Decentralized Computations

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Decentralized vs Cloud computing

- Low delay
- Lower bandwidth usage
- Lower energy consumption
- Low cost

- Untrusted nodes
- Trust in big companies
- Privacy issues
Decentralized computing

To make decentralized computing a realistic alternative:

- Security and privacy must be built in the system design
- It must be easy to join the network to submit/execute tasks/repartition tasks
- Nodes need to be rewarded for their work
- Fully decentralized without "trusted" 3rd parties
Scenario

Input

Payment

Requestor

Execution Node
Building blocks

- Rewards
- Result Verification
- Tasks dispatching
- Privacy
Rewards

- Nodes need to be rewarded for used resources
- It can be the main motivation for nodes to join
- Work need to be proved/verified before payment
- But when should be the payments done?
Result Verification

- Different types of tasks
- Cryptographic proof
  - High cost
  - Not available for every computation
- Parallel execution
  - Partial or complete
  - Highly inefficient
  - How to prevent colluding?
Task Dispatching

- How to connect requestors and execution nodes?
- Advertise tasks vs node capacities
- High volume of advertised data
- For delay-sensitive tasks a DNS-like system is impossible
- If rewards are involved, the system must be fair
Privacy

- Called functions
- Input Parameters
- Result Data

All of the above should be hidden from the network and from the execution node.
Calls Privacy

- If we advertise, the calls become public
- Usage of pseudonyms does not solve the problem
- Calls privacy requires a proxy (zerocash)
Input/Result Privacy

- Homomorphic encryption
  - Introduces overhead
  - Not always possible
- Trusted Execution Environment
  - Creates a trusted environment within an untrusted node
  - Low overhead
  - Requires dedicated hardware
Industry

- Golem, Somn
- Run on Ethereum Blockchain
- Payments using smart contracts
- No automatic, reliable result verification mechanism
- 3rd parties to resolve conflicts
NFaaS

- Rewards
- Result Verification
- Tasks dispatching
- Privacy
NFaaS

- Task dispatching environment for delay-sensitive tasks
- Function represented as stateless unikernels
- Implemented on top of NDN
- Nodes quickly adapt to network dynamics
- Fully decentralized
- Encrypted communication with functions
Function Execution
Named Function as a Service
Encryption

private public

Cloud

Database
NFaaS

- Quickly adapts to network needs
- Small function size based on rumprun
- Fast boot time
SPOC

- Rewards
- Result Verification
- Tasks dispatching
- Privacy
SPOC

• Automatic payments and result verification
• Based on Smart Contracts and Intel SGX
• No 3rd parties involved
SPOC

- Secure against Rational Attacker
- Minimal computational overhead
- No calls privacy
Thank you