President Toomas Hendrik Ilves discusses how his country went from living behind the Iron Curtain to leading the world in innovation and technology.

To say that Toomas Hendrik Ilves has led an interesting life is an understatement. Born in Stockholm to Estonian refugees who fled from the Soviets after the Second World War, he was raised in New Jersey just over the river from New York City, graduated as valedictorian from Leonia High School, and attended Columbia and Penn, where he earned two degrees.

In the 1980s, he covered the Velvet Revolution as a journalist with Radio Free Europe. In the 1990s, he returned to his parent's homeland to start a different kind of revolution – one that was driven by technology and fueled by the same fire for freedom that brought communism to its knees. Under Ilves' leadership, Estonia has become, in the words of The Guardian, an "Internet Titan" – a nation that the human rights organization Freedom House last fall called, "among the most wired and technologically-advanced countries in the world."

Nearly 80 percent of Estonians are connected to the Internet. For the past 10 years, WiFi has been available for free nationwide. Estonians pay their taxes online, do their banking online and, increasingly in recent years, even vote. Every Estonian over the age of 15 also has what Ilves calls a personal access key, a card similar to a driver's license with one key difference – it contains a SIM Chip. With the chip, Estonians can use the card for a range of services – from filling prescriptions to riding on a bus. They can also use the card to access their medicalrecords, personal tax data, and other information central to their lives. Recently, a pilot program was launched to teach programming to Estonian children beginning in the 1st grade.

Central to all of this innovation has been Ilves. From 1993 to 1996, he served as Estonia's Ambassador to the U.S., Canada, andMexico. Later, he served as the country's Minister of Foreign Affairs, and was a member of both the Estonian Parliament and European Parliament. Elected President of Estonia in 2006, he is currently serving his second and -- because of term limits -- last term.

The Forum spoke by phone with President Ilves on February 20th about the role technology has played in his country's development and how his government has embraced and encouraged innovation in recent years.

Ripon Forum: Just over two decades ago, the people of Estonia lived behind the Iron Curtain. Today, they live in a country that is referred to as "E-stonia" and has set the world standard for empowering people online. Did this focus on innovation happen by accident, or was it by design?

President Ilves: Both. There is some serendipity there, which we can get to later on. But in the beginning, there were a couple of people who started thinking about these things, and I was one of them.

What did we face in 1991? After 50 years of Soviet occupation, we had infrastructure at the level of the 1930s. We also had a population in northern Estonia who watched Finnish television and knew that our two countries had essentially been at the same level of development in 1939, and that we were now really behind. We were also limited in what we could do -- you just can't build things overnight. On the other hand, we were also at the start of the Internet revolution. Mosaic came out in 1992, if I remember correctly. And so I thought, well, this is the way we ought to go.

The second motivation was reading a fairly Luddite neo-Marxist book by Jeremy Rifkin called "The End of Work." The thesis of his book was basically that automatization and computerization were going to be the death of work. As an example, he wrote about a steel mill in Kentucky which employed 12,000 people and produced X tons of steel. The mill was then automatized, and continued to produce the same amount of steel if not more with some 100 workers. From the Kentucky perspective, this was of course terrible. But from the Estonian perspective, it was intriguing, because our fundamental existential angst is tied to our smallness.

So I reversed the logic and said that this was how we could increase our functional size by many orders of magnitude. In other words, if 100 people can do the work of 12,000, then my country does not have to suffer from the then prevailing logic that economic success required an economy of scale. From there, I figured we ought to computerize as much as possible. I had the amazing luck of having a really innovative math teacher in 8th grade in Leonia, New Jersey who taught us how to program. And we'd write our programs out on perfo tape, and then we'd check them by sending them via modem to a computer 50 miles away. Once you learn how to program, it's not very difficult.

And so I got together with the Estonian minister of education, who had a PhD in physics, and we drew up a plan to computerize the school systems so all schools would be online. We did that in 1995. By 1997-1998, all Estonian schools were online. As with all education reforms, you never really feel it or see any effects until about 15 years afterward. We are seeing that right now. We have a huge number of startups in Estonia. And I remember reading in a venture capitalist magazine about two years ago an interview with a VC person from California who said there's nothing happening in Europe. But there's this place called Estonia, where in fact, all kinds of things -- most famously Skype – are going on.

