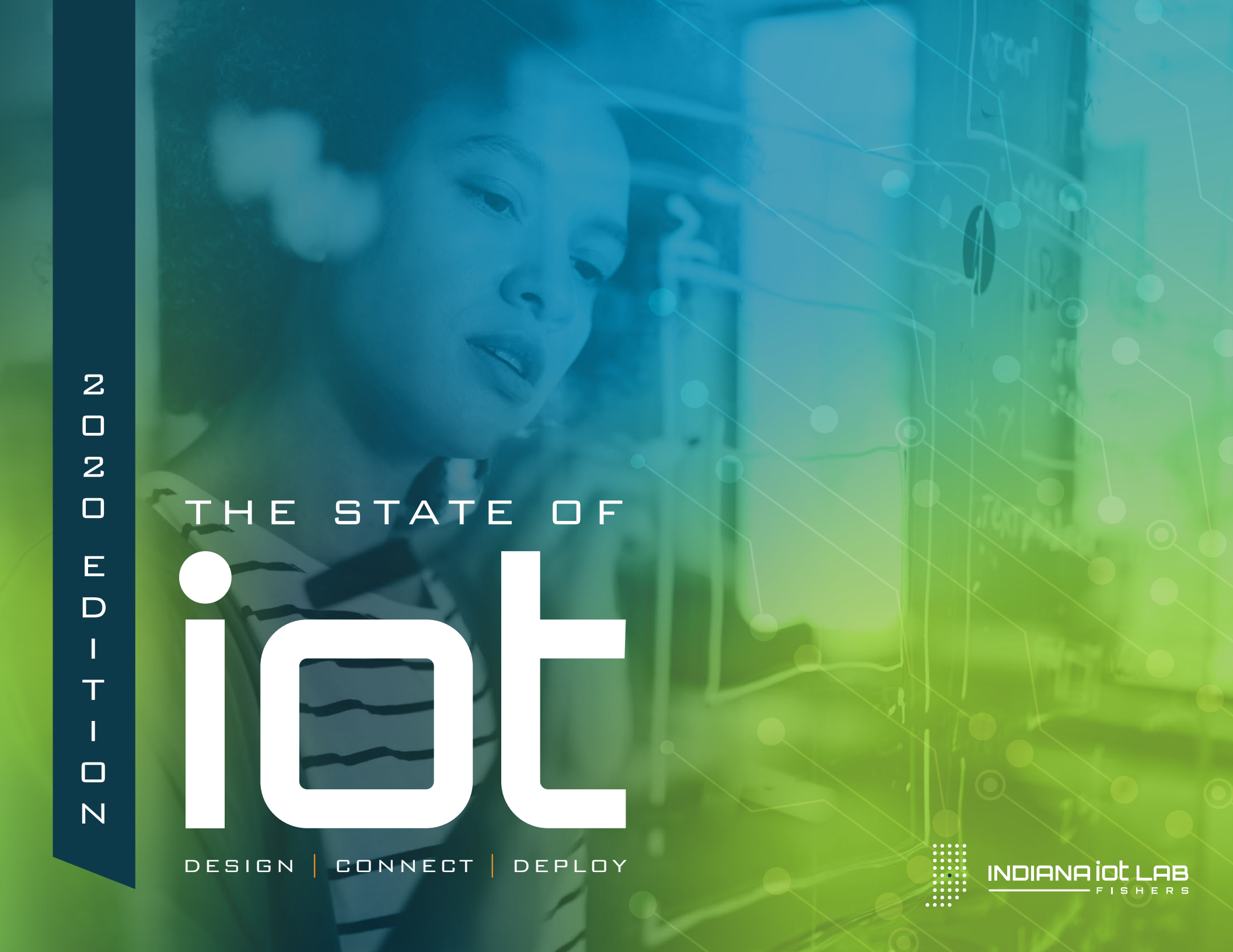


2020 EDITION

THE STATE OF IOT

DESIGN | CONNECT | DEPLOY

INDIANA IOT LAB
FISHERS


INDIANA iot LAB
FISHERS
INDIANAiOT.COM

SECTION 1
INTRODUCTION

SECTION 2
12 DESIGN

Intro to what makes the IoT

SECTION 3
46 CONNECT

Connecting the people and ideas

SECTION 4
68 DEPLOY

Deploying IoT in our everyday life

LETTER FROM THE GOVERNOR

We live in the age of connectivity. Airports allow people to travel around the globe in a matter of hours. The internet connects people to a wealth of knowledge in seconds. Cellphones let us connect to others in incredible ways.

As technology continues to shape the way we work, learn, and play, I want to make sure Indiana is making the most of these changes to set up our state for long-term success. We're expanding broadband internet access in rural areas so they aren't left behind. We're working with airlines to get more non-stop flights in and out of our airports. And we're making sure Indiana has a great business climate for entrepreneurs who want to come here to build their tech companies.

We're seeing the rewards for our work as we set job records, earn national recognition for our positive business climate, and have more Hoosiers engaged in the workforce today than at any other time in our state's history.

We have reached this level of success because of the many great businesses who make Indiana their homes. Organizations such as the Internet of Things Lab provides entrepreneurs unique opportunities and resources to develop new ideas that will keep elevating Indiana to the next level. I appreciate their efforts to highlight some of the cutting-edge technological advances made in Indiana through this publication.

You'll see in this report that in Indiana we are growing the Internet of Things to continue to explore the ways technology can make life better for Hoosiers. We are developing ecosystems of tech-focused regional hubs in areas of the state that previously haven't had access to such resources. We are embracing emerging technology such as 5G networks and so much more. Hoosier thought leaders, entrepreneurs, and global innovators have a lot in store for the future of IoT. I invite you to join in the discussion.

What an exciting time to be a Hoosier! As we race to become the state best prepared for a super-connected future, we need to continue to innovate, grow our IoT network, and train, attract, and retain the best and brightest minds in these fields.

Sincerely,

Eric Holcomb

Eric Holcomb
Governor

State of Indiana
State House, Second Floor
Indianapolis, Indiana 46204

Scott A. Fadness
Mayor

Fishers Indiana City Hall
1 Municipal Dr
Fishers, IN 46038

LETTER FROM THE MAYOR

Each time I walk through the Indiana IoT Lab – Fishers, one thing consistently comes to mind: Fishers is leading innovation of Internet of Things for our state.

Leading on innovation doesn't start and end with the physical space of the IoT Lab. It's in the stories of the entrepreneurs who have an idea, who connect with other entrepreneurs to create a better idea, which then becomes a product ready to test for market.

The success also lives with the caliber of companies who call the IoT Lab home. With a mix of both domestic and international firms expanding or relocating to the IoT Lab, it's home to a great group of companies dedicating resources to changing how individuals and businesses interact with technology.

In Fishers, we're no stranger to leading the way. And the Indiana IoT Lab is no different. We've created a best-in-class model of bringing together entrepreneurs, global companies, and targeted programming to create the next generation of innovation companies and entrepreneurs.

Yours in service,

Scott A. Fadness

LETTER FROM THE CEO

When we founded Launch Fishers in 2012, our mission was to create an entrepreneurial accelerator to help transform Fishers, Indiana into a smart, vibrant, and entrepreneurial city. Since then, one of the first coworking spaces in Indiana has grown into one of the largest in the midwest, producing hundreds of companies which have raised more than $100M in venture financing and generated several hundred million dollars of stakeholder value.

What began as a local effort evolved into a statewide network of more than fifty coworking locations, combining to create the Indiana Coworking Passport. This unique reciprocal relationship between organizations recognizes the value of connecting entrepreneurs in Indiana, and works toward supporting and building upon the entrepreneurial ecosystem across the state. Adding the Indiana Technology and Innovation Association, a collection of more than 100 tech organizations small and large, public and private, has provided a common voice to elected leaders for Indiana's innovation economy.

In 2016, we recognized an emerging set of companies working with physical products in need of resources, prototyping equipment, and opportunities to grow their connected products. The Indiana IoT Lab was developed by Launch Fishers and the City of Fishers, along with additional supporters, to serve these hardware-driven companies representing the Internet of Things. Concurrently, the IoT has become a disruptive force in our innovation economy. Innovation hubs forming around the state represent a focused, networkable opportunity for all Hoosiers to participate in the IoT, reminiscent of the collaborative coworking movement of the prior decade.

In developing these networks and cultivating relationships, we capitalize on advancements in Indiana's core competencies, strengthen our communities, and future-proof our industries. I hope you'll join us as we work toward growing the innovation economy between cities, counties, regions, and beyond.

Sincerely,

John Wechsler

John Wechsler
Founder & CEO

Indiana IoT Lab
9059 Technology Lane
Fishers, IN 46038

Jason Pennington
Executive Director

Indiana IoT Lab
9059 Technology Lane
Fishers, IN 46038

2019 PROVED TO BE A YEAR OF GROWTH AND DEVELOPMENT FOR THE INDIANA IOT LAB AND ITS MEMBERS

GROWTH

Having focused on launching and growing a sustainable initiative in 2018, the Indiana IoT lab turned its focus to expanding the tech ecosystem, developing tangible IoT solutions, and increasingly engaging the community throughout 2019. Individual membership more than doubled, five new companies launched operations at the lab, and, in partnership with state government organizations, three international companies reached agreements to launch their North American activities at the IoT Lab in Fishers, Indiana.

Outreach programming to attract local tech entrepreneurs and enthusiasts expanded. Targeted meet-up groups covering topics including hardware, Blockchain developers, and Artificial Intelligence generated more than thirty engagement sessions attended by hundreds of participants. To complement these grass-root campaigns, corporate events designed to educate and engage the local tech community were presented with AT&T, Rohde & Schwarz, Beck's Hybrids, Arrow Electronics, Silicon Labs, and Comcast's Artificial Intelligence and X-Finity Home™ Brand management teams.

A defining moment for the IoT Lab was realized in August 2019 with the inaugural Indiana Festival

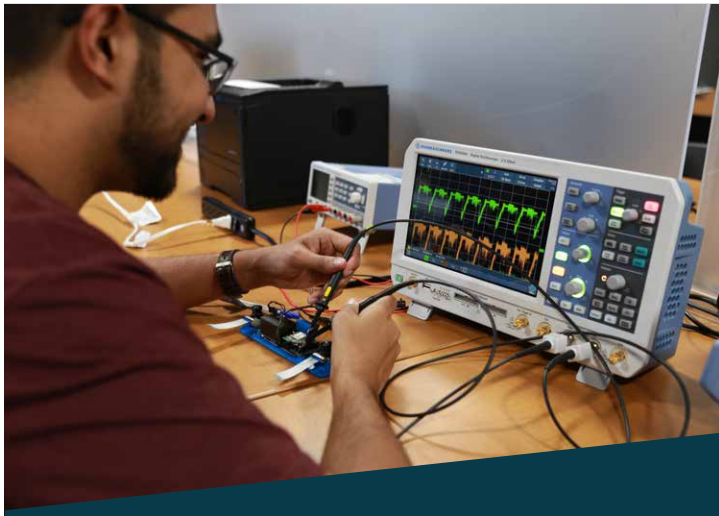
of Autonomy. The two-day event was held in partnership with the Association of Unmanned Vehicle Systems International[1], and presented an interactive opportunity for professionals and community members young and old to explore advanced technologies in robotics, vehicles, drones, and more. The festival featured exhibits and engagement opportunities from 20 companies and universities, and was attended by more than 500 people from across the region.

In total, the programming, partnerships, and events helped the lab generate more than 4,000 visitors from across the globe during 2019.

DEVELOPMENT

A core mission for the IoT lab is bringing together people, tech, and opportunities to advance Indiana's ecosystem. These partnership opportunities are reflective of the complex and interconnected nature of IoT. Edge computing, analytics, and advanced networks require opportunities and ideas, but just as important, they require people to build trust in solutions while executing a vision.

Indiana University Kelley School of Business Professor and Indiana IoT Lab tenant Amrou Awaysheh provides a great example of the



> "A core mission for the IoT lab is bringing together people, tech, and opportunities to advance Indianaís ecosystem.

multi-disciplined approach to IoT. Awaysheh's research leverages connected machines, monitored systems, and business acumen to generate millions in potential energy savings for heavy industrial users. "In this lab, I'm working to develop the parts and components to make these smart meters. Metering the machines within the facilities will help managers better control certain machines or lines – to shut them down or reduce the energy when not in use. It's like sleep mode for your manufacturing equipment." [2]

The Omni Automation team completed the Smartest Home in the fall of 2019, challenging today's market of connected things in the residential space. Utilizing multi-sense arrays, sensory inputs, and an artificial intelligence core, Omni creates a symbiotic experience between our homes and their inhabitants – not just connected things. The Indiana IoT Lab, its visitors, and tenants will use the space as a lab to qualify and integrate connected home products such as locks, lights, faucets, and media to explore user experience versus user expectations. The team is currently scheduling tours, demonstrations, and fundraising to perpetuate the technology in a variety of residential opportunities.

IoT Lab tenant company Qumulex, a pre-revenue, cloud-based surveillance and access controls venture led by industry veterans, received a seed infusion from Indiana University Ventures in the fall. The company plans to raise an additional financing round and launch their product in 2020 to an excited integrator network. The team from Qumulex grew from 4 people with a vision to more than 20

JAN 2019

Omni Automation Begins construction on The Smartest Home

FEB 2019

Rhode And Schwarz Test & Measurement Roadshow

MARCH 2019

State of IoT Release

APRIL 2019

1st Anniversary Celebration

MAY 2019

Arrow Electronics And Silicon Labs Prototype In A Day

JUNE 2019

Indy 5G Summit

high performing individuals creating a highly-anticipated solution for a well understood, yet slow moving $70B industry.[3]

To further enhance the IoT lab and surrounding area as a sandbox for physical product development, a proposed agreement with Energy Systems Network and Perceptin was announced in fall 2019. The agreement paved the way for launching autonomous vehicle technology in the form of people mover shuttles in the Fishers technology park, and potentially throughout selected city routes over a two-year period.[4,5] The IoT Lab will offer Perceptin and their partners such as Columbus, IN based LHP Engineering a space to develop autonomous platforms and the opportunity to utilize and test infrastructure with complementary member companies ECO Parking Technologies[6,7,8] and Magment, a German-based innovation firm specializing in magnetizable concrete.[9]

OUTLOOK

In February of 2019, the City of Fishers and the Indiana IoT Lab were featured in the Walmart publication America at Work: A national mosaic and roadmap for tomorrow.[10] As we move forward with the idea of a mosaic in mind, the focus will shift to building relationships to further network a statewide system of hard tech catalysts. In nearly all regions, initiatives are growing to further leverage the strengths of public:private partnership in a way that is uniquely Indiana. By networking this ecosystem, tech entrepreneurs can gain visibility, access to stakeholders, and connect to like-minded individuals from Evansville to Fort Wayne, the Wabash Heartland to South Bend's manufacturing corridor, the military

JULY 2019

HC WIN Summer Sprint

AUG 2019

Indiana Festival of Autonomy

SEPT 2019

AI/Machine Learning Meetup Launched

OCT 2019

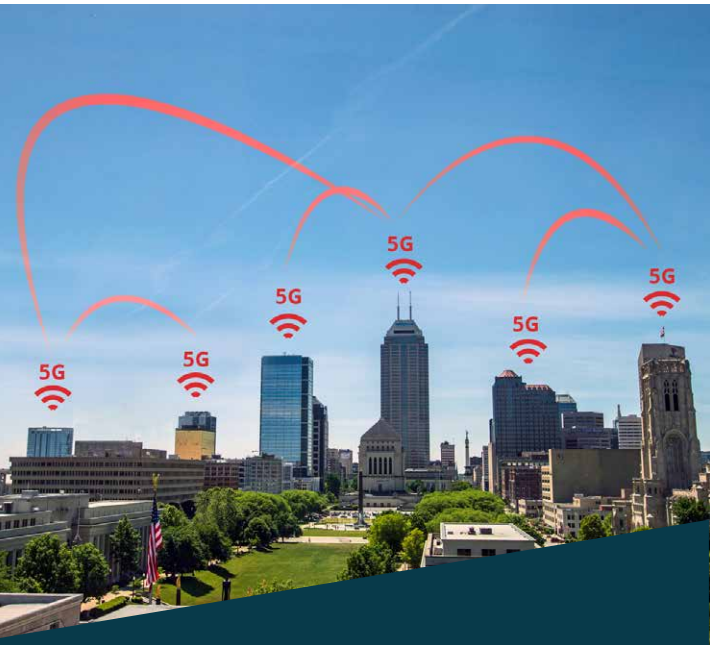
International Economic Development Council Annual Conference Tour

NOV 2019

PerceptIn Announces Move To IoT Lab

DEC 2019

Comcast AI Event



> “With emerging technology initiatives like 5G, cyber security, and IoT squarely at the center of these hubs, the future offers a chance for Hoosiers to innovate and demonstrate that Indiana truly is the State of IoT.

and civic oriented hubs of the southwest central region near Crane and Bloomington, and back to the clusters for consumer products, design, corporate innovation zones. The ecosystem in Indiana is a powerhouse of opportunity.

5G networks present a truly unique opportunity for innovation that transcends a variety of sectors and disciplines. The Indiana 5G Zone is poised to open its doors in late spring 2020. Using the tagline “Where Speed Matters”, the effort is focused on bringing together users, developers, and research institutions to create a first of its kind hub to accelerate the network technology. In partnership with Purdue Research Foundation, major carriers AT&T and Verizon, and the Indiana Economic Development Corporation, the Indiana 5G Zone will offer a world-class testing facility, center of competence for networking technologies, and a unique node within Indiana’s tech ecosystem.[11]

In the IoT Lab, a renewed focus and new tenant base is creating

opportunities to expand development projects beyond sensing and vision. SensorHound, led by Purdue researcher and computer engineer Dr. Vinai Sundaram, is focused on securing the IoT. The SensorHound family of products offers a unique, architecture-agnostic monitoring, management, and diagnostic tool set that adds security and reliability from device through cloud.[12] A second tenant in the hardware space, TAOT – The Audio of Things, is comprised of industry veterans from MWM Acoustics, Klipsch, Unified Computer Intelligence Corporation (UCIC), and Harman International.[13] TAOT is engaged in designing and developing voice and audible technologies from sensory input, output, digital signal processing, and natural language processing. The TAOT team is actively building a sound lab and test center within the Indiana IoT Lab to offer professional services and develop their products.

With emerging technology initiatives like 5G, cyber security, and IoT squarely at the center of these hubs, the future offers a chance for Hoosiers to innovate and demonstrate that Indiana is the true State of IoT.

Sources:
1. *(AUVSI) https://www.auvsi.org*
2. *(IU, Awaysheh) https://blog.kelley.iupui.edu/2019/12/12/kelley-school-professor-works-with-manufacturing-facilities-to-save-millions-in-energy-costs/*
3. *(Qumulex) https://iuventures.com/venture-fund-invests-in-qumulex/*
4.. *(Perceptin) https://iedc.in.gov/news/details/2019/11/21/perceptin*
5. *(Energy Systems Network) https://energysystemsnetwork.com/who-we-are/*
6. *(Perceptin) https://iedc.in.gov/news/details/2019/11/21/perceptin*
7. *(LHP Engineering) https://lhpes.com*
8. *(ECO Parking Technologies) https://www.ecolightingsolutions.com*
9. *(Magment) https://www.magment.de/en-home*
10. *(Walmart) https://corporate.walmart.com/media-library/document/america-at-work-report/_proxyDocument?id=00000168-dec5-d9f9-a7f8-deed73c70001*
11. *(Indiana 5G Zone) https://www.wherespeedmatters.com*
12. *(SensorHound) https://www.sensorhound.com*
13. *(TAOT) http://taot.co*

DESIGN

The Internet of Things (IoT) connects devices to each other and to the internet. It seems simple enough. However, as the available technology matures in the market, hard and soft topics evolve to create a growing opportunity for innovative pursuits. The IoT has moved beyond simply viewing a remote value on a mobile app. Today's IoT is pushing technological boundaries for device design, networkability, interoperability, data management, and security throughout a sprawling and ever-inclusive value chain. As these new product and service capabilities have emerged, the discipline and drive to develop customer-centric solutions has never been more important.

DESIGN

Mark Caswell

Chief Executive Officer
KSM Consulting, LLC

Mark is a proven business leader with experience successfully leading multi-national teams and projects. This diversity of experience, both in execution and leadership of projects, helps him lead KSMC's strategic growth as well as maximize the value KSMC brings to our clients. In addition to engineering and business primary and secondary degrees, Mark trained in Design Thinking at the Stanford d.School. He is passionate about helping organizations and individuals grow their problem-solving expertise to drive better outcomes.

KSM CONSULTING

KSM CONSULTING

FEARLESS PROBLEM SOLVING

At the most basic level, consultants are problem solvers. At KSM Consulting, we understand that clients don't bring us their easy problems. We're asked to address the most complex ones. That's why Fearless Problem Solving is one of our core values and why, at our best, we see ourselves not as simply technologists, data scientists, project managers, or subject matter experts, but as problem solvers.

When tackling complex challenges, traditional approaches to problem solving simply do not work. An approach rooted in innovative thinking and creativity and aimed at finding the best solution, not simply the first solution, is needed. At KSMC, we tackle challenges with an approach rooted in Design Thinking and developed through our experience working on some of our community's deepest challenges across government, non-profit, private-sector, healthcare, and education sectors. This approach includes many things, but these three key factors are of special interest: Always Start with People, Solve the Right Problem, and Avoid the "Ta-Da" Moment.

