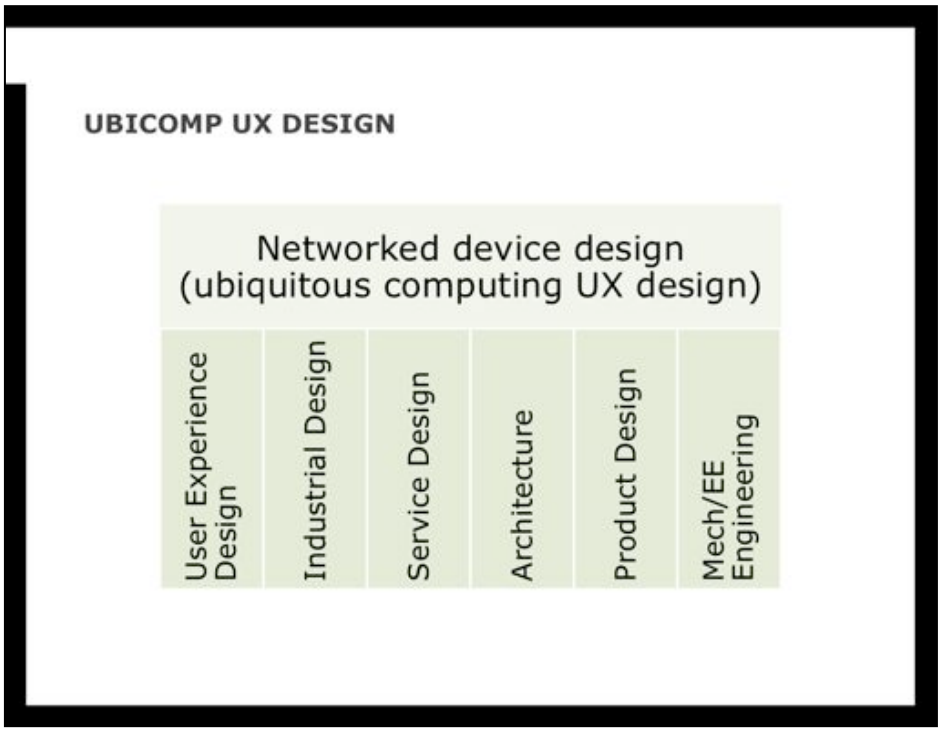

Q&A



Now what does this mean for the user experience design of such devices.



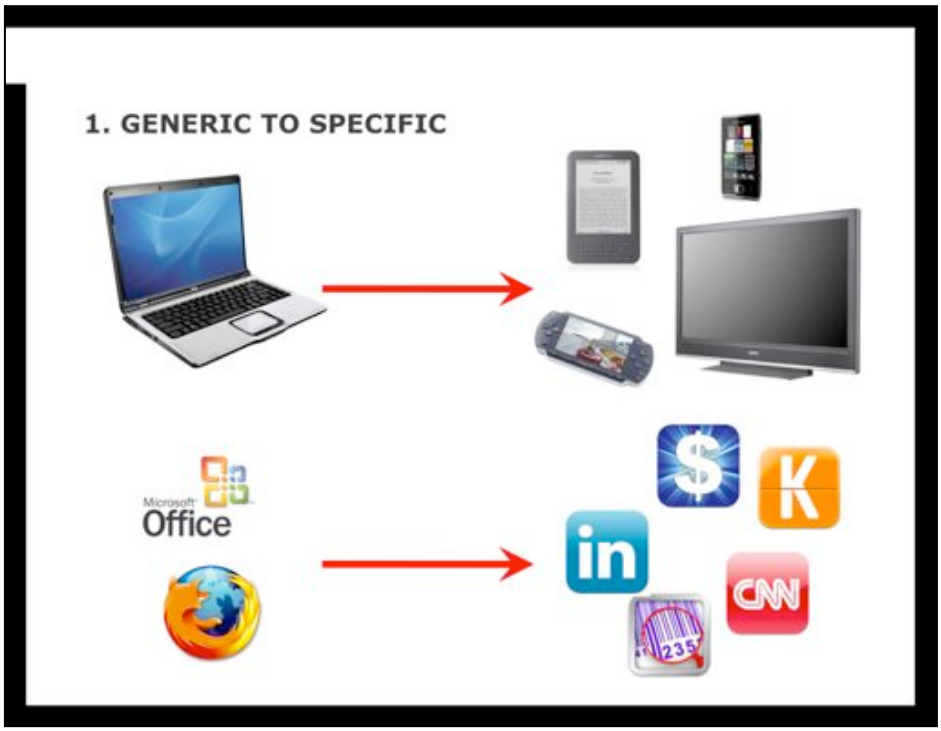
First, let me define user experience as it relates to ubicomp. In 2004 Peter Boersma defined user experience design as a combination of these eight disciplines: Interaction design, Information Architecture, marcomm, usability engineering, visual design, information design, copywriting and CS. This is an accurate description of screen-based experience design.



Because ubiquitous computing can no longer assume a generic computer platform, we have to ad several disciplines. In addition to all of the things Peter mentioned in 2004, there are now considerations of the physical design of devices, what services they connect to, how they operate in space, how they're created as marketable products, and what the technical capabilities of the specific technologies involved.

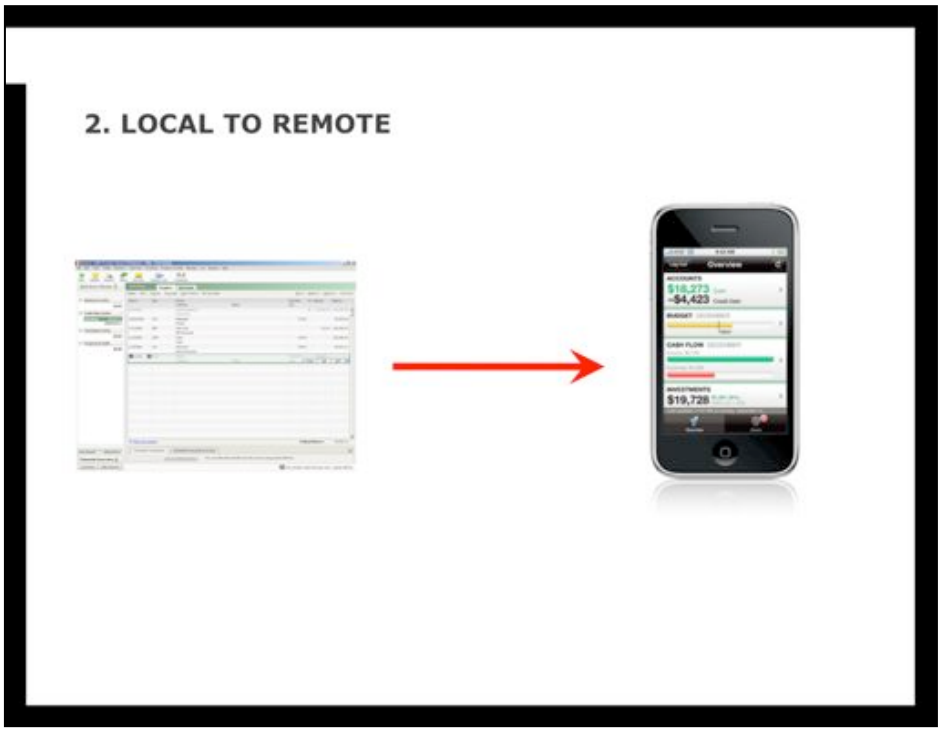
This makes it a really exciting and challenging multidisciplinary field to work in. And just as in traditional screen-based UX you didn't have to know everything about server configuration and identity design, but needed to know that there are people with those skills who you'd need to interact with at some point, so you'll need to know that there are industrial designers and mechanical engineers that may be involved in making decisions about the final experience.

Before I dive into specific techniques, there are some things that I deeply affect the user experience of networked objects.



