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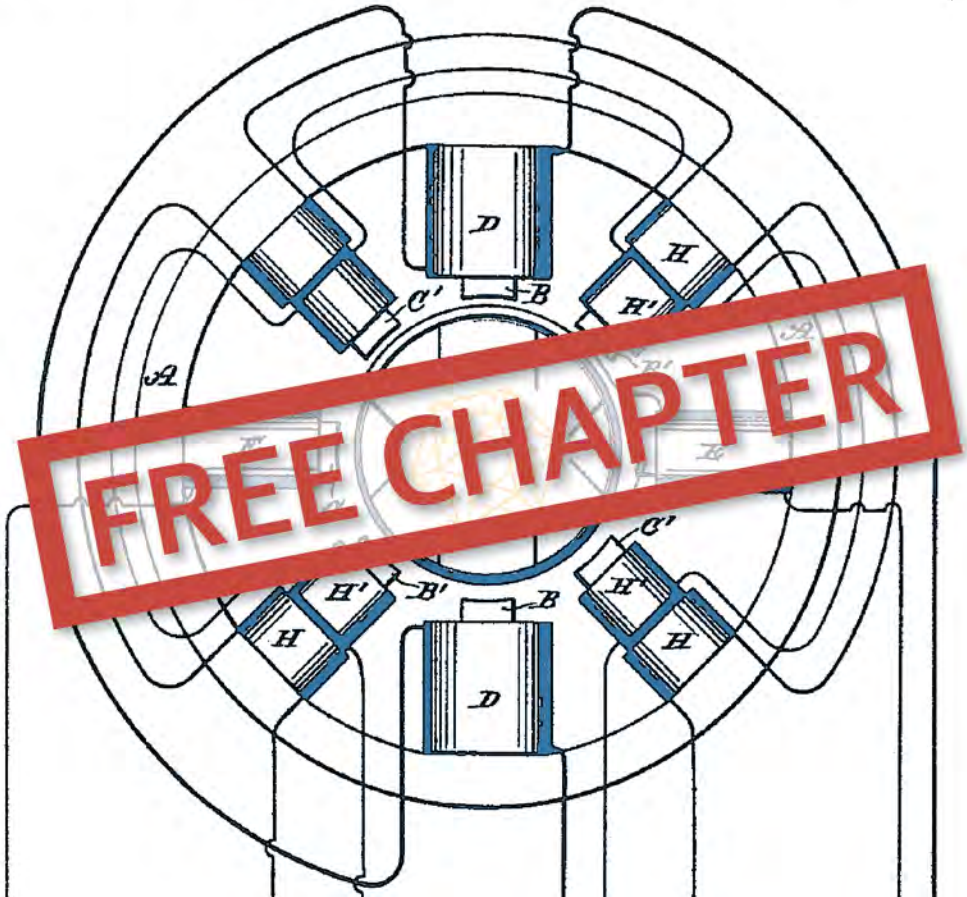
Dirk Slama, Frank Puhlmann,
Jim Morrish & Rishi M. Bhatnagar

Enterprise IoT

Strategies & Best Practices for Connected Products & Services



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Enterprise IoT

Current hype aside, the Internet of Things will ultimately become as fundamental as the Internet itself, with lots of opportunities and trials along the way. To help you navigate these choppy waters, this practical guide introduces a dedicated methodology for businesses preparing to transition towards IoT-based business models.

With a set of best practices based on case study analysis, expert interviews, and the authors' own experience, the Ignite | IoT Methodology outlined in this book delivers actionable guidelines to assist you with IoT strategy management and project execution. You'll also find a detailed case study of a project fully developed with this methodology.

This book consists of three parts:

- Illustrative case studies of selected IoT domains, including smart energy, connected vehicles, manufacturing and supply chain management, and smart cities
- The Ignite | IoT Methodology for defining IoT strategy, preparing your organization for IoT adoption, and planning and executing IoT projects
- A detailed case study of the IIC Track & Trace testbed, one of the first projects to be fully developed according to the Ignite | IoT Methodology

Dirk Slama is the Director of Business Development at Bosch Software Innovations.

Frank Puhlmann is head of Project Methodology and Solution Architecture at Bosch Software Innovations.

Jim Morrish is the Founder and Chief Research Officer at Machina Research.

Dr. Rishi Bhatnagar is the VP of Digital Enterprise Services at Tech Mahindra Research.

"The Ignite | IoT methodology is a very valuable tool for IoT product managers, IoT project managers, and IoT solution architects. Open sourcing Ignite | IoT and allowing for crowd-sourced input perfectly fits the open philosophy of the IoT."

—**Dr. Volkmar Denner**
Chairman and Managing Director,
Bosch Group

"Enterprise IoT will be the dominant theme for industrial companies in the coming decade. This book provides actionable guidelines for business and IT executives to master the challenges and reap the rewards of this transformation."

—**Anand Mahindra**
Chairman and Managing Director,
Mahindra Group

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Enterprise IoT

This Excerpt contains Chapter 6 of the book *Enterprise IoT*. The full book is available on *oreilly.com* and through other retailers.

Dirk Slama, Frank Puhlmann, Jim Morrish, and Rishi M. Bhatnagar

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Enterprise IoT

by Dirk Slama, Frank Puhlmann, Jim Morrish, and Rishi M. Bhatnagar

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CHAPTER 1

Smart City

The smart city is a very interesting possible application of the IoT. In this chapter, we will examine some of the key drivers of the smart city, as well as the corresponding relevance of the IoT. We will then take a look at a case study of the smart city in action.

Key Drivers

Global megatrends such as population growth, urbanization, climate change, and resource limitations are placing considerable pressure on cities around the world. Population growth and urbanization, in particular, threaten to aggravate existing problems like congestion, crime, smog, and aging public infrastructure.

Cities are becoming increasingly important in a global context. This is due to a trend toward urbanization, which means that, in the future, more and more people will live in urban areas. As a result, the majority of resources will be consumed in urban areas, giving cities the greatest potential to implement measures for the conservation of these resources.

Life in cities is becoming increasingly complex. This is because sectors such as mobility and energy are merging and becoming interconnected, a development that is partly driven by new communication technologies. Complex challenges faced by cities, such as reducing CO_2 emissions and securing energy supply, require integrated solutions that are aligned with the interdependencies that exist between individual sectors and silos.

Human behavior is also changing. This can be seen most clearly in areas such as mobility. The focus has shifted outward from owning a car to wider mobility opportunities. Innovative solutions like car-sharing services are seeing more widespread use, and intermodal transportation is becoming increasingly important.

Smart cities could be the answer to these transitions and challenges. Complete, integrated solutions are an essential part of managing this new urban model.

