

## Roadmap for the Development of Academic and Medical Applications of Blockchain Technology: Joint Statement from OPUS 12 Global and Litecoin Cash Foundation

Technological progress is reshaping multiple domains of human activity, from financial transactions to medical care.<sup>[1]</sup> This paradigm shift represents a global movement that will transform our lives for generations to come.<sup>[2]</sup> The democratization of decision-making capacity, including consensus-based mechanisms for transaction verification, will enable global implementation of projects that were previously not feasible because of the requirement for centralized control.<sup>[3,4]</sup> Blockchain represents a decentralized ledger technology that operates by consensus and serves to democratize decision-making processes and to disintermediate traditionally understood intermediaries.<sup>[1]</sup> According to Deutsche Bank forecasts, by mid-2020's, approximately 10% of the worldwide gross domestic product could be regulated by blockchain-based solutions.<sup>[5]</sup> It is estimated that more than \$400 billion will be invested in this technology in 2019 to advance its capabilities.<sup>[6]</sup> Within this broader context, it is important to understand that cryptocurrencies and financial transactions constitute only one small aspect of the blockchain concept, which also incorporates areas like verification, transparency, encryption, and maintenance of data integrity.<sup>[3,7,8]</sup>

Blockchain technology appears to be following a fairly typical pattern of adoption, with multiple early entrants into the increasingly crowded and competitive cryptocurrency space and the fast-growing sphere of blockchain-based applications.<sup>[9-11]</sup> It is the latter that will help truly define, and be responsible for the societal impact of, "the era of distributed ledgers" that is under way.<sup>[11,12]</sup> The primary goal of the strategic global partnership between Litecoin Cash Foundation (LCCF, <https://litecoinca.sh/>) and OPUS 12 Foundation, Inc. (O12FI, <http://www.opus12.org/>), is to leverage our collective resources to establish early leadership in the development and implementation of practical, real-life, blockchain-based solutions in academic and clinical medicine.<sup>[1,13,14]</sup>

The practicality of the dual blockchain utilization, featuring both currency and application layers, becomes apparent with the realization that the need for ongoing data processing relies on constant verification and encryption activity throughout the entire network of blockchain nodes.<sup>[1,13]</sup> Thus, the approach selected by the LCCF-O12FI consortium creates significantly more synergy than a single-track approach based on subcomponent strategy. Within this context, the technology provides not only a "digital wallet" functionality for currency exchange, but also different blockchain-based

use cases incorporating academic and medical information. In one example, cell phones are ubiquitous in low- and middle-income countries (LMIC) whereas electronic health records are not. Older, less costly cell phone technology would suffice as only SMS capability is needed to utilize blockchain or cryptocurrency, enabling broad access to the populations of LMICs. Blockchain can support information exchange across disparate data types, while providing digital payments on a global scale and across borders. The functional dimension of introducing the primary currency feature of Litecoin Cash (LCC) cryptocurrency has the potential to bring tremendous benefits to the areas of the world where banking services (and infrastructure) are severely underdeveloped, yet basic components for the successful adoption of cryptocurrencies clearly exist (e.g., limited internet access and mobile devices capable of supporting blockchain transactions). Much like entire regions of the world that essentially "bypassed" landline-based telephony following the introduction of cellular networks, many localities stand to "bypass and leapfrog" traditional banking, and progress directly to distributed ledger technologies.<sup>[15-20]</sup> There is growing recognition of the role of microeconomies and the critical need for efficient, dependable, accessible, safe, and scalable financial transactions and infrastructures, especially in low-resource regions, a topic that was recently recognized with a Nobel Prize in Economics.<sup>[21,22]</sup> Of note, this does not necessarily preclude traditional banking firms from participation; however, they will need to adapt to new competitive pressures across economic realities for which high-resource environment models are not optimized. Ability to appropriately scale current blockchain capabilities will be critical to such implementations.<sup>[3,23,24]</sup> Blockchain-based mechanisms also allow for crossover of monetary value from various loyalty cards and rewards programs, similar to currency exchange between different nations. Such reward points (mileage, car rental, and hotel stay) can then become an alternative subsidy for healthcare services. This can, for example, help establish a modernized barter system where a patient could use their "frequent flyer miles" to pay for medical costs, exchanging their reward points for "health care coins" through an intermediary exchange market. Institutions, such as nongovernmental organizations, could turn "flyer miles" used to shuttle staff between locations into vaccine and medical equipment purchases. Further, direct and real-time transparent payment for services in healthcare could lead to a reduction of both "intermediary" insurance

companies and inefficiencies in the system. This streamlining would result in substantial healthcare savings, translating to lower costs, more access for patients, and decreased overhead with increased revenue for clinics, hospitals, and providers.

