Department of Software Engineering
Building 70-1690
Phone: (585) 475-5461

Senior Project Proposal
UNDERGRADUATE

Project Title:	Cross-Chain Trading Bridge
Organization:	JPMorgan Corporate & Investment Bank
Primary Contact:	John Casey Samer Falah
Email:	John.p.casey@jpmorgan.com; samer.falah@jpmchase.com
Phone:	Casey: 212-622-1883 Falah: 212-552-0941

(Instructions for completing this proposal can be found at

http://www.se.rit.edu/~swen-561/CourseInformation/ProposalInstructions.pdf)

Background Information

J.P. Morgan development of Distributed Ledger Technology is an area of strategic focus and continued expansion. Quorum is one area of key investment.

- Quorum is an Ethereum-based distributed ledger protocol
- Ethereum is an open-source, public, blockchain-based distributed computing platform and operating system featuring smart contract (scripting) functionality.

Quorum has been developed to provide the Financial Services Industry with a permissioned implementation of Ethereum that supports transaction and contract privacy.

Quorum includes a minimalistic fork of the Go Ethereum client (aka geth), and as such, leverages the work that the Ethereum developer community has undertaken.

The primary features of Quorum, and therefore extensions over public Ethereum, are:

- Data privacy
- Multiple voting-based consensus mechanisms
- Network/Peer permissions management
- Higher performance

Quorum currently includes the following components:

- Quorum Node (A fork of the Ethereum Geth Client)
- Constellation - Transaction Manager
- Constellation – Enclave – (An encryption and decryption service)

Whilst Quorum has been designed with Financial Services use cases in mind, its implementation is not Financial Services specific and hence is appropriate for other industries that are interested in utilizing Ethereum but require the above primary features.

Medium.com: Cross-Chain Bridges: Paving the Way to Internet of Blockchains

> ***What is the value that cross-chain bridges bring to the community?***
>
> *In the pre-bridges world, there was no way of transferring funds directly between blockchains. For a chain to be viable, it had to have a self-sustaining ecosystem. Since an ecosystem is not easy to build, many small chains were not able to develop long-term. Many projects, on the other hand, choosing to build on Ethereum blockchain, would soon find themselves captive to the high transaction fees on the congested network.*
>
> *With cross-chain bridges, having your business built on a small network doesn't mean that you can target only the clients that are also on this network. Now the value can travel seamlessly between the two Ethereum-compatible chains.*

Coindesk.com: The Opportunity for Interoperable Chains of Chains (Samani)