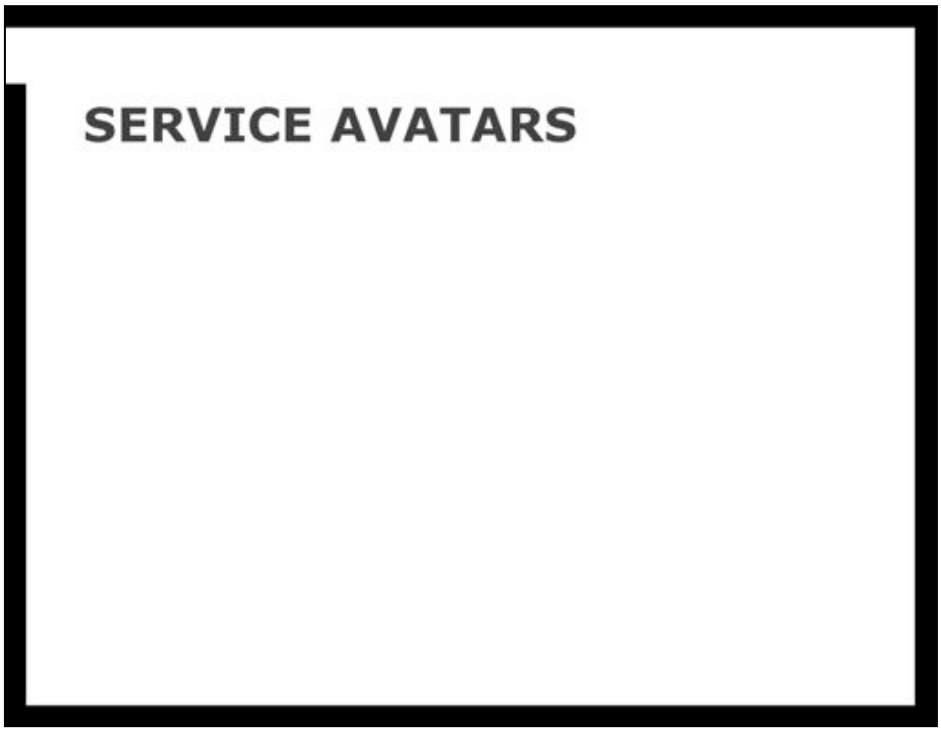
The first is a shift from generic devices and software to specialized devices and software. Cheap processing and cloud-based services mean that devices and applications can have a high degree of specialization. Your tool is now a tool BOX, a combination of 10, 20, or 30 computing devices that you acquire as needed, and often the thing you buy is a subscription that gives you access to services.

The use of these apps and devices much more direct. You pick up a Kindle, you know what it's for. You launch the CNN app and you know what content to expect there. However, it now creates a burden of deciding WHAT to put in your toolbox and finding it when it's there, and in terms of divergent user experiences since there's no consistent experience being enforced by a single application or operating system.



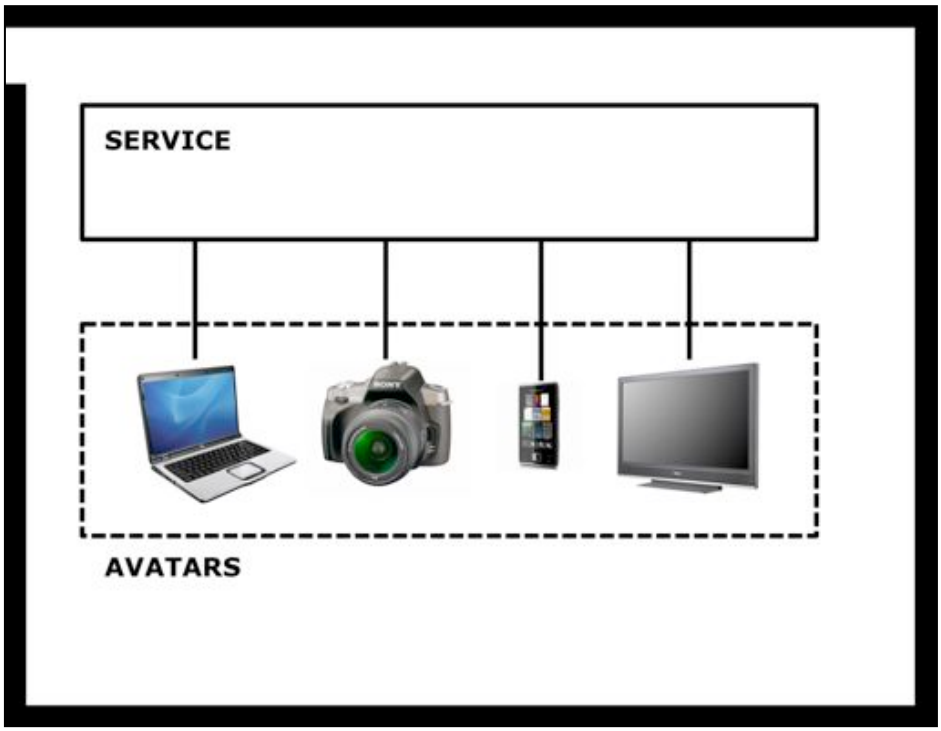
To this we add the effect of widely networked devices, which is to move value away from the local environment to a remote one.

The lasting legacy of the Web is that we have a shift in people's perception of the value digital technology from being primarily local to being primarily remote. The Web demonstrated that moving functionality online enables access to more compute power, continuous updates, real-time usage analytics, and (of course) social connections. It also created a shift in people's expectations. Today, most people understand that the experience you see on one device is often a part of something that's distributed throughout the world. There's no longer a need to pack everything into a single piece of software, and there's no expectation that everything will be there.



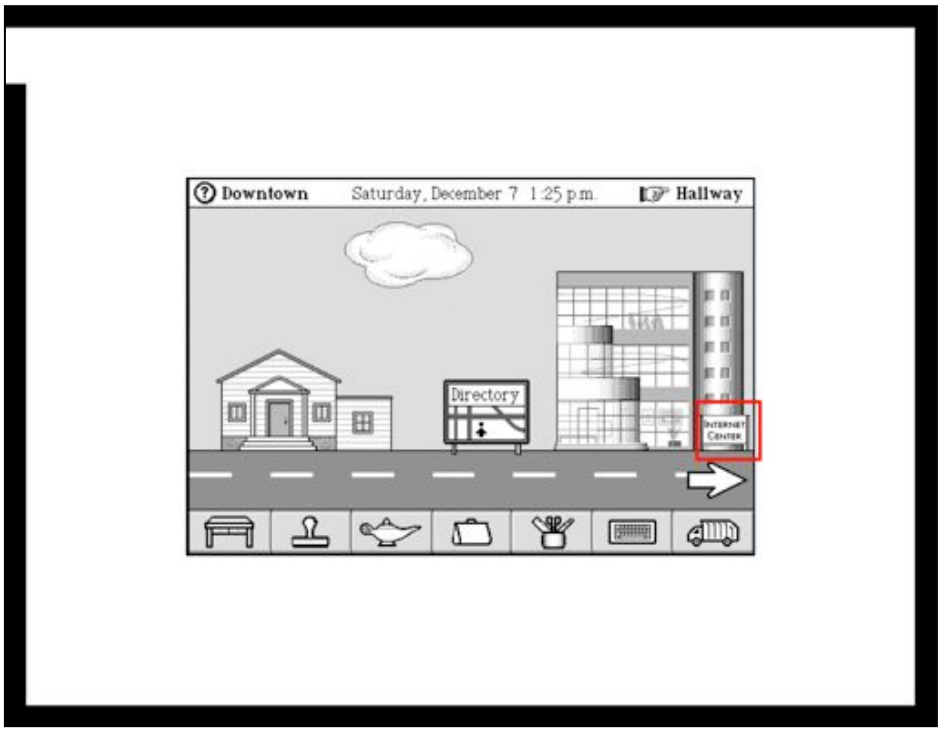
What these two trends mean is that services unify user experiences, not applications or operating systems or form factors. Internet-based services create consistent experiences across devices and use contexts and that means all the value lies with the service.

The value of an experience has moved from what the local device does, to how it enables access to cloud-based services. Devices, applications and websites have become secondary, each only only exists as a means to deliver a service to a specific use context.

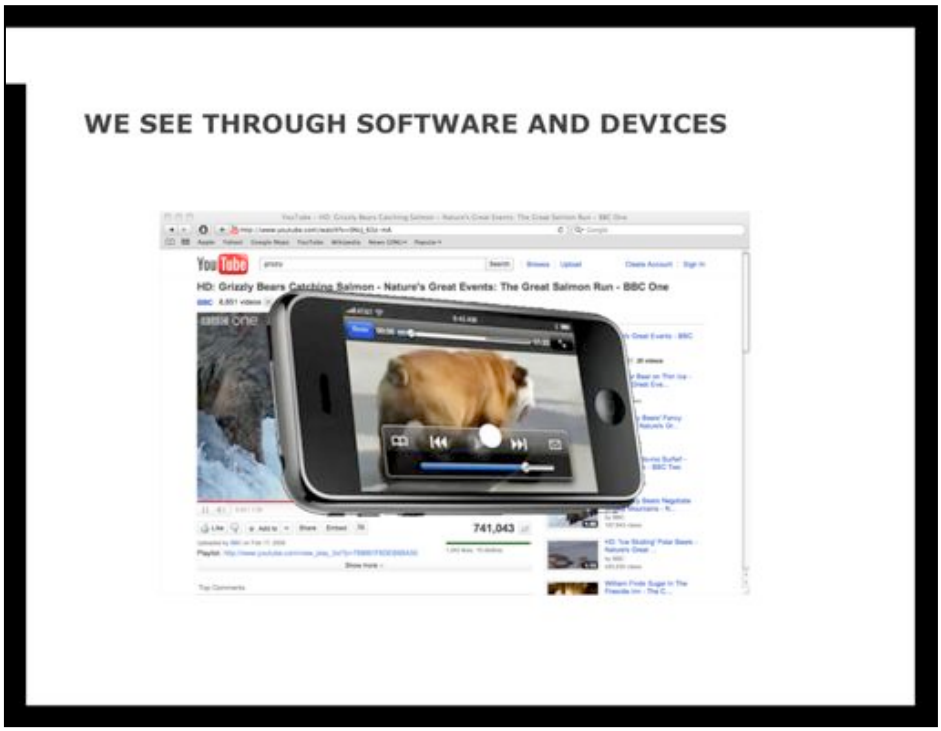


A camera becomes a really good appliance for taking photos for Flickr, while a TV becomes a nice Flickr display that you don't have to log into every time, and a phone becomes a convenient way to take your Flickr pictures on the road.

