ANNA GERBER
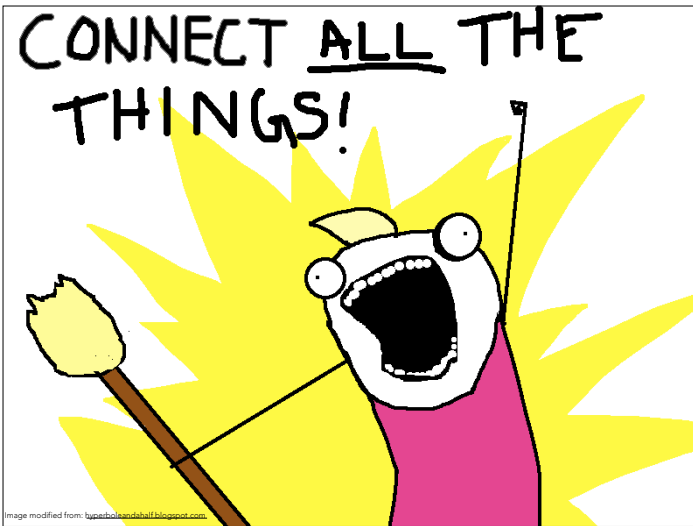
FUTURE MAKERS

Hi my name's Anna and I'm a maker. I'm here to talk about the future.

INTERNET OF THINGS

Specifically I'm here to talk about the Internet of things - the global network of interconnected smart devices

- except that IoT isn't the future - it's the present.

CONNECT ALL THE THINGS!

The number of devices connected to the internet surpassed the number of humans online in 2008. There are an estimated 30 billion devices connected right now and depending on which analyst report you believe, with more than 5.5 million new smart devices being connected every day,that number will increase to over 50 billion by 2020, with more than $6 trillion being spent on the IoT over the next five years.

Image modified from: hyperboleandahalf.blogspot.com

Connect all the things?

If that seems difficult to believe, consider how many devices you deal with on a daily basis - not just devices used directly by humans - smartphones, tablets, PCs etc. you wake up, perhaps you have an alarm or a radio,
head to the kitchen to make some breakfast (coffee maker, toaster, fridge)
Clean your teeth with your electric toothbrush
Swipe on with go card
Smart car, smart tag, smart parking station
All of this before you even get started with your day
From sensors monitoring our home and office environments, adaptive appliances, industrial equipment and personal devices including smart phones, wearable fitness trackers and health monitors devices are everywhere

Image modified from: hyperboleandahalf.blogspot.com

Now i realise that you probably don't have a smart toaster or an internet fridge - yet.
(you may never have an internet fridge - i think they're rather silly)
but smart meters and smart appliances have been rolling out across QLD for a number of years now - if you've had an air conditioner installed recently, it's almost certainly an adaptive appliance - one that - if you have a smart meter installed - can take advantage of periods of low electricity demand and reduce usage during peak periods
Image CC-BY https://www.flickr.com/photos/lge/5633727630

When we talk about smart devices in the context of IoT - we're often referring to the mundane - devices that use sensors to measure or respond to their environment, and collect or communicate data, to solve some fairly ordinary problem or improve our every day experience
Wherever we go we are surrounded by such devices, many of which are already networked, or soon will be, and many of which you probably don't even register - the point of sale device, the cameras, the door sensor
so the internet of things is already here - a network of ubiquitous, largely invisible devices
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Other images from quirky.com and beamtoothbrush.com

But i said that i was here to talk about the future

But first: the past. I began my career in technology as a Research Scientist at the Distributed Systems Technology Centre here at UQ campus in late 2000, and since then, I've worked in IT research, software development in startups. So I like to think of myself as a bit of digital pioneer. Keeping abreast of trends, working on the bleeding edge, Pushing the boundaries of what is possible, exploring new worlds and boldly going where no-one has gone before. but the IoT is truly an undiscovered country, the underlying technologies and their applications are evolving at an unprecedented rate, so predicting the future of IoT is challenging
Image CC-BY https://www.flickr.com/photos/buckaroobay/3721809183

