Analysis of Ethereum Smart Contracts and Opcodes

2nd Distributed Ledger Technology Workshop (DLT 2019)

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How can we spend less on smart contract fees?

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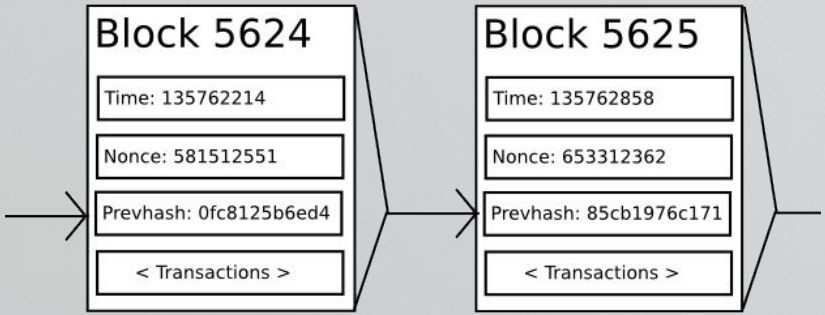
Chapters

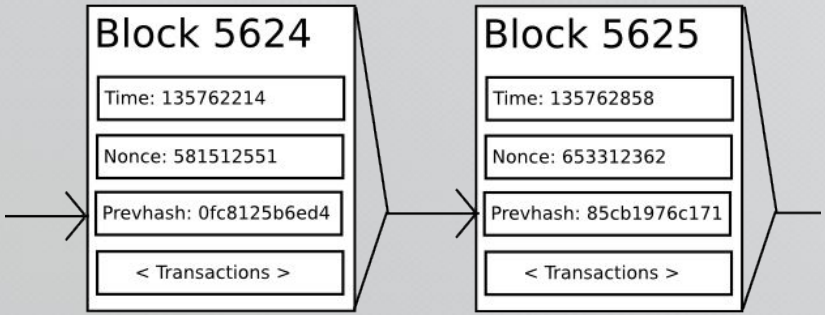
1) Get an understanding about *blockchain* and *smart contracts*

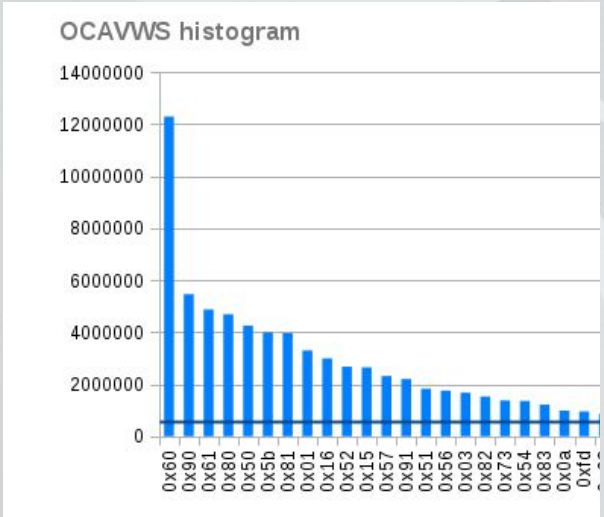


How can we spend less on smart contract fees?

Chapters

1) Get an understanding about *blockchain* and *smart contracts*
2) Perform a statistical analysis on *opcodes*





Blockchain and Ethereum

Smart contracts are programs deployed on the blockchain and executed in the network

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Ethereum introduced *turing-complete* contracts

Opcodes and gas

The contracts are translated into **opcodes** and executed in the **Ethereum Virtual Machine**

```
PUSH1 0x09
PUSH1 0xFA
MUL
```

Opcodes and gas

The contracts are translated into **opcodes** and executed in the **Ethereum Virtual Machine**

Each opcode has a different execution cost in terms of **gas**

Opcodes and g

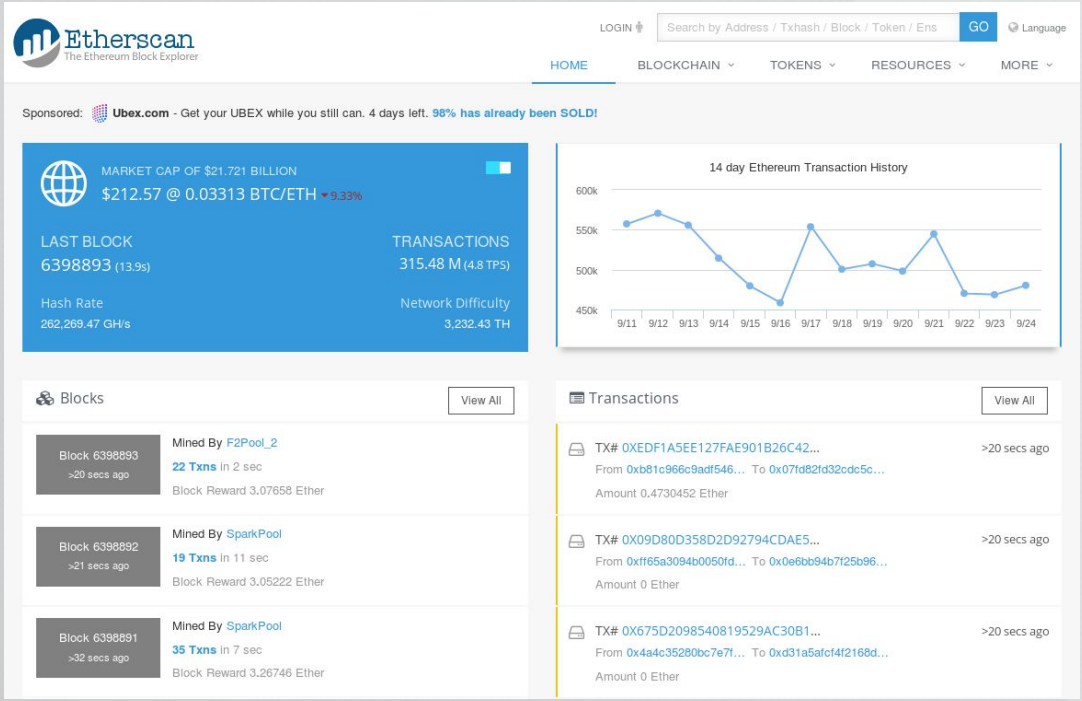
The contracts are tr executed in the **Ethereum Virtual M**

