

Towards Verifying the Bitcoin-S Library

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Bitcoin-S

```
1  val privKey = ECPrivateKey.freshPrivateKey
2  val creditingSPK = P2PKHScriptPubKey(pubKey = privKey.
    publicKey)
3
4  val amount = Satoshis(Int64(10000))
5
6  val utxo = TransactionOutput(currencyUnit = amount,
    scriptPubKey = creditingSPK)
7
8  val tx = BaseTransaction(
9      version = Int32.one,
10     inputs = List.empty,
11     outputs = List(utxo),
12     lockTime = UInt32.zero
13 )
```

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Stainless: Example

```
1  def factorial(n: Int): Int = {
2      require(n >= 0)
3      if (n == 0) {
4          1
5      } else {
6          n * factorial(n - 1)
7      }
8  } ensuring(res => res >= 0)
```

Stainless: Example

Stainless output for the factorial function

```
[ Info ] - Now solving 'postcondition' VC for factorial @10:3...
[ Info ] - Result for 'postcondition' VC for factorial @10:3:
[Warning ] => INVALID
[Warning ] Found counter-example:
[Warning ]   n: Int -> 17
[ Info ]
[ Info ] stainless summary
[ Info ]
[ Info ] | factorial postcondition          valid from cache      src/TestFactorial.scala:10:3  1.055 |
[ Info ] | factorial postcondition          invalid                U:smt-z3  src/TestFactorial.scala:10:3  7.861 |
[ Info ] | factorial precondition. (call factorial(n - 1)) valid from cache      src/TestFactorial.scala:15:11 1.054 |
[ Info ] |
[ Info ] | total: 3   valid: 2   (2 from cache) invalid: 1   unknown: 0   time:   9.970 |
[ Info ] |
```

- Pure Scala
- Pre- and Postcondition
- Outcome: valid, invalid, unknown

Properties

- Bitcoin-S
- No-Inflation Property
- Addition-with-Zero Property

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Inheriting Objects

This:

```
1 object Satoshi extends BaseNumbers[Satoshi] {  
2   val zero = Satoshi(Int64.zero)  
3   val one = Satoshi(Int64.one)  
4 }
```

Becomes this:

```
1 case object Satoshi extends BaseNumbers[Satoshi] {  
2   val zero = Satoshi(Int64.zero)  
3   val one = Satoshi(Int64.one)  
4 }
```

Abstract Type Members

This:

```
1 sealed abstract class CurrencyUnit {  
2     type A  
3  
4     protected def underlying: A  
5 }  
6  
7 sealed abstract class Satoshis extends CurrencyUnit {  
8     override type A = Int64  
9 }
```

Becomes this:

```
1 sealed abstract class CurrencyUnit {  
2     protected def underlying: Int64  
3 }  
4  
5 sealed abstract class Satoshis extends CurrencyUnit
```

Missing Bitwise &-Function on BigInt

This:

```
1 sealed abstract class Number {  
2   def andMask: BigInt  
3   def checkResult(result: BigInt): BigInt = {  
4     require((result & andMask) == result)  
5     result  
6   }  
7 }
```

Becomes this:

```
1 sealed abstract class Number {  
2   // removed redundant checkResult function  
3 }
```

Formal Specification

```
1 def +(c: CurrencyUnit): CurrencyUnit = {  
2   require(c.satoshis == Satoshis.zero)  
3   Satoshis(  
4     satoshis.underlying + c.satoshis.underlying  
5   )  
6 } ensuring(res => res.satoshis == this.satoshis)
```

Output of Stainless

```
[Warning] The Z3 native interface is not available. Falling back onto smt-z3.
[ Info] - Checking cache: 'cast correctness' VC for underlying @59:30...
[ Info] - Checking cache: 'cast correctness' VC for inv @59:30...
[ Info] - Checking cache: 'cast correctness' VC for inv @59:30...
[ Info] Cache hit: 'cast correctness' VC for inv @59:30...
[ Info] Cache hit: 'cast correctness' VC for inv @59:30...
[ Info] Cache hit: 'cast correctness' VC for underlying @59:30...
[ Info] - Checking cache: 'cast correctness' VC for underlying @43:33...
[ Info] Cache hit: 'cast correctness' VC for underlying @43:33...
[ Info] - Checking cache: 'precond. (call checkResult(thiss, underlying(thiss) + u ...)' VC for + @22:11...
[ Info] - Checking cache: 'precond. (call +(@unchecked ( ...))' VC for + @4:3...
[ Info] Cache hit: 'precond. (call checkResult(thiss, underlying(thiss) + u ...)' VC for + @22:11...
[ Info] Cache hit: 'precond. (call +(@unchecked ( ...))' VC for + @4:3...
[ Info]
[ Info] stainless summary
[ Info]
[ Info] +      precondition. (call +(@unchecked ( ...))      valid from cache      BasicArithmetic.scala:4:3      0.022
[ Info] +      precondition. (call checkResult(thiss, underlying(thiss) + u ...) valid from cache      NumberType.scala:22:11      0.021
[ Info] inv      cast correctness      valid from cache      NumberType.scala:59:30      0.249
[ Info] inv      cast correctness      valid from cache      NumberType.scala:59:30      0.247
[ Info] underlying cast correctness      valid from cache      CurrencyUnits.scala:43:33    0.010
[ Info] underlying cast correctness      valid from cache      NumberType.scala:59:30      0.849
[ Info] -----
[ Info] total: 6      valid: 6      (6 from cache) invalid: 0      unknown: 0      time: 1.398
[ Info] Shutting down executor service.
```

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Found Bug in Bitcoin-S

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▼ 6 core-test/src/test/scala/org/bitcoins/core/protocol/transaction/TransactionTest.scala ...
@@ -294,6 +294,12 @@ class TransactionTest extends FlatSpec with MustMatchers {
294 294     }
295 295     }
296 296
297 + it must "check transaction with two out point referencing the same tx with different indexes" in {
298 +   val hex = "0200000002924942b0b7c12ece0dc8100d74alcd29acd6cfc60698bfc3f07d83890eac20b6000000006a47304402202831
299 +   val btx = BaseTransaction.fromHex(hex)
300 +   ScriptInterpreter.checkTransaction(btx) must be(true)
301 +   }
302 +
297 303   private def findInput(
298 304     tx: Transaction,
299 305     outPoint: TransactionOutPoint): Option[(TransactionInput, Int)] = {
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