Blockchain Technology for Healthcare Innovation Salon

December 6, 2016

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Blockchain Innovation Salon

A healthcare innovation salon was hosted on December 6, 2016 by the University of St. Thomas, Opus College of Business and U.S. Bank, Innovation Research and Development to explore "Blockchain Technology for Healthcare". The session was structured as an interactive opportunity to explore how this emerging, distributed technology may unlock the benefits of value-based health care models.

Participants shared the learnings from the financial services industry in blockchain prototyping to understand how their experiences could be leveraged to advance technology innovations in health care.

Participant Take-Aways

- Understand how macro trends in health care, such as consumerism, new care venues, interoperability/security, align with the properties of emerging blockchain technology models.
- Learn about blockchain, a distributed transaction ledger.
  - What is blockchain?
  - Benefits and challenges.
  - Application to health care from financial services experiences.
  - Consortia approach used in financial services to pilot technology.
- Explore its application in health care
  - National efforts to define "use cases".
  - Real examples of how it can be used.
- How to recognize opportunities – why its important to you. Should Minnesota-based collaborations be pursued?

Meeting Location

University of St. Thomas, Opus College of Business
Center for Innovation in the Business of Healthcare
Terrence Murphy Hall, Room 460
1000 LaSalle Avenue Minneapolis, MN 55403

Meeting Agenda
December 6, 2016

8:00 - 8:30 am
Gathering/Networking

8:30 - 8:45 am
Welcome and Introductions

Dr. Stefanie Lenway
Dean Opus College of Business
University of St. Thomas

Stephanie Hammes-Betti
Senior Vice President Innovation
US Bank

8:45 - 9:00 am
Salon Kick-Off
Overview of Innovation Session

Dr. John Olson
Opus College of Business

9:00 - 10:00 am
Blockchain Presentations
Derek Gaasch, PwC
Chris Swanson, US Bank

10:00 - 11:00 am
Panel Discussion
Derek Gaasch, PwC
Chris Swanson, US Bank
Mike Jacobs, Optum
Kevin Peterson, Mayo Clinic

11:00 - 11:30 am
Breakout Session

11:30 - 12:00 am
Closing Summary

Session Moderator

John R. Olson, PhD
John Olson is a Program Director for Business Analytics as well as Research Director of the Center for Innovation in the Business of Healthcare at the University of St. Thomas. He holds a doctorate in operations and supply chain management from the University of Nebraska and is a master black belt in Six Sigma and a Lean sensei. His teaching focus has been on helping both students and companies learn how to make better decisions using data.

Over the past 15 years, he has worked with Fortune 500 companies and health care organizations on their strategic planning process, business analytics implementation and the implementation of quality and continuous improvement programs. He has published over 20 articles in leading academic journals and two books related to the subject material and has given over 100 presentations at national conferences.

Session Presentations

Chris Swanson
As a Vice President in U.S. Bank's Innovation Research & Development practice, Chris Swanson is an expert in creating new revenue streams and pioneering new market entries. A business creative and product designer with 15 years of experience in the financial services industry, Mr. Swanson is responsible for discovery, design, and development of emerging fintech experiences, technology evangelism and venture partnering, in addition to leading the bank's distributed ledger practice. Mr. Swanson's financial services background includes product development and management, digital strategy, data analytics and small business banking.
Mr. Swanson is a graduate of the Carlson School of Management at the University of Minnesota with an MBA in Finance and Strategic Management, and holds a Bachelor's degree in Philosophy from Hamline University. He is also a trained design thinking coach, a creative facilitator and an expert in numerous emerging technologies.

Derek Gaasch
Derek Gaasch is the lead director of PricewaterhouseCooper's (PwC's) New Entrants and Innovators in Health practice where he helps traditional and non-traditional health companies understand how new technologies, funding models, and consumer expectations are changing the health economy in the United States, and address how these changes will impact the role they play in the future.

Prior to this role, Derek worked with a broad variety of traditional health care companies including payers, providers, and pharmaceutical companies as they looked to improve efficiency or achieve profitable growth. He has helped clients in various roles from strategic design to detailed implementation, including strategic visioning and business strategy, technology strategy, enterprise architecture, and IT program delivery management.