Security of the blockchain (including various “side chains” and “layers”) is of paramount importance to ensuring trust and wider mainstream adoption of this technology.<sup>[25-27]</sup> The inherent risk in the concept of distributed ledger “democratization” is the possibility of emerging inequality due to maldistribution of infrastructure responsible for the maintenance and ongoing operations of the blockchain.<sup>[28,29]</sup> Within this broader topic area, our group previously described the risk of ill-intended, third-party actors to project massive bursts of “hashing power” and effectively take over the blockchain for a limited duration of time.<sup>[1]</sup> This, in turn, allows such destructive actors to “double spend” cryptocurrency output to the detriment of the broader populace.<sup>[1,14]</sup> To effectively prevent the risk of the blockchain being “hijacked,” the LCCF Developer Team devised an innovative paradigm of agent-based mining (e.g., the creation of new cryptocurrency) that helps ensure democratization of the LCC generation/transaction process while providing sustainable, long-term security of the distributed ledger.<sup>[14]</sup> Another significant advantage of this prototype mining technique is that it is not based on technologies that are becoming increasingly energy and resource inefficient, thus not requiring ever greater amounts of energy to generate diminishing amounts of block rewards (e.g., “coins”). The synergy between secure mining processes and the need for the highest possible levels of distributed ledger security creates a unique environment for the development of blockchain-based educational and medical applications. Our joint implementation framework of blockchain-based application layer includes clearly stated and reasonably achievable milestones, each defined within the broader contexts of adoption readiness and resource availability. Parallel to these developments will be the phased introduction of LCC as a voluntary medium of exchange for various international medical programs (IMPs) collaborating within our global network of institutions, providers, and clinical sites.<sup>[30]</sup>

The initial step in the strategic LCCF-O12FI collaboration will be the development of a cryptography-based “Secure ID” (SID) that will serve as the foundation for the future developments. This SID will contain each user’s unique identifying information, accessible only to the end-user (incorporating various best practices in cyber security such as 2-factor or multisource verification), and shareable for viewing and information verification only with end-user’s designees. The SID will also serve as a “Secure Key” to access other, downstream blockchain-based applications including “Academic Activity Logger” (AAL) and “Credentialing Document Repository” (CDR). We will now discuss the development and implementation of AAL and CDR.

The AAL will be the first step toward the integration of blockchain technology into real-life academic international

medicine (AIM) applications. Powered by the global LCC network, the AAL will help record and track activities by faculty members, facilitating the categorization and quantification of academic efforts into the following subtypes: (a) teaching, (b) clinical medicine, (c) community/government interactions, (d) research, and (e) other/miscellaneous. Each entry will include the activity date/time/duration as well as basic description, with a number of generic entries available through a drop-down menu. Activities entered by academic faculty will then be analyzed periodically and will serve as a basis for resource mobilization and allocation. Access to the AAL will only be possible using the SID, thus making the AAL a logical extension and a springboard for subsequent LCC blockchain-based implementations. On this foundation, the CDR and ultimately a “basic electronic medical record” (BEMR, see below) will be constructed. Although the task of constructing a high-fidelity, immutable, and accurate ledger of academic activities will not be easy, certain steps can be taken to minimize the likelihood of “false claims.” Much like the blockchain-based cryptocurrency paradigm, a secure mechanism for consensus building and data verification can be constructed. Such a “network of trust” (NOT) is technically workable and analogous to how “pretty good privacy” keys were distributed at signing parties attended by people known to each other, and also similar to the way “secure socket layer” certificate authorities work.<sup>[31,32]</sup> For example, if Party A’s certificate is signed by some Party B who is trusted by Party C, Party C can trust Party A’s certificate, etc.