Every city has its own definition or ideas about what makes a smart city. What all of these different perspectives have in common is the intelligent use of integrated solutions. Speaking

about the Smart City Wien framework strategy, Mayor of Vienna Michael Häupl describes it as "an umbrella strategy that aspires to create smart solutions to complex problems," while Wolfgang Volz of Bosch Software Innovations notes that "a smart city breaks down silos to create a web. It does this via a technological platform that interconnects systems to optimize performance and create new business models. Smart cities focus on the citizen, not only on the technology."

Smart City Examples

The first functioning smart cities are now emerging in North America, Europe, and Asia. For the most part, these start with intelligent solutions in one particular sector. In time, this is extended to include further intelligent solutions across other sectors. Few smart cities currently address all urban challenges. However, the number of smart cities out there is certainly growing...

SMART CITY PROJECTS IN CHICAGO: IMPLEMENTING LIVE PILOT TESTS

There are three main application areas for smart city and open data projects in Chicago, namely investment in infrastructure, focus on economic development, and promotion of community engagement:

Infrastructure investment

The city plans to invest in a new fiber-optic ring to achieve gigabit speed over an open network. By combining this new network with a competitive price point, it hopes to create an incentive for digital technology companies to locate in, or relocate to, Chicago. The City of Chicago has run out of unlicensed radio spectrum. It is working, together with the Federal Communications Commission on Spectrum, on the concept of sharing spectrum allocated for public safety, so that, when available, it can be used for small cells, cell phones, and so on.

Economic development

With a view to improving the existing Chicago health system, the city is investing in Chicago Health Atlas, a website used to display aggregate, map-based health information. It is also investing in Windy Grid, a program and platform for real-time, open data infrastructure investment. In collaboration with the Illinois Science and Technology Challenge, the Illinois Open Technology Challenge has been launched to bring government, developers, and communities together. The city also offers hosted web space to support people or organizations that want to create services that make Chicago better.

Community engagement

Much of the community engagement work in Chicago is carried out by the Smart Chicago Collaborative. Initiatives include:

The City that NetWorks
: A key positioning report on what steps the Smart Chicago Collaborative would like to take in the area of digital inclusion.

Digital Skills Initiative
: A central hub for coordinating technology training across departments and delegate agencies that have received federal funding.

Connect Chicago
: A loose network of more than 250 places in the city where Internet and computer access, digital skills training, and online learning resources are available free of charge.

Smart Health Centers
: Trained health information specialists are placed in clinics in low-income areas to help patients connect to their own medical records and find reliable information about their conditions.

SMART CITY PROJECTS IN RIO DE JANEIRO: USING SAFETY TO ATTRACT NEW BUSINESS

Smart city initiatives in Rio de Janeiro largely center on safety and security, both in terms of disaster prevention and management, and freedom of information.

Originally planned for the Olympics in 2016, a fatal landslide in 2010 prompted Rio's mayor to bring forward the construction of a Center of Operations to tackle natural disasters and coordinate relevant emergency responses. The center was built in just eight months in partnership with IBM and Oracle, and is used by city decision makers to manage day-to-day city services, as well as for the aforementioned purposes. The center additionally allows these two types of service to be linked. For example, garbage trucks are coordinated via GPS so that, in an emergency, these trucks can be repurposed for other tasks, improving response times for the city.

To facilitate the flow of information, there is a press room located within the Center of Operations, where all media, television, and radio companies are accommodated also. In addition to enabling these more traditional information networks, the city has also made a significant amount of its data available to the public, including information on crime and mortality rates, as well as daily weather and congestion reports.

SMART CITY PROJECTS IN STOCKHOLM: STRUCTURING A DIALOG WITH CITIZENS AND PRIVATE COMPANIES

The main focus for Stockholm as a smart city has been to bring its citizens, government, and other constituent parts together, enabling simple, effective communication, and an open flow of information.

One such example is the city's investment of €70 million in high-quality, accessible e-government services since 2007, which has created over 50 new digital services and cut management costs substantially.

The city's fiber network is managed by a public company named Stokab. Formed in 1994 to create a forward-looking fiber-optic infrastructure, the company is also charged with fostering a growth environment, one which favors competition and development throughout the Stockholm region.

Another major communications development in Stockholm is the establishment of the Kista Science City, an innovation cluster specializing in ICT. Companies such as Ericsson, Microsoft, and IBM are among those with a presence in Kista, while 6,800 students are now studying ICT courses at Stockholm University and the Royal Institute of Technology in Kista Science City.

The city of Stockholm is working toward energy and transport efficiency via a number of initiatives, such as the Royal Seaport smart district, which aims to be CO_2 neutral by 2030, using the smart grid to enable electricity in different houses at different times of day.

It is also exploring ways to make better use of existing traffic monitoring and congestion mechanisms, and has implemented a Green IT initiative to reduce environmental impact through the use of IT, as well as to limit the impact of the IT sector itself.

SMART CITY PROJECTS IN BOSTON: CONNECTING CITIZENS WITH CITY SERVICES

The Mayor's Office of New Urban Mechanics in Boston (MONUM) is responsible for the three core programs that make up the city's smart masterplan: "Participatory Urbanism," "Clicks and Bricks," and "21st Century Learning."

Participatory Urbanism

Participatory Urbanism describes how smart technologies are fostering a new wave of citizen involvement in their community. The projects that form part of this program are intended to support the creation of new, citizen-centric products and services. Initiatives include:

Citizens Connect

This smartphone application enables members of the population to make their neighborhoods better by giving them an easy tool to report service problems, starting with a pilot SMS version called "citizens connect txt."

Community PlanIt

A platform to explore how online platforms can complement in-person community meetings, as well as trying to reach audiences that might not attend community meetings.

Innovation District Welcome Home Challenge

A competition focused on attracting and growing businesses in Boston's Innovation District.

Participatory Chinatown

Participatory Chinatown is a video-game-like platform that aims to engage a broader range of people in informative and deliberative planning and development conversations.

Clicks and Bricks

Clicks and Bricks is a program of projects that investigates how new technologies are linking the building of the city to how it is managed and experienced. Most specifically, Clicks and Bricks focuses on how to link designers and technology specialists outside of City Hall with leaders and staff from the city's Public Works and Transportation departments. Initiatives include:

Redesigning the Trash System

The city is partnering with IDEO to tackle this challenge by means of human-centered design.

Street Bump

Street Bump is a mobile app that helps residents to improve their street. As they drive, the mobile app collects data about the smoothness of the ride. That data provides the city with real-time information that it can then use to fix problems and plan long-term investments.

City Worker

To help city staff better manage infrastructure and respond to citizen requests, the city has developed a smartphone application that allows workers to easily check their daily work list and access and record information about the condition of city infrastructure such as street lights, trees, and roads.

Adopt-A-Hydrant

A pilot project that encourages Boston residents to shovel out snowed-in hydrants during the winter. Through the app, residents can claim hydrants they intend to shovel out after storms.

Complete Streets

A project led by the Boston Transportation Department, Complete Streets is an effort to improve the flow of people and goods through Boston.

