# Analog Devices Inc. (aux.)

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HARLAN SUR:   Welcome to the afternoon session. Again my name is Harlan Sur, semiconductor and semiconductor capital equipment analyst at J.P. Morgan. We're very pleased to have the team from Analog Devices, here with us this afternoon. Joining us is Martin Cotter, vice president of Healthcare and IoT.

We also have Ali Husain, head of investor relations, joining us as well. What I've asked Martin to do, is to provide us with a brief overview of his responsibilities at Analog devices, and an overview of what his team is showcasing here at CES this year. I'll kick it off with the first few questions, and then we'll turn it over to the audience for any other questions.

Martin, Ali, thank you very much for joining us this afternoon.

MARTIN COTTER:   Thank you Harlan. In terms of the whole IoT position for ADI my responsibility is healthcare and when you look at the IoT strategy for the company, with our history in industrial and our history in measurement, it's a very natural place for us to be.

We're seeing this picture of problems we can solve due to that 50 years of analog processing, that 50 years of insight into the measurement as being exactly what solves problems in the IoT space. So I'm in the exciting position of having that responsibility for the company.

We are committing a lot to the domain-based insights into each of those particular problems whether it's in the industrial space, or the healthcare space, or maybe later on in the automotive space.

The combination of different sensing technologies and the context of sensing is really what we see as making the difference as each of these different businesses, in smart city, in healthcare transform with different ways to change from CapEx type models to different OpEx models.

We're seeing the early space here in consumer and fitness, healthcare systems being the evidence that eventually we'll get to that bigger problem that we're solving. So I think it's certainly

a very exciting time for us as we define a more specific domain investment together with our customers in this space.

HARLAN:   That was a good introduction, thank you for that. The team has called IoT the third wave of computing, or ubiquitous sensing. Martin can you just translate that for investors from the perspective of what does that mean from an IoT applications perspective, and more importantly, what does ADI uniquely bring to the table in terms of portfolio and expertise in IoT?

MARTIN:   Sure, yeah. That picture that you see in terms of the first two waves, difference in those waves was it wasn't that relevant for ADI. You had the computing wave which was a lot about the processor, the big processor and getting to integrate more along Moore's Law. You look at the second wave going to mobile devices, that's not a space that ADI really plays in.

But if you look at the history of that 50 years of measurement, on the industrial problems and healthcare problems, and the things that will really make the difference long term, that's where ADI has always had expertise, that's where our technologies lay.

The technologies that really make the difference there, sensors and the ability to extract more insight from a particular sensor, measurement in all its forms between the interface of the sensor, optimizing that local processing for the sensor, and trying to transform it into information that does something, makes a difference to a problem.

We would have strong technology in any AFE problem that you find in any processing problem locally at the node, we're investing quite heavily on low power microcontrollers that would go close to the sensor, and we believe when you couple that with more efficient local transmission, that optimizes the whole sensor to the cloud problem that we see.

The early generations in IoT would be really trying to sell more dumb sensors, and we don't think that's really the business model that wins in the end, so we think that what makes a difference in terms of the end problem is optimizing that processing at the node, optimizing the measurement, and then getting to the data analytics of the cloud reflecting back on that measurement and that optimization.

We think that's really what's going to make the bigger problems in each of these businesses generate value.

HARLAN:   I think that's the critical differentiator for ADI. Martin maybe you could tell us more about this concept of this dumb sensor versus this smart sensor, and why it has been quite inefficient to have this sort of dumb sensor model, and maybe tell us about it.

MARTIN:   The truth is 80 percent of data that gets captured is never used. So it gets captured, it

gets transmitted, all that takes power. So each case you flood the networks with data, you store all that data, and nothing much gets done with it.

We don't think that generates the greatest value, it certainly is not the optimum power solution at the node, it doesn't get to have the most efficient latency to generate a measurement that might be time critical at the node, and in terms of the overall solution it doesn't get to extract that real information, the real insight from the sensor because of the flood of data and the real insight gets lots.

