

Blockchain Tutorial

What Is Blockchain?



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1. Blockchain Overview

In 2018, the word blockchain became a very popular term which continues to be discussed today and the terms blockchain, bitcoin and cryptocurrency are often used synonymously and quickly became household names. Everyone talked about it but very few people understood what these terms actually meant and how they could impact our personal and business lives.

To help readers understand what blockchain is and what value this technology holds for us personally and in business, we need to separate blockchain technology and cryptocurrency. Blockchain is a new technology and bitcoin was its first use case of cryptocurrency that utilized blockchain technology. They essentially were born together. We may cover cryptocurrency in a separate tutorial in the future.

Fundamentally there are two types of blockchains *public* and *private*. In a public blockchain, anyone can connect to the blockchain and with an appropriate computer and software and become a blockchain server node. No permission is needed. In a private blockchain which is typically owned and managed by a company or group of companies, permission is needed to join the private blockchain. This tutorial focuses on private blockchain.

The focus of this tutorial is to help readers understand blockchain technology from a practical uses scenarios and how it might deliver value in the future. The scenarios described in this tutorial are visions of what is possible to build on blockchain. Our hope is that technology vendors will share these visions and adopt similar forward looking plans and seize the opportunity to develop practical applications that will revolutionize how we conduct business in the future.

2. What is Blockchain?

Blockchain is a new technology intended to reduce costs and introduce new capabilities by streamlining and speeding up multi-party business transactions and processes. Today each participant in a multi-party transaction records transactions in their own ledger and reconciles it with information provided by the other parties. This requires significant manpower, is prone to errors and is time consuming. Transactions such as banking or stock trading where thousands of small transactions are involved this requires clearing houses **Fig 1.0** to validate and process each transaction, assure security and prevent fraud.

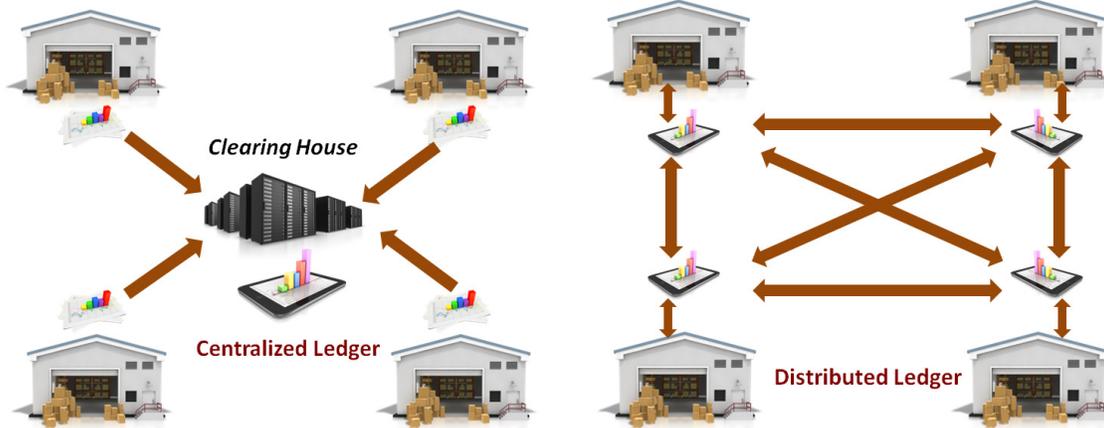


Fig 1.0 Centralized Ledger

Fig 2.0 Distributed Ledger

Blockchain introduces a new way for parties which conduct business activities together to share the same transaction ledger thus reducing the duplication of effort and the cost of processing. As illustrated in **Fig 2.0**, in blockchain all transactions are recorded in a single ledger which is distributed over blockchain network and is shared with every business partner involved.

For each transaction to be recorded in the shared ledger, the transaction information is written into a transaction data block that is uniquely identified, sequenced, secured and validated by all parties involved. In blockchain, each business party involved in shared business activities is represented as a node on the blockchain network

3. How it Works

To illustrate how blockchain could work in a business scenario, let's illustrate functionally how a blockchain based solution would work in an order creation and processing scenario.

