MASTERING THE INTERNET OF THINGS

BENEFITS | BUSINESS IMPACT | REGULATIONS
SECURITY | CONNECTIVITY | TECHNOLOGY
MASTERING THE INTERNET OF THINGS

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During our work as Internet of Things experts in the past decades, we gave quite a bit of effort into understanding the challenges brought about by connected objects and answering them in the simplest way. We realized that most of our customers were facing the same challenges and that it was hard to find a broad perspective on the topic.

For us, it was a natural step to start putting our thoughts on paper, with one main focus: be able to explain the Internet of Things and its challenges using simple and understandable language. This is what led us to this book.

“Mastering the Internet of Things” provides the methods and lessons learned to understand the in’s and out’s of IoT and help you to make choices.

Enjoy and do not hesitate to contact us to share your thoughts.

Gilles & Robert

Amsterdam / The Hague, 15th November 2016
The Internet of Things revolution is happening. As company executive, decision maker, or just an individual trying to understand how IoT could change your life or business, you might feel overwhelmed.

The methods described in this book are not only theory but also practice. They have been tested and fine-tuned in dialog with customers.

Develop and apply your 360 view on the Internet of Things:

- Benefits: discover the opportunities brought by smart objects.
- Business impact: get insight into the impact of connected services on your business or organization.
- Security and regulations: realize the challenges posed by those to-be-taken-seriously topics.
- Connectivity: identify your needs, your options, selection criteria, and make future-proof choices.
- Technology: get started, be aware of the challenges, the common pitfalls and good practices, and create partnerships.

Are you looking for an understandable and broad view about the Internet of Things? Are you looking for very concrete methods to start your IoT journey and to prevent common mistakes? This book is for you!
“Mastering the Internet of Things” not only helps you to understand the context of the connected objects revolution but also describes a concrete approach and methods to start an IoT project or to select an IoT solution.

The methodology is based on the 5 stages shown on Figure 1 and described in more details in the subsequent chapters of this book.
Based on the nature and IoT maturity of your organization, each of those different steps can be taken with its own priority and focus, but the overall iterative 5-stages process guarantees an answer not only to the “How” of IoT, but also to the “What” and “Why.” The methodology proves to be very useful to organize short-term IoT pilots and projects, but also to keep in mind the critical factors for the long-term.

As writer and reader, it might be considered a challenge to present and read information about such different topics as business, technology, or regulations. But, at the same time, it is also the key to success for your IoT project to look with a 360 view at all those aspects. The 5-stages approach gives you and your colleagues an opportunity to learn about the IoT opportunities and challenges, and how they relate to each other.

So do not hesitate to share this book and exercise its methods with your colleagues who come from different disciplines. Without noticing, you have already completed your first steps to master the Internet of Things!

Please check the section “Resources” of this book to access more online IOTC360 posters, presentations, or check-lists. Also, do not hesitate to leave us feedback, questions, or requests about this book and the 5-stages method.
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IOT (INTERNET OF THINGS) - WHAT IS IT?

The Internet as we know it is defined as an interconnection of worldwide networks, or a net of nets, and it came about in the early 80’s. As end users, we also know that the most interesting part of this network is not the infrastructure itself, but the smart devices and smart applications that it connects with and that make our work easier and our life better. The Internet started to connect computers, mobile phones, and more recently tablets, and smartphones.

The expression “Internet of Things,” abbreviated as “IoT,” consists of an important word: the word “Things.” This word highlights the fact that the Internet is now also connecting any sort of object on the planet.

WHY IS IoT HAPPENING?

IoT is becoming another word for IT (Information Technology). Information automation has not stopped with the server room, computers, or smartphones and is now reaching all objects around us.

Most devices around us are either already or will become connected in the coming years. They will be able to sense and exchange all sorts of useful data information with smart applications. Telecommunications, databases, and applications are becoming such an important part of our everyday life that they will become a sort of digital net, or skin, to our lives. Ironically, with the image of this future digital world in our heads, we could even say, “No Net, No Planet!”
IS IOT NEW? WHY SO MANY NAMES FOR IT?

Connected objects are not new; they have been around for some time, probably as long as the Internet or communications have existed. To some extent, computers and (smart) phones can even be considered as some of the earliest examples of connected things, although with one major difference to stand-alone objects as they still need a user to manipulate them.

Some of the first IoT applications were used to connect industrial machines, infrastructure, or commercial fleets under the names telemetry or telematics. There were also a lot of innovative ideas in the consumer space, including that of a connected fridge.

The term “machine-to-machine”, usually found in its short form M2M, came into use, putting the main focus on connectivity (“M2M communications”).

Nowadays, the catchy expression “Internet of Things,” or its abbreviation “IoT,” has taken over and is used everywhere: in books, blogs, company slogans and visions, and even in the speech of the Chinese Prime Minister. A lot of variants of this expression can also be found: Internet of Everything (IoE), Internet of Industrial Things, Internet of Heavy Things, etc.
“We clearly see the benefits of connected and automated driving. We are going to save lives. *It is a necessity, not a nice-to-have.*”

Edwin Nas, dep. project leader of self-driving vehicles at the Dutch Ministry of Infrastructure and The Environment

“The notion of verticals within the IoT is fading away.”

Chris Greer, Senior Executive for Cyber-Physical Systems, NIST

“It’s not a coincidence that the rise of IoT is sometimes called a revolution. Not only a technical and a business one, but also for the entire society, transforming our way of relating to physical objects and to our environment. In short, of living, of working, of keeping in touch with friends, of thinking, in a nutshell of being humans.”

Jacques Durand, Director R & D at Fujitsu America, Inc
WHAT ARE EXAMPLES OF THE INTERNET OF THINGS?

By now you are probably asking yourself: why are we connecting those “things?” So let’s provide some concrete examples and illustrate more clearly just what those smart objects can do for us.

