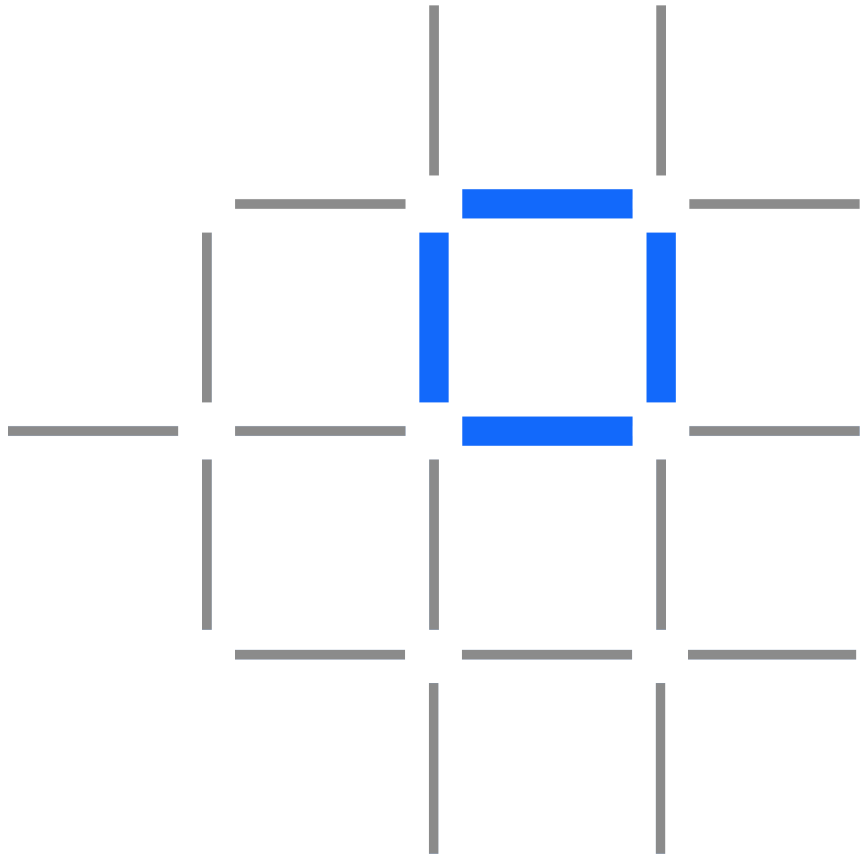
# Blockchain Developed

*An Introduction to chaincode development*

IBM **Blockchain**



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IBM

# Acknowledgements




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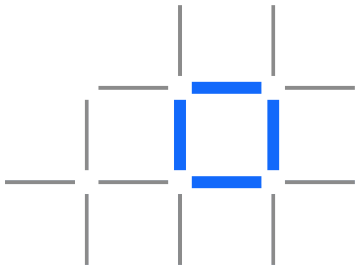
- My thanks also go to Jean-Yves Girard, IBM Blockchain Competency Center team leader, IBM Montpellier, who reviewed and completed the material.

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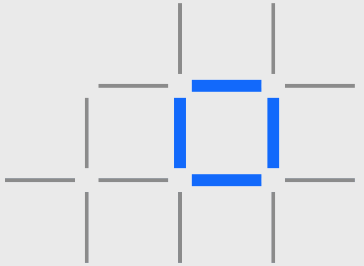
How is it implemented ?

Let’s create our own!



# Hyperledger Fabric: Ledger

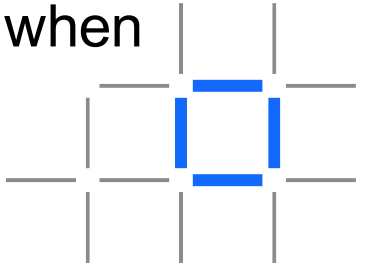


**Ledger:**

- A sequence of cryptographically-linked blocks, containing transactions and the current world-state. In addition to data from previous transactions, the ledger also contains the data for currently-running chaincode applications.

**World-state:**

- Key-value database used by chaincodes to store their state when executed by a transaction.