Each opcode has a erms of **gas**

Wei	1000000000000000000
Kwei, Ada, Femtoether	1000000000000000
Mwei, Babbage, Picoether	1000000000000
Gwei, Shannon, Nanoether, Nano	1000000000
Szabo, Microether,Micro	1000000
Finney, Milliether,Milli	1000
Ether	1
Kether, Grand,Einstein	0.001
Mether	0.000001
Gether	0.000000001
Tether	0.000000000001
USD(at 245.827$ p/ ether)	245.827
EUR(at 211.334€ p/ ether)	211.334

Analysis

We used **Etherscan.io** to retrieve all the contracts surces



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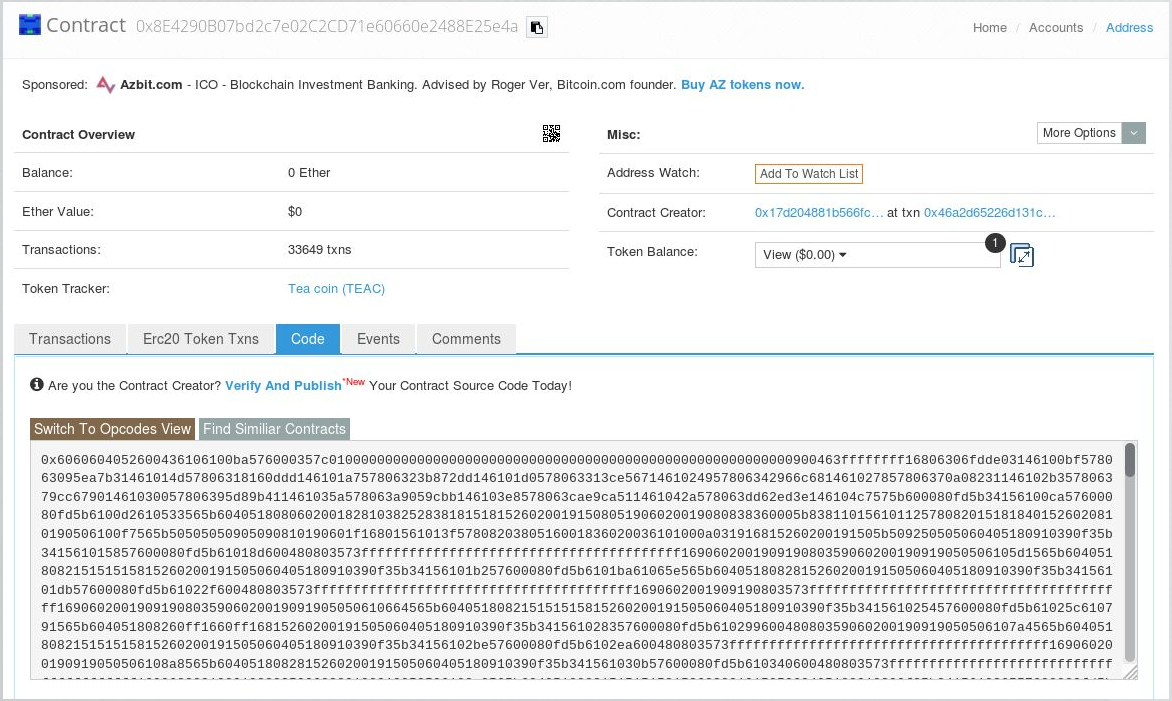