Imagine a world where a vending machine tells you when it needs to be refilled, or a garbage bin that it needs to be emptied.

Imagine a world where your home calls you when it detects unusual heat or a water leakage.

Imagine a world where your child’s babysuit constantly monitors his/her movements and breathing, and alerts you when needed.

This world is not only part of your imagination or fantasy but actually exists. This is the world of the Internet of Things (IoT)! In this world, communications are not only taking place between human beings, but also between machines.

You might not have realized it yet, but plenty of objects around you are already communicating. Take, for example, your navigation system; it is already using mobile communications to exchange information with traffic databases and to compute in real-time the fastest trip from A to B. Another example are cars; most of them are already designed to send an alert to emergency services by themselves at the exact moment you have an accident on the road. This system is called eCall and will become mandatory in all European vehicles starting in 2018. You have probably also heard about the smart meter. By 2020, most electricity and gas meters will be connected (at least in Europe). This will allow not only homeowners, but also third parties to analyze and optimize our power generation, distribution, and consumption.
Some of the applications and objects are more exotic. For example, take the connected rat cage. A pest control service employee installs a rat cage at a customer facility plagued with rats. At the very moment that a rat is being caught, the cage sends a signal to the pest control company. An employee can immediately drive to the site to remove the cage, resulting in improved customer experience and service efficiency. Even rats are facing the reality of the Internet of Things!

Figure 2: The connected rat cage
To understand the potential of a connected object, think about what this product could bring to the table now that it is online. Let’s consider this rat cage one more time. Let’s connect it. We just saw that this cage can inform us when a rat has been captured. But it can do more. For example, add a presence sensor to the cage and you could detect whether one or more rats come near the cage and therefore whether it is worth keeping this cage where it is or move it to a different location. Add a connected temperature sensor and you could make it a remote weather station. Add a vibration sensor or a microphone, and you could make it a remote alarm system.

Are you starting to realize the extent of the Internet of Things? Connected cars, connected homes, connected rat cages, dogs, machines. The list is limitless. A lot of companies have already figured out which benefits connecting their products could bring them or their customers. In the years to come, nearly all existing businesses will do the same, not to mention the fact that new businesses will flourish by offering connected digital services. IoT solutions are unlimited; it is up to you and your imagination to come up with ideas about what you can do with a connected object and what it might bring to you or your customers.
Write down 3 examples of connected objects that you think could send interesting data. Be creative!
DIGITAL, CONNECTED, AND SMART

An object takes part in the Internet of Things in 3 steps described in Figure 3.

Firstly, it becomes digital. It contains embedded sensors and electronics which generate binary data.

Secondly, the object gets connected. It can send this data to a data platform.

Thirdly, smart applications make use of this object and that is when it can be considered smart. This last step is probably the most challenging. Think back (if you can) to the time of the first PDAs (Personal Digital Assistant). The youngest among us probably don’t even know that word. Those handy pieces of digital equipment were “smart ready,” but it took a bit more time to get the apps and really make it a “smart” phone. IoT is not any different. Digital plumbing takes place at a fast pace and forms the basis for smart applications to develop.
Figure 3: IoT business and consumer benefits

DIGITAL

CONNECTED

SMART

BUSINESS BENEFITS
Improves processes efficiency

CONSUMER BENEFITS
Improves quality of lives
IOT BENEFITS: BUSINESS AND CONSUMER

The word “smart” is obviously subject to interpretations. What you consider a smart object or solution might be different from what your neighbor does.

But most of us would probably agree to use this word to designate a solution or object bringing tangible benefits.

The beneficiaries of IoT solutions can be roughly organized into two categories: businesses and consumers.

1. On the business side, IoT helps companies to improve the efficiency of their processes and to sell additional services. The business benefits are often financial. Nevertheless, IoT can also help improve the quality of products and services offered by those companies and, therefore, their image and brand.

2. On the consumer side, IoT makes our lives easier and better. In that space, the most critical factor in the adoption of IoT is consumer acceptance and perception of the benefits.

The benefits usually take place on both sides. Consider, for example, a connected soda vending machine. On the business side, it can assist the vending machine manufacturer to pro-actively maintain its vending machines fleet. It also helps the soda distributor to manage its employees and fill those distribution points on demand. On the consumer side, such a remote connection can help optimize the availability of soda and the soda product offering per location, thus improving customer experience.

With time, IoT solutions will become more and more critical to our society and save more and more lives. Think about remote monitoring of the condition and health of old people, automated cars communicating with each other to react faster by themselves to a dangerous situ-
ation, control of critical infrastructure or buildings to detect in advance unexpected failures, measurements of pollution or chemical hazards at object level, and so forth. The expectations of our society towards IoT will transform from “nice-to-have” to “must-have.”

VERTICALS...OR NO VERTICALS?

As nearly all objects around us become “active” with time, it is nearly impossible for our mind to comprehend the number of potential smart applications to which they can give birth.

A common and pragmatic approach to establish a bit of structure in this cloud of applications is to organize them by sectors, also called vertical markets. For which specific industry or group of enterprises can such a smart solution be interesting?

Some examples of vertical denominations are illustrated in Figure 4. Needless to say, those names are not unique and many more can be used.

On the other side, thinking about IoT in terms of verticals is only the beginning. The true power of IoT and the smartest solutions to come will arise by mixing and crossing those different markets. Objects will not only talk with each other within the same vertical but will cross borders and sectors, simultaneously bringing benefits to more verticals. At some stage the notion of an object or application belonging to a certain vertical is going to disappear. We will start to talk about a smart city, smart work, smart life, or smart planet!
“I do not think that the radio waves I have discovered will have any practical application.” - Heinrich Hertz
PART 1 - THE OPPORTUNITY
THE BEDROOM DOOR slammed, making the entire flat shake as Katheryn marched out on her half-naked boyfriend.

