Open Source Voices | Interview Series
Podcast, Episode 03: How Is Open Source Important to the Future of Robotics?
English Transcript

[Black text: Host, Nicole Huesman]

Welcome to Open Source Voices. My name is Nicole Huesman.

The robotics industry is predicted to drive incredible growth due, in part, to open source development and the Robotics Operating System, known as ROS or ROS2.

I'm really excited to welcome Greg Burns, Chief IoT Software Technologist at Intel, and Joe Speed, CTO of IoT at ADLINK, to tell us more about this. Greg, Joe, thanks for joining us!

Before we dive in, Greg, can you introduce yourself and tell us a little bit about what you do at Intel.
Greg: I'm in Intel's Open Source Technology Center. Basically, I'm in a group that does pretty much nothing but open source development and open source contributions. I'm a software architect in OTC. My focus over the last many years has been Internet of Things, specifically Internet of Things network protocols, and later, technologies. I've been involved in the robotics space now at Intel for about eighteen months.

And Joe, tell us about yourself and your experience in IoT.
Joe: You know, Greg and I are old hands at this. Greg and I have worked together on making IoT open, so open standard, open source IoT for a number of years now. One of the things that I'd done earlier on is get some technology in the space, MQTT, I worked to get that made open standard, open source, and get that put into vehicles and many other things. Also, the past few years, I've been spending a lot of time around how IoT applies to people and experiences and how people and things interact. And so you look at my efforts on autonomous vehicles, autonomous people movers, and the work that we did on the #AccessibleOlli, crowd-sourced, open source autonomous mobility for the elderly and disabled.

Q: So let's dive in and talk about why open source, and specifically ROS2, has been so important in helping drive the growth that we're seeing in robotics. Greg, can you talk a little bit about that?
Greg: Although ROS is referred to as the Robot Operating System, it's actually not an operating system in the sense of Linux or Windows. It's a collection of facilities and communication protocols that make it much easier to assemble software components to build a robot or robotic system. And it's had immense success. There's an enormous ecosystem that has built up around ROS over the last ten years, and what it has done is it has enabled people involved in the robotics space, particularly people in the research and in the academic space to build and share and collaborate on software components that are necessary for building robotic systems. These software components are, in some cases, fairly low level, like they would interface with sensors or cameras, et cetera. In other cases, they're more high-level functions such as navigation or motion planning. But the fact that you can take these components and build them and then share them with other developers so that those other developers can use them without necessarily understanding in detail what they do internally but increases the rate of innovation and really lets people be building robots out of these powerful components. Now, the ROS ecosystem, I say, is large—by some estimates, it's about 100,000 developers worldwide that are using or familiar with ROS—and just about anybody coming out of academia who has robotics experience will have used ROS. So, it's already a very successful open source project, open source ecosystem, with many participants. Although ROS has been a phenomenal success by any measure, it doesn't get used frequently in deployment. So, it's used for research and development, but when it comes to actually building a robot and fielding it and putting it

out as a commercial product, most frequently developers will turn to proprietary solutions. Now, about five years or so ago, an initiative was started to build ROS2. ROS2 attempts to address some of what is perceived as technical shortcomings in the original ROS and addresses things like security, and performance, and some other use cases that will make it possible and more practical to deploy solutions based on ROS, and of course, that's going to result in a far more efficient process where ROS is actually used not just for the prototyping but is actually used for the deployment.

Q: One of the things that I really appreciated when we were talking earlier was this whole move from single robots to multiple robots communicating with each other and occupying the same space that humans occupy. Joe, can you talk to us about these swarms of robots and really what that means, what capabilities we need for that to happen?
Joe: With ROS2, one of the keys there was to get in place the kind of communication so that you could have low-latency messaging between the components, so that you could have quality of service, so that you could have robots communicating with one another so you can get these coordinated behaviors, these swarm behaviors, where one robot holds a piece while another robot works on it. But the part that's very interesting to me is the fact that internal to a robot, all the communications on this DDS bus where you have the vision, the decisioning, the actuators, all of these—well, those resources can also be shared securely with other robots, so it gets very interesting to me to think about, if you can have Robot A borrowing Robot B's eyes, and Robot C borrowing Robot A's arms, and these kinds of things, and being able to have this work in such a way that even if a robot had a loss of vision, being able to share these across the swarm, I think there's tremendous things that can be done there. And I look at the examples of what others are doing, even for autonomous wheelchairs with putting the vision, putting the LIDAR in cameras in the ceiling, building it into the infrastructure, and then having that be a shared resource with the robots themselves.

