Ethereum Consortium Network Deployments Made Easy

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Overview

The next phase of our support of blockchain on Microsoft Azure is the release of the Ethereum Consortium Blockchain Network solution template in the Azure Quick Start Templates that simplifies the infrastructure and protocol substantially. This template deploys and configures a private Ethereum network from the Azure Portal or cmdline with a single click. While there are many valuable scenarios for the public Ethereum network, we expect in many enterprise scenarios, you will want to configure Ethereum to build out and deploy your own consortium network.

After reading this article, you will

- Obtain working knowledge of blockchain, Ethereum, and one consortium network architecture
- Learn how to deploy and configure a multi-node Ethereum consortium network with the published ARM template

About blockchain

For those of you new to the blockchain community, this is a great opportunity to learn about the technology in an easy and configurable manner on Azure. Blockchain is the underlying technology behind Bitcoin; however, it is much more than just a virtual currency. It is a composite of existing database, distributed system, and cryptographic technologies that enables secure multi-party computation with guarantees around immutability, verifiability, auditability, and resiliency to attack. Different implementations employ different mechanisms to provide these attributes. Ethereum is one such protocol, with several different implementations.

While this article will not go into the details of the Ethereum protocol, implementations, architecture, or public network, it is still important to briefly describe a simplified application and network architecture better understand the different deployment topology options now available. Ultimately, there is no single canonical network layout; it all depends on the use cases and stage within the development lifecycle.

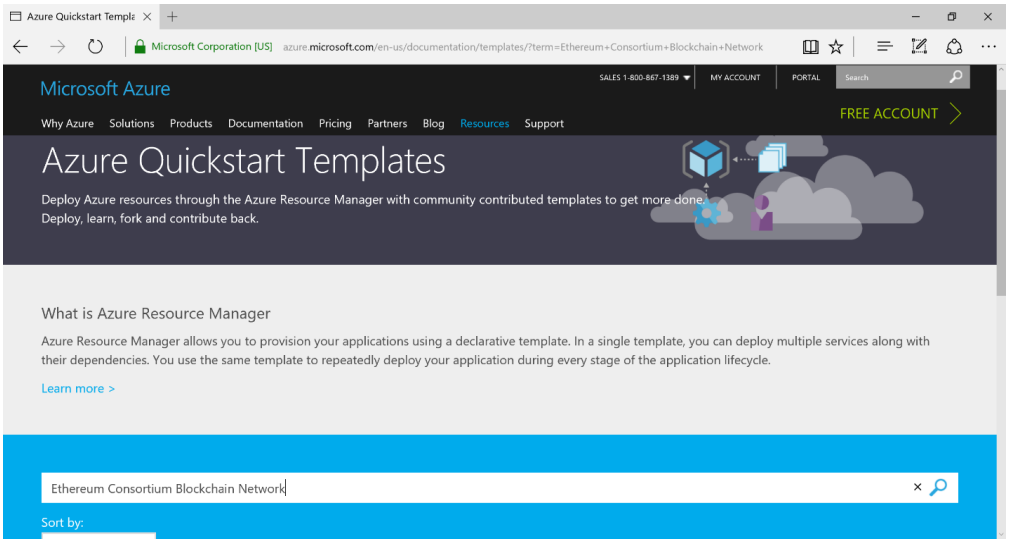
Similar to applications interacting with databases today, decentralized applications will communicate and execute logic against the Ethereum blockchain. A private Ethereum network consists of a peer-to-peer decentralized network of nodes. These nodes maintain a copy of the data store (i.e. distributed ledger) and run a virtual machine to support arbitrary computation against the ledger, while maintaining consensus. Smart contracts are the mechanism that allows for this complicated computation on the network, similar to stored procedures on traditional databases.

Nodes are divided into mining and transaction nodes (non-mining nodes). Transaction nodes maintain a copy of the distributed ledger, but are used to submit or look up transactions from the network. Applications interact with these nodes using Ethereum's web3 JavaScript object to execute and store important transactions within their application. A wallet is usually backed by a transaction node on the public network. Mining nodes process and commit transactions to the underlying distributed database (i.e. ledger) through a consensus process.

Getting Started

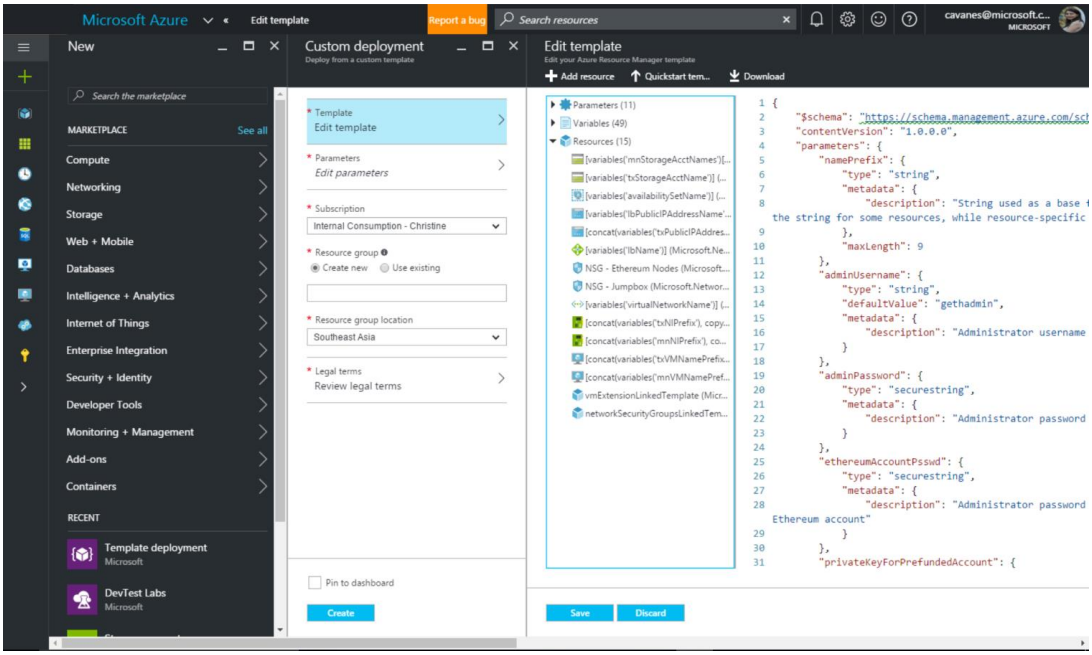
To begin, you will need an Azure subscription that can support deploying several virtual machines and standard storage accounts. By default, most subscription types will support a small deployment topology without needing to increase quota.

