Collaborative Internet of Things (C-IoT)

for Future Smart Connected Life and Business

Fawzi Behmann • Kwok Wu

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Foreword

I recall sitting in the Bell Labs auditorium in Holmdel, New Jersey in 1980 listening to a lecture by the head of research, Arno Penzias. He had recently won the Nobel Prize for his radio astronomy work on the origins of the universe. But this day he was evangelizing a technology we all knew, but did not fully appreciate; at least that was Dr. Penzias' message. As engineers and scientists we did not lack appreciation for the *invention*, the microprocessor. The Intel 8080 and Motorola 6800 replaced thousands of discrete small- and medium-scale integrated circuits used in random logic designs, cutting development time and costs dramatically. Some in the room were even determined to invent the next generation of microprocessors. That was not what Dr. Penzias was proselytizing. His was a challenge of *innovation* with the microprocessor. That vision was one of thousands of microprocessors in homes, automobiles, and offices. By sharing his vision, he was spurring us to think not about problem solving but about possibilities. At the time, I dare say most of us failed to grasp the full import of his message because of our linear thinking. Engineers in particular are prone to linear thinking. We are skilled at wrapping our minds around a single complex problem, going ever deeper, searching for clever ways to overcome natural barriers to achieve a novel and useful design.

Even in hindsight we think linearly, as does much of the general public. If you ask "who changed America's homes by lighting them with electricity?" you are likely to hear the name of Thomas Edison, not Nikola Tesla and certainly not James Watt. Yes, Edison is credited with the invention of the incandescent light bulb, but he waged a long legal and publicity war against Tesla's invention of alternating current (AC), advocating his own choice of direct current (DC). In that way he impeded, not hastened the lighting of America's homes. Without AC generation and transmission, we would all need DC power plants in our basements to light our homes. Tesla made centralized power a practical and commercial reality. As for James Watt, it was his steam turbines that converted fossil fuel, primarily coal, into electricity so that it could be transmitted over Tesla's network to power Edison's bulb. Without Watt's steam engine, Edison and Tesla's inventions would have been subjects for demonstration in undergraduate physics.

Behind the invention of the Internet is a similar story. Vint Cerf and Robert Kahn are the names that come to many engineers when asked about the origins of the Internet. That recognition is richly deserved. Their contribution of TCP is foundational to today's network, and without their guidance and advocacy, the Internet would not have evolved to the one we know today. Yet most of the general public knows little or nothing of TCP. It is more likely that when they think of the Internet, they see the World Wide Web and the web browser, invented by Tim Berners-Lee and Marc Andreesen, respectively. While the public is not likely to recognize those names either, they do recognize the names of Steve Jobs and Bill Gates, and so they may receive popular credit. That too is deserved, without the personal computer, the Internet would look very different indeed. Perhaps, the most underappreciated Internet engineers are Dr. Emmanuel Desurvire and Dr. David N. Payne. Without their invention of the Erbium Doped Fiber Amplifier (EDFA) or the invention of modern fiber-optic cable, Internet backbones would be operating over coaxial cable at speeds of megabits per second, not terabits per second. We would be stuck with our 38 kbps voice band modems. Remember how much fun it was downloading a song or an image with that? To be fair, it took all of these inventions and contributions to make our Internet a reality.

These stories are tales of the convergence of inventions at a single place and time in history that unleashed floods of innovation that flowed for decades, transforming societies, businesses, and even cultures. No one sat down and decided that to have a successful Internet, they would need a reliable transport protocol, fiber-optic communication, a multimedia web protocol, personal computers, and a browser. However, when they all came together in the early 1990s, innovators and venture capitalists began to see and explore the possibilities. In the late 1990s and early 2000s, the public, investors, and media saw new sites and businesses announced daily, as eCommerce, eBusiness, and B2B (business-to-business) were added to the lexicons of the world. Some companies rose from nothing to great heights, such as Webvan, only to fall again as unsustainable. Others, such as Egghead, saw their entire business model turned on its head. An industry it had helped create, the personal computer industry, and a technology they made popular, the voice band modem, turned on them. Their success made their brick and mortar franchise obsolete. Software could be downloaded without going to the local Egghead store, and much of the software was free.

