PROVING API IDENTITY WITH PKI AND RSA-2048

Authenticity, integrity, non-repudiation for APIs
Practical FastAPI integration with automated key management, JSON and binary payload support, and acceptable performance.

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ASYMMETRIC CRYPTOGRAPHY AND RSA-2048

Public/private keys for signatures and encryption; security balanced with performance

CORE PRINCIPLES OF ASYMMETRIC CRYPTOGRAPHY

- Uses paired public and private keys for trust
- Enables encryption and digital signatures
- Private key secrecy is critical to security

WHY RSA-2048 IS CHOSEN

- Provides strong cryptographic security
- Common standard for signatures and key exchange
- Balanced security and performance for many uses

PRACTICAL TRADE-OFFS AND STRATEGY

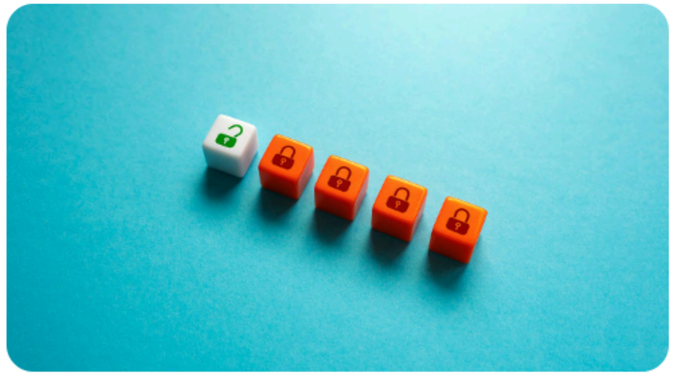
- Computationally heavier than symmetric algorithms
- Use asymmetric for signing and key exchange
- Use symmetric crypto for bulk encryption

IMPLEMENTATION TIP: PROTECT PRIVATE KEYS

- Store keys in secure vaults or hardware modules
- Limit exposure in runtime environments
- Enforce access controls and rotated keys

INTRODUCTION: APPLICATION-LEVEL TRUST GAPS

Prove API request origin without shared secrets



PROBLEM

- MICROSERVICES GROWTH INCREASES CYBERSECURITY CHALLENGES
- TLS DOES NOT ADDRESS APPLICATION-LAYER AUTHENTICATION
- MANY APIS LACK REQUEST SOURCE VERIFICATION

OBJECTIVE

- ESTABLISH CRYPTOGRAPHIC REQUEST AUTHENTICITY BETWEEN SENDER API
- RECEIVER API WITHOUT SHARED SECRETS

CHALLENGE

- ENSURE CONSISTENT MESSAGE CANONICALIZATION ACROSS LANGUAGES AND PLATFORMS FOR VERIFIABLE SIGNATURES

HYBRID CRYPTOGRAPHY: AUTHENTICATE WITH ASYMMETRIC, ENCRYPT WITH SYMMETRIC

Preserve performance while ensuring strong authentication

ASYMMETRIC FOR AUTHENTICATION

- Use asymmetric signatures solely for authentication and integrity
- Protects identity and non-repudiation without encrypting bulk payloads
- Common pattern: sign with RSA or ECDSA

SYMMETRIC FOR BULK ENCRYPTION

- Use symmetric algorithms such as AES for confidentiality
- Optimized for high throughput and low latency
- Combine with ephemeral keys for forward secrecy when needed