Need for Value in Healthcare

The American health care system is undergoing historic change with evolving national policy focused on insurance regulation and financing for patient access. Across this changing landscape, there remains a lingering dissatisfaction in the complexity and cost of our health system. Consumers of health care are asking the system to deliver higher value for the money expended – an opening for new entrants and new solutions in the business of health care.

PricewaterhouseCoopers (PwC) works to help non-traditional (i.e. retail, consumer, technology, digital) and traditional sectors of health care to understand and respond to changes in the market. To kick-off the innovation salon, PwC characterized several key trends that are creating a New Health Economy, all highly consumer-centric and technologically enabled, potentially creating a case for the introduction of blockchain technologies.

Key Health Trends

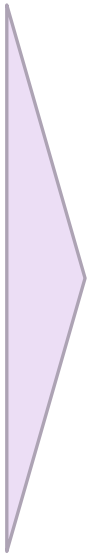
Demographics – Our society is aging with increasing ethnic diversity.

Consumer Empowerment – We are taking greater responsibility for our own healthcare needs and are demanding value.

Technology Enablement - Social, mobile, analytics and cloud technologies are merging.

Care Anywhere - Healthcare is now more accessible through mobile and retail options.

New Entrants - Non-traditional players are disrupting the status quo.



These trends are decentralizing and democratizing the $9T global ($3T US) health marketplace, where traditional and non-traditional participants serve the needs of consumers. Source: PwC Health Research Institute.

Source: PwC Health Research Institute

The platforms and support environments in healthcare (i.e. technology platforms, digital communications, data exchange infrastructure) are adapting to emerging requirements driven by changes in care venues, focus on wellness, advances in therapies and diagnostics and alternative financial/payment models. These alternative platforms are creating new opportunities and market entrants.

Partnerships are increasingly playing a role in addressing complexities. Collaborations are providing both traditional and non-traditional health care organizations access to new markets and customers, expanding access to talent, innovative thinking, and new technologies. This has created strengthened brands with shared risk for entry to new markets.

Blockchain as an Emerging Technology

Despite the revolution in peer-to-peer communications facilitated by the Internet, items of "value" (e.g., money, private information, intellectual property) are still exchanged using existing networks through a tri-party arrangement. Third party service administrators, including banks, insurance companies, escrow agents, payment networks are still used to manage the exchange of items of value. These parties use contracts to reduce the risk of default for each party and act as a trusted gateway to confirm the identity of each party and facilitate the exchange of items of value.

This model is now under pressure to evolve as consumers recognize the value of peer-to-peer exchange including lower administrative costs and faster, less burdensome, self-directed trade. Additionally, concern over security and privacy in today's electronic commerce practices is rising. The market is seeking alternatives to having institutions maintain large, centralized data collections with transactional processes often vulnerable to fraudulent practices and attacks.

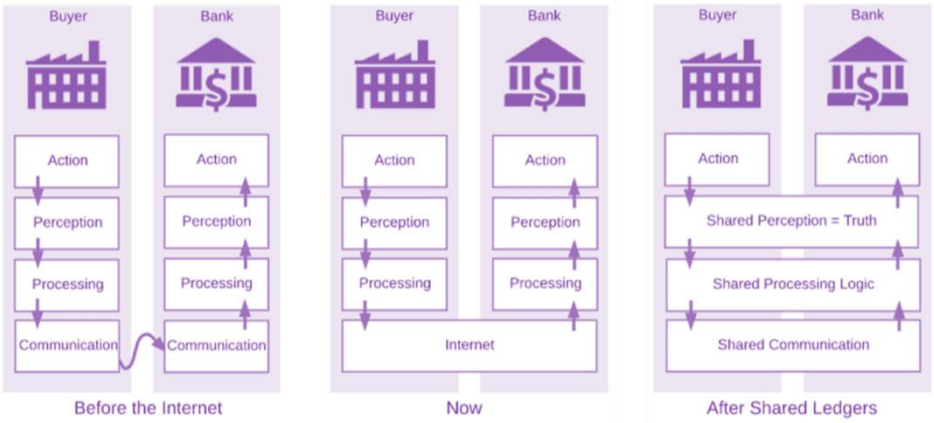
Research and innovation teams at US Bank have been participating in a financial consortium, R3, to study, test and evaluate blockchain applications. US Bank explained the origin, progress and learnings of the financial industry in their experimentation with the technology.

What is Blockchain?

