incode

Using events to unit test smart contracts

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About me

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Contents

- Introduction to events
- Events in dapps
- Events in unit tests

What are events?

- Log of smart contract usage
- Stored in transaction log
- Can have indexed arguments for searching

```
    event Bet(address indexed player, bytes32 qid, uint256 betSize, uint8 betNumber);
    event Play(address indexed player, bytes32 qid, uint256 betSize, uint8 betNumber, uint8 winningNumber);
    event Payout(address indexed winner, bytes32 qid, uint256 payout);
```

```
        emit Bet(msg.sender, qid, betValue, number);
```

What are events used for in dapps?

- Logging smart contract functionality & updating user interface
- Event.watch() + Event.get() / EventEmitter
- Filtering on indexed parameters

```
const betEvent = deployedRoulette.Bet({player: account}, {fromBlock: 0, toBlock: 'latest'});
const playEvent = deployedRoulette.Play({player: account}, {fromBlock: 0, toBlock: 'latest'});
const payoutEvent = deployedRoulette.Payout({player: account}, {fromBlock: 0, toBlock: 'latest'});

betEvent.get(this.initialiseBets);
betEvent.watch(this.addBet);
```

`EventEmitter`: The event emitter has the following events:

- `"data"` returns `Object`: Fires on each incoming event with the event object as argument.
- `"changed"` returns `Object`: Fires on each event which was removed from the blockchain. The event will have the additional property `"removed: true"`.
- `"error"` returns `Object`: Fires when an error in the subscription occours.

Eth Roulette

Select Account

Address

0x16c1a94c8C027c011A4097D24dF55893CFb5D268

Roulette Player | Roscoin Market

Bet

Bet Number: 10

Bet Amount: 0.1

Bet

Current Bets

Bet Size	Block Number	Bet Number

Bet History

Bet Size	Block Number	Bet Number	Winning Number	Payout
0.1	15	10	33	

Testing for a purpose

- Tests should be based on actual application usage
- Solidity testing vs JavaScript testing

Why are events not widely used in tests?

- Cumbersome to watch for events in unit tests
- Logs are difficult to parse

```
const getFirstEvent = (_event) => {
  return new Promise((resolve, reject) => {
    _event.once('data', resolve).once('error', reject)
  });
}
```

```
assert.equal(tx.logs[0].event, 'Play');
assert.equal(tx.logs[0].args.betNumber, tx.logs[0].args.winningNumber);

const playEvents = tx.logs.filter((ev) => {
  return ev.name == 'Play';
});
assert.isNotEmpty(playEvents);
```

```
getFirstEvent = (_event) => {
  return new Promise((resolve, reject) => {
    _event.watch((error, log) => {
      _event.stopWatching();
      if (error !== null)
      reject(error);
      resolve(log);
    });
  });
}
```

Overcoming these issues

- Don’t go through logs manually
- Libraries
  - contract-events
  - truffle-assertions

Quick Usage Guide

Install from NPM: `npm i contract-events`.

Import and initalise object:

```
let DebugEvents = require('contract-events');
let debugEvents = new DebugEvents(Flight);
```

Actual Usage in code

```
const tx = await flight.book(1, {from: customer});

debugEvents.setTx(tx);

let bookingEvents = debugEvents.getEvent('SeatBooked'); // or
let bookingEvents = debugEvents.setTx(tx).getEvent('SeatBooked');
```

truffleAssert.eventEmitted(result, eventType[, filter][, message])

The `eventEmitted` assertion checks that an event with type `eventType` has been emitted by the transaction with result `result`. A filter function can be passed along to further specify requirements for the event arguments:

```
truffleAssert.eventEmitted(result, 'TestEvent', (ev) => {
    return ev.param1 === 10 && ev.param2 === ev.param3;
});
```

When the `filter` parameter is omitted or set to null, the assertion checks just for event type:

```
truffleAssert.eventEmitted(result, 'TestEvent');
```

Optionally, a custom message can be passed to the assertion, which will be displayed alongside the default one:

```
truffleAssert.eventEmitted(result, 'TestEvent', (ev) => {
    return ev.param1 === 10 && ev.param2 === ev.param3;
}, 'TestEvent should be emitted with correct parameters');
```

The default messages are

```
`Event of type ${eventType} was not emitted`
`Event filter for ${eventType} returned no results`
```

