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ADI - Analog Devices Inc Analyst Day

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## CORPORATE PARTICIPANTS

**Ali R. Husain** *Analog Devices, Inc. - Director of IR and Treasurer*

**Greg N. Henderson** *Analog Devices, Inc. - SVP - Automotive, Communications and Aerospace & Defense*

**Kevin Carlin** *Analog Devices, Inc - VP, Automation, Energy, and Sensors*

**Mark Gill** *Analog Devices, Inc - VP, Automotive Electrification and Infortainment*

**Peter Real** *Analog Devices, Inc. - CTO and SVP*

**Steve Pietkiewicz** *Analog Devices, Inc. - SVP of Power Products*

**Vincent T. Roche** *Analog Devices, Inc. - CEO, President and Director*

**Yusuf Jamal** *Analog Devices, Inc. - Senior VP - Industrial, Healthcare, Consumer and IoT Solutions & Security*

## CONFERENCE CALL PARTICIPANTS

**Ambrish Srivastava** *BMO Capital Markets Equity Research - MD of Semiconductor Research and Senior Research Analyst*

**Amit Jawaharlaz Daryanani** *RBC Capital Markets, LLC, Research Division - Analyst*

**Christopher Caso** *Raymond James - Analyst*

**Harlan Sur** *JP Morgan Chase & Co, Research Division - Senior Analyst*

**Harsh V. Kumar** *Stephens Inc., Research Division - MD*

**John William Pitzer** *Credit Suisse AG, Research Division - MD, Global Technology Strategist, Global Technology Sector Head, and Semiconductor/Semiconductor Capital Equipment Analyst*

**Ross Clark Seymore** *Deutsche Bank AG, Research Division - MD*

**Tore Svanberg** *Stifel, Nicolaus & Company, Incorporated, Research Division - MD*

**William Shalom Stein** *SunTrust Robinson Humphrey, Inc., Research Division - MD*

**Blayne Curtis** *Barclays - Analyst*

## PRESENTATION

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

All right. Well, good morning, everybody. Welcome. Thanks for joining us today. Some of you know me, some of you don't, but I'm Ali Husain. I run capital markets for ADI. I'm the Treasurer and I head up Investor Relations as well. So welcome to our 2017 Analyst Day. It's frankly great to have you here this morning. I'm also delighted to have senior people from Linear Tech here, as well, in addition to the folks from ADI.

In a few moments, you'll hear from Steve Pietkiewicz. Steve? Raise your hand. So Steve ran power at Linear and now he's running power for the combined company and as of last week, he is on Vincent's staff.

The other person we have here from Linear is the gentleman called Erik Soule. Erik started the battery management business at Linear. And he's not in the room, but he's going to us for lunch, and he will be at the product demo. So the product demo, you come out of here, you take a left, you'll see the product demo. So feel free to interact with folks from ADI and Linear while you're here today.

Now we don't do these Analyst Days very often, but I promise you we have a lot to tell you this morning. And I think it's going to be a great use of your time.

Okay. First things first. I have to do this. I'm sorry, but we're here to talk about the long-term. This is going to be a 5-year kind of journey. We haven't updated our guidance for the third quarter. Our lawyers absolutely have us on a tight leash, so we don't want to have any questions about the near



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term. And honestly, the earnings release was 2 weeks ago. So I don't know how much more we could add to that main event. So it's really about talking about the long-term today, and I ask you that you please respect that.

Okay. Do we have the agenda slide up? Okay. Let's go through the agenda quickly. So as we think about this -- the long-term drivers of the business, we've picked the most salient themes that we think are going to be of the most interest to shareholders. The day starts with Vincent Roche, our CEO, he will set the strategy envelope for today's presentations. Then we'll get into the technology and then Peter Real, our CTO, will walk you through how we think about our investments in R&D.

And I think that's when really the fun is going to start to begin. Then we'll get Steven to talk about how he's thinking about running the new ADI Linear Tech power business. Then we'll have a slew of great presentations, Kevin Carlin will go through factory automation,

Mark Gill will go through automotive, Greg Henderson will go through RF and microwave. And Greg is a former Hittite guy, and he's running the entire RF business for the combined ADI/Hittite. And as of last week, he is also on Vincent's staff, and he's running basically 1/3 of ADI's markets and engineering related to those.

So we keep talking about the best of both, best of both companies. We did indicate of Hittite and again that's really the blueprint, again, to do it in the case of Linear here.

Okay. Then we'll have Yusuf, who will talk about our consumer strategy. And at the end of the day, I'll give you our new financial model for what we think we can do over the next 5 years and beyond. After we're done here through the formal part of today's presentations, we'll have a Q&A session. And then after the Q&A session, feel free to roam about talk to us, talk to folks from Linear. And I'll guess we're all part of one company now. Check out the product demos outside. Christina Dervin here is in Investor Relations, Mike Lucarelli is in Investor relations, grab anyone of those, and we can help you around.

Okay. So this is the one I apologize for but where is the forward-looking statement slide? Yes, Okay. I got this flipped here. Okay. So 2 minutes here. Let me start by reminding everybody that the presentation today will contain forward-looking statements, which address a variety of subjects, including, for example, ADI's expected product development and technical advances, financial goals and expectations, the expected benefits and synergies of the Linear Technology acquisition, including the effect of the transaction on ADI's non-GAAP earnings. These forward-looking statements include risks and uncertainties, which could cause our results to differ materially from the forward-looking statements made during today's presentation. Therefore, today's presentation will include time-sensitive information that may be accurate only as of the date of the live broadcast, which is today, June 20, 2017. Accordingly, participants listening to this presentation are cautioned not to place undue reliance on these statements, which reflect management's opinions only as of today. Well, I feel like I'm really earning my paycheck here this morning. Okay. It's another paragraph. Okay. Information on the factors that could affect our results is included in our filings with the SEC, including, but not limited to, our most recent Form 10-Q and our other filings. ADI undertakes no obligation to update the statements made in today's events to reflect subsequent events or circumstances.

In addition, today's presentation will present some non-GAAP measures, which are intended to serve as a complement to our GAAP results. A reconciliation of our non-GAAP measures to the most directly comparable GAAP measures is available at the end of the presentation, which will be posted on investor.analog.com. And so that is out of the way, it's my great pleasure to invite up here, Vincent Roche, ADI's CEO and -- President and CEO.

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### **Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Thank you, Ali. Good morning, everybody. You're all very welcome. Those of you who made it through the deluge here into Norwood, and those of you who are on the webcast. So by the time we wrap up today, I hope you can draw 3 fundamental conclusions from what we've told you: that ADI plays an increasingly critical role at the intersection of the physical and digital domains; that we are uniquely positioned to drive future success as physical and digital opportunities inflect and enable us to drive the long-term profitable and sustainable growth; and that we're in a very unique position to benefit from the -- as the premier high-performance analog leader. And of course, the crescendo will be the new financial model, which we will unveil, as Ali said, at the end of the pitch here.



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So first, I'd like to talk a little bit about our business philosophy. Many of you know that we play a very long game with consistency of purpose in relation to our business, our people and of course, our customers. Over the past 5-plus decades, we've been guided by a few core principles. One, the belief that superior innovation drives superior revenue growth and profitability. We focus on the toughest challenges out there in applications that matter most. And this is really the root of our value-creation journey as a company. We believe that diversity and technologies, product applications and customers drives our sustainability and robustness. And we believe that if we continuously raise our standards across the company to ever higher levels of effectiveness, we extend the value we deliver to our customers, generate increasing levels of free cash flow and ultimately, improve our shareholder returns.

Around a decade ago, we made a strategy pivot towards more sustainable innovation. Our focus was shifted largely to B2B applications and also on a few selected customer or consumer applications to drive sustainable and profitable growth for ADI over the long term. As a result of these actions, greater than 90% of R&D investments were shifted to create a more effective match between our products and our applications. In addition, we created the organization structure and the capabilities to get us closer to our target markets and of course, our customers.

And as you'll see here, these shifts are now bearing fruit for ADI. As you'll see our new product returns are encouraging with a crop of new products that are producing revenue and taking share in the market across many diverse areas.

At our 2014 Analyst Day, we presented an aggressive financial model at that time. As you'll see here, we've made very solid progress by hitting the high end of our model on all key metrics. And we're well ahead of schedule to hit our 2020 EPS target. Notably, we also successfully integrated Hittite and acquired Linear Tech, which improves our financial model even further.

Out of the gates, our financials place us toward the very high end of the S&P 500, with over \$5 billion in revenue, gross margins of 70% and free cash flow margins of 37% right now. These stats alone place ADI in the top 5% of all S&P 500 companies, and the earnings power and free cash flow power of the combined company will get even better in future.

The combination with LTC enables us to drive revenue and cost synergies in the short, the medium and the long-term. And in a while, Ali will walk you through the highly accretive LTC acquisition, and what we think we can do in terms of our combined operating model in the years ahead.

So it's really time now to talk a little bit about what the future holds for ADI. And I believe we're really well positioned more so than we ever have been. We have a long heritage in sensing, measuring and interpreting the physical world. And everything that we do in this company is consistent with that heritage.

Over the years, we've differentiated ourselves with cutting-edge innovation and no other company in our sphere comes close to our depth and breadth of signal processing and in our power management expertise. In fact, we have more than 10 decades of accumulated knowhow and IP across ADI, Hittite and LTC, and most importantly, with dedicated, focused and talented employees to deliver the value.

And ADI technology has made possible many extraordinary things that are now commonplace in the business world and in our lives. For example, industrial OEMs depend on ADI solutions to enable precise measurement and control of their critical processes. We supply analog solutions for critical health care systems that save lives every day. Every packet of cellular data is processed in ADI silicon. And automotive OEMs are increasingly depending on ADI to guide their innovation, processes and decisions.

In addition, we've aggressively leveraged our balance sheet to drive value, while the overarching theme of consolidation in our industry, in recent times, has been driven by rationalization of costs in a maturing industry, we've taken a very different tack.

Our M&A strategy has been firmly driven by customer needs and our desire for sustainable long-term profitable growth. With the acquisitions of Hittite and LTC, we've increased our scale and scope enormously in the analog sector. We've also made some exciting tuck-in acquisitions that you'll hear about during the course of the day here.



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And with approximately \$1 billion in annual R&D spend, we intend to remain on the cutting-edge of what's possible. So what makes the combination of ADI and LTC so compelling? Well, our technologies and products are largely complementary. So together, we strengthen and diversify our capabilities and increase both our scope and scale in signal processing and power management, that's the complete spectrum of analog.

We now have a #1 or #2 position in all the critical analog technology areas. Our exposure to B2B markets is increased, which further enhances our diversity and robustness. And in fact, we just about doubled our addressable market. Though we have some overlap in customer engagements, the primary emphasis for ADI over the years has been on directly serving the largest 1,000 customers or so. With the addition of the LTC sales in FY '18, we can now directly engage with about 3,500 to 4,000 customers directly. And significantly, the addition of LTC is immediately accretive to non-GAAP EPS and free cash flow. And as a result, as I said earlier, we've created a best-in-class financial model.

Now where most of these mergers get derailed is in figuring out how to integrate 2 different cultures. In our case, we're combining 2 world-class companies. And as such, we've adopted a best of both approach to our integration. Thus, we're being very patient and very, very careful in the integration process. Of course, our cultures are different, but I view this as a source of strength that comes from our diversity. We share the same business values as we're both focused on innovation with a great passion for serving our customers, ultimately with a mind towards the creation of long-term value. That's basically in our DNA.

We've begun our journey together by combining LTC leaders into critical roles in the ADI leadership team across all functions in the new company. Across all aspects of running our companies, we each do some things better than the other, and where this is the case, we loved the best approach irrespective of its origin. In essence, we're developing a new operating system for ADI. But I'm really delighted to say, we've made excellent progress in pollinating ideas, knowledge and processes across our R&D, sales and operations team.

In our business, brand matters, and as LTC's power brand is synonymous with the highest performance power technologies, we're maintaining that brand as a key source of our ongoing identity. From my ADI and LTC walkabouts, it's very clear that our people are very excited about the opportunity for the combined company and also for them as individuals.

I believe we're living in a time of astonishing innovation in the information and communications technology sphere where the world is being ubiquitously sensitive, as we've talked about many times before. We're moving to a phase where humans and information technology are interacting in a more immersive way. And in this data-hungry world, analog technology is increasingly critical as you'll see during the course of the day. The problems we tackle enable our customers to bring the world of physics, chemistry and biology into ever sharper focus, to enable better decisions and actions to take place. And these problems are becoming ever more difficult. In essence, analog technologies set the performance benchmarks and boundaries for electronic systems.

Our customers have an increasing scarcity of available analog design engineering talent, and thus, they're increasingly turning to ADI to engage with them as a critical innovation partner, to help them build their analog solutions across the spectrum of their product development activities. And we continue to work very hard to extend our leadership in our legacy businesses, but there are many exciting new opportunities for our technologies to drive growth as we play in areas such as industrial 4.0, autonomous transportation, next-generation mobility infrastructure, clinical grade vital signs monitoring, artificial intelligence and augmented reality to name just a few. And as the world becomes more digital, more autonomous, becomes more intelligent, ADI's cutting-edge capabilities create great opportunity for future value-creation for our company. And we're better equipped than we have ever been to take on these challenges. And today, we provide you with a lot more granularity about what we mean.

So all that said, I believe the future looks very, very bright for ADI. Each line item of our financial model has a driver. And by the end of today's presentations, I'm confident that you'll be as excited about the drivers we have in our business from playing in the right markets, to having the right slate of technologies, to our deep level of engagement with customers, all wrapped in a culture of operational excellence to drive tremendous shareholder returns in future.

So with that, without further ado, I'd like to invite our CTO, Peter Real up on the stage. Peter is going to kick off the day by articulating how we innovate to drive value, what it takes to stay at the cutting-edge in our business, and how we generate the scale and the scope necessary to be a leader in this complex and diverse world of analog.



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So with that, I will invite Peter.

**Peter Real** - *Analog Devices, Inc. - CTO and SVP*

Thanks Vince. So good morning, everybody. As Vince said, I'm Peter Real. I'm Chief Technology Officer here for Analog Devices. So I'd like to begin this morning by setting the context in which ADI invests to ensure our technology advancement and more importantly, its profitable application continues well into the future. So this is an image I'm sure most of you or all of you are well familiar with. It illustrates the 3 ways of computing and how the user-to-device ratio split over the past 50-plus years. From the initial mainframe era when many people accessed a single device, the core mainframe device itself, to the current era, in which users are outnumbered by the number of devices they access and even more significantly outnumbered by the number of instrumented nodes they rely on, nodes that are generating more data than users can make sense of. This trend towards the digitalization of our businesses, our environment, our societies and indeed our lives is a significant boost for ADI. Thanks to the corresponding growth in the need for mixed signal technology to connect the physical world in which we live to this digital world.

These digital systems increasingly rely on real-world information to make mission-critical, even life-and-death decisions and the accuracy and integrity of this information is becoming more and more important. While the actual challenge of identifying and extracting signals in the presence of increasing levels of noise is becoming a harder and harder problem to solve.

Just think of wireless communications and how the frequency spectrum is becoming increasingly cluttered as new wireless standards continue to be introduced. Not to mention, the escalating challenge in developing robust navigation systems for autonomous vehicles in what is a very noisy environment. These are demanding applications and difficult challenges that are only getting tougher. As a result, the opportunity to innovate at the boundary between the physical and the digital worlds continues to grow. It's not a question of can we innovate, but rather, which opportunities we will choose to address? We've chosen the path of selecting and addressing only those high-performance opportunities for our expertise and our insights command a premium and where we are uniquely positioned to address these opportunities in ways that others just cannot.

This has been ADI's strategy for decades, but one of the topics I want to talk to this morning, is how the acquisition of Linear Technology when coupled with other acquisitions and investments we have made, supercharges our strategy and allows us to address the most profitable applications more comprehensively than any of our competitors.

Think of ADI as a bridge builder, where the road represents the signal chain, the supporting infrastructure represents the power chain and the 2 land masses on either side are the physical and the digital worlds. This bridge includes anchor points on either side to manage the on/off ramps into the adjacent environments, sensors on the physical side and connectivity on the digital side. And just as with physical structures, spectacular results can be achieved when all these elements are tightly coupled.

As a bridge builder, ADI is unique in being able to address signal chain challenges from D.C. to 100 gigahertz, and power chain challenges from nanowatts to kilowatts. Some compelling examples of the high-value applications we are able to address more completely are shown on this chart. And many will be talked about later this morning and indeed, some of our demos will reflect some of these initiatives also.

ADI is the only high-performance semiconductor company, developing and delivering such a combination of industry-leading signal chain and power chain solutions, solutions that will increasingly be tightly integrated into the future. And here is why. First, extracting maximum performance from the signal chain solutions increasingly requires highly accurate and very stable power supplies. For example, when moving to higher speeds or to lower power consumption, this typically means using smaller geometry processes, processes that need to operate on lower power supply voltages. To maximize signal chain performance, these voltages need to be controlled very precisely, and being able to co-design the signal and power chains is core to achieving this.

Second, a new challenge and a new opportunity has emerged for ADI as the hardware expertise that many of our customers has been deemphasized in favor of other areas of investment. Many customers are now looking for more complete solutions from their semiconductor partners as they focus their resources elsewhere.



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Back to the bridge analogy. They're contracting out the complete bridge build, not just the cables, bolts or load surface. And the winners in our industry will be those companies that are capable of delivering on this need more effectively than their competition.

In short, our industry-leading technology portfolio positions us extremely well to serve both current and emerging signal processing needs for years to come. So how do we leverage and extend this strong position to exploit current opportunities and investments while simultaneously exploring new ones in our drive for profitable growth over the short and the long-term? This is best described using the 3 horizon framework introduced in the 1999 book, *The Alchemy of Growth*. Horizon 1 represents our core business today, and it's where we spend about 75% of our R&D. This is where we extend and defend our core business. Horizon 2 represents investments in technology and in products that have a longer time horizon and accounts for roughly 20% of our R&D. This is where we build new business momentum. And horizon 3 accounts for roughly 5% of our R&D. And these investments worked for the longest time horizons and it is where we create options for future business growth.