Once you have a subscription, go to [Azure Quick Start Templates] and search for “Ethereum Consortium Blockchain Network”.



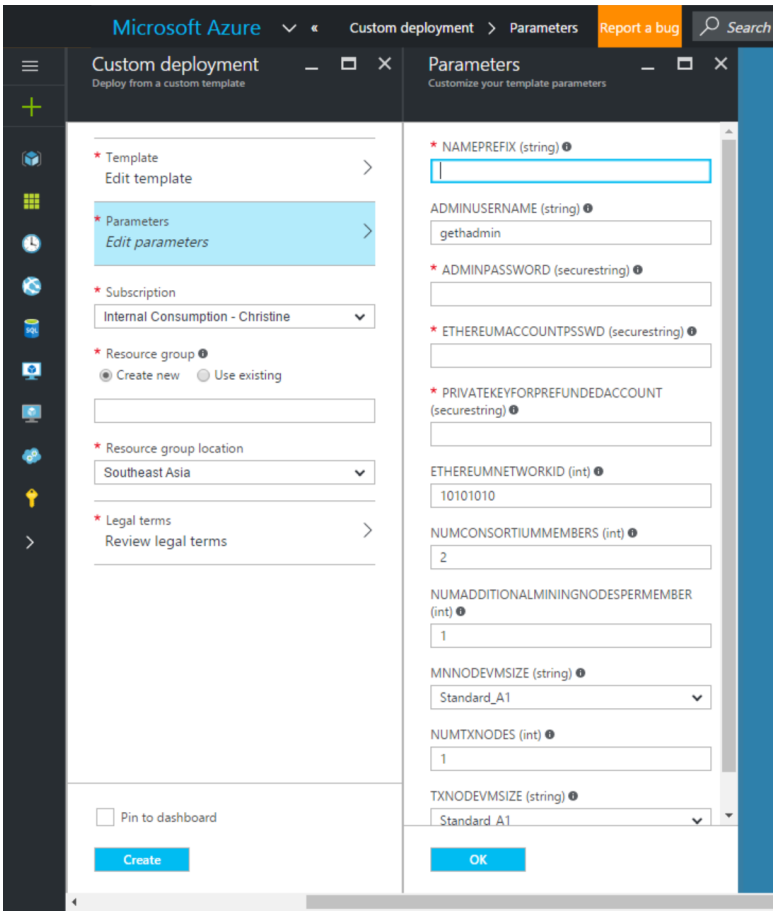
Select the template that is returned in the search results to take you to the Deployment page and then the ‘Deploy to Azure’ button to take you to the Template deployment wizard in the Azure Portal. Note, you will be prompted to sign into your account and Azure subscription in the process if you are not already logged in.

Once signed in, you land within the Template deployment wizard as shown below. The template section is filled out with the main azuredeploy.json ARM template file.



If you are interested in understanding or modifying the ARM template itself, select the template tab to open the editor in the Azure portal. For a more detailed inspection, you can also select the 'Browse on Github', instead of 'Deploy To Azure' button to take you to the Azure Github repository that contains the Ethereum Consortium Blockchain Network template.

Under the Parameters section, the wizard will prompt you for a set of simple inputs to configure the deployment properly.



You will need to specify:

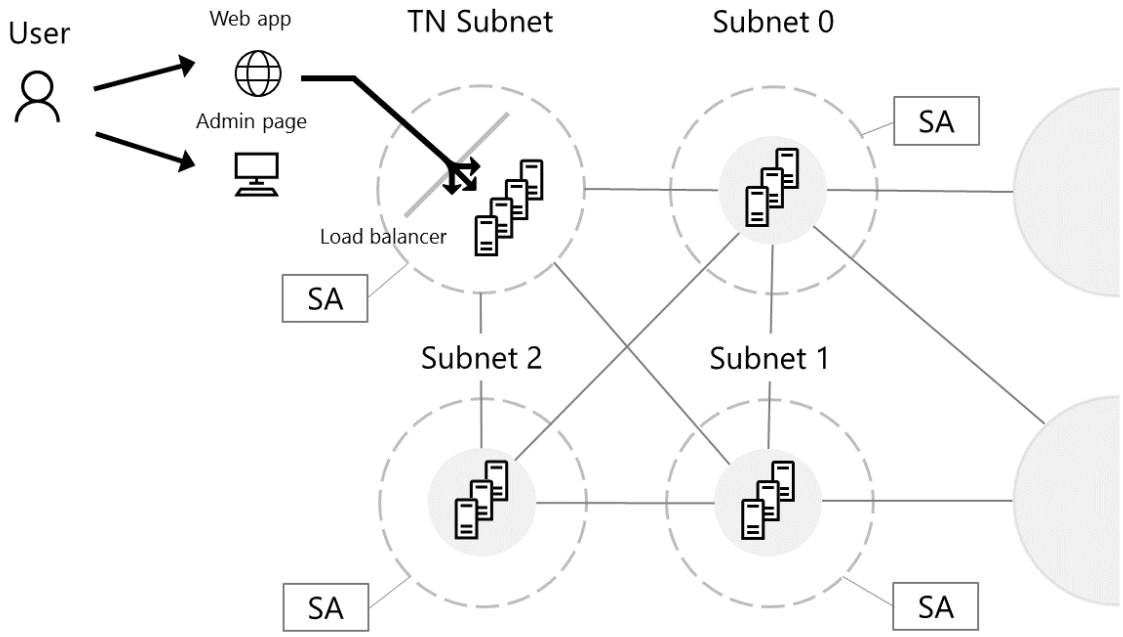
Parameter Name	Description	Allowed Values	Default Value
Name Prefix **(namePrefix)**	A string used as a base for naming the deployed resources.	9 characters or less	NA
Administrator User Name **(adminUserName)**	The user name of the administrator for each of the virtual machines deployed. This user name is also used when creating the Ethereum account.		gethadmin
Administrator User Password **(adminUserPassword)**	The password for the administrator account for each of the virtual machines deployed. While all VMs initially have the same password, you can change the password after provisioning.		NA

Ethereum Account Password **(ethereumAccountPsswd)**	The administrator password used to secure the Ethereum account imported into each node. This account is setup in the genesis block and pre-allocated with one trillion Ether.		NA
Private Key For Prefunded Account **(privateKeyForPrefundedAccount)**	This is the private key used to create the Ethereum account. You can use a variety of methods to generate an elliptic curve cryptography private, public key pair.		NA
Ethereum Network ID **(ethereumNetworkID)**	The network ID for the consortium Ethereum network being deployed. Each Ethereum network has its own Network ID, with 1 being the ID for the public network. While we have restricted network access for mining nodes, we still recommend using a large number to prevent collisions.		10101010
Number of Consortium Members **(numConsortiumMembers)**	The number of members to simulate within the network. Each consortium member receives a subnet containing one mining node (virtual machine) backed by one storage account as the initial footprint.	2-5	2
Number of Additional Mining Nodes per Member **(numAdditionalMining NodesPerMember)**	The number of mining nodes in addition to the single mining node per subnet. The total number of mining nodes equals NumConsortiumMembers + NumConsortiumMembers x NumAdditionalMiningNodesPerMember. For example, setting Number of Consortium Members to 3 and Number of Additional Mining Nodes per Member to 4 will result in a network with 3 subnets each containing 5 mining nodes, for a total of 15 deployed VMs.	1 - 19	1
Mining Node VM Size **(mnNodeVMSize)**	The virtual machine size used for mining nodes.	Standard A, Standard D, Standard D-v2, Standard F series	Standard A1
Number of Transactional Nodes **(mnNodeVMSize)**	The number of transaction nodes to provision as part of the network.	1 - 5	1
Transaction Node VM Size **(txNodeVMSize)**	The virtual machine size used for transactional nodes.	Standard A, Standard D, Standard D-v2, Standard F series	Standard A1

Once you have specified all parameters, specify a resource group and region to which to deploy all resources. We recommend using a new separate resource group for ease of management and deletion. Finally, acknowledge legal terms and click to 'Create.' Depending on the number of VMs being provisioned, deployment time can vary from a few minutes to tens of minutes.

Ethereum consortium network architecture on Azure

While there is no single canonical architecture for a consortium network, this template provides a sample architecture to use to get started quickly. Fundamentally, the network consists of a set of shared transaction nodes with which an application can interact to submit transactions and a set of mining nodes per consortium member to record transactions. All nodes are within the same virtual network, though each consortium member's subnet can be easily pulled into individual VNets communicating through application gateways. The network is illustrated in the figure below.



Mining Nodes

Each consortium member is given a separate, identical subnet containing one or more mining nodes, backed by a storage account. The first default VM in the subnet is configured as a boot node to support dynamic discoverability of the nodes in the network. Mining nodes communicate with other mining nodes to come to consensus on the state of the underlying distributed ledger. There is no need for your application to be aware of or communicate with these nodes. Since we are focused on private networks, these nodes are isolated from the public internet adding a secondary level of protection. While each member's VMs are in a separate subnet, the individual nodes are still connected and communicating with one another via Ethereum's discovery protocol.

All nodes have the latest stable Go Ethereum (Geth) client software and are configured to be mining nodes. All nodes have an Ethereum account (Ethereum address and key pair) that is protected by the Ethereum account password. The public private key pair is stored on each of the Geth nodes. As mining nodes mine, they collect fees that are added to this account.

Transaction Nodes

All consortium members share a set of load-balanced transaction nodes. These nodes are reachable from outside the virtual network so that applications can use these nodes to submit transactions or execute smart contracts within the blockchain networks. All nodes have the latest stable Go Ethereum (Geth) client software and are configured to maintain a complete copy of the distributed ledger.

We have explicitly separated the nodes that accept transactions from the nodes that mine transactions to ensure that the two actions are not competing for the same resources. We have also load-balanced the transaction nodes to maintain high availability.

