UN-CHAINED: EXPERIMENTS AND LEARNINGS IN CRYPTO AT UNICEF

CHRISTOPHER FABIAN

UNICEF has a 70-year history of investing in new solutions that benefit children. Examples of such technologies over the past decade include feature phone platforms like RapidPro, which, with more than 4.5 million users in 50 countries, has allowed governments and their partners to hear from young people via SMS about where diseases are spreading, what services they need most, or where relief might be needed after a disaster.[1.] Smartphone app MobileVRS has helped raise the birth registration rate in Uganda from 28 percent to 70 percent.[2.] The mHero platform has provided real-time information that assists in the fight against Ebola by connecting health workers who needed actionable information.[3.] Now we are preparing for a change that may rival the shift brought on by the exponential increase in mobile phone ownership and access during the 2000s—the possibility of immutable, accessible, decentralized global networks of information and data. This potential change is often described as the era of blockchain for development.

WHAT IS UNICEF?

The United Nations Children's Fund, universally known as UNICEF, works to protect the rights of children around the world. It is a $5.5 billion agency with over 12,000 personnel working in more than 190 countries.[4.] In its efforts to provide opportunity and choice for the world's most vulnerable children, UNICEF works with governments to build programs that ensure that every child has access to education, health care, personal identity, and other essential rights. The organization works in both emergency situations (344 emergencies in 2017 alone) and more traditional development and non-emer-

gency settings.[5] The agency uses data from household surveys, tools like RapidPro, and science platforms like the Magic Box to identify where and how it can help children achieve their full potential.[6]

UNICEF, like any organization that is 72 years old, needs to reinvent itself frequently and rethink the tools it uses in a world of rapid technological, political, and social change. To help the organization prepare for change, UNICEF's Venture Fund invests in emerging technologies and creates portfolios of products and entrepreneurs that can benefit humanity.[7] In so doing, the Fund team considers the size of a new industry and its potential to have a positive impact on a billion children. In 2017, no technology had a steeper "hype-curve" or greater promise for solving any conceivable problem than blockchains, digital-crypto assets, smart contracts, and distributed ledgers.

While the UNICEF Ventures team tracks rapidly accelerating areas of scientific and technological progress, it adheres to a set of principles derived from years of failed attempts to build technology in some of the most challenging environments in the world.[8] This article lays out three areas where UNICEF Ventures is using principle-based investment to explore the impact blockchain will have on UNICEF's work.

Since 2015, UNICEF Ventures has been working to understand the role blockchain can play in a world now offering increased transparency and connectivity. We on the Ventures team tend to follow a heuristic learn-by-doing model with any new technology, and the last two

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The Ventures team also makes larger secondary investments in platforms like UNICEF's drone testing corridors in Malawi and Vanuatua, as well as the Magic Box, an open source analytics platform that combines data and engineering skills from companies like Amadeus, IBM, Google, Redhat, and Telefonica to produce insights that help the organization make better real-time decisions. Previously, Chris's teams have built solutions for problems facing low infrastructure environments including award-winning work on RapidPro, an SMS-based information system with more than 4.5M active users in 50 countries.

Chris's teaches at NYU, Tsinghua University, IIT Delhi, and Singularity University and is an invited speaker at major technology companies, national government, and United Nations senior leadership fora exploring how to create fairness in a world of rapid technological change. His holds fellowships from the Tribeca Disruptor Foundation and Edmund Hillary Fellowship, both focusing on investments in a more equitable global future. In 2013 he was recognized as one of TIME Magazine's "100 Most Influential People."

years have been no different. We have built prototypes and sample applications. We have used the knowledge we gained to create new partnerships. We have shared our findings and failures with other organizations that are similarly interested.

Our explorations have led us to see three potential uses for blockchain:

1. To focus more resources on problems that affect children
2. To create greater efficiencies within the public sector
3. To fundamentally disrupt some existing models for development and social good

OUR PROCESS FOR EXPLORING NEW TECHNOLOGY

The process our team followed for blockchain is similar to the one we followed when exploring previous emerging or frontier technologies. It goes like this.

First, we develop an understanding of what the technology is. This involves asking simple questions such as, What is a token? What is a blockchain? What is a smart contract? What do "permissions" mean? Then we begin to build our own products. We do this expecting failure and are rarely disappointed. Our failures thus far include an app to help register a refugee on a blockchain and a system for collaborative decisionmaking. After each attempt, we record what we learned, what did and did not work.[9] Our various failed attempts gave us stories to tell and created a framework within which to talk with our partners.