The other thing I personally fought hard against were legacy technologies. I remember in 1993 having to fax the [U.S.] State Department from the embassy in Washington; I couldn't send them an email because they only had Wang computers. The same thing happened here when the City of Helsinki in Finland decided to upgrade to digital phone connections. They offered to give our capital city of Tallinn for free their 1970s analog phone telephone exchange. This would have covered all of our needs for free. But we had a 1938 phone system, and they were offering us a system from the 1970s. I yelled and screamed and fought tooth and nail against accepting this gift because we would be stuck with legacy technology. We don't want that. And the government took me seriously and decided to actually invest in a digital phone exchange -- which then gave me better connections between Estonia and Washington than from the Estonian Embassy, where I was at the time and the State Department 3 miles away.

The first thing we ever did with government computerization was put tax returns online. You can fill your taxes out in about five minutes because they're all pre-filled. Everything's added up and done for you and you just have to look at it and see if it looks right. We also had the additional sweetener that if you filled out your tax return online, you got your money back in a week. If you did it on paper, it might take maybe three months.

The next step -- and this is where the serendipity comes in – is we thought that if this tax thing worked, we wanted to put other things online and computerize administration in general. We realized we were too poor to have one centralized system with a big server bank -- it was just too expensive. In order to solve this problem, we developed a system we call the X-road using an enterprise service bus. It's all interconnected and everything has to be authenticated. So we ended up with this much better architecture than most countries and most companies have for secure communication.

On top of that, we have a two layer authentication, which means that -- Google has this now -- if

you want secure communication, you have to stick in a card and toggle in numbers which are yours. And that's the two levels -- one is a chip and the other is what you put in yourself.

This is infinitely more secure than giving your credit card number with a 3-digit CVC code. I don't understand how people do that, but they do.

Ripon Forum: You all had that before Google though?

President Ilves: Oh we've had it since 2003. It's not as if they stole it -- it's kind of a no-brainer. It's just that we did it. And other countries since then have adopted the same system.

The second part is that we are using PKI, Public Key Infrastructure. This binary key code is a sophisticated system with encryption that was conceptually invented in the 1960s but not put to use on a wide scale. There's a public key and a private key. It means that we have extremely secure communications. So far, it hasn't been broken, except from the inside. But even then, as soon as someone does something illegal, they're immediately flagged. When a police woman was checking up on her boyfriend, we discovered it immediately.

This worked and then we started attaching both public and private services to this system, from banks to digital prescriptions. Which means that if your doctor says you need penicillin, he toggles it into the computer, go with your card to any pharmacy in Estonia, stick in your card, and the pharmacist will say, "Ok, you get this." It means that if you need a refill, you don't have to go to the doctor. You don't need another chicken scrawl prescription. He'll say, "Right, this didn't work -- I'll give you more." Then he'll toggle it into the computer.

We have also done something that here and elsewhere finds even more opposition from the medical establishment. In Estonia, you own your own data -- including your medical data -- so you have the right to access it any time, and you do it with a secure system.

What that means, however, is that we've broken a two thousand year Hippocratic tradition in which the doctor is the priest and the patient is the supplicant. If you're told in most places you

can get a second opinion, all you have to do is authorize some other doctor to look at your medical records. You don't have to get two opinions -- you can get 200. It's kind of tedious if you want to get that many, but the point is that in owning your own data, you can do whatever you want with it.

The other benefit of all of this has been transparency. You can't bribe a computer. All kinds of transactions become public. Greater transparency means less corruption. What we also have here is a digital signature. You can sign legal documents with your ID card and a binary key code, which assures the recipient that who is sending the document is really the person who signed it. In the beginning of December 2012, we did our 100 millionth digital signature -- which isn't bad for a country of 1.3 million.

Ripon Forum: And that started about when -- in the mid-90s as well?

President Ilves: That was later -- in 2001, I think, because I was in government when we did it. The card is basically -- I don't like using the term ID card. I prefer using the term personal access key. Because the fact is it's not a card. It's basically a SIM card -- a SIM chip card. The chip is embedded in plastic, like European credit cards these days. And almost as an afterthought, it can and does serve as an ID card. You can scan it as you go across the border. Many people, especially for some reason in English-speaking countries are averse to a national identity card, but that is merely one of some 330 services available to the card, and its most primitive.

