Dr. Raymond Colladay
1988-1989

Interview: January 16, 2007

Interviewer: Can you give us your name and your tenure at DARPA?
Colladay: My name is Ray Colladay, and my tenure was the beginning of 1988 through May of 1989.

I: Now, what did you do before you became Director?
Colladay: I was an associate administrator at NASA.

I: Was DARPA something that you wanted to do?
Colladay: Actually, I never thought about it. I worked with DARPA on a lot of joint programs in aeronautics and space technology, and I never really even figured that that was in my future—in my career, because I was just happy where I was. But that's happened throughout my career. I never plan for the next job, just enjoyed the one I had.

Things happen. The same thing happened at Lockheed Martin when I became president of the astronautics company at Lockheed Martin.

I: How did you happen to become DARPA Director?
Colladay: It was in 1987 at Christmas time, and Cliff Duncan, who was the former DARPA Director, called me and said, "Have I got a job for you." (Chuckles.) And I said, "Oh, really?" And he said, "How would you like to come to DARPA?" I said, "I don't know. I'll think about it." And called him back after Christmas, and it just happened. It was a great experience, one of the best jobs in all of government, I think.

I: When you walked into DARPA, what kind of an organization did you find there?
Colladay: Pretty laid-back, about what I expected, a little more administrative

259

support and bureaucracy than the legend of DARPA would have you believe, but it's still an agency run by program managers, and that's what I found. They're the king. A Director tries to provide top cover for them to do their thing.

I: Did it take a while to get used to that? Did Duncan help to show you the ropes, so to speak?
Colladay: No, it didn't take long, because I was so familiar with most of the people in DARPA at the time, or at least the program management side in various joint programs that I had worked with DARPA on from NASA.

I: Like what programs?
Colladay: Well, we had some big ones and some little ones; and some big failures and some pretty good successes. The National Aerospace Plane was one of the bigger ones that had a lot of visibility at the time, and the X-wing was another program—the X-29, forward-swept wing. A lot of experimental airplanes over the years that DARPA started, and then NASA would do the flight testing for them out at Dryden. So, there were a number of those in rocket propulsion, some of the early work in small launch vehicles for the LightSat program.

So, they were obviously all in aerospace, but a number of programs, some of which were really spectacular failures, I would (chuckles) say. But, that's typical of DARPA. I mean, as long as you fail because you reach too far and not by mismanagement, those are forgivable failures in an agency like DARPA.

I guess the X-wing was one of the more spectacular failures that we had, which was vertical takeoff and landing like a helicopter, but fixed-wing for high-speed, horizontal flight. And it was just too tough. We couldn't do what we had hoped to do, and—from a standpoint of budget problems—that was a spectacular failure. From a technical standpoint, I think we learned a lot.

I: What sort of things were learned and then later applied?
Colladay: Well, I think in the X-wing, what we learned was the difficulty of control. The control problems that we ran into were severe. Aerodynamically, it was feasible, but it was a nightmare from a control standpoint, and so you learn, in solving problems, how to apply them to the next challenge.

And with the Aerospace Plane, that had its own difficulties. You know, one of the problems I faced when I first got to DARPA on that program was scaling it back from the spotlight it was in—I mean it was mentioned in the State of the Union message, and that gave it visibility that actually got in the way. And it was the kind of visibility that wasn't good for it. Like, in the State of the Union, President Reagan said you'd be able to fly from New York to Tokyo in 45 minutes or an hour, and that was basically just nonsense. (Chuckles.)

But it was a good program from the standpoint of hypersonics research. So, the challenge that I faced was to dial down the hyperbole and settle it in for as good a hypersonics research program as could be sustained for the decades that would be required. And it was probably 10 or 15 years' worth of really challenging work in propulsion and high-speed flight. It would've benefited the country if we'd have been able to stay with it, but it had too much visibility and too

many promises were made that couldn't be kept. That's really DARPA's biggest undoing, when it gets proponents that are too apt to hype a subject. Fortunately, most DARPA programs are under the radar, and people don't know about them, but when they get politicized and visible, then DARPA has to fight off the critics, and that's a problem. But it was a good program for as long as it lasted.

I: Did the President surprise you with that?
Colladay: I remember going over to the White House two days before the State of the Union and met with Pat Buchanan, who at the time was his lead for communications, (he wasn't Press Secretary, but some other position having to do with communications). And he showed me the paragraph that he had drafted to put in the State of the Union, and I (chuckles) said, "You can't say that. That's nonsense."

And he said, "Well, we're going to. We've got to relate this program to the American people and in a way that they can understand it."

Obviously, his mind was made up, and I wasn't (chuckles) about to change it, but it really, in effect, set the program back, because it hyped it too much.

I: Did you inherit any of the Star Wars program?
Colladay: No, actually that was all spun off before I got to DARPA, and SDIO had been formed. Well, I guess then it was still called "Star Wars," but their organization was Strategic Defense Initiative Organization, so that was pretty much gone. There were remnants of directed-energy programs at Los Alamos and other parts of DARPA, but most of it was gone.

I: When a director steps into the position, they look at the menu, and some things have to be weeded out. Did you find that to be the case?
Colladay: I did, and, in fact, that's one of the biggest challenges, I think, any Director has. It's not hard to start programs. It's very hard—just human nature—to stop things and know when to pull the plug and create the budget wedges or resources to start new programs. You have to continually look to roll things over and stop.

So, I tried, in my tenure to create maybe 10 to 20 percent of that kind of rollover, to stop some of the ongoing programs so new things could be started.

As it turned out, we were in a period where Congress loved DARPA to death, and they would add typically $200 million to $300 million to our budget, so we had new money, but it wasn't the kind of new money you always wanted.