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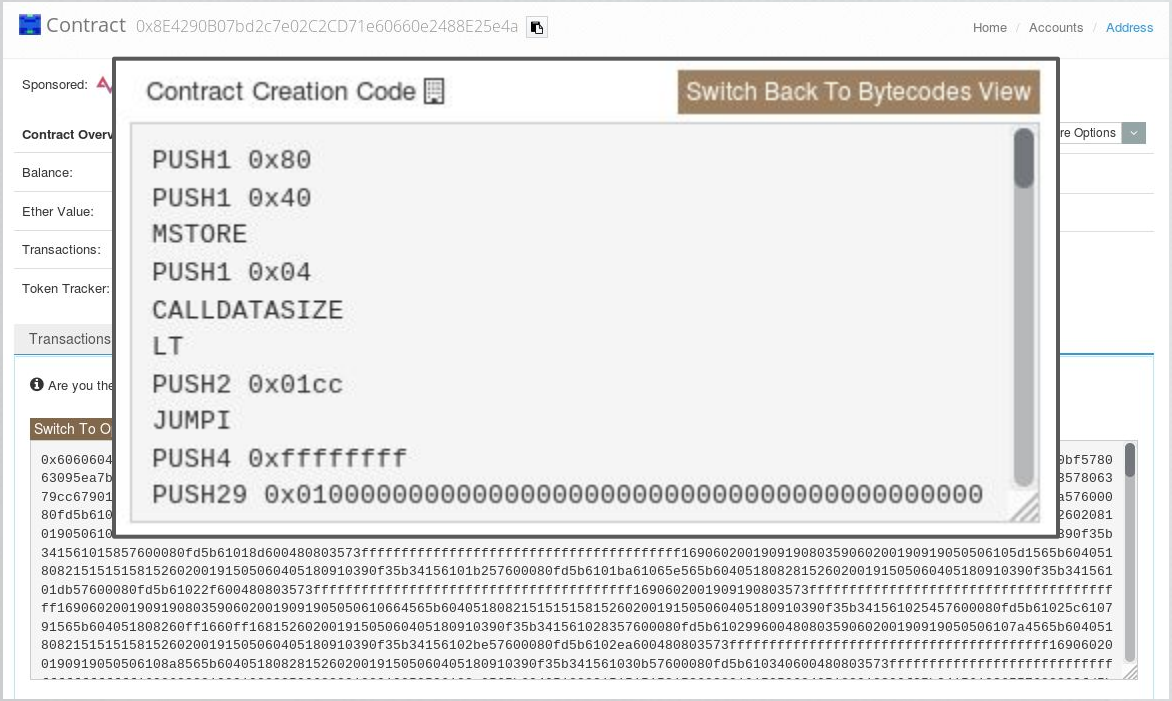
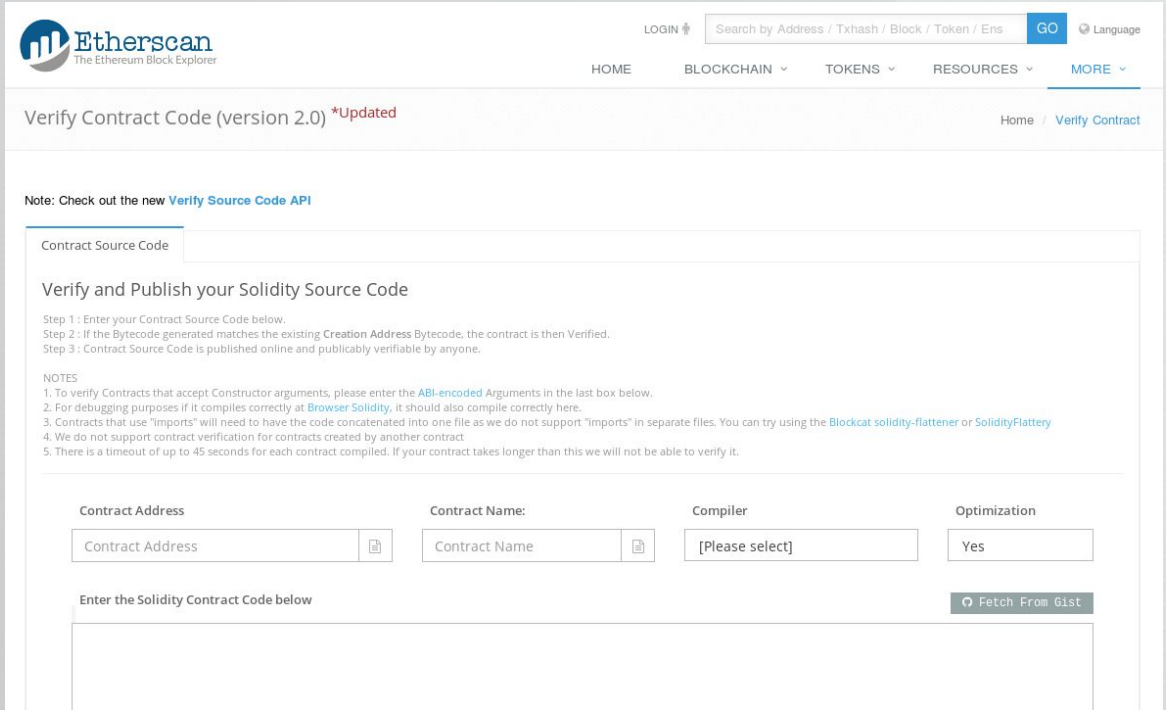


