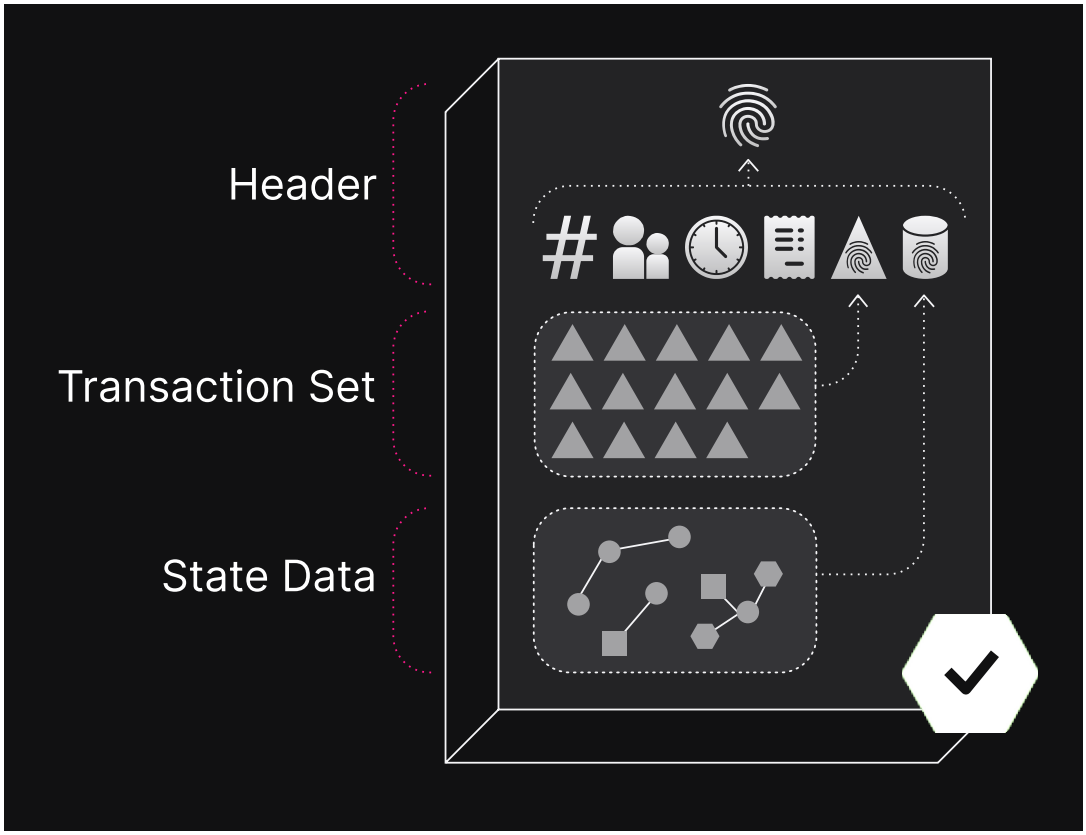
Welcome to Peter Parser (Draft)

In these files I will detail how the XRPL ledger is structured, how addresses are constructed and how various transaction types are serialized

Ledger Structure

The ledger structure is described at a high level in the XRPL docs here: https://xrpl.org/docs/concepts/ledgers/ledger-structure



Each ledger version has 3 parts:

- Header
- Transaction Set
- State Data

Header

Lets get the ledger header for ledger version 38129. Why 38129? Well this is the first ledger version I could find that contains a transaction, and since ledgers 0-32569 were lost (https://web.archive.org/web/20171211225452/https://forum.ripple.com/viewtopic.f=2&t=3613) and it is more interesting to look at one with a transaction than

not (more detail below), lets look at that one :)

First get the ledger header data:

In [33]:
```
from xrpl.clients import JsonRpcClient
import xrpl
import json
# I needed to add the next 2 lines to stop the error "RuntimeError:
import nest_asyncio
nest_asyncio.apply()

# Connect to the API
client = JsonRpcClient("https://s1.ripple.com:51234/")

# Create a ledger object model
ledger = xrpl.models.requests.Ledger(ledger_index="38129", binary=F

# Request the ledger object
ledger_result = client.request(ledger).result

# Print the ledger object
print(json.dumps(ledger_result, indent=2))
```


```
{
  "ledger_hash": "E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3F9
F5AAE4569D758E",
  "ledger_index": 38129,
  "validated": true,
  "ledger": {
    "account_hash": "2C23D15B6B549123FB351E4B5CDE81C564318EB845449CD
43C3EA7953C4DB452",
    "close_flags": 0,
    "close_time": 410424200,
    "close_time_human": "2013-Jan-02 06:43:20.000000000 UTC",
    "close_time_resolution": 10,
    "close_time_iso": "2013-01-02T06:43:20Z",
    "ledger_hash": "E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3
F9F5AAE4569D758E",
    "parent_close_time": 410424200,
    "parent_hash": "3401E5B2E5D3A53EB0891088A5F2D9364BBB6CE5B37A337D
2C0660DAF9C4175E",
    "total_coins": "99999999999996310",
    "transaction_hash": "DB83BF807416C5B3499A73130F843CF615AB8E797D7
9FE7D330ADF1BFA93951A",
    "ledger_index": 38129,
    "closed": true
  }
}
```


The output above should show the following json:

```
{
  "ledger_hash":
"E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3F9F5AAE4569D75
# sha512-half hash of ledger header, more detail below
  "ledger_index": 38129, # the ledger number, starting at 0
```

```
increasing by 1 each new ledger every ~3 seconds for XRPL
  "validated": true, # shows if the ledger version is part
of the XRPL completed ledgers
  "ledger": {
    "account_hash":
"2C23D15B6B549123FB351E4B5CDE81C564318EB845449CD43C3EA7953C4DB4
# sha512-half of account state data, more detail below
    "close_flags": 0, #
    "close_time": 410424200, # time that the ledger closed
in ripple epoch (seconds since 01/01/2000 00:00:00 UTC
    "close_time_human": "2013-Jan-02 06:43:20.000000000
UTC", # close time in readable format
    "close_time_resolution": 10, #
    "close_time_iso": "2013-01-02T06:43:20Z", # close time
in different format
    "ledger_hash":
"E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3F9F5AAE4569D75
# same as above
    "parent_close_time": 410424200, # close time of previous
ledger version in ripple epoch time
    "parent_hash":
"3401E5B2E5D3A53EB0891088A5F2D9364BBB6CE5B37A337D2C0660DAF9C417
# parent ledger hash, in this case its the "ledger_hash" for
"ledger_index"=38128
    "total_coins": "99999999999996310", # amount of XRP
drops remaining, total XRP for all accts minus any fees
    "transaction_hash":
"DB83BF807416C5B3499A73130F843CF615AB8E797D79FE7D330ADF1BFA9395
# sha512-half of the Merkle Patricia Trie root of
transaction data contained in this ledger version
    "ledger_index": 38129, # same as above
    "closed": true #
  }
}
```

This is the ledger header for ledger version 38129. It's immutable, transparent and secure.