I: Did you have trouble with Congress—with their earmarking those particular funds for political reasons?
Colladay: Oh, yeah, yeah. That's what I mean by "loving DARPA to death." It was a place where they could earmark money for their favorite projects. Sometimes it came without strings attached, but most of the time, it was to build a building at some university in some state, which I would resist.

One time, I resisted a little bit too much, and the senator from a state I'll

261

leave unnamed (chuckles) because it wouldn't be hard to figure out, called the Secretary of Defense—Secretary Carlucci at the time—and complained that I wouldn't cooperate. I resisted as long as I could, but in the end, I had to cooperate and say, "Put the money in for that purpose." But that annoyed me, as I'm sure it did every DARPA Director. And it's worse now than it was then. But sometimes it was done for other reasons, like at one point, at the beginning of my tenure, the Congress was upset with the Navy R&D program in submarine technology, so they pulled the R&D money out of the Navy and gave it to DARPA and then said, "You will cooperate with the Navy to undertake anti-submarine warfare technology and submarine technology." So we had to go up on the Hill and do joint testimony. They were trying to poke the Navy in the eye a little bit. But we turned out a pretty good program by cooperating, and the cooperation in that case worked, even though I think the Congress was trying to stir things up.

I: What was the relationship with the Services?

Colladay: You know it was kind of a love-hate relationship. I was pretty aware of the friction between DARPA and the Services from my vantage point at NASA, so I tried to build bridges and do whatever I could to improve or to, where it was good, maintain good cooperation, but it's understandable. Cherry picks selected technologies, proves feasibility in a limited sense, and then tries to hand it off when they're done with it and sometimes DARPA doesn't prepare the Services to take the technology to the next level.

So, it's always going to be a challenge. Too much cooperation and DARPA can't be as free as they need to be to do the kinds of revolutionary technology work that needs to be done, and not enough cooperation then there's no way to hand it off. So, it's always a delicate balance, and I think it worked pretty well.

When I was Director, we had—and I don't think it was unique; it happened before and after, as well—a big push to do more work with the commanders-in-chief and the Commands around the world to understand what their problems are. And I think that aggravated and caused some problems with the Services, because, in a sense, it was an end-run around them.

I: What sorts of things did you do to mend fences?

Colladay: I just worked with them a lot. It's more of a social problem than anything else, and it does rest on personalities. So, I worked with the secretaries and undersecretaries of the various Services and just maintained a dialogue, so we weren't the enemy. It just takes a lot of time, a lot of investment and effort to build those kinds of relationships.

I: Did you have to answer the question: "Why DARPA?"

Colladay: No, that really wasn't a problem, because I think the Services recognized the role of DARPA. The beauty of DARPA is it doesn't have to maintain the technical base in all the disciplines. It doesn't have to be broad or wide and deep in what it does. It's kind of like rifle-shots versus a shotgun approach to technology development, so we could afford to just cherry pick the things we thought were important, and that could lead to major, what we call,

262

"disruptive technology advances" that tilted the status quo. And the Services, really, they try to do that, but they also have a responsibility to maintain broad disciplines in their specific, respective areas, and they have to maintain balance and diversity in their workforce. Well, those are all things that DARPA doesn't need to worry about.

So, DARPA has the luxury to do things that the Services can't do, and I think the Services understood that. The people that I dealt with respected that, and while there was some friction, I think we maintained a pretty good relationship.

I: Why was DARPA doing the mach 5 jet and not the Air Force? What were the questions?
Colladay: Well, the Air Force actually ended up taking the program over. They were partners in the early research program and so it wasn't throwing a program over the transom and expecting them to catch it. They were part of it. And I think—when I spoke before about the Aerospace Plane program and dialing back the rhetoric, calming things down—that that actually was also the objective of the Air Force. So, in that case, they were partners in what I was trying to do. They thought that the hyperbole was too off-scale, as well.

I: Regarding your portfolio of projects—can you talk about how you transitioned programs out of DARPA?
Colladay: Well, you know, when it works best, it's so diffuse that you can't paint the trail. You can't even find the trail. It's not necessarily from an organization like DARPA to the Services, because it very often is with the industry that ends up bidding on a development program with the Services, and so it goes into an industry R&D effort, and then back to the service in a proposal that may be five or ten years later. It may be early work sponsored by DARPA in a university, which then results in a team that is formed between industry and the university, and the service that ultimately inherits it.

So, you know I can't really, nor would I even try, to paint the trail that technology-transition takes, because it would be an oversimplification and probably wrong. And, sometimes it can only be done by looking back in history, at a time when you thought that it wasn't going to happen at all, or it dead-ended, only to find ten years later that it really did find its way into the Services or into the marketplace. And there are a lot of DARPA successes, but I would venture to say that at the time, you couldn't ever have predicted the path that technology transition would take.

I: Looking back at it from our vantage point now, can you point out some of those projects that did make it? Any big successes?
Colladay: Yeah, a lot of the materials research: high-temperature materials and carbon composites, and a lot of the strategic computing technology that came out of that program found its way into next generations of computers. For instance, parallel processing that is commonplace now; we worked on at the time. And the next generation of the Internet work that was done is now commonplace.

263

So, a lot of the smaller discipline-research programs in computer science and advanced materials, information technology and artificial intelligence have, in a diffuse way, found their way into the marketplace. The bigger programs—well, I guess probably the biggest successes were when we started another run at short takeoff and vertical landing, which is now the JSF program—Joint Strike Fighter. It had been tried before several times but all the pieces never fit into place, and the last one that DARPA made a run at did succeed.