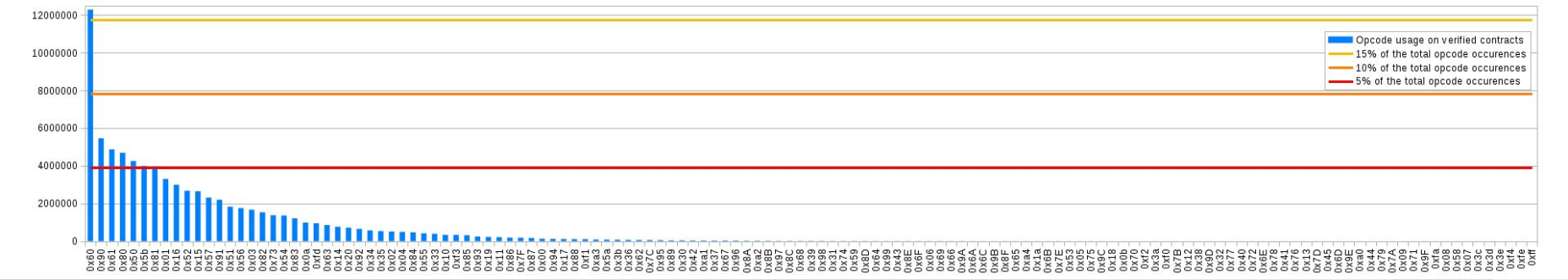
Analysis

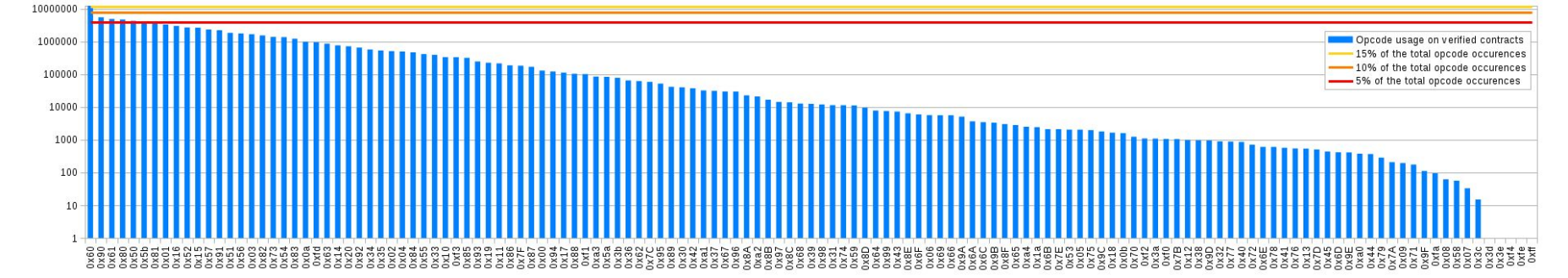
On Etherscan is possible to **verify contracts** compiled with *SolC*