When a business partner issues an order, new transaction is created on the issuer's node and is packaged into a data block that includes critical information about; identity of the partner, order information, identity of the block, and special sequence number of the block. This new data block is now shared with all nodes (partners) on the network and all nodes (partners) must agree (provide consensus as in **Fig 3.0**) that this transaction block is valid before it is recorded into the shared ledger on every node. In private blockchain it can be designed that each partner sees only the part of the ledger/block that they are allowed to view and/or alter. This and the fact that the entire block is encrypted keeps the whole process secured. Any subsequent transactions related to this order e.g. filling the order, shipping the order, payment, etc... that are created by other partners are also packaged into data blocks and distributed and validated by all nodes. Each data block is then

connected with the one before and after it creating a chain of transaction blocks (the entire history of the transaction), hence the name blockchain.

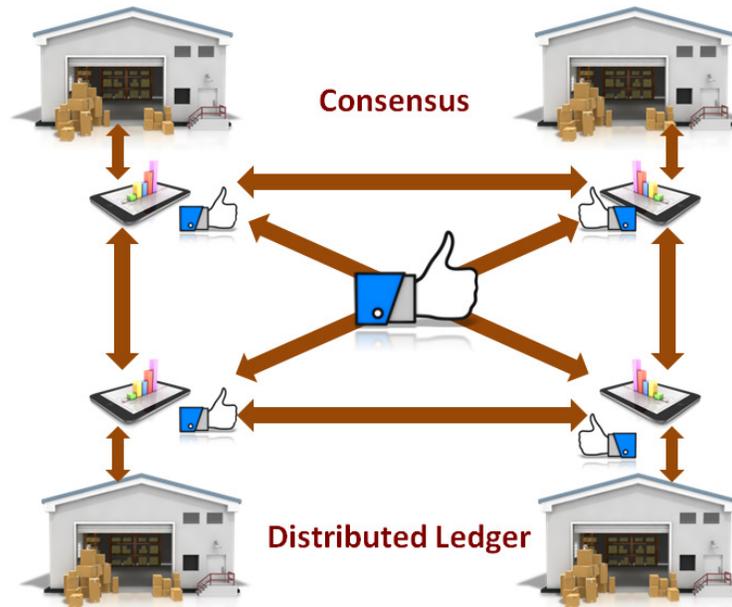


Fig 3.0 Consensus Process

Once each transaction block is written into the shared and distributed ledger, it is permanently recorded becoming part of the history of the transactions and it cannot be altered or deleted by anyone. This feature prevents fraud by one of the parties. If there is a need to modify an issued and recorded transaction, the modified transaction becomes a new transaction that will be created and will follow the same validation and sharing process.

In this scenario, the key benefits that blockchain technology introduces include:

- **Reduced transaction complexity** - The single shared transaction ledger simplifies the complexity of monitoring, reconciling and processing business transactions that would normally be generated and managed by individual business partners in multiple disparate ledgers
- **Increased accuracy** - The unique consensus validation process creates almost an instant audit and validation of all transactions thereby increasing the accuracy of transactions between business partners
- **Reduced effort** – Transactions are validated, correlated and approved automatically and in real time requiring little to no human effort to process them other than entering changes/updates.

- **More tamper proof** – By distributing a shared ledger to all nodes on blockchain network, reduces the risk of transaction tampering and fraud. Tampering with recorded transactions will alert all business nodes and partners
- **Improved security** - Reduces the risk of data breaches and theft. Hackers would need to break into all nodes on the network to breach and modify recorded data as a change/hack of one node or several nodes will be discovered by the rest of the nodes in the network during the validation step.

4. Potential uses of blockchain technology

The distributed ledger based blockchain technology introduces the potential to conduct commerce in a uniquely different and more efficient way than today's traditional centralized systems. And although blockchain technology is still in its early stages of evolution and maturity, there are many visionaries who are creating very interesting out of the box thinking and new visions on how blockchain will revolutionize our commerce and our personal lives.

Today there are already number of companies which are experimenting with blockchain technology in areas such as; supply chain management, insurance, asset tracking, insurance, auto industry, financial transaction processing to name a few.