Making assertions on emitted events

- Check that events have been emitted

```
truffleAssert.eventEmitted(callbackTx, 'Play', (ev) => {
    return ev.player === bettingAccount && ev.betNumber.eq(ev.winningNumber);
});
truffleAssert.eventEmitted(callbackTx, 'Payout', (ev) => {
    return ev.winner === bettingAccount && ev.payout.eq(betSize.muln(36));
});
```

- Check that events have not been emitted

```
truffleAssert.eventEmitted(callbackTx, 'Play', (ev) => {
    return ev.player === bettingAccount && !ev.betNumber.eq(ev.winningNumber);
});
truffleAssert.eventNotEmitted(callbackTx, 'Payout');
```

Strategically placed events

- Test for certain preconditions

```
    function payout(address winner, bytes32 qid, uint256 amount) internal {
        require(amount > 0, "Payout amount should be more than 0");
        require(amount <= address(this).balance, "Payout amount should not be more than contract balance");

        emit PrePayout(address(this).balance);
        winner.transfer(amount);
        emit Payout(winner, qid, amount);
    }
```

```
    truffleAssert.eventEmitted(tx, 'PrePayout', (ev) => {
        return ev.bankroll.gt(MINIMUM_BANKROLL);
    })
```

Awaiting callback execution

- Oraclize callback or callback from a different contract
- Would happen automatically inside dapp
- Await the event & retrieve the corresponding transaction result

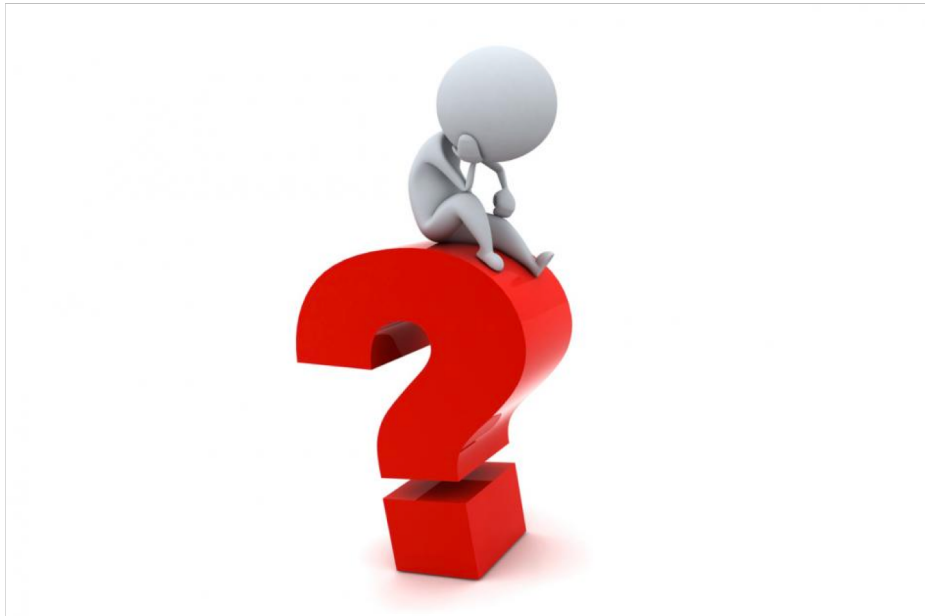
```
function __callback(bytes32 qid, string result) public {
    require(msg.sender == oraclize_cbAddress(), "Can only be called from oraclize callback address");
    require(players[qid].player != address(0), "Query needs an associated player");

    uint8 winningNumber = uint8(parseInt(result));
    PlayerInfo storage playerInfo = players[qid];

    emit Play(playerInfo.player, qid, playerInfo.betSize, playerInfo.betNumber, winningNumber);
```

```
await roulette.bet(betNumber, {from: bettingAccount, value: betSize});
let playEvent = await getFirstEvent(roulette.Play({fromBlock: 'latest'}));
let callbackTx = await truffleAssert.createTransactionResult(roulette, playEvent.transactionHash);
```

Recap & Questions

- Events and their usage
- Testing for a purpose
- truffle-assertions library
- Asserting emitted events
- Strategically placed events
- Testing callback functions

How would you use events inside your own unit tests?



Information & Resources

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