EVM Yellow Paper Analysis vs BSC Behavior

1. Message Call Execution (Section 7)

Yellow Paper Specification

```
CALL: σ' ≡ μ's[μ'g, μ'a, μ'o]

Where:
σ' = resultant state
μ's = state after execution
μ'g = remaining gas
μ'a = recipient address
μ'o = output data
```

Key Rules: 1. Code Existence Check: - Must verify σ[μ’a].code ≠ ∅ - If code doesn’t exist, should return 0 (failure) - State should remain unchanged

BSC’s Deviation

- Ignores code existence requirement
- Processes value transfer even when code = ∅
- Modifies state despite missing code

2. Transaction Execution (Section 6.2)

Yellow Paper Specification

```
Y(σ, T) ≡ Ξ(σ', μ, I, {})

Where:
Y = state transition function
Ξ = execution function
σ = world state
T = transaction
```

Required Steps: 1. Validate transaction format 2. Check sufficient balance 3. Verify code existence for contract calls 4. Execute or revert entirely

BSC’s Deviation

- Introduces undocumented fallback path
- Modifies execution function Ξ

- Splits transaction processing based on code existence
- Creates new state transition path not in specification

3. Account State (Section 4.1)

Yellow Paper Specification

```
σ[a] ≡ (nonce, balance, storageRoot, codeHash)

Where:
a = address
codeHash = hash of account code (if exists)
```

Rules for Contract Interaction: 1. If codeHash = KECCAK256(∅): - Account is EOA or non-existent - Contract calls should fail - Only basic value transfers allowed

BSC’s Deviation

- Treats contract calls to empty codeHash as valid
- Converts contract calls to value transfers
- Ignores method signature in transaction data

4. Gas Computation (Section 5.2)

Yellow Paper Specification

```
g0 = gas cost
g' = remaining gas after execution
```

For failed contract calls: - Should consume all gas - Revert state changes - Return failure

BSC’s Deviation

- Processes partial gas consumption
- Completes transaction despite failure
- Maintains state changes

Summary of Critical Deviations

1. Transaction Processing:
    - Yellow Paper: Strict validation and execution path
    - BSC: Introduces alternative execution paths
2. Contract Interaction:
    - Yellow Paper: Must verify code existence
    - BSC: Optional code existence check

3. State Transitions:
    - Yellow Paper: Atomic success or revert
    - BSC: Partial execution with fallback behavior
4. Gas Handling:
    - Yellow Paper: Full consumption on failure
    - BSC: Partial consumption with success status

Security Implications

1. Predictability:
    - Standard EVM: Deterministic behavior
    - BSC: Conditional execution paths
2. Cross-Chain Operations:
    - Increased risk of unexpected behavior
    - Potential for unintended value transfers
3. Contract Development:
    - Cannot rely on standard EVM guarantees
    - Need additional safety checks for BSC

Recommendations

1. Development:
    - Always verify contract existence before calls
    - Don’t assume standard EVM behavior on BSC
    - Implement additional safety checks
2. Cross-Chain Operations:
    - Verify contract deployment status
    - Test with minimal values first
    - Implement chain-specific safeguards