Let's explore at high level some examples of potential uses of blockchain technology in different business verticals. Let's imagine how these businesses could operate differently using blockchain technology.

4.1. Construction Industry

Today commercial and residential construction industries face many logistical challenges that often impact the bottom line costs and timelines. In this industry where multiples of independent contractors and suppliers are involved in a single project which relies on timely and on budget deliverables, managing the sea of many moving parts is always a challenge. More often than not, many projects fail to be completed on time and on budget.

Imagine a future where every contractor and project owner can visualize their projects in what their projects will look like in days and weeks ahead and being able to predict with great accuracy what will happen to their projects. No matter how complex their projects are, they can ask why delays are coming, what is the problem and be able to take action to resolve problems before they impact the project.

4.2. Single Renovation Project with Multiple Contractors

Consider a house renovation project scenario illustrated in **Fig 4.0** and how it might be managed today. If there is a general contractor assigned to this project, this individual has to manually coordinate all renovation activities with each independent contractor such as painters, carpenters, decorators, plumbers, electricians, long list of suppliers, cabinet makers, etc.... to determine the status of work activity, adjust for delays, modify schedules, track materials and costs, resolve unexpected problems, update each contractor on any changes and update the overall project plan to ensure that all renovation activities are completed on time and budget.

Contractors, trades and specialists work independently. They exhibit a wide range of organizational skills and often lack good information on the status of work activities performed by other parties in the same project. It's not unusual to find a drywall installer show up at the job site to put up dry wall only to find out that the work inside the walls has not been completed. This is disruptive and costly to not only the overall renovation project; the drywall contractor now has to reschedule his/her work on other projects he/she is involved. This delay now creates a ripple effect that will cause delays for other subcontractors who are working on this renovation.

