SmartChainDB: Towards Semantic Events on Blockchains for Smart Manufacturing

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Introduction

- Blockchains are increasingly being appropriated for different business processes
- Business processes typically comprise of different kinds of transactions, events and actors
- Beyond the need to support codifying of complex transactional processes, there is also a need to enable actors be notified about business process events relevant to them.

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Smart Contracts

- Mainstream blockchain platforms provide two core first-class primitives that support the ability to `create` and `transfer` assets
- Beyond the steps of creating and transferring assets, the rest of business process behavior is ”hidden” in programs referred to as `Smart Contracts.`
    - immutable blocks of code that when deployed on a blockchain executes automatically when certain conditions are met

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Blockchains – Smart Contracts

- Steps in a business process, other than creating and transferring assets, are encoded as functions e.g. `bid, withdraw..`, etc.
- These functions emit ”events” (represented as strings in an event log) that can be consumed by the external environment
- From the point of view of usability, there are three key things that target users need from platforms managing smart contracts:
  - to be able to discover their existence
  - to be able to understand their behavior
  - to know when interesting application events have occurred during their execution

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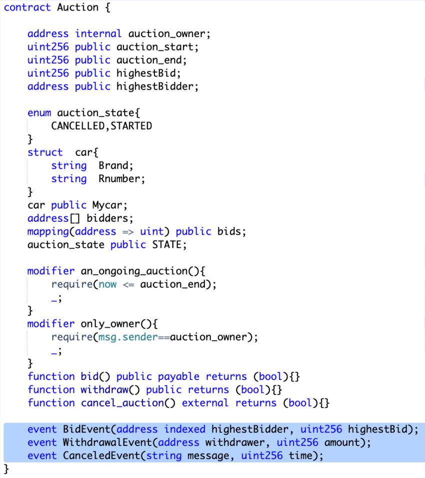
An Example Smart Contract



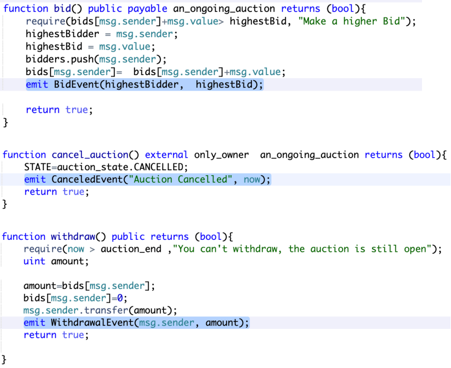
```
contract Auction {

    address internal auction_owner;
    uint256 public auction_start;
    uint256 public auction_end;
    uint256 public highestBid;
    address public highestBidder;

    enum auction_state{
        CANCELLED,STARTED
    }
    struct  car{
        string  Brand;
        string  Rnumber;
    }
    car public Mycar;
    address[] bidders;
    mapping(address => uint) public bids;
    auction_state public STATE;

    modifier an_ongoing_auction(){
        require(now <= auction_end);
        _;
    }
    modifier only_owner(){
        require(msg.sender==auction_owner);
        _;
    }
    function bid() public payable returns (bool){}
    function withdraw() public returns (bool){}
    function cancel_auction() external returns (bool){}

    event BidEvent(address indexed highestBidder, uint256 highestBid);
    event WithdrawalEvent(address withdrawer, uint256 amount);
    event CanceledEvent(string message, uint256 time);
}
```



```
function bid() public payable an_ongoing_auction returns (bool){
    require(bids[msg.sender]+msg.value> highestBid, "Make a higher Bid");
    highestBidder = msg.sender;
    highestBid = msg.value;
    bidders.push(msg.sender);
    bids[msg.sender]=  bids[msg.sender]+msg.value;
    emit BidEvent(highestBidder,  highestBid);

    return true;
}

function cancel_auction() external only_owner  an_ongoing_auction returns (bool){
    STATE=auction_state.CANCELLED;
    emit CanceledEvent("Auction Cancelled", now);
    return true;
}

function withdraw() public returns (bool){
    require(now > auction_end ,"You can't withdraw, the auction is still open");
    uint amount;

    amount=bids[msg.sender];
    bids[msg.sender]=0;
    msg.sender.transfer(amount);
    emit WithdrawalEvent(msg.sender, amount);
    return true;

}
```

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Motivation(1)

- Several issues with the current model
  - Anyone who wants to setup an auction has to implement auction contract with perhaps similar behavior
  - Potential consumers/customers will need to understand the terms of contract implemented in code
  - But how does one find out that there is an auction contract of interest in the first place? e.g. `auction for an automobile by their preferred manufacturer`
  - It may be possible to implement a publish/subscribe model based on the data in the event log, buts it usability will be limited by the well known "keyword search problem"

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Motivation(2): Need for More Complex Event Detection

- Consider a CyberManufacturing scenario (being made increasingly popular by the increasing complexity of manufacturing and technologies like 3D-printing)
    - Manufacturers may want to post `requests for quotes` for manufacturing capabilities
    - Potential suppliers will need to be made aware of requests for quotes that match their capabilities
- Even simple manufacturing capability description requests cannot be suitably represented with just textual phrases
    - terminological differences will present the first obstacle e.g. additive manufacturing vs. 3D-printing
    - descriptions may be implicit and may require some semantic mapping, e.g. **If Material = PolyCarbonate and Quantity < 10 Then Capability is 3D-Printing**
- Existing topic-based publish/subscribe models that are based on keyword topic labels will not be adequate

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Our Position

- It is necessary to introduce additional primitives that will support a broader range of business process steps to be captured declaratively e.g. `Request For Quote, Bid, ..`
  - A major success factor for relational database systems!!
- Need to support semantic technologies e.g. ontologies and ontological reasoning integrated with publish/subscribe models
- Additional requirements such as privacy
- These ideas are being implemented in a project called `SmartChainDB`
  - SmartChainDB builds on the BigChainDB blockchain platform
  - BigChainDB's architecture is more amenable to the nature of extensibility desired

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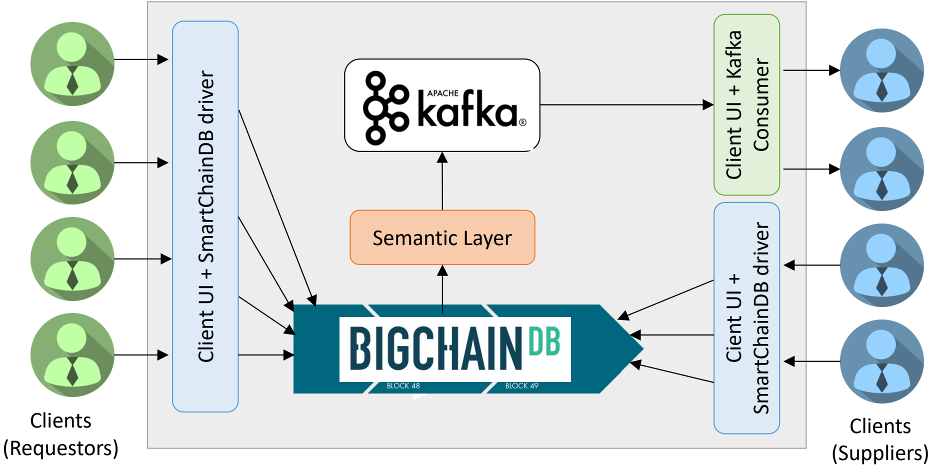
SmartChainDb – Architecture



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Conclusion

- Work is ongoing a
- Contact: kogan@ncsu.edu
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