In horizon 1, we are focused on delivering unique and industry-leading products across the core technology categories, which we refer to as building the base. While we are also moving up the value stack in terms of adding algorithms, analytics and other ancillary functions necessary to address the toughest real-world challenges, Vince showed this visual earlier. And as Vince also indicated, we now have either the #1 or #2 market position in the core technology categories of converters, power management, amplifiers, interface and RF and microwave. And we are increasing our expertise in domains such as sensors and algorithms.

For example, our next-generation vital signs monitoring solutions, we use our own optical sensors together with our own motion resistance cartridge algorithms, to deliver accurate and reliable motion -- the accuracy and reliability necessary to successfully address home-based clinical grade health care applications. This expands the scope for our health care offerings, beyond our traditional big iron medical imaging applications.

But having a winning recipe is not just about being the best in any one technology category, it's more about how we bring our capabilities together to address the most difficult customer challenges. We support hundreds of applications and thousands of customers through our industry-leading combination of differentiated hardware, software, process technology and packaging capabilities. Capabilities that have been developed over many years and which are very difficult and very expensive to replicate.

In horizon 2, we are simultaneously driving technology advances along what I referred to as the More Moore and the More than Moore axes of innovation. Moore's law or, the doubling of transistors per unit area every 2 years, has driven the semiconductor industry for over 50 years. On the More Moore access, the primary dimensions of innovation have been reducing gate lengths and increasing wafer sizes. High-performance analog or mixed signal products for the most part use processes that have been at least 1 or 2 generations behind the leading edge, as analog circuits don't benefit from the reducing gate lengths to the same extent as digital circuits do.

Given the scale of investment involved in developing these processes, we at ADI find it much more economical to access these processes through external foundry partnerships. From a volume perspective, over 80% of our high-performance analog and mix signal products would need only 1 or 2 12-inch wafer lots to service a year's demand. So we buy what we need, and we don't carry the overhead of what we've much underutilized assets for a company like ours. Such a partnership supports our high-speed strategy on 28-nanometer, where we use ADI's enhanced high-frequency models on industry standard processes, to develop the best high-speed data converters in the industry. It also supports the development of proprietary process technologies of foundries, processes which are co-developed by process development engineers at both ADI and our foundry partner.

In short, we work very effectively with our foundries to access and economically develop high-value products on advanced CMOS-based processes.

Another critical dimension of innovation in the semiconductor industry referred to as More than Moore addresses the challenges associated with robustly interfacing to the physical world. These interface challenges drive innovations that are more about materials innovations and novel technology combinations than about reducing transistor gate lengths.

Our internal wafer facilities are central to our strategy of developing highly differentiated process technologies. Many of which are based on the use of nontraditional materials, which are then leveraged into unique product solutions. For example, our industry-leading iCoupler and isoPower



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isolation technologies support the fastest and most robust non-optical data and power isolation products in the industry and are manufactured in-house.

Our PH sensing technology for industrial and medical applications is also manufactured in-house, both terrific examples of where process and product developments come together to create industry-leading solutions. And we bring all these capabilities together through advanced packaging techniques, to develop and deliver highly integrated solutions, solutions that leverage both hardware and software engineering skill sets and rely on expanding domain expertise to address our customers' most difficult applications. We've increased our software engineering capabilities through the addition of algorithm and machine-learning experts, expertise we've applied to many opportunities, including clinical grade health care solutions, I mentioned earlier, as well as our recently announced 77-gigahertz Drive360 advanced driver assistance platform.

Our solutions have also been enhanced by the addition of skill sets we might have traditionally considered to be more in our customers' wheelhouse such as biomedical engineering, electrochemical engineering and data analytics.

And finally, as we balance our efforts to both exploit and explore opportunities, we come to horizon 3, where we explore early-stage technologies that, if successful, promise to deliver outsized returns on our investments. Horizon 3 is where we take bigger risks, looking to learn fast while occasionally failing fast. In this environment, we work extensively with external incubators, accelerators, startups and universities to be inspired by, to learn from and leverage the larger ecosystem.

For example, under the horizon 3 umbrella, we incubate and nurture early exploration initiatives in areas that include algorithms, sensors, imaging and energy harvesting. Many of these initiatives include research engagements with universities and research centers. Recent graduates have included far-field voice recognition platforms, digital predistortion algorithms for communications applications that command a significant revenue premium when enabled, and materials innovations that have greatly enhanced the lifetime revenue potential of our micromachined sensors and actuators. These are not science projects, they are initiatives that have a very positive impact on our current and future revenue potential.

So through our 3 horizons approach to innovation, we are well positioned for continued long-term profitable growth. Our most important and our most profitable advances are being built on the pillars of ubiquitous sensing, intelligent computing and connectivity, initiatives that impacts just about every industry today.

For ubiquitous sensing, we have a strategy that supports a rapidly expanding array of sensors, sensors that support critical end applications such as real-time environmental monitoring in home and industrial applications, machine health monitoring in factories and wear-free position detection in critical automobile subsystems.

For intelligent computing, we have initiatives like the far-field voice recognition platform, I just mentioned, that push greater intelligence to the edge nodes of systems to support the efficient transformation of data to information and information to insights. These initiatives help mitigate against the deluge of data we're facing in a connected world while much of the data generated is of little value.

And for connectivity, we have a strategy that supports multigenerational wired and wireless communications protocols. We have the preeminent position in wireless infrastructure radio signal chains, we have radio technology embedded in industry communications applications, which you'll see a demo of later. And we're setting the standard in proprietary communications links such as the Automotive Audio Bus.

So in conclusion, there are high barriers to enter and even higher barriers to be competitive in the domains we compete in. Beyond the extremely asset-intensive nature of our business, success over the long term requires a constant focus on innovation. Innovation in high-performance signal and power chain solutions requires tremendous domain expertise and experience, both of which are increasingly limited and valuable resources. ADI is the center of gravity for both, and our market leadership position continues to grow. Thanks to having unique, highly differentiated and extremely difficult to replicate suite of capabilities, capabilities that deliver substantial and increasing value to our customers and position us for continued success.

So we'll now break down into the next series of presentations, and I'll transfer to Steve Pietkiewicz, and he'll talk about power products.



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**Steve Pietkiewicz** - Analog Devices, Inc. - SVP of Power Products

Thanks, Peter. Good morning. I'm Steve Pietkiewicz, Senior VP of Power, here at ADI. And previously VP and General Manager of Linear Technologies power management products business. I worked at Linear for almost 30 years. I was hired as design engineer #12 in 1987. Linear was a \$50 million dollar company then and Bob Swanson who founded Linear was in everyone's business. I watched Bob take business only at his price and walk away from bad deals. Our margins showed the results of that mindset year after year. That practice shaped my thinking. We became the industry leader in power management. Our products always had something new, something better, that customers would pay for. Bob Dobkin, who cofounded Linear and hired me, used to say someone's going to get that socket why not us? To get the win, you'd have to have the best part because we were not going to win on price. Our parts pushed the envelope, we stayed ahead of our competitors and our engineers became entrepreneurs and business people, developing their intuition about what products to make. We were aggressive about getting into new markets and aggressive about getting out of them when the profits were gone.

We grew the power business to about \$1 billion by focusing on the tough problems that our competitors would not or could not take on. We found power to be a pretty lucrative area because there is a lack of expertise inside the customer base. Power was the thing that everyone needs, but no one wants. And we were able to exploit that need with superior products that worked better than other guys. We focused on B2B markets and made the best power products out there, developing the Linear brand, producing great products, giving great technical support, with high quality and dependable delivery.

So today, we have this \$1 billion power franchise within ADI, with a broad portfolio of high-performance power products, focused on what we think are profitable and sustainable growth areas in automotive, industrial, communications infrastructure, where power requirements get more difficult year-after-year with a diverse base of thousands of customers. We have a strong team, a deep bench - power experts who live and breathe power, a culture of innovation and the tenacity to stay out in front. As we integrate into ADI, we have a huge new opportunity to first leverage ADI's customer relationships to win near-term business with today's power portfolio. And second, to get the engineering teams in the power groups working with ADI's signal chain and SOC teams to design power products that fit perfectly with their products, and this is already happening. This will give us an enormous advantage over our competitors, most of whom don't have the scale and expertise to pull it off.

Mission-critical applications are becoming more complex. Solutions are harder, payback takes more time and products need a bigger engineering investment, scaring off many suppliers. We are in this for the long-term with design expertise, applications and field support, quality fulfillment, everything that - and everything else that our customers need to trust and depend on us.

This automotive market example shows how in 2000, power demands were just not that hard. There weren't much electronics in vehicles, just a handful of microcontrollers and maybe a stereo, only high-end cars have the electronics that everyone takes for granted today. The typical task was to connect from the car battery, 12-volt nominal, 8 to 16-volt range and convert it to 5 volts and a few watts. Not that hard, a fair number of suppliers could do that.

In 2010, electronics in cars gained real momentum. Navigation systems were standard along with other electronics that made cars fun or convenient or easy to drive and power supply demands increased. Battery voltage had a wireless band, 8 to 16 wasn't good enough anymore. The power supply had the work from a 3-volt to 60-volt stand. Many competitors could not solve this tougher problem, but Linear could and did.

Looking ahead to 2020, automotive power demands will get really difficult. A second 48-volt battery will power motors and pumps and high-powered items in the car, and energy will need to be shuttled between that battery and the legacy 12-volt battery. Now we need bidirectional power conversion and even more voltages at higher power levels, all this in a space that's shrinking every year. And as electronics become more mission-critical, the quality and reputation of the power supplier becomes even more important, only a few suppliers besides us can get this done.

Form factor, efficiency and EMI, these are the performance metrics of any power supply, but until a few years ago, no one could get the high-performance in all 3 at the same time. We, along with our competitors, worked mutually exclusive metrics as best we could, but there is always a compromise. A few years ago, the designers at Linear had a breakthrough discovering by leveraging many interdependent technologies, how to get all 3 metrics simultaneously. Now our customers can make power supplies that have a small form factor, leaving there more room for other functions and other features, high efficiency means (inaudible) think is not needed, saving money and space and EMI standards can be met without



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compromise. EMI standards get tougher every year and meeting them used to mean either lowering efficiency, creating more heat or increasing form factor, but our products emit, in the order of magnitude, less noise than our competitors, giving customers everything they want, small form factor, high efficiency and low EMI.

So power is a physical business. Power supply know-how is not just in circuit designs, power supplies are physical things. They manage 10s of watts, 100s of watts, kilowatts and our design teams have developed expertise beyond silicon in material science, electromagnetics, metallurgical signs and thermal engineering. This sets us apart and gives us the skill to design products that not only convert one voltage to another, but do it with the highest performance on the market.

Material science is knowledge of how materials work together, silicon, copper or plastics, critical for making power supplies that work over wide temperature swings. Automotive Tier 1s have pretty demanding expectations about temperature cycling. We have the hard-fought know-how to make products that pass the stringent quality testing. Managing heat is not obvious. We know the science, we have the experience. All power supplies generate heat. We can't make them 100% efficient but our power products have high efficiency, if you can't get the heat out of the silicon, you have to de-rate the power supply, customers don't get what they pay for. We minimize heat and get it out of the silicon and out of the package efficiently. We have expertise in metallurgy, understanding of how metals and alloys work together, how to make them interact properly with silicon and plastics and keep working in the field.

Temperature cycling and extended temperature operations are tough to do at sub-bpm quality levels unless you have a deep understanding of the science.

Switching regulators, convert electrical energy into magnetic energy and back again, understanding electromagnetics is important to make power products that outperform the competition. Our knowledge in this field lets us make products that don't cause radio interference. And I'll show you more of that in a couple of slides.

Power is ubiquitous, and every market segment needs power, but Linear did not participate in all of them. We were successful in many areas, instrumentation, factory automation, networking, electric vehicles, LED lighting and so on, but we didn't participate in these other market segments here, the orange color. As part of ADI, we will take advantage of the strong relationships with customers in these segments to get us opportunities to sell power here as well.

For instance, we have products that are compelling to customers in wireless infrastructure, but no sales presence. The ADI sale teams are opening doors and getting the power teams good looks at these opportunities. In automotive, Linear has a strong position, but there is room for even more wins in these new segments in safety and sensing. And by the way, it's working the other way around as well, Linear's broad market salesforce is now carrying the ADI catalog and the potential for synergistic business is big there too.

Here's an example of how our expertise in solving the 3 power supply metrics is realized. Both of these PCBs show a 65-volt, 40-watt power supply. Our competitor is on the left, and our solution is on the right. We call this breakthrough technology, Silent Switcher, and it's easy to see the advantage we have. Solution size is everything. Customers want to either pack more stuff on the same-size PCB or make a smaller one. We cut PCB area by a factor of 3. High efficiency minimizes self-heating, which means our power supply doesn't need a heat sink. Low EMI allows the customer to pass EMI testing and ship their product. We solve all 3 of the customers' pain points, form factor, efficiency and EMI, all at the same time. This is value, and we get paid a premium for it. We've had these products on the market only a few years, but we've got hundreds of design wins in the auto and industrial markets where we first targeted the products and are seeing wins across all market segments, even in communications and computer where we didn't originally target.

Our microModules are an even more physical business. These products leverage our silicon and our know-how beyond silicon. We miniaturize and integrate the passives to make complete power supply solutions in a solid molded package. They save even more space, and they find their way on to very expensive PCBs, and can save \$10, \$15 a square inch, often in the wired infrastructure market where PCB area is worth real money. These products are exciting for customers in all markets, because they are finished power supplies. They're easy-to-use, no design required. As our customers shed analog and power expertise, they become more dependent on us. microModules let our customers focus on what they are good at and leave the power supplies to us. For the broad market, microModules are a slam dunk, and they're finding homes even in high-volume markets



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where the integration and simplicity are so attractive, customers see the value. This microModule picture on the right is a quad-output voltage regulator. It takes about 60 components, all the stuff on the left, and gets it into a package, 15 millimeters by 9 millimeters. Power density, 3x to 6x higher, which our customers greatly appreciate, and they're willing to pay for that value. They save PCB area, and they can use it to add value to their product. We make more than 100 different microModules and sell them to thousands of customers. We've been in the microModule business for about 10 years now, and we've learned a tremendous amount about how to build them reliably and consistently.

I'll show you a couple of examples of opportunities for synergies. This 77-gigahertz radar system needs power like every other system out there. Today, Linear brings the high-voltage preregulator, and ADI makes a low-voltage regulator, built for driving the digital monolithic microwave IC, the DigiMMIC, and other parts of the system. But what if, in the future, we integrate all those regulators into one piece of silicon and put in the performance and functions the system needs to work its very best and make it easy so that all customers can immediately use it without any engineering effort at all. They can get to market faster with a higher density optimized solution. These collaborative efforts within ADI can drive real compelling value for our customers in high-volume, mission-critical automotive applications that generate long-lasting, stable, predictable revenue streams. There is a tremendous amount of cross-pollination that is occurring within the engineering community at ADI. And as these concepts of intimately integrating LTC's power with ADI's signal chain products gain traction, we will bring to market solutions that are optimally, ideally, perfectly engineered to let our customers get to market faster and easier. They will get complete solutions that work out-of-the-box without having to bring in multiple suppliers for each piece of the system as they do now. That's something our competitors simply can't do. They don't have the scale, innovation mindset or expertise in all the fields of power, analog and mixed signal technology like we do. So we think this capability sets us up really well for future growth.

Base station OEMs have been telling us 2/3 of the radio card is power, and can we please do something about that? They anticipate the ADI LTC combination will help them with this difficult problem. They have a fixed board size for their base station product that goes up on the tower, and they'd rather put more channels or more data capability on radio cards as opposed to all those power supplies. Their end customers want more data capability, they feel the pressure. There is an opportunity for our form factor, efficiency and EMI play, which frees up PCB area for more radio channels. We have the opportunity to win with power products in our portfolio now, but the real excitement comes from future collaboration between these OEMs, our communications teams and our power teams. We can and will design power products that exactly fit what the ADCs, RF components, FPGAs, PLLs need to work their best. Like in the last example, a seamless perfectly integrated system, including power, in a smaller form factor than our competitors can achieve because we've got the know-how and technology will give us more integration, reduction in size, improve signal chain performance and a more attractive solution overall for our customers who can use that space saved to make their products better.

So in summary, our power business is \$1 billion franchise. We've been targeting automotive and industrial high-growth B2B markets. The demands on power are increasing and more and more customers demand high-performance power. ADI is uniquely positioned to leverage the natural complementarity of our products in power and signal chain to exploit growing markets, opening up huge revenue creation opportunities. We've got the best power products in the industry, and customers look to us when they need that best performance. We've got a broad product portfolio that serves many different markets, the best power engineering teams in the business, a large and diverse customer base. We are focused on the right markets that we believe will deliver profitable growth now and into the future. Thank you.

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

So thanks, Steve. That was great. We will take a 10-minute break. It's about 9:25. So let's all be back at 9:35, and then we'll get started with our next round of presentations. All right. Thank you.

(Break)

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

All right. So welcome back, folks. What a compliant lot, everyone's back at 9:35. Okay. So the next set of sessions are going to be, it's 3 or 4 presentations, about some of the more investable themes. We'll run through factory automation, we'll run through, help me out here, Mike, what



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else are we doing here? Automotive, we'll run through RFMG, and then we'll run through consumer. So 4 themes that we think are of the most interest to shareholders. So okay, Kevin, take it away.

**Kevin Carlin** - *Analog Devices, Inc - VP, Automation, Energy, and Sensors*

Okay. Thank you. Good morning, everyone. My name is Kevin Carlin. I'm the Vice President of Automation, Energy and Sensors. Today, we'll focus on ADI's long-standing position in the industrial automation sector and how we're preparing customers for the transition to the new connected enterprise.

There are some powerful forces at work driving change in the industrial automation market. So let me summarize a few of them for you. Historically, the manufacturing sector has strived for increased productivity. In short, that means higher throughput of products and higher quality while managing costs. We're now witnessing a new wave of productivity gains. Across so many markets, end customers and consumers are demanding a higher variety of options. Options, for example, of a car, if you are to order, options when you're ordering a new car or for a cell phone, drug types for pharmaceutical companies and the list goes on. Manufacturers need to be more agile and flexible to respond to these market demands.