DIGITAL SIGNATURES AND PUBLIC KEY INFRASTRUCTURE

Authentication, integrity, non-repudiation with SHA-256 and PSS

AUTHENTICATION: SIGNER IDENTITY TIED TO PUBLIC KEY

Verifies who created the message

INTEGRITY: SHA-256 ENSURES MESSAGE HAS NOT CHANGED

Detects any modification to the signed data

NON-REPUDIATION: SIGNER CANNOT DENY THE SIGNATURE

Provides legal and forensic evidence

SIGNATURE METHOD: SHA-256 WITH PSS PADDING

Probabilistic padding used for signatures

SIGNING STEPS: CREATE DIGEST, APPLY PSS, BASE64 ENCODE

Include resulting string in Authorization header

WHY PSS: PROBABILISTIC PADDING REDUCES DETERMINISTIC RISKS

Adds randomness to prevent signature reuse attacks

SIGN HEADERS AND METADATA: INCLUDE CANONICALIZED VALUES

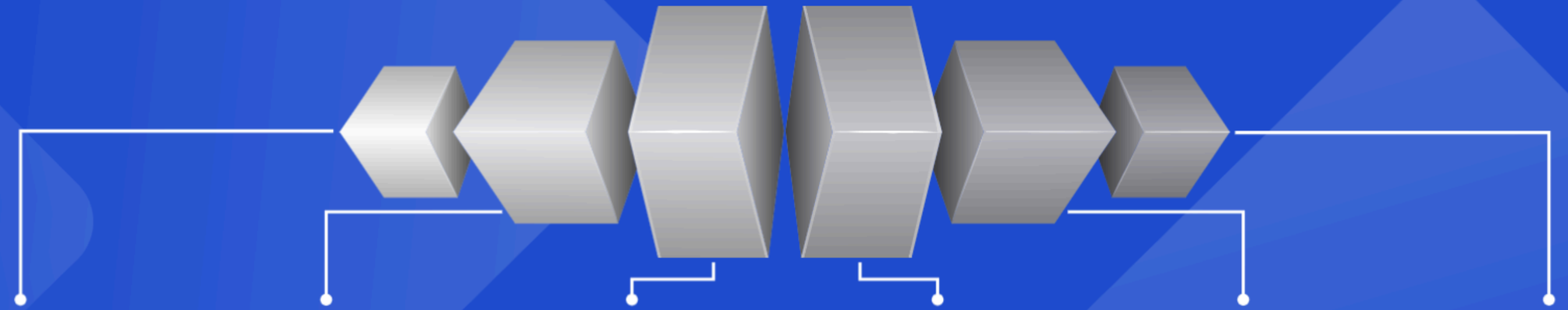
Prevents header tampering and inconsistent parsing

AUTHORIZATION HEADER PLACEMENT: CENTRALIZES VERIFICATION

Requires consistent header handling across servers

SECURE REQUEST SIGNING ARCHITECTURE

Sender API signing to Receiver API verification with deployment and testing guidance



1

SENDER API

Create signed requests using Falcon and cryptography library; place signature in Authorization header.

2

SIGNED REQUEST (AUTHORIZATION HEADER)

Canonicalize payload, compute signature with cryptography, include signature in Authorization header.

3

RECEIVER API

Verify signatures using Falcon and cryptography; log verification events and reject tampered payloads.

4

TOOLING STACK

Python 3.8+, FalconAPI, cryptography library, httpx for requests and testing.

5

DEPLOYMENT BEST PRACTICES

Isolate private keys from app containers; use KMS or secret store; enforce HTTPS for transport; enable audit logging.

6

TESTING RECOMMENDATIONS

Unit test canonicalization; integration tests that simulate tampered payloads and verify rejection.

SECURE KEY GENERATION, STORAGE AND MANAGEMENT

Practical workflow and recommended protections for private and public keys

1

GET_OR_CREATE_KEYS

Generate or load an existing RSA/ECC key pair using generate_key_pair()

2

SAVE PRIVATE AND PUBLIC

Persist private_key.pem and public_key.pem using save/load functions

3

SHARE PUBLIC KEY

Distribute public_key.pem to receivers or public key store for discovery

SIGNATURE CREATION FOR SENDER API

Deterministic JSON signing with PKI Authorization

1. **SERIALIZE JSON WITH SORTED KEYS**

   Ensure consistent key ordering across languages

2. **ENCODE UTF-8 THEN SIGN WITH PRIVATE KEY USING SHA-256 AND PSS**

   Use SHA-256 with PSS padding for robust signatures

3. **BASE64-ENCODE THE SIGNATURE**

   Prepare binary signature for header transport

4. **INCLUDE IN AUTHORIZATION HEADER AS "PKI "**

   Header value format required by Sender API

5. **ADD TIMESTAMP AND NONCE TO SIGNED PAYLOAD (FUTURE WORK)**

   Protect against replay attacks with time and nonce

6. **VALIDATE MAXIMUM HEADER SIZES FOR LARGE SIGNATURES OR BINARY UPLOADS**

   Avoid server rejects due to oversized headers

7. **TESTING TIP: NEGATIVE TESTS THAT ALTER FIELDS OR ORDERING**

   Confirm altered payloads are rejected by verifier

8. **ENSURE DETERMINISTIC SERIALIZATION ACROSS LANGUAGES**

   Normalize whitespace, numeric formats, and key ordering

9. **CODE SNIPPET: SERIALIZE -> UTF8 -> SIGN(SHA-256+PSS) -> BASE64 -> AUTHORIZATION**

   Concise callout of the code flow

SIGNATURE VERIFICATION AND MESSAGE FORMATS

Receiver API steps, canonicalization, multipart handling, and defensive logging

1

EXTRACT AUTHORIZATION HEADER

Read Authorization header and check prefix equals "PKI " before decoding signature.

2

DECODE SIGNATURE

Base64-decode the signature value after the PKI prefix for verification.

3

RECONSTRUCT CANONICAL BODY

Recreate body JSON with keys sorted; apply identical canonicalization rules used by sender.

4

HANDLE CONTENT TYPES

For application/json use canonical JSON; for multipart/form-data canonicalize non-file fields and treat files consistently.

5

VERIFY SIGNATURE

Verify using the sender's public key with SHA-256 and PSS padding.

6

REJECT ON FAILURE

Return 401 Unauthorized when verification fails.

7

LOG FAILURES SAFELY

Record verification failures but avoid logging sensitive payloads; include metadata only.

8

RATE LIMIT FAILED ATTEMPTS

Throttle repeated failed authentications to mitigate abuse.