“Kat wait,” Paul called after her through his closed bedroom door and stumbled out of bed with only his boxers on. It was nearly 6 am in Amsterdam, and he’d only just come to bed after a wild and crazy night with his computer. Katheryn had reached her limit a moment ago when she’d told Paul she was too exhausted to get ‘cosy’ with him and he’d complained they never spent time together.

“No,” Katheryn yelled back at him as she stood by the front door, already shoving on her brown boots, “I’ve had enough. This is getting ridiculous.” Paul came out to stand in front of her. “First of all,” she seethed at him, “I can’t believe you have the guts to say we don’t spend time together. You’re the one that’s always on that damn thing!” Katheryn’s eyes cut over to the laptop on a table in front of the living room sofa.

Paul’s gaze followed and his mind automatically flicked to the comet-detection algorithm he was working on – the reason he’d come to bed so late. Katheryn took in her boyfriend’s dishevelled dark hair with his dazed expression and let out a sigh.

“Look Paul,” she spoke in a softer tone, “How can we have a proper relationship if we never spend time together – never talk?”

“Okay, let’s do something today then. We’ll go have a picnic at the park this afternoon or something, I promise.” Kat regarded him for a moment,
about to relent, but then her face hardened, hurt and resolve flickering in her
golden brown eyes.

“I’ll believe that when I see it,” she said wryly, “Do you know how many
times you’ve promised to go out with me, or get dinner with friends or even
just watch TV, and then you came too late or forgot all-together?” Paul
thought about this and opened his mouth to respond, but Katheryn wasn’t
finished.

“It’s all the time Paul. Then you say you’re sorry, yet it happens again and
again. I don’t need apologies, I need you to do something about it. But now
it’s clear - I don’t think you ever will. I think you love your precious games and
programmes more than me. I’m almost jealous.” She let out a bitter laugh and
crossed her arms over her chest. Paul crossed his own arms.

“That’s simply not true,” Paul retorted, his apologetic demeanor replaced
with a defensive frown, “You’re exaggerating.” Apparently, this was the wrong
thing to say. Katheryn’s face drained of all colour then turned a deep shade of
red as she levelled him with a scowl.

“Exaggerating?” she hissed, “Are you kidding me?” Paul swallowed hard,
but stood his ground since she was, in his mind, over-dramatizing the situ-
ation. “Well, then, that’s it Paul. I’m done. Here!” She was almost at the point
of hysteria, tears streaming down her cheeks as she pulled out her keychain
and took off a silver key with trembling fingers.

“Here, you can keep your stupid flat key along with your stupid com-
puter. I hope you two are very happy together!” She then proceeded to throw
the key straight at Paul’s chest.

“Ow!” He stepped back in surprise and the key clattered to the floor.
Before he could react further, Katheryn yanked open the door, nearly hitting
his face, strode partially out, then stopped and looked at him.

“We’re over Paul - completely over.”

Perhaps a little too late, Paul felt regret at not being more understanding,
now that she was running down the two flights of stairs and leaving him
for good. “Hold on,” he called down as he raced after her all the way to the
sidewalk. “Will you wait just a minute, please Kat!” Paul stood there, still in
his boxers as Katheryn paused and turned around from five feet away. She
sighed, wiped at her teary eyes and gave him a look full of pain, but still with
utter resolve etched into her expression.

“Sorry Paul,” she said simply, “I won’t wait for you any longer. Goodbye.”
Then she turned and walked down the street, boots clicking with each step. Paul watched, still too stunned by it all to cry or scream or do much of anything.

When an older couple walked by, presumably on their way for an early coffee, and gave the barefooted young man a strange look, Paul decided it was time to go back in and sort through the storm of emotions raging inside.

***

Rafael Silva hit the gas-pedal of his silver car and smiled at the silent hum of its electro-motor as his new ‘gadget’ accelerated on the highway. There was nothing quite like the thrill of adrenaline pumping through his veins while smoothly flying along the road. It was almost midnight that Friday and Rafael was headed home after a great time with some old friends at Dugans, his favourite Atlanta sportsbar.

While he was born in a southern Brazilian city, Curitiba, Rafael had moved with his family to the States when he was just five. So these friends were from both grade school as well as college right around Atlanta.

As head of sales at Idrel Toys Inc., Rafael was the odd man out among his buddies who were mostly in finance and banking. “You guys are just selling air bubbles,” he’d stated while he sipped a frothy ale.

“At least we get to wear a decent suit,” one of his pals had smirked as he glanced at Rafael’s jeans and casual tee-shirt. Rafael had shrugged with a grin. He loved not having to wear one of those stuffy suits and besides, it’d been a really good year for him. The company board was happy, which in turn made him happy. Due to their deal with a super popular Korean TV series, Rafael’s salary had gone well into six-figures over the last two years. In his mid-forties, he was at the top of his game.

Though at the height of his work-world, Rafael had this unsettled feeling inside, a yearning to try something new and more innovative. He felt this restless sense now as he turned up the car radio’s volume, pressed his foot down on the accelerator and sped off into the night.

***

Rafael woke up late the next day to the sound of his fourteen-year-old daughter’s whiny complaints. “Dad, my phone is totally broken, and won’t
get fixed ‘til Monday! You know what that means?” She sounded near tears. Rafael pulled a weary hand over his face and grunted. He and his wife had divorced four years ago, and Rafael had the kids every other weekend, which he usually loved. But at this exact moment, he just wished he could sleep in a bit more.

Unfortunately, his daughter wasn’t done, and answered her own question with, “It means that I can’t contact any of my friends all weekend and it completely sucks, that’s what it means! What am I supposed to do?” Carolina could be a major drama-queen sometimes.