Rather than do that, we would think that the second IoT wave is going to be more based on having that tight insight into what's being measured and the problem that it's solving, optimizing that at the node and just transmitting the information that really makes the difference to the end problem. So I think that effect will be the difference, I believe, that you are referring to. That's what we see as being the true value that we're investing in.

HARLAN: When you think about that value proposition, map that, map that to us in terms of your product portfolio. So obviously sensor, you've got to have something that converts real world to digital, so that's your leadership in A to D and D to A converters, you mentioned MCU, talk about that signal path and the building blocks that ADI has to drive this initiative.

MARTIN: You could, from a sensor point of view, we've been in medical devices [inaudible 7:07] for many, many years. A tough problem to solve and we've solved it with the lowest power you can get on the market.

You look at the next generation of heart rate of even spectrometer if you want to recognize materials, you want to recognize devices, that usually goes to an optical sensor. You've got requirements galvanic resistance, look at stress analysis for healthcare, again that's ADI's space.

Transforming each of those sensing modalities, temperature, look at temperature. Transforming each of those modalities into an actual piece of information, it's more than one of those sensing modalities that effects the value of that piece of information.

For example, if you want to get good heart rate, you've got to reject motion. You want to know what the core temperature of the patient is, you want to know a lot of context, maybe humidity is required.

I'm wearing a sensor device here that checks humidity, checks the temperature of the room, and it also will get my position anywhere in the show area. It goes up to a service we have in the cloud, it's one of the things we're demoing at the show. We see that the combination of the different sensing devices is a space where AFE can really make a difference, if you want to make low power you've got to be able to combine those together efficiently.

Having embedded micros, embedded low power micros at the node gets you that real multiplier of value. So we for many years, we have low power micros embedded in our devices. Almost all of our advanced integrations would already have a very optimized microcontrollers.

Similarly when you want to transmit to the cloud you need to do that efficiently so one of that sub-gate kind of radios which would have differences of seven kilometers or more going to, our history has been in large infrastructure, wireless communication at the aggregator we've got some technologies that can reconfigure radio solutions to cover any spectrum that you may require to do.

With our investment in [inaudible 9:15] we believe that as we get to 5G, you get into the 30 gig kind of range for the infrastructure wireless network, so we're well-positioned to cover all of that space getting from the measurement, optimizing that for information, and then just sending that particular piece of information to do something really impactful with analytics in the cloud.

One piece I should mention is that we're investing very heavily in algorithms to go with our sensing devices.

Part of that may exist in the cloud to get you extra knowledge, and part of that will obviously exist locally. So we believe that's pretty much the optimized signal chain, and that's our approach with is we're well positioned with a broad array of technologies as they combine in industrial, healthcare, and eventually in automotive. So I think that a lot of our technologies apply to IoT as it evolves.

HARLAN:   I think it's kind of an underappreciated aspect of the ADI team in sort of this IoT space is the fact that you've amassed this portfolio of key building blocks to enable your customers IoT applications and I think it comes probably as a surprise to me and to many investors that you've got actually solid MCU and connectivity capabilities.

So maybe starting from there on the microcontroller side, it's an embedded solution, I'm assuming it's embedded in some sort of SOC-type chip. Can you give us more details? Is it 16-bit is it 32-bit, is it MIPS, ARM, proprietary, what type of MCU product family is this?

MARTIN:   Typically it would be low power 32-bit ARM core, so M3, M4 kind of technology. In many cases you have more than one, so there may be one that optimizes the sensor itself. We have to make sure that any aspect of security in anything that's programmable gets taken care of.

As that evolves we can see that we can leverage that external ecosystem. Also it gives us opportunity to go even further than that, because in many cases security may be tied to the signature of what's being measured itself.

We think that's a very exciting area, and we think we're well positioned to be able to exploit that as you go forward. For example, if you've got two patients and you want to know that, even measure to the same device, it's a specific patient, it can be secure from the measurement, from the sensor, but maybe at point you need to also be able to tag to the particular patient itself.