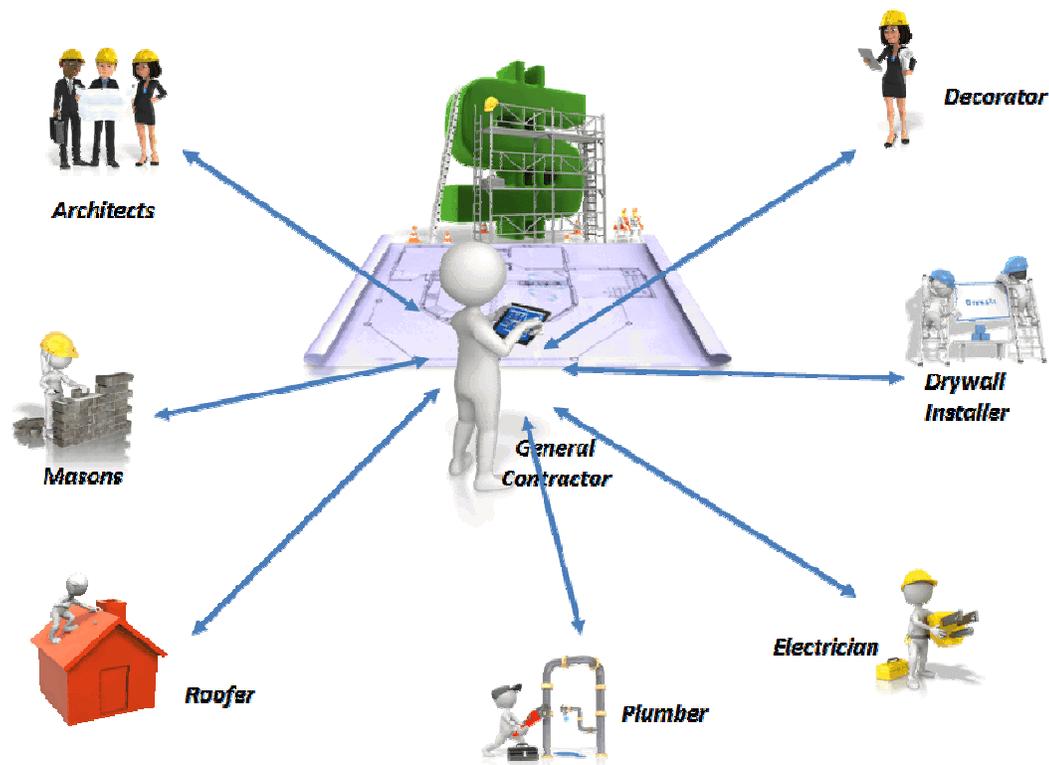


Fig 4.0 Managing renovation project today

Let's consider this drywall installer scenario that just discovered an unexpected delay. As illustrated in **Fig 5.0** below, a single drywall installer will typically engage with many projects that run concurrently. Completing work on time on each project is critical. When a dry wall installer shows up to complete his scheduled work on "Project #1" and finds out that the work inside the wall has been delayed because the electrician did not complete his work on time and he didn't know this, the ripple effect of schedule changes begins. A delay lay in "Project #1" will cause delays in commitments this subcontractor made in projects # 2-5. All clients involved are now affected.