ALWAYS START WITH PEOPLE

When every challenge is related to people, it's vital to start and end with the people involved. To accomplish this, we first spend time understanding how the problem impacts them; why it's an important problem to solve; and whether the solutions developed will be accepted

by them – or not. Even the most seemingly technical challenges in the world have considerable people-related components.

Empathy is the key to beginning with people and deeply understanding the end user. This is arguably the most important step. A great solution – one that will be adopted and truly solve the challenges at hand – is rooted in deep consideration for the people involved.

While there are many tools available to build empathy, one of the simplest and most impactful tools we've found is the empathy interview. In the empathy interview, deep understanding is developed through one-on-one interviews. These interviews lead to understanding of perspectives, constraints, assumptions, needs, and desires, as well as their reality and their perception.

From this deep and fundamental understanding, a new picture of the problem(s) will emerge, and it will be a problem worth solving.

SOLVE THE RIGHT PROBLEMS

There's another saying in consulting: The stated problem isn't always – or ever the actual problem. Fearless problem solving means we must solve the right problem.

When we begin with people and develop empathy with the impacted parties, the problem gets harder. There are more components than originally understood, and some of them are deeply emotional and human. Some of them are related to areas of the organization or technology not anticipated. In a word, it's messy.

However, patterns begin to emerge. People don't just ask for new

> "The stated problem isn't always – or ever the actual problem.

FEARLESS PROBLEM SOLVING

1. Always start with people
2. Solve the right problems
3. Avoid the "Ta-da!" Moment

technology, but also new processes, or even a new leader for that process. We discover things that had seemingly nothing to do with a problem up front, but are critical to solving it. In other words, the fundamental challenges materialize.

Once the fundamental problems are identified, we write them down. Then, we pick those problem statements apart using a process called Problem Deconstruction. We consider why we chose that particular way or that particular word to state the problem. Is there a better way to phrase it? Is there a piece missing? Do any other challenges emerge?

By going through this rigorous process, we begin to develop agreement on a clear definition of the problem.

AVOID THE "TA-DA!" MOMENT

We've all done the "Ta-da!" thing. We work tirelessly to create the perfect widget, presentation, or process. Everything's lined up, and we walk into a meeting and reveal our perfect creation. "Ta-da!"

The problem is: our creation is never perfect, whether people are willing to tell you that or not. It needs iteration and polish. Sometimes the entire thing is junk, and we need to start over. Unfortunately, when weeks or months were spent perfecting it, that's hard news to hear. Often, we end up ignoring it and moving forward with an imperfect solution.

This is the part of fearless problem solving that quite literally involves fear: the fear of failure and rejection. Everything in our brains and training tells us that our worth is tied to being 100% right, all the time. We therefore think we must wait until something is perfect to show it to others. We

all logically know this isn't correct when we stop to think about it, but emotionally we just can't get over it.

Too bad. If we are to be fearless problem solvers, we must bravely wade into failing fast. We need feedback early and often, so we must ask for it. We must show people our unpolished ideas, walk people through our poorly drawn designs, and create rapid prototypes with nothing but duct tape and cardboard. We must ask them questions about it and really unpack their thoughts, even when it's not pleasant.

This is the only way to really understand whether the solution we are pursuing will work and get feedback to make it better. It is absolutely critical to fearless problem solving.

CONCLUSION

There are many other aspects to creating great solutions, but we have found the three above to be quite often missed. Starting with people, solving the right problem, and avoiding the "Ta-da!" moments are all key steps to becoming a fearless problem solver.

Learn more at:
ksmconsulting.com

DESIGN

Randy Parmerlee

CEO

Glassboard

Randy is a graduate of IUPUI with a degree in Electrical Engineering. For over a decade he has worked in product development ranging from autonomous mowers to innovative micro-mobility solutions. Randy now leads a team of talented developers and innovators helping clients launch products in the IoT landscape.

glassboard

PRODUCT DEVELOPMENT

IOT DEMANDS MULTI-DISCIPLINED PRODUCT DEVELOPMENT

Glassboard was founded with a passion for co-innovation and a mission to be a premiere resource in supporting hardware design and product development. In today's fast-paced and ever-connected economy, we built a team big enough to do it well and small enough to do it fast. Developing a physical product or hardware-enabled software is a process which requires a variety of disciplines for technical and non-technical roles, and our customers are engaged in this process. Glassboard is built on a premise for customer-centric development, and a philosophy to augment solution development as extensions of our customer's intrinsic team.

CREATIVITY AND COMMUNICATION

Launching a new product or bringing a solution to the market is not easy. When hardware is involved, balancing requirements and departments requires resources. Many companies don't have the expertise to fulfill a complete product development process in house. Hardware driven solutions are becoming more demanding. Ultimately, the product goals haven't changed, but customer expectations have. Consider the number of connected products existing in the market today. As cost versus capabilities evolve, connected products for the Internet of Things (IoT) are being specified with more features and functionality than ever before, often in a smaller footprint or physical form factor. This generates a complexity for electro-mechanical teams to coexist, or align from decentralized locations across the globe, to bring a product to market.

These are the demands creating both opportunity and complexity. The Glassboard

team is designed to eliminate inadvertent productivity barriers that can arise with decentralized teams. To avoid common issues, it is important to operate in real time and under one roof, with face to face discussions between the electrical, mechanical, software, firmware, and user experience design teams. Our customer centric culture promotes more fluid and organic discussions, ultimately sparking creative communication while fulfilling an aligned project with our customer.

MANAGING OVERLOAD

Glassboard is entrepreneurial. We're both originators and engineers. This balance of innovators willing to sketch big ideas on napkins is appreciated by pragmatic teammates willing to ask "why?" We pride ourselves on considering new ideas and potentially better products. This entrained culture helps us empathetically interact with a customer potentially losing their identity in a product while trying to produce a catch-all solution.

Glassboard has worked with companies with truly unique ideas, and with companies trying to make products so complex they have delayed time to market with features, apps, and connectivity creating an overload of decisions. Glassboard has experience to ask a deeper why and push for customer engagement. Will such a feature change customer behavior, or drive a purchase?

Our focus is what makes a minimum viable product (MVP). While it's fun to innovate a variety of features and tech, our credibility is on the line with our customers. We ultimately have to ask – will the customer even care?

GETTING TO MARKET FASTER AND SAVING COSTS ALONG THE WAY

While there are many reasons for using a multidisciplinary development team, perhaps the most important is cost savings. This idea transcends the dilemma of navigating disparate product teams or worse, geographically diverse teams.

While there are benefits to perspective and even voice of market with decentralized product teams, the idea of iteration and bringing sharable prototypes and tangible products to market is difficult to realize in a timely or productive manner. Considering the overhead associated with a new piece of hardware from originator, through engineering, and voice of customer analysis and feedback, the strong level of focus at Glassboard can help create a competitive advantage for innovating in the IoT.

Ultimately, it's nearly impossible to create a one-stop shop to solve every aspect of product needs. However, our experience and team development throughout the rise of the IoT has created a history of learning from failures, ultimately making our customers' success feel more like our own.

Learn more at:
glassboard.com

DESIGN

Ron Kern

Director of Technical Marketing
Indesign

Ron's work at Indesign consists of new business development, account management, and new technology investigation. Prior to joining Indesign, he was an MTS Product Marketing Engineer in the Communication Products Division at AMD in Austin, Texas. Ron's technical background is in electrical engineering. As a Member of Technical Staff with AT&T/Lucent Bell Laboratories, he designed electronics for consumer telephony products. He has over 25 years of experience in product design and marketing. Ron has a B.S. degree from Purdue Calumet and an M.B.A. from Indiana University.

IMPLEMENTING A CONNECTIVITY SOLUTION

You already have your latest and greatest electronic prototype developed, it functions and measures what it's supposed to measure, it controls what it's supposed to control and in general, does the things it's supposed to do….mostly. Now the process of adding in the cloud connectivity and getting it ready for production looms. How do you get to the end goal, which is a production-ready design developed by the design team you have in place? If you already have your hands full with developing you own IP, your design team may not be able to expend the effort and time to add connectivity and Design-For-Manufacturability.

From a connectivity perspective, do you require a Bluetooth, Wi-Fi, LoRa, LTE, or some other type of technology connected product? Which service provider/carrier are you going to utilize? How do you even get certified on a network? What about regulatory agency certifications like FCC, UL, CE? Do you even need them? You haven't even considered manufacturability yet. And how do you make sure the product being produced has even an ounce of good quality to it? These are all tough questions with not so obvious answers. Again, none of this is "secret sauce" material and is certainly not part of the intellectual property you need to invent. But nevertheless, unless you've done it before, at least a few times, is difficult to manage.

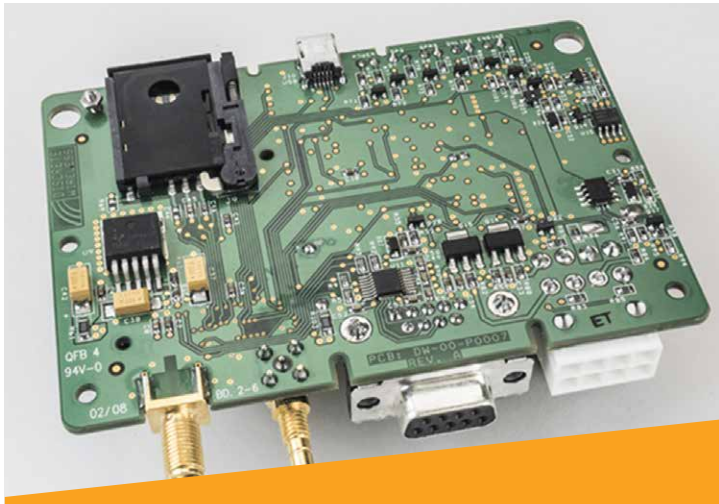
Our company, Indesign, has gone through this process numerous times with a lot of different clients in many vertical markets. Although we are a company with limited market expertise in many of our clients' industries, we are very much expert at what we do. We know connectivity and DFM. We are an integrated, full-turnkey electronic product design company that is expert in embedded processing

and wireless connectivity. We are a true technology company. We work with our clients to help them identify an appropriate connectivity solution, help them implement it, get certified, and get into production. Our team has done this so many times, it's almost second nature. We know what issues we might encounter and know how to successfully deal with them. When we partner with our clients, they count on us to get their product ready for production and ultimately, ready to bring to market.

The relationship we form with our clients is our key focus and is really what drives product development success. We really count on them to know their market. They are bringing their secret sauce to the table. We work with them to add the connectivity solution and design the electronics hardware and firmware so the product can be reliably produced in quantity at a contract electronics manufacturer of their choosing. We follow a proven development process…. Product Concept, Architecture, Design & Development, Testing, and Production. We interact closely with our clients throughout all these phases, to make sure what we develop meets their needs. Our team supports over 75 product designs a year, so it is clear that our process is proven and we've learned some lessons over the 23 years we've been in business.

When it comes right down to it, we worry about the production ready design and how to implement a connectivity solution so you don't have to.

Learn more at:
indesign-llc.com



> "We follow a proven development processÖ. Product Concept, Architecture, Design & Development, Testing, and Production.

DESIGN

Dr. Vinai Sundaram

Founding CEO

SensorHound, Inc.

Dr. Sundaram is a recognized expert in the field of IoT edge and cloud reliability and security. He has years of R&D experience at Tier-1 universities such as Purdue and leading companies including Google and Motorola. His work has won several awards, including grants from the NSF and DoD, as well as Maurice Halstead Memorial award for outstanding research from Purdue University. He has 5 US patents and has published at several top-tier scientific venues. He holds a PhD in Electrical and Computer Engineering (ECE) from Purdue University.

SensorHound™

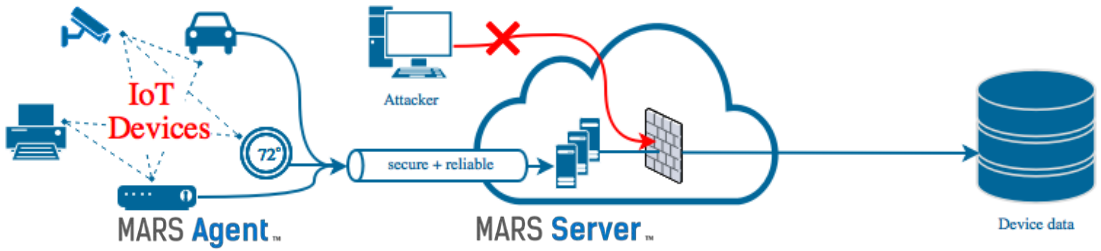
SENSORHOUND - SECURE BY DESIGN

2020 is likely to be the breakout year for IoT as the value is being increasingly realized in many sectors including manufacturing, agriculture and transportation, where Indiana is among the national leaders. This trend is likely to be accelerated by the recent standardization of the narrowband spectrum in 5G by 3GPP, which helps to build more power-efficient and easy-to-deploy IoT devices.

IoT Devices are Vulnerable

HP Internet of Things Research Study, 2015

To capitalize on the growing market, many millions of these smart devices are being rushed to market by OEMs often without due consideration to cybersecurity. One of the most infamous examples is that the vulnerable IoT devices, mainly surveillance IP cameras, using default passwords were recruited into a bot network by malware Mirai in October of 2016, and used them to attack the popular DNS service provider Dyn, which brought down the Internet in many Northeastern states of the US,



including Indiana. More and more attacks on IoT devices are being discovered every day from baby monitors to sophisticated industrial control networks.

To be fair to the OEMs and network operators, securing IoT devices is complex and requires multi-level, multi-layer solutions. This is because the devices are exposed to a multitude of attack vectors and to make things worse, attacks constantly evolve as cybersecurity is an arms race. To win this arms race, the most important step is to make these devices secure by design. To counter evolving threats, these devices need to be continuously monitored and updated even after deployment.

However, this is easier said than done because many available cybersecurity solutions are not applicable for IoT devices. Unlike PCs or smart phones, IoT devices have severe resource constraints due to cost and battery power, and have real-time constraints due to interaction with the physical environment. Therefore, these devices typically require efficient solutions built specifically for them. SensorHound provides comprehensive cybersecurity-as-a-service solution specifically designed for IoT devices. Our complementary products include MARS, a solution that hardens the device by building security into the device, and HOUND, a continuous monitoring solution to detect and fix unexpected breaches in the field. The key features of MARS include providing strong identity and access managessment, robust encryption and crucial secret management, and firewall-like capabilities to prevent intrusions. Our HOUND solution includes embedded machine learning-based solution to detect unexpected failures and breaches in the field, diagnose the root cause and securely apply patches.

SensorHound's goal is to democratize IoT security. Our products pack a punch in terms of cyber defense, yet are simple to integrate and significantly lower the bar to make IoT devices secure and trustworthy. Given the proliferation of IoT cyber-attacks, SensorHound helps our OEM and system integrator customers to deploy IoT solutions with confidence.

Learn more at:
sensorhound.com

DESIGN

Jason Ortiz

Sr. Product Engineer

Pondurance

Jason is Sr. Product Engineer and has worked in cybersecurity and IoT Security roles for 10 years since graduating from Purdue University with a BS in Computer Science. Prior to joining Pondurance, Jason worked as a defense contractor in the Washington D.C. area and was a NASA intern while attending Purdue. Jason loves the challenges brought forward by a career in cybersecurity and working to secure national infrastructure.

PONDURANCE

SECURITY AS A FOUNDATION

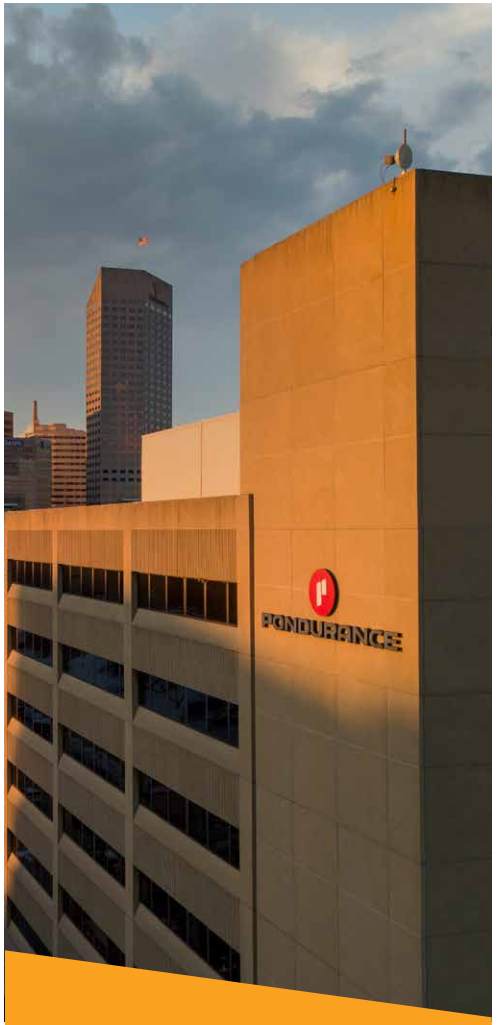
The Internet of Things (IoT) has blasted open the proverbial door to innovation. Thousands of organizations are determining how to use IoT to reduce their risk and increase their profits. IoT holds the promise to exponentially increase the amount of data available for analysis, machine learning, and artificial intelligence. Despite the amazing opportunity of IoT, none of the potential gains will be realized if the devices, communications, and data are not secured. Security must be a pivotal piece of the design of any IoT implementation and must be thought of as part of the overall solution.

IoT solutions represent a completely new challenge to security in many ways. The sheer number of edge devices and data is unlike anything we have ever experienced before. With traditional systems, we could count on some layer of physical security, but IoT lacks that protection. Another challenge is the simplicity of an individual device puts extreme constraints on endpoint-based security options. Many traditional antivirus tools quite literally will not function on edge devices. Most IoT endpoints do not have the processing power or memory available to perform in-depth scans or analysis. Some are even too simple to implement strong encryption. Nevertheless, these simple devices are producing data at an exponential rate that is only projected to increase in the coming years. Add the need for third-party vendors to place devices inside trusted networks and access those devices to perform maintenance, updates, and troubleshooting to the list of challenges.

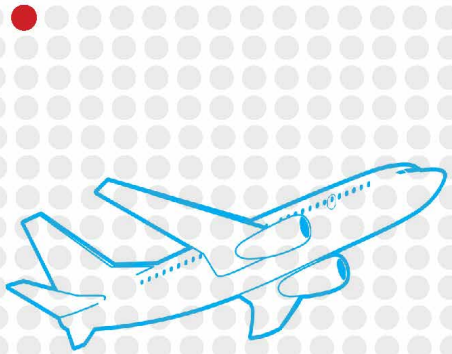
The good news is there is already a blueprint for successfully securing the Internet of Things. We discovered long ago security is not simply a tool that can be bought, and there is no silver bullet, even with traditional systems. The core of cybersecurity, as defined by the National Institute of Standards and Technology (NIST), is an ongoing process or cycle composed of five major functions; identification, protection (prevention), detection, response, and recovery.

Integrating this process of security requires careful thought and planning and thus must be designed into any IoT solution and not simply added later. Each function of the cybersecurity cycle must be considered as part of the overall implementation of any IoT solution. The following are solutions that map to the NIST framework to consider when designing security into any IoT solution.

The main objective of identification and protection is understanding which components make up a solution and managing the organization's risk regarding those components. The first step, as with traditional implementations, is establishing asset management. Without a clear understanding of IoT assets in place at any given time, it will be impossible to determine the risk to those assets. A key piece of the asset management should be the understanding of who (if dealing with vendors) should have access to those assets. In addition to an asset management plan, designing a solution which includes a vulnerability management program will be one of the keys to a successful implementation of identification and protection. Vulnerability management will help identify the threat surface as it relates to the assets. If any specific vulnerability identified cannot be fixed and that asset cannot be removed from the solution, then at the very least, knowledge of the risk will factor into detection plans.



