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Trade-off Model of Fog Cloud Computing for Space Information Networks

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Outline

- Introduction
- Risks and Vulnerabilities
- Solutions
- Proposed Model
- Drawbacks
- Conclusion

Introduction

- Fog computing is the choice to process data wherever most necessary
- Cloud computing emerged as a business opportunity with virtualized services
- A steadily-growing request for internet-based services has led to an increase in complexity and number of clients within the client/server model
- Directly proportional relationship with cybersecurity concerns

Objective

To investigate the existing works for eliminating/mitigating vulnerabilities in fog-cloud computing and space information networks to allow for the creation of a model using various types of layered encryption and appropriately allocated physical hardware for risk mitigation.

Risks + Vulnerabilities

- Cloud computing is typically delivered in a pay-as-you-go manner, requiring data centers and services to be readily available
- Prevalence of cloud computing ensures minimal overhead
- Low latency is a benefit of fog nodes being at the edge of a network, but what about the consequences?
- Issues with fog and cloud computing negatively affect space information networks
- Satellite processing systems must be split to protect data from unauthorized access
- Key management centers present an issue within high-latency systems

Background

- Satellite processing systems must be split to protect data from unauthorized access
- Key management centers present an issue within high-latency systems

Programmatic Solutions

The authors of *Coding for Distributed Fog Computing* discuss coding concepts of minimum bandwidth codes and minimum latency codes to illustrate their impacts on fog computing.

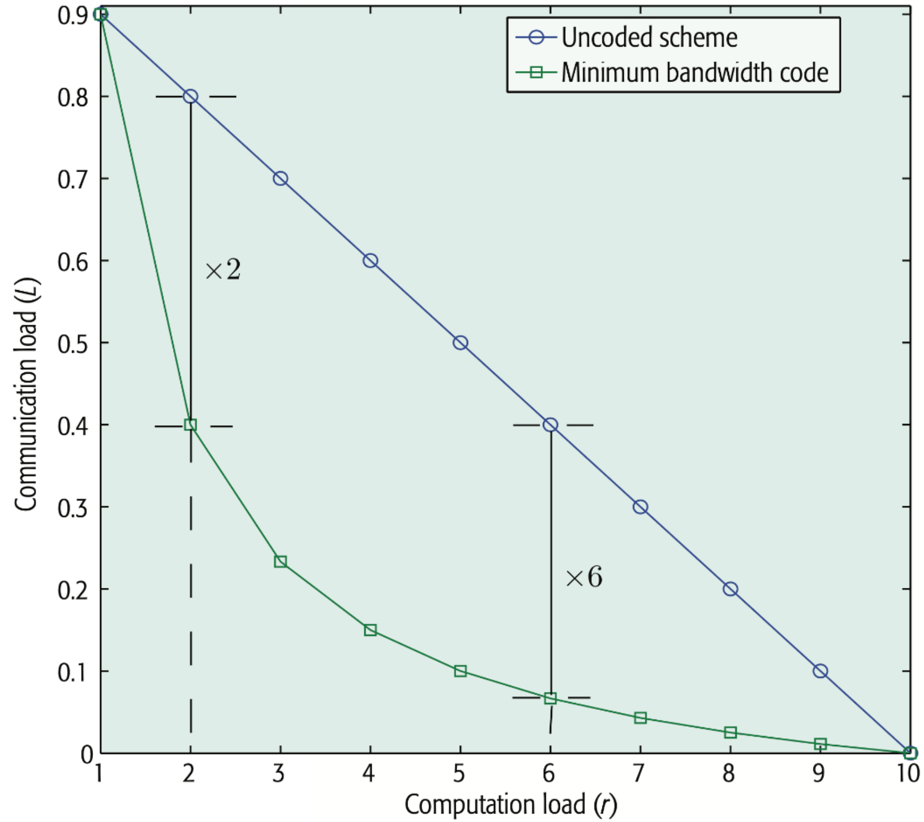
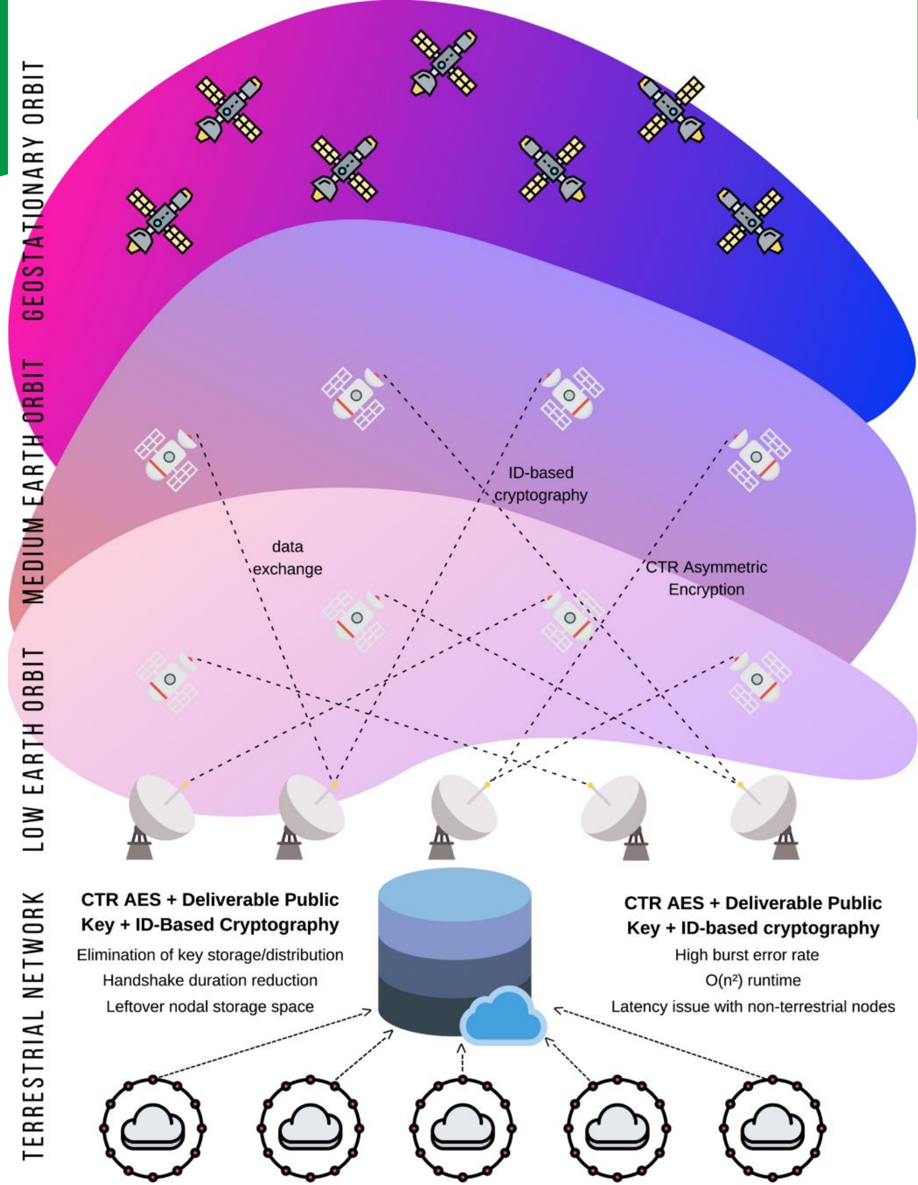