Second, we seek to establish partnerships. While working with blockchain, our teams spent several months with friends and collaborators at conferences, at workshops we hosted, and at events that addressed questions stemming from our initial applications: Can blockchain solve the question of identity? (probably not by itself) Is a crypto-kitty similar to a food voucher?[10] (no, but it's not entirely different) Should we have a token for . . .? (almost certainly not). This time with our colleagues was invaluable, as it allowed us to be playful while exploring a new technology and to ground that exploration in the needs we had seen through our own experimentation. Our partners in turn helped us develop our first call for proposals for a cohort of blockchain companies that the Venture Fund would invest in.

Third, we develop a call for proposals to find the companies the Venture Fund can invest in. We have created portfolios around data science, virtual and augmented reality, and drones and UAVs. Blockchain has been no different, and we would not have been able to define the parameters of this call or conduct credible assessments of the companies that applied if we hadn't first built up our own internal resources and understanding.[11] Moreover, we would not have received as many diverse applications if we had not built up a network of partners who could share our opportunities through hackathons, media, and personal connections. These portfolios enable us to manage the risk of a new technology area and to test multiple hypotheses simultaneously. This approach allows us to start with a problem space without having to define the solution so closely that we are stuck with a specific blockchain, or with a particular and exclusive technology approach.

We grounded our explorations in three identified areas of need—resources, efficiencies, and solutions—which we examine below.

OUR FIRST EXPERIMENT

In 2015 we conducted our first experiments with a blockchain—specifically, with the Bitcoin blockchain. Our hypothesis was that we could take a photo of a person, link it to their personal information (date of birth, name, etc.), encode those elements, and publish a cryptographically secure link to the encoded information on the blockchain. That link, because it would be on a public, permissionless network, would last "forever" and would be an immutable identity. We further posited that, because a UNICEF address would post that link to the blockchain as a microtransaction, it would be linked to a credible organization. This would provide irrefutable provenance.

Our initial tests had positive results. We were able to register and encrypt photos of our team members. We then were able to recover the photographs using the link posted on the blockchain. Finally, we compared the photo to the actual team member, creating a cycle of identity capture, management, and validation.

But, as with many early experiments, we built the technology prototype without having any users and without the context of a larger system. For our prototype to work, government officials would have to be trained and would need devices on which the UNICEF application was installed, and we would need to finance the cost of many repeated transactions on a public ledger. Every user would have to be trained to memorize their personal passcode (in a world where even sophisticated users have "password" as their password). Our first pilot failed quickly and taught us a great deal.

OUR FIRST PROBLEM AREA: MORE RESOURCES TO HELP CHILDREN

At the time of this writing, June 2018, the market capitalization of all major cryptocurrencies is around $250 billion.[12.] A quarter-trillion-dollar capitalization, having grown from nothing, must certainly raise questions, including this one: Is this a pool of resources that can be tapped to increase funding for global development and humanitarian work? Looking at some of the most robust cryptocurrencies, such as Bitcoin and Ether, we must ask if these relatively stable currencies offer an opportunity to finance the work of international development in a different way.

There seems to be such potential. In early 2018, the Pineapple Fund donated $55 million in Bitcoin to charities and included the tagline, "Because once you have enough money, money doesn't matter." Mexican crypto-exchange Bitso offered to send donations to earthquake survivors that were made in Bitcoin, Ether, and XRP (three current major cryptocurrencies). UNICEF France mobilized the online gaming community to "mine" Ether on their own computers and send the newly minted digital coins to a UNICEF account.[13.] This simple prototype ended up raising 84 Ether (more than US $40,000 at the time of writing).

Many of the organizations that accept cryptocurrency in the charitable and development space translate it directly into standard national fiat currency, as was the case with our Ether mining experiment. In such cases, when an amount of cryptocurrency (e.g., 2 Bitcoin) is "sent" to a charity, it goes initially to an intermediary NGO or company that translates it into fiat (usually dollars or euros), takes a commission, and passes the fiat currency along to the intended recipient. This is a mostly win-win-win approach, as it allows someone to give cryptocurrency in a form that is easy and comfortable for them, then allows that currency to be translated into the "normal" currency the receiving organization prefers.