There is something slightly weird (at least I think) about this ledger, that the close_time and parent_close_time are the same, this is not usually the case, I don't know why this is the case here!

Ledger Hash

Let's calculate the ledger_hash:

In [49]:
```
import hashlib

def Sha512Hash(Password):
    HashedPassword=hashlib.sha512(Password.encode('utf-8')).hexdige
    print(HashedPassword)

# Copy the necessary values from the above output and convert hex v
```

```
data = bytes.fromhex(
    "4C575200"          # HashPrefix::ledgerMaster, this is static
    "000094F1"          # ledger_index, 38129
    "016345785D89F196"  # total_coins, 99999999999996310
    "3401E5B2E5D3A53EB0891088A5F2D9364BBB6CE5B37A337D2C0660DAF9C417
    "DB83BF807416C5B3499A73130F843CF615AB8E797D79FE7D330ADF1BFA9395
    "2C23D15B6B549123FB351E4B5CDE81C564318EB845449CD43C3EA7953C4DB4
    "18769388"          # parent_close_time, 410424200
    "18769388"          # close_time, 410424200
    "0A"                # close_time_resolution, 10
    "00"                # close_flags, 0
)

# Compute SHA-512
sha512_hash = hashlib.sha512(data).digest()

# Take the first 32 bytes (SHA-512Half)
ledger_hash = sha512_hash[:32].hex().upper()

print("Ledger Hash:", ledger_hash)
```

```
Ledger Hash: E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3F9F5AAE
4569D758E
```

So we calculated the ledger hash E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3F9F5AAE4569D7 which is equal to the ledger_hash from the ledger header. All good so far :)

Most of the fields make sense, but what are the transaction_hash and account_hash? How do we construct these?

Transaction Hash

The transaction_hash is a sha512-half of the Merkle Patricia Trie of the transaction data from the ledger version.

HOW IS THIS DONE? Maybe do a pic?

First we will get the transaction data from the network:

In [50]:
```
from xrpl.clients import JsonRpcClient
import xrpl
import json
# I needed to add the next 2 lines to stop the error "RuntimeError:
import nest_asyncio
nest_asyncio.apply()

# Connect to the API
client = JsonRpcClient("https://s1.ripple.com:51234/")

# Create a ledger object model
ledger = xrpl.models.requests.Ledger(ledger_index="38129", binary=F

# Request the ledger object
```

```
ledger_result = client.request(ledger).result

# Print the ledger object
print(json.dumps(ledger_result, indent=2))
```


```
{
  "ledger_hash": "E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3F9
F5AAE4569D758E",
  "ledger_index": 38129,
  "validated": true,
  "ledger": {
    "account_hash": "2C23D15B6B549123FB351E4B5CDE81C564318EB845449CD
43C3EA7953C4DB452",
    "close_flags": 0,
    "close_time": 410424200,
    "close_time_human": "2013-Jan-02 06:43:20.000000000 UTC",
    "close_time_resolution": 10,
    "close_time_iso": "2013-01-02T06:43:20Z",
    "ledger_hash": "E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3
F9F5AAE4569D758E",
    "parent_close_time": 410424200,
    "parent_hash": "3401E5B2E5D3A53EB0891088A5F2D9364BBB6CE5B37A337D
2C0660DAF9C4175E",
    "total_coins": "99999999999996310",
    "transaction_hash": "DB83BF807416C5B3499A73130F843CF615AB8E797D7
9FE7D330ADF1BFA93951A",
    "ledger_index": 38129,
    "closed": true,
    "transactions": [
      {
        "validated": true,
        "ledger_index": 38129,
        "close_time_iso": "2013-01-02T06:43:20Z",
        "ledger_hash": "E6DB7365949BF9814D76BCC730B01818EB9136A89DB2
24F3F9F5AAE4569D758E",
        "hash": "3B1A4E1C9BB6A7208EB146BCDB86ECEA6068ED01466D933528C
A2B4C64F753EF",
        "tx_json": {
          "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
          "DeliverMax": "10000000000",
          "Destination": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
          "Fee": "10",
          "Flags": 0,
          "Sequence": 62,
          "SigningPubKey": "034AADB09CFF4A4804073701EC53C3510CDC9591
7C2BB0150FB742D0C66E6CEE9E",
          "TransactionType": "Payment",
          "TxnSignature": "3045022022EB32AECEF7C644C891C19F87966DF9C
62B1F34BABA6BE774325E4BB8E2DD62022100A51437898C28C2B297112DF8131F2BB
39EA5FE613487DDD611525F1796264639"
        },
        "meta": {
          "AffectedNodes": [
            {
              "CreatedNode": {
                "LedgerEntryType": "AccountRoot",
```

```
                "LedgerIndex": "4C6ACBD635B0F07101F7FA25871B0925F883
615546215217275584 5CE691C49E",
                "NewFields": {
                  "Account": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
                  "Balance": "10000000000",
                  "Sequence": 1
                }
              }
            },
            {
              "ModifiedNode": {
                "FinalFields": {
                  "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
                  "Balance": "981481999380",
                  "Flags": 0,
                  "OwnerCount": 0,
                  "Sequence": 63
                },
                "LedgerEntryType": "AccountRoot",
                "LedgerIndex": "B33FDD5CF3445E1A7F2BE9B06336BEBD73A5
E3EE885D3EF93F7E3E2992E46F1A",
                "PreviousFields": {
                  "Balance": "991481999390",
                  "Sequence": 62
                },
                "PreviousTxnID": "2485FDC606352F1B0785DA5DE96FB9DBAF
43EB60ECBB01B7F6FA970F512CDA5F",
                "PreviousTxnLgrSeq": 31317
              }
            }
          ],
          "TransactionIndex": 0,
          "TransactionResult": "tesSUCCESS",
          "delivered_amount": "unavailable"
        }
      }
    ]
  }
}
```


Now we need to serialize this data into two parts: transaction_blob, and metadata_blob.