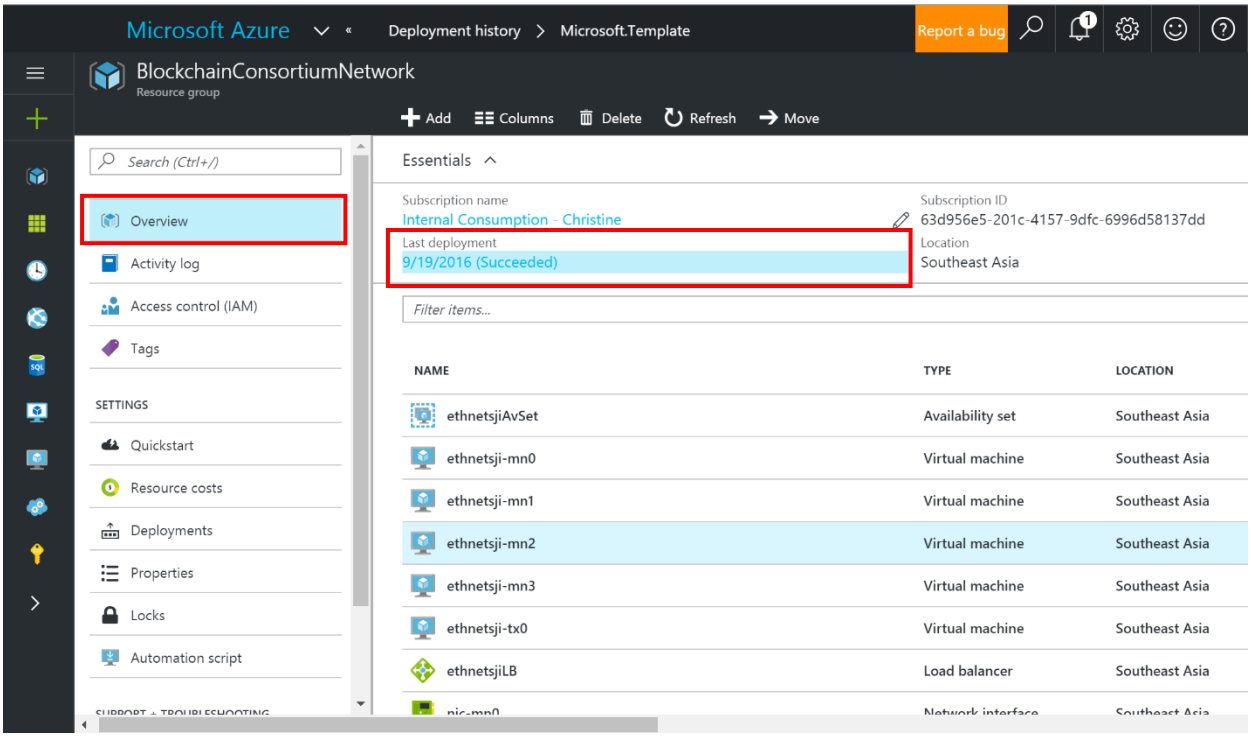
Ethereum configuration

Besides the infrastructural footprint and configuration of nodes, the blockchain network itself is created. The genesis block is configured with the desired Ethereum network id, an appropriate mining difficulty, and a pre-configured account. The mining difficult varies depending on the number of mining nodes deployed to ensure mining time remains short even in the beginning. The pre-configured account contains 1 trillion Ether to seed the consortium network with enough gas (Ethereum's fuel) to handle millions of transactions. Since the mining nodes use this account, their collected fees feed back into the account ensure continual funds.

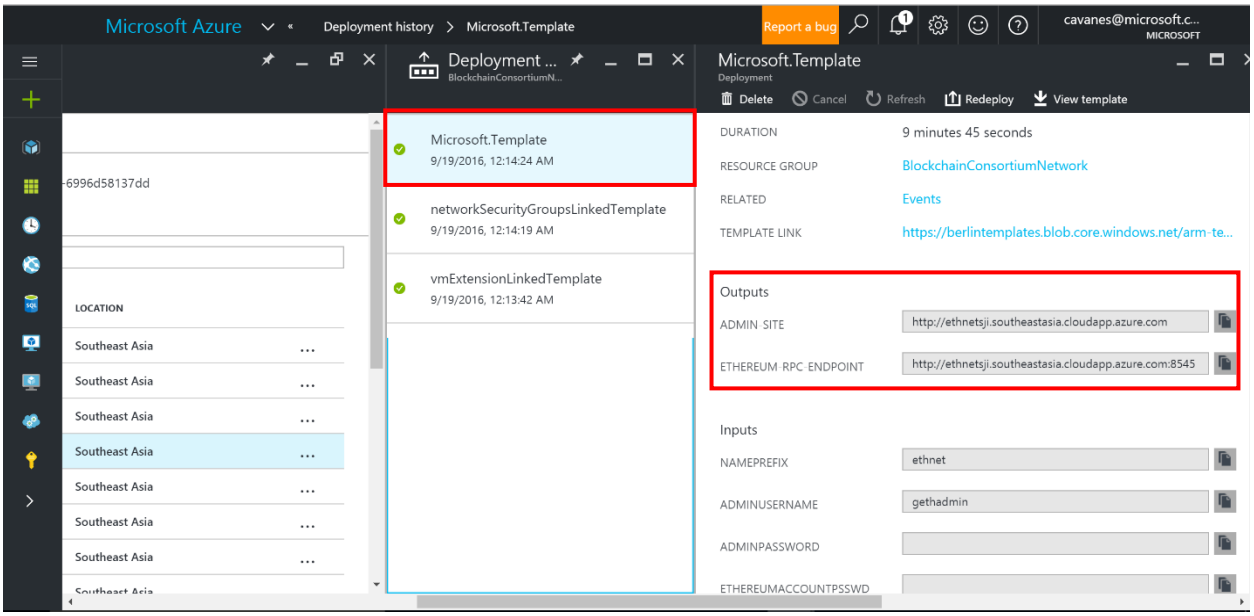
Administrator page

Once the deployment has completed successfully and all resources have been provisioned, you can go to the administrator page to get a simple view of your blockchain network.

