CARLSON SCHOOL OF MANAGEMENT
UNIVERSITY OF MINNESOTA

BUILDING THE INFRASTRUCTURE & SERVICES TO SUPPORT

THE INTERNET OF THINGS

by Lee C. Thomas with Norm Chervany

Although he's worked here for years, Kemal Badur has never been in this building before, let alone this particular conference room. This is not unusual, given the size of the University of Minnesota's Twin Cities campus. The large urban campus often feels like a city within a city to Kemal. Thousands of students, faculty, and staff move around "the U" each day on their way to classes, offices, and research labs.

One thing Kemal likes about working at a large research university: there are always interesting new things to learn about. With 18 colleges, dozens of academic departments, and hundreds of active research projects, the University of Minnesota has people working on a huge range of topics, from aerospace engineering to urban planning, biology to sports management, and everything in between. As a senior director in the Office of Information Technology (OIT), Kemal often gets the chance to meet with people from all kinds of disciplines.

Today for instance, Kemal is meeting with crop and plant scientists on the U's St. Paul campus. Although not as populated as its sister campus in Minneapolis, the St. Paul site covers a large swath of land and houses a number of departments, units, and research centers. Students attending classes here study agriculture, veterinary medicine, design, nutrition, and environmental sciences, among other subjects.

Kemal takes out his laptop and sets it on the conference table. He's a few minutes early and the first to arrive at the meeting. He doesn't have to wait long.

NOTE: *Although based on actual business needs, the character names, titles, projects, and conversations depicted are fictional inventions, and do not represent actual persons or teams. The one exception is Kemal Badur, who is indeed senior director for infrastructure and production at the University of Minnesota's central Office of Information Technology (OIT). Mr. Badur and OIT sponsored this case for the 2017 CoMIS Case Competition hosted by the Carlson School of Management.*

"Hello," says a voice at the door, "You must be Kemal. I'm Denise Jackson-Bearse." A woman in a fleece zip-up vest enters the room. Her pale blonde hair falls loosely around a pair of turquoise-framed eyeglasses. "Nice to meet you in person," she says, extending a hand.

"Likewise," says Kemal as they shake, "I'm glad we were able to find time to meet. I'm interested to hear more about your project."

"Wait, don't start without us!" booms a new voice as two more people entered the room. The man speaking has a graying beard, big smile, and laugh lines around the eyes. "I'm Gerald Wu," he says, "And this is one of our graduate students, Brady Willis." The younger man nods hello and pulls out a chair. He wears a faded plaid shirt, sleeves rolled up to the elbows, and carries a notebook in one hand.

"We wouldn't dream of it, Gerald … as if you'd let us," says Denise, and Kemal gets the impression that these two colleagues have a habit of teasing one another. Denise turns to Kemal, "Thanks again for coming over."

"Of course, happy to," says Kemal, "From the emails you sent I understand you might be looking for some help from the Office of Information Technology."

"Exactly right," says Denise. "As I mentioned in the emails, Gerald and I conduct research on various growing conditions for different crop types. Things like temperature, water levels, soil composition and nutrients, sunlight intensity and duration—all the conditions that influence how well a crop grows and how much it yields the farmers or growers."

"That isn't new, of course," adds Gerald, "But today's methods are much more sophisticated than *The Old Farmer's Almanac.* Everything's gone techie, as you might imagine. Even dirt is digital now!"

THE INTERNET OF THINGS (IoT) refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.

Forrest Stroud, *Webopedia* definition

http://www.webopedia.com/TERM/I/internet_of_things.html

Denise gives Gerald an almost imperceptible smirk. "He's talking about precision agriculture," she explains, "The field is growing by leaps and bounds as technology becomes more powerful and more affordable. We can do things now that people didn't dream of a few decades ago."

"It's amazing stuff," says Kemal, "I read those articles you sent me. From what I understand all the big players are pouring R&D money into this. Pioneer, Monsanto, Winfield."