The move to more automated robotics in manufacturing is expanding rapidly and globally across all industrial economies, driving some high industrial growth rates and SAM expansion for ADI. And the move to the connected enterprise has started, which is really the key to the whole Industrial 4.0 movement.

I'll just keep going until we get the slides ready. So ADI is the long-term automation supplier. We're also committed to enabling these market trends to become reality. And as you will see, we're expanding our products and technology offering, our customers are pivoting their R&D to more software and services and are asking ADI to do more, more of the hardware, more of the sensing, more measuring, connecting and increasingly the interpreting of data as well.

We'll expand our SAM from roughly \$3 billion today to \$4 billion by 2022. We'll fix the PowerPoint presentation within that time as well. Hopefully. Yes. If you looked out on the web, we're back in the room. Thank you. And we will deliver above-average market growth, at least I got your attention. And ultimately, we will help lead the Industry 4.0 transition, which is a worldwide phenomenon, which we hear so many of us talk about today.

Now before we go deeper into the automation business, let me remind everyone of ADI's overall industrial business, and that's approximately \$2.2 billion today or 45% of ADI's total revenue. In addition to automation, our key industrial market segments includes instrumentation, aerospace and defense, energy, health care and also an emerging set of industrial IoT sensing applications such as smart cities, infrastructure and agriculture. Now we do have a long heritage in this factory automation market. So why do we really love this business? Well, for decades, our core products and technology innovations have been adopted by our largest customers, medium customers and the many thousands of small customers around the world. We're either #1 or #2 in the key product categories of Converters, Linear, Isolation plays a significant role in the industrial automation business. And now with the addition of Linear Technologies, we add power to that leading portfolio. The combined business is approximately \$500 million today. Those power solutions are critical to solving more and more of the design challenges our customers face. And LTC portfolio and expertise are of high value to our customers and are highly complementary to the ADI signal chains. Both ADI and LTC have been committed to serving this long lifecycle business, where customers expect you will support your products for a minimum of 15 to 20 years. And once those products are qualified and deployed in these strict industrial requirements operating in the most harshest of environments, customers just keep using these proven ADI components and technologies from ADI. Now this makes this business extremely sticky with a high barrier to entry.

We've been adding system engineering and building our domain expertise for many years. That allows us to engage our customers at the system problem level, which usually leads to more impactful innovation. To name one example, with our deep understanding of functional safety, we now supply functional safe components which greatly reduce the effort needed for our customers to achieve certification. Our customers utilize the full breadth of our product and technology capability and build robust equipment, which comply to the highest safety standards. These types of equipment are found at what we call the factory floor level. Our industrial customers then deliver that equipment to a very diverse set of end markets, such as automotive manufacturing, pharmaceutical, oil and gas, smartphones, chemical manufacturing, food and beverage and many, many others.



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Now, let's step into that factory floor, and let's see how all of these pieces come together. On the left and representing the control room are the IT part of the factory. The control room then interfaces to the factory floor. This is where the OT or the operational technology part resides and this is where ADI takes control. We've got the programmable logic controllers, these control box in the slide, we'll refer to these as I/Os. And these programmable logic controllers accept and send command signals to and from a large complex network of inputs or sensors, outputs commonly known as actuators, and we'll refer to this network as the I/O network. It's a full breadth of our core technology, it's extensively used across these areas, of what we call the factory floor, sometimes is referred to as the edge of the automation network. Here we can see also how both motors and robotics are given commands by control units such as PLCs. In this illustration, we've just shown 2 field devices and 1 image of a robotic system, but it's common in factory and process plants to have thousands of edge nodes or sensors. And there is a wide variety of legacy communication protocols running through these systems. Now with such a large number of devices, you can imagine the complexity of the wiring and the installation challenges.

All of these systems, the controllers, the field instruments, motors and robots rely heavily on the precision and robustness that ADI signal chains, converters, Linear isolation power technology -- technologies bring to bear, and it's our full signal chains across these systems that add up to that \$500 million of revenue.

Now let's go even closer to this PLC, this I/O control box. And you can see the complexity of this architecture and the associated wiring. Now as seen here, the traditional method of commissioning these architectures requires skilled technicians who are needed to connect thousands of these sensors and actuators to control boxes using miles of very expensive cabling and wiring. Any error during these wiring installation negatively impacts productivity with additional downtime costs. Often final adjustments are needed during these phases, forcing the installation crews to carry a large mix of expensive spares. The systems are also inherently inflexible and trying to reconfigure these post commissioning is no easy task. Simply stated, manufacturers need to move away from the traditional centralized rigid control structures with legacy equipment to a distributed flexible architecture.

Now we're solving this complexity challenge with, what we call, software configurable I/O. Allowing I/Os to be configured in software post installation are the ideal solution, and we view this as the first step in the transition to a flexible connected factory. Bringing the control to a more local, distributed and flexible architecture allows for easier scalability, and you can clearly see that the wiring has been significantly simplified.

Now the concept of software configurable I/O has been around for some years. However, our customers require highly integrated solutions at the silicon level to handle the larger number and variety of channels to fit in a very constrained space. This is first and foremost a hardware play and enabling our customers to use their software to reconfigure I/O channels when needed. For ADI, this is an analog and digital integration challenge at the highest levels of silicon complexity. With our leading technology and superior domain expertise, ADI has already delivered the first highly integrated silicon solutions to our leading customers. And it turns out that the complexity of integrating this solution at the silicon level has proven so far to be too complex for our competitors. Now the big value comes in the total cost of ownership at the factory. Significant cost savings for ADI's customers and their customers can be realized in several ways. And the first benefit is speed, which can include up to 8 weeks on average faster installation time. The wiring costs decrease, ADI silicon content value increases. It's got savings on engineering and a significant reduction in factory space as well. In addition, factory production flows can be adopted more easily and these changes that could traditionally take hours can now be down in minutes.

And let's say, a typical installation example would use, let's say, 5,000 of these sensors and actuators or I/O nodes. For such an example, the average cost savings with software configurable I/O would be in the range of \$2 million per installation in savings. That equates to about 26% all-in savings over the traditional method.

All right. Let's turn our attention to robotics -- factory robotics. For many years, our expertise and precision technology solutions for motion control can be found in those large-scale robotics systems commonly used for car manufacturing. These systems are a safety hazard for humans and typically operate in a safe and closed environment. There is a new fast-emerging market, however. Across many regions, we see investment to upgrade from a labor-intensive manufacturing footprint to a sophisticated automated infrastructure. And many repetitive tasks previously carried out by human hands are now being performed by collaborative robots, commonly know as cobots. These are smaller robots that work in collaboration with their fellow human workers. An automotive robot has the ability to work at constant speed without pausing for breaks, sleep or vacations and, ultimately, has the potential to produce more in a shorter time than a human worker. They improve quality and reliability as tasks are performed



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with precision and repeatability. As they now work close -- in close proximity to humans, the inherent safety requirements demand additional state-of-the-art technology from ADI.

Now we are unique in our ability to combine all of the key technologies for the traditional scale robots as well as the fast-growing cobot segment. Our systems solutions provide the high-precision control technology for each axis or motor in the machine and drive increased energy efficiency. We now also deliver the robust, synchronized and real-time communications solutions that enable higher precision and increasing robot productivity. Just think about the enhanced quality of your cell phone as a robot is working faster with higher precision while it places components together, or even more importantly, the quality of the welds that are holding your car together. These robots can be quickly reconfigured and perform any -- many different tasks, enabling factories to produce a wider variety of products. And working in close proximity to humans, sophisticated sensing and control is required. Along with the traditional control technology solutions, we effectively double our content opportunity with the addition of the communications and sensors for both safety and machine health monitoring.

Now we mentioned the large-scale industrial robotics industry, which remains healthy and growing, while the newer collaborative robotics market is driving the significant growth we see today. Collectively, this market is expected to grow at more than 13% annually, adding more than 500,000 systems annually by the year 2022. We estimate the combined electronics for the control, communication and sensing solutions is approximately \$500 per cobot. This represents a new additional \$300 million robotic SAM by 2022 for ADI on top of the traditional large-scale industrial robots market.

Now there's been a lot of talk about Industry 4.0, or the fourth industrial revolution. You're familiar, of course, with the previous 3 revolutions from the introduction of steam power and mechanization, to the efficient mass production line of the Model T Ford and to the introduction of computer-controlled automation introduced in the 1970s. Now each and every time, these manufacturing revolutions injected growth into the economy by boosting productivity. Today, the fourth industrial revolution is already underway and represents the new wave of opportunity for productivity gains and industrial growth. Industry 4.0, as I mentioned, is a global phenomenon. It is also commonly referred to as industrial IoT or the connected enterprise. By bringing the Internet to the automation network, manufacturers are turning to this new digital connected enterprise to unlock new levels of productivity and flexibility. To enable this, a transition to more intelligent sensors and control systems with secure connectivity is needed and will drive a significant increase in CapEx spending in this sector.

To enable this transition to the cyber-physical world, more sensors must be introduced and connected to the factory floor. Now remember, this is where ADI dominates. Now here are 3 examples where ADI is making the difference. Firstly, machine uptime is maximized with the aid of ADI's MEMS vibration sensors that are uniquely capable of providing the high-quality machine health data needed for analytics. ADI is also collaborating with the leading industry partners to bring Deterministic Ethernet to the edge of the factory floor, previously unachievable due to power size and cost. Now this connectivity inherently introduces the risk of cyber attack, which is one of the most important challenges to be solved in the industry today, and ADI's recent acquisitions allows us to embed sophisticated identity-based technology and secure the network from the edge to the cloud and back again.

So let me summarize. The manufacturing sector is going through a new transformation. New flexible architectures are needed to manufacture the wide variety of new products while improving overall productivity. ADI has served this market for decades. Customers value our long-term commitment, and our core technologies and solutions will deliver sustainable growth for years to come. Our customers are asking us to do more, more of the sensing, measuring, connecting and data interpretation. And building off our core technology strength and domain expertise, along with the recent investments in acquisitions, not only are we creating more value while growing SAM, we are also enabling and accelerating the transition to this new secured digital connected enterprise. And later, I would like to encourage or invite you to join us at the demo room nearby, so that you can take a look at some of these innovations.

And with that, I'll hand you over to Mark Gill, who will take -- talk to you about the car of tomorrow. Thank you.

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**Mark Gill** - Analog Devices, Inc - VP, Automotive Electrification and Infotainment

Thank you very much. So welcome, good morning, everybody. I'm Mark Gill. I'm responsible for the automotive electrification and infotainment business. So I think the last time we had an opportunity to talk was at spring 2014 in New York City. And since then, the automotive industry has



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painted a really increasingly exciting vision of the future. Car cabins are going to be replaced by living rooms, vehicles are going to transfer themselves across the country with no human intervention, electric vehicles are going to accelerate faster than any living animal, and we're even going to have cars that fly. So I think at this point in time, these are great visions to capture our hearts. What I'd like to do in this discussion is bring that picture back to ground and focus on 2 important trends that we believe will provide tangible and -- a tangible acceleration to ADI's revenue growth, mainly the electrification of the vehicle and the progression from advanced driver systems to autonomous driving.

I think the closer that I look at these opportunities, the more I realize that ADI's core strength, which is forming the bridge between the physical and the digital worlds, is really the catalyst for accelerating vehicle content growth for us. So I'm sure you're aware of this, but ADI has enjoyed creating innovations in the industry -- in the automotive industry for more than 25 years at this point in time, using different technologies from across the entire company. For example, high-speed converters have built the basis for rear-view camera systems. High-precision converters underpin our battery monitoring portfolio. Advance sound processing is built on 20 years of digital signal processing leadership while signal integrity in electric vehicles builds on our industry-leading isolation capabilities.

Now including the recently acquired revenues into the picture, we see total ADI automotive revenue at about \$900 million annualized run rate across hundreds of customers and a really diverse set of applications. Some examples of the technologies deployed today include the family of A2B weight-saving microphone and audio connection products, high-efficiency LED headline controllers and precision converters to start-stop. The emerging trends of increasing electrification of the vehicle and the path to autonomous driving build on this base. And they deliver the opportunity for \$600 of content in a well-equipped vehicle, which is more than double the \$250 opportunity per vehicle today for ADI.

So yes, I agree it's a pretty bold claim. And so we'll use the next few minutes to talk about the details. So let's start with electrification of the vehicle. Around the world from China to California, from Brussels to Boston, we hear the hue and cry against pollution in our rivers, our foods and our skies. No matter who we are, it's difficult to object for the desire for increasingly clean energy, and we see many governments setting this direction with ever-efficient, ever-tougher fuel efficiency and pollution standards. Electrification of the approximate 100 million new vehicles added every year to the worldwide fleet represents a major opportunity for countries, for cities and for individuals to change their pollution footprint. So today, I think I see hybrid electric vehicles reasonably often and they outnumber electric vehicles on the road by about 10 to 1. ADI projects, however, that hybrid vehicles are nearing the limit of their technical capability, while we're just beginning to see the possibilities created by an all-electric drive vehicle. ADI expects to see more than a 10-fold increase in the number of electric vehicles over the next 7 years. Additionally, the increased higher voltage battery packs for electric vehicles suggests the doubling of battery cell monitoring required for each car. So the key point here is that electric vehicles represents a fast-growing market, which double the opportunity for ADI content over today's platforms, which accelerates our overall potential growth rate.

Electrification of the vehicle represents about \$1.5 billion SAM in 2017 for ADI, which we project will more than double by 2022. There are 2 key technologies that I'll highlight here that we believe are essential to achieving the industry's goals for reduced pollution and increased energy efficiency, namely battery monitoring and the efficient electrical power distribution throughout the car.

ADI's recent acquisition of Linear Technology brings to our portfolio the leading provider of precision power regulation solutions and battery management systems. As we develop our fourth generation of products, we estimate the SAM for BMS and electric vehicles will grow to more than \$1 billion in the next 5 years. Now while the idea behind BMS is simple, BMS technology is complex. BMS measures the energy that goes in and out of a battery and constantly monitors the voltage of that battery, which leads to an accurate assessment of the remaining energy in it. And it's this accurate measurement of the battery that allows OEMs to lower overall system costs and increase driving range. Now our recent breakthrough is the combination of the most accurate cell monitoring technology with a robust, smart, mesh wireless network, which turned heads at OEMs from all corners of the world. What makes this stand out is that the wireless network removes the need for expensive communication wiring between the battery packs and delivers built-in isolation from whatever battery voltage is desired. With the option of outfitting the battery pack right at the battery factory with the wireless sensors, the battery packs can easily be observed and calibrated throughout production, vehicle use and then into their second life. Once the energy has been stored in the vehicle battery safely, it needs to be distributed accurately and efficiently throughout the vehicle. With vehicle systems running from 100s of volts down to 1 volt and everything in between, efficient power regulation is a really critical function. The new ADI portfolio leads the industry in terms of power regulation with solutions that provide the lowest noise, lowest quiescent current, highest power density and highest efficiency.



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For example, the new portfolio of silent switcher voltage regulators, also by far the industry's lowest levels of radiant switching noise, or EMI, a key specification demanded by car manufacturers. The critical point is that BMS and efficient power distribution require precision signal conditioning, high-performance data conversion, deep systems knowledge and high levels of functional safety expertise. All of these represents significant barriers to entry for companies without ADI's analog signal processing and efficient power heritage.

So the second trend I mentioned is the path towards autonomous driving. The journey -- and I think it is going to be a journey, but the journey to autonomous driving is already going on all around us. Advanced driver assistance systems enabled by vision or radar sensors are often today an upsell to a newly purchased vehicle. Now by 2022, automatic emergency braking, which is a foundational autonomous driving feature, will be deployed in almost all new North American vehicles. And that move will require broad deployment of high-performance radar systems. In the same time frame, we also project we will see the initial deployment of long-range scanning LIDAR systems to augment the vehicle's ability to identify objects and to avoid accidents. ADI's recently announced Drive360 autonomous driving platform, coupling 77 gigahertz, LIDAR -- scanning LIDAR systems and inertial systems is perfectly aligned to take advantage of the need to upgrade from ADAS systems to ones where the car is able to make more informed safety decisions. ADI's technology advances and the expected explosion in market adoption combined to create yet another multi-billion dollar opportunity for ADI.

So it's important to remember that ADI's core strength is forming this bridge between the physical and the digital worlds. As we move from assisted to autonomous vehicles, ADI has the critical performance technologies to make the best sensing and acting solutions possible. With sensing, the greater accuracy describing the situation around us, the better the decision. The more precisely we can deploy this guidance systems of the vehicle, the fewer the errors. The accuracy, the performance, the precision from ADI directly accelerates the shifts from today's driver assistance systems to full autonomous systems. It's actually because of ADI's unique analog leadership in analog signal processing that the digital AI engines will have the complete information to make the right decisions. So our focus is on the highest performance, highest value autonomous driving applications. The generic radar and LIDAR system may well be able to tell you that there are parked cars on the side of the street, and this lower performance system has a place in the market and it's where we see a number of our competitors. By comparison, a high-performance ADI radar and LIDAR system can precisely identify a partially visible small target next to a car as a child moving out towards the road. This is the solution will save lives. In radar, our products stand out in that they combine leading RF performance with superior integration through CMOS. With higher RF output power, we enable greater range and identification of smaller objects. Our best-in-class phase noise provides superior detection of those small objects in the presence of larger ones. Our high channel count flexibility allows systems to be built with a large number of receive channels, again, providing superior detection of small objects, by increasing angular precision of the image. Customer feedback suggests that our performance is a generation or more ahead of our competitors.

In 2018, ADI's Drive360 platform will demonstrate radar systems with an unparalleled 32 receive channels. Greater than 8 times higher than typical radar systems today, delivering unrivaled detection capabilities for autonomous driving applications. With our low-power RF CMOS solution, we can also deliver high levels of system integration that, for example, will deliver interference mitigation techniques required by an industry that will see rapidly increasing density of radar systems. Add in the newly acquired power solutions, and we have a highly optimized solution for the market in 2020, ready for the market shift to 77 gigahertz. Within a few years from now, the same for ADI, with more than \$2 billion.