But all of that is history, where are we now and where are we going? If we have learned anything from the history of invention, innovation, and adoption in the last 200 years, it should be humility. If you need evidence, look at the aftermath of the dot-com bubble or read a 10-year-old article from the popular press on the future of technology. As the President of AT&T Labs, I was often asked about the next great innovations and what they meant for our networks, which ones would drive bandwidth growth in our homes and businesses, and how they would change the way we work and recreate. My answer was that I did not know what applications and innovations would drive our networks and lives; that response never failed to disappoint the interlocutor. But what I did share with audiences inside and outside AT&T were technologies and

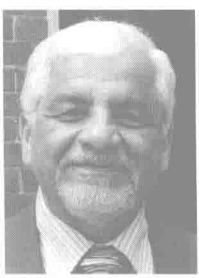
trends that would shape that future. Those technologies and network trends were the subjects of investigation and innovation of the Members of Technical Staff at AT&T Labs, and I had the great privilege of seeing their work daily. What I could predict was the exponential growth in bandwidth, at 40–50% each year for decades, as postulated at Nielsen's Law, a corollary to Moore's Law, and what I could see were technologies that mattered in the shaping of our future.

In a broad sense, "Collaborative Internet of Things (C-IoT) for Future Smart Connected Life and Business" by Fawzi Behmann and Kwok Wu presents the reader with such a view of emerging technologies, and how at this point in time, they will work together to usher forth another flood of innovations, changing our lives. The theme of the book, Internet of Things or IoT is a term meant to capture the pervasiveness of the Internet, the wide adoption of mobile computing and connectivity, and their incorporation into everyday things in our lives. Those technologies are leading directly to the ubiquity of embedded computing in the most common place and also into the most complex items in our lives. There are already shoes, pet collars, and light bulbs connected to the Internet, and our homes and automobiles are living out Dr. Penzias' vision of thousands of embedded processors. Add to those technologies cloud computing, the introduction of IPv6, and the emergence of Big Data analytics and we begin to see the possibilities and models for adoption that are explored in this book.

Few if any of us can predict the next Facebook or iPhone. But by identifying technologies that matter and a likely framework for their evolution and adoption, we can begin to see the possibilities, much as Dr. Penzias urged us to do back in Holmdel NJ.

G. Keith Cambron
President and CEO of AT&T Labs, retired

About the Authors



Fawzi Behmann
President, TelNet Management Consulting, Inc.

Fawzi Behmann is the president of TelNet Management Consulting, Inc., a results-driven firm incorporated in 2009 in Texas, USA. The focus is in providing consulting services in the areas of empowering smart communications and networking and providing insights in several vertical markets. Company capabilities include the development of global strategic initiatives, products, solutions, training, and support in the areas of Internet of Things (IoT), wireless, public safety, enterprise, industrial, medical, supply-chain infrastructure, and big data analytics.

Fawzi Behmann has many years of experience in global communications and networking spanning supply chain from semiconductor, networking equipment, and service providers in Canada and the United States. This in turn helped in understanding customers' requirements, market and technological trends, developing strategy, and plan of execution applying best of practices.

- With coauthoring the book Collaborative Internet of Things (C-IoT) for Future Smart Connected Life and Business, Fawzi Behmann has pioneered the development of early-IoT system for telecom in the late 1980s and early 1990s based on ITU TMN M.3000 standards.
- As a Consultant/Executive Marketing Director since 2009, he provided support to Power.org, a nonprofit worldwide Trade Association, in advancing $5 Billion dollars Power Architecture (Power PC) processor technology and promoting ecosystem solutions in select key markets. Fawzi develops corporate strategic plans and facilitates business collaboration with developers, academia, and other forums. Key served markets include cellular LTE/Wi-Fi communications and networking and server/big data analytics.
- As a consultant, Fawzi has been supporting public safety projects based on risk management approach. The focus is in the areas of communications and networking for emergency command and control, radio, data networking, and

video surveillance. Fawzi also collaborates with other consortium members and suppliers in defining turnkey integrated solutions-based geographic information system/global positioning system GIS/GPS and following international standards for Fire Fighter Cover Safety Plan.

- As a senior member of IEEE and the Chair of IEEE Communications and Signal Processing Joint chapters in Austin, TX, Fawzi organizes monthly technical seminars, workshop, and outreach programs for the local professionals and academia. He serves as Central Texas PACE chair, NA Distinguished Lecturer/Speaker coordinator, and the Chair of Local Arrangement and Marketing Chair for IEEE International Globecom and leads the automation of PACE program for IEEE USA.