"You got it," says Gerald, "They all know this is the future. In some ways, it's already here. Agronomists can make much more accurate recommendations for what to plant in which fields, what sort of fertilizers and other treatments to use, when to apply those treatments, and so on. All the better to increase yield and feed a hungry planet."

Not to mention, make a profit, thinks Kemal.

A GROWING FIELD FOR EXPERIMENTATION AND STUDY

"Data drives a lot of it—like so many things these days," says Denise. "Brady here is doing his dissertation on the analytics behind it all."

"I'm a data jockey," says Brady. "I also come from a farming family so I've been around this stuff my whole life. We hope this new project will provide an interesting dataset for us to work on."

"Yes, so tell me more about the project," says Kemal.

"Essentially, we're applying for a grant that will fund new data collection using a variety of sensors in actual growing fields—one of the U's test fields and one at a partner site. The basic idea is to place the sensors in the field and calibrate them to collect readings at given time intervals. As that data is collected, we can run analyses on it, sometimes in real time," Denise pauses.

"In some cases, it will be hundreds of readings per hour," adds Brady. "Multiplied by all the individual devices. Our scale is fairly large compared to what other schools are doing."

"We have the test fields," says Gerald, "And the grant will pay for all the devices. But, we have to show in the grant proposal that we're ready and able to collect all that data and use it. The funding agency wants to know the plan for connecting all those devices to Wi-Fi, where the data will be stored, how it will be accessed. That kind of thing."

"So we were hoping to get your help on that," says Denise. "None of us here has that kind of infrastructure expertise, and we also thought that OIT might already have something in place elsewhere on campus that could be used."

"Sure," answers Kemal. "That's certainly something our office can work on." What that would look like exactly, Kemal wasn't yet sure.

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A few days later Kemal is in another conference room, this time at the facilities management office on the Minneapolis campus. Dale McGinty, assistant director of facility engineering and energy management for the Twin Cities campus, sits across the conference table. Two engineers and an IT manager are also in attendance. They are part of the operational unit that oversees the collection of systems that deliver light, heat, water, and power to more than 200 buildings across campus.

"Electric, HVAC, water. Automatic door locks and other systems. Steam and cooled water utilities. All of it's monitored through one of our systems." Dale pauses, drumming his pen against the table, "If we're doing our jobs people don't notice because things are working as they should."

"That takes a lot of people power, of course. Our staff count is close to 700," notes one of the engineers, a man named Mike. "That includes maintenance staff, various technicians, building supervisors, custodial, grounds crews."

"Right," agrees Dale. "Ours is one of the primary units of Facilities Management. We focus on energy management and efficiency, as well as sustainability initiatives."

"A big job," says Kemal, "I read in one of the reports on your web page that you saved the University 2.6 million dollars in energy costs in one year. Am I remembering that right?"

"Yes, that was a few years ago, actually. The 2010 report most likely."

"Impressive," says Kemal.

"We've been able to accomplish a lot over the years," Dale admits, "But there's still more we'd like to do."

"So what are some of the challenges today?" asks Kemal.

Mike jumps in, "There are plenty. Starting with the mix of buildings. Some of them are 150 years old. Others are brand new, state of the art."

"The reason we're here today, and where we're hoping to get help from your group, is with our connected devices and sensors," explains Dale. "We've been using various types for at least 20 years, if you can believe it. Obviously, technology has changed a lot during that time. As we all know."

Dale turns to Abel Vasquez, the group's IT manager, who leans forward and continues.

"All those sensors are critical to the energy management program," he says. "They take readings for temperature, water consumption, electricity usage. You name it. As Dale said, building and energy management fields have been doing this kind of monitoring for decades.

"As I'm sure you know, there's been a lot of innovation in this space in recent years, with new kinds of sensors, Wi-Fi enabled devices. It's gone mainstream with all the smart home devices showing up on the market and at the Consumer Electronics Show. What we've got here is a much bigger scale compared to a house, of course. It's more sophisticated in many ways. In other ways it's outdated, or at least in need of upgrades and enhancements."

"Got it," says Kemal, "So what are we talking about? Give me the rundown."