Blockchain is an emerging technology being explored as a potential breakthrough model to enable peer-to-peer exchange of value items without using a third party administrator. Many are describing blockchain as a new foundational technology, even calling it the "internet of value". Early collaborative successes in application of the technology have prompted significant investment across the world. Blockchain is a distributed ledger (DL) system that enables parties that don't fully trust each other to form and maintain consensus about the existence, status and evolution of a set of shared facts (Brown 2016). Think of it as a "secured spreadsheet" that sits in the cloud that multiple parties can review. Each set of transactions is guaranteed by a set of cryptographic keys to generate interlinked blocks (Nakamoto 2008) that can be appended to a timestamped and irreversible chain. Multiple copies of the chain are created and stored at different nodes in the network formed by participating institutions, thus eliminating the need for expensive interfaces which in turn reduces the cost of data exchange. Therefore, a blockchain has the potential to ensure secure and cost-effective data exchange. Automated logic can be added to the ledger to trigger rules and actions.

As shown in this diagram, in shared distributed ledgers the movement of value between two parties is facilitated through logic built into the technology mechanisms.

There is no need for a centralized third party to perform that function.



Source: R3 Financial Innovation Firm

Blockchain Deployment

Blockchain technology was first introduced in 2009 as the underlying technology enabling the bitcoin digital currency. Today, experimentation with the technology has evolved from collaborative consortiums testing the application of the technology, to investment in start-up companies anxious to disrupt established industries, to blockchain-based transactions actively functioning in the marketplace.

While blockchain has shown potential for new, innovative approaches to how society executes transactions, there remains much uncertainty and many challenges that must be overcome to determine if this technology is scalable and effective for full deployment. The diagram below describes anticipated timing and stages of evolution of blockchain technologies.

Four waves of anticipated blockchain deployments

Wave	Advancement
1 **Information Sharing** **2016-2019**	• Blockchain used to share and communicate data • Used internally and between trusted external organizations • Distributed ledger solutions tested in parallel with current workflows as proof of concept • Augmentation of existing processes
2 **Data Solutions** **2017-2025**	• Blockchain enables an environment to store and manipulate data • Incorporation of distributed ledger technology as part of existing solutions, supporting new efficiencies in operations and workflows • Initial pilots may run in parallel with existing processes, until user confidence is high enough to begin migrating volumes • Users are faced with a choice of infrastructures developed by providers
3 **Critical Infrastructure** **2020-2030**	• Blockchain adopted by market participants as main infrastructure for critical functions • Centralized authority still required for administrative functions (e.g., granting access rights, transaction and payments infrastructure) • Replacement of existing asset, transaction and payments infrastructure • Participants forced to adopt and integrate new blockchain-based infrastructure
4 **Fully Decentralized** **Uncertain Timing**	• Blockchain replaces centrally controlled infrastructure with fully decentralized solutions. • Direct engagement in digital asset transactions for organizations and individuals • Legal and regulatory frameworks support asset ownership and transfers via distributed ledgers • Disintermediation of legacy infrastructure owners

Source: Oliver Wyman and JP Morgan

Blockchain's Value for Healthcare

PwC further discussed the potential role and value of blockchain technologies in health care. They believe that the benefits of blockchain may contribute to improvements in administrative transactions (i.e. more efficient, less cost, reduction in fraud/abuse), consumer empowerment and information exchange with advanced security. They have established an "incubator" within their organization for further exploration.