This middleman approach, however, does not enjoy some of the main benefits of cryptocurrency. Because it gets exchanged for fiat quite quickly, the benefits stemming from that donation are not linked to the actual funder. The cryptographic provenance ("electronic fingerprint") that allows a recipient to identify the history of any Bitcoin or Ether it receives has been broken. In light of this, the Ventures team soon started to ask, what if we could hold crypto-assets on our books without exchanging them for dollars? That would enable UNICEF to receive, hold, and use a cryptocurrency in its original form.

Efforts to ensure that cryptographic assets classifications follow the necessary laws and regulatory frameworks are occurring throughout the technology sector, and within certain governments that see the potential. The recent U.S. Securities and Exchange Commission ruling that Bitcoin and Ether are assets, not securities, certainly helped point the field in a new direction.[14] As more governments and markets solidify their positions as the "grandparents" of cryptocurrencies, organizations will be increasingly interested in bringing these assets onto their own books.

Being able to prove where donated money is going is important. To achieve that level of transparency with cryptocurrencies, organizations will need to be able to receive, manage, and distribute crypto funds without converting them. In other words, to track where your Bitcoin donation went, it has to end up at the point of need *still as Bitcoin*.

OUR SECOND CHALLENGE: INCREASED TRANSPARENCY MEANS OPERATING DIFFERENTLY

An international organization like UNICEF moves a lot of money. In 2016, UNICEF procured $1.6 billion worth of vaccines, paid the salaries of 12,000 global staff and subcontractors, and in 2017 transferred $158 million in cash to more than 10 million people in need.[15] The more we can reduce friction in these transactions, the more of each dollar can reach its intended recipient.

In addition to the regulatory questions surrounding cryptocurrency, there is a range of governance and security issues. Financial disbursement usually is done through an existing table of authority: one person makes a request for money to move, then someone above them in the accountability structure signs off on that request. Much of this functionality can be described in what is known as a smart contract (see "Blockchain for Global Development" in this issue), in particular a multisignature wallet (see "Blockchain and Property 2018" in this issue) that control access to an organization's cryptocurrency.

A multisignature wallet allows an organization the same functionality that exists in normal financial tables of authority, but it can write that functionality into code that is publicly viewable, auditable, and difficult to compromise. The following is an example of how a standard table of authority might be described in English: "In order to move X money, person a has to make a request, person b has to co-sign that request, and person c has to look at (a + b signatures) and authorize the movement of X money." That same logic can be written into a smart contract, which will automatically check what has happened and who has agreed at various stages, and then

WHY "KEEP CRYPTO CRYPTO"

The approaches we consider most valuable are those that enable us to receive bitcoin, for example, then to invest it without converting it into a fiat or sovereign currency. As Vitalik Buterin wrote recently on Twitter, "Reminder: cryptocurrencies are still a new and hyper-volatile asset class, and could drop to near-zero at any time. Don't put in more money than you can afford to lose. If you're trying to figure out where to store your life savings, traditional assets are still your safest bet."[1.]

Having a system that enables us to receive, store, and distribute the cryptocurrency sent to us would keep its volatility firewalled from traditional organizational resources. Practically speaking, that may mean having a separate section in a financial report for cryptocurrency. It will certainly mean considering what type of asset it is within the relevant jurisdiction of one's organization or what the impact of dispensing it would be in the jurisdictions where it is being spent.

This may seem like a lot of work, but we believe it has benefits. In initial analyses, crypto-donors' expectations tend to differ from those of traditional donors. For example, early investors in or architects of various blockchain-related systems are comfortable with a higher level of experimentation, failure, and risk than traditional development donors (e.g., governments and foundations). This may create opportunities to develop funding proposals or programs that present greater risks in the early stages but potentially lead to greater innovations.

The transparency of those technologies may also create new expectations about how accountable organizations can be. As more of our partners offer services that can be paid for in cryptocurrency, the number of ways to disburse Bitcoin, Ether, or similar currencies will increase. One can imagine a world in which pharmaceutical companies or connectivity providers (e.g., mobile network operators) accept payments in Bitcoin, which would enable international organizations holding these assets to invest them directly—and to enable their donors to see exactly where their resources are being used and how. If this type of radical transparency and traceability becomes an assumption for international development money from both individual donors and governments, large organizations that depend on voluntary funding would do well to start understanding the intricacies of the new financial networks sooner rather than later.