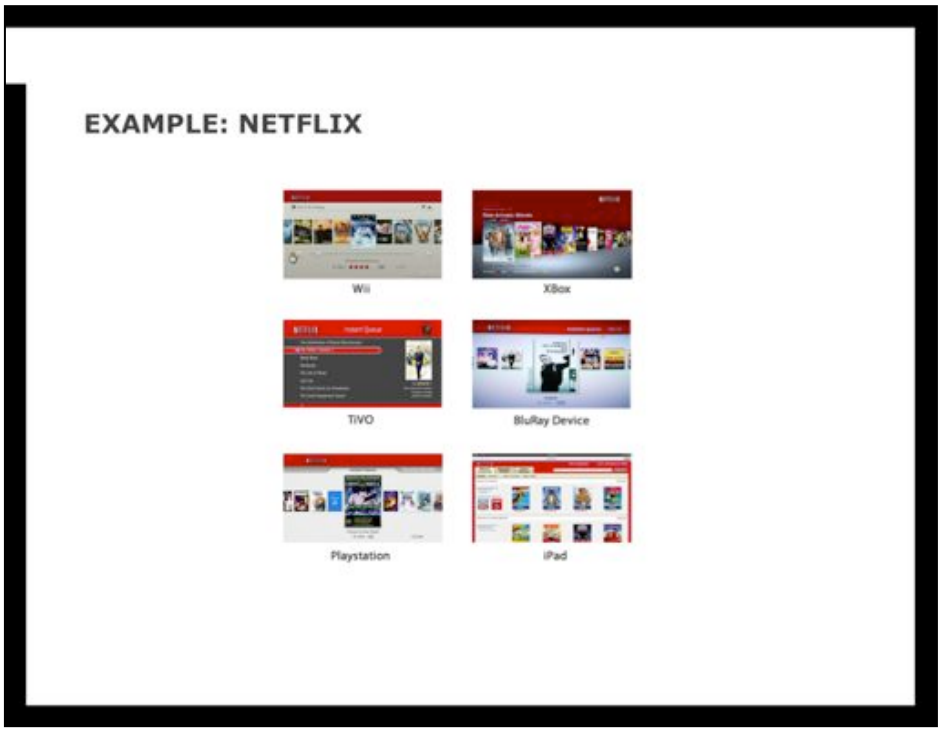
Hardware and apps become simultaneously more specialized and devalued because users see "through" to the services they represents. I call these devices and apps the avatars of the service. They are the local manifestation of something bigger that's in the cloud.



We have stopped thinking of things as being “online” or not online. The Internet is not a special place you go, as in this example from the Magic Cap tablet operating system from 1995, but we have inverted our expectation and assume that the Net is always there and that the value of the experience ALWAYS lies in the cloud and not in the local manifestation.



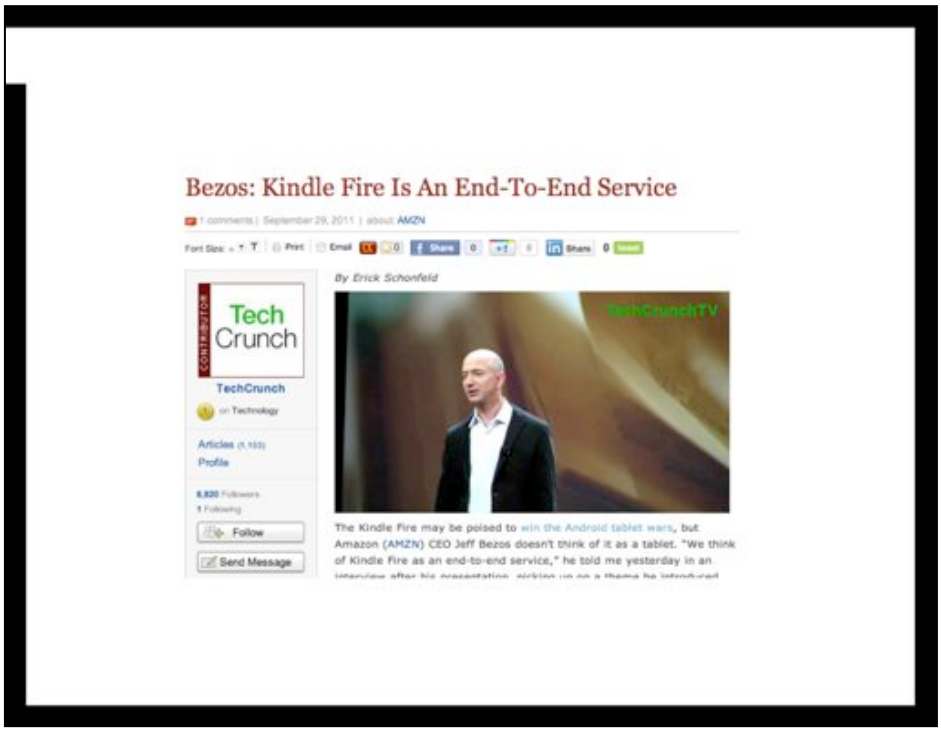
This is a fundamental change in our relationship to both devices and software, since the expectation is now that it' s neither the device nor the software running on it that' s the locus of value, but the service that device and software provide access to. We think of only one YouTube, accessed through many different ways, not many different YouTube apps. If we love YouTube, our loyalty is therefore not to the app or the device that it's running on, but to the features and brand of the service. The user experience is therefore not primarily of the app or the website, but of the service.



Netflix is a great example of this. You can now get Netflix on virtually any terminal that has a screen and a network connection. Because they understand that your relationship is with the service, and not the app, they try to make using the service as transparent as possible. You can pause a Netflix movie on one device and then upause it on another. This seems natural because we have internalized the notion that there are servers that stream content and maintain state regardless of the device being used, but if you think about how that's designed, it's designed from the service outward to all of the players, rather than from the players inward.

To a Netflix customer, any device used to watch a movie on Netflix is just a hole in space to the Netflix service. It's a short-term manifestation of a single service. The value, the brand loyalty, and the focus is on the service, not the frame around it. The technology exists to enable the service, not as an end to itself. The frame has no value.

Another example is the Kindle. Here's a telling ad from Amazon for the Kindle. It's essentially saying "Look, use whatever avatar you want. We don't care, as long you stay loyal to our service. You can buy our specialized device, but you don't have to."



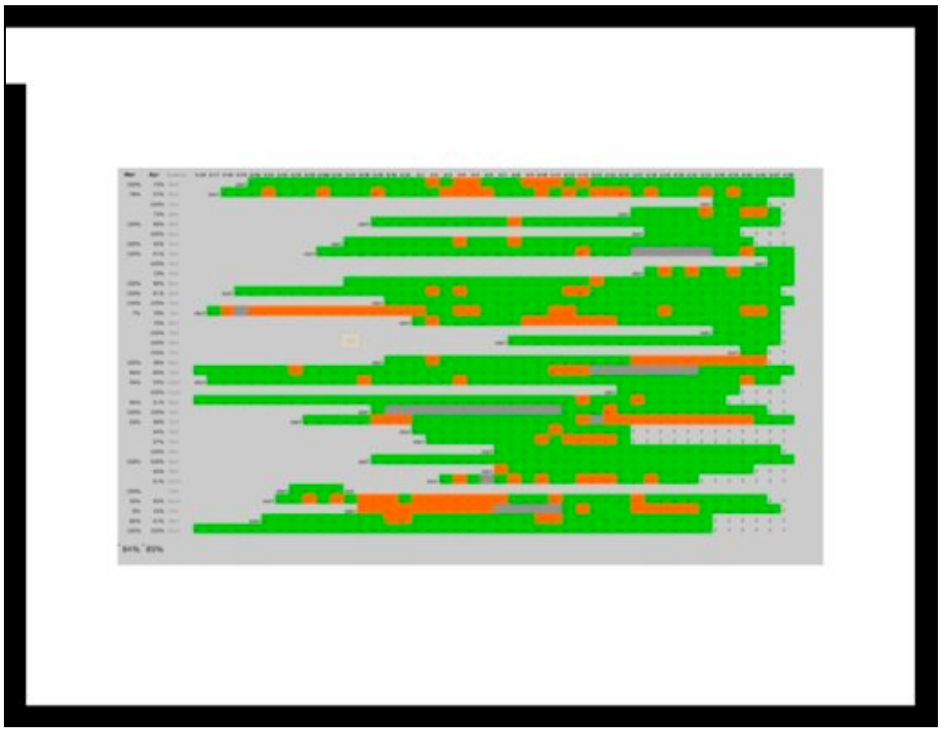
Jeff Bezos is now even referring to it in these terms.