We think the area of security in terms of standards, it has a huge amount of runway to go, but also in terms of even connecting it to the measurement itself we think is very interesting in terms of what we can do.

Then you take that and you want to transmit that to an aggregator of some sort, Bluetooth is typical, and we would in many cases have a Bluetooth radio or in some cases in industrial applications, it may be a thread protocol run on a sub-gate radio which also we would have with a very good sensitivity on to be able to get good distance from.

Optimizing the power is about getting the most out of the analog processing and making sure that you don't spend any microwatts on anything that's not needed. That's what we don't sell a broad array of microcontrollers, that's not our business. Our business is optimizing the full solution sensors to the cloud.

HARLAN:  On the connectivity side which is again, could be another certainly a surprise for me, you talked about Bluetooth but when I think about connecting nodes, end points to gateway or gateway to whatever data analysis repository, I can think of WiFi, I can think of Bluetooth, I can think of more near-field NFC type stuff. ZigBee is used more in industrial applications, do you guys have the full portfolio of wireless connectivity building blocks?

MARTIN:  We have the portfolio of technology, we don't necessarily supply every piece of that space, and by choice in some cases. We have a wide array of partners that we would work with and most of those cases where there is an advantage that our technology can generate, we don't typically have any barrier to generating that.

For example in cases where industrial applications want to have very secure connections, want to have very long distances, we would have our own proprietary radios.

In cases where for some clinical healthcare solutions, we're investing in some particular proprietary radio solutions there. In cases where we can use an external solution that is widely available, we would in many cases either license that or else use an external component. So I think in cases where we see areas that we can generate value we invest to solve that problem.

HARLAN:  From a hardware platform perspective for IoT it seems like you've got a full platform approach. You talked about algos and having algos, what about the software piece of this? What is Analog done to build more differentiated barriers around its IoT platform with software

solutions?

MARTIN:   That's a great question. If you look at the way the conversation has changed at ADI in the last few years, a lot of it has been around the need to leverage the mixed signal technology together with algorithms, and they typically are more domain-based algorithms.

For example, if you want to get the types of people we're hiring now would tend to be specialized skillsets that are non-semiconductor to drive some algorithms development which is very different to seven, eight years ago.

If you look at many cases on the medical side, and we're demoing some of this at the show, we would have some biomedical engineers who can talk the language of medical with our customers. That's really what makes the difference, because we're not trying to invent our customer's business, we're trying to leverage it in a more efficient way what we can do to generate higher value with them.

In those cases then we have investment in specific algorithms that would maybe reject motion as part of measuring an optical signal to do with heartrate, and that's what gets you that robust, trusted measurement in heart rate. That's just an example.

If you want to go farther, you see many different cases where the context of humidity, or body temperature, that will all play. We eventually need to get things like blood pressure.

You want diabetes to be solved. If you look at industrial we've got confident, we've got a demo in smart building which is about conference room management where you've got a vision system which extracts how many people are in the room, it extracts in some cases whether or not there's a threat from some of those people.

You can use it to do things like manage a car park asset, so these are all valuable things to optimize as assets. In many cases that information is very valuable when it's put together with analytics in the cloud.

So we are demoing that full capability, if you want to measure heart rate, in some cases remotely, it takes a radar, a low-power radar solution, which we have demoed in one of our automotive seats.

First off, it's many different things that are required to be measured can be done in multiple ways depending on the application, and they're optimized in multiple ways depending on the application. That takes algorithms optimized with our insight in terms of the solution. That's really what's exciting about it.

HARLAN:   You've pretty much got a full platform approach, hardware, software, algos, I would

assume that this is kind of a key differentiator relative to what your customers are looking for.

What's ADI's go to market strategy? Is it your customers come to you, here's our problem, help us put something together? Or you've got all the building blocks, do you put together reference platforms for different verticals like industrial, healthcare, consumer?

MARTIN:   That's a great question. The good thing about it is, ADI has a very strong customer base in this areas that are really going to be valuable in IoT, particularly the industrial side and also the healthcare side as is most active right now. So we're finding the biggest customers invite us in. In order to showcase the best of our technology we typically have to be able to demonstrate that the piece of information we have really makes that difference.