Analysis

Opcode count on verified contracts

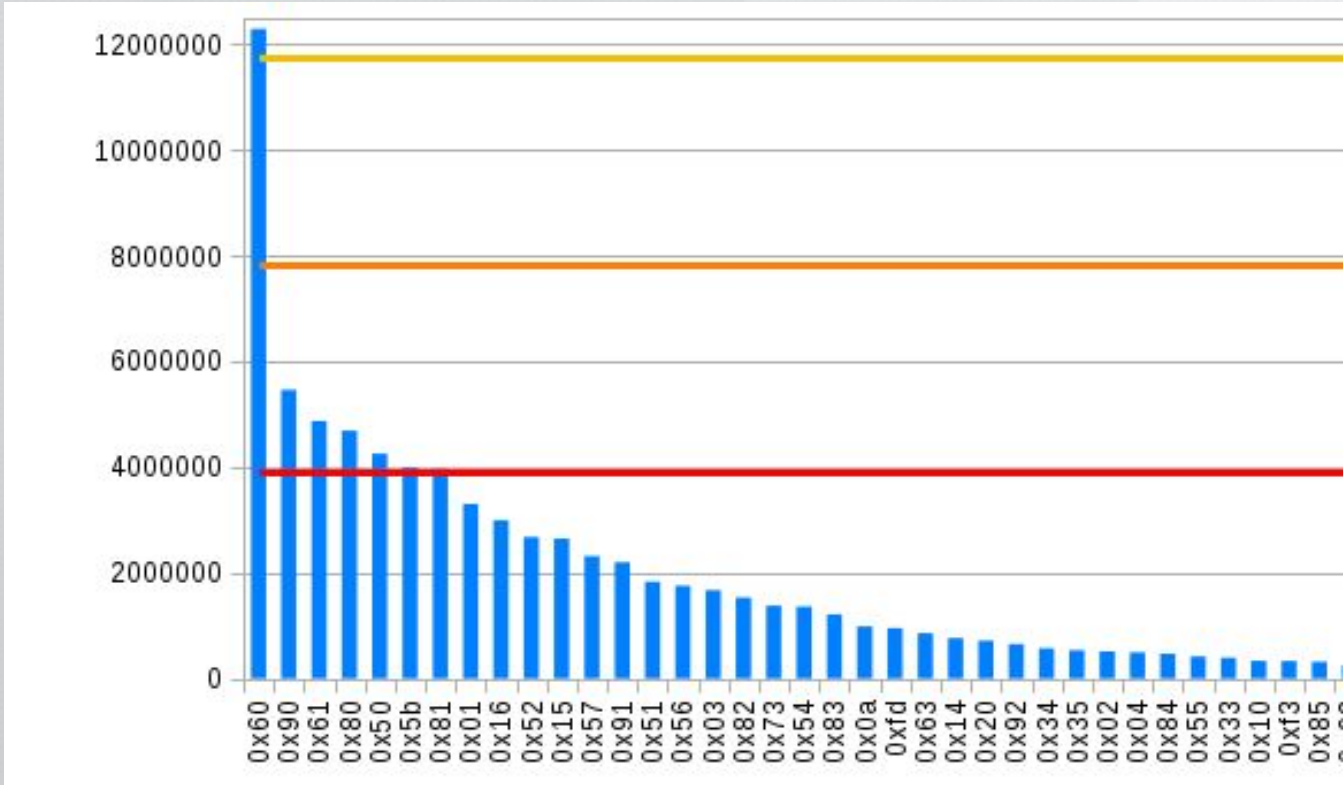




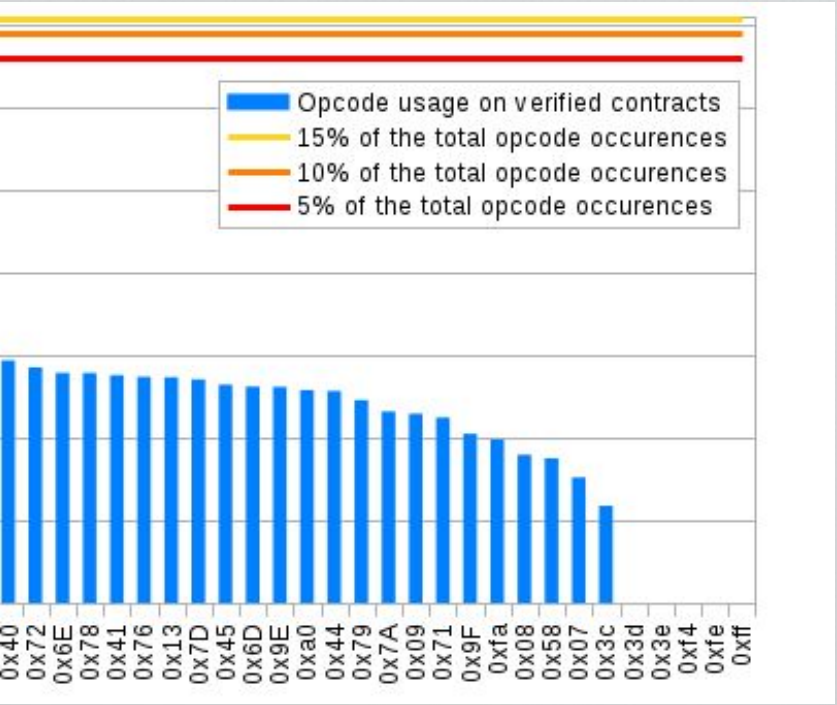
Analysis

	Most used PUSH opcodes on verified contracts
1	PUSH1
3	PUSH2
18	PUSH20
23	PUSH4
41	PUSH32

	Most used opcodes on verified contracts
1	PUSH1
2	SWAP1
3	PUSH2
4	DUP1
5	POP
6	JUMPDEST
7	DUP2
8	ADD
9	AND
10	MSTORE

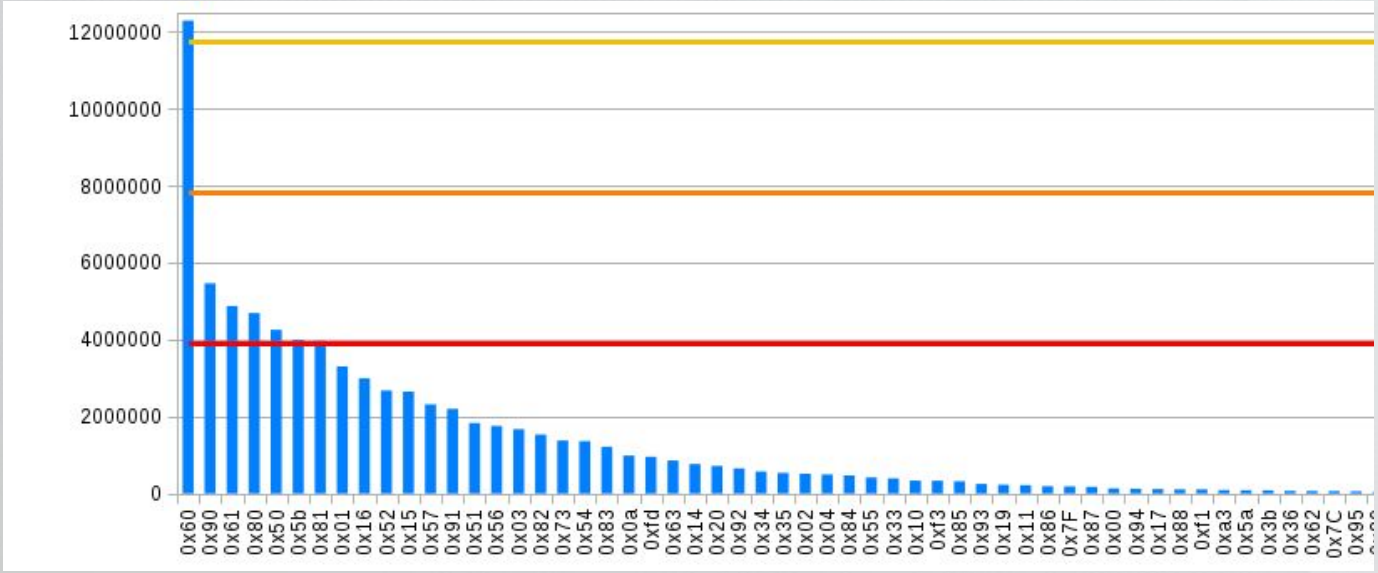


Analysis



	Unused opcodes on verified contracts
131	RETURNDATASIZE
132	RETURNDATACOPY
133	DELEGATECALL
134	INVALID
135	SELFDESTRUCT