Ripon Forum: But it has everybody's picture and physical identification?

President Ilves: It's on there, but its fundamental use is in the e-governance system. The problem many people have is that this is "Big Brother". My argument has been that in an age of complete market failure, when it comes to online security, if a bank writes off computer credit card theft as a business expense when it is avoidable, or when an electrical company calls a cyber attack on an electrical plant an act of God, this is for me tantamount to market failure.

The government has the wherewithal and capacity to actually provide secure communications

for the citizen. You have to trust the government a little bit. But whom do you trust more -- putting your credit card number online with a three-digit CVC code? Or is the government sort of the guarantor of your identity?

It doesn't sit with some people, but I trust my government more than I do some open communication on the Internet. As it is, you've read so many stories about credit card numbers being stolen.

Ripon Forum: It happens all the time here.

President Ilves: Well, you can't do that with this system because each identity is unique. You'd have to put together two separate things that you can't put together -- the person's own number, which he has in his head, and then the SIM card, which is in his possession.

I think that, eventually, countries will adopt in one form or another a two-factor authentication system, because it's the only thing that's secure right now, and it will have to use binary key code system because that's the only one that works. Similar systems have been adopted by many countries in Europe, but they don't have the range of services behind them. We just try to put as much online as possible.

The fundamental thing is that you have to prove your identity online. If you do that, then you have access to services and you don't have as many bureaucrats and you don't have to do what you have to do in many countries -- which is to pay a bribe to get something that already belongs to you.

Ripon Forum: You touched on many things, but are there any specific policies and proposals – such as tax incentives or regulations -- that make this type of innovation possible?

President Ilves: The main incentive which got everyone used to it was having a really easy

way to fill your taxes. Of course, it does help if you have, like this country, a flat rate income tax.

Ripon Forum: Well, that's another debate.

President Ilves: But a flat rate income tax is much easier to do online. You just add up what you made and you take a percent.

Ripon Forum: And that is one of the main incentives that got people into the whole concept?

President Ilves: The most awful thing I ever did when I was younger was every April fill out my tax return -- by hand.

And one of the key things to understand about e-government is that it can't just be a paper format that's available online. It has to be interactive. What you are offering has to have real added value and not simply be a form on a computer screen.

But basically, we've had the fortune of people sort of going along with this. Of course, sometimes you get really annoyed with the degree of transparency, because every expenditure is put online. And in fact, I think one of the big philosophical issues that we will face more and more is what is privacy and what is transparency. Not that it's new. We are very transparency-oriented.

Ripon Forum: And that is one of the main incentives that got people into the whole concept?

President Ilves: The most awful thing I ever did when I was younger was every April fill out my

tax return -- by hand. And one of the key things to understand about e-government is that it can't just be a paper format that's available online. It has to be interactive. What you are offering has to have real added value and not simply be a form on a computer screen.

But basically, we've had the fortune of people sort of going along with this. Of course, sometimes you get really annoyed with the degree of transparency, because every expenditure is put online. And in fact, I think one of the big philosophical issues that we will face more and more is what is privacy and what is transparency. Not that it's new. We are very transparency-oriented.

For example, we pushed through in the European Union a provision that all EU public money must be publicly reviewable, after all it is public, i.e. tax-payers money. Forty percent of the EU budget -- which over a seven-year period is a trillion Euros, or $1.3 trillion -- goes to agricultural payments. Until the late 2000s, that figure was completely non-transparent. No one knew how much anyone got. We pushed through with a few other countries that this had to be transparent and we had to know who gets public taxpayers' money. But then that was struck down by the European court for violating privacy.

We are more on the transparency side. We don't want to know what you do with your own money. But we want to know where our taxpayer Euros go. And that I think is going to be a very big conflict, not only in Europe, but elsewhere as well in the future.

Ripon Forum: To an extent that the Estonian people went from living in a closed society to one that is very open and transparent today, was there a cultural hurdle to overcome in gaining acceptance for these changes, or were they embraced?

President Ilves: Well, there were early adopters and there were late adopters. For example, when we introduced the digital prescription, there was a huge amount of grumbling because it was different. In the beginning, the first couple of months, no one used it. Six months later, it just took off, with a 95% penetration rate because people started seeing how comfortable it was.