"A lot of the legacy sensors were connected to intranets," continues Abel, "But the latest wave of devices are designed to connect to the Internet for a variety of reasons. There are advantages to doing that, to make monitoring the systems more efficient and effective, so we want to head in that direction. But it requires a new level of security."

"Absolutely," nods Kemal, "I was just going to say …"

"You can imagine right?" says Abel, "The old intranets were easier to secure, relatively speaking. But to get all the component systems, as well as the overall system, to where we need it today will require a whole new set of network management and firewall rules to ensure that these devices can communicate effectively with each other and the Internet, but cannot be compromised. That means the tools the engineers use to manage buildings need to be refactored to ensure no functionality is accidentally exposed to the Internet." Abel pauses.

"The information collected by these devices is more sensitive than people realize," adds Dale. "If building occupancy counts or security cameras or the management systems themselves were compromised, our building controls and campus safety would be at risk."

"So we're looking to partner with central IT to make sure we're building the right system, with the appropriate security measures, backups, etc." says Abel. "Our IT function within the department is limited, so we're looking for guidance and expertise we don't have."

"We can certainly team up with you on this," says Kemal. "I'll need to bring in some other people from my team, but absolutely we can find a way to work together."

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As the week comes to an end, Kemal arrives at campus on Friday morning, pleased by the knowledge that he'll have most of the day free to work in his own office. He hangs up his coat, opens the window blinds, and sits down at his desk. He already knows which project he wants to focus on today. The conversations he had with the energy management people and the crop science researchers have been rolling around in his head all week. Both are interesting projects in their own

KEMAL BADUR

Senior Director for Infrastructure & Production

Office of Information Technology
University of Minnesota

right; however, the coincidence that both meetings happened in the course of one week has Kemal thinking beyond project particulars.

A knock at the door draws his attention. "Hey, Kemal. How's it going?" Natalie Hines, a systems architect on Kemal's team, asks from the doorway. She's holding a travel mug and has just come from the coffee station in the office kitchen.

If we're right about the increasing interest in IoT, and we continue to get more requests to support IoT projects, we're going to need to rethink how we operate as the University's central IT organization. Do we have the right expertise? The right services ready to deploy?

"Good, good. Come on in, Natalie. How are you? How's your week been?"

"Busy," she says, taking a seat in one of the guest chairs in front of Kemal's desk. "But good. I made good progress on a couple of things."

"Nice. Hey, I wanted to run something by you, get your thoughts." Briefly, Kemal recaps the two meetings he had earlier in the week. Natalie listens, asking a question now and then.

"Interesting stuff," she says, after Kemal has finished. "Reminds me of a conversation I had with a friend of mine who's doing the Master's of Supply Chain Management program at the business school. My friend has worked in that field for several years. She's back in school now because the field is changing really fast. In large part because of data analytics and the Internet of Things. They can do so much more because of the data from connected devices and systems."

"That's exactly what I want to talk with you about," says Kemal. "We've been reading about the Internet of Things for a couple of years now. Suddenly we've got groups here on campus asking for our help with projects related to IoT. And these two this week, they're not little projects. These are big."

"For sure," agrees Natalie. "They're not the only ones. The med school and health sciences people are ramping up projects in this area too. It's potentially huge for them, the research that could come from it. We're talking improved health outcomes, even saved lives."

"I wonder if we're ready for this. The Office of Information Technology, I mean. If we're right about the increasing interest in IoT, and we continue to get more requests to support IoT projects, we're going to need to rethink how we operate as the University's central IT organization. Do we have the right expertise? The right services ready to deploy?

"Moreover," continues Kemal, "It seems likely that we'll need reconsider our approach to security and privacy, as well as our overall strategic priorities."

"I see what you're getting at, Kemal. From what I've read, some are saying that IoT could be as big a disrupter as mobile was ten years ago. It's moving fast. It's unpredictable. Trying to architect network and security infrastructure to meet the needs of tomorrow's devices is almost impossible." Natalie takes a

sip from her coffee.