21st-Century Learning

21st-Century Learning is a series of e-education projects that aim to deliver convenient, integrated, and life-long learning to the citizens of Boston. It also aims to facilitate relationships between educators, students, and parents to improve both the in-school and out-of-school educational experience. Initiatives include:

Boston One Card

As part of the city's effort to have its schools, community centers, and libraries provide a seamless system of educational opportunities for young people, the city is piloting a single card that provides access to all these resources for Boston Public School students.

Discover BPS

This web app helps parents navigate the public school options available to their children.

Where's My School Bus

This app allows parents to view the real-time location of their child's school bus on their computer or smartphone.

Autism App/Assistive Technologies

The city is working with two local companies and an international robotics company to develop new learning applications for children with autism.

Classtalk

Classtalk is designed to help teachers send text message reminders to students about homework and tests.

MONUM is also considering education from an open data perspective. It believes that opening up school-related data such as student behavior, grades, and disciplinary records would create massive opportunities for value-added education services and after-school programs.

SMART CITY PROJECTS IN HONG KONG: FOCUSING IN ON ICT

Hong Kong's approach to becoming a smart city has been to focus intensively on ICT and what it can bring to the life of the city. This is most clearly visible in their approach to information and data management, improvements to WiFi networks, and development of e-government solutions.

Electronic Information Management was central to Hong Kong's 2008 Digital 21 Strategy, the aim being to ensure that information is better managed and more readily available. The approach focuses on three key areas, namely content management, records management, and knowledge management.

The Office of the Chief Information Officer is responsible for the city's main web portal. Their aim is to satisfy 80% of citizen requests via e-government services. As of December 2012, there were 49 government mobile applications and 38 mobile sites. By placing WiFi facilities at designated government premises, the GovWiFi program aims to transform Hong Kong into a wireless city, providing free wireless Internet to all citizens.

In terms of open data, the government holds a significant amount of data that could be of significant value to the public (e.g., demographic, economic, geographical, and meteorological data, historical documents, and archives). However, this information has not historically been in a format that facilitated value-added reuse by third parties.

In order to combat this, Hong Kong's government has launched a data portal entitled Data One. This 18-month pilot scheme has made geo-referenced public facilities data and real-time traffic data available for free. A competition held to find the best applications of this data was won by an app that located the nearest doctor and tracked patient appointments. Following the success of this trial, and support from citizens and industry, the government plans to continue with the portal, and gradually add more datasets.

Business Models and KPIs for Smart Cities

A smart city project must be financially sustainable. It is not enough to think about funding for just the initial stages of the project, as any project must live long enough to change the life of the city. As such, once the city's most specific pain point has been identified (this will be the initial focus of the project), other use cases must also be defined to ensure life-long sustainability for the project. These uses cases should generally either increase city income or reduce city expenditure to a degree that enables the project to be funded as a whole.

The concrete benefits of the smart city can be classified into three main categories, namely financial savings, creation of new revenue, or resolution of a pain point:

New revenue

Barcelona has reduced its parking costs by 22% while increasing its parking revenue by between 20%–30%. With the implementation of smart parking solutions, cities can increase efficiency, reduce time wasted in traffic congestion, and introduce simple automatic billing, to name a few examples.

Savings

In France, 20% of drinkable water is spoiled by leakage attributable to aging pipes. By implementing smart water grid solutions, a city can reduce consumption and thus save money.

Pain point

On French public transport, 1 in 2 passengers feel unsafe (47%). By increasing visible security on transportation, those responsible for France's public systems would help to resolve a major pain point. In the long term, the increase in security should also be beneficial in terms of passenger numbers.

When measuring the success of a smart city initiative, relevant KPIs could be simple, quantitative ones (the number of 0-emission buildings for example, or a measurable increase in parking revenue), or they could be more complex, qualitative improvements (such as an increase in the city's attractiveness, or greater happiness among citizens). The difficulty lies in agreeing on feasible, concrete KPIs when the customer is a city. Cities generally do not have a global picture when it comes to the improvements made available by the Internet of Things. The role of a supplier is to smoothly translate the city's needs into smart solutions, with adapted KPIs.

Keynote Contribution: Wim Elfrink, EVP at Cisco

Wim Elfrink is Executive Vice President for Industry Solutions and Chief Globalization Officer at Cisco, and is a leading expert on the subject of smart cities. In the following interview with Wolfgang Volz, Project Manager (Smart City) at Bosch Software Innovations, he talks about his vision for the smart city, as well as how it can best be measured in terms of drivers, criteria, and success.

Wolfgang Volz: What first attracted you to the subject of smart cities?

Wim Elfrink: My initial interest in the subject came about eight or nine years ago, as I traveled through China, India, and Africa. The Western world is aging. As the United States grows older and Europe shrinks, the populations of India, Africa, and the Middle East are increasing by more than 40% to 50%!

The 21st century will therefore be dominated by shifting dynamics and massive demographic change, as the world grows more and more heterogeneous. One of the principal trends will be in global urbanization. 50% of the world's population now lives in cities and urban areas for the first time in history. This figure is set to reach 70% by 2050. We're talking transformation on a huge scale!

For example, I used to live in Bangalore, where I built Cisco's second headquarters. Six hundred new people join that city every day. That means you need a new school every quarter, or a new hospital for each new year! Obviously, this is not a demand that can physically be met. So I started to think about what technology could do, how it could help. And that's how Cisco's IoT initiative came about. At Cisco, we now call this the Internet of Everything—the connection of people, processes, data, and things.

My father was an architect in Rotterdam. He was a physical architect; I became a digital architect.

We can now put a digital overlay on top of anything physical and say, "What can this enable?" This opens the way for unprecedented opportunities, increased productivity, and new revenue. We think that, in total, the IoE can create $19 trillion of economic value over the next decade, and one of the biggest areas is in urban services of smart cities, which can capture €3 trillion in value. To realize this IoT/IoE opportunity, information and communications technology (ICT) must become the new essential infrastructure along with water, gas, and electricity.

Wolfgang Volz: Can you tell us more about the concept of "urban services"—more specifically, what the major drivers are?

Wim Elfrink: Back in 2000, the IoT was associated almost exclusively with RFID. Nowadays, about 15 billion devices are connected to the Internet, which is still just 1% of what's

possible. We estimate that this figure will be closer to 50 billion by 2020. This translates to 300,000 devices, from mobile devices to industrial sensors, being connected each hour. It's happening as we speak—this is the smart revolution, right now. One of the major drivers for this, as ever, is financial. The price of devices and sensors is no longer prohibitive, and the lifetime of batteries is increasing. The explosion of smartphones, tablets, and apps has led to the generation of large amounts of data, as well as opening up new opportunities to monetize this data. We're in a new era of digitization. We also have IP version 6 now, which enables us to handle data from a massive number of devices. All of these considerations, plus the emergence of new standards, are the tipping point for new services.

Wolfgang Volz: In your experience, which use cases are most attractive for smart cities? And what exactly does "smart" mean to you?