Transaction Blob

Take the transaction data from the above output and serialize it:

In [51]:
```
import xrpl
import json
tx_json = """{
          "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
          "DeliverMax": "10000000000",
          "Destination": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
          "Fee": "10",
          "Flags": 0,
```

```
          "Sequence": 62,
          "SigningPubKey": "034AADB09CFF4A4804073701EC53C3510CDC959
          "TransactionType": "Payment",
          "TxnSignature": "3045022022EB32AECEF7C644C891C19F87966DF9
        }"""

transaction_1 = """{
          "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
          "Amount": "10000000000",
          "Destination": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
          "Fee": "10",
          "Flags": 0,
          "Sequence": 62,
          "SigningPubKey": "034AADB09CFF4A4804073701EC53C3510CDC959
          "TransactionType": "Payment",
          "TxnSignature": "3045022022EB32AECEF7C644C891C19F87966DF9
        }"""


#test = xrpl.transaction.transaction_json_to_binary_codec_form(json
#print(json.dumps(test, indent=2), type(test))
'''print(xrpl.models.transactions.Payment.from_blob("12000022000000
#payment_from_dict=xrpl.models.transactions.Payment.from_dict(json.
#print("Transaction blob: ",payment_from_dict.blob())



from xrpl.core.binarycodec import encode, decode
print("Encoded: ", encode(json.loads(transaction_1)))
```

```
Encoded:  1200002200000000240000003E6140000002540BE40068400000000000
000A7321034AADB09CFF4A4804073701EC53C3510CDC95917C2BB0150FB742D0C66E
6CEE9E74473045022022EB32AECEF7C644C891C19F87966DF9C62B1F34BABA6BE774
325E4BB8E2DD62022100A51437898C28C2B297112DF8131F2BB39EA5FE613487DDD6
11525F17962646398114550FC62003E785DC231A1058A05E56E3F09CF4E68314D4CC
8AB5B21D86A82C3E9E8D0ECF2404B77FECBA
```

In [52]:

```
test_decode=xrpl.core.binarycodec.decode("120000220000000024000000003
print("Transaction Decode: ", json.dumps(test_decode, indent=2))
tx_string = transaction_1="""{
          "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
          "Amount": "10000000000",
          "Destination": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
          "Fee": "10",
          "Flags": 0,
          "Sequence": 62,
          "SigningPubKey": "034AADB09CFF4A4804073701EC53C3510CDC959
          "TransactionType": "Payment",
          "TxnSignature": "3045022022EB32AECEF7C644C891C19F87966DF9
        }"""
print("Transaction encode: ", xrpl.core.binarycodec.encode(test_dec
print(xrpl.core.binarycodec.encode(json.loads(tx_string)))
```

```
Transaction Decode:  {
  "TransactionType": "Payment",
  "Flags": 0,
  "Sequence": 62,
  "Amount": "10000000000",
  "Fee": "10",
  "SigningPubKey": "034AADB09CFF4A4804073701EC53C3510CDC95917C2BB015
0FB742D0C66E6CEE9E",
  "TxnSignature": "3045022022EB32AECEF7C644C891C19F87966DF9C62B1F34B
ABA6BE774325E4BB8E2DD62022100A51437898C28C2B297112DF8131F2BB39EA5FE6
13487DDD611525F1796264639",
  "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
  "Destination": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj"
}
Transaction encode:  1200002200000000240000003E6140000002540BE400684
00000000000000A7321034AADB09CFF4A4804073701EC53C3510CDC95917C2BB0150
FB742D0C66E6CEE9E74473045022022EB32AECEF7C644C891C19F87966DF9C62B1F3
4BABA6BE774325E4BB8E2DD62022100A51437898C28C2B297112DF8131F2BB39EA5F
E613487DDD611525F17962646398114550FC62003E785DC231A1058A05E56E3F09CF
4E68314D4CC8AB5B21D86A82C3E9E8D0ECF2404B77FECBA
1200002200000000240000003E6140000002540BE4006840000000000000000A732103
4AADB09CFF4A4804073701EC53C3510CDC95917C2BB0150FB742D0C66E6CEE9E7447
3045022022EB32AECEF7C644C891C19F87966DF9C62B1F34BABA6BE774325E4BB8E2
DD62022100A51437898C28C2B297112DF8131F2BB39EA5FE613487DDD611525F1796
2646398114550FC62003E785DC231A1058A05E56E3F09CF4E68314D4CC8AB5B21D86
A82C3E9E8D0ECF2404B77FECBA
```

Metadata Blob

In [53]:
```
test_decode=xrpl.core.binarycodec.decode("201C00000000F8E3110061564
print(json.dumps(test_decode, indent=2))
print(xrpl.core.binarycodec.encode(test_decode))
```

```
{
  "TransactionIndex": 0,
  "AffectedNodes": [
    {
      "CreatedNode": {
        "LedgerEntryType": "AccountRoot",
        "LedgerIndex": "4C6ACBD635B0F07101F7FA25871B0925F88361554621
52172755845CE691C49E",
        "NewFields": {
          "Sequence": 1,
          "Balance": "10000000000",
          "Account": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj"
        }
      }
    },
    {
      "ModifiedNode": {
        "LedgerEntryType": "AccountRoot",
        "PreviousTxnLgrSeq": 31317,
        "PreviousTxnID": "2485FDC606352F1B0785DA5DE96FB9DBAF43EB60EC
BB01B7F6FA970F512CDA5F",
        "LedgerIndex": "B33FDD5CF3445E1A7F2BE9B06336BEBD73A5E3EE885D
3EF93F7E3E2992E46F1A",
        "PreviousFields": {
          "Sequence": 62,
          "Balance": "991481999390"
        },
        "FinalFields": {
          "Flags": 0,
          "Sequence": 63,
          "OwnerCount": 0,
          "Balance": "981481999380",
          "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV"
        }
      }
    }
  ],
  "TransactionResult": "tesSUCCESS"
}
201C00000000F8E3110061564C6ACBD635B0F07101F7FA25871B0925F88361554621
52172755845CE691C49EE824000000016240000002540BE4008114D4CC8AB5B21D86
A82C3E9E8D0ECF2404B77FECBAE1E1E51100612500007A55552485FDC606352F1B07
85DA5DE96FB9DBAF43EB60ECBB01B7F6FA970F512CDA5F56B33FDD5CF3445E1A7F2B
E9B06336BEBD73A5E3EE885D3EF93F7E3E2992E46F1AE6240000003E62400000E6D8
EEB01EE1E722000000002400000003F2D0000000062400000E484E2CC148114550FC6
2003E785DC231A1058A05E56E3F09CF4E6E1E1F1031000
```