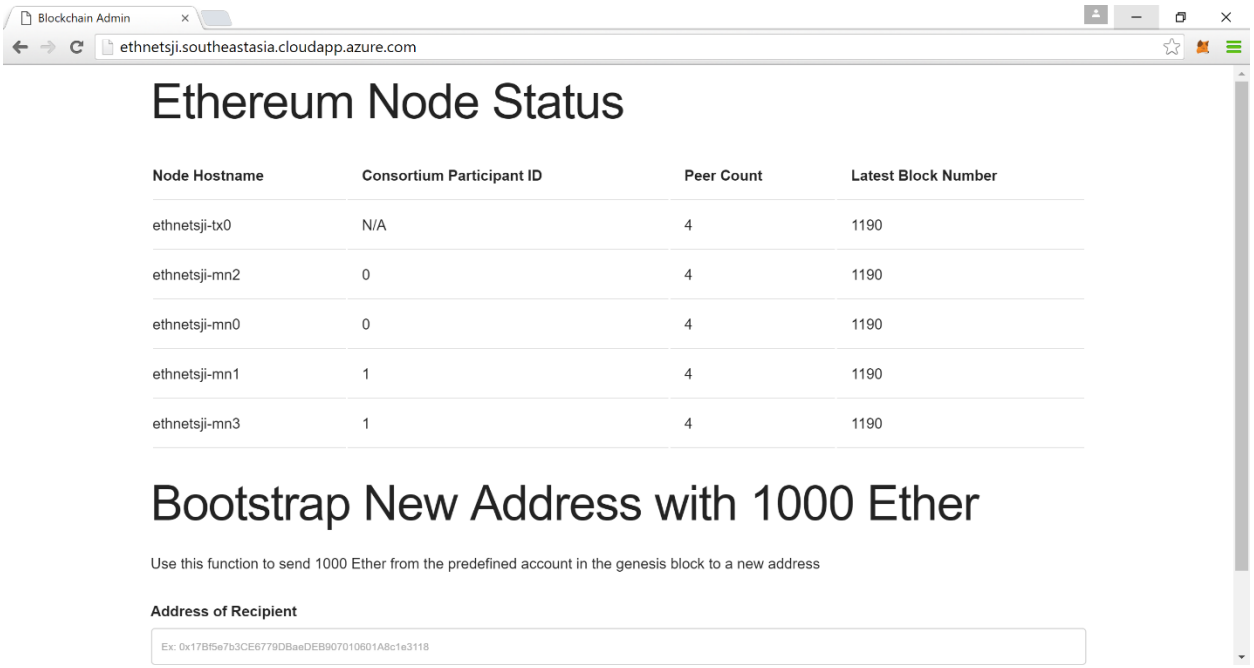
The admin site URL is the DNS name of the load balancer; it is also the first output of the template deployment. To find the template output, select the resource group just deployed. Select the Overview tab, then Last Deployment.



Finally, select Microsoft.Template and look for the outputs section.

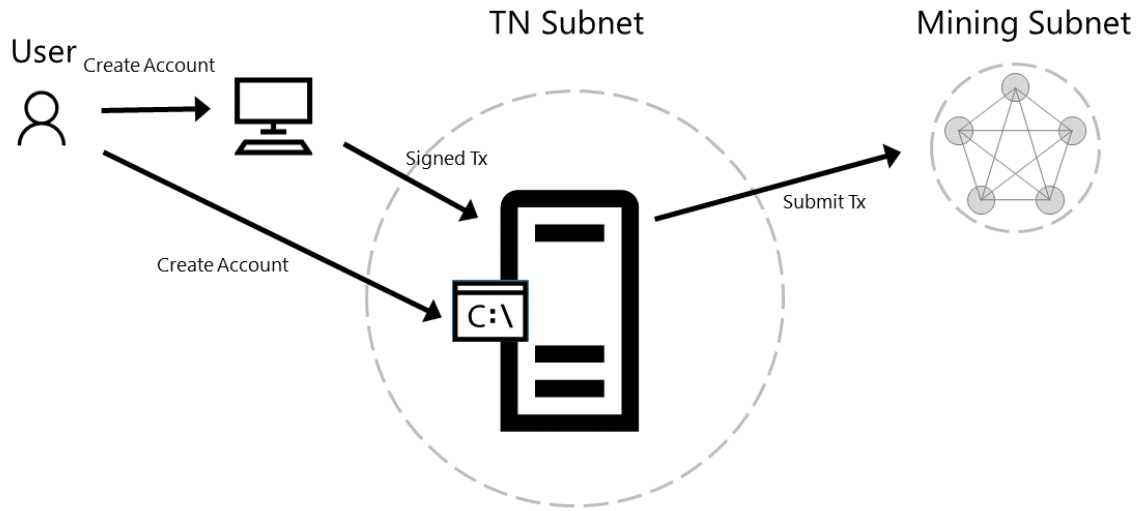


You can get a high level overview of the topology you just deployed by reviewing the Ethereum Node Status section. This section includes all node hostnames and the participant to which the node belongs. It also displays node connectivity with the peer count. Peer count is the minimum of the number of mining nodes in the network and twenty-five where twenty-five is the configured maximum peer count, as in the public Ethereum network. Note, that peer count does not restrict the number of nodes that can be deployed within the network. Occasionally, you will see peer count fluctuate and be less for certain nodes. This is not always a sign that the nodes are unhealthy, since forks in the ledger can cause minor changes in peer count. Finally, you can inspect the latest block seen by each node in the network to determine forks or lags in the system.