Now while radar is a critical part of the autonomous driving solution, multiple modalities of sensing are required to create a system that is accurate over long range, varying weather conditions and provides the redundancy needed for a safety system. LIDAR technology complements radar, delivering the best in position resolution, resistance to rain and fog and is more suitable to high precision 3D mapping. ADI is developing a complete solid state LIDAR system with high levels of integration and intrinsic reliability. ADI's liquid crystal optical waveguide technology is a solid state approach to the really difficult problem of optical beam-steering. In contrast to other LIDAR solutions being developed, our technology is more robust to vibration, delivers flexible scanning patterns and doesn't suffer from blind spots. We can electrically steer the beam of light in any pattern we like and focus on any target: another vehicle, a person, a pothole, dynamically steering the entire performance of the LIDAR system at that target, rapidly obtaining the best possible identification information. So ADI projects the scanning LIDAR market to be about \$1 billion by '27 and will grow rapidly as autonomous driving develops. ADI's differentiated solid state LIDAR solution puts us in pole position to provide the best sensors for autonomous driving. The bottom line here is that ADI has innovative radar, LIDAR and industrial technologies that we believe can grow our revenue at every step along this long and winding path to autonomous driving. ADI's Drive360 platform positions us perfectly to grow at an accelerated pace.



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So before closing, it's worth noting the changing dynamics of how ADI is involved in the automotive market. Increasingly, ADI is deeply engaged with the critical thinkers of the car OEMs as they explore problems and consider solutions. Bringing the best of precision analog processing to the table can often challenge existing assumptions and develop real insight into a better solution. We're moving from being a simple component supplier to the Tier 1 to being an innovative extension of the car OEM's engineering team, testing architectures, testing technologies to find the most valuable fit for everybody involved. This places ADI in a very strong position to create value and leads to a long-lasting relationship. A practical example for us is the automotive audio bus, or A2B. Now in mass production with Ford, A2B is poised for production with nearly a dozen of a car manufacturers across the world. The A2B technology, you may remember, delivers audio and control data over a single unshielded twisted pair wire, enabling feature-rich infotainment systems while reducing wiring weight and system costs. Now each stage of that road map is jointly defined with car OEMs, leading to the very best solution for high-end audio transport, active noise cancellation or in-cabin communication solutions. And we'll continue to develop these deep OEM engagements, adding the technologies from over half a dozen recent acquisitions into the ADI portfolio, creating a level of completeness that very few companies can achieve.

So at ADI, we model our traditional automotive revenue growth at greater than 2 times the worldwide light vehicle sales growth. As we look more closely now at the path to electrification and autonomous driving, we see this multiple could grow 50% faster. The enabling factor to this accelerated revenue is content growth where ADI can now leverage a broad portfolio of high performance analog signal processing and power management leadership. So today, I'm asking you to be part of our vision of ADI's future as a premier analog innovator in the automotive industry: an innovator in high-performance automotive driving sensors, helping us all arrive home safely; an innovator in precision electrification, minimizing our pollution footprint; an innovator ahead of what's possible in the automotive industry.

So now I'd like to hand over to Greg Henderson to talk about the opportunities in the microwave world.

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Thanks, Mark, and thanks (inaudible) speaking, after Greg's session, we'll have a Q&A session and then you can ask questions of all the presenters thus far, and then we will take a break after that.

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**Greg N. Henderson** - Analog Devices, Inc. - SVP - Automotive, Communications and Aerospace & Defense

Okay. Good morning. I'm Greg Henderson, responsible for the Automotive, Communication and Aerospace and Defense Group. And I am going to -- on my presentation -- okay. All right. There we go. Thank you. I'm going to talk to you today about, is important franchise in our group, which is the RF and microwave business. So today I have kind of 2 key themes. I'm going to talk about our vision for this business, where we see the future in the business in the microwave and millimeter wave frequencies. And there's kind of 2 themes to this. One, is the market trends, the dynamics that are driving this market to high frequency. And then second is our strategy to develop the core platforms and solutions to enable this transition to a millimeter wave world.

So with that, I'd like to introduce who we are in the RF and microwave business, and by that, I'll introduce myself. I have been in the wireless industry for much of my career. A lot of it as the semiconductor and component supplier, but also on the systems side. And I was the Vice President of the RF and microwave business at Hittite, when we were acquired by Analog Devices. And after that acquisition, we did an organizational change that combined what was the Hittite microwave business with what was the ADI organically developed RF and microwave business. And together, we are the market leader in the performance segment of this market. So we have over \$500 million of revenue, and we have the broadest portfolio of components from to DC to 100 gigahertz. Our strategy in this market is to develop complete signal chain solutions to ease our customers' design journey. You heard Peter talked earlier about the fact that our customers have fewer and fewer design engineers trying to get to market quicker, and so our strategy is to develop these complete signal chain solutions to ease that design journey. Through that, we have a very broad base of customers throughout the performance market segments. And I'll turn to talk about those segments at this time.

So defining the performance market segment, I show the sub-segments of the market that we're in today. We start with communication infrastructure. So this is all forms of communication infrastructure, cellular communications, microwave, radio, satellite communications. The second is aerospace and defense. So this is applications for communications and sensing in the aerospace and defense markets. The third is automotive. Automotive



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radar is the large modality today. You heard Mark talk about automotive radar, but there is other emerging applications in automotive we'll talk about. The fourth is industrial. This is the broad industrial market. Kevin talked about industrial automation. This is wireless sensing applications primarily to enable robotics in the industrial market. And then the fifth is the instrumentation test and measurement market. This is not a core end segment by itself. But as these other markets need high-performance RF and microwave technologies, you need the test equipment to test them in and that's the end market that we are in.

So combined together, these are a \$3 billion market and is growing. We estimate this to grow to be a \$4 billion SAM by 2022. The other point I want to make is that all of these, as I said, we are in the performance market segments. So this \$4 billion is the signal chain, that's the bridge, that Peter talked about, it's the signal chain for this market. But there is also a large market for the high-performance power solutions that attached to these, and you heard Steve talk about some of those. You will see, I give the same signal chain examples that Steve had earlier. So there is a large power market that attaches to go along with this as well.

So moving on, I want to talk a little bit about this market in more detail. And I show a spectrum -- a graphic here of the electromagnetic spectrum to kind of show the main applications that are driving this market. If you think of the applications that you are most familiar with that have driven the wireless industry for the last 20 years, these are typically RF applications. So these are in this frequency range from DC to 60 gigahertz on the left side of the chart. These RF applications like 2G, 3G, 4G, cellular communications, GPS, WiFi, these have really driven the market. But if you'd look at the applications that are emerging, they tend to be microwave and millimeter wave applications. So while the RF applications still very important part of our business, and I'll talk about that, there is a lot of growth in these microwave and millimeter applications. These are, for example, automotive radar at 24 and 77 gigahertz. 5G cellular communications, which are going to be a 28 and 39 gigahertz. Next generation WiFi, sometimes called WiGig, which are going to be at 60 gigahertz. And this is in the microwave and millimeter wave frequency range. And we estimate actually that the microwave and millimeter wave subsegment of the market is going to grow 4x faster than the RF subsegment over the next 5 to 10 years. There is actually a good technical reason why applications are moving to higher frequency. If you have a communication application, you want a higher data rate. Main way to get that is to go to a wider bandwidth. To get a wider bandwidth, you have to go to a higher frequency. So higher data rate, wider bandwidth drives you to higher frequency and that's for communications applications.

But for sensing applications, it turns out there is also a technical reason to go to higher frequency. And again, it's to get a wider bandwidth and that's for resolution. So if you want a higher resolution radar, like Mark talked about, our 77 gigahertz automotive radar strategy, you move to 77 gigahertz to get that wider bandwidth and have a higher resolution. So these are real technical reasons to drive to the higher frequency. One thing to understand is that the design complexity goes up at higher frequency as well. The design challenges get harder. It's no longer just an analog circuit design. It's an electromagnetic design. The packaging is more complex. And so this is a great space for Analog Devices, because its high performance, its high complexity, we have a lot of competency in this microwave and millimeter wave design, and that's converging with the market moving to this at the same time.

So I'd like to switch now and kind of talk about our strategy for this market. And there's 3 key initiatives that I want to talk about that are -- that we're working on to basically enable this microwave and millimeter wave market. The first one is to enable multi-gigabit per second communications. So we are developing the core technologies and platforms to enable 5G communications effectively, and I will talk about that in a minute. The second is the democratizing phased array. So phased array is a multi-antenna technology, it's very prevalent in aerospace and defense. I'll talk more about the technology in a minute. But our strategy is to democratize that technology and make it more accessible in all the markets that we participate in. And the third is to make wireless sensing ubiquitous. Those key areas that I talked about are wireless sensing, if you think about wireless, you mostly think about communications today. But there is a lot of sensing applications, automotive radar being one, but there's others. We have a strategy to bring this wireless sensing technology to ubiquitous across the markets, and I'll talk about that. A key thing about these 3 initiatives is they're not dependent on any one of these markets. And you'll see this as a theme as we go through the presentation. Being the leader in the performance markets that we're in, we're developing core platforms and solutions that scale across the markets. We're not dependent on any one of these markets. And we get a lot of technology leverage across the markets as well, and I'll talk about that as we go forward.

So now I'm going to turn and talk about each of these initiatives individually. The first one to talk about is enabling multi-gigabit per second communications. If you look at the communications trend, as carriers have gone from 2G to 3G to 4G, typically that's about a 10x increase in bandwidth. And going from 2G to 4G was mostly about waveform optimization in that RF spectrum. But that waveform optimization has pretty much run its course. And to get the data rate increase from 4G to 5G, carriers have to go to kind of new technologies to be able to get that data



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rate increase. And I would say there's 2 key technologies that they're looking at, and ADI is participating in driving both of those. The first is going to multiple antennas. So this is sometimes called massive MIMO in the communications industry. And this is instead of having a small number of antennas on the tower, you have a very large number, 64, 128 antennas. And by doing that, you can use those antennas to collaboratively send data to multiple subscribers using multiple paths and you significantly increase the capacity of the base station. The second is to simply go to higher frequency. So like we talked about before, higher frequencies, higher bandwidths, this is the essence of millimeter wave 5G that we talked about at 28 and 39 gigahertz. And Analog Devices is developing the core platforms and technologies to enable both of these transitions in multi-gigabit per second wireless communication.

I'm going to show you one example here, which is that of our software-defined radio platform. You probably heard us talk about this before. So on the left-hand side of this chart, you see a traditional multi-channel base station. This is actually a 2-channel transfer and 2-channel receiver, multi-channel base station design, which is done traditionally by our customers on the board. And I show our latest generation of the software-defined radio in the center, which reduces the board area by a factor of 10. Beyond that board area reduction, because of all that reduction you get, actually it reduces the overall base station footprint for our customers by 50%. At the same time, it gives them a big power savings and also a big time-to-market advantage because they no longer have to do the design, we've done that design for them. And as a matter of fact, if you look at this kind of design on the left, you see that you really can't get to these massive MIMO deployments that have 64, 128 antennas without this kind of integration.

Other advantage of this platform, this is a software-defined platform. It's a software-defined radio platform. So we have the same technology that can scale from a macrocell to a small cell to a massive MIMO. That gives a huge advantage to our customers because once they design that in, they can take their software and leverage it across, but it's also a huge advantage to us. Because once we're designed into those platforms, there is a lot of stickiness and the fact that the software is harder for our customers to change. So this is designed in across the ecosystem for massive MIMO, macro and small cell, and we're like on our third generation of this technology. So this is a key way that we are enabling multi-gigabit per second communications.

The next initiative I want to talk about is democratizing phased array. To do this, I'm going to take a little bit of a detour and talk about what phased array technology is in general. And I show here on the left hand side of the chart a traditional radar architecture. So this is like an old-fashioned radar you might see at the airport, and the key is, is that on that radar, at the front of the nose, there's a single high-performance radio. And then that single high-performance radio is mechanically scanned by the antenna as it rotates around. So this radar has basically a single beam and it scans on a well-defined trajectory that goes around 360. It has some significant disadvantages being that it's a mechanical. Mechanical stand has mechanical challenges, in that it has reliability challenges, et cetera. Also that single beam has to -- once it scans the location, has to come all the way back around before it can see that location again. So in the aerospace and defense market, they developed a technology called phased array, where instead of using 1 radio that's mechanically scans on the antenna, you have thousands of elements that are electronically scanned. And there's a bunch of small antennas and by controlling the interference between those antennas, you can electronically steer the beam. So it has a huge advantage that it's a fully electronic system that can be electronically scanned. It also has a big advantage because you can have a multi-beam capability. So now instead of just having 1 beam, you can have multiple beams, and you can scan those beams wherever you want, similar to what Mark said on the LIDAR. As a component supplier, it's a big deal because instead of having 1 high-performance radio, you have thousands of radio channels. So the system level impact to us, we can sell for a single system millions of dollars of components for a single phased array deployment. However, there is a downside to this technology that tends to be very complex. You have this thousands of channels, you have to control them, you have to calibrate them. So tends to be a very complex technology, and that's the reason why it tends to only to be deployed in very high-performance aerospace and defense markets. So our strategy is to try to democratize this by making the technology more accessible. I show on the left-hand side of this chart, kind of a typical phased array deployment. So you'll see the panel on the front of this see that plane, but behind that there is a huge amount of electronics where you integrate all of these channels together all-in-all to control. They tend to use very discrete signal chains today, lots of individual components. We sell a lot of products into there today, but we are looking at where this to go for the next generation. So our strategy is to bring the levels of integration, like you saw on the cellular, to this market. We're developing ICs that do multiple channels integrated into a single IC. And by the levels of integration that we're bringing, we can actually significantly reduce the complexity. And instead of having all those electronics behind the panel, you can actually mount the whole thing on the back of the panel. So we're developing this for multi-market. Even for the aerospace and defense market, this is very attractive because it significantly simplifies the design for them. But our strategy here is beyond that as well. We want to leveragethis multi-antenna technology to all of these other markets. The benefits of these



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multi-antenna technologies are there in 5G communications and satellite communications and automotive radar. And so our strategy is to bring that multi-antenna technology across those markets.

And that takes me to the third initiative, which is making wireless sensing ubiquitous. As I said at the beginning, if you think about the wireless industry that's really driven the volume, it's mostly about communications. But there is one market where sensing is probably as ubiquitous as communications and that's the aerospace and defense market. So a wireless sensing radar, if you like, is very ubiquitous in the aerospace and defense market for applications like perimeter security et cetera. But there are many other markets where wireless sensing can have the same impact and we think this market -- these markets are really just starting. One of those key markets is automotive. You heard Mark talk about our strategy in automotive radar. So we're driving a lot of capability there. But there's a lot of broad industrial markets that benefit from wireless sensing as well: factory automation and robots. You heard Kevin talk about that there's a lot. As you automate the factory, this wireless sensing and awareness of the environment is very important. And in addition, there's other broad industrial applications. Applications like UAV collision avoidance, UAV ground altimeter, smart city deployments to put radars on traffic corners to understand the count of cars. So there's a lot of applications across these industrial markets. But one of the keys here is, is that these are markets that aren't very familiar with RF and microwave, especially when you get to the millimeter wave frequencies that you have to get for these applications. So our strategy to make wireless sensing ubiquitous is to try to bring more turnkey solutions to these markets.

I show an example of that here. This is our recently released 24 gigahertz radar solution for the industrial market. So this a complete reference design, and actually if you come to the demo later, we have a demo, -- we have this in our demo room to show you, it's a complete reference design for a 24 gigahertz radar. It has the Analog Devices chipset for the 24 gigahertz radar, the Analog front end and the DSP. On the back of the board is the antenna. It's actually integrated on the back of the board. But in addition to having the components and the antenna there, we also have it integrated completely with the software stack, detection and tracking algorithms included. So basically you can get this reference design from us and try out these radars in these industrial applications. And then if it works, if you find that it's good for the applications, you can take that reference design and design it straight in. So the way we're enabling this and making it ubiquitous is by having this complete solution, going all the way from the components up through the software, is really easing our customers' design journey in this industrial market.

So we look at these 3 initiatives together. I think we have -- really have a key strategy where we see we have elements of -- layered elements of differentiation. Starting back at the beginning we talked about our portfolio, we have the broadest portfolio of components, we have over 10,000 components. And we have a very large competency in high-frequency design. But beyond this, I think you can see in the 3 examples that we bring here, beyond just having all of the bits and pieces to develop a system solution, we are working at the system level to ease our customers' design journey, and I gave you 3 examples of that, really going beyond silicon to have system level solutions. So for us, this is key, because we think we're going to capture more market share. We're making the customer design journey easier that allows them to get to market quicker. But in addition, we're creating competitive barriers. We have competitors that compete with us in elements of our portfolio. They compete with us on parts of the signal chain. But there is no competitor that is really effectively competing across all of these performance markets and across the vertical stack that we're working on. And finally, we're enabling new applications. We're very excited about the new markets for wireless sensing and other applications whereby bringing these system level solutions we can enable new applications that even we haven't thought about to date.

So with that, I kind of bring to conclusion the presentation. And I think there's 2 key points I want to you -- to hope that you can carry away from this. First, this is a very good market. The RF and microwave market is a very good market. It has grown over the last years and will continue to grow. And that growth is going to be driven by these high-frequency microwave and millimeter wave applications. So that's the first thing. And the second thing is that we have a good strategy in this market. We are building the core platforms and technologies that are going to enable this market to happen. We are expecting to have a double-digit growth in this market. And that we have a diversity across these markets. So we're not dependent on any one market transition like 5G or automotive radar, but we're developing core platforms and technologies that go across his market, and we're able to get that scale and leverage.

With that, I hand back to Ali.



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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Great. Thanks (inaudible). Okay, folks. So let's get on to the Q&A. At this point in time, let's see -- you can ask any questions of either Peter Real, our CTO's; Steve Pietkiewicz, who runs our power business now; Kevin Carlin, on factory automation; Mark Gill, on automotive; and you just heard from Greg Henderson as well. So anybody have questions? We have a question. So how this is working by the way? So these guys are mic'd up wirelessly and that's working. And then I walk this around, is that how it works? You've got that side of the room and I have this side of the room. Sorry, Tore how does this work? You want to grab this?

## QUESTIONS AND ANSWERS

**Tore Svanberg** - Stifel, Nicolaus & Company, Incorporated, Research Division - MD

Yes. Thank you. Do we like keep it to one question and one follow-up or just?