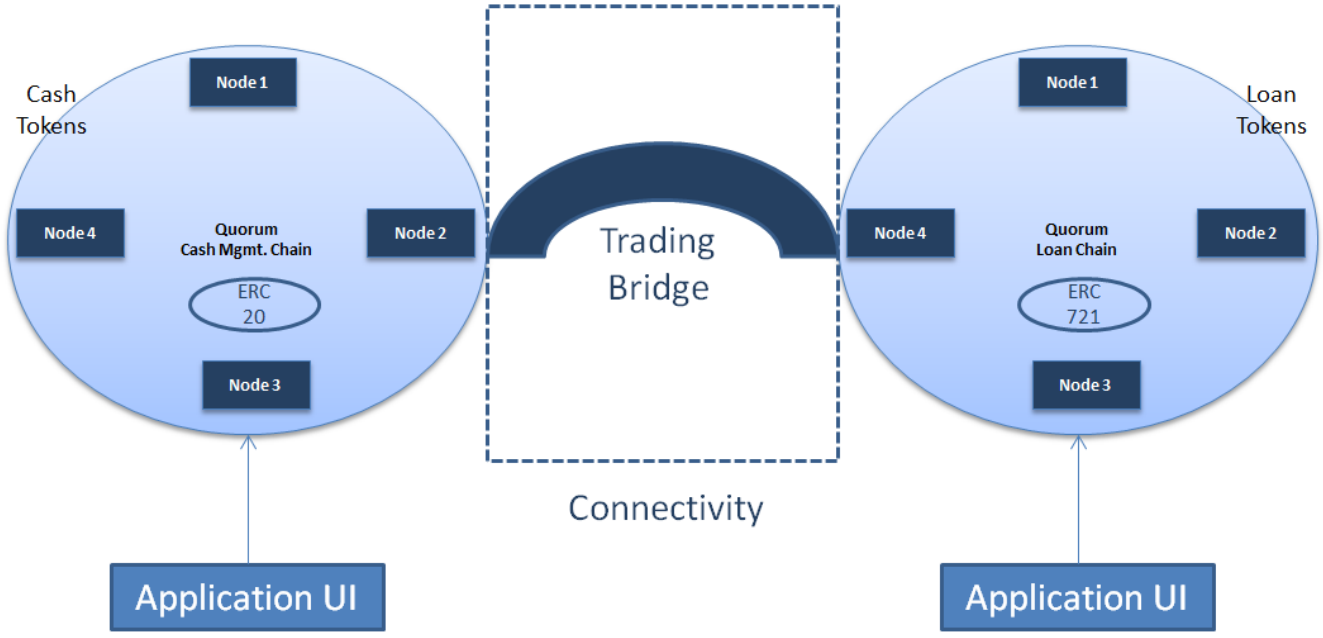
> ***Today, blockchain interoperability is virtually non-existent.***
>
> *If you want to move value across chains, you must do so by moving tokens into a centralized exchange, trade on the exchange's in-house ledger and then withdraw the new asset on a new chain. This process is slow, expensive and involves substantial counterparty risk.*
>
> *Fundamentally, there are two types of chain interoperability:*
>
> *Relaying messages about the state of one chain to another. This includes synthetic tokens (AKA one-to-one pegs, two-way pegs, or sidechains).*
>
> *Cross-chain atomic swaps. The exchange of tokens between users across chains, without trusting a third-party.*

Project Description

Enterprise adoption of Quorum by J.P. Morgan businesses and other entities necessitates enterprise grade support of trading functions reliant on scalable and interconnected solutions.

Currently all Quorum networks lack interconnectivity or the possibility of transferring assets from one chain to another. E.g. it isn't possible to trade a token that represents cash for a token that represents a Loan across two different chains.

At JPM, we view this as an important requirement as it will eliminate redundancy across chains and it provide interoperability between multiple Quorum networks.



Project Scope

1. Response to proposal with follow-up questions and implementation plan
2. Setup 2 private chain networks (a cluster of quorum nodes that is permissioned for a predefined list of participants)
    a. Cash tokens chain
    b. Loan tokens chain
3. Establish baseline performance and scalability metrics for transactions executed on a single chain
4. Evidence performance and scalability of transactions executed on connected chains using single chain metrics as baseline
5. Transact between Quorum chains where transaction initiated on one chain triggers a response on the second chain utilizing enterprise grade smart contracts. The ERC 20 and ERC 721 standards can be used as a reference
    a. Atomic swaps across multiple Quorum chains
6. Develop approach to maintain data privacy across interconnected chains.
    a. All data encrypted or otherwise must remain private to the participants in the transaction. No intermediary service can see the details.
7. If time allows, prove a common bridge model can be used across common blockchain protocols (e.g. Ethereum, Ripple, Hyperledger, Corda etc.)

Project Challenges

- Blockchain technology is still in early stages in development so finding good reference material can be difficult
- Privacy implementations across blockchains are largely still in the research phase
- As a financial company, encrypted data cannot be saved on nodes within a chain by any participants other than those in the transaction

Constraints & Assumptions

- Must be developed for Quorum
- Java or Go programming language must be used for any new components
- Smart contracts must be written in Solidity
- Some components of the project may be open source, while others held as proprietary in a secure source code repository

Sponsor-Provided Hardware and Software

Quorum, Geth, Atom ,Remix Solidity IDE, Git

Project Search Keywords

Blockchain, Ethereum, Quorum, Cross-chain Bridge, Smart Contracts, Chain interconnectivity