[1.] Vitalik Buterin is a programmer/writer who was a cofounder of Ethereum and *Bitcoin Magazine*.

implement the same checks and balances as a regular contract—but it will do so faster, more transparently, and in an easily repeatable manner. This type of organizational security—essentially replicating existing processes but describing them in a new technology—can enable an organization to start working with blockchains with the comfort of knowing that there is

both something new and something familiar at play.

The ability to describe contractual logic on a public blockchain means that the author (or authors) of a contract can write stipulations into code; for example, "Only pay the vendor when the goods have been received" or "When the vaccines have arrived, create a new purchase order for one of the five delivery companies on the following list." This means that, once a certain contractual logic has been described, it can be replicated easily and at low cost. A second benefit of writing contractual logic onto a public blockchain is that it becomes visible and immutable.

A publicly visible, immutable contractual vehicle that can automatically check for certain conditions and carry out actions based on those conditions creates opportunities for an organization to be more efficient. We can imagine a future in which many human actions—verifying that a shipment has arrived by filling out a paper form, waiting for that form to be transformed into an electronic record, waiting for that record to go to a supervisor, and so on—can be done quickly and automatically, thereby saving a large organization and its partners time and money.

A secondary effect is that, because an organization like UNICEF would describe its logic publicly, it could immediately begin to get advice and share best practices with other public institutions and perhaps find new ways of doing their work because of sharing.

Smart contracts can easily connect to other smart contracts. One could imagine UNICEF connecting its smart contracts to those of its partners, thereby creating logical pathways for sharing payments or deciding on actions jointly. Radical openness, however, is an imposing concept for any organization. Thus the Ventures team decided to start with a concrete problem and, most importantly, to work in a context where smart contracts could actually be used.

UNICEF's Kazakhstan country office, one of its 190 offices around the globe, is located in Astana. In the first half of 2017, the Kazakhstan team had been exploring faster and more agile ways to complete contracts. Through discussions with local startup incubators and accelerators, and with partners in the Kazakh financial sector, the UNICEF office offered a challenge: could local software developers, working in Solidity (the programming language used to create smart contracts on the Ethereum blockchain), create an electronic version of a traditional UNICEF payment contract.

In October 2017, UNICEF Kazakhstan invited more than 150 software engineers and developers from the Russian-speaking world to a hackathon in Astana. Our lead blockchain engineer came from New York to work with local technology experts, finalize the challenge, and launch the two-day workshop.

During the hackathon, our team presented the need for a smart contract that would enable transactions between two specific entities: UNICEF and a hypothetical software development consultancy. Our setup mirrored a typical UNICEF-vendor relationship: a service is desired; a contract is created to break that service into specific deliverables; deliverables are achieved (or not); payment is rendered; the contract is concluded.

The challenge was to create the Solidity code that would automatically pay deliverables on their completion. The basic logic that would power the contract would be as follows: A service is desired, a contract is created, and Ether (cryptocurrency) in the amount established in the contract is held in escrow. As each deliverable is marked complete, the smart contract checks the code the vendor produced to confirm certain indicators of

UNICEF Hackathon in Astana Kazakhstan, 2017

Source: The Astana Times.

completion. When the smart contract confirms that each piece of the code meets certain requirements, it transfers a predetermined portion of the Ether to the software developer.

As with many early stage efforts, we learned more than we gained directly from the exercise. First, and not entirely surprisingly, UNICEF contractual logic is complicated and can be confusing to well-intentioned software developers. We spent a good portion of the time explaining our own procedures without even getting close to technical development.

Key blockchain lesson learned— Simply saying blockchain does not fix a broken system. As with any technology, the foundation needs to be clean and solid before building something new. We must be able to express our problem statement clearly, including describing the need and the stakeholders, before we bring that problem into contact with new technology.

Second, we learned that, although Solidity is similar to existing languages, some of the fundamentals were missing for the software developers we brought together. We also spent a significant amount of time teaching the programming language rather than applying it to actual problems.

Blockchain lesson learned—The blockchain technology itself is moving quickly, and there may be fewer programmers and developers who are familiar with the technology than are needed. We suggest that efforts to build capacity in key markets begin immediately by teaching fundamental skills and concepts of distributed networks, as there will be a learning curve, even for programmers who are used to corporate software development.