"That worries me," says Kemal. "Because of the commoditization of the devices and sensors, there are no standards to follow. Researchers or students might end up with devices that either don't work on our infrastructure or become security risks."

"That's certainly one of the down sides," Natalie agrees, "But there are upsides too, like we've discussed. Sensor data and the analytics that go along with it have incredible potential."

Suddenly both Kemal's and Natalie's cell phones start to ring, almost simultaneously. Before either can answer, a colleague appears at Kemal's door looking rushed. "We've got a problem," he says, "Calls are coming in like crazy. It looks like a server problem is affecting the student portal. Students are getting locked out of their accounts."

Kemal and Natalie both jump to their feet to join the effort to diagnose and fix the problem. Over the next hour, the Office of Information Technology receives 1,300 calls from people across campus. It's all hands on deck for the duration of the day. Kemal's plans for a quiet few hours at his desk disappear.

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Two weeks later Kemal convenes a meeting of some of his IT colleagues. Natalie attends, along with team members who work on infrastructure, applications, services, data and information security, privacy, and compliance.

"Thanks for coming everyone," begins Kemal. He stands in front of the room's whiteboard as people take seats. "I invited you here because I want to get your input on something that's coming up more often from our constituents across campus. As I mentioned in the email invitation, we're getting more requests for resources and services to support IoT projects. Some of those needs can be met with our current services and structure; however, other requests are likely to require new responses from us as an organization."

The group waits for Kemal to explain what he means by this statement. They're interested, but they've also got to-do lists and projects to attend to.

Kemal continues, "You've all read about IoT and know how fast it's evolving. My email included links to a few stories with examples. My question to the group is: How will the Internet of Things affect the University and specifically, Office of Information Technology's role at the University?

LINKS SHARED IN KEMAL'S EMAIL

Ricart, Glenn. "Configuring and Managing a Digital Town Square." 2016 Technology Exchange. September 28, 2016. Accessed March 20, 2017. http://z.umn.edu/1dkh

Buntz, Brian. "Why Chicago is a Smart City King." IoT Institute. May 06, 2016. Accessed March 20, 2017. http://z.umn.edu/1dki

Davies, Alex. "A Très Dinky Self-Driving Shuttle Nudges Paris Into the Future." Wired. January 25, 2017. Accessed March 20, 2017. http://z.umn.edu/1dkj

Cisco White Paper. "IoT Threat Environment. 2015. Accessed March 20, 2017. http://z.umn.edu/1dkk

Battelle. (2017, January 27). The Big Data Difference: Predictive Analytics. Accessed March 20, 2017. http://z.umn.edu/1dkl

National Science Foundation. "NSF commits more than $60 million to Smart Cities Initiative. September 26, 2016. Accessed March 20, 2017. http://z.umn.edu/1dkp

"What I mean by that is, how should we as an organization evolve, given this trend?" Kemal pauses for reaction. "Do we agree that this could be the next big thing? Or at least, *a* next big thing?"

A woman named Annette is the first to speak up. "It certainly looks that way," she says. "There's a growing sense among industry analysts that IoT could be on par with Big Data, Wi-Fi, and mobile computing. A trend with the potential to dramatically change the way people communicate, work, and live."

"It's already happening," says Natalie. "It's maybe not as obvious as seeing everyone suddenly carrying a smartphone, but it's happening. Fitness trackers, app-connected parking meters, weather-sensitive streetlights, NFC payments. Examples are everywhere."

"Some of those things will stick," says a man at the other end of the table, "But others are going to die out. I mean, how long before people get tired of wearing these fitness bracelets? Some of this feels like a fad in search of a need."

"Maybe so," counters Natalie, "A few fads may come and go. That doesn't mean there isn't a bigger trend at play."

"Even if there is," says another colleague at the back of the room, "our office can't afford to go chasing trends. Our resources should go toward keeping core systems up and running. We need to focus on real nuts and bolts, not bleeding edge stuff."