This service-centric way of thinking about technology starts with concrete ways of creating value for people, and then uses every available technology to deliver that value through avatars. Of course some avatars may be particularly advantageous for delivering a service, say a specialized piece of hardware that no one else has, but the avatar is not where the value, impact and profit are.

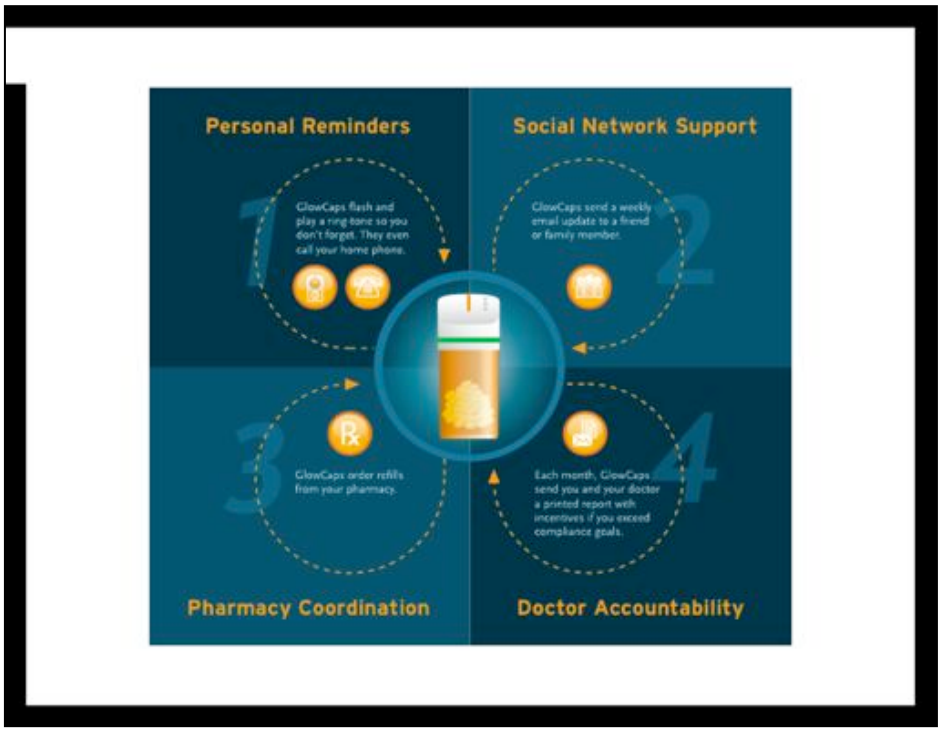
Let me give you another example. This is Vitality's Glowcap, which is a wireless network-connected pill bottle appliance that's an avatar to Vitality's service for increasing compliance to medicine prescriptions. When you close the cap, it sends a packet of information through a mobile phone-based base station to a central server and it starts counting down to when you next need to take your medicine. When it's time, it lights up the LED on the top of the bottle.

However, the real power is in the packet of data it sends. That packet opens a door to the full power of an Internet-based service. Now Vitality can create sophisticated experiences that transcend a single piece of software or a single device.

For example, another avatar of the Vitality service is an online progress report that can be used interactively or delivered by email. It's like Google Analytics for your medicine.

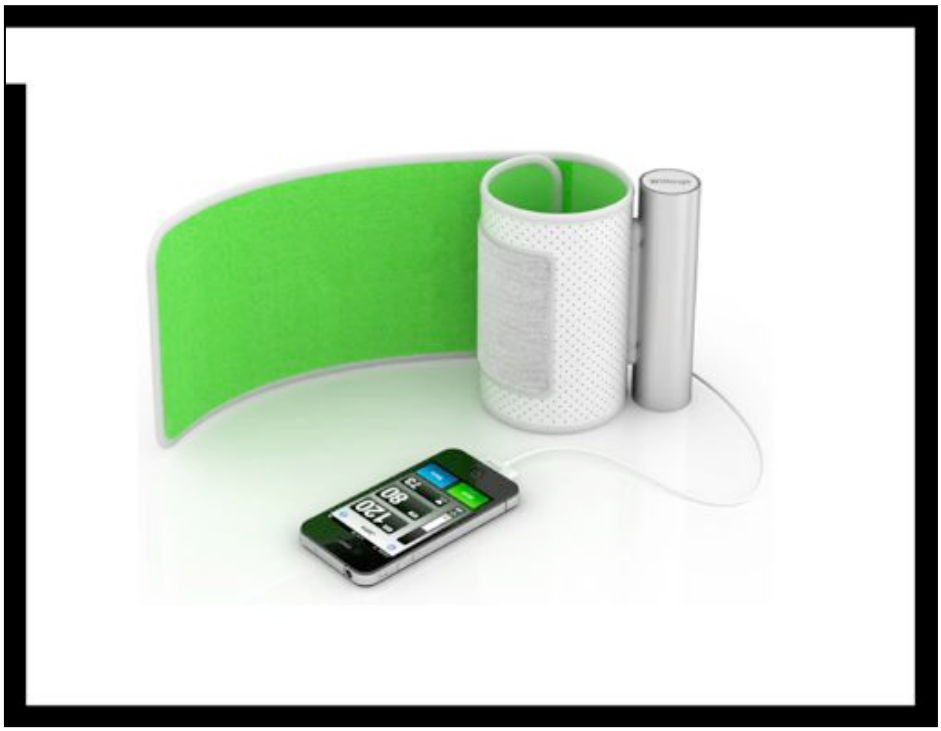


Health care practitioners get yet another avatar that gives them long-term and longitudinal analytics about compliance across medications and time.

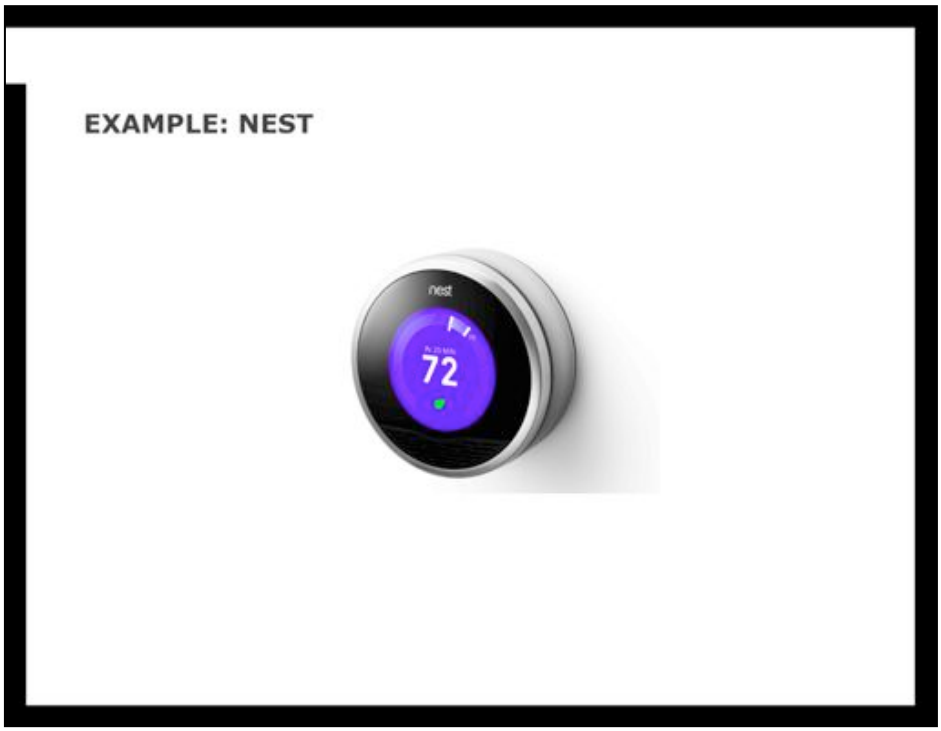


Vitality has developed a complete system around this service that includes a social component, and different avatars for patients, patients families, health care practitioners and pharmacies. Each avatar looks different and has different functionality, but they're perceived, and designed as a single system.