Wim Elfrink: Over the past few years, the definition of the smart city has evolved to mean many things to many people. Yet, one thing remains constant—an essential part of being "smart" is knowing how to utilize ICT and the Internet to address urban challenges. To use the example of India again, where new cities are in the planning stage, one of the fundamental questions being raised well upstream of breaking any ground is: do we build a road structure first or a digital infrastructure? There is a paradigm shift occurring here—at a basic level, what does connectivity mean in this day and age: is it physical or digital?

I have two boys, 15 and 17. They have two physical states: they are asleep or they are online. They work differently, study differently. When I arrive in a city, I look around; I am educated physically. While I look up, they look down—at their phones. They get all of their information online. The next decade will be the decade of data. All these devices (or "things") generate massive amounts of data. According to IDC, only 0.5% of this data is currently being used or analyzed. The challenge for the smart city is to determine how to turn this data into information, this information into knowledge, and this knowledge into wisdom, by proposing the kind of *what-if* scenarios that lead to the creation of urban services.

Every city has its own specific pain points. For example, if you're in Mumbai, it may be sewage systems, in San Francisco it may be parking, in Hamburg it may be dockside services. The main use cases we have seen to date have been in the areas of parking, lighting, and water. In Hamburg, for example, we have managed to massively reduce traffic through the introduction of smart parking. But the really exciting thing is when we can mash up these services to move away from a traditional stovepipe system and create a truly horizontal infrastructure. Think about the possibilities—if you combine, say, street lighting services and public video monitoring systems—you can remotely monitor the number of people in a given square on a given evening and adjust the level of street

lighting in that area accordingly. Barcelona is one of the best smart city examples I can think of. They have created an entirely new governance model, mashed up services to create a horizontal infrastructure, and embraced technology as an integral part of their urban infrastructure.

Wolfgang Volz: You publish a lot about the smart city. In some of your recent publications, you offered some excellent examples of how the IoT/IoE can contribute to the urban environment. Can you give us a brief summary?

Wim Elfrink: Yes, of course.

As I mentioned previously, Barcelona is an excellent example. Mayor Xavier Trias has developed a showcase smart city that anticipates the creation of $3.6 billion in economic, social, and environmental value over the next decade through the use of the IoE. Citizens in Barcelona can interact with government officials via kiosks or mobile devices, alert one another to accidents or potholes, find parking spaces or store discounts on their cell phones, or have their sensor-equipped garbage cans picked up when they're full—not just on Tuesday mornings.

The IoE is real and is functioning in real-life environments—not only in Barcelona, but in numerous other smart cities around the world, including Copenhagen, Amsterdam, Chicago, Hamburg, Songdo, Abu Dhabi, and Brisbane, to name just a few.

Cisco has been working with the city of Barcelona for a while now to tackle its messy parking problems. The local government has installed a network of light and metal detectors to sense whether or not parking spots are occupied. Drivers get information on which spots are free through a combination of apps and digital signs linked to the Internet. The city also collects valuable information on parking and driving patterns that can improve traffic management, and drivers can use the app to pay for their spots. The city says these new urban services boost parking revenue by $50 million.

Wolfgang Volz: What do you see as the main success criteria for smart cities?

Wim Elfrink: I think four main criteria need to be satisfied:

Visionary approaches and thought leadership

You need to have a smart city master plan that addresses the question of what ICT can add. Without a master plan, it's not going to work—it will remain a set of fragmented and disjointed ideas.

Global open standards and smart regulations

The city needs to provide protocols, standards, and regulations that enable the use of free data. Existing regulations will need to be rethought with a view to removing old-world barriers; looking to the future rather than the past.

Openness to public-private partnerships and participation
: Cities need to create a business model that allows for investment and carefully consider what the best model for a public-private partnership may be. (Pay as you go? A one-off investment?)

Balanced ecosystems integrating global, international, and local facets
: The creation of innovation centers for local urban services will be an important element of this.

Wolfgang Volz: How do we measure the success of a smart city? What are the key performance indicators?

Wim Elfrink: To my mind, there are five clear indicators of a smart city's success:

Investments
: Can you attract investors and create jobs by marketing yourself as a smart city?

Energy savings
: 70% of the world's energy consumption is by cities. A large proportion of this usage is waste! We project that it is possible to reduce consumption by 30%–50% using smart approaches.

Reduction in water consumption
: 30% of water is lost through leakage. A simple sensor-based warning system could generate massive savings and reduce waste by up to 50%.

Traffic improvement
: 30% of traffic is caused by people looking for a parking space. That's 30% of traffic, which is total redundancy, and easily fixable.

Reduction in crime rates
: Put simply, if the social environment improves in a city, people are happier, and the crime rate goes down.

Wolfgang Volz: Thank you for this great insight into the Internet of Everything and the potential of smart cities for our future.

Relevance for IoT

New developments in software, IT, and the Internet have made it possible to reach out to any member of an urban population in seconds, whether on a one-to-one, one-to-many, or many-to-many basis. Smartphones, social media, and blogs provide a direct way for members of the public to share their interaction with the city. Open data like city maps, parking guidance, and public transport timetables further feed into this bank of information. Once both the people

and the things in the city connect to one another, as is envisioned, it should quickly become possible to make more intelligent use of the city infrastructure, particularly where this may currently be limited during peak times.

Connecting things like cars, homes, and public or private systems via sensors opens up multiple opportunities to meet such challenges. However, it is important to understand that the connection alone is not enough; the connected things and associated data have to be utilized in a meaningful way. They must become an active part of the stakeholder's daily interaction with the city—for example, informing both the family and the fire service in the event of a fire in the family home. This is the essence of the emerging "Internet of Things and Services": to connect physical and virtual worlds, users, and business entities, thereby enabling new possibilities and synergies. For the first time in history, we can create a connected city that directly improves our quality of life.

The key technological challenge is to link all systems via an open platform that can be used as broadly as possible, as the cross-pollination of data is integral to success. What we need is a city platform capable of integrating data from all services in the city, including power plants, transportation, buildings, traffic, industrial machinery, security systems, and more. A solution like the Bosch Smart City suite should have the capability to collect, process, and analyze enormous data flows from the complete spectrum of smart city layers. By leveraging such capabilities and data, these technologies would be able to help city administrators make informed key decisions and support citizens in their day-to-day lives.

The smart city is closely linked to ICT, and benefits from the expertise that has been built up over time. The smart city is not only about huge projects, but also about minor improvements. Innovation-led projects are the best way to explore the smart city's possibilities. Public-private collaboration should create many business cases, with a smart city system leveraging various layers of existing ICT investment, such as infrastructure, operations, data, processes, and so on.

The following key architectural principles, standards, and integration requirements should be considered when designing smart city ICT architecture:

- Open standards and capacity for integration—by hardware providers, city service providers, city administration and citizens, and third-party solution providers.
- Reusability of data, availability of data, provision for multidimensional data.
- User-driven, flexible, and user-friendly upper-layer solution implementation.