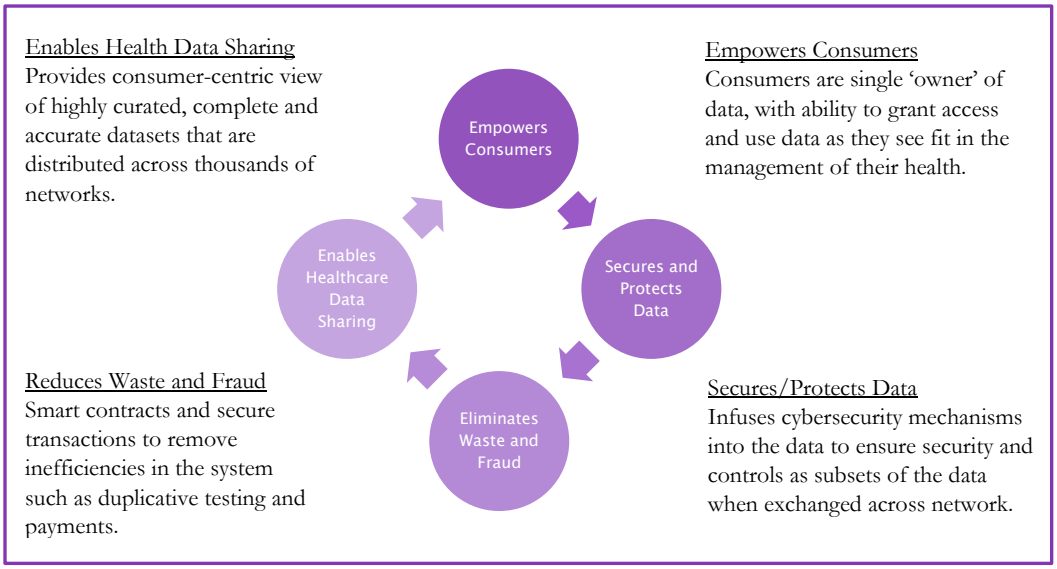
In particular, blockchain may simplify access to today's complex web of patient data distributed across thousands of health care silos. Our need to amalgamate and manage a secure, comprehensive set of patient data across a care continuum – all while applying complex algorithms and analytics to delivery better care and a better patient experience – clearly requires expanded technological capabilities.

Nevertheless, there are very significant hurdles to cross if blockchain is to be deployed in health care. The key issue that needs to be addressed is the fragmented nature of the patient data and HIPAA regulations on data sharing, such as:

- Patient records are generated by a number of different care providers (hospitals, labs, pharmacies, etc), necessitating the requirement for a large number of entities within the care delivery network to be able to access and commit new information to the ledger.
- HIPAA regulations currently prevent sharing of patient data in a distributed ledger and require different security protocols for healthcare networks.
- Data structures and definitions vary across health care institutions necessitating the development of a blockchain framework of structure and semantics with transaction protocols that would need to be validated at the source or at the time of appending blocks.

The application of blockchain technologies will require a customized healthcare strategy including design characteristics (i.e. exchange policies, identity, transaction structures) with agreement across health institutions and regulators in order to proceed in scale across the industry.

Key Value Proposition in Health – PwC Analysis



Use Cases for Blockchain in Healthcare

In August 2016, the Office of the National Coordinator for Health IT unveiled winners of a Department of Health and Human Services challenge to identify uses for blockchain digital technology in health care. This included ways to protect and secure the exchange of electronic health data that are under increased risk due to centralization of patient records, evidenced by the increased number of cyber-attacks on hospitals (Peterson et al, 2016) and susceptible operating environments as seen in the recent ransomware attack on the National Health Service (NHS) in Britain. The contest highlighted the potential for innovative ways to use blockchain in healthcare. We were pleased to have been joined at the innovation salon by members of the Mayo Clinic team named as one of the 15 winners of the national blockchain challenge.

At the innovation session, PwC further described market viability by aligning use cases with market impact gained through improvement in health care costs.

Illustrative Use Cases – PwC Analysis

Eliminating Medicare and Medicaid Fraud $98B Lost Annually to Fraud	Health care information is exchanged and structured as a "patient-centric" chain of care events across multiple providers. Validated, secure and accurate medical and transaction history may greatly diminish fraud attempts.
Reducing Duplicative Testing Based on 2004 data, eliminating redundant tests has potential to save more than $8B.	Significant gaps, lack of consensus and access to medical transactions is common in healthcare. Blockchain health transactions could simplify this process, improve work flow and accuracy. A shared, replicated ledger would provide immutable proof of the type and time of tests, reducing the need for redundant data and reconciliation.
Enabling Consumer-Directed Preventive Care The preventive health technology market valued at $145B by 2020.	Consumers/patients directly engaging and authorizing data exchange, can create peer-to-peer support networks or personalize health services. Secure consumer-directed health records could empower patient control to facilitate care and enable wellness, support and prevention programs.
Secure IoT Connected Medical Devices 23% of data breaches happen in healthcare.	Blockchain is the backbone of newer distribution technologies; an "auditable record of actions" will follow that information wherever it goes. The technology reduces the risk of cyber-attack and cyber-piracy.
Improved Supply Chain for Pharma	Distributed ledgers can improve operational efficiencies in supply chain transfers tracked throughout the manufacturing process and to the end user/patient.