Greg: So, robots are essentially edge compute devices. No matter how you look at it, they require a lot of sensors. Computer vision is very essential to the way we see robotics evolving. We talk a lot about autonomous vehicles. Autonomy is the big change that is happening in robotics now. We're moving from relatively fixed-function robots that are pre-programmed to do repetitive operations to robots that are now becoming autonomous. And as they become autonomous, they require far more compute, there's a lot more software running. With more software running, there's more concerns about security, there's more concerns about management. How do I do software updates? And as you look at that, it is exactly the same kind of capabilities that we have in data centers today. So, it's no great exaggeration to say that a robot is basically a data center on wheels or a data center legs. That is a big inflection point—it's a big change from the way things have been—and this change is being driven primarily by the fact that we have computer vision, but also, all of the things that go along with that, such as machine learning and object recognition. And increasingly, robots are being let out of their cages. Historically, robots are kept away from humans. They're big, they're powerful, they move fast, they can be quite dangerous. But, the new thing that's emerging is a class of robots called co-bots—collaborative robots—and these are robots that work alongside you. They're not in cages anymore. Now, if you've got a robot arm that's moving close to a human, obviously you have to have far more capable sensor systems, you have to have cameras that can detect the position of the human, you've got to be very concerned about safety-critical operations and maintaining safety to avoid injury. The robot has to become aware of its environment, aware of where it's operating. The data from the canvas is being processed. That brings in a lot of the machine learning and inference engines that are required to do object recognition. So, areas that we *think are going to be increasingly important are functional safety, the evolution of computer vision, machine learning algorithms, and the ability to run those algorithms efficiently and easily on the robot hardware. And as with any edge compute device that's running a lot of software, there's going to be a need to manage the software update, manage the software development lifecycle, and bring to bear a lot of the technologies that we're seeing today in data centers, like containerization, that facilitate the management of the significant software that is running on these robot systems.*

Joe: And Greg, for us with ADLINK, we're all about edge. We've been working with Intel for many years doing edge compute and machine vision systems. But with the robotics, it's kind of amazing some of the things people have done with this. We have this partner, Recognition Robotics, that they've actually developed a package for … we have this kind of brilliant little piece of engineering, it's this rugged industrial edge compute camera with Intel compute built in … and these folks have figured out how to take this and put it on existing industrial robots on an auto manufacturer floor or in a build facility and teach hand-eye coordination to existing robots in about an hour. And I think that's an important aspect here is that, with the ROS2, there's the ability to—yeah, you can do greenfield, you can do new systems, new robots—but the reality is, for most of us, these things are going into existing environments with existing systems and how to work with what they've got, and the fact that we've got the DDS messaging underlying this, and some of the work that we and others have been doing on how do you bridge from DDS to all the legacy industrial protocols and interfaces so that you can have these things go in and work as part of, on the long side, an existing line with the existing systems with the existing cameras that are already in place.

Greg: Joe, actually, you make a good point, that one of the key aspects of ROS2, compared with ROS, is that ROS2 has chosen to change the underlying protocol layer in the software so that it's possible to use a variety of different lower layer protocols as the data bus for establishing communication between the software components. You can use DDS and, as you mentioned, DDS has been widely deployed in the industry for many years, and in fact, multiple implementations of DDS. I know ADLINK, of course, has their own open splice DDS implementation, but there are others. And I think that's one of the powerful things about ROS2 is that it also gives you the ability to even run other alternative protocols. You mentioned MQTT earlier, and ROS2 could clearly be put on top of MQTT if that made sense.

Joe: And even the fact that it's got this open standard, open source messaging, that then gives you the interfaces, the on-ramps to get to other things, right? So, like, with our built-in support out-of-the-box to go to the Watson IoT and ThingWorx and Azure IoT device gateway and AWS IoT and others, and the ability that we and others have to bridge from that to things like the OPC UA and Modbus and all these other kinds of things so that you can interface them with what exists, right? So, the robot and your automation doesn't have to be complete new install, new kit. It can exploit the sensors and the systems that are there. So if you're going to have a robot as a cell on a manufacturing line, what are the things upstream, what are the things downstream, so that it can coordinate all of that, so the materials coming in and product going out.