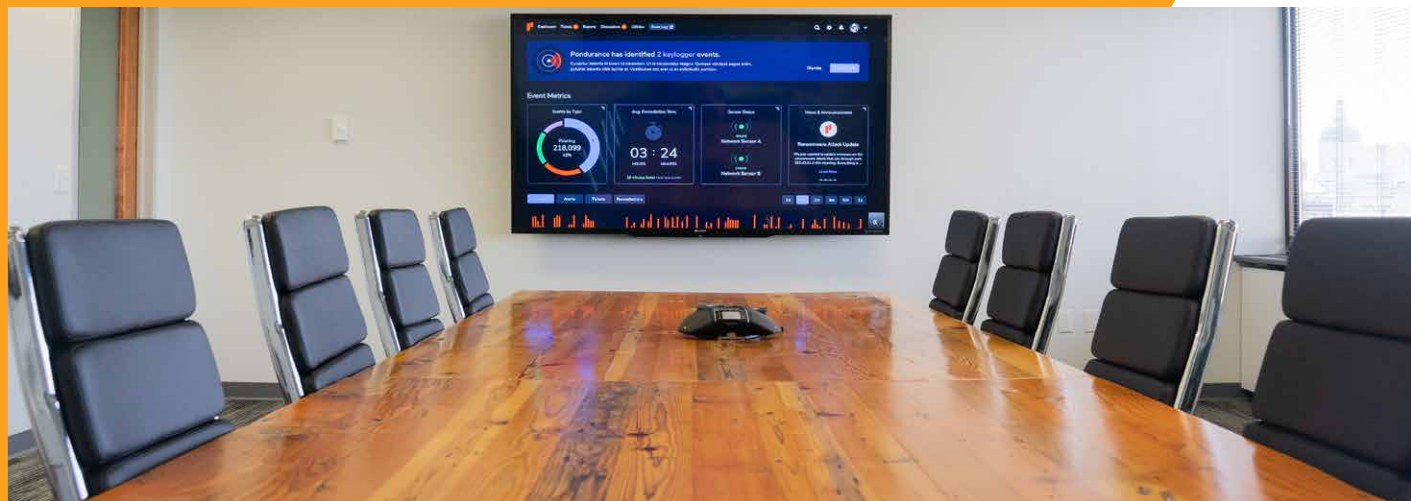
PONDERANCE HEADQUARTERS IN DOWNTOWN INDIANAPOLIS

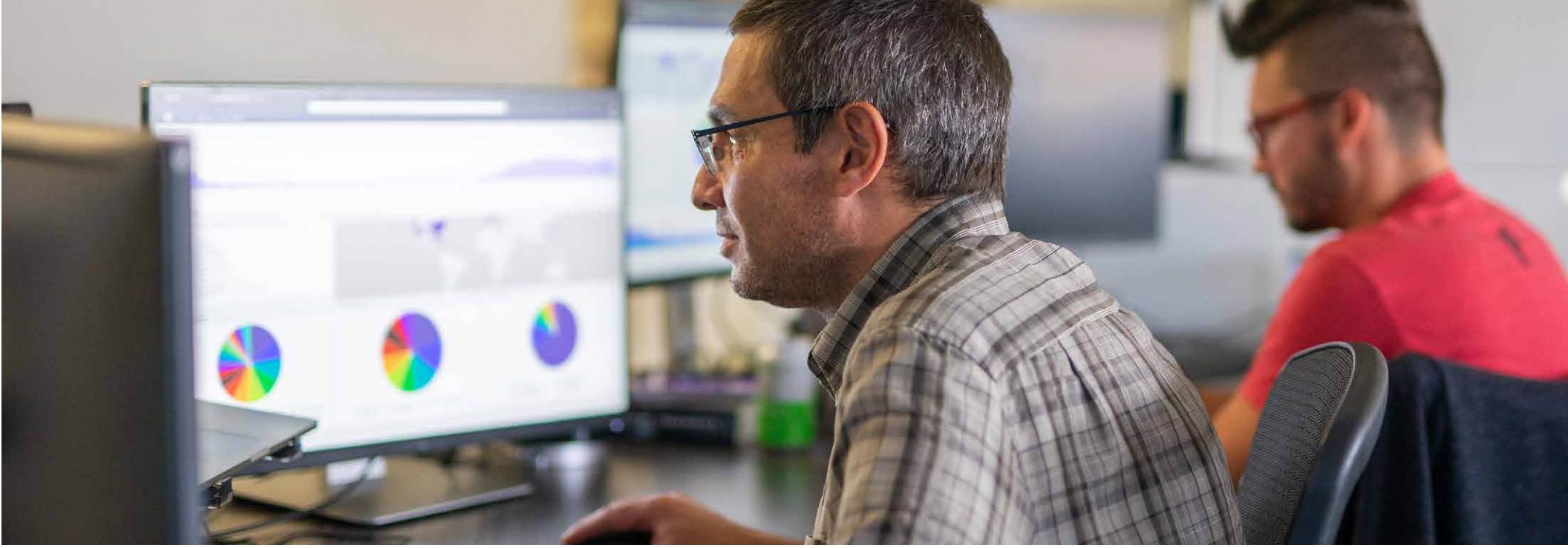


> “ Consider the case of the Boeing 737-Max where a single malfunctioning angle of attack sensor could (and did) lead to aircraft crashes and the grounding of every similar aircraft globally, causing loss of life as well as costing airlines and Boeing billions in lost revenue.

Another key consideration is how devices and data are going to be monitored. Detecting malicious activity will require clever design decisions regarding network communications and logging. In traditional network architectures, log and network monitoring provide the single most important tool in detection. In many IoT solutions, however, endpoints do not even keep logs, and network communications are unrestricted. Any design plan for an IoT solution should define logging practices and profile network communications to more easily detect deviations from standard endpoint profiles. For example, many IoT devices should only communicate with a very limited number of destinations, and any other communications could be flagged as suspect. Communications protocols, data formats, and 3rd party access can all be profiled. Any and all deviations from device profiles could be easily detected using network and log monitoring provided the devices were designed to properly log data and have consistent, documented communications protocols.

A disaster recovery plan, as is always the case, will be the key to successful response and recovery. Extra consideration must be given





to disaster recovery when designing an IoT solution, as there are likely many more components with more complex interactions and integrations than traditional solutions. Identifying which of those components are critical and which are not, as well as how to recover those components, will be more difficult. Physical access to impacted components may be challenging, and those impacted components will likely affect other components. Consider the case of the Boeing 737-Max where a single malfunctioning angle of attack sensor could (and did) lead to aircraft crashes and the grounding of every similar aircraft globally, causing loss of life as well as costing airlines and Boeing billions in lost revenue. Even in something as complex as a modern aircraft, a single sensor may be a critical component of an IoT implementation, and therefore must be part of the disaster recovery plan.

There is no doubt that IoT solutions and the data generated from those solutions represent an incredible economic opportunity for many organizations. Better products and more efficient services can be delivered, massive amounts of data can be collected and analyzed and insight gained from these solutions could be invaluable to global organizations. Still, the scale and complexity of these solutions mandate that security must be part of designing any IoT solution. If security is not at the forefront of the design, the full potential of any given IoT solution may never be realized.

Learn more at: pondurance.com
Twitter: @pondurance, @rafiki1337

DESIGN

Luke Mongin
Project Manager

Lexi Ochoa
Marketing Specialist

CSpring

Lexi and Luke are Consultants for CSpring, a technology consulting firm focusing on providing data-driven solutions. CSpring helps organizations achieve their goals through technology-enabled solutions such as self-service dashboards and reporting, data quality assessments, data architecture services, and custom business applications.

c|spring

DESIGNING A DATA STRATEGY

It's no doubt "data" continues to be a big buzzword, especially with the rise of 5G and IoT devices. Organizations are investing in data privacy, cybersecurity, data visualization – the list goes on. Harvard Business Review reports "less than half of an organization's structured data is actively used in making decisions, and less than 1% of its unstructured data is analyzed or used at all." Organizations have data to use to their advantage, so, why aren't they?

Everyone wants to talk about data, but struggle to act, equating designing a data strategy to "boiling the ocean." However, most leaders don't realize there's no need to start from scratch. A process for collecting, storing, and managing data already exists. Designing a data strategy should come from pre-existing conditions along with your overall business strategy.

A COMPANY-WIDE PROJECT

According to Domo, 90% of data was created in the last two years, meaning some quintillion bytes of data are created each day. Data is created not only by IT and operations, but every department, team, person, and product in an organization. Therefore, implementing a successful data strategy will require the efforts of your entire organization.

KEY ELEMENTS OF A DATA STRATEGY

A data strategy is a plan to utilize your data to its highest potential while keeping it secure, and tells the story of how data will be used, managed, stored, and shared.

A GOOD DATA STRATEGY INCLUDES:

- **A collection of agreed-upon rules of how data will be shared, stored, used, and managed**
- **Goals that align with the strategic vision of the organization**
- **Identification of metrics to measure success**

- **Roles and responsibilities of each department and position**
- **Protocols on how to act and change SOPs from the results of your data assessments**
- **A way to archive information no longer being used, but still accessible**
- **Education for all employees (data fluency)**

A DATA STRATEGY IS NOT:

- **A one-size-fits-all format**
- **Just an "IT problem" or an IT department's sole responsibility**
- **A "one and done" scenario**

THE VALUE OF A DATA STRATEGY

Organizations have both internal data and external data. Internal data can be classified as the data you track to measure your success, or data that was created/stays inside your own organization. External data is the data you collect from your customers (like financial information and contact information), or data that was created from someone, or something, outside of your organization.

Keeping information secure should be a goal for every organization, but it's especially important in organizations who carry sensitive information – i.e. banks, insurance, healthcare. Organizations should ensure that they are compliant with regulations such as HIPAA, FERPA, COPPA, GDPR or CCPA. Cost of non-compliance can be significant.

Governance of data should not be a responsive action to a security breach. Organizations need to be proactive in utilizing and protecting their data. Investing in a data strategy before a crisis emerges can save your organization significant time, money, and frustration. Good data strategies can save smaller companies in the event of a breach.

Aside from keeping your data secure, a data strategy is valuable component in accomplishing business goals. Having access to data improves everyday operations, which can be achieved through automating manual tasks, authorizing sharing permissions, and measuring what is important to your organization.

STEPS FOR SUCCESS

1. **IDENTIFY YOUR GOALS:**
   Since a data strategy will look different for every organization, it is important to identify the reasons you are investing in one.
2. **APPOINT A DATA STEWARD:**
   The Data Steward will own the strategy, implement it, and continuously manage and evaluate its effectiveness.
3. **EVALUATE CURRENT SYSTEMS:**
   Evaluate your data, current systems, and software or tech stack. Identify gaps in information or management capabilities.
4. **START DESIGNING YOUR DATA STRATEGY:**
   Plan what your data strategy will look like and document the roles and responsibilities of each department, manager, and individual contributor.
5. **IMPLEMENT, MEASURE, AND OPTIMIZE:**
   Make sure everyone is still on the same page and know their roles and responsibilities and evaluate your efforts monthly, bi-monthly, or quarterly and make changes as needed.

Designing and implementing a data strategy can help your organization reach its true operating potential. By utilizing your data to its fullest potential, you can make more informed business decisions, achieve your goals faster, protect your organization from security breaches and fraud, and deliver a more successful, seamless experience to your customers.

DESIGN

Jeff Ready

CEO and Co-founder
Scale Computing

Current CEO and co-founder of Scale Computing, Jeff defines a serial entrepreneur – starting his first company at the age of 11. Jeff has not only proven himself as a pack leader but as a negotiator, fundraiser, technologist, marketer and trusted advisor, having started numerous companies and raising over $100 million in investment capital. Prior to founding Scale Computing, Jeff was co-founder and CEO of Corvigo, a Linux-based anti-spam appliance, where he oversaw the company from startup through funding to acquisition. After the acquisition, Jeff served as VP of Marketing at Tumbleweed Communications.

SCALE COMPUTING

LIVING ON THE EDGE WITH SCALE COMPUTING

For more than a decade, hyperconverged infrastructure has been disrupting the traditional costly and complex nature of disparate server, storage, and hypervisor silos seen across the data center landscape. The introduction of hyperconverged solutions transformed this industry and brought an option to market that drives cost and complexity out of the data center equation.

Among a wide range of applications, edge computing has emerged as a pivotal use case for hyperconverged infrastructure. Specifically, 'edge' is an amalgamation of a number of formerly separate use cases, including familiar remote office and branch office (ROBO) environments.

Edge computing and ROBO needs are often (but not always) lesser than those that exist in the primary data center. Workloads may include point of sale systems, security cameras, and time clocks (among others). In other words, there is a limited range of applications that operate in such environments, so the infrastructure doesn't need to be as substantial as that of the centralized data center.

With edge computing, you can run applications and process data outside centralized data centers, at the edge of your network closest to where that data is created and utilized. Another advantage is that you can centrally monitor and manage hundreds or thousands of distributed edge infrastructure deployments with few or no on-site IT personnel.

BENEFITS OF HYPERCONVERGED INFRASTRUCTURE

With this in mind, nodes often need to be smaller in size and the stack still has to be highly available. And, to solve the expense problem, the hardware and software need to be aligned to these miniaturized workloads. Going small doesn't just mean supporting edge environments either. There are tens of thousands of businesses from SMB to large enterprises that require robust data center architecture that is cost-effective and simple to use.

However, these environments have always been difficult and expensive to support as central IT has had to place a full stack of data center hardware on-premises in these locations or try to work out ways in which these locations can consume centralized IT resources. As a result, this is a scenario that can introduce a precarious dependence on an 'always on' connection to the internet.

Furthermore, edge environments carry with them some critical challenges that aren't always present in more environmentally controlled centralized data center locations. The first is lack of support. Very few edge environments have dedicated support staff, so outages may take longer to repair and be more expensive. In addition, some locations simply don't have space for a full-height rack of servers, nor do they have the dedicated cooling that would be necessary to support it.

Then, there is the problem of cost. Traditional multi-tier IT deployments aren't generally inexpensive, making it difficult to scale to hundreds or thousands of individual sites in a cost-effective way. Yet, there is often a need for speed, but having small workload requirement needs shouldn't be delivered at the detriment of performance.

In contrast, hyperconverged infrastructure addresses these challenging issues, particularly that of storage management. The technology is clearly more than just storage, but this was the key driver behind its initial development. As a result, as a part of the architectural decisions being made in product development, how storage management is accomplished is a milestone design decision. The choice impacts the solution's ultimate scale, performance, and cost.

In general, there are two methods by which most hyperconverged solutions on the market choose to handle storage management. The first is to create a virtual machine dedicated to managing all of the storage resources on a local node. This controller virtual machine is in the data path for all I/O operations that take place on the host and between hosts in the cluster. The second method is to make use of a

hypervisor operating system construct – a kernel model, for example – to handle storage operations. Rather than a controller virtual machine, this kernel module is the key player in the data path to handle storage operations.

Each approach has pros and cons. The controller virtual machine approach provides more portability and flexibility when it comes to hypervisor choice. The kernel module approach provides a bit more performance and integration with the rest of the I/O stack. But, vendors on both sides have made architectural decisions that are now impacting their ability to meet emerging demands in the market.

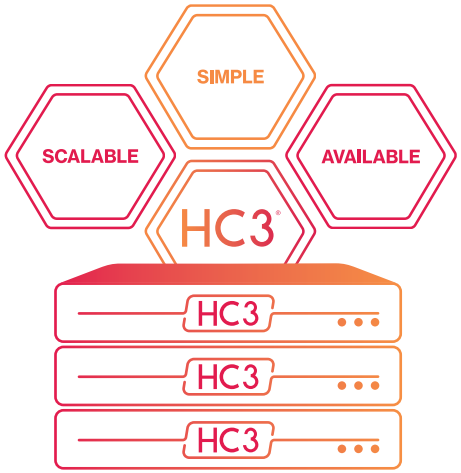
SCALE COMPUTING AT THE EDGE

In contrast, Scale Computing's approach is based on a storage management model that results in the consumption of a fraction of the processing overhead of competing solutions.

Scale Computing's HC3 Edge series brings on-premises edge computing with high availability and disaster recovery to remote locations at an affordable entry level cost. All edge models can be deployed quickly, managed locally or remotely, and can self-heal almost instantly. Enjoy affordable edge computing infrastructure that is reliable, easy to deploy, and easy to use.

This architecture makes it possible to place more workloads on individual nodes and enables a solution that meets every requirement of today's edge environments. Scale Computing allows customers to match the right storage configuration against their workloads. Storage solutions start with appliances that include four hard drives anywhere from 1 TB to 8 TB in size each up through an all-flash solution that sports up to four 960 GB SSD - and everything in between.

For those that need the option, all Scale Computing edge-based clusters can be configured to back themselves up to a centralized cluster to enable data protection and disaster recovery for edge sites. For edge computing needs, for example, cost is a key consideration. Thanks to Scale Computing's inclusion of a purpose-built hypervisor, users don't have infrastructure-centric software



licensing costs to deal with. In fact, affordable three-node clusters make Scale Computing eminently suitable for edge computing, ROBO sites, disaster recovery, and core workload needs.

In addition, the simple nature of Scale Computing's solutions means that a store manager or IT generalist can perform maintenance on the cluster, including replacing failed drives, rebooting virtual machines, and rebooting nodes. There's no more need to roll out an expensive technician for routine maintenance tasks, which in the long-term it can result in significant cost savings.

While many commentators have focused on how much hyperconvergence can scale up to enterprise requirements, Scale Computing has delivered products that drive inefficiency out of their architecture in an effort to scale down. This ability to deliver smaller nodes has enabled Scale Computing to help small businesses and sprawling organizations create highly available edge computing and branch office solutions that are affordable, supportable, and dependable.

Learn more at: scalecomputing.com

THE SCALE COMPUTING HC3 SOLUTION: SIMPLE, SCALABLE, HIGHLY AVAILABLE

DESIGN

Brian Walker

Senior RF Design Engineer

Copper Mountain Technologies

Brian Walker is the Senior RF Engineer at Copper Mountain Technologies where he helps customers to resolve technical issues and works to develop new solutions for applications of VNAs in test and measurement. Previously, he was the Manager of RF design at Bird Electronics, where he managed a team of RF Designers and designed new and innovative products. Prior to that he worked for Motorola Component Products Group and was responsible for the design of ceramic comb-line filters for communications.

COPPER MOUNTAIN® TECHNOLOGIES

KEY CONSIDERATIONS FOR ANTENNA DESIGN IN IOT DEVICES

The reliability and performance of an Internet of Things (IoT) device depends heavily on the reliability and performance of its antenna. Antenna performance is a crucial link for integrating an IoT device into its ecosystem. To ensure the best transmitted power or the best received signal, the antenna must be matched to a certain impedance, mostly 50 Ohms for a passive antenna solution for IoT applications, inside and outside of the device. The designer needs to create the best possible environment in the IoT device to provide the optimal antenna matching for less losses, and transmit the maximum power from the radio into the air, or reciprocally receive the maximum signal back to the radio.

It can seem intimidating, but antenna design in IoT devices doesn't need to be daunting. Here are some things one should consider when designing IoT devices:

ANTENNA LENGTH

Antenna length is critical to maximize performance and provide the proper radiation characteristics. The length of the antenna determines the frequency of the standing wave which generates the electromagnetic field. A short antenna or an antenna which is too long will not radiate efficiently.

FREQUENCY RANGE REQUIRED

Most IoT is channeled through the Industrial/Scientific/Medical (ISM) bands, with future expansion into 5G

offering much higher bandwidth and ubiquitous connectivity, connecting more devices at higher speeds to deliver an enhanced user experience.

NUMBER OF FEEDS REQUIRED

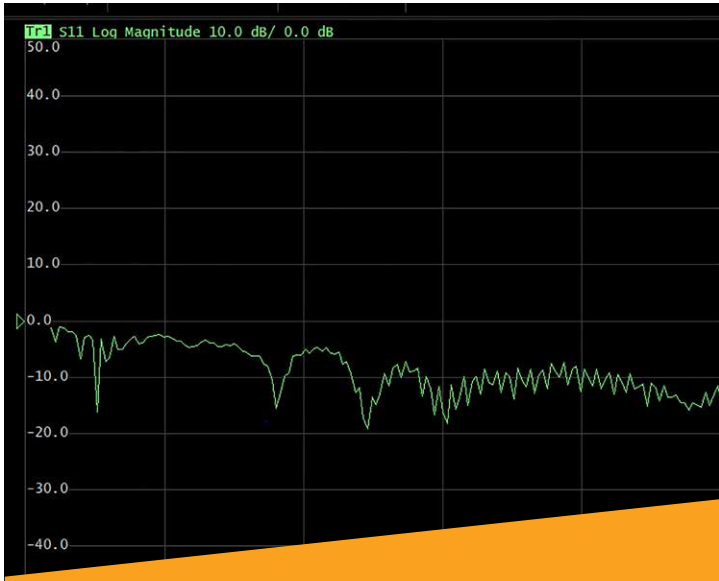
Based on the RF front end design, including numbers of RF switches, chipset capabilities, and RF performances required, antennas can be tuned for multiband or single band applications with single or multiple feeds. Each feed is going to be connected to a radio output pad. For example: dual band GPS/Bluetooth antenna (1 feed or 2 feeds), multiband 4G antenna using 1 feed or 2 feeds (1 for low band, 1 for high band).

PROPER GROUNDING

Ground planes are required to properly impedance-match quarter-wave or collinear. An efficient and compact antenna may utilize a ground plane. The plane acts like a mirror, creating a virtual image of the actual antenna allowing dipole performance with a single element. Analysis of the antenna/ground plane system is important to verify radiation efficiency. Half-wave or 5/8-wave radiators can be stacked vertically to achieve higher gain. The proper ground plane dimensions are defined by a ground plane which is much larger in both directions than the antenna length.

IMPORTANCE OF GAIN

A point source, or isotropic, radio source radiates in a spherical pattern with a significant amount of energy being radiated straight up. This is wasteful. An antenna with “gain” has a radiation pattern which is biased towards the horizontal. An “omnidirectional” antenna might radiate horizontally in all directions equally but might still have gain since energy that would otherwise



> “To ensure the best transmitted power or the best received signal, the antenna must be matched to a certain impedance, mostly 50 Ohms for a passive antenna solution for IoT applications, inside and outside of the device.

be sent upwards is channeled horizontally. In addition, it is possible to have a preferred horizontal direction and only radiate over a particular horizontal angle. A “Yagi” or “Dish” antenna is an example of a directional antenna. The gain is defined by the vertical and horizontal angles of radiation. High gain antennas are necessary for millimeter wave frequencies to make up for the increased loss in air. A system may be communicating point-to-point where an antenna that is optimized for a narrow “beam” might be optimal.