IoT has been described as the industrial revolution of the 21st century. The IR was the beginning of the rise of the machines. But no one would have believed in the last years of the 19th century (perhaps with the exception of HG Wells) the impact that connecting machines would have, not just on industry and manufacturing processes, but across every aspect of our lives.
If there's one thing I'd like you to take away from this talk, it's that the Internet of things is a big deal. it's transformative - it will fundamentally change the way that we understand and interact with the world around us and with each other
Public Domain image https://commons.wikimedia.org/wiki/File:Hartmann_Maschinenhalle_1868_(01).jpg
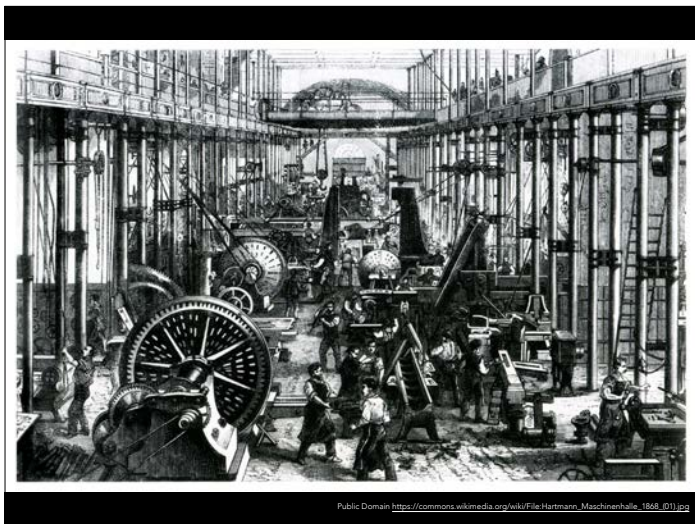
If you want to see the beginnings of this of this head to Roma St parklands on Sunday and you will find hundreds if not thousands of people out and about playing Pokemon Go.

This one little game in the space of a few of weeks since its release has become:

Most popular mobile game ever

More daily users than Twitter

In a single day Nintendo (show only own a small share in the pokemon company) sold over US $4.5 billion of shares - all time record at the Tokyo Stock Exchange and more than doubling the value of the company.

And it hadn't even been released in Japan yet - it's still only available in a few countries.

Image CC-BY https://www.youtube.com/watch?v=ykzgK60qpvY
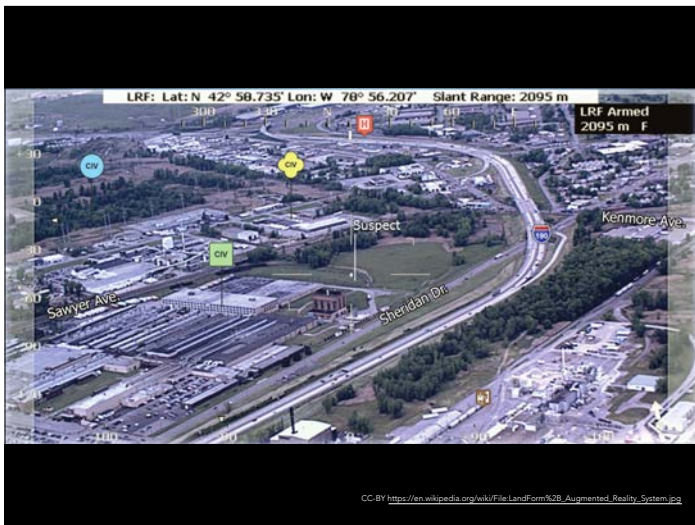
For those of you who aren't familiar with it Pokemon Go, it's an Augmented Reality app. The idea behind AR is that you overlay digital information or content (in this case highly collectable pocket monsters) over the real world. AR has been around for decades (e.g. this LandForm+ example - used for search and rescue). AR and IoT go hand in hand - AR is a promising interface for IoT devices - if you've got smart devices sensing and communicating information about the world, what better interface for us to interact with that information than the world?

Pokemon Go is possibly just a fad. It's just the beginning of this transformation - we're seeing people altering their behaviour, and the impact that this can have- bringing communal spaces alive, boosting local businesses, impacting the global stock exchange.