"That is important," concedes Kemal. "At the same time, I think we're going to need to evolve. The world is only going to get more interconnected, and it will rely on technology to make those connections. The University will need to be ready and able to partner with external organizations to achieve its mission of education and research."

Discussion continues among the group members. A number of comments center on specific IoT projects or devices. Most of these examples come from things people have read about—everything from refrigerators that reorder milk to entire "Smart Cities"—but a few of the stories shared come from projects happening at the University. Or in some cases, projects that Kemal can imagine happening here.

The examples and stories are helpful in that they reinforce Kemal's belief that IoT is going to become a more frequent topic of conversation, one that will likely be accompanied by requests for support from the Office of Information Technology. Frustratingly, whenever Kemal tries to steer the conversation back to the question of what their organization should do, discussion stalls. Kemal sees Natalie trying to help with comments about the bigger picture, but for some reason the group doesn't seem ready to have this conversation.

Maybe it's premature, thinks Kemal, as their hour comes to an end. Or maybe this is just the beginning of what will be a much larger conversation. He has learned throughout his career that change can be slow to come, especially in an organization as large as the University.

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After the group discussion, Kemal sits in his office at the end of the day, thinking about what was said, the research he's done about IoT, and the various conversations he's had with people on campus. He takes out a legal pad and begins to jot down some thoughts.

His notes range from big picture:

> What will IoT mean to a University … specifically, a major land-grant research institution?

To the strategic:

> Do we have the right skills and expertise within the IT organization to handle these needs? Where are the gaps?

To the beginnings of a list of operational details:

> Just how many IoT projects can show up on campus? How soon? What kind of scope and scale should we expect?

The paper is soon filled with questions. Kemal leans back in his chair and stares at the ceiling. I need a way to shape this, he thinks, some sort of framework to share with others so that we can have productive conversations about it.

A moment later, he grabs a blank sheet of paper and at the top he writes:

> Roadmap to IoT Innovation

Below that, he writes the overarching question that has been forming in his mind over the past few weeks, perhaps longer. It is a large, messy question, and an intriguing idea simultaneously:

> If IoT is a next-level evolution in computing, how should the Office of Information Technology adapt its service strategy to meet the needs of a University community that will use, conduct research on, and collaborate with industry on IoT devices, platforms, and related initiatives?

Kemal tears this sheet off the pad and lays it on the desk in front of him. As he stares at it, he begins a new list of initial questions he believes need to be addressed in the roadmap, including:

- **Scope**: How widespread is IoT generally? Which disciplines, industries, and areas of study are furthest along in terms of IoT adoption and integration? How much overlap is there between those areas and the University's mission?
- **Definition**: How do we define IoT and IoT readiness? Are there standards we should follow or adopt?
- **Feasibility**: What are the challenges the Office of Information Technology must overcome in order to become an IoT-ready organization?
- **Hardware/software:** How much do we know about the mix of hardware, software, and other technology elements necessary to create an IoT-ready infrastructure for an institution that is one of the country's largest universities?
- **Service models:** Which current services are likely to remain relevant to IoT initiatives? What kind of new service models should we consider in order to serve the IoT needs of researchers and educators across campus?
- **Risks**: What new procedures do we need to develop to ensure data security, privacy, and compliance?
- **Skillsets**: What kind of skills does the Office of Information Technology need to acquire or develop in order to service IoT-related projects across campus?
- **Project management**: In what order must tasks and milestones be met? What are the dependencies and timing expectations?

Looking over his list, Kemal thinks, it's not complete. There are things missing. But it's a start.

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The next day, Kemal gathers a few members of his team. Natalie and Annette are there, along with two others, Rudy and Glenn. Kemal hands each of them a copy of his roadmap sketch. Then he asks them to help him put together a more fleshed-out version of a roadmap, one that would be suitable for future conversations with the University's CIO and other decision-makers.

"Essentially," explains Kemal, "I want your help developing this idea. What other topics and questions should we add to my initial list? What are some initial ideas for how we answer or address these questions as an institution? I want something that will point us in the right direction and allow us to get ahead of this trend."