Salon Focused on Four Innovation Strategies

In 2016, St. Thomas Opus College of Business established the Center for Innovation in the Business of Healthcare to create opportunities for multidisciplinary discussion, collaboration and partnerships in health care.

To facilitate discussion on blockchain technologies, a "salon" meeting format was utilized. This format enabled information sharing and breakouts where further ideation and discussion were possible. Four innovation strategies (listed below) were used to prompt creative thinking.

Participant insights and discussion were captured and organized in the next section by the four strategies.

Innovation Session Strategies

1. **LEARN FROM INDUSTRIES OUTSIDE OF TRADITIONAL HEALTHCARE TO DRIVE NEW APPROACHES**
2. **EMBRACE NEW HEALTH ECONOMY FOR CONSUMER-FOCUSED SOLUTIONS**
3. **COLLABORATE AND REDESIGN ACROSS THE VALUE CHAIN**
4. **DEVELOP KNOWLEDGE AND LEADERSHIP**

Salon Focused on Four Innovation Strategies (Continued)

1. LEARN FROM INDUSTRIES OUTSIDE OF TRADITIONAL HEALTHCARE TO DRIVE NEW APPROACHES

Panel Discussion and Breakout Session Insights:

Blockchain technology is being explored outside of healthcare and has advanced more quickly than applications in health care. If learnings could be applied to health care, it may jumpstart industry efforts towards innovative solutions. US Bank offered insights from financial industry investment and blockchain exploration:

- It's important to target areas of strategic importance and areas where there are risks/opportunities for disruption in industry practices. Understand that the introduction of blockchain technology for use in standard business transactions is still at least several years away.
- Collaboration with other organizations in the business value chain is imperative. Because blockchain is a foundational technology, it isn't possible to "do it alone". The financial industry has pursued collaborative efforts in blockchain technology. They have established a Consortium to explore the use of blockchain technologies, called R3. It is continuing to expand membership and now includes most global banking institutions.
- It may be possible to run health care transactions through the banking R3 consortium testing process. This would only work for basic transactions (i.e. a hospital purchasing supplies) that don't have privacy or clinical health information.
- Open source blockchain platforms or tools are available to anyone on Ethereum. Healthcare also has several private consortiums exploring blockchain: Hashed Health, and GoDoc. There are health care consortiums beginning to form (e.g. Phillips Healthcare, Gem Health).
- Pursue blockchain applications or use cases in areas where there is common language, defined industry practices, or defined regulation, etc. In this way, work efforts can make progress on applying the technology (i.e. rather than debating terminology and process). Strong, standardized practices helped the financial industry simplify the implementation of new technologies.
- Blockchain use cases that focus on the exchange of items of value (i.e. transfer of mortgage documents, reference data, etc.) is a good place to start experimentation. These areas are easier than working through the complexities of business transaction exchange. Outside "oracles" can be used to pull in information as needed. Note that not all information has to reside in a blockchain transaction.

Salon Focused on Four Innovation Strategies (Continued)

1. LEARN FROM INDUSTRIES OUTSIDE OF TRADITIONAL HEALTHCARE TO DRIVE NEW APPROACHES (CONTINUED)

Panel Discussion and Breakout Session Insights (Continued):

- Permissioned networks, not open public networks, may be a long-term solution for collaboration.
- Interoperability - there won't be a "one blockchain" that will be implemented across an industry, etc. There are currently no standards in place to dictate how different ledgers will play/operate with each other.
- Security – we don't know how secure the on-ledger information is until they've lived in the wild a bit. The more valuable the information, the higher the bounty.
- Identity – determine whether "who" or "what" it claims to be is a predicate to everything on the blockchain. Getting agreement from myriad parties about how to do that is not an insignificant task.
- Retail and legal industries are also quite far along in blockchain experimentation and may be industries for additional health care industry study.

Salon Focused on Four Innovation Strategies (Continued)

2. EMBRACE NEW HEALTH ECONOMY FOR CONSUMER-FOCUSED SOLUTIONS

PricewaterhouseCoopers presented major trends in the New Health Economy and shared insights related to these changes. The following notes focus on consumer application:

- In the New Health Economy, the case for the use of blockchain applications may be driven by consumer demand, especially when the technology begins to be actively used in other industries such as in retail.