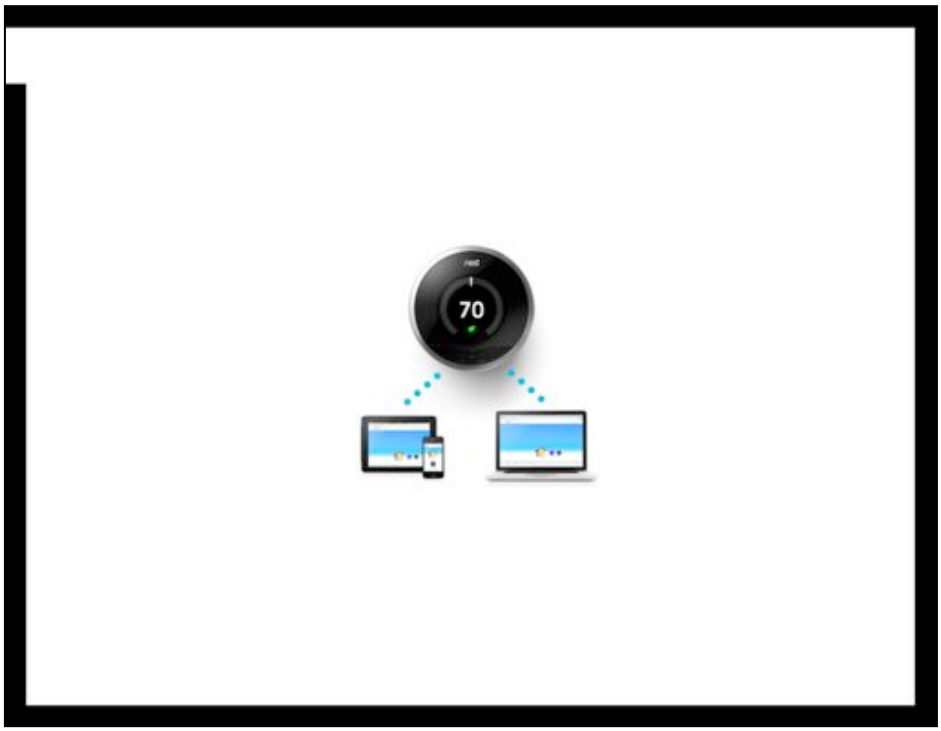
Another example. The first Withings product was an internet connected scale. At first people thought it was a gimmick. “You can tweet your weight to your friends!” was one of the ways it was originally pitched. That’s of course not particularly interesting, but that was not the purpose of the device. The device is an avatar to a health service. The scale is the way the service differentiates itself from other health tracking services, but the value is not in the scale, but in the service, which is fully experienced using other avatars, such as the ones depicted on the right.



Withings has now expanded the service to include a blood pressure cuff. Again, the value is not in the devices, but in the knowledge that they create by collecting simple pieces of information and then providing users with the full power of cloud-based services to make use of that piece of information. Withings can keep adding avatars, new sensors and new ways to display the information the sensors collect, without fundamentally changing the promise of the service.



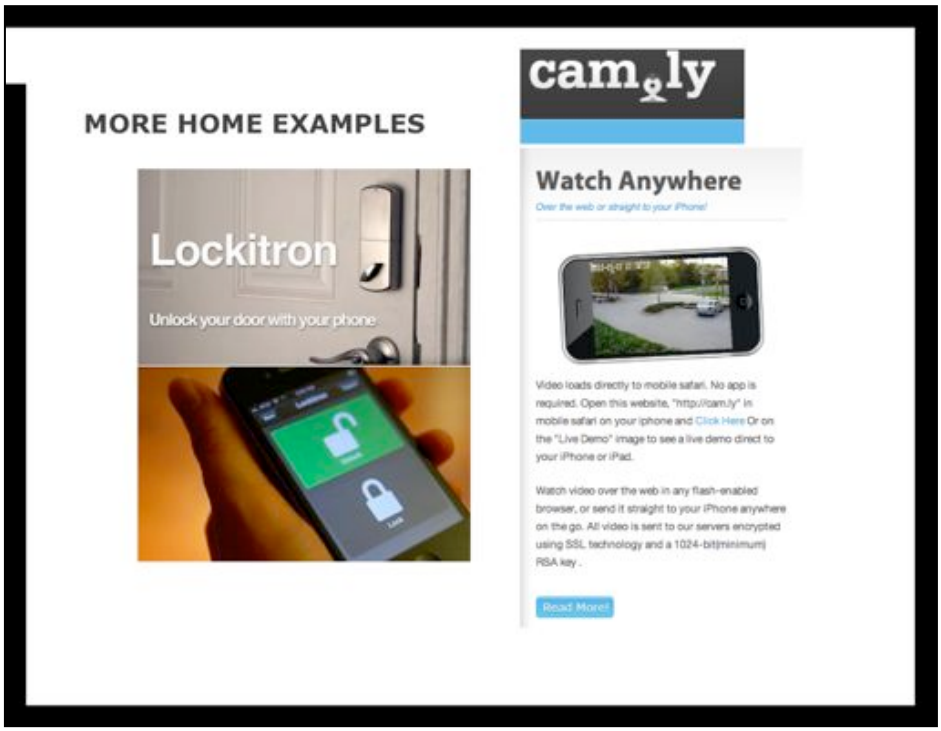
The Nest thermostat is a wireless thermostat that uses information collected from the thermostat, the internet, and people's behavior to learn what the optimal temperature conditions are for an environment given how people use that environment.



The sensor is pretty simple, but the service it provides access to is sophisticated. You can imaging them branching out into a wide variety of avatars for collecting information about your house and then acting on it in interesting ways, automatically moving money you save to special bank account when you behave in a particularly energy-saving way, but they begin with this very simple one that's almost a physical manifestation of an iPhone app. It even looks a bit like an app.

I'm sure they're also going to integrate other hardware avatars.

There is a whole class of such devices that are essentially projections of a cloud service through a limited functionality hardware product. Here are some that monitor personal health and fitness, there's the Fitbit pedometer, the Zeo sleep sensor and the Bodymedia sensor that can sense heart rate, skin temperature and other senses. These are of course sensor-based devices, but what they're selling is not the capabilities of the sensor, but of the cloud-based service the sensor connects to.

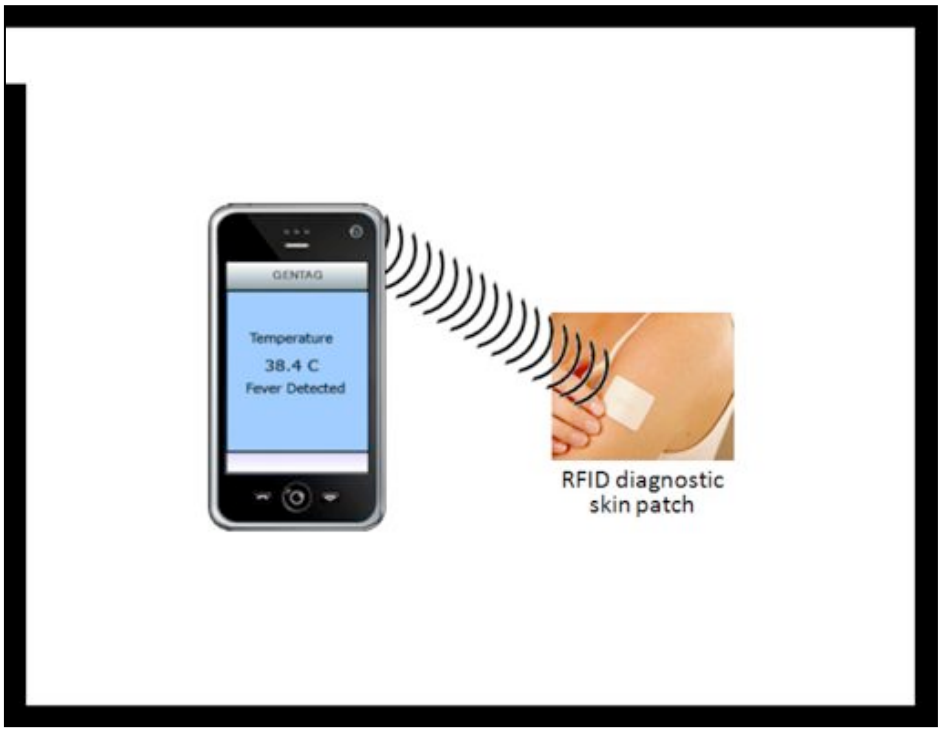


Here are a couple startups focused on the home security sector. Lockitron lets you control digital locks over the internet, so that you can, for example, use your phone to create a unique code for people who are renting your apartment that only opens it during certain times, or keep track of when a specific door has been opened. Cam.ly takes cheap internet security cameras and adds many of the features that a sophisticated surveillance system provide, such as the ability to review many days of video quickly, or to have it alert you when it notices movement in a specific area. They charge $20 a month for this instead of hundreds of dollars. They can do this because most of the functionality is in the cloud.