Natalie grabs a marker and heads to the whiteboard. "Let's get started."

Supporting Material

The Office of Information Technology (OIT) is the University of Minnesota's central IT unit. OIT provides enterprise-level technologies that are broadly consumed, core to central administrative business operations, and tend to offer substantial economies of scale.

These services are governed and delivered with extensive feedback and guidance from across the University. Through the IT Governance Process, technologists discover the technology needs of students, faculty, and staff and determine how best to meet those needs through a collaborative decision-making process, sustainable funding model, and implementation.

Local or collegiate IT units often offer discipline-specific, niche, and complementary services to the 20 enterprise services.

Learn more about OIT:

Service delivery model
https://it.umn.edu/about/service-delivery-model

Service catalog
https://it.umn.edu/services/service-catalog

Organizational structure
See enclosed charts

ABOUT THE CASE

Created for the 2017 CoMIS Case Competition at the University of Minnesota's Carlson School of Management. Developed by Professor Emeritus Norman Chervany, Lee C. Thomas, and Kemal Badur. Written by Lee C. Thomas.

Although based on actual business needs, the character names, titles, projects, and conversations depicted are fictional inventions, and do not represent actual persons or teams. The one exception is Kemal Badur, who is indeed senior director for infrastructure and production at the University of Minnesota's central Office of Information Technology (OIT).