That's the reason we're ending up, our customers are asking us to do more, they're asking us to demonstrate the full capability to solve that problem.

In many cases they're enabling us to do that, because they're looking to get that extra efficiency that we can bring from knowing the architecture, and together within some cases system guidance, or system knowledge from them, they can concentrate on the difficult problem of the answer of this in many cases, and in order to get that to really show that it makes a difference in the problem, we end up needing to demonstrate that full capability.

In some cases for growing our market space we will produce that full solution for a broader set of customers. Again, because of our history in industrial we're well connected in terms of that broad set of 50,000 to 100,000 customers.

It really pays off for us to be able to take the measurement, generate that full solution and some of the insight, show that in very deep engagement with key customers, and then in some cases take it broader where it makes sense.

HARLAN:   ADI's reportable segments of industrial, consumer, automotive, are all areas where we'll probably see your IoT and applications, so it's tough to break out as sort of a separate segment, but can you just give us a rough idea of the size of the IoT business?

MARTIN:   That's one of the things about IoT, there's a lot of hype. Lots of people define it different ways, the space that we're really interested in and looking at how our other customers define it, it's setting up towards about a half a billion in terms of the problems that we're really interested in, that would be the healthcare consumer side, typically. So it's healthcare and industrial side issues.

On consumer side we typically don't have, we have some early adopter home automation business that tends to be on the more programmable side, but most of all we would have is lots of

sensor business in the industrial piece, the consumer or the healthcare wearable devices, and in some cases the fitness space or the home space is the early adopter, but eventually it will go into these broader clinical for healthcare and also the industrial smart machines, smart city type of application.

Those are what takes up most of our time with our customers, and would be those strong industrial and healthcare discussions. The business is divided pretty much along the lines of ADI's business, we're seeing the picture in terms of growth really just starting for what are proper types of IoT problems that are being solved.

In most cases there isn't a lot of business being charged for IoT services yet, but with our key customers we're having those types of discussions in terms of transforming the business model.

HARLAN:   I think maybe in past conference calls you discussed the growth rate from 2010 to 2014 timeframe for your IoT as sort of mid-single digits type of growth, and on a go-forward basis as you mentioned, you're looking to at least double that growth rate now through kind of 2025. So is it healthcare, is it industrial, what are going to be the top three drivers of this enhanced growth rate in the IoT business going forward?

MARTIN:   The picture in terms of enhanced growth rate I think is when you get in both the industrial and healthcare businesses when you get them solving the problems that really matter to those markets.

If you look at healthcare, I think 18 percent of US GDP is now being taken up by healthcare. The population will double by, the over 65 population will double by 2035 I think is the prediction in terms of world population. So you can't have that percentage doubling.

Healthcare costs are continuing to grow all the time. As we see the discussion on the healthcare side, we need to take the care equal or better care out of the hospital and put it into more mobile care. So that takes a very high degree of patient monitoring, we're showing some demos at the show to demonstrate what that might look like.

It turns out that you get a lot better overall care, so if you look at diabetes patients progressing from pre-diabetic to being actually diabetic, and then needing in many cases if they need dialysis, the cost escalate dramatically.

So not alone do we end up managing their health better for longer, but also ends up reducing cost. To do that, we need to generate more value and for that we expect higher business growth. So that's just a healthcare example. If you look at a position of very valuable asset in industrial, then keeping something like a plant worth a million dollars' worth of machinery in a plant, keeping the whole plant up, making sure that machine doesn't go down, pays for lots of instrumentation.

We're seeing, and we've indeed in some cases we've instrumented our own fab to look at how that might work, learned from that and then gone to our customers with that information. So these are the types of things we're now doing and because of those proof points, we're seeing the customer traction from that type of activity predict a strong acceleration in terms of this wave of IoT that gets to really solve valuable problems.