I: What were some of the things that are now commonplace?
Colladay: Well, the most celebrated program everybody points to is the ARPANET, the packet switching, and the communication architecture that formed the Internet. But other, less glamorous, more invisible kind of work that was done in the computer program was parallel processing and it's analog in simulation technology. I remember the program called SIMNET that was a simulation network of small simulators—capable simulators—on an Internet-type connection networked together. It was a fabulous idea, where it was really like war gaming, and in this case it was simulators for Army tanks, but it could be anything—anything where there had to be a coordinated response from many different platforms. It was a great concept, and it finally was recognized as such by the Services. I'm not sure how it ended up. I lost track of its development after I left, but it was a great idea that really came from the computing- and numerical-simulation research work that was done.

So, there were a lot of big successes—artificial intelligence and neural networks—you can point to in the marketplace, but yet, lots of work is still being done in that area.

I: So, Congress was adding more money, and we were in the middle of a peace dividend. Hadn't the Soviet Union collapsed?
Colladay: Well, it hadn't yet, but it was on the verge (chuckles). That happened just as I left and went to Martin Marietta. We actually lived through Martin Marietta's and Lockheed Martin's restructuring of their whole companies as a result of the collapse of the Soviet Union. But, when I was still at DARPA, we had the benefit of the Reagan build-up that I think was a factor in causing the Soviet Union's collapse. So, we enjoyed unprecedented growth in R&D spending and in research and development. We were sort of on the leading edge of that, and so our budget was on a growth trend through the time that I was there, which, again, made stopping programs harder, because you had to do it not to create the resources to start new things, but really just to force the kind of discipline that programs should be stopped.

I: How big was the budget?
Colladay: As I recall, it was about $1.3 billion, and then Congress added $200 million or $300 million every year to that, so it was running $1.5 to $1.6 billion.

I: Did that inhibited the flexibility of the organization?
Colladay: No, I didn't find that, really. It certainly would've been a different

climate in a decreasing budget. It would've changed the whole tenor of the Agency, and that, of course, has happened periodically. But the additional resources or the growth in budget year to year, did let us undertake some major prototyping. Prototyping was the new era that came out of the Packard Commission recommendations to add resources to DARPA. And so those kinds of budgets let us undertake some good prototyping programs that, in and of themselves, take more money than the more disciplinary, basic research.

I: Was that a change in the philosophy?
Colladay: There was a change in terms of trying to emphasize this transitional technology more gracefully; that perhaps prototyping would demonstrate the feasibility in such a way that it would be easier for the Services to pick it up. But DARPA always did prototyping. They may have not called it that, but fundamentally, it didn't change. It was just from my perspective a different budget category that let us grow the budget in a way we hadn't been able to before. I don't think it inherently changed what DARPA tried to do in demonstrating the feasibility of a technology.

I: How did you walk that line?
Colladay: Again, by building relationships. I think both the Navy at the time — Admiral Demars — and I realized we would probably have to do joint budget hearings before the Congress, and we went up to do that. We were determined to put a face of cooperation on everything we said, even if the Congress was trying to cause some controversy between the two agencies.

The Congress was unhappy at the time with the Navy not being aggressive enough in their traditional submarine R&D work. And I think their intent was to get the Navy's attention by giving their R&D money to DARPA, and then force DARPA to cooperate with the Navy. But it worked well, because we agreed that we weren't going to have a wedge driven between us and that we were going to work together. And we did, and the program was successful. But it could've gone the other way if DARPA had taken the money and run, and said, you know, "We'll get with you when we need to," and hadn't worked in a cooperative way with the Navy. But I think in this case, it worked pretty well. I think the Navy could have done what it needed to do and convinced the Congress that they were aggressive, but it worked a different way. DARPA worked on some really great, advanced technology for anti-submarine warfare, acoustic and non-acoustic ASW, as well as submarine technology, and remotely piloted undersea vehicles, all of which I think were good for the program.

I: How could they possibly be mad at that?
Colladay: Well, I think the Congress thought the Navy was too traditional in its approach to submarine technology, and I personally don't think they were. But the Congress thought that it needed some fresh eyes and a different look. So we hired some people out of the Navy, and worked on some pretty interesting technology at the time.

I: That's the reason ARPA came into existence in the first place, isn't it? It's not that there weren't missile projects being done, but it took ARPA to pick and choose.

Colladay: Yes. There're a lot of parallels in what you say. DARPA is anything but traditional, so if there is a tendency for the Services to just follow a traditional path, DARPA is not going to do that. And in this case, we had a blend of doing things that the Navy thought was important on the one hand, but taking our own look at what's possible and what we could do with the resources.

I: Did you find that DARPA was applying scientific honesty to some of the projects?

Colladay: I don't think we second-guessed what the Services were doing from that standpoint so much. We had enough challenges asking those kind of questions of ourselves just on the work we were doing and making sure we weren't pursuing something that violated the laws of physics just because it would be neat to do if we (chuckles) could do it.

I actually worried a lot about that. Its one thing to say there's a real need and a requirement, and wouldn't it be neat if we could achieve this or that to apply to that need, and it's quite another to stand back and say, "Is it feasible? Is this good science? Is this good physics? Does it make sense from that standpoint?" because there is plenty of need pull in what DARPA does. I mean it's not hard to understand a need and create a program to address that. And sometimes it takes a little while to really appreciate and understand the physics; what you have to address to make it feasible. And so we actually spent quite a bit of time challenging ourselves to make sure that what we were doing made technical sense.

I: Does anything come to mind?

Colladay: (Chuckles) Yeah. I think in the case of the National Aerospace Plane—that was a good example where we were trying to do something that the physics just wasn't there. And, in fairness to the concept of the program, it may be that we were just ahead of ourselves, that the physics was sound behind it. There were just too many inventions between (chuckles) where we were and where we needed to be that hadn't happened yet. But, yeah—I'd say the X-wing was another case, although that wasn't so much physics as just sheer technical challenge.