Among other key achievements:

- As a Director of strategic marketing with Motorola/Freescale in the United States, Fawzi developed wireless technology positioning and market trends for products and solutions. He articulated value proposition in supporting scalable broadband traffic, multicore, multi-threading SoC – System on a chip, scalable input/output, and scalable security for diverse markets. Fawzi led networking working group at International Technology Roadmap for Semiconductors (ITRS) in defining networking platform vision and roadmap for the next 15 years, which was issued as a part of ITRS publication.
- As a senior product and solution manager with Nortel Networks, Fawzi defined Intelligent building structured wiring, Internet-based LAN – local area network product management, IP – Broadband services node switch/router product for the edge of the network, and product release of Core WAN – wide area network switch. He supported pilot project serving 10 000 clients for a residential broadband services.
- As a project and team leader and acting section manager, Fawzi was responsible for defining multi-year, $50 million strategic corporate R&D and Network Management program for Teleglobe, Canada (now TATA Communications). He championed the definition, specification, and development of monitoring, control, and supervisory network management system. The system was implemented for Teleglobe Telecom at local, regional, and national levels. Fawzi led the development of state-of-the-art network control center, which was equipped with graphical real-time display, and LED (light-emitting diode) of world-map identifying facility failure and impact on traffic and services.

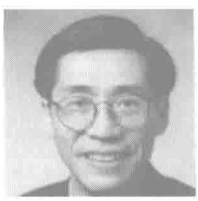
Fawzi has been an agent of change at three fronts: Moving from analog world to the digital world in the service provider space, penetrating the enterprise space with rapid acceleration of technology to IP, and embedding intelligence into the semiconductor space.

Fawzi has been active in international forums. As a member of the Canadian Delegation team, Fawzi participated in the development of ITU M.3000 standards for Telecom Management Networks in Geneva.

Fawzi organized over 1000 h of technical sessions and international conferences and held over 250 h of media briefings. He has written and published several white papers and has been a keynote speaker and presenter at several conferences domestically and internationally.

Fawzi holds a Bachelor of Science Honors in Mathematics with Distinction from Concordia University, Masters in Computer Science from Waterloo University, and an Executive MBA from Queens University in Canada. Fawzi was a recipient of the Freescale CEO Diamond Chip Award (2008) and recently an IEEE R5 Outstanding Member Award (2013).

Fawzi Behmann can be reached at Fawzi.behmann@telnetmanagement.com.



Kwok Wu, PhD

Head of Embedded Software and Systems Solutions, Freescale Semiconductor.

Dr. Kwok Wu, an award-winning industry veteran and sought-after speaker, has been awarded 2012 Innovator of the Year by ECD – Embedded Computing Design Magazine for his platform approach to Wireless Smart IOT Gateways.[1]

In addition, Kwok was awarded the 2011 Innovative Networking Product Award, from the Broadband World Forum with Secured Broadband multi-service Gateway. He was also a recipient of the 2012 Best Networking and Communication Product Award, Smart Metering at Australia, and New Zealand Summit.

Dr. Wu has many years of diverse experience in advanced embedded systems and software. He has delivered high-performance scalable software platforms and products for Freescale's Power Architecture, ARM, and ZigBee SoCs in the wireless broadband networking, telecommunications, enterprise, consumer, automotive, industrial, smart energy, and health segments.

He has held various executive management positions at AT&T Bell Laboratories, Lucent Technology, Actel, AMD, Lattice, and Freescale Semiconductor. Kwok is a member of the IEEE Computer Society and holds a Treasurer position at the Austin Chapter of IEEE Communications Society, and he holds a PhD, EECS (Computer Engineering) from the University of Texas at Austin.

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[1] http://embedded-computing.com/articles/2012-solutions-freescale-semiconductor/

Preface

Every day, the market is bombarded with information and news about Internet of Things (IoT). This comes in a variety of forms such as articles, books, seminars, and conferences.

This book deals with the explosion of information on IoT with a simplified visionary approach for the future of IoT. Today, we witness a discrete IoT solution (point solution) within a given vertical market. The focus in the future is a collaborative intelligence that will impact our connected life and businesses. The future or next-generation IoT will be called Collaborative Internet of Things (C-IoT) in this book. The focus is on core concept that has impact on improving the quality of our lives and also improving business efficiency.