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

You must be on our earnings call Tore.

**Tore Svanberg** - Stifel, Nicolaus & Company, Incorporated, Research Division - MD

^ My first question is for Greg. Greg, you talked about the software-defined radios. I was just hoping you could elaborate a little bit on how that stacks up versus competition, especially thinking about the architectures like full spectrum capture from some other suppliers out there. If you can just elaborate on that, that would be great.

**Greg N. Henderson** - Analog Devices, Inc. - SVP - Automotive, Communications and Aerospace & Defense

So I would say that we don't talk about our competition specifically. But what I can tell you is, is that we believe we have the right architectures for all the ecosystem, macrocell, massive MIMO and multi-band. And we are participating in all of those deployments we've designed in and across the ecosystem. So we have the right architecture and partitioning, and we are gaining share in this market.

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Do you want to? All right. Will?

**William Shalom Stein** - SunTrust Robinson Humphrey, Inc., Research Division - MD

Questions for Steve. Thanks for sort of introducing us to Linear as part of ADI. You talked about this concept of someone's going to get that slot, so why not us. Can you talk about how that idea developed over time at Linear and how that's going to perhaps influence the approach at ADI? And whether you see -- how you see these cultures merging, because you characterize the culture of Linear as pretty special and maybe little bit different from Analog?

**Steve Pietkiewicz** - Analog Devices, Inc. - SVP of Power Products

Yes. The idea of someone's going to get that socket, why not us? That's just how Bob Swanson and Bob Dobkin took a look at that business in general, very aggressive mindset, and let's go up there and win. That created a culture of winning in Linear technology where -- like I didn't play



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high school sports, but I like to win. And that kind of idea carried us through. I find that, as part of the Analog Devices, everyone at Analog also likes to win, so in that sense, the cultures are just in lock step.

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

We have Ross

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**Ross Clark Seymore** - Deutsche Bank AG, Research Division - MD

Ross Seymore from Deutsche Bank. Question for Mark Gill on the automotive side of things. We've heard a number of companies talk about this being an exciting market, and I have no doubt it will be. One unique part about ADI and Linear together is the margin-centric focus of the company as well. So when you talk about going from, I think, it was \$250 per vehicle to \$600 per vehicle, can you talk about how the margin structure changes as you get up into those higher dollar content areas?

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**Mark Gill** - Analog Devices, Inc - VP, Automotive Electrification and Infortainment

What think I prefaced one of the paragraphs in there to talk about the highest value sockets we're looking at radar and LIDAR. And there's clearly a complete spectrum of the applications out there. I think what we're looking to do is to make sure we can extract the value that's commensurate for the technology that we're putting into this. So I think what you'll see is us moving towards those higher value sockets, bringing in the BMS capabilities from LT and looking at our own radar and LIDAR capabilities in there as well.

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Charles.

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### Unidentified Analyst

Just 2 quick questions. One for Steve. In one of your slides, you had this automotive radar solution, and you were talking about how you could have integrated power management module with ADI. Could you just maybe talk in general about the timing of when these things can happen? Are we talking about 2 to 3 years? Or is this really low-hanging fruit that in the next several quarters we can start seeing some of these integrated modules? And then maybe for Mark. I think Deutsche Bank recently had this forecast on auto SARs, just in the U.S., talking about down 2% to 3% this year, many 5% to 10% through 2021. And you don't have to talk about the forecast, but just in an environment where Tier 1 OEMs have unit pressures and profitability pressures, can you just talk about your automotive business and how you think that might play out?

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**Steve Pietkiewicz** - Analog Devices, Inc. - SVP of Power Products

Okay. I will take the first question. With regards to integrated power products, we closed in March and that's when we -- the engineering teams got busy and got working together closely. So new products that are completely new, clean sheet products, they do take a couple of years to get into production. Now that said, we also have an existing very broad portfolio, as I mentioned in my presentation. And we have this micro module capability and manufacturing technology that's well in hand. And there are also opportunities use leveraging existing silicon to make micro module products, which can, they don't always, but they can come out more quickly than fully new silicon. So we're exploring whether there's opportunities to take some of the existing silicon and put those in micro modules to get there a little quicker. So we're going to do both.



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**Mark Gill** - *Analog Devices, Inc - VP, Automotive Electrification and Infortainment*

From the topic of SAR, I'd say when we started this year, there are a variety of folks who were looking at reductions in China, for example. And I didn't really believe that. So I spent some time in China talking to car manufacturers, talking to Tier 1s there, and they didn't believe it either. And I think we've seen a fairly strong start to the year in China. So I think it's a difficult thing to honestly predict SAR and with the autonomous vehicles coming out, I think, there's lots of very wide predictions about what the impact of that may be. And for me, I think I tried to touch on here in the conversation, SAR is one portion of the equation, but the content of vehicle is really important. And if I take the conversation on radar that we discussed here, for example, content is encapsulated in 2 different ways, one of them is the number of radars per vehicle. It's not just one, right? People talk about 1, 5, up to 20. Just depends upon what you want to try to do with those radars in the vehicle. So that's one element of content. The other thing is what is our content within that application, within that socket. We're moving from situations where we had a simple A2B converter or a simple RF device to a complete antenna to bit solution that contains a whole lot more value. So I really think the catalyst for us is content growth. There's a SAR component absolutely, but again, we will see that when the days actually arrive. But content growth is really what's the most important for us at this point.

**John William Pitzer** - *Credit Suisse AG, Research Division - MD, Global Technology Strategist, Global Technology Sector Head, and Semiconductor/Semiconductor Capital Equipment Analyst*

It's John Pitzer with Credit Suisse. I have like sort of a broad question for anybody who spoke this morning. But what's been unique about Analog historically is that scale, size hasn't necessarily translated into dominant market share, which is very different than the digital side of the world where scale and size tends to move to dominant market share positions. Whether it was Greg's presentation or Mark's presentation, there clearly seems to be some trends afoot that are leading to more system-level development and potentially faster market share aggregation. Vince, in your presentation, you talked about being #1 or #2 in all the markets you play. I'm wondering if you could actually quantify what market share you have in those markets? And how you think about terminal market share over time? The largest analog player only has about 19%, 20% market share. You're hovering right around 10%. With all these trends, how does each of you think about where your terminal market share should be 3, 5 years from now?

**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

I think there are many, many places you can play in the plethora of applications in which we participate. I think our business -- where our business differs from the book scale of the digital area, for example, is that -- and as Peter talked about, the analog business is characterized by diversity. There are literally thousands of applications in which you play. The broad base of products that we build can address all those different applications. Where do we focus our R&D on application-specific things? Well, where we know we can deliver great value, great value for money. Where we can capture that value in good margin of free cash flow. So I would say the more application-specific type things we're doing are automotive. I think virtually everything that's to do with automotive is an application-specific type thing. I would say in the industrial area, more than 80% of what we do, in terms of the many, many thousands of products out there, a lot more than 80% are very generic, open market type products. So there's a spectrum of kind of integration activities, and I would say the communications market is becoming really a case of its bimodel. One part of it is highly integrated, more ASSP, and a lot of it is, I would say, very generic open market type products. But there is also a ping-pong effect where you get the system-level product designed in. You got an opportunity to bring the kind of more standard product things with you. So that's the nature of our business. Where is terminal market share or market penetration, I think the analog business is going to become more and more diverse, with more and more applications, more and more products. And I think what we would consider to be dominant market share in an application would be 35% plus, I think that's how we view it.

**Christopher Caso** - *Raymond James - Analyst*

Chris Caso from Raymond James. It's a question about Linear. Vince or Steve, I guess, either of you can answer it. But one of the things that was always pounded into our head by Linear management was how difficult it was for what they did and how few people that were available that were able to do it. I guess first question, is that still the case? And assuming that it is, with some of the new markets that you look to address with Linear,



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how do you do that with the existing team? And how do you find the bandwidth to both defend the markets that you are already strong in, in addition to kind of going after some of these new markets that you're looking to get into?

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

I think it's a good question, Chris. The beauty of the combination of the 3 franchise: it's ADI on the signal path; Hittite on the microwave, RF side of things; and now LTC largely around power. When you look at the -- I mean, first of all, our business -- the business of analog is a business of craft. It's a business where you hire people, typically speaking, early in their careers and you bring them along. And a lot of people spend their entire careers at companies like ADI and LTC. So I think the combination of those 3 franchises gives us our unfair share of the talent and ability to attract more talent. And Peter talked about from a competitive moat standpoint. We have 50,000 plus product SKUs in the company. We're putting out many hundreds of new products a year. So I think part of what we do is we build on the legacy. We're getting deeper and deeper into our customers. As I talked about earlier on, our customers are experiencing -- as they put more and more of their efforts into software and systems. There is more of a vacuum, which we are now, I think, uniquely positioned as a combined company of these 3 great franchises. So not only protect the legacy in the franchise of what we've built, but to attack in a more complete wave of these new opportunities across base of spectrum of frequencies, the different types of converters, the different types of power. And so I think at this point in time, as the industry diversifies, we have both the scale and the scope now in the company to be able to attack more and more of the opportunities.

**Unidentified Analyst**

Another culture strategy question. And maybe there's similarities and differences across the other segments and comparing power where Linear was the bigger player, maybe with some of the other segments where ADI was the bigger player pre the merger and how the -- maybe culture and strategy would be same or different across segments?

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Well, one of the things that -- let me step back a second. So roughly 1/3 of Linear, I would say, overlapped quite directly with ADI, at least on paper, so a lot of the Linear convertor activity. But the truth was Linear did a superb job at figuring out where we were playing and trying to avoid us as much as possible. So on paper, the things look the same. And when you look at the portfolios, LTC did masterfully well, I think, in retroshuffling new products into the crux in the portfolio that maybe ADI another set. So there's a tremendous amount of uniqueness. We are folding. The design teams are already working, they've already been working for several months together, trying to figure out how to build a new road map of convertors for big customers and small customers. And I think on the power side, LTE was very, very dominant. ADI roughly \$100 million worth of power revenue, LTE roughly \$1 billion. So again, there's a lot -- we took -- the ADI folks took the opposite direction with LTC -- the ADI power people looked for sockets where LTC probably wasn't playing as dominantly as it might have been. So we've got our engineering teams working together. New road maps. We are converging, where there might be little overlap. We're making sure that we're doing things that are unique. That all the talent is deployed in this new company. And the customer side of things, we're very same. We're preserving all the LTE sales and applications people on the ground, going more direct. So I think when you look at the technology story, the customer story, we are leveraging the diversity and the complementarity of both companies and creating something, as I said earlier, greater than the sum of the parts here. And culturally, everybody focuses on culture. But I think what's very important to remember is that the reason that we can make this work, and the reason we made Hittite work, inside ADI was that our business values are essentially the same. We're innovation focused. We care passionately about doing impactful things that add value to our customers for which we get well paid. And that is true whether it's an ADI engineer, an LTC engineer, or a Hittite engineer. So I think those core values, once you've established those, it's very hard to change those because they're part of your DNA. But those values are deeply embedded in all 3 companies. And I welcome, by the way, when you talk about the routines and the processes for how you do things in both companies. Yes, they're different somewhat. But at the end of the day, we have to get products to markets. We have to get to customers. We have to manage our employees in a fair and competitive way. And we're being very patient and careful at making sure that we take the best of the LTC routines, the best of the ADI routines as we did with Hittite, and combine those in a meaningful way. And it is working very, very well today.



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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

All right thanks, next question here.

**Amit Jawaharlaz Daryanani** - RBC Capital Markets, LLC, Research Division - Analyst

Amit Daryanani, RBC. I guess, Steve, you talked about a \$1 billion power portfolio today. Can you just touch on how big do you think this TAM is and if you were willing to sacrifice somewhat on pricing today versus what Linear did, how big could this opportunity be for you guys? And I'm just wondering if you focus on more on perhaps 40% free cash flow margin versus 80% growth, is there a large attractive revenue opportunity for you guys to go after?

**Steve Pietkiewicz** - Analog Devices, Inc. - SVP of Power Products

Yes. Let me take a piece of that. So there's a portion of that, that I'll cover in my presentation, and I'll help you size up the opportunity. But then, in terms of how you think about the strategy, I'll leave that up to you. So wait on the first one, I'll fill you in and then go to...

**Steve Pietkiewicz** - Analog Devices, Inc. - SVP of Power Products

Well, we are focused on operating margin and free cash flow. You may have been aware of some hard stops in the Linear way to look at gross margin and selling price and things like this. And we've got now as part of ADI, I'd say, some amount of additional flexibility in how we attack business. And so we will be taking close looks at business as it comes our way. And making the intelligent rational decision whether we take it or not. So I anticipate that we'll have additional opportunities in revenue. Without stealing from Ali's thunder's later, yes...

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

I only give the path.

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

We care about long-term profitable growth. And we will manage the opportunities very smartly, within the bounds of our business model across the entire portfolio. And as Steve said, I mean, there's 2 sides to margin. One is price and the other is cost. We believe that we're generating products with inherently high value, we get well paid. And with the additional -- just the scale of ADI's manufacturing operational and the ability to, if you like, leverage cost of goods more aggressively, we have more flexibility as a company to go after our share.

**Amit Jawaharlaz Daryanani** - RBC Capital Markets, LLC, Research Division - Analyst

Perfect. And I guess, Mark, if you could maybe just talk about on the automotive side, what is the geographic breakdown for revenues? And where do you see the more attractive opportunities? I think Linear used to be at least more China heavy. So what does that aggregate automotive company look like? And where are the opportunities from your perspective?

**Mark Gill** - Analog Devices, Inc - VP, Automotive Electrification and Infortainment

To be quite honest with you, I haven't done the detailed math. But you're correct in that ADI was previously more Europe than Asia, and the Linear technology brought more Asia than Europe. If you ask me today, where that would look, I'd say it's fairly well-balanced at this point in time around the 3 major global territories. It's a fairly diverse portfolio, quite honestly, at this point in time really isn't being quite distributed around the world.



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**Harsh V. Kumar** - *Stephens Inc., Research Division - MD*

Harsh Kumar, Stephens. So ADI is an exciting and interesting company now. You've got things like RF, things like power management, different kind of combinations you typically don't see under one roof. I'm curious in the automotive market, who would you consider as the closest competitor? And then part 2 of that question is, let's say, you won a socket in radar or LIDAR, does that make it incrementally easier for you to walk in behind with power management sale and close some of the part?

**Mark Gill** - *Analog Devices, Inc - VP, Automotive Electrification and Infortainment*

I think increasingly our customers -- we've touched on a couple of items here, they often moving their engineering to different parts of their organization, addressing different types of challenges, that leaves some vacancies with their engineering teams. And if they do that, it creates an opportunity for ADI to have more of their solution sale. So whether we are leading with our power management and following with our radar solution or leading with a radar solution following that with a power management solution, together at this point in time, we can go with that complete package. And the value that's Steve touched on here is, you need really good precision power management to get the very best out of the RF capabilities that we have. That's one of the wonderful 1 plus 1 is greater than 2 elements to this. We can really optimize both sides of that the equation. So I think it presents us with a much stronger position to say to our customers, these things work perfectly together. You don't worry about some of the things, no. They can go and think about some other parts of the equation. So whether that's in radar, whether that's in LIDAR, quite honestly, in our audio business, there's a lot of power technology, we can bring into that as well. And clearly we talked here about BMS and the great portfolio that ADI has that complements the great portfolio that LTE has. So I think there's many situations where our sales team now is going to be really empowered bringing 2 bags with them, it's a much stronger sale for them.

**Unidentified Analyst**

And in terms of competition?

**Mark Gill** - *Analog Devices, Inc - VP, Automotive Electrification and Infortainment*

I think you look at us on a scale of revenue in the automotive business, there's some big players out there. I think what Vince identified in the charts here is, we look to be top suppliers in particular marketplaces that we choose to be in. So it's not about just going after everything and being the biggest in total dollar value. It's picking those really key places for us to go after. And I think if you look at the types of differentiation that I tried to identify today, this real world analog signal processing, this connection from the analog world to the digital world, the physical world, this really where we own that space. I think that does us great things across the broad portfolio technologies that we offer.

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

All right. We got Blayne here.

**Blayne Curtis** - *Barclays - Analyst*

I think, Peter, you might have made this comment, but you said 80% of parts can use only few 12-inch wafers. I was just kind of curious, if you look at these new areas of growth, maybe autos, but even maybe some of the infrastructure, automation, maybe higher volumes. Just your perspective on 12-inch as well as just internal, external views, I think, Linear was internal and probably some of the small slots in the industry are kind of curious as you look at these new growth opportunities, how that changes.



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**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Well, I think we've got -- I think the power in what we have in our manufacturing strategy is that the balance between the internal and external. I think we've become a lot more sophisticated over the years in terms of what we've positioned where in terms of use of technology. And clearly, if there's a very high-volume opportunity, we've an appropriate strategy to get to the right cost position on that base. So we can swing. We have a strategy where you can either swing or position where our technology goes. So whether it's high volume opportunities or low volume opportunities, I feel very comfortable that we can position an appropriate manufacturing strategy. Now irrespective of which one we pick, we have a maniacal focus internally and continually reducing cost. So that layers on no matter which way we go with this. So I feel quite comfortable with those statistics where we can position our different technologies. And it is true, the statistic I gave us sort of a scaled up statistic, if you take all the units, all the types of products we run and you scale them up to the equivalent of the 12-inch wafer lot, which is 25 wafers, well in excess of 80% of those units would only use 1 lot or 2 lots a year, which creates a whole other series of headaches in your manufacturing strategy for you in terms of managing reserves and deliveries and the associated metrics that go with that. So I think we have that balanced really well. Now we continuously look at it since we've balanced it pretty well.

**Greg N. Henderson** - Analog Devices, Inc. - SVP - Automotive, Communications and Aerospace & Defense

I think also -- I mean, we also are market leading on low geometry for high-performance analog mixed signal. In the comm space, we are on 28 nanometer for the software-defined radio platform, I showed. We've announced our automotive radar platform on 28-nanometer. So we market lead on the geometries for high performance. Again that's not where the digital is at. But we are -- so we do both. We have these kind of more internal, more volume capabilities, but we also market lead on the low geometry, high volume, high performance when we need it. And that's the balance of the strategy.