The next developmental step in our strategic plan will be the implementation of the CDR, where provider credentials will be securely uploaded and stored in decentralized fashion. These documents will follow predefined credentialing requirements by most institutions globally such as record of college education/graduation, professional school record/diploma, professional licensing/verification/certification, and any additional elements deemed important to the safe conduct of AIM efforts globally. Uploading of credentialing information will be voluntary, and access to this information will only be possible with the permission of the record owner, utilizing his or her unique SID. Optimally, this important credentialing instrument will help providers verify their identity, education, and qualifications, and ensure that appropriate standards are followed by all stakeholders. The end-result will be the provision of safe and efficient care to the patients worldwide. Similar to the academic activity verification process, there will be important challenges to consider before successfully implementing the global CDR. In principle, there will need to exist some form of “data onboarding” authority. This should be performed by a “verification agent” (e.g., independent organization/group) with equivalent authority to that which it takes to set up a legitimate record of specific type (e.g., a medical school diploma and medical board specialty certification). In terms of identity verification, for example, the level of diligence required is similar to that already present in “know your customer” legislation. The case for verifying professional credentials would be similar, including

the process of independent data validation and certification. Again, this is technically possible with a NOT arrangement as mentioned above; however, there will be obvious limitations inherent to the workability of credential verification similar to traditional efforts already in place. If a practitioner is claiming to possess credentials from some credentialing provider, only that particular provider really has (and only should have) the authority to confirm that. At the same time, there must also be a mechanism to revoke trust and to hardwire time-defined recertification processes based on the expiry of records currently on file. The final step in the strategic LCCF-O12FI collaboration will be the development of a super secure, BEMR that could be deployed in low-resource environments, utilizing rudimentary portable device technology, and containing fundamental health information for each end-user. Much like the SID, information stored on the BEMR would be owned by the end-user and could be shared with healthcare providers only with the end-user's consent, requiring SID as the "Secure Key" to unlock information. We recognize the substantial challenges in the global implementation of this concept, especially with regards to the enormity of healthcare-related data (often from multiple systems and sources), the need for privacy, timely and accurate access, and verification of data. Other potential shortcomings, at this time, include the need for further development of the technology, limited availability of expert knowledge, significant gaps in public awareness, along with growth-related issues of scalability, security, and user adoption.<sup>[6]</sup> Nonetheless, it is our hope that the lessons learned from other blockchain application layers will serve as the foundation for successful development, evolution, and adoption of BEMR.<sup>[1]</sup>

There are many other considerations related to blockchain technology implementations in healthcare. Although full discussion of such a broad topic is beyond the scope of this manuscript, certain key ramifications must be discussed in the context of the proposed O12FI-LCCF initiatives. Blockchain technology may be an important tool for increasing transparency of how charities collect and allocate funds, propelling a much leaner system that will benefit intended recipients to a much greater degree.<sup>[1]</sup> This application of the blockchain technology will help verify the integrity of an organization's operations such as the transparency regarding the proportion of contributions distributed to medical and educational causes versus the overhead. In turn, the public, philanthropic donors, and potential collaborators will be able to make more informed choices regarding where their contributions can be allocated most efficiently.

Pharmaceutical companies may utilize blockchain to keep track of medications manufacturing and shipment, supply, expiration, and possible points of contamination.<sup>[33]</sup> By extension, similar technological approaches could be useful for tracking opiates in this age of epidemic prescription drug abuse.<sup>[34]</sup> In such cases, blockchain would make it easier to investigate and determine the source of access as the supply chain would become much more transparent. Various

built-in data verification and safety features could also be used to prevent duplication of medications from different providers and other hazards that occur with polypharmacy. Furthermore, the same tracking approaches could be used to secure food supply chains and safeguard against disease outbreaks.<sup>[35]</sup> Contaminated food products could be quickly and more efficiently traced to specific farms, processing or packaging plants for immediate identification, and removal from circulation.

When combined with potential applications for AIM and global health equity, blockchain-based applications could help catalyze further innovation. First, they can enable universal access to financial resources by removing third-party intermediaries and offering transparent, secure, and accountable means for AIM financing.<sup>[36]</sup> Next, they could help facilitate multilateral financing mechanisms dedicated to health system development and strengthening.<sup>[1,36]</sup> In addition, they could reduce fraud and corruption through the use of immutable, tamper-proof transaction ledgers.<sup>[1,36]</sup> Finally, entire new capital markets for healthcare data could be created, providing better access (and opportunities) to patients, institutions, governments, researchers, and other key stakeholders.<sup>[1,36]</sup> Additional benefit offered by any token with fixed or "capped" supply as a medium of international exchange – subject to harmonization with region-specific laws and regulations – is the noninflationary character of such cryptocurrency. This, in turn, may help provide end-users with a protective mechanism against inflation and loss of monetary value – a phenomenon experienced across many LMICs.<sup>[37,38]</sup>

In conclusion, the global partnership between OPUS 12 Foundation (including its allied partners and subsidiaries) and LCCF provides a unique platform for the parallel development of both global currency support framework and medical/educational application layer for the academic international medical community.

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