Department of Software Engineering Required Deliverables

1. Project website holding all work products and project artifacts maintained in the project account on the se.rit.edu web server.
2. Project plan, schedule and process methodology definition prepared by the end of week 3 of the first term.
3. Tracking report for time/effort worked on the project, and at least two other product/process metrics appropriate to the project and development methodology. Tracking reports updated on the project website at least every two weeks.
4. Interim status and final project presentations
5. Project poster and presentation at "SE Senior Project Day"
6. Project technical report
7. All source code, build instructions and design documentation

Sponsor and Project Specific Deliverables

By completion of the project,

Proprietary Information

Sponsor Availability

	Availability for Weekly Project Meetings
X	Sponsor personnel will be available to meet with the team once per week during the time set for meeting with the sponsor which is Tuesday and Thursday (fall/spring) or Monday and Wednesday (spring/summer) from 5:00 – 6:30pm Eastern US time. We will give a selection preference to proposals whose sponsors are available during this time.

Project Agreements and Assignment of Rights

RIT policy gives students full ownership of any work done as part of coursework which includes their work on senior project. As the sponsor of a course project, you can select one of three approaches for dealing with ownership of project artifacts and intellectual property, and the disclosure of proprietary information. If you seek assignment of rights, the individual team members will sign a project agreement based on the rights that you want.

Please get any corporate and legal clearances that you feel are needed to use the **unmodified** project agreement, before submitting your project proposal. This is necessary to prevent any delays in starting a project. A team will not be assigned to a project if the sponsor has not confirmed that the project agreements are OK. Indicate that this has been done with an **X** in the left box below.

	Corporate and Legal Clearance of Project Agreement
____	

	We have the necessary corporate or legal clearances to use the **unmodified** project agreement. (Note: The project agreements are cleared for RIT internal projects.)

Select one of the following approaches for assignment of the rights to the project artifacts and intellectual property, and the disclosure of proprietary information by placing an **X** in the box to the left of the appropriate paragraph below.

X	**Assignment of Full Rights** If a team is assigned to this project, all students on the team will sign a standard Student Course Project Intellectual Property and Non-Disclosure Agreement. This agreement assigns the rights to the team's project work to the sponsor, and describes the process whereby the project sponsor can reveal proprietary information to the team. For non-RIT projects, the faculty coach will sign a standard Faculty Course Project Non-Disclosure Agreement which describes the same process for revealing proprietary information.
	Assignment of Limited Use Rights If a team is assigned to this project, all students on the team will sign a standard Student Course Project Limited Use and Non-Disclosure Agreement. This agreement assigns the sponsor rights to the team's project work for internal or non-commercial use by the sponsor. The sponsor may maintain and extend the project but not transfer it to a third party or use it in a commercial product. The project team will retain patent and commercialization rights. The agreement also describes the process whereby the project sponsor can reveal proprietary information to the team. For non-RIT projects, the faculty coach will sign a standard Faculty Course Project Non-Disclosure Agreement which describes the same process for revealing proprietary information.
	Open Source Project If a team is assigned to this project, all students on the team will sign a standard Student Course Project Open Source Agreement. The team will develop this as an open source project and will publish all artifacts via an open source mechanism agreed upon through discussions with the project sponsor. The sponsor will gain access to project artifacts only through this open source repository. No rights need to be assigned exclusively to the project sponsor, and there will be no transfer of proprietary information.

The agreements and policies can be found at:

- Student Course Project Intellectual Property and Non-Disclosure Agreement
  http://www.se.rit.edu/~swen-561/CourseInformation/StudentCourseProjectAgreement.doc
- Student Course Project Limited Use and Non-Disclosure Agreement
  http://www.se.rit.edu/~swen-561/CourseInformation/StudentCourseProjectLimitedAgreement.doc

- Student Course Project Open Source Agreement
  http://www.se.rit.edu/~swen-561/CourseInformation/StudentCourseProjectOpenSourceAgreement.doc
- Faculty Course Project Non-Disclosure Agreement
  http://www.se.rit.edu/~swen-561/CourseInformation/FacultyCourseProjectAgreement.doc
- RIT Intellectual Property Policy C03.0. The project agreements are consistent with section C03.0 1.V.B.2
  http://www.rit.edu/academicaffairs/policiesmanual/c030