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

And I talked about the fab strategy at Linear. It's true, Linear was mostly captive fab, but that's changing quickly.

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

We'll grab it here because I think you asked one before, so.

**Ambrish Srivastava** - BMO Capital Markets Equity Research - MD of Semiconductor Research and Senior Research Analyst

Question for you, Peter. From a CTO view, if you could help us understand, your product portfolio has expanded tremendously as there is a process technology portfolio as well. Give us a little more insight into how -- maybe Vince, you can chime in as well, how are you prioritizing projects that are being worked on, and obviously, they are in conjunction with business leaders. But had the metrics changed at all with Linear now, much different product portfolio? And then what are the ways that you are integrating the similar organization from Linear into the overall ADI technology fold?

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Well, there's a number of questions there, Ambrish. In terms of, let's say, we're spending a \$1 billion in R&D now combined. So what do we care about? We play in applications where we believe we got a good match between our technologies and the applications in which we play to drive profit and free cash flow ultimately over multiple years per product, typically, and we pay a lot of attention to the effect of new product revenue in the overall stream of ADI and its ability to generate growth. And that is probably more true in the ADI side than it was LTE. So we're fusing our product development efforts, and we're paying rapt attention to what it is we're going to do together to leverage the entire talent base that we've got across both companies. And really focus intensely on that new product return metric. And I think I showed in one of my charts with the pivot we made to the B2B market several years ago, we're really beginning to see the benefit now of the return that we're getting on the new products

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side, particularly in that B2B area, and in the high quality areas also of consumer. So I think it's a question -- for us, it's a question of being very, very clear on the markets in which you play, the applications that give us the kind of the attractive returns that we want and getting to market as first as we can, so we pay attention to time, the quality of the opportunity time and the effect on new product revenue ultimately. What was the other part of the question, Ambrish, I've forgotten. Can you just repeat?

**Peter Real** - *Analog Devices, Inc. - CTO and SVP*

Let me just take the second part of it. There is no -- and people laugh at this internally. There is no shortage in ways we look at our business internally in ADI. We cut our data by product category, by end market. We look at technology -- individual technology portfolios. We look at customer position. And actually the power of bringing LTE in here is that even -- it even puts more pressure on us to clarify big customer and small customer and look at supporting that constant diversity. So it is -- we are a quite a complex organization internally and hopefully we try and simplify that when we face our customers. But all this balancing goes on dynamically internally. It isn't overhead. But I think it's an overhead that we manage very effectively, looking at pillar technology positions, looking at solution positions by focused market segments, looking at the priorities of big customers versus small customers and getting that balance right. All those dynamics are managed internally. So there is no one North Star that we use internally. The North Star is -- the priorities are engineering excellence, impactful innovation and really making an impact in every customer engagement we engage in. And within that, all the balances and the levers we pull internally are quite complicated and don't lend themselves to one algorithm to solve that problem.

**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

I mean, one of the hardest things we do, we are very opportunity-rich. One of the hardest things we do is sift through which ones to focus on, but we've gotten better and better at that as a company.

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

All right. Will, go ahead. Is that not working?

**William Shalom Stein** - *SunTrust Robinson Humphrey, Inc., Research Division - MD*

Hi Will Stein from SunTrust, wanted to ask you about LIDAR.

This is an area you think you should (inaudible) some of our established (inaudible). Can you maybe compare and contrast to what Analog has from an availability and traction (inaudible)

**Mark Gill** - *Analog Devices, Inc - VP, Automotive Electrification and Infotainment*

Sure. So maybe I'll make it straight forward. The technology that we acquired from Vescent is sort of in the advanced -- in the advanced technology area, and our role at this point in time is to bring that from advanced technology to being productizable and bring that out to the marketplace. When we're talking here in the conversations, we're looking to intersect that in the 2020, 2021 time frame just as we see this as a pushout for autonomous driving and with the need to bring that scanning light (inaudible) system in with that. So that's the time frame, I think, you would see the real impact of that technology going forward.

**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

I think as well, given that ours is solid state now you can talk to the competition better, Mark. But being solid state, our technology is immune from mechanical vibration, for example, compared to some of these rotating towers, so to speak. So that's the bet we're making that our solid state

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systems being a lot smaller, being a lot more cost effective and immune from some of the environmental noise, if you like, will make it very, very attractive. That's the bet we're making, but as Mark said, it's a little bit out yet.

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Okay. Tore, go ahead.

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**Tore Svanberg** - Stifel, Nicolaus & Company, Incorporated, Research Division - MD

I had a follow-up question for Peter. Peter, your closest competitor really emphasizes manufacturing as their main competitive advantage. Now ADI does more and more outsourcing. And I think, Analog, in general, does more and more outsourcing. I'm just thinking about process technology. You mentioned you actually do develop some process technology with your funded partners. Just hoping you could elaborate on that. How much do you -- because I think in the long run, I think, investors worry about too much analog getting outsourced using foundry process technologies and there being less and less differentiation. So if you can elaborate on that, that would be great.

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**Peter Real** - Analog Devices, Inc. - CTO and SVP

Yes, it was in -- actually, the answer to a level of sophistication we have in the outsourcing strategy is embedded in one of those wheels in my slides, if you go back, look. So even though we engage with an external foundry as -- as probably over 50% of our revenue is generated through external foundries. We have all sorts of models how we work with external actual foundries, all the way from using whatever they offer. So that's standard technology access to embellishing those processes in conjunction with them so that they are more effective for our applications, to developing proprietary processes in their structures that only we have access to. So it fits within the foundry category, but it's only available to us. And we use some of those technologies for some of these applications -- these high-speed applications that were discussed by Greg this morning. So even though we run a foundry model, we get access to proprietary process technology through that model, and it is the best way and the most impactful and economic way for us to take advantage of some of those more fine-line processes. So I think we've got -- while there is a sophisticated wheel internally, there's also a very sophisticated wheel externally. And the simple notion that external means generic is not the model to think of. We put as much effort and as much attention into it, iterating what's available to us externally in conjunction with good foundry partners that we have that can actually be part of the product differentiation at the end as we put into circuit innovations.

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**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

So we've been actually, Tore, doing external fab procurement -- foundry procurement for 25 years, 27 years? And maintaining the edge all through that period of time. Now there is another side to the equation as well. Yes, more and more of what we're doing is going external, but we're actually building a lot of new internal capabilities as well, particularly on the sensor side of things. So that's where the material sets are unique. They are not easily fabricated on a foundry, so we build those things internally. So it's -- as Peter said, it's a huge mix of recipes and different models to build this complex analog technology.

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

It's our last question.

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**John William Pitzer** - Credit Suisse AG, Research Division - MD, Global Technology Strategist, Global Technology Sector Head, and Semiconductor/Semiconductor Capital Equipment Analyst

It's John Pitzer from Credit Suisse. Question for Greg. Greg, just going back to the Hittite IP and acquisition. At the time of the acquisition, the feedback we received from customers was very positive, great technology company in Hittite, now marrying with a much larger distribution,



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resource company of ADI. But just given the long product life cycles of Hittite, it was going to take time to be able to leverage that. I wonder if you could give us an update as to where we are in that design cycle. Hittite being able to leverage just the broader footprint they received with ADI, would we expect to see an acceleration of Hittite revenue here over the next, call it, 4 to 6 quarters?

**Greg N. Henderson** - Analog Devices, Inc. - SVP - Automotive, Communications and Aerospace & Defense

I won't steal Ali's thunder, who has slide on a little bit of that. but I can give you a little bit color and then Ali can hit some of the numbers later. But I think a few things first. Hittite, a little bit like Linear. We had a very broad portfolio, but unlike Linear, we didn't have that big a sales force. So there's been a big opportunity to put our products into the ADI channel, and where there's been a lot of leverage was at the big customers, because of the strategic relationships that ADI had that we didn't really have as much at Hittite because we were just smaller. So I would say that we have seen channel leverage. Again, there's a design cycle there, but we're starting to see that and Ali will talk about that in detail. We got a lot of design leverage because, again, Hittite was really good at the microwave and RF, but we couldn't go down to the digital part of the signal chain right through the data converge they were trying -- we were trying, but ADI brought that. So in these vertical market segments, the things I talked about automotive radar, military-phased array, communications, we've been able to bring those technologies together. So the first codesign products are coming out now, I would say, that we have as the codesign team. So we consider this to continue to accelerate over time. But we have the 2 benefits -- the same 2 benefits that Steve talked about. There's kind of the channel synergy and then the product synergy. And given that we're in that 3-some years, that product synergy has just started.

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

So I'd say, John, to add a little more color to what Greg has said. The Hittite franchise today is between 20% and 25% bigger than it was when we acquired it. So that's a mixture of the momentum that was in the pipeline and the new things that ADI has been able to convert and get synergy on, over the last, what's it, 3 years now. So I think that's probably the approximation for what's happened.

**Unidentified Company Representative**

All right. Thanks, John. Okay, folks. So let's move onto a break and when we get back, we'll talk about our consumer strategy and the new financial model. So give us about 15 minutes. It's 11:07. Let's meet back around 11:20.

(Break)

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

All right. Welcome home, everybody. So we have Yusuf Jamal. Yusuf, until a couple of weeks ago, was leading our consumer business. Today, Yusuf is actually leading 1/3 of ADI and all the associated engineering, maybe half depending on how you measure it. And so we'll talk about consumer specifically today. Yusuf will tell us about what we're doing in consumer, what the strategy is, how we invest our precious R&D to drive really good returns. And then after Yusuf is done, I'll come on and give you guys the new financial model. Okay. Yusuf. It's all yours.

**Yusuf Jamal** - Analog Devices, Inc. - Senior VP - Industrial, Healthcare, Consumer and IoT Solutions & Security

All right. You did half my pitch. I'm Yusuf Jamaal. I'm responsible for the industrial, healthcare, consumer as well as IoT solutions and security businesses in ADI. But today, I'm here to talk about our consumer strategy and how ADI's technology is transforming the user experience.

So ADI has quite a sizable and healthy consumer business where we use our core technology and our domain expertise and market focus to drive the transformation of the human machine interface and the user experience for the consumer. With the acquisition of LTC, we've added powerful capability in our portfolio and our customer relationships are stronger than ever. So over the next 15 minutes, I will show you what the consumer



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business looks like for ADI, why we think it's a good business for accelerating technology development, and how it drives technology leverage into industrial and automotive markets.

I will also talk about initiatives underway to diversify our SAM -- our playground, so to speak, and more importantly, how we win in this space. So there are reasons why ADI should not invest in the consumer market. It commoditizes quickly. There's a lot of volatility. One generally can't get paid for the value of the innovation, but I'm here to tell you today why ADI should invest in the consumer market, how we will drive long-term profitable growth in this market and by the end of my talk, if I'm successful, you will agree that this is an area worthy of our attention.

So consumer market is unlike any other market served by Analog Devices. We like this market for its velocity of new technology development, for driving innovation at scale and for the skills and capabilities that are developed as a consequence. The stunning financial returns we generate from playing in this space make it a very attractive market for us as well. So our strategy in consumers is quite straightforward. We pick difficult problems to solve. Because it's hard for us as a leader in this real world to digital world interface, it is near impossible for anyone else to do. Our goal is to keep finding more challenges that our customers need to overcome. So that's point number one, that we focus on the toughest, high-impact problems to solve. Secondly, and quite importantly, we focus on customers that value the differentiation that we bring.

We aren't cheap, and we will never be the lowest-cost player in the industry. Our strategy is all about enabling affordable differentiation. Now with those customers, we do not lead with a discussion on price. It is always about solving the most challenging, high-impact problems with affordable technology. The core technology already exists in many cases in our B2B markets and is cross-purposed at consumer velocity to drive ROI in the consumer markets. But the core thesis remains that we can drive leverage from our investments either into consumer or from consumer into the B2B markets. That is the third important point to note.

So when done right, the consumer business is a free cash-flow generating machine and we do all this in a constrained R&D environment, which drives laser focus on the business. We could do a lot more in the consumer space for short-term revenue growth, but we choose not to because we want sticky business with good margins over multiple generations. The key to getting it right is to take a broader perspective of technology and the application space, use the consumer velocity to commercialize the technology quickly and over time, enable technology leverage in industrial, healthcare and automotive markets in second and third grades. So we think it's a great market to play in.

So consumer business for ADI is about \$800 million, and we split our consumer business into 2 buckets: prosumer; and portables. Now within prosumer, we're talking about things like acoustic noise canceling solutions, SHARC, DSP and mid-power Class D for audio solutions, digital video for video distribution applications. Now it's important to note that these applications and products are very, very long life cycle, and with that, I mean, 7 to 10 years with above-average corporate profitability and very, very sticky sockets.

So this is relatively slower growth market, though. Portables, on the other hand, include everything from smart phones to tablets to wearables. Inherently, this is a lot more volatile space. Product life cycles are shorter, but we've got the ability to drive stellar revenue growth, strong ROI and strong free cash flow for the company. The core technology feeding this market is highly differentiated sensing and measurement platforms, power management and DSP. Combining deep domain knowledge with highly differentiated core technology to solve the most impactful problem for our customers, that's what transforms the user experience.

So let me share an example of this. ADI enabled a customer to harness the power of their smart audio filtering algorithms in a package small and low power enough to fit in our ear. ADI's technology gives consumer the power to hear just the sounds they want and ignore the ones they don't care about. With a variety of filter options from many real-world applications selectable from a companion app as well as the ability to adjust them on the fly, consumers gain an unprecedented level of control over the soundtrack of their lives. Wouldn't we all as frequent business travelers like to reduce the sound of a baby crying on an airplane in addition to canceling the engine noise? So this is just one of the examples of how our prosumers technology is delivering a new user experience.

Now you've had a long history in the consumer sector, but we were reacting to the market needs. So as a result, we made a deliberate strategy shift to target areas in consumer that would sustain over time. So we started investing in our user interface and portable imaging technology platforms, for example, which are the major drivers of growth in the portable sector today. Our approach to the consumer market today is quite different. It is a proactive approach.



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Over the last 5 years, we've had -- we're really focusing on the areas where our innovation is valued, where we can differentiate our position and where our precious R&D investments can drive growth for the long term.

Now the key to investing in the consumer market for ADI is to pick the right problems to focus on and develop technology platforms that span multiple generations and markets over time as waves of adoption materialize. All this starts with strong, differentiated core technology as the basis for these solutions. That core technology is the enabling factor for the solutions we develop, and it helps us play broadly while keeping direct R&D investments in consumer quite low. For example, our precision converter technology is the fundamental building block in our user interface solutions. The high-speed converter technology that enabled many, many years of profitable consumer business is now enabling differentiated depth-sensing solutions, which I will talk about in a few minutes. So as we deliver the technology into the lead applications, we deepen our domain knowledge. That knowledge, by the way, is absolutely essential to engage at a systems level in the later adoption markets like automotive, industrial and health care. And finally, the domain knowledge developed and leveraged in these markets uncovers the need for the differentiated core technology to drive the next wave of innovation, the virtuous circle, like -- as we like to call it.

So let's look at some facts with one example of that leverage, legacy analog video technology. This chart shows actual sales of analog video products over the past decade. We made spectacular returns on this investment with the consumer market up till 2010. As the consumer market for this legacy analog video platform started to decline, we drove growth in the automotive market and that story continues to play out even today.

We effectively made as much money outside the consumer as within the consumer market for this technology platform. This is what success looks like when we pick the right problems to focus on.

So let's shift our gaze from the rearview mirror to the future, with another example of technology incubated in consumer. Time of flight, which is a way to measure depth in a scene, allows us to do three-dimensional depth mapping. Now this is something we humans take for granted. But machines need to overcome that handicap as we move into a world of collaborative robots or cobots that Kevin had talked about earlier. Now depth mapping allows the camera or machine to understand where it is with respect to other objects in the physical environment, to allow reduction of safety curtains on factory floors, for instance. So in a different yet related application, immersive experiences in virtual reality require a high level of fidelity in detecting our real arms and fingers as we immerse ourselves in the virtual world. About 1/3 of our brain is dedicated to vision and small errors in that perception are picked up and cause a real experience albeit an unpleasant one with headaches and dizziness when the fidelity isn't high enough.

So the precision required to accurately sense ourselves in that virtual world is key to delivering a transformative user experience in this application. The same technology platform for reduction of safety curtains on factory floors could help high-speed drones avoid obstacles in very bright and very dark conditions. They can monitor the driver as a backup system in autonomous vehicles, much better than 2D cameras would be able to do today. Now these and many other applications we are yet to discover speak to the richness of this application space, of this technology and what ADI -- of the value that ADI will deliver.

Now since consumer adopted the technology earlier and on a faster clock rate, we're learning on an accelerated time line and now that learning has elevated our conversations with our customers from components to an application-level impact as we seed the technology into other markets.

So that raises the question, how do we choose where to invest in a market where technology is consumed and commoditized at a blazingly fast pace. So society is driven by human wants and needs. These wants and needs are also the drivers for consumers and the product that they buy to improve the safety, productivity, comfort and enjoyment in their lives.

In 2012, we undertook a vision engineering exercise with the best minds inside ADI and identified 7 megatrends that represent fundamental needs and were, therefore, expected to last for decades or longer rather than being short-term fads. So things like environmental and contextual awareness, personal devices complementing our senses; human-like natural communication and expression, voice as a user interface is a great example of that trend; Media and learning -- learning through an immersive experience in 3 dimensions instead of weaving words on a page into a picture in our minds; human-machine interface, machines adapting to humans, humans interacting naturally with machines; automation, as Kevin and Mark talked about with factories and vehicles, respectively; health and vitality, improve outcomes for the system while transforming the patient and consumer experience as the drive towards better health; safety and security, augmenting our natural defenses with better technology.



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We then mapped these 7 megatrends to technology and applications where wants and needs were currently unmet and people desired better solutions. These trends help us separate the signal from the noise in the consumer space. Now once we've identified a technology or application, we next evaluate if it will require a high-performance differentiated technology to solve a problem and whether customers care enough about solving this problem to pay for it. If so, we can be confident that ADI will be able to create and capture value -- significant value for our solution that will sustain over multiple generations. This, in essence, is our consumer strategy.