WIRELESS COEXISTENCE

With IoT becoming prevalent, we see many benefits from our devices as they share data and react in beneficial ways. These devices will proliferate as we become dependent on them. It will be imperative to properly manage interference. This will be a challenge because so many kinds of devices will be manufactured all over the world. The consequences can vary from being late to an appointment because an alarm malfunctioned to a fatality in a hospital setting because a monitoring device was “jammed” by a device brought in by the patient.

ABOUT COPPER MOUNTAIN TECHNOLOGIES

Copper Mountain Technologies develops innovative, robust RF test and measurement solutions for engineers all over the world. Our innovative products and partnership approach enable engineers to realize their potential through access to lab-grade instrumentation at affordable prices. Our world-class metrology and engineering resources work as an extension of your team. Our VNAs include an RF measurement module and a software application that runs on an external Windows or Linux PC and connects to the measurement hardware via USB interface. Our creative approach earned us awards from Frost & Sullivan in 2015 and 2017 for innovation and product leadership.

Learn more at:
coppermountaintech.com
@CopperMtnTech

Compass radome scanning

DESIGN

Adam Morrison

Owner & CEO

Streamline Designs, LLC

Adam Morrison is a leading strategy and technical consultant serving both manned and unmanned aircraft markets. For 18 years, his company Streamline Designs has been helping organizations strategically navigate a highly complex and changing regulatory landscape to get their aviation products and operations approved and to market much faster. Adam is an industry leader in standardsbased aircraft certification of Unmanned Aircraft Systems (UAS), Urban Air Mobility (UAM), Light Sport Aircraft (LSA), and General Aviation (GA). He is known for enduring leadership in developing creative solutions to aircraft design and certification since 2002.

Streamline DESIGNS

STREAMLINE DESIGNS

Streamline Designs is a technical consulting and certification engineering firm that exists to be an enabler for flight. With customers ranging from brand new startups to Fortune 50 companies, Streamline Designs provides critical strategic expertise for navigating a global, dynamic, and rapidly changing aviation regulatory environment. In the past, we would never have described aircraft certification as Lean, Agile, or Flexible. But now we do. We provide everything companies need to get to market under a single roof, including interface with regulatory bodies, validation testing, agile project management, and seamless digital technical publications.

ENABLING FLIGHT IN THE INTERNET OF THINGS LANDSCAPE

How do you get an idea, related to flight, off the ground? Literally and from a business standpoint? The old sci-fi question of the integration of man and machine continues to play out with increasing force as we lean into the capabilities afforded and enabled by autonomous flight.

In the span of the past decade, nearly every commercial market has embraced highly automated and internet-connected unmanned aircraft as a means to an end: a means to lowering risk while spraying crops; a means to compelling photography and video shots; a means to doing dirty work never really suited for humans; a means to imagery and visualization used in a thousand different ways. While the uses for aerial data collection devices that fly are innumerable and limited only by our collective imagination, the roadmap to that future is anything but automated.

Somewhat ironically, enabling flight in today's "Sky of Things" requires inherently human skills: like navigational prowess, finesse, relational strength, and trust. Now is the time when we are prototyping and proving out what the best automation-integrated world will look like and how we will get there. With considerations in land, sea, air, cyber, and human domains, companies who want automated aerial data, services, and transportation must navigate today's swiftly changing landscape of vehicle, systems, manufacturing, and operational regulations and methods. And while old ways inform our action today, those old ways of safety-assurance do not support the future of aviation.

> "Streamline Designs is a technical consulting and certification engineering firm that exists to be an enabler for flight. With customers ranging from brand new startups to Fortune 50 companies, Streamline Designs provides critical strategic expertise for navigating a global, dynamic, and rapidly changing aviation regulatory environment.

After decades of being stagnant, the pace of change in the aviation industry has been accelerating rapidly for the past 15 years with the movement away from heavy-handed governmental regulation toward the use of industry-driven safety standards. This approach, as intended, enables faster speed to market, lower development costs, and more flexibility to innovate; however, industry-driven certifications present unique challenges to the manufacturer and operator alike. Instead of a large checklist of clearly-defined processes to develop and safety factors to achieve, manufacturers and operators are required to consider methods of compliance in a performance-based, outcome-driven system.

So what does this look like for an enabler like Streamline Designs? It looks very human. It looks like meeting with manufacturers, operators, business owners, and regulators around the world and helping them clarify their place in the Unmanned Aircraft Systems (UAS) space. It looks like helping clients determine their own unique strategic posture with existing technologies and services, but in a new data landscape. It looks like connecting multi-layered, complex systems with one another (like Global Navigation Satellite Systems to vehicle-specific Command and Control Systems) to enable the future of flight. It looks like collaborating with industry to conduct research and development flight testing to stack projects and capabilities for maximum return on investment for all parties. It looks like influencing and writing the future of traffic and airspace management for manned, unmanned, and aerial mobility aircraft from right here in Indiana.

From our existing clients, which range from brand new startups to Fortune 50 companies, we have gained deep insight into what it takes to make it and move forward in the “Sky of Things”:

• Company cultures must have a clear vision for their core business, but must also be able to flex with the inevitable changes associated with introducing new technologies to market.

• Leaders who engage in standards and rulemaking can sometimes be out of touch without intentionally engaging manufacturers, pilots, users, and the community.

• Enlisting a team of trusted partners to provide support outside of the core business is key to rapid and definitive forward progress. This is especially true for navigating the closely intertwined regulatory and technical issues.

• The Silicon Valley mentality is new to aviation. Bringing together unique company cultures with regulators is more challenging than the hardest technical opportunities.

Headquartered in Franklin, IN, Streamline Designs has been providing supporting services for every aspect of aviation certification—traditional and novel—day-by-day, for 17 years. This includes becoming trusted strategic partners to aviation manufacturers and service providers, trusted technical partners in engineering, and a trusted document partners in cutting edge technical publications. Whether manned, unmanned, or Urban Air Mobility (UAM) oriented, Streamline Designs exists to enable flight around the world, in the US, and right here in Indiana.

Learn more at:
enablingflight.com

> “So what does this look like for an enabler like Streamline Designs?... It looks like influencing and writing the future of traffic and airspace management for manned, unmanned, and aerial mobility aircraft from right here in Indiana.

DESIGN

Tahira Reid Smith

Associate Professor

Purdue University

Tahira Reid is an Associate Professor in the School of Mechanical Engineering at Purdue University and is the director of the Research in Engineering and Interdisciplinary Design (REID) Laboratory. Her research interests include quantifying and integrating human-centered considerations in the design process and human-machine systems. Prior to arriving to Purdue, she completed a postdoctoral position in the Mechanical Engineering Department at Iowa State University. In 2010, she received her PhD from the University of Michigan-Ann Arbor in Design Science, with Mechanical Engineering and Psychology as her focus areas. Dr. Reid received both her BS and MS degrees in Mechanical Engineering from Rensselaer Polytechnic Institute (RPI) in 2000 and 2004, respectively.

PURDUE UNIVERSITY

College of Engineering

THE HUMAN SIDE OF DESIGNING AUTONOMOUS SYSTEMS: REAL-TIME TRUST CONSIDERATIONS

With the arrival of a new age of automation, humans now have to interact and collaborate with a variety of intelligent and autonomous systems. Such systems include those from daily life such as automobiles and home lighting systems to those that are more complex like unmanned aerial systems and healthcare systems. Significant efforts have been invested to ensure high functionality of the algorithms and the hardware that enable these systems to perform. Nonetheless, a human improperly trusting these systems can lead to catastrophic failures. Others have considered the role of the human such as their trust in the automation, mainly through the use of surveys, theoretical frameworks, and other empirical studies. However, these prior studies were limited since they captured static information about a person's trust levels. Therefore, important questions to answer include: What are humans' real-time trust levels during interactions with autonomous systems? How well can machines respond and adjust to human trust levels in real-time? What is the nature of human trust across various human-machine collaborations? These questions and more have been the motivation for the interdisciplinary research being conducted between two research labs at Purdue University in the School of Mechanical Engineering: The REID Laboratory led by Dr. Tahira Reid Smith and the Jain Research Laboratory led by Dr. Neera Jain.

TRUST IN AUTOMATION

The word trust often elicits thoughts about human-to-human relationships. However, trust in automation has been studied since the 1980s and has been well established as critical for successful human-machine collaborations. Of critical importance is the need for real-time estimation and closed-loop feedback to enable effective human-machine collaborations. Over the past five years, we have conducted a number of studies to capture trust in a variety of simulated autonomy contexts including an obstacle detection system, autonomous driving, and a reconnaissance mission. Through our work we have been able to achieve the following:

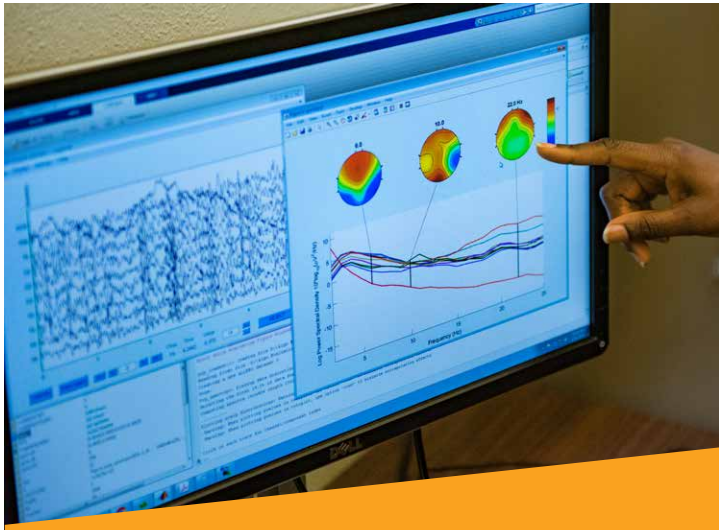
• Demonstrate that the use of psychophysiological sensors (i.e., electroencephalography and skin conductance) can be used to sense trust in real-time.

• Increase the efficacy and accuracy of existing models to better capture human trust dynamics

• Incorporate dispositional trust factors such as gender and national culture in our models

• Capture the differences in trust response to faulty vs. reliable automation between different genders and cultures

• Establish a framework to improve performance during human-machine collaborations using real-time estimation of trust



> “What are humansí real-time trust levels during interactions with autonomous systems?

Below are two areas in which trust in automation is important:

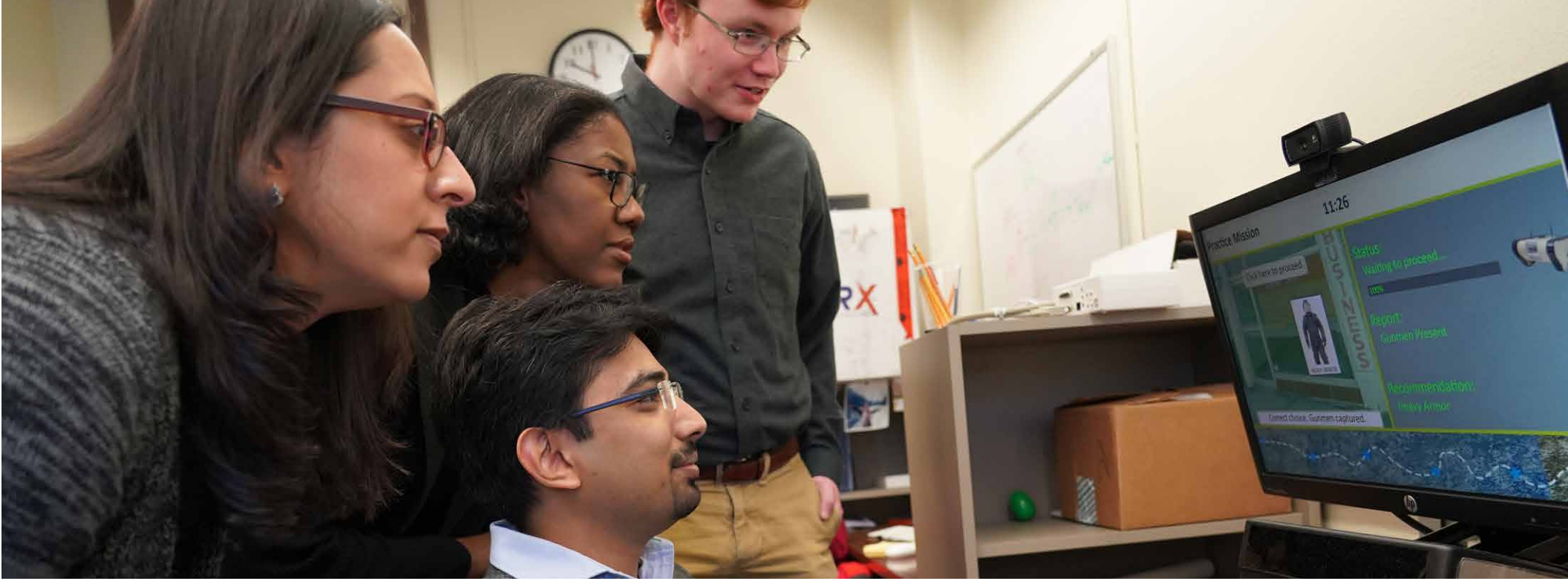
AUTONOMOUS VEHICLE SYSTEMS

One of the major sectors of society greatly impacted by advances in IoT is transportation systems. Vehicles of today have advanced driver assistance systems that help drivers to stay alert while driving, assists with lane keeping, and initiates automatic emergency braking, among other features. Beyond driver feedback, IoT has enabled autonomous or self-driving vehicles. A variety of automakers have taken the plunge to design, manufacture and distribute vehicles with higher levels of automation. According to Allied Market Research, the global self-driving vehicle market is estimated to be worth $557 billion just 6 years from now. Several companies envision partnering with services like Uber and Lyft to provide driverless taxi service to individuals. The element of trust is critical in such contexts. In addition, autopilot features such as those found in the Tesla can cause drivers to overtrust the system, which could lead to unintended consequences.

This reality has important implications on product design. Creators of products (e.g., engineers, designers, etc.) will need to consider user experiences and the extent to which they want to improve the human-machine collaboration. For instance, imagine a passenger getting in a driverless taxi and as the taxi begins to drive off, a wearable device he is wearing, allows the taxi to sense the trust levels in the passenger. The passenger shows low trust levels, so the taxi asks the passenger if they would like to end the ride, call a human driver, or proceed. In the case of vehicles where drivers can over trust the automation, perhaps the wearable can detect instances of over trust - perhaps high levels of trust in conjunction with several indicators that an unsafe operating condition is underway. This may include sensors that detect eyes off the road and hands off the wheel, while auto-pilot settings are in operation. Such feedback could lead to the vehicle slowing down and pulling over until the driver is ready to resume safe and appropriate driving procedures.

NSF CPS: FRONTIER: COGNITIVE AUTONOMY FOR HUMAN CYBER PHYSICAL SYSTEMS - TURNING NOVICES INTO EXPERTS

Although cyber-physical systems (CPS) do not always require the internet, they still represent a class of systems that are interconnected with other objects and people. Currently, we are working on a National Science Foundation (NSF) Collaborative project with with two other faculty members at Purdue (Dr. Inseok Hwang, Aeronautical Engineering and Dr. Brandon Pitts, Industrial Engineering)



and three other universities. Our interdisciplinary team (where our team was the only one selected in 2019 for this highly competitive award) is working to address the following question: How can we design cyber-physical systems to be responsive and personalized, yet also provide high-confidence assurances of reliability? The objective here is to create a system that adapts to the human while the human is interacting with a given CPS. As the system adapts, it provides feedback to the human to enhance the human's performance. We are building on our discoveries from the last five years, to build a human-architecture our team calls "cognitive autonomy" where we combine human psychophysiological and behavioral measures with objective measures of performance. In this work, the architecture provides transparent communication which supports trust and situational awareness.

SABBATICAL TIME AT IOT INDY

While at IoT Indy, my objective is to explore ways in which my research can be tested and/or applied across various contexts, products and systems, and/or explored in real-world settings. In addition, as a non-traditional thinker and doer, being in a space shared by others that think unconventionally and creatively about problems and solutions will be intellectually stimulating. The facility provides a space to think, create, and pursue ideas. I look forward to engaging with and learning from other members of the IoT lab.

Learn more at:
engineering.purdue.edu/Engr

CONNECT

As Hoosiers, we have a long and proud history for making things, moving things, and growing things. Across Indiana, technology hubs are emerging to reflect a spirit of cooperation between the public and private sectors. These regional hubs serve as catalysts for like-minded individuals and bring together the resources, market opportunities, and funding vital to advancing innovation and ideas. Offering more than just facilities, they connect Indiana's emerging tech ecosystem to the world.

CONNECT

David Roberts

Chief Innovation Officer at IEDC StateWorks

David Roberts serves as Chief Innovation Officer and Senior Vice President at the Indiana Economic Development Corporation. Previously, David was president of the Battery Innovation Center, a global battery company, IP counsel for a Fortune 50 company and an engineer in the defense industry. He is a practicing patent attorney, receiving his law degree from the Indiana University Robert H. McKinney School of Law and a Bachelor's Degree in Materials Science & Engineering from Lehigh University.

Indiana
A State that Works

IEDC ñ FUELING INNOVATION

In Indiana, innovation is more than just a buzzword. It is a strategic advantage for a state that embraces emerging technologies such as artificial intelligence, robotics, and IoT to cultivate a strong and diverse economy.

From agriculture and advanced manufacturing to defense and life sciences, Indiana is home to countless companies in a variety of industries finding success here. These companies are going to be key elements of the state's future, utilizing technology to fuel their growth in today's 21st century economy.

As a state, we're developing an entrepreneurial ecosystem encouraging innovation across the board, with resources designed to support businesses through all stages of growth. With innovation hubs such as the Indiana IoT Lab and programs fueling entrepreneurship across the state, Indiana has established itself as a great launching

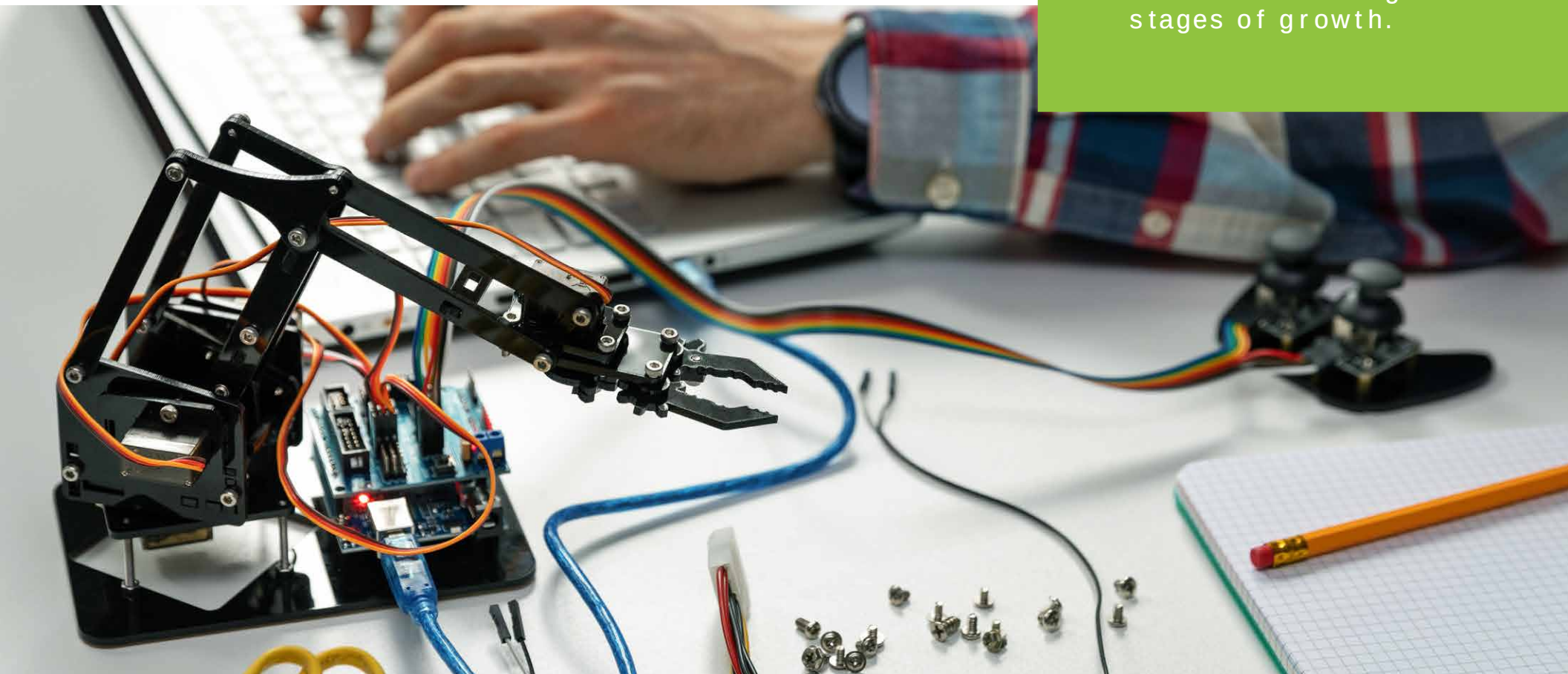
pad for entrepreneurs and startups, supporting Hoosiers as they develop new solutions and transform their ideas into successful companies.

To keep this momentum going, we will continue creating an environment where big ideas and bold ventures can flourish.

We will support disruptive industry trends and invest in infrastructure allowing our state and businesses to compete on a global scale. Let's make history together, right here in Indiana!