This is a massive social and economic shift that is occurring as a consequence of these highly connected devices, connecting people and processes, data and things.

Image CC-BY https://en.wikipedia.org/wiki/File:LandForm%2B_Augmented_Reality_System.jpg

As a software developer, this transformation and the unprecedented opportunities is provides are pretty amazing.
To meet this demand for smart devices, and the apps and online services around these devices and their data, we're going to need a lot more developers, designers, usability experts, engineers, data scientists, dev ops, and other IT professionals.
But technology or technologies are just tools.
One of the things that makes us humans so effective is our ability to invent and adapt to new tools but more importantly to use them to shape the world around us. And there is not one field of human endeavour that will not be touched by the IoT. So it's not just the nerds like me who are going to have to learn new tricks.
But what does this connected world look like? Let's take a quick tour
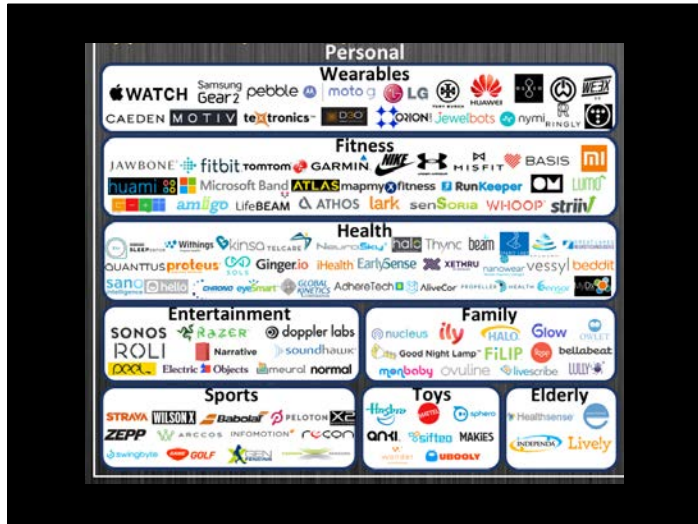Image CC-BY
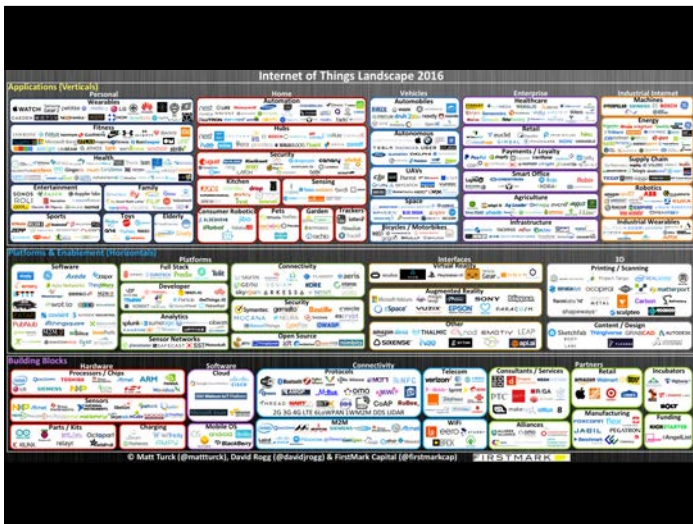
Let's start with a map:

Here's the state of IoT from March this year (produced by Matt Turck).

Applications: wearables, ingestibles, connected homes, drones, smart cities (talk through examples e.g. nest, rubbish bin sensors)

No clear market leader, no dominant platform
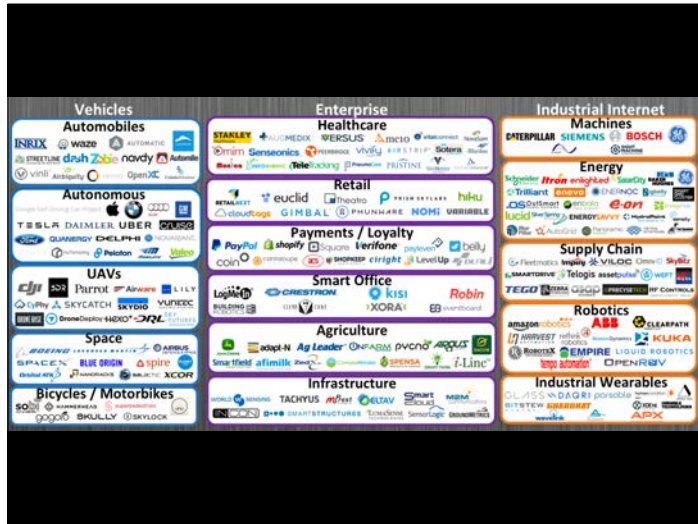
Image: Matt Turck