So let me talk about the initiatives to grow our SAM. Within the portable space, we've narrowed down our focus to drive success. So we've been spending a lot of time diversifying at our biggest customers and then broadly within the consumer space as well, with initiatives like spectrometry, advanced biometrics, voice of user interface and depth-sensing, as I just talked about.

Now our management capabilities significantly strengthens our base, but the same discipline will apply with power management as we've applied broadly to the consumer business. We will not take on every piece of power management business and consumer. ADI consumer strategy is a value play. Where we see value, we will play and deliver affordable differentiation to the market.

So while our portfolio has changed, our approach to the market stays the same. So we believe these initiatives together with the newly acquired world-leading power management technology enable us to expand our SAM by about \$1 billion.

So in summary, I would like to bring your attention back to a couple of points I made earlier in the talk. Firstly, ADI's consumer strategy of enabling affordable differentiation is working and is delivering results in line with our expectations. We're focused on solving high-impact, difficult problems for our customers in a high velocity market that drives stellar financial returns, while creating technology leverage into other markets.

Secondly, the consumer market is not a monolithic business. The portable and prosumer pieces are very different in nature. And the prosumer business is a lot like our industrial business with very long life cycles and very diverse set of customers.

Thirdly, we will not be shying away from consumer power business as long as it meets our requirements of difficult problems to solve in high-impact applications and partner with customers who value the innovation that we bring. So I hope I've given you a strong sense of why we're in this market, how this drives value for our investors and what we're doing to diversify and grow our business. Thank you for your time, and I'll hand it back to Ali.

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Great. Thanks. Well, done.

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**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

And now the crescendo. (inaudible)

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Okay. So for those who don't know me, my name is Ali Husain, I've been at ADI for about 13 years in a variety of different finance roles. Never in a million years would I think that I'll be standing up here presenting the new financial model but here we are. And I think you'll like what you're going to see. You've seen a variety -- I guess, you've heard a variety of accents here today from Ireland to the U.K. It's all over the place. And I'll introduce you to my mix of Pakistani-Canadian, which I think is a very unique accent, but don't hold me -- don't hold it against me.

Okay. That's -- by the way, that's Erik. Hi, Erik. Well, Erik is -- why don't you tell us, Erik? I introduced you earlier. So Erik, formerly of Linear Tech, ran their battery management solution business. I want to just identify Erik for those folks that are here, so that they can grab him and ask him all kinds of questions. And I'm sure he would be happy to answer willingly and happily. All right. Thanks, Erik.

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Okay, you've heard some great presentations here today. As the finance guy, let me try and bring a little bit of tough love into the room and maybe level set a little bit, because I think everything you heard today is very exciting. I think if you're a long-term investor, these are exciting themes to play. As the finance guy, I have a different view. I'm certainly -- I believe it, I'm there, great, but I share your view that in a lot of these markets it takes a lot of time. And...

Okay. Let's start this presentation. So we're going to put a nice financial wrapper here now on everything that you've heard. So for those that are new to the ADI story, let me just spend 2 seconds level setting. We're now a \$5-plus billion revenue company with the vast majority of our products, about 80% or so, coming from these very long life cycle sticky markets, like industrial, communications infrastructure and automotive.

If you look at the combined histories of ADI, Linear and Hittite, that amounts to over 100 years of high performance analog leadership, helping our customers solve some very, very tough challenges. You may be hard-pressed to see other competitors out in the space focused on high-performance analogs that have been doing this on a collective basis for as long as we have.

In addition, we now have the #1 or #2 position across all of the building blocks of analog, so a market leader. We have tremendous diversity in our business. We have 50,000 products that are servicing 150,000-plus customers, tremendous degree of sustainability and great constancy here as we progress.

And then lastly, and you saw in the quality of the presentations, there is just a whole bunch of these secular drivers that are going to be driving our business over the long term. And the mantra at ADI is profitable growth, free cash flow growth. So when you think about ADI, think about ADI under those 2 lenses.

Now if somebody woke up from 2007 and said, what has ADI become over the last 10-odd years, and again, this is excluding Linear. Over the last 10 years, the company has become vastly bigger. It has become vastly more profitable. Revenues have increased from \$2.4 billion to \$3.9 billion. Our operating margins have expanded from 23% to 36% as we pivoted to the highest value applications in industrial, automotive, infrastructure, for example. In addition, we have a series of operational efficiencies that we executed over this period of time that helped drive operating margins as well. And, of course, you do all those things and your free cash flow margins expand as well. And what that's done is we are now officially a top 5% S&P free cash flow generator. And I think you'll see today as we get to the end of this presentation, about our plan for driving these free cash flow margins even higher.

Now when you generate a lot of free cash flow, we've been returning a lot of free cash flow as well. So over that 10-year period, we've returned \$7 billion of our cash flow here to shareholders, to our owners.

Again, you do all of those things, generally speaking, the stock price responds. And so over the last 10 years, the ADI total shareholder return has been about 2x that of the S&P 500. So John, we talked about this earlier. There was question about Hittite.

So on the left side of this chart is had Hittite remained a stand-alone company, again, with the leverage that you get as a combined company. Hittite's revenues would have grown at a mid-single-digit CAGR since acquisition. The markets recall has been pretty flat since then, so we've outperformed the market.

Number two, the first codesigned products are now coming to market this year across these high-value applications of automotive, communications infrastructure and industrial. Again, there is a certain cadence to these products. It takes a while, but we're now starting to see the results of those investments. And I'd like to point out that the integration was very successful. If you look at the sales pipeline today, it is 2x that what Hittite's stand-alone revenues were back in 2014, leveraging the distribution channel, leveraging a vastly larger sales force.

On the cost synergy side, we've captured all of the cost synergies that we talked about. There is the Pakistani-Canadian accent coming out, talked about. And I think, importantly, on the integration side, we did employ this. I mean, you've heard this notion, you've heard this theme throughout today's presentation, "Taking the best of both." So we have adopted the best processes from both companies. We've adopted the best leadership from both companies and I'd say, overall, it's been a very, very successful acquisition and integration. And it's, I think, in investors' minds serves as



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a proof-point about how we think about M&A. By the way, this blueprint is exactly -- not exactly, but is really how we think about M&A and how we're thinking about the integration of Linear.

Okay, let's talk about Linear. On the left side of the screen is everything we told you when we announced the acquisition last July. There are compelling strategic and financial benefits to doing this acquisition.

Out of the gates in our first full quarter, we expect accretion from the deal to be 15%. I expect that to accelerate into 2018. And I think if you look at this on a 5-year period, you should expect to see even greater accretion from this deal. Secondly, we've talked about this before. Our TAM expands from \$8 billion to \$14 billion by virtue of the complementarity of our product focus. And lastly, there is a great deal of complementarity between our products, as I mentioned, our customer base -- our respective customer bases, I should say, and the various applications we play in. And you've seen it throughout today's presentations and again, I'm just -- I'm not telling anything you haven't already seen today, but a great deal of complementarity even in areas where you think they are not complementary. When you kind of dig under the covers a little bit, you see that they are very complementary.

So now we've acquired this \$15 billion asset. Vince reminds me, it's \$14.7 billion, but we've acquired this great asset. And I think in the minds of investors what we'd like to communicate today is how we plan to extract the value using your terminology, Charles, when we talked last. I think you do these types of acquisitions as we did in the case of Hittite for the purpose of revenue synergy. Now I know shareholders discount those, but let's talk about them, and we'll size up the opportunity for investors. Now inherently, when you do an acquisition, there are going to be cost synergies. There is duplicative activities, there's areas that you can scale up in terms of your purchasing power, for example. And we'll talk to you about that as well. And then lastly, I think in terms of the acquisition, we did take on a fair amount of debt and there is a really nice balance sheet deleveraging story that should provide tailwinds to earnings per share as we delever from the acquisition.

Okay, let's talk about revenue synergies first. So there are really 3 sources of revenue synergies: one is in the complementarity of the customer bases; one is in the complementarity of the applications sets that we plan; and lastly, it's to have more of a profitable growth focus to drive free cash flow. Steve earlier talked about this in one of the answers to the questions. I'll try and size it up for you here, but it's having a very -- a real laser focus on driving free cash flow.

Okay. So let's talk about the complementary customer bases. On the blue side of this chart, you see, this is stand-alone ADI. 60% of our revenue was derived from, what we call, the strategic and key customers, the large customers; 40% of our revenue was derived from broad market customers, smaller, midsized customers.

With Linear in red, you can see the flip is actually true. Vincent made a comment earlier about Linear sort of rifle-shooting areas where ADI wasn't playing. This is a great proof-point of that strategy with 70% of its revenues, almost a flip of ADI, coming from broad markets and 30% of its revenues coming from the larger customers. So in the larger customers, the opportunity is to sell more products. And the broad market customer is to sell to more customers and potentially more products.

We've already seen this slide. The gray area here is where ADI has historically been strong. The green areas here are where Linear have been historically strong. There are some areas of overlap, but even as we talked about earlier, even in areas where there is overlap, there is a great deal of complementarity. And certainly, from a product perspective, we, I think, talked about it ad nauseam about how complementary power is to the signal chain.

In the past, I'd say the Linear focus was primarily on profit optimization and who can blame them? They had best gross margins, the best operating margins in the industry. Our focus is not only profit optimization, it is also the optimization of growth and free cash flow. So I think as we look today on day 1 or day 1 plus, we're looking to shift this focus to drive growth, profits, and importantly, free cash flow generation.

So here is the opportunity. We've sized it up. There is up to \$1 billion of annual revenue synergies that we think we can drive from this acquisition. Now it's up to \$1 billion. We're likely not to get all the \$1 billion, but I wanted to make sure that we sized it up. This translates into an approximate 300 basis point adder to the stand-alone or -- sorry, the combined company revenue growth. I think that's an important point to make. I don't think it's 0. You do these -- the kinds of acquisitions ADI -- and I showed Hittite as the proof-point, right? So we have grown the revenue above the



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market. And I think there is a tremendous opportunity to drive revenue synergies. They'll likely start in 2019, but as you know, half of our revenue is from the industrial market that has a certain cycle to it, takes longer uplift. But I think we should start to see some of these synergies in the 2019 time frame.

Okay, let's talk about cost synergies. So we've always talked \$150 million of cost synergies when you bring the 2 companies together. Two points I'd like to make: One is we're firmly on track on those \$150 million of cost synergies. On a cost of sales side, we should start to see that benefit in the first quarter of 2018. On the OpEx side, \$20 million of the \$100 million run rate is now baked in to the guidance that we gave you for the third quarter. So there's an additional \$80 million on the comp there. And I guess, the other incremental is that we're upping the cost synergy target from \$150 million to \$250 million. The incremental \$100 million is to come from really -- taking a look at the combined company cost base, across really the entire business, all the operations, and that should start to kick in, in the 3- to 5-year time frame. In total, the \$250 million synergy here represents 8% of the combined company cost base.

Okay, let's talk about the capital structure. I know this is very important to a lot of investors. I think the high-level takeaway from this particular chart is, we have ample liquidity. Currently, we have \$2.9 billion of liquidity. \$1.9 billion of that is in the form of essentially cash, and there's an additional \$1 billion in revolver capacity. We, at the time of the acquisition or actually once we closed the financing, we had \$8.9 billion as our total debt load. As of the end of the second quarter, we made a \$200 million payment on our term loan balance. So now we're at \$8.7 billion in total debt. Of that \$8.7 billion of total debt, you can see the split on the right side of the screen, and really the takeaway there is that \$4.8 billion of that \$8.7 billion is in the form of term loans, and the remainder is in the form of fixed rate debt, bonds essentially.

Okay. Now when we announced the deal, we targeted a 3.8x net debt to EBITDA out of the gates. And in typical ADI fashion, we execute aggressively at those targets, and so we came out at 3x net leverage, which I think is significantly better. The plan is to pay down over \$1 billion of that debt per year. We have confidence in our model that we can do that, and maybe we can do a little bit better than that, but that's what we're modeling.

We should get to 2x net debt by the first half of our fiscal year '19, and that essentially is early calendar 2019. Now once we get to the 2x net debt to EBITDA, that will trigger a new capital allocation model. Now we've always held the dividend to be the cornerstone of our capital allocation policy. That will continue. The incremental news -- well, there's 2 pieces of incremental news: one is we're going to turn the share buyback program on once we hit the 2x number; and we're going to target free cash flow return of 80% to 100% of our free cash flow after debt service. So the way to think about it is every dollar of cash that gets generated will go to pay down the debt to the extent we can in that particular year. What's left over will go towards steadily increasing dividend and then depending how the stock price valuation is that we look at intrinsic value as well for our share buyback program. But overall, investors should know that we're targeting the 80% to 100% free cash flow return after debt service as soon as we hit the 2x net debt to EBITDA.

Okay. So here is the summary of what we plan to do over the next few years. We've already talked about the \$250 million of synergies. Here's the time line. We've talked about the up to \$1 billion revenue synergy opportunity starting in earnest in 2019. We've talked about the \$1 billion plus per year debt paydown to get us to a 2x net debt-to-EBITDA number, somewhere in early calendar 2019, at which point we'll reinstitute the share buyback, and we're going to continue growing the dividend between now and then and beyond. And like I said, the target free cash flow return is 80% to 100% after debt service.

Okay. I'm getting close -- we're getting close to end. I wanted to give you a bit of context around how we're thinking about our revenue growth over the mid-to long term.

You've heard some great things today. And what I wanted to do is give you a little bit of context on how we're thinking about the revenue growth buildup. By end market, we think consumer and communications infrastructure can grow up to the mid-single digits. In automotive, I think there's a real tailwind there, so we think we can grow that market up to 3x the SAR. And in industrial, I think, just based on the crop of new products that are coming out, the investments that we've made over the last 7 to 10 years that are now starting to bear fruit, we feel very confident about that particular number. All told, that will add up to somewhere in the mid-single digits over the next several years.

Now we consider that to be a base growth rate. We consider that to be in a GDP environment that we've frankly been in over the last few years. There's additional growth drivers that we think we'll get, but we have not baked in to the mid-single digit growth rate, Linear Tech-related revenue



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synergies, for example. Half of our business is in industrial, it's very sensitive to CapEx and GDP. If we get into a stronger GDP environment, we should do better. And the other thing I'd point out is, you saw the quality of Yusuf's presentation on consumer. There are a plethora of opportunities to drive revenue growth that's profitable, that will generate a lot of free cash flow. That would be incremental to this number.

Frankly, we've been investing in the markets that we play in at a pretty healthy clip, and so we expect to see these kinds of growth rates. And I'd say it's not some kind of a pipe dream either. We're seeing the products coming out, we're seeing them taking a hold of the marketplace. So that gives us a fair amount of confidence that we can do this. And boy if we can't do then we have a problem.

So let's talk about how we're thinking about the various pieces of the long-term financial model. We already talked about mid-single-digit growth. We already talked about the areas for upside. On the gross margin side, we're targeting 70-plus percent gross margins, and so it will be somewhere around there, maybe a little bit better, but at the low end, it'd be in the 70-plus percent range. At that kind of gross margin model range, we're still leading the industry, And I think for the investments that we've made, for the areas that we play in, for the value that we create for our customers, I think that's a testament to the value that we can generate.

On the operating margin side, we expect operating expenses to, of course, lag revenue growth. And so we're targeting operating margins to be in the range of 39% to 45% over the next few years. I would view that as more of a journey rather than an absolute -- we're not going to get to 45% operating margins tomorrow. But I think based on the inputs that I just gave you in the various slides, I think over the next 3 to 5 years, could we get there? I think so.

In terms of how we're thinking about earnings per share and free cash flow growth over the next several years, if you plug in all the inputs I just gave you and boy I did because I jockeyed the excel myself, that should generate earnings per share of free cash flow growth per year of 8% to 12%. Assuming a 2% dividend yield, that is 10% to 14% annual total shareholder return, which, I think, is pretty meaningful for investors.

On a free cash flow margin basis then, we think we can drive free cash flow margins of 34% to 42% of revenue. These would be industry-leading free cash flow margins at the high end of the range. And again, I view this more as a journey over the next 3 to 5 years. I think we can get to the high end of that free cash flow margin model range. And we talked about incremental leverage to the top line and those, again, would be incremental levers as you think about the P&L.

And then we've already talked about how we're thinking about the capital allocation model. 80% to 100% of our free cash flow returned after debt service as soon as we have the 2x net leverage ratio.

So let's bring it all home. This is why we're all here. Okay. This is it. This is the slide. You want to invest in ADI, this is the slide. So number one, market leader across all high-performance analog product categories. We talked about that. We've got growth drivers across, really, all of our markets. We have up to \$1 billion of revenue synergies, and we have \$250 million of long-term cost synergies that we have identified. There is a tailwind to EPS simply by virtue of deleveraging. And so there's a fair amount of self-help levers, I would say, as some of the sell-side like to refer to it. And then, again, we're targeting this very strong free cash flow return after debt service.

So overall, let me read from the green bubble: high-performance analog leader driving long-term profitable growth. So with that, I'm done with the official piece of the, I guess, today's presentation. We can now move on to the Q&A session. I'd like to invite Vince up on to the stage of ours and you can ask questions of either Vince or myself.

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**Tore Svanberg** - *Stifel, Nicolaus & Company, Incorporated, Research Division - MD*

Thanks for doing this, very informative. Ali, you mentioned the Linear Technology synergies, 300 basis points of help starting in '19. Was that an opportunity? Or you're basically saying that you can grow mid-single digits with the Linear synergies, you've been out to get to maybe...

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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

No, what I'm saying is the incremental. So we've -- based on how we think about -- if you just take the 2 companies and combine them and did nothing else to leverage the sales channel, did nothing else to leverage distribution, we think we can grow this business at a mid-single digit rate. If we do get those revenue synergies, then we should grow better than that.

**Tore Svanberg** - Stifel, Nicolaus & Company, Incorporated, Research Division - MD

Okay. And then as my follow-up, you didn't mention M&A at all in this presentation. I was hoping you could elaborate a little bit on that, and especially focusing a little bit on what are some of metrics that you guys look at internally, especially returns metrics for M&A?