Learn more at:
iedc.in.gov

> "As a state, weíre developing an entrepreneurial ecosystem encouraging innovation across the board, with resources designed to support businesses through all stages of growth.



CONNECT

Stephanie El Tawil

Director of Innovation & Entrepreneurship

Innovation Pointe

Stephanie El Tawil is the Director of Innovation & Entrepreneurship with the Growth Alliance for Greater Evansville, an economic development group driving collaboration, innovation, and job growth in Southwest Indiana. Stephanie is tasked with growing the local entrepreneurial community and recently launched MAKE IT Evansville, a maker space with an IoT edge, at Innovation Pointe.

Growth Alliance
Greater Evansville Economic Development

Innovation Pointe | COWORK EVANSVILLE | MAKE IT EVANSVILLE

INNOVATION MEETS OPPORTUNITY IN GREATER EVANSVILLE

Evansville Indiana is synonymous with manufacturing and agriculture; however, our story and our region are transforming every day. With quality of place as our top priority, attracting new talent and business, innovation in southwest Indiana is steadily on the rise.

Our Industrial strength, highly productive workforce and easy access to roads, rail, runways, and the river position Evansville Indiana as an attractive destination for health and life sciences, advanced manufacturing, plastics, logistics, and distribution. Southwest Indiana is home to thriving employers including Alcoa, SABIC, Mead Johnson, AstraZeneca, Toyota, Old National Bank, Berry Global, and many more. With our economy centered around manufacturing and distribution and our history linked with making, building, and moving, it's easy to assume large business takes precedent over entrepreneurial development and growth; however, a closer look at the community endeavors will highlight a more robust and innovative identity for this ever-expanding riverbend community.

Managed by the Growth Alliance and supported by the City of Evansville, Innovation Pointe is carefully curated to offer affordable workspaces, facilitate beneficial collisions, provide access to small business resources, and establish an environment of collaboration, for entrepreneurs to start and thrive.

The stories below highlight just a few of Innovation Pointe's successful graduates and their current and forecasted impact on our region.

SaaS TECHNOLOGY FOR STRATEGIC CLINICAL SPEND MANAGEMENT

Founded in 2013 by Andy Perry and Steve Suhrheinrich, Curvo offers a Software-as-a-Service technology platform for strategic clinical spend management that equips hospital supply chain leaders and CFOs with the ability to reduce costs while maintaining quality.

In 2019, with 17+ employees, Curvo Labs raised an additional $2M in Series Funding. The company, which has seen revenue growth of over 5X since its last funding round in 2017, will use the funds to expand the leadership team and further develop the product offering.

ENGINEERING FIRM EXPANDS CAPABILITIES TO INCLUDE IoT

Envolve Engineering was founded in 2013 by a group of former Whirlpool appliance engineers. Each is an expert in their field with over 70 years of combined experience among them. Envolve found a home at Innovation Pointe with support from the Growth Alliance for Greater Evansville and the City of Evansville.

In 2019 Envolve Engineering proudly announced their expansion from incubator space at Innovation Pointe into a 5,000 sq. ft. state-of-the-art facility within the community.

DRIVING EFFICIENCY. MAKING SAFETY SAFER. INDUSTRIAL IoT.

Founded in 2015, Quarion Technology is an Evansville-based tech company that has developed market-disrupting technology focused on providing real-time three-dimensional tracking and control of motor lift equipment – with the goal of eliminating associated accidents, injuries, and property damage. Additionally, the technology generates critical data that leads users to uncover greater process performance and productivity.

In addition to winning Indiana's 2018 Innovation Showcase, Quarion Technologies recently announced a $700,000 investment supported by Elevate Southwest Indiana.

Learn more at:
innovationpointe.com

Sodam Kim

Marketing and Communications Manager

WestGate Technology Hub

Sodam is an experienced digital media and marketing professional with a passion for storytelling, content marketing and communications for business. She specializes in Corporate Communications, Online Marketing, Project Management, and Public Relations, with a demonstrated history of working in the information technology and consulting industries. She co-authored WORLD BUSINESS TRENDS 2018. She lives in Bloomington, Indiana with her husband, Joel.

WestGate Technology Hub

WESTGATE ACADEMY

WestGate Academy, located in WestGate@ Crane Technology Park, is an innovation and technology hub connecting startups, venture capital, established corporations, research universities, The Battery Innovation Center, local government entities and state development initiatives, such as Radius and Indiana Innovation Initiative (IN3), to support workforce development, entrepreneurship and innovation initiatives throughout southern Indiana. Formed through a partnership between WestGate Authority, the Naval Surface Warfare Center - Crane Division (NSWC Crane), Purdue University and the Purdue Research Foundation, WestGate combines a unique set of institutional strengths to advance educational, R&D and technology commercialization efforts across southern Indiana and beyond.

INNOVATION

WestGate provides a cohort-based program designed to guide entrepreneurs through the "ideation" and startup development process, by connecting entrepreneurs with the resources and tools they need to commercialize their ideas. Employing a curriculum developed by Purdue Foundry in West Lafayette, this nine-week program, known as 'Firestarter', covers a wide range of entrepreneurial topics including ideation, value proposition, market discovery and validation, and business plan development.

COMMUNITY

WestGate Academy is home to a unique, vibrant, and diverse community of entrepreneurs, cybersecurity, IoT, AI, and

8,000 S F
Unfinished Lab Space

$55M
Annual Payroll

COMMUNITY
Engaging tenants and Coworking Space members

300,000 SF
DEVELOPED

800
TECH PARK EMPLOYEES

78
Startups since 2018

aerospace experts, applied researchers and academic scholars. Technology companies (such as ManTech and Booz Allen) intersect with AI startups (Semiring and Aerotonic), battery tech startups (Brightvolt and Ateios) and researchers from the DoD, Purdue and Indiana University. The Purdue Foundry actively supports opportunity discovery, development, and scaling of ideas to impact.

Our monthly event, First Tuesdays @ WestGate and the networking session, The Spirited Entrepreneur, take place every first Tuesday of the month at WestGate Academy. Since 2018, WestGate has had more than 2,300 attendees, including investors, entrepreneurs, startup founders, government and business leaders and local community members. Under its mission to "extend key assets and knowledge in Purdue Foundry's innovation and entrepreneurial ecosystem for technology-inspired growth and activity", WestGate Academy is serving as an entrepreneurial catalyst in southern Indiana and beyond.

COLLABORATION AND AGILITY - NAVALX

In 2019, NSWC Crane was chosen as a Midwest Tech Bridge site for NavalX, a direct-report initiative under the Assistant Secretary of the Navy for Research, Development, and Acquisition (ASN RDA). Tech Bridges have been tasked with improving collaboration and agility throughout the U.S. Department of the Navy by creating off-base acceleration ecosystems to support the Navy's mission. As part of this initiative, IN3, one of WestGate's key tenants, will facilitate engagement with local Navy and Department of Defense (DoD) partners at its innovation space located off-base at the WestGate Academy.

SUSTAINABILITY AND GROWTH OPPORTUNITY

WestGate@Crane Technology Park is Indiana's only tri-county technology park. As home to the Battery Innovation Center (BIC) and proximity to Crane, WestGate provides a perfect location for startups and

established corporations seeking technology transfer from BIC and NSWC Crane. Currently WestGate@Crane Tech Park has over 30 small businesses and Fortune 500 companies creating jobs, partnerships and various opportunities for growth. The Technology Park has built over 300K square feet of office buildings, research and manufacturing facilities, laboratory, conferencing, and training space.

Learn more at:
westgate-academy.com

Pat East

Managing Director
The Mill

Pat East is Executive Director of The Mill. Located in the Trades District, The Mill is 19,000 square feet of coworking and incubator space. With nearly 300 members and 30 companies, they are the fastest-growing coworking space in the state. Their mission is to launch and accelerate high-potential companies, and their vision is to become the center of coworking and entrepreneurship in Indiana.

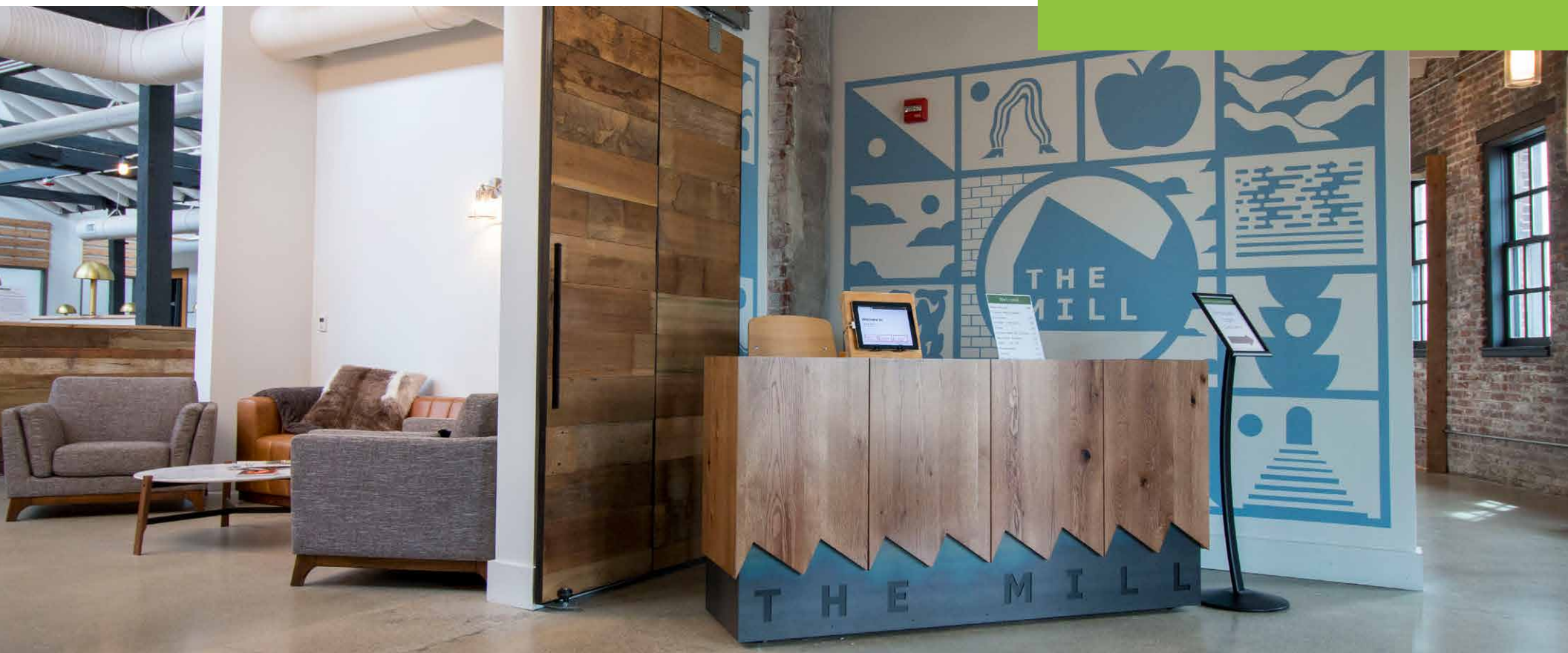
THE MILL

Home to 300 members and 30 companies, The Mill is 19,000 square feet of coworking and incubator space in downtown Bloomington. If you haven't visited The Mill, we hope you will soon. The design and construction team outdid themselves - marrying the old with the new, preserving the wood floors and exposed brick, carefully selecting the materials to define the workspaces and create collisions, and transforming a century-old building for the 21st century. This is a place where people create and grow together, and it is the anchor of our new economy. The Mill has been producing events and programming to support the technology and innovation community since summer 2017. Our mission is to launch and accelerate high-potential companies, and our vision is to become the center of coworking and entrepreneurship in Indiana. In 2019 alone, one of our member companies, FormAssembly raised $10 Million in Series A funding. Another, Cloudseal, after

winning an SBIR (Small Business Innovation Research) grant from the National Science Foundation, sold to Facebook. With Elevate Ventures and Columbus, The Mill formed the Velocities partnership, a $2.5mm initiative to boost innovation across the region. Thank you to City of Bloomington, Cook Group, and Indiana University for being our cornerstone sponsors. Your financial support enables our day-to-day operations, the weekly programming, hiring our staff, caring for our members, and has propelled us to become the fastest-growing coworking space in Indiana.

Learn more at:
dimensionmill.org

> “ Our mission is to launch and accelerate high-potential companies, and our vision is to become the center of coworking and entrepreneurship in Indiana.



CONNECT

Johnny Park

CEO

Wabash Heartland Innovation Network

Johnny Park is the CEO of WHIN, a non-profit organization focused on advancing ag and manufacturing technology to improve the quality of life in north-central Indiana. Formerly, Johnny was a Purdue University professor of electrical and computer engineering. He also founded and ran Spensa Technologies, a precision agriculture startup acquired by DTN.

WHIN
WABASH HEARTLAND INNOVATION NETWORK

DATA DECAGON

Over the last 30 years, the U.S. coasts have become known for software, innovation, and technology, while the Midwest has continued to grow its leadership role as an agriculture and manufacturing powerhouse.

Over this same period, circuit miniaturization, smartphone penetration, and the growth of broadband and Wi-Fi has created the environment to usher in the next generation of software, innovation, and technology: the Internet of Things (IoT).

Soon, everything from cars and kitchen appliances to heart monitors will be connected to through the internet. Experts expect around 24 billion IoT devices on earth by 2030, which is enough for every human on the planet x 4. All those devices will need to be manufactured, which creates an incredible opportunity for the Midwest – if we're able to achieve it.

It is with this vision we have formed a partnership among the most talented manufacturers, agriculturalists, scientists, educators, and community leaders in a nexus of opportunity: a 10-county region of north-central Indiana along the Wabash River valley called the Wabash Heartland Innovation Network.

This Data Decagon is accelerating the adoption of IoT in north-central Indiana's two strongest sectors by forming an Agriculture and a Manufacturing Alliance. These Alliances are exclusive consortiums of affiliated businesses receiving products and services designed to

support the adoption of internet-enabled technologies to reduce costs, increase efficiencies, and optimize operations.

WHIN works with technology providers, including multi-nationals with no current footprint in Indiana, emerging startups from around the country, and new homegrown technology out of research labs at Purdue University and Ivy Tech. Along with the help of our partners, WHIN subsidizes the cost of the technology adoption and makes sure the partners can implement its application. The Alliance members in turn share their data with WHIN, anonymously and privatized, with WHIN making it available for research. This completes a virtuous cycle, ensuring our region will continue to be the global epicenter of IoT-based precision agriculture and advanced manufacturing for many years to come.

Learn more at: whin.org
@WHINnetwork

CONNECT

Natalie Stahl

Director

Innovation Park At Notre Dame

Natalie Stahl is the Director of Innovation Park at Notre Dame, overseeing start up tenant relationships, events and property management. As part of Innovation Park's founding team in 2008, her project management skills have built community partnerships to assist growth of startup companies, developed leasing and operational policies to effectively manage and serve startup needs and create an environment where the tenant community can grow and develop.

INNOVATION PARK
Notre Dame

INNOVATION PARK AT NOTRE DAME - CREATING A PLACE

IDEAS. ENERGY. PEOPLE. CONNECTIONS.

Innovation Park at Notre Dame is more than a building. It's a place for aspiring entrepreneurs and those wanting to work with startups to bring their tech; meet other like-minded techies with lofty aspirations; and leverage University resources to buildout the tech, commercialize it and find talent. While space is important, the magic happens in the collisions, the connections and the spirit that drives people with a vision. It's a spirit of creativity, of possibility, of dedication and uncompromising grit. The Innovation Park space is designed to enhance the work and social environment to inspire and foster the belief in what's possible while bringing together the intellectual and technical resources to help create the marketplace reality.

Technology is a broad tenant industry base at the Innovation Park. Many companies located here and within northern Indiana are making a real impact in the IoT space, of which this is only a sampling.

SIMBA

SIMBA Chain, is a cloud-based, smart-contract-as-a-service (SCaas) platform enabling users across a variety of skill levels to implement dapps (decentralized applications). Formed in 2017 through a grant awarded by the Defense Advanced Research Projects Agency (DARPA) to Indiana Technology and Manufacturing Companies (ITAMCO) and the Center for Research Computing at the University of Notre Dame,

SIMBA Chain creates a simple, consistent and secure source of data tracking with Blockchain. Its technological beauty lies in its ability to gather, track and report accurate, unchangeable business data securely.

Joel Niedig, CEO was recently appointed to the SME Member Council for 2020 and Co-Founder and Board Member Jarek Nabrzyski, presented to the International Conference on ICT Convergence last October. The SIMBA team was named a TechCrunch Top Pick for Disrupt Berlin in 2019 and recently closed a $1.5 Million Seed Investment Round setting their stage for strategic growth in 2020.

FROST CONTROL SYSTEMS

Frost Control Systems manufactures and services an IoT device that measures environmental conditions, including road temperature, through a cost-effective unit that connects to industry leading mobile and desktop software. Developed by Brad Tener, a Notre Dame graduate, the ability to gather accurate data on road temperatures can save money, time and lives. The device uses non-invasive, non-contact sensors and the data is then centrally analyzed and informs city engineers how and where to most accurately distribute salt to maintain safe roadways.

Frost Controls received a $20,000 High Potential Startup Grant from Indianapolis-based Elevate Ventures in 2019, allowing them to grow rapidly and profitably without traditional investment. With successful pilot programs in 2018, FCS has quickly expanded and now has sensors deployed in 12 states and Canada.

aunalytics

Aunalytics had an exciting 2019 continuing and extending work with some of its largest partners in the IoT space. Aunalytics continued to provide the signal processing system of record for a Fortune 500 consumer products company, collecting and parsing over 200 billion messages throughout the year. Aunalytics completed a successful remote diagnostics pilot which correctly and proactively identified products in the field under duress. Additionally, Aunalytics continues to provide dozens of views and dashboards providing insights surrounding product engagement and utilization.

Lena works

Incorporated in 2019, Lena Works uses a patented control system that continuously monitors outdoor weather to protect building systems (plumbing, cooling, etc). Using smart technology and the internet, Lena keeps facility temperatures regulated appropriately at a level that avoids overheating and over cooling resulting in an average of 70% savings on monthly utility bills. The difference: the traditional ‘safe’ temperature of 55 degrees Fahrenheit, and didn’t take into weather temperatures.

Learn more at: ideacenter.nd.edu

Karl R. LaPan

President and CEO
The NIIC

Karl R. LaPan is the first President & CEO of the Northeast Indiana Innovation Center (The NIIC). He has served in this capacity since the formation of the organization October 16, 2000. The NIIC is a non-profit, vibrant entrepreneurial community designed to advise entrepreneurs to plan, launch, and grow successful business ventures. Our mission is to fuel great ideas, people, and companies. Our vision is growing and inspiring global business builders.

THE NIIC 20 years IN 2020
AN ENTREPRENEURIAL COMMUNITY

A PLACE OF SUBSTANCE FOR PEOPLE OF SUBSTANCE

We have a saying at The NIIC. "Dream big. Get real. Start small." Entrepreneurs have been doing this for 20 years through the NIIC—ever since collaboration among city, county, state, university, and private entities led to The NIIC becoming a 501(c)(3) nonprofit community-based entrepreneurial service organization (ESO). Collaboration remains integral to what we do.

Our purpose was and is to help grow the hometown team through higher quality, higher-paying jobs, and companies. Strengthening the regional economy is in our DNA, at the heart of what we do. Here, we highlight three key areas where we innovate and serve business builders in our entrepreneurial ecosystem.

The NIIC Emerging Issues in Connected Health attendees

CONNECTED HEALTH LAB—GROWING INDIANA'S IOT FOOTPRINT

The NIIC is one of 40 organizations from 28 states and two territories awarded funds to create and expand cluster-focused commercialization programs. The Connected Health Lab (CHL) is part of the Economic Development Administration (EDA) 2018 Regional Innovation Strategies (RIS) Program. The lab's vision is to help Indiana to be a recognized, global Health IoT leader.

The CHL connects people, resources, and ideas to lead to transformative products, businesses, and markets. One way we do this is Third Thursday Connections at The NIIC. "The Internet of Things is everywhere, and it is changing everything in healthcare. From patient to provider to product to payer. Its endless opportunities bring healthcare into the digital age," said John McDonald, founder, ClearObject, and panelist at a recent event. CHL also offers business coaching, custom-designed labs, on-site office space, and the NIIC Navigator® Online Toolset for entrepreneurial support. The lab is creating a platform and network for people to advance ideas into products and engage in these dynamic, transforming markets.

Founding partners, local corporations, universities, and foundations provided the required local match and are serving as active partners in the Connected Health Lab.

For a list of partners visit:
theniic.org/iot

LAUNCH WOMEN BUSINESS BUILDERS FOR TECH FOUNDERS

The Women's Entrepreneurial Opportunity Center (WEOC) serves as a U. S. Small Business Administration (SBA) Women's Business Centers

WEOC Caffeinated Conversations Workshop

"The Launch Women Business Builder Program is an accelerator/incubator for women in tech. The program includes training, coaching, and mentoring. The 12-month program runs two cohorts per year, including up to 10 businesses per cohort.

INCLUSIVE ENTREPRENEURSHIP
The NIIC partners with local, regional, and state nonprofit agencies and innovative leaders to help reduce barriers and obstacles for inclusive and diverse founders.

(one of two in Indiana). Through WEOC, The Launch Women Business Builder Program is an accelerator/ incubator for women in tech. The program includes training, coaching, and mentoring. The 12-month program runs two cohorts per year, including up to 10 businesses per cohort.