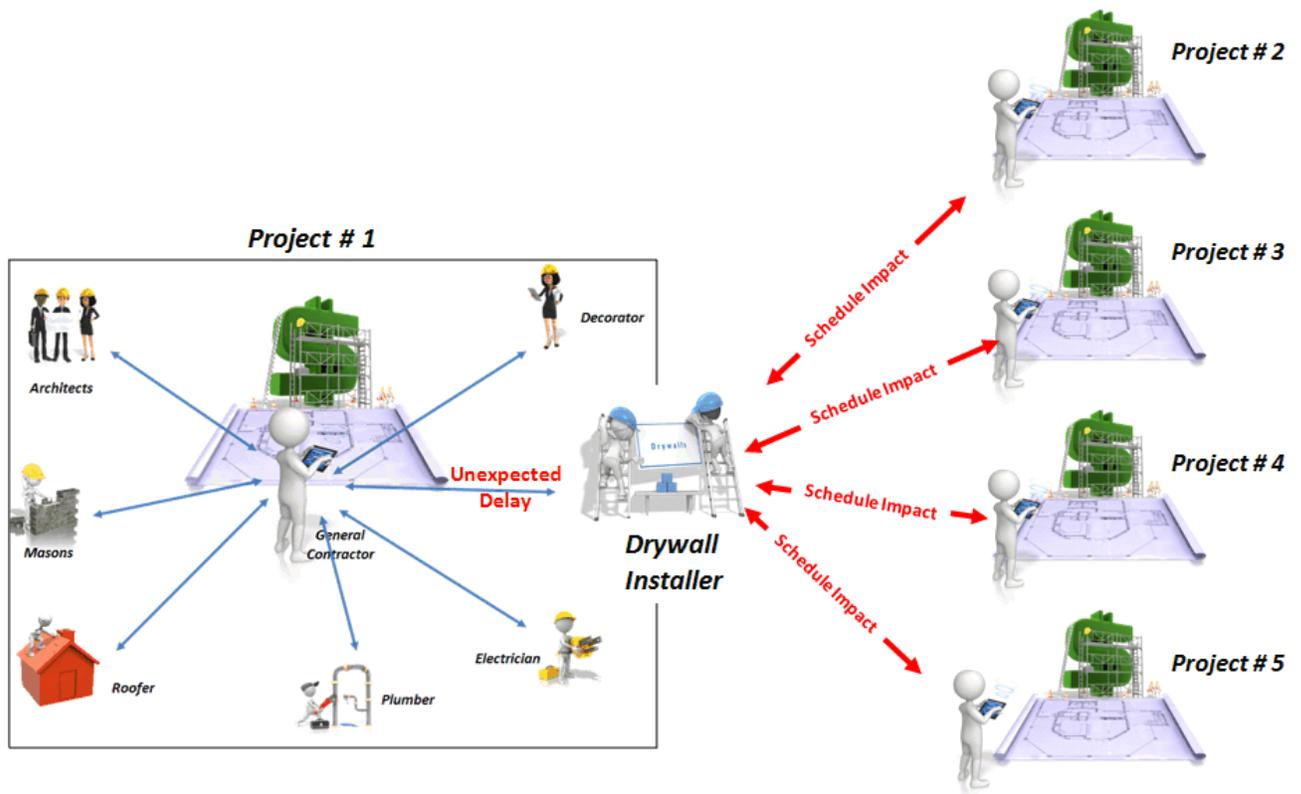


Fig 5.0 Ripple effect of unexpected delay

When one factors in the number of subcontractors and suppliers involved in a renovation project, it is easy to see how quickly things can get out of control. Most common problems that can be resolved include; other contractors didn't complete their activities on time and didn't report it, unexpected difficulties discovered and weren't reported, contractors didn't show up to complete their work because they were delayed on other jobs, and the list goes on. This is further complicated by change orders that are common. A small change may require bringing back a subcontractor on an unscheduled task causing yet another ripple effect for this and other projects. Change orders account for most project cost overruns which can easily add up to 10% or more of the project. Most of us at one time or another have experienced renovation or construction project delays and cost overruns and

understand the frustrations well. There are always good explanations for why delays happened but it's usually too late to prevent the ripple effect delays and recover lost time and costs. And inevitably, renovation projects are delayed and run over budget.

Consider the same renovation project scenario but one that is managed using a blockchain based solution as illustrated in **Fig 6.0**. Imagine that every contractor who is involved in the renovation project has the same status view of all renovation activities for that project on their Smartphone or Tablet application. Using blockchain distributed ledger, every contractor receives instant updates on scheduled work activity status and share the same project view. When a problem is discovered by one contractor, that contractor issues a new transaction/blockchain entry indicating what needs to be done to resolve the issue and if he is going to resolve it and finally, he states the date the work will be done. Now blockchain solution distributes this new transaction to all parties involved. Using consensus mechanism in this distributed ledger, all recipients validate the proposed change, accept it or suggest additional modifications. This collaborative process happens in minutes and when accepted by all parties, everyone now has an updated schedule to work with.

