AIMer Standard Format

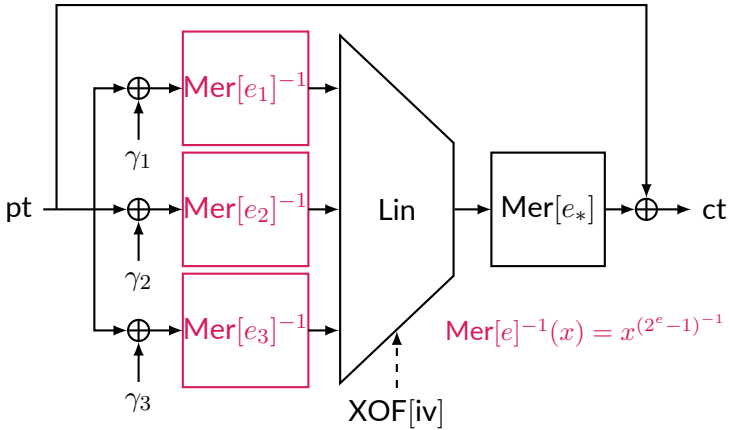
KpqC Conference (2025.11)

Seongkwang Kim

Samsung SDS

Recap of AIMer

AIM2


pt
γ_1
γ_2
γ_3
$\mathrm{Mer}[e_1]^{-1}$
$\mathrm{Mer}[e_2]^{-1}$
$\mathrm{Mer}[e_3]^{-1}$
Lin
$\mathrm{Mer}[e_*]$
ct
XOF[iv]
$\mathrm{Mer}[e]^{-1}(x) = x^{(2^e-1)^{-1}}$

AIMer KeyGen

1. Sample $\mathsf{pt}, \mathsf{iv} \leftarrow_{\$} \{0,1\}^{\lambda}$
2. Compute $\mathsf{AIM2}(\mathsf{pt}, \mathsf{iv}) = \mathsf{ct}$
3. Set $\mathsf{sk} = (\mathsf{pt}, \mathsf{iv}, \mathsf{ct})$, $\mathsf{pk} = (\mathsf{iv}, \mathsf{ct})$

Structure of AIMer Sign

- 5-round Challenge-Response structure
- Challenges are generated using Fiat-Shamir transform
- Phase 1, 3, 5 are repeated τ times, and each repetition computes views of N parties
- In Phase 2, 4, a single digest is generated by hashing all τ responses, and is expanded to challenges of specific length

AIMer Sign

0. Instantiate AIM2 (generating linear layer)
1. Generate views of each parties
    - Generate each party's seed by using GGM tree
    - Random views are genereted from PRG fed by the seeds
    - Compute the corrections between the random views and the real values
    - Commit to the seeds

AIMer Sign

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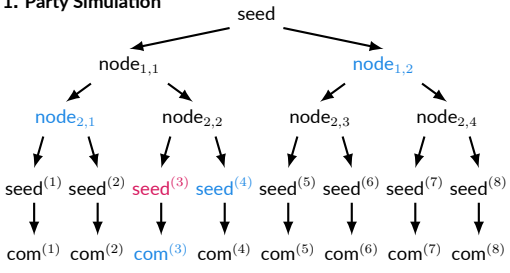
6. Signature is (GGM copath, commitment to the hidden seeds, corrections, challenge hashes, mult. check masking value)

AIMer Sign

1. Party Simulation



2. Multiplication triple generation

$\mathrm{PRG}(\mathrm{seed}^{(1)}) =$ Witness$^{(1)}$ | Mult. triple$^{(1)}$

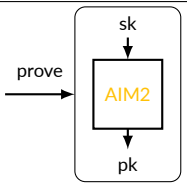
$\vdots$

$\mathrm{PRG}(\mathrm{seed}^{(N)}) =$ Witness$^{(N)}$ | Mult. triple$^{(N)}$

$+\Delta$Witness | $+\Delta$Mult. triple

3. Proof

MultCheck($, ,) = Output shares



4. Party Opening

Choose $i = H(\ )$

Structure of AIMer Verification

- Recompute Phase 1-4 and check whether the second challenge is same
- Commitments to the hidden seeds are in the signature

AIMer Verification

- Instantiate AIM2
- Recompute Phase 1&2
  - Reconstruct opened seeds by using GGM copath
  - Reconstruct views of the opened parties using opened seeds
  - Recomputed opened commitments, and recompute the first challenge hash

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  - Recompute the second challenge

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  - Recompute multiplication check protocol for opened parties and get output share of hidden party
  - Recompute the second challenge
- Accept if the second challenges are same, reject otherwise

AIMer Verification

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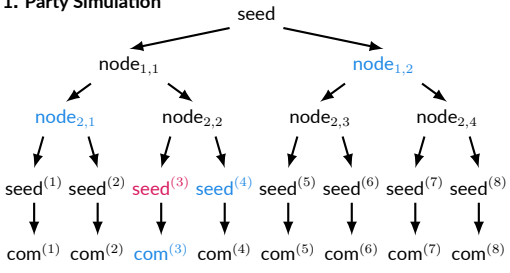

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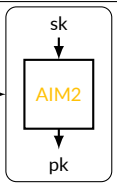

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Notes on Standard Document

Function Call Map: KeyGen

- AIMer_keygen - AIMer_keygen_internal
  - AIM2
    - AIM2_GenerateLinear

Function Call Map: Sign/Verify

- AIMer_sign - AIMer_sign_internal
  - Hash: $H_0, \ldots, H_5$, ExpandH1, ExpandH2
  - AIM2_SboxOutputs
  - AIM2_GenerateLinear
  - ExpandTree / ReconstructTree
    - Hash function H_4
  - AIM2_MPC
  - RevealAllBut

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- AIM2_SboxOutputs function
- Multiplication check protocol details

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- As in Specification v2.1, we only use SHAKE rather than SHA2/3 for hash functions
- Unlike ML-DSA/SLH-DSA, we don't have pre-hash variant

Changes

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- Now index of arrays starts at 0 rather than 1
- Now a context string is inputted to Sign/Verify similarly to ML-DSA

Name Changes from AIMer v2.1

- ReconstructSeedTree $\rightarrow$ ReconstructTree
- KeyGen $\rightarrow$ AIMer_keygen
- Sign $\rightarrow$ AIMer_sign
- Verify $\rightarrow$ AIMer_verify
- GenerateLinear $\rightarrow$ AIM2_GenerateLinear

Q&A