One area where uptake has been slower is electronic voting. You use the same card and two-level, two-factor authentication process to vote. Twenty five percent of the people in the last

general election voted by computer.

Ripon Forum: You had no hanging chads then?

President Ilves: No. People are more worried about whether their votes are anonymous. But there are all kinds of skeptics who come here to look at all of this, and it looks pretty good. And it has a much, much lower failure rate than those same chads.

Ripon Forum: What about cybersecurity? Given the continuous attacks underway on computer systems around the globe, how vulnerable are Estonians to an online attack?

President Ilves: What we have experienced in Estonia are D-DOS, Distributed Denial Of Service attacks, which basically shut down your services because your servers are overloaded with too many messages coming in. Those attacks don't get into the system. They just isolate you.

Ripon Forum: But is it a continuing problem for your country just as much as it is here in the U.S. and elsewhere?

President Ilves: It's less of a problem in that they're not as interested in us. However, my friends at Skype here said it's just ridiculous – they're under constant attack.

As a sidebar, I worked for years trying to convince European governments to pay more attention to cyber. One large country in Europe, which speaks English, said, "No." Then all of the sudden, David Cameron and William Hague come to a Munich security conference, and all they talk about is cyber security.

When I asked what happened an old friend from the UK government said: we realized how much money we were losing to cyber theft, from others stealing our intellectual property, the result of our R&D.

Our wealth is a function of intellectual property. And if you look at the testimony by now former deputy director of the FBI, Sean Henry, before Congress in April of last year some time before he left the government, he talked about a company that lost in one weekend 10 years and $1 billion of R&D. It got sucked out. So this is an increasing problem for advanced countries whose national wealth is a function of innovation, research and development.

If you look at drug companies, they put a huge amount of investment in pharmaceuticals. And if someone sucks it out, they haven't paid anything for it and someone else has the formula and they've started producing it. That's going to destroy our economy unless we get a handle on all of it.

Ripon Forum: Looking at all of the changes you have help put in place, what has been their economic impact in terms of jobs created and growth in Estonia's GDP?

President Ilves: Well, it's hard to say because what do you compare it to? Certainly, there are many, many investments coming into Estonia because of the ease of doing things here. You can set up a company in 15 minutes online. It's not three months like in some countries in Europe. It's hard to measure because compared to what? What it would have been otherwise? But we don't know what we would have had otherwise. Certainly in terms of interest and investment and ease of doing business, companies love it. So that's been good.

In terms of jobs created, our problem with jobs is that we can't produce enough software engineers. At the height of the crisis here, I had a meeting here with the organization of IT companies. I asked them, "How is the economic crisis affecting you? And they replied, "We still have a severe labor shortage." So it's one area where unemployment is really nonexistent.

The problem is that not everyone has an IT company. There are other areas as well. But at least right now, and I suspect for quite a while, if one knows how to write code, one will have a job.

Ripon Forum: You mentioned earlier your 8th grade teacher in New Jersey. To the extent that you did spend a good part of your childhood in the United States, and in fact graduated from two Ivy League colleges, how much did your background affect your thinking on innovation and change?

President Ilves: Maybe indirectly in terms of "let's try something." Clearly, the math part or the computer science part had an effect because I knew that in fact that you can do something you want. And in fact this year we've instituted a program where we start teaching kids to program in first grade.

We've also introduced a new math program that is sort of a computer-based math. It's sort of like statistics; it's pointless to do statistics if you don't know how to use a computer. No one who really does statistics does it by hand. But the idea is that you can, as a child, learn how to program just as you learn a new language. I became a firm believer of that at an early age, so that helped.

More broadly, because of my education's fundamental effect on me -- between my parents fleeing as children from the Soviets and the Nazis and my Columbia "Great Books" program -- I'm sort of a committed liberal democrat. Small "l." I'm liberal, but it's more Locke, Hume, and Mill.

I think that's where we all have to follow, and that's guided my thinking in all sorts of things, not just computerization.

Ripon Forum: One last question -- what advice, if any, would you give U.S. lawmakers as they work to embrace technology and promote innovation here in America?

President Ilves: Create a legal framework for secure communications, which comes down to having a legal signature that works only if you have the right architecture.

If things have the force of legal contract online, you can move fairly quickly.

Original article in the Ripon Forum magazine (PDF).