I: I understand that personnel turnover is important. Did you find it difficult to start weeding out people?

Colladay: No. That is very important, and one of the things I tried to do, which probably every Director has tried to do is impress upon new hires that this wasn't a place to build a career, that you weren't going to stay in DARPA for very long. And to get that point across in my interviews with them—with the Directors before they were hired, when they were on a track to be hired—I would ask them as a first question: "What do you plan to do when you leave?" "Where do you plan to go, and what do you hope to do when you leave DARPA?"

266

Of course, they were mainly interested in what are they going to do when they come to DARPA, and I wanted them to think about what they were going to do after DARPA. We tried to instill a discipline of program managers staying for only two or three years. That's the life of a typical program, and a program manager should come with an idea already well formulated, so they could hit the ground running, stay for three years and then leave. That happened a fair bit of the time, but there were other program managers who, I think, stayed too long. And so forcing that rollover in personnel is one of the important jobs of the Director. It's comfortable to just stay with the status quo, so you have to get out of your comfort zone. From a leadership standpoint, you have to do what's best for the Agency and enforce that kind of turnover.

I: Where did new people come from?
Colladay: From the Services; in some cases, from universities; fewer from industry than I would have liked just because of the difficulty in conflict-of-interest and revolving-door policy. It made it difficult to bring people from industry, and then have them go back to industry. I would've liked more of that, but those were the sources of personnel.

I: Did you have any difficulty recruiting?
Colladay: No. No, DARPA has such a reputation that I never found it difficult to attract people. Program managers have extraordinary responsibility for their age or point in their career, and it's such an attractive place, with a very minimum of bureaucracy. As the government goes, it's probably the best place to work from an R&D standpoint, and so I never found it difficult to attract people, although it wasn't my job to do much of the recruiting. I did some, but most of it you leave to the program-office directors who are close to the program. They know what they want to accomplish. I was sort of a gatekeeper, to say "no," because there were far more hiring opportunities than we could realize. So, I had the luxury of sorting through and agreeing to the best of the best.

I: Did the influx of money add personnel?
Colladay: Well, not so much. The trouble with earmarked money is that it's one-year money, and while DARPA can do wonders with short programs and accomplishing breakthroughs in a short period of time, one-year money is very difficult to deal with. And you certainly don't want to go out and hire program managers who you have to let go in a year. So, we didn't generally hire to oversee and manage the earmarked money.

I: Who would take one-year money? I can't imagine a university—
Colladay: That's true. One-year money to a university is the most difficult. Industry could accomplish a lot with one-year money if it augmented what they were already doing. And often we tried to look at it that way: what can we do that meets the intent of Congress, and also augments and expands what we wanted to do, or were already doing? In some cases, you couldn't do that. You had to literally invent a program that could be finished in one year. It's very

difficult. That's what caused a lot of the difficulty with earmarked money.

I: Did you find that during congressional hearings, members would just get up and leave?

Colladay: Well, I was used to that with NASA, when I testified, so I wasn't surprised. Often, only the Chairman was present. They'd come in at the beginning, when you'd have quite a few of the members there for their little speeches, and then they'd get up and leave. Very often, you'd be answering a question asked by someone who wasn't even there anymore, and you'd be talking to an empty chair. That just wasn't apparent when the record was published, but you had to pretty much behave as though the full committee were there. But, it was a pretty friendly relationship with the Congress. They loved DARPA. I think, in general, they usually do. And certainly that was the case during my tenure.

I used to plead with them not to give me more money, and I guess that added to my credibility, because (chuckles) I guess they figured, "somebody that is asking us not to give them more money, this would be a good place to add money." And so we always ended up getting earmarked money that, in some cases, wasn't even earmarked. They would ask, you know, "If we could give you more money, where would you like to put it?" And, of course, every DARPA Director has to answer that question very carefully, or he gets in trouble with the comptroller and the budget folks back in the Pentagon, but after two or three times of saying, "Senator, I really don't want any more money. I can't tell you where I'd put it, because I'm happy with what we have," I would finally answer the question with my arms suitably wrenched behind my back, that I'd put it in A, B, or C part of the budget. And that money generally came without strings attached, which you would think would be the kind of money that would help DARPA. But you had to be careful there, because the budget director back in the Pentagon would make sure that that money wasn't added in subsequent years. So, it, too, was one-year money. And even if it was a good idea, they would try not to acquiesce to the Congress by adding the run-out years to whatever the Congress added for the first year.

I: Tell us about other transaction authority.

Colladay: Well, it was motivated in part by this new effort of prototyping, which, as I said before, wasn't really a new effort, but it was in a new disguise. And the principle argument for contracting authority was to be able to get under contract in certain, select areas on a fast track. That was started during my tenure, and the upside of it was that we really could—in selected areas, where we could do our own contracting through this broad agency announcement approach—get a prototyping program under contract quickly in institutions like universities or small, entrepreneurial companies. These would be entities that didn't have the resources for big bid in proposal efforts in the normal competition in contracting. It worked well in those areas.

The downside was that it added more administrative bureaucracy to DARPA because you needed to do our own contracting. We needed a

contracting office. It was expanded over what we had when an agent would do the contracting. And so it changed the balance between program management and administration personnel.

I: DARPA had to add a contracting department?

Colladay: We had a contracting office within DARPA that oversaw and followed the contracting authority that we had previously given to the Services, or other agencies, and it was just a matter of expanding the administrative personnel in that contracting office. I always thought that if it was kept small and the contracting authority was used judiciously and only in selected cases, that it would be good for DARPA. But I also was well aware that it could become an Achilles heel of DARPA in that it could be the normal contracting route, rather than the exceptional one.