Monaco Case Study

On July 10, 2012, the Principality of Monaco and the Bosch Group signed an agreement targeting Monaco 3.0, a connected city. Since then, initial feasibility studies have been conducted with the Principality in order to jointly explore the connected city concept, including the following application areas: communications, mobility, energy, security, and health. As a first

direct result, an operational on-site demonstration has been developed to illustrate the capabilities of Bosch's technology platform, as well as its implementation as part of a connected city approach. In this approach, Monaco's existing services, systems, and data are integrated into the platform while new and innovative services are developed in parallel. The four examples we will look at here are use cases of the demo and were defined around the topic of mobility together with Monaco's Public Works, Environment, and Urban Development department.

The essential goals to be achieved were as follows:

- Operational on-site connected city demo
- Seamless and secure data exchange between different departments for faster decision making and creation of new services
- Improvements to mobility, security, and quality of life in Monaco
- Better interaction with citizens and visitors
- Reduction of operational costs while introducing new and better services

THE CITY PLATFORM

The City Platform serves as a central communication and integration platform for existing and new systems. It allows the implementation of new processes and services by managing captured data, with existing systems remaining sovereign in terms of internal data and functionalities. In the event of direct access to existing department systems not being possible for reasons of security or privacy, data that is relevant for other attached systems can be explicitly pushed to the City Platform. The Bosch City Platform allows the interconnection of data and services from various sources, which facilitates the creation of new services and enables greater visibility of available data. Data reporting, statistics, and analytics can be viewed via one common tool. This means participating departments can easily create additional services, or adjust and model rules and processes. Basing cross-departmental communication on a single platform and sharing common data significantly reduces IT costs and enables easier information flow.

Figure 1-1 shows the Asset Integration Architecture (AIA) for the Monaco City Platform.

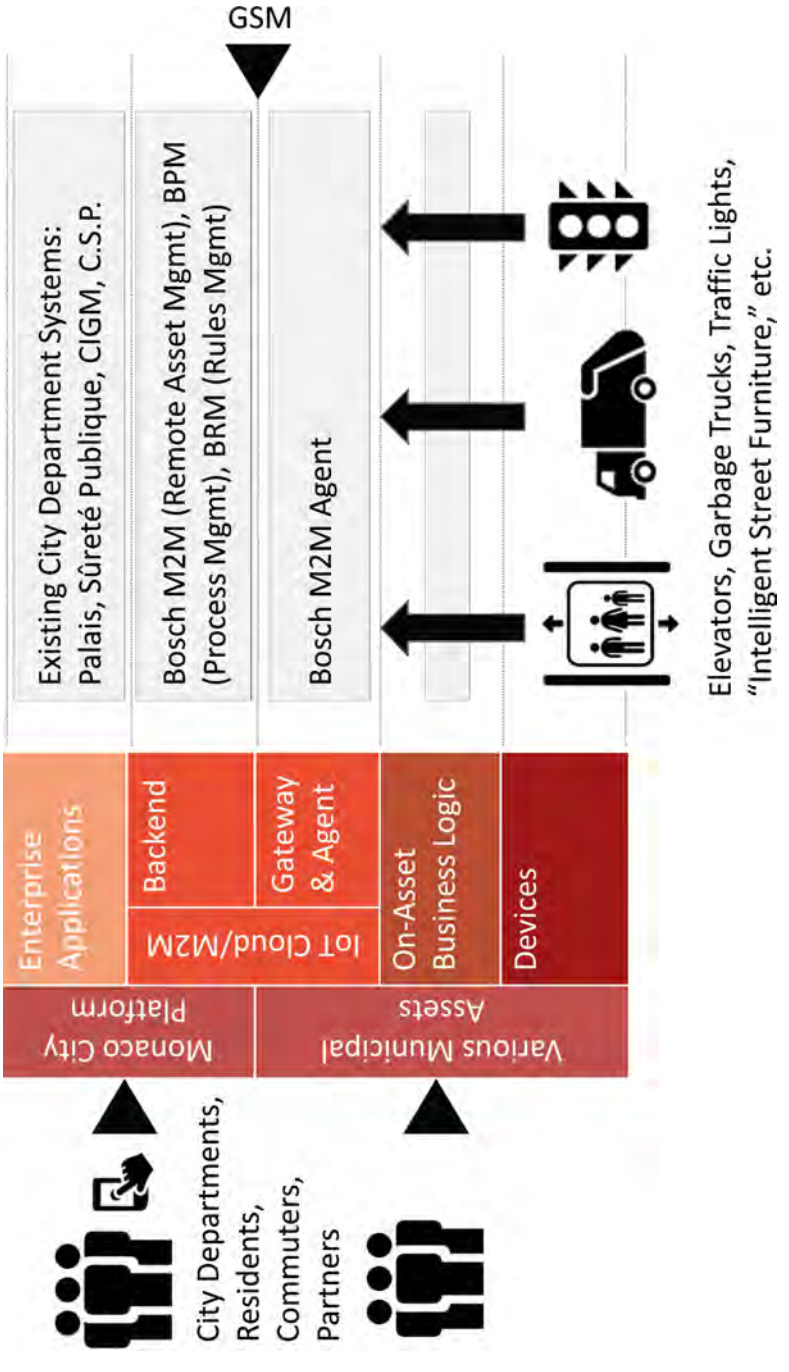


FIGURE 1-1. AIA for Monaco City Platform

CROWD MANAGEMENT AT AND AROUND THE MONACO TRAIN STATION

Bosch cameras will be mounted in defined areas of the Monaco train station to monitor entrances and exits, as well as points of interest (such as elevators). The cameras are intelligent; the integrated Intelligent Video Analysis (IVA) module analyzes a permanent video stream recorded by each camera and reports the number of people present. This data is added to the actual video stream to form a separate metadata stream, which is securely transferred into the backend via a virtual private network. Crowd management is integrated with camera intelligence. This sends alerts to the platform, which allows better management of crowding at elevators. It also means traffic control can be redirected immediately to avoid a buildup of congestion as people leave the station. As a result, pedestrian traffic flows in and around the train station will be much smoother. Long-term data collection enables statistical analysis for the purposes of urban planning and city development. Easier information sharing between different parties (e.g., ambulances and fire brigades) enables public service departments to deliver a higher level of security and service.

FLEET MANAGEMENT BY GEOLOCALIZATION

Everybody loves a clean city, but nobody wants to be stuck in traffic behind a garbage truck. Three of Monaco's garbage trucks will be equipped with Bosch geolocalization sensors to provide information on their current locations. These sensors are capable of capturing geolocation data, which will be transmitted via GSM networks to the City Platform. Sensor data contains a limited number of data fields (e.g., sensor ID, timestamp, data type, data value) and will be enriched with further meta and master data before being processed in backend systems. This data allows a dynamic presentation of the truck ID and current location on a map for better resource allocation, route planning, avoiding downtime, or preventing traffic jams. In a subsequent step, current vehicle routes and positions will be added to the mobility app for smartphones to assist citizens, commuters, and tourists in their choice of travel route through the Principality.