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Yes. Good question, Tore. Yes. So we've got our hands full right now, integrating LTC so that's our priority. But we're all the time scanning. We have a kind of a 2-pronged M&A strategy. We've done a lot of tuck-in acquisitions over the last several years, and we'll continue to look for those opportunities. Those are kind of further out, typically. These are more technologies that are synergistic with the strategy of the company like the LIDAR thing we talk about. So we will continue to do those. But everything we've presented here today is really about the combination - it's organic. It's about ADI and LTC together, and that's what we're basing this entire model off of.

**Unidentified Participant**

I think -- a question about the leverage. So it sounds like you're planning to get to 2 turns, but after that, continue to pay down debt. I just want to make sure I understand, you're going to be -- with that capital allocation strategy, you're going to get below 2 turns and should go down, presumably, to 0, over time, and I know you have to be prepared to do that, but how do you think about that relative to reducing your total cost of capital (inaudible)?

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Yes. So let me turn it back to -- maybe Vince can add as well if he'd like, but I think as we're -- we just did the fact -- we just completed the acquisition a few months ago. This is our current thinking. We think we can pay this debt down -- and again, remember \$5 billion was term loan. The remainder up to \$3.9 billion is still going to remain in the balance sheet for 5, 7, 10, 20, 30 years. I think we're probably going to keep some leverage on the balance sheet, no doubt. The other thing I'd tell you is as we get into the 80% to 100% free cash flow return, we still intend to have our current free cash flow generation model, where 1/3 of the cash flow gets generated onshore, 2/3 gets generated offshore. So as a result, we're returning 80% to 100%. By virtue of doing that, you would see some of the leverage building up on the (inaudible).

**Harlan Sur** - JP Morgan Chase & Co, Research Division - Senior Analyst

A question here. Harlan Sur with JPMorgan. Thank you for putting on this presentation today. With the \$1 billion of annualized synergies, starting 2019. Obviously, I'm sure you guys have put a lot of thought into this. Can you help us understand sort of -- I know some of the design cycles are a lot longer for certain segments. So help us understand over the next few years, where we start to see the synergies starting to roll in from an end market perspective?

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Yes. Good question. So clearly, let's say the ones that are more tangible right now are in automotive. For example, where we talk about a little earlier on, the combination of LTE's power with our Advanced Driver Assistance radar technology, LIDAR, of course. So I think in terms of being able to get to a run rate in a predictable -- as predictable as things can be, I think that's clearly one. There may be some areas of consumer where



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we have the product and technology, where we can create attach with -- in attractive opportunities. I would say as well in the communications infrastructure area, in 5G systems, massive MIMO, where, as I think it was Steve or Greg talk about, there's a huge amount of the radio board space today consumed by power. So that's a big opportunity for us, given the advanced power systems that we can bring to play. So I think those are the big ones -- the big tangible ones. And then, when it comes to industrial, it's hundreds of applications, many, many hundreds of different products, that will probably -- and just given the ramp cycles as well, kind of probably take a bit long. Yes, Ross?

**Ross Clark Seymore** - *Deutsche Bank AG, Research Division - MD*

A couple of quick ones for you. On the free cash flow return, one of your bigger competitors set a really high bar with that 100%. It's good to see you guys hitting up against that theoretical limit as well. One advantage they tend to have is a lot of that cash is actually onshore. They don't have to repatriate things. Historically, that's not been the case with either you or Linear. So can you talk about where your cash flow is generated? And maybe even talk a little bit about the tax rates that the company will pay over time?

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

Yes. I think I answered a part of that when I answered Will's question. We have generated about 1/3 of our cash onshore, 2/3 offshore. I think that will continue to be the case. From a tax rate perspective, we've guided to a combined company tax rate of 15%, and so I think that will continue to be the case as well. It's an interesting philosophical question. If you get the higher tax rate and all the cash or you're not. You're the opposite. I like what we're doing. Because I think it offers a pretty nuanced and a pretty rational and a reasonable approach to it. We like having a competitive tax rate. And I think as we've shown, we've had the ability to either raise debt in the U.S. or in the case of acquisitions, to use our global cash reserve to pay for deals, and do that in an effective way. So I'm not keeping score, by the way, I don't know. You guys are running the Q&A. So keep it casual.

**Unidentified Participant**

I had a question on the consumer business spend. Thanks to Yusuf for putting it in perspective on why you should be investing things like you should be, given the ROI target you had. I just wanted to get it back to more medium term over maybe the next 1 year or 1.5 year. And Ali, tying it back to the presentation you had, you said the other would be large-volume consumer wins. I'm usually the last one to find out, but it sounds like you don't have anything, so would it be prudent post the next fiscal year, we should all have 0 in that adder that you have there?

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

Yes. I don't know if it will be 0, but I think the way to think about it, I think -- and we've talked about it a little bit on the earnings call a couple of weeks ago. I think we're probably going to be in a period of slower growth in the consumer market. And my sense is that 2018 is probably going to continue that weakness. And I've seen people put out notes down 20% to 30%. I mean, that's probably as good as any other number out there because we, frankly, just don't have the visibility, but the consumer business is likely to be down next year. On the flip side, all of the earnings related to that particular market should be replaced by earnings from the acquisition. And so your taking away consumer EPS, replacing it with industrial and automotive-type EPS. And so 2 points is, one, is kind of this notion of EPS replacement. The other notion I talk about is just simply by doing that, you mix the B2B markets with (inaudible) in order for to have more investments to add more -- the higher valuation from what I hear.

**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

I think, very hard to predict consumer in a short period of time, but I think it's reasonable to assume we can grow that businesses mid-single digits for a long period of time, just given the mix of businesses that we have. As Yusuf said, we've got this more B2B part of consumer that is very fragmented in terms of product and customers, highly profitable. And the portable part is the piece where the volatility is strongest. So -- but I think that's the way to look at it, rather than trying to predict what it's going to be in the short term, overly kind of medium, long-term, even without some of the bigger, more quotable orient of things we're working on. Mid-single digits is a reasonable target.



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**John William Pitzer** - *Credit Suisse AG, Research Division - MD, Global Technology Strategist, Global Technology Sector Head, and Semiconductor/Semiconductor Capital Equipment Analyst*

A couple of questions. I'll blame this question as a reflection of some of the questions I'm getting from your investors and owners, but a couple of things. First, the observation. You must be so concerned about hitting the original synergy targets for the deal that upping by \$100 million just to raise the bar, make life more difficult for you. But that being said, Bob Swanson did leave the board in relative short order. And I think there's a lot of investors out there who look at that data point as perhaps the integration is not going that well, so maybe your commentary around that departure. And any update on the CFO search would be helpful?

**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

Yes. Okay. Thank you. Well, I think, in terms of Bob Swanson, what we put in the 8-K is -- that was written by Bob. So -- I've nothing more to say, really, than that. Bob remains very, very interested in the combined company. And obviously, the legacy that he's built. And he's offered to be available at any time, to offer advice and wisdom, and I have a connection with Bob as many others have. So there's really nothing more to say than that. I think Bob is at a point in his life as we've already said. I've built a great Company. I've been deeply involved for 36 years, and it's time to do something different. So I think it was very much a personal decision for Bob. In terms of the CFO search. Again, I don't have much to say beyond what I said at the earnings call a few weeks ago, but we're making very good progress in terms of the search. And what I had said at the outset is that, I expect to have a very, very good solution placed by the end of the fiscal year, hoping it will be sooner, but I'm sticking by that, so I think we'll have a very, very good answer. What I can tell you as well is that, you look at the quality of the staff we've got in the financial team, in accounting, financial planning, treasury, IR. We've got (inaudible) in this company, and we're well on track in terms of the integration activity. We have tremendous consistency there. The people who worked on the integration of Hittite are the people who are working on the program management of the LTC and integration as well. So things are working well, [John].

**Unidentified Participant**

I guess, 2 questions. One, on the incremental \$100 million of synergies that you guys are talking about. Just talk about this -- is that really manufacturing synergies? And what the split I guess, from OpEx versus (inaudible) of that incremental \$100 million?

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

Well, I think -- look, I mean, it's 3 to 5 years out. We have a pretty good sense of where it's going to come from, but I think it's premature to talk about it. But I think the way we're thinking about is \$100 million is a good number to use over the next 3 to 5 years. And I think over the next few quarters as we get our thinking around the exact parts, we'll be sure to update you.

**Unidentified Participant**

Please, if I could follow up. The last Analyst Day you guys did a few years back, the discussion was free cash flow EPS growth of 8% to 15%. I think today it's 8% to 12% despite the Linear integration itself. Why is the high end getting taken down?

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

Yes. I'll answer that. So one point I'll make is we delivered on that, okay? The other point I'd make is, when we gave the model at the last Analyst Day, we were talking about a 2x to 3x of GDP growth rate at the topline. It's a very high-level growth rate number, without a lot of context. I think what we've given you today is just a tremendous amount of context around how to think about the growth rate for the company. So at a mid single-digit growth rate overall, we're not growing 3x GDP, right? So it's a hedge down number, I guess, from that perspective. So there's nothing



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that changes but actually it would be -- it's better. You can run the math in your model, but 2x to 3x GDP at that point in time was 6% to 9%. And now we're talking just single-digit growth there. Apples-to-apples, exactly, I would think better, to your point.

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**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

But we will not constrain ourselves as well.

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**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

Yes. It's a good question. The one that we did contemplate on the Q&A right before we came back. We knew somebody would ask that question.

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**Unidentified Participant**

Just a question regarding Linear and how you intend to operate it differently. And I think somebody said in the past, perhaps Linear would have grown in the top line faster. Have they taken a different approach? Consumer is one example, right? It sounds like you are willing to take a different approach, is that a situation where, perhaps, some of the business you take from Linear would be lower gross margin, accretive to operating margin going forward. How should we think of that? And what sort of pieces of business will you take that perhaps the Linear management team would not take on?

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**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

Yes. I think #1, when you talk about margins, the markets in which you play largely determine what kinds of margin you can get, what the extremity of that is, and then the quality of the innovation that you're putting in place. So I think clearly, we are focused -- across the portfolio, we're saying that financial model will govern our decision ultimately. But there will be a mix of margins that we can take in different markets with different kinds of products in different applications. But the end result we'll hit this target. So what people are going to be focused on is think of a growth in operating margin first and foremost. And if we do that in the markets in which we play, we'll be able to hit the targets in this P&L. So we will be flexible in that regard.

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**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

And the other point I would make is, if you remember, Linear Tech, on a stand-alone basis at 45% operating margins, had a \$1.5 billion revenue run rate. If we execute like I know we're going to be able to execute over the next 3 to 5 years, the combined company will have, I'm hoping, 45% operating margin at a vastly higher revenue base. So that's what we're driving towards is revenue growth, profitability, driving operating margins higher, driving free cash flow.

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**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

Sure.

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**Unidentified Participant**

And on the way to that target model, how do you manage your OpEx? Because you're making assumptions your mid-single-digit growth rate, it doesn't include some of the revenue synergies you might get.



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**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

It doesn't. Right.

**Christopher Caso** - Raymond James - Analyst

Right. So how should we expect OpEx to grow in that period? Recognize that OpEx comes first, and the revenue growth comes second?

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Yes. We have a rule of thumb that we don't grow OpEx at more than half the rate of growth. That's the rule of thumb.

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

So I mean, I think the take away, is, [Chris], look, we've been in this business -- been in this industry a long time. We know how to manage the business. If the take away is simply, look, the OpEx is kind of like revenue growth, and it should provide stellar leverage to the model. And at the end of the day, it ends up driving op margin, free cash flow margin. So how do we get there? Leave it to us, in the sense. Like, we'll manage that, but it's really at the end of the day about driving operating margin and free cash flow. If I can come to you 3 to 5 years from now, Chris and tell you, we're now a, I don't know, \$6 billion, \$7 billion revenue company at 45% operating margins. We essentially took the best of both. Linear has stellar margins. We converted that to a much larger company. I think that would be a great result for investors.

**Unidentified Participant**

Question for, actually, Yusuf. Yusuf, you put up a slide talking about 10% R&D for your business. Is that the target for your business? In other words, compared to whatever it is 18%, 19% for ADI? You spent 10% in our business? Or is that what you spend as a percentage of the total R&D budget?

**Yusuf Jamal** - Analog Devices, Inc. - Senior VP - Industrial, Healthcare, Consumer and IoT Solutions & Security

So the way I like to look at it is, whatever number you pick, if it's 8%, 10%, 12%, that core people behind it is laser-focused on the business. And that focus provides the filter to let only the most difficult problem come through to the top. So as we look at it, we really protect the winner on 10% off the consumer sales to invest in that business. And the reason for that is to bring a level of discipline into it. We could spend a lot more. But like I talked about, we don't want to because we want to take only the part of the business that are high value and that are very sticky.

**Unidentified Participant**

And one for you guys. So 80% to 100% of free cash flow to be returned to the shareholders, why not keep some of it back. You've had some tremendous acquisition. Hittite, you talked about the success there, talked about Linear Tech, would it not make sense to talk about another Linear Tech in 5 years rather than give the cash back?

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Well, I mean, I think we're focused right now on 2 things, okay? We're focused on integrating this acquisition with the best of our ability. We're focused on deleveraging the balance sheet with the best of our ability. As far as we can tell, those are the 2 things we're focused on. So as we stretch out to the next 3 to 5 years, that's as best we can tell you is that we've got this model to return to free cash flow number that we gave you.



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**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

And there aren't many Linear Techs out there.

**Ali R. Husain** - *Analog Devices, Inc. - Director of IR and Treasurer*

How are we doing folks? Are people getting hungry? Not yet?

#### Unidentified Participant

Just a quick follow-up question for Yusuf on the consumer business. You talked about taking IP developed in consumer and kind of trying to leverage that into other end markets. When you look at some of your largest consumer customers, the Cupertino customer, the Googles and Amazons. You could make the argument that they are starting to broaden out their own sort of activities outside of what was traditionally maybe just bubbles. So how important is that for the consumer business to be engaged with these large customers to try to drive opportunities that those larger customers grow out and do more things?

**Yusuf Jamal** - *Analog Devices, Inc. - Senior VP - Industrial, Healthcare, Consumer and IoT Solutions & Security*

The ADI thinks is its diversity. Now it's diversity of technology, diversity of market, the diversity of customer. I won't comment on specific customers, but the whole world is changing. What we call consumer by the time we're done with the definition, the definition changes. So the way we're looking at it is, without the application and the problems that drive development of technology at an accelerated pace. And who are the customers that are at the leading the edge of that? And that's where we engage, and that's where we play.

#### Unidentified Participant

Yes. I actually also had a question. Maybe I can ask a little bit differently. So when it comes to consumer business, do you actually try and anticipate what your customers are going to working on and you spend a lot of effort there? Or are you more waiting for them to come to you and say, "Hey, we're looking at this investment design. Can you help us out?" Because I think from our perspective, even though you kind of quantify the R&D, it's still difficult for us to fully capture how much you're actually investing in your customer's roadmaps from an R&D perspective?

**Yusuf Jamal** - *Analog Devices, Inc. - Senior VP - Industrial, Healthcare, Consumer and IoT Solutions & Security*

Yes. So I think the second part of your choice, which is customers. We take something that we've done and go to customers and see what they want. That's much more reactive mode. And while maybe in some instances that might happen. Our dominant strategy is to really slide back to those mega trends that I talked about. Because that is what's driving even our customers and their customers. If you're aligned with those spends that our core technology investment to put in place, eventually pay off. And the customers starts coming to you for the right solutions if they know you've built the domain expertise in that area. I would rather see it as being driven by those trends and us making those choices in a much more reactive approach than we might have had in the past.

**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

I'd say in this particular area -- story, more and more of the engagement is early, and it tends to be about the capability that we've got versus what the customer is looking for. So it's a much earlier engagement. And we have to get ahead. We have to have the capabilities ahead of the need. And thus, I think what Yusuf was just (inaudible).



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**Unidentified Participant**

Operating margins, the range is a bit wide. But can you just maybe walk us through what gets it to that low end and the high end? And then, maybe just a more philosophical question, at the high-end of this range, do you think semis as an industry is structurally over-earning? Or do you think there are reasons why folks like you all are and several of your peers are at these ranges of operating margins and (inaudible)?

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Go ahead and -- you go -- okay.

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

We've spent too much time together, since we already know which questions we going to answer now.

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

Yes. We should just (inaudible)...

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

Okay. So yes, look, on the operating margin range. I think if you dial in everything we just give you, I think over the next 5 years, you're likely to get to the higher end of that 4% to 5% (inaudible) but we gave you guys a range. So you don't have to manage this every quarter, but I think that's a reasonable range. Given that I think about it as more of a progression for us than just simply, overnight, we're going to flip on a switch. I think as you think about the progression over the next 3 to 5 years, those are the types of margins that you should expect to see from us. Okay.

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

So I think there are kind of 2 parts to the kind of operating margin optimization. I think one, our innovation value is increasing. We're getting more ASP as a company. LTC was getting more and more ASP as well. So that helps. And I think from our perspective as well the market in which we're playing enable us to get the kind of long-term returns that we expect. Also, I think just in terms of the consolidation of the industry over the past 5 years or so stabilizes things. It gives the consolidators more buying power, more selling power. So I think that helps, at least from emerging.

**Unidentified Participant**

Consolidation and margins have gone down, not up. So consolidation by itself doesn't necessarily...

**Vincent T. Roche** - Analog Devices, Inc. - CEO, President and Director

No. That's right. I think you -- that gets you so far, and then you reach your terminal limit, but you have to innovate. You've got to be able to grow.

**Ali R. Husain** - Analog Devices, Inc. - Director of IR and Treasurer

So looks like we are done. Well, listen, thank you very much. We really appreciate you all coming out. Specifically, given all of these weather patterns, and it's just been very tough for a lot of folks. So we really appreciate you coming out.



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So just in terms of how we're managing the rest of the day. We're going to go down and have lunch. Just come out here and take a left. We'll have lunch, and then about 30 to 40 minutes later, we'll start with the product demos. It's just close by there as well. And the rest of the day is really up to how you choose to spend it.

We're here all day. We'll have our products here. We'll have our engineers, both from ADI and Linear. And the day is yours. So seize the day. All right. Thank you, again.

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**Vincent T. Roche** - *Analog Devices, Inc. - CEO, President and Director*

Thank you. Thank you.

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