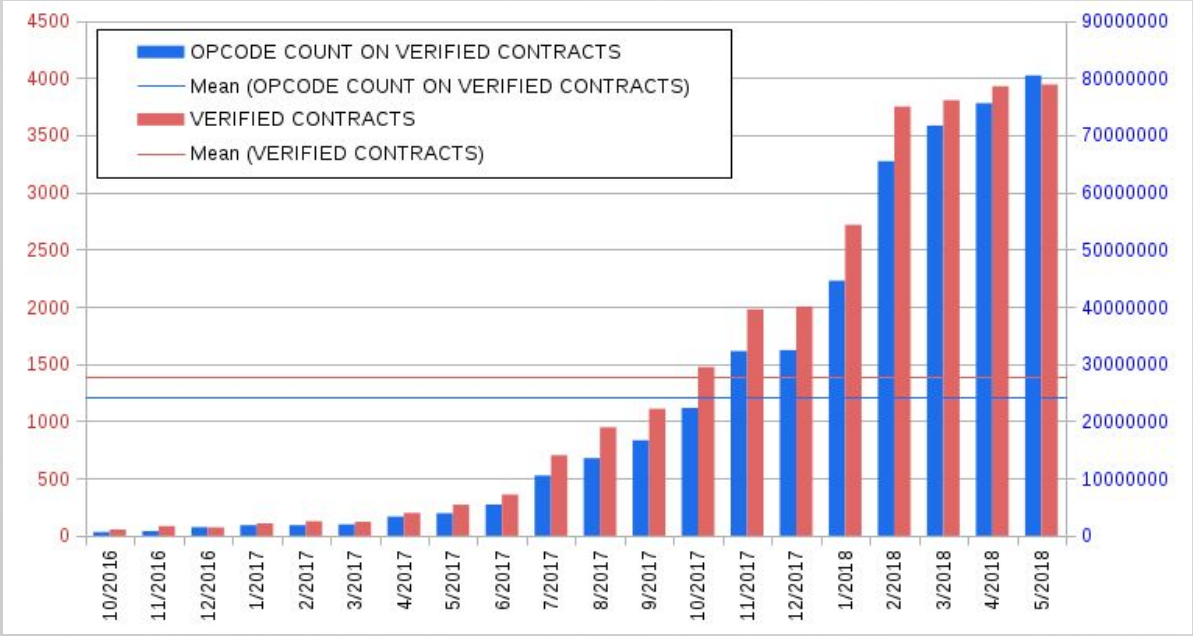
Analysis



	Environmental Information opcodes on verified contracts
27	CALLVALUE
28	CALLDATALOAD
33	CALLER
50	EXTCODESIZE
51	CALLDATASIZE
56	ADDRESS
59	CALLDATACOPY
68	CODECOPY
70	BALANCE
100	GASPRICE
104	CODESIZE
106	ORIGIN
130	EXTCODECOPY
131	RETURNDATASIZE
132	RETURNDATACOPY

Analysis

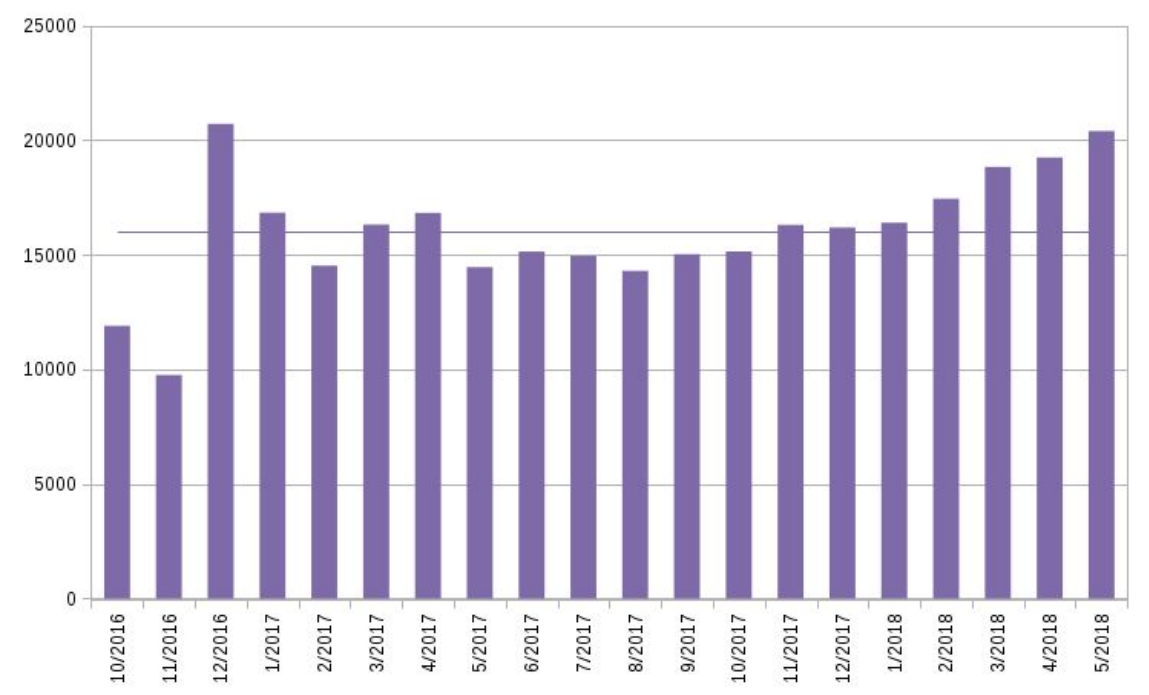
Opcode count per month and contract count per month



MONTH	VERIFIED CONTRACTS	OPCODE COUNT ON VERIFIED CONTRACTS
10/2016	53	630859
11/2016	83	809555
12/2016	72	1491497
1/2017	108	1818251
2/2017	126	1830664
3/2017	120	1958167
4/2017	198	3332301
5/2017	270	3903969
6/2017	359	5436532
7/2017	702	10495739
8/2017	947	13541032
9/2017	1108	16653251
10/2017	1473	22308628
11/2017	1977	32242058
12/2017	2002	32415653
1/2018	2716	44550116
2/2018	3749	65411651
3/2018	3804	71645646
4/2018	3926	75555729
5/2018	3941	80398664