In [54]:
```
test_meta = """{"AffectedNodes": [
{
  "CreatedNode": {
    "LedgerEntryType": "AccountRoot",
    "LedgerIndex": "4C6ACBD635B0F07101F7FA25871B0925F88361554621521
    "NewFields": {
      "Account": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
      "Balance": "10000000000",
      "Sequence": 1
```

```
    }
  }
},
{
  "ModifiedNode": {
    "FinalFields": {
      "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
      "Balance": "981481999380",
      "Flags": 0,
      "OwnerCount": 0,
      "Sequence": 63
    },
    "LedgerEntryType": "AccountRoot",
    "LedgerIndex": "B33FDD5CF3445E1A7F2BE9B06336BEBD73A5E3EE885D3EF
    "PreviousFields": {
      "Balance": "991481999390",
      "Sequence": 62
    },
    "PreviousTxnID": "2485FDC606352F1B0785DA5DE96FB9DBAF43EB60ECBB0
    "PreviousTxnLgrSeq": 31317
  }
}
],
"TransactionIndex": 0,
"TransactionResult": "tesSUCCESS",
"delivered_amount": "unavailable"
}"""

test_meta2 = """{"AffectedNodes": [
{
  "CreatedNode": {
    "LedgerEntryType": "AccountRoot",
    "LedgerIndex": "4C6ACBD635B0F07101F7FA25871B0925F88361554621521
    "NewFields": {
      "Account": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
      "Balance": "10000000000",
      "Sequence": 1
    }
  }
},
{
  "ModifiedNode": {
    "FinalFields": {
      "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
      "Balance": "981481999380",
      "Flags": 0,
      "OwnerCount": 0,
      "Sequence": 63
    },
    "LedgerEntryType": "AccountRoot",
    "LedgerIndex": "B33FDD5CF3445E1A7F2BE9B06336BEBD73A5E3EE885D3EF
    "PreviousFields": {
      "Balance": "991481999390",
      "Sequence": 62
    },
    "PreviousTxnID": "2485FDC606352F1B0785DA5DE96FB9DBAF43EB60ECBB0
```

```
    "PreviousTxnLgrSeq": 31317
  }
}
],
"TransactionIndex": 0,
"TransactionResult": "tesSUCCESS"
}"""

test_meta_json = json.loads(test_meta2)
print(json.dumps(test_meta_json, indent=2))
#print(xrpl.core.binarycodec.encode(test_decode))
print(xrpl.core.binarycodec.encode(test_meta_json))
```

```
{
  "AffectedNodes": [
    {
      "CreatedNode": {
        "LedgerEntryType": "AccountRoot",
        "LedgerIndex": "4C6ACBD635B0F07101F7FA25871B0925F88361554621
52172755845CE691C49E",
        "NewFields": {
          "Account": "rLQBHVhFnaC5gLEkgr6HgBJJ3bgeZHg9cj",
          "Balance": "10000000000",
          "Sequence": 1
        }
      }
    },
    {
      "ModifiedNode": {
        "FinalFields": {
          "Account": "r3kmLJN5D28dHuH8vZNUZpMC43pEHpaocV",
          "Balance": "981481999380",
          "Flags": 0,
          "OwnerCount": 0,
          "Sequence": 63
        },
        "LedgerEntryType": "AccountRoot",
        "LedgerIndex": "B33FDD5CF3445E1A7F2BE9B06336BEBD73A5E3EE885D
3EF93F7E3E2992E46F1A",
        "PreviousFields": {
          "Balance": "991481999390",
          "Sequence": 62
        },
        "PreviousTxnID": "2485FDC606352F1B0785DA5DE96FB9DBAF43EB60EC
BB01B7F6FA970F512CDA5F",
        "PreviousTxnLgrSeq": 31317
      }
    }
  ],
  "TransactionIndex": 0,
  "TransactionResult": "tesSUCCESS"
}
201C00000000F8E3110061564C6ACBD635B0F07101F7FA25871B0925F88361554621
52172755845CE691C49EE824000000016240000002540BE4008114D4CC8AB5B21D86
A82C3E9E8D0ECF2404B77FECBAE1E1E51100612500007A55552485FDC606352F1B07
85DA5DE96FB9DBAF43EB60ECBB01B7F6FA970F512CDA5F56B33FDD5CF3445E1A7F2B
E9B06336BEBD73A5E3EE885D3EF93F7E3E2992E46F1AE6240000003E62400000E6D8
EEB01EE1E722000000002400000003F2D000000006240000E484E2CC148114550FC6
2003E785DC231A1058A05E56E3F09CF4E6E1E1F1031000
```


In [ ]:

Check this is the same as the on-chain data:

In [55]:
```
from xrpl.clients import JsonRpcClient
import xrpl
import json
# I needed to add the next 2 lines to stop the error "RuntimeError:
import nest_asyncio
```

```
nest_asyncio.apply()

# Connect to the API
client = JsonRpcClient("https://s1.ripple.com:51234/")

# Create a ledger object model
ledger = xrpl.models.requests.Ledger(ledger_index="38129", binary=T

# Request the ledger object
ledger_result = client.request(ledger).result

# Print the ledger object
print(json.dumps(ledger_result, indent=2))
```


```
{
  "ledger_hash": "E6DB7365949BF9814D76BCC730B01818EB9136A89DB224F3F9
F5AAE4569D758E",
  "ledger_index": 38129,
  "validated": true,
  "ledger": {
    "ledger_data": "000094F1016345785D89F1963401E5B2E5D3A53EB0891088
A5F2D9364BBB6CE5B37A337D2C0660DAF9C4175EDB83BF807416C5B3499A73130F84
3CF615AB8E797D79FE7D330ADF1BFA93951A2C23D15B6B549123FB351E4B5CDE81C5
64318EB845449CD43C3EA7953C4DB45218769388187693880A00",
    "closed": true,
    "transactions": [
      {
        "meta_blob": "201C00000000F8E3110061564C6ACBD635B0F07101F7FA
25871B0925F883615546215217275584 5CE691C49EE824000000016240000002540B
E4008114D4CC8AB5B21D86A82C3E9E8D0ECF2404B77FECBAE1E1E51100612500007A
55552485FDC606352F1B0785DA5DE96FB9DBAF43EB60ECBB01B7F6FA970F512CDA5F
56B33FDD5CF3445E1A7F2BE9B06336BEBD73A5E3EE885D3EF93F7E3E2992E46F1AE6
240000003E62400000E6D8EEB01EE1E722000000002400000 03F2D00000000624000
00E484E2CC148114550FC62003E785DC231A1058A05E56E3F09CF4E6E1E1F103100
0",
        "tx_blob": "120000220000000024000000 3E6140000002540BE4006840
0000000000000A7321034AADB09CFF4A4804073701EC53C3510CDC95917C2BB0150F
B742D0C66E6CEE9E74473045022022EB32AECEF7C644C891C19F87966DF9C62B1F34
BABA6BE774325E4BB8E2DD62022100A51437898C28C2B297112DF8131F2BB39EA5FE
613487DDD611525F17962646398114550FC62003E785DC231A1058A05E56E3F09CF4
E68314D4CC8AB5B21D86A82C3E9E8D0ECF2404B77FECBA",
        "hash": "3B1A4E1C9BB6A7208EB146BCDB86ECEA6068ED01466D933528C
A2B4C64F753EF"
      }
    ]
  }
}
```