“Calm down, sweetie,” Rafael told her with a sigh, “You’ll be fine. It’s not the end of the world, it’s only one weekend. And look at it this way, you can really focus on your homework.”

“Are you serious,” Carolina’s voice became even higher-pitched, “Only a weekend? All my photos and music are on there. Plus how am I going to keep up with my friends without texting? And homework? Ugh.” With that she turned on her foot and marched out of the bedroom in a huff.

When Rafael was more awake, a cup of coffee and a scone in hand, his more rational and thankfully lower-pitched seventeen-year-old son, Jackson, came in. He wanted to show off the modifications on the remote-controlled car he’d been working on with his friends.

“Dad, check it out,” Jackson tilted his RC-car so Rafael could see, “We’ve adapted the software to get more power from the motors.” His son’s eyes shone with excitement as he pointed out the changes. “And here, see? We’ve drilled holes in the body to make it lighter and lowered the battery for higher stability in turns.”

“Cool,” Rafael nodded with approval, feeling a wash of pride for his son, “Very cool indeed.”
Life

PAUL’S GRANDMA, EMMA, decided to throw a party to celebrate life, and everyone was invited. A mixture of heat and a light summer breeze created the perfect atmosphere. Although her husband had passed away three years ago, Emma van Dijk was happy to be surrounded by her children and grandchildren, all running, talking and laughing in the garden of her flat’s complex.

Today was August 27, the anniversary of Emma’s wedding and the reason she thought it was especially important to revel in life with her entire family. Despite the fact that, due to her age, she’d lost a bit of her eyesight, she watched as everyone enjoyed their drinks and talked animatedly over her favourite light classical music.

Emma’s grandson Paul sat next to her, happily eating one of her specialties - smoked chicken salad. As she watched her lively party guests, Emma noticed that some of the kids simply sat off in the shadows, immersed in their electrical devices. With a shake of her head, Emma leaned towards Paul. “I think children should get away from those tiny screens and play with each other, like in the old days when they ran around all day. It’s so much healthier.”

Paul nodded, though he wasn’t one to talk, especially since Kat had broken up with him a week ago due to him being glued to his own electrical device – his laptop. His stomach twisted at the thought of his ex-girlfriend’s angry yet sad expression, and the chicken salad suddenly tasted a bit sour. He hadn’t told his Grams about the break-up yet. “Oh Paul,” she said, as if
on cue, “You should bring that nice young lady with you next time you visit. How is she doing?”

“We, uh,” Paul stammered, swallowing the lump in his throat, “Actually, Grams, we aren’t together anymore. It’s okay though, just wasn’t meant to be.” He added the last part with a forced smile when he saw Grams’ concerned frown.

“Oh, sweetie, I’m so sorry,” she sympathized with a kind pat on her grandson’s shoulder, “I guess young love can be hard. You’ll find someone else though, and soon. I can feel it.” She looked intently into his eyes and gave a mysterious smile. Paul tried to hide the scepticism in his expression.

“Really? Well, I guess we’ll see. Right now I’m good with being single. It leaves more time for my programming, you know.” He gave another tight smile, as if he was trying to convince himself as well as Grams. Paul had suffered quite a lot over the last week, since Kat had left him.

Before Emma could respond, her other grandson, Chris held up a beer from across the garden and beckoned for Paul to head over. “Looks like I’m being summoned, I’ll be back, Grams.” With a kiss on her soft, wrinkled cheek, Paul walked over to his brother. “How’s it going?” Chris asked, giving his brother a firm pat on the back along with a half-hug.

“I’m alright, uh, nothing new,” Paul shrugged, not wanting to tell his recently married older brother about the break-up, “How’s married life?”

“It’s different, but Valentina’s great. And work keeps me busy.” Chris was running a dozen trendy clothing pop-up stores in the region and drove an Alfa Romeo. Though he was now a married man, Chris had been something of a hot-shot playboy before meeting his Italian wife, who’d been a student in Amsterdam.

“So, I have some news,” Chris’ dark blue eyes glittered, “I’m going to be a dad.” Paul almost choked on his beer, and blinked incredulously at Chris.

“You what now?” he asked, “Are you joking? Man, never expected that from you of all people.”

“Don’t worry,” Chris said, looking down at his shoes then back up, “I’ve accepted it. Valentina and I are moving from my flat to this crazy country house near the river. But, it’s just twenty minutes from here which Grams is excited about, especially with her great grandchild on the way.”

“Wow,” Paul broke into a grin, “That’s a huge change, Chris - sure you can handle it?”
“I think so,” Chris chortled nervously, then shrugged, “It’s kind of like a new adventure.” They both took another long draught of beer and turned to look at Valentina who was now chatting with Grams and proudly showing her four-month pregnant belly.

Emma was positively beaming, and couldn’t have asked for more joyous news at her life-celebration party.

***

Paul felt a rush of excitement as he worked on a new algorithm in his programme. It was by far the best he’d ever created, and he hadn’t even been looking for the idea – it had come to him as if in a dream. The gist was that tiny smart pieces of software would duplicate themselves and share information. They would run on smart devices which were all connected to the internet. “Pure genius,” Paul told himself as his fingers tapped away at the keys.

These smart pieces would collaborate with each other, like self-creating ‘life’ on cyber space - computer ‘bacteria’ that would grow into adaptive organisms. ‘Turchaea,’ is what Paul typed as the file name while saving it. The name was a concoction of the founding father of computers, Alan Turing, and the primordial bacteria, Archaea. “This is way too big for just me,” Paul said to himself, “Definitely needs to go on the open source community.”

And after five days of in-depth work on Turchaea, where he virtually disappeared from friends and family, it finally happened – the code ran beautifully. Waves of pride washed through Paul along with muscle-cramp pain in his fingers and sheer exhaustion. But it was all worth it. He smiled as he felt the rush from being a part of the new technological movement - the Internet of Things, or IoT - which was about to spread through the world like wild-fire.