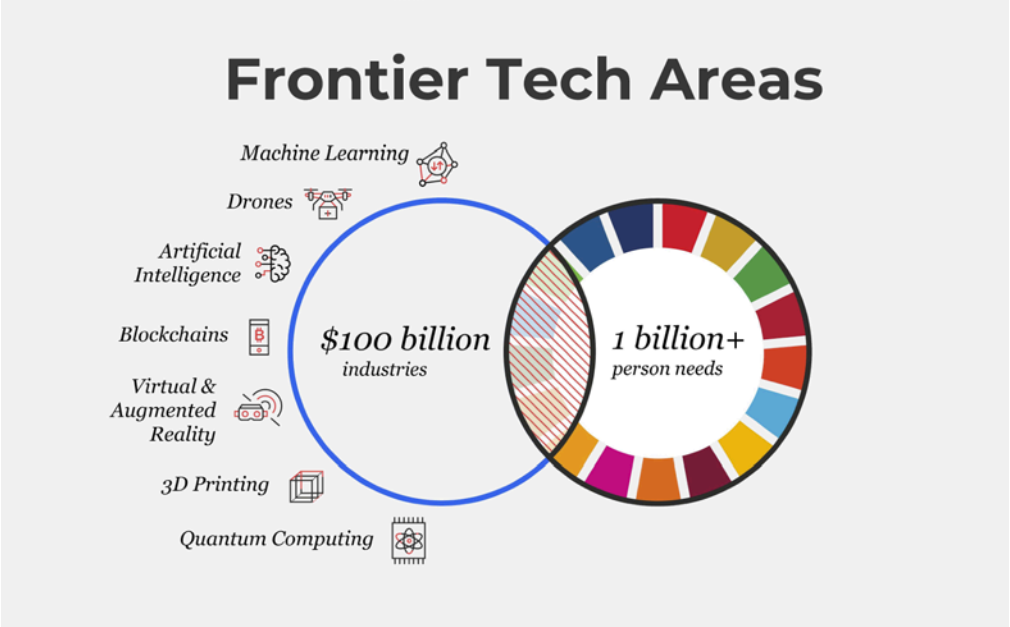

Figure 1. Investment thesis for UNICEF's Venture Fund
www.unicefinnovationfund.org

We will be running another set of hackathons in the second half of 2018. In these workshops, which will focus on operational applications of blockchain, our aim will be to use what we learned from our first attempt:

- We have further articulated our challenges, with a view to making the problems clear and universal. We are focusing on issues that could apply to any supply or logistics context, which may include a specific example from a UNICEF contract or situation.
- We are working with local technology groups to provide advance reading/pre-work to all participants to ensure that they have a common set of skills coming into the workshop.
- We are offering the challenge through more internal channels, as it became clear that part of the benefit of the Kazakhstan workshop was involving our own staff and bringing the concepts of distributed ledgers and smart contracts into our office. This will be a main goal of the coming workshops, as we believe that having a basic understanding of this technology permeate the organization will enhance its eventual uptake.

These types of workshops, which involve framing an organizational challenge, inviting external experts to participate, and building internal understanding and acceptance of a new technology, are a valuable tool for scanning the horizon, as they provide a low-risk environment for experimentation and learning. The results must be captured and built on, as the value of a hackathon as a stand-alone, solution-oriented event is relatively low. Partners developed for one workshop must be involved in subsequent work; it must be noted that the effort that goes into building partnerships and collaborations is not small, and these relationships should be treated as valuable assets.

While a two-day workshop cannot provide complete solutions or answers, it can encourage organizational learning and provide the scaffolding for later

THE CONTENT OF THE UNICEF CALL FOR PROPOSALS

When we posted our call for proposals through UNICEF's Venture Fund, we focused on the four major areas presented here. Some will be familiar from the text of this article, others may provide ground for further exploration. Overall, this list highlights our vision of where blockchain may take us. It will be as incorrect as was any list written in 1995 about the potential of the Internet.

Here is the original text of the UNICEF call for proposals issued in April 2018:

> The UNICEF Innovation Fund is looking to make $50-90K equity-free investments to provide early stage (seed) finance to for-profit technology start-ups that have the potential to benefit humanity.
>
> If you've got a start-up registered in one of UNICEF's programme countries and have a working, open source prototype (or you are willing to make it open-source) showing promising results, the UNICEF Innovation Fund is looking for you.
>
> We are currently looking to invest in a group of companies developing software solutions on open blockchains. Examples of these include, but are not limited to:
>
> **Smart Contracts**
>
> Using smart contracts to replicate and improve on existing organizational mechanisms
>
> Efficiencies, transparencies, and accountabilities in contractual engagements (i.e. multi-sig contracts that guarantee certain actors were involved)
>
> Transparency in distribution of resources (can we better show where our money is going?)
>
> Interactions across groups (what would a SWIFT code for development look like, if described in Solidity?)
>
> Increasing access and use of tokenized systems by creating more user friendly and more secure interfaces
>
> **Analyzing data**
>
> Using machine learning to understand the activities on public blockchains.
>
> Can we develop unicity from transactions on public blockchains?
>
> Could we use crypto-flows to help organizations and governments do and understand their transactions more efficiently? Can we use blockchain-derived data to solve humanitarian challenges?
>
> **Tokens**
>
> Can crypto tokens work to incentivize or support behavior that benefits humanity?
>
> How could we connect various tokens to each other to maximize human potential?
>
> How could we utilize digital scarcity, non-fungible tokens, or digital collectibles for social good?
>
> **Mining**
>
> Can we use passive distributed mining networks to create investment funding opportunities for the UNICEF Venture Fund?
>
> As noted in the main text, this call resulted in 100 applications from companies registered in 45 different countries. UNICEF Ventures will be announcing the complete portfolio of investments mid-Summer, 2018.

Source: UNICEF Original Text of UNICEF Call for Proposals, April, 2018 http://unicefstories.org/blockchaincall/

acceptance and scale of a new technology, such as distributed ledgers.

BLOCKCHAIN VENTURE INVESTMENTS IN TECHNOLOGY FOR SOCIAL GOOD

Once an organization is comfortable with the internal or operational ramifications of working with distributed cryptographic technology, it can start to examine ways to improve its programmatic functions. While the application of blockchains for transactions and accounting is quite clear, the Ventures team has started to look at what role this can play in some of UNICEF's external activities: Could blockchains be used to store education records and identities? Is there a role for this technology in paying teachers and other frontline workers? Can blockchain be used to create liquidity and build economic potential in environments where people are unbanked or traditional infrastructure does not exist?

The third area of UNICEF Ventures' approach to blockchain involves defining these questions clearly and then investing in several low-cost experiments and startups to establish a portfolio of encouraging emergent solutions. The portfolio approach is important because we are still at such an early stage with blockchain technology that many of our investments will fail. Having a cluster of approaches will enable the team to learn from the failures and to share what it learns with the organization; we believe this is the best way to manage the early stage risk while maintaining currency with the technology itself.

In April 2018, UNICEF's Venture Fund opened up a specific call for companies in our 135 program countries that are experimenting with blockchain to do social good. This first public portfolio call generated applications from more than 100 companies in 45 of UNICEF's focus countries.

AN ANALOGOUS EXAMPLE OF PRIOR TECHNOLOGY: MOBILE BIRTH REGISTRATION

Over the last decade, similar UNICEF-led exploration into emerging technology has generated lessons that are directly informing our approach to finding where blockchains can help UNICEF work more effectively. Between 2009 and 2012, UNICEF's Uganda-based innovation team developed, tested, and began to scale a system for mobile phone-based birth certification. A 2016 UNICEF paper captures several of the reasons a birth certificate is vital:

> Apart from being the first legal acknowledgement of a child's existence, birth registration is central to ensuring that children are counted and have access to basic services such as health, social security and education. Knowing the age of a child is central to protecting them from child labour, being arrested and treated as adults in the justice system, forcible conscription in armed forces, child marriage, trafficking and sexual exploitation. A birth certificate as proof of birth can support the traceability of unaccompanied and separated children and promote safe migration. In effect, birth registration is their "passport to protection." Despite the importance of obtaining official and documented proof of registration, around 290 million children (or 45 per cent of all children under age five worldwide), do