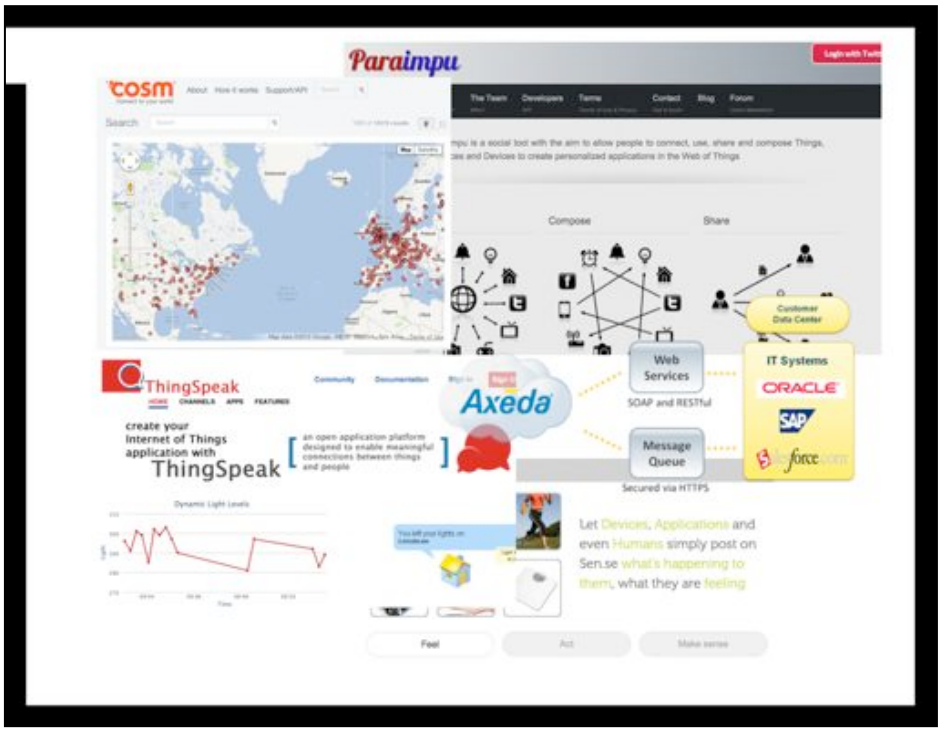
Sensors allow us to represent virtually everything in our environment, from shipping boxes to cows as service avatars. They cast information shadows into the cloud that we can then aggregate and manipulate to track things, identify them, group them, sort them, attach metadata to them, and have conversations about them. We ourselves are probably the most common kind of information shadow casting object in the world, but soon everything can have as rich and complex a social life on the internet as we do.

For example, the FedEx Senseaware tag has a bunch of sensors, a GPS and the equivalent of a phone in it. It enables a service for tracking high value items that need to be shipped under precisely maintained conditions, such as human organs. It's a component that you, the end consumer never even see, but it enables a powerful service that has enormous consumer value, but using a very small amount of information processing and sensing.

This is from Green Goose, a sensor platform based here in San Francisco. They sell these stickers that are actually tiny computers with a wireless transmitter and a sensor pack. They create information shadows for things that don't have them already. You create the meaning for the sensors. These are available right now.

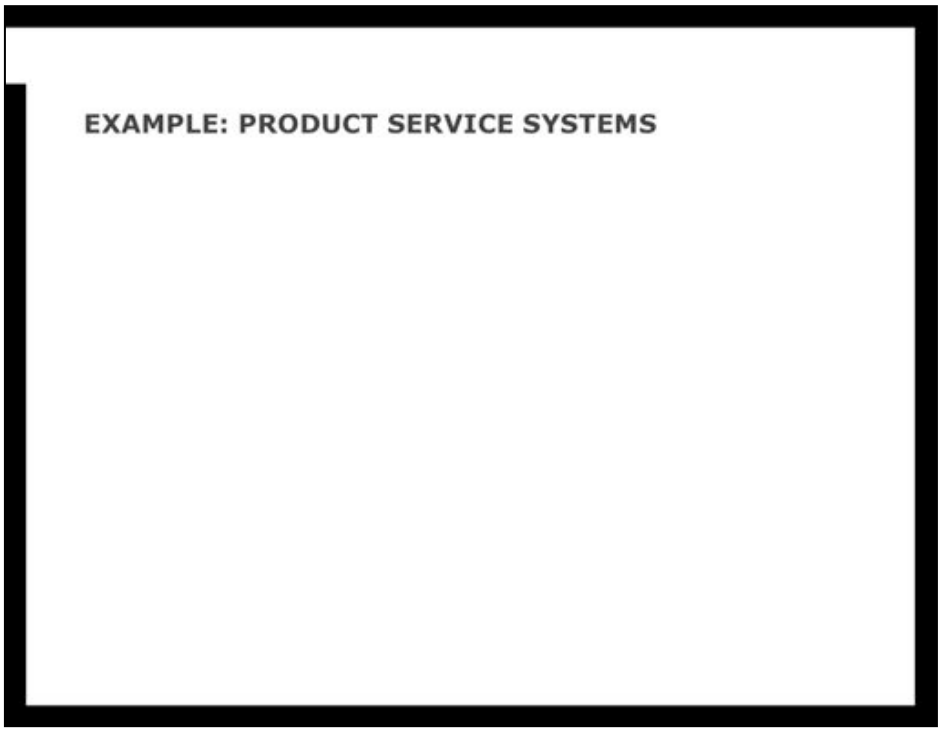


This is a stick on patch measures temperature and then transmits it to NFC phones. It came out earlier this year. The company, Gentag, claims they're developing patches that can test for pregnancy, the AIDS virus, drugs, allergens and certain types of cancers.



These devices can upload their data to services such as Cosm, sen.se, Thingspeak, Paraimpu and Axeda. These take arbitrary data streams, then republish them as RSS-style subscriptions for other devices. The services do the buffering, the protocol translation, the analytics, everything. These products enable services to be quickly built on top of simple sensors.

Pachube, which is what Cosm was called until a couple of weeks ago, was used to connect tiny personal digital radiation dosimeters all over Japan to measure radiation levels to a resolution inconceivable before. The service was put together within several days by Haiyan Zhang of IDEO and several other folks, essentially creating a mashup between Google Maps and a thousand different hardware devices. This points to the real power of the combination of device identification and pervasive networking. The Internet of Things is not just about computational things, but EVERYTHING having an information shadow and being represented on the internet.



When you can uniquely identify an object and make it the avatar of a service, you change the business model around the ownership of that object. For example, Amazon loses some money on the sale of every Kindle Fire because they know that the value is not in the sale of the device, but in the service subscription that the device gives access to. This is how mobile phones have worked for a long time. The cost of the device is subsidized by the profit made from the service it gives access to.

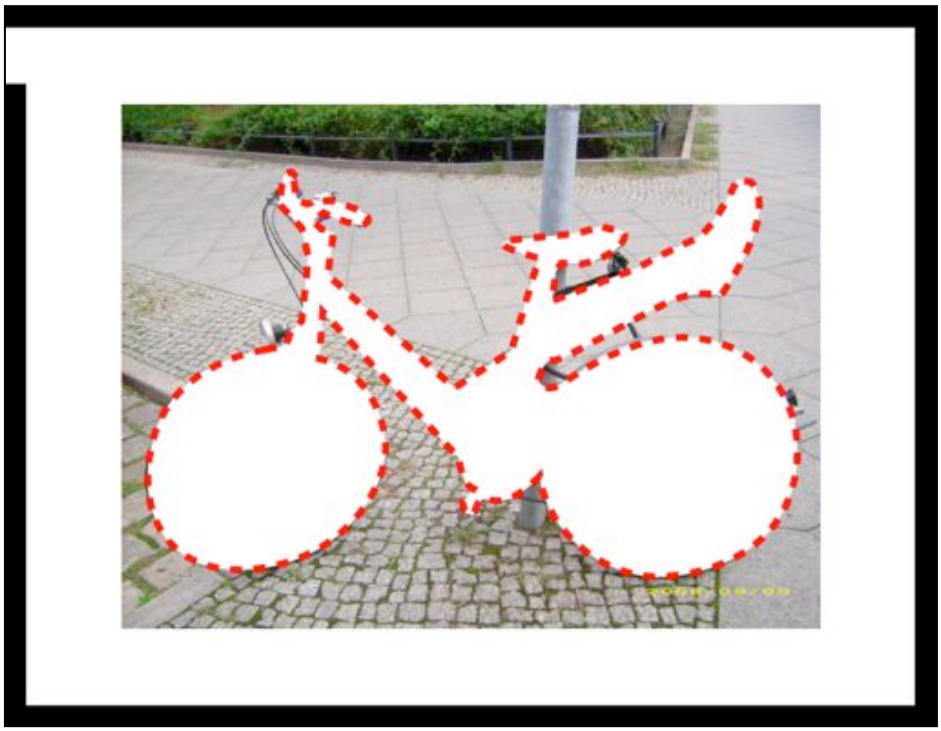
Eventually, some avatars no longer have to sold at all, but can be purely avatars of the service.