HARLAN:   That's great. Let's focus a little bit on the healthcare segment. I know it's embedded within your industrial segment right now, maybe you can just start off with an overview of the healthcare segment. Rough size, kind of revenue contribution-wise, profitability profile relative to corporate growth and operating margins, and maybe as it stands right now, the top two or three areas that ADI has a leadership position in.

MARTIN:   If you look at the traditional healthcare business, really was about half of it was on big box business, you talk about CT machines, or in some cases ultrasound machines, or the real in-hospital care.

They tended to have very, very long lifecycles. You needed to make sure that technology was supplied for more than 20 years. Tends to be a time to get that technology adopted, so very much an industrial nature to it. That business sustains for a long time, and will continue to sustain for a long time.

If you look at the new emerging piece, it's really taking the patient mobile, and you look at vital signs monitoring portion, we're seeing that growing in the last couple years as people got more aware wellness, more aware of health. Your fitness devices in many cases we would have significant technology in there. People wanting to more continuously monitor glucose and know more about how to manage diabetic conditions.

We think the future of it is looking at disease, that's the vital signs monitoring is a strong acceleration. As we get to company margins I think the business tends to have the same nature as each of the different segments would have had in the past. If you're solving a problem that you need to be around for 20 years in terms of technology, it determines industrial type margins.

As you go to fitness it's more consumer type margins, but as you go to clinical healthcare, again it solves very valuable problems and being able to deliver on that level of performance, we think is going to determine very healthy growth business and also very healthy sustainable quality business.

HARLAN:   Any questions from the audience? If I look at your consumer business, and obviously I would assume that your IoT portfolio goes out to some portion of the wearables market, the fitness market.

Now you take that into your healthcare business, and now you're talking about clinical-grade vital signs monitoring, taking the patient mobile, how long does it take before something like a wearable that we can buy in retail is bullet-proof enough, is robust enough to be considered clinical grade?

MARTIN:   I wouldn't say all our VSM is fitness consumer. We've got quite a significant portion of it that is already clinical and particularly in the glucose space we would have some portion there. Obviously if you get the level of quality in terms of the measurement, we need to go through that approval process, and some of it is a delay in terms of adoption in the business to go to clinical levels. Also hospitals are very careful in changing their care plans.

So I think we're looking this adoption cycle will be typical of a clinical type business in terms of adoption, but we do have strong engagements that would suggest that that business model will adopt that technology. So we are investing to prove that robustness of the measurement, more than it's a combined set of sensing cases in many situations. That's what's going on right now. So I think you see that demo at the show here, we're showing a couple of cases of that.

Of course the mix between taking somebody mobile out of the hospital and what's a wellness type coming from fitness is starting to blur a little bit. So the fact that we've got strong fitness business is giving us a very good insight into what happens in terms of an early adopter taking it mobile.

HARLAN:   Just back to the IoT question, and I was just thinking about it. Post the Hittite acquisition you've got a really nice aerospace and defense business. I'm assuming things like threat detection, threat monitoring are important IoT applications as well as things like troop monitoring. Do you see a big IoT opportunity within the A&D business?

MARTIN:   We do see some of that opportunity, and it has overlapped with industrial. As you see you are looking at worker safety, looking at monitoring the health and well-being of a worker. It's not that different to a troop. So life signs monitoring is applied in many different places. You look at how to communicate with some of these communications devices.

Again, having very configurable radio technology, having that Hittite technology that goes into very high frequency in many cases some of the future of remote detection, remote heart rate for example, can be done with [inaudible 30:17] .

It's kind of interesting the way we can apply some of the technologies that don't seem to be connected, in terms of what emerges for IoT. Whether we call it aerospace and defense or whether we call it industrial, or even healthcare, a lot of the same technology tends to apply.

HARLAN:   Exactly, that's right.

MARTIN:   So that's one of the really [inaudible 30:39] leverages we can see.

HARLAN:   We're out of time. Martin, thank you very much. Ali thank you very much for participating. Best of luck in 2016.

MARTIN:   Thank you. Thank you too, everyone, for listening.

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