Let's zoom in. Talk through wearables examples.
What we consider to be normal is changing
e.g. Ingestibles

Image: Matt Turck

IoT can be a gimmick i.e. internet fridge.
Best current examples are incremental improvements in our lives e.g. adaptive appliances improving energy efficiency, safety, or industrial applications / logistics and tracking.

Image: Matt Turck

Startups as well as big companies
Not US-centric
Lots of innovation coming from China
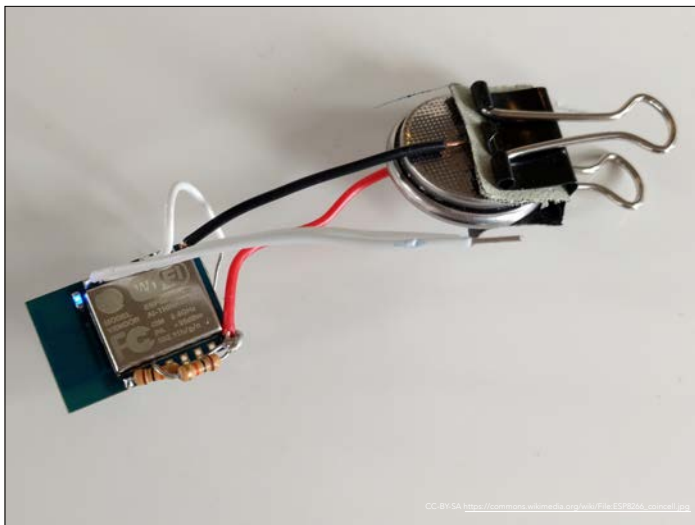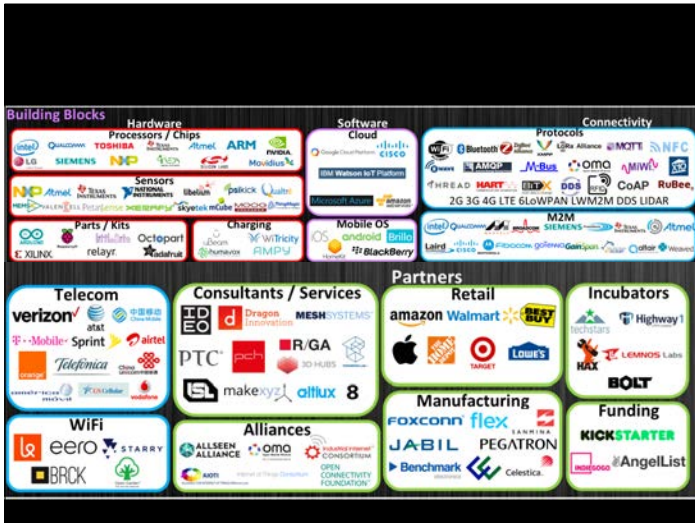
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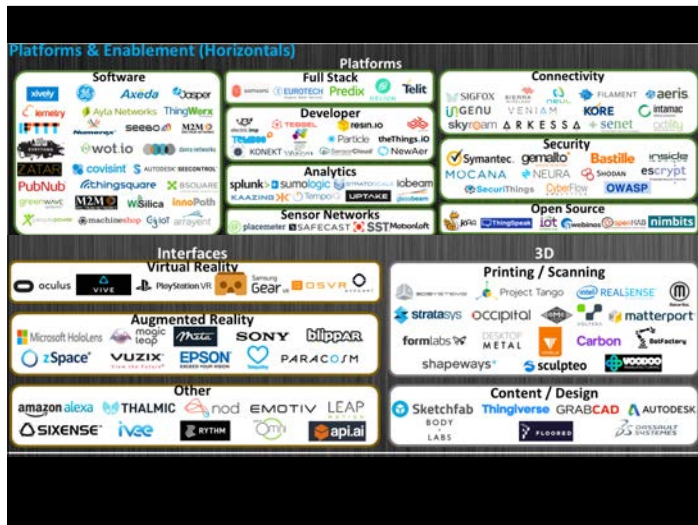
No clear market leader, no dominant platform