The old phone network is the classic example of this. People did not own their own phones in the US until 1984, when the old phone system was broken up. The phone was your avatar to the system, something that's now called a product service system, which is a system based on the delivery of value, rather than the sale of goods. Ubicomp and the Internet of Things are enabling the rise of more product service

Let me give you a couple of examples.

When you buy into a car sharing service such as City Carshare or Zip Car you subscribe to a service.

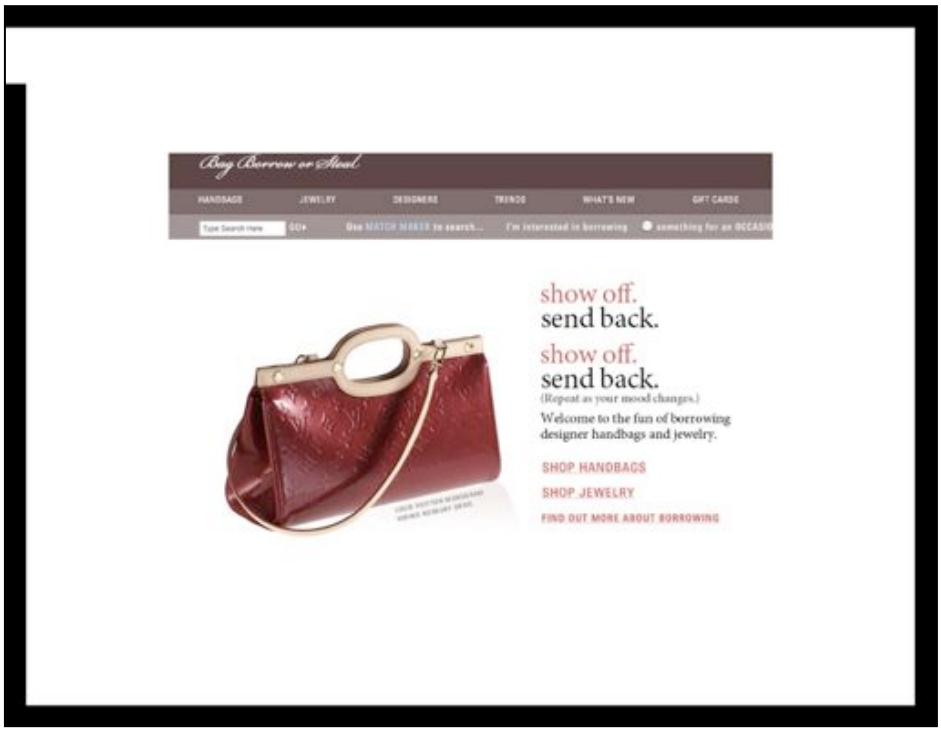
Each car is an avatar of its respected service, actively connected to the service at all times. You can only open the car and start the engine the service allows it, when the car has your permissions in its information shadow. The car logs whether it's been dropped off at the right location, and how far it's been driven. Your relationship with these cars becomes something different than with rentals and with ownership. It's like having your own car because you have access to it 24 hours a day, 7 days a week, with very little advance notice, but you can't leave your carseat in it, because it's not yours. It's different kind of relationship.



This is the German Call-a-Bike program, run by the rail service. You need a bike, you find one of these bikes, which are usually at major street corners. You use your mobile phone to call the number on the bike. It gives you a code that you punch in to unlock the bike lock. You ride the bike around and when you've arrived, you lock it. The amount of time you rode it automatically gets billed to your phone, by the minute. Each bike is an avatar of the bicycle service, its state maintained as part of its—and your phone's—information shadow.

See where I'm going?

Photo CC by probek, found on Flickr.

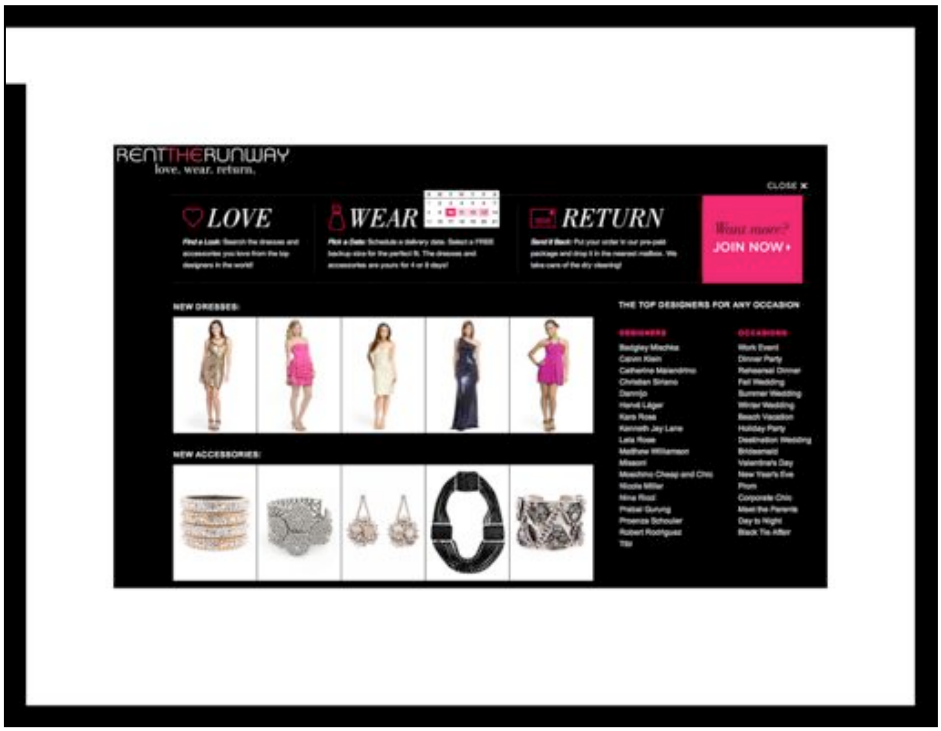


Here's another example that points to some exciting possibilities. Bag, Borrow or Steal is a designer purse subscription site. It works like Netflix, but for really expensive handbags.

It's fashion by subscription. From a user-centered design perspective, it’s great. Here’s a class of infrequently-used, highly desired, expensive objects whose specific instantiation changes with the seasons. You don’t want a specific bag as much as you want whatever the current appropriate thing to fill the dotted line is, but actually keeping up with that fashion is expensive.

This service, btw, is also about five years old.

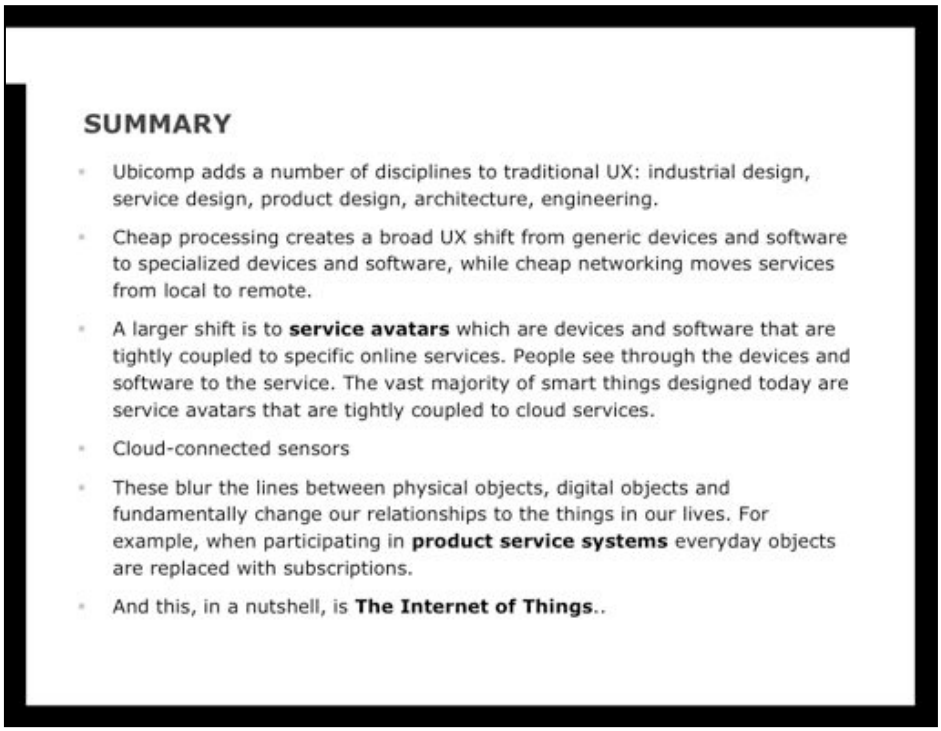
Photo CC by bs70, Flickr



Here's another one called Rent the Runway that has expanded this idea to dresses and accessories.