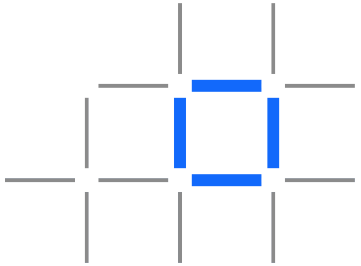


# Chaincode



Embedded logic that encodes the rules for specific types of network transactions. Developers write chaincode applications and deploy them to the network. End users then invoke chaincode through a client-side application that interfaces with a network peer, or node. Chaincode runs network transactions, which if validated, are appended to the shared ledger and modify world state.

- Consist of **code** and **data**.
- Chaincode is the term used to describe a smart contract in Hyperledger
- Chaincode can currently be written in Go.
- Chaincode **must** be deterministic!



# Chaincode: deterministic



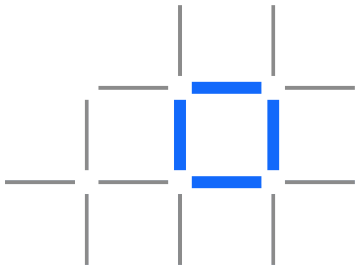
Chaincode **must** be deterministic.

Chaincode is run on each peer within the blockchain network, and when invoked on each peer for the same transaction, they must write the same values to the world-state.

Things to watch for are:

- Date/Time stamps
- Random values

Chaincode must not call external systems.



# Chaincode : programming language



As the time of writing, Golang is the only option for chaincode development.

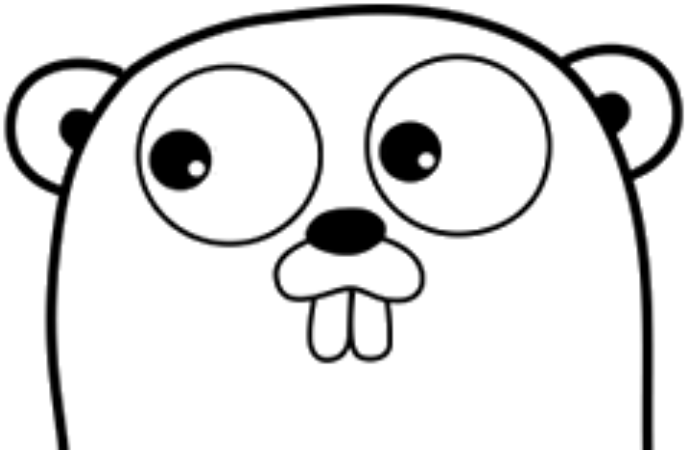
Hyperledger Fabric 1.1 (to be released) is expected to include Javascript chaincode support.

Java chaincode support was removed after 1.0.0-alpha2 for lack of testing. It will eventually come back.