- Blockchain applications may prove to be especially helpful for consumers through the elimination of intermediary functions, increased automation, fewer processing delays, less human error, reduced data duplication, reduced level of reporting. There is the potential to reduce health care administrative costs.

- Blockchain stops the need to administratively "reconcile" payments against complex health care fee schedules; all data is viewable and transparent to consumers and their providers.

- Consumers/patients can directly engage and authorize data exchange within a health care peer-to-peer network based on the consumer's defined terms and timeframes. In this way, a patient could release data for clinical research and/or to personalize health services.

- Blockchain applications may be helpful in the application of personal finance transactions (HRAs/HSAs, private exchange benefit administration).

Salon Focused on Four Innovation Strategies (Continued)

3. COLLABORATE AND REDESIGN ACROSS THE VALUE CHAIN

Healthcare systems, providers, stakeholders are seeking ways to drive value in health care delivery by reducing cost and increasing quality and access. To meet these objectives in healthcare, blockchain will need to differentiate its ability to redesign administrative and care processes for less cost (as a key benefit) in order to drive participation. Savings and administrative benefits would need to be large enough to justify the cost of moving from existing technology infrastructure to a blockchain based system. At the moment there is no environmental pressure to move to blockchain in healthcare – so use cases will need to show a positive return to be considered for implementation. Key considerations include:

- Healthcare will face potential challenges in implementing blockchain applications because blockchain is a **foundational technology** that requires collaboration to succeed. Determinations would need to be made in defining how a consortium works, in protecting organizational assets and intellectual property to enable collaboration without the fear of competition. Blockchain "permissioned networks" may be a solution because collaboration could be controlled including: 1) approvals prior to any organization joining the collaborative effort and 2) definition of the transactions/work efforts to be undertaken.

- Healthcare organizations will also be concerned about experimentation and implementation of blockchain to ensure compliance with health care regulation. Hence, regulatory agencies would need to engage in understanding and accepting blockchain applications or use case experimentation.

- Because there are often conflicting work processes or lack of standards in health care, experimentation with blockchain may be best undertaken focused on greenfield opportunities where no competing solutions exist. Additionally, many health care administrative and care processes are not currently optimally designed; hence blockchain experimentation may best be undertaken by "starting over" and working through new design. For example, new reimbursement models are currently being implemented; these processes may represent a good niche area where greenfield development is possible.

Salon Focused on Four Innovation Strategies (Continued)

3. COLLABORATE AND REDESIGN ACROSS THE VALUE CHAIN (CONTINUED)

The following areas were identified and discussed as potential areas of collaboration, using blockchain to:

- **Facilitate Patient Data Exchange.** Mayo Clinic has undertaken efforts within their system to experiment in this area to exchange radiology images across their own internal system (Peterson et al, 2016). It may be most helpful to continue needed cross-industry collaboration in interoperability, patient identity definition, scalability, privacy/security, upgradability as it is necessary for health care to establish a new foundation of data exchange. Following that work, blockchain may be a helpful tool. It is difficult today to have providers share data, even in Integrated Delivery Systems. Especially complex is that patient care can take place in many separate locations and many different venues. Additionally, providers range in specialty, care levels and service type (diagnostic, pharmacy, medical device). Resistance to electronic health record access and interoperable data management from health IT vendors could also create a barrier.

- **Assist in Longitudinal Product Tracking.** Blockchain technologies have the potential to create "patient-centric" chains of care events across multiple providers, regardless of site of care. These chains could be used to create episodes of care, track supply chains or specific medical/pharmaceutical products.

- **Use Healthcare "Smart Contracts".** Blockchain technologies could improve purchasing and administrative functions by streamlining and automating processes with enhanced sophistication and control mechanisms - moving to "self-enforcing" smart contracts. Two parties can trust and execute transactions through "smart contracts" that can be self-executed through predefined rules. These rules, or algorithms, can be used to trigger when to exchange health care value, transfer information or trigger management events. Smart contracts are actually straightforward algorithms build into the blockchain structure and prospectively agreed upon by parties to the blockchain. Examples were discussed such as supply chain - health care supplier contracts can be tied to protocols; and automatically executed when protocols are met.