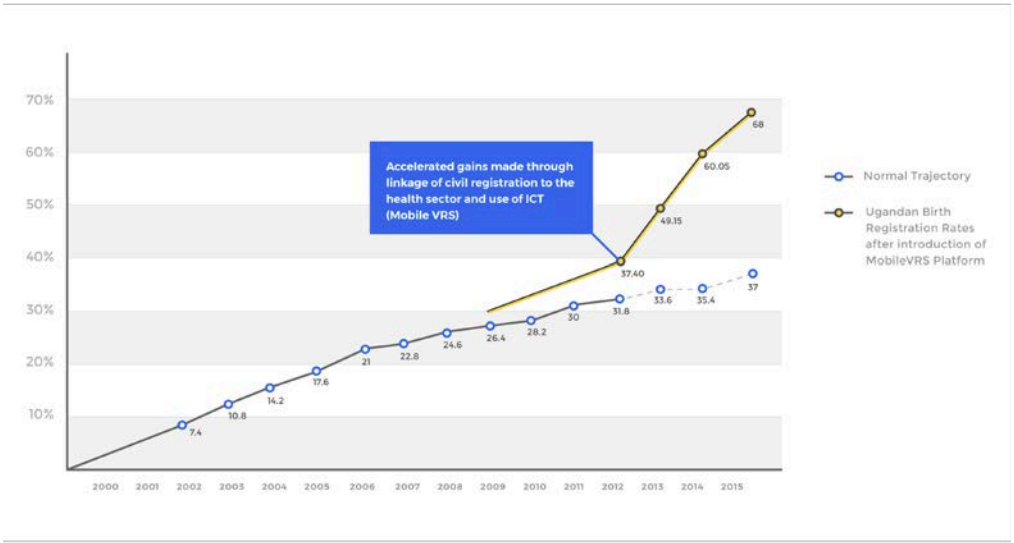

Figure 2. Birth registration coverage for children in Uganda, 2000-2015
Source: UNICEF

not possess a birth certificate.[16.]

In 2009 in Uganda, the number of children without birth certificates was even higher; 74 percent of young Ugandans had no certification of their birth. Many of the reasons for this had to do with the difficulty new mothers had in accessing the government personnel in charge of registration services. If no one in a town or village could provide a birth certificate, a mother would have to travel for several days to a large city to get one, at great personal expense. When interviewed in 2010, UNICEF Uganda child protection specialist Augustine Wassago, one initiator of the mobile registration project, noted that, in addition to the high cost and time delays, "the paperwork [to get a certificate had] to move through several overly bureaucratic stages."[17.]

In 2010, Augustine and the UNICEF Uganda team looked at mobile technology in the way many innovators are looking at blockchain today. They thought that the capacity smart phones provide could create more accurate records, increase the speed of service delivery, and "leapfrog" over broken and distressed infrastructure. After several years of development, the MobileVRS system—the platform they built for birth registration—was ready to deploy. By 2015, birth registration rates in Uganda were above 68 percent, well above the global average, but it had taken six years for the system to become functional on a national level. The chart above shows the system's growth and compares it the projected increases if there had been no technological intervention. It took years for MobileVRS to prove its potential, and the effort in Uganda will continue to scale. Meanwhile, a similar program is being rolled out in neighboring Tanzania.

Two other relevant takeaways from the figure above relate to timing.

First, MobileVRS runs on smartphones. In 2010, smartphone penetration was minimal in Uganda. The initial versions of MobileVRS used a basic feature phone (one that uses only SMS) and a

simple keypad for data entry. We were building the system even when the technology was not fully in place.

Second, for the first three years MobileVRS was in use (2009-2012) there was almost no difference between the rate births registered on the new platform and traditional methods. The effort could have been shut down at any point along the way with the easy excuse that it was adding little value. The steep rate of growth did not begin until 2012-2013. The takeaway? Building new things and changing national systems takes time. While we should be excited about the promise of new technology, we should not underestimate how impervious large systems are to rapid change.

We learned many other lessons through our work with MobileVRS, RapidPro, and other large-scale use of new technologies in the space of development and social good. In 2017, UNICEF's Venture Fund invested in a South African startup called Trustlab, which was building Amply, a solution to track attendance in early childhood development centers. Trustlab staff described Amply:

> Amply is changing [children's lives] by giving every child a digital identity that proves who they are. With Amply, children can access benefits that they are entitled to receive. For instance, Amply is enabling children in South Africa to get personalized pre-school education, by proving that they exist and that they are attending class. This is a simple, but important start to greater possibilities.
>
> Amply is designed to store a child's digital identity and personal information, privately—in a way that is "self-sovereign" and directly beneficial to them. Over time, their records become a rich source of data and value that can be used to receive services. Their gathered data will also generate insights to tailor the service to be more predictive, precise, personalized, preventive, and participatory. Due to Amply's flexibility, one can create an entirely new kind of services which can be delivered locally or virtually.[18.]