# Go Overview

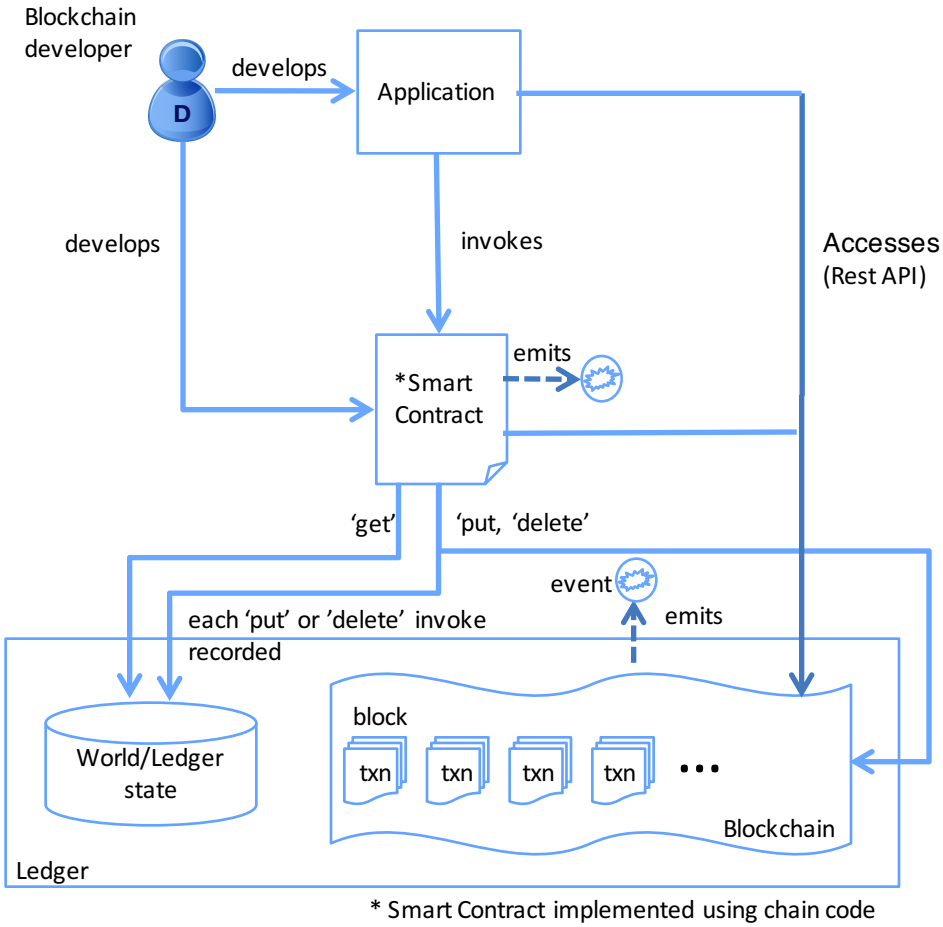


- Go is an open source programming language that makes it easy to build simple, reliable, and efficient software.
- Hyperledger Fabric is built using Go.
- Available for Windows, Linux and Mac
- Download from https://golang.org/dl/
- Some quotes about Go:
  - "Simple, minimal syntax"
  - "Garbage collection built-in"
  - "A flexible interface system"
  - "Easy concurrency support via goroutines"
  - "Fast compilation times"
  - "Simple compile build/run procedures"
  - "Statically linked binaries that are simple to deploy"
  - "Fun to write, fast to run"
  - "Go is familiar to most developers making on-boarding easier."
  - "Go is, in essence, a perfected version of C"



# Blockchain applications and the ledger





# Blockchain applications

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**Application**

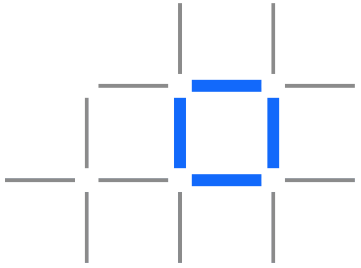
- Focuses on Blockchain user business needs and experience
- Calls smart contract for interactions with ledger state
- Can access transaction ledger directly, if required
- Can process events if required

**Smart Contract**

- Chain code encapsulates business logic. Choice of implementation language
- Contract developer defines relevant interfaces (e.g. queryOwner, updateOwner …)
- Different interfaces access ledger state accordingly – consistent read and write provided
- Each invocation of a smart contract is a “Blockchain transaction”

**Ledger**

- World/Ledger state holds current value of smart contract data
- e.g. vehicleOwner=Daisy
- Blockchain holds historic sequence of all chain code transactions
- e.g. updateOwner(from=John, to=Anthony); updateOwner (from=Anthony, to=Daisy);etc



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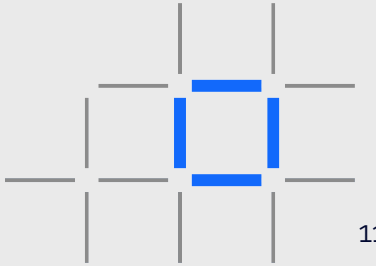