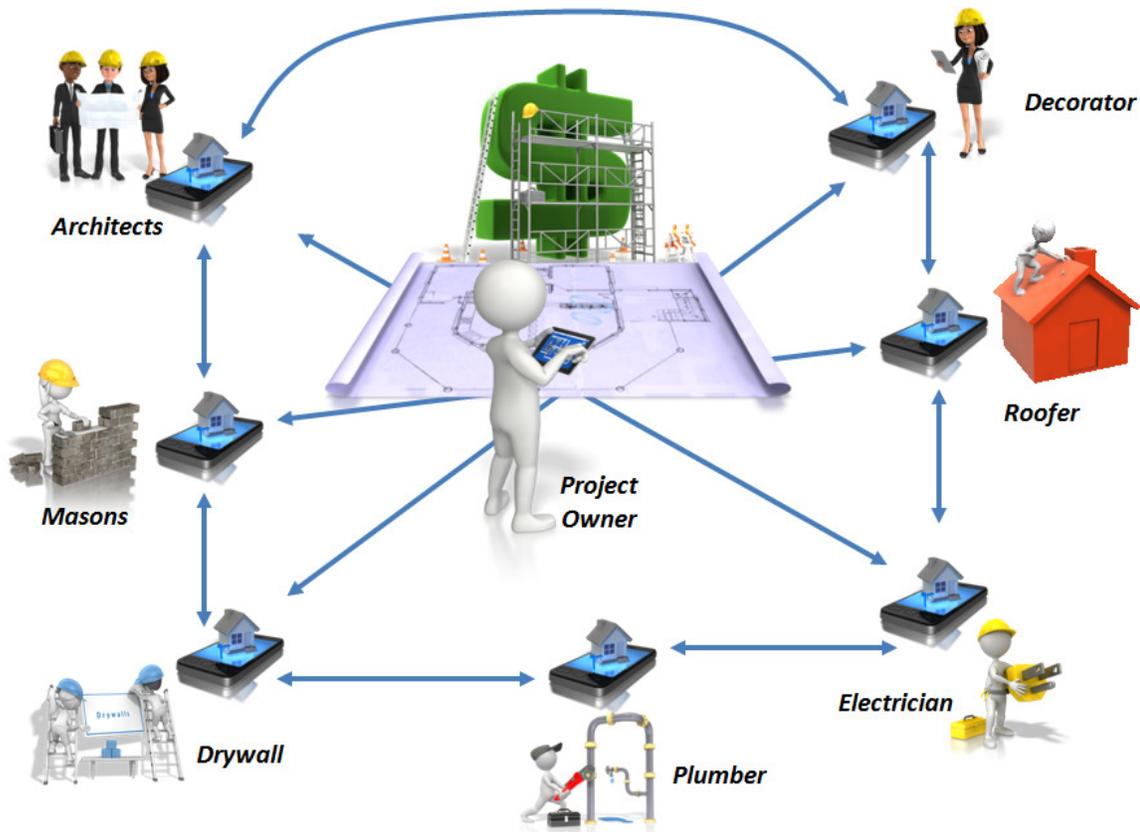


Fig 6.0 Managing renovation project with blockchain based solution

Unlike in today's scenario where a drywall installer shows up to cover up the walls before the electrician or plumber has completed their work inside the wall, with blockchain solution every contractor would know instantly when the electrician and plumber have completed or delayed their work. Instead of showing up at the renovation site before preceding work has been completed, they can now effectively plan their work to be at the renovation site at the right time to complete their work.

Imagine that every contractor can now visualize what their project will look like in few days or weeks. Sharing the same ledger that shows real time status of changes, each contractor and project owners can predict with great accuracy the status of their project no matter how complex the project is and take actions to keep the projects on time and cost. In this scenario, there is no need for central function or a general contractor to follow up with each contractor and supplier to track deliveries or to discover status. The project owner which could be the home owner could have complete real-time status of all work activities, costs, problems and their resolutions and renovation progress.

4.3. Single Contractor with Multiple Projects

Let's expand the single project scenario to illustrate how blockchain based solution could help a single contractor like the roofer to manage multiple projects he is involved in. As illustrated in **Fig 7.0**, a single roofer has 4 roofing projects to work on during a month where schedule is tight with little spare time between projects. This contractor will make commitments to his clients based on the starting schedule and changes in one project will impact his work schedule in all remaining projects.

Imagine a blockchain solution that serves single contractor who works on many projects like the one in **Fig. 7.0**. A single contractor like the roofer installs a blockchain application on his smart device and that application enables him to manage (interact with) all other individual projects that he is involved with using a single dashboard. And each project that he is involved with is already managed by its own blockchain application like the one illustrated in **Fig. 6.0**. This single dashboard enables the roofer to connect and synchronize his entire work availability schedule with all of his other projects he is involved with. When this roofer assigns specific work days to Project # 1, the remaining available days are now visible to projects 2 – 4. When the schedules for projects 2-4 are created, this roofer can assign with certainty his availability to other projects as needed and be able to manage his time much more effectively.

