

PoH Engine
(Proof of History Timer)BPF VM
(Berkeley Packet Filter Engine)Turbine Protocol
(Block Broadcasting Protocol)Validators
(Execution + Voting Nodes)Tower BFT
(Consensus Algorithm)Ledger
(Permanent State Storage)

Step 1: Transaction Composition

Initiates TX (e.g., send SOL or interact with contract)

Wallet prepares transaction with:
- From (sender pubkey)
- To (receiver pubkey)
- lamports (amount)
- Instructions (program + params)
- Gas payer
- Fee limit
- Latest blockhash (anti-replay)

Optional: Simulate TX (fee + compute budget)

Returns fee estimation, success simulation

Requests digital signature

Signs transaction with private key

Step 2: Submission to RPC

Submits signed transaction

RPC validates structure, signature, and blockhash freshness.

alt [Blockhash Expired]

Reject TX - blockhash too old, re-fetch needed

Step 3: Forwarding to Future Leaders

Forwards TX to Gulf Stream

Gulf Stream bypasses mempool.
• Sends TX to **future leader validators**
• Enables **pre-processing** before leader slot

Routes TX to Leader Node

Step 4: Timestamping via PoH

Appends TX to PoH ledger

PoH = Verifiable delay function
• Ticks every 400ms
• Sequences TXs without direct coordination
• Ensures ledger timing integrity

Returns timestamp hash

Step 5: Transaction Execution

Executes TX in BPF Virtual Machine

• Accounts loaded into runtime
• Smart contract instructions executed
• Gas metering enforced
• State updated in temp buffer

alt [TX Fails (e.g., program error, out of compute)]

Rollback state changes

Sends failure reason

Step 6: Block Creation

Packages block results into "Shreds"

Turbine = Tree-based multicast protocol
• Splits blocks into shreds (data + coding)
• Transmits over UDP
• Retransmits lost packets

Distributes block shreds

Step 7: Replay & Verification

Rebuild blocks from shreds

• All validators independently verify execution
• Confirms deterministic behavior

Re-execute TXs locally

Step 8: Voting & Consensus

Vote on proposed block

Tower BFT rules:
• Uses past votes (voting lockout)
• Penalizes vote switching
• Votes signed by validator's keypair
• Finalization on 2/3 quorum

Commits block to permanent ledger

Step 9: User Confirmation

Block confirmed

Status = Confirmed or Finalized

Updates UI - TX Successful

Wallet App
(e.g., Phantom, Solflare)RPC Node
(JSON RPC Gateway)Gulf Stream
(Forwarding Layer)Leader Node
(Current Block Producer)PoH Engine
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