Geolocalization of garbage trucks offers the following benefits:

- Information about current truck location
- Reduction of traffic congestion
- Improved traffic flow for a given infrastructure
- Optimization of necessary service time per house and street
- Better resource planning, including reassignment of available capacity, and quick replacement of broken trucks

MONACO 3.0 MOBILITY APP

The Bosch Connected City is a win-win for public services, residents, commuters, and tourists. Within the demonstration platform, a smartphone app is provided to selected test users.

This mobility app brings connected technology together with public services, such as bus networks, parking lot management, waste collection, and roadwork information. It also provides up-to-date information to users and helps various city departments to operate more efficiently. Furthermore, the app has a crowdsourcing function that allows people to actively participate in and improve city life. In addition to the existing fault recognition system, users will be able to log relevant visual and status information about the condition of public services such as elevators or escalators.

The bidirectional smartphone app offers the following benefits:

- Route assistance for users with reduced mobility
- Simplified use of public transport to reduce traffic flows and CO_2 emissions
- Involvement of citizens and visitors in city life and development
- Receipt of up-to-date feedback on conditions and quality of public services and infrastructure
- Significant reduction of downtimes due to quicker awareness

Lessons Learned and Outlook

Didier Manning, Bosch Software Innovations, summarizes his experience with smart city projects as follows [DB1]:

> *As cities evolve, they bring new challenges for technology developers and manufacturers alike. It used to be enough just to deliver a good product. But the city of tomorrow demands more. Take cameras, for example. In the past, camera manufacturers simply weren't concerned with what the city was planning, or what exactly the cameras would be used for. Today, the technology must offer a solution; city administrators expect to see not just a sophisticated camera, but a business plan as well. That business plan should ideally be carefully tailored to the customer city and its needs. For companies, this means they have to work more closely with their customers and put themselves in the customer's shoes. The customer-supplier relationship will change as a result. One challenge that applies particularly to software is the timely processing and analysis of data; after all, a connected city generates at least 100,000 events per second. When it comes to getting connected, a city has two basic options. One calls for equipping things (sensors/actuators) with local intelligence. The advantage of this option is that the system can collect data where the data is generated, and will forward it only as dictated by the logic in place. However, the downside is a loss in flexibility should the city choose to install a new or overarching system. The second option is central control: a central platform receives all data and then routes it as needed.*
>
> *The reality will probably lie somewhere between these two options. Targeted application and the cost-benefit effect will ultimately decide what makes more sense: a centralized or decentralized system.*

All of this is still quite a way off, since, in most cases, cities lack a strategic structure. What's needed is a kind of authority, someone to take the lead and shape the city of tomorrow. This way of thinking is strange to most cities, but if they want to get connected, they have to change how they do things—they need to get out of their silos and into a network.

PART I CONCLUSIONS AND OUTLOOK

A large part of the M2M and emerging IoT solutions rely on wireless connectivity, and this is a trend that we see increasing in the future. The GSMA is the global trade association of mobile operators and related companies, and is responsible, among many other activities, for the development and promotion of new business opportunities and ecosystems. Naturally, the GSMA is very close to the pulse of the IoT market and an ideal candidate to discuss with us the current state of the cellular IoT space and also future developments. The following Interview with Alex Sinclair, CTO of GSMA, provides an interesting outlook.

Jim Morrish: What are the leading cellular M2M/IoT applications right now?

Alex Sinclair: Machine-to-machine (M2M) connections accounted for 2.8% of all global mobile connections, or 189 million, at the end of 2013, according to GSMA Intelligence (GSMAi), so it is still very much a nascent technology at a relatively early stage in its development. We believe that with the right standards and regulation in place, it will have a fundamental impact on the way we live and work, reducing waste and inefficiencies and delivering major social and environmental benefits in security, healthcare, transportation and logistics, education, and energy, among many other sectors of the economy. However, it is also having an impact right now.

Regulation

Advances in the M2M market have often been underpinned by regulation, on a national level, as well as in verticals such as automotive and utilities.

Scalable Opportunities for MNOs in Automotive

The car automotive sector is by far the largest scalable opportunity in M2M for a number of reasons:

- Long production and in-use cycles for connected vehicles present the need to future-proof connected cars, and consequently OEMs are fitting LTE modules into vehicles.
- Additional revenue-related streams are presented by the connected car, such as the insurance market, which has introduced pay-as-you-drive usage-based plans for consumers that have helped to lower costs significantly.

- Both OEMs and infotainment designers have seen the potential to develop in-car entertainment services within connected cars.
- The opportunity to implement multibilling mechanisms and combine multiservices via a single connection (e.g., the connected car). AT&T, for example, has introduced its AT&T Drive service which aims to package connectivity, data analytics, and infotainment for both automakers and developers specialized in providing live linear TV and video-on-demand streaming services within automotive vehicles.

Fleet Management Tracking Services

Real-time GPS tracking used in fleet management represents a huge segment for a range of global operators. Fleet management enables companies to track both individual vehicles and shipped cargoes, including vehicles that need to be serviced. Fleet management also helps to ensure that drivers are obeying speed limits and following the best routes.

Government Mandates

Other initiatives such as Emergency Call (eCall), a road accident alert system that requires an embedded in-vehicle SIM using satellite positioning and mobile connectivity, is scheduled to be integrated into all new vehicles in Europe over the next few years. Russia is also in the process of deploying an accident notification system called ERA-GLONASS, and Brazil has introduced another regulation-driven telematics project tracking stolen vehicles called SIMRAV, which allows all new vehicles to be fitted with a capability to be tracked and disabled in the event of theft.

Implementing Legislation: Smart Metering

Smart metering is also an area where we are seeing huge growth driven in part by legislation in the European Union. The systematic use of embedded mobile connectivity to create smart utility grids and smart energy environments can improve suppliers' ability to effectively manage demand for energy, and enable consumers and businesses to use energy and water more efficiently. Mobile connectivity can give both utility companies and their customers' real-time information about energy and water usage, enabling them to spread demand across the day and take action to reduce wastage. Millions of residential electricity, gas, water, and heating meters are becoming "smart," meaning they can be monitored, controlled, and managed at preset intervals, be it hourly or daily. To date, EU member states have committed to rolling out close to 200 million smart meters for electricity and 45 million for gas by 2020, at a total potential investment of 45 billion.

Implementing Legislation: Healthcare

The healthcare sector is another vertical that is seeing positive traction in development terms and has the potential to see huge growth if provided with a positive regulatory envi-

ronment. It is a challenging area, where mobile operators need to work closely with government and other regulatory stakeholders at a national level. We have already seen government-led projects in this sector in markets such as Singapore, France, and the United Arab Emirates—countries that have instigated initiatives on mobile health, while in the United States, government policies are in place to incentivize mHealth (e.g., ePrescriptions and incentives for hospitals to administer in order to reduce readmissions).