Now we have all of the ingredients for the transaction hash, lets calculate it

We're aiming for
DB83BF807416C5B3499A73130F843CF615AB8E797D79FE7D330ADF1BFA9395

In [56]:
```
#This calculates the "key" or "index" this is defines where the tra

import hashlib
```

```
tx_blob = "1200002200000000240000003E6140000002540BE400684000000000
meta_blob = "201C00000000F8E3110061564C6ACBD635B0F07101F7FA25871B09

data = bytes.fromhex(
    "54584E00"+
    tx_blob
)


ledger_hash = hashlib.sha512(data).digest()[:32].hex().upper()
print(ledger_hash)
```

```
3B1A4E1C9BB6A7208EB146BCDB86ECEA6068ED01466D933528CA2B4C64F753EF
```

In [57]:

```
# Now lets calculate the leaf node has, based on this: https://gith
from binascii  import hexlify, unhexlify
import math

# Create a variable length prefix for a xrpl serialized vl field
def make_vl_bytes(l):
    if type(l) == float:
        l = ceil(l)
    if type(l) != int:
        return False
    if l <= 192:
        return bytes([l])
    elif l <= 12480:
        b1 = math.floor((l - 193) / 256 + 193)
        return bytes([b1, l - 193 - 256 * (b1 - 193)])
    elif l <= 918744:
        b1 = math.floor((l - 12481) / 65536 + 241)
        b2 = math.floor((l - 12481 - 65536 * (b1 - 241)) / 256)
        return bytes([b1, b2, l - 12481 - 65536 * (b1 - 241) - 256
    else:
        return err("Cannot generate vl for length = " + str(l) + ",

def hash_txn(txn):
    if type(txn) == str:
        txn = unhexlify(txn)
    return sha512h(b'TXN\x00' + txn)

def sha512h(x):
    m = hashlib.sha512()
    m.update(x)
    return m.digest()[:32]

# Hash the txn and meta data as a leaf node in the shamap
def hash_txn_and_meta(txn, meta):
    if type(txn) == str:
        txn = unhexlify(txn)

    if type(meta) == str:
        meta = unhexlify(meta)

    vl1 = make_vl_bytes(len(txn))
    vl2 = make_vl_bytes(len(meta))
```

```
    if vl1 == False or vl2 == False:
        return False

    payload = b'SND\x00' + vl1 + txn + vl2 + meta + hash_txn(txn)
    #print("payload1", hexlify(payload), payload.hex(), sha512h(pay
    return sha512h(payload)

print("hash: ", hash_txn_and_meta(tx_blob, meta_blob).hex().upper()
```

```
hash:  D42EE1686B347D14144A2398049A29E69BC3CF76140965EB1DAFC6BC351CA
683
```

In [58]:
```
print(b'MIN\x00' + unhexlify("3B1A4E1C9BB6A7208EB146BCDB86ECEA6068E

data = bytes(32)
print(data)

print(hashlib.sha512(b'MIN\x00' + data + data + data + b'\xd4.\xe1h
```

```
b'MIN\x00;\x1aN\x1c\x9b\xb6\xa7 \x8e\xb1F\xbc\xdb\x86\xec\xea`h\xed\
x01Fm\x935(\xca+Ld\xf7S\xef\xd4.\xe1hk4}\x14\x14J#\x98\x04\x9a)\xe6\
x9b\xc3\xcfv\x14\te\xeb\x1d\xaf\xc6\xbc5\x1c\xa6\x83'
b'\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x
00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00'
DB83BF807416C5B3499A73130F843CF615AB8E797D79FE7D330ADF1BFA93951A
```

Account State

Now lets do the same for the account state

Now we have all of the inputs, lets calculate the transaction hash:

XRPL Accounts

An XRPL account such as r4wkuwG3PWNvSV8hWYKM3qsBdT1PdLD9GA is what is used to uniquely identify where your XRP (and other tokens) are stored. You may have asked what is this seemingly random string of characters starting with an r, or how do I know this is secure? This section is aiming to answer these questions by describing in detail how these addresses get created.

Some great resources are available here: https://xrpl.org/docs/concepts/accounts/addresses#address-encoding, and code samples here: https://github.com/XRPLF/xrpl-dev-portal/tree/master/_code-samples

To begin with, there are 2 types of addresses "clasic" and "X-addresses". Only "classic" are considered here as these are the only addresses supported by tge XRPL ledger [https://xrpl.org/docs/concepts/accounts/addresses]

Within the "classic" addresses there are 2 options for the signing algorithm secp256k1 and Ed25519. Either of these methods can be used to create a Master Public Key, which is then encoded to produce the Address.

In short it is a 2 step process

1. Create a Master Public Key (either using secp256k1 or Ed25519)
2. Create the Address from the Master Public Key

Step 1: Create the Master Public Key

Type 1: SECP256K1 Master Public Key

SECP256k1 is an elliptic curve defined by these 6 parameters T = (p,a,b,G,n,h)

SECP256k1 is a definition of an elliptic curve with the following properties:

1. p = 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEFFFFF(
2. a = 0x0000000000000000000000000000000000000000000000000000000000000(
3. b = 0x0000000000000000000000000000000000000000000000000000000000000(
4. G = (x = 0x79BE667EF9DCBBAC55A06295CE870B07029BFCDB2DCE28D959F2815E
   y = 0x483ADA7726A3C4655DA4FBFC0E1108A8FD17B448A68554199C47D08F
5. n = 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEBAAEDCE6AF48A03BBFD25E8CD0
6. h = 01

So the curve is defined as: y^2 = x^3 + 7 mod p, over Zp.

What this means is that every pair of coordinates (x, y) that satisfy the above equation (except G) can be used as a public key for an XRPL account.