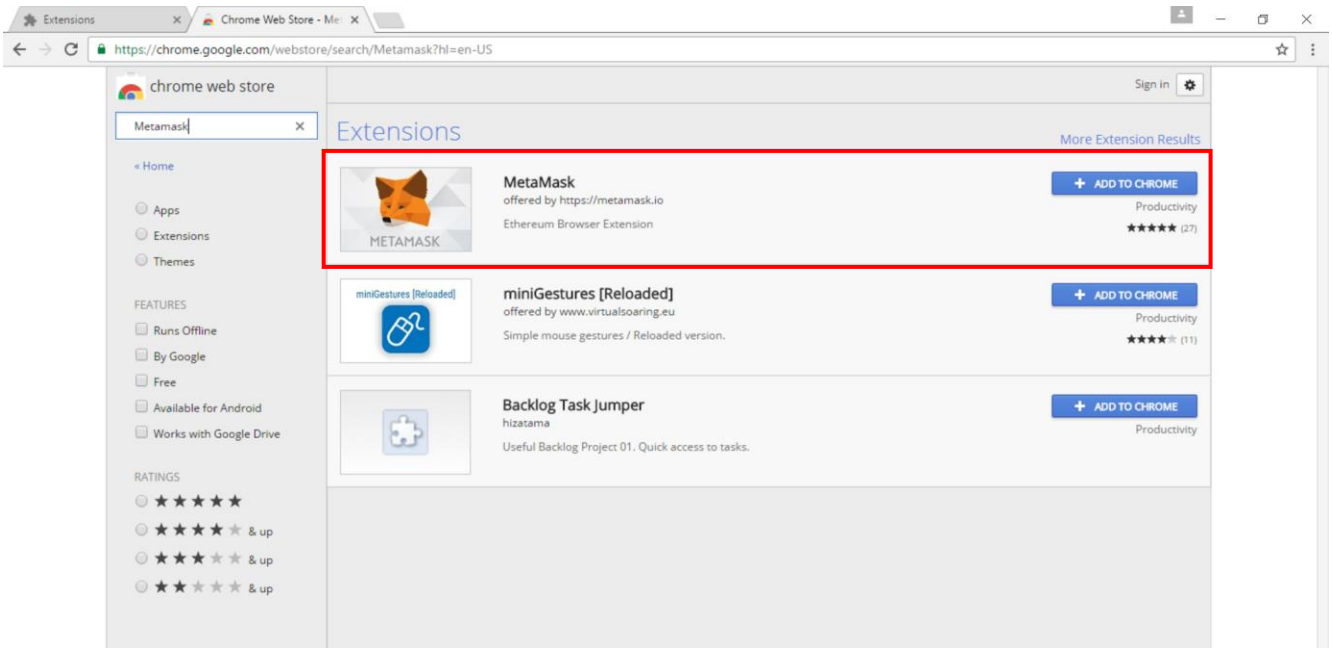


Create Ethereum Account

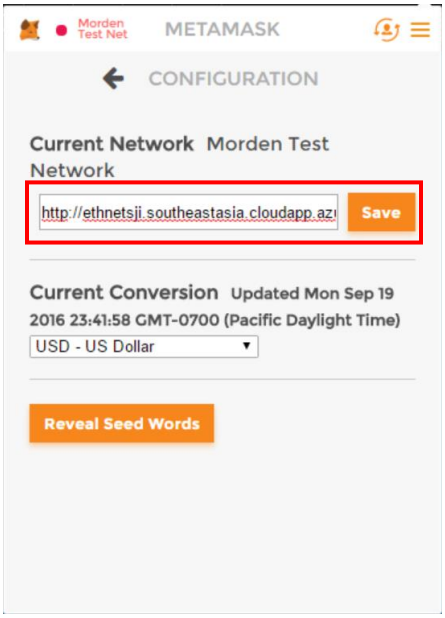
To create an additional account, you can use a variety of solutions. One such solution is MetaMask, a Chrome extension that provides an "identity vault" and connection to an Ethereum network, public, test or custom. MetaMask formulates a transaction to register the account in the network. This transaction, like any other transaction, will go to one of the transaction nodes, and eventually be mined into a block as illustrated below.



