Secure Distributed Protocols

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Digitális szolgáltatások

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Motivation

Theory: secret sharing

- Goal: distribution of sensitive data
- Challenge: security + efficiency
- Tool: interesting combinatorial constructions

Practice: distributed communication systems

- Goal: secure distributed*
- Challenge: decentralization + constraints
- Tool: network + crypto protocols

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Secret sharing

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Motivation

Secret sharing scheme

- Some secret data is distributed into shares
- Each participant get a share
- The "good" guys can recover the secret
- Perfect SS: the other guys learn „nothing"

Algorithmic point of view

- Distribution: $s \to (s_1, \ldots, s_n)$ by the dealer
- Reconstruction $(s_{i_1}, \ldots, s_{i_k}) \to s$ by $\{i_1, \ldots, i_k\} \subseteq \mathcal{P}$

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Research problem

Multilevel conjunctive hierarchical threshold schemes

- $\mathcal{P} = \bigcup_{i=1}^{m} \mathcal{L}_i$
- Different thresholds for different levels: $t_1 < \cdots < t_m$
- $|A \cap \bigcup_{i=1}^{j} \mathcal{L}_j| \geq t_j$
- $\mathcal{A} = \{A \subseteq \mathcal{P} : \forall j (|A \cap \bigcup_{i=1}^{j} \mathcal{L}_j| \geq t_j)\}$

Existing solutions

- Mostly for 2 levels only
- Construction: random or monotone allocation of elements (Tassa '04)
- Reconstruction: Birkhoff interpolation (Tassa '04)
- Reconstruction: bivariate Lagrange interpolation (Tassa, Dyn '09)
- Drawback: restrictions for the field size/characteristics

Solution

Results (Sziklai, Takáts, LP '21)

- Novel construction for 3 levels: finite geometry tools
- Construction: intersection properties in a projective space
- Reconstruction: linear algebra
- Advantages: ideal, smaller field size ($O(n^3)$ improvement)
- Sziklai, Takáts, LP: *Generalized threshold secret sharing and finite geometry*, Designs, Codes and Cryptography, **89** pp. 2067–2078 (2021)

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Distributed communication systems

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Motivation

Problems

- Centralized vs. distributed protocols
- Security drawbacks: DOS, TTP, ...
- Device constraints: computation, communication, location, ...
- Crypto drawbacks: efficient tools only

Examples

- Data validation in IIoT
- Attribute based access control
- Distributed address distribution
- Location-awareness, lightweight devices

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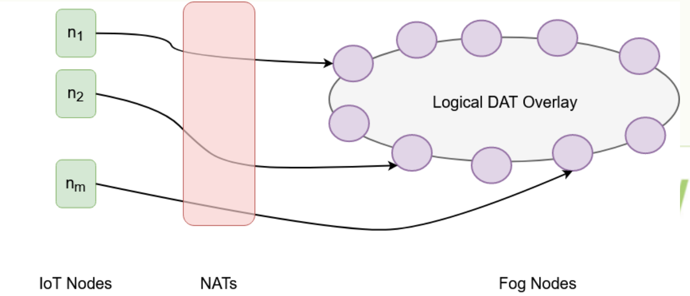
Research problem

Distributed Address Table (DAT)

- Decentralized end-to-end communication in IoT
- Address distribution without TTP
- NAT traversal problem
- Efficiency/security trade-off



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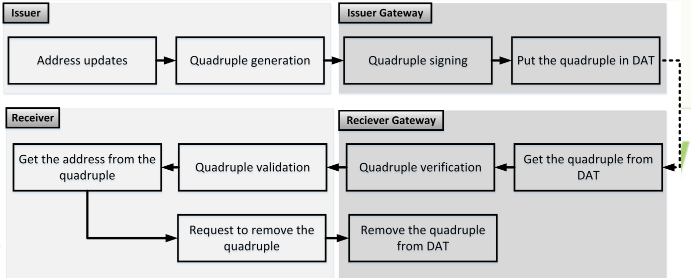
Solution

Building blocks

- Communication
  - structured P2P overlay
  - DHT + F2F
- Crypto
  - hash functions
  - symmetric/public key methods



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Solution

Results (Kamel, Nagy, Reich, LP '22)

- ID generation + address distribution algorithms
- Simple + realistic assumptions
- Precise security requirements + proofs
- Preliminary implementation results (PeerSim + RPI3)
- Kamel, Nagy, Reich, LP: *Distributed Address Table (DAT): A Decentralized Model for End-to-End Communication in IoT*, Peer-to-Peer Networking and Applications, **15** pp. 178–193 (2022)

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Q&A

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