Note 128 bits of entropy

In [6]:
```
x_g = 0x79BE667EF9DCBBAC55A06295CE870B07029BFCDB2DCE28D959F2815B16F
prime = 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEFF
y_g = 0x483ADA7726A3C4655DA4FBFC0E1108A8FD17B448A68554199C47D08FFB1
print((pow(x_g,3,prime)+7)%prime, pow(y_g,2,prime))
```

```
32748224938747404814623910738487752935528512903530129802856995983256
684603122 32748224938747404814623910738487752935528512903530129802856
6995983256684603122
```

How to get a Master Public Key using secp256k1:

In the above flow chart the yellow parallelograms are data fields, the blue rectangles are processes or calculations, red diamonds are decisions, the irregular pentagon are encodings and the pink oval is an output.

As you can see there are 10 processes and 2 decisions to get to a Master Public Key.

First select a passphrase

This passphrase is the most critical step and will determine how secure your eventual address will be. It is like a password but it should be the most secure password you ever create. If this is guessed or shared by anyone they can steal all the funds in your address.

In this example I will use the passphrase "passphrase" for education purposes.

In [7]:
```
# Process 1/10: Hashing the passphrase
import hashlib
from binascii  import hexlify, unhexlify

passphrase = b"passphrase"
raw_seed = hashlib.sha512(passphrase).digest()[:16]
print("Raw Seed (in hex): ", raw_seed.hex().upper())


#raw_seed = unhexlify("787250756d706b696e674973436f6f54")
```

```
Raw Seed (in hex):  33C2E05B6113E8D17FB08429DE1CC1D5
```

Now we have a raw seed we can take a quick detour at the top of the flowchart to create ourselves a seed that can be used in XRP client libraries.

For this we will take the static value 0x21 for the Version Byte,m and the 16 bytes we just created as the Raw Seed. We will encode using base58_check encoding method (note this is different to base58 encoding).

For passphrase "passphrase" the Seed is ssR3HqUtQvNRYfZHb6xnE76dLeX9J.

In [8]:
```
import base58

version_byte = b"\x21"

seed = base58.b58encode_check(version_byte + raw_seed, alphabet=bas
print("Seed: ", seed)
```

```
Seed:  ssR3HqUtQvNRYfZHb6xnE76dLeX9J
```

Now we will create the Root Private Key The root private key (RPRK) is the first half of sha512(Raw Seed +

Root Key Sequence). However there is a condition that must be met from the elliptic curve defintion. The condition is that any private key must be less than the order n of the generating point G. We can check this with a simple condition, since we know the value of n as a property of secp256k1. If the RPK is greater than the order n of the generating point of secp256k1, we increment the Root Key Sequence by adding 1 and trying again, until we find an RPK that satisfies our requirement.

In [9]:
```
# Process 2/10: Generate the Root Private Key, and validate that it

root_key_sequence = bytes(4)
root_private_key = hashlib.sha512(raw_seed + root_key_sequence).dig

n = 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEBAAEDCE6AF48A03BBFD25E8CD0364

if int(root_private_key, 16) >= 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEB
    print("ERROR")
else:
    print("Root Private Key: ", root_private_key)
```

```
Root Private Key:  34DD5B6E2CCC68491A0BE8FB18B8BDF04DF4785EF15998517
D5D0D14031BAC56
```

In [10]:
```
# Process 3/10: If the RPRK >= n, incrememnt root_key_sequence and
# left as an exercise for the reader
```

Now we have a root private key and have validated it, we can derive the Root Public Key in compressed form.

The Root Public Key (RPUK), as with all public keys in secp256k1, is based on an (x,y) coordinate that satisfies the curve conditions. In its compressed form it is just the x coordinate with a prefix to say if the y coordinate is odd (03 prefix) or even (02 prefix).

To derive the public key we need to use Elliptic Curve multiplication to calculate RPUK = RPRK * G where RPRK is the Root Private Key and G is the generating point for secp256k1.

We will use the fastecdsa library to do this.

In [11]:
```
# Process 4/10: Derive the Root Public Key (RPUK) in compressed for
import fastecdsa
from fastecdsa.keys import get_public_key
from fastecdsa.curve import secp256k1

root_private_key_int = int.from_bytes(unhexlify(root_private_key),

root_public_key = get_public_key(root_private_key_int, secp256k1)
print("Root Public Key: ", root_public_key)

def compress_secp256k1_public(point):
    """
    Returns a 33-byte compressed key from an secp256k1 public key,
    which is a point in the form (x,y) where both x and y are 32-by
    """
    if point.y % 2:
        prefix = b'\x03'
```

```
    else:
        prefix = b'\x02'
    return prefix + point.x.to_bytes(32, byteorder="big", signed=Fa

root_public_key_compressed = compress_secp256k1_public(root_public_
print("Root Public Key in compressed form: ", root_public_key_compr
```

```
Root Public Key:  X: 0xba8a910044fbadde4d46bdeade79724fa3cf0b3222f32
d22572dddc65889293
Y: 0x5e4a8cfbddf17a7be64b485efa65b2ae4366066501acd2a1d453e675092e990
4
(On curve <secp256k1>)
Root Public Key in compressed form:  020ba8a910044fbadde4d46bdeade79
724fa3cf0b3222f32d22572dddc65889293
```

Now we have a Root Public Key (RPUK) we can use this to calcualate the Intermediate Private Key (IPRK).

Since this is a private key, again it must be less than the order n of the generating point G of the curve secp256k1.

In [12]:
```
# Process 5/10: Calculate the Intermediate Private Key and validate

family_number=b"\x00\x00\x00\x00"
int_key_sequence=b"\x00\x00\x00\x00"

intermediat_private_key = hashlib.sha512(root_public_key_compressed

if int(intermediat_private_key, 16) >= 0xFFFFFFFFFFFFFFFFFFFFFFFFF
    print("ERROR")
else:
    print("Intermediate Private Key: ", intermediat_private_key)
```

```
Intermediate Private Key:  57C28A29615723F6C4F27D74BE4E9D5B495D9EE56
5C0CDD6D6F3B2D7B907E0D0
```

In [13]:
```
# Process 6/10: If the Intermediate Private Key is greater than ord
# this is left as an exercise to the reader
```

Now we have a valid Intermediate Private Key (IPRK) we can derive the Intermediate Public Key (IPUK). This is the same as Process 4

In [14]:
```
# Process 7/10: Same as Process 4 but for the IPUK

intermediat_private_key_int = int.from_bytes(unhexlify(intermediat_

intermediate_public_key = get_public_key(intermediat_private_key_in
print("Intermediate Public Key: ", intermediate_public_key)

intermediate_public_key_compressed = compress_secp256k1_public(inte
print("Intermediate Public Key in compressed form: ", intermediate_
```

```
Intermediate Public Key:  X: 0x43dcaa9b4e755834ccf7f0fece34fe4748cdf
a23b1ffcc394f24a3d3f90b898e
Y: 0xc325ed7195f80bed1beabbaf1d97a7e3ccfe15a4bf103014ad2577f0c06f6d4
2
(On curve <secp256k1>)
Intermediate Public Key in compressed form:  0243dcaa9b4e755834ccf7f
0fece34fe4748cdfa23b1ffcc394f24a3d3f90b898e
```

Now we have Root Public Key and Intermediate Public Key, we can calculate the Master Public Key in compressed form. To do this we add the two points together using ellipic curve addition.