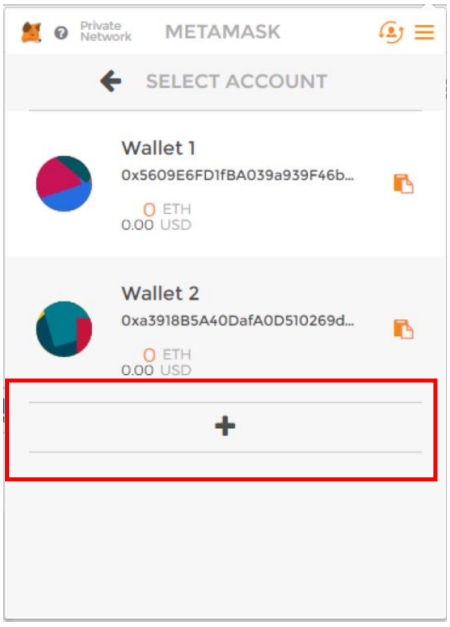
To install the extension in Chrome, go to Customize and control Google Chrome (Overflow button), More Tools, Extensions, Get More Extensions, and search for MetaMask.



Once installed, open MetaMask and create a new vault. By default, the vault will be connected to the Morden Test Network. You will need to change this to connect to the deployed private consortium network, specifically to the load balancer in front of the transaction nodes. From the template output, retrieve the exposed Ethereum RPC endpoint at port 8545, the second template output, and enter it in custom RPC as shown below.

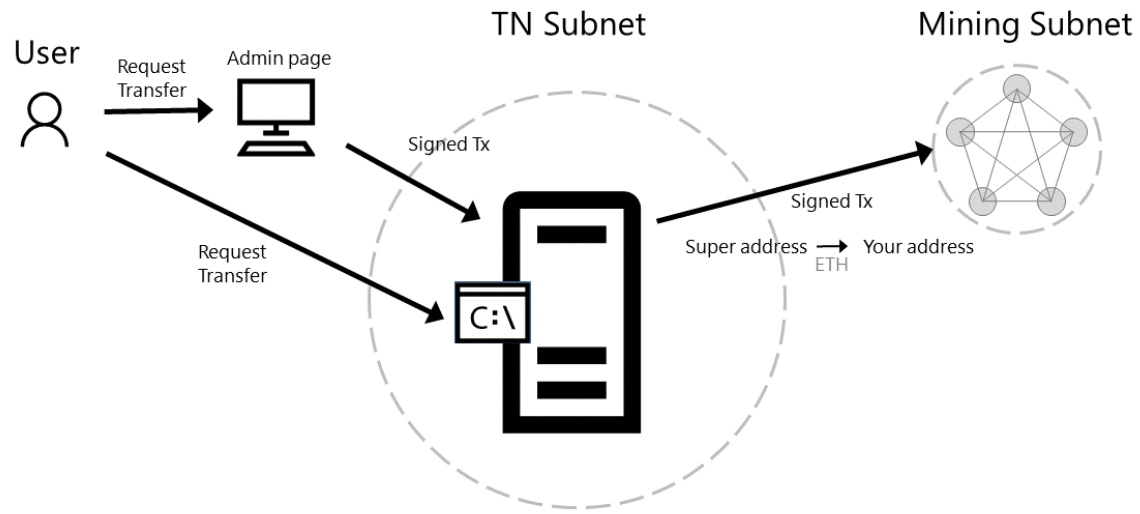


By creating the vault, you create a wallet containing an account. To create additional accounts, select Switch Accounts and then the '+' button as shown below.