I'm not sure what it is today, but I think the concept of forcing DARPA to contract through other agents, like the Services, or NASA, or the labs of the Department of Energy, was sound and the right approach. It kept the bureaucracy small and forced DARPA to work through other agencies. So, I think, for mainstream contracting, it was the preferred approach. But we went ahead, with this special authority notwithstanding, and I think it served a useful purpose in the beginning. And I hope it's stayed small.

I: Would you explain to me exactly how it worked?

Colladay: It was just that you could put the emphasis on a particular contract and getting under way more quickly than through the priorities established by the Services. I mean, we didn't get any special treatment when we would contract, say, through the Air Force. We would go through their administration, and we would be on a pile of other contracts within the Air Force, just like everybody else. And we couldn't fast-track things very well. With our own contracting authority and through what we called a "broad agency announcement" for competition, we could just control our own priorities better and be under contract more quickly.

I: One of the earlier directors mentioned he'd get an idea on his desk that morning and write the check that afternoon." When did that flexibility change? And why did it change?

Colladay: I did that a few times. In fact, one time—it wasn't within the same day, but over a weekend, from a Friday to a Monday—we were able to start a major program by calling industry in and working over a weekend, and I thought that was pretty cool, compared to the NASA bureaucracy I was used to, to be able to do that.

But that was in the late'80s, and those were rare. I think under special circumstances, you could do it, but the normal, routine approach to getting a program started was to solicit ideas and go through a broad competition, because we still couldn't violate procurement laws that required competition in contracting. So, we went through a competition of ideas of some sort, wrote an ARPA order, got it signed off by the Director, and then it would go to one of the

Services or agencies as the procurement agent. And then it would get lost. Unless the program manager dogged it all the way along and made daily phone calls, it would go in a pile that the contracting officer would get to sooner or later.

So, even though DARPA could be fast-track, sometimes the longest time was consumed just working its way through the process with the agent doing the contracting. It just took a lot of work on the part of the program manager to make sure it stayed visible and a high priority. And then, of course, when we provided contracting authority within DARPA, that's when you could shortcut that path and get under contract pretty quickly.

I: Were there any "wow" categories or priorities you saw? What were the factors that got something "fast tracked"?
Colladay: They tended to be the smaller programs, not a big platform or experimental vehicle that flew, or swam, or crawled along the surface. They were more areas in computing and advanced materials and things like that.

I: So, the difference between aerospace plane and ball bearing technology was pretty huge?
Colladay: Yeah (chuckles). That's the beauty of DARPA. You cover a broad range, from very basic research to things that fly and swim and crawl.

I: What is the relationship between basic and applied research, and what did that mean in terms of how DARPA functioned?
Colladay: There was a tension within the Agency in the balance of resources between the two areas. During my tenure, I had two deputies who made sure that the tension stayed tight. One was responsible for applied and systems work, and the other for the more basic, science-related work. And, I think that tension is healthy.

I: So, there was a need to walk the line between 10, 15, 20, 30 years into the future and responding to immediate needs.
Colladay: Somewhat, but, if I tilted the balance between those two tension points in any way, it was towards the longer-term focus. I would far rather give up on addressing some specific, near-term need that the Services had, in favor of a longer-term opportunity that could lead to a fundamental change in the way of doing things, or thinking about a problem. I think DARPA should err on the side of the long term. If the Services can articulate a specific need that they have today, then my thinking is they should do it.

I: Did you ever get out in the field and either watch the experiment or participate?
Colladay: I did (chuckles)—in fact, in submarine technology, I was used to space and aeronautics and things that flew in space and flew in the atmosphere—my whole career up to that point in time. We had some advanced sonar-detection equipment we wanted to test doing trial runs on a submarine. So, we went down in the test range in the Caribbean on a submarine for two

days, which to a space guy, that's about as alien as you can get (chuckles). But it was fun. So, I tried to do that and get out in the lab and into the places where we were sponsoring work as much as I could.

I: Can you talk about those field trips?
Colladay: Well, gee, there were a lot of them. I went to the Department of Energy Labs at Los Alamos, and to Livermore, looking at some of the directed-energy work and the atomic particle accelerators we were supporting in a small way. I visited some of the industry sites, which I was familiar with in the aerospace industry, and some of the airplane work we were doing—the Aerospace Plane contractors. I remember talking to Ben Rich at the Skunk Works at Lockheed, and they were doing some conceptual work on the Aerospace Plane. They weren't a prime contractor, but it's a group of very smart people, and I respected Ben's judgment as the head of the Skunk Works. And I think they wanted to be part of the program in the worst way, because it was potentially a huge program that would provide a successor for the Space Shuttle in transporting people to space.

Ben worked on it in the Skunk Works for a year, and I visited out there three or four times to get his take on the program and what we were doing, and at the end of nine- months-to-a-year of study, he said, "This isn't going to work. This violates the physics that I talked about earlier (chuckles). We don't have the materials. We don't have the basic propellant technology. We don't have the propulsion supersonic ramjet-scramjet technology, and we can't get there from here."

So, after that series of visits to the Skunk Works, I was confident that as a contractor he was telling me what I needed to hear. Here was a case where they could've taken the money and run with it, and then after three or four years said, "We can't get there from here." He said right up front, "This isn't going to work."

I: They already had the SR-71, didn't they?
Colladay: Yes, and if anybody could pull it off, you would think, with the Skunk Works' background and history, they could do it. But, the payload fraction, the structural efficiency of the vehicle, and the amount of propellant it had to carry was just beyond the state of the art. And, there was no way it could be achieved within the timeframe the program was advertising.

I: Wasn't there also a problem with the skin melting?
Colladay: Well, it did take some high-temperature structural materials that needed to be invented, but that was probably the most realistic requirement of the project. I'd say, the structural mass fraction the vehicle required was the biggest challenge, and then going through the propulsion regimes from ground through takeoff, climbing to high altitude, and then into space was just too challenging.