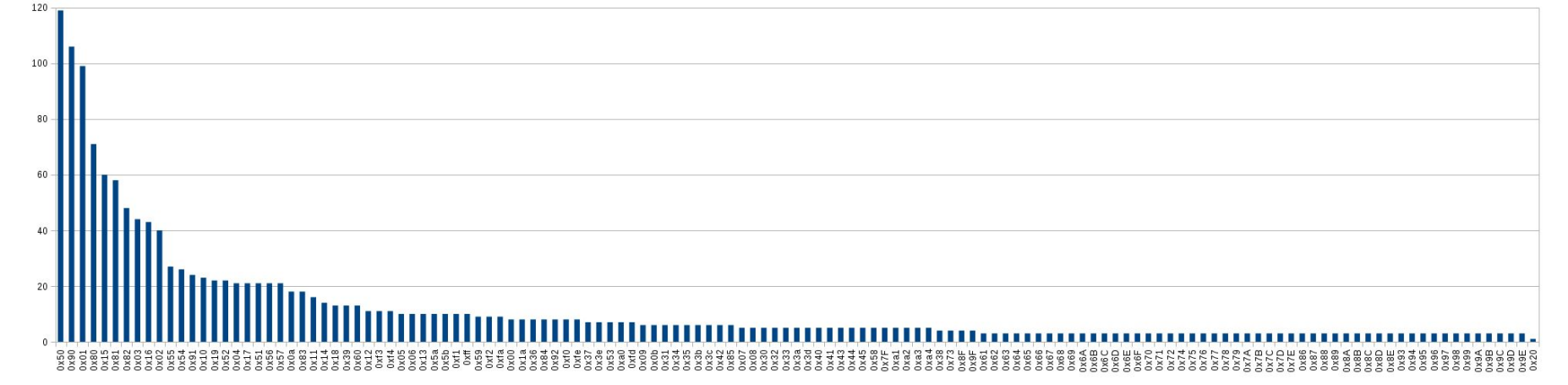
Analysis

Opcodes over contract count per month



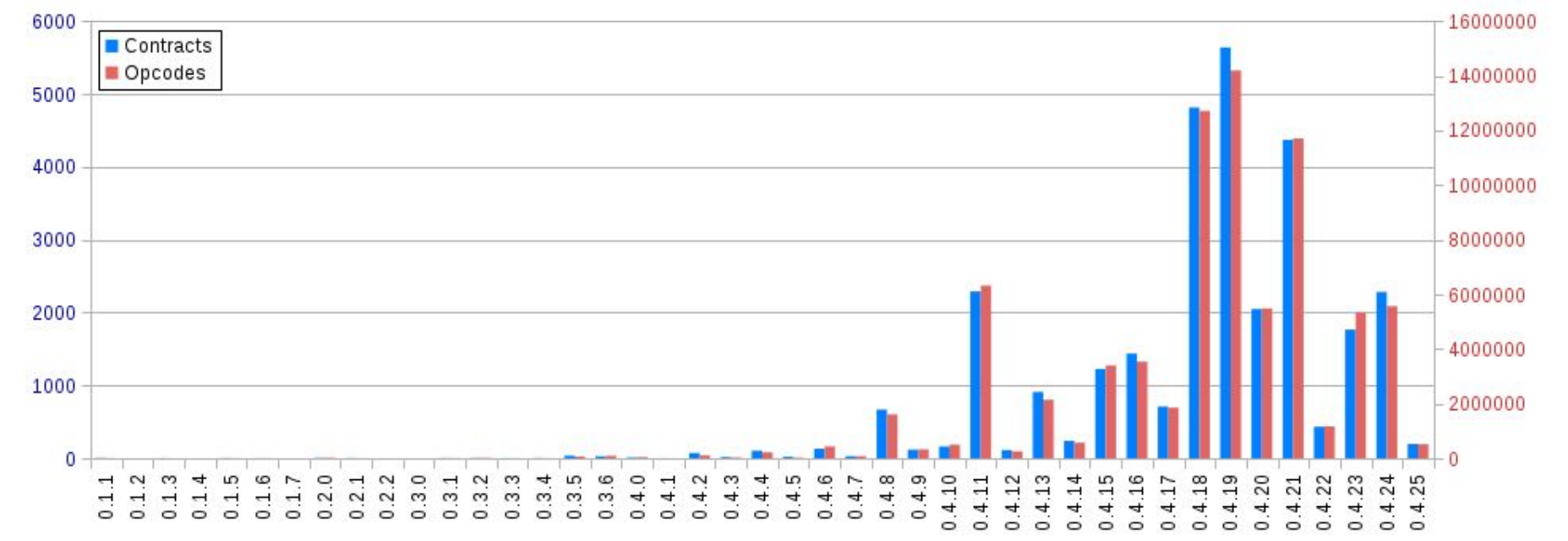
Analysis

Opcode occurrences on Solidity v0.4.19 source code



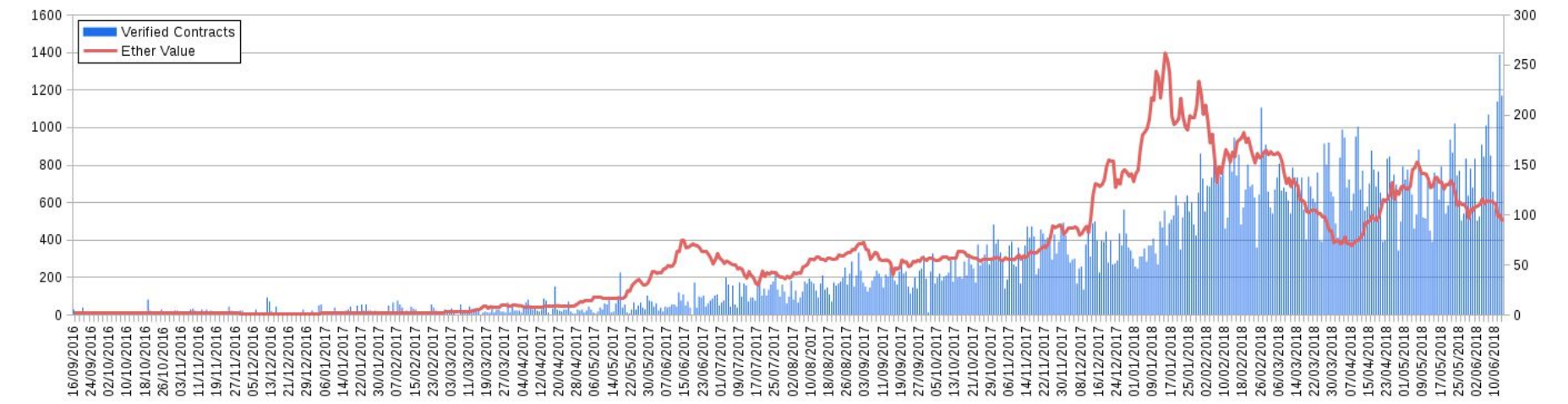
Analysis

Opcode count and contract deployment on different versions of Solidity



Analysis

Verified contracts per date and line chart of Ether value over time

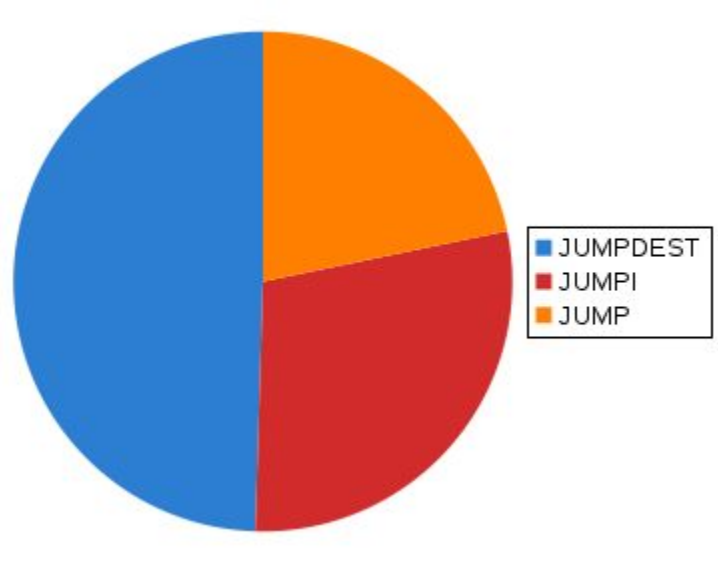


Analysis

Verified contracts per date and line chart of Ether value over time

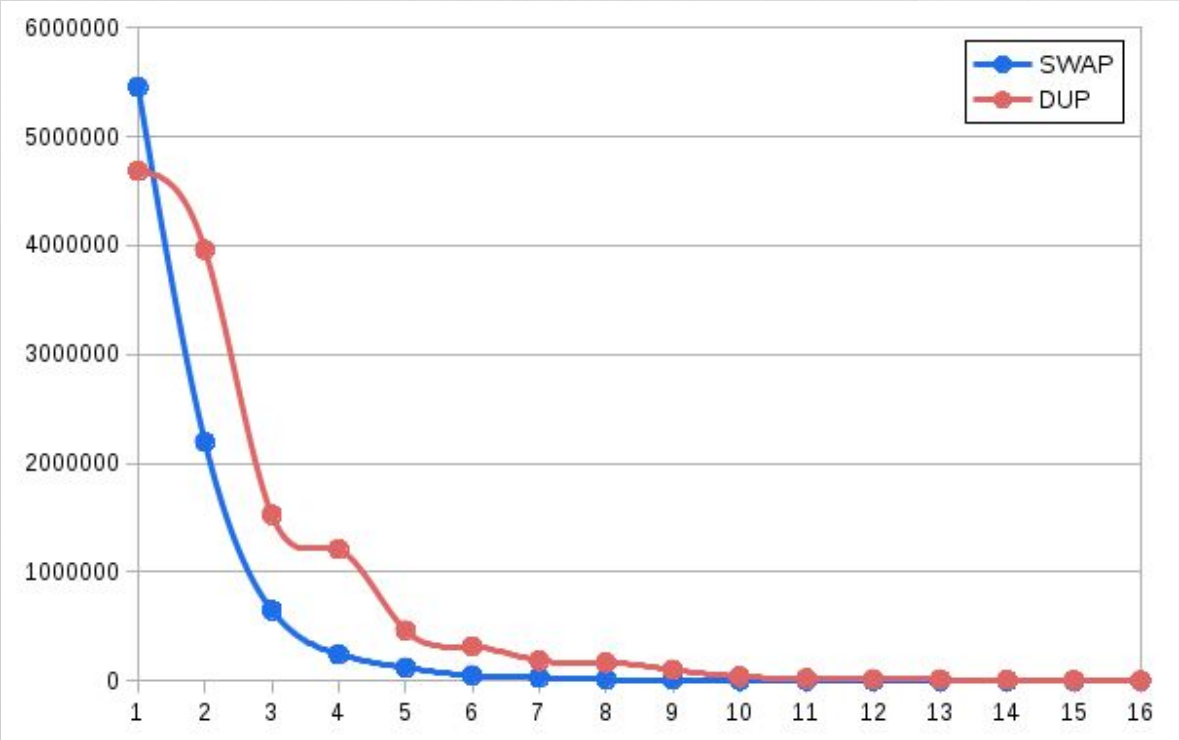
Analysis

JUMP, JUMPI and JUMPDEST opcodes occurrences percentage



Analysis

Comparison of SWAP and DUP occurrences



Conclusions and future works

By analysing the verified Ethereum smart contracts the last two years, we monitored opcodes usage.

We plan to:

- Investigate the correlation between opcodes usage and the corresponding Solidity code to identify relevant patterns.

- Extend our study to non-verified contracts.

Conclusions and future works

We plan to study and analyse the gas consumption of the contracts in order to

- support formal analyses on smart contracts
- define DSLs for specific application domains

Thanks for
Your attention