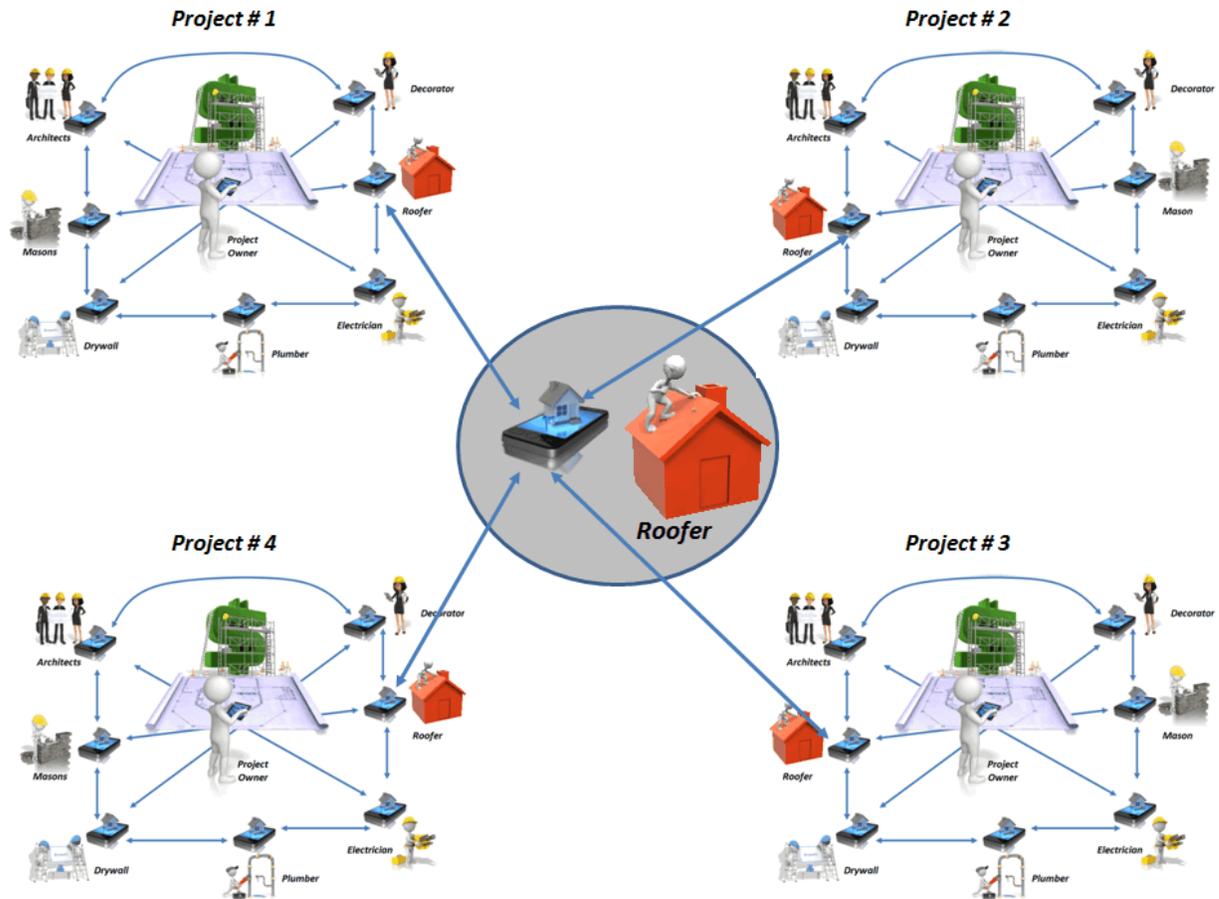


Fig 7.0 Single contractor with multiple projects

If the roofer completes his work on Project #1 earlier than planned, he adjusts his availability and makes it known to projects 2-4 which can take advantage of the new availability and add that to their project. If the roofer is delayed on Project #1, this delay is communicated to other projects which are able to determine the impacts on their schedule and are now able to take action before it is too late. Some may choose to modify their schedule and others may seek to find alternative contractors.

Unlike today where the roofer does not show up in Project #2 on the expected day because he was delayed in Project #1, with blockchain solution in **Fig 7.0**, information about delays or even faster progress is available from the roofer in minutes. Project #2 can react to roofer's delays and minimize the impacts on its schedule.

4.4. Large Construction Projects

Now imagine managing a much larger construction project like construction of a major high rise office towers, shopping malls, large residential subdivisions and the list can go on. Managing all individual activities performed by all parties involved is done today but it is not a simple or is always an effective process. The complexities of such projects are hundred fold greater than in a simple house renovation. The opportunities for delays and cost overruns are significantly higher and delays and cost overruns frequently happen.

Imagine if a blockchain solution described above was used to manage mega projects where there are hundreds of contractors, suppliers, specialists and trades involved. The opportunity to unite all of their activities under a single and shared ledger project view that is updated in real time by all parties involved and is shared with all parties involved, would revolutionize the way major construction projects are managed.

Being able to know in real time the status of project activities, managers of major projects would be able to react to problems, delays, and unexpected surprises in real time and resolve them before they impact the project cost and timeline. The parties involved would be able to help each other resolve problems so they can complete their work and avoid costly delays.

Mega projects that would use blockchain based solution would realize major benefits which would include:

- Construction completes on time and budget
- Improved quality of constructions
- Tenants move in on schedule
- Rental revenue starts on time
- Reduction in staff needed to manage the project

The possibilities for uniting large disparate and complex work groups and activities are endless with blockchain based solutions. Uniting such complex operations under a single digital view is a goal of every large project. Blockchain technology framework enables small and large organizations to develop specific applications for such purposes.