But good research will, in the end, I think, solve those problems. It's going to take a long time, and the program couldn't be sustained for that long a time.

I: It seems like the era of the chemical rocket is about at its end, anyway, so—

Colladay: Well, when you stop and think of it, we're getting things to space through controlled explosions of chemical propulsion, the way the Chinese (chuckles) invented it 5,000 years ago. Nothing much has changed since that time. I mean, basically, it's the same rocket technology—refined, to be sure, a lot—but, still, not terribly different from what the Chinese invented.

We need some breakthroughs. We need some major breakthroughs in rocket propulsion and thrust and propellants, and I'm not sure where it will come. It's a tough problem. It's a lot of energy density required.

I: One Director mentioned receiving mail from someone outside DARPA that said, "I know how we can get a better rocket," and it had a picture of a rocket with a little circle and an arrow that said "SECRET FUEL." Did anything like that ever come across your desk?

Colladay: Yeah. Seems like getting a pound of payload to orbit generates some of the craziest ideas in the technical world, and I saw many of them during my career. In NASA, I saw them. In DARPA, they came out of the woodwork. And of course, I was in the launch business as president of Lockheed Martin Astronautics, and saw lots of crazy ideas.

One of the programs that was big in DARPA that I inherited was the LightSat program, and there were two components to it, one of which was good, one of which I could never get excited about. The part that was good was small satellites, small payloads—more with a constellation of smaller payloads than these "Battlestar Galactica"- doing huge, multi-billion-dollar satellites that did everything on one platform. In concept, that was the right way to go, and I think we'll see more and more of that.

The other component was small rockets to launch these payloads, which never made sense to me. That's the most expensive way to launch a pound of payload to orbit—launching a lot of small satellites to go in a constellation. It's much cheaper to launch a lot of satellites on one big launch vehicle than individually on small launch vehicles. And that program, I think, suffered from too much hype on the launch-vehicle side and ended up being a distraction to the small satellites, which as the right thing to do at the time. It turned out to be the right thing, in retrospect.

I: That sounds like a classic DARPA pick-and-choose.

Colladay: Yeah, there are a lot of examples like that, and sometimes the real payoff comes where you least expect it. So, you start a program, and you pursue something with one thought in mind, but then something serendipitous happens, and it's a big breakthrough in an area that you don't anticipate. There's a lot of luck involved in this business.

I: What role does serendipity play?

Colladay: I think it plays a big role, probably a bigger role than most people would like to admit, but I think the key in an organization like DARPA is to be

272

structured or unstructured enough to let serendipity work. I think that is actually one of the big benefits of an agency like DARPA. Serendipity has a place in DARPA. It's not so structured and bureaucratic and run by program managers with tunnel vision, where serendipity can't work. You enable serendipity by the environment you create.

I: With the ongoing recruiting and turnover, what do people do after DARPA?
Colladay: Well, the service people generally go back to the service from which they came. Industry people try to go back. As I said, there are fewer people from industry than I think DARPA should have. They need more diversity of backgrounds that bringing industry in would achieve. That career track needs to be emphasized, I think, but it's not easy because there are laws and restrictions that prevent abuse of conflict-of-interest, so it makes it harder.

But some that did come from industry went back to industry, and for a number of people—like me who come from another government agency— DARPA is a transition to industry. That's the path I took, and DARPA is a great springboard to industry; it augmented my experience-base beyond aerospace. I had hit 20 years in government service at that point, and that was enough time to build another career in the private sector. So when I left DARPA, I transitioned into industry.

I: Do you read the newspapers the same way?
Colladay: Well, I always read newspapers suspiciously, anyway (chuckles), if that's what you mean. But that's not really a change.

I: What do you think some of the keys to DARPA's continued success need to be?
Colladay: I think since one of the key founding tenets of DARPA is pursuing technology to avoid surprises —surprises that somebody else catches us off-balance by inventing something we didn't know was possible—DARPA really needs to be focused on the longer term, rather than filling nearer-term needs. They shouldn't be all that concerned about technology transition, in my view. I mean good technology will find its way into the marketplace or into service developments, regardless of how much time and attention is put on hand-wringing about whether the handoff is smooth. And also, if the focus is suitably long-term, nobody should be that worried in the near term about transition of technology. I think they should devote, therefore, most of their attention to avoiding being surprised.

Probably the other thing I would think, which is what I worried about, and I think every DARPA Director worries about, is this fear of an asymmetric kind of weapon that can neutralize the most advanced military force in the world by something really simple. These roadside explosives in Iraq are a good example of how all the technology in the world can be defeated by some simple bomb contraption that can blow up a Humvee. Those are the kind of surprises I think DARPA exists to defend against. And so DARPA, I think, should worry about having our sophisticated technology defeated by some simple countermeasure.

I: During your tenure, what was the geopolitical climate? What was going on in the world?

Colladay: It was before the collapse of the Soviet Union—just before. We were building up Strategic Defense Initiative Missile Defense, so directed-energy in various forms, space-based or ground-based, was important.

We were trying to build on, I would say, a competitive edge in technology over what we thought the Soviet Union had. As it turns out, we had a pretty big edge—more than we knew.

The main emphasis was on system-of-systems. That is, coordinating platforms with intelligent systems—for instance, smart bombs—and sharing of information. The public saw it initially during the First Gulf War, but now it's commonplace. And that was our main systems emphasis when I was Director, and so it was gratifying to see, three years later in the First Gulf War, the things that we were working on paying off in terms of smart weapons, and coordinated platforms.