Program participants meet weekly for 1.5 hours, which forms two of WEOC's Master Mind Groups. The business builders value this. "I was unsure of what direction I should take, what path I should follow. I didn't know where to start. Working with a group of women that felt just as I have—hesitant, unsure, overwhelmed with what it takes to start a business—helped. We had each other. We need each other," said Jennifer Hunter, Founder, Gensyn Design, and program participant.

"Through the program, I did a lot of self-refection because of the (Master Mind) group and looked inside myself. I saw that I am worthy of success. I am worthy of doing this," said Ariel Christian, Founder of Kiddie Garden Cooks, and program participant.

Learn more at: inweoc.net

INCLUSIVE ENTREPRENEURSHIP FOR PROSPERITY

Indiana ranks 47th in the United States in starting new companies. This is not okay. What would happen if we provide access and equity in social and economic prosperity to under-represented entrepreneurs and business builders? For this reason, the NIIC partners with local, regional, and state nonprofit agencies and innovative leaders to help reduce barriers and obstacles for inclusive and diverse founders. "We want to help them realize economic and human potential through entrepreneurship. Our passion is to close the opportunity

gap, level the playing field, and increase prosperity," said Karl R. LaPan, President & CEO, The NIIC. Here are some ways we do this.

FAST-IN Program serves science and technology-oriented companies doing innovative research. The focus is on businesses located in Opportunity Zones, women, and rural businesses in Indiana. The aim is to increase the number of SBIR/STTR proposals written and to grow the number of SBIR/STTR awards. The NIIC is leveraging existing partnerships and networks to support underserved markets and increase entrepreneurial activity. The U.S. SBA powers this program through the Federal and State Technology (FAST) Partnership Program.

OPENS (Optimized Path for Entrepreneurial Network Success) Program—serves low-income microentrepreneurs and those located in Opportunity Zones in Northeast and Central Indiana looking to access capital. This program provides an on-ramp to typically underserved low-income populations. We do this by reaching out with network partners across the region using a customized process and toolset to deliver specialized business-building support. The U. S. SBA PRIME powers our work in this area.

WEOC is celebrating its 5th Anniversary this year and serves business builders at all stages of their ventures. This program is for women, immigrants, and ethnic minorities at all stages of their business ventures. U.S. SBA and The NIIC power our work in this area.

Breakthrough Grant Project uses community-based entrepreneurship to catalyze talent in underserved markets and increase entrepreneurial activity. This will result in increased participation in economic prosperity and social well-being of currently unreached entrepreneurs. This includes under-represented entrepreneurial talent sources, ex-offenders, rural business builders, disabled persons, immigrants, and other historically excluded community segments. This project is powered by Connected Communities and funded by the Foellinger Foundation.

Learn more at: theniic.org

16 Tech

Innovation for
Indiana's Economy

THE FUTURE OF INNOVATION

Rehabilitating the former Indianapolis Water Company headquarters on the near west side is 16 Tech – a ~100,000 square foot Innovation Hub developed to facilitate collaboration among innovators and entrepreneurs in the life sciences, technology and advanced manufacturing and engineering fields in an urban live-work-play-learn environment.

Innovation communities reflect a new economy where, according to the Brookings Institution, "innovation, entrepreneurship, creativity and placemaking intersect." Like many innovation communities, 16 Tech is in a dense urban core. Unique to 16 Tech is its proximity to more than 60 percent of the region's advanced industry sectors and an insatiable appetite for cross-industry collaboration toward innovation and commercialization.

In 16 Tech, Indianapolis has a unique opportunity to harness the diverse downtown Indianapolis advanced industry assets (Salesforce, Eli Lilly and Company, Cummins and Rolls-Royce and many more), proximate research institutions (Indiana University School of Medicine, IUPUI, Eskenazi Health and research hospitals), and nearby community efforts to attract jobs and create advantages for its residents. 16 Tech is the city's common thread that brings these opportunities together, resulting in unprecedented community and economic development impact.

PURPOSEFULLY BUILT TO FOSTER COLLABORATION

16 Tech is being purposefully designed as a place where researchers, entrepreneurs, established companies

and start-ups converge to innovate. The first phase will include up to 3 million square feet of work space that supports companies at a variety of stages, including:

- Office and lab space
- Incubator and accelerator space
- Makerspace

In 2020, 16 Tech will open the district with its anchor building, Innovation Building 1. The first building will be home to researchers, entrepreneurs and advanced industry leaders in tech, life sciences, advanced manufacturing, renewable energy, ag-bioscience and talent development – the ideal cross-section of industry expertise and entrepreneurial energy that will drive innovation in Indiana's economy. Tenants include the Indiana Biosciences Research Institute (IBRI), Central Indiana Corporate Partnership (CICP) and Indiana University School of Medicine researchers focused on industry collaborations and commercialization.

Knowing that innovation occurs outside the traditional 9-5 workday, 16 Tech also is creating a 24-hour environment where people can live and play with:

- Housing
- Retail
- Hotel
- 15 acres of green space
- 3 miles of biking and walking trails
- Access to the White River & Fall Creek

16 Tech has created a Community Investment Fund to ensure broader community benefit and to support inclusion projects for residents of nearby neighborhoods to participate in the economic opportunities created by the district. The Fund was seeded with $3 million from the City of Indianapolis and will be financially sustained through an assessment of future district occupants at a rate of $0.20 per square foot annually. The fund will be used primarily to upskill nearby residents through job training and other talent development programs, giving them firm footing to succeed in careers at 16 Tech.

Learn more at: 16Tech.com

Geoff Zentz

Indiana Director
gBETA

Geoff came to gener8tor after spending the last 14 years leading different sales, service, and client success teams. Throughout his career, Geoff has focused on work that makes an impact both on customers and on teammates and he is excited for the opportunity to help companies in the gBETA program make that same impact on their clients and community.

ACCELERATING EARLY-STAGE STARTUPS

In comparison to its other markets nationwide, the gener8tor team has found Indiana to be a consistent leader in IoT. This is largely in part to the best-in-class support ecosystem that has been built to encourage and enable IoT R&D activity throughout the state. Indiana entrepreneurs are fortunate to have committed partners and supporters like the IEDC, IoT Lab, 16 Tech, and many more to help lower the barrier to bring a new product or solution to market.

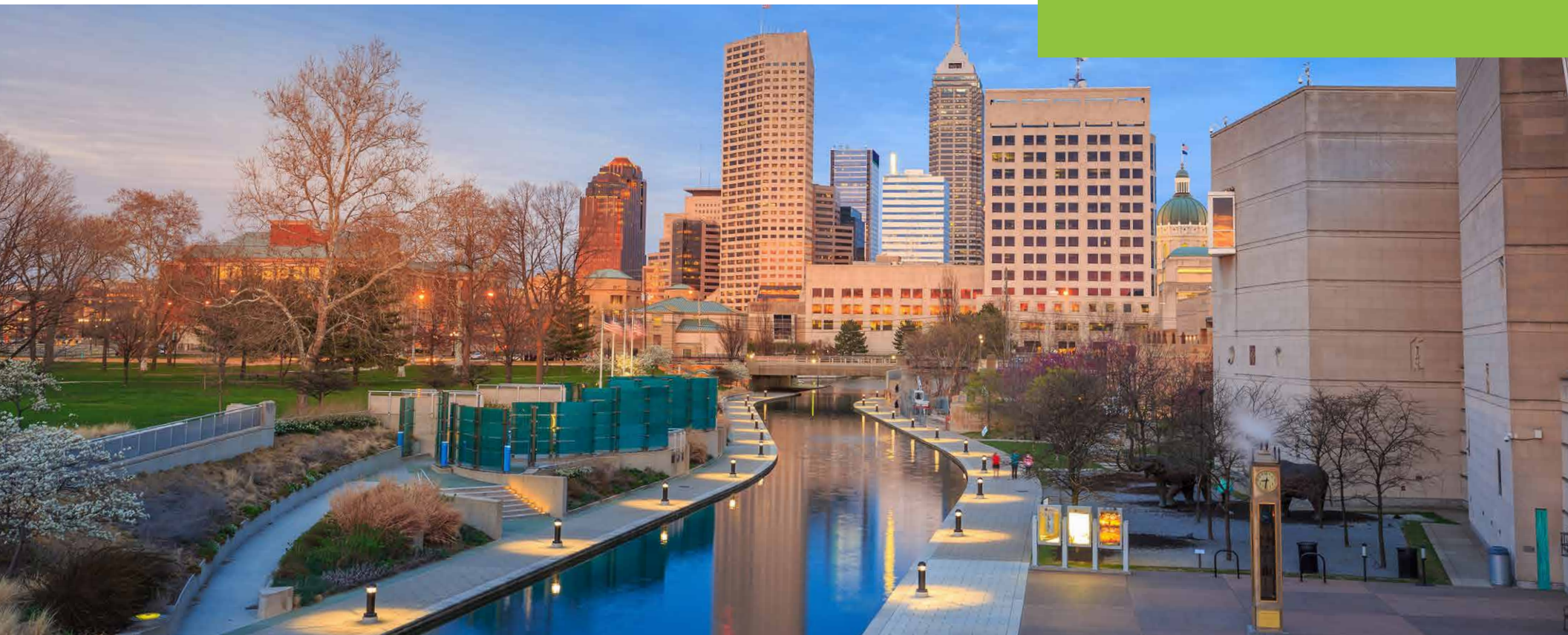
gBETA is a program of nationally ranked startup accelerator gener8tor. gBETA is a free, seven-week accelerator for early-stage companies with local roots. Each program is capped at five teams, and requires no fees and no equity. Since its start in 2018, the gBETA Indy program has consistently had strong tech startups in its cohorts. From the B2B SaaS offerings that Indiana has become known for, to the recent AgBioScience cohort, the gener8tor team has seen firsthand the confluence of technology across many different verticals. Recently, there has been an uptick in IoT related gBETA Indy participants, such as IoT Lab member company Project Process. Due to the past success, gener8tor has begun expanding throughout the state with new gBETA Terre Haute and Ft. Wayne cohorts taking place this spring.

The gener8tor team is thrilled to announce its newest Indiana program, the gALPHA 5G program. Launching in May of 2020, this program will further support the development

of IoT in the state. gALPHA is a free, four-week venture-creation workshop designed to help entrepreneurially-minded individuals and technologists create high-growth startups. gALPHA's hybrid hackathon/accelerator format is designed to help would-be entrepreneurs identify promising business models and design minimum viable products or roadmaps. This unique opportunity to ideate and iterate on a brand-new technology platform is one the Indiana tech community is poised to capitalize on.

Learn more at:
gbetastartups.com/indiana

> "In comparison to its other markets nationwide, the gener8tor team has found Indiana to be a consistent leader in IoT.



DEPLOY

It can be said that ideas are commodities until they're executed. The promise and hype surrounding IoT presents an evergreen dialogue for what is possible. While ideas can be truly fascinating, the possibilities present nothing more than outlook, and in some cases, opportunity. What is possible and what is deployable should therefore be distinguished as wildly different. As the IoT evolves and presents new possibilities to leverage sensors, vision and voice technologies, and advanced networks, the ability to execute ideas and deploy technology against real-world problems will continue to be seen in many facets of our everyday lives.

DEPLOY

Bill Soards

President

AT&T Indiana

Bill Soards was named President of AT&T Indiana in October 2013. Bill is responsible for external affairs for AT&T Indiana including; state and local government relations, community affairs, regulatory and legislative activities, and initiatives before the Indiana General Assembly and the Indiana Utility Regulatory Commission (IURC).

2020 STATE OF IOT IN INDIANA

There's never been a more exciting time for the Internet of Things (IoT). The Internet of Things connects people, processes, and applications to enhance communications on land, overseas, and in the air. In 2019, IoT connected the unexpected – like beehives and atmospheric water generators – to improve daily life with smart solutions. Looking ahead, we'll see 2020 continue delivering and expanding IoT's potential.

We're operating in a world where virtually anything can be connected to the internet. In addition to hundreds of millions of smartphones, we connected nearly 48 million devices to our AT&T network including nearly 24 million connected cars, more than 3 million connected fleet vehicles, and nearly 2.5 million asset management devices. Device ownership is expanding to new types of connected devices, such as fitness trackers (with a U.S. device ownership rate of 25%), smart home devices (15%), and many others.

Wireless technologies like 5G will be a part of what enables a multitude of possibilities in our connected society. 5G is the next generation of wireless technology and is expected to deliver these revolutionary technological enhancements—ubiquitous gigabit connection speeds (for faster downloads), dramatically decreased latency (to increase network responsiveness), and unrestricted density (to connect many more devices at once)—that will jumpstart the next wave of unforeseen innovation for consumers and businesses. With 5G, the future holds

unimaginable possibilities with new devices, new apps, and new capabilities.

Indiana is a world leader in innovation and entrepreneurship. Since 2015, Indiana has recognized the importance of 5G and IoT to our economy. Indiana's public and private sectors have been working together to quickly develop and assemble the necessary infrastructure to deploy 5G, making Indianapolis one of the first cities to rollout 5G Evolution.

In an increasingly interconnected world, it's rather difficult to imagine a modern industry that won't be positively affected by 5G's arrival. In Indiana, our agriculture and manufacturing industries and office workplaces are first to realize innovation through IoT.

PRECISION AGRICULTURE

At AT&T, we have been exploring how our connectivity can enable agriculture solutions. We collaborated with PrecisionKing, a provider of smart farming solutions, to take the guess work out of farming.

PrecisionKing's SoilKing solution lets farmers monitor the one key factor they have control over – water irrigation. AT&T's services let the SoilKing collect data from the soil and transmit it to the PrecisionKing console. Farmers receive alerts when it's time to irrigate. Not over-watering saves fuel and equipment costs and preserves an important natural resource.

PrecisionKing also uses AT&T IoT technology to help monitor weather conditions and track equipment. Access to wind, temperature, and humidity data provides farmers with a remote view of crop conditions so they can make real-time decisions to move or shut off irrigation—from virtually anywhere. This is the future of agriculture.

INDIANA MANUFACTURERS

Indiana's manufacturing industry is an economic powerhouse.

27.84%
output of the state

17.24%
state workforce

SMART FACTORIES

At AT&T, we are currently working with Swedish IT company, Prevas, to fast track IoT and connected services for businesses. One of the things we are exploring now is a way to make factory floors smarter and safer. AT&T can use our IoT technology to collect and relay performance from connected systems designed by Prevas in near real-time. This data provides monitoring insights as well as predictive maintenance, which can help reduce on-the-job injuries. They can also provide a way to plan for efficient production and maximum operational uptime.

IOT IN THE WORKPLACE

Facilities managers and architects are just beginning to recognize the new possibilities created by a workplace where everything—from a lighting fixture to a coffee maker—is a rich data source and ripe for automation.

Regulating the proper temperature for a large, diverse office population has always been complicated. Smart office sensors are already tracking workspace usage patterns by adjusting lighting and HVAC settings to suit a room's occupants, as well as those expected to arrive soon.

Furthermore, office meetings will be more convenient with telepresence robots already being deployed on an experimental basis to put a new spin on the face-to-face meeting experience. These self-guided robots simulate an in-person meeting, automatically navigating hallways on behalf of a remote user to meet with employees in their own environments.

LOOKING TOWARD THE FUTURE

We're creating a fabric of varying network technologies to deliver a more connected world. We offer a seamless suite of connectivity -- a network of networks -- to address a full range of use cases for our customers. In December 2019, we

announced the launch of 5G for millions of consumers and businesses nationwide over low-band 5G, including Hoosiers in Indianapolis.

With the launch of AT&T 5G for consumers, we're bringing our customers new and innovative ways to connect with each other and their communities. Our 5G launch sets the stage for the development of new and immersive experiences as we prepare to deliver AT&T 5G nationwide in the first half of 2020.

5G is essential to Indiana's transformation in the future marketplace. To ensure Hoosiers benefit from innovative IoT solutions, we are working with Purdue University's College of Engineering to create a test bed for 5G-based research and development at Purdue Research Lab. The lab will be using AT&T's 5G+ millimeter wave and commercially available Multi-access Edge Computing (MEC) technologies to develop IoT technology in advanced manufacturing, agricultural technology, and more.

Additionally, we took part in creating the Indiana 5G Zone, a 5G-related resource network where private and public stakeholders can work together to develop and test new technologies, products or service applications, while also having access to shared spaces for programming and events.

In both these initiatives, entrepreneurs, business leaders, and researchers are invited to leverage our 5G network to further explore and build new applications or products that could help advance technology across Indiana and the rest of the country. These technological solutions have the potential to solve real problems and make meaningful impacts to our Indiana community. We look forward to seeing the exciting new ideas that emerge from these collaborations.

Learn more at: att.com

DEPLOY

Zack James

Founder

Rabbit Tractors

Zack James is the founder of Rabbit Tractors. He founded Rabbit Tractors while studying corporate and securities law at the University of Michigan Law School as a solution to his own problem, being able to efficiently operate a farm operation spread over hundreds of miles.

AUTONOMOUS VEHICLES IN AGRICULTURE

The modern farm operation has been designed around the tractor, but the modern tractor has been designed around maximizing labor efficiency at the cost of other concerns. At Rabbit Tractors, we are using autonomous driving technologies to remove this design constraint and re-envision farm management practices to maximize yield and environmental stewardship without sacrificing profit.

At Rabbit, we are building the world's first multi-purposed, modular, compact and autonomous "farm utility robot." Designed specifically for row-crop farmers, it operates

in swarms with other Rabbits to achieve the same productivity as large modern tractors without the problems of large tractors such as soil compaction, huge capital costs, and complex maintenance requirements. These smaller units are more efficient both operationally and energy-wise, are simple in design, and can be assembled in different configurations for use throughout the year. Farmers who utilize our product see an immediate increase in yield and decrease in cost, all while opening the door to a new world of high-tech precision implements and innovative management techniques.

Deploying autonomous tractors in real row crop farm fields has some unique technical challenges that differentiate it from on-road and indoor autonomy. Farm fields are expansive, repetitive, dirty, and remote. The lack of access to cellular or WiFi networks means all computer power must

be kept on board the vehicle where cost and environmental protections are driving design criteria. Common applications of technologies like LIDAR and localization break down in dust filled fields with no differentiating features to track. Even GPS sometimes fails on cloudy days or at the edge of the field close to a tree line. One example is path planning, or determining the optimal route through a field. Unlike most applications, agriculture is concerned not with getting from point A to point B, but with covering an area with an implement facing a certain direction. Because these missions can take hours, small efficiency increases, such as minimizing turns and elevation changes, add up to huge absolute time savings.

The adoption of new technology by farmers is also a challenge. This is a group who has seen "the next big thing" come and go dozens of times, and have built a healthy level of skepticism. On top of that, the tractor is the core tool used in the most stressful times of a farm operation. To replace a trusted piece of machinery at a crucial time requires trust in the technology and an understanding of how to operate and troubleshoot it. Farmers need to explore, experiment, and learn a technology before they integrate it fully into their operations. Our first use-cases are selected with this in mind.

Cover crop seeding and soil sampling take place later in the season or after harvest when there is a relatively large time window to accomplish the task, meaning a technology failure can be remedied. The value-propositions of lowering labor costs, removing human error, and minimizing hours on expensive planting units are easy to understand. Most importantly though, these use-cases demonstrate key features a farmer will be investigating, such as the ability to traverse crops without damaging them and the ability to monitor a complex robotic process autonomously.

FARMING BENEFITS:
Lower Labor Costs
Remove Human Error
Minimize Work Hours

Learn more at: rabbittractors.com

DEPLOY

Ganesh Gandhieswaran

CEO and Co-founder

ConverSight.ai

Prior to founding ConverSight.ai, Ganesh was the Senior Director of Analytics and Information Management for Cognizant Technology Solutions directing global systems integrators in the IT services space. He has led award-winning enterprise information and analytics teams for 18+ years and has played critical roles in solution architecture, business development, customer relationship, delivery and operations management.

ConverSight.ai

BRINGING VOICE AND AI TO THE WORKPLACE

CONVERSATIONAL AI: THE NEW WAY TO ENHANCE PRODUCTIVITY AND IMPROVE VISIBILITY

As we step into the new decade, businesses can expect to see the growing use of data to make informed decisions to guide the smallest to the largest of tasks. Users in all roles and corners of the business will become increasingly dependent on insights that result in advanced data-driven decision making and overall improved efficiency and productivity. Read along to discover the role conversational artificial intelligence (AI) will play in propelling businesses forward in their digital transformation journey.

DIGITAL INITIATIVES RESULTING IN DATA GROWTH

Adoption of digital and IoT initiatives are growing day by day with companies implementing a plethora of new technologies. From autonomous cars to humanoid robots and intelligent personal assistants to smart home devices, the world around us is undergoing a fundamental digital change, transforming the way we live, work, and play.

Data has become critical to all aspects of business and personal life over the course of the last three decades. This new decade will witness the fastest growth in data and connected systems. As a result of these heightened expectations in the wake of this data boom, business will need data to be instantly available whenever and wherever anyone needs it.

THE POWER OF CONVERSATION BASED USER INTERACTION - FROM ON-SCREEN TO VOICE

The introduction of Amazon Alexa, Google Assistant and Siri into our homes and offices provides a new way of interacting with home

devices as well as business applications like conversational banking, e-commerce, automated contact centers and analytics, and more.