What Trustlab was proposing, and what interested the Venture Fund, was the ability to use a combination of blockchain technology to both register children's attendance in South Africa's early childhood development centers and use the immutability of a blockchain to provide a record for a teacher so they could be paid for their work. Trustlab was part of the Fund's first portfolio of investments, and it was funded long before we had undertaken much of the workd described in this article. Nonetheless, working closely with a company that was applying blockchain technology in a learning and experimenting phase helped us develop our own understanding and fluency with the technology.

By the end of its investment period, Trustlab had made significant progress with the Amply platform. Here is their description from our end-of-investment presentations:

> Amply platform has field-tested in 77 Centers with 2,700 children registered, and we've digitized 55,000 attendance records during our pilot in South Africa.
>
> Amply is a blockchain application platform for digitizing service-delivery claims. [Note: the ability to pay a teacher based on attendance is a "claim" of a "service" provided; it is verified by the ongoing collection of attendance data.]

> A closer look: Teachers use the Amply mobile app to register children. Each day they capture and submit digitally signed service-delivery claims. A software protocol automatically processes these claims and creates trustworthy accounting and performance records, with verified data—producing cryptographic [records] that can be exchanged for funding.
>
> In South Africa, Trustlab has succeeded in securing a revenue-generating contract to customise the Amply applications for the Smartstart ECD Social Franchise and to provide this platform as a service to 3,000 community-based agents. The ambition of Smartstart is to grow this agent network to 100,000 agents by 2020.

Reflecting on the comparisons between Amply and Uganda's MobileVRS stories can guide our early investments in blockchain technology and how we might apply distributed ledgers to resolve issues with national-level systems gaps—like the difficulty in capturing records accurately or paying frontline workers like teachers or health specialists—and create faster, more responsive systems. The registration of 2,300 students and the resulting 55,000 records may not seem large compared to the 800,000 students in South Africa who are currently receiving subsidies for part of their education, but it is a beginning.

The cohort of blockchain companies we are funding in the summer of 2018 will vastly diversify our activities and give us a range of other applications far beyond education payments. It will also deepen our technological understanding as we select a subset of companies that are pushing the current limits of cryptographic technologies, our hope being that they can give us a better sense of what lies ahead.

Finally, this portfolio of investments will make these lessons learned far more available across the organization: each company can be connected with the UNICEF office in its respective country of registration, which will allow for sharing knowledge, critiques, and advice. These connections will create a greater ability to understand the needs of our global organization and build products to address those needs.

CONCLUSION

UNICEF is trying to be careful and humble about our work in the exciting and often over-hyped world of cryptographic technology because we believe that it can give us tools to do our jobs better and to serve the world's most vulnerable children more effectively. However, in addition to providing opportunities for the children of today, we need to understand and be ready for the world of the children of tomorrow. This includes considering the following questions:

How will we work with cryptocurrencies in a way that fits our legal and regulatory frameworks?

How can we start building organizational efficiencies using smart contracts, which we must do to keep pace with the best practices of global businesses today?

What should we experiment with to show future uses for blockchain technologies, and how can we support our portfolio of startups so we will be ready for where the technology may take us?

We are pursuing these areas in small and iterative steps, and closely following our principles of innovation.[19.] The journey thus far has enabled us to work with governments, major corporations, and other international organizations, and with the UN Innovation Network, to

share what we are learning and to build collaboration around a quickly changing set of technologies.[20.]

We know that if our technological efforts do not respond to requests from the people who most need positive change in their lives, we will fail to construct robust, meaningful solutions. While technologies are so often built for the most connected, wealthiest consumers, we have the potential to direct the positive, framework-shifting energy of the cryptographic community toward creating opportunities for the world's most marginalized citizens. We know that if we do not build openly and collaboratively and create pathways for other open-source projects, entrepreneurs, and organizations to participate in developing new distributed approaches to development, we will end up replicating entrenched systems of control, ambiguity, and isolation.

Finally, as with any new approach that involves new actors, initiatives, languages, and opportunities, there is enormous pressure to deliver first and deliver biggest. We in the international technology community will have many failures as we begin to translate the potential, and limitations, of blockchains into accessible principles and practice. We must share our failures with the public and try not to repeat them as we build new ways to address some of the most pressing problems our planet faces.

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3. See http://www.mhero.org/; https://www.intrahealth.org/news/mhero-updates-health-workers-on-ebola-in-real-time.

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9. See www.unicefstories.org/blockchain.

10. See https://www.nytimes.com/2017/12/28/style/cryptokitties-want-a-blockchain-snuggle.html.

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19. See https://ssir.org/articles/entry/the_ethics_of_innovation.

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