Proof-of-Work Consensus Applied to the Byzantine Generals Problem

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Objectives

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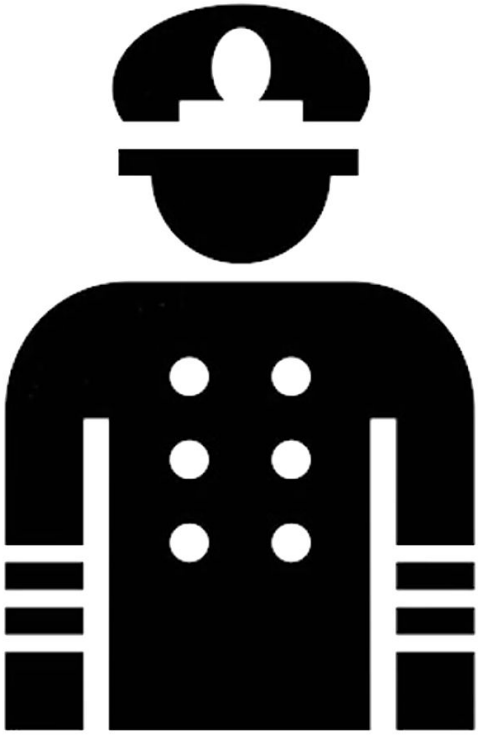
Explain the importance of the Byzantine Generals Problem regarding consensus for blockchain networks

BGP - Recap (1/2)

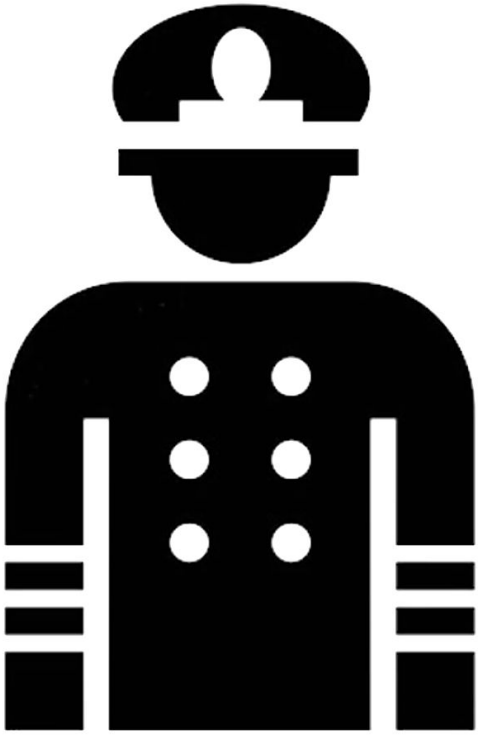
- Goal of finding an algorithm that…
  - allows a decentralized network to come to consensus
  - guarantees two properties
    1. All loyal general decide upon same plan of action
    2. Small amount of traitors cannot cause loyal generals to adopt a bad plan
- Reduce the problem to how a single node communicates his information



BGP - Recap (2/2)

- A commanding general must send an order to his n-1 lieutenant generals such that…
  - IC1: All loyal lieutenants obey the same order.
  - IC2: If the commanding general is loyal, then every loyal lieutenant obeys the order he sends.

QUESTION: How does Proof-of-Work Consensus solve the Byzantine Generals Problem?



Proof-of-Work Consensus Algorithm

- Probabilistic solution to Byzantine Generals Problem
  - Probability of a malicious node generating an alternate history quicker than honest history decreases per added block

Achieving Consensus: Abstract PoW Example (1/2)

1. Byzantine generals will agree on a specific PoW problem (calculation and verification processes)
    - First plan received with a valid solution will be the accepted plan
2. The generals begin solving the PoW problem
    - Attempt to create a block and broadcast it
3. The general who solves the problem send messengers to the other generals
    - The plan of action
    - A solution to the problem

Achieving Consensus: Abstract PoW Example (2/2)

- When a general receives a block, he will independently verify the solution and incorporate it into his block of it is valid
  - Then begins working on next PoW problem
- As the process continues and more generals solve the PoW problem, the chain grows
  - Makes clear the generals which chain has the majority contribution for all the generals

Consensus Process Outcome

- Generals can get a probability of how many other nodes are also in agreement with them
  - Results of being able to calculate the time it takes for block production for entire chain they believe to be the honest plan
- PoW prevents conflicting signals
  - Generals build PoW blocks on top of each other
  - Essentially seal/vote for information in parent block

EXAMPLE: If it takes an average of 10 minutes for a block with all generals' computational power combined, and within an hour six blocks are produced, the generals can surmise that there is consensus on the plan of attack.