After a microwaved chicken and potato dinner, he tested and added examples to Turchaea. Thus, Thursday evening of September 23rd, Paul van Dijk posted the getTurchaea.zip version 0.1 on his open source community. He switched his monitor off and his phone back on. Hello again friends, family - world.

***

Everyone in China went crazy. As always, they discovered Paul’s open source
posting in lightning speed and, though some of their software code was a little dirty, they jumped on the Turchaea source code. The forums exploded with feedback and within two days Paul’s Chinese RC-racer friend, Bruce, messaged him.

“Paul, it’s incredible,” he wrote, “The improvements from my Chinese friends make Turchaea smaller!” Paul grinned as he read the whole message where Bruce went on and on about the brilliance of this algorithm and all the developments and twists that had been made to the original Turchaea. And within a few days Turchaea was used in a variety of beta-released Smartphone apps and cloud services. Paul was on top of the world.

That Monday night, he woke with a start, a new idea had struck him like lightning. He could incorporate Turchea into the RC cars he loved to race. Paul was so excited that he signed onto skype at 7 am and started chatting with his German hardware friend, Thomas. “Listen,” his friend said with a tired grin, “If you get the money, we can do it easily.” Paul’s eyes sparked with excitement, though still heavy with sleep as Thomas continued,

“We’ll just use existing components and downscale everything. Um, can I go back to bed now?” Paul ignored this last remark and adjusted his glasses as he responded.

“I’m gonna grab a cup of coffee - you wanna get one too and meet back in two minutes?” Thomas stifled a yawn and sighed.

“Fine – no sleep for me. Let’s do it then.” Coffee in hand, Thomas delved right back in moments later, talking details. Paul listened then asked,

“How much money do we need and when can we have it done?” Paul now wore his Bluetooth and was in action-mode while he paced through his messy bedroom and took sips of straight black coffee.

“Hold on, Paul,” Thomas laughed, “One thing at a time. Let me sleep on this first, okay?” Before Paul could respond, Thomas had ended the call.
“THAT’S NEVER GOING to fit in a remote controlled RC-racer,” Paul told Thomas as he threw his hands in the air in disbelief. It was two weeks after their skype-chat and the two friends were in the lobby of a youth hostel in Berlin.

At the moment Paul was gaping down at all the hardware his German friend had brought with him. Thomas held up a hand. “Paul wait, this is just a prototype. When the design is finished, I’ll downscale it to fit in an RC car, I swear.” Paul arched an eyebrow, not fully convinced. But Thomas pointed at him and declared, “Believe me buddy, it will all fit in a single chip - don’t you worry about that.”

Though they didn’t have any money to miniaturize it into a single chip yet, a business loan wasn’t their first priority. They wanted to get the idea itself to work. “Come on, grumpy,” Thomas urged, “Get your laptop connected and show me your Turchaea babies and I’ll get some proper coffee to fuel our brains.”

The next few days, Paul and Thomas practically lived in the corner of the hostel lobby. The receptionists were used to all kinds of strange people, but they’d never seen two young men sit there, never leaving to go and party. The only drinking these guys did involved caffeinated beverages and the occasional dark German beer.

Finally, after three days, their hard work paid off, Turchaea was successfully integrated into the prototype. It didn’t look like a racing car at all, just a
wired suitcase, but it was in fact a very sophisticated piece of mobile-internet connected IoT machinery.

Once powering the prototype, they put it online through Paul’s home network server. Now that Turchaea was online and connected to the suitcase, the prototype woke up, created an internet cloud storage and began to replicate itself. After their baby’s ‘awakening’, a green LED blinked and a robotic voice sounded. “Hello world.”

Paul and Thomas exchanged eager grins. “Looks like our baby’s alive and kicking,” Paul said with a gleeful gleam in his dark blue eyes. Then, just like that, the mobile internet connection dropped and the robotic voice said, “Sorry, no network.”

“You know,” Thomas said jokingly, “I prefer the sound of a burp over this ‘no-network’ robot voice crap.”

“Well,” Paul replied with a laugh, “In that case…” And he quickly used his phone to record his own deep burp, easily triggered from the beer he currently held. Chuckling like schoolboys, Paul and Thomas rebooted using the factory defaults. Paul then deactivated the mobile connection, restarted the suitcase prototype and the green LED appeared yet again.

Much to their amusement, as well as that of the current hostel receptionist, a low burp echoed through the room. Paul and Thomas exchanged a look and burst into laughter. Paul held up his beer bottle. “Cheers to the cheap beer burp!” Thomas clinked his bottle with Paul’s and they drank to the birth of their new baby.

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“Perhaps you drilled too many holes,” Rafael gently suggested to his son, Jackson, as they stood in the test zone of the RC Club. Jackson’s car had just crashed and he was desperately trying to repair it with carbon rods and ty raps.

“Yeah, yeah – I know,” Jackson snapped irritably, “Can you just bring me the duct tape?” A moment later Jackson’s RC friends came over and explained how they’d just upgraded their cars using an innovative new software that caused their special-tuned firmware to push the cars to their limits. Rafael looked at the group of Jackson’s friends and asked, “Where do you get all your components from?”

“Different places,” a teenage girl, one of the only females in the club,
responded, “We swap and buy from a guy here at the club and sometimes get them through eBay. The software is open-source - top quality stuff!”

“Cool, thanks,” Rafael smiled. While he watched Jackson and his friends continue to fix the car, Rafael wondered how this whole open-sourced software worked. Was it really all online, and for free? Who, if anyone, earned money from it - who owned the intellectual property rights?

Searching ‘open source’ on his phone, Rafael’s eyes locked on a crowd-funding project by two students, one from Germany and one from The Netherlands. He motioned for his son to come over. “Jackson, come check this out.”