B2B2C mHealth services are also a big opportunity with some operators, such as Telefónica and Orange, seeing good traction with mHealth offerings. Many operators have dedicated health divisions in their operational structure. Such a setup has been established in order to seek the best way to provide sufficient healthcare support via a multitude of technologies, including Bluetooth and cellular.

Jim Morrish: Are there any specific industry initiatives that we should know about?

Alex Sinclair: The GSMA recently issued guidelines for the IoT market that outline how devices and applications should communicate via mobile networks in the most intelligent and efficient way. You should also be aware of the GSMA Embedded SIM Specification for remote SIM provisioning, which is now being deployed by operators around the world.

The guidelines called "IoT Device Connection Efficiency Guidelines," are designed to support device and application developers as the IoT market develops and are intended for use by all players in the mobile ecosystem, ensuring that mobile networks can efficiently accommodate the increased number of connected devices and services resulting from the rapid growth of M2M. The guidelines will help IoT device and application developers expand the number of devices connecting to mobile networks, whilst preventing service outages and ensuring optimal performance that will ultimately enable the market to scale across a diverse range of sectors, including automotive, transportation, utilities, and health. The guidelines include a number of best practice areas such as data aggregation within devices, nonsynchronous network access, application scalability, and guidance on how to manage signalling traffic from deactivated or out-of-subscription SIMs. They have received the backing of leading mobile operators, including AT&T, China Mobile, China Telecom, China Unicom, Deutsche Telekom, Etisalat, KT Corporation, Orange, NTT DOCOMO, Tata Teleservices Ltd., Telefónica, Telenor Connexion, and VimpelCom.

The GSMA's Embedded SIM specification allows mobile network operators to provide scalable, reliable, and secure connectivity for M2M connected devices that are often hermetically sealed, such as in the connected car or smart meters. It also facilitates over-the-air operator provisioning and management, which provides service flexibility to end customers. The GSMA's Embedded SIM specification promotes a common global architecture that will reduce costs, drive efficiencies, and further accelerate the rapidly growing

M2M market, which is set to reach 244 million global connections this year according to GSMA Intelligence. A number of organizations have launched compliant solutions, including AT&T, Etisalat, NTT DOCOMO, and Telefónica; as well as Gemalto, Giesecke & Devrient, Morpho (Safran), Oberthur Technologies, Sierra Wireless, and Telit. The GSMA also commissioned independent research from Beecham Research that estimated that the immediate industry-wide adoption and deployment of the GSMA Embedded SIM Specification will deliver 34% higher market growth by 2020.

Jim Morrish: Mobile industry has been waiting for the M2M hockey stick for 5–10 years, do you still see this happening?

Alex Sinclair: GSMA Intelligence recently released its latest figures that show that global cellular M2M connections are currently set to reach close to one billion by 2020. At the current rate of trajectory, global cellular M2M connections will reach 974 million by 2020, growing at 26% per year (CAGR) in the period between 2014 and 2020. We believe that this growth rate could go above 40% a year if a number of favorable market conditions are achieved, leading to a potential two billion cellular M2M connections globally by 2020. These could include the introduction of additional government policies enabling a wider deployment of cellular M2M in key sectors such as utilities, smart cities, automotive, and healthcare, in addition to increased standardization on remote provisioning and APIs, and significant M2M module cost reduction enabling a wider range of connected products and services.

Jim Morrish: What are the biggest opportunities for the mobile industry in the Internet of Things?

Alex Sinclair: Recent research commissioned by the GSMA highlighted that the two biggest opportunities lie in the connected car and consumer electronics markets. A number of these we have already highlighted, but others such as the wearables market, for example, will also be a significant area of development. It currently has the perception as an extension of the smartphone, but this will change. It also has a diverse use potential across business and consumer sectors.

Jim Morrish: Can you give some examples of where mobile connectivity has proven key to unlocking value?

Alex Sinclair: Mobile operators' M2M revenues are dependent on application type, scale, and on the approach to service delivery. For example, connectivity-only deals reap far less revenue than end-to-end (E2E) solutions. So it is important for the mobile operator to be able to provide a more value-added offering, either via acquiring expertise or by partnering with other companies, in order to increase revenues from M2M. For example, KT

Corporation achieved this by launching a Taxicall solution generating higher revenue, increasing customer stickiness, and reducing churn. We are still only at the beginning, but Vodafone, for example, recently revealed that its M2M revenue as of end of June 2014 was up 30.7% year-on-year "driven by increased innovation and a widening range of vertical markets."

About the Authors

Dirk Slama, Director of Business Development at Bosch Software Innovations, has 20 years experience in large-scale distributed system design (EAM, SOA, BPM, M2M). He is also coauthor of *Enterprise CORBA*, *Enterprise SOA*, and *Enterprise BPM*.

Frank Puhlmann, Head of Project Methodology and Solution Architecture at Bosch Software Innovations, has a strong background in distributed systems design, including research, project execution, and methodology.

Jim Morrish, Founder and Chief Research Officer at Machina Research, is a respected M2M and IoT industry expert with over 20 years experience in strategy consulting, operations management, and telecoms research.

Dr. Rishi Bhatnagar, VP Digital Enterprise Services at Tech Mahindra, has around 20 years experience in managing global customers in the United States, the UK, Germany, Africa, and India. He is an IoT thought leader and recognized business planning and strategy expert.

Community Members

Veronika Brandt joined Bosch Software Innovations in 2010. As Senior Expert for Solution Architecture & Methodology, she focuses on implementing the IoT methodology in projects with respect to requirements analysis and solution design. Before joining Bosch, she worked as an IT consultant for Siemens and BearingPoint. She holds an MBA from the LMU Munich.

Peter Busch is Senior Expert for Corporate Research of Robert Bosch with 20+ years experience in international project management, coaching, and training in SW/HW development. He holds a diploma in computer science and business administration and has worked for, among others, JP Morgan, Sun Microsystems, and the Bosch Group. His current research topics are new business models and ecosystems for all engineering disciplines.

Tobias Conz has been working for Bosch Software Innovations since 2011. As Senior Solution Architect, he is responsible for one of the company's Industry 4.0 solutions for machine monitoring. Before joining Bosch, he worked as consultant for Software AG and IDS Scheer AG.

Peter Fürst's expertise in innovation and innovation management is built on 15+ years of experience. As a managing partner of five i's innovation consulting, he supports companies in their aim to grow through new products, services, and businesses. Peter also trains individuals and teams in innovation management through open seminars, and is a lecturer at the University of Applied Sciences – Vorarlberg.