Conversational AI is changing the way people interact with technology and increasing access to growing amounts of data. It takes natural language processing and allows enterprises to create advanced dialogue systems that utilize memory, personal preferences and contextual understanding to deliver a realistic and engaging conversation with data sets.

Conversational AI removes the complex user interface to enable users to engage with technology in a human-like contextual conversation. As a result, the user receives personalized responses to their queries. Layered into this streamlined interaction with data is the added ability to uncover valuable insights within seconds.

Automated reports and checklists take the laborious steps and research out of recurring report generation, cutting minutes and hours for users on a daily basis saving businesses valuable money, time and resources.

ADOPTION OF CONVERSATIONAL AI & VOICE INTERACTION

Voice interface technology is relatively new and presents unlimited possibilities for organizations to explore. The business benefits of building technology capabilities that utilize a voice interface early on are numerous; it presents an incredible opportunity for organizations to enhance the consumer experience in their industry, allowing them to get ahead of the curve. Similarly, voice-based systems can improve operational efficiency by providing supply chain visibility, raising alerts in the case of quality issues, and ultimately empowering sales folks to easily access business metrics.

The supply chain world uses massive amounts of data that changes daily, requiring a great amount of inter-team coordination and organized workflows. The end-to-end process of inputting, tracking and completing orders is time consuming, laborious and vulnerable to human error. Normal, pre-defined screen-based systems are not dynamic and agile enough to handle this volume and variety of data. Voice and text base conversational interaction removes the boundary and provides easy and real-time access to key insights.

For example, one of the leading packaging material distributors uses ConverSight.ai's ATHENA, a voice assistant, to provide supply chain visibility to their sales teams and customers. Unlike traditional systems, users are able to naturally interact with ATHENA without going through any training.

Conversational AI systems and voice assistants are becoming common in the business place to access key insights and perform critical tasks more accurately and naturally.

Learn more at: conversight.ai

DEPLOY

Photo courtesy of Benjamin Stout

Aaron Pierce

CEO

Pierce Aerospace

Aaron Pierce is a Mitch Daniels Leadership Fellow with his Bachelor's Degree from Indiana University. He was the Entrepreneur in Residence for the first US Air Force Accelerator with Techstars, is a founding member to the White House charted Unmanned Aircraft Safety Team, and led Indiana's UAS Integration Pilot Program by organizing 60 entities and nearly 100 airspaces. He's written drone policy/ops manuals, taught at the University of Indianapolis, and mentored US Army Futures Command and SOCOM hackathons focused on counter-drone technologies.

PIERCE AEROSPACE

PIERCE AEROSPACE

We are a restless species. We continually reinvent and challenge ourselves with new conditions of evolution. The challenges we set today drive our current industrial revolution and fuel the inspiration for those who follow. In Indiana, we've led the pack in these challenges. Our forbearers laid down the transportation and automobile challenges that forever mark our state as The Racing Capital of the World.

In today's challenges, we look up and see the skies overhead on the verge of the biggest revolution in a century. The Wright Brothers (Wilbur, a native-born Hoosier) brought us the wonder of flight and made the world a much smaller place, while the contemporary drone brings us the daily interaction of flight, delivering instant access to the sky for all. Our new era and the drone challenges we address defines modern commerce and presents an opportunity to mark our place in history as the capital of unmanned aviation.

At Pierce Aerospace, we are focused on developing a new aviation identification technology we call Flight Portal. This technology is crucial for assuring who is who in the airspace, very much like a digital license plate. Flight Portal's identity assurance of unmanned systems is at the heart of the complex digital landscape of the Fourth Industrial Revolution.

Flight Portal is a digital utility. It powers the applications involved in unmanned aviation, primarily Unmanned Traffic Management systems (UTM), and Counter - Unmanned Aircraft Systems (C-UAS). UTM manages drones in low-level airspace, which will soon be quite crowded, and C-UAS performs security and defense of our skies at home and abroad.

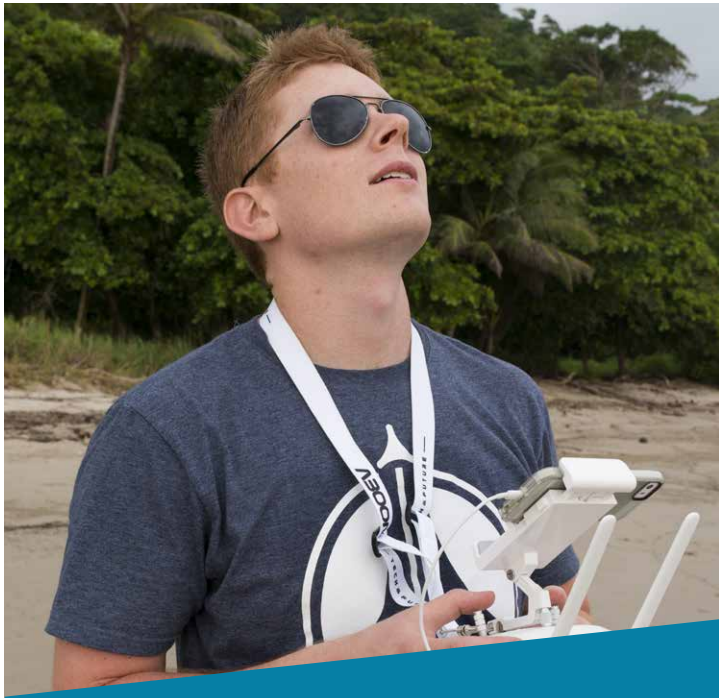
We are on the verge of this industry taking off, and Flight Portal is firmly establishing itself as a leading technology enabling and powering future drone flight. Drones can be used in

life-saving applications with first responders, infrastructure inspection, agricultural yield improvements, and, of course, package delivery. Flight Portal will be involved in all of these applications as the common factor enabling drones to navigate overhead.

Identity assurance of unmanned aircraft is a dual-use problem experienced by military and commercial stakeholders. We have designed Flight Portal to serve both sectors, and in late 2019 we fielded a live-fire experiment with the US Army. In this experiment, we set the flight records for the broadcast of Remote ID. We also integrated with a Northrop Grumman and Liteye C-UAS system. Flight Portal successfully provided them with Identification of Friend or Foe assurance, which they used to obtain clearance to fire on hostile aircraft.

Pierce Aerospace's role is that of an integrator of identity data, which our customers can use to enable drones to fly beyond visual line of sight. We are open to collaboration in our integrator role, and look forward to growing the more than 30 partnerships we've established to date. Forecasts project the delivery market alone to save tens of billions annually by converting delivery methods to drones. Every one of those deliveries needs Flight Portal to comply with government regulation to fly beyond visual line of sight. This is no small challenge, but our team is leading the way, right here in Indiana: the birthplace of aviation.

Photo courtesy of Lacey Lynn Seymour



> "Once you have tasted flight, you will forever walk the earth with your eyes turned skyward. For there you have been, and there you will always long to return.
> - Leonardo da Vinci

Learn more at: pierceaerospace.net

DEPLOY

Jeff Pinyot

President ECO

ECO Parking Technologies

Jeff is a graduate engineer from the University of Pittsburgh. After more than two decades with Trane, Jeff felt called to follow his God given entrepreneurial desires and jumped out without a parachute. Jeff is an accomplished author, speaker, and a Lowell Harwood Award winner. He was also named a Sustainability Leadership Pioneer by the Green Parking Council, and is a member of the Temecula Think Tank. He lives in Fishers with his wife Ruth and their four children.

ecoparking TECHNOLOGIES

ECO FALCON VISION:
DIRECTING THE FUTURE OF PARKING

Fishers company ECO Parking Technologies is onto something. Starting as a simple lighting provider specializing in commercial parking garage illumination, the team recognized an opportunity to disrupt the parking industry by combining multiple functions of parking into a single marketable product.

Parking, a traditionally heavy personal touch industry, is in a transition. As owners and drivers desire faster transactions, gateless experiences, on-line reservations, and hi-tech solutions, ECO has stepped in with their Falcon Vision Parking Guidance System (PGS). Falcon Vision is the world's only vision based PGS that is integrated into a lighting fixture. Why? Two reasons: a significantly lower installed cost that results in both market expansion and market share, and a built-in ECO-friendly lighting control system. Described as "elegant" by the industry, the ECO Falcon Vision stands alone.

Falcon is connecting a historically brick and mortar industry to the Internet of Things. Having gained the trust of the industry by providing quality solutions to some of the country's largest energy projects and gaining a physical presence in the garage, ECO sees their LED light fixture as a nest to house a smart lighting and parking solution. Think Mr. Potato Head. The basic head is a light fixture – the ECO FlexTech LED. The optional eyes are the cameras ECO adds to their fixtures through Falcon Vision to identify occupied and unoccupied parking spots and recognize motion to control lighting output. The mouth is the wireless Mesh Network allowing the fixtures to communicate with each other. The arms

and legs are the private WiFi network connecting all the data to the ECO Falcon Vision Gateway: the brains of the system.

Falcon Vision connects valuable parking data to wanting owners. Knowing exact space availability can significantly increase revenue. Parking metrics like parking patterns related to time of day and spot selection allow an owner to maximize their revenue by dynamically pricing a parking spot based on its up-to-the-second demand. Also, an owner can "Right Size" their garage by multi-tasking a parking spot. Gone are the days of dedicated reserved parking spaces that are often empty. Today, through a Parking Guidance System like the ECO Falcon Vision, a 600-space garage can perform as an 800-space garage by multi-purposing individual spaces, reserving them through various color indication that changes throughout the day based on actual demand.

As the connected car continues to develop and mature into the industry, the ECO Falcon Vision remains current with Evergreen Software and the latest technology to communicate a car location and parking patterns.

Today, Fishers-born ECO Parking Technologies and ECO Falcon Vision are being accepted with open arms and open parking spaces from the Silicon Valley in California to the beaches of South Florida.

Learn more at: ecolightingsolutions.com

> "Falcon Vision embraces the autonomous vehicle and its impact on the future of parking.

DEPLOY

Everett Berry

CEO

Perceive, Inc.

Everett has successfully written over 10 NSF grants resulting in Perceive receiving more $1.5 million to do groundbreaking computer vision research. The team of Purdue graduates that Everett assembled has more than 40+ years of experience building and delivering enterprise SaaS applications and hardware. They have worked for companies like Qualcomm, Oracle, Springbuk and Purdue University. Perceive has been honored to be a part of both Daniel Gross's Pioneer Accelerator as well as the Alchemist Accelerator. Alchemist Accelerator was given a platinum rating alongside of Y Combinator and 500 Startups.

perceive

GAINING INSIGHT TO THE TANGIBLE WORLD

Generating insights and improvements in the field of user engagement is both an art and a science. Both the online and the offline world need metrics describing how visitors interact with their space. In the online world, companies want to understand and attach meaning to every click, page visit and browsing duration. Software like Google Analytics have made it easy for the online world to create detailed measurable metrics and workflow. However, there exists a void on how to produce accurate metrics for the experiential offline world. There is no easy way to gather detailed accurate and visual metrics about engagement for the tangible world.

Perceive built a winning equation to drive impact for the offline world.

Find the What:

• Highlight trends or exceptions in the offline space on our analytics platform

Understand the Why:

• Automate looking through thousands of hours of video into a set of curated videos

• Collate the curated videos and metrics.

• Videos paint the story behind the raw numbers

Figure out the How:

• Facilitate collaborative feedback about video and metrics

Perceive's solution is called VisitorX and consists of the following:

• 3d cameras that click into existing track lights

• AI engine
• Web-based analytics, collaboration and workflow platform

VisitorX's innovation is a game changer for companies that have a physical space. There have been cameras and analytics before but none have been able to connect "real life videos" with metrics while providing collaboration and workflow tools that facilitate conversations about next steps.

Brand Showrooms

• Product designers want an increased amount of non-intrusively obtained feedback
• Need to drive a faster feedback loop for product design
• Drive showroom remodel dollars by engagement metrics
• Understand the engagement number associated with the different products.
• Collaborate ideas and opinion based upon engagement videos

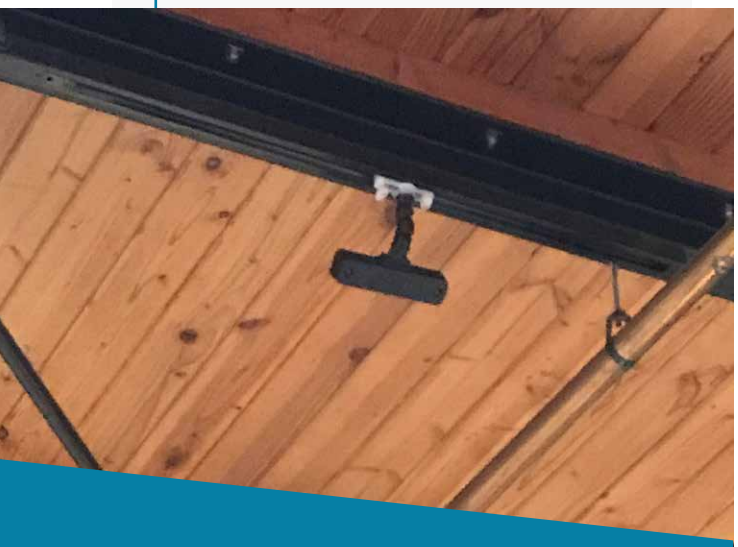
Experiential Spaces

• Experiential space needs to identify which experience draws people and keeps them engaged.
• An attraction needs to engagement metrics to sell buyers on their impact to a space
• Marketing the space based upon sharing engagement videos

Direct 2 Consumer Showrooms & Retail

• Drive revenue by leveraging the accurate metrics and videos to identify placement or display issues
• Driving loyalty to providing detailed insights for URL brands that are moving into the IRL space.
• Strengthen communication with the brand by sharing and collaborate around engagement videos and demonstrating the impact the showroom is having
• Larger quantity and most consistent feedback about products and consumers by integrating the metrics and the video.

> "Perceive built a winning equation to drive impact for the offline world.



> “The Indiana IoT Lab has been the perfect home for the Perceive team. The amazing space provides an area to ideate, ability to have access to cutting-edge equipment and has facilitated collaboration of forward-thinking leaders.

Museums

• Return on investment. We spent 100k on an exhibit. What were the engagement metrics? Was it worth it? Did we get the expected engagement or do we need new signage?
• Confirm Wayfinding
• Drive retail revenue in the giftshop leveraging engagement metrics and heatmaps
• Gathering more complete engagement to prepare for next
• Ability to share and collaborate around engagement videos

The Indiana IoT Lab has been the perfect home for the Perceive team. The amazing space provides an area to ideate, ability to have access to cutting-edge equipment and has facilitated collaboration of forward-thinking leaders.

Perceive started at Purdue University when a group of students and faculty asked the question, “How do we provide insights on how people behave in a space?” Through iteration and research, a multi-disciplined team of engineering, computer science, and business researchers developed a hardware and software solution called VisitorX.

What is VisitorX’s secret ingredient: Specially built cameras, AI engine and collaboration tools

Our competitors use cameras that can only capture “top down” views. This means their cameras can only gather data about the top of people’s heads. Top down cameras can’t tell the direction that people are looking and this drastically impacts engagement metrics. The “top down view” prevents our competitors from providing engagement videos which capture actual visitors’ engagement. Live video feeds are the only way of really getting to the ‘why’ something occurred.

Collaboration is critical to having analytics succeed because decisions aren't made in silo. Today it is difficult to share and provide comments and have discussions about videos. VisitorX has enabled different teams to work together by integrating the collaboration into the analytics platform.

Perceive's NSF grants paved the way to spend 4 years building innovative cameras and an AI engine second to none.

Perceive's innovation addresses problems for brand showrooms, retail, entertainment and experiential centers

Perceive technology has continued to grow and provide insights to improve user experiences for the physical world around us.

Learn more at: visitorx.co

DEPLOY

Michael S. King

President, Data Analytics & IoT Solutions
LHP Engineering Solutions

Michael King is President, Data Analytics & IoT Solutions at LHP Engineering. In this position, Michael is responsible for implementing large-scale Digital Transformation initiatives, Advanced Analytics, and a full range of Internet of Things (IoT) capabilities for major OEMs in the Transportation, Industrial, and Manufacturing industries. Prior to joining LHP, Michael was the Director of Enterprise Business Analytics for Cummins, the global leader in diesel engines.

GLOBAL LEADERS IN AUTONOMOUS FUNCTIONAL SAFETY

Founded in 2001 with the mission to create a safer, smarter and more connected world, LHP Engineering Solutions (LHP) has provided functional safety engineering services and technology integration for embedded controls, telematics, data analytics, and model-based design. We specialize in creating custom, flexible, and comprehensive technology solutions in the automotive, aerospace, and medical fields.

Through our knowledge in embedded controls, telematics, and data analytics, we deliver technology solutions and engineering services built on intelligence, connectivity, and actionable insight.

We deliver by deploying engineering services, technology integration, innovative tools, training, and data analytic solutions to enable product development, engineering process redesign, standard compliance, and clarity in the face of accelerating complexity.

LHP believes by developing technology solutions and engineering services built on intelligence, connectivity, and actionable insight, that real autonomy is possible.

Organizations strive to meet demands for innovation as electronic control unit requirements increase in complexity. At the same time, you are pushed to refine internal processes, establish strong documentation standards, and utilize your workforce effectively.

ABOUT LHP DATA ANALYTICS & IOT SOLUTIONS

As part of LHP Engineering Solutions, the

LHP Data Analytics & IoT business unit was founded on a simple yet compelling concept. Combine the deep engineering expertise & telematics of LHP with our analytics, cloud, manufacturing, and large-scale systems experience to create a team unlike anything in the industry.

Our vision is to transform how companies today utilize Data and Connectivity to drive business results converting underutilized data in to actionable results. Now more than three years later, we have gone from start-up to triple-digit growth, helping transform LHP into an industry leader in Digital Transformation and Industrial IoT solutions.

Our mission is to provide a new atmosphere of easy to use IoT and Analytics solutions that allows business decision makers to quickly access, combine, analyze, and present information, lower business and IT process complexity, lower costs, and provide leadership data driven decisions and high end user satisfaction.

OUR APPROACH

We believe in the agile approach to IoT and analytics (specifically: Distributed Agile Development). When we combine our technology approach to processes, support, and expertise with our business domain and engineering knowledge, results follow.

At a high level, our approach consists of rapid iterations and continuous reapplication of the key insights. Start small if needed and live and learn with your data, prototype often, and get the information to the key stakeholders early and often. This foundational approach yields significant results (50%) in the first few weeks pass, with substantial value (80%) by the second few weeks pass. As you follow this approach, the quality of the model, data, and most importantly business value improves. Finally, this approach allows you to focus on individual PoCs within a factory, business unit, function, or region or with a connected enterprise solution, or IoT connected ecosystem.

OUR CLIENTS TYPICALLY NEED

Efficiency to Reduce Costs and Maximize Profitability:

- Integrated Digital Strategies and execution plans to achieve economic profit targets
- Industrial connectivity to achieve global economies of scale
- Large scale systems integration to enable cross-functional opportunities

Advanced Data to Optimize Revenue, Organizational Scale:

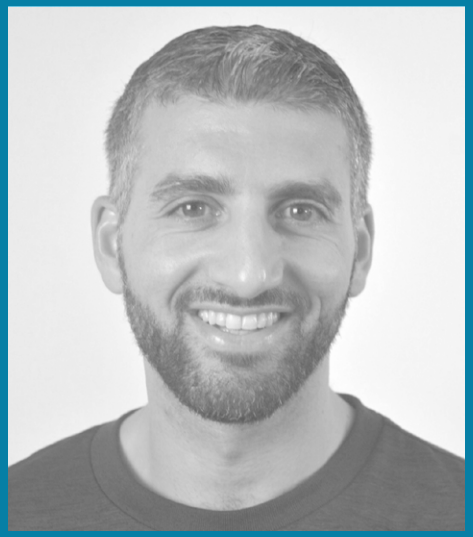
- Achieve business case results from Digital Transformation
- Leverage Data to improve customer satisfaction, competitive position
- Drill-down, drill through analytical capability throughout the global enterprise

Leadership and Innovation as a Service:

- Leadership through the complexities of a digital enterprise
- Solve problems no one else can solve
- Partners that can teach, train, and inspire

Learn more at: lhpes.com

DEPLOY



Mohammad Afaneh

Founder

Novel Bits, LLC

Mohammad Afaneh is a Bluetooth Low Energy (BLE) developer and expert who specializes in helping engineers acquire the in-depth knowledge needed to build a high-quality BLE product and take it to market faster. He does so by providing online courses, books, and tutorials on his website: www.novelbits.io.

NovelBits

BLUETOOTH TECHNOLOGY

INTRODUCTION

The “Things” in the term “Internet of Things” make up a crucial part of any system that is considered to be an IoT system. In this context, “Things” refers to the end-node embedded devices in an IoT system, and wireless connectivity is usually the main communication medium for such devices.

There are quite a few options for wireless connectivity these days. Not all of them are created equal, and none of them is a one-size-fits-all solution. Bluetooth, and more specifically Bluetooth Low Energy, has become one of the prominent connectivity technologies primarily due to its existence in 100% of all new smartphones[1], but also due to how well it has been able to keep up with demands of the market.

THE HISTORY OF BLUETOOTH

Over the past 20+ years of its existence, Bluetooth has proven itself to be a technology that has adapted well to the needs and demands of the market by adding new features and enhancing the existing ones. You may be aware of Bluetooth as a consumer for wireless audio (speakers, headsets, and car infotainment systems), but Bluetooth exists in so many other applications outside the consumer electronics space, which we’ll touch on in this article.