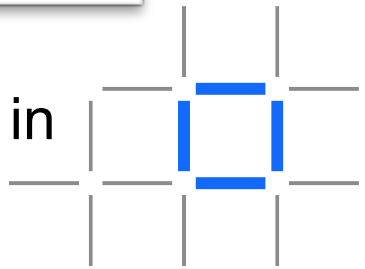
# Chaincode interface



- Each chaincode must implement the chaincode interface
  - Interface is defined in core/haincode/shim/interfaces.go (from line 28 onwards)
  - Chaincode methods are called in response to received transactions.
- For example:

```
import (
        "errors"
        "fmt"
        "strconv"

        "github.com/hyperledger/fabric/core/chaincode/shim"
)
```

- Other methods to access and modify the ledger are defined in ChaincodeStubInterface

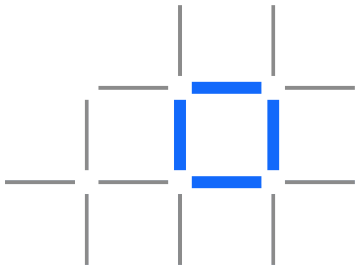


# Chaincode functions



Fabric chaincode consists of the 2 main functions:

- **`Init()`** – Called when the chaincode is deployed. Can be used to initialize the ledger.
- **`Invoke()`** – Transaction added to the blockchain and creates/updates/deletes information in the worldstate



# Chaincode : skeleton



The simplest possible chaincode would look like this:

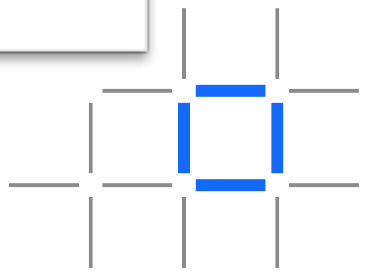
```
package main

import (
	"fmt"
	"github.com/hyperledger/fabric/core/chaincode/shim"
	pb "github.com/hyperledger/fabric/protos/peer"
)

type HelloWorld struct {
}

func (t *HelloWorld) Init(stub shim.ChaincodeStubInterface) pb.Response {
	return shim.Success(nil)
}

func (t *HelloWorld) Invoke(stub shim.ChaincodeStubInterface) pb.Response {
	return shim.Success(nil)
}

func main() {
	err:= shim.Start(new(HelloWorld))
	if err!= nil{
	fmt.Printf("Error starting HelloWorld chaincode: %s", err)
	}
}
```

# Chaincode : Error handling



Many functions return an error as the 2nd parameter.

```
Bvalbytes, err := stub.GetState(B)
if err != nil {
        return nil, errors.New("Failed to get state")
}
if Bvalbytes == nil {
        return nil, errors.New("Entity not found")
}
Bval, _ = strconv.Atoi(string(Bvalbytes))
```



# World state : Update



Updating and querying the world-state is done simply within the chaincode.

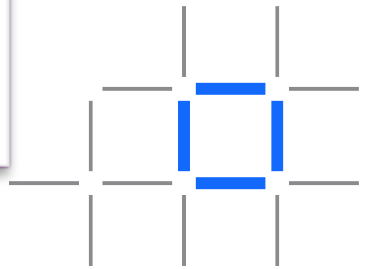
To update the world-state:

```
err := stub.PutState(key, value)
```

where key is a string, and value is an array of bytes

Example:

```
// Write the state back to the ledger
err = stub.PutState(A, []byte(strconv.Itoa(Aval)))
if err != nil {
        return nil, err
}
```



# World state: Query



Updating and querying the world-state is done simply within the chaincode.

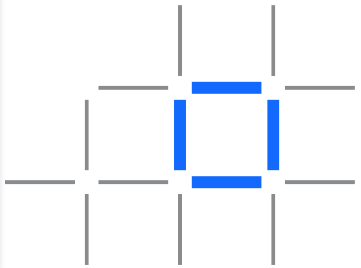
To query the world-state:

**`result, error := stub.GetState(key)`**

where key is a string, and value is an array of bytes

Example:

```
Bvalbytes, err := stub.GetState(B)
if err != nil {
        return nil, errors.New("Failed to get state")
}
if Bvalbytes == nil {
        return nil, errors.New("Entity not found")
}
Bval, _ = strconv.Atoi(string(Bvalbytes))
```



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