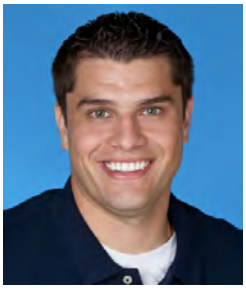
Jason Garbis, Director of Product Marketing for Identity Management, RSA, has over 25 years of experience in roles that span engineering, professional services, product management, and marketing at various technology companies. Currently, he's responsible for RSA's go-to-market initiatives for Identity and Access Management, and the Internet of Things. He has a BS in computer science from Cornell, an MBA from Northeastern, and is also a published author.

Anuj Jain is a Managing Director at Bosch Software Innovations. He is an entrepreneurial executive with experience in general management, sales, business development, marketing, and alliances. His previous work experience includes Oracle, Nucleus Software, and Honda Cars India.

Michael Jungmann, Managing Director, Dr. Wehner, Jungmann & Wambacher, has a strong background in the development of distributed systems and seven years' experience in the delivery of international large-scale IoT projects. As a co-founder and managing director of WJW, Michael works closely with customers in Industrial and Consumer IoT projects to derive requirements from business goals, leads system architecture, project, and supplier management.

Sven Kappel joined Robert Bosch in 2014. As Senior Expert for Embedded Software & Connected Services, he focuses on IoT Ecosystems within the Bosch business sector Mobility Solutions with respect to requirements engineering and coordination. He is also responsible within the corporate department for the open ideation community. Before joining Robert Bosch, he worked as project leader and senior manager at Bosch Engineering.

Dr. Stephan Otto, Group Manager, Fraunhofer-Gesellschaft, studied computer science and economics. From 2006 to 2009 Mr. Otto gained professional experience in software engineering in different industrial projects (logistics, automotive, healthcare). In 2009, he entered Fraunhofer as a senior researcher. In parallel, he finished his PhD thesis. Since 2010, he is a group manager and is active in the areas of sensor fusion, real-time analysis, and positioning.



Brian Phillippi, Product Marketing Manager for the Embedded Control and Monitoring team at National Instruments, helps manage the I/O modules for the company's industrial, embedded, and data acquisition platforms. Phillippi joined NI in 2011 as an applications engineer and moved to product marketing in 2012. He holds a bachelor's degree in mechanical engineering from Brigham Young University.

Christiane Prager, Business Development Intern, Bosch Software Innovations, has several years' professional experience in strategic management and business development in IT and the Internet industry. Currently, she is responsible for organizing the book project *Enterprise IoT* and its marketing program at Bosch Software Innovations. Christiane holds a BA in business communication management from the University of Applied Sciences Berlin and is working toward an MA in business management.

Mike Prince, Principal M2M Platform Product Manager, Vodafone Group, has 20 years' international experience in telecoms technology and product management with equipment vendors and mobile network operators. He has been working in Vodafone M2M since 2009, initially as the technical architect for the connectivity management platform. Today he leads the product management team responsible for Vodafone's expanding range of global M2M platform products.

Narayanan Ramanathan is VP & Global Head of the Connected Engineering & Analytics Practice at Tech Mahindra and has been instrumental in building this practice as one of the fastest growing global engineering service providers. NR has more than 17 years of professional experience in product design and engineering management. Widely recognized as a thought leader among customers, industry analysts, and media, he has published 31 technical papers in national and international conferences.

Adi Reschenhofer is the founder and CEO of Wyconn. After working for many years on M2M, branch connectivity, and management of enterprise networks for some of Europe's largest firms, Adi launched Wyconn in 2013 with the vision of a radically simpler approach to meeting the needs of OEMs and enterprises, telecom companies, and solution providers in the area of IoT.

Jamie Smith, Director of Embedded Systems, National Instruments, is the global leader of product management and go-to-market strategies for the company's industrial and embedded products, including NI CompactRIO, Vision, Motion, and Wireless. Since joining NI in 1996, Jamie has held key leadership positions in sales, engineering, product strategy, corporate development, and marketing. He has been recently recognized as a Top Embedded Innovator by Embedded Computing Design and received an R&D 100 Award.

Robin J. Smith, Product Management/Strategy Director at Oracle Corporation, is responsible for the Oracle Stream Explorer Event Processing Platform encompassing real-time, event-driven architecture and complex event processing technologies. Evolving and delivering award-winning, innovative products, including the latest Oracle Stream Explorer (a business user friendly visual tool), foundational technologies of Oracle OSGi Fast Data (real-time streaming analytics), and IoT strategies.

Christian Thiemich is located in Singapore and is responsible for shaping the future of manufacturing in Asia by delivering Industry 4.0 solutions. As Senior Solution Architect at Bosch Software Innovations, he is closely working together with customers and Bosch industry experts. Being an Agile development enthusiast, he is clearly driven by business value. Over the last few years, he supported quite a number of complex projects across industries as coach and consultant.

Mitko Vasilev has worked in high technologies since 1996. He has worked for service providers, industrial companies, and lately (since 2003), for Cisco Systems. As of 2013, Mitko is Technology Leader in the EMEA IoT team and CTO/co-founder at openBerlin, Cisco IoT Innovation Platform.

Arthur Viegers joined MongoDB in 2013. As Manager Central Europe & Solutions Architecture, he leads the pre-sales team for MongoDB in central Europe. With over 20 years of experience in logistics, fleet, and engine management systems, he specializes in IoT/M2M solutions. Prior to joining MongoDB, Arthur ran his own fleet management software company with operations in Europe, USA, Brazil, and China.

Silke Vogel joined Bosch Corporate Marketing & Sales in 2012. As Strategic Marketing Manager, she integrates market and customer expertise, enabling new business models and quick decisions. The Web3.0@BBM is one key initiative in this scope. Before joining Bosch, she has worked for 10 years as product marketing manager in an innovation incubator called "Domain Driving Assistance" with the Tier 1 supplier Valeo.

Wolfgang Volz is Senior Project Manager Smart City at Bosch Software Innovations. Wolfgang joined Bosch in 2000. He started within the cooperate research group as project manager and moved on to setting up activities in Asia Pacific in the energy field and managing startup investments. Since 2013, he has been responsible for Smart City projects at Bosch Software Innovations and the strategic alignment of Smart City activities within the Bosch Group worldwide.

Roman Wambacher is Co-Founder and Managing Director, Dr. Wehner, Jungmann & Wambacher. Roman has a technical background in designing embedded systems. Supplemented by deep domain knowledge of the machinery industry, he has 8 years' experience in the delivery of international large-scale industry IoT projects. As a co-founder and managing director of WJW, Roman has specialized in development of value-based business cases, embedded system architecture, as well as project and supplier management.

Dr. Ted Wilke is Senior Principal Engineer at Intel Labs. Ted leads a team that researches large-scale machine learning and data mining techniques for Intel Labs. He developed his expertise in data center technologies over his 17 years with Intel. Ted holds a doctorate in electrical engineering from Columbia University. He won Intel's highest award in 2014 for starting a venture focused on the processing of graph-shaped data.

Colophon

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