To better understand the state of Bluetooth, it helps to get some level of understanding of the technical aspects of the technology. The first important aspect to be aware of is that there are two Bluetooth radio options: The original Bluetooth Classic (referred to

[1] 2019 Bluetooth Market Update: https://www.bluetooth.com/bluetooth-resources/2019-bluetooth-market-update/

as BR/EDR) officially released in 1999, and Bluetooth Low Energy (sometimes referred to as BLE) which was officially released in 2010 part of the Bluetooth 4.0 specification.

Bluetooth Classic is used mostly in streaming applications, mainly audio, where data is continuously transmitted between two Bluetooth devices such as wireless speakers, wireless headsets, and in-car infotainment systems.

Bluetooth Low Energy, on the other hand, is best suited for applications where data is exchanged infrequently in short bursts. It has a significant advantage over Bluetooth Classic in terms of power consumption allowing devices to run on coin cell batteries for months or even years.

The key advantage of Bluetooth Low Energy over Bluetooth Classic is that it provides a foundation that is much more flexible allowing developers to adjust and customize certain parameters and the configuration to satisfy the requirements of their project. This is the reason that most of the updates and new features introduced in the official Bluetooth specification in the past few years have been focused primarily on Bluetooth Low Energy.

APPLICATIONS OF BLUETOOTH TECHNOLOGY

Now you might be thinking "well, this all sounds good on paper, but what I really care about is the application and implementation of Bluetooth in real-life products in the market", and that's a valid point. So, in terms of actual products that utilize Bluetooth technology, the easiest way to think of them is in terms of the network topology of the application. Bluetooth Low Energy provides the flexibility to support any of the following network topologies:

2 TYPES OF BLUETOOTH TECHNOLOGY

Bluetooth Classic is used mostly in streaming applications, where data is continuously transmitted.

Bluetooth Low Energy is best suited for applications where data is exchanged infrequently in short bursts

> “ Bluetooth, and more specifically Bluetooth Low Energy, has become one of the prominent connectivity technologies primarily due to its existence in 100% of all new smartphones, but also due to how well it has been able to keep up with demands of the market.

• Point-to-point (one-to-one): where two devices are directly connected to each other provides a bi-directional communication channel.

• One-to-many: think of it like a broadcast-based application where one (or more) device sends data in one direction for multiple other devices to discover.

• Many-to-many: this refers to mesh-based systems where most or all devices in a system can communicate with each other in a bi-directional fashion. Introduced in the Bluetooth mesh specification (2017).

Let’s look at some of the most popular applications of Bluetooth:

• Wearables and fitness trackers (point-to-point): Fitbit, Apple Watch, etc.

• Medical and health devices (point-to-point): Continuous Glucose Monitoring device, Pacemakers, etc.

• Smart home appliances (point-to-point): Connected door locks, Smart Fridges, etc.

• Indoor Location Systems (one-to-many): Beacons, Indoor Navigation Systems, Asset Tracking solutions, etc.

• Smart Building systems (many-to-many): Commercial Lighting Systems, Smart HVAC systems, etc.

From a technical point of view, here are a couple of facts about Bluetooth Low Energy that you might find interesting:

• Data Rate: Up to 2Mbps raw data transmission rate, allowing user data transmission rates of up to 1.4 Mbps

• Range: Up to 1.5 kilometers utilizing the long-range mode introduced in Bluetooth version 5.0.

As you can see, Bluetooth Low Energy is no longer a short-range technology and not just suited for one type of application. In fact, the technology is changing so rapidly that at CES 2020, the Bluetooth Special Interest Group (the organization that governs the Bluetooth brand) announced the next generation of Bluetooth audio: LE Audio.

LE Audio not only utilizes BLE to provide solutions for the same applications currently implemented using Bluetooth Classic but it also improves the quality and introduces solutions for completely new applications such as:

• Broadcast audio (e.g. tuning into audio streams from public sources such as TVs or a PA in an airport)

• Enhanced Bluetooth Hearing Aids

• Audio sharing (e.g. sharing audio with friends and family from your phone directly to their Bluetooth earbuds)

Learn more at: novelbits.io

DEPLOY

Jeff Marston

Vice President of Business Services

Comcast

Jeff is responsible for the strategies used by our Business Services team to grow Comcast Business in the Heartland Region footprint. This includes directing Small-to-Medium Business (SMB) and Enterprise sales, along with being responsible for our marketing, operations and financial performance.

COMCAST BUSINESS

BEST PRACTICES FOR SMALL BUSINESSES TO COMBAT CYBERSECURITY THREATS

Companies need a front-line defense against malware and other threats, or risk crippling consequences of a breach.

Cybersecurity attacks have become a destructive and all too common occurrence. And the harsh reality is that no organization is too large – or too small – to be a target.

While cyberattacks impacting large corporations and government entities may dominate headlines, small businesses are victim to the majority of cybersecurity breaches. In fact, nearly half of small businesses in the United States suffered a cyberattack in 2017, according to a recent study.

Cybersecurity attacks are constantly evolving to accommodate the latest technologies. Small businesses contend with several existing and emerging internet-related threats, including malware, ransomware, phishing and botnet infections.

Faced with increased competition and restricted resources, it is easy to imagine the daunting challenge small businesses face to defend themselves from nefarious cyber actors. But as the threat landscape becomes increasingly sophisticated and prevalent, small businesses cannot afford inaction.

SMALL BUSINESS' PATH TO CYBER SAFETY

For businesses large and small it's less about "if" a breach will happen and more about "when" it will happen. That's why it's best to invest in protection and prevention

before a crippling attack occurs. According to security firm Kaspersky, the average cost of a breach in North America is $149,000. Just as damaging, the loss in public trust and reputation can be irreparable.

Cybersecurity keeps business owners up at night because they face an onslaught of challenges, from various, ever-changing forms of cyberthreats that can result in the loss of sensitive information or the disruption of business operations. When it comes to defending against cybersecurity threats, owners need solutions that can protect all devices connected to their networks without straining budgets.

In the past, cybersecurity tools were developed to suit the needs of larger companies, which have the money and resources available to deploy complex solutions and continually enhance security networks. Now, many small businesses are turning to cloud-based internet security solutions that are engineered to help them effectively manage the growing risk of cyberattacks while maximizing resources without compromising security.

In many cases, small businesses have already established a digital infrastructure but lack the bandwidth to expand it further. Using cybersecurity technology that can be built into existing hardware offers these businesses an all-in-one solution requiring no additional investments in equipment or setup. To further maximize their cybersecurity investments, small businesses can look for tools that automatically cover all connected devices on their networks, from mobile phones to wireless printers, without requiring new software installations.

Comprehensive cybersecurity solutions shouldn't just protect small businesses against external breaches – tools which block access to compromised or malicious domains can help prevent business owners, employees, or guests from accidentally accessing an infected internet site. Businesses with little to no IT support can also look for tools with dashboards and features that can be customized based on their needs. For example, a tool that allows owners to filter web content will give them more visibility into their network safety.

The ability to gather insights from cybersecurity solutions is critical, but sometimes there is not enough time in a fast-paced work day to pull a threat assessment. Tools that automatically update internet domain threats in real-time can protect companies from attacks without needing manual downloads or updates. Your business works hard to carve out a competitive space – your cybersecurity tools should be a hassle-free addition to the workplace.

Learn more at:
comcastbusiness.com/securityedge

DEPLOY

Luddy School of Informatics, Computing, and Engineering

IU Bloomington

INDIANA UNIVERSITY

LUDDY SCHOOL OF INFORMATICS, COMPUTING, AND ENGINEERING AT INDIANA UNIVERSITY BLOOMINGTON

From the outside, the building doesn't look like anything special. It can be the home of insurance adjusters or a company that sells beige shoelaces.

But inside the doors of the Multidisciplinary Engineering and Sciences Hall (MESH), part of the Department of Intelligent Systems Engineering at the Luddy School of Informatics, Computing, and Engineering at Indiana University, innovative research is being conducted that will change the world.

MESH recently opened a suite of laboratories that will keep ISE on the cutting edge of research in the realms of drone technology, biology, "smart" fibers, and biomedical systems. The effort also brings ISE labs from around the IU campus under one roof, providing a central hub for research.

"The new labs are going to be great, but the most important aspect will be bringing all the engineering labs together," says Maria Bondesson, associate chair of intelligent systems engineering and the director of the Bondesson Lab. "That's going to be a huge advantage and really facilitate collaboration between the engineering groups. Having the combination of labs that we have housed in one place will really be something special."

The Bondesson Lab focuses on identifying toxic chemicals among environmental pollutants and deciphering the mechanisms by which they act. Bondesson and her team study zebra fish in various stages of development to learn how they might be impacted by different substances introduced into their environment.

The lab previously was housed in a small lab in Simon Hall, a biochemistry building on the southern edge of campus.

“My lab at Simon Hall is quite small,” Bondesson says. “The new lab at MESH is roughly double the size. That means I can have many more fish, which will allow us to run more tests at once and expand our research.”

Bondesson shares the lab with James Glazier, a professor of intelligent systems engineering, and the increased space also means more room for their equipment, including fluorescence and confocal microscopes.

“We can see very detailed things in living fish—in my case—or in cells, or whatever you’re looking at,” Bondesson says. “We’ve been able to design what the microscope rooms look like to make it more efficient.”

The lab will also include a chemical room and a cell culture room.

“It’s a perfect space for my work,” Bondesson says. “It brings everything together, and it shows a nice commitment to our research from the Luddy School.”

Another new lab at MESH is sure to bring plenty of buzz.

The Vehicle Autonomy and Intelligence Lab focuses on developing methodologies that enhance the autonomy and intelligence of robotic systems such as unmanned ground, aerial, and aquatic vehicles. The variation in the environments in which the drones will operate creates a challenge and a demand for a unique lab space.

The VAIL will feature three levels. The bottom level will provide space for a water testing chamber. There, researchers will be able to test simple drone behaviors and sensor performance in water. Its location below ground level will allow researchers to limit the amount of light allowed in the space, providing a more realistic testing ground for aquatic drones.

“It’s like a mini pool,” said Lantao Liu, an assistant professor of intelligent systems engineering and the director

of the VAIL. “What we see in the air and in the water is different. There is more darkness in water, and there are particles in water, plus there are issues with refraction and reflection. They all have to be considered when developing these drones. Then, you have to test sonar and ultrasound equipment to image the environment. If there are obstacles or something in front of the robot, we want the drone to “see” it and reconstruct it, and ultimately know how to avoid it.”

Autonomous Underwater Vehicles have existed for years, but they’re getting ever more sophisticated. They can be used for search and rescue operations that allow humans to search a larger area with better vision, especially in murky water, and sonar applications can look for wreckage and pinpoint what dangers may lie around wreckage. AUVs also can be used for agriculture. They can be used to monitor underwater agriculture, such as clam or seaweed farms, and AUVs can monitor water quality.

The upper floors of the VAIL will serve multiple purposes. The top floor includes work space for faculty, students, and other researchers, as well as space for observers to watch and conduct tests of flying drones, or Unmanned Aerial Vehicles. UAV research will be conducted in a 1,000-square-foot flight arena that will include camera-assisted navigation devices that will allow for extremely precise flying. All of this will take place in an area enclosed by concrete walls three- to four-feet thick covered by a glass ceiling.

The VAIL will focus on two types of drones for flight. One is a larger UAV that normally doesn’t fly inside because they’re too big and heavy, which makes them dangerous for testing. They also generally navigate via GPS. The VAIL will conduct research with the larger UAVs outside, but refinements will be made indoors via a smaller UAV that is roughly the size of the palm of a hand.

“Those drones can be used for testing flight behavior, such as control performance,” Liu says. “How well does it perform in flight? How does it perform different behaviors, such as pitch and yaw? It allows us to decide how aggressive flight plans can be, and we can play very complicated trajectories and test how well it performs indoors. The camera system will replace the GPS system indoors because GPS won’t work in the flight arena. But the camera system is also more precise, and the accuracy of our flight plan can be within millimeters.”

Thanks to the flight arena, the UAVs can fly regardless of the time of day or the weather. They also will be able to fly in swarms where multiple UAVs will work together in formation, an application that has already been showcased at major events such as the Olympics and the Super Bowl. Most importantly, the tests conducted by the smaller UAVs can be translated and applied to larger, outdoor UAVs, and a combination of GPS and camera-assisted navigation, plus sensors, can create UAVs that can be used in a variety of applications.

For instance, air quality can be tested using UAVs, and they can be used for monitoring crops, assessing soil moisture, and judging when crops are ready to be harvested.

“People might not be able to tell the exact time crops should be picked, but drone cameras can,” Liu says. “For example, there are many grapes on one vineyard, but the drone images and AI algorithms can estimate how much yield there can be from certain sections of a vineyard at different times. And then you can focus your resources and maximize the yield. A drone can also water crops or deploy pesticides.”

The UAVs also can fly to and enter buildings, which is critical in disaster situations. In the event of a bombing or some sort of structural collapse, UAVs can be deployed to assess the integrity of a building and pinpoint the locations of victims while also mapping the condition of the interior of the structure to provide more information for responders.

The use of artificial intelligence will allow the vehicles to “learn” in a lab setting how to react to various obstacles and situations, providing them with the ability to be deployed in the field with greater success. The same systems can be also used with a third type of drone, Underground Vehicles, or UGVs.

“We don’t have to deploy a human inside a building that might be unsafe,” Liu says. “The same goes for underground situations, such as a mine collapse. If there are people trapped inside, we have to assess the situation for emergency personnel. The drone can fly or we can deploy an underground rover, and sensors can build a 3-dimensional image and an accurate map. It’s more than just pictures or measurements. There are no humans in there, and the drone has to be able to do the task by itself, and we need artificial intelligence for that.”

The design of the VAIL incorporates Liu’s input, and the customized space

has been designed to optimize the lab experience.

"I'm very excited about it," Liu says. "I've talked to colleagues from places like MIT, Carnegie Mellon, and other world-class researchers of drones, and I've talked to them about the pitfalls to avoid. We're learning from others to have a design that incorporates the most positive aspects of a research space possible."

The VAIL's location provides it with an advantage over other similar facilities.

"This lab will be very different from other labs in the United States and worldwide," Liu says. "I'm working on all different kinds of vehicles. We're connecting air, ground, and sea. There is a unique opportunity to build a system that connects different types of vehicles. The IU Bloomington area is unique from other universities in urban areas because we have lakes nearby. We have caves nearby. We have wide-open spaces to test aerial vehicles. If you're in a large urban area, such as Boston, you can't test drones due to FAA rules. We can do it, and we don't have to go very far to do it. It makes research much easier and more efficient. MESH is walking distance to a lake, to the forest, to farmlands. There are so many areas and space for us to research."

The VAIL thrives on open spaces, but another new lab at MESH, Alexander Gummenik's Fibers and Additive Manufacturing Enabled Systems Laboratory, needed height above all else.

The FAMES Lab engineers fibers and fabrics, and it embeds ensembles of nano-transducers and sensors into the materials that allow them interact with their surroundings and feed input back to computers. Through the use of 3D printers, fiber preforms are created that include embedded transducers and sensors for the desired functionality. The preform is then run through a tower that thermally draws the material down two stories to create fibers that can be integrated into fabric.

"The FAMES Lab is basically designed for full vertical integration including design, material processing, fiber preform production, fiber drawing, and the characterization of fibers," says Gummenik, who is an assistant professor of intelligent systems engineering and director of the FAMES Lab. "These materials have active functionality. If you're wearing a t-shirt, it can keep you warm, but it can't sense your stress level and give

you a massage if you're stressed. The fibers I'm designing will have active functionalities that will serve a host of purposes."

The FAMES Lab includes a 27-foot tall draw tower, a pair of optical labs, two preform labs, and additive manufacturing lab, and an area to house hazardous chemicals.

"Most of the spaces in my lab are designed as clean rooms," Gummenik says. "We build with materials that are used in clean rooms, and air filtration, pressure balancing, and humidity control are part of those spaces. We use 3D printing to create the preforms before we make the fiber, and we have 3D printing that incorporates those fibers after they have been drawn. It's almost like recursive manufacturing. You 3D print with the fiber that was created from a preform that was 3D printed. And because I designed the lab, I had the opportunity to optimize the design. It's different from getting a lab that is ready to go and randomly throwing equipment into the space that you're assigned. I could group processes by some logical constraints."

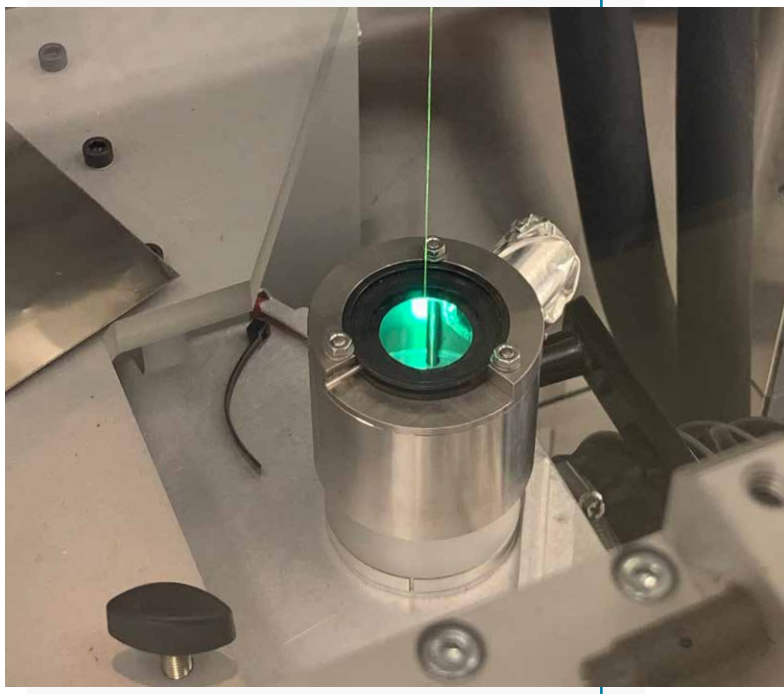
The fibers also can be used in bioprinting and even quantum computing applications.

"For instance, you can 3D print an ear," Gummenik says. "You lay it out with bio ink on an anatomical ear, and it looks like an ear, but it's not an ear. If you dissect it on a micro-level, you'll see a soup of hydrogel with cells inside. It's not tissue in any way. It doesn't have nerves or cartilage or muscles.

"What I try to do with fibers is provide those functionalities artificially from within. They can be fibers that serve

THE FAMES LAB

The lab ensembles nano-transducers and sensors into the materials that allow them interact with their surroundings and feed input back to computers.



as micromusculartures and serve as artificial muscles that allow the promotion of growth of natural structures from within."

The FAMES Lab is a flexible research facility, which opens the possibility of the lab being contracted to entities outside of the Luddy School. Because it is not a production facility, the parameters of the machines is not rigid. Machines are not designed to do only one job as is often the case in production facilities. Companies which might want to create a prototype of some product can rent the space from the FAMES Lab, and local start-ups will have the opportunity to break into a market by first testing the feasibility of their ideas.

"Here, you can play," Gummenik says.

The FAMES Lab and its focus on fibers is unique, and there isn't another lab like it in the Midwest. It is expected to draw attention from the Department of Defense and other research entities, which will also create self-sustaining funding for the lab.

A fourth ISE lab in the MESH complex, the Intelligent Biomedical Systems Lab directed by Assistant Professor of Intelligent Systems Engineering Feng Guo, will focus on the development of novel intelligent devices, sensors, and systems based on microfluidics, acoustics, electronics, and materials to address the problems in translational medicine and life sciences.

Guo is excited about working with the other labs in MESH and how the convenience of the location will help push his research forward.

"Bringing together the animal facility, the confocal microscopes, and other spaces will be very helpful," Guo says. "It will allow us to conduct our research on cancer immunotherapy, neuroscience, biomedical devices and systems, and so much more."

For instance, Guo and his colleagues have developed a method to study cell-to-cell communication by first positioning cells using acoustic waves. The surface acoustic wave (SAW)-based technology allows them to be positioned with precision, and they can be kept in that state to make it easier to study their communication. Understanding the mechanism by which cells communicate will allow researchers to develop approaches to cancer treatment, immunological interactions, and more.

"Combining an acoustic device with artificial intelligence will allow us

to create unique bioengineering technology," Guo says. "It will allow my lab to answer many challenging questions that others cannot begin access."

IU RESEARCH

Indiana University's world-class researchers have driven innovation and creative initiatives that matter for nearly 200 years. From curing testicular cancer to collaborating with NASA to search for life on Mars, IU has earned its reputation as a world-class research institution. Supported by $680 million last year from our partners, IU researchers are building collaborations and uncovering new solutions that improve lives in Indiana and around the globe.

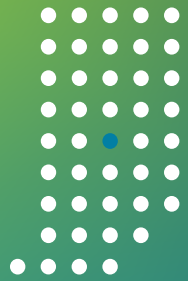
Learn more at: luddy.indiana.edu

> "From curing testicular cancer to collaborating with NASA to search for life on Mars, IU has earned its reputation as a world-class research institution.

THANK YOU TO OUR SPONSORS

DESIGN | CONNECT | DEPLOY

SCHEDULE A VISIT OR BECOME A MEMBER AT INDIANAIOT.COM



INDIANA iot LAB
FISHERS

www.indianaiot.com

9059 Technology Lane
Fishers, IN 46038