Image: Comparison of the communication load of minimum bandwidth codes with that of an uncoded scheme. Retrieved from Coding for Distributed Fog Computing, *Li, Ali, et.al, 2017.*

Other Solutions

NASA's Space Communications and Navigation (SCaN) Program has been working on 100 Gbps space and ground terminals for LEO Direct-to-Earth communication.

Image: Near Earth Network (NEN) AS-2 Antenna Declared Operational by NASA, Jan. 10, 2018. Retrieved from https://www.nasa.gov/directorates/heo/scan/images/history/October2017


GEOSTATIONARY ORBIT
MEDIUM EARTH ORBIT
LOW EARTH ORBIT
TERRESTRIAL NETWORK
ID-based cryptography
data exchange
CTR Asymmetric Encryption
CTR AES + Deliverable Public Key + ID-Based Cryptography
Elimination of key storage/distribution
Handshake duration reduction
Leftover nodal storage space
CTR AES + Deliverable Public Key + ID-based cryptography
High burst error rate
O(n²) runtime
Latency issue with non-terrestrial nodes

Proposed Model

- Stream-like CTR asymmetric encryption scheme with a derivable public key
  - E(seed, public key)
- ID-based cryptography for handshake duration reduction
- Decentralized key management
- Satellites possess an extra processor not to be accessed by any other entity
- Implementation of Secure Socket Proxy for business use
  - $81 for five
  - $895 for 90

Drawbacks of Proposed Model

- Shared keys within asymmetric encryption must be distributed
- High burst error rates
- Propagation delays are eminent
- Quality of Service and price are directly proportional
- Cost and number of users are directly proportional

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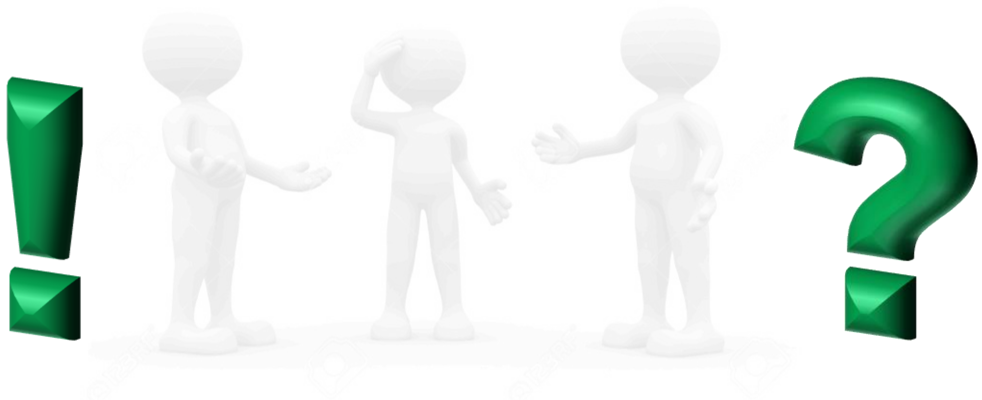
Conclusion

We first identified existing problems within space information networks and proposed a model of fog-cloud integrated space information network.

The most important issues surrounding the trade-off between fog and cloud computing involve encryption scheme, key management schemes, and long/variable propagation latency.

Further testing in a cloud simulation environment is required to determine runtime and a numerical estimate of feasibility of such a model for space information networks.



Thank You!

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