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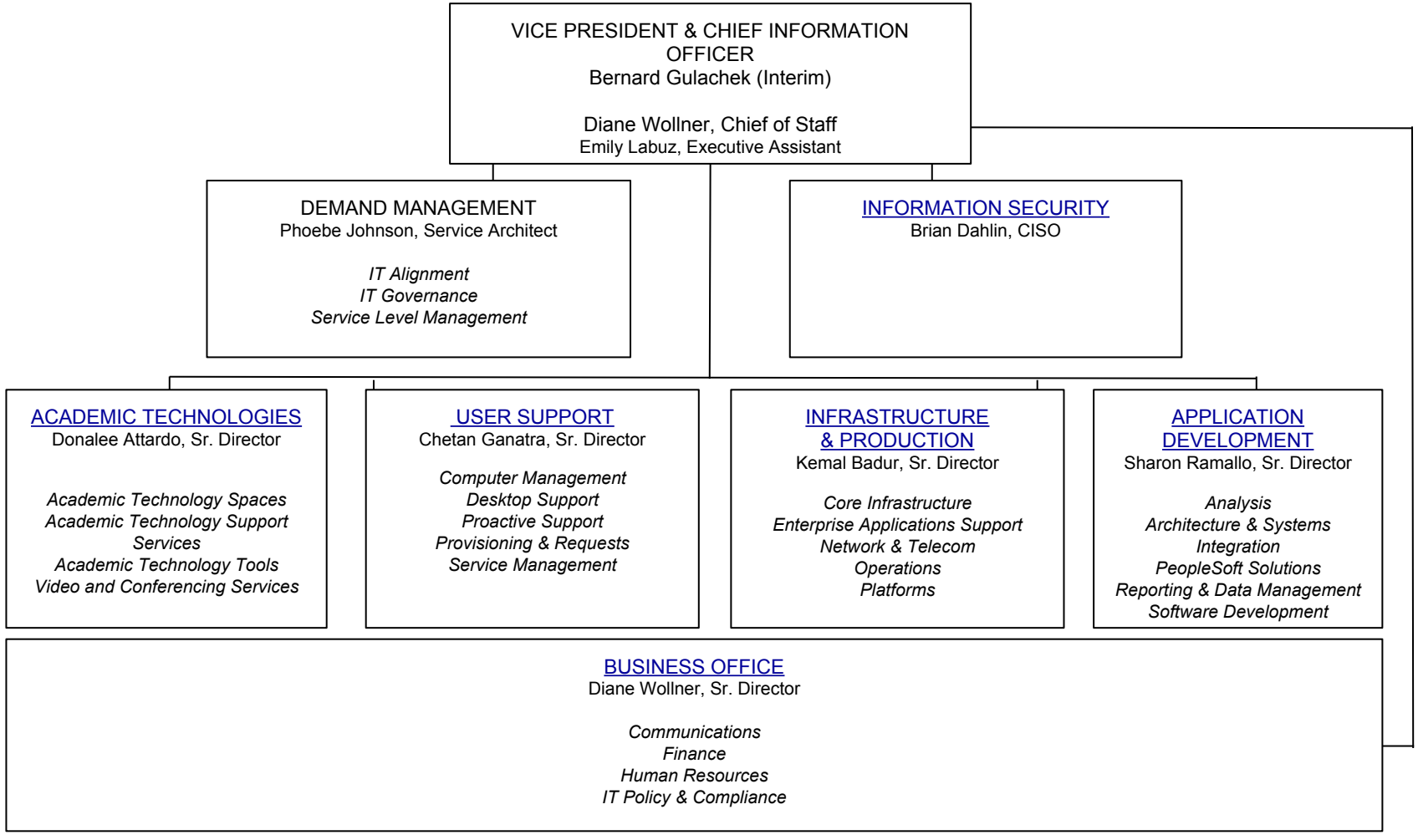
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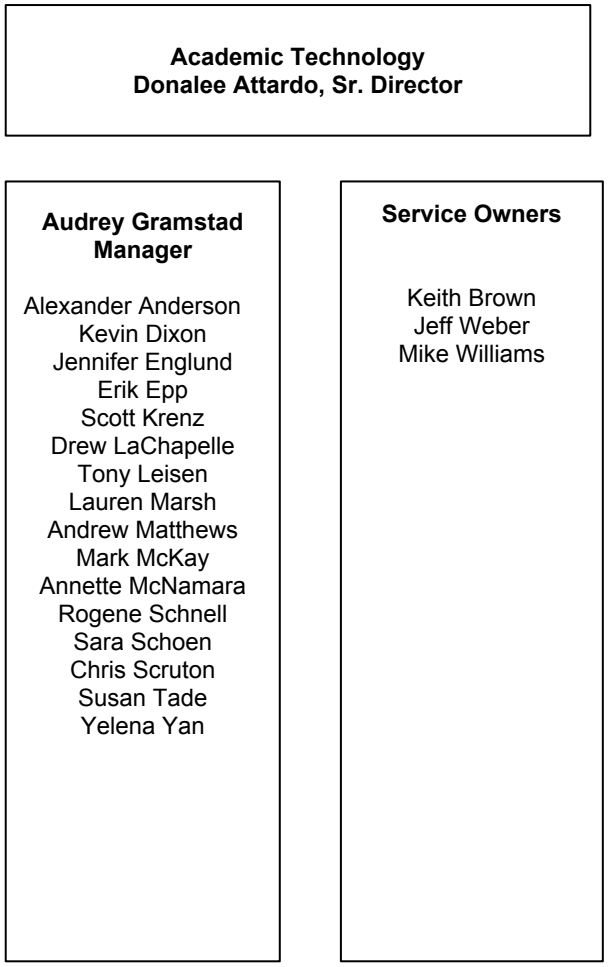
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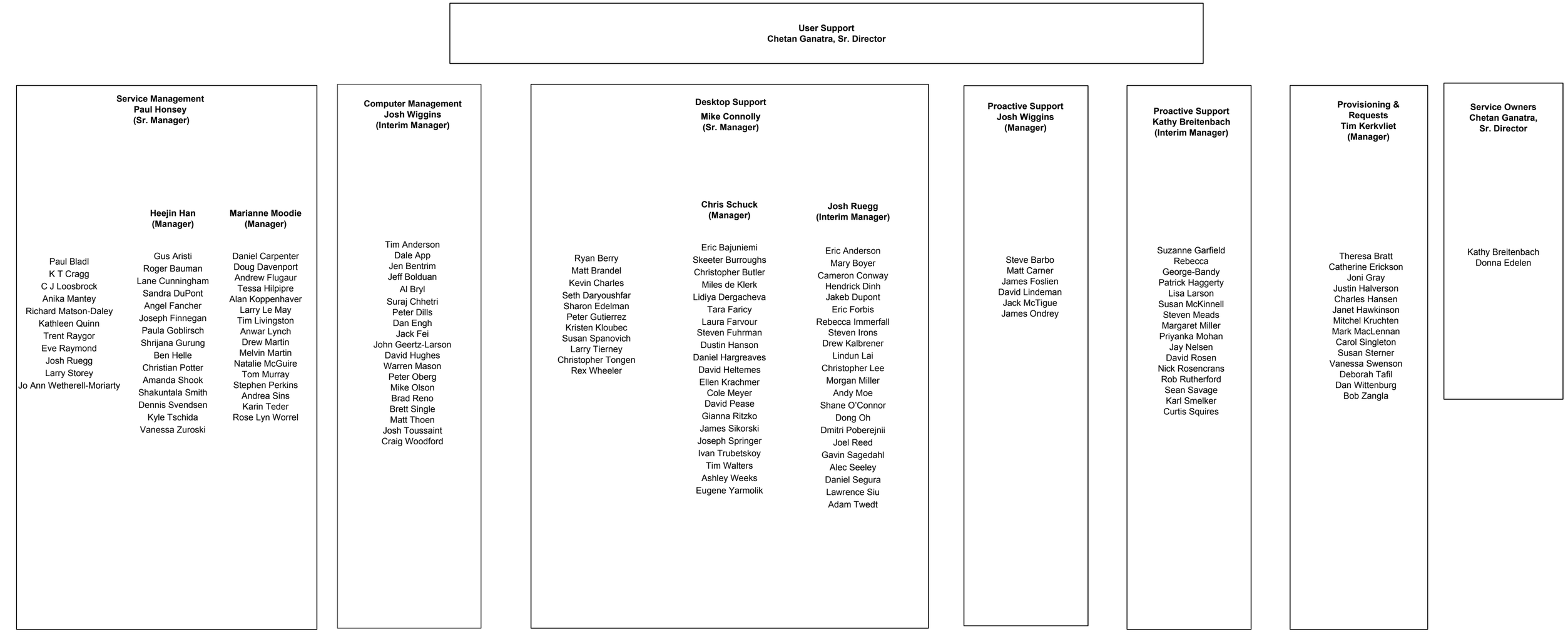
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K T Cragg
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Donna Edelen