To us, really the peace dividend hadn't come about in that form. It was the Reagan buildup that provided, I think, an overwhelming advantage and contributed in some way to the Soviet Union just figuring that "we can't keep up."

I: In terms of national defense, is there a way DARPA can still maintain its traditional role as the science honesty broker when fighting an asymmetric enemy?

Colladay: I think what DARPA can do is think out of the box, understand the problem, and have the freedom and flexibility to think about it in a different conceptual way. The Services' R&D efforts are really trying to respond to their requirements in a more rigid way—and thank goodness the Services exist to do that. Their R&D programs exist to do that. They can't step out as easily and look at things from a different perspective, and I think that's what DARPA can do. I think that's one of the reasons why we put such emphasis on working with the commanders-in-chief of the various CINCs around the world. We really need to understand the problems they face and then go back home and think about them in an unconventional way, and figure out how we can help make the CINC's job easier.

I: Does that apply to the Global War on Terror, too?

Colladay: I think very much so—even more so with this kind of unstructured enemy than we had with the more monolithic Soviet Union. I would think DARPA would be even more important and well-equipped to think about that kind of unstructured enemy, if you will, because that's what DARPA does. They sit back and think about a problem from a different perspective.

I: Like how U.S. ground troops in Iraq are using Silly String to hang on detonating wires. "Out of the box" and a simple idea.

Colladay: Ha. Interesting, and a simple idea.

274

I: Big-idea issues came from the White House, but what was the relationship with DDR&E.

Colladay: I had a very good relationship with the Undersecretary of Defense for Acquisition, who at the time was Bob Costello. He liked technology, so DARPA was a fun place for him to think about. He didn't spend much time there, but he was very supportive.

Cliff Duncan was at DDR&E at the time, and, of course, he was my predecessor, so there was no relationship that needed building there; it already existed. Plus, I worked with Cliff when I was in NASA, when he was Director at DARPA.

I had a few meetings with Deputy Secretary of Defense Taft, and Secretary Carlucci, the entrance interview and exit interview, and about three meetings in between, which were my initiative to keep DARPA on his radar screen.

I always thought it was important in the founding history of DARPA that it has a relationship with the Secretary of Defense. It, in fact, was one of the concerns I had that DARPA not be demoted in its reporting structure, and it's one of the things I talked to Cliff about when I first came. At the time, the Director, on paper, reported to USDA, and the Undersecretary of Defense for Acquisition, and we maintained that during my tenure. We had this understanding between Cliff Duncan, Bob Costello, and me that we would keep that reporting structure and I would go to both staff meetings—both the USDA staff meeting and DDR&E—and that our day-to-day would report to Cliff, but maintain that channel to USDA. So, USDA was already one reporting level below what the first Director of DARPA had in reporting to the Secretary of Defense, and I tried to keep it as elevated as possible.

It worked in my case because of those personalities, and very little direction came from the Pentagon, from those offices. So, I can't think of one case where we were sort of directed to, "Go do this because it's important to DDR&E." There were some areas where it came close to that. Through Internet protocol we had some of the first examples of hackers getting into secure systems. Of course, everybody looked to DARPA. "Well, you invented the system. What are you going to do about it?"

I: You got hit with a virus, didn't you?

Colladay: We got hit with a virus, and during one of my meetings with the Deputy Secretary of Defense, we walked into Taft's office and he said just, "Okay, you invented this crazy thing." He was not a computer jockey and wasn't interested in that, but he sure was interested when his secure computer systems were penetrated with a virus. So, when I walked in his office, he said, "What are you going to do about this?"

We marshaled our forces to deal with it, and then had a press conference in the Pentagon, where he was in the background and told me to field the reporters' questions while they had their hair on fire. This was some kind of breach of security, in fact, that was snuffed out in a matter of minutes. But it was an example of what is commonplace today, but was rare at that time.

275

But that was the most attention I think I ever received (chuckles) from the top of the Department of Defense in E-Ring.

I: —to look into cyber security?
Colladay: Yeah.

I: Did you?
Colladay: Well, we did. And I mean we were prepared with fairly good defenses against it at the time. Nothing like what exists today, but it didn't take us long to track the source.

I: What was the source?
Colladay: I don't even remember.

I: Some kid at MIT.
Colladay: (Chuckles) yeah, probably—right.

I: What strikes you as being one of your most proud moments?
Colladay: Oh, gosh, there were a lot of them. I mean, it's such a fun job being Director of DARPA and such an exceptional experience that a person in a technical career can have, that just being there and providing some leadership for the agency was a source of was pride. I mean, I was proud to be able to do that, and I thought my job was to provide top cover for the program managers and support them where I could, and provide that kind of leadership.

And I was proud of some of the technology we were able to develop—not the flashy things we did, but the simple things that made a difference.

I: Such as what?
Colladay: Well, I think, some of the computing technology and parallel processing, some of the early work in artificial intelligence and neural nets in a systems approach where we were able to share information and coordinate targeting from multiple platforms, and some of the very early work in target recognition and moving target indication—real tough problems we worked on that made some major breakthroughs. Not the flashy things, but the things that had to be done in order to field systems eventually.

I think I was proud of the way DARPA handled the submarine technology, which could've been very divisive and worked against us in coordinating with the Services. I think we accomplished some good things there, showed that DARPA could work with the Services.

I: What was it like in a submarine for two days?
Colladay: Really different—I mean, the first thing that struck me, compared to airplanes and satellites, was the massiveness of the structure. I mean there's nothing delicate about a submarine. And just the attitude of professionalism of the submarine force was impressive, and the hardships that they have to endure. It gave me a lot of respect for the submarine force.

276

But it was different. I mean, I thought it would bother me being underwater for two days, but you quickly forget where you are.