Salon Focused on Four Innovation Strategies (Continued)

3. COLLABORATE AND REDESIGN ACROSS THE VALUE CHAIN (CONTINUED)

- **Rethink Benefit and Insurance Administration.** Areas such as enrollment/eligibility, insurance claims, provider network contracts, prior-authorization, care approvals could be automated to improve administrative efficiency. Reinsurance review could be more easily facilitated by enabling access to the blockchain network rather than requiring access to siloed information sites and/or complex reporting requirements. Redistribution of excess pooled insurance funds could be automated. Peer-to-peer insurance, or shared risk, would be immediately transparent between parties. Insurance consortiums (made up of payers, providers, employers, reinsurers, consumers, etc.) could proliferate and evolve to be more real time and individualized. New types of insurance models could be supported including short term "spot" insurance, microinsurance and peer-to-peer insurance plans.

- **Create a Platform for Cognitive Computing and Internet of Things (IoT)**. IoT data could be integrated into blockchain transactions as a rule-based protocol or used as comparative diagnostics for improved decision making.

- **Track Fraud and Abuse**. Transactions and changes are viewable by all parties creating transparency; abuse is reduced through blockchain-enabled traceability and accountability. Outside audits are more easily conducted for management of fraud. Blockchain could be helpful for audit organizations to improve access to data from siloed sites. If a "single source of truth" based on blockchain could be achieved in healthcare, many operational problems could be overcome. Possible uses are for fraud prevention, personal health records, wearable/medical devices.

Salon Focused on Four Innovation Strategies (Continued)

4. DEVELOP KNOWLEDGE AND LEADERSHIP

Academic institutions may be best prepared to support industry in the pursuit of blockchain research & development, general education and leadership development. Universities may be able to facilitate collaborative efforts, develop research-based applications and advance the education of future leaders. Ideas were explored on how university-based efforts could advance work in blockchain, including:

General Development of Knowledge Base Through Collaboration

- Increase regional health care knowledge of blockchain technologies and use cases.
  - Create a "hackathon" session on blockchain with both IT, health care professionals and financial services.
  - Have a blockchain case study session in the evening for a broader audience.

- Further salon or work sessions to share blockchain information. May include:
  - Exploring today's topics in more depth,
  - Reconvening the salon with other industries represented (i.e. retailing, manufacturing),
  - Including consumers for redesign of health care,
  - Exploring specific problem areas,
  - Exploring blockchain across a specific value chain (i.e. bring in multiple companies representing a use case across the value chain.

Student-Focused Educational Programs

- Development of educational programs by either adding stand-alone courses on decentralized computing systems or including a section on cryptocurrencies to existing curriculum – expand student knowledge to imagine new blockchain technologies and applications.

- Development of educational health care data analytic programs that include decentralized computing systems for health care applications.

- Student participation in university-based "blockchain clubs" with the opportunity to join national/international networks of clubs interested in development of blockchain technologies.

- Support student projects based on blockchain to develop business prototypes: College of Business and Engineering school.

Salon Focused on Four Innovation Strategies (Continued)

4. DEVELOP KNOWLEDGE AND LEADERSHIP (CONTINUED)

Student-Focused Educational Programs (Continued)

- Prepare students for future employment in a region that is actively exploring collaborations for the use of blockchain technology.

- Engage students in blockchain innovation design and development for health care.

- Bring blockchain case studies into classrooms.

Research and Development

Conduct research to establish fundamental blockchain concepts, including implementation, validation and deployment of prototypes useful in regional businesses.

- Pursue research publications in collaboration with industry and national academic networks on blockchain technology and/or health care applications including smart contracting and data exchange.

- Establish a blockchain laboratory, partnering with regional organizations as a research and development collaboration to establish blockchain concepts & capabilities, applications and test environments.

- Determine a specific blockchain use case/topic to explore and test. Then form a health care consortium to work on it.

References:

Brown, Richard G., 2016. On Distributed Databases and Distributed Ledgers. *Richard Gendal Brown Thoughts on the Future of Finance*, 8 November 2016, gendal.me/2016/11/08/on-disributed-databases-and-disributed-ledgers/.

Peterson, K., Deeduvanu, R., Kanjamala, P. and Boles, K., 2016. A Blockchain-Based Approach to Health Information Exchange Networks.

Nakamoto, S. 2008. Bitcoin: A peer-to-peer electronic cash system.

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For more information on the Center for Innovation in the Business of Healthcare visit www.stthomas.edu/centers/healthmedical/cibh/