Image: Matt Turck

The building blocks for the layers above

Image: Matt Turck

One thing you might notice from the map, or from talking to people about IoT, is that a lot of the focus, a lot of the excitement around IoT is around the things. As someone who loves to build my own devices, i get it - the appeal of the shiny devices, the hardware. The very fact that we're calling this the internet of things and not just the internet or web 4.0 reflects that.

The miniaturization / commodotization of hardware is driving the fact that we can build these devices at all - that they can be everywhere and that we can effectively hide them in plain sight

This is an esp8266 micro controller:
•   on board wifi
•   around 16 GPIO pins for connecting to sensors / actuators
As a consumer, as a hobbyist - I can buy one of these online for around $2 including postage - these don't have a huge amount of memory - 64K ram, not a huge processor 80mhz, but this device is more powerful than the Apollo guidance computer that put us on the moon.
But would we do it today? Surprisingly (for a vision that talks of connected devices) Very little connectivity / interoperability between these - we're dealing with silos.
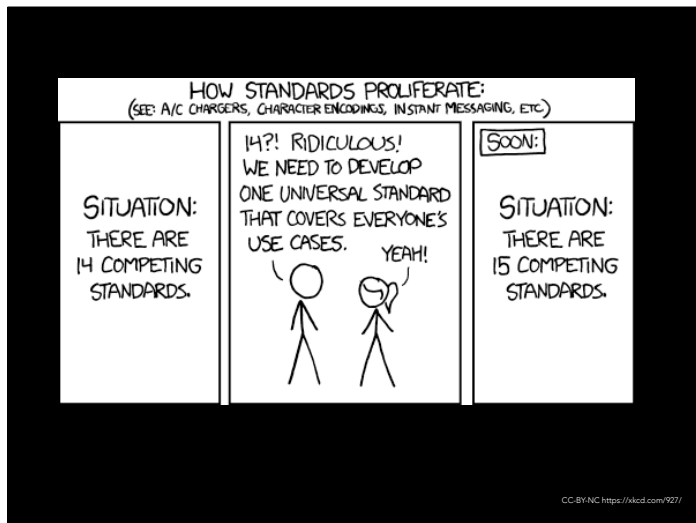
This is true also for the underlying technologies. Many existing solutions exist within their own bubble with their own associated standards groups,
while we talk about IoT we often really mean a web of things - humans talking to machines talking to machines talking to humans integrated with our existing ecosystem of web applications, mobile apps

There's nothing wrong with standards - standardisation is the reason that the web works at all
but crucially these should be be open standards with interoperability as a specific goal. These kinds of standards initiatives tend to take a little bit longer to come about - a lot longer to get right
- longer to be implemented
- longer to be updated
and IoT is moving fast. So there's a tension between developing standards-based solutions and being able to rapidly evolve them to meet demand, new opportunities and changing requirements

One area where this is particularly important is when it comes to Security & Privacy
You might not be aware of this search engine: Shodan - for internet connected devices. it crawls the net looking for devices with open ports. you can search for devices by type, you can even search for devices based on whether their default password is known. Not safe to rely on security through obscurity. The default username/password remains unchanged on many devices so it's not actually "hacking" - just unauthorized access.
Increased connectivity between personal devices and availability of personal data combined with improvements in commodity hardware makes it easier for trolls, cyberstalkers etc to leverage sensitive information. Particularly important where there are actuators involved as in devices that effect some change in the world (eg. controllers for medical devices, building environmental control systems, industrial control system etc). Just because these devices are not at the forefront of our attention doesn't mean that these issues go away. e.g. you may not think of a baby monitor as a networked device that requires securing but there are plenty of them available through the site, and there was an incident reported in the media several years ago where a troll accessed a baby monitor (fortunately not harm was done).
When you have people clamouring to use new technologies - and technologies and applications like Pokemon Go that to scale to millions of users within the space of days - our ability to secure these technologies just can't keep up with our demand for, indeed our reliance on these technologies.
And even assuming that our devices are perfectly secure and only collecting and publishing the information that we tell them too, how do we maintain privacy & anonymity in a world - sea of interconnected data streams - a few correlated data points can be enough to identify an individual.
Security and Privacy are hard problems, if we ignore them they won't go away and they will require not just smart people to develop solutions around them, but also smart consumers, if IoT changes the way we interact with the world and each other, part of that will require a heightened understanding of what's at stake and new patterns of behaviour to protect ourselves. Image: screenshot of Shodan website