In [15]:
```
# Process 8/10: Derive the Master Public Key from the intermediate

master_public_key_from_public_keys = compress_secp256k1_public(inte
print("Master Public Key from public keys in compressed form: ", ma
```

```
Master Public Key from public keys in compressed form:  0335F3819CFC
36DEDC183EFECCB68FE3522A4499450397BB8AA9617B9A63334B0C
```

Now we have shown the first way to get to the Master Public Key, using the public keys, we can get the same result using the private keys

First add the two private keys

In [16]:
```
# Process 9/10: Addition modulo secp256k1.p

p = 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEFFFFF
master_private_key_int = (intermediat_private_key_int + root_privat

print("Master Private Key as integer: ", master_private_key_int)
```

```
Master Private Key as integer:  6360631207079138821358613578908065915
05090391014999206859963293037828665213 82
```

Lastly derive the Master Public Key in compressed form from the Master Private Key

In [19]:
```
# Proces 10/10: Derive master public key from private keys

master_public_key_from_private_keys = compress_secp256k1_public(get
print("Master Public Key from private keys in compressed form: ", m
```

```
Master Public Key from private keys in compressed form:  0335F3819CF
C36DEDC183EFECCB68FE3522A4499450397BB8AA9617B9A63334B0C
```

In [20]:
```
# Check they're the same:

print(master_public_key_from_private_keys==master_public_key_from_p
```

```
True
```

Type 2: Ed25519

TBC

Validation

This course and all of the code in here is meant to be for education purposes only, to give a deeper technical understanding of how components of the XRPL ledger work. It is not meant as a base to use for production code.

When writing production code that leverages cryptographic techniques it is important to use well established, tested and audited libraries. I also find it useful to compare the results of the tests with other code.

We can validate the above code using a _code_sample found in xrpl-dev-portal here: https://github.com/XRPLF/xrpl-dev-portal/blob/master/_code-samples/key-derivation/py/key_derivation.py

Validate the below result with the above code:

```
# python3 key_derivation.py passphrase

    Seed (base58): ssR3HqUtQvNRYfZHb6xnE76dLeX9J
    Seed (hex): 33C2E05B6113E8D17FB08429DE1CC1D5
    Seed (true RFC-1751): PIE GIL GET NAVE SUM CODA
FEUD FOND CAN MINK RAIN THUD
    Seed (rippled RFC-1751): SAIL BUD RID BARN ALLY
TED ROOK TIE SEAT MART CRY HEN
    Ed25519 Secret Key (hex):
05054A93B9490295B4E6FDDB9234BE990B23BF7077E99EE1B3DFB2D8B7F
    Ed25519 Public Key (hex):
ED8251C593D31EC21A5BA1B0D1F9943DF14F9C604CE1B9F2CAECC1A556A
    Ed25519 Public Key (base58 - Account):
aKEkqHyoLCAgoVUCYwrT3DN5ac1f2uakZ6ZgcRxpcjgoyA6wD7FV
    secp256k1 Secret Key (hex):
8C9FE5978E238C3FDEFE666FD7075B4B97521744571A66285450BFEBBC2
    secp256k1 Public Key (hex):
0335F3819CFC36DEDC183EFECCB68FE3522A4499450397BB8AA9617B9A6
    secp256k1 Public Key (base58 - Account):
aBQKrHjuxotoS3zs4F9JtPtcBT1f9pLtzQRDUhMXEnq6Y7Sb9ZxL
    secp256k1 Public Key (base58 - Validator):
n9JddgVa3kGwMFpgZST5H5c84YD4bcuUkG9hm1Mg7EABRb42wgpq
```

Step 2: Create the Address form the Master Public Key

Now we have the Master Public Key we can create the recognizable XRP Address, the one that starts with r

In [21]:
```
# https://xrpl.org/docs/concepts/accounts/addresses

address = base58.b58encode_check(master_public_key_from_private_key
print("Address: ", address)
```

```
Address:  fNze3RqRFzLpXwpwLhpJ2Z7EqGv4iTHAcecwNDhLT8gtQzAQmd
```

Now convert to Classic Address 

In [31]:
```
from hashlib import sha256

sha256_of_mpk = sha256(master_public_key_from_private_keys).digest(
account_id = hashlib.new('ripemd160', sha256_of_mpk).digest()
print(ripemd160_of_sha)

type_prefix = b"\x00"

checksum = sha256(sha256(type_prefix + account_id).digest()).digest
print("Checksum: ", checksum)

address_classic = base58.b58encode(type_prefix + account_id + check
print(address_classic)
```

```
b'\xfeH\xb5\xa2\xb6\xe98\xb5K;\x9f\x82{<q3\xc8v\x91*'
Checksum:  b'#t\x89\x8c'
rQBXjCtCg9KCLm6YsZjVWNNsjH5DpN1RQA
```

Now we have seen the inner workings, lets do it all using xrpl-py

In [ ]:

1. There are 2 types of accepted addresses on XRPL based on 2 cryptographic curves ed25519 and secp256k1 (the same one as bitcoin). Ed25519 is Edwards Curve Digital Signature algorithm, SECP256k1 is Elliptic Curve Digital Signature Algorithm.
2. Both are both Elliptic Curve approaches to Public Key cryptography. This simply means the following: a.
3. SECP256K1 a. Generate a key pair “keypair_secp256k1 = xrpl.core.keypairs.derive_keypair(seed=)” b. OUTPUT: (‘’,’’) “keypair: ('03038CAB8D9A21904487416F64F960A3765A82F105F7EBC3054B94BD0 '008860E6AB41B773E05117D11919AD0A3963F6AE9658593E8292346078F c. This represents two things: (this is a bit mathsy but this is as deep as this course will go into maths!) i. first the public key is the x coordinates of a point P=(x,y) on the curve y^2=x^3+7 modulo 2**256−2*32−977, this is a 66 byte hexadecimal string prefixed with 02 if the corresponding y coordinate is even, and 03 if the corresponding y coordinate is odd. ii. second is a multiplier point for the elliptic curve prefixed with 00. iii. To validate the point do this
4. (Optional we can just validate private key generates public key) Split the string into 2 parts 03038CAB8D9A21904487416F64F960A3765A82F105F7EBC3054B94BD05
5. (Optional, we can just validate the private generates the public key) In python work out y coordinate using the script uncompress_point.py. You’ll need to add the address to the script. For the above address the