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As Rafael took a taxi to the Berlin youth hostel, he quickly scanned the printed document in his hands once more. He felt a wave of excitement at the thought of these remote controlled cars ‘RCJoy Racers’ that these two young men, Paul and Thomas, were working on. This was the innovative new project Rafael had been yearning for. It was perfect for the company and he was eager to, yet again, bring a successful new idea to Idrel Toys.

Ten minutes later Rafael paid the taxi, claimed a room in the hostel and grabbed a coffee from the lobby. He’d just poured in some creamer when a young man who he assumed was one of the many students approached.

“Are you Rafael?” the guy asked. Before Rafael could answer the student held out a hand, eyes bright with excitement, and said, “I’m Paul van Dijk.” Rafael tried not to gape in surprise at the young man. This boy wasn’t much older than his own son. His gaze went from Paul to another young guy who sat in the back, busy with some kind of electronics in a suitcase.

“Did I really fly all the way for these guys – they’re practically teenagers,” Rafael thought. The guy with the mess of wires looked up and called out a simple, “Hello, I’m Thomas.” Then he promptly went back to work on the suitcase.

As Paul energetically told Rafael all about the RCJoy Racer idea and Turchaea, they sat near Thomas who studiously tested the prototype hardware. The three of them made for a nice, well-rounded team – Thomas was clearly the hardware guy, Paul was the software brains and Rafael had money as well as the brand and sales channels.

“So - today, why don't we first discuss what we want, and tomorrow we'll
talk about how to make it happen,” Rafael suggested. Thomas, finally done
with his repairs, joined the conversation by launching into a twenty minute
explanation about how they wanted low-cost, high volume chipsets and
miniaturization.

Once Thomas was done, Paul added, “Our idea is based on a distributed
open source IoT-system.”

“Sorry guys,” Rafael said with a furrowed brow, “I might sound like
some naïve old guy, but what’s IoT?” Thomas raised both of his eyebrows and
exchanged a look with Paul. Did this guy really not know?

“IoT is an abbreviation for ‘Internet of Things’,” Paul began, “Every day,
new devices all over the world can communicate with each other by using the
internet. When they’re equipped with sensors and connected to algorithms
they become ‘smart’. Whether it’s a connected car, a thermostat or a smart-
watch, in the end the Internet of Things improves quality of life.”

“Okay, I think I understand,” Rafael nodded, “Sounds like IoT has
potential in a lot of fields, including toy production like with my company.
Well, I’m gonna get some rest for tonight, but let’s talk tomorrow about all
the details, okay?”

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“So,” Rafael looked from Thomas to Paul across the café table at 10:30 am
the next morning, “If I remember correctly, you guys have a miniaturized
computer in mind which can be used in all kinds of toys and you’ve already
distributed the software code among RC-racers - for free. Is that right?” They
both nodded and continued to eat breakfast as Rafael went on, “And your
software named ‘Turkey’ is based on a smart algorithm which enables the
toys to share learned behaviour and limits, and…”

“It’s called ‘Turchaea’,” Paul interrupted, “And its open sourced.” The
young man then launched into a bunch of techy explanations as Rafael’s
head began to spin. After five minutes of tech-talk, Paul tried to explain how
it wasn’t fully their idea.

“See, it’s really based on preceding open-source code and we’ve been working
with hundreds of people online – everyone openly shares their codes.”

“But who gets the money?” Rafael asked as his forehead creased. Thomas
decided to chime in here, over a mouthful of scrambled egg.

“You see,” he told Rafael, “Nobody gets paid for it, we just share software
source code. When an individual or a company uses it, they’ll post the improved version back to the community. This lets us all move full steam ahead, you know?”

“Software isn’t the issue,” Paul interjected, “The hardware is, well, the ‘hard’ part. We need to develop it properly, scaling way down from the suitcase to a single chip.” Rafael looked from Paul to Thomas.

“What do you need to be able to do that?” he asked.

“To put it simply - money, time and a production partner,” Thomas answered without looking up from his second cup of coffee. At this, Rafael leaned forward and lowered his voice, demanding their attention.

“Listen guys, RC cars are a niche in the market. If we want to make a good amount of volume, we should market to a wider range of customers. Would you guys be able to alter this project for children’s dolls?”

“We can put it in anything,” Thomas replied, “We just need the money and a production partner.” Rafael looked out the window, thinking for several moments.

“Okay,” he finally said, “I think we have a deal. Let’s get the stuff on the market before Christmas, sound good?” Thomas and Paul both broke into wide smiles, eyes shining.

“Thank you, we’ll definitely drink to that,” Paul replied with a raised cup of orange juice. The three of them clinked their orange juice glasses and Rafael summarized their next step,

“Let’s do this!”

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“Really guys, trust me. Definitely keep up with your RC-racing and everything, but let’s focus on the mass market. Children’s dolls are much more interesting than remote controlled cars,” Rafael spoke loud and clear on the conference call. If those young men really wanted to move forward they had to focus on mainstream toys.

“To be honest Rafael,” Paul said as his eyebrows drew together, “I prefer cars over of dolls – by quite a bit. We really don’t know anything about dolls, or kids for that matter.”

“Look, Rafael,” Thomas added, “We just want to make good hardware and software. We’re definitely not going to decide what type of clothes these dolls wear or how they look or anything.”
“Relax guys,” Rafael assured them, “No one’s going to make you choose doll outfits. Just give me two weeks, and I’ll arrange the marketing part. You guys just focus on the technology. Could you please take RCJoy from the crowdsourcing platform for those two weeks, and I’ll get some trustworthy people on board?” Paul and Thomas both looked worried. Rafael sensed their hesitation.