So recap:

the internet of things is here - the genie is out of the bottle
It's changing the world in ways that no-one can predict.
It's "a time of unprecedented opportunity".
From a technology point of view - IoT is in its difficult adolescent period

We need smart people and we need them fast.
But how can we prepare students to make the most of the opportunities?

(My training is in Computer Science not education, so the following are non-expert reflections based on my own experiences)

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File:Genie_Lamps_007.JPG

This is an example of a custom 3D printed action figure - with electronics from one of my workshops.
Technology does not exist in a vacuum - people rarely use technology for its own sake
We use it as a tool to solve problems and that's what motivates us e.g. when i learnt to code as a kid - logo (Turtle graphics) - to produce art.
So often technology has been taught without real world context - or to solve abstract challenges that some students can't relate to.
Tech often taught as part of STEM alongside maths, engineering, science. but IoT is transforming all fields - the humanities, social sciences and the arts. The code to take a reading from an environmental sensor to create a scientific application is not very different than reading from an accelerometer to create a custom game controller, or to produce a sound responsive interactive art piece. We need to do better at making technology skills relevant to all students. IoT gives us the opportunity
Image: CC-BY Anna Gerber
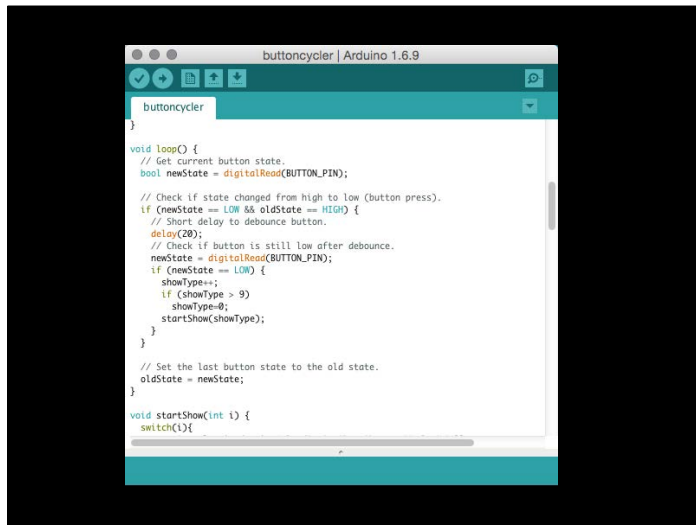
Current focus on coding and robotics in the classroom - both relevant to IoT. But coding & electrical engineering are not the only tech skills required for IoT (we need data scientists, sys admins, network engineer,s dev ops, UX, design etc).

The rate of change in IoT - especially languages, platforms - code generation, model based, semantics based, AI - how we develop for IoT is already changing. We don't know what tech & tools will be used to develop in future, so don't sweat the details e.g. Python vs Scratch. Teach computational thinking not specifics.

Image: screenshot of Arduino IDE

GET EXCITED AND MAKE THINGS

IoT is all about digital meets physical world - changing the way we interact with and understand the physical world. Teach through Maker Ed - learning by doing & building physical things.

Most people I know working in startups have a spark - keeping up with demands of changing world of tech is hard work, you never stop learning, you need to have thick skin and be motivated by an internal drive so you don't give up. To succeed in IoT students need to develop skills in problem solving, leadership and resilience. IoT is changing the world - so learning technology skills gives students the power to be agents of change and make the future.