uncompressed address is of the format : 04038CAB8D9A21904487416F64F960A3765A82F105F7EBC3054B94BD05
6. Add the private key and run the script multiply_point.py 0x38cab8d9a21904487416f64f960a3765a82f105f7ebc3054b94bd051b88c 0x3bbe072531fce2c0e51a74c1b2fda9d3088082564e48a9017ce4de7ef759c a. The first part is the x coordinate and should be the same as the in the public key. b. The prefix is 02 if the y coordinate is even and 03 if it is odd iv. Sign a message
7.
8. Ed25519 a.
9. Now we have a public/private key pair in SECP256k1 we can sign a message. Lets sign the message “XRP is cool” a. What is message signing? Well I have a private key that is secret only to me, and a public key that I give to anyone (I want to send me money). How does the payee know that the public key they have is actually for me? Well one way is they can send me a message that only they know like “Hi, I think you’re really cool! Please sign this and send me the signature, then I’ll send you the money I owe you :)”, I can sign the message, and then you can prove (using the public key) that I have the private key for the public key you will pay to. b. Lets try by example i. I have a public and private key. I send you the public key because I want you to send me some XRP. That public key is: “03483543312967AAC0C5A805BF68F6A188B33863A55B0B7AA710F50333 ii. Send me a message “Hi, think you’re really cool! Please sign this and send me the signature, then I’ll send you the money I owe you :)” iii. Sign the message and get result “304402204B4266DB40B1AB33EC71654ED84AA89ED99383A742E7F7CA5 iv. Validate the message
10. Interesting facts: a. Both are 128 bits – this is how XRP works

Lab Exercises

TBC

1. Generate the Classic address for the phrase "XXX" put the answers to each part here and validate them against the xrpl-py library etc.
2. Generate for seed 0123456789012345 and 01234567890123456 -> what do you notice?
3. Validate the same result using xrpl-py for phrase "XXX"

Quiz

1. Can I derive a seed from the Root Private Key? -> Answer no. The seed is

hashed into the RPK, there is no way to reverse the hash (other than brute force)
2. What happens when you use a seed longer than 16 bytes in the xrpl-py? -> Answer: it doesn't catch it (right now) or throw an error, it just ignores everything over 16 bytes!

XRPL Transactions

There are various types of transactions that are possible on the XRPL ledger: https://xrpl.org/docs/references/protocol/transactions/types

Payment Transactions

Payment transaction send XRP

In [ ]:
```
###################################
# Step 1: Create and FUND a source wallet on the testnet
# 1.1 Create and fund a wallet: xrpl-py > Wallet Methods > generate
# 1.2 Define a client connection for JsonRPC: xrpl-py > Network Cli
# 1.3 (Optional) Save the output of the wallet secret object
# Result: Wallet on the testnet, with a balance, that we can contro
###################################
import xrpl

testnet_client = xrpl.clients.JsonRpcClient(url="https://s.altnet.r

## Run this bit the first time you run the script only
#source_wallet = xrpl.wallet.generate_faucet_wallet(client=testnet_
#print(source_wallet)
#print(source_wallet.seed)

source_wallet_seed = "ssR3HqUtQvNRYfZHb6xnE76dLeX9J"
source_algorithm = xrpl.constants.CryptoAlgorithm('ed25519')
source_wallet = xrpl.wallet.Wallet.from_seed(seed=source_wallet_see
print("source_wallet: ", source_wallet)



###################################
# Step 2: Create destination wallet
# 2.1 Create a wallet: xrpl-py > Wallet Methods > xrpl.wallet.Walle
# 2.2 Create a seed: xrpl-py > XRPL Core Codecs > XRPL Keypairs Cod
# 2.3 Create entropy: any 16 byte string
# 2.4 Create algorithm object: xrpl-py > XRPL Global Variables > xr
# 2.5 Get the sequence: for a new wallet sequence can be set to 0
# Result: Wallet that does not yet exist on the testnet that we can
###################################

destination_entropy = xrpl.utils.str_to_hex("xrpumpkingiscool")
destination_algorithm = xrpl.constants.CryptoAlgorithm('secp256k1')
destination_seed = xrpl.core.keypairs.generate_seed(entropy=destina
```

```
destination_wallet = xrpl.wallet.Wallet.from_seed(seed=destination_
print("destination_wallet: ", destination_wallet)


###################################
# Step 3: Make the payment transaction
# 3.1 Create the payment transaction: xrpl-py > XRPL Models > XRPL
# 3.1 Get the address for source wallet: Step 1 > source_wallet.cla
# 3.2 Get the amount: xrpl-py > Utilities > xrpl.utils.xrp_to_drops
# 3.3 Get the destination address: Step 2 > destination_wallet.clas
# Result: Payment transaction object
###################################

import json
transaction_amount = xrpl.utils.xrp_to_drops(1000)
payment_transaction=xrpl.models.transactions.Payment(account=source
print(payment_transaction)

###################################
# Step 4: Signe the transaction
# 4.1 Sign the transaction: xrpl-py > Transaction Methods > xrpl.tr
# Result: signed Payment transaction object
###################################
signed_transaction = xrpl.transaction.autofill_and_sign(transaction
print(signed_transaction)

###################################
# Step 5: Submit the transaction
# 5.1 Submit the transaction: xrpl-py > Transaction Methods > xrpl.
# Result: successful Payment transaction on the testnet that debite
###################################
submit_transaction = xrpl.transaction.submit(transaction=signed_tra
print(submit_transaction)

###################################
# Step 6: Validate on the ledger
# 6.1 Get the balance for the destination wallet: xrpl-py > Account
# Result: print the balance of the destination wallet
###################################
print("Balance of destination: ", xrpl.account.get_balance(address=
```

Appendix A: ECDSA - The maths

In [ ]:

```
TBC - describe:
1. How Public/private key encryption works
2. How the curve is done and what is the "difficult" problem
3. Impact of Quantum computing - https://xrpl.org/docs/concepts/acc
```

Debugging

NameError: name 'ripemd160' is not defined

https://stackoverflow.com/questions/72409563/unsupported-hash-type-

ripemd160-with-hashlib-in-python

This seemed to work for a bit but then I just changed how I call ripemd160 completely