“Look, I’ll figure the doll part of it out, I promise,” he assured the two, “Next week we’ll have a production expert meet with you to discuss the first steps. Please trust me, I really believe in your idea - in your dream.” He seemed to speak with utter honesty. Thomas took a breath and said,

“Okay, two weeks is fine.”

“Yeah,” Paul agreed with a nod, “We’ll focus on the improvements.”

“Great. And remember, no worries,” Rafael smiled, “Do whatever it is you need to do. Oh, and try to figure out what kind of behaviour you want to give the dolls, okay?”

“Can we collect some insights from internet forums?” Paul asked.

“However you want to get the information is fine with me,” Rafael shrugged, “Let’s talk again next Friday, same time.”

As soon as the call ended Paul shook his head. “I’m not going to spend all my time on investigating doll behavior,” he grumbled to Thomas, “Let’s post something on a web forum to ask about it, then we’ll be ready for Friday’s call.”

Minutes later, Thomas and Paul had found a specialized ‘Children’s Cognitive Development’ forum and posted a message:
What Do You Think About an Educational, Smart Doll for Children?

Summary - We’re making a sophisticated, interactive smart doll that is both a friend and a teacher.
It looks like a normal doll but contains a miniaturized computer that enables it to learn and recognize children’s behaviour.
When children meet, their dolls will interact and play together along with the children.
This smart doll is mobile-connected to the internet which enables it to use learning programmes from other sources such as SchoolForge, Open Source Schools, and so forth. Parents will have a smartphone app to monitor the learning progress of their children.
We’re currently developing and are interested in your opinion. We would also appreciate it if you could respond to our questions:

1. Do you like this concept?
2. What functions should it have and which ones should be avoided?

Thanks in advance for your feedback!

T&P
"WE’RE A TRADITIONAL company and our business methods hail from the last millennium," Rafael started as he looked around at everyone that Monday in Idrel Toy’s monthly board meeting. His gaze also included Jason Zhing on a video link from China. Rafael had passed out his ‘Opportunities of the Internet of Things’ and began the projected slideshow from his laptop. Once he was sure he had everyone’s attention, he continued,

“We at Idrel Toys design, manufacture and sell products via retail and online channels. And we know exactly who our customers are, what they like, how they make purchasing decisions and how high they’re willing to pay. We always keep track of market share and recommendation indicators from customers. In a nutshell, everything seems well and good.” Now Rafael got to the interesting part.

“The only problem is…” Here Rafael paused for several beats and made solid eye-contact with each and every board member before he went on. “The only problem is that we only sell products.” His colleagues looked at him as if he’d become slightly unhinged. Through the video, Jason was first to respond.

“Sounds like we’re doing great to me, Rafael. And what else would we sell besides products?” Rafael stood up and started to pace around as he went into full-on presentation mode.

“Idrel’s brand is strong and our distribution channel is good for the moment, I agree,” he replied, “But, the question is, how long will it stay like this? We face cheap competition that’s slowly growing and taking over market share. We have to find a way to ensure that customers will return to us in this
day and age. Is there maybe a way we can achieve this by incorporating the 'Internet of Things', or IoT, into our company? IoT enables us to make our toys smart and add value by offering content.”

Though there was some throat-clearing and a few mumbled words, everyone listened attentively. Rafael sat down again, leaned forward and spoke in his most convincing voice, “I say we look at the future, move ahead, and keep our lead in the market by leaps and bounds. I say we shift from ‘buying’ customers to ‘subscribing’ customers. And how can we do that?”

The others could see that he was getting worked up over this one, but they weren’t surprised. Rafael Silva was always the forward-thinker of the team, constantly vying for change. So they waited quietly as he answered his own question. “We can do this by using the Internet of Things. Let’s put out some awesome pilots and give IoT a try.” Maria, head of Idrel’s finance department, interrupted him at this point.

“Good ideas Rafael, we hear you. But please give us a specific example of how we can embrace this ‘Internet of Things’, or IoT as you phrased it. We ship and sell products for children. We don’t offer any service.” Mutters erupted throughout the room at this ‘show-down’ of sorts. Rafael gave a tight smile – he’d anticipated the most resistance from Maria and was prepared.

“A very good question,” he said, “Thank you Maria. Let me start here - we have a customer-focused goal to improve the life of each and every one of our loyal buyers. IoT fits into this vision perfectly, and I believe that we already offer a service. For example, with our dolls.” Maria opened her mouth to question him, but Rafael beat her to it.

“In a way,” he explained, “Idrel dolls offer children friendship - a lifetime buddy to play with. Kids learn from engaging in pretend-play. I simply suggest we merge products like these dolls with a service.” Ignoring whispers throughout the room, Rafael took a doll from the display case against the wall and held it up.

“We should put technology inside this doll, or maybe something more soft and cuddly like a teddy bear. And with a simple electronic chip and a mobile internet connection to our new Idrel Toy content platform, we can offer educational programmes in the teddy bears that teach young children new languages, counting, even reading. Parents can load new learning programmes into it when their kids get older – the possibilities are endless.” Rafael was now in full-swing, but Maria forcefully interrupted.
“Rafael, hold on a moment,” she said in her most authoritative voice, “This does not match our vision whatsoever. We offer life-time friends to children, not some crazy technological addiction. I’ve never heard of such a thing in my whole time with the company!” She took a deep, calming breath, and proceeded a little more gently. “It’s an innovative idea for sure, but I think we shouldn’t get involved with IoT at the present time. Let’s keep it simple. Why don’t we develop an Idrel partner programme and gain sales with our existing retail channels?”

Most of the other board members nodded and mumbled in agreement as Maria added, “I don’t want to simply wave this away for good, but getting into IoT requires a dramatic strategy change. I suggest we ask our existing external consultants to work on it and come up with an IoT-market analysis in three months, okay?” Rafael let out a sigh. “Sheep,” he thought.