How long until you get a subscription to Zara and instead of buying your clothes, you just pay a monthly fee to get whatever is seasonal for your type of work in your part of the world at your price point.

We already have Exactitudes and people seem quite comfortable with it. Why not turn it into a subscription business model for Zara?

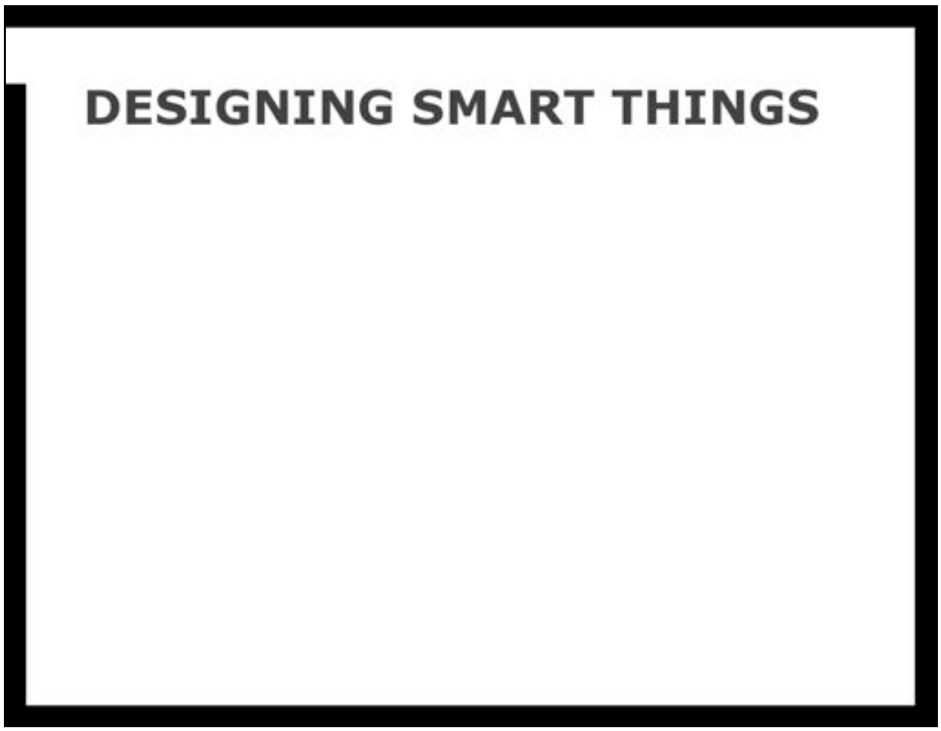


My goal in this review was to describe the general lay of the land in ubiquitous computing. We working in a complex environment with a number of interrelating factors, each of which represents both an opportunity for innovation and a challenge to the status quo in the design of consumer electronics. Things are moving fast and shifting our view of the world as they go. In effect, what we're seeing is the discovery of a new design material. Networked information processing is changing from being special thing that certain specialized devices do, to being a core building block, like plastic or aluminum, and a basic manufacturing process, like standardization in the creation of anything.

This is a huge and fundamental change, and we're just at the beginning of it. All of these other things are just symptoms of that one deep shift that we're going to see play out for the rest of our lives.


Q&A


BREAK!



You will notice that I've talked about networked things almost exclusively, rather than traditional embedded computing things. That's intentional. Although there was a time when standalone computational devices existed, that time is almost nearly passed. We will not have Roombas and Tickle Me Elmos that do not connect to the Internet in some way for much longer. Virtually every embedded digital product, from microwave ovens, to cars, the building-wide air conditioning systems are being connected to the Net. Eventually everything that has a processor in it will be connected to the Net, and almost everything will have a processor. I'm so focused on the design of service avatars not just because I think they're an interesting subset of smart things, but because I think they represent the direction where ALL digital things will go very soon.

With that in mind, let me introduce the exercises that we're going to do this afternoon. And as an introduction, let me show you a short video that came out about a month ago.

Since IKEA is getting into electronics, and IKEA makes virtually every kind of product for home and work life, and their products are simple and approachable, I though that it would be fun to Imagine IKEA products in the future, given the ideas I've discussed today.

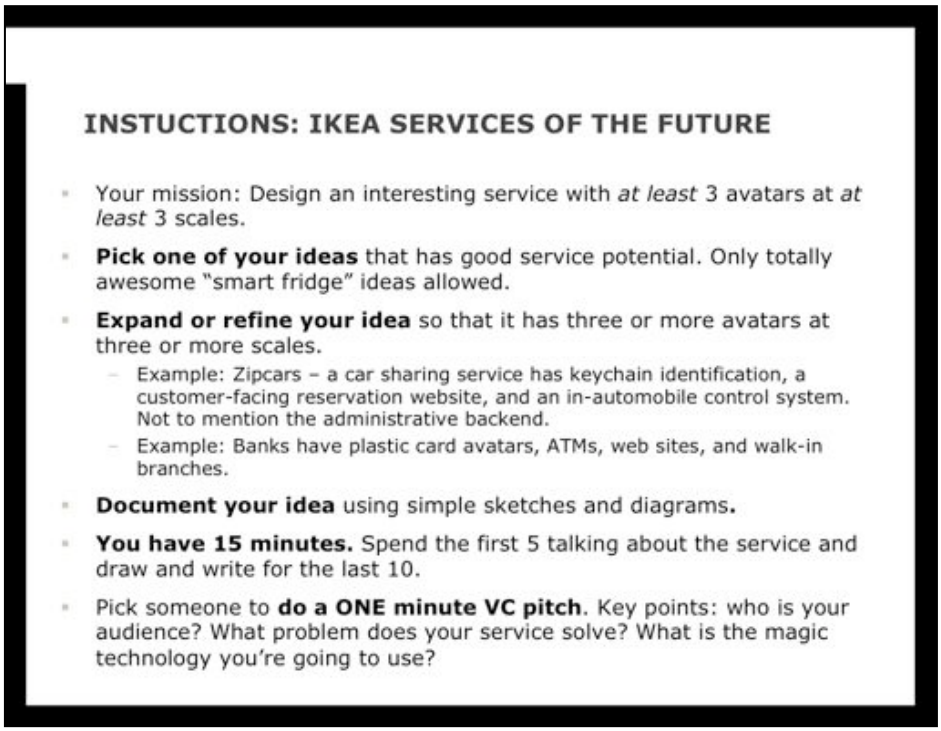
INSTRUCTIONS: IKEA PRODUCTS OF THE FUTURE

- **Mike will tell you what group you're in**
- **Say hello to your group mates**
- **Get a copy of the IKEA catalog PDF from Mike's shared folder**
- **Pick an area of the house** (kitchen, bathroom, kid's room, patio, office etc)
- Using catalog pictures as a basis, **brainstorm as many different ideas for service avatars and systems as possible.** You can use the images as direct references for your ideas, or you can feel free to use them simply for inspiration.
- **Each idea must have**
  - A title (extra credit for fake IKEA names)
  - A brief description.
  - An explanatory image, whether a freehand sketch, annotated catalogue page, or collage of images. *It doesn't have to be pretty.*
- **Stuck? Ask yourself**
  - What happens if I connect this to a net service? To Facebook? To LinkedIn?
  - What happens if I put a sensor in this? What kind of sensor?
  - What happens if I embed 10 tiny computers in this? What if it knows what other devices are nearby? What if it knows what people are nearby?
  - Pick two random things. What is the service that ties these together?

Remember: quantity, not quality. You have 15 minutes.


DESCRIBE YOUR PRODUCTS
YOU HAVE 90 SECONDS

RELAX



Again, I'm calling it a sprint to emphasize speed and agility, not rigor and thoroughness.

Who is your audience?

What problem does your service solve?

What is the magic technology you're going to use?

What are your 3 avatars?

PITCH THE VC


THING
M
Mike Kuniavsky
mikek@thingm.com
SMART THINGS
Ubiquitous Computing User Experience Design
MK
MIKE KUNIAVSKY

Thank you.