Achieving Consensus on Spectrum Usage in the Presence of Faults

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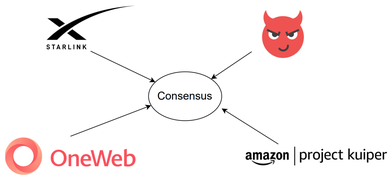
BACKGROUND

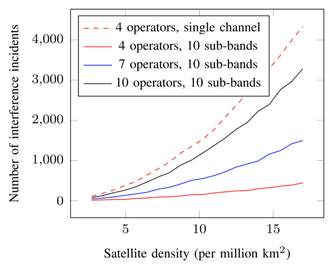
When multiple network operators want to voluntarily share spectrum in a decentralized manner, they need to run a protocol to come to consensus on spectrum usage. Each operator starts with an initial analog usage measurement in the consensus protocol.



RESEARCH QUESTIONS

Our goal is to design decentralized mechanisms to enable shared spectrum usage.

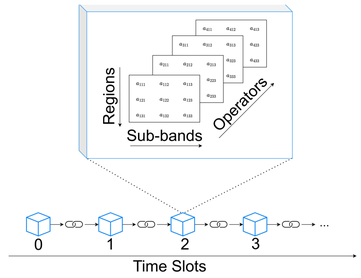
- Why do we need decentralized spectrum-sharing?
- What if some operators behave maliciously?
- How do we keep track of spectrum usage?



METHODS AND MATERIALS

- We define a *resource block* as a sub-band in a given region and time period.
  - Operators measure spectrum usage in the block resource.
  - Operators, in each period, come to consensus on each resource block.
  - Consensus can be on a value (exact agreement) or an interval (approximate agreement).

- To record a unique value agreed by all, we propose:
  - An operator is elected as proposer and proposes its local value. Other operatos accept or reject it.
  - Others accept it only if it's equal to (exact BFT) or close to (approximate BFT) their local value.



RESULTS

Exact Agreement:

Two approaches for the exact agreement:

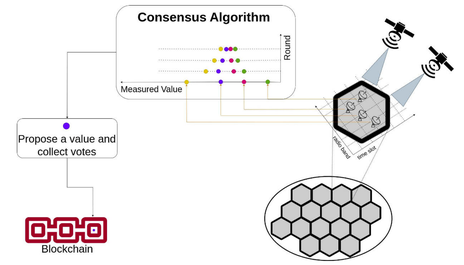
Method 1) Binary Value Agreement: Decide whether interference occured based on a predefined threshold..

Method 2) Arbitrary Value Agreement: First run a BFT protocol for initial value of every node. Honest operators will have the same view, meaning they have the same vector of initial values. All honest operators apply an averaging function to come to the same value at the end.

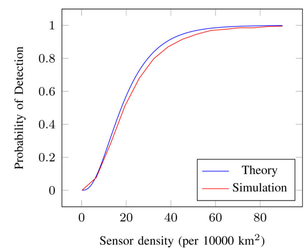
Approximate Agreement:

- Honest operators output values close to each other.
- The output values are within the range of initial values of all honest operators.

Method 3) Approximate Agreement: Using the protocol proposed in [1], the output values will be within some predefined value. Assuming the initial values of honest operators are near the ground truth, the elected proposer is disencentivized to propose values far away from GT.



Sensor density to detect interference is within reasonable bounds.



CONCLUSION

By employing Byzantine Fault Tolerant protocols, network operators can reach agreement on spectrum usage, even in the presence of malicious entities.
The proposed mechanisms can have various use cases. For instance, different NGSO satellite internet providers, each having their own mega-constellation, can share spectrum, keeping interference incidents to a minimum.

ACKNOWLEDGEMENTS

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REFERENCES

[1]D. Dolev, N. Lynch, S. Pinter, E. Stark, and W. Weihl, "Reaching approximate agreement in the presence of faults", 1986.
[2] A. Mollakhani and D. Guo, "Achieving consensus on spectrum usage in the presence of faults," arXiv, 2023, Available: https://arxiv.org/abs/2312.05213.