This book introduces a simple innovative model for C-IoT and a new way of looking at the market. The C-IoT model, in its simplest form, consists of sensing, gateway, and services. Sensing will tap into what matters, and gateway will add intelligence and connectivity for action to be taken at the local level and/or communicate information to the cloud level. The services will capture information and digest, analyze, and develop insights of ways that help improve quality of lives or improve business operation. Relevant standards and technology enablers will be highlighted for each segment of the model. The model will address both present and future IoT opportunities and provide the reader with clear positioning as to where radio frequency identification (RFID), machine-to-machine (M-M), and others fit in the model.

In addition, this book introduces simplified market segmentation for C-IoT using domains and business applications. The three C-IoT domains are 3Is: Individual, Industrial, and Infrastructure. Individual C-IoT represents smart living covering consumer electronics and wearable devices, smart homes, and smart connected cars. Industry C-IoT is for business efficiency, which covers several markets associated with industry such as smart factory, smart buildings, smart machine, and smart retails. Infrastructure C-IoT represents smart communities and cities for sustainable environment and living, which include public transportation and highways, public safety, disaster management, smart education, and smart health care. Business applications such as Health & Fitness can easily span the three domains: Individual (e.g., wearable devices), Industry (e.g., physicians, labs, and hospitals), and Infrastructure (e.g., FDA, law, and enforcement). Collaborative IoT solutions will impact breaking

down the barriers between traditional vertical markets and supply chains as the Internet broke down the geographical barriers.

Gaining insights in each IoT domains will result in driving better results in each business application in that domain. Spanning to other IoT domains creates value for a better strategic decision. Take for example, a smart grid of the future; it is feeding into a network of power distribution connecting cities, businesses, and residential buildings. Having a smart meter in the home not only will help to lower the operating energy costs but also will link to the grid and becomes aware of the environment and opportunities that may result in incremental savings. Similar example can be applied to health care from wearable devices for fitness and health monitoring, connecting to physicians and hospitals for diagnostics and treatments to networking with insurance and government agencies for policy and governance. Another example would be video surveillance for homes, enterprises, and public safety. This book highlights several other use cases including tracking and monitoring using RFID, wireless WiFi, 3G for location tracking, GPS, and so on.

Thus, the C-IoT for the future is a disruptive technology that spans all vertical markets causing convergence and breaking down the barriers.

The core of this book is to highlight a series of cases spanning from the requirements to the solution for present market and business opportunities and to explore future opportunities.

The C-IoT enables convergence of several technologies and consequently impacts the overall architecture of the network. We envision a common software platform for most of the vertical markets, adaptation, and customization through applications and special devices to address the specific needs of a given market. This unified smart C-IoT software platform enables one to build and deploy smart C-IoT product, systems solutions, and services for different vertical markets in a quick time-to-market fashion. This will be described in a later chapter of this book including the 4A's and 4S's that characterize smart C-IoT products that would facilitate delivery of Internet of Service (IOS). The 4A's stand for Automated Remote Provisioning and Management, Augmented Reality, Awareness of Context and Location, Analyze, and Take Action, Automate and Autonomous, and Anticipate. The 4S's stand for Simplicity, Security, Smart, and Scalable. Chapter 3 ends with covering the Secured IoT.

This book provides examples of do-it-yourself (DIY) kits aimed at bringing the concept, approach to hands-on experience that inspires innovative thinking in exploring untapped opportunities that improves the quality of humanity and business efficiency in general.

Finally, this book will address the emerging new wave of new devices such as wearable/mobile and cloud technology (local, public, and inter-cloud), analytics, and social media as key building blocks of collaborative IoT distributed intelligence. This book also examines the Collaborative IoT impact on our digital lives and businesses and some of the future challenges such as privacy and security.

On the long term, we see major technology players such as nanotechnology, 5G–10G, and others as disruptive technology that calls for distributed collaborative intelligence making sensing more intelligent, moving services from edge of the network to be distributed between End sensing node and cloud intelligence, inter-collaborative cloud will remove global barriers and finally solutions and services will also be hosted by a distributed providers (as a result of consolidation among service providers, carriers, etc.).

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