I: Did you look through the periscope?
Colladay: Oh, yeah. And we had some war games where we threw all kinds of torpedoes and countermeasures in the water with a lot of submarines playing "enemy." And it was hectic at times. I appreciated what they have to deal with.

I: What was it like sleeping?
Colladay: That was not a problem (chuckles). We went out in the middle of the night, on a night of a new moon, so it was pitch-dark, in a rubber raft, and the submarine surfaced and picked us up, and we dove, and were down for a couple of days. It was quite an experience for a space jockey like me.

I: "Here I am, the Director of DARPA, in a rubber raft in the dark."
Colladay: (Laughs.)

I: Any regrets?
Colladay: I guess a few of them I've already mentioned: not being able to recruit more people from industry; and not being able to more quickly damp-down the hyperbole in the National Aerospace Plane program so that it could've settled into a longer-term, good hypersonics research effort.

But not many regrets. I mean, I look back on my tenure with such fond memories. Maybe I've sort of repressed the regrets, but I don't remember any that stand out, other than those few I already mentioned.

I: Any projects you wish you had pushed a little harder?
Colladay: Yeah. I was a skeptic on ASTOVL, affordable short takeoff and vertical landing. It turned out to be one of DARPA's big successes because we'd made a run at it several times over the previous 20 years. I didn't stop it, or stand in the way, or put a roadblock up, but I wasn't a strong advocate, either. And it turned out I should have been a strong advocate. But DARPA was successful in spite of the fact that I didn't throw a lot of my support behind it at first. I left when it was just starting, but I could have given it a stronger parting shot than I did.

I: What was it like leaving DARPA?
Colladay: It was hard—yeah. I mean, I knew when I came onboard I didn't want to stay too long. If I was going to impress upon program managers that they should not stay longer than three years, then I knew I had to set an example by not staying longer than that.

I think I missed DARPA the first few years—just that I would have liked to have probably stayed another year longer than I did. But it was opportunity-driven to leave when I did, and so, from that standpoint, I don't have any regrets. But just the fun of working in DARPA—you always miss that.

277

I: Was it an administration change?

Colladay: No, actually. I spanned the first part of the first Bush administration, and could have stayed, but that factored in to why it was timely to leave, though, because I could see that a commitment would need to be made for the next administration. I think I was six months into the administration, but generally, a longer term—up to four years—would typically be required. It's not a political appointment, but, you know, I didn't see myself staying that long. So, while I went through the transition, a new administration did factor into the timing.

I: Was there a change in the philosophy between one administration to the next?

Colladay: I didn't see it.

I: There was a change in Secretaries—right?

Colladay: The Secretary changed from Carlucci to Cheney, and while I was there, I didn't see a big change in philosophy. R&D was still emphasized. DARPA was still an important element of that R&D mission, and I had strong support from the Secretary—both Secretaries. So, there was no tension created by a change of administration.

I: Was there any restructuring in the bureaucratic reporting?

Colladay: I could see that was probably going to happen, where DARPA reporting finally was dealt down the notch that I feared it would when I was Director.

I: Anything else?

Colladay: No, just that DARPA has a great reputation, and deservedly so. It's not an inflated reputation. They deserve the reputation they have, in my opinion. They've got a lot of smart people working hard to try to do what DARPA was created to do. And if we didn't have a DARPA today, we'd have to invent one. It's that important, I think, to our national defense.

A lot of people try to mimic it in all kinds of institutions, including industry. And I've been approached for the last 20 years about, "How can we create a DARPA in our environment?" And you just can't replicate it. It's a unique creation that can't be cookie-cutter created. It works because the Services have their own R&D, and DARPA, if you will, is an overlay that lets it be free of the institutional requirements that most institutions have to worry about. And it works because of the turnover; because it succeeds. If it fails, it's because they reach too far, not because of mismanagement. And I really think it's an important element of our national security.

I: Why can't it be replicated?

Colladay: Well, for example, the question comes from NASA a lot, and NASA has an operational mission to fly to space, and it has an R&D mission. So, on the surface, you'd think, well, it's very similar. But, psychologically, the culture is different in NASA than in the Services and the military. The military has a very structured, requirements-driven process, and DARPA is kind of—at least

conceptually– a relief valve on that disciplined process.

NASA has more flexibility across the board in many respects in its whole mission, so it's free to do some of the kinds of things that DARPA does, but then it takes the burden of being responsive to a broad breadth of requirements; whereas, DARPA can afford the luxury of just doing what it wants to do, not meeting anybody's requirement.

So, I think the main thing is it's an overlay organization to what exists anyway, and so, it doesn't need to respond to anybody. You know, it's hard to create that kind of organizational structure anywhere else.

I: Did you deal with the JASONs at all?

Colladay: Yes. I looked to that group as individuals, primarily, to offer advice and counsel. I came from an organization at NASA that had a very structured process for getting advice. I mean, that's the way NACA (National Advisory Committee for Aeronautics) was formed. And NASA maintained that aeronautics committee structure, and applied it to space, and so advice came through formal channels.

As DARPA Director, it was more fun, because I could just tap individuals whom I respected around the country. JASONs was a group that had a lot of smart people whom you could tap for advice. So, the advice I sought was more relational-based, with people I knew and respected, than the structured one in NASA.

I: Any examples?

Colladay: I can't think of a specific example of a program. It was just—there were a lot of people I respected and called on for advice

A lot of times you get these ideas, and the DARPA Director gets a lot of advocate input from program managers, and you need to sort of do a sanity check on that. So, you pick up the phone and you call people who you know are going to give you a straight answer, and a lot of it is, "Is this going to work?" "Does this make sense?" "Would you do it if you were me?"—That kind of thing. And that's an important channel of input to the DARPA Director.

I: Dr. Colladay, thank you.
Colladay: Thank you.