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Dack Anderson, Manager

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Jacob Krotzer
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Luat Nguyen
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Kuwam Alowonle
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Marianna Dobkina
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David Lewerenz
Nick Lintgen
Benjamin Mwaura
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Pragati Tripathi
Andy Wattenhofer
Nathan Werner

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Ryan De Baker
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Kevin Martin
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Travis Sobeck
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Kyle Weeks

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Michael Langhus
Joe Zanmiller

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Sr. Manager

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Tom Illg
Jeremy Irrthum
Monica Kelly
Rajesh Paul
Michael Roselle
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James Ed
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Jayashree Krishnakumar
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Pamela Rose
Sudheer Singidi
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Xuelin Zhuang

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Kevin Henninger
Mark Skweres

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Manager

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Phuong Huynh
Imtiaz Khan
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Gedion Woldesellassie

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David Imdieke
Brian Krupski
Brett Lee
Brandon McHugh
Steve Nguyen

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Mike Dowdle
Sr. Manager

Kristin Jones
Manager

LeeAnn Afdjeie
Thomas Alfonso
Greg Borchardt
Chris Hofacker
Tommy Stith
Pamela Swenson
Sandra Wever

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Joseph Moore
Heather Nisan
Susanne Vandergon
Ron White

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Kendric Moore
Manager

Jan Boyer
Meghan Johnson
Amanda Low
Heather Rafshol

IT Policy and Compliance

Candice Hansen

Communications
Kellie Greaves
Communications
Consultant

John Bothe
Christina Goodland
Russell Kos
Elizabeth Lijewski