Greg: Yeah, and I think it's worth giving a shout out to the ROS Industrial organization that's working on exactly that space that is the brownfield. How do you take existing robot manufacturing standards and best practices and advance them into this autonomous future? You don't get typically the ability to go in and completely replace every robot with an autonomous robot. You have to be able to do it in an *evolutionary and incremental fashion. As we're talking about brownfield, one of the big areas that we're seeing a lot of excitement and growth in the deployment of robots is in warehouses. The majority of warehouses is not that big. The opportunity there is there are so many of these warehouses, and they can all benefit from adding automation be it for doing inventory or for moving things around. So autonomous robots really come into their own in that environment. And there are several companies that are building fully autonomous robots that essentially go around the warehouse and map it in real time based on the cameras and sensors that they have, and very quickly they can become a valuable asset and capable of performing useful operations that streamline the handling of materials in the warehouse, and we can expect to see an awful lot of that emerging, not just in warehouses but delivery robots, and we're going to see more and more of that.*

Q: Can you guys talk a little bit about the way that Intel and ADLINK worked together on one of the proofs of concepts …
Greg: Yeah, let me talk a little bit about some of the contributions that Intel has been making. The first thing that we did is we have the Intel RealSense cameras, and depth cameras are extremely useful for many of these robotics scenarios. So, what we did is we put a ROS wrapper, called a package, that encapsulated the functionality of that depth camera so that it can be now incorporated easily by roboticists into robots. And we've continued to evolve that, and we're now engaged in actually moving that onto ROS2, and onto the latest RealSense cameras. We've also done the same thing with our Movidius neural compute stick. You now have the ability to incorporate that as a software component that is the ROS package into an existing robot. You don't have to understand any of the internal details of how that neural compute stick works and it makes each much easier to incorporate as a component. So, those are a couple of things that we've done. We've also added some additional packages on top of that. And ADLINK has taken some of these components and started to integrate them.

Joe: Yeah, so we talk about the neuron board product. It's a ROS starter kit and taking much of the work that Greg and his team have done and packaging that together with the Intel compute, the Movidius, the RealSense depth camera, and having done all the integration and packaging of that together. The team's been doing some pretty interesting things, ranging from high-speed wheeled drones—basically, reworking off-road remote control vehicles to drive around at very high speed but completely autonomous, ranging from that to other things like a robot that is more meant to engage and work with and be around people. It's called a "follow me" … It follows you around, but if you walk towards it, it backs up, if you start to walk away, it follows you again, and then some other things around some swarming behavior. So, some of these robots working cooperatively and being aware of each other since they're all sharing each other's telemetry on the messaging bus.

Q: Can you talk about what kinds of things you're excited about as you look forward?
Joe: One of them that was really striking for me is Dr. Philip Freeman, the Chief Roboticist at Boeing, at the last ROS Industrial event, he said something that I thought was rather telling, rather poignant. He said that "ROS feels like we are at an amazing tipping point like Linux in 1993." For those of us that were working around open source and operating systems back in the early '90s, it was an amazing time. You could feel the energy, you could see what's going to happen, you could see that it was inevitable that Linux was going to be everywhere and in everything at some point, and that's the momentum, that's the energy that we feel in this community around ROS right now, today.

Q: That's really inspiring, that's something so exciting to get involved with and be a part of. For listeners who want to get involved, want to learn more, where do you recommend they go, what should they check out, how should they get involved?

Greg: Well, the first place to look is ros.org, and for information about ROS2, ros2.org, which will actually redirect you to the source code on Github. There is documentation and other information there. There are also tutorials, and there are multiple books on ROS. There's ROS Industrial, which is focused on manufacturing robots and moving them to more agile and more autonomous devices. And ROS Industrial builds on top of ROS; it's not an alternative, it is additive. And then there's the annual ROSCon meet-up, and that's in September in Madrid.

Well, it's time to wrap up but I'd like to thank both of you, Greg and Joe, for joining us today. Robotics is such an exciting area with such innovation, and we look forward to hearing more from you in the future!

Until next time, thanks for listening.