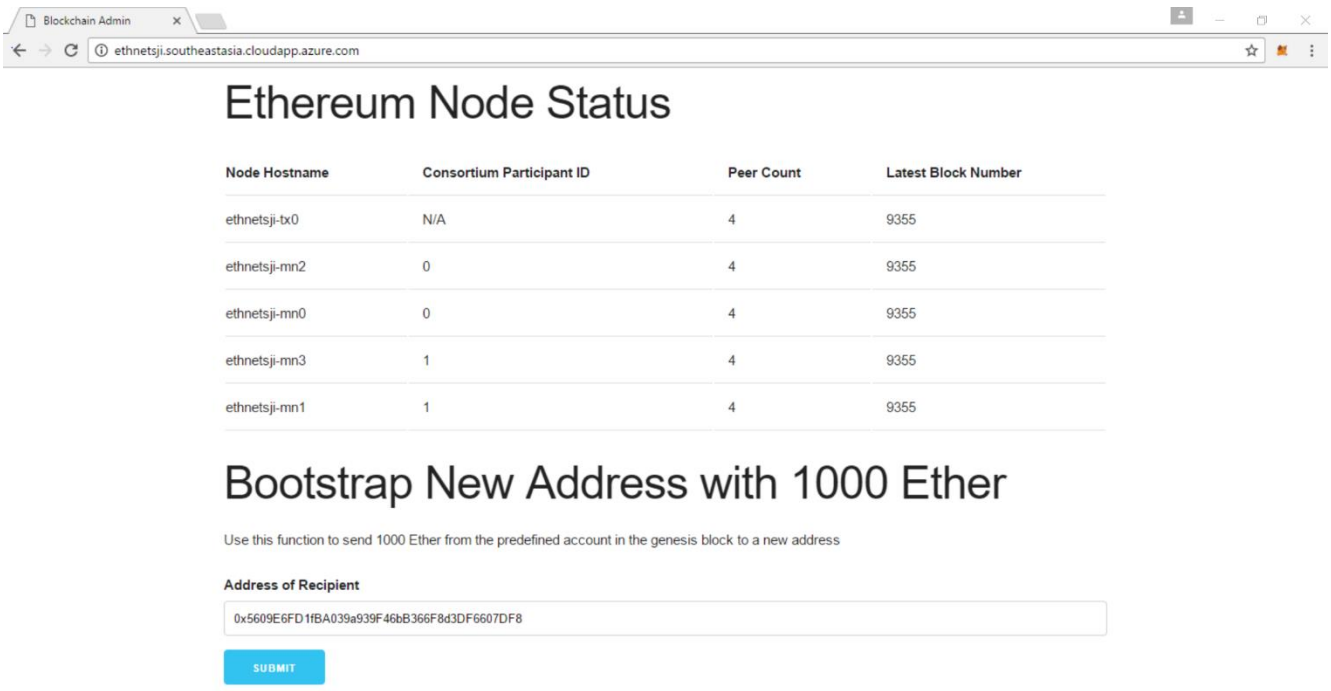


Initiate Initial Ether Allocation

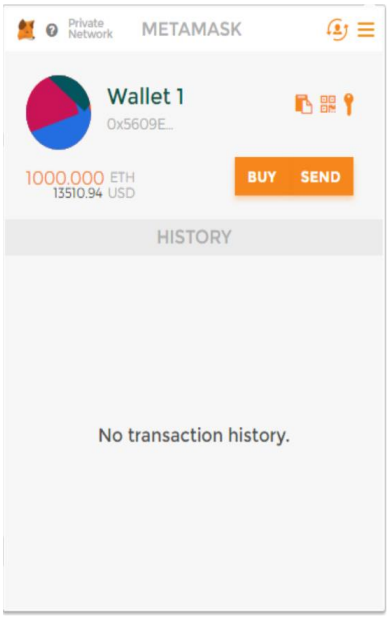
Through the administrator page, you can formulate a transaction to transfer Ether from the pre-allocated account to another Ethereum account. This Ether transfer is a transaction that is sent to the transaction node and mined into a block as illustrated below.



Via the clipboard icon in the MetaMask wallet, copy the address of the Ethereum account to which you want to transfer ether and go back to the administrator page. Paste the copied account into the input field to transfer 1000 ether from the pre-allocated Ethereum account to your newly created account. Click submit and wait for the transaction to be mined into a block.



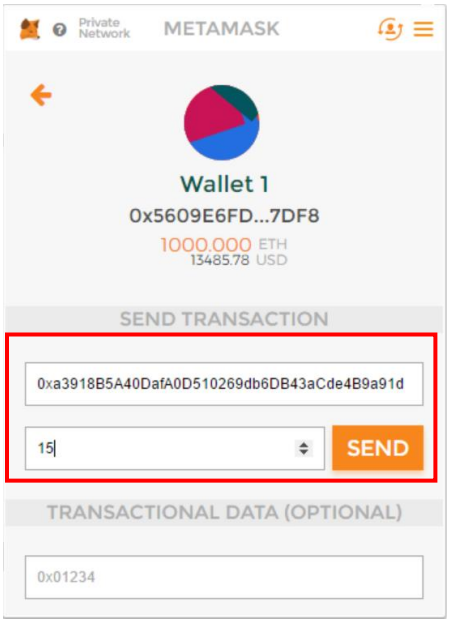
Once the transaction is committed into a mined block, the account balance in MetaMask for your account will reflect the transfer of 1000 Ether.



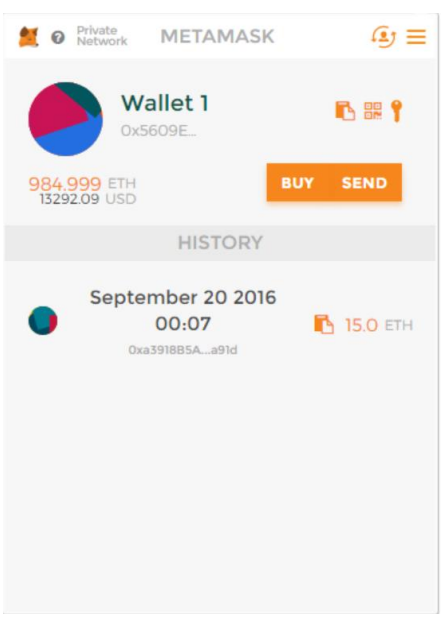
Transfer of Ether between Accounts

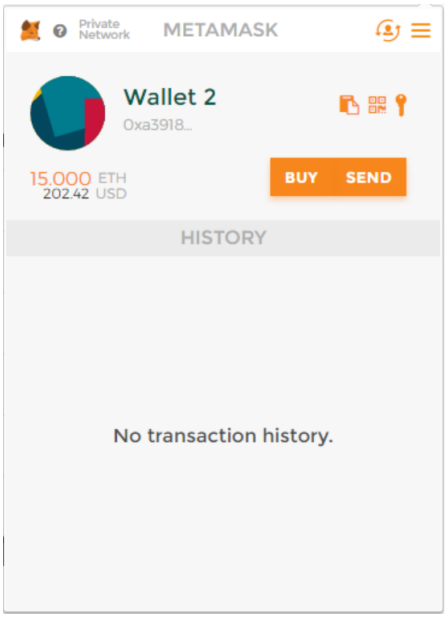
At this point, you are ready to execute transactions within your private consortium network. The simplest transaction is to transfer Ether from one account to another. To formulate such a transaction, you can use MetaMask once again, transferring money from the first account used above to a second account.

From Wallet 1 in MetaMask, click on send. Copy the address of the second wallet created into Recipient Address input field and amount of Ether to transfer in the Amount input field. Click send and accept the transaction.



Once again, when the transaction is mined and committed into a block, the account balances will be reflected accordingly. Note, wallet 1's balance is deducted a bit more than 15 Ether, since you had to pay a mining fee to process the transaction.





Next Steps

You are now ready to focus on application and smart contract development against your private consortium blockchain network. Happy coding!