After the board meeting, ‘Idrel-IoT-Innovations’ became a very small action item on the minutes of the meeting and was assigned to one of his marketing colleagues. Rafael now knew that the corporate culture of Idrel Toys Inc was not ready for IoT yet. If he wanted to move ahead, he’d have to find another way.

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Out of the 46 responses to the ‘Children’s Cognitive Development’ forum post, which included both good, bad, helpful and unhelpful feedback, one in particular stood out to Paul. It was from a guy with the screen-name “John1990” and his response was quite extraordinary. The message began,

“As a teacher in South Korea, I really like the idea of offering technology to kids as a way of learning. Along with being a part-time teacher while studying, I follow research in cognitive learning.”

The response spanned four more pages after that, including his data, theories and assumptions about children’s learning strategies, source references and a bullet-wise analysis on the methods of how children play and learn in particular age groups. The message ended with,

“I’m fascinated by children’s learning processes and try to assist
parents and teachers by getting their kids interested in learning through robot-play. I’m convinced that we need more than just screen-based devices.

Currently, I’m working on my thesis and writing a development programme for children. It’s based on a pilot project I did over the last two months with 250 kids (aged 8-12) using a tablet app which contained in-game learning tasks. Although the results aren’t published yet, I can assure you that I see significant learning improvements in the gaming kids compared to their peer group.

I would like to ask you for a short interview that I could use in my thesis. It enables me (as a non-tech person) to understand and explain the technical possibilities of toy robots for today and the future. I can assure you I won’t take too much of your time!

Thanks in advance,

Best regards,

John.

Paul turned to Thomas and said, “This is someone we absolutely have to talk to.”

“Yeah,” Thomas nodded, “It definitely seems like he’s on the same track as us, and can add a different point a view. Let’s drop him an email suggesting a morning Skype.” Paul sent a quick response to John, made a copy, then forwarded it all to Rafael with the subject line, ‘Em-Teaching Strategy’.

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“Why can’t the time-zones be reversed - ugh,” Paul grumbled to himself as he got up at the ungodly hour of 9 am, which was afternoon in South Korea, to Skype with John. With a huge yawn, he pulled his fingers through his messy brown hair, put on his glasses and answered the Korean teacher’s skype call.

Paul’s eyes blinked in surprise at what he saw. He was, quite frankly, shocked. In place of the male Korean teacher he’d expected ‘John1990’ to be, was a young woman. A really, really attractive young woman with vivid green eyes and dark blond hair, right around his age. He felt suddenly very
self-conscious and ran a hand over his hair again, hoping he didn’t look too dishevelled.

“Hey, I’m Paul.” He tried to sound casual.

“Hey there, Paul, I’m Jane. How’s your morning going?” She had a really nice voice, with a cool accent.

“My morning’s good, thanks. You’re, uh, not Korean,” he said with a blush. He was stating the obvious.

“Yeah, I know.” Jane replied with a light laugh, “I’m from Christchurch, New Zealand. I moved here to South Korea two years ago after university. Just wanted to explore the world outside my little native island, you know?”

“That’s really cool,” Paul smiled shyly. He was about to ask about her screenname, when she said,

“Sorry, on top of thinking I was Korean you probably thought I was a guy too, right?” Before Paul could respond she explained, “I used to go by ‘Jane1990’, but got tons of these ridiculous fake private messages, so I changed to ‘John1990’. And that did the trick.” She smiled widely and Paul noticed how warm and down-to-earth her smile was.

A moment of pleasantries later and Paul, getting his head mostly together, finally asked about the project at hand. She answered, “I seriously think traditional schools are outdated these days. We really need to reach the next level of education, like the School-of-Clouds concept based on the idea that children are able to learn on their own and teach each other. The only thing we need to do is facilitate this process, you know?” Paul nodded, impressed with her enthusiasm.

“So, how do you think we can change the school system?” Paul asked. Jane considered this for a moment as she brushed her shoulder-length hair away from her cheeks.

“You know,” she finally answered, “I was really inspired by Sugata Mitra on TED-Talks. He talked about how these kids, who were supposedly in ‘learning slumps’, taught themselves English and computer programming. If we offer kids robots filled with know-how, open questions and some emphatic behaviour, it’d be amazing.” Paul watched her continue, his mind in a half-mesmerized state as he stared at her sparkling eyes – this girl was incredible.

“If we could also hook these doll-computers up to a School-of-Clouds,” she continued passionately, “And get them to collaborate, we could be a huge part of future schools. Children could do what comes so naturally to them, so
intrinsically - learn through playing.” Paul opened his mouth to agree, but Jane
continued,

“And don’t forget, three years ago the UN reported that 58 million primary
school-aged children dropped out of school. With Em we can make learning
accessible to kids all over the world. But the thing is, I programmed the chil-
dren’s lessons in Scratch and my possibilities are limited. So, when I read your
forum post, I was intrigued. I’d like to start a pilot project using Em and, Paul,
I need you guys to get me started on this.”

Jane now sat back and looked a little shy from having opened up so much
to a virtual stranger, who was pretty cute at that. “Absolutely.” Paul responded
after thinking a moment, “Of course we’ll help you with a pilot learning sys-
tem. It sounds fantastic.” He grinned and nervously adjusted his glasses before
continuing, “I think we can make Em so that it allows users to run Scratch
programmes. The emphatic behaviour would be based on Turchaea’s self-adap-
tive method. You see,” he started, but Jane held up a hand and laughed.

“Please, Paul, hold off on all these techy terms. You’re making my head
spin,” she grinned and added, “When do you plan to have Em working? I’d
love to test it.”

“Um, let me have a chat with the other guys to see about that, and I’ll drop
you a line as soon as I find out, okay?”

“Perfect, thanks Paul,” she said with a little wave, “And nice to meet you.